JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Lightweight Fairway Mower
7500, 7700, 8500, 8700, 8800 (SN 020001-)
7500 E-Cut Hybrid and 8500 E-Cut Hybrid (SN 010001-)

TM107919 MAY 2009

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho In U.s.a.

INTRODUCTION

Manual Description

This technical manual is written for an experienced technician and contains sections that are specifically for this product. It is a part of a total product support program.

The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

- Table of Contents
- Specifications and Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

Note: Depending on the particular section or system being covered, not all of the above groups may be used.

The bleed tabs for the pages of each section will align with the sections listed on this page. Page numbering is consecutive from the beginning of the Safety section through the last section.

We appreciate your input on this manual. If you find any errors or want to comment on the layout of the manual please contact us.

Safety

Specifications and Information

Engine

Electrical

Power Train

Hydraulics

Steering

Brakes

Attachments

All information, illustrations and specifications in this manual are based on the latest information at the time of publication. The right is reserved to make changes at any time without notice.

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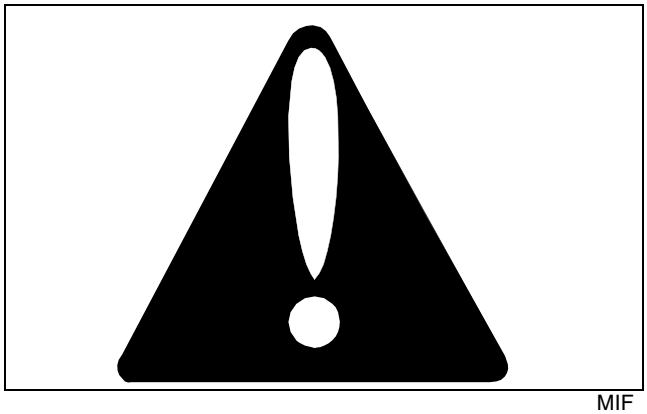
Recognize Safety Information



MIF

This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

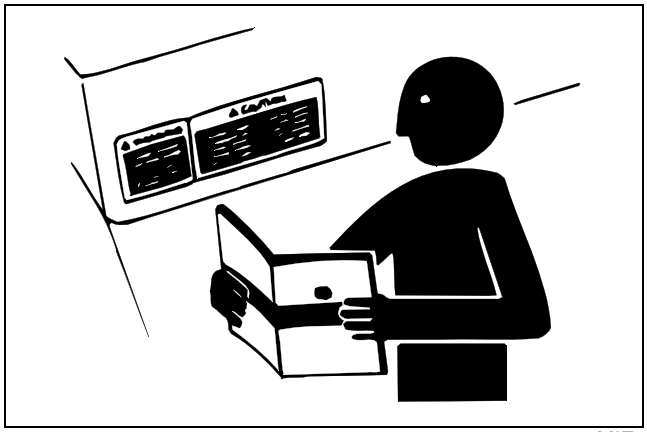
Follow recommended precautions and safe servicing practices.

Understand Signal Words

A signal word - DANGER, WARNING, or CAUTION - is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

Replace Safety Signs



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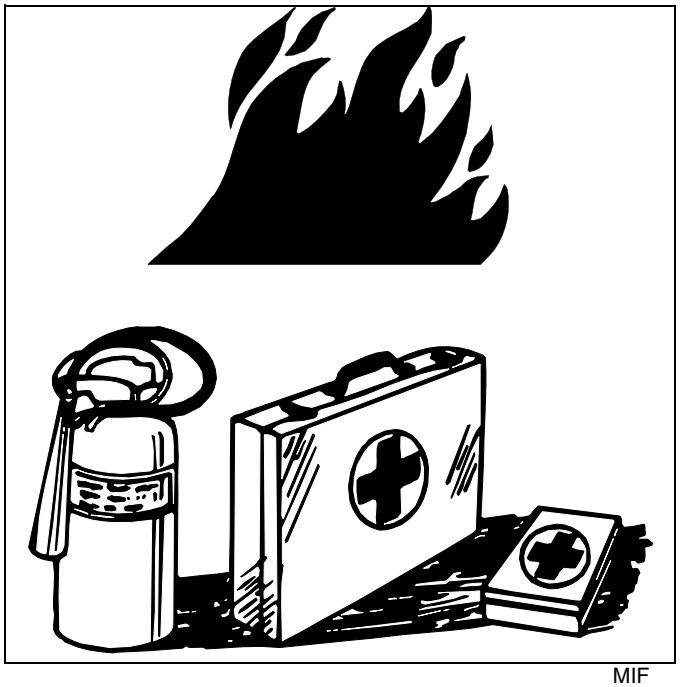
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



MIF

When you work around fuel, do not smoke or work near heaters or other fire hazards.

Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.

Make sure machine is clean of trash, grease, and debris.

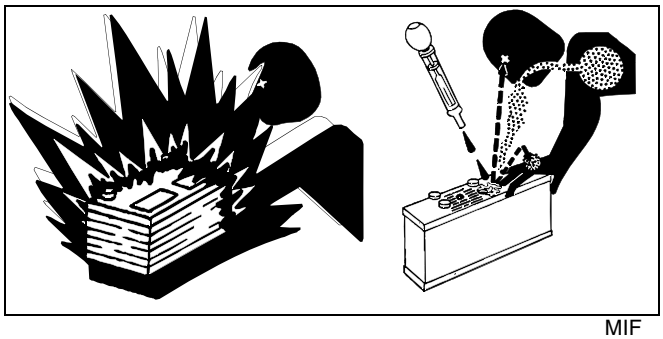
Do not store oily rags; they can ignite and burn spontaneously.

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

Use Care in Handling and Servicing Batteries



MIF

Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
- Never check battery charge by placing a metal object across the posts. Use a voltmeter or hydrometer.
- Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

Prevent Acid Burns

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid acid burns by:

1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Using proper jump start procedure.

If you spill acid on yourself:

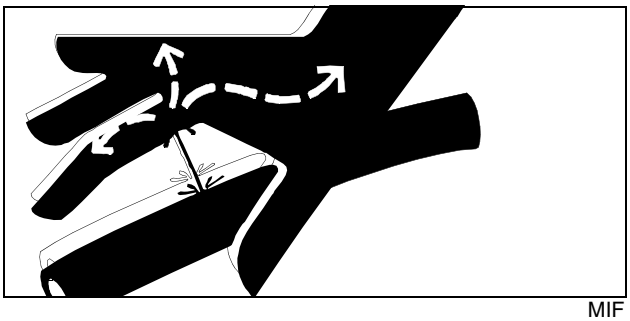
6. Flush your skin with water.
7. Apply baking soda or lime to help neutralize the acid.
8. Flush your eyes with water for 10-15 minutes.
9. Get medical attention immediately.

If acid is swallowed:

10. Drink large amounts of water or milk.
11. Then drink milk of magnesia, beaten eggs, or vegetable oil.
12. Get medical attention immediately.

Use Care Around High-Pressure Fluid Lines

Avoid High-Pressure Fluids



MIF

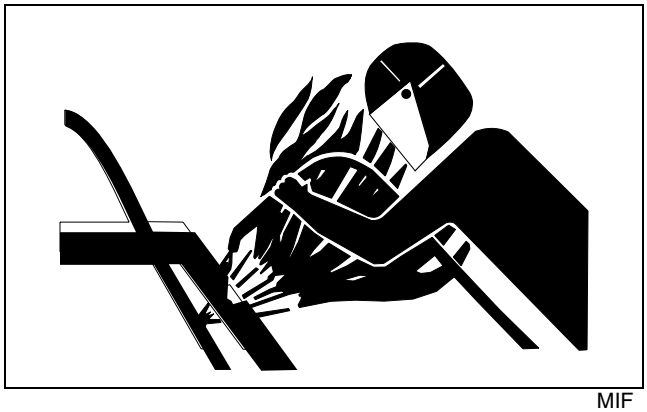
Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid injury from escaping fluid under pressure by stopping the engine and relieving pressure in the system before disconnecting or connecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

Avoid Heating Near Pressurized Fluid Lines

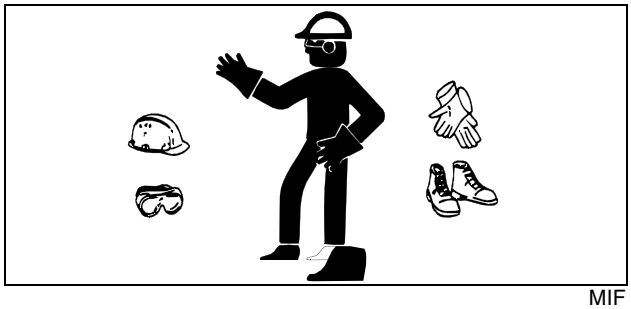


MIF

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

Use Safe Service Procedures

Wear Protective Clothing



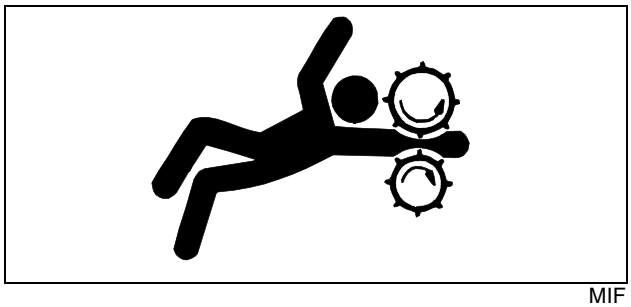
MIF

Wear close-fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

Service Machines Safely



MIF

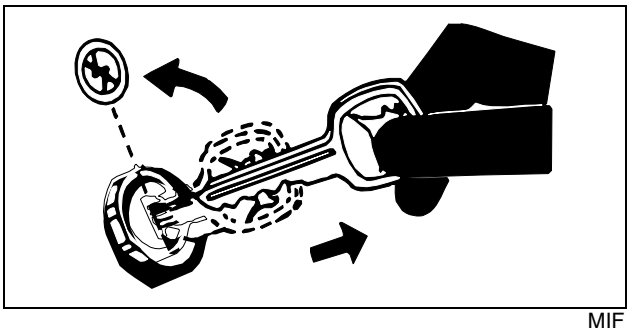
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

Use Proper Tools

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards. Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, use the correct size tools. **DO NOT** use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches. Use only service parts meeting John Deere specifications.

Park Machine Safely

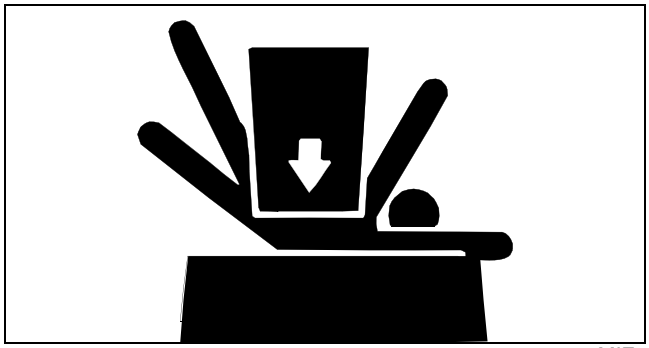


MIF

Before working on the machine:

1. Lower all equipment to the ground.
2. Stop the engine and remove the key.
3. Disconnect the battery ground strap.
4. Hang a “DO NOT OPERATE” tag in operator station.

Support Machine Properly and Use Proper Lifting Equipment



MIF

If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

Lifting heavy components incorrectly can cause severe injury or machine damage. Follow recommended procedure for removal and installation of components in the manual.

Work in Clean Area

Before starting a job:

1. Clean work area and machine.
2. Make sure you have all necessary tools to do your job.
3. Have the right parts on hand.
4. Read all instructions thoroughly; do not attempt shortcuts.

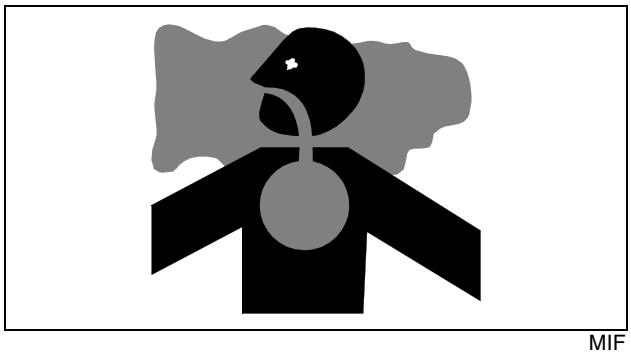
Using High-Pressure Washers

Directing pressurized water at electronic/electrical components or connectors, bearings, hydraulic seals, fuel injection pumps or other sensitive parts and components may cause product malfunctions. Reduce pressure and spray at a 45 to 90 degree angle.

Illuminate Work Area Safely

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

Work in Ventilated Area



MIF

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.

WARNING: California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Remove Paint Before Welding or Heating

Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. Do all work outside or in a well ventilated area. Dispose of paint and solvent properly. Remove paint before welding or heating: If you sand or grind paint, avoid breathing the dust. Wear an approved respirator. If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

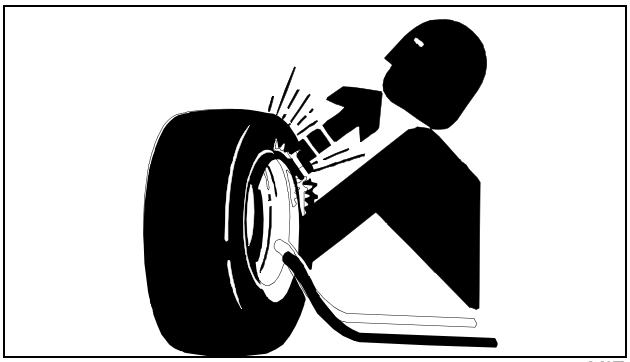
Avoid Harmful Asbestos Dust

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos. Keep bystanders away from the area.

Service Tires Safely



MIF

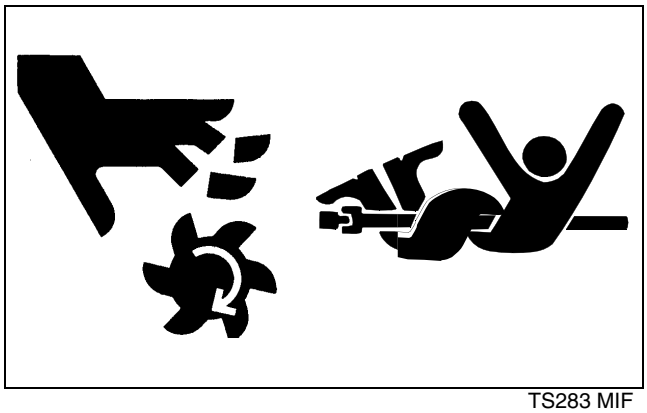
Explosive separation of a tire and rim parts can cause serious injury or death.

Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job. Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and NOT in front of or over the tire assembly. Use a safety cage if available.

Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

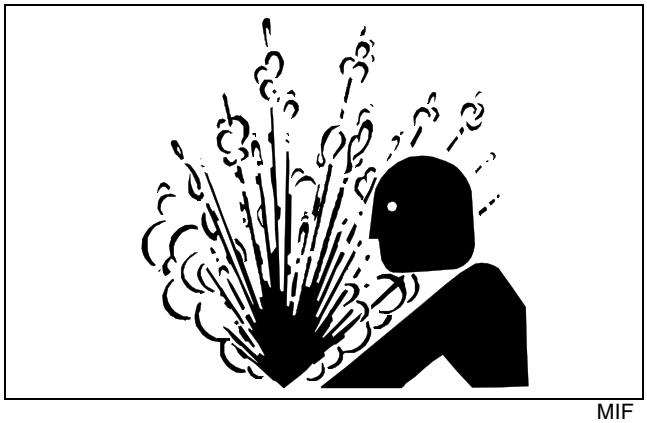
Avoid Injury from Rotating Blades and Drive Shafts



TS283 MIF

Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades or drive shafts.

Service Cooling System Safely

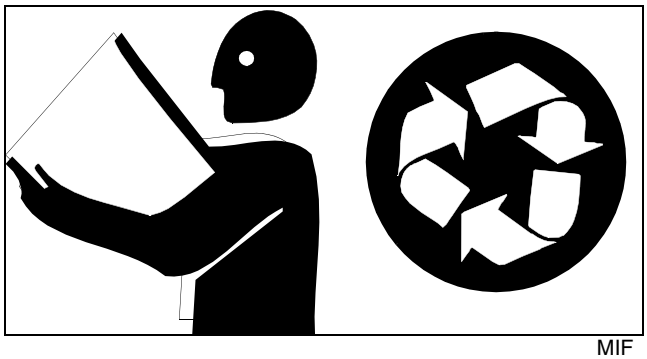


MIF

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off machine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve the pressure before removing completely.

Handle Chemical Products Safely



MIF

Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques. Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment includes such items as oil, fuel, coolant, brake fluid, filters, and batteries. Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them. Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

LIVE WITH SAFETY

MIF

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

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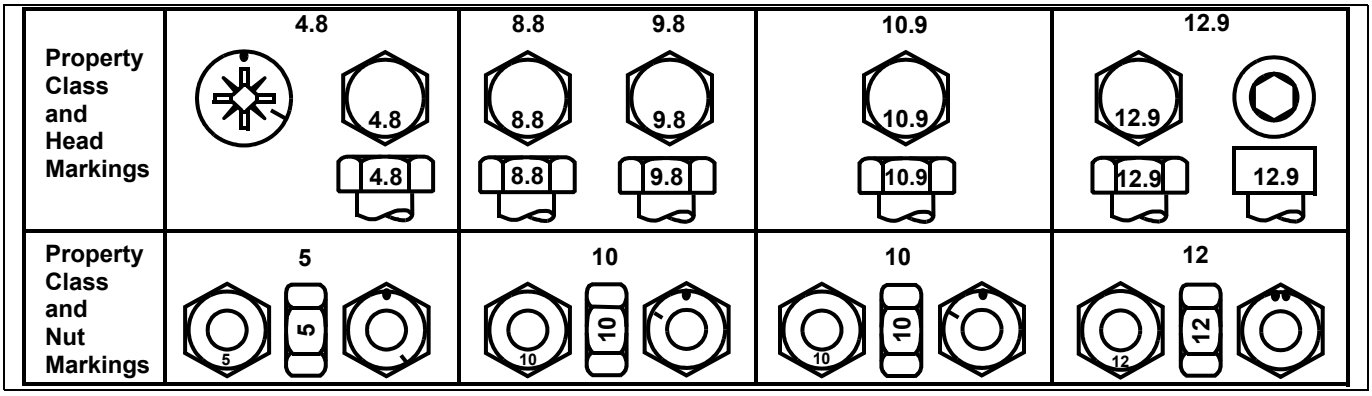
General Information

Metric Fastener Torque Values



MIF (TS1163)

	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated[1]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]		Lubricated[a]		Dry[a]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

1. "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

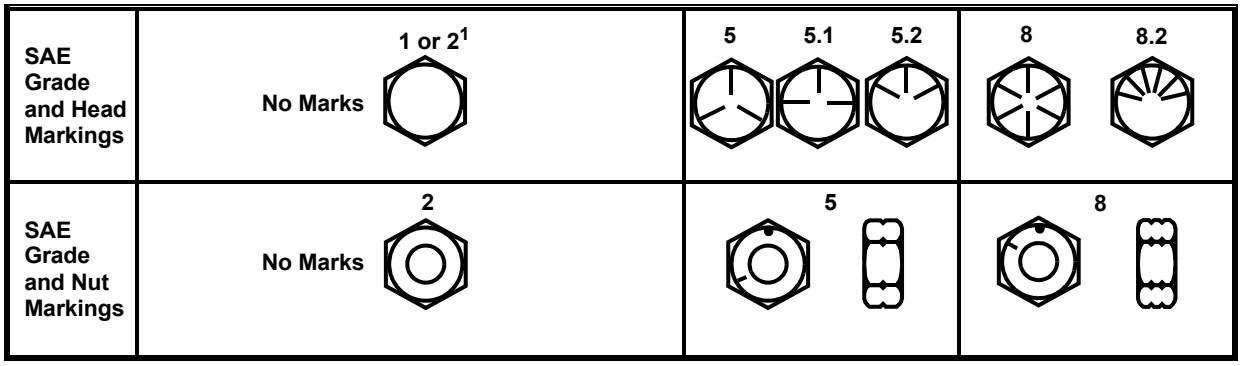
Fasteners should be replaced with the same class. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

Reference: JDS-G200.

Inch Fastener Torque Values



MIF (TS1162)

	Grade 1				Grade 2[1]				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated[2]		Dry[2]		Lubricated[2]		Dry[2]		Lubricated[2]		Dry[2]		Lubricated[2]		Dry[2]	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

1. "Grade 2" applies for hex cap screws (not hex bolts) up to 152 mm (6 in.) long. "Grade 1" applies for hex cap screws over 152 mm (6 in.) long, and for all other types of bolts and screws of any length.

2. "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

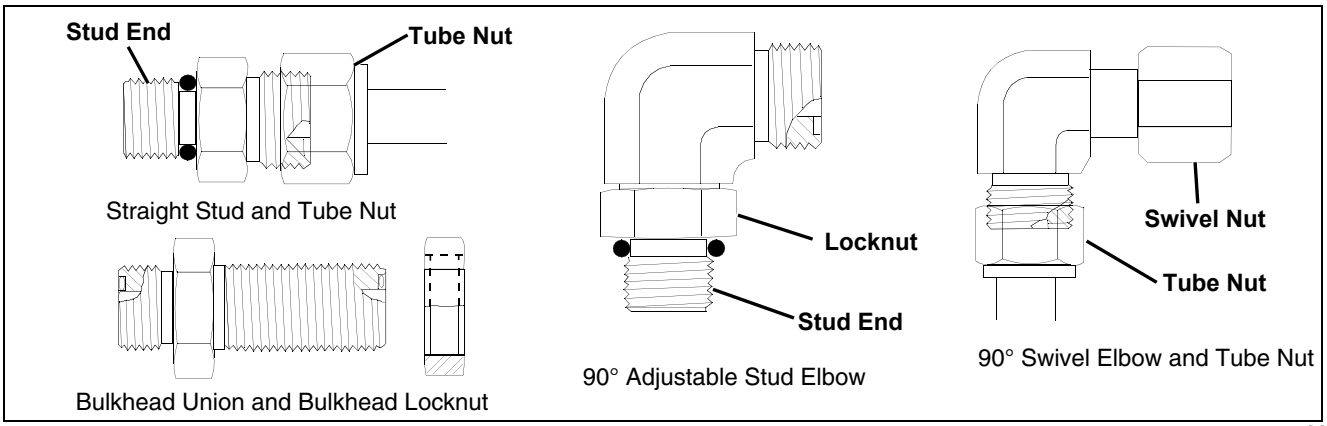
Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

Tighten toothed or serrated-type locknuts to the full torque value.

Reference: JDS-G200.

Face Seal Fittings with Inch Stud Ends Torque

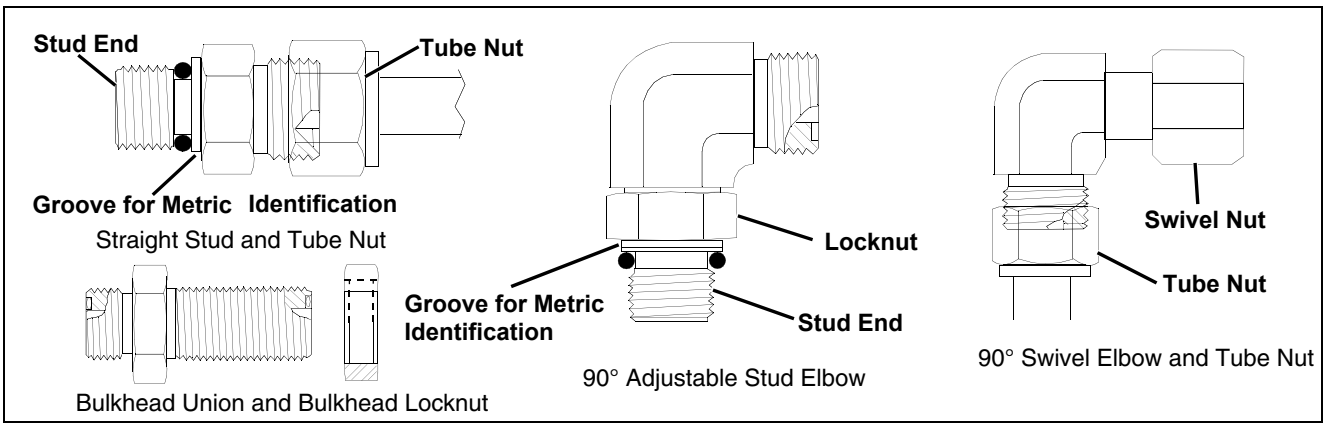


MIF

Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Straight Fitting or Locknut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

Note: Torque tolerance is +15%, -20%.

Face Seal Fittings with Metric Stud Ends Torque

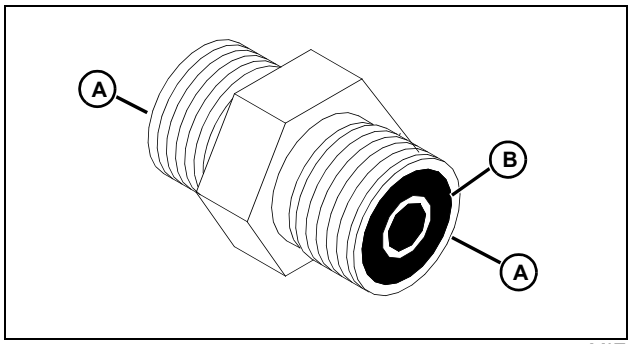


MIF

Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Locknut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Locknut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12x1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14x1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16x1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18x1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22x1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27x2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30x2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33x2	41	158	116	71	52
28										M38x2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42x2	50	190	140	85	63
38	-24	1.50	38.10	2-12	60	217	160	217	160	M48x2	55	217	160	98	72

Note: Torque tolerance is +15%, -20%.

O-Ring Face Seal Fittings



MIF

1. Inspect the fitting sealing surfaces (A). They must be free of dirt or defects.

2. Inspect the O-ring (B). It must be free of damage or defects.

3. Lubricate O-rings and install into groove using petroleum jelly to hold in place.

4. Push O-ring into the groove with plenty of petroleum jelly so O-ring is not displaced during assembly.

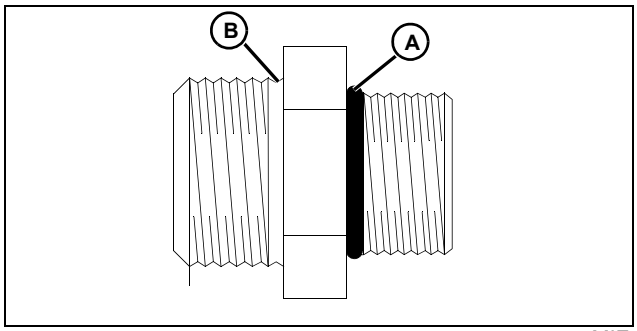
5. Index angle fittings and tighten by hand-pressing joint together to ensure O-ring remains in place.

Important: Avoid Damage! DO NOT allow hoses to twist when tightening fittings. Use two wrenches to tighten hose connections: one to hold the hose, and the other to tighten the swivel fitting.

6. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting.

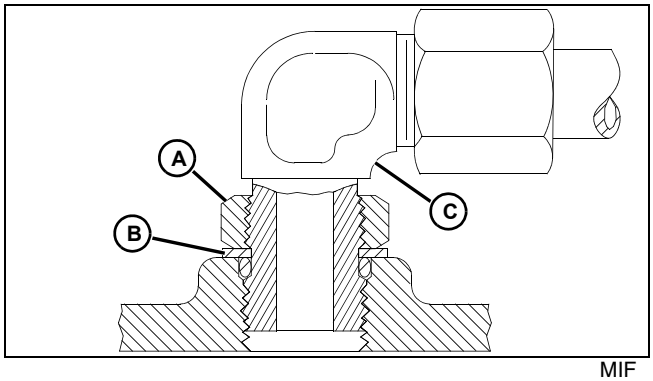
O-Ring Boss Fittings

1. Inspect O-ring boss seat. It must be free of dirt and defects. If repeated leaks occur, inspect for defects with a magnifying glass. Some raised defects can be removed with a slip stone.



MIF

2. Put hydraulic oil or petroleum jelly on the O-ring (A). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (B) of fitting. Remove tape.



MIF

3. For angle fittings, loosen special nut (A) and push special washer (B) against threads so O-ring can be installed into the groove of fitting.

4. Turn fitting into the boss by hand until special washer or washer face (straight fitting) contacts boss face and O-ring is squeezed into its seat.

5. To position angle fittings (C), turn the fitting counter-clockwise a maximum of one turn.

6. Tighten straight fittings to torque value shown on chart. For angle fittings, tighten the special nut to value shown on the chart while holding body of fitting with a wrench.

Thread Size	Torque[1]		Number of Flats[2]
	N•m	lb-ft	
3/8-24 UNF	8	6	2
7/16-20 UNF	12	9	2
1/2-20 UNF	16	12	2
9/16-18 UNF	24	18	2
3/4-16 UNF	46	34	2
7/8-14 UNF	62	46	1-1/2
1-1/16-12 UN	102	75	1
1-3/16-12 UN	122	90	1
1-5/16-12 UN	142	105	3/4
1-5/8-12 UN	190	140	3/4
1-7/8-12 UN	217	160	1/2

1. Torque tolerance is ±10 percent.

2. To be used if a torque wrench cannot be used. After tightening fitting by hand, put a mark on nut or boss, then tighten special nut or straight fitting the number of flats shown.

Using Proper Fuel (Diesel) - North America

Use the proper diesel fuel to help prevent decreased engine performance and increased exhaust emissions. Failure to follow the fuel requirements listed below can void your engine warranty.

Contact your local fuel distributor for properties of the diesel fuel in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended.

Required fuel properties

In all cases, the fuel shall meet the following properties:

Cetane number of 45 minimum. Cetane number greater than 50 is preferred, especially when temperatures are below -20°C (-4°F) or elevations above 1500 m (5000 ft).

Cold Filter Plugging Point (CFPP) below the expected low temperature OR **Cloud Point** at least 5°C (9°F) below the expected low temperature.

Fuel lubricity should pass a minimum load level of 3100 grams as measured by ASTM D6078 or maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

If a fuel of low or unknown lubricity is used, addition of John Deere PREMIUM DIESEL FUEL CONDITIONER at the specified concentration is recommended.

Sulfur content

- Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.
- Sulfur content less that 0.05% (500 ppm) is recommended for best performance.
- Diesel fuel sulfur content greater than 0.5% (5000 ppm) should not be used.

Important: Avoid Damage! Do not mix diesel engine oil or any other type of lubricating oil with diesel fuel.

Handling and Storing Diesel Fuel

Caution: Avoid Injury! Handle fuel carefully. Do not fill the fuel tank when engine is running.

Do not smoke while you fill the fuel tank or service the fuel system.

Important: Avoid Damage! Do not use galvanized containers - diesel fuel stored in galvanized containers reacts with zinc coating in the container to form zinc flakes. If fuel contains water, a zinc gel will also form. The gel and flakes will quickly plug fuel filters and damage fuel injectors and fuel pumps.

- Fill fuel tank at end of each day's operation to prevent water condensation and freezing during cold weather.

Important: Avoid Damage! The fuel tank is vented through the filler cap. If a new cap is required, always replace it with an original vented cap.

- When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and to prevent water condensation. Contact your fuel supplier for recommendations.

Diesel Fuel - Europe

In general, diesel fuels are blended to satisfy the low air temperature requirements of the geographical area in which they are sold.

In Europe, diesel fuel is usually specified to **EN590** and sold in five different classes or six different grades.

If diesel fuels being supplied in your area DO NOT meet any of the above specifications, use diesel fuels with the following equivalent properties:

- Cetane Number 40 (Min)

A cetane number greater than 50 is preferred, especially for air temperatures below -20°C (-4°F) or elevations above 1500 m (5000 ft).

- Cold Filter Plugging Point (CFPP)

The temperature at which diesel fuel begins to cloud or jell. Use diesel fuels with a CFPP which is at least 5°C (9°F) below the expected low air temperature.

- Sulfur Content of 0.05% (Max)

If diesel fuel being used has a sulfur content greater than 0.05%, reduce the service interval for engine oil and filter by 50%.

Consult your local diesel fuel distributor for properties of the diesel fuel available in your area.

Diesel Fuel Storage

Important: Avoid Damage! DO NOT USE GALVANIZED CONTAINERS - diesel fuel stored in galvanized containers reacts with zinc coating in the container to form zinc flakes. If fuel contains water, a zinc gel will also form. The gel and flakes will quickly plug fuel filters and damage fuel injectors and fuel pumps.

It is recommended that diesel fuel be stored ONLY in a clean, approved POLYETHYLENE PLASTIC container WITHOUT any metal screen or filter. This will help prevent any accidental sparks from occurring. Store fuel in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark; this includes any appliance with a pilot light.

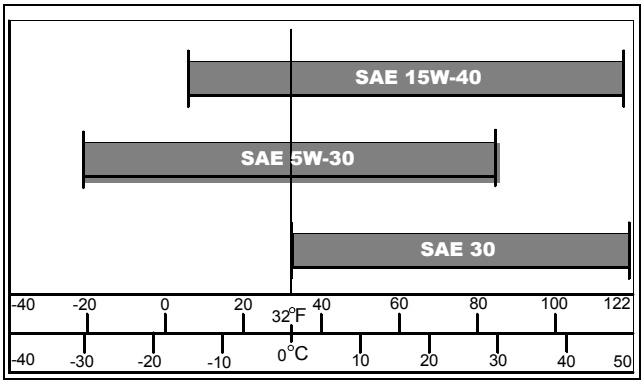
Important: Avoid Damage! Keep all dirt, scale, water, or other foreign material out of fuel.

Keep fuel in a safe, protected area and in a clean, properly marked (“DIESEL FUEL”) container. DO NOT use deicers to attempt to remove water from fuel. DO NOT depend on fuel filters to remove water from fuel. It is recommended that a water separator be installed in the storage tank outlet. BE SURE to properly discard unstable or contaminated diesel fuel and/or their containers when necessary.

4-Cycle Diesel Engine Oil - North America

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following John Deere oils are preferred:



- PLUS-50™
- TORQ-GARD SUPREME™

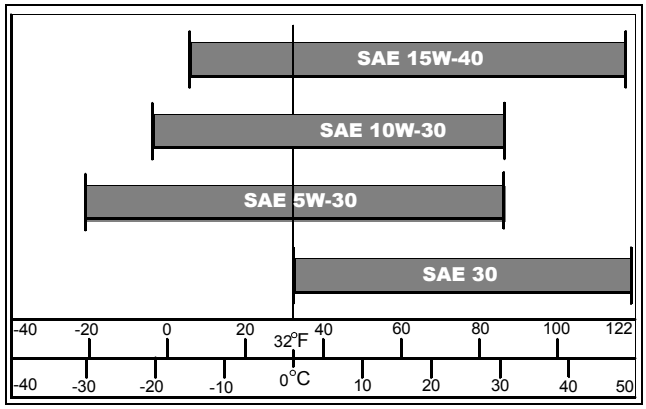
Other oils may be used if above John Deere oils are not available, provided they meet the following specifications:

- API Service Classification CF or higher.

4-Cycle Diesel Engine Oil - Europe

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following John Deere oils are preferred:



- TORQ-GARD SUPREME®- SAE 15W-40.
- UNI-GARD® - SAE 15W-40.
- TORQ-GARD SUPREME - SAE 5W-30.
- TORQ-GARD SUPREME - SAE 5W-30.
- UNI-GARD - SAE 5W-30.

The following John Deere oils are also recommended, based on their specified temperature range:

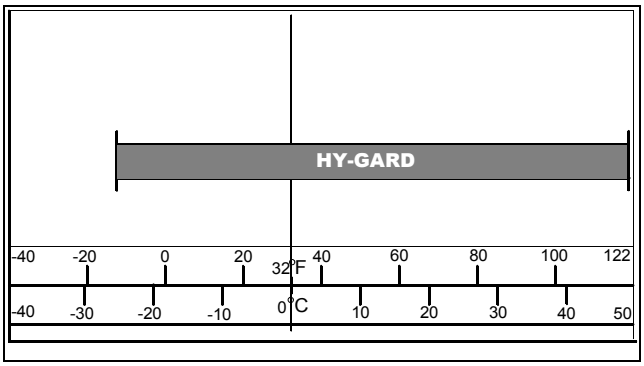
- TORQ-GARD SUPREME- SAE 10W-30.
- UNI-GARD - SAE 10W-30.
- TORQ-GARD SUPREME - SAE 30.
- UNI-GARD - SAE 30.

Other oils may be used if above John Deere oils are not available, provided they meet the following specification:

- CCMC Specification D4 or Mercedes Benz MB228.1 or higher.

Transmission and Hydraulic Oil

Important: Avoid Damage! Machine is filled with John Deere HY-GARD™ (J20C) Transmission/ Hydraulic Oil at the factory. DO NOT mix oils. DO NOT use type "F" automatic transmission fluid or J20D Low Viscosity HY-GARD.



Use the following oil viscosity based on the air temperature range. Operating outside of the recommended oil air temperature range may cause premature hydrostatic transmission failure.

John Deere HY-GARD™ (J20C) Transmission Oil is specially formulated to provide maximum protection against. mechanical wear, corrosion, and foaming.

Grease - North America

Important: Avoid Damage! ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO-GREASE in this application.

The following John Deere greases are preferred for the machine and lift arms:

- **John Deere Multi-Purpose SD Polyurea Grease (TY6341).**
- **John Deere Special-Purpose HD Moly (TY6333).**

The following John Deere greases are preferred for the cutting units and unit attachments:

- **John Deere Special Purpose Golf and Turf Cutting Unit Grease (TY25083).**
- **John Deere Special Purpose Cornhead Grease (AN102562).**
- **John Deere Multi-Purpose SD Polyurea Grease (TY6341).**

Other greases may be used if above preferred John Deere greases are not available, provided they meet the following specifications:

- Polyurea Grease - NLGI Grade 2.
- Calcium Complex Grease - NLGI Grade 2.
- John Deere Standard JDM J13E4 - NLGI Grade 2.

Grease - Europe

Use the following grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature failures.

Important: Avoid Damage! ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO-GREASE in this application.

The following John Deere greases are PREFERRED:

- **GREASE-GARD™ - JDM J13E4, NLGI Grade 2.**
- **Reel Support Grease - JDM J13E6, NLGI Grade 0.**

Other greases may be used if above preferred John Deere greases are not available, provided they meet the following specifications:

Reel Support Grease Applications:

- Polyurea Grease - NLGI Grade 2.
- Calcium Complex Grease - Grade 2.
- Lithium Complex Grease - NLGI Grade 0.
- John Deere Standard JDM J13E4 - NLGI Grade 2.

Alternative Lubricants

Conditions in certain geographical areas outside the United States and Canada may require different lubricant recommendations than the ones printed in this technical manual or the operator's manual. Consult with your John Deere Dealer, or Sales Branch, to obtain the alternative lubricant recommendations.

Important: Avoid Damage! Use of alternative lubricants could cause reduced life of the component.

If alternative lubricants are to be used, it is recommended that the factory fill be thoroughly removed before switching to any alternative lubricant.

Synthetic Lubricants

Synthetic lubricants may be used in John Deere equipment if they meet the applicable performance requirements (industry classification and/or military specification) as shown in this manual.

The recommended air temperature limits and service or lubricant change intervals should be maintained as shown in the operator's manual.

Avoid mixing different brands, grades, or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements. Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Lubricant Storage

All machines operate at top efficiency only when clean lubricants are used. Use clean storage containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides. Make sure all containers are properly marked as to their contents. Dispose of all old, used containers and their contents properly.

Mixing of Lubricants

In general, avoid mixing different brands or types of lubricants. Manufacturers blend additives in their lubricants to meet certain specifications and performance requirements. Mixing different lubricants can interfere with the proper functioning of these additives and lubricant properties which will downgrade their intended specified performance.

Oil Filters

Important: Avoid Damage! Filtration of oils is critical to proper lubrication performance. Always change filters regularly.

The following John Deere oil filters are PREFERRED:

- **Automotive and light truck engine oil filters**.

Most John Deere filters contain pressure relief and anti-drainback valves for better engine protection.

Other oil filters may be used if above recommended John Deere oil filters are not available, provided they meet the following specification:

- ASTB Tested in Accordance with SAE J806.

Diesel Engine Coolant - North America

Important: Avoid Damage! Using incorrect coolant mixture can damage the radiator:

- **Do not operate engine with plain water.**
- **Use ethylene-glycol based antifreeze approved for use in aluminum radiators or aluminum engines.**
- **Do not exceed a 50% mixture of coolant and water.**
- **Do not pour coolant or water into the radiator when the engine is hot.**

The following John Deere coolants are preferred:

- COOL-GARD™ PRE-DILUTED SUMMER COOLANT (TY16036).
- COOL-GARD™ CONCENTRATED SUMMER COOLANT (TY16034).

If neither of recommended engine coolants is available, use a glycol base coolant that meets the following specification:

- ASTM D4985 (JDM H24A2).

Check container label before using to be sure it has the appropriate specifications for your machine. Use coolant with conditioner or add conditioner to coolant before using.

If using concentrate, mix approximately 50 percent antifreeze with 50 percent distilled or deionized water before adding to cooling system. This mixture will provide freeze protection to -37 degrees C (-34 degrees F).

Certain geographical areas may require lower temperature protection. See the label on your antifreeze container or consult your John Deere dealer to obtain the latest information and recommendations. Never exceed the maximum dilution rate for the coolant you are using. Exceeding the maximum rate will greatly reduce the coolant effectiveness.

Diesel Engine Coolant Drain Interval - North America

When using John Deere Pre-Diluted (TY16036) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 36 months or 3,000 hours of operation, whichever comes first.

When using John Deere Concentrate (TY16034) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 24 months or 2,000 hours of operation, whichever comes first.

If above John Deere Automobile and Light Duty Engine Service coolants are not being used, drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

Diesel Engine Coolant - Europe

The engine cooling system, when filled with a proper dilution mixture of anti-freeze and deionized or distilled water, provides year-round protection against corrosion, cylinder liner pitting, and winter freeze protection down to -37°C (-34°F).

The following John Deere coolant is **PREFERRED**:

- **COOL-GARD™ COOLANT CONCENTRATE.**

If above preferred coolant is not available, use any Automobile and Light Duty Engine Service ethylene glycol base coolant meeting the following specification:

- ASTM D3306 (JDM H24C1).

Read container label completely before using and follow instructions as stated.

Important: Avoid Damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze mixture in the cooling system. DO NOT mix or add any additives/conditioners to the cooling system in Lawn and Grounds Care/Golf and Turf Division equipment. Water used to dilute engine coolant concentrate must be of high quality - clean, clear, potable water (low in chloride and hardness - Table 1) is generally acceptable. DO NOT use salt water. Deionized or distilled water is best to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Water Quality	
Property	**Requirements**
Total Solids (Max)	340 ppm (20 grns/gal)
Total Hardness (Max)	170 ppm (10 grns/gal)
Chloride (as Cl) (Max)	40 ppm (2.5 grns/gal)
Sulfate (as SO_4) (Max)	100 ppm (5.8 grns/gal)

Mix 50 percent anti-freeze concentrate with 50 percent distilled or deionized water. This mixture will protect the cooling system down to -37°C (-34°F) and up to 108°C (226°F).

Certain geographical areas may require lower air temperature protection. See the label on your anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Diesel Engine Coolant Drain Interval - Europe

When using John Deere COOL-GARD Coolant Concentrate for Automobile and Light Duty Engine Service, drain and flush the cooling system and refill with fresh coolant mixture every 24 months or 2,000 hours of operation, whichever comes first.

If above John Deere Automobile and Light Duty Engine Service coolant is not being used, drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

Identification Numbers

Serial Number Location

When ordering parts or submitting a warranty claim, it is IMPORTANT that you include the mower product identification number and the component serial numbers.

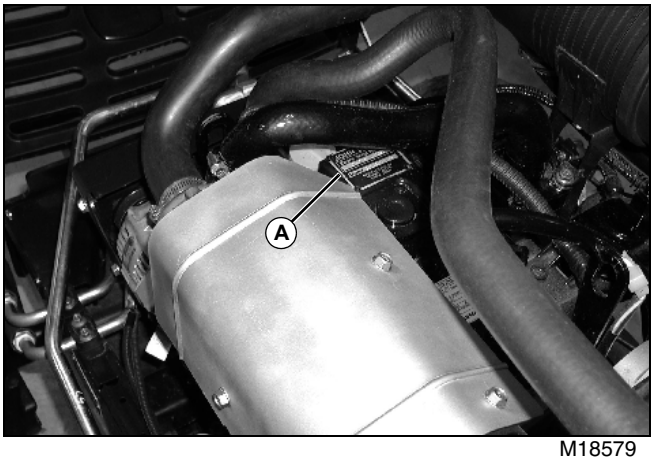
The locations of mower identification number and component serial numbers are shown.

Machine Identification Number

MX24806

The mower identification number plate (A) is located on the right-hand frame under the engine compartment.

Engine Serial Number



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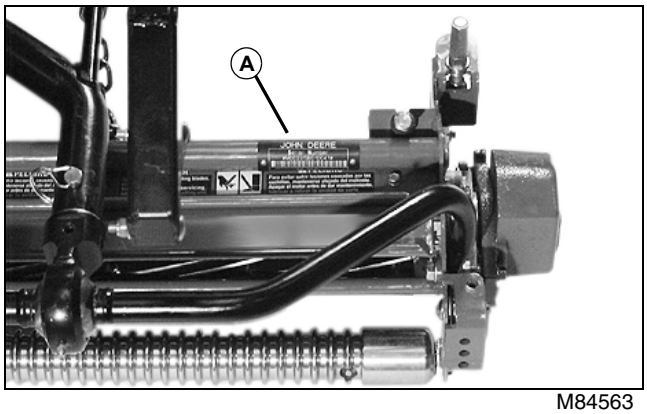
The engine serial number plate (A) is located on the top of the valve cover.

Cutting Unit Serial Numbers

Note: The rotary cutting units do not have serial number plates.



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Picture Note: 22 In. Standard

MX18036

Picture Note: 22 In. Heavy Duty ESP

The cutting unit serial number plate (A) is located on top of the cutting unit.

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Specifications

Engine Specifications

3TNV84T

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Make	Yanmar
Model	3TNV84T
Output Power	27.7 kW (37.1 hp)

3TNV84HT

Machine Models Used On	8500, 8500 E-Cut, 8700, 8800
Make	Yanmar
Model	3TNV84HT
Output Power	32.1 kW (43.1 hp)

General Specifications

Type	4-cycle diesel
Cylinders	3
Bore	84 mm (3.31 in.)
Stroke	90 mm (3.54 in.)
Displacement	1.496 L (91.3 cu. in.)
Firing Order	1-3-2
Direction of Rotation	Counterclockwise (viewed from flywheel)
Combustion System	Direct injection type
Compression Ratio	18:1
Cooling	Liquid
Governor	Centrifugal
RPM at Slow Idle Speed	1400 ± 50 rpm
RPM at Fast Idle (No-Load) Speed	2800 ± 50 rpm
Rated RPM	2600
Torque Rise	20 percent minimum

Startability

W/O Block Heater	-17.8°C (0°F)
W/ Block Heater	-28.9°C (-20°F)

Repair Specifications

12 V Alternator

Drive Belt Deflection @ 98 N (22 lb-force)	8.0-13.0 mm (0.315-0.512 in.)
Slip Ring Diameter (Minimum)	14 mm (0.550 in.)
Exposed Brush Length (Minimum)	4.50 mm (0.170 in.)
Exposed Brush Length (Maximum)	10.50 mm (0.410 in.)
Output	40 amp

48 V Alternator

Drive Belt Deflection at 50 N (11 lb-force)	30 mm (1.2 in.)
Output at 2800 rpm	180 amp

Cam Follower Bore

Bore ID	12.00-12.02 mm (0.472-0.473 in.)
Wear Limit	12.04 mm (0.474 in.)
Clearance	0.010-0.043 mm (0.001-0.002 in.)

Cam Follower Stem

Stem OD	11.98-11.99 mm (0.471-0.472 in.)
Wear Limit	11.93 mm (0.470 in.)

Camshaft

Camshaft End Play	0.05-0.20 mm (0.002-0.010 in.)
Wear Limit	0.03 mm (0.012 in.)
Camshaft Bend (Maximum)	0.03 mm (0.002 in.)
Camshaft Lobe Height	38.64-38.77 mm (1.521-1.526 in.)
Wear Limit	38.40 mm (1.512 in.)

Camshaft Bushings

Camshaft Bushing ID at Gear Housing	44.990-45.055 mm (1.771-1.774 in.)
Camshaft Bushing ID at Intermediate and Flywheel End	45.000-45.025 mm (1.772-1.773 in.)
Wear Limit	45.10 mm (1.776 in.)
Camshaft Bushing-to-Journal Clearance	0.23 mm (0.009 in.)

Camshaft Journals

Gear Housing and Flywheel End Camshaft Journals OD	44.93-44.95 mm (1.769-1.770 in.)
Intermediate Camshaft Journals	44.91-44.94 mm (1.768-1.769 in.)
Wear Limit	44.85 mm (1.766 in.)

Connecting Rod Bearing

Bearing ID	47.952-47.962 mm (1.888-1.891 in.)
Wear Limit	48.07 mm (1.893 in.)
Bearing Oil Clearance	0.038-0.074 mm (0.001-0.003 in.)
Wear Limit	0.150 mm (0.006 in.)

Crankshaft and Main Bearings

Crankshaft Bend Variation	0.02 mm (0.001 in.)
Connecting Rod Journal OD	47.95-47.96 mm (1.8878-1.8882 in.)
Wear Limit	47.91 mm (1.886 in.)
Main Bearing Journal OD	53.95-53.96 mm (2.1240-2.1244 in.)
Wear Limit	53.91 mm (2.122 in.)
Main Bearing Oil Clearance	0.038-0.074 mm (0.001-0.003 in.)
Wear Limit	0.15 mm (0.006 in.)

Cylinder Bore

Standard Cylinder Bore ID	84.00-84.03 mm (3.307-3.308 in.)
Wear Limit	84.20 mm (3.315 in.)
Oversize Cylinder Bore ID	84.25-84.28 mm (3.317-3.318 in.)
Wear Limit	84.45 mm (3.325 in.)
Piston-to-Cylinder Bore Clearance	0.040-0.070 mm (0.001-0.003 in.)
Cylinder Roundness	0.00-0.01 mm (0.0000-0.0004 in.)

Wear Limit . . . . . 0.03 mm (0.001 in.)
Cylinder Taper . . . . . 0.00-0.01 mm (0.0000-0.0004 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)

Cylinder Head

Cylinder Head Flatness (Maximum Distortion) . . . . . 0.15 mm (0.006 in.)
Cylinder Head Flatness (Resurface Range) . . . . . 0.00-0.05 mm (0.000-0.002 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)

Flywheel

Flatness . . . . . 0.02 mm (0.001 in.)

Fuel Injection Nozzles

Nozzle Contact Surface . . . . . 0.10 mm (0.004 in.)

Idler Gear

Shaft OD . . . . . 45.950-45.975 mm (1.809-1.810 in.)
Wear Limit . . . . . 45.93 mm (1.808 in.)
Bushing ID . . . . . 46.000-46.025 mm (1.811-1.812 in.)
Wear Limit . . . . . 46.08 mm (1.814 in.)
Shaft and Bushing Clearance . . . . . 0.18 mm (0.007 in.)

Oil Pressure Regulating Valve

Spring Free Length . . . . . 46 mm (1.810 in.)
Spring Compressed Length at 20.5 N (4.6 lb-force) . . . . . 27.5 mm (1.080 in.)

Oil Pump

Oil Pump Gear Backlash . . . . . 0.12 mm (0.005 in.)
Rotor Shaft OD-to-Backing Plate ID Clearance . . . . . 0.013-0.043 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.20 mm (0.008 in.)
Rotor Recess . . . . . 0.03-0.09 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)
Outer Rotor-to-Pump Body Clearance . . . . . 0.10-0.16 mm (0.004-0.006 in.)
Wear Limit . . . . . 0.25 mm (0.010 in.)
Inner-to-Outer Rotor Clearance . . . . . 0.02-0.07 mm (0.001-0.003 in.)
Wear Limit . . . . . 0.12 mm (0.006 in.)

Piston

Standard Piston OD . . . . . 83.95-83.98 mm (3.305-3.306 in.)
Wear Limit . . . . . 83.90 mm (3.303 in.)
Oversize Piston OD . . . . . 84.20-84.23 mm (3.315-3.316 in.)
Wear Limit . . . . . 84.10 mm (3.311 in.)

Piston-to-Cylinder Head

Clearance . . . . . 0.72 ± 0.06 mm (0.025 ± 0.002 in.)

Piston Pin Bore

Piston Pin Bore ID . . . . . 26.00-26.01 mm (1.0236-1.0240 in.)
Wear Limit . . . . . 26.04 mm (1.025 in.)
Piston Pin-to-Piston Oil Clearance . . . . . 0.00-0.02 mm (0.00-0.001 in.)

Wear Limit	**0.12 mm (0.005 in.)**

Piston Pin Bushing

Piston Pin Bushing ID	**26.025-26.038 mm (1.0246-1.0251 in.)**
Wear Limit	**26.07 mm (1.026 in.)**
Piston Pin-to-Rod Bore Oil Clearance	**0.03-0.05 mm (0.001-0.002 in.)**
Wear Limit	**0.10 mm (0.004 in.)**

Piston Pin Diameter

Piston Pin OD	**25.99-26.00 mm (1.023-1.024 in.)**
Wear Limit	**25.97 mm (1.022 in.)**

Piston Ring End Gap

Piston Ring End Gap	**0.20-0.40 mm (0.008-0.016 in.)**
Wear Limit	**1.50 mm (0.059 in.)**

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance	**0.075-0.11 mm (0.003-0.004 in.)**
Wear Limit	**0.025 mm (0.010 in.)**
Second Compression Ring Groove Side Clearance	**0.045-0.080 mm (0.002-0.003 in.)**
Wear Limit	**0.025 mm (0.010 in.)**
Oil Control Ring Groove Side Clearance	**0.025-0.060 mm (0.001-0.002 in.)**
Wear Limit	**0.020 mm (0.008 in.)**

Push Rods

Maximum Bend	**0.03 mm (0.001 in.)**
Length	**178.25-178.75 mm (7.018-7.037 in.)**

Rocker Arm Shaft

Rocker Arm Shaft OD	**15.97-15.98 mm (0.628-0.629 in.)**
Rocker Arm Shaft Wear Limit	**15.94 mm (0.628 in.)**

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance	**0.02-0.05 mm (0.001-0.002 in.)**
Oil Clearance Wear Limit	**0.13 mm (0.005 in.)**

Rocker Arms and Supports

Rocker Arm and Support ID	**16.00-16.02 mm (0.630-0.631 in.)**
Rocker Arm and Support Wear Limit	**16.07 mm (0.633 in.)**

Springs

Valve Spring Free Length	**44.4 mm (1.748 in.)**
Wear Limit	**43.9 mm (1.730 in.)**
Spring Inclination	**1.40 mm (0.055 in.)**

Valve Guides

Valve Guide ID	**8.010-8.025 mm (0.3154-0.3160 in.)**
Wear Limit	**8.10 mm (0.319 in.)**
Oil Clearance	**0.035-0.070 mm (0.001-0.003 in.)**
Valve Guide Projection	**15 mm (0.591 in.)**

Valve Seats

Intake Valve Seat Width	**1.77 mm (0.070 in.)**
Wear Limit	**2.27 mm (0.089 in.)**
Exhaust Valve Seat Width	**1.34 mm (0.053 in.)**
Wear Limit	**1.84 mm (0.072 in.)**

Valve Recession

Valve Recession	**0.30-0.50 mm (0.012-0.020 in.)**
Wear Limit	**0.80 mm (0.031 in.)**

Valves

Valve Head (Minimum Thickness)	**0.50 mm (0.020 in.)**
Intake and Exhaust Valve Stem OD	**7.96-7.97 mm (0.3134-0.3138 in.)**
Wear Limit	**7.90 mm (0.311 in.)**

Test and Adjustment Specifications

Camshaft

End Play	**0.05-0.20 mm (0.002-0.010 in.)**
Wear Limit	**0.30 mm (0.012 in.)**

Connecting Rod

Side Play	**0.2-0.4 mm (0.008-0.016 in.)**
Connecting Rod-to-Crankshaft Journal Clearance	**0.038-0.074 mm (0.001-0.003 in.)**

Cooling System

Maximum Pressure	**97 kPa (14 psi)**
Minimum Pressure (After 15 Seconds)	**88 ± 15 kPa (12.8 ± 2.2 psi)**
Radiator Cap Pressure	**88 kPa (12.8 psi)**
Temperature Switch (Contact Closing Temperature)	**107-113°C (225-235°F)**

Crankshaft

End Play	**0.13-0.23 mm (0.005-0.009 in.)**
Wear Limit	**0.28 mm (0.011 in.)**
Main Bearing-to-Crankshaft Journal Oil Clearance	**0.038-0.068 mm (0.001-0.003 in.)**
Wear Limit	**0.150 mm (0.006 in.)**

Cylinder Compression Pressure @ 250 RPM

Standard	**2833-3040 kPa (411-441 psi)**
Limit	**2344-2551 kPa (340-370 psi)**
Difference Between Cylinders @ 250 RPM (Maximum)	**200-296 kPa (29-43 psi)**

Fuel Injection Nozzles

Opening Pressure	**21 600-22 600 kPa (3133-3278 psi)**

Oil Pressure

Engine Oil Pressure	**345 ± 48 kPa (50.0 ± 7.0 psi)**

Thermostat

Begins to Open	**70°C (158°F)**
Fully Open	**85°C (184°F)**
Lift Height	**8 mm (0.310 in.)**

Timing Gear

Backlash	**0.0028-0.0059 mm (0.07-0.15 in.)**
Limit	**0.0067 mm (0.17 in.)**

Throttle Lever

Friction	**36-53 N (8-12 lb-force)**

Rotor Shaft Axial Play

Standard	**0.022-0.053 mm (0.009-0.0021 in.)**
Wear Limit	**0.07 mm (0.0028 in.)**

Rotor Shaft Radial Play

Standard	**0.061-0.093 mm (0.0024-0.0037 in.)**
Wear Limit	**0.12 mm (0.0047 in.)**

Valve Adjustment

Clearance	**0.15-0.25 mm (0.006-0.010 in.)**

Valve Lift

Valve Lift	**8.8 mm (0.350 in.)**

Torque Specifications

Alternators

12V Alternator Pulley Nut	**69 N•m (51 lb-ft)**
48V Alternator Tensioner Locknut Torque[1]	**74.5 N•m (55 lb-ft)**

Camshaft

Thrust Plate Mounting Cap Screw	**26 N•m (226 lb-in.)**

Crankshaft

Main Bearing Cap Screw	**98 N•m (72 lb-ft)**
Connecting Rod Cap Screw	**47 N•m (35 lb-ft)**

Cylinder Head Cap Screw[2]

Initial Torque	**44 N•m (33 lb-ft)**
Second Torque	**62 N•m (45 lb-ft)**
Final Torque	**88 N•m (65 lb-ft)**

Exhaust Manifold

Cap Screws and Nuts	**26 N•m (19 lb-ft)**

1. Back off 1/8 turn after tightening to specification.

2. Cylinder head cap screw torque must be checked for proper torque after 50 hours of engine operation.

Fuel Injection Pump

Drive Gear Nut	**78-88 N•m (58-65 lb-ft)**
Fuel Injector Tube Nut	**29-34 N•m (21-25 lb-ft)**
Oil Lube LIne Mounting Bolt	**25 N•m (217 lb-in.)**

Fuel Injector

Retaining Cap Screw	**24-28 N•m (18-21 lb-ft)**

Intake Manifold

Cap Screw	**26 N•m (19 lb-ft)**

Oil Pressure Regulating Valve

Housing Cap Screw	**27 N•m (20 lb-ft)**

Rocker Arm Assembly

Support Cap Screw	**26 N•m (19 lb-ft)**

Rocker Arm Cover

Rocker Arm Cover Nut	**16.7-22.5 N•m (148-199 lb-in.)**
Breather Cover Cap Screw	**22 N•m (16 lb-ft)**
Engine Mounting Cap Screws	**80 N•m (60 lb-ft)**
Drive Shaft Cap Screws	**80 N•m (60 lb-ft)**

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Straight Adapter	23622	Used to test fuel injection nozzles.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzles.
Adapter Set	D01110AA	Used to test fuel injection nozzles.
Cooling System Pressure Pump	D05104ST	Used to test cooling system and radiator cap pressure.
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.
Valve Guide Knurler	D-20019WI	Used to knurl valve guides.
Valve Guide Reamer	D-20021WI	Used to ream valve guides.
Valve Guide Driver	JDE118	Used to install new valve guides.
Fuel Injection Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.
Belt Tension Gauge	JDG529 or JDST28	Used to adjust belt tension.
Adapter	JDG560	Used to measure cylinder compression and pressurize cylinder with compressed air for cylinder leakdown test.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test cooling system and radiator cap pressure.
Compression Gauge Assembly	JT01682	Used to measure cylinder compression.
Hose Assembly	JT03017	Used to test engine oil pressure.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Connector 1/8 in. Male BSP x 7/16 in. Male 37° Flare	JT03349	Used to test engine oil pressure.
Elbow 7/16 in. Male 37° Flare x 7/16 in. Male 37° Flare	JT05483	Used to test engine oil pressure.
Inductive Electronic Tachometer	JT05801	Used to check engine rpm when setting slow idle speeds.
Pressure Gauge 689 kPa (100 psi)	JT07034	Used to test engine oil pressure.
Yanmar TNV Diesel Engine Timing Tool Kit	JDG10436	Adjust Fuel Injection Timing
Heating Unit	N/A	Used to check coolant temperature switch.
Dial Indicator	N/A	Used to measure valve lift, to check crankshaft-to-engine block side clearance, to check camshaft gear end journal-to-thrust plate side clearance, and to check wear between meshing gears.
Glass Container	N/A	Used to check coolant temperature switch.
Ohmmeter	N/A	Used to check coolant temperature switch.
PLASTIGAGE™	N/A	Used to measure oil clearance between connecting rod and crankshaft journal. Also used to check main bearing-to-crankshaft journal clearance.
Straightedge	N/A	Used to adjust belt tension.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	N/A	Used to check thermostat opening temperature and coolant temperature switch.
Volt-Ohm-Amp Meter	N/A	Used to test alternator components.
Yanmar TNV Diesel Engine Timing Tool Kit	JDG10436	Adjust Fuel Injection Timing.

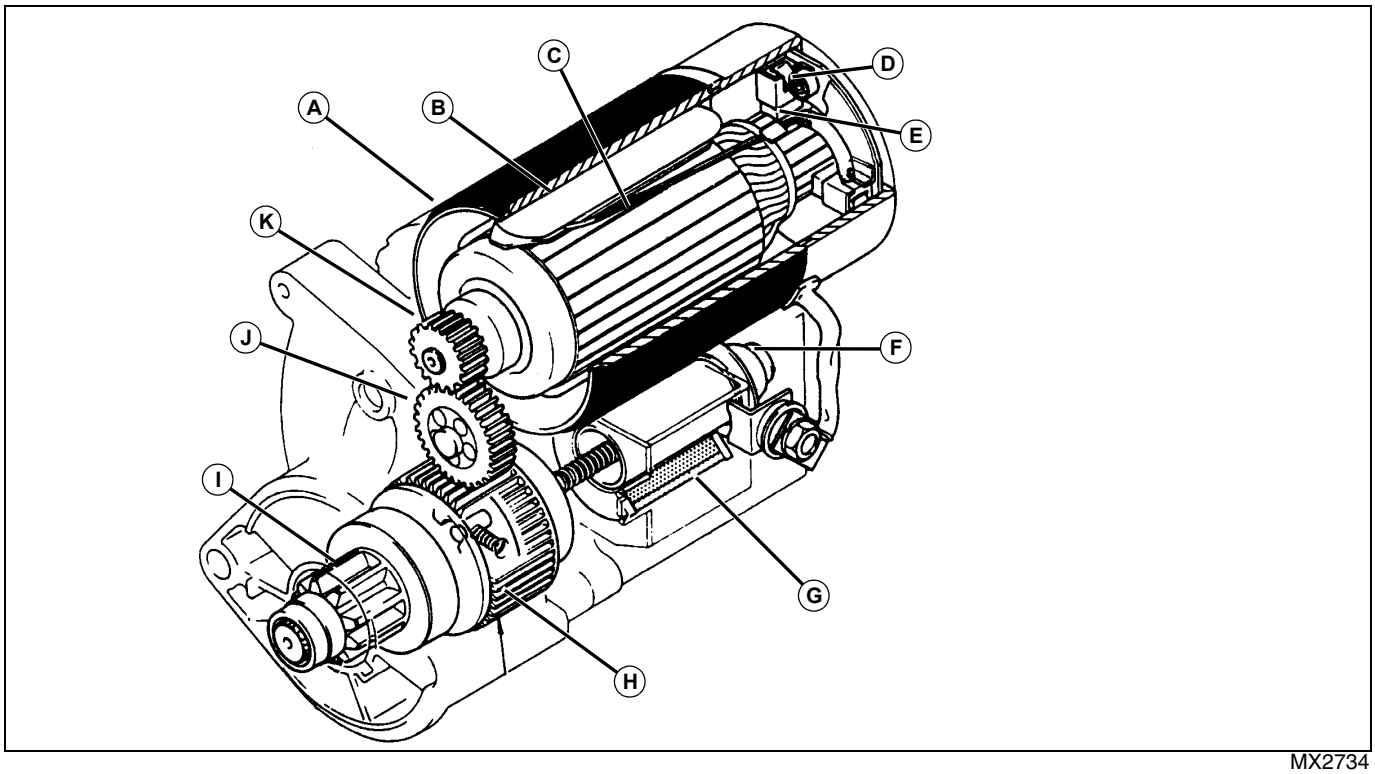
Other Materials

Other Material

Part No.	Part Name	Part Use
PM37465 (US)/ PM38628 (Canada)	Ultra-Blue RTV Silicone Form-in-Place Gasket	Applied to oil seal case mounting surface before installation.

Component Location

Starter Components



MX2734

A- Motor
B- Field Coil
C- Armature
D- Brush Spring
E- Brush
F- Plunger
G- Solenoid
H- Overrunning Clutch
I- Pinion
J- Idler Gear
K- Drive Gear

Theory of Operation

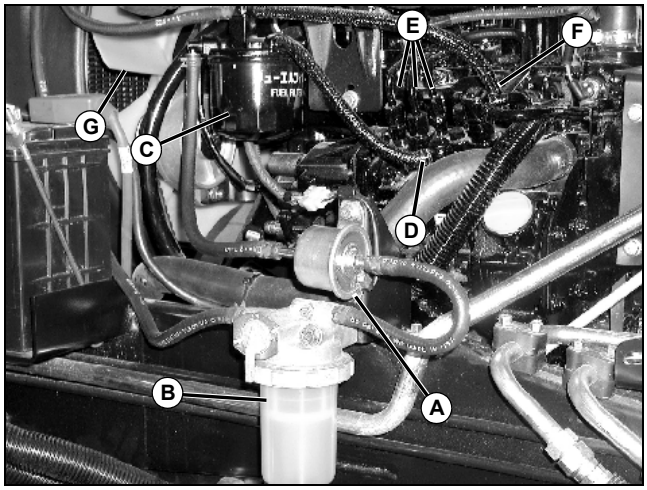
Fuel and Air System Operation

Function

The fuel system supplies fuel to injection nozzles.

The air intake system filters and supplies air needed for combustion.

Theory of Operation



MX17927

Fuel System

An electric fuel transfer pump (A) draws fuel through the water separator (B) from the tank outlet. The low-pressure fuel from the fuel pump flows through the filter (C) to the fuel injection pump inlet (D). The injection pump then directs high-pressure fuel through the injection lines (E) to the injectors, where it is injected into the cylinders for combustion. Excess fuel from the injectors and the injection pump is returned by line (F) to the filter where, if needed, it can be sent back to the injection pump. If not needed, the fuel is sent back to the tank by line (G).

If the unit runs out of fuel, there are two air bleed lines that allow air to escape from the top of the filter and the injection pump. These two lines allow the system to be self-bleeding.

The engine speed is controlled by the throttle lever and cable. The cable is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (key in the START or ON position), the engine can be started. When the key is turned off, return springs on the shutoff shaft extend the solenoid, moving the shutoff linkage to the shutoff position.

The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles.

The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines contain trapped fuel whenever injection is not taking place.

A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

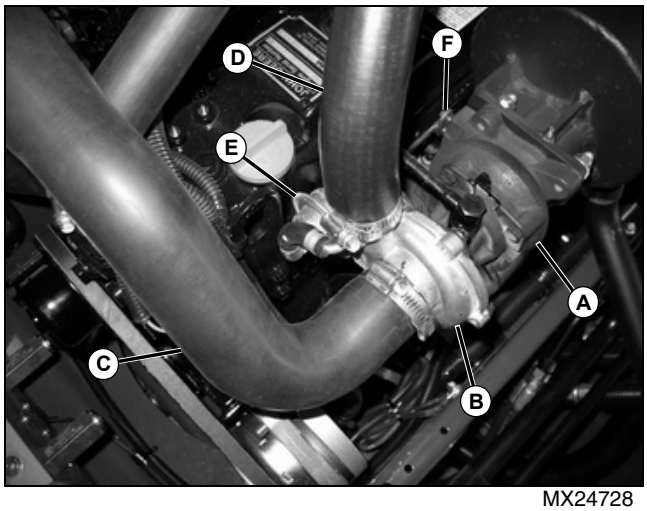
A fuel float gauge is mounted in the fuel tank to inform the operator of the fuel level.

Air Intake System

Air enters the air filter through the perforated side holes. The primary and secondary elements filter the air before entering the intake manifold.

An air filter restriction switch informs the operator when the air filter needs servicing. The air filter restriction switch closes when the vacuum reaches a specified level and lights a lamp. A small amount of vacuum is always present due to some restriction of air movement through the filter elements. The unloading valve is like a one-way valve. It ejects heavy dirt particles from the air stream during engine operation, but does not let air into the air filter housing. The operator can squeeze the valve to let the large particles out.

Turbocharger



MX24728

The turbocharger provides additional air, to burn more fuel and produce more power without increasing the size of the engine. The turbine in the turbocharger may spin as fast as 150,000 rpm.

The turbine is on a shaft inside the turbine housing (A). The shaft is connected to the compressor wheel, which is inside the compressor housing (B). The shaft is supported by two floating bearings, which are located between the turbine and compressor housings.

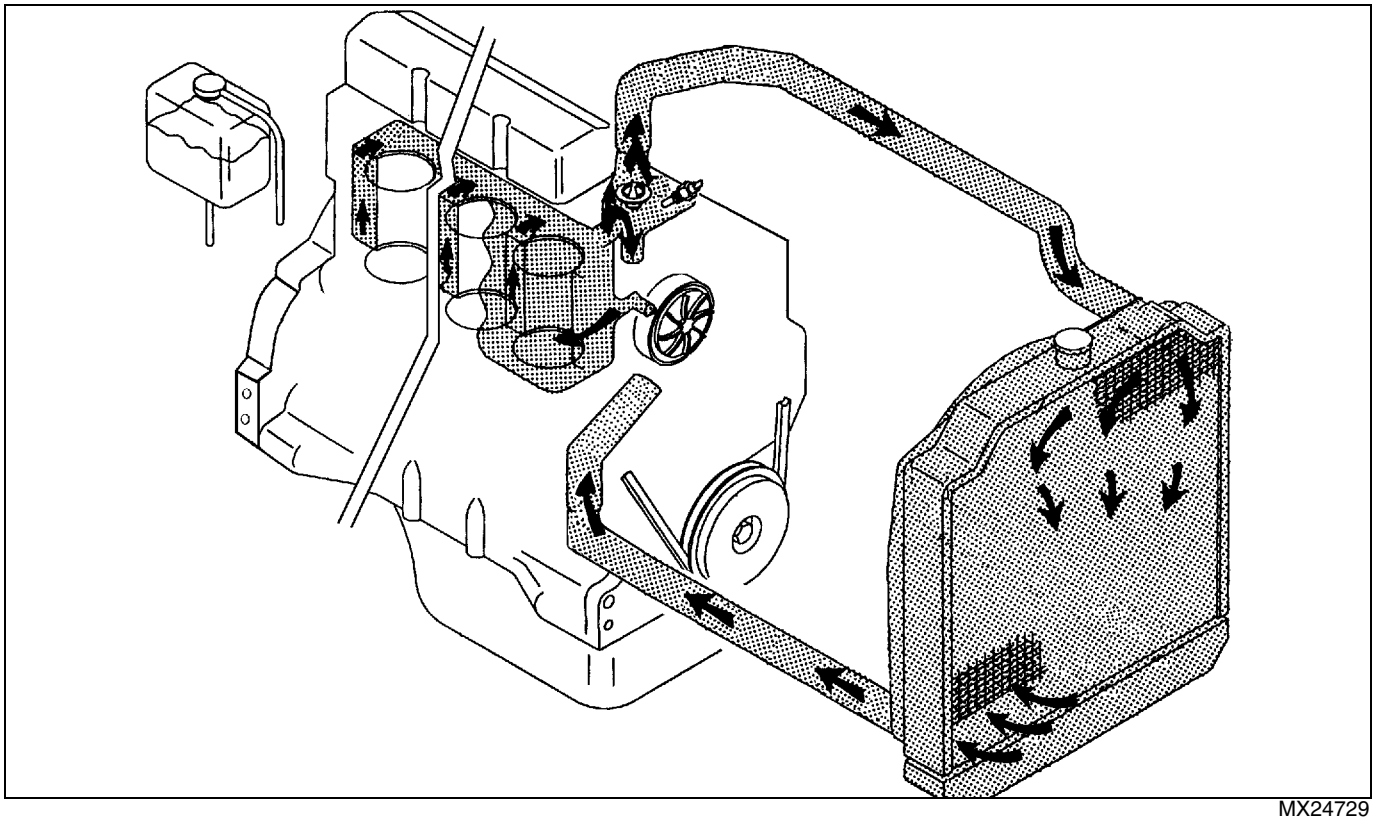
Exhaust gases from the engine pass through the turbine housing, causing the turbine to rotate before the exhaust gas is discharged. The compressor wheel also begins to rotate in the compressor housing. Air from the air cleaner is supplied to the inlet side of the compressor housing by hose (C). The air is compressed inside the housing and delivered to the intake manifold by hose (D).

The turbocharger is equipped with a waste gate (F). If the turbocharger goes above a specified pressure, a diaphragm (E), sensing inlet pressure from the compressor, opens a waste gate valve (F) to allow excess exhaust gases to bypass the turbine. The waste gate valve limits boost pressure at high engine rpm to prevent damage to the engine.

Intercooler

An intercooler is an air-to-air or air-to-liquid heat exchange device used on turbocharged and supercharged internal combustion engines to improve their volumetric efficiency by increasing intake air charge density through isochoric cooling. A decrease in air intake temperature provides a denser intake charge to the engine and allows more air and fuel to be combusted per engine cycle, increasing the output of the engine.

Cooling System Operation



MX24729

Function

The coolant pump circulates coolant through the cooling system, drawing hot coolant from the engine block and circulating it through the radiator for cooling.

Theory of Operation

The pressurized cooling system includes the radiator, coolant pump, fan, and thermostat.

During the warm-up period, the thermostat remains closed and the impeller-type coolant pump draws coolant from the bypass tube. Coolant from the pump flows to the cylinder block water jacket and up through the cylinder head, providing a fast warm-up.

Once the engine has reached operating temperature, the thermostat opens and coolant is pumped from the bottom of the radiator via the lower radiator hose into the cylinder block. Here it circulates through the block and around the cylinders.

From the block, coolant is then directed through the cylinder head and into the thermostat housing. With the thermostat open, warm engine coolant passes through the housing into the top of the radiator, where it is circulated to dissipate heat.

When coolant system pressure exceeds 88.3 kPa (12.8 psi), a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

When temperature is reduced, a vacuum is produced in the radiator and coolant is drawn back out of the coolant recovery tank through a valve in the radiator cap.

A coolant temperature switch informs the operator of the engine coolant temperature and warns of a high-temperature condition by lighting a lamp.

Lubrication System Operation

Function

A full-pressure system lubricates engine parts with filtered oil.

Theory of Operation

The pressure lubrication system consists of a positive displacement gear-driven pump, oil strainer, full-flow oil filter, oil pressure regulating valve, and an electrical pressure warning switch.

The pump draws lubrication oil from the oil pan through a strainer and a suction tube. The oil is then pumped through an oil passage to the oil filter and through the engine block main oil galley.

From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals and idler gear shaft. Drilled cross-passages in the crankshaft distribute the oil from the main bearings to connecting rod bearings.

Lube oil holes in main bearing oil grooves direct oil to the camshaft bearings.

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft. The hollow shaft distributes oil to the rocker arms, cam followers, and valves.

Lubrication oil is supplied to the fuel injection pump from the main oil galley through external oil lines.

An oil pressure switch activates an indicator light to alert the operator to shut down the engine if oil pressure drops below specification.

Turbocharger Lubrication

Engine oil under pressure from the engine lubrication system is pumped through passages into the center housing of the turbocharger and directed to the bearings.

The turbocharger contains two floating bearings that have clearance between the bearing OD and the housing wall, as well as clearance between the bearing ID and the shaft OD.

These clearances are lubricated by the pressurized oil supply, which allows the bearings to be protected by a cushion of oil.

The pressure-free oil drains by gravity from the center housing to the engine crankcase.

Diagnostics

Symptom: Engine Will Not Start

Caution: Avoid Injury! The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Coolant in the radiator is extremely hot during operation.

Procedure

1. Proper starting procedure being used is correct for conditions?

Yes: Go to next step.

No: Use correct procedure for conditions. (See the Operator's Manual.)

2. Battery 12.7 VDC or higher?

Yes: Go to next step.

No: Charge and check battery.

3. No open circuits in wiring?

Yes: Go to next step.

No: Repair or replace as needed.

4. Starting motor functioning properly?

Yes: Go to next step.

No: Repair or replace starting motor. (See "Disassemble and Assemble Starting Motor" on page 109.)

5. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of proper viscosity and type. Replace oil filter.

6. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

7. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

8. No air leak in fuel system?

Yes: Go to next step.

No: Repair fuel system.

9. Fuel lines not plugged, pinched, or cracked?

Yes: Go to next step.

No: Repair or replace fuel lines as needed.

10. Correct volume of fuel supplied to injection pump?

Yes: Go to next step.

No: Replace fuel transfer pump.

11. Intake and/or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See "Adjust Valve Clearance" on page 48.)

12. Injection pump timing correct?

Yes: Go to next step.

No: Correctly time injection pump.

13. Intake and/or exhaust valve not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See "Disassemble and Assemble Cylinder Head and Valves" on page 74.)

14. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See "Inspect Cylinder Bore" on page 85.)

15. Piston rings, piston, or cylinder not worn?

Yes: Go to next step.

No: Replace piston and/or rings; bore or hone cylinder. (See "Inspect Piston and Connecting Rod" on page 82. See "Inspect Cylinder Bore" on page 85.)

16. Crankshaft pin or bearing not seized?

No: Regrind crankshaft and replace bearings. (See "Inspect Crankshaft and Main Bearings" on page 89.)

Symptom: Engine Starts but Does Not Continue Running

No Exhaust Smoke

1. Engine oil of proper viscosity and type?

Yes: Go to next step.

No: Replace engine oil filter and use oil of proper viscosity and type.

2. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

3. No air leak in fuel system?

Yes: Go to next step.

No: Repair fuel system.

4. Fuel lines not plugged, pinched, or cracked?

Yes: Go to next step.

No: Repair or replace fuel lines as needed.

5. Correct volume of fuel supplied to injection pump?

Yes: Go to next step.

No: Replace fuel transfer pump.

6. Valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See “Adjust Valve Clearance” on page 48.)

7. Crankshaft pin or bearing not seized?

No: Regrind crankshaft and replace bearings. (See “Inspect Crankshaft and Main Bearings” on page 89.)

Excess Exhaust Smoke

1. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

2. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

3. Intake and/or exhaust valve not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

4. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See “Inspect Piston and Connecting Rod” on page 82. See “Inspect Cylinder Bore” on page 85.)

5. Piston rings, piston, or cylinder not worn?

No: Replace piston and/or rings; bore or hone cylinder. (See “Inspect Piston and Connecting Rod” on page 82. See “Inspect Cylinder Bore” on page 85.)

Symptom: Low Engine Output

Exhaust Color NORMAL

1. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

2. Proper type and viscosity of oil being used?

Yes: Go to next step.

No: Replace engine oil and filter.

3. Fuel filter not clogged?

Yes: Go to next step.

No: Replace fuel filter.

4. Fuel lines not clogged, cracked, or pinched?

Yes: Go to next step.

No: Clean or replace fuel lines.

5. No air leakage into fuel system?

Yes: Go to next step.

No: Repair fuel supply system.

6. Proper volume of fuel to injection pump?

Yes: Go to next step.

No: Check or replace fuel transfer pump.

7. Intake and exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See “Adjust Valve Clearance” on page 48.)

8. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See “Grind Valve Seats” on page 78. See “Inspect Cylinder Head and Valves” on page 74.)

9. Intake or exhaust valves not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 74.)

10. Cylinder head gasket not leaking compression?

No: Replace head gasket. (See “Remove and Install Cylinder Head and Valves” on page 73.) Resurface head and block if necessary. (See “Inspect Cylinder Head and Valves” on page 74.)

Exhaust Color WHITE

1. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Even volume of fuel being injected?

Yes: Go to next step.

No: Repair or replace fuel injection pump or fuel injectors.

4. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See “Remove and Install Fuel Injection Nozzles” on page 105.)

5. Intake or exhaust valve stems not worn?

Yes: Go to next step.

No: Replace valve guides and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

6. Injection pump timing correct?

Yes: Go to next step.

No: Correctly time injection pump.

7. Piston rings installed correctly?

Yes: Go to next step.

No: Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 81.)

8. Piston ring ends staggered?

Yes: Go to next step.

No: Stagger piston ring ends. (See “Disassemble and Assemble Piston and Connecting Rod” on page 81.)

9. Piston, rings, or cylinder not worn?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

10. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

Exhaust Color BLACK

1. Is engine NOT being run under high altitude or high temperature conditions?

Yes: Go to next step.

No: Reduce load.

2. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Air filter elements not clogged?

Yes: Go to next step.

No: Clean or replace air filter elements.

4. Exhaust pipe not clogged?

Yes: Go to next step.

No: Clean exhaust pipe.

5. Engine running cool enough?

Yes: Go to next step.

No: Check thermostat. (See “Test Thermostat Opening” on page 55.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

6. Cooling system filled to correct level?

Yes: Go to next step.

No: Check for leaks and fill system to correct level.

7. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

8. Correct pattern from fuel injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 54.)

9. Injection pump timing correct?

Yes: Go to next step.

No: Correctly time injection pump.

10. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See “Grind Valve Seats” on page 78. See “Inspect Cylinder Head and Valves” on page 74.)

11. Intake or exhaust valve not seized?

No: Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 74.)

Symptom: Exhaust Color WHITE Under Load

Procedure

1. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Engine not running too cool?

Yes: Go to next step.

No: Check thermostat. (See “Test Thermostat Opening” on page 55.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

4. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump.

5. Correct pattern from fuel injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 54.)

6. Injection pump timing correct?

Yes: Go to next step.

No: Adjust injection pump timing.

7. Piston rings installed correctly?

Yes: Go to next step.

No: Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 81.)

8. Pistons, rings, or cylinders not worn?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

9. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

Symptom: Exhaust Color BLACK Under Load

Procedure

1. Is engine NOT being run under high altitude or high temperature conditions?

Yes: Go to next step.

No: Reduce load.

2. Correct type of fuel?

Yes: Go to next step.

No: Drain and replace fuel.

3. Air filter elements not clogged?

Yes: Go to next step.

No: Clean or replace air filter elements.

4. Exhaust pipe not clogged?

Yes: Go to next step.

No: Clean exhaust pipe.

5. Even volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

6. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

7. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 54.)

8. Injection pump timing correct?

Yes: Go to next step.

No: Adjust injection pump timing. (See “Adjust Fuel Injection Timing” on page 47.)

9. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See “Grind Valve Seats” on page 78. See “Inspect Cylinder Head and Valves” on page 74.)

10. Intake or exhaust valves not seized?

No: Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 74.)

Symptom: Exhaust Temperature Too High

Procedure

1. Cooling system filled to correct level?

Yes: Go to next step.

No: Check for leaks and fill system to correct level.

2. Engine running cool enough?

Yes: Go to next step.

No: Check thermostat. (See “Test Thermostat Opening” on page 55.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

3. Exhaust pipe not clogged?

Yes: Go to next step.

No: Clean exhaust pipe.

4. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

5. Intake or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See “Adjust Valve Clearance” on page 48.)

6. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See “Grind Valve Seats” on page 78. See “Inspect Cylinder Head and Valves” on page 74.)

7. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

Symptom: Engine Runs Rough

Misfiring

1. Intake or exhaust valve clearance correct?

Yes: Go to next step.

No: Adjust valve clearance. (See “Adjust Valve Clearance” on page 48.)

2. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Injection pump timing correct?

Yes: Go to next step.

No: Adjust injection pump timing. (See “Adjust Fuel Injection Timing” on page 47.)

4. Backlash of timing gear not excessive?

Yes: Go to next step.

No: Repair gears as needed. (See “Check Timing Gear Backlash” on page 53.)

5. Combustion chambers clean of foreign matter?

Yes: Go to next step.

No: Clean combustion chambers. (See “Remove and Install Cylinder Head and Valves” on page 73.)

6. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See “Grind Valve Seats” on page 78. See “Inspect Cylinder Head and Valves” on page 74.)

7. Intake or exhaust valves not seized?

Yes: Go to next step.

No: Replace valve and check valve guide. (See “Inspect Cylinder Head and Valves” on page 74.)

8. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

Uneven Combustion Sound

1. Correct type of fuel being used?

Yes: Go to next step.

No: Drain and replace fuel.

2. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel. Check fuel filter.

3. Even volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

4. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 54.)

5. Air filter elements not clogged?

Yes: Go to next step.

No: Clean or replace air filter elements.

6. Exhaust pipe not clogged?

No: Clean exhaust pipe.

Engine Surges DURING IDLING

1. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel. Check fuel filter.

2. Even volume of fuel injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See “Test Fuel Injection Nozzles” on page 54.)

4. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See “Remove and Install Piston

and Connecting Rod" on page 79. See "Inspect Cylinder Bore" on page 85.)

Engine Surges UNDER LOAD

1. No water in fuel?

Yes: Go to next step.

No: Drain and replace fuel. Check fuel filters.

2. Even volume of fuel injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Test Fuel Injection Nozzles" on page 54.)

4. Piston rings not broken or seized?

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 79. See "Inspect Cylinder Bore" on page 85.)

Excessive Engine Vibration

1. Even volume of fuel injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

2. Proper spray pattern from injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Test Fuel Injection Nozzles" on page 54.)

3. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Replace pistons if damaged. Bore cylinder if damaged. (See "Remove and Install Piston and Connecting Rod" on page 79. See "Inspect Cylinder Bore" on page 85.)

4. Crankshaft pin or bearing not worn or seized?

Yes: Go to next step.

No: Regrind crankshaft and replace bearings. (See "Inspect Crankshaft and Main Bearings" on page 89.)

5. Connecting rod bolts tightened properly?

No: Replace damaged components. Tighten to correct specification. (See "Remove and Install Cylinder Head and Valves" on page 73.)

Symptom: Excessive Fuel Consumption

Procedure

1. Engine not running too cool?

Yes: Go to next step.

No: Check thermostat. (See "Test Thermostat Opening" on page 55.) Replace if faulty. Adjust fan belt tension. (See "Adjust Fan and Alternator Drive Belt" on page 56.)

2. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

3. Correct pattern from fuel injectors?

Yes: Go to next step.

No: Clean or replace fuel injection nozzles. (See "Test Fuel Injection Nozzles" on page 54.)

4. Intake or exhaust valves not leaking compression?

No: Grind valves and seats. (See "Grind Valve Seats" on page 78. See "Inspect Cylinder Head and Valves" on page 74.)

Symptom: Excessive Oil Consumption

Procedure

1. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of proper viscosity and type. Replace oil filter.

2. No external or internal oil leak?

Yes: Go to next step.

No: Repair as needed.

3. Intake or exhaust valve stems not worn?

Yes: Go to next step.

No: Replace valve guides and valves. (See "Remove and Install Cylinder Head and Valves" on page 73.)

4. Piston rings installed correctly and properly staggered?

Yes: Go to next step.

No: Install piston rings correctly. (See "Disassemble and Assemble Piston and Connecting Rod" on page 81.)

5. Pistons, rings, or cylinders not worn?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See "Remove and Install Piston and Connecting Rod" on page 79. See "Inspect Cylinder Bore" on page 85.)

6. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See “Inspect Piston and Connecting Rod” on page 82. See “Inspect Cylinder Bore” on page 85.)

7. No foreign matter in combustion chamber?

No: Clean head and top of piston. Check for damage.

Symptom: Fuel Oil in Crankcase

Procedure

1. Correct volume of fuel being injected?

Yes: Go to next step.

No: Replace faulty fuel injection pump or fuel injectors.

2. Intake or exhaust valve not seized or broken?

Yes: Go to next step.

No: Replace valve and check valve guide. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

3. Piston rings not broken or seized?

Yes: Go to next step.

No: Replace rings. Check piston and cylinder. (See “Inspect Piston and Connecting Rod” on page 82. See “Inspect Cylinder Bore” on page 85.)

4. Piston rings, pistons, or cylinders not worn?

No: Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

Symptom: Coolant in Crankcase

Procedure

1. Cylinder head gasket not leaking?

Yes: Go to next step.

No: Replace head gasket. Resurface head and block if necessary. (See “Remove and Install Cylinder Head and Valves” on page 73. See “Inspect Cylinder Head and Valves” on page 74.)

2. Cylinder block not cracked?

Yes: Go to next step.

No: Replace cylinder block.

Symptom: Low Oil Pressure

Procedure

1. Oil at correct level?

Yes: Go to next step.

No: Add oil.

2. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of proper viscosity and type. Replace oil filter.

3. No external or internal oil leak?

Yes: Go to next step.

No: Repair as needed.

4. Oil pressure relief valve not worn or damaged?

Yes: Go to next step.

No: Clean or replace relief valve. (See “Disassemble and Assemble Oil Pump” on page 99.)

5. Crankshaft pin or bearing not worn?

Yes: Go to next step.

No: Regrind crankshaft and replace bearings. (See “Inspect Crankshaft and Main Bearings” on page 89.)

6. Connecting rod bolts tightened properly?

Yes: Go to next step.

No: Replace damaged components. Tighten to correct specification.

7. Engine not worn excessively?

No: Replace oil pump. (See “Remove and Install Oil Pump” on page 99.)

Symptom: Engine Is Overheating

Procedure

1. Is engine NOT being run under high altitude or high temperature conditions?

Yes: Go to next step.

No: Reduce load on engine.

2. Cooling system filled to correct level?

Yes: Go to next step.

No: Check for leaks and fill system to correct level.

3. Radiator clear of debris?

Yes: Go to next step.

No: Clean radiator fins.

4. Radiator core free from blockage?

Yes: Go to next step.

No: Clean or replace radiator.

5. Thermostat operating correctly?

Yes: Go to next step.

No: Check thermostat. (See “Test Thermostat Opening” on page 55.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

6. Cylinder head gasket not leaking?

Yes: Go to next step.

No: Replace head gasket. Resurface head and block if necessary. (See “Remove and Install Cylinder Head and Valves” on page 73. See “Inspect Cylinder Head and Valves” on page 74.)

7. Cylinder block not cracked?

No: Replace cylinder block.

Symptom: Low Engine Coolant Temperature

Procedure

1. Thermostat operating correctly?

No: Check thermostat. (See “Test Thermostat Opening” on page 55.) Replace if faulty. Adjust fan belt tension. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

Symptom: Low Compression

Procedure

1. Engine oil of correct viscosity and type?

Yes: Go to next step.

No: Replace engine oil with oil of correct viscosity and type. Replace oil filter.

2. Intake or exhaust valves not leaking compression?

Yes: Go to next step.

No: Grind valves and seats. (See “Grind Valve Seats” on page 78. See “Inspect Cylinder Head and Valves” on page 74.)

3. Intake or exhaust valve stems not worn?

Yes: Go to next step.

No: Replace valve guides and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

4. Intake or exhaust valve not seized?

Yes: Go to next step.

No: Replace valve guides and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

5. Pistons, rings or cylinders not worn or seized?

Yes: Go to next step.

No: Replace pistons and rings; bore or hone cylinders. (See “Remove and Install Piston and Connecting Rod” on page 79. See “Inspect Cylinder Bore” on page 85.)

6. Piston rings installed correctly and properly staggered?

No: Install piston rings correctly. (See “Disassemble and Assemble Piston and Connecting Rod” on page 81.)

Tests and Adjustments

Test Cylinder Compression

Reason

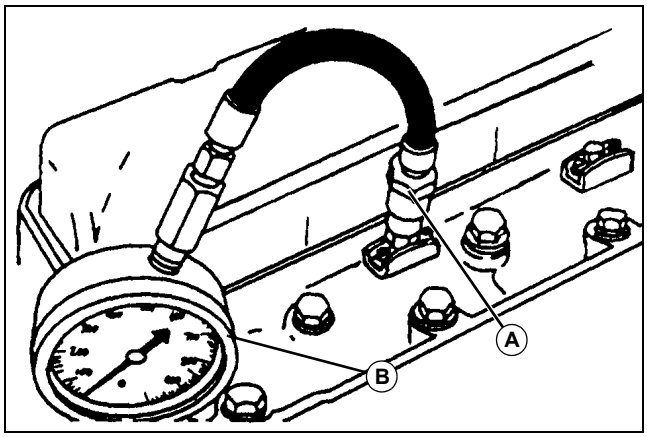
To determine the condition of the pistons, rings, cylinder walls, and valves.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Compression Gauge Assembly	JT01682	Used to measure cylinder compression.
Adapter	JDG560	Used to measure cylinder compression.

Procedure

1. Remove injection nozzles.



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2. Install heat protector on end of injector and install on JDG560 Adapter (A).

3. Install JT01682 Compression Gauge Assembly (B) and adapter.

4. Disconnect fuel control solenoid connector.

Important: Avoid Damage! DO NOT overheat starting motor during test.

5. Crank the engine for 5 seconds with the starting motor. Minimum cranking speed is 250 rpm.

6. Record the pressure reading for each cylinder.

Results

- If pressure reading is below specification, squirt clean engine oil into cylinders through injector ports and repeat test.
- If pressure increases significantly, check piston, rings, and cylinder walls for wear or damage.
- If pressure does not increase significantly after retest, check for leaking valves, valve seats or cylinder head gasket.

Specifications

Cylinder Compression Pressure @ 250 RPM . . . . . 2833-3040 kPa (411-441 psi)
Cylinder Compression Pressure @ 250 RPM (Minimum) . . . . . 2344-2551 kPa (340-370 psi)
Difference Between Cylinders @ 250 RPM (Maximum) . . . . . 200-296 kPa (29-43 psi)

Adjust Slow Idle

Reason

To achieve proper slow idle rpm setting. Provides adequate rpm to keep the engine running smoothly without stalling.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Inductive Electronic Tachometer	JT05801	Used to check engine rpm when setting slow idle speed.

Procedure

Note: Make sure the air cleaner is clean and not restricted. Replace the air cleaner element as necessary.

1. Place a small piece of reflective tape on the crankshaft pulley.

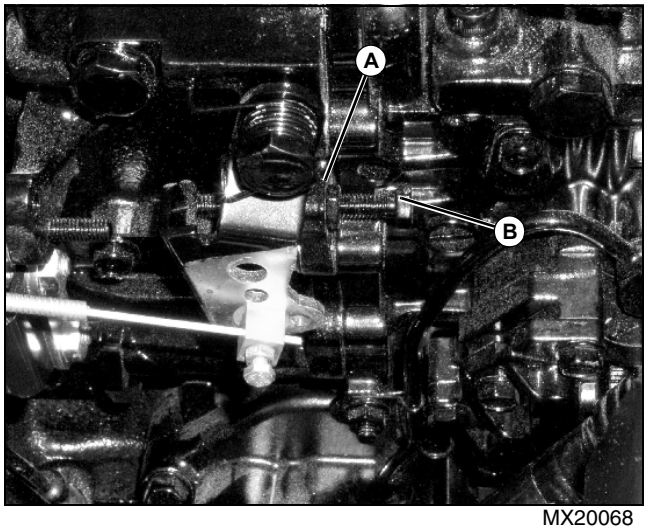
2. Start the engine and run for 5 minutes to attain operating temperature.

3. Move the throttle lever to slow idle position.

4. Use JT05801 Inductive Electronic Tachometer to check engine speed at the crankshaft pulley.

5. Visually check that the injection pump throttle lever is against slow idle stop screw.

Results



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• If the slow idle rpm is not according to specifications, loosen the nut (A) and turn the slow idle stop screw (B) clockwise to increase the engine speed, or counterclockwise to decrease the engine speed, until the slow idle speed is correct. After adjustment, tighten the nut.

Specifications

Slow Idle Speed . . . . . .1400 ± 50 rpm

Adjust Torque Capsule

Important: Avoid Damage! The slow idle adjustment is the only adjustment that can be made on this engine.

The fast idle and torque capsule adjustments are preset by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable ONLY by authorized diesel service facilities.

Because the FAST idle speed and torque capsule are NOT adjustable, the throttle cable adjustment becomes very critical to proper engine operation. Therefore, first MAKE SURE that the throttle cable obtains its full range of motion, stop-to-stop, before performing any diagnostic procedures.

Injection Pump Static Timing

Check Injection Pump Timing

Note: Locate and record the fuel injection pump timing index number stamped into the boss on the engine side of the fuel injection pump housing. Treat this number as though there is a decimal point between the two digits, that is, 68 = 6.8.

Using the chart below, find the correct Fuel Injection Reference (FIR) for the model that you are working on.

John Deere Model & Tractor Serial Number	Yanmar Engine Model	FIR (Fuel Injection Reference Number)
7000	3TNV84T-KJFM	5
8000	3TNV84HT-BJFM	5

Insert the numbers you have recorded into the following equation:

(Fuel Injection Pump Timing Index Number x 2) + FIR Number = FIT° (Fuel Injection Timing in Degrees).

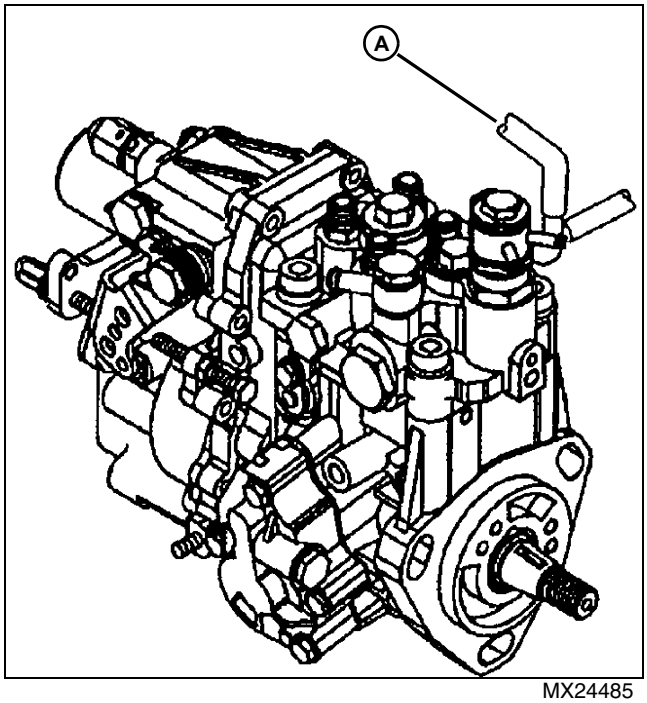
Record the calculated fuel injection timing in degrees.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Yanmar TNV Diesel Engine Timing Tool Kit	JDG10436	Adjust Fuel Injection Timing.

Note: Some fuel may drain from the fuel injection pump during the process. Make provisions to contain any such spillage.

1. Turn off the fuel valve in the fuel supply hose and the fuel return hose.



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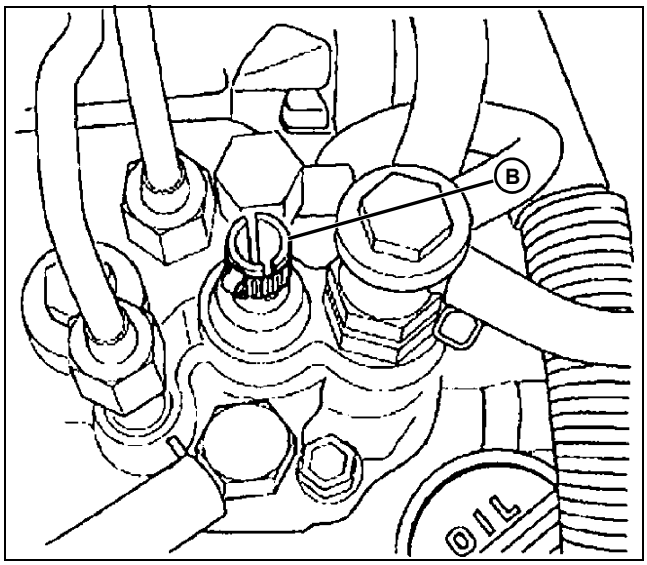
2. Clamp shut the fuel injection pump return hose (A) leading to the fuel filter.

3. Remove the forward fuel injection pump plunger plug on top of the fuel injection pump.



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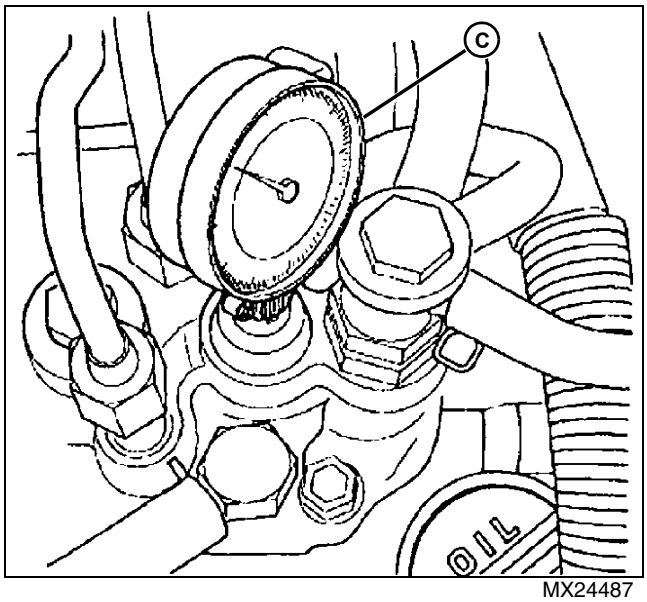
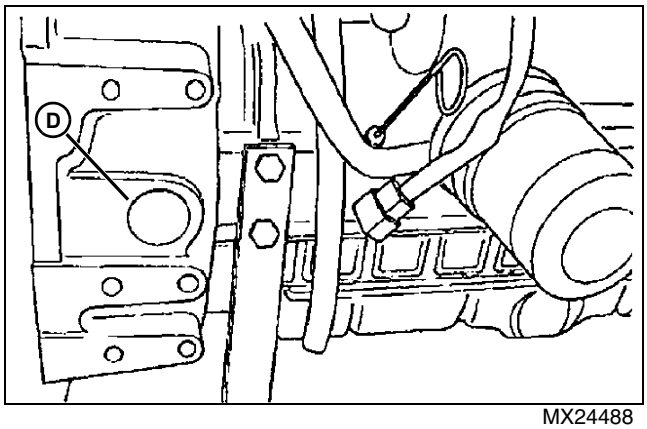
4. Install a dial adapter and clamp (B) from the Yanmar TNV Diesel Engine Timing Tool Kit (JDG10436) into the pump plunger opening.



MX24487

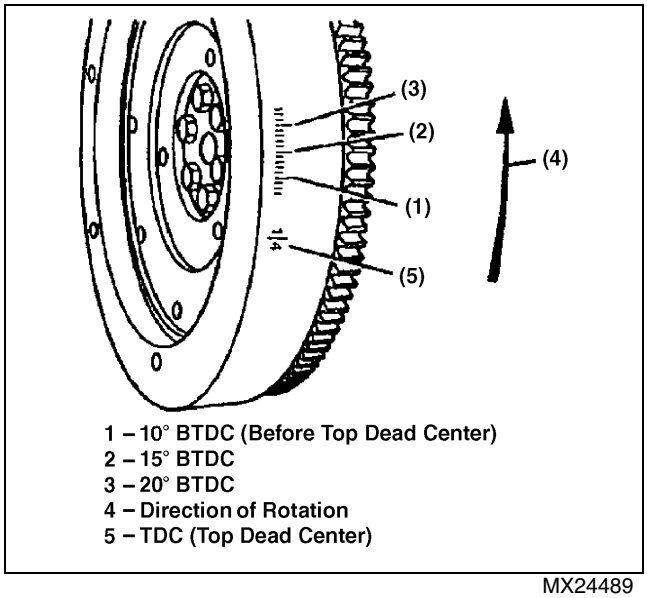
5. Install the dial indicator (C) with extension from the Yanmar TNV Diesel Engine Timing Tool Kit into the adapter. Secure the adapter clamp at approximately the midpoint of its travel.

Note: The following references to the direction of rotation are facing the coolant pump end of the engine and are adjusted by turning the crankshaft pulley.



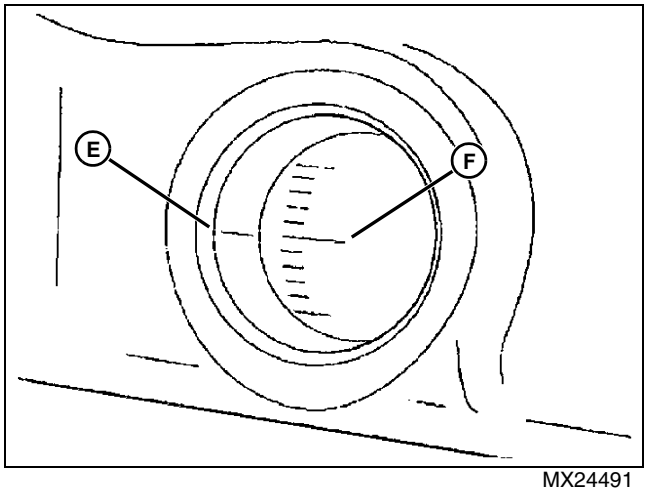
MX24488

6. Using a wrench on the crankshaft pulley bolt, rotate the crankshaft in a clockwise direction while looking through the flywheel inspection port (D). Rotate the crankshaft until the injection timing marks on the flywheel are visible.



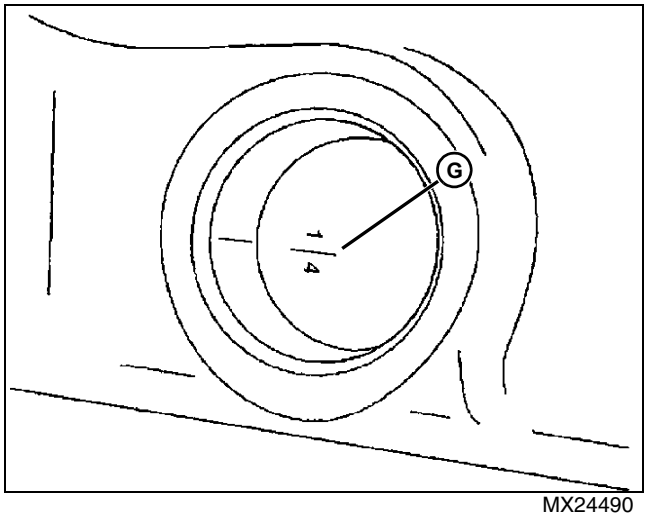
MX24489

Picture Note: A typical flywheel will have multiple timing grids, depending on the number of cylinders. Any grid can be used to check the fuel injection timing.



MX24491

7. Highlight the timing reference mark (E) on the flywheel housing or engine backplate. Highlight the TDC mark (F) on the flywheel.

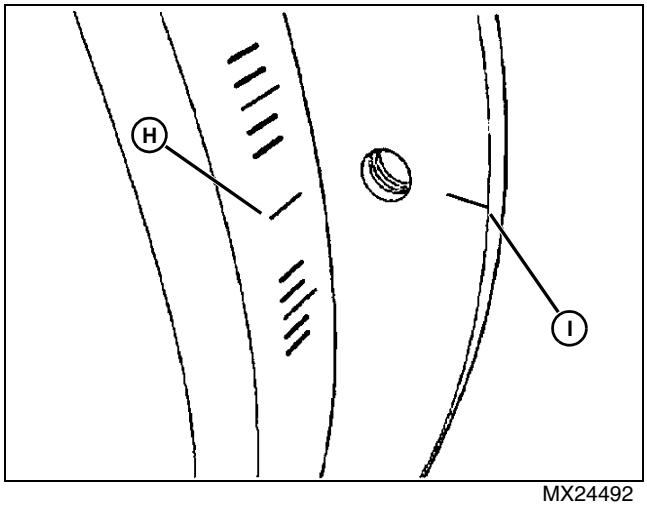


MX24490

8. Highlight the target timing mark (G) on the flywheel as calculated earlier.

9. Rotate the crankshaft counterclockwise until the dial indicator shows that the injection pump plunger is at the bottom of its stroke. Rock the crankshaft back and forth slightly to confirm a point where the dial indicator shows no movement. Zero the dial indicator.

10. Slowly rotate the crankshaft clockwise until the dial indicator shows a pump plunger lift of 2.5 mm (0.100 in.).



MX24492

11. Check the position of the flywheel target timing mark (H) in relation to the timing reference mark on the flywheel housing or engine backplate (I). If the two marks are aligned, the fuel injection timing is correct. If the marks do not align, the fuel injection timing must be adjusted.

12. If the injection timing is correct, remove the indicator and adapter. Replace the pump plunger plug and its copper gasket and tighten to specifications. Replace the flywheel inspection port cover. Open the fuel supply valve and remove the clamp from the fuel supply hose and the fuel return hose.

13. Prime the fuel system. Operate the engine and check for leaks.

Specifications

Pump Plunger Torque . . . . . 34 N•m (25 lb-ft)

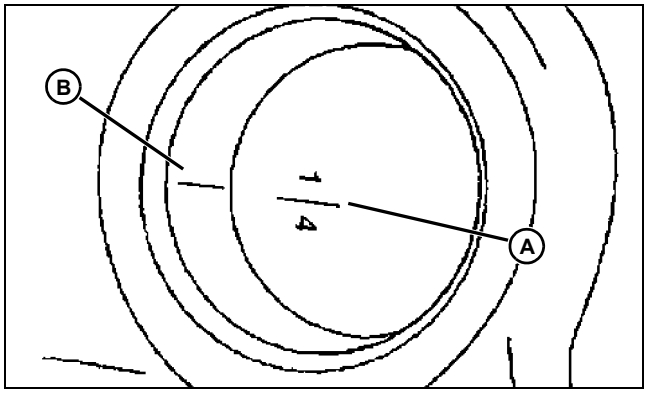
Adjust Fuel Injection Timing

Note: If the timing marks did not align above, the following steps need to be performed to properly time the injection pump to the engine.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Yanmar TNV Diesel Engine Timing Tool Kit	JDG10436	Adjust Fuel Injection Timing

1. Leave the dial indicator installed in the fuel injection pump. Do not disturb the reading on the dial indicator.



2. Rotate the flywheel until the target timing mark (A) and the timing reference mark on the flywheel housing or backplate (B) are aligned.

3. Note the reading on the dial indicator. If the reading is less than 2.5 mm the fuel injection timing is “retarded.” If the dial indicator reading is greater than 2.5 mm (0.100 in.) the fuel injection timing is “advanced.”

4. Loosen the nuts fastening the fuel injection pump to the gearcase or front plate. Loosen the rear bracket(s) on the fuel injection pump.

Note: Some engine models may require the intake manifold and fuel injection pump insulator be removed to access the inner fuel injection pump retaining nuts.

Loosening the high pressure injection line nuts on the fuel injection pump may make rotating the pump easier.

5. Rotate the fuel injection pump until the dial indicator reads 2.5 mm (0.100 in.). To “advance” the injection timing, rotate the top of the fuel injection pump away from the engine. To “retard” the injection timing, rotate the top of the fuel injection pump toward the engine.

6. When the dial indicator reads 2.5 mm (0.100 in.) of pump plunger lift, and the target timing mark on the flywheel aligns with the reference mark on the flywheel housing or engine back plate, the injection timing is correct.

7. Tighten the fuel injection pump mounting nuts and rear bracket(s).

8. Remove the dial indicator and adapter. Replace the plug in the pump plunger opening and tighten it to specification. If removed, install the intake manifold and pump insulator. Tighten the high-pressure injection line nuts to specification. Open the fuel return line and prime the fuel system. Operate the engine and check it for leaks.

Specifications

Pump Plunger Torque . . . . . 34 N•m (25 lb-ft)
High-Pressure Injection Line Nut . . . . 32 N•m (24 lb-ft)

Adjust Valve Clearance

Reason

To set valve clearance for proper engine operation.

Procedure

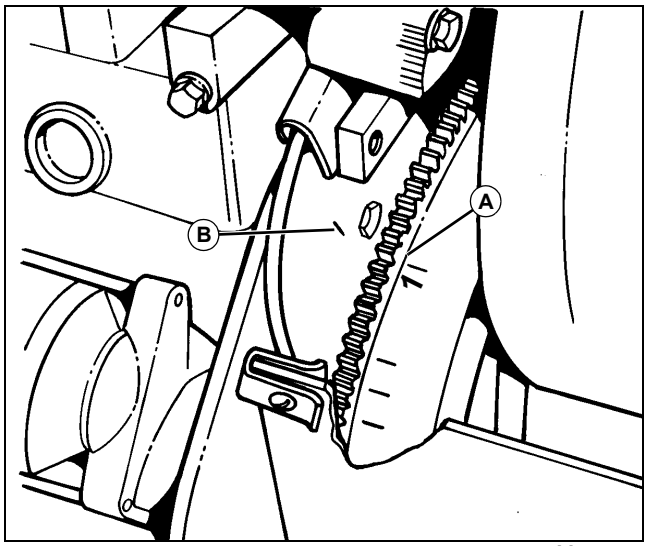
Caution: Avoid Injury! Be sure ignition key is OFF before attempting to turn engine by hand.

Note: The engine must be cool (room temperature) before the valve clearance is checked.

1. Remove battery.

2. Remove rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 70.)

3. Remove flywheel cover from starter side of engine.

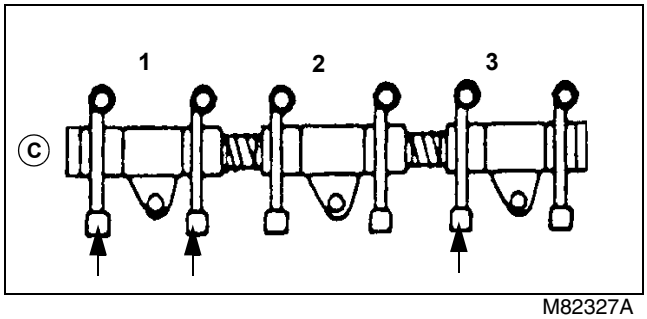


M76565

4. Turn crankshaft pulley clockwise, as viewed from flywheel end, until No. 1 cylinder top dead center (TDC) mark (A) on flywheel aligns with index mark (B) on flywheel plate.

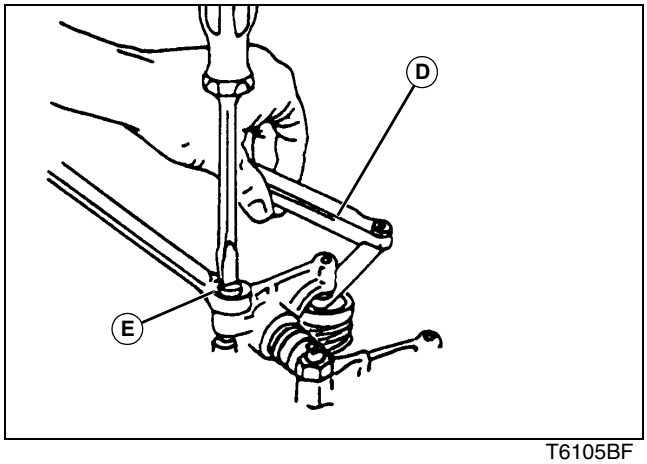
5. Try to move rocker arms and/or push rods for No. 1 cylinder:

- If the rocker arms and push rods are loose, the piston is at TDC on the compression stroke. Go to step 8.
- If the rocker arms and/or push rods are not loose, rotate the flywheel one revolution (360°), and recheck the rocker arms and push rods.



M82327A

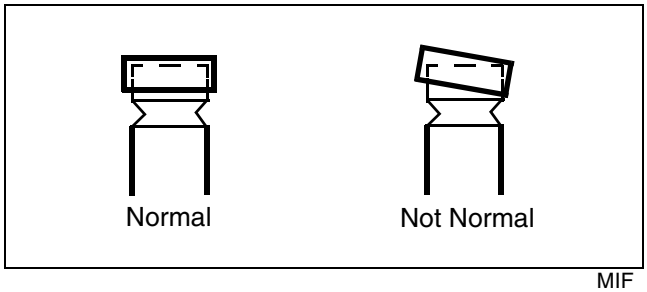
6. Measure and adjust valve clearance (if necessary) on the valves (arrows) with No. 1 piston at TDC. No. 1 piston is at the flywheel end (C). Valve clearance should be at specifications.



T6105BF

7. If valve clearance is not at specifications, loosen the locknut and turn the adjusting screw (E) until the blade of the feeler gauge (D) can be inserted between the rocker arm and valve cap. Hold the adjusting screw while tightening the locknut.

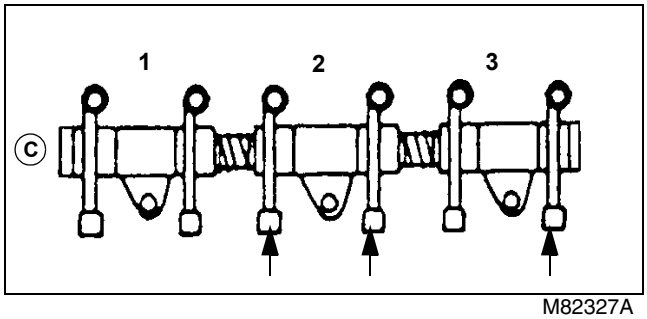
8. Recheck the valve clearance after tightening the locknut.



MIF

9. Check that the valve cap on the valve stem remained seated on the valve and inside the valve spring retainer.

10.Turn crankshaft pulley one revolution (360°). This puts the piston in No. 2 cylinder at TDC compression stroke.



M82327A

11.Measure and adjust valve clearance (if necessary) on the valves (arrows) with No. 2 piston at TDC.

12.Install flywheel cover.

13.Install rocker arm cover. Tighten rocker arm cover nuts to specifications.

Results

If valve clearance cannot be adjusted to specification, check rocker arm assembly for wear or damage.

Specifications

Valve Clearance . . . . . 0.15-0.25 mm (0.006-0.010 in.)
Rocker Arm Cover Nut Torque . . . . . 18 N•m (160 lb-in.)

Check Valve Lift

Reason

Check wear on cam lobes, followers, and/or push rods.

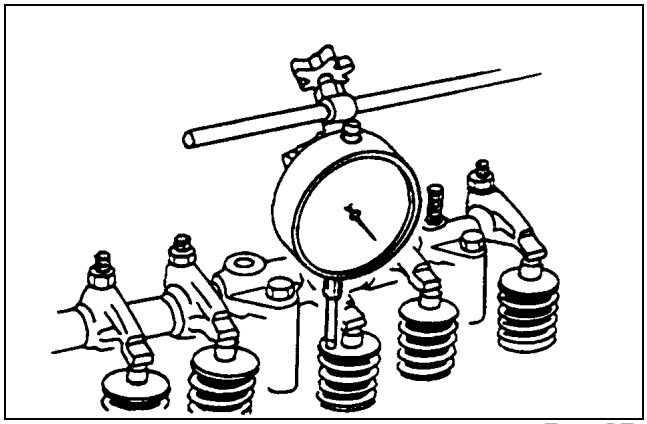
Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	N/A	Used to measure valve lift.

Procedure

1. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 70.)

2. Adjust the valve clearance. (See “Adjust Valve Clearance” on page 48.)



T6333DT

3. Fasten the dial indicator to the engine and position the indicator tip on the valve retainer. The valve must be fully closed and the rocker arm must move freely.

4. Zero the dial indicator.

5. Manually turn the crankshaft pulley clockwise (viewed from flywheel end).

6. Observe the dial indicator as the valve is moved to the full open position and compare with specification. Repeat for each valve.

Results

- The valve lift should be the same for all valves. If one or more valves have less travel than the others, remove and inspect the camshaft, followers, and push rods. (See "Remove and Install Camshaft" on page 91.) If the camshaft, followers, and push rods are within specification, remove and inspect the cylinder head. (See "Remove and Install Cylinder Head and Valves" on page 73.)

Specifications

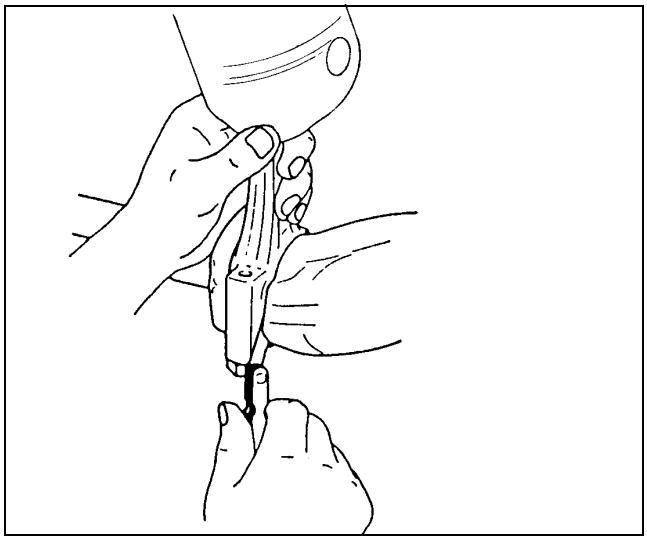
Valve Lift . . . . . 8.8 mm (0.350 in.)

Check Connecting Rod Side Play

Reason

To determine proper side clearance between the crankshaft and the connecting rod.

Procedure



M82116A

1. Insert a feeler gauge, according to specifications, between the connecting rod cap and the crankshaft.

Results

- If the side play exceeds specification, replace the bearing inserts or the connecting rod.

Specifications

Connecting Rod
Side Play . . . . . 0.2-0.4 mm (0.008-0.016 in.)

Check Connecting Rod Bearing Clearance

Reason

To measure oil clearance between connecting rod bearing and crankshaft journal.

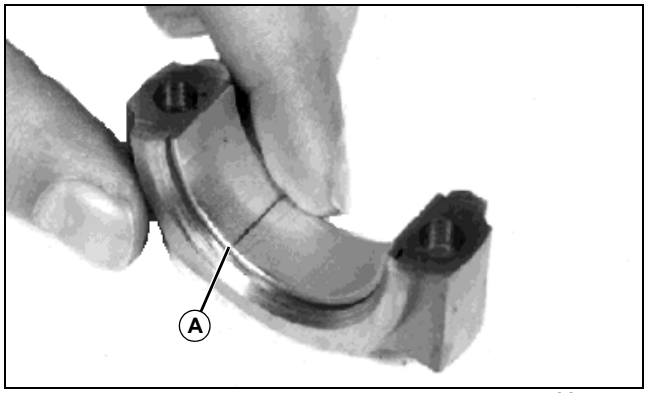
Special or Required Tools

Tool Name	Tool No.	Tool Use
PLASTIGAGE™	N/A	Used to measure oil clearance between connecting rod and crankshaft journal.

Procedure

Important: Avoid Damage! The connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

1. Remove the connecting rod cap.
2. Wipe oil from the bearing insert and the crankshaft journal.

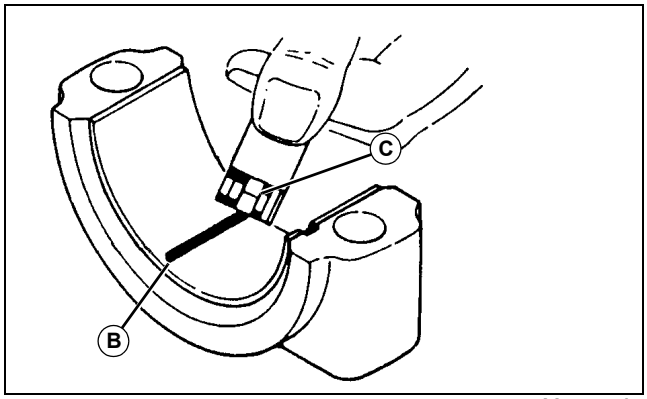


M35351

3. Put a piece of PLASTIGAGE (A), or an equivalent, along the width of the bearing insert approximately 6 mm (0.25 in.) off center.
4. Turn the crankshaft approximately 30° from bottom dead center.
5. Install the connecting rod end cap and original rod end cap screws. Tighten the rod end cap screws to specification.

Note: The flattened PLASTIGAGE will be found on either the bearing insert or crankshaft journal.

6. Remove the rod end cap screws and the connecting rod cap.



M82117A

7. Use the graduation marks on the envelope (C) to compare the width of the flattened PLASTIGAGE (B) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.
8. Measure the connecting rod bearing oil clearance.
9. Remove the PLASTIGAGE.

Results

- If the clearance exceeds the wear limit specification, replace the bearing inserts.

Specifications

Connecting Rod-to-Crankshaft Journal Clearance . . . . . 0.038-0.074 mm (0.001-0.003 in.)
Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)

Check Crankshaft End Play

Reason

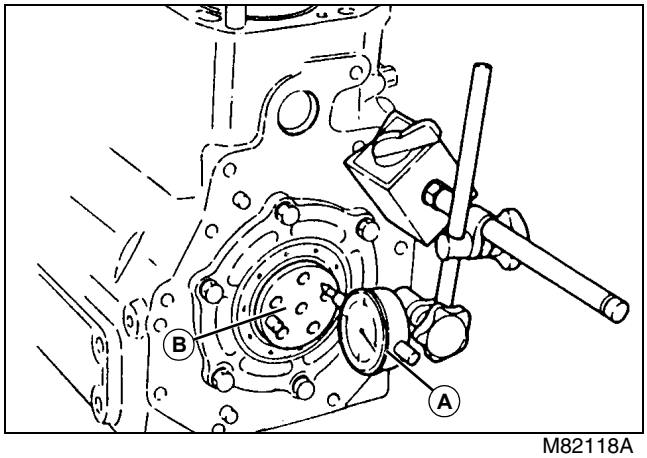
To determine proper side clearance between the crankshaft and the engine block.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	N/A	Used to check crankshaft-to-engine block side clearance.

Procedure

Note: Crankshaft end play can be measured at front end or rear end of crankshaft. Procedure is performed from the rear end. The flywheel is removed to show detail.



M82118A

1. Fasten the dial indicator (A) to engine and position indicator tip on end of crankshaft (B).

Important: Avoid Damage! Do not use excessive force when moving crankshaft to avoid damaging bearings.

2. Push the crankshaft toward rear as far as possible.

3. Zero the dial indicator.

4. Using a bar, gently pry the crankshaft as far forward as possible.

Results

- If the end play exceeds specifications, replace the thrust bearings.

Specifications

Crankshaft End Play. . . . 0.13-0.23 mm (0.005-0.009 in.)
Wear Limit . . . . . 0.28 mm (0.011 in.)

Check Crankshaft Main Bearing Clearance

Reason

To measure oil clearance between main bearing and crankshaft journal.

Special or Required Tools

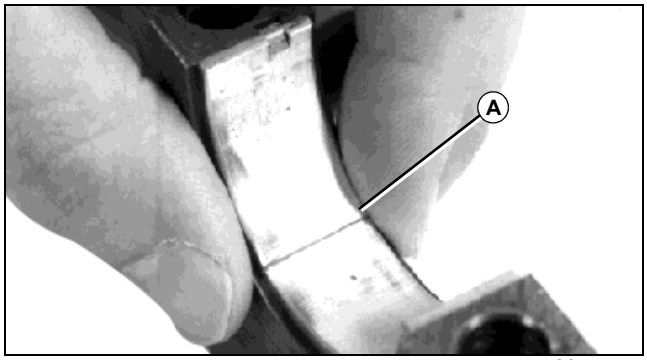
Tool Name	Tool No.	Tool Use
PLASTIGAGE™	N/A	Used to check main bearing-to-crankshaft journal clearance.

Procedure

Important: Avoid Damage! Main bearing caps must be installed on the same main bearing and in the same direction to prevent crankshaft and main bearing damage.

1. Remove the main bearing cap.

2. Wipe oil from the bearing insert and the crankshaft journal.



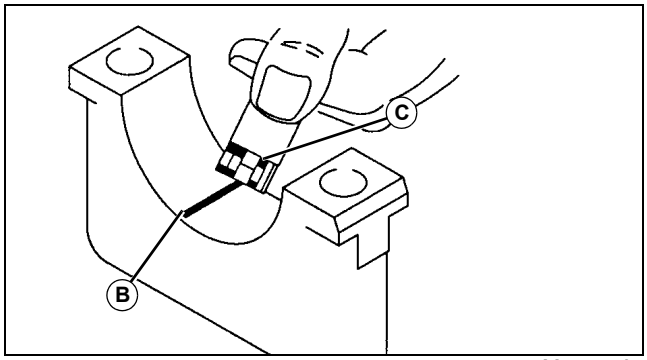
M35382

3. Put a piece of PLASTIGAGE (A), or an equivalent, along the width of the bearing insert approximately 6 mm (0.25 in.) off center.

4. Install the main bearing cap and cap screws. Tighten the cap screws to specification.

Note: The flattened PLASTIGAGE will be found on either the bearing insert or crankshaft journal.

5. Remove the cap screws and main bearing caps.



M82119A

6. Use the graduation marks (C) on the envelope to compare the width of the flattened PLASTIGAGE (B) at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters, depending on which side of the envelope is used.

7. Remove PLASTIGAGE.

Results

- If the clearance exceeds the wear limit specification, replace the bearing inserts.

Specifications

Main Bearing-to-Crankshaft Journal
Oil Clearance . . . . . 0.038-0.068 mm (0.001-0.003 in.)
Wear Limit. . . . . 0.150 mm (0.006 in.)
Main Bearing Cap Screw Torque . . . . . 98 N•m (72 lb-ft)

Check Camshaft End Play

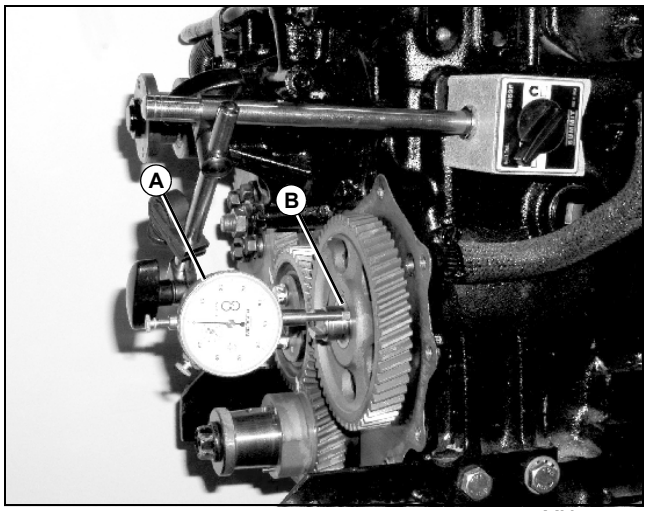
Reason

To determine proper side clearance between camshaft gear end journal and thrust plate.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	N/A	Used to check camshaft gear end journal-to-thrust plate side clearance.

Procedure



MX20063

1. Remove the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 96.)
2. Fasten the dial indicator (A) to the engine and position indicator tip on end of camshaft (B).
3. Push the camshaft toward the rear as far as possible.
4. Zero the dial indicator.
5. Pull the camshaft forward as far as possible.

Results

- If the end play exceeds specifications, remove the camshaft and replace the thrust plate. (See “Remove and Install Camshaft” on page 91.)

Specifications

Camshaft End Play . . . . . 0.05-0.20 mm (0.002-0.010 in.)
Wear Limit . . . . . 0.30 mm (0.012 in.)

Check Timing Gear Backlash

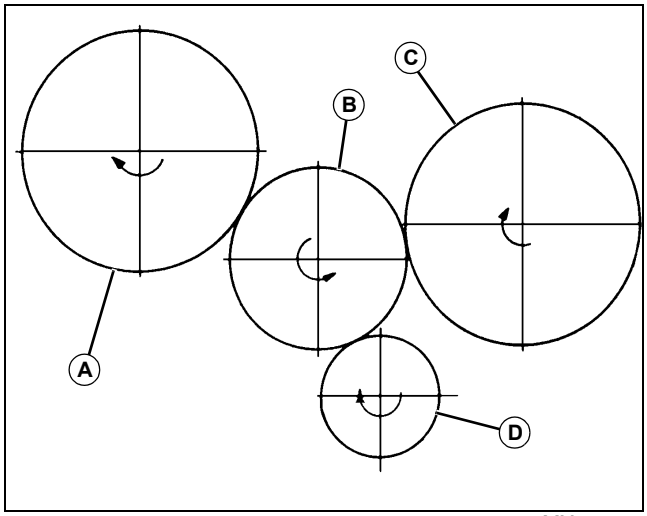
Reason

To check for wear between meshing gears, resulting in excessive noise and poor engine performance.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Dial Indicator	N/A	Used to check wear between meshing gears.

Procedure



MX20048

1. Measure the backlash between meshing gears.

Results

If the backlash exceeds specifications, replace meshing gears as a set:

- Fuel Injection Pump Gear (A)
- Idler Gear (B)
- Camshaft Gear (C)
- Crankshaft Gear (D)

Specifications

Gear Backlash . . . . . 0.07-0.15 mm (0.0028-0.0059 in.)

Test Fuel Injection Nozzles

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.

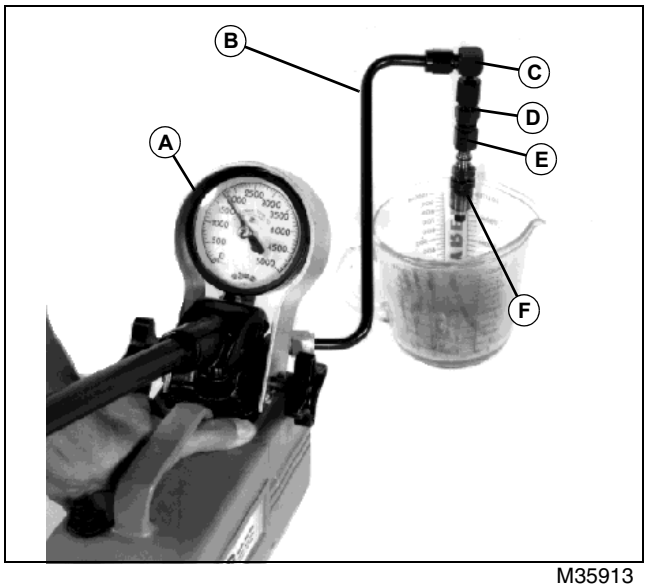
Reason

To determine opening pressure, leakage, chatter, and spray pattern of the fuel injection nozzle.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter Set	D01110AA	Used to test fuel injection nozzles.
Diesel Fuel Injection Nozzle Tester	D01109AA	Used to test fuel injection nozzles.
Straight Adapter	23622	Used to test fuel injection nozzles.

Connections



M35913

1. Connect the fuel injection nozzle (F) to D01109AA Diesel Fuel Injection Nozzle Tester (A) using parts 36352 (B), 23617 (C), and 23621 (D) from D01110AA Adapter Set, and 23622 Straight Adapter (E).

Important: Avoid Damage! Use clean filtered diesel fuel when testing injection nozzles to get best test results.

Procedure 1

Test the fuel injection nozzle opening pressure following the nozzle tester manufacturer's instructions. The opening pressure should be at specifications.

Results

- If the pressure reading does not meet specifications, disassemble the injection nozzle and inspect for contamination or a stuck valve. If necessary, add or remove shims to change opening pressure.

Procedure 2

Test fuel injection nozzle leakage following the nozzle tester manufacturer's instructions.

1. Dry the nozzle completely using a lint-free cloth.
2. Pressurize injection nozzle to 19 400 kPa (2814 psi).
3. Watch for leakage from nozzle spray orifice for a minimum of 5 seconds.

Results

- Fuel should not leak from the nozzle when the nozzle is pressurized.

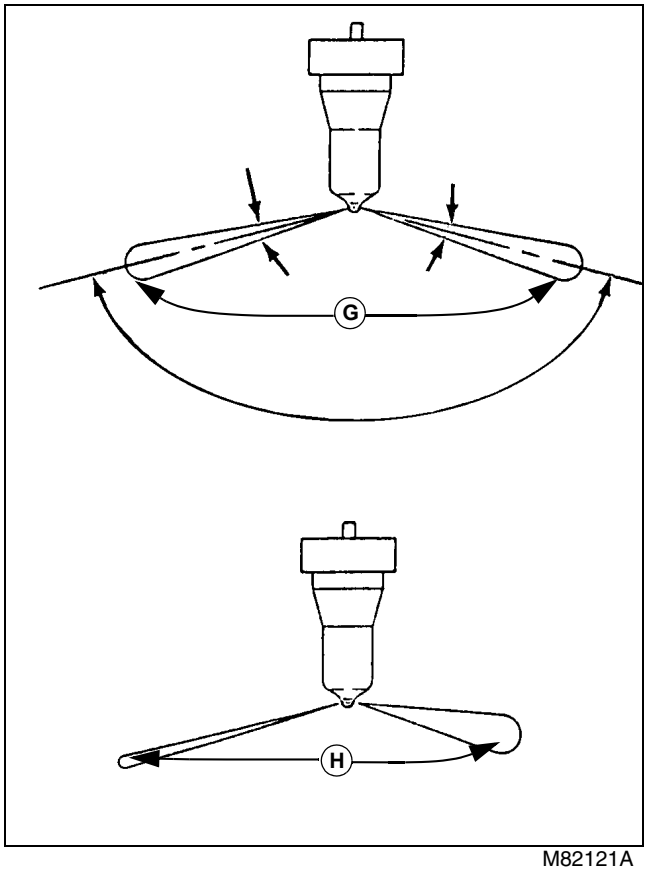
• If the injection nozzle leaks fuel, disassemble and inspect the nozzle assembly for contamination. Inspect the valve seating surface. Replace the nozzle assembly if necessary.

Procedure 3

Test the fuel injection nozzle chatter and spray pattern following the nozzle tester manufacturer's instructions.

1. Pressurize injection nozzle to 21 600-22 600 kPa (3133-3278 psi).

2. Listen for chatter sound and watch spray pattern.



M82121A

3. With slow hand lever movement there should be a “chatter” sound and a fine stream spray pattern.

4. With fast hand lever movement, the nozzle should exhibit an even, fine atomized spray pattern (G), unlike spray pattern (H).

5. Place a sheet of white paper 30 cm (12 in.) below the nozzle. The injection spray should form a perfect circle on the paper.

Results

• If nozzle chatter or the spray pattern does not meet specifications, disassemble the injection nozzle and inspect the nozzle assembly for contamination. Inspect the valve seating surface. Replace the nozzle assembly if necessary.

• If there is excessive difference in the spray angle or injection angle, incomplete atomizing or sluggish starting/stopping of injection (H), disassemble the injection nozzle and inspect the nozzle assembly for contamination. Replace the nozzle assembly if necessary.

Specifications

Fuel Injection Nozzle Opening Pressure . . . . . 21600-22600 kPa (3133-3278 psi)

Test Thermostat Opening

Reason

To determine opening temperature of thermostat.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	N/A	Used to check thermostat opening temperature.

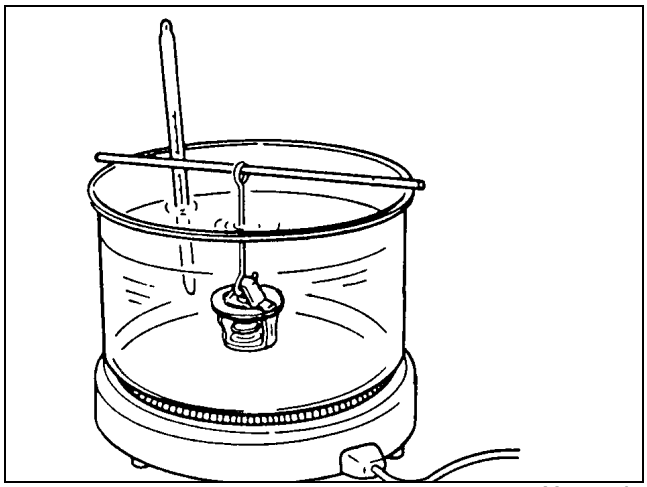
Procedure

Caution: Avoid Injury! DO NOT allow thermostat or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.

1. Suspend the thermostat and a thermometer in a container of water.

2. Heat and stir the water. Observe the opening action of the thermostat as the water heats up.

3. Remove the thermostat and observe the closing action as it cools.



M82122A

Results

Thermostat opening temperature, fully open temperature, and lift height should meet specifications.

Specifications

Thermostat Begins to Open . . . . . 70°C (158°F)
Thermostat Fully Open . . . . . 85°C (184°F)
Thermostat Lift Height . . . . . 8 mm (0.310 in.)

Adjust Fan and Alternator Drive Belt

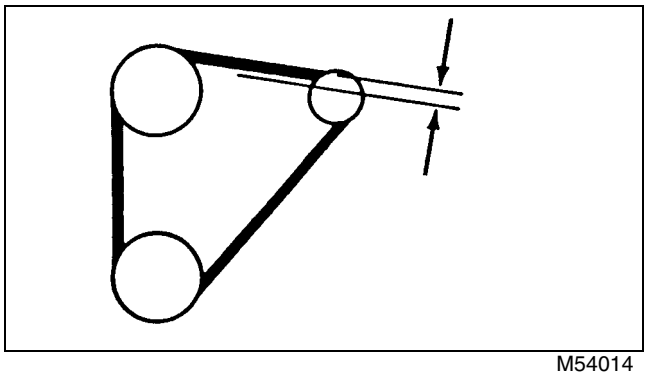
Reason

To keep proper tension on the belt to drive the coolant pump and the alternator. To prevent shortened belt and bearing life.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Belt Tension Gauge	JDG529 or JDST28	Used to adjust belt tension.
Straightedge	N/A	Used to adjust belt tension.

Procedure (Check Belt Tension)



M54014

1. Check belt tension between coolant pump and alternator using a belt tension gauge and a straightedge. Belt deflection should be at specification. If not, adjust belt.

2. Check belt tension between fan and crankshaft pulley using belt tension gauge and a straightedge. Belt deflection should be at specifications. If not, adjust fan belt.

Procedure (Adjust Alternator Belt)

1. Loosen both alternator mounting cap screws/nuts.

2. Apply force to FRONT alternator housing only (near the belt) until tension is to specifications.

3. Tighten cap screws and nuts.

Procedure (Adjust Fan Belt)

1. Loosen idler pulley mounting cap screws/nuts.

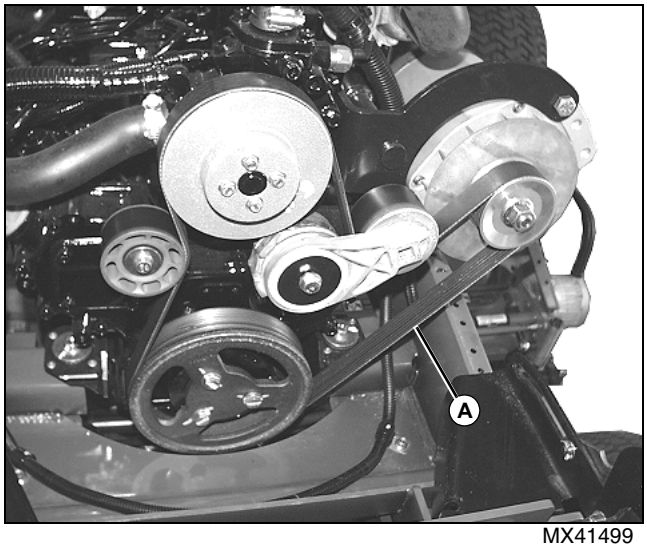
2. Apply force to pulley (near belt) until tension is correct.

3. Tighten cap screws and nuts.

Specifications

Belt Deflection @ 98 N (22 lb-force)
. . . . . 8.0-13.0 mm (0.315-0.512 in.)

Test 48 Volt Generator Belt Tension



MX41499

1. Inspect belt, replace if cracked worn or frayed.

2. Check belt tension. Apply specified force to pulley (near point A) and check belt deflection.

3. If belt deflection is incorrect, inspect belt and tensioner. Adjust tensioner as needed.

Specifications

Belt Deflection @ 50 N (11 lb-force) . . . 30 mm (1.2 in.)

Test Cylinder Leakdown

Reason

To determine if compression pressure is leaking from cylinder.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Adapter	JDG560	Used to pressurize cylinder with compressed air for cylinder leakdown test.

Procedure

1. With the coolant at the proper level and the radiator cap tight, run the engine for 5 minutes to bring it to operating temperature.

2. Remove the recovery tank cap.

3. Check for bubbles coming from the overflow hose at the bottom of the tank.

4. If bubbles are present, isolate the source of the compression leak.

   a. Remove the injection nozzles.

   b. Install JDG560 Adapter in the injection port of the cylinder to be tested.

   c. Move the piston to the bottom of the stroke with intake and exhaust valves closed.

   d. Connect the hose from a compressed air source to the adapter.

   e. Apply shop air pressure into the cylinder.

   f. Check for bubbles in the recovery tank or air escaping from the muffler, air cleaner or oil fill opening.

   g. Repeat for each cylinder.

Results

- If bubbles are present in the recovery tank, check for cracks in the cylinder head and block. Check for a damaged head gasket.
- If air escapes from the muffler, check for a worn exhaust valve.
- If air escapes from the air cleaner, check for a worn intake valve.
- If air escapes from the engine oil fill, check for worn piston rings.

Test Cooling System Pressure

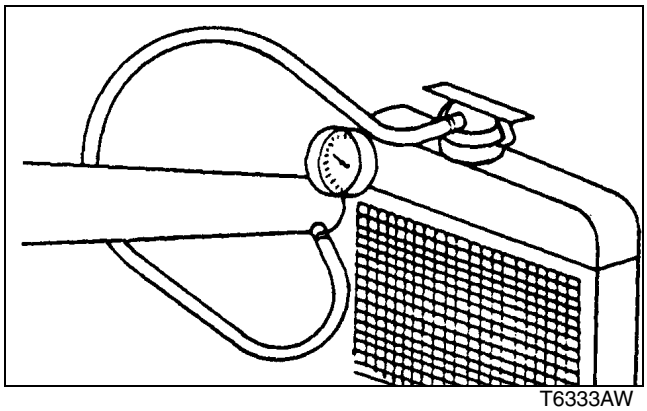
Reason

Inspect the cooling system for leaks.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to test cooling system pressure.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test cooling system pressure.

Procedure



T6333AW

1. Remove cap and attach pressure pump to radiator.

2. Apply pressure according to specifications. DO NOT exceed maximum pressure specification.

3. Check for leaks throughout the cooling system. The pressure should not go below the minimum pressure specification for at least 15 seconds.

Results

- If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If the pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause. (See “Test Cylinder Leakdown” on page 56.)

Specifications

Maximum Pressure . . . . . 97 kPa (14 psi)
Minimum Pressure
(After 15 Seconds) . . . . . 88 ± 15 kPa (12.8 ± 2.2 psi)

Test Radiator Pressure Cap

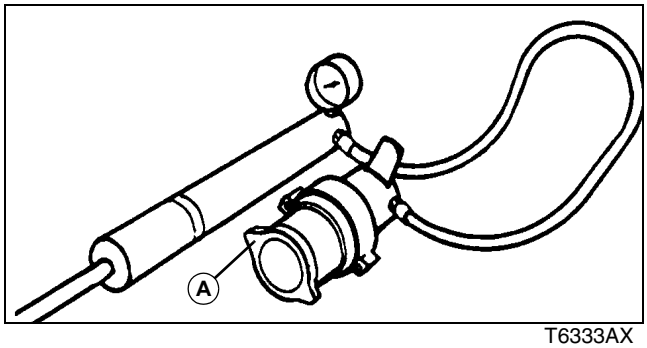
Reason

Test the radiator cap for operating in the correct pressure range.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Cooling System Pressure Pump	D05104ST	Used to test radiator cap pressure.
Radiator Pressure Test Kit (Adapters)	JDG692	Used to test radiator cap pressure.

Procedure



T6333AX

1. Install the radiator cap (A) on the pressure pump.
2. Apply pressure. Pressure valve in the cap should open at specification.

Results

- If the cap leaks, retighten and test again. Replace the cap if pressure is not within specification.

Specifications

Radiator Cap Pressure. . . . . 88 kPa (12.8 psi)

Test Engine Oil Pressure

Reason

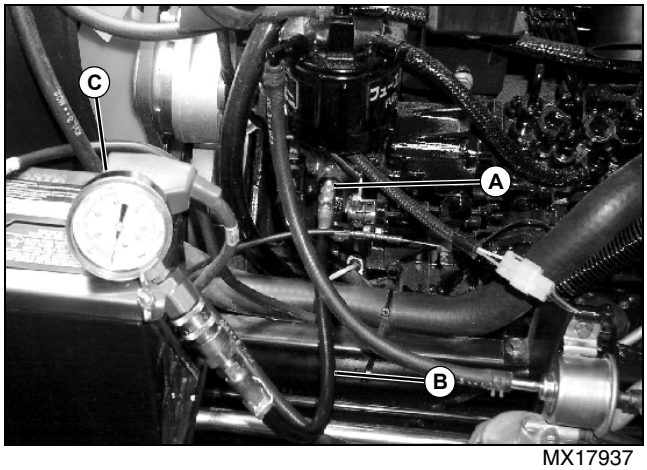
To determine if engine bearings or lubrication system components are worn.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Assembly	JT03017	Used to test engine oil pressure.
Pressure Gauge 689 kPa (100 psi)	JT07034	Used to test engine oil pressure.
Connector 1/8 in. Male BSP x 7/16 in. Male 37° Flare	JT03349	Used to test engine oil pressure.

Procedure

1. Remove oil pressure sender.



MX17937

2. Install JT03349 Connector (A).
3. Connect JT03017 Hose Assembly (B) and JT07034 Pressure Gauge (C).

Important: Avoid Damage! DO NOT run engine if there is insufficient oil pressure!

4. Start engine. If pressure reading is below 69 kPa (10 psi), STOP engine and discontinue this procedure.
5. Run engine approximately 5 minutes to heat oil, then check oil pressure at fast idle.

Results

- If the oil pressure is not within specifications, inspect the oil pump.
- Inspect oil pressure regulating valve for wear or damage. Add or remove shims as necessary.

Specifications

Engine Oil Pressure . . . . . 345 ± 48 kPa (50.0 ± 7.0 psi)
Fast Idle Speed. . . . . 2800 ± 50 rpm

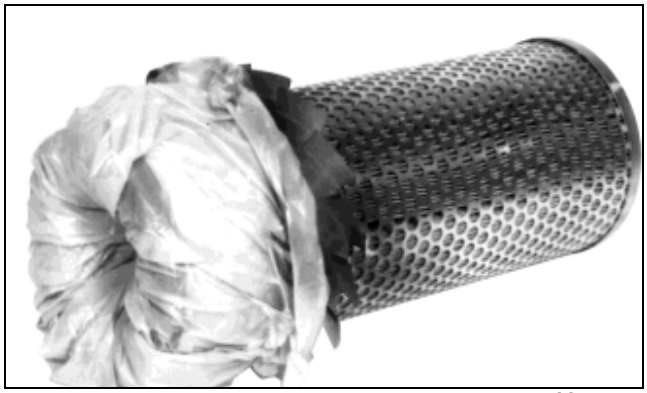
Test Air Intake System Leakage

Reason

Check for leaks in air intake system.

Procedure

1. Remove air filter restriction switch.
2. Remove air cleaner cover and main filter element.



M82124

3. Put plastic bag into and over end of main filter element. Install main filter element and cover.
4. Apply 34-69 kPa (5-10 psi) air pressure to air intake system. If air intake system cannot be pressurized, turn engine slightly to close valves.
5. Spray soap solution over all connections from air cleaner to intake manifold and check for leaks.

Results

- Find leaks and repair or replace parts as necessary.

Adjust Throttle Cable

Reason

To make sure that throttle lever and cable move governor lever fully from slow idle to fast idle position.

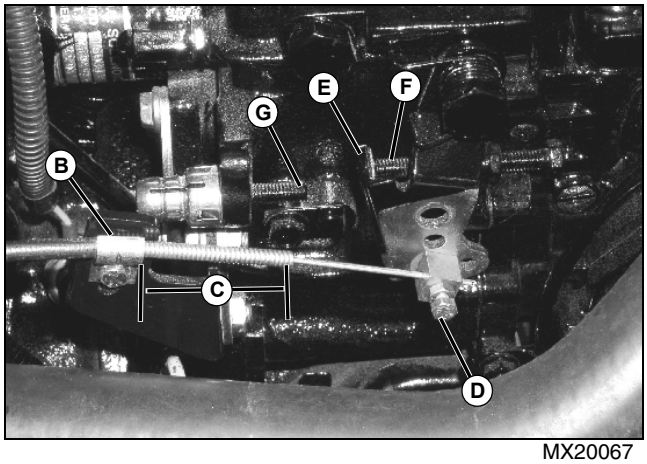
Procedure

MX24730

MX41801

Picture Note: 8500E Shown

1. Move throttle lever on instrument panel to within approximately 7 mm (0.275 in.) from slow idle end of slot (A).



MX20067

2. Loosen throttle cable clamp (B). Outer cable measurement (C) should be approximately 41 mm (1.625 in.). Tighten clamp.

3. Loosen screw and jam nut (D). Throttle arm (E) should be against slow idle stop screw (F).

4. Tighten screw and jam nut.

Results

Throttle lever should move governor linkage throughout full range of travel, touching slow idle stop screw (F) and fast idle stop screw (G).

Test Fuel System Leakage

Reason

Tests fuel system plumbing for external leakage. This test also determines if air is entering the fuel system at connections, allowing fuel to siphon back to tank.

Procedure

1. Disconnect fuel lines from fuel filter.

2. Place fuel line from fuel pump to fuel filter into a suitable container to catch drained fuel.

Caution: Avoid Injury! DO NOT apply more than 103 kPa (15 psi) air pressure to the fuel system. Damage to the injection pump or personal injury may result.

3. Apply 34-69 kPa (5-10 psi) air pressure to fuel supply hose until all fuel is drained from the system. DO NOT exceed maximum pressure of 103 kPa (15 psi).

4. Apply liquid soap and water solution to all joints and connections in the fuel system and inspect for leaks.

Results

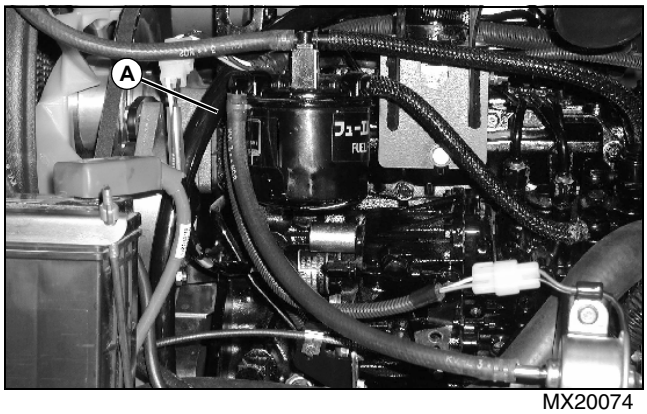
- Find leaks and repair or replace parts as necessary.

Fuel Transfer Pump Pressure Test

Reason

To determine fuel transfer pump operating pressure.

Procedure



MX20074

1. Disconnect transfer pump hose (A) from outlet side of pump at fuel filter.

2. Install the hose and gauge to outlet-side hose of pump.

3. Turn key switch to ON position for 15 seconds.

4. Record fuel pressure reading on gauge.

Results

- If the pressure is below specification, replace the fuel transfer pump.

Specifications

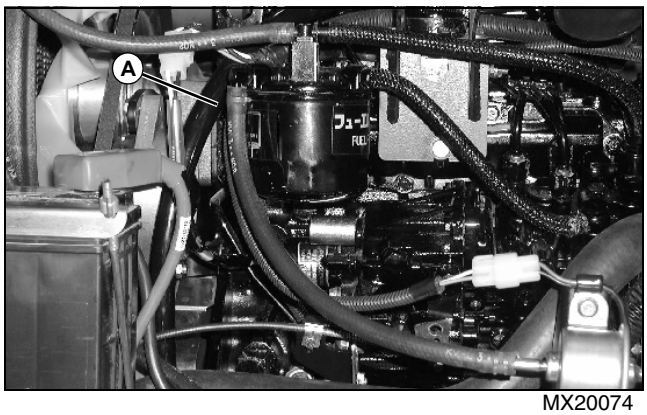
Fuel Transfer Pump Pressure . . . . . 37.3 kPa (5.4 psi)

Fuel Transfer Pump Flow Test

Reason

To determine fuel transfer pump flow.

Procedure



MX20074

1. Disconnect transfer pump hose (A) from outlet side of pump at fuel filter.
2. Place hose in a graduated container.
3. Turn key switch to ON position for 15 seconds.
4. Compare fuel amount to specification.

Results

- If the pressure is below specification, replace the fuel transfer pump.

Specifications

Fuel Transfer Pump Flow. . . . . 100 mL (3.4 oz)

Bleed Fuel System

Caution: Avoid Injury! Be careful of moving fan blades, alternator pulley and belts when engine is running. Engine may also be hot.

Important: Avoid Damage! Modification or alteration of the injection pump, pump timing or the injection nozzles in any way not approved by the manufacturer will terminate the warranty obligation.

All engines are equipped with an automatic air venting system that makes the fuel system self-bleeding.

1. Ensure that all fuel line connections are securely tightened.
2. Add fuel to the fuel tank.
3. Crank engine to allow fuel system to bleed itself.

Test Coolant Temperature Switch

Reason

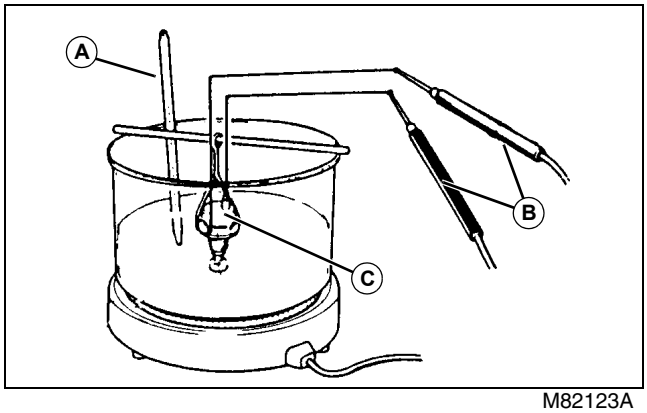
To determine operating temperature of sender.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	N/A	Used to check coolant temperature switch.
Glass Container	N/A	Used to check coolant temperature switch.
Heating Unit	N/A	Used to check coolant temperature switch.
Ohmmeter	N/A	Used to check coolant temperature switch.

Procedure

Important: Avoid Damage! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



M82123A

1. Connect lead wires from ohmmeter probes (B) to sender terminal and body.
2. Suspend sender (C) and a thermometer (A) in a container of water.
3. Heat and stir the water. Observe water temperature when continuity occurs. Water temperature should be at specifications.

Results

- If continuity does not occur within temperature listed, replace sender.

Specifications

Coolant Temperature Switch (Contact Closing Temperature) . . . . . 107-113°C (225-235°F)

Extending Turbocharger Life

Turbochargers are designed to last the life of the engine, but because they operate at such high speeds (100,000 rpm or more), a moment's carelessness can cause them to fail in seconds.

The major causes of turbocharger failure are:

- Lack of lube oil (quick starts and hot shutdowns)
- Oil contamination
- Ingestion of foreign objects
- Restricted oil drainage
- Low oil level
- Operation on excessive side slopes
- Abnormally high exhaust temperatures

Lack of Lube Oil

Oil not only lubricates the turbocharger's spinning shaft and bearings, it also carries away heat. When oil flow stops or is reduced, heat is immediately transferred from the hot turbine wheel to the bearings, which are also heating up because of the increased friction due to the lack of oil. This combination causes the turbocharger shaft temperature to increase rapidly.

If oil flow does not increase and the process continues, bearings will fail. Once the bearings fail (which can happen in just seconds), seals, shaft, turbine, and compressor wheels can also be damaged.

The principal causes of turbocharger bearing lubrication problems are low pressure; a bent, plugged, or undersized oil lube supply line; plugged or restricted oil galleries in the turbocharger; or improper machine start-up and shutdown procedures.

Oil levels and pressure should always be closely monitored, and all worn hoses and lines should be replaced. The turbocharger oil supply line should be checked frequently to make sure it is not kinked or bent, and it should always be replaced with a line of equal size, length, and strength.

Important: Avoid Damage! Allow engine to idle for two minutes before shutting down after running under load to avoid damage to turbocharger.

The easiest way to damage a turbocharger is through improper start-up and shutdown procedures. Always idle the engine for at least 2 minutes (no load) after start-up and before shutdown. Warming the engine up before applying a load allows oil pressure to build up and lines to fill with oil.

Idling the engine before shutdown allows the engine and turbocharger to cool. "Hot" shutdowns can cause the turbocharger to fail because after high-speed operation the turbocharger will continue to rotate long after the engine has been shut off and oil pressure has dropped to zero. This will cause heat buildup and possible bearing damage. It can also cause carbon and varnish deposits to form.

Oil Contamination

A second cause of turbocharger failures is contaminated oil. It can be caused by a worn or damaged oil filter or by not changing the lube oil at recommended intervals. Expecting the oil filter to remove dirt, sand, metal chips, etc., from the oil before they reach the engine or turbocharger can be a costly mistake because contaminated oil may completely bypass the engine oil filter if the oil filter or oil cooler is clogged, if the filter element is improperly installed, or if the oil is thick during cold weather.

Four good ways of avoiding oil contamination are:

- Always inspect the engine thoroughly during major overhaul. Look especially for any sludge or debris left in lube oil galleries.
- Change lube oil at recommended intervals. Analysis of oil samples at filter change periods can help identify potentially harmful contaminants in the oil.
- Clean the area around the oil fill cap before adding oil.
- Use a clean container when adding oil.

Ingestion of Foreign Objects

The third cause of turbocharger damage is the ingestion of foreign objects. Foreign objects or particles can be ingested and cause damage to the turbocharger on both compressor and turbine sides. This is easy to avoid.

On the compressor side, foreign objects usually take the form of dust, sand, or shreds of air cleaner element that enter through improperly installed air cleaner elements. Leaky air inlet piping (loose clamps or torn rubber joints) or torn pleats in dry-type air cleaner elements also create problems.

The result is erosion of compressor blades that can cause the delicately balanced wheel to wobble.

Important: Avoid Damage! Whenever an internal engine failure (valve, valve seat, piston) occurs, a thorough inspection of the turbocharger MUST BE performed before returning engine to service.

Restricted Oil Drainage

A fourth cause of turbocharger damage is restricted lube oil drainage. The lubricating oil carries away heat generated by friction of the bearings and from the hot exhaust gases. If drainage back to the sump is impeded, the bearings will overheat with damage that will ultimately lead to failure.

There are two primary reasons for restricted drainage:

- A blocked drain tube, due to either damage or a buildup of sludged oil.
- High crankcase pressure, due to restricted crankcase breather or excessive engine blow-by.

Periodically check both the turbocharger oil drain tube and engine breather tube for damage or restriction. Correction of these conditions leads to longer turbocharger life.

Low Oil Level

Check engine oil level periodically according to the Operator's Manual. Proper oil level will prevent turbocharger failure.

Operation on Excessive Side Slopes

Operating equipment on excessive side slopes will prevent oil from being transferred up to the turbocharger, causing overheating wear of moving parts.

Abnormally High Exhaust Temperatures

A seventh cause of turbocharger damage is abnormally high exhaust temperatures. This can cause coking of oil, which can lead to bearing failure. Extreme over-temperature operation can cause wheel burst.

There are two basic causes of over-temperature:

- Restricted air flow
- Overpowering the engine

In either case, the engine has more fuel than available air for proper combustion. This over-fueled condition leads to elevated exhaust temperatures.

Causes of restricted air flow can include:

- Damaged inlet piping
- Clogged air filters
- Excessive exhaust restriction
- Operation at extreme altitudes

Overpowering generally is due to improper fuel delivery or injection timing. If over-temperature operation has been identified, an inspection of the air inlet and exhaust systems should be performed. Also, check the fuel delivery and timing.

Turbocharger Seven-Step Inspection

The following inspection procedure is recommended for systematic failure analysis of a suspected failed turbocharger. This procedure will help to identify when a turbocharger has failed, and why it has failed, so the primary cause of failure can be corrected.

Proper diagnosis of a non-failed turbocharger is important for two reasons.

1. Identification of a non-failed turbocharger will lead to further investigation and repair of the cause of a performance complaint.

2. Proper diagnosis eliminates the unnecessary expense incurred when a non-failed turbocharger is replaced.

Note: To enhance the turbocharger inspection, use an inspection sheet (Form No. DS-2280 available from Distribution Service Center) to list the inspection steps in the proper order and show potential failure modes for each step. Check off each step of the inspection and record any details or problems obtained during inspection. Retain this with the work order for future reference.

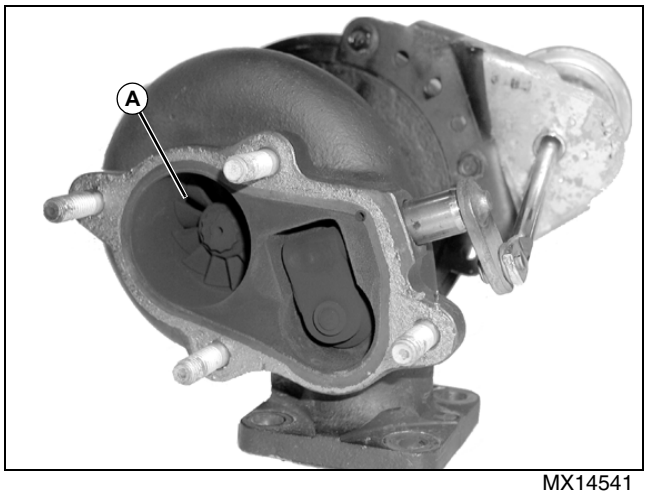
The seven recommended inspection steps, which are explained in detail on the following pages, are:

- Compressor Housing Inlet and Compressor Wheel
- Compressor Housing Outlet
- Turbine Housing Inlet
- Turbine Housing Outlet and Turbine Wheel
- External Center Housing and Joints
- Internal Center Housing
- Turbo Bench Test

Compressor Housing Inlet and Compressor Wheel

Note: Foreign object damage may be extensive or minor. In either case, the source of the foreign object must be found and corrected to eliminate future damage.

Use a good light source for this check.



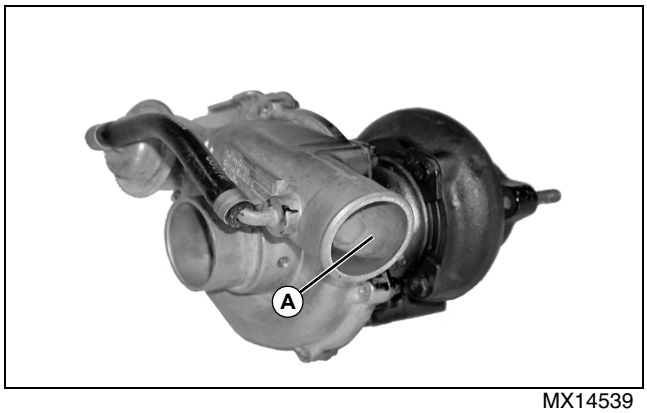
MX14541

1. Check compressor inlet and blade (A) for foreign object damage.

2. Check compressor inlet for wheel rub on the housing. Look very closely for any score marks on the housing itself and check the tips of the compressor wheel blades for damage.

3. Mark findings on your checklist and continue the inspection.

Compressor Housing Outlet

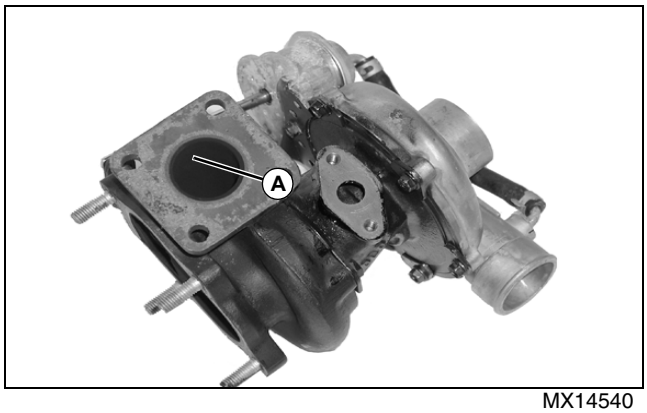


MX14539

1. Check compressor housing outlet (A). The outlet should be clean and free of dirt or oil.

2. Mark the checklist if dirt or oil is found and continue the inspection.

Turbine Housing Inlet

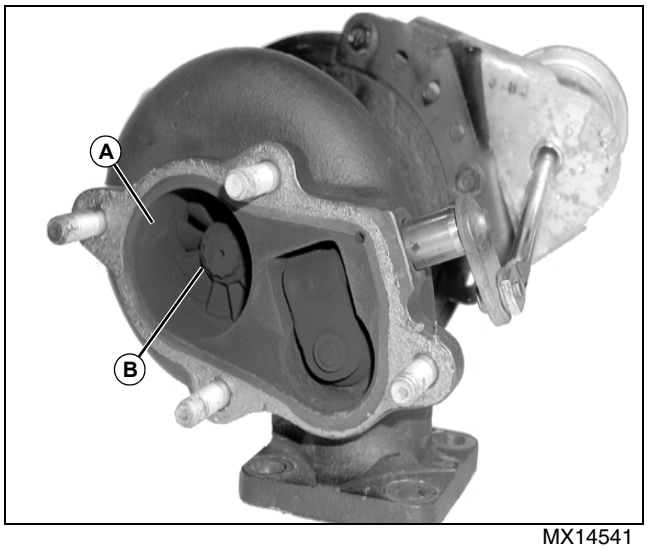


MX14540

Check the turbine housing inlet port (A) for oil in housing, excessive carbon deposit, or erosion of walls.

Note: If the inlet is wet with oil or has excessive carbon deposits, an engine problem is likely. Wall erosion (cracking or missing pieces) indicates excessive exhaust temperature.

Turbine Housing Outlet and Turbine Wheel

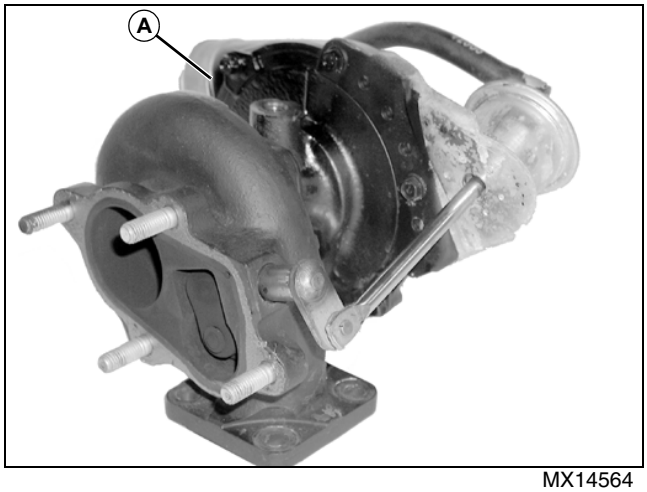


MX14541

1. Use a flashlight to look up inside the turbine housing outlet (A) and check blades (B) for foreign object damage.

2. Inspect the wheel blades and housing for evidence of wheel rub. Wheel rub can bend the tips of the blades with the housing showing wear or damage.

External Center Housing and Joints

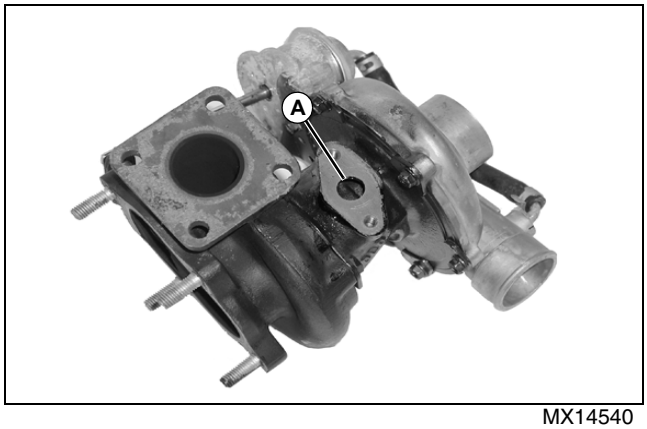


MX14564

Visually check the outside of the center housing (A), all connections to the compressor housing, and turbine housing for oil.

Note: If oil is present, make sure it is not coming from a leak at the oil supply or return line.

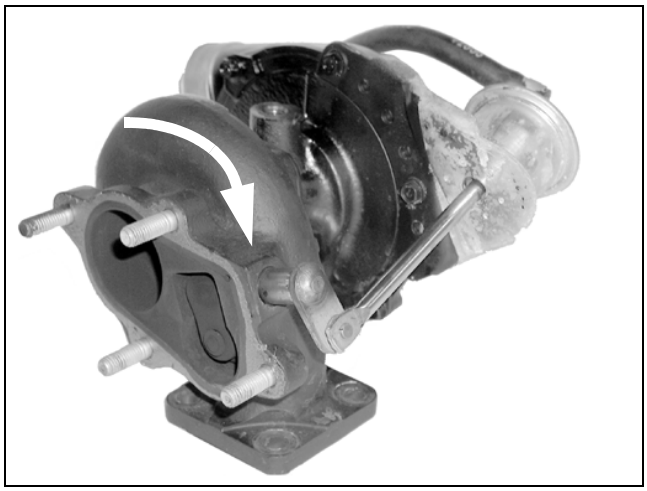
Internal Center Housing



MX14540

Using a flashlight, look through the oil return hole (A) to check the condition of the shaft and/or bearings. There should not be excess carbon deposits on the shaft or in the housing.

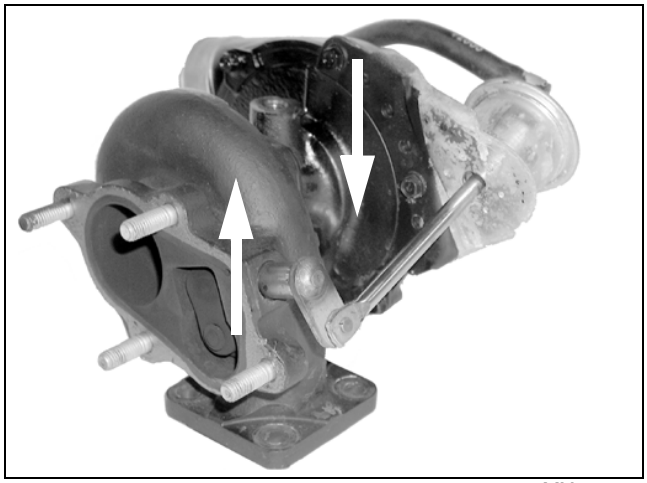
Turbo Bench Test



MX14564

1. Mount the turbocharger in a vise.

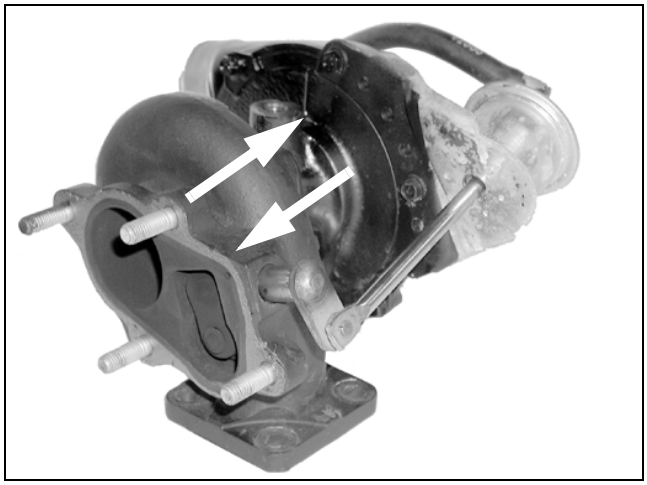
2. Rotate the shaft, using both hands, to check rotation and clearance. The shaft should turn freely; however, there may be a slight amount of drag.



MX14564

3. Pull up on the compressor end of the shaft and press down on the turbine end while rotating shaft. Neither the compressor wheel nor the turbine wheel should contact the housing at any point.

Note: There will be some "play" because the bearings inside the center housing are free floating.



MX14564

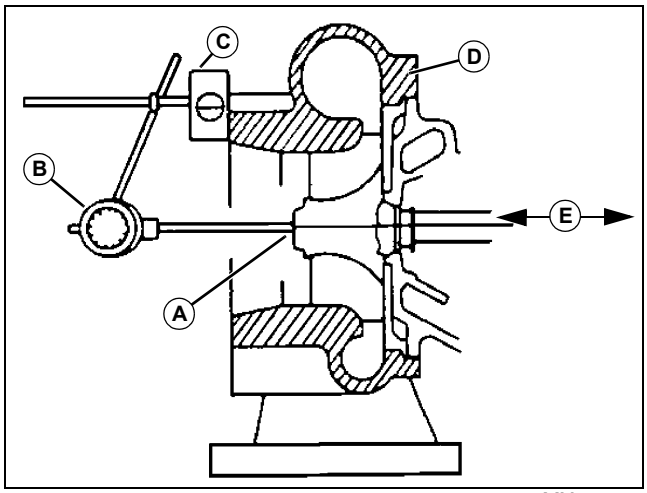
4. Check shaft end play by moving the shaft back and forth while rotating. There will be some end play, but not to the extent that the wheels contact the housing.

Important: Avoid Damage! Before you finalize your conclusion that the turbocharger has not failed, it is strongly recommended to check rotor shaft axial and radial play. (See procedures later in this group.) These procedures are not required if a failure mode has already been identified.

Note: These diagnostic procedures will allow you to determine the condition of the turbocharger. If the turbocharger has failed, analysis of your inspection notes should direct you to the specific areas of the engine to correct the problems causing the turbocharger failure. It is not unusual to find that a turbocharger has not failed. If your turbocharger passes all the inspections, the problem lies somewhere else.

Check Turbocharger Rotor Shaft Axial Play

This test will give an indication of the condition of the axial bearing within the center housing and rotating assembly.



MX14542

A- Shaft End
B- Dial Indicator
C- Magnetic Base
D- Turbine Housing
E- Axial Direction

1. Mount magnetic base (C) so that indicator tip rests on end of shaft (A). Preload indicator tip and zero dial on indicator (B).
2. Move shaft axially back and forth by hand.
3. Observe and record total dial indicator movement.

If axial play is not within specification, replace turbocharger.

Specifications

Rotor Shaft Axial Play

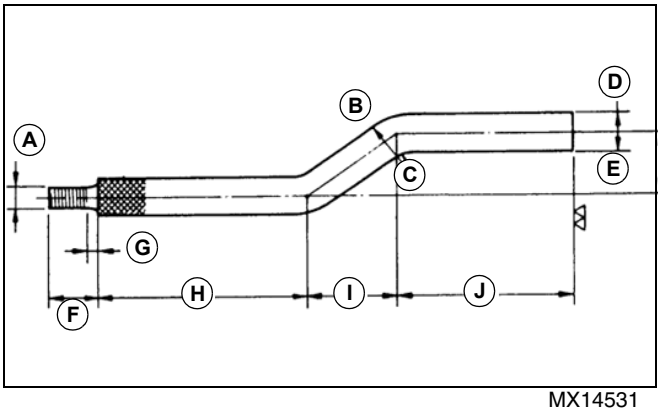
Standard . . . . . 0.022-0.053 mm (0.009-0.0021 in.)
Wear Limit . . . . . 0.07 mm (0.0028 in.)

Check Turbocharger Rotor Shaft Radial Play

This test will give an indication of the condition of the radial bearing within the center housing and rotation assembly.

Note: Prelube center housing bearing prior to performing radial play test. (See "Prelube Turbocharger" on page 115.)

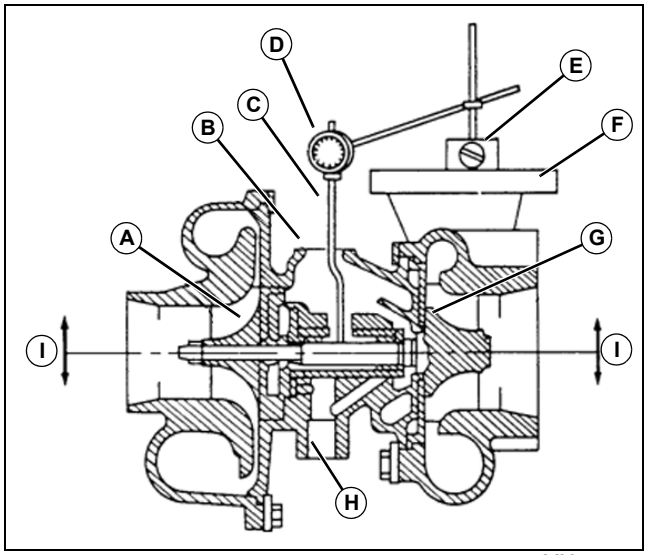
1. Purchase an extended indicator tip from a local supplier with the following approximate dimensions:
   - Length: 76 mm (3.0 in.)
   - Diameter: 5.0 mm (0.197 in.)



MX14531

A- M2.6, P0.45
B- Radius: 10 mm (0.3937 in.)
C- Radius: 5 mm (0.1968 in.)
D- Diameter: 5 mm (0.1968 in.)
E- Distance: 7 mm (0.2755 in.)
F- Length: 8 mm (0.3149 in.)
G- Length: 1 mm (0.0393 in.)
H- Length: 40 mm (1.5748 in.)
I- Length: 10 mm (0.3937 in.)
J- Length: 15 mm (0.5905 in.)

2. Heat and bend to size as shown.



MX14530

A- Compressor Wheel
B- Oil Return Cavity
C- Extension Adapter
D- Dial Indicator
E- Magnetic Base
F- Turbocharger Mounting Flange
G- Turbine Wheel
H- Oil Inlet
I- Radial Direction

3. Position dial indicator (D) with extension adapter (C) onto turbocharger mounting flange (F), so that tip rests on shaft by extending through oil return cavity (B).

4. Grasp rotation shaft at both ends and move the shaft toward the indicator and then away from the indicator (arrows) by applying moderate force.

5. Observe and record total indicator movement.

6. If total indicator reading is not within specification, replace turbocharger.

Specifications

Rotor Shaft Radial Play

Standard . . . . . 0.061-0.093 mm (0.0024-0.0037 in.)
Wear Limit . . . . . 0.12 mm (0.0047 in.)

Turbocharger Waste Gate Test

Equipment

- Pressure regulating valve - Allowing gradual adjustment in a range from 0 to 200 kPa (0 to 29 psi).

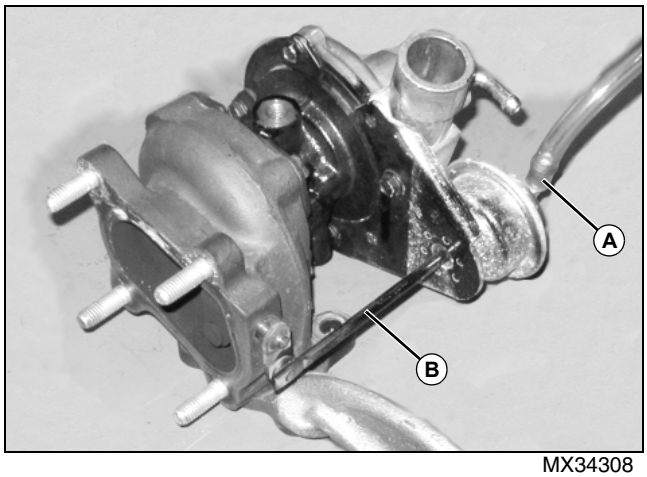
Procedure

1. Park machine safely. See “Park Machine Safely” in the Safety section.

2. Allow engine to cool.

3. Raise hood.

4. Check hose to waste gate actuator for kinks or cracks. Replace if damaged.



MX34308

5. Disconnect hose from waste gate actuator (A).

6. Connect a regulated air source to actuator fitting.

Important: Avoid Damage! Do not apply more than 400 kPa (58 psi) to the actuator.

7. Vary pressure to wastegate actuator from 0-193 kPa (0-20 psi). Check results below.

8. Apply 117 kPa (17 psi) to actuator, shut off and seal air supply. Wait 1 minute and measure pressure in actuator.

Results

- Actuator rod (B) should move in and out freely as pressure is varied.
- If rod does not move freely, disconnect turbocharger waste gate linkage. Check for movement and repair or replace components as necessary.
- After 117 kPa (17 psi) is applied, the pressure should not drop below 103 kPa (15 psi) after 1 minute. Replace actuator if pressure drop exceeds specification.

Repair

Remove and Install Engine

Removal

1. Disconnect negative (-) cable from battery.

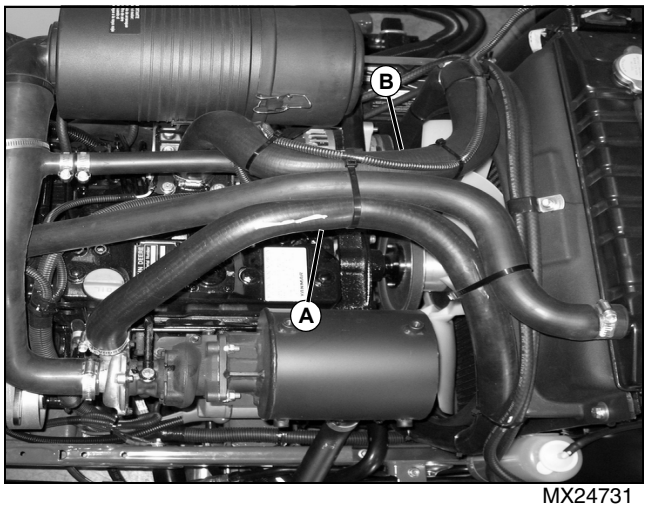
2. Remove starter. (See “Remove and Install Starting Motor” on page 109.)

3. Drain coolant. Disconnect upper and lower hoses from radiator.

4. Remove three cap screws attaching driveshaft to flex plate. Loosen cap screws holding driveshaft to pump input shaft and slide driveshaft toward pump.

5. Remove two cap screws and clamps securing positive battery cable to bottom of engine.

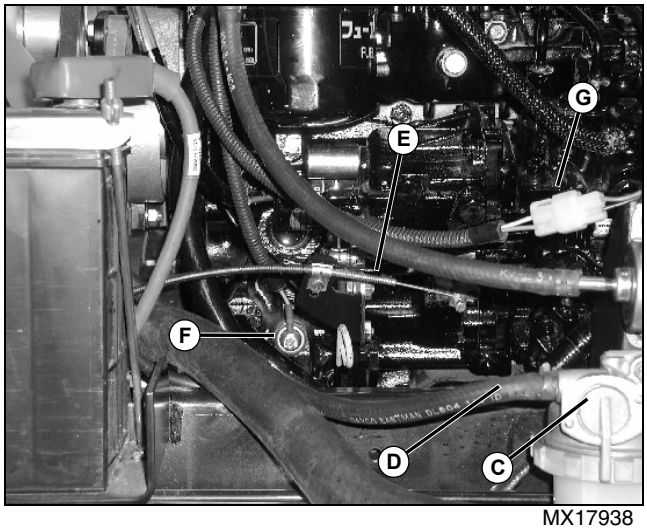
Note: Models with intercooled turbo only.



MX24731

6. Disconnect and remove intake (A) and exhaust (B) intercooler tubes.

7. Remove air cleaner assembly.



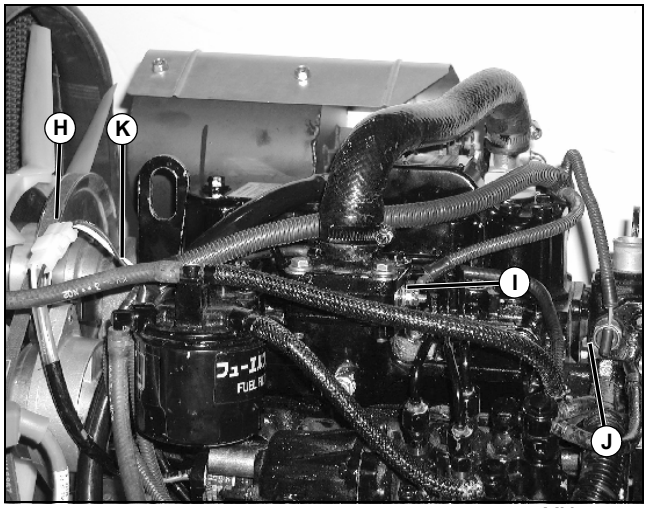
MX17938

8. Close fuel shutoff (C) at fuel filter.

9. Disconnect and plug fuel line (D).

10. Disconnect throttle cable (E).

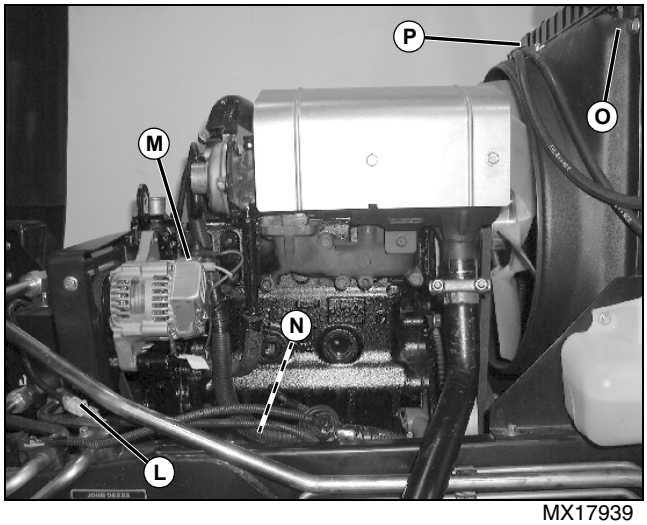
11. Disconnect wire connectors at oil pressure sender (F) and fuel pump (G).



MX20069

12. Disconnect engine wiring harness at fuel shutoff solenoid (H), air intake preheater (I), and water temperature sender (J).

13. Disconnect and plug fuel line (K).

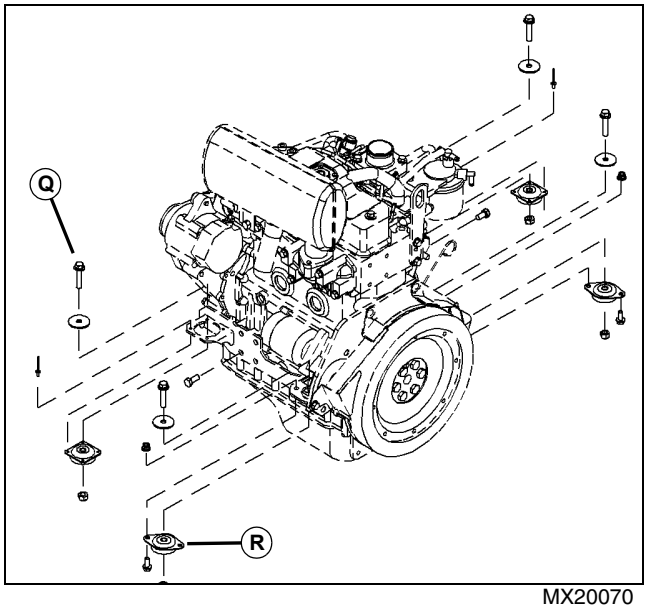


MX17939

14.Disconnect four-wheel drive solenoid wire connector (L) and wires from alternator (M).

15.Disconnect engine ground strap (N).

16.Remove the four cap screws (O) securing the fan shroud to the radiator, and cap screw and clamp (P) securing fuel lines to shroud. Position the shroud over the fan for removal with the engine and lay fuel lines on radiator, clear of shroud.



MX20070

17.Attach a suitable hoist to engine lifting eyes.

18.Remove mounting cap screws and nuts (Q). Remove engine.

19.Inspect rubber isolators (R) for wear. Replace if required.

Installation

1. Loosely install engine mounting screws and nuts. Do not tighten.

2. Install driveshaft to engine. Tighten cap screws to specification.

3. Tighten cap screws on pump input shaft yoke.

4. Tighten engine mounting screws to specification.

5. Install positive battery cable clamps to bottom of engine.

6. Install fan shroud cap screws and fuel line clamp.

7. Connect engine ground strap.

8. Connect wire harness.

9. Install and adjust throttle cable. (See “Adjust Throttle Cable” on page 59.)

10.Install fuel lines and open fuel shutoff at fuel filter.

11.Install air cleaner assembly.

Note: For intercooled turbo engines only.

12.Install intake and exhaust intercooler tubes.

13.Connect radiator hoses and fill radiator with coolant.

14.Install starter. (See “Remove and Install Starting Motor” on page 109.)

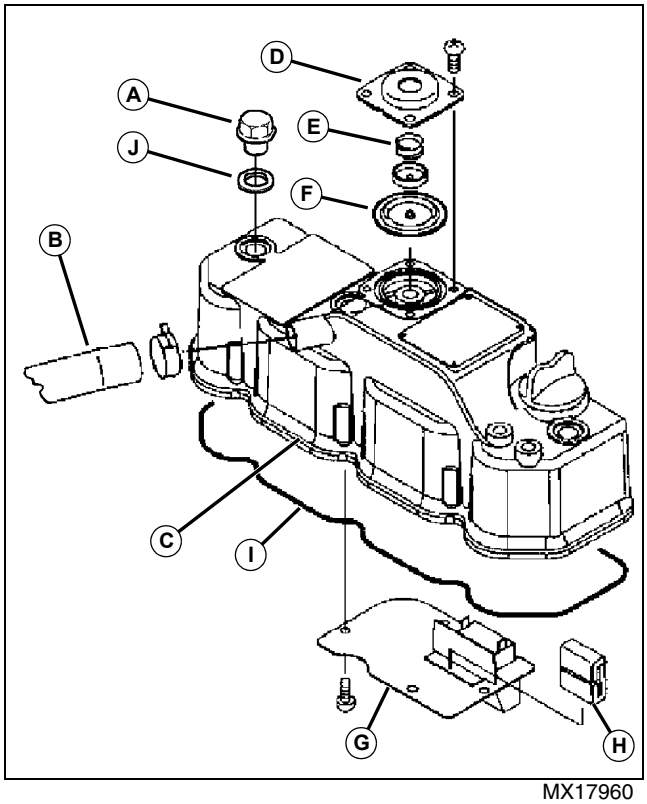
15.Connect battery.

Specifications

Engine Mounting Cap Screw Torque . . 80 N•m (60 lb-ft)
Driveshaft Cap Screw Torque . . . . . 80 N•m (60 lb-ft)

Remove and Install Rocker Arm Cover

Removal



MX17960

1. Remove three rocker cover nuts (A).
2. Remove breather hose (B).
3. Remove rocker cover (C) from the cylinder head.
4. Remove diaphragm cover (D).
5. Remove and inspect spring (E) and diaphragm (F). Replace as needed.
6. Remove baffle plate (G) and baffle (H).
7. Wash the baffle in a safe solvent and blow dry with air. Replace the baffle if it comes apart or is deteriorated.

Installation

1. Install baffle and baffle plate.
2. Install diaphragm, plate, spring and diaphragm cover.
3. Inspect the rocker cover gasket (I) and O-rings (J). Replace if damaged.
4. Clean the cylinder head surface and install rocker cover to cylinder head. Tighten rocker cover nuts to specification.
5. Install breather hose.

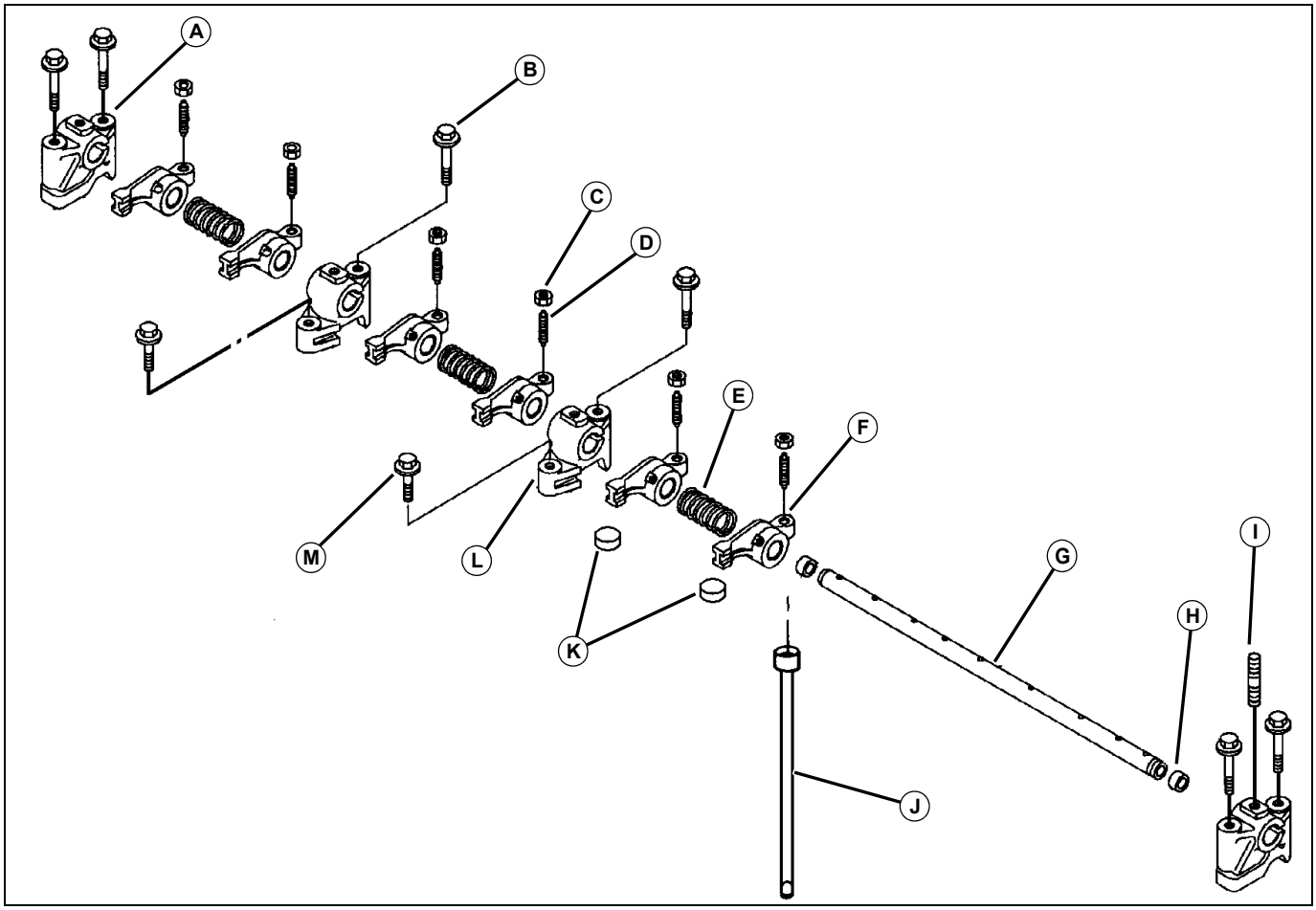
Specifications

Rocker Arm Cover Nut . . 16.7-22.5 N•m (148-199 lb-in.)

Remove and Install Rocker Arm Assembly

Removal

1. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 70.)



M91949B

A- Shaft End Support (2)
B- Cap Screw, M8x50 (6)
C- Jam Nut (6)
D- Adjuster Screw (6)
E- Spring (3)
F- Rocker Arm
G- Rocker Arm Shaft
H- Plug (2)
I- Stud
J- Push Rod (6)
K- Valve Cap (6)
L- Center Support (2)
M- Cap Screw, M8x25 (2)

2. Remove the rocker arm end supports (A) and rocker arm center support mounting cap screws (B and M).

3. Lift the rocker arm assembly from the cylinder head and set the assembly on a bench.

Note: If the rocker arm shaft assembly is to be disassembled, replace components in same location on the rocker arm shaft they were removed from.

4. Note the positions of the rocker arm assembly components. Slide the components off the rocker arm shaft.

5. Lift the push rods from the cylinder head and note the order of removal for reassembly.

6. Inspect the rocker arm components and push rods.

Installation

1. Install the push rods in their original locations in the cylinder head, with the ball-shaped end down in head.

2. Lubricate all parts with clean oil during assembly.

3. Assemble the rocker arm assembly components in the reverse order of removal.

4. Place the rocker arm assembly on the cylinder head.

- Align the rocker arms with the valves and push rods.
- Align the rocker arm end supports and center supports with the corresponding holes in the head.

5. Install the rocker arm support cap screws. Tighten the cap screws to specification.

6. Adjust the valve clearance. (See “Adjust Valve Clearance” on page 48.)

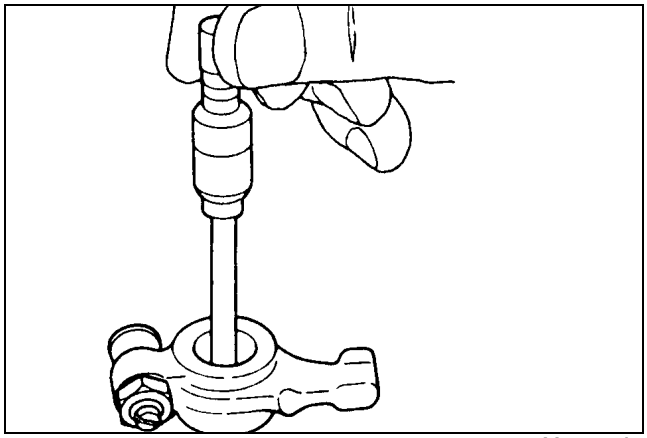
Specifications

Rocker Arm Support Cap Screw Torque . . . . . 26 N•m (19 lb-ft)

Inspect Rocker Arm Assembly

M35262

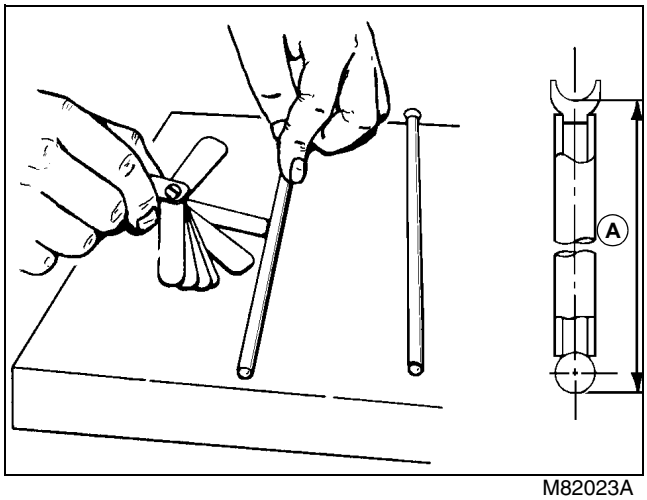
1. Measure the rocker arm shaft OD and compare with specifications. Replace rocker arm shaft if below wear limit.



M82022A

2. Measure the inner diameters of the rocker arms and supports. Compare with specifications. Replace rocker arms or supports if greater than wear limit.

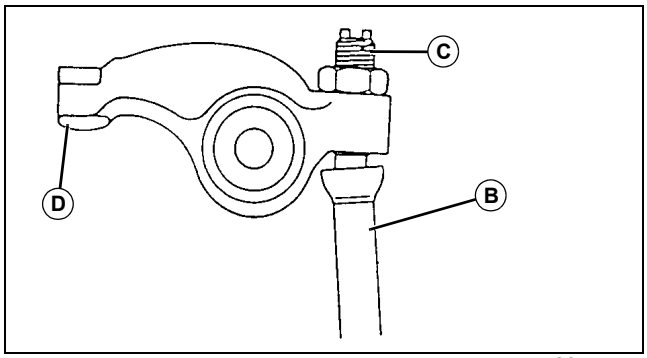
3. Measure the rocker arm shaft-to-rocker arm bushing oil clearance. Oil clearance is the difference between the OD of the rocker arm shaft and the ID of the rocker arms. If oil clearance is not within specifications, replace parts as necessary.



M82023A

4. Place the push rod on a flat surface. Use a feeler gauge to measure any gaps between the push rod and flat surface. Replace push rod(s) if not within specification.

5. Measure push rod length (A). If not within specification, replace push rod.



M76398

6. Check the surface of the adjusting screw that contacts the push rod (B) for wear. Replace the adjusting screw (C) if it is worn or damaged.

7. Check the surface (D) of the rocker arm that comes in contact with the valve cap for wear. Replace rocker arm if necessary.

8. Check the socket portion of the push rod where the valve clearance adjusting screw contacts the push rod. Replace the push rod if it is worn or damaged.

Specifications

Rocker Arm Shaft

Rocker Arm
Shaft OD . . . . . 15.97-15.98 mm (0.628-0.629 in.)
Rocker Arm Shaft Wear Limit . . . . 15.94 mm (0.628 in.)

Rocker Arms and Supports

Rocker Arm and
Support ID . . . . . 16.00-16.02 mm (0.630-0.631 in.)
Rocker Arm and Support
Wear Limit . . . . . 16.07 mm (0.633 in.)

Rocker Arm Shaft-to-Rocker Arm Bushing

Oil Clearance. . . . . 0.02-0.05 mm (0.001-0.002 in.)
Oil Clearance Wear Limit . . . . . 0.13 mm (0.005 in.)

Push Rods

Maximum Bend . . . . . 0.03 mm (0.001 in.)
Length . . . . . 178.25-178.75 mm (7.018-7.037 in.)

Remove and Install Cylinder Head and Valves

Removal

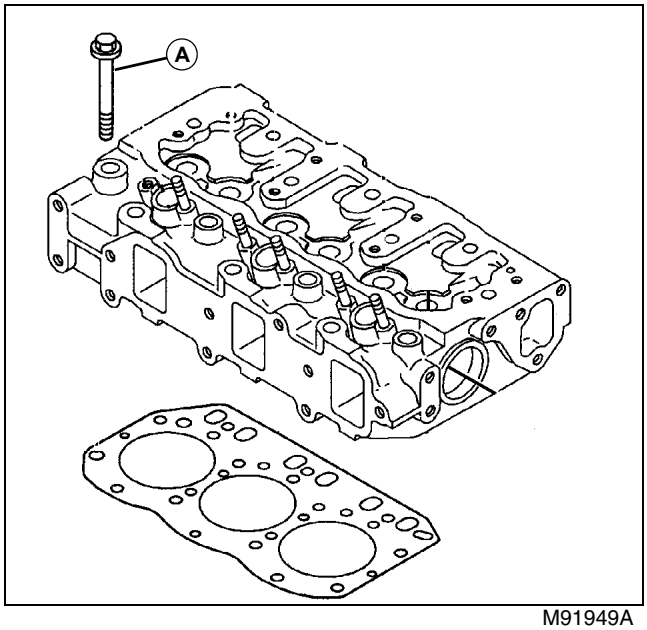
1. Remove the rocker arm cover. (See “Remove and Install Rocker Arm Cover” on page 70.)

2. Remove the rocker arm assembly, push rods and valve caps. (See “Remove and Install Rocker Arm Assembly” on page 71.)

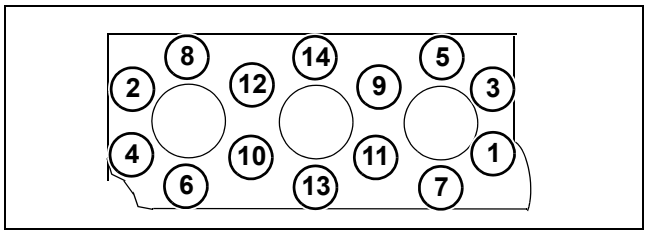
3. Remove the exhaust and intake manifolds. (See “Remove and Install Exhaust Manifold” on page 77. See “Remove and Install Intake Manifold” on page 78.)

4. Remove the coolant pump. (See “Remove and Install Coolant Pump” on page 102.)

5. Remove the fuel injection nozzles. (See “Remove and Install Fuel Injection Nozzles” on page 105.)



M91949A



MIF

6. Remove the cylinder head cap screws (A) in the order shown.

7. Remove the cylinder head from the engine block.

8. Disassemble and inspect the cylinder head and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

Installation

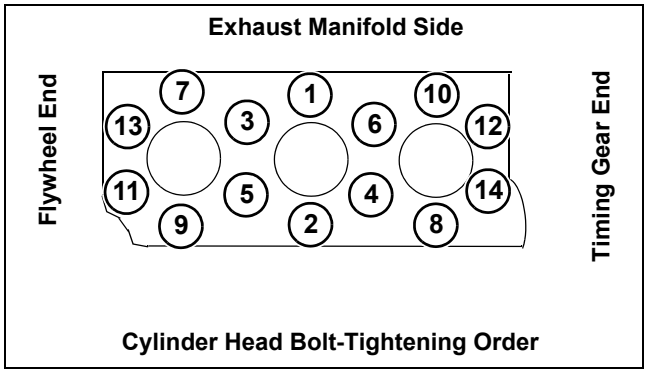
1. Reassemble cylinder head and valves. (See “Disassemble and Assemble Cylinder Head and Valves” on page 74.)

Important: Avoid Damage! The oil passage in the gasket must be located over the oil passage in cylinder block.

2. Place a new cylinder head gasket on the engine block. Dowels in the engine block will assist in aligning the gasket.

3. Place the cylinder head on the engine block. Dowels in the engine block will again assist in alignment.

Important: Avoid Damage! Cylinder head cap screws must be checked for proper torque after 50 hours of engine operation.



MIF

4. Dip the cylinder head cap screws in clean engine oil. Install and tighten in the sequence shown, using the three stages of torque values listed in specifications.

5. Install the fuel injection nozzles.

6. Install the coolant pump.

7. Install the exhaust and intake manifolds.

8. Install rocker arm assembly, push rods and valve caps.

9. Install rocker arm cover.

Specifications

Engine Cylinder Head Cap Screw

Initial Torque . . . . . 44 N•m (33 lb-ft)
Second Torque . . . . . 62 N•m (45 lb-ft)
Final Torque . . . . . 88 N•m (65 lb-ft)

Disassemble and Assemble Cylinder Head and Valves

Removal

1. Remove the valve caps from the valves. The valve caps should be installed on the valves they were removed from.

2. Compress the valve spring using a valve spring compressor and remove the collet halves, retainer, valve spring and valve stem seal for each valve.

3. The intake and exhaust valve guides are press fit. Remove the guides only if necessary.

Installation

Important: Avoid Damage! Do not reuse stem seals if removed. Used seals will leak.

1. Install new valve stem seals over the valve guides.

2. Apply clean engine oil on intake and exhaust valve stems during assembly.

3. Install the valve springs with smaller pitch end or paint mark toward cylinder head.

4. Compress the valve springs and retainer until the collet halves are able to be installed in the grooves of the valve stem.

5. Carefully release the tension on the spring compressor.

6. Tap on the end of the valve with a plastic hammer to ensure the collet halves have seated properly on the valve stem.

7. Repeat for the remaining valves.

8. Measure valve recession if new valves were installed. (See “Inspect Cylinder Head and Valves” on page 74.)

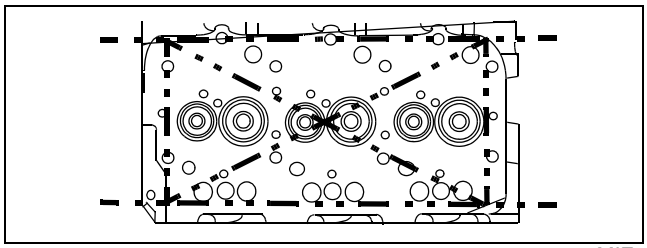
Inspect Cylinder Head and Valves

Special or Required Tools

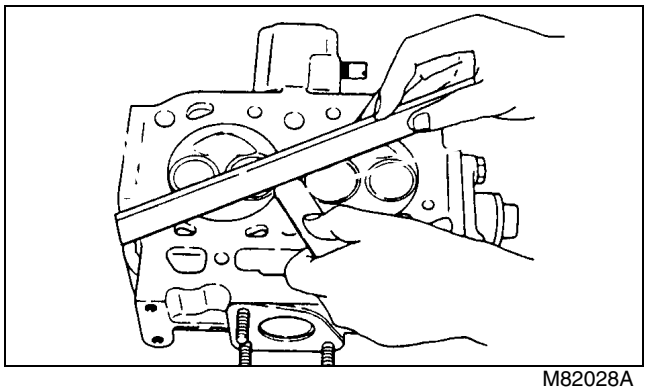
Tool Name	Tool No.	Tool Use
Valve Guide Knurler	D-20019WI	Used to knurl valve guides.
Valve Guide Reamer	D-20021WI	Used to ream valve guides.
Valve Guide Driver	JDE118	Used to install new valve guides.

Important: Avoid Damage! Before inspection, thoroughly clean all components of carbon or dirt.

Cylinder Head



MIF



M82028A

1. To measure cylinder head flatness, place a straightedge along each of the four sides and each diagonal. Measure clearance between straightedge and combustion surface

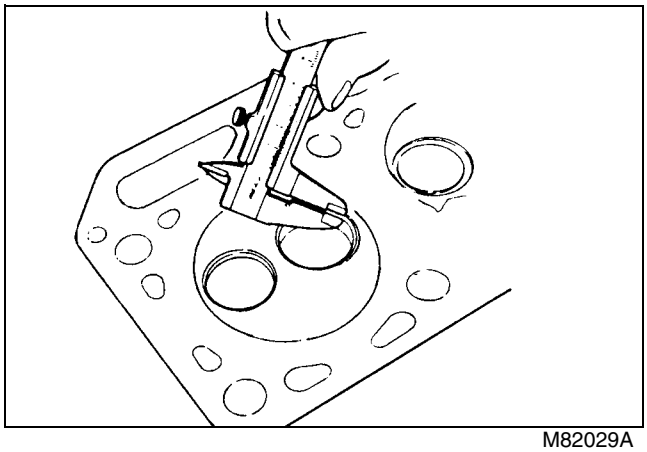
with a feeler gauge and compare with specifications.

2. If the cylinder head was resurfaced:

- Measure piston-to-cylinder head clearance. (See “Measure Piston-to-Cylinder Head Clearance” on page 79.)
- Measure valve recession. (See “Inspect Cylinder Head and Valves” on page 74.)
- Measure valve seat width in this procedure.

Valve Seats

Note: The valve seats are not replaceable. If inspection of the cylinder head reveals valve seats that are damaged or worn beyond repair, the cylinder head must be replaced.

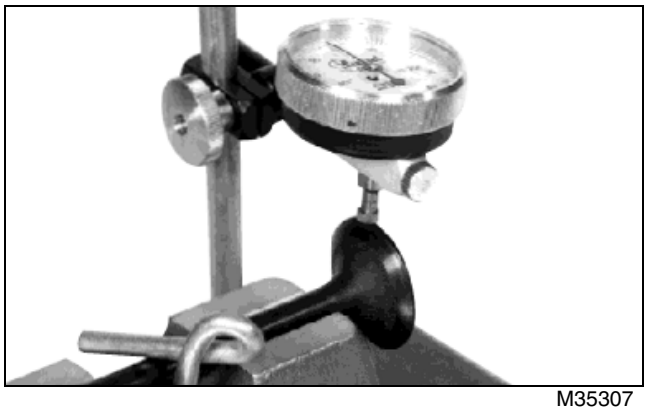


M82029A

1. Measure the valve seat widths and compare with specifications.

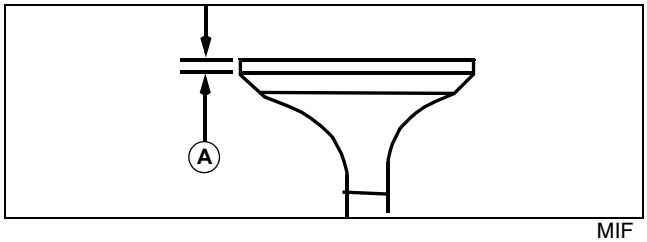
2. If necessary, grind the valve seats to meet specifications. (See “Grind Valve Seats” on page 78.)

Valves



M35307

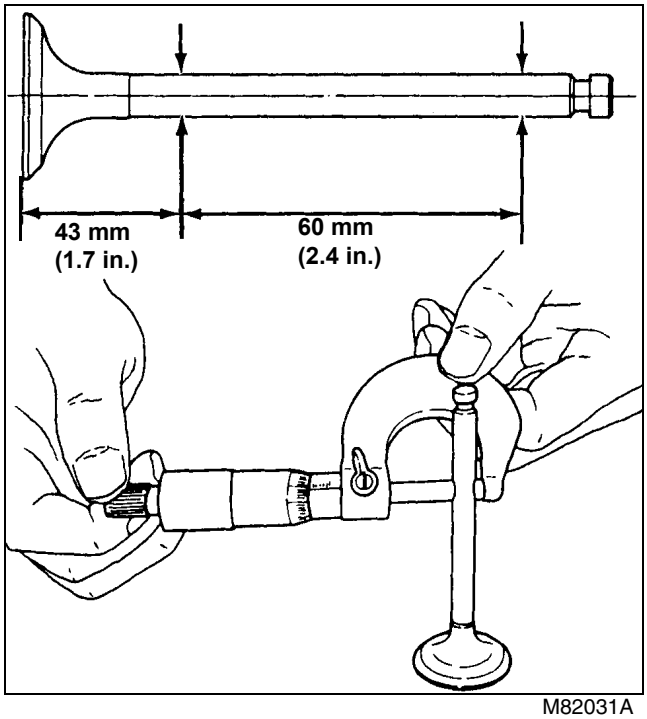
1. Check valves for out-of-round, bent or warped condition using a valve inspection center. Replace valve if necessary.



MIF

2. If the valve faces are worn, burned or pitted, grind valves to proper face angle.

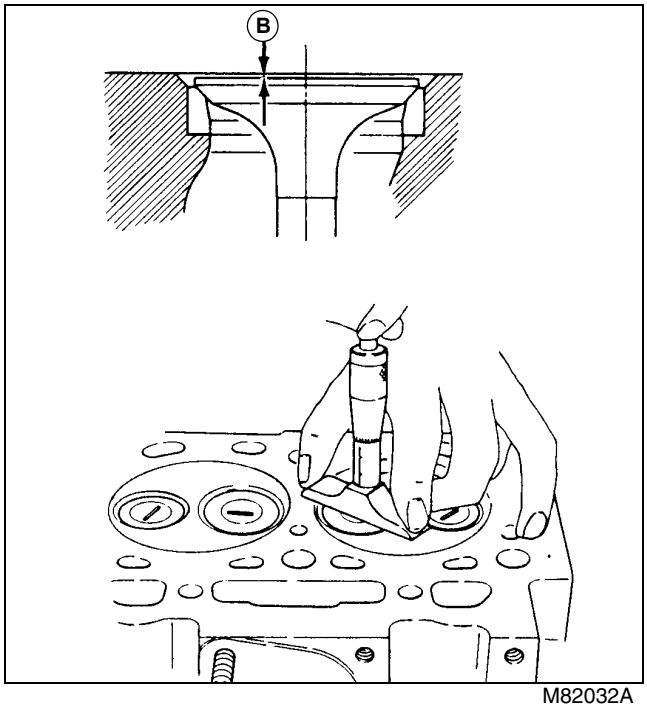
3. Measure valve head thickness (A). If measurement is less than specifications after grinding, replace valve.



M82031A

4. Measure the valve stem diameter at two locations, as shown. If valve stem diameter is less than specifications, replace the valve.

Valve Recession



M82032A

1. Measure valve recession (B) using a depth gauge. If recession is not within specifications, repair or replace parts as needed.

Valve Guides

1. Clean the valve guides using a valve guide brush.

2. Measure the valve guide inside diameter and compare with specifications.

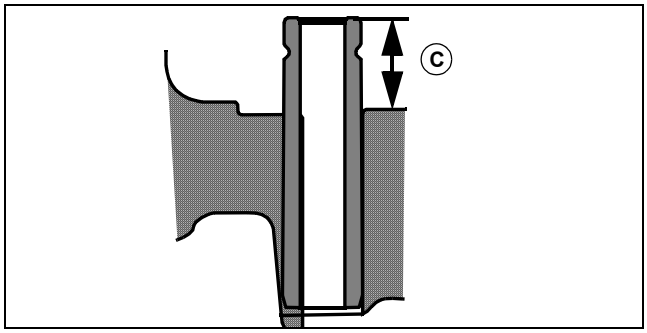
3. Subtract the valve stem OD from the valve guide ID to obtain the oil clearance and compare with specifications.

4. Determine the guide-to-stem oil clearance (guide diameter minus stem diameter).

- If the oil clearance exceeds 0.15 mm (0.006 in.) but is less than 0.20 mm (0.008 in.), knurl the valve guides using D-20019WI Valve Guide Knurler.
- If clearance exceeds 0.20 mm (0.008 in.), replace valve guides using JDE118 Valve Guide Driver.

Important: Avoid Damage! New valve guides must be cooled in a container of liquid nitrogen, or equivalent, before driving into cylinder head.

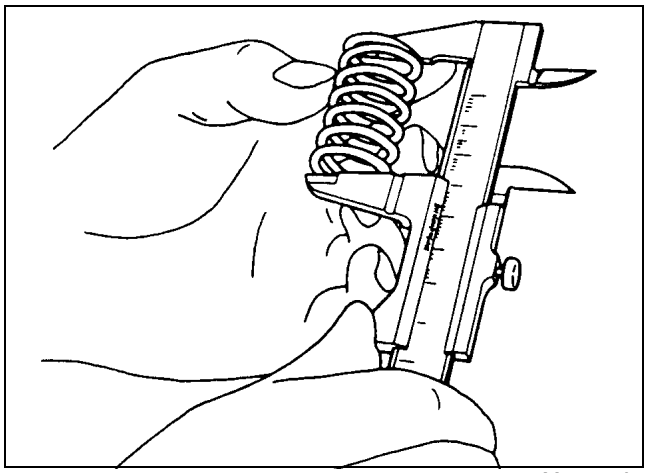
The intake and exhaust valve guides are different. The exhaust valve guide has one groove and the intake valve guide has none.



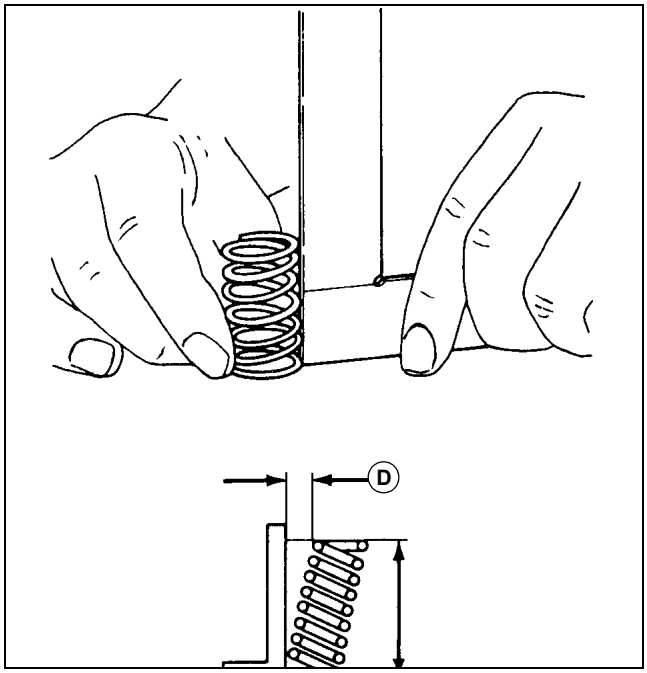
5. If replacing valve guide, install the valve guides with the tapered ends down. Push the valve guides into the cylinder head until the valve guide projection (C) is within specification.

6. Ream the inside diameter of valve guides using D20021WI Valve Guide Reamer.

Springs


M82034A

1. Measure the valve spring free length and compare with specifications.



M82035A

2. Measure the spring inclination (D) and compare with specifications.

Specifications

Cylinder Head

Cylinder Head Flatness (Allowable Distortion Without Resurfacing) . . . . . 0.05 mm (0.002 in.)
Cylinder Head Flatness (Resurface Range) . . . . . 0.00-0.05 mm (0.000-0.002 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)
Cylinder Head Flatness (Maximum Distortion). . . . . 0.15 mm (0.006 in.)

Valve Seats

Intake Valve Seat Width . . . . . 1.77 mm (0.070 in.)
Wear Limit . . . . . 2.27 mm (0.089 in.
Exhaust Valve Seat Width . . . . . 1.34 mm (0.053 in.)
Wear Limit . . . . . 1.84 mm (0.072 in.)

Valves

Valve Head (Minimum Thickness). . . . . 0.50 mm (0.020 in.)
Intake and Exhaust Valve Stem OD . . . . . 7.96-7.97 mm (0.3134-0.3138 in.)
Wear Limit . . . . . 7.90 mm (0.311 in.)

Valve Recession

Valve Recession . . . . . 0.30-0.50 mm (0.012-0.020 in.)
Wear Limit . . . . . 0.08 mm (0.031 in.)

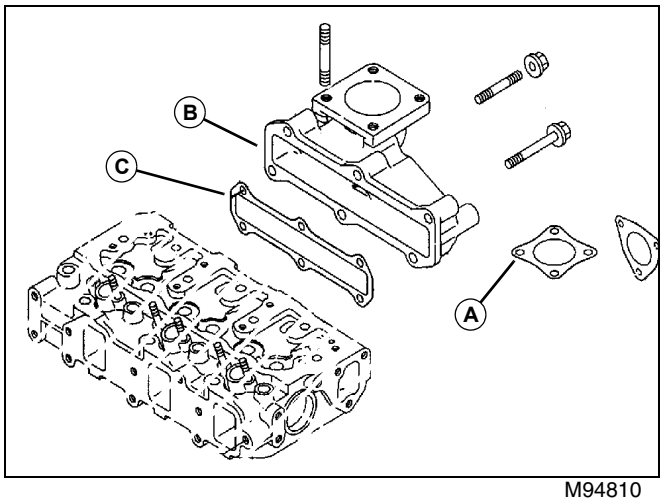
Valve Guides

Valve Guide ID . . . . 8.010-8.025 mm (0.3154-0.3160 in.)
Wear Limit. . . . . 8.10 mm (0.319 in.)
Oil Clearance . . . . . 0.035-0.070 mm (0.001-0.003 in.)
Valve Guide Projection . . . . . 15 mm (0.591 in.)

Springs

Valve Spring Free Length . . . . . 44.4 mm (1.748 in.)
Wear Limit. . . . . 43.90 mm (1.730 in.)
Spring Inclination. . . . . 1.40 mm (0.055 in.)

Remove and Install Exhaust Manifold



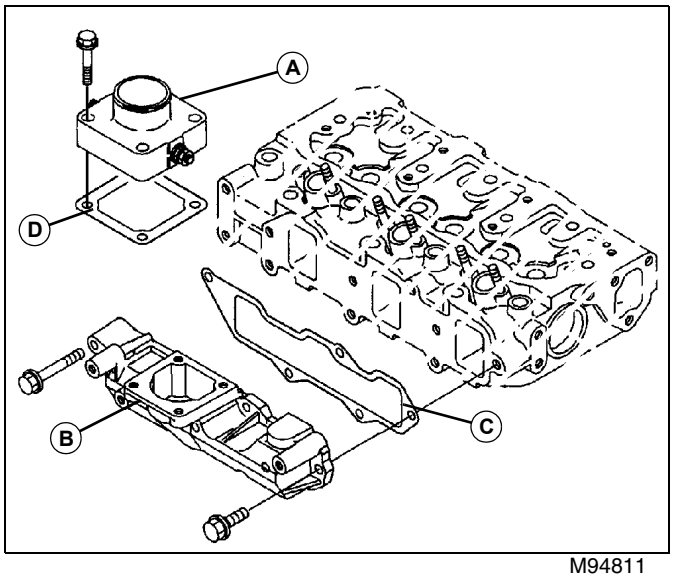
M94810

1. Remove the muffler and gasket (A).
2. Remove the exhaust manifold (B) and gasket (C).
3. Clean the mating surfaces and replace the exhaust manifold gasket.
4. Install the exhaust manifold. Tighten all fasteners to specification.

Specifications

Exhaust Manifold Cap Screw and Nut Torque . . . . . 26 N•m (19 lb-ft)

Remove and Install Intake Manifold



M94811

1. Remove the fuel filter bracket (not shown).
2. Remove the intake air heater (A).
3. Remove the fuel injection lines (not shown).
4. Remove the intake manifold (B).
5. Clean the mating surfaces and replace the intake manifold gasket (C).
6. Install the intake manifold.
7. Replace the intake air heater gasket (D), and install the intake air heater.
8. Install the fuel injection lines.
9. Tighten all fasteners to specification.

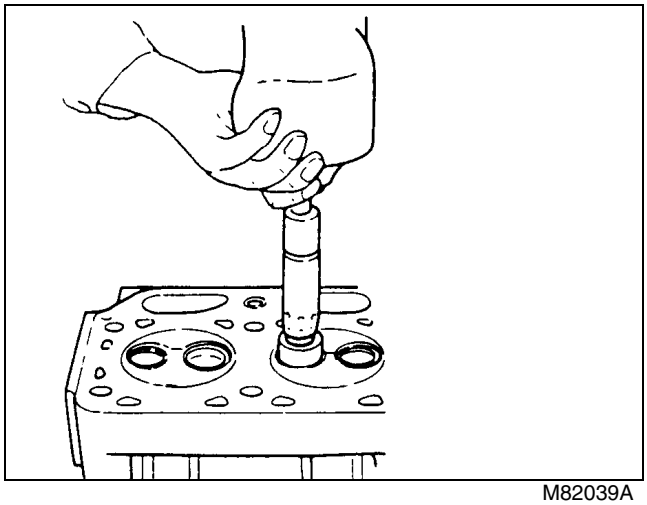
Specifications

Intake Manifold Cap Screw Torque . . . 26 N•m (19 lb-ft)

Grind Valve Seats

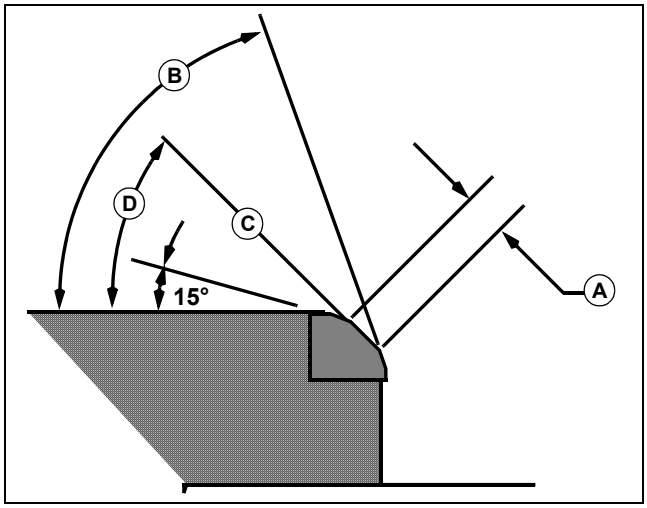
Note: LIGHTLY grind the valve seats for only a few seconds to avoid excessive valve seat width.

1. Grind the intake valve seat using a 30° seat grinder and the exhaust valve seat using a 45° seat grinder. Follow the tool manufacturer's instructions.



M82039A

2. Measure the valve seat width after grinding and compare with specifications.



MIF

3. If the seat width (A) is too wide after grinding, grind the lower seat surface (B) using a 70° seat grinder until the seat width is close to specifications.
4. Grind the upper seat surface (C) using a 15° seat grinder until the seat width is narrowed to specifications.
5. If the valve seats (D) are ground, measure valve recession. (See "Inspect Cylinder Head and Valves" on page 74.) Check the contact pattern between the seat and valve with bluing dye.
6. Lap the valves. (See "Lap Valves" on page 79.)

If the valve recession exceeds the maximum specifications or the seats cannot be reconditioned, replace the valves or the cylinder head.

Specifications

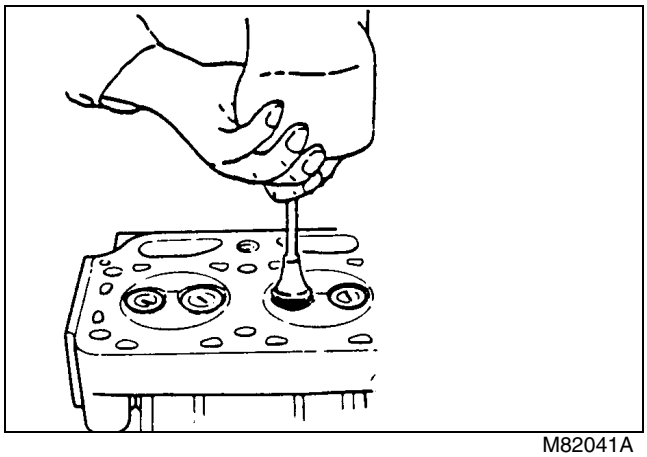
Valve Seats

Intake Valve Seat Width . . . . . 1.77 mm (0.070 in.)
Wear Limit . . . . . 2.27 mm (0.089 in.)
Exhaust Valve Seat Width . . . . . 1.34 mm (0.053 in.)
Wear Limit . . . . . 1.84 mm (0.072 in.)

Lap Valves

Note: Use a rubber-type lapping tool for valves without a lapping tool groove slit.

If the seat does not make proper contact, lap the valve into the seat:

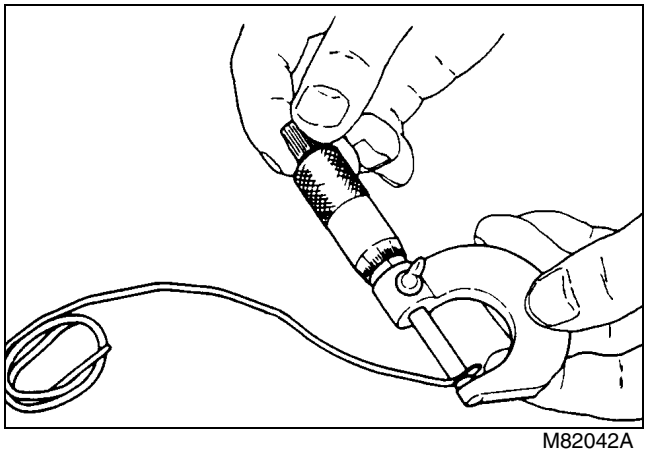


M82041A

1. Apply a small amount of fine lapping compound to the face of the valve.
2. Turn the valve to lap the valve to the seat.
3. Lift the valve from the seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry all parts.
5. Check the position of the lap mark on the valve face. Lap marks must be on or near the center of the valve face.

Measure Piston-to-Cylinder Head Clearance

1. Place three 10 mm (0.4 in.) long pieces of 1.5 mm (0.06 in.) diameter soft wire in three positions on the flat part of the piston head.
2. Install the cylinder head and old gasket. Install cylinder head bolts and tighten in proper sequence. (See “Remove and Install Cylinder Head and Valves” on page 73.)
3. Slowly turn the crankshaft one complete revolution.
4. Remove the cylinder head and gasket.



M82042A

5. Measure the thickness of the flattened section of each piece of wire. Calculate the average thickness of the wires to obtain the piston-to-cylinder head clearance specification.
   - If the clearance is less than specification, replace cylinder head.

Specifications

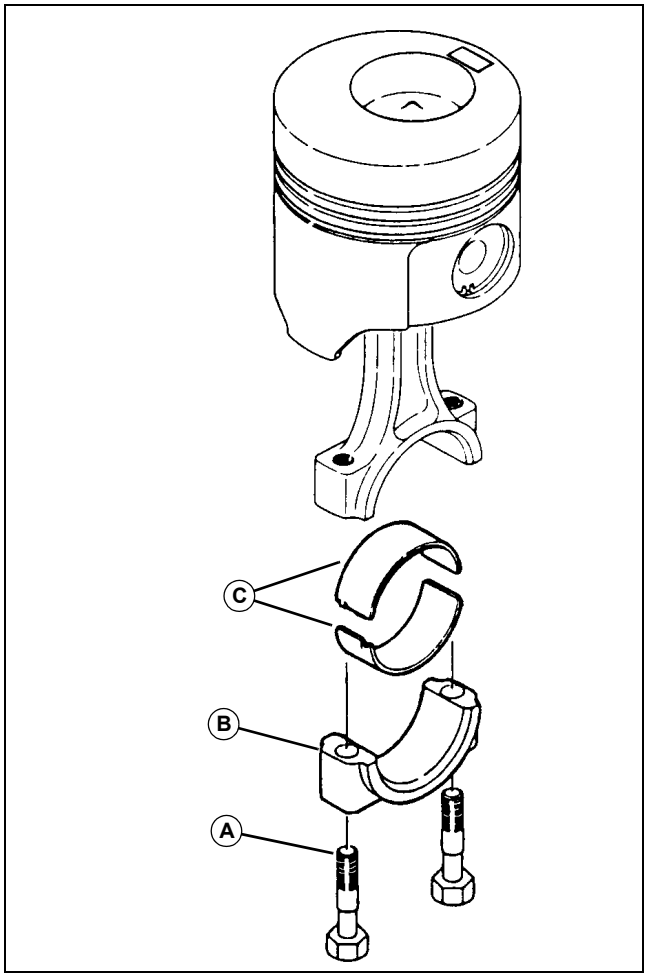
Piston-to-Cylinder
Head Clearance . . . . 0.72 ± 0.06 mm (0.025 ± 0.002 in.)

Remove and Install Piston and Connecting Rod

Removal

1. Remove the oil pan and oil pickup tube.
2. Remove the cylinder head. (See “Remove and Install Cylinder Head and Valves” on page 73.)
3. Check the cylinder bore for ridges. These ridges can cause damage to piston if ridge is not removed.
4. If necessary, remove any ridge from the top of the cylinder bore using a ridge reamer.
5. Measure the connecting rod side play. (See “Check Connecting Rod Side Play” on page 50.)
6. Measure the crankshaft end play. (See “Check Crankshaft End Play” on page 51.)
7. Measure the connecting rod bearing clearance. (See “Check Connecting Rod Bearing Clearance” on page 51.)

Important: Avoid Damage! Keep the connecting rods and rod caps together. Rods and caps are a matched set. Note the alignment marks on each part.



M82196AB

8. Remove the rod cap screws (A), connecting rod cap (B), and bearing inserts (C).

Important: Avoid Damage! The pistons and cylinders are matched. Pistons must be installed in the cylinders from which they were removed.

9. Note the connecting rod alignment mark in relation to the cylinders. Start at the flywheel end with cylinder No. 1, then No. 2, etc.

10.Push the piston and connecting rod out of the cylinder bore using a wooden dowel.

11.Disassemble and inspect all parts for wear or damage.

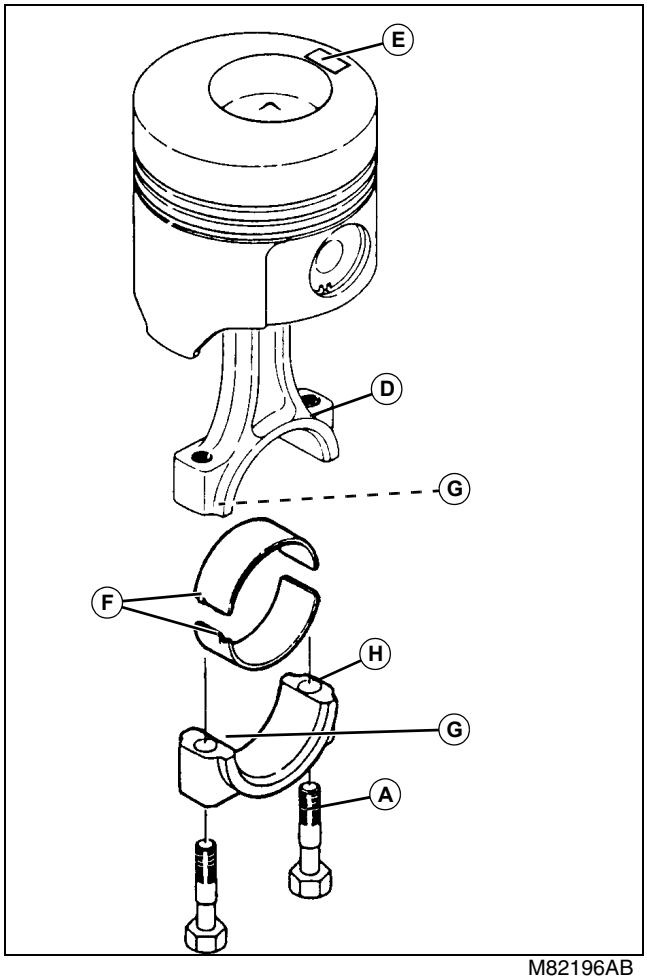
12.Inspect the cylinder bore. (See “Inspect Cylinder Bore” on page 85. See “Inspect Cylinder Bore Taper and Out-of-Round” on page 87.)

Installation

- Apply clean engine oil to all parts during installation.
- Always replace the connecting rod cap screws. DO NOT reuse the cap screws.

Important: Avoid Damage! Pistons must be installed in the cylinders from which they were removed and in the same direction. Be careful not to damage the crankshaft rod journals while installing pistons.

1. Assemble the piston and connecting rod. (See “Disassemble and Assemble Piston and Connecting Rod” on page 81.)



M82196AB

2. Install the piston and connecting rod into the cylinder from which it was removed. The alignment mark on the connecting rod (D) and/or the piston size mark (E) on top of piston should point toward the fuel injection pump.

Important: Avoid Damage! Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

3. Install the bearing inserts to the connecting rod and rod cap, aligning tangs (F) with grooves (G).

Important: Avoid Damage! Connecting rod caps must be installed on the same connecting rods they were removed from.

4. Match the connecting rods to caps using alignment marks (H). Install the rod caps.

5. Dip the entire connecting rod cap screw in clean engine oil. Install new cap screws (A) and tighten to specification.

6. If a new piston and connecting rod were installed, stamp a number corresponding to the cylinder number on the connecting rod and rod cap.

7. Install the cylinder head.

8. Install oil pan and oil pickup tube.

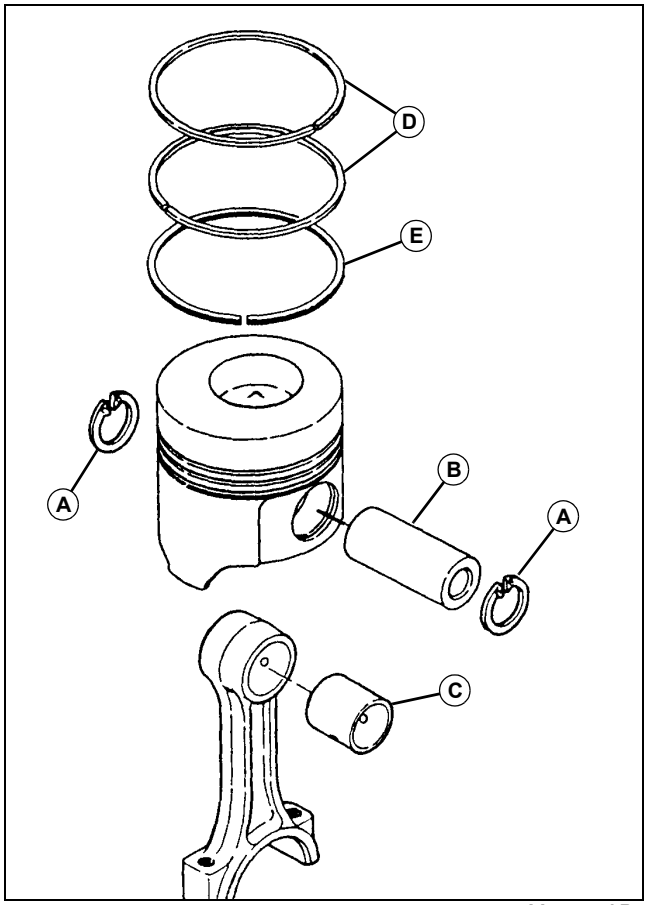
Specifications

Connecting Rod Cap Screw Torque . . 47 N•m (35 lb-ft)

Disassemble and Assemble Piston and Connecting Rod

Disassembly

Important: Avoid Damage! Pistons must be installed on the same connecting rod they were removed from.



M82197AB

1. Put a mark on each piston and connecting rod to aid in assembly.

2. Remove snap rings (A) from piston pin (B) and remove pin.

3. The piston pin bushing (C) is a press fit in the connecting rod. Remove the bushing only if replacement is necessary.

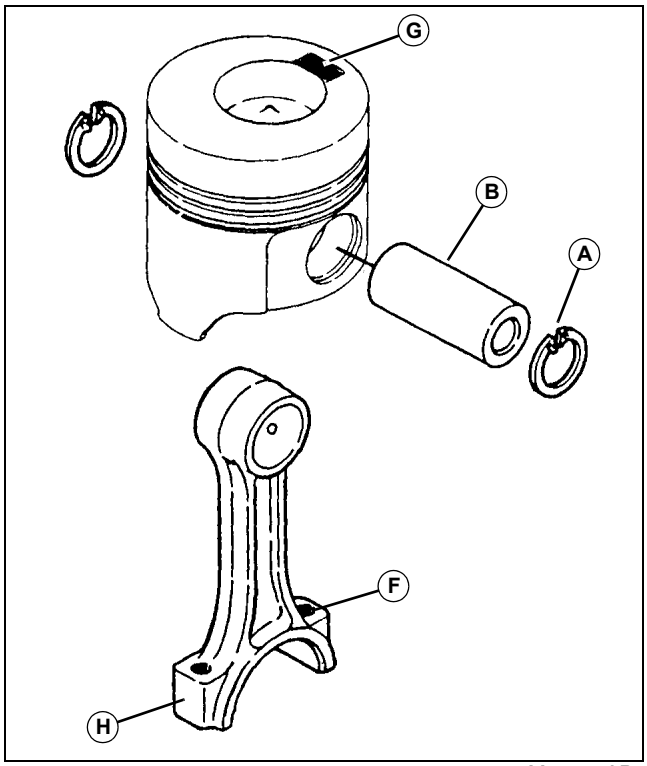
4. Inspect all parts for wear or damage. Replace as necessary.

5. Remove the 1st and 2nd compression rings (D) and oil ring with expander (E).

Assembly

- Apply clean engine oil to all parts during assembly.

Important: Avoid Damage! The pistons must be installed on the same connecting rod they were removed from.

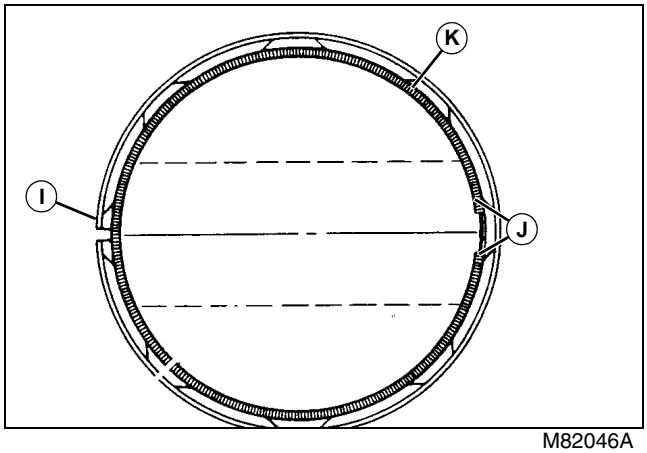


M82198AB

1. Assemble the piston to the connecting rod with piston mark (G) on the same side as the connecting rod stamped mark (F). If a new connecting rod is used, assemble the piston to the connecting rod with piston mark opposite the connecting rod bearing insert groove (H). Be sure the oil hole in the piston pin bushing is aligned with the hole in the connecting rod.

2. Install the piston pin (B) and retaining rings (A).

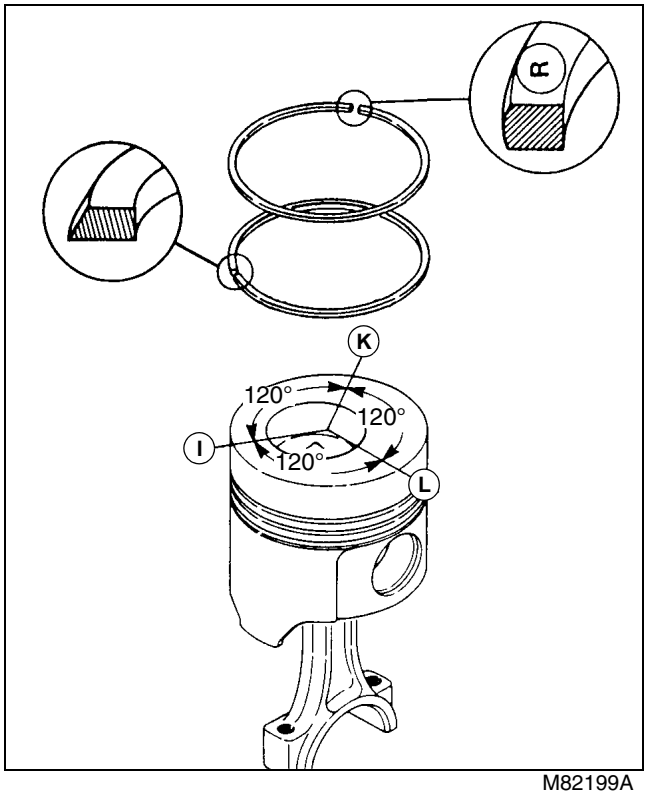
3. Install an oil ring expander (E) in the bottom ring groove of the piston, with the ends above either end of the piston pin.



M82046A

4. Install the oil ring over the expander with the ring gap (I) opposite (180°) of the expander ends (J).

5. Install the second compression ring, with the small diameter of taper toward top of piston, in the middle groove. Turn the ring until the gap (K) is 120° away from the oil ring gap (I).



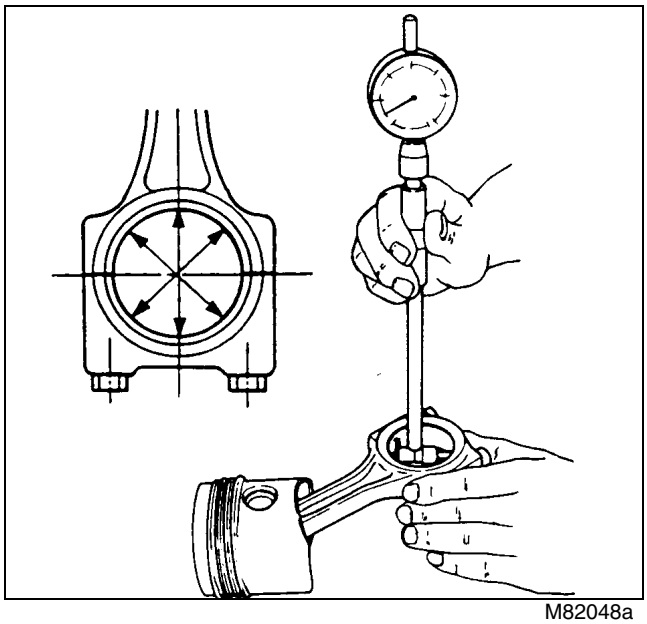
M82199A

6. Install the first compression ring (chrome plated), with the manufacturer's mark “R”, “T”, or “RN” (near the ring gap) toward the top of the piston, in the top groove. Turn the ring until the gap (L) is 120° away from the second ring gap (K) and 120° away from the oil ring gap (I).

Inspect Piston and Connecting Rod

Connecting Rod Bearing

1. Install the connecting rod cap and bearing inserts on the connecting rod. Install the old connecting rod cap screws and tighten to specification.

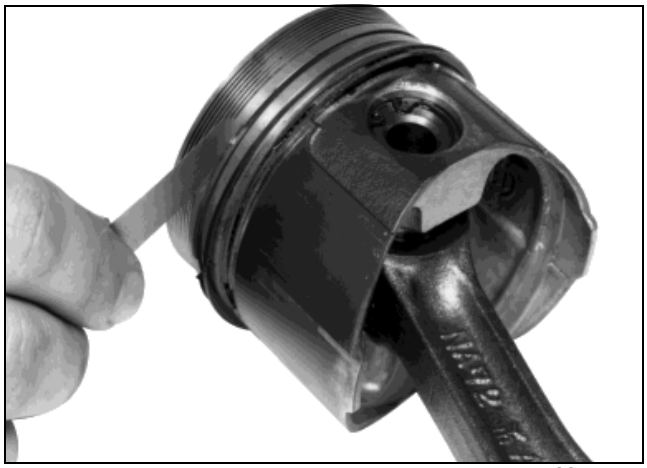

M82048a

2. Measure the connecting rod bearing inside diameter and compare with specifications. Replace bearing if bearing ID is greater than wear limit.

3. Measure the oil clearance between the bearing inserts and the crankshaft. Compare measurement with specification.

- If the bearing oil clearance exceeds the wear limit, grind the crankshaft connecting rod journals and install undersized bearing inserts, or replace the bearing inserts and the crankshaft.

Piston Ring Groove Clearance

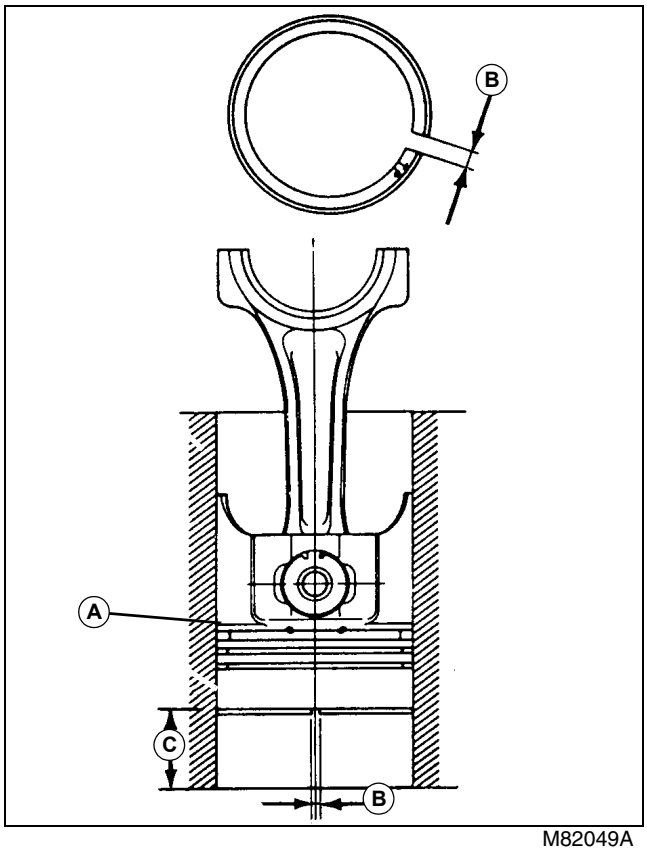


M35360

1. With the rings installed on the piston, measure the piston ring groove side clearance. Measure at several places around each piston and compare with specification.

2. Replace the rings or the piston if the clearances exceed specification.

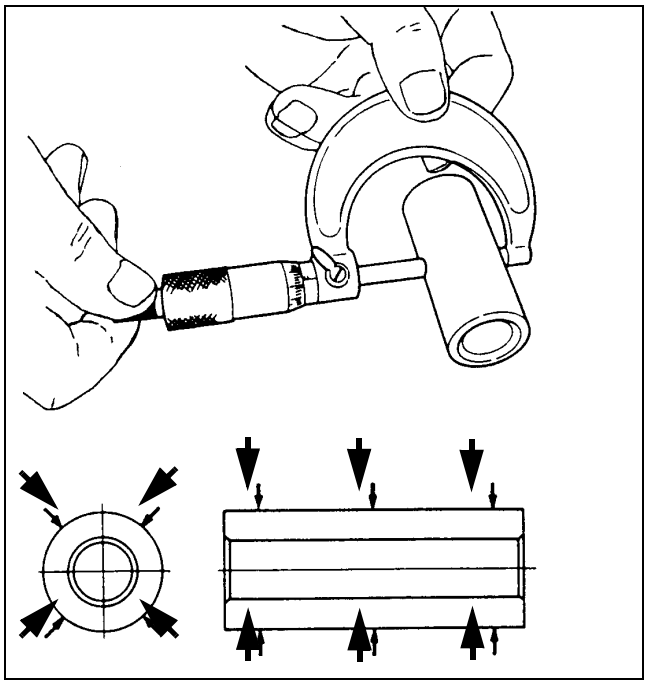
Piston Ring End Gap



M82049A

1. Use a piston to push the ring (A) approximately 30 mm (1.18 in.) (C) from the bottom of the cylinder bore. Measure the piston ring end gap (B) and compare with specifications.

Piston Pin Diameter



M82050A

1. Measure the piston pin diameter at six places and compare with specifications. Replace any pin that is not within specification.

Piston Pin Bore

M37683

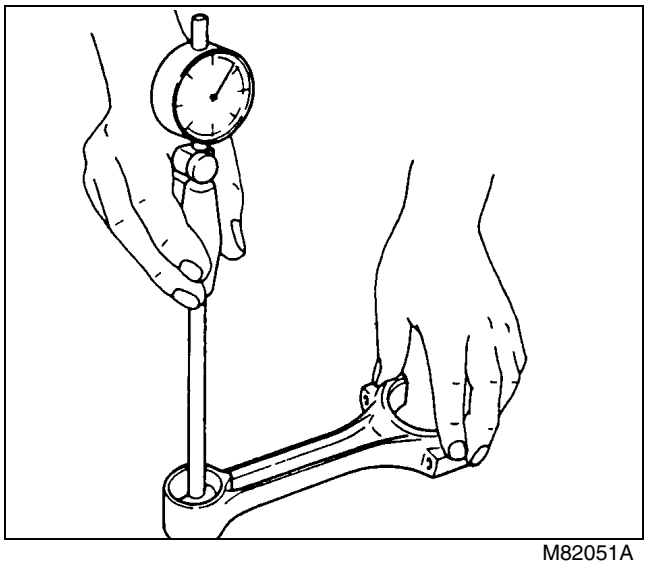
1. Measure the pin bore diameter in the piston and compare with specifications.

2. Piston pin-to-piston oil clearance is the bore ID minus the pin OD. Compare piston pin-to-piston clearance with specifications.

- If the piston pin bore exceeds the wear limit, replace the piston.
- If the piston pin is less than the wear limit, replace the piston pin.
- If the bore clearance exceeds the wear limit, replace the piston, piston pin, or both.

Piston Pin Bushing

Note: The piston pin bushing is press fit. Replace the bushing using a driver set. When installing the bushing, make sure to align the oil hole in the bushing with the hole in the connecting rod.



M82051A

1. Measure the piston pin bushing diameter in the connecting rod and compare with specifications.

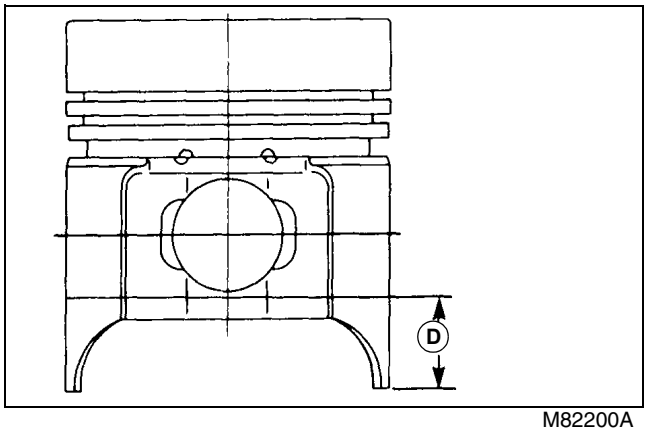
   • If the bushing diameter exceeds the wear limit, replace bushing.

2. Piston pin-to-rod bore oil clearance is the bore ID minus the pin OD.

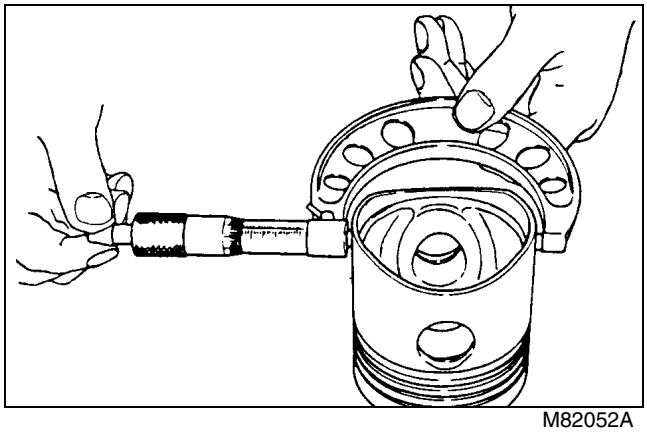
   • If the bushing clearance (bushing ID minus pin OD) exceeds specification, replace the bushing or the piston pin.

Piston Diameter

Note: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.



M82200A



M82052A

1. Measure the piston diameter perpendicular to the piston pin bore 23 mm (0.905 in.) (D) from the bottom of the piston skirt and compare with specifications.

• If piston diameter is less than wear limit, install a new piston.

Specifications

Connecting Rod Bearing

Connecting Rod Cap Screw Torque . . . 47 N•m (35 lb-ft)
Bearing ID . . . . . 47.952-47.962 mm (1.888-1.891 in.)
Wear Limit . . . . . 48.07 mm (1.893 in.)
Bearing Oil Clearance . . . . . 0.038-0.074 mm (0.001-0.003 in.)

Piston Ring Groove Clearance

First Compression Ring Groove Side Clearance . . . . . 0.075-0.11 mm (0.003-0.004 in.)
Wear Limit . . . . . 0.025 mm (0.010 in.)

Second Compression Ring Groove
Side Clearance . . . . . 0.045-0.080 mm (0.002-0.003 in.)
Wear Limit . . . . . 0.025 mm (0.010 in.)
Oil Control Ring Groove
Side Clearance . . . . . 0.025-0.060 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.020 mm (0.008 in.)

Piston Ring End Gap

Piston Ring End Gap . . . 0.20-0.40 mm (0.008-0.016 in.)
Wear Limit . . . . . 1.50 mm (0.059 in.)

Piston Pin Diameter

Wear Limit . . . . . 22.90 mm (0.902 in.)
Piston Pin OD . . . . . 25.99-26.00 mm (1.023-1.024 in.)
Wear Limit . . . . . 25.97 mm (1.022 in.)

Piston Pin Bore

Piston Pin
Bore ID. . . . . 26.00-26.01 mm (1.0236-1.0240 in.)
Wear Limit . . . . . 26.04 mm (1.025 in.)
Piston Pin-to-Piston
Oil Clearance. . . . . 0.00-0.02 mm (0.00-0.001 in.)
Wear Limit . . . . . 0.12 mm (0.005 in.)

Piston Pin Bushing

Piston Pin
Bushing ID. . . . . 26.025-26.038 mm (1.0246-1.0251 in.)
Wear Limit . . . . . 26.07 mm (1.026 in.)
Piston Pin-to-Rod Bore
Oil Clearance. . . . . 0.03-0.05 mm (0.001-0.002 in.)
Wear Limit . . . . . 0.10 mm (0.004 in.)

Piston

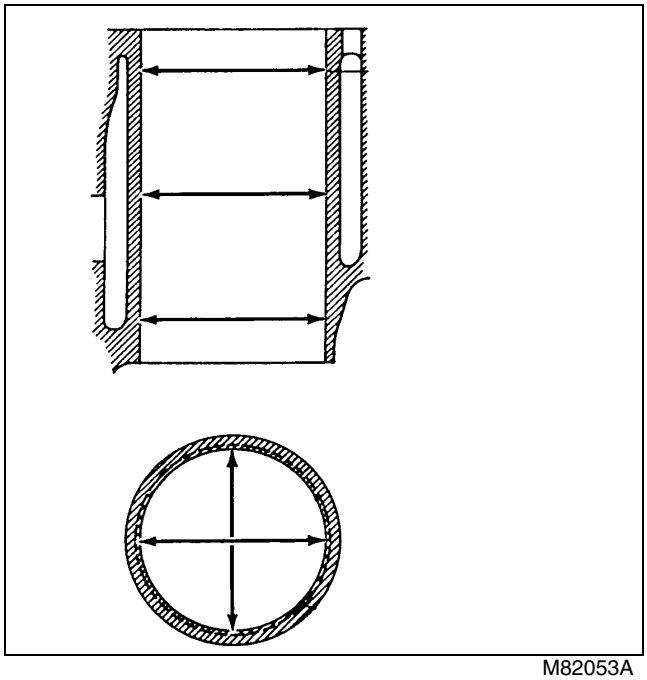
Standard
Piston OD . . . . . 83.95-83.98 mm (3.305-3.306 in.)
Wear Limit . . . . . 83.90 mm (3.303 in.)
Oversize
Piston OD . . . . . 84.20-84.23 mm (3.315-3.316 in.)
Wear Limit . . . . . 84.10 mm (3.311 in.)

Inspect Cylinder Bore

Note: If the engine has had a previous major overhaul, the cylinders may have been bored oversize. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

Cylinder Bore Diameter

Note: Slight uneven wear, flaws, or minor damage may be corrected by deglazing.



M82053A

1. Measure the cylinder bore diameter at three positions: top, middle, and bottom. At these three positions, measure in both directions: along the crankshaft centerline and the direction of the crankshaft rotation. Compare measurements with specifications.

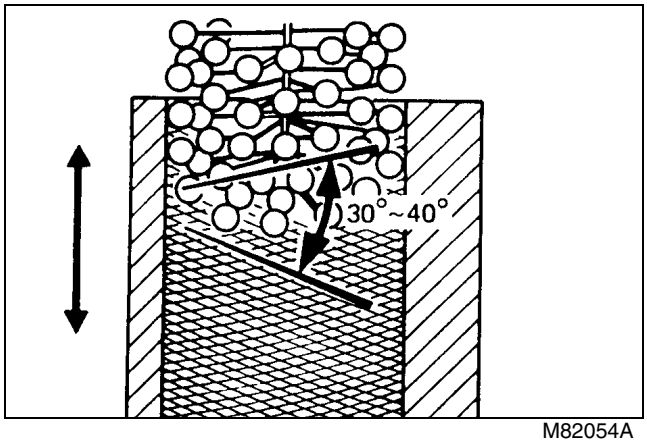
   - If the cylinder bore standard ID exceeds the wear limit, have the cylinder rebored.
   - If the cylinder is rebored, oversize pistons and rings must be installed.
   - If the cylinder bore exceeds the oversize bore ID, replace the cylinder block.

2. Determine piston-to-cylinder bore clearance (cylinder bore ID minus piston OD). If piston-to-cylinder bore clearance exceeds specifications, replace the cylinder block, piston, or both, or rebore cylinder and install oversize piston and rings.

Deglazing

Important: Avoid Damage! If the cylinder bores are to be deglazed with crankshaft installed in engine, put clean shop towels over crankshaft to protect journal and bearing surfaces from any abrasives.

1. Deglaze the cylinder bores using a flex-hone with 180 grit stones.



M82054A

2. Use the flex-hone as instructed by the manufacturer to obtain a 30-40° crosshatch pattern as shown.

Important: Avoid Damage! Do not use gasoline, kerosene or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Remove excess abrasive residue from the cylinder walls using a clean, dry rag. Clean the cylinder walls using clean white rags and warm soapy water. Continue to clean the cylinder until white rags show no discoloration.

Reboring

Note: The cylinder block can be rebored to use oversize pistons and rings. Pistons and rings are available in 0.25 mm (0.010 in.) oversize.

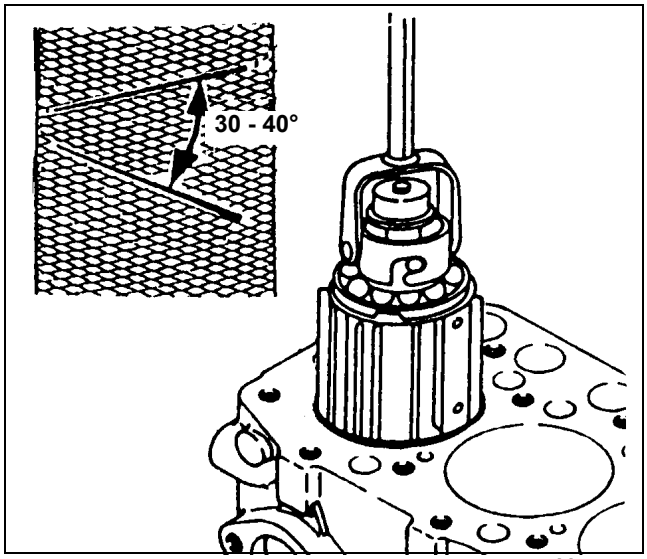
1. Align the center of bore to the drill press center.

Important: Avoid Damage! Check stone for wear or damage. Use a rigid hone with 300-grit stones.

2. Adjust the hone so the lower end is even with the lower end of cylinder bore.

3. Adjust the rigid hone stones until they contact the narrowest point of the cylinder.

4. Coat the cylinder with honing oil. The hone should turn by hand. Adjust the hone if it is too tight.



M52959

5. Run the drill press at about 250 rpm. Move the hone up and down in order to obtain a 30-40° crosshatch pattern.

Note: Measure the bore when the cylinder is cool.

6. Stop the press and check the cylinder diameter.

Note: Finish should not be smooth. It should have a 30-40° crosshatch pattern.

7. Remove the rigid hone when the cylinder is within 0.03 mm (0.001 in.) of desired size.

8. Use a flex-hone with 180-grit stones for honing to final size.

9. Check the bore for size.

10. Check bore for taper and out-of-round. (See “Inspect Cylinder Bore Taper and Out-of-Round” on page 87.)

Important: Avoid Damage! Do not use solvents to clean the cylinder bores. Solvents will not remove all the metal particles and abrasives produced during honing.

11. Clean the cylinder thoroughly using warm soapy water until clean white rags show no discoloration.

12. Dry the cylinder and apply engine oil.

Specifications

Cylinder Bore

Standard Cylinder
Bore ID . . . . . 84.00-84.03 mm (3.307-3.308 in.)
Wear Limit. . . . . 84.20 mm (3.315 in.)
Oversize Cylinder
Bore ID . . . . . 84.25-84.28 mm (3.317-3.318 in.)
Wear Limit. . . . . 84.45 mm (3.325 in.)

Piston-to-Cylinder
Bore Clearance . . . . . 0.040-0.070 mm (0.001-0.003 in.)

Inspect Cylinder Bore Taper and Out-of-Round

1. Use a cylinder dial gauge and inside micrometer, or a telescope gauge and outside micrometer, to measure cylinder bore.

2. Measure the bore parallel to the crankshaft at the top end of the ring travel zone.

3. Measure the bore in the same position at the bottom end of the ring travel zone.

4. Measure the bore at right angles to the crankshaft at the top end of the ring travel zone.

5. Measure the bore in the same position at the bottom end of the ring travel zone.

6. Compare measurements from steps 2 and 4 to find the out-of-round wear at the top end of the bore.

7. Compare measurements from steps 3 and 5 to find the out-of-round wear at the bottom end of the bore.

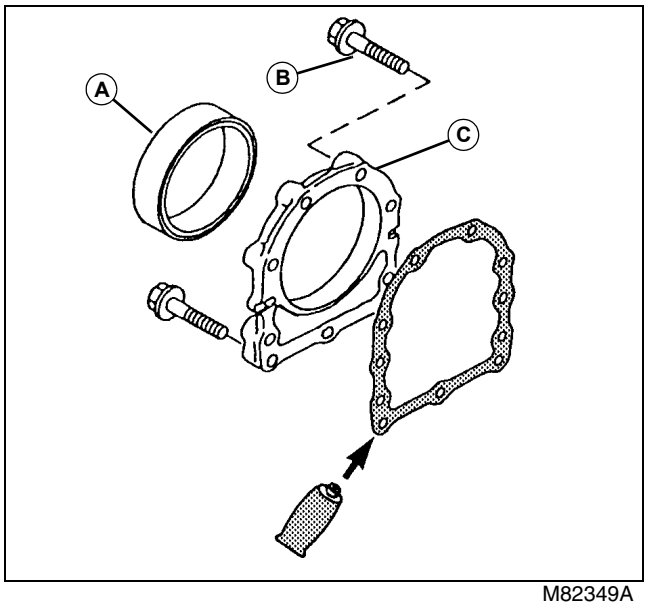
8. Compare results of measurements from steps 2, 3, 4, and 5 to find out whether the bore has worn tapered.

Specifications

Cylinder Roundness. . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)
Cylinder Taper. . . . . 0.00-0.01 mm (0.00-0.0004 in.)
Wear Limit . . . . . 0.03 mm (0.001 in.)

Replace Crankshaft Rear Oil Seal

1. Remove flywheel. (See “Remove and Install Flywheel” on page 90.)



M82349A

2. Remove the rear oil seal (A), case-to-crankcase extension cap screws, and the oil seal case-to-crankcase cap screws (B).

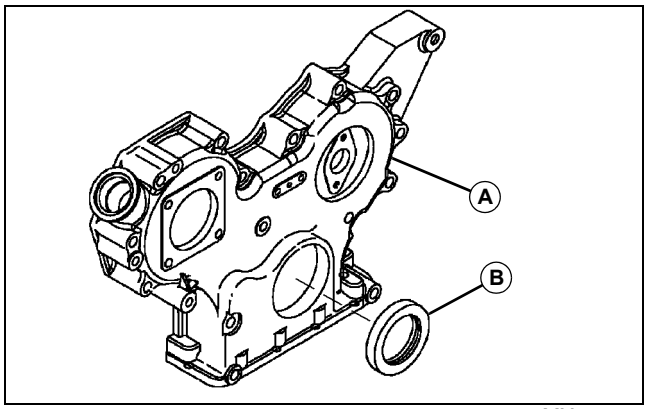
3. Remove the rear oil seal case (C).

4. Replace the oil seal using an appropriate seal driver, with the lip toward the cylinder block, flush with the surface of the oil seal case.

Note: If the crankshaft is grooved at the oil seal contact point, the seal can be installed 3 mm (0.12 in.) farther into the oil seal case.

5. Install the oil seal case to the crankcase and crankcase extension.

Replace Crankshaft Front Oil Seal



MX25184

1. Remove the timing gear cover (A). (See “Remove and Install Timing Gear Cover” on page 96.)

2. Replace the oil seal (B). Install new seal with the lip toward inside of gear housing cover, flush with the surface of the cover.

Remove and Install Crankshaft and Main Bearings

Removal

1. Check the crankshaft end play. (See “Check Crankshaft End Play” on page 51.)

2. Remove the cylinder head. (See “Remove and Install Cylinder Head and Valves” on page 73.)

3. Remove rear oil seal. (See “Replace Crankshaft Rear Oil Seal” on page 87.)

4. Remove timing gear cover mounting plate. (See “Remove and Install Timing Gear Cover Mounting Plate” on page 98.)

5. Check the crankshaft rod bearing clearance. (See “Check Connecting Rod Bearing Clearance” on page 51.)

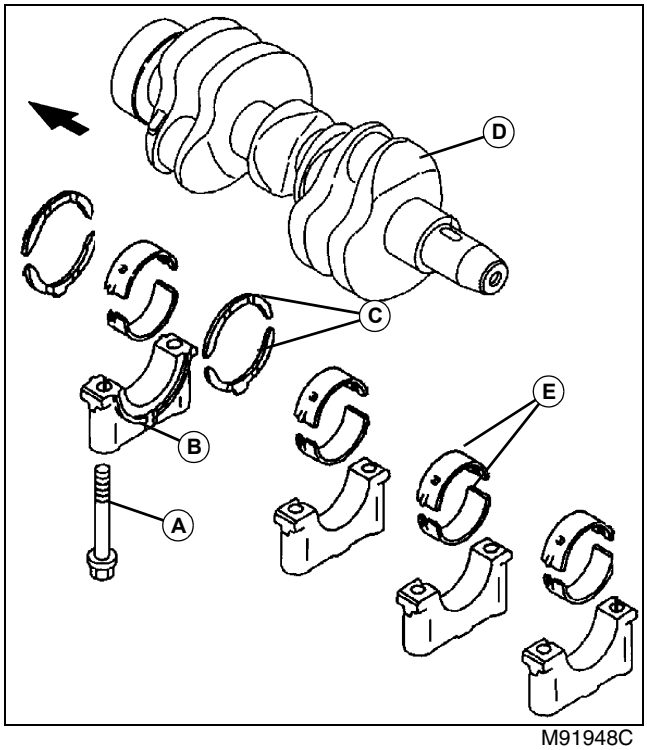
Important: Avoid Damage! Connecting rod caps must be installed on the same connecting rods from which they were removed. Note the alignment marks on the caps and rods.

6. Check the crankshaft main bearing clearance. (See “Check Crankshaft Main Bearing Clearance” on page 52.)

Important: Avoid Damage! Main bearing caps must be installed on the same main bearings from which they were removed.

7. Remove the connecting rod cap screws and rod caps. Discard the connecting rod cap screws.

8. Push the pistons and connecting rods away from crankshaft.



M91948C

9. Remove the main bearing cap screws (A), main bearing caps (B) and thrust bearings (C).

10. Remove the crankshaft (D).

11. Remove the block thrust bearings and main bearing inserts (E).

12. Inspect all parts for wear or damage.

Installation

Important: Avoid Damage! Do not touch bearing insert surfaces. Oil and acid from your finger will corrode the bearing surface.

1. Apply clean engine oil to all parts during installation.

2. Install the grooved bearing inserts in the crankshaft bearing bores, aligning the tangs with the slots in the bores.

3. Install the thrust bearings with the oil grooves facing away from the engine block.

4. Install the crankshaft.

5. Install the bearing inserts in the main bearing caps, aligning the tangs with the slots in the caps.

Note: The main bearing caps have raised arrows that are stamped with numbers. Both correspond to their location on the engine block. Install all bearing caps with the arrow toward the flywheel end of the engine. Install the bearing caps, beginning with the thrust bearing cap (no number), No. 1, then No. 2, etc. The main bearing cap at the gear train end does not have a number.

6. Install the thrust bearings, with the oil grooves facing away from the cap, in the No.1 main bearing cap.

7. Install the main bearing caps in their original locations with arrows pointing toward the flywheel side of the engine.

Important: Avoid Damage! DO NOT use high-speed power tools or air wrenches to tighten main bearing cap screws.

8. Dip each main bearing cap screw entirely in clean engine oil. Install the cap screws but do not tighten.

9. Using a soft-faced hammer, tap the front end of the crankshaft, then the rear end of the crankshaft, to align the thrust bearings.

10.Tighten the main bearing cap screws to specification. When tightening, start at the center main bearing cap and work your way out, alternating to the ends. Turn the crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

Important: Avoid Damage! The connecting rod caps must be installed on the same connecting rods they were removed from.
Never reuse connecting rod cap screws; replace with new.

11.Match the connecting rod caps to the rods using alignment marks. Install the caps to the rods.

12.Dip entire connecting rod cap screw in clean engine oil. Install new cap screws and tighten to specification. Turn crankshaft by hand. If it does not turn easily, disassemble the parts and find the cause.

13.Install the timing gear cover mounting plate.

14.Install the rear oil seal.

15.Install the flywheel.

16.Install the timing gear cover.

17.Install the front oil seal.

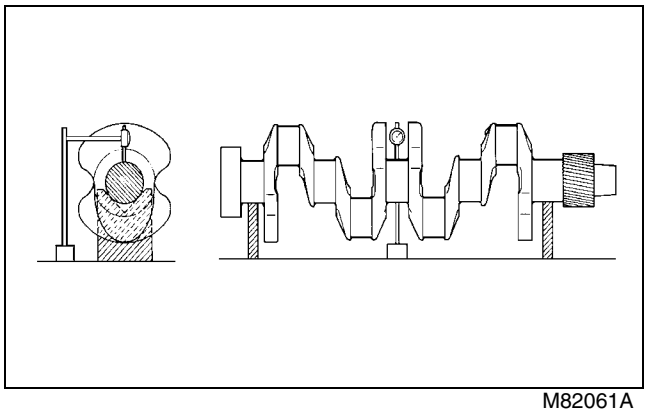
18.Install the oil pan.

Specifications

Main Bearing Cap Screw Torque. . . . . 98 N•m (72 lb-ft)
Connecting Rod Cap Screw Torque . . 47 N•m (35 lb-ft)

Inspect Crankshaft and Main Bearings

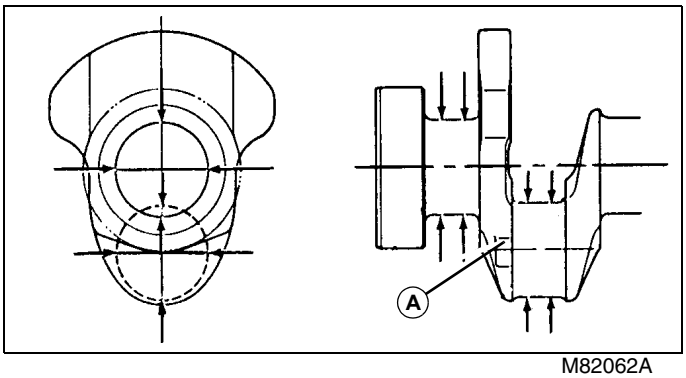
1. Inspect the crankshaft gear for chipped or broken teeth. Replace if necessary.



M82061A

2. Inspect the crankshaft for bend using V-blocks and a dial indicator. Turn the crankshaft slowly and read variations on the indicator. If the variation is greater than specification, replace the crankshaft.

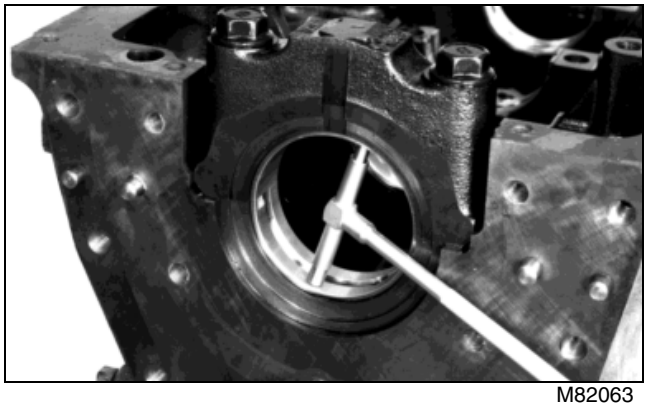
3. Measure the crankshaft connecting rod journal and main bearing journal diameters at several places around each journal.



M82062A

- If the journal diameter (A) is less than the specification but greater than the wear limit, have the journals ground undersize by a qualified machine shop.
- If journals are ground, undersize bearing inserts must be installed. Bearing inserts are available in 0.25 mm (0.010 in.) undersize.
- If the journal diameter is less than the wear limit, replace the crankshaft.

4. Install the bearing inserts and main bearing caps on the main bearings. Tighten the main bearing cap screws to specification.



M82063

5. Measure the main bearing inner diameter.

6. Subtract the main bearing journal OD of the crankshaft from the main bearing ID to obtain the main bearing oil clearance.

- If the crankshaft is within specification but the main bearing oil clearance exceeds the wear limit, replace the bearing inserts.
- If the crankshaft is not within specification, have crankshaft journals ground undersize by a qualified machine shop and install undersized bearing inserts.
- If the crankshaft is worn past the wear limit, replace the crankshaft.

7. Clean and inspect the oil passages in the main bearing journals, connecting rod journals, and main bearing bores in cylinder block.

8. Inspect the crankshaft for cracks or damage. Replace if necessary.

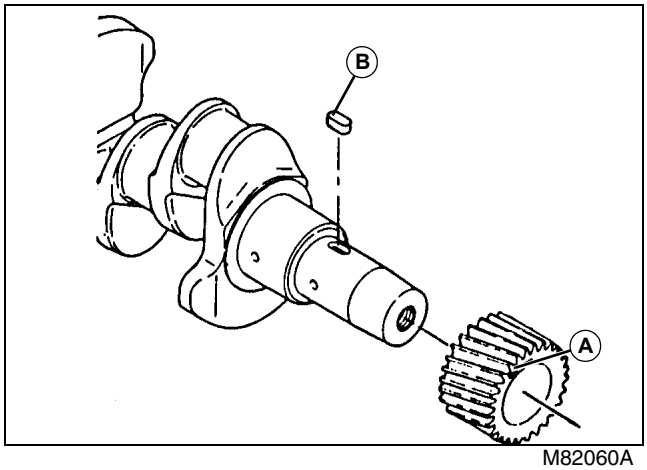
Specifications

Crankshaft Bend Variation. . . . . 0.02 mm (0.001 in.)
Connecting Rod
Journal OD . . . . . 47.95-47.96 mm (1.8878-1.8882 in.)
Wear Limit . . . . . 47.91 mm (1.886 in.)
Main Bearing
Journal OD . . . . . 53.95-53.96 mm (2.1240-2.1244 in.)
Wear Limit . . . . . 53.91 mm (2.122 in.)
Main Bearing
Oil Clearance. . . . . 0.038-0.074 mm (0.001-0.003 in.)
Wear Limit . . . . . 0.15 mm (0.006 in.)
Main Bearing
Cap Screw Torque . . . . . 98-100 N•m (71-74 lb-ft)

Remove and Install Crankshaft Gear

1. Remove the gear from crankshaft using a knife-edge puller and a press.

Caution: Avoid Injury! DO NOT heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

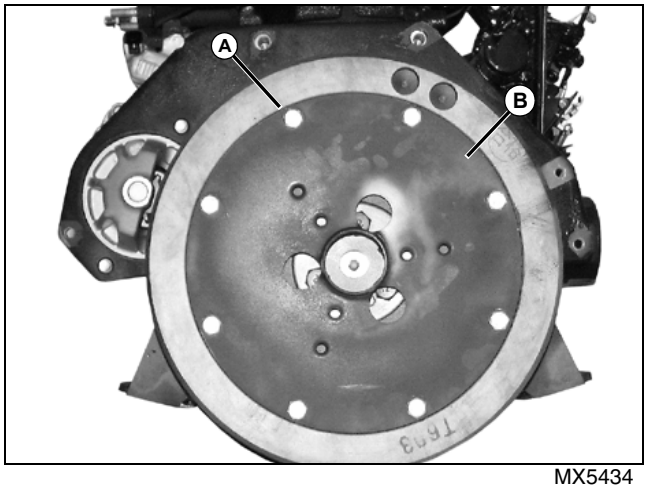


M82060A

2. Heat new gear to approximately 150°C (302°F). Install gear with timing mark (A) toward press table. Align slot in gear with key (B) in shaft. Press crankshaft into gear until gear is tight against crankshaft shoulder.

Remove and Install Flywheel

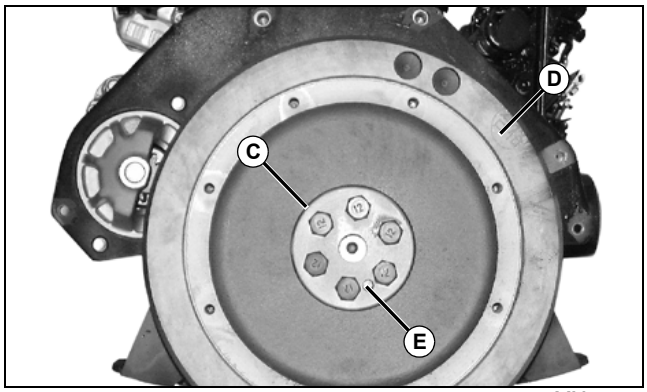
1. Flywheel can be removed without removing engine from machine. If removing flywheel in machine, remove engine driveshaft first.



MX5434

2. Remove eight cap screws (A) and flex plate (B).

Important: Avoid Damage! Always install new flywheel mounting cap screws.



MX5435

3. Remove the flywheel mounting cap screws (C) and remove the flywheel (D) from crankshaft.

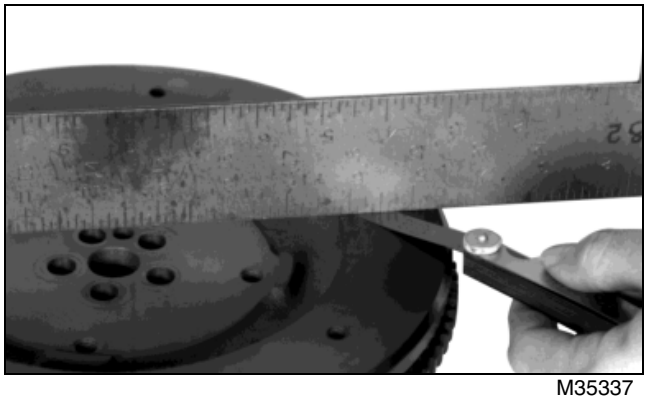
Installation

1. Use pin (E) in crankshaft to correctly locate the flywheel on the crankshaft.

2. Install the flywheel. Apply lubrication oil to the mounting cap screws and tighten to specification.

3. Install flex plate with raised hub facing away from flywheel.

4. Install cap screws and tighten to specification.


M35337

5. Measure flywheel flatness. Place a straightedge across the flywheel surface opposite of ring gear. Measure the clearance between the straightedge and the flywheel surface with a feeler gauge. Replace the flywheel if the clearance exceeds specification.

Specifications

Flywheel Out-of-Flat (Maximum) . . . 0.02 mm (0.001 in.)
Flywheel Mounting
Cap Screw Torque . . . . . 83-88 N•m (62-65 lb-ft)

Remove and Install Camshaft

Special or Required Tools

Tool Name	Tool No.	Tool Use
Magnetic Follower Holder Kit	D15001NU	Used to hold cam followers away from camshaft.

Removal

1. Remove the rocker arm assembly and push rods. (See “Remove and Install Rocker Arm Assembly” on page 71.)

2. Remove the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 96.)

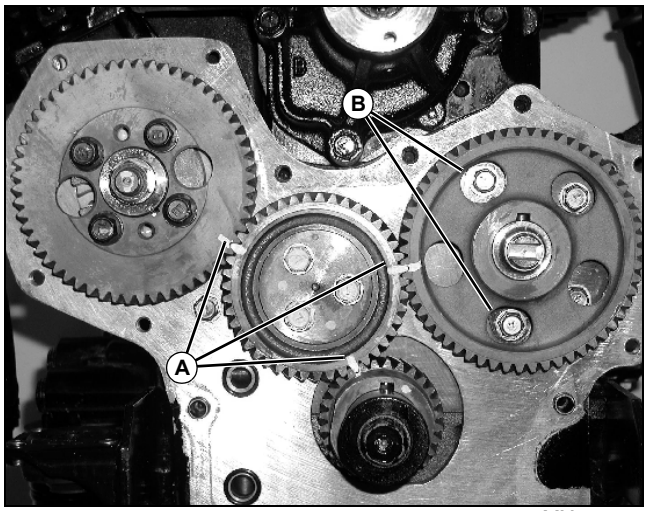
3. Check the camshaft end play. (See “Check Camshaft End Play” on page 53.)

4. Check the backlash of the timing gears. (See “Check Timing Gear Backlash” on page 53.)

Note: If a magnetic follower holder kit is not available, turn engine until oil pan is upward to hold cam followers away from camshaft.

5. Hold the cam followers away from the camshaft using D15001NU Magnetic Follower Holder Kit, or equivalent.

Note: Several rotations may be required to line up all timing marks.



MX20049

6. Rotate the crankshaft and align the timing marks (A).

Important: Avoid Damage! DO NOT allow the camshaft lobes to hit any bearing surfaces while removing the camshaft. Machined surfaces can be damaged.

7. Remove two thrust plate mounting cap screws (B), the thrust plate, and the camshaft.

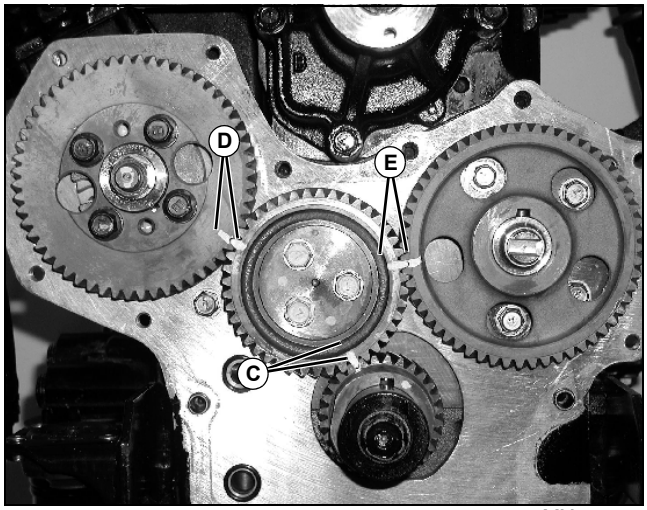
8. Inspect all parts for wear or damage.

Installation

Apply clean engine oil on all parts during installation.

Important: Avoid Damage! DO NOT allow camshaft lobes to hit bearing surfaces while installing camshaft. Machined surfaces and bearings can be damaged.

Note: Several rotations may be required to line up all timing marks.



MX20049

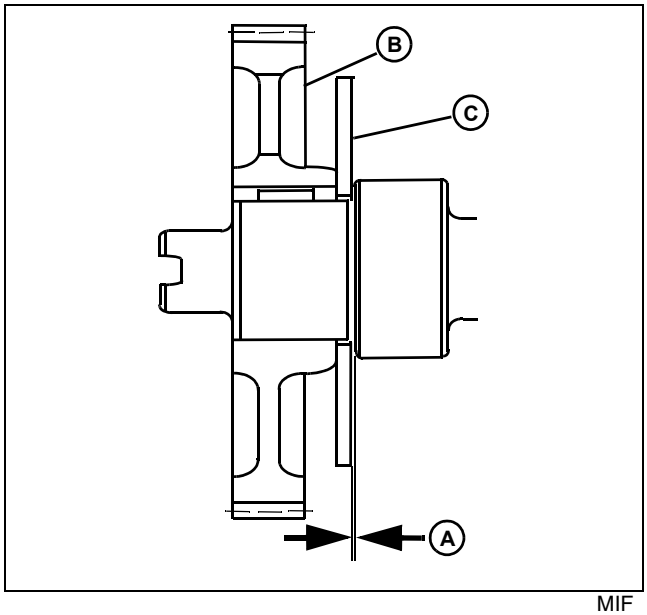
1. Rotate the crankshaft to align the timing marks (C, D, and E).
2. Install the camshaft.
3. Install the thrust plate and thrust plate mounting cap screws. Tighten cap screws to specification.
4. Install the timing gear cover.
5. Install push rods and rocker arm assembly.

Specifications

Thrust Plate Mounting
Cap Screw Torque . . . . . 26 N•m (226 lb-in.)

Inspect Camshaft

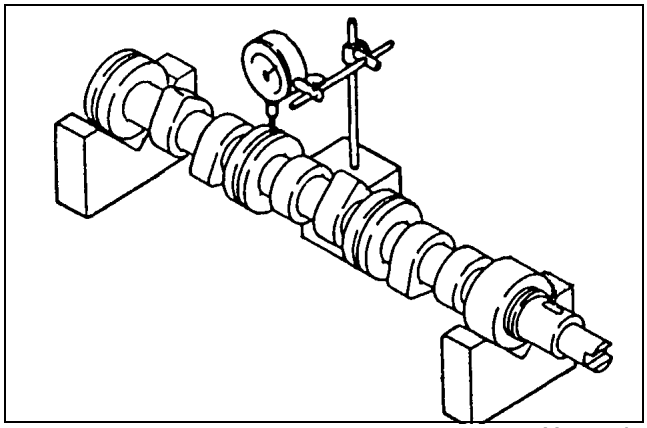
Camshaft End Play



MIF

1. Check the camshaft end play (A) using a feeler gauge.
2. If the end play exceeds specification, remove the camshaft gear (B) and replace thrust plate (C). (See “Remove and Install Camshaft Gear” on page 94.)

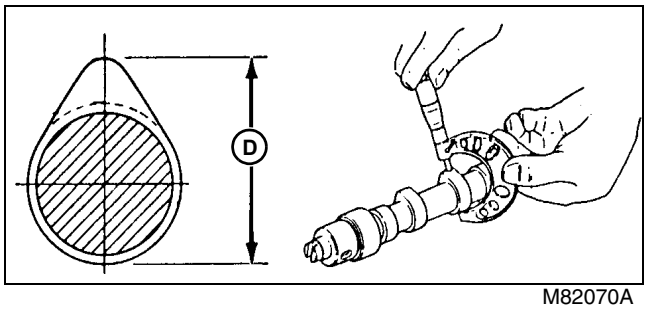
Camshaft Bend



M82291A

1. Inspect the camshaft for bend using V-blocks and a dial indicator. Turn the camshaft slowly and read variation on the indicator.
   - If the variation is greater than specification, replace the camshaft.

Camshaft Lobe Height

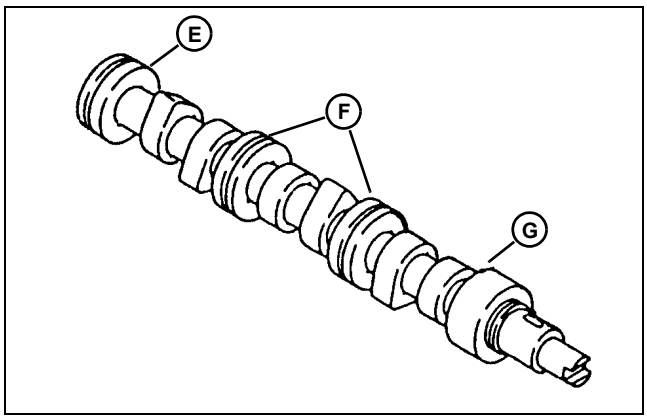


M82070A

1. Measure the camshaft lobe height (D) and compare with specifications.

   • If the lobe height is less than wear limit, replace the camshaft.

Camshaft Journals



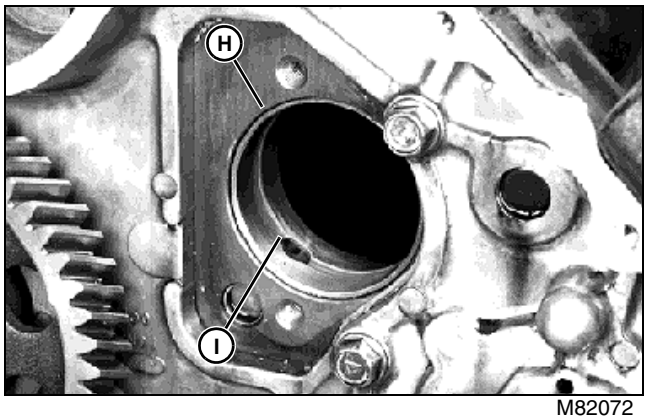
M82292A

1. Measure gear housing (G) and flywheel end (E) camshaft journal outside diameters and compare with specifications.

2. Measure intermediate (F) camshaft journal outside diameters and compare with specifications.

3. If journal diameters are less than wear limit, replace the camshaft.

Camshaft Bushings



M82072

1. Measure the camshaft bushing (H) inside diameter at the gear housing end and compare with specifications.

2. If bushing diameter exceeds wear limit, replace bushing.

3. If bushing clearance (bushing ID minus camshaft journal OD) exceeds specification, replace bushing, camshaft, or both.

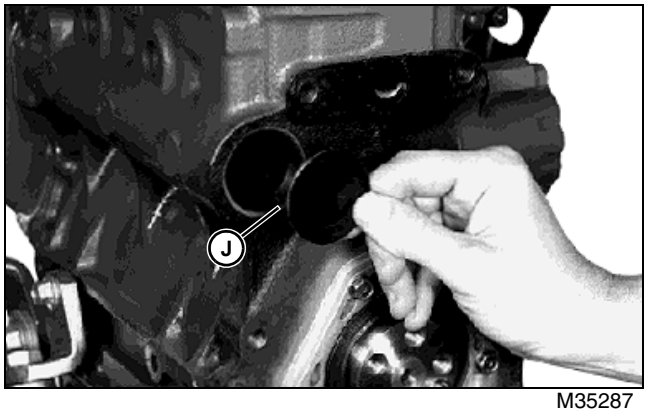
4. If replacing the camshaft bushing:

   a. Use a chisel to remove the bushing. Be careful not to push the bushing inside the engine.

   b. Align the oil holes (I) in new bushing and cylinder block. Install bushing using a driver set.

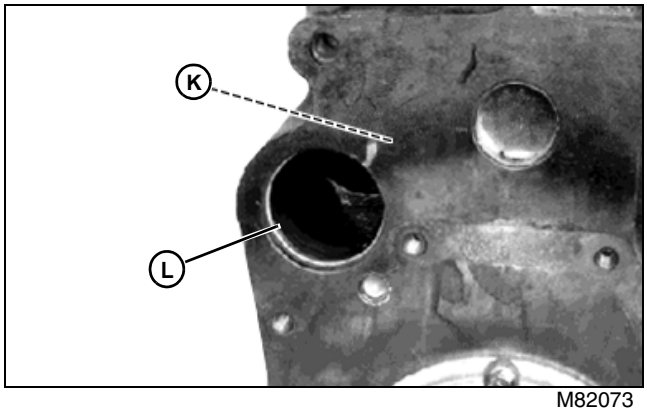
Note: Flywheel plate must be removed to measure camshaft intermediate and flywheel end bearing diameters.

5. Remove flywheel plate.



M35287

6. Remove plug (J) using a long wooden dowel. Insert wooden dowel through gear housing side.



M82073

7. Measure the intermediate (K) and flywheel end (L) camshaft bore diameters and compare with specifications.

8. Apply John Deere Form-In-Place Gasket, or an equivalent, on the outer edge of the plug. Install the plug until it bottoms in the bore.

Specifications

Camshaft End Play . . . . . 0.05-0.20 mm (0.002-0.010 in.)
Wear Limit . . . . . 0.30 mm (0.012 in.)
Camshaft Bend (Maximum) . . . . . 0.05 mm (0.002 in.)
Camshaft
Lobe Height. . . . . 38.64-38.77 mm (1.521-1.526 in.)
Wear Limit . . . . . 38.40 mm (1.512 in.)

Camshaft Journals

Gear Housing and Flywheel End Camshaft
Journal OD . . . . . 44.93-44.95 mm (1.769-1.770 in.)
Intermediate Camshaft
Journal. . . . . 44.91-44.94 mm (1.768-1.769 in.)
Wear Limit . . . . . 44.85 mm (1.766 in.)

Camshaft Bushings

Camshaft Bushing ID at
Gear Housing . . . . . 44.990-45.055 mm (1.771-1.774 in.)
Camshaft Bushing ID at Intermediate and
Flywheel End. . . . . 45.00-45.025 mm (1.772-1.773 in.)
Wear Limit (All) . . . . . 45.10 mm (1.776 in.)
Camshaft Bushing-to-Journal
Clearance (All) . . . . . 0.23 mm (0.009 in.)

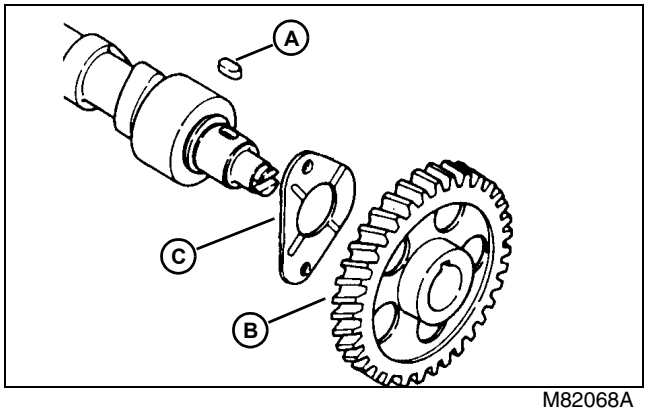
Remove and Install Camshaft Gear

Caution: Avoid Injury! DO NOT heat oil over 182°C (360°F). Oil fumes or oil can ignite above 193°C (380°F). Use a thermometer. Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

1. Heat the gear in oil to approximately 150°C (300°F).

Important: Avoid Damage! Be sure thrust plate is not between camshaft gear and camshaft shoulder while installing gear.

Note: Thrust plate must spin freely on camshaft.



M82068A

2. Install the thrust plate (C) if removed. Install the gear (B) with timing mark “C” side toward press table. Align the slot in the gear with key (A) in shaft. Press the camshaft into gear until gear is tight against camshaft shoulder.

Remove and Install Cam Followers

Removal

1. Remove camshaft. (See “Remove and Install Camshaft” on page 91.)

2. Remove the oil pan and strainer.

Important: Avoid Damage! Cam followers must be installed in the same bores from which they were removed.

3. Put a mark on each cam follower and cylinder block bore to aid in installation.

4. Remove cam followers.

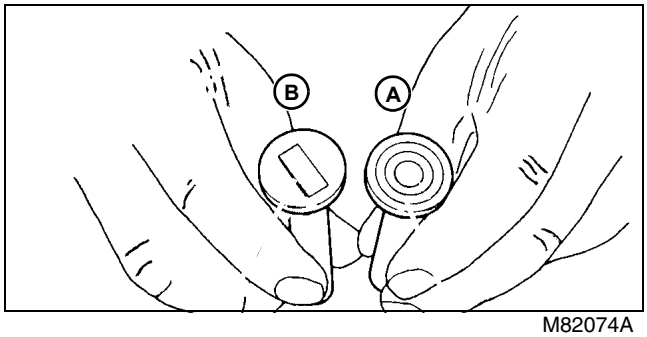
5. Inspect all parts for wear or damage.

6. Apply clean engine oil to all parts during installation.

Installation

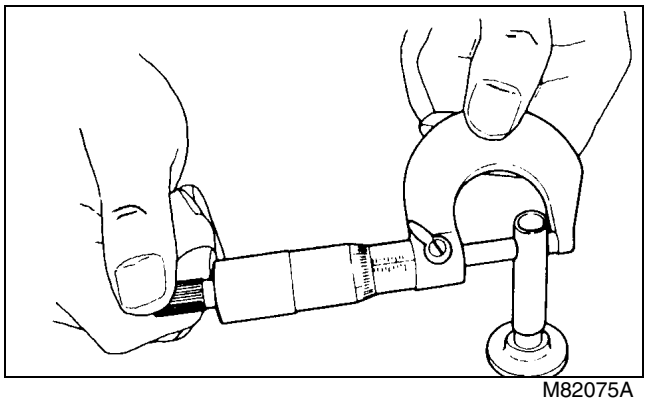
Installation is done in the reverse order of removal.

Inspect Cam Followers



M82074A

1. Inspect the cam follower contact surface for normal contact (A) or abnormal wear (B). Replace if necessary.



M82075A

2. Measure the cam follower stem diameter and compare with specifications. If stem diameter is less then wear limit, replace cam follower.

3. Measure the cam follower bore diameter in the cylinder block and compare with specifications. If the cam follower bore diameter exceeds wear limit, replace the cylinder block.

4. If the bore clearance (bore ID minus follower stem OD) exceeds specification, replace the cam follower, cylinder block or both.

Specifications

Cam Follower Stem

Stem OD . . . . . 11.98-11.99 mm (0.471-0.472 in.)
Wear Limit . . . . . 11.96 mm (0.470 in.)

Cam Follower Bore

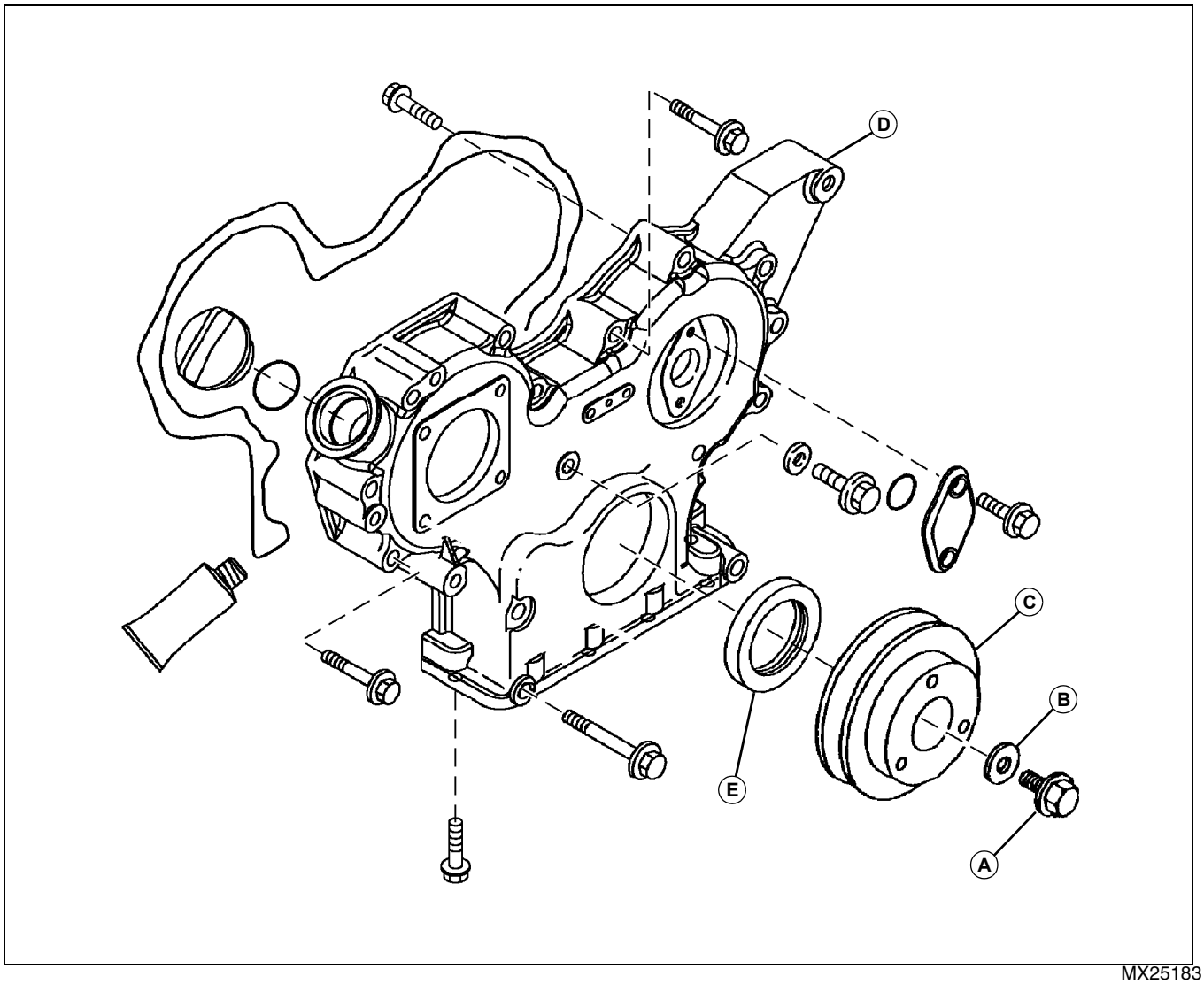
Bore ID. . . . . 12.00-12.02 mm (0.472-0.473 in.)
Wear Limit . . . . . 12.04 mm (0.474 in.)
Clearance . . . . . 0.010-0.043 mm (0.0.001-0.002 in.)

Remove and Install Timing Gear Cover

Other Material

Part No.	Part Name	Part Use
PM37465 (US)/ PM38628 (Canada)	Ultra-Blue RTV Silicone Form-in-Place Gasket	Applied to oil seal case mounting surface before installation.

Removal



MX25183

1. Remove engine.
2. Remove oil pan and pan extension.
3. Remove alternator and belt.
4. Remove crankshaft pulley cap screw (A) and washer (B).
5. Remove crankshaft pulley (C) using a puller.

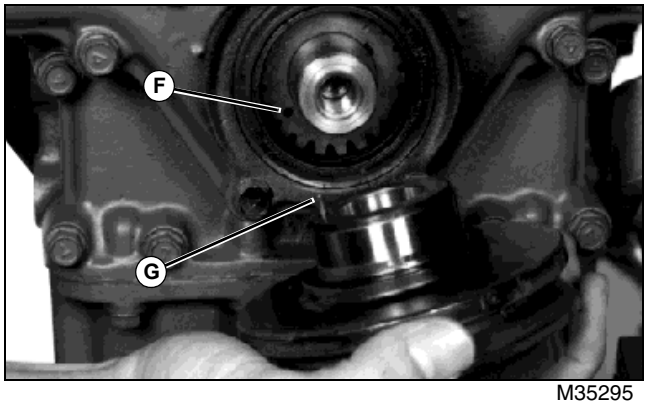
Note: It is not necessary to remove end cover and O-ring or fuel injection pump gear cover to remove timing gear cover.

6. Remove mounting cap screws and timing gear cover (D).
7. Inspect crankshaft oil seal (E) for wear or damage. Replace if necessary.

Installation

Installation is done in the reverse order of removal.

- Replace oil seal using a driver set. Install seal with lip toward inside of gear housing cover. Install seal flush with surface of cover.
- Clean surfaces and apply a bead of PM37465 RTV Form-in-Place Gasket to timing cover.
- Tighten all timing gear cover mounting cap screws to specifications.



M35295

- Align pin (G) in crankshaft pulley with hole (F) in crankshaft gear. Install crankshaft pulley.
- Adjust alternator drive belt tension. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

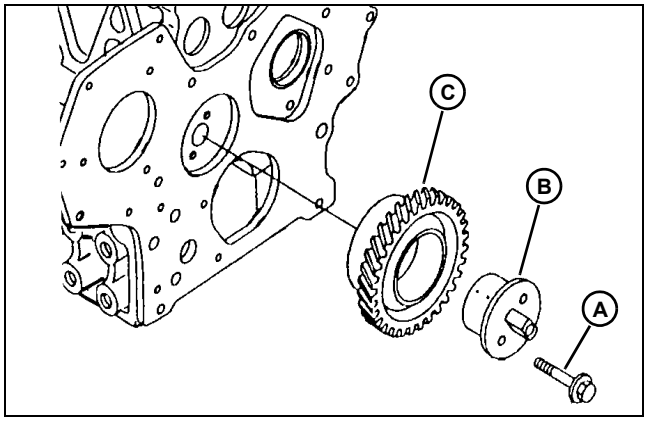
Remove and Install Idler Gear

Removal

1. Remove the timing gear cover. (See “Remove and Install Timing Gear Cover” on page 96.)
2. Check the backlash of timing gears. (See “Check Timing Gear Backlash” on page 53.)

Note: Due to the odd number of teeth on the idler gear, timing marks will only align periodically. When all timing marks on gears align, the piston closest to the coolant pump is at TDC on compression stroke. No. 1 cylinder is closest to the flywheel.

3. Rotate the crankshaft and align the timing marks.



M82209A

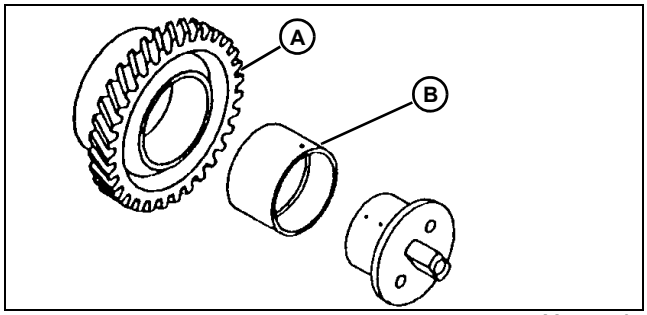
4. Remove two cap screws (A), shaft (B), and gear (C).
5. Inspect all parts for wear or damage.

Installation

Installation is done in the reverse order of removal.

Inspect Idler Gear

1. Inspect the gear for chipped or broken teeth. Replace if necessary.
2. Measure the idler gear shaft diameter and compare with specifications.
3. Measure the idler gear bushing diameter and compare with specifications.
4. If the bore clearance (bushing ID minus shaft OD) exceeds specification, replace the bushing, shaft, or both.



M82210A

5. Remove and install bushing:
   a. Replace the bushing using a driver set.
   b. Align the oil holes in bushing (B) and idler gear (A).
   c. Install the bushing flush with surface of idler gear.

Specifications

Idler Gear
Shaft OD . . . . . 45.950-45.975 mm (1.809-1.810 in.)
Wear Limit . . . . . 45.93 mm (1.808 in.)
Idler Gear
Bushing ID. . . . . 46.000-46.025 mm (1.811-1.812 in.)
Wear Limit . . . . . 46.08 mm (1.814 in.)
Idler Gear Shaft and
Bushing Clearance . . . . . 0.18 mm (0.007 in.)

Remove and Install Timing Gear Cover Mounting Plate

Removal

1. Remove the camshaft. (See “Remove and Install Camshaft” on page 91.)

2. Remove the idler gear. (See “Remove and Install Idler Gear” on page 97.)

3. Remove the fuel injection pump.

4. Remove the oil pump. (See “Remove and Install Oil Pump” on page 99.)

5. Remove the mounting cap screws and plate.

6. Replace the O-rings.

Installation

Installation is done in the reverse order of removal.

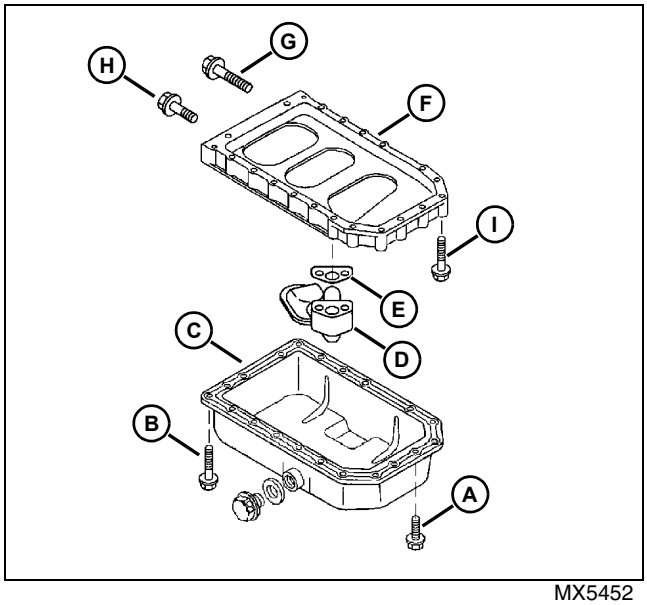
Remove and Install Oil Pan, Crankcase Extension, and Strainer

Other Material

Part No.	Part Name	Part Use
PM37465 (US)/ PM38628 (Canada)	Ultra-Blue RTV Silicone Form-in-Place Gasket	Applied to oil seal case mounting surface before installation.

Removal

Note: Engine must be removed from machine to remove the oil pan.



MX5452

1. Remove six (A) and sixteen (B) cap screws. Remove oil pan (C).

2. Remove cap screws for strainer and remove strainer (D) and gasket (E).

3. If crankcase extension (F) is being removed, remove flywheel, three lower cap screws (G) in rear oil seal housing, four flywheel housing cap screws (H), and six cap screws (I) in front. Then remove crankcase extension.

Installation

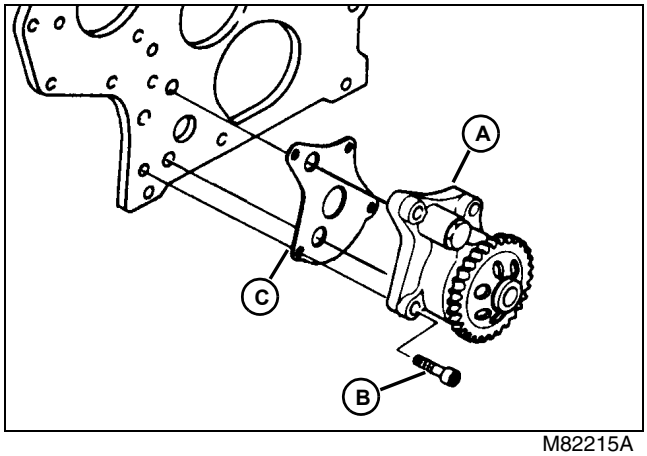
Installation is done in the reverse order of removal.

- Clean all mounting surfaces.
- Replace strainer gasket.
- Apply PM37465 Ultra-Blue RTV Silicone Form-in-Place Gasket to oil pan and crankcase extension.

Remove and Install Oil Pump

1. Remove timing gear cover (See “Remove and Install Timing Gear Cover” on page 96).

2. Check oil pump gear backlash. Replace the entire oil pump if backlash is more than specification.



M82215A

3. Remove three mounting cap screws (B).

4. Remove oil pump (A) and gasket (C).

5. Inspect all parts for wear or damage.

Installation

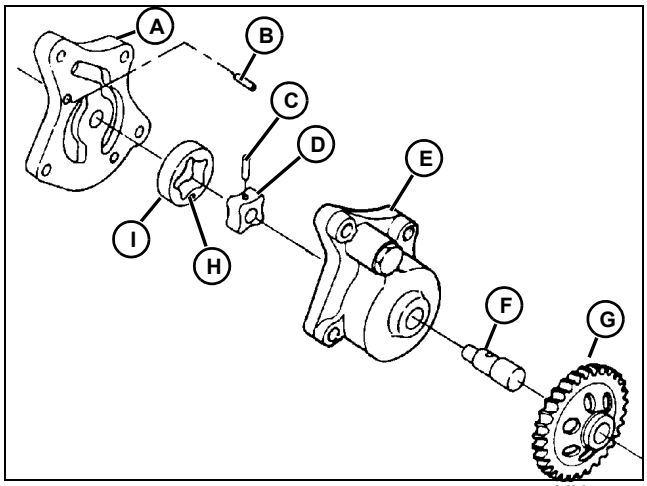
Installation is done in the reverse order of removal.

- Use a new gasket for installation.

Specifications

Gear Backlash (Max) . . . . . 0.12 mm (0.005 in.)

Disassemble and Assemble Oil Pump



MX2426

A- Backing Plate
B- Alignment Pin (2 used)
C- Pin
D- Inner Rotor
E- Pump Body
F- Rotor Shaft
G- Drive Gear
H- Alignment Mark
I- Outer Rotor

Note: The oil pump drive gear is press fit to the shaft.

1. Remove drive gear (G) using a knife-edge puller and a press.

2. Remove backing plate (A)

3. Remove outer rotor (I).

4. Remove pin (C) and inner rotor (D).

5. Remove rotor shaft (F).

6. Inspect all parts for wear or damage.

Assembly

Assembly is done in the reverse order of disassembly.

- Coat all parts with a light coat of clean engine oil before assembly.

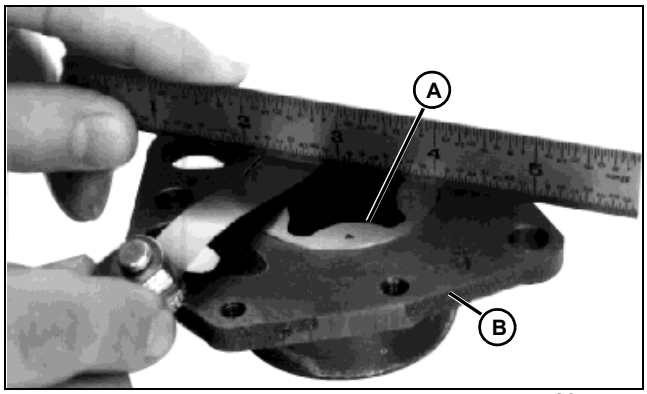
- Install the outer rotor with the alignment mark (H) facing toward the pump body (E).

Inspect Oil Pump

1. Measure the rotor shaft outside diameter. Record the measurement.

2. Measure the inside diameter of the rotor shaft bore. Record the measurement.

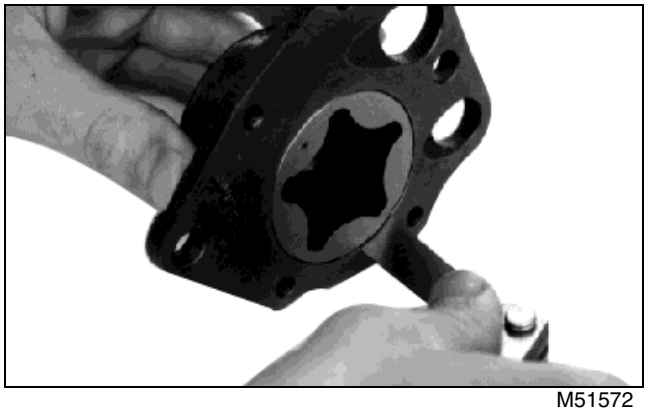
3. Subtract the rotor shaft outside diameter from the rotor shaft bore inside diameter to determine the rotor shaft-to-bore clearance. Replace the pump if the clearance is greater than specification.



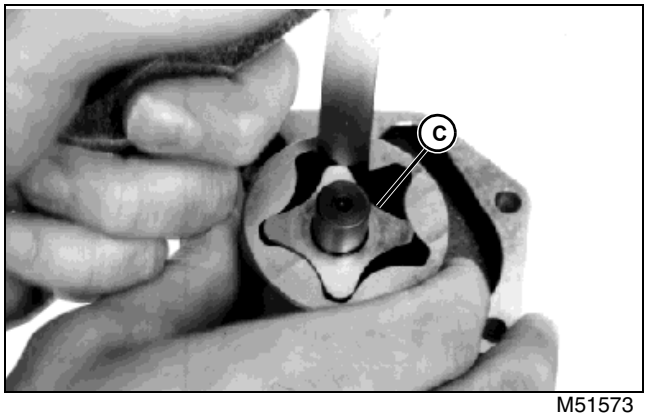
M51571

4. Install outer rotor (A) in pump body (B).

5. Place a straightedge across the pump body mounting surface and measure outer rotor recess using a feeler gauge. Replace the entire pump if clearance is greater than specification.


M51572

6. Check outer rotor-to-pump body clearance using a feeler gauge. Replace the entire pump if clearance is greater than specification.



M51573

7. Install the inner rotor (C) in the outer rotor.

8. Check clearance between the tip of the inner rotor and the outer rotor. Replace the entire pump if clearance is greater than specification.

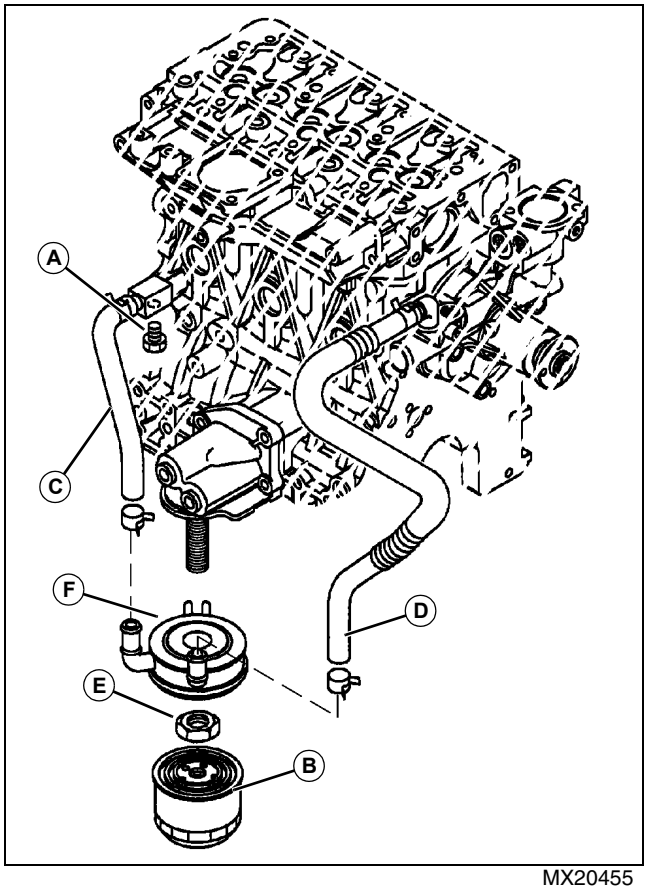
Specifications

Oil Pump

Outer Rotor Outside Clearance . . . . . 0.12-0.21 mm (0.0047-0.0083 in.)
Outer Rotor Side Clearance . . . . . 0.02-0.07 mm (0.0008-0.0028 in.)
Outer Rotor-to-Inner Rotor Tip Clearance Limit . . . . . 0.16 mm (0.0063 in.)
Rotor Shaft Clearance (Rotor Shaft O.D.) . . . . . 09.955-9.967 mm (0.3919-0.3924 in.)
Rotor Shaft Clearance Rotor Clearance) . . . . . 0.033-0.060 mm (0.0013-0.0024 in.)

Remove and Install Optional Oil Cooler

Removal



MX20455

1. Remove drain plug (A) to drain engine cooling system.
2. Remove oil filter (B).
3. Disconnect coolant hoses (C and D).
4. Remove nut (E) and oil cooler (F).
5. Pressure test oil cooler for leakage by applying 206-483 kPa (30-70 psi) of compressed air to oil cooler and submersing in water.

Installation

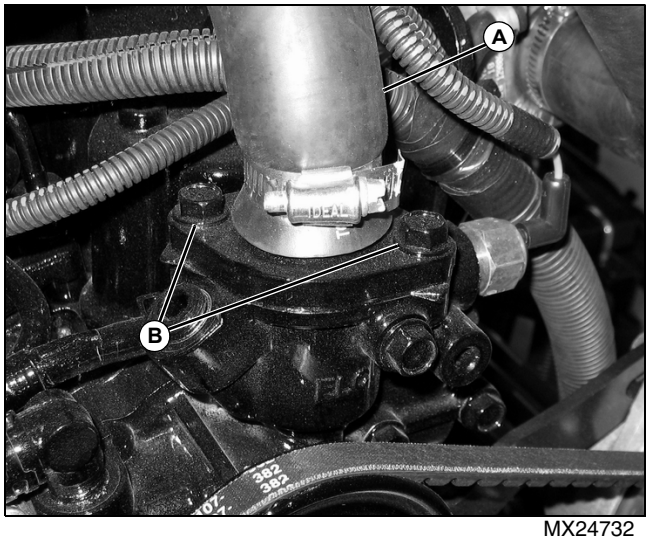
Installation is done in the reverse order of removal.

- Replace O-rings.

Remove and Install Thermostat

Removal

1. Drain coolant from radiator.



MX24732

2. Remove upper radiator hose (A).
3. Remove cap screws (B), thermostat flange, and gasket.
4. Remove thermostat from housing.
5. Inspect all parts for wear or damage. Replace as necessary.
6. Test thermostat. (See “Test Thermostat Opening” on page 55.)

Installation

Installation is done in the reverse order of removal.

Inspect Coolant Pump

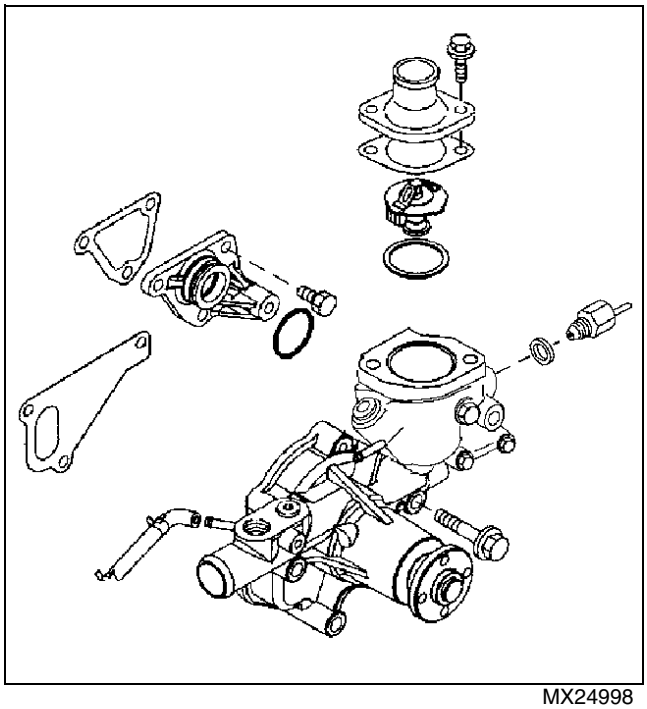
1. Inspect coolant pump for coolant leakage. If origin of leak cannot be determined, pressurize coolant system. (See “Test Cooling System Pressure” on page 57.)
   - If coolant leaks at pulley flange, shaft seal is defective. Replace coolant pump.
   - If coolant leaks between plate and pump housing, gasket between plate and pump housing is defective. Remove plate and replace gasket.
   - If coolant leaks between plate and engine block, remove coolant pump and replace gasket.
2. Inspect coolant pump for worn bearing shaft by removing alternator belt and checking for excessive movement of pulley. Replace coolant pump if excessive movement is noticed.
   - If bearing shaft is making noise when operating, check alternator belt tension. (See “Adjust Fan and

Alternator Drive Belt" on page 56.) If adjustment does not relieve the noise, bearing shaft is defective. Replace coolant pump.

Remove and Install Coolant Pump

Removal

1. Drain engine coolant.
2. Remove the coolant pump/alternator drive belt.
3. Remove the coolant pump pulley.



MX24998

4. Disconnect the upper and lower radiator hoses.
5. Disconnect electrical connector from coolant temperature sensor.
6. Remove coolant line and bracket securing line to pump.
7. Remove lines from coolant pump.
8. Remove the mounting cap screws, pump and gasket.
9. Inspect the pump for wear or damage.
10. Test the thermostat for proper operation. (See "Test Thermostat Opening" on page 55.)

Installation

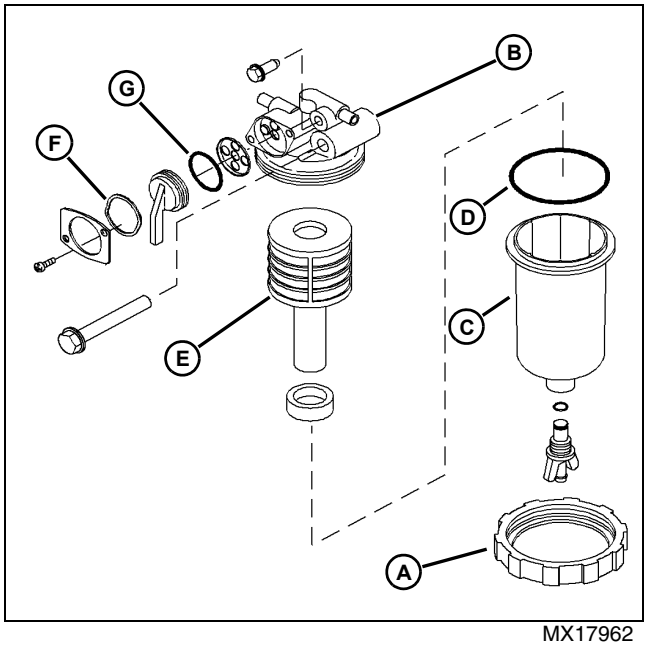
Installation is done in the reverse order of removal.

- Adjust the coolant pump/alternator drive belt tension. (See "Adjust Fan and Alternator Drive Belt" on page 56.)

Disassemble and Assemble Water Separator

Important: Avoid Damage! Replace all copper washers on injection pump fittings. Damaged or used washers will leak.

Always use new O-ring seals when replacing separator.



MX17962

1. Remove the retaining ring (A) from the mounting base (B) while holding on to the separator bowl (C).
2. Remove the separator bowl from the mounting base.
3. Remove and replace O-ring (D) and strainer (E).
4. Remove shutoff valve cover. Inspect and replace wave washer (F) and O-ring (G) as necessary.
5. Before installing the bowl and strainer in the mounting base, verify the O-ring is in the groove inside the mounting base.
6. Install the separator bowl and the strainer in the mounting base.

Important: Avoid Damage! Tighten only enough to keep the filter assembly from leaking. Overtightening the retaining nut may damage the filter cover or retaining ring.

7. Place the retaining ring over separator bowl and screw on the mounting base to retain bowl to mounting base.

Remove Fuel Injection Pump

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other high-pressure lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

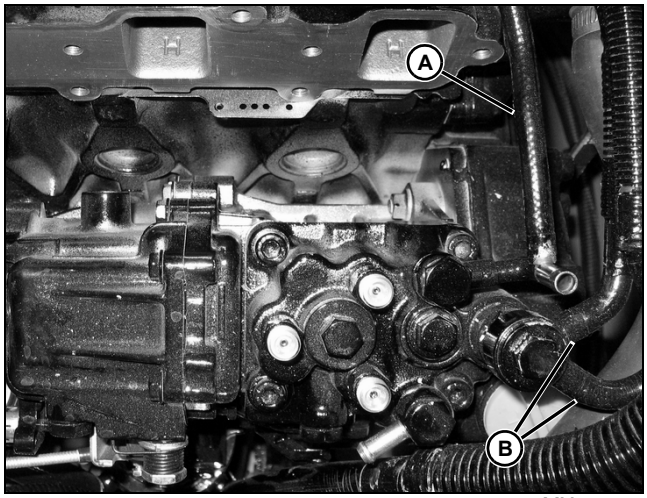
If an accident occurs, see a doctor immediately. Any fluid injected into the skin, must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

Important: Avoid Damage! DO NOT attempt to service the injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace entire unit.

DO NOT rotate engine while injection pump is removed. If engine is rotated, timing gear cover must be removed to ensure correct timing.

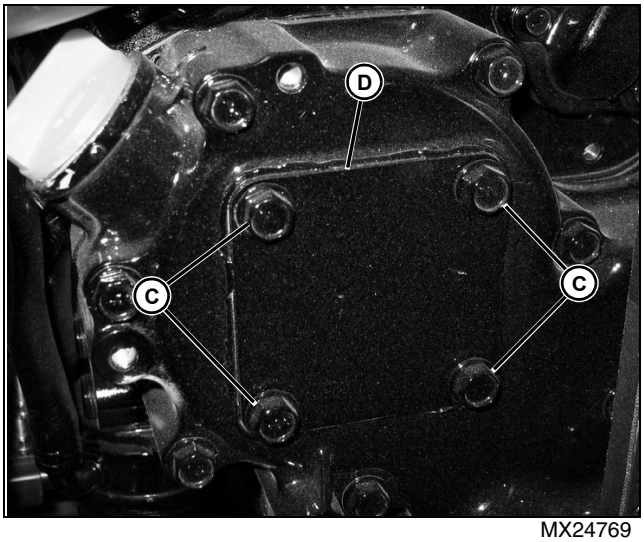
Important: Avoid Damage! Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean injection pump lines and area around pump using a parts cleaning solvent or steam cleaner.
2. Remove intake manifold. (See “Remove and Install Intake Manifold” on page 78.)
3. Disconnect throttle cable.
4. Drain coolant from radiator.



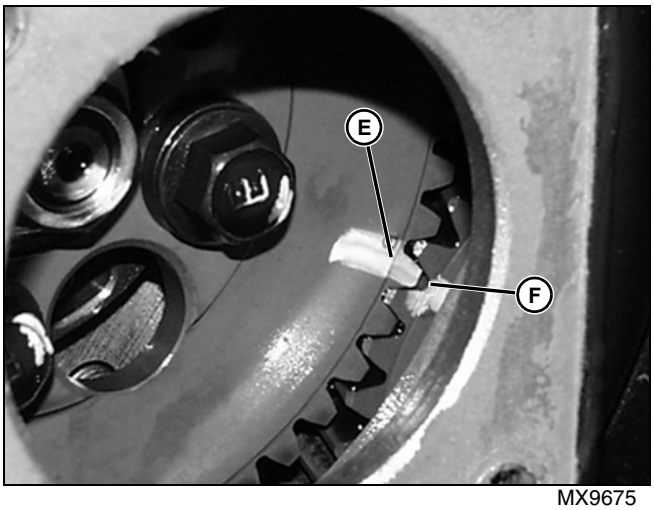
MX24775

5. Disconnect leak-off line (A).
6. Disconnect coolant lines (B).



MX24769

7. Remove four cap screws and washers (C), cover (D), and gasket.

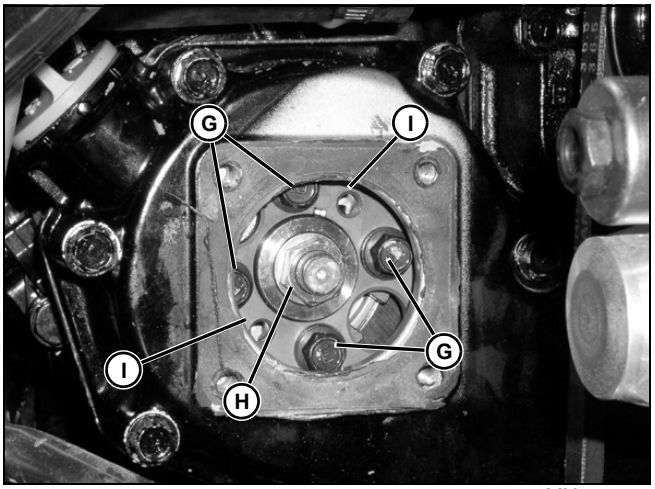


MX9675

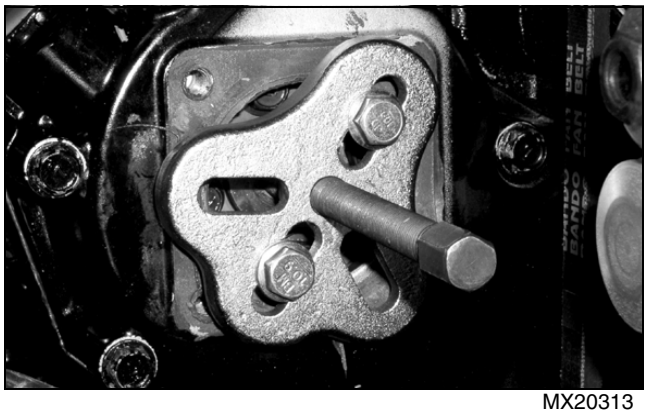
8. Rotate engine in direction of rotation until timing mark (E) on pump gear aligns with mark on idler gear (F).

Important: Avoid Damage! DO NOT loosen or disturb cap screws (G) securing gear to hub. This gear/hub assembly times the injection pump camshaft in relation to the crankshaft for precise timing of EPA engines. This procedure is done at the pump manufacturing plant and cannot be duplicated in the field!

Gear-to-hub adjustment is pre-set by the engine manufacturer to comply with strict California Air Resources Board/Environmental Protection Agency (CARB/EPA) emissions requirements and is NOT adjustable. Tampering with the gear-to-hub adjustment may result in severe fines or penalties. If hub or gear is damaged, the entire engine must be replaced.



MX20312

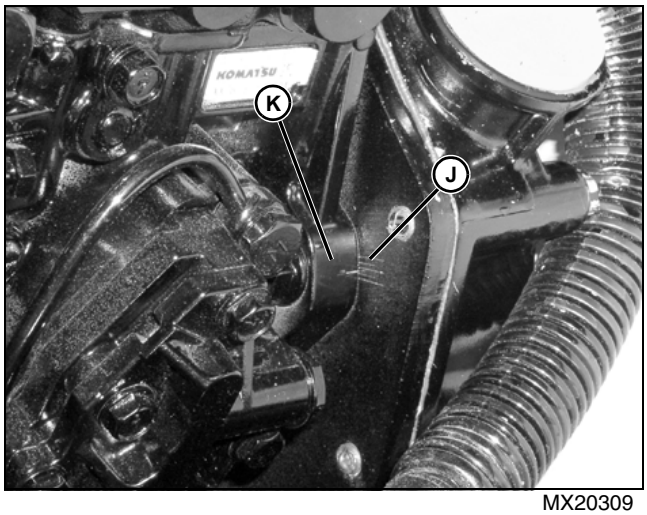

MX20313

9. Remove nut (H) and lock washer from pump shaft.

10.Install puller using tapped M8 holes (I) in gear.

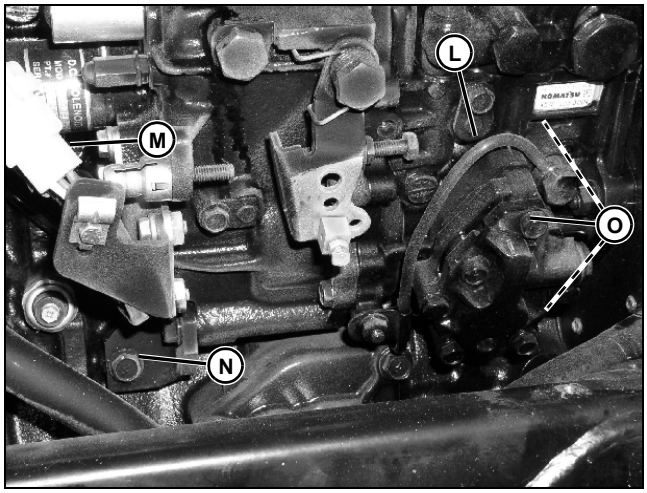
11.Remove gear from pump shaft. The gear will remain in timing cover.

Important: Avoid Damage! Pump must be installed at exact location where it was removed.



MX20309

12.Note the position of timing marks on gear cover mounting plate (J) and injection pump (K).



MX17947

13.Remove lube line (L) from pump.

14.Disconnect fuel shutoff solenoid wire connector (M).

15.Remove cap screw (N) from bracket.

16.Remove three pump mounting nuts (O) and remove pump.

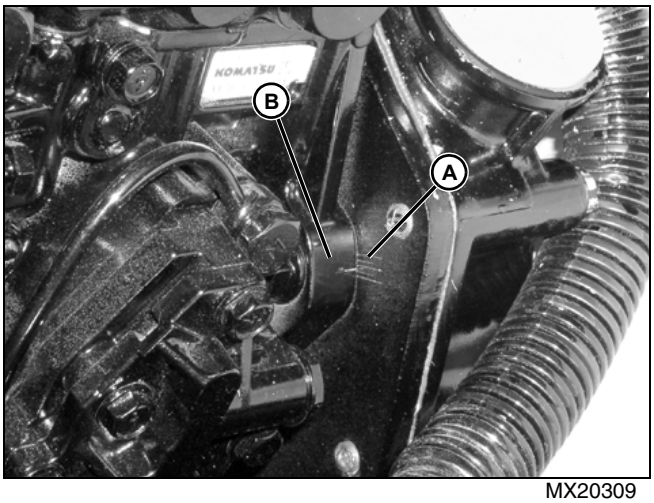
Important: Avoid Damage! Do not attempt to service the injection pump or governor. If unit is in need of repair, it must be serviced by a qualified fuel injection repair shop. If replacement is necessary, replace the entire unit.

Install Fuel Injection Pump

1. Install new O-ring on injection pump.

2. Put injection pump onto back of gear cover mounting plate. Install three mounting nuts and one cap screw through bracket. Do not tighten. Align key on shaft with keyway in gear. Be sure to align marks on gears made during removal.

3. Install nut on timing gear. Tighten to specification.



MX20309

4. Align marks on mounting plate (A) and injection pump (B) to the exact location as when removed. Tighten nuts and cap screw securely.

5. Place a thin bead of form-in-place gasket on access cover and install.

6. Connect fuel shutoff solenoid wire connector.

MX24775

7. Connect leak-off line (C).

8. Install coolant lines (D).

9. Install intake manifold. (See “Remove and Install Intake Manifold” on page 78.)

10. Install and adjust throttle cable. (See “Adjust Throttle Cable” on page 59.)

Important: Avoid Damage! If oil has been drained out of fuel injection pump housing, add oil as necessary. Fuel injection pump can become damaged if operated dry or without proper amount of oil.

11. Add oil through external lube line inlet until oil begins to drip out of inlet hole.

12. Install external lube line. When installing line, put one copper washer between mounting cap screw head and lube line and the other between lube line and housing.

13. Fill engine coolant to proper level.

Specifications

Fuel Injection Pump Drive Gear Nut Torque (No Lubricant). . . . . 78-88 N•m (58-65 lb-ft.)
Fuel Injector Tube Nut Torque (No Lubricant). . . . . 29-34 N•m (21-25 lb-ft.)

Remove and Install Fuel Injection Nozzles

Important: Avoid Damage! Never steam clean or pour cold water on injection pump while the pump is running or warm. Doing so can damage the pump.

1. Clean the injection pump lines and area around the pump using a parts cleaning solvent or steam cleaner.

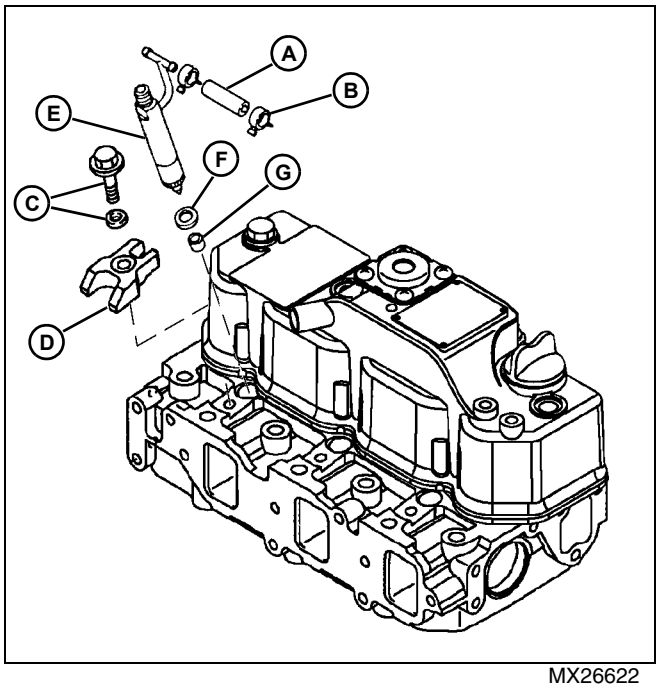
Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department in Moline, Illinois, U.S.A.

2. Loosen fuel injection line connectors to nozzles slightly to relieve pressure in the fuel system.

Note: Nozzles are matched to the cylinders. If removing more than one nozzle, tag each one, according to the cylinder from which it was removed.

3. Loosen line clamp(s) and remove fuel injection lines.

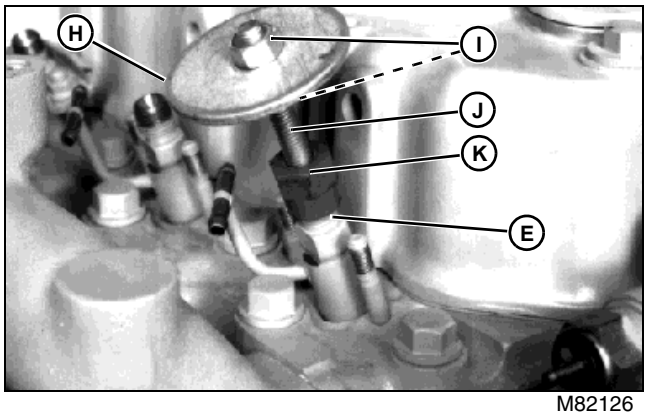


MX26622

4. Remove clamps (A) and leak-off hoses (B).

5. Remove cap screw and washer (C) and retaining plate (D).

6. Remove injection nozzle (E), ring (F), and TEFLON™ heat protector (G). If ring and protector stay in cylinder head, thread a cap screw into protector and pull from cylinder head.



M82126

7. If nozzles are stuck in cylinder head:

   • Grind the head of a cap screw (J) so it fits inside a nut from an old injection line (K).

   • Use two nuts (I) to attach a large flat washer (H) to the cap screw.

   • Install assembly onto nozzle (E) and use a puller and slide hammer to pull nozzle from cylinder head.

8. Test injection nozzles. (See “Test Fuel Injection Nozzles” on page 54.)

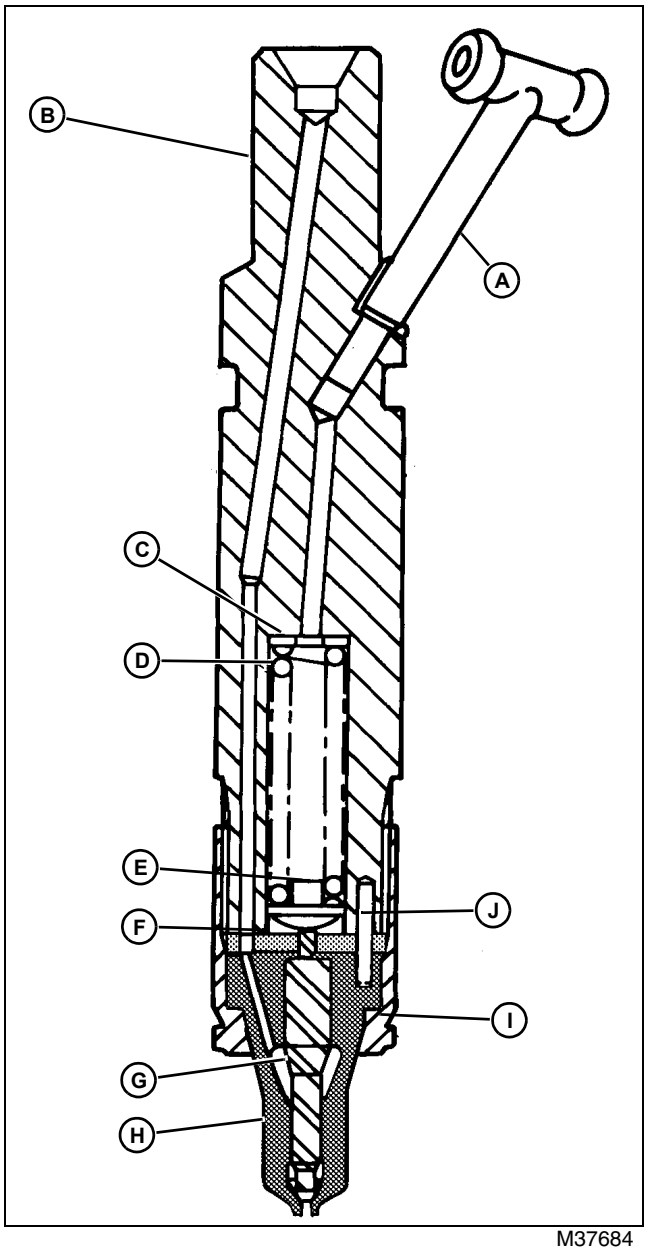
Installation

Installation is done in the reverse order of removal.

• Install a new ring and heat protector when installing injection nozzles.

Disassemble and Assemble Fuel Injection Nozzles

Cross Section

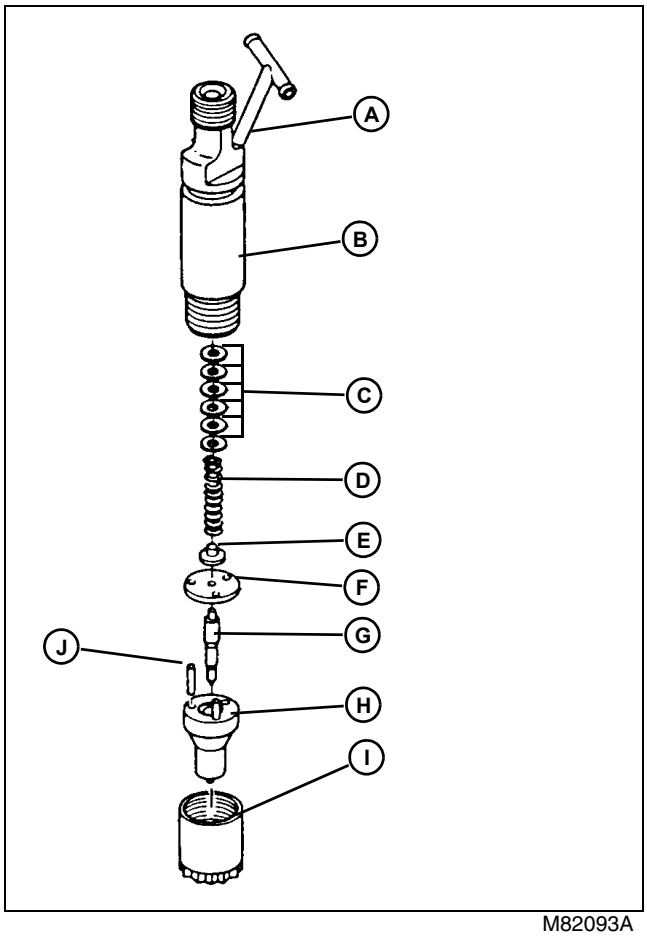


M37684

A- Return Pipe
B- Injector Body
C- Shim(s)
D- Spring
E- Spring Seat
F- Separator Plate
G- Nozzle Valve
H- Nozzle Body
I- Retaining Nut
J- Index Pin

Disassembly

Note: If servicing more than one nozzle, keep parts for each nozzle separate from one another.



M82093A

A- Return Pipe
B- Injector Body
C- Shim(s)
D- Spring
E- Spring Seat
F- Separator Plate
G- Nozzle Valve
H- Nozzle Body
I- Retaining Nut
J- Index Pins

1. Remove retaining nut (I) and disassemble internal parts of injection nozzle. Keep parts organized for ease of assembly.

2. Clean and inspect nozzle assembly. (See “Inspect and Clean Fuel Injection Nozzles” on page 108.)

Assembly

1. Carefully clamp injector body (B) in a soft-jawed vice.

Note: Insert the same number of shims (C) that were removed from the injector. Number of shims will affect the opening pressure of the fuel nozzle and will be tested after assembly.

2. Assemble fuel nozzle in the order shown.

3. Tighten retaining nut to specification.

4. After assembly is complete, test injection nozzle. (See "Test Fuel Injection Nozzles" on page 54.)

Specifications

Fuel Injector Retaining Nut Torque . . . 8 N•m (70 lb-in.)

Inspect and Clean Fuel Injection Nozzles

Special or Required Tools

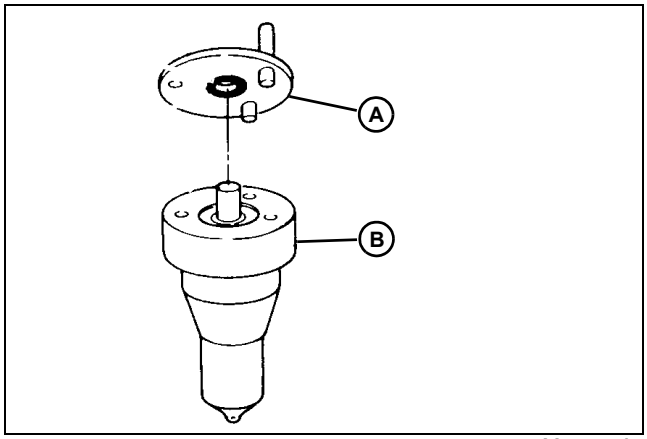
Tool Name	Tool No.	Tool Use
Fuel Injection Nozzle Cleaning Kit	JDF13	Used to clean fuel injection nozzles.

Note: To clean nozzles properly, JDF13 Fuel Injection Nozzle Cleaning Kit is recommended. The Cleaning Kit is available through the John Deere SERVICEGARD™ Catalog.

1. Remove anti-corrosive grease from new or reconditioned nozzles by washing them thoroughly in diesel fuel.

Important: Avoid Damage! Never use a steel brush to clean nozzles as this will distort the spray hole.

2. Remove carbon from used nozzles, and clean by washing in diesel fuel. If parts are coated with hardened carbon or lacquer, it may be necessary to use a brass wire brush (supplied in JDF13 Fuel Injection Nozzle Cleaning Kit).

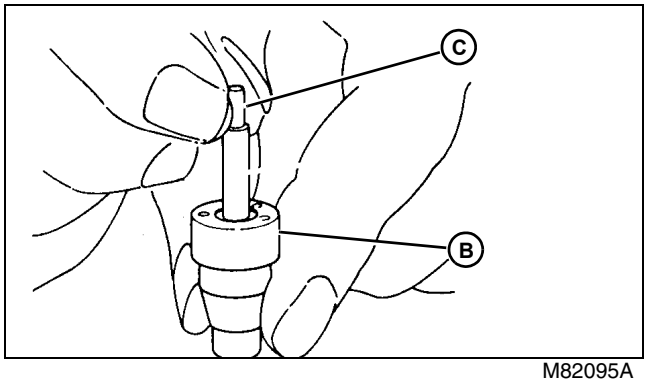


M82094A

3. After removing carbon or lacquer from the exterior of nozzle, inspect sealing surfaces between separator plate (A) and nozzle body (B) for nicks or scratches.

4. Contact area of separator plate (both parts) must not be scored or pitted. Use an inspection magnifier (No. 16487 or equivalent) to aid in making the inspection.

5. Check nozzle contact surface on separator plate for wear. If contact surface is more than specification, replace nozzle assembly.



M82095A

6. Inspect the piston (large) part of nozzle valve (C) to see that it is not scratched or scored and that lower (tip) end of valve is not broken. If any of these conditions are present, replace the nozzle assembly.

7. Further inspect the nozzle assembly by performing a slide test. Use the following procedure:

- Dip the nozzle valve (C) in clean diesel fuel. Insert valve in nozzle body (B).
- Hold nozzle vertical, and pull valve out about 1/3 of its engaged length.
- Release valve. Valve should slide down to its seat.

Replace nozzle assembly if the valve does not slide freely to its seat.

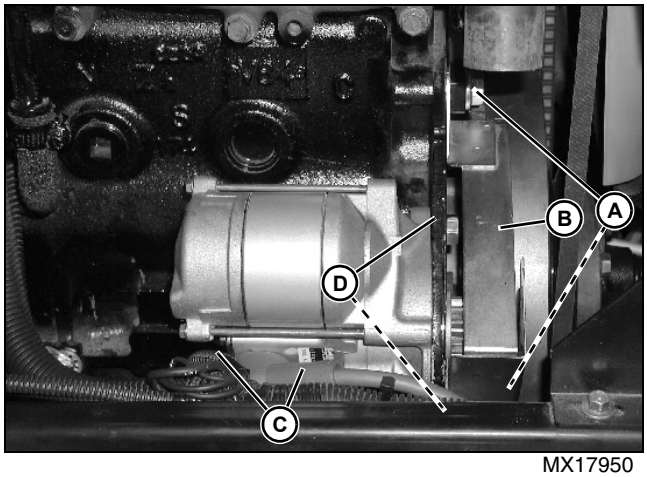
Specifications

Nozzle Contact Surface . . . . . 0.10 mm (0.004 in.)

Remove and Install Starting Motor

Removal

1. Disconnect battery.



MX17950

2. Remove shield mounting cap screws (A) and shield (B).
3. Disconnect wires (C) to starting motor.
4. Remove starting motor mounting cap screws (D) and nuts.

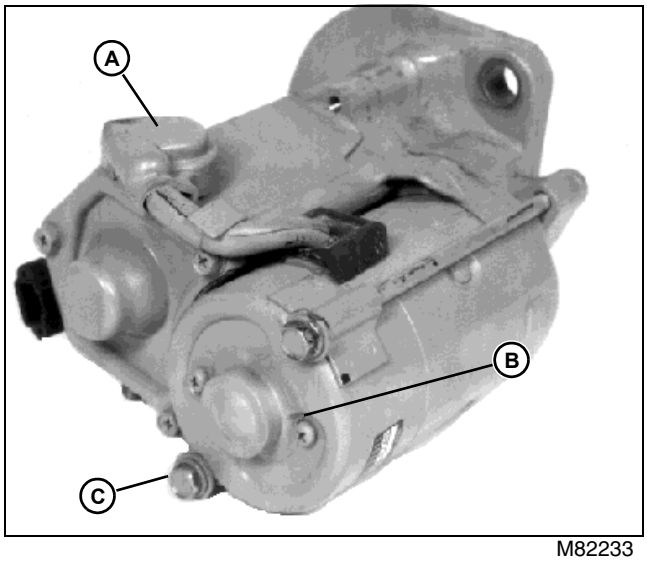
Installation

Note: One side of the two starting motor nuts is machined flat and should be installed toward the starting motor flange.

Installation is done in the reverse order of removal.

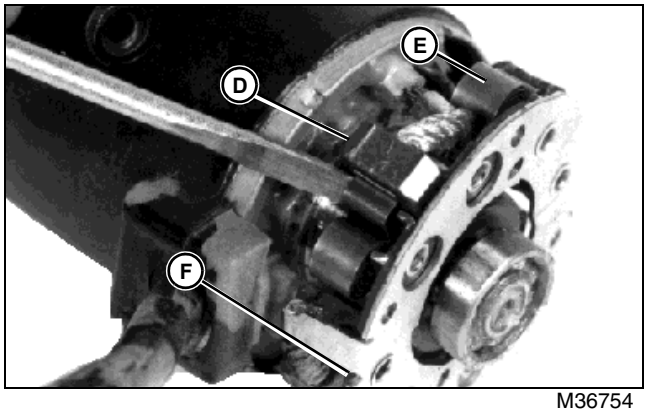
Disassemble and Assemble Starting Motor

Disassembly



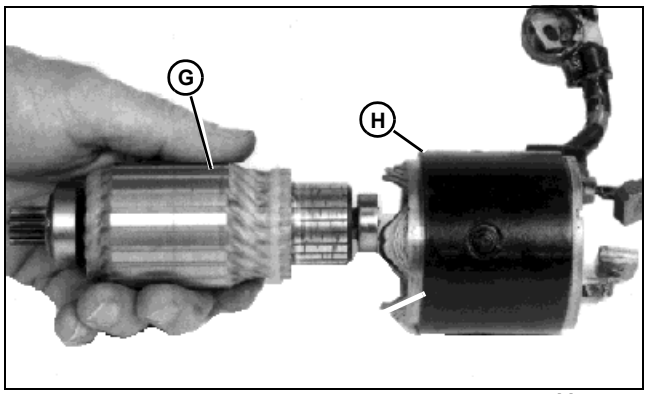
M82233

1. Disconnect field lead (A).
2. Remove two cap screws (C) that attach motor to clutch housing. Remove motor.
3. Remove two screws (B) that attach rear cover to brush holder.



M36754

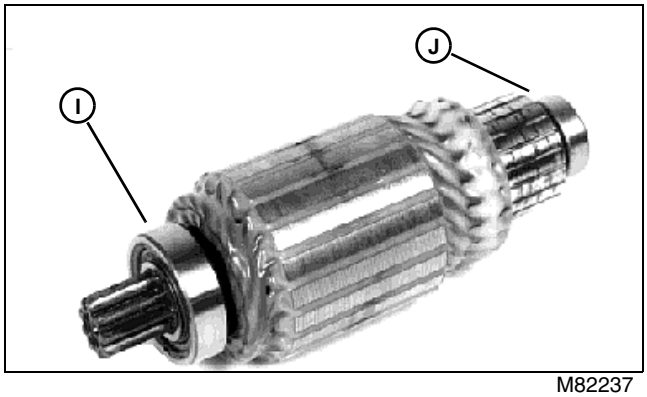
4. Remove both field coil brushes (D) from brush holder (F).
5. Pry brush springs (E) away and pull negative brushes up enough to allow spring to hold brush in place.
6. Remove brush holder.



M36759

7. Remove armature (G) from field coil housing (H).

Replace Bearings



M82237

1. Bearings are press fit. Remove bearings using a knife-edge puller set.

Important: Avoid Damage! Install both bearings with sealed side toward armature.

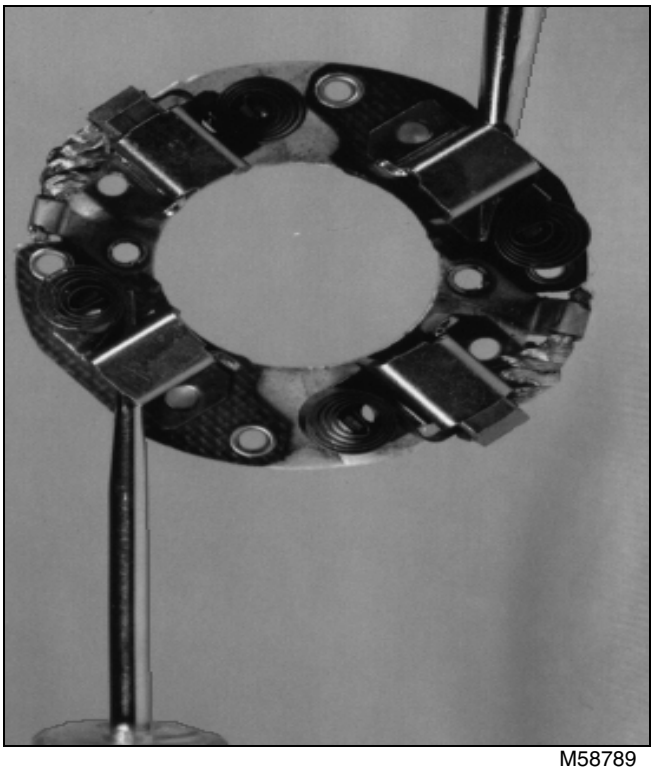
2. Install new housing bearing (I) tight against shoulder of shaft using a piece of pipe.

3. Install new rear cover bearing (J) tight against shoulder of shaft using a driver set.

4. Inspect and test brushes, holder, field coil, and armature. (See “Inspect and Test Starting Motor” on page 110.)

Assembly

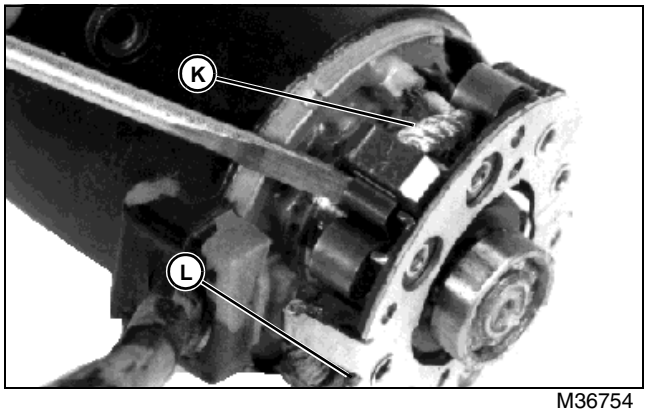
Assembly is done in the reverse order of disassembly.



M58789

Note: A pair of small screwdrivers inserted between the brush springs and the housing before assembly will aid in inserting the brushes.

Note: Apply multipurpose grease to bearing cup inside rear cover.



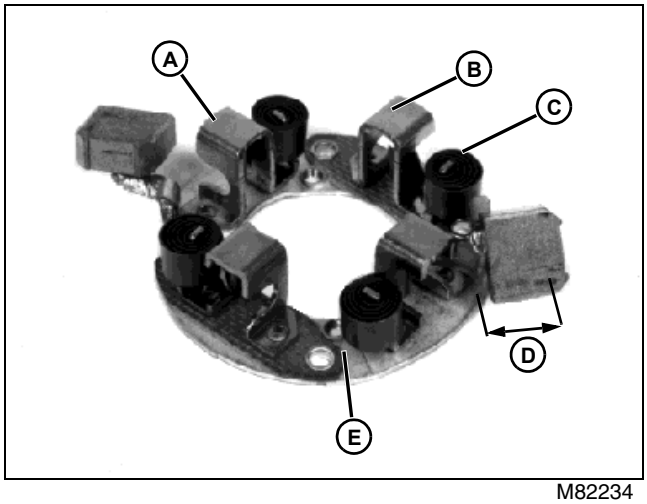
M36754

1. Turn brush holder (L) slightly to take up slack in brush wires.

Important: Avoid Damage! When installing rear cover, be sure field coil brush wires do not touch cover.

2. Press wires (K) inward to clear rear cover.

Inspect and Test Starting Motor



M82234

1. Measure brush lengths (D). Replace brush if length is below specification.

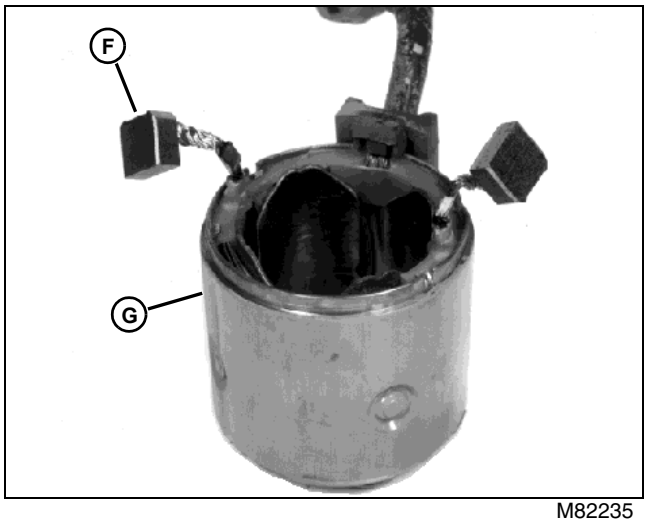
Note: Test brush holder using an ohmmeter or test light.

2. Test brush holder (E):

   • Touch one probe of tester to negative brush holder (A) and other probe to field brush holder (B). If there is continuity, replace the brush holder.

3. Inspect springs (C) for wear or damage. Replace if necessary.

Note: Test field coil using an ohmmeter or test light.



M82235

4. Test for grounded field winding:

   • Touch one probe of tester to field coil brush (F) and other probe to field coil housing (G).

   • Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing assembly must be replaced.

Important: Avoid Damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a soft bristle brush.

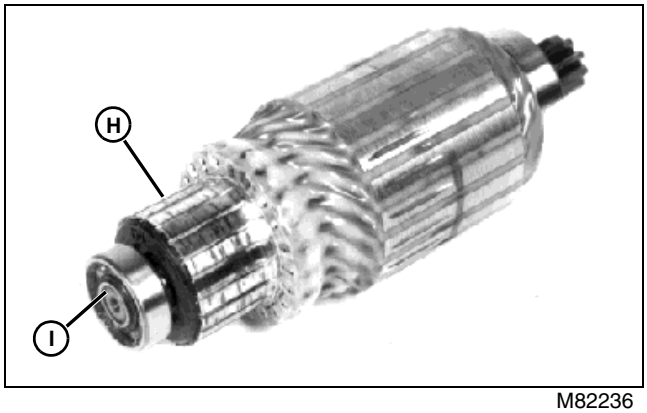
5. Test for open field coil:

   • Touch one probe of tester to each field coil brush. If there is no continuity, the field coil is open and the field coil housing assembly must be replaced.

6. Inspect armature. Look for signs of dragging against pole shoes.

7. Inspect commutator. Look for roughness, burned bars, or any material that might cause short circuits between bars. If necessary, clean and touch up with 400-grit sandpaper. NEVER use emery cloth. Clean all dust from armature when finished.

Note: Test armature windings using an ohmmeter or test light.



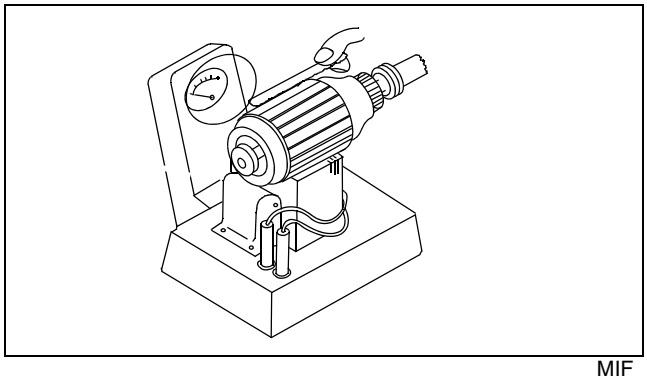
M82236

8. Test for grounded windings:

   • Touch probes on one commutator bar (H) and armature shaft (I). Armature windings are connected in series, so only one commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.

9. Test for open circuit windings:

   • Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.



MIF

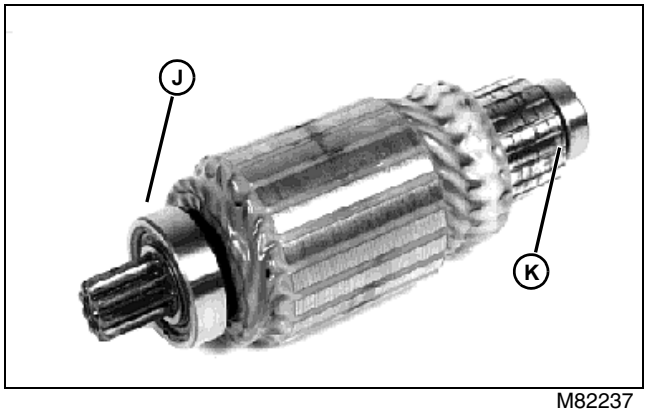
10. Test for short circuit windings using a growler:

   • Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature. If coil is shorted, the blade will vibrate on the slot.

Note: A short circuit most often occurs because of copper dust or filings between two commutator segments.

11. If test indicates short circuit windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

12. Inspect armature cover and housing bearings for wear or damage. Replace if necessary.



M82237

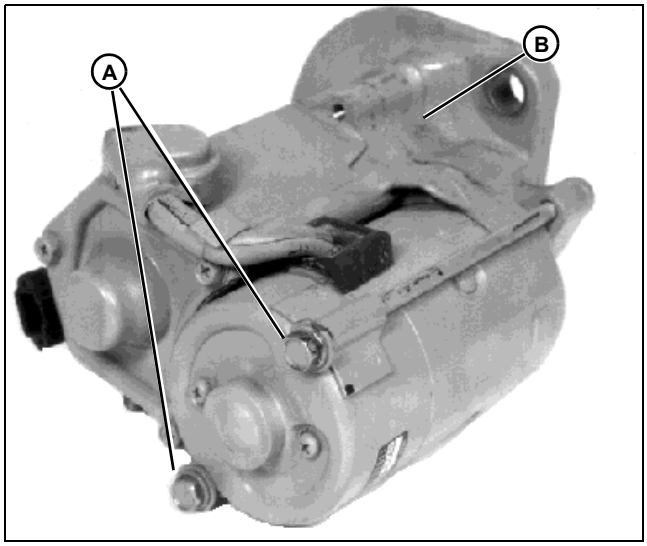
13.Replace bearings (J and K) if necessary. (See “Disassemble and Assemble Starting Motor” on page 109.)

Specifications

Brush Length (Minimum) . . . . . 9.0 mm (0.354 in.)

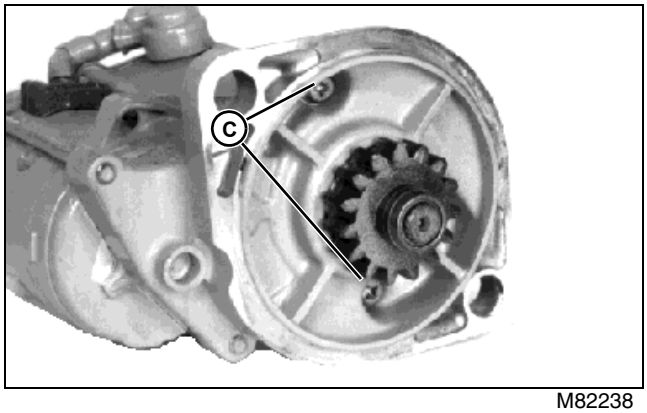
Disassemble and Assemble Starter Gear Train

Disassembly



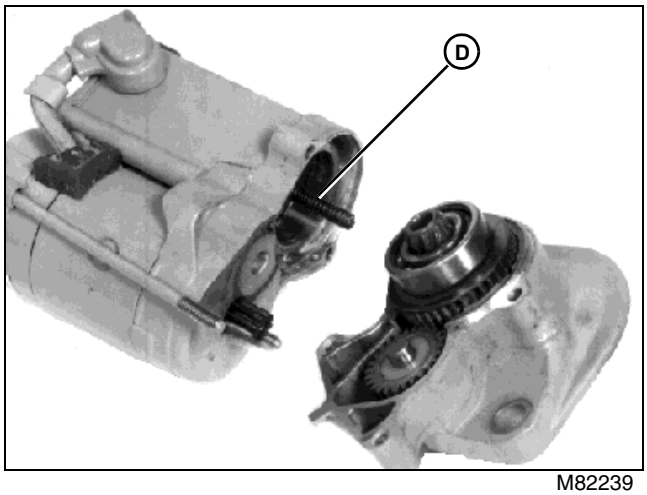
M82233

1. Remove field wire and two motor-to-clutch housing cap screws (A).
2. Remove motor from clutch housing (B).



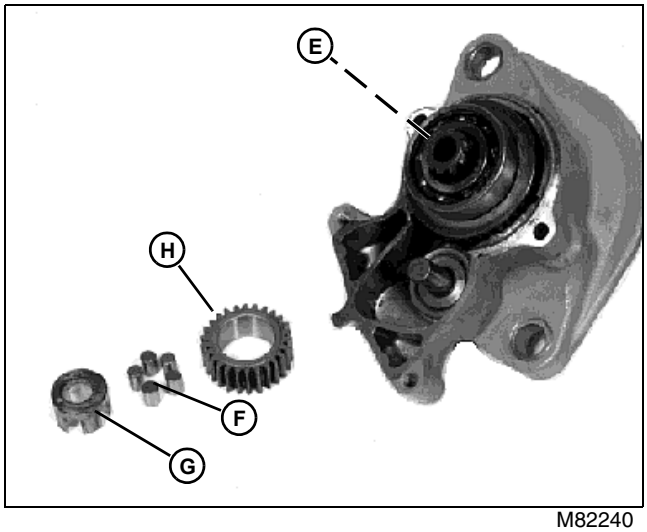
M82238

3. Remove two clutch housing-to-solenoid housing screws (C) to separate clutch housing from solenoid/motor assembly.



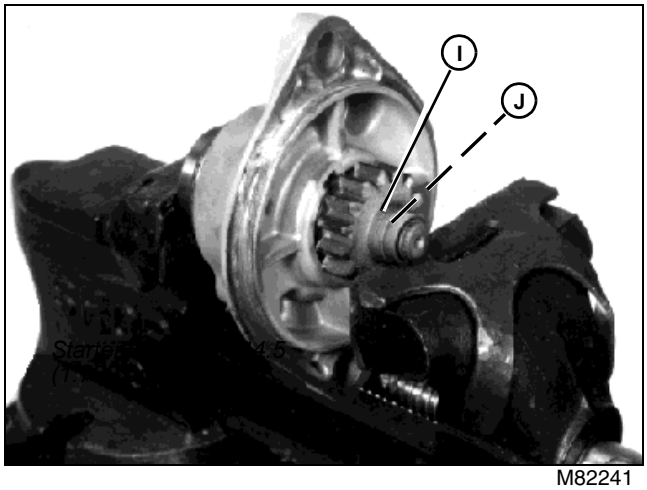
M82239

4. Remove plunger spring (D).



M82240

5. Remove retainer (G), five rollers (F) and pinion gear (H).
6. Remove steel ball (E).

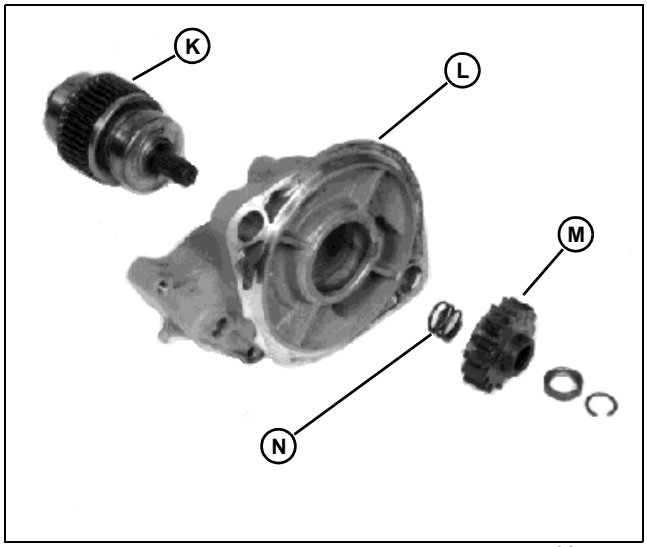


M82241

7. Place clutch (housing) assembly into a soft-jawed vise, as shown.
8. Tighten vise slowly, until drive gear compresses.
9. Remove retainer (I) and circlip (J).

Caution: Avoid Injury! Shaft could be propelled from clutch unit with considerable force if spring is not allowed to extend fully while in vise.

10.While holding clutch assembly, slowly open vise until all spring compression is relieved.

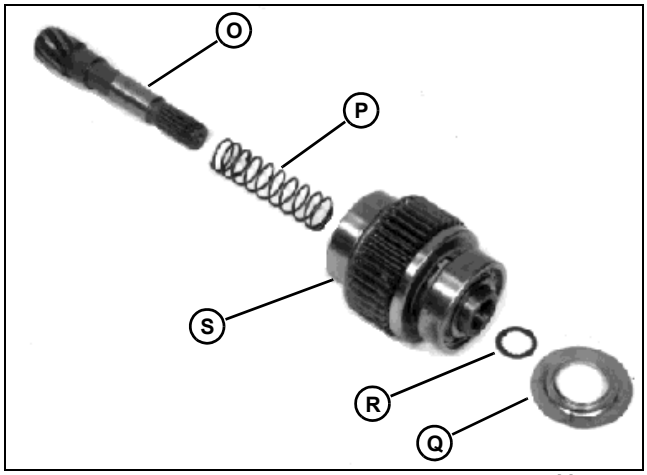


M82242

11.Remove drive gear (M), spring (N) and clutch assembly (K) from housing (L).

12.Remove large washer, toothed washer, spring, and clutch shaft.

13.Inspect all parts for wear or damage. Replace as necessary.



M82243

14.Remove large washer (not applicable to all models) (Q), toothed washer (R), spring (P), and clutch shaft (O) from clutch (S).

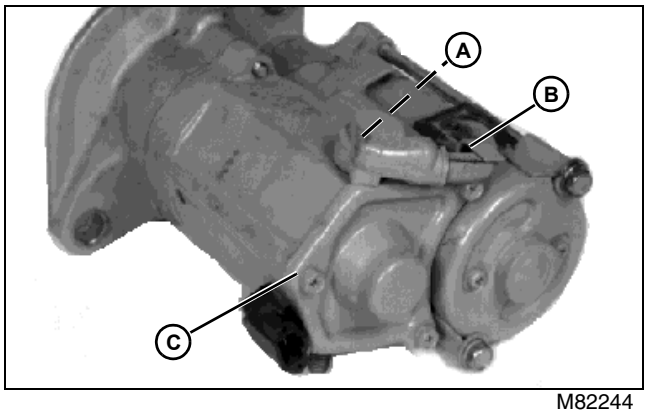
Assembly

Assembly is done in the reverse order of disassembly.

- Apply multipurpose grease to bearings, clutch shaft, springs, pinion gears, retainer, rollers, and steel ball.
- Install large washer (not applicable to all models) with flat side toward clutch assembly.
- Install retainer with cupped side away from clutch assembly.

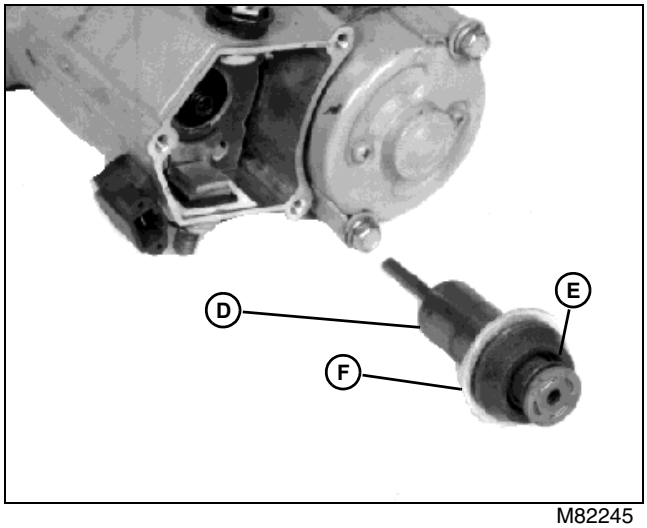
Disassemble, Inspect, and Assemble Starter Solenoid

Disassembly



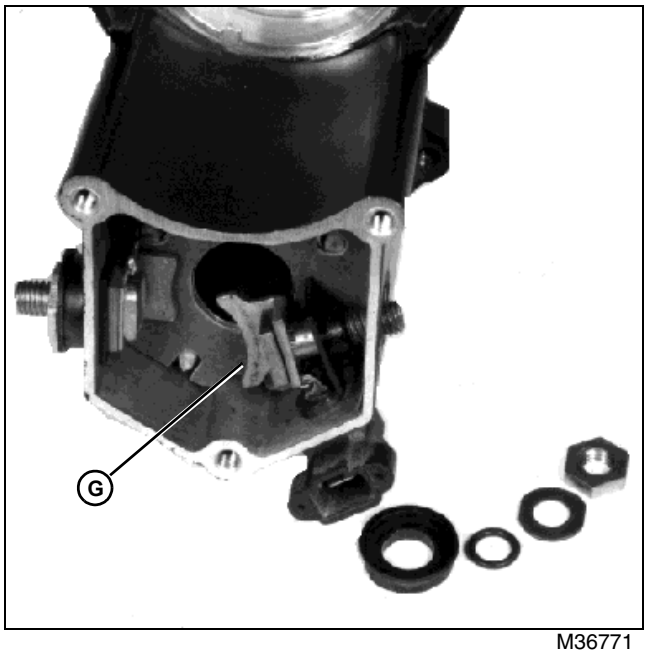
M82244

1. Disconnect field lead (A).
2. Remove three screws (C) and clip (B).
3. Remove cover and gasket.



M82245

4. Remove plunger (D).
5. Inspect the copper washer (F) and spring (E).



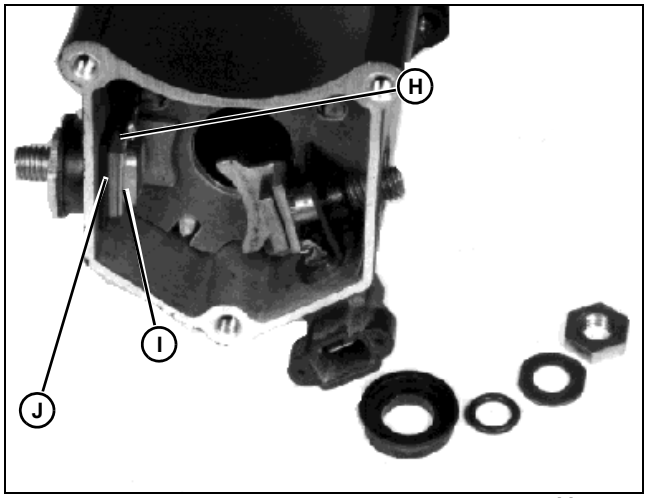
M36771

6. Inspect the contact plates (G) for excessive burning or pitting. Contacts and plunger come as a kit. If plunger or contacts are defective, replace all the parts with the kit.

Assembly

Assembly is done in the reverse order of disassembly.

Note: The assembly sequence of the left and right terminals is similar. Make sure smaller contact plate is on the left side.



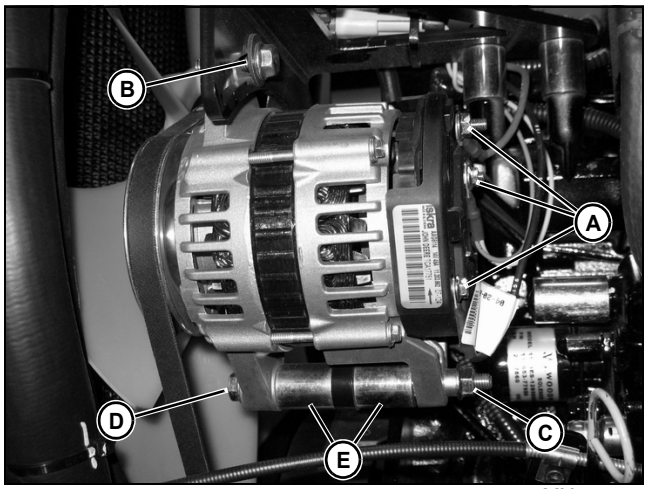
M36771

- Install solenoid terminal lead (H) between terminal bolt (I) and contact plate (J).

Remove and Install 12V Alternator

Removal

1. Disconnect battery.



MX24770

2. Disconnect and label wires (A).
3. Remove cap screw (B).
4. Remove nut from stud (C).
5. Remove cap screw (D) and spacers (E).
6. Remove belt from alternator pulley and slide alternator from stud.

Installation

Installation is done in the reverse order of removal.

- Adjust alternator belt. (See “Adjust Fan and Alternator Drive Belt” on page 56.)

Remove and Install Turbocharger

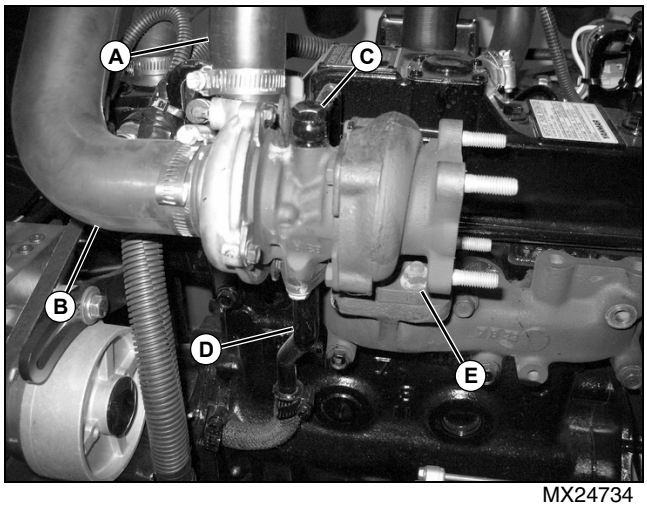
Removal

Caution: Avoid Injury! Muffler may be hot. Allow muffler to cool before removing. A hot muffler can cause serious burns.

Important: Avoid Damage! When cleaning turbocharger, DO NOT spray directly into compressor turbine housing. If inspection is required of turbocharger, do not clean exterior prior to removal. Doing so may wash away evidence of a potential failure mode

If inspection is not required, thoroughly clean exterior of turbocharger and surrounding area to prevent entry of dirt into the air intake system during removal.

1. Remove muffler and exhaust gasket.



MX24734

2. Remove turbocharger-to-intake manifold or intercooler hose (A).

3. Remove air cleaner-to-turbocharger hose (B).

4. Remove oil supply line (C) with copper washers on top and bottom surface of oil supply line.

5. Remove oil drain line (D).

6. Remove three nuts (E).

7. Remove turbocharger and gasket.

8. Close all openings using caps and plugs to prevent contamination.

Installation

Installation is done in the reverse order of removal.

- Prelube turbocharger: Fill oil inlet or drain port with clean oil and while turning rotating assembly (by hand) to properly lubricate bearings.
- Install new gasket between exhaust manifold and turbocharger.
- Install new O-ring on oil drain line.
- Install new copper washers on oil supply line.

Important: Avoid Damage! A new or repaired turbocharger does not have an adequate oil supply for immediate start-up of engine. Perform the following steps to prevent damage to turbocharger bearings.

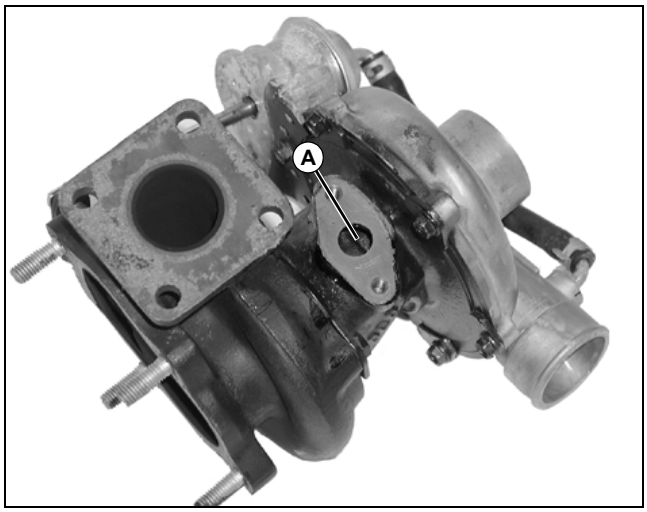
1. Disconnect fuel shutoff connector.

2. Crank engine over with starter until oil pressure light goes out. DO NOT crank engine longer than 30 seconds at a time to avoid damaging the starter.

Repair Turbocharger

Turbochargers used on the engines covered in this manual are available through service parts as a complete assembly only. Individual components for repair are not available.

Prelube Turbocharger



MX14540

Important: Avoid Damage! DO NOT spin the rotor assembly with compressed air. Damage to bearings can occur when using compressed air.

Fill oil inlet or drain port (A) with clean engine oil and turn rotating assembly (by hand) to properly lubricate bearings.

If turbocharger is to be stored for an extended period of time, lubricate internally and install protective covers on all openings.

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Specifications

General Specifications

Battery

Voltage	12 volts
BCI Group	51
CCA Rating at -18°C (0°F)	500 amps
Reserve Capacity	85 min
Specific Gravity	1.225 or above
Load Test for 5 Seconds	480 amps

Starter

Type	Denso solenoid shift
Loaded Draw at 900 RPM	280 amps
No-Load (Free Spinning) Draw at 3000 RPM	90 amps

Alternator

Type	Iskra
Regulator	Internal
Rating	45 amps
Resistor Pack at 25°C (77°F)	47-53 ohms
Regulated Voltage	13.9-14.6 volts

Electrical Components

Engine Coolant Temperature Switch Closing Temperature	107-113°C (225-235°F)
Fuel Shutoff Solenoid Pull-In Coil Resistance	0.4 ohms
Fuel Shutoff Solenoid Hold-In Coil Resistance	23.6 ohms
Engine Oil Pressure Switch Closing Pressure	0.05 ± 0.01 MPa (7 ± 1.5 psi)
4WD Bypass Solenoid Coil Resistance	10 ± 2 ohms
Mow Solenoid Coil Resistance	10 ± 2 ohms
Raise Solenoid Coil Resistance	10 ± 2 ohms
Lower Solenoid Coil Resistance	10 ± 2 ohms
Hydraulic Oil Temperature Switch Closing Temperature	93°C (200 ± 7.5°F)
Hydraulic Oil Filter Restriction Switch Closing Pressure	276 ± 28 kPa (40 ± 4 psi)
Hydraulic Oil Filter Restriction Switch Opening Pressure	207 kPa (30 psi)
Air Preheater Resistance	0.40-05.0 ohm
Cruise Control Magnet Coil Resistance	20 ± 4 ohms
Headlights (Halogen) Three @ 50 Watts	150 watts

General Information

Theory of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and shows only the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures are used to test the complete circuit regardless of the problem or complaint. Select a circuit or symptom from Circuit Operation and Diagnosis and follow the test procedures under that heading.

The diagnostic procedure provides:

- Test conditions
- Test location
- A question regarding the normal reading
- A yes or no answer based on the test results

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully.

Common Circuit Tests

Shorted Circuit

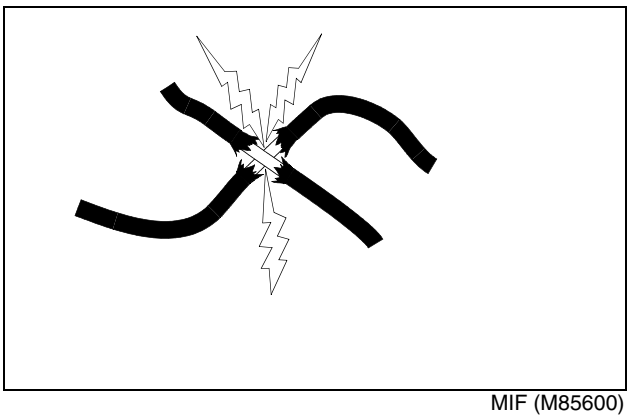
A shorted circuit may result in the wrong component operating (i.e., improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

1. Turn component switch ON.

2. Start at the controlling switch of the component that should not be operating.

3. Follow the circuit and disconnect wires at connectors until component stops operating.

4. Shorted or improper connections will be the last two wires disconnected.



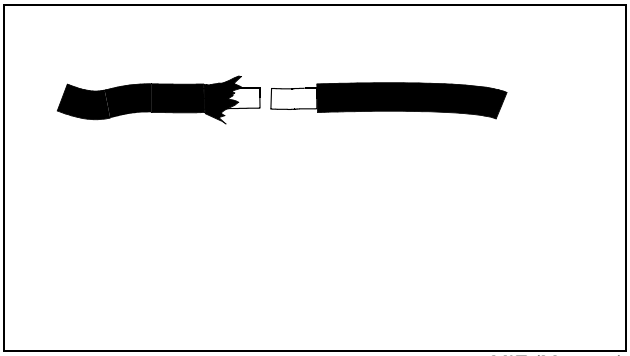
MIF (M85600)

High Resistance or Open Circuit

High resistance or open circuits usually result in slow, dim, or no component operation (i.e., poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.

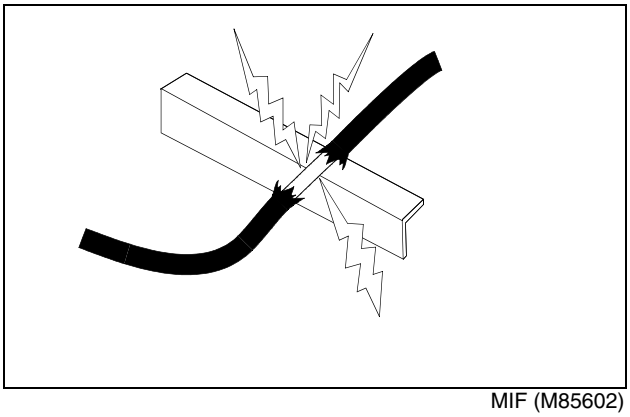
2. If terminals are not corroded or loose, the problem is in the component or wiring.



MIF (M85601)

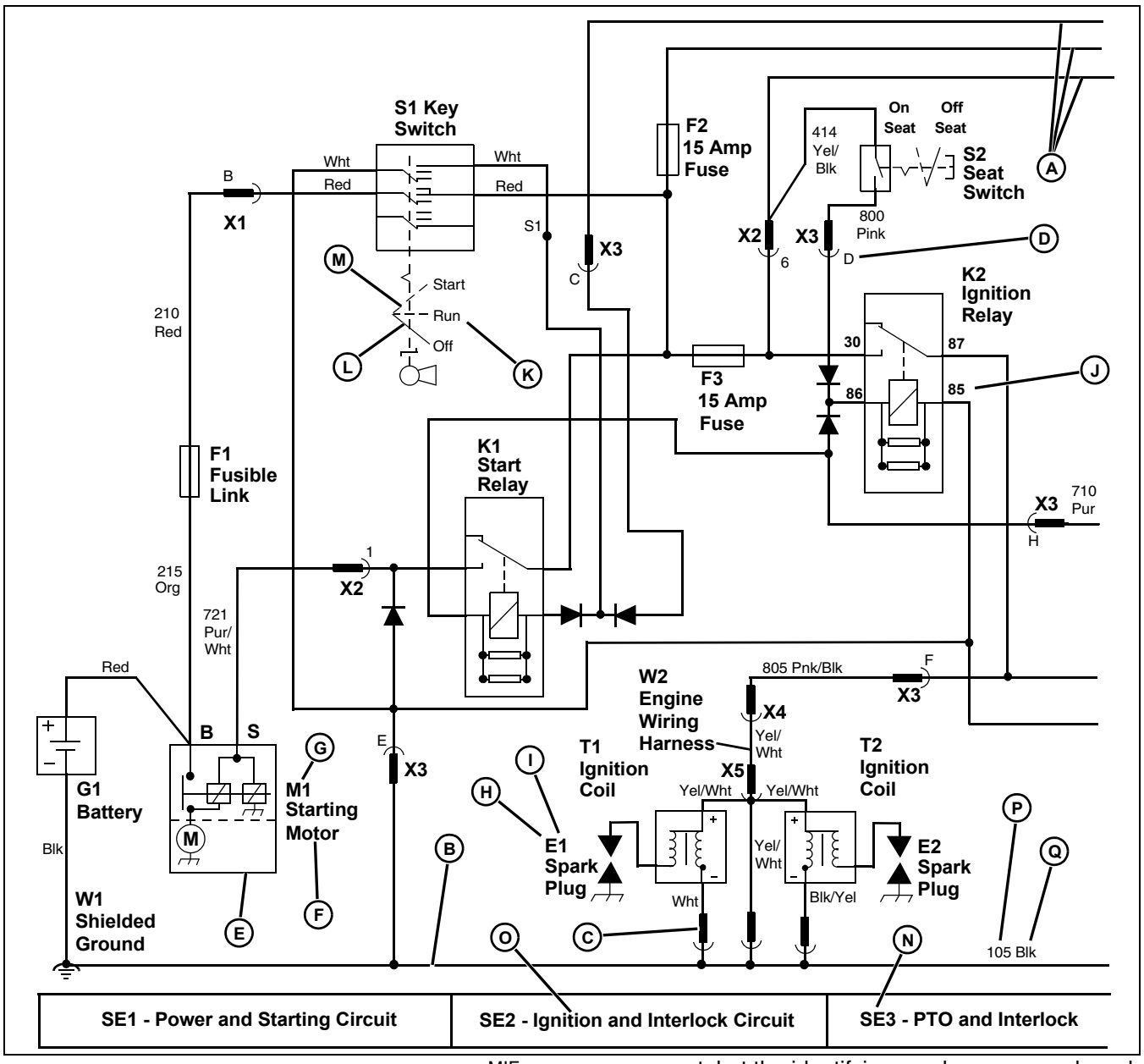
Grounded Circuit

Grounded circuits usually result in no component operation or a blown fuse.



MIF (M85602)

Reading Electrical Schematics



MIF

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in, and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Wire Color Abbreviation Chart

Blk . . . . . **Black**
Blu . . . . . **Blue**
Brn . . . . . **Brown**
Grn . . . . . **Green**
Gry . . . . . **Gray**
Org . . . . . **Orange**
Pnk . . . . . **Pink**
Pur . . . . . **Purple**
Red . . . . . **Red**
Tan . . . . . **Tan**
Wht . . . . . **White**
Yel . . . . . **Yellow**

Conductors for 12-Volt Circuits

Stranded Conductors for 12-Volt Circuits									
SAE Wire Size (Gauge)	20	18	16	14	12	10	8	6	4
Metric Wire Size (mm)	0.5	0.8	1.0	2.0	3.0	5.0	8.0	15.0	20.0
Typical Stranding	7 x 28	16 x 30	19 x 29	19 x 27	19 x 25	19 x 23	19 x 21	37 x 21	61 x 22
Minimum Conductor Area in Circular Mils	1072	1537	2336	3702	5833	9343	14,810	25,910	37,360

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	N/A	Used to test battery.
Battery Load Tester	JT05685	Used to test battery, alternator amperage and voltage, and starter loaded amperage draw.
Battery Charger (Variable Rate) (use according to manufacturer's instructions)	N/A	Used to charge battery.
Digital Multimeter	JT05791A	Used to test alternator amperage and voltage. Used to test diodes, switches, relays, solenoids, and fuses for continuity.
Current Clamp-On Probe	JT02153	Used to measure starting motor current.
Hand Held Digital Tachometer	JT05719	Used to measure rpm.
Weatherpack, Narrow	JDG777	Used to remove terminal from connector body.
Weatherpack, Extractor	JDG364	Used to remove terminal from connector body.
Weatherpack, Extractor Wide	JDG776	Used to remove terminal from connector body
Electrician's Pliers	JDG145	Used to strip insulation from wire.
Crimper	JDG360	Used to crimp terminals on wire.
Thermometer	N/A	Used to measure water temperature.
Two (2) Jumper Wires	N/A	Used to test starter solenoid, relays, and fuel pump.
Two (2) Jumper Cables	N/A	Used to test starter solenoid.
12-Volt Battery	N/A	Used to test starter solenoid and relays.

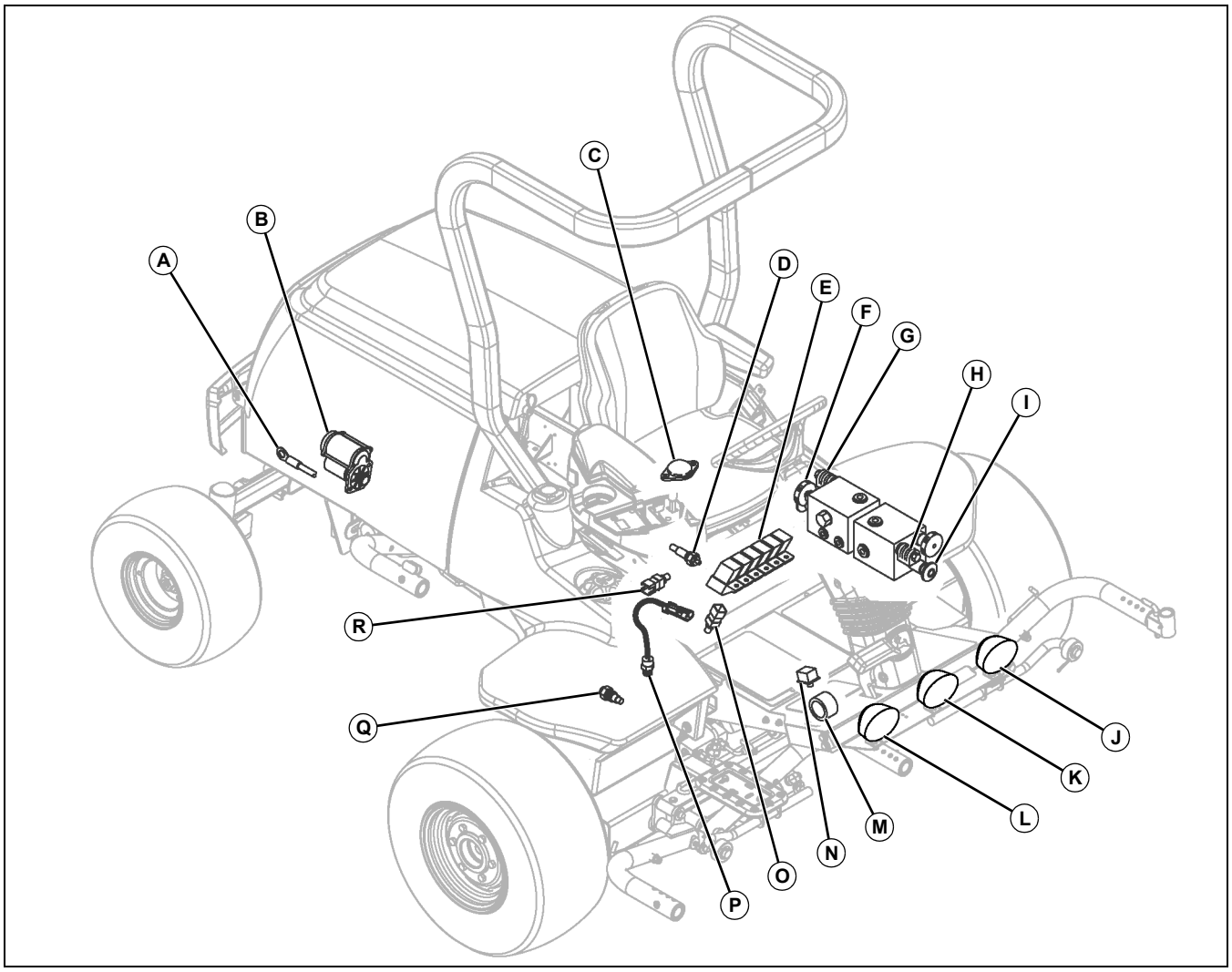
Materials

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Seal connections.
N/A	Dow 739 RTV Sealant	Waterproof connections.

Component Location

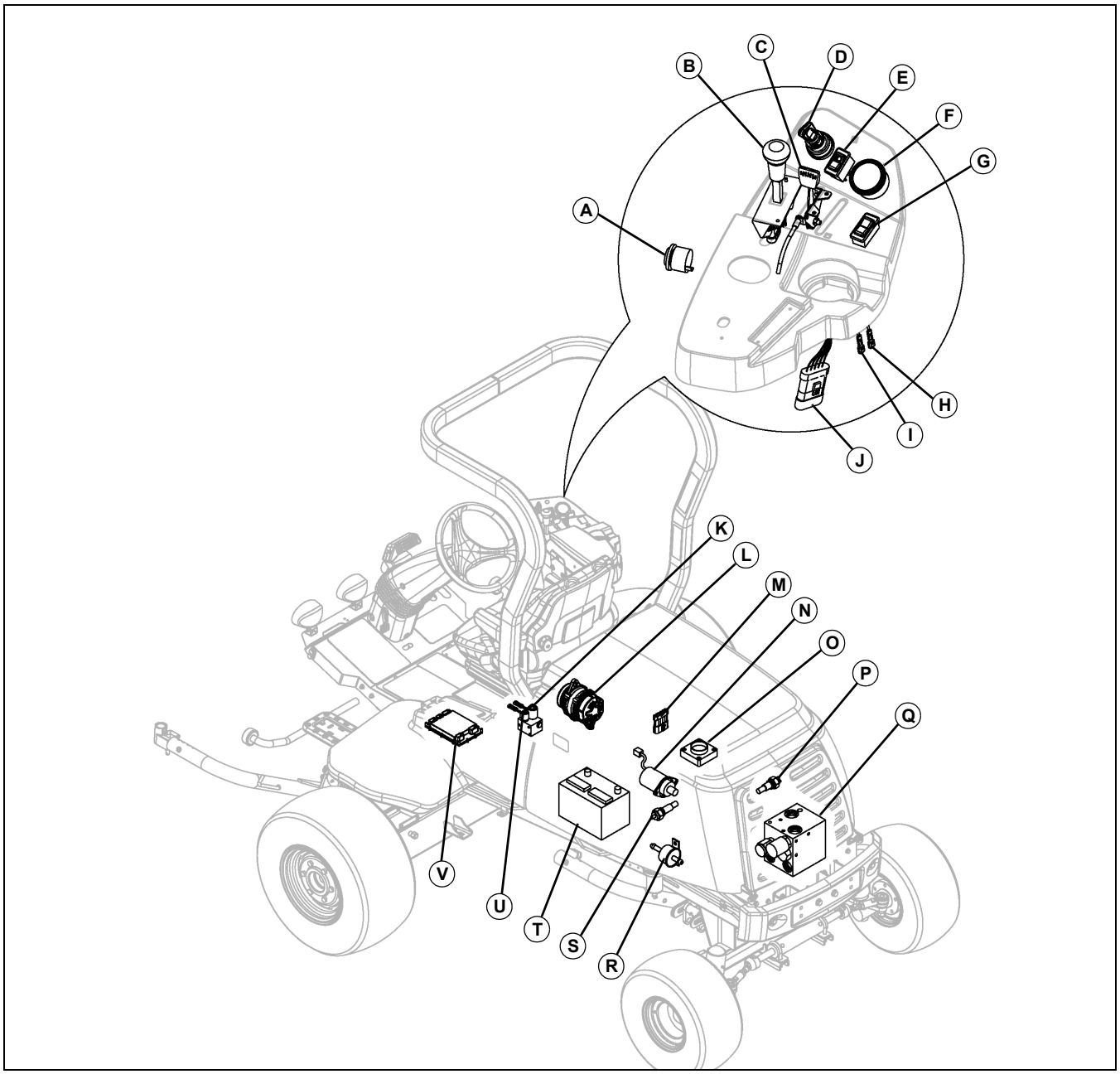
Electrical Components



MX24584

A- Engine-to-Frame Ground Strap
B- Starting Motor (M1)
C- Seat Switch (S5)
D- Neutral Switch (S6)
E- Relays (K1-K6)
F- Rear Backlap Switch (S9)
G- Rear Mow Solenoid (Y4)
H- Front Mow Solenoid (Y3)
I- Front Backlap Switch (S8)
J- Left Headlight (E1)
K- Center Headlight (E2)
L- Right Headlight (E3)
M- Cruise Control Magnet (Y9)
N- Park Brake Switch (S3)
O- Mow-Transport Switch (S2)
P- Filter Restriction Switch (B1)
Q- Hydraulic Oil Temperature Switch (B4)
R- Reverse Switch (S4)

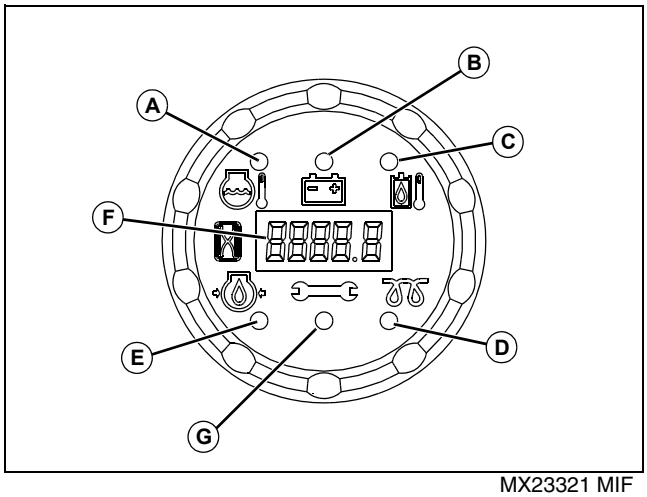
ELECTRICAL COMPONENT LOCATION



MX24583

A- Buzzer (H1)
B- Raise-Lower Switch (S10)
C- Mow-Transport Lever
D- Key Switch (S1)
E- Light Switch (S12)
F- Instrument Cluster (A2)
G- Cruise Control Switch (S11)
H- Hydraulic Filter Restriction Diode (V5)
I- Not Used (V6)
J- Diode Pack (V4)
K- Raise Solenoid (Y8)
L- Alternator (G2)
M- Resistor Pack (R2)
N- Fuel Shutoff Solenoid (Y1)
O- Air Preheater (R1)
P- Engine Coolant Temperature Switch (B3)
Q- 4WD Bypass Solenoids (Y5 and Y6)
R- Fuel Pump (M2)
S- Engine Oil Pressure Switch (B2)
T- Battery (G1)
U- Lower Solenoid (Y2)
V- Electronic Control Module (A1)

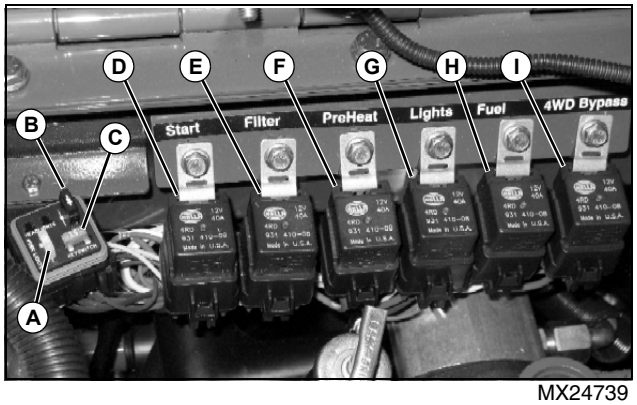
Instrument Cluster



MX23321 MIF

A- Engine Coolant Temperature LED
B- Battery LED
C- Hydraulic Oil Temperature LED
D- Preheat LED
E- Filter Restriction LED
F- Engine Oil Pressure LED
G- Hour Meter

Fuse/Diode Block and Relays



MX24739

A- Work Light Fuse (F6) (20A)
B- 4WD Diode (V3)
C- Key Switch Fuse (F3) (15A)
D- Start Relay (K1)
E- Filter Restriction Relay (K6)
F- Air Preheater Relay (K4)
G- Light Relay (K5)
H- Fuel Pull-In Relay (K2)
I- 4WD Bypass Relay (K3)

Schematics and Harnesses

Schematic and Wiring Harness Legend

Component

A1 - Electronic Control Module (SE7, W2)

A2 - Instrument Cluster (SE12, W1)

B1 - Filter Restriction Switch (SE12, W2)

B2 - Engine Oil Pressure Switch (SE12, W2)

B3 - Engine Coolant Temperature Switch (SE12, W2)

B4 - Hydraulic Oil Temperature Switch (SE12, W2)

E1 - Left headlight

E2 - Center headlight

E3 - Right Headlight

F1 - Fusible Link (SE2, W2)

F2 - Fusible Link (SE2, W2)

F3 - Key Switch Fuse (SE2, W2)

F6 - Work Light Fuse (SE14, W2)

G1 - Battery (SE1, W2)

G2 - Alternator (SE1, W2)

H1 - Buzzer (SE12, W1)

H2 - Air Preheater LED (SE12, W1)

H3 - Hydraulic Oil Temperature LED (SE12, W1)

H4 - Engine Oil Pressure LED (SE12, W1)

H5 - Engine Coolant Temperature LED (SE12, W1)

H6 - Battery LED (SE12, W1)

H7- Caution LED (SE12, W1)

K1 - Start Relay (SE2, W2)

K2 - Fuel Pull-In Relay (SE3, W2)

K3 - 4WD Bypass Relay (SE6, W2)

K4 - Air Preheater Relay (SE11, W2)

K5 - Light Relay (SE14, W2)

K6 - Filter Restriction Relay (SE12, W2)

K7 - Down Pressure Relay (SE15, W15)

M1 - Starting Motor (SE2, W2)

M2 - Fuel Pump (SE11, W2)

P1 - Hour Meter (SE12, W1)

R1 - Air Preheater (SE11, W2)

R2 - Resistor Pack (SE1, W2)

S1 - Key Switch (SE2, W1)

S2 - Mow-Transport Switch (SE5, W2)

S3 - Park Brake Switch (SE4, W10)

S4 - Reverse Switch (SE4, W6)

S5 - Seat Switch (SE4, W2)

S6 - Neutral Switch (SE4, W2)

S8 - Front Backlap Switch (SE9, W2)

S9 - Rear Backlap Switch (SE9, W2)

S10 - Raise-Lower Switch (SE10, W1)

S11 - Cruise Control Switch (SE13, W1)

S12 - Light Switch (SE14, W1)

V2 - Fuel Shutoff Solenoid Diode (SE3, W2)

V3 - 4WD Diode (SE6, W2)

V4 - Diode Pack (SE12, W1)

V5- Hydraulic Filter Restriction Diode (SE12, W1)

V6 - Not Used (SE12, W1)

W1 - Command Arm Wiring Harness

W2 - Main Wiring Harness

W3 - Battery Ground (SE1)

W4 - Frame Ground (SE1, W2)

W5 - Frame Ground (SE1, W2)

W6 - Reverse Switch Wiring Harness

W10 - Park Brake Switch Wiring Harness

W13 - Down Pressure Kit Y-Wiring Harness

W14 - Down Pressure Kit Relay Wiring Harness

Y1 - Fuel Shutoff Solenoid (SE3, W2)

Y2 - Lower Solenoid (SE10, W2)

Y3 - Front Mow Solenoid (SE5, W2)

Y4 - Rear Mow Solenoid (SE5, W2, W13)

Y5 - 4WD Bypass Solenoid (SE6, W2)

Y6 - 4WD Bypass Solenoid (SE6, W2)

Y8 - Raise Solenoid (SE10, W2)

Y9 - Cruise Control Magnet (SE13, W2)

Connectors

X3 - Light Switch Connector (W1)

X6 - Key Switch Connector (W1)

X8 - Mow-Transport Switch Connector (W2)

X9 - Cruise Control Switch Connector (W1)

X10 - Raise-Lower Switch Connector (W1)

X11 - 4WD Bypass Solenoid Connector (W2)

X12 - Diode Pack Connector (W1)

X13 - 4WD Bypass Solenoid Connector (W2)

X14 - Command Arm Harness Connector (W1, W2)

X15 - Command Arm Harness Connector (W1, W2)

X16 - Instrument Cluster Connector (W1)

X17 - Left Work Light Connector (W2)

X18 - Right Work Light Connector (W2)

X19 - Buzzer Connector (W1)

X20 - Park Brake Switch Harness Connector (W2, W10)

X21 - Cruise Control Magnet Connector (W2)

X22 - Rear Mow Solenoid Connector (W2)

X23 - Rear Backlap Switch Connector (W2)

X24 - Hydraulic Oil Temperature Switch Harness Connector (W2)

X25 - Hydraulic Filter Restriction Switch Connector (W2)

X26 - Fuse/Diode Block Connector (W2)

X27 - Start Relay Connector (W2)

X28 - Hydraulic Filter Restriction Relay Connector (W2)

X29 - Air Preheater Relay Connector (W2)

X30 - Light Relay Connector (W2)

X31 - Fuel Pull-In Relay Connector (W2)

X32 - 4WD Bypass Relay Connector (W2)

X33 - Front Mow Solenoid Connector (W2)

X34 - Front Backlap Switch Connector (W2)

X35 - Reverse Switch Harness Connector (W2, W6)

X36 - Seat Switch Connector (W2)

X37 - Neutral Switch Harness Connector (W2)

X38 - Raise Solenoid Connector (W2)

X39 - Lower Solenoid Connector (W2)

X40 - Electronic Control Module (J5) Connector (W2)

X41 - Electronic Control Module (J2) Connector (W2)

X42 - Not Used (W1)

X43 - Filter Restriction Diode Connector (W1)

X44 - Electronic Control Module (J1) Connector (W2)

X45 - Electronic Control Module (J3) Connector (W2)

X46 - Electronic Control Module (J4) Connector (W2)

X47 - Fuel Shutoff Solenoid Connector (W2)

X48 - Fuel Shutoff Solenoid Diode Connector (W2)

X49 - Fuel Pump Connector (W2)

X50 - Command Arm Ground Connector (W1)

X51 - W4 Frame Ground Connector (W2)

X52 - Engine Oil Pressure Switch Connector (W2)

X53 - Engine Coolant Temperature Switch Connector (W2)

X54 - Air Preheater Connector (W2)

X55 - Alternator Battery Terminal (W2)

X56 - Alternator Ground Terminal (W2)

X57 - Starting Motor Solenoid Connector (W2)

X58 - Alternator Connector (W2)

X59 - Hood Switch Connector (W2)

X60 - Resistor Pack Connector (W2)

X61 - Starting Motor Battery Terminal (W2)

X62 - W5 Frame Ground Terminal (W2)

X63 - Not Used (W2)

X64 - Center Work Light Connector (W2)

X65 - Command Arm Ground Connector (W1)

X66 - Down Pressure Relay Wiring Harness-to-Electronic Control Module Connector (J3) (W14)

X67 - Down Pressure Relay Wiring Harness-to-Main Wiring Harness Electronic Control Module Connector (X45) (W14)

X69 - Down Pressure Relay Connector (W14)

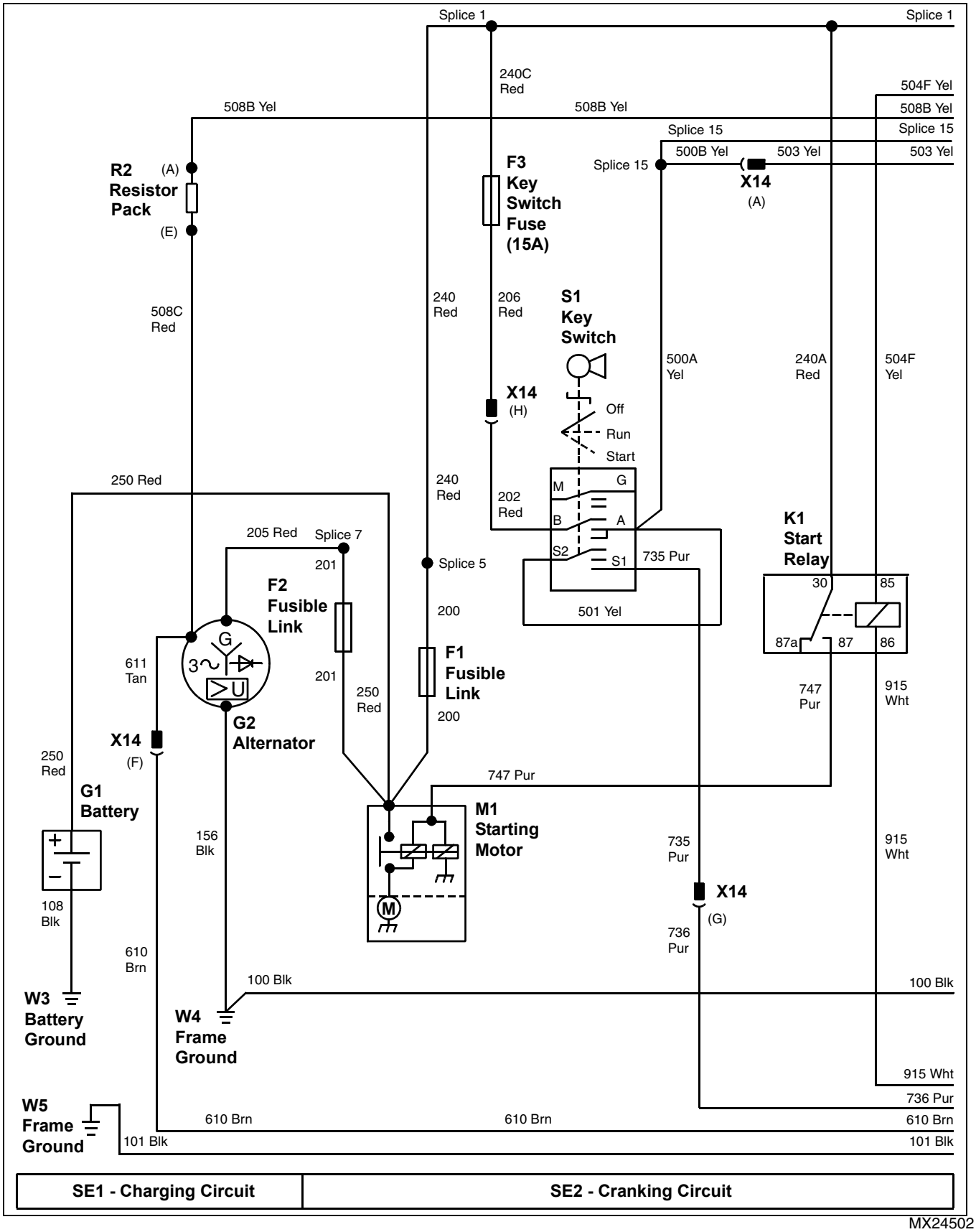
X70 - Down Pressure Solenoid connector (W14)

X71 - Down Pressure Relay Wiring Harness-to-Down Pressure Y-Wiring Harness Connector (W13, W14)

X72 - Down Pressure Y-Wiring Harness-to-Main Wiring Harness Rear Mow Solenoid Connector (W13)

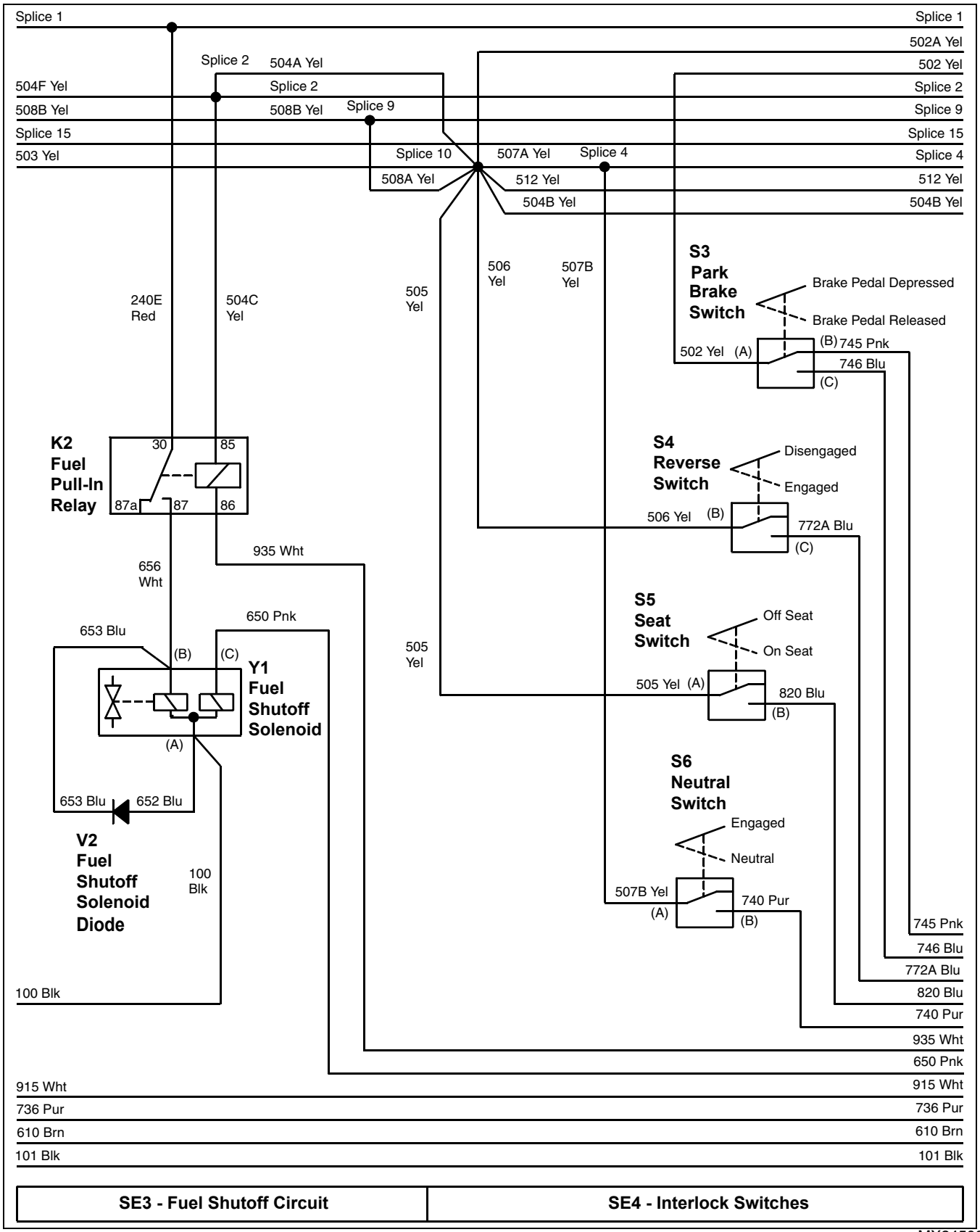
X73 - Rear Mow Solenoid Connector (W13)

Main Electrical Schematic (Sheet 1 of 9)



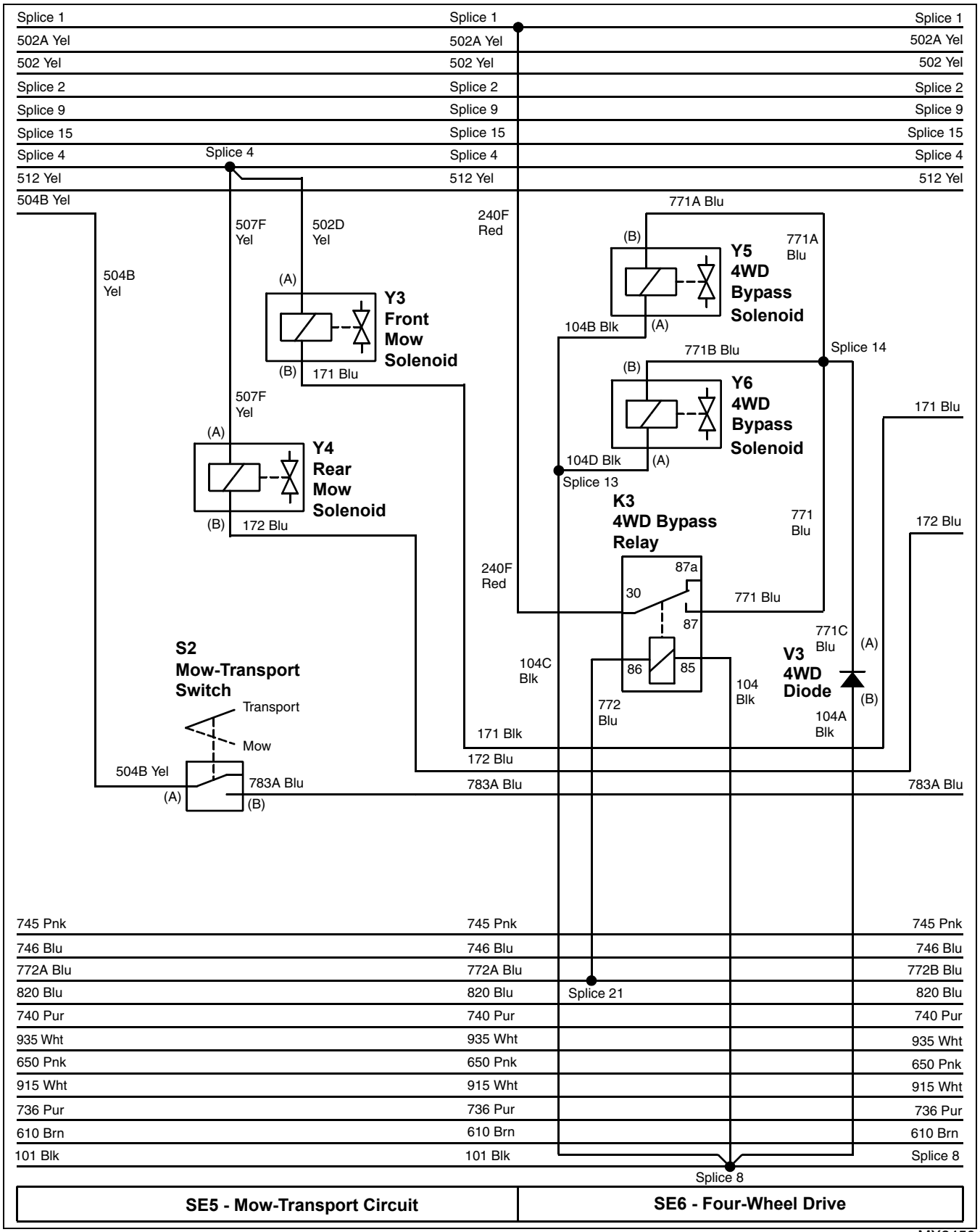
MX24502

Main Electrical Schematic (Sheet 2 of 9)



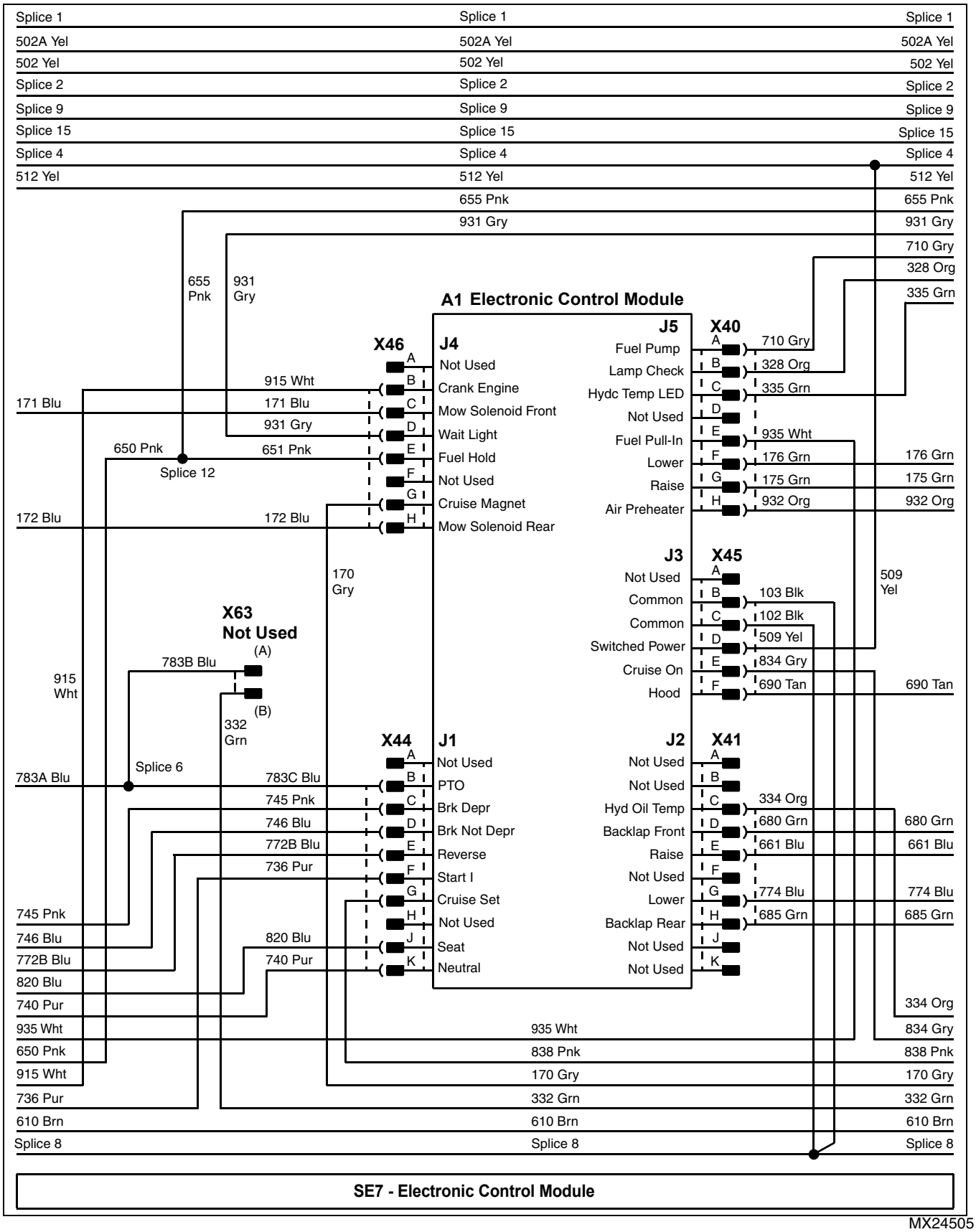
MX24503

Main Electrical Schematic (Sheet 3 of 9)

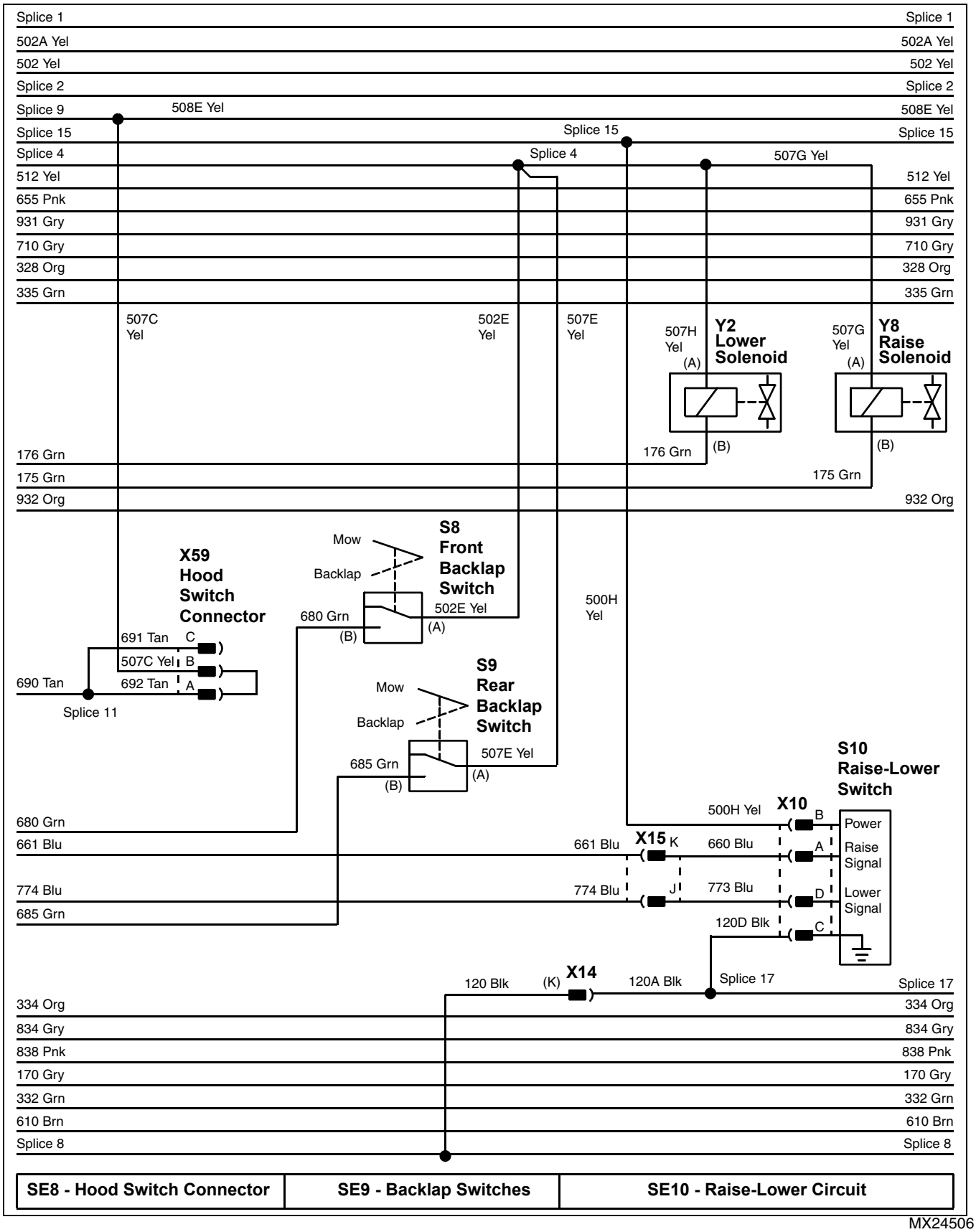


MX24504

Main Electrical Schematic (Sheet 4 of 9)



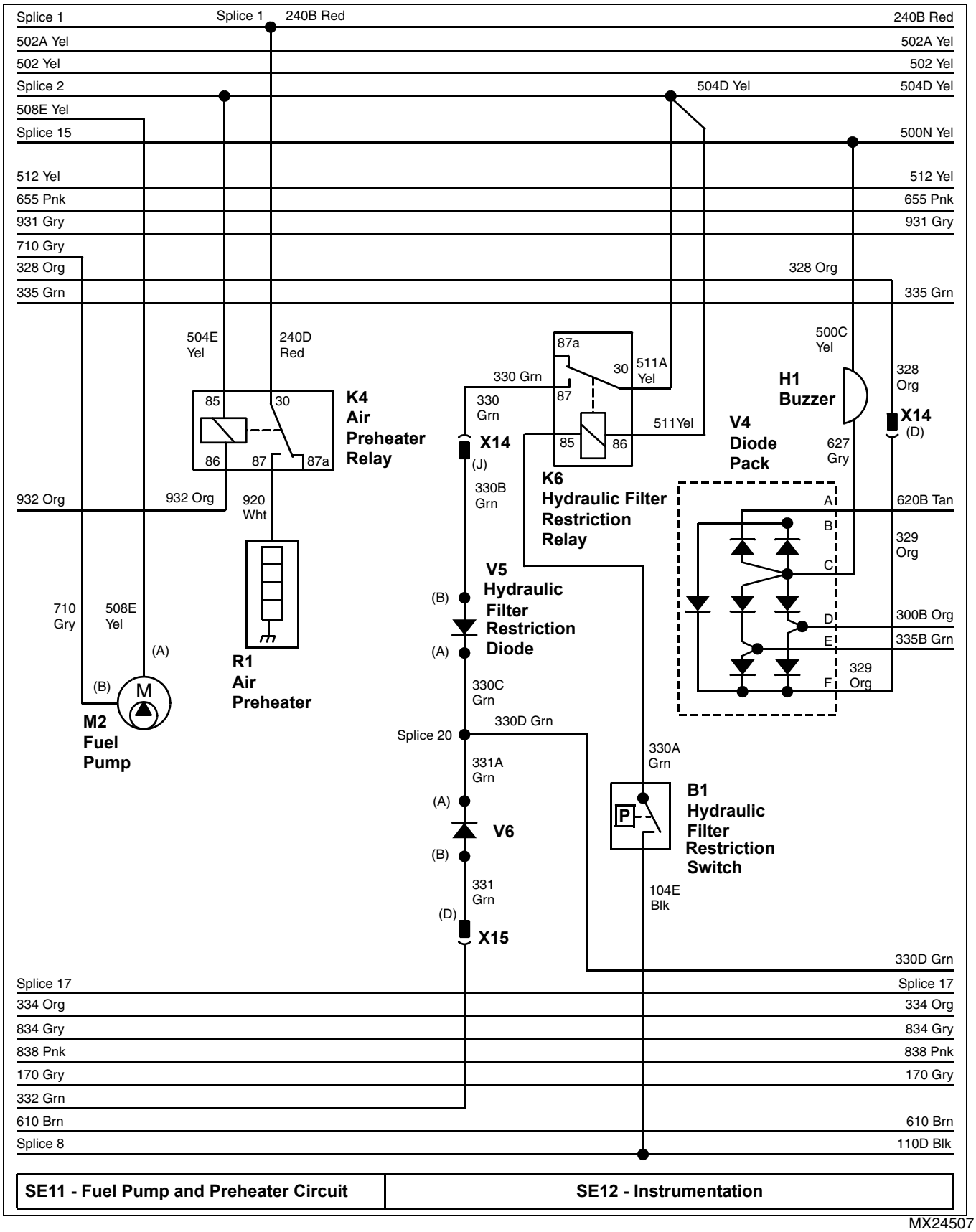
Main Electrical Schematic (Sheet 5 of 9)



SE8 - Hood Switch Connector	SE9 - Backlap Switches	SE10 - Raise-Lower Circuit

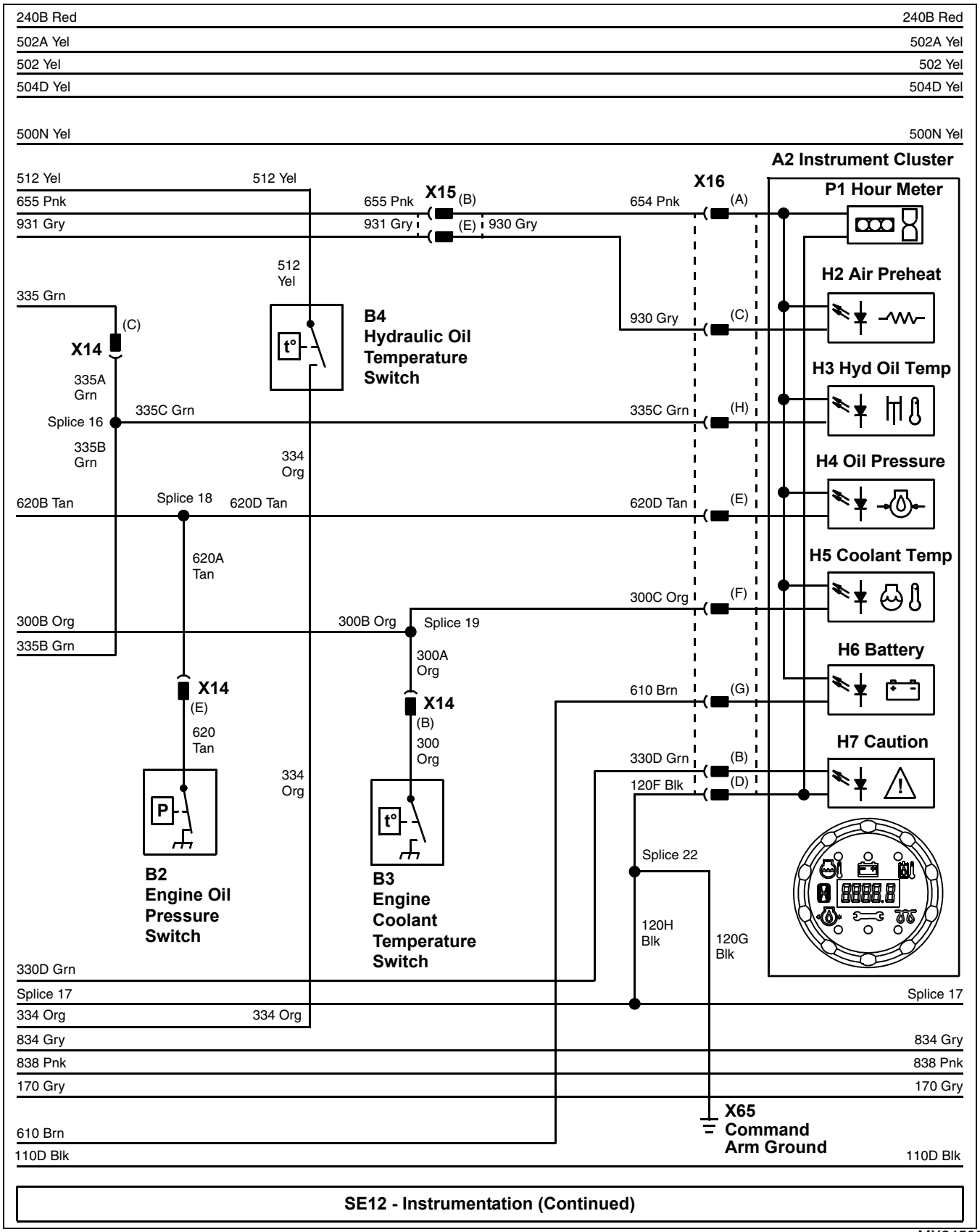
MX24506

Main Electrical Schematic (Sheet 6 of 9)



MX24507

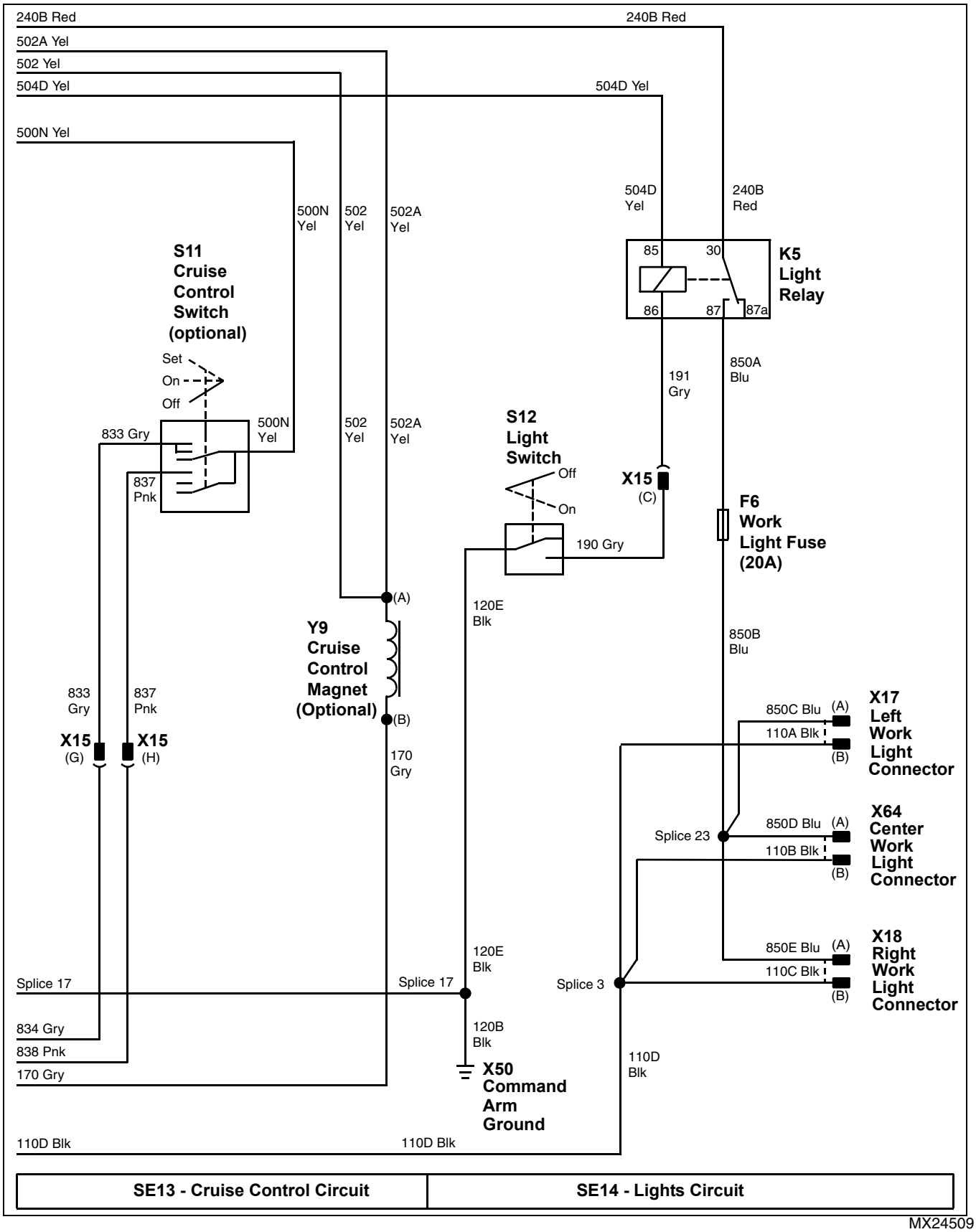
Main Electrical Schematic (Sheet 7 of 9)



SE12 - Instrumentation (Continued)

MX24508

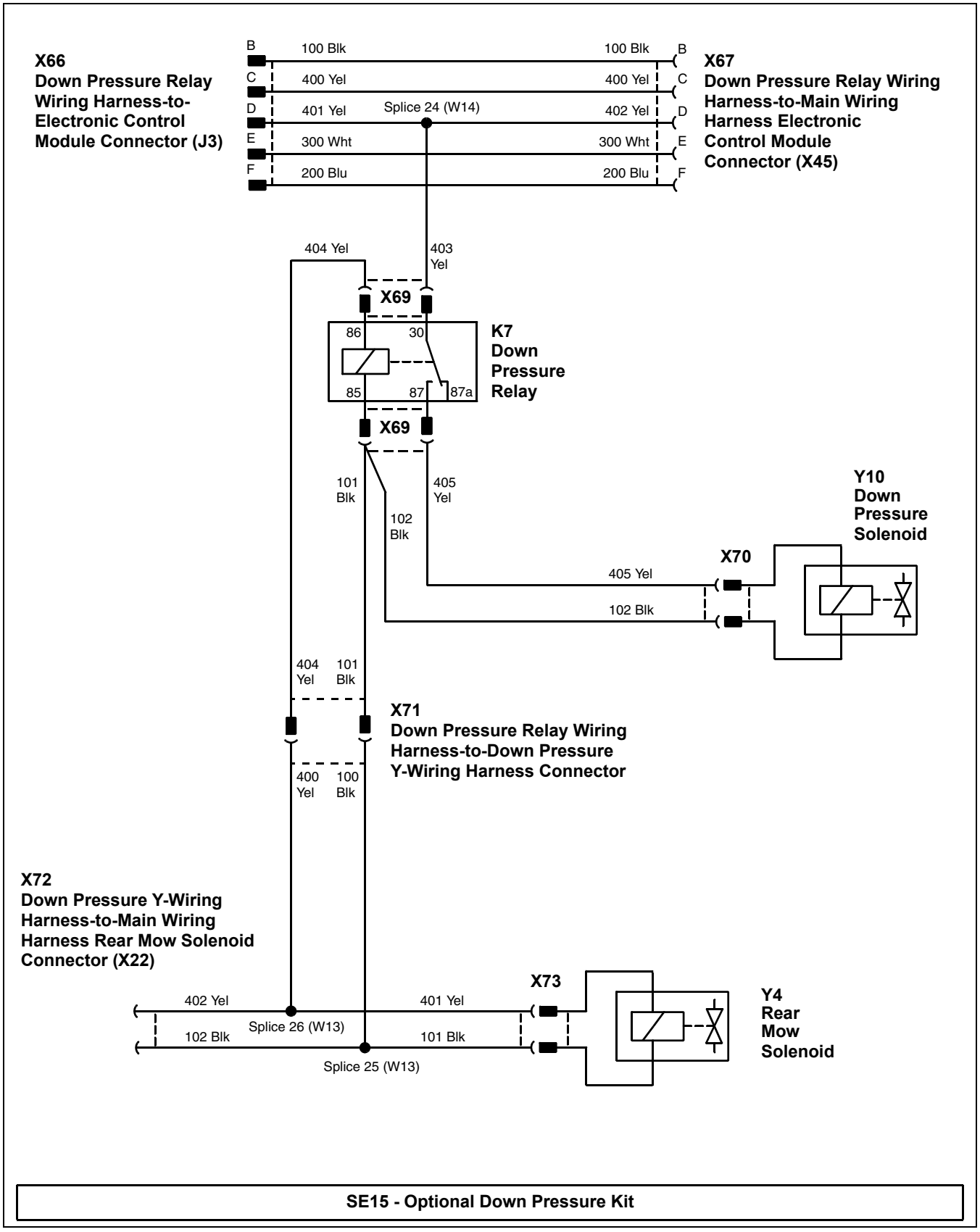
Main Electrical Schematic (Sheet 8 of 9)



SE13 - Cruise Control Circuit	SE14 - Lights Circuit

MX24509

Main Electrical Schematic (Sheet 9 of 9) - Optional

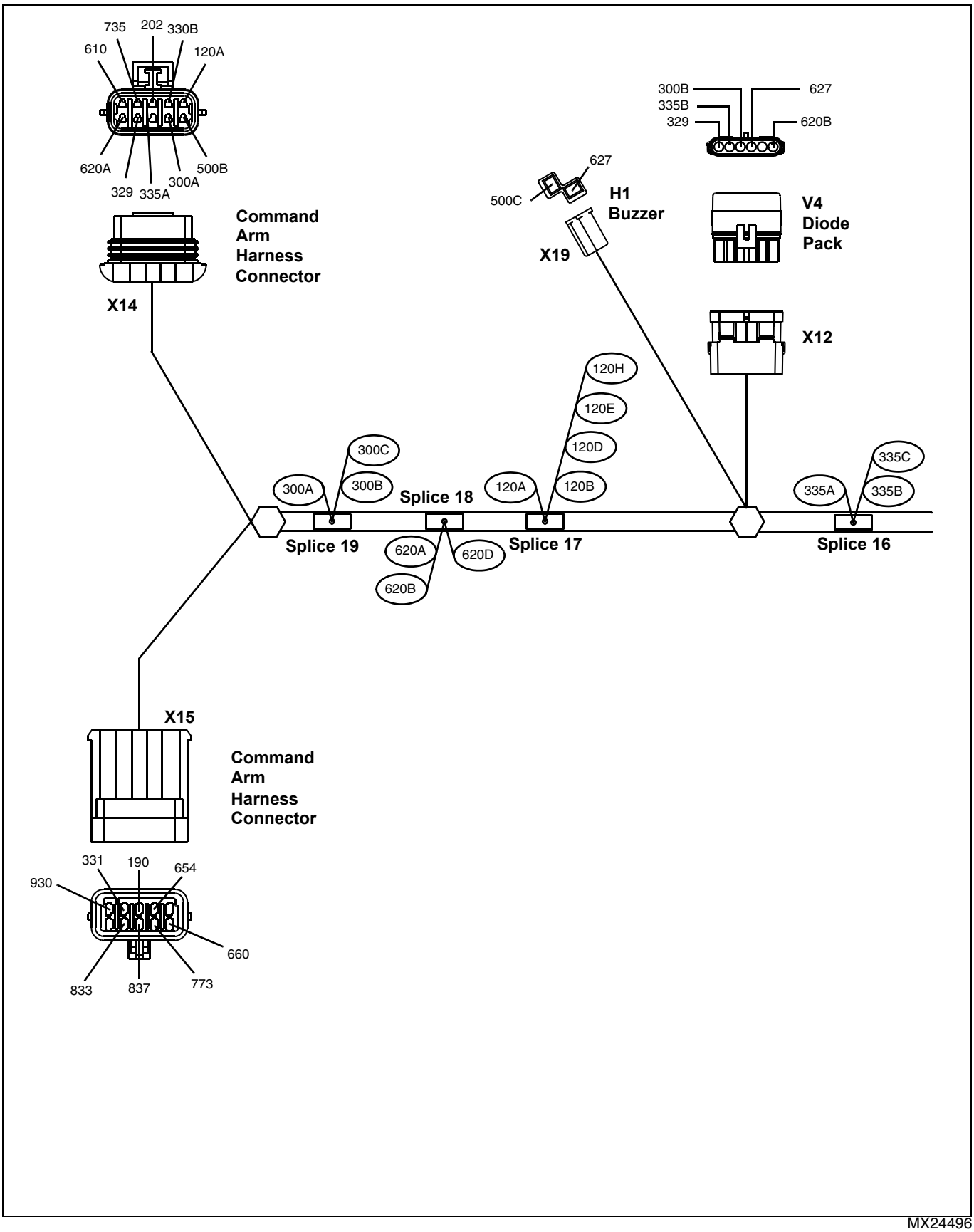


SE15 - Optional Down Pressure Kit

Command Arm Wiring Harness (W1) Wire Code Table

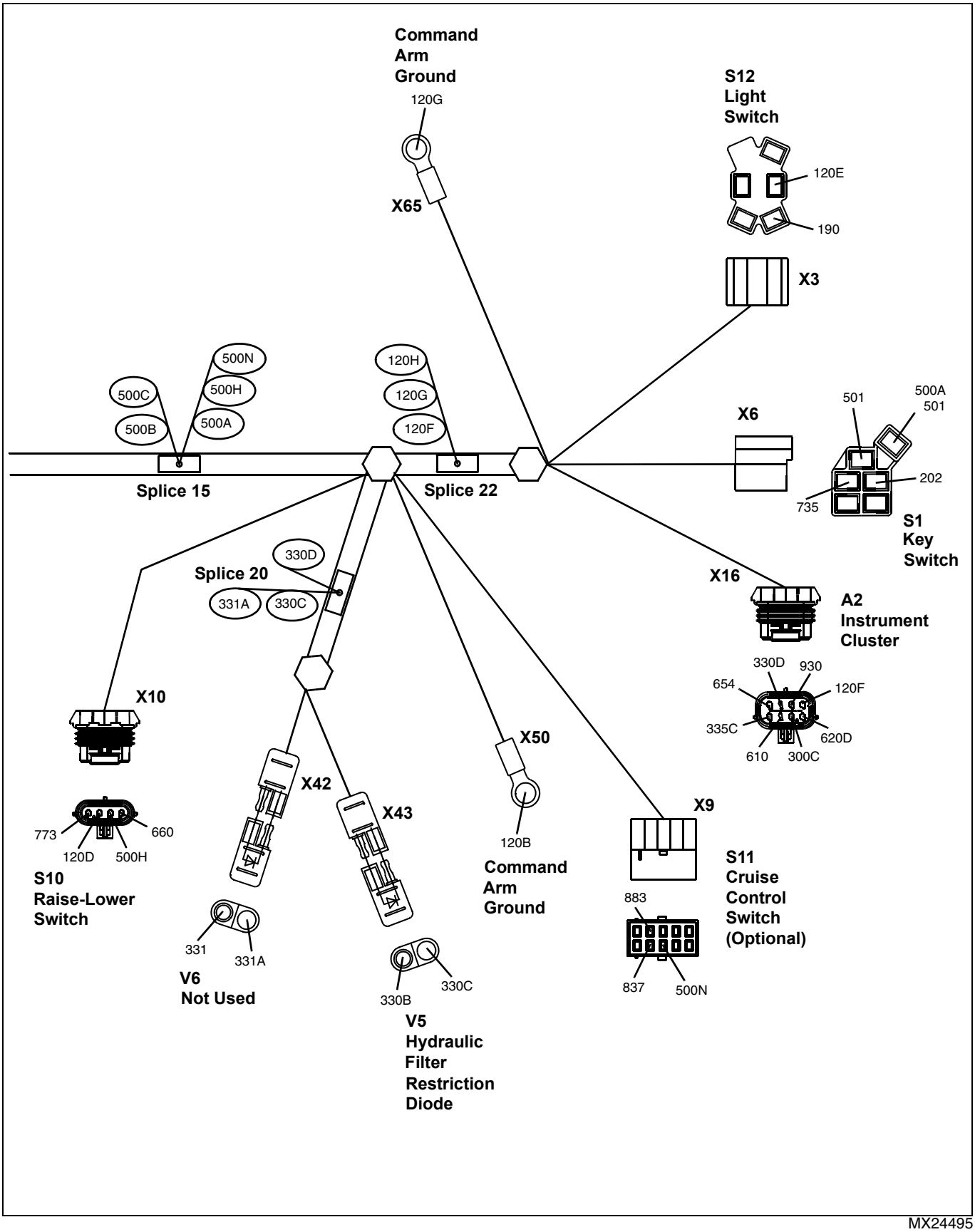
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
120A	0.8	Blk	X14 (K), Splice 17
120B	0.8	Blk	Splice 17, X50
120D	0.8	Blk	X10 (C), Splice 17
120E	0.8	Blk	X3 (1), Splice 17
120F	0.8	Blk	X16 (D), Splice 22
120G	0.8	Blk	X65, Splice 22
120H	0.8	Blk	Splice 22, Splice 17
190	0.8	Gry	X15 (C), X3 (2)
202	1.0	Red	X14 (H), X6 (B)
300A	0.8	Org	X14 (B), Splice 19
300B	0.8	Org	X12 (D), Splice 19
300C	0.8	Org	X16 (F), Splice 19
329	0.8	Org	X14 (D), X12 (F)
330B	0.8	Grn	X14 (J), X43 (B)
330C	0.8	Grn	X43 (A), Splice 20
330D	0.8	Grn	X16 (B), Splice 20
331	0.8	Grn	X42 (B), X15 (D)
331A	0.8	Grn	X42 (A), Splice 20
335A	0.8	Grn	X14 (C), Splice 16
335B	0.8	Grn	X12 (E), Splice 16
335C	0.8	Grn	X16 (H), Splice 16
500A	1.0	Yel	X6 (A), Splice 15
500B	1.0	Yel	X14 (A), Splice 15
500C	0.8	Yel	X19 (B), Splice 15
500H	0.8	Yel	X10 (B), Splice 15
500N	0.8	Yel	X9 (2), Splice 15
501	0.8	Yel	X6 (A), X6 (S2)
610	0.8	Brn	X14 (F), X16 (G)
620A	0.8	Tan	X14 (E), Splice 18
620B	0.8	Tan	X12 (A), Splice 18
620D	0.8	Tan	X16 (E), Splice 18
627	0.8	Gry	X12 (C), X19 (B)
654	0.8	Pnk	X15 (B), X16 (A)
660	0.8	Blu	X15 (K), X10 (A)
735	0.8	Pur	X14 (G), X6 (S1)
773	0.8	Blu	X15 (J), X10 (D)
833	0.8	Gry	X15 (G), X9 (6)
837	0.8	Pnk	X15 (H), X9 (3)
930	0.8	Gry	X15 (E), X16 (C)

Command Arm Wiring Harness (W1) (Sheet 1 of 2)



MX24496

Command Arm Wiring Harness (W1) (Sheet 2 of 2)



MX24495

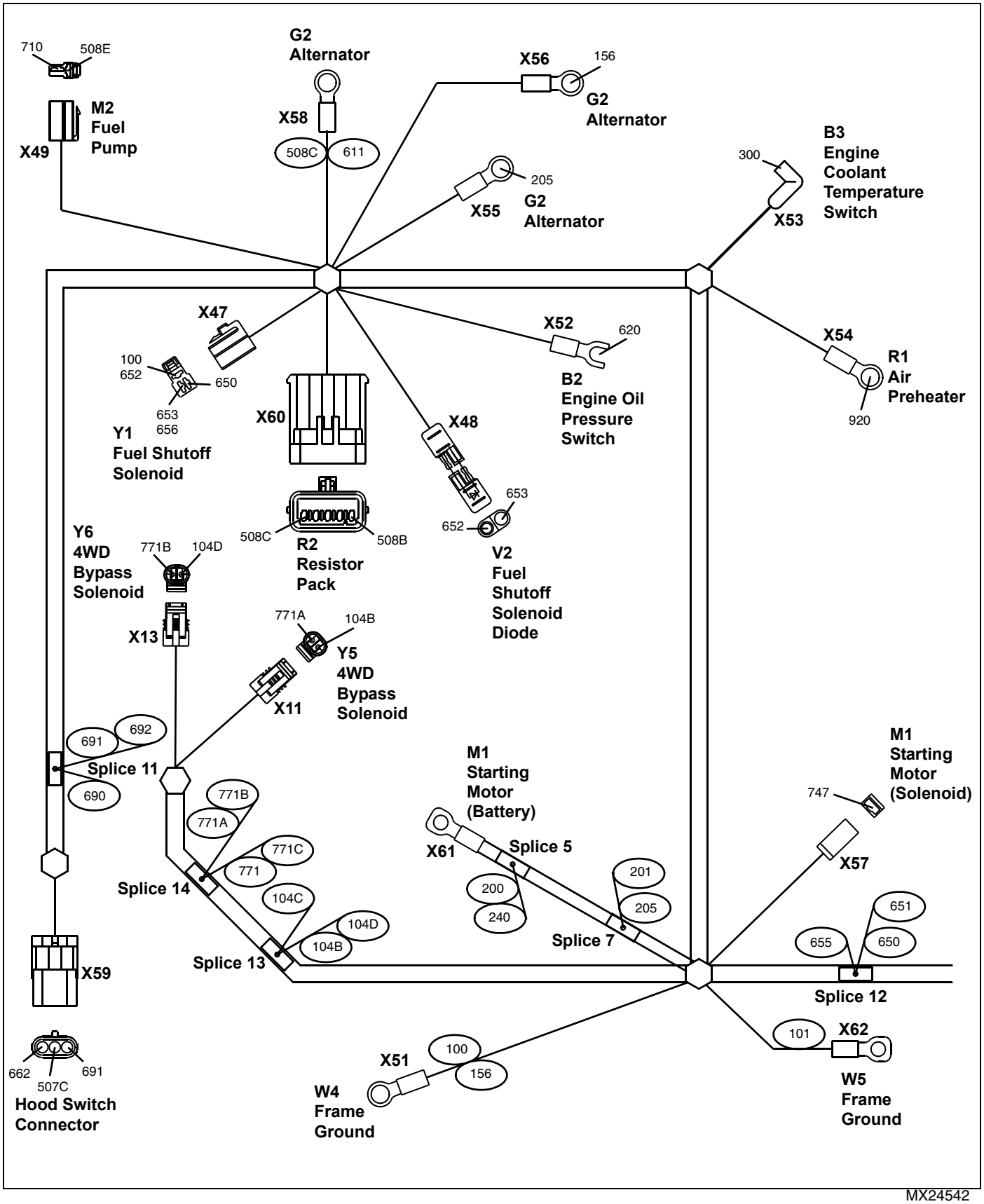
Main Wiring Harness (W2) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	3.0	Blk	X51 (W4), X47 (A)
101	5.0	Blk	X62 (W5), Splice 8
102	1.0	Blk	X45 (J3-C), Splice 8
103	1.0	Blk	X45 (J3-B), Splice 8
104	0.8	Blk	X32 (85), Splice 8
104A	0.8	Blk	X26 (1), Splice 8
104B	0.8	Blk	X11 (B), Splice 13
104C	0.8	Blk	Splice 13, Splice 8
104D	0.8	Blk	X13 (A), Splice 13
104E	0.8	Blk	X25 (A), Splice 8
108	13.0	Blk	G1(-), Battery Ground (W3)
110A	1.0	Blk	X17 (B), Splice 3
110B	1.0	Blk	X64 (B), Splice 3
110C	1.0	Blk	X18 (B), Splice 3
110D	1.0	Blk	Splice 3, Splice 8
120	0.8	Blk	X14 (K), Splice 8
156	3.0	Blk	X56, X51 (W4)
170	0.8	Gry	X21 (B), X46 (G)
171	0.8	Blu	X33 (B), X46 (C)
172	0.8	Blu	X22 (B), X46 (H)
175	0.8	Grn	X38 (B), X40 (G)
176	0.8	Grn	X39 (B), X40 (F)
191	0.8	Gry	X30 (86), X15 (C)
200	2.0	Red	X61, Splice 5
201	1.0	Red	X61, Splice 7
205	3.0	Red	X55, Splice 7
206	1.0	Red	X14 (H), X26 (3)
240	8.0	Red	Splice 1, Splice 5
240A	3.0	Red	X27 (30), Splice 1
240B	3.0	Red	X30 (30), Splice 1
240C	3.0	Red	X26 (4), Splice 1
240D	3.0	Red	X29 (30), Splice 1
240E	3.0	Red	X31 (30), Splice 1
240F	3.0	Red	X32 (30), Splice 1
250	13.0	Red	G1(+), M1 (Battery)
300	0.8	Org	X53, X14 (B)
328	0.8	Org	X14 (D), X40 (B)
330	0.8	Grn	X14 (J), X28 (87)
330A	0.8	Grn	X25 (B), X28 (85)
332	0.8	Grn	X15 (D), X63 (B)
334	0.8	Org	X24 (A), X41 (C)
335	0.8	Grn	X14 (C), X40 (C)
502	0.8	Yel	X20 (A), X21 (A)
502A	1.0	Yel	X21 (A), Splice 10
502D	0.8	Yel	X33 (A), Splice 4
502E	0.8	Yel	X34 (A), Splice 4
503	1.0	Yel	X14 (A), Splice 10
504A	0.8	Yel	Splice 10, Splice 2
504B	0.8	Yel	X8 (A), Splice 10
504C	0.8	Yel	X31 (85), Splice 2
504D	0.8	Yel	X30 (85), Splice 2
504E	0.8	Yel	X29 (85), Splice 2
504F	0.8	Yel	X27 (85), Splice 2
505	0.8	Yel	X36 (A), Splice 10
506	0.8	Yel	X35 (B), Splice 10
507A	1.0	Yel	Splice 10, Splice 4
507B	0.8	Yel	X37 (A), Splice 4
507C	0.8	Yel	X59 (B), Splice 9
507E	0.8	Yel	X23 (A), Splice 4
507F	0.8	Yel	X22 (A), Splice 4

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
507G	0.8	Yel	X38 (A), Splice 4
507H	0.8	Yel	X39 (A), Splice 4
508A	0.8	Yel	Splice 9, Splice 10
508B	0.8	Yel	X60 (A), Splice 9
508C	0.8	Yel	X58, X60 (E)
508E	0.8	Yel	X49 (A), Splice 9
509	1.0	Yel	X45 (D), Splice 4
511	0.8	Yel	X28 (86), Splice 2
511A	0.8	Yel	X28 (30), Splice 2
512	0.8	Yel	Splice 10, X24 (B)
611	0.8	Tan	X14 (F), X58
620	0.8	Tan	X14 (E), X52
650	1.0	Pnk	X47 (C), Splice 12
651	1.0	Pnk	Splice 12, X46 (E)
652	2.0	Blu	X47 (A), X48 (B)
653	2.0	Blu	X47 (B), X48 (A)
655	0.8	Pnk	X15 (B), Splice 12
656	3.0	Wht	X47 (B), X31 (87)
661	0.8	Blu	X15 (K), X41 (E)
680	0.8	Grn	X34 (B), X41 (D)
685	0.8	Grn	X23 (B), X41 (H)
690	0.8	Tan	X45 (F), Splice 11
691	0.8	Tan	X59 (C), Splice 11
692	0.8	Tan	X59 (A), Splice 11
710	0.8	Gry	X49 (B), X40 (A)
736	0.8	Pur	X14 (G), X44 (F)
740	0.8	Pur	X37 (B), X44 (K)
745	0.8	Pnk	X20 (B), X44 (C)
746	0.8	Blu	X20 (C), X44 (D)
747	2.0	Pur	X57, X27 (87)
771	1.0	Blu	X32 (87), Splice 14

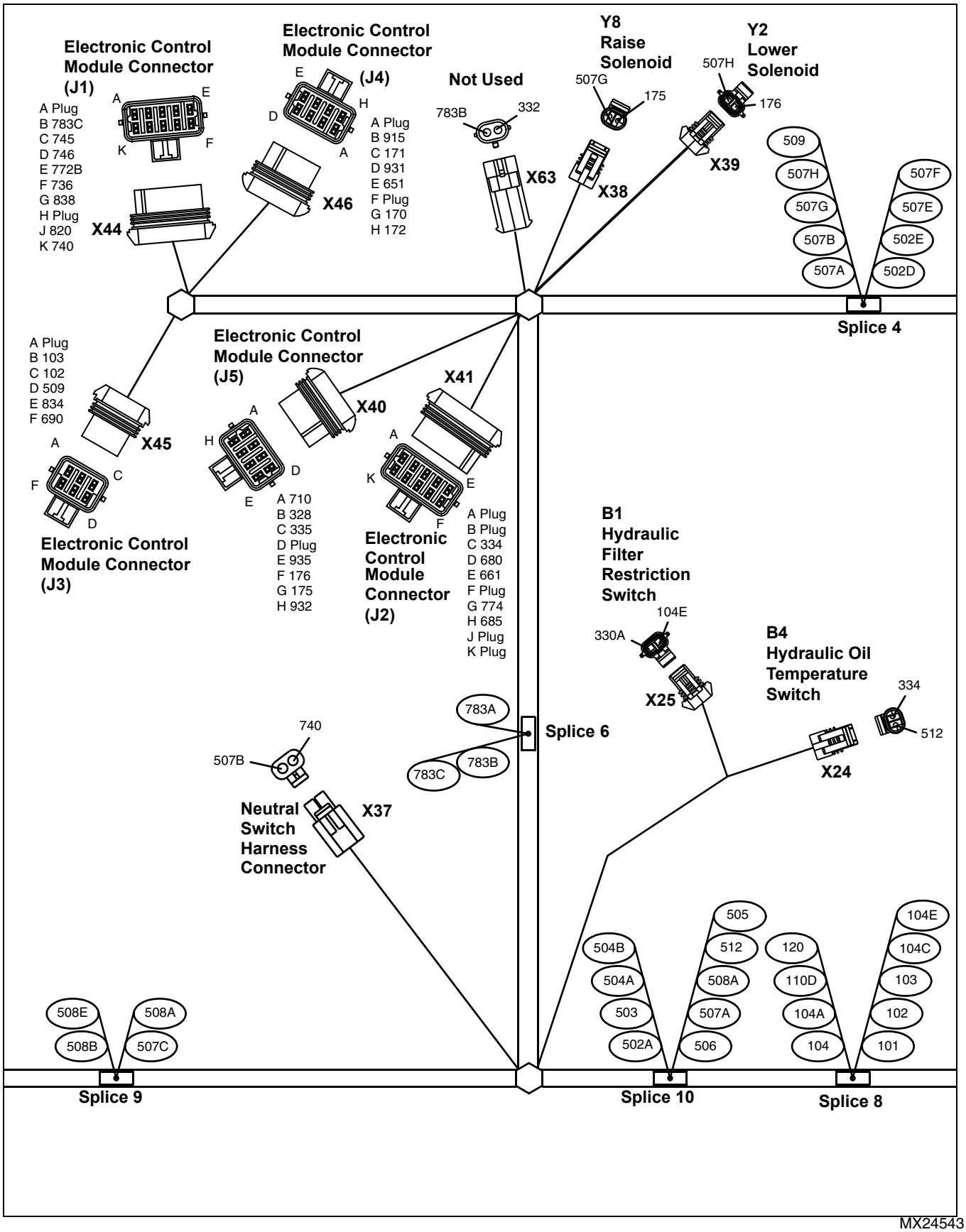
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
771A	0.8	Blu	X11 (A), Splice 14
771B	0.8	Blu	X13 (B), Splice 14
771C	0.8	Blu	X26 (A), Splice 14
772	0.8	Blu	X32 (86), Splice 21
772A	0.8	Blu	X35 (C), Splice 21
772B	0.8	Blu	X44 (E), Splice 21
774	0.8	Blu	X15 (J), X41 (G)
783A	0.8	Blu	X8 (B), Splice 6
783B	0.8	Blu	X63 (A), Splice 6
783C	0.8	Blu	X44 (B), Splice 6
820	0.8	Blu	X36 (B), X44 (J)
834	0.8	Gry	X15 (G), X45 (E)
838	0.8	Pnk	X15 (H), X44 (G)
850A	2.0	Blu	X26, X30 (87)
850B	2.0	Blu	X26, Splice 23
850C	1.0	Blu	X17, Splice 23
850D	1.0	Blu	X64, Splice 23
850E	1.0	Blu	X18, Splice 23
915	0.8	Wht	X27 (86), X46 (B)
920	3.0	Wht	X54, X29 (87)
931	0.8	Gry	X15 (E), X46 (D)
932	0.8	Org	X29 (86), X40 (H)
935	0.8	Wht	X31 (86), X40 (E)

Main Wiring Harness (W2) (Sheet 1 of 4)



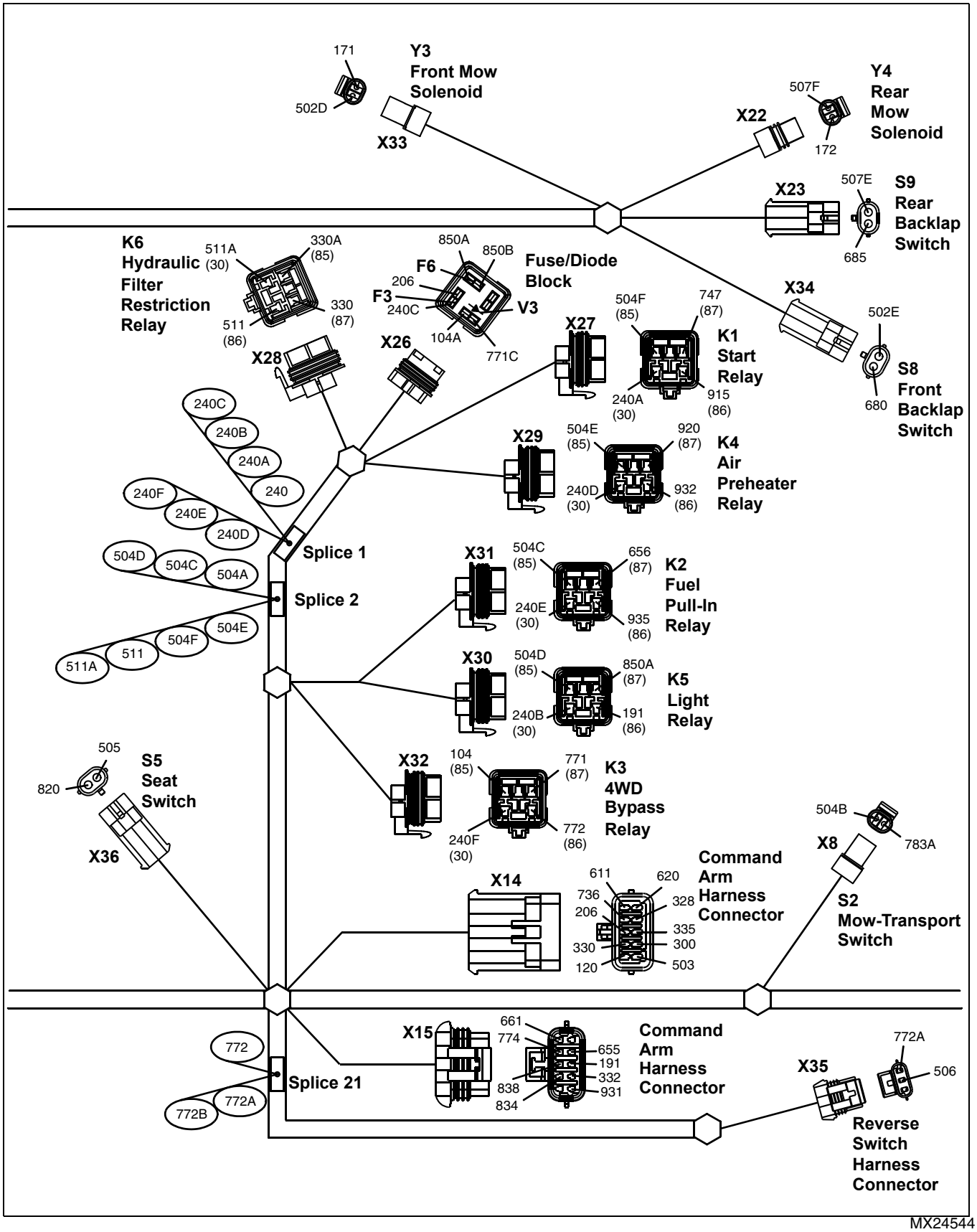
MX24542

Main Wiring Harness (W2) (Sheet 2 of 4)



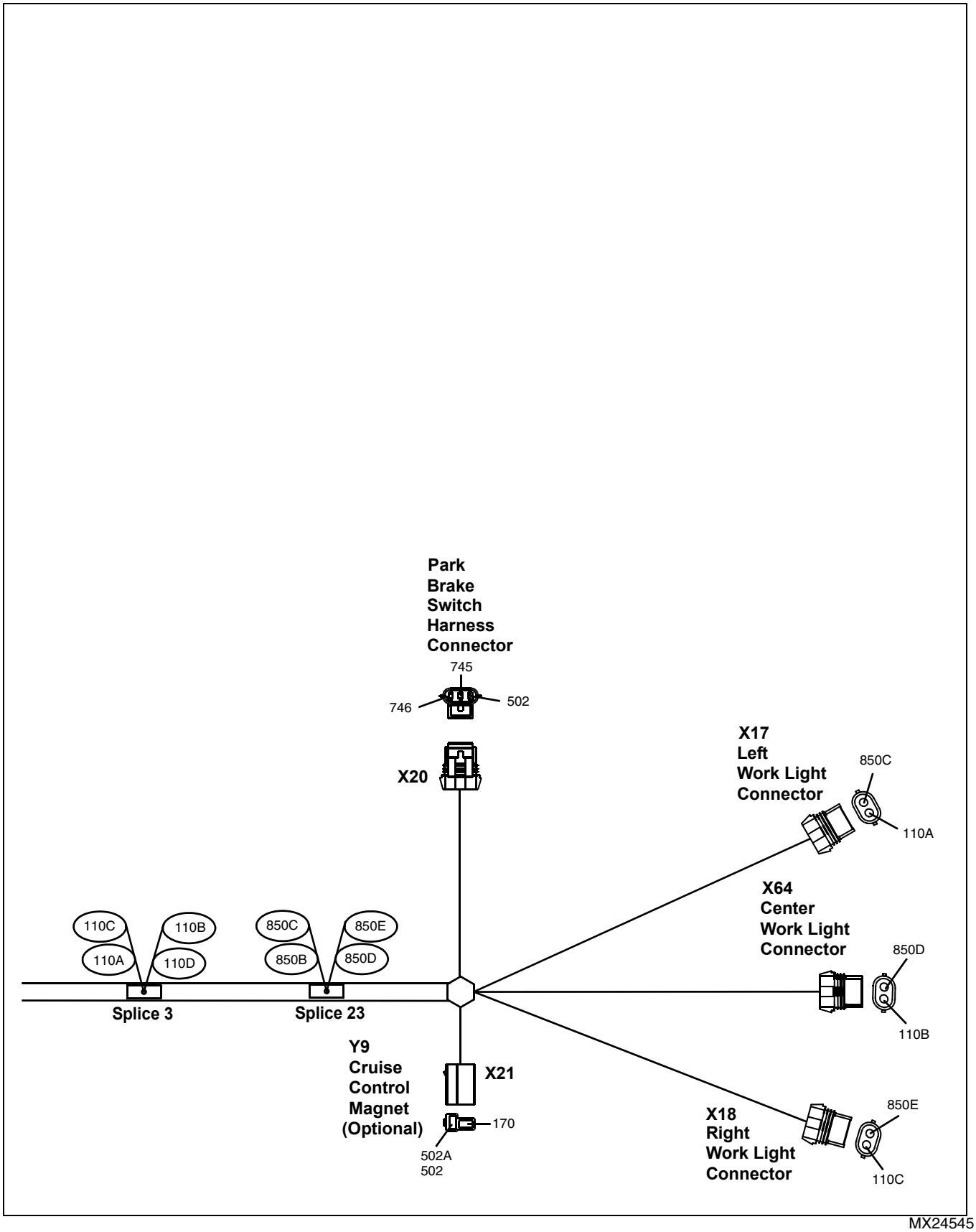
MX24543

Main Wiring Harness (W2) (Sheet 3 of 4)

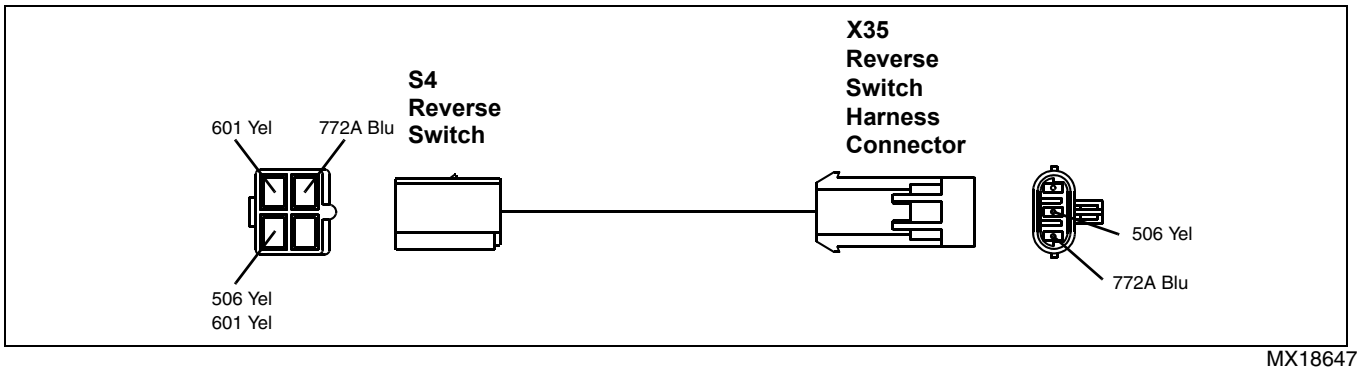


MX24544

Main Wiring Harness (W2) (Sheet 4 of 4)

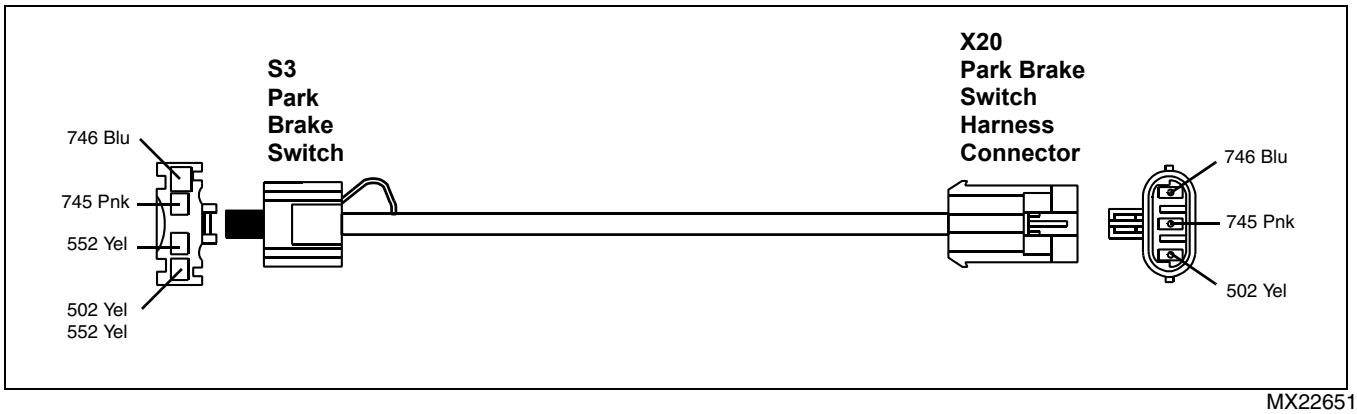


Reverse Switch Wiring Harness (W7)



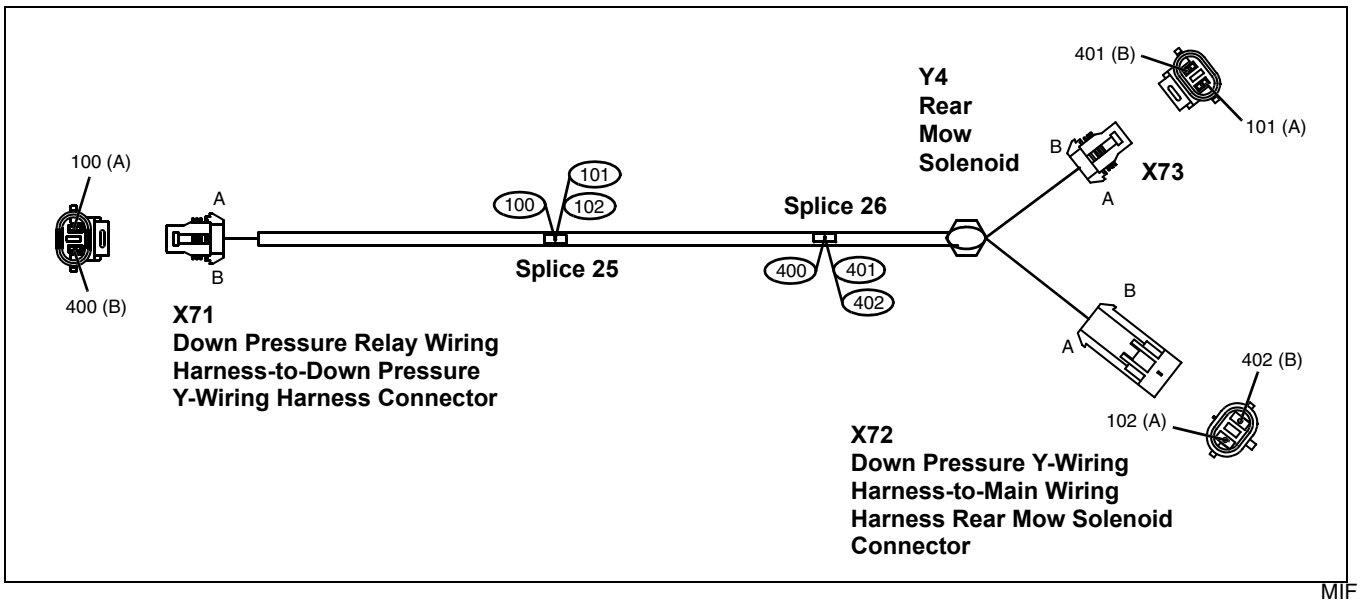
MX18647

Park Brake Switch Wiring Harness (W10)



MX22651

Down Pressure Kit Y-Wiring Harness (W13) - Optional

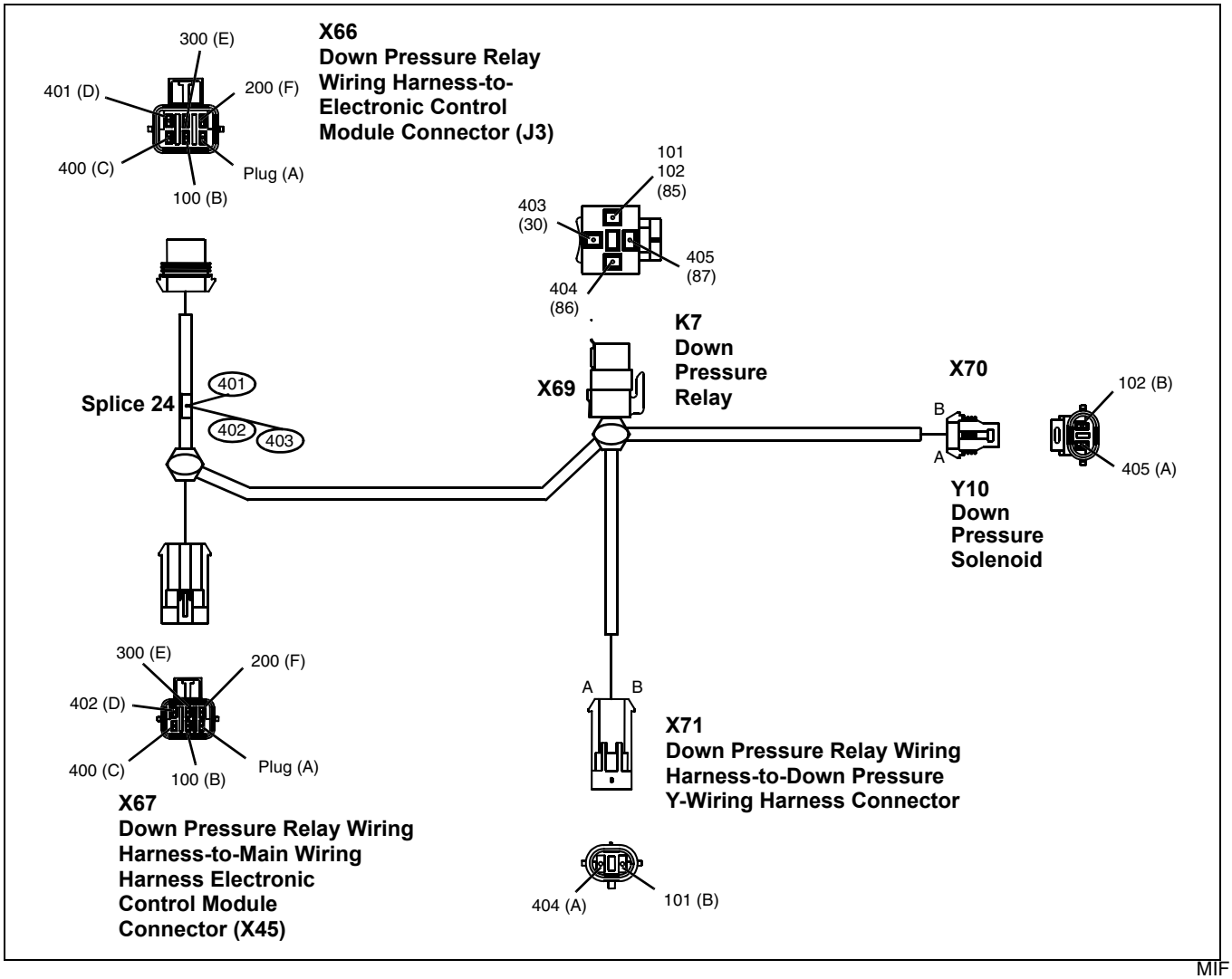


MIF

Down Pressure Kit Y-Wiring Harness (W13) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	X71 (A), Splice 25
101	0.8	Blk	Splice 25, X73 (A)
102	0.8	Blk	Splice 25, X72 (A)
400	0.8	Yel	X71 (B), Splice 26
401	0.8	Yel	Splice 26, X73 (B)
402	0.8	Yel	Splice 26, X72 (B)

Down Pressure Relay Wiring Harness (W14) - Optional



MIF

Down Pressure Kit Relay Wiring Harness (W14) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	0.8	Blk	X66 (B), X67 (B)
101	0.8	Blk	X69 (85), X68 (B)
102	0.8	Blk	X69 (85), X70 (B)
200	0.8	Blu	X66 (F), X67 (F)
300	0.8	Wht	X66 (E), X67 (E)
400	0.8	Yel	X66 (C), X67 (C)
401	0.8	Yel	X66 (D), Splice 24
402	0.8	Yel	Splice 24, X67 (D)

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
403	0.8	Yel	Splice 24, X69 (30)
404	0.8	Yel	X69 (86), X68 (A)
405	0.8	Yel	X69 (87), X70 (A)

Operation and Diagnostics

Electronic Control Module Operation

This machine is equipped with an electronic control module (A1). The module controls and monitors all safety interlock functions and the engine air preheater function.

When key switch (S1) is in RUN position, current flows through the following circuits, causing the electronic control module to power up:

- Key switch (S1), terminals B and A.
- 500A and 500B Yel wires.
- Command arm harness connector (X14), terminal A.
- 503, 507A, and 509 Yel wires.
- Electronic control module connector (X45), terminal D.

Ground is provided to the control module through:

- W5 frame ground.
- 101 Blk wire.
- 102 and 103 Blk wires.
- Electronic control module connector (X45), terminals B and C.

The electronic control module features input LEDs, output LEDs, and a status LED (known as the “heartbeat” LED) to aid in electrical circuit diagnosis.

The input LEDs will light whenever a function switch has been activated. This will indicate that the input circuit is functioning properly.

The output LEDs, when lit, indicate that the control module circuitry for that particular function is operating properly, and that a controlled ground is available for that circuit at the control module output terminal.

If all circuits are OK, the status LED will flash at a steady rate called the heartbeat. The heartbeat pattern is 130 milliseconds ON and 830 milliseconds OFF.

If the control module detects a malfunction, the LED will flash a specific pattern to indicate one of the diagnostic codes. The flash pattern is 280 milliseconds ON and 280 milliseconds OFF for a given digit. There is a 1-second OFF delay between digits and a 2-second OFF delay before the code is repeated.

- For diagnostic codes caused by the operator, see “Safety Interlock Diagnostic Codes” on page 151.
- For diagnostic codes most likely caused by a system malfunction on an input circuit, see “Electronic Control Module Input Circuits Diagnostic Codes” on page 151.
- For diagnostic codes most likely caused by a system malfunction on an output circuit, see “Electronic Control Module Output Circuits Diagnostic Codes” on page 152.

Safety Interlock Diagnostic Codes

The Sit On Seat (SOS) diagnostic feature alerts the operator when an attempt is made to start the machine when one or more safety interlock switches are not in the correct position for starting.

The following diagnostic codes are displayed by the flashing of the status LED on the electronic control module and the air preheater lamp on the control arm.

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

- **Code 1-2** (One pulse followed by a short pause followed by two pulses.) Indicates that the park brake switch is not activated and/or forward/reverse pedals are not in the NEUTRAL position during an attempted start.
- **Code 1-3** (One pulse followed by a short pause followed by three pulses.) Indicates that the mow-transport switch is in the MOW position during an attempted start.
- **Code 2-2** (Two pulses followed by a short pause followed by two pulses.) Indicates that hydraulic oil is in an over-temperature condition.
- **Code 2-3** (Two pulses followed by a short pause followed by three pulses.) Indicates that the hood switch is not activated (European machines) or jumper wire is missing from hood switch connector (North American machines). No instrument LEDs ON and no hour meter.

Electronic Control Module Input Circuits Diagnostic Codes

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

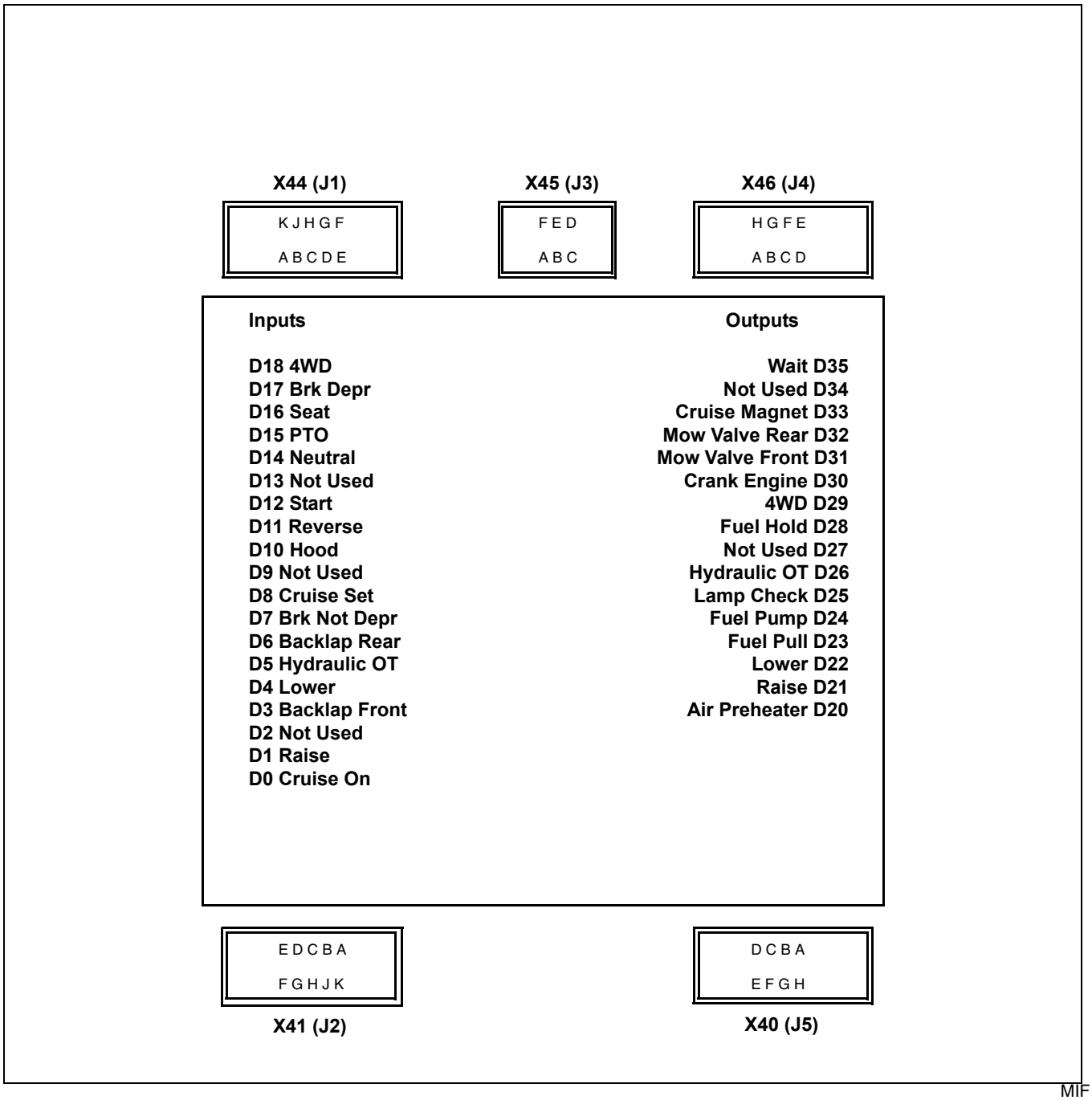
- **Code 3-1** (Three pulses followed by a short pause followed by one pulse.) Indicates an over-voltage condition (voltage input to control box over 18 volts). This could also be caused by attempting to jump-start the machine with a 24-volt power source.
- **Code 3-5** (Three pulses followed by a short pause followed by five pulses.) Indicates control module is missing ground connection.
- **Code 3-6** (Three pulses followed by a short pause followed by six pulses.) Indicates control module is missing supply voltage.

- **Code 3-7** (Three pulses followed by a short pause followed by seven pulses.) Indicates control module has an internal over-temperature condition.

Electronic Control Module Output Circuits Diagnostic Codes

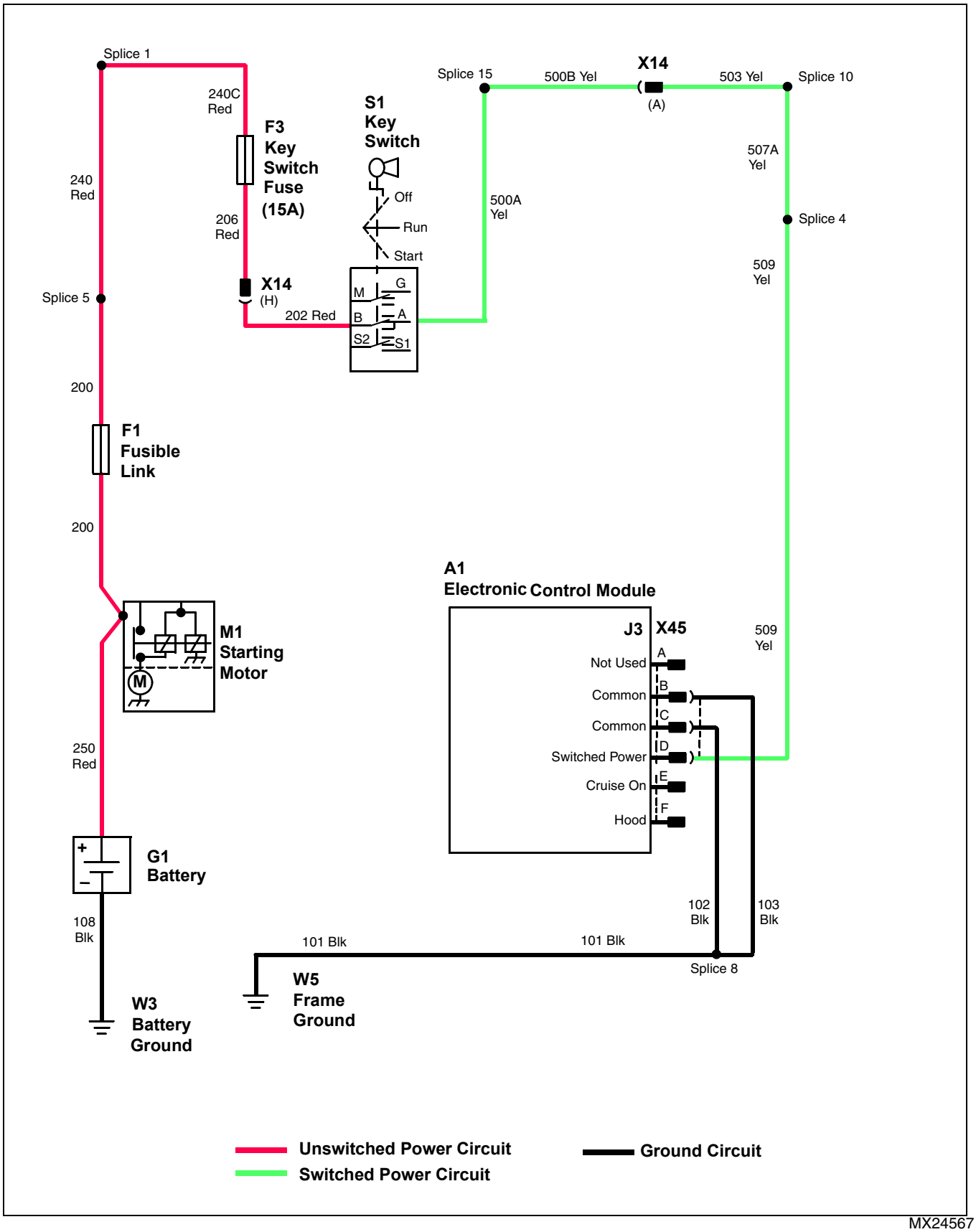
- **Code 4-1** (Four pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning 4WD bypass solenoid circuit.
- **Code 4-2** (Four pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning start relay circuit.
- **Code 4-3** (Four pulses followed by a short pause followed by three pulses.) Indicates a malfunctioning front mow solenoid circuit.
- **Code 4-4** (Four pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning air preheater LED circuit.
- **Code 4-5** (Four pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel hold-in coil circuit.
- **Code 4-7** (Four pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning cruise control magnet circuit.
- **Code 4-8** (Four pulses followed by a short pause followed by eight pulses.) Indicates a malfunctioning rear mow solenoid circuit.
- **Code 5-1** (Five pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning fuel pump circuit.
- **Code 5-2** (Five pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning lamp check circuit.
- **Code 5-3** (Five pulses followed by a short pause followed by three pulses.) Indicates a malfunctioning hydraulic temperature LED circuit.
- **Code 5-4** (Five pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning mow-transport solenoid circuit.
- **Code 5-5** (Five pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel pull-in coil circuit.
- **Code 5-6** (Five pulses followed by a short pause followed by six pulses.) Indicates a malfunctioning lower solenoid circuit.
- **Code 5-7** (Five pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning raise solenoid circuit.
- **Code 5-8** (Five pulses followed by a short pause followed by eight pulses.) Indicates a malfunctioning air preheater circuit.

Electronic Control Module Input and Output Identification



MIF

Electronic Control Module Circuit Schematic



MX24567

Electronic Control Module Circuit Test

Test Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when checking and testing.

Electronic Control Module Circuit

Note: Before replacing the electronic control module, the following must be checked:

- ***Electrical components connected to the control module must be checked for an internal short circuit. Failure to do so may damage the replacement control module.***
- ***Verify control module has power, a good ground, and valid inputs for proper operation.***

1. Measure voltage at electronic control module connector (X45), terminal D, 509 Yel wire. Is battery voltage present?

   Yes: Go to next step.

   No: Test 509, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure ground circuit resistance at electronic control module connector (X45), terminal B, 103 Blk wire. Is there less than 0.1 ohm of resistance?

   Yes: Go to next step.

   No: Test 103 and 101 Blk wires and connections.

3. Measure ground circuit resistance at electronic control module connector (X45), terminal C, 102 Blk wire. Is there less than 0.1 ohm of resistance?

   Yes: Replace electronic control module.

   No: Test 102 and 101 Blk wires and connections.

Electronic Control Module Checks

Operating Conditions

- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Key switch in OFF position.

Procedure

1. Key switch in RUN position.
2. Check the status LED, input LEDs, and output LEDs.

NORMAL

- Status (heartbeat) LED flashing in a regular, even rate (about once per second).

NOT NORMAL

- If the status LED and input/output LEDs are not lit, check key switch fuse (F3). If fuse is good, check power to the control module. (See “Electronic Control Module Circuit Test” on page 155.)

3. Key switch in START position.

NORMAL

- The engine must crank and start.

NOT NORMAL

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed for additional codes.

- Engine does not crank and the air preheater LED begins to flash one of the following codes:

  CODE 1-2

  Indicates that the park brake switch or neutral switch is not activated during an attempted start.

  Park brake in LOCKED position, then repeat procedure. If the code continues to flash after the park brake has been LOCKED, perform Park Brake Switch Input check. (See “Park Brake Switch Input” on page 156.)

  For neutral switch, make sure that forward and reverse pedals are in NEUTRAL position, then repeat procedure.

  If the code continues to flash after the forward and reverse pedals are in NEUTRAL position, perform Neutral Switch Input check. (See “Neutral Switch Input” on page 156.)

CODE 1-3

Indicates that the mow-transport switch is in the MOW position during an attempted start.

If the code continues to flash after the mow-transport lever has been moved to the TRANSPORT position, perform Mow-Transport Switch Input check. (See “Mow-Transport Switch Input” on page 156.)

Input Circuit LED Check

Key Switch Input

1. Disable the starting motor by disconnecting the starting motor solenoid connector, 747 Pur wire.

2. Move key switch to START position and back to RUN position.

3. Observe the START input LED. The LED must be ON when the key switch is in the START position and OFF when the key switch is in the RUN position.

If the LED does not come ON when the key switch is in the START position: Test key switch circuit. (See “Key Switch Circuit Test” on page 170.)

Seat Switch Input

1. Key switch in RUN position.

2. Press down on the lower cushion of the seat to close the seat switch contacts.

3. Observe the SEAT input LED. The LED must be ON when the seat switch contacts are closed (operator ON seat).

4. Release seat cushion.

5. Observe the SEAT input LED. The LED must be OFF when the seat switch contacts are open (operator OFF seat).

If the LED does not come ON: Test seat switch circuit. (See “System: Interlock Circuit Diagnosis” on page 170.)

Park Brake Switch Input

1. Key switch in RUN position.

2. Depress the park brake pedal.

3. Observe the BRK DEPR input LED and BRK NOT DEPR input LED. The BRK DEPR LED must be ON and the BRK NOT DEPR LED must be OFF.

4. Release the park brake pedal.

5. Observe the BRK DEPR input LED and BRK NOT DEPR input LED. The BRK DEPR LED must be OFF and the BRK NOT DEPR LED must be ON.

If the LEDs do not function as described: Test park brake switch circuit. (See “System: Interlock Circuit Diagnosis” on page 170.)

Mow-Transport Switch Input

1. Key switch in RUN position.

2. Move mow-transport lever to the MOW position.

3. Observe the PTO input LED. The LED must be ON when the mow-transport lever is in the MOW position and OFF when the mow-transport lever is in the TRANSPORT position.

If the LED does not function as described: Test the PTO input circuit (Known as the mow-transport circuit). (See “System: Interlock Circuit Diagnosis” on page 170.)

Reverse Switch Input

Note: Reverse switch used only on machines with 4WD.

1. Key switch in RUN position.

2. Alternately, depress and release the reverse pedal.

3. Observe the REVERSE input LED. The LED must be ON when the pedal is depressed and OFF when the pedal is released.

If the LED does not function as described: Test the reverse switch input circuit. (See “System: Interlock Circuit Diagnosis” on page 170.)

Neutral Switch Input

1. Key switch in RUN position.

2. Alternately, depress and release the forward and reverse pedals.

3. Observe the NEUTRAL input LED. The LED must be OFF when either pedal is depressed and ON when both pedals are released.

If the LED does not function as described: Test the neutral switch input circuit. (See “System: Interlock Circuit Diagnosis” on page 170.)

Power Circuit Operation - Unswitched

Function

Provides power to the primary circuit whenever the battery is connected.

Operating Conditions

- Key switch in OFF position.

Theory of Operation

Voltage must be present at the following components with the key switch in the OFF position:

- Battery (G1) positive (+) terminal.
- Battery terminal of starting motor (M1) solenoid.
- Battery terminal of alternator (G2).
- Battery terminal of key switch (S1).
- Terminal 30 of start relay (K1).
- Terminal 30 of air preheater relay (K4).
- Terminal 30 of light relay (K5).
- Terminal 30 of fuel pull-in relay (K2).
- Terminal 30 of 4WD bypass relay (K3).

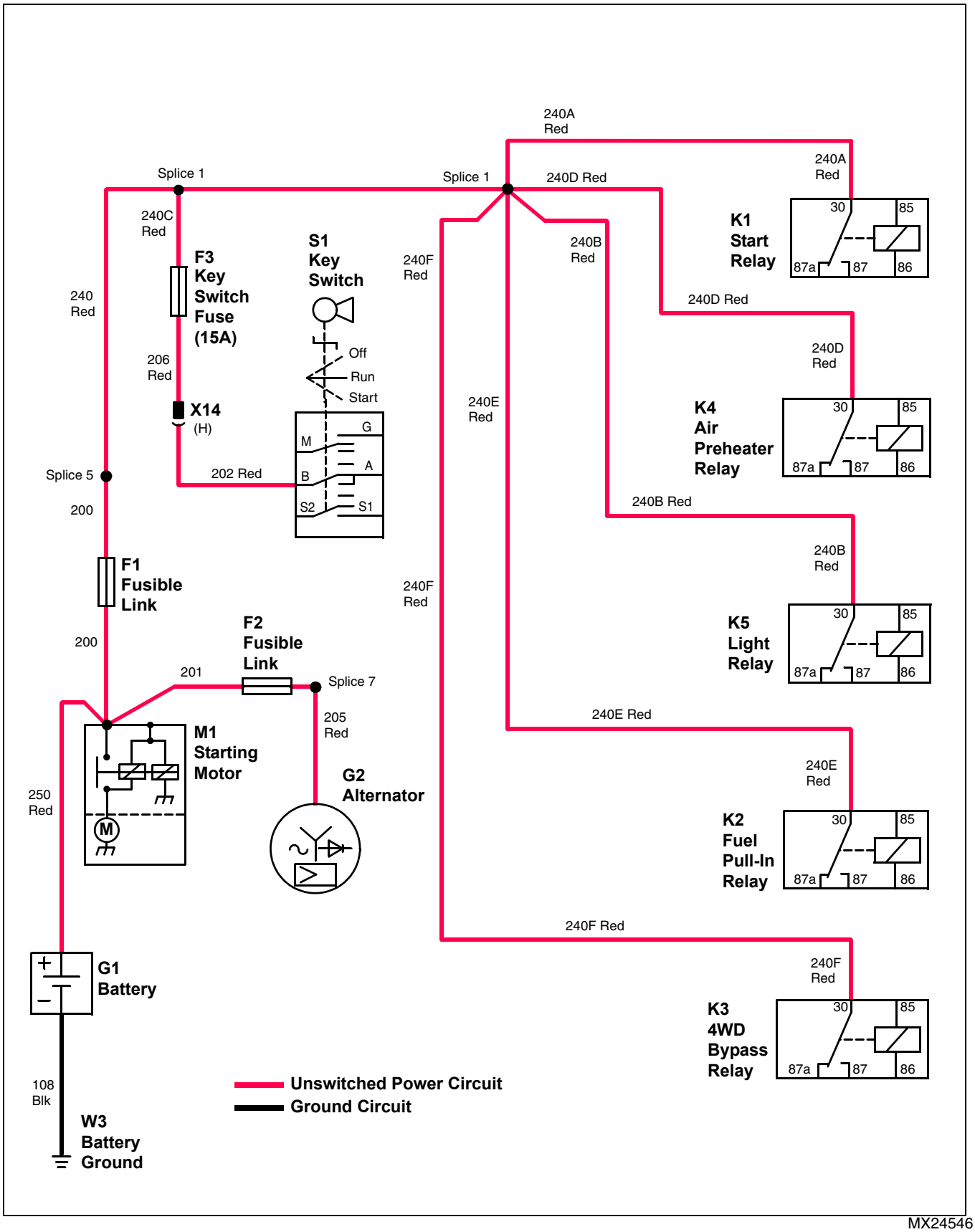
The positive (+) battery cable connects the battery to the starting motor solenoid. The starting motor solenoid connection is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor solenoid connections must be in good condition for the electrical system to function properly.

The ground cable connections are equally as important as the positive (+) cable. Starting motor operation depends on these cables and connections to carry the high current necessary for its operation.

The power circuit is protected by fusible link (F1). The link is a short length of wire that is designed to fail if load current becomes excessive or if a short circuit occurs.

Unswitched Power Circuit Schematic



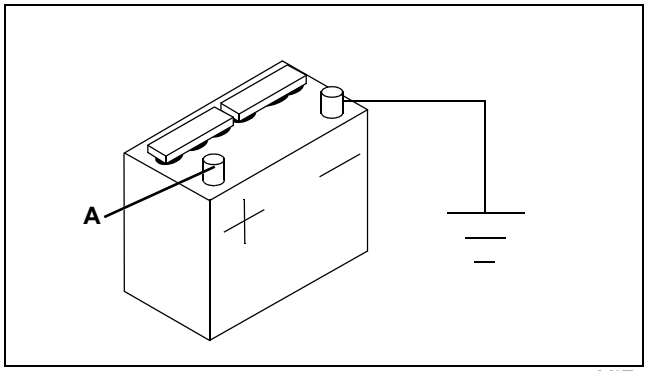
MX24546

System: Power Circuit Diagnosis

Unswitched Power Circuit

Test Conditions

- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

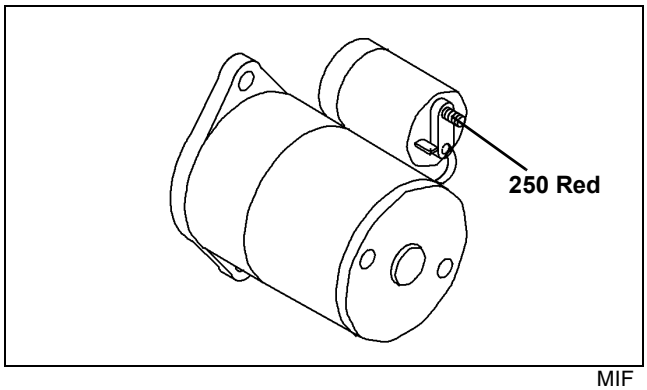


MIF

1. Measure voltage at battery positive (+) terminal A. Is voltage in the range of 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. (See “Battery Test” on page 243.)



MIF

2. Measure voltage at starting motor solenoid (M1), 250 Red wire. Is battery voltage present?

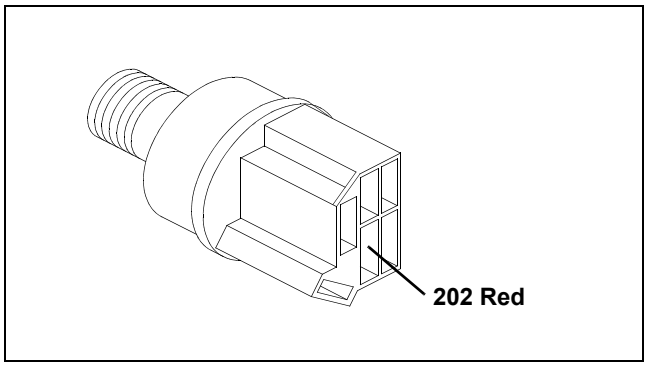
Yes: Go to next step.

No: Check battery positive (+) cable and clamps. Clean and tighten connections.

3. Measure voltage at alternator battery terminal. Is battery voltage present?

Yes: Go to next step.

No: Test 205 Red wire, 201 fusible link (F2) and connections.

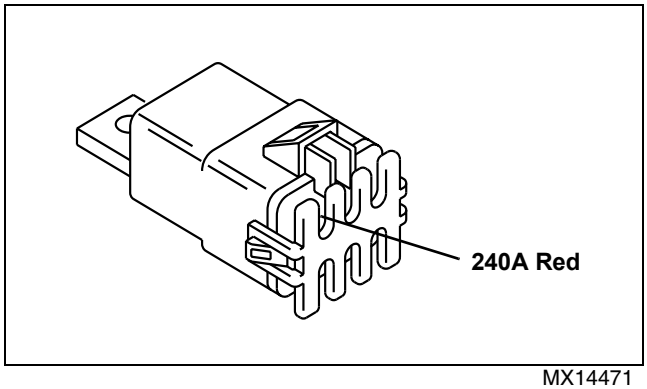


MIF

4. Measure voltage at key switch (S1), terminal B, 202 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 202, 206, 240C, and 240 Red wires, key switch fuse (F3), 200 fusible link (F1) and connections.



MX14471

5. Measure voltage at start relay (K1), terminal 30, 240A Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240A Red wire and connections.

6. Measure voltage at air preheater relay (K4), terminal 30, 240D Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240D Red wire and connections.

7. Measure voltage at light relay (K5), terminal 30, 240B Red wire. Is battery voltage present?

No: Test 240B Red wire and connections.

8. Measure voltage at fuel pull-in relay (K2), terminal 30, 240E Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240E Red wire and connections.

9. Measure voltage at 4WD bypass relay (K3), terminal 30, 240F Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240F Red wire and connections.

Power Circuit Operation - Switched

Function

Provides power to components by means of a key switch.

Operating Conditions:

- Key switch in RUN position.

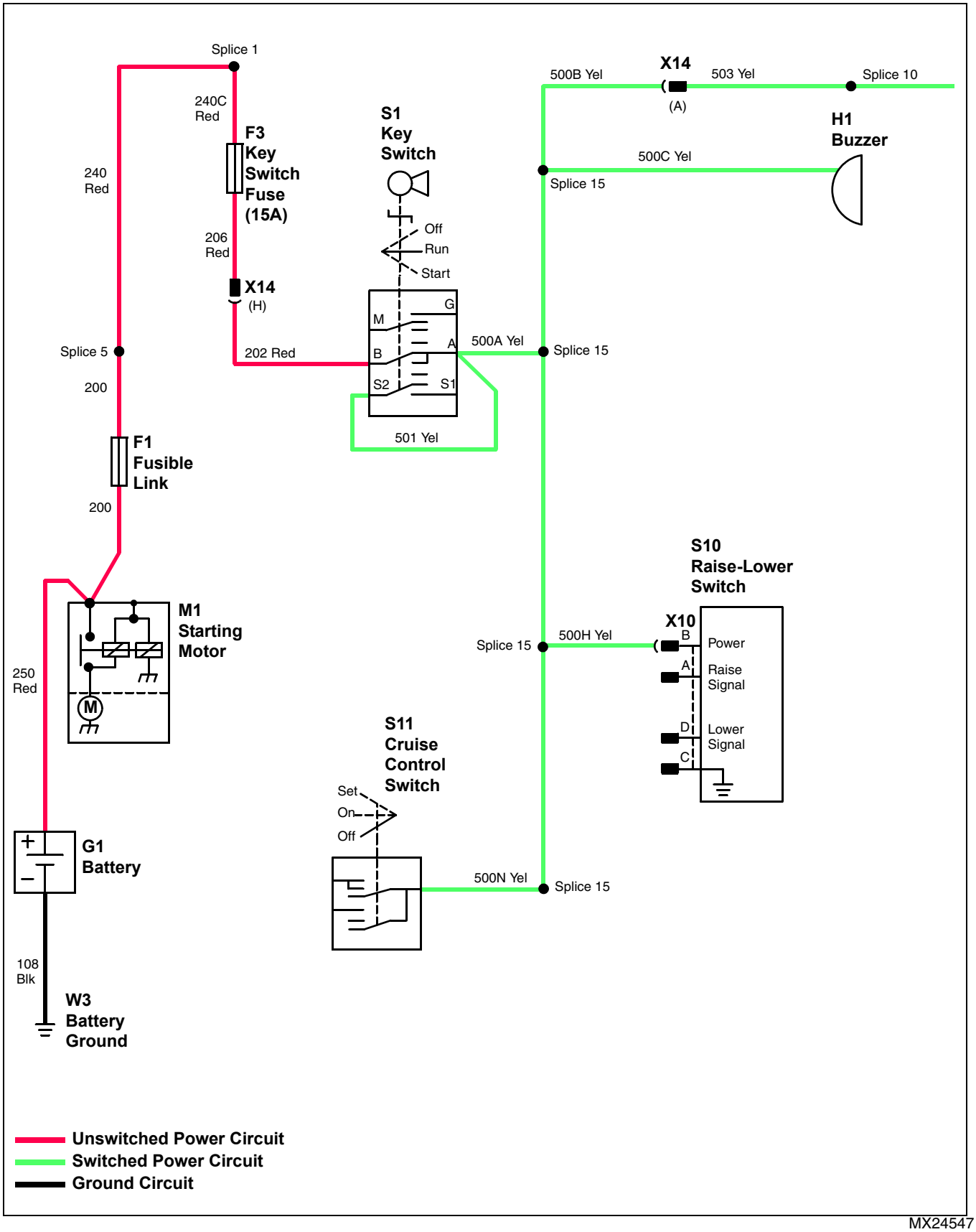
Theory of Operation

Voltage must be present at the following components with the key switch in the RUN position:

- Key switch (S1), terminals A and S2.
- Alternator (G2), 508C Yel wire.
- Start relay (K1), terminal 85.
- Hydraulic filter restriction relay (K6), terminals 30 and 86.
- Air preheater relay (K4), terminal 85.
- Light relay (K5), terminal 85.
- Fuel pull-in relay (K2), terminal 85.
- Mow-transport switch (S2), 504B Yel wire.
- Park brake switch (S3), 502 Yel wire.
- Reverse switch (S4), 506 Yel wire.
- Seat switch (S5), 505 Yel wire.
- Neutral switch (S6), 507B Yel wire.
- Front mow solenoid (Y3), 502D Yel wire.
- Electronic control module (A1), 509 Yel wire.
- Rear mow solenoid (Y4), 507F Yel wire.
- Raise-lower switch (S10), 500H Yel wire.
- Hood switch connector (X59), 507C Yel wire.
- Front backlap switch (S8), 502E Yel wire.
- Rear backlap switch (S9), 507E Yel wire.
- Lower solenoid (Y2), 507H Yel wire.
- Raise solenoid (Y8), 507G Yel wire.
- Fuel pump (M2), 508E Yel wire.
- Buzzer (H1), 500C Yel wire.
- Cruise control switch (S11), 500N Yel wire.
- Cruise control magnet (Y9), 502A Yel wire.

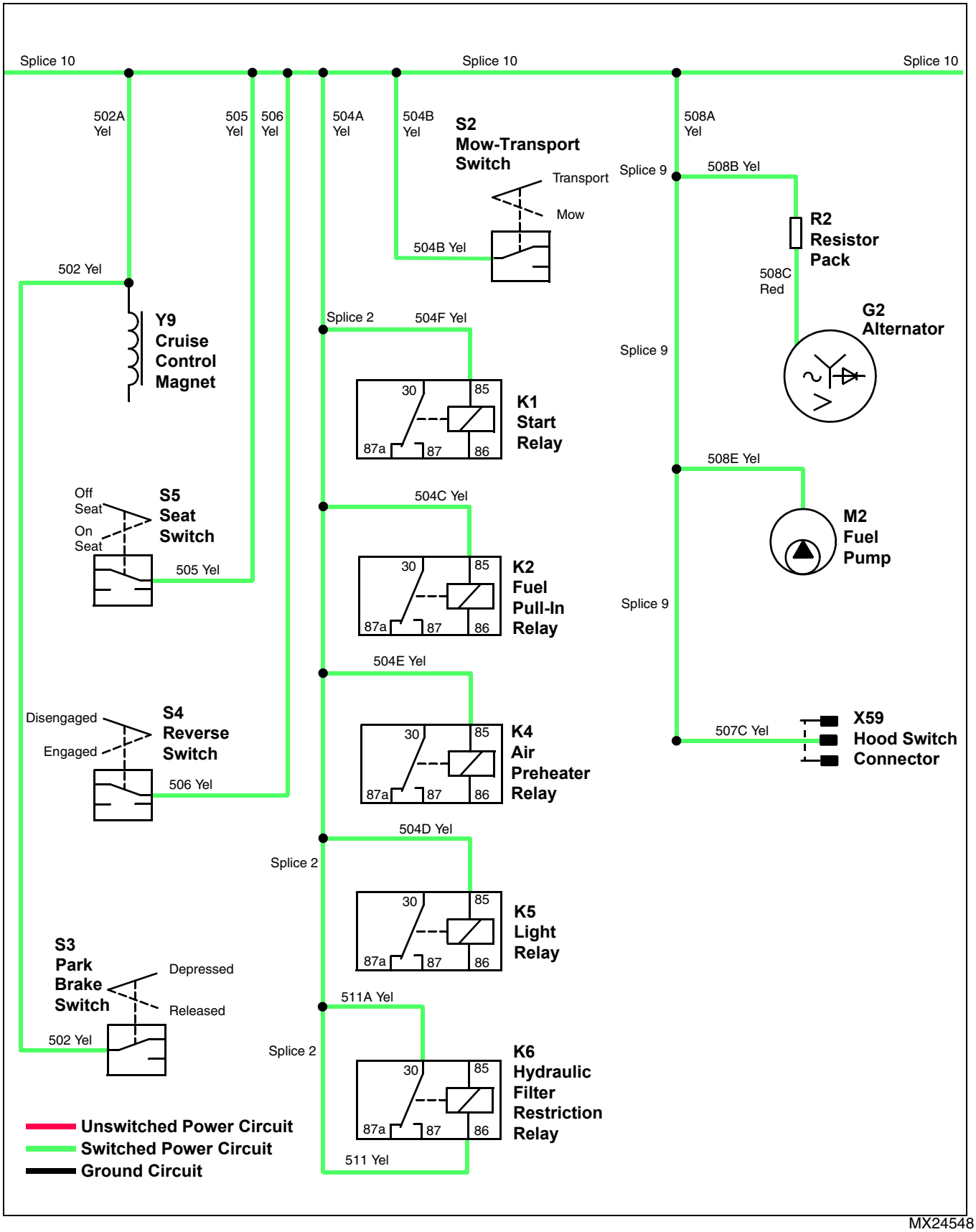
The switched power circuit is protected by 15-amp key switch fuse (F3).

Switched Power Circuit Schematic (Sheet 1 of 3)



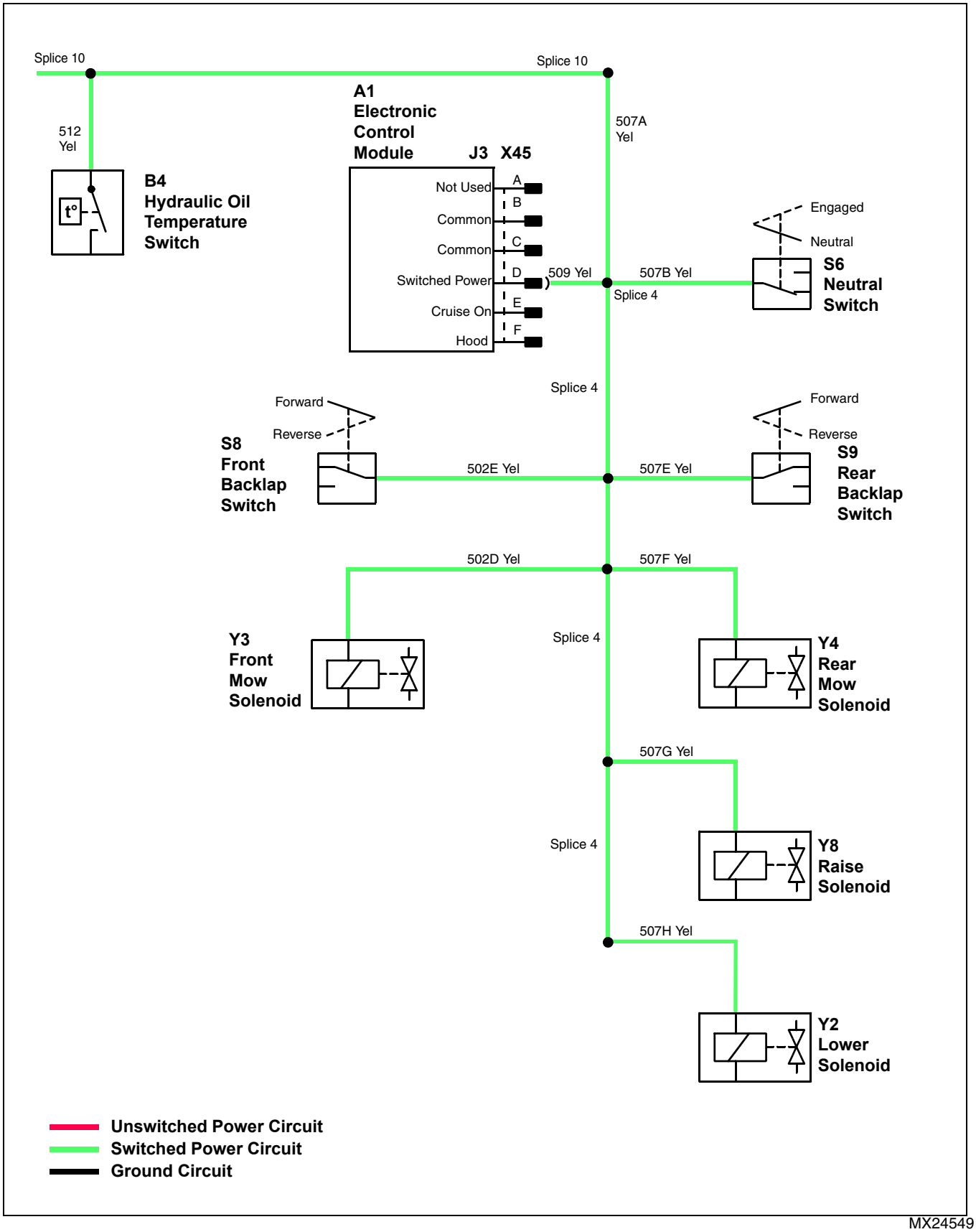
MX24547

Switched Power Circuit Schematic (Sheet 2 of 3)



MX24548

Switched Power Circuit Schematic (Sheet 3 of 3)



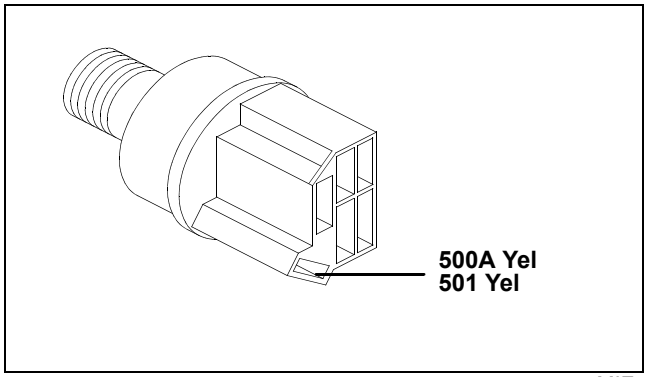
MX24549

System: Switched Power Circuit Diagnosis

Switched Power Circuit

Test Conditions

- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

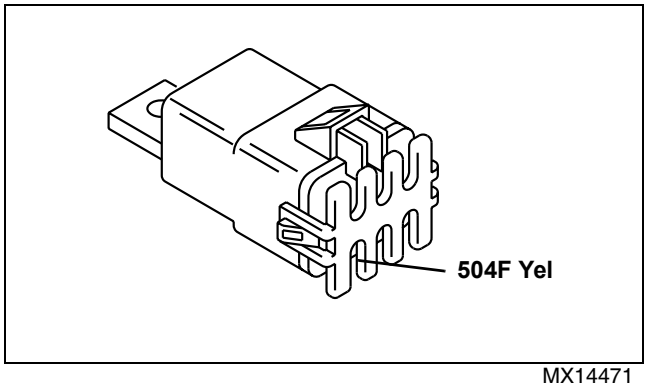


MIF

1. Measure voltage at key switch (S1), terminal A, 500A and 501 Yel wires. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See “Key Switch Test” on page 250.)

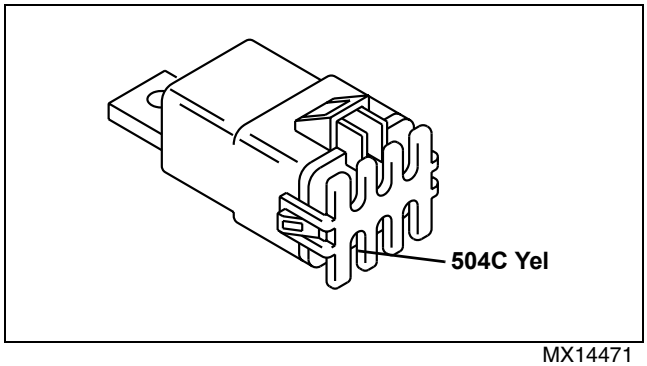


MX14471

2. Measure voltage at start relay (K1), terminal 85, 504F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504F, 504A, 503, 500B, and 500A Yel wires and connections.

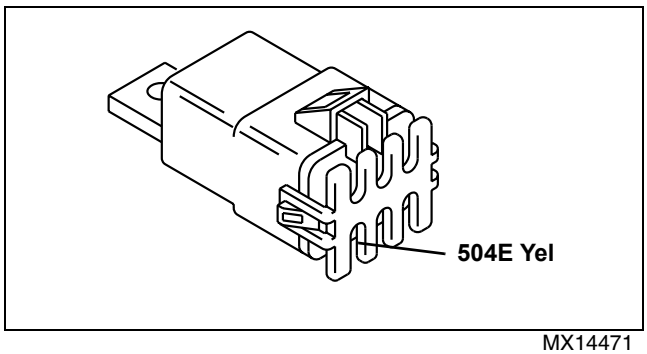


MX14471

3. Measure voltage at fuel pull-in relay (K2), terminal 85, 504C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504C, 504A, 503, 500B, and 500A Yel wires and connections.

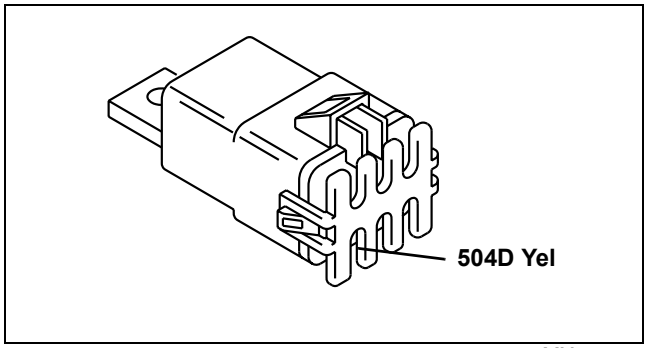


MX14471

4. Measure voltage at air preheater relay (K4), terminal 85, 504E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504E, 504A, 503, 500B, and 500A Yel wires and connections.

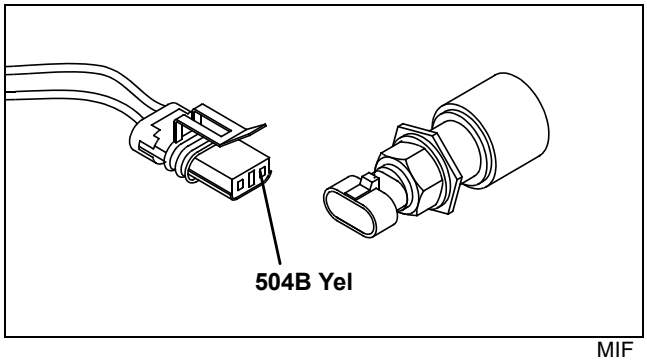


MX14471

5. Measure voltage at light relay (K5), terminal 85, 504D Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504D, 504A, 503, 500B, and 500A Yel wires and connections.

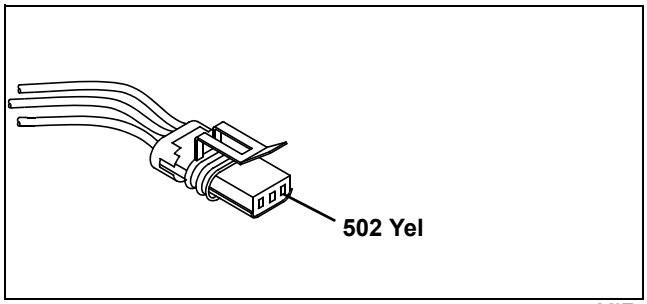


MIF

6. Measure voltage at mow-transport switch (S2), 504B Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504B, 503, 500B, and 500A Yel wires and connections.

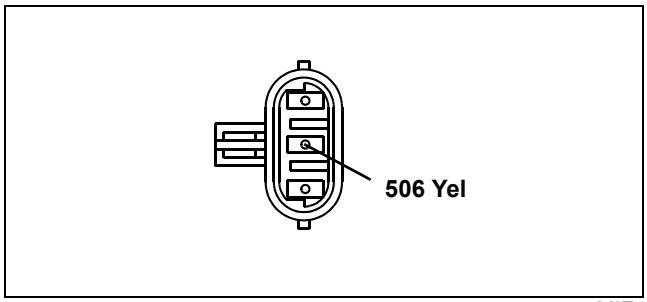


MIF

7. Measure voltage at park brake switch (S3), 502 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 502, 502A, 503, 500B, and 500A Yel wires and connections.

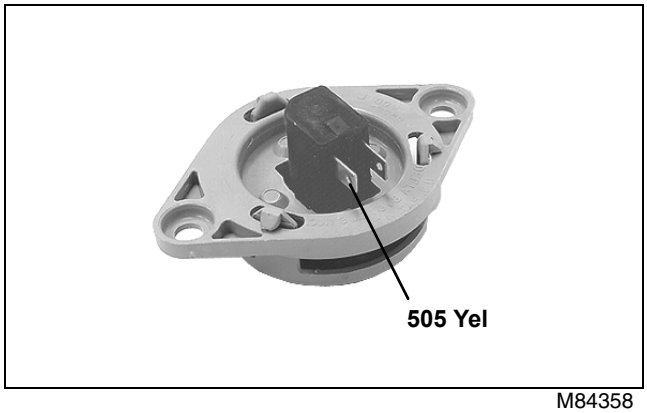


MIF

8. Measure voltage at reverse switch (S4), 506 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 506, 503, 500B, and 500A Yel wires and connections.

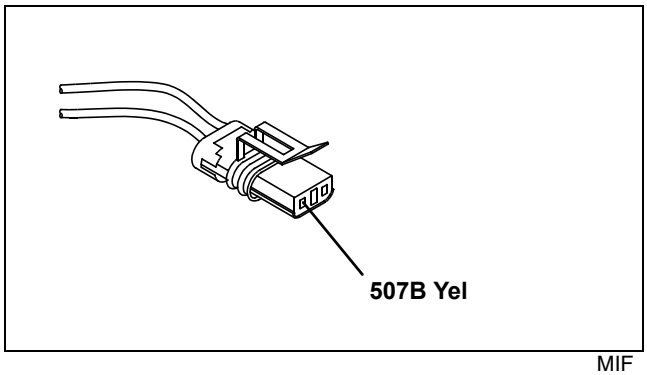


M84358

9. Measure voltage at seat switch (S5), 505 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 505, 503, 500B, and 500A Yel wires and connections.

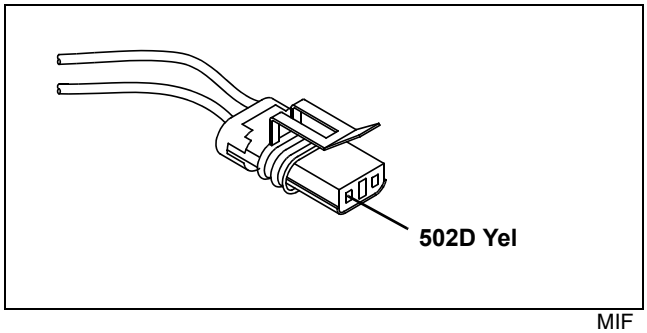


MIF

10. Measure voltage at neutral switch (S6), 507B Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507B, 507A, 503, 500B, and 500A Yel wires and connections.

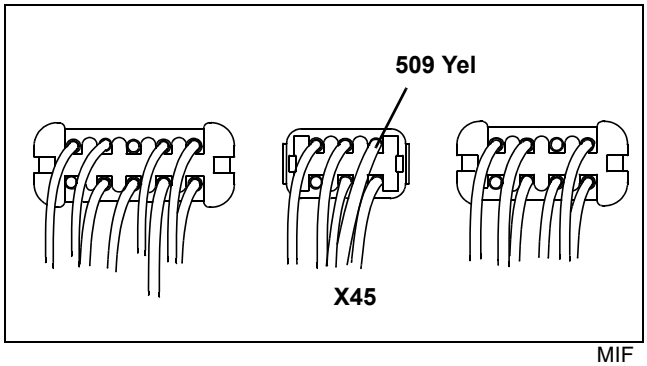


MIF

11. Measure voltage at front mow solenoid (Y3), 502D Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 502D, 507A, 503, 500B, and 500A Yel wires and connections.

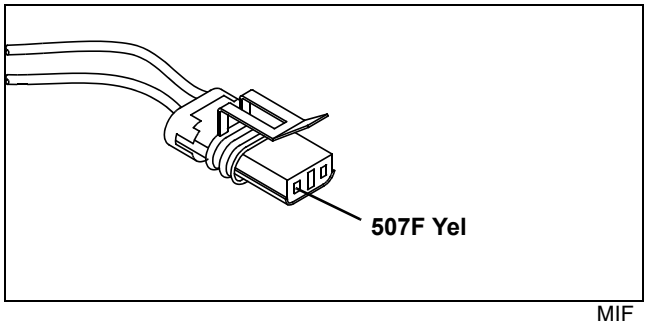


MIF

12. Measure voltage at electronic control module (A1), connector (X45), terminal D, 509 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 509, 507A, 503, 500B, and 500A Yel wires and connections.

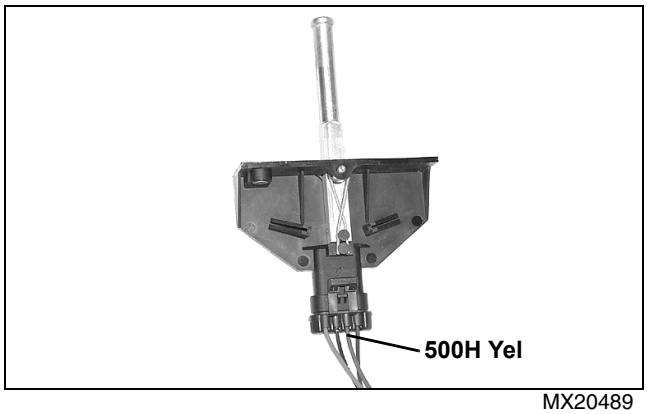


MIF

13. Measure voltage at rear mow solenoid (Y4), 507F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507F, 507A, 503, 500B, and 500A Yel wires and connections.



MX20489

14. Measure voltage at raise-lower switch (S10), connector (X10), terminal B, 500H Yel wire. Is battery voltage present?

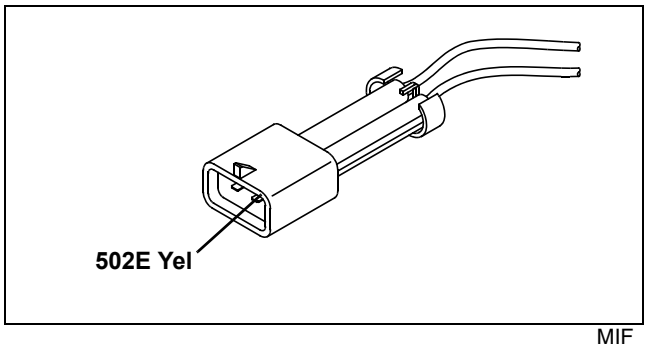
Yes: Go to next step.

No: Test 500H and 500A Yel wires and connections.

15. Measure voltage at hood switch connector (X59), 507C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507C, 508A, 503, 500B, and 500A Yel wires and connections.

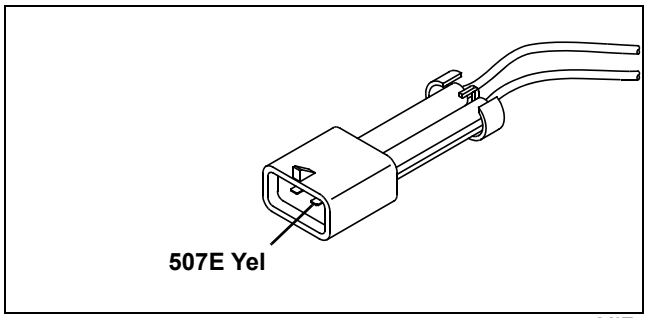


MIF

16. Measure voltage at front backlap switch (S8), 502E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 502E, 507A, 503, 500B, and 500A Yel wires and connections.

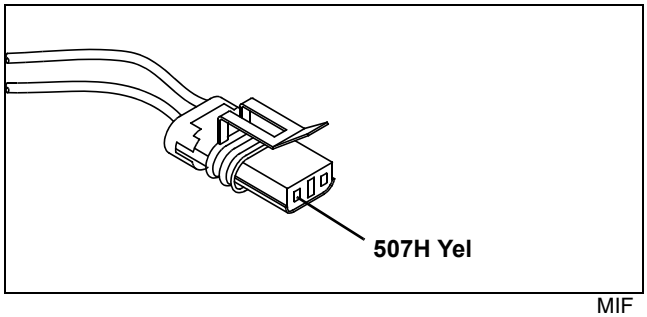


MIF

17. Measure voltage at rear backlap switch (S9), 507E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507E, 507A, 503, 500B, and 500A Yel wires and connections.

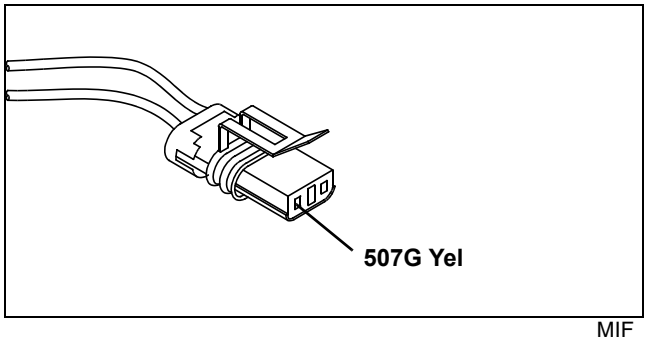


MIF

18. Measure voltage at lower solenoid (Y2), 507H Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507H, 507A, 503, 500B, and 500A Yel wires and connections.

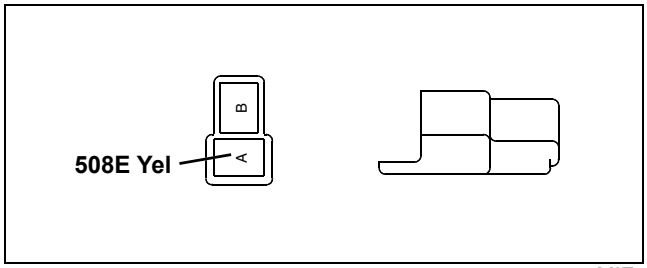


MIF

19. Measure voltage at raise solenoid (Y8), 507G Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507G, 507A, 503, 500B, and 500A Yel wires and connections.

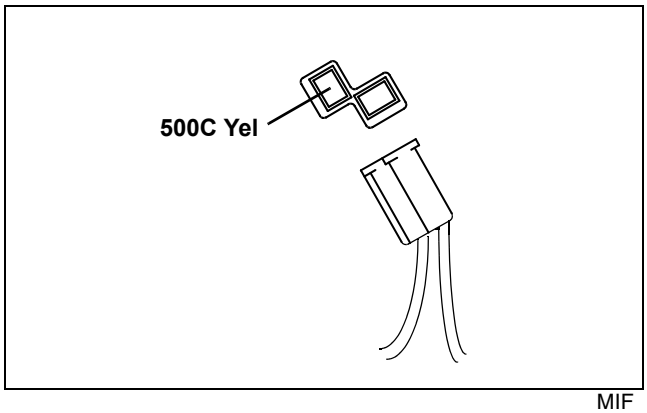


MIF

20. Measure voltage at fuel pump (M2), 508E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508E, 508A, 503, 500B, and 500A Yel wires and connections.



MIF

21. Measure voltage at buzzer (H1), 500C Yel wire. Is battery voltage present?

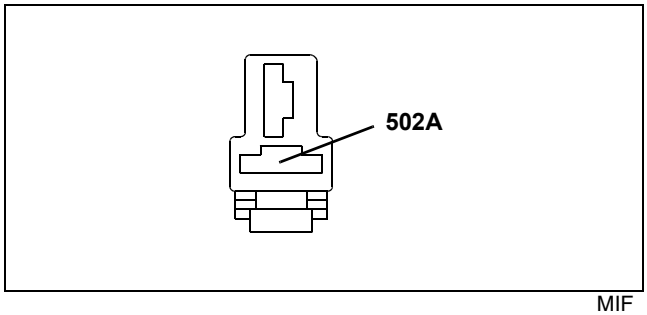
Yes: Go to next step.

No: Test 500C and 500A Yel wires and connections.

22. Measure voltage at cruise control switch (S11), 500N Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500N and 500A Yel wires and connections.



MIF

23. Measure voltage at cruise control magnet (Y9), 502A Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 502A, 503, 500B, and 500A Yel wires and connections.

24. Measure voltage at alternator (G2), 508C Yel wire. Is battery voltage present?

No: Test 508C, 508B, 508A, 503, 500B, and 500A Yel wires and connections.

Interlock Circuit Operation

Function

To enable and disable the start relay (K1) and the fuel shutoff solenoid (Y1), based on inputs from various switches and controls.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow-transport lever in TRANSPORT position.
- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.

Theory of Operation

With the key switch (S1) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following:

- Mow-transport switch (S2), 504B Yel wire.
- Park brake switch (S3), 502A and 502 Yel wires.
- Seat switch (S5), 505 Yel wire.
- Neutral switch (S6), 507A and 507B Yel wires.

From each switch, current flows to the electronic control module (A1) as follows:

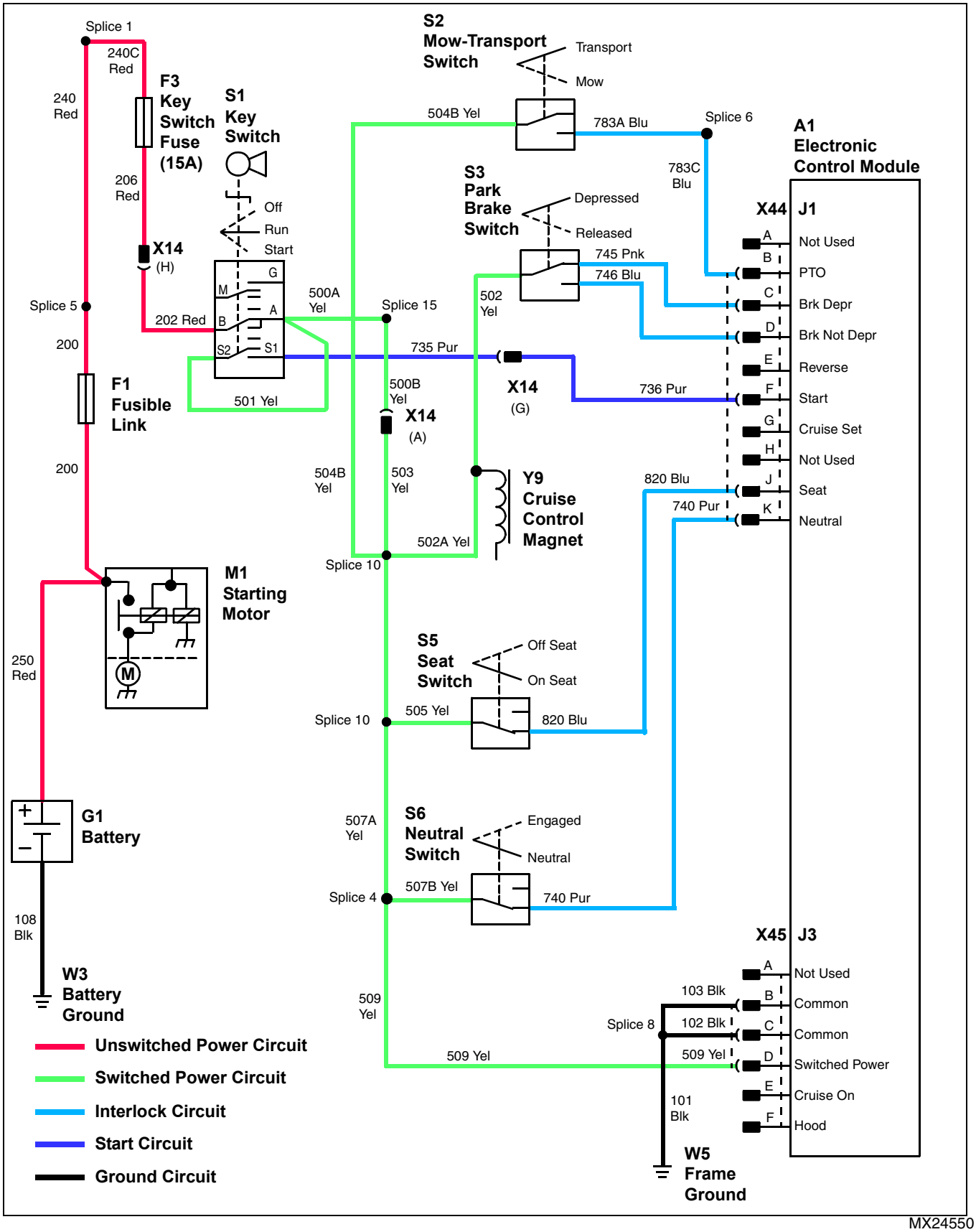
- Mow-transport switch - When in the MOW position, current flows to electronic control module connector (X44), terminal B, 783A and 783C Blu wires, indicating that the switch is in the ON position.

- Park brake switch - When in UNLOCKED position, current flows to control module connector (X44), terminal D, 746 Blu wire, indicating that the park brake switch is in the UNLOCKED position. When in LOCKED position, current flows to control module connector (X44), terminal C, 745 Pnk wire, indicating that the park brake switch is in LOCKED position.

- Seat switch - When in the ON SEAT position, current flows to control module connector (X44), terminal J, 820 Blu wire, indicating that the seat switch is in the ON SEAT position.

- Neutral switch - When in the NEUTRAL position, current flows to control module connector (X44), terminal K, 740 Pur wire, indicating that the neutral switch is in the NEUTRAL position.

Interlock Circuit Schematic



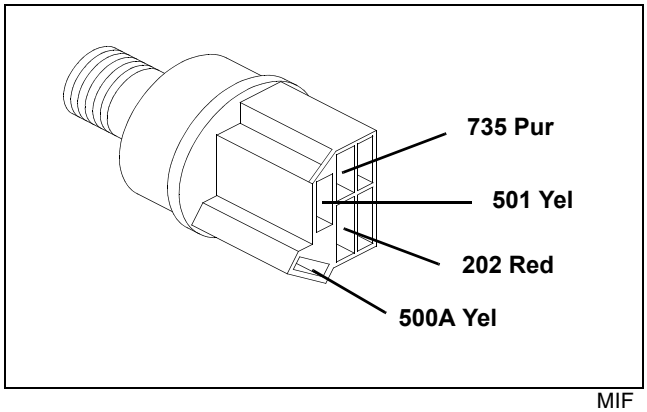
MX24550

System: Interlock Circuit Diagnosis

Key Switch Circuit Test

Test Conditions

- Key switch in START position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at key switch (S1), terminal B, 202 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test key switch fuse (F3). If fuse tests good, test 202, 206, 240C, and 240 Red wires and 200 fusible link (F1) and connections.

2. Measure voltage at key switch (S1), terminal A, 500A and 501 Yel wires. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See “Key Switch Test” on page 250.)

3. Measure voltage at key switch (S1), terminal S2, 501 Yel wire. Is battery voltage present?

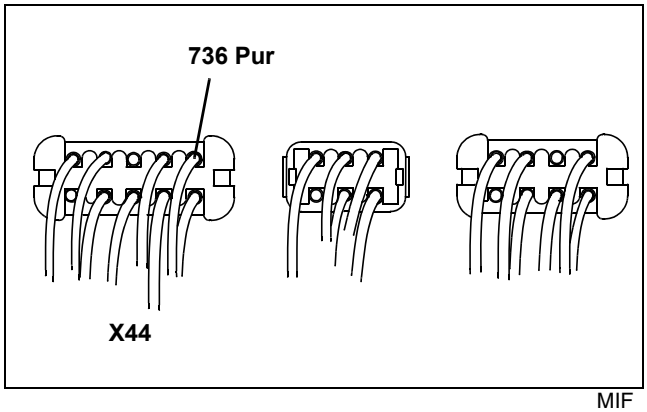
Yes: Go to next step.

No: Test 501 Yel wire and connections.

4. Measure voltage at key switch (S1), terminal S1, 735 Pur wire. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See “Key Switch Test” on page 250.)



MIF

5. Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44), terminal F, 736 Pur wire. Is battery voltage present?

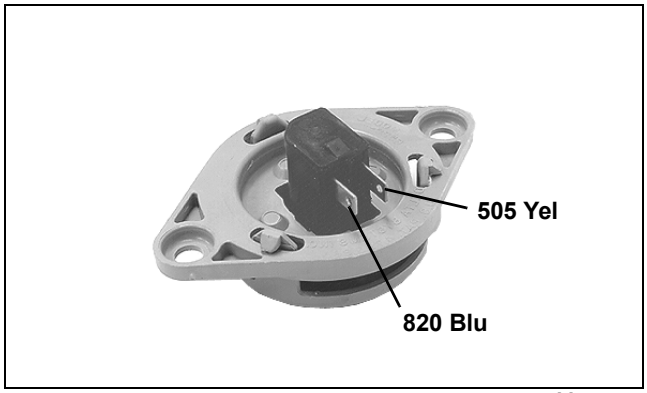
Yes: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

No: Test 736 and 735 Pur wires and connections.

Seat Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Seat switch depressed.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



M84358

1. Measure voltage at seat switch (S5), 505 Yel wire. Is battery voltage present?

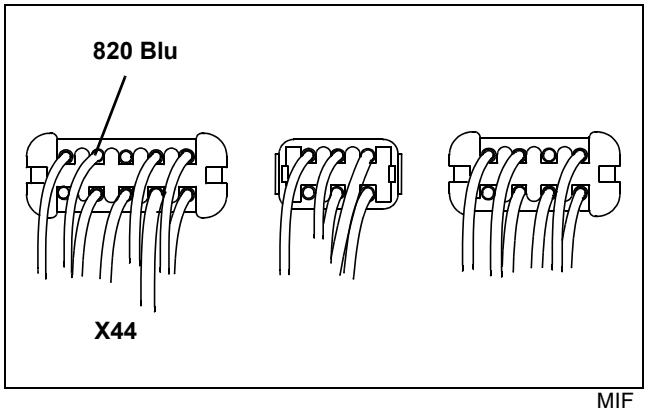
Yes: Go to next step.

No: Test 505, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at seat switch (S5), 820 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test seat switch. (See “Seat Switch Test” on page 251.)



MIF

3. Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44), terminal J, 820 Blu wire. Is battery voltage present?

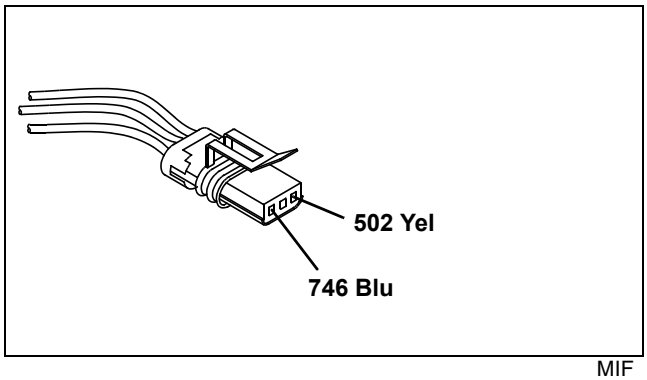
Yes: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

No: Test 820 **B**lu wire and connections.

Park Brake Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Park brake pedal in UNLOCKED position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at park brake switch (S3), 502 Yel wire. Is battery voltage present?

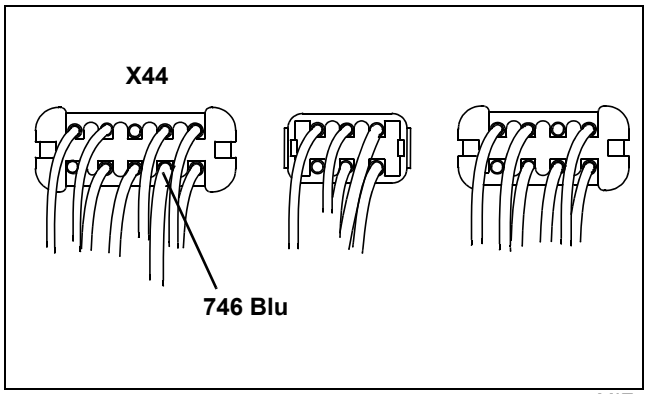
Yes: Go to next step.

No: Test 502, 502A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at park brake switch (S3), 746 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test park brake switch. (See “Park Brake Switch Test” on page 253.)

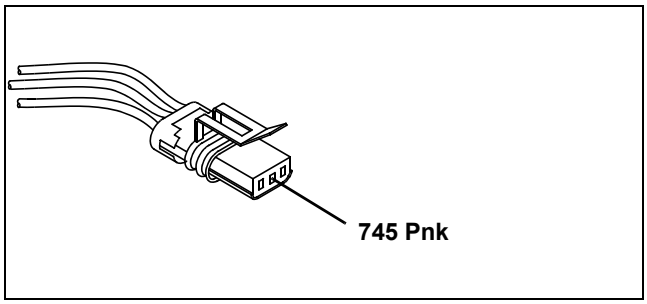


MIF

3. Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44), terminal D, 746 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 746 Blu wire and connections.

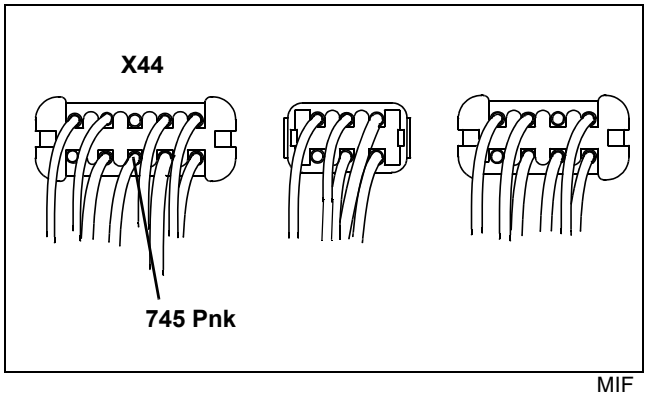


MIF

4. Depress park brake pedal. Measure voltage at park brake switch (S3), 745 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test park brake switch. (See “Park Brake Switch Test” on page 253.)



MIF

5. Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44), terminal C, 745 Pnk wire. Is battery voltage present?

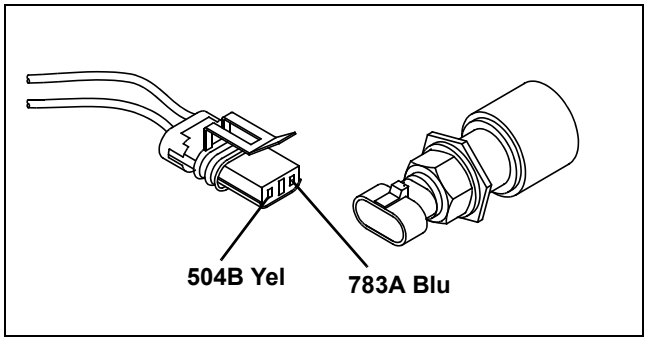
Yes: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)

No: Test 745 Pnk wire and connections.

Mow-Transport Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Mow-transport lever in MOW position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at mow-transport switch (S2), 504B Yel wire. Is battery voltage present?

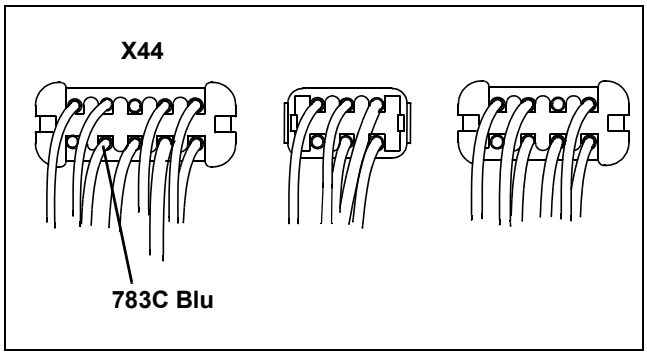
Yes: Go to next step.

No: Test 504B, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at mow-transport switch (S2), 783A Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test mow-transport switch. (See “Mow-Transport Switch Test” on page 250.)



MIF

3. Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44), terminal B, 783C Blu wire. Is battery voltage present?

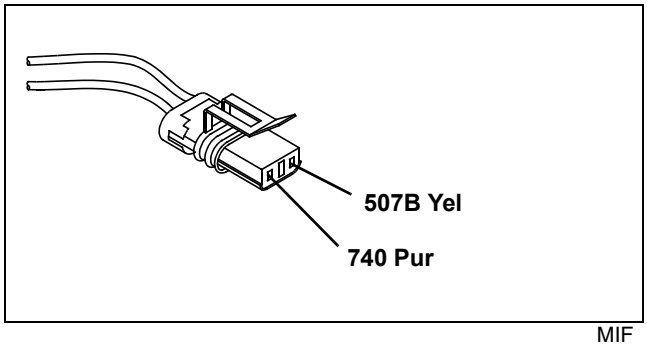
Yes: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

No: Test 783A and 782C Blu wires and connections.

Neutral Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Forward and reverse pedals released.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at neutral switch (S6), 507B Yel wire. Is battery voltage present?

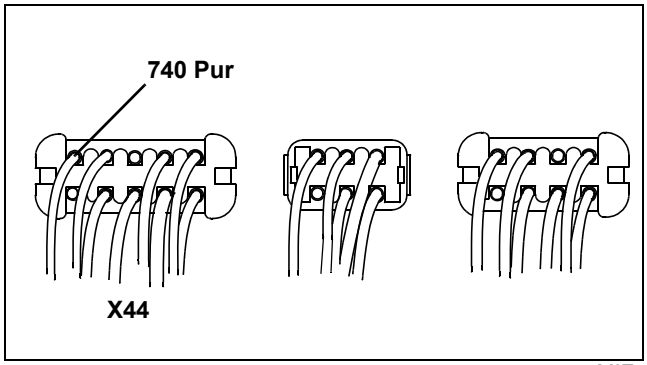
Yes: Go to next step.

No: Test 507B, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at neutral switch (S6), 740 Pur wire. Is battery voltage present?

Yes: Go to next step.

No: Test neutral switch. (See “Neutral Switch Test” on page 253.)



MIF

3. Disconnect electronic control module connector (X44). Measure voltage at electronic control module connector (X44), terminal K, 740 Pur wire. Is battery voltage present?

Yes: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

No: Test 740 Pur wire and connections.

Cranking Circuit Operation

Function

Provides power to the starting motor (M1) to crank the engine.

Operating Conditions

To crank the engine, the following conditions must be met:

- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Key switch in START position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

The power circuit provides current to the key switch (S1) and protects the cranking circuit with a fusible link (F1) and 15-amp key switch fuse (F3).

Unswitched power from the battery (G1) positive (+) terminal is available at the following components:

- Starting motor (M1), battery terminal, 250 Red wire.
- Key switch (S1), terminal B, 202, 206, 240C, and 240 Red wires and 200 fusible link (F1).
- Start relay (K1), terminal 30, 240A and 240 Red wires and 200 fusible link (F1).
- Fuel pull-in relay (K2), terminal 30, 240E and 240 Red wires and 200 fusible link (F1).

Moving key switch (S1) to the START position allows power to be present at all the components as when in the RUN position. (See “Power Circuit Operation - Switched” on page 160.)

When the key switch (S1) is in the START position, current flows from key switch terminal S1 to control module connector (X44), terminal F, 735 and 736 Pur wires.

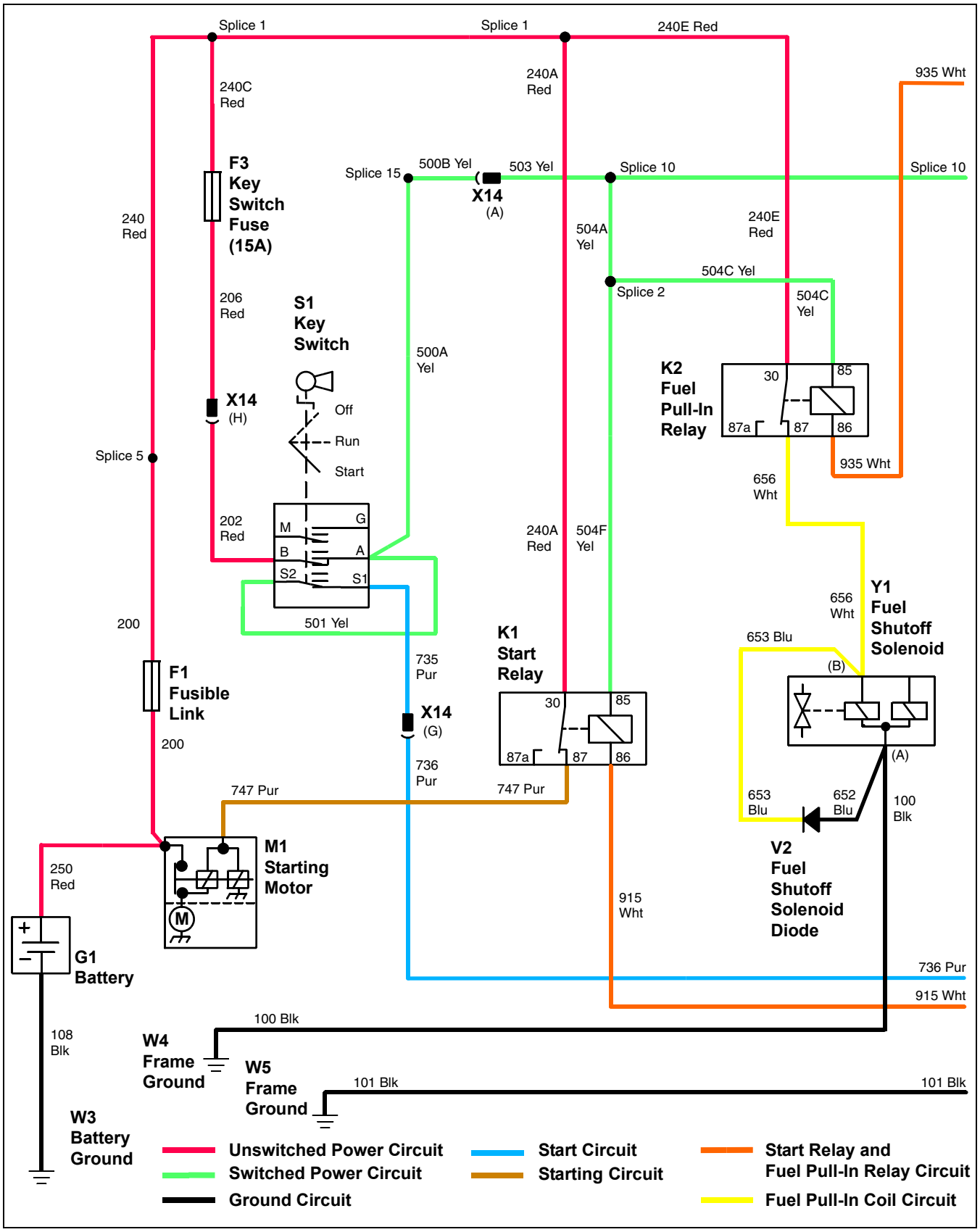
With the key switch in the START position, the control module will energize start relay (K1) and at the same time momentarily energize fuel pull-in relay (K2). This can only occur when the following conditions are met from the interlock circuit:

- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.
- Mow-transport lever in TRANSPORT position.

With the key switch in the START position and operating conditions met, electronic control module (A1) provides a controlled ground to start relay (K1), terminal 86, through 915 Wht wire, energizing the relay. With start relay energized, current flows between start relay terminals 30 and 87 to the solenoid of starting motor (M1), 747 Pur wire, engaging the starting motor.

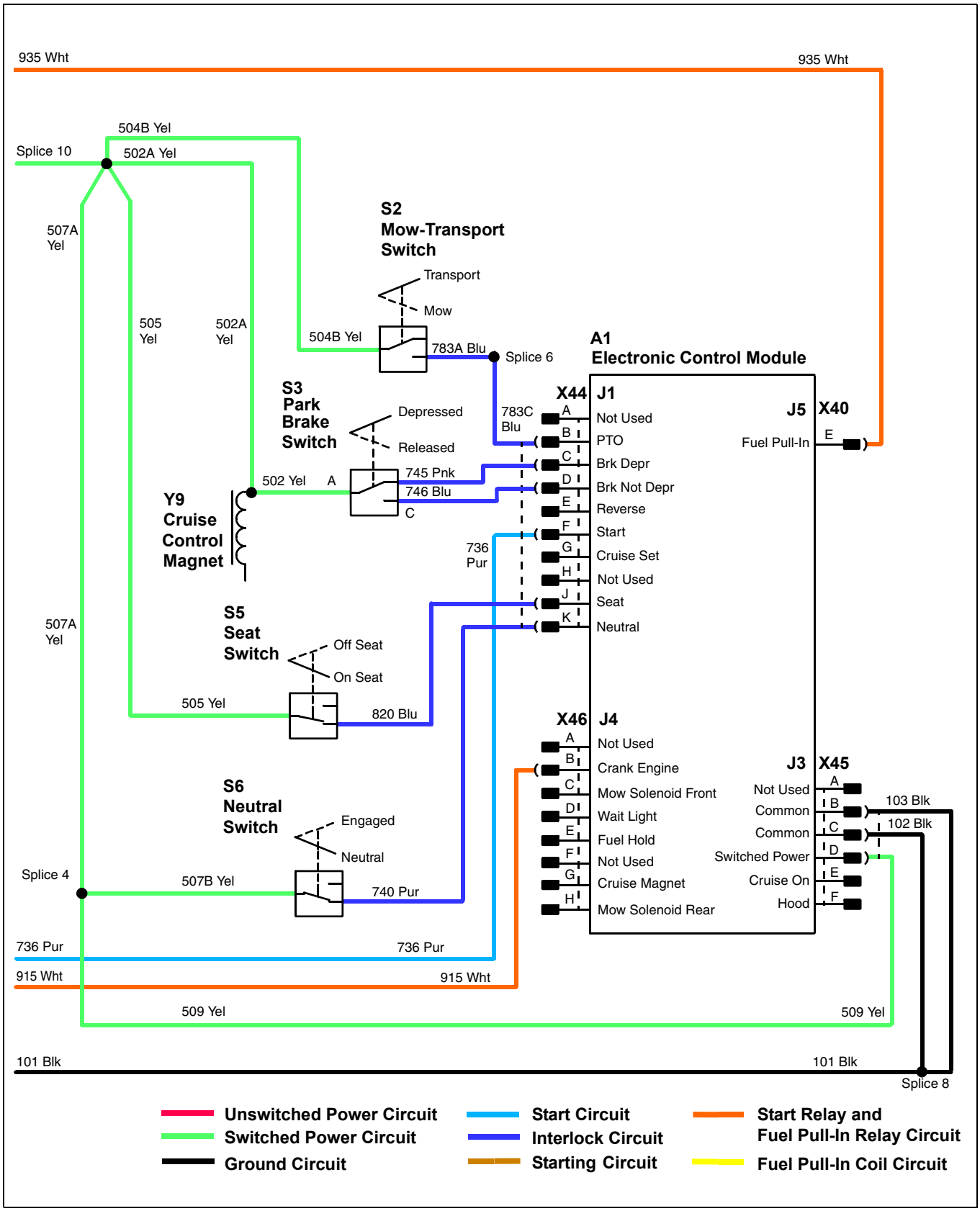
At the same time, electronic control module (A1) momentarily provides a controlled ground to fuel pull-in relay (K2), terminal 86, 935 Wht wire, momentarily energizing the relay. With fuel pull-in relay momentarily energized, current flows between fuel pull-in relay terminals 30 and 87 to fuel shutoff solenoid pull-in coil, 656 Wht wire, momentarily energizing the fuel shutoff solenoid pull-in coil.

Cranking Circuit Schematic (Sheet 1 of 2)



MX24551

Cranking Circuit Schematic (Sheet 2 of 2)



MX24552

System: Cranking Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

The multi-step process is as follows:

Important: Avoid Damage! When diagnosing the cranking circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 155.)

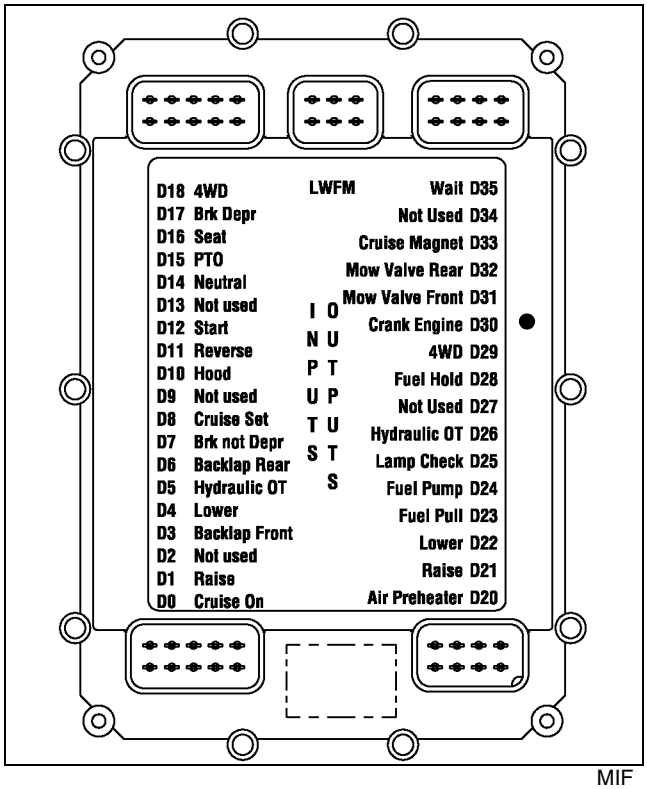
2. Cranking Circuit Tests. (See “Cranking Circuit Tests” on page 177.)

Cranking Circuit Tests

Start Relay Circuit

Test Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward-reverse pedals in NEUTRAL position.
- Starting motor solenoid connector (X57), 747 Pur wire disconnected.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.

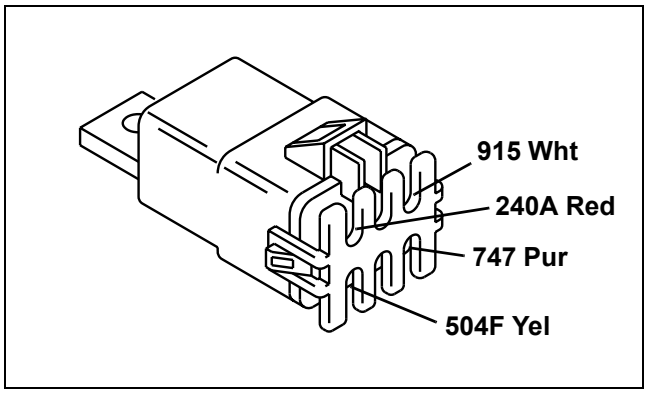


MIF

1. Electronic control module (A1) output (D30) LED check. Cycle key switch between RUN and START positions. Is crank engine output (D30) LED ON when key switch is in START position and output (D30) LED OFF in RUN position?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)



MIF

2. Measure voltage at start relay (K1), terminal 85, 504F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504F, 504A, 503, 500B, and 500A Yel wires and connections.

3. Key switch in START position. Measure voltage at start relay (K1), terminal 86, 915 Wht wire. Is voltage approximately 0.90 volt?

Yes: Go to next step.

No: Test 915 Wht wire and electronic control module connector (X46), terminal B.

4. Measure voltage at start relay (K1), terminal 30, 240A Red wire. Is battery voltage present?

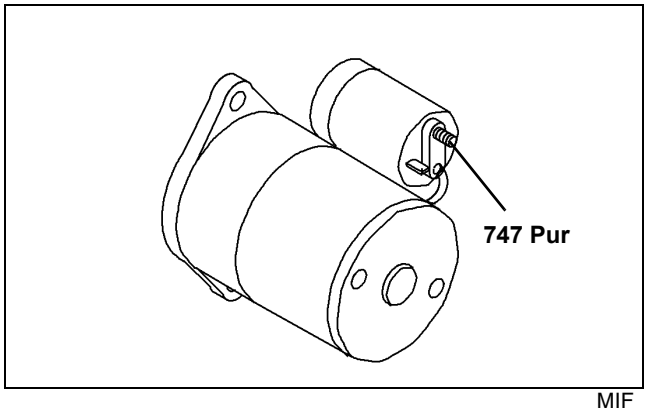
Yes: Go to next step.

No: Test 240A and 240 Red wires and 200 fusible link (F1).

5. Measure voltage at start relay (K1), terminal 87, 747 Pur wire. Is battery voltage present when key switch is in the START position?

Yes: Go to next step.

No: Test relay. (See “Electrical Relays Test” on page 256.)



MIF

6. Measure voltage at starting motor solenoid (M1), 747 Pur wire. Is battery voltage present?

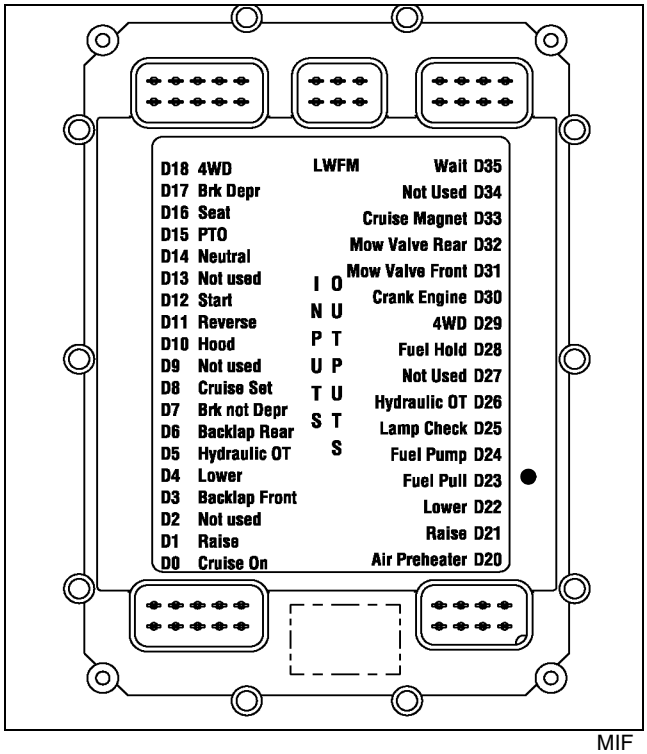
Yes: Test starter solenoid. (See “Starter Solenoid Test” on page 249.)

No: Test 747 Pur wire and connections.

Fuel Shutoff Hold-In Coil Circuit

Test Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward-reverse pedals in NEUTRAL position.
- Starting motor solenoid connector (X57), 747 Pur wire disconnected.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.

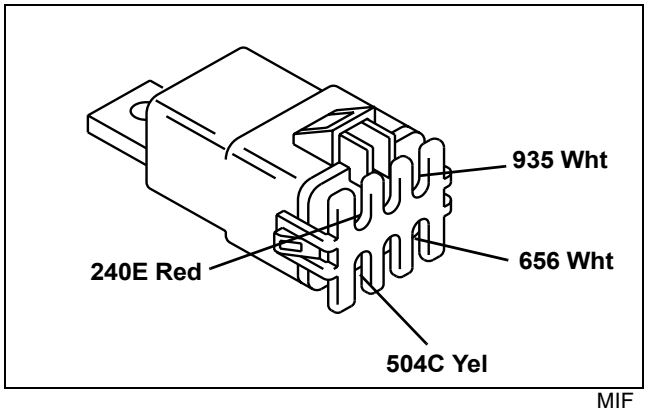


MIF

1. Electronic control module (A1) output (D23) LED check. Cycle key switch between RUN and START positions. Is fuel pull-in output (D23) LED ON when key switch is in START position and output (D23) LED OFF in RUN position?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)



MIF

2. Measure voltage at fuel pull-in relay (K2), terminal 30, 240E Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240E and 240 Red wires and 200 fusible link (F1).

3. Measure voltage at fuel pull-in relay (K2), terminal 85, 504C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504C, 504A, 503, 500B, and 500A Yel wires and connections.

4. Measure continuity between fuel pull-in relay (K2), terminal 86, 935 Wht wire and electronic control module connector (X40), terminal E, 935 Wht wire. Is there continuity?

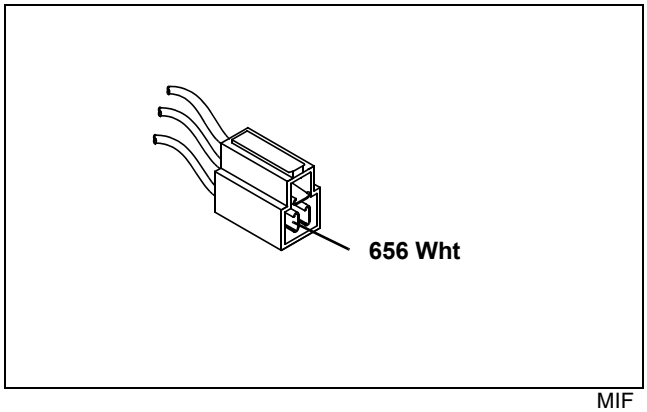
Yes: Go to next step.

No: Test 935 Wht wire and connections.

5. Key switch in START position. Measure voltage at fuel pull-in relay (K2), terminal 87, 656 Wht wire. Is battery voltage present?

Yes: Go to next step.

No: Test relay. (See “Electrical Relays Test” on page 256.)



MIF

6. Measure voltage at fuel shutoff solenoid (Y1), 656 Wht wire. Is battery voltage present?

Yes: Test fuel shutoff solenoid. (See “Fuel Shutoff Solenoid Test” on page 257.)

No: Test 656 Wht wire and connections.

Run Circuit Operation - Operator ON Seat

Function

To allow the engine to run with the operator on the seat.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following:

- Electronic control module (A1), 509 and 507A Yel wires.
- Fuel pump (M2), 508E and 508A Yel wires.

The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 168.) as follows:

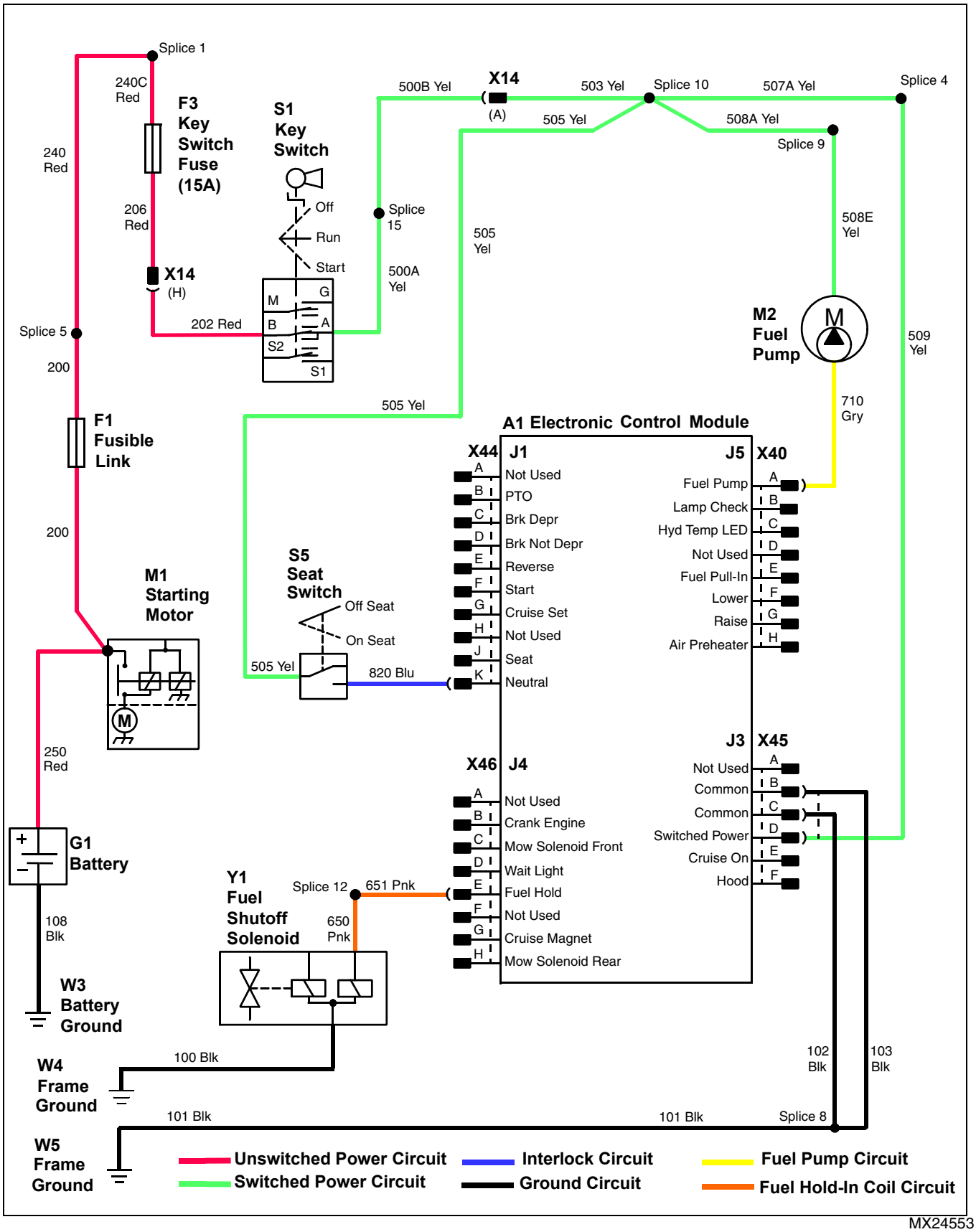
- Seat switch (S5), 505 Yel wire.

With the operator ON seat and the key switch in the RUN position, the electronic control module (A1) provides a controlled ground circuit for the fuel pump (M2), 710 Gry wire, and energizes the fuel pump. Also, the electronic control module provides current to the hold coil of the fuel shutoff solenoid (Y1), 651 and 650 Pnk wires. The hold coil is provided ground from 100 Blk wire, and the fuel shutoff solenoid is held in the energized position, and the engine continues to run.

The electronic control module will shut down the engine by opening the outputs to the fuel shutoff solenoid hold coil and fuel pump circuits when the following conditions exist:

- Operator OFF seat.
- Hood OPEN (European machines).
- Hood switch connector with jumper wire disconnected (North American machines).

Run Circuit Schematic - Operator ON Seat



MX24553

System: Run Circuit Diagnosis - Operator ON Seat

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the fuel pump circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 155.)

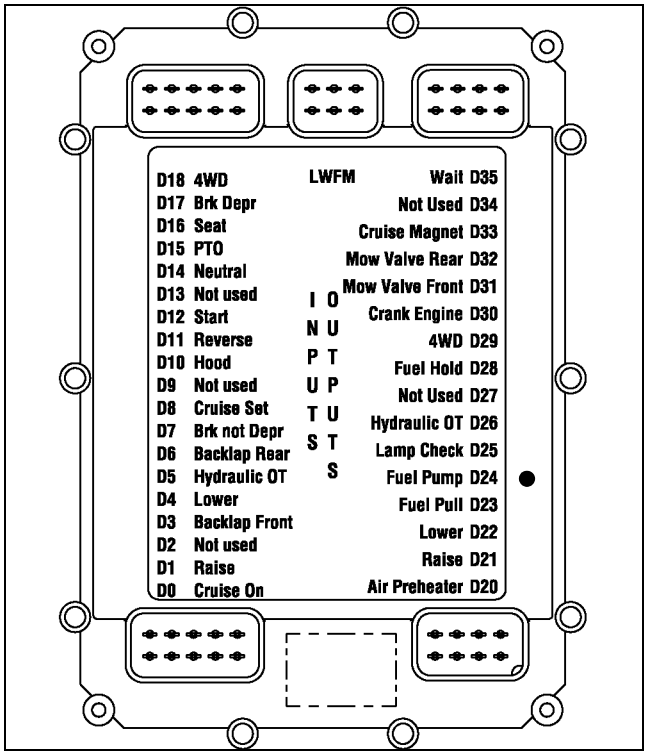
2. Run Circuit Test. (See “Run Circuit Operation - Operator ON Seat” on page 180.)

Run Circuit Test

Fuel Pump Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

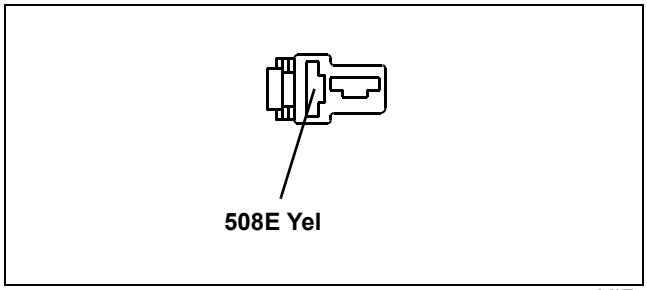


MX24569

1. Electronic control module (A1) output (D24) LED check. Is fuel pump output (D24) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

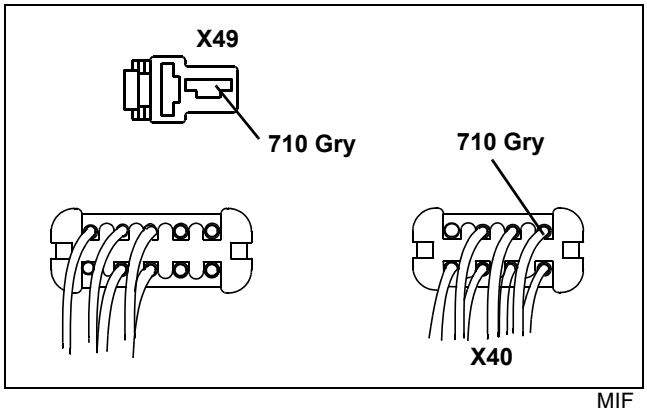


MIF

2. Measure voltage at fuel pump (M2), 508E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508E, 508A, 503, 500B, and 500A Yel wires and connections.



MIF

3. Disconnect electronic control module connector (X40). Measure resistance between electronic control module connector (X40), terminal A, 710 Gry wire and fuel pump (M2), connector (X49), 710 Gry wire. Is resistance less than 0.1 ohm?

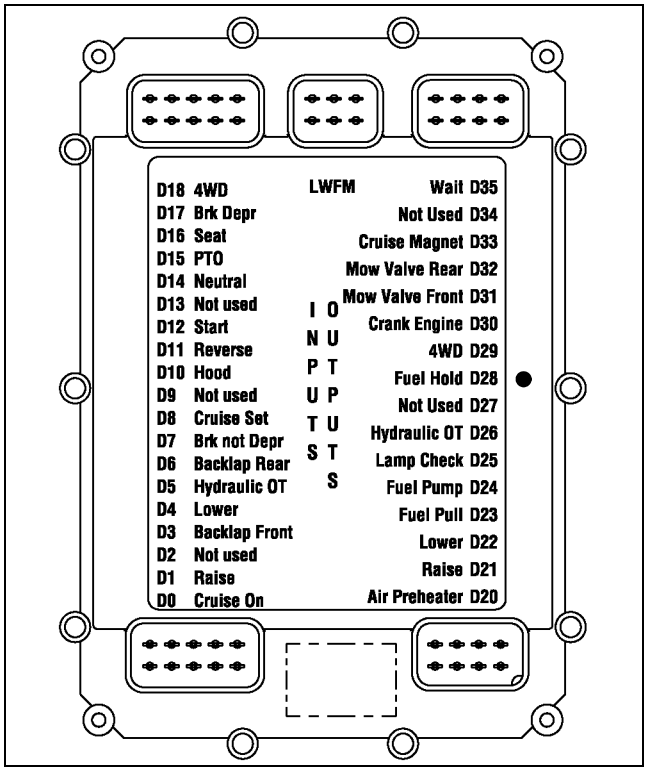
Yes: Test fuel pump. (See “Fuel Pump Test” on page 258.)

No: Test 710 Gry wire and connections.

Fuel Shutoff Solenoid Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

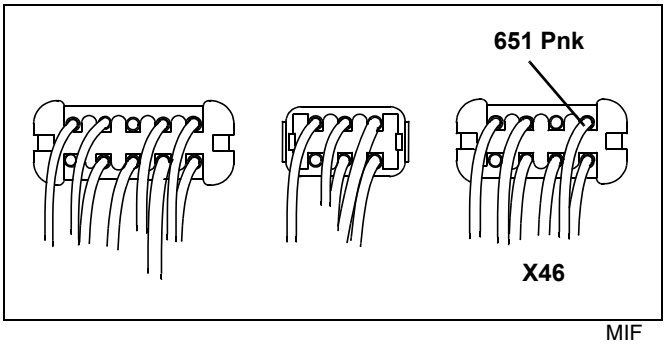


MX24569

1. Electronic control module (A1) output (D28) LED check. Is fuel hold output (D28) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

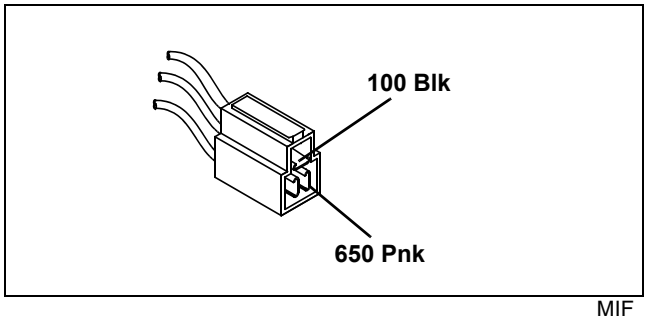


MIF

2. Measure voltage at electronic control module connector (X46), terminal E, 651 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Unplug connector (X46) and test connector terminal E, 651 Pnk wire and connections.



MIF

3. Measure voltage at fuel shutoff solenoid connector (X47), 650 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 650 and 651 Pnk wires and connections.

4. Measure voltage at fuel shutoff solenoid connector (X47), 100 Blk wire. Is voltage less than 0.10 volt?

Yes: Test fuel shutoff solenoid. (See “Fuel Shutoff Solenoid Test” on page 257.)

No: Test 100 Blk wire and connections.

Run Circuit Operation - Operator OFF Seat

Function

To allow the engine to run with the operator off the seat.

Operating Conditions

- Key switch in RUN position.
- Mow-transport lever in TRANSPORT position.
- Park brake in LOCKED position.
- Neutral switch in NEUTRAL position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following:

- Electronic control module (A1), 509 and 507A Yel wires.
- Fuel pump (M2), 508E and 508A Yel wires.

When the operator is OFF the seat, electronic control module will allow the engine to operate, when the following conditions are met:

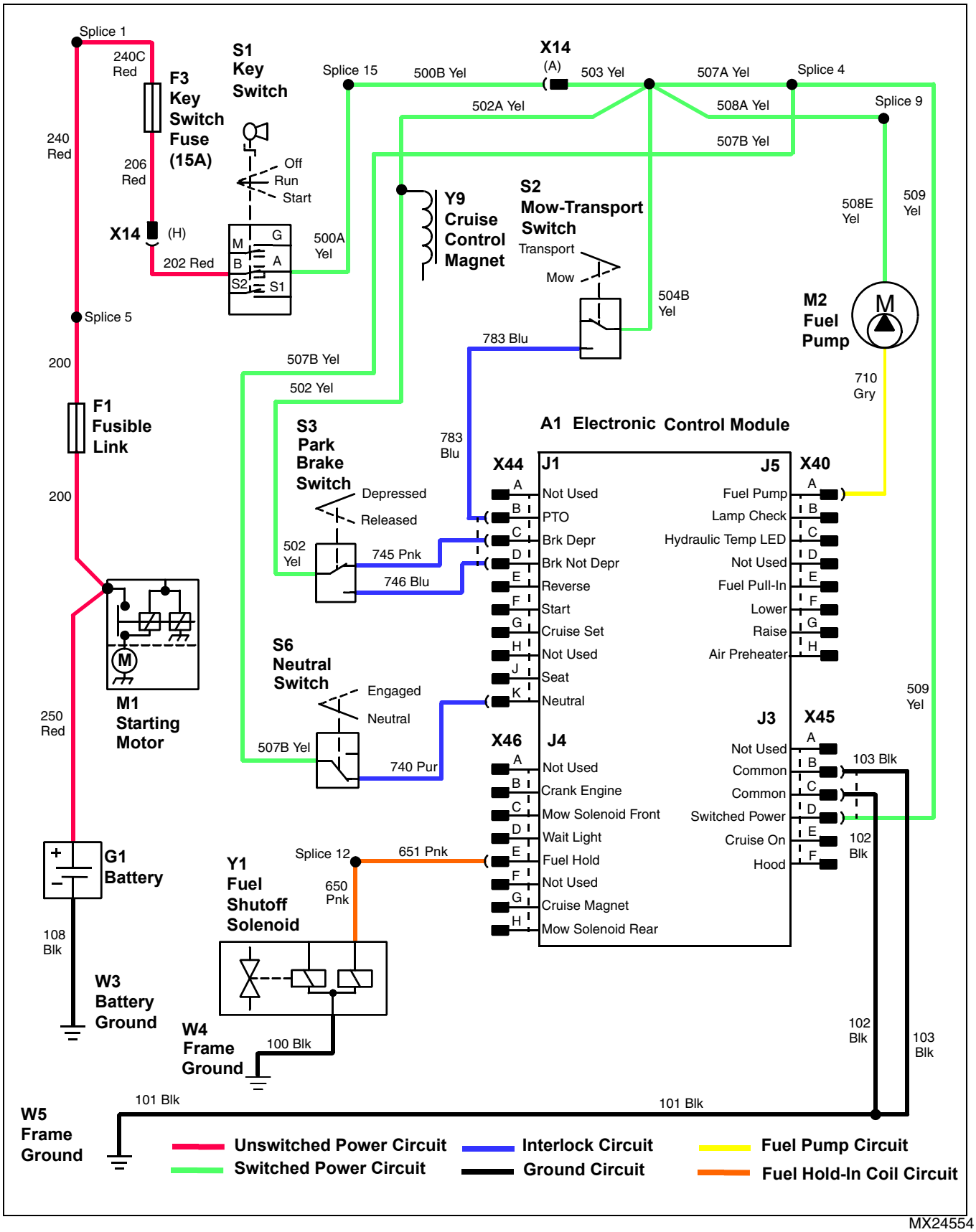
- Mow-transport switch (S2) is in the TRANSPORT position.
- Park brake switch (S3) is in LOCKED position.
- Neutral switch (S6) is in the NEUTRAL position.

The electronic control module provides a ground circuit for the fuel pump (M2), 710 Gry wire, and energizes the fuel pump. Also, the electronic control module provides current to the hold coil of the fuel shutoff solenoid (Y1), 651and 650 Pnk wires. The hold coil is provided ground through 100 Blk wire and the fuel shutoff solenoid is held in the energized position, and the engine continues to operate.

With the operator OFF the seat, the electronic control module will shut down the engine by opening outputs to the fuel shutoff solenoid hold coil and fuel pump circuits when any of the following conditions exist:

- Park brake in the UNLOCKED position.
- Forward or reverse pedals NOT in the NEUTRAL position.
- Mow-transport lever in the MOW position.
- Hood OPEN position (European machines).
- Hood switch connector with jumper wire disconnected (North American machines).

Run Circuit Schematic - Operator OFF Seat



MX24554

System: Run Circuit Diagnosis - Operator OFF Seat

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the fuel pump circuit, it is important to perform the following steps in the sequence shown.

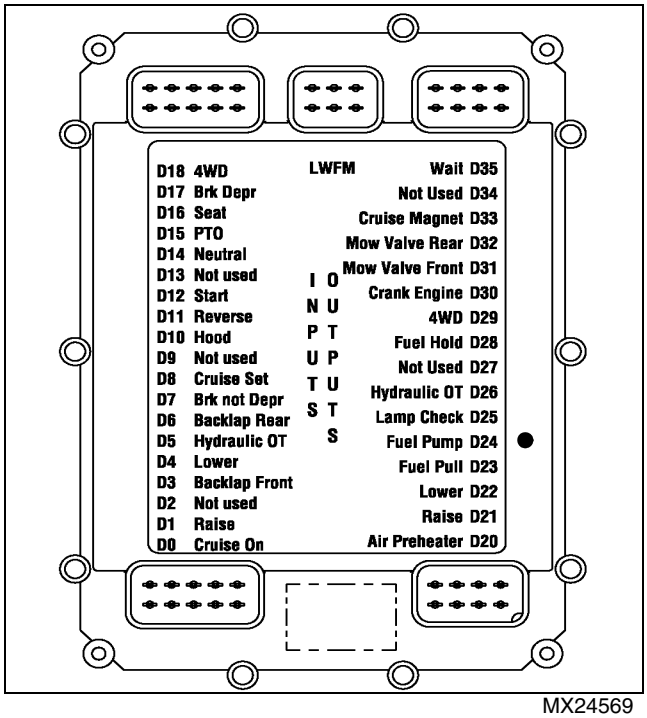
1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 155.)

2. Run Circuit Tests. (See “Run Circuit Schematic - Operator OFF Seat” on page 185.)

Fuel Pump Circuit

Test Conditions

- Operator OFF seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Neutral switch in NEUTRAL position.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness.

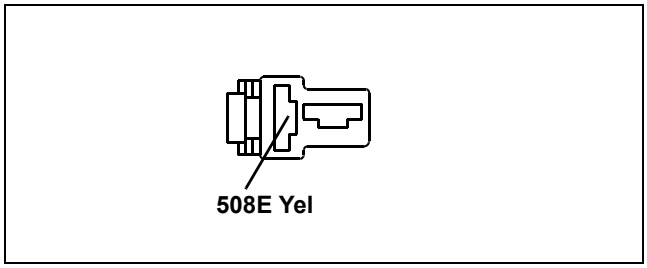


MX24569

1. Electronic control module (A1) output (D24) LED check. Is fuel pump output (D24) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

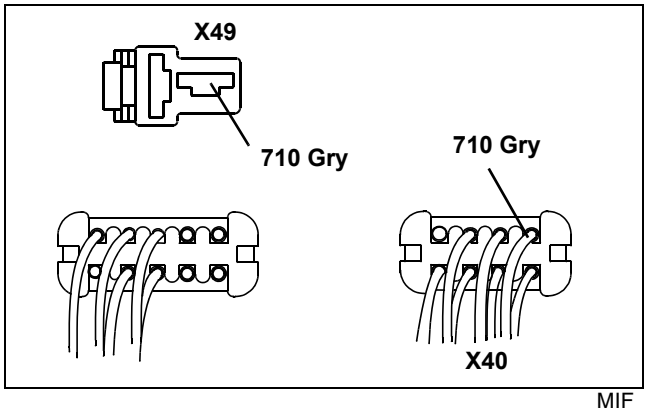


MIF

2. Measure voltage at fuel pump (M2), 508E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508E, 508A, 503, 500B, and 500A Yel wires and connections.



MIF

3. Disconnect electronic control module, connector (X40). Measure resistance between electronic control module connector (X40), terminal A, 710 Gry wire and fuel pump (M2), connector X49, 710 Gry wire. Is resistance less than 0.1 ohm?

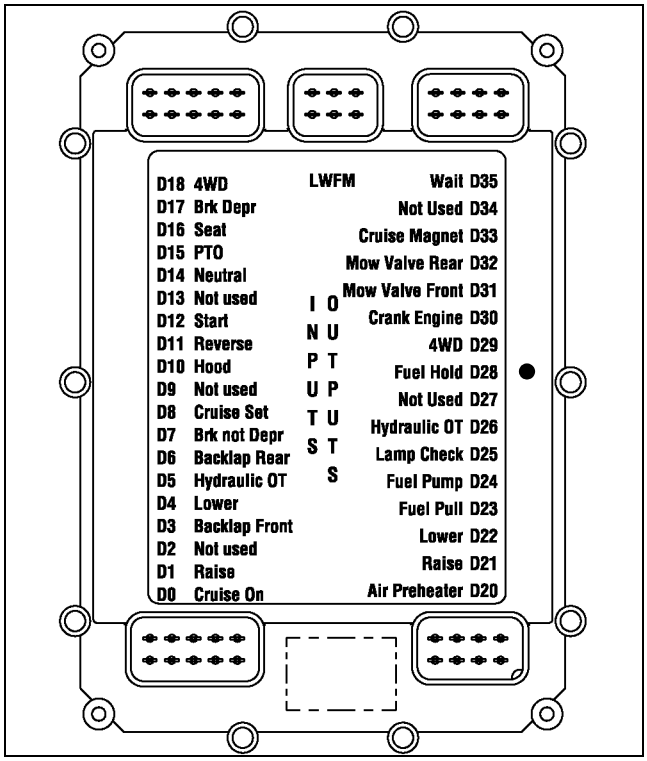
Yes: Test fuel pump. (See “Fuel Pump Test” on page 258.)

No: Test 710 Gry wire and connections.

Fuel Shutoff Solenoid Hold Coil Circuit

Test Conditions

- Operator OFF seat.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

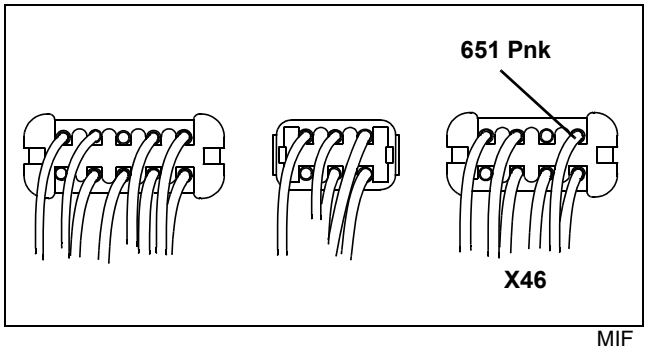


MX24569

1. Electronic control module (A1) output (D28) LED check. Is fuel hold output (D28) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

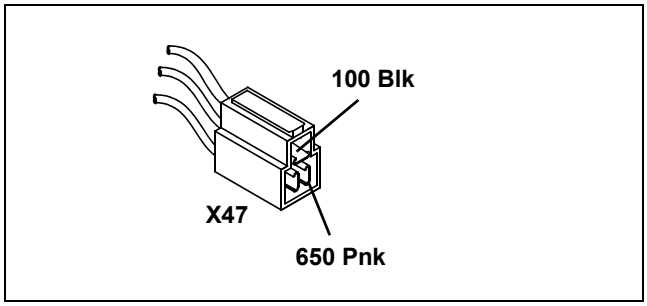


MIF

2. Measure voltage at electronic control module connector (X46), terminal E, 651 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Unplug connector (X46) and test connector terminal E, 651 Pnk wire and connections.



MIF

3. Measure voltage at fuel shutoff solenoid connector (X47), 650 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 650 and 651 Pnk wires and connections.

4. Disconnect fuel shutoff connector (X47). Measure resistance at fuel shutoff solenoid connector (X47), 100 Blk wire and (-) terminal of battery. Is resistance less than 0.1 ohm?

Yes: Test fuel shutoff solenoid. (See “Fuel Shutoff Solenoid Test” on page 257.)

No: Test 100 Blk wire and connections.

Charging Circuit Operation

Function

To maintain battery voltage between 11.8 and 13.2 VDC.

Operating Conditions

- Key switch in RUN position.
- Engine running.

Theory of Operation

With the key switch (S1) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following:

- Electronic control module (A1), 509 and 507 Yel wires.
- Battery LED (H6), 654, 655, and 651 Pnk wires.
- Alternator (G2), 508C Red wire, 508B and 508A Yel wires.

The alternator has an internal voltage regulator that monitors battery voltage and increases alternator output to maintain proper running voltage and battery charge. Alternator output is determined by the intensity of magnetism at the field coil. As the battery voltage fluctuates, the regulator adjusts the voltage to the field coil, which intensifies the magnetic field at the field coil and increases alternator output.

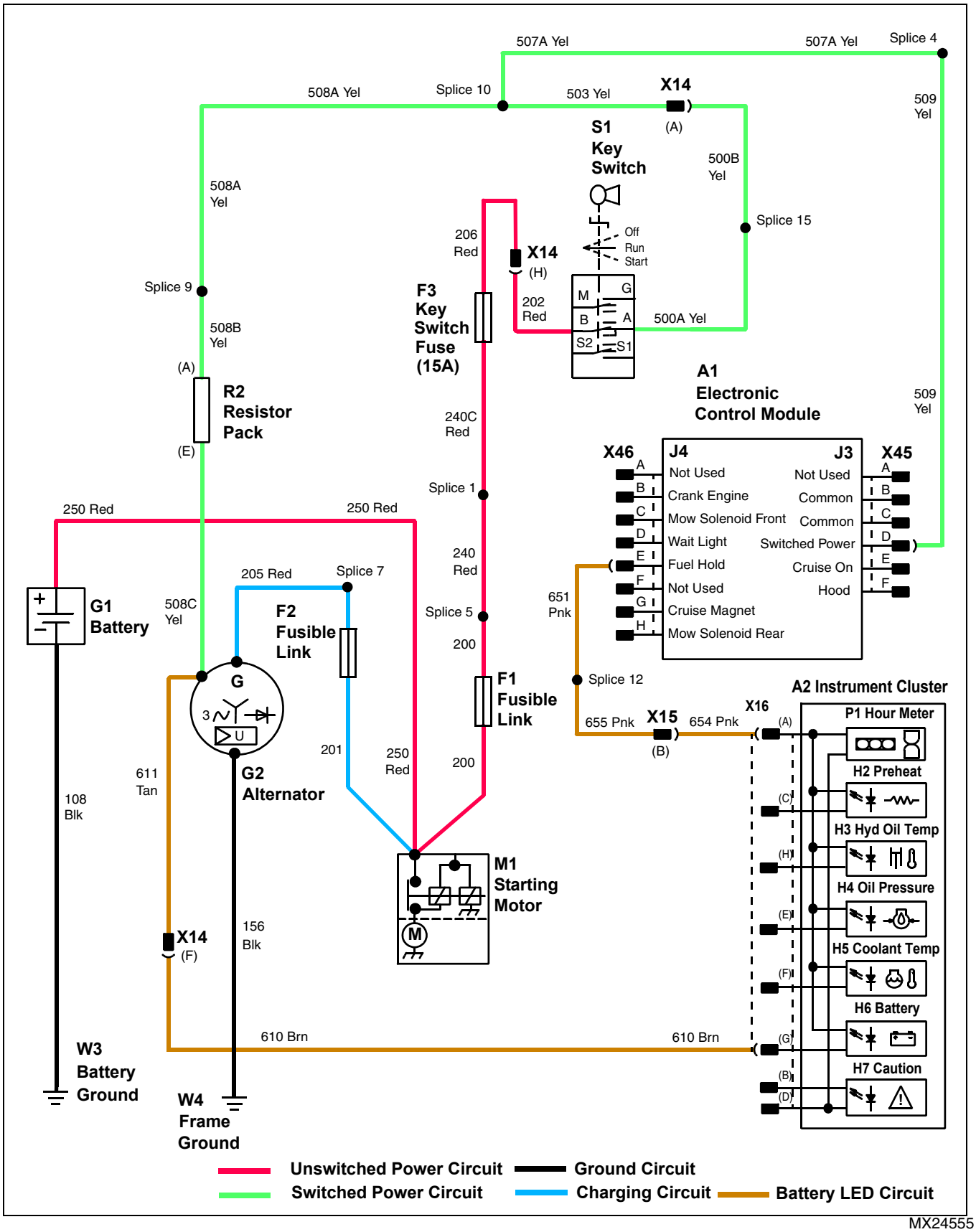
The alternator produces alternating current (AC), which is then rectified to direct current (DC) by an internal rectifier in the alternator.

Charging current flows from the alternator to the battery terminal on starting motor (M1), 205 Red wire, 201 fusible link (F2), and then to the battery positive (+) terminal through the positive (+) battery cable, 250 Red wire.

When the alternator has no output or low output, battery LED (H6) is turned on by providing ground on 610 Brn wire and 611 Tan wire. The alternator provides the ground internally.

Ground for alternator (G2) is provided by 156 Blk wire.

Charging Circuit Schematic



MX24555

System: Charging System Diagnosis

Charging System Test

Test Conditions

- Key switch in RUN position, engine OFF.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

1. Measure ground circuit for resistance at alternator (G2), 156 Blk wire. Is the resistance less than 0.1 ohm?

Yes: Go to next step.

No: Test 156 Blk wire and connections.

2. Measure voltage at alternator (G2), 205 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 205 and 250 Red wires, 201 fusible link (F2), and connections.

3. With alternator connector (X58) disconnected, measure voltage at alternator (G2), 508C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508C, 508B, 508A, 503, 500B, and 500A Yel wires, resistor pack (R2), and connections.

4. With alternator connector (X58) connected, measure voltage at instrument cluster (A2), terminal A, 654 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 654, 655, and 651 Pnk wires and connections.

5. Measure voltage at instrument cluster (A2) terminal G. Is battery voltage present?

Yes: Go to next step.

No: Check battery LED in instrument cluster (A2). Replace instrument cluster (A2) if bad.

6. With alternator connector (X58) disconnected, measure voltage at harness side of connector, 611 Tan wire. Is battery voltage present?

Yes: Test alternator regulated amperage and voltage. (See “Regulated Voltage Output Test” on page 247.)

No: Test 611 Tan wire and 610 Brn wire and connections.

Cruise Control Circuit Operation

Note: Cruise control is offered as an option.

Function

To provide a means of keeping the speed of the machine constant without the need of having the operator's foot on the forward hydrostatic control pedal.

The circuit controls an electromagnet that, when energized, holds the forward hydrostatic control pedal at the desired position.

Operating Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in UNLOCKED position.
- Cruise control switch in the SET or ON position.

Theory of Operation

Note: To engage the cruise control, the cruise control switch must first be moved to the SET position to energize the circuit.

When the key switch (S1) is in the RUN position, switched power (See "Power Circuit Operation - Switched" on page 160) flows from key switch terminal A through 500A Yel wire to the following:

- Electronic control module (A1), 500B, 503, 507A, and 509 Yel wires.
- Cruise control switch (S11), 500N Yel wire.
- Cruise control magnet (Y9), 500B, 503, and 502A Yel wires.

The electronic control module requires inputs from the interlock circuit (See "Interlock Circuit Operation" on page 168) as follows:

- Park brake switch (S3) in UNLOCKED position.
- Seat switch (S5), operator ON seat.

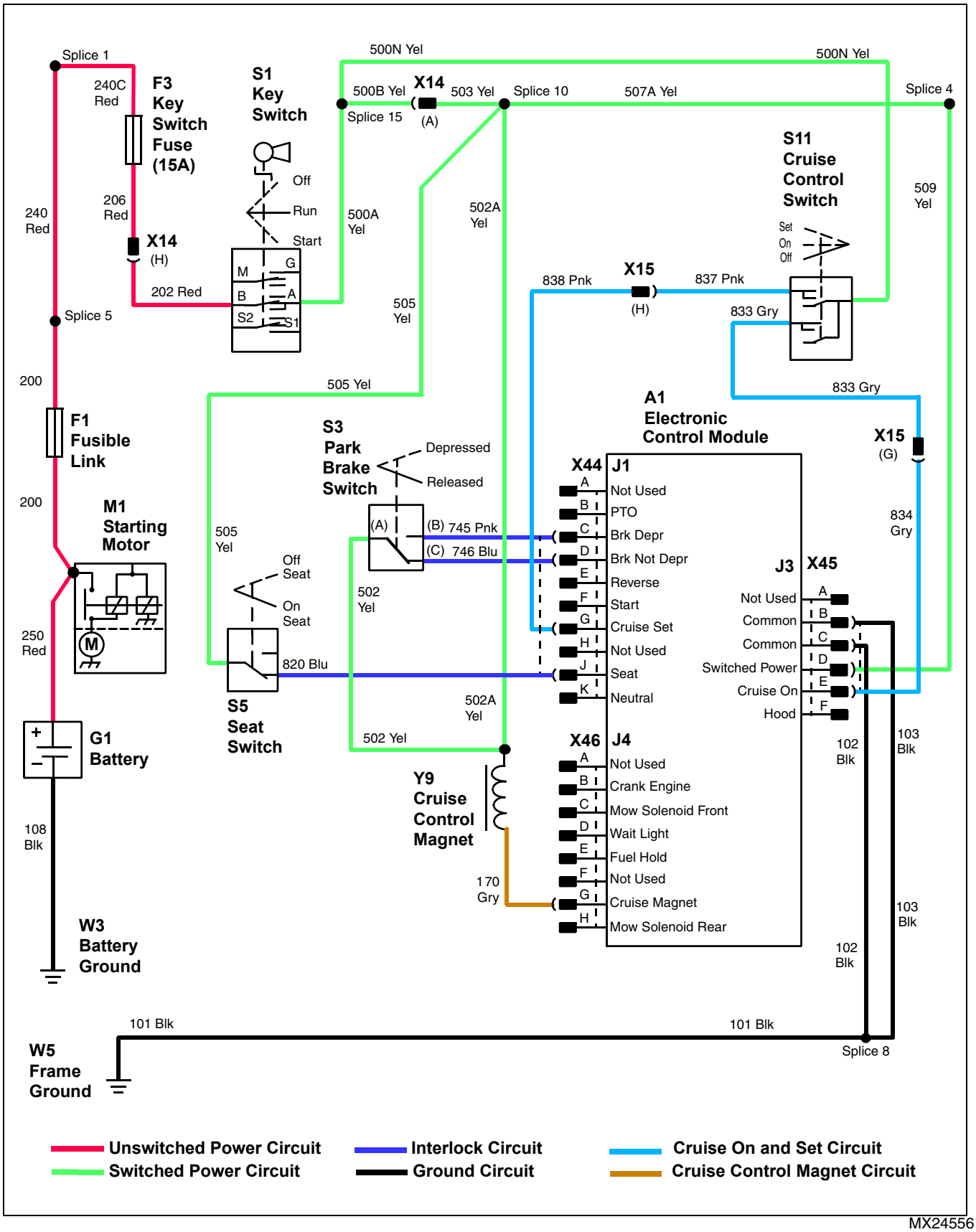
With the cruise control switch at the momentary SET position, current flows from the cruise control set switch to the electronic control module connector (X44), terminal G, 838 and 837 Pnk wires. Current also flows to the electronic control module connector (X45), terminal E, 834 and 833 Gry wires. The electronic control module connector (X46), terminal G, 170 Gry wire then supplies a ground path to the cruise control magnet (Y9), energizing the magnet.

When energized, the magnet pushes against the arm of the forward hydrostatic control pedal, holding the pedal at the desired position.

The cruise control remains energized unless any of the following occurs:

- Cruise control switch moved to the OFF position.
- Operator OFF seat.
- Key switch turned to OFF position.

Cruise Control Circuit Schematic



MX24556

System: Cruise Control Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the cruise control circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See "Electronic Control Module Checks" on page 155.)

2. Cruise Control Circuit Tests. (See "System: Cruise Control Circuit Diagnosis" on page 193.)

Cruise Control Circuit Tests

Test Conditions

- Operator ON seat.
- Park brake in UNLOCKED position.
- Key switch in RUN position, engine OFF.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

1. Measure voltage at cruise control switch (S11), 500N Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500N and 500A Yel wires and connections.

2. Hold the cruise control switch (S11) in the SET position. Measure voltage at cruise control switch (S11), 837 and 838 Pnk wires. Is battery voltage present?

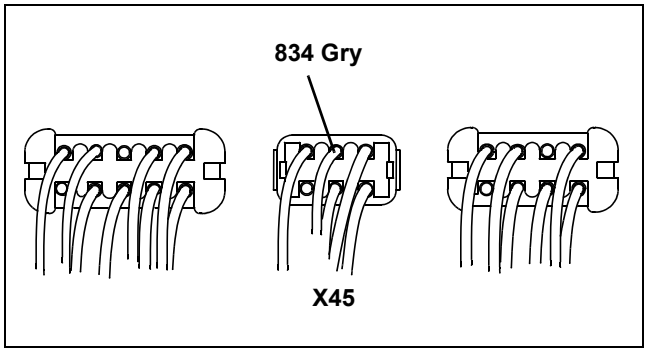
Yes: Go to next step.

No: Test cruise control switch. (See "Cruise Control Switch Test" on page 254.)

3. With the cruise control switch (S11) in the ON position, measure voltage at cruise control switch (S11), 833 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test cruise control switch. (See "Cruise Control Switch Test" on page 254.)

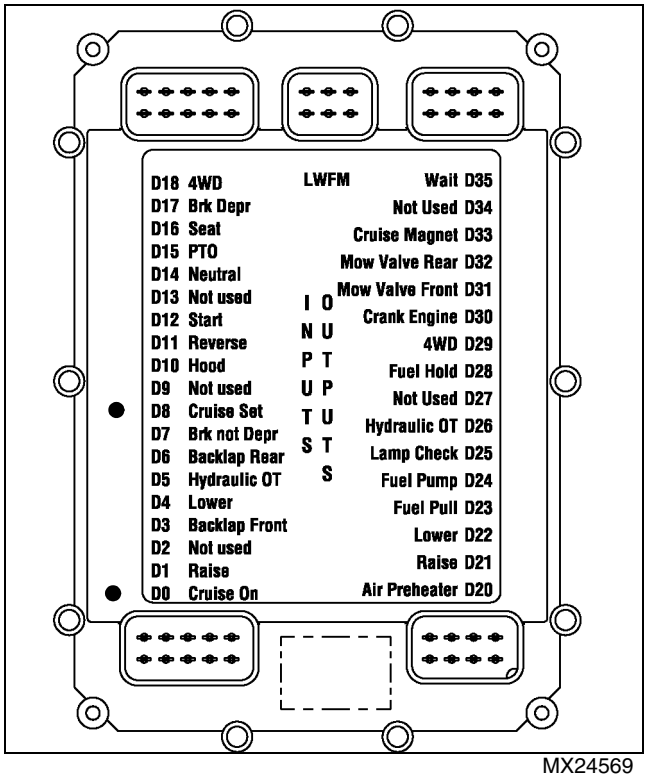


MIF

4. Disconnect electronic control module connector (X45). Measure voltage at connector (X45), terminal E, 834 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test 833 and 834 Gry wires and connections.



MX24569

5. Connect electronic control module connector (X45). Cruise control switch (S11) in the ON position. Electronic control module (A1) input (D0) LED check. Is cruise on input (D0) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See "Electronic Control Module Circuit Test" on page 155.)

6. Cruise control switch (S11) in the SET position. Electronic control module (A1) input (D8) LED check. Is cruise set input (D8) LED ON?

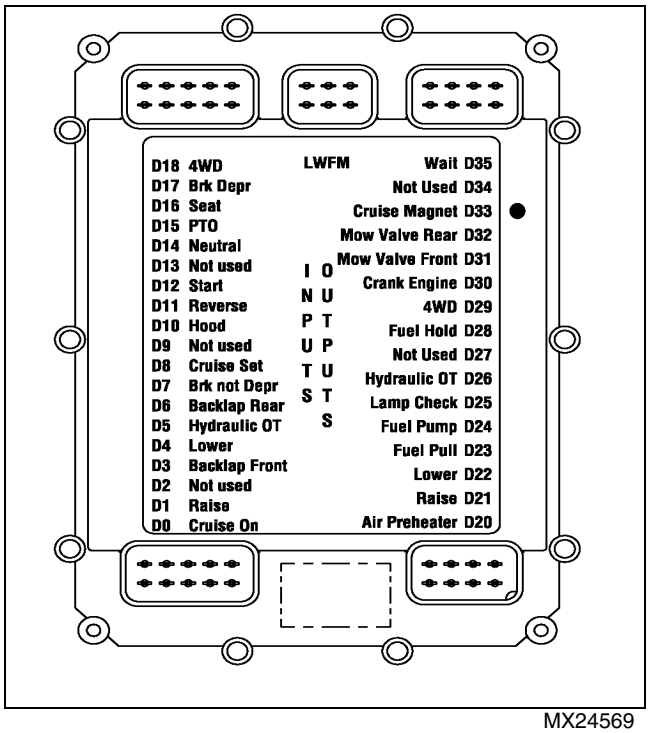
No: Test electronic control module circuit. (See

"Electronic Control Module Circuit Test" on page 155.)

Cruise Control Magnet Test

Test Conditions

- Operator ON seat.
- Park brake in UNLOCKED position.
- Key switch in RUN position, engine OFF.
- Cruise control switch (S11) in ON position. Push switch to momentary SET position, then release.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

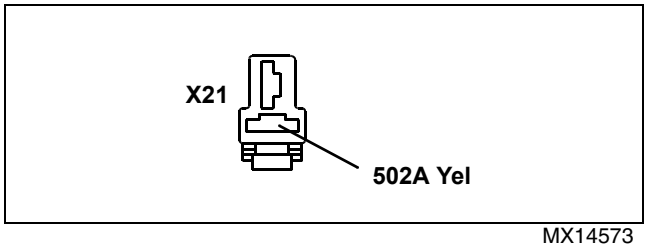


MX24569

1. Electronic control module (A1) output (D33) LED check. Is the cruise magnet output (D33) LED ON?

Yes: Go to next step.

No: Test 502A, 503, 500B, and 500A Yel wires and connections.

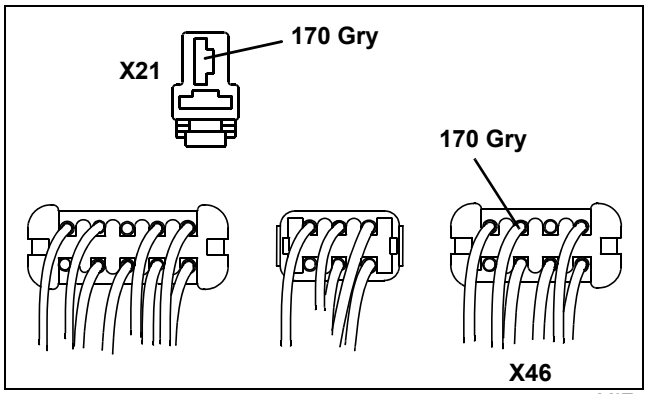


MX14573

2. Measure voltage at cruise control magnet (Y9), connector (X21), 502A Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test electronic control module circuit. (See "Electronic Control Module Circuit Test" on page 155.)



MIF

3. Disconnect electronic control module connector (X46). Measure resistance between electronic control module connector (X46), terminal G, 170 Gry wire and cruise control magnet (Y9), connector (X21), 170 Gry wire. Is resistance less than 0.1 ohm?

Yes: Test cruise control magnet (Y9). (See "Cruise Control Magnet Test" on page 260.)

No: Test 170 Gry wire and connections.

Mow Circuit Operation

Function

To energize and de-energize the mow solenoids which, in turn, engage and disengage the cutting units.

Operating Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Mower in the lowered position.
- Mow-transport lever in MOW position.

Theory of Operation

When the key switch is in RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A Yel wire to the following:

- Electronic control module (A1), 500B, 503, 507A, and 509 Yel wires.
- Front mow solenoid (Y3), 500B, 503, 507A, and 502D Yel wires.
- Rear mow solenoid (Y4), 500B, 503, 507A, and 507F Yel wires.
- Raise-lower switch (S10), 500H Yel wire.
- Lower solenoid (Y2), 500B, 503, 507A, and 507H Yel wires.

The electronic control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 168) as follows:

- Mow-transport switch (S2), 783A and 783C Blu wires.
- Seat switch (S5), 820 Blu wire.

Ground is provided to the raise-lower switch through 120D, 120A, 120, and 101 Blk wires. The raise-lower switch has two outputs to signal the electronic control module. The outputs go to the electronic control module indicating the position of the raise-lower switch as follows:

- Electronic control module connector (X41), terminal E, 661 and 660 Blu wires, indicating that the raise-lower switch is in the RAISE position.
- Electronic control module connector (X41), terminal G, 774 and 773 Blu wires, indicating that the raise-lower switch is in the LOWER position.

The electronic control module will energize the lower solenoid (Y2), front mow solenoid (Y3), and rear mow solenoid (Y4) when the following conditions are met:

- Mow-transport lever in the MOW position.
- Raise-lower switch in the LOWER position.

With the operating conditions met and when the raise-lower switch is placed in the LOWER position, a signal is provided from the raise-lower switch to the electronic control module, activating the lower input. With the lower input active, the electronic control module provides a controlled ground to lower solenoid (Y2), front and rear mow solenoids (Y3 and Y4), energizing the solenoids. With the solenoids energized, the cutting units are lowered and the cutting units start operating.

If the raise-lower switch is moved to the RAISE position, the electronic control module will disengage the front and rear mow solenoids. The raise-lower switch must be moved back to the LOWER position before the solenoids will be engaged again.

The electronic control module provides a controlled ground path for each solenoid as follows:

- Lower solenoid (Y2), 176 Grn wire.
- Front mow solenoid (Y3), 171 Blu wire.
- Rear mow solenoid (Y4), 172 Blu wire.

To activate the lower input, current flows through the following circuits and components:

- Raise-lower switch (S10).
- 773 and 774 Blu wires.
- Electronic control module connector (X41), terminal G.

To activate the mow input, current flows through the following circuit and components:

- Mow-transport switch (S2).
- 783A and 783C Blu wires.
- Electronic control module connector (X44), terminal B.

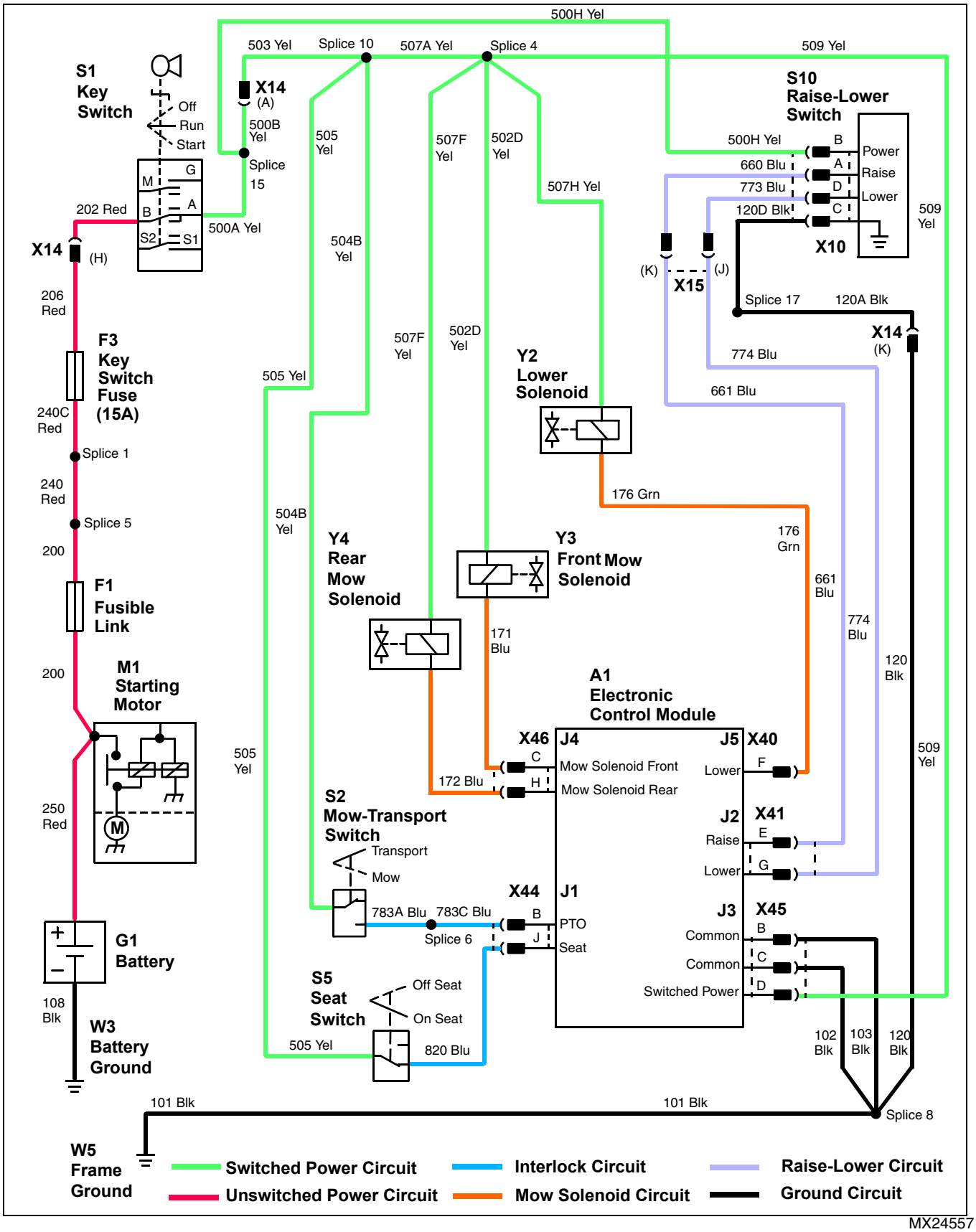
With lower input activated, the electronic control module provides a continuously controlled ground to the lower solenoid (Y2) through the following circuit and components:

- Electronic control module connector (X40), terminal F.
- 176 Grn wire.

To energize the mow solenoids, the electronic control module provides a controlled ground to the mow solenoids through the following circuit and components:

- Electronic control module connector (X46), terminal C, 171 Blu wire.
- Electronic control module connector (X46), terminal H, 172 Blu wire.

Mow Circuit Schematic



MX24557

System: Mow Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the mow circuit, it is important to perform the following steps in the sequence shown.

1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 155.)

2. Raise-Lower Circuit Diagnosis. (See “System: Raise-Lower Circuit Diagnosis” on page 212.)

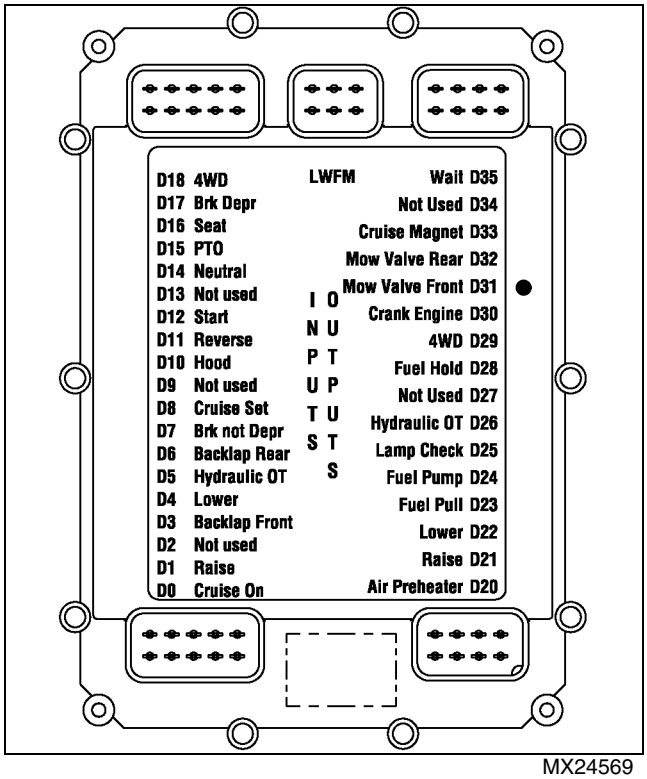
3. Mow Circuit Tests. (See “System: Mow Circuit Diagnosis” on page 197.)

Mow Circuit Diagnosis

Front Mow Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow-transport lever in MOW position.
- Move raise-lower switch to LOWER position and release.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

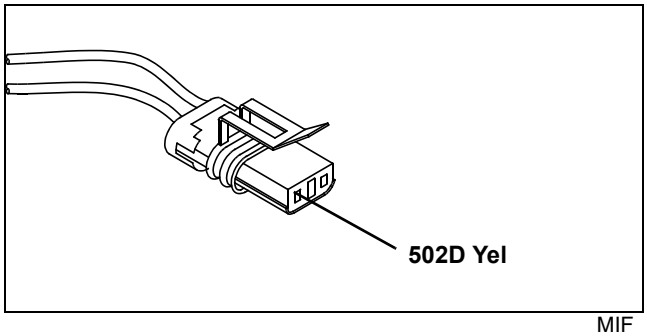


MX24569

1. Electronic control module (A1) output (D31) LED check. Is mow valve front output (D31) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

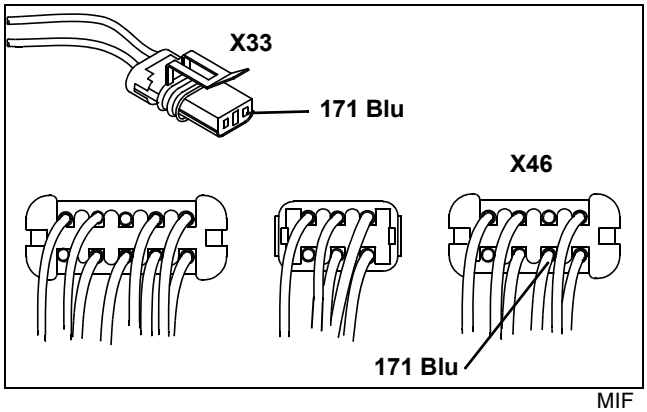


MIF

2. Measure voltage at front mow solenoid (Y3), 502D Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 502D, 507A, 503, 500B, and 500A Yel wires and connections.



MIF

3. Disconnect electronic control module connector (X46). Measure resistance between electronic control module connector (X46), terminal C, 171 Blu wire and front mow solenoid (Y3), connector X33, 171 Blu wire. Is resistance less than 0.1 ohm?

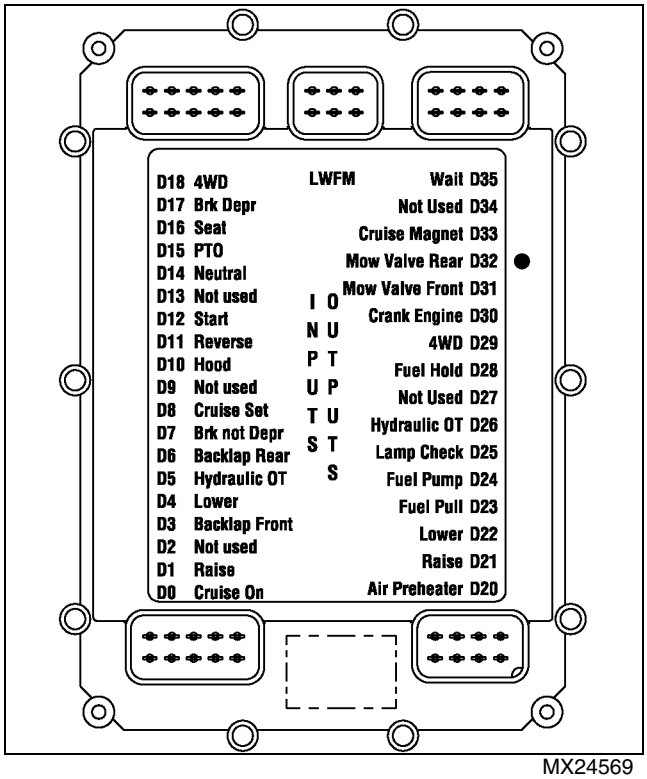
Yes: Test front mow solenoid (Y3). (See “Mow Solenoid Test” on page 259.)

No: Test 171 Blu wire and connections.

Rear Mow Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow-transport lever in MOW position.
- Move raise-lower switch to LOWER position and release.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

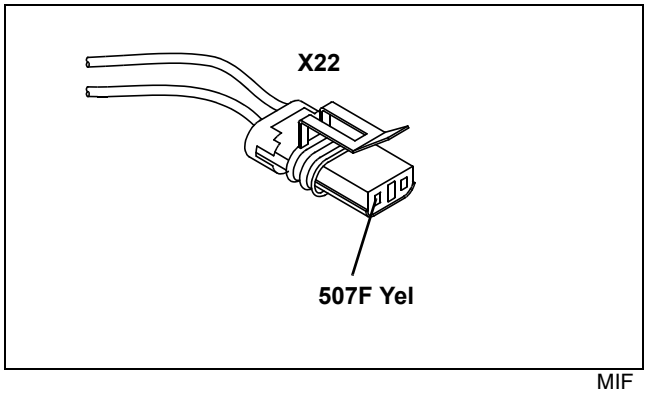


MX24569

1. Electronic control module (A1) output (D32) LED check. Is mow valve rear output (D32) LED ON?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

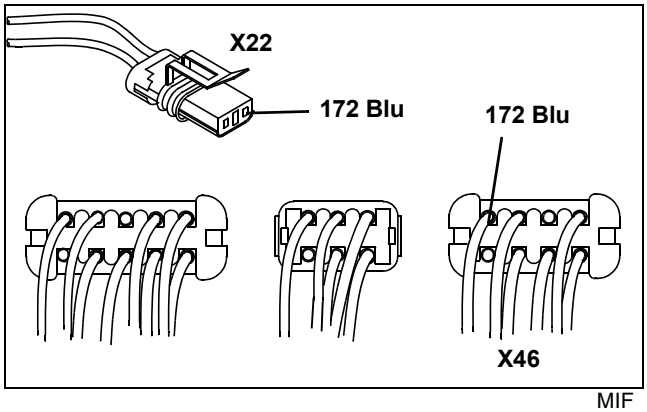


MIF

2. Measure voltage at rear mow solenoid (Y4), 507F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507F, 507A, 503, 500B, and 500A Yel wires and connections.



MIF

3. Disconnect electronic control module connector (X46). Measure resistance between electronic control module connector (X46), terminal H, 172 Blu wire and rear mow solenoid (Y4), connector X22, 172 Blu wire. Is resistance less than 0.1 ohm?

Yes: Test rear mow solenoid (Y4), (See “Mow Solenoid Test” on page 259.)

No: Test 172 Blu wire and connections.

4WD Bypass Circuit Operation

Note: 4WD bypass is offered as an option.

Function

To allow the machine to operate in front-wheel drive (2WD) when the reverse pedal is depressed.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.

Theory of Operation

With key switch in the OFF position, the unswitched power (See “Power Circuit Operation - Unswitched” on page 157) is present on the following:

- 4WD bypass relay (K3), terminal 30, 240F and 240 Red wire and 200 fusible link (F1).

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) current flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following:

- Electronic control module (A1), 507A and 509 Yel wires.
- Reverse switch (S4), 506 Yel wire.
- Seat switch (S5), 505 Yel wire.

The electronic control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 168) as follows:

- Reverse switch (S4), 772A and 772B Blu wires.
- Seat switch (S5), 820 Blu wire.

The reverse switch (S4) provides two machine functions:

- Provides a signal to electronic control module reverse input.
- Energizes 4WD bypass relay (K3).

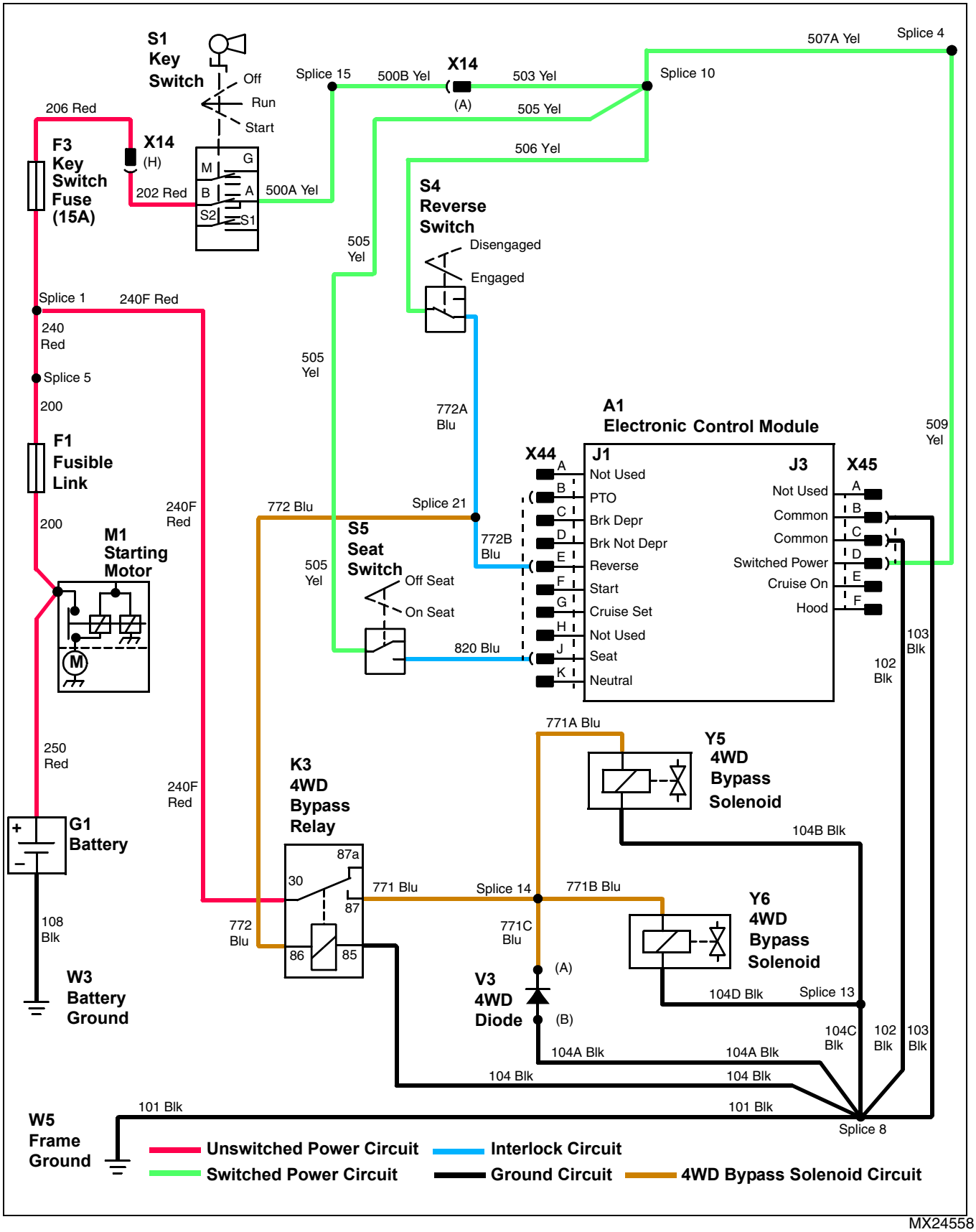
When the reverse pedal is depressed, the reverse switch is placed in the ENGAGED position. With the reverse switch engaged, current flows through 772A and 772 Blu wires, energizing the 4WD bypass relay (K3). With the bypass relay energized, current flows between relay terminals 30 and 87 to 4WD bypass solenoids (Y5 and Y6), energizing the solenoids.

With the solenoids energized, the hydraulic fluid is diverted from the rear drive motors, allowing the machine to operate in front-wheel drive (2WD).

When the reverse pedal is released, the reverse switch is placed in the disengaged position. With the reverse switch in the DISENGAGED position, the 4WD bypass circuit de-energizes 4WD solenoids (Y1 and Y2). As the 4WD solenoids de-energize, a reverse voltage is generated, 4WD diode (V3) conducts the reverse voltage to ground.

With the 4WD solenoids de-energized, hydraulic fluid is allowed to flow to the rear drive motors, allowing the machine to operate in 4WD when the forward pedal is depressed.

4WD Bypass Solenoid Circuit Schematic



MX24558

System: 4WD Bypass Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the 4WD bypass circuit, it is important to perform the following steps in the sequence shown.

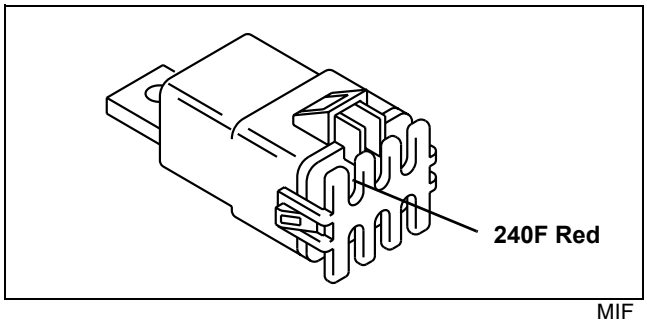
1. Electronic Control Module Checks. (See "Electronic Control Module Checks" on page 155.)

2. 4WD Bypass Circuit Tests. (See "4WD Bypass Circuit Operation" on page 200.)

4WD Bypass Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Reverse switch in ENGAGED position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

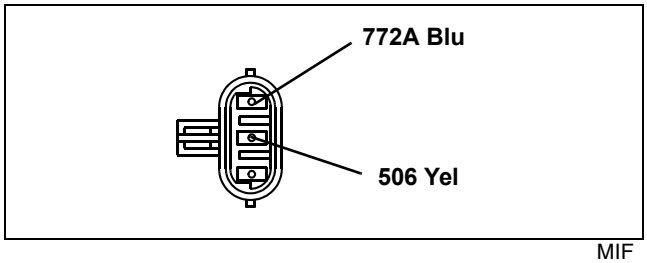


MIF

1. Measure voltage at 4WD bypass relay (K3), terminal 30, 240F Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240F and 240 Red wires, 200 fusible link (F1) and connectors.



MIF

2. Measure voltage at reverse switch (S4), 506 Yel wire. Is battery voltage present?

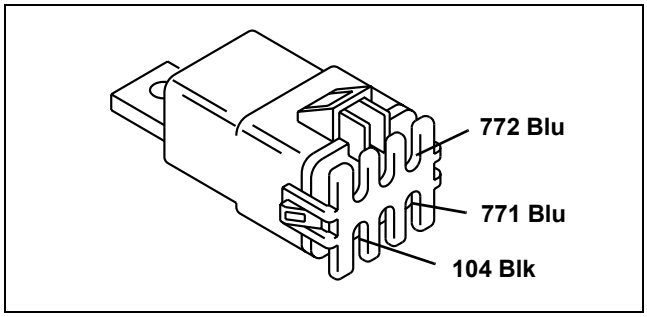
Yes: Go to next step.

No: Test 506, 503, 500B, and 500A Yel wires and connections.

3. Measure voltage at reverse switch (S4), 772A Blu wire. Is battery voltage present?

Yes: Go to next step.

No: See reverse switch test. (See "Reverse Switch Test" on page 251.)



MIF

4. Measure voltage at 4WD bypass relay (K3), terminal 86, 772 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 772 and 772A Blu wires.

5. Measure voltage at 4WD bypass relay (K3), terminal 85, 104 Blk wire. Is voltage less than 0.1 volt?

Yes: Go to next step.

No: Test 104 and 101 Blk wires and connections.

6. Measure voltage at 4WD bypass relay (K3), terminal 87, 771 Blu wire. Is battery voltage present?

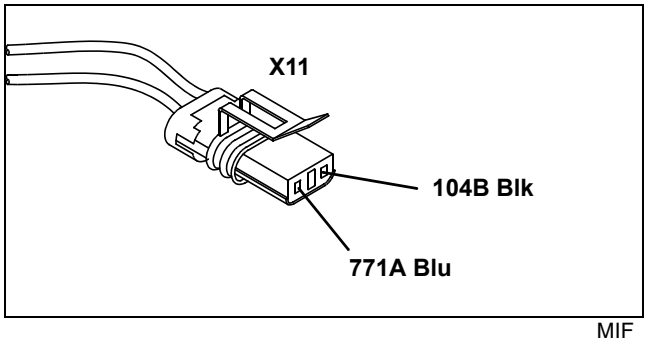
Yes: Go to next step.

No: See electrical relay test. (See "Electrical Relays Test" on page 256.)

4WD Bypass Solenoids (Y5 and Y6) Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Reverse switch in ENGAGED position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at 4WD bypass solenoid (Y5), connector X11, 771A Blu wire. Is battery voltage present?

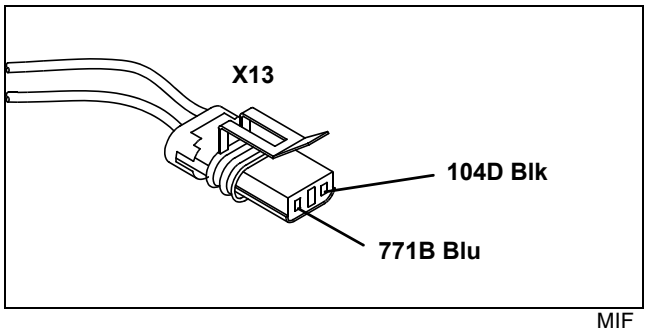
Yes: Go to next step.

No: Test 771A and 771 Blu wires and connections.

2. Measure resistance at 4WD bypass solenoid (Y5), connector X11, 104B Blk wire and neg (-) side of battery. Is resistance less than 0.1 ohm?

Yes: Test 4WD bypass solenoid (Y5), (See “4WD Bypass Solenoid Test” on page 257.)

No: Test 104B, 104C, and 101 Blk wires and connections.



MIF

3. Measure voltage at 4WD bypass solenoid (Y6), connector X13, 771B Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 771B and 771 Blu wires and connections.

4. Measure resistance at 4WD bypass solenoid (Y6), connector X13, 104D Blk wire and neg (-) side of battery. Is resistance less than 0.1 ohm?

Yes: Test 4WD bypass solenoid (Y6). (See “4WD Bypass Solenoid Test” on page 257.)

No: Test 104D, 104C, and 101 Blk wires and connections.

Backlap Circuit Operation

Function

To allow the engine to run and engage the reel motors when the operator is OFF the seat and a backlap switch is in the BACKLAP position.

Operating Conditions

- Backlap switches in the BACKLAP position (pulled out into locked position).
- Park brake in LOCKED position.
- Key switch in RUN position.
- Engine running.
- Mow-transport lever in MOW position.
- Operator OFF seat.

Theory of Operation

When the key switch (S1) is in RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B,and 503 Yel wires to the following:

- Electronic control module (A1), 507A and 509 Yel wires.
- Front backlap switch (S8), 507A and 502E Yel wires.
- Rear backlap switch (S9), 507A and 507E Yel wires.
- Front mow solenoid (Y3), 507A and 502D Yel wires.
- Rear mow solenoid (Y4), 507A and 507F Yel wires.
- Mow-transport switch (S2), 504B Yel wire.
- Seat switch (S5), 505 Yel wire.
- Neutral switch (S6), 507B Yel wire.
- Park brake switch (S3), 502 and 502A Yel wires.

The electronic control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 168) as follows:

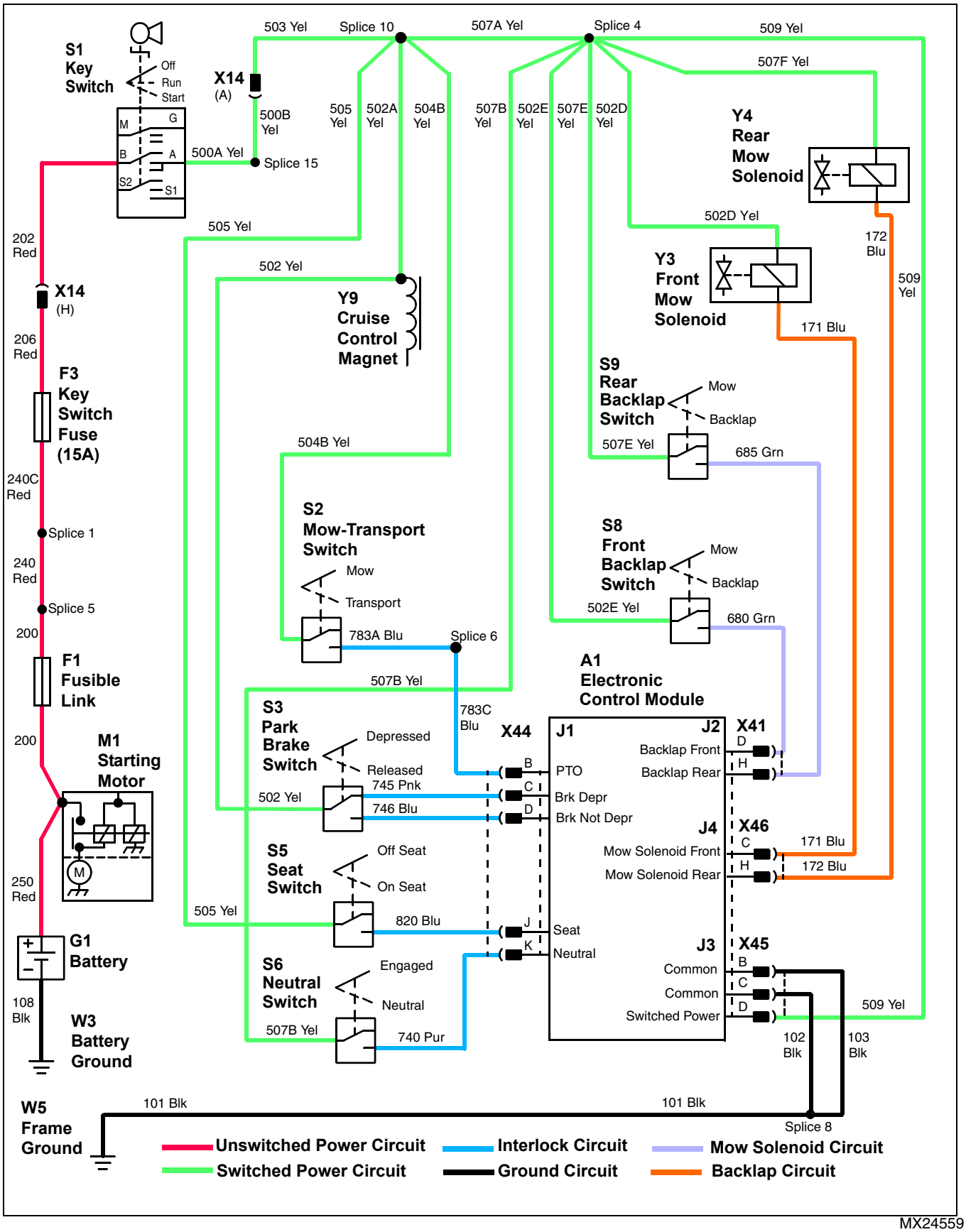
- Mow-transport switch (S2), 783A and 783C Blu wires.
- Seat switch (S5), 820 Blu wire.
- Neutral switch (S6), 740 Pur wire.
- Park brake switch (S3), 745 Pnk wire.

When the electronic control module receives an input from the front backlap switch (S8), 680 Grn wire, the electronic control module provides a ground for the front mow solenoid (Y3), 171 Blu wire, energizing the solenoid. With the front mow solenoid energized, the front cutting units are lowered and the cutting motors operate in the reverse direction.

When the electronic control module receives an input from the rear backlap switch (S9), 685 Grn wire, the electronic control module provides a ground to the rear mow solenoid (Y4), 172 Blu wire, energizing the solenoid. With the rear mow solenoid energized, the rear cutting units are lowered and the cutting motors operate in the reverse direction.

Normally, when the mow-transport switch is in the MOW position and the operator is OFF the seat, the engine will stop. However, if either the front backlap switch (S8) or rear backlap switch (S9) is in the ON position and the operator leaves the seat (operator OFF seat), the engine will continue to run.

Backlap Circuit Schematic



MX24559

System: Backlap Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the backlap circuit, it is important to perform the following steps in the sequence shown.

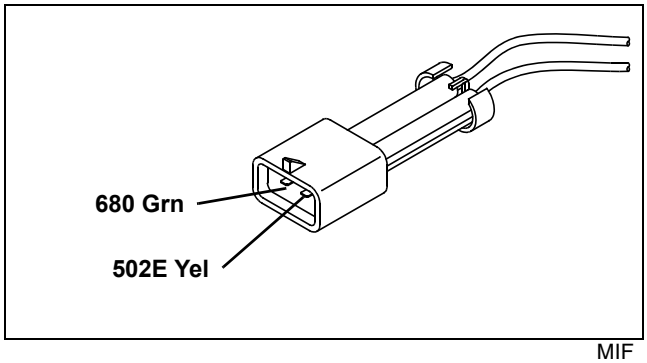
1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 155.)

2. Backlap Circuit Tests. (See “Front Backlap Switch (S8) Circuit Test” on page 206.)

Front Backlap Switch (S8) Circuit Test

Test Conditions

- Operator OFF seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in MOW position.
- Front backlap switch in BACKLAP position.
- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at front backlap switch (S8), 502E Yel wire. Is battery voltage present?

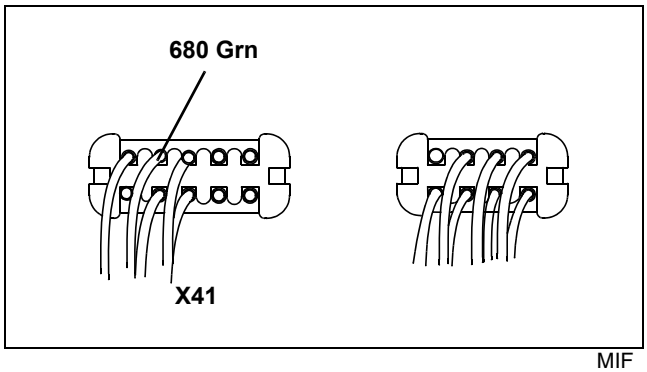
Yes: Go to next step.

No: Test 502E, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at front backlap switch (S8), 680 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test front backlap switch. (See “Backlap Switch Test” on page 252.)

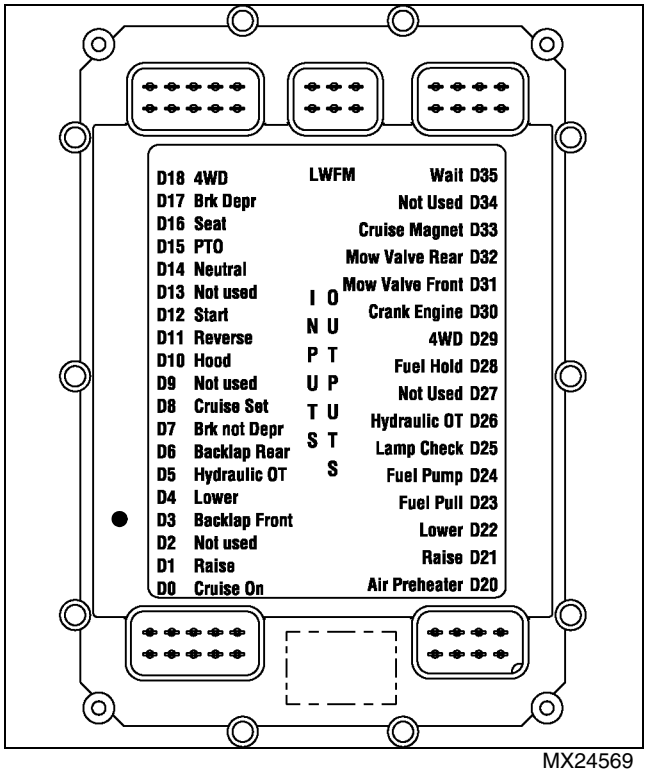


MIF

3. Measure voltage at electronic control module connector (X41), terminal D, 680 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 680 Grn wire and connections.



MX24569

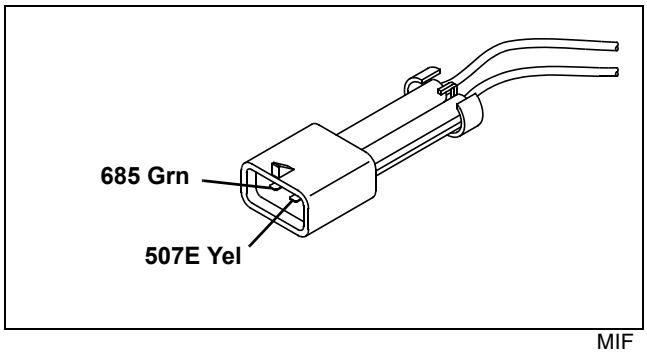
4. Electronic control module (A1) input LED check. Is backlap front input (D3) LED ON?

No: Test electronic control module connector (X41), terminal D, 685 Grn wire. If connector terminal tests good, test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

Rear Backlap Switch (S9) Circuit

Test Conditions

- Operator OFF seat.
- Park brake in LOCKED position.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in MOW position.
- Rear backlap switch in BACKLAP position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at rear backlap switch (S9), 507E Yel wire. Is battery voltage present?

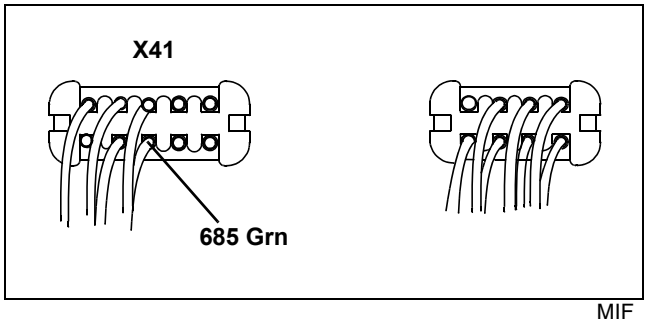
Yes: Go to next step.

No: Test 507E, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at rear backlap switch (S9), 685 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test rear backlap switch. (See “Backlap Switch Test” on page 252.)

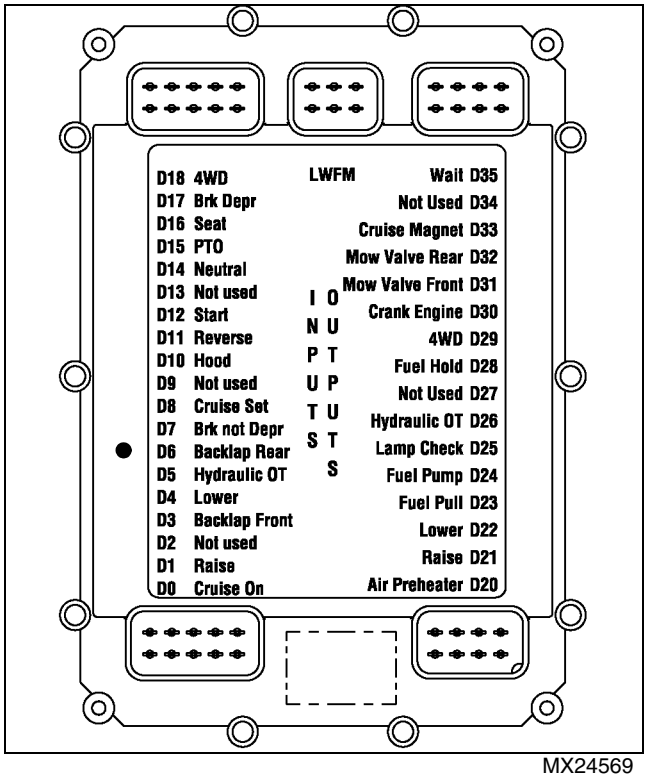


MIF

3. Measure voltage at electronic control module connector (X41), terminal H, 685 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 685 Grn wire and connections.



MX24569

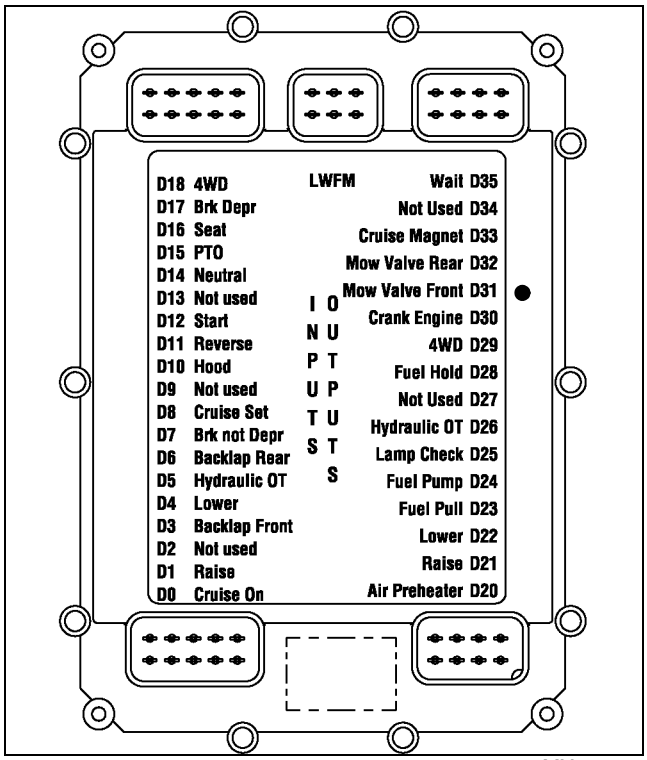
4. Electronic control module (A1) input LED check. Is backlap rear input (D6) LED ON?

No: Test electronic control module connector (X41), terminal H. If connector terminal tests good, test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)

Front Mow Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in MOW position.
- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

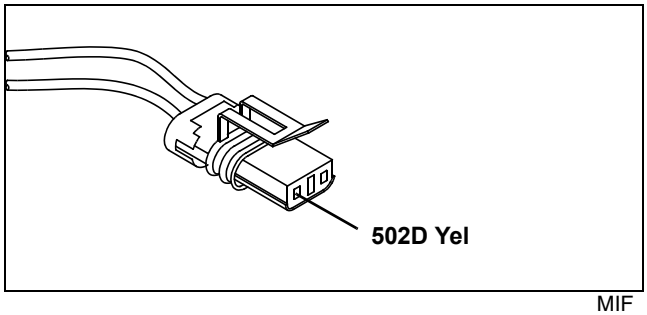


MX24569

1. Electronic control module (A1) output LED check. Is mow valve front output (D31) LED ON?

Yes: Go to next step.

No: Test 502D, 507A, 503, 500B, and 500A Yel wires and connections.

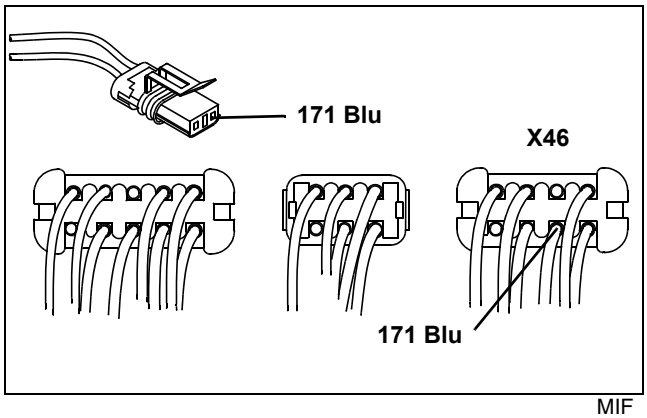


MIF

2. Measure voltage at front mow solenoid (Y3), 502D Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)



MIF

3. Disconnect electronic control module connector (X46). Measure resistance between electronic control module terminal C, 171 Blu wire and front mow solenoid (Y3), 171 Blu wire. Is resistance less than 0.1 ohm?

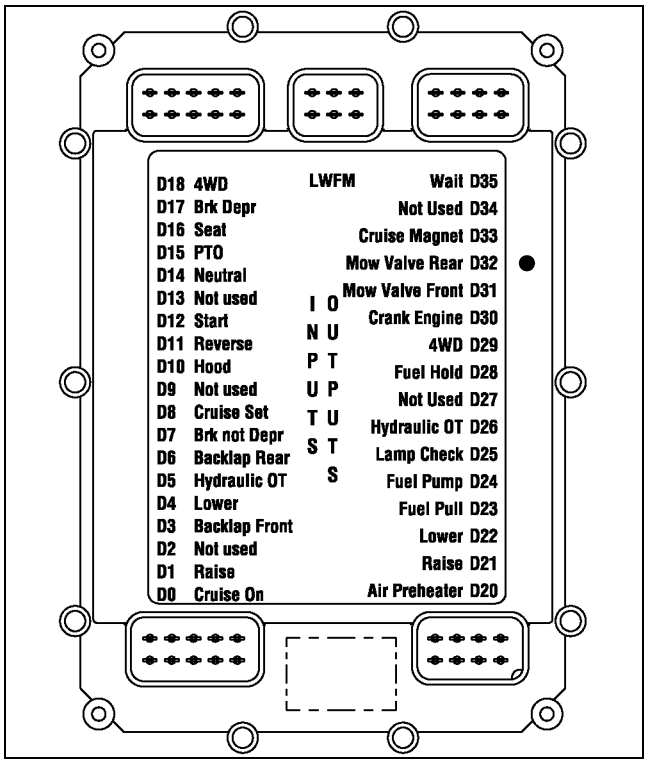
Yes: Test front mow solenoid. (See “Mow Solenoid Test” on page 259.)

No: Test 171 Blu wire and connections.

Rear Mow Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in MOW position.
- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

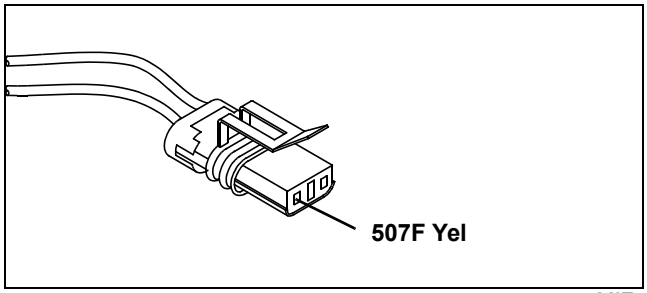


MX24569

1. Electronic control module (A1) output LED check. Is mow valve rear output (D32) LED ON?

Yes: Go to next step.

No: Test 507F, 507A, 503, 500B, and 500A Yel wires and connections.

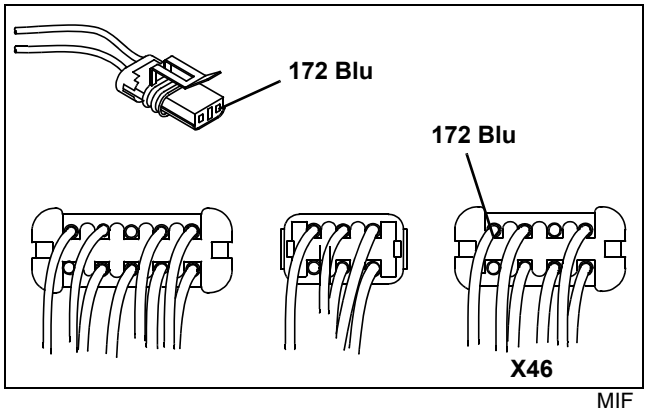


MIF

2. Measure voltage at rear mow solenoid (Y4), 507F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)



MIF

3. Disconnect electronic control module connector (X46). Measure resistance between electronic control module connector (X46), terminal H, 172 Blu wire and rear mow solenoid (Y4), 172 Blu wire. Is resistance less than 0.1 ohm?

Yes: Test rear mow solenoid. (See “Mow Solenoid Test” on page 259.)

No: Test 172 Blu wire and connections.

Raise-Lower Circuit Operation

Function

To energize the raise and lower solenoids (Y8 and Y2) as necessary to raise and lower the cutting units.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A Yel wire to the following:

- Electronic control module (A1), 500B, 503, 507A, and 509 Yel wires.
- Lower solenoid (Y2), 500B, 503, 507A, and 507H Yel wires.
- Raise solenoid (Y8), 500B, 503, 507A, and 507G Yel wires.
- Raise-lower switch (S10), 500H Yel wire.
- Seat switch (S5), 500B, 503, and 505 Yel wires.
- Mow-transport switch (S2), 500B, 503, and 504B Yel wires.

The electronic control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 168) as follows:

- Mow-transport switch (S2), 783A Blu wire.
- Seat switch (S5), 820 Blu wire.

The raise-lower switch is provided ground through 120D, 120A, 120, and 101 Blk wires. The two outputs go to the electronic control module, indicating the raise-lower switch position as follows:

- Electronic control module connector (X41), terminal E, 660 and 661 Blu wires, indicating that the raise-lower switch is in the RAISE position.
- Electronic control module connector (X41), terminal G, 773 and 774 Blu wires, indicating that the raise-lower switch is in the LOWER position.

Raise Circuit

When the electronic control module senses that the mow-transport switch is in the MOW position and the raise-lower switch is in the RAISE position, the electronic control module provides ground at connector (X40), terminal G.

When this ground is provided, current flows from the raise solenoid (Y8) to ground though 175 Grn wire, energizing the solenoid to raise the cutting units. The electronic control module provides this ground for only about 3 seconds, even if the raise-lower switch is returned to the MIDDLE position. Ground is not provided again until the raise-lower switch is returned from the MIDDLE position and then back to the RAISE position.

When the mow-transport switch is in the TRANSPORT position, the operator must hold the raise-lower switch in the RAISE position to move the cutting units to the full up position.

Lower Circuit

When the electronic control module senses that the raise-lower switch is cycled between the MIDDLE and LOWER positions, the module provides ground at electronic control module connector (X40), terminal F, 176 Grn wire. Current flows from the lower solenoid (Y2) to ground though 176 Grn wire, energizing the solenoid to lower the cutting units. The electronic control module continuously provides this ground after the raise-lower switch is released to the MIDDLE position.

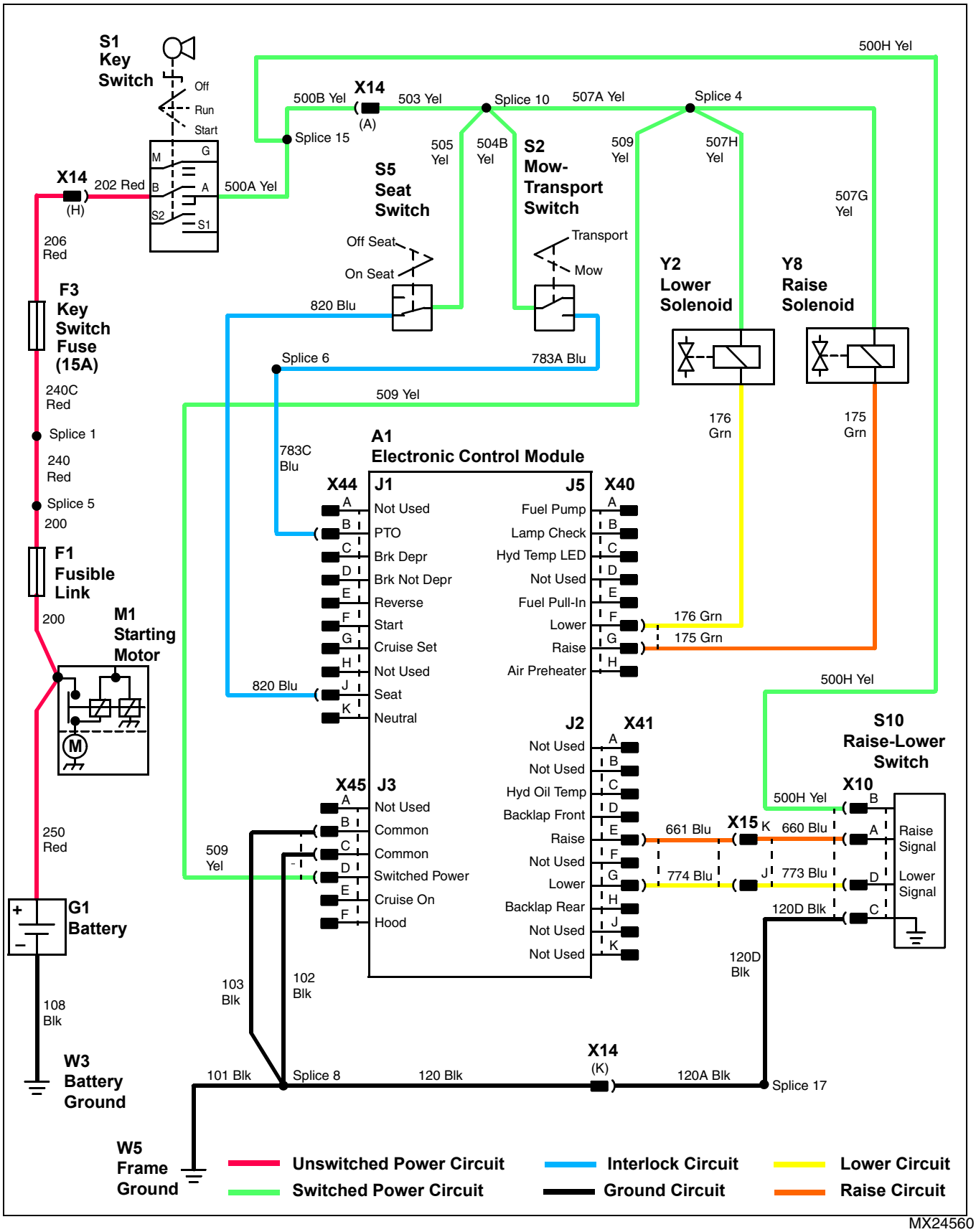
The electronic control module will energize the lower solenoid (Y2) when the following conditions are met:

- Mow-transport lever in the MOW position.
- Raise-lower switch in the LOWER position.

With the operating conditions met and when the raise-lower switch is placed in the LOWER position, a signal is provided from the raise-lower switch to the electronic control module lower input, activating the lower input. With the lower input active, the electronic control module provides a controlled ground to lower solenoid (Y2), energizing the solenoid. With the solenoid energized, the cutting units are lowered.

If the raise-lower switch is moved to the RAISE position, the electronic control module will disengage the front and rear mow solenoids. The raise-lower switch must be moved back to the LOWER position before the solenoids will be engaged again.

Raise-Lower Circuit Schematic



MX24560

System: Raise-Lower Circuit Diagnosis

Diagnostics of circuits that include the electronic control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the electronic control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the raise-lower circuit, it is important to perform the following steps in the sequence shown.

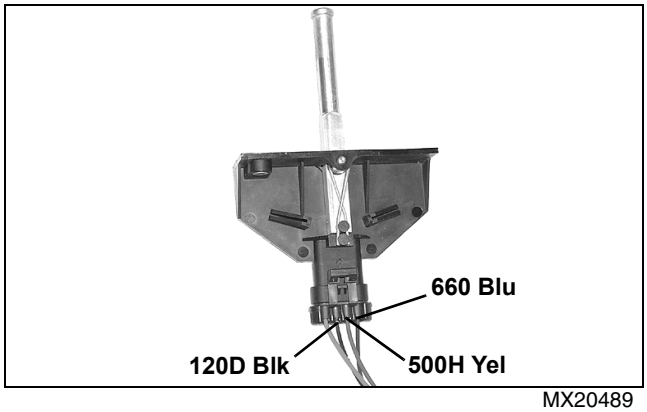
1. Electronic Control Module Checks. (See “Electronic Control Module Checks” on page 155.)

2. Raise-Lower Circuit Tests. (See “Raise-Lower Circuit Tests” on page 212.)

Raise-Lower Circuit Tests

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX20489

1. Disconnect raise-lower switch connector (X10). Measure voltage at raise-lower switch connector (X10), 500H Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500H and 500A Yel wires and connections.

2. Measure ground circuit resistance at raise-lower connector (X10), 120D Blk wire. Is there less than 0.1 ohm of resistance?

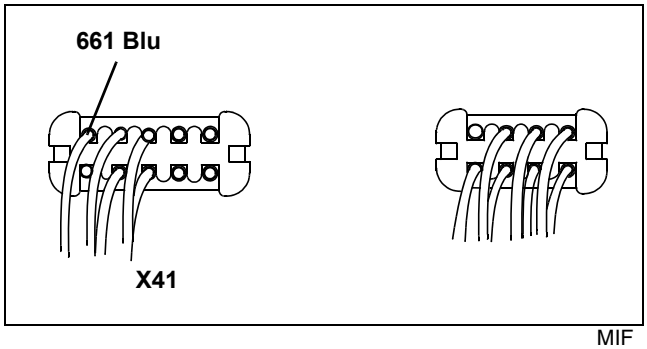
Yes: Go to next step.

No: Test 120D, 120A, 120, and 101 Blk wires and connections.

3. Connect raise-lower switch connector (X10). Move raise-lower switch (S10) to the RAISE position and hold. Measure voltage at raise-lower switch connector (X10), 660 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test raise-lower switch. (See “Raise-Lower Switch Test” on page 254.)

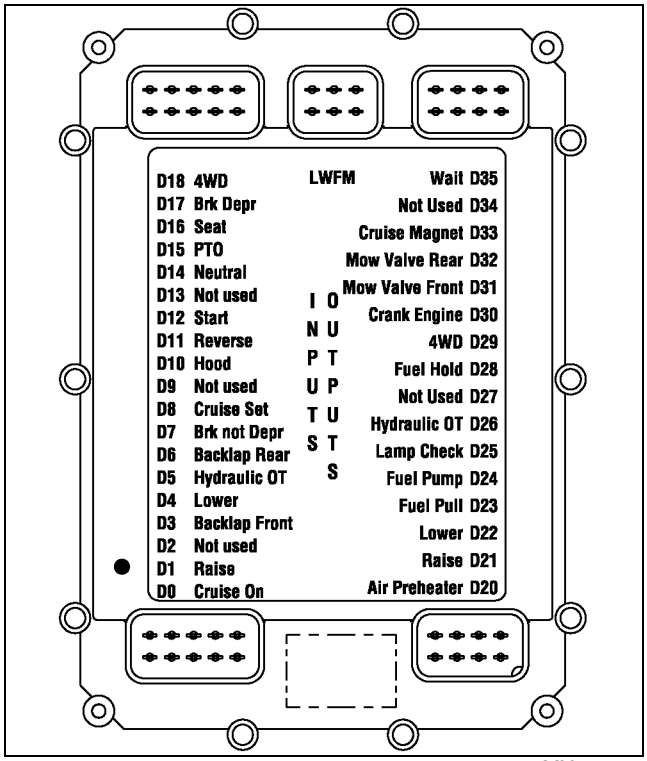


MIF

4. With the raise-lower switch (S10) in the RAISE position, measure voltage at electronic control module connector (X41), terminal E, 661 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 661 and 660 Blu wires and connections.



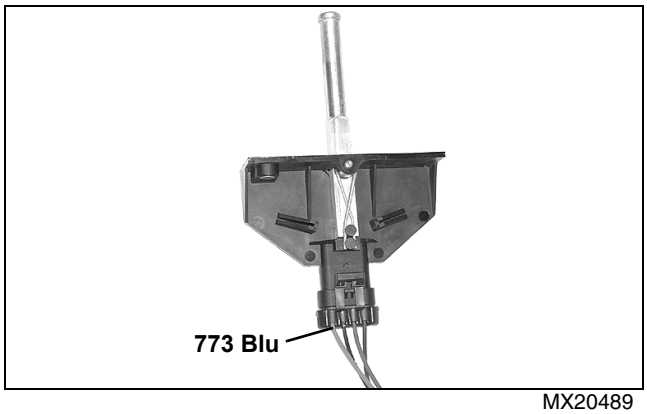
MX24569

5. Raise-lower switch (S10) in the RAISE position. Electronic control module (A1) input (D1) LED check. Is

raise input (D1) LED ON?

Yes: Go to next step.

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)

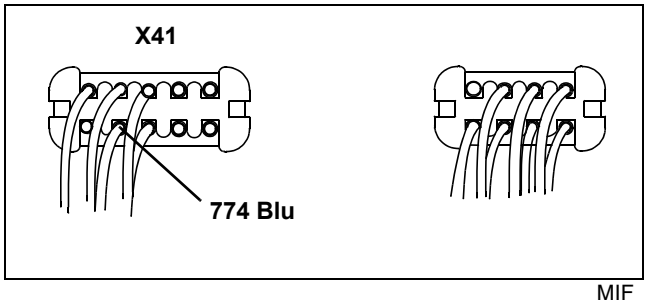


MX20489

6. Move raise-lower switch (S10) to LOWER position. Measure voltage at raise-lower switch connector, 773 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test raise-lower switch. (See “Raise-Lower Switch Test” on page 254.)

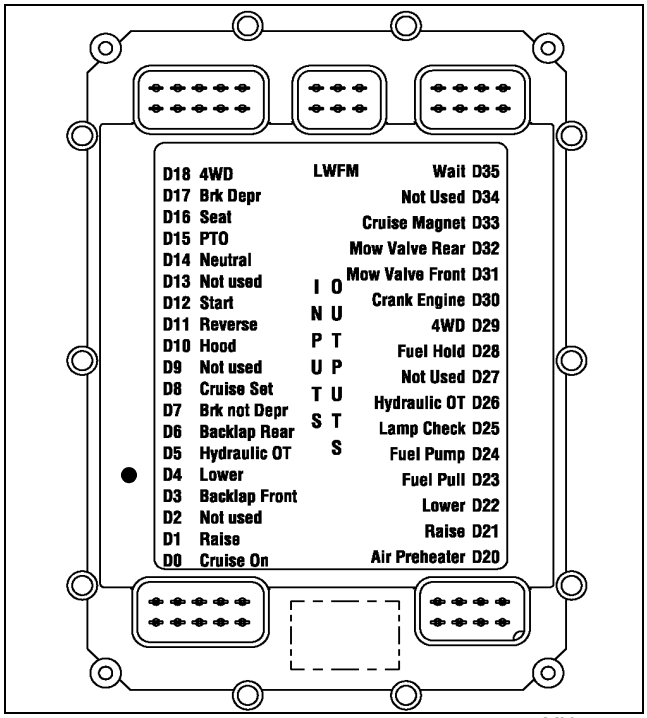


MIF

7. With the raise-lower switch (S10) in the LOWER position, measure voltage at electronic control module connector (X41), terminal G, 774 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 773 and 774 Blu wires and connections.



MX24569

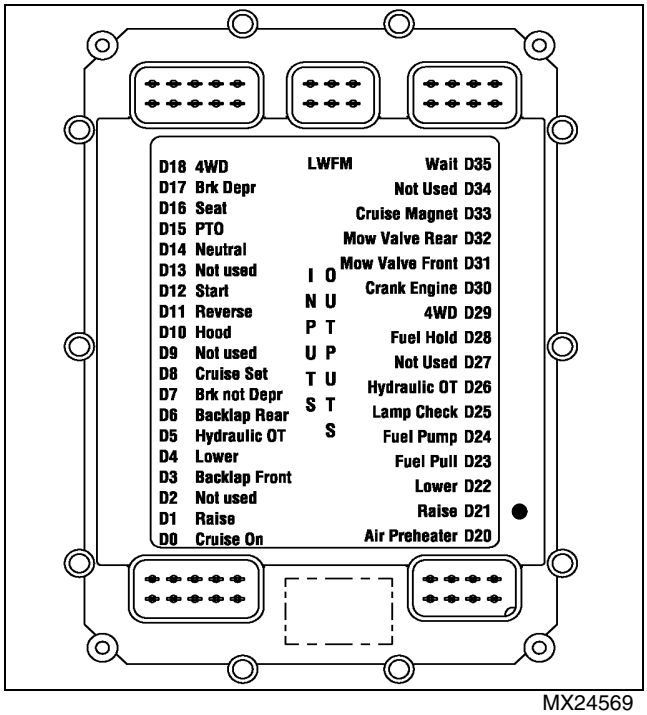
8. Raise-lower switch (S10) in the LOWER position. Electronic control module (A1) input LED check. Is lower input (D4) LED ON?

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)

Raise Solenoid Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX24569

1. Hold raise-lower switch (S10) in the RAISE position. Electronic control module (A1) output LED check. Is raise output (D21) LED ON?

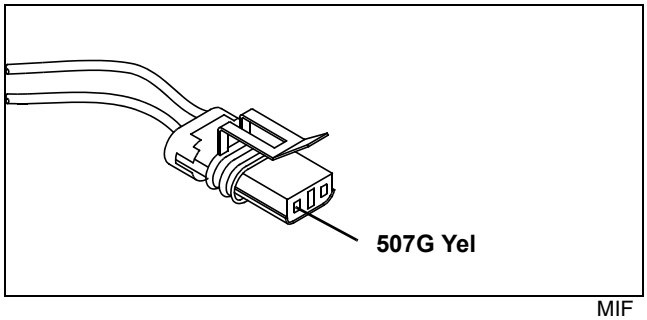
Yes: Go to next step.

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)

2. Mow-transport switch (S2) in MOW position. Move raise-lower switch (S10) to RAISE position and release to MIDDLE position. Electronic control module (A1) output LED check. Is raise output (D21) LED ON for approximately 3 seconds?

Yes: Go to next step.

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)

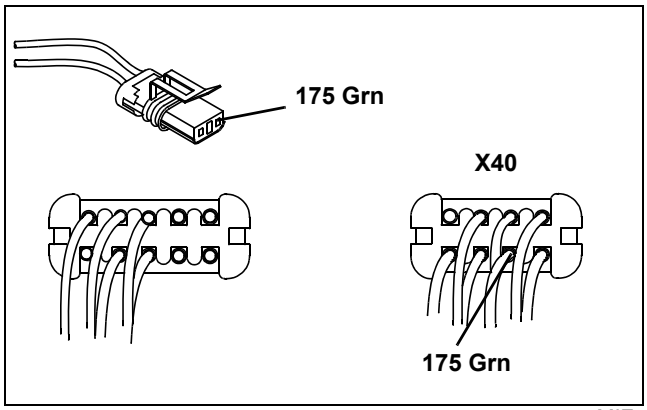


MIF

3. Mow-transport switch (S2) in TRANSPORT position. Hold raise-lower switch (S10) in RAISE position. Measure voltage at raise solenoid (Y8), 507G Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507G, 507A, 503, 500B, and 500A Yel wires and connections.



MIF

4. Disconnect electronic control module connector (X40). Measure resistance between electronic control module connector (X40), terminal G, 175 Grn wire and raise solenoid (Y8), 175 Grn wire. Is resistance less than 0.1 ohm?

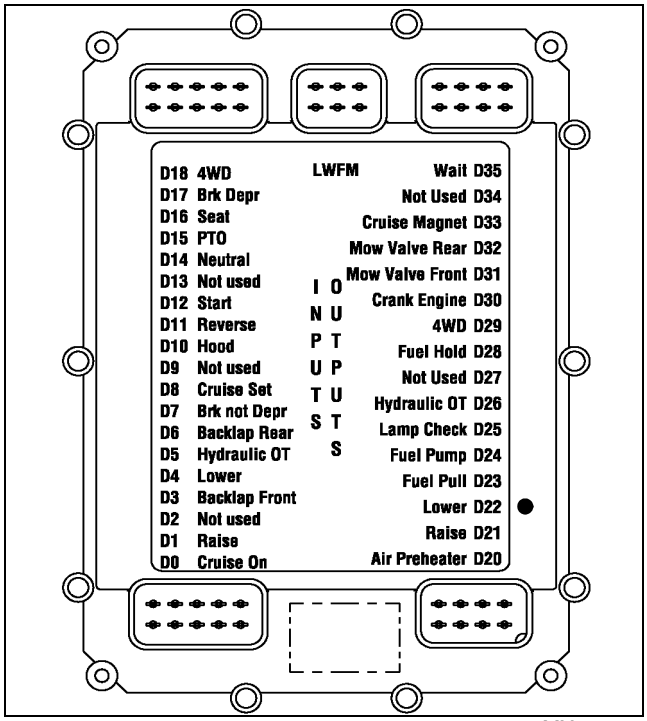
Yes: Test raise solenoid. (See “Raise-Lower Solenoid Test” on page 259.)

No: Test 175 Grn wire and connections.

Lower Solenoid Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

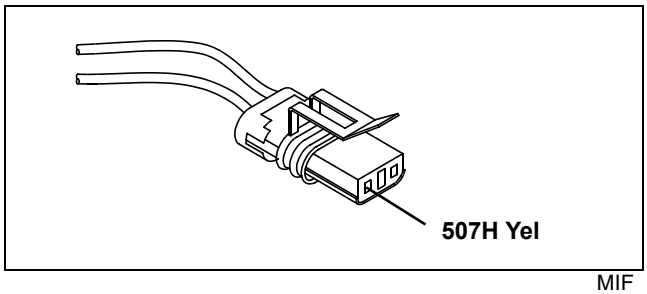


MX24569

1. Move raise-lower switch (S10) to LOWER position and release to MIDDLE position. Electronic control module (A1) output LED check. Is lower output (D22) LED ON?

Yes: Go to next step.

No: Test 507H, 507A, 503, 500B, and 500A Yel wires and connections.

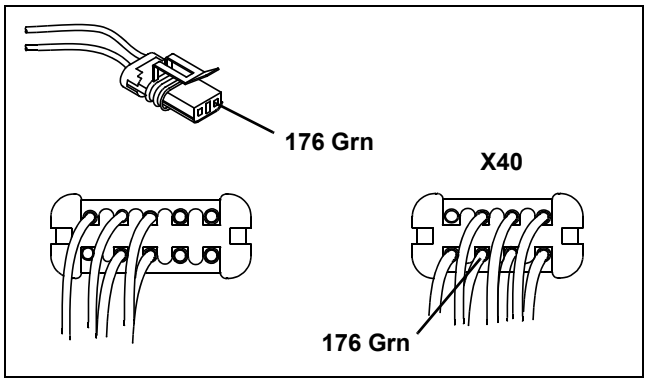


MIF

2. Measure voltage at lower solenoid (Y2), 507H Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)



MIF

3. Disconnect electronic control module connector (X40). Measure electronic control module (A1) connector (X40), terminal F, 176 Grn wire and lower solenoid (Y2), 176 Grn wire. Is resistance less than 0.1 ohm?

Yes: Test lower solenoid. (See “Raise-Lower Solenoid Test” on page 259.)

No: Test 176 Grn wire and connections.

Air Preheater Circuit Operation

Function

To provide power to the air preheater (R1) and to automatically turn it on and off as needed.

Operating Conditions

- Key switch in RUN position.

Theory of Operation

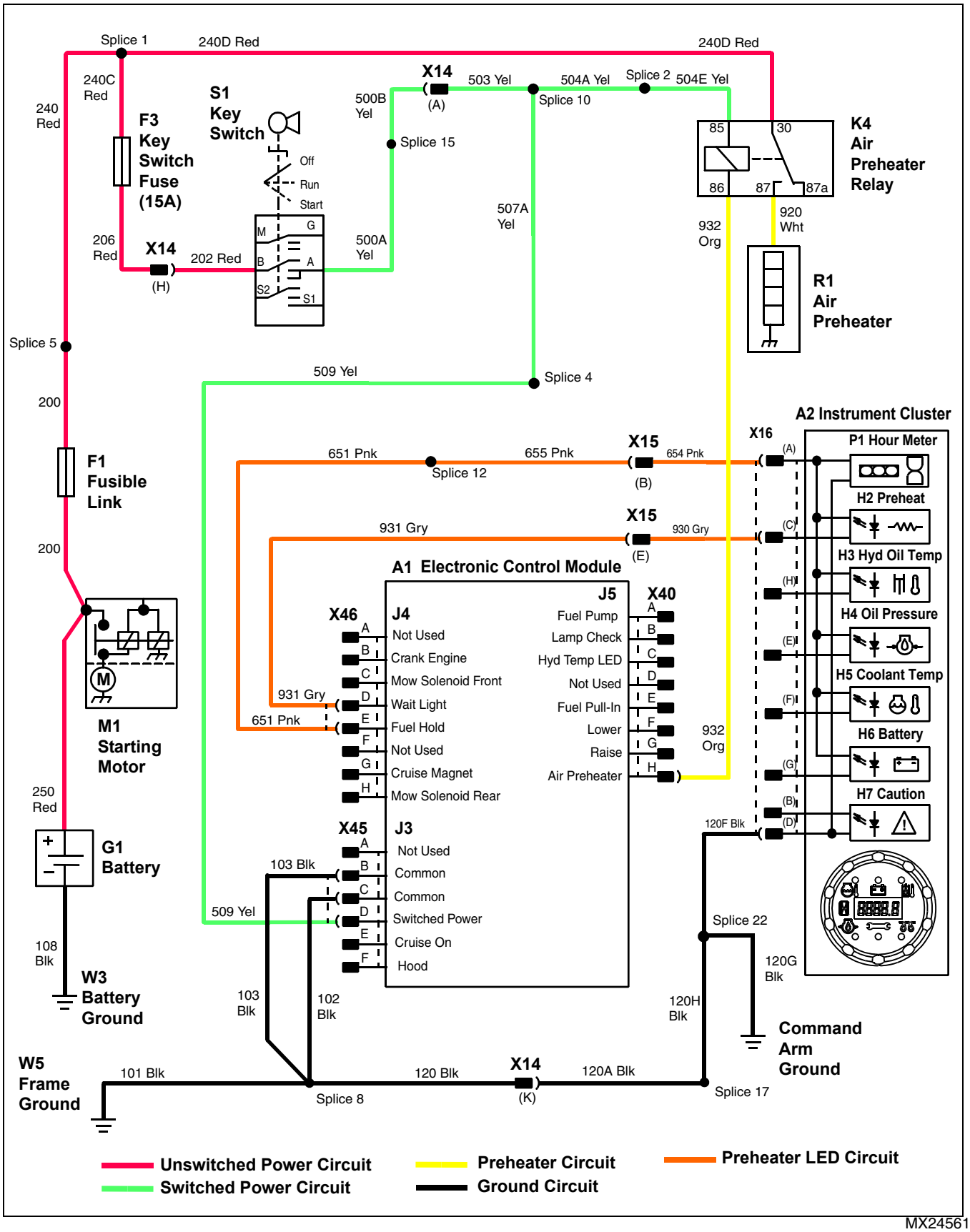
Unswitched power is provided to the air preheater relay (K4), terminal 30, 240D and 240 Red wires and 200 fusible link (F1).

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, 503, 504A, and 504E Yel wires to the air preheater relay (K4), terminal 85.

With the key switch in the RUN position, the electronic control module connector (X40), terminal H, 932 Org wire, provides a ground circuit for the air preheater relay (K4), terminal 86, 932 Org wire, and energizes the relay.

With the air preheater relay energized, current flows from the relay to the air preheater (R1), 920 Wht wire. The air preheater has an internal ground to the engine that allows current to flow through the air preheater, causing it to heat the air as it enters the engine. After approximately 5 seconds, electronic control module (A1) automatically turns OFF the air preheater circuit.

Air Preheater Circuit Schematic



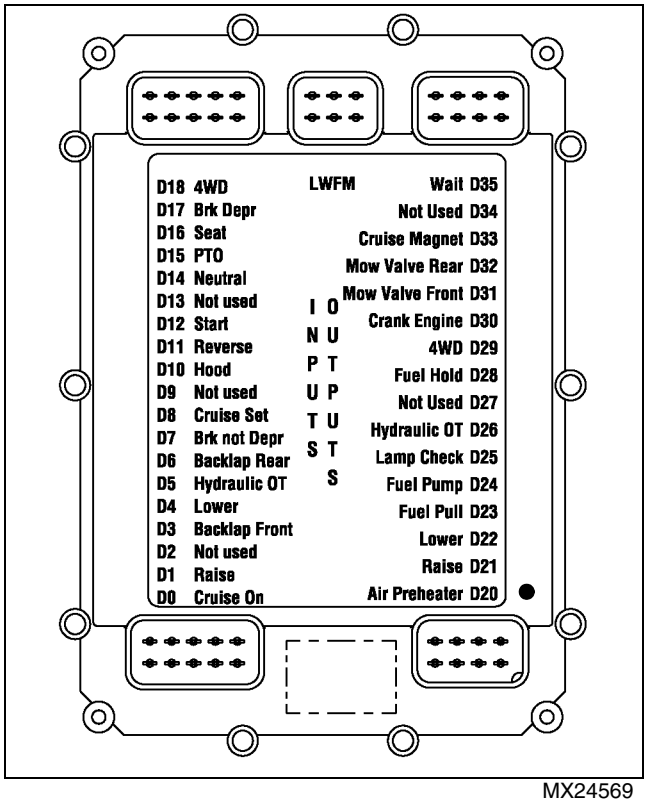
MX24561

System: Air Preheater Circuit Diagnosis

Air Preheater Circuit

Test Conditions

- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

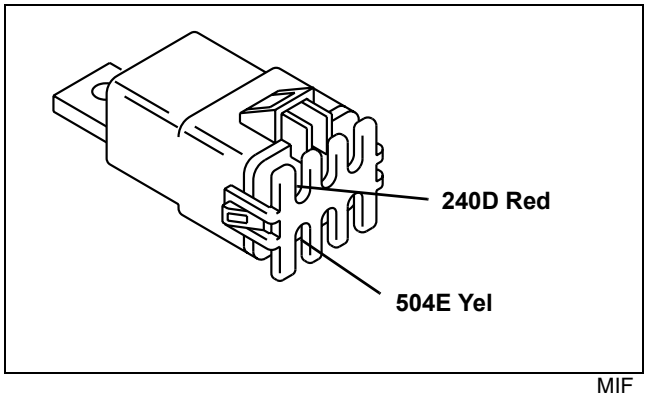


MX24569

1. Cycle key switch (S1) between OFF and RUN positions. Electronic control module (A1) output LED check. Is air preheater output (D20) LED ON for approximately 5 seconds?

Yes: Go to next step.

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)



MIF

2. Key switch in RUN position. Measure voltage at air preheater relay (K4), terminal 30, 240D Red wire. Is battery voltage present?

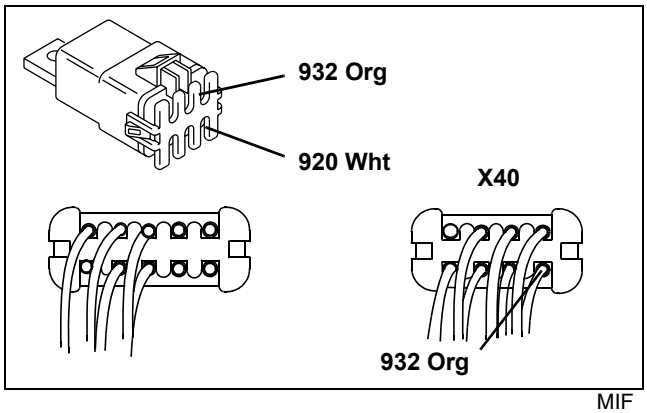
Yes: Go to next step.

No: Test 240D and 240 Red wires and 200 fusible link (F1) and connections.

3. Measure voltage at air preheater relay (K4), terminal 85, 504E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504E, 504A, 503, 500B, and 500A Yel wires and connections.



MIF

4. Disconnect electronic control module (A1) connector (X40). Measure resistance between electronic control module connector (X40), terminal H, 932 Org wire and air preheater relay (K4), terminal 86, 932 Org wire. Is resistance less than 0.1 ohm?

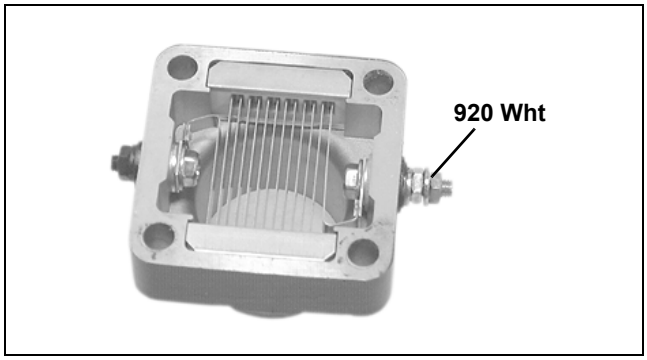
Yes: Go to next step.

No: Test 932 Org wire and connections.

5. Cycle key switch (S1) between OFF and RUN positions. Measure voltage at air preheater relay (K4), terminal 87, 920 Wht wire. Is battery voltage present for approximately 5 seconds?

Yes: Go to next step.

No: Test relay. (See “Electrical Relays Test” on page 256.)



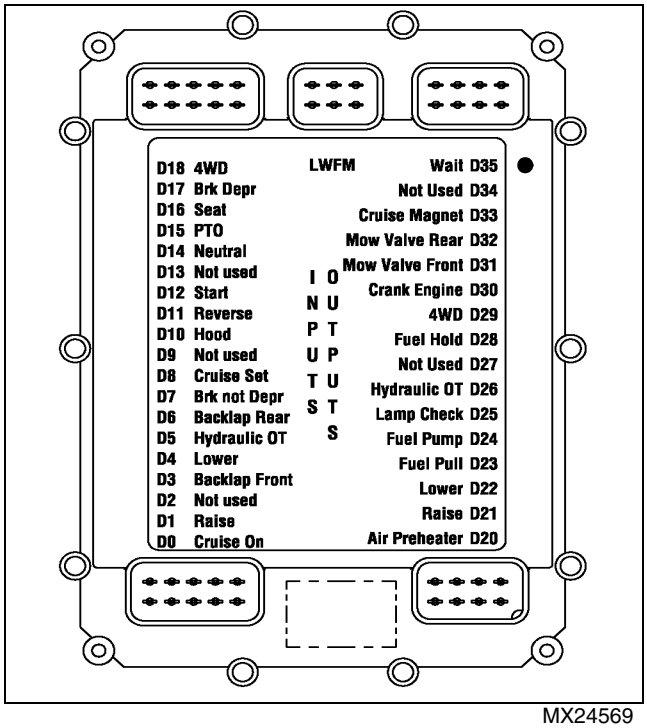
MX2344

6. Cycle key switch (S1) between OFF and RUN positions. Measure voltage at air preheater (R1), 920 Wht wire. Is battery voltage present for approximately 5 seconds?

Yes: Test air preheater. (See “Air Preheater Test” on page 261.)

No: Test 920 Wht wire and connections.

Air Preheater LED Circuit

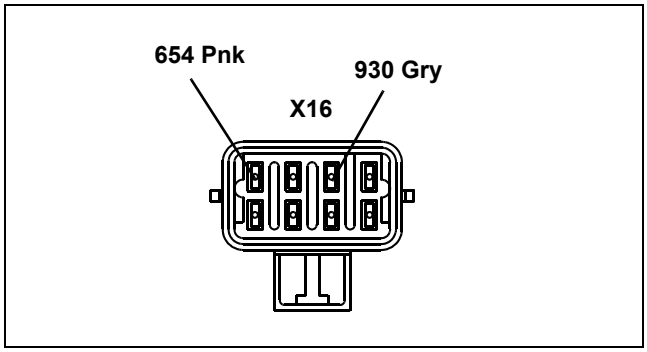


MX24569

1. Cycle key switch (S1) between OFF and RUN positions. Electronic control module (A1) output LED check. Is wait output LED (D35) ON for approximately 5 seconds?

Yes: Go to next step.

No: Test electronic control module. (See “Electronic Control Module Circuit Test” on page 155.)



MX24573

2. Key switch in RUN position. Measure voltage at air preheater LED (H2), connector (X16) terminal A, 654 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 654, 655, and 651 Pnk wires and connections.

3. Disconnect electronic control module (A1) connector (X46). Measure resistance between electronic control module connector (X46), terminal D, 931 Gry wire and air preheater LED (H2), connector (X16), terminal C, 930 Gry wire. Is resistance less than 0.1 ohm?

Yes: Check air preheater LED connections and, if good, replace instrument cluster.

No: Test 931 and 930 Gry wire and connections.

Engine Oil Pressure and Hour Meter Circuit

Function

Engine oil pressure - To warn the operator if the engine oil pressure drops below the safe operation level.

Hour meter - To energize the hour meter when the key switch is turned on, indicating total machine operating time.

Operating Conditions

- Key switch in RUN position.

Theory of Operation

Engine Oil Pressure Circuit

When the key switch (S1) is in RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A Yel wire to the following:

- Buzzer (H1), 500C Yel wire.
- Engine oil pressure LED (H4), 620D Tan wire.

When the engine oil pressure is below operating pressure, the engine oil pressure switch (B2) closes. With the engine oil pressure switch closed:

- Current flows from the engine oil pressure LED (H4) to the engine oil pressure switch (B2), 620D, 620A, and 620 Tan wires. The engine oil pressure switch allows the current to flow to ground, causing the engine oil pressure LED to come on.
- Current flows from the buzzer (H1) to diode pack (V4), 627 Gry wire. From the diode pack, current flows to the engine oil pressure switch (B2), 620B, 620A, and 620 Tan wires. The engine oil pressure switch allows the current to flow to ground, causing the buzzer to come on.

When the engine oil pressure is at operating pressure (engine running), the engine oil pressure switch (B2) opens. With the engine oil pressure switch open:

- Current flows from the engine oil pressure LED (H4) on 620D, 620A, and 620 Tan wires.

Hour Meter Circuit

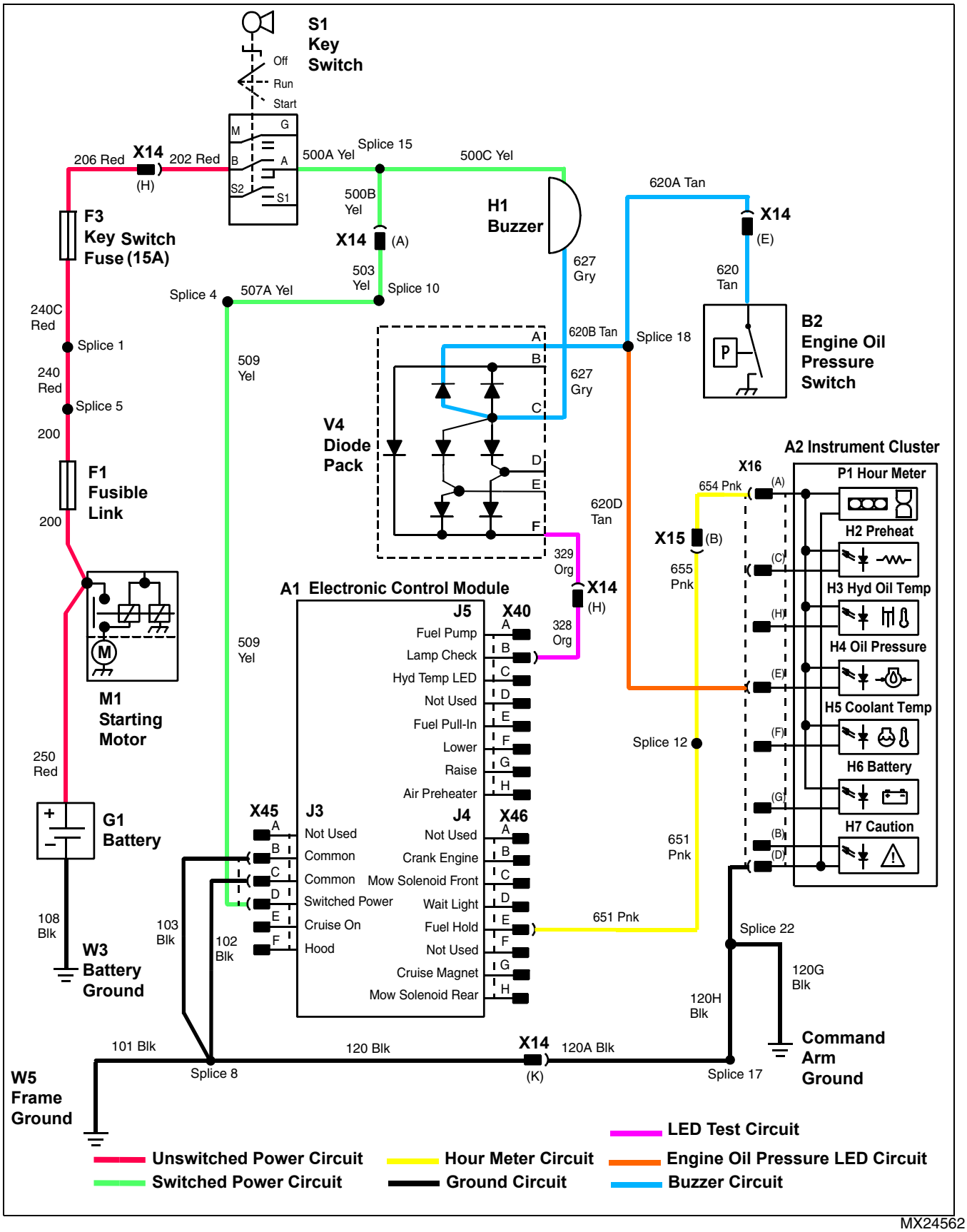
When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, 503, 507A, and 509 Yel wires to the electronic control module connector (X45), terminal D, 509 Yel wire, powering up the electronic control module. The electronic control module continues to operate until the key switch is turned to the OFF position.

Current flows to the instrument cluster (A2) through the following:

- Electronic control module connector (X46), terminal E.
- 651, 655, and 654 Pnk wires.
- Instrument cluster (A2) connector (X16), terminal A.

The hour meter is supplied a ground through the following wires: 120F and 120G Blk wires that causes the hour meter to operate.

Engine Oil Pressure and Hour Meter Circuit Schematic



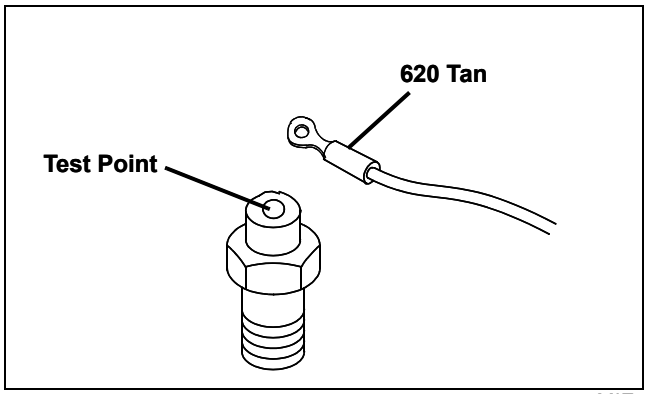
MX24562

System: Engine Oil Pressure and Hour Meter Circuit Diagnosis

Engine Oil Pressure Switch Circuit

Test Conditions

- Key switch in OFF position.
- Disconnect 620 Tan wire from engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure ground circuit for continuity at engine oil pressure switch (B2) terminal. Is there continuity?

Yes: Go to next step.

No: Test oil pressure switch. (See “Engine Oil Pressure Switch Test” on page 255.)

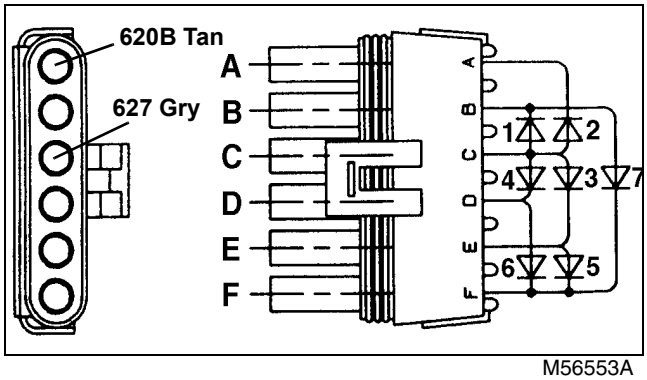
2. Key switch in RUN position, engine OPERATING. Measure ground circuit for continuity at engine oil pressure switch (B2) terminal. Is there continuity?

Yes: Test oil pressure switch. (See “Engine Oil Pressure Switch Test” on page 255.)

Engine Oil Pressure Buzzer Circuit

Test Conditions

- Key switch in OFF position.
- Connect 620 Tan wire to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



M56553A

1. Measure ground circuit for continuity at diode pack (V4), 620B Tan wire. Is there continuity?

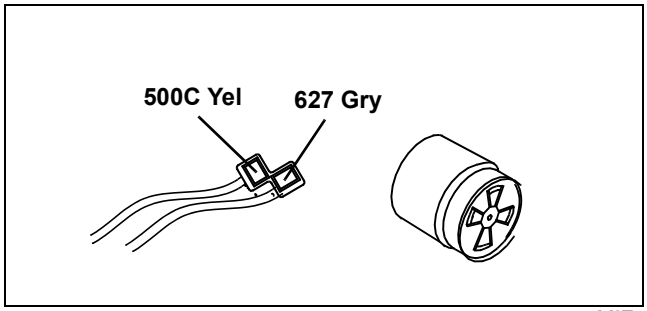
Yes: Go to next step.

No: Test 620B, 620A, and 620 Tan wires and connections.

2. Set meter to diode test. Measure forward voltage drop at diode pack (V4), 627 Gry wire. Is voltage in the range of 0.7-0.5 volt?

Yes: Go to next step.

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 242.)



MIF

3. Measure forward voltage drop at buzzer (H1), 627 Gry wire. Is voltage in the range of 0.7-0.5 volt?

Yes: Go to next step.

No: Test 627 Gry wire and connections.

4. Key switch in RUN position. Set meter to measure voltage. Measure voltage at buzzer (H1), 500C Yel wire. Is battery voltage present?

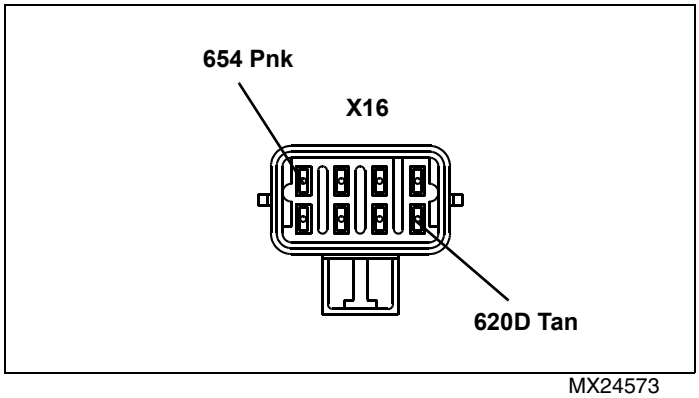
Yes: Replace buzzer.

No: Test 500C and 500A Yel wires and connections.

Engine Oil Pressure LED Circuit

Test Conditions

- Key switch in OFF position.
- Connect 620 Tan wire to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX24573

1. Measure ground circuit for resistance at instrument cluster (A2) connector (X16), terminal E, 620D Tan wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 620D, 620A, and 620 Tan wires and connections.

2. Key switch in RUN position. Measure voltage at instrument cluster (A2), 654 Pnk wire. Is battery voltage present?

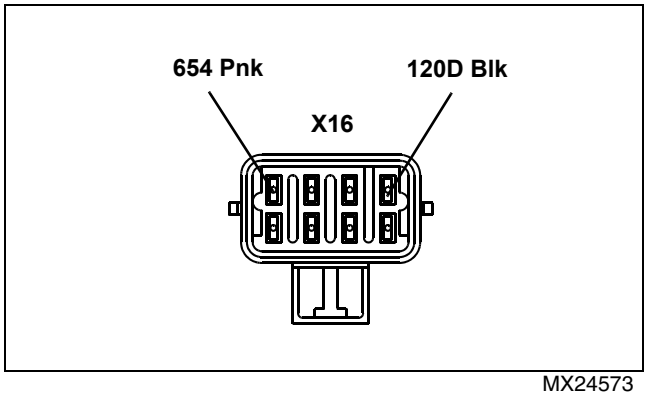
Yes: Test engine oil pressure LED (H4) and replace instrument cluster.

No: Test 654, 655, and 651 Pnk wires and connections.

Hour Meter Circuit

Test Conditions

- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX24573

1. Measure ground circuit for resistance at hour meter (P1), connector (X16), terminal D, 120F Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 120F and 120G Blk wires and connections.

2. Key switch in RUN position with engine OPERATING. Measure voltage at hour meter (P1), connector (X16), terminal A, 654 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 654, 655, and 651 Pnk wires and connections.

3. Key switch in RUN position with engine OPERATING. Hour meter LCD display check. Does hour meter increment after 10 minutes?

No: Replace instrument cluster.

Engine Coolant Temperature LED Circuit Operation

Function

To warn the operator if the engine coolant temperature exceeds the safe operating level.

Operating Conditions

- Key switch in RUN position, engine OFF.

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A Yel wire to the following:

- Buzzer (H1), 500C Yel wire.
- Electronic control module (A1), 500B, 503, 507A, and 509 Yel wires.

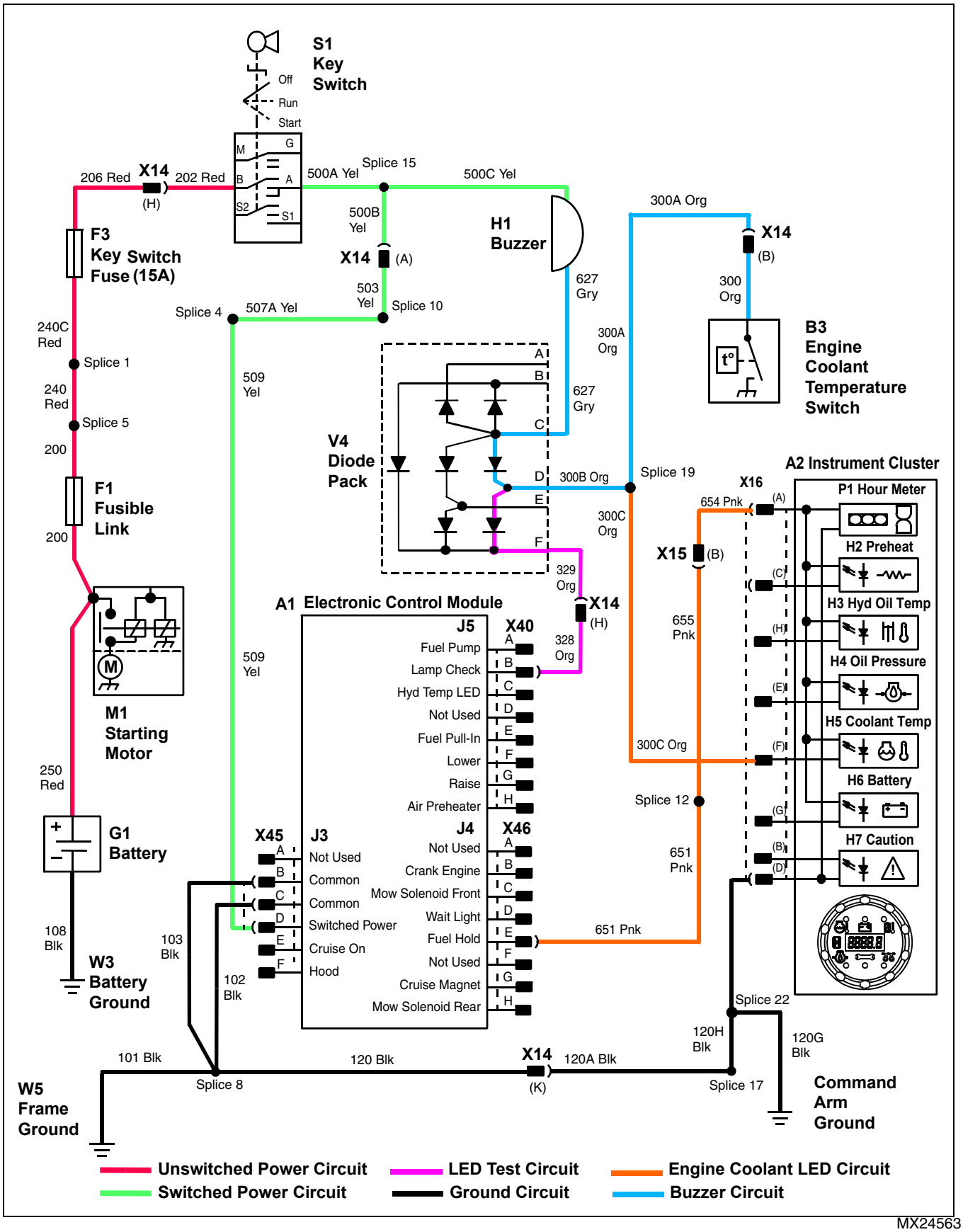
When the coolant temperature exceeds the safe operating level, the engine coolant temperature switch (B3) closes and completes the circuit to ground, 300, 300A, and 300C Org wires, causing the coolant temperature LED to come on. The coolant temperature switch also completes the buzzer (H1) ground circuit, 300B, 300A, and 300 Org wires and 627 Gry wire, causing the buzzer to come on. Diode pack (V4) is used to isolate the coolant temperature LED from other circuits that turn on the buzzer.

When the key switch is moved from the OFF to the RUN position, the electronic control module provides a controlled ground to electronic control module connector (X40), terminal B, for approximately 5 seconds. When this happens, current flows for approximately 5 seconds through:

- Engine coolant temperature LED (H5), 300C and 300B Org wires.
- Diode pack (V4), terminal D, 300B Org wire.
- Diode pack (V4), terminal F, 329 Org wire.
- 329 and 328 Org wires.

This completes the circuit for the buzzer and coolant temperature LEDs to turn them on. This serves as a way to check the operation of the buzzer and coolant temperature LEDs.

Engine Coolant LED Circuit Schematic



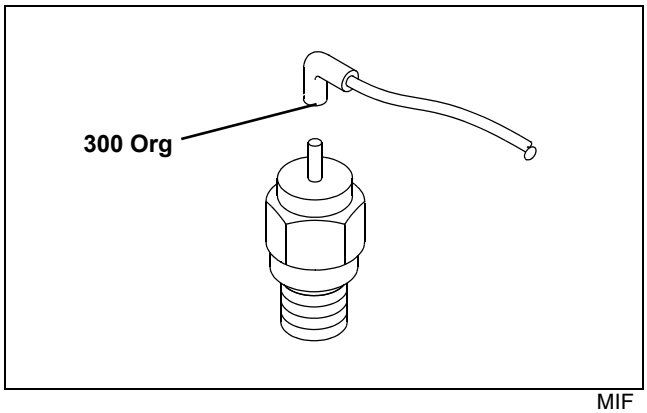
MX24563

Engine Coolant Temperature Circuit Diagnosis

Engine Coolant Temperature Switch

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Engine coolant temperature switch 300 Org wire disconnected.
- Engine at normal operating temperature.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

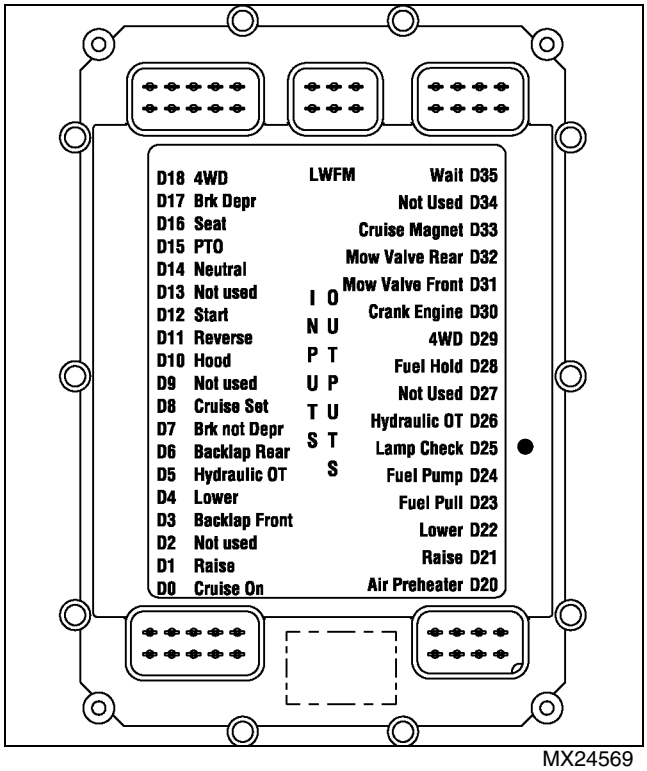
1. Measure ground circuit for resistance at engine coolant temperature terminal. Is there less than 0.1 ohm of resistance?

   Yes: Test temperature switch. (See “Engine Coolant Temperature Switch Test” on page 256.)

Engine Coolant Temperature LED Circuit

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Key switch in RUN position.
- Diode pack disconnected.
- Electronic control module connector (X40) disconnected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

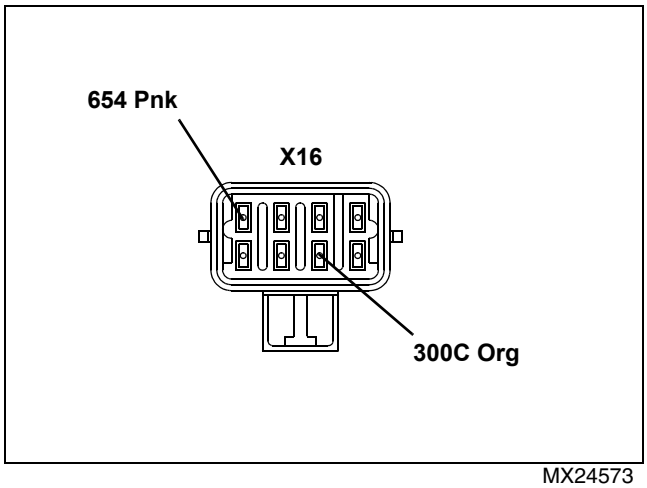


MX24569

1. Cycle key switch between OFF and RUN positions. Electronic control module (A1) output LED check. Is electronic control module lamp check output (D25) LED ON for approximately 5 seconds?

   Yes: Go to next step.

   No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)



MX24573

2. Measure voltage at instrument cluster (A2), 654 Pnk wire. Is battery voltage present?

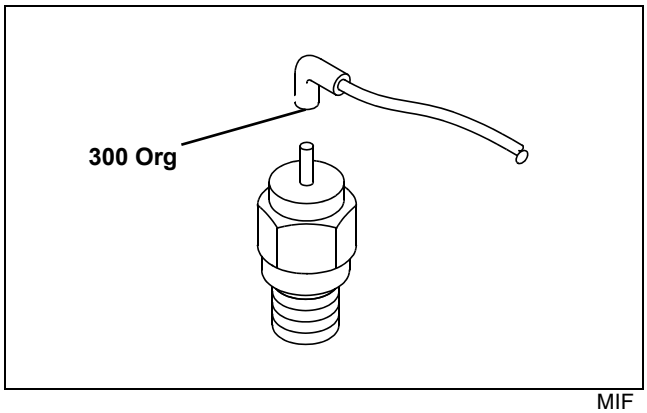
   Yes: Go to next step.

   No: Test 654, 655, and 651 Pnk wires and connections.

3. Measure voltage at instrument cluster (A2), terminal F, 300C Org wire. Is battery voltage present?

Yes: Go to next step.

No: Replace instrument cluster.

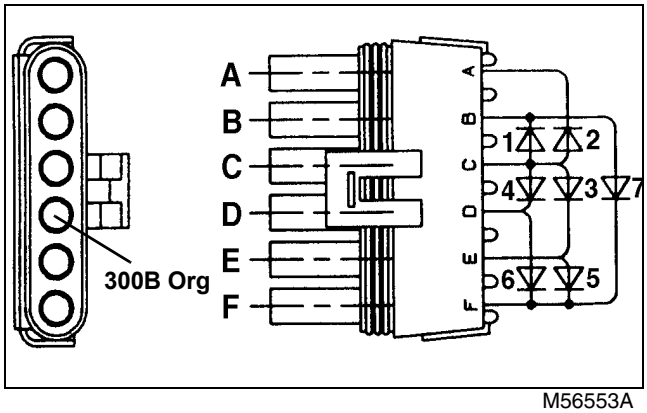


MIF

4. Measure voltage at engine coolant temperature switch (B3), connector (X53), 300 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300, 300A, and 300C Org wires.



M56553A

5. Measure voltage at diode pack connector (X12), terminal D, 300B Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300B and 300C Org wires.

6. Measure continuity between diode pack connector (X12), terminal F, 329 Org wire and electronic control module connector (X40), terminal B, 328 Org wire. Is there continuity?

Yes: Go to next step.

No: Test 328 and 329 Org wires and connections.

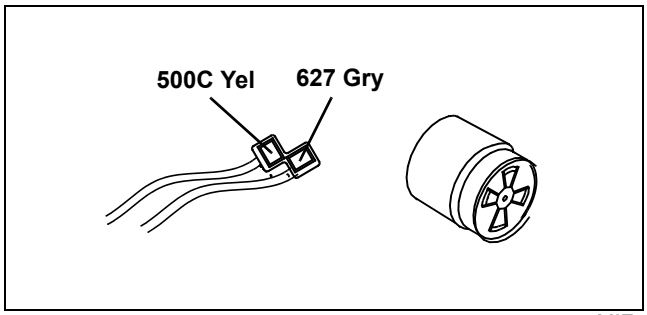
7. Diode pack connected. Electronic control module connector (X40) connected. Cycle key switch between OFF and RUN positions.Instrument cluster (A2) LED check. Is engine coolant temperature LED ON for approximately 5 seconds?

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 242.)

Buzzer Circuit

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Electronic control module connector (X40) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at buzzer (H1), 500C Yel wire. Is battery voltage present?

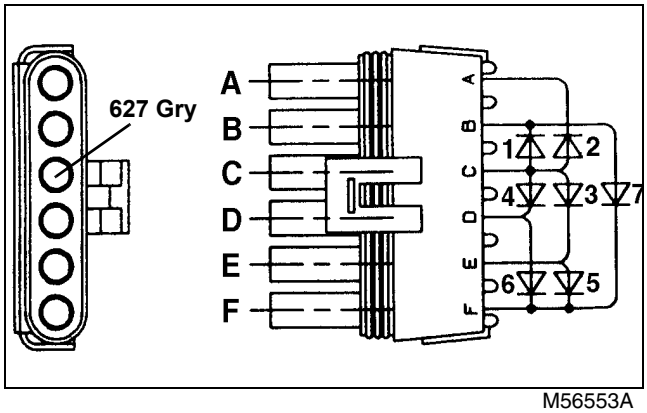
Yes: Go to next step.

No: Test 500C and 500A Yel wires and connections.

2. Measure voltage at buzzer (H1), 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Replace buzzer.



M56553A

3. Measure voltage at diode pack connector (X12), terminal C, 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test 627 Gry wire.

4. With a jumper wire, connect diode pack connector (X12), terminal C, to ground. Buzzer (H1) check. Is buzzer operating?

Yes: Go to next step.

No: Replace buzzer.

5. Diode pack connected. Buzzer (H1) check. Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 242.)

Hydraulic Filter Restriction LED Circuit Operation

Function

To warn the operator that the hydraulic filter needs service.

Operating Conditions

- Key switch in RUN position.

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A, 500B, 503, and 504A Yel wires to the following:

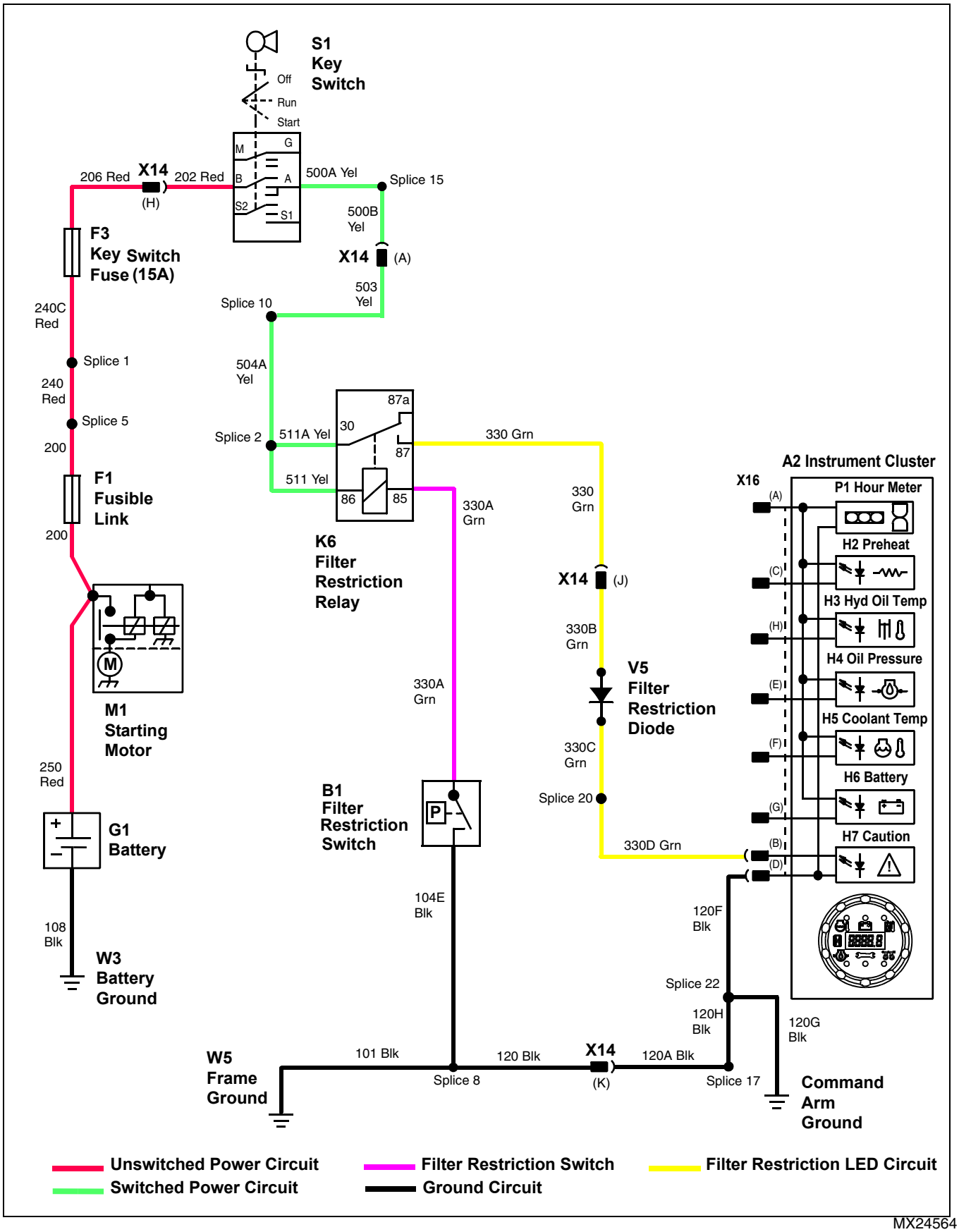
- Hydraulic filter restriction relay (K6), terminal 86, 511 Yel wire.
- Hydraulic filter restriction relay (K6), terminal 30, 511A Yel wire.

When the hydraulic oil pressure reaches 276 ± 28 kPa (40 ± 4 psi), the hydraulic filter restriction switch (B1) closes, completing the ground circuit for the hydraulic filter restriction relay, through 330A Grn wire, 104E and 101 Blk wires. The hydraulic filter restriction relay is energized, closing the relay when the hydraulic filter restriction switch is closed. The hydraulic filter restriction relay closes, allowing battery voltage to flow to the caution LED. The hydraulic filter restriction relay closes allowing current to flow through 330, 330B, 330C, and 330D Grn wires to caution LED (H7), terminal B, turning it on. The hydraulic filter restriction diode (V5) is used to isolate the caution LED from other circuits that turn on the instrument cluster.

The hydraulic filter restriction switch will not open until hydraulic oil pressure drops to 207 kPa (30 psi).

The ground circuit for the caution LED is as follows: 120F and 120G Blk wires. This completes the circuit for the hydraulic filter restriction LED to turn ON.

Hydraulic Filter Restriction LED Circuit Schematic



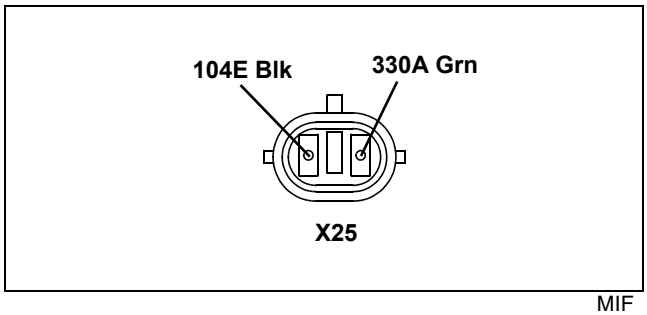
MX24564

System: Hydraulic Filter Restriction Circuit Diagnosis

Hydraulic Filter Restriction Switch

Test Conditions

- Hydraulic filter restriction switch connector disconnected.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure continuity between hydraulic filter restriction switch connector (X25), terminals 104E Blk wire and ground. Is there continuity?

Yes: Test hydraulic filter restriction switch. (See “Hydraulic Filter Restriction Switch Test” on page 260.)

No: Test 104E and 101 Blk wires and connectors.

No: Go to next step.

2. Key switch (S1) in RUN position. Measure voltage at hydraulic filter restriction switch connector (X25), 330A Grn wire. Is there battery voltage?

Yes: Go to next step.

No: Test 330A Grn wire and connectors.

3. Disconnect connector (X25) at hydraulic filter switch. Jumper between 330A Grn and 104E Blk wires on connector (X25). Does hydraulic filter restriction relay close?

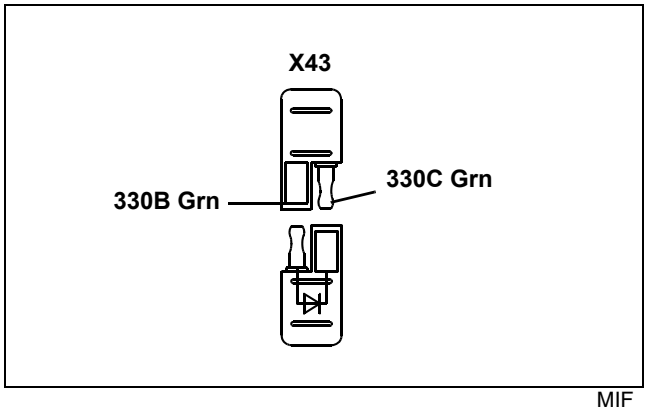
Yes: Test complete.

No: Test hydraulic filter relay. (See “Electrical Relays Test” on page 256.)

Hydraulic Filter Restriction LED Circuit

Test Conditions

- f Hydraulic filter restriction switch connector disconnected and a jumper between 330A Grn wire and 104E Blk wire.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at hydraulic filter restriction diode (V5) connector (X43), terminal B, 330B Grn wire. Is battery voltage present?

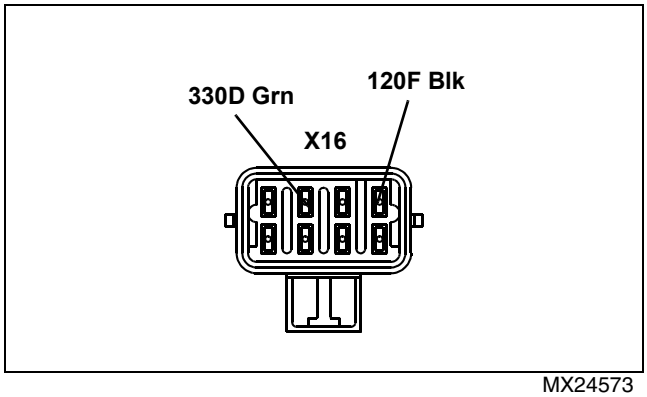
Yes: Go to next step.

No: Test 330B and 330 Grn wires and connections.

2. Measure voltage at hydraulic filter restriction diode (V5) connector (X43), terminal A, 330C Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 330D and 330C Grn wires.



MX24573

3. Measure voltage at Caution LED (H7), connector (X16), terminal B, 330D Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test diode. (See “Diode Test” on page 258.)

4. Measure voltage at connector (X16), terminal D, 120F Blk wire. Is there less than 0.7 volt?

Yes: Replace instrument cluster (A2).

No: Test 120F and 120G Blk wires and connections.

Hydraulic Oil Temperature LED Circuit Operation

Function

To warn the operator if the hydraulic oil temperature exceeds the safe operating point.

Operating Conditions

- Key switch in RUN position, engine OFF.

Theory of Operation

When the key switch (S1) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch terminal A through 500A Yel wire to the following:

- Buzzer (H1), 500C Yel wire.
- Hydraulic oil temperature switch (B4), 500B, 503, and 512 Yel wires.
- Electronic control module (A1), 500B, 503, 507A, and 509 Yel wires.

The electronic control module (A1), connector (X41) terminal C, receives input voltage from the hydraulic oil temperature switch (B4), 334 Org wire. When the hydraulic oil temperature rises above set temperature, the hydraulic oil temperature switch closes.

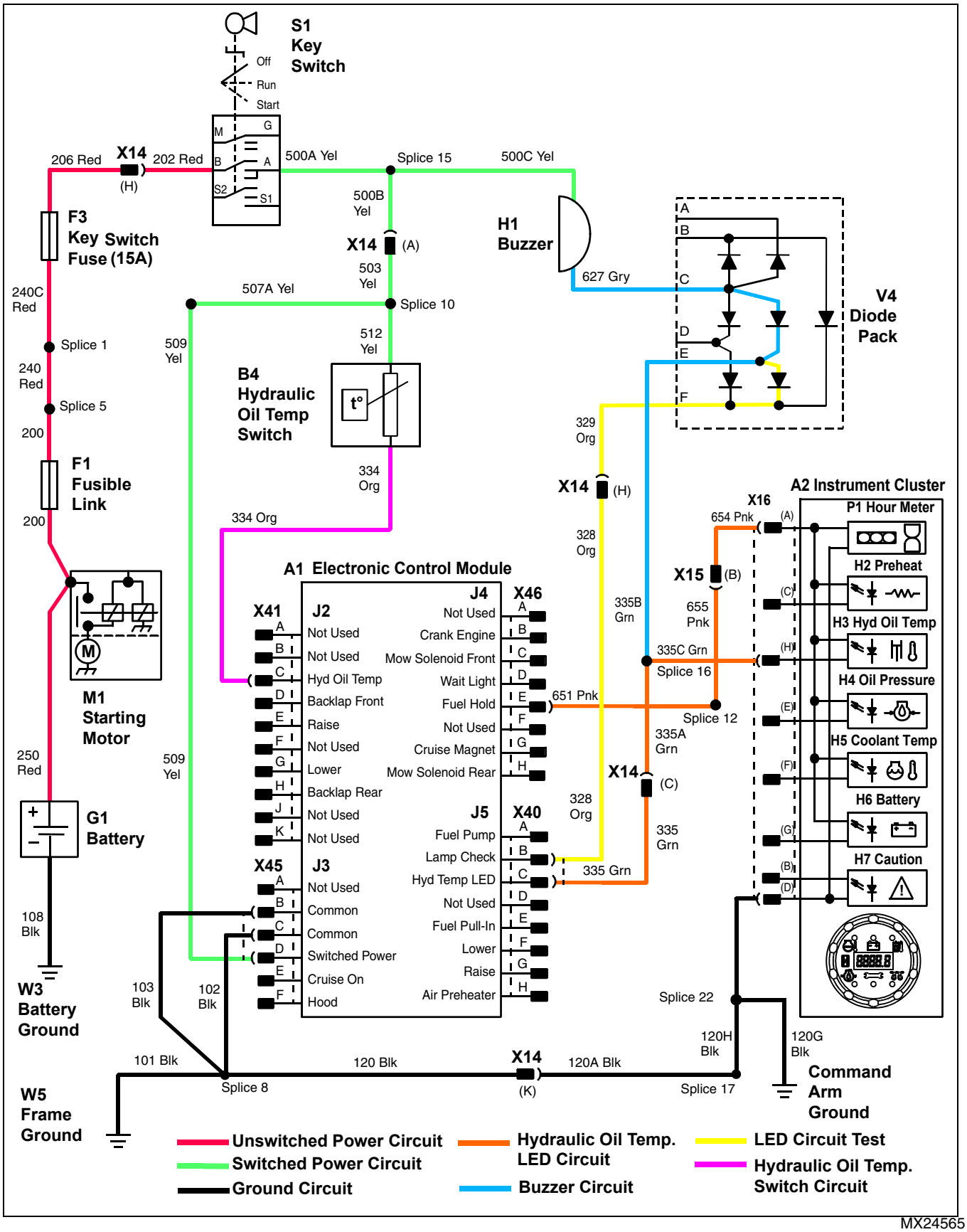
When the hydraulic oil temperature switch (B4) is closed, the electronic control module senses this and completes a circuit to controlled ground. The electronic control module supplies a control ground to the hydraulic oil temperature LED though 335, 335A, and 335C Grn wires, causing the hydraulic oil temperature (H2), LED to turn ON. The electronic control module also completes the buzzer (H1) ground circuit, 335, 335A, and 335B Grn wires, diode pack (V4), and 627 Gry wire, causing the buzzer to come ON. Diode pack (V4) is used to isolate the hydraulic oil temperature LED from other circuits that turn on the buzzer.

When the key switch is moved from the OFF to the RUN position, the electronic control module provides a controlled ground to electronic control module connector (X40), terminal B, for approximately 5 seconds. When this happens, current flows for approximately 5 seconds through the following:

- Buzzer (H1), 627 Gry wire.
- Diode pack (V4), terminal C, 627 Gry wire.
- Hydraulic oil temperature LED (H3), 335C and 335B Grn wires.
- Diode pack (V4), terminal E, 335B Grn wire.
- Diode pack (V4), terminal F, 329 Org wire.
- 329 and 328 Org wires.

This completes the circuit for the buzzer and hydraulic oil temperature LED. This serves as a way to check the operation of the buzzer and hydraulic oil temperature LED.

Hydraulic Oil Temperature LED Circuit Schematic



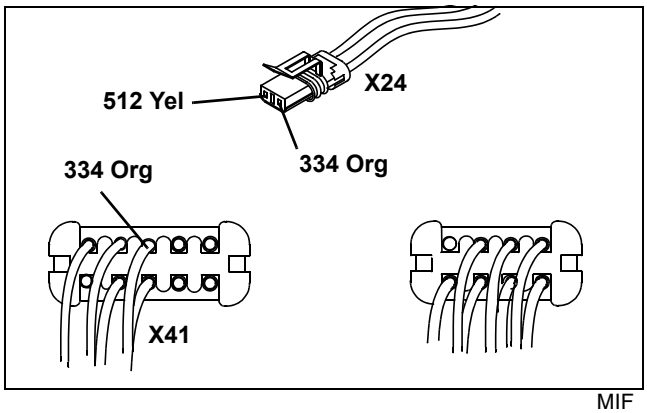
MX24565

System: Hydraulic Oil Temperature Circuit Diagnosis

Hydraulic Oil Temperature Switch Circuit

Test Conditions

- Key switch in RUN position.
- Disconnect electronic control module connector (X41).
- Disconnect hydraulic oil temperature switch connector (X24).
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at hydraulic oil temperature sensor connector (X24), 512 Yel wire. Is battery voltage present?

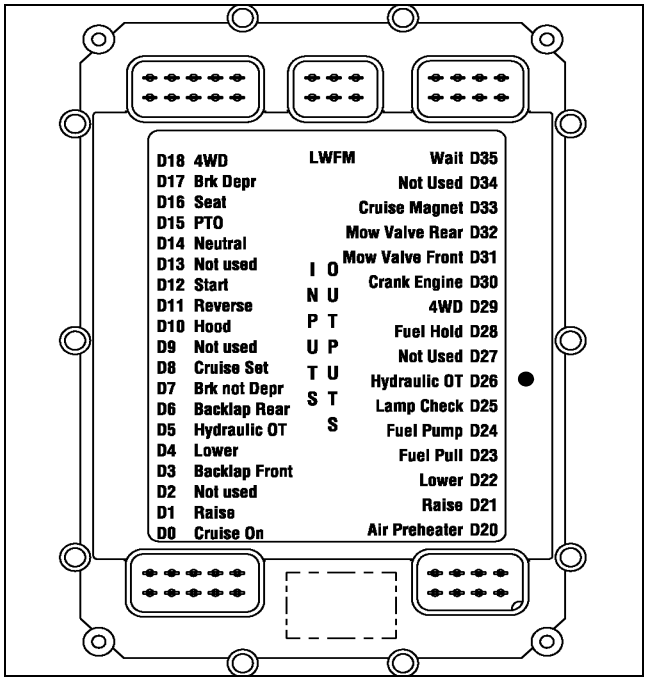
Yes: Go to next step.

No: Test 512, 503, 500B, and 500A Yel wires and connections.

2. Measure wire for resistance between electronic control module connector (X41), terminal C, 334 Org wire and hydraulic oil temperature switch (B4), 334 Org wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 334 Org wire and connections.



MX24569

3. Electronic control module connector (X41) connected. Jumper wire connected between hydraulic oil temperature switch connector (X24), terminals 334 Org wire and 512 Yel wire. Electronic control module (A1) output LED check. Is hydraulic oil temperature output (D26) LED ON?

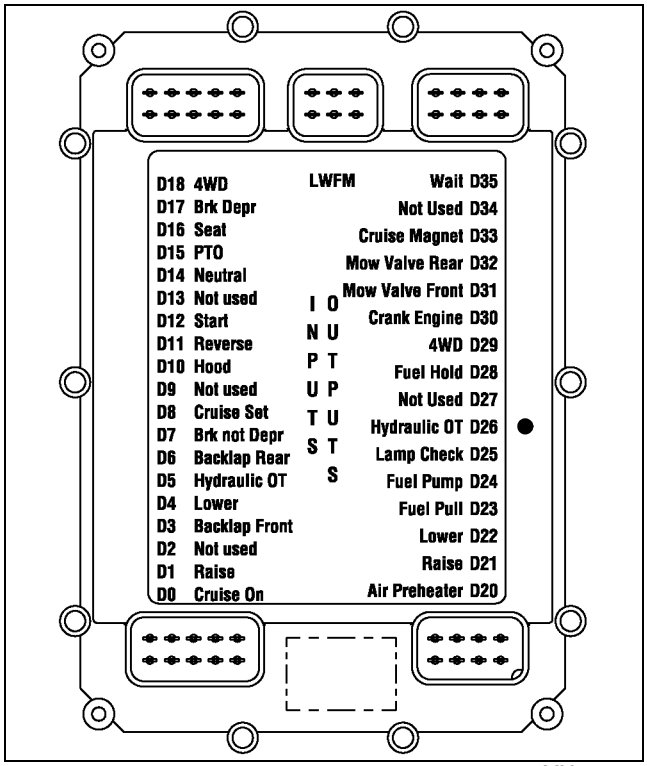
Yes: Test hydraulic oil temperature switch. (See "Hydraulic Oil Temperature Switch" on page 255.)

No: Test electronic control module circuit. (See "Electronic Control Module Circuit Test" on page 155.)

Hydraulic Oil Temperature LED Circuit

Test Conditions

- Key switch in RUN position, engine OFF.
- Electronic control module connector (X40) connected.
- Electronic control module connector (X41) connected.
- Diode pack disconnected.
- Hydraulic oil temperature switch connector (X24) connected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

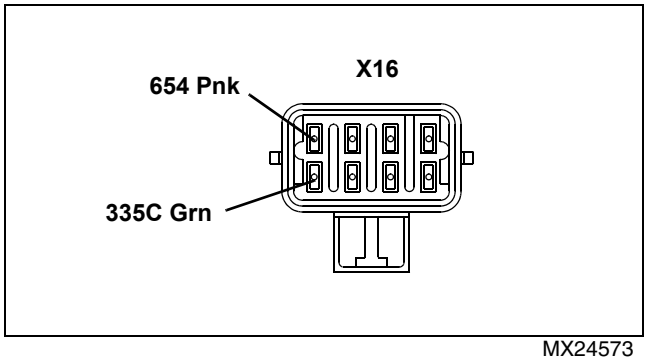


MX24569

1. Cycle key switch between OFF and RUN positions. Electronic control module (A1) output LED check. Is electronic control module hydraulic oil temperature output (D26) LED ON for about 5 seconds?

Yes: Go to next step.

No: Test electronic control module circuit. (See “Electronic Control Module Circuit Test” on page 155.)



MX24573

2. Measure voltage at instrument cluster (A2), connector (X16), terminal A, 654 Pnk wire. Is battery voltage present?

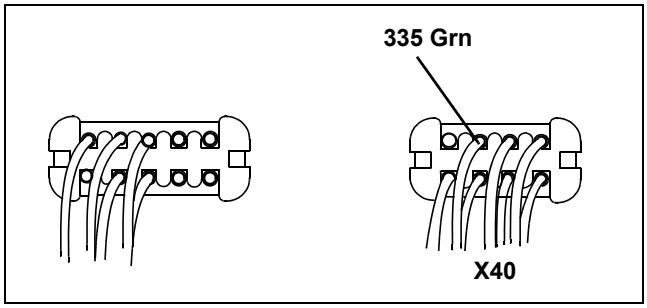
Yes: Go to next step.

No: Test 654, 655, and 651 Pnk wires and connections.

3. Measure voltage at instrument cluster (A2), connector (X16), terminal H, 335C Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test connections. Replace instrument cluster.

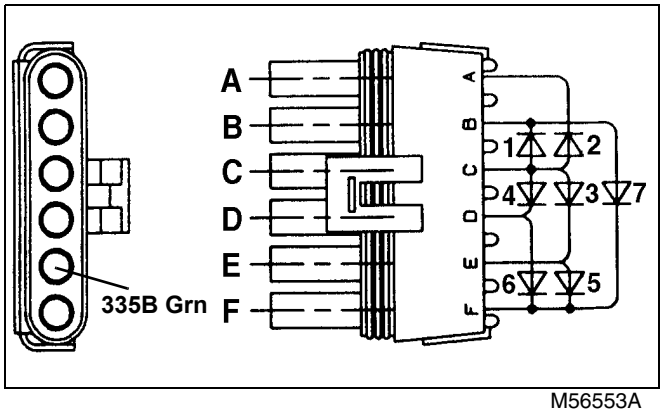


MIF

4. Measure voltage at electronic control module connector (X40), terminal C, 335 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 335, 335A, and 335C Grn wires.

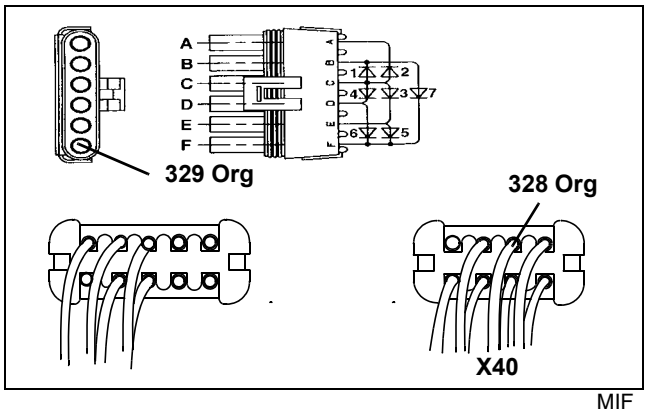


M56553A

5. Measure voltage at diode pack connector (X12), terminal E, 335B Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 335B Grn wire.

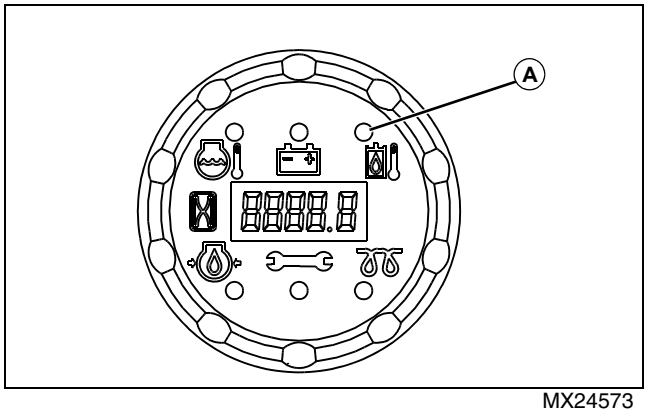


MIF

6. Measure continuity between diode pack connector (X12), terminal F, 329 Org wire and electronic control module connector (X40), terminal B, 328 Org wire. Is there continuity?

Yes: Go to next step.

No: Test 328 and 329 Org wires and connections.



MX24573

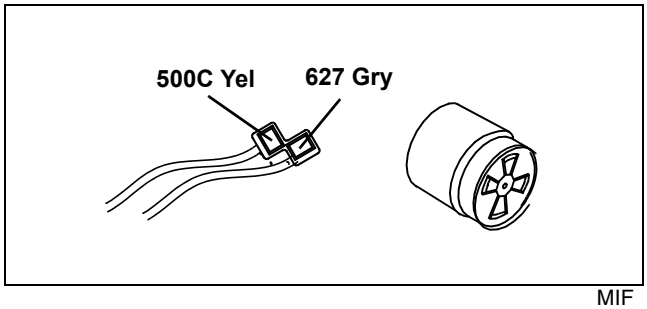
7. Diode pack connected. Electronic control module connector (X40) connected. Cycle key switch between OFF and RUN positions. Instrument cluster (A2) LED test. Is hydraulic oil temperature LED (A) ON for approximately 5 seconds?

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 242.)

Buzzer Circuit

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Electronic control module connector (X40) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Hydraulic oil temperature switch connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at buzzer (H1), 500C Yel wire. Is battery voltage present?

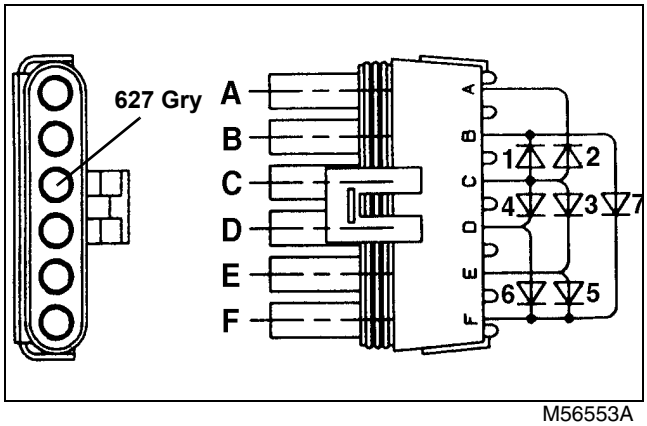
Yes: Go to next step.

No: Test 500C and 500A Yel wires and connections.

2. Measure voltage at buzzer (H1), 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Replace buzzer.

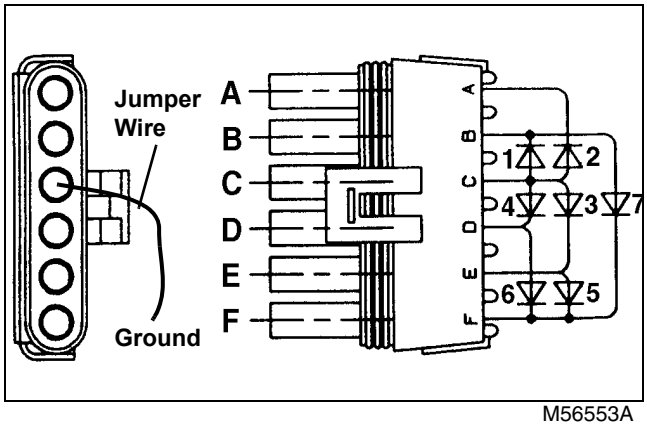


M56553A

3. Measure voltage at diode pack connector (X12), terminal C, 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test 627 Gry wire.

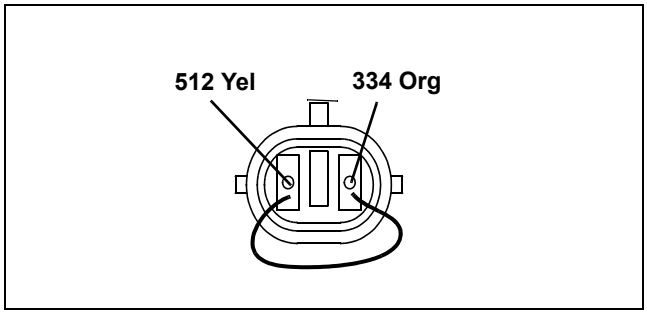


M56553A

4. With a jumper wire, connect diode pack connector (X12), terminal C, 627 Gry wire to ground. Test buzzer (H1). Is buzzer operating?

Yes: Go to next step.

No: Replace buzzer.



MIF

5. Diode pack connected. Jumper wire connected between terminals at hydraulic oil temperature switch connector (X24), 334 Org wire and 512 Yel wire. Test buzzer (H1). Is buzzer operating?

Yes: Go to next step.

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 242.)

6. Disconnect jumper wire from hydraulic oil temperature switch connector. Test buzzer (H1). Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No: Test diode pack (V4). (See “Diode Pack AMT386 Test” on page 242.)

Light Circuit Operation

Function

To provide power to the work lights and provide a means to turn them on and off.

Operating Conditions:

- Key switch in RUN position.
- Light switch in ON position.

Theory of Operation

Unswitched power is supplied to the light relay (K5) from the battery and is protected by a fusible link (F1). Current flows from the battery positive (+) terminal to starting motor (M1), 250 Red wire. From the starting motor, current flows to light relay, terminal 30, 240 and 240B Red wires, and 200 fusible link (F1).

With the key switch (S1) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 160) flows from key switch, terminal A, to light relay (K5), terminal 85, 500A, 500B, 503, 504A, and 504D Yel wires. Current flows from the coil, terminal 86, 191 Gry wire of the light relay to the light switch (S12), 191 and 190 Gry wires.

When the light switch is in the ON position, current flows to ground, 120E and 120B Blk wires, energizing the light relay.

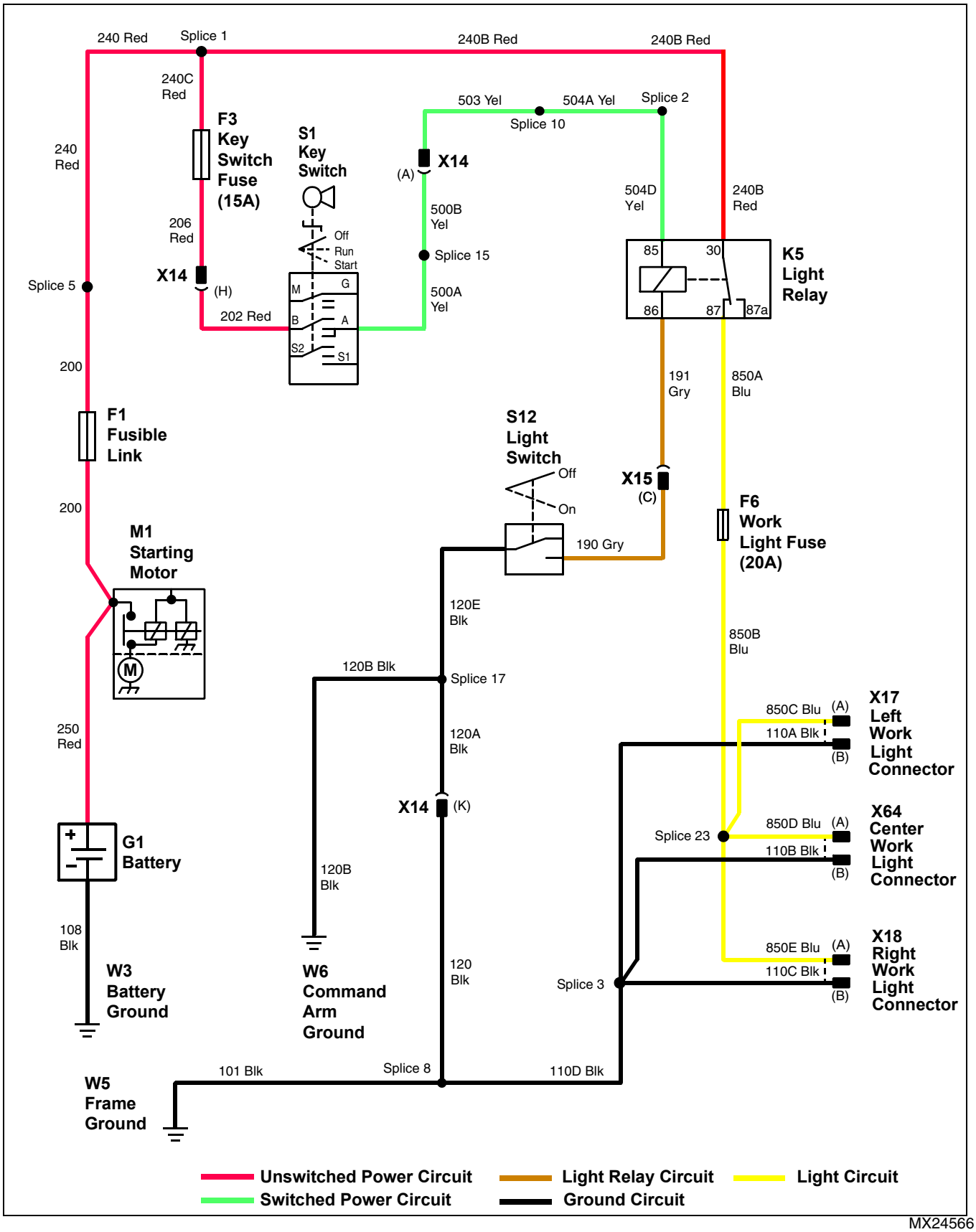
With the light relay energized, current flows to work light fuse (F6) on 850A Blu wire and through 850B Blu wire to the following:

- Right work light connector (X18), 850E Blu wire.
- Center work light connector (X64), 850D Blu wire.
- Left work light connector (X17), 850C Blu wire.

Ground circuits are provided as follows:

- Right work light connector (X18), 110C, 110D, and 101 Blk wires.
- Center work light connector (X64), 110B, 110D, and 101 Blk wires.
- Left work light connector (X17), 110A, 110D, and 101 Blk wires.

Light Circuit Schematic



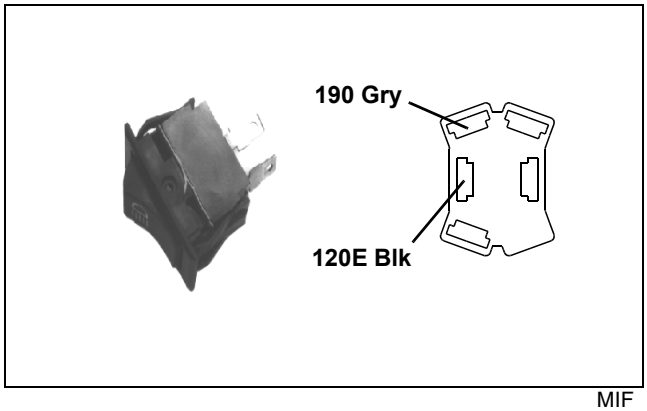
MX24566

System: Light Circuit Diagnosis

Light Circuit Test

Test Conditions

- Key switch in OFF position.
- Light switch in ON position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure ground circuit for resistance at light switch connector (X3), 120E Blk wire. Is there less than 0.1 ohm of resistance?

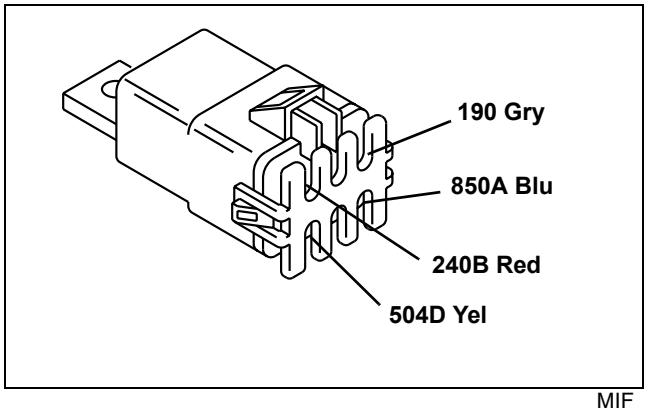
Yes: Go to next step.

No: Test 120E and 120B Blk wires and connections.

2. Measure ground circuit for resistance at light switch connector (X3), 190 Gry wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test light switch. (See “Light Switch Test” on page 252.)



MIF

3. Measure ground circuit for resistance at light relay (K5), terminal 86, 190 Gry wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 191 and 190 Gry wires.

4. Measure voltage at light relay (K5), terminal 30, 240B Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240B, 240, and 250 Red wires, 200 fusible link (F1), and connections.

5. Key switch in RUN position. Measure voltage at light relay (K5), terminal 85, 504D Yel wire. Is battery voltage present?

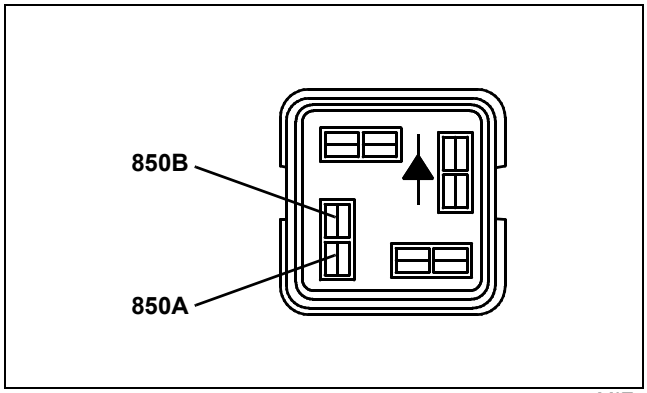
Yes: Go to next step.

No: Test 504D, 504A, 503, 500B, and 500A Yel wires and connections.

6. Measure voltage at light relay (K5), terminal 87, 850A Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test relay. (See “Electrical Relays Test” on page 256.)



MIF

7. Measure voltage at work light fuse (F6), 850A Blu wire. Is battery voltage present?

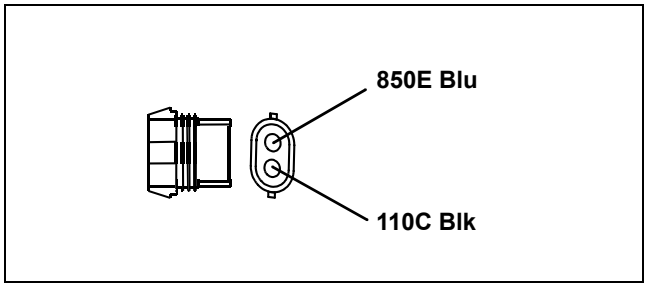
Yes: Go to next step.

No: Test 850A Blu wire and connections.

8. Measure voltage at work light fuse (F6), 850B Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test work light fuse (F6) and connections.



MIF

9. Measure voltage at right work light connector (X18), 850E Blu wire. Is battery voltage present?

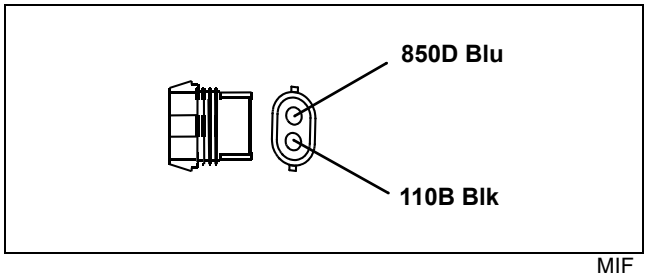
Yes: Go to next step.

No: Test 850E and 850B Blu wires and connections.

10. Measure ground circuit for resistance at right work light connector (X18), 110C Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110C, 110D, and 101 Blk wires and connections.



MIF

11. Measure voltage at center work light connector (X64), 850D Blu wire. Is battery voltage present?

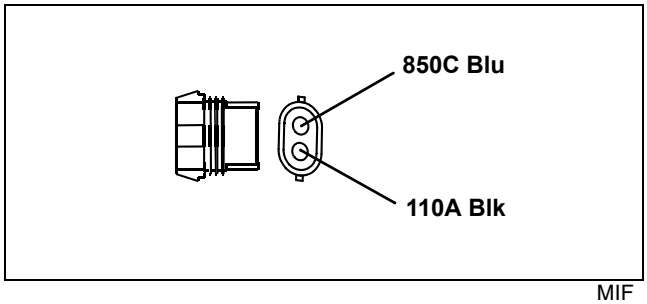
Yes: Go to next step.

No: Test 850D and 850B Blu wires and connections.

12. Measure ground circuit for resistance at center work light connector (X64), 110B Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110B, 110D, and 101 Blk wires and connections.



MIF

13. Measure voltage at left work light connector (X17), 850C Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 850C and 850B Blu wires and connections.

14. Measure ground circuit for resistance at left work light connector (X17), 110A Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110A, 110D, and 101 Blk wires and connections.

Tests and Adjustments

Diode Pack AMT386 Test

Reason

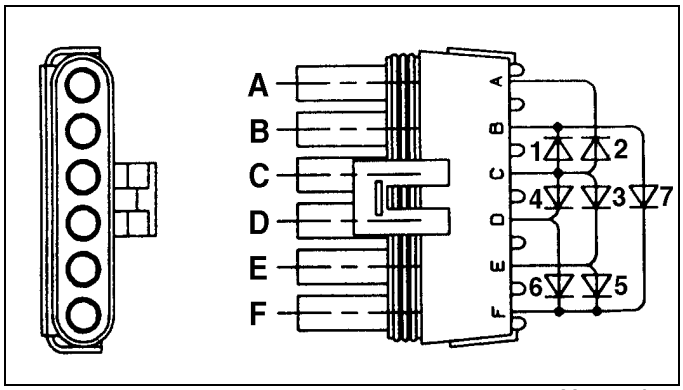
To verify proper operation of the diode pack

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test diode pack

Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Key switch in OFF position.
4. Park brake in LOCKED position.



M56553A

1. Remove diode pack and test with a JT05791A Digital Multimeter or a diode tester as follows.

Diode	Red Lead	Black Lead	Result
1	C	B	Continuity
1	B	C	No Continuity
2	C	A	Continuity
2	A	C	No Continuity
3	C	E	Continuity
3	E	C	No Continuity
4	C	D	Continuity
4	D	C	No Continuity
5	E	F	Continuity
5	F	E	No Continuity
6	D	F	Continuity
6	F	D	No Continuity
7	B	F	Continuity
7	F	B	No Continuity
4 and 6 3 and 5	C	F	Continuity
4 and 6 3 and 5	F	C	No Continuity

Results

- If any of the tests are not to the chart replace diode pack.

Ground Circuit Test

Reason

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

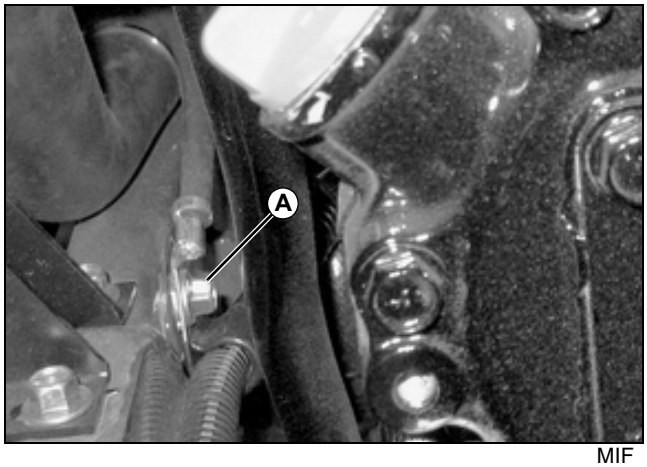
Note: In a "switched ground" system, not all components are grounded directly to the battery. Most circuit components are grounded through the electronic control module (A1).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Connect JT05791A Digital Multimeter on ohm scale, negative (black) lead to negative (-) terminal of battery.



MIF

6. Connect JT05791A Digital Multimeter red lead to ground terminal of circuit (A) or component to be tested that is closest to the battery negative terminal. Set digital multimeter to the ohm scale. The resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohm[3]. Check both sides of the connectors closely, as disconnecting and connecting may temporarily solve problem.

7. Disconnect component and clean the mating surfaces before reassembling.

3. Some digital multimeters may not provide an accurate reading at a very low resistance. Touch meter probe leads together, and subtract shorted probe reading from the measured resistance reading.

Battery Test

Caution: Avoid Injury! Battery electrolyte contains sulfuric acid. It is poisonous and can cause serious burns:

- **Wear eye protection and gloves.**
- **Keep skin protected.**
- **If electrolyte is swallowed, get medical attention immediately.**
- **If electrolyte is splashed into eyes, flush immediately with water for 15-30 minutes and get medical attention.**
- **If electrolyte is splashed onto skin, flush immediately with water and get medical attention if necessary.**

Note: The original battery supplied with this machine is a sealed battery and is not serviceable. This procedure is for a serviceable battery that has replaced the original sealed battery.

Do not attempt to open, add fluid to, or service a sealed battery.

To test a sealed battery, perform a battery load test. (See "Load Battery Test" on page 245.)

Reason

To check condition of battery and determine voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	N/A	Used to check specific gravity.
Digital Multimeter	JT05791A	Used to check battery voltage.
Battery Load Tester	JT05685	Used to check battery voltage.

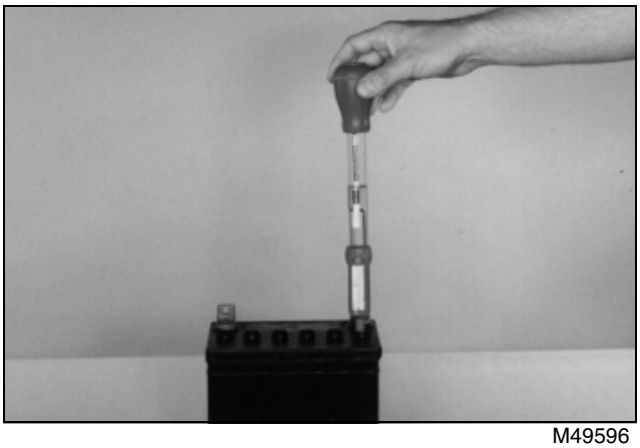
Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Clean cable ends, battery terminals, and top of battery. (See "Clean Battery" on page 247.)
6. Remove battery. (See "Battery Removal and Installation" on page 246.)
7. Inspect battery terminals and case for breakage or

cracks.

8. Check electrolyte level in each battery cell. Add clean, distilled water as needed. If water is added, charge battery for 20 minutes at 10 amps.

9. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

10.Use a hydrometer to check for a minimum specific gravity of 1.225 with less than a 50-point variation in each cell. If specific gravity is not within range, perform one of the following:

- If all cells are less than 1.175, charge battery at 10-amp rate.
- If all cells are less than 1.225 with less than 50-point variation, charge battery at 10 amps.
- If all cells are more than 1.225 with less than 50-point variation, load test battery.
- If more than 50-point variation, replace battery.

11.Use JT05791A Digital Multimeter or JT05685 Battery Load Tester to check for a minimum battery voltage of 12.4 volts. One of the following may result:

- If battery voltage is less than 12.4 VDC, charge battery.
- If battery voltage is more than 12.4 VDC, test specific gravity. (See step 10.)

12.Install battery if all battery checks are within specification. (See “Battery Removal and Installation” on page 246.)

Charge Battery

Caution: Avoid Injury! The battery produces a flammable and explosive gas. The battery may explode:

- **Do not smoke near battery.**
- **Wear eye protection and gloves.**
- **Do not allow direct metal contact across battery posts.**
- **Remove negative cable first when disconnecting.**
- **Install negative cable last when connecting.**

Reason

To increase battery charge after the battery has been discharged.

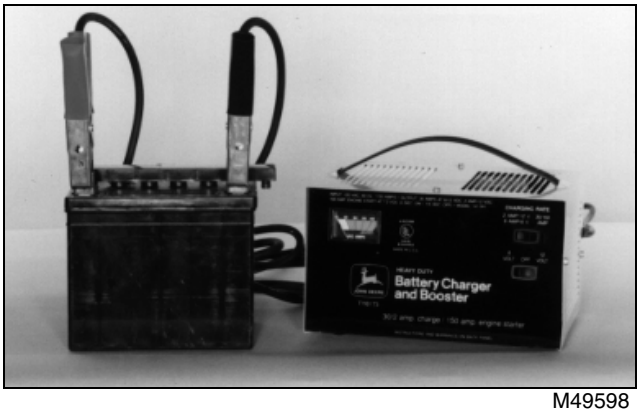
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (Variable Rate)	N/A	Used to charge battery.

Procedure

Note: Before charging serviceable battery, check electrolyte level. (See “Battery Test” on page 243.)

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Clean cable ends, battery terminals, and top of battery. (See “Clean Battery” on page 247.)
6. Remove battery. (See “Battery Removal and Installation” on page 246.)



M49598

7. Connect variable-rate charger to battery.

8. Start charger at SLOW rate. Increase charge rate ONE setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10-amp charge rate. Use boost setting as necessary.

9. Check if battery is accepting 10-amp charge rate after 10 minutes at boost setting. One of the following may result:

- If battery WILL NOT accept 10-amp charge after 10 minutes at boost setting, replace battery.
- **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 12 and 13.
- **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, but battery DID need water or all cells were BELOW 1.175, go to steps 11 and 12.

10.Set charger at 15-25 amps.

Important: Avoid Damage! Decrease charge rate if battery gasses or bubbles excessively or becomes too warm to touch.

11.**Serviceable batteries only:** Check specific gravity after 30 minutes. One of the following problems may result:

- If MORE THAN 50-point variation between cells, replace battery.
- If LESS THAN 50-point variation between cells, go to steps 13 and 14.

Note: Serviceable batteries: If battery was discharged at slow or unknown rate, charge battery at 10-15 amps for 6-12 hours.

Maintenance-free batteries: Follow battery charger manufacturer's recommendations.

12.Load test battery following the battery charger manufacturer's recommendations.

13.Install battery if battery passes.

Specifications

Battery Specific Gravity. . . . . 1.225-1.275 points

Load Battery Test

Reason

To check condition of battery under load.

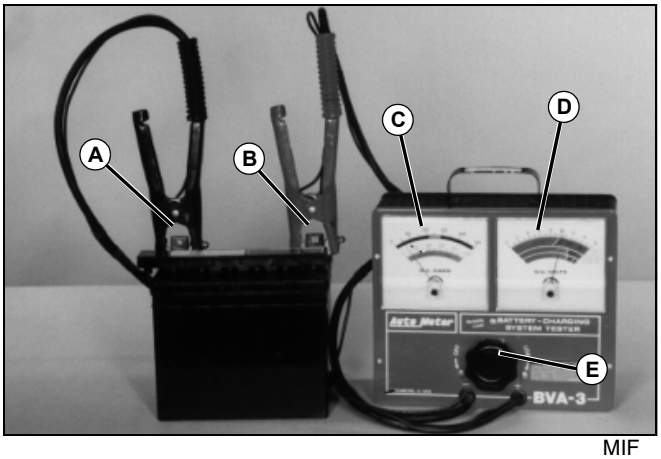
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Load Tester (use according to manufacturer's instructions)	JT05685	Used to test battery.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
5. Remove battery from machine. (See "Battery Removal and Installation" on page 246.)
6. Clean battery terminals and case. (See "Clean Battery" on page 247.)

Important: Avoid Damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.



MIF

7. Connect positive cable of J05685 Battery Load Tester to battery positive (+) terminal (A).
8. Connect battery tester's negative cable (black) to battery negative (-) terminal (B).

Important: Avoid Damage! Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5-10 seconds.

9. Turn load knob (E) of battery tester clockwise until amperage reading (C) is equal to:

- Cold cranking amperage rating of battery (use blue scale).
  -or-
- Three times ampere hour rating (use black scale).

10.Hold for 15 seconds and turn load knob (A) of battery tester counterclockwise to OFF position.

11.Repeat steps 9 and 10 above and read condition of battery at DC volts scale (D).

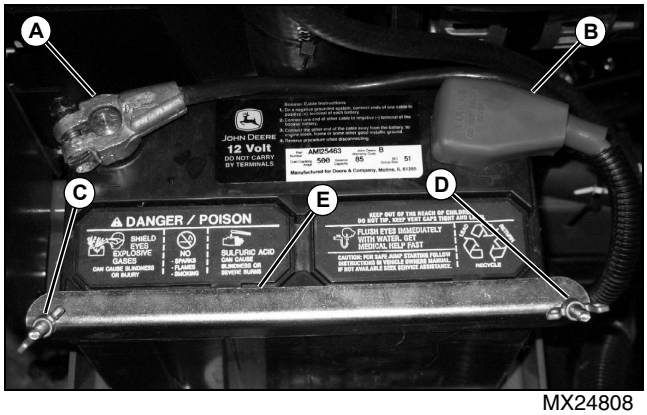
12.If battery DOES NOT pass test and HAS NOT been charged, charge battery and retest. (See “Charge Battery” on page 244.)

13.If battery DOES NOT pass test and HAS been charged, replace the battery.

Battery Removal and Installation

Caution: Avoid Injury! Battery electrolyte contains sulfuric acid. It is poisonous and can cause serious burns:

- **Wear eye protection and gloves.**
- **Keep skin protected.**
- **If electrolyte is swallowed, get medical attention immediately.**
- **If electrolyte is splashed into eyes, flush immediately with water for 15-30 minutes and get medical attention.**
- **If electrolyte is splashed onto skin, flush immediately with water and get medical attention if necessary.**



MX24808

1. Disconnect negative (-) cable (A) first, then positive (+) cable (B).

2. Remove nuts (C and D) on each side of battery and bracket (E).

3. Remove battery.

Installation

Installation is done in the reverse order of removal.

- Clean battery if dirty. (See “Clean Battery” on page 247.)
- Inspect battery terminals and case for breakage or cracks. Replace if needed.
- Test battery condition. (See “Battery Test” on page 243.)
- Connect negative (-) cable last.

Clean Battery

1. Remove battery from machine. (See “Battery Removal and Installation” on page 246.)

Note: Keep cleaning solution out of battery cells.

2. Clean battery case, battery terminals, cable ends, bracket, and battery box with a solution of one part baking soda and four parts water.

3. Rinse all parts with clean water. Let dry thoroughly.

4. Apply petroleum jelly to battery terminals to prevent corrosion.

Regulated Voltage Output Test

Reason

To check the regulated voltage (charging) output of the alternator.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure voltage.

Procedure

1. Park machine on level surface.

2. Key switch in OFF position.

3. Park brake in LOCKED position.

4. Remove surface charge from battery by cranking the engine for 15 seconds.

5. Set JT05791A Digital Multimeter to measure voltage.

MX24808

6. Connect meter red lead to battery positive (+) terminal (A).

7. Connect meter black lead to battery negative (-) terminal (B).

8. Start and run engine at FAST idle.

9. Read meter several times during 5 minutes of running time. Voltage should remain at specification.

Specifications

Regulated Voltage . . . . . 14.3-14.7 volts

Results

- If the DC voltage remains below the minimum specification, perform unregulated voltage output tests. (See “Regulated Voltage Output Test” on page 247.)
- If the DC voltage goes above the maximum specification, replace the voltage regulator.

Starter Loaded Amperage Draw Test

Reason

To determine the amperage required to crank the engine and check starting motor operation under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used with current clamp.
Current Clamp-On Probe	JT02153	Used to measure starting motor current.

Procedure

1. Park machine on level surface.

2. Key switch in OFF position.

3. Park brake in LOCKED position.

4. Disconnect fuel shutoff solenoid connector.

5. Test system ground circuit connections. (See “Ground Circuit Test” on page 242.)

6. Load test battery. (See “Load Battery Test” on page 245.)

7. Connect JT02153 Current Clamp-On Probe around battery positive cable.

8. Set JT05791A Digital Multimeter to DC amperage.

9. Disconnect the fuel pump connector.

Important: Avoid Damage! Perform the following procedure within 20 seconds to prevent damage to electrical components.

10.Crank engine. Read and record amperage on DC amp scale of digital multimeter.

11.Key switch to OFF position.

Results

- If amperage is above specification, test starter no-load amperage and rpm to determine if starter is binding or damaged. (See “Starter No-Load Amperage and RPM Test” on page 248.).
- If starter passes no-load test but amperage draw remains high, check internal engine components for binding, wear, or damage.

Specifications

Starting Motor @ 900 RPM . . . . . 280 amps

Starter No-Load Amperage and RPM Test

Reason

To determine if starter is binding or has excessive amperage draw under no-load.

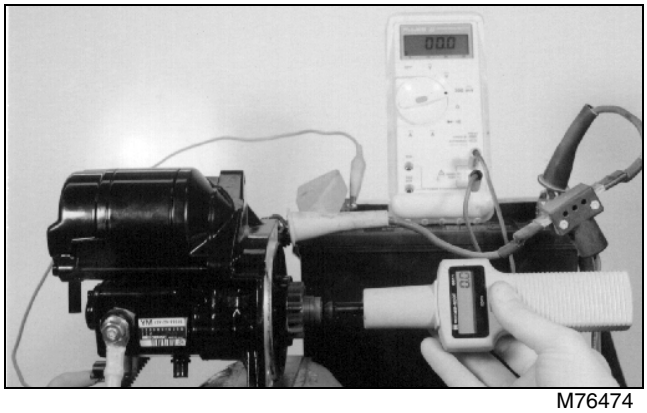
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test starter no-load amperage and rpm.
Current Clamp-On Probe	JT02153	Used with multimeter to test current draw.
Hand Held Digital Tachometer	JT05719	Used to test starter no-load amperage and rpm.
One (1) Jumper Wire	N/A	Used to test starter no-load amperage and rpm.
One (1) Jumper Cable	N/A	Used to test starter no-load amperage and rpm.
12-Volt Battery	N/A	Used to test starter no-load amperage and rpm.

Procedure

Note: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



M76474

7. Install JT02153 Current Clamp-On Probe leads as follows:
   - Red male plug to VOLT/OHM socket on JT05719A Digital Multimeter.
   - Black male plug to COM socket on digital multimeter.
   - Shunt black clamp to the negative (-) battery post.
   - Shunt red clamp to starter case ground.
8. Set digital multimeter to read 300 mV.
9. Connect positive jumper cable between starter solenoid terminal and positive battery post.

Important: Avoid Damage! Complete the following step in 20 seconds or less to prevent starter damage.

10. Momentarily connect a jumper lead from positive battery post to small solenoid spade terminal. Solenoid should pull in and the drive gear and shaft should move out and spin.
11. Record amperage from multimeter.
12. Place JT05719 Hand Held Digital Tachometer drive cone against end of spinning starter drive gear, and record rpm.
13. Remove jumper from solenoid.

Results

- If amperage is above specification, check for binding or seized bearings, sticking brushes, and dirty or worn commutator. Replace starter.
- If starter passes no-load test but amperage draw remains high when mounted on engine, check internal engine components for binding, wear, or damage.

Specifications

Starting Motor No-Load Draw at 3000 RPM . . .90 amps

Starter Solenoid Test

Reason

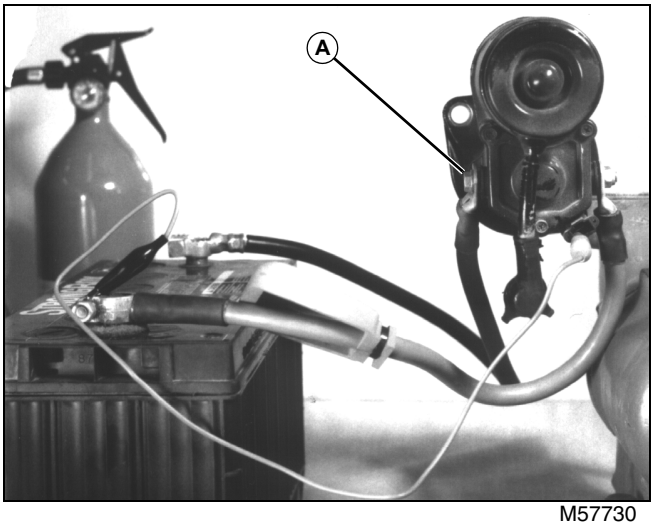
To determine if starter solenoid is defective. The solenoid has separate pull-in and hold-in windings, which do not ground together. This test requires two ground jumper cables in order to test the winding.

Special or Required Tools

Tool Name	Tool No.	Tool Use
One (1) Jumper Wire	N/A	Used to test starter solenoid.
Two (2) Jumper Cables	N/A	Used to test starter solenoid.
12-Volt Battery	N/A	Used to test starter solenoid.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



M57730

7. Disconnect starting motor lead from left side solenoid terminal (A).
8. Connect NEGATIVE jumper cable from the left side solenoid terminal to NEGATIVE battery post.
9. Connect POSITIVE jumper cable from the right side solenoid terminal to POSITIVE battery post.
10. Momentarily connect a jumper wire from the positive battery post to the small solenoid spade terminal. The solenoid should pull in and the drive gear should move out.
11. Remove the positive jumper wire to the solenoid spade terminal. The solenoid drive gear should move back.

Results

- The solenoid should pull in freely with a loud click when energized. The starter drive gear should move out.
- If solenoid does not move, disconnect jumper leads and try to pull drive gear out by hand by rotating counterclockwise:
  - If drive gear will not turn by hand, check starting motor for bad bearings, frozen armature, or sticking brushes.
  - If drive gear turns but will not pull out, check solenoid plunger and shaft for binding.
  - If drive gear turns and moves out freely, but solenoid does not energize, check continuity from solenoid primary spade terminal to left side terminal lug (where starting motor lead attaches). Maximum resistance should be 1.0 ohm through solenoid. Replace open or shorted coil solenoid.

Key Switch Test

Reason

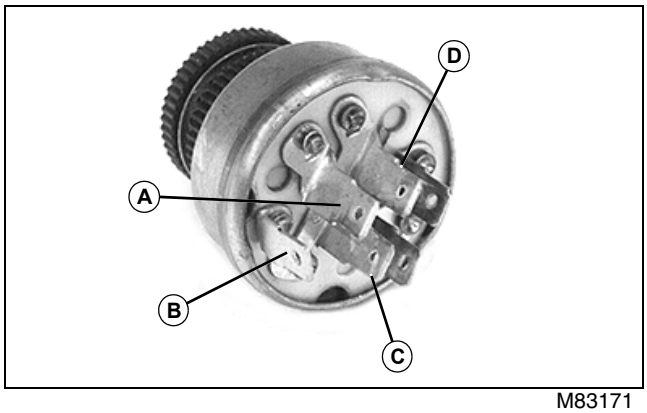
To verify that the key switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Disconnect key switch connector (X6).



M83171

6. Check continuity with digital multimeter between switch terminals with switch in OFF, RUN, and START positions.

NOTE: DO NOT refer to markings stamped on terminals. Identify by art keys ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity	
Switch Position	**Terminal Continuity**
OFF	NONE
RUN	B and C
START	B and C A and D

Results

If any continuity is NOT correct, replace the switch.

Mow-Transport Switch Test

Reason

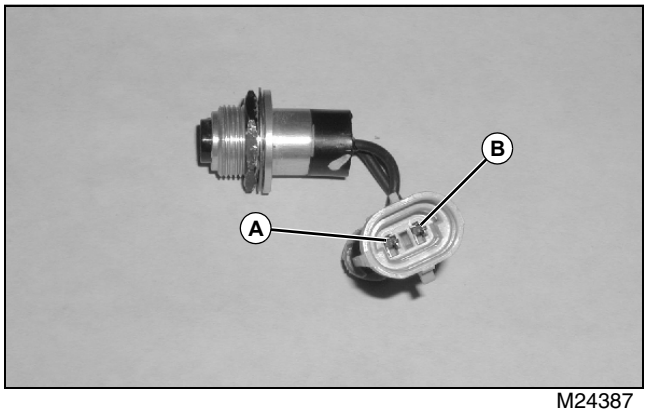
To verify continuity between the switch terminals when the mow-transport switch has been activated.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position
5. Disconnect mow-transport switch connector (X8).



M24387

6. Check continuity with JT05791A Digital Multimeter across switch terminals (A and B). There should be no continuity.
7. Depress plunger.
8. Check continuity with digital multimeter across terminals. There should be continuity.

Results

If continuity is not correct in either position, replace switch.

Seat Switch Test

Reason

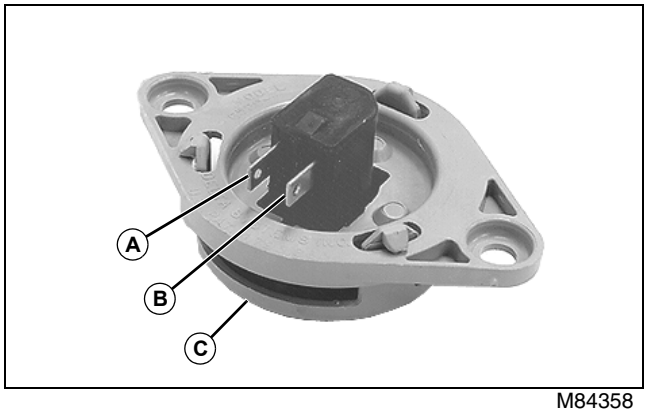
To verify continuity between the seat switch terminals when the operator is on the seat.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Remove seat from platform.
6. Disconnect seat switch connector.



M84358

7. Check continuity with JT05791A Digital Multimeter across switch terminals (A and B). There should be no continuity.
8. Depress plunger (C).
9. Check continuity with digital multimeter across switch terminals (A and B). Continuity should exist between terminals.

Results

If continuity is not correct, replace the switch.

Reverse Switch Test

Reason

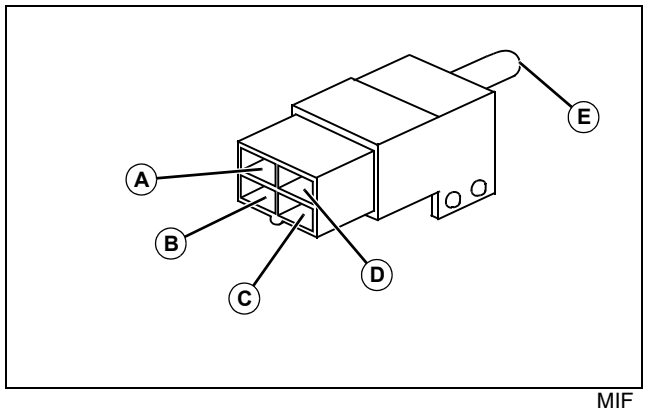
To determine proper operation of the reverse switch used in the 4WD circuit.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine safely on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Remove connector from reverse switch.



MIF

6. Connect JT05791A Digital Multimeter leads to (A and B). There should not be continuity.
7. Connect digital multimeter leads to terminal (C and D). There should be continuity.
8. Press and release plunger (E) of switch; then hold the plunger in.
9. Connect digital multimeter leads to terminal (A and B). There should be continuity with the plunger pushed in.
10. Connect digital multimeter leads to terminal (C and D). There should be no continuity with the plunger pushed in.

Results

- If switch does not pass all tests, replace switch.

Backlap Switch Test

Reason

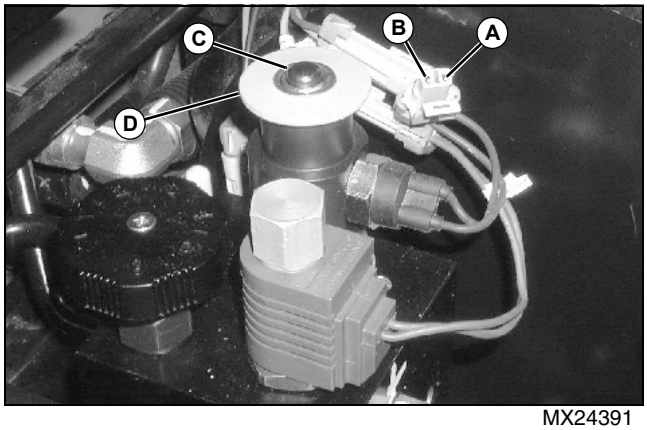
To verify continuity between the switch terminals when the machine is in the MOW and BACKLAP modes.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Disconnect backlap switch wiring connector.



MX24391

6. Backlap switch in MOW position (pushed in).
7. Check continuity with JT05791A Digital Multimeter across connector terminals (A and B). There should be no continuity.
8. Press down on button (C) and pull out on backlap switch (D), until it clicks into BLACKLAP position.
9. Check continuity with digital multimeter across connector terminals. There should be continuity.

Results

If continuity is not correct, replace switch.

Light Switch Test

Reason

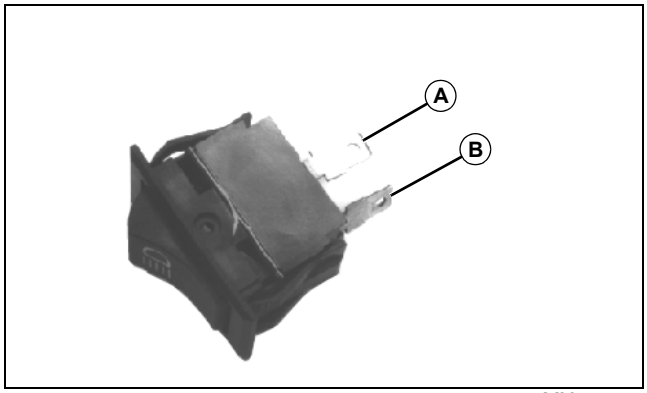
To verify that the headlight switch terminals have continuity when the headlight switch is ON.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect headlight switch connector.



MX48378

5. Check continuity with JT05791A Digital Multimeter between switch terminals (A and B) with the switch in OFF position. There should be no continuity.
6. Check continuity with digital multimeter between switch terminals (A and B) with the switch in ON position. There should be continuity.

Results

- If there is NO continuity with the switch in the ON position, replace the switch.
- If continuity exists with the switch in the OFF position, replace the switch.

Park Brake Switch Test

Reason

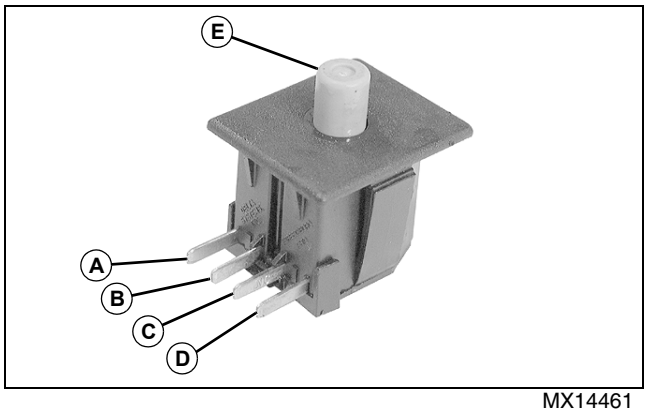
To verify continuity between the switch terminals when the park brake switch has been activated.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in UNLOCKED position.
5. Disconnect park brake switch connector.



MX14461

6. Check continuity with JT05791A Digital Multimeter across switch terminals (A and D). There should be no continuity.
7. Check continuity with digital multimeter across switch terminals (B and C). There should be continuity.
8. Depress plunger (E) and hold.
9. Check continuity with digital multimeter across switch terminals (A and D). There should be continuity.
10. Check continuity with digital multimeter across switch terminals (B and C). There should be no continuity.

Results

If continuity is not correct in either position, replace switch.

Neutral Switch Test

Reason

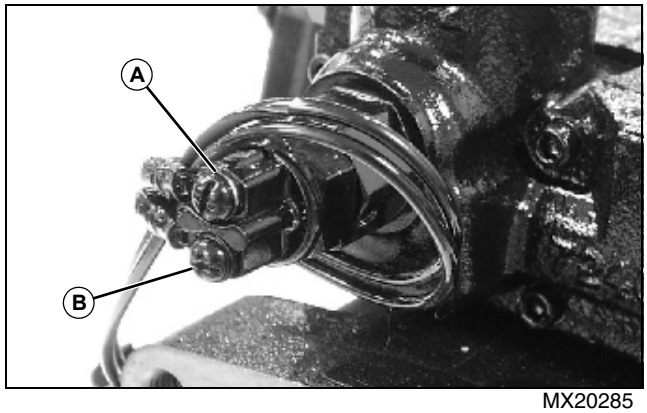
To verify continuity between the switch terminals when the switch is in the neutral position.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in UNLOCKED position.
5. Remove connector (X37) from neutral switch.



MX20285

6. Connect JT05791A Digital Multimeter leads to pairs of switch posts (A and B). Place the forward and reverse pedals in the neutral position. There should be continuity.
7. Move the forward or reverse pedals. There should be no continuity.

Results

- If switch does not pass all tests, replace switch.

Cruise Control Switch Test

Reason

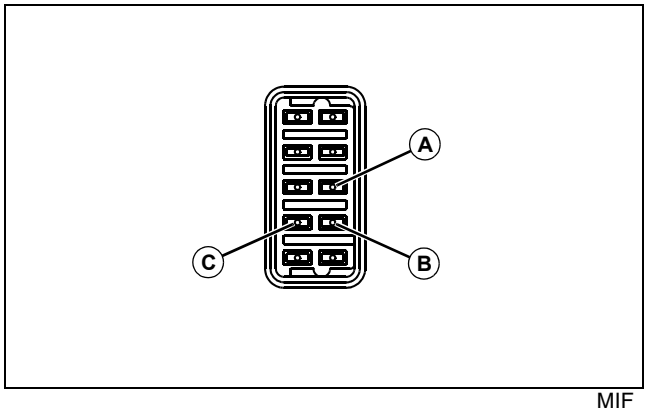
To verify continuity between the switch terminals when the cruise control switch has been activated.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Cruise control switch connector (X9) disconnected.
6. Cruise control switch in OFF position.



MIF

7. Check continuity with JT05791A Digital Multimeter across switch terminals (A and B) and switch terminals (A and C). There should be no continuity.
8. Cruise control switch in the ON position.
9. Check continuity with digital multimeter across terminals (A and B). There should be continuity, but there should be no continuity across terminals (A and C).
10. Cruise control switch in the SET position and hold.
11. Check continuity with digital multimeter across terminals (A and B) and terminals (A and C). There should be continuity.

Results

If switch shows no continuity or resistance higher than 0.05 ohm when contacts are closed, replace switch. If continuity is not correct in either position, replace switch.

Raise-Lower Switch Test

Reason

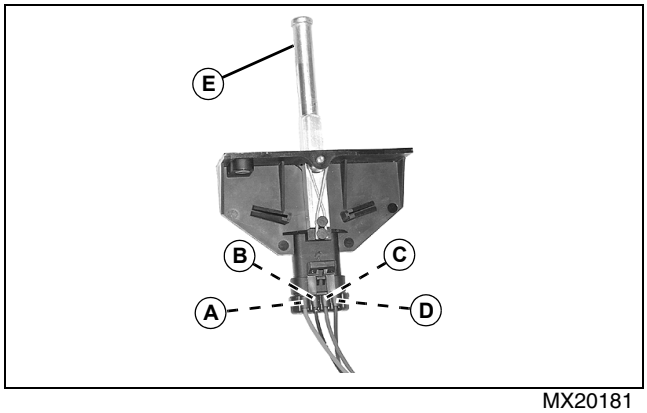
To determine if raise-lower switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test switch continuity.

Procedure

1. Key switch in RUN position.



MX20181

2. Connect JT05791A Digital Multimeter negative lead (-) to raise-lower switch connector terminal (C), 120D Blk wire. Connect digital multimeter red lead positive (+) to raise-lower switch connector terminal (B), 500H Yel wire. There should be battery voltage. If there is NO battery voltage, test raise-lower circuit. (See “System: Raise-Lower Circuit Diagnosis” on page 212.)
3. Leave digital multimeter negative lead (-) connected to raise-lower switch connector terminal (C), 120D Blk wire for rest of procedure.
4. Connect digital multimeter positive lead (+) to raise-lower switch terminal (A), 660 Blu wire. Move raise-lower switch lever (E) to RAISE position. There should be battery voltage.
5. Connect digital multimeter positive lead (+) to raise-lower switch terminal (D), 773 Blu wire. Move raise-lower switch lever (E) to LOWER position. There should be battery voltage.

Results

- If there is NO battery voltage with switch in the RAISE position, replace raise-lower switch.
- If there is NO battery voltage with switch in the LOWER position, replace raise-lower switch.

Hydraulic Temperature Switch Test

Reason

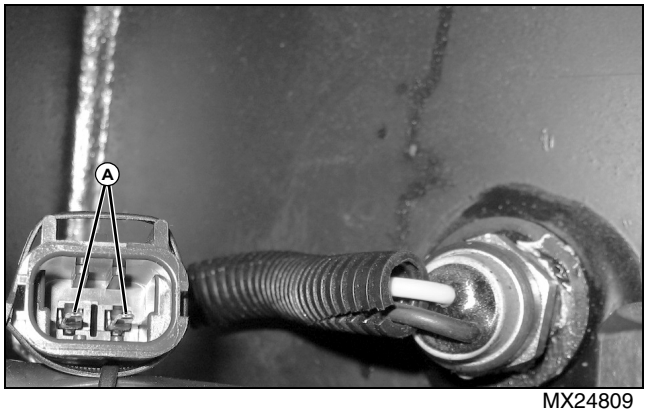
To verify that the hydraulic oil temperature switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Allow the hydraulic oil to cool to room temperature.
6. Disconnect hydraulic oil temperature sensor connector from main harness connector (X24), 512 Yel wire and 334 Org wire.



MX24809

7. Check for continuity with JT05791A Digital Multimeter between the switch connector terminals (A). There should be no continuity between the switch terminals at room temperature.
8. Start and run engine at FAST idle.
9. Bring the hydraulic oil to normal operating temperature.
10. Check continuity between the sensor terminals. There should be no continuity.

Results

Replace the switch if there is continuity at room temperature.

Specifications

Hydraulic Oil Temperature Switch

Closing Temperature . . . . . 93°C (200 ± 7.5°F)

Engine Oil Pressure Switch Test

Reason

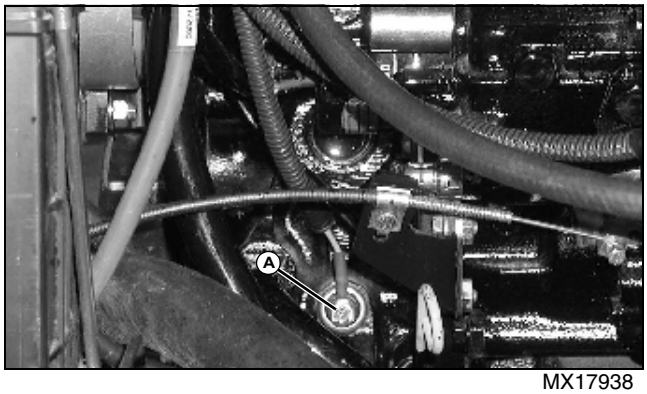
To determine if the engine oil pressure switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Disconnect 620 Tan wire from oil pressure switch.



MX17938

6. Connect digital multimeter black lead to engine block and connect red lead to terminal of switch (A).
7. Check continuity between the switch terminal and engine block or ground. There should be continuity between switch terminal and ground.
8. Start and run engine at FAST idle.
9. Check continuity between the switch terminal and engine block or ground. There should be no continuity between switch terminal and ground.

Results

Note: Apply pipe sealant with TEFLON® to threads of switch anytime it is installed.

- If there is NO continuity between switch terminal and engine block or ground with engine NOT running, replace the oil pressure switch.
- If the switch DOES have continuity between switch terminal and engine block or ground with engine running, check oil pressure. If oil pressure is to specification, replace the oil pressure switch.

Engine Coolant Temperature Switch Test

Reason

To determine the operating temperature of the switch.

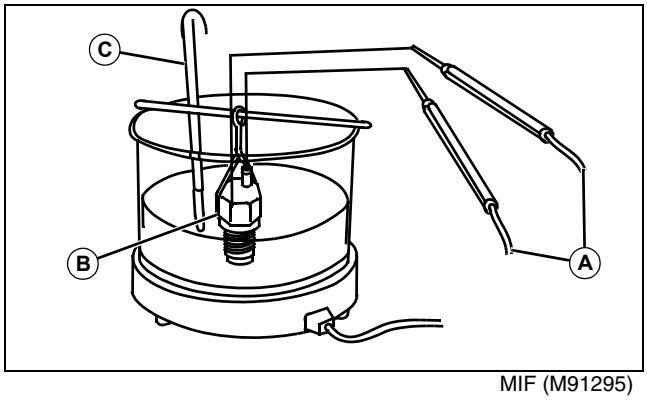
Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	N/A	Used to measure water temperature.
Glass Container	N/A	Used to contain water in test.
Heating Unit	N/A	Used to heat water.
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Remove coolant temperature switch.

Caution: Avoid Injury! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



MIF (M91295)

3. Connect lead wires from JT05791A Digital multimeter (A) to switch terminal and body.
4. Suspend switch (B) and a thermometer (C) in a container of water and coolant 50/50 mixture.
5. Heat and stir the mixture. Observe temperature, when continuity occurs. Temperature must be to specification.
6. Apply pipe sealant with TEFLON® in the threads of the temperature switch, and install switch. Tighten to specification.

Results

If continuity does not occur within specification, replace switch.

Specifications

Engine Coolant Temperature Switch

Operating Temperature . . . . . 107-113°C (225-235°)

Electrical Relays Test

Reason

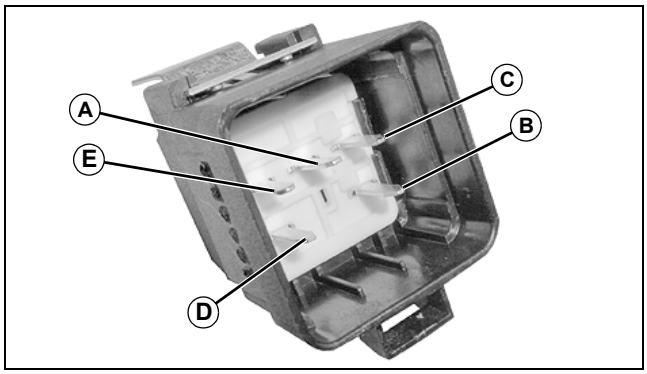
To determine if electrical relay coils are actuating correctly and resistance of relay contact points is correct.

Special or Required Tools

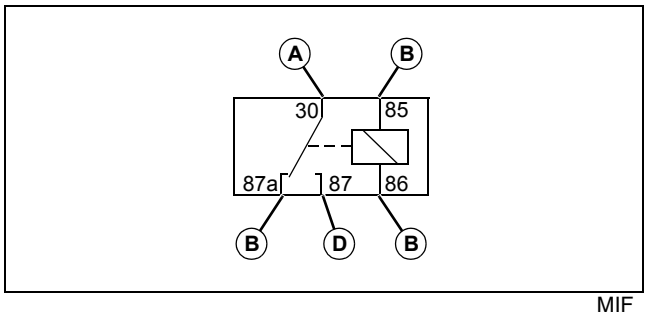
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test relays.
Jumper Wires (2)	N/A	Used to test relays.
12-Volt Battery	N/A	Used to test relays.

Procedure

Note: All relays function the same. The relay schematic below reflects the operation of the relays.



MX14471



MIF

1. Check continuity between terminals using JT05791A Digital Multimeter.
   - Continuity should exist between relay terminals 30 and 87a (A and E) and between 85 and 86 (B and C).
   - No continuity should exist between relay terminals 30 and 87 (A and D).

2. Connect jumper wire from battery positive (+) terminal to relay terminal 86 (C). Connect another jumper wire from relay terminal 85 (B) to battery negative (-) terminal.

- Continuity should exist between relay terminals 30 and 87 (A and D).
- No continuity should exist between relay terminals 30 and 87a (A and E).

Results

If continuity is not correct, replace relay.

Fuel Shutoff Solenoid Test

Reason

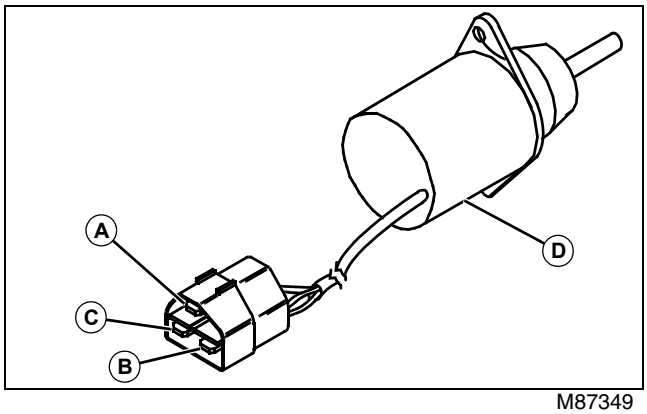
To determine if the fuel shutoff solenoid is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test fuel shutoff solenoid.

Procedure

1. Disconnect fuel shutoff solenoid connector.



M87349

2. Check pull-in coil resistance with JT05791A Digital Multimeter, at terminals (A and B). Resistance must be to specification.

3. Check hold coil resistance, terminals (A and C). Resistance must be to specification.

4. Check resistance of both coils (combined), terminals (A and C). Resistance must be to specification.

5. Check for grounds or shorts between solenoid terminals (A, B, and C) and solenoid housing (D). There must be NO continuity between terminal (A, B, or C) and solenoid housing (D).

Results

- If resistance does not meet specification, replace fuel shutoff solenoid.
- If continuity exists between connector terminals and solenoid housing, replace fuel shutoff solenoid.

Specifications

Fuel Shutoff Solenoid Resistance

Terminals A and B . . . . . 0.4 ohms
Terminals A and C . . . . . 23.6 ohms
Terminals B and C . . . . . 24 ohms

4WD Bypass Solenoid Test

Reason

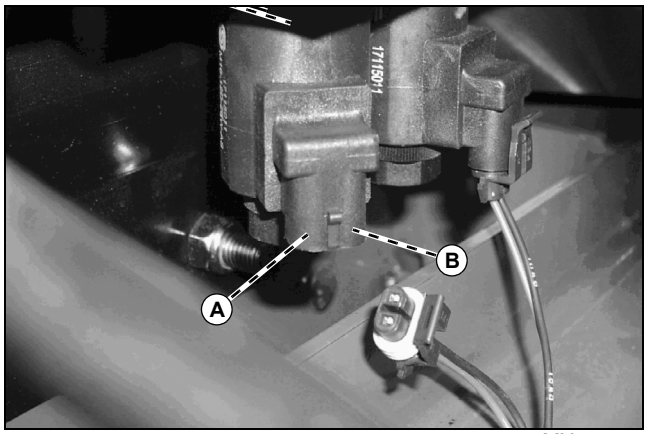
To determine if the 4WD bypass solenoid is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test 4WD bypass solenoid.

Procedure

1. Disconnect 4WD bypass solenoid connector.



MX24880

2. Check resistance with JT05791A Digital Multimeter between terminals (A and B). Resistance must be to specification.

3. Check for grounds or shorts between solenoid terminals (A and B) and solenoid housing. There must be NO continuity between terminal (A or B) and solenoid housing.

Results

- If resistance is not to specification, replace 4WD bypass solenoid.
- If continuity exists between connector terminals and solenoid housing, replace 4WD bypass solenoid.

Specifications

4WD Bypass Solenoid

Coil Resistance . . . . . 10 ± 2 ohms

Fuel Pump Test

Reason

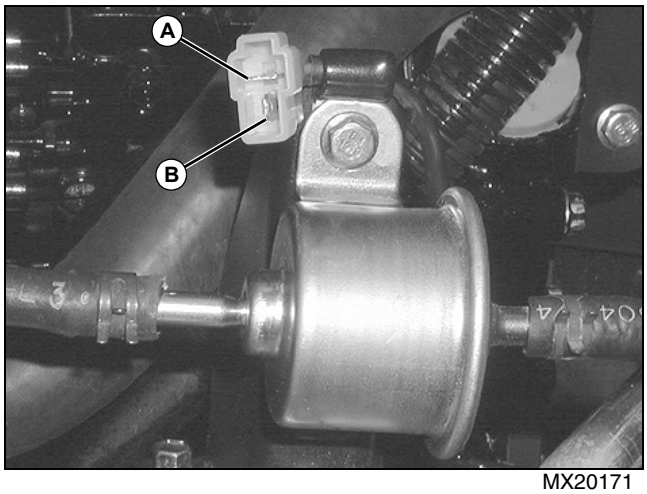
To determine if the fuel pump is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Two (2) Jumper Wires	N/A	Used to test fuel pump.

Procedure

1. Disconnect fuel pump connector.



MX20171

2. Connect jumper wire from battery positive (+) terminal to fuel pump terminal (A).

3. Connect another jumper wire from battery negative (-) terminal to fuel pump terminal (B). Fuel pump must operate.

4. Reverse jumper wire connections, fuel pump terminal (A) to battery negative (-) terminal and fuel pump terminal (B) to battery positive (+) terminal. Fuel pump must not operate.

Results

- If fuel pump does not operate with correct polarity and power applied, replace fuel pump.
- If fuel pump operates with reverse polarity, internal diode is shorted. Replace fuel pump.

Fuse Test

Reason

To determine if fuse has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test fuse continuity.

Procedure

1. Remove fuse to be tested.
2. Set JT05791A Digital Multimeter to ohm function.
3. Connect one meter lead to one post of fuse. Connect other meter lead to other post of fuse.

Results

If there is no continuity between posts, replace fuse.

Diode Test

Reason

To determine if diode has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test diode.

Procedure

1. Remove diode from connector.
2. Set JT05791A Digital Multimeter to diode test.
3. Connect meter leads to each lead or end of diode. Check for continuity.
4. Reverse test leads. Check for continuity.

Results

Diode must have a low resistance reading in one direction only. Replace defective diode if low resistance reading occurs in both directions.

Mow Solenoid Test

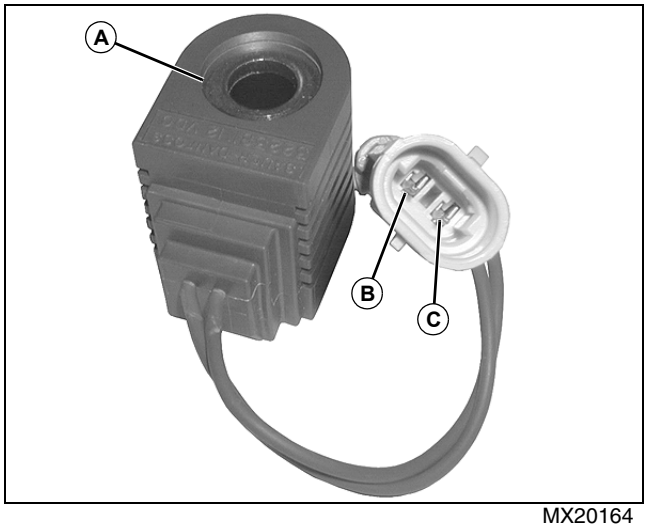
Reason

To determine condition of mow solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test mow solenoid.

Procedure



MX20164

1. Measure resistance with JT05791A Digital Multimeter between mow solenoid connector terminals (B and C). Resistance must be within specification.

2. Check for grounds or shorts between solenoid terminals (B and C) and bare metal of the coil core (A). There must be NO continuity between terminal (B or C) and core.

Results

- If resistance between terminals (B and C) is not within specification, replace solenoid.
- If continuity exists between terminals and core, replace solenoid.

Specifications

Mow Solenoid Resistance . . . . . 10 ± 2 ohms

Raise-Lower Solenoid Test

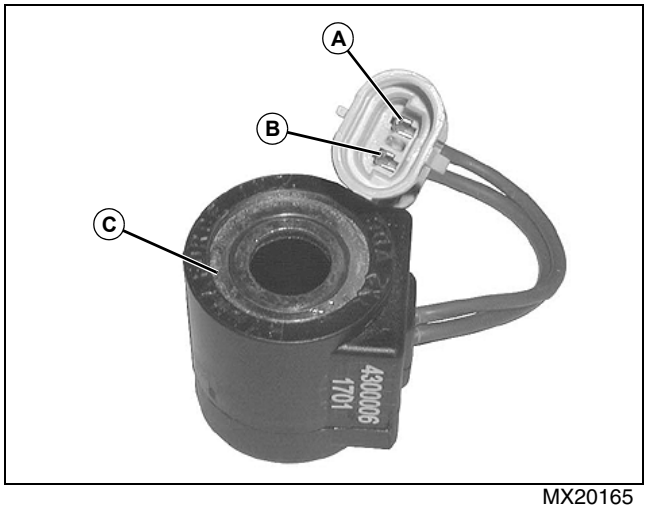
Reason

To determine condition of the raise-lower solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test solenoid.

Procedure



MX20165

1. Measure resistance with JT05791A Digital Multimeter between solenoid connector terminals (A and B). Resistance must be within specification.

2. Check for grounds or shorts between solenoid terminals (A and B) and bare metal of the solenoid core (C). There must be NO continuity between terminal (A or B) and core.

Results

- If resistance between terminals is not within specification, replace solenoid.
- If continuity exists between terminals and core, replace solenoid.

Specifications

Raise Solenoid Resistance . . . . . 10 ± 2 ohms
Lower Solenoid Resistance . . . . . 10 ± 2 ohms

Hydraulic Filter Restriction Switch Test

Reason

To determine if the hydraulic filter restriction switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test hydraulic filter restriction switch.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect hydraulic filter restriction switch connector from main harness connector (X25), 330A Grn wire and 104E Blk wire.
5. Check for continuity with JT05791A Digital Multimeter between the switch connector terminals.
6. Start and run engine at FAST idle.
7. Check for continuity between the switch terminals.

Results

- There must be NO continuity between the switch terminals when hydraulic oil pressure is 207 kPa (30 psi) or lower.
- There must be continuity between the switch terminals when hydraulic oil pressure is 276 ± 28 kPa (40 ± 4 psi) or higher.
- If not to specification, replace hydraulic filter restriction switch.

Specifications

Hydraulic Filter Restriction Switch

Closing Pressure . . . . . .276 ± 28 kPa (40 ± 4 psi)
Opening Pressure. . . . . .207 kPa (30 psi)

Cruise Control Magnet Test

Reason

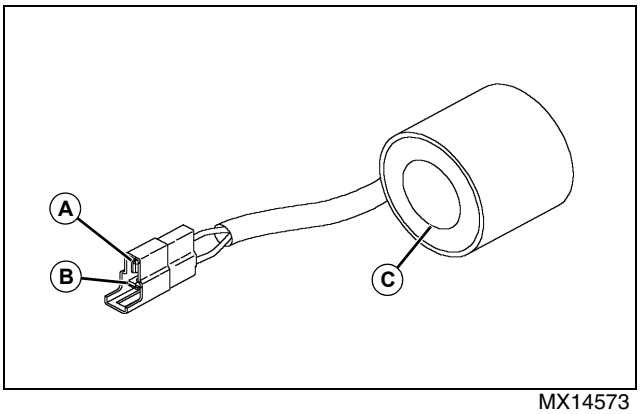
To determine condition of the cruise control magnet.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test cruise control magnet.

Procedure

1. Disconnect cruise control magnet connector from main wire harness.



MX14573

2. Check resistance with JT05791A Digital Multimeter between cruise control magnet connector terminal (A and B). Resistance must be within specification.
3. Check for grounds or shorts between magnet terminals (A and B) and bare metal of the magnet core (C). There must be NO continuity between terminal (A or B) and core (C).

Results

- If resistance between terminals is not within specification, replace magnet core.
- If continuity exists between terminal and core, replace magnet core.

Specifications

Cruise Control Magnet Core

Coil Resistance . . . . . 20 ± 4 ohms

Air Preheater Test

Reason

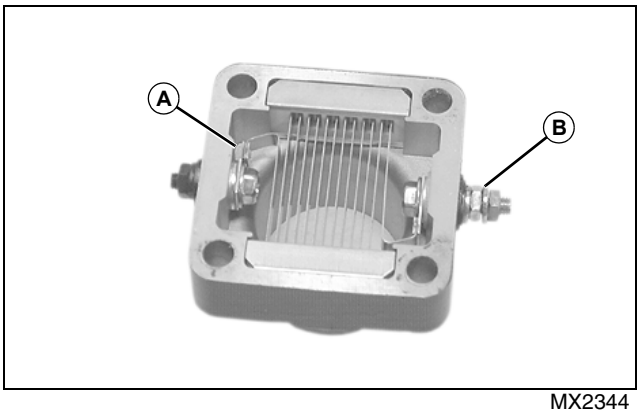
To test the condition of the engine air preheater.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure the resistance of the air preheater element.

Procedure

1. Remove air preheater.



MX2344

2. Measure the resistance with JT05791A Digital Multimeter between terminals (A and B). The reading must be to specification.

Results

If the resistance of the air preheater element is high or completely open, replace the element.

Specifications

Air Preheater

Element Resistance . . . . . 0.40-0.50 ohm

Reel Motor Test

Special or Required Tools

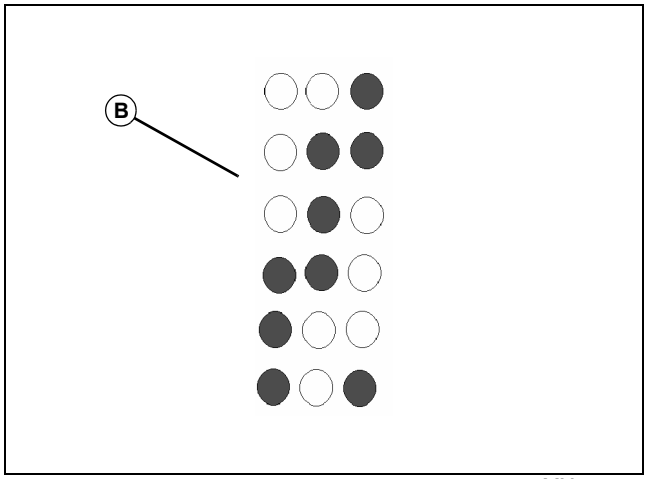
Tool Name	Tool No.	Tool Use
Diagnostic Tool	JDG10429	Used to test electric reel motor.

Reason

To determine if reel motor is operating properly.

Procedure

1. Machine parked on a level surface.
2. Key switch in STOP position.
3. Brake pedal in LOCKED position.
4. Connect reel motor 6-pin connector (A) to the diagnostic tool.



MX23605

5. When the gear on the motor is rotated, the diagnostic tool will light the LEDs in the order as indicated on pattern (B). Depending on the direction the gear is rotated, the pattern may be indicated in the reverse order. Amber LED must be ON at all times.
6. While rotating the gear, move the wires near the connector terminals. Observe the light pattern. An erratic light pattern indicates a broken wire. Use the following chart to pinpoint which wire is broken:

Symptom	Probable Cause
No lights.	Broken black wire or contamination of the black wire terminal.
No red lights.	Broken red wire or contamination of the red wire terminal.
No amber light.	Broken blue wire or contamination of the blue wire terminal.
One red light not functioning.	Broken green, white, or orange wire or contamination of one of these terminals.

7. Repair broken wires and clean terminals as needed.

8. While rotating the gear, move the wire harness at the area where the harness enters the body of the motor. Observe the light pattern. If any of the lights flickers or goes out while moving the wire harness, replace the motor.

Results

- Repair broken wires and clean terminals as needed.
- If a broken wire is determined to be near or inside the motor body, the motor must be replaced.

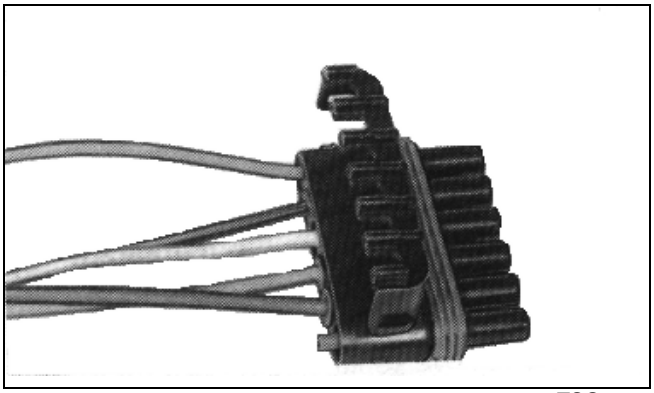
Repair

WEATHER PACK™ Connector Removal

Special or Required Tools

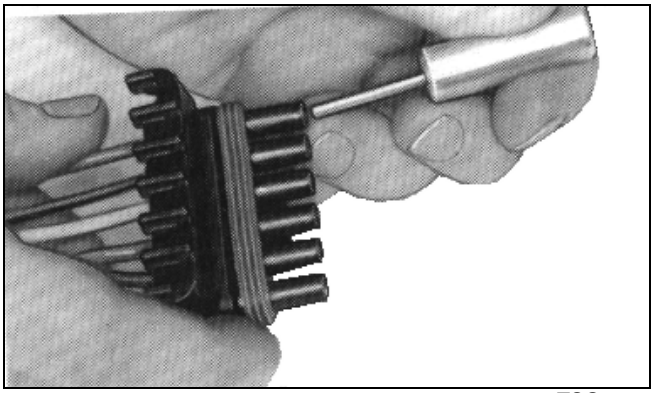
Tool Name	Tool No.	Tool Use
Weatherpack extractor	JDG364	Used to extract terminals.

Important: Avoid Damage! Identify wire color locations with connector terminal letters.



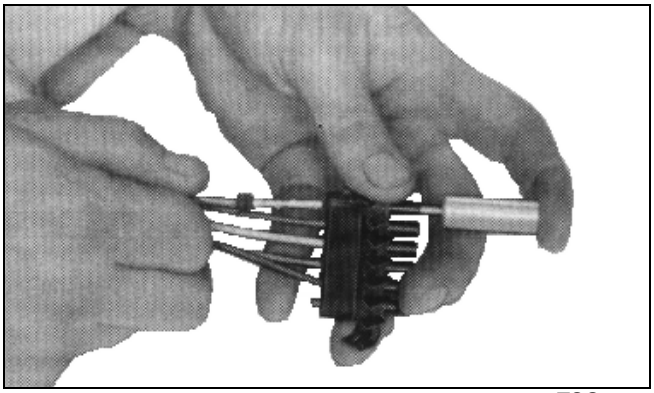
TSO127

1. Open connector body.



TSO128

2. Insert JDG364 Weatherpack extractor, over terminal contact in connector body.



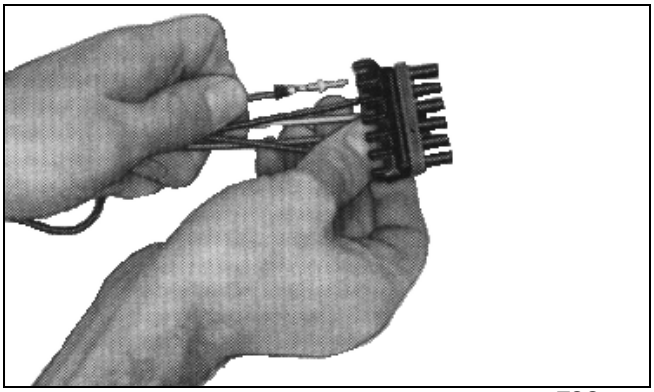
TSO129

3. Hold the extraction tool fully seated and pull wire from connector body.

Important: Avoid Damage! Carefully spread contact lances to ensure good seating on connector body.

Note: If terminal cannot be removed, insert wire or nail through extractor tool handle and push terminal contact from connector.

Connector bodies are "keyed" for proper contact mating. Be sure contacts are in proper alignment.



TSO130

4. Push contact into new connector body until fully seated.

5. Pull on wire slightly to be certain contact is locked in place.

6. Transfer remaining wires to correct terminal in new connector.

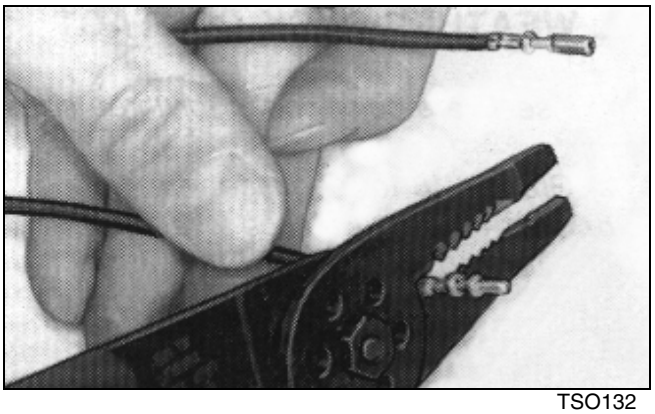
7. Close connector body.

WEATHER PACK™ Connector Terminal Replacement

Special or Required Tools

Tool Name	Tool No.	Tool Use
Electrician's Pliers	JDG145	Used to cut and strip wire.
Crimper	JDG360	Used to crimp contact in place on wire. Used to secure cable seal to contact.

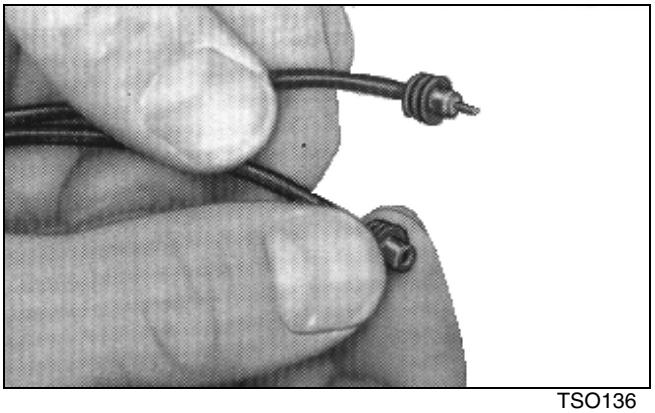
1. Remove wire from connector body as described above.



TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

Important: Avoid Damage! WEATHER PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.



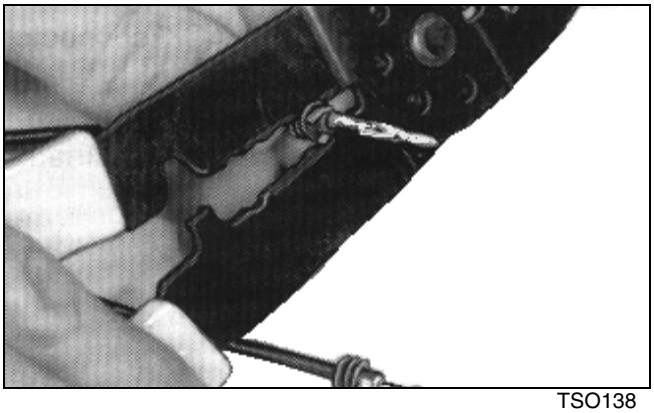
TSO136

3. Install correct size cable seal on wire.

Note: Cable seals are color coded for three sizes of wire:

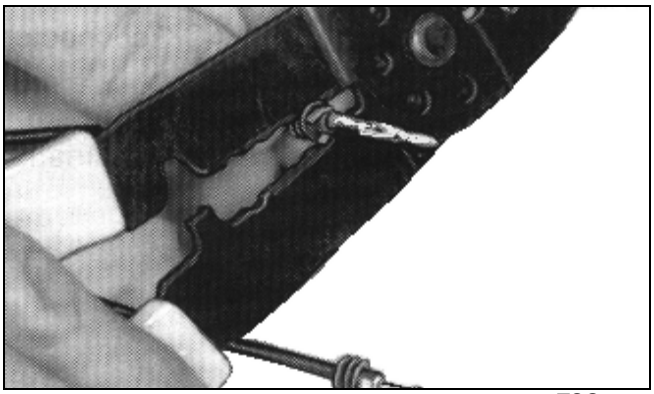
- ***Green - 18 to 20 gauge wire***
- ***Gray - 14 to 16 gauge wire***
- ***Blue - 10 to 12 gauge wire***

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.



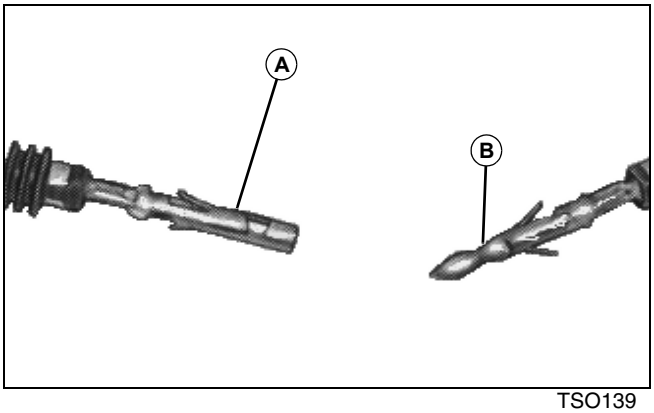
TSO138

5. Place proper size contact on wire and use JDG360 Crimper to crimp contact in place with a "W" type crimp.



TSO138

6. Use crimper to secure cable seal to contact as shown.



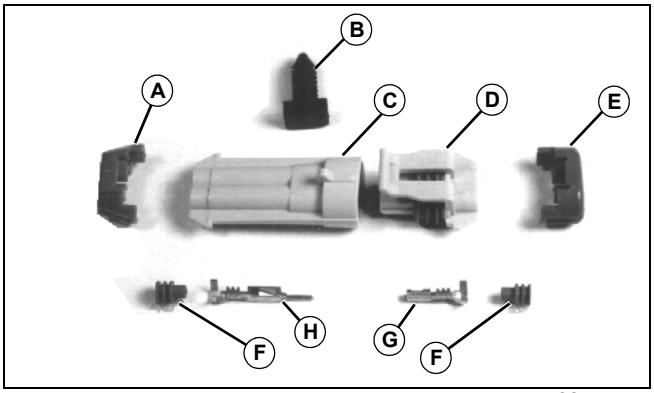
TSO139

Important: Avoid Damage! Proper contact installation for sleeve (A) and pin (B) is shown.

METRI-PACK™ Connector Removal

Special or Required Tools

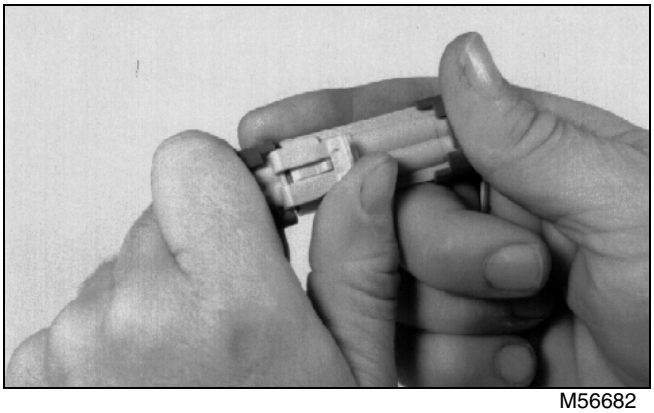
Tool Name	Tool No.	Tool Use
Extractor Weatherpack, Narrow	JDG777	Used to depress locking tang and remove contact.



M56685

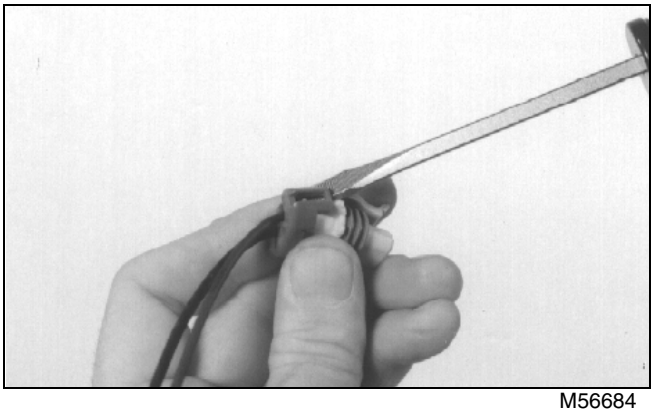
A- Wire Retainer
B- Mounting Post
C- Pin Body
D- Sleeve Body
E- Wire Retainer
F- SHURE-Seal
G- Sleeve
H- Pin

Important: Avoid Damage! Identify wire number/ color locations with connector terminal letters.



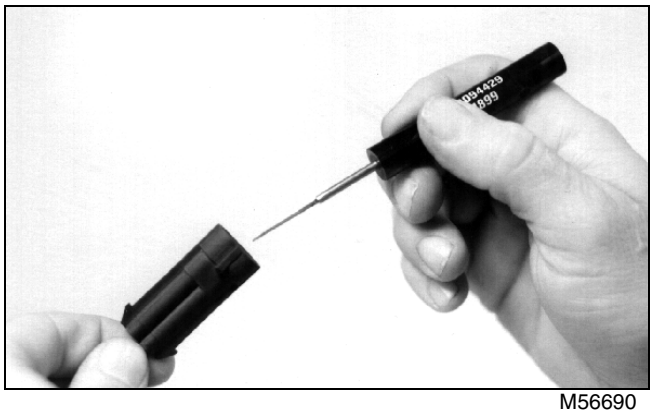
M56682

1. Open connector body.

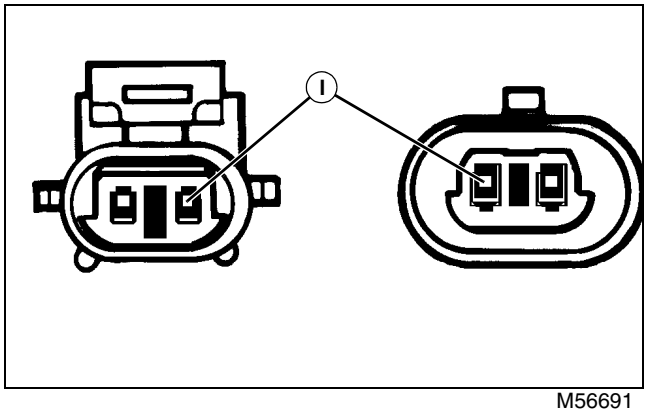


M56684

2. Remove retainer on wire end of connector with a screwdriver.



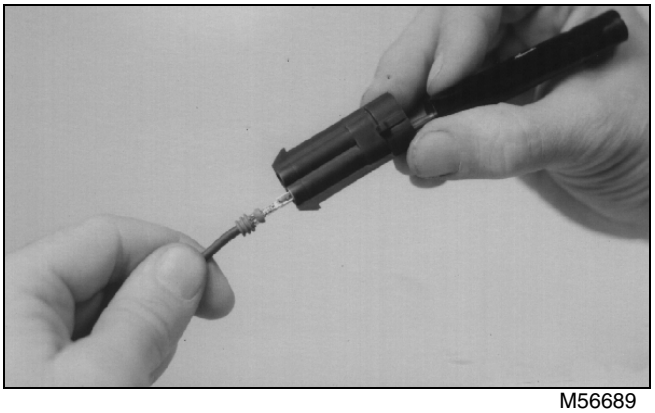
M56690



M56691

3. Use JDG777 Weatherpack, narrow extractor to remove contact from connector body at position (I).

Note: To remove sleeve connector from sleeve body (short connector half), insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half), insert tool in center of contact.


M56689

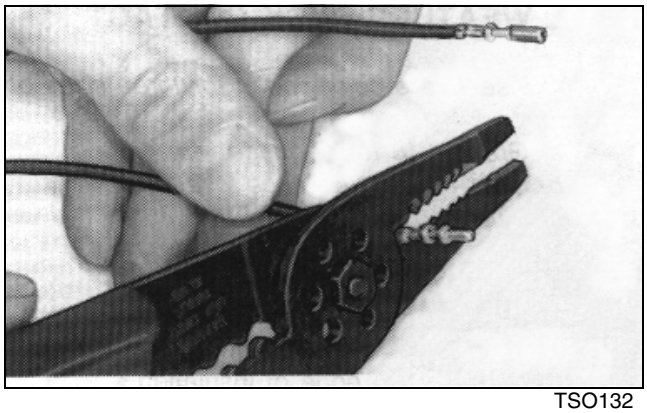
4. Hold the removal tool fully seated and pull wire from connector body.

METRI-PACK™ Connector Replacement

Special or Required Tools

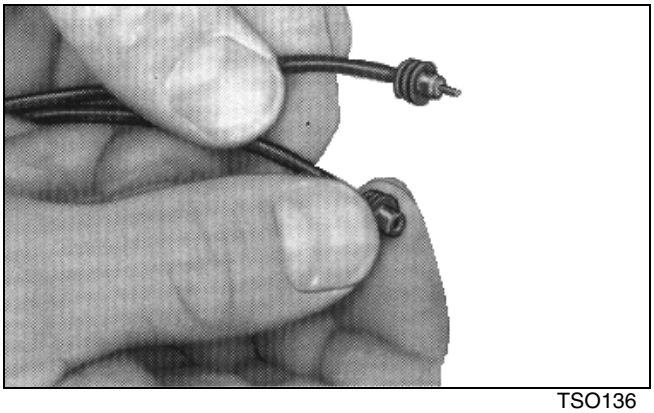
Tool Name	Tool No.	Tool Use
Electrician's Pliers	JDG145	Used to cut and strip wire.
Crimper	JDG360	Used to crimp contact in place on wire. Used to secure cable seal to contact.

1. Remove wire from connector body as described above.


TSO132

2. Use JDG145 Electrician's Pliers to remove wire as close as possible to old contact.

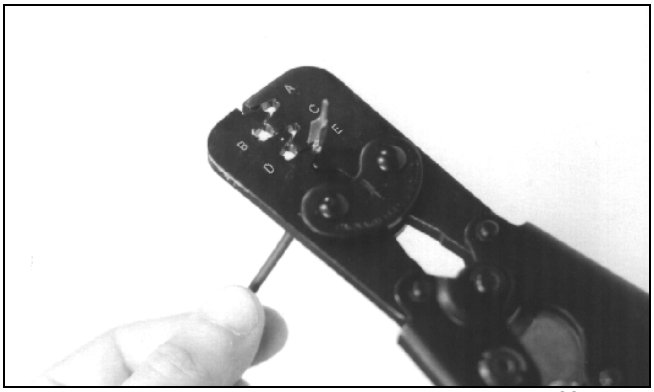
Important: Avoid Damage! METRI-PACK connectors are keyed A, B, C, etc., for proper contact mating. Be sure contacts and wire colors/numbers match and are in proper alignment.


TSO136

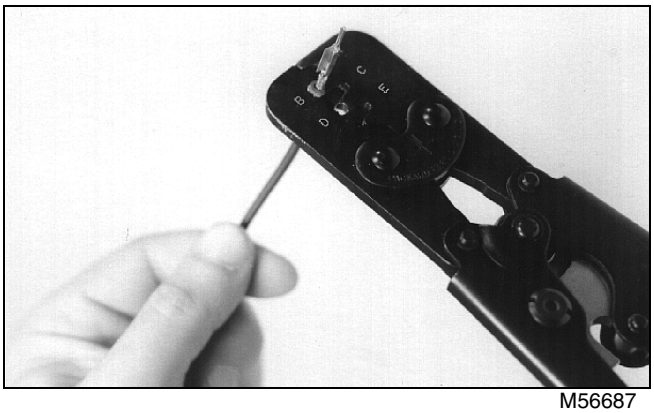
3. Install correct size cable seal on wire.

Note: Cable seals are available for three sizes of wire:
- ***Large - 1.0 mm (16 gauge) wire***
- ***Medium - 0.8 mm (18 gauge) wire***
- ***Small - 0.5 mm (20 gauge) wire***

4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.


M56686

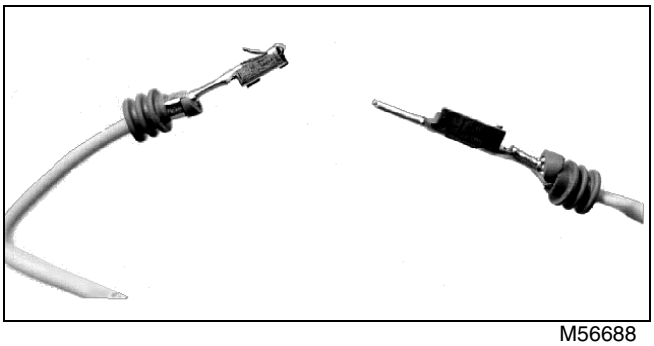
5. Place proper size contact on wire and use crimper to crimp contact in place with a "W" type crimp.


M56687

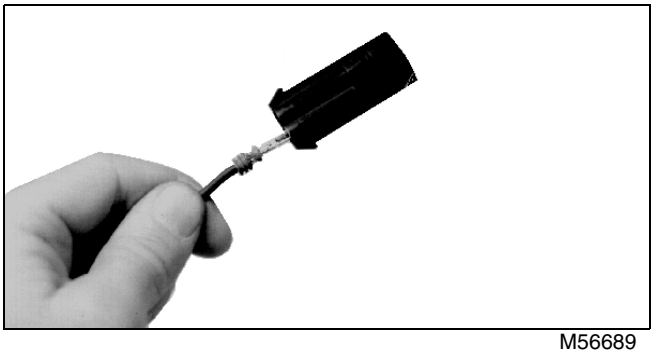
6. Use crimper to secure cable seal to contact as shown.

Important: Avoid Damage! Proper barb location and orientation for installation of sleeve and pin are shown.

Note: Connector bodies are keyed for proper contact mating. Be sure contacts are in proper alignment.



M56688

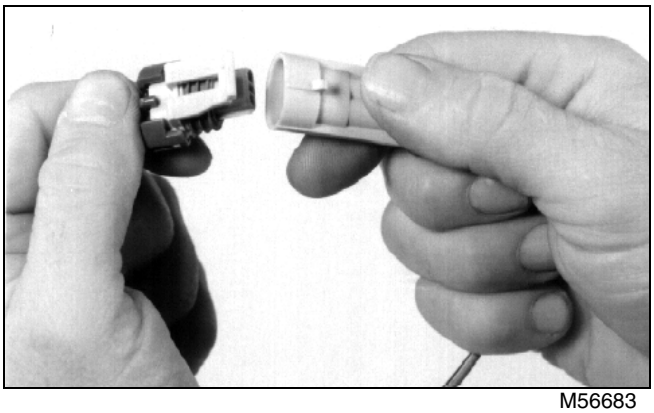


M56689

7. Push contact into new connector body until fully seated.

8. Pull on wire slightly to be certain terminal is locked in place.

9. Install wire retainer.



M56683

10.Transfer remaining wires to correct terminal in new connector.

11.Place retainer on wire end of connector and snap in place.

12.Close connector body.

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Remove and Install Battery 466
Clean Battery 466
Remove METRI-PACK™ Connector 466
Replace METRI-PACK™ Connector 467
Remove WEATHER PACK™ Connector 469
Repair Reel Motor Wiring Harness 470

Specifications

General Specifications

Battery

Voltage	12 volts
BCI Group	51
CCA Rating at -18°C (0°F)	500 amps
Reserve Capacity	85 min
Specific Gravity	1.225 or above
Load Test for 5 Seconds	480 amps

Starter

Type	Denso solenoid shift
Loaded Draw at 900 RPM	280 amps
No-Load (Free Spinning) Draw at 3000 RPM	90 amps

Alternator - 12 Volt

Type	Denso
Regulator	Internal
Rating	45 amps
Regulated Voltage	13.9-14.6 volts

Alternator - 48 Volt

Type	Iskra
Regulator/Rectifier	Internal
Rating	180 amps
Regulated Voltage	48 volts

Electrical Components

Engine Coolant Temperature Switch Closing Temperature	107-113°C (225-235°F)
Fuel Shutoff Solenoid Pull-In Coil Resistance	0.4 ohms
Fuel Shutoff Solenoid Hold-In Coil Resistance	23.6 ohms
Engine Oil Pressure Switch Closing Pressure	0.05 ± 0.01 MPa (7 ± 1.5 psi)
4WD Bypass Solenoid Coil Resistance	10 ± 2 ohms
Raise Solenoid Coil Resistance	10 ± 2 ohms
Lower Solenoid Coil Resistance	10 ± 2 ohms
Hydraulic Oil Temperature Switch Closing Temperature	93°C (200 ± 7.5°F)
Hydraulic Oil Filter Restriction Switch Closing Pressure	276 ± 28 kPa (40 ± 4 psi)
Hydraulic Oil Filter Restriction Switch Opening Pressure	207 kPa (30 psi)
Air Preheater Resistance	0.40-05.0 ohm
Cruise Control Magnet Coil Resistance	20 ± 4 ohms
Headlights (Halogen) Three @ 50 Watts	150 watts

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	N/A	Used to test battery.
Battery Load Tester	JT05685	Used to test battery, alternator amperage and voltage, and starter loaded amperage draw.
Battery Charger (Variable Rate) (use according to manufacturer's instructions)	N/A	Used to charge battery.
Digital Multimeter	JT05791A	Used to test alternator amperage and voltage. Used to test diodes, switches, relays, solenoids, and fuses for continuity.
Current Clamp-On Probe	JT02153	Used to measure starting motor current.
Hand Held Digital Tachometer	JT05719	Used to measure rpm.
Weatherpack, Narrow	JDG777	Used to remove terminal from connector body.
Weatherpack, Extractor	JDG364	Used to remove terminal from connector body.
Weatherpack, Extractor Wide	JDG776	Used to remove terminal from connector body
Electrician's Pliers	JDG145	Used to strip insulation from wire.
Crimper	JDG360	Used to crimp terminals on wire.
Thermometer	N/A	Used to measure water temperature.
Two (2) Jumper Wires	N/A	Used to test starter solenoid, relays, and fuel pump.
Two (2) Jumper Cables	N/A	Used to test starter solenoid.
12-Volt Battery	N/A	Used to test starter solenoid and relays.

Materials

Other Material

Part No.	Part Name	Part Use
N/A	Dielectric Grease	Seal connections.
N/A	Dow 739 RTV Sealant	Waterproof connections.

General Information

Theory of Operation Information

The theory of operation stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and shows only the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematics are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures are used to test the complete circuit regardless of the problem or complaint. Select a circuit or symptom from Circuit Operation and Diagnosis and follow the test procedures under that heading.

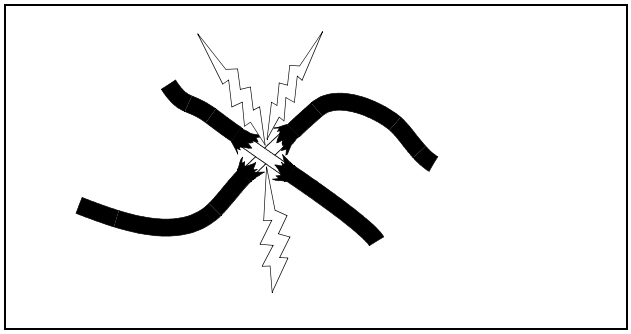
The diagnostic procedure provides:

- Test conditions
- Test location
- A question regarding the normal reading
- A yes or no answer based on the test results

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully.

Common Circuit Tests

Shorted Circuit



MIF (M85600)

A shorted circuit may result in the wrong component operating (i.e., improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

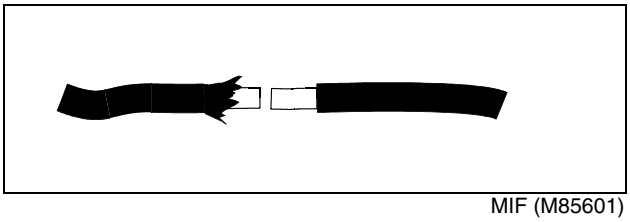
1. Turn component switch ON.

2. Start at the controlling switch of the component that should not be operating.

3. Follow the circuit and disconnect wires at connectors until component stops operating.

4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Open Circuit



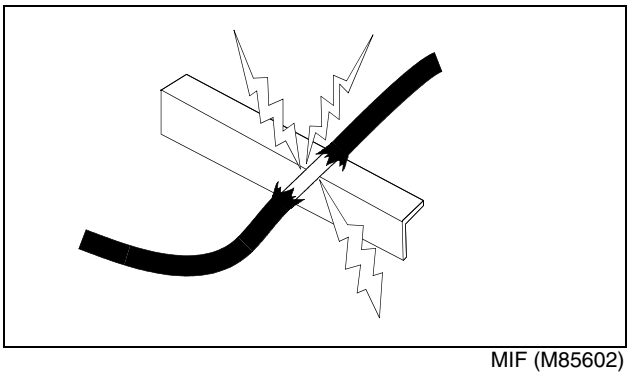
MIF (M85601)

High resistance or open circuits usually result in slow, dim, or no component operation (i.e., poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.

2. If terminals are not corroded or loose, the problem is in the component or wiring.

Grounded Circuit



MIF (M85602)

Grounded circuits usually result in no component operation or a blown fuse.

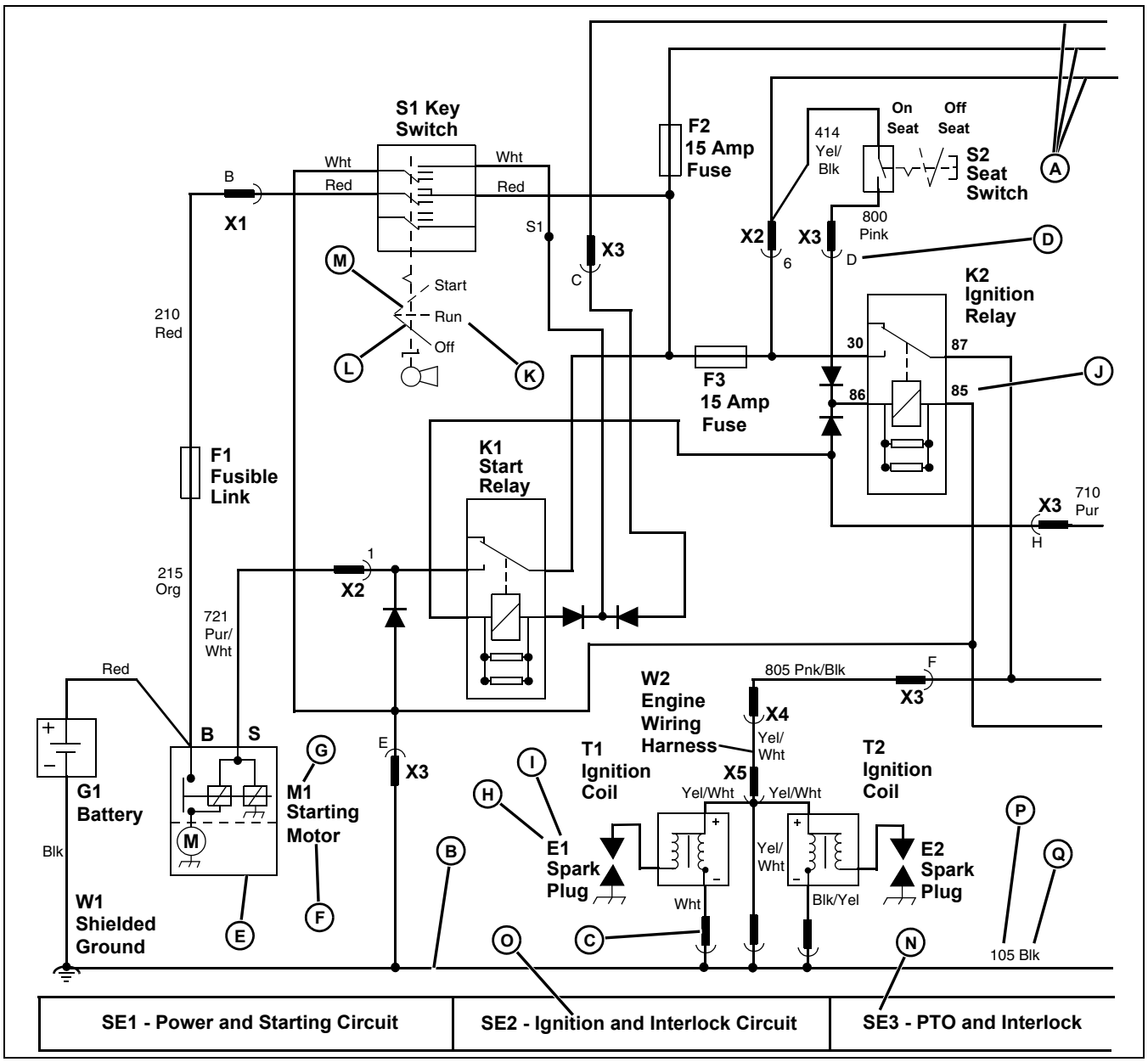
1. Turn machine power OFF.

2. Test component between power side of component and ground with an ohmmeter.

3. If there is low resistance, the component or wiring is likely shorted to ground.

4. Trace wiring back and check for broken or melted insulation and contact to a ground source or another failed component in the circuit.

Reading Electrical Schematics



MIF

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the OFF position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly outside the symbol. The solid line (L) shows the position the switch is currently in, and dash lines (M) represent other switch positions.

Each circuit is identified at the bottom of the drawing by a section number (N) and section name (O).

The circuit number (P) and wire color (Q) are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

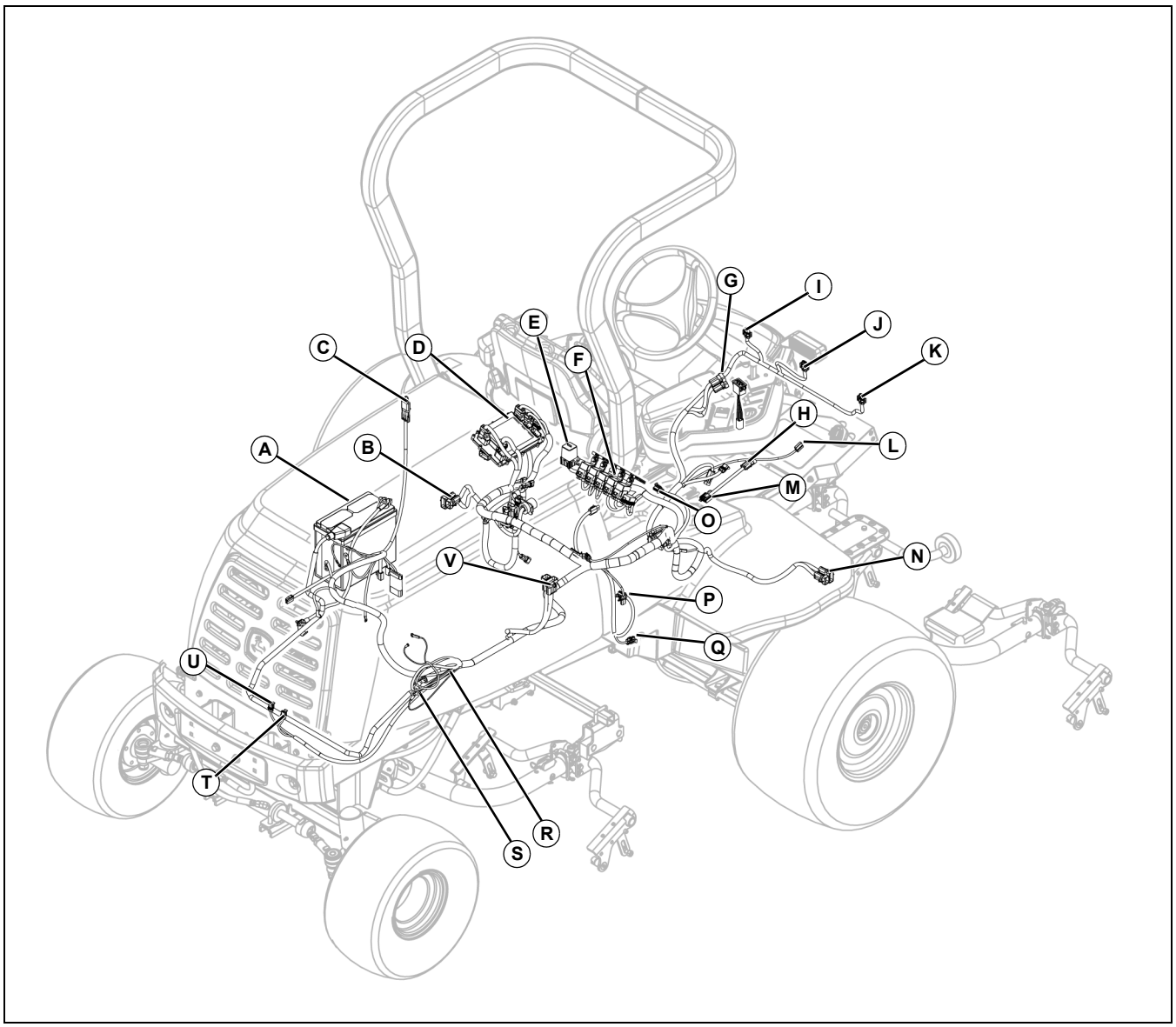
Wire Color Abbreviation Chart

Blk . . . . . **Black**
Blu . . . . . **Blue**
Brn . . . . . **Brown**
Gry . . . . . **Gray**
Org . . . . . **Orange**
Pnk . . . . . **Pink**
Pur . . . . . **Purple**
Red . . . . . **Red**
Tan . . . . . **Tan**
Wht . . . . . **White**
Yel . . . . . **Yellow**

Conductors for 12-Volt Circuits

Stranded Conductors for 12-Volt Circuits									
SAE Wire Size (Gauge)	20	18	16	14	12	10	8	6	4
Metric Wire Size (mm)	0.5	0.8	1.0	2.0	3.0	5.0	8.0	15.0	20.0
Typical Stranding	7 x 28	16 x 30	19 x 29	19 x 27	19 x 25	19 x 23	19 x 21	37 x 21	61 x 22
Minimum Conductor Area in Circular Mils	1072	1537	2336	3702	5833	9343	14,810	25,910	37,360

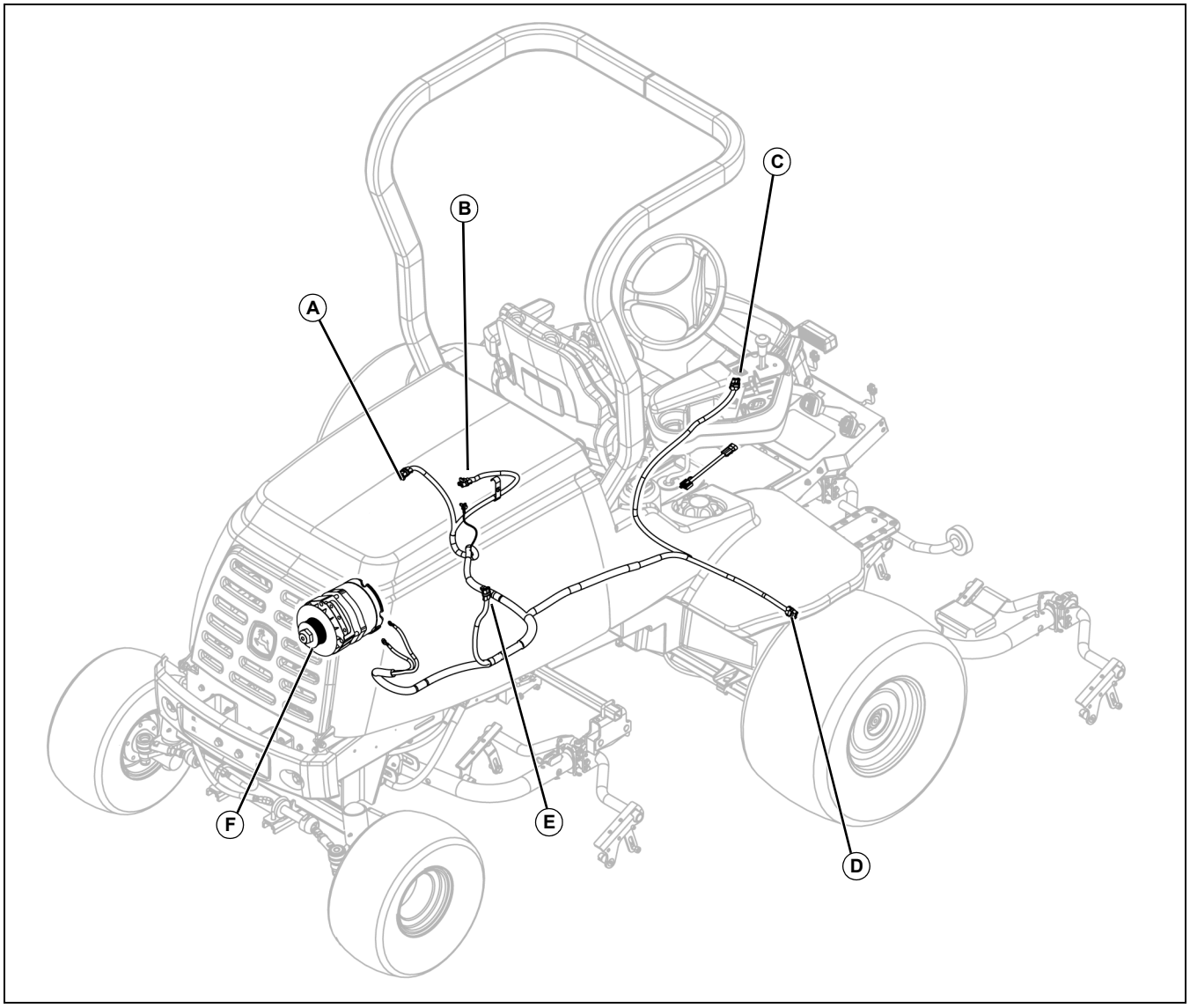
Component Location **Electrical Components**



MX41256

A- Battery
B- Controller
C- Seat Switch (S5)
D- A1 Controller (SOS)
E- Fuse/Diode Block (MC-FB1)
F- Relays
G- Front Center Controller (MC-35)
H- Motion Sensing Switch (MC-160)
I- Left Worklamp Connector (MC-1)
J- Center Worklamp Connector (MC-2)
K- Right Worklamp Connector (MC-3)
L- Cruise Control Connector (MC-4)
M- Park Brake Switch (MC-7)
N- Front Right Controller Connector (MC-36)
O- Seat Switch (MC-10)
P- Hydraulic Oil Temp Switch (MC-9)
Q- Hydraulic Filter Restriction Switch (MC-8)
R- Engine-to-Frame Ground Strap
S- Starting Motor Connectors
T- 4WD Bypass Connector (MC-52)
U- 4WD Bypass Connector (MC-53)
V- Right Rear Controller Connector (MC-33)

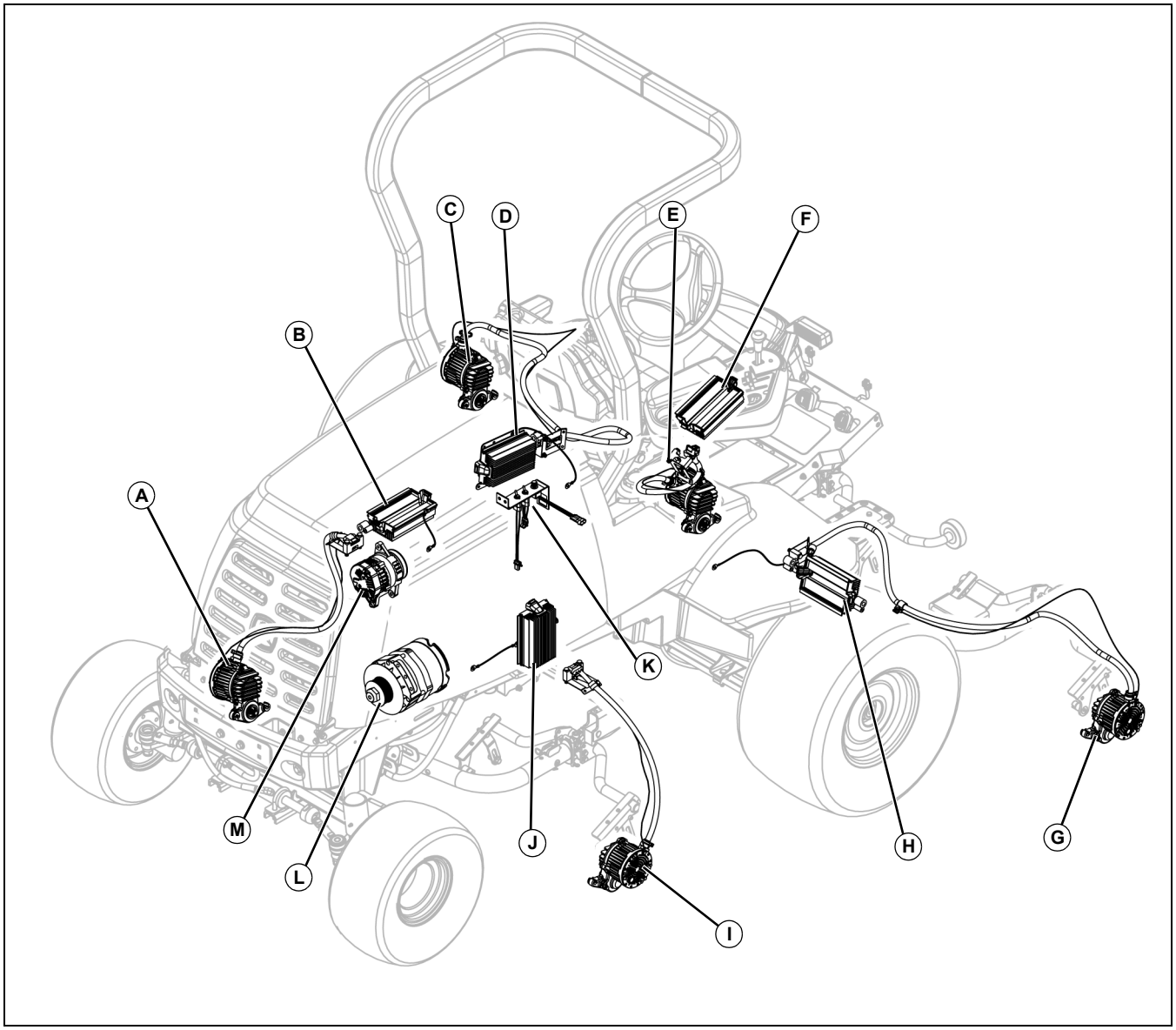
48 Volt Controller Harness



MX41258

A- 48V Alternator
B- FL48 Connector to FL Controller RMC1
C- FC48 Connector to FC Controller RMC3
D- FR48 Connector to FR Controller RMC5
E- RR48 Connector to RR Controller RMC6
F- RL48 Connector to RL Controller RMC2

Controllers and Reel Motors



MX41257

A- RL Reel Motor
B- RL Controller RMC2
C- FL Reel Motor
D- FL Controller RMC1
E- FC Reel Motor
F- FC Controller RMC3
G- FR Reel Motor
H- FR Controller RMC5
I- RR Reel Motor
J- RR Controller RMC6
K- Control Switches
L- 48 V Generator
M- 12 V Generator

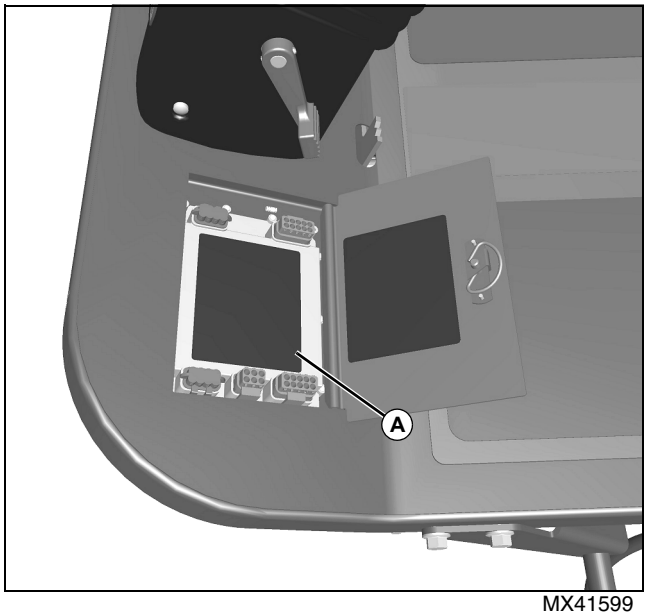
Instrument Cluster Diagnostic Indicators

Using Diagnostics

Note: When switching from transport to mow the indicator light will come on for a short period. This indicates the 48-Volt system has been activated.

If multiple cutting units shut down the codes will overlap and be more difficult to diagnose.

Reel controller diagnostics are provided to help diagnose problems with the electric powered cutting units.



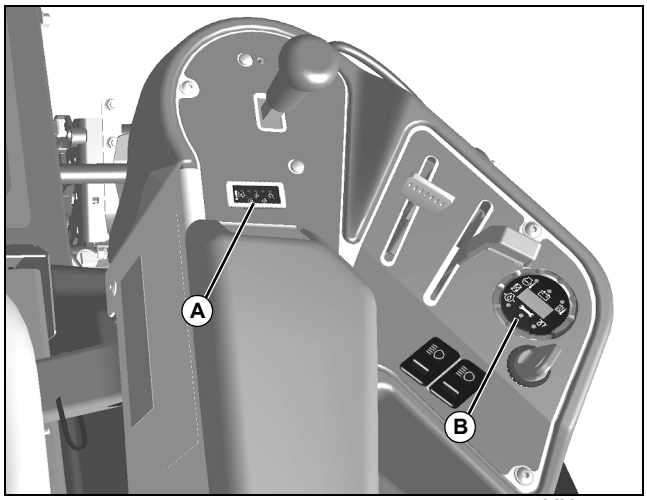
MX41599

The master control module (A) is located under the left floor panel cover. The module controls and monitors all safety interlock functions and the engine air preheater function

D18	4WD		LWFM	Wait	D35
D17	Brk Depr			Not Used	D34
D16	Seat			Cruise Magnet	D33
D15	PTO			Mow Valve Rear	D32
D14	Neutral			Mow Valve Front	D31
D13	Not used		I O	Crank Engine	D30
D12	Start		N U	4WD	D29
D11	Reverse		P T	Fuel Hold	D28
D10	Hood		U P	Not Used	D27
D9	Not used		T U	Hydraulic OT	D26
D8	Cruise Set		S T	Lamp Check	D25
D7	Brk not Depr		S	Fuel Pump	D24
D6	Backlap Rear			Fuel Pull	D23
D5	Hydraulic OT			Lower	D22
D4	Lower			Raise	D21
D3	Backlap Front			Air Preheater	D20
D2	Not used				
D1	Raise				
D0	Cruise On				

TCU22970

Instrument Indicator Cluster



MX41250

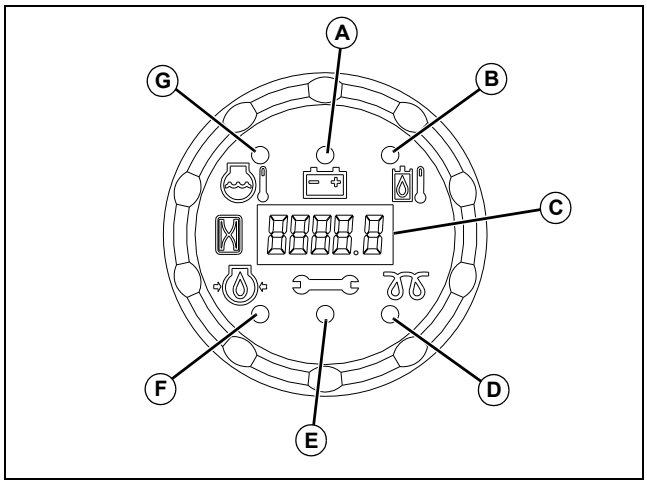
A- Fault Indicator Light (Reel Controller)

B- Indicator Light and Hour meter Module

Note: A Sit-On-Seat diagnostic code label is located on the side panel of the right side command arm, and the indicator light/hour meter module is on top of the command arm.

SIT ON SEAT DIAGNOSTIC CODES:	CODIGOS PARA DIAGNOSTICO DE FALLA CON ASIENTO OCUPADO:
1-2 Brake not engaged	1-2 Freno no aplicado
1-3 Attempted start with PTO turned on	1-3 Se intentó el arranque con la TDF engranada
2-1 Traction pedals out of neutral	2-1 Pedales de la tracción fuera del hilo neutro
2-2 Hydraulic overtemp	2-2 Sobretemperatura del aceite hidráulico
2-3 Hood switch open	2-3 Interruptor de la capilla abierto
HARNESS TROUBLE CODES FOR CHECKING SOFTWARE:	**CODIGOS DE AVERIA DE ARNES PARA COMPROBACION DE SOFTWARE:**
3-1 Overvoltage	3-1 Sobrevoltaje
3-5 Missing ground input connection	3-5 Conexión a tierra faltante en entrada
3-6 Missing power input connection	3-6 Conexión a alimentación faltante en entrada
3-7 Internal overtemperature	3-7 Sobretemperatura interna
9-1 Invalid software selected	9-1 Selección no válida de software
SEE OPERATOR'S MANUAL FOR MORE DETAIL	VER EL MANUAL DEL OPERADOR PARA MAS INFORMACION

TCU16303



MIF

A- Battery LED
B- Hydraulic Oil Temperature LED
C- Hour Meter
D- Preheat LED
E- Hydraulic Filter LED
F- Engine Oil Pressure LED
G- Engine Coolant Temperature LED

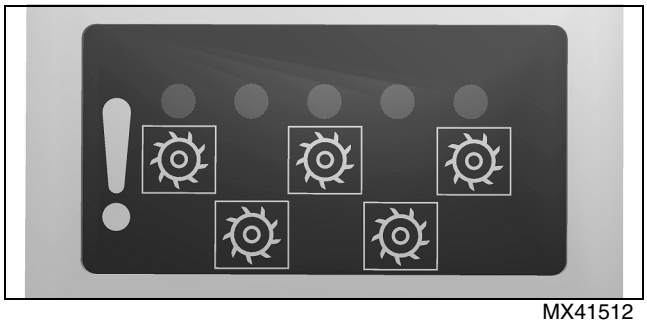
Harness Troubleshooting Codes for Checking Software

Reel Controller Diagnostic Codes

Note: Reel controller diagnostic code label is located on the side panel of the right side command arm, and the fault indicator light (reel controller) is on top of the command arm.

REEL CONTROLLER DIAGNOSTIC CODES:		CODES DE DIAGNOSTIC DE CONTRÔLEUR DE CYLINDRE:
1-5	Motor No Start	Pas de démarrage du moteur
1-6	Reel Stalled	Cylindre calé
1-7	48VDC Low	Tension 48 V c.c. basse
2-5, 2-6	Motor Over Current	Surintensité du moteur
2-10	Motor Over Temp	Surchauffe du moteur
SEE OPERATOR'S MANUAL FOR MORE DETAIL		CONSULTER LE LIVRET D'ENTRETIEN POUR DE PLUS AMPLES DÉTAILS

TCU26195



MX41512

Fault Indicator Light (Reel Controller)

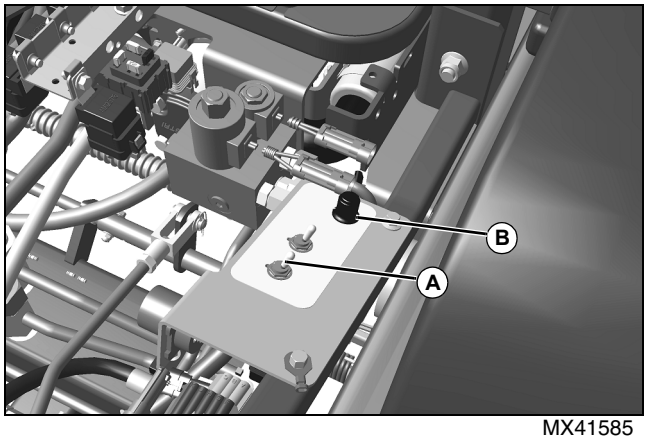
E-Cut Hybrid LED Fault Review Mode

Entering Fault Code Review Mode

Fault codes are stored in the controller memory and can be recalled, reviewed and erased at a later time. To recall the LED Fault blink codes:

Note: If engine is started and PTO is engaged then diagnostic review mode can not be entered.

- Turn key on, do not start engine.



MX41585

Note: The toggle of switch (A) must happen within the first 3 minutes of the key on or the mode will be disabled and the sequence must be completed within 3 seconds of starting the sequence.

- To retrieve codes, toggle the reel direction switch (A) in one direction then the opposite direction two complete times within 3 seconds.

- The reel controller fault indicator lights will illuminate.
  - A solid LED indicates no codes are recorded in the controller.
  - A blinking LED indicates at least one code is stored.

Stepping Through Codes

- To retrieve the next stored code, toggle the reel direction switch (A) in one direction then the opposite direction. Each time you toggle the reel direction switch in one direction then the opposite direction, you will move onto the next stored code.

Erasing Single Fault Codes

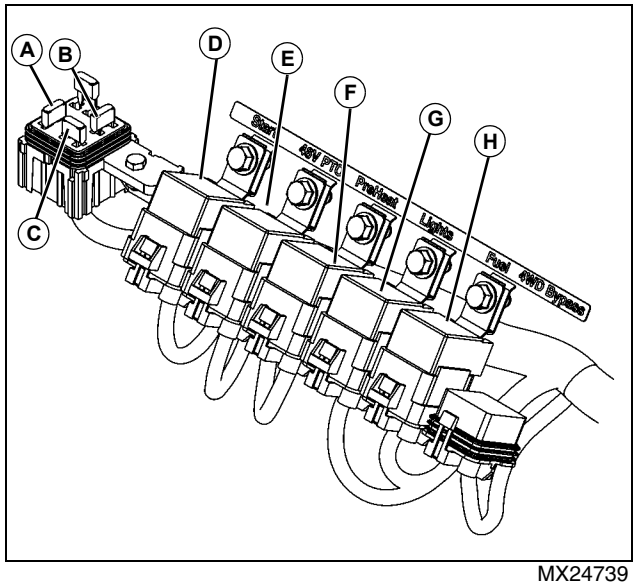
- Fault Codes can be deleted by turning the speed control knob (B) to the opposite extreme of where it is and back to other extreme.
  - The LED will turn solid for three seconds to confirm the fault code has been erased and then the next code will flash.
- When no more codes exist the LED will stay solid.

Erasing Multiple Fault Codes

- Two fault codes can be deleted by turning the speed control knob (B) to the opposite extreme three times.
- Three fault codes can be deleted by turning the speed control knob (B) to the opposite extreme four times.
  - The LED will turn solid for three seconds to confirm the fault code has been erased and then the next code will flash.

Components

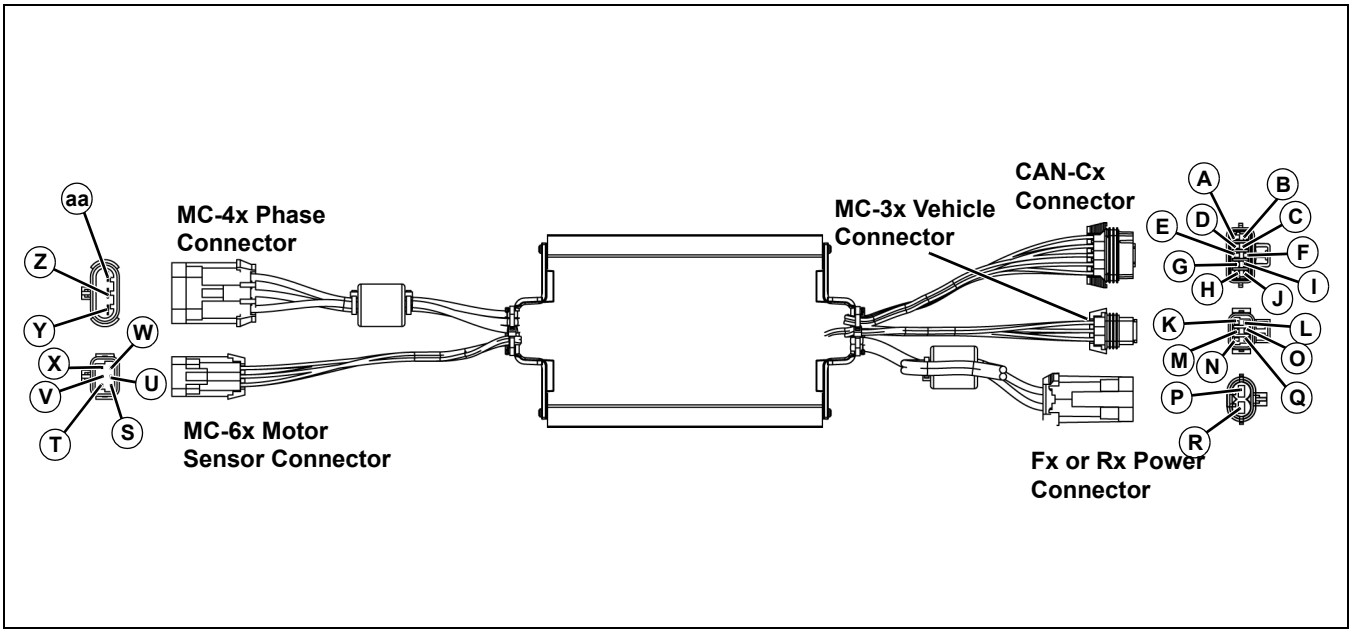
Fuse/Diode Block and Relays



MX24739

A- Work Light Fuse (F6) (20A)
B- 4WD Diode (V3)
C- Key Switch Fuse (F3) (15A)
D- Start Relay (K1)
E- 48V PTO Relay (K6)
F- Air Preheater Relay (K4)
G- Light Relay (K5)
H- Fuel Pull-In Relay (K2)

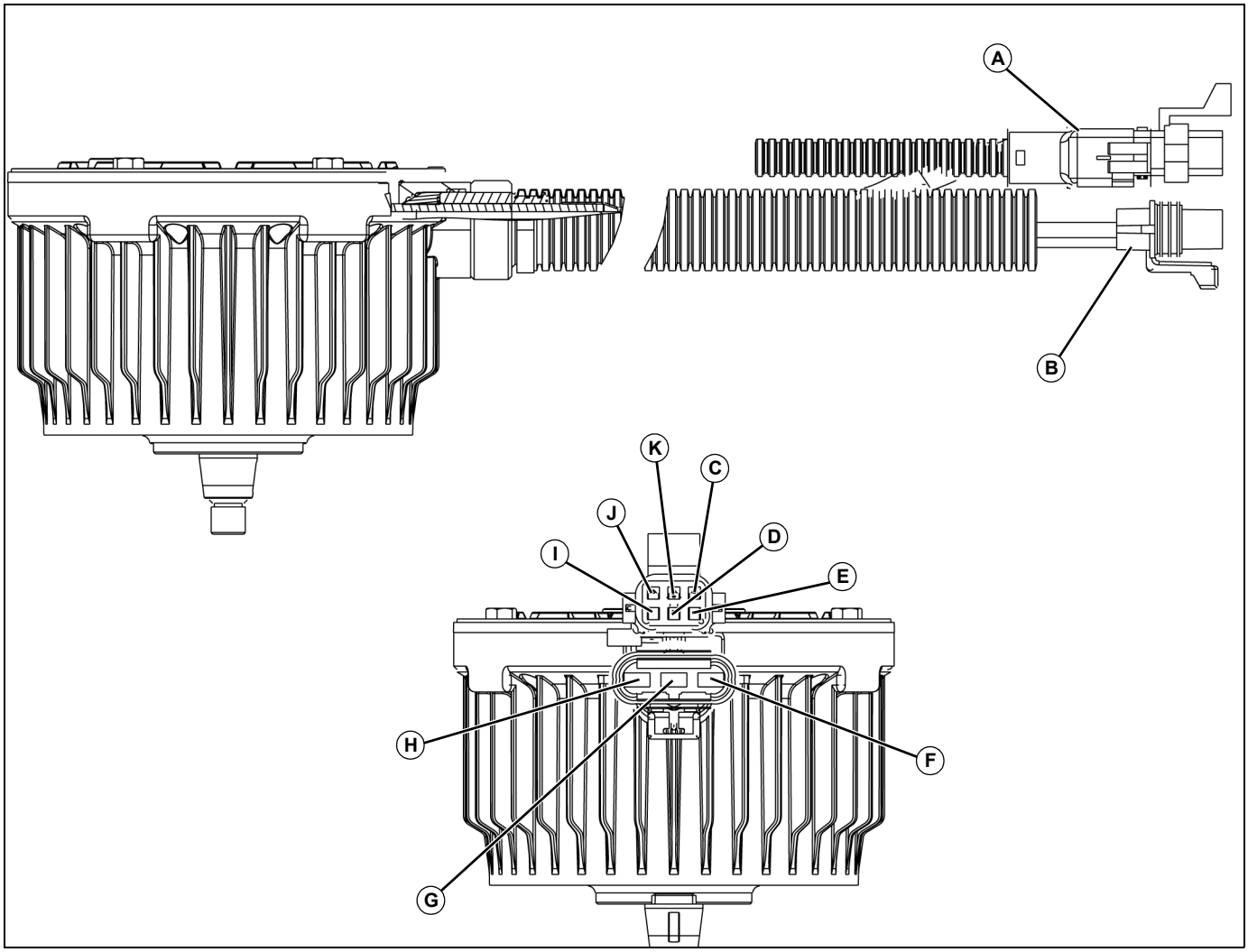
Reel Controller



MX41907

A- Red, pin E - 12Vdc Power in
B- Not Used
C- Yel, pin G - CAN Hi
D- Not Used
E- Wht, pin C - Address Bit
F- Grn, Pin H - CAN Lo
G- Pur, pin B - Address Bit (LSB)
H- Not Used
I- Not Used
J- Blu, pin K Address Bit (MSB)
K- Wht, pin C - Speed Input
L- Red, Pot Supply 4.3Vdc Out
M- Blk, pin B - Speed Potentiometer Return
N- Grn, pin A - Enable (Gnd when active)
O- Brn, pin E - Direction Control (Gnd when in Reverse)
P- Blk, pin B - 48Vdc Gnd
Q- Blu, Pin F - Fault Out (
R- Red, pin A - 48Vdc Power In
S- Blk, pin A - Sensor Return
T- Grn, pin F - Hall A-B
U- Red, pin B - 12Vdc Sensor Power Out
V- Wht, pin E - Hall B-C
W- Blu, pin C - Thermal Shutdown
X- Brn, pin D - Hall C-A
Y- Grn, pin C - Phase C
Z- Blk, pin B - Phase B
AA- Org, pin A - Phase A

Reel Motor



MX41988

A- MC6x - Motor Sensor Connector
B- MC4x - Phase Connector
C- Grn, pin F - Hall C Output
D- Red, pin B - 12Vdc Sensor Power Input
E- Blk, pin A - Gnd
F- Org, pin A - Phase A Input
G- Blk, pin B - Phase B Input
H- Grn, pin C - Phase C Input
I- Blu, pin C - Thermal Switch Output
J- Org, pin D - Hall A Output
K- Wht, pin E - Hall B Output

Schematics and Harnesses

Schematic and Wiring Harness Legend

Component

A1	Master Control Module (SE8, W2)
C2	Key Switch (SE2, W1)
C4	Raise-Lower Switch (SE9, W1)
C5	Buzzer (SE13, W1)
C6	Cruise Control Switch (SE14, W1)
C13	Diode Pack (SE13, W1)
C14	Light Switch (SE15, W1)
C15	Hybrid Cluster (SE13, W1)
C16	Controller Fault LED Array (SE7, W1)
CAN-C7	CAN Terminating Resistor (SE12, W2)
CAN-C8	CAN Terminating Resistor (SE12, W2)
E1	Left headlight
E2	Center headlight
E3	Right Headlight
F1	Fusible Link (SE2, W2)
F2	Fusible Link (SE2, W2)
F3	Key Switch Fuse (SE2, W2)
F6	Work Light Fuse (SE15, W2)
FB1	Fuse/Diode Block (SE2-5-15, W2)
G1	Battery (SE2, W2)
G2	12V Alternator (SE2, W2)
G3	48V Alternator (SE1, W3)
H2	Air Preheater LED (SE13, W1)
H3	Hydraulic Oil Temperature LED (SE13, W1)
H4	Engine Oil Pressure LED (SE13, W1)
H5	Engine Coolant Temperature LED (SE13, W1)
H6	Battery LED (SE13, W1)
H7	Filter LED (SE13, W1)
K1	Start Relay (SE2, W2)
K2	Fuel Pull-In Relay (SE3, W2)
K4	Air Preheater Relay (SE11, W2)
K5	Light Relay (SE15, W2)
K6	PTO Relay (SE11, W2)
M1	Starting Motor (SE2, W2)
MC4	Cruise Control Magnet (SE14, W2)
MC5	Speed Pot (SE6, W2)
MC6	Forward/Reverse Switch (SE6, W2)
MC7	Park Brake Switch (SE4, W10)
MC8	Filter Restriction Switch (SE13, W2)
MC9	Hydraulic Oil Temperature Switch (SE13, W2)
MC10	Seat Switch (SE4, W2)
MC11	Reverse Switch (SE4, W7)
MC19	Backlap Switch (SE9, W2)
MC21	Raise Solenoid (SE9, W2)
MC22	Lower Solenoid (SE9, W2)
MC24	Neutral Switch (SE4, W2)
MC26	Fuel Shutoff Solenoid (SE3, W2)
MC27	Fuel Pump (SE10, W2)
MC28	Resistor Pack (SE2, W2)
MC50	Fuel Shutoff Solenoid Diode (SE3, W2)
MC57	Mow Rear Diode (SE8, W2)
MC58	Mow Front Diode (SE8, W2)
MC160	Mow-Transport Switch (SE4, W2)
MT1	Engine Oil Pressure Switch (SE13, W2)
MT2	Air Preheater (SE11, W2)
MT8	Engine Coolant Temperature Switch (SE13, W2)
P1	Hour Meter (SE13, W1)
RMC1	Reel Motor Controller, Front Left (SE1, W3) (SE6, W2) (SE12, W2)
RMC2	Reel Motor Controller, Rear Left (SE1, W3) (SE6, W2) (SE12, W2)
RMC3	Reel Motor Controller, Front Center (SE1, W3) (SE6, W2) (SE12, W2)

RMC5	Reel Motor Controller, Front Right (SE1, W3) (SE6, W2) (SE12, W2)
RMC6	Reel Motor Controller, Rear Right (SE1, W3) (SE6, W2) (SE12, W2)
V3	4WD Diode (SE5, W2)
W1	Command Arm Wiring Harness
W2	Main Wiring Harness
W3	48V Wiring Harness
W7	Reverse Switch Wiring Harness
W10	Park Brake Switch Wiring Harness
4WD	4WD Bypass Relay (SE5, W2)

Connectors

C2	Key Switch Connector (W1)
C4	Raise-Lower Switch Connector (W1)
C5	Buzzer Connector (W1)
C6	Cruise Control Switch Connector (W1)
C13	Diode Pack Connector (W1)
C14	Light Switch Connector (W1)
C15	Hybrid Cluster Connector (W1)
C16	Controller Fault LED Array Connector (W1)
CT5	Command Arm Ground Connector (W1)
CT6	Command Arm Ground Connector (W1)
CAN -C1	Front Left Reel Motor Controller CAN Bus Connector (W1)
CAN -C2	Rear Left Reel Motor Controller CAN Bus Connector (W1)
CAN -C3	Front Center Reel Motor Controller CAN Bus Connector (W1)
CAN -C4	Rear Right Reel Motor Controller CAN Bus Connector (W1)
CAN -C5	Front Right Reel Motor Controller CAN Bus Connector (W1)
CAN -C6	CAN Bus Service Connector (W1)
CAN -C7	CAN Bus Termination Resistor Connector (W1)
CAN -C8	CAN Bus Termination Resistor Connector (W1)
FB1	Fuse/Diode Block Connector (W2)
FG1	Frame Ground Connector (W2)
FC48	Front Center Reel Motor Controller 48V Power Connector (W3)
FL48	Front Left Reel Motor Controller 48V Power Connector (W3)
FR48	Front Right Reel Motor Controller 48V Power Connector (W3)
G1(+)	12V Battery Positive Terminal (W2)
G1(-)	12V Battery Negative Terminal (W2)
G2(+)	12V Alternator Battery Terminal (W2)
G2(-)	12V Alternator Ground Terminal (W2)
G3(+)	48V Alternator Positive Terminal (W3)
G3(-)	48V Alternator Negative Terminal (W3)
J1	A1 Master Control Module Connector (W2)
J2	A1 Master Control Module Connector (W2)
J3	A1 Master Control Module Connector (W2)
J4	A1 Master Control Module Connector (W2)
J5	A1 Master Control Module Connector (W2)
K1	Start Relay Connector (W2)
K2	Fuel Pull-In Relay Connector (W2)
K4	Air Preheater Relay Connector (W2)
K5	Light Relay Connector (W2)
K6	PTO Relay Connector (W2)
MC1	Left Work Light Connector (W2)
MC2	Center Work Light Connector (W2)
MC3	Right Work Light Connector (W2)
MC4	Cruise Control Magnet Connector (W2)
MC5	Speed Pot Connector (W2)
MC6	Forward / Reverse Switch Connector (W2)
MC7	Park Brake Switch Harness Connector (W2, W10)
MC8	Hydraulic Filter Restriction Switch Connector (W2)

MC9 Hydraulic Oil Temperature Switch Harness Connector (W2)

MC10 Seat Switch Connector (W2)

MC11 Reverse Switch Harness Connector (W2, W6)

MC12 Command Arm Harness Connector (W1, W2)

MC13 Command Arm Harness Connector (W1, W2)

MC14 Master Control Module (J1) Connector (W2)

MC15 Master Control Module (J2) Connector (W2)

MC16 Master Control Module (J4) Connector (W2)

MC17 Master Control Module (J5) Connector (W2)

MC18 Master Control Module (J3) Connector (W2)

MC19 Backlap Switch Connector (W2)

MC21 Raise Solenoid Connector (W2)

MC22 Lower Solenoid Connector (W2)

MC24 Neutral Switch Harness Connector (W2)

MC26 Fuel Shutoff Solenoid Connector (W2)

MC27 Fuel Pump Connector (W2)

MC28 Resistor Pack Connector (W2)

MC31 Starting Motor Solenoid Connector (W2)

MC32 Rear Left Reel Motor Controller Connector (W2)

MC33 Rear Right Reel Motor Controller Connector (W2)

MC34 Front Left Reel Motor Controller Connector (W2)

MC35 Front Center Reel Motor Controller Connector (W2)

MC36 Front Right Reel Motor Controller Connector (W2)

MC37 Command Arm Harness Connector (W1, W2)

MC50 Fuel Shutoff Solenoid Diode (W2)

MC52 4WD Bypass Solenoid Connector (W2)

MC53 4WD Bypass Solenoid Connector (W2)

MC54 (not used) (W2)

MC55 (not used) (W2)

MC57 Rear Mow Diode Connector (W2)

MC58 Front Mow Diode Connector (W2)

MC99 Hood Switch Connector (W2)

MC160 Mow-Transport Switch Connector (W2)

MT1 Engine Oil Pressure Switch Connector (W2)

MT2 Air Preheater Connector (W2)

MT3 Starting Motor Battery Terminal (W2)

MT8 Engine Coolant Temp Switch Connector (W2)

MT10 12V Alternator Field Terminal (W2)

MT11 48V Alternator Regulator Terminal (W2)

PTO 48V Power Relay Connector (W2)

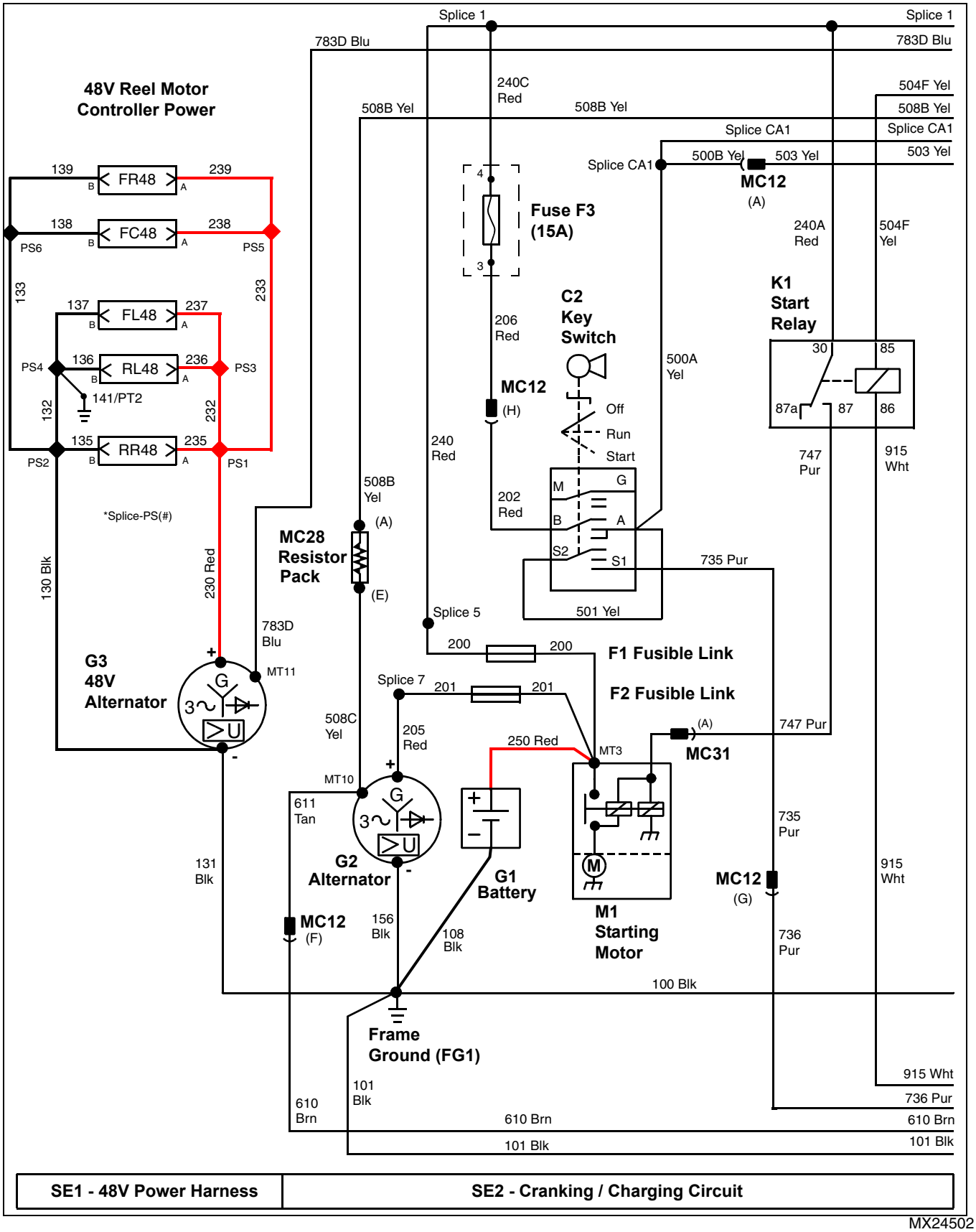
PT2 48V Power Harness Ground Connector (W3)

RL48 Rear Left Reel Motor Controller 48V Power Connector (W3)

RR48 Rear Right Reel Motor Controller 48V Power Connector (W3)

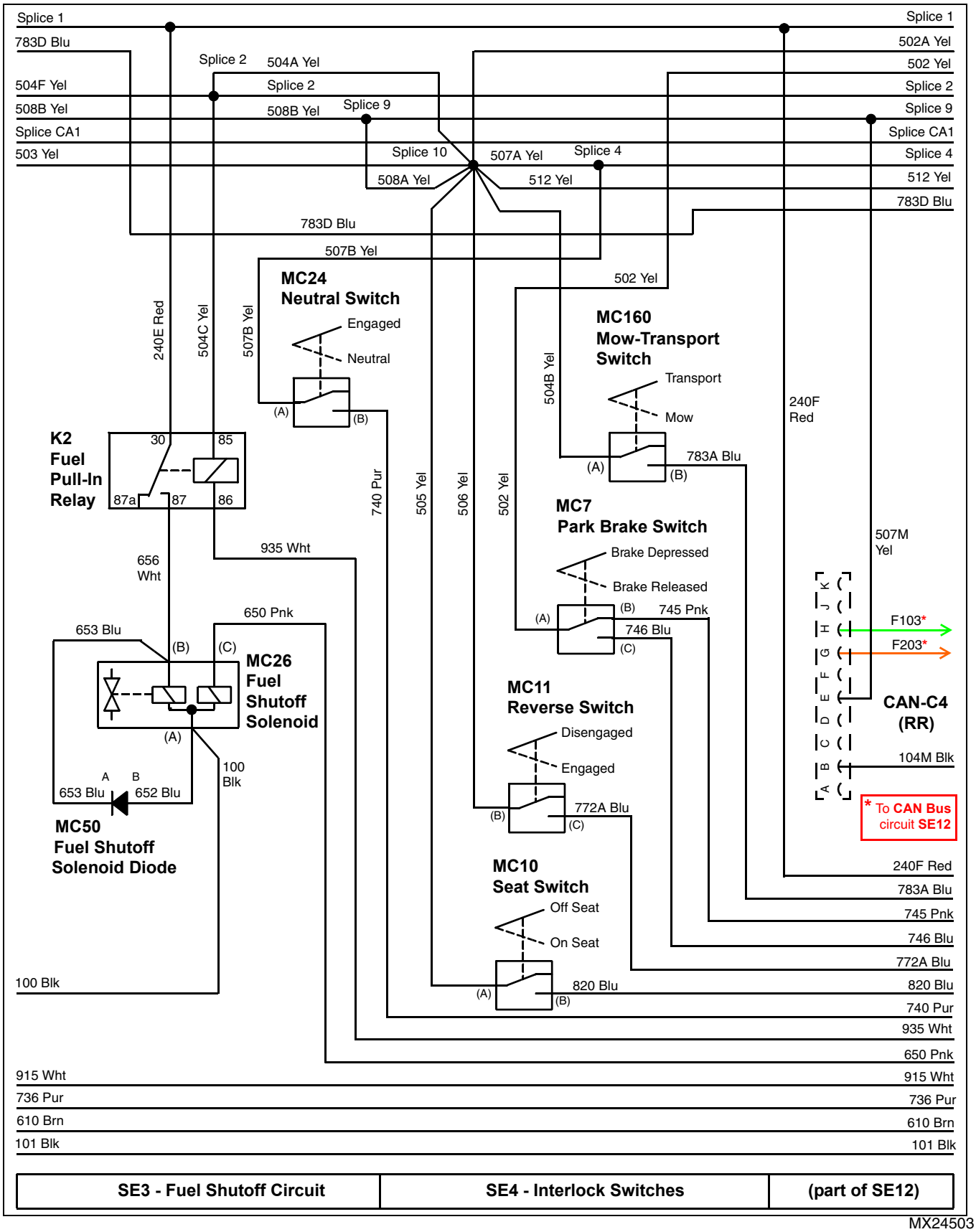
4WD 4WD Bypass Relay Connector (W2)

Main Electrical Schematic (Sheet 1 of 8)



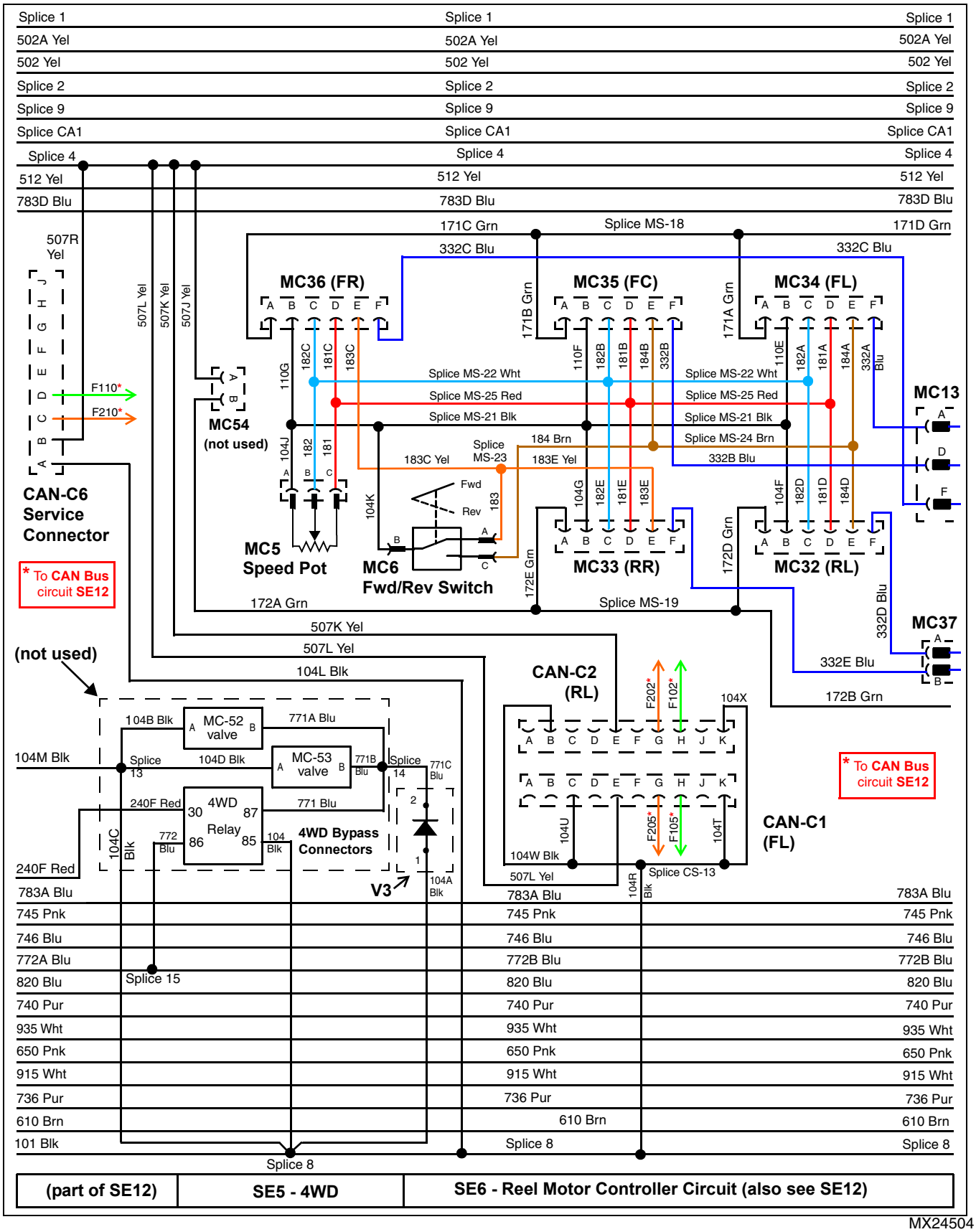
MX24502

Main Electrical Schematic (Sheet 2 of 8)



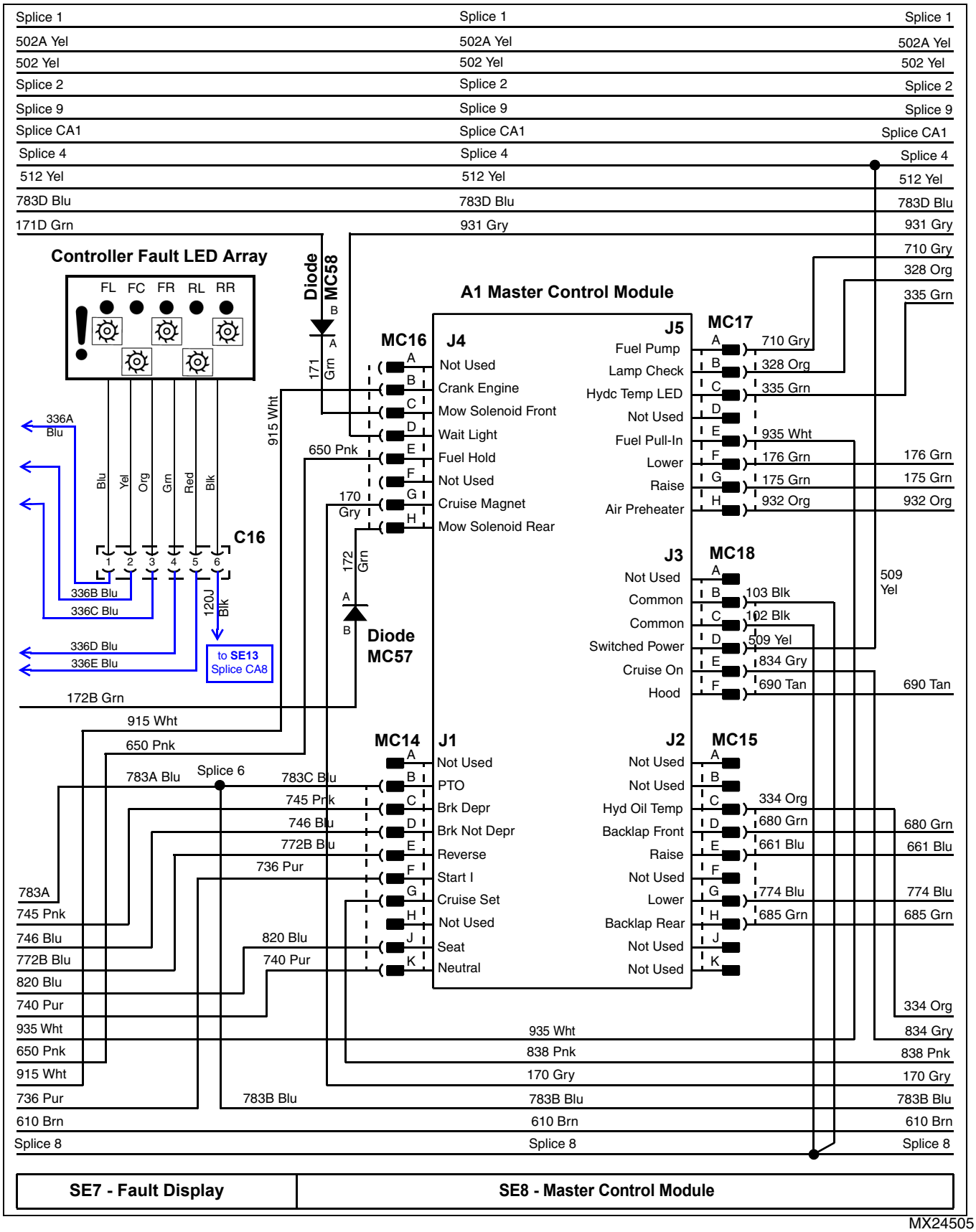
MX24503

Main Electrical Schematic (Sheet 3 of 8)



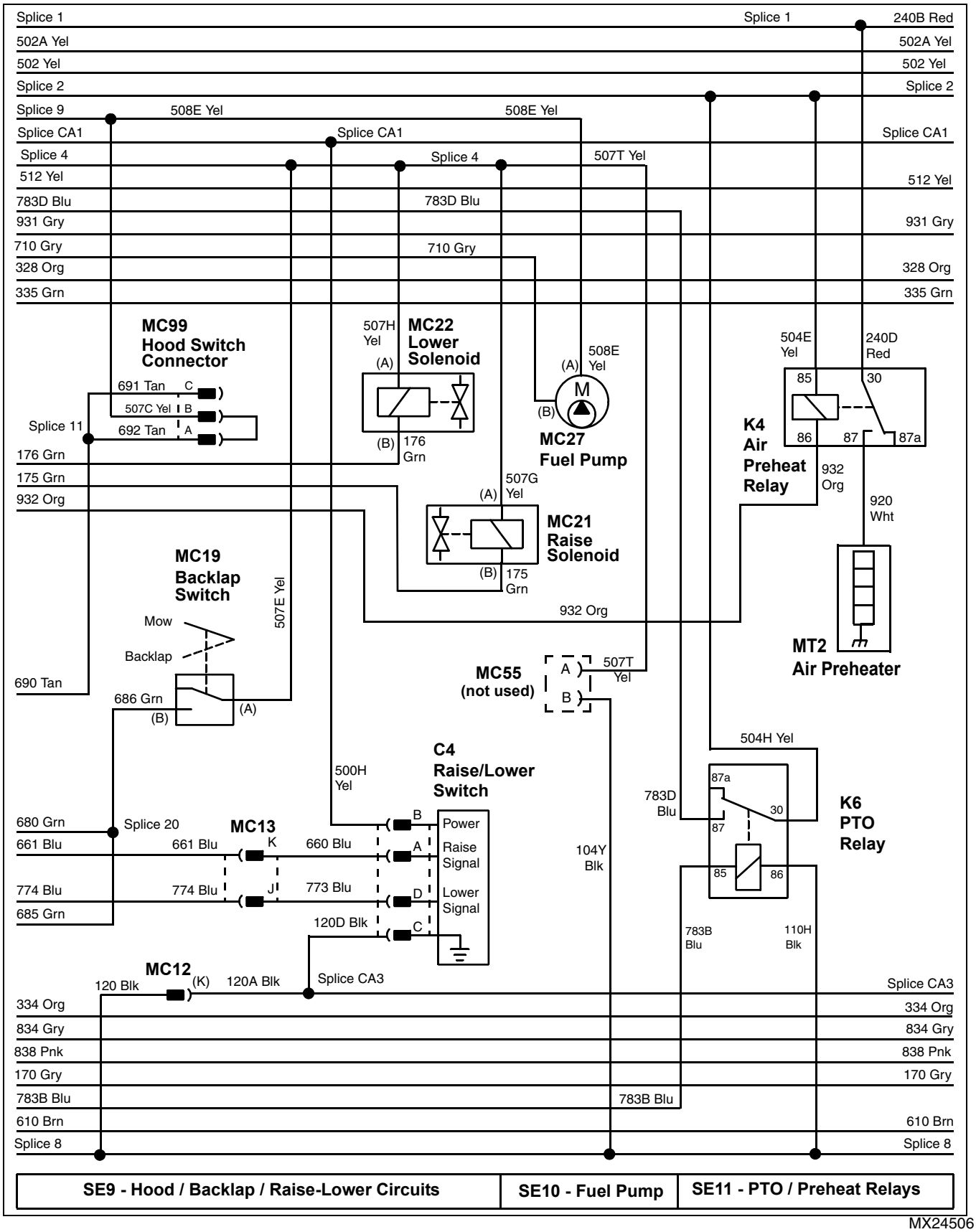
MX24504

Main Electrical Schematic (Sheet 4 of 8)



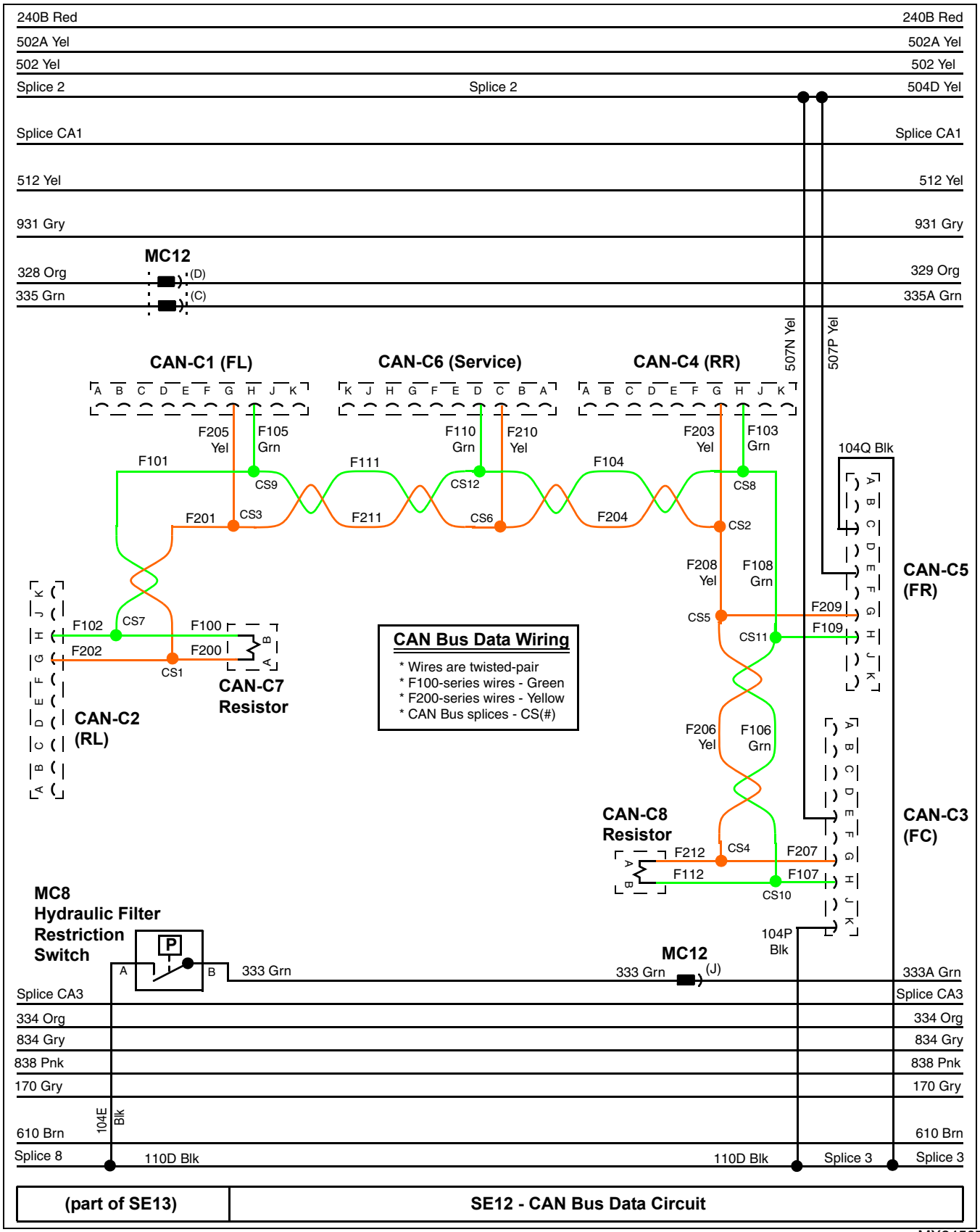
MX24505

Main Electrical Schematic (Sheet 5 of 8)



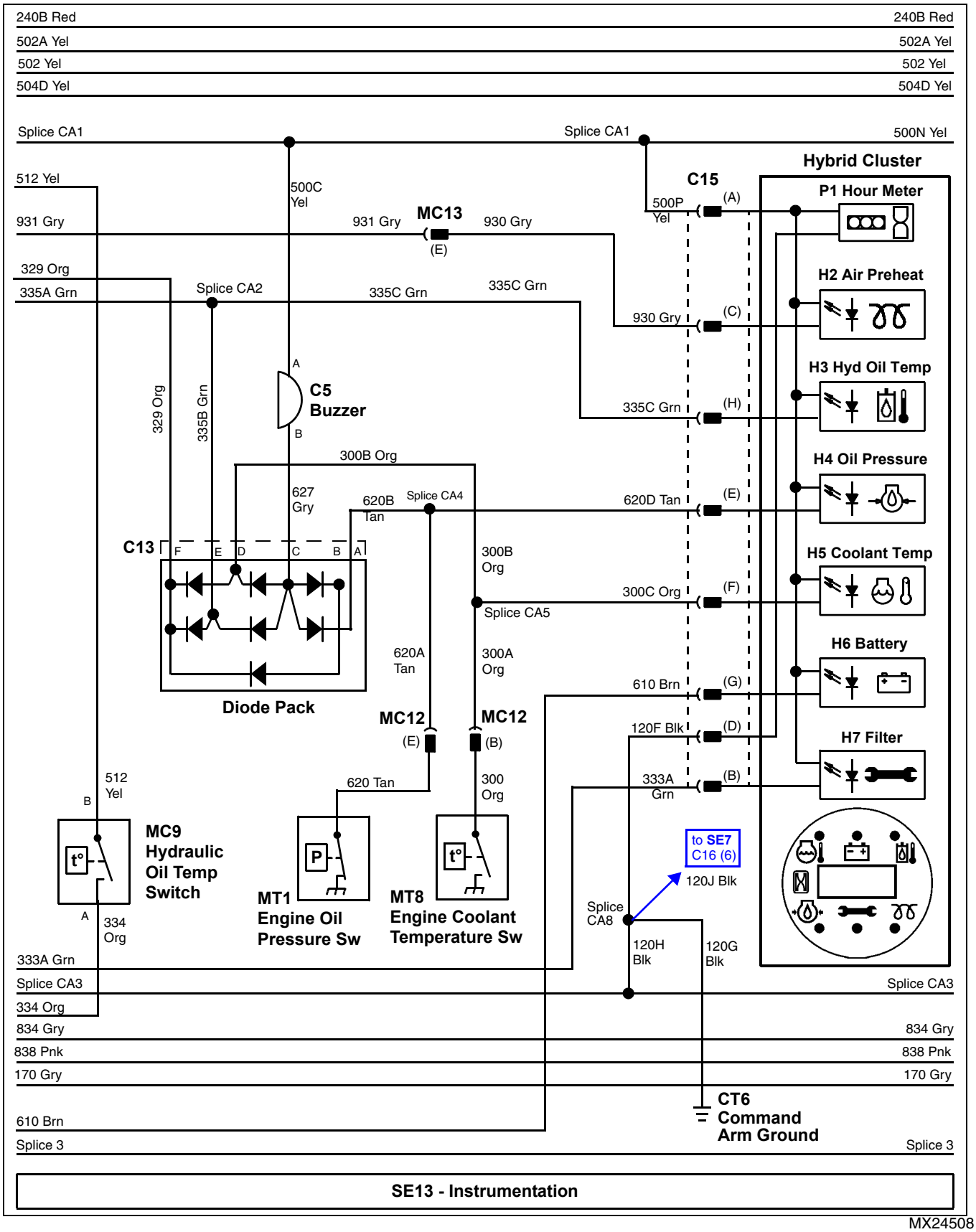
MX24506

Main Electrical Schematic (Sheet 6 of 8)

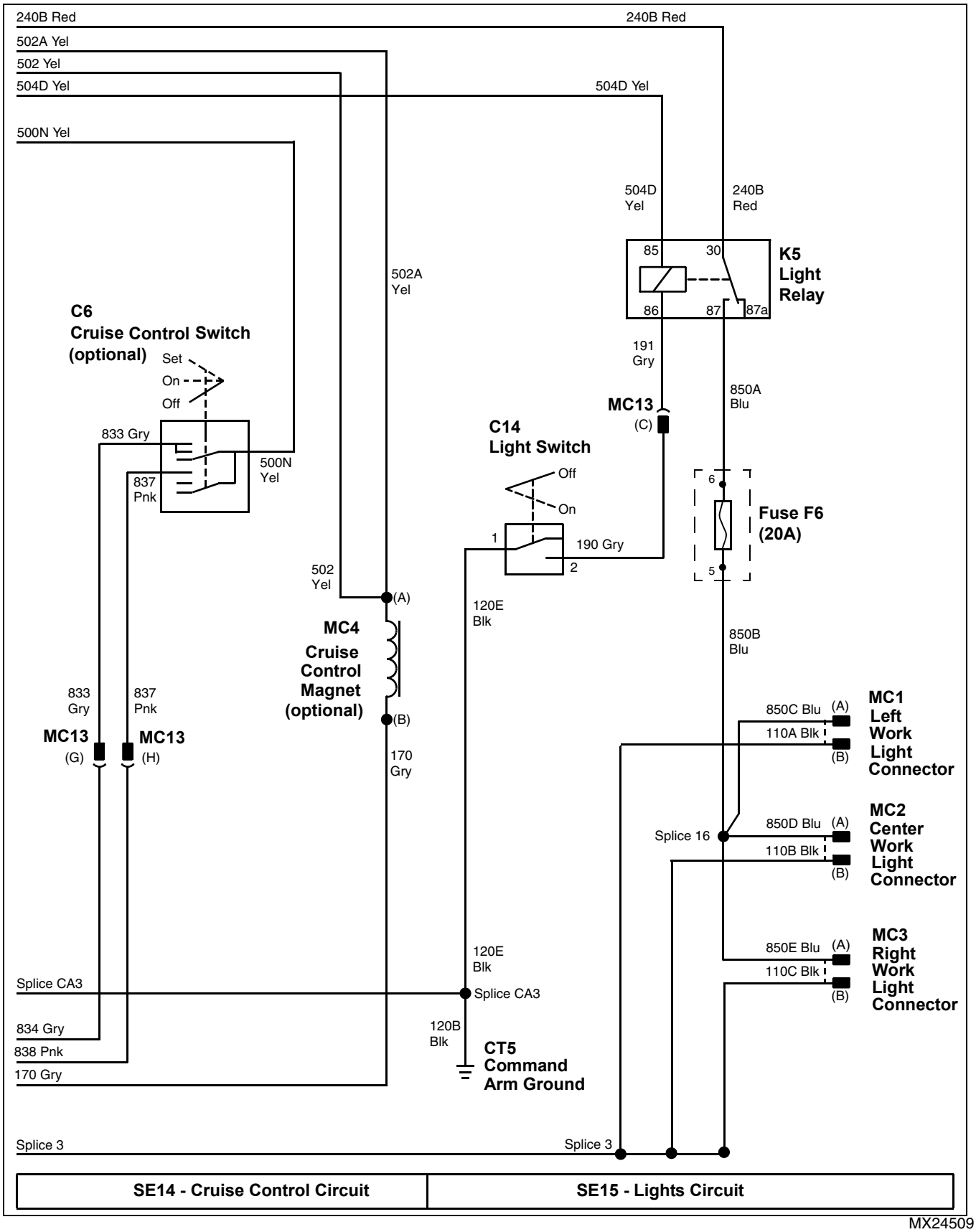


MX24507

Main Electrical Schematic (Sheet 7 of 8)

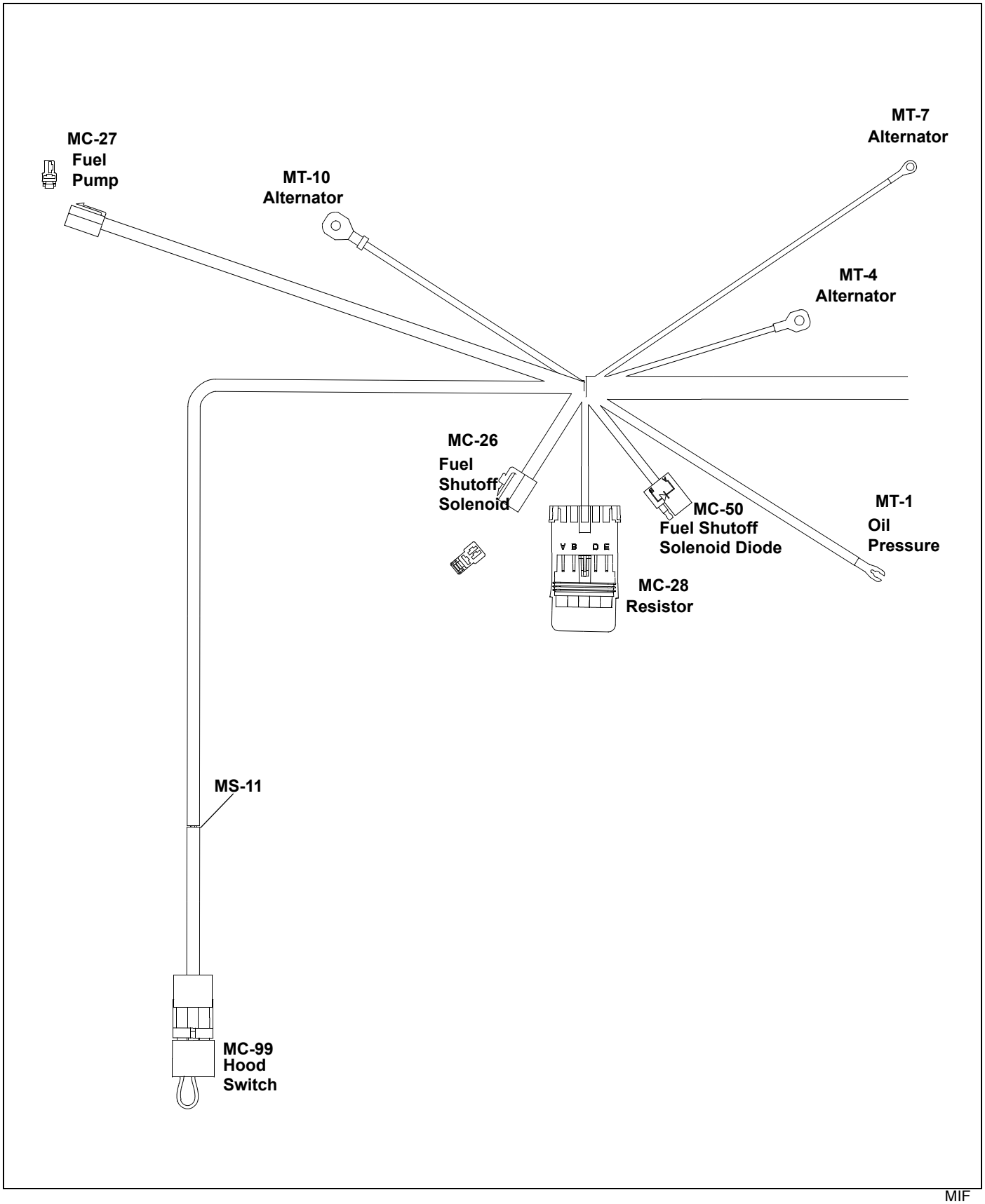


Main Electrical Schematic (Sheet 8 of 8)



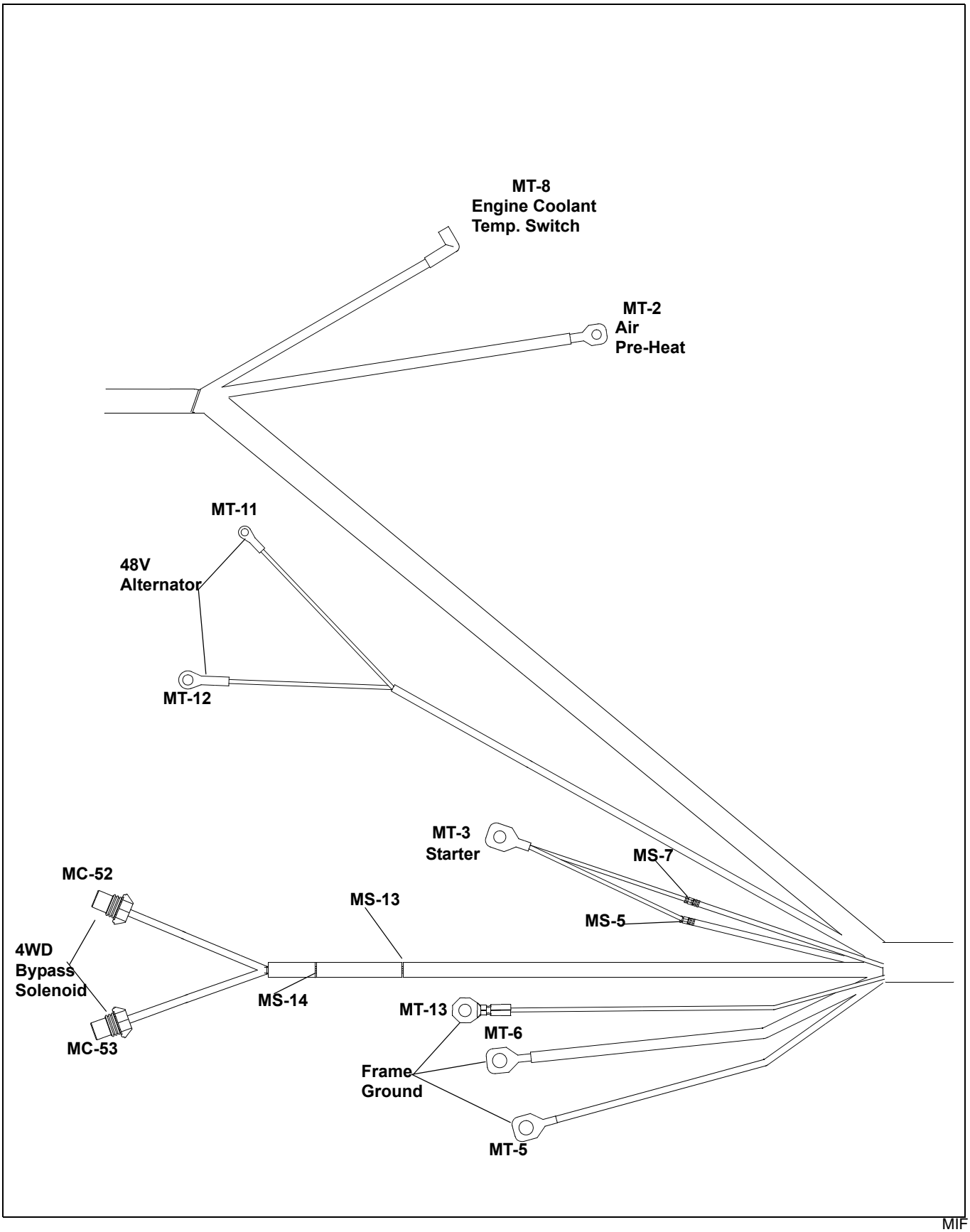
MX24509

Main Wiring Harness (W2) (Sheet 1 of 6)



MIF

Main Wiring Harness (W2) (Sheet 2 of 6)



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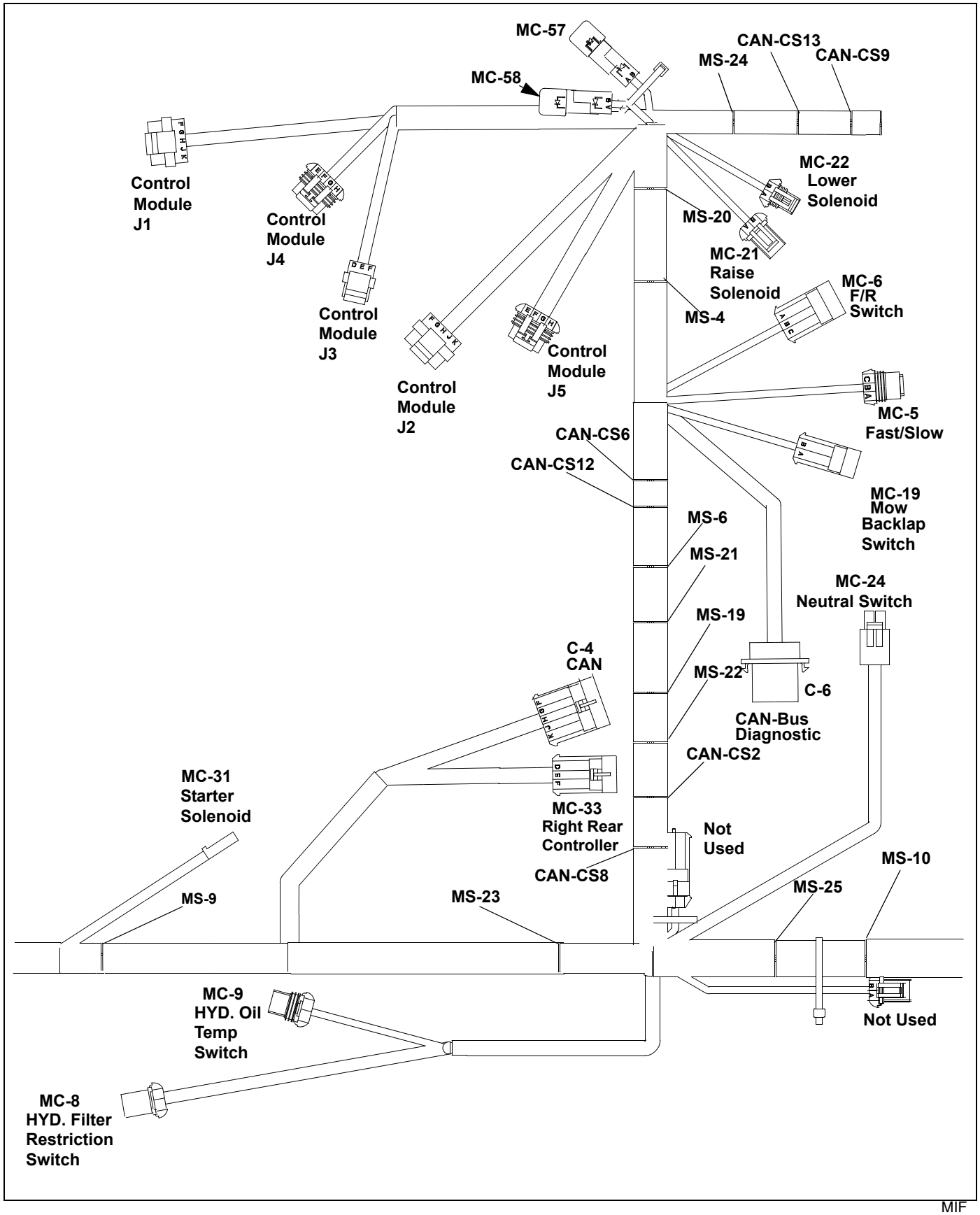
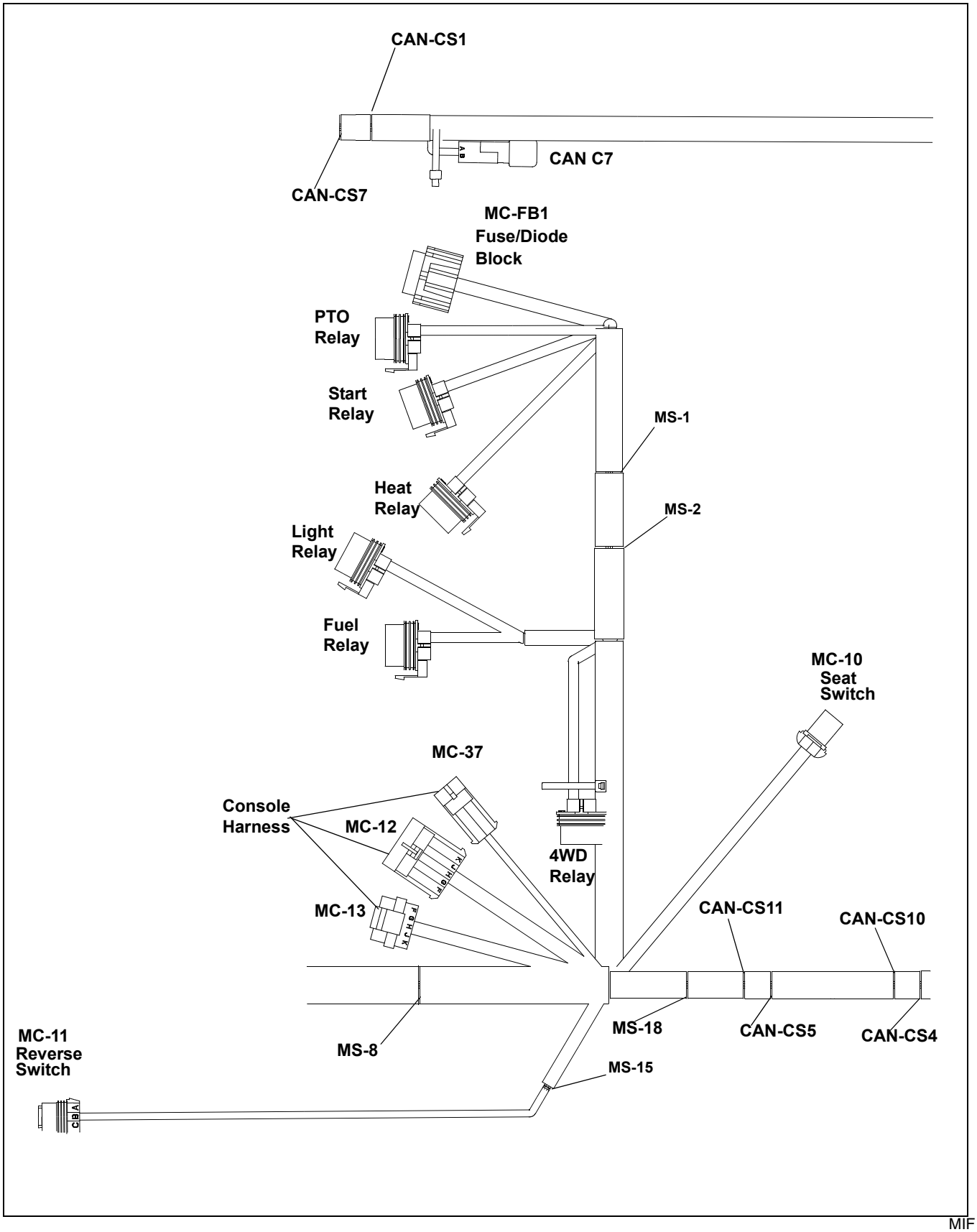
Main Wiring Harness (W2) (Sheet 3 of 6)



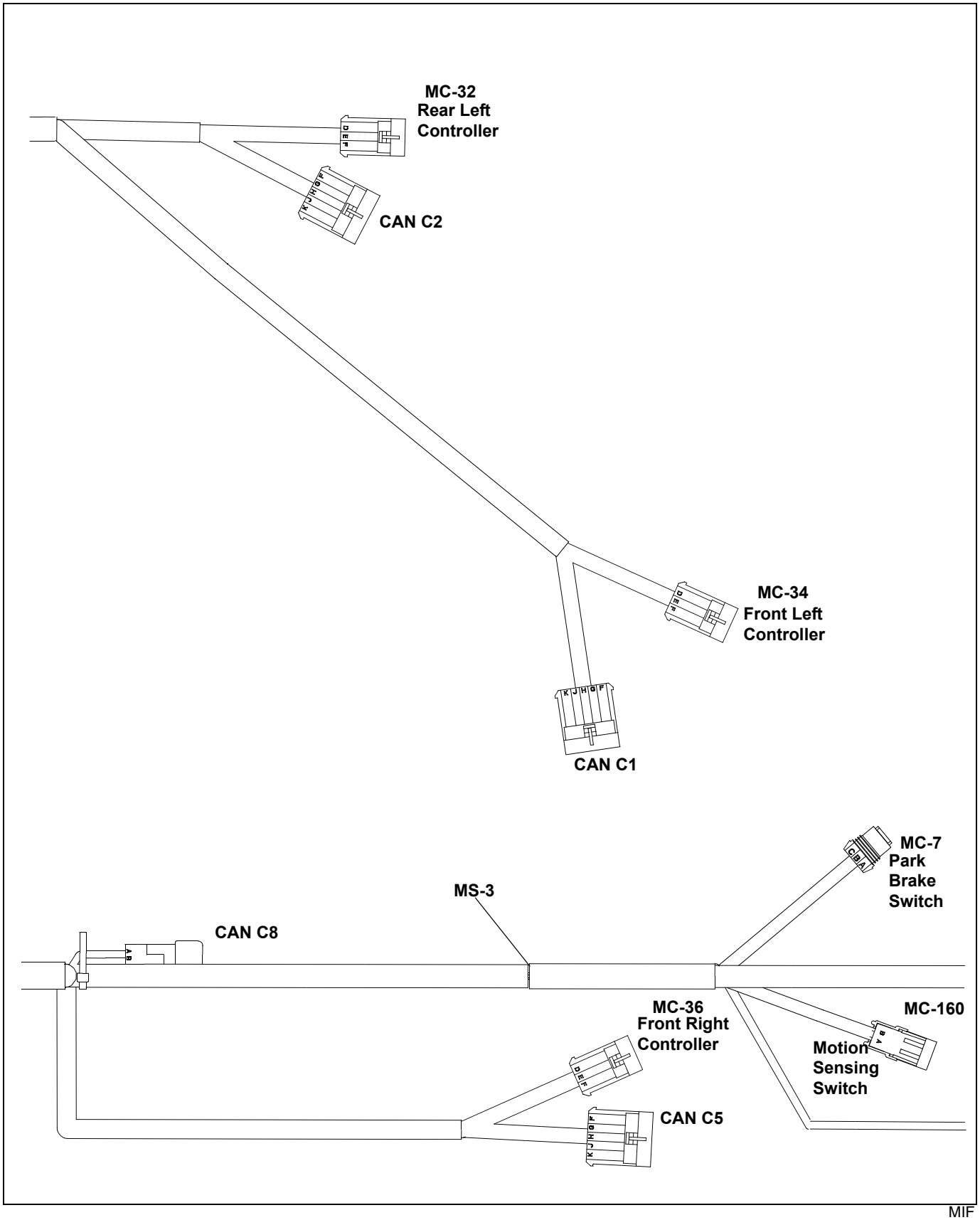
MIF

Main Wiring Harness (W2) (Sheet 4 of 6)



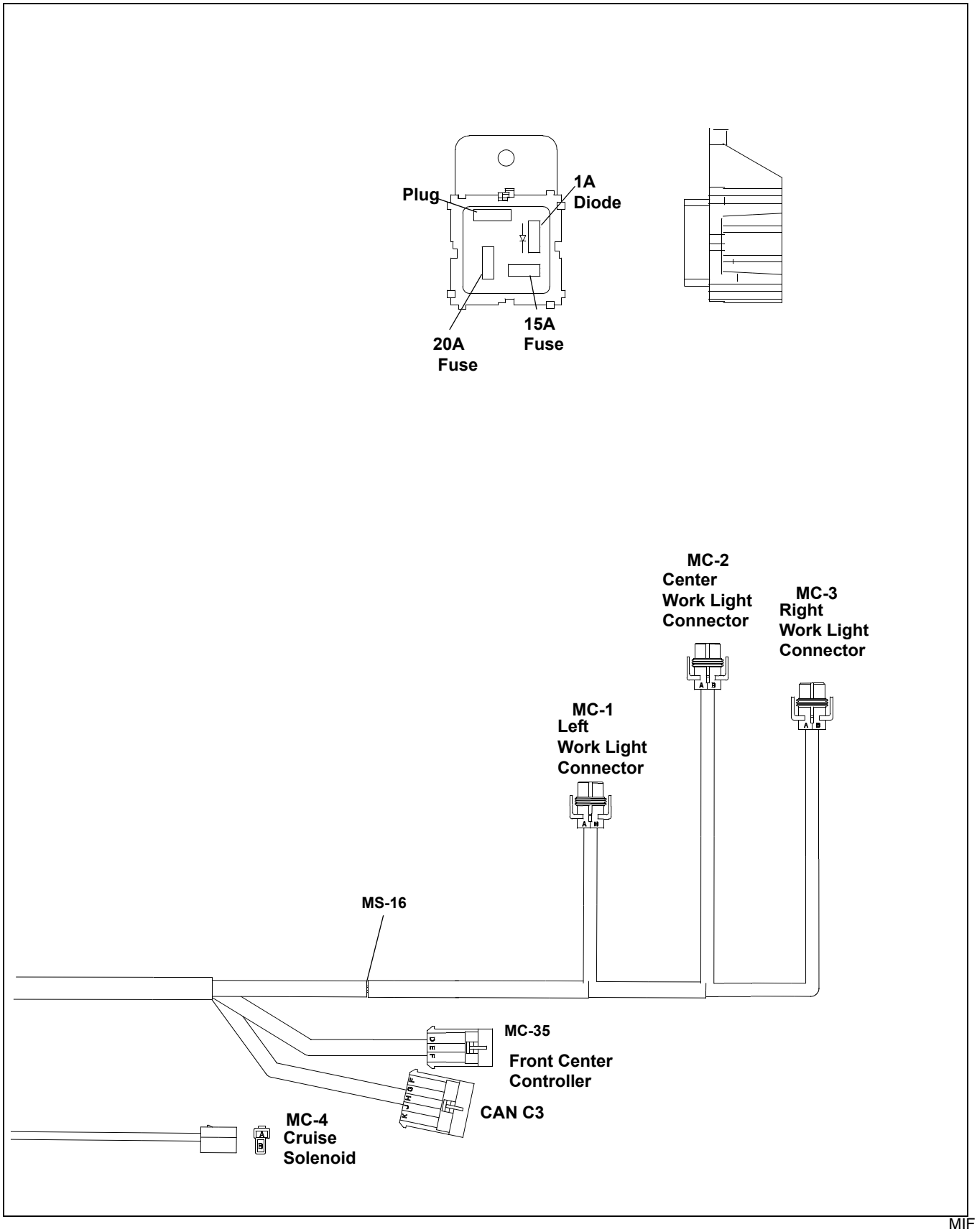
MIF

Main Wiring Harness (W2) (Sheet 5 of 6)



MIF

Main Wiring Harness (W2) (Sheet 6 of 6)



MIF

Main Wiring Harness (W2) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
100	3.0	Blk	FG1, MC26 (A)
101	5.0	Blk	FG1, Splice 8
102	1.0	Blk	MC18 (J3-C), Splice 8
103	1.0	Blk	MC18 (J3-B), Splice 8
104	0.8	Blk	4WD (85), Splice 8
104A	0.8	Blk	FB1 (1), Splice 8
104B	0.8	Blk	MC52 (A), Splice 13
104C	0.8	Blk	Splice 13, Splice 8
104D	0.8	Blk	MC53 (A), Splice 13
104E	0.8	Blk	MC8 (A), Splice 8
104F	0.8	Blk	MC32 (B), Splice MS-21
104G	0.8	Blk	MC33 (B), Splice MS-21
104J	0.8	Blk	MC5 (A), Splice MS-21
104K	0.8	Blk	MC6 (B), Splice MS-21
104L	0.8	Blk	CAN-C6 (A), Splice 8
104M	0.8	Blk	CAN-C4 (B), Splice 13
104P	0.8	Blk	CAN-C3 (K), Splice 3
104Q	0.8	Blk	CAN-C5 (C), Splice 3
104R	0.8	Blk	Splice CS-13, Splice 8
104T	0.8	Blk	CAN-C1 (K), Splice CS-13
104U	0.8	Blk	CAN-C1 (C), Splice CS-13
104W	0.8	Blk	CAN-C2 (B), Splice CS-13
104X	0.8	Blk	CAN-C2 (K), Splice CS-13
104Y	0.8	Blk	MC55 (B), Splice 8
108	13.0	Blk	G1(-), FG1
110A	1.0	Blk	MC1 (B), Splice 3
110B	1.0	Blk	MC2 (B), Splice 3
110C	1.0	Blk	MC3 (B), Splice 3
110D	1.0	Blk	Splice 3, Splice 8
110E	0.8	Blk	MC34 (B), Splice MS-21
110F	0.8	Blk	MC35 (B), Splice MS-21
110G	0.8	Blk	MC36 (B), Splice MS-21
110H	0.8	Blk	K6 (86), Splice 8
120	0.8	Blk	MC12 (K), Splice 8
131	1.0	Blk	G3(-), FG1
156	3.0	Blk	G2(-), FG1
170	0.8	Gry	MC4 (B), MC16 (J4-G)
171	0.8	Grn	MC58 (A), MC16 (J4-C)
171A	0.8	Grn	MC34 (A), Splice MS-18
171B	0.8	Grn	MC35 (A), Splice MS-18
171C	0.8	Grn	MC36 (A), Splice MS-18
171D	0.8	Grn	Splice MS-18, MC58 (B)
172	0.8	Grn	MC57 (A), MC16 (J4-H)
172A	0.8	Grn	MC54 (B), Splice MS-19
172B	0.8	Grn	Splice MS-19, MC57 (B)
172D	0.8	Grn	MC32 (A), Splice MS-19
172E	0.8	Grn	MC33 (A), Splice MS-19
175	0.8	Grn	M21 (B), MC17 (J5-G)
176	0.8	Grn	M22 (B), MC17 (J5-F)
181	0.8	Red	MC5 (C), Splice MS-25
181A	0.8	Red	MC34 (D), Splice MS-25
181B	0.8	Red	MC35 (D), Splice MS-25
181C	0.8	Red	MC36 (D), Splice MS-25
181D	0.8	Red	MC32 (D), Splice MS-25
181E	0.8	Red	MC33 (D), Splice MS-25
182	0.8	Wht	MC5 (B), Splice MS-22
182A	0.8	Wht	MC34 (C), Splice MS-22
182B	0.8	Wht	MC35 (C), Splice MS-22
182C	0.8	Wht	MC36 (C), Splice MS-22
182D	0.8	Wht	MC32 (C), Splice MS-22

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
182E	0.8	Wht	MC33 (C), Splice MS-22
183	0.8	Yel	MC6 (A), Splice MS-23
183C	0.8	Yel	MC36 (E), Splice MS-23
183E	0.8	Yel	MC33 (E), Splice MS-23
184	0.8	Brn	MC6 (C), Splice MS-24
184A	0.8	Brn	MC34 (E), Splice MS-24
184B	0.8	Brn	MC35 (E), Splice MS-24
184D	0.8	Brn	MC32 (E), Splice MS-24
191	0.8	Gry	K5 (86), MC13 (C)
200	2.0	Red	M1 (MT3), Splice 5
201	2.0	Red	M1 (MT3), Splice 7
205	3.0	Red	G2(+), Splice 7
206	1.0	Red	MC12 (H), FB1 (3)
240	8.0	Red	Splice 1, Splice 5
240A	3.0	Red	K1 (30), Splice 1
240B	3.0	Red	K5 (30), Splice 1
240C	3.0	Red	FB1 (4), Splice 1
240D	3.0	Red	K4 (30), Splice 1
240E	3.0	Red	K2 (30), Splice 1
240F	3.0	Red	4WD (30), Splice 1
250	13.0	Red	G1(+), M1 (MT3)
300	0.8	Org	MC17 (J5-B), MC12 (B)
328	0.8	Org	MC12 (D), MC17 (J5-B)
332A	0.8	Blu	MC34 (F), MC13 (A)
332B	0.8	Blu	MC35 (F), MC13 (D)
332C	0.8	Blu	MC36 (F), MC13 (F)
332D	0.8	Blu	MC32 (F), MC37 (A)
332E	0.8	Blu	MC33 (F), MC37 (B)
333	0.8	Grn	MC8 (B), MC12 (J)
334	0.8	Org	MC9 (A), MC15 (J2-C)
335	0.8	Grn	MC12 (C), MC17 (J5-C)

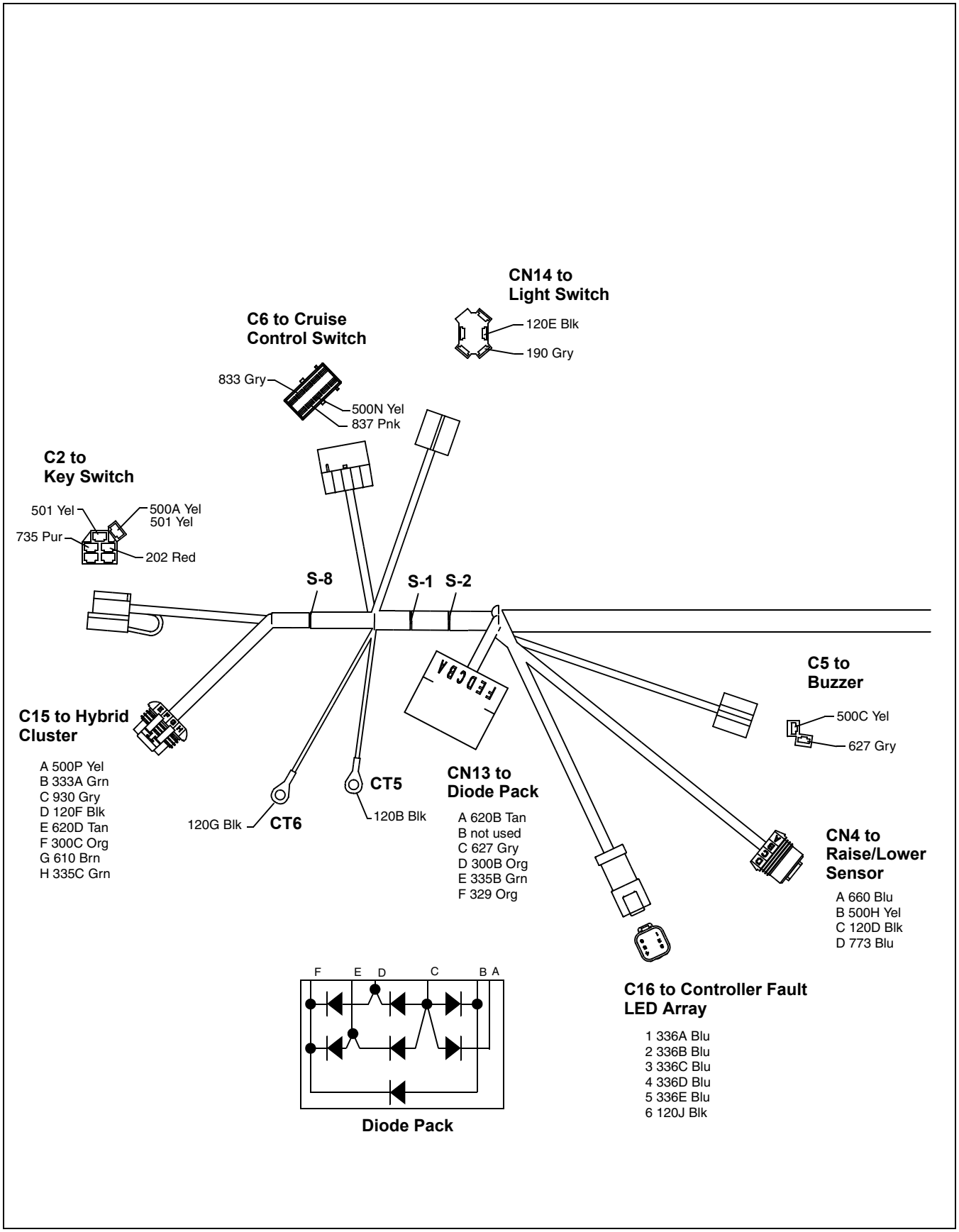
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
502	0.8	Yel	MC4 (A), MC7 (A)
502A	1.0	Yel	MC4 (A), Splice 10
503	1.0	Yel	MC12 (A), Splice 10
504A	0.8	Yel	Splice 10, Splice 2
504B	0.8	Yel	MC160 (A), Splice 10
504C	0.8	Yel	K2 (85), Splice 2
504D	0.8	Yel	K5 (85), Splice 2
504E	0.8	Yel	K4 (85), Splice 2
504F	0.8	Yel	K1 (85), Splice 2
504H	0.8	Yel	K6 (30), Splice 2
505	0.8	Yel	MC10 (A), Splice 10
506	0.8	Yel	MC11 (B), Splice 10
507A	1.0	Yel	Splice 10, Splice 4
507B	0.8	Yel	MC24 (A), Splice 4
507C	0.8	Yel	MC99 (B), Splice 9
507E	0.8	Yel	MC19 (A), Splice 4
507G	0.8	Yel	MC21 (A), Splice 4
507H	0.8	Yel	MC22 (A), Splice 4
507J	0.8	Yel	MC54 (A), Splice 4
507K	0.8	Yel	CAN-C2 (E), Splice 4
507L	0.8	Yel	CAN-C1 (E), Splice 4
507M	0.8	Yel	CAN-C4 (E), Splice 9
507N	0.8	Yel	CAN-C3 (E), Splice 2
507P	0.8	Yel	CAN-C5 (E), Splice 2
507R	0.8	Yel	CAN-C6 (B), Splice 4
507T	0.8	Yel	MC55 (A), Splice 4
508A	0.8	Yel	Splice 9, Splice 10
508B	0.8	Yel	MC28 (A), Splice 9
508C	0.8	Yel	MC28 (E), G2 (MT10)
508E	0.8	Yel	MC27 (A), Splice 9
509	1.0	Yel	MC18 (J3-D), Splice 4

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
512	0.8	Yel	Splice 10, MC9 (B)
611	0.8	Tan	MC12 (F), G2 (MT10)
620	0.8	Tan	MC12 (E), MT1
650	1.0	Pnk	MC26 (C), MC16 (J4-E)
652	2.0	Blu	MC26 (A), MC50 (B)
653	2.0	Blu	MC26 (B), MC50 (A)
656	3.0	Wht	MC26 (B), K2 (87)
661	0.8	Blu	MC13 (K), MC15 (J2-E)
680	0.8	Grn	MC15 (J2-D), Splice 20
685	0.8	Grn	MC15 (J2-H), Splice 20
686	0.8	Grn	MC19 (B), Splice 20
690	0.8	Tan	MC18 (J3-F), Splice 11
691	0.8	Tan	MC99 (C), Splice 11
692	0.8	Tan	MC99 (A), Splice 11
710	0.8	Gry	MC17 (J5-A), MC27 (B)
736	0.8	Pur	MC12 (G), MC14 (J1-F)
740	0.8	Pur	MC24 (B), MC14 (J1-K)
745	0.8	Pnk	MC7 (B), MC14 (J1-C)
746	0.8	Blu	MC7 (C), MC14 (J1-D)
747	2.0	Pur	MC31 (A), K1 (87)
771	1.0	Blu	4WD (87), Splice 14
771A	0.8	Blu	MC52 (B), Splice 14
771B	0.8	Blu	MC53 (B), Splice 14
771C	0.8	Blu	FB1 (2), Splice 14
772	0.8	Blu	4WD (86), Splice 15
772A	0.8	Blu	MC11 (C), Splice 15
772B	0.8	Blu	MC14 (J1-E), Splice 15
774	0.8	Blu	MC13 (J), MC15 (J2-G)
783A	0.8	Blu	MC160 (B), Splice 6
783B	0.8	Blu	K6 (85), Splice 6
783C	0.8	Blu	M14 (J1-B), Splice 6

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
783D	0.8	Blu	K6 (87), G3 (MT11)
820	0.8	Blu	MC10 (B), MC14 (J1-J)
834	0.8	Gry	MC13 (G), MC18 (J3-E)
838	0.8	Pnk	MC13 (H), MC14 (J1-G)
850A	2.0	Blu	FB1 (6), K5 (87)
850B	2.0	Blu	FB1 (5), Splice 16
850C	1.0	Blu	MC1 (A), Splice 16
850D	1.0	Blu	MC2 (A), Splice 16
850E	1.0	Blu	MC3 (A), Splice 16
915	0.8	Wht	K1 (86), MC16 (J4-B)
920	3.0	Wht	MT2, K4(87)
931	0.8	Gry	MC13 (E), MC16 (J4-D)
932	0.8	Org	K4 (86), MC17 (J5-H)
935	0.8	Wht	K2 (86), MC17 (J5-E)
F100	0.8	Grn	CAN-C7 (B), Splice CS7
F101	0.8	Grn	Splice CS7, Splice CS9
F102	0.8	Grn	CAN-C2 (H), Splice CS7
F103	0.8	Grn	CAN-C4 (H), Splice CS8
F104	0.8	Grn	Splice CS8, Splice CS12
F105	0.8	Grn	CAN-C1 (H), Splice CS9
F106	0.8	Grn	Splice CS11, Splice CS10
F107	0.8	Grn	CAN-C3 (H), Splice CS10
F108	0.8	Grn	Splice CS8, Splice CS11
F109	0.8	Grn	CAN-C5 (H), Splice CS11
F110	0.8	Grn	CAN-C6 (D), Splice CS12
F111	0.8	Grn	Splice CS9, Splice CS12
F112	0.8	Grn	CAN-C8 (B), Splice CS10
F200	0.8	Yel	CAN-C7 (A), Splice CS1
F201	0.8	Yel	Splice CS1, Splice CS3
F202	0.8	Yel	CAN-C2 (G), Splice CS1
F203	0.8	Yel	CAN-C4 (G), Splice CS2

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
F204	0.8	Yel	Splice CS6, Splice CS2
F205	0.8	Yel	CAN-C1 (G), Splice CS3
F206	0.8	Yel	Splice CS5, Splice CS4
F207	0.8	Yel	CAN-C3 (G), Splice CS4
F208	0.8	Yel	Splice CS2, Splice CS5
F209	0.8	Yel	CAN-C5 (G), Splice CS5
F210	0.8	Yel	CAN-C6 (C), Splice CS6
F211	0.8	Yel	Splice CS3, Splice CS6
F212	0.8	Yel	CAN-C8 (A), Splice CS4

Command Arm W1 Wiring Harness



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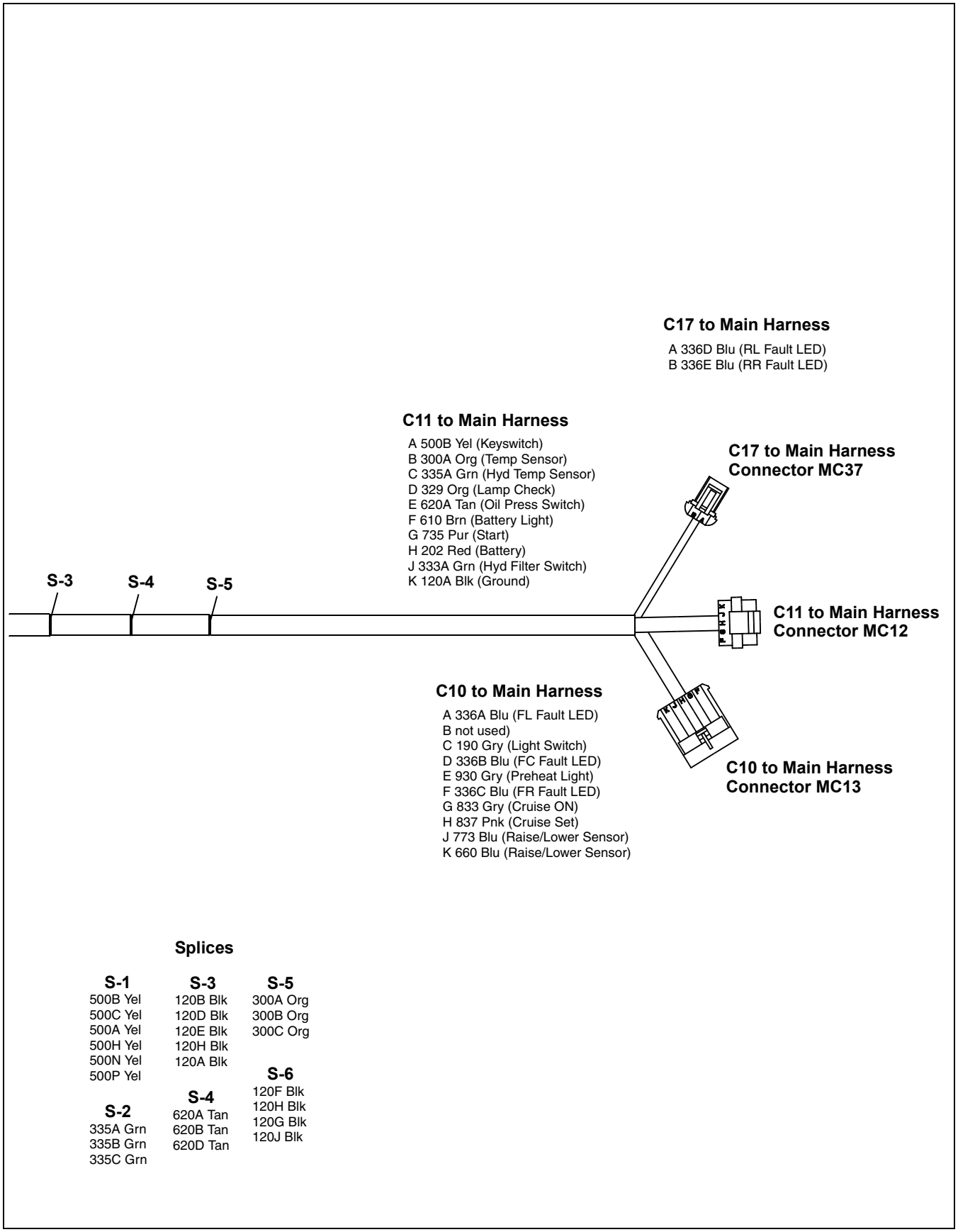
W1 Control Arm Wiring Harness (2 of 2)



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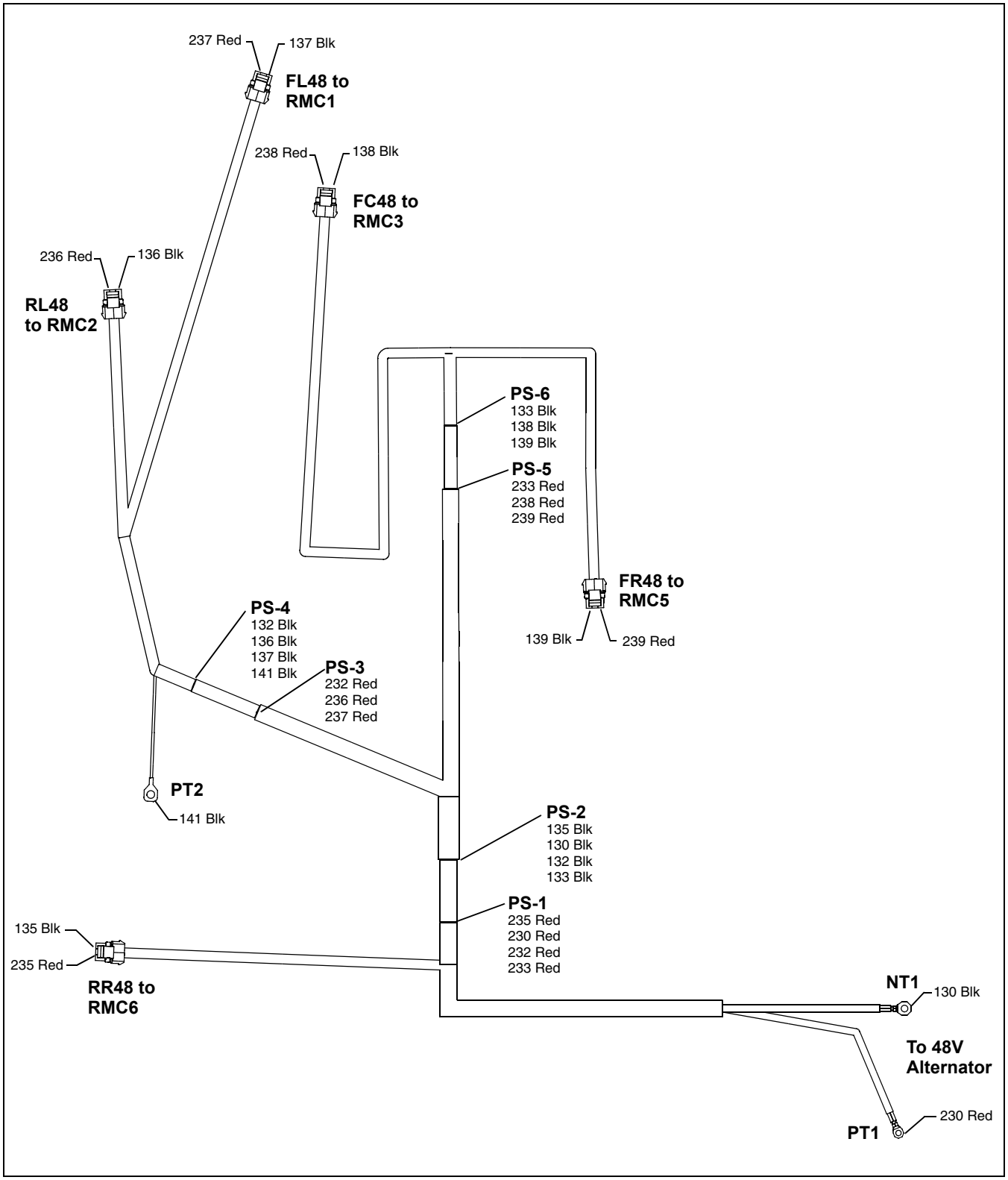
Command Arm Wiring Harness (W1) Wire Code Table

Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
120A	0.8	Blk	C11 (K), Splice CA3
120B	0.8	Blk	Splice CA3, CT5
120D	0.8	Blk	C4 (C), Splice CA3
120E	0.8	Blk	C14 (1), Splice CA3
120F	0.8	Blk	C15 (D), Splice CA8
120G	0.8	Blk	CT6, Splice CA8
120H	0.8	Blk	Splice CA8, Splice CA3
120J	0.8	Blk	Splice CA8, C16 (6)
190	0.8	Gry	C10 (C), C14 (2)
202	0.8	Red	C11 (H), C2 (B)
300A	0.8	Org	C11 (B), Splice CA5
300B	0.8	Org	C13 (D), Splice CA5
300C	0.8	Org	C15 (F), Splice CA5
329	0.8	Org	C11 (D), C13 (F)
333A	0.8	Grn	C11 (J), C15 (B)
335A	0.8	Grn	C11 (C), Splice CA2
335B	0.8	Grn	C13 (E), Splice CA2
335C	0.8	Grn	C15 (H), Splice CA2
336A	0.8	Lt Blu	C10 (A), C16 (1)
336B	0.8	Lt Blu	C10 (D), C16 (2)
336C	0.8	Lt Blu	C10 (F), C16 (3)
336D	0.8	Lt Blu	C17 (A), C16 (4)
336E	0.8	Lt Blu	C17 (B), C16 (5)
500A	0.8	Yel	C2 (A), Splice CA1
500B	0.8	Yel	C11 (A), Splice CA1
500C	0.8	Yel	C5 (A), Splice CA1
500H	0.8	Yel	C4 (B), Splice CA1
500N	0.8	Yel	C6 (2), Splice CA1
500P	0.8	Yel	C15 (A), Splice CA1
501	0.8	Yel	C2 (A), C2 (S2)
610	0.8	Brn	C11 (F), C15 (G)
620A	0.8	Tan	C11 (E), Splice CA4
620B	0.8	Tan	C13 (A), Splice CA4
620D	0.8	Tan	C15 (E), Splice CA4
627	0.8	Gry	C13 (C), C5 (B)
660	0.8	Blu	C10 (K), C4 (A)
735	0.8	Pur	C10 (G), C2 (S1)
773	0.8	Blu	C10 (J), C4 (D)
833	0.8	Gry	C10 (G), C6 (6)
837	0.8	Pnk	C10 (H), C6 (3)
930	0.8	Gry	C10 (E), C15 (C)

W3 48V Power Supply Harness



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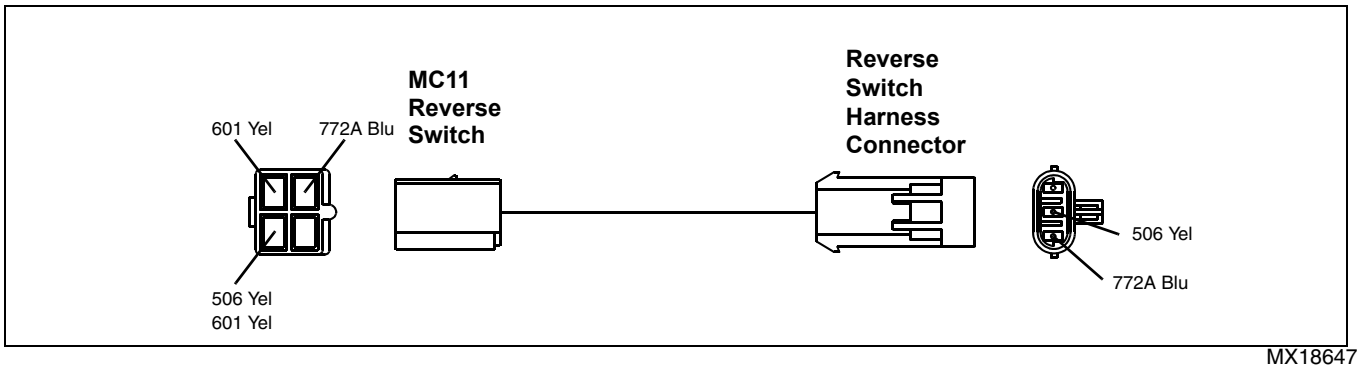
48V Power Supply Harness (W3) Wire Code Table

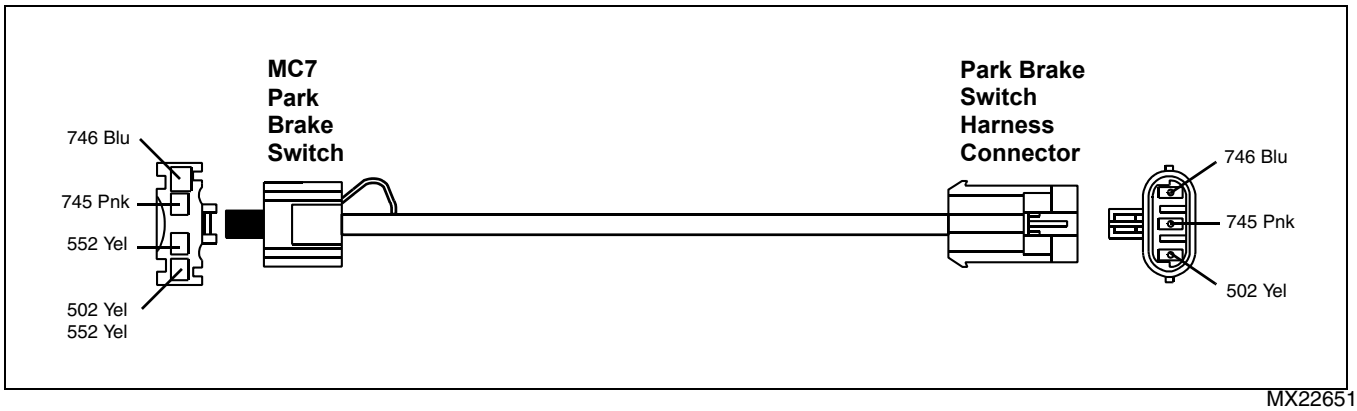
Circuit Number	Wire Size (mm^2)	Wire Color	Termination Points
130	19.0	Blk	NT1, Splice PS-2
132	13.0	Blk	Splice PS-2, Splice PS-4
133	13.0	Blk	Splice PS-2, Splice PS-6
135	5.0	Blk	RR48, Splice PS-2
136	5.0	Blk	Splice PS-4, RL48
137	5.0	Blk	Splice PS-4, FL48
138	5.0	Blk	Splice PS-6, FC48
139	5.0	Blk	Splice PS-6, FR48
141	2.0	Blk	Splice PS-4, PT2
230	19.0	Red	PT1, Splice PS-1
232	13.0	Red	Splice PS-3, Splice PS-1
233	13.0	Red	Splice PS-5, Splice PS-1
235	5.0	Red	RR48, Splice PS-1
236	5.0	Red	RL48, Splice PS-3
237	5.0	Red	FL48, Splice PS-3
238	5.0	Red	FC48, Splice PS-5
239	5.0	Red	FR48, Splice PS-5

Reverse Switch



MX18647

Park Brake Switch Wiring Harness (W10)



MX22651

Operation and Diagnostics

Master Control Module Operation

This machine is equipped with an Master control module (A1). The module controls and monitors all safety interlock functions and the engine air preheater function.

When key switch (C2) is in RUN position, current flows through the following circuits, causing the Master control module to power up:

- Key switch (C2), terminals B and A.
- 500A and 500B Yel wires.
- Command arm harness connector (MC12), terminal A.
- 503, 507A, and 509 Yel wires.
- Master control module connector (MC18), terminal D.

Ground is provided to the control module through:

- FG1 frame ground.
- 101 Blk wire.
- 102 and 103 Blk wires.
- Master control module connector (MC18), terminals B and C.

The Master control module features input LEDs, output LEDs, and a status LED (known as the “heartbeat” LED) to aid in electrical circuit diagnosis.

The input LEDs will light whenever a function switch has been activated. This will indicate that the input circuit is functioning properly.

The output LEDs, when lit, indicate that the control module circuitry for that particular function is operating properly, and that a controlled ground is available for that circuit at the control module output terminal.

If all circuits are OK, the status LED will flash at a steady rate called the heartbeat. The heartbeat pattern is 130 milliseconds ON and 830 milliseconds OFF.

If the control module detects a malfunction, the LED will flash a specific pattern to indicate one of the diagnostic fault codes. The flash pattern is 280 milliseconds ON and 280 milliseconds OFF for a given digit. There is a 1-second OFF delay between digits and a 2-second OFF delay before the code is repeated.

- For fault codes caused by the operator, see “Safety Interlock Fault Codes” on page 408.
- For fault codes most likely caused by a system malfunction on an input circuit, see “Electronic Control Module Input Circuits Fault Codes” on page 408.
- For fault codes most likely caused by a system malfunction on an output circuit, see “Electronic Control Module Output Circuits Fault Codes” on page 409.

Safety Interlock Diagnostic Codes

The Sit On Seat (SOS) diagnostic feature alerts the operator when an attempt is made to start the machine when one or more safety interlock switches are not in the correct position for starting.

The following fault codes are displayed by the flashing of the status LED on the Master control module.

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

- **Code 1-2** (One pulse followed by a short pause followed by two pulses.) Indicates that the park brake switch is not activated and/or forward/reverse pedals are not in the NEUTRAL position during an attempted start.
- **Code 1-3** (One pulse followed by a short pause followed by three pulses.) Indicates that the mow-transport switch is in the MOW position during an attempted start.
- **Code 2-2** (Two pulses followed by a short pause followed by two pulses.) Indicates that hydraulic oil is in an over-temperature condition.
- **Code 2-3** (Two pulses followed by a short pause followed by three pulses.) Indicates that the hood switch is not activated (European machines) or jumper wire is missing from hood switch connector (North American machines). No instrument LEDs ON and no hour meter.

Master Control Module Input Circuits Fault Codes

Note: The code will cycle continuously with a 2-second pause between display cycles.

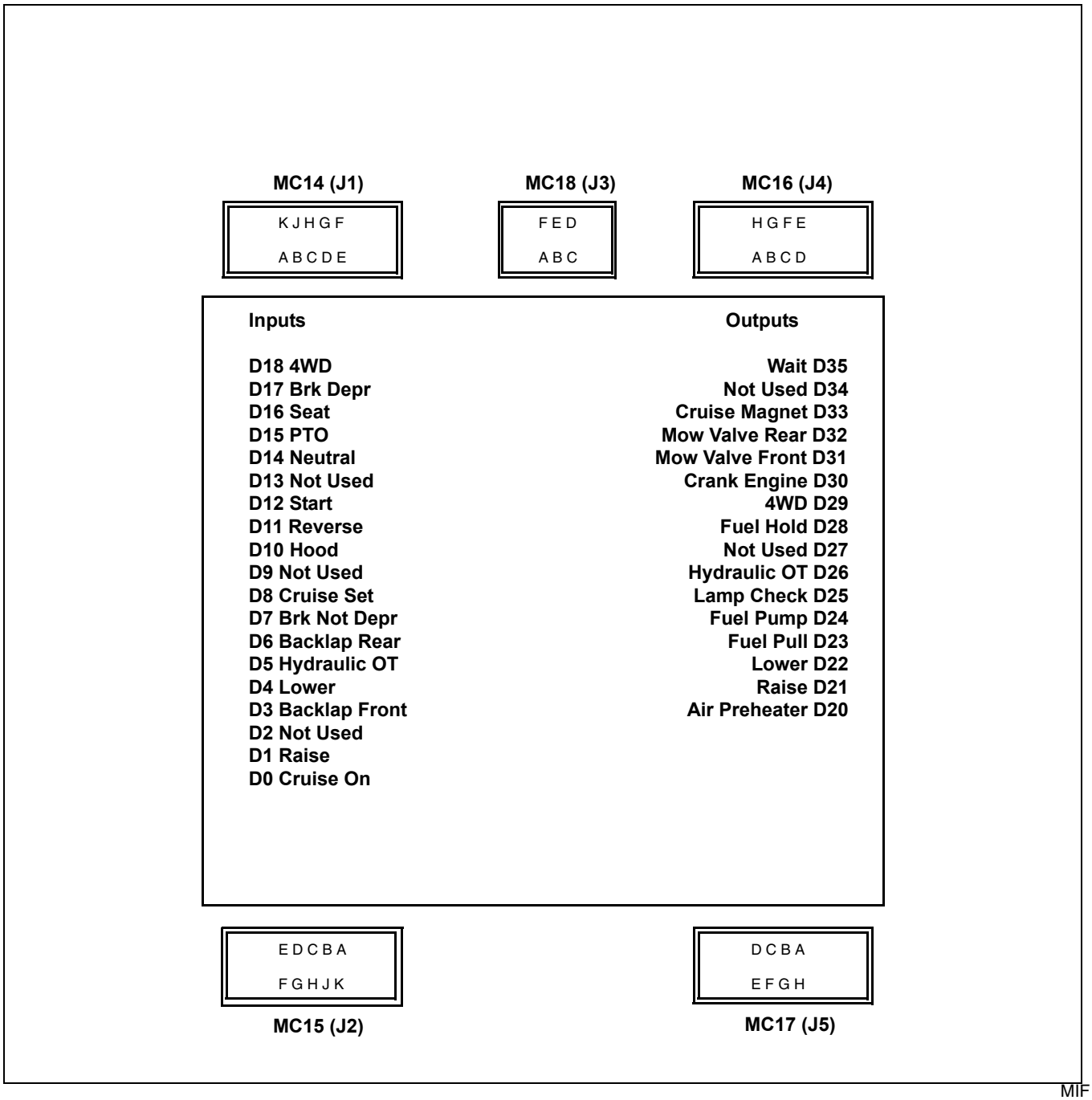
Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

- **Code 3-1** (Three pulses followed by a short pause followed by one pulse.) Indicates an over-voltage condition (voltage input to control box over 18 volts). This could also be caused by attempting to jump-start the machine with a 24-volt power source.
- **Code 3-5** (Three pulses followed by a short pause followed by five pulses.) Indicates control module is missing ground connection.
- **Code 3-6** (Three pulses followed by a short pause followed by six pulses.) Indicates control module is missing supply voltage.
- **Code 3-7** (Three pulses followed by a short pause followed by seven pulses.) Indicates control module has an internal over-temperature condition.

Master Control Module Output Circuits Fault Codes

- **Code 4-1** (Four pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning 4WD bypass solenoid circuit.
- **Code 4-2** (Four pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning start relay circuit.
- **Code 4-4** (Four pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning air preheater LED circuit.
- **Code 4-5** (Four pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel hold-in coil circuit.
- **Code 4-7** (Four pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning cruise control magnet circuit.
- **Code 5-1** (Five pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning fuel pump circuit.
- **Code 5-2** (Five pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning lamp check circuit.
- **Code 5-3** (Five pulses followed by a short pause followed by three pulses.) Indicates a malfunctioning hydraulic temperature LED circuit.
- **Code 5-4** (Five pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning mow-transport solenoid circuit.
- **Code 5-5** (Five pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel pull-in coil circuit.
- **Code 5-6** (Five pulses followed by a short pause followed by six pulses.) Indicates a malfunctioning lower solenoid circuit.
- **Code 5-7** (Five pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning raise solenoid circuit.
- **Code 5-8** (Five pulses followed by a short pause followed by eight pulses.) Indicates a malfunctioning air preheater circuit.

Master Control Module Input and Output Identification



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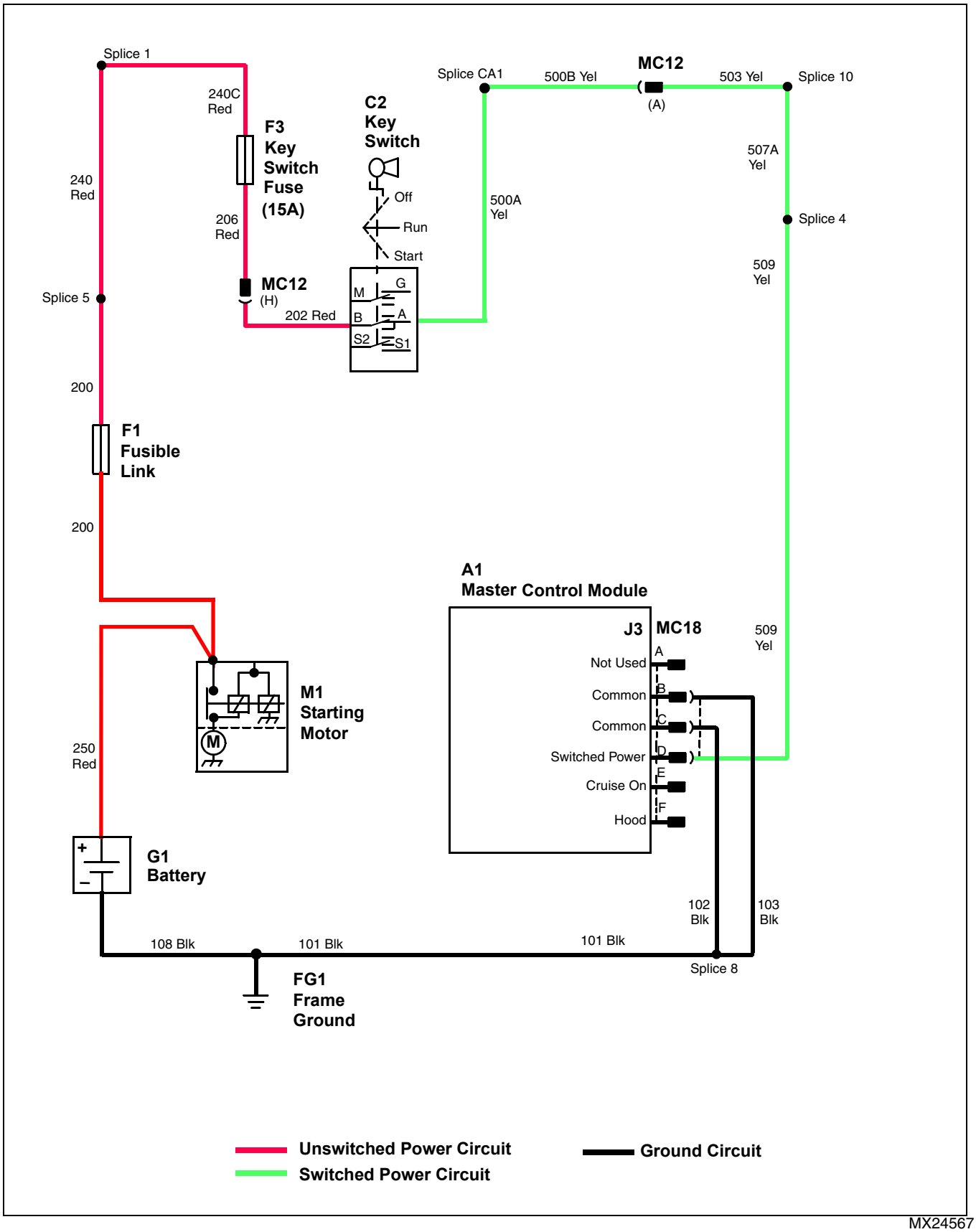
Master Control Module Circuit Schematic



MX24567

Master Control Module Circuit Test

Test Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when checking and testing.

Master Control Module Circuit

Note: Before replacing the Master control module, the following must be checked:

- ***Electrical components connected to the control module must be checked for an internal short circuit. Failure to do so may damage the replacement control module.***
- ***Verify control module has power, a good ground, and valid inputs for proper operation.***

1. Measure voltage at Master control module connector (MC18), terminal D, 509 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 509, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure ground circuit resistance at Master control module connector (MC18), terminal B, 103 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 103 and 101 Blk wires and connections.

3. Measure ground circuit resistance at Master control module connector (MC18), terminal C, 102 Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Replace Master control module.

No: Test 102 and 101 Blk wires and connections.

Master Control Module Checks

Operating Conditions

- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Key switch in OFF position.

Procedure

1. Key switch in RUN position.
2. Check the status LED, input LEDs, and output LEDs.

NORMAL

- Status (heartbeat) LED flashing in a regular, even rate (about once per second).

NOT NORMAL

- If the status LED and input/output LEDs are not lit, check key switch fuse (F3). If fuse is good, check power to the control module. (See “Master Control Module Circuit Test” on page 316.)

3. Key switch in START position.

NORMAL

- The engine must crank and start.

NOT NORMAL

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed for additional codes.

- Engine does not crank and the status LED begins to flash one of the following codes:

CODE 1-2

Indicates that the park brake switch or neutral switch is not activated during an attempted start.

Park brake in LOCKED position, then repeat procedure. If the code continues to flash after the park brake has been LOCKED, perform Park Brake Switch Input check. (See “Park Brake Switch Input” on page 317.)

For neutral switch, make sure that forward and reverse pedals are in NEUTRAL position, then repeat procedure.

If the code continues to flash after the forward and reverse pedals are in NEUTRAL position, perform Neutral Switch Input check. (See “Neutral Switch Input” on page 317.)

CODE 1-3

Indicates that the mow-transport switch is in the MOW position during an attempted start.

If the code continues to flash after the mow-transport lever has been moved to the TRANSPORT position, perform Mow-Transport Switch Input check. (See "Mow-Transport Switch Input" on page 317.)

Input Circuit LED Check

Key Switch Input

1. Disable the starting motor by disconnecting the starting motor solenoid connector MC31 (747 Pur wire).

2. Move key switch to START position and back to RUN position.

3. Observe the START input LED. The LED must be ON when the key switch is in the START position and OFF when the key switch is in the RUN position.

If the LED does not come ON when the key switch is in the START position: Test key switch circuit. (See "Key Switch Circuit Test" on page 331.)

Seat Switch Input

1. Key switch in RUN position.

2. Press down on the lower cushion of the seat to close the seat switch contacts.

3. Observe the SEAT input LED. The LED must be ON when the seat switch contacts are closed (operator ON seat).

4. Release seat cushion.

5. Observe the SEAT input LED. The LED must be OFF when the seat switch contacts are open (operator OFF seat).

If the LED does not come ON: Test seat switch circuit. (See "System: Interlock Circuit Diagnosis" on page 331.)

Park Brake Switch Input

1. Key switch in RUN position.

2. Depress the park brake pedal.

3. Observe the BRK DEPR input LED and BRK NOT DEPR input LED. The BRK DEPR LED must be ON and the BRK NOT DEPR LED must be OFF.

4. Release the park brake pedal.

5. Observe the BRK DEPR input LED and BRK NOT DEPR input LED. The BRK DEPR LED must be OFF and the BRK NOT DEPR LED must be ON.

If the LEDs do not function as described: Test park brake switch circuit. (See "System: Interlock Circuit Diagnosis" on page 331.)

Mow-Transport Switch Input

1. Key switch in RUN position.

2. Move mow-transport lever to the MOW position.

3. Observe the PTO input LED. The LED must be ON when the mow-transport lever is in the MOW position and OFF when the mow-transport lever is in the TRANSPORT position.

If the LED does not function as described: Test the PTO input circuit (Known as the mow-transport circuit). (See "System: Interlock Circuit Diagnosis" on page 331.)

Reverse Switch Input

Note: Reverse switch used only on machines with 4WD.

1. Key switch in RUN position.

2. Alternately, depress and release the reverse pedal.

3. Observe the REVERSE input LED. The LED must be ON when the pedal is depressed and OFF when the pedal is released.

If the LED does not function as described: Test the reverse switch input circuit. (See "System: Interlock Circuit Diagnosis" on page 331.)

Neutral Switch Input

1. Key switch in RUN position.

2. Alternately, depress and release the forward and reverse pedals.

3. Observe the NEUTRAL input LED. The LED must be OFF when either pedal is depressed and ON when both pedals are released.

If the LED does not function as described: Test the neutral switch input circuit. (See "System: Interlock Circuit Diagnosis" on page 331.)

Power Circuit Operation - Unswitched

Function

Provides power to the primary circuit whenever the battery is connected.

Operating Conditions

- Key switch in OFF position.

Theory of Operation

Voltage must be present at the following components with the key switch in the OFF position:

- Battery (G1) positive (+) terminal.
- Battery terminal (MT3) of starting motor (M1) solenoid.
- Battery terminal of alternator (G2+).
- Battery terminal (B) of key switch (C2).
- Terminal 30 of start relay (K1).
- Terminal 30 of air preheater relay (K4).
- Terminal 30 of light relay (K5).
- Terminal 30 of fuel pull-in relay (K2).
- Terminal 30 of 4WD bypass relay (4WD).

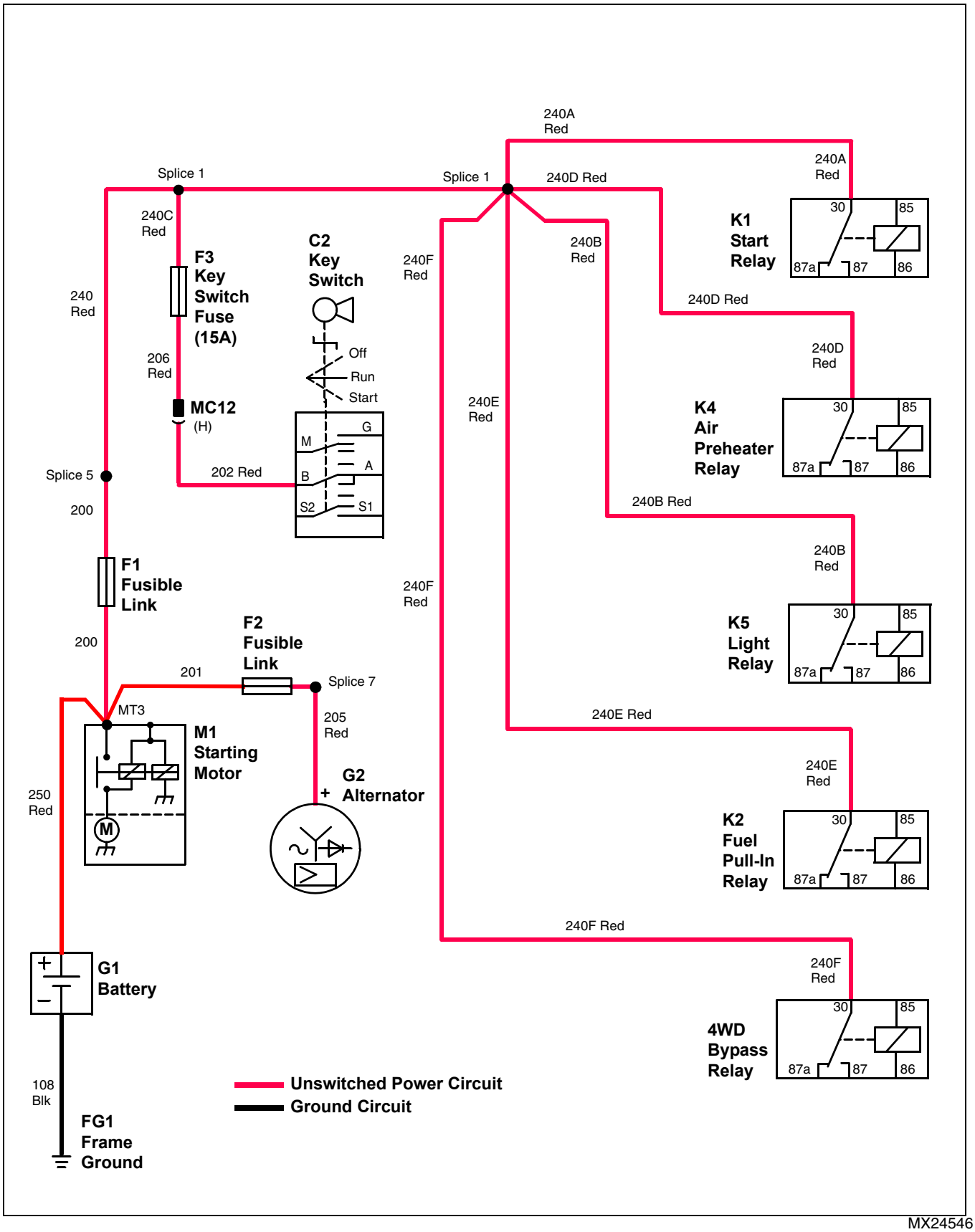
The positive (+) battery cable connects the battery to the starting motor solenoid. The starting motor solenoid connection is used as a tie point for the rest of the electrical system.

The battery cables and the starting motor solenoid connections must be in good condition for the electrical system to function properly.

The ground cable connections are equally as important as the positive (+) cable. Starting motor operation depends on these cables and connections to carry the high current necessary for its operation.

The power circuit is protected by fusible link (F1). The link is a short length of wire that is designed to fail if load current becomes excessive or if a short circuit occurs.

Unswitched Power Circuit Schematic



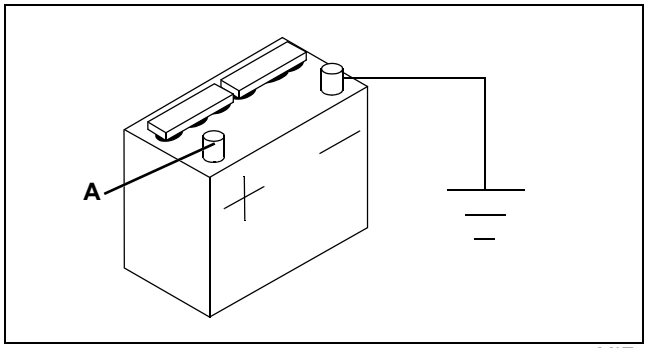
MX24546

System: Power Circuit Diagnosis

Unswitched Power Circuit

Test Conditions

- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

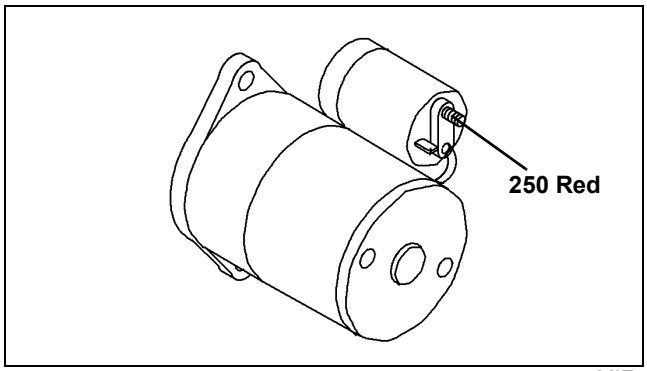


MIF

1. Measure voltage at battery positive (+) terminal A. Is voltage in the range of 11.8-13.2 volts?

Yes: Go to next step.

No: Check battery condition. “Battery Test” on page 446.



MIF

2. Measure voltage at starting motor solenoid (M1), 250 Red wire. Is battery voltage present?

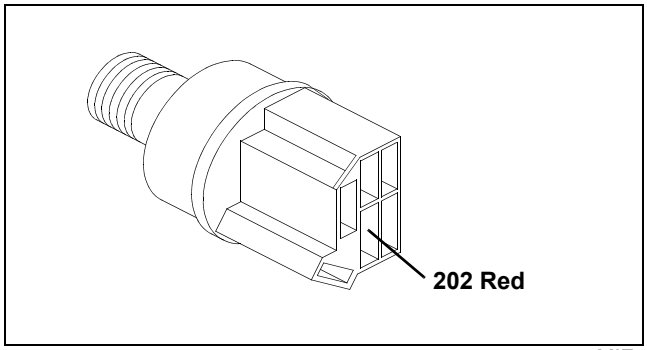
Yes: Go to next step.

No: Check battery positive (+) cable and clamps. Clean and tighten connections.

3. Measure voltage at alternator battery terminal. Is battery voltage present?

Yes: Go to next step.

No: Test 205 Red wire, 201 fusible link (F2) and connections.

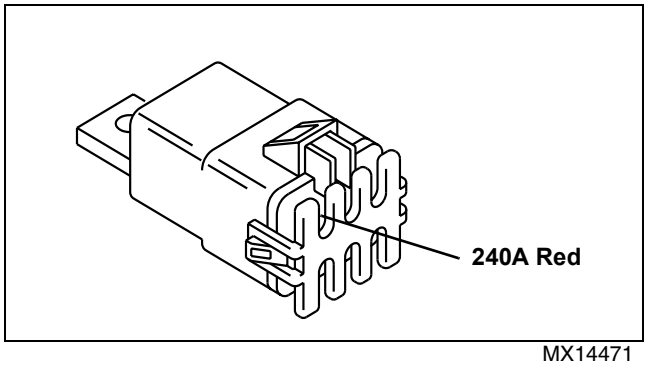


MIF

4. Measure voltage at key switch (C2), terminal B, 202 Red wire. Is battery voltage present

Yes: Go to next step.

No: Test 202, 206, 240C, and 240 Red wires, key switch fuse (F3), 200 fusible link (F1) and connections.



MX14471

5. Measure voltage at start relay (K1), terminal 30, 240A Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240A Red wire and connections.

6. Measure voltage at air preheater relay (K4), terminal 30, 240D Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240D Red wire and connections.

7. Measure voltage at light relay (K5), terminal 30, 240B Red wire. Is battery voltage present?

No: Test 240B Red wire and connections.

8. Measure voltage at fuel pull-in relay (K2), terminal 30, 240E Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240E Red wire and connections.

9. Measure voltage at 4WD bypass relay (4WD), terminal 30, 240F Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240F Red wire and connections.

Power Circuit Operation - Switched

Function

Provides power to components by means of a key switch.

Operating Conditions:

- Key switch in RUN position.

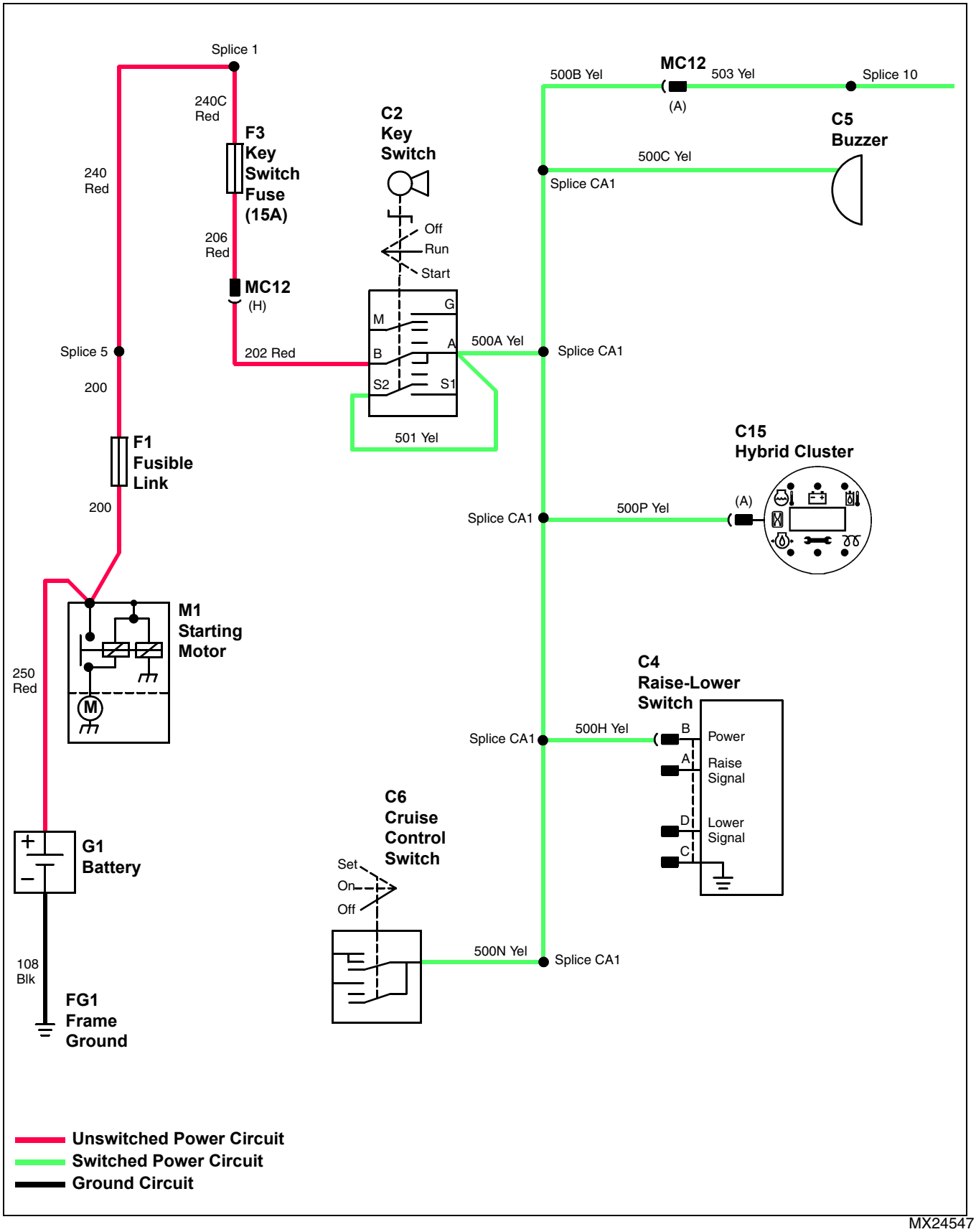
Theory of Operation

Voltage must be present at the following components with the key switch in the RUN position:

- Key switch (C2), terminals A and S2
- Alternator (G2) terminal MT10 (508C Yel wire)
- Start relay (K1), terminal 85.
- PTO relay (K6), terminal 30
- Air preheater relay (K4), terminal 85.
- Light relay (K5), terminal 85.
- Fuel pull-in relay (K2), terminal 85.
- Mow-transport switch (MC160), 504B Yel wire.
- Park brake switch (MC7), 502 Yel wire.
- Reverse switch (MC11), 506 Yel wire.
- Seat switch (MC10), 505 Yel wire.
- Neutral switch (MC24), 507B Yel wire.
- Tilt Sensor connector (MC55), 507T Yel wire.
- Master control module (A1), 509 Yel wire.
- CAN-C1 (FL Controller), 507L Yel wire.
- CAN-C2 (RL Controller), 507K Yel wire.
- CAN-C3 (FC Controller), 507N Yel wire.
- CAN-C4 (RR Controller), 507M Yel wire.
- CAN-C5 (FR Controller), 507P Yel wire.
- CAN-C6 Service connector, 507R Yel wire.
- Down Pressure connector (MC54), 507J Yel wire.
- Raise-lower switch (C4), 500H Yel wire.
- Hood switch connector (MC99), 507C Yel wire.
- Hybrid Cluster (C15), 500P Yel wire.
- Backlap switch (MC19), 507E Yel wire.
- Lower solenoid (MC22), 507H Yel wire.
- Raise solenoid (MC21), 507G Yel wire.
- Fuel pump (MC27), 508E Yel wire.
- Buzzer (C5), 500C Yel wire.
- Cruise control switch (C6), 500N Yel wire.
- Cruise control magnet (MC4), 502A Yel wire.

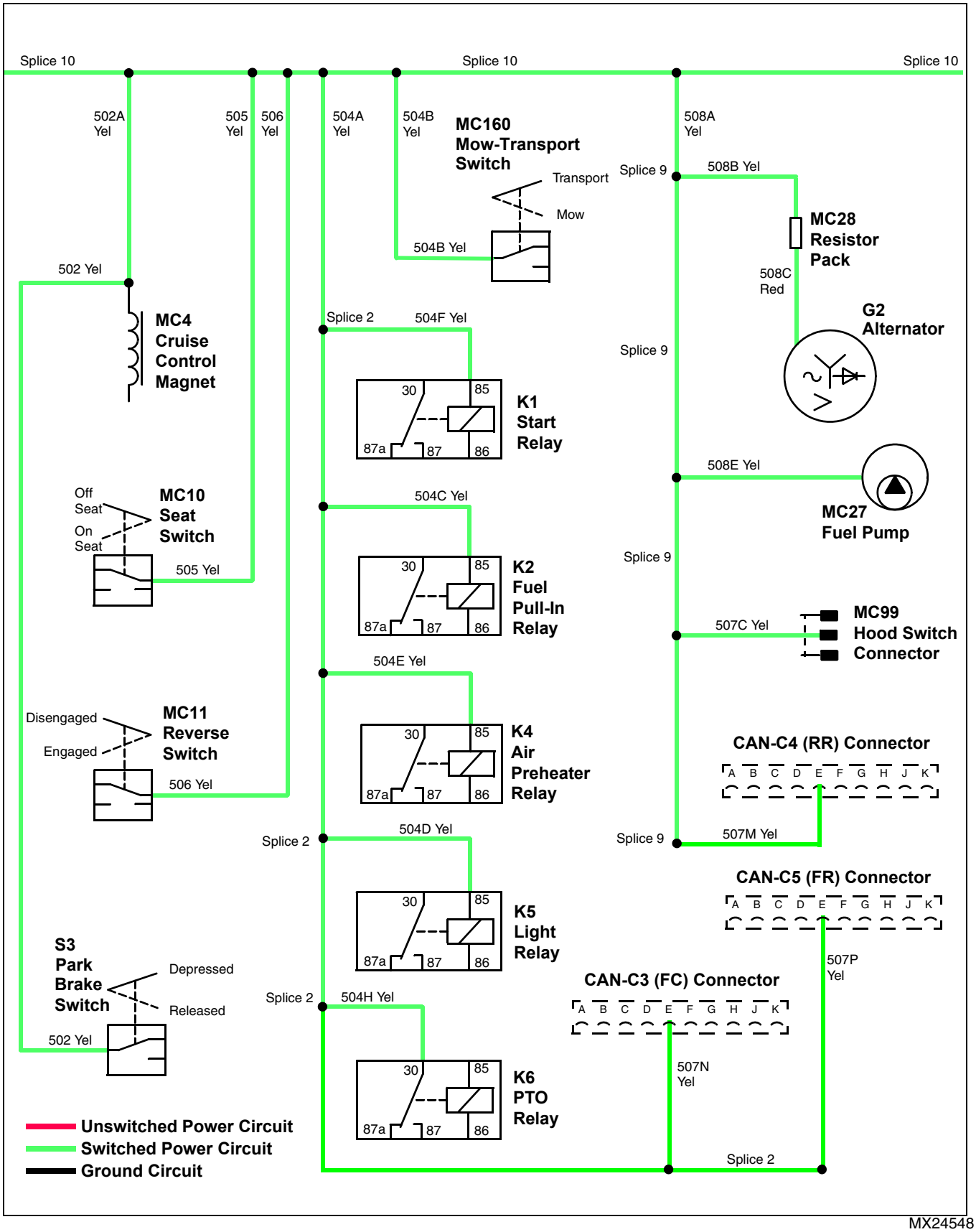
The switched power circuit is protected by 15-amp key switch fuse (F3).

Switched Power Circuit Schematic (Sheet 1 of 3)



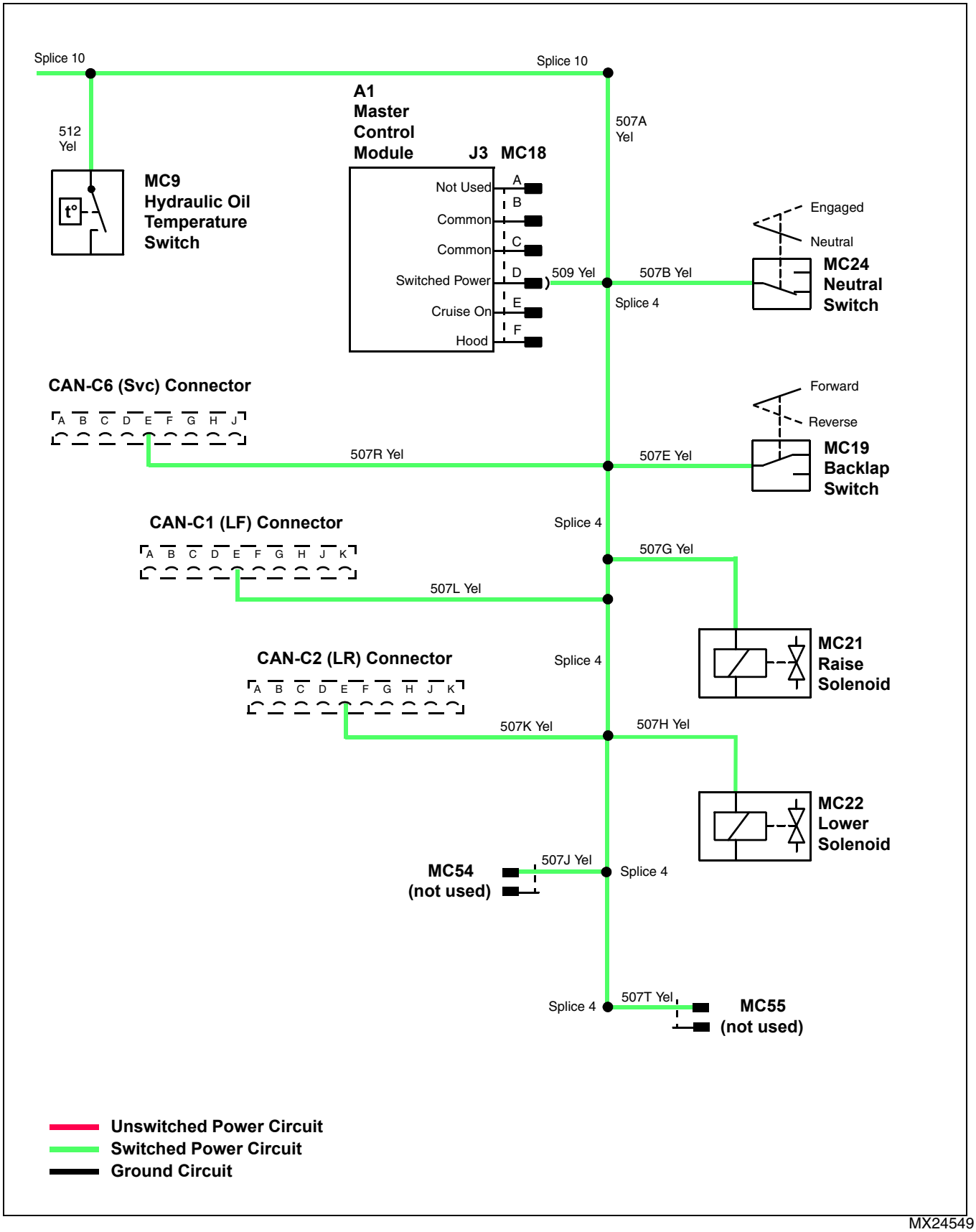
MX24547

Switched Power Circuit Schematic (Sheet 2 of 3)



MX24548

Switched Power Circuit Schematic (Sheet 3 of 3)



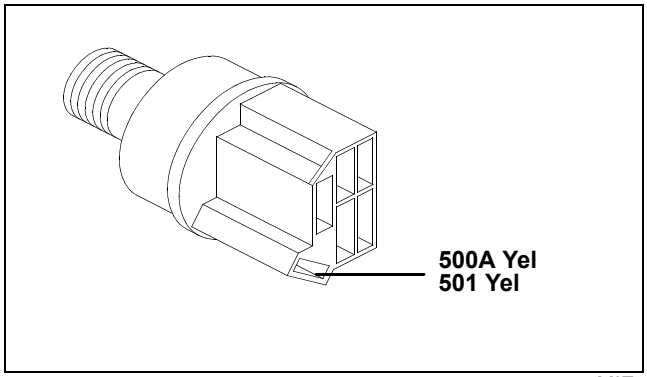
MX24549

System: Switched Power Circuit Diagnosis

Switched Power Circuit

Test Conditions

- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

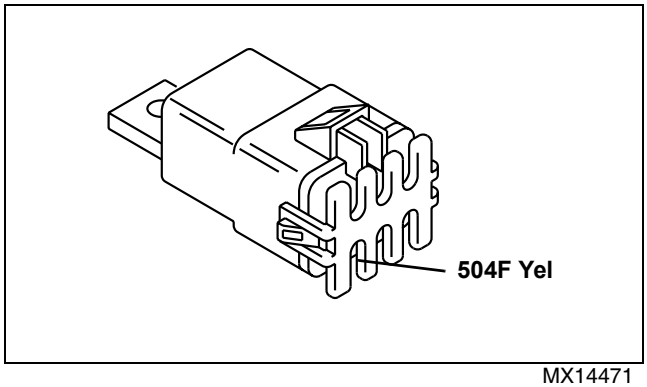


MIF

1. Measure voltage at key switch (C2), terminal A, 500A and 501 Yel wires. Is battery voltage present

Yes: Go to next step.

No: Test key switch. (See “Key Switch Test” on page 453.)

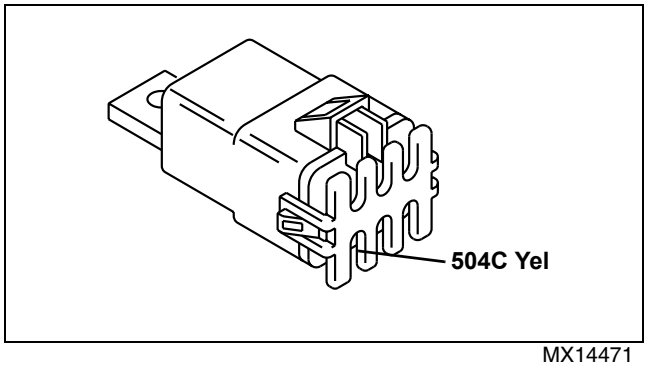


MX14471

2. Measure voltage at start relay (K1), terminal 85, 504F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504F, 504A, 503, 500B, and 500A Yel wires and connections.

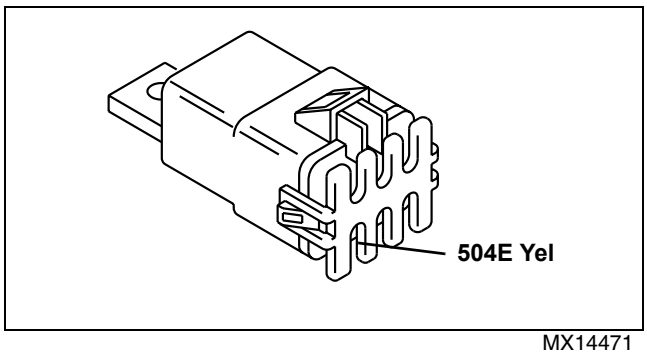


MX14471

3. Measure voltage at fuel pull-in relay (K2), terminal 85, 504C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504C, 504A, 503, 500B, and 500A Yel wires and connections.

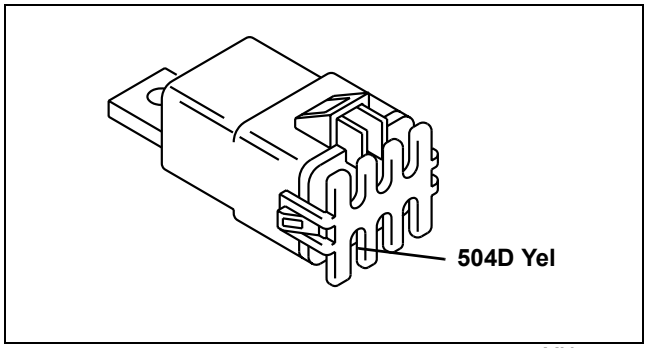


MX14471

4. Measure voltage at air preheater relay (K4), terminal 85, 504E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504E, 504A, 503, 500B, and 500A Yel wires and connections.

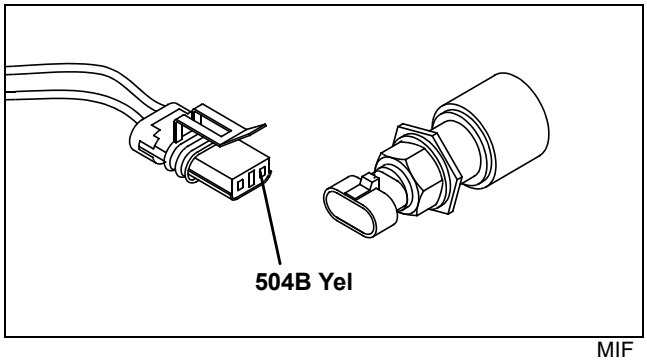


MX14471

5. Measure voltage at light relay (K5), terminal 85, 504D Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504D, 504A, 503, 500B, and 500A Yel wires and connections.

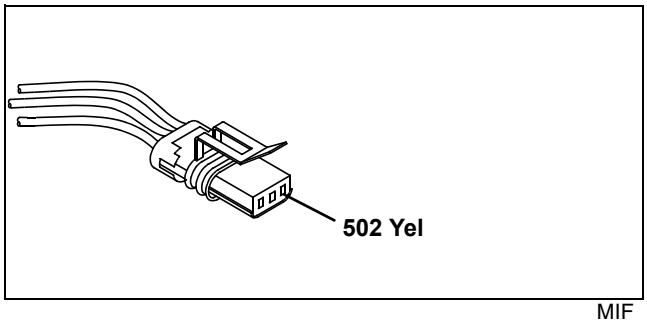


MIF

6. Measure voltage at mow-transport switch (MC160), 504B Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504B, 503, 500B, and 500A Yel wires and connections.

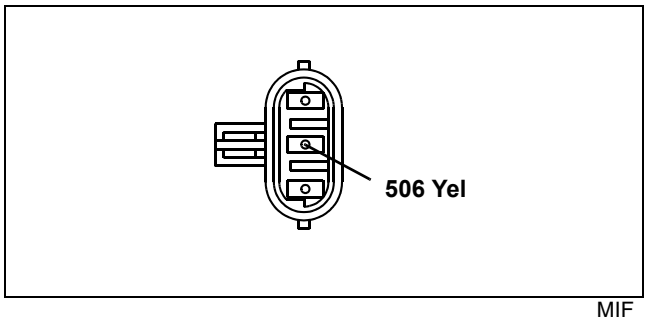


MIF

7. Measure voltage at park brake switch (MC7), 502 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 502, 502A, 503, 500B, and 500A Yel wires and connections.

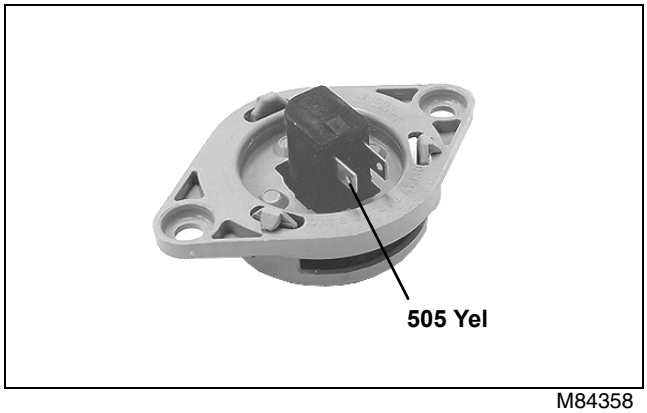


MIF

8. Measure voltage at reverse switch (MC11), 506 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 506, 503, 500B, and 500A Yel wires and connections.

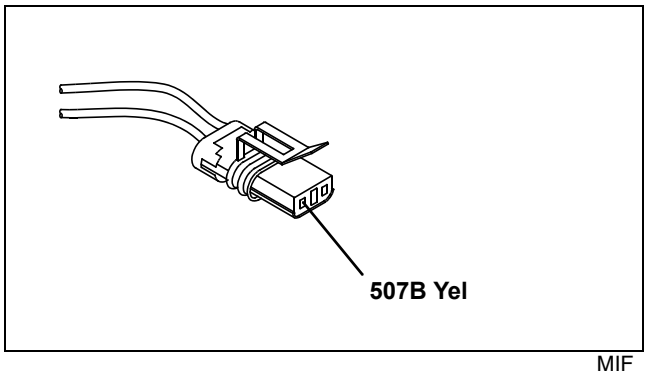


M84358

9. Measure voltage at seat switch (MC10), 505 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 505, 503, 500B, and 500A Yel wires and connections.

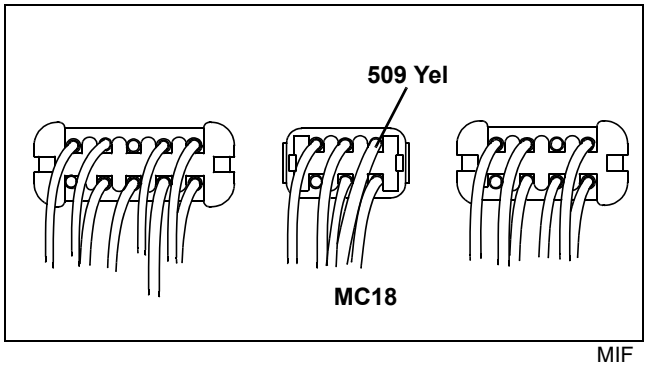


MIF

10. Measure voltage at neutral switch (MC24), 507B Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507B, 507A, 503, 500B, and 500A Yel wires and connections.

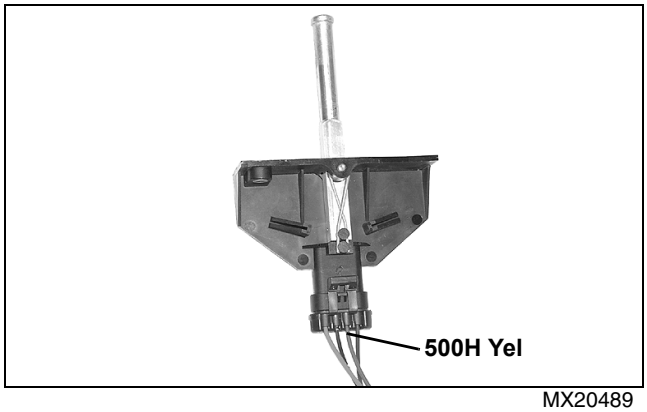


MIF

11. Measure voltage at Master control module (A1), connector (MC18), terminal D, 509 Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 509, 507A, 503, 500B, and 500A Yel wires and connections.



MX20489

12. Measure voltage at raise-lower switch (C4), connector (C4), terminal B, 500H Yel wire. Is battery voltage present?

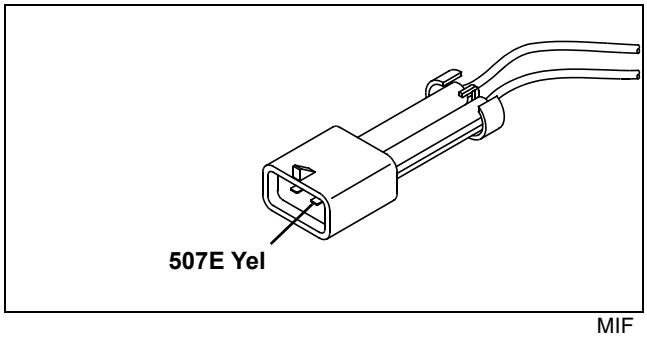
Yes: Go to next step.

No: Test 500H and 500A Yel wires and connections.

13. Measure voltage at hood switch connector (MC99), 507C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507C, 508A, 503, 500B, and 500A Yel wires and connections.

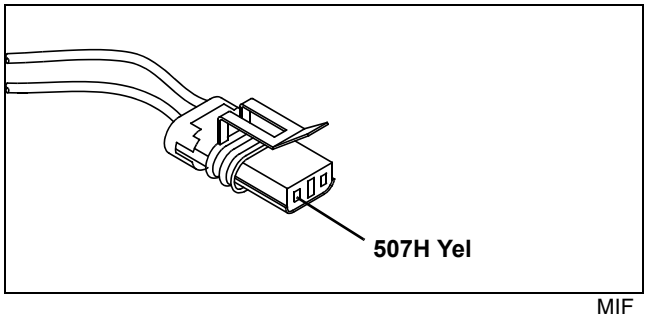


MIF

14. Measure voltage at backlap switch (MC19), 507E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507E, 507A, 503, 500B, and 500A Yel wires and connections.

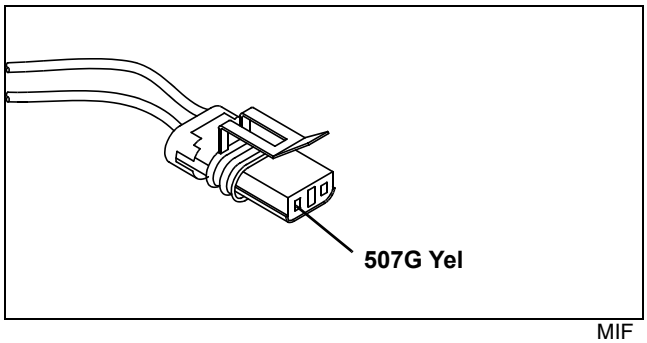


MIF

15. Measure voltage at lower solenoid (MC22), 507H Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507H, 507A, 503, 500B, and 500A Yel wires and connections.

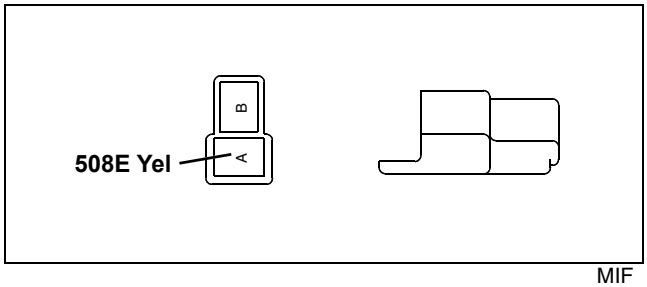


MIF

16. Measure voltage at raise solenoid (MC21), 507G Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507G, 507A, 503, 500B, and 500A Yel wires and connections.

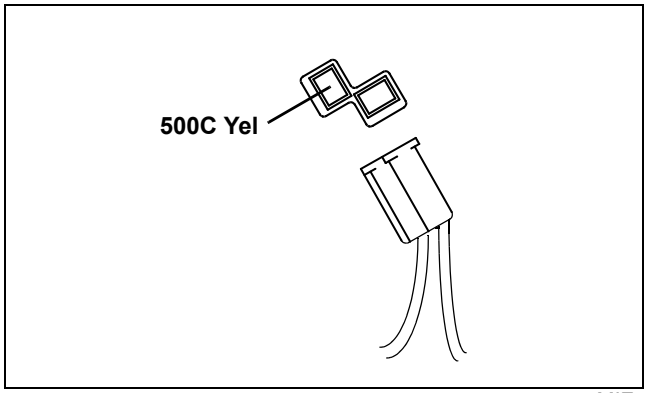


MIF

17. Measure voltage at fuel pump (MC27), 508E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508E, 508A, 503, 500B, and 500A Yel wires and connections.



MIF

18. Measure voltage at buzzer (C5), 500C Yel wire. Is battery voltage present?

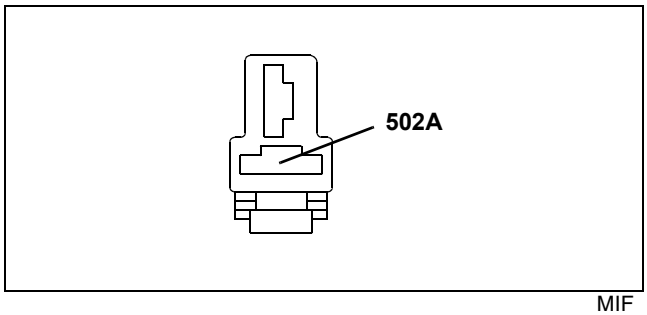
Yes: Go to next step.

No: Test 500C and 500A Yel wires and connections.

19. Measure voltage at cruise control switch (C6), 500N Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500N and 500A Yel wires and connections.



MIF

20. Measure voltage at cruise control magnet (MC4), 502A Yel wire. Is battery voltage present?

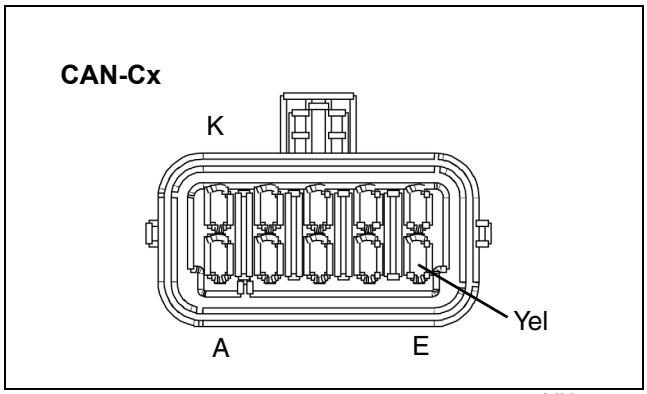
Yes: Go to next step.

No: Test 502A, 503, 500B and 500A Yel wires and connections.

21. Measure voltage at alternator (G2), 508C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508C, 508B, 508A, 503, 500B and 500A Yel wires and connections.



MX41797

22. Measure voltage at FL controller (RMC1), connector (CAN-C1), terminal E, 507L Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507L, 507A, 503, 500B and 500A Yel wires and connections.

23. Measure voltage at RL controller (RMC2), connector (CAN-C2), terminal E, 507K Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Check 507K, 507A, 503, 500B and 500A Yel wires and connections.

24. Measure voltage at FC controller (RMC3), connector (CAN-C3), terminal E, 507N Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Check 507N, 504A, 503, 500B and 500A Yel wires and connections.

25. Measure voltage at RR controller (RMC6), connector (CAN-C4), terminal E, 507M Yel wire. Is battery voltage present?

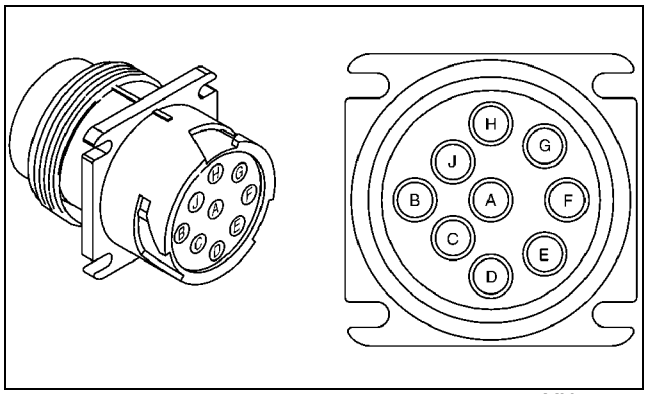
Yes: Go to next step.

No: Check 507M, 508A, 503, 500B and 500A Yel wires and connections.

26. Measure voltage at FR controller (RMC5), connector (CAN-C5), terminal E, 507P Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507P, 507A, 503, 500B and 500A Yel wires and connections.



MX40887

27. Measure voltage at CAN Bus service connector (CAN-C6), terminal B, 507R Yel wire. Is battery voltage present?

No: Check 507R, 507A, 503, 500B and 500A Yel wires and connections.

Interlock Circuit Operation

Function

To enable and disable the start relay (K1) and the fuel shutoff solenoid (MC26), based on inputs from various switches and controls

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow-transport lever in TRANSPORT position.
- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.

Theory of Operation

With the key switch (C2) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following:

- Mow-transport switch (MC160), 504B Yel wire.
- Park brake switch (MC7), 502A and 502 Yel wires.
- Seat switch (MC10), 505 Yel wire.
- Neutral switch (MC24), 507A and 507B Yel wires.

From each switch, current flows to the Master control module (A1) as follows:

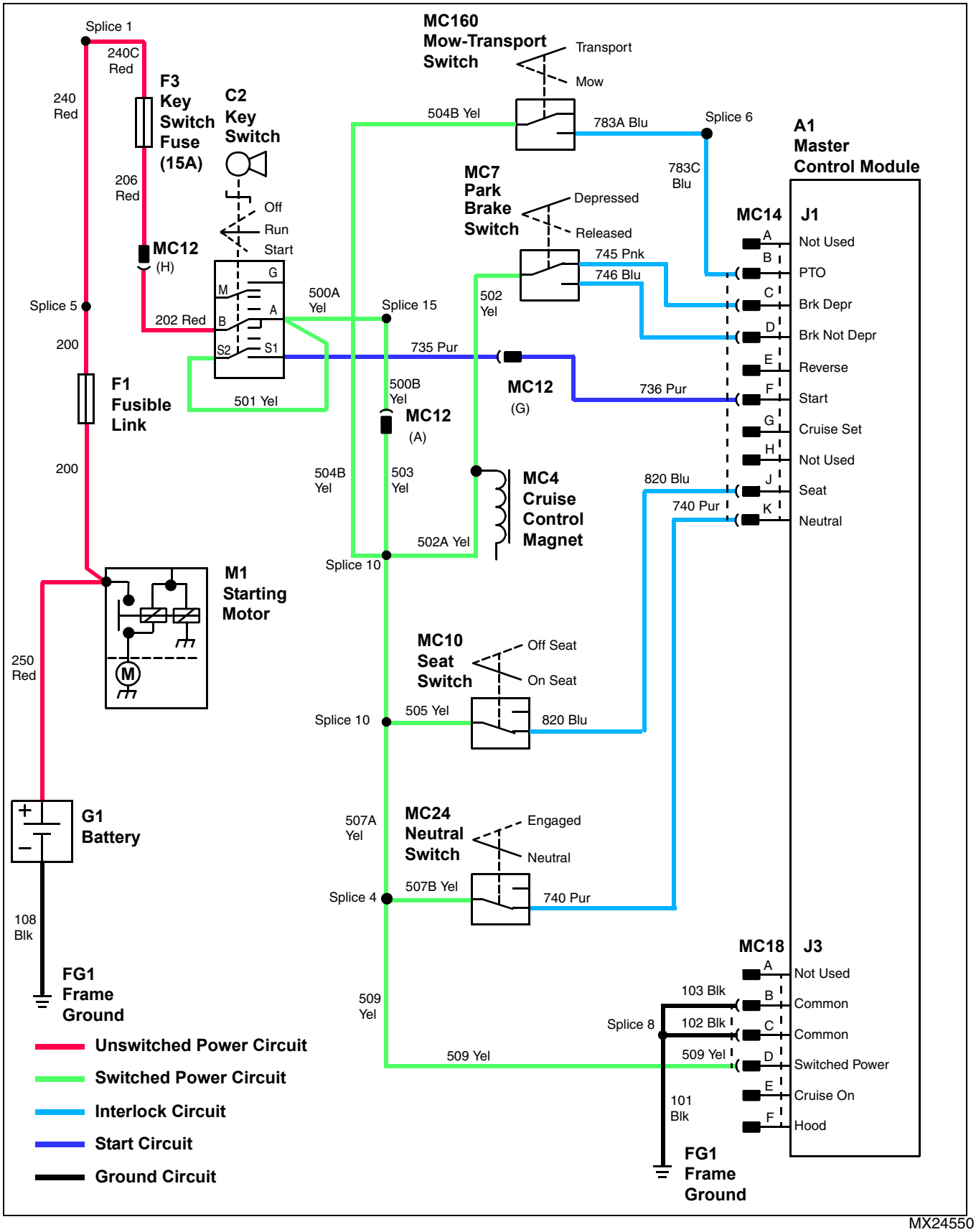
- Mow-transport switch - When in the MOW position, current flows to Master control module connector (MC14), terminal B, 783A and 783C Blu wires, indicating that the switch is in the ON position.

- Park brake switch - When in UNLOCKED position, current flows to control module connector (MC14), terminal D, 746 Blu wire, indicating that the park brake switch is in the UNLOCKED position. When in LOCKED position, current flows to control module connector (MC14), terminal C, 745 Pnk wire, indicating that the park brake switch is in LOCKED position.

- Seat switch - When in the ON SEAT position, current flows to control module connector (MC14), terminal J, 820 Blu wire, indicating that the seat switch is in the ON SEAT position.

- Neutral switch - When in the NEUTRAL position, current flows to control module connector (MC14), terminal K, 740 Pur wire, indicating that the neutral switch is in the NEUTRAL position.

Interlock Circuit Schematic



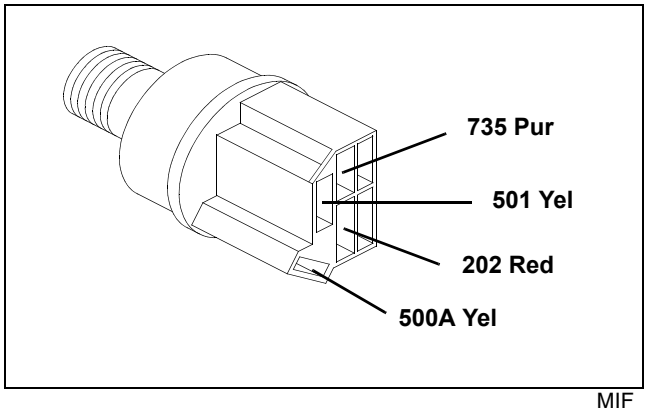
MX24550

System: Interlock Circuit Diagnosis

Key Switch Circuit Test

Test Conditions

- Key switch in START position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at key switch (C2), terminal B, 202 Red wire. Is battery voltage present

Yes: Go to next step.

No: Test key switch fuse (F3). If fuse tests good, test 202, 206, 240C, and 240 Red wires and 200 fusible link (F1) and connections.

2. Measure voltage at key switch (C2), terminal A, 500A and 501 Yel wires. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See “Key Switch Test” on page 453.)

3. Measure voltage at key switch (C2), terminal S2, 501 Yel wire. Is battery voltage present?

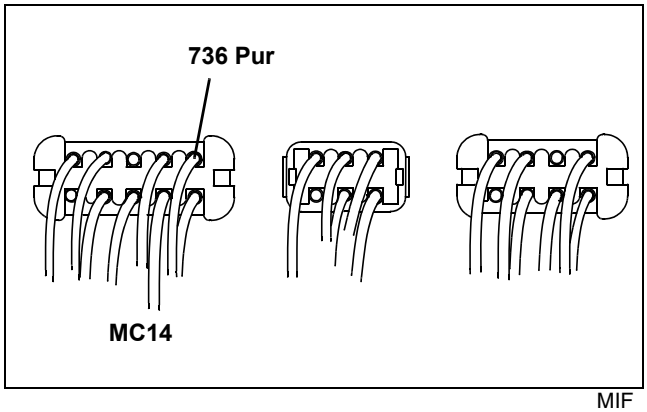
Yes: Go to next step.

No: Test 501 Yel wire and connections.

4. Measure voltage at key switch (C2), terminal S1, 735 Pur wire. Is battery voltage present?

Yes: Go to next step.

No: Test key switch. (See “Key Switch Test” on page 453.)



MIF

5. Disconnect Master control module connector (MC14). Measure voltage at Master control module connector (MC14), terminal F, 736 Pur wire. Is battery voltage present?

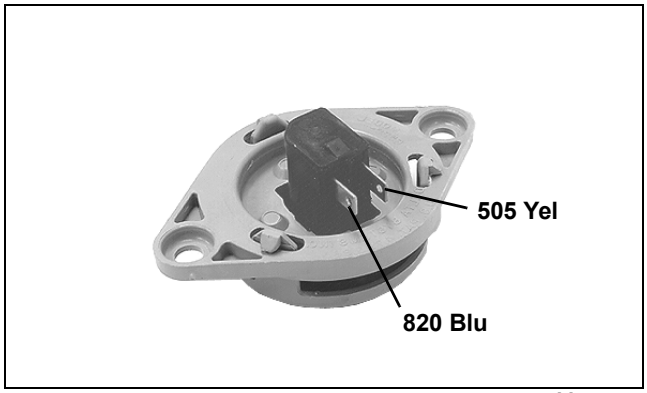
Yes: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

No: Test 736 and 735 Pur wires and connections.

Seat Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Seat switch depressed.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



M84358

1. Measure voltage at seat switch (MC10), 505 Yel wire. Is battery voltage present?

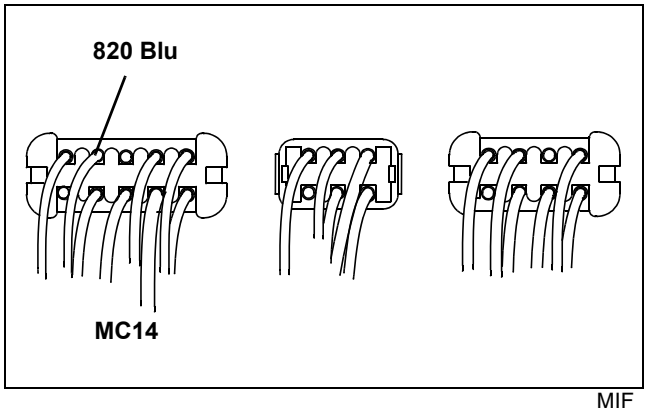
Yes: Go to next step.

No: Test 505, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at seat switch (MC10), 820 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test seat switch. (See “Seat Switch Test” on page 455.)



MIF

3. Disconnect Master control module connector (MC14). Measure voltage at Master control module connector (MC14), terminal J, 820 Blu wire. Is battery voltage present?

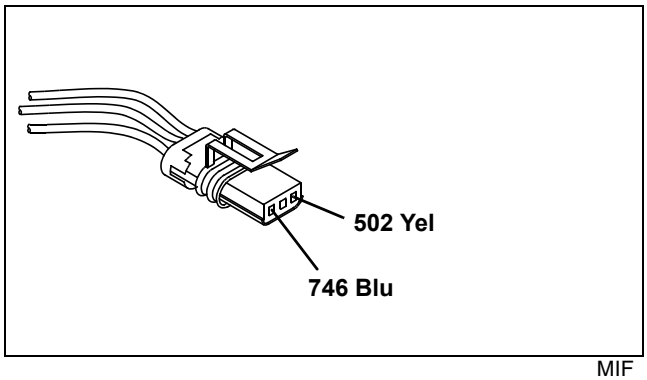
Yes: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

No: Test 820 Blu wire and connections.

Park Brake Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Park brake pedal in UNLOCKED position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at park brake switch (MC7), 502 Yel wire. Is battery voltage present?

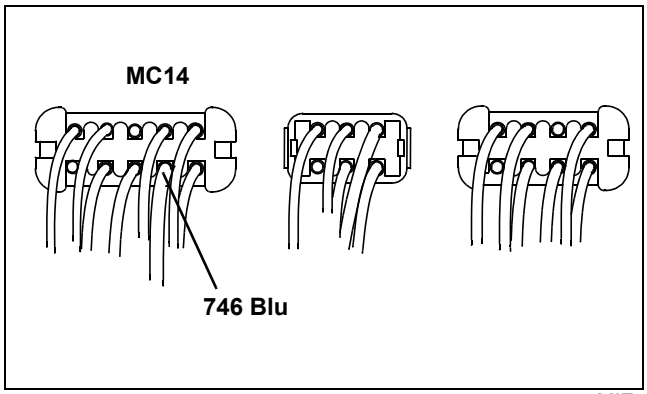
Yes: Go to next step.

No: Test 502, 502A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at park brake switch (MC7), 746 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test park brake switch. “Park Brake and Mow-Transport Switch Test” on page 453.

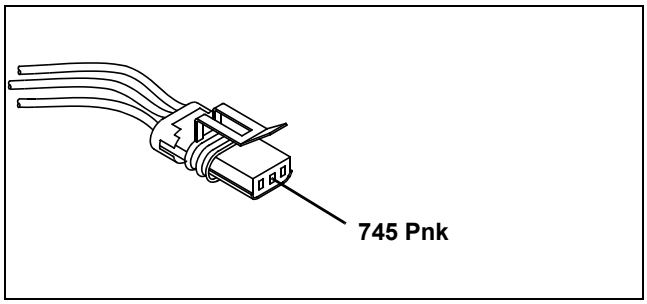


MIF

3. Disconnect Master control module connector (MC14). Measure voltage at Master control module connector (MC14), terminal D, 746 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 746 Blu wire and connections.

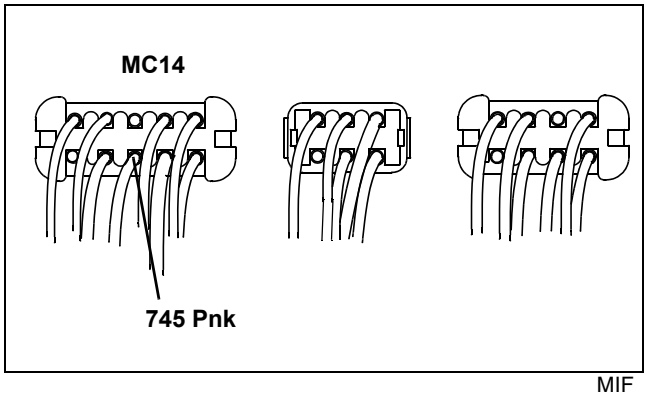


MIF

4. Depress park brake pedal. Measure voltage at park brake switch (MC7), 745 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test park brake switch. “Park Brake and Mow-Transport Switch Test” on page 453.



MIF

5. Disconnect Master control module connector (MC14). Measure voltage at Master control module connector (MC14), terminal C, 745 Pnk wire. Is battery voltage present?

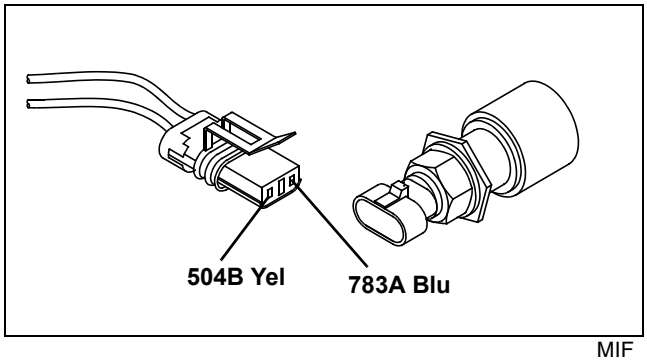
Yes: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)

No: Test 745 Pnk wire and connections.

Mow-Transport Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Mow-transport lever in MOW position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at mow-transport switch (MC160), 504B Yel wire. Is battery voltage present?

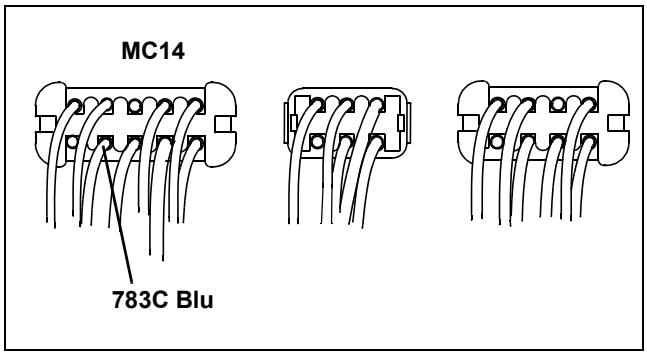
Yes: Go to next step.

No: Test 504B, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at mow-transport switch (MC160), 783A Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test mow-transport switch. “Park Brake and Mow-Transport Switch Test” on page 453.



MIF

3. Disconnect Master control module connector (MC14). Measure voltage at Master control module connector (MC14), terminal B, 783C Blu wire. Is battery voltage present?

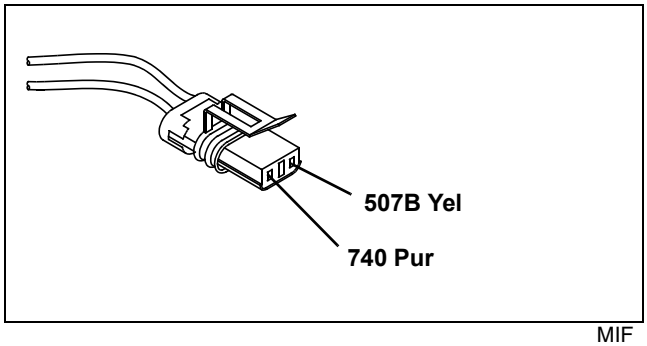
Yes: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

No: Test 783A and 783C Blu wires and connections.

Neutral Switch Circuit Test

Test Conditions

- Key switch in RUN position.
- Forward and reverse pedals released.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at neutral switch (MC24), 507B Yel wire. Is battery voltage present?

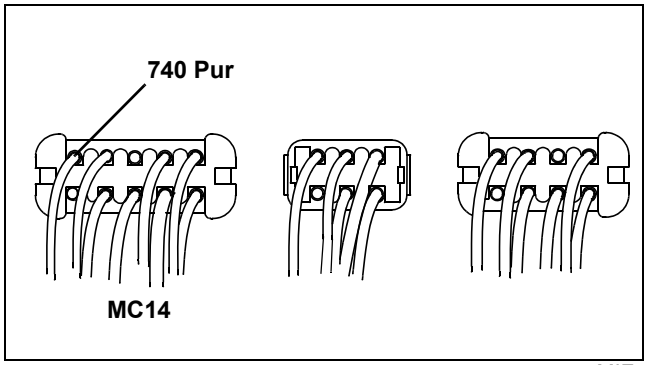
Yes: Go to next step.

No: Test 507B, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at neutral switch (MC24), 740 Pur wire. Is battery voltage present?

Yes: Go to next step.

No: Test neutral switch. (See “Neutral Switch Test” on page 454.)



MIF

3. Disconnect Master control module connector (MC14). Measure voltage at Master control module connector (MC14), terminal K, 740 Pur wire. Is battery voltage present?

Yes: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

No: Test 740 Pur wire and connections.

Cranking Circuit Operation

Function

Provides power to the starting motor (M1) to crank the engine.

Operating Conditions

To crank the engine, the following conditions must be met:

- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.
- Key switch in START position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

The power circuit provides current to the key switch (C2) and protects the cranking circuit with a fusible link (F1) and 15-amp key switch fuse (F3)

Unswitched power from the battery (G1) positive (+) terminal is available at the following components:

- Starting motor (M1), battery terminal, 250 Red wire.
- Key switch (C2), terminal B, 202, 206, 240C, and 240 Red wires and 200 fusible link (F1).
- Start relay (K1), terminal 30, 240A and 240 Red wires and 200 fusible link (F1).
- Fuel pull-in relay (K2), terminal 30, 240E and 240 Red wires and 200 fusible link (F1).

Moving key switch (C2) to the START position allows power to be present at all the components as when in the RUN position. (See “Power Circuit Operation - Switched” on page 321.)

When the key switch (C2) is in the START position, current flows from key switch terminal S1 to control module connector (MC14), terminal F, 735 and 736 Pur wires.

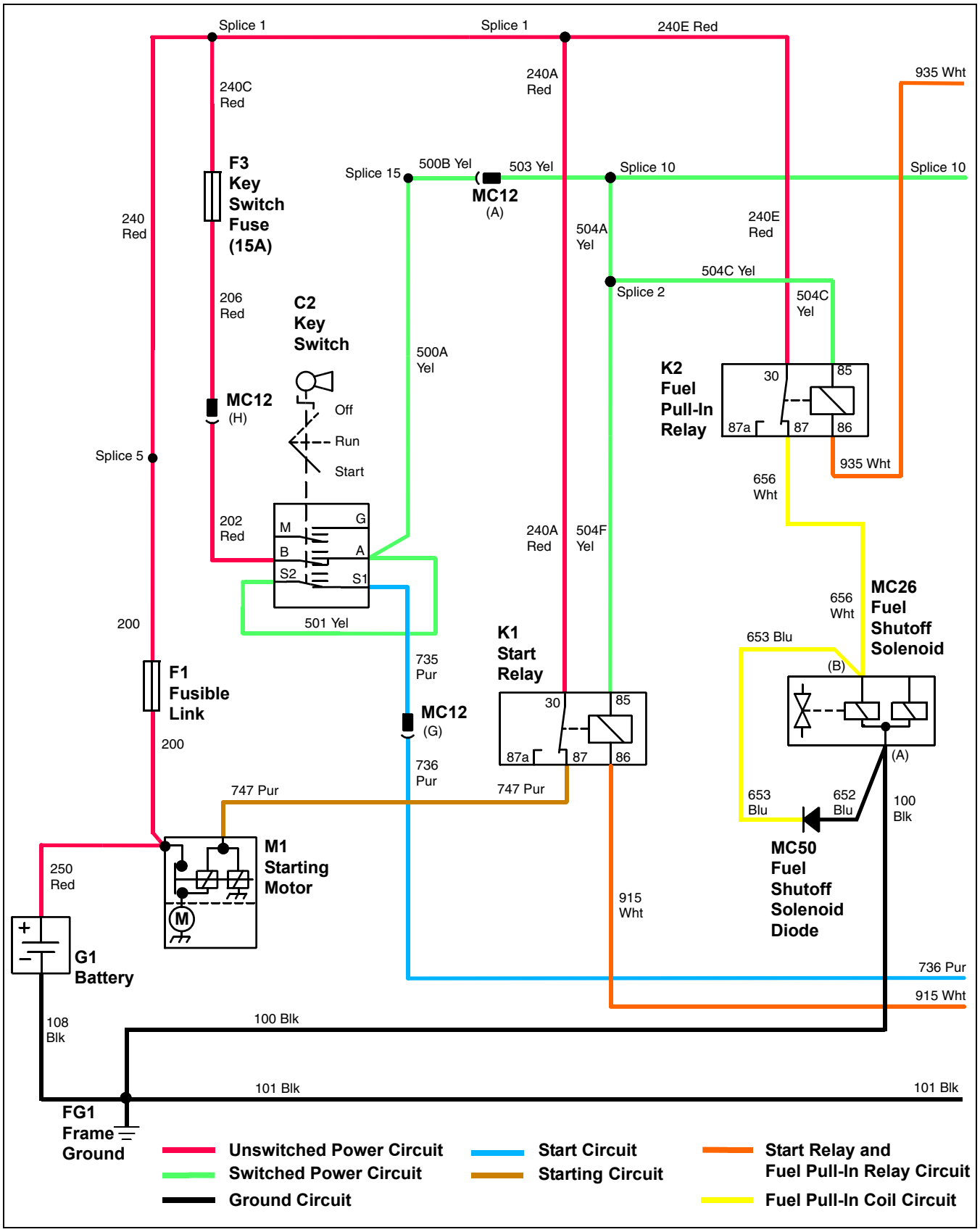
With the key switch in the START position, the control module will energize start relay (K1) and at the same time momentarily energize fuel pull-in relay (K2). This can only occur when the following conditions are met from the interlock circuit:

- Park brake in LOCKED position.
- Forward and reverse pedals in NEUTRAL position.
- Mow-transport lever in TRANSPORT position.

With the key switch in the START position and operating conditions met, Master control module (A1) provides a controlled ground to start relay (K1), terminal 86, through 915 Wht wire, energizing the relay. With start relay energized, current flows between start relay terminals 30 and 87 to the solenoid of starting motor (M1), 747 Pur wire, engaging the starting motor.

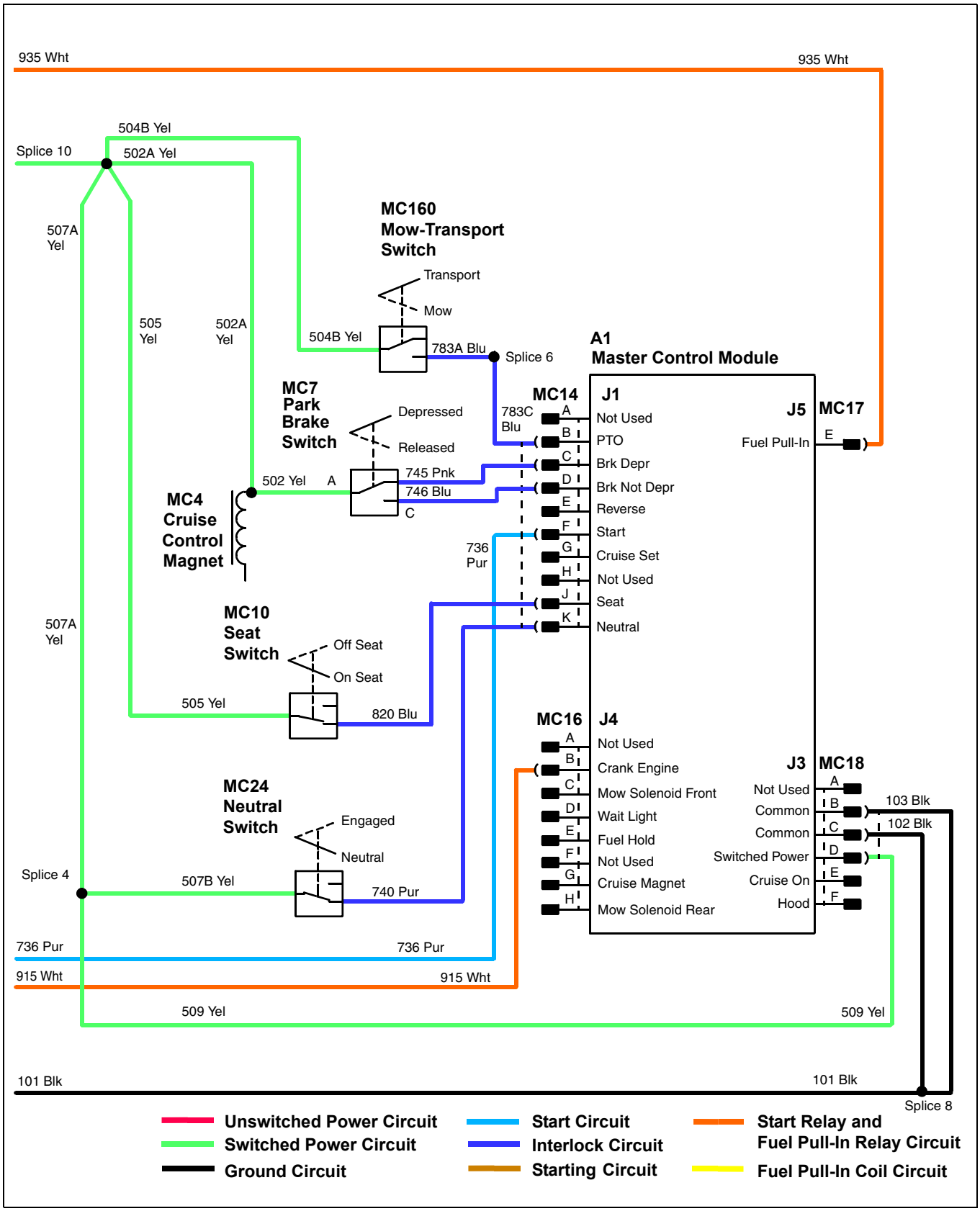
At the same time, Master control module (A1) momentarily provides a controlled ground to fuel pull-in relay (K2), terminal 86, 935 Wht wire, momentarily energizing the relay. With fuel pull-in relay momentarily energized, current flows between fuel pull-in relay terminals 30 and 87 to fuel shutoff solenoid pull-in coil, 656 Wht wire, momentarily energizing the fuel shutoff solenoid pull-in coil.

Cranking Circuit Schematic (Sheet 1 of 2)



MX24551

Cranking Circuit Schematic (Sheet 2 of 2)



MX24552

System: Cranking Circuit Diagnosis

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

The multi-step process is as follows:

Important: Avoid Damage! When diagnosing the cranking circuit, it is important to perform the following steps in the sequence shown.

1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

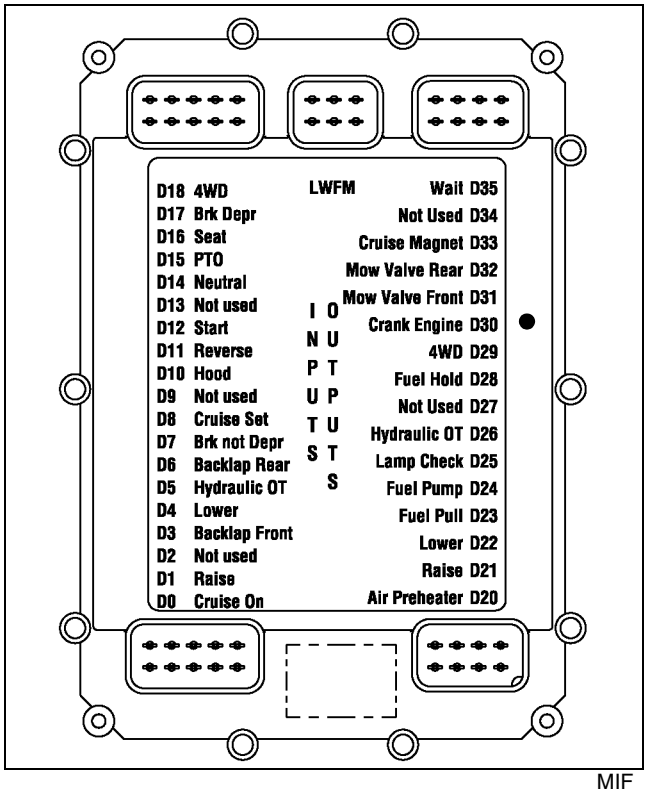
2. Cranking Circuit Tests. (See “Cranking Circuit Tests” on page 338.)

Cranking Circuit Tests

Start Relay Circuit

Test Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward-reverse pedals in NEUTRAL position.
- Starting motor solenoid connector (MC31), 747 Pur wire disconnected
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.

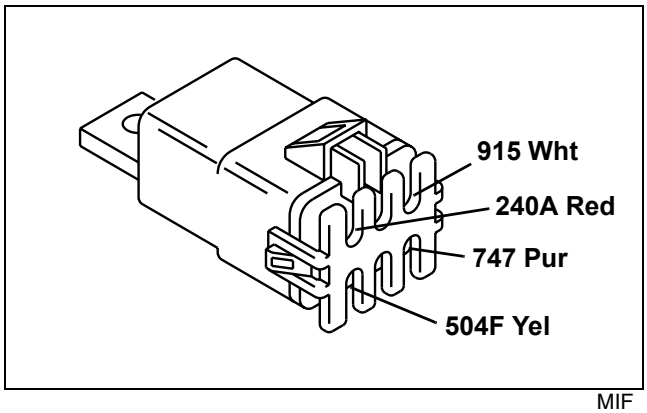


MIF

1. Master control module (A1) output (D30) LED check. Cycle key switch between RUN and START positions. Is crank engine output (D30) LED ON when key switch is in START position and output (D30) LED OFF in RUN position?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)



MIF

2. Measure voltage at start relay (K1), terminal 85, 504F Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504F, 504A, 503, 500B, and 500A Yel wires and connections.

3. Key switch in START position. Measure voltage at start relay (K1), terminal 86, 915 Wht wire. Is voltage approximately 0.90 volt?

Yes: Go to next step.

No: Test 915 Wht wire and Master control module connector (MC16), terminal B.

4. Measure voltage at start relay (K1), terminal 30, 240A Red wire. Is battery voltage present?

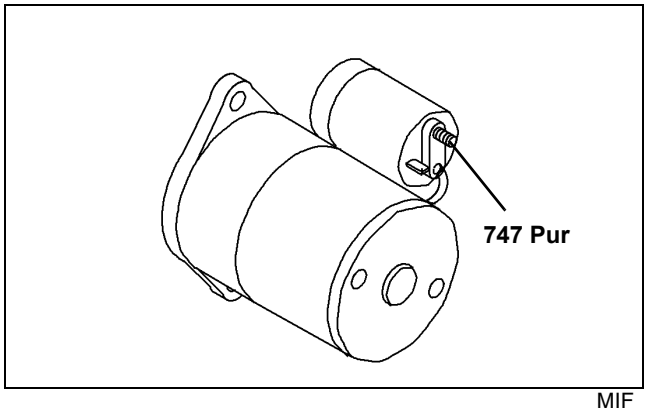
Yes: Go to next step.

No: Test 240A and 240 Red wires and 200 fusible link (F1).

5. Measure voltage at start relay (K1), terminal 87, 747 Pur wire. Is battery voltage present when key switch is in the START position?

Yes: Go to next step.

No: Test relay. (See “Relay Test” on page 452.)



MIF

6. Measure voltage at starting motor solenoid (M1), 747 Pur wire. Is battery voltage present?

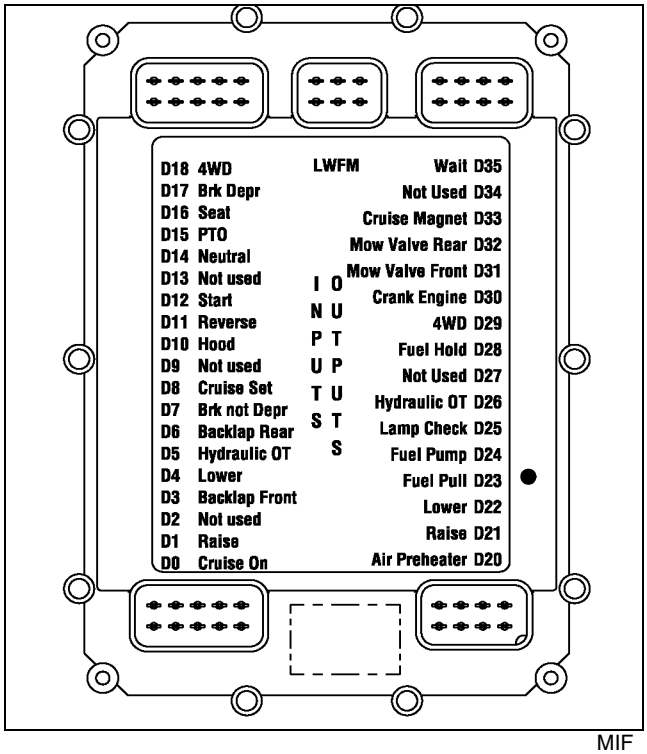
Yes: Test starter solenoid. (See “Starter Solenoid Test” on page 450.)

No: Test 747 Pur wire and connections.

Fuel Shutoff Hold-In Coil Circuit

Test Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Forward-reverse pedals in NEUTRAL position.
- Starting motor solenoid connector (MC31), 747 Pur wire disconnected.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.

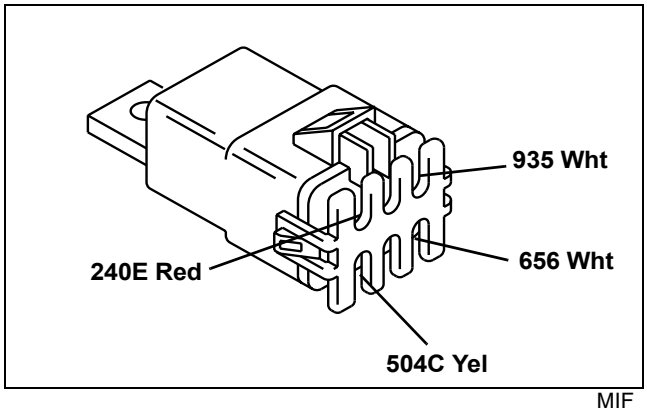


MIF

1. Master control module (A1) output (D23) LED check. Cycle key switch between RUN and START positions. Is fuel pull-in output (D23) LED ON when key switch is in START position and output (D23) LED OFF in RUN position?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)



MIF

2. Measure voltage at fuel pull-in relay (K2), terminal 30, 240E Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240E and 240 Red wires and 200 fusible link (F1).

3. Measure voltage at fuel pull-in relay (K2), terminal 85, 504C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504C, 504A, 503, 500B, and 500A Yel wires and connections.

4. Measure continuity between fuel pull-in relay (K2), terminal 86, 935 Wht wire and Master control module connector (MC17), terminal E, 935 Wht wire. Is there continuity?

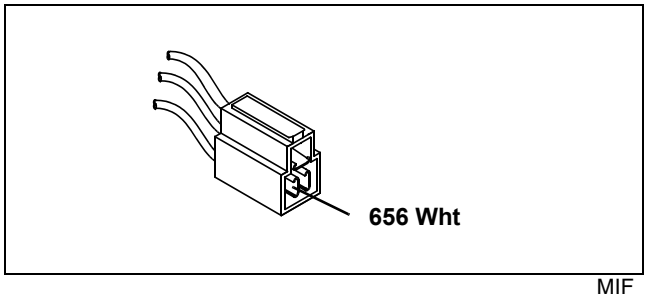
Yes: Go to next step.

No: Test 935 Wht wire and connections.

5. Key switch in START position. Measure voltage at fuel pull-in relay (K2), terminal 87, 656 Wht wire. Is battery voltage present?

Yes: Go to next step.

No: Test relay. (See “Relay Test” on page 452.)



MIF

6. Measure voltage at fuel shutoff solenoid (MC26), 656 Wht wire. Is battery voltage present?

Yes: Test fuel shutoff solenoid. “Fuel Shutoff Solenoid Test” on page 457.

No: Test 656 Wht wire and connections.

Run Circuit Operation - Operator ON Seat

Function

To allow the engine to run with the operator on the seat.

Operating Conditions

- Operator ON seat.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following

- Master control module (A1), 509 and 507A Yel wires.
- Fuel pump (MC27), 508E and 508A Yel wires.

The control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 329.) as follows:

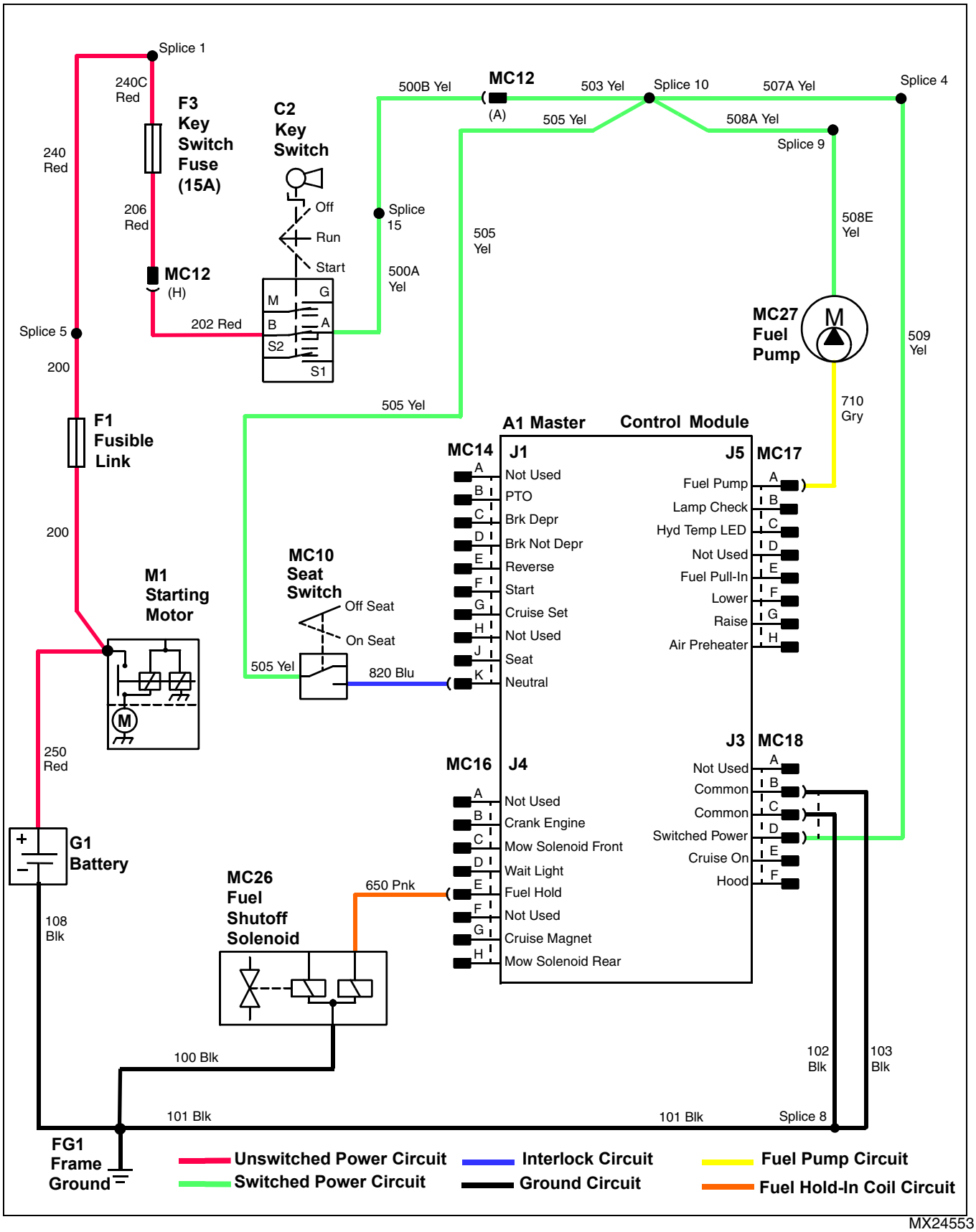
- Seat switch (MC10), 505 Yel wire.

With the operator ON seat and the key switch in the RUN position, the Master control module (A1) provides a controlled ground circuit for the fuel pump (MC27), 710 Gry wire, and energizes the fuel pump. Also, the Master control module provides current to the hold coil of the fuel shutoff solenoid (MC26), 650 Pnk wire. The hold coil is provided ground from 100 Blk wire, and the fuel shutoff solenoid is held in the energized position, and the engine continues to run.

The Master control module will shut down the engine by opening the outputs to the fuel shutoff solenoid hold coil and fuel pump circuits when the following conditions exist:

- Operator OFF seat.
- Hood OPEN (European machines).
- Hood switch connector with jumper wire disconnected (North American machines).

Run Circuit Schematic - Operator ON Seat



MX24553

System: Run Circuit Diagnosis - Operator ON Seat

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the fuel pump circuit, it is important to perform the following steps in the sequence shown.

1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

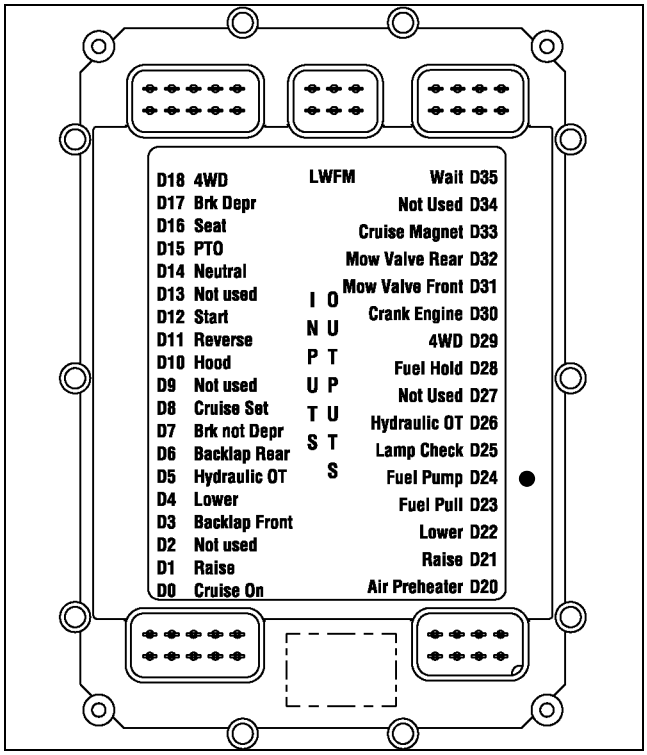
2. Run Circuit Test. (See “Run Circuit Operation - Operator ON Seat” on page 341.)

Run Circuit Test

Fuel Pump Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

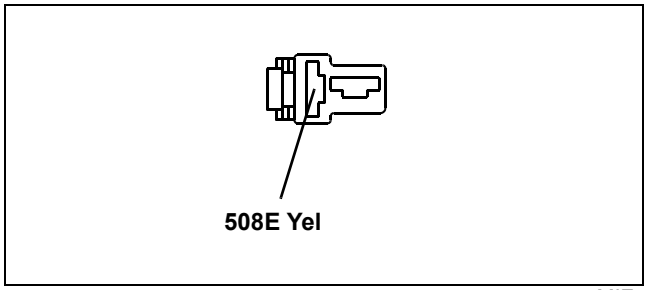


MX24569

1. Master control module (A1) output (D24) LED check. Is fuel pump output (D24) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

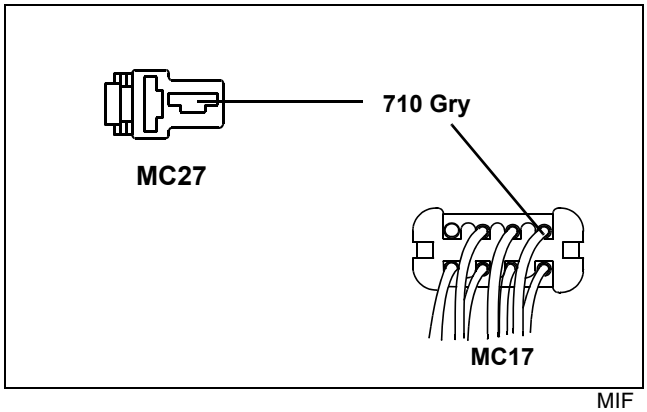


MIF

2. Measure voltage at fuel pump (MC27), 508E Yel wire. Is battery voltage present

Yes: Go to next step.

No: Test 508E, 508A, 503, 500B, and 500A Yel wires and connections.



MIF

3. Disconnect Master control module connector (MC17). Measure resistance between Master control module connector (MC17), terminal A, 710 Gry wire and fuel pump (MC27), connector (MC27), 710 Gry wire. Is resistance less than 0.1 ohm?

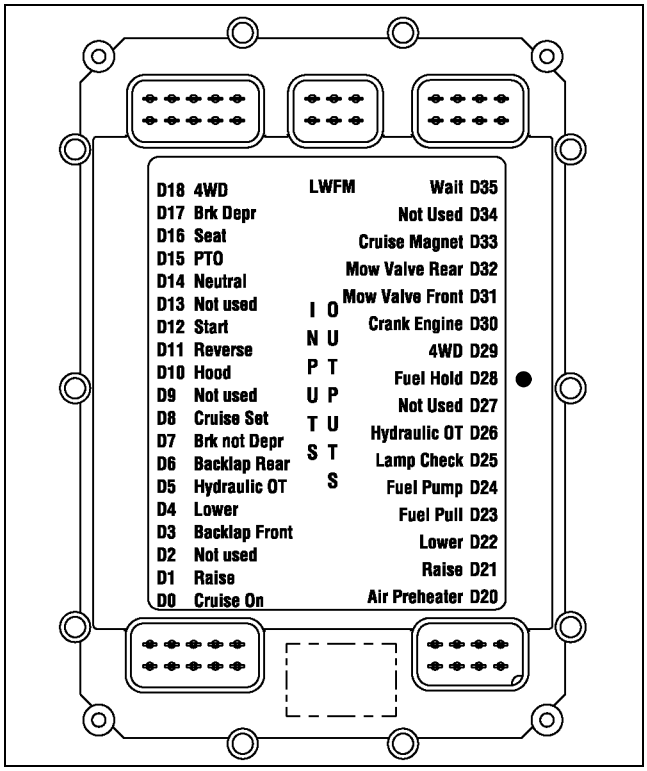
Yes: Test fuel pump. See “Fuel Pump Test” on page 458

No: Test 710 Gry wire and connections.

Fuel Shutoff Solenoid Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

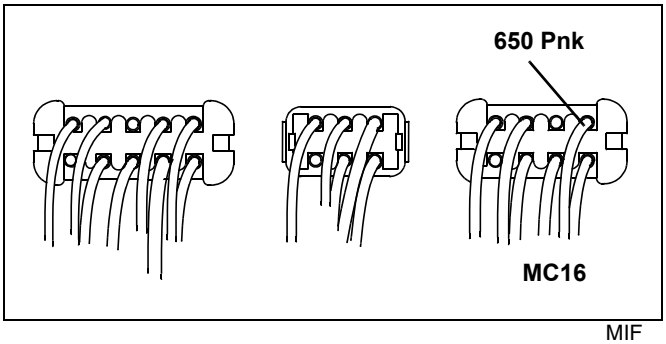


MX24569

1. Master control module (A1) output (D28) LED check. Is fuel hold output (D28) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

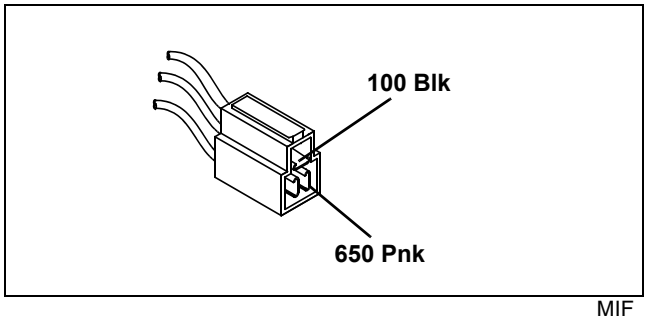


MIF

2. Measure voltage at Master control module connector (MC16), terminal E, 650 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Unplug connector (MC16) and test connector terminal E, 650 Pnk wire and connections.



MIF

3. Measure voltage at fuel shutoff solenoid connector (MC26), 650 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 650 Pnk wire and connections.

4. Measure voltage at fuel shutoff solenoid connector (MC26), 100 Blk wire. Is voltage less than 0.10 volt?

Yes: Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test” on page 457.

No: Test 100 Blk wire and connections.

Run Circuit Operation - Operator OFF Seat

Function

To allow the engine to run with the operator off the seat.

Operating Conditions

- Key switch in RUN position.
- Mow-transport lever in TRANSPORT position.
- Park brake in LOCKED position.
- Neutral switch in NEUTRAL position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).

Theory of Operation

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A, 500B, and 503 Yel wires to the following

- Master control module (A1), 509 and 507A Yel wires.
- Fuel pump (MC27), 508E and 508A Yel wires.

When the operator is OFF the seat, Master control module will allow the engine to operate, when the following conditions are met:

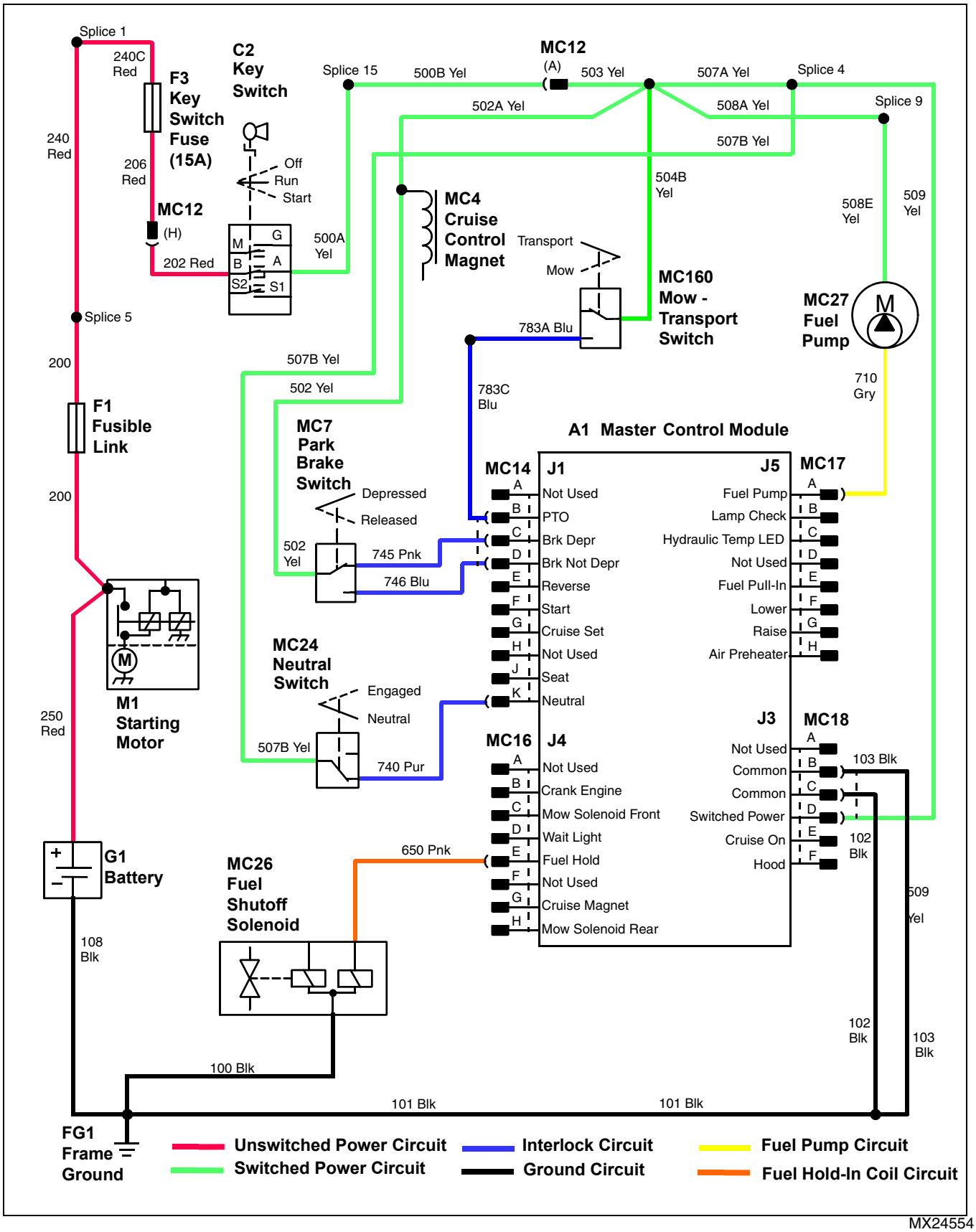
- Mow-transport switch (MC160) is in the TRANSPORT position.
- Park brake switch (MC7) is in LOCKED position.
- Neutral switch (MC24) is in the NEUTRAL position.

The Master control module provides a ground circuit for the fuel pump (MC27), 710 Gry wire, and energizes the fuel pump. Also, the Master control module provides current to the hold coil of the fuel shutoff solenoid (MC26), 650 Pnk wire. The hold coil is provided ground through 100 Blk wire and the fuel shutoff solenoid is held in the energized position, and the engine continues to operate.

With the operator OFF the seat, the Master control module will shut down the engine by opening outputs to the fuel shutoff solenoid hold coil and fuel pump circuits when any of the following conditions exist:

- Park brake in the UNLOCKED position.
- Forward or reverse pedals NOT in the NEUTRAL position.
- Mow-transport lever in the MOW position.
- Hood OPEN position (European machines).
- Hood switch connector with jumper wire disconnected (North American machines).

Run Circuit Schematic - Operator OFF Seat



MX24554

System: Run Circuit Diagnosis - Operator OFF Seat

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the fuel pump circuit, it is important to perform the following steps in the sequence shown.

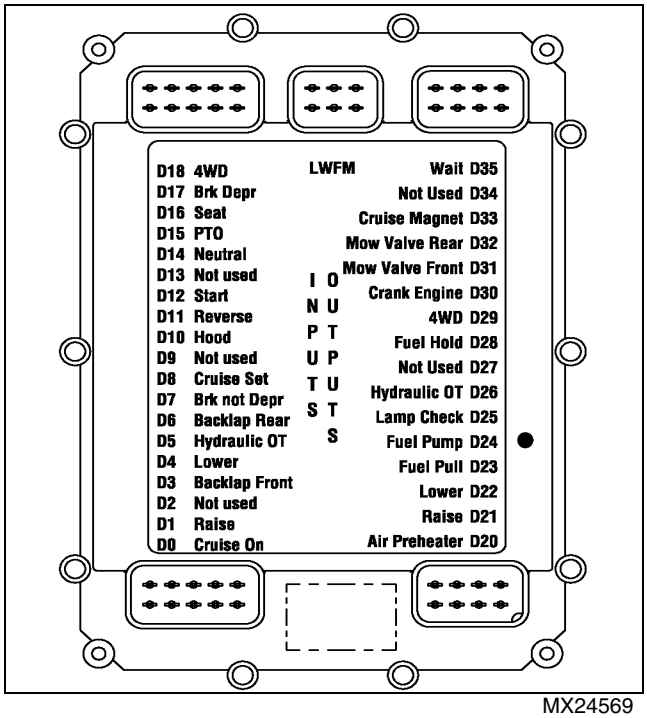
1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

2. Run Circuit Tests. (See “Run Circuit Schematic - Operator OFF Seat” on page 346.)

Fuel Pump Circuit

Test Conditions

- Operator OFF seat.
- Park brake in LOCKED position.
- Mow-transport lever in TRANSPORT position.
- Neutral switch in NEUTRAL position.
- Key switch in RUN position.
- Hood closed (European machines).
- Hood switch connector with jumper wire properly connected (North American machines).
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness.

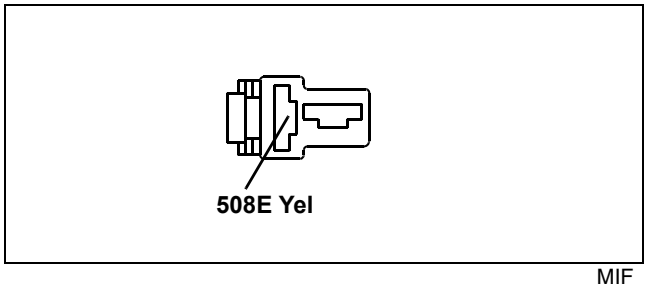


MX24569

1. Master control module (A1) output (D24) LED check. Is fuel pump output (D24) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

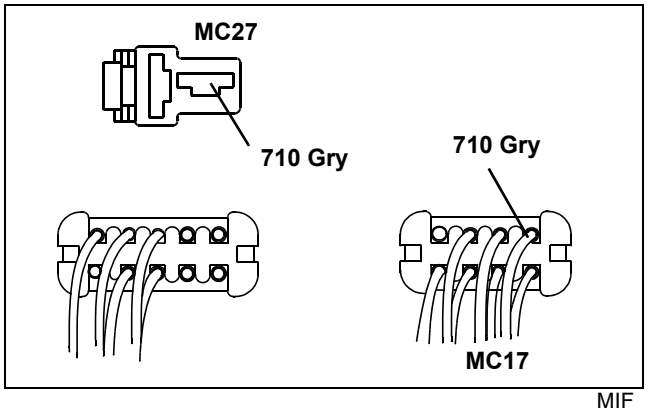


MIF

2. Measure voltage at fuel pump (MC27), 508E Yel wire. Is battery voltage present

Yes: Go to next step.

No: Test 508E, 508A, 503, 500B, and 500A Yel wires and connections.



MIF

3. Disconnect Master control module, connector (MC17). Measure resistance between Master control module connector (MC17), terminal A, 710 Gry wire and fuel pump (MC27), connector MC27, 710 Gry wire. Is resistance less than 0.1 ohm?

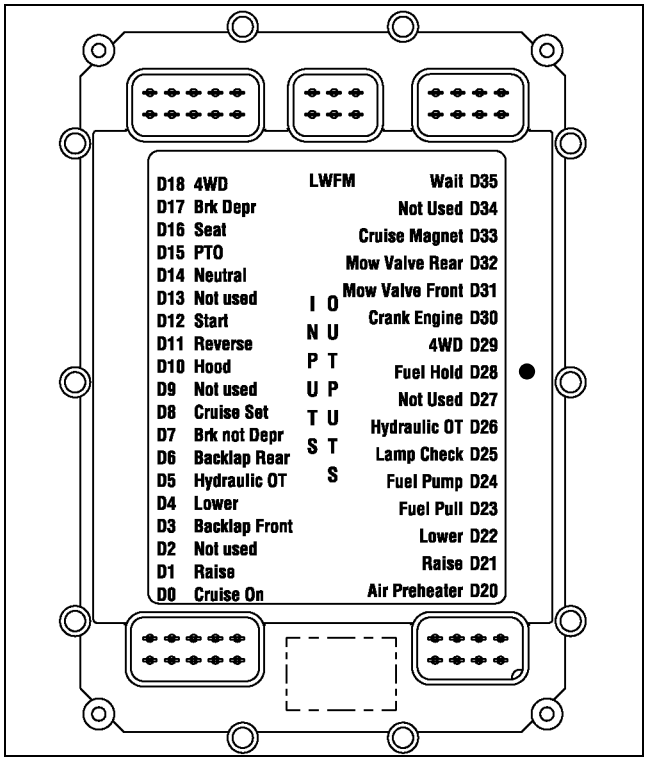
Yes: Test fuel pump. (See “Fuel Pump Test” on page 458.)

No: Test 710 Gry wire and connections.

Fuel Shutoff Solenoid Hold Coil Circuit

Test Conditions

- Operator OFF seat.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

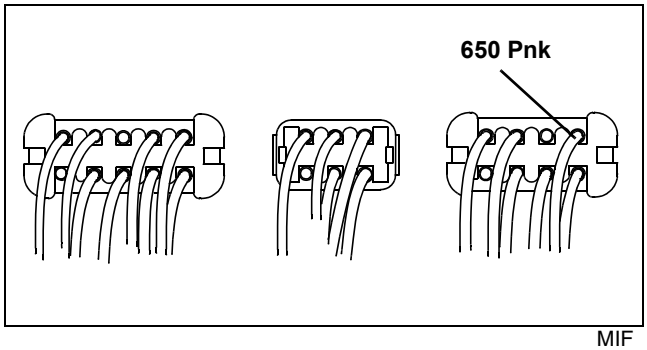


MX24569

1. Master control module (A1) output (D28) LED check. Is fuel hold output (D28) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

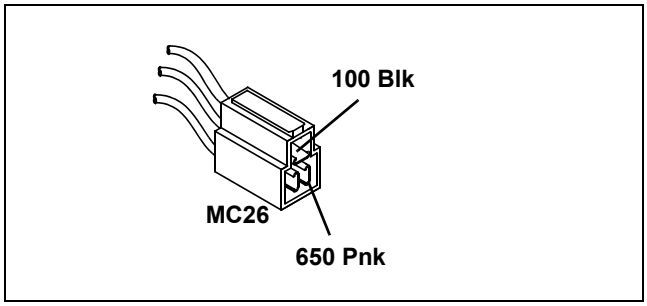


MIF

2. Measure voltage at Master control module connector (MC16), terminal E, 650 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Unplug connector (MC16) and test connector terminal E, 650 Pnk wire and connections.



MIF

3. Measure voltage at fuel shutoff solenoid connector (MC26), 650 Pnk wire. Is battery voltage present?

Yes: Go to next step.

No: Test 650 Pnk wire and connections.

4. Disconnect fuel shutoff connector (MC26). Measure resistance at fuel shutoff solenoid connector (MC26), 100 Blk wire and (-) terminal of battery. Is resistance less than 0.1 ohm?

Yes: Test fuel shutoff solenoid. See “Fuel Shutoff Solenoid Test” on page 457.

No: Test 100 Blk wire and connections.

Charging Circuit Operation

Function

To maintain battery voltage between 11.8 and 13.2 VDC.

Operating Conditions

- Key switch in RUN position.
- Engine running.

Theory of Operation

With the key switch (C2) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A Yel wire to the following:

- Master control module (A1), 509, 507A, 503 and 500B Yel wires.
- Battery LED (H6), 500P Yel wire.
- Alternator (G2), 508C, 508B, 508A, 503 and 500B Yel wires.

The alternator has an internal voltage regulator that monitors battery voltage and increases alternator output to maintain proper running voltage and battery charge. Alternator output is determined by the intensity of magnetism at the field coil. As the battery voltage fluctuates, the regulator adjusts the current to the field coil, which intensifies the magnetic field and increases alternator output.

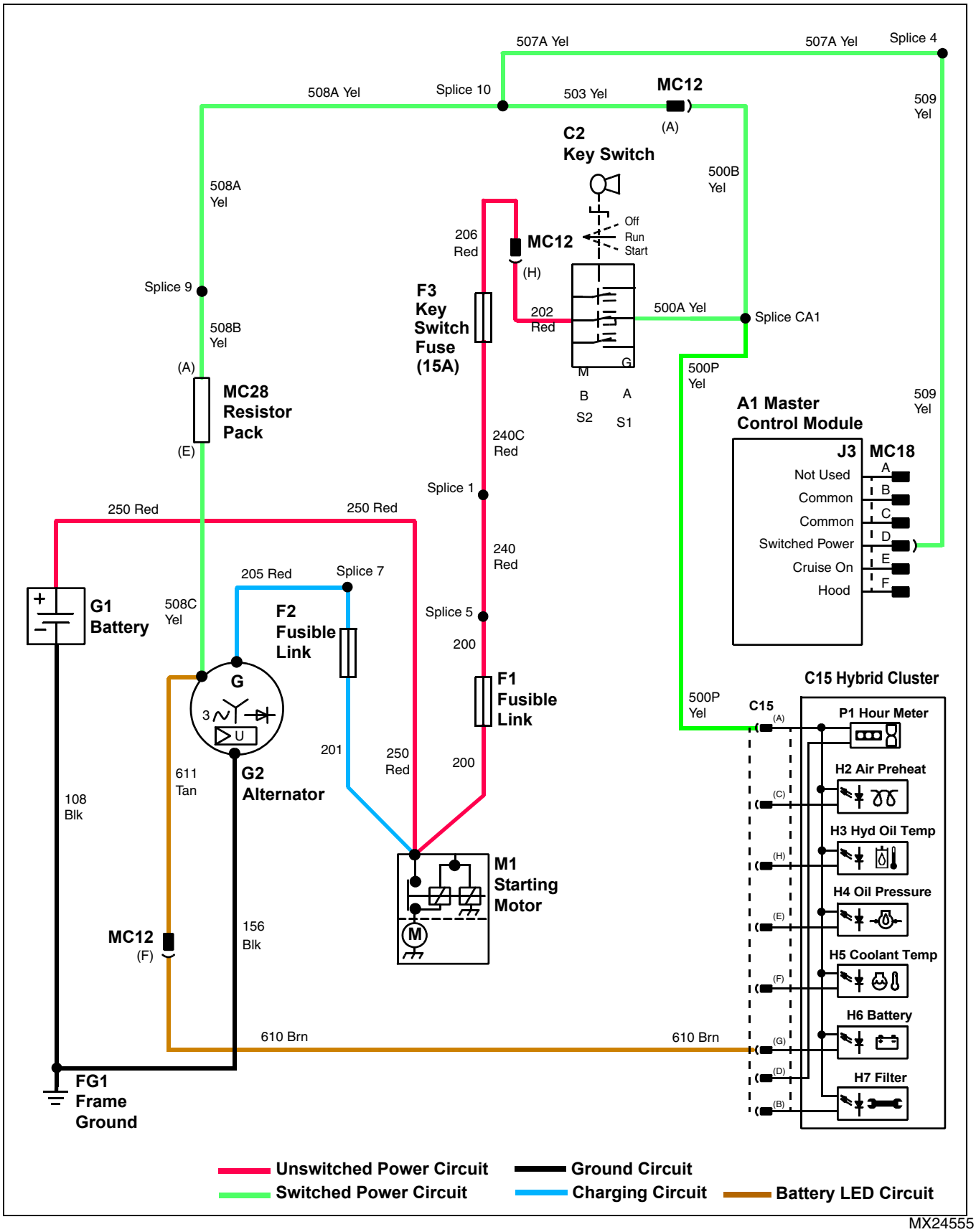
The alternator produces alternating current (AC), which is then converted to direct current (DC) by internal rectifiers in the alternator.

Charging current flows from the alternator to the battery terminal on starting motor (M1), 205 Red wire, 201 fusible link (F2), and then to the battery positive (+) terminal through the positive (+) battery cable, 250 Red wire.

When the alternator has no output or low output, battery LED (H6) is turned on by providing ground on 610 Brn wire and 611 Tan wire. The alternator provides the ground internally.

Ground for alternator (G2) is provided by 156 Blk wire.

Charging Circuit Schematic



MX24555

System: Charging System Diagnosis

Charging System Test

Test Conditions

- Key switch in RUN position, engine OFF.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

1. Measure ground circuit for resistance at alternator (G2), 156 Blk wire. Is the resistance less than 0.1 ohm?

Yes: Go to next step.

No: Test 156 Blk wire and connections.

2. Measure voltage at alternator (G2), 205 Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 205 and 250 Red wires, 201 fusible link (F2) and connections.

3. With alternator connector (MT10) disconnected, measure voltage at alternator (G2), 508C Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 508C, 508B, 508A, 503, 500B and 500A Yel wires, resistor pack (MC28) and connections.

4. With alternator connector (MT10) connected, measure voltage at hybrid cluster (C15), terminal A, 500P Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500P and 500A Yel wires and connections.

5. Measure voltage at hybrid cluster (C15) terminal G. Is battery voltage present?

Yes: Go to next step.

No: Check battery LED in hybrid cluster (C15). Replace hybrid cluster (C15) if bad.

6. With alternator connector (MT10) disconnected, measure voltage at harness side of connector, 611 Tan wire. Is battery voltage present?

Yes: Test alternator regulated amperage and voltage. (See “Regulated Voltage Output Test” on page 448.)

No: Test 611 Tan wire and 610 Brn wire and connections.

Cruise Control Circuit Operation

Note: Cruise control is offered as an option.

Function

To provide a means of keeping the speed of the machine constant without the need of having the operator's foot on the forward hydrostatic control pedal.

The circuit controls an electromagnet that, when energized, holds the forward hydrostatic control pedal at the desired position.

Operating Conditions

- Key switch in RUN position.
- Operator ON seat.
- Park brake in UNLOCKED position.
- Cruise control switch in the SET or ON position.

Theory of Operation

Note: To engage the cruise control, the cruise control switch must first be moved to the SET position to energize the circuit.

When the key switch (C2) is in the RUN position, switched power (See "Power Circuit Operation - Switched" on page 321) flows from key switch terminal A through 500A Yel wire to the following:

- Master control module (A1), 500B, 503, 507A and 509 Yel wires.
- Cruise control switch (C6), 500N Yel wire.
- Cruise control magnet (MC4), 500B, 503 and 502A Yel wires.

The master control module requires inputs from the interlock circuit (See "Interlock Circuit Operation" on page 329) as follows:

- Park brake switch (MC7) in UNLOCKED position.
- Seat switch (MC10), operator ON seat.

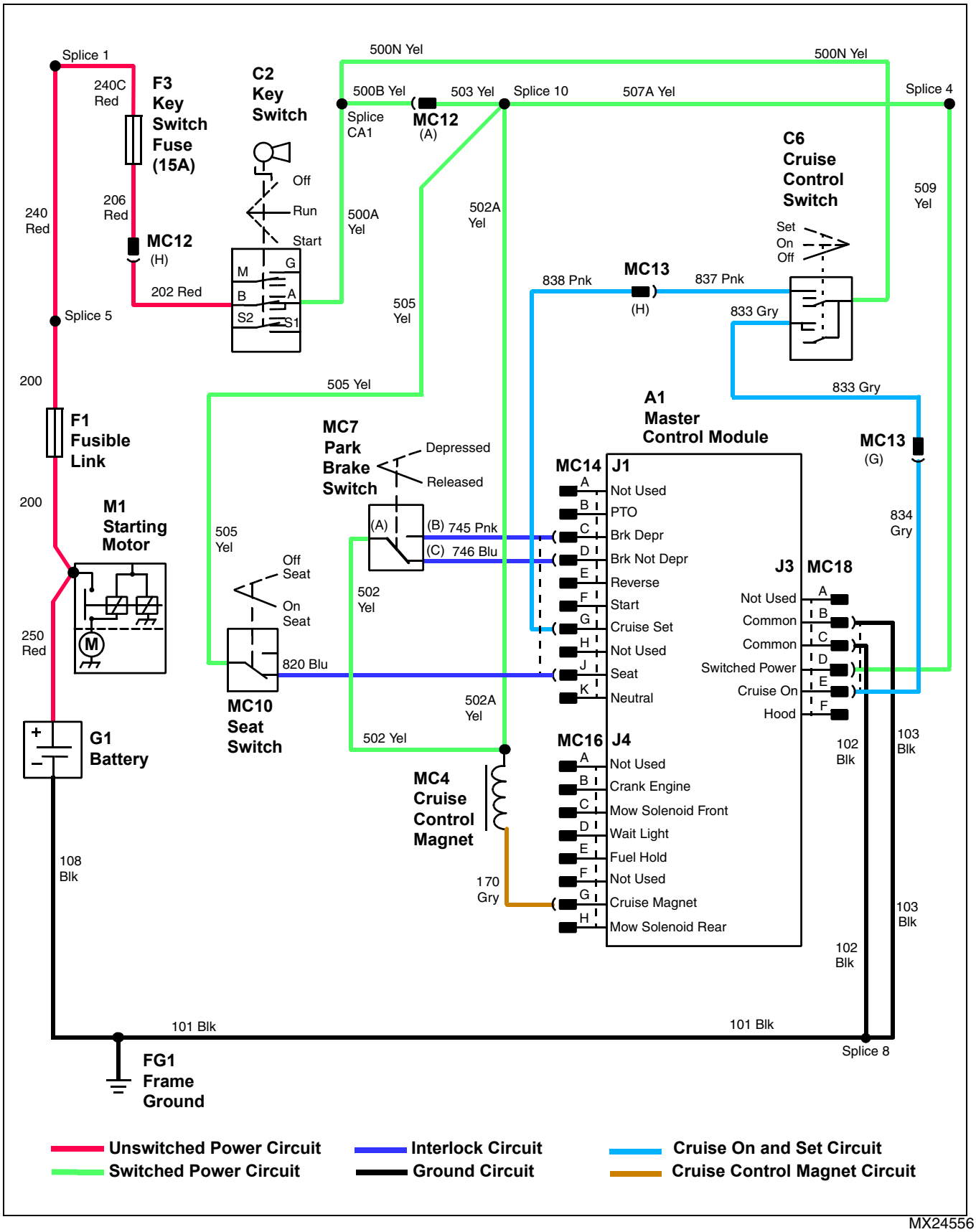
With the cruise control switch at the momentary SET position, current flows from the cruise control set switch to the master control module connector (MC14), terminal G, 838 and 837 Pnk wires. Current also flows to the master control module connector (MC18), terminal E, 834 and 833 Gry wires. The master control module connector (MC16), terminal G, 170 Gry wire then supplies a ground path to the cruise control magnet (MC4), energizing the magnet.

When energized, the magnet pushes against the arm of the forward hydrostatic control pedal, holding the pedal at the desired position.

The cruise control remains energized unless any of the following occurs:

- Cruise control switch moved to the OFF position.
- Operator OFF seat.
- Key switch turned to OFF position.

Cruise Control Circuit Schematic



MX24556

System: Cruise Control Circuit Diagnosis

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the cruise control circuit, it is important to perform the following steps in the sequence shown.

1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

2. Cruise Control Circuit Tests. (See “System: Cruise Control Circuit Diagnosis” on page 354.)

Cruise Control Circuit Tests

Test Conditions

- Operator ON seat.
- Park brake in UNLOCKED position.
- Key switch in RUN position, engine OFF.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

1. Measure voltage at cruise control switch (C6), 500N Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500N and 500A Yel wires and connections.

2. Hold the cruise control switch (C6) in the SET position. Measure voltage at cruise control switch (C6), 837 and 838 Pnk wires. Is battery voltage present?

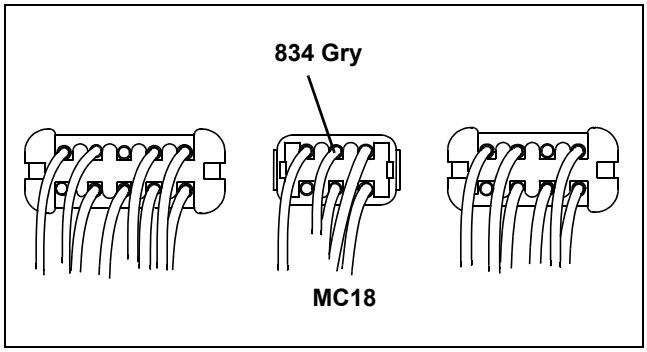
Yes: Go to next step.

No: Test cruise control switch. (See “Cruise Control Switch Test” on page 454.)

3. With the cruise control switch (C6) in the ON position, measure voltage at cruise control switch (C6), 833 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test cruise control switch. (See “Cruise Control Switch Test” on page 454.)

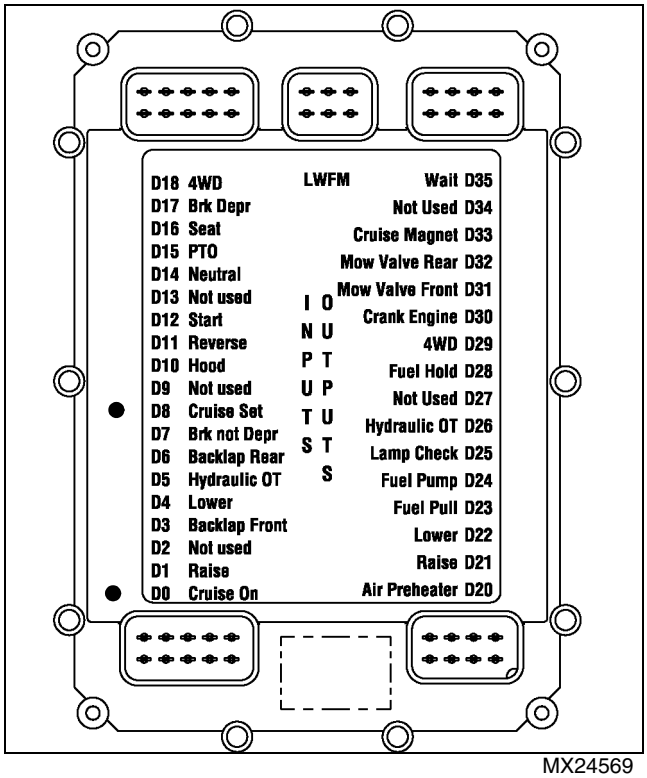


MIF

4. Disconnect Master control module connector (MC18). Measure voltage at connector (MC18), terminal E, 834 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test 833 and 834 Gry wires and connections.



MX24569

5. Connect Master control module connector (MC18). Cruise control switch (C6) in the ON position. Master control module (A1) input (D0) LED check. Is cruise on input (D0) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

6. Cruise control switch (C6) in the SET position. Master control module (A1) input (D8) LED check. Is cruise set input (D8) LED ON?

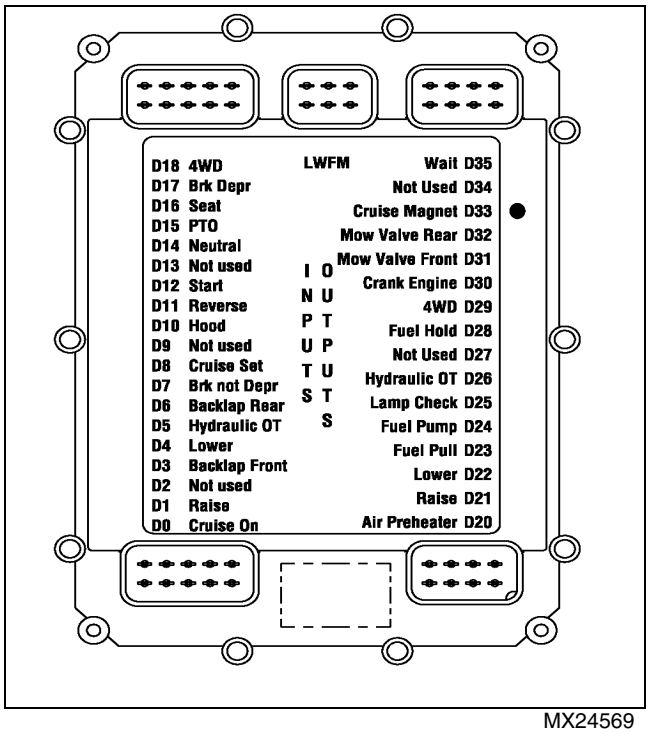
No: Test Master control module circuit. (See “Master

Control Module Circuit Test" on page 316.)

Cruise Control Magnet Test

Test Conditions

- Operator ON seat.
- Park brake in UNLOCKED position.
- Key switch in RUN position, engine OFF.
- Cruise control switch (C6) in ON position. Push switch to momentary SET position, then release.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

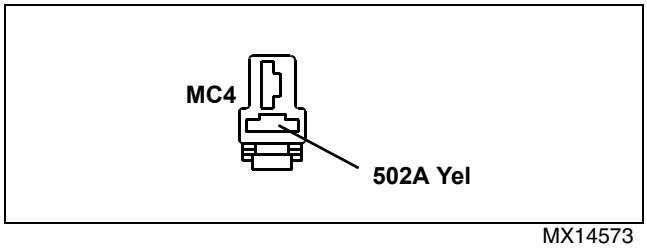


MX24569

1. Master control module (A1) output (D33) LED check. Is the cruise magnet output (D33) LED ON?

Yes: Go to next step.

No: Test 502A, 503, 500B, and 500A Yel wires and connections.

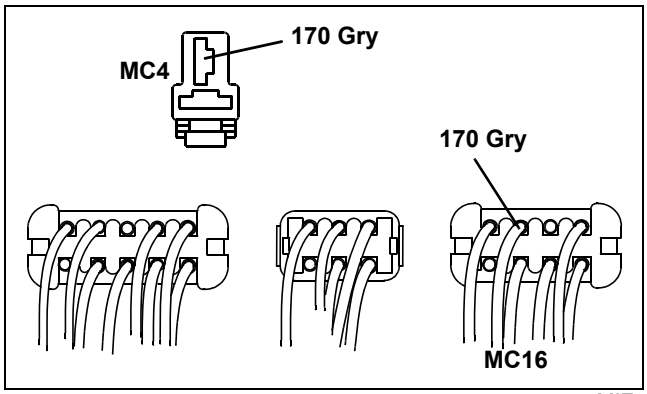


MX14573

2. Measure voltage at cruise control magnet (MC4), connector (MC4), 502A Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test Master control module circuit. (See "Master Control Module Circuit Test" on page 316.)



MIF

3. Disconnect Master control module connector (MC16). Measure resistance between Master control module connector (MC16), terminal G, 170 Gry wire and cruise control magnet (MC4), connector (MC4), 170 Gry wire. Is resistance less than 0.1 ohm?

Yes: Test cruise control magnet (MC4). (See "Cruise Control Magnet Test" on page 460.)

No: Test 170 Gry wire and connections.

Mow Circuit Operation

Function

Provides the operator with the controls to engage the reel motors when the cutting units are lowered.

Operating Conditions:

- Operator ON seat.
- Key switch in RUN position.
- Mower in the lowered position.
- Mow-transport lever in MOW position.

Theory of Operation

When the key switch is in RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A Yel wire to the following:

- Master control module (A1), 500B, 503, 507A and 509 Yel wires.
- Raise solenoid (MC21), 500B, 503, 507A and 507G Yel wires.
- Lower solenoid (MC22), 500B, 503, 507A and 507H Yel wires.
- Raise-lower switch (C4), 500H Yel wire.
- PTO Relay (K6), 500B, 503, 504A and 504H Yel wires.
- Seat switch (MC10), 500B, 503 and 505 Yel wires
- Mow-transport switch (MC160), 500B, 503 and 504B Yel wires.

In addition, the reel motor controllers (RMCs) receive power from the 500A, 500B and 503 Yel wires, and then out to the individual controllers:

- (RMC1), 507A and 507L Yel wires.
- (RMC2), 507A and 507K Yel wires.
- (RMC3), 504A and 507N Yel wires.
- (RMC5), 504A and 507P Yel wires.
- (RMC6), 508A and 507M Yel wires.

The Master control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 329) as follows:

- Mow-transport switch (MC160), 783A and 783C Blu wires.
- Seat switch (MC10), 820 Blu wire.

The raise-lower switch sends two signals to the Master control module, indicating the position of the raise-lower switch as follows:

- Connector (MC15), terminal E, 661 and 660 Blu wires, indicating that the raise-lower switch is in the RAISE position.
- Connector (MC15), terminal G, 774 and 773 Blu wires, indicating that the raise-lower switch is in the LOWER position.

Mow-transport switch (MC160) provides two machine functions: When in the MOW position, a signal is sent via the 783A and 783C Blu wires to the Master control module PTO input, connector (MC14), terminal B. This same signal, via the 783A and 783B Blu wires, also energizes PTO relay (K6). Relay (K6) connects power from the 504H Yel wire to the 783D Blu wire, which then activates the regulator of the 48-volt alternator (G3). The alternator provides the power to operate the reel motor system.

Reel motors are engaged when a reel controller’s ENABLE input, located at connector (MC32...36), terminal F, is grounded by the Master control module.

The Master control module will begin the power-up sequence of the cutting units when the following conditions are met:

- Mow-transport lever in the MOW position.
- Raise-lower switch in the LOWER position.

With safety and operating conditions met, the Master control module provides a controlled ground to the following outputs:

- Lower solenoid - connector (MC22), terminal F, 176 Grn wire
- Front mow - connector (MC16), terminal C, 171 Grn wire
- Rear mow - connector (MC16), terminal H, 172 Grn wire

The 171 Grn wire connects to the ENABLE inputs of the front reel controllers (RMC1, 3 and 5) by way of Diode (MC58), the 171D Grn wire, and the controllers’ respective 171A, B and C Grn wires. Likewise, the 172 Grn wire connects to the ENABLE inputs of the rear reel controllers (RMC2 and 6) via Diode (MC57), the 172B Grn wire, and the controllers’ respective 172D and E Grn wires.

If the raise-lower switch is moved to the RAISE position, the Master control module will disengage the front and rear reel controllers. The Master control module then raises the cutting units by energizing the raise valve solenoid (MC21) by grounding the Raise solenoid output (MC17), terminal G, and the 175 Grn wire. The raise-lower switch must be moved back to the LOWER position before the reel controllers will be engaged again.

Reel Motor Forward-Reverse Circuit

When the reel controller direction input is activated by a ground signal from (MC6), Forward/Reverse switch, the control module will operate the reel motor in the REVERSE direction. When the direction input is not activated, the reel controller operates the motor in the FORWARD direction.

When reel motor Forward/reverse switch (MC6) is in the FORWARD position, the right-side reel controllers (RMC5 and 6) directional inputs are provided a ground, activating the input. With the direction input active, the right-side reel controllers operate the right reel motors in the REVERSE direction. The left and center reel controllers (RMC1, 2 and 3) have no grounds applied to their directional inputs and operate their respective motors in the FORWARD direction.

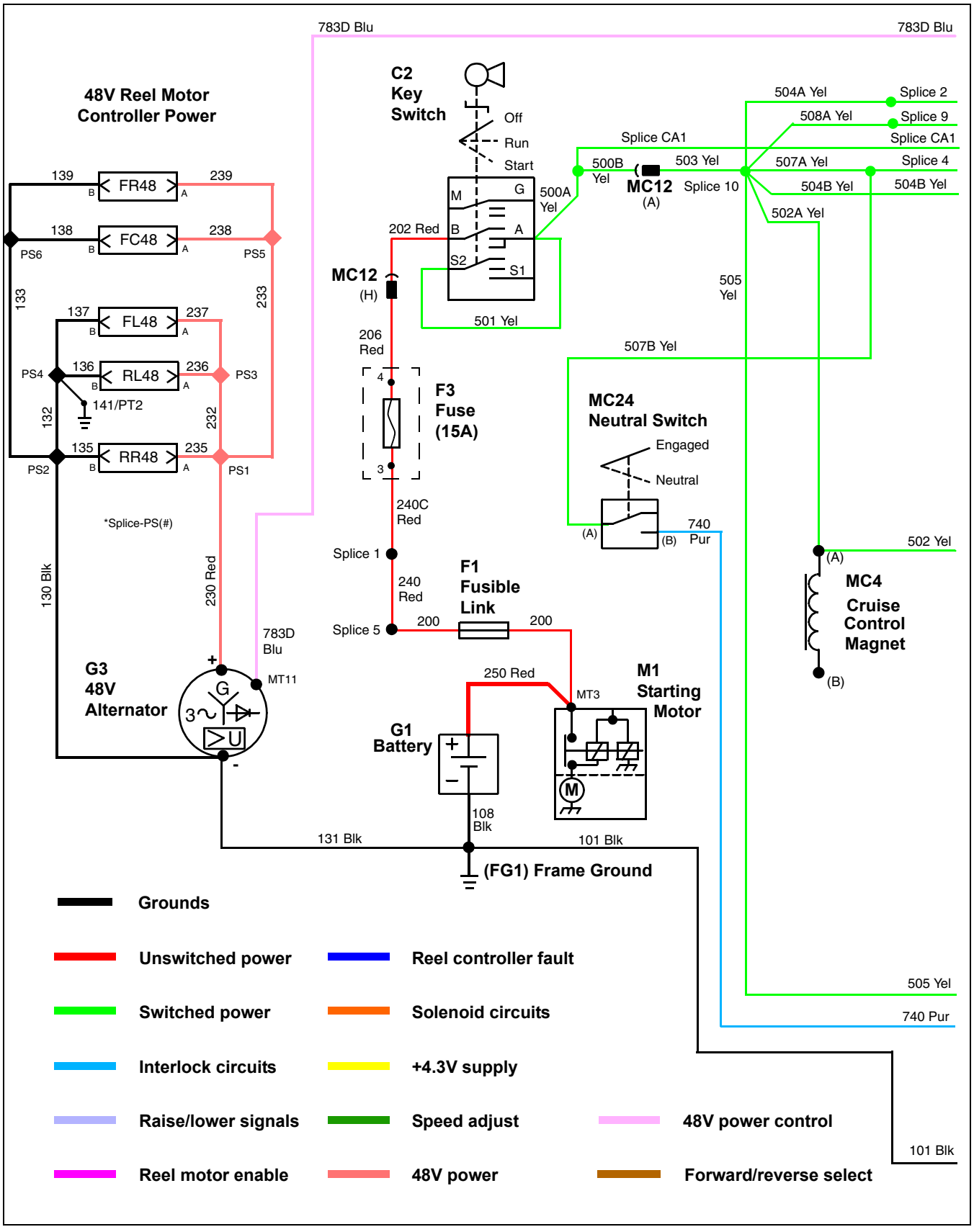
The reason for the right-side motors to rotate in the REVERSE direction while the left and center motors rotate in the FORWARD direction is because the right motors are mounted on the side opposite of the cutting unit that the left and center motors are mounted on their cutting units.

When the reel motor Forward/reverse switch is in the REVERSE position, the opposite occurs: the right-side reel controllers directional inputs are NOT provided a ground and the controllers operate the right-side motors in the FORWARD direction. The left and center reel controllers ARE provided a ground to their directional inputs. With the inputs active, the left and center reel controllers operate their motors in the REVERSE direction.

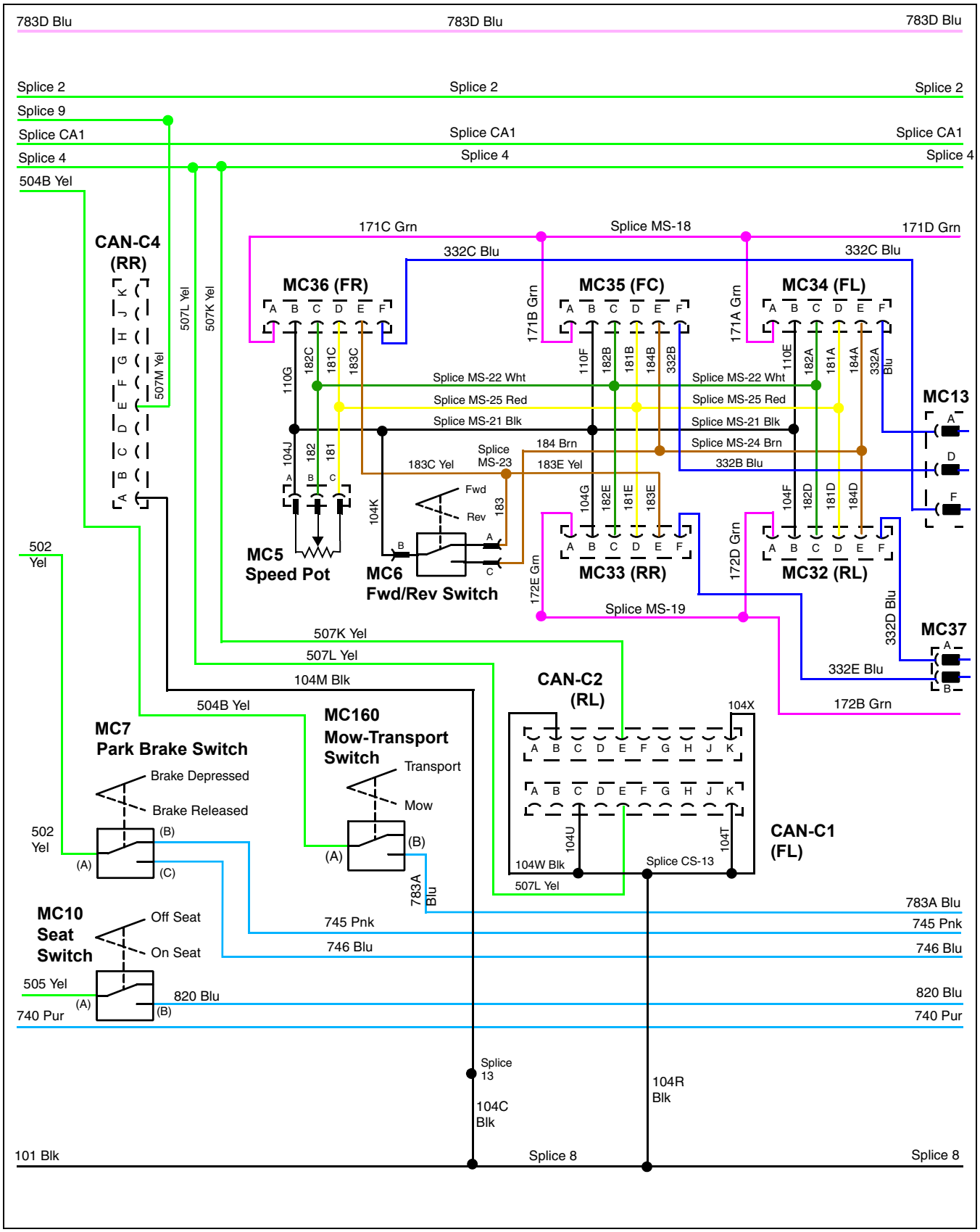
Reel Motor Speed Control Circuit

Reel motor speed is controlled by reel motor speed control (MC5), a 5 k-ohm potentiometer. The reel controllers (RMC1, 2, 3, 5 and 6) provide a 4.3-volt reference voltage to the speed control. The variable output voltage from the speed control is applied to each reel controller speed input. With the same adjustment voltage applied to the five reel controllers, the five reel controllers operate their motors at the same speed.

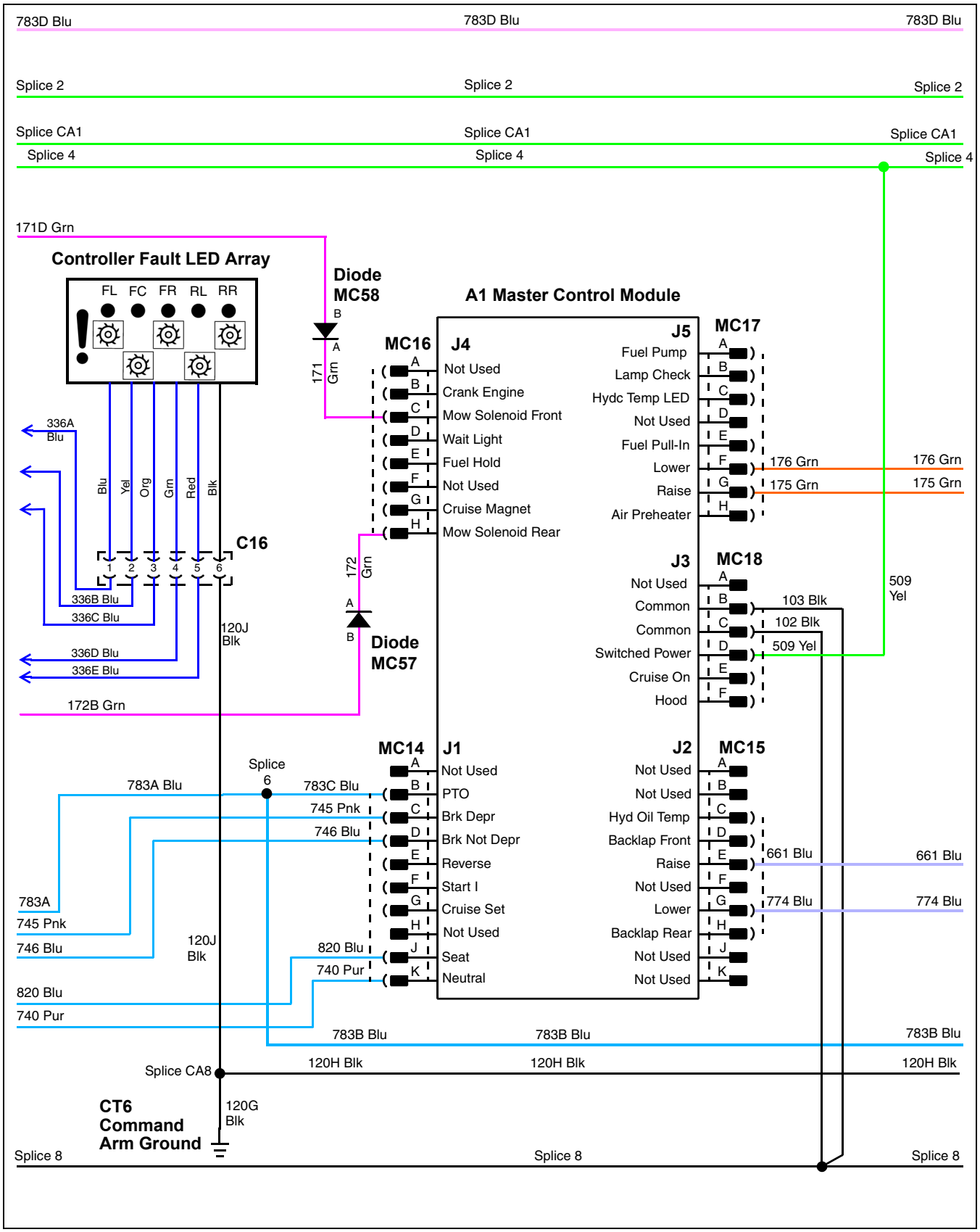
Mow Circuit Schematic



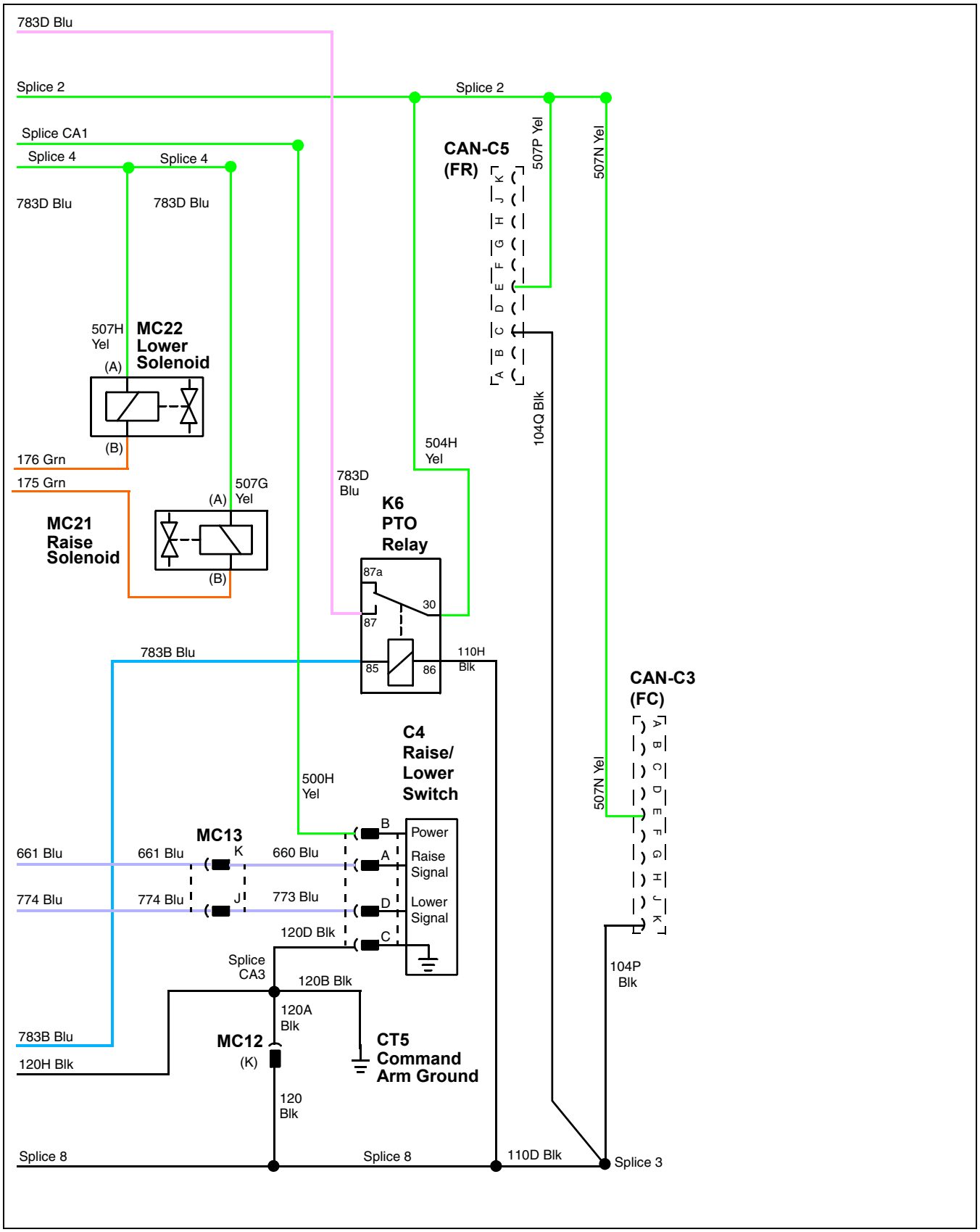
Mow Circuit Schematic



Mow Circuit Schematic



Mow Circuit Schematic



System: Mow Circuit Diagnosis

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the mow circuit, it is important to perform the following steps in the sequence shown.

1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

2. Raise-Lower Circuit Diagnosis. (See “System: Raise-Lower Circuit Diagnosis” on page 374.)

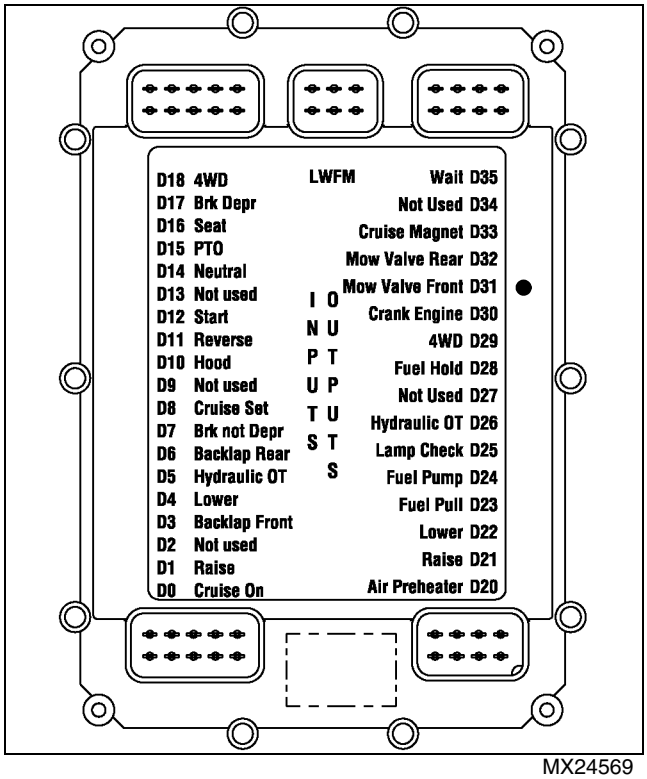
3. Mow Circuit Tests. (See “System: Mow Circuit Diagnosis” on page 363.)

Mow Circuit Diagnosis

Front Mow Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow-transport lever in MOW position.
- Move raise-lower switch to LOWER position and release.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

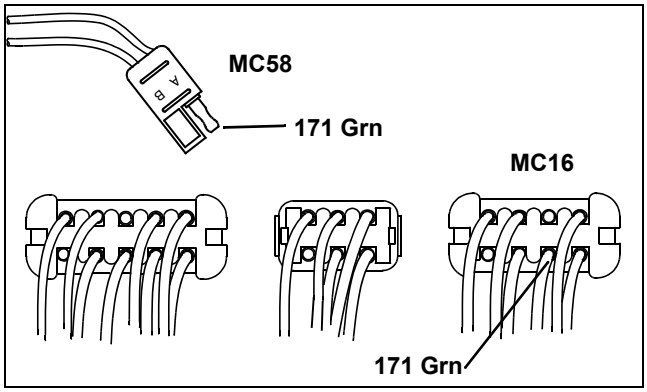


MX24569

1. Master control module (A1) output (D31) LED check. Is mow valve front output (D31) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

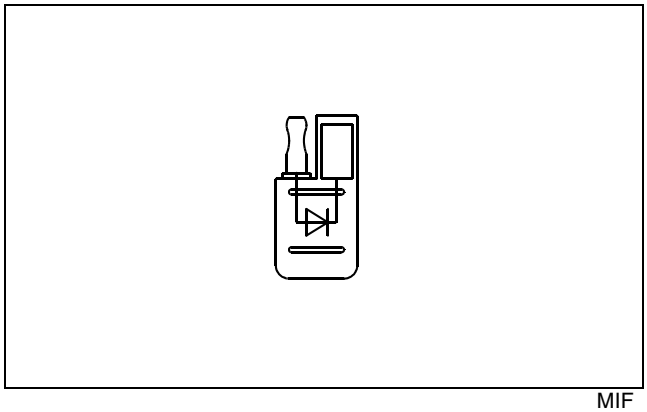


MIF

2. Disconnect Master control module connector (MC16). Unplug Diode (MC58) from its connector. Measure resistance between connector (MC16), terminal C, 171 Grn wire and connector (MC58), terminal A. Is resistance less than 0.1 ohm?

Yes: Go to next step.

No: Test 171 Grn wire and connections.



MIF

3. Check Diode (MC58). See “Diode Test” on page 452. Does the diode test good?

Yes: Go to next step.

No: Replace with new Diode.

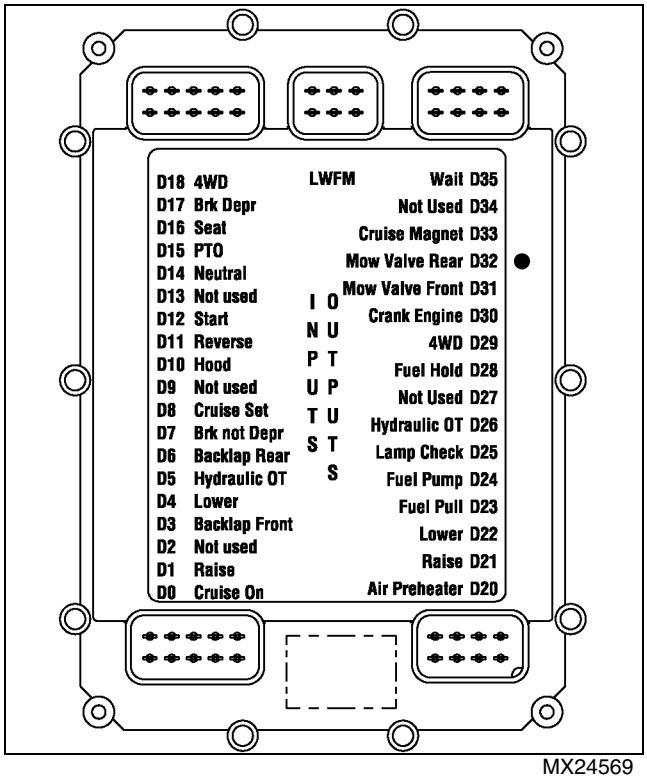
4. Measure resistance between Diode connector (MC58), terminal B, 171D Grn wire and: RMC1 connector (MC34), terminal A, 171A Grn wire; RMC3 connector (MC35), terminal A, 171B Grn wire; RMC5 connector (MC36), terminal A, 171C Grn wire. Is resistance between the respective connectors less than 0.1 ohm?

No: Test 171D Grn wire and connections to the 171A, B and C Grn wires.

Rear Mow Circuit Test

Test Conditions

- Operator ON seat.
- Key switch in RUN position.
- Mow-transport lever in MOW position.
- Move raise-lower switch to LOWER position and release.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

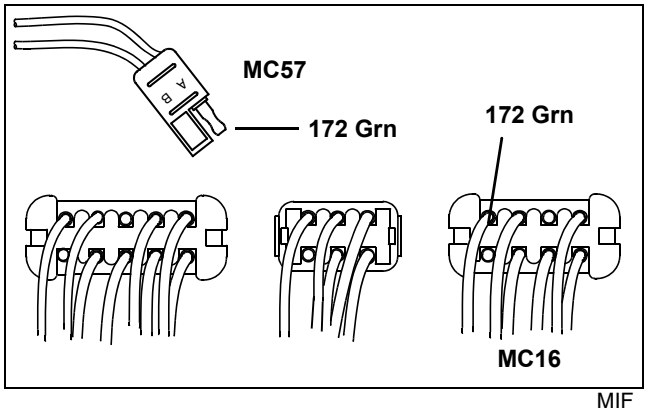


MX24569

1. Master control module (A1) output (D32) LED check. Is mow valve rear output (D32) LED ON?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

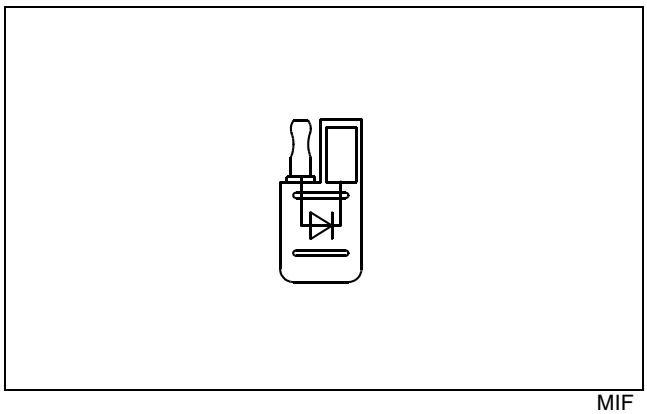


MIF

2. Disconnect Master control module connector (MC16). Unplug Diode (MC57) from its connector. Measure resistance between connector (MC16), terminal H, 172 Grn wire and connector (MC57), terminal A. Is resistance less than 0.1 ohm?

Yes: Go to next step.

No: Test 172 Grn wire and connections.



MIF

3. Check Diode (MC57). See “Diode Test” on page 452. Does the diode test good?

Yes: Go to next step.

No: Replace with new Diode.

4. Measure resistance between Diode connector (MC57), terminal B, 172B Grn wire and: RMC2 connector (MC32), terminal A, 172D Grn wire; RMC6 connector (MC33), terminal A, 172E Grn wire. Is resistance between the respective connectors less than 0.1 ohm?

No: Test 172B Grn wire and connections to the 172D and E Grn wires.

Backlap Circuit Operation

Function

To allow the engine to run and engage the reel motors when the operator is OFF the seat and a backlap switch is in the BACKLAP position.

Operating Conditions

- Backlap switch in the BACKLAP position (pulled out into locked position)
- Park brake in LOCKED position.
- Key switch in RUN position.
- Engine running.
- Mow-transport lever in MOW position.
- Operator OFF seat.

Theory of Operation

When the key switch (C2) is in RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A, 500B,and 503 Yel wires to the following:

- Master control module (A1), 507A and 509 Yel wires.
- Backlap switch (MC19), 507A and 507E Yel wires.
- Mow-transport switch (MC160), 504B Yel wire.
- Seat switch (MC10), 505 Yel wire.
- Neutral switch (MC24), 507B Yel wire.
- Park brake switch (MC7), 502 and 502A Yel wires.

The Master control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 329) as follows:

- Mow-transport switch (MC160), 783A and 783C Blu wires.
- Seat switch (MC10), 820 Blu wire.
- Neutral switch (MC24), 740 Pur wire.
- Park brake switch (MC7), 745 Pnk wire.

The backlap switch (MC19) sends a signal to the Master control module Backlap inputs. This will connect the Master control module Mow Front and Mow Rear outputs, enabling the reel motor controllers. The operator then moves:

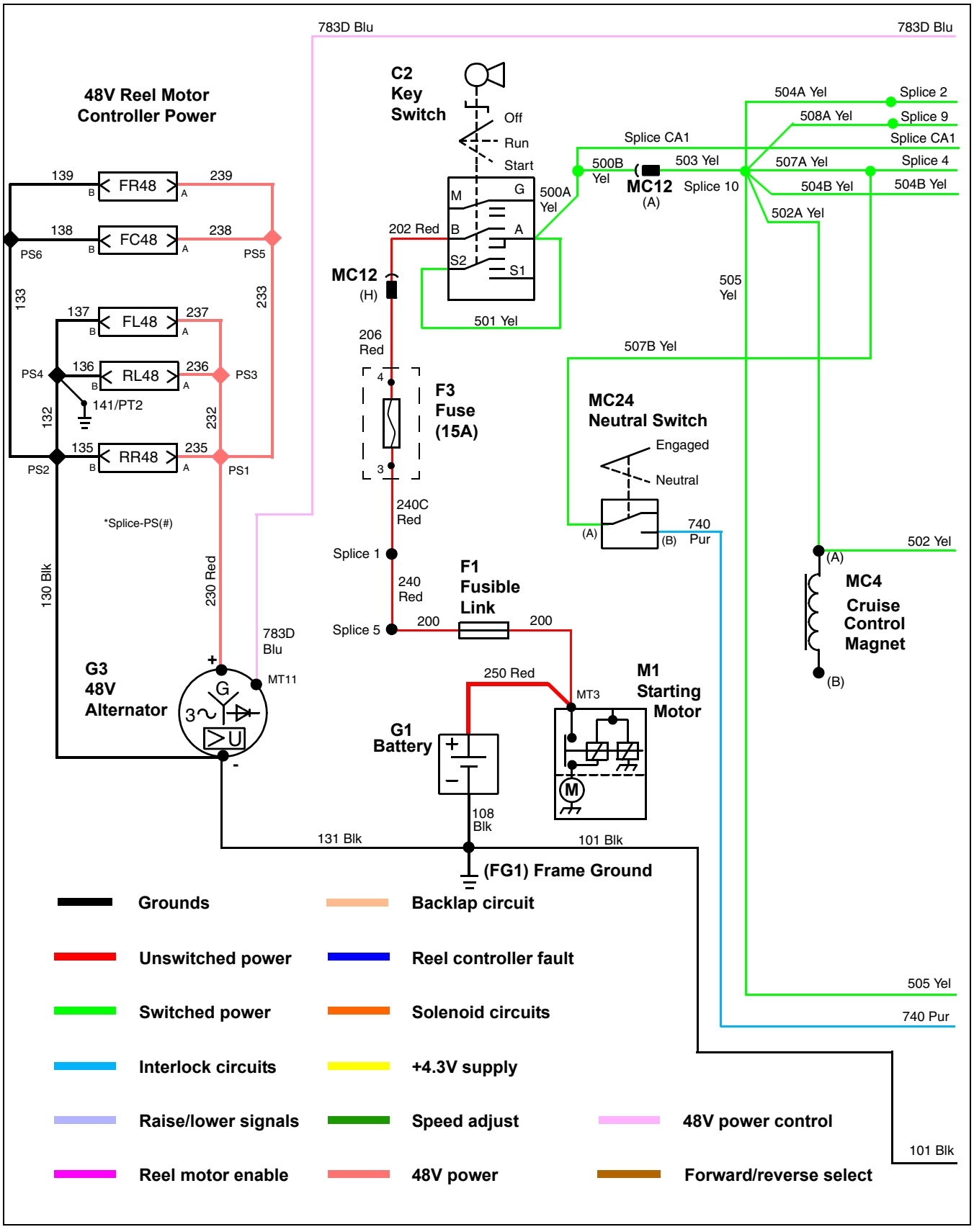
- Forward/Reverse switch (MC6) to REVERSE
- Mow/Transport switch (MC160) to MOW
- Raise/Lower switch (C4) to LOWER

The cutting units will lower and rotate in reverse for the backlapping operation.

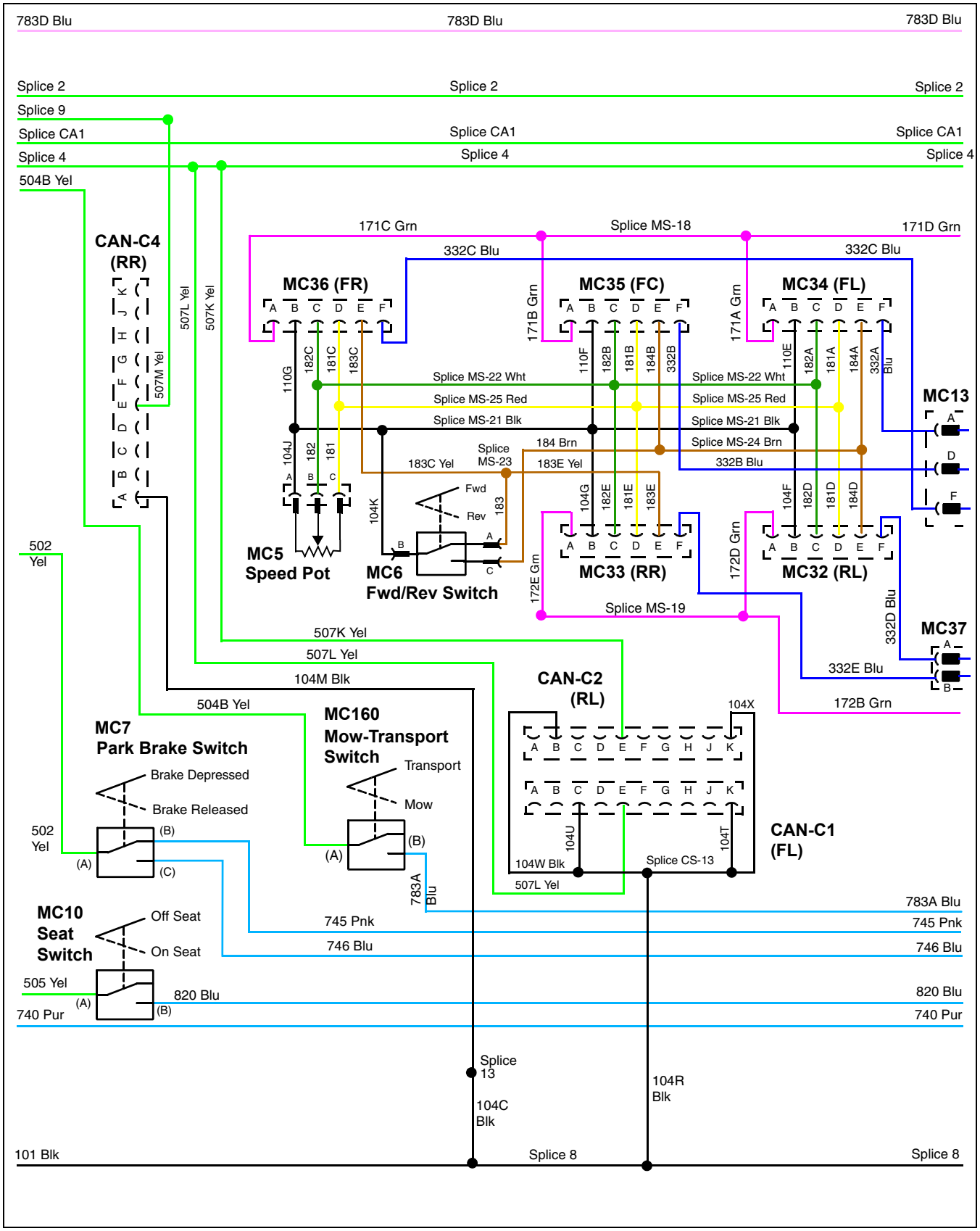
Normally, when the mow-transport switch is in the MOW position and the operator is OFF the seat, the engine will stop. However, if backlap switch (MC19) is in the ON position and the operator leaves the seat (operator OFF seat), the engine will continue to run.

Backlap Circuit Schematic

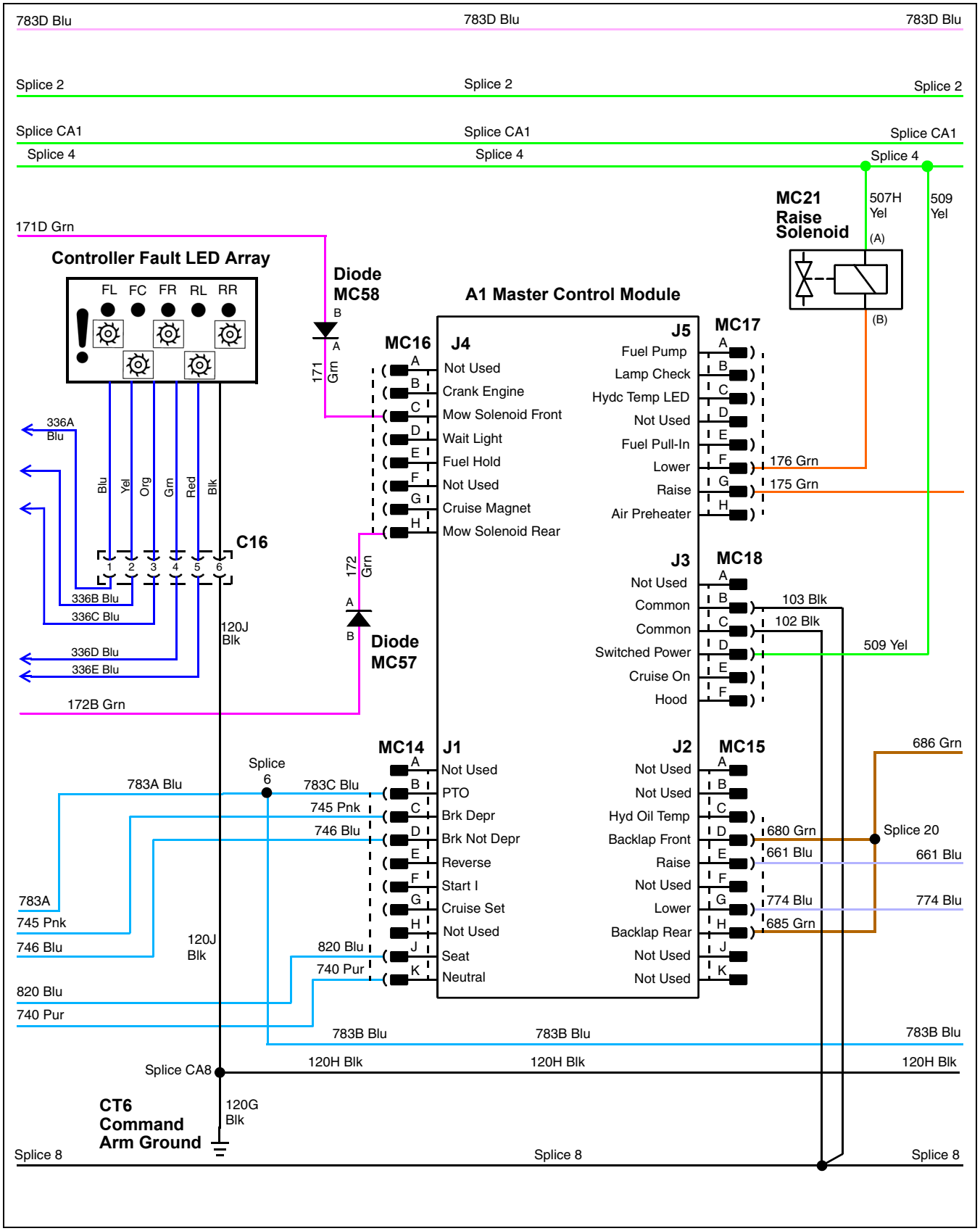
Backlap Circuit Schematic



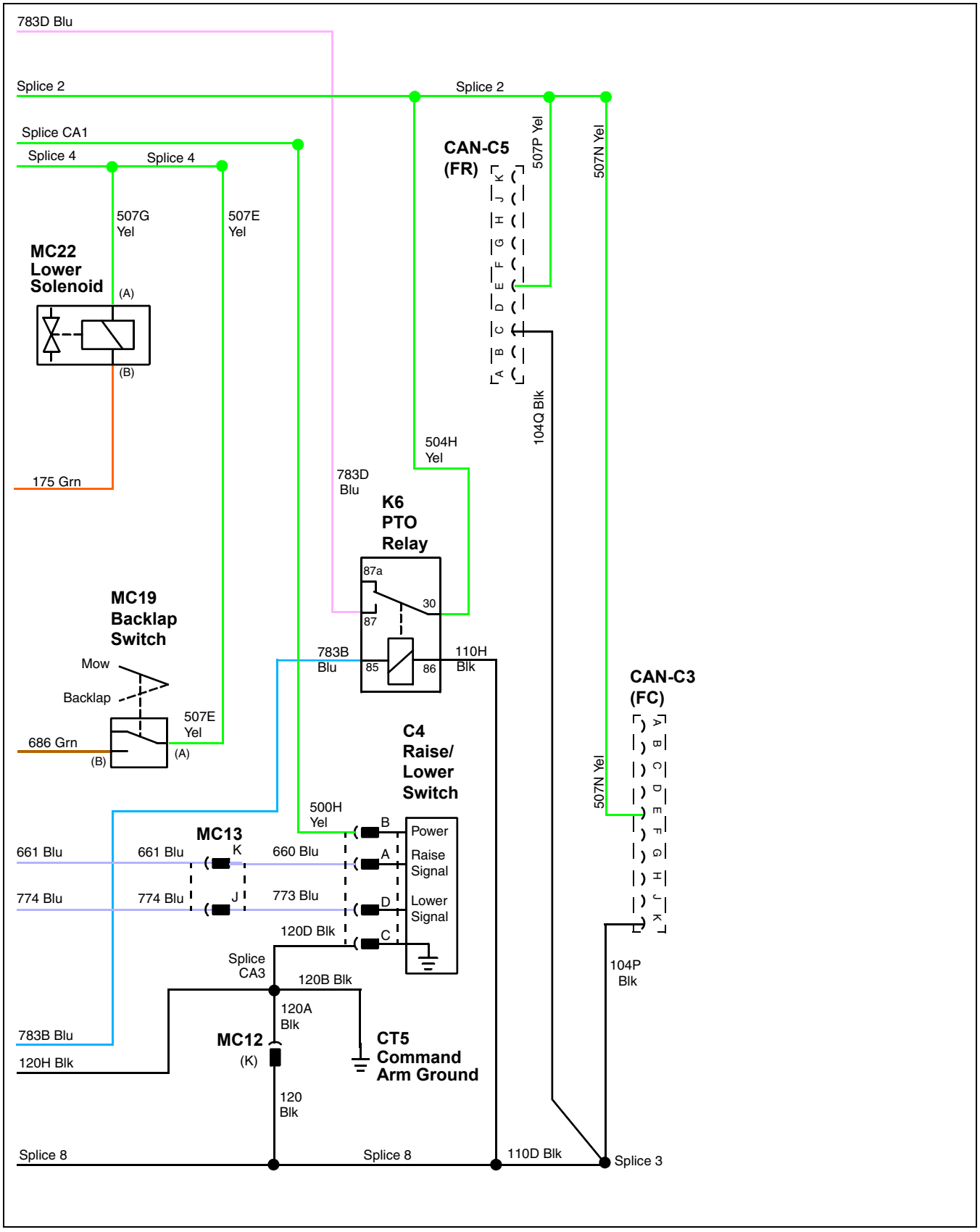
Backlap Circuit Schematic



Backlap Circuit Schematic



Backlap Circuit Schematic



System: Backlap Circuit Diagnosis

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the backlap circuit, it is important to perform the following steps in the sequence shown.

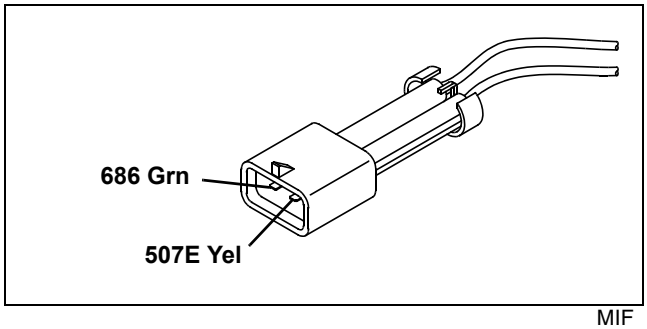
1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

2. Backlap Circuit Tests. See “Backlap Switch Test” on page 461.

Backlap Switch (MC19) Circuit

Test Conditions

- Operator OFF seat.
- Park brake in LOCKED position.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in MOW position.
- Rear backlap switch in BACKLAP position.
- Forward and reverse pedals in NEUTRAL position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at backlap switch (MC19), 507E Yel wire. Is battery voltage present?

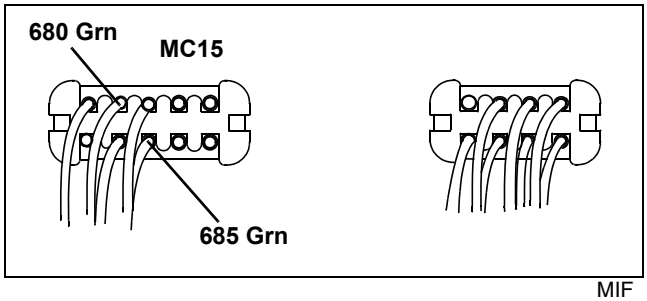
Yes: Go to next step.

No: Test 507E, 507A, 503, 500B, and 500A Yel wires and connections.

2. Measure voltage at backlap switch (MC19), 686 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test backlap switch. See “Backlap Switch Test” on page 461.

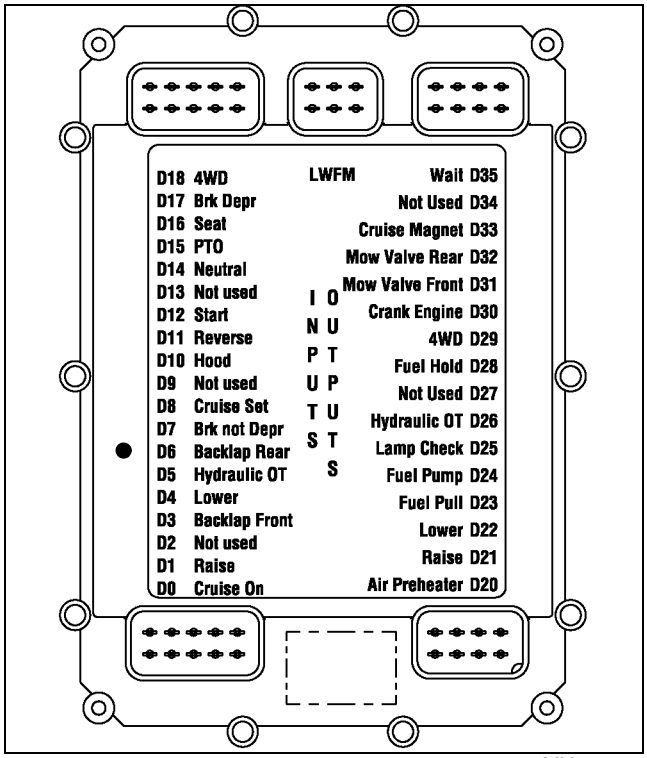


MIF

3. Measure voltage at Master control module connector (MC15), terminals D, 680 Grn wire, and H, 685 Grn wire. Is battery voltage present at both terminals?

Yes: Go to next step.

No: Test 680, 685 and 686 Grn wires and connections.



MX24569

4. Master control module (A1) input LED check. Are backlap rear input (D6) and front input (D3) LEDs both ON?

No: Test Master control module connector (MC15), terminals D and H. If connector terminals test good, test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

Mow Circuit:

For mow circuit diagnostics, see “Mow Circuit Diagnosis” on page 363.

Raise-Lower Circuit Operation

Function

To energize the raise and lower solenoids (MC21 and MC22) as necessary to raise and lower the cutting units

Operating Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Forward and reverse pedals in NEUTRAL position.

Theory of Operation

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A Yel wire to the following:

- Master control module (A1), 500B, 503, 507A, and 509 Yel wires.
- Lower solenoid (MC22), 500B, 503, 507A, and 507H Yel wires.
- Raise solenoid (MC21), 500B, 503, 507A, and 507G Yel wires.
- Raise-lower switch (C4), 500H Yel wire.
- Seat switch (MC10), 500B, 503, and 505 Yel wires.
- Mow-transport switch (MC160), 500B, 503, and 504B Yel wires.

The Master control module requires inputs from the interlock circuit (See “Interlock Circuit Operation” on page 329) as follows:

- Mow-transport switch (MC106), 783A and 783C Blu wires.
- Seat switch (MC10), 820 Blu wire.

The raise-lower switch is provided ground through 120D, 120A, 120, and 101 Blk wires. The two outputs go to the Master control module, indicating the raise-lower switch position as follows:

- Master control module connector (MC15), terminal E, 660 and 661 Blu wires, indicating that the raise-lower switch is in the RAISE position.
- Master control module connector (MC15), terminal G, 773 and 774 Blu wires, indicating that the raise-lower switch is in the LOWER position.

Raise Circuit

When the Master control module senses that the mow-transport switch is in the MOW position and the raise-lower switch is in the RAISE position, the Master control module provides ground at connector (MC17), terminal G. When this ground is provided, current flows from the raise solenoid (MC21) to ground though 175 Grn wire, energizing the solenoid to raise the cutting units. The Master control module provides this ground for only about 3 seconds, even if the raise-lower switch is returned to the MIDDLE position. Ground is not provided again until the raise-lower switch is returned from the MIDDLE position and then back to the RAISE position.

When the mow-transport switch is in the TRANSPORT position, the operator must hold the raise-lower switch in the RAISE position to move the cutting units to the full up position.

Lower Circuit

When the Master control module senses that the raise-lower switch is cycled between the MIDDLE and LOWER positions, the module provides ground at Master control module connector (MC17), terminal F, 176 Grn wire. Current flows from the lower solenoid (MC22) to ground though 176 Grn wire, energizing the solenoid to lower the cutting units. The Master control module continuously provides this ground after the raise-lower switch is released to the MIDDLE position.

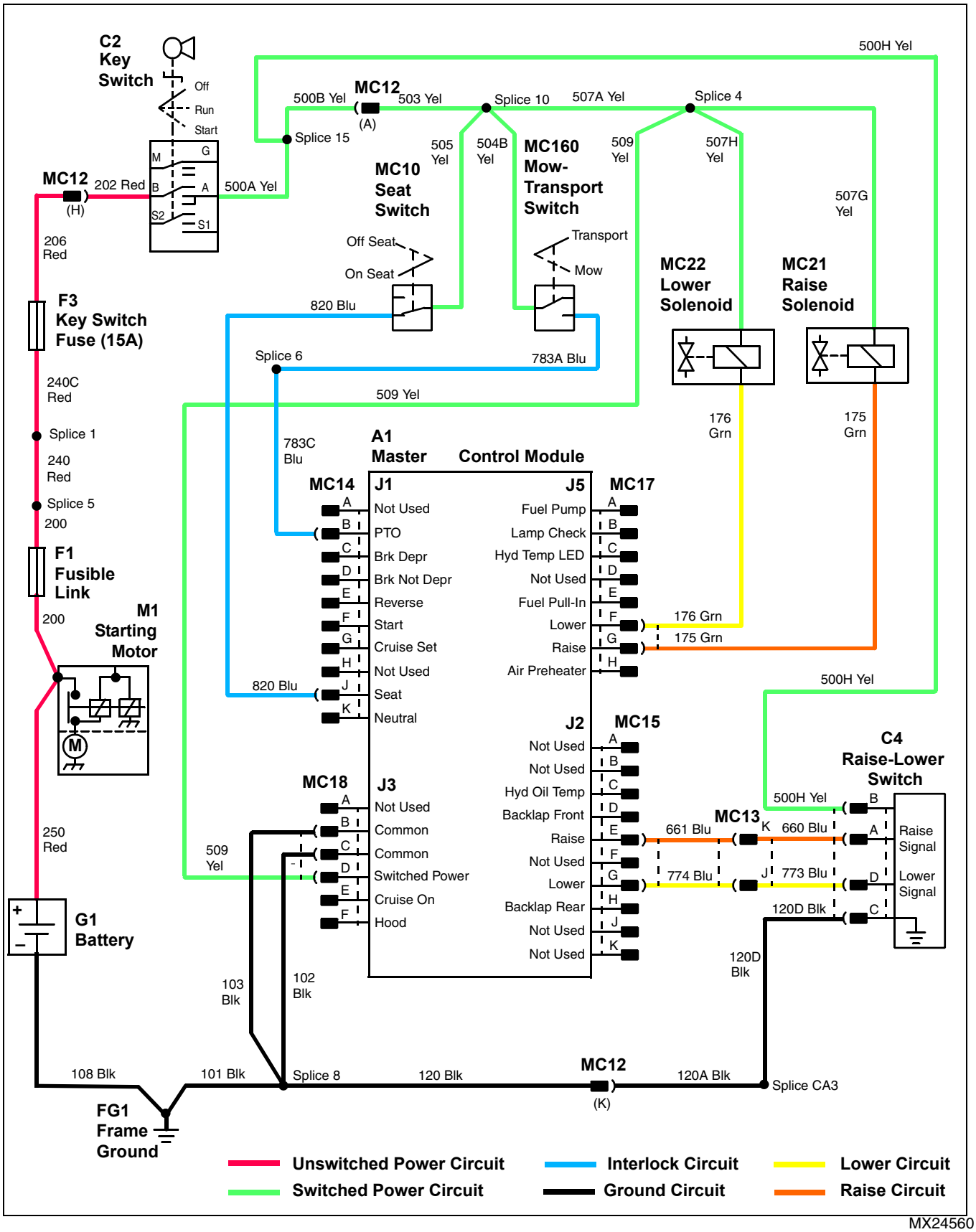
The Master control module will energize the lower solenoid (MC22) when the following conditions are met:

- Mow-transport lever in the MOW position.
- Raise-lower switch in the LOWER position.

With the operating conditions met and when the raise-lower switch is placed in the LOWER position, a signal is provided from the raise-lower switch to the Master control module lower input. With the lower input active, the Master control module provides a controlled ground to lower solenoid (MC22), energizing the solenoid. With the solenoid energized, the cutting units are lowered.

If the raise-lower switch is moved to the RAISE position, the Master control module will disable the reel motor controllers. The raise-lower switch must be moved back to the LOWER position before the solenoids will be engaged again.

Raise-Lower Circuit Schematic



MX24560

System: Raise-Lower Circuit Diagnosis

Diagnostics of circuits that include the Master control module is a multi-step process. This process is designed to take advantage of the self-diagnostic feature of the Master control module and to minimize the need to perform voltage and continuity checks.

Important: Avoid Damage! When diagnosing the raise-lower circuit, it is important to perform the following steps in the sequence shown.

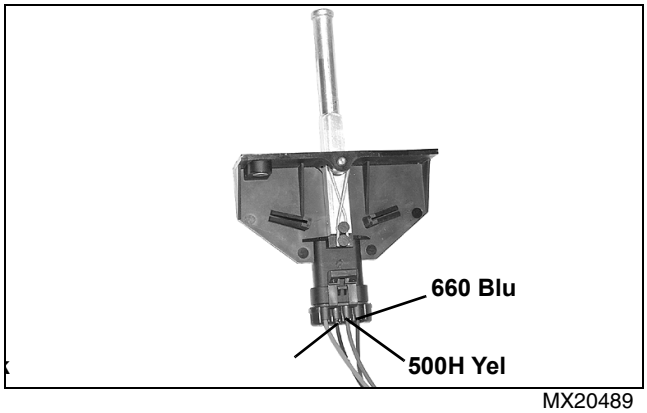
1. Master Control Module Checks. (See “Master Control Module Checks” on page 316.)

2. Raise-Lower Circuit Tests. (See “Raise-Lower Circuit Tests” on page 374.)

Raise-Lower Circuit Tests

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX20489

1. Disconnect raise-lower switch connector (C4). Measure voltage at raise-lower switch connector (C4), 500H Yel wire. Is battery voltage present

Yes: Go to next step.

No: Test 500H and 500A Yel wires and connections.

2. Measure ground circuit resistance at raise-lower connector (C4), 120D Blk wire. Is there less than 0.1 ohm of resistance?

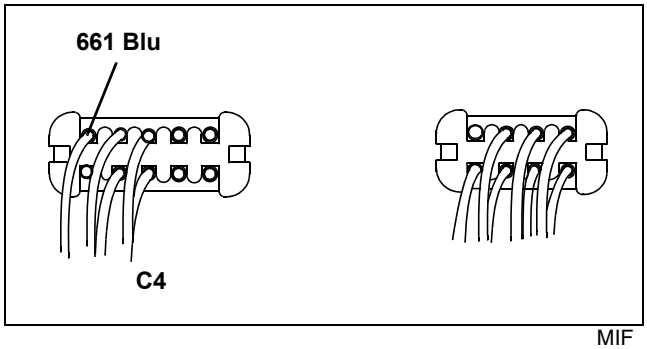
Yes: Go to next step.

No: Test 120D, 120A, 120 and 101 Blk wires and connections.

3. Connect raise-lower switch connector (C4). Move raise-lower switch to the RAISE position and hold. Measure voltage at raise-lower switch connector (C4), 660 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test raise-lower switch. (See “Raise-Lower Switch Test” on page 455.)

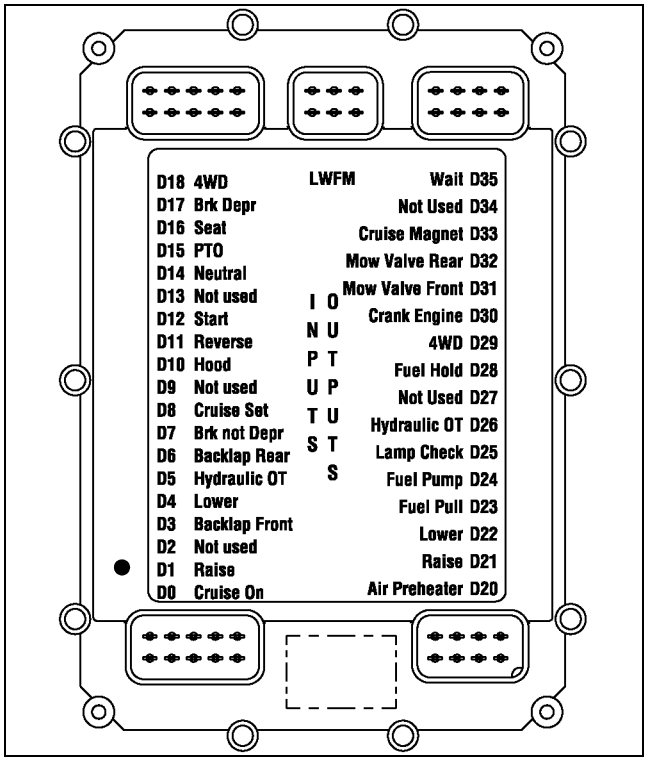


MIF

4. With the raise-lower switch (C4) in the RAISE position, measure voltage at Master control module connector (MC15), terminal E, 661 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 661 and 660 Blu wires and connections.

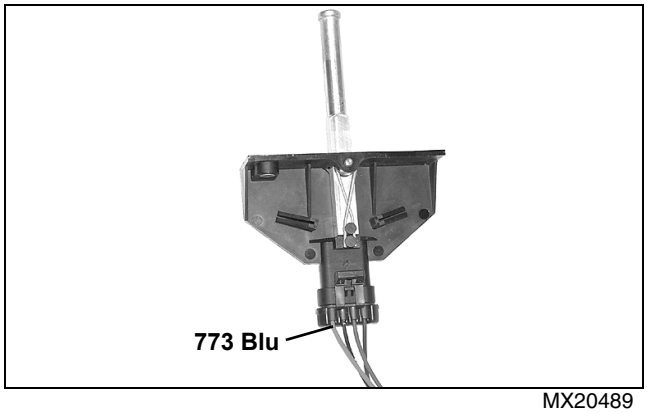


MX24569

5. With Raise-lower switch (C4) in the RAISE position, check Master control module (A1) input (D1) LED. Is raise input (D1) LED ON?

Yes: Go to next step.

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)

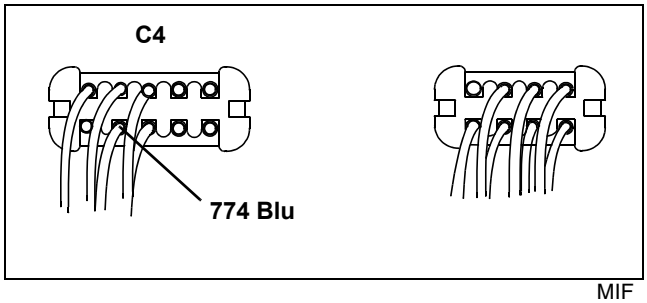


MX20489

6. Move raise-lower switch (C4) to LOWER position. Measure voltage at raise-lower switch connector, 773 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test raise-lower switch. (See “Raise-Lower Switch Test” on page 455.)

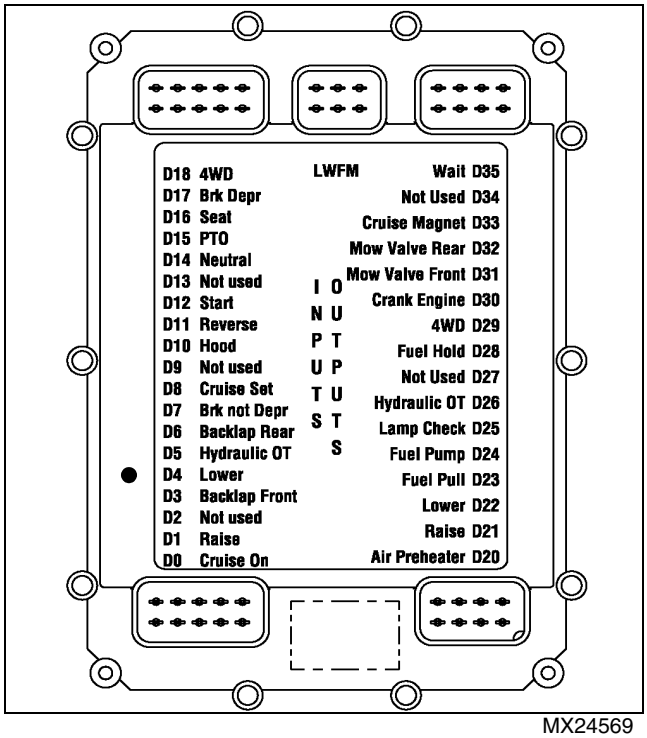


MIF

7. With the raise-lower switch (C4) in the LOWER position, measure voltage at Master control module connector (MC15), terminal G, 774 Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 773 and 774 Blu wires and connections.



MX24569

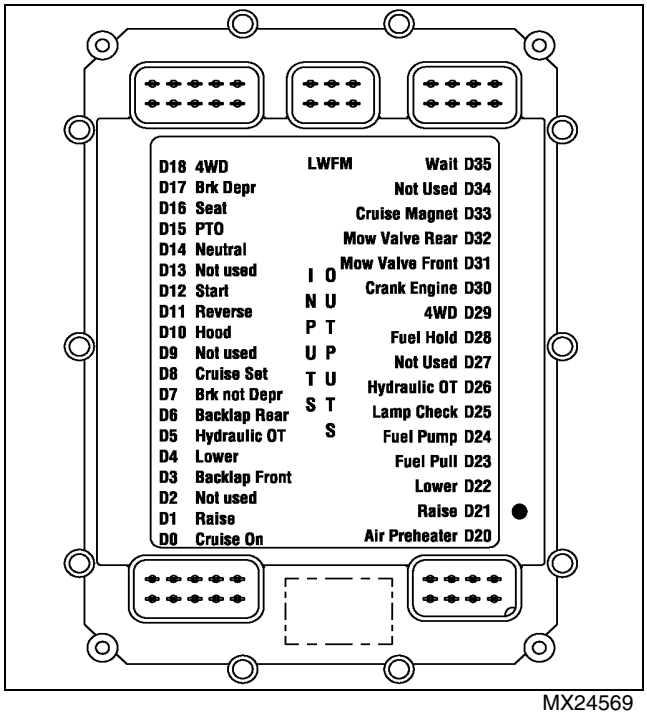
8. With Raise-lower switch (S10) in the LOWER position, check Master control module (A1) input LED. Is lower input (D4) LED ON?

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)

Raise Solenoid Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX24569

1. Hold raise-lower switch (C4) in the RAISE position. Check Master control module (A1) output LED (D21). Is raise output (D21) LED ON?

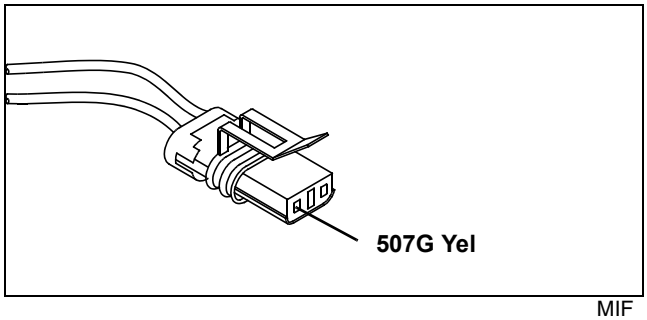
Yes: Go to next step.

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)

2. Mow-transport switch (MC160) in MOW position. Move raise-lower switch (C4) to RAISE position and release to MIDDLE position. Check Master control module (A1) raise output LED. Is raise output (D21) LED ON for approximately 3 seconds?

Yes: Go to next step.

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)

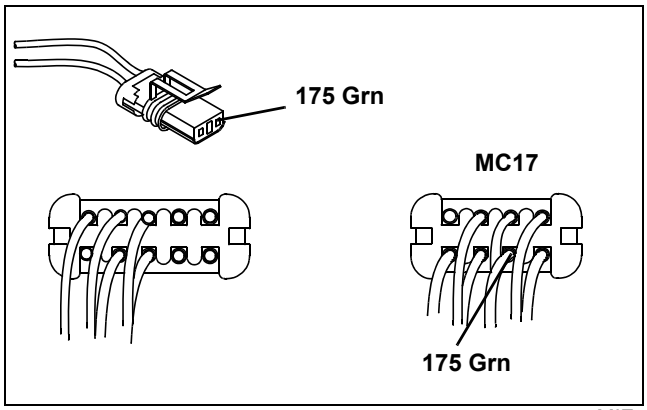


MIF

3. Mow-transport switch (MC160) in TRANSPORT position. Hold raise-lower switch (C4) in RAISE position. Measure voltage at raise solenoid (MC21), 507G Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 507G, 507A, 503, 500B, and 500A Yel wires and connections.



MIF

4. Disconnect Master control module connector (MC17). Measure resistance between Master control module connector (MC17), terminal G, 175 Grn wire and raise solenoid (MC21), 175 Grn wire. Is resistance less than 0.1 ohm?

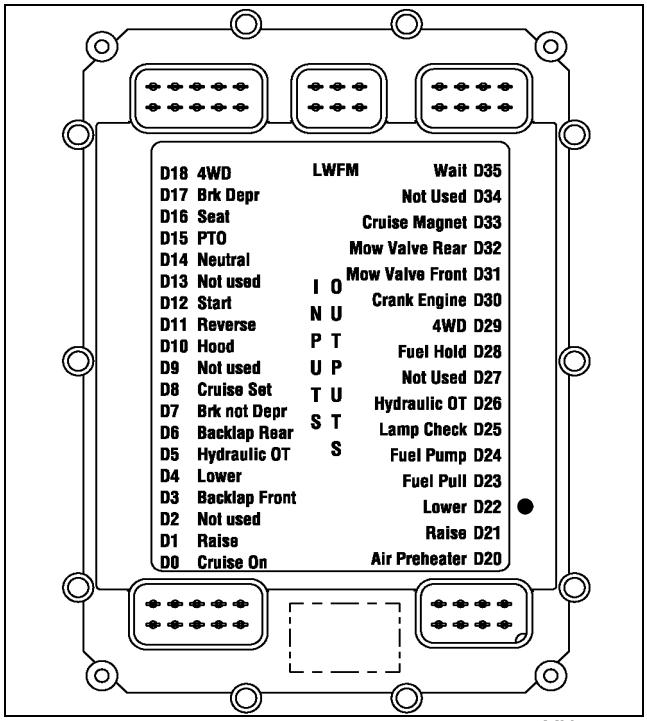
Yes: Test raise solenoid. (See “Raise or Lower Solenoid Test” on page 456.)

No: Test 175 Grn wire and connections.

Lower Solenoid Circuit

Test Conditions

- Operator ON seat.
- Key switch in RUN position, engine OFF.
- Mow-transport lever in TRANSPORT position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

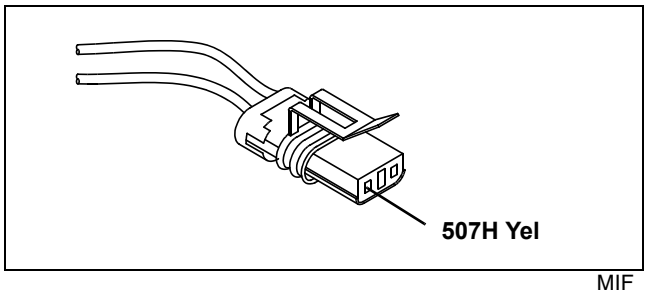


MX24569

1. Move raise-lower switch (C4) to LOWER position and release to MIDDLE position. Check Master control module (A1) lower output LED. Is lower output (D22) LED ON?

Yes: Go to next step.

No: Test 507H, 507A, 503, 500B, and 500A Yel wires and connections.

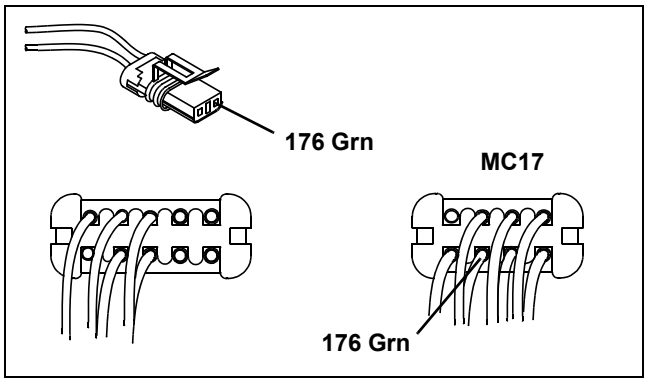


MIF

2. Measure voltage at lower solenoid (MC22), 507H Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)



MIF

3. Disconnect Master control module connector (MC17). Measure Master control module (A1) connector (MC17), terminal F, 176 Grn wire and lower solenoid (MC22), 176 Grn wire. Is resistance less than 0.1 ohm?

Yes: Test lower solenoid. (See “Raise or Lower Solenoid Test” on page 456.)

No: Test 176 Grn wire and connections.

Air Preheater Circuit Operation

Function

To provide power to the air preheater (MT2) and to automatically turn it on and off as needed.

Operating Conditions

- Key switch in RUN position.

Theory of Operation

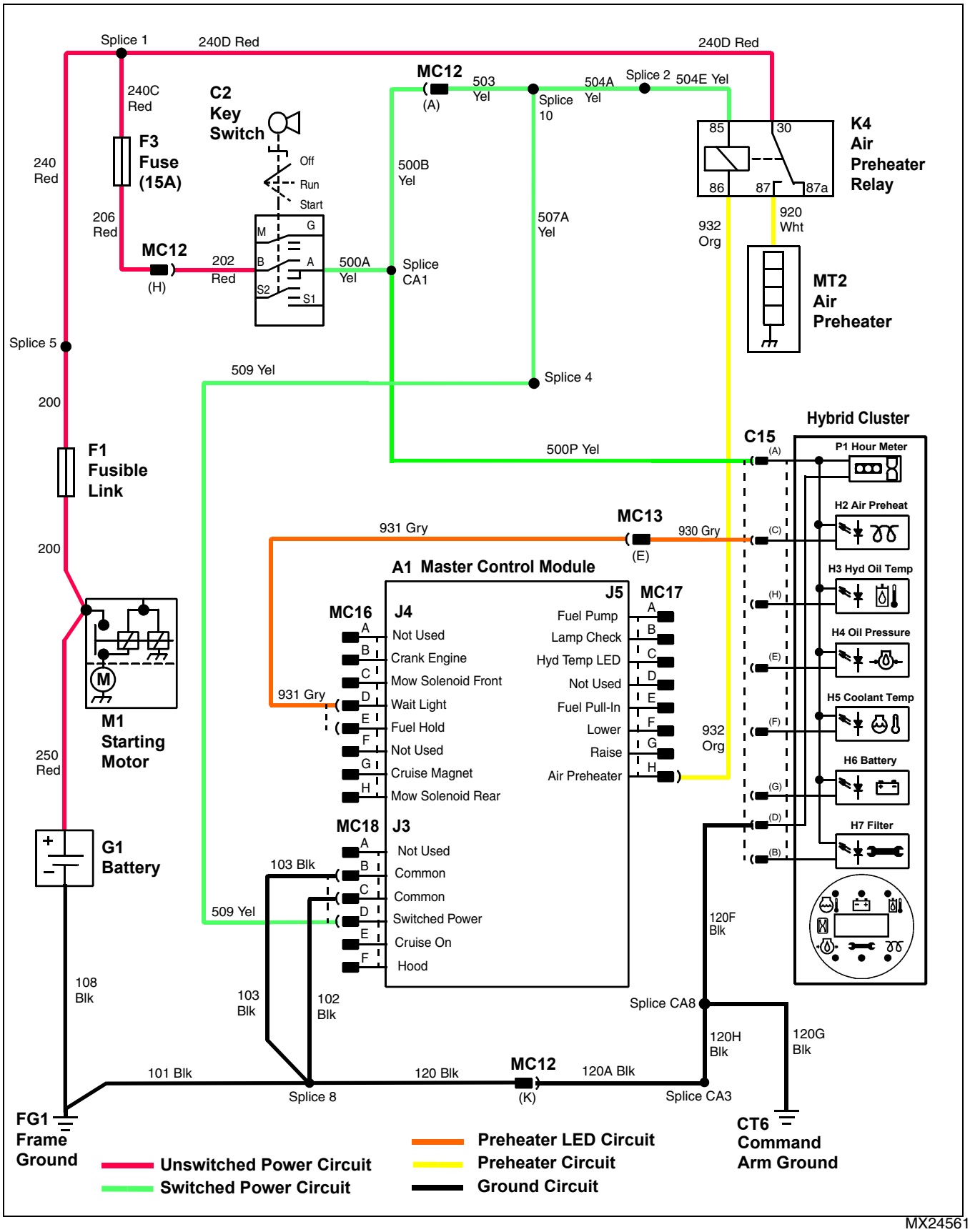
Unswitched power is provided to the air preheater relay (K4), terminal 30, 240D and 240 Red wires and 200 fusible link (F1).

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A, 500B, 503, 504A, and 504E Yel wires to the air preheater relay (K4), terminal 86.

With the key switch in the RUN position, the Master control module connector (MC17), terminal H, 932 Org wire, provides a ground circuit for the air preheater relay (K4), terminal 86, 932 Org wire, and energizes the relay.

With the air preheater relay energized, current flows from the relay to the air preheater (MT2), 920 Wht wire. The air preheater has an internal ground to the engine. After approximately 5 seconds, Master control module (A1) automatically turns OFF the air preheater circuit.

Air Preheater Circuit Schematic



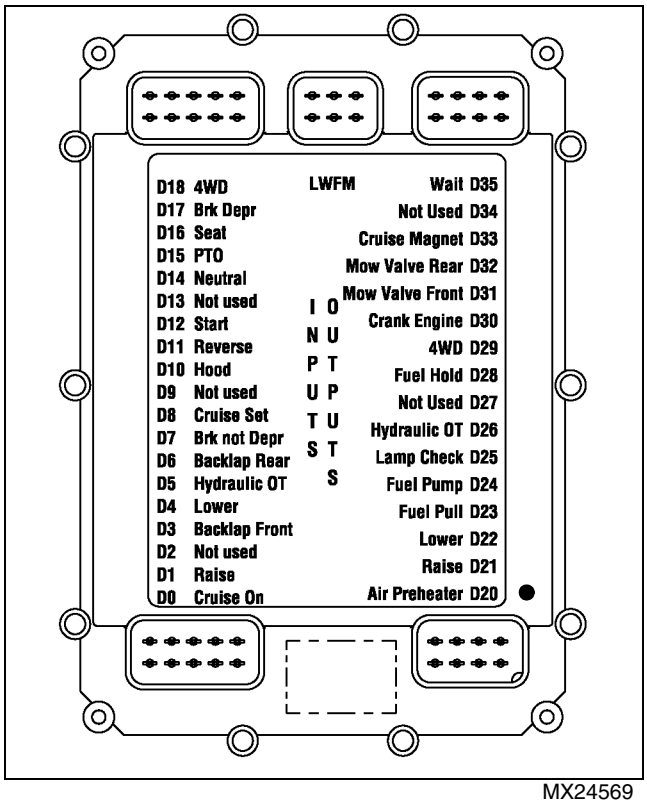
MX24561

System: Air Preheater Circuit Diagnosis

Air Preheater Circuit

Test Conditions

- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

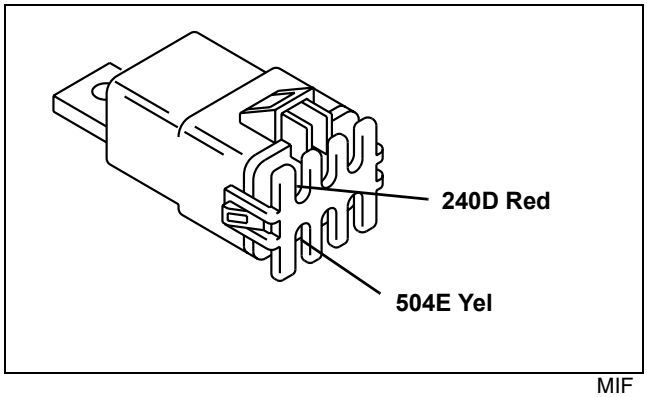


MX24569

1. Cycle key switch (C2) between OFF and RUN positions. Check Master control module (A1) output LED (D20). Is air preheater output (D20) LED ON for approximately 5 seconds?

Yes: Go to next step.

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)



MIF

2. Key switch in RUN position. Measure voltage at air preheater relay (K4), terminal 30, 240D Red wire. Is battery voltage present?

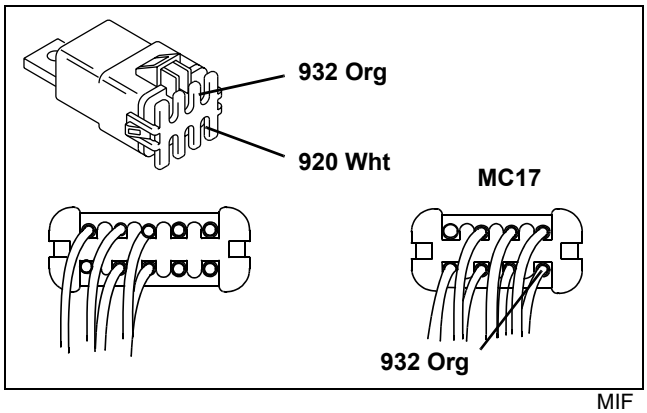
Yes: Go to next step.

No: Test 240D and 240 Red wires and 200 fusible link (F1) and connections.

3. Measure voltage at air preheater relay (K4), terminal 85, 504E Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 504E, 504A, 503, 500B, and 500A Yel wires and connections.



MIF

4. Disconnect Master control module (A1) connector (MC17). Measure resistance between connector (MC17), terminal H, 932 Org wire and air preheater relay (K4), terminal 86, 932 Org wire. Is resistance less than 0.1 ohm?

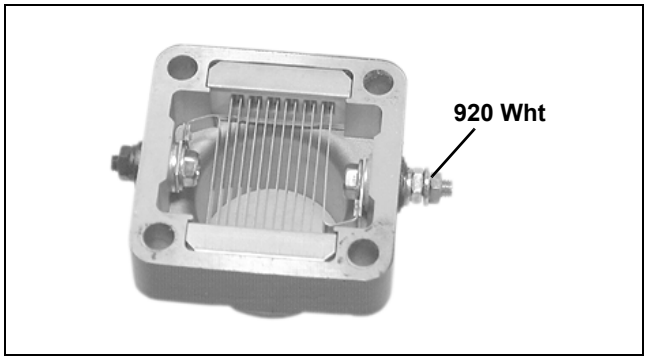
Yes: Go to next step.

No: Test 932 Org wire and connections.

5. Cycle key switch (C2) between OFF and RUN positions. Measure voltage at air preheater relay (K4), terminal 87, 920 Wht wire. Is battery voltage present for approximately 5 seconds?

Yes: Go to next step.

No: Test relay. (See “Relay Test” on page 452.)



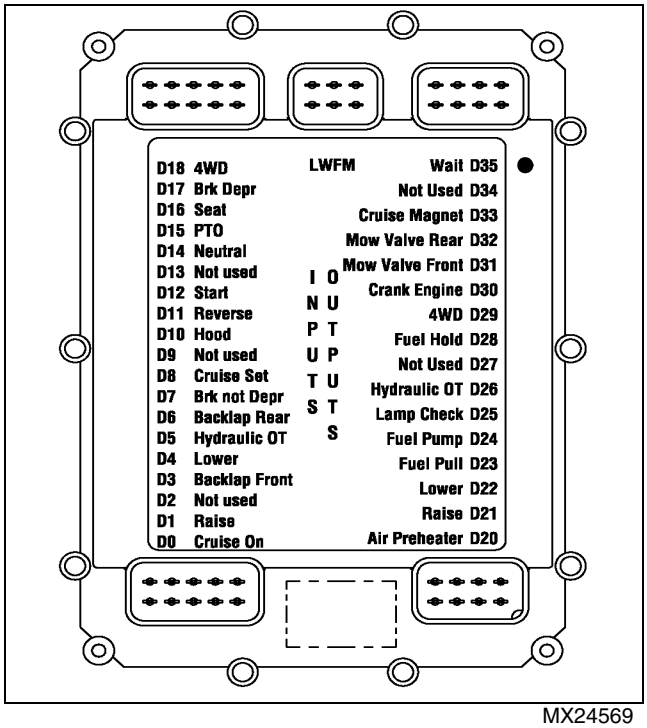
MX2344

6. Cycle key switch (C2) between OFF and RUN positions. Measure voltage at air preheater (MT2), 920 Wht wire. Is battery voltage present for approximately 5 seconds?

Yes: Test air preheater. (See “Air Preheater Test” on page 460.)

No: Test 920 Wht wire and connections.

Air Preheater LED Circuit

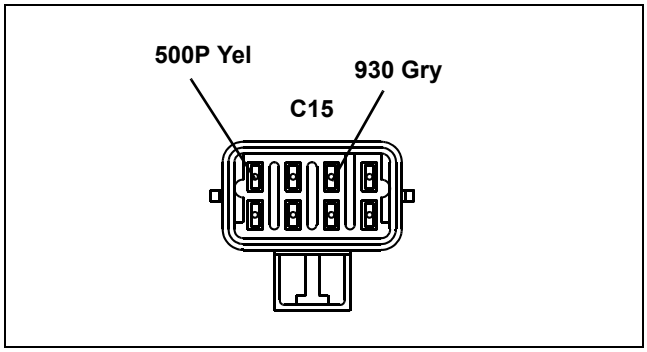


MX24569

1. Cycle key switch (C2) between OFF and RUN positions. Check Master control module (A1) wait output LED (D35). Is wait output LED (D35) ON for approximately 5 seconds?

Yes: Go to next step.

No: Test Master control module. (See “Master Control Module Circuit Test” on page 316.)



MX24573

2. Key switch in RUN position. Measure voltage at hybrid cluster, connector (C15) terminal A, 500P Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500P and 500A Yel wires and connections.

3. Disconnect Master control module (A1) connector (MC16). Measure resistance between connector (MC16), terminal D, 931 Gry wire and air preheater LED (H2), connector (C15), terminal C, 930 Gry wire. Is resistance less than 0.1 ohm?

Yes: Check air preheater LED connections and, if good, replace instrument cluster.

No: Test 931 and 930 Gry wires, connector (MC13), terminal E and connections.

Engine Oil Pressure and Hour Meter Circuit

Function

Engine oil pressure - To warn the operator if the engine oil pressure drops below a safe operating level.

Hour meter - Indicates total machine operating time.

Operating Conditions

- Key switch in RUN position.

Theory of Operation

Engine Oil Pressure Circuit

When the key switch (C2) is in RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A Yel wire to the following

- Buzzer (C5), 500C Yel wire.
- 500P Yel wire to hybrid cluster, connector (C15), terminal A and Engine oil pressure LED (H4).

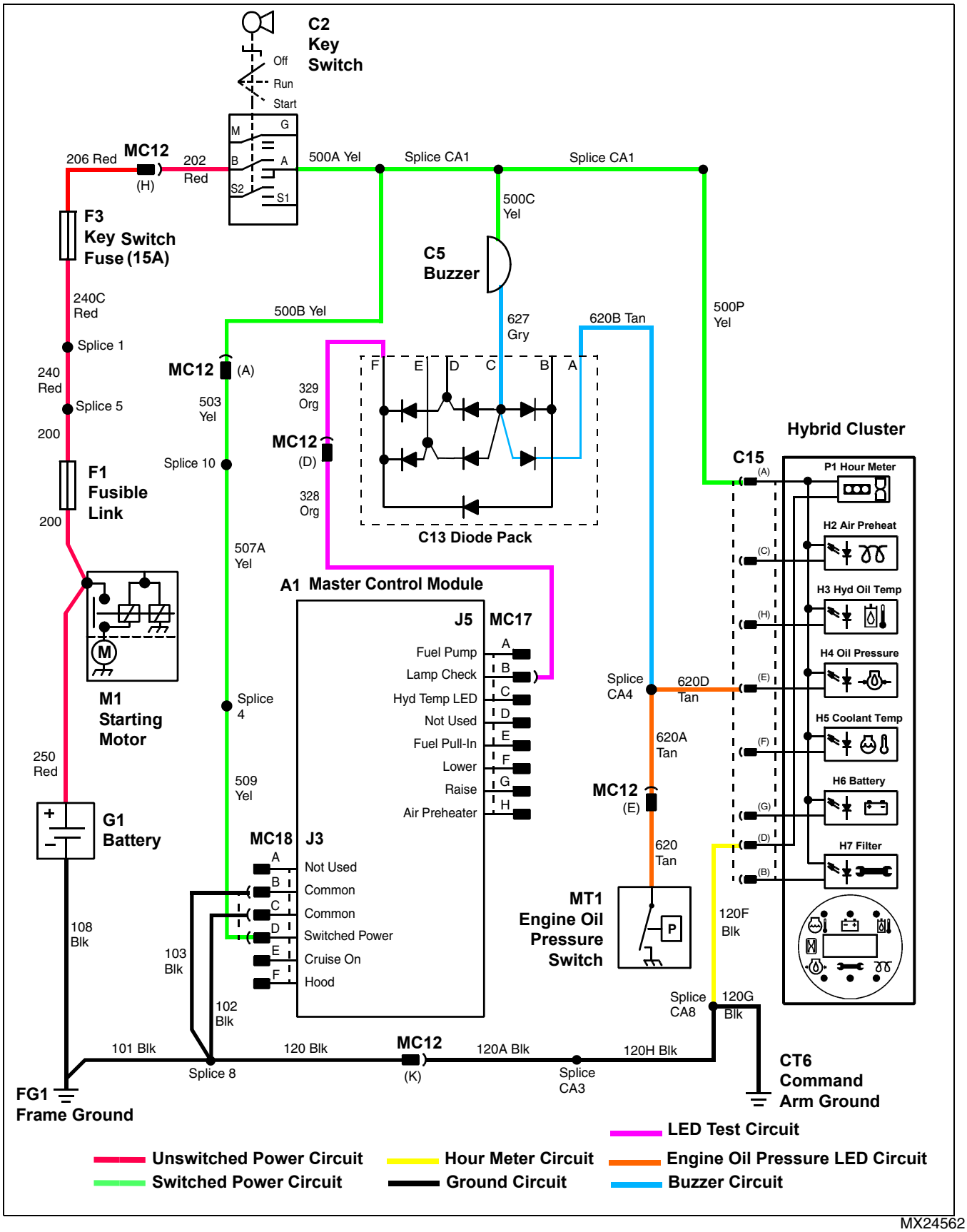
With the engine running and engine oil at operating pressure, the engine oil pressure switch (MT1) is open. If the engine oil pressure falls below acceptable limits, the engine oil pressure switch closes. With the switch closed, a ground connection is made for:

- The 620, 620A and D Tan wires, allowing the engine oil pressure LED (H4) to light.
- Diode Pack (C13) via the 620, 620A and B Tan wires. Current flows through the Diode Pack from terminal A to terminal C, and on to the 627 Gry wire. This causes the buzzer (C5) to sound.

Hour Meter Circuit

When the key switch (C2) is in the RUN position, (See “Power Circuit Operation - Switched” on page 321), battery voltage from key switch terminal A is supplied to the hybrid cluster (C15), terminal A, via the 500A and P Yel wires. This energizes the hour meter (P1). The hour meter ground (C15), terminal D, is connected to circuit ground by way of the 120F and 120G Blk wires.

Engine Oil Pressure and Hour Meter Circuit Schematic



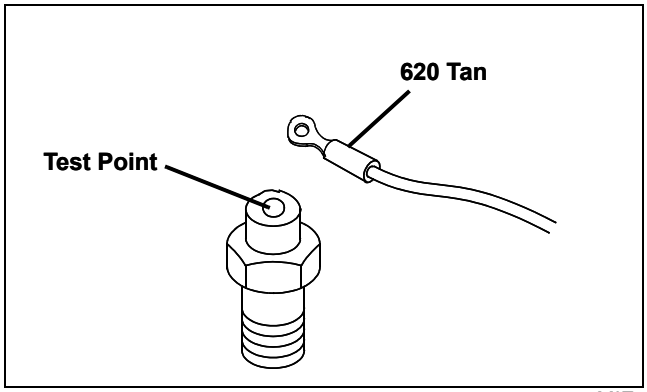
MX24562

System: Engine Oil Pressure and Hour Meter Circuit Diagnosis

Engine Oil Pressure Switch Circuit

Test Conditions

- Key switch in OFF position.
- Disconnect 620 Tan wire from engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure ground circuit for continuity at engine oil pressure switch (MT1) terminal. Is there continuity

Yes: Go to next step.

No: Test oil pressure switch. (See “Engine Oil Pressure Switch Test - Diesel Engine” on page 458.)

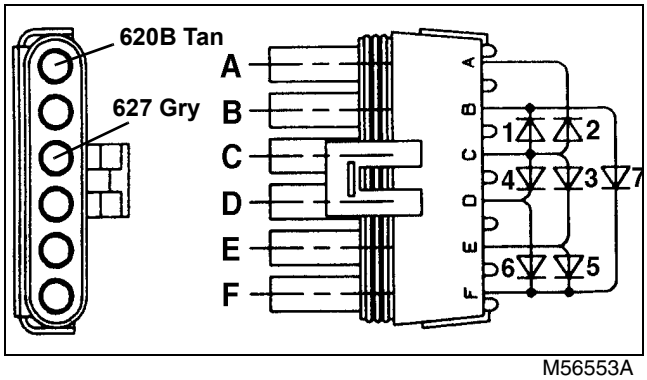
2. Key switch in RUN position, engine OPERATING. Measure ground circuit for continuity at engine oil pressure switch (MT1) terminal. Is there continuity?

Yes: Test oil pressure switch. (See “Engine Oil Pressure Switch Test - Diesel Engine” on page 458.)

Engine Oil Pressure Buzzer Circuit

Test Conditions

- Key switch in OFF position.
- Connect 620 Tan wire to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



M56553A

1. Measure ground circuit for continuity at diode pack (C13), 620B Tan wire. Is there continuity?

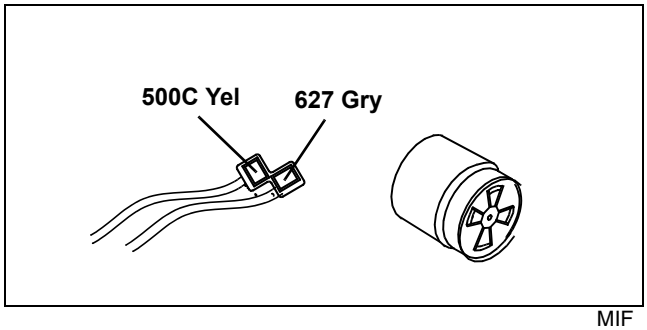
Yes: Go to next step.

No: Test 620B, 620A, and 620 Tan wires and connections.

2. Set meter to diode test. Measure forward voltage drop at diode pack (C13), 627 Gry wire. Is voltage in the range of 0.7-0.5 volt?

Yes: Go to next step.

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 463.)



MIF

3. Measure forward voltage drop at buzzer (H1), 627 Gry wire. Is voltage in the range of 0.7-0.5 volt?

Yes: Go to next step.

No: Test 627 Gry wire and connections.

4. Key switch in RUN position. Set meter to measure voltage. Measure voltage at buzzer (C5), 500C Yel wire. Is battery voltage present?

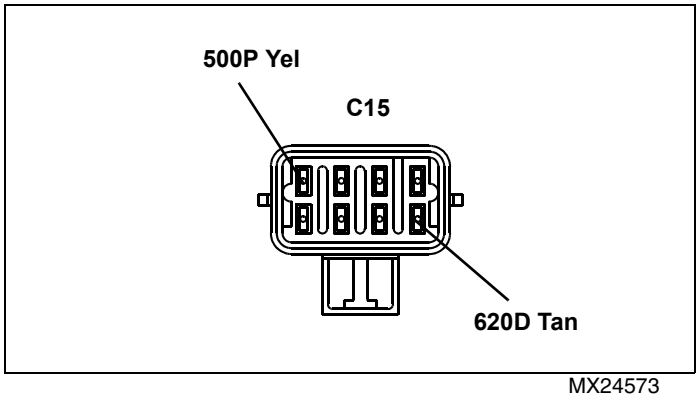
Yes: Replace buzzer.

No: Test 500C and 500A Yel wires and connections.

Engine Oil Pressure LED Circuit

Test Conditions

- Key switch in OFF position.
- Connect 620 Tan wire to engine oil pressure switch terminal.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX24573

1. Measure ground circuit for resistance at hybrid cluster connector (C15), terminal E, 620D Tan wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 620D, 620A, and 620 Tan wires and connections.

2. Key switch in RUN position. Measure voltage at hybrid cluster (C15), 500P Yel wire. Is battery voltage present?

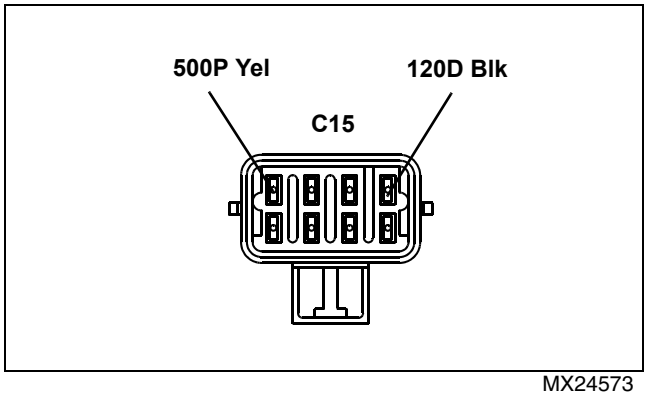
Yes: Test engine oil pressure LED (H4) and replace hybrid cluster.

No: Test 500P and 500A Yel wires and connections.

Hour Meter Circuit

Test Conditions

- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MX24573

1. Measure ground circuit for resistance at hour meter (P1), connector (C15), terminal D, 120F Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 120F and 120G Blk wires and connections.

2. Key switch in RUN position with engine OPERATING. Measure voltage at hour meter (P1), connector (C15), terminal A, 500P Yel wire. Is battery voltage present?

Yes: Go to next step.

No: Test 500P and 500A Yel wires and connections.

3. Key switch in RUN position with engine OPERATING. Hour meter LCD display check. Does hour meter increment after 10 minutes?

No: Replace hybrid cluster.

Engine Coolant Temperature LED Circuit Operation

Function

To warn the operator if the engine coolant temperature exceeds the safe operating level.

Operating Conditions

- Key switch in RUN position, engine OFF.

Theory of Operation

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A Yel wire to the following

- Buzzer (C5), 500C Yel wire.
- Hybrid cluster (C15), 500P Yel wire.
- Master control module (A1), 500B, 503, 507A, and 509 Yel wires.

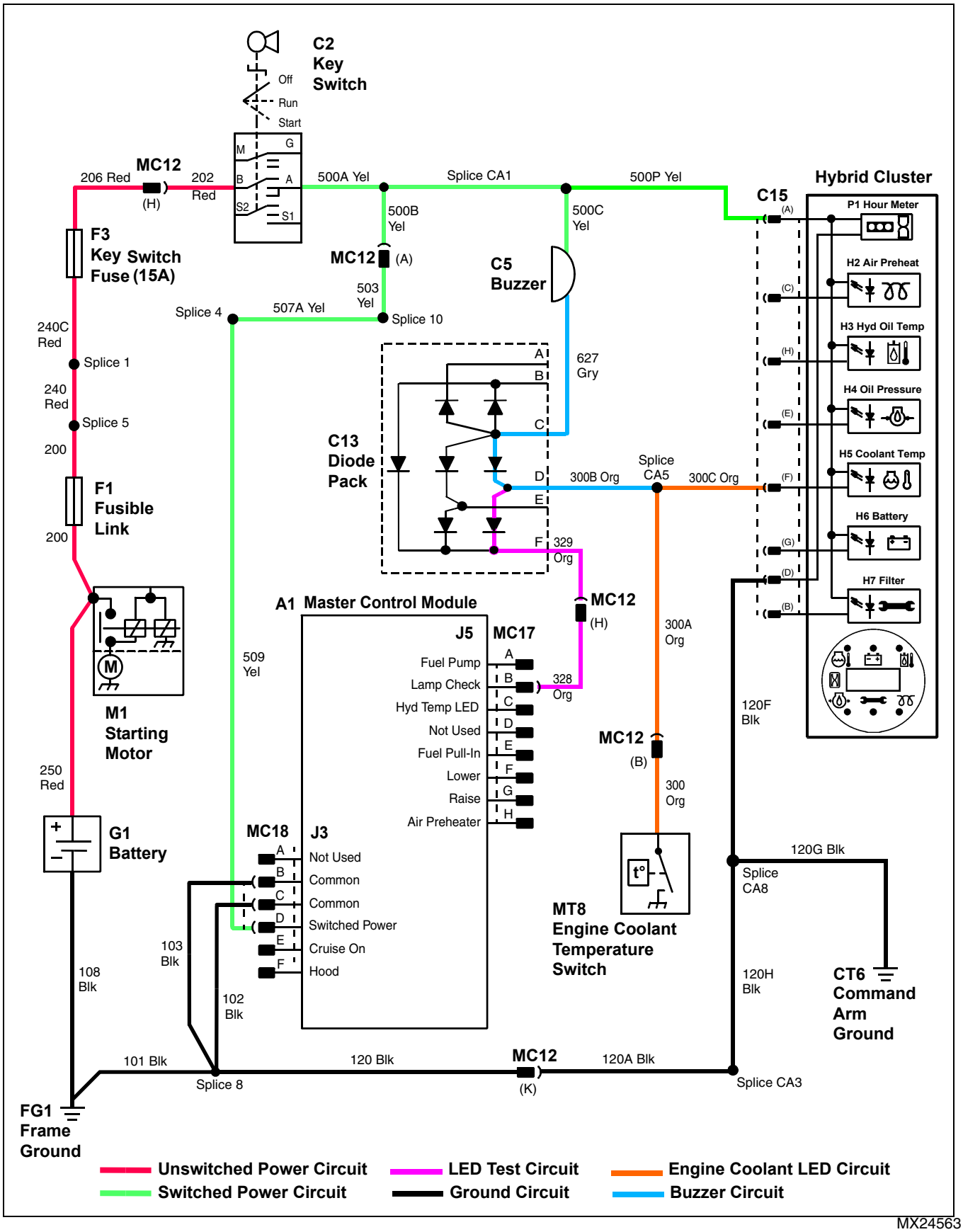
When the coolant temperature exceeds the safe operating level, the engine coolant temperature switch (MT8) closes and completes the circuit to ground, 300, 300A, and 300C Org wires, causing the coolant temperature LED to come on. The coolant temperature switch also completes the buzzer (C5) ground circuit, 300B, 300A, and 300 Org wires and 627 Gry wire, causing the buzzer to come on. Diode pack (C13) is used to isolate the coolant temperature LED from other circuits that turn on the buzzer.

When the key switch is moved from the OFF to the RUN position, the Master control module provides a controlled ground to Master control module connector (MC17), terminal B, for approximately 5 seconds. When this happens, current flows for approximately 5 seconds through:

- Engine coolant temperature LED (H5), 300C and 300B Org wires.
- Diode pack (C13), terminal D, 300B Org wire.
- Diode pack (C13), terminal F, 329 Org wire.
- 329 and 328 Org wires.

This completes the circuit for the buzzer and coolant temperature LEDs to turn on. This serves as a way to check the operation of the buzzer and coolant temperature LEDs.

Engine Coolant LED Circuit Schematic



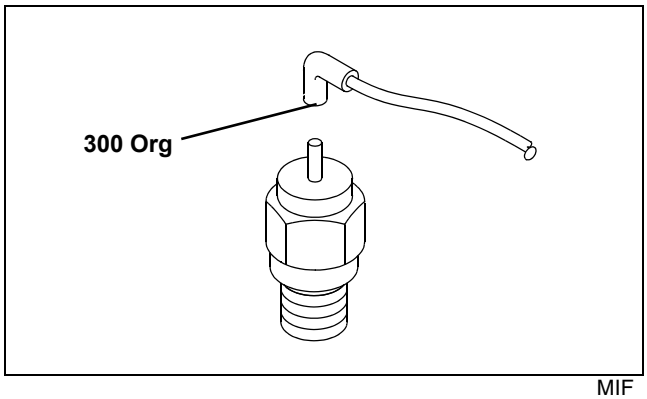
MX24563

Engine Coolant Temperature Circuit Diagnosis

Engine Coolant Temperature Switch

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Engine coolant temperature switch 300 Org wire disconnected.
- Engine at normal operating temperature.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

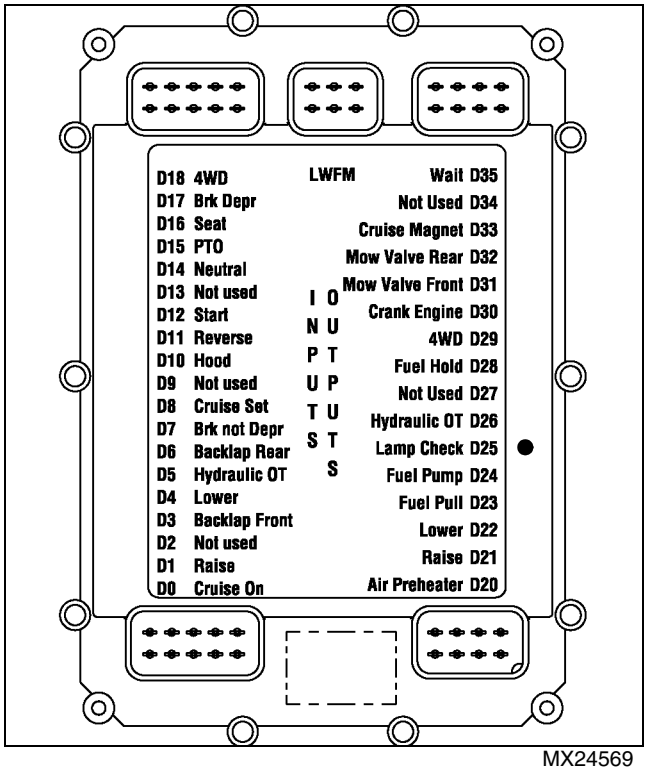
1. Measure ground circuit for resistance at engine coolant temperature terminal. Is there less than 0.1 ohm of resistance?

   Yes: Test temperature switch. (See “Engine Coolant Temperature Switch Test” on page 459.)

Engine Coolant Temperature LED Circuit

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Key switch in RUN position.
- Diode pack disconnected.
- Master control module connector (MC17) disconnected
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

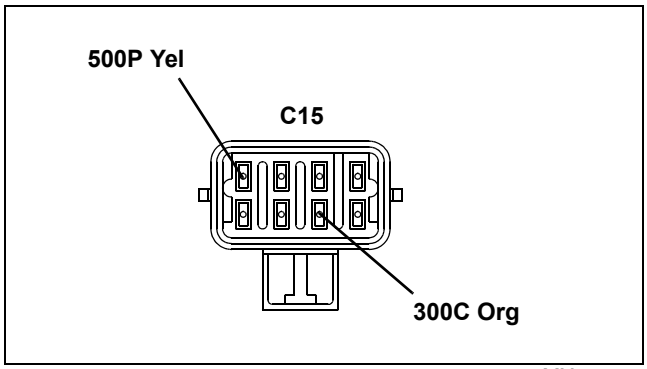


MX24569

1. Cycle key switch between OFF and RUN positions. Master control module (A1) output LED check. Is Master control module lamp check output (D25) LED ON for approximately 5 seconds?

   Yes: Go to next step.

   No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)



MX24573

2. Measure voltage at hybrid cluster (C15), 500P Yel wire. Is battery voltage present?

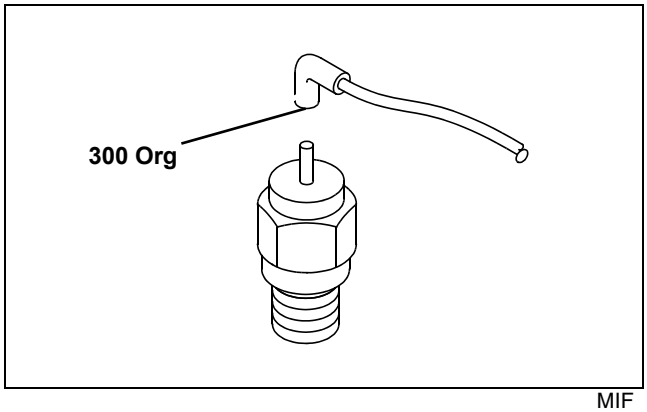
   Yes: Go to next step.

   No: Test 500P and 500A Yel wires and connections.

3. Measure voltage at hybrid cluster (C15), terminal F, 300C Org wire. Is battery voltage present?

   Yes: Go to next step.

   No: Replace instrument cluster.

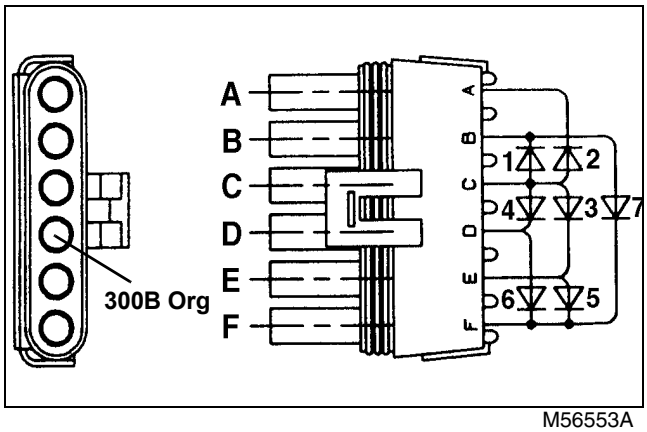


MIF

4. Measure voltage at engine coolant temperature switch connector (MT8), 300 Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300, 300A and 300C Org wires and connections.



M56553A

5. Measure voltage at diode pack connector (C13), terminal D, 300B Org wire. Is battery voltage present?

Yes: Go to next step.

No: Test 300B and 300C Org wires.

6. Measure continuity between diode pack connector (C13), terminal F, 329 Org wire and Master control module connector (MC17), terminal B, 328 Org wire. Is there continuity?

Yes: Go to next step.

No: Test 328 and 329 Org wires and connections.

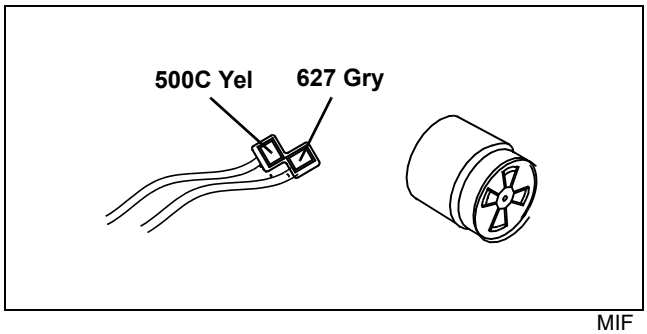
7. Diode pack connected. Master control module connector (MC17) connected. Cycle key switch between OFF and RUN positions. Hybrid cluster (C15) LED check. Is engine coolant temperature LED ON for approximately 5 seconds?

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 463.)

Buzzer Circuit

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Master control module connector (MC17) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at buzzer (C5), 500C Yel wire. Is battery voltage present?

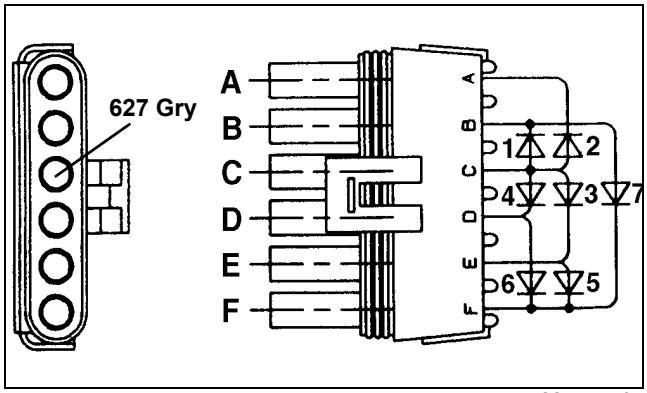
Yes: Go to next step.

No: Test 500C and 500A Yel wires and connections.

2. Measure voltage at buzzer (C5), 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Replace buzzer.



M56553A

3. Measure voltage at diode pack connector (C13), terminal C, 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test 627 Gry wire.

4. With a jumper wire, connect diode pack connector (C13), terminal C, to ground. Buzzer (C5) check. Is buzzer operating?

Yes: Go to next step.

No: Replace buzzer.

5. Diode pack connected. Buzzer (C5) check. Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 463.)

Hydraulic Filter Restriction LED Circuit Operation

Function

To warn the operator that the hydraulic filter needs service.

Operating Conditions

- Key switch in RUN position.

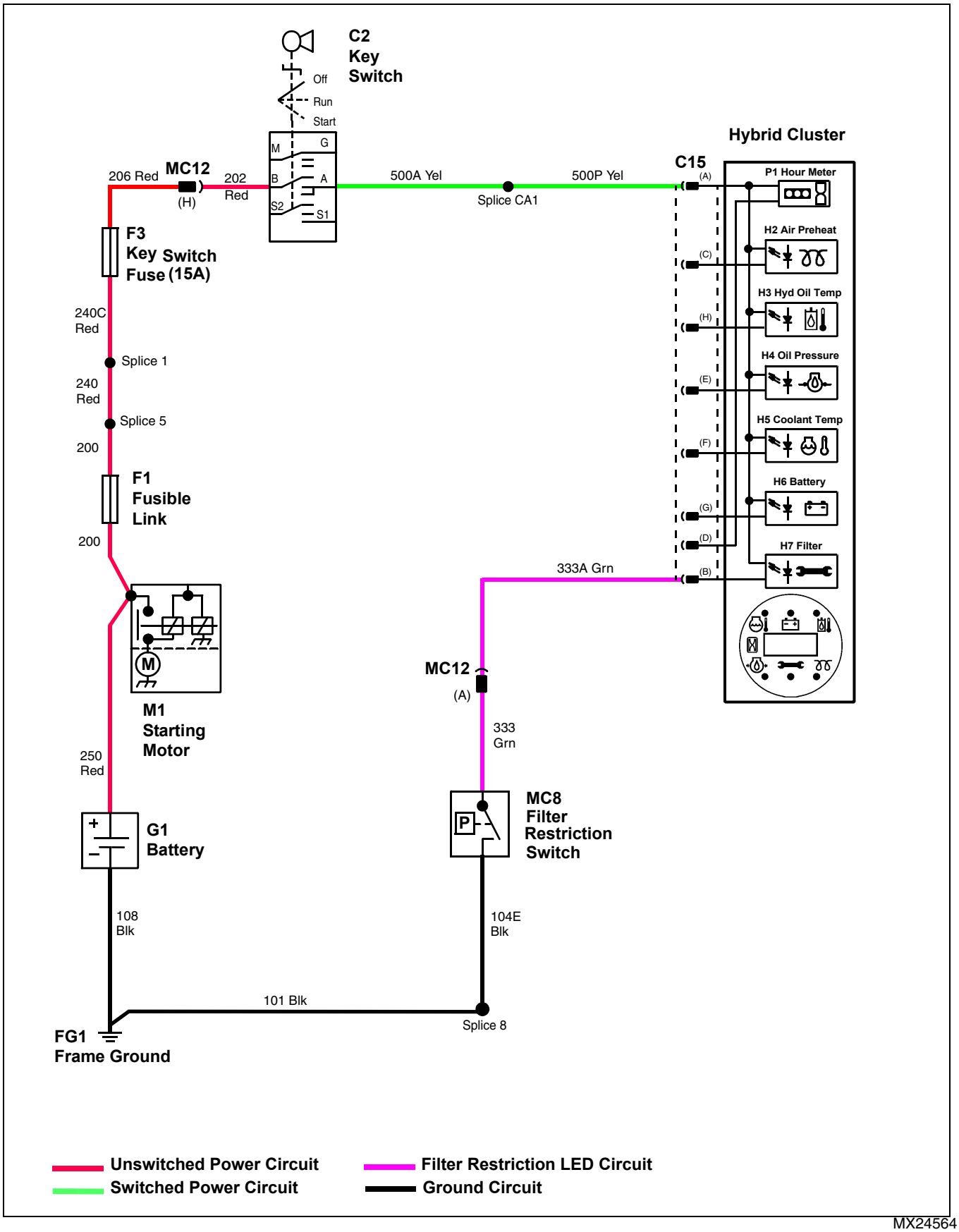
Theory of Operation

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) is supplied from key switch terminal A to the hydraulic filter restriction LED (H7) of hybrid cluster (C15) via the 500A and 500P Yel wires.

When the hydraulic oil pressure reaches 276 ± 28 kPa (40 ± 4 psi), the hydraulic filter restriction switch (MC9) closes. A ground path, through Green wires 333 and 333A, and Black wires 104E and 101, is made to hybrid cluster (C15), terminal B, lighting hydraulic filter restriction LED (H7).

The hydraulic filter restriction switch will not open until hydraulic oil pressure drops to 207 kPa (30 psi).

Hydraulic Filter Restriction LED Circuit Schematic



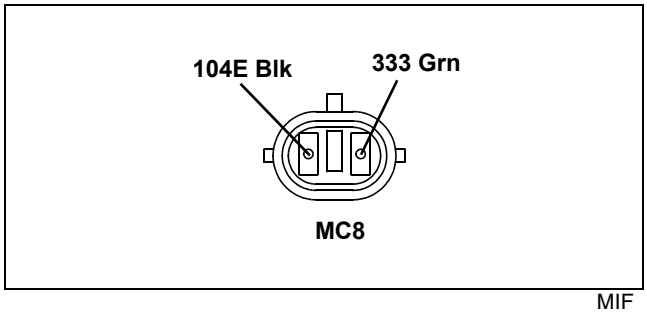
MX24564

System: Hydraulic Filter Restriction Circuit Diagnosis

Hydraulic Filter Restriction Switch

Test Conditions

- Hydraulic filter restriction switch connector disconnected.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure continuity between hydraulic filter restriction switch connector (MC8), terminals 104E Blk wire and ground. Is there continuity?

Yes: Go to next step.

No: Test 104E and 101 Blk wires and connectors.

2. Key switch (C2) in RUN position. Measure voltage at hydraulic filter restriction switch connector (MC8), 333 Grn wire. Is there battery voltage?

Yes: Go to next step.

No: Test 333 and 333A Grn wires and connectors.

3. Disconnect connector (MC8) at hydraulic filter switch. Jumper between 333 Grn and 104E Blk wires on connector (MC8). Does hydraulic filter restriction LED (H7) light up?

Yes: Test switch. See “Hydraulic Filter Restriction Switch Test” on page 457

No: Test hybrid cluster LED circuit.

Hydraulic Filter Restriction LED Circuit

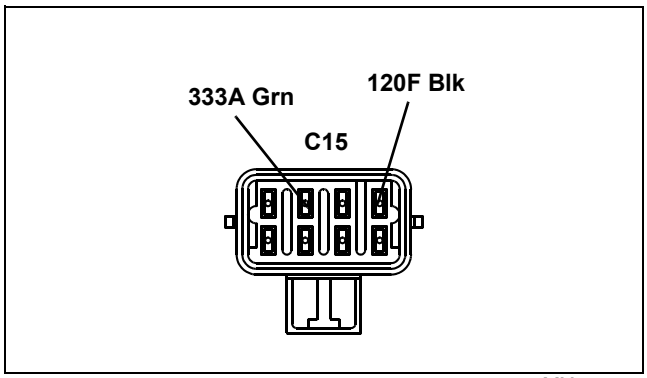
Test Conditions

- Hydraulic filter restriction switch connector disconnected and a jumper between 333 Grn wire and 104E Blk wire.
- Key switch in RUN position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

1. Measure voltage at hybrid cluster (C15), terminal A. Is battery voltage present?

Yes: Go to next step.

No: Test 500A and 500P Yel wires and connections.



MX24573

2. Measure voltage at Filter Restriction LED (H7), connector (C15), terminal B, 333A Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 333A Grn wire and connections.

3. Jumper hybrid cluster (C15), terminal B, to frame ground. Does hydraulic filter restriction LED (H7) light up?

Yes: Test completed.

No: Replace hybrid cluster (C15).

Hydraulic Oil Temperature LED Circuit Operation

Function

To warn the operator if the hydraulic oil temperature exceeds the safe operating point.

Operating Conditions

- Key switch in RUN position, engine OFF.

Theory of Operation

When the key switch (C2) is in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch terminal A through 500A Yel wire to the following

- Buzzer (C5), 500C Yel wire.
- Hydraulic oil temperature switch (B4), 500B, 503, and 512 Yel wires.
- Master control module (A1), 500B, 503, 507A, and 509 Yel wires.

The Master control module (A1), connector (MC15) terminal C, receives input voltage from the hydraulic oil temperature switch (MC9), 334 Org wire. When the hydraulic oil temperature rises above a set temperature, the hydraulic oil temperature switch closes.

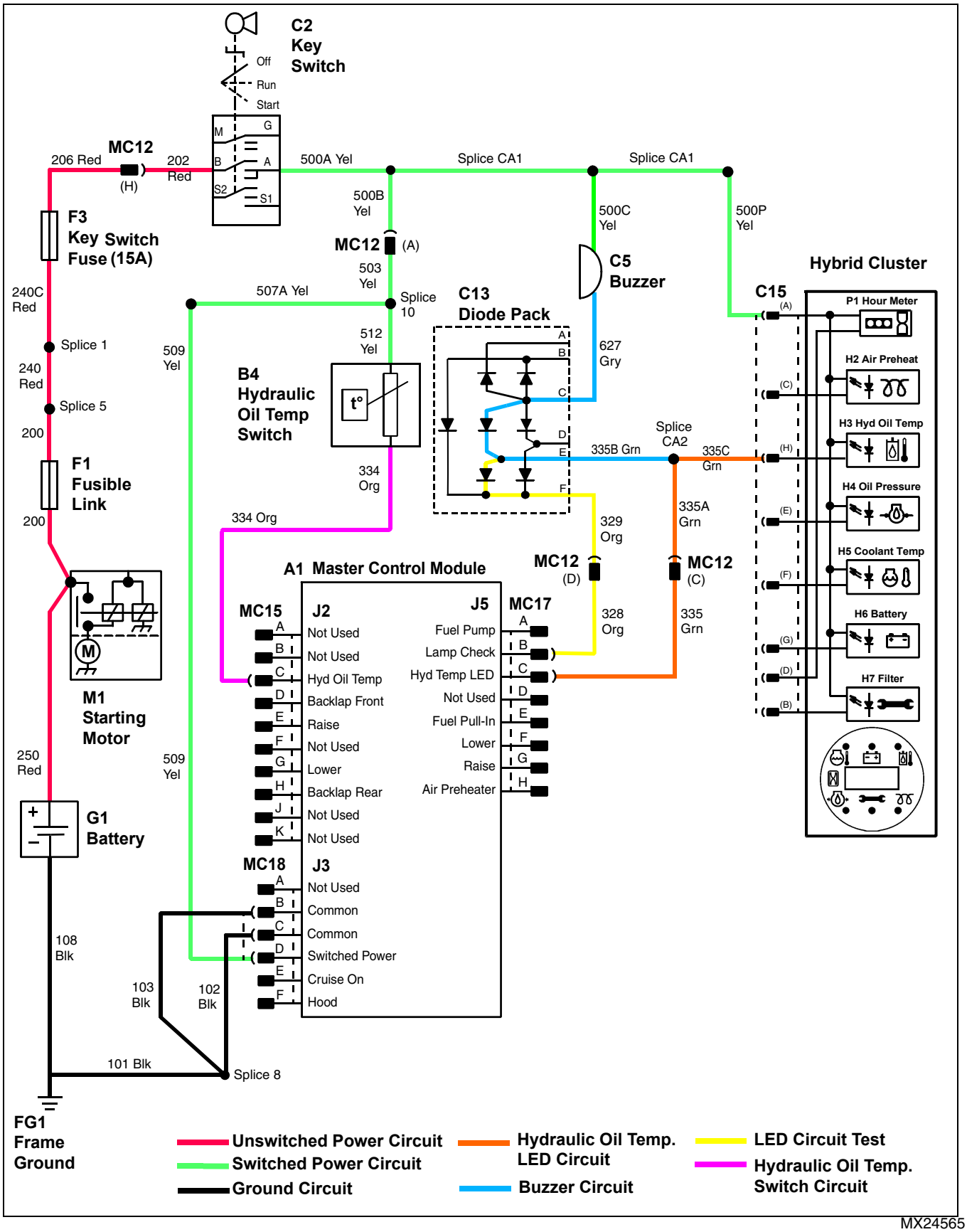
The Master control module senses this voltage and turns ON the hydraulic oil temperature LED (H3) by suppling a control ground through the 335, 335A, and 335C Grn wires. The Master control module also activates the buzzer (C5) via the 335, 335A, and 335B Grn wires, diode pack (C13) and 627 Gry wire. Diode pack (C13) is used to isolate the hydraulic oil temperature LED from other circuits that turn on the buzzer.

When the key switch is moved from the OFF to the RUN position, the Master control module provides a controlled ground to Master control module connector (MC17), terminal B, for approximately 5 seconds. When this happens, current flows through the following:

- Buzzer (C5), 627 Gry wire.
- Diode pack (C13), terminal C, 627 Gry wire.
- Hydraulic oil temperature LED (H3), 335C and 335B Grn wires.
- Diode pack (C13), terminal E, 335B Grn wire.
- Diode pack (C13), terminal F, 329 Org wire.
- 329 and 328 Org wires.

This serves as a way to check the operation of the buzzer and hydraulic oil temperature LED.

Hydraulic Oil Temperature LED Circuit Schematic



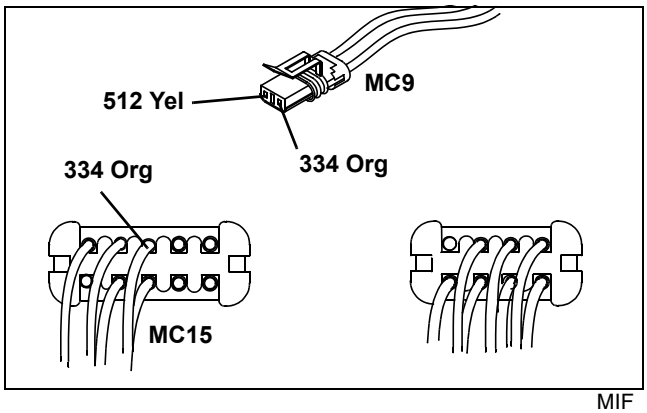
MX24565

System: Hydraulic Oil Temperature Circuit Diagnosis

Hydraulic Oil Temperature Switch Circuit

Test Conditions

- Key switch in RUN position.
- Disconnect Master control module connector (MC15)
- Disconnect hydraulic oil temperature switch connector (MC9).
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at hydraulic oil temperature sensor connector (MC9), 512 Yel wire. Is battery voltage present?

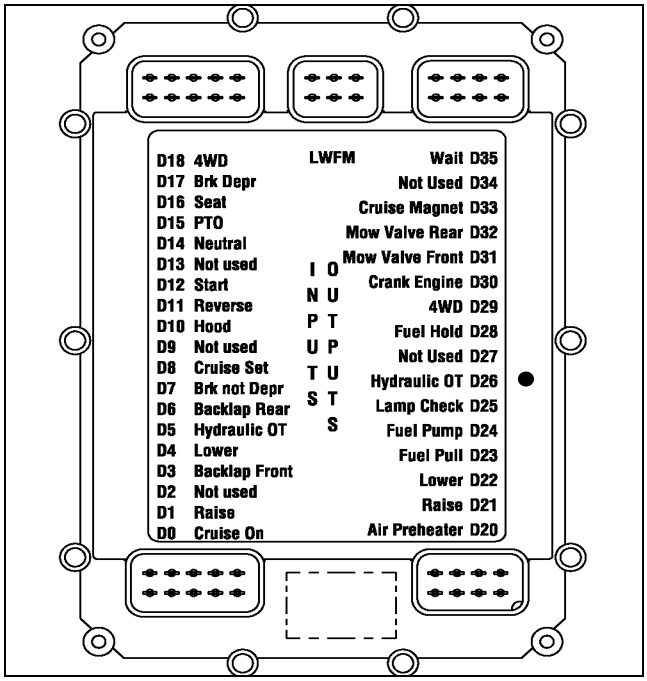
Yes: Go to next step.

No: Test 512, 503, 500B, and 500A Yel wires and connections.

2. Measure wire for resistance between Master control module connector (MC15), terminal C, 334 Org wire and hydraulic oil temperature switch (MC9), 334 Org wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 334 Org wire and connections.



MX24569

3. Master control module connector (MC15) connected. Jumper wire connected between hydraulic oil temperature switch connector (MC9), terminals 334 Org wire and 512 Yel wire. Master control module (A1) output LED check. Is hydraulic oil temperature output (D26) LED ON?

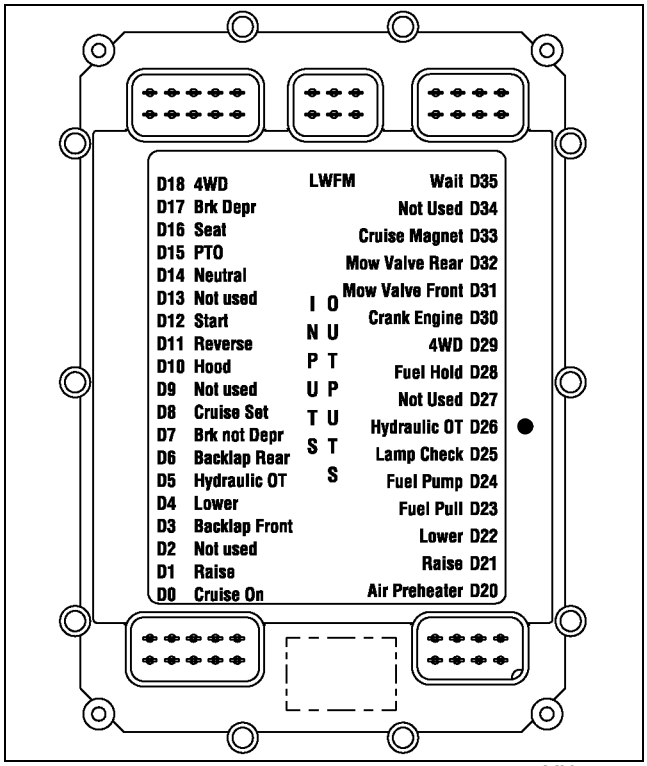
Yes: Test hydraulic oil temperature switch. “Hydraulic Temperature Switch Test” on page 456.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)

Hydraulic Oil Temperature LED Circuit

Test Conditions

- Key switch in RUN position, engine OFF.
- Master control module connector (MC17) connected.
- Master control module connector (MC15) connected.
- Diode pack (C13) disconnected.
- Hydraulic oil temperature switch connector (MC9) connected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.

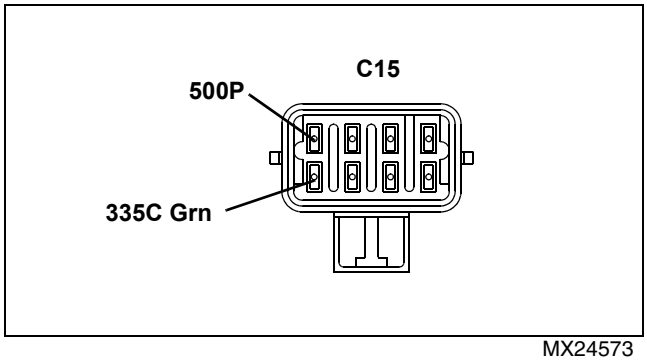


MX24569

1. Cycle key switch between OFF and RUN positions. Master control module (A1) output LED check. Is Master control module hydraulic oil temperature output (D26) LED ON for about 5 seconds?

Yes: Go to next step.

No: Test Master control module circuit. (See “Master Control Module Circuit Test” on page 316.)



MX24573

2. Measure voltage at hybrid cluster connector (C15), terminal A, 500P Yel wire. Is battery voltage present?

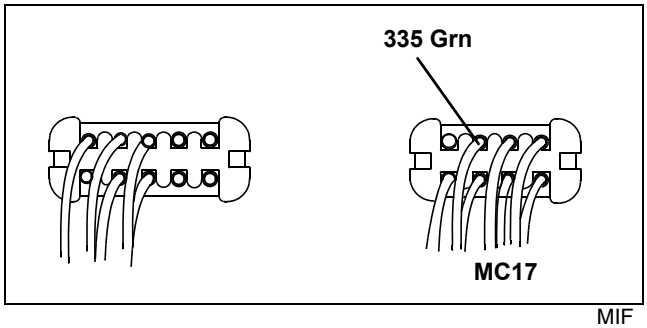
Yes: Go to next step.

No: Test 500P and 500A wires and connections.

3. Measure voltage at hybrid cluster connector (C15), terminal H, 335C Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test connections. Replace hybrid cluster.

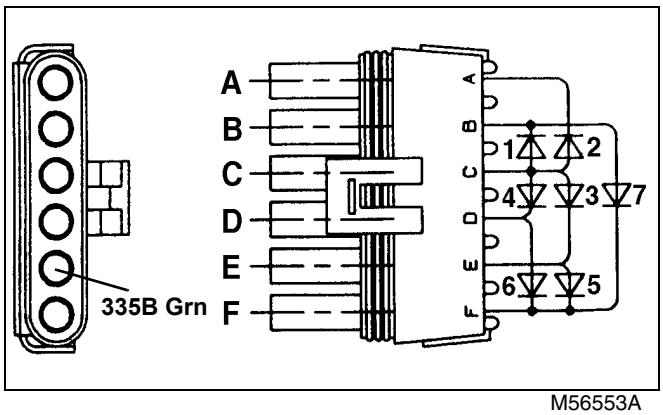


MIF

4. Measure voltage at Master control module connector (MC17), terminal C, 335 Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 335, 335A, and 335C Grn wires.

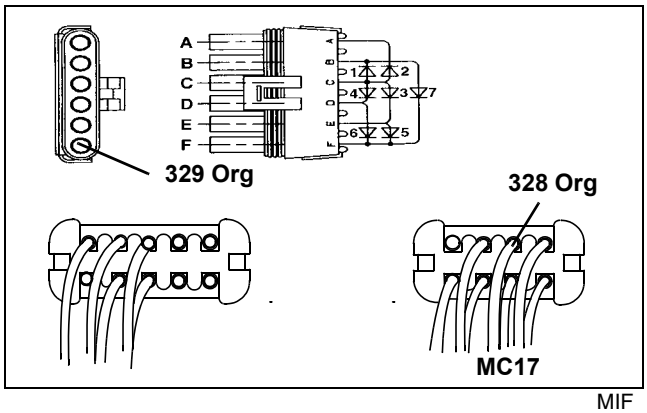


M56553A

5. Measure voltage at diode pack connector (C13), terminal E, 335B Grn wire. Is battery voltage present?

Yes: Go to next step.

No: Test 335B Grn wire.

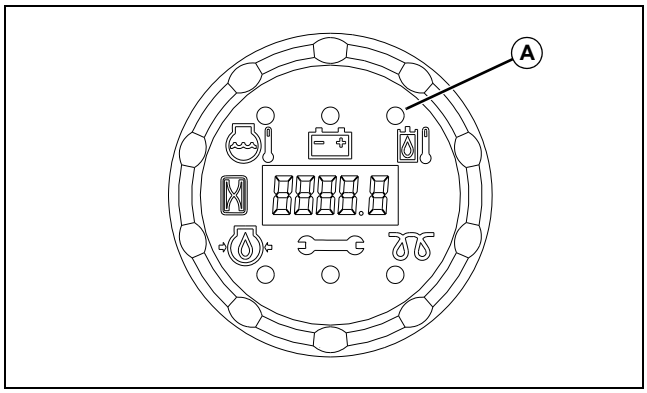


MIF

6. Measure continuity between diode pack connector (C13), terminal F, 329 Org wire and Master control module connector (MC17), terminal B, 328 Org wire. Is there continuity?

Yes: Go to next step.

No: Test 328 and 329 Org wires and connections.



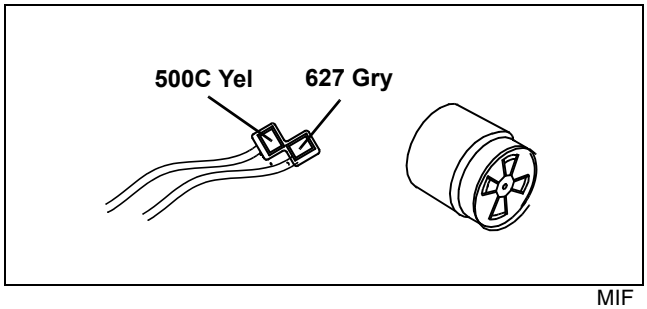
7. Diode pack connected. Master control module connector (MC17) connected. Cycle key switch between OFF and RUN positions. Instrument cluster (A2) LED test. Is hydraulic oil temperature LED (A) ON for approximately 5 seconds?

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 463.)

Buzzer Circuit

Test Conditions

- Engine oil pressure switch 620 Tan wire disconnected.
- Master control module connector (MC17) connected.
- Key switch in RUN position.
- Diode pack disconnected.
- Hydraulic oil temperature switch connector disconnected.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure voltage at buzzer (C5), 500C Yel wire. Is battery voltage present?

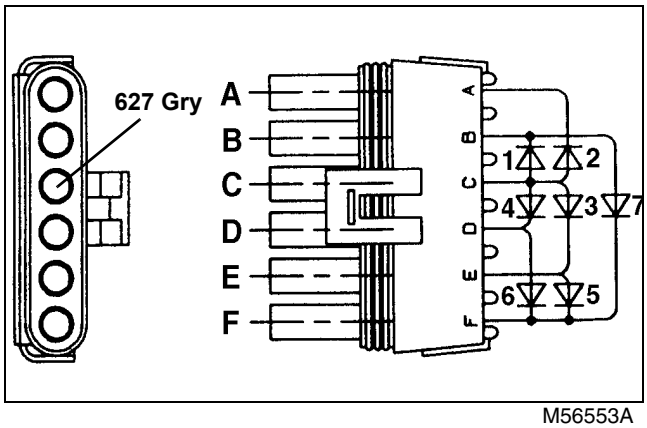
Yes: Go to next step.

No: Test 500C and 500A Yel wires and connections.

2. Measure voltage at buzzer (C5), 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Replace buzzer.

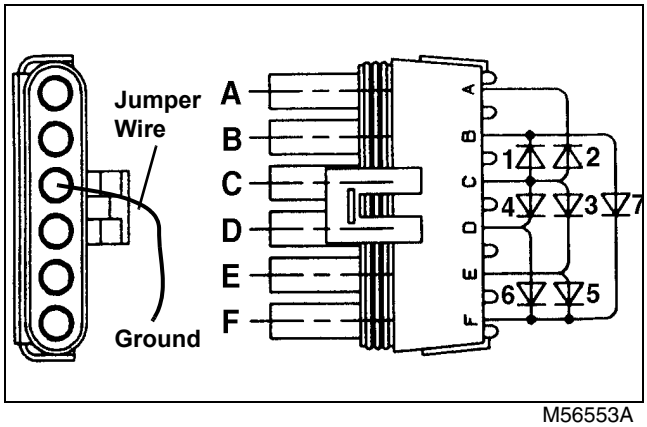


M56553A

3. Measure voltage at diode pack connector (C13), terminal C, 627 Gry wire. Is battery voltage present?

Yes: Go to next step.

No: Test 627 Gry wire.

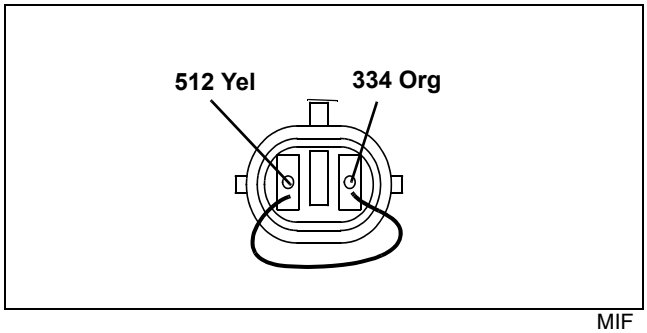


M56553A

4. With a jumper wire, connect diode pack connector (C13), terminal C, 627 Gry wire to ground. Test buzzer (C5). Is buzzer operating?

Yes: Go to next step.

No: Replace buzzer.



MIF

5. Diode pack connected. Jumper wire connected between terminals at hydraulic oil temperature switch connector (MC9), 334 Org wire and 512 Yel wire. Test buzzer (C5). Is buzzer operating?

Yes: Go to next step.

No: Test diode pack. (See “Diode Pack AMT386 Test” on page 463.)

6. Disconnect jumper wire from hydraulic oil temperature switch connector. Test buzzer (C5). Cycle key switch between OFF and RUN positions. Is buzzer operating for about 5 seconds?

No: Test diode pack (C13). (See “Diode Pack AMT386 Test” on page 463.)

Light Circuit Operation

Function

To provide power to the work lights and provide a means to turn them on and off.

Operating Conditions:

- Key switch in RUN position.
- Light switch in ON position.

Theory of Operation

Unswitched power is supplied to the light relay (K5) from the battery and is protected by a fusible link (F1). Current flows from the battery positive (+) terminal to starting motor (M1), 250 Red wire. From the starting motor, current flows to light relay, terminal 30, 240 and 240B Red wires, and 200 fusible link (F1).

With the key switch (C2) in the RUN position, switched power (See “Power Circuit Operation - Switched” on page 321) flows from key switch, terminal A, to light relay (K5), terminal 85, 500A, 500B, 503, 504A, and 504D Yel wires. Current flows from the coil, terminal 86, 191 Gry wire of the light relay to the light switch (C14), 191 and 190 Gry wires

When the light switch is in the ON position, current flows to ground, 120E and 120B Blk wires, energizing the light relay.

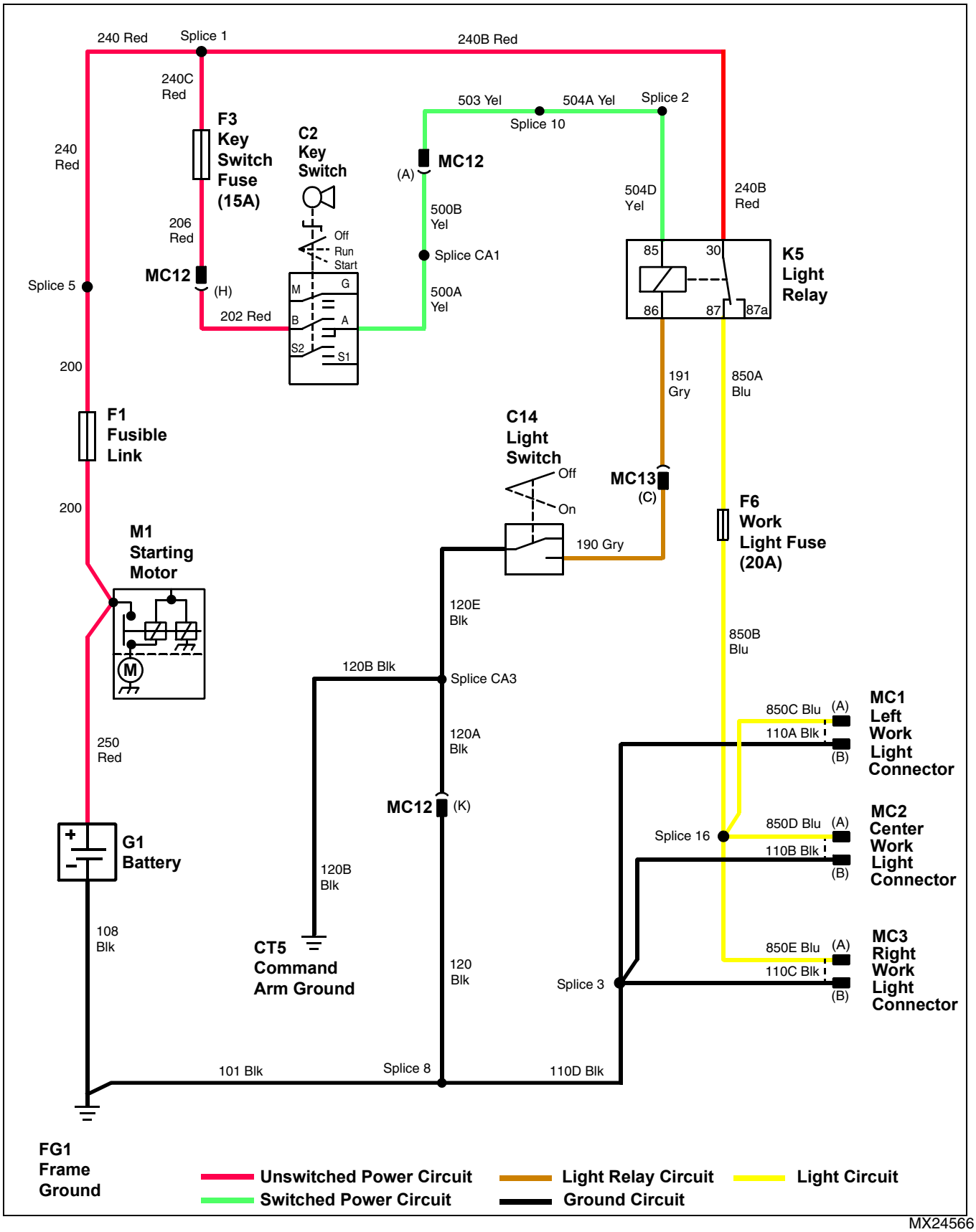
With the light relay energized, current flows to work light fuse (F6) on 850A Blu wire and through 850B Blu wire to the following:

- Right work light connector (MC3), 850E Blu wire.
- Center work light connector (MC2), 850D Blu wire.
- Left work light connector (MC1), 850C Blu wire.

Ground circuits are provided as follows:

- Right work light connector (MC3), 110C, 110D, and 101 Blk wires.
- Center work light connector (MC2), 110B, 110D, and 101 Blk wires.
- Left work light connector (MC1), 110A, 110D, and 101 Blk wires.

Light Circuit Schematic



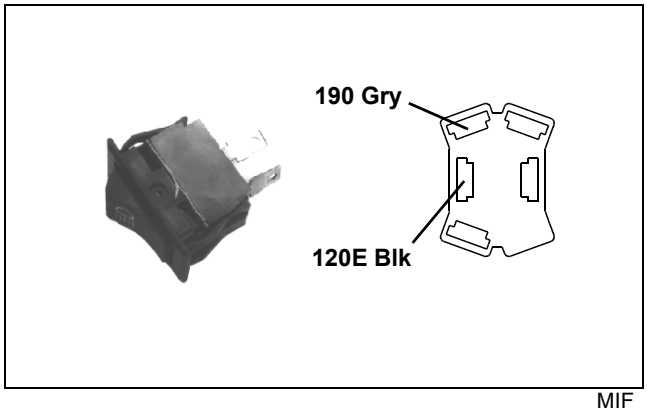
MX24566

System: Light Circuit Diagnosis

Light Circuit Test

Test Conditions

- Key switch in OFF position.
- Light switch in ON position.
- Meter negative (-) lead on battery negative (-) terminal or frame ground.
- Check connections for corrosion and looseness when testing.



MIF

1. Measure ground circuit for resistance at light switch connector (C14), 120E Blk wire. Is there less than 0.1 ohm of resistance

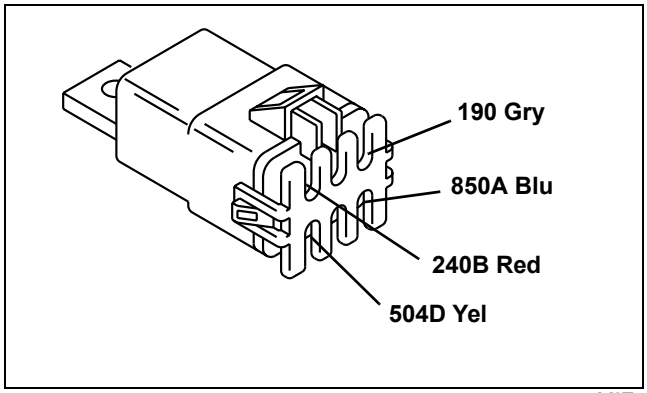
Yes: Go to next step.

No: Test 120E and 120B Blk wires and connections.

2. Measure ground circuit for resistance at light switch connector (C14), 190 Gry wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test light switch. (See “Headlight Switch Test (Optional)” on page 459.)



MIF

3. Measure ground circuit for resistance at light relay (K5), terminal 86, 190 Gry wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 191 and 190 Gry wires.

4. Measure voltage at light relay (K5), terminal 30, 240B Red wire. Is battery voltage present?

Yes: Go to next step.

No: Test 240B, 240, and 250 Red wires, 200 fusible link (F1), and connections.

5. Key switch in RUN position. Measure voltage at light relay (K5), terminal 85, 504D Yel wire. Is battery voltage present?

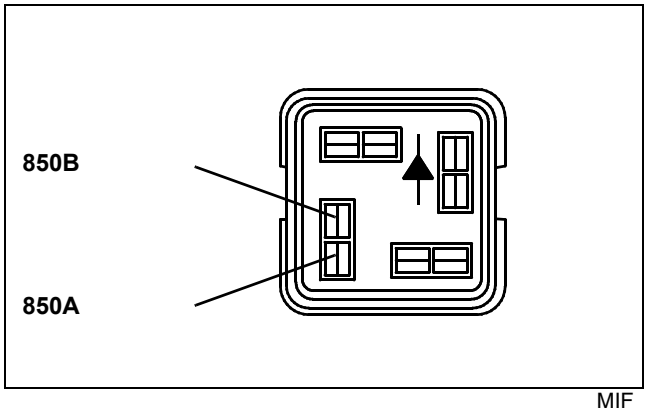
Yes: Go to next step.

No: Test 504D, 504A, 503, 500B, and 500A Yel wires and connections.

6. Measure voltage at light relay (K5), terminal 87, 850A Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test relay. (See “Relay Test” on page 452.)



MIF

7. Measure voltage at work light fuse (F6), 850A Blu wire. Is battery voltage present?

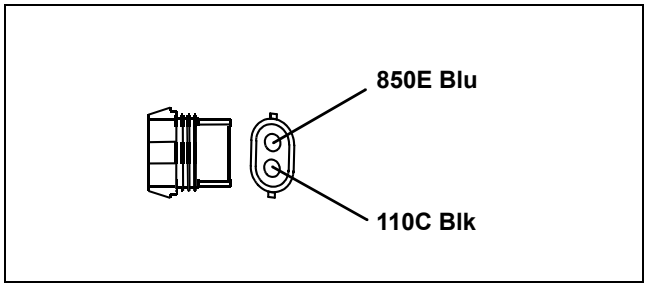
Yes: Go to next step.

No: Test 850A Blu wire and connections.

8. Measure voltage at work light fuse (F6), 850B Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test work light fuse (F6) and connections.



MIF

9. Measure voltage at right work light connector (MC3), 850E Blu wire. Is battery voltage present?

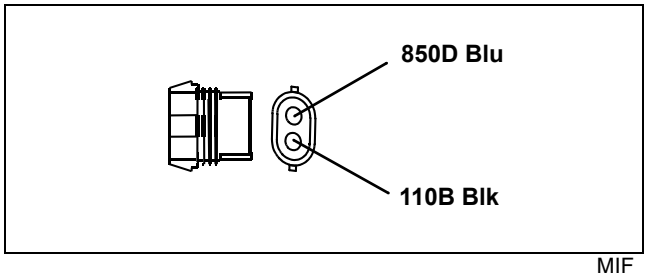
Yes: Go to next step.

No: Test 850E and 850B Blu wires and connections.

10. Measure ground circuit for resistance at right work light connector (MC3), 110C Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110C, 110D, and 101 Blk wires and connections.



MIF

11. Measure voltage at center work light connector (MC2), 850D Blu wire. Is battery voltage present?

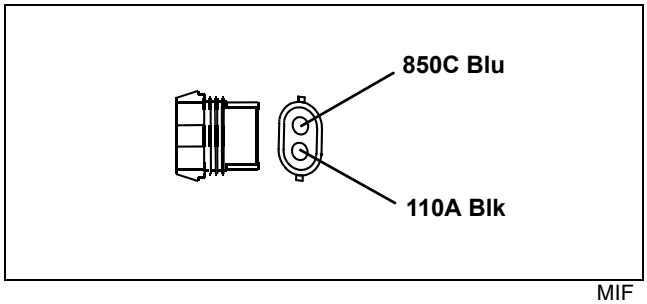
Yes: Go to next step.

No: Test 850D and 850B Blu wires and connections.

12. Measure ground circuit for resistance at center work light connector (MC2), 110B Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110B, 110D, and 101 Blk wires and connections.



MIF

13. Measure voltage at left work light connector (MC1), 850C Blu wire. Is battery voltage present?

Yes: Go to next step.

No: Test 850C and 850B Blu wires and connections.

14. Measure ground circuit for resistance at left work light connector (MC1), 110A Blk wire. Is there less than 0.1 ohm of resistance?

Yes: Go to next step.

No: Test 110A, 110D, and 101 Blk wires and connections.

Electronic Controllers

Data Bus Systems

The following electronic control units are equipped. These are:

- RMC - Reel Motor Controller (5)
- Master Control Module (not connected to CAN bus)

The RMC electronic control units are connected to each other via data Bus systems (CAN BUS [CAN = CONTROLLER AREA NETWORK]).

The data BUS system forms a communication network for data-sharing between controllers.

The lines that link up the elements of a data BUS system are known as communication lines.

CAN Bus Theory of Operation

The Controller Area Network (CAN-BUS) is used to allow communication between control units on a machine. When the key switch is turned on, the electronic control units start to send and receive information over the CAN-BUS. Information may also continue to be transmitted by some controllers for a short time after the key switch is turned off. Some of the information is broadcast more frequently than others, depending on what the data is and which controller is sending it.

The CAN bus has a terminating resistor after the last physical controller on each end of the bus. The terminating resistors are required to reduce faults in the communication lines.

Each control unit can send and receive digital messages via the CAN-BUS.

In order to regulate the information being transmitted, each electronic control unit has an interface controller built in. While the electronic control unit is fully occupied performing its own tasks, the interface controller manages the large amount of information being broadcast on the CAN-BUS and only passes required information onto the bus.

Diagnostic Trouble Codes (DTCs) are based on the CAN ISO and J1939 SAE Standards. These are worldwide standards for automotive and off-highway machines and are controlled by an ISO industry committee.

CAN Bus Message Structure

Basically, the electronic control units consist of two elements.

- The electronic control unit

- The interface controller

The electronic control unit is fully occupied with performing its tasks.

The interface controller manages the data that is broadcast and recalled via the CAN BUS [CAN = CONTROLLER AREA NETWORK] communication lines. The data it passes on to the electronic control unit is only the data that the control unit actually requires.

The electronic control units share their monitoring, operational and display data with each other by continually "broadcasting" it on the CAN BUS line.

In CAN BUS systems, addresses are allocated according to the importance of the data.

In order to transmit data on the CAN BUS system, a data frame is required. The data frame consists of seven fields that follow on one from the other.

- Start signal - Indicates the start of the data frame and synchronizes all the electronic control units.
- Assignment field - Consists of identifier and control bit. The identifier indicates the priority accorded to the data. During transmission of this field, the sender checks that it has the right to transmit, or if priority should be given to another electronic control unit. The control bit indicates whether the data is a question or an answer.
- Control field - Contains information on the size of the data in the data field.
- Data field - Contains the actual data.
- Cyclic redundancy check (CRC) field - To recognize any errors that may occur in transmission, this field contains a CRC code name; this code name must be known by every electronic control unit.
- Acknowledgement field - Contains the acceptance signals from data that have been received without error by the various electronic control units.
- End signal - Indicates the end of the frame.

The sender (electronic control unit) initiates a data transfer by sending a data frame. However, the receiver (electronic control unit) can also request data from the sender. To do this, the receiver issues a request. Question (request) and answer both have the same identifier. The only difference lies in the control bit.

An acceptance check is carried out within the electronic control units. This means that only data with an identifier

stored in a list is actually accepted by the control units. The code numbers that are otherwise required for data transmission are thus eliminated.

The identifier determines the priority with which the data is transmitted. Each electronic control unit can transmit its data, provided the CAN communication lines are free. If several want to transmit at the same time, the data sent first are the ones with the highest priority. The other electronic control units then go automatically to the "receive" mode and do not send their data until the CAN BUS communication lines are free.

If a malfunction is registered, the electronic control unit interrupts the current transmission. The electronic control units are capable of telling the difference between malfunctions that only occur occasionally and malfunctions that persist. This is achieved by making a statistical assessment of the error situation.

All the electronic control units send and receive data while the key switch is on, so the CAN communication lines are continually carrying "broadcast" data. Some is ”broadcast” more frequently than others, depending on what data it is.

Terminating resistors are located at the ends of the CAN-BUS communication lines. The terminating resistors are required to reduce faults in the communication lines.

CAN Network Voltage Checks

Note: These procedures should be followed in sequence until the problem is resolved.

Reason:

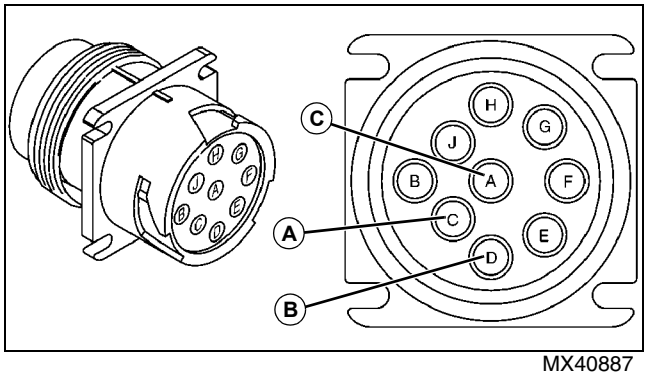
To check the CAN Hi(+) and CAN Lo(-) signals for proper voltage.

Equipment:

- Multimeter

Check for proper voltage:

1. Turn key to on position (engine off).



MX40887

2. Use a multimeter to measure CAN Hi (A) and CAN Lo (B) voltages at the Service ADVISOR diagnostic connector.
3. Correct readings (desired):
   - CAN Hi: 2.50 - 3.50 V
   - CAN Lo: 1.50 - 2.49 V
4. Incorrect readings:
   - One or both voltages above 5 V.
   - One or both voltages below 1 V.
   - CAN Hi and CAN Lo voltages are equal.
   - Voltages out of specification but between 1 - 5 V.

Ground Checks:

1. Turn key to off position.
2. Locate and remove one of the two passive terminators.
3. Check resistance to ground (C).
4. Resistance should be less than 1 ohm.

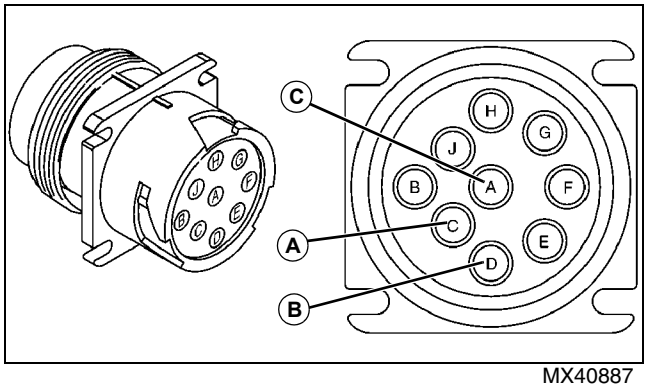
Check for Short Circuits to CAN Hi and CAN Lo:

1. This check should only be performed if the previous checks of CAN Hi and CAN Lo indicated:
   - Voltage at or near battery voltage.
   - Voltage above 5 volts and ground checks OK.

- Voltage below 1 volt.
- Voltages of CAN Hi and CAN Lo were equal.

2. Verify all connectors and terminators are connected.

3. Turn key switch to RUN position (engine OFF).



MX40887

4. Use a multimeter to measure CAN Hi (A) and CAN Lo (B) voltages at the Service ADVISOR diagnostic connector, from CAN ground (C) to CAN Hi and CAN Lo. Record values.

5. Remove one of the two CAN passive terminators.

6. Check for a change in voltage on CAN Hi and CAN Lo from value recorded. If voltage changed, terminator is bad, replace passive terminator.

7. Repeat procedure for the other terminator.

Note: Voltage higher than 5 V on either CAN Hi or CAN Lo indicates a short to high voltage. Voltage lower than 1 V indicates a short to ground. If CAN Hi and CAN Lo are equal, they could be shorted together.

Compare CAN Hi and CAN Lo Voltages:

Note: The CAN bias voltage is 2.5 V. To evaluate the CAN Hi and CAN Lo circuits, the voltage recorded for each must be calculated in reference to this bias.

1. To calculate CAN voltage bias differential where A=CAN Hi voltage and where Y=CAN Lo voltage and:

- CAN Hi: Recorded voltage - 2.5V=A
- CAN Lo: 2.5V - Recorded voltage=B

2. Compare results from CAN Hi and CAN Lo calculations. Values must be within 35% of each other. Use the following table to evaluate:

CAN Hi Result (A)	CAN Lo Result (B)
0.1V	0.06 - 0.14
0.2V	0.13 - 0.27
0.3V	0.21 - 0.4
0.4V	0.26 - 0.54
0.5V	0.33 - 0.67
0.6V	0.39 - 0.81
0.7V	0.46 - 0.94
0.8V	0.52 - 1.0
0.9V	0.59 - 1.0
1.0V	0.65 - 1.0

3. If results are within acceptable limits according to table:

- CAN differential voltage is OK.

4. If results are not within acceptable limits according to table:

- CAN Hi result approximately 2X CAN Lo result. Loss of CAN Lo between controller and passive terminator.
- CAN Lo result approximately 2X CAN Hi result. Loss of CAN Hi between controller and passive terminator.

Voltages Within Range but Out of Specification:

Perform the following until voltages are within specification:

1. Check voltages at Service ADVISOR diagnostic connector after each of the next steps. (Turn key switch to the OFF position when removing fuses or disconnecting control units, and to the RUN position (engine OFF) when measuring voltages.)

- One at a time, remove fuse or connector supplying power to each control unit and repeat voltage checks.
- One at a time, disconnect all connectors at each control unit and repeat voltage checks.
- Results:

❏ If removing fuse to any control unit causes voltage to come within specification, check CAN Hi and CAN Lo, power and ground circuits to control unit. Replace control unit if circuits check OK.
If removing fuse did not cause voltage to return to normal but disconnecting control unit resulted in voltage within specification, replace control unit.

2. Replace or test passive terminators.

3. With key switch off and terminators removed, perform continuity checks on all CAN bus circuits. See CAN Bus Topology diagrams for machine's configuration.

Troubleshooting Electronic Controllers

Note: This reference is a guideline for troubleshooting problems that still exist after standard diagnostics have been performed. These problems are typically due to specific operating conditions, intermittent failures or, in rare cases, control unit failures. Depending on the situation, some or all of the following may be important.

Problems Due to Specific Operating Conditions:

Review all recorded codes and consult with operator to determine operating and machine conditions when the problem occurs. Record details.

- Does code/problem occur at the same time as other problems?
- Does code/problem occur when machine is warm or cold?
- Does code/problem occur during field or transport operation?
- Does code/problem occur while performing a specific action?
- When did code/problem first appear? Was there any maintenance performed recently? (If yes, inspect areas of maintenance for inadvertent damage or improper installations.)

Attempt to recreate code/problem based on conditions. If possible, repeat operational, system, electrical or mechanical checks under these conditions.

Problems Due to Intermittent Electrical Failures:

Note: Electrical intermittent failures are usually caused by harness, terminal or connector problems.

- Inspect all connectors and terminals of related circuits.
- Inspect mechanical linkages for interference with harnesses or connectors.
- Inspect harnesses for missing or improperly installed clamps or bands. Loose harnesses that are allowed to move too freely or harnesses that are banded too tightly may result in worn or damaged wires.
- Inspect mechanical linkages for proper operating condition.

Problems Due to Control Unit Failures:

Note: Before replacing control unit, review all tests. Control units are the least likely cause of failure!

- If all checks have been made with no problems identified, check power and ground circuits. Power inputs must be within 1 V of battery voltage and ground circuits must be less than 1.0 ohm to the machine single point ground.
- Inspect all connectors and terminals of associated control units.

Accessing Addresses and Diagnostic Trouble Codes

Diagnostic Trouble Codes (DTCs)

DTCs are CAN bus system codes that are created by the controller and stored in the controller memory. They are non-volatile codes that can be recalled and displayed using Service ADVISOR software. The Service ADVISOR software can used used to clear DTCs from the controller memory.

Fault Codes (LED Display Blink Codes)

Fault codes are created by the controller and sent as an output to an LED as a visual representation of faults.

Each fault code driven blink code may represent several different DTCs.

Fault codes are displayed at the time that they occur and are also stored in the controller memory. Fault codes can be recalled, reviewed and erased at a later time. See “Instrument Cluster Diagnostic Indicators” on page 281, or “Reading Reel Controller Fault Codes (Onboard Controller Blink Code Display)” on page 412 for this procedure.

Accessing Codes

Every control unit monitors certain electrical circuits within the network of circuits for which it is responsible. The unit then stores the relevant diagnostic trouble code if there is a malfunction (error) or if the operator makes a mistake. However, not all of the diagnostic trouble codes indicate a current problem, since most of the circuits are monitored only at the actual moment of activation or when they are actually activated (switched on). To make sure that the diagnostic trouble code you are troubleshooting is ”active”, you should proceed as follows:

1. **General procedure for dealing with diagnostic fault codes:**
   - Access the diagnostic fault codes See “Reading Reel Controller Fault Codes (Onboard Controller Blink Code Display)” on page 412.
   - Note and clear the code(s)
   - Carry out an operational test (activate the circuit affected) or test drive the machine
   - Switch off ignition and turn it on again after five seconds (re-initiate the control units)
   - Access the diagnostic fault codes again and process them
   - If it is not possible to (re-)produce a relevant diagnostic fault code by means of a functional check and

the problem is still present in the circuit, deal with the codes you noted earlier.

2. **Procedure for dealing with diagnostic trouble codes using Service ADVISOR:**

- Access diagnostic trouble codes via the ”Diagnostic” tab
- ”Active” diagnostic trouble codes take priority
- If no "ACTIVE" diagnostic trouble codes are present:

❑ Perform and the save the results of a Snapshot Test under the Interactive Test tab

❑ Delete diagnostic trouble code(s)

❑ Carry out an operational test (activate the circuit affected) or test drive the machine

❑ Switch off ignition and turn it on again after five seconds (re-initiate the control units)

❑ If no active diagnostic trouble codes are present, deal with the ”SAVED” codes

❑ If it is not possible to (re-)produce a relevant diagnostic trouble code by means of a functional check or test-drive, and the circuit problem persists, the cleared diagnostic trouble codes must be checked; if the codes are associated with the problem on the machine, they must be processed.

Note: Cleared diagnostic trouble codes should only be dealt with if it is not possible to (re-)produce the problem on the machine (no active or saved codes are present after a functional test/test drive has been carried out) and when the description of diagnostic trouble code can be associated with the machine problem.

3. **Processing cleared diagnostic trouble codes using Service ADVISOR:**

- Every time a diagnostic trouble code is accessed, it is saved in Service ADVISOR in the ”Readings Logs” of the job that is being processed. Before it is cleared, the diagnostic trouble code status of the machine can be accessed via the ”Sessions” menu or ”Logs”. A Snapshot Test should always be performed before clearing codes.

4. **Status of diagnostic trouble codes in Service ADVISOR:**

- Status: ”ACTIVE” (priority I):

❑ Diagnostic trouble code cannot be cleared.

❑ Current problem with the machine.

- Status: ”SAVED” (priority 2):

❑ Diagnostic trouble code can be cleared

❑ At present the problem is not recognized by the control unit (example: faulty solenoid valve, switch or circuit not activated at the moment).

Approved Software for Control Units

Important: Avoid Damage! When reprogramming electronic control units, always comply with the relevant instructions (e.g. installation instructions, DTAC or PIP).

Do NOT reprogram the control unit if the version numbers of the new and current software are identical, or if the control unit is already programmed with a newer software version.

Note: New software always includes the properties that were newly introduced with the previous software. However, not all software versions can be used on every machine.

Note: The software for reprogramming is either supplied with the Service ADVISOR data DVD, or else it must be downloaded from John Deere's Intranet (**John Deere Custom Performance** (Software Delivery System)).

For the current summary of software, see PATHWAYS or DTAC.

All identical controllers on the machine should be running the same software version.

RMC and Motor Diagnostics

Electronic Controllers Theory of Operation

Controllers Onboard Machine:

- A1 Master Control Module - Controls safety interlock functions, displays safety and mechanical related error codes.
- RMC1, RMC2, RMC3, RMC5, and RMC6 Reel Motor Controllers - Control the reel motor functions, monitor for faults, and drive reel and motor related error codes.

Master Control Module:

The electronic control module features input LEDs, output LEDs, and a status LED (known as the “heartbeat” LED) to aid in electrical circuit diagnosis.

The input LEDs will light whenever a function switch has been activated. This will indicate that the input circuit is functioning properly.

The output LEDs, when lit, indicate that the control module circuitry for that particular function is operating properly, and that a controlled ground is available for that circuit at the control module output terminal.

If all circuits are OK, the status LED will flash at a steady rate called the heartbeat. The heartbeat pattern is 130 milliseconds ON and 830 milliseconds OFF.

If the controller generates an error code, the status LED will flash an error code. If there are multiple codes, up to four codes will be displayed, with a long pause between each subsequent code. The series of codes will then repeat.

The flash pattern is 280 milliseconds ON and 280 milliseconds OFF for a given digit. There is a 1-second OFF delay between digits and a 2-second OFF delay before the code is repeated.

Fault codes are stored in the controller memory and can be recalled, reviewed and erased at a later time. See “E-Cut Hybrid LED Fault Review Mode” on page 282 for the procedure to manually recall the LED fault blink codes.

The master control module will also send each reel controller an “enable” signal if safe operating conditions are met. This will allow the reel controllers to function.

Note: The A1 master control module is not connected to the CAN bus.

- For diagnostic codes caused by the operator, see “Safety Interlock Fault Codes” on page 408.
- For diagnostic codes most likely caused by a system malfunction on an input circuit, see “Electronic Control Module Input Circuits Fault Codes” on page 408.
- For diagnostic codes most likely caused by a system malfunction on an output circuit, see “Electronic Control Module Output Circuits Fault Codes” on page 409.

Safety Interlock Fault Codes

The Sit On Seat (SOS) diagnostic feature alerts the operator when an attempt is made to start the machine when one or more safety interlock switches are not in the correct position for starting.

The following diagnostic fault codes are displayed by the flashing of the status LED on the electronic control module.

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

- **Code 1-2** (One pulse followed by a short pause followed by two pulses.) Indicates that the park brake switch is not activated during an attempted start.
- **Code 1-3** (One pulse followed by a short pause followed by three pulses.) Indicates that the mow-transport switch is in the MOW position during an attempted start.
- **Code 2-1** (Two pulses followed by a short pause followed by one pulse.) Indicates forward/reverse pedals are not in the NEUTRAL position during an attempted start.
- **Code 2-2** (Two pulses followed by a short pause followed by two pulses.) Indicates that hydraulic oil is in an over-temperature condition.
- **Code 2-3** (Two pulses followed by a short pause followed by three pulses.) Indicates that the hood switch is not activated (European machines) or jumper wire is missing from hood switch connector (North American machines). No instrument LEDs ON and no hour meter.

Electronic Control Module Input Circuits Fault Codes

Note: The code will cycle continuously with a 2-second pause between display cycles.

Only one code can be displayed at a time. Repeat check procedure after repairs have been completed.

- **Code 3-1** (Three pulses followed by a short pause followed by one pulse.) Indicates an over-voltage condition (voltage input to control box over 18 volts). This could also be caused by attempting to jump-start the machine with a 24-volt power source.
- **Code 3-5** (Three pulses followed by a short pause followed by five pulses.) Indicates control module is missing ground connection.
- **Code 3-6** (Three pulses followed by a short pause followed by six pulses.) Indicates control module is missing supply voltage.

- **Code 3-7** (Three pulses followed by a short pause followed by seven pulses.) Indicates control module has an internal over-temperature condition.

- **Code 9-1** (Nine pulses followed by a short pause followed by one pulse.) Indicates there was wrong software selected.

Electronic Control Module Output Circuits Fault Codes

- **Code 4-1** (Four pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning 4WD bypass solenoid circuit.

- **Code 4-2** (Four pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning start relay circuit.

- **Code 4-4** (Four pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning air preheater LED circuit.

- **Code 4-5** (Four pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel hold-in coil circuit.

- **Code 4-7** (Four pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning cruise control magnet circuit.

- **Code 5-1** (Five pulses followed by a short pause followed by one pulse.) Indicates a malfunctioning fuel pump circuit.

- **Code 5-2** (Five pulses followed by a short pause followed by two pulses.) Indicates a malfunctioning lamp check circuit.

- **Code 5-3** (Five pulses followed by a short pause followed by three pulses.) Indicates a malfunctioning hydraulic temperature LED circuit.

- **Code 5-4** (Five pulses followed by a short pause followed by four pulses.) Indicates a malfunctioning mow-transport solenoid circuit.

- **Code 5-5** (Five pulses followed by a short pause followed by five pulses.) Indicates a malfunctioning fuel pull-in coil circuit.

- **Code 5-6** (Five pulses followed by a short pause followed by six pulses.) Indicates a malfunctioning lower solenoid circuit.

- **Code 5-7** (Five pulses followed by a short pause followed by seven pulses.) Indicates a malfunctioning raise solenoid circuit.

- **Code 5-8** (Five pulses followed by a short pause followed by eight pulses.) Indicates a malfunctioning air preheater circuit.

Reel Motor Controllers:

The reel motor controllers control all aspects of reel motor functionality when provided with an “enable” signal from the A1 master control module. The controllers are capable of monitoring many operating conditions and sending DTCs to the diagnostic indicator lights located on the command arm. See “Reading Reel Controller Fault Codes (Onboard Controller Blink Code Display)” on page 412 for reading procedure.

The reel motor controllers use the CAN bus system to communicate with each other and supply Service ADVISOR with readings and diagnostic information. The CAN bus is not connected to the A1 master control module.

For CAN communications, the controllers get their addressing via hard wiring on the wiring harness. Each controller has up to three addressing wires. If a controller is replaced or moved, it will assume the old controller’s address. The address is a three bit binary number, based on the presence (binary 0) or absence (binary 1) of address wires, which is converted to its decimal equivalent when viewed in Service ADVISOR. The addressing scheme is not sequential. Some addresses will be skipped when viewed in Service ADVISOR.

Unlike the A1 master control module, the reel motor controllers have the ability to store some DTCs/Fault codes for later retrieval for troubleshooting purposes.

When no DTCs/Fault codes are active, all five controllers will be functioning identically. If a controller has an active DTC/Fault code, it may shut down or function independently from the other controllers.

With the machine turned on, control units are constantly broadcasting messages (data) at the rate of at least 80 per second on the CAN bus for proper machine operation and Service ADVISOR connectivity.

Reel Motor Theory of Operation

Overview:

The machine has 5 electric reel motors, each controlled by an individual reel motor controller (RMC). The motors have various sensors to provide feedback to the controllers for command, safety, and diagnostic functions.

Theory of Operation:

The motor is a brushless DC, three phase, bidirectional type. All aspects of the motor's functionality is controlled by the RMC, and to some extent, the master control module (commonly known as the "white box").

When conditions are correct for motor operation, three phase, pulse width modulated, current at 48Vdc will be supplied to each motor in a staggered fashion (to prevent power supply overload). All motors will then spin at a nominal 2800 rpm (±10%). The motor's normal ambient operating temperature is -20°C to +40°C (-4°F to 104°F).

As the motor spins, three internal Hall effect sensors provide the controller with speed, stalling, and direction of spin information.

The motor also has a thermal protection circuit. This is a normally closed switch when operating conditions are met. If the motor experiences an internal overtemp condition (140±5°C [284±11°F}), the switch will open and the RMC will derate the motor until it cools.

As the motor sends sensor information back to the RMC, the controller broadcasts this information on the CAN bus. This will consist of either motor operational parameters or as diagnostic trouble codes. This information can be read using Service ADVISOR.

The white box can pass operator initiated motor command information to the RMC, which will in turn, sends control information to the motor. These commands concern trim speed and motor spin direction.

Reel Motor Controller Signals

Note: Connector numbers on the controller side may not match the connector number on the main harness side. Use location key in tables as a guide.

Note: The lower case 'x' represents a variable, depending upon the reel controller location on the machine.

Replace "x" with:	Controller Location
1	Front Left
2	Rear Left
3	Front Center
5	Front Right
6	Right Rear

CAN:

Note: Not all addressing wires may be used. See "Electronic Controllers Theory of Operation" on page 408.

- CAN-Cx, pin A - Not used
- CAN-Cx Pur, pin B - Controller address LSB (Gnd)
- CAN-Cx Wht, pin C - Controller address (Gnd)
- CAN-Cx, pin D - Not used
- CAN-Cx Red, pin E - 12Vdc in
- CAN-Cx, pin F - Not used
- CAN-Cx Yel, pin G- CAN Hi
- CAN-Cx Grn, pin H - CAN Lo
- CAN-Cx, pin J - Not Used
- CAN-Cx Blu, pin K - Controller address MSB (Gnd)

Motor Control:

- MC3x Grn, pin A - Controller 'Enable' input from White Box. (0Vdc to enable)
- MC3x Blk, pin B - Gnd
- MC3x Wht, pin C - Speed potentiometer in, 4.3Vdc to 0Vdc
- MC3x Red, pin D - Speed potentiometer supply, 4.3Vdc
- MC3x Brn, pin E - Reel direction (0Vdc= FWD, 4.3Vdc= REV)
- MC3x Grn, pin F - Fault out to indicator lights (reel blink code)

Motor Sensors:

- MC-6x Blk, pin A - Sensor Return Input
- MC-6x Red, pin B - 12Vdc Sensor Power Output
- MC-6x Blu, pin C - Thermal Shutdown Input
- MC-6x Brn, pin D - Hall C-A Input
- MC-6x Wht, pin E - Hall B-C Input
- MC-6x Grn, pin F - Hall A-B Input

Reel Motor Power:

- MC-4x Org, pin A - Phase A Output
- MC-4x Blk, pin B - Phase B Output
- MC-4x Grn, pin C - Phase C Output

Controller Power:

Note: "F" connector prefix designates a front controller and "R" designates a rear controller.

Note: The lower case 'y' represents a variable, depending upon the reel controller location on the machine.

Replace "y" with:	Controller Location
R	Right
C	Center
L	Left

- Fy48 or Ry48, Red, pin A - 48Vdc Input
- Fy48 or Ry48, Blk, pin B - 48Vdc Gnd

Reel Motor Signals

Note: The lower case 'x' represents a variable, depending upon the reel motor location on the machine.

Replace "x" with:	Controller Location
1	Front Left
2	Rear Left
3	Front Center
5	Front Right
6	Right Rear

Sensors:

- MC-6x Blk, pin A - Sensor Return Output
- MC-6x Red, pin B - 12Vdc Sensor Power Input
- MC-6x Blu, pin C - Thermal Shutdown Output
- MC-6x Org, pin D - Hall C-A Output
- MC-6x Wht, pin E - Hall B-C Output
- MC-6x Grn, pin F - Hall A-B Output

Reel Motor Power:

- MC-4x Org, pin A - Phase A Input
- MC-4x Blk, pin B - Phase B Input
- MC-4x Grn, pin C - Phase C Input

Reel Motor Safety Interlock Operating Conditions

Note: This table shows the various interlock states for reel operation.

Raise-Lower Lever to LOWER	Park Brake Pedal Depressed	Mow-Transport Lever in MOW Position	Directional Pedals NOT Depressed	Operator on Seat	Backlap Switch ON	Hood Switch Jumper in Place	Hydraulic Temp Warning OFF
X		X		X		X	X
X	X	X			X	X	X

Reading Reel Controller Fault Codes (Onboard Controller Blink Code Display)

If there is an active fault code, the affected reel indicator will flash it's respective indicator. This will be a series of flashing lights followed by a pause and another series of flashing lights.

In the event of multiple reels having simultaneous codes, all other indictor lights will have to be covered up and only one reel's fault code will have to be observed. After this code is recorded, cover up the previous indicator and observe and record the next. Repeat this for all controllers indicating a trouble code.

In the event that a reel has multiple DTCs, the codes will flash in sequence separated by a brief pause. They will repeat until cleared.

Retrieving Stored Codes:

In order to retrieve stored codes through the control module, place the key switch in the on position. Within three minutes, cycle the reel forward/reverse switch twice. Observe and record codes.

To clear a code, turn the speed potentiometer to the opposite extreme from where it is and then back to the other extreme.

Fault Codes and DTC Relationship (Display Panel)

The display panel (Blink codes) will display a fault code corresponding to a DTC error to inform the operator of a problem. This code will corollate to the RMC error, but will not reveal the specific type of failure (i.e. - will reveal what component that is having trouble, but not necessarily what the specific problem is). See "Reading Reel Controller Fault Codes (Onboard Controller Blink Code Display)" on page 412 for more information.

Error Codes Table

Note: Some Blink Codes have multiple RMC codes associated with them. These Blink Codes are:

- ***1-7***
- ***2-5***
- ***7-2***
- ***7-3***
- ***7-4***
- ***7-5***
- ***9-3***
- ***9-5***
- ***9-7***

Diagnostic Trouble Code (DTC)	Fault Blink Code	PTO Cycle Enable	Shutdown Required	Fault Description	Possible Cause/Solution
RMC_00628.12 See "RMC_000628.12 (Blink Code SOLID ON) - Stuck in Boot Block" on page 419	SOLID ON	false	false	STUCK IN BOOT BLOCK	Install latest payload into controller
RMC_2513.03 See "RMC_002513.03 (Blink Code 7-3) - Orange Phase (A) is Shorted to Supply" on page 419	{7 - 3}	false	true	PHASE A SHORT TO SUPPLY (PHASE HIGH)	Inspect high current wires to motor.
RMC_2513.4 See "RMC_002513.04 (Blink Code 7-2) - Orange Phase (A) is Shorted to Ground" on page 420	{7 - 2}	false	true	PHASE A SHORT TO GND (PHASE LOW)	Most likely short in high-amperage phase wire. Inspect for damage.
RMC_2513.5 See "RMC_002513.05 (Blink Code 7-4) - Orange Phase (A) is Open" on page 420	{7 - 4}	false	true	PHASE A OPEN	Open high-amperage wire. Check harness and connector.
RMC_2514.3 See "RMC_002514.03 (Blink Code 7-3) - Black Phase (B) is Shorted to Supply" on page 421	{7 - 3}	false	true	PHASE B SHORT TO SUPPLY (PHASE HIGH)	Inspect high current wires to motor.

Diagnostic Trouble Code (DTC)	Fault Blink Code	PTO Cycle Enable	Shutdown Required	Fault Description	Possible Cause/Solution
RMC_2514.4 See “RMC_002514.04 (Blink Code 7-2) - Black Phase (B) is Shorted to Ground” on page 422	{7 - 2}	false	true	PHASE B SHORT TO GND (PHASE LOW)	Most likely short in high-amperage phase wire. Inspect for damage.
RMC_2514.5 See “RMC_002514.05 (Blink Code 7-4) - Black Phase (B) is Open” on page 422	{7 - 4}	false	true	PHASE B OPEN	Open high-amperage wire. Check harness and connector.
RMC_2515.3 See “RMC_002515.03 (Blink Code 7-3) - Green Phase (C) is Shorted to Supply” on page 423	{7 - 3}	false	true	PHASE C SHORT TO SUPPLY (PHASE HIGH)	Inspect high current wires to motor.
RMC_2515.4 See “RMC_002515.04 (Blink Code 7-2) - Green Phase (C) is Shorted to Ground” on page 424	{7 - 2}	false	true	PHASE C SHORT TO GND (PHASE LOW)	Most likely short in high-amperage phase wire. Inspect for damage.
RMC_2515.5 See “RMC_002515.05 (Blink Code 7-4) - Green Phase (C) is Open” on page 424	{7 - 4}	false	true	PHASE C OPEN	Open high-amperage wire. Check harness and connector.
RMC_3509.0 See “RMC_003509.00 (Blink Code 7-5) - Pot Signal Voltage High” on page 425	{7 - 5}	true	true	HIGH FAULT POT	Indicates speed potentiometer wire is shorted to battery or the sensor return wire is open.
RMC_3509.1 See “RMC_003509.01 (Blink Code 7-5) - Pot Signal Voltage Low” on page 426	{7 - 5}	true	true	LOW FAULT POT	Indicates speed potentiometer wire is shorted to ground or sensor return or the pot supply is open.
RMC_3510.0 See “RMC_003510.00 (Blink Code 9-7) - Pot Supply Voltage High” on page 426	{9 - 7}	true	true	HIGH FAULT POT SUPPLY	Poor connection or bad connection between controller and potentiometer, or potentiometer malfunction.
RMC_3510.1 See “RMC_003510.01 (Blink Code 9-7) - Pot Supply Voltage Low” on page 427	{9 - 7}	true	true	LOW FAULT POT SUPPLY	Poor connection or bad connection between controller and potentiometer, or potentiometer malfunction.

Diagnostic Trouble Code (DTC)	Fault Blink Code	PTO Cycle Enable	Shutdown Required	Fault Description	Possible Cause/Solution
RMC_3511.0 “See “RMC_003511.00 (Blink Code 9-5) - Hall Voltage High” on page 428	{9 - 5}	true	true	HIGH FAULT HALL PWR	9-5 Blink Code: Motor control sensor wire voltage is High. Signal wires shorted to external power line. Inspect connector and wires. Possible internal controller regulator failure. Disconnect motor and inspect sense wire output from control.
RMC_3511.1 See “RMC_003511.01 (Blink Code 9-5) - Hall Voltage Low” on page 428	{9 - 5}	true	true	LOW FAULT HALL PWR	9-5 Blink Code: Motor control sensor wire voltage is Low. Signal wires shorted to Ground. Inspect connector and wires. Possible internal controller regulator failure. Disconnect motor and inspect sense wire output from control.
RMC_3597.0 See “RMC_003597.00 (Blink Code 9-3) - Controller 14V High” on page 429	{9 - 3}	true	true	HIGH FAULT 14V	Connections/Controller
RMC_3597.1 See “RMC_003597.01 (Blink Code 9-3) - Controller 14V Low” on page 430	{9 - 3}	true	true	LOW FAULT 14V	Connections/Controller
RMC_521153.0See “RMC_521153.00 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.” on page 430	NONE	false	false	System reaction monitor, not a fault. Used for internal data collection.	Manufacturer Service Code
RMC_521153.15See “RMC_521153.15 (Blink Code 2-9) - Controller Shutdown Over Temp” on page 431	{2 - 9}	true	true	CONTROLLER OVER TEMP	2-9 Blink Code: Internal controller temperature resulted in controller shutting down motor. Likely heavy load on motor/ controller combined with high ambient temperature. If controller is cool to touch and fault does not clear then suspect controller.

Diagnostic Trouble Code (DTC)	Fault Blink Code	PTO Cycle Enable	Shutdown Required	Fault Description	Possible Cause/Solution
RMC_522327.0See “RMC_522327.00 (Blink Code 2-10) - Motor Over Temp” on page 431	{2 - 10}	true	true	MOTOR OVER TEMP	2-10 Blink Code: Internal motor temperature resulted in controller shutting down motor. Likely heavy load on motor/ controller. If happens with 6-1 invalid start position then connector is off. Let motor cool and if signal does not clear then check motor wires for damage. Do continuity check of internal motor temperature switch.
RMC_522917.0See “RMC_522917.00 (Blink Code 2-5) - Controller Current Threshold 3 Shutdown” on page 432	{2 - 5}	true	true	OVER CURRENT3	2-5 Blink Code: Motor current over the limit. Likely cause is excessive load. Check for jammed reels; Check reel to bedknife clearance; Monitor current into controller. Check for jammed reels or failed bearings;
RMC_522917.6See “RMC_522917.06 (Blink Code 2-8) - Controller Hardware Current Shutdown” on page 433	{2 - 8}	true	true	HARDWARE OVERCURRENT	2-5 Blink Code: Motor current over the limit. Likely cause is excessive load. Check for jammed reels; Check reel to bedknife clearance; Monitor current into controller. Check for jammed reels or failed bearings;
RMC_522917.15See “RMC_522917.15 (Blink Code 2-5) - Controller Current Threshold 1 Shutdown” on page 434	{2 - 5}	true	false	OVER CURRENT1	2-5 Blink Code: Motor current over the limit. Likely cause is excessive load. Check for jammed reels; Check reel to bedknife clearance; Monitor current into controller. Check for jammed reels or failed bearings;
RMC_522917.16See “RMC_522917.16 (Blink Code 2-5) - Controller Current Threshold 2 Shutdown” on page 435	{2 - 5}	true	false	OVER CURRENT2	2-5 Blink Code: Motor current over the limit. Likely cause is excessive load. Check for jammed reels; Check reel to bedknife clearance; Monitor current into controller. Check for jammed reels or failed bearings;
RMC_522918.0See “RMC_522918.00 (Blink Code 1-5) - Motor Start Failed 3x Fault” on page 436	{1 - 5}	false	false	START FAILED	1-5 Blink Code: Motor failed to start. Likely mechanical obstruction in reel. Likely cause is excessive load. Check for jammed reels; Check reel to bedknife clearance; Monitor current into controller. Check for jammed reels or failed bearings;

Diagnostic Trouble Code (DTC)	Fault Blink Code	PTO Cycle Enable	Shutdown Required	Fault Description	Possible Cause/Solution
RMC_522918.2See “RMC_522918.02 (Blink Code 1-10) - Motor Spin Direction Shutdown” on page 437	{1 - 10}	true	false	DIR ERROR3	1-10 Blink Code: Reel direction reversed for 1/4 turn of motor. Hit obstacle or attachment issue. Check reel, bedknife, attachment for damage.
RMC_522918.15See “RMC_522918.15 (Blink Code 1-6) - Motor Stalled While Running” on page 437	{1 - 6}	true	false	MOTOR STALLED	1-6 Blink Code: Motor stalled while running. Reel obstructed while turning. Likely cause is excessive load. Check for jammed reels; Check reel to bedknife clearance; Monitor current into controller. Check for jammed reels or failed bearings;
RMC_522919.2See “RMC_522919.02 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.” on page 438	NONE	false	false	System reaction monitor, not a fault. Used for internal data collection.	Manufacturer Service Code
RMC_522919.3See “RMC_522919.03 (Blink Code 6-6) - Hall Resync Shutdown” on page 438	{6 - 6}	true	false	HALL RESYNC ERROR	6-3 Blink Code: Motor position sensor error while running; If accompanied multiple stalls or motor hot likely due to heavy load. Check for contamination in connectors; bent pin; broken wiring, failed internal motor sensor.
RMC_522919.4See “RMC_522919.04 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.” on page 439	NONE	false	false	System reaction monitor, not a fault. Used for internal data collection.	Manufacturer Service Code
RMC_522919.8See “RMC_522919.08 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.” on page 439	NONE	false	false	System reaction monitor, not a fault. Used for internal data collection.	Manufacturer Service Code

Diagnostic Trouble Code (DTC)	Fault Blink Code	PTO Cycle Enable	Shutdown Required	Fault Description	Possible Cause/Solution
RMC_522919.9See “RMC_522919.09 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.” on page 439	NONE	false	false	System reaction monitor, not a fault. Used for internal data collection.	Manufacturer Service Code
RMC_522919.12See “RMC_522919.12 (Blink Code 6-4) - Invalid Hall State Detected at Start-Up” on page 439	{6 - 4}	false	true	START POSITION INVALID	6-1 Blink Code: Motor position sensor error at start. When motor not running there is an invalid hall pattern. If occurs with 2-10 motor temperature fault, most likely is that connector is disconnected. Check for connector off; contamination in connectors; bent pin; broken wiring, failed internal motor sensor.
RMC_523666.0See “RMC_523666.00 Bus Voltage High (Blink Code 9-2)” on page 440	{9 - 2}	true	false	HIGH FAULT VBUS	9-2 Blink Code: Alternator output exceeding 48v. Check alternator internal regulator and connections.
RMC_523666.1See “RMC_523666.01 Bus Voltage Low (Blink Code 1-7)” on page 440	{1 - 7}	true	false	LOW FAULT VBUS	1-7 Blink Code: 48V DC Low - Alternator voltage Below 20 Volts when running. Overloaded reels or insufficient engine rpms. Possible alternator malfunction.
RMC_523666.2See “RMC_523666.02 Low VBUS on Start (Blink Code 1-7)” on page 441	{1 - 7}	true	false	LOW VBUS ON START	1-7 Blink Code: 48V DC Low - Alternator voltage Below 20 Volts when running. Overloaded reels or insufficient engine rpms. Possible alternator malfunction.
RMC_523666.15See “RMC_523666.15 (Blink Code - NONE) System reaction monitor, not a fault. Used for internal data collection.” on page 442	NONE	false	false	System reaction monitor, not a fault. Used for internal data collection.	Manufacturer Service Code

RMC_000628.12 (Blink Code SOLID ON) - Stuck in Boot Block

System: Reel Operation

Code Caused By:

Software error.

Alarm Level:

Stop

To Clear Display:

N/A

Control Unit Response:

Function degraded

Snapshot Recorded:

N/A

Required Tools:

Service ADVISOR

Preliminary Checks:

None

Check for presence of these codes to assist diagnosis:

- RMC_522976.12 (Blink Code 8-4) Incorrect Application Software

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

Procedure:

1. Connect Service ADVISOR and install available payload for controller. Does this clear error code?

   Yes: End of procedure.

   No: Open DTAC case.

RMC_002513.03 (Blink Code 7-3) - Orange Phase (A) is Shorted to Supply

System: Reel Operation

Code Caused By:

High voltage to phase A in orange wire or motor (phase high).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code.

- ***Phase wire shorted to 48V supply or another phase wire.***

- ***Faulty controller.***

Procedure:

1. Visually verify that the phase leads to the motor are not frayed or shorted together. Inspect connector for damage. Are phase wires and connector to motor okay?

Yes: Replace reel controller.

No: Repair wire or connector.

RMC_002513.04 (Blink Code 7-2) - Orange Phase (A) is Shorted to Ground

System: Reel Operation

Code Caused By:

Low current to phase A in orange wire or motor (phase low).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase or current errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire shorted to ground.***
- ***Faulty motor or controller.***

Procedure:

1. Visually verify that the phase leads to the motor are not frayed or shorted together. Inspect connector for damage. Are phase wires or connector to motor damaged?

Yes: Repair wire or connector.

No: Go to next step.

2. Disconnect motor from controller and observe Service ADVISOR diagnostics. Is the currently active fault for the controller now showing OPEN phase?

Yes: Replace reel motor.

No: Replace controller.

RMC_002513.05 (Blink Code 7-4) - Orange Phase (A) is Open

System: Reel Operation

Code Caused By:

No current to phase A in orange wire or motor (phase low).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire open.***
- ***Faulty motor or controller.***

Procedure:

1. Are heavy current wires and connectors damaged?

Yes: Repair wire or connector.

No: Go to next step

2. Swap motor with another motor on machine. Is problem resolved or does problem move?

Yes: Replace reel motor. DTAC case should be submitted showing this fault with the serial# of the controller.

No: Go to next step.

3. Does problem remain in same location?

Yes: Replace reel controller.

4. Connect to Service ADVISOR and check all RMC Current readings. Are all RMCs showing similar readings? RLK motor current

Yes: Clear code and retest.

5. Does problem return?

Yes: Open DTAC case.

No: Intermittent problem. Duplicate conditions to cause code and repeat procedure.

RMC_002514.03 (Blink Code 7-3) - Black Phase (B) is Shorted to Supply

System: Reel Operation

Code Caused By:

High voltage to phase B in black wire or motor (phase high).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Tests)and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire shorted to 48V supply or another phase wire.***
- ***Faulty controller.***

Procedure:

1. Visually verify that the phase leads to the motor are not frayed or shorted together. Inspect connector for damage. Are phase wires and connector to motor okay?

Yes: Replace reel controller.

No: Repair wire or connector.

RMC_002514.04 (Blink Code 7-2) - Black Phase (B) is Shorted to Ground
System: Reel Operation

Code Caused By:

Low current to phase B in black wire or motor (phase low).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase or current errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Test(s))and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire shorted to ground.***
- ***Faulty motor or controller.***

Procedure:

1. Visually verify that the phase leads to the motor are not frayed or shorted together. Inspect connector for damage. Are phase wires or connector to motor damaged?

Yes: Repair wire or connector.

No: Go to next step.

2. Disconnect motor from controller and observe Service ADVISOR diagnostics. Is the currently active fault for the controller now showing OPEN phase?

Yes: Replace reel motor.

No: Replace controller.

RMC_002514.05 (Blink Code 7-4) - Black Phase (B) is Open
System: Reel Operation

Code Caused By:

No current to phase A in black wire or motor (phase low).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the

”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire open.***
- ***Faulty motor or controller.***

Procedure:

1. Are heavy current wires and connectors damaged?

Yes: Repair wire or connector.

No: Go to next step

2. Swap motor with another motor on machine. Is problem resolved or does problem move?

Yes: Replace reel motor. DTAC case should be submitted showing this fault with the serial# of the controller.

No: Go to next step.

3. Does problem remain in same location?

Yes: Replace reel motor.

4. Connect to Service ADVISOR and check al RMC Current readings. Are all RMCs showing similar readings? RLK motor current

Yes: Clear code and check for return of problem.

5. Does problem return?

Yes: Open DTAC case.

No: Intermittent problem. Duplicate conditions to cause code and repeat procedure.

RMC_002515.03 (Blink Code 7-3) - Green Phase (C) is Shorted to Supply

System: Reel Operation

Code Caused By:

High voltage to phase C in green wire or motor (phase high).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Test s and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire shorted to 48V supply or another phase wire.***
- ***Faulty controller.***

Procedure:

1. Visually verify that the phase leads to the motor are not frayed or shorted together. Inspect connector for damage. Are phase wires and connector to motor okay?

Yes: Replace reel controller.

No: Repair wire or connector.

RMC_002515.04 (Blink Code 7-2) - Green Phase (C) is Shorted to Ground
System: Reel Operation

Code Caused By:

Low current to phase C in green wire or motor (phase low).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase or current errors on reel controller in question

Diagnosis

- Recall, record, and clear codes.
- SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes.
- If not using SERVICE ADVISOR™ or if unable to make a connection: See “Reading Reel Controller Fault Codes (Onboard Controller Blink Code Display)” on page 412 for the on-board display procedure.
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire shorted to ground.***
- ***Faulty motor or controller.***

Procedure:

1. Visually verify that the phase leads to the motor are not frayed or shorted together. Inspect connector for damage. Are phase wires or connector to motor damaged?

   Yes: Repair wire or connector.

   No: Go to next step.

2. Disconnect motor from controller and observe Service ADVISOR diagnostics. Is the currently active fault for the controller now showing OPEN phase?

   Yes: Replace reel motor.

   No: Replace controller.

RMC_002515.05 (Blink Code 7-4) - Green Phase (C) is Open
System: Reel Operation

Code Caused By:

No current to phase C in green wire or motor (phase low).

Alarm Level:

Stop

To Clear Display:

Cycle key switch.

Alarm Frequency:

Only when active.

Control Unit Response:

Reel stops.

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Inspect high current wires to motor.

Check for presence of these codes to assist diagnosis:

- Any other 48V phase errors on reel controller in question

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the

”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Phase wire open.***
- ***Faulty motor or controller.***

Procedure:

1. Are heavy current wires and connectors damaged?

Yes: Repair wire or connector.

No: Go to next step

2. Swap motor with another motor on machine. Is problem resolved or does problem move?

Yes: Replace reel motor. DTAC case should be submitted showing this fault with the serial# of the controller.

No: Go to next step.

3. Does problem remain in same location?

Yes: Replace reel motor.

4. Connect to Service ADVISOR and check al RMC Current readings. Are all RMCs showing similar readings? RLK motor current

Yes: Clear code and check for return of problem.

No: Test 48V alternator. See “48V Alternator Voltage Output Test” on page 462 and “48 Volt Alternator Circuit Diagnosis” on page 462

5. Does problem return?

Yes: Open DTAC case.

No: Intermittent problem. Duplicate conditions to cause code and repeat procedure.

RMC_003509.00 (Blink Code 7-5) - Pot Signal Voltage High

System: Reel Operation

Code Caused By:

Indicates potentiometer speed control voltage is high.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

Multimeter

Preliminary Checks:

Access RLK RMC Drive Motor Speed

Check for presence of these codes to assist diagnosis:

- RMC_003510.00 Pot Supply Voltage High (Blink Code 7-5)
- RMC_003597.00 14V Voltage High (Blink Code 9-3)

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Faulty potentiometer***
- ***Potentiometer signal wire shorted to battery voltage.***
- ***Faulty potentiometer external wiring***
- ***Faulty controller power supply***

Procedure:

1. Check the connector for water, corrosion or bent pins. Is 4.3Vdc present at speed control potentiometer, Red wire?

Yes: Go to next step.

No: If no 003597.00 (Blink Code 9-3) code present, go to next step. Otherwise, troubleshoot high 14Vdc code.

2. Is there continuity to ground at speed control potentiometer, 104J Blk wire?

Yes: Test potentiometer.

Yes: Check for Wht wire, short to battery voltage.

No: Test ground circuit.

3. Replace controller with known good or swap controllers on machine. Does problem move?

Yes: Replace controller.

No: Open DTAC case.

RMC_003509.01 (Blink Code 7-5) - Pot Signal Voltage Low

System: Reel Operation

Code Caused By:

Indicates potentiometer speed control voltage is low.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

Multimeter

Preliminary Checks:

Access RLK RMC Drive Motor Speed

Check for presence of these codes to assist diagnosis:

- RMC_003510.01 Pot Supply Voltage low (Blink Code 9-7)
- RMC_003597.01 14V Voltage low (Blink Code 9-3)

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Poor wire connections***
- ***Faulty potentiometer***
- ***Potentiometer signal wire shorted to ground.***

Procedure:

1. Is 4.3Vdc present at speed control potentiometer, Red wire?

Yes: Go to next step.

No: If no 003597.01 (Blink Code 9-3) code present, go to next step. Otherwise, troubleshoot low 14Vdc code.

2. Is there continuity to ground at speed control potentiometer, 104J Blk wire?

Yes: Test potentiometer.

Yes: Check for Wht wire short to ground.

No: Test ground circuit.

3. Check wires and connectors. Swap controllers on machine. Does problem move?

Yes: Replace controller.

No: Open DTAC case.

RMC_003510.00 (Blink Code 9-7) - Pot Supply Voltage High

System: Reel Operation

Code Caused By:

Indicates supply voltage from controller to speed control potentiometer is high.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

Multimeter

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_003509.00 Pot Signal Voltage High (Blink Code 7-5)
- RMC_003597.00 14V Voltage High (Blink Code 9-3) - Indicates failed controller voltage regulator

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Faulty potentiometer***
- ***Potentiometer supply wire shorted to battery voltage.***
- ***Faulty potentiometer external wiring***
- ***Faulty controller power supply***

Procedure:

1. Is 4.3Vdc present at speed control potentiometer Red wire?

Yes: Go to next step.

No: If no 003597.00 (Blink Code 9-3) code present, go to next step. Otherwise, troubleshoot high 14Vdc code.

2. Is 4.3Vdc present at controller?

Yes: Check Red wire for short to power.

Yes: Check for Wht wire short to ground.

No: Replace controller.

3. Swap controllers on machine. Does problem move?

Yes: Replace controller.

No: Open DTAC case.

RMC_003510.01 (Blink Code 9-7) - Pot Supply Voltage Low

System: Reel Operation

Code Caused By:

Indicates supply voltage from controller to speed control potentiometer is low.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Snapshot Recorded:

No

Control Unit Response:

None

Required Tools:

Multimeter

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_003509.01 Pot Signal Voltage Low (Blink Code 7-5)
- RMC_003597.01 14V Voltage Low (Blink Code 9-3) - Indicates failed controller voltage regulator or low input voltage.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Faulty potentiometer***
- ***Potentiometer supply wire shorted to ground voltage.***
- ***Faulty controller power supply***

Procedure:

1. Check wires and connectors for damage. Is 4.3Vdc present at speed control potentiometer Red wire?

Yes: Go to next step.

No: If no 003597.01 (Blink Code 9-3) code present, go to next step. Otherwise, troubleshoot low 14Vdc code.

2. Is 4.3Vdc present at controller?

Yes: Check Red wire for short to ground

Yes: Check for Wht wire short to ground.

No: Replace controller.

3. Replace controller with known good or swap controllers on machine. Does problem move?

Yes: Replace controller.

No: Open DTAC case.

RMC_003511.00 (Blink Code 9-5) - Hall Voltage High

System: Reel Operation

Code Caused By:

Indicates voltage from controller to Hall sensors is high.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

Multimeter

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_003510.00 Pot Signal Voltage High (Blink Code 7-5)
- RMC_003597.00 14V Voltage High (Blink Code 9-3) - Indicated failed controller voltage regulator.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Faulty controller***

Procedure:

1. Is Hall voltage over 15 V?

Yes: Replace controller.

No: Go to next step.

2. Swap controller with another controller on machine. Is problem resolved or does problem move?

Yes: Replace controller. DTAC case should be submitted showing this fault with the serial# of the controller.

No: Open DTAC case.

RMC_003511.01 (Blink Code 9-5) - Hall Voltage Low

System: Reel Operation

Code Caused By:

Indicates signal voltage from Hall sensor to controller is low.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

Multimeter

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_003510.01 Pot Signal Voltage Low (Blink Code 7-5)
- RMC_003597.01 14V Voltage Low (Blink Code 9-3) - Indicated failed controller voltage regulator.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Hall supply wire shorted to ground.***
- ***Faulty controller power supply***

Procedure:

1. Unplug the motor for test. Is at least 11.3Vdc present at Hall power output.

Yes: Plug motor back in. If voltage is low with motor plugged back in, but not when unplugged then swap motor to see if problem moves with the motor or stays with the controller. Go to next step.

No: If no 003597.01 (Blink Code 9-3) code present, go to next step. Otherwise, troubleshoot low 14Vdc code.

2. Is 14Vdc present at controller, Red wire?

Yes: Check Red wire for short to ground.

Yes: Check for Wht wire short to ground.

No: Replace controller.

3. Swap controller with another controller on machine. Is problem resolved or does problem move?

Yes: Replace controller. DTAC case should be submitted showing this fault with the serial# of the controller.

No: Open DTAC case.

RMC_003597.00 (Blink Code 9-3) - Controller 14V High

System: Reel Operation

Code Caused By:

Indicates an internal 14V voltage regulator failure in reel motor controller.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- Any other controllers with RMC_003597.00 (Blink Code 9-3) - Controller 14V High. If so, look for:
- RMC_523666.00 (Blink Code 9-2) 48V Alternator High. If code appears, troubleshoot first.
- RMC_003510.00 (Blink Code 9-7) - Pot Supply Voltage High
- RMC_003511.00 (Blink Code 9-5) - Hall Voltage High

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the

”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***If code happened once, cleared, and did not reoccur, suspect possible transient voltage spike***
- ***Faulty 48V alternator***
- ***Faulty controller ground connection***
- ***Faulty controller power supply***

Procedure:

1. If none of the above symptoms or causes can be found, swap controller with another controller on machine. Is problem resolved or does problem move?

   Yes: Replace controller. DTAC case should be submitted showing this fault with the serial# of the controller.

   No: Open DTAC case.

RMC_003597.01 (Blink Code 9-3) - Controller 14V Low

System: Reel Operation

Code Caused By:

Indicates an internal 14V voltage regulator failure in reel motor controller.

Alarm Level:

Service Alert

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- Any other controllers with RMC_003597.01 (Blink Code 9-3) - Controller 14V Low. If so, look for:
- RMC_523666.01 (Blink Code 9-2) - 48V Alternator Low. If code appears, troubleshoot first.
- RMC_003510.01 (Blink Code 9-7) - Pot Supply Voltage Low
- RMC_003511.01 (Blink Code 9-5) - Hall Voltage Low

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Faulty 48V alternator***
- ***Faulty controller ground connection***
- ***Faulty controller power supply***

Procedure:

1. If none of the above symptoms or causes can be found, swap controller with another controller on machine. Is problem resolved or does problem move?

   Yes: Replace controller. DTAC case should be submitted showing this fault with the serial# of the controller.

   No: Open DTAC case.

RMC_521153.00 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.

System: Reel Operation

RMC_521153.15 (Blink Code 2-9) - Controller Shutdown Over Temp
System: Reel Operation

Code Caused By:

Indicates controller/motor drawing too much current and controller is shut down.

Alarm Level:

Stop

To Clear Display:

Cycle power

Alarm Frequency:

Only when active.

Control Unit Response:

Controller/Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_522917.00 Controller Current Threshold 3 Shutdown (Blink Code 2-5)
- RMC_522917.06 Controller Hardware Current Shutdown (Blink Code 2-5)
- RMC_522918.15 Motor Stall While Running (Blink Code 1-6)
- RMC_522919.12 (Blink Code 6-4) This code likely indicates that the reel motor connector is disconnected.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Controller cooling fins blocked***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***High ambient temperature***

Procedure:

1. Does controller feel warm to the touch?

   Yes: Allow controller to cool and check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current.

   Yes: Suspect motor or reel problems.

   No: Go to next step.

3. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522327.00 (Blink Code 2-10) - Motor Over Temp
System: Reel Operation

Code Caused By:

Indicates high internal motor temperature resulted in controller shutting down motor.

Alarm Level:

Stop

To Clear Display:

Cycle power

Alarm Frequency:

Only when active.

Control Unit Response:

Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_522917.00 Controller Current Threshold 3 Shutdown (Blink Code 2-5)
- RMC_522917.06 Controller Hardware Current Shutdown (Blink Code 2-5)
- RMC_522918.15 Motor Stall While Running (Blink Code 1-6)
- RMC_522919.12 (Blink Code 6-1) This code likely indicates that the reel motor connector is disconnected.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***High ambient temperature***

Procedure:

1. Does controller feel warm to the touch?

   Yes: Allow controller to cool and check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. RLK RMC motor driver heat sink temperature AND RLK RMC motor current Remove and swap reels to look for a high load. Is problem resolved or does problem move?

   Yes: Go to next step.

   No: Go to step 4.

3. Temperature sensor check - Unplug motor from controller. Check continuity between P1 pin C and P1 pin A on motor harness end. Is there continuity?

   Yes: Go to next step.

   No: If motor is cool and no continuity, test or replace motor. See “Reel Motor Test” on page 464.

4. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522917.00 (Blink Code 2-5) - Controller Current Threshold 3 Shutdown

System: Reel Operation

Code Caused By:

Indicates high controller current draw (most severe level)

Alarm Level:

Stop

To Clear Display:

Cycle power

Alarm Frequency:

Only when active.

Control Unit Response:

Controller/Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

Note: The presence of any stored 522917.xx codes for the controller in question likely indicate ongoing problems with controller/reel combination.

• RMC_522917.15 Controller Current Threshold 2 Shutdown (Blink Code 2-5) (least severe level)

• RMC_522917.16 Controller Current Threshold 1 Shutdown (Blink Code 2-5) (moderately severe level)

• RMC_522917.06 Controller Hardware Current Shutdown (Blink Code 2-5)

• RMC_522918.15 Motor Stall While Running (Blink Code 1-6)

Diagnosis

• Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

• Recall codes again and check for return of this code.

• Recreate operating conditions that caused code.

• End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Controller cooling fins blocked***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***High ambient temperature***

Procedure:

1. Does controller feel warm to the touch?

   Yes: Allow controller to cool and check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

   Yes: Suspect motor or reel problems.

   No: Go to next step.

3. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522917.06 (Blink Code 2-8) - Controller Hardware Current Shutdown

System: Reel Operation

Code Caused By:

Indicates high controller current draw

Alarm Level:

Stop

To Clear Display:

Cycle power

Alarm Frequency:

Only when active.

Control Unit Response:

Controller/Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

Note: The presence of any stored 522917.xx codes for the controller in question indicate ongoing problems with controller/reel combination.

• RMC_522917.15 Controller Current Threshold 2 Shutdown (Blink Code 2-5) (least severe level)

• RMC_522917.16 Controller Current Threshold 1 Shutdown (Blink Code 2-5) (moderately severe level)

• RMC_522917.00 Controller Current Threshold 3 Shutdown (Blink Code 2-5)

• RMC_522918.15 Motor Stall While Running (Blink Code 1-6)

Diagnosis

• Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot

Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Controller cooling fins blocked***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***High ambient temperature***
- ***Controller 3-phase output shorted to ground***

Procedure:

1. Does controller feel warm to the touch?

   Yes: Allow controller to cool and check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

   Yes: Suspect motor or reel problems.

   No: Go to next step.

3. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522917.15 (Blink Code 2-5) - Controller Current Threshold 1 Shutdown

System: Reel Operation

Code Caused By:

Indicates high controller current draw (least severe level)

Alarm Level:

Stop

To Clear Display:

Cycle power

Alarm Frequency:

Only when active.

Control Unit Response:

Controller/Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

Note: The presence of any stored 522917.xx codes for the controller in question likely indicate ongoing problems with controller/reel combination.

- RMC_522917.15 Controller Current Threshold 2 Shutdown (Blink Code 2-5) (least severe level)
- RMC_522917.06 Controller Hardware Current Shutdown (Blink Code 2-5) (moderately severe level)
- RMC_522917.00 Controller Current Threshold 3 Shutdown (Blink Code 2-5)
- RMC_522918.15 Motor Stall While Running (Blink Code 1-6)

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Controller cooling fins blocked***
- ***Jammed reel***
- ***Incorrect bedknife clearance***

- ***Failing bearings on reel***
- ***High ambient temperature***

Procedure:

1. Does controller feel warm to the touch?

Yes: Allow controller to cool and check for common conditions to cause problem. Are any common problems found?

Yes: Correct problem.

No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

Yes: Suspect motor or reel problems.

No: Go to next step.

3. Swap controller with another controller on machine. Does problem move with controller?

Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522917.16 (Blink Code 2-5) - Controller Current Threshold 2 Shutdown

System: Reel Operation

Code Caused By:

Indicates high controller current draw (moderately severe level)

Alarm Level:

Stop

To Clear Display:

Cycle power

Alarm Frequency:

Only when active.

Control Unit Response:

Controller/Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

None

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

Note: The presence of any stored 522917.xx codes for the controller in question likely indicate ongoing problems with controller/reel combination.

- RMC_522917.15 Controller Current Threshold 1 Shutdown (Blink Code 2-5) (least severe level)
- RMC_522917.06 Controller Hardware Current Shutdown (Blink Code 2-5) (moderately severe level)
- RMC_522917.00 Controller Current Threshold 3 Shutdown (Blink Code 2-5)
- RMC_522918.15 Motor Stall While Running (Blink Code 1-6)

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Controller cooling fins blocked***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***High ambient temperature***

Procedure:

1. Does controller feel warm to the touch?

Yes: Allow controller to cool and check for common conditions to cause problem. Are any common problems found?

Yes: Correct problem.

No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK

RMC motor current

Yes: Suspect motor or reel problems.

No: Go to next step.

3. Swap controller with another controller on machine. Does problem move with controller?

Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522918.00 (Blink Code 1-5) - Motor Start Failed 3x Fault

System: Reel Operation

Code Caused By:

Motor failed to start after 3 tries. No Hall effect state changes reported to controller.

Alarm Level:

Stop

To Clear Display:

Cycle PTO switch

Alarm Frequency:

Only when active.

Control Unit Response:

Controller/Motor shutdown

Snapshot Recorded:

Yes

Required Tools:

JDG10429 Electric Reel Motor tester or multimeter

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_522918.15 Motor Stalled While Running (Blink Code 1-6)
- RMC_522919.02 Unexpected Hall Received (Blink Code NONE)

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Obstruction in reel***
- ***Excessive debris in reel***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***

Procedure:

Note: If available, use the JDG10429 Electric Reel Motor Tester. See “Reel Motor Test” on page 464.

1. Does motor feel warm to the touch?

Yes: Allow motor to cool and check for common conditions to cause problem. Are any common problems found?

Yes: Correct problem.

No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

Yes: Go to next step

No: Go to step 4.

3. Test motor sensors. Do sensors pass test?

Yes: Go to next step.

No: Replace reel motor.

No: Check for broken or damaged wires.

4. Swap controller with another controller on machine. Does problem move with controller?

Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522918.02 (Blink Code 1-10) - Motor Spin Direction Shutdown
System: Reel Operation

Code Caused By:

Reel direction reversed for 1/4 turn of motor.

Alarm Level:

Stop

To Clear Display:

Lift and lower reel arms

Alarm Frequency:

Only when active.

Control Unit Response:

All reels shutdown

Snapshot Recorded:

Yes

Required Tools:

JDG10429 Electric Reel Motor tester or multimeter

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_522918.15 Motor Stalled While Running (Blink Code 1-6)
- RMC_522919.02 Unexpected Hall Received (Blink Code NONE)

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Reel obstructed while running or attachment issue - Check reel, bedknife, and attachment for damage***

Procedure:

Note: If available, use the JDG10429 Electric Reel Motor Tester. See “Reel Motor Test” on page 464.

1. Check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

   Yes: Go to next step

   No: Go to step 4.

3. Test motor sensors. Do sensors pass test?

   Yes: Go to next step.

   No: Replace reel motor.

   No: Check for broken or damaged wires.

4. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522918.15 (Blink Code 1-6) - Motor Stalled While Running
System: Reel Operation

Code Caused By:

Reel stopped while running

Alarm Level:

Stop

To Clear Display:

Lift and lower reel arms

Alarm Frequency:

Only when active.

Control Unit Response:

All reels shut down

Snapshot Recorded:

Yes

Required Tools:

JDG10429 Electric Reel Motor tester or multimeter

Preliminary Checks:

Access RLK RMC drive motor speed AND RLK RMC Drive Motor Speed

Check for presence of these codes to assist diagnosis:

None

Diagnosis

- Recall, record, and clear codes.
- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Reel obstructed while running or attachment issue - Check reel, bedknife, and attachment for damage***
- ***Excessive load***
- ***Obstruction in reel***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***Excessive debris in reel***

Procedure:

Note: If available, use the JDG10429 Electric Reel Motor Tester. See “Reel Motor Test” on page 464.

1. Check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

   Yes: Go to next step

   No: Go to step 4.

3. Test motor sensors. Do sensors pass test?

   Yes: Go to next step.

   No: Replace reel motor.

   No: Check for broken or damaged wires.

4. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522919.02 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.

System: Reel Operation

RMC_522919.03 (Blink Code 6-6) - Hall Resync Shutdown

System: Reel Operation

Code Caused By:

Motor position sensor error while running

Alarm Level:

Stop

To Clear Display:

Lift and lower reel arms

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

Yes

Required Tools:

JDG10429 Electric Reel Motor tester

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

None

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed

by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Heavy load on reel***
- ***Excessive debris in reel***
- ***Controller cooling fins blocked***
- ***Jammed reel***
- ***Incorrect bedknife clearance***
- ***Failing bearings on reel***
- ***Water in motor***

Procedure:

Note: If available, use the JDG10429 Electric Reel Motor Tester. See “Reel Motor Test” on page 464.

1. Check for common conditions to cause problem. Are any common problems found?

   Yes: Correct problem.

   No: Go to next step.

2. Investigate current draw using “Readings” in Service ADVISOR. Remove and swap reels to look for a high load. Is problem resolved or does problem move? RLK RMC motor driver heat sink temperature AND RLK RMC motor current

   Yes: Go to next step

   No: Go to step 4.

3. Test motor sensors. Do sensors pass test?

   Yes: Go to next step.

   No: Replace reel motor.

   No: Check for broken or damaged wires.

4. Swap controller with another controller on machine. Does problem move with controller?

   Yes: Replace controller. DTAC case should be submitted showing this fault stayed with controller when controller is moved.

RMC_522919.04 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.

System: Reel Operation

RMC_522919.08 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.

System: Reel Operation

RMC_522919.09 (Blink Code NONE) - System reaction monitor, not a fault. Used for internal data collection.

System: Reel Operation

RMC_522919.12 (Blink Code 6-4) - Invalid Hall State Detected at Start-Up

System: Reel Operation

Code Caused By:

Motor position error at start.

Alarm Level:

Stop

To Clear Display:

Cycle key switch

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

No

Required Tools:

JDG10429 Electric Reel Motor tester

Preliminary Checks:

Check for presence of these codes to assist diagnosis:

- RMC_522327.00 (Blink Code 2-10) Motor Over Temp - Most likely motor connector is disconnected, contaminated terminals, bent pins, etc.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests)and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the ”Diagnostics” tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Bad connections or wiring between controller and reel motor.***
- ***Water in motor***

Procedure:

Note: If available, use the JDG10429 Electric Reel Motor Tester. See "Reel Motor Test" on page 464.

1. Do sensors pass test?

   Yes: Go to next step.

   No: Check for broken or damaged wires, contaminated connector terminals, bent pins, etc.

   No: Replace reel motor.

2. Swap controller with another controller on machine. Is problem resolved or does problem move?

   Yes: Replace controller

   No: If controller replaced and problem does not clear, suspect motor problems.

RMC_523666.00 Bus Voltage High (Blink Code 9-2)

System: Reel Operation

Code Caused By:

48V alternator over voltage.

Alarm Level:

Stop

To Clear Display:

Raise and lower lift arms

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

Yes

Required Tools:

Multimeter

Preliminary Checks:

Access RLK RMC ECU Power Supply Voltage #1, Switched

Check for presence of these codes to assist diagnosis:

- Check for RMC_523666.00 codes from other controllers. If additional controllers report a problem, suspect 48V alternator. If only one controller reports problem, check controller connections and ground.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the "Diagnostics" tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault.

- Clear codes using Diagnostic tab
- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Failed 48V regulator***

Procedure:

1. Test output of 48V alternator. See "48 Volt Alternator Circuit Diagnosis" on page 462 and "48V Alternator Current Output Test" on page 463. Is alternator ok?

   Yes: Go to next step.

   No: Check for broken or damaged wires, shorts to ground from alternator to controller on negative wire.

2. Swap controller with another controller on machine. Is problem resolved or does problem move?

   Yes: Replace controller.

   No: If controller replaced and problem does not clear, return to alternator troubleshooting.

RMC_523666.01 Bus Voltage Low (Blink Code 1-7)

System: Reel Operation

Code Caused By:

48V alternator low.

Alarm Level:

Stop

To Clear Display:

Raise and lower lift arms

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

Yes

Required Tools:

Multimeter

Preliminary Checks:

Access RLK RMC ECU Power Supply Voltage #1, Switched

Note: the RMC PTO State reading is the enable signal status for the 48 volt alternator. This signal must in the "enable" state to generate alternator output.

Check for presence of these codes to assist diagnosis:

- Check for RMC_523666.01 codes from other controllers. If additional controllers report problem, suspect 48V alternator. If only one controller reports problem, check controller wiring and connections. See "48 Volt Alternator Circuit Diagnosis" on page 462.

Diagnosis

- Recall, record, and clear codes.
- Recall, record (Snapshot test under Interactive Tests)and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the "Diagnostics" tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Engine under-speed***
- ***Failed 48V alternator/regulator***
- ***Excessive load on reel(s).***

Procedure:

1. Check to see that ADDRESSES for controllers are 1, 3, 5, 2 & 6. Start sequence with delays are based upon controller address. Errors in address can cause insufficient power to start reels. Are the addresses okay?

   Yes: Go to next step

   No: Inspect for bent pins on any controller that does not have proper address.

2. Test output of 48V alternator. See "48 Volt Alternator Circuit Diagnosis" on page 462 and "48V Alternator Current Output Test" on page 463.

   Yes: Go to next step.

   No: Check for broken or damaged wires, shorts to ground from alternator to controller on positive wire.

3. Swap controller with another controller on machine (if only one controller reporting problem). Is problem resolved or does problem move?

   Yes: Replace controller.

   No: If controller replaced and problem does not clear, return to alternator troubleshooting.

RMC_523666.02 Low VBUS on Start (Blink Code 1-7)

System: Reel Operation

Code Caused By:

48V alternator below 20V at start

Alarm Level:

Stop

To Clear Display:

Raise and lower lift arms

Alarm Frequency:

Only when active.

Control Unit Response:

None

Snapshot Recorded:

Yes

Required Tools:

Multimeter

Preliminary Checks:

Access RLK RMC ECU Power Supply Voltage #1, Switched

Note: the RMC PTO State reading is the enable signal status for the 48 volt alternator. This signal must in the

"enable" state to generate alternator output.

Check for presence of these codes to assist diagnosis:

- Check for RMC_523666.02 codes from other controllers. If additional controllers report problem, suspect alternator. If only one controller reports problem, suspect wiring or controller problems.

Diagnosis

- Recall, record (Snapshot test under Interactive Tests) and clear codes.

SERVICE ADVISOR™: This procedure can be performed by making a connection to the machine and using the "Diagnostics" tab to view and clear codes. Use Snapshot Test under Interactive Test tab for specific controller to record fault. Clear codes using Diagnostic tab

- Recall codes again and check for return of this code.
- Recreate operating conditions that caused code.
- End of tests if code does not return.

Note: Common conditions to cause code

- ***Engine under-speed***
- ***Failed 48V alternator/regulator***
- ***Excessive load on reel(s) at start up.***

Procedure:

1. Check to see that ADDRESSES for controllers are 1, 3, 5, 2 & 6. Start sequence with delays are based upon controller address. Errors in address can cause insufficient power to start reels. Are the addresses okay?

   Yes: Go to next step

   No: Inspect for bent pins on any controller that does not have proper address.

2. Test output of 48V alternator. See "48 Volt Alternator Circuit Diagnosis" on page 462 and "48V Alternator Current Output Test" on page 463. Is alternator ok?

   Yes: Go to next step.

   No: Check for broken or damaged wires, shorts to ground from alternator to controller on positive wire.

3. Swap controller with another controller on machine (if only one controller reporting problem). Is problem resolved or does problem move?

   Yes: Replace controller.

   No: If controller replaced and problem does not clear, return to alternator troubleshooting.

RMC_523666.15 (Blink Code - NONE) System reaction monitor, not a fault. Used for internal data collection.

System: Reel Operation

Observed Symptoms

Marcelling

Procedure

1. Is the ground speed correct?

Yes: Go to next step.

No: Increase or decrease ground speed as necessary. (See “Performance Variables” on page 618.)

2. Is engine rpm correct (not too low)?

Yes: Go to next step.

No: Increase engine speed to specification. (See Operator’s Manual.)

3. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure” on page 623.)

4. Is the correct number of reel blades being used for desired clip ratio (CR)?

No: Install reel with correct number of blades. (See “Performance Variables” on page 618.)

5. Are all reel motors rotating within 10% of drive motor speed? (RLK link to RMC_Drive motor speed AND RMC_drive motor speed AND RMC motor current)

Yes: Ensure that mow switch is engaged and alternator output is consistent. RLK RMC ECU power supply voltage #1, switched

No: Troubleshoot reel by associated DTC/Fault code.

6. Is ambient temperature extremely low? (Lower than -30° C -22° F)

Yes: Allow reels to warm up sufficiently (less viscous lubricant). (RLK Motor driver heat sink temperature)

Striping

Insure reel motor is turning the correct direction. Any motor on machine left should have a - value when cutting grass and any motor on the machine right side of cutting unit should have a +value when cutting grass when connected to Service ADVISOR. RLK RMC Drive Motor Speed

Procedure

1. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes: Go to next step.

No: Perform reel-to-bed knife adjustment. (See “Adjust Bed Knife to Reel Clearance QA-5” on page 629, or See “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

2. Are the reel and bed knife in good condition (no nicks, uneven wear, or distortions)?

No: Grind reel and bed knife. (See “Reel and Bed Knife Grinding” on page 616.)

3. Are all reel motors rotating within 10% of drive motor speed? (RLK link to RMC_Drive motor speed AND RMC_drive motor speed)

Yes: Ensure that mow switch is engaged and alternator output is consistent.

No: Troubleshoot reel by associated DTC/Fault code.

4. Are any DTCs/Fault codes present?

Yes: Troubleshoot DTCs/Fault codes.

No: Go to next step.

5. Does an over temp derate condition exist? (RLK Motor driver heat sink temperature)

Yes: Allow controller to cool.

No: Go to next step.

6. Access direction switch (RLK RMC_Direction Switch). Are motors rotating in proper direction?

Yes: Observe rotating reels a nd verify direction.

No: See “Mow Circuit Operation” on page 356.

7. Toggle reel direction switch. Do all reels change direction? RLK RMC drive motor speed.

Note: Any motor on machine left should have a - value when cutting grass and any motor on the machine right side of cutting unit should have a +value when cutting grass.

Yes: End of tests.

No: Troubleshoot direction control circuits.

Height-of-Cut Changes

Procedure

1. Is the grass dry enough for proper cutting (not too wet)?

Yes: Go to next step.

No: Allow sufficient time for grass to dry before cutting.

2. Is the roller clean (no grass or dirt collecting on the roller)?

Yes: Go to next step.

No: Install scraper or power brush on roller.

3. Is the condition of the soil good (not rough or changing)?

Yes: Go to next step.

No: Use a smooth roller.

4. Is the cutting unit floating properly?

Yes: Go to next step.

No: See Operator's Manual.

5. Are the roller clamp bolts tight?

Yes: Go to next step.

No: Perform height-of-cut (HOC) adjustment. (See "Adjust Height-of-Cut (HOC) - QA-5 Reel" on page 626, or "Adjust Height-of-Cut (HOC) QA-7" on page 630.)

6. Are the rollers concentric (not out-of-round)?

Yes: Go to next step.

No: Replace roller. (See procedure in this section.)

7. Are the roller bearings in good condition (not worn)?

No: Replace roller bearings. (See procedure in this section.)

Poor Quality of Cut

Insure reel motor is turning the correct direction. Any motor on machine left should have a - value when cutting grass and any motor on the machine right side of cutting unit should have a +value when cutting grass when connected to Service ADVISOR. RLK RMC Drive Motor Speed

Procedure

1. Is the grass at an acceptable height (not too high)?

Yes: Go to next step.

No: Mow grass more frequently.

2. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See "Backlapping Procedure" on page 623.)

3. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

No: Perform reel-to-bed knife adjustment. (See "Adjust Bed Knife to Reel Clearance QA-5" on page 629, or See "Adjust Reel-to-Bed Knife Clearance QA-7" on page 633.)

Reel Does Not Rotate

Procedure

1. Is the machine operating properly?

Yes: Go to next step.

No: See machine operator's manual.

2. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes: Go to next step.

No: Perform reel-to-bed knife adjustment. (See "Adjust Bed Knife to Reel Clearance QA-5" on page 629, or See "Adjust Reel-to-Bed Knife Clearance QA-7" on page 633.)

3. Are the roller bearings in good condition (not worn or seized)?

Yes: Go to next step.

No: Replace roller bearings.

4. Access RLK RMC ECU power supply voltage #1, switched Is 48V present?

Note: The "RMC PTO State" reading is the enable signal status for the 48 volt alternator. This signal must in the "enable" state to generate alternator output.

Yes: Go to next step.

No: Trouble shoot mow circuit. "Mow Circuit Diagnosis" on page 363.

5. Observe motor current (RLK RMC_Motor Current) Is current extremely high or near zero?

Yes: Recall error codes and follow related diagnostic procedure.

Unit Not Cutting

Insure reel motor is turning the correct direction. Any motor on machine left should have a - value when cutting grass and any motor on the machine right side of cutting unit should have a +value when cutting grass when connected to Service ADVISOR. RLK RMC Drive Motor Speed AND RLK RMC ECU power supply voltage #1, switched.

Note: the RMC PTO State reading is the enable signal status for the 48 volt alternator. This signal must in the "enable" state to generate alternator output.

Procedure

1. Is the grass dry and height of the grass not too excessive?

No: Allow sufficient time for grass to dry and mow more frequently.

Tests and Adjustments

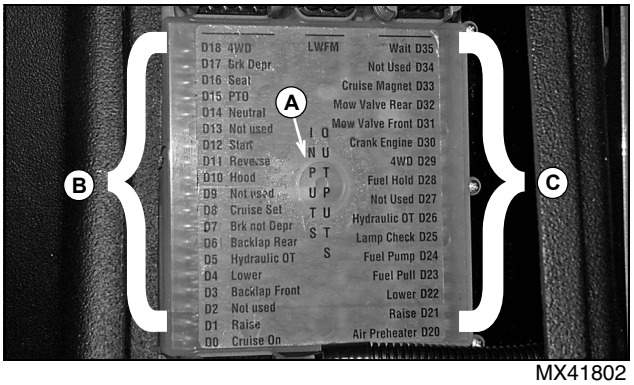
Interlock Module Check

Reason

To determine the operating condition of the electronic control module. The interlock module includes several self-protection features and is designed to last the life of the machine. Most electrical problems are caused by harness or component failures, and are rarely a result of a control module failure.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Move key switch to RUN position.



MX41802

7. Check “heartbeat” light (A) and input/output indicator LEDs (B and C).

Results

Normal

- “Heartbeat” light flashing at a regular, even rate.
- Input indicator light(s) corresponding to activated switch(es) lit.
- Output indicator light(s) corresponding to active component(s) lit.

Not Normal

If the “heartbeat” light and input/output indicator lights are not lit, check F3 main fuse. If fuse is good, check current supply to the control module. See “Switched Power Circuit” on page 325.

Note: The code will cycle continuously with a 2-second pause between display cycles.

If there is more then one fault code, they are displayed sequentially, and then the cycle is repeated. Repeat check procedure after repairs have been completed.

Ground Circuit Test

Reason

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Note: In a “switched ground” system, not all components are grounded directly to the battery. Most circuit components are grounded through the Master control module (A1).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure resistance.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Connect JT05791A Digital Multimeter on ohm scale, negative (black) lead to negative (-) terminal of battery.
6. Connect JT05791A Digital Multimeter red lead to ground terminal of circuit or component to be tested that is closest to the battery negative terminal. Set digital multimeter to the ohm scale. The resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery on the ground side of the problem circuit until the resistance reading increases above 0.1 ohm. The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohm[4]. Check both sides of the connectors closely, as disconnecting and connecting may temporarily solve problem
7. Disconnect component and clean the mating surfaces before reassembling.

4. Some digital multimeters may not provide an accurate reading at a very low resistance. Touch meter probe leads together, and subtract shorted probe reading from the measured resistance reading.

Battery Test

Caution: Avoid Injury! The battery produces a flammable and explosive gas. The battery may explode:

- **Do not smoke near battery.**
- **Wear eye protection and gloves.**
- **Do not allow direct metal contact across battery posts.**
- **Remove negative cable first when disconnecting.**
- **Install negative cable last when connecting.**

Note: The original battery supplied with this machine is a sealed battery and is not serviceable. This procedure is for a serviceable battery that has replaced the original sealed battery.

Do not attempt to open, add fluid to, or service a sealed battery.

To test a sealed battery, perform a battery load test. (See "Battery Load Test" on page 448.)

Reason

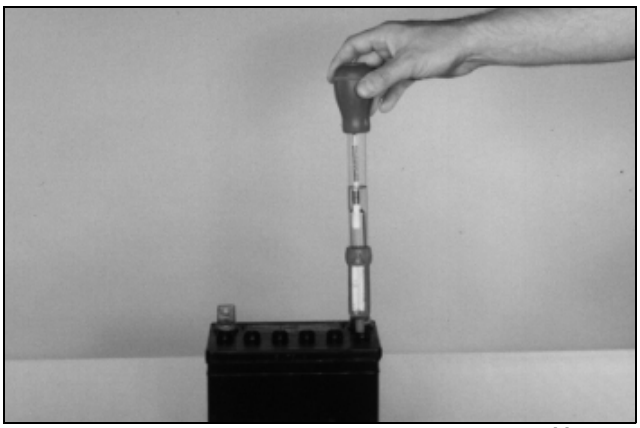
To check condition of battery and determine battery voltage.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hydrometer	NA	Used to check specific gravity.
Voltmeter	NA	Used to check battery voltage.
Battery Tester	JT05685	Used to check battery voltage.

Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Clean cable ends, battery terminals and top of battery. (See "Clean Battery" on page 466.)
7. Remove battery. (See "Remove and Install Battery" on page 466.)
8. Inspect battery terminals and case for breakage or cracks.
9. Check electrolyte level in each battery cell. Add clean, distilled water as needed. If water is added, charge battery for 20 minutes at 10 amps.
10. Remove surface charge by placing a small load on the battery for 15 seconds.



M49596

11. Use a hydrometer to check for a minimum specific gravity of 1.225 with less than a 50-point variation in each cell. If specific gravity is not within range perform one of the following:
    - If all cells are less than 1.175, charge battery at 10-amp rate.
    - If all cells are less than 1.225 with less than 50-point variation, charge battery at 10 amps.
    - If all cells are more than 1.225 with less than 50-point variation, load test battery.
    - If more than 50-point variation, replace battery.
12. Use a voltmeter or JT05685 Battery Tester to check for a minimum battery voltage of 12.4 volts. One of the following may result:
    - If battery voltage is less than 12.4 VDC, charge battery.
    - If battery voltage is more than 12.4 VDC, test specific gravity. (See step 11.)
13. Install battery. (See "Remove and Install Battery" on page 466.)

Charge Battery

Caution: Avoid Injury! The battery produces a flammable and explosive gas. The battery may explode:

- **Do not smoke near battery.**
- **Wear eye protection and gloves.**
- **Do not allow direct metal contact across battery posts.**
- **Remove negative cable first when disconnecting.**
- **Install negative cable last when connecting.**

Reason

To increase battery charge after the battery has been discharged.

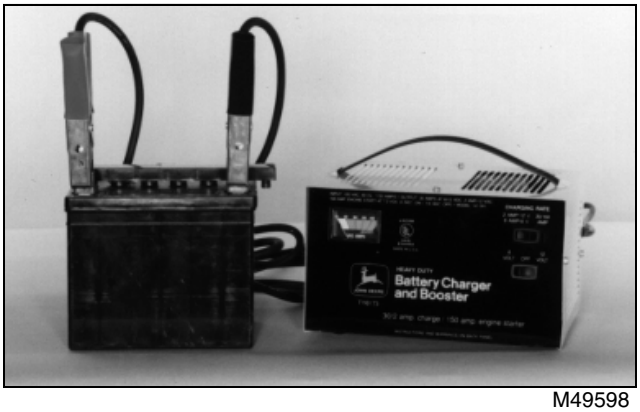
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Charger (Variable Rate)	NA	Used to charge battery.

Procedure

Note: Before charging serviceable battery, check electrolyte level. (See "Battery Test" on page 446.)

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Turn key switch to OFF position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Clean cable ends, battery terminals, and top of battery.
7. Remove battery. (See "Remove and Install Battery" on page 466.)



M49598

8. Connect variable-rate charger to battery.
9. Start charger at SLOW rate. Increase charge rate ONE setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10-amp charge rate. Use boost setting as necessary.
10. Check if battery is accepting 10-amp charge rate after 10 minutes at boost setting. One of the following may result:
    - If battery WILL NOT accept 10-amp charge after 10 minutes at boost setting, replace battery.
    - **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 12 and 13.
    - **Serviceable batteries only:** If battery is accepting 10-amp charge after 10 minutes at boost setting, but battery DID need water or all cells were BELOW 1.175, go to steps 11 and 12.
11. Set charger at 15-25 amps.

Important: Avoid Damage! Decrease charge rate if battery gasses or bubbles excessively or becomes too warm to touch.

12. **Serviceable batteries only:** Check specific gravity after 30 minutes. One of the following problems may result:
    - If MORE THAN 50-point variation between cells, replace battery.
    - If LESS THAN 50-point variation between cells, go to steps 13 and 14.

Note: Serviceable batteries: If battery was discharged at slow or unknown rate, charge battery at 10-15 amps for 6-12 hours.

Maintenance-free batteries: Follow battery charger manufacturer's recommendations.

13. Load test battery.
14. Install battery. (See "Remove and Install Battery" on page 466.)

Specifications

Battery Specific Gravity. . . . . 1.230-1.265 points

Battery Load Test

Reason

To check condition of battery under load.

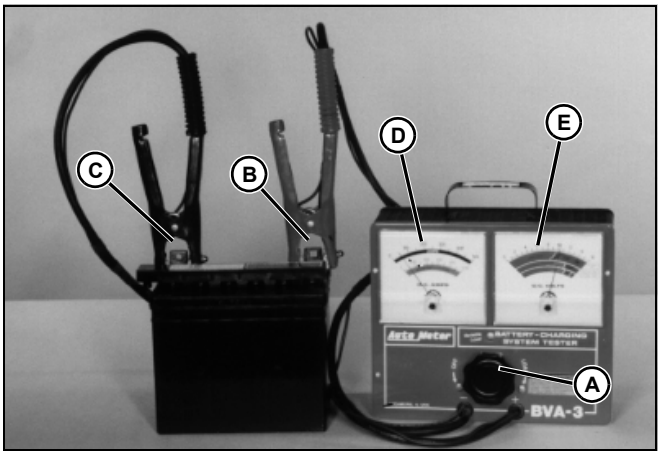
Special or Required Tools

Tool Name	Tool No.	Tool Use
Battery Tester (use according to manufacturer's instructions)	JT05685	Used to test battery.

Procedure

1. Park machine on level surface.
2. Turn key OFF and lock park brake.
3. Open engine cover.
4. Disconnect negative (-) and positive (+) battery cable clamps. Remove battery hold-down clamps.
5. Remove battery from machine.
6. Clean battery terminals and case.

Important: Avoid Damage! Turn load knob on battery tester fully out (counterclockwise) BEFORE making any test connections.



M49597

7. Connect tester positive cable (red) to battery positive (+) terminal (B).
8. Connect tester negative cable (black) to battery negative (-) terminal (C).

Important: Avoid Damage! Perform this test quickly to prevent damage to battery tester. DO NOT apply full load to battery for more than 5-10 seconds.

9. Turn load knob (A) of tester clockwise (in) until amperage reading (D) is equal to:
   - cold cranking amperage rating of battery (use blue scale).
   -or-
   - three times ampere hour rating (use black scale).
10. Hold for 15 seconds and turn load knob (A) of tester counterclockwise (out) into OFF position.
11. Repeat steps 9 and 10 above and read condition of battery at DC volts scale (E).
12. If battery DOES NOT pass test and HAS NOT been charged, charge battery and retest. (See "Charge Battery" on page 447.)
13. If battery DOES NOT pass test and HAS been charged, replace the battery.

Regulated Voltage Output Test

Reason

To check the regulated voltage (charging) output of the alternator.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure voltage.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Remove surface charge from battery by cranking the engine for 15 seconds.
5. Set JT05791A Digital Multimeter to measure voltage.

MX24808

6. Connect meter red lead to battery positive (+) terminal (A).

7. Connect meter black lead to battery negative (-) terminal (B).

8. Start and run engine at FAST idle.

9. Read meter several times during 5 minutes of running time. Voltage should remain at specification.

Specifications

Regulated Voltage. . . . . 14.3-14.7 volts

Results

- If the DC voltage remains below the minimum specification, perform unregulated voltage output tests. (See “Regulated Voltage Output Test” on page 448.)
- If the DC voltage goes above the maximum specification, replace the voltage regulator.

Starting Motor Cranking Amperage Draw Test

Reason

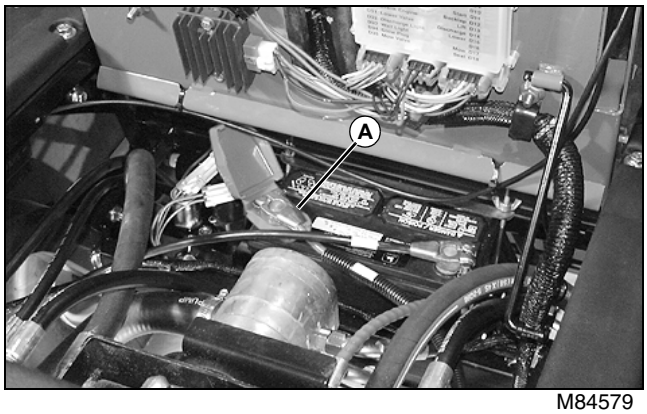
To determine the amperage required to crank the engine and check starter motor operation under load.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Current Clamp	JT02153	Used to measure starting motor current.
Digital Multimeter	JT05791	Used with current clamp.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Test system ground circuit connections. (See “Ground Circuit Test” on page 445.)
7. Test battery. (See “Battery Test” on page 446.)



M84579

8. Connect JT02153 Current Clamp around battery positive (+) cable.
9. Set multimeter to measure DC amperage.
10. Connect multimeter to current clamp.
11. Remove spark plug high-tension leads and ground to engine.

Important: Avoid Damage! Perform the following procedure within 15 seconds to prevent damage to electrical components.

12. Crank engine and read amperage on DC amp scale of multimeter.
13. Turn key switch to OFF position.

Specifications

Starting Motor Cranking Amperage Draw (maximum) at 225 engine RPM . . . . . .180 amps

Results

- If amperage is above specifications or rpm is low, check starter for binding or damage.
- If starter is good, check engine for internal binding or damage.

Starter No-Load Amperage and RPM Test

Reason

To determine if starter is binding or has excessive amperage draw under no-load.

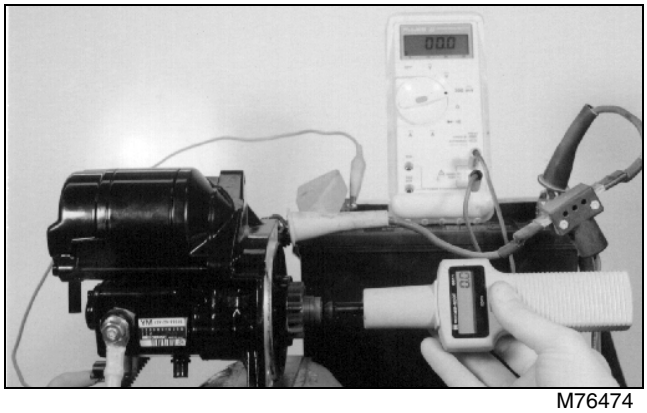
Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test starter no-load amperage and rpm.
Current Clamp-On Probe	JT02153	Used with multimeter to test current draw.
Hand Held Digital Tachometer	JT05719	Used to test starter no-load amperage and rpm.
One (1) Jumper Wire	N/A	Used to test starter no-load amperage and rpm.
One (1) Jumper Cable	N/A	Used to test starter no-load amperage and rpm.
12-Volt Battery	N/A	Used to test starter no-load amperage and rpm.

Procedure

Note: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



M76474

7. Install JT02153 Current Clamp-On Probe leads as follows:
   - Red male plug to VOLT/OHM socket on JT05719A Digital Multimeter.
   - Black male plug to COM socket on digital multimeter.
   - Shunt black clamp to the negative (-) battery post.
   - Shunt red clamp to starter case ground.
8. Set digital multimeter to read 300 mV.
9. Connect positive jumper cable between starter solenoid terminal and positive battery post.

Important: Avoid Damage! Complete the following step in 20 seconds or less to prevent starter damage.

10. Momentarily connect a jumper lead from positive battery post to small solenoid spade terminal. Solenoid should pull in and the drive gear and shaft should move out and spin.
11. Record amperage from multimeter.
12. Place JT05719 Hand Held Digital Tachometer drive cone against end of spinning starter drive gear, and record rpm.
13. Remove jumper from solenoid.

Results

- If amperage is above specification, check for binding or seized bearings, sticking brushes, and dirty or worn commutator. Replace starter.
- If starter passes no-load test but amperage draw remains high when mounted on engine, check internal engine components for binding, wear, or damage.

Specifications

Starting Motor No-Load Draw at 3000 RPM . . .90 amps

Starter Solenoid Test

Reason

To determine if starter solenoid is defective. The solenoid has separate pull-in and hold-in windings, which do not ground together. This test requires two ground jumper cables in order to test the winding.

Special or Required Tools

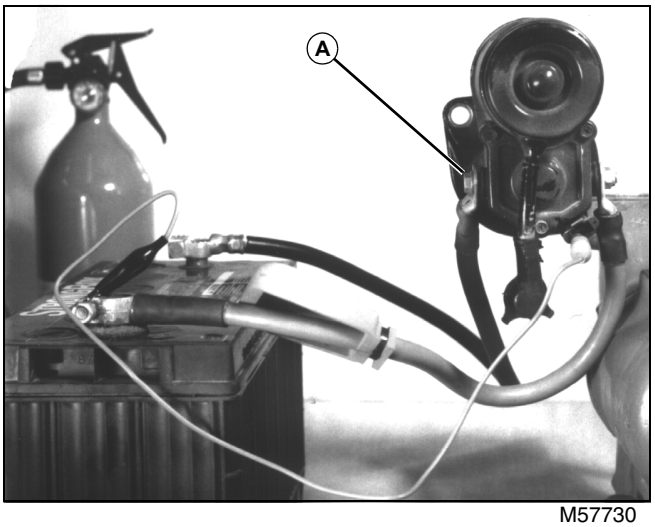
Tool Name	Tool No.	Tool Use
One (1) Jumper Wire	N/A	Used to test starter solenoid.
Two (2) Jumper Cables	N/A	Used to test starter solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
12-Volt Battery	N/A	Used to test starter solenoid.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect negative (-) battery cable clamp from battery.
5. Remove and tag all wires to the starter.
6. Remove starter from engine and mount to bench.



M57730

7. Disconnect starting motor lead from left side solenoid terminal (A).
8. Connect NEGATIVE jumper cable from the left side solenoid terminal to NEGATIVE battery post.
9. Connect POSITIVE jumper cable from the right side solenoid terminal to POSITIVE battery post.
10. Momentarily connect a jumper wire from the positive battery post to the small solenoid spade terminal. The solenoid should pull in and the drive gear should move out.
11. Remove the positive jumper wire to the solenoid spade terminal. The solenoid drive gear should move back.

Results

- The solenoid should pull in freely with a loud click when energized. The starter drive gear should move out.
- If solenoid does not move, disconnect jumper leads and try to pull drive gear out by hand by rotating counterclockwise:
  - If drive gear will not turn by hand, check starting motor for bad bearings, frozen armature, or sticking brushes.
- If drive gear turns but will not pull out, check solenoid plunger and shaft for binding.
- If drive gear turns and moves out freely, but solenoid does not energize, check continuity from solenoid primary spade terminal to left side terminal lug (where starting motor lead attaches). Maximum resistance should be 1.0 ohm through solenoid. Replace open or shorted coil solenoid.

Fuse Test

Reason

To determine if fuse has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test fuse continuity.

Procedure

1. Remove fuse to be tested.
2. Set ohmmeter to ohms function.

M48391

3. Connect one meter lead to one post of fuse. Connect other meter lead to other post of fuse.

Results

If there is no continuity between posts, replace fuse.

Diode Test

Reason

To determine if diode has failed.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test diode.

Procedure

1. Remove diode from connector.
2. Set meter to diode test.

3. Connect meter test lead to each lead of diode. Check for continuity.
4. Reverse test leads. Check for continuity.

Results

Diode must have a low resistance reading in one direction only. Replace defective diode.

Relay Test

Reason

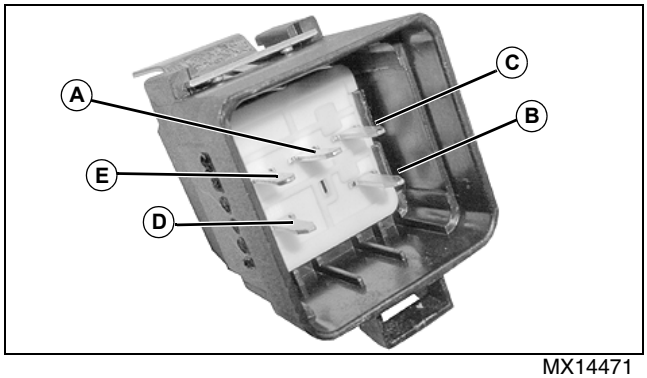
To determine if electrical relay coils are actuating correctly and resistance of relay contact points is correct.

Special or Required Tools

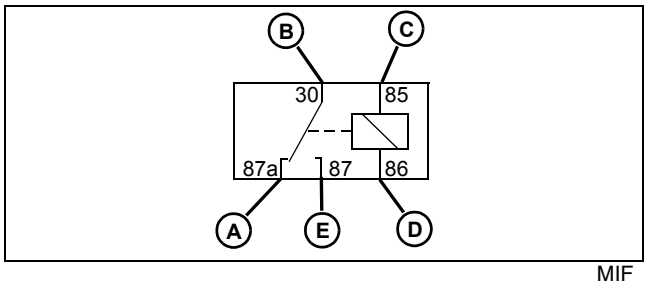
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test relays.
Jumper Wires (2)	NA	Used to test relays.
12-Volt Battery	NA	Used to test relays.

Procedure

Note: All relays function the same. The relay schematic below reflects the operation of the relays.



MX14471



MIF

1. Check terminal continuity using an ohmmeter or continuity tester.
   - Continuity should exist between relay terminals 87a and 30 (A and B) and between 85 and 86 (C and D).
   - No continuity between relay terminals 30 and 87 (B and E).
2. Connect jumper wire from battery positive (+) terminal to relay terminal 85 (C). Connect another jumper wire from relay terminal 86 (D) to battery negative (-) terminal.
   - Continuity could exist between relay terminals 30 and 87 (B and E).
   - No continuity between relay terminals 30 and 87a (B and A).

Results

If continuity is not correct, replace relay.

Key Switch Test

Reason

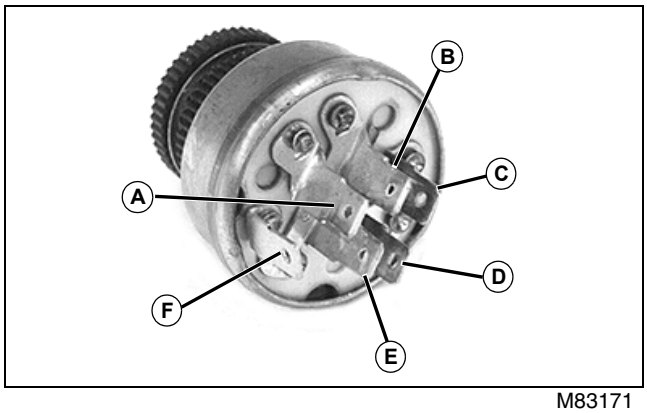
To verify that the key switch is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure key switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Raise hood.
6. Disconnect key switch connector.



M83171

7. Measure for continuity between switch terminals with switch in OFF, RUN, and START positions.

Note: DO NOT refer to markings stamped on terminals. Identify by art keys ONLY. Terminal combinations other than those listed should not have continuity.

Key Switch Continuity	
Switch Position	**Terminal Continuity**
OFF	C and D
RUN	E and F
START	E and F A and B

Results

If any continuity is NOT correct, replace the switch.

Park Brake and Mow-Transport Switch Test

Reason

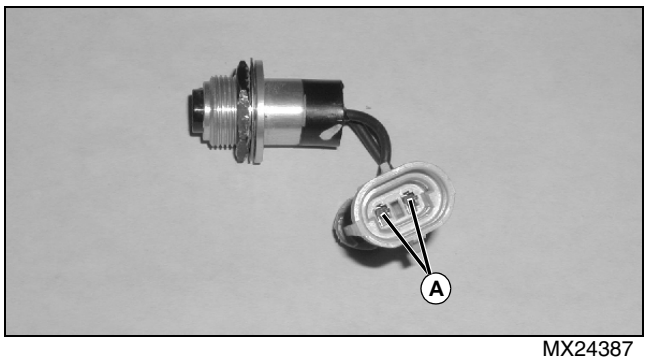
To verify continuity between the switch terminals when the switch is activated.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Disconnect switch connector.



MX24387

5. Check continuity across switch terminals (A). There should be no continuity.
6. Depress plunger.
7. Check continuity across terminals. There should be continuity.

Results

If continuity is not correct in either position, replace switch.

Neutral Switch Test

Reason

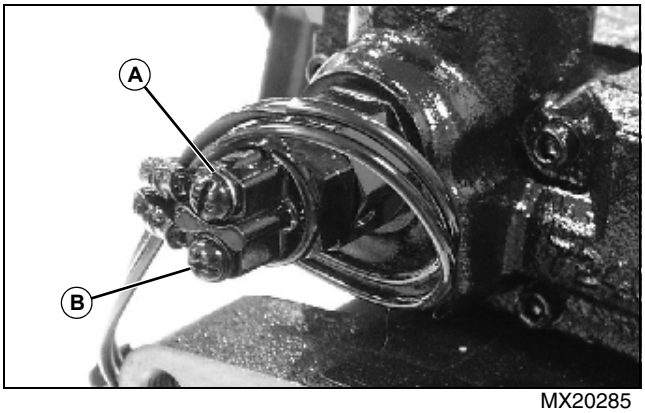
To verify continuity between the switch terminals when the switch is in the neutral position.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in UNLOCKED position.
5. Remove connector (X37) from neutral switch.



MX20285

6. Connect JT05791A Digital Multimeter leads to pairs of switch posts (A and B). Place the forward and reverse pedals in the neutral position. There should be continuity.
7. Move the forward or reverse pedals. There should be no continuity.

Results

- If switch does not pass all tests, replace switch.

Cruise Control Switch Test

Reason

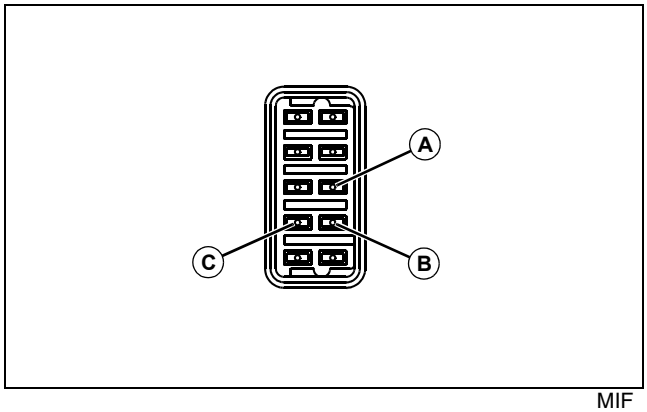
To verify continuity between the switch terminals when the cruise control switch has been activated.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Cruise control switch connector (X9) disconnected.
6. Cruise control switch in OFF position.



MIF

7. Check continuity with JT05791A Digital Multimeter across switch terminals (A and B) and switch terminals (A and C). There should be no continuity.
8. Cruise control switch in the ON position.
9. Check continuity with digital multimeter across terminals (A and B). There should be continuity, but there should be no continuity across terminals (A and C).
10. Cruise control switch in the SET position and hold.
11. Check continuity with digital multimeter across terminals (A and B) and terminals (A and C). There should be continuity.

Results

If switch shows no continuity or resistance higher than 0.05 ohm when contacts are closed, replace switch. If continuity is not correct in either position, replace switch.

Raise-Lower Switch Test

Reason

To determine if raise-lower switch is operating properly.

Special or Required Tools

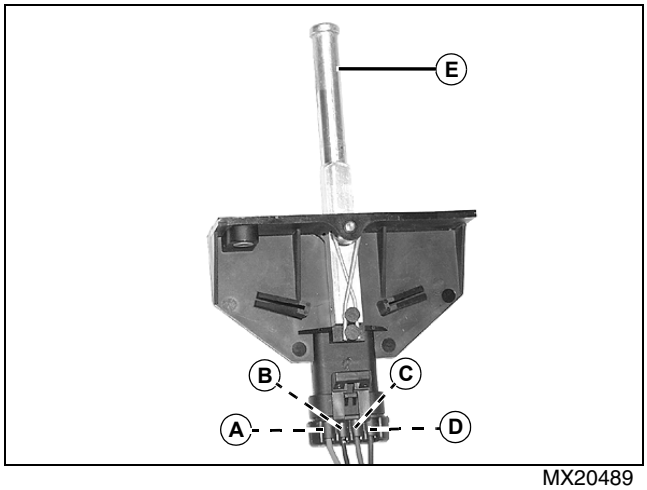
Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test raise-lower switch.

Procedure

Important: Avoid Damage! Do not use a diagnostic test light. It will damage the raise/lower switch.

Note: This switch can be checked using the white box input LED without disconnecting the switch and performing a component check. See "Raise-Lower Circuit Tests" on page 374.

1. Turn key switch to RUN position.



MX20489

2. With a small-diameter probe, connect meter negative (-) lead to raise-lower switch connector terminal (B) 100 Blk wire. With a small-diameter probe, connect meter positive (+) lead to raise-lower switch connector terminal (C) 224 Red wire. There must be battery voltage. If there is NO battery voltage, test raise-lower circuit.

3. Leave meter negative (-) lead connected to raise-lower switch connector terminal (B) 100 Blk wire for remainder of procedure.

4. With a small-diameter probe, connect meter positive (+) lead to raise-lower switch connector terminal (D) 608 Brn wire. Move raise-lower switch lever (E) to RAISE position. There must be battery voltage.

Move lever to the LOWER position. Voltage should go to 0.

5. With a small-diameter probe, connect meter positive (+) lead to raise-lower switch connector terminal (A) 300 Org wire. Move raise-lower switch lever (E) to RAISE position. There must be battery voltage.

Move lever to the LOWER position. Voltage should go to 0.

Results

- If voltage is not as specified, replace raise-lower switch.

Seat Switch Test

Reason

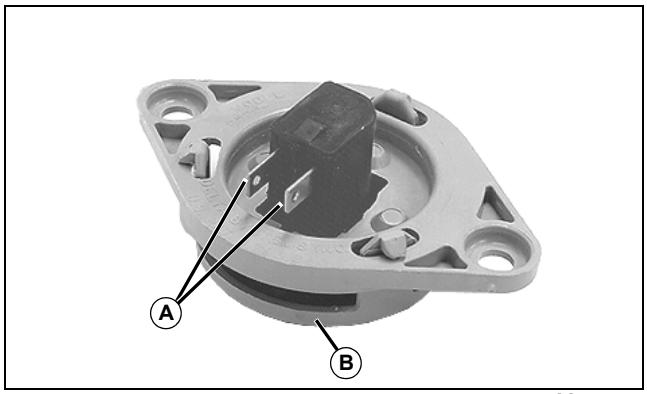
To verify continuity between the seat switch terminals when the operator is on the seat.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Raise and latch seat platform.
6. Disconnect seat switch connector.



M84358

7. Check continuity across switch terminals. There should be no continuity.
8. Depress plunger (B).
9. Check continuity across switch terminals (A). Continuity should exist between terminals.

Results

If continuity is not correct, replace the switch.

Raise or Lower Solenoid Test

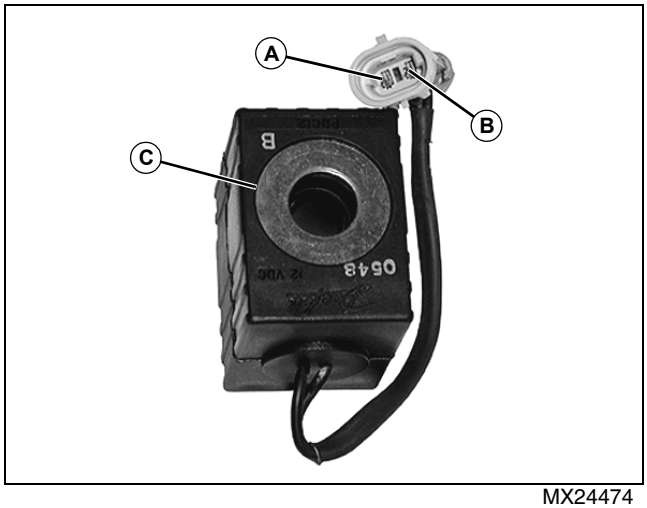
Reason

To determine condition of the raise or lower solenoid.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to test mow solenoid.

Procedure



MX24474

1. Measure resistance between solenoid connector terminals (A and B). Resistance must be within specification.

2. Check for grounds or shorts between solenoid terminals (A and B) and bare metal of the solenoid core (C). There must be NO continuity between terminal (A or B) and core.

Results

- If resistance between terminals is not within specification, replace solenoid.
- If continuity exists between terminal and core, replace solenoid.

Specifications

Raise Solenoid Resistance . . . . . 10 ± 2 ohms
Lower Solenoid Resistance. . . . . 10 ± 2 ohms

Hydraulic Temperature Switch Test

Reason

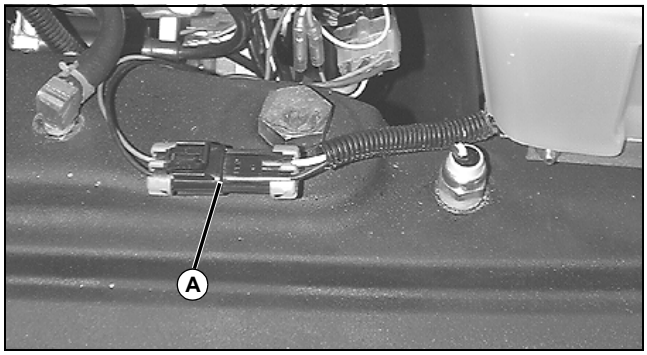
To verify the hydraulic oil temperature switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

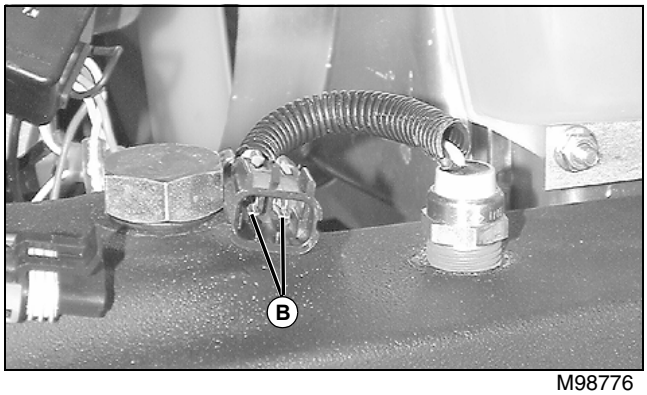
Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position and allow the hydraulic oil to cool to room temperature.
4. Lock park brake.
5. Raise hood.



M98650

6. Disconnect wiring connector (A).



M98776

7. Measure resistance across switch terminals (B). There should be no continuity across the terminals at room temperature.

Results

Replace the switch if continuity is read at room temperature.

Hydraulic Filter Restriction Switch Test

Reason

To determine if the hydraulic filter restriction switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test hydraulic filter restriction switch.

Procedure

1. Park machine on level surface.
2. Key switch in OFF position.
3. Park brake in LOCKED position.
4. Disconnect hydraulic filter restriction switch connector from main harness connector (MC8), 333 Grn wire and 104E Blk wire
5. Check for continuity with JT05791A Digital Multimeter between the switch connector terminals.
6. Start and run engine at FAST idle.
7. Check for continuity between the switch terminals.

Results

- There must be NO continuity between the switch terminals when hydraulic oil pressure is 207 kPa (30 psi) or lower.
- There must be continuity between the switch terminals when hydraulic oil pressure is 276 ± 28 kPa (40 ± 4 psi) or higher.
- If not to specification, replace hydraulic filter restriction switch.

Specifications

Hydraulic Filter Restriction Switch

Closing Pressure . . . . . .276 ± 28 kPa (40 ± 4 psi)
Opening Pressure. . . . . .207 kPa (30 psi)

Fuel Shutoff Solenoid Test

Reason

To verify proper fuel shutoff solenoid operation.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Ohmmeter	NA	Used to measure resistance of fuel shutoff solenoid coils.

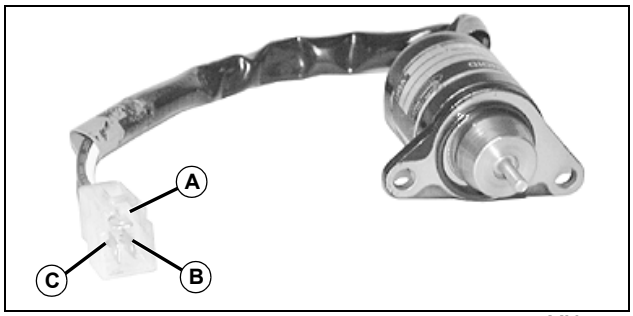
Procedure

1. Park machine safely on a level surface.
2. Disengage PTO.
3. Turn key switch to STOP position.
4. Move travel pedals to NEUTRAL position.
5. Lock park brake.
6. Turn key switch to RUN position. A click should be heard as the solenoid engages.

Results

- If a click is not heard, proceed to next step.

7. Open engine cover.
8. Disconnect the solenoid connector from the harness.



MX2492

9. Using an ohmmeter, check resistance across terminals (A and B). Resistance should be within specification for fuel shutoff solenoid pull-in coil.
10. Using an ohmmeter, check resistance across terminals (A and C). Resistance should be within specification for fuel shutoff solenoid hold-in coil.

Results

- If resistance is not to specifications, replace solenoid.

Specifications

Fuel Shutoff Solenoid Resistance

Pull-In Coil . . . . . .0.4 ohm
Hold-In Coil. . . . . .23.6 ohms

Fuel Pump Test

Reason

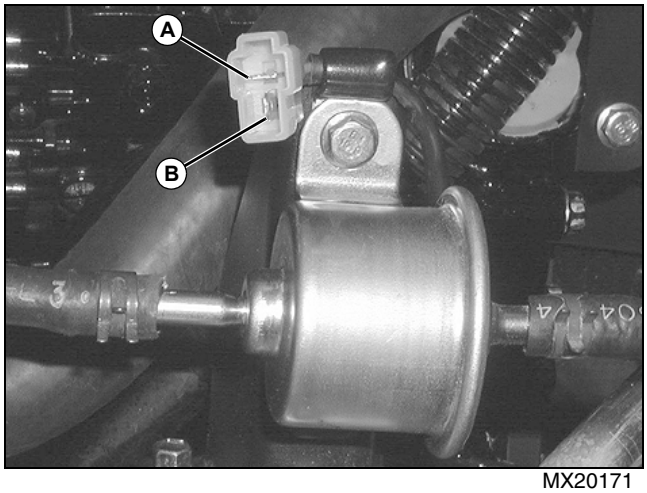
To determine if the fuel pump is operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Two (2) Jumper Wires	N/A	Used to test fuel pump.

Procedure

1. Disconnect fuel pump connector.



MX20171

2. Connect jumper wire from battery positive (+) terminal to fuel pump terminal (A).

3. Connect another jumper wire from battery negative (-) terminal to fuel pump terminal (B). Fuel pump must operate.

4. Reverse jumper wire connections, fuel pump terminal (A) to battery negative (-) terminal and fuel pump terminal (B) to battery positive (+) terminal. Fuel pump must not operate.

Results

- If fuel pump does not operate with correct polarity and power applied, replace fuel pump.
- If fuel pump operates with reverse polarity, internal diode is shorted. Replace fuel pump.

Engine Oil Pressure Switch Test - Diesel Engine

Reason

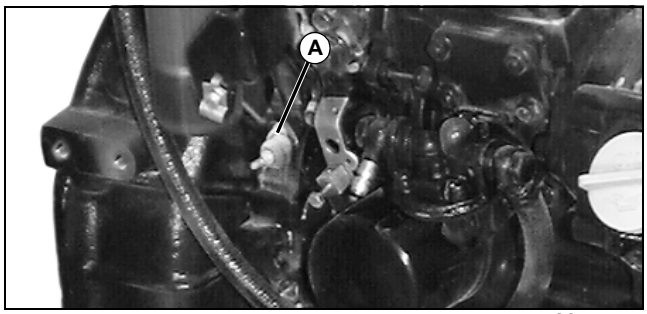
To determine if the engine oil pressure switch is functioning properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Turn key switch to STOP position.
4. Lock park brake.
5. Raise hood.
6. Disconnect 105 Brn wire from oil pressure switch.



M99029

7. Connect black lead of ohmmeter to engine block and red lead of ohmmeter to terminal of switch (A).

8. Measure resistance between the switch terminal and engine block. There should be continuity between switch terminal and ground.

9. Start and run engine at FAST idle.

10. Measure resistance between the switch terminal and engine block. There should be NO continuity between switch terminal and ground.

Results

Note: Apply pipe sealant with TEFLON® to threads of switch any time it is installed.

- If there is NO continuity between switch terminal and engine block (ground) with engine NOT running, replace the oil pressure switch.
- If the switch DOES have continuity between switch terminal and engine block (ground) with engine running, check oil pressure. If oil pressure is to specification, replace the oil pressure switch.

Engine Coolant Temperature Switch Test

Reason

To determine the operating temperature of the switch.

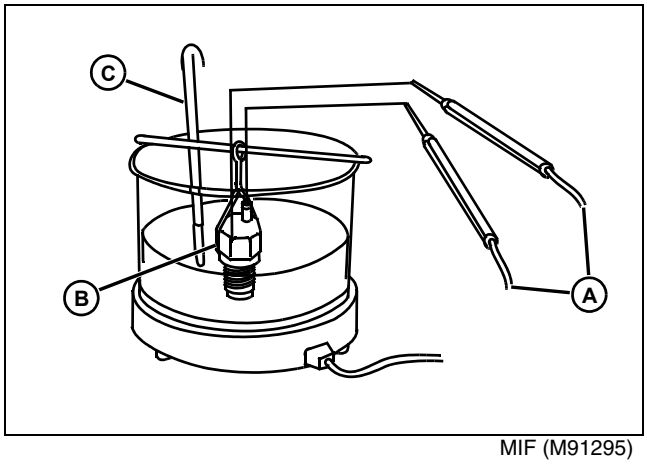
Special or Required Tools

Tool Name	Tool No.	Tool Use
Thermometer	NA	Used to measure water temperature.
Glass Container	NA	Used to contain water in test.
Heating Unit	NA	Used to heat water.
Ohmmeter	NA	Used to measure continuity.

Procedure

1. Park machine on level surface.
2. Remove coolant temperature switch.

Caution: Avoid Injury! DO NOT allow switch or thermometer to rest against the side or bottom of glass container when heating water. Either may rupture if overheated.



MIF (M91295)

3. Connect lead wires from ohmmeter probes (A) to switch terminal and body.
4. Suspend switch (B) and a thermometer (C) in a container of water and coolant mixture.
5. Heat and stir the mixture. Observe temperature when continuity occurs. Temperature must be to specification.
6. Install temperature switch using pipe sealant with TEFLON® in the threads. Tighten to specification.

Specifications

Engine Coolant Temperature Switch

Operating Temperature . . . . . 108-114°C (226-237°F)

Results

If continuity does not occur within specification, replace switch.

Headlight Switch Test (Optional)

Reason

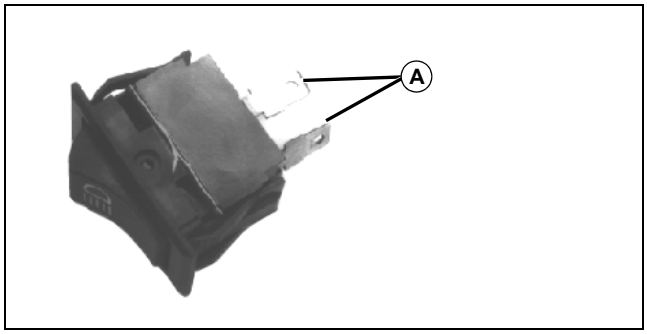
To verify that the headlight switch terminals have continuity when the headlight switch is ON.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine on level surface.
2. Lock park brake.
3. Turn key switch to STOP position.
4. Disconnect headlight switch connector.



M48378

5. Check continuity between switch terminals (A) with the switch in the ON and OFF positions.

Results

- If there is NO continuity with the switch in the ON position, replace the switch.
- If continuity exists with the switch in the OFF position, replace the switch.

Air Preheater Test

Reason

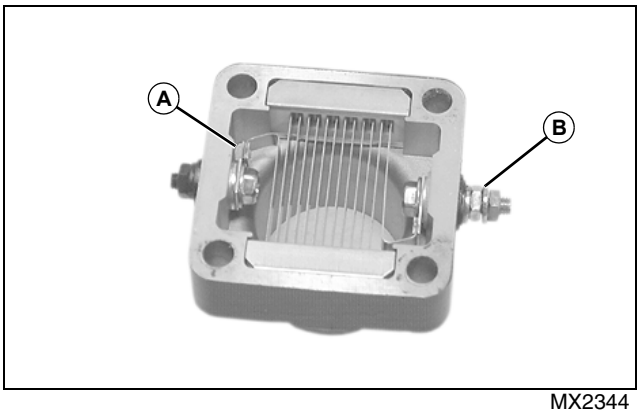
To test the condition of the engine air preheater.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure the resistance of the air preheater element.

Procedure

1. Remove air preheater.



MX2344

2. Measure the resistance with JT05791A Digital Multimeter between terminals (A and B). The reading must be to specification.

Results

If the resistance of the air preheater element is high or completely open, replace the element.

Specifications

Air Preheater

Element Resistance . . . . . 0.40-0.50 ohm

Cruise Control Magnet Test

Reason

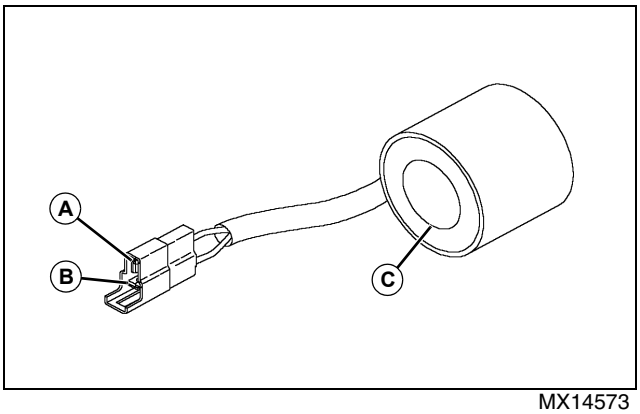
To determine condition of the cruise control magnet.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to test cruise control magnet.

Procedure

1. Disconnect cruise control magnet connector from main wire harness.



MX14573

2. Check resistance with JT05791A Digital Multimeter between cruise control magnet connector terminal (A and B). Resistance must be within specification.

3. Check for grounds or shorts between magnet terminals (A and B) and bare metal of the magnet core (C). There must be NO continuity between terminal (A or B) and core (C).

Results

- If resistance between terminals is not within specification, replace magnet core.
- If continuity exists between terminal and core, replace magnet core.

Specifications

Cruise Control Magnet Core

Coil Resistance . . . . . 20 ± 4 ohms

Reel Speed Potentiometer Test

Reason:

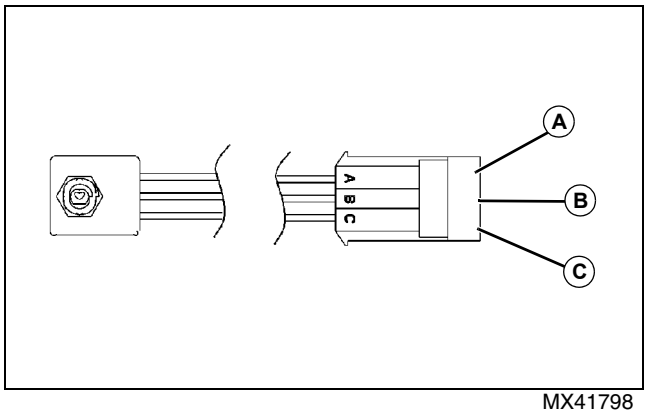
To check for correct potentiometer function if a related DTC/Fault code is displayed, or if reel speed cannot be adjusted properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to measure potentiometer continuity and output range.

Procedure:

1. Park machine on level surface.
2. Lower cutting units to the ground.
3. Key switch in OFF position.
4. Park brake in LOCKED position.
5. Disconnect reel speed control potentiometer.
6. Turn potentiometer fully to the high speed position.



MX41798

7. Measure resistance between pin (C) and pin (B).
8. Turn potentiometer fully to the low speed position.
9. Measure resistance between pin (C) and pin (B).
10. Measure resistance between pin (A) and pin (C).

Results:

If potentiometer does not meet specifications, replace potentiometer.

Specifications:

Pin C to Pin B (High Speed). . . . . .0.5k - 1.5k ohms
Pin C to Pin B (Low Speed) . . . . . .3.5k - 4.5k ohms
Pin A to Pin C . . . . . .4k - 6k ohms

Backlap Switch Test

Reason

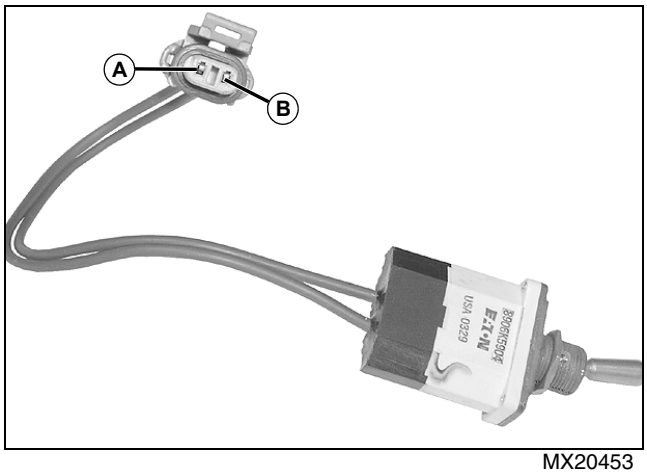
To verify proper backlap switch operation.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to measure switch continuity.

Procedure

1. Park machine safely on a level surface.
2. Turn key switch to STOP position.
3. Lock park brake.
4. Disconnect backlap switch connector and remove switch.
5. Use an ohmmeter to test switch continuity.



MX20453

6. Test continuity between switch terminals (A and B) with the switch in the MOW and BACKLAP positions.

Backlap Switch Continuity	
Switch Position	**Terminal Continuity**
Mow	No Continuity
Backlap	Continuity

Results

- If continuity is not correct, replace switch.

Reel Motor Forward-Reverse Switch Test

Reason

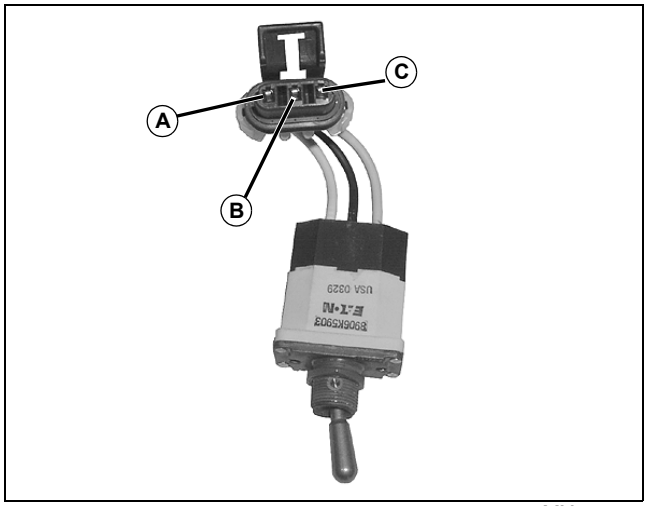
To verify proper reel motor forward-reverse switch operation.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791	Used to check continuity of reel motor forward-reverse switch.

Procedure

1. Park machine safely on a level surface.
2. Turn key switch to STOP position.
3. Lock park brake.
4. Disconnect reel motor forward-reverse switch connector and remove switch.
5. Use an ohmmeter to test switch continuity.



MX20452

Reel Motor Forward-Reverse Switch Continuity	
Switch Position	**Terminal Continuity**
Forward	B and C
Reverse	B and A

Results

- If continuity is not correct, replace switch.

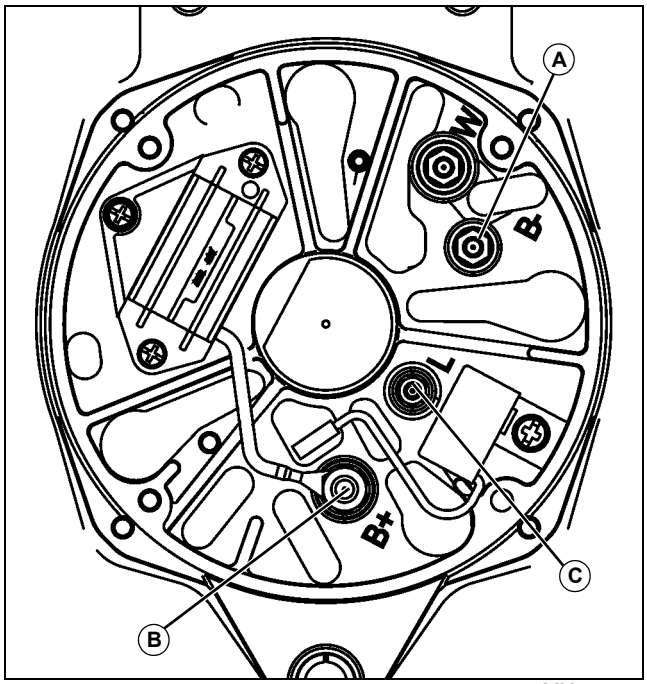
48V Alternator Voltage Output Test

If a reel motor does not operate or operates erratically, test the reel motor. (See “Reel Motor Test” on page 464.)

48 Volt Alternator Circuit Diagnosis

Test Conditions

- Machine parked on a level surface.
- Cooling duct removed from rear of alternator.
- Key switch in RUN position (engine operating at medium idle).
- Mow-transport lever in the MOW position.
- Meter negative (-) lead on battery negative (-) terminal or chassis ground.
- Check connections for corrosion and looseness when testing.



MX41794

1. Measure ground circuit resistance at 48 volt alternator B- terminal (A) to frame ground. Is resistance at or less than 0.1 ohm?

Yes: Go to next step.

No: Check 130 and 131 Blk ground wire and alternator brackets.

2. Check condition of ground terminals. Are the ground terminals clean?

Yes: Go to next step.

No: Clean and tighten terminals.

3. Measure voltage at 48-volt alternator regulator

power terminal L, 783D Blu wire (C). Is battery voltage ±10% present?

Yes: Go to next step.

No: Check 783D Blu wire and connections between K6 PTO relay and 48-volt alternator field terminal.

No: Test PTO circuit.

4. Measure voltage at 48-volt alternator positive (+) output terminal B+, 230 Red wire (C). Is voltage in the range of 48Vdc ±10%?

Yes: Go to next step.

No: Replace 48-volt alternator.

48V Alternator Current Output Test

Reason:

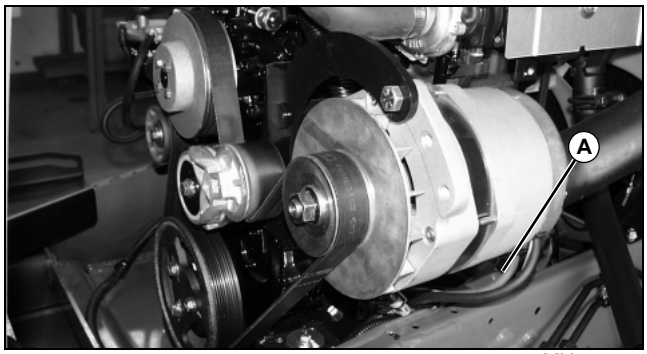
To determine if the 48V alternator adequate current output to supply the reel controllers.

Required Tools:

DC Clamp-On inductive ammeter

Procedure:

1. Park machine on a level surface with park brake locked and key switch off.



MX41989

2. Locate positive Red cable (A) at rear of 48V alternator.
3. Clamp DC inductive ammeter to positive cable.
4. Start unit and engage the reel motors.
5. Measure the current draw displayed on the ammeter.
6. Current draw should be within specifications.

Note: Current draw will vary based on reel bedknife clearance. If readings are incorrect, check/adjust bedknife clearance. See Attachments section adjustment for installed type reel.

Specifications:

Nominal Current Draw . . . . . 120A (sustained)
Current Draw. . . . . 150A (peak)

Diode Pack AMT386 Test

Reason

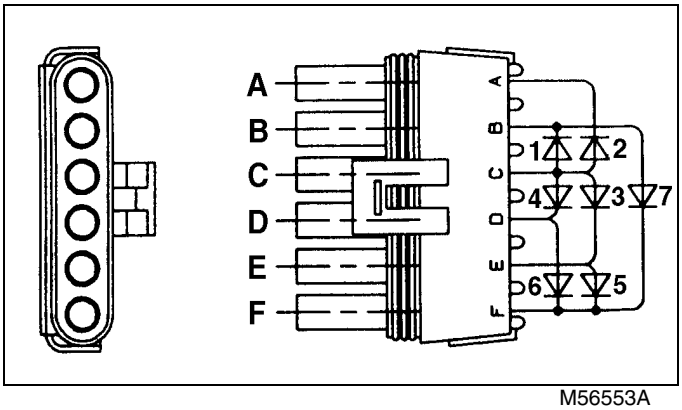
To verify proper operation of the diode pack

Special or Required Tools

Tool Name	Tool No.	Tool Use
Digital Multimeter	JT05791A	Used to test diode pack

Procedure

1. Park machine on level surface.
2. Move control levers to NEUTRAL position.
3. Key switch in OFF position.
4. Park brake in LOCKED position.



M56553A

1. Remove diode pack and test with a JT05791A Digital Multimeter or a diode tester as follows.

Diode	Red Lead	Black Lead	Result
1	C	B	Continuity
1	B	C	No Continuity
2	C	A	Continuity
2	A	C	No Continuity
3	C	E	Continuity
3	E	C	No Continuity
4	C	D	Continuity
4	D	C	No Continuity
5	E	F	Continuity
5	F	E	No Continuity
6	D	F	Continuity
6	F	D	No Continuity

Diode	Red Lead	Black Lead	Result
7	B	F	Continuity
7	F	B	No Continuity
4 and 6 3 and 5	C	F	Continuity
4 and 6 3 and 5	F	C	No Continuity

Results

- If any of the tests are not to the chart replace diode pack.

Reel Motor Test

Special or Required Tools

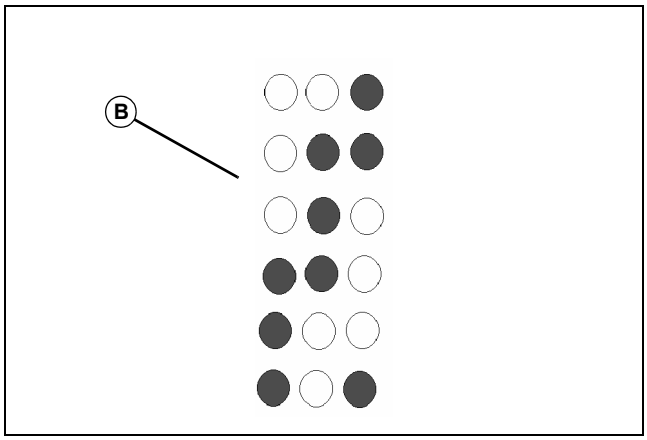
Tool Name	Tool No.	Tool Use
Diagnostic Tool	JDG10429	Used to test electric reel motor.

Reason

To determine if reel motor is operating properly.

Procedure

1. Machine parked on a level surface.
2. Key switch in STOP position.
3. Brake pedal in LOCKED position.
4. Connect reel motor 6-pin connector (A) to the diagnostic tool.



MX23605

5. When the gear on the motor is rotated, the diagnostic tool will light the LEDs in the order as indicated on pattern (B). Depending on the direction the gear is rotated, the pattern may be indicated in the reverse order. Amber LED must be ON at all times.
6. While rotating the gear, move the wires near the connector terminals. Observe the light pattern. An erratic light pattern indicates a broken wire. Use the following chart to pinpoint which wire is broken:

Symptom	Probable Cause
No lights.	Broken black wire or contamination of the black wire terminal.
No red lights.	Broken red wire or contamination of the red wire terminal.
No amber light.	Broken blue wire or contamination of the blue wire terminal.
One red light not functioning.	Broken green, white, or orange wire or contamination of one of these terminals.

7. Repair broken wires and clean terminals as needed. (See “Repair Reel Motor Wiring Harness” on page 470.)
8. While rotating the gear, move the wire harness at the area where the harness enters the body of the motor. Observe the light pattern. If any of the lights flickers or goes out while moving the wire harness, replace the motor.

Results

- Repair broken wires and clean terminals as needed.
- If a broken wire is determined to be near or inside the motor body, the motor must be replaced.

Reel Motor Wiring/Phase Test

Reason:

To test the motor internal phase to phase resistance in order to troubleshoot erratic motor performance.

Required Tools:

- Digital Multimeter

Procedure:

Important: Avoid Damage! Perform this procedure only if all other diagnostics (Service ADVISOR or Blink Codes) have been performed. Repeated disconnection of connectors will cause damage to the connector.

1. Park machine safely with park brake locked.
2. With key switch off, disconnect reel motor phase

connector from controller.

3. Measure for continuity between all pin combinations.

Important: Avoid Damage! Do not cut or remove conduit from phase wires. If wiring is damaged within conduit, motor must be replaced.

4. If continuity is not present, check for damaged wiring or connectors (exposed from conduit).

5. While connected to multimeter, move wiring to different positions and note if continuity changes sporadically. If so, this is indicative of faulty wiring or connector.

6. If continuity is not present or does not change, replace reel motor. if repair not possible.

Specification:

Continuity between all phase combinations . . . . . Motor external wiring OK

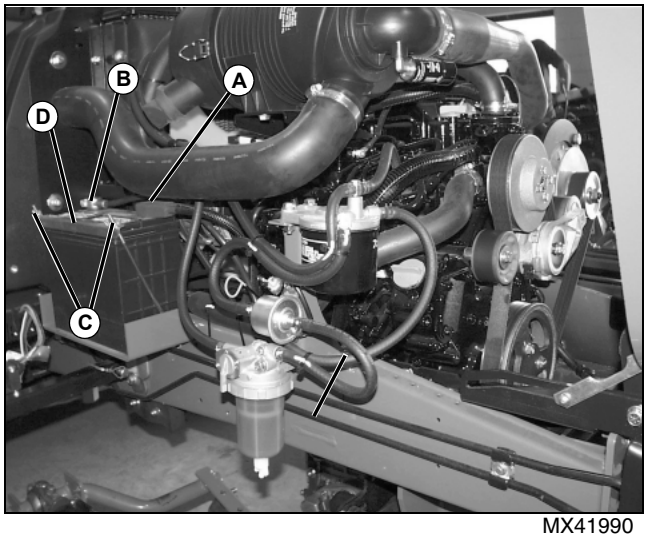
Repair

Remove and Install Battery

Caution: Avoid Injury! Battery electrolyte contains sulfuric acid. It is poisonous and can cause serious burns:

- **Wear eye protection and gloves.**
- **Keep skin protected.**
- **If electrolyte is swallowed, get medical attention immediately.**
- **If electrolyte is splashed into eyes, flush immediately with water for 15-30 minutes and get medical attention.**
- **If electrolyte is splashed onto skin, flush immediately with water and get medical attention if necessary.**

1. Raise and latch seat platform.



MX41990

2. Disconnect negative (-) cable (B) first, then positive (+) cable (A).
3. Remove wing nuts (C) and bracket (D).
4. Remove battery.

Installation

Installation is done in the reverse order of removal.

- Clean battery if dirty. (See “Clean Battery” on page 466.)
- Inspect battery terminals and case for breakage or cracks. Replace if needed.
- Test battery condition. (See “Battery Test” on page 446.)
- Connect negative (-) cable last.

Clean Battery

1. Remove battery from machine. (See “Remove and Install Battery” on page 466.)

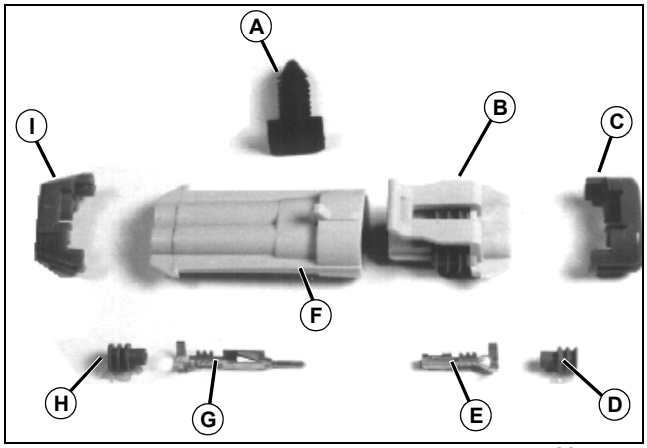
Note: Keep cleaning solution out of battery cells.

2. Clean battery, battery terminals, cable ends, bracket and battery box with a solution of one part baking soda and four parts water.
3. Rinse all parts with clean water. Let dry thoroughly.
4. Apply petroleum jelly to battery terminals to prevent corrosion.

Remove METRI-PACK™ Connector

Special or Required Tools

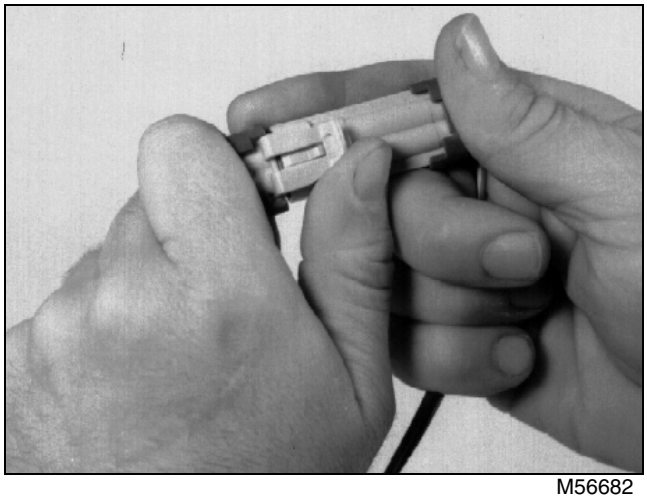
Tool Name	Tool No.	Tool Use
Terminal Removal Tool	JSG777	Used to depress locking tang and remove contact.



M56685

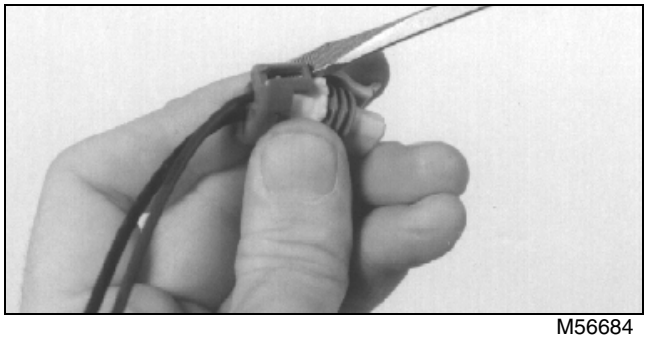
A- Mounting Post (Optional)
B- Sleeve Body
C- Wire Retainer
D- Sure-Seal
E- Sleeve
F- Pin Body
G- Pin
H- Sure-Seal
I- Wire Retainer

Important: Avoid Damage! Identify wire number/ color locations with connector terminal letters.



M56682

1. Open connector body.

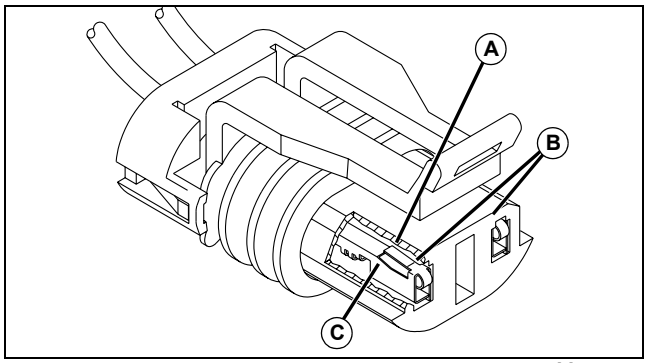


M56684

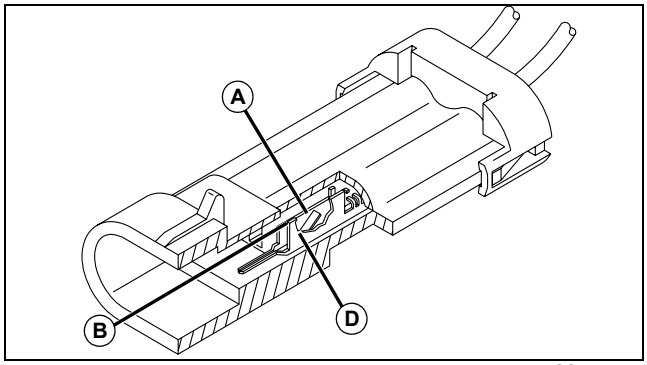
2. Remove retainer on wire end of connector with a screwdriver.

Important: Avoid Damage! Insertion of the tool in the correct location is critical when removing contact from connector body. Incorrect insertion can damage connector.

Note: To remove sleeve contact from sleeve body (short connector half), insert the tool in slot between terminal contact and connector body. To remove pin contact from body (long connector half), insert tool in center of contact.



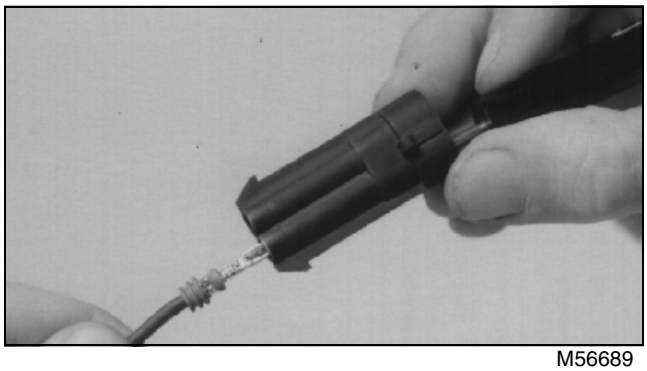
M83501



M83502

A- Locking Tang
B- Tool Insertion Point
C- Sleeve Contact
D- Pin Contact

3. Use JSG777 Terminal Removal Tool to depress locking tang. Remove contact from connector body.



M56689

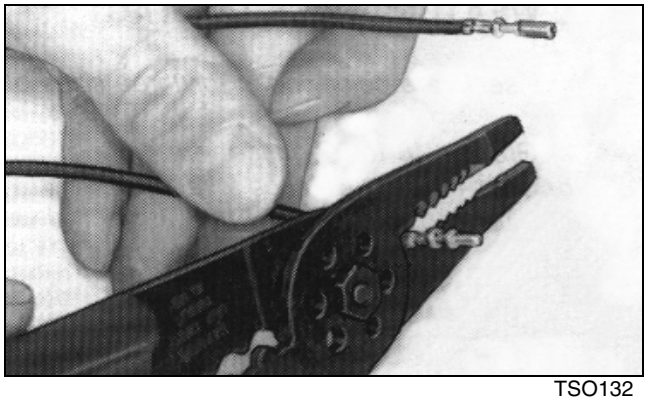
4. Hold the removal tool fully seated and pull wire from connector body.

Replace METRI-PACK™ Connector

Special or Required Tools

Tool Name	Tool No.	Tool Use
Universal Electrical Pliers	JDG145	Used to cut wire.
Crimper	JDG865	Used to crimp contact in place on wire and secure cable seal to contact.

1. Remove wire from connector.



TSO132

2. Use JDG145 Universal Electrical Pliers to cut wire as close as possible to connector.

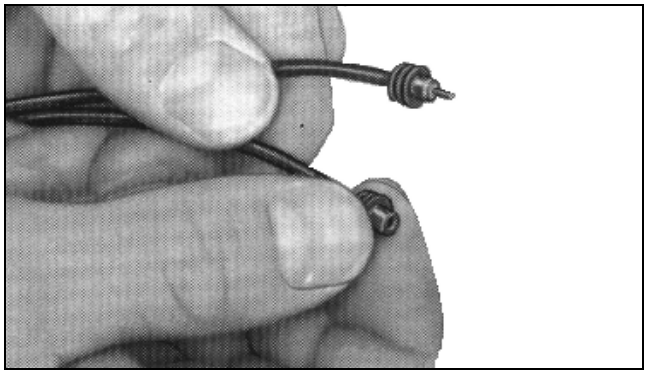
Important: Avoid Damage! METRI-PACK™ connectors are "keyed" (A, B, C, etc.) for proper contact mating. Be sure contacts and wire color/ numbers match and are in proper alignment.

Note: Cable seals are available for three sizes of wire:

Large - 1.0 mm (16 gauge) wire

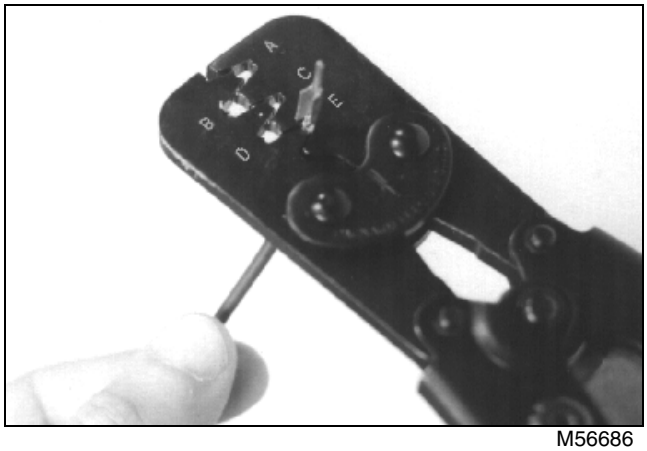
Medium - 0.8 mm (18 gauge) wire

Small - 0.5 mm (20 gauge) wire



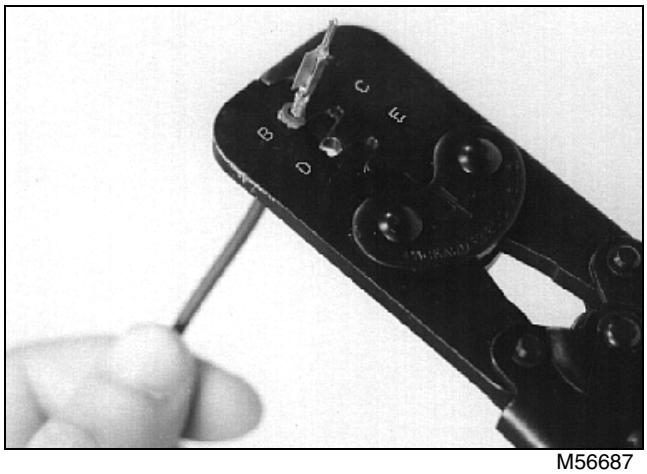
TSO136

3. Remove enough insulation to expose 6 mm (0.25 in.) of wire. Align cable seal with edge of insulation.



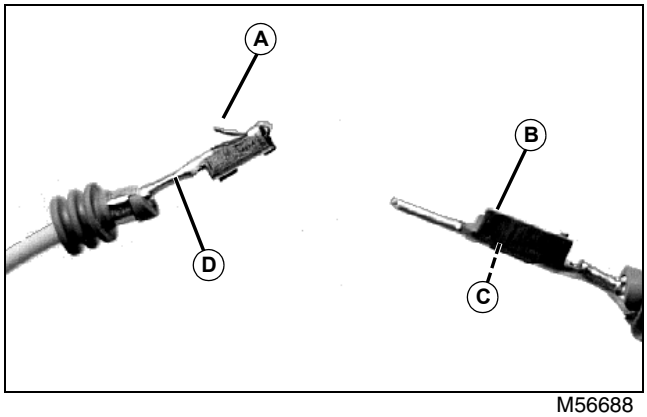
M56686

4. Place proper size contact on wire and use JDG865 Crimper to crimp contact in place with a "W" type crimp.



M56687

5. Use JDG865 Crimper to secure cable seal to contact as shown.

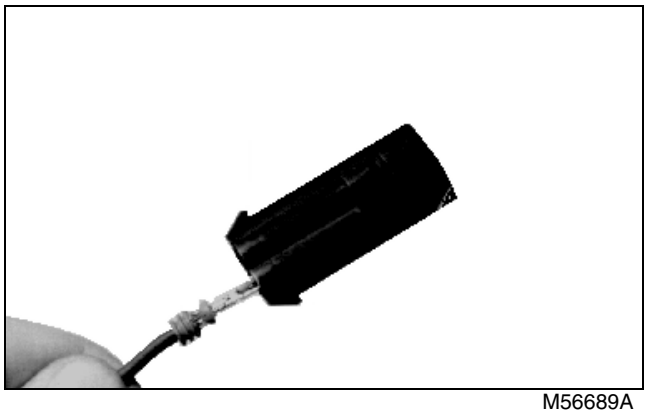


M56688

A- Barb
B- Pin
C- Barb (Inside)
D- Sleeve

Important: Avoid Damage! Proper barb location and orientation for installation of sleeve and pin is shown.

Note: Connector bodies are "keyed" for proper contact mating. Be sure contacts are in proper alignment.

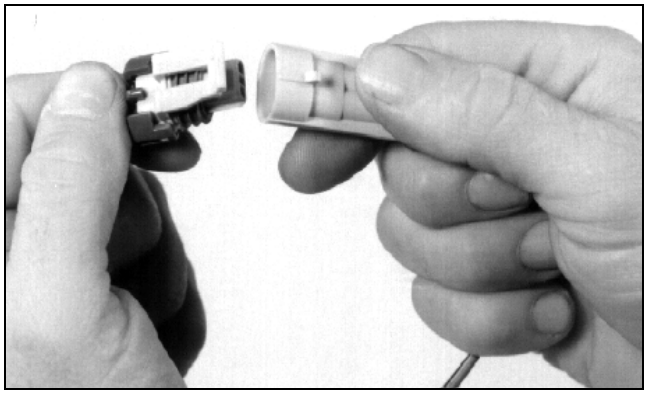


M56689A

6. Push contact into new connector body until fully seated.

7. Pull on wire slightly to be certain terminal is locked in place.

8. Install wire retainer.



M56683

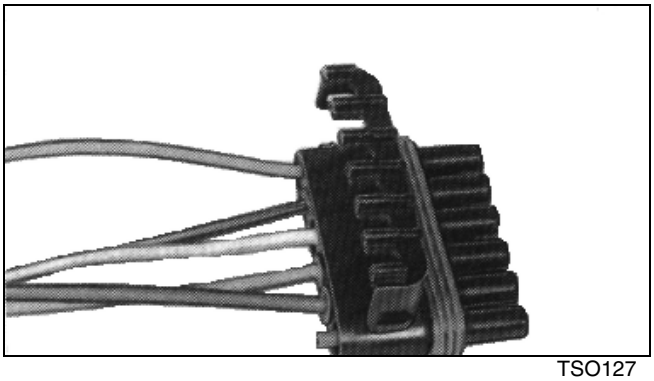
9. Transfer remaining wires to correct terminal in new connector.

10.Place retainer on wire end of connector and strap in place.

11.Close connector body.

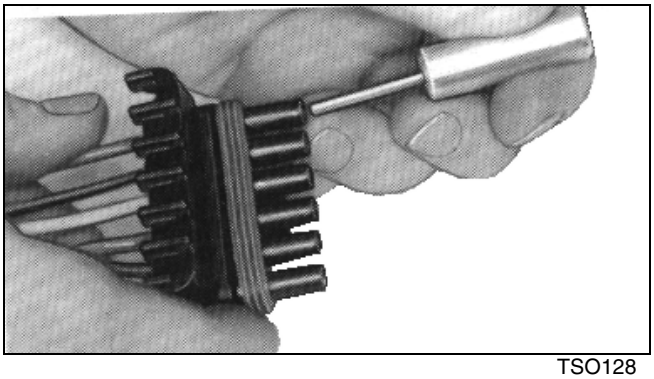
Remove WEATHER PACK™ Connector

Important: Avoid Damage! Identify wire color locations with connector terminal letters.



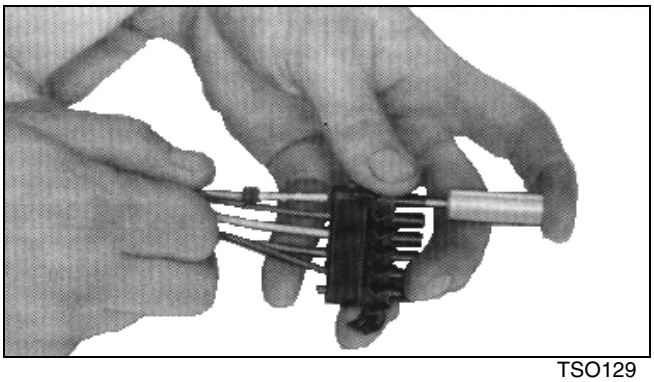
TSO127

1. Open connector body.



TSO128

2. Insert JDG364 Extraction Tool over terminal contact in connector body.



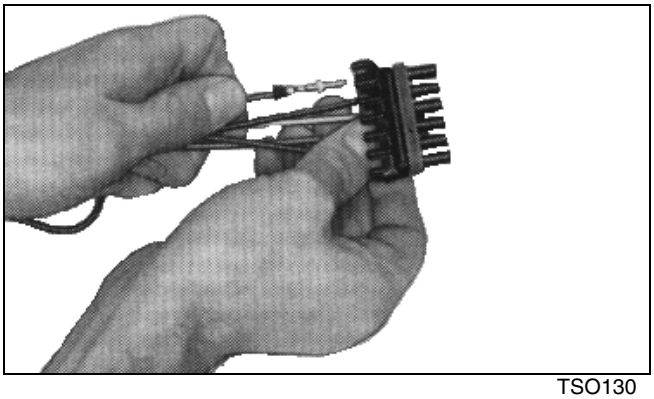
TSO129

3. Hold the extractor tool fully seated and pull wire from connector body.

Important: Avoid Damage! Carefully spread contact lances to ensure good seating on connector body.

Note: If terminal cannot be removed, insert wire or nail through extractor tool handle and push terminal contact from connector.

Connector bodies are "keyed" for proper contact mating. Be sure contacts are in proper alignment.


TSO130

4. Push contact into new connector body until fully seated.

5. Pull on wire slightly to be certain contact is locked in place.

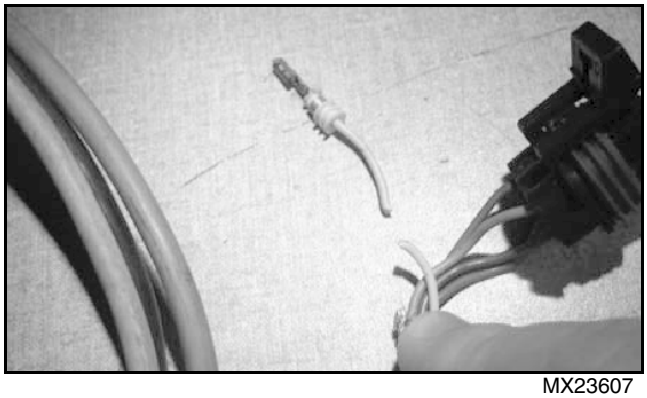
6. Transfer remaining wires to correct terminal in new connector.

7. Close connector body.

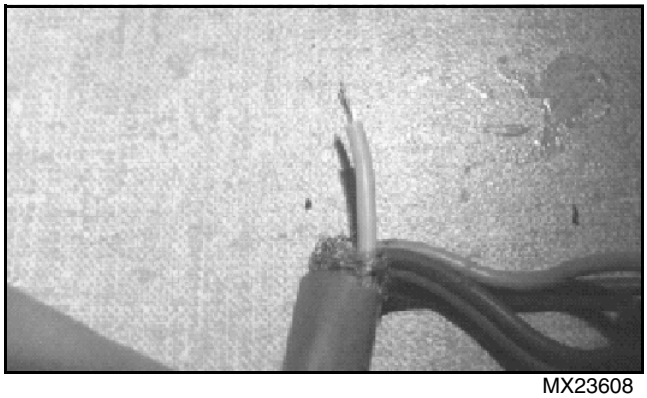
Repair Reel Motor Wiring Harness

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pin Extraction Tool	JDG777	Used to extract terminals.
Crimper	JDG865	Used to crimp terminals in place on wire and secure cable seal to terminal.

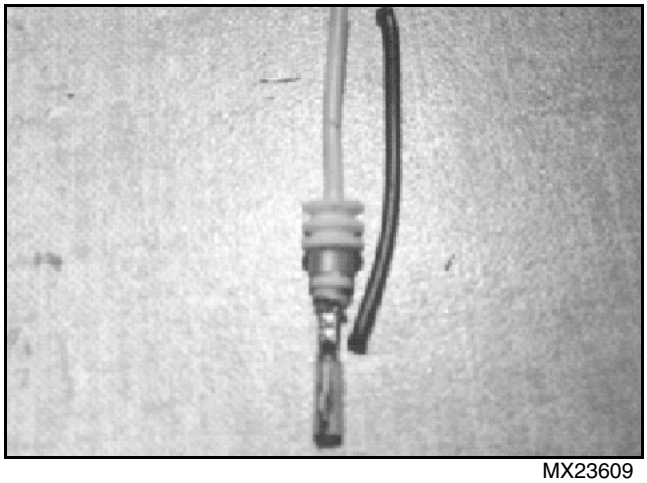

MX23607

1. Cut the wire where it is broken.

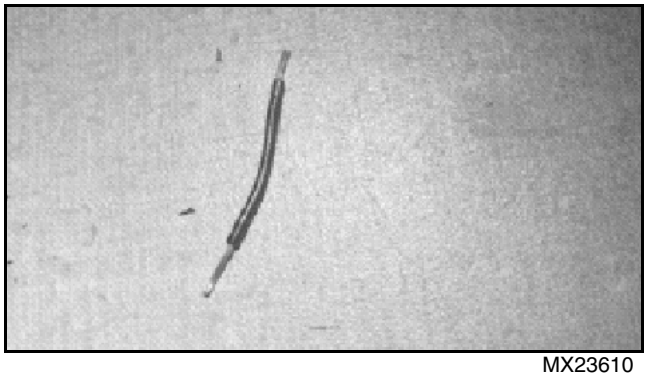

MX23608

2. Strip back the motor end of the wire so that it can be soldered later.

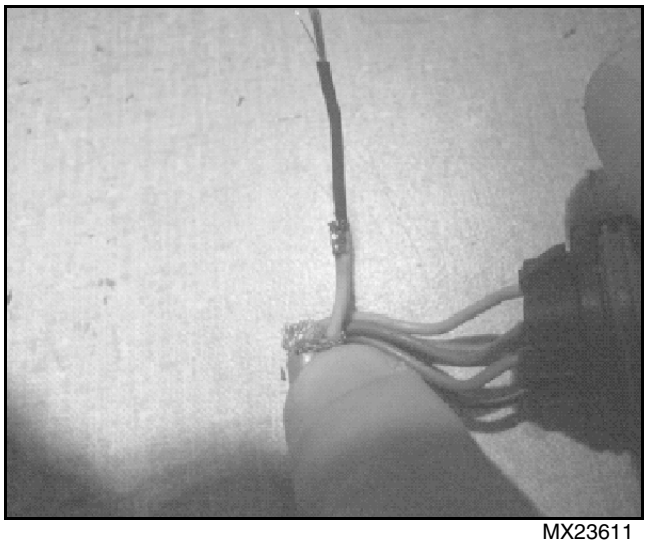
Note: When performing this repair in the field, use the same color wire as the wire that is broken. Black wire has been used in these instructions for clarity.


MX23609

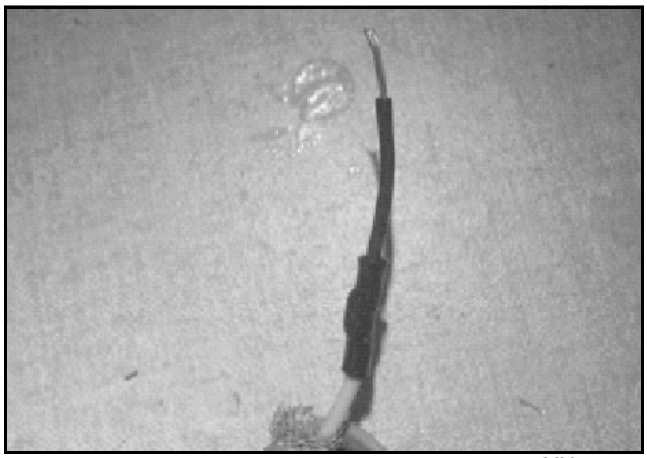
3. Measure a length of 16-gauge wire that is the same length as the broken wire, measuring from the break to the end of the crimp on the connector. It is very important that this wire be the same length as the other wires, or increased breakage of this wire or other wires could occur.


MX23610

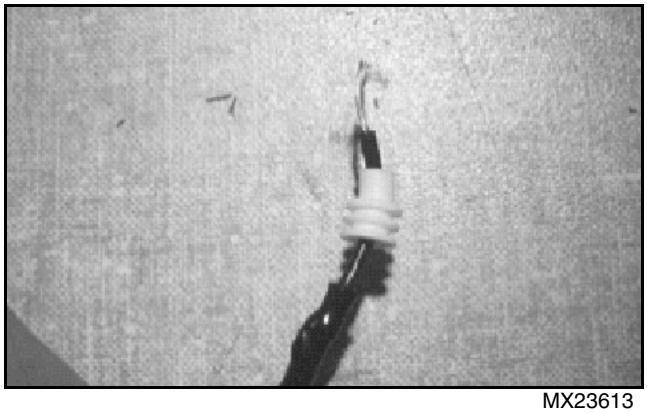
4. Strip the ends of the repair wire that you have cut.


MX23611

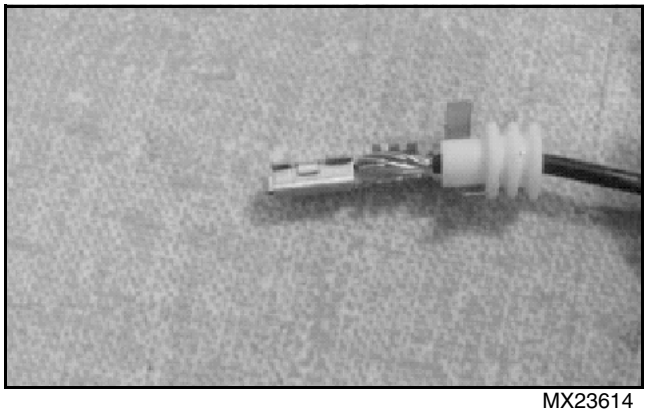
5. Solder the repair wire to the motor end of the broken wire. Ensure that you have a good, strong solder joint.


MX23612

6. Place a length of shrink tubing over the solder joint. Heat the tubing and seal the joint. It is very important to do this so that the exposed wires do not corrode or rust.


MX23613

7. Place a 57M7258 wire seal on the wire.


MX23614

8. Place a new R104846 terminal onto the wire.

MX23615

9. Crimp the terminal and the seal onto the wire using JDG865 crimper.

10. Reinsert repaired wire with terminal back into the connector body. Ensure that the terminal locks in place. Test the repaired motor on a machine and ensure that the motor is functioning correctly.

HYDROSTATIC POWER TRAIN TABLE OF CONTENTS

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Specifications

General Specifications

Triple Charge Pump (Front Gear Set)

Make	Hema
Flow	19.6 L/min (5.2 gpm)

Filter

Type	Spin on
Filter Bypass	345 kPa (50 psi)
Filter Restriction Indicator	276 kPa (40 psi)

Hydrostatic Transmission (7000 Series)

Make	Eaton
Model	72400 Series
Displacement	40.6 cm^3/rev (2.48 in^3/rev)
Type	Servo Controlled Variable Displacement Piston Pump
Main Relief Valve Setting	31 026 ± 1379 kPa (4500 ± 200 psi)
Charge Relief Valve Setting	1241 - 1517 kPa (180 - 220 psi)

Hydrostatic Transmission (8000 Series)

Make	Eaton
Model	72400 Series
Displacement	49.2 cm^3/rev (3.00 in^3/rev)
Type	Servo Controlled Variable Displacement Piston Pump
Main Relief Valve Setting	31 026± 1379 kPa (4500 ± 200 psi)
Charge Relief Valve Setting	1241 - 1517 kPa (180 - 220 psi)

Front Wheel Motors (7000 Series)

Make	Parker Hannifin
Left Model	TH Series
Right Model	TH Series
Displacement	280 cc^3/rev (17.1 in^3/rev)

Front Wheel Motors (8000 Series)

Make	Parker Hannifin
Left Model	TH Series
Right Model	TH Series
Displacement	310 cc^3/rev (19.0 in^3/rev)

Rear Wheel Motors (8700 and 8800)

Make	Parker Hannifin
Model	TF Series
Displacement	240 cc^3/rev (14.5 in^3/rev)

HYDROSTATIC POWER TRAIN SPECIFICATIONS

Repair Specifications

Hydrostatic Transmission (7000 and 8000 Series)

Needle Bearing Recessed Inside Bore	1.8 mm (1/16 in.)
Pump Piston Distance from Edge of Cylinder (Installed)	12.7 mm (0.500 in.)
Gerotor Bearing Position in Bore	2.29 mm (0.090 in.)
Roll Pin Protrusion from Backplate	4.39 mm (0.173 in.)
Backplate Assembly Resting Position	1.5 mm (0.06 in.)
Gerotor Bearing Race Position in Bore	2.41 mm (0.095 in.)

Torque Specifications

Hydrostatic Transmission

Cylinder Cap and Gasket (w/ Piston Screw Hole in Center) Mounting Screw	5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Outside Jam Nut	17.5 ± 1 N•m (155 ± 5 lb-in.)
Cylinder Cap and Gasket Mounting Screw	5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Servo Valve Feedback Rod Mounting Screw	5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Cradle Mounting Screw	36 ± 2 N•m (26 ± 2 lb-ft)
Wear Plate Retaining Screw	1.7 ± 0.1 N•m (15 ± 1 lb-in.)
Gerotor Housing Cap Screw (4 used)	40 ± 2 N•m (29 ± 2 lb-ft)
Main Drive Pressure Relief Valve	143 ± 6 N•m (105 ± 5 lb-ft)
Charge Pump Relief Valve	39 ± 2 N•m (29 ± 1 lb-ft)
Manual Servo Control Set Screw	2-3 N•m (17-25 lb-in.)

Front Wheel Motors

Disc Brake Rotor Nut	190 - 217 N•m (140 - 160 lb-ft)
Wheel Motor Mount Cap Screw	142 N•m (105 lb-ft)
B Nut at T Fitting	142 N•m (105 lb-ft)
90° Fitting at Wheel Motor	81 N•m (60 lb-ft)
B Nut at Wheel Motor	68 N•m (50 lb-ft)

Hydrostatic Pump

90° Fitting	108 N•m (80 lb-ft)
B Nut at 90° Fitting	95 N•m (70 lb-ft)
B Nut at Straight Fitting	95 N•m (70 lb-ft)

Rear Wheel Motors

Disc Brake Rotor Nut	190 - 217 N•m (140 - 160 lb-ft)
Wheel Motor Mount Cap Screw	142 N•m (105 lb-ft)
45° Fitting at Wheel Motor	81 N•m (60 lb-ft)
B Nut at Wheel Motor	68 N•m (50 lb-ft)
Hose to Tube Fittings	68 N•m (50 lb-ft)

4wd Valve

Straight Fitting	81 N•m (60 lb-ft)
B Nut at Straight Fitting	68 N•m (50 lb-ft)
90° Fitting	156 N•m (115 lb-ft)
B Nut at 90 °Fitting	142 N•m (105 lb-ft)

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D010744AA	Used to measure hydraulic circuit flow.
Pressure Diagnostic Kit	JDG2031	Used to test hydraulic pressure.
Diagnostic Flow Kit	JDG2032	Used to test hydraulic circuit flow.
Pressure Gauge Kit	JDG2033	Used to measure hydraulic pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

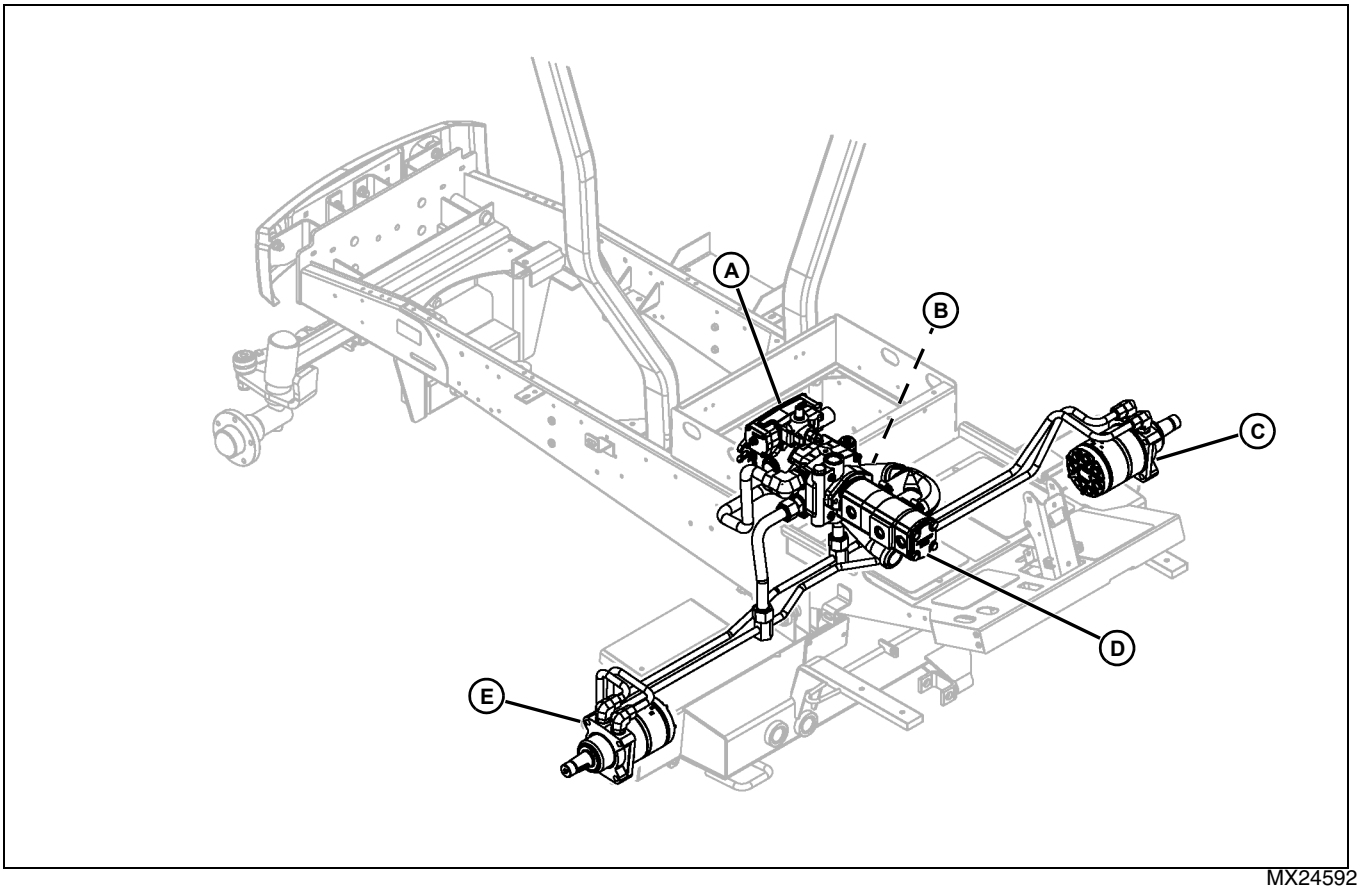
Materials

Other Material

Part No.	Part Name	Part Use
PM37477 (US) PM38621 (Canada)	Thread Lock and Sealer (Medium Strength)	Apply to threads of setscrew.

Component Location

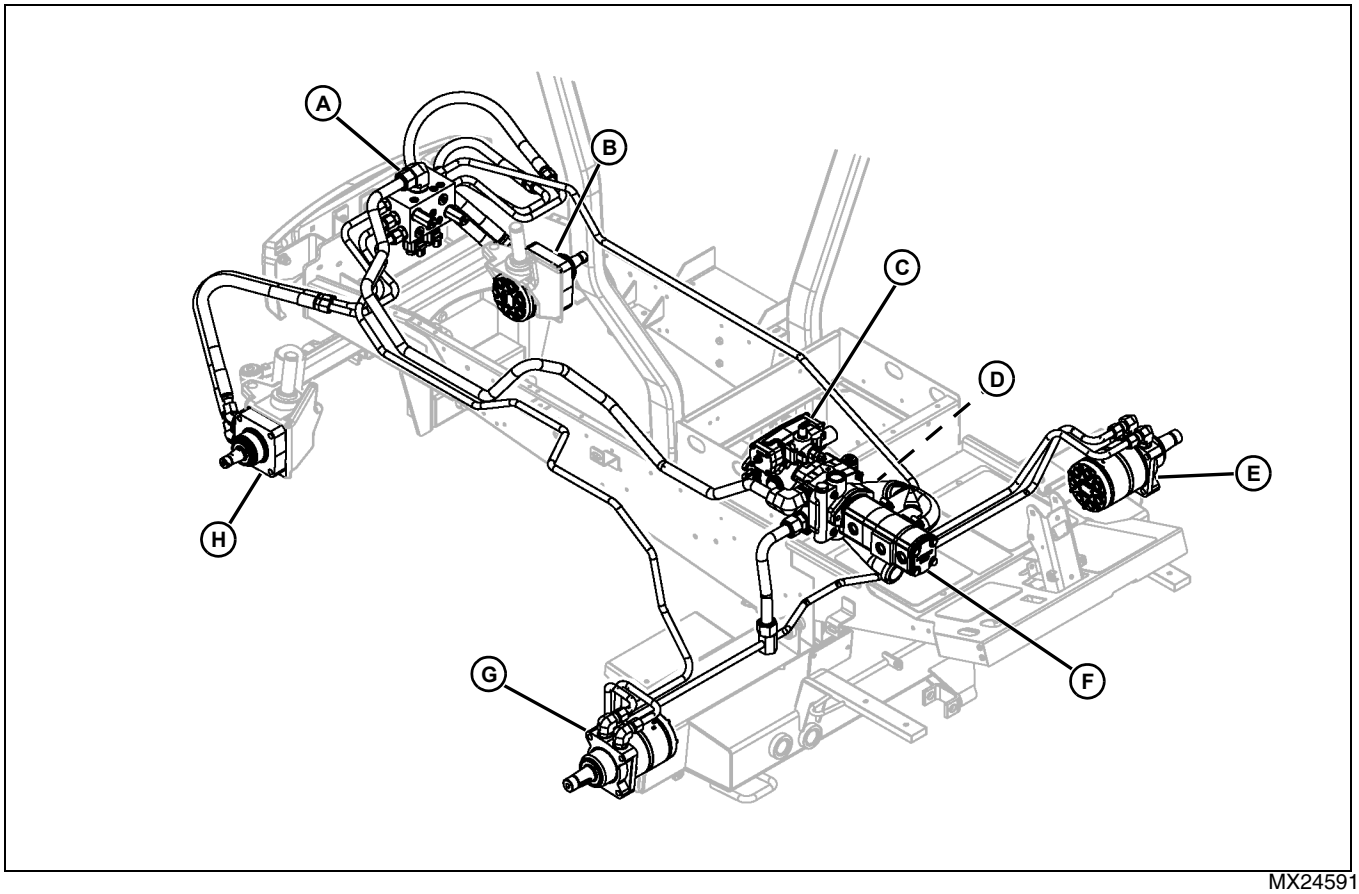
Component Location - Two Wheel Drive



MX24592

A- Hydrostatic Pump
B- Hydraulic Oil Filter
C- Left Hydraulic Wheel Motor
D- Hydraulic Triple Pump Assembly
E- Right Hydraulic Wheel Motor

Component Location - Four Wheel Drive

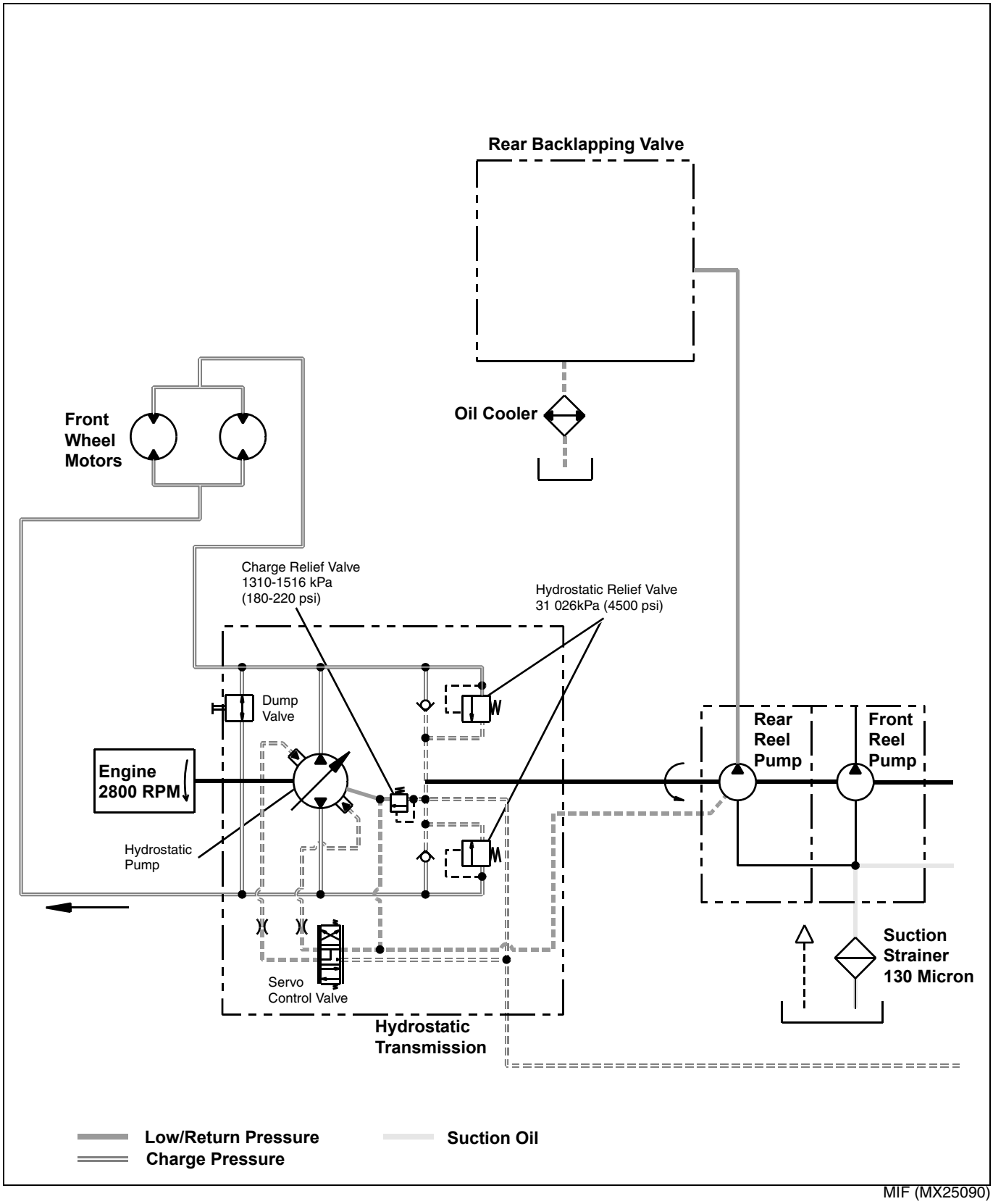


MX24591

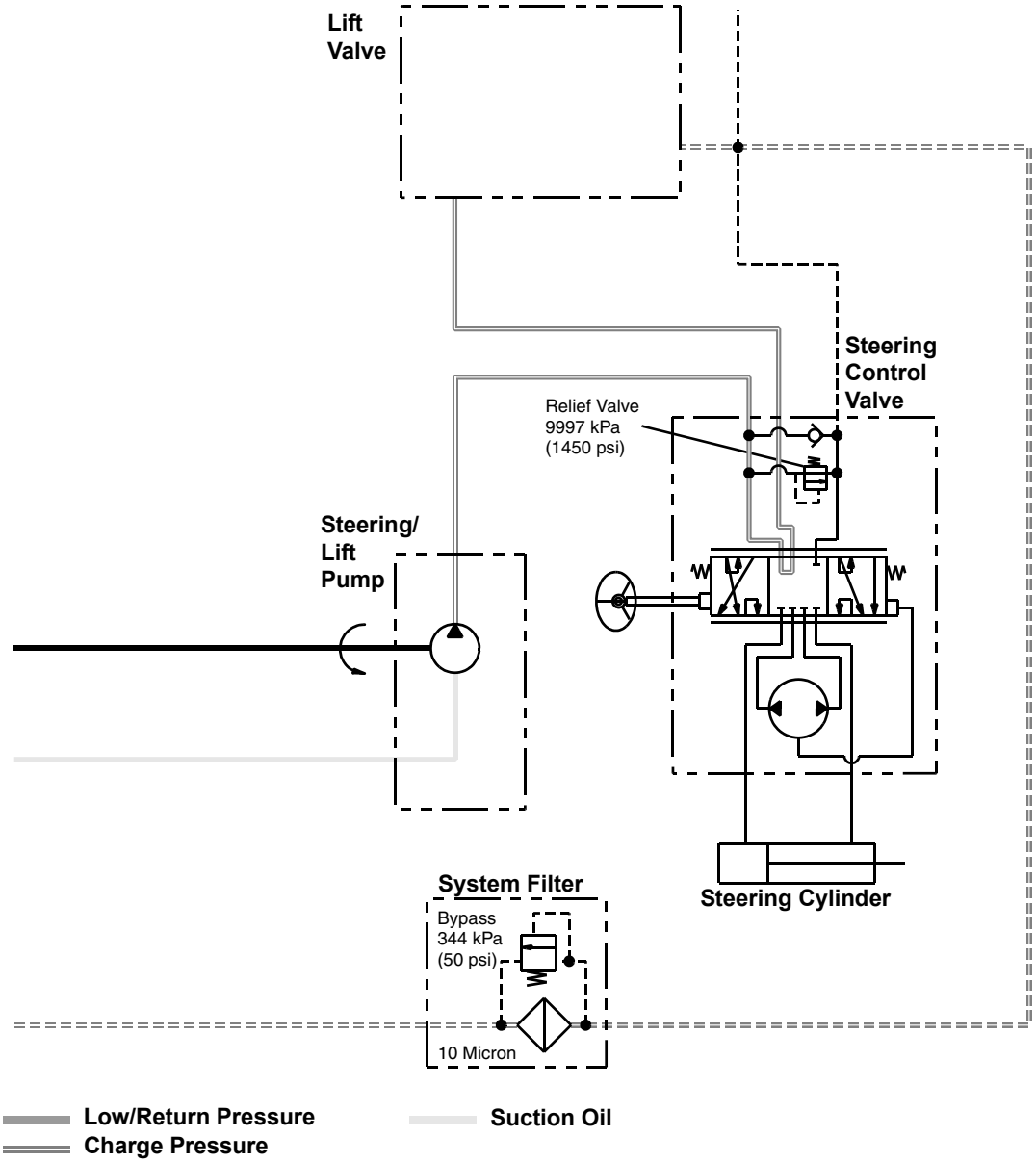
A- Four Wheel Drive Valve
B- Rear Left Hydraulic Wheel Motor
C- Hydrostatic Pump Assembly
D- Hydraulic Oil Filter
E- Front Left Hydraulic Wheel Motor
F- Hydraulic Triple Pump Assembly
G- Front Right Hydraulic Wheel Motor
H- Rear Right Hydraulic Wheel Motor

Hydrostatic Schematics

Neutral - Two Wheel Drive

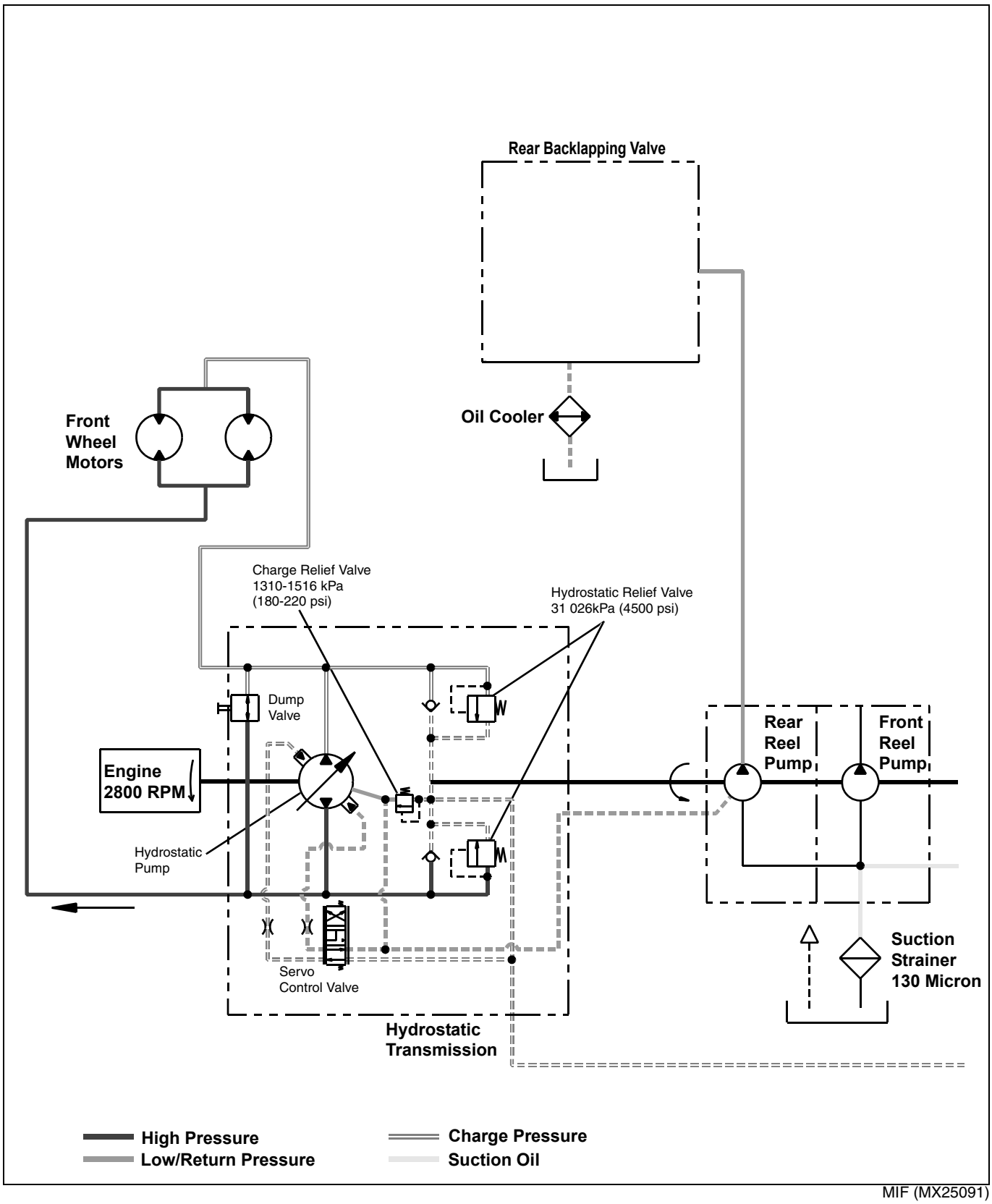


MIF (MX25090)

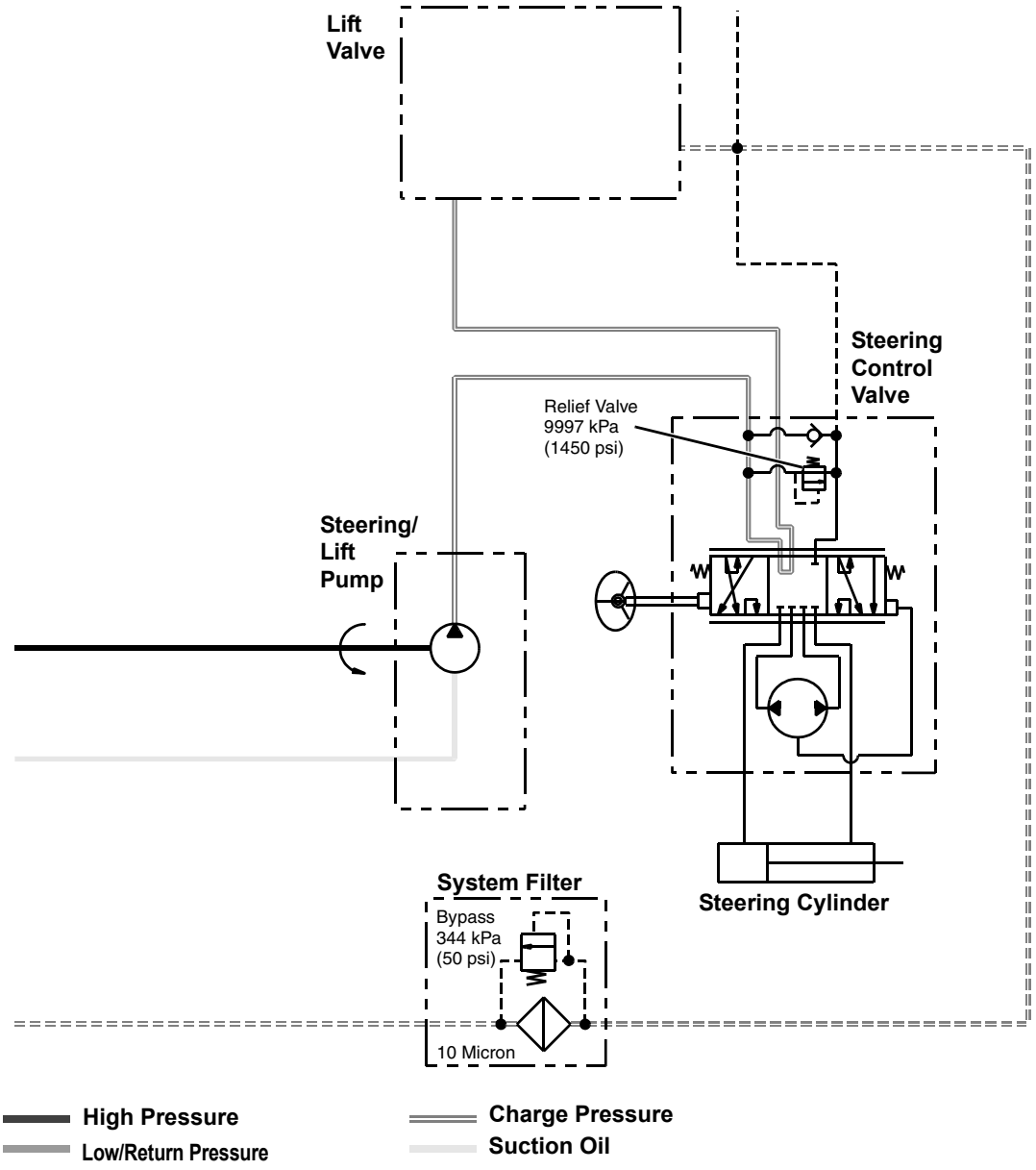

Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
Low/Return Pressure
Charge Pressure
Suction Oil

MIF (MX25019)

Forward - Two Wheel Drive

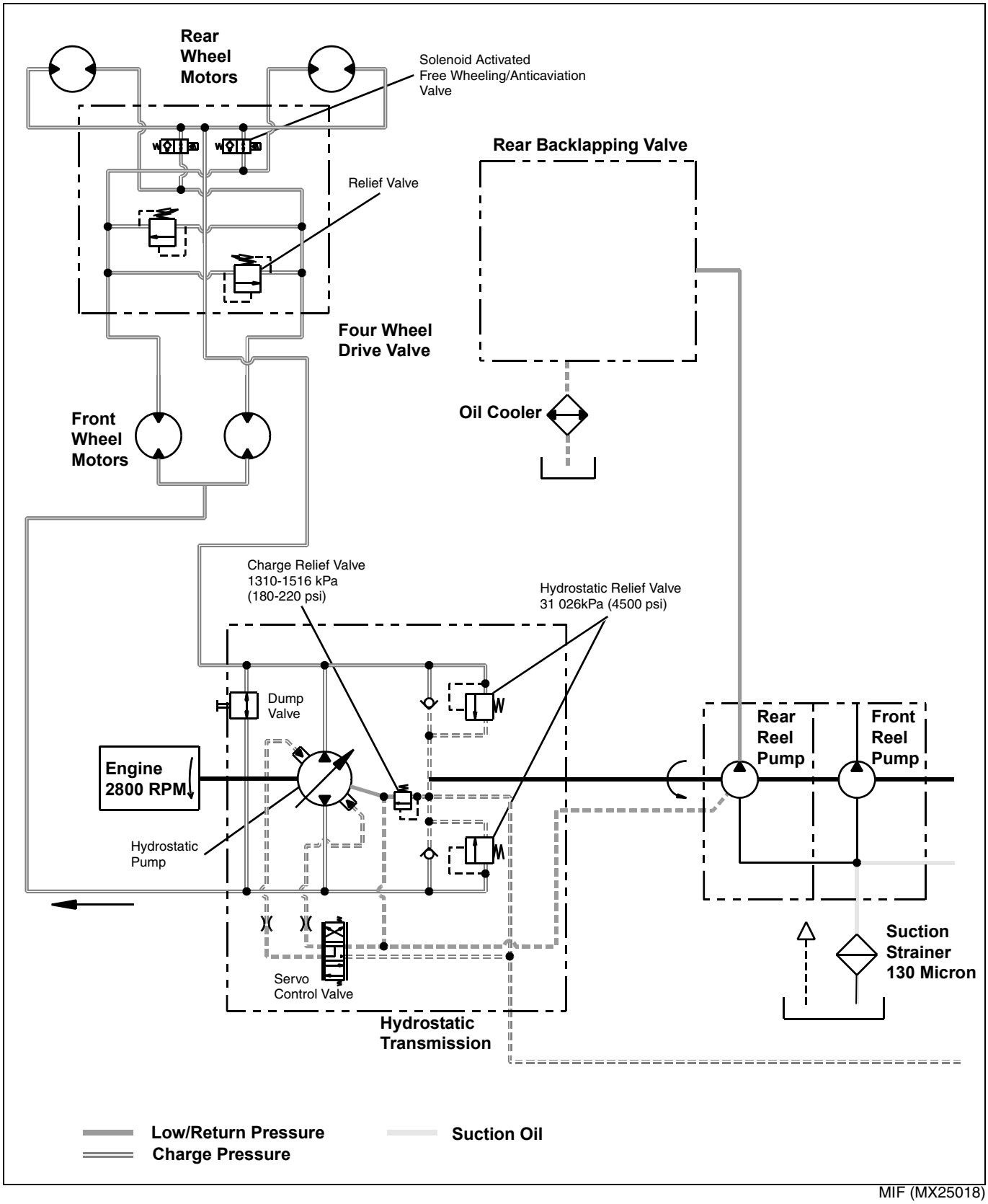


MIF (MX25091)

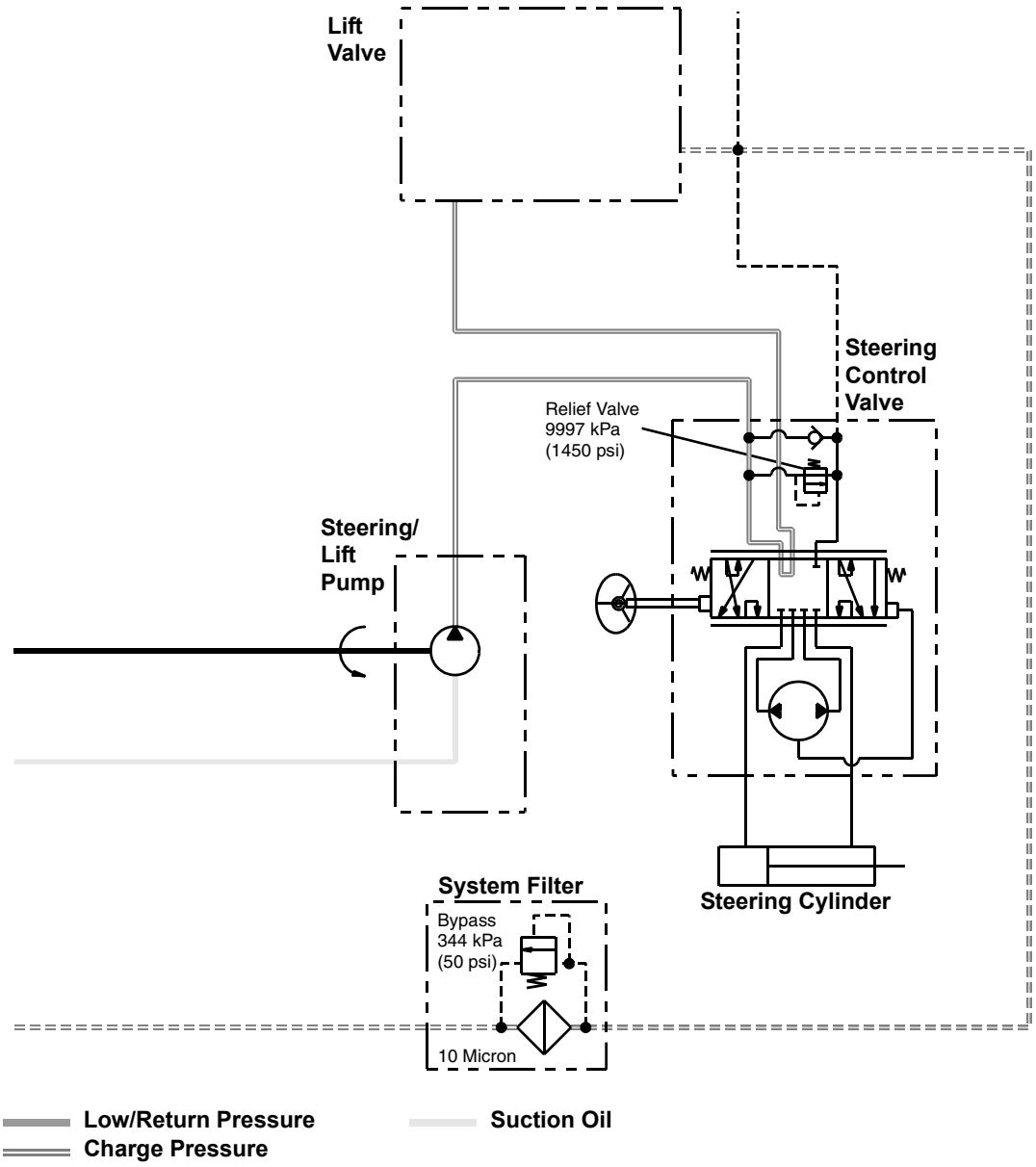

Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
High Pressure
Low/Return Pressure
Charge Pressure
Suction Oil

MIF (MX25024)

Neutral - Four Wheel Drive

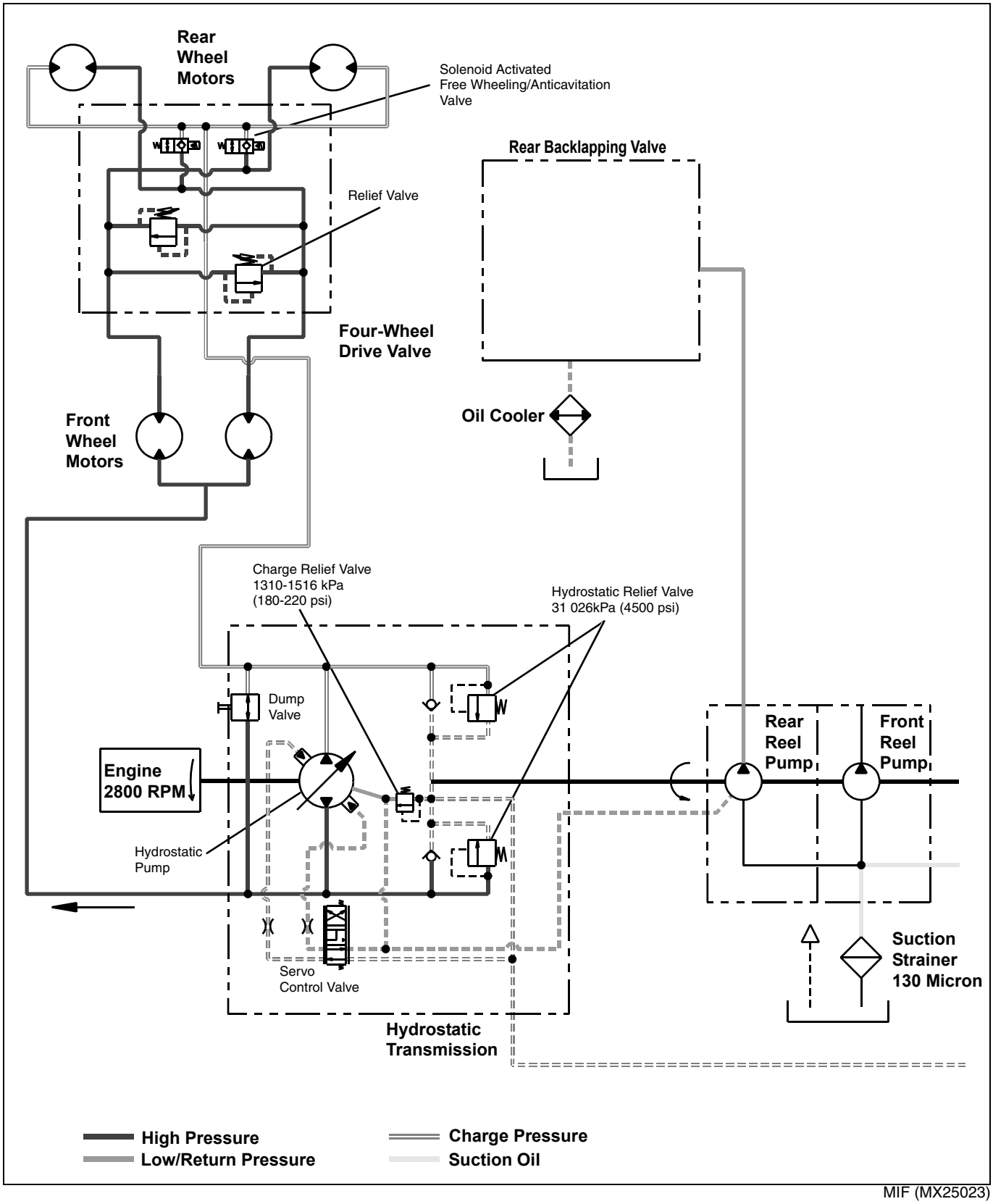


MIF (MX25018)

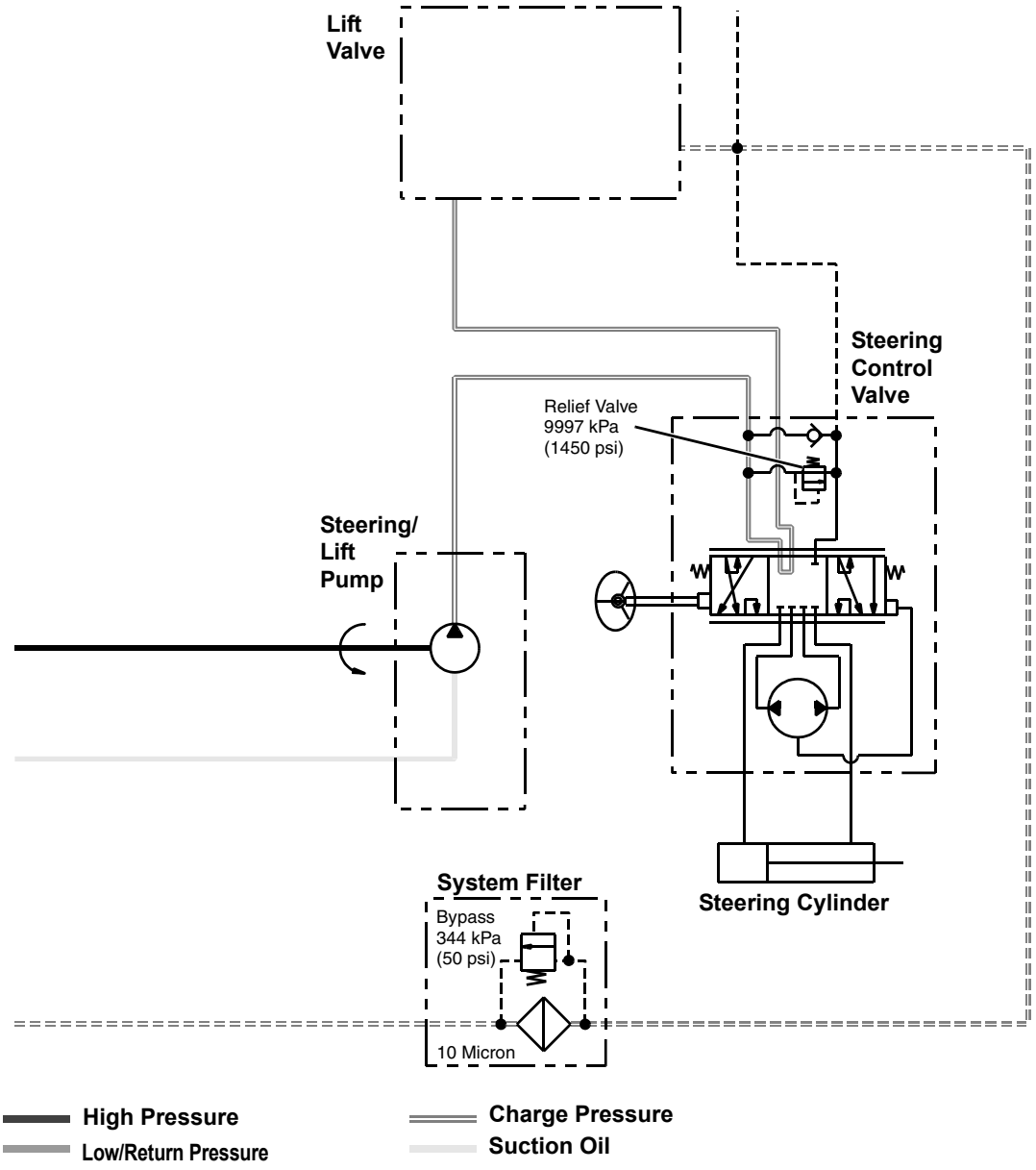

Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
Low/Return Pressure
Charge Pressure
Suction Oil

MIF (MX25019)

Forward - Four Wheel Drive



MIF (MX25023)


Lift
Valve
Steering
Control
Valve
Relief Valve
9997 kPa
(1450 psi)
Steering/
Lift
Pump
System Filter
Bypass
344 kPa
(50 psi)
10 Micron
Steering Cylinder
High Pressure
Low/Return Pressure
Charge Pressure
Suction Oil

MIF (MX25024)

Theory of Operation

Hydrostatic Transmission

Function

The hydrostatic system provides a means to transfer power from the engine to the final drive for the wheels. It also provides infinitely variable speed control.

Theory

The hydrostatic system is a closed loop fluid power system that consists of an Eaton piston pump and two (two-wheel drive) or four (four-wheel drive) motors. Speed and direction are controlled by two foot pedals.

Engine power is transferred to the hydrostatic pump by a drive shaft connected to the engine flywheel. The Eaton piston pump, or hydrostatic transmission, is mounted to a bulkhead under the operators platform.

Hydrostatic fluid is provided to the hydrostatic pump from a pressurized charge pump flow. Fluid from the steering/charge pump is directed through two dual-purpose system relief/check valves located in the pump backplate. An internal charge pump relief valve maintains a minimum charge pressure level. Excess charge fluid is returned to the gear pump inlet.

The hydrostatic pump provides hydraulic fluid in varying amounts to the motors through hydraulic lines and fittings. The hydraulic fluid in the power train circulates in a closed loop. The amount and pressure of the fluid is a result of the displacement of the pump pistons, which are controlled by a variably angled surface called a swash plate or cam plate. Fluid leaves the pump, flows through the motor(s) and is returned to the pump, not the reservoir.

During operation, some fluid intentionally leaves this closed loop circuit, such as case drain, and is replenished by cool filtered fluid from the front gear set (steering/charge pump) of the triple pump assembly. (See Hydraulic section.) This fresh fluid enters through the check valve part of the relief/check valve assembly. If the pressure going to the wheel motors exceeds a certain preset amount, the relief valve for that circuit will move off its seat and allow some fluid to pass to the low-pressure side of the system.

Hydrostatic Pump

The pump is an Eaton Model 72400 servo-controlled piston pump. It consists of a manual servo-controlled variable piston pump.

Hydrostatic fluid is provided to the hydrostatic pump from a pressurized charge pump flow. An internal charge relief valve maintains a minimum charge pressure level of 1241-1517 kPa (180-220 psi). Charge oil pressure is also used to operate the servo control and four-wheel drive control.

During operation, some fluid is intentionally “leaked” from the hydrostatic circuit and is routed back into the gear pump inlet. This fluid is replaced by charge oil that enters the closed loop through one of the relief/check valves, thereby introducing cool filtered oil into the hydrostatic system.

Speed and direction are controlled by the direction of, and angle of the cam plate rotation. The cam plate is controlled by a hydraulic servo which is controlled by a mechanical linkage. The greater the angle of the cam plate from the center position (neutral), the greater the volume of fluid the pistons will displace and the faster the vehicle travels.

Servo Control Function

Transmission output is initiated by movement of the variable displacement pump control lever. As the lever is rotated, it moves the servo control spool first, from its spring-centered position, allowing pressurized charge pump flow past the spool to one side of the servo piston. The pressurized servo piston pushes against the cam plate causing the cam plate to rotate to a position out of neutral. Fluid on the opposite side of the servo piston is exhausted through the control valve spool to the pump housing.

As the cam plate attains any position selected by the control lever, by the connecting feedback link and servo piston, it relocates the control valve spool to a metering position. The spool meters the fluid between the spool and servo piston to hold the cam plate in its desired position.

As the control lever is slowly moved forward or reverse, the vehicle starts a forward or reverse movement. The movement of the pump cam plate in either the forward or reverse position controls the direction of the motor rotation. In the reverse position, the pump shaft still rotates in the same direction, but the discharge of oil from the pump is reversed, thus reversing the motor rotation. When the cam plate begins to move, the piston assemblies start to reciprocate farther, generating a flow; more oil is being pumped and the speed of the vehicle is increased. Flow rate is determined by length and frequency of stokes. When full cam angle is reached, which also is maximum volume of oil being discharged from the pump, the speed of the motor increases. When the cam plate begins to move, the relief valve on the discharge or pressure side seats because of the higher pressure differential. The other relief valve serves as a charge check, remaining open, on the intake or low-pressure side to continue supplying the closed loop system with cool filtered charge oil.

System Pressure Relief

The pressure relief valves are combination relief and check valves mounted within the hydrostatic pump assembly. One serves the forward pressure loop, and one serves the reverse pressure loop.

The function of the system relief valve is to relieve excess hydrostatic pressure if the vehicle encounters a heavy load or stalls out.

When a preset pressure is reached, the large spring in the relief valve compresses and opens an orifice, allowing oil to bypass into the low-pressure side of the system. The opposite relief valve, serving as a check valve, opens and allows the oil to flow to the intake side of the pump.

Steering/Charge Pump

The steering/charge pump provides several functions to the hydrostatic circuits:

- Provides flow to keep circuits primed and make up internal leakages.
- Provides flow, under pressure, for maintaining back pressure on pump/motors pistons.
- Provides flow, under pressure, for hydraulic control purposes.
- Provides cooled and cleansed fluid for temperature control and flushing.

Wheel Motors

The wheel motors are Parker low speed, high torque positive displacement motors. The front being a Parker TH Series and the rear a TF Series.

Both motors are fixed displacement type delivering a constant output torque for a given pressure throughout the speed range of the motor.

The motors for the front wheels are mounted on the ends of the fluid reservoir. The motors for the rear wheels, with rear wheel drive option only, are mounted on the ends of the control arms.

The drive wheels are mounted on hubs which are keyed onto the output shaft of each motor.

Four-Wheel Drive Solenoid Valve

The four-wheel drive solenoid valves are electrically operated, spring return shuttle valve system. The solenoids are energized during the reverse. In this modes the solenoids are energized and the spools shift open allowing fluid pressure flow to bypass the rear motors allowing them to freewheel. The fluid pressure returns to the forward side of the rear motors when the solenoids are de-energized and the spring pressure in the valve returns the valve to the standard position.

Hydrostatic Relief Valves

During operation while descending steep grades it is possible to build higher than normal pressure in the return lines. This happens when the machine's momentum develops more pressure in the return lines of the hydraulic system than the hydrostatic pump develops in the directional/pressure flow line.

Effectively, the wheel motors try to drive the hydrostatic pump. Higher pressure in the return lines could cause the wheels to stop turning or start turning in the reverse direction. Either case could result in a loss of motion control. Hydrostatic relief valves are installed in the high and low/return pressure lines to counteract this effect.

The hydrostatic relief valve opens when the pressure in the return line reaches and exceeds a predetermined pressure value and then relieves the pressure in the return line through recirculation.

Dump Valve

Important: Avoid Damage! Serious damage to the hydrostatic drive will result if the vehicle is towed.

The purpose of the dump valve is to allow the movement of a disabled vehicle, or if you want to just push it a short distance, without starting the engine. If an attempt is made to push the vehicle, the hydrostatic motor becomes a pump, trying to pump oil to the hydrostatic pump. This creates a hydraulic lock between the motor and pump. To overcome this condition, a dump valve has been installed between the high-pressure relief valves in the backplate of the piston pump.

The dump valve is a plug that contains a rotating stem with a flat spade end that fits between the two ends of the high-pressure relief valves. When the dump valve is in the closed position, the relief valves are also in the closed position. When the dump valve stem is rotated 90°, the flat spade end spreads the relief valves to the open position. This allows the oil in the hydrostatic closed loop to bypass around the high-pressure relief valves inside the pump backplate. The bypassing of oil inside the pump backplate will allow the motor to rotate freely when the vehicle is moved a short distance. The dump valve is intended only for moving a vehicle a very short distance and not intended for towing a vehicle behind a truck or tractor.

Diagnostics

Troubleshooting Hints

The most noticeable result of a worn pump or motor is reduced travel speed. This results from either the pump's inability to provide the necessary flow at the required pressure, or the pump/motor bypassing fluid to case drain.

Component wear is normally caused by either fluid contamination or pump cavitation. Pump cavitation can be a result of fluid contamination, clogged filter, or insufficient fluid in the system.

Before testing the hydrostatic pump, check the charge pump pressure. (See Hydraulics section.) Once you are satisfied that charge pressure is sufficient, test the hydrostatic pump efficiency (forward and reverse) with a flow meter. If the hydrostatic pump is delivering the required flow at full output pressure, the problem is probably with a wheel motor.

Symptom: Mower Will Not Move in Forward or Reverse

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes: Go to next step.

No: Replace hydraulic oil with correct grade of proper viscosity.

3. Is dump valve closed?

Yes: Go to next step.

No: Close dump valve.

4. Do the pedals move freely down and back? Is the linkage connected properly?

Yes: Go to next step.

No: Check linkage for bent or broken components. Repair or replace parts as necessary.

5. Is the suction strainer clear of restrictions?

Yes: Go to next step.

No: Clean suction strainer.

6. Check charge pressure. (See "Test Charge Pressure - Static" on page 493.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

7. Is the driveshaft secure?

No: Secure, repair or replace driveshaft.

Symptom: Mower Will Not Reach Full Speed

Procedure

1. Is the linkage hardware tight?

Yes: Go to next step.

No: Tighten hardware on linkages.

2. Has the speed been adjusted?

Yes: Go to next step.

No: Adjust speed.

3. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

4. Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes: Go to next step.

No: Replace hydraulic oil with correct grade of proper viscosity.

5. Is dump valve closed?

Yes: Go to next step.

No: Close dump valve.

6. Do the pedals move freely down and back? Is the linkage connected properly?

Yes: Go to next step.

No: Check linkage for bent or broken components. Repair or replace parts as necessary.

7. Is the suction strainer clear of restrictions?

Yes: Go to next step.

No: Clean suction strainer.

8. Is hydraulic fluid free from air bubbles?

Yes: Go to next step.

No: Check suction line for air leaks. Repair as necessary.

9. Check charge pressure. (See "Test Charge Pressure - Static" on page 493.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

10. Perform hydrostatic transmission flow test. (See “Test Hydrostatic Transmission Pump Flow” on page 494.) Is hydrostatic transmission flow within specifications?

No: Check and/or replace relief valves. Repair or replace pump as necessary. Remove drive motors and bench check. (“Disassemble and Inspect Wheel Motor” on page 512.) Repair or replace as necessary.

Symptom: Sluggish Response to Acceleration or Deceleration

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level.

2. Is correct grade hydraulic oil used (hydraulic oil viscosity not too high for operating conditions)?

Yes: Go to next step.

No: Replace hydraulic oil with correct grade of proper viscosity.

3. Is dump valve closed?

Yes: Go to next step.

No: Close dump valve.

4. Is the suction strainer clear of restrictions?

Yes: Go to next step.

No: Clean suction strainer.

5. Is hydraulic fluid free from air bubbles?

Yes: Go to next step.

No: Check suction line for air leaks. Repair as necessary.

6. Check charge pressure. (See “Test Charge Pressure - Static” on page 493.) Is charge pressure within specifications?

Yes: Go to next step.

No: If pressure does not meet specification, follow results of procedure.

7. Perform hydrostatic transmission flow test. (See “Test Hydrostatic Transmission Pump Flow” on page 494.) Is hydrostatic transmission flow within specifications?

Yes:

No: Replace relief valve.

Symptom: Hydrostatic System Operating Hot

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Go to next step.

No: Fill reservoir to proper level with hydraulic fluid.

2. Are oil cooler fins free of dirt and debris?

Yes: Go to next step.

No: Clean oil cooler fins of dirt and debris.

3. Perform hydrostatic transmission forward and reverse relief valve tests. (See “Test Hydrostatic System Relief Pressure” on page 492.) Are the hydrostatic transmission forward and reverse relief valves opening at the correct pressure?

No: Replace relief valve(s).

Symptom: Noisy Pump

Procedure

1. Is hydraulic fluid at proper level in reservoir?

Yes: Got to next step.

No: Fill reservoir to proper level.

2. Is dump valve closed?

Yes: Go to next step.

No: Close dump valve.

3. Is hydraulic fluid free from air bubbles?

Yes: Go to next step.

No: Check suction line for air leaks. Repair as necessary.

4. Is oil filter clean (free from restrictions)?

Yes: Go to next step.

No: Replace filter. Find source of any excess contamination.

5. Perform hydrostatic transmission forward and reverse relief valve tests. (See “Test Hydrostatic System Relief Pressure” on page 492.) Are the hydrostatic transmission forward and reverse relief valves opening at the correct pressure?

Yes: Go to next step.

No: Replace relief valve(s).

6. Is charge pressure correct?

Yes: Go to next step.

No: Test and adjust charge pressure. (See “Test Charge Pressure - Static” on page 493. See “Test Charge Pressure - Dynamic” on page 494.)

7. Disassemble and inspect pump for damage. (See “Disassemble Hydrostatic Pump” on page 500.) Was any damage found?

Yes: Repair or replace as necessary.

Tests and Adjustments

Test Hydrostatic System Relief Pressure

Reason

To ensure that the hydrostatic system forward and reverse relief valves are operating properly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydrostatic system relief pressure.
Pressure Gauge Kit	JDG2033	Read hydrostatic system pressure.
Diagnostic Flow Kit	JDG2032	Connect flow meter to hydrostatic system.
Pressure Diagnostic Kit	JDG2031	Connect pressure gauge for hydrostatic system pressure test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

MX25050

1. Install diagnostic fitting into right test port (A) located on "T" fitting behind front axle.
   - 2WD machines- Use right test port for forward test and the left test port for reverse test.
   - 4WD machines - Use right test port for forward test and the GP REV port, located on the front surface of the 4wd valve, for reverse test.
2. Connect pressure gauge to diagnostic fitting.
3. Secure machine to an immovable object.

Note: Check engine rpm with electronic tachometer.

4. Start engine and set throttle to fast idle (2800 ± 50 rpm).
5. Charge pressure reading on gauge must be:
   - 7000 Series - 1241 kPa (180 psi) (Minimum)
   - 8000 Series- 1241 kPa (180 psi) (Minimum)
6. Slowly depress forward or reverse pedal, depending on direction being tested, while observing the pressure gauge reading.
7. Depress pedal until maximum pressure is reached. Relief pressure reading should be:
   - 7000 and 8000 Series - 31 026 ± 1379 kPa (4500 ± 200 psi)
8. Repeat test in opposite direction.

If relief pressures are reached, test is complete. If relief pressures are not reached, there are possibilities of leakage in the wheel motors, relief valves, or pump. Proceed to next step to determine origin of leakage.

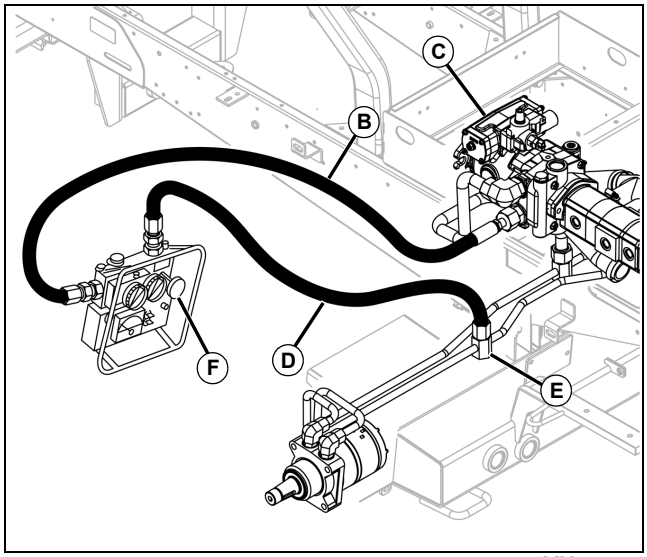
Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands.

Note: On 4WD machines, raise all 4 wheels off of the ground.

9. Raise machine so wheels are off the ground. Support machine with jackstands.

Note: 2WD machines- Use right test port for forward test and the left test port for reverse test.

4WD machines - Use right test port for forward test and the GP REV port, located on the front surface of the 4wd valve, for reverse test.



MX25053

10.Remove the line from the hydrostatic pump to “T” fitting.

11.Connect flow gauge inlet hose (B) to the hydrostatic pump (C), and outlet hose (D) to the axle bulkhead fitting (E).

12.Turn flow control knob (F) completely open (counterclockwise).

Note: Check engine rpm with electronic tachometer.

13.Start engine and set throttle to fast idle (2800 ± 50 rpm).

14.For forward test, depress the forward pedal and read right test port fitting pressure gauge.

15.For reverse test, depress the reverse pedal and read left test port fitting pressure gauge.

16.Slowly close flow control knob (clockwise) until maximum pressure is reached.

17.Pressure reading should be:

- 7000 and 8000 Series - 31 026 ± 1379 kPa (4500 ± 200 psi)

Results

If machine is four-wheel drive and relief pressure is reached, inspect four-wheel drive cartridges for worn O-rings.

If relief pressure is reached, remove and inspect wheel motors and associated hoses.

If relief pressure is not reached, remove and inspect relief valves and replace as necessary. If problem persists, repair or replace pump.

Specifications

Engine Speed at Fast Idle . . . . . .2800 ± 50 rpm
Hydrostatic Charge Pressure
7000 Series (Minimum). . . . . 1241 kPa (180 psi)
Hydrostatic Charge Pressure
8000 Series (Minimum) . . . . . 1241 kPa (180 psi)
Hydrostatic System Relief Pressure 7000 and 8000 Series . . . . . 31 026 ± 1379 kPa (4500 ± 200 psi)

Test Charge Pressure - Static

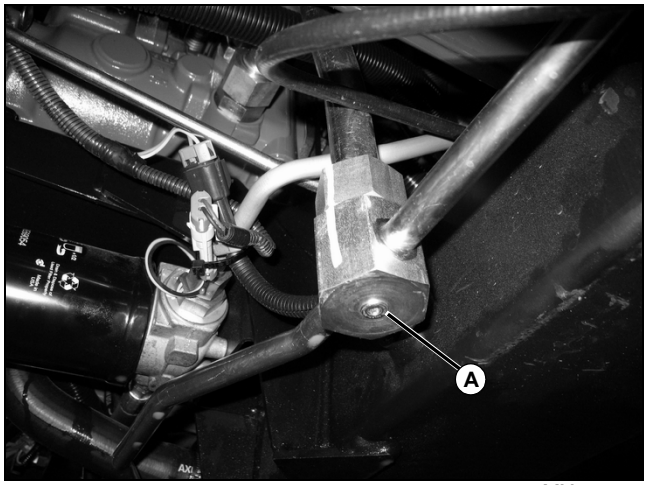
Reason

To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit-4	JDG2033	Used to measure hydrostatic pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure



MX25050

1. Install diagnostic fitting into test port (A) located on “T” fitting behind front axle.

2. Connect pressure gauge to diagnostic fitting.

Note: Check engine rpm with electronic tachometer.

3. Start engine and set throttle to fast idle (2800 ± 50 rpm).

Note: DO NOT move steering wheel or actuate lift arms while performing this test. Inaccurate readings will result.

4. Note reading on gauge. Charge pressure reading should be:

- 7000 Series - 1241 kPa (180 psi) (Minimum)
- 8000 Series - 1241 kPa (180 psi) (Minimum)

Results

If charge pressure is within specification, perform dynamic charge pressure test to determine if there is system leakage under load. (See “Test Charge Pressure - Dynamic” on page 494.)

If charge pressure is below specification, perform a lift/ steering pump flow test and check hydraulic filter for restrictions. (See “Test Lift and Steering Pump Flow” on page 558.)

If flow test and filter are good, remove and inspect hydrostatic pump. Repair or replace as necessary.

Specifications

Hydrostatic Pump Charge Pressure
7000 Series (Minimum). . . . . 1241 kPa (180 psi)
Hydrostatic Pump Charge Pressure
8000 Series (Minimum). . . . . 1241 kPa (180 psi)

Test Charge Pressure - Dynamic

Reason

To ensure that there is sufficient pressure to keep the hydrostatic pump properly charged under load.

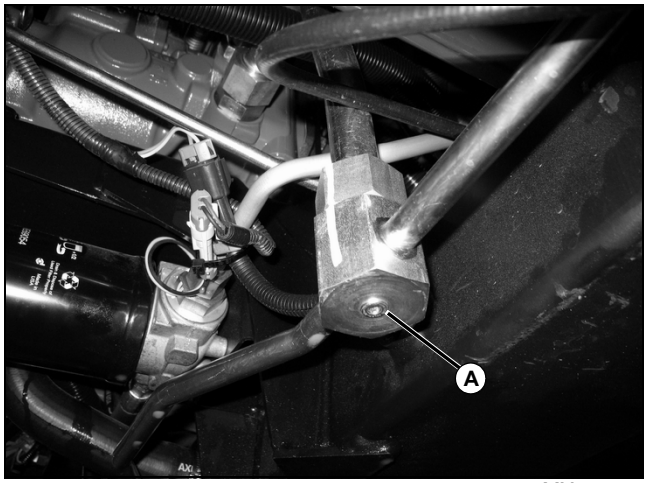
Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit-4	JDG2033	Used to measure hydrostatic pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine RPM.

Procedure

Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands. On 4wd machines, all wheels must be off the ground.

1. Raise machine so wheels are off the ground and support with suitable jackstands.



MX20343

2. Install diagnostic fitting into test port (A) located on “T” fitting behind front axle.

3. Connect pressure gauge to diagnostic fitting.

4. Disconnect brake switch located under operator platform.

Note: Check engine rpm with electronic tachometer.

5. Start engine and set throttle to fast idle (2800 ± 50 rpm).

6. Depress brake pedal to apply a load to the hydrostatic drive system.

7. Note reading on gauge and compare to specifications.

Results

If charge pressure meets specification in the static test but is below specification in the dynamic test, this indicates that system leakage develops under a loaded condition.

Perform latter part of hydrostatic system relief pressure test to determine origin of leakage. (See “Test Hydrostatic System Relief Pressure” on page 492.)

Specifications

Hydrostatic Pump Charge Pressure
7000 Series (Minimum) . . . . . 1241 kPa (180 psi)
Hydrostatic Pump Charge Pressure
8000 Series (Minimum) . . . . . 1241 kPa (180 psi)

Test Hydrostatic Transmission Pump Flow

Reason

To verify that hydrostatic pump is operating at optimum

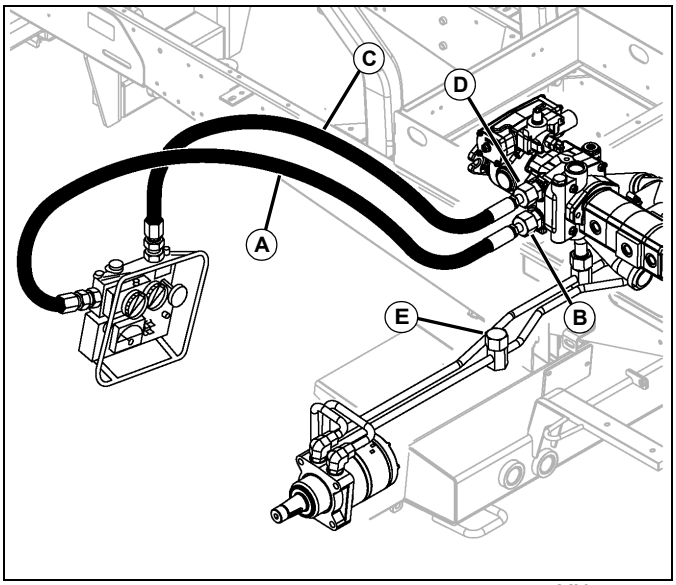
efficiency.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydrostatic circuit flow.
Diagnostic Flow Kit	JDG2032	Connect flow gauge for hydrostatic pump flow test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

Caution: Avoid Injury! Raise the machine safely and support it with suitable jackstands.



MX25054

1. Raise machine so all wheels are off the ground. Support machine with jackstands.

2. Remove the lines from the hydrostatic pump to the “T” fittings.

3. Connect flow meter inlet hose (A) to pump fitting (B).

4. Connect flow meter outlet hose (C) to pump fitting (D).

5. Cap both “T” fittings (E).

6. Depress forward pedal completely and secure into position. Pump must be fully stroked. Adjust traction rod if necessary.

7. Connect inductive electronic tachometer.

8. Start engine and set throttle to fast idle (2800 ± 50 rpm).

9. Record free-flow gpm and engine rpm. Flow meter knob must be adjusted to have no restriction (knob turned fully counterclockwise).

Important: Avoid Damage! Make sure that pressure control valve on tester is screwed out completely (counterclockwise). Be careful not to screw handle completely out of valve.

10. Adjust flow control knob clockwise until pressure reading is 13 790 kPa (2000 psi). Record gpm and engine rpm.

11. Calculate pump efficiency:

- Pump Free Flow x 231 ÷ Engine RPM = Displacement A
- Pump Flow at 13 790 kPa (2000 psi) x 231 ÷ Engine RPM = Displacement B
- Displacement B ÷ Displacement A x 100 = Pump Efficiency
- Example:
- Pump Free Flow = 114 L/min (30 GPM) @ 2800 Engine RPM
- Pump Flow at 13 790 kPa (2000 psi) = 91 L/min (24 GPM) @ 2800 Engine RPM
- 114 x 231 ÷ 2800 = 9.41(Displacement A)
- 91 x 231 ÷ 2432 = 8.64 (Displacement B)
- 8.64 ÷ 9.41 x 100 = 91.82 or 92% Efficiency

Results

If pump efficiency is below the minimum specification, verify charge pressure is within specification. (See “Test Charge Pressure - Static” on page 493.)

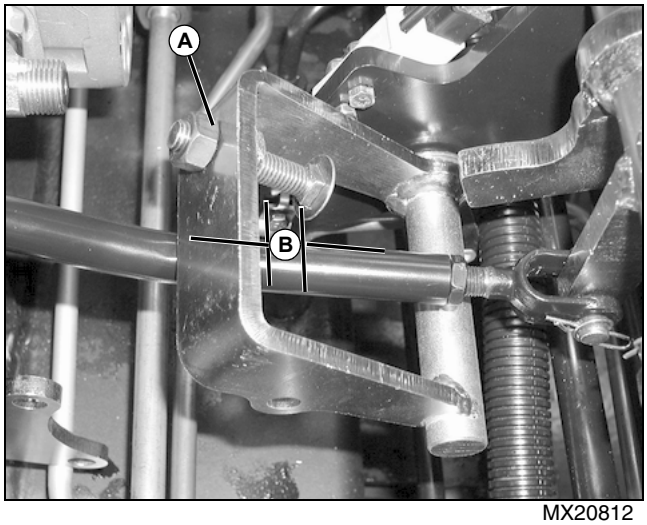
If charge pressure is to specification, repair or replace hydrostatic pump.

Specifications

Pump Efficiency (Minimum) 80%

Adjusting Mow and Transport Speeds

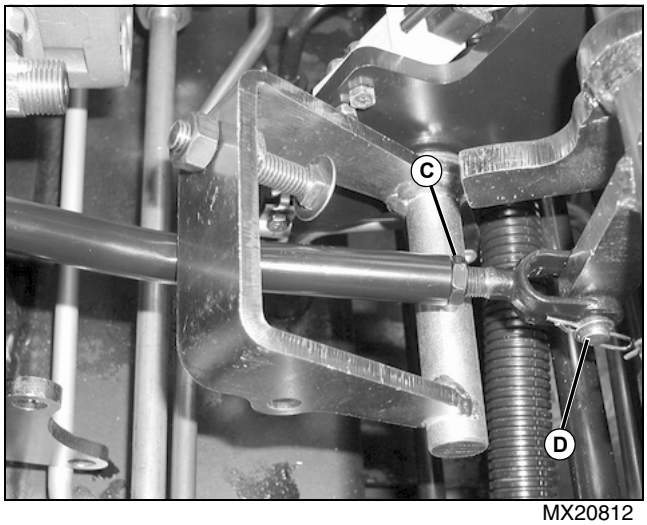
Adjusting Mow Speed



MX20812

1. Push mow-transport lever forward to mow position.
2. Loosen jam nut (A).
3. Adjust stop dimension.
   - Decrease dimension (B) for increased mowing speed.
   - Increase dimension (B) for decreased mowing speed.

Adjusting Transport Speed



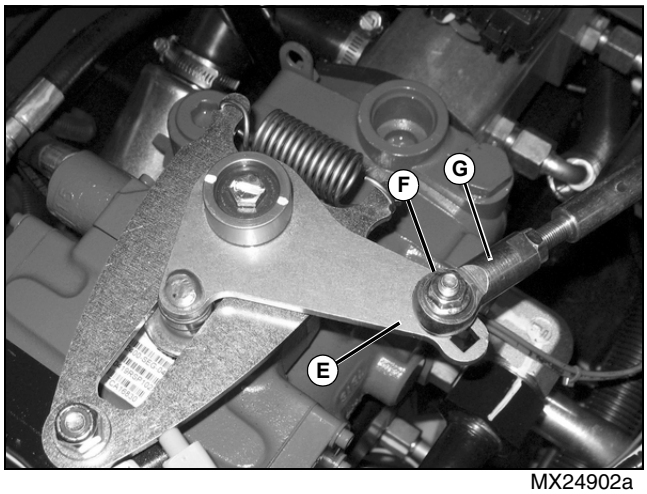
MX20812

1. Loosen jam nut (C) and pull the pin (D) at the clevis. Turn clevis out to increase forward and in to reduce forward speed.
2. Install pin and tighten jam nut.

Changing Ground Speed

The cam plate (E) has two holes. The inside hole is the standard hole for ground speeds. The outer one drops the speeds by about 4mph.

Note: The speeds can be adjusted here by turning the rod end (G) in and out. But the preferred place is shown in picture above.



MX24902a

1. Remove nut (F).
2. Place hardware for link rod end (G) in desired hole and install nut.

Test and Adjust Transmission Neutral Position

Reason

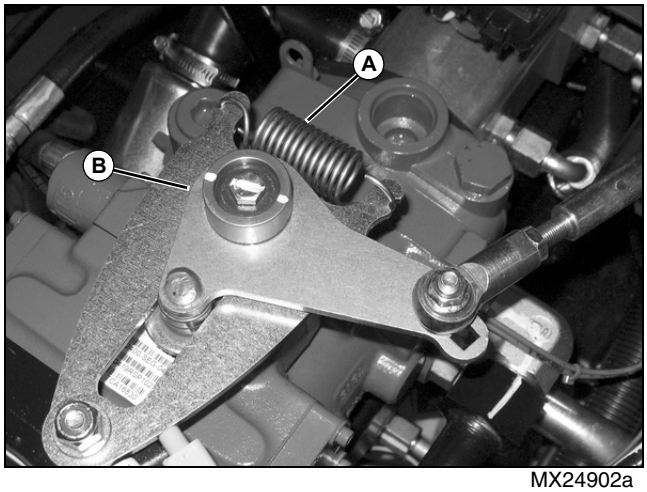
To ensure that the machine does not creep when pedals are released.

Test Procedure

1. Park machine on a hard and level surface.

Note: On 4wd machines, all wheels must be off the ground.

2. Lift and support the entire unit with jackstands.
3. Raise seat platform.



MX24902a

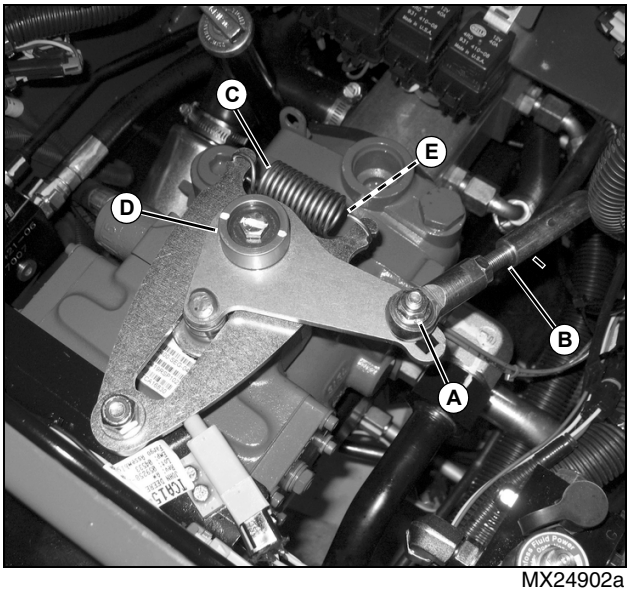
4. Detach spring (A) from pump control arm (B).
5. Start engine and set throttle to fast idle (2800 ± 50 rpm).
6. Check for wheel creep. The wheels should not be turning in any direction. If they are, the pump needs to be adjusted.

Adjust Procedure

Important: Avoid Damage! This adjustment should be done only if the machine creeps when pedals are in neutral position. If creep is intermittent, inspect transmission control linkage for wear or damage or return-to-neutral linkage for binding before adjusting transmission neutral.

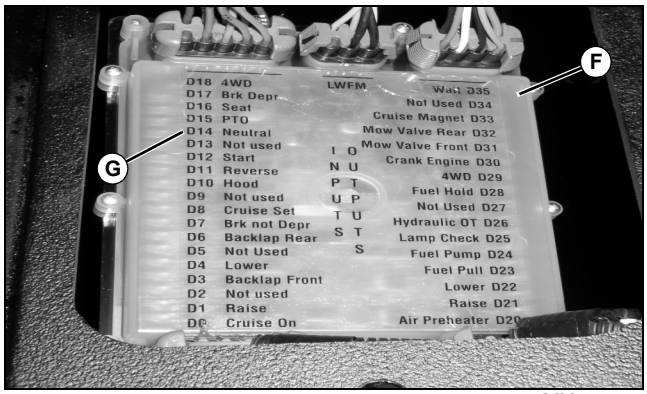
1. Stop engine.
2. Before making any adjustment, perform a thorough visual inspection of linkages and return springs for damage. Repair as necessary.
3. Raise seat platform.

Note: Observe location of spacers on traction rod (B).



MX24902a

4. Remove nut (A) and detach traction rod (B).
5. Remove spring (C). Pump control arm (D) will move to neutral position.

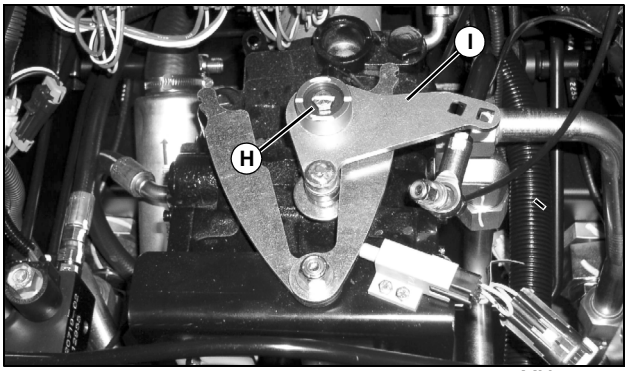


MX22791

6. Access electronic control module (F). When pump control arm is in neutral position and key switch is turned on, input D14 (G) should be illuminated.
7. If input D14 is not illuminated when pump control arm is in released position, check adjustment of neutral switch (E).

Note: Adjustment of neutral switch is unlikely unless switch was removed or replaced.

8. Loosen setscrew on neutral switch (E) and turn in small increments until D14 input stays illuminated.



MX22792a

9. If D14 input will not stay illuminated after the previous steps, remove cap screw (H). Using a three-jaw puller, remove pump control arm (I).

10.Loosely place pump control arm (I) on pump tapered shaft.

11.Install spring. Use cap screw (H) to install pump control arm in pump neutral position.

12.Turn key on; D14 input should be illuminated.

13.Install traction control rod and two spacers UNDER the pump control arm, and secure with nut.

14.Lower the seat platform and test drive machine.

Results

Machine should remain stationary while in neutral. If not, repeat adjustment.

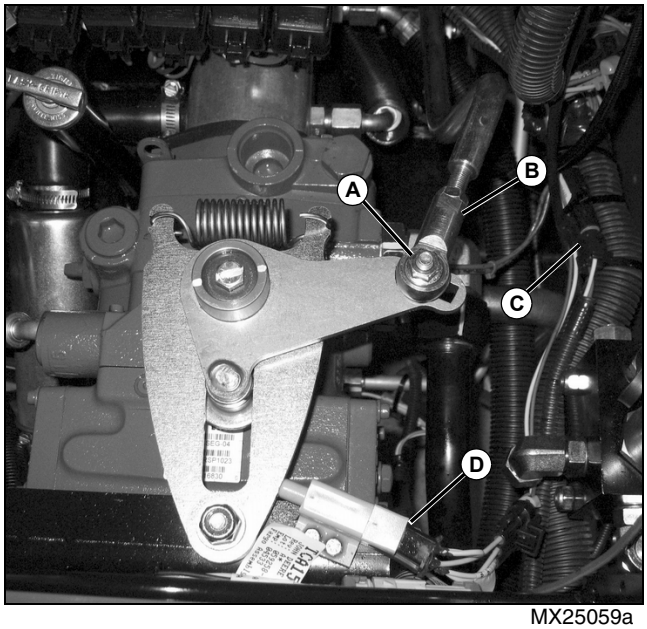
Repair

Remove Hydrostatic Pump

Caution: Avoid Injury! Lower cutting units to the ground and relieve all pressure prior to removing any hydraulic lines or fittings.

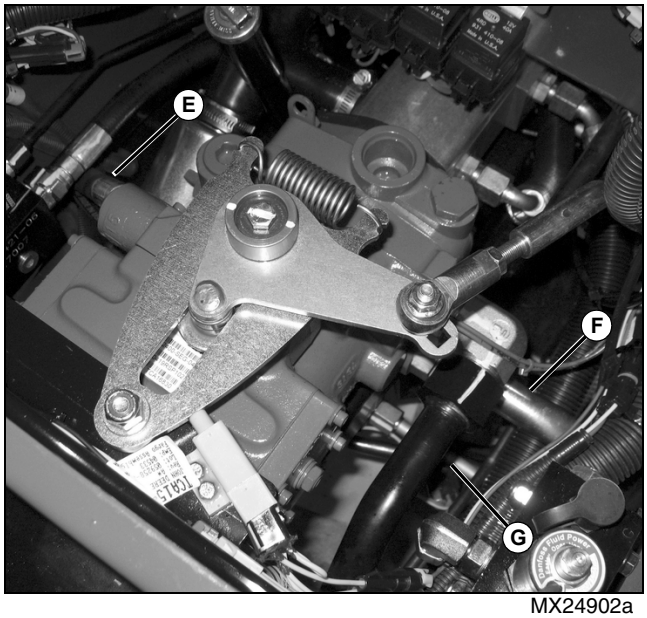
1. Park vehicle on a level surface, cutting units lowered, park brake locked, engine OFF. Block wheels to prevent movement of machine.
2. Disconnect battery.
3. Remove operator seat and deck.
4. Remove operator foot platform.

Note: Observe location of spacers on traction rod (B).



MX25059a

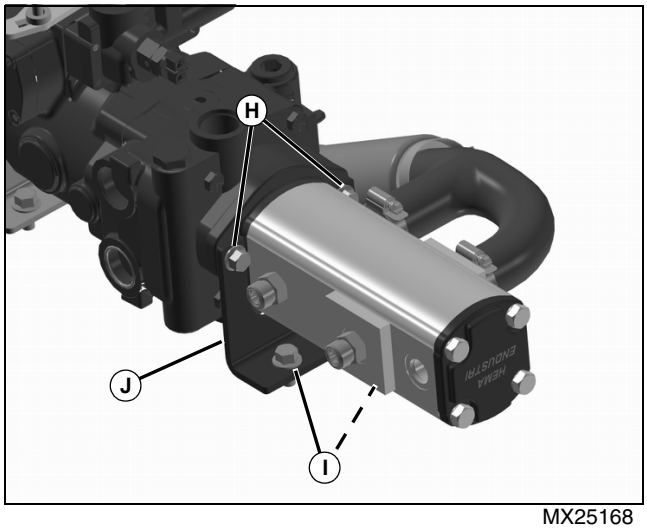
5. Remove nut (A) and detach traction rod (B).
6. Disconnect neutral and reverse switch connectors (C and D).



MX24902a

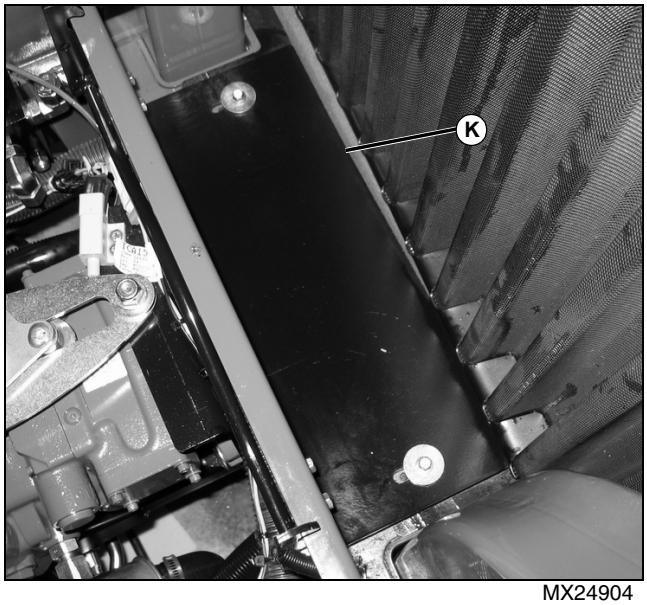
7. Remove hydraulic hose (E) and hydraulic lines (F and G). Use appropriate fluid containment procedures.

Note: Parts have been removed for picture clarity.



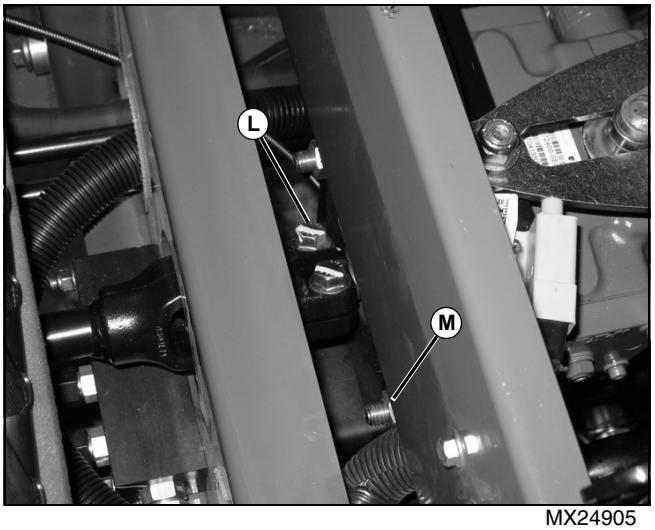
MX25168

8. Remove triple pump mounting cap screws and washers (H).
9. Remove cap screws (I) and mounting bracket (J).
10. Disconnect triple pump from hydrostatic pump.



MX24904

11.Remove driveshaft shield (K).



MX24905

12.Remove cap screws to driveshaft (L).

13.Remove hydrostatic pump mounting plate cap screws and nuts (M).

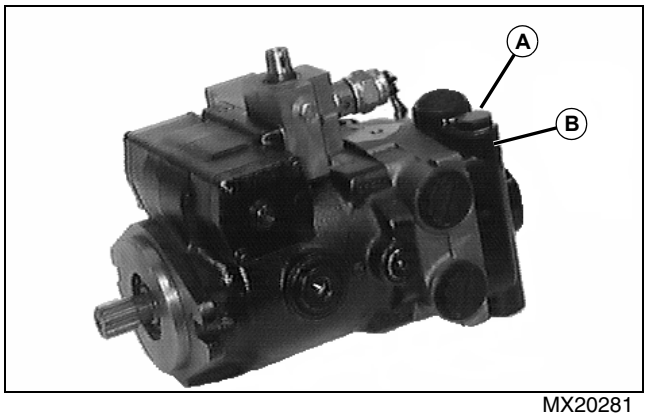
14.Slide hydrostatic pump to disconnect from driveshaft and mounting plate.

15.Remove hydrostatic pump from machine.

16.Rebuild or replace pump as necessary.

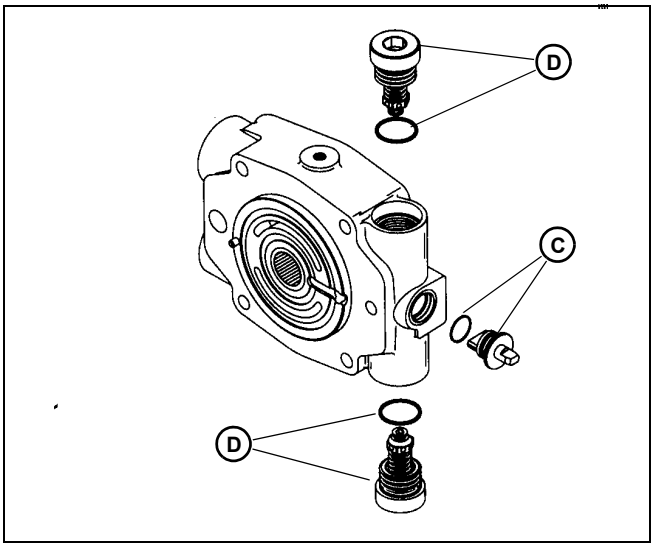
Disassemble Hydrostatic Pump

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the cap screws up. Mark the relationship of the working ports (for reassembly identification) to the servo control assembly with a scribe.



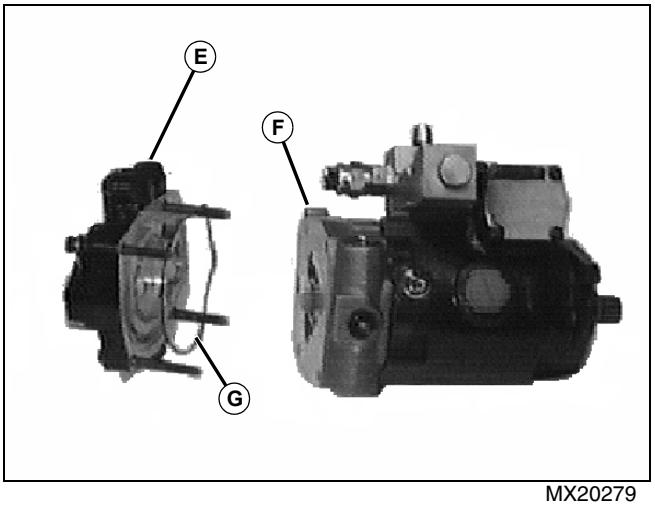
MX20281

2. Remove charge pump relief valve (A) from charge pump housing (B).



MX20282

3. From backplate, remove dump valve (C) and relief valve assemblies (D).



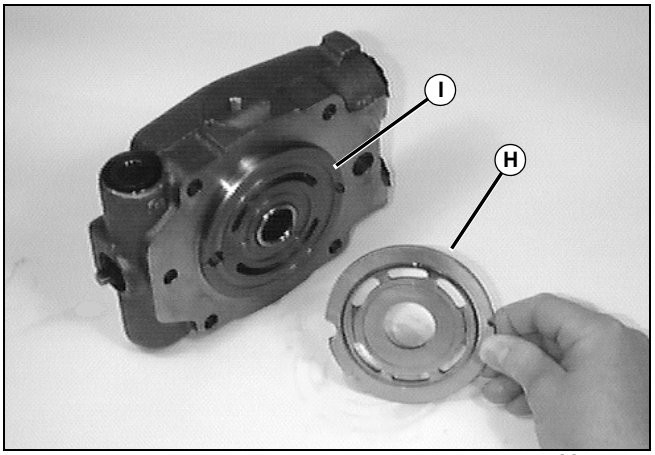
MX20279

4. Remove the four cap screws that hold the charge pump housing (E) to the backplate (F).

5. Pull the housing away from the backplate and remove the O-ring (G).

6. Tap the backplate with a plastic mallet to loosen it from the housing.

7. Remove the backplate and gasket from the hydrostatic pump housing.

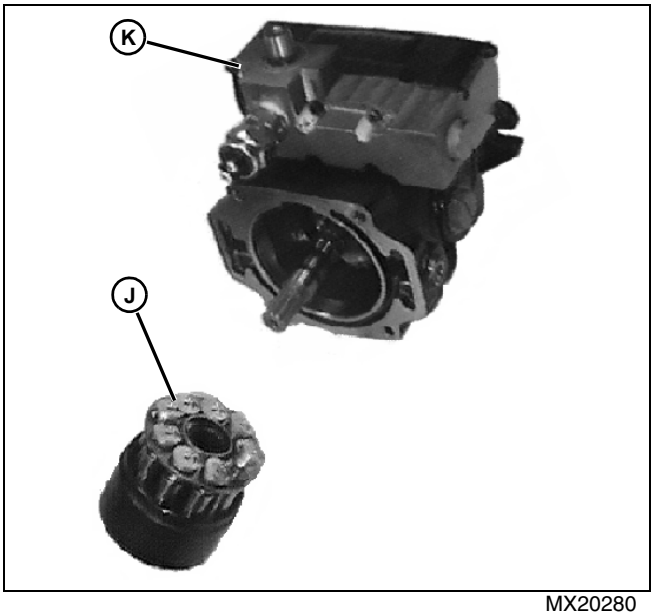


M86012

8. Remove the valve plate (H) from the backplate. The valve plate is not fastened to the backplate, but may adhere slightly due to oil between machined surfaces.

9. In most cases it should not be necessary to remove the spring pin (I) that is used to keep the valve plate located. However, if the spring pin is damaged, remove it, being extremely careful not to scratch the surface of the backplate.

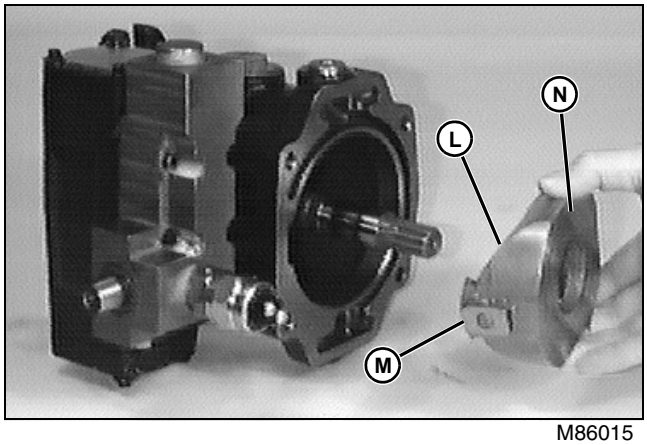
Note: Cam plate and follower may stay in pump housing. Remove separately if necessary.



MX20280

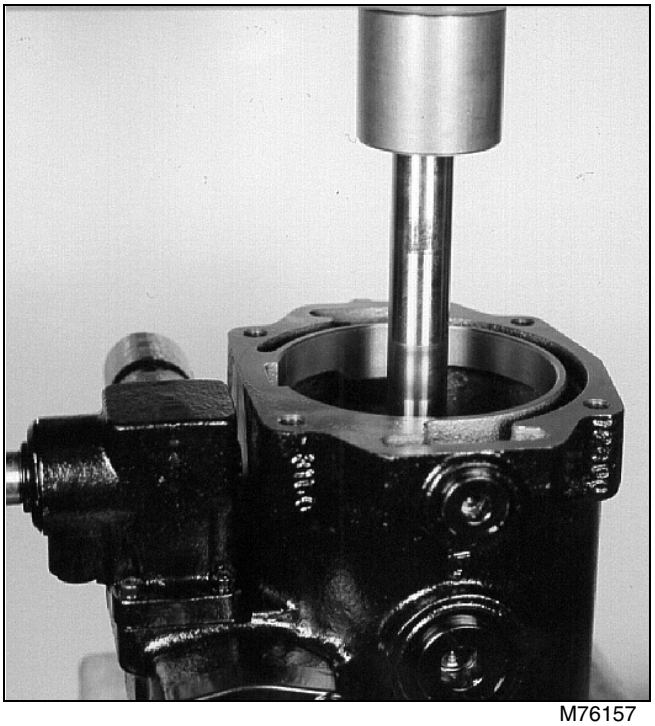
10.Remove pump from vise and lay it on its side. Hold rotating assembly (J) with hand and carefully stand pump up on output end of main shaft. Lower rotating assembly, cam plate, and follower to bench and lift pump housing (K) away.

11.If the pistons did not come out with the piston block, remove the pistons along with the spider and pivot.

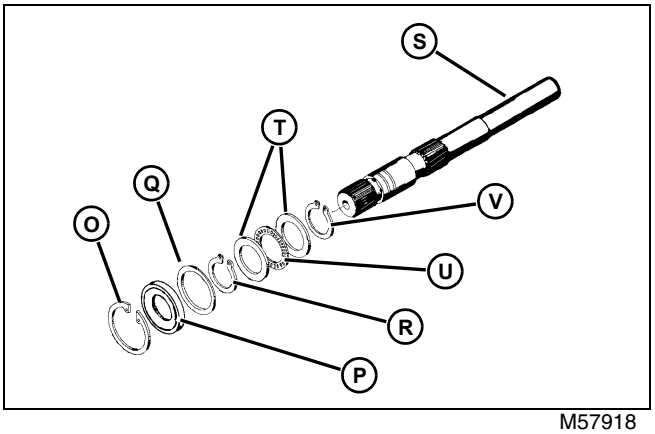


M86015

12.If needed, remove the cam plate (L) and follower (M) from the housing. When removing the cam plate, be sure not to damage the shoe surface (N).



M76157

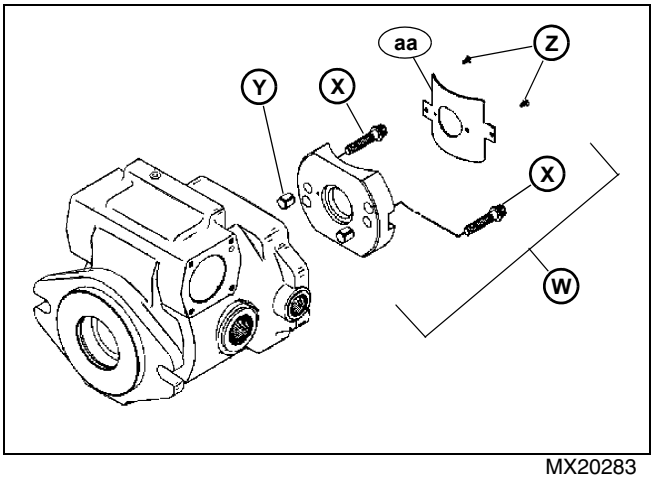


M57918

13.Remove retaining ring (O) and press the shaft out of the housing as shown until the rubber seal (P) releases from the bore. Be sure that the shaft is supported below so that it does not drop and become damaged when it releases from the housing.

14.Remove the seal (P) and washer (Q).

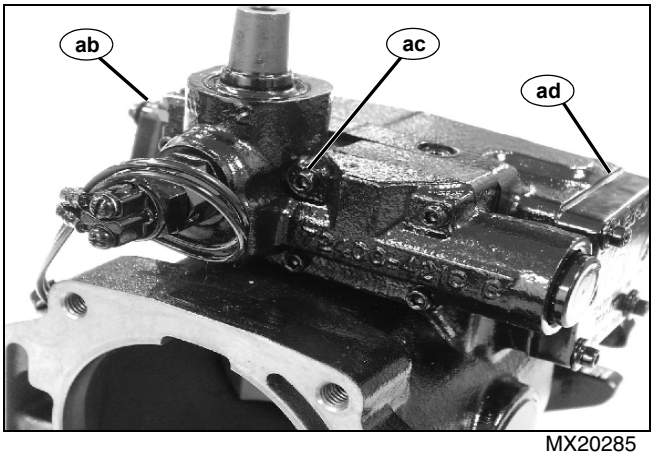
15.Remove the retaining ring (R) from the main shaft (S) and remove the thrust washers (T), thrust bearing (U), and retaining ring (V).



MX20283

16.Remove the cradle sub-assembly (W) by removing two retaining screws (X), retaining cradle inside housing. Move the cradle back and forth to release the dowel bushings (Y) and remove the cradle sub-assembly from the housing.

17.Remove the button head cap screws (Z) to remove the bushing (aa).

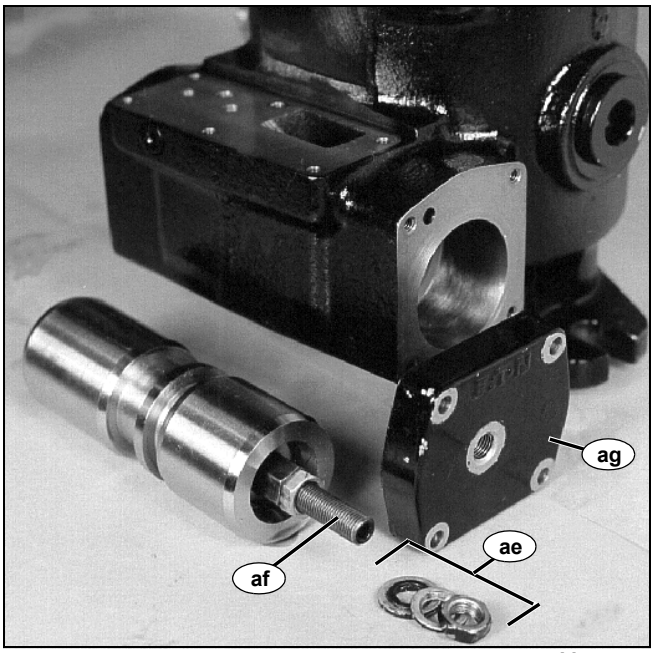


MX20285

18.Remove the servo valve (ab) and gasket by removing the six socket head cap screws (ac) that fasten the valve to the housing.

19.Remove the cylinder cap (ad) that does not have the screw and locknut through the center.

Note: Do not disassemble the piston any farther than specified. The piston spring tension is preset at the time of manufacture. The service piston assembly is sold only as an assembled unit.



M76165

20.Remove the locknut, flat washer, and rubber washer (ae) from the piston screw (af).

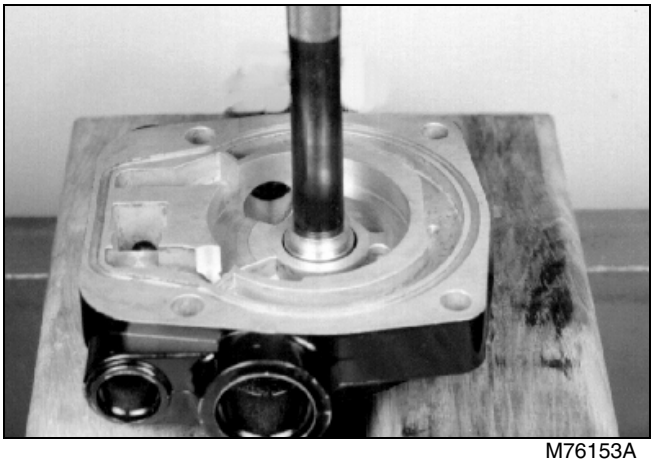
21.Using a hex key wrench in the end of the piston screw, turn it clockwise until it threads completely out of the cover.

22.Remove the cap (ag) with the piston screw hole through the center.

23.Push the piston out of the piston bore.

Inspect Hydrostatic Pump

1. Inspect the needle bearings and bushing in the charge pump adapter housing, the backplate, and the pump housing. If the needles remain in the cage and spin freely, there is no need to replace them. Check bushing for excessive scoring; replace if necessary.



M76153A

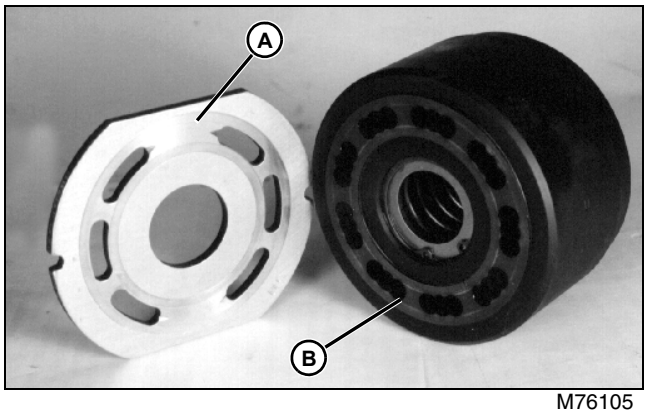
2. If it is necessary to remove the bushing from the charge pump adapter housing, it can be pressed from the inside of the housing to the outside as shown.

Important: Avoid Damage! The charge pump adapter housing is aluminum and the machined surfaces can be easily damaged. Do not press the housing against unprotected steel surfaces.

3. If the bearing in the backplate needs to be replaced, it can be pressed out in the same fashion as that of the charge pump adapter housing.

Important: Avoid Damage! When removing bearing from backplate, be extremely careful not to damage machined surfaces.

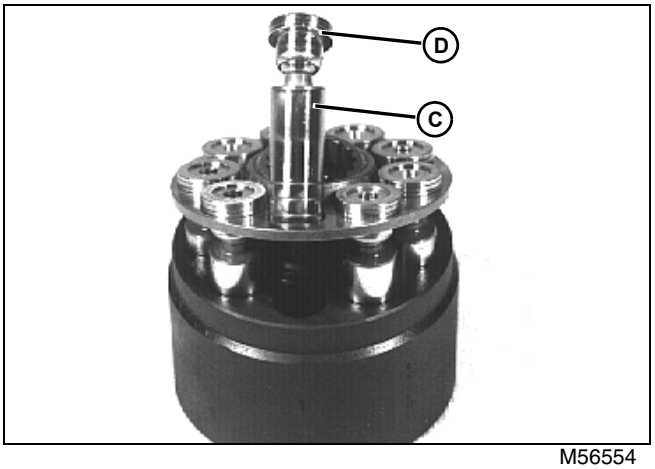
4. Inspect the charge pressure relief valve and valve seat in the charge pump adapter housing. Be sure that there are no burrs, excessive wear, or defects on the relief valve or valve seat.



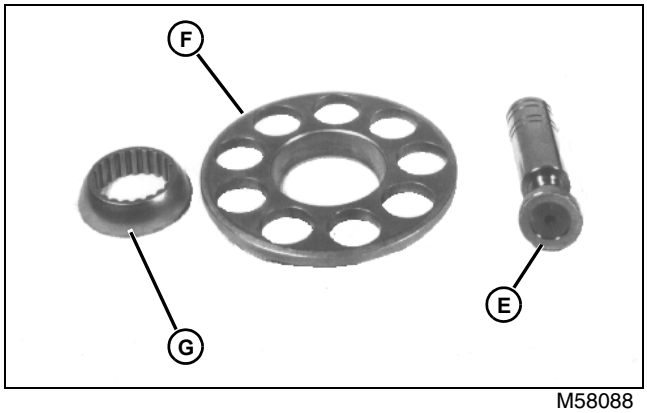
M76105

5. Inspect the valve plate (A) on the bronze side next to the piston block for wear. Replace the valve plate if any wear, scoring, or deep scratches exist.

6. Inspect the piston block surface (B) that makes contact with the valve plate. This surface should be smooth and free of deep scratches.



M56554



M58088

7. Check the piston (C) movement in the block bore. If the pistons are sticky in the bore, examine the bore for scoring or contamination.

8. Examine the OD of the pistons for finish condition. They should not show wear or deep scratches.

9. Inspect each piston shoe (D) for a snug fit on the ball end of the pistons. Check the shoe face (E) for a flat smooth surface.

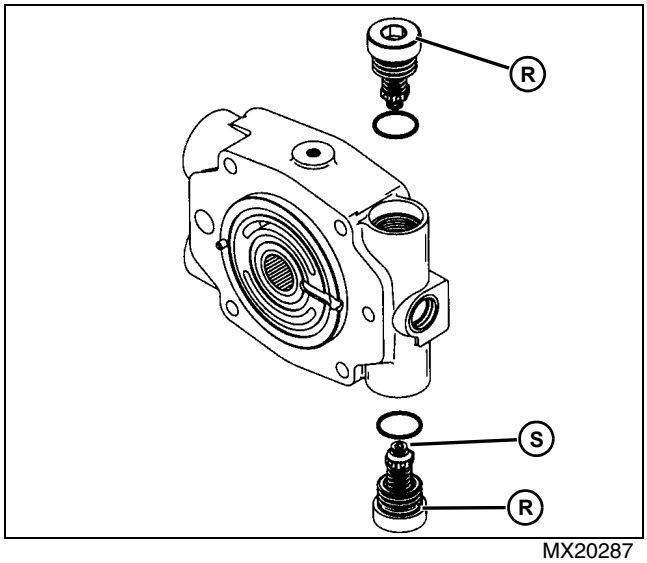
10.Examine the spider (F) for wear in the pivot area.

11.Examine the pivot (G) to ensure smoothness and no signs of wear.

The following parts will be needed to disassemble the piston block:

- 3/8 in. ID x 1-1/4 in. OD flat washers (2 ea)
- 3/8 in. x 5 in. NC cap screw (1 ea)
- 3/8 in. NC nut (1 ea)
- 1/2 in. drive socket with 1-1/8 in. OD (1 ea)

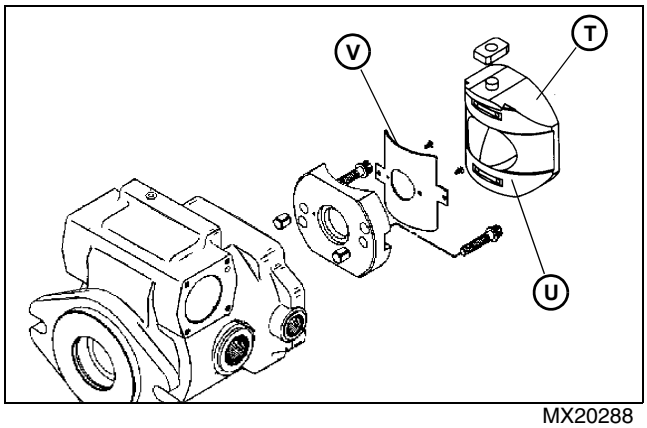
12.Replace pins as needed.



MX20287

13.Examine the main drive pressure relief valves (R) and seats. Inspect the check valve (S) at the end of the relief valve. The check valve at the end of the relief valve should be loose and easily operated. The seat for the check valve should be free of burrs and defects.

14.Examine the machined surfaces of the backplate.

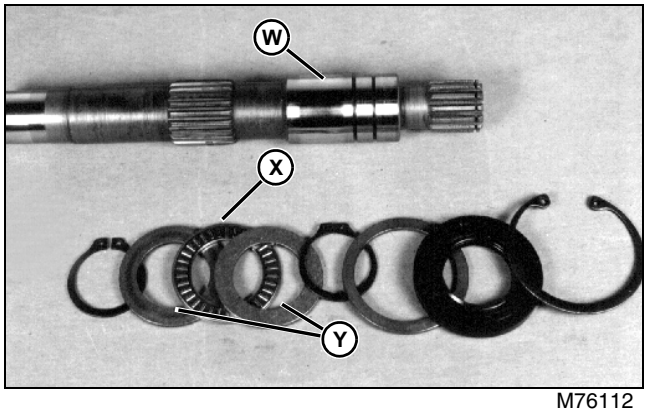


MX20288

15.Examine the shoe surface (T) of the cam plate. Be sure that there are no grooves, or excessive wear on the shoe surface. Check that the lubrication holes in the cam plate are open.

16.Inspect the cradle surface (U) on the back side of the cam plate for excessive wear.

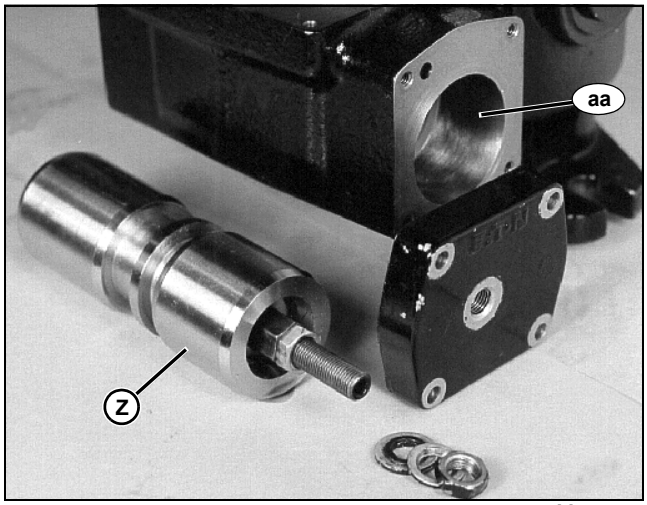
17.Examine the wear plate (V); if the fiber surface of the wear plate is worn, replace the wear plate.



M76112

18.Inspect the shaft (W) for fretting in the bearing and spline area.

19.Inspect thrust bearing (X) and washers (Y) for wear.



M76165

20.Inspect the servo piston (Z) for scratches and wear.

21.Examine the servo piston cylinder (aa) in the pump housing and seals for damage.

Assemble Hydrostatic Pump

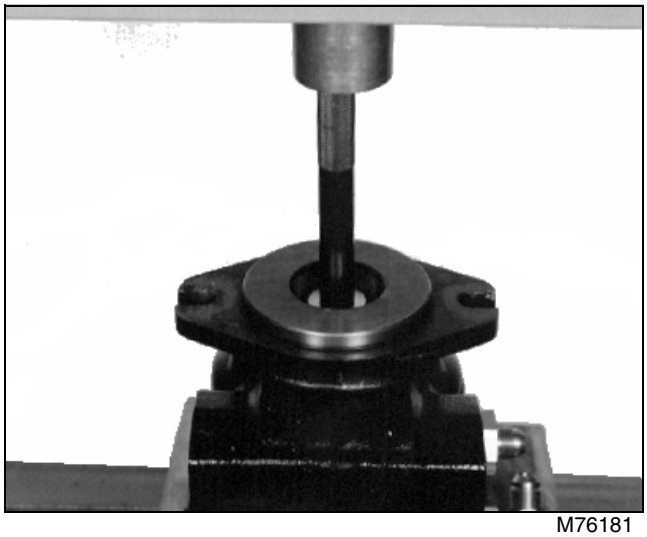
Other Material

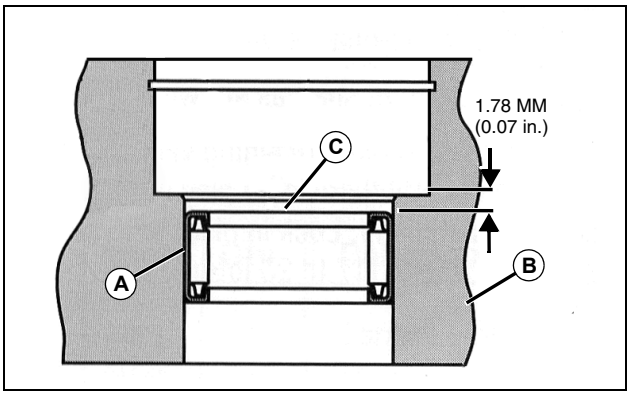
Part No.	Part Name	Part Use
PM37477 (US) PM38621 (Canada)	Thread Lock and Sealer (Medium Strength)	Apply to threads of setscrew.

Important: Avoid Damage! Due to extremely tight tolerances and finish of pump internal surfaces, it is very important to maintain absolute cleanliness during the assembly of the pump. Coat all internal surfaces with clean hydraulic fluid when assembling the pump.

Clean all parts in a suitable solvent and dry with a lint-free rag.

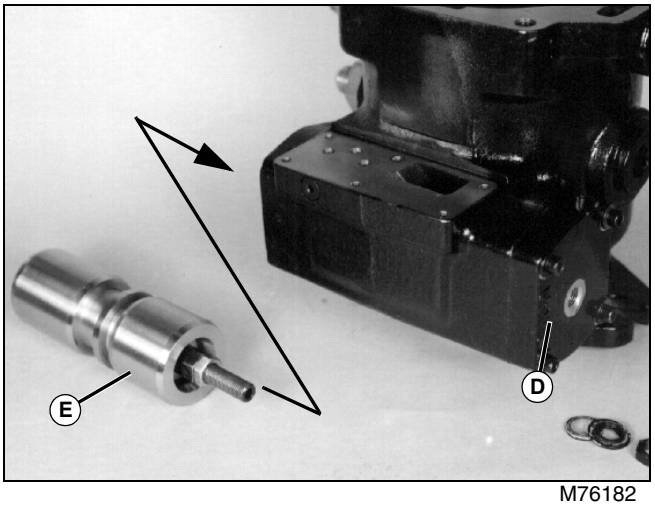
Always replace O-rings and seals. Old O-rings and seals will leak. Lubricate new seals and O-rings with petroleum jelly when assembling.


M76181



M20271

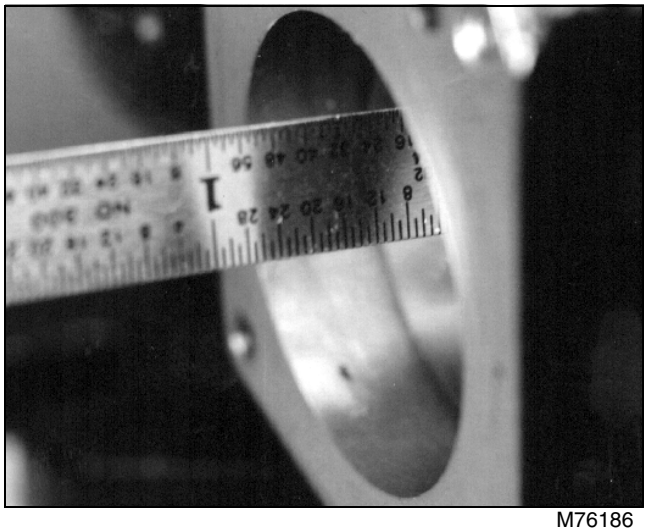
1. If the needle bearing (A) was removed from the housing (B), the new one can be pressed from the outside inward until the bearing race is recessed in the bore according to specifications. Be sure that the numbers on the bearing race (C) are facing to the outside of the housing.



M76182

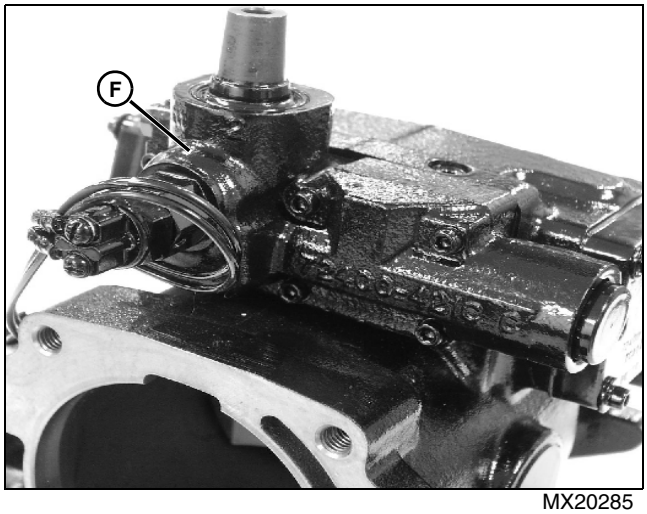
2. Install the gasket and cylinder cap (D) that has the piston screw hole through the center. Tighten the mounting screws to specifications.

3. Install the piston (E) into the cylinder as indicated above.


M76186

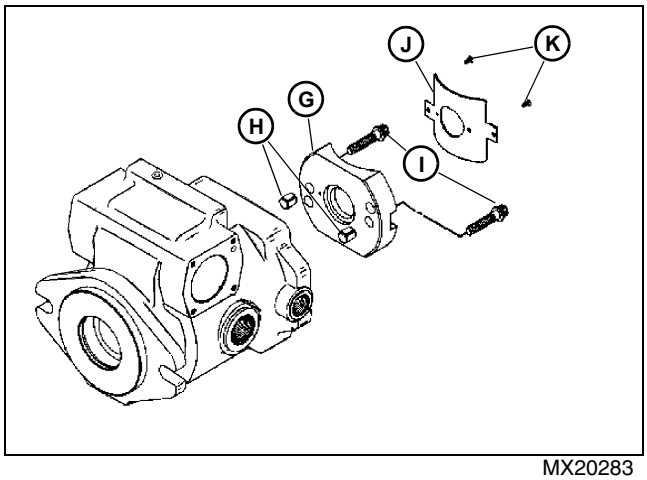
4. Insert a hex key wrench into the end of the piston screw and thread it through the cover until the opposite end of the piston is located according to specification from the edge of the cylinder.

5. Install the rubber washer, flat washer, and outside jam nut onto the piston screw. Tighten the jam nut to specification.



MX20285

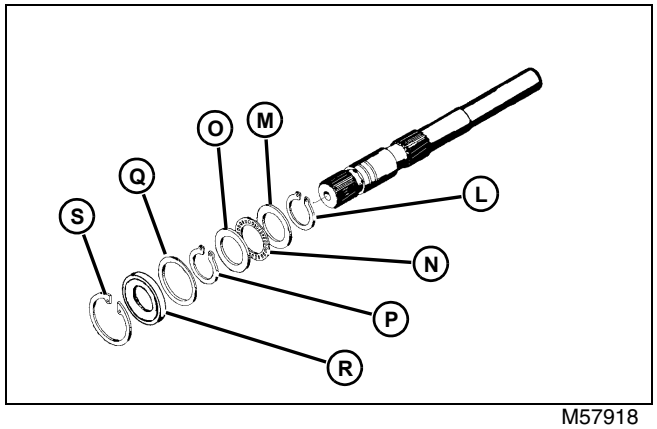
6. Clean the mating surface and install the servo valve (F) and gasket onto the housing. Be sure the servo valve feedback rod is positioned into the narrow groove on the servo piston. Tighten the mounting screws to specification.



MX20283

7. Place the cradle (G) into the housing, being sure that the dowel bushings (H) are located in the holes in the housing. Draw the cradle tight by evenly torquing the two mounting screws (I) to specification.

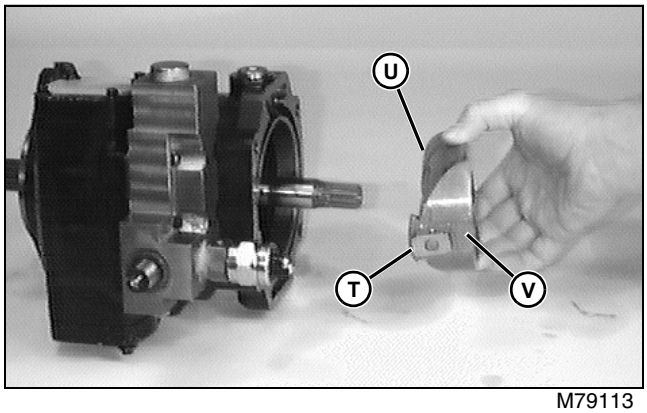
8. Install the wear plate (J) onto the cradle and tighten the retaining screws (K) to specification.



M57918

9. Install the inside retaining ring (L), thrust washer (M), and thrust bearing (N) on the shaft. Install the outside thrust washer (O) and retaining ring (P).

10.Install the shaft into the housing. Install the washer (Q) and a new shaft seal (R). Secure it with the retaining ring (S).



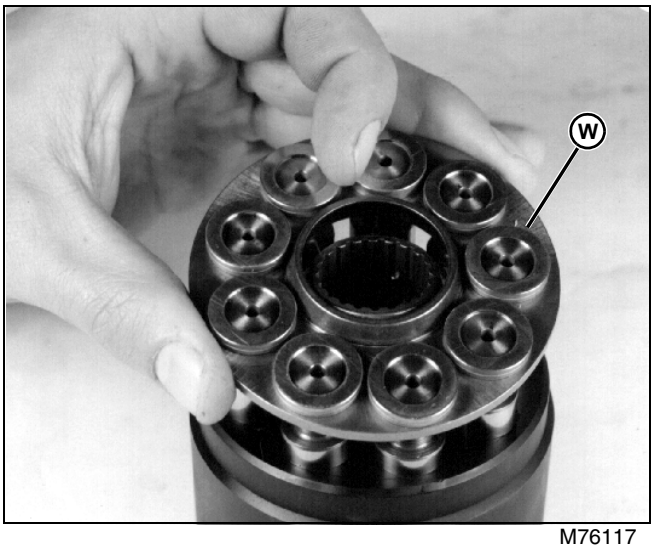
M79113

11.Install the cam plate follower (T) onto the cam plate (U).

12.Place the camplate over the shaft with the shoe surface (V) outward.

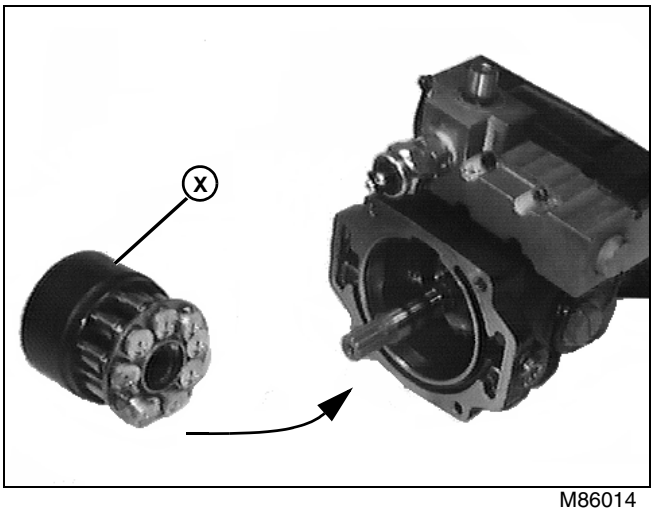
13.Use a long screwdriver to guide the cam plate follower into the large groove in the servo piston.

Note: It is not necessary to put the pistons in the original positions. Any piston can be installed in any hole.



M76117

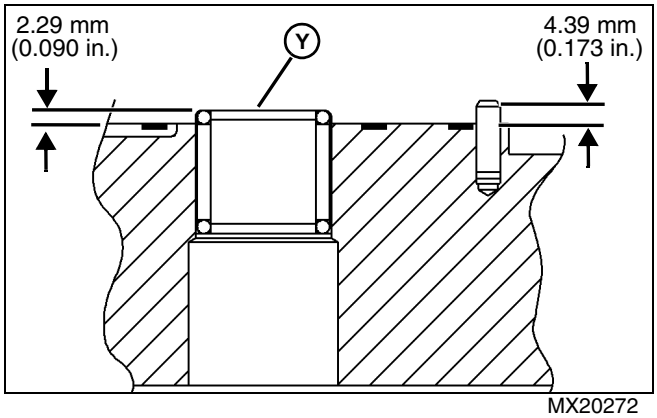
14.With each piston (W) in place in the spider, lower the pistons into the piston block.



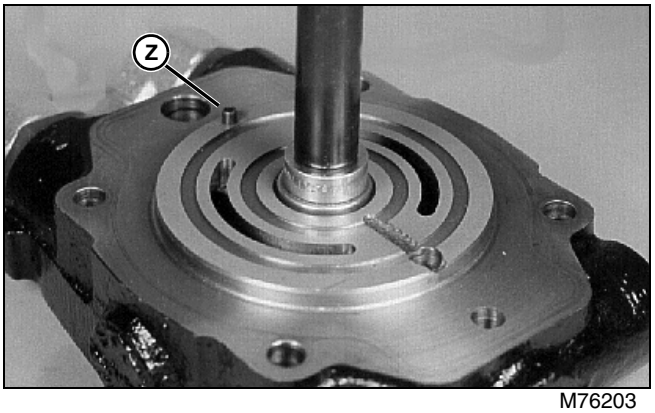
M86014

15.Tilt the pump housing so that the open end is facing slightly downward, but not so much that the cam plate falls out of position.

16.Slide the rotating unit (X) up the shaft until it meshes with the splines on the shaft.



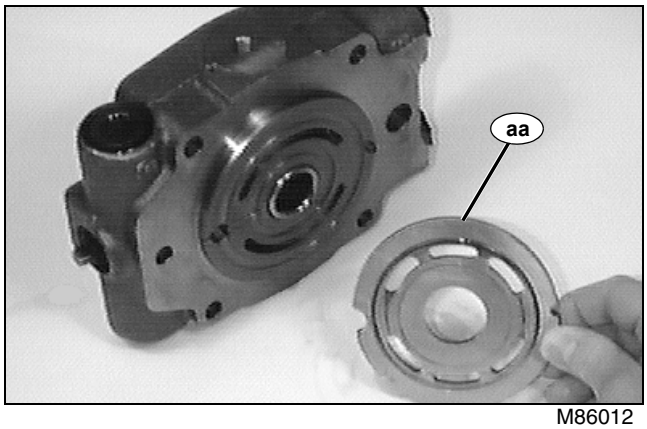
MX20272



M76203

17.If the bearing was removed from the backplate, press new one into position as shown. The numbers (Y) on the bearing should be positioned toward the inside of the pump housing. Press the bearing in until the race remains above the surface of the backplate according to specification.

18.Install the roll pin (Z) (if removed) that is used to position the valve plate. Allow the pin to protrude from the backplate to specification.

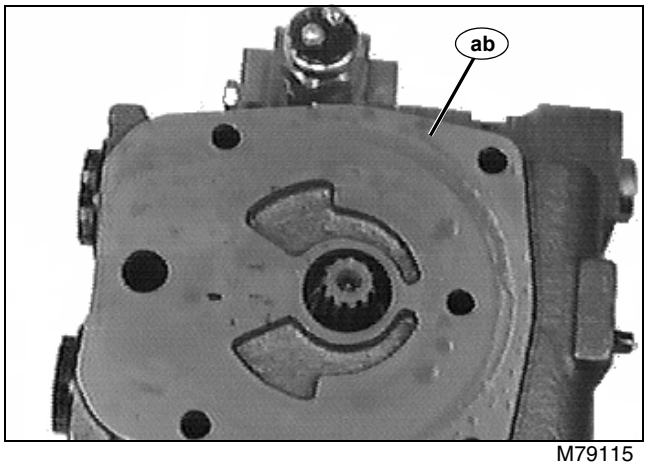


M86012

19.Apply a small amount of clear petroleum jelly to the steel side of valve plate (aa) to hold it in place for installation.

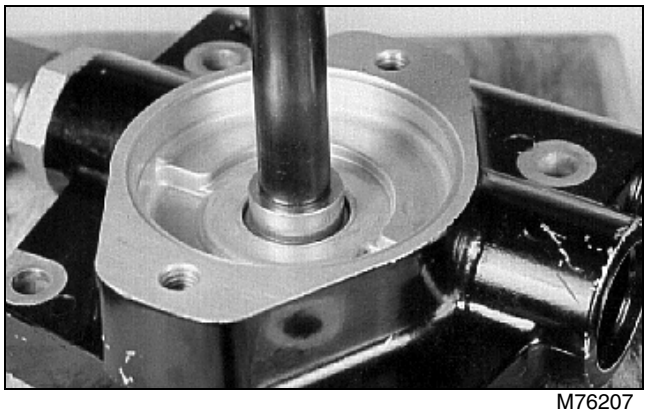
20.Install the valve plate onto the backplate with the steel side facing the backplate and the bronze side facing the inside of the housing.

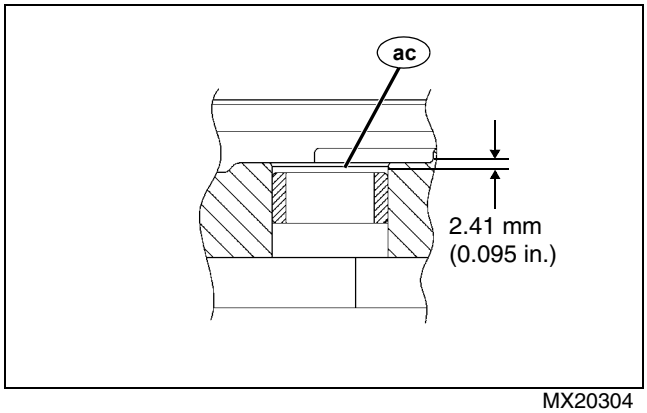
21.Place a new gasket on the housing.



M79115

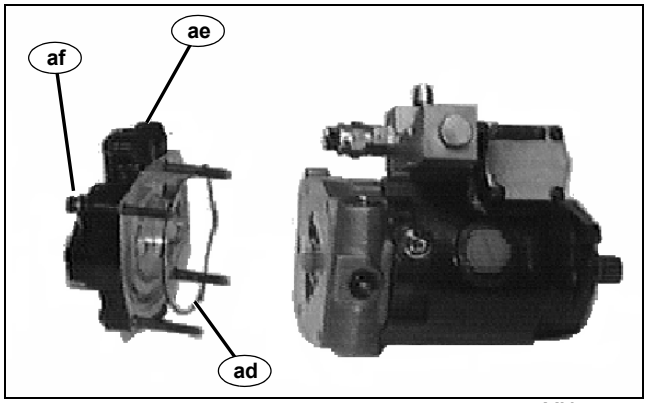
22.Install the backplate assembly (ab) onto the housing assembly, making sure valve plate stays in position. The backplate should rest off of the housing at the backplate assembly resting position specification until it is tightened down. This is due to the spring tension within the rotating assembly.


M76207



MX20304

23.If necessary, press a new bushing (ac) into the charge pump adapter housing. Press the bearing into the housing from the outside inward. Press the top of the bushing until it is positioned below the top edge of the bore to specification (as shown).

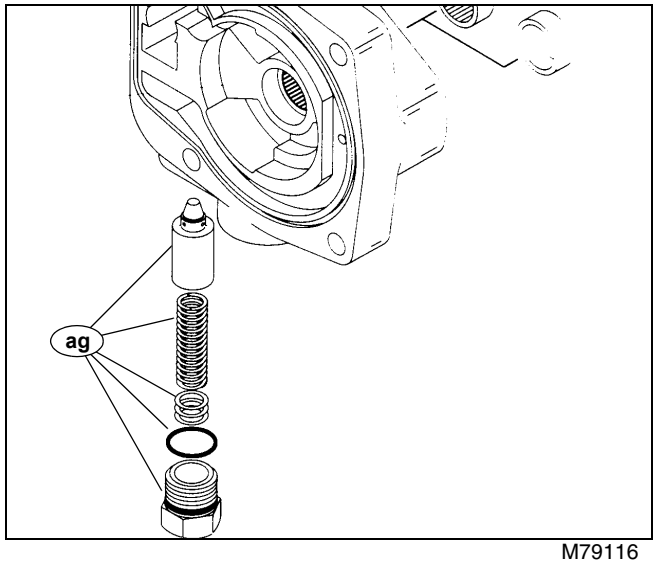


MX20279

24.Install the O-ring (ad) into the charge pump adapter housing. Use petroleum jelly to lubricate and hold the O-ring in place in the housing (ae).

25.Place the charge pump adapter housing over the shaft. Insert the four cap screws (af) and tighten evenly to specification.

26.After installing new O-rings, install the main drive pressure relief valves in the same cavities in the backplate from which they were removed. Tighten to specification.



M79116

27.Install the charge pressure relief valve assembly (ag). Tighten to specification.

Specifications

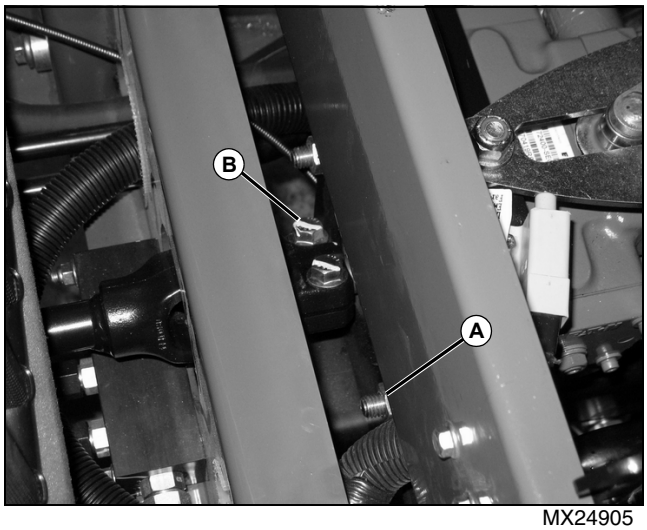
Main Shaft Needle Bearing Position (Below Surface) . . . . . 1.78 mm (0.070 in.)
Servo Piston Cover Mounting Screw Torque . . . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Servo Piston Distance from Edge of Cylinder (Installed) . . . . . .12.7 mm (0.500 in.)
Outside Jam Nut Torque . . . . . 17.5 ± 1 N•m (155 ± 5 lb-in.)
Servo Control Mounting Screw Torque . . . . . 5.0 ± 0.5 N•m (44 ± 4 lb-in.)
Cradle Mounting Screw Torque . . . . . 36 ± 2 N•m (26 ± 2 lb-ft)
Wear Plate Retaining Screw Torque . . . . . 1.7 ± 0.1 N•m (15 ± 1 lb-in.)
Backplate Bearing Position (Above Surface) . . . . . 2.29 mm (0.090 in.)
Roll Pin Protrusion from Backplate . . . . . 4.39 mm (0.173 in.)
Backplate Assembly Resting Position . . . . . 1.5 mm (0.06 in.)
Charge Pump Adapter Bushing Position (Below Surface). . . . . 2.41 mm (0.095 in.)
Main Drive Pressure Relief Valve Torque . . . . . 143 ± 6 N•m (105 ± 5 lb-ft)
Charge Pump Adapter Assembly Torque . . . . . 39 ± 2 N•m (29 ± 1 lb-ft)

Install Hydrostatic Pump

1. Install hydrostatic pump mounting bracket and control linkage (if removed) to pump.

2. Place the hydrostatic pump into position in machine.

3. Install a new O-ring between hydrostatic and triple pump.



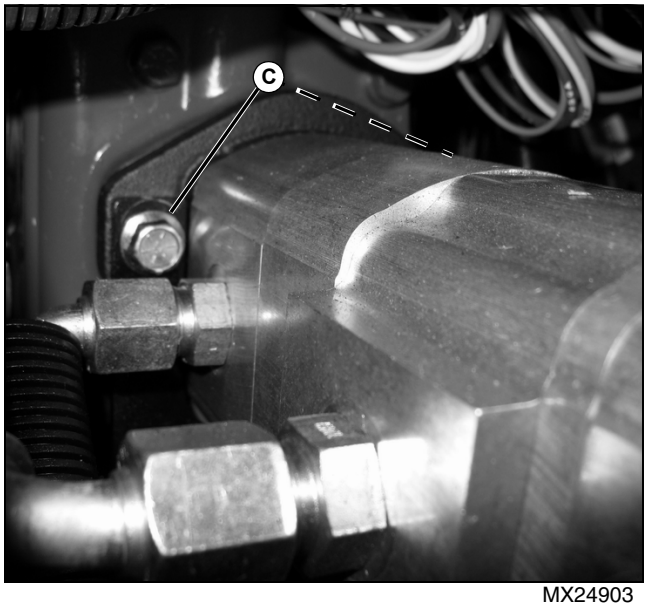
MX24905

4. Install hydrostatic pump to mounting plate and driveshaft.

5. Install hydrostatic pump mounting plate cap screws and nuts (A).

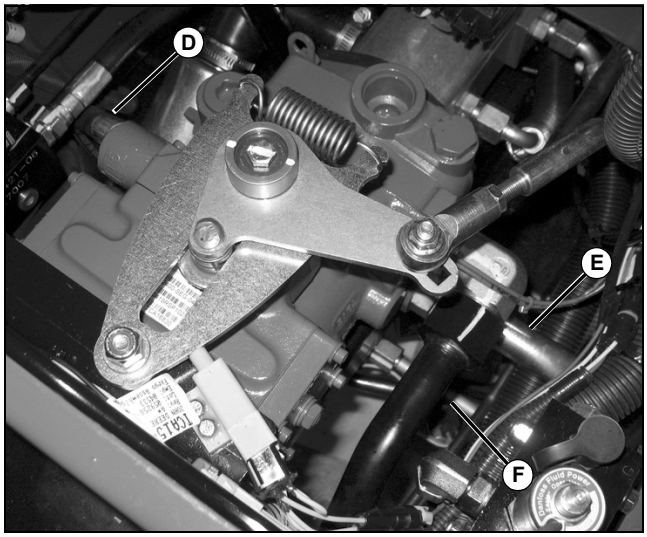
6. Install cap screw to driveshaft (B).

7. Install driveshaft shield.



MX24903

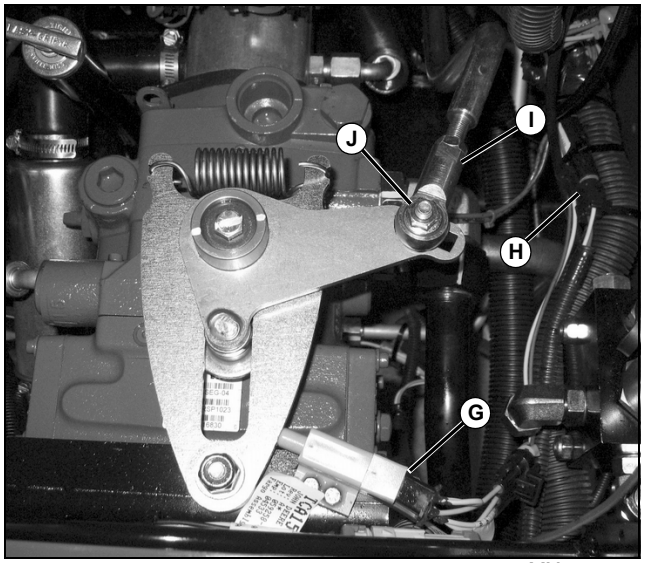
8. Install triple pump mounting, cap screws and washers (C).



MX24902a

9. Connect hydraulic hose (D) and hydraulic lines (E and F).

Note: Observe location of spacers on traction rod (J).



MX25059a

10. Connect neutral and reverse switch connectors (G and H).

11. Install traction rod and spacers (I) and nut (J) in the cam plate inside hole for standard ground speeds.

12. Fill hydraulic reservoir.

13. Install operator foot platform.

14. Install operator seat and deck.

15. Connect battery.

16. Perform start-up procedure. (See “Start-Up Procedure” on page 524.)

17. Adjust neutral position. (See “Test and Adjust Transmission Neutral Position” on page 497.)

18. If pump was removed for either replacement or rebuild, check forward and reverse relief pressures. (See “Test Hydrostatic System Relief Pressure” on page 492.)

Specifications

Hydrostatic Pump

90° Fitting . . . . . 108 N•m (80 lb-ft)
B Nut at 90° Fitting . . . . . 95 N•m (70 lb-ft)
B Nut at Straight Fitting . . . . . 95 N•m (70 lb-ft)

Remove and Install Front Wheel Motor

Caution: Avoid Injury! Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

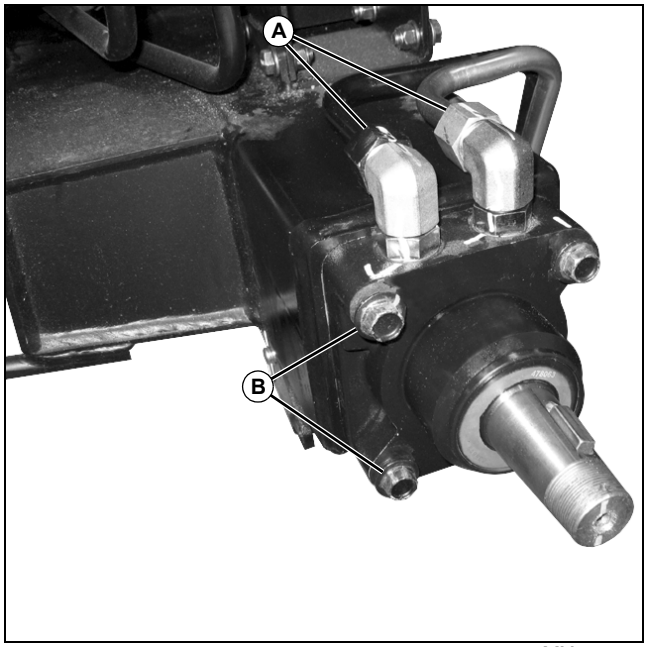
- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

Important: Avoid Damage! The front hydraulic wheel motors are the same physical motor except the right has a reversed timed manifold. This manifold allows an opposite shaft rotation and a synchronized forward or reverse motion when the vehicle is engaged. It is critical when removing wheel motor(s) for service, record or label motor(s) accordingly for proper installation. Improper installation of the wheel motor(s) can result in serious personal injury or vehicle damage.

Removal

1. Remove park brake assembly.
2. Remove brake rotor.

Note: Use proper fluid containment procedures when removing wheel motor.



MX24906

3. Disconnect hydraulic lines (A). Install caps and plugs.
4. Remove mounting cap screws (B).
5. Remove the wheel motor.
6. Remove fittings if the motor is to be repaired or exchanged.

Installation

Note: Replace the o-ring between the wheel motor and axle/reservoir.

Installation is done in the reverse order of removal.

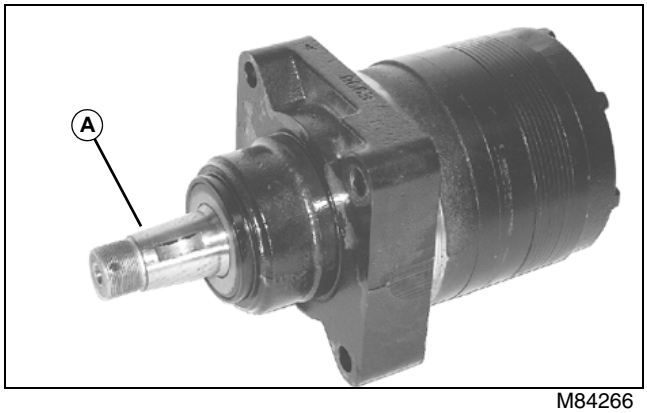
- Apply multipurpose grease to wheel motor shaft and key. (See “Grease - North America” on page 16.)
- Tighten the nut securing the rotor to the motor to specification.
- Fill hydraulic reservoir to correct level with oil of proper specifications. (See “Transmission and Hydraulic Oil” on page 16.)
- Bleed air from hydraulic system. (See “Bleed Hydraulic System” on page 550.)

Specifications

Brake Rotor Retaining Nut Torque . . . . . 190 - 217 N•m (140 - 160 lb-ft)
90° Fitting at Wheel Motor. . . . . 81 N•m (60 lb-ft)
B Nut at Wheel Motor. . . . . 68 N•m (50 lb-ft)

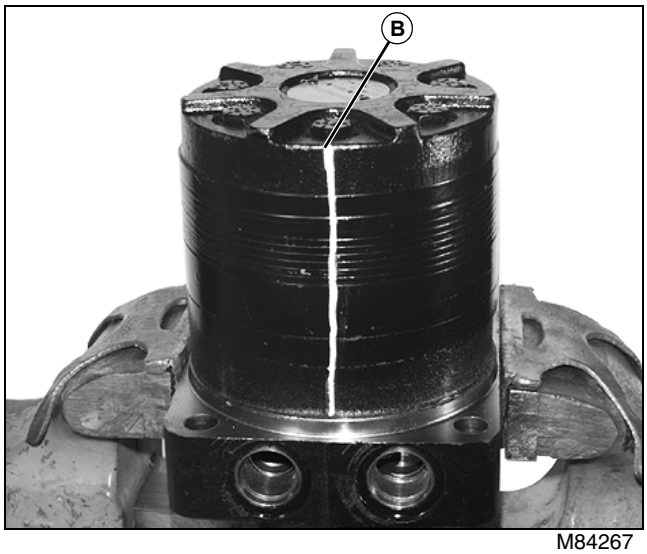
Disassemble and Inspect Wheel Motor

Note: Disassembly and inspection of front and rear wheel motors is similar. Rear motors have a 8mm keyway and the front motors have a 9.5mm keyway. Right hand front motor is marked with a yellow dot and contains a reverse flow manifold.



M84266

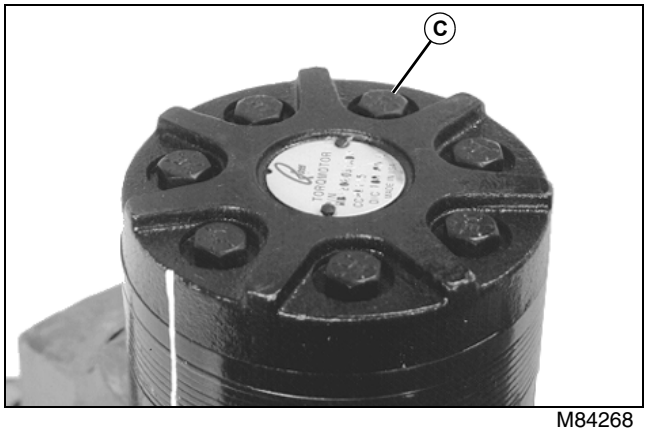
1. Clean rust, dirt and corrosion from coupling shaft (A).



M84267

2. Place wheel motor in a soft-jawed vise with the output shaft down, clamping firmly on sides of the housing, mounting flange or port bosses.

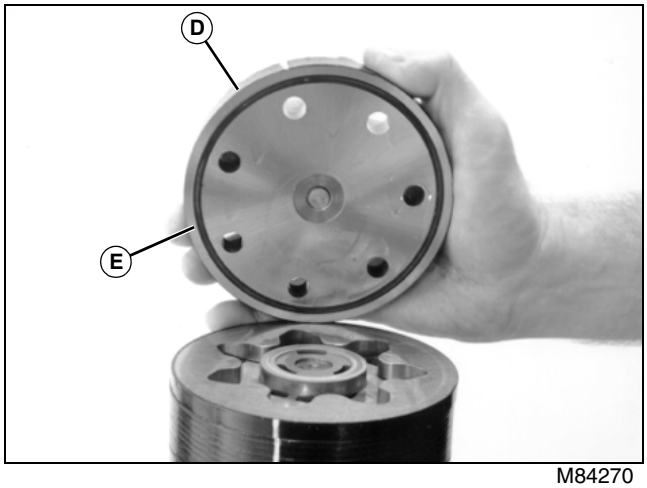
3. Scribe (or paint) an alignment mark (B) across the motor housing.



M84268

4. Remove seven retaining bolts (C).

5. Inspect bolts for damaged threads and damage to sealing ring under the bolt head.



M84270

6. Remove end cover assembly (D) and seal ring (E). Discard seal ring.

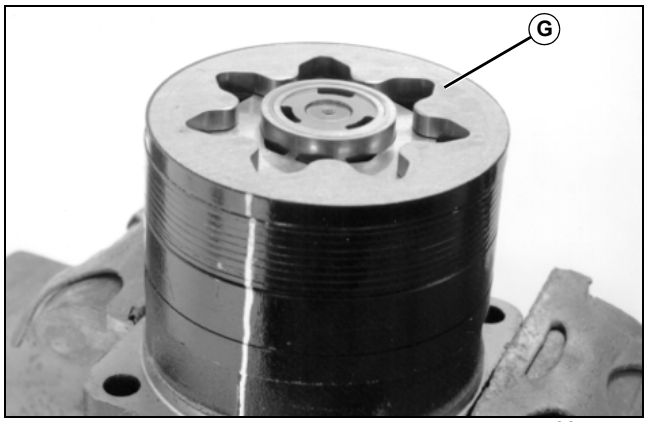
Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

M84271

7. Thoroughly clean end cover (F) with solvent and blow dry with compressed air.

Note: A polished pattern on the face of the cover caused by rotation of the commutator is normal; however, the face should be free of scratches. Discoloration of the face surface may be caused by excessive fluid temperature, thermal shock or excessive speed. If discoloration is noted, thoroughly inspect all motor components for further damage. Inspect the entire drive/hydraulic system and correct any problems to prevent any possible further damage.

8. Inspect end cover for cracks, damage, discoloration or unusual wear.

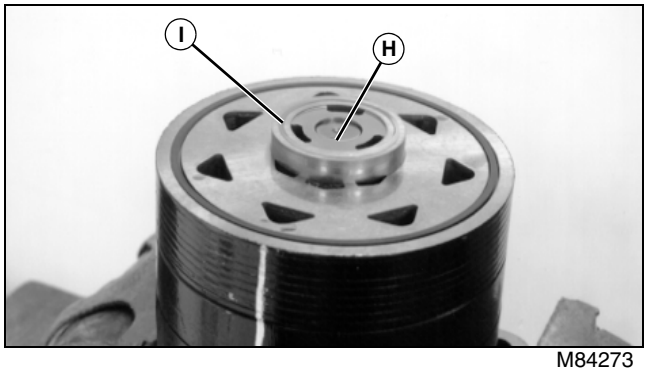


M84272

9. Remove commutator ring (G).

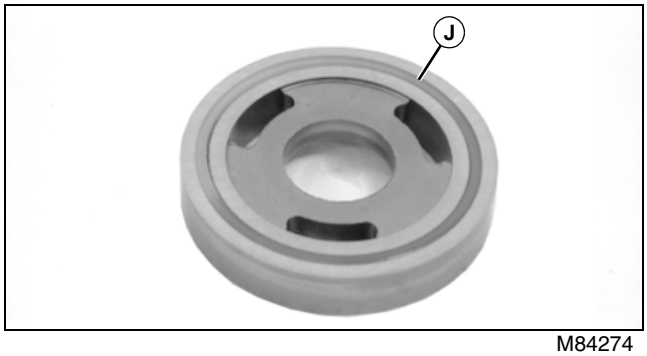
10.Inspect commutator ring for cracks or burrs.

Note: Drive link (H) may stick to commutator (I). Hold drive link in place while removing commutator.



M84273

11.Remove commutator.

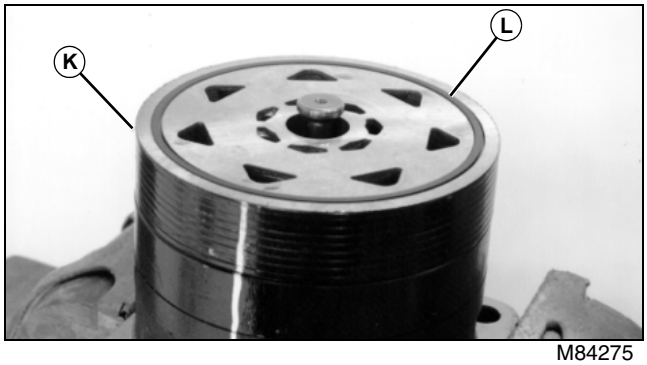


M84274

12.Remove seal ring (J) from commutator by blowing compressed air into the ring grove until the seal ring is lifted out of the groove. Discard seal ring.

13.Inspect commutator for cracks, burrs, scoring, spalling, brinelling or unusual wear.

Note: The right wheel motor has a reversed time manifold and should be marked accordingly for proper re-assembly and operation



M84275

14.Remove manifold (K).

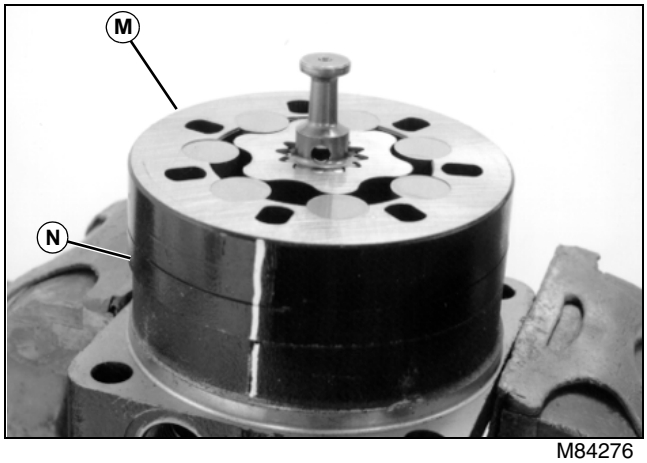
15.Remove seal rings (L) from both sides of the manifold. Discard seals.

Note: A polished pattern on the ground surface of the manifold caused by rotation of the commutator is normal.

16.Inspect manifold for cracks, surface scoring, spalling or brinelling.

Note: Hold rotor set and wear plate together while removing to maintain rotor vane-to-stator contact surfaces.

The drive link may come out with the rotor set. If it does, hold the drive link while removing the rotor set/ wear plate.



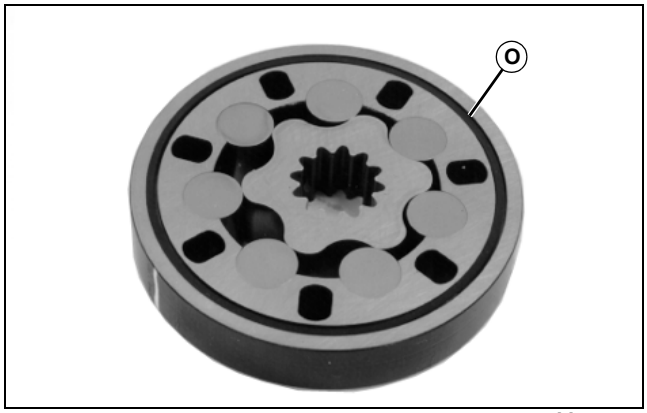
M84276

Picture Note: Bottom of rotor set shown.

17.Remove rotor set (M) and wear plate (N) as a set.

Note: Maintain rotor set components in their original positions. DO NOT disassemble.

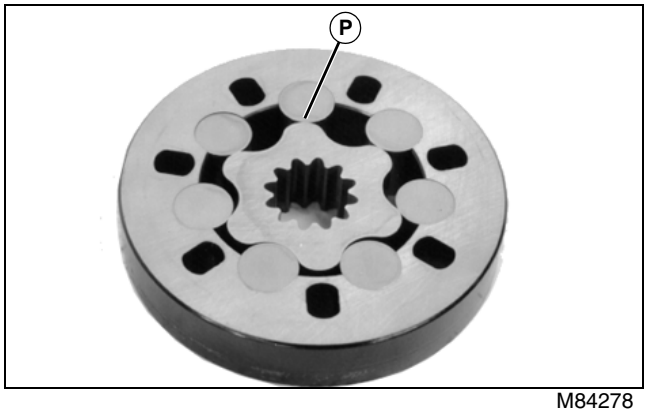
If disassembly is required, mark the upper surface of the rotor and stator, and all rotor components, to ensure correct installation during assembly.



M84277

18.Separate the rotor set from the wear plate. Discard seal ring (O).

19.Inspect rotor set for nicks, scoring or spalling on any surface, or for broken or worn splines.



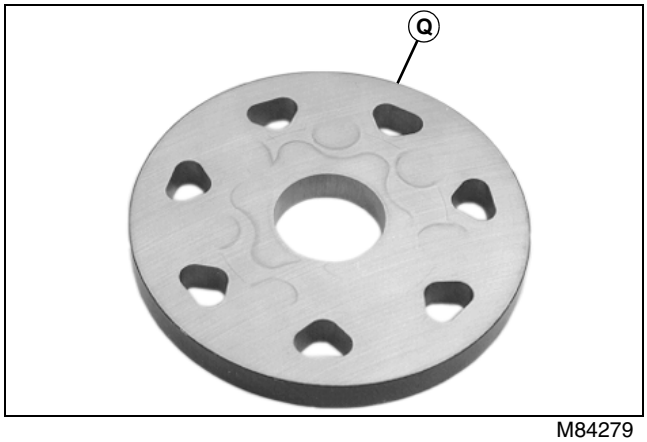
M84278

20.Place rotor set on a surface plate.

21.Position the rotor in the stator so that two rotor lobes (180° apart) and roller vane centerline are on the same stator centerline.

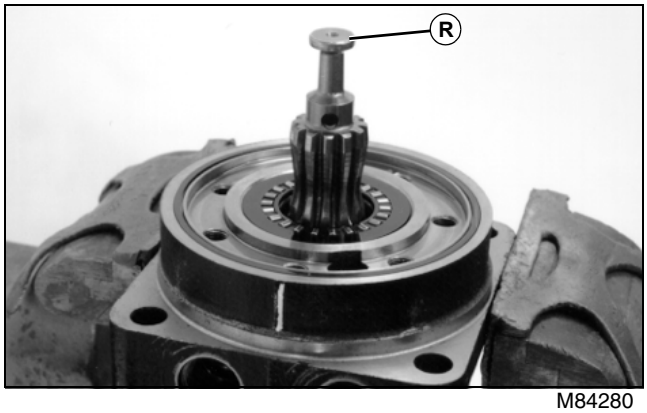
22.Check the rotor lobe-to-roller vane clearance at the common centerline (P) using a feeler gauge. Clearance should not be greater than 0.13 mm (0.005 in.).

Note: A polished pattern on the ground surface of the wear plate caused by rotation of the rotor is normal.



M84279

23.Inspect wear plate (Q) for cracks, brinelling or scoring.

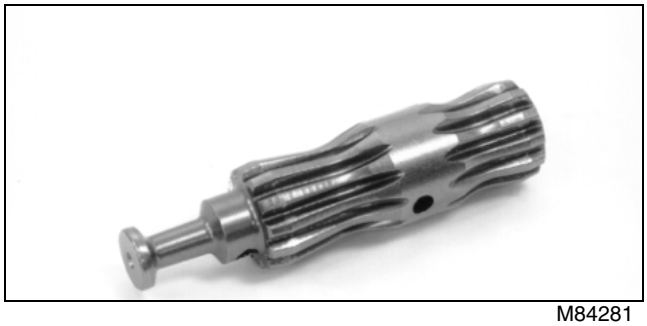


M84280

24.Inspect for play between drive link (R) and coupling shaft. There should be no noticeable play.

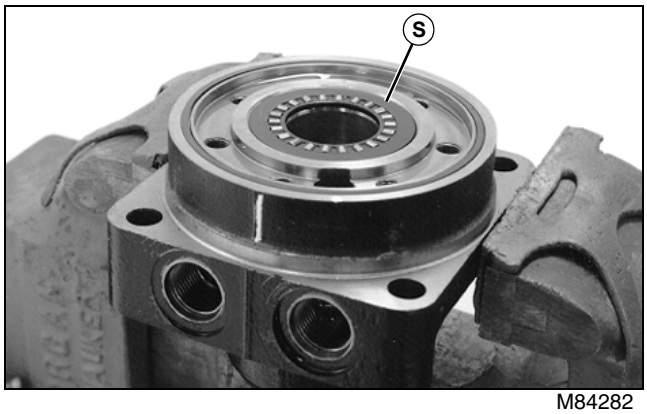
25.Mark drive link and coupling shaft splines to ensure reassembly in the original positions.

26.Remove drive link from the coupling shaft.



M84281

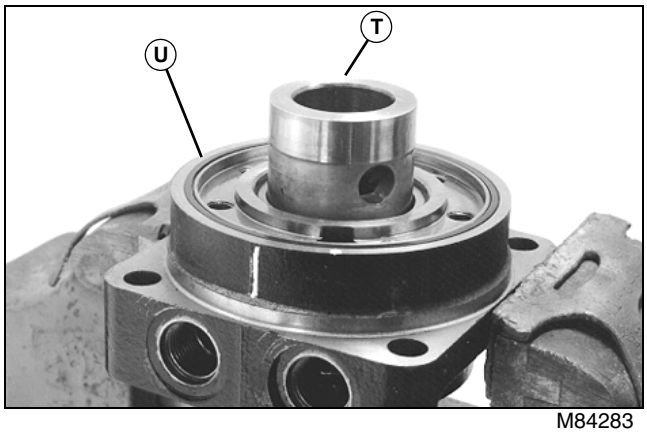
27.Inspect the drive link for cracks and worn or damaged splines.



M84282

28.Remove thrust bearing (S) from coupling shaft.

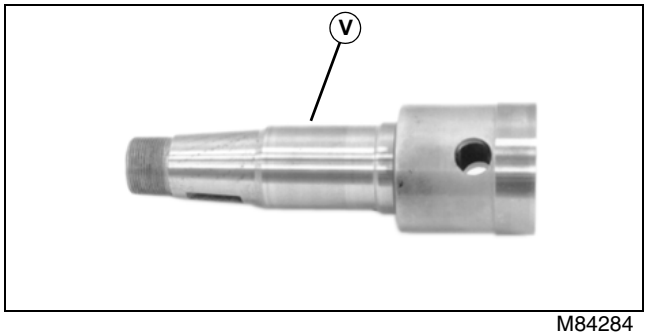
29.Inspect thrust bearing for wear, brinelling, corrosion and missing rollers.



M84283

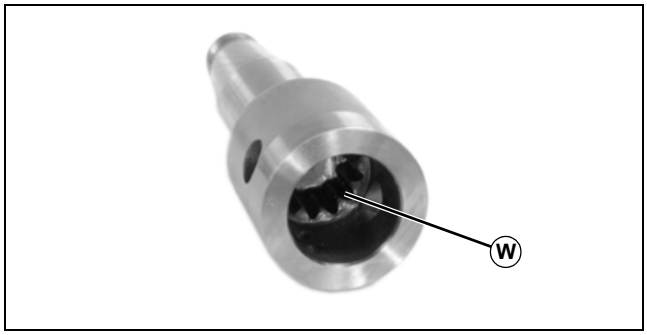
30.Remove coupling shaft (T).

31.Remove seal ring (U) from housing. Discard seal.



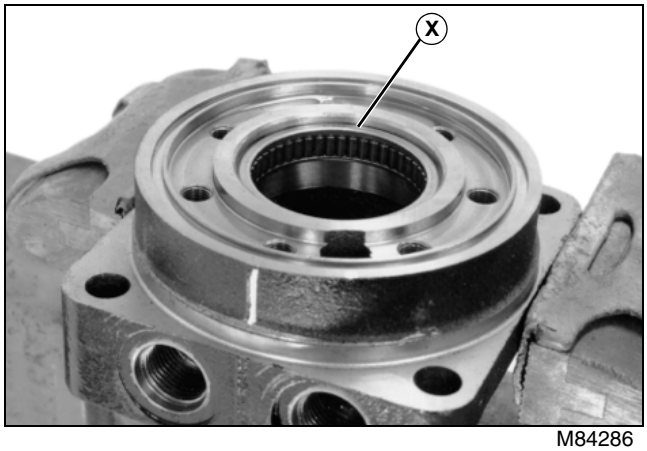
M84284

32.Inspect coupling shaft bearing and seal surface (V) for spalling, nicks, excessive wear or corrosion.



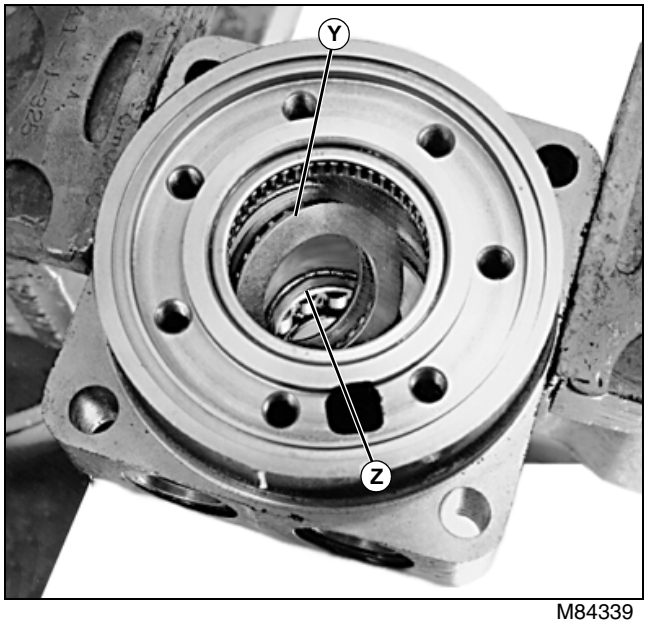
M84285

33.Inspect coupling shaft splines (W) for wear or damage.



M84286

34.Inspect inner bearing (X) for free rotation and excessive play in bearing cage. Also inspect bearing for brinelling or corrosion.

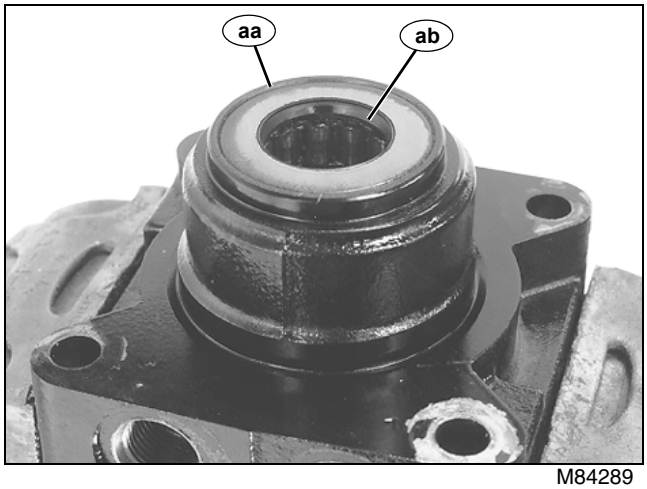


M84339

35.Inspect thrust bearing.

Note: A dental pick or similar device can be used to remove the seal.

36.Push thrust bearing and washers (Y) aside and remove seal and backup washers (Z).



M84289

37.Remove wheel motor from vise. Invert it and install it in vise.

38.Remove seal (aa) using a blind-hole bearing or seal puller.

39.Inspect the housing for cracks, excessive wear or damage. Inspect machined surfaces for nicks, burrs, brinelling or corrosion. Inspect tapped holes for thread damage.

40.Inspect bearings (ab) for free rotation and excessive play in bearing cages. Also inspect bearings for brinelling or corrosion.

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

Important: Avoid Damage! Absolute cleanliness is essential when working on wheel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/ hydraulic system and cause damage.

41.Clean all metal parts with solvent and blow dry with compressed air.

42.Inspect all parts for damage, nicks or unusual wear. Replace entire wheel motor assembly if any parts other than seal rings, seals or outer bearing are worn or damaged.

Specifications

Rotor Lobe-to-Roller Vane
Maximum Clearance . . . . . .0.13 mm (0.005 in.)

Assemble Wheel Motor

Other Material

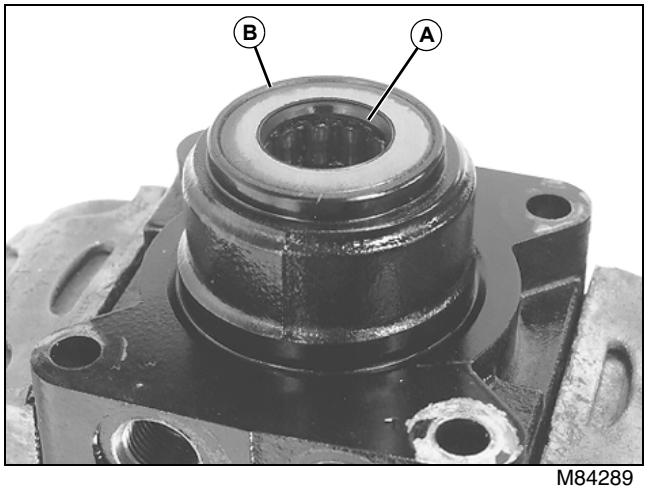
Part No.	Part Name	Part Use
	Mobilith SHC® Grease	Apply to wheel motor seals and seal rings.

Important: Avoid Damage! Always use new O-rings. Damaged or used parts will leak.

Note: Assembly of front and rear wheel motors is similar. Alignment studs screwed finger tight into the bolt holes 180° apart can be used to assist alignment during assembly. Alignment studs can be made by cutting the heads off 3/8-24 UNF 2A x 5-in. cap screws.

Lubricate all seals and seal rings with Mobilith SHC® 460 grease (supplied with seal kit) during assembly.

Important: Avoid Damage! The outer bearing is not lubricated by the system's hydraulic oil. Thoroughly pack the bearing with grease before installation.

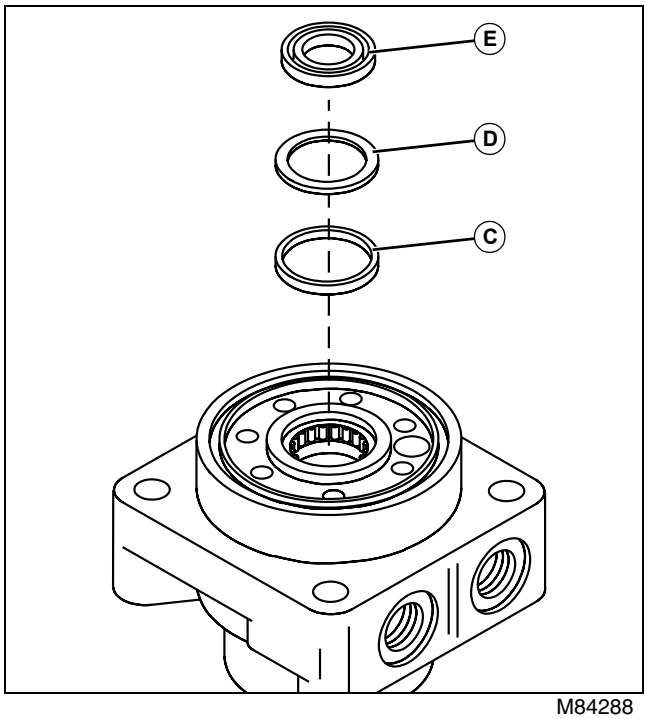


M84289

1. Pack and coat the new outer bearing/bushing (A) with anti-corrosion grease.

2. Install a new outer bearing seal (B) with the lip facing out. Press seal into housing until the seal is flush with the end of the housing.

3. Remove wheel motor from vise. Invert it and reinstall it in vise.



M84288

4. Install backup ring (C) and washer (D).

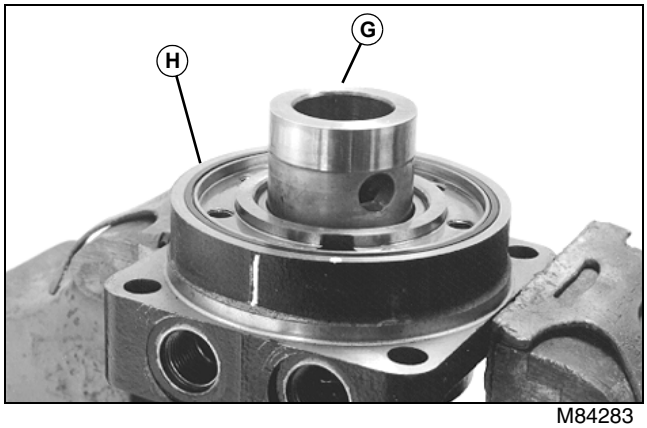
Important: Avoid Damage! Make sure the seal is completely seated in bore. Improper seating may result in seal damage when installing coupling shaft, resulting in leakage.

5. Install a new seal (E) with the lip facing toward the inside of the motor.

M84339

6. Seat thrust bearing and thrust washers (F) (one above and one below the thrust bearing).

Important: Avoid Damage! Apply anti-corrosion grease to the outer bearing/bushing and tape to the threads and keyway of the coupling shaft to prevent damage to the seal during installation.



M84283

7. Apply tape to the threads and keyway of the coupling shaft (G) to prevent damage to the seal during installation.

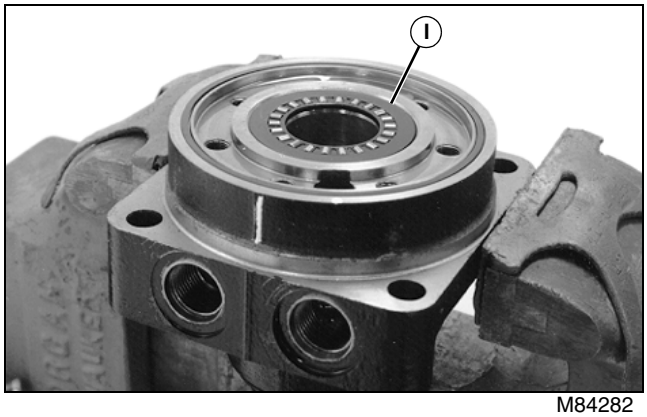
8. Apply grease to the seal.

Note: When properly installed, the coupling shaft will be approximately 2.54 mm (0.10 in.) below the housing wear surface plate. The coupling shaft must rotate freely on the thrust bearing assembly.

9. Install the coupling shaft into the housing until it rests against the thrust washer.

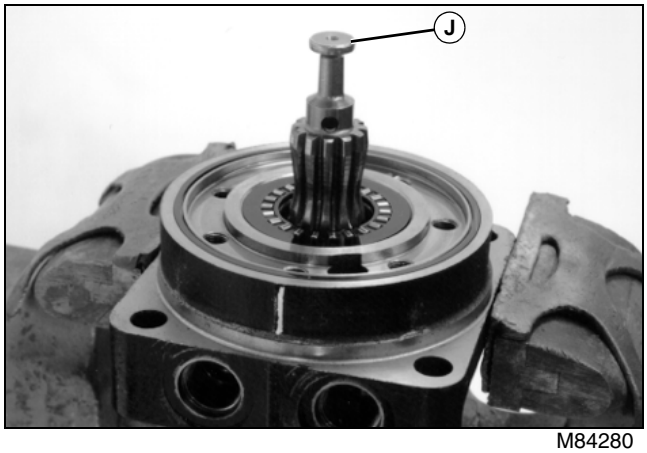
10. Apply a light coat of grease to the seal ring (H).

11. Install seal ring in the groove in the housing.



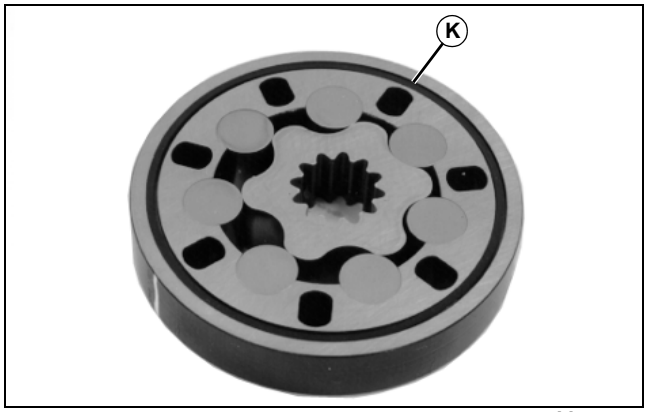
M84282

12.Install thrust bearing (I) on the coupling shaft.



M84280

13.Install drive link (J) with the splined end toward the coupling shaft. Align marked splines on drive link and coupling shaft.



M84277

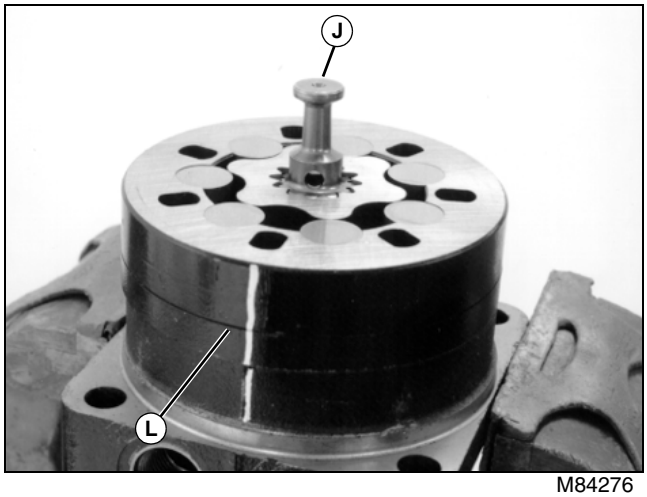
Picture Note: Bottom of rotor set shown.

14.Apply a light coat of grease to seal ring (K).

15.Install seal ring in the groove in the rotor set assembly.

16.Install wear plate on rotor set.

17.Carefully flip rotor set/wear plate assembly over, while holding rotor set components in place.



M84276

18.Install rotor set/wear plate assembly (L) over the drive link (J).

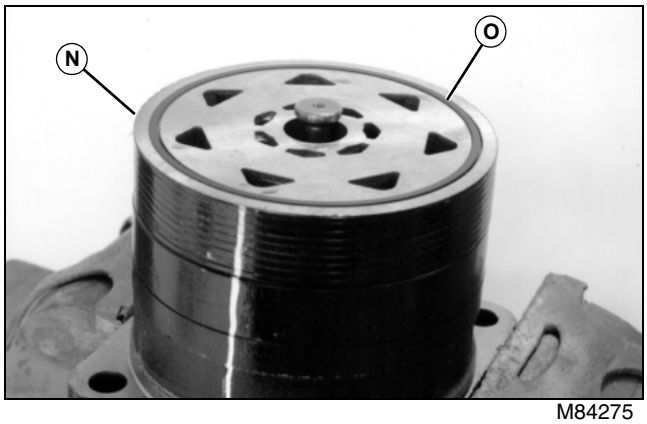
M84340

Picture Note: Bottom of manifold shown.

19.Apply a light coat of grease to seal ring (M).

20.Install seal ring in the groove in the bottom of manifold.

Note: Correct installation of the manifold is important for proper operation. The right hand wheel motor has a reversed timed manifold and should be installed with the surface with the irregular shaped cavities on the largest circumference toward the rotor set.

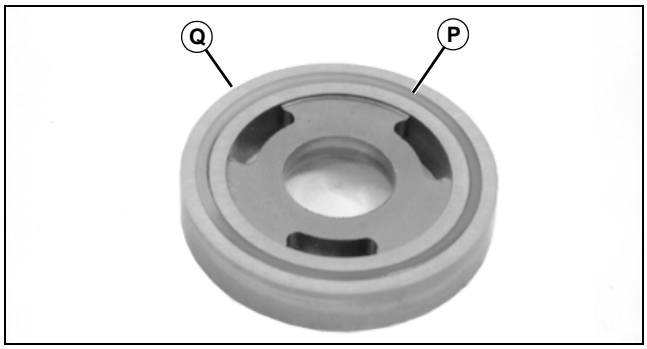


M84275

21.Install manifold (N).

22.Apply a light coat of grease to the seal ring (O).

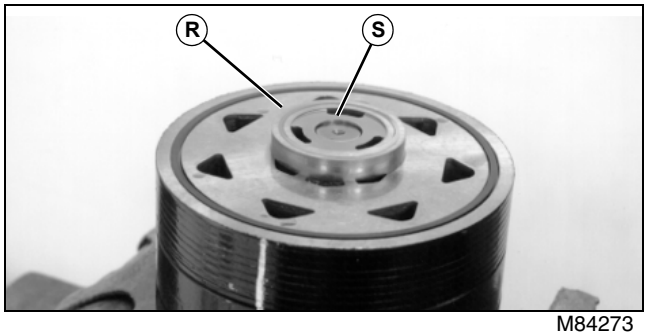
23.Install seal ring in the groove in the manifold.



M84274

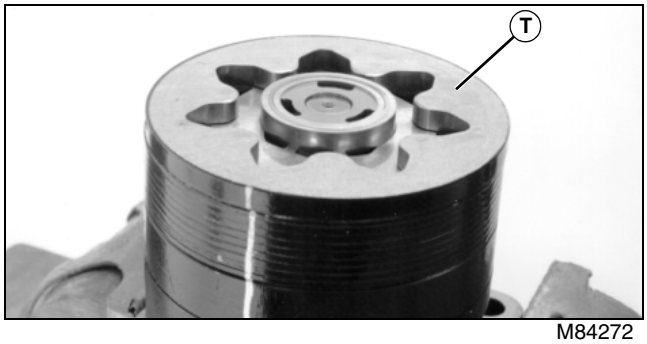
24.Apply a light coat of grease to the seal ring (P).

25.Install seal ring in the groove in the commutator (Q).



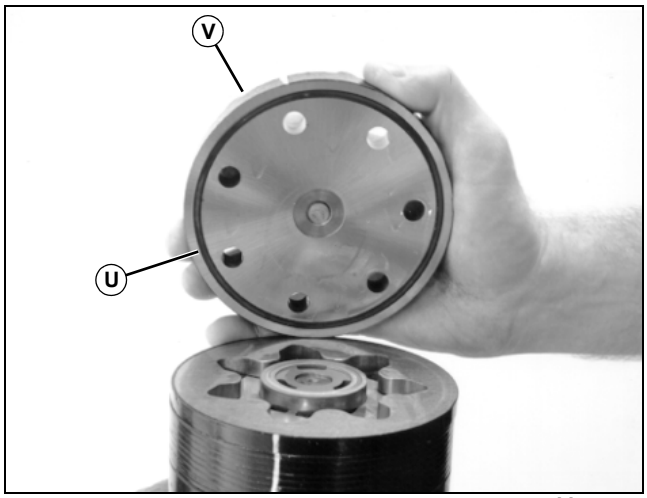
M84273

26.Install commutator (R) on drive link (S).



M84272

27.Install commutator ring (T).

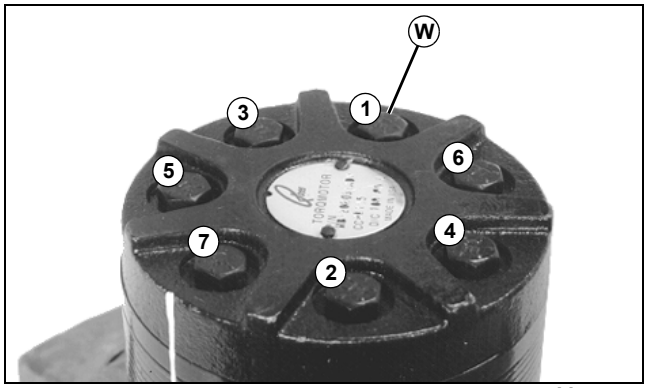


M84270

28.Apply a light coat of grease to seal ring (U).

29.Install seal ring in the groove in the end cover (V).

30.Install end cover.



M84268

31.Install cap screws (W).

32.Tighten cap screws evenly, in the sequence shown, to specification.

Specifications

Coupling Shaft Installed Depth (Below Housing Wear Surface Plate) . . . . . 2.54 mm (0.10 in.)

Retaining Cap Screw Torque. . . . . 68 N•m (50 lb-ft)

Wheel Motor Final Checks

1. Pressurize the wheel motor with 100 psi dry air or nitrogen and submerge in solvent to check for external leaks.

2. Check wheel motor for rolling drag. Torque required to rotate the coupling shaft should not be more than specifications.

3. Use test stand if available, to check for proper operation of the wheel motor.

Note: Bleed hydraulic system after installing wheel motor to the machine. (See "Bleed Hydraulic System" on page 550.)

Specifications

Rolling Drag Torque . . . . . 68 N•m (50 lb-ft)

Remove Rear Wheel Motor (Four Wheel Drive)

1. Park vehicle on a level surface and lock park brake.

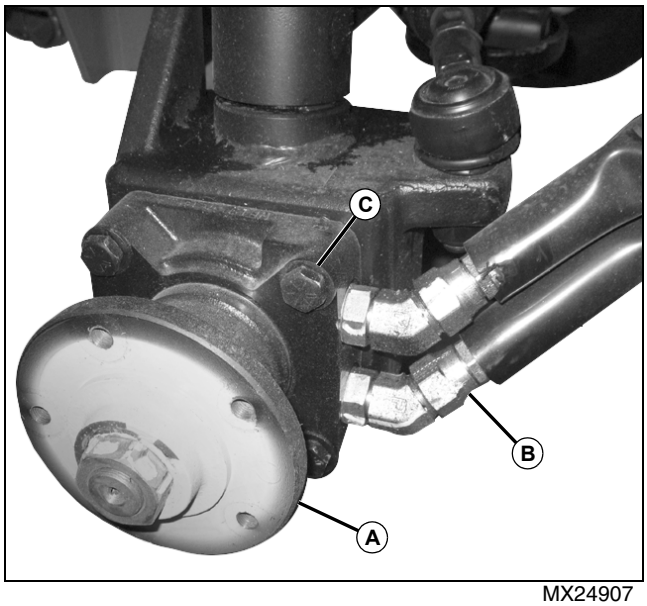
2. Raise rear of vehicle and support safely with jackstands or wood blocks.

3. Remove rear wheel from side of machine requiring motor removal.

Note: Pipe wrench is used to prevent disk from rotating when removing nut without air tools.

4. Remove nut from keyed motor shaft with 1-7/16 in. socket.

Caution: Avoid Injury! Disk will release from motor shaft with force. Stand out of the way of disk when tapping with hammer.



MX24907

5. Remove rotor (A) from motor shaft using a three-jaw puller by applying tension and tapping with a hammer.

6. Remove hydraulic lines (B) from motor. Use appropriate fluid containment procedures.

7. Remove four mounting bolts (C) from hydraulic mounting flange.

8. Remove wheel motor from rear axle housing.

9. Remove fittings if the motor is to be repaired or exchanged.

Install Rear Wheel Motor (Four Wheel Drive)

1. Install fittings in wheel motor.

2. Place hydrostatic motor in rear axle housing.

3. Position motor so the fittings on the backplate of the motor face rear of the machine.

4. Install four bolts through motor mounting flange and into rear axle housing. Tighten hardware to specifications.

5. Install hydraulic lines on motor.

6. Place rotor on motor shaft and install nut. Use pipe wrench to keep disk from turning if not using air tools. Tighten to specifications.

7. Install wheel and tire assembly.

8. Start machine and operate motor to determine if motor rotates in the proper direction.

If motor rotates in wrong direction, the hydraulic lines are reversed or timing procedure of the motor is incorrect. (See "Assemble Wheel Motor" on page 516) for timing procedure.

Specifications

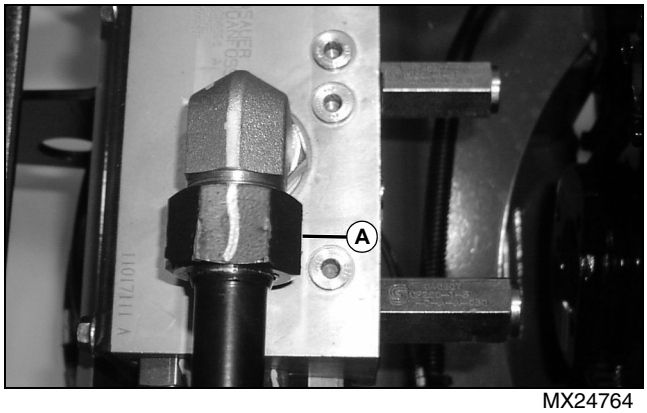
Rear Axle Housing Bolt Torque . . . . 140 N•m (105 lb-ft)
Rotor Nut Torque . . . . . 190 - 217 N•m (140 - 160 lb-ft)
45° Fitting at Wheel Motor. . . . . 81 N•m (60 lb-ft)
B Nut at Wheel Motor. . . . . 68 N•m (50 lb-ft)

Remove Four Wheel Drive Valve

Caution: Avoid Injury! Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

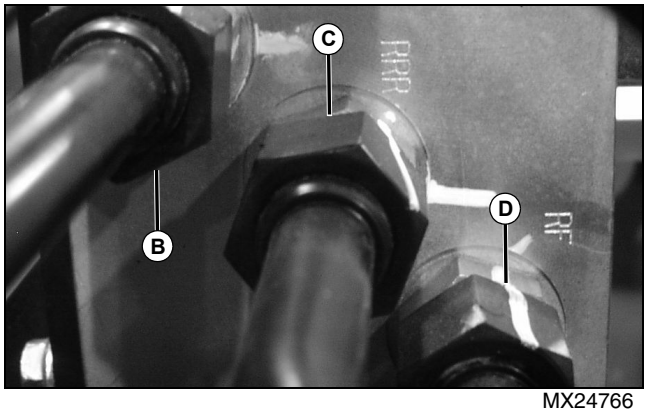
- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

Removal



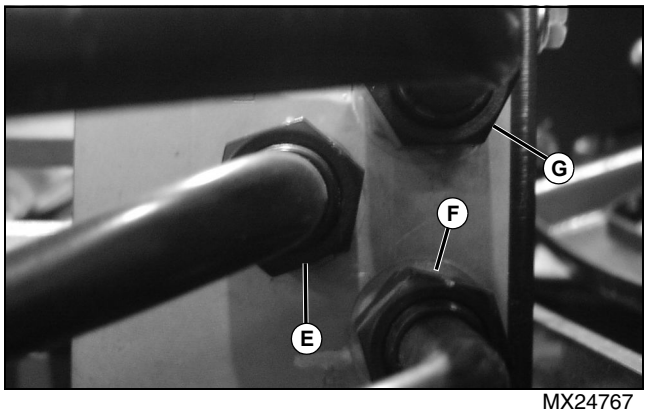
MX24764

1. Remove main hydraulic fluid supply line (A).



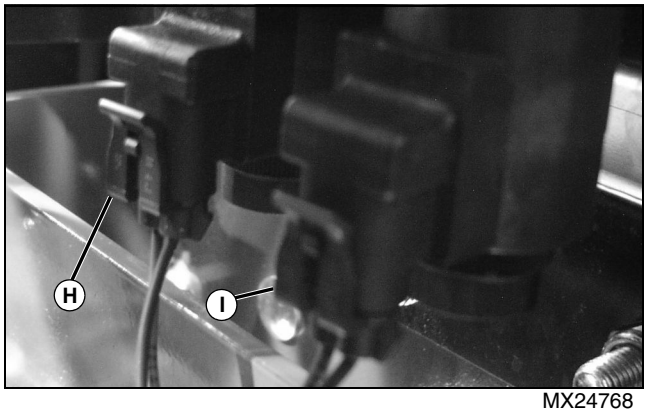
MX24766

2. Remove hydraulic lines (B-D) from the right side of the four wheel drive valve.



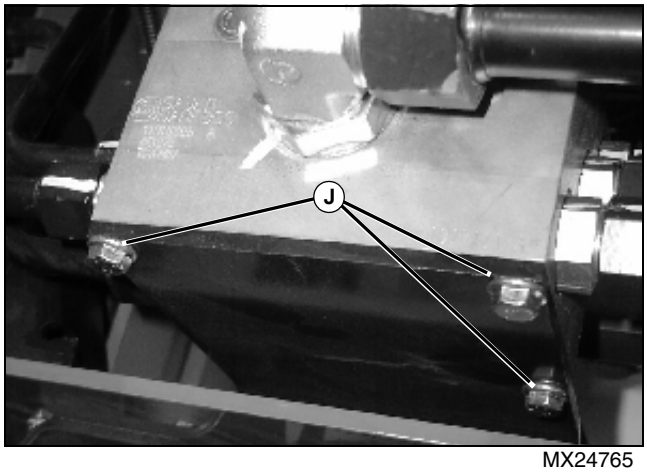
MX24767

3. Remove hydraulic lines (E-G) from the left side of the four wheel drive valve.



MX24768

4. Disconnect left and right solenoid coil electrical harness (H-I).

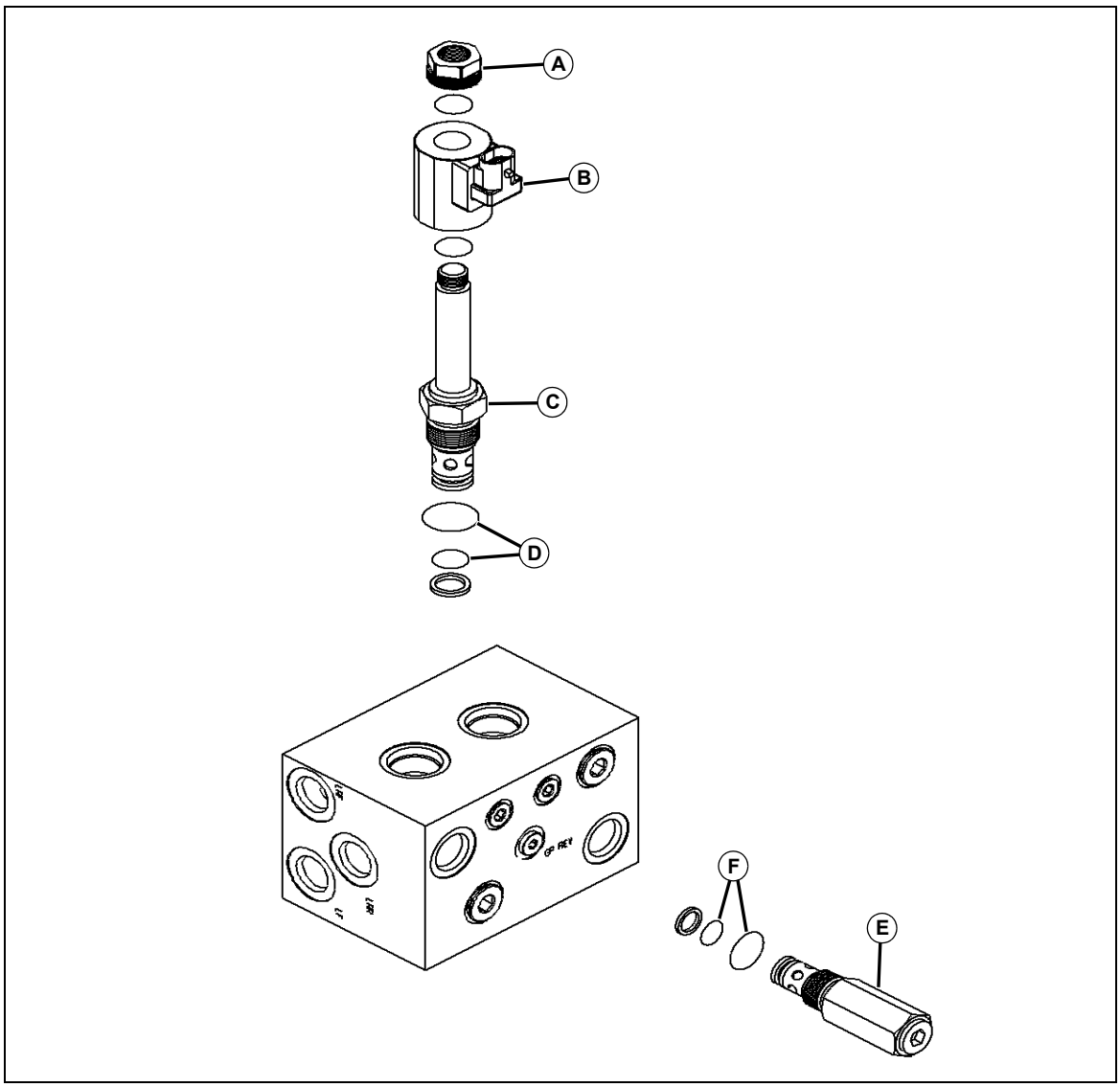


MX24765

5. Remove mounting bolts (J) that secure four wheel drive valve to vehicle frame.

6. Cap off all hydraulic lines to prevent loss of hydraulic fluid.

Disassemble Four Wheel Drive Valve



MX24574

1. Loosen and remove nuts (A) and lift off solenoid coils (B).
2. Loosen and remove solenoid valves (C) and o-rings (D).
3. Loosen and remove relief valves (E) and o-rings (F).

Inspect Four Wheel Drive Valve

1. Inspect all components for any signs of damage or abnormal wear. Replace components that are worn or damaged.
2. Inspect o-rings, replace if damaged or worn

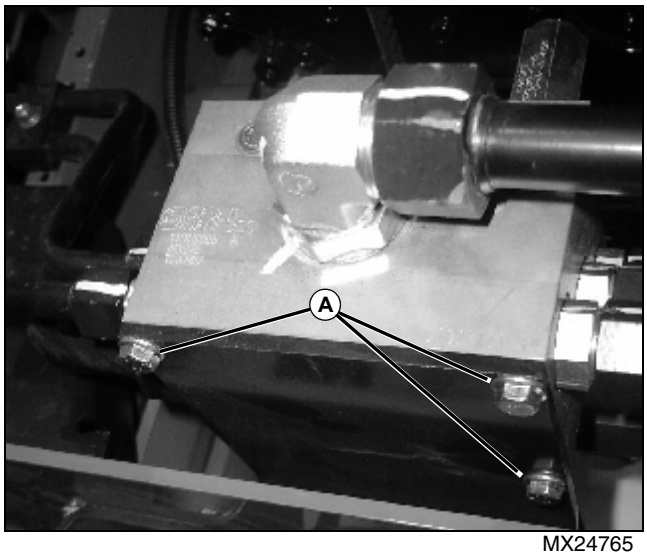
Assemble Four Wheel Drive Valve

1. Install solenoid valves (C) with new o-rings (D) and tighten to specification.
2. Place solenoid coils (B) over solenoid valves (C) and secure with nuts (A).
3. Install relief valves (E) with new o-rings (F) and tighten to specification.

Specifications

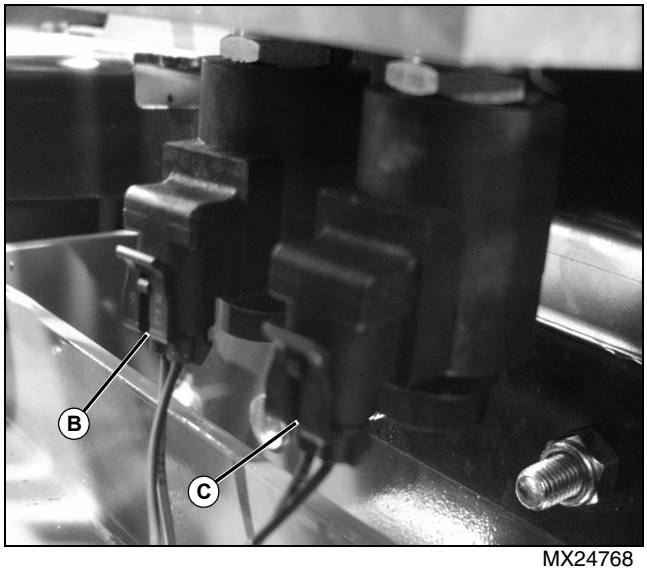
Solenoid Valve Torque. . . . . 50 N•m (37 lb-ft)
Relief Valve Torque . . . . . 50 N•m (35 lb-ft)

Install Four Wheel Drive Valve



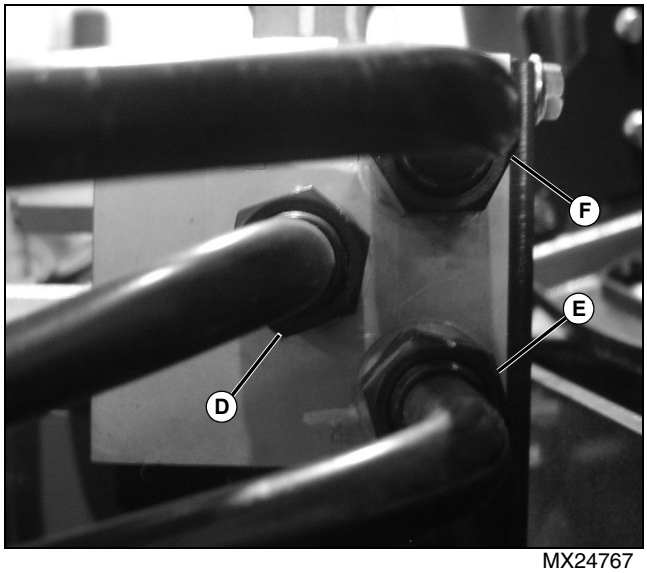
MX24765

1. Install mounting bolts (A) that secure four wheel drive valve to vehicle frame.



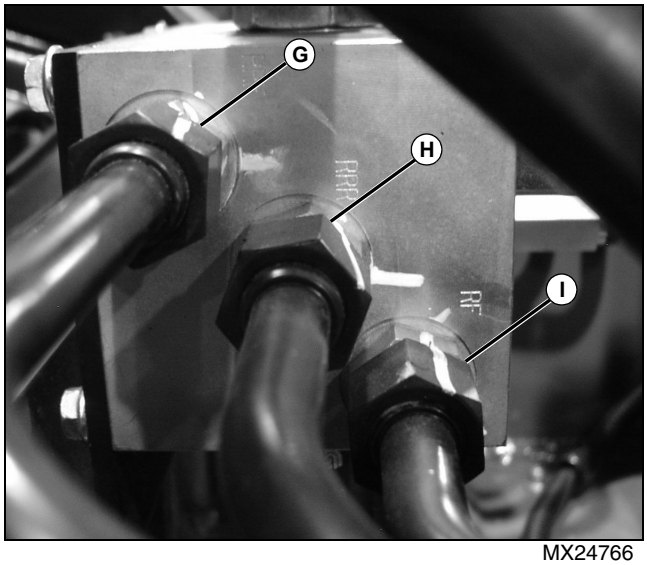
MX24768

2. Reconnect left and right solenoid coil electrical harness (B-C).



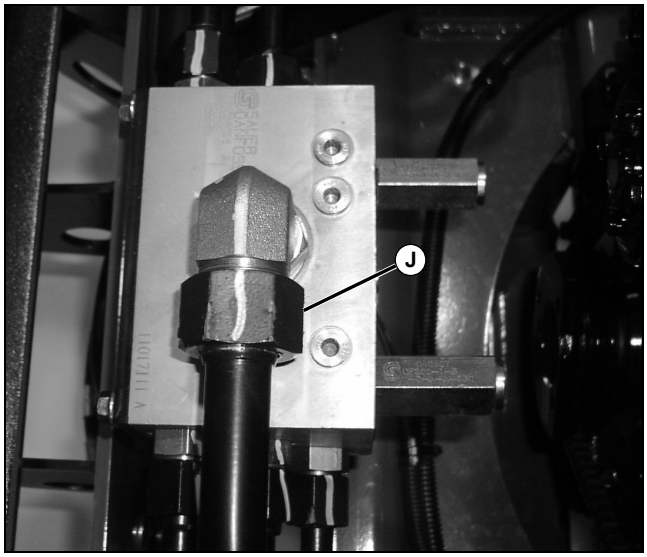
MX24767

3. Install hydraulic lines (D-F) to the left side of the four wheel drive valve.



MX24766

4. Install hydraulic lines (G-I) to the right side of the four wheel drive valve.



MX24764

5. Install main hydraulic fluid supply line (J).

4wd Valve

Straight Fitting . . . . . 81 N•m (60 lb-ft)
B Nut at Straight Fitting . . . . . 68 N•m (50 lb-ft)
90° Fitting . . . . . 156 N•m (115 lb-ft)
B Nut at 90 °Fitting . . . . . 142 N•m (105 lb-ft)

Start-Up Procedure

Important: Avoid Damage! Follow this procedure to properly purge the hydrostatic drive system before returning the machine to service.

1. Ensure hydraulic reservoir is full.

2. Disconnect fuel shutoff solenoid connector and crank engine for 15 seconds.

3. Reconnect fuel shutoff solenoid connector.

4. With transmission in neutral, start engine and run at slow idle.

5. Operate steering and lift system through several cycles. Slowly operate the machine in forward and reverse to purge the air from the system.

6. Check and replenish the reservoir.

7. Check all connections for leaks and tighten if necessary.

8. Short hour filter changes are recommended for the first two changes after returning the machine back to service. Change the first filter after 3-5 hours of operation and the second after 50 hours.

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Specifications

General Specifications

Triple Pump (Front Gear Set)

Make	Hema
Flow	20.8 L/min (5.5 gpm)
Relief Valve Setting - 7500, 7700, 8500, and 8700 (In Hydrostatic Pump)	1241-1517 kPa (180-220 psi)
Relief Valve Setting - 8800 (In Hydrostatic Pump)	1241-1517 kPa (180-220 psi)

Reel Pumps

Make	Hema
Flow	32.6 L/min (8.6 gpm)
Type	Gear, positive displacement

Rotary Mower Pumps

Make	Hema
Flow	36 L/min (9.5 gpm)
Type	Gear, positive displacement

Reel Motors

Make	Danfoss
Displacement (Standard Reels)	13.9 cm^3 (0.85 cu in.)
Displacement (Heavy Duty Reels)	19 cm^3 (1.16 cu in.)
Type	Gear, with case drain flow

Rotary Mower Motors

Make	Danfoss
Displacement	13.9 cm^3 (0.85 cu in.)
Type	Gear, with case drain flow

Front Inboard and Rear Lift Cylinders

Stroke	152 mm (6 in.)
Compressed Length	289 mm (6 in.)

Front Outer Lift Cylinder

Stroke	203 mm (8 in.)
Compressed Length 7500, 7700, 8500, 8700	975 mm (38-3/8 in.)
Compressed Length 8800	1032 mm (40-5/8 in.)

Hydraulic Filter

Type	10 micron spin-on
Clogged Filter Bypasses Fluid to Tank At	344.74 kPa (50 psi)
Filter Bypass Light Comes On At	275.79 kPa (40 psi)

Test and Adjustment Specifications

Front and Rear Mower Motor Circuit Relief Pressure	20684 ± 1380 kPa (3000 ± 200 psi)
Reel Circuit Pump Flow at 13790 kPa (2000 psi) and 2800 Engine RPM (Minimum)	30.2 L/min (8 gpm)
Rotary Mower Circuit Pump Flow at 13790 kPa (2000 psi) and 2800 Engine RPM (Minimum)	33.3 L/min (8.8 gpm)
Cutting Unit Motor Case Drain @ 13790 kPa (2000 psi) (Maximum)	1.9 L/min (0.5 gpm)
Lift System Relief Valve Pressure	11721-13790 kPa (1700-2000 psi)
Lift/Steering System Pump Flow at 6895 kPa (1000 psi) and 2800 Engine RPM (Minimum)	18.9 L/min (5 gpm)

Torque Specifications

Lift Valve

Mounting Cap Screw	43 N•m (32 lb-ft)
Check Valve	26-28 N•m (19-21 lb-ft)
Solenoid Valve	27-34 N•m (20-25 lb-ft)
Retaining Nut	5-7 N•m (48-60 lb-in.)

Triple Pump

Hex Head Screw (3/8-in.)	40-43 N•m (30-32 lb-ft)
Hex Head Screw (5/16-in.)	21-24 N•m (190-210 lb-in.)

Rotary/Reel Mower Motor

Standard Duty, Cap Screw	45 N•m (33 lb-ft)
Rotary/Reel Heavy Duty, Hex Head Screw (5/16-in.)	21-24 N•m (190-210 lb-in.)
Rotary/Reel Heavy Duty, Hex Head Screw (3/8-in.)	40-43 N•m (30-32 lb-ft)

Backlapping Valve - 7500, 7700, 8500, and 8700

Forward/Reverse Switch	4-7 N•m (36-60 lb-in.)
Forward/Reverse Valve	108-136 N•m (80-100 lb-ft)
Solenoid Valve	27-34 N•m (20-25 lb-ft)
Coil Nut	7-9 N•m (65-75 lb-in.)
Flow Control Knob Screw	2-3 N•m (18-24 lb-in.)
Flow Control Valve	34-41 N•m (25-30 lb-ft)
Check Valve Plug	47-54 N•m (35-40 lb-ft)
Logic Element	41-47 N•m (30-35 lb-ft)

Mow Valve

Relief Valve Torque	33-40 N•m (25-30 lb-ft)
Piston Plug Torque	54-61 N•m (40-45 lb-ft)
Large Check Valve Torque	135-149 N•m (100-110 lb-ft)
Small Check Valve	54-61 N•m (40-45 lb-ft)
Solenoid Valve Torque	47-54 N•m (35-40 lb-ft)
Solenoid Coil Nut Torque	5-8 N•m (48-72 lb-in.)

Tools and Materials

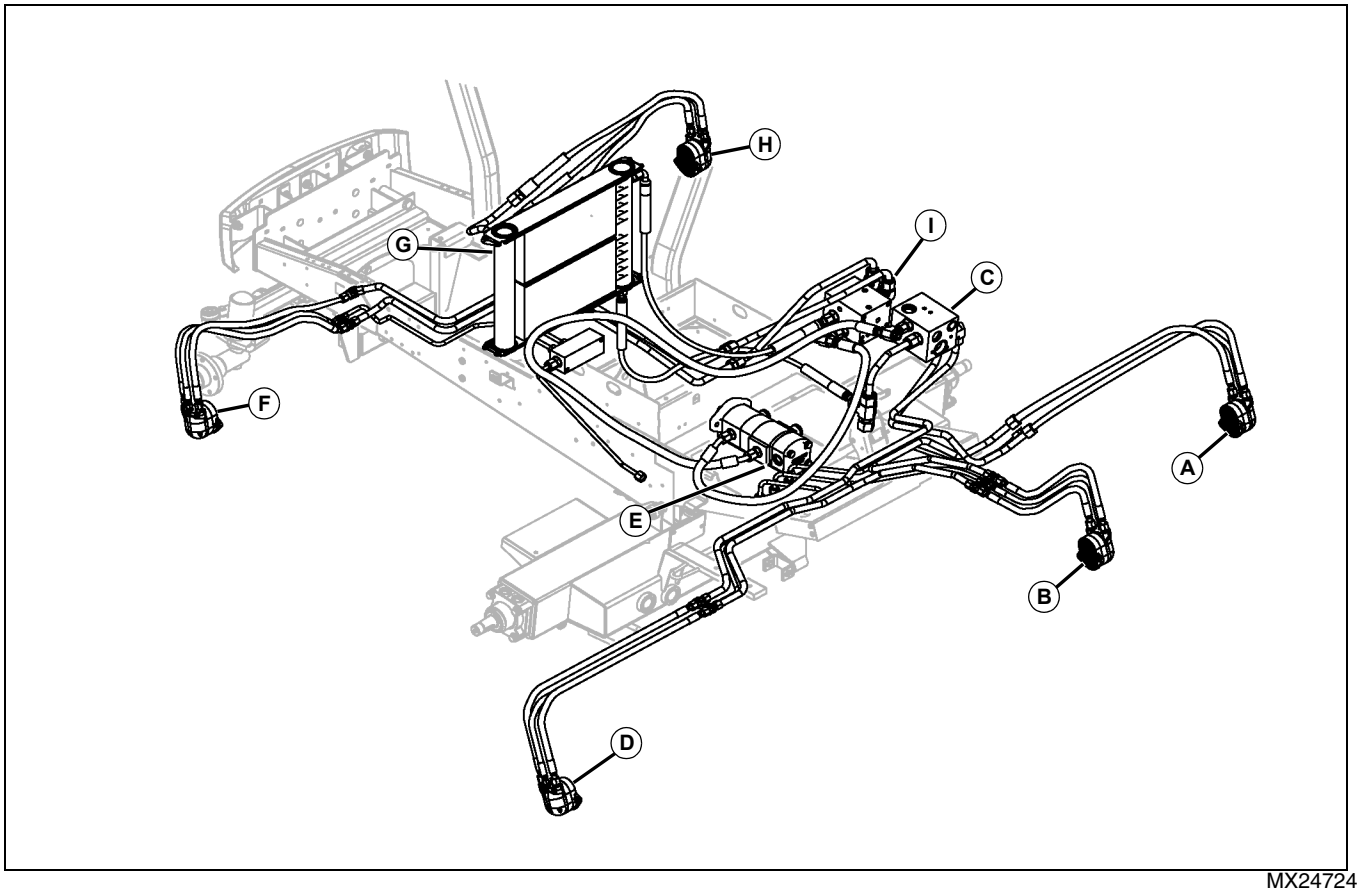
Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Pressure Diagnostic Kit	JDG2031	Used to test mower motor relief and lift system relief and to adjust optional down pressure valve.
Diagnostic Flow Kit	JDG2032	Used to measure hydrostatic pump, mow circuit, and case drain hydraulic oil flow.
Pressure Gauge Kit	JDG2033	Used to test mower motor relief and lift system relief and to adjust optional down pressure valve.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Component Location

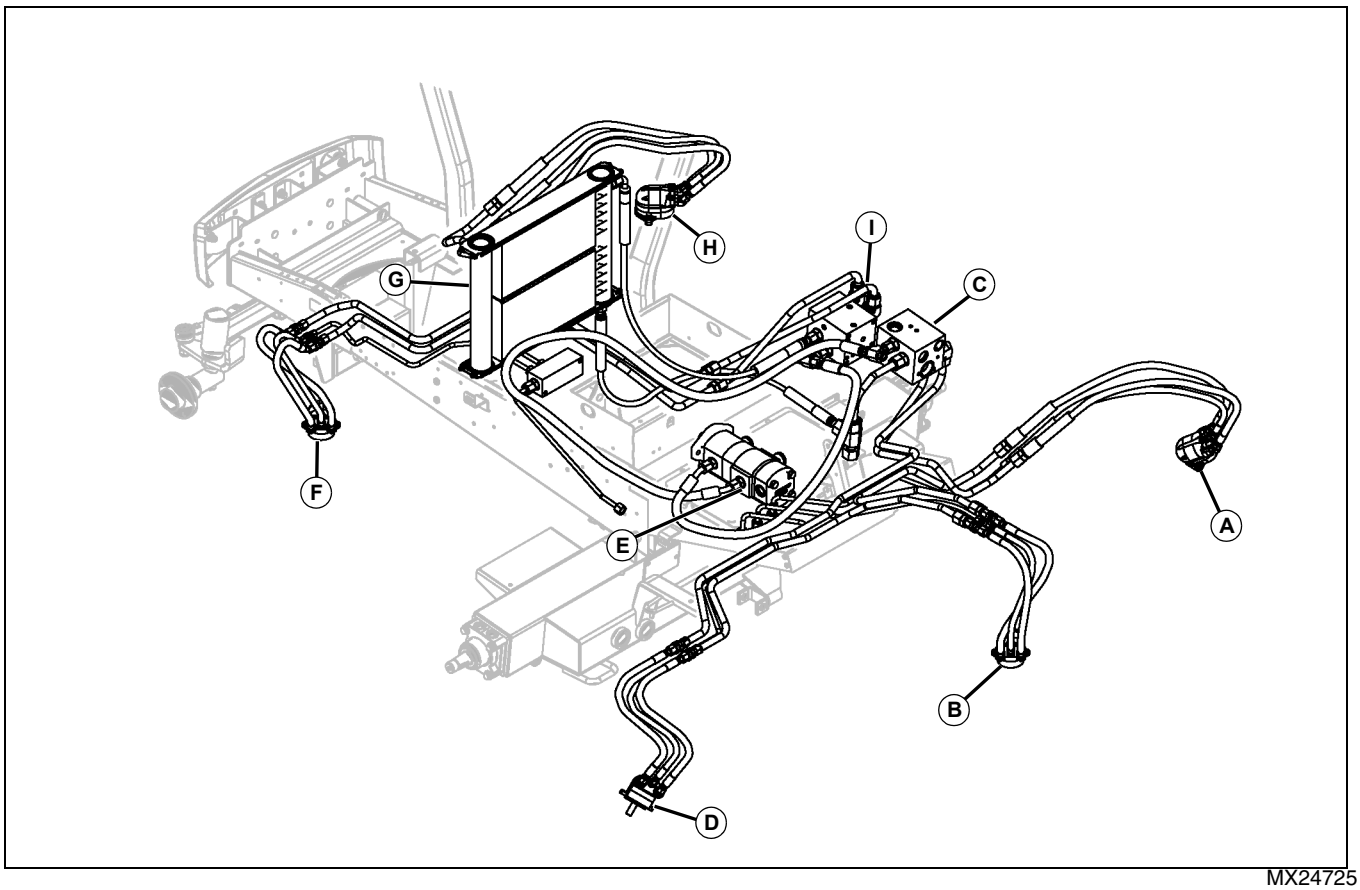
Reel Mower Circuit Component Location - 7500, 7700, 8500, 8700



MX24724

A- Left Front Reel Motor
B- Center Front Reel Motor
C- Mow/Backlapping Valve (Front)
D- Right Front Reel Motor
E- Triple Pump Assembly
F- Right Rear Reel Motor
G- Hydraulic Oil Cooler
H- Left Rear Reel Motor
I- Mow/Backlapping Valve (Rear)

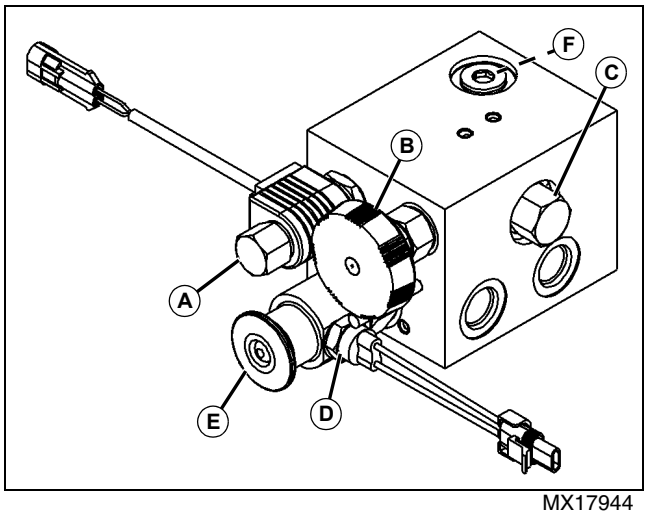
Rotary Mower Circuit Component Location - 8800



MX24725

A- Left Front Rotary Mower Motor
B- Center Front Rotary Mower Motor
C- Mow Valve (Front)
D- Right Front Rotary Mower Motor
E- Triple Pump Assembly
F- Right Rear Rotary Mower Motor
G- Hydraulic Oil Cooler
H- Left Rear Rotary Mower Motor
I- Mow Valve (Rear)

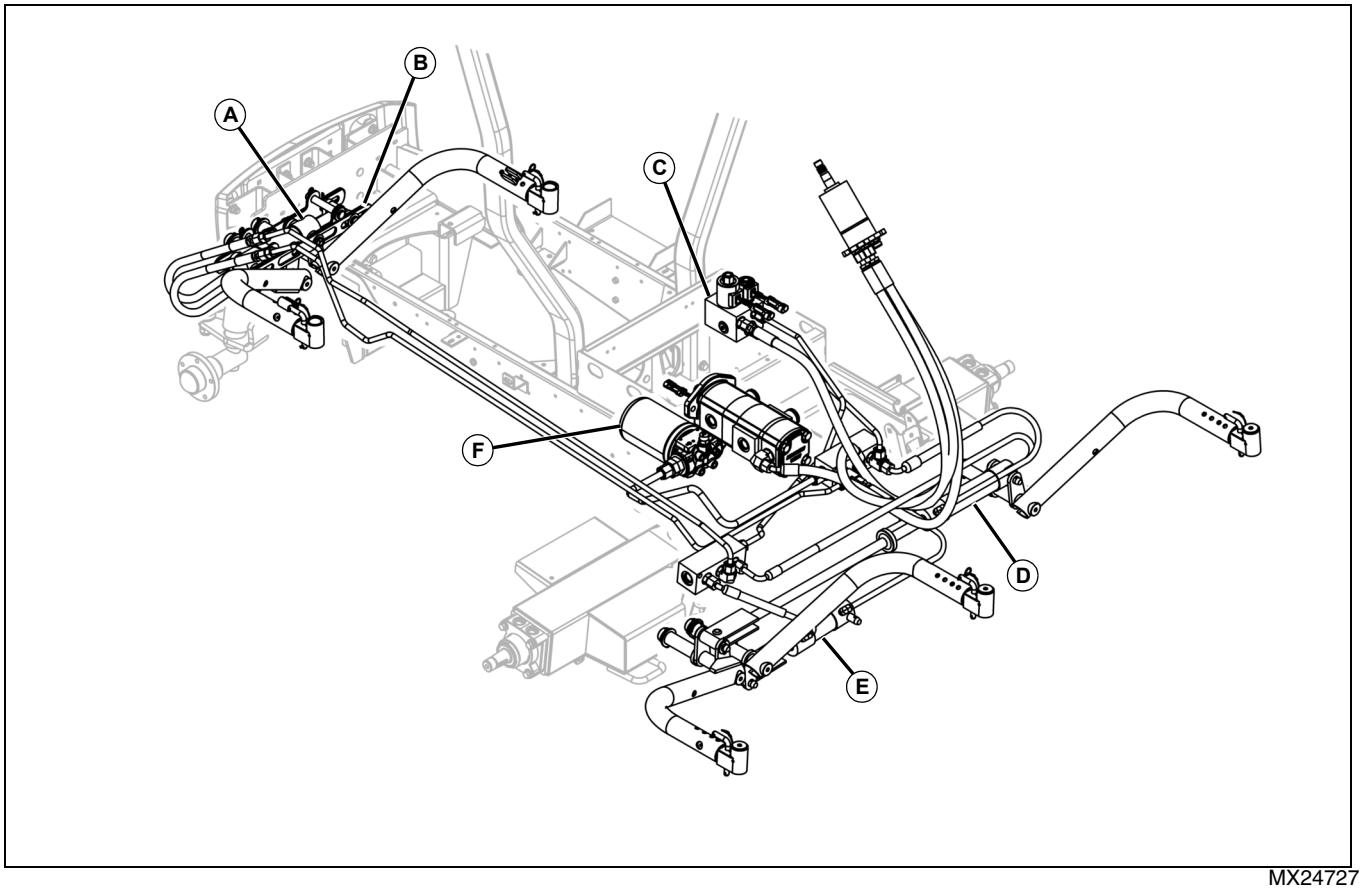
Backlapping Valve Component Location - 7500, 7700, 8500, 8700



MX17944

A- Mow Valve
B- Flow Control Valve
C- Logic Element
D- Switch
E- Forward/Reverse Valve
F- Check Valve

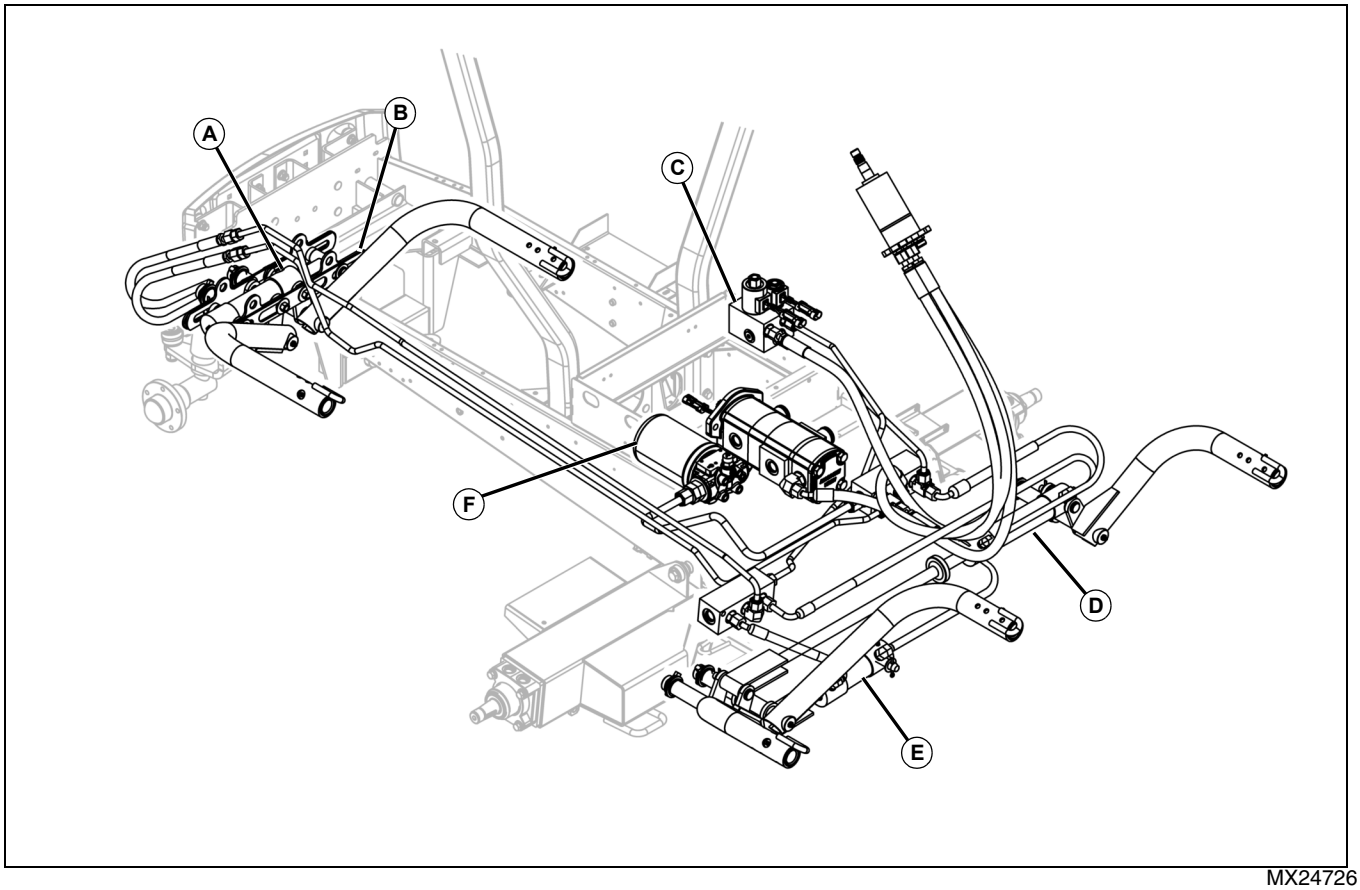
Reel Lift Circuit Component Location



MX24727

A- Rear Lift Cylinder
B- Lost Motion Linkage
C- Lift Valve
D- Left/Right Wing Lift Cylinder
E- Center Lift Cylinder
F- System Filter

Rotary Deck Lift Circuit Component Location



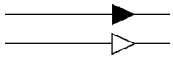
MX24726

A- Rear Lift Cylinder
B- Lost Motion Linkage
C- Left/Right Wing Lift Cylinder
D- Center Lift Cylinder
E- System Filter
F- Lift Valve

Schematics and Harnesses

JIC Hydraulic Circuit Symbols

Lines

1		Working (Main) Lines
2		Pilot Control Lines
3		Drain Line
4		Hydraulic/Pneumatic Flow Direction
5		Crossing Lines
6		Joining Lines
7		Flexible Line

Pumps

8		Fixed Displacement
9		Variable Displacement

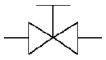
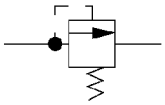
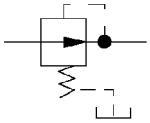
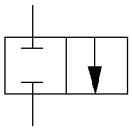
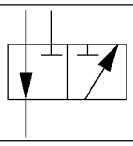
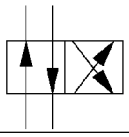
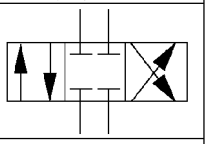
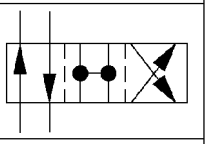
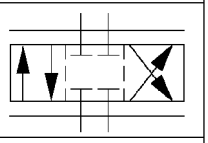
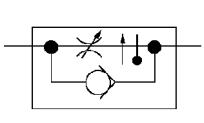
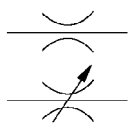
Motors

10		Fixed Displacement
11		Variable Displacement

Reservoir

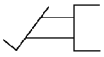
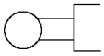
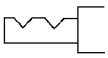
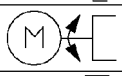
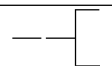
12		Vented Reservoir
13		Pressurized Reservoir
14		Reservoir Return -Above Fluid Level
15		Reservoir Return -Below Fluid Level

Valves

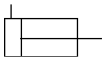
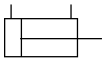
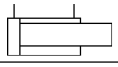
16		Check Valve
17		Manual On/Off Valve
19		Pressure Relief Valve
20		Pressure Reduction Valve
21		Two-Position, Two-Connection Valve
22		Two-Position, Three-Connection Valve
23		Two-Position, Four-Connection Valve
24		Three-Position, Four-Connection Valve
25		Two-Position, Four-Connection Valve with Transmission
26		Three-Position, Four-Connection Valve with Infinite Positioning
27		Adjustable Flow Control Valve (Temperature and Pressure Compensated)
18		Fixed/Variable Orifice

MX30024

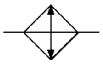
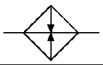
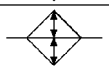
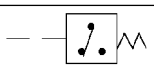
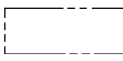
Valve Operators

28		Spring
29		Manual
30		Push Button
31		Push/Pull Lever
32		Pedal or Treadle
33		Mechanical
34		Detents
35		Pressure Compensated
36		Solenoid Single Winding
37		Reversing Motor
38		Pilot Pressure Remote Supply
39		Pilot Pressure Internal Supply

Cylinders

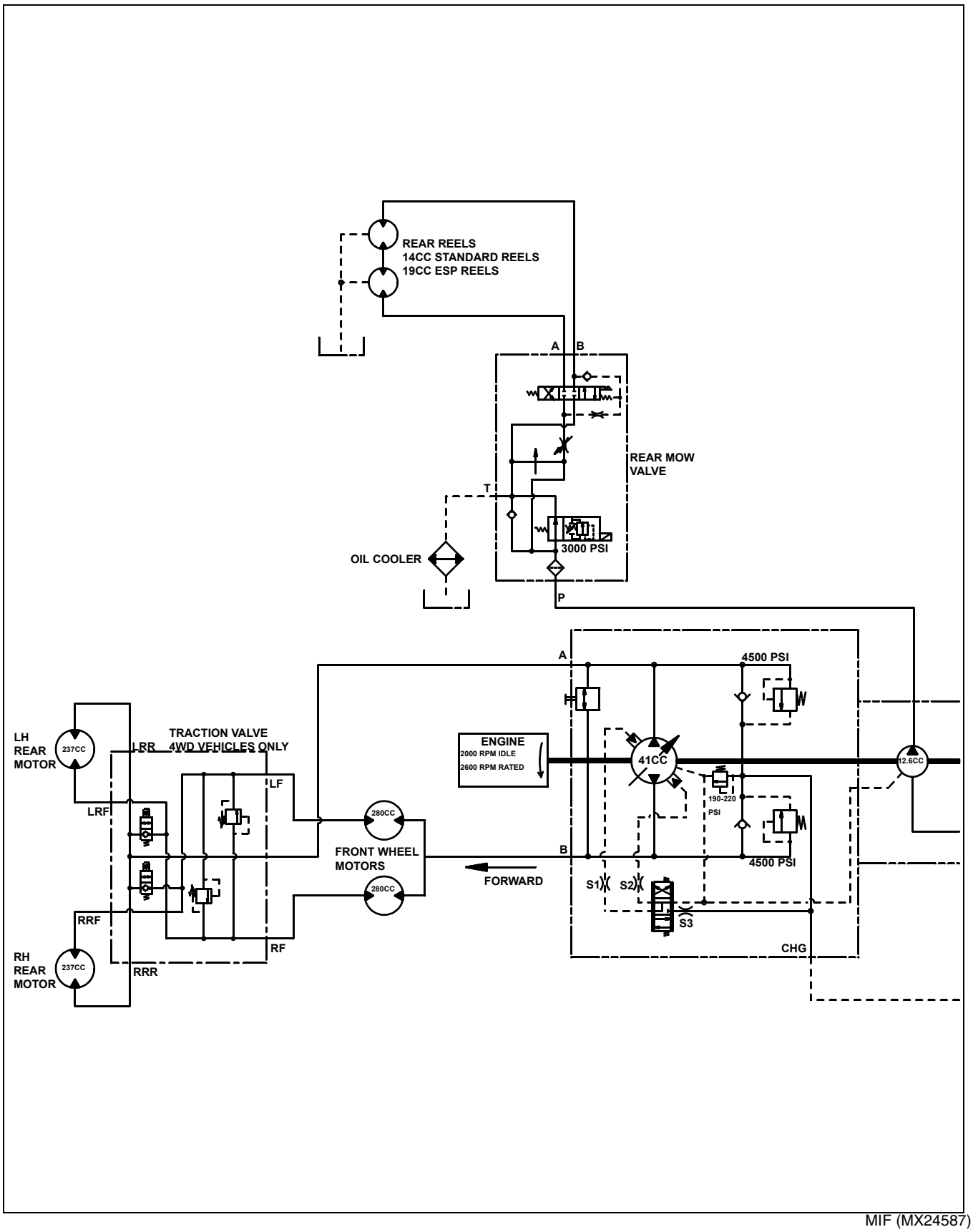
40		Single Acting
41		Double Acting Single Rod
42		Double Acting Double Rod
43		Double Acting, Adj. Cushion, Extend Only
44		Double Acting Differential Piston

Miscellaneous

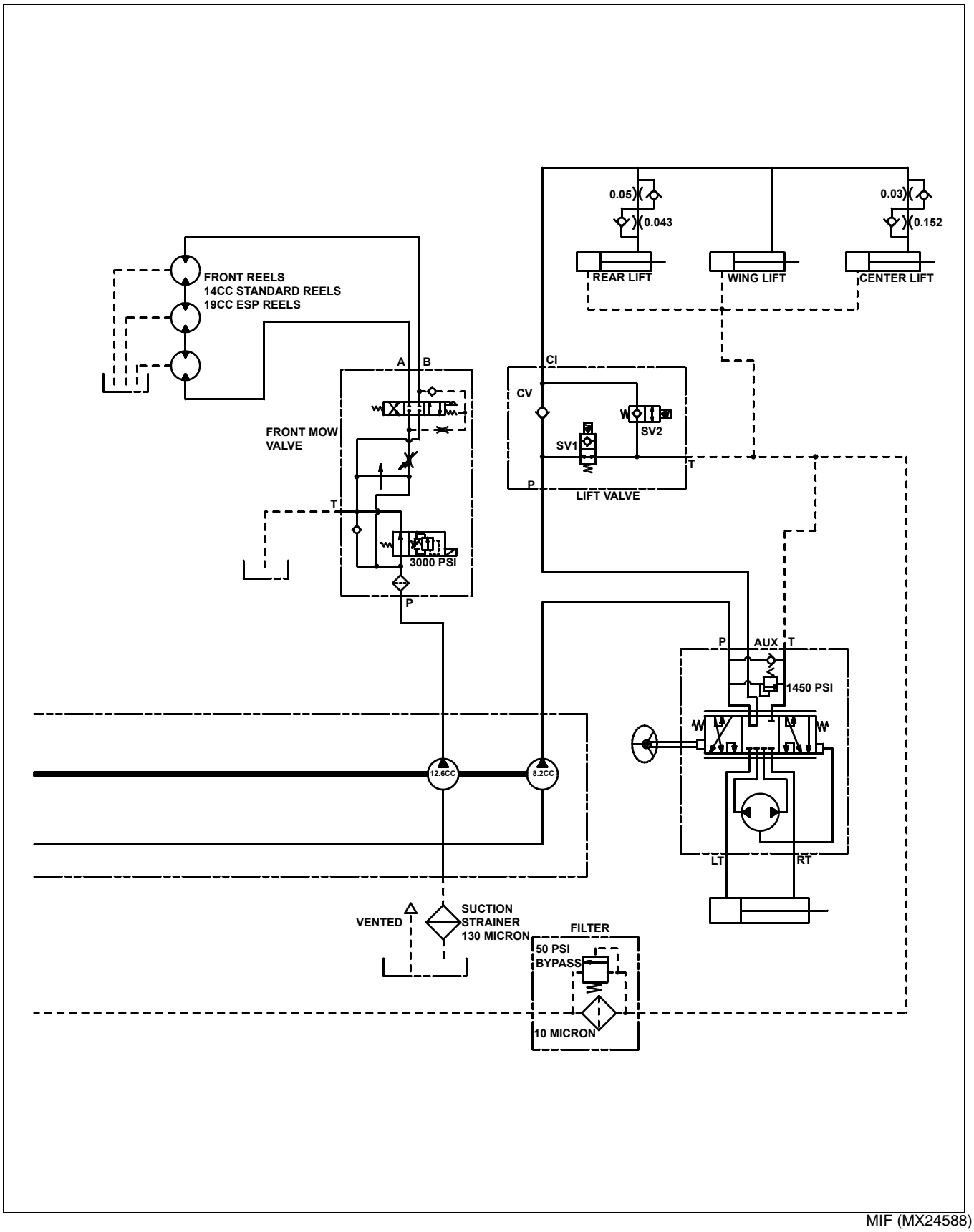
45		Cooler
46		Filter, Strainer
47		Heater
48		Temperature Controller
49		Pressure Switch
50		Pressure Indicator
51		Temperature Indicator
52		Pressure Compensated Variable Component (Symbol Through Component)
53		Plug, Test Port, Pressure Supply Test
54		Gas Charged Accumulator
55		Spring Loaded Accumulator
56		Electric Motor
57		Shaft Rotation (Arrow on Near Side of Shaft)
58		Component Outline
59		

MX30025

Hydraulic Schematic - 7000 Series Precision Cut

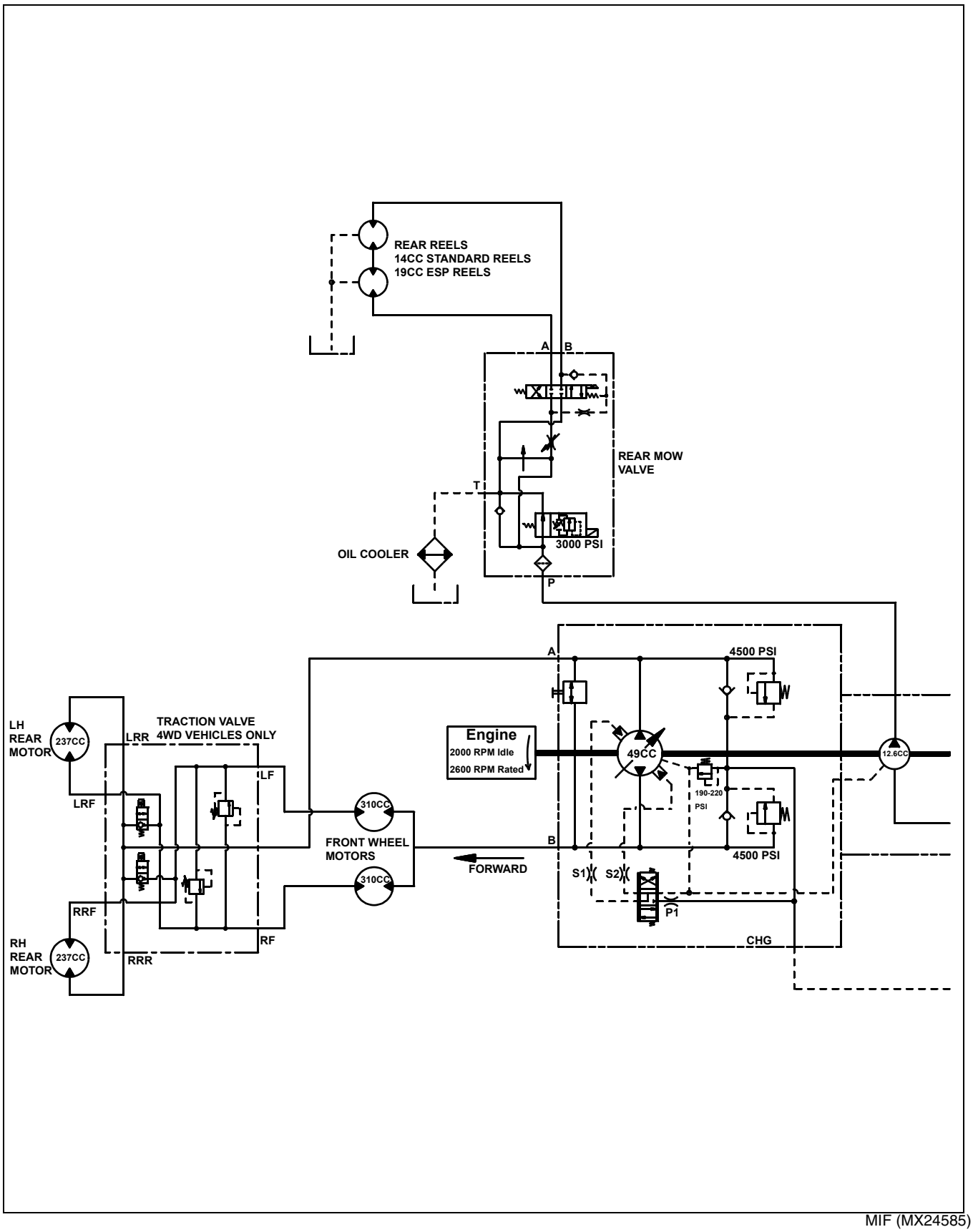


MIF (MX24587)

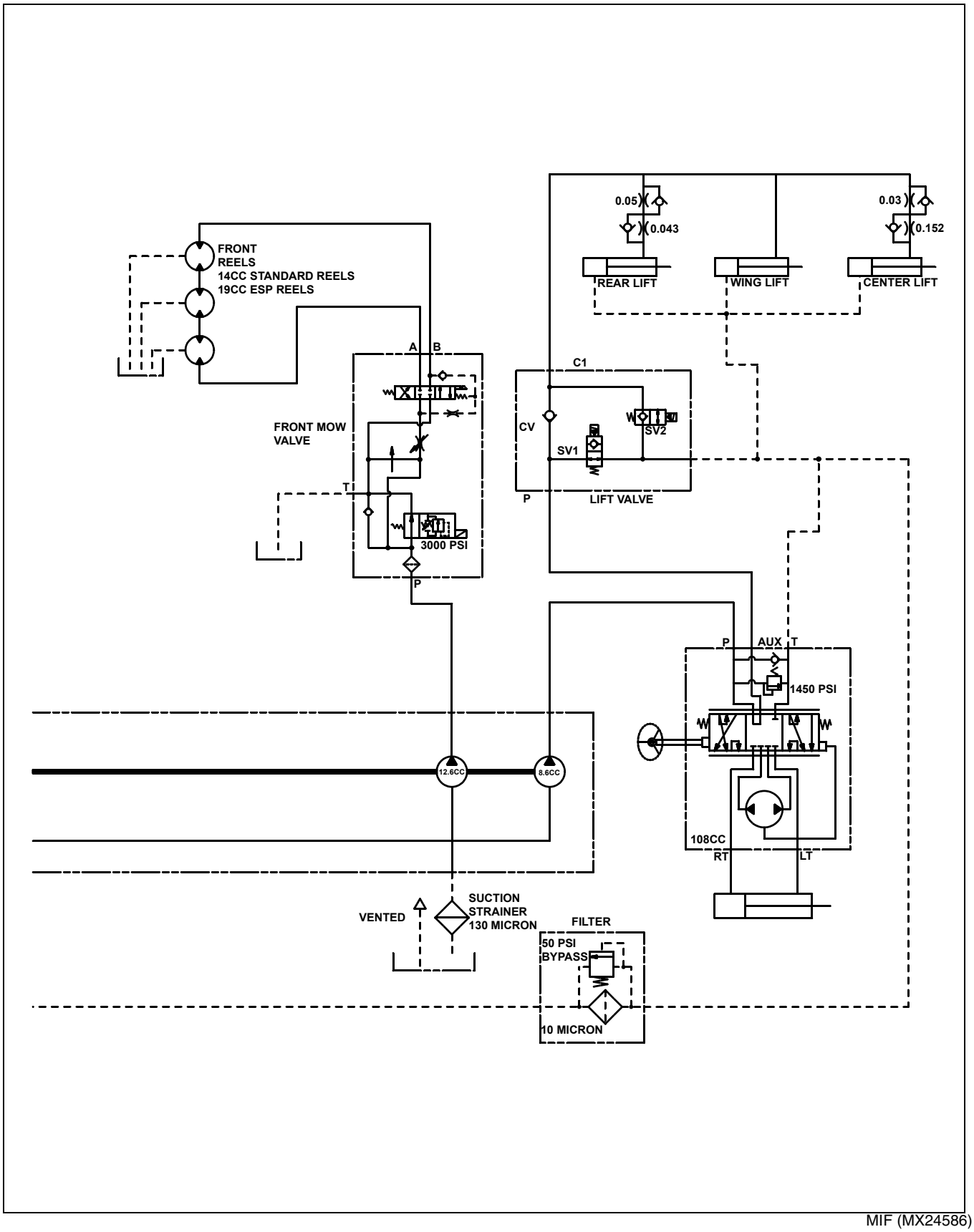

0.05
0.043
0.03
0.152
REAR LIFT
WING LIFT
CENTER LIFT
FRONT REELS
14CC STANDARD REELS
19CC ESP REELS
A
B
FRONT MOW
VALVE
T
3000 PSI
P
CI
CV
SV1
SV2
T
P
LIFT VALVE
P
AUX
T
1450 PSI
12.6CC
8.2CC
LT
RT
VENTED
SUCTION
STRAINER
130 MICRON
FILTER
50 PSI
BYPASS
10 MICRON

MIF (MX24588)

Hydraulic Schematic - 8000 Series Precision Cut

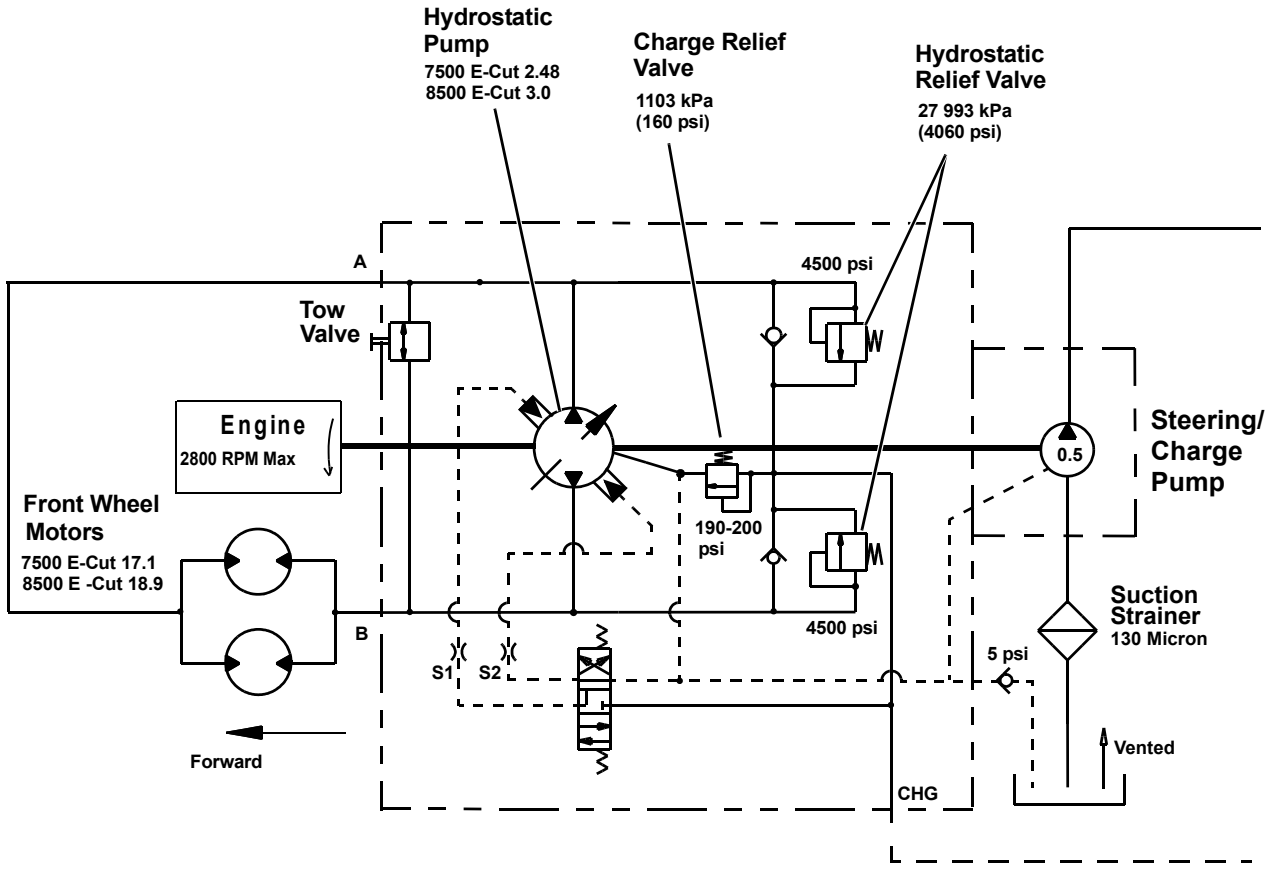


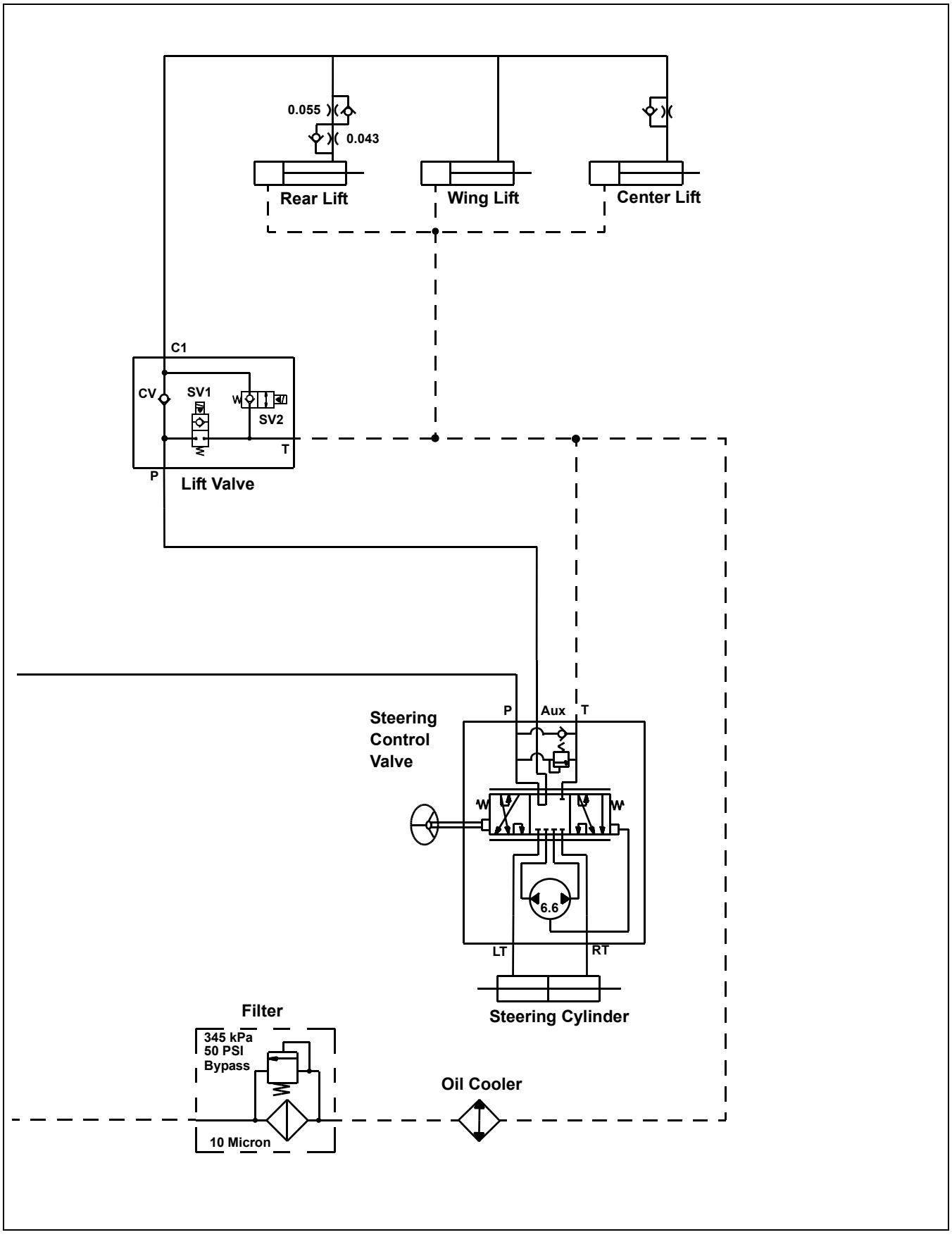
MIF (MX24585)


FRONT
REELS
14CC STANDARD REELS
19CC ESP REELS
0.05
0.043
0.03
0.152
REAR LIFT
WING LIFT
CENTER LIFT
A
B
C1
FRONT MOW
VALVE
CV
SV1
SV2
T
P
LIFT VALVE
3000 PSI
P
AUX
T
1450 PSI
12.6CC
8.6CC
108CC
RT
LT
VENTED
SUCTION
STRAINER
130 MICRON
FILTER
50 PSI
BYPASS
10 MICRON

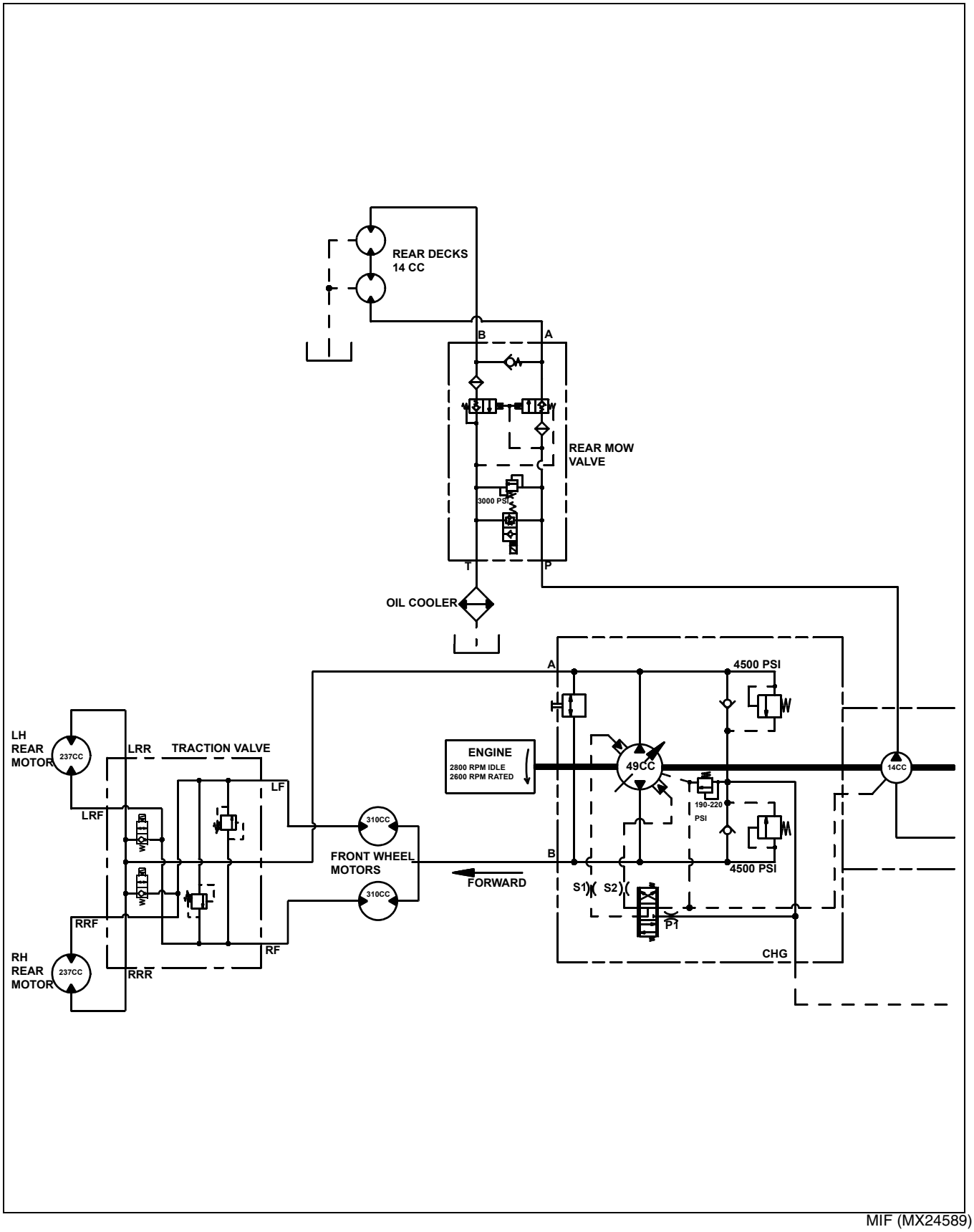
MIF (MX24586)

Hydraulic Schematic - 7500/8500 E-Cuts

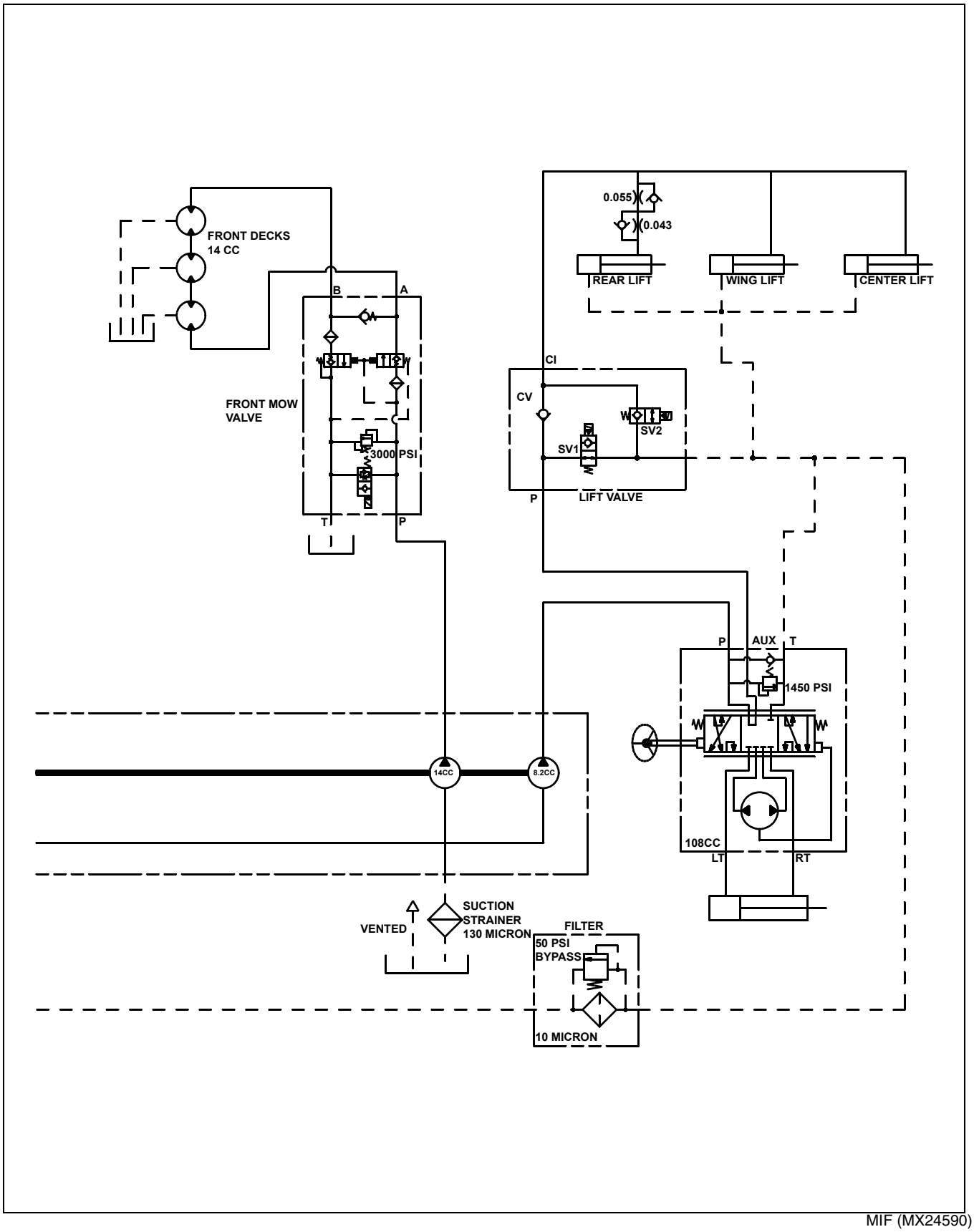



0.055
0.043
Rear Lift
Wing Lift
Center Lift
C1
CV
SV1
SV2
T
P
Lift Valve
Steering
Control
Valve
P
Aux
T
6.6
LT
RT
Steering Cylinder
Filter
345 kPa
50 PSI
Bypass
10 Micron
Oil Cooler

Hydraulic Schematic - 8800 Precision Cut



MIF (MX24589)


FRONT DECKS
14 CC
B
A
FRONT MOW
VALVE
3000 PSI
T
P
0.055
0.043
REAR LIFT
WING LIFT
CENTER LIFT
CI
CV
SV1
SV2
P
LIFT VALVE
P
AUX
T
1450 PSI
14CC
8.2CC
108CC
LT
RT
VENTED
SUCTION
STRAINER
130 MICRON
FILTER
50 PSI
BYPASS
10 MICRON

MIF (MX24590)

Operation and Diagnostics

Reel Drive System Theory of Operation - 7500, 7700, 8500, 8700

System Function

Rotates the cutting reels for forward mowing and reverses for backlapping operations.

Reel Pump

The reel pumps are part of the triple pump assembly that is mounted to the hydrostatic pump. The rear cutting units are powered by the rear pump section, and the front cutting units are powered by the middle section of the triple pump assembly.

Mow Valve

The mow valve is a solenoid-actuated, pressure-limiting shuttle valve. It is used to control the flow to the reel motors. The mow valve is energized through the control module during mowing operations. It limits pressure in the reel drive circuit to 20 684 kPa (3000 psi). The mow valve is contained within the backlapping valve.

Flow Control Valve

The flow control valve, located in the backlapping valve, is a manually operated flow restrictor. It is used to control reel speed when backlapping. It is adjusted by rotating the knob clockwise to restrict and counterclockwise to increase flow.

Forward/Reverse Valve

The forward/reverse valve, located in the backlapping valve, is a manually operated, three-position, four-way valve that changes fluid flow direction. The knob, when pushed in, directs the fluid flow to the motors for forward cutting. When pulled out, the cutting units will reverse direction for backlapping, and a switch is actuated to allow the engine to run with the operator off the seat and the PTO switch in the MOW position.

Theory

When the mow solenoid is energized, the pressure-limiting part of the mow valve shifts to limit pressure in the mow circuit to a maximum of 20 684 kPa (3000 psi).

Pressure and flow are now routed to the flow control valve. The flow control valve determines the rpm of the reels. Pressure in the reel circuit will vary according to the amount of resistance that the cutting units are generating.

The logic element, a pilot-operated dump valve, compares pressure at the inlet and outlet ports of the flow control valve. As the flow is restricted, pressure builds on the input side of the flow control valve to a value higher than that on the output side. This forces the logic element to open and dump excess flow to the tank. As flow returns to the reservoir, pressure to the input side of the flow control valve drops and the logic element closes. The logic element will continue this cycle as needed to equalize pressure on both sides of the flow control valve.

After leaving the flow control valve, fluid enters the forward/reverse valve, where it is directed to the forward or reverse side of the reel motors. The forward/reverse valve is spring-centered and is equipped with a detent to hold the valve in the forward position.

A soft start feature is used in the reel circuit to prevent damage to the cutting units from full pressure start-ups.

After leaving the backlapping valve, flow is directed to the forward or reverse side of the reel motors. The reel motors are connected in series starting with the left front, center, and right front motor.

Rotary Mower Drive System Theory of Operation - 8800

System Function

Rotates the cutting blades for forward mowing operation.

Rotary Mower Pump

The rotary mower pumps are part of the triple pump assembly that is mounted to the hydrostatic pump. The rear rotary mowers are powered by the rear pump section, and the front rotary mowers are powered by the middle section of the triple pump assembly.

Mow Valve

The mow valve is a solenoid-activated, two-position, poppet style valve. It is used to control the flow to the rotary mower motors. Incoming oil flows through the valve's strainer/filter. The mow valve is activated through the control module during mowing operations. The pressure relief valve limits pressure in the rotary mower drive circuit to 20 684 kPa (3000 psi). A 620 kPa (90 psi) check valve is located at the rotary motor return side, which allows the mower blades to coast to a controlled stop when the mow valve solenoid is deactivated. The check valve also allows the mower blades to be manually turned when the mow valve is deactivated.

Theory

When the mow valve solenoid is activated, flow is directed to the poppet valves which are piloted open, allowing flow to the motors

The rotary mower motors are connected in series.

Lift System Theory of Operation

Function

Provides a means to raise or lower the cutting units for three operating modes:

- Transport
- Mowing and Backlapping (Reel Mowers Only)
- Service

Steering/Lift Pump

The steering/lift pump is the front pump section of the triple pump assembly. The triple pump operates in an “open center” type hydraulic system consisting of the steering, lift, down pressure (if equipped), and hydrostatic charging systems. Each system has a controlling valve with an open center that allows fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit.

Lift Valve

The lift valve is a solenoid-operated, spring-returned valve. The raise solenoid, when energized in mow mode, will hold the valve in the raise position for 3 seconds, then release it. When the raise solenoid is de-energized, the lift cylinders will stay in the raised position. When the lower solenoid valve is energized, the lift cylinders will go to the lower (cutting) position.

Down Pressure Valve (Optional Equipment)

The down pressure valve is used to maintain downward force on the cutting units when mowing. The valve is operated by the rear mow solenoid. Hydraulic pressure is routed through the neutral position of the lift valve and to the down pressure valve. The down pressure valve regulates pressure to the fixed end of the lift cylinder. Pressure is set at the factory to 1724 kPa (250 psi) and can be adjusted to a maximum of 4826 kPa (700 psi). Pressure must be adjusted while the system is pressurized.

Lift System Theory

The lift system receives pressure from the charge pump through the steering valve. The steering valve will take first priority, and limited pressure will be available to the lift system during steering operations.

The lift system has two different raised positions, which are controlled by the PTO switch as follows:

- With the PTO switch up in the MOW position, the raise/lower lever will raise the cutting units to the crosscut position, to allow for turning the machine during mowing operations.
- With the PTO switch in the TRANSPORT position, the raise/lower lever will raise the cutting units to the full up position for transport or servicing operations.

The lower position is the same for both of the above conditions, and the cutting units will be lowered completely to the ground for cutting or backlapping operations.

The lift valve is solenoid-operated and timed to allow lift for 3 seconds before disengaging. This allows the operator to only tap the lift lever before entering a turn during mow operation.

The lift system is timed to allow a “clean-up cut” transition off the fairway. As the mower leaves the fairway and the operator moves the raise/lower lever to the raise position, the front cutting units rise first. This allows the rear cutting units to continue cutting until the end of the fairway. Conversely, when the operator is approaching the fairway to begin cutting and moves the raise/lower lever to the lower position, the front cutting units lower first, keeping the rear cutting units raised until they are over the fairway.

Delay of the rear lift arms is accomplished by the use of orifices on the rod end of the rear lift cylinder, which limits flow and slows the lowering and raising of the rear lift arm.

An orifices is used on the rod end of the center lift cylinder, to time its movement with the wing lift cylinder.

System: Reel Drive Troubleshooting

Note: The front three cutting units and the rear two cutting units are driven by separate hydraulic systems. Problems that affect both systems are either electrical or lift system related.

One Reel Turns Slowly

1. Is reel-to-bed knife clearance adjusted properly?

Yes: Go to next step.

No: Adjust reel-to-bed knife clearance to specification. (See “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

2. Is reel motor operating properly?

Yes: Go to next step.

No: Check reel motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 555.)

3. Are cutting unit bearings in good condition?

No: Inspect cutting unit bearings; replace if necessary.

All Reels in One System Are Turning Slowly

1. Is flow control knob in the fully open position?

Yes: Go to next step.

No: Move flow control knob to position “6.”

2. Is reel-to-bed knife clearance adjusted properly?

Yes: Go to next step.

No: Adjust reel-to-bed knife clearance to specification. (See “Adjust Bed Knife to Reel Clearance QA-5” on page 629, or “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

3. Is backlap valve inlet screen clean and free of debris?

Yes: Go to next step.

No: Clean backlap valve inlet screen.

4. Is system relief pressure adjusted properly?

Yes: Go to next step.

No: Perform reel motor pressure relief test. (See “Test Front and Rear Mower Circuit Relief Pressure (all except 7500-E, 8500-E)” on page 550.)

5. Is reel drive pump operating properly?

Yes: Go to next step.

No: Check pump for wear. (See “Test Reel Circuit Pump Flow - 7000 and 8000” on page 552.)

6. Are reel motors operating properly?

No: Check reel motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 555.)

One Cutting Unit Is Not Turning

1. Are hydraulic motor spline and coupler in good condition?

Yes: Go to next step.

No: Repair or replace as necessary.

2. Are cutting unit bearings in good working condition?

Yes: Go to next step.

No: Replace cutting unit bearings.

3. Is reel drive motor operating properly?

No: Check reel motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 555.)

One System Will Not Backlap

1. Is backlap knob in the up secured position?

Yes: Go to next step.

No: Place backlap knob in the up secured position.

2. Is flow control valve fully open?

Yes: Go to next step.

No: Move control knob to the open position.

3. Is mow solenoid operating?

Yes: Go to next step.

No: Check if 12 V is present at solenoid.

4. Is mow solenoid valve operating properly?

No: Remove solenoid valve and check function.

Pump Is Noisy

1. Is hydraulic oil reservoir at proper level?

Yes: Go to next step.

No: Fill reservoir to proper level with recommended oil.

2. Is reel drive pump operating properly?

Yes: Go to next step.

No: Check pump for wear. (See “Test Reel Circuit Pump Flow - 7000 and 8000” on page 552.)

3. Is backlap valve inlet screen clean and free of debris?

No: Clean backlap valve inlet screen.

System: Rotary Mower Drive Troubleshooting

Note: The front three cutting units and the rear two cutting units are driven by separate hydraulic systems. Problems that affect both systems are either electrical or lift system related.

One Rotary Mower Turns Slowly

1. Are blade coupler and bolt properly installed with

key?

Yes: Go to next step.

No: Install parts as necessary.

2. Is hydraulic drive motor operating properly?

No: Check cutting unit motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 555.)

All Rotary Mowers in One System Are Turning Slowly

1. Is drive pump operating properly?

Yes: Go to next step.

No: Check pump for wear. (See “Test Rotary Mower Circuit Pump Flow - 8800” on page 553.)

2. Is mow valve inlet screen clean and free of debris?

Yes: Go to next step.

No: Remove and clean screen.

3. Is system relief valve operating properly?

Yes: Go to next step.

No: Perform rotary mower motor pressure relief test. (See “Test Front and Rear Mower Circuit Relief Pressure (all except 7500-E, 8500-E)” on page 550.)

4. Is mow solenoid operating properly?

No: Check function of solenoid spool. Check voltage to solenoid.

One Rotary Mower Is Not Turning

1. Are blade coupler and bolt properly installed with key?

Yes: Go to next step.

No: Install parts as necessary.

2. Is mower drive motor operating properly?

No: Check cutting unit motor case drain. (See “Test Cutting Unit Motor Case Drain” on page 555.)

Pump Is Noisy

1. Is hydraulic oil reservoir at proper level?

Yes: Go to next step.

No: Fill reservoir to proper level with recommended oil.

2. Is mower drive pump operating properly?

Yes: Go to next step.

No: Check pump for wear. (See “Test Rotary Mower Circuit Pump Flow - 8800” on page 553.)

3. Is mow valve inlet screen clean and free of debris?

No: Remove and clean screen.

System: Lift System Troubleshooting - All Machines

Front and Rear Lift Arms Will Not Rise

1. Is 12 V present at SV1 lift solenoid?

Yes: Go to next step.

No: Check control module for proper function. (See “Interlock Module Check” on page 445.)

2. With key switch on, operate the lift lever. Is SV1 lift solenoid poppet moving?

Yes: Go to next step.

No: Remove and inspect SV1 solenoid cartridge. Replace if necessary.

3. Is steering system working?

Yes: Go to next step.

No: Perform lift and steering pump flow test. See “Test Lift and Steering Pump Flow” on page 558

4. Is lift system free of air?

Yes: Go to next step.

No: Start engine and cycle lift arms to purge air from system.

5. Are lift system hydraulic fittings tight and free from leaks?

Yes: Go to next step.

No: Tighten fittings and replace O-rings as needed.

6. Is lift valve operating properly?

Yes: Go to next step.

No: Repair or replace as needed.

Front and Rear Lift Arms Will Not Lower

1. Is 12 V present at SV2 lift solenoid?

Yes: Go to next step.

No: Check control module for proper function. (See “Interlock Module Check” on page 445.)

2. Is lift valve operating properly?

Yes: Go to next step.

No: Repair or replace lower cartridge (SV2) as required.

3. Is down pressure valve operating properly?

No: Perform down pressure valve test. (See “Test Optional Down Pressure Valve” on page 559.)

Front and Rear Lift Arms Will Not Stay in Raised Position

1. Are lift system hydraulic fittings tight and free from leaks?

Yes: Go to next step.

No: Tighten fittings and replace O-rings as needed.

2. Is lift valve operating properly?

Yes: Go to next step.

No: Perform lift system leakage test. (See “Test Lift System Leakage” on page 558.)

3. Is down pressure valve operating properly?

No: Perform down pressure valve test. (See “Test Optional Down Pressure Valve” on page 559.)

Tests and Adjustments

Bleed Hydraulic System

Reason

To ensure that air is purged from hydraulic system after the hoses or lines have been disconnected.

Procedure

1. Park machine on a level surface.
2. Move forward and reverse travel pedals to neutral position.
3. Lower cutting units to the ground.
4. Move mow-transport lever to the transport position.
5. Turn key switch to stop position.
6. Lock park brake.
7. Check level of hydraulic oil. Fill as needed.

Caution: Avoid Injury! Engine exhaust fumes contain carbon monoxide and can cause serious illness or death.

Move the machine to an outside area before running the engine.

Do not run an engine in an enclosed area without adequate ventilation.

- **Connect a pipe extension to the engine exhaust pipe to direct the exhaust fumes out of the area.**
- **Allow fresh outside air into the work area to clear the exhaust fumes out.**

8. Start engine and run at slow idle.
9. Turn steering wheel full left and hold for 5 seconds.
10. Turn steering wheel straight forward and hold for 10 seconds.
11. Turn steering wheel full right and hold for 5 seconds.
12. Cycle cutting units up and down ten times.
13. Return steering wheel to straight forward position.
14. Drive machine straight forward for 6 meters (20 feet), then make two hard left turns, then make two hard right turns.
15. Drive machine in reverse approximately 3 meters (10 feet).
16. Turn key switch to stop position.
17. Check all hoses and connections for leaks. Tighten connections and/or replace hoses as needed.
18. Check oil level on the hydraulic expansion tank. Add oil as needed.

Specifications

Slow Idle Speed . . . . . 1400 ± 50 rpm

Test Front and Rear Mower Circuit Relief Pressure (all except 7500-E, 8500-E)

Reason

To make sure that front and rear mower circuit relief valves are functioning properly and adjusted correctly.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit	JDG2033	Measure mower circuit relief.

Procedure

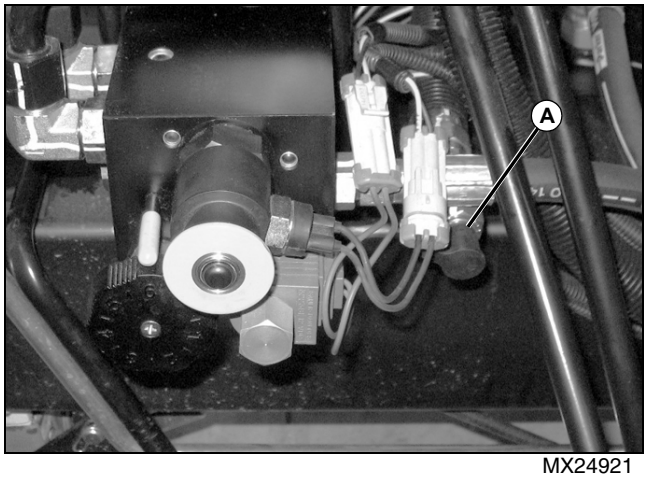
Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

Important: Avoid Damage! Check and adjust service brake, if necessary, prior to performing this test.

Note: Procedure is shown testing rear mower motor circuit. Procedures for the front mower motor circuit are the same except where noted.

For rear mower motor circuit, pressure is read between rear section of triple pump and rear mow/backlapping valve.

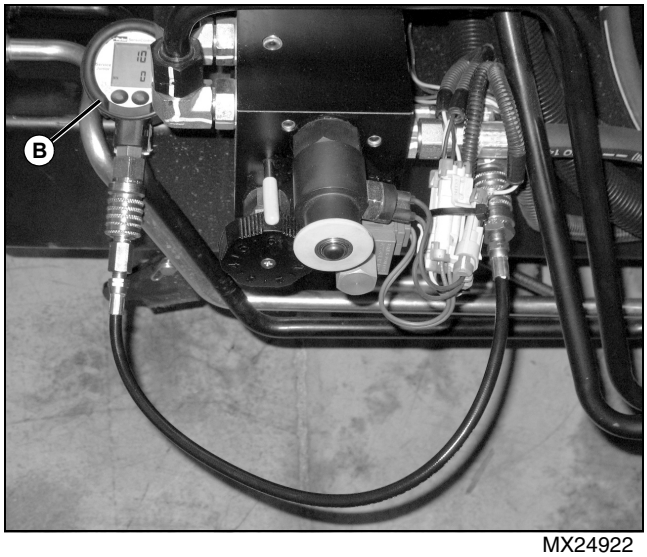
For front mower motor circuit, pressure is read between center section of triple pump and front mow/backlapping valve.



MX24921

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

2. Remove cap (A) from tee fitting at mow/backlapping valve “P” port.



MX24922

3. Install JDG2033 Pressure Gauge Kit (B).

4. With cutting units lowered to ground, place wooden block in a cutting unit to prevent rotation.

5. For reel mowers, place valve in backlap mode.

6. Start engine and set engine speed to a minimum of 2000 rpm.

Note: If the engine stalls while performing this test, set the engine speed to fast idle and repeat test.

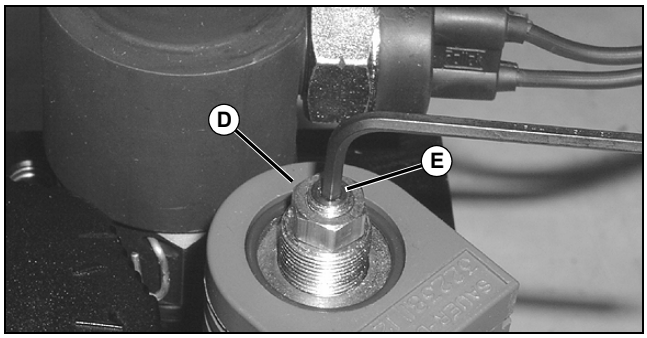
7. Push PTO knob forward (mow position) and push lift/lower lever forward to engage mowers.

8. Note reading on gauge.

Results

Relief valve pressure reading should be to specification; if necessary, adjust relief valve as follows:

Note: Counterclockwise rotation of the setscrew will decrease pressure relief setting, and clockwise rotation will increase pressure relief setting.



MX20019

- Remove backlap/mow solenoid retaining nut.
- Loosen jam nut (D) and turn setscrew (E) with hex key wrench to adjust pressure relief setting while watching gauge.

If adjustment does not meet specifications, replace solenoid cartridge.

Specifications

Engine Speed (Minimum) . . . . . 2000 rpm
Front and Rear Mower Motor Circuit
Relief Pressure . . . . . 20684 ± 1380 kPa (3000 ± 200 psi)

Test Reel Circuit Pump Flow - 7000 and 8000

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to measure reel circuit flow.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Reason

To determine if front and rear reel circuit pumps are worn by testing hydraulic flow at reel motors.

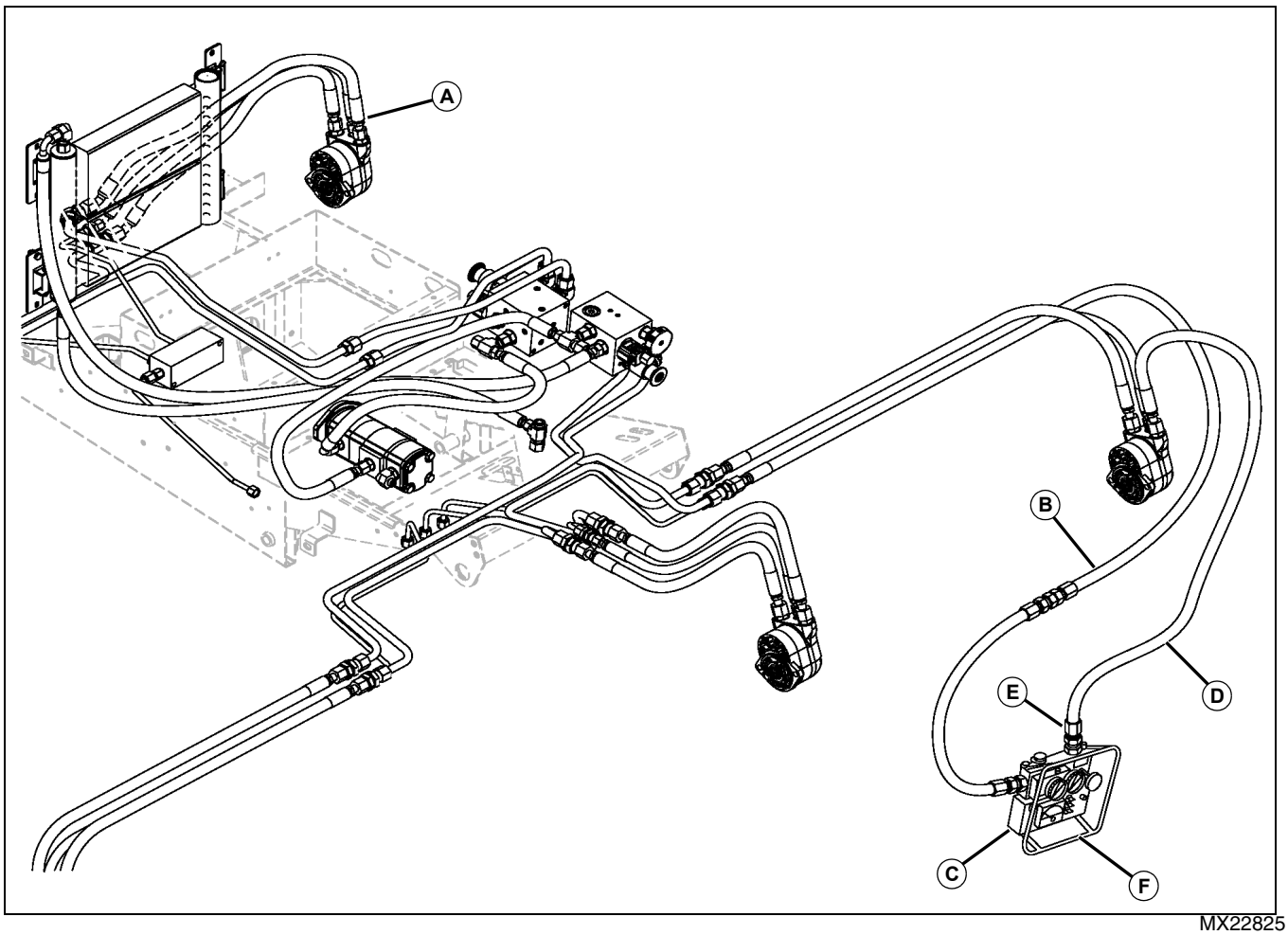
Procedure

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

Caution: Avoid Injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

Note: Procedure is shown testing front reel motor circuit. Procedures for the rear reel motor circuit are the same except where noted.



MX22825

2. Remove reel motor inlet hose:
   - For rear reel circuit, disconnect hose (A) from left rear motor.
   - For front reel circuit, disconnect hose (B) from left front motor.
3. Connect hose (A or B) to flow gauge inlet (C).
4. Attach a hose (D) from D01074AA Flow Meter outlet (E) to open port of motor circuit being tested.
5. Turn tester control knob (F) out (counterclockwise) completely.

6. Set backlapping valve of circuit being tested, to forward (mow) position.

Note: Check engine rpm with JT05501 Inductive Electronic Tachometer.

7. Have a helper technician start engine, run at FAST idle, and engage reels.

8. Slowly turn tester control knob in (clockwise) until pressure reaches 13 790 kPa (2000 psi). Note flow reading.

Results

The reel circuit pump flow must be at specification. If not, repair or replace pump as necessary.

Specifications

Engine Fast Idle . . . . . .2800 ± 50 rpm
Reel Circuit Pump Flow at 13 790 kPa (2000 psi) (Minimum) . . . . . 26.4 L/min (7 gpm)

Test Rotary Mower Circuit Pump Flow - 8800

Reason

To determine if front and rear rotary mower circuit pumps are worn by testing hydraulic flow at rotary mower motors.

Special or Required Tools

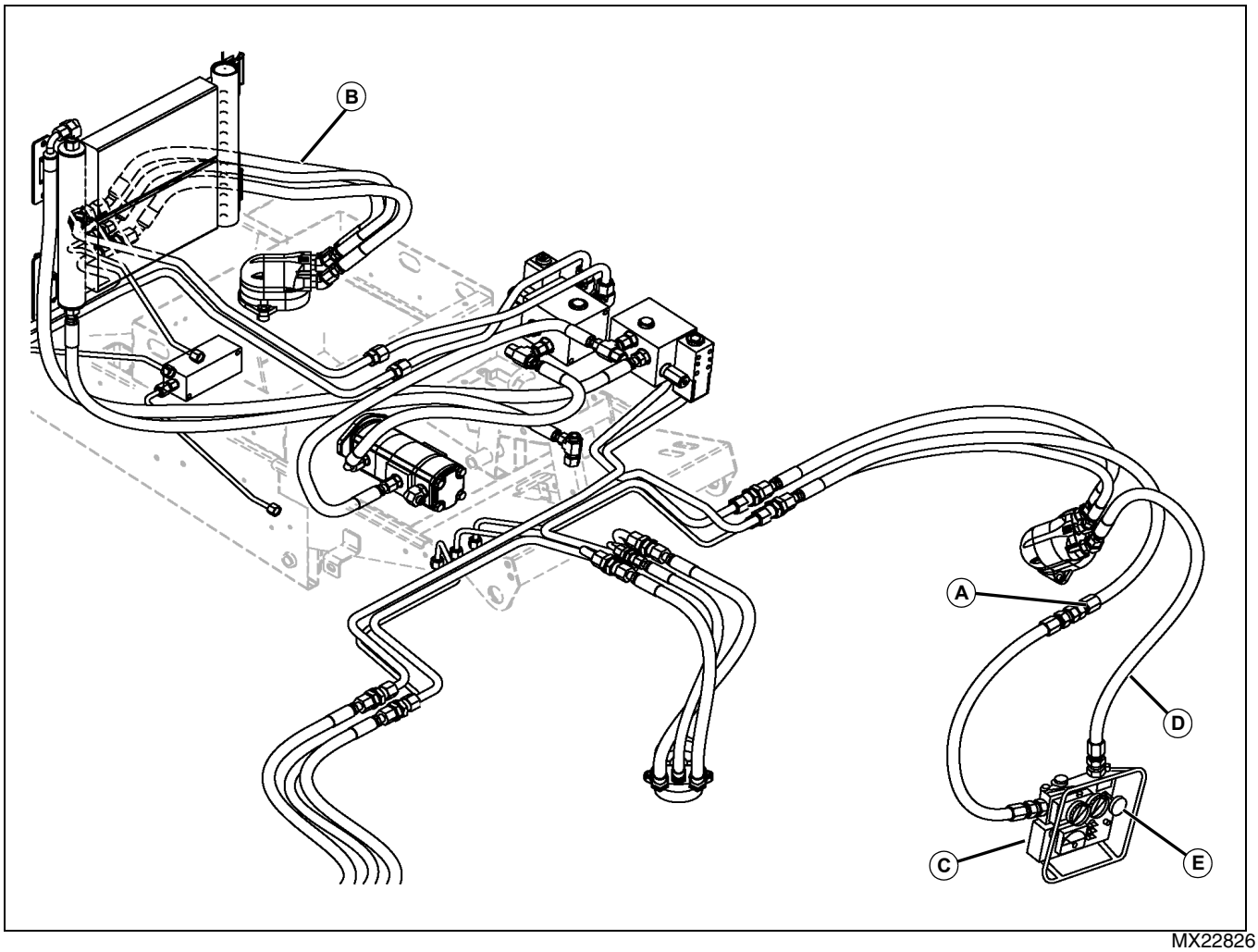
Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to measure mower circuit flow.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

Note: Procedure is shown testing front mower motor circuit. Procedures for the rear mower motor circuit are the same except where noted.



MX22826

2. Remove mower motor inlet hose:

   • For front mower circuit, disconnect hose (A) from left front motor.

   • For rear mower circuit, disconnect hose (B) from left rear motor.

3. Connect hose (A or B) to D01074AA Flow Meter inlet (C).

4. Attach a hose (D) from outlet of D01074AA Flow Meter to open port of motor circuit being tested.

5. Turn tester control knob (E) out (counterclockwise) completely.

Caution: Avoid Injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

Note: Check engine rpm with JT05801 Inductive Electronic Tachometer.

6. Have a helper technician start engine, run at FAST idle, and engage mowers.

7. Slowly turn tester control knob in (clockwise) until pressure reaches 13 790 kPa (2000 psi). Note flow reading.

Results

The rotary mower circuit pump flow must be at specification. If not, repair or replace pump as necessary.

Specifications

Engine Fast Idle . . . . . 2800 ± 50 rpm
Rotary Mower Circuit Pump Flow at 13 790 kPa (2000 psi) (Minimum) . . . . . 30 L/min (8.0 gpm)

Test Cutting Unit Motor Case Drain

Reason

To test the cutting unit motor internal leakage to case drain. As the motor gears wear, more case drain oil is bypassed to the hydraulic reservoir.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to test hydraulic case drain.

Procedure

Note: Procedure is shown testing front reel mower motor circuit.

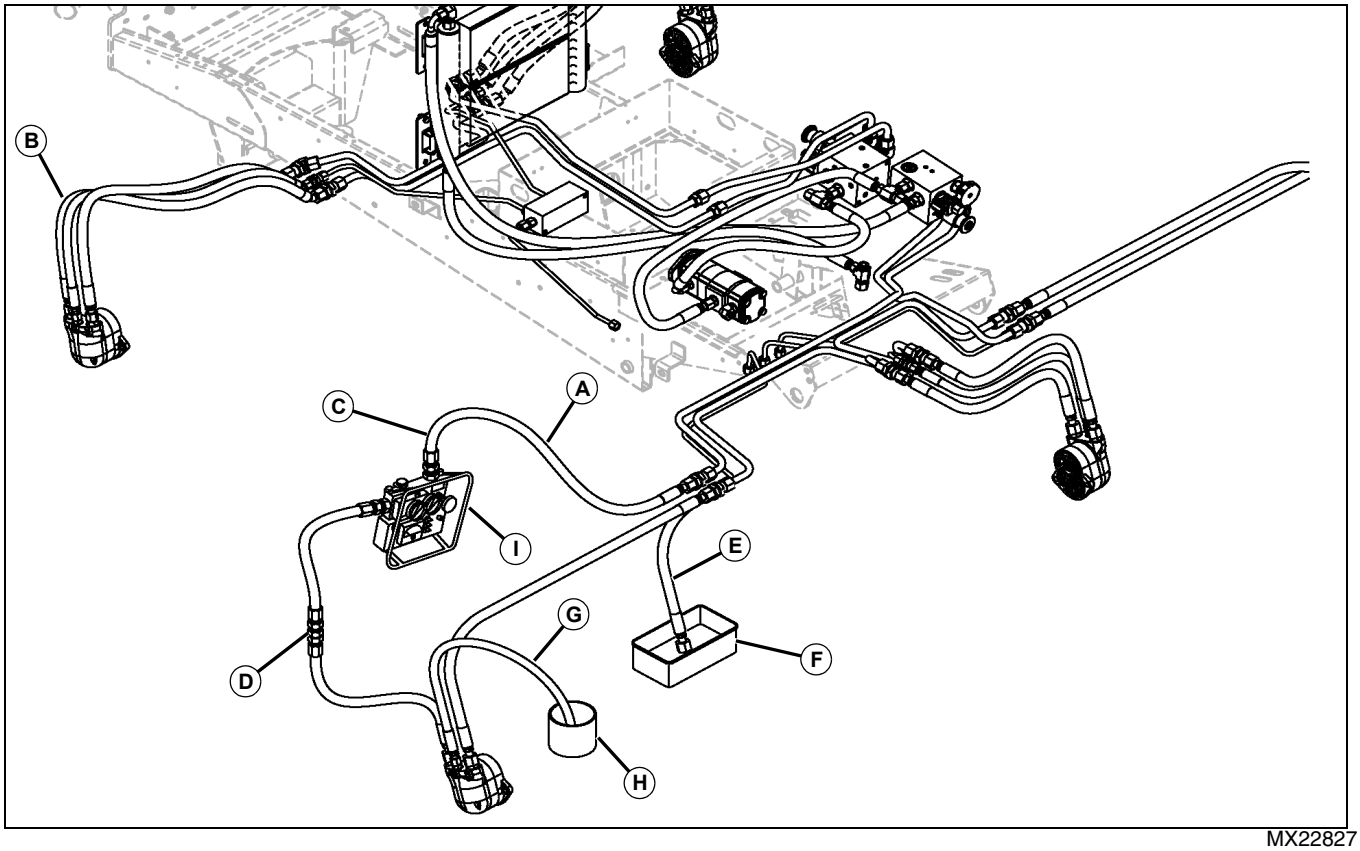
Procedures for the rear circuit are the same except where noted.

Procedures for the front and rear rotary mower motor circuit are also the same except where noted.

Note: Case drain oil from all three front cutting unit motors can be tested with flow meter connected to right front cutting unit motor. All rear cutting unit motors can also be tested with flow meter connected to right rear cutting unit motor.

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX22827

2. Remove mower motor return hose:
   - For front mower circuit, disconnect hose (A) (return hose to mow valve) from right front motor.
   - For rear mower circuit, disconnect hose (B) (return hose to mow valve) from right rear motor.
3. Connect hose (A or B) to flow gauge outlet port (C).
4. Attach a hose (D) from flow gauge inlet port to open port of motor circuit being tested.
5. Disconnect center case drain hose (E) from cutting unit being tested and place open end into a clean drain pan (F).
6. Connect a hose (G) on center port fitting of cutting unit motor and place open end of hose into drain pan (F).
7. Place a clean container (H) next to drain pan (F).
8. Turn tester control knob (I) fully counterclockwise.
9. For reel mower circuits, set rear backlapping valve to forward (mow) position (knob pushed in).

Caution: Avoid Injury! Use extreme care when working around operating cutting units. Cutting units have the capability of causing serious bodily injury.

10.Have an assistant start machine, run engine at FAST idle, and engage cutting units.

11.Turn tester control knob in (clockwise) until pressure reaches 13 790 kPa (2000 psi).

12.Move open end of hose (G) from drain pan (F) to container (H) for 15 seconds, then return to drain pan (F).

13.Measure amount of oil in container (H). Multiply volume of oil by 4 to arrive at amount of motor case drain in 1 minute.

14.Leaving flow gauge at right front or right rear hydraulic motor, repeat steps 6-13 on remaining motors of circuit being tested.

Results

The cutting unit motor case drain from any motor should not exceed specification. If case drain exceeds specifications, rebuild or replace motor.

Specifications

Cutting Unit Motor Case Drain @ 13 790 kPa (2000 psi) (Maximum). . . . . 3.8 L/min (1.0 gpm)

Test Lift System Relief Pressure

Reason

To verify triple pump (front gear set) pressure is maintained at correct level for steering and lift systems without causing damage to the system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit	JDG2033	Used to test lift system relief pressure.
Pressure Diagnostic Kit	JDG2031	Used to test lift system relief pressure.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

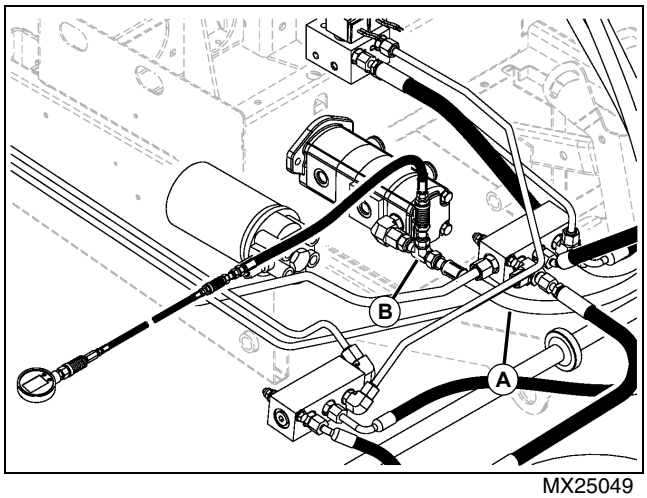
1. Operate hydraulic system until fluid is at a minimum temperature of 43°C (110°F).

2. Park machine safely. (See “Park Machine Safely” in Safety section.)

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

3. Relieve system pressure by operating the lift system.



MX25049

4. Disconnect steering supply hose (A) from front section of triple pump. Install a tee fitting (B) and reconnect supply hose to fitting.

5. Connect JDG 2033 Pressure Gauge Kit to tee fitting.

Note: Check engine rpm with JT05801 Inductive Electronic Tachometer.

6. Apply park brake, start engine, and run at FAST idle.

7. Pull lift lever back to raise cutting units and hold. Record steady pressure reading.

Results

Pressure should be to specification. If pressure is not within specification, replace steering valve.

Specifications

Lift System Relief Valve
Pressure . . . . . 11 721-13 790 kPa (1700-2000 psi)

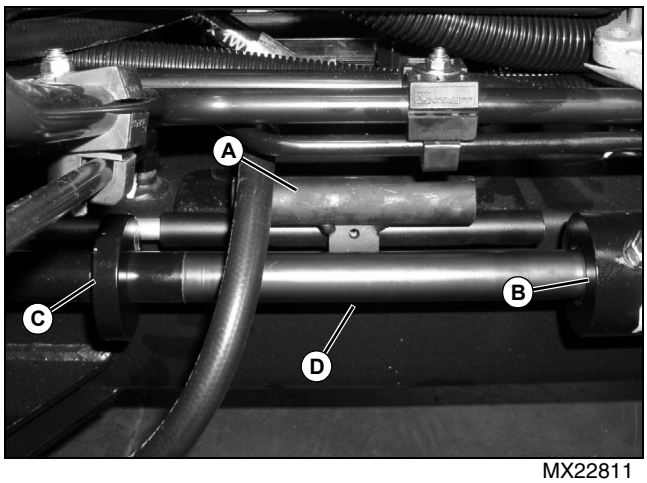
Check and Adjust Wing Cutting Units Upstop

Reason

To make sure wing lift arms cylinder and upstop casting are properly aligned.

Check

1. Before adjusting wing cutting units upstop, a thorough inspection of the upstop and linkage should be performed.
2. Lock park brake.
3. Start engine.
4. Move mow-transport lever to MOW position.



MX22811

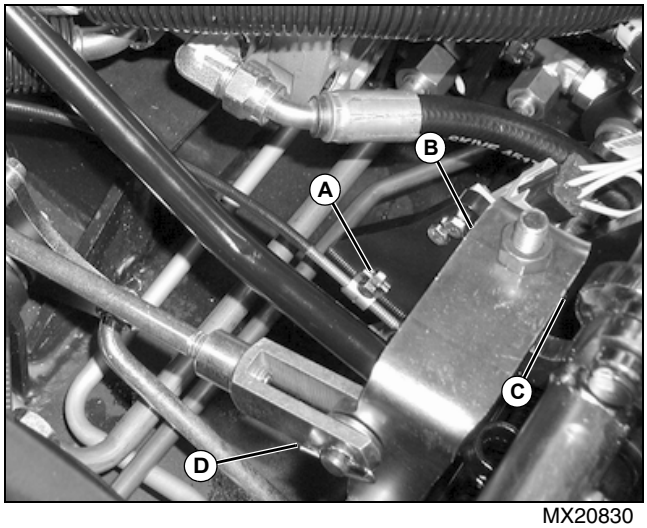
5. Raise cutting units until lift stop (A) contacts wing cutting unit cylinder barrel (B) and cylinder washer (C).
6. Check for clearance between upstop and cylinder rod (D).
7. Stop the engine.
8. Adjust clevis until distance between lift stop and cylinder reaches gap specification.
9. If lift stop is out of clearance range, proceed to adjustment procedure.

Specification

Clearance Gap . . . . . 2 - 5 mm (0.08 - 0.20 in.)

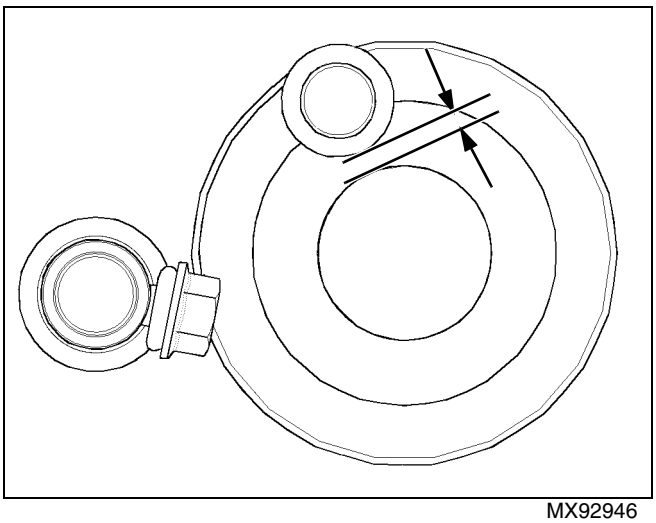
Adjust

1. Move mow/transport lever to MOW position. Remove operator foot platform.



MX20830

2. Loosen cable clamp (A).
3. Rotate bracket (B) until approximately 2-6 mm (0.078-0.236 in.) clearance (C) is between bracket and pedal bellcrank.
4. Hold bracket (B) in place and tighten cable clamp (A).
5. Move mow-transport lever through its entire range of motion. Clearance (C) must be maintained.
6. If adjustment is needed, adjust clevis (D).


MX92946

7. Rotate clevis in or out as required for proper lift stop to cylinder rod gap adjustment.
8. Cycle cutting units up and down as required.
9. Check wing cutting unit upstop. Repeat procedure as needed.

Results

Wing lift arms should raise and lower fully without damaging the lift arm cylinder or upstop.

Test Lift and Steering Pump Flow

Reason

To determine if lift and steering circuit pump is worn by testing hydraulic flow at pump.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flow Meter	D01074AA	Used to measure hydraulic circuit flow.
Diagnostic Flow Kit	JDG2032	Used to connect flow gauge to lift/steering pump.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Procedure

1. Park machine safely. (See “Park Machine Safely” in Safety section.)
2. Disconnect steering supply hose from front section of triple pump.
3. Connect hose from inlet side of flow gauge to triple pump.
4. Connect hose from outlet side of D01074AA Flow Meter to steering supply hose.
5. Turn tester control knob fully open (counterclockwise).

Note: Check engine rpm with JT05801 Inductive Electronic Tachometer.

6. Apply park brake, start engine, and set throttle to FAST Idle.

Caution: Avoid Injury! DO NOT fully close tester control knob while running test.

7. Slowly turn tester control knob clockwise until pressure reading is 6895 kPa (1000 psi).
8. Record flow reading.

Results

Flow must be a minimum of 13.2 L/min (3.5 gpm). If flow is not within specification, repair or replace pump as necessary. (See “Disassemble Triple Pump” on page 568.) (See “Assemble Triple Pump” on page 570.)

Specifications

Engine Speed (Fast Idle) . . . . . 2800 ± 50 rpm
Lift/Steering Pump Flow at 6895 kPa (1000 psi) (Minimum) . . . . . 18.9 L/min (5 gpm)

Test Lift System Leakage

Reason

To determine cause of lift arm drift.

Procedure

1. Raise lift arms.
2. Support lift arms and mowers with a block or hoist.
3. Remove hose from rod end of cylinder. Close end of hose and cylinder fitting using caps or plugs.
4. Remove block or hoist from lift arms.
5. If within 5 minutes any of the lift arms drift down, replace the corresponding lift cylinder.

If No Lift Arms Drift Down

1. Connect cylinder hose, and lower lift arms to the ground.
2. Remove CV1 check valve and SV2 solenoid cartridge from lift valve.
3. Clean and inspect components and seals, and install in lift valve.
4. Raise lift arms and check for drift.
5. If lift arms continue to drift, replace CV1 check valve.
6. Raise lift arms and check for drift.
7. If lift arms continue to drift, replace SV2 solenoid cartridge.

Results

Faulty component identified and replaced. Lift arms no longer drift.

Test Optional Down Pressure Valve

Reason

To adjust the optional down pressure valve to set downward force on lift system and cutting units.

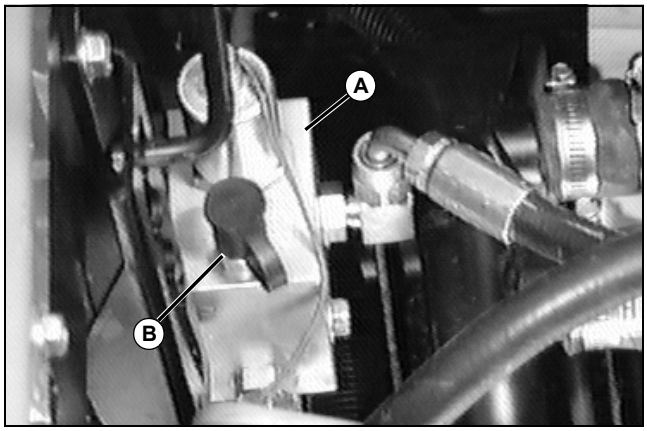
Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit	JDG2033	Read pressure needed to adjust down pressure valve.

Procedure

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

2. Test is performed by reading system pressure at down pressure valve. A test connector is located on the top of the valve block.



M58745

3. If machine does not have optional test kit installed, a test fitting (B) will have to be installed into the top of the down pressure valve block (A). A quick-disconnect fitting will allow the test gauge to be easily installed and removed for service.

4. Install pressure gauge to the test fitting.

Important: Avoid Damage! DO NOT move steering wheel while test is in progress.

5. Start engine.

6. Unlock park brake.

7. Set mow-transport lever to MOW position.

8. Set raise-lower lever to LOWER position.

9. Move throttle to full forward (full throttle) position.

10. Note reading on gauge.

11. Stop engine.

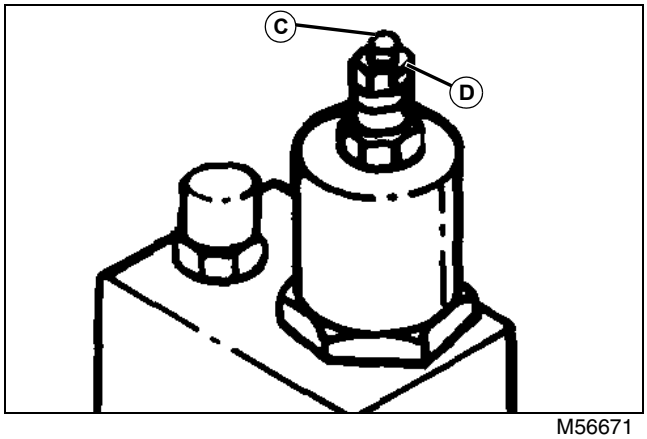
Adjusting Down Pressure Force

Use the chart below to determine pressure setting needed to achieve the required down force.

Important: Avoid Damage! Adding down force to cutting unit will decrease mower traction. Do not exceed 4826 kPa (700 psi) at the down pressure valve.

Pressure Reading at Down Pressure Valve	Down Force at Cutting Unit
1379 kPa (200 psi)	93 N (21 lb)
2068 kPa (300 psi)	142 N (32 lb)
2758 kPa (400 psi)	187 N (42 lb)
3447 kPa (500 psi)	236 N (53 lb)
4137 kPa (600 psi)	285 N (64 lb)
4826 kPa (700 psi)	334 N (75 lb)

Important: Avoid Damage! All pressure adjustments must be made with the engine running and the reel drive system at normal operating pressure (mow solenoid energized).



M56671

1. Loosen locknut (D) on top of down pressure solenoid plunger.

2. Follow steps 1-10 from Test Optional Down Pressure Valve section to determine current pressure setting.

3. Turn pressure setscrew (C) while watching pressure gauge.

Results

Down pressure valve checked for function and adjusted for optimal downward force on lift system and cutting units.

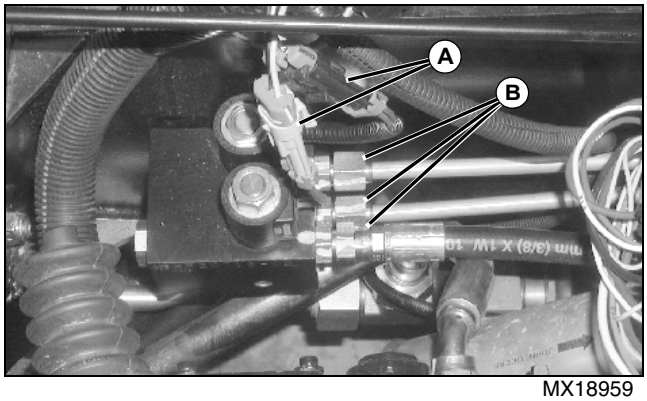
Repair

Remove and Install Lift Valve

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin, causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Removal



MX18959

1. Disconnect two electrical connectors (A).
2. Disconnect hydraulic lines (B) at lift valve.
3. Remove mounting cap screws and remove valve.

Installation

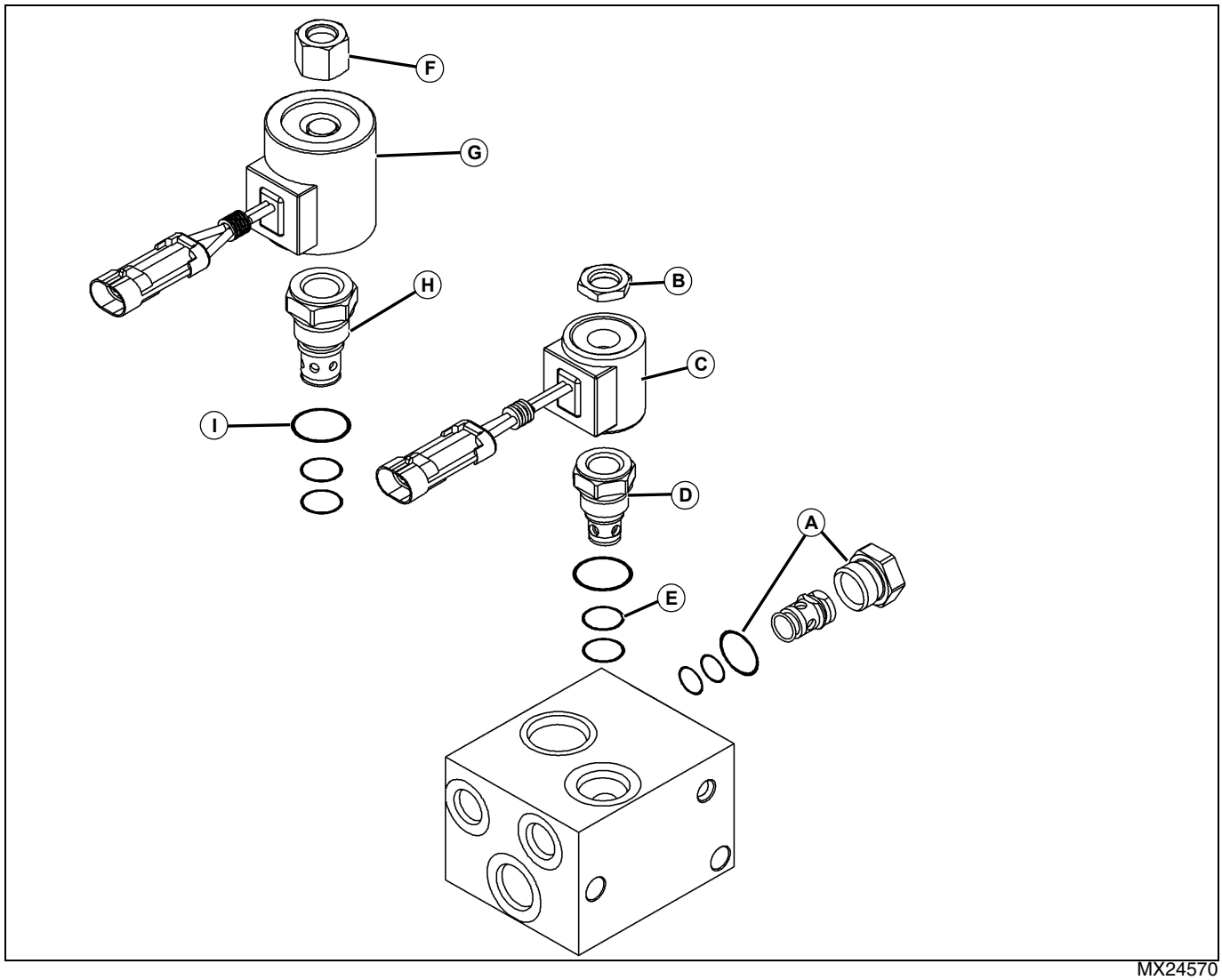
Installation is done in reverse order of removal.

- Tighten mounting cap screws to specification.

Specifications

Mounting Cap Screw Torque . . . . . 43 N•m (32 lb-ft)
Fitting Torque . . . . . 47 N•m (35 lb-ft)
Tube/Hose Torque . . . . . 33 N•m (25 lb-ft)

Disassemble, Inspect, and Assemble Lift Valve



MX24570

Disassemble

Note: Remove fittings, plug all ports, and wash valve assembly with a suitable solvent before disassembly.

1. Remove check valve (A).

Note: Mark position of lift and lower spools prior to removal.

2. Remove nut (B) and solenoid coil (C).
3. Remove solenoid valve (D) and O-rings (E).
4. Remove nut (F) and solenoid coil (G).
5. Remove solenoid valve (H) and O-rings (I).

Inspect

1. Clean all parts with a suitable solvent. Clean bores with a brush hone and solvent.
2. Inspect bores in valve housing for scoring.
3. Inspect spools for scoring, fretting, and straightness.
4. Replace all O-rings.

Assemble

Important: Avoid Damage! Use plenty of fresh hydraulic oil to lubricate parts during assembly.

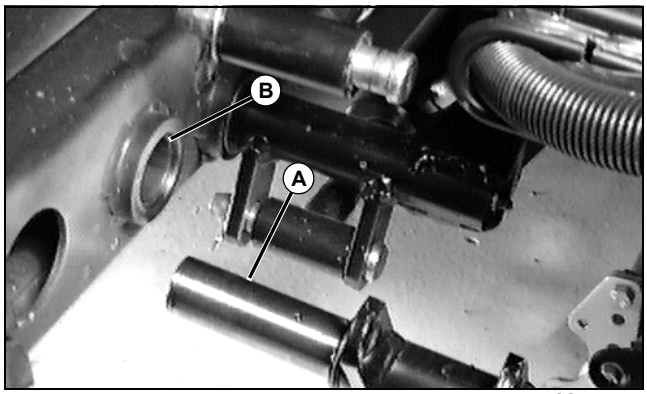
1. Lubricate and install O-rings onto solenoid valves. Install solenoid valves into previously marked location in valve housing. Tighten to specification.
2. Install solenoid coils over solenoid valve shafts. Install nuts and tighten to specification.
3. Lubricate and install O-rings on check valve. Install check valve and tighten to specification.

Specifications

Check Valve Torque . . . . . 26-28 N•m (19-21 lb-ft)
Solenoid Valve Torque . . . . . 27-34 N•m (20-25 lb-ft)
Coil Retaining Nut Torque . . . . . 5-7 N•m (48-60 lb-in.)

Remove Lift Arm

1. Remove cutting units from lift arm being serviced.



M57767

2. Remove hydraulic cylinder attachment pin from lift arm yoke. Secure cylinder to frame with wire to keep work area clear.

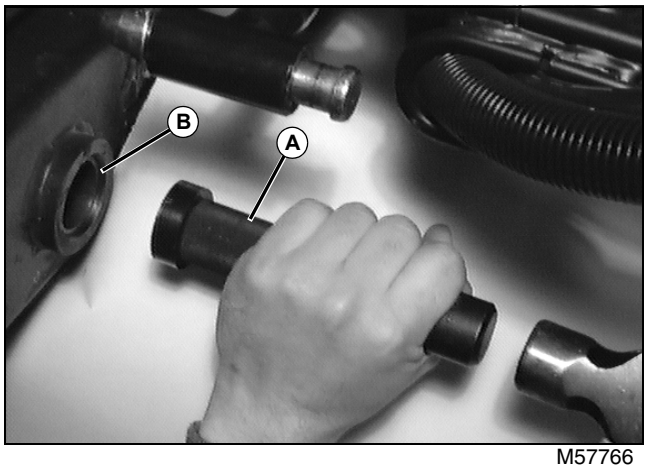
3. Remove lock pin, washers, and O-ring from back side of lift arm pivot.

4. Remove lift arm shaft (A) from lift arm bushing (B).

5. Remove O-ring, washer, and spacer from lift arm shaft.

Remove Lift Arm Bushing

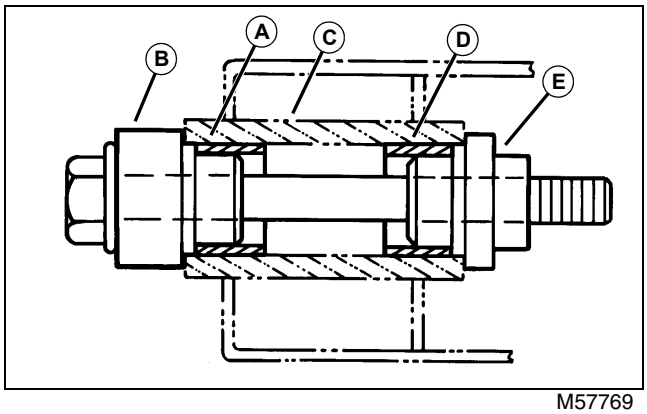
1. Remove lift arm. See “Remove Lift Arm” on page 562.



M57766

2. Using a 1-5/8 in. bearing driver (A), drive front and rear lift arm bushings (B) out back of frame pivot tube.

Install Lift Arm Bushing



M57769

1. Place rear bushing (A) on threaded end of JDG892 Installation Tool (B) and place on back of frame pivot tube (C). Place front bushing (D) on front half of tool (E) and thread bolt from front to rear of tool.

2. Tighten bolt on tool to pull bushings into frame pivot tube. Tool will set correct depth for proper O-ring clearance.

Install Lift Arm

1. Clean grease from lift arm and frame tube.

2. Inspect bushings for wear. Replace if necessary.

3. Place spacer, washer, and O-ring on lift arm pivot shaft.

4. Apply grease to lift arm pivot shaft.

5. Insert lift arm pivot shaft into frame tube.

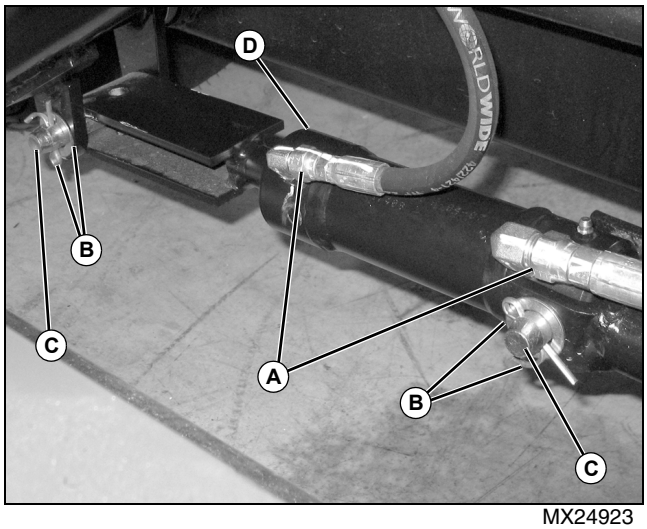
6. Install O-ring, washers, and lock pin on end of pivot shaft.

7. Grease lift arm pivot using grease fitting.

Remove and Install Front Lift Cylinder

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX24923

2. Label and remove hydraulic hoses (A).

3. Remove cotter keys and washers (B) at end of hydraulic cylinder mounting pins (C).

4. Remove mounting pins (C) and cylinder (D).

Note: Cylinder must be installed with the rod end to the right side of machine.

Install flow restrictor in port of lift cylinder. (See “Remove and Install Front Center Lift Cylinder Flow Restrictor” on page 566.)

5. Install cylinder using mounting pins, washers, and cotter keys.

6. Install new O-rings on fittings, and connect hydraulic hoses as previously labeled.

7. Grease mounting pins at grease fittings.

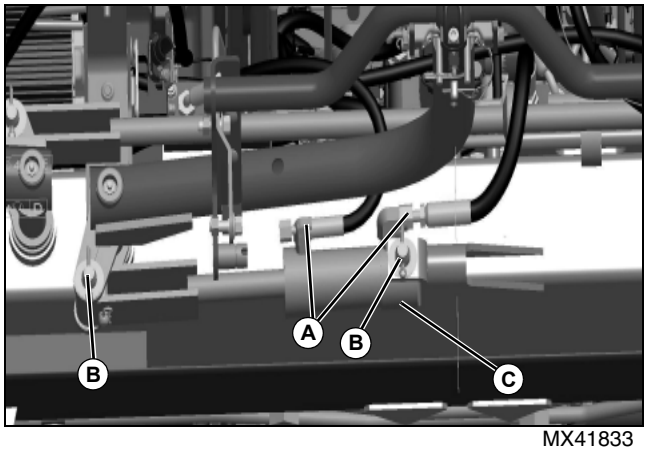
8. Start machine and cycle lift cylinders to purge air from system.

9. Check machine hydraulic fluid level.

Remove and Install Center Front Lift Cylinder (7500/8500 E-Cuts)

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX41833

2. Label and remove hydraulic hoses (A).

3. Remove cotter keys and washers (B) at end of hydraulic cylinder mounting pins.

4. Remove mounting pins and cylinder (C).

Note: Cylinder must be installed with the rod end to the right side of machine.

5. Install cylinder using mounting pins, washers, and cotter keys.

6. Install new O-rings on fittings, and connect hydraulic hoses as previously labeled.

7. Grease mounting pins at grease fittings.

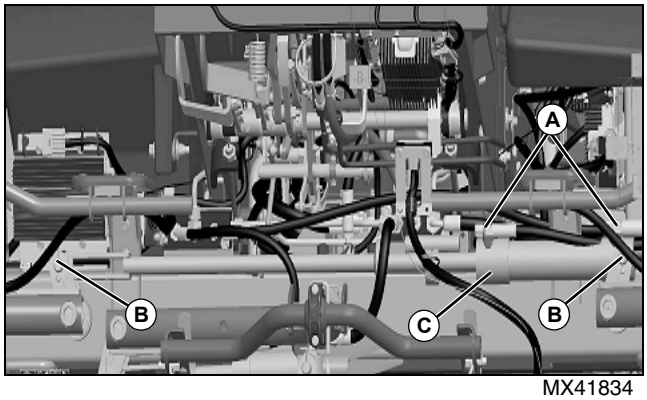
8. Start machine and cycle lift cylinders to purge air from system.

9. Check machine hydraulic fluid level.

Remove and Install Front Wings Lift Cylinder (7500/8500 E-Cuts)

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX41834

2. Label and remove hydraulic hoses (A).

3. Remove cotter keys and washers (B) at end of hydraulic cylinder mounting pins.

4. Remove mounting pins and cylinder (C).

5. Install cylinder using mounting pins, washers, and cotter keys.

6. Install new O-rings on fittings, and connect hydraulic hoses as previously labeled.

7. Grease mounting pins at grease fittings.

8. Start machine and cycle lift cylinders to purge air from system.

9. Check machine hydraulic fluid level.

Remove and Install Rear Lift Cylinder

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

1. Label and remove hydraulic hoses.

2. Remove lost motion linkage. (See “Remove and Install Rear Lift Cylinder Lost Motion Linkage” on page 567.)

3. Remove cotter keys, washers, and rear lift cylinder.

Note: On reel mower machines, install flow restrictor in port of rear lift cylinder.

Install rear lift cylinder with rod end to the left side of machine.

4. Install rear lift cylinder using washers and cotter keys.

5. Install lost motion linkage. (See “Remove and Install Rear Lift Cylinder Lost Motion Linkage” on page 567.)

6. Install new O-rings on fittings, and connect hydraulic hoses as previously labeled.

7. Grease mounting pins at grease fittings.

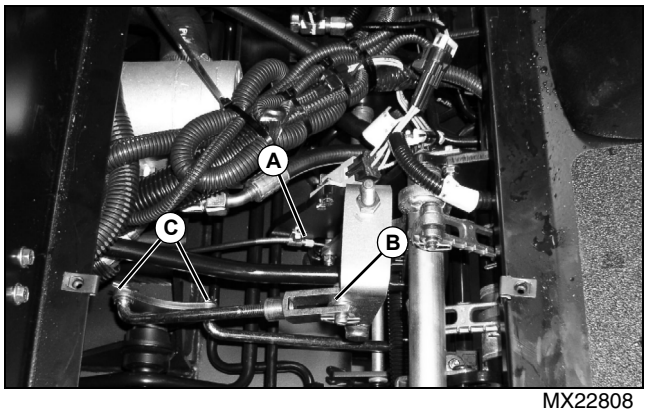
8. Start machine and cycle lift cylinders to purge air from system.

9. Check machine hydraulic fluid level.

Inspect Wing Lift Arms Upstop and Linkage

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

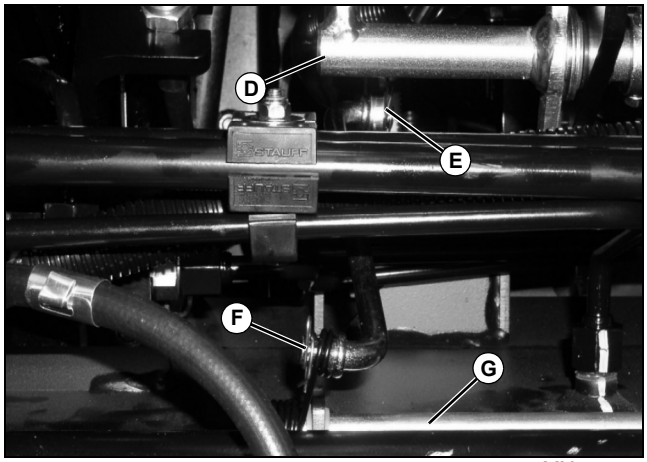
2. Remove operator foot platform.



MX22808

3. Operate mow-transport cable (A) several times, making sure cable is secure and operating freely.

4. Check pivot points (B and C) for wear. Check for missing or bent parts. Check that all pivot points move freely and do not bind.



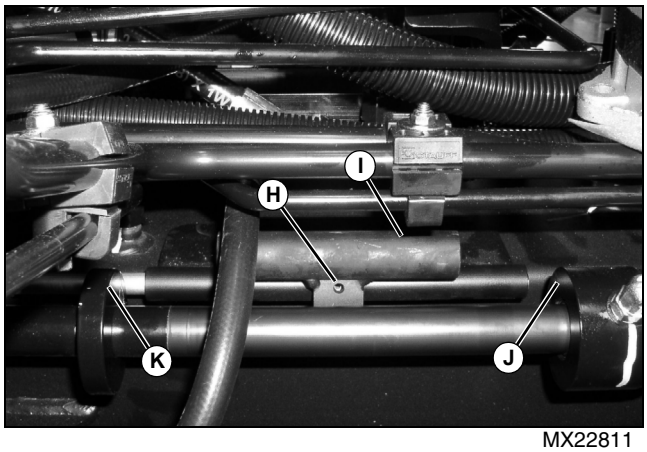
MX22810

5. Check that cross shaft (D) moves freely.

6. Check pivot (E) for wear and proper operation.

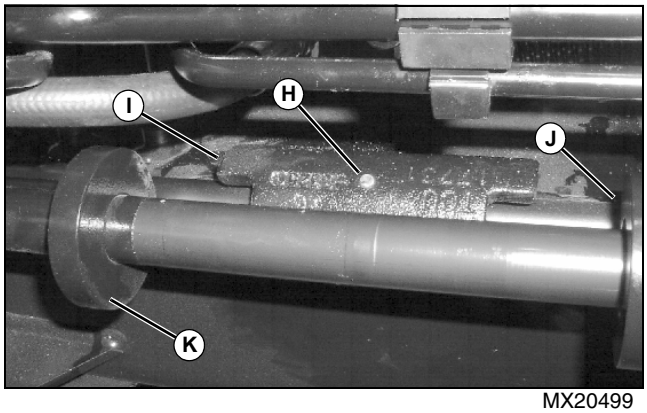
7. Check pivot and spring (F) for wear and proper operation.

8. Check pivot shaft (G) for wear and proper operation.



MX22811

7500, 7700, 8500, and 8700 only.



MX20499

8800 shown.

9. Check placement and condition of roll pin (H). Inspect upstop (I) for excessive wear.

10.Inspect cylinder rod washer (K) and cylinder body (J) for damage or wear.

Note: If cylinder rod washer has only a small chip missing from the outer edge, rotate cylinder rod so that the damaged area on the washer is 180° opposite the upstop casting.

11.Check for damage on cylinder rod washer (J). If washer is damaged, replace cylinder as an assembly.

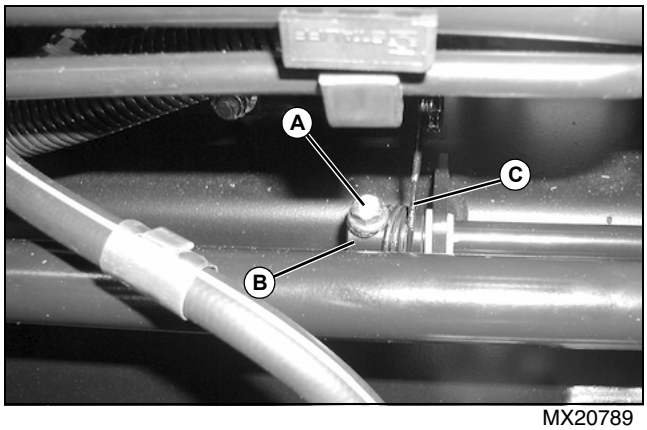
12.Check upstop casting (K) and cylinder barrel (L) for damage. If damage is evident on either component, replace damaged component.

13.Adjust wing cutting units upstop. See “Check and Adjust Wing Cutting Units Upstop” on page 557.

Remove and Install Upstop

Removal

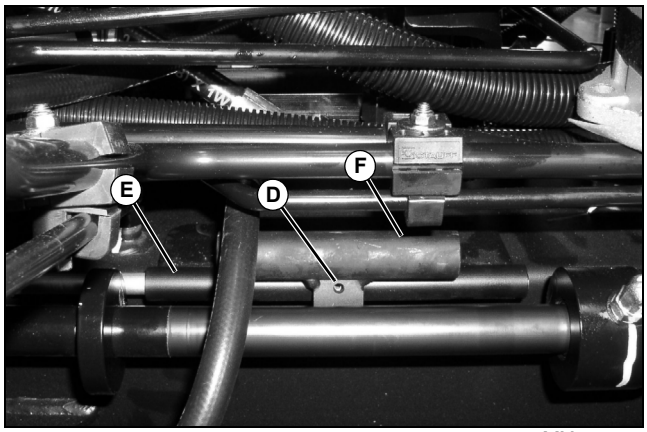
1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX20789

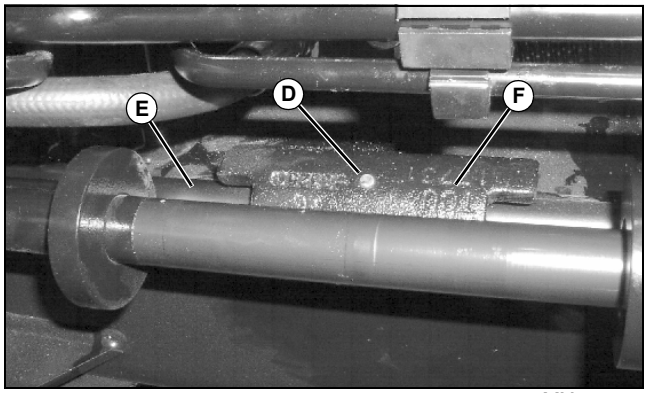
2. Remove cap screw (A) and sleeve (B).

3. Pull spring (C) away from upstop shaft.



MX22811

7500, 7700, 8500, and 8700 only.



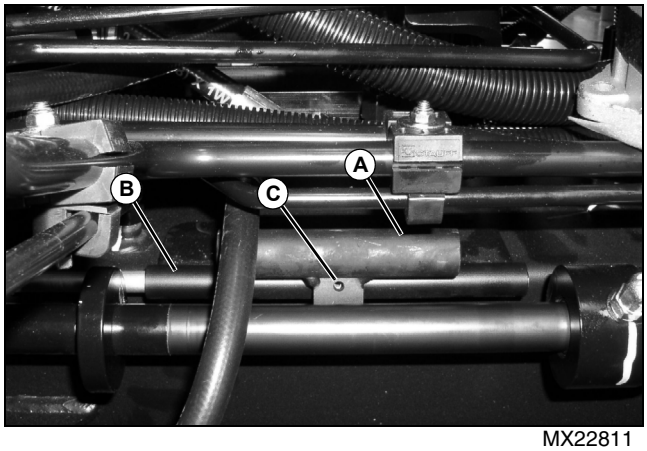
MX20499

8800 shown.

4. Remove roll pin (D). Remove upstop shaft (E) and upstop (F).

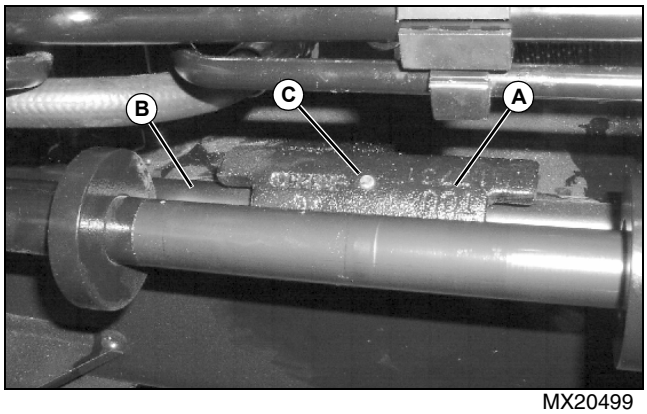
Installation

1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX22811

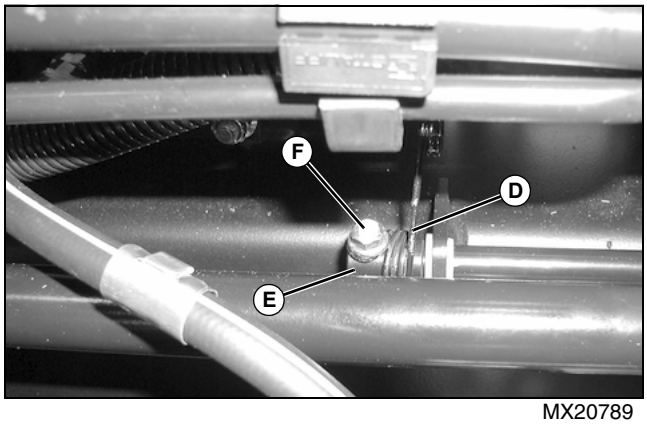
7500, 7700, 8500, and 8700 only.



MX20499

8800 shown.

2. Install upstop (A) and upstop shaft (B). Secure with roll pin (C).



MX20789

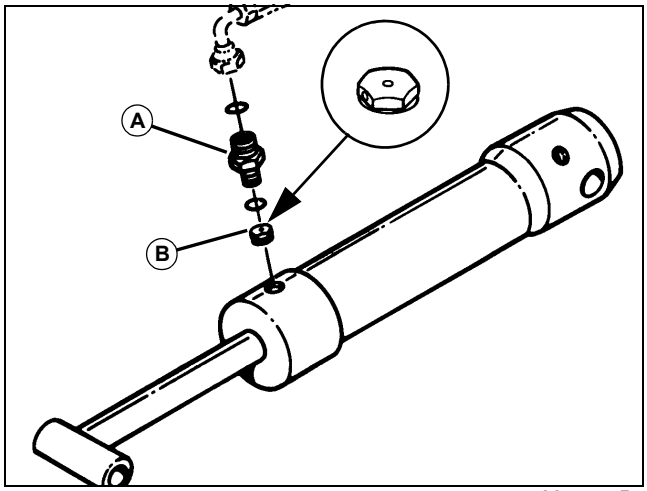
3. Install spring (D), sleeve (E), and cap screw (F).

Remove and Install Rear Lift Cylinder Flow Restrictor

Removal

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

2. Remove hydraulic hose from rod end of rear lift cylinder.



M58761B

3. Remove fitting (A) from hydraulic cylinder.

4. Remove flow restrictor (B) from under fitting.

Installation

Note: The flow restrictor is installed with the round end of the body inserted into the cylinder first.

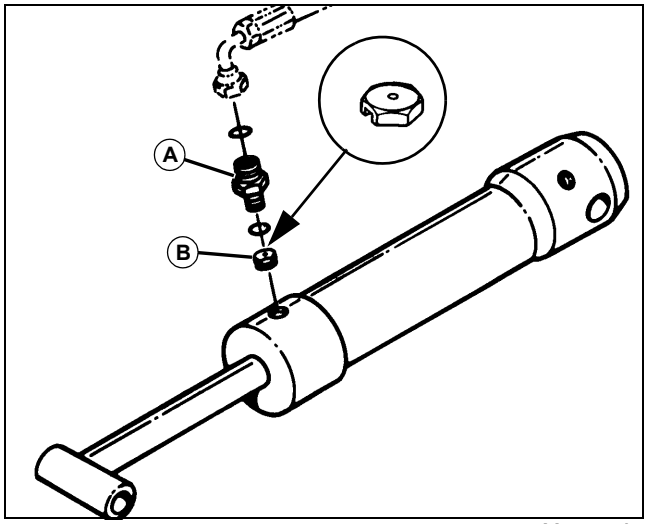
Installation is done in reverse order of removal.

Remove and Install Front Center Lift Cylinder Flow Restrictor

Removal

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

2. Remove hydraulic hose from rod end of front lift cylinder.



M58761A

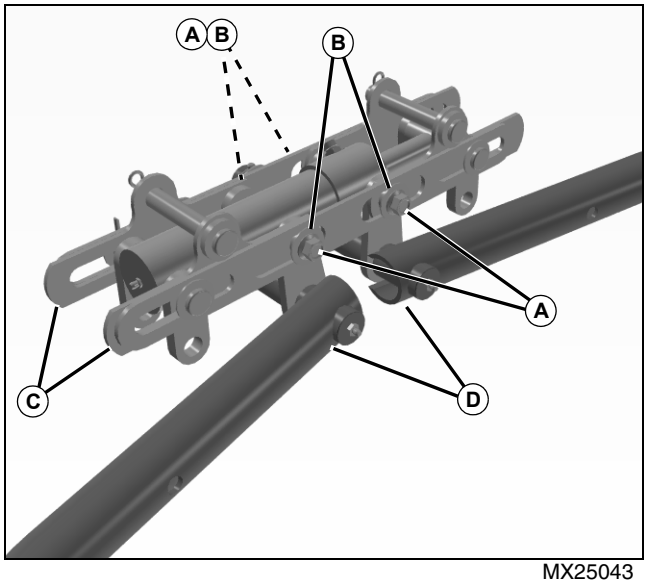
3. Remove fitting (A) from hydraulic cylinder.
4. Remove flow restrictor (B) from under fitting.

Installation

Note: The flow restrictor is installed with the slot of the restrictor inserted into the cylinder first.

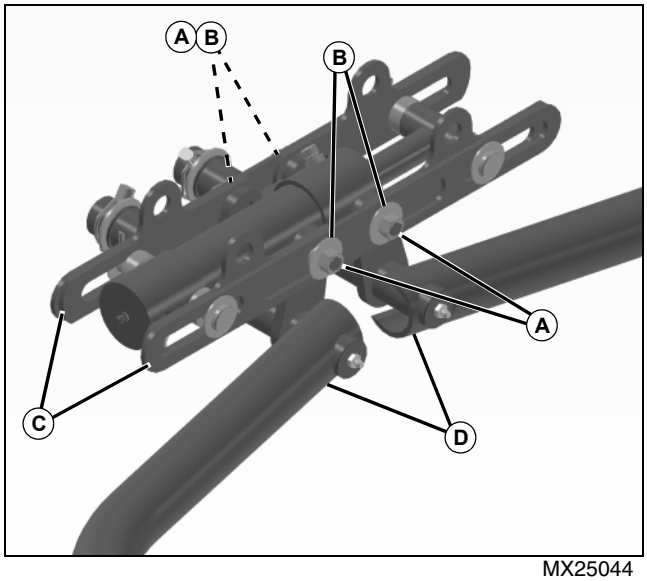
Installation is done in reverse order of removal.

Remove and Install Rear Lift Cylinder Lost Motion Linkage



MX25043

7500, 7700, 8500 and 8700 only.



MX25044

8800 shown

1. Remove rear lift cylinder and hydraulic hoses. See “Remove and Install Rear Lift Cylinder” on page 564.
2. Remove four nuts (A) and washers (B) holding lost motion linkage (C) to lift arms (D).
3. Inspect linkage and lift arms for wear or bending.
4. Install lost motion linkage and rear lift cylinder.

Remove and Install Triple Pump (except E models)

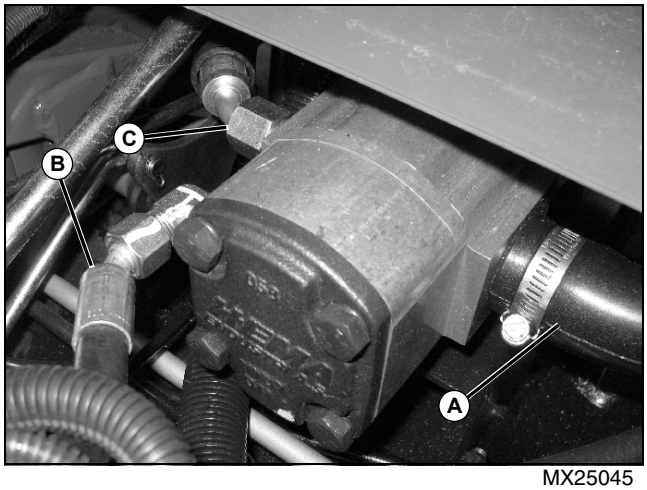
Note: Removal and installation of the triple pump is similar for all models; 8000 is shown.

Removal

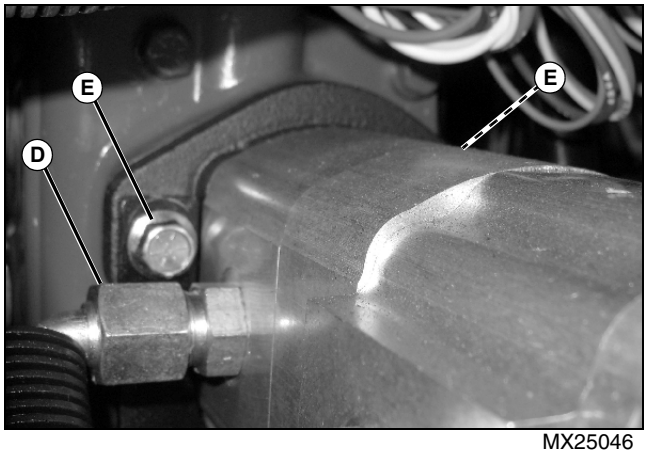
1. Park machine safely. (See “Park Machine Safely” in Safety section.)

Caution: Avoid Injury! Lower cutting units to the ground prior to removing any hydraulic lines or fittings.

2. Disconnect battery and remove floor plate.



MX25045



MX25046

3. Disconnect hose (A).

4. Mark and disconnect lines (B-D).

5. Remove two cap screws (E) and separate triple pump assembly from hydrostatic pump.

6. Remove triple pump from machine.

7. Remove coupler and O-ring from pump.

Installation

1. Apply petroleum jelly to pump flange O-ring and install on pump.

2. Install coupler on pump input shaft.

3. Install triple pump onto hydrostatic pump and install cap screws (E).

4. Connect lines (B-D) as marked.

5. Connect hose (A).

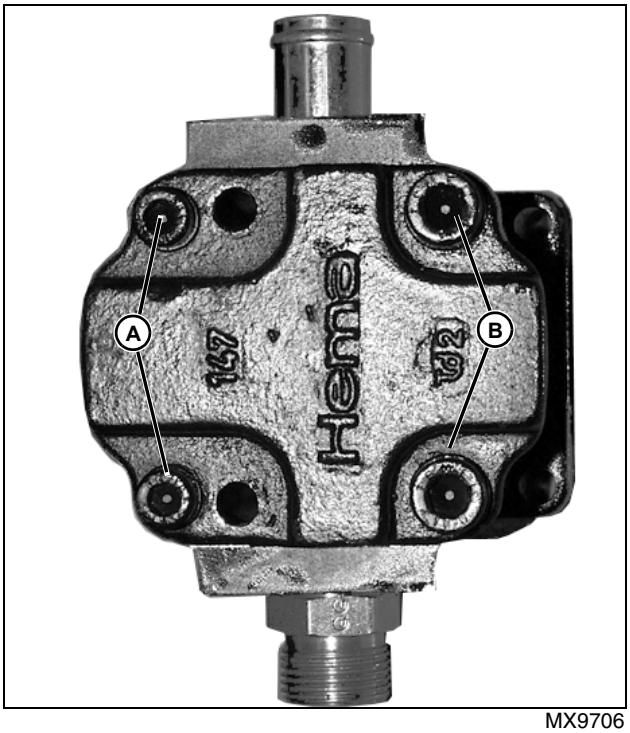
6. Install floor plate and connect battery.

Disassemble Triple Pump

Note: Available pump components are serviced only in the seal kit for the pump. Verify the availability of pump components before disassembling the pump.

Important: Avoid Damage! Replace all body seals, gaskets, and seals anytime the pump is opened. Used or damaged body seals, gaskets, and seals will leak.

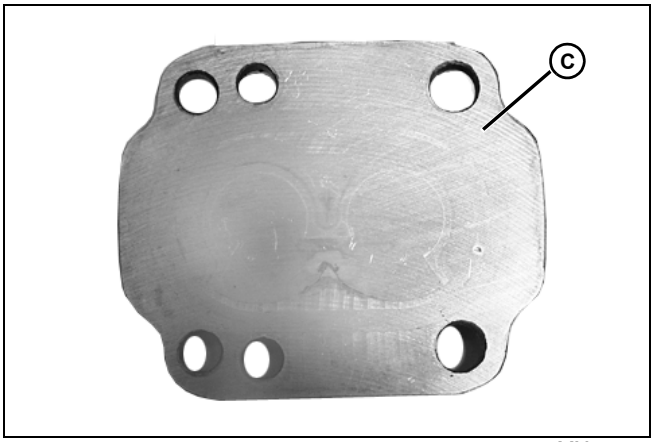
1. Remove the pump from machine.



MX9706

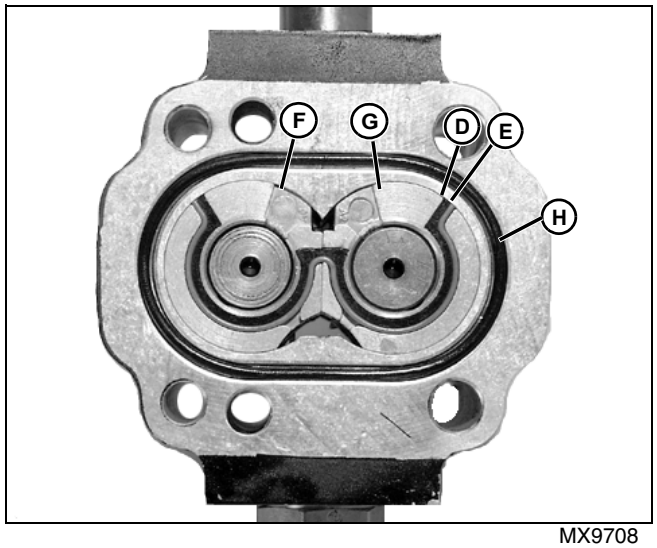
2. Remove two M8 socket head cap screws (A) and two M10 socket head cap screws (B) securing the rear pump cover to the pump body and front cover.

3. Remove the rear pump cover (C).



MX9707

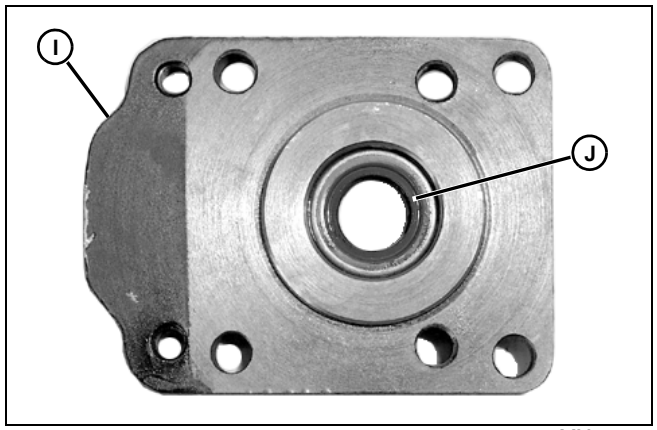
4. Inspect the inside of the pump cover for wear or damage.



MX9708

5. Remove the seal (D) and backing ring (E) from the rear pump bushings (F and G).

6. Replace the body seal (H).

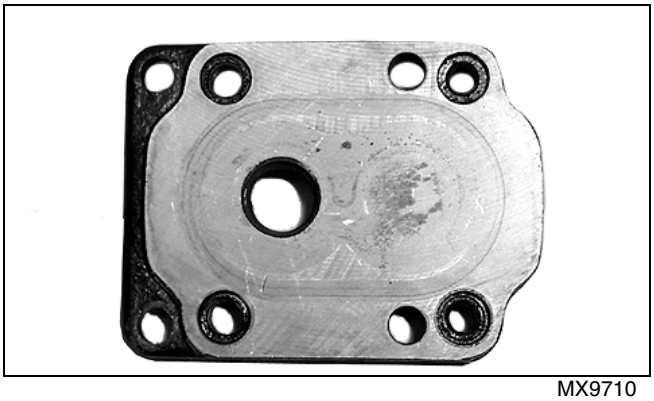


MX9709

7. Remove the front cover (I).

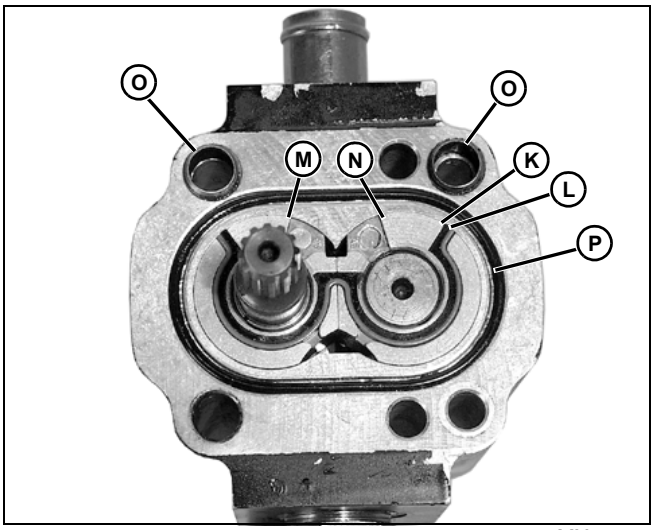
8. Inspect the outside of the front cover for wear or damage.

9. Inspect the shaft seal (J) for cracks, wear, or damage. If necessary, replace the shaft seal.



MX9710

10. Inspect the inside of the front cover for scoring, wear, or damage.



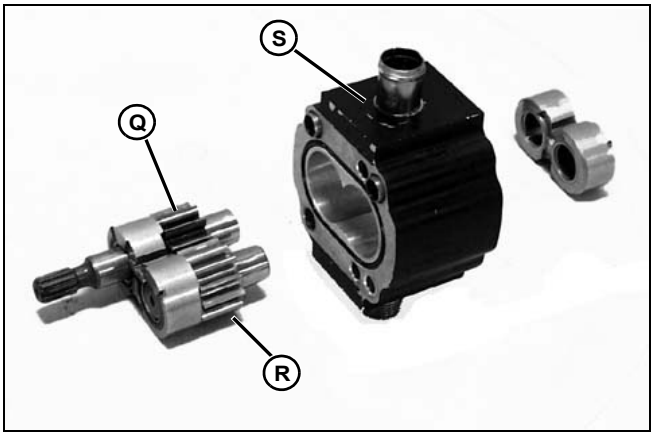
MX9711

11. Remove the seal (K) and backing ring (L) from the front pump bushings (M and N).

12. Inspect two alignment dowels (O) for damage. Replace if required.

13. Replace the body seal (P).

Note: The dowels may remain in either the pump cover or body when the cover is removed.

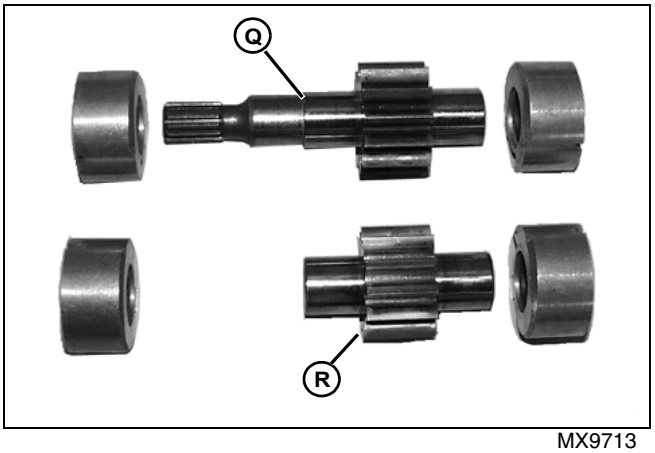


MX9712

14.Note the location and markings on the front and rear bushings to ensure correct orientation at assembly.

Note: Place alignment marks on gear mating teeth before removing from pump housing.

15.Remove the front bushings, drive gear (Q), and driven gear (R) from the pump housing (S).



MX9713

16.Remove the bushings from the gears (Q and R).

17.Inspect the gear and bushing faces for scoring, scratches, or damage.

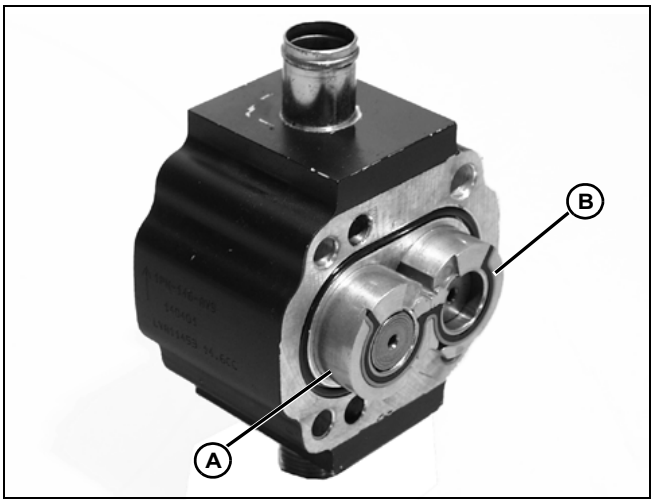
18.Inspect the drive gear (Q) shaft splines and bearing surfaces for wear or damage.

19.Inspect the gear shaft bearing surfaces for wear or damage.

20.Inspect inside of bushings for scoring or excessive scratching.

21.Inspect pump housing internal surfaces for scoring or scratching. Replace pump if damaged.

Assemble Triple Pump

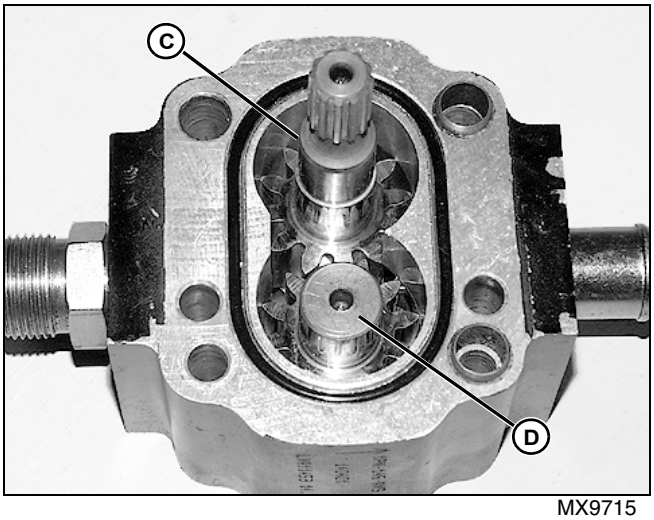


MX9714

1. Lubricate all parts with hydraulic oil before assembly.

2. Install the rear bushings (A and B) into the pump housing bore as shown. Push the bushings in by hand until they are flush with the back of the pump housing.

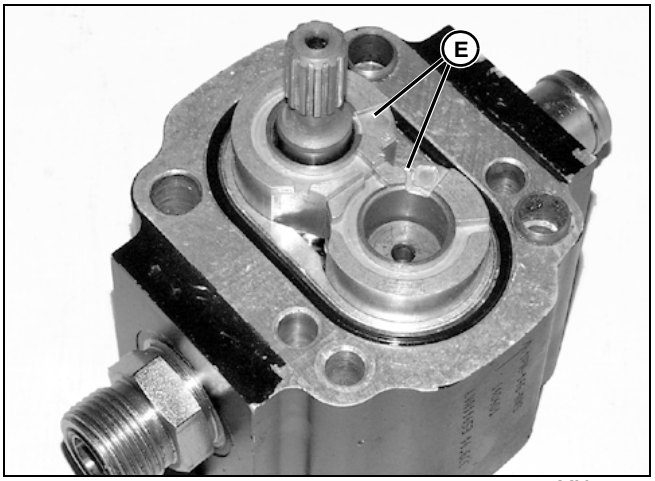
Note: The bushings should be oriented so that the opening formed by the seal faces the top of the pump.



MX9715

3. Lay the back of the pump body on a clean, flat surface. Align marks on gears made during disassembly and install the drive gear (C) and driven gear (D) into the pump body and rear bushings.

Note: The driven gear is symmetrical and can be placed in the pump body either end first.



MX9716

4. Install the front bushings (E) into the pump housing, and onto the drive gear and idler gear shafts.

Note: The bushings should be oriented so that the opening formed by the seal faces the top of the pump.

5. Replace the seal backing ring and seal in the front and rear bushings.

Note: The seal and the backing ring MUST be installed in the correct orientation. The flat side of the seal must face the bushings. The flat side of the backing ring must face the pump cover.

6. Replace the front and rear body seals.

7. Install front cover over the drive gear shaft and onto pump body.

8. Install rear cover and secure the covers with two M8 and two M10 socket head cap screws. Tighten M8 and M10 cap screws to specification.

9. Install the pump.

Specifications:

M8 Cap Screw Torque . . . . . 22 N•m (195 lb-in.)
M10 Cap Screw Torque . . . . . 43 N•m (32 lb-ft)

Remove and Install Reel Motor QA-5

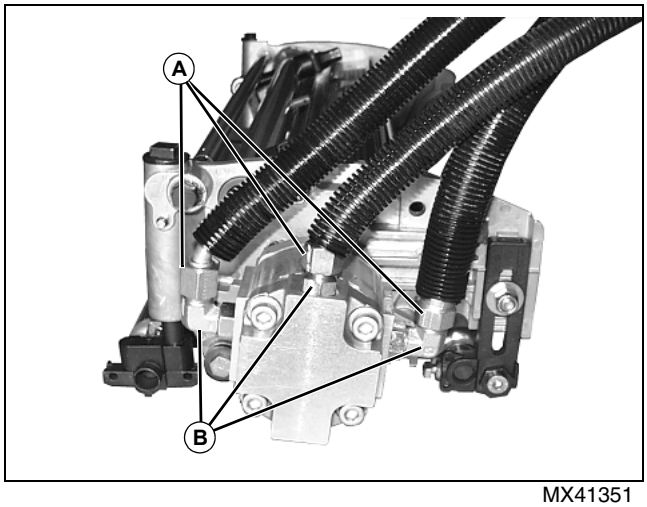
Caution: Avoid Injury! Escaping fluid under high pressure can penetrate the skin and cause serious injury. Avoid the hazard by relieving pressure before connecting hydraulic or other lines. Tighten all connections before applying pressure.

- **Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**
- **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. In the United States and Canada only, this information may be obtained by calling 1-800-822-8262.**

Motor Removal

1. Park machine on a level surface.
2. Lower cutting units to the ground.
3. Move mow-transport lever to the transport position.
4. Turn key switch to stop position and allow the machine to cool.
5. Lock park brake.

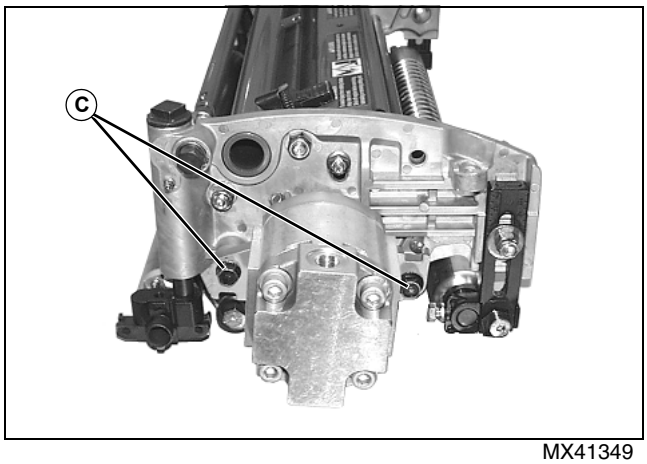
Note: Mark all hydraulic hoses before removing to ensure correct installation.



MX41351

6. Remove and cap three hydraulic hoses (A).

7. If the motor is to be replaced, remove three hydraulic fittings (B).

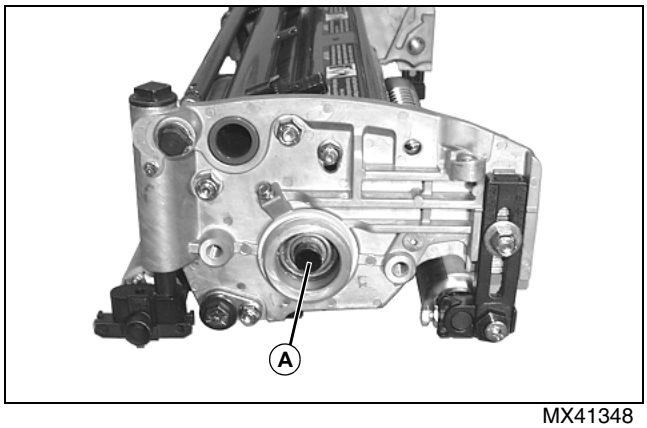


MX41349

8. Loosen reel motor mounting cap screws (C).

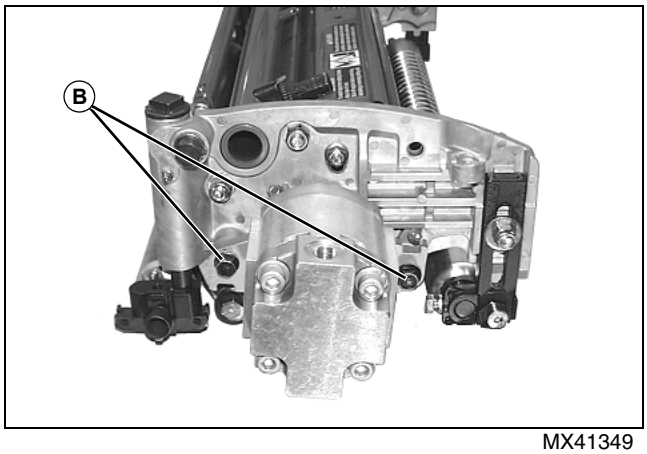
9. Remove the reel motor.

Motor Installation



MX41348

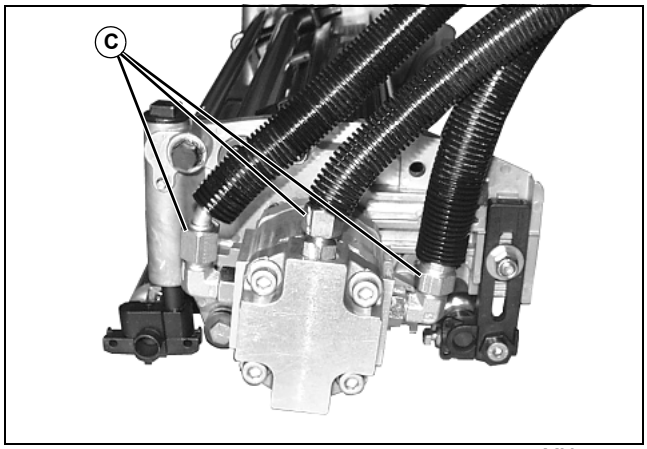
1. Apply multipurpose grease to coupler (A). (See “Grease - North America” on page 16.)



MX41349

2. Install motor on reel. Install two cap screws (B), and tighten to specification.

3. Install three fittings on pump (if previously removed).



MX41351

4. Remove caps from three hydraulic hoses (C), and connect to fittings on motor.

5. Fill hydraulic reservoir tank to correct level with oil meeting correct specifications. (See “Transmission and Hydraulic Oil” on page 16.)

6. Bleed air from hydraulic system. See “Bleed Hydraulic System” on page 550.

Specifications

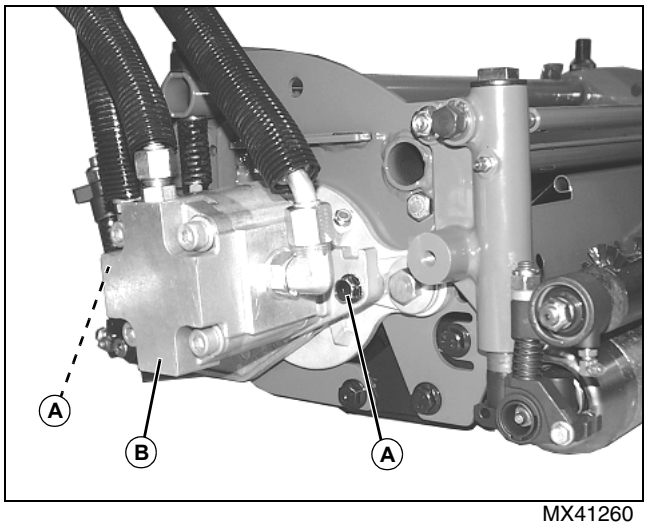
Motor Cap Screw Torque . . . . . 42 N•m (31 lb-ft)

Remove and Install Reel Motor QA-7

Removal

1. Park machine safely. (See “Park Machine Safely” in Safety section.)

2. Mark lines to be disconnected from reel motor.



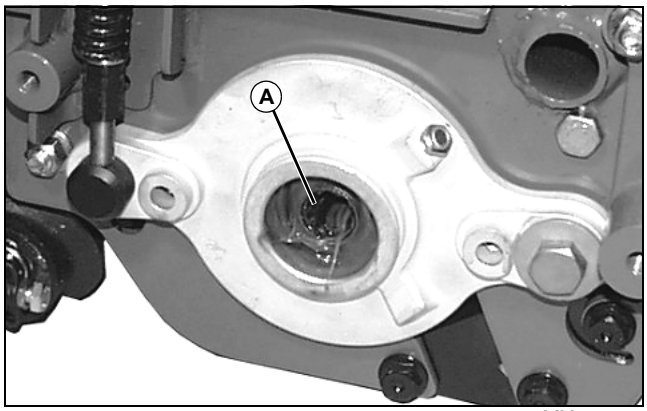
MX41260

3. Loosen two bolts (A), and rotate and remove hydraulic motor (B) from bolts.

4. If the motor is to be replaced, remove three hydraulic fittings.

5. Repeat procedure for other cutting units if necessary.

Install Hydraulic Motor



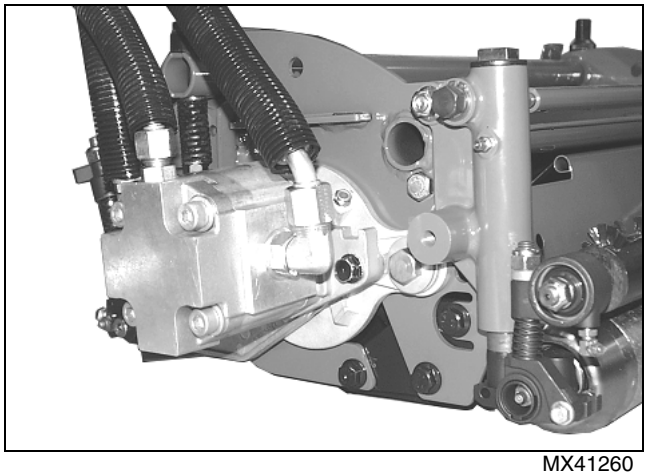
MX41550

1. Inspect inside of reel bearing housing (A) for grease. Add John Deere Special Purpose HD Cornhead Grease to housing if additional lubrication is needed.

2. Check splines for wear. Replace reel if splines are excessively worn and can't effectively engage motor splines. Make sure splines are lubricated with grease.

3. Align reel spline with motor drive shaft, and install motor onto the reel bearing housing.

4. Secure assembly with cap screws.



MX41260

5. Install three hose hydraulic fittings.

6. Install hydraulic fittings and connect hydraulic hoses (G) to appropriate fittings marked during disassembly.

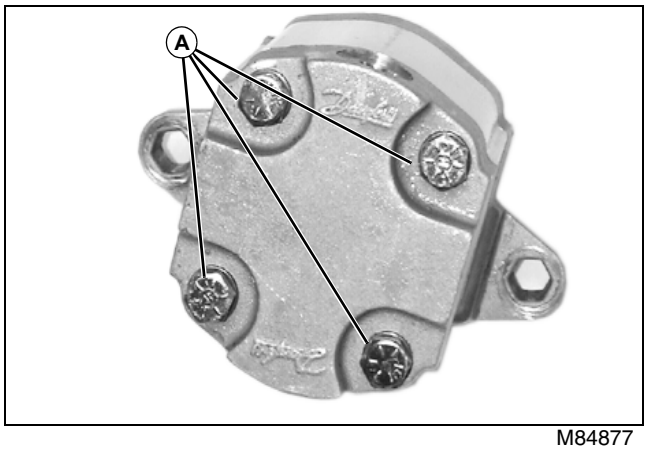
Disassemble and Assemble Motor - QA-5

Disassembly

1. Thoroughly clean and dry outside of motor.

Important: Avoid Damage! Never pry components apart. Light tapping with a plastic hammer on input shaft will separate components without damage.

Be careful not to drop any parts or disengage gear mesh when separating assemblies.

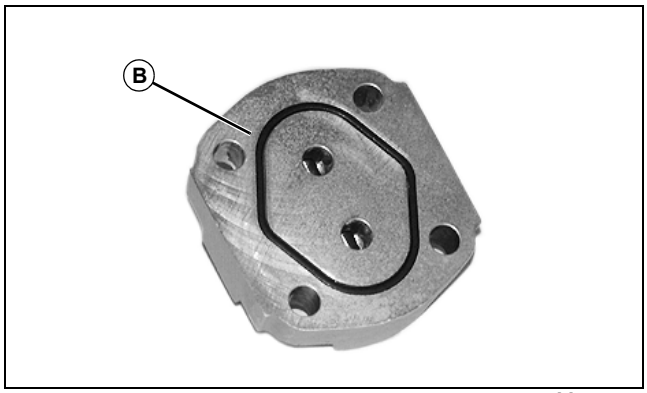


M84877

2. Place motor in a soft-jaw vise using just enough pressure to prevent the motor from turning when removing cap screws.

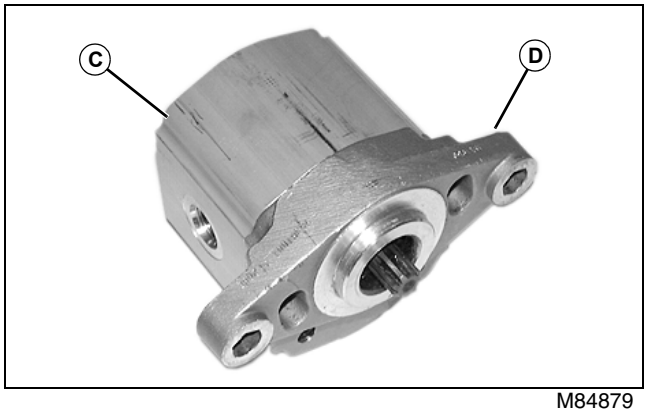
3. Remove four cap screws (A).

4. Remove end cover.



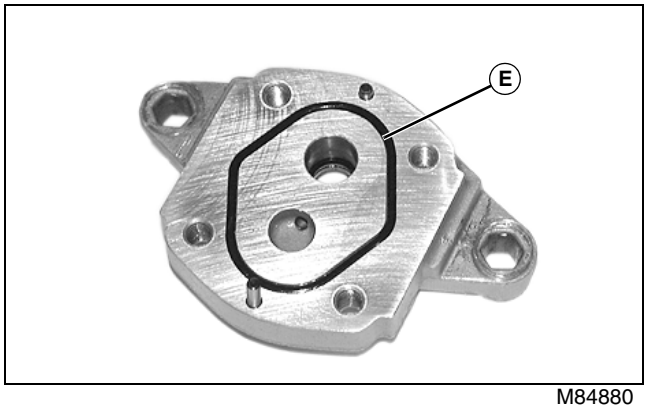
M84878

5. Remove O-ring (B) from end cover.



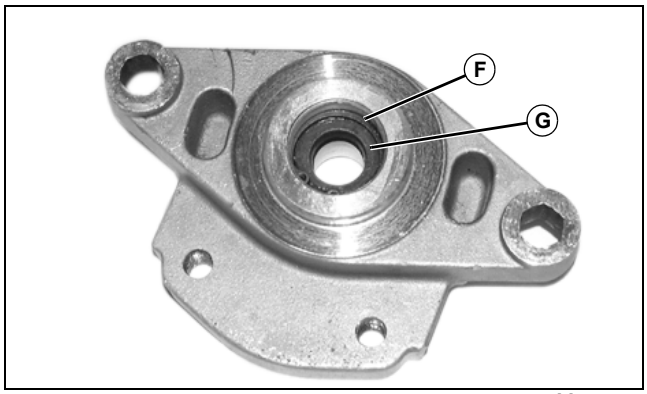
M84879

6. Separate front end cover (D) from main body (C).



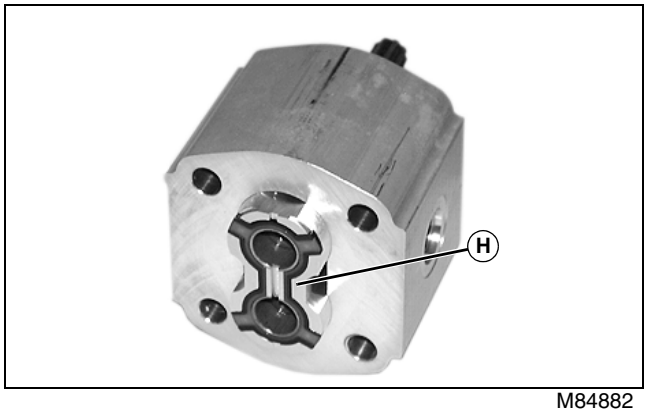
M84880

7. Remove O-ring (E) from front end cover.



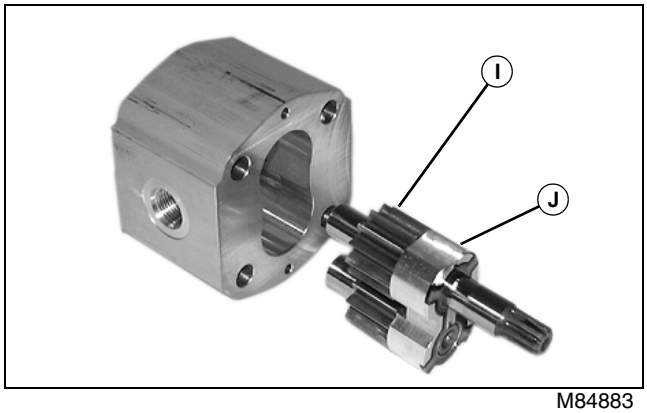
M84881

8. Remove retaining ring (F).
9. Remove seal (G).



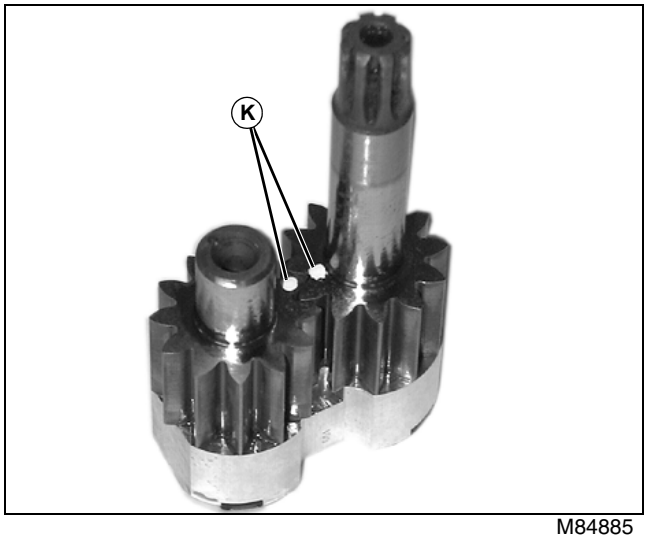
M84882

10. Remove rear wear block assembly (H).



M84883

11. Remove front block assembly (J) and gear set (I).



M84885

12. Place alignment marks (K) on gear mating teeth and remove gears from wear block assembly.

M84886

13.Inspect housing bore (L) for signs of damage.

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

Important: Avoid Damage! Absolute cleanliness is essential when working on reel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/ hydraulic system and cause damage.

14.Clean all metal parts with solvent and blow dry with regulated compressed air.

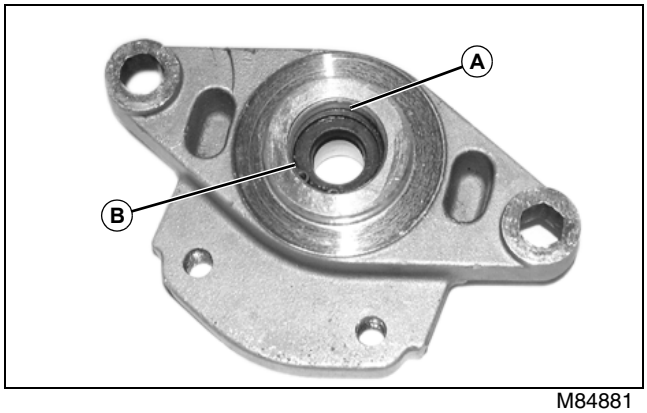
15.Inspect all parts for damage, nicks, or unusual wear. Replace entire reel motor assembly if any parts other than seal rings, seals, or outer bearing are worn or damaged.

Assembly

Important: Avoid Damage! Always use new O-rings and seals. Used or damaged O-rings and seals will leak.

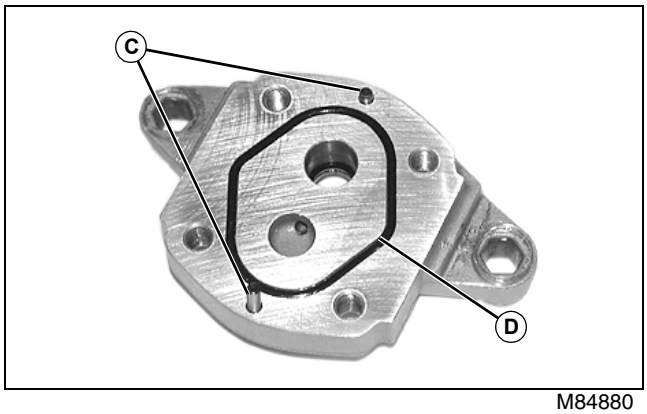
Note: Lubricate all seals and O-rings with petroleum jelly during assembly.

Apply a light coat of clean hydraulic oil to all internal parts when assembling the reel motor.



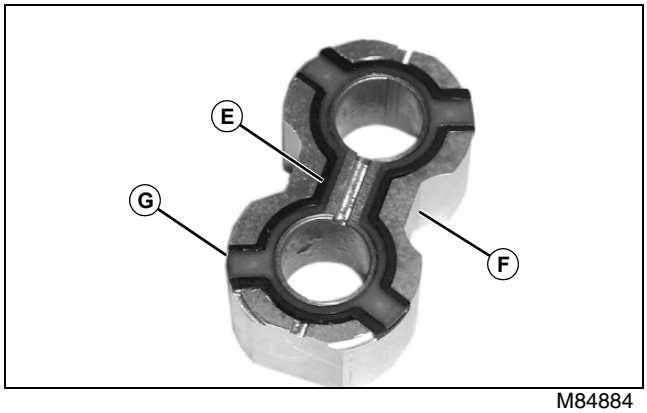
M84881

1. Apply multi-purpose grease to lips of seal (B).
2. Install a new seal parallel to the bore and seat tight against shoulder of bore.
3. Install retaining ring (A).



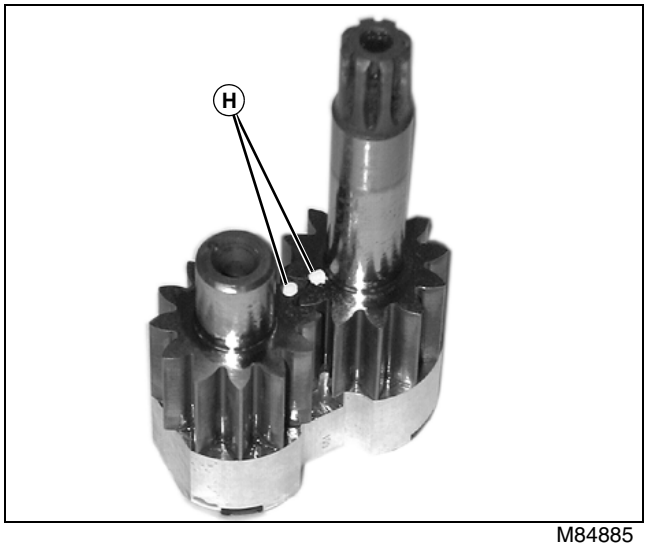
M84880

4. Install new O-ring (D).
5. Install alignment pins (C), if removed.



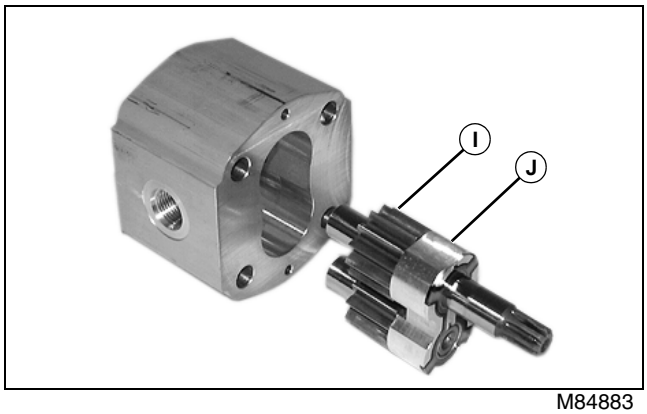
M84884

6. Install new seals (E) and spreaders (G) in wear block (F).



M84885

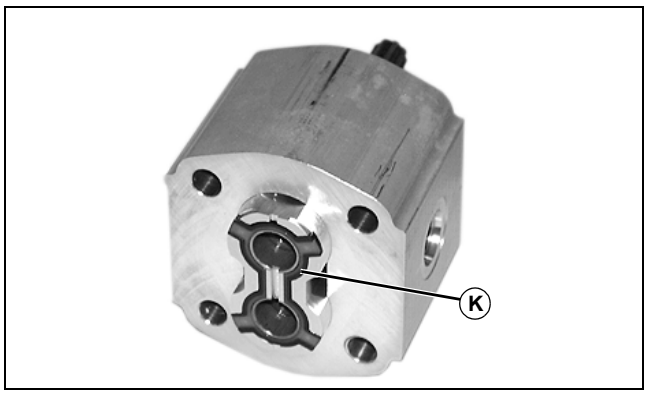
7. Align marks (H) and install gears in wear block.



M84883

8. Apply a light coat of clean hydraulic oil to wear block (J) and gear assembly (I).

9. Install front wear block/gear set assembly in housing.

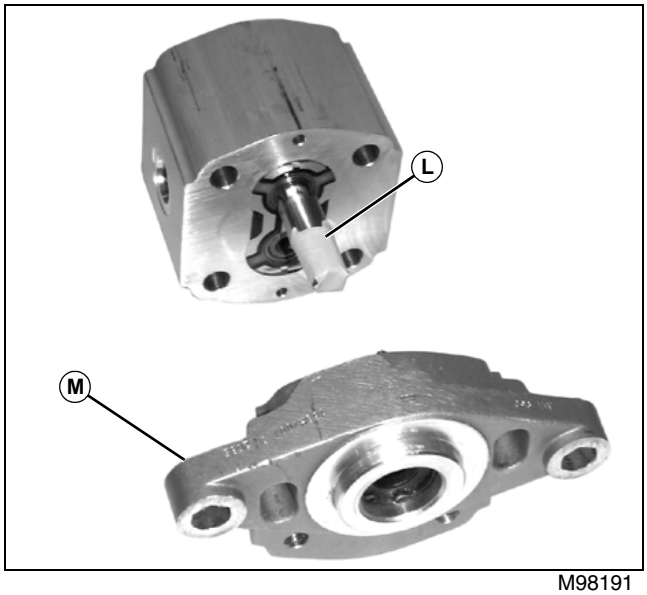


M84882

10.Apply a light coat of clean hydraulic oil to wear block/ gear set assembly.

11.Install rear wear block/gear set assembly (K) in housing.

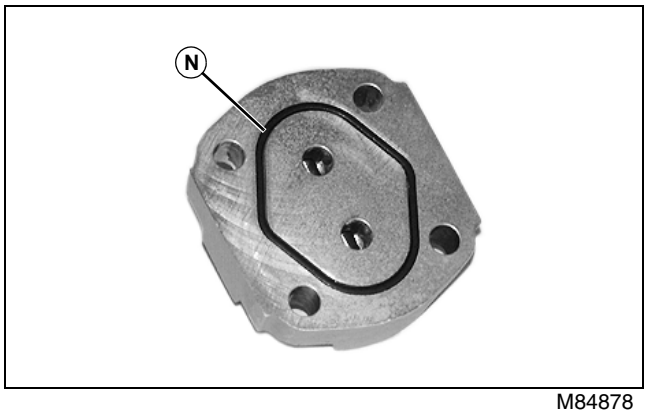
Note: The repair kit may include a plastic sleeve to cover the input shaft in order to prevent damage to the seal.



M98191

12.Cover the splines of the input shaft with tape (L) (or sleeve included with the repair kit) to prevent damaging the seal during installation.

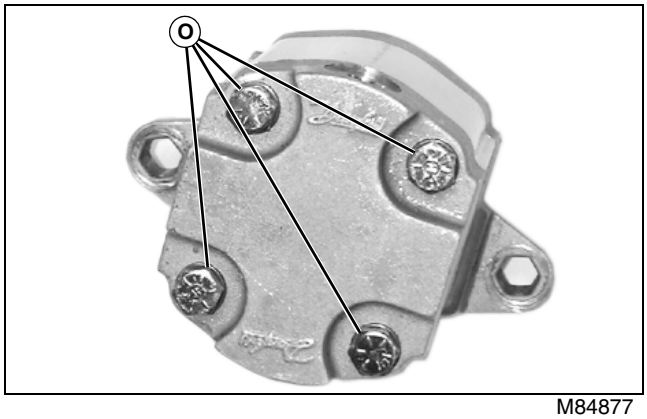
13.Install front cover (M).



M84878

14.Install new O-ring (N) in rear cover.

15.Install rear cover.



M84877

16.Install cap screws (O). Do not tighten to specification at this time.

17.Rotate input shaft to verify that all parts are mating smoothly.

18.Tighten cap screws in an alternating pattern to specifications.

Specifications

Standard Duty, Cap Screw Torque . . . 45 N•m (33 lb-ft)

Disassemble and Assemble Motor QA-7

Disassemble

Important: Avoid Damage! Never pry components apart. Light tapping with a plastic hammer on input shaft will separate components without burring.

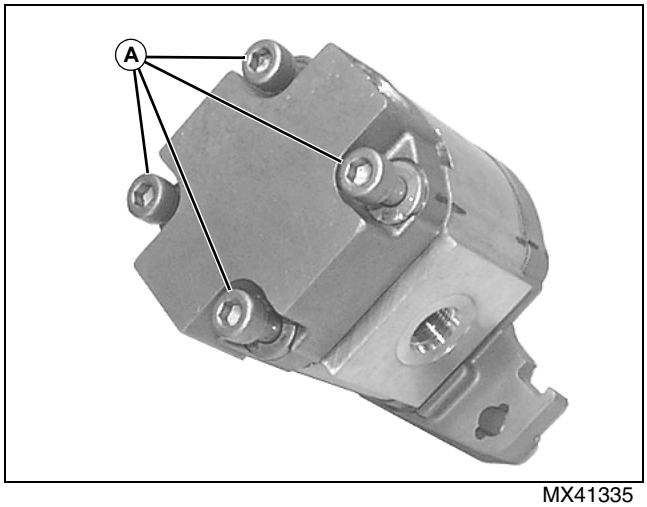
Be careful not to drop any parts or disengage gear mesh when separating assemblies.

Excessive clamping pressure will distort motor housing.

Note: In the steps that follow, keep careful track of order of disassembly, and the location and orientation of all parts removed.

1. Thoroughly clean and dry outside of motor.

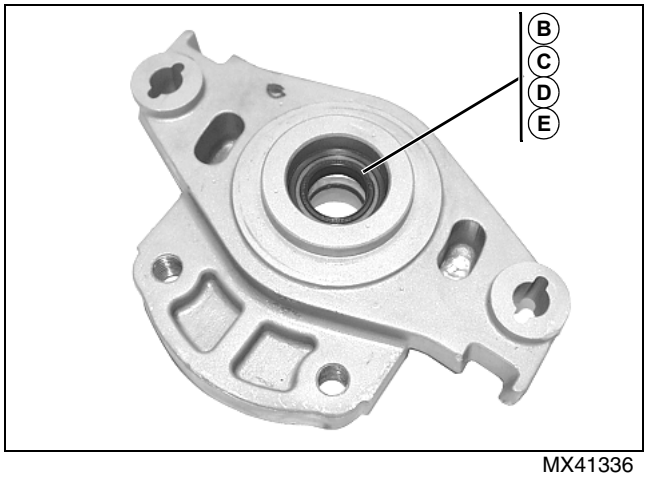
2. Place motor in a soft-jaw vise using just enough pressure to prevent the motor from turning when removing cap screws.



MX41335

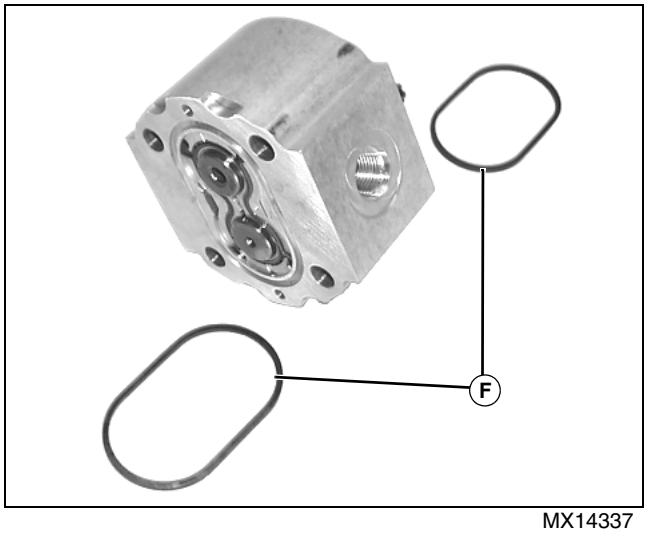
3. Remove four socket head cap screws (A).

4. Separate front and rear end covers from pump housing.



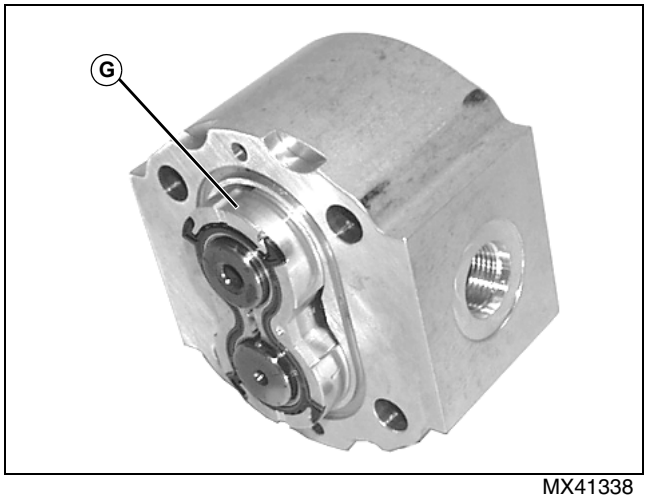
MX41336

5. Remove outer shaft seal (B), snap ring (C), backup ring (D) and inner shaft seal (E) from front cover.



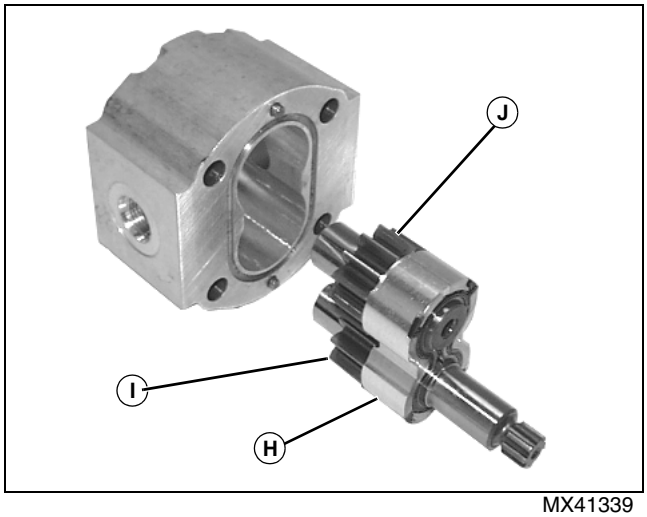
MX14337

6. Remove O-rings (F) from each side of pump housing.



MX41338

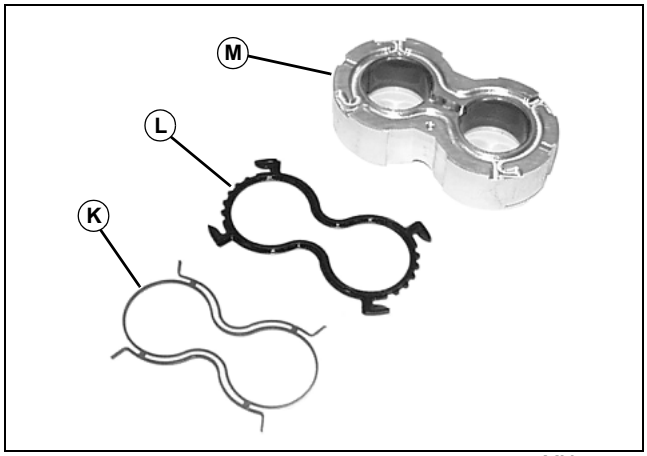
7. Remove rear wear block (G).



MX41339

8. Remove front wear block (H) with drive gear (I) and driven gear (J).

9. Remove both gears from wear block.



MX41341

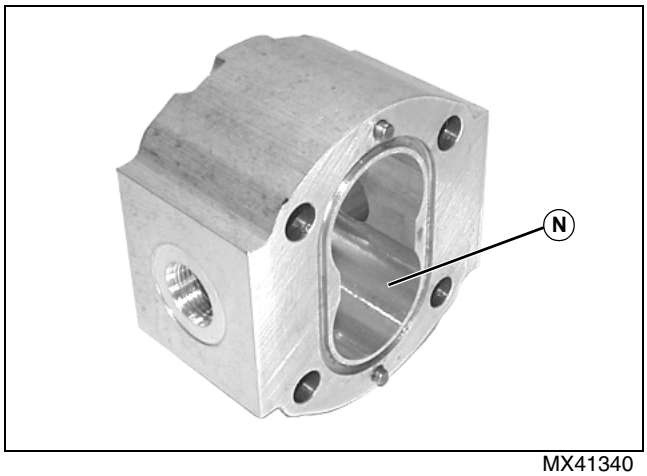
10.Remove the backup ring (K) and seal (L) from each wear block (M).

Caution: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

Important: Avoid Damage! Absolute cleanliness is essential when working on reel motor. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry cleaned parts. Lint will clog passages in the hydrostatic/ hydraulic system and cause damage.

11.Clean all metal parts with solvent and blow dry with compressed air.



MX41340

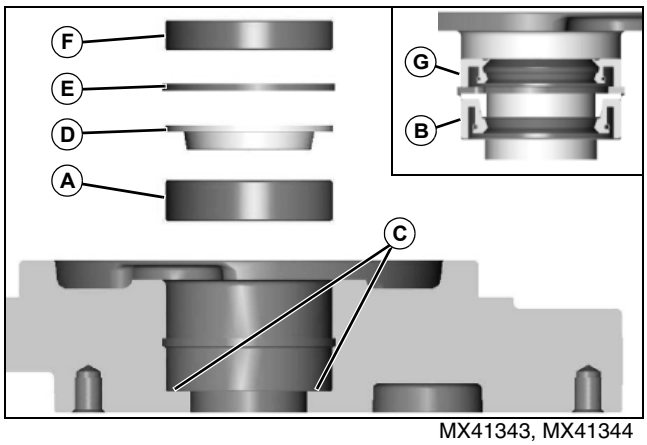
12.Inspect the housing bore (N) for scoring, scratches, unusual wear or other signs of damage.

13.Inspect all remaining parts for scoring, scratches, nicks, unusual wear or other damage. Replace the complete reel motor assembly if any part other than seals, seal rings or O-rings are worn or damaged.

Assemble

Important: Avoid Damage! Replace all O-rings, gaskets and seals any time the motor is opened. Used or damaged O-rings, gaskets and seals will leak.

Note: Lubricate all parts with clean hydraulic oil before assembly.



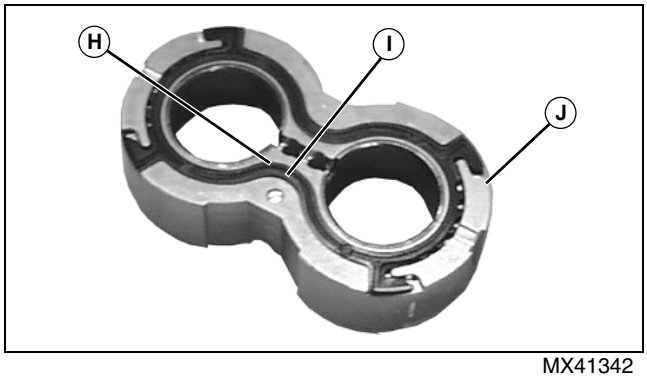
MX41343, MX41344

1. Install inner shaft seal (A), positioned as shown in inset (B) in the front cover. Seat the seal tight against the bottom shoulder of bore (C).

2. Install backup ring (D). Seat the ring fully against the inner shaft seal.

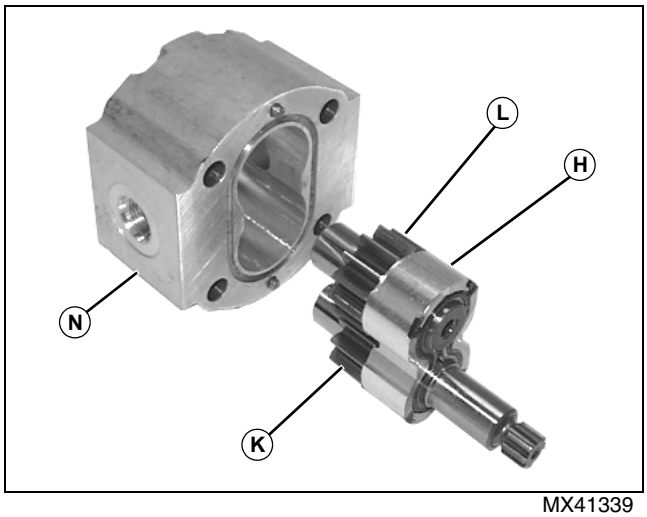
3. Install snap ring (E). Seat the snap ring securely in groove.

4. Install outer shaft seal (F), positioned as shown in inset (G). Seat the seal tight against the snap ring (E).



MX41342

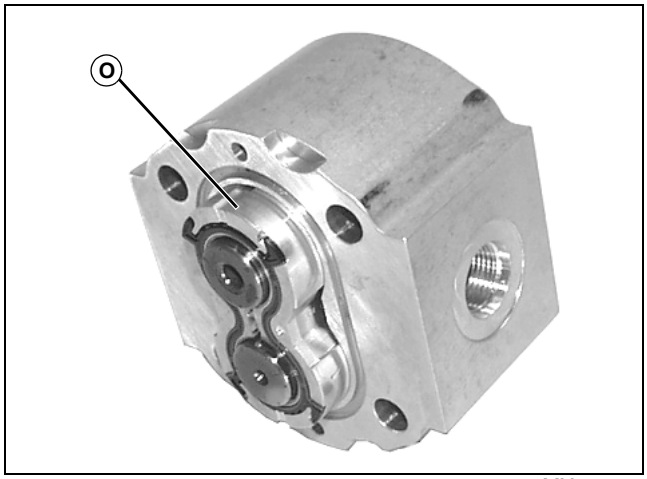
5. Install seal (H) and backup ring (I) in each wear block (J).



MX41339

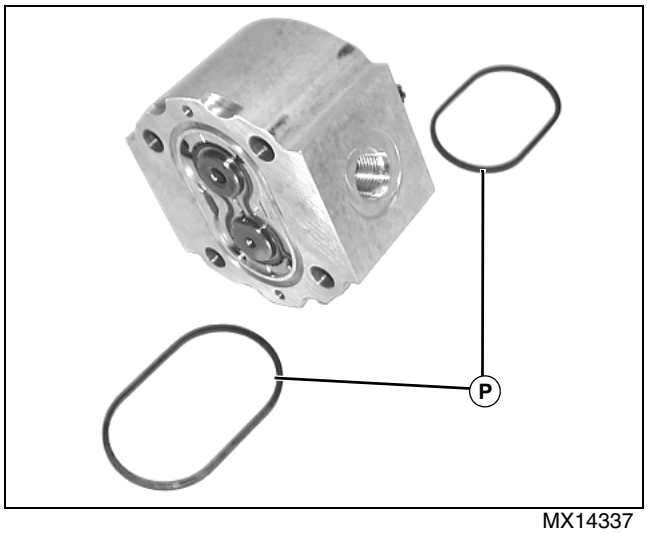
6. Install drive gear (K) and driven gear (L) in front wear block (M).

7. Install gear and wear block assembly in pump housing (N) until wear block is flush with the front housing face.



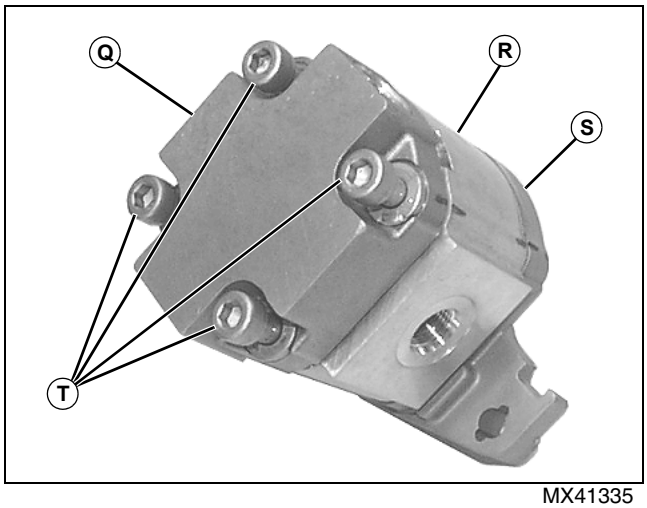
MX41338

8. Install rear wear block assembly (O) in pump housing until wear block is flush with the rear housing face.



MX14337

9. Install one O-ring (P) in each groove on the front and rear face of the pump housing.



MX41335

10.Assemble the rear cover (Q), the pump housing (R) and front cover (S).

11.Install four socket head cap screws (T), and tighten to specification.

12.Rotate input shaft to verify that all parts are mating smoothly.

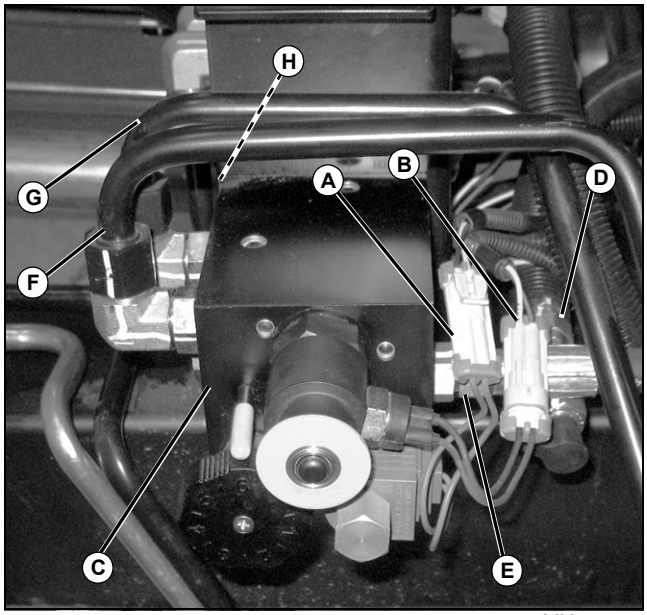
Specifications

Reel Motor Rear Cover Cap Screw
Torque . . . . . 42 N•m (31 lb-ft)

Remove and Install Backlapping Valve - 7000 and 8000

Removal

1. Park machine safely. (See “Park Machine Safely” in Safety section.)



MX24921

Hydraulic Backlapping Valve Shown

2. Disconnect electrical connectors (A and B).

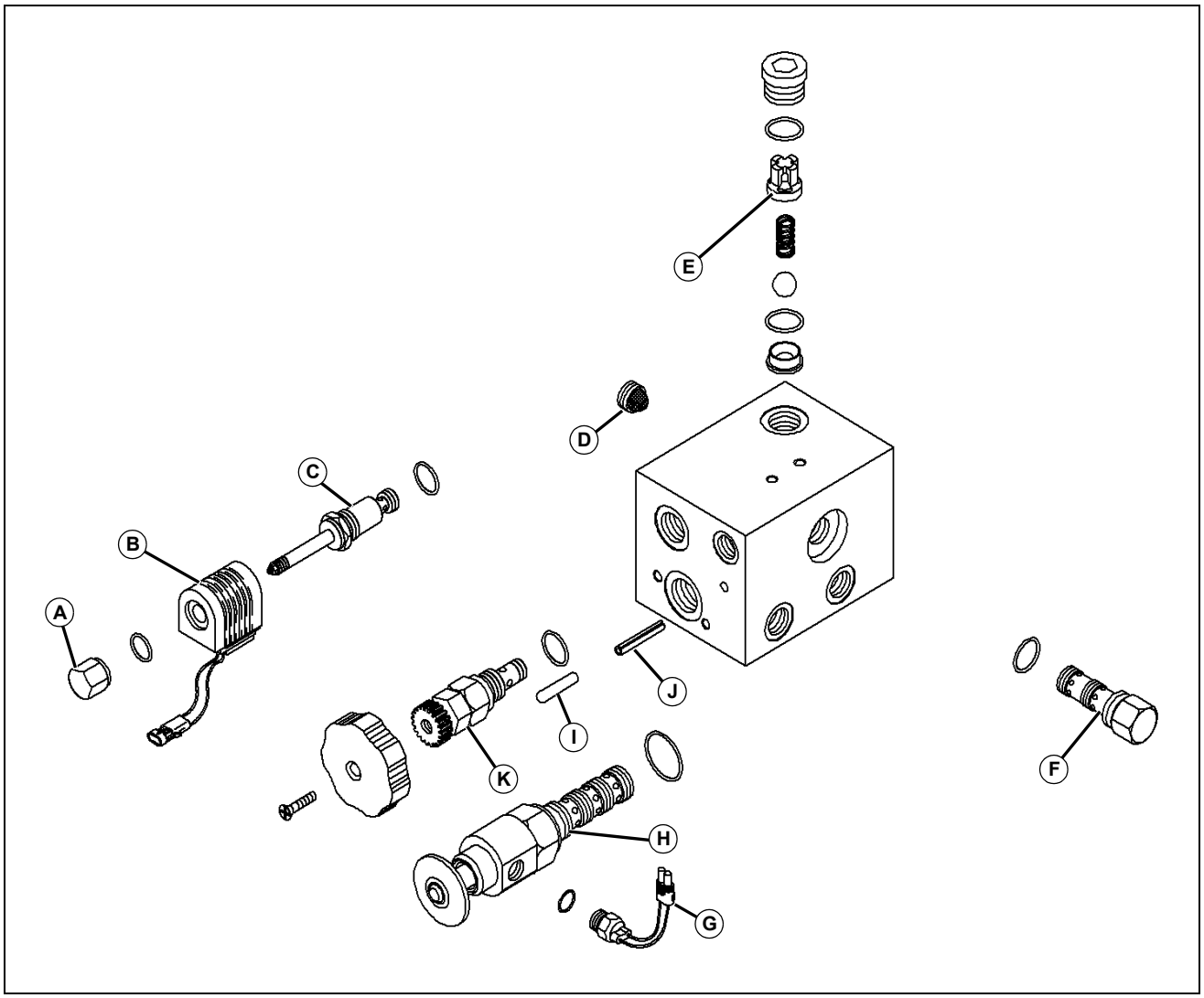
3. Place a suitable container under backlapping valve (C). Mark and disconnect lines (D-G).

4. Remove four mounting cap screws (H) and backlapping valve.

Installation

Installation is done in reverse order of removal.

Disassemble, Inspect, and Assemble Backlapping Valve - 7000 and 8000



MX24571

Disassemble

Note: Lubricate all O-rings and backup rings and replace with new. Note location of O-rings and backup rings to aid in assembly.

1. Remove coil nut (A), coil (B), and solenoid valve (C).
2. Remove filter screen (D).
3. Remove check valve (E).
4. Remove hydraulic actuated control valve (F).
5. Remove switch (G).
6. Remove hydraulic actuated control valve (H).
7. Remove cap (I) and pin (J).
8. Remove valve (K).

Inspect

Important: Avoid Damage! Always use new O-rings and backup rings. Used or damaged O-rings and backup rings will leak.

Note: Lubricate all O-rings and backup rings with petroleum jelly during assembly.

Apply clean hydraulic oil to all internal parts when assembling the backlapping valve.

1. Clean and inspect all components for wear or damage. Replace parts as necessary.

Assemble

1. Lubricate all O-rings and backup rings before installation. Install all O-rings and backup rings in their proper location as noted during removal.

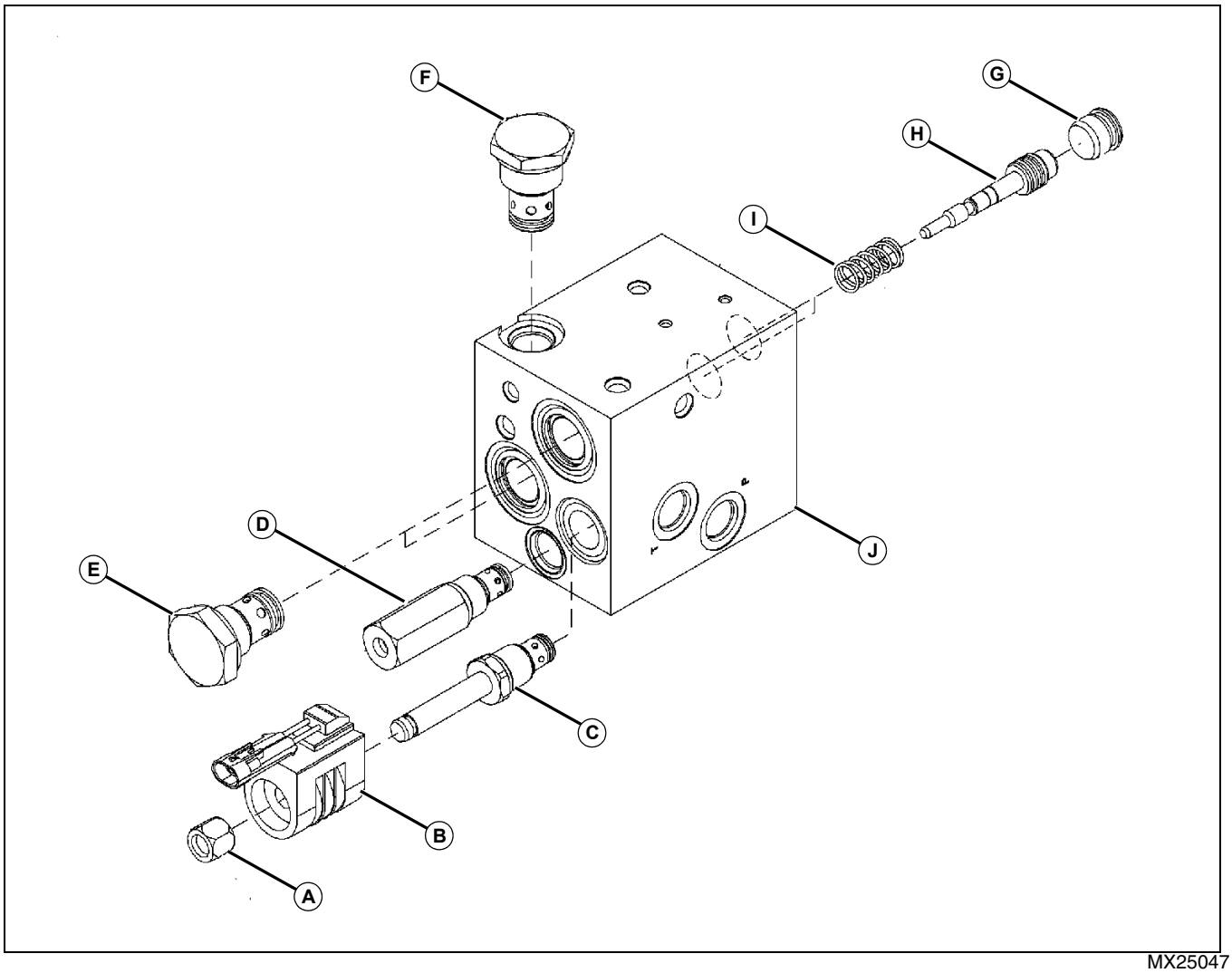
2. Lubricate all internal parts before installation.

3. Install components (A-K) to specification.

Specifications

Forward/Reverse Switch
Torque . . . . . 4-7 N•m (36-60 lb-in.)
Forward/Reverse Valve
Torque . . . . . 108-136 N•m (80-100 lb-ft)
Filter Screen
(Installation Below Spot Face). 16-17 mm (0.64-0.68 in.)
Solenoid Valve Torque . . . . . 27-34 N•m (20-25 lb-ft)
Coil Nut Torque. . . . . 7-9 N•m (65-75 lb-in.)
Flow Control Knob Screw
Torque . . . . . 2-3 N•m (18-24 lb-in.)
Flow Control Valve Torque . . . . 34-41 N•m (25-30 lb-ft)
Check Valve Plug Torque. . . . . 47-54 N•m (35-40 lb-ft)

Disassemble, Inspect, and Assemble Mow Valve - 8800



MX25047

Disassemble

Note: Remove all O-rings and backup rings and replace with new. Note location of O-rings and backup rings to aid assembly.

1. Remove coil nut (A), solenoid coil (B), and valve (C).
2. Remove relief valve (D) and two check valves (E).
3. Remove check valve (F).
4. Remove two piston plugs (G), pistons (H) and springs (I) from mow valve body (J).

Inspect

1. Clean and inspect all components for wear or damage. Replace parts as necessary.

Assemble

Important: Avoid Damage! Always use new O-rings, seals, and backup rings. Used or damaged O-rings, seals, and backup rings will leak.

Note: Lubricate all O-rings, seals, and backup rings with petroleum jelly during assembly.

Apply clean hydraulic oil to all internal parts when assembling the mow valve.

1. Lubricate all O-rings and backup rings before installation. Install all O-rings and backup rings in their proper location as noted during removal.

2. Lubricate all internal parts before installation.
3. Install components (A-H) to specification.

Specifications

Relief Valve Torque. . . . . 33-40 N•m (25-30 lb-ft)
Piston Plug Torque. . . . . 54-61 N•m (40-45 lb-ft)
Large Check Valve Torque. 135-149 N•m (100-110 lb-ft)
Small Check Valve Torque. . . . . 54-61 N•m (40-45 lb-ft)
Solenoid Valve Torque . . . . . 47-54 N•m (35-40 lb-ft)
Solenoid Coil Nut Torque. . . . . 5-8 N•m (48-72 lb-in.)

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Specifications

Test and Adjustment Specifications

Steering Control Unit	
Steering and Lift System Relief Valve Pressure	**9997 kPa (1450 psi)**
Steering System and Steering Control Unit (SCU) Leakage, Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque	**6 (Maximum)**

Tools and Materials

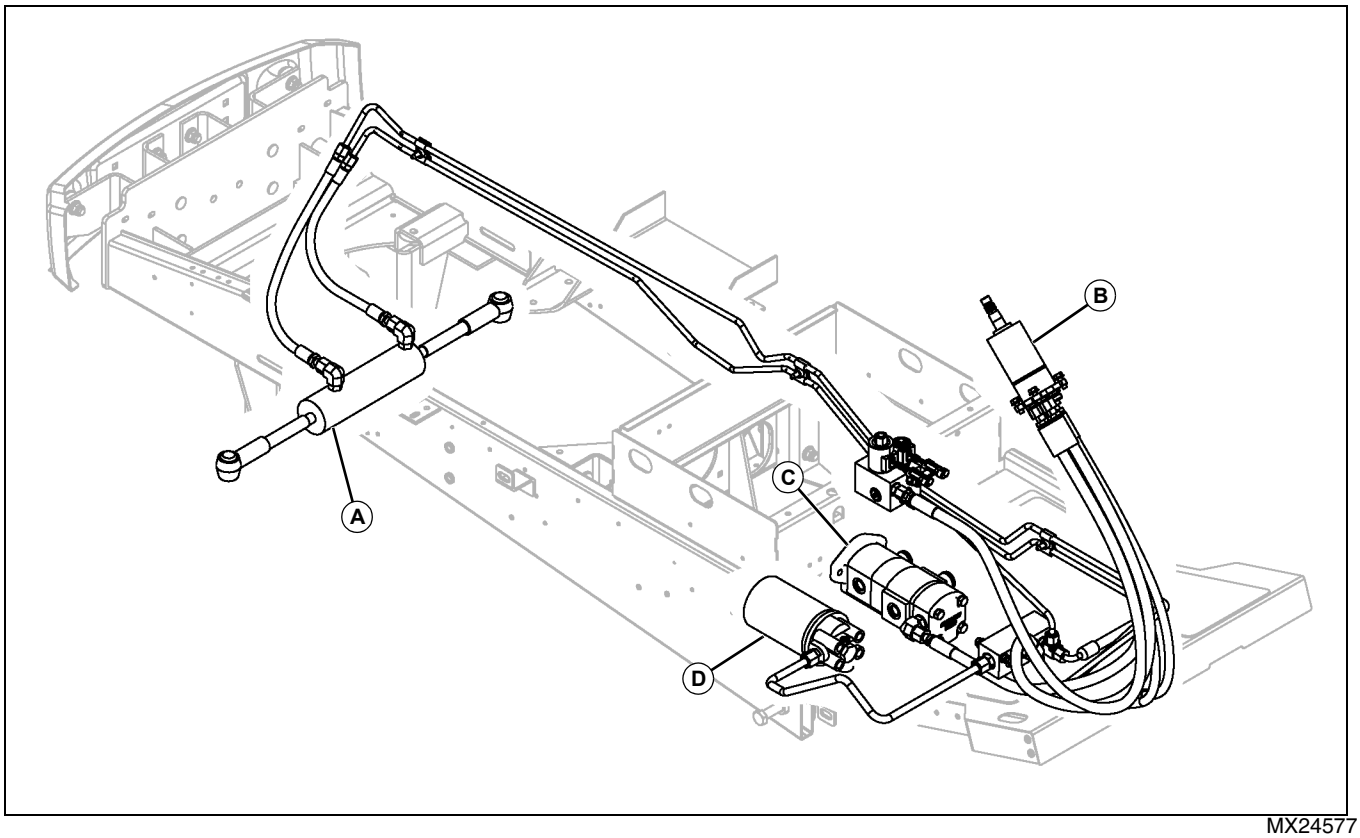
Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit	JDG2033	Connect pressure gauge for steering and lift system pressure test.
Pressure Diagnostic Kit	JDG2032	Connect pressure gauge for steering and lift system pressure test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

Component Location

Steering Components

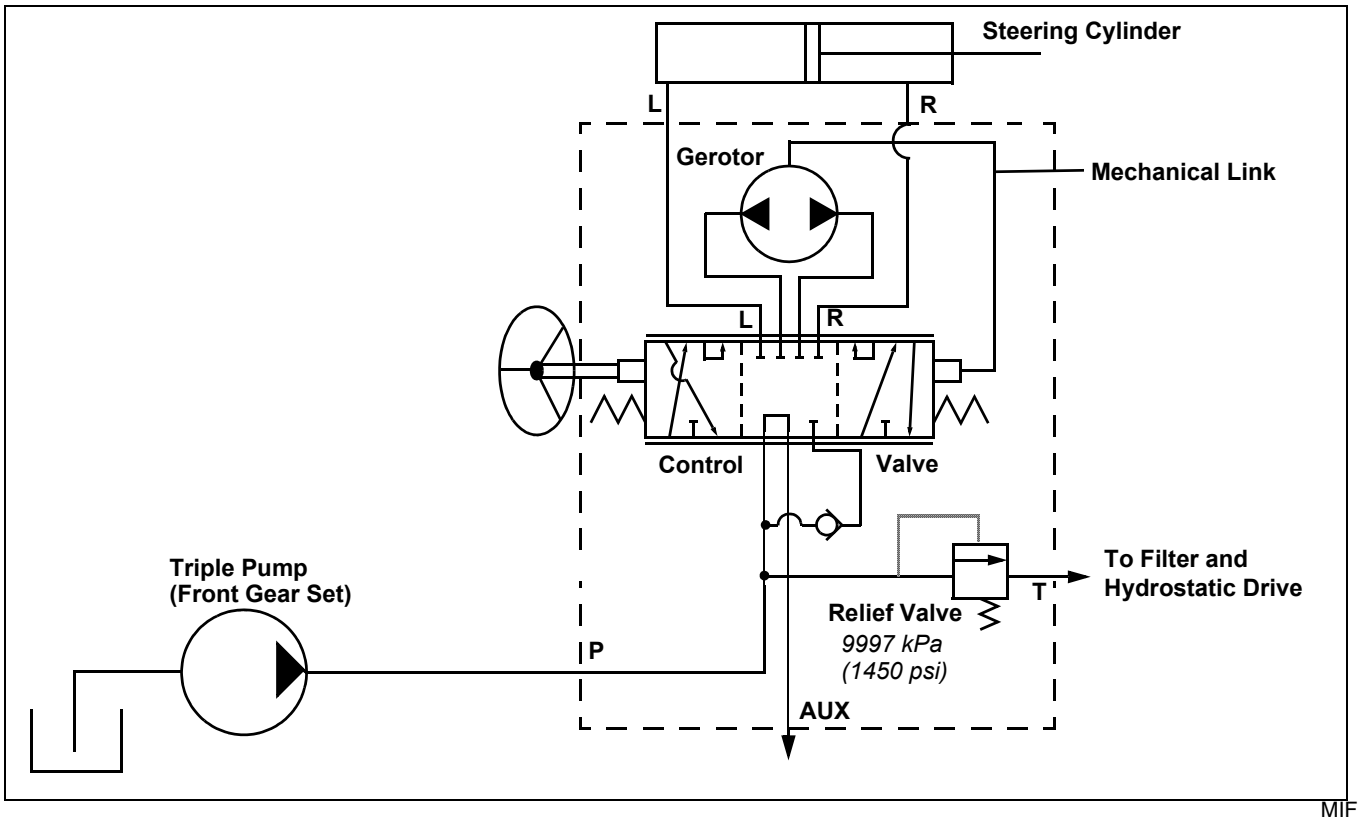


MX24577

A- Steering Cylinder
B- Steering Control Unit (SCU)
C- Triple Pump (Front Gear Set)
D- Hydraulic Oil Filter

Theory of Operation

Steering System



Port Identification

Port P . . . . . Inlet Pressure
Port T . . . . . To Filter and Hydrostatic Drive
Port AUX . . . . . To Lift Valve
Port L . . . . . Left Turn
Port R . . . . . Right Turn

Function

Provides power-assisted steering and manual steering if hydraulic pressure is lost.

Triple Pump (Front Gear Set)

The triple pump (front gear set) is the forward pump of the triple pump assembly. The triple pump (front gear set) provides fluid to the steering mechanism.

Steering Control Unit (SCU)

This unit operates in an “open center series” type hydraulic system which allows hydraulic flow through an open center port when the valve is in the center position. This allows operation of other equipment such as lift, down pressure (if equipped) and hydrostatic drive systems. Each system, except the hydrostatic drive, has a controlling valve with an open center that directs fluid flow, in series, to operate each system in the order mentioned above. Also, in this type of circuit, the first controlling valve (steering) takes priority over the next valve downstream in the circuit.

Theory

Charge pressure flows to a three-position, spring centered control valve inside the steering control unit (SCU). When the control valve is in neutral, oil flows through the open center of the valve and is available for lift operation, for the down pressure system and to charge the hydrostatic drive system. When a turn is initiated, fluid flows to either the left or right side of the steering actuator to position the mechanical steering linkage and wheels for a left or right turn. When the steering wheel is held in any position, except full left or full right, the control valve returns to neutral by centering springs and the fluid is available for use downstream in the circuit. If the steering wheel is held in the full left or full right position, the charge pump pressure will build until the pressure reaches the steering valve internal relief valve setting of 9997 kPa (1450 psi).

Manual steering is available during vehicle towing or in the event charge pressure is lost to the SCU. A mechanical link inside the SCU connects the gerotor to the steering wheel. The gerotor is a manual pump that is driven by the operator when he turns the steering wheel, delivering fluid under pressure to actuate the steering cylinder.

Diagnostics

Symptom: Steering Wanders

Procedure

1. Are tires of proper type and inflated to proper pressure?

Yes: Go to next step.

No: Replace tires with tires of proper type. Inflate tires to proper pressure.

2. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

3. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

4. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

5. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

6. Perform steering system leakage test. (See “Test Steering System Leakage” on page 593.) Is test within specifications?

No: Perform steering valve leakage test. (See “Test Steering Control Unit (SCU) Leakage” on page 593.) Follow results of test.

Symptom: Steering Shimmy

Procedure

1. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

2. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary?

3. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

4. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

5. Check hydraulic fluid. Is fluid free of contamination?

No: Remove contaminated fluid, flush system and find source of contamination.

Symptom: Sluggish Steering Response

Procedure

1. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

2. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

3. Is hydraulic filter clean and free from restrictions?

Yes: Go to next step.

No: Replace filter as needed.

4. Perform steering system leakage test. (See “Test Steering System Leakage” on page 593.) Is test within specifications?

No: Perform steering valve leakage test. (See “Test Steering Control Unit (SCU) Leakage” on page 593.) Follow results of test.

Symptom: Excessive Steering Wheel Free-Play

Procedure

1. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

2. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

3. Is steering valve mounted securely?

No: Secure steering valve.

Symptom: High Steering Effort in One Direction

Procedure

1. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

2. Perform steering system leakage test. (See “Test Steering System Leakage” on page 593.) Is test within specifications?

No: Perform steering valve leakage test. (See “Test Steering Control Unit (SCU) Leakage” on page 593.) Follow results of test.

Symptom: High Steering Effort in Both Directions

Procedure

1. Are tires of proper type and inflated to proper pressure?

Yes: Go to next step.

No: Replace tires with tires of proper type. Inflate tires to proper pressure.

2. Are the steering cylinder ball joints in good condition, not worn?

Yes: Go to next step.

No: Replace parts as needed.

3. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

4. Is hydraulic filter clean and free from restrictions?

Yes: Go to next step.

No: Replace filter as needed.

5. Test triple pump (front gear set). (See “Test Lift and Steering Pump Flow” on page 558.) Is pump flow within specifications?

Yes: Go to next step.

No: Repair or replace pump as necessary.

6. Perform steering system leakage test. (See “Test Steering System Leakage” on page 593.) Is test within specifications?

No: Perform steering valve leakage test. (See “Test Steering Control Unit (SCU) Leakage” on page 593.) Follow results of test.

Symptom: Steering Cylinder Will Not Fully Extend or Retract

Procedure

1. Is engine rpm within operating range?

Yes: Go to next step.

No: Adjust slow and/or throttle cable for full range of motion. (See “Adjust Slow Idle” on page 44 and See “Adjust Throttle Cable” on page 59.)

2. Is the steering linkage in good condition, not damaged or worn?

Yes: Go to next step.

No: Repair or replace parts as necessary.

3. Is hydraulic system free of air? Hydraulic fluid not aerated?

Yes: Go to next step.

No: Purge air from system. Check suction line to charge pump for air leaks.

4. Are the hydraulic fittings tight, preventing fluid loss?

Yes: Go to next step.

No: Tighten hydraulic fittings.

5. Is steering rod free of damage, not bent?

Yes: Go to next step.

No: Replace steering cylinder.

6. Test triple pump (front gear set). (See “Test Lift and Steering Pump Flow” on page 558.) Is pump flow within specifications?

Yes: Go to next step.

No: Repair or replace pump as necessary.

7. Perform steering system leakage test. (See “Test Steering System Leakage” on page 593.) Is test within specifications?

No: Perform steering valve leakage test. (See “Test Steering Control Unit (SCU) Leakage” on page 593.) Follow results of test.

Tests and Adjustments

Test Steering System Leakage

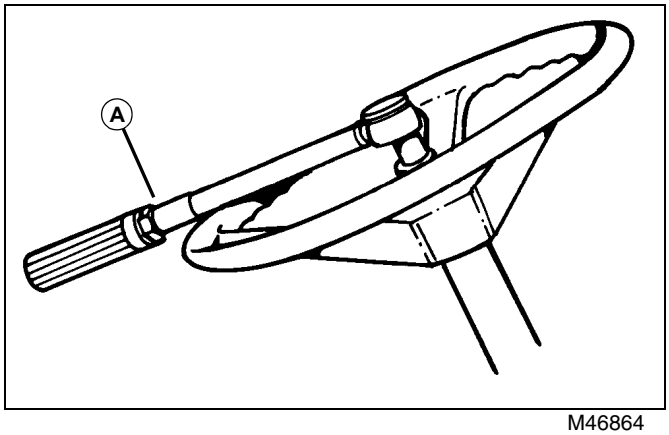
Reason

To check hydraulic steering system for internal leakage.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

2. Start engine and set throttle to slow idle.



M46864

3. With steering wheel at maximum right turn position, use a torque wrench (A) to apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute.

4. Repeat step 3 with steering wheel at a maximum left turn position.

Results

If rotations per minute exceed specification, perform the steering control unit (SCU) leakage test to isolate the SCU from the steering cylinder. (See "Test Steering Control Unit (SCU) Leakage" on page 593.)

Specifications

Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque . . . . . 6 (Maximum)

Test Steering Control Unit (SCU) Leakage

Reason

The steering system leakage test should be performed first to verify internal steering system leakage. (See "Test Steering System Leakage" on page 593.)

This procedure isolates steering system leakage between the SCU and the steering cylinder.

Procedure

1. Operate hydraulic system until fluid temperature is at least 43°C (110°F).

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

Important: Avoid Damage! Cap or plug all openings to avoid contamination.

2. Disconnect and cap the lines at the steering cylinder.

3. Start engine and set throttle to slow idle.

4. With steering wheel at a maximum right turn position, apply a constant torque of 6.8 N•m (72 lb-in.) and count the number of rotations occurring in one minute. Repeat with steering wheel at maximum left turn position.

Results

If rotations/min exceed specification, replace the SCU.

If rotations/min are less than specification, replace the steering cylinder.

Specifications

Steering Wheel Turns per Minute at 6 N•m (72 lb-in.) Constant Torque. . . . . 6 (Maximum)

Test Steering System Relief Pressure

Reason

To verify triple pump (front gear set) pressure is maintained at correct level for steering and lift systems without causing damage to the system.

Special or Required Tools

Tool Name	Tool No.	Tool Use
Pressure Gauge Kit	JDG2033	Connect pressure gauge for steering and lift system pressure test.
Pressure Diagnostic Kit	JDG2032	Connect pressure gauge for steering and lift system pressure test.
Inductive Electronic Tachometer	JT05801	Used to measure engine rpm.

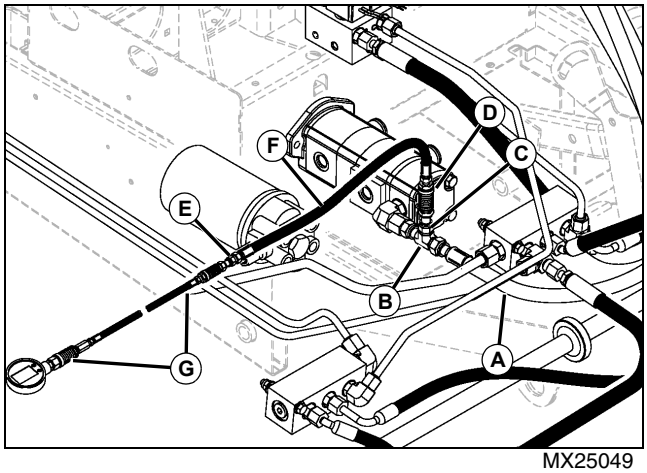
Procedure

1. Operate hydraulic system until fluid is at a minimum temperature of 43°C (110°F).

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A. Information may be obtained in the United States and Canada only by calling 1-800-822-8262.

2. Relieve system pressure by operating the lift system.



MX25049

3. Disconnect steering supply hose (A) from front section of triple pump and install a tee fitting (B) and reconnect hose to fitting.

4. Install a diagnostic fitting (C) on tee fitting.

5. Install quick couplers (D and E).

6. Connect gauge and hose (G) to hose (F) and connect hose to diagnostic fitting (C).

Note: Check engine rpm with electronic tachometer.

7. Apply park brake, start engine, and run at 3000 ± 50 rpm.

8. Turn steering wheel completely in one direction and hold. Record steady pressure reading.

Results

Pressure should be 9997 kPa (1450 psi). If pressure is not within specification, replace steering valve.

Specifications

Steering System Relief Valve Pressure . . . . . 9997 kPa (1450 psi)

Repair

Remove and Install Steering Control Unit (SCU)

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hose Removal Tool	JDG1518	Used to remove steering hoses from steering valve.

Removal

Caution: Avoid Injury! Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other high-pressure lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high-pressure fluids.

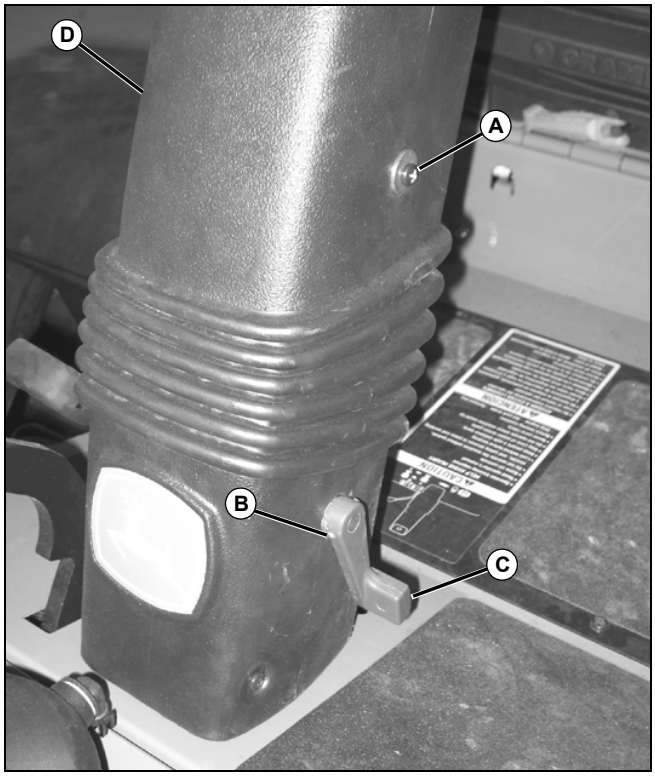
If an accident occurs, see a doctor immediately. Any fluid injected into the skin, must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable source. Such information is available from the Deere & Company Medical Department, Moline, Illinois, U.S.A.

Important: Avoid Damage! Cleanliness is extremely important when repairing the hydraulic SCU. Before disconnecting the hydraulic lines, clean the port area of the SCU to avoid getting contaminants into SCU and hydraulic system.

1. Remove steering wheel center cap.
2. Remove steering wheel retaining nut.

Note: Normally, slight upward pressure on the steering wheel combined with light taps on the steering wheel shaft will disengage steering wheel foremast splines. DO NOT damage steering wheel shaft. If steering wheel does not disengage from shaft with slight taps, use a combination knife-edge puler or 2-jaw puller to remove steering wheel.

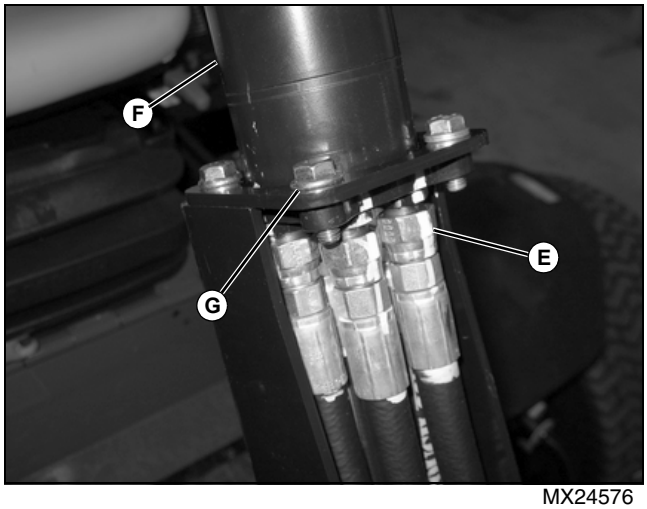
3. Remove steering wheel.



MX24575

4. Remove the two screws (A) from each side of the steering column cover.
5. Remove roll pin (B) and tilt steering handle (C).
6. Remove steering column cover (D).

Note: Label steering lines to aid during installation.



MX24576

7. Disconnect steering lines (E) from steering control unit (F). Install caps and plugs to avoid contamination.
8. Remove four cap screws (G).

Installation

Installation is performed in reverse order of removal.

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BRAKES TABLE OF CONTENTS

Specifications

General Specifications

Disc Brakes

Brake Type	**Mechanical**
Rotor Diameter (Nominal)	**209.54 mm (8.250 in.)**
Rotor Thickness (New)	**4.78 mm (0.188 in.)**
Rotor Minimum Thickness	**3.6 mm (0.142 in.)**
Rotor Run-Out	**0.635 mm (0.025 in.)**
Pad Thickness, Usable	**2.9 mm (0.114 in.)**

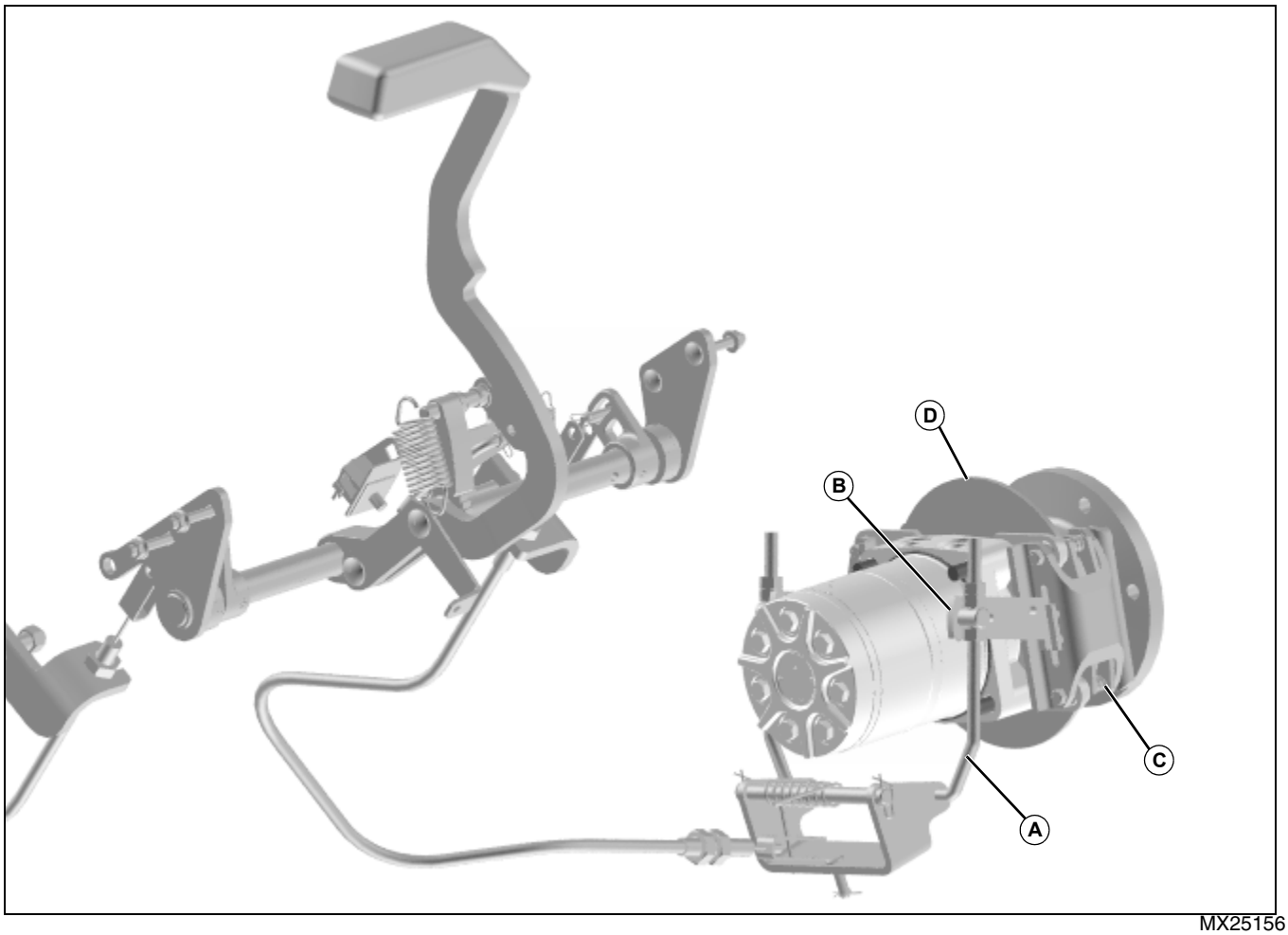
Torque Specifications

Disc Brakes

Rotor Nut	**190 - 217 N•m (140 - 160 lb-ft)**

Theory of Operation

Brake System



MX25156

Function

The park brake is used to prevent movement when the mower is not in use and to assist in stopping the mower while on a slope. The brake is not used to stop the mower on level ground. Primary braking is accomplished by the back pressure in the hydrostatic transmission.

The brake interlock switch stops the engine if operator the attempts to move the unit with the brake engaged or leaves the seat without engaging the brake. The switch also prevents the reels from rotating if the brake is engaged.

Theory

When the brake pedal is depressed, the link rod (A) pushes the caliper link (B), which in turn causes the brake caliper (C) to force the brake pads against the rotor (D). This prevents the unit from moving. Operating the brake pedal or park brake lock also operates the brake interlock switch, which will stop the engine and/or the reels under certain circumstances.

The brake is locked by fully depressing the brake pedal and engaging the lock pedal located on the floor pan. It is unlocked by pushing the brake pedal down, which will disengage the lock pedal. When the lock pedal is engaged, the brakes will remain engaged until the lock pedal is disengaged. Without the pedal lock engaged, the brakes will be engaged only while the brake pedal is being pushed.

Diagnostics

Symptom: Park Brake Does Not Hold

Procedure

1. Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes: Go to next step.

No: Adjust brakes. See “Adjust Park Brake” on page 602. Repair or replace linkage as required.

2. Are pads and rotors clean with no excessive wear or damage?

Yes: Go to next step.

No: Replace pads. Cut or replace rotors.

3. Are calipers functioning properly?

No: Repair or replace as required.

Symptom: Excessive Brake Wear

Procedure

1. Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes: Go to next step.

No: Adjust brakes. See “Adjust Park Brake” on page 602. Repair or replace linkage as required.

2. Are calipers functioning properly, not binding or damaged?

Yes: Go to next step.

No: Repair or replace as required.

3. Are rotor machined surfaces smooth and free of excessive wear or damage?

No: Cut or replace rotors.

Symptom: Brakes Do Not Release

Procedure

1. Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes: Go to next step.

No: Adjust brakes. See “Adjust Park Brake” on page 602. Repair or replace linkage as required.

2. Are calipers functioning properly, not binding or damaged?

No: Repair or replace as required.

Symptom: Brake Pedal Does Not Return

Procedure

1. Are brakes adjusted properly? Linkage not worn, binding or damaged?

Yes: Go to next step.

No: Adjust brakes. See “Adjust Park Brake” on page 602. Repair or replace linkage as required.

2. Are calipers functioning properly, not binding or damaged?

Yes: Go to next step.

No: Repair or replace as required.

3. Is the brake pedal return spring functioning properly, not broken?

No: Replace brake pedal return spring.

Symptom: Brakes Noisy

Procedure

1. Are pads and rotors clean with no excessive wear or damage?

Yes: Go to next step.

No: Replace pads. Cut or replace rotors.

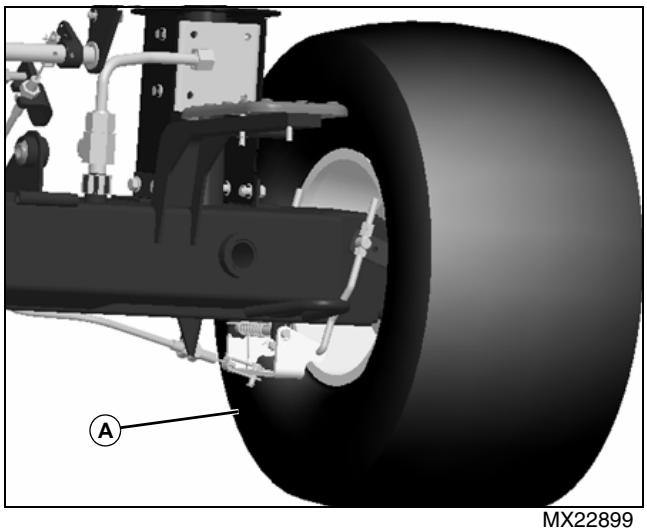
2. Are calipers functioning properly, not binding or damaged?

No: Repair or replace as required.

Tests and Adjustments

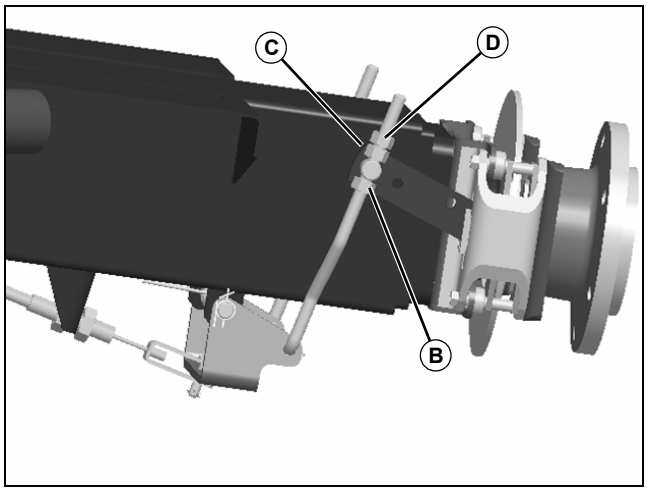
Adjust Park Brake

1. Park machine on level surface and turn off engine.
2. Block rear wheels and unlock park brake.
3. Support the front wheels off the ground safely. Use jack stands.



MX22899

4. Remove wheel (A).



MX22900

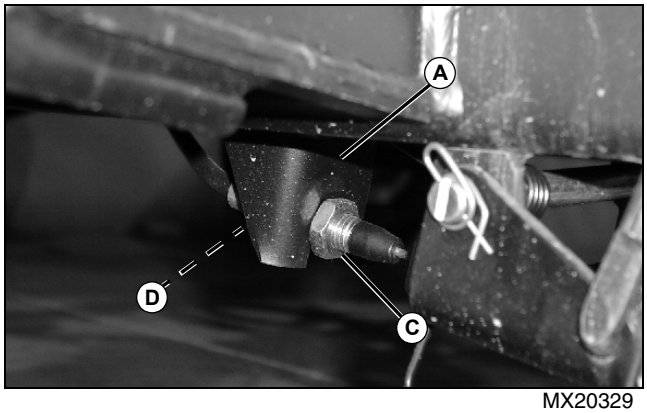
5. Loosen bottom nut (B) on the pull rods (both sides).

Note: Make sure park brake pedal does not contact floor plate with brakes fully engaged.

6. Tighten coupler nut (C) while rotating wheel until brake pads begin to contact disk. Loosen coupler until brake releases. Tighten bottom nut (B) to (both sides).
7. Tighten top jam nut (D) (both sides)

Results

- Brakes should fully engage with pedal depressed and disengage while the brake pedal is released, preventing the brake pads from dragging on the rotors.



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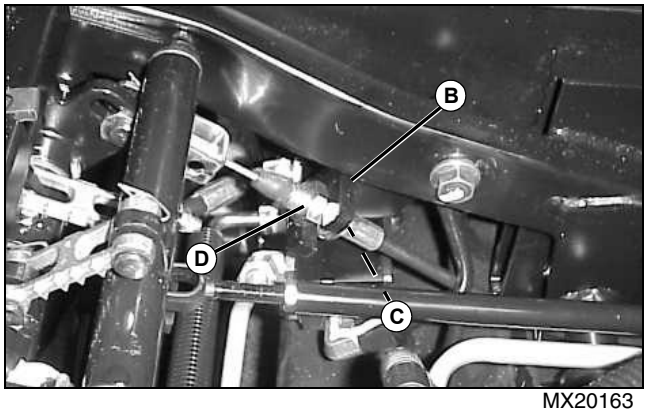


MX20163

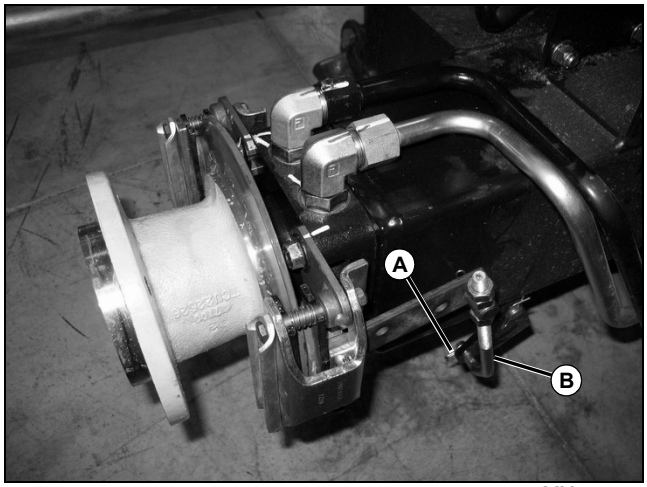
1. Additional adjustment is available at the brake (A) and pedal ends of the brake cable (B).
2. Loosen jam nut (C) and adjust coupler nut (D).
3. Adjust brake cable accordingly and tighten jam nut.

Repair

Replace Brake Pads

1. Park machine on firm and level surface.
2. Lift front axle and support with jack stands.
3. Remove wheel and tire assembly.
4. Release park brake, if applied.

Note: When properly adjusted, brake pads should wear evenly and be replaced as a complete set. If the situation should arise where either the front or rear brake pads have worn to limits, replace that one set and adjust brake linkage accordingly.



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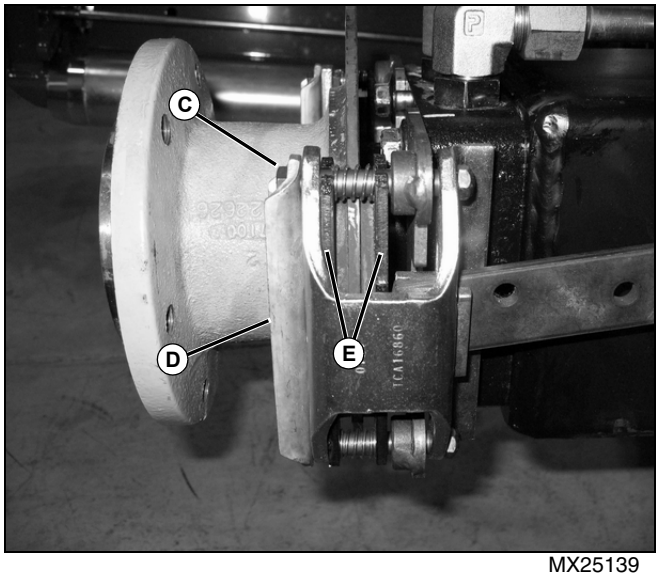
5. Remove cotter pin (A) from each linkage rod (B).



MX25139

6. Remove hardware (C) from top of caliper (D).
7. Swing caliper away from rotor and remove old pads (E).

Note: Install spring properly to avoid premature wear of brake pads.

8. Install new pads into place and swing caliper toward rotor.
9. Secure caliper into place with hardware.
10. Connect linkage rod (B) and secure with cotter pin (A).
11. Install wheel and tire assembly.
12. Adjust brakes. See “Adjust Park Brake” on page 602.

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Specifications

Cutting Units

There are three models (22-In. QA-7, 22-In. QA-5, and Rotary) of cutting units.

General Specifications

Cutting Units

Make	**John Deere**
Backlapping	**On machine, variable speed**
Clip Ratio	**See Theory of Operation (Performance Variables)**
Front Rollers	**Choice of smooth, grooved, or spiral**
Size	**55.9 cm (22 in.)**
Reel Diameter QA-5	**12.7 cm (5 in.)**
Reel Diameter QA-7	**17.78 cm (7 in.)**
Height-of-Cut	**2.38 to 19 mm (3/32 to 3/4 in.)**
Cutting Unit Drive QA-5	**Electric or Hydraulic**
Cutting Unit Drive QA-7	**Hydraulic**

Adjustment Specifications - QA-5 and QA-7 Reels

Cutting Units

Bed Knife-to-Cutting Reel Clearance	**0.025 - 0.05 mm (0.001 - 0.002 in.)**
Front Roller Out-of-Parallel (Maximum)	**0.05 mm (0.002 in.)**
Cutting Shield-to-Cutting Reel Clearance (Maximum)	**1.5mm (0.06 in.)**

Bed Knife Grinding Specification

Bed Knife Top Surface	**6.5° relief angle**
Front Surface	**5° relief angle**
Reel	**Spin grind with 20° relief angle**

Repair Specifications - Rotary Deck

Rotary Deck

Rear Roller Shaft End Play	**0.00-0.15 mm (0.000-0.006 in.)**

Torque Specifications

Bed Knife and Support

Bed Knife Shoe Mounting Screw (Dry)	**35-45 N•m (26-34 lb-ft)**
Bed Knife Shoe Mounting Screw (Lubricated)	**24-36 N•m (18-27 lb-ft)**
Bed Knife Mounting Screw	**7 N•m (62 lb-in.)**

Reel Mounting

Reel-to-Pivot Arm	**68 N•m (50 lb-ft)**
Pivot Arm-to-Frame (Forward)	**47 N•m (35 lb-ft)**
Pivot Arm-to-Frame (Rear)	**81 N•m (60 lb-ft)**

Roller

Shaft Locknut	**0.34-0.79 N•m (3-7 lb-in.)**

Cutting Units

Bed Knife Screw	**6.5 N•m (58 lb-in.)**
Bed Knife Mounting Screw QA-5	**7 N•m (62 lb-in.)**
Bed Knife Shoulder Screw.	**55 N•m (40 lb-ft)**
FTC Shaft Retaining Nut	**47 N•m (35 lb-ft)**

Rotary Deck

Rotary Deck Blade Cap Screw	**47.5 N•m (35 lb-ft)**
Spindle Housing Cap Screw	**24 N•m (18 lb-ft)**

Tools and Materials

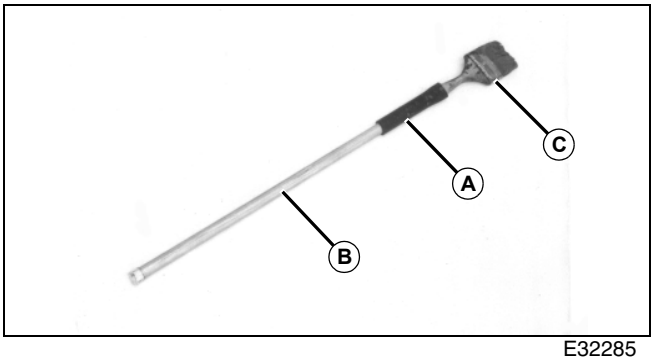
Special or Essential Tools

Note: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Bearing Installer	JDG243	Used to install bearings.
Bearing Installer	JDG506	Used to install bearings.
Roller Bearing Puller	JDG795	Used to remove bearings from rollers.
Height-of-Cut Gauge Bar	AMT2978	Used to adjust cutting height.
Bench Plate	N/A	Used to adjust front roller.

Dealer-Fabricated Tools



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Attach a piece of rubber hose (A) and additional handle (B) to a paint brush (C) to extend its length. This is used to apply lapping compound.

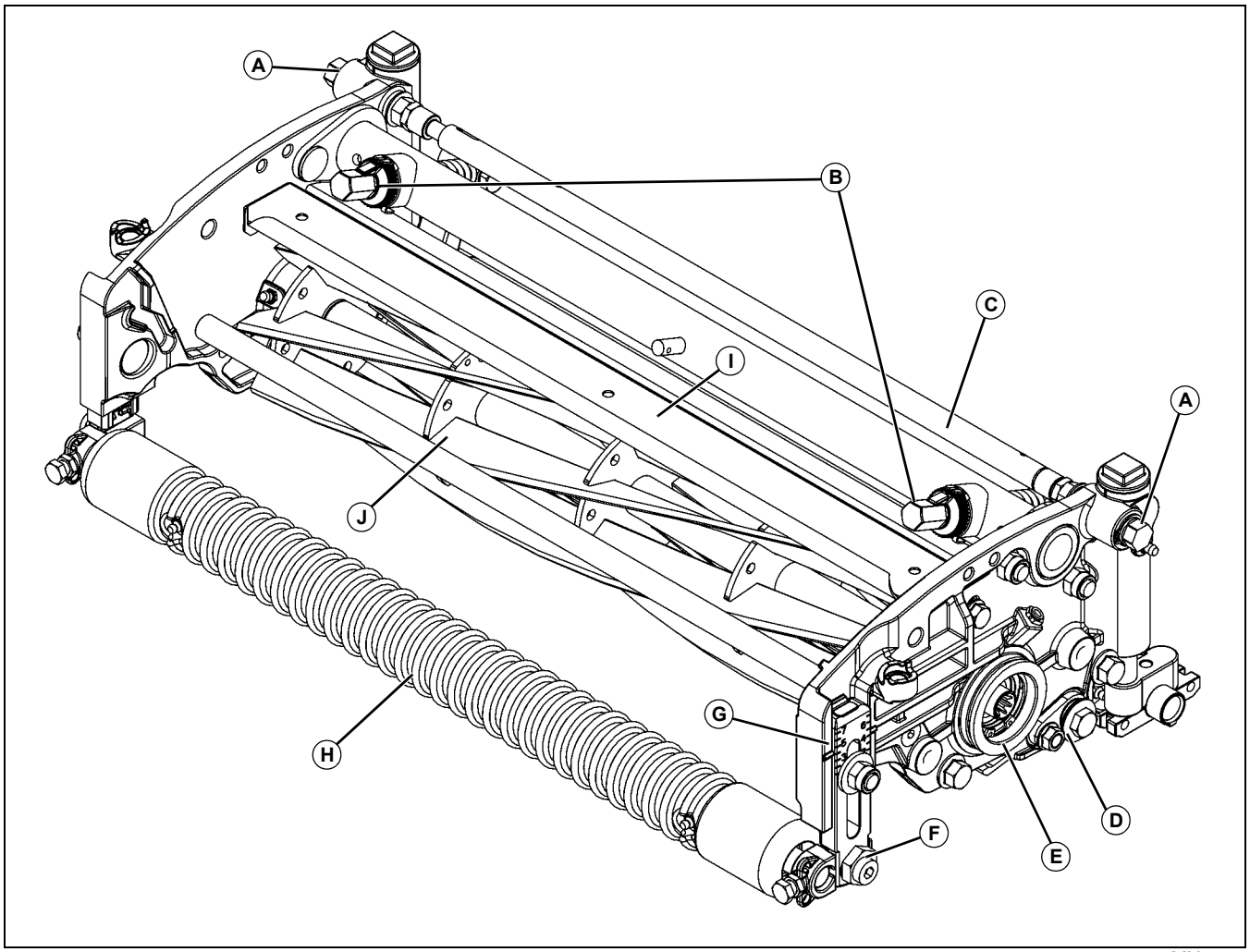
Other Materials

Other Material

Part No.	Part Name	Part Use
N/A	Lapping Compound	Used to backlap bed knife and cutting reels.

Component Location

Cutting Unit QA-5

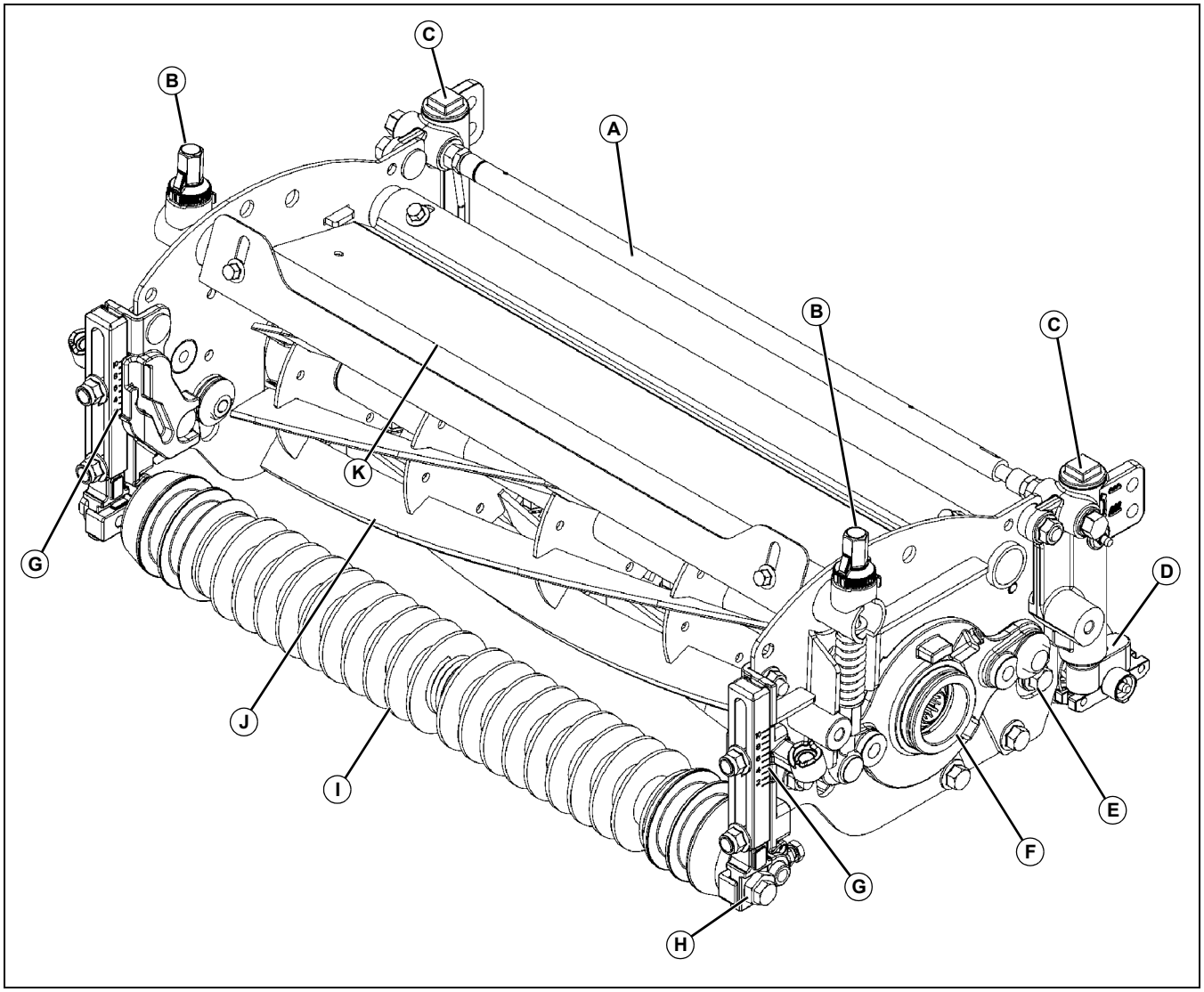


MX41240

A- Rear Roller Height Adjuster
B- Bed Knife Adjusters
C- Connecting Shaft, Rear Roller Height
D- Bed Knife Cam Plate
E- Bearing Housing / Motor Mount[1]
F- Front Roller Parallel Adjustment Cam
G- Front Roller Height Adjustment (one on each side)
H- Front Roller
I- Discharge Shield
J- Reel

1. Motor may be mounted on either side of reel with balance weight mounted on opposite side.

Cutting Unit QA-7

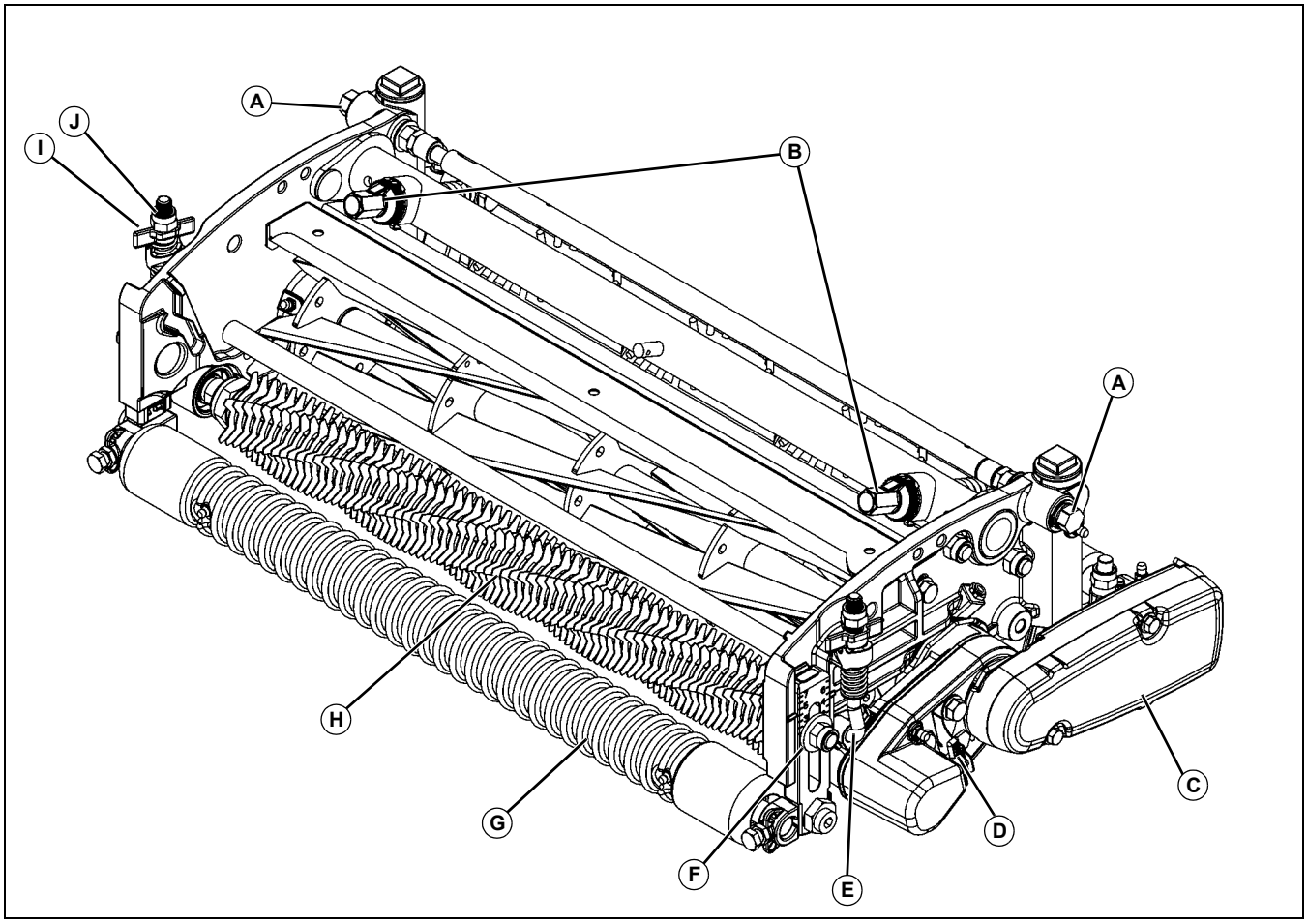


MX42125

A- Connecting Shaft, Rear Roller Height
B- Bed Knife Adjusters
C- Rear Roller Height Adjuster
D- Rear Roller Attachment
E- Cam Plate
F- Bearing Housing / Motor Mount[1]
G- Front Roller Height-of-Cut Range Adjustment
H- Front Roller Parallel Adjustment Cam
I- Front Roller
J- Reel
K- Discharge Shield

1. Motor may be mounted on either side of reel with balance weight mounted on opposite side.

Fairway Tender Conditioner (FTC)



MX41242

As Shown on QA-5, Available on QA-7

A- Rear Roller Height Adjuster

B- Bed Knife Adjuster

C- Brush Drive Housing

D- Fairway Tender Conditioner Engage/Disengage Lever

E- Fairway Tender Conditioner Height and Tension Mechanism (one on each side)

F- Front Roller Height Adjustment (one on each side)

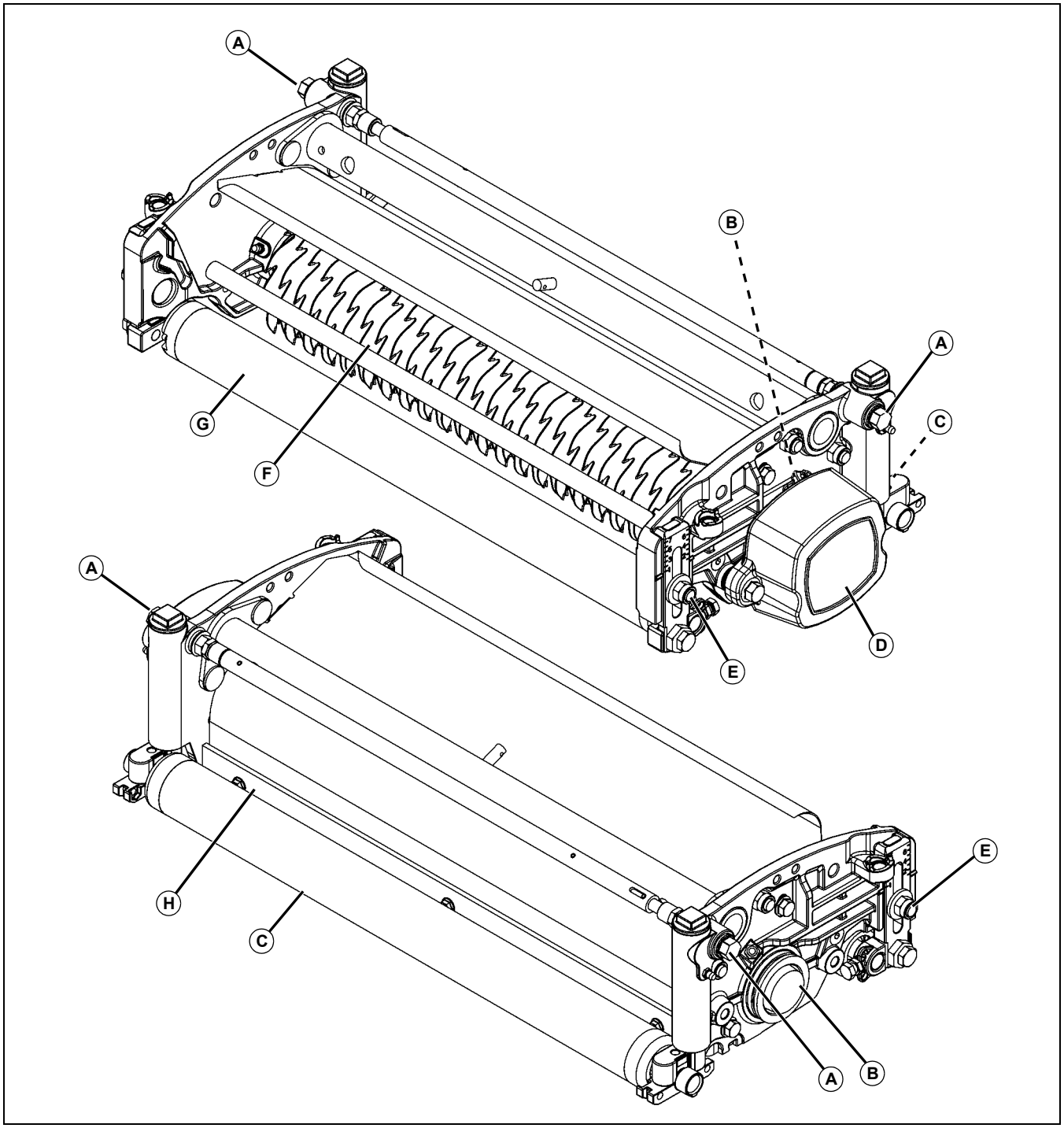
G- Front Roller

H- Fairway Tender Conditioner

I- Fairway Tender Conditioner Raise/Lower Wing Nut (one on each side)

J- Fairway Tender Conditioner Height Adjustment Nut (one on each side)

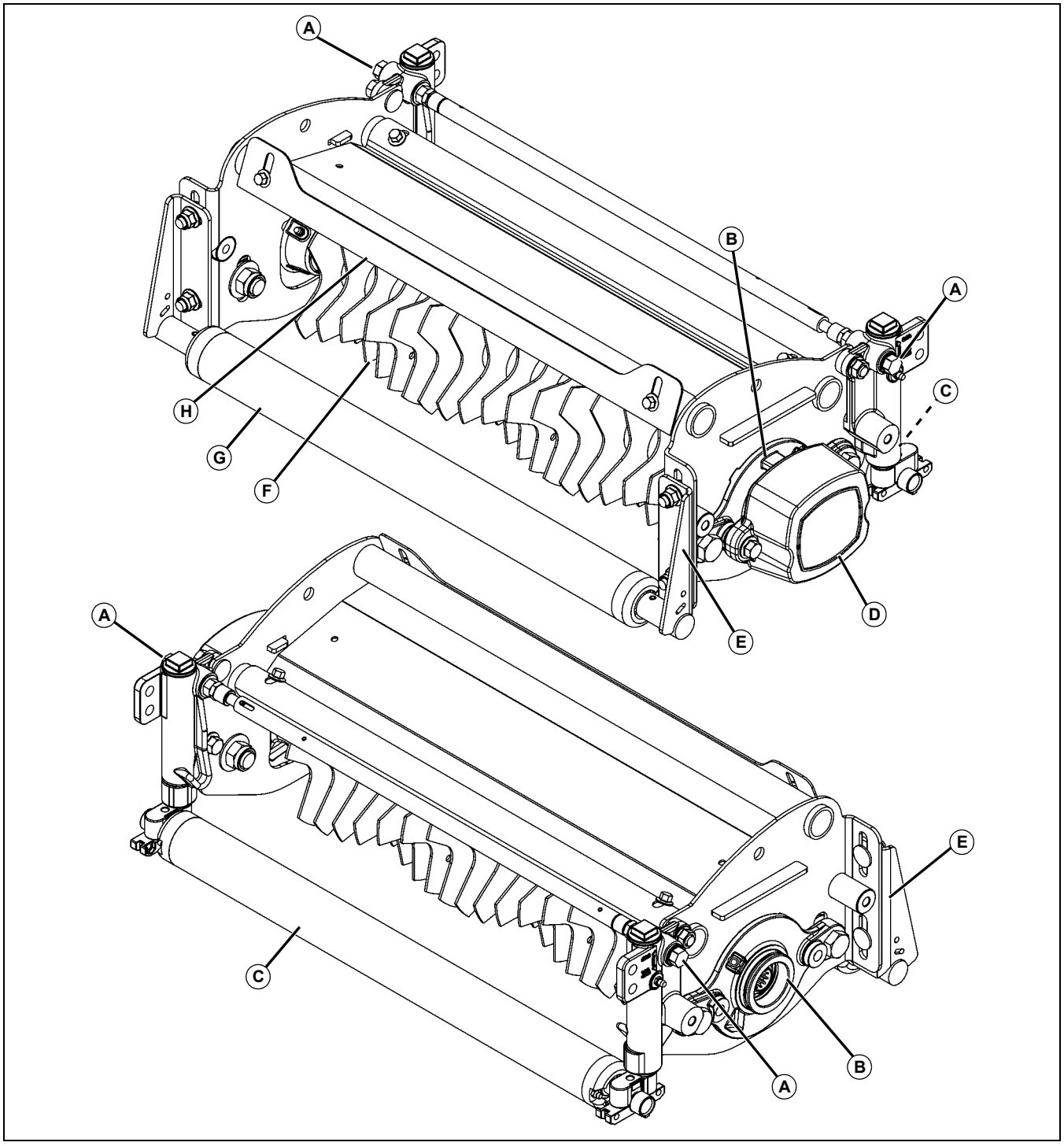
Verticut QA-5



MX41950

A- Rear Roller Height Adjuster
B- Bearing Housing
C- Rear Roller
D- Counterweight
E- Front Roller Height Adjuster
F- Vertical Blades
G- Front Roller
H- Discharge Flap

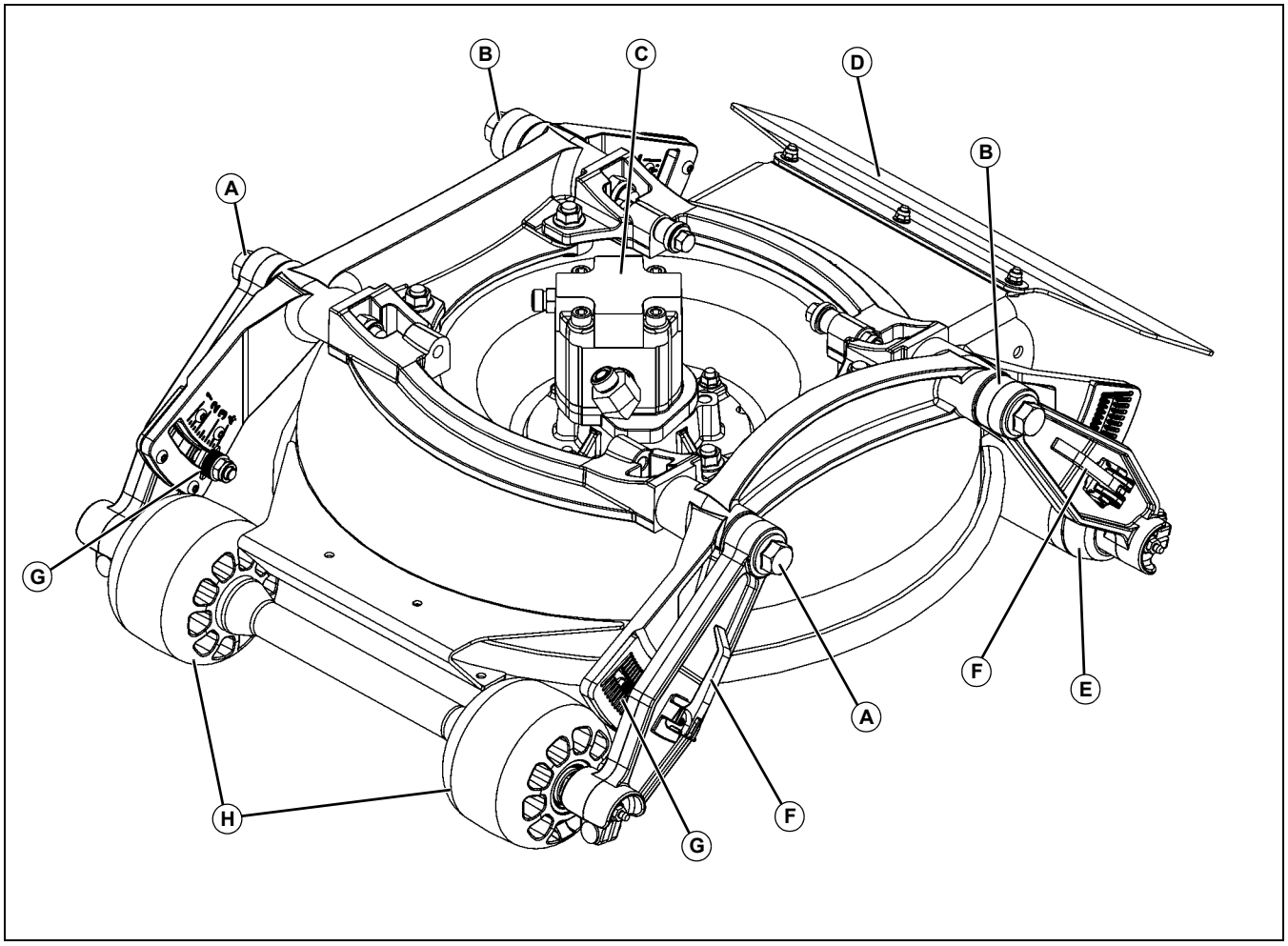
Verticut QA-7



MX41951

A- Rear Roller Height Adjuster
B- Bearing Housing
C- Rear Roller
D- Counterweight
E- Front Roller Height Adjuster
F- Vertical Blades
G- Front Roller
H- Discharge Shield

Rotary Cutting Deck



MX41945

A- Front Roller Pivots
B- Rear Roller Pivots
C- Hydraulic Motor
D- Shield
E- Rear Roller
F- Quick Release Height Adjustment Levers
G- Front Roller Height-of-Cut Range Adjustment
H- Front Rollers

Theory of Operation

Reel and Bed Knife Grinding

Reel and Bed Knife Relationship

Reel mowers are precision machines requiring daily maintenance to maintain the well-groomed appearance of turfgrass. The scissor-like shearing action, which only a reel mower is capable of achieving, is only possible if the reel and bed knife are sharp and the reel-to-bed knife clearance is maintained.

Close examination of the reel-to-bed knife relationship reveals two square edges passing one another with approximately 0.050 mm (0.002 in.) clearance. There are several reasons why this clearance is necessary.

- When the reel is allowed to contact the bed knife, the square (sharp) edges of the reel and bed knife will roll over, becoming dull.
- Contact between the reel and bed knife generates heat. Heat generated through this contact will distort the shape of the bed knife. Distortion causes the bed knife to draw closer to the reel, resulting in more rollover of the cutting surfaces and more heat generated in the bed knife.
- Drag produced by an improperly adjusted cutting unit may result in an unacceptable clip ratio, undue strain on drive mechanisms and premature wear of the cutting unit. This also increases horsepower used from the engine and more fuel consumption.

Reasons for Grinding

- To restore the cylindrical shape of a reel that has become cone-shaped due to improper adjustment of the reel-to-bed knife clearance or worn reel bearings.
- To restore the edge when the grass is not being cut across the entire length of the bed knife, evidenced by streaks of grass left after the mower has passed, usually the result of nicked blades caused by hitting foreign objects in the grass.
- To restore the edge when the lack of frequent backlapping allowed the edge to be rounded beyond the capability of the backlapping procedure to restore the edge.
- To restore the edge when the reel-to-bed knife clearance has been improperly adjusted (reel contacting bed knife).

Cutting action begins as the bed knife positions the grass to be cut at the cutting edge. The reel then pulls the grass toward the bed knife, where it is sheared by the cutting edges as they pass one another.

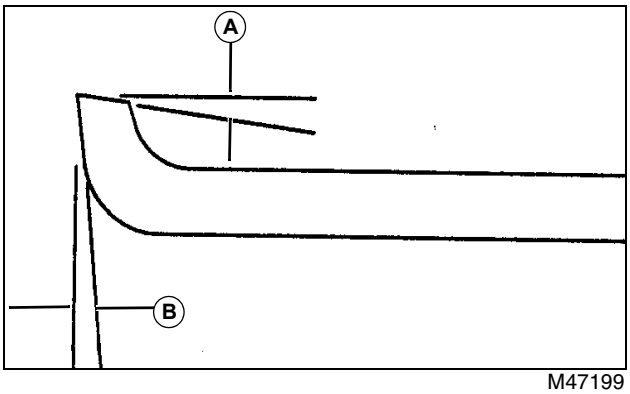
In order for the grass to be cut at the proper height, it must contact the bed knife at the cutting edge. This is accomplished by grinding a 5° relief angle on the front face of the bed knife. Without a relief angle, the blade of grass will contact the lower edge of the bed knife and be bent over at too much of an angle prior to being cut. In the case of mowing greens, where very small cuts are being taken, the reel may not capture the grass at all, and no grass will be cut.

Although some spin grinding machine manufacturers say backlapping is not necessary, John Deere recommends backlapping after spin grinding to remove burrs and rough edges left from the spin grinding procedure. Backlapping produces a honed edge that will cut the grass evenly and leave the tops of the grass with clean, straight edges.

It is important to note, dull cutting edges will tear rather than shear the grass drawn into the bed knife. This will shock the grass plant and retard its growth.

Grinding the Bed Knife

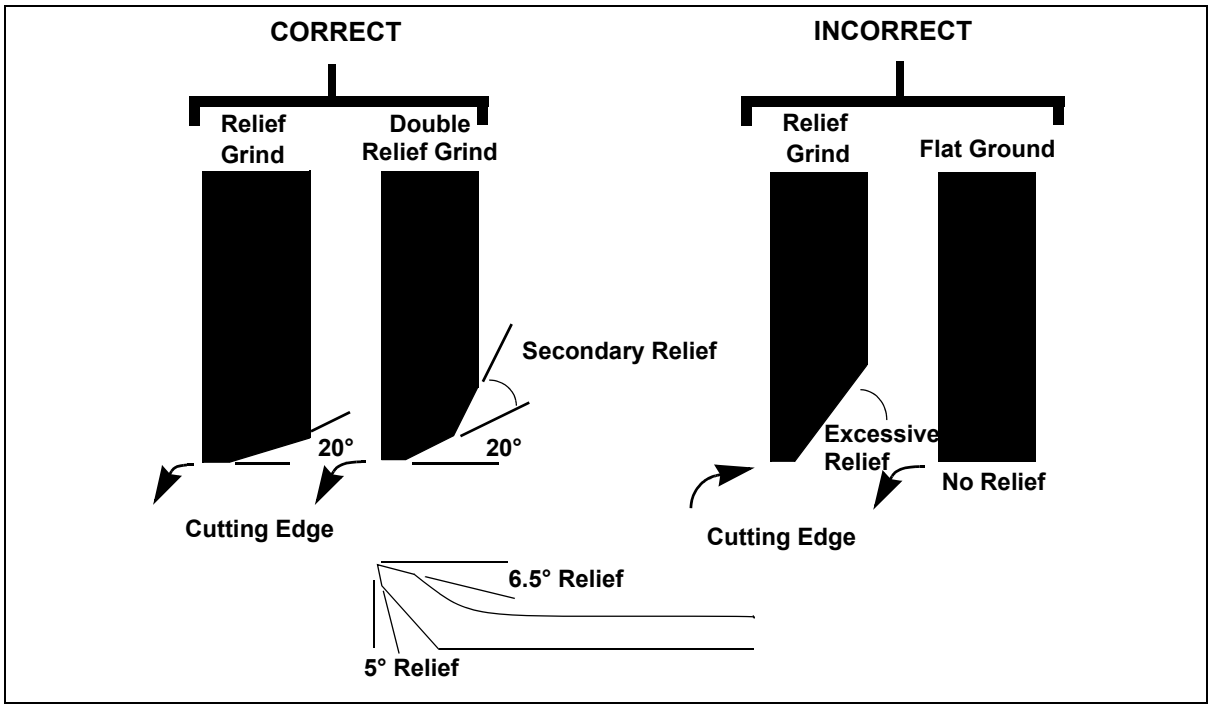
Note: Bed knife and support assembly must be ground as a complete unit.



M47199

1. When grinding the bed knife, it is important to have a 6.5° relief angle on the top surface (A) and a 5° relief angle on the front surface (B).
2. Put entire bed knife support and bed knife in a suitable grinder and grind until material is consistently removed from the entire length of the top and front surfaces of the bed knife.

Grinding the Reel



MIF

John Deere recommends relief grinding the reels before spin grinding for these reasons:

- Reduced blade contact area results in less friction, requiring less horsepower to drive the reel and increases fuel efficiency.
- Ensures longer wear life.
- Less time is required to backlap.
- Reduces pulling and tearing of the grass as the unit gets dull by use.
- Provides an area for backlapping compound to be trapped to more effectively backlap reels.
- Relief grinding removes metal from the trailing edge of the blade, forming an angle (relief angle) to reduce the contact area of the cutting edges.
- Because of the relief grind it is possible, with backlapping, to true a reel (make it round) if a blade is 0.025-0.050 mm (0.001-0.002 in.) out of round.

Backlapping

Backlapping is used to sharpen the cutting edges when grinding is not necessary.

When compared to grinding, backlapping removes a very small amount of metal, requires less time, and will effect a smooth, clean cut.

The backlapping procedure is accomplished by spinning the reel backwards while applying special abrasive compounds to the reel. Usually, coarse compounds are used initially, followed by a finer abrasive for final honing. Recommended grits for fairways and roughs are 60, 80, and 120-grit. Reel sharpening compounds should not be toxic, oily, or greasy.

The cutting unit should be inspected, backlapped, adjusted, and checked daily for a uniform cut along the complete length of the bed knife. It is important that the adjustment allows the reel to turn freely without dragging against the bed knife. Metal-to-metal contact will generate heat, causing the reel to expand and intensifying the dragging that produces more heat. This vicious cycle will quickly “shut down” the mower.

Vertical Cutting Unit

The vertical cutting unit is a dedicated cutting unit used to de-thatch fairways, greens, and tees prior to topdressing. This tends to promote vertical growth for better consistency of play on the golf course.

The vertical blades are positioned in a helix pattern and are placed 3/4 in. apart as shipped from the factory. Spacing is accomplished by placing three 1/4 in. spacers together between each blade. If a closer spacing is desired, spacers can be removed and blades added.

The helix pattern in the cutters is formed by indexing the center hexagonal cut one additional flat.

Normal rotational direction for the reel is forward; however, for very aggressive cutting, the reel should be operated in the reverse direction. This will prevent the cutting blades from pulling the machine and will provide a more desirable cutting action.

To operate the reel in reverse, the hydraulic hoses must be reversed at the reel motors.

Rollers

Smooth Roller

The roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward. A smooth roller is generally used on the rear of a cutting unit to establish the cutting height range. (Under certain circumstances, grooved rollers are used on the rear.) A front roller used in conjunction with a rear roller is needed to achieve more exact cutting heights under 25 mm (1 in.).

Grooved Roller

The grooved roller is used as a ground sensing device to detect changes in the contour of the turf as the mower moves forward. The main advantage in using a grooved roller rather than a smooth one comes when cutting long grass that is very wet. Grass that is wet will tend to stay down rather than spring up after the roller passes. Grooved rollers will not bend the grass over, allowing it to be cut rather than passed over.

Along with advantages come disadvantages. Because of the reduced contact area inherent with a grooved roller, the roller may penetrate deeper into the soil (especially in wet conditions), lowering the effective cutting height and possibly scalping the turf. Serious consideration should be given to mowing fairways or greens with a grooved roller attached, especially when the turf is very wet.

Spiral Roller

The 3-in. diameter spiral-grooved front roller with spiral end caps allows more grass to stand up along the entire width of the cutting unit, providing a better quality of cut. This roller is also self-cleaning, reduces material buildup on the ends, and improves the overall appearance of the finished cut.

Performance Variables

Three performance variables that affect the quality of cut are:

- Number of reel blades
- Reel rpm
- Ground speed of machine

Note: When discussing performance variables, we must assume that other factors such as rate of growth, mowing frequency, soil fertility, and equipment condition have been considered and are not affecting the quality of cut.

To apply performance variables to a formula, we need to understand three terms:

Shear Point - A single point of cutting contact between the cutting unit and the turf. Due to the reel mower design, there are an infinite number of shear points across the bed knife.

Clip Ratio (CR) - The forward distance traveled between successive cutting contacts at any one shear point.

Cutting Height (CH) - The distance above the soil line that grasses are clipped.

The most uniform cut occurs when the Clip Ratio (CR) equals the Cutting Height (CH). If CR is 20% greater than CH, marcelling (a wavy, rib-like appearance) can occur. CR should be within 20% of CH. Therefore, a CH of 13 mm (0.50 in.) requires a CR of 10-15 mm (0.40-0.60 in.). If CH is 20% greater than CR, the rotating blades create a fanning effect that blows the grass down without cutting it.

CR is controlled by the performance variables (the number of blades on the reel, ground speed, and reel speed). In most cases, only two of these performance variables (the number of blades on the reel and/or the vehicle ground speed) are changeable for a given cutting height.

Since the number of blades on the reel, the reel speed, the cutting height, and the clip ratio (since CR must equal CH) are known, the formula to calculate optimum vehicle ground speed (mph) is:

mph = (reel rpm) x (CR) x (No. of blades) ÷ 1056

Example:

Using:

- 7000/8000 Lightweight Fairway Mower at a tested reel speed of 2100 rpm
- 9-blade reel
- CH = 0.14 (therefore, CR = 0.14)

Optimum vehicle ground speed (mph) is:

(2100) x (0.14) x (9) ÷ 1056 = 2.5 mph

Note: To measure vehicle ground speed (mph):

• Measure off an 88-ft distance and record the length of time (in seconds) it takes to travel that distance.

• Vehicle ground speed equals 60 divided by that time.

Diagnostics - Reel Mowers

Marcelling

Procedure

1. Is the ground speed correct?

Yes: Go to next step.

No: Increase or decrease ground speed as necessary. (See “Performance Variables” on page 618.)

2. Is engine rpm correct (not too low)?

Yes: Go to next step.

No: Increase engine speed to specification. (See Operator’s Manual.)

3. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure” on page 623.)

4. Is the correct number of reel blades being used for desired clip ratio (CR)?

No: Install reel with correct number of blades. (See “Performance Variables” on page 618.)

Streaking

Procedure

1. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes: Go to next step.

No: Perform reel-to-bed knife adjustment. (See “Adjust Bed Knife to Reel Clearance QA-5” on page 629, or “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

2. Are the reel and bed knife in good condition (no nicks, uneven wear, or distortions)?

No: Grind reel and bed knife. (See “Reel and Bed Knife Grinding” on page 616.)

Height-of-Cut Changes

Procedure

1. Is the grass dry enough for proper cutting (not too wet)?

Yes: Go to next step.

No: Allow sufficient time for grass to dry before cutting.

2. Is the roller clean (no grass or dirt collecting on the roller)?

Yes: Go to next step.

No: Install scraper or power brush on roller.

3. Is the condition of the soil good (not rough or changing)?

Yes: Go to next step.

No: Use a smooth roller.

4. Is the cutting unit floating properly?

Yes: Go to next step.

No: See Operator’s Manual.

5. Are the roller clamp bolts tight?

Yes: Go to next step.

No: Perform height-of-cut (HOC) adjustment. (See “Adjust Height-of-Cut (HOC) - QA-5 Reel” on page 626, or “Adjust Height-of-Cut (HOC) QA-7” on page 630.)

6. Are the rollers concentric (not out-of-round)?

Yes: Go to next step.

No: Replace roller. (See procedure in this section.)

7. Are the roller bearings in good condition (not worn)?

No: Replace roller bearings. (See procedure in this section.)

Poor Quality of Cut

Procedure

1. Is the grass at an acceptable height (not too high)?

Yes: Go to next step.

No: Mow grass more frequently.

2. Are the reel and bed knife sharp?

Yes: Go to next step.

No: Perform backlapping and reel-to-bed knife adjustment. (See “Backlapping Procedure” on page 623.)

3. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

No: Perform reel-to-bed knife adjustment. (See “Adjust Bed Knife to Reel Clearance QA-5” on page 629, or “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

Reel Does Not Rotate

Procedure

1. Is the machine operating properly?

Yes: Go to next step.

No: See machine operator's manual.

2. Is the reel-to-bed knife clearance within specification and consistent along the bed knife?

Yes: Go to next step.

No: Perform reel-to-bed knife adjustment. (See "Adjust Bed Knife to Reel Clearance QA-5" on page 629, or "Adjust Reel-to-Bed Knife Clearance QA-7" on page 633.)

3. Are the roller bearings in good condition (not worn or seized)?

No: Replace roller bearings.

Unit Not Cutting

Procedure

1. Is the grass dry and height of the grass not too excessive?

No: Allow sufficient time for grass to dry and mow more frequently.

Diagnostics - Rotary Mowers

Mower Deck Cuts Unevenly

Procedure

1. Are decks adjusted evenly?

Yes: Go to next step.

No: Adjust mower decks. (See "Adjust Height-of-Cut (HOC) Rotary Deck" on page 636.)

2. Are tires inflated to specification?

Yes: Go to next step.

No: Inflate tires to specification.

3. Are front and rear rollers clean and free of debris?

Yes: Go to next step.

No: Clean front and rear rollers.

4. Are front and rear rollers and bearings in good condition and not damaged or worn?

Yes: Go to next step.

No: Repair or replace rollers or bearings as required.

5. Are blades in good condition and not damaged or bent?

Yes: Go to next step.

No: Replace blades. (See "Remove and Install Blades" on page 665.)

6. Are blades properly sharpened and balanced?

Yes: Go to next step.

No: Sharpen and balance blades. (See "Sharpen Blades" on page 665.)

7. Are spindle assemblies in good condition?

No: Repair or replace as required.

Mower Deck Vibrates Excessively

Procedure

1. Are rotary decks properly mounted on the machine?

Yes: Go to next step.

No: Install decks on machine properly. (See "Remove and Install Rotary Decks" on page 665.)

2. Is rotary deck mounting hardware in good condition and not worn?

Yes: Go to next step.

No: Repair or replace as necessary.

3. Are blade cap screws properly tightened?

Yes: Go to next step.

No: Tighten blade cap screws to specification.

4. Are blades in good condition and not damaged or bent?

Yes: Go to next step.

No: Replace blades. (See “Remove and Install Blades” on page 665.)

5. Are blades properly balanced?

Yes: Go to next step.

No: Sharpen and balance blades. (See “Sharpen Blades” on page 665.)

6. Are spindle assemblies clean and free of debris?

Yes: Go to next step.

No: Remove debris from spindle assemblies.

7. Are spindle assemblies in good condition?

No: Repair or replace as required.

Excessive Noise from Mower Deck

Procedure

1. Are blades in good condition and not damaged or bent?

Yes: Go to next step.

No: Replace blades. (See “Remove and Install Blades” on page 665.)

2. Are blade cap screws properly tightened?

Yes: Go to next step.

No: Torque blade cap screws to specification.

3. Are blades properly balanced?

Yes: Go to next step.

No: Sharpen and balance blades. (See “Sharpen Blades” on page 665.)

4. Are spindle assemblies in good condition?

Yes: Go to next step.

No: Repair or replace as required.

5. Are mower deck drive motors in good condition?

No: Repair or replace as necessary.

Specifications

Front Tire Pressure . . . . . 69-83 kPa (10-12 psi)
Front Tire Pressure (8800 Only) 124-138 kPa (18-20 psi)
Rear Tire Pressure (All) . . . . . 69-83 kPa (10-12 psi)
Rotary Blade Cap Screw Torque . . . . 47.5 N•m (35 lb-ft)

Tests and Adjustments

Backlapping and Bed Knife-to-Reel

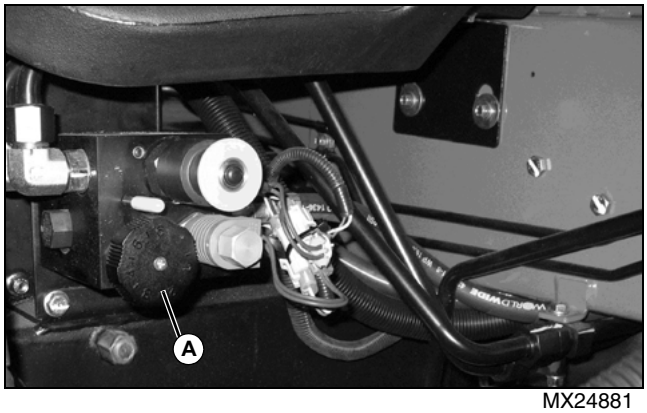
It is best to think of backlapping and bed knife-to-reel adjustments as one procedure. Although backlapping removes only a small amount of metal, the clearance between the reel and bed knife will be increased and must be readjusted.

Another very important point to remember is that adjustments can only be successful if the frame integrity (straightness and strength) is maintained. Attaching bolts must be secure and bearings must be well lubricated and not worn.

Adjust Reel Speed

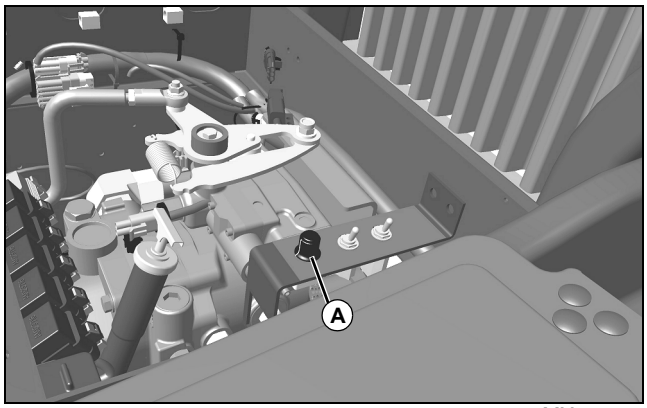
Important: Avoid Damage! It is recommended to use the highest speed necessary to avoid marcelling. Reduced reel speed may help reduce bed knife and reel wear.

1. Park fairway mower on a hard, level surface.
2. Stop engine and lock park brake.



MX24881

Hydraulic Models Shown



MX41495

Hybrid Models Located Under Seat Shown

3. Locate reel speed control knob (A) below the left front fender (hydraulic models. Reel speed control knob (A) (electric models) located under seat.

Note: Variances in reel speed may occur when knob settings are equal. Use a reel tachometer to verify that the front and rear reels are turning at the same speed for the same knob settings.

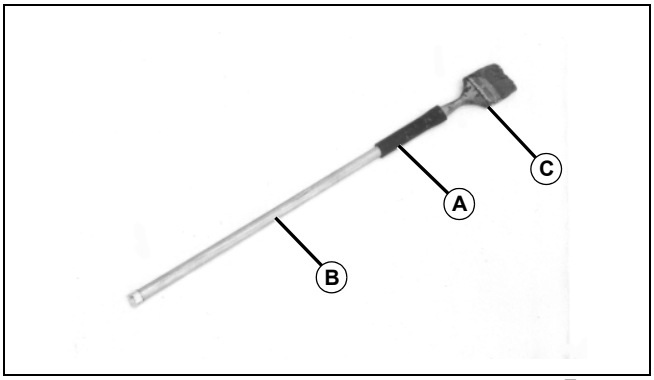
4. Adjust reel speed:
   - Reel speed can be adjusted depending on the type of application for the fairway mower, which type of cutting units are used, and grass height and conditions.
   - It may be appropriate to reduce reel speed when cutting taller grass to prevent grass from being blown over and not being cut. Faster reel speeds with dry grass may cause grass clippings to be thrown over the grass catcher.
   - For mowing fairways, set the speed control knob (A) to the highest setting fully to the left (counterclockwise) for best cutting performance.
   - For mowing roughs, reel speed may be reduced by turning the speed control knob to the right (clockwise).

Backlapping Procedure

Reason

To provide a consistent cutting action and prolong reel life.

Dealer-Fabricated Tools



E32285

Attach a piece of rubber hose (A) and additional handle (B) to a paint brush (C) to extend its length. This is used to apply lapping compound.

Other Material

Part No.	Part Name	Part Use
N/A	Lapping Compound	Used to backlap bed knife and cutting reels.

Setup for Procedure

Caution: Avoid Injury! Avoid injury from rotating blades. Keep hands and feet away from blades while machine is running. Always wear protective gloves when working on or near the reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

Never allow more than one person at a time to work on any one cutting unit. Never allow work to be accomplished on more than one cutting unit at the same time. Serious personal injury could result.

Disengage the fairway tender conditioner before backlapping. Severe personal injury may result from rotating blades.

Note: Perform reel-to-bed knife adjustment before performing backlapping procedure.

Before starting procedure: Rotate cutting units for service or RFS (Rotate for Service™). (See “Rotating Reel Cutting Units” on page 646.)

Procedure

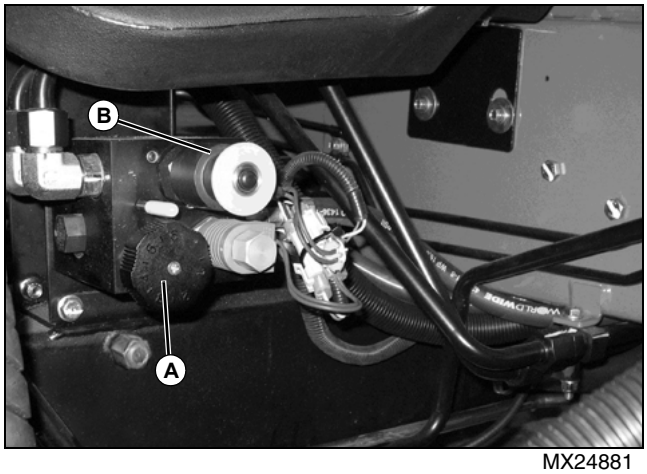
Conditions:

- Park machine safely
- Cutting units rotated for service
- Park brake locked

1. The machine should be running with the park brake locked. Step down from the machine.

2. Set the speed control knob(s).

7500, 7700, 8500 and 8700



MX24881

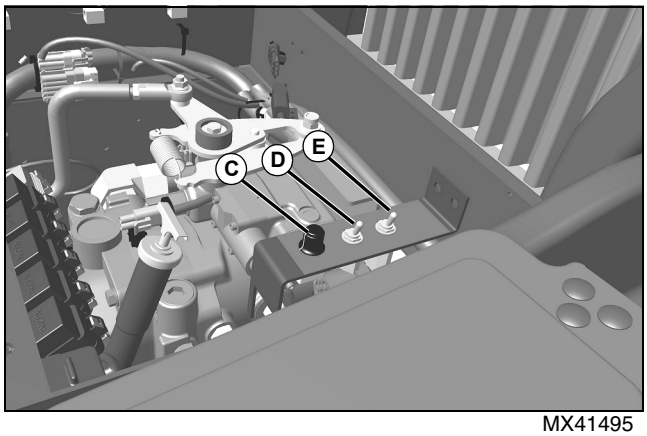
Hydraulic Machine Shown (right side)

- Locate the backlapping valves below the left front fender. The valve facing forward controls the front three cutting units, and the valve facing rearward controls the rear two cutting units.

- Turn speed control knob (A) clockwise to (1) on knob. Repeat on opposite side.

- Press in on the release button at the center of the forward/reverse knob (B) and pull the knob out until it locks into the reverse position. Repeat on opposite side.

7500 and 8500 E-Cut Hybrid

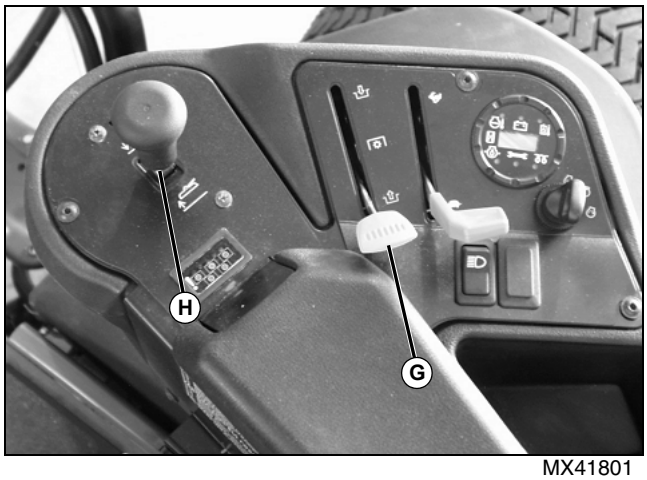


MX41495

Hybrid Unit Shown (controls under seat)

- Turn speed control knob (C) counter clockwise to slow.

- Move mow-backlap switch (D) to the backlap position for front cutting units. Move mow-backlap switch (E) to the backlap position for the rear cutting units.



MX41801

8500E Shown

3. Push forward on the mow-transport lever (G). Push the lift-lower lever (H) forward to lower position to engage. The reels should now be rotating in the reverse direction.

4. Set reel speed to prevent the backlapping compound from being thrown from the reel blades:

- Hydraulic Reel Motors: Using the flow control knob (E), adjust machine speed to rotate reels at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.
- Electric Reel Motors: Using speed control knob (G), adjust machine speed to rotate reels at 100-200 rpm, or slow enough to prevent the backlapping compound from being thrown from the reel blades.

Note: Apply 60- to 80-grit compound for units with extended service time, and 120-grit compound for new, newly ground reels or when applied on a weekly basis.

5. Apply lapping compound to the rotating reel evenly from one side to the other and back again using a long-handled brush.

6. Allow the reel to spin until quiet. If desired, follow with a 220-grit compound to achieve a smoother finish.

Important: Avoid Damage! Never operate cutting unit in the forward direction until abrasive compounds are removed from the cutting unit. The abrasive compound will dull the cutting edge.

7. Rinse the lapping compound off the cutting unit with low pressure water.

8. Pull the lift-lower lever back to raised position. Pull back on the mow-transport lever to disengage, and shut off the engine.

- For Hydraulic Models: Turn the flow control knob (E) fully counterclockwise. Press in on the release button at the center of the forward/reverse knob (D) and push the knob in until it locks into the forward position.
- For Electric Models: Move mow backlap switch to “Mow” position. Move forward-reverse switch to the forward position.

9. Check reel-to-bed knife clearance. (See “Adjust Bed Knife to Reel Clearance QA-5” on page 629, or “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.

10.Prepare cutting units for mowing. (See “Rotating Reel Cutting Units” on page 646.)

11.Adjust reel speed. (See “Adjust Reel Speed” on page 623.)

Results

Reel and bed knife should be sharp and free from minor nicks and scratches.

Adjust Height-of-Cut Range QA-5 Reel

Reason

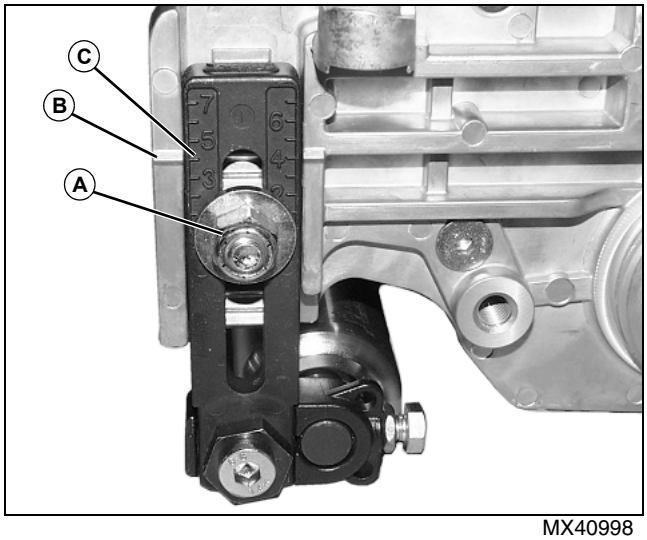
To set front roller range for proper height-of-cut position.

Procedure

1. Remove cutting units from mower. (See “Remove and Install Reel - QA-5 Reel” on page 644.)

2. Place cutting unit on a stable working surface with the front roller facing up.

Note: The effective height-of-cut may differ from the bench setting due to the weight of options used, type of roller (grooved or smooth), soil conditions, grass condition and the use of competitive machines in conjunction with one another.



MX40998

3. Loosen nut (A) on each roller bracket.

4. Align desired mark on roller bracket (C) and cutting unit frame marks (B) on each side of the cutting unit to determine the HOC adjustment range. Each mark represents approximately 5mm (0.2 in.) change in height. Refer to charts for desired setting. Make sure brackets on each side are on the same mark.

5. Tighten nuts.

6. Adjust parallelism of front roller. (See “Adjust Front Roller - QA-5 Reel” on page 627.)

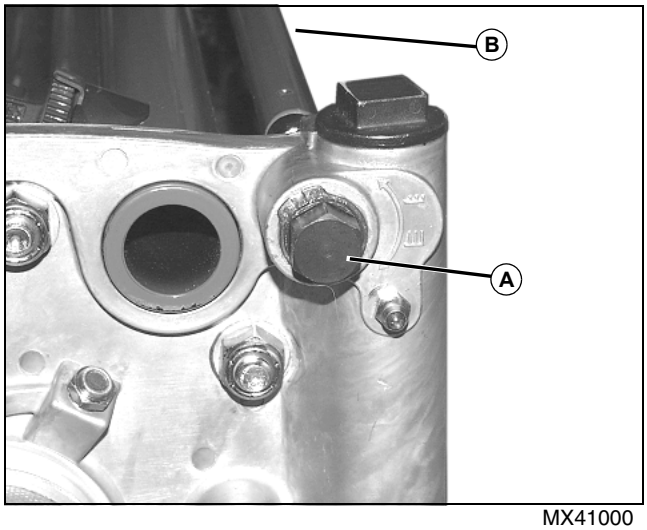
Height-of-Cut Range (2-Inch Front Roller Without FTC)		Front Roller Setting
mm	in.	
Not Recommended	Not Recommended	1
-4 - 4	0.00 - 0.16	2
1 - 9.5	0.04 - 0.37	3
6 - 15	0.24 - 0.60	4
11 - 21	0.43 - 0.83	5
16 - 27	0.63 - 1.06	6
21 - 33	0.83 - 1.30	7

Height-of-Cut Range (3-Inch Front Roller Without FTC)		Front Roller Setting
mm	in.	
4 - 10	0.16 - 0.40	1
9 - 17	0.35 - 0.67	2
12 - 22.5	0.55 - 0.90	3
19 - 28	0.75 - 1.10	4
24 - 34	0.95 - 1.34	5
29 - 40	1.14 - 1.57	6
34 - 46	1.35 - 1.80	7

Height-of-Cut Range (2-Inch Front Roller With FTC)		Front Roller Setting
mm	in.	
Not Recommended	Not Recommended	1
0 - 5	0.00 - 0.00	2
0 - 11	0.00 - 0.43	3
5 - 17	0.20 - 0.67	4
10 - 24	0.40 - 0.94	5
15 - 30	0.60 - 1.18	6
20 - 36	0.80 - 1.42	7

Adjust Height-of-Cut (HOC) - QA-5 Reel

1. Park machine safely.

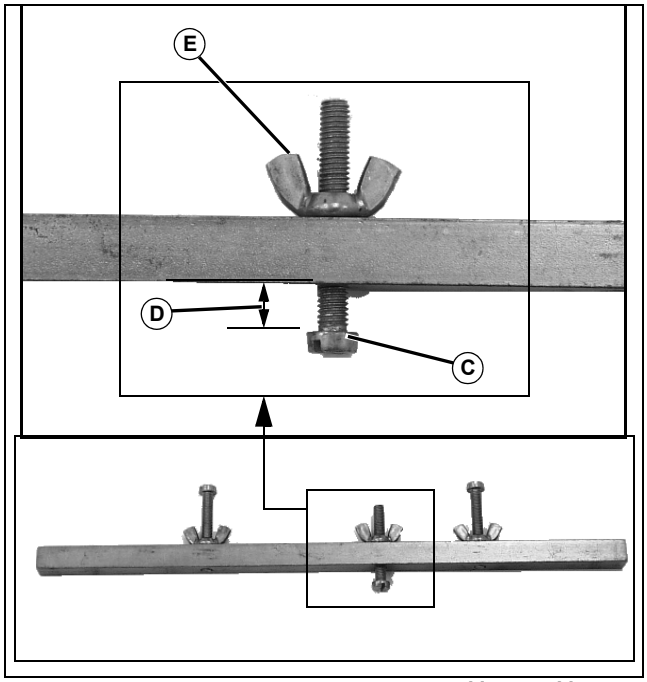


MX41000

2. Locate the height of cut adjuster (A) on top rear of reel side casting (either side).

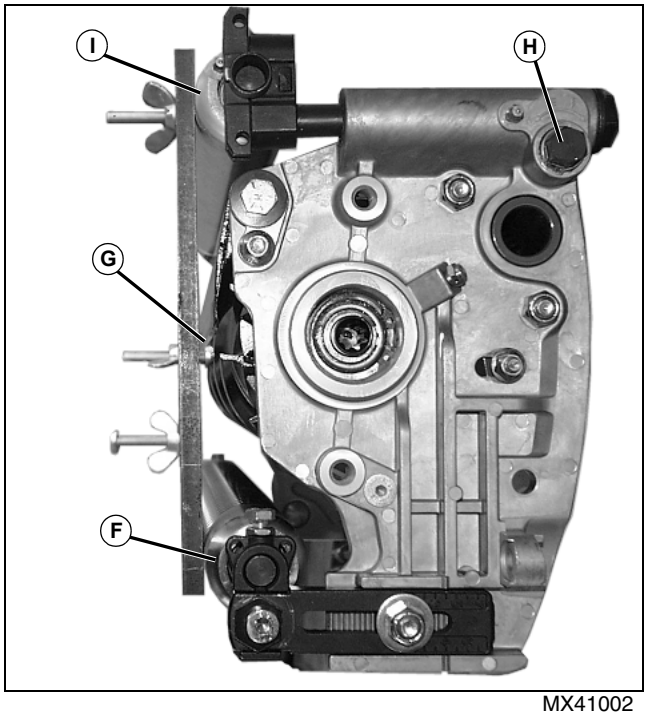
3. Turn the height of cut adjustment counterclockwise to shorten height of cut or clockwise to lengthen height of cut.

NOTE: Adjusters are connected with cross shaft (B) so turning one side simultaneously turns the other.



M97423, M97422

4. On the height-of-cut (HOC) gauge bar, set center adjustment bolt head (C) at the desired height of cut (D). Lock wing nut (E).



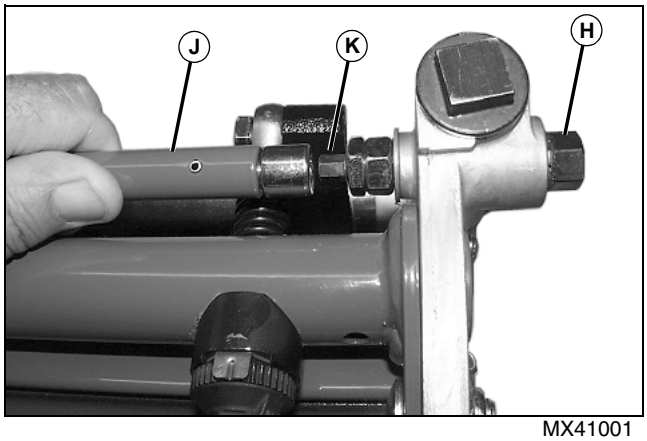
MX41002

5. Rest HOC gauge bar against front roller (F) approximately 51 mm (2 in.) from the end of the bed knife. Set the inside of the bolt head (G) against the edge of the bed knife.

Note: Bottom of screw head on gauge bar should be engaged with cutting edge of bedknife.

6. Turn adjuster (H) until the rear roller (I) contacts the HOC gauge bar. Repeat for the other side of the cutting reel.

7. Check if rear roller is parallel to the front rollers and adjust if necessary.



MX41001

8. If rear roller parallel adjustment is necessary, pull against spring tension on cross shaft (J) to disconnect it from hex coupling (K). Remove the cross shaft.

9. Turn adjuster (H) until side to side parallelism is equal, and then reinstall cross shaft.

Adjust Front Roller - QA-5 Reel

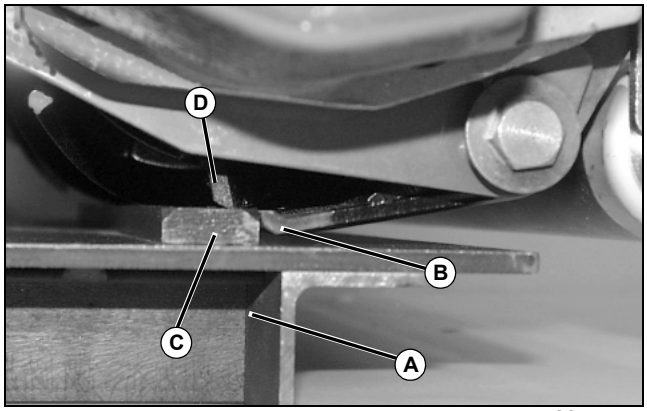
NOTE: Use of a bench plate or a three bolt height-of-cut gauge bar is recommended when adjusting front roller parallel with the bed knife.

Always adjust bed knife-to-reel before adjusting front roller for parallelism.

Always make parallelism adjustment after adjusting front roller height of cut range.

Parallelism Adjustment with Bench Plate

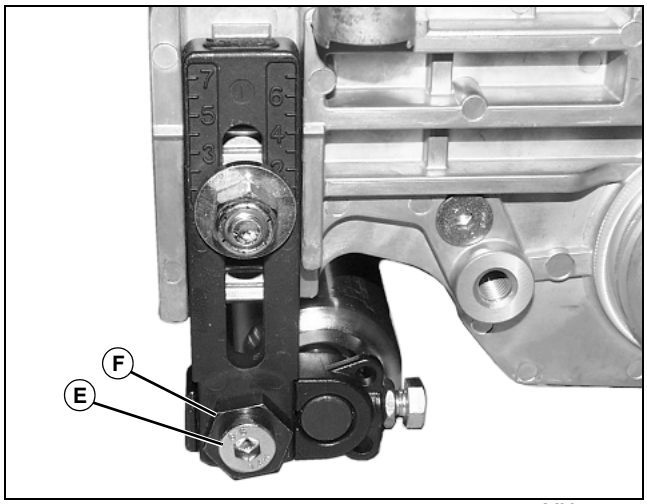
1. Position cutting unit upright on flat surface or workbench.



M97254

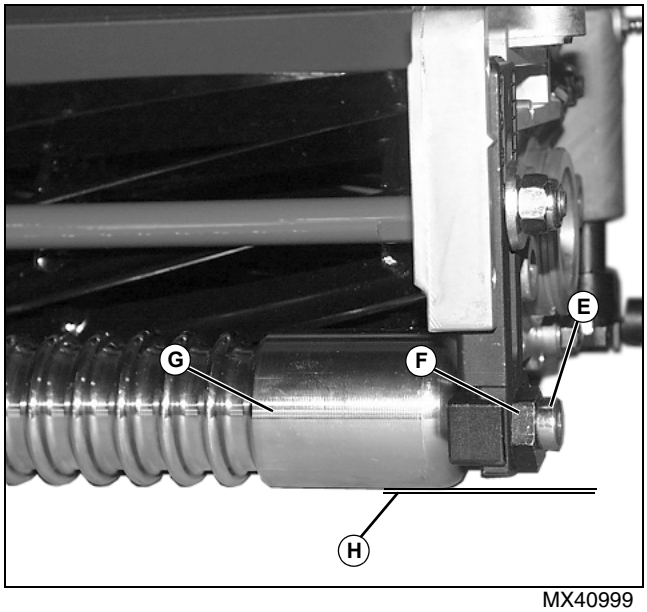
2. Set bench plate (A) on a level surface.

3. Set cutting unit on top of bench plate. The bed knife (B) must rest firmly against the plate stop (C), with the cutting reel blade (D) on top of plate stop.



MX40998

4. Loosen capscrew (E) on one of the roller brackets.

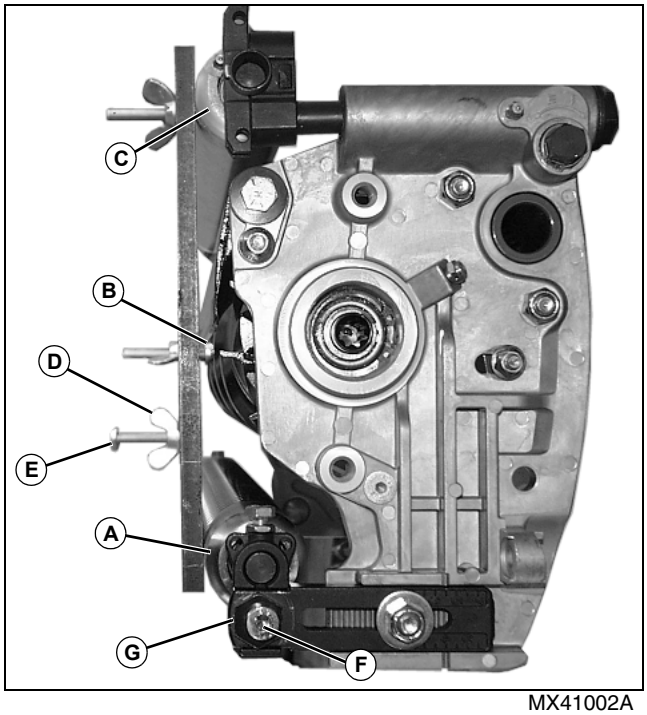


MX40999

5. Rotate eccentric adjuster (F) until the front roller (G) sits flat and parallel with the bench plate. Gap (H) should not exceed 0.050 mm (0.002 in.) maximum.

6. Hold roller eccentric adjuster (F) and tighten capscrew (E).

Parallelism Adjustment with HOC Gauge Bar



MX41002A

1. Position cutting unit upright on flat surface or workbench.

2. Rest HOC gauge bar against front roller (A) approximately 51 mm (2 in.) from the end of the bed knife. Set the inside of the bolt head (B) against the edge of the bed knife.

3. Hold end of gauge bar against the bottom of front roller (C).

4. Loosen wing nut (D). Turn lower gauge screw (E) clockwise until top of screw makes contact with flat edge of bed knife.

5. Tighten wing nut (D).

6. Adjust position of front roller:

   - Loosen socket head capscrew (F) and rotate eccentric adjuster (G) until top of lower gauge screw (E) makes contact with the bed knife.

7. Repeat procedure for opposite side.

Adjust Cutting Unit Shield QA-5

Reason

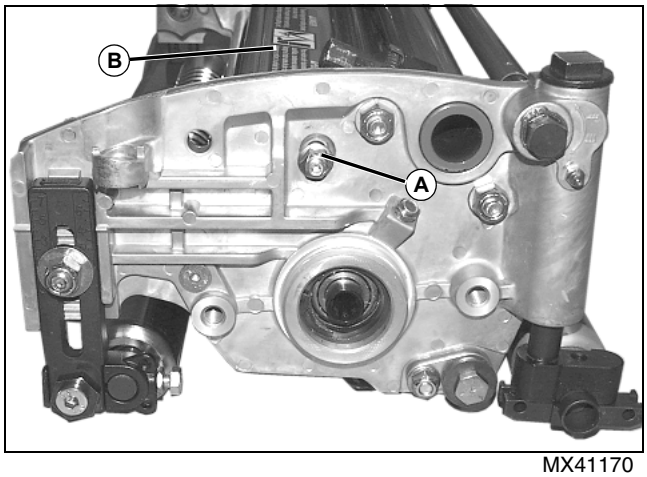
Correct adjustment of the cutting shield improves the performance of the grass catcher.

Procedure

Caution: Avoid Injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Rotate reels for service. (See “Rotating Reel Cutting Units” on page 646.)

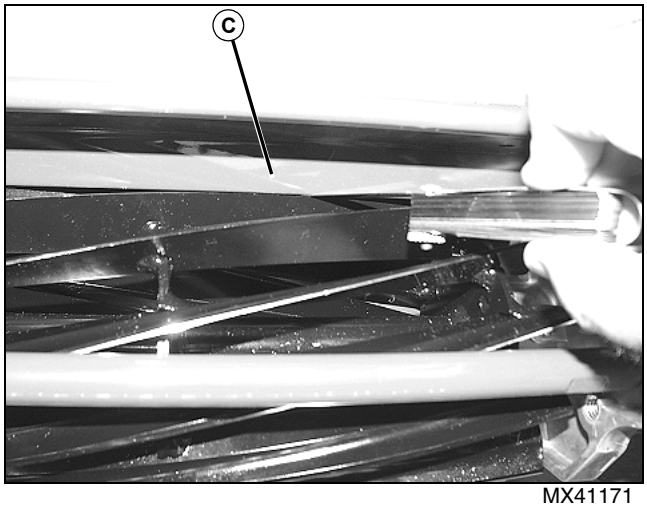
2. Place cutting unit on a stable working surface.



MX41170

3. Loosen two bolts (A) and locknuts on each side of cutting unit.

4. Raise or lower shield (B) to specification.



MX41171

5. Maintain an approximate 1.5 mm (0.06 in.) clearance (C) between the bottom of the shield and the top of the cutting blades.

6. Tighten bolts and locknuts.

Results

Proper clearance between shield and cutting blades will result in greater grass catching performance.

Specifications

Cutting Shield Clearance . . 1.5 mm (0.06 in.) Maximum

Adjust Bed Knife to Reel Clearance QA-5

Reason

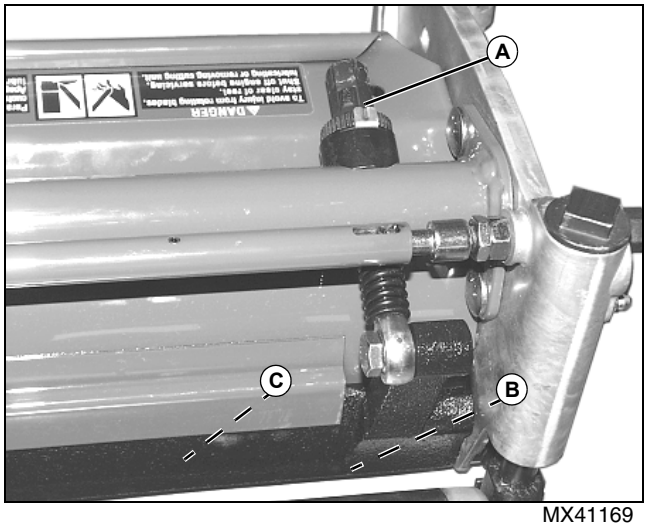
To maintain bed knife to reel clearance for clean, consistent cutting.

Procedure

Caution: Avoid Injury! Always wear protective gloves when working on or near the cutting reel or bed knife. Severe personal injury can result from contact with the sharp cutting edges.

1. Remove cutting units from mower. (‘See “Remove and Install Cutting Unit” on page 638.)

2. Position cutting unit upright on workbench as shown.

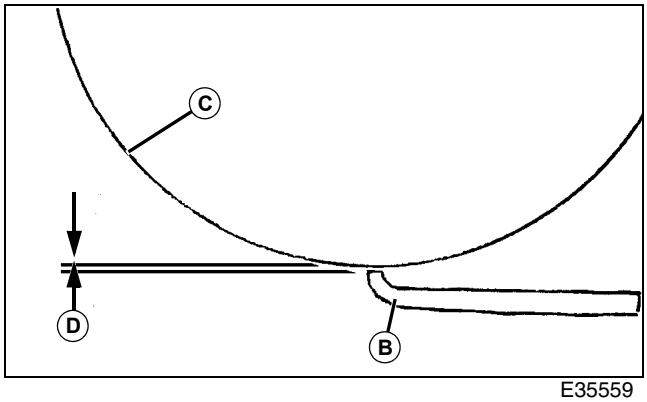


MX41169

3. Turn bed knife tower adjuster (A) on each side of cutting unit counterclockwise equal amounts until bed knife (B) is tight against cutting reel (C)

4. Slowly tighten tower adjuster (A) clockwise, alternating from side to side until bed knife begins to pull away from the cutting reel. Cutting reel should rotate freely.

Note: Make sure that when making the final adjustment, the bed knife is moving away from cutting reel.



E35559

5. Alternately turn adjusters (A) no more than one flat at a time until bed knife (B) to reel (C) clearance (D) measures 0.025 mm to 0.050 mm (0.001 in. to 0.002 in.).

Important: Avoid Damage! Always rotate the cutting wheel backwards to prevent damaging or dulling the cutting edges of the reel and/or bed knife.

6. Slowly rotate the cutting reel backwards and check the gap at several points along the entire length of the bed knife using a 0.050 mm (0.002 in.) feeler gauge. The feeler gauge should not pass between the bed knife and cutting reel at any point.

Results

- **If the gap is 0.050 mm (0.002 in.) or greater at the center of the bed knife:** Grind the reel and/or bed knife to eliminate the “smile” in the bed knife or the out-of-round condition of the reel.
- **If there is contact at the center of the bed knife:** Grind the reel and/or bed knife to eliminate the “frown” in the bed knife or the out-of-round condition of the reel.

Specifications

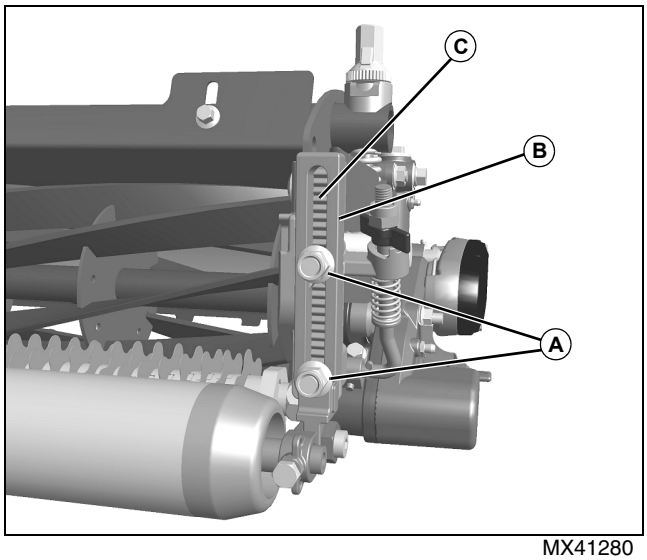
Reel-to-Bed Knife Clearance . . . . . 0.05 mm (0.002 in.)

Adjust Height-of-Cut Range QA-7

Adjust front roller brackets for the height of cut (HOC) range desired.

1. Remove cutting unit(s) from machine. See “Remove and Install Cutting Unit” on page 638

2. Select height-of-cut (HOC) adjustment range by adjusting the position of both front roller brackets.



MX41280

3. Loosen nuts (A) on each roller bracket.

4. Align desired mark on roller bracket (C) and cutting unit frame marks (B) on each side of the cutting unit to determine the HOC adjustment range. Each mark represents approximately 5 mm (0.2 in.) change in height. Make sure brackets on each side are on the same mark (see chart below). Tighten nuts.

5. Adjust front roller brackets for the height of cut (HOC) range desired. Refer to charts for desired setting.

Height-of-Cut Range (3-Inch Front Roller Without FTC)		Front Roller Setting
mm	in.	
9 - 16	0.35 - 0.63	1
14 - 21	0.55 - 0.83	2
19 - 26	0.75 - 1.02	3
24 - 31	0.95 - 1.22	4
29 - 37	1.14 - 1.46	5
34 - 42	1.34 - 1.65	6
39 - 47	1.53 - 1.85	7
44 - 52	1.73 - 2.05	8
49 - 58	1.93 - 2.28	9
54 - 63	2.13 - 2.48	10

Height-of-Cut Range (3-Inch Front Roller With FTC)		Front Roller Setting
mm	in.	
9 - 17	0.35 - 0.71	1
14 - 23	0.55 - 0.91	2
19 - 28	0.75 - 1.10	3
24 - 33	0.95 - 1.30	4
29 - 39	1.14 - 1.54	5
34 - 44	1.34 - 1.73	6
39 - 49	1.53 - 1.93	7
44 - 54	1.73 - 2.13	8
49 - 60	1.93 - 2.36	9
54 - 63	2.13 - 2.48	10

Adjust Height-of-Cut (HOC) QA-7

Caution: Avoid Injury! Do not service or adjust cutting units while the engine is running. Shut off engine prior to making any adjustments.

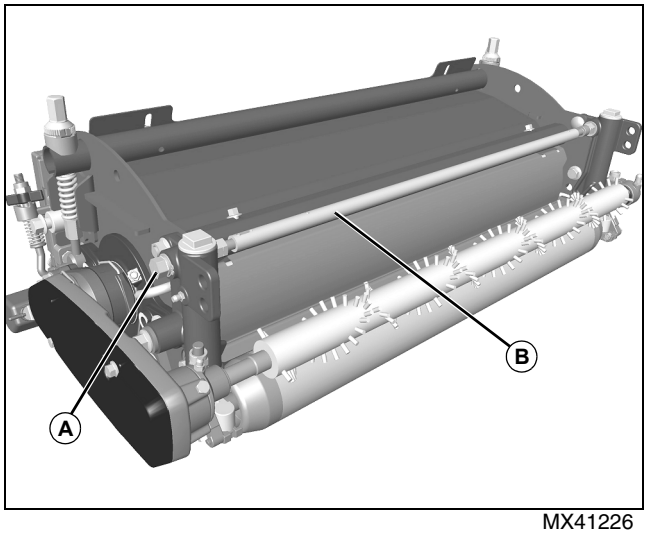
Always wear protective gloves when working on or near the reel or bed knife.

Never allow more than one person at a time to work on any one cutting unit. Never allow adjustments to be made on more than one cutting unit at the same time.

Important: Avoid Damage! All cutting units must be set at the same height to obtain an even cut. Never adjust rollers so that there is more than 1.6 mm (1/16 in.), or one notch, difference between front and back rollers or cutting geometry will be affected. Floating units will not provide a quality cut in grass over approximately 38 mm (1-1/2 in.) tall.

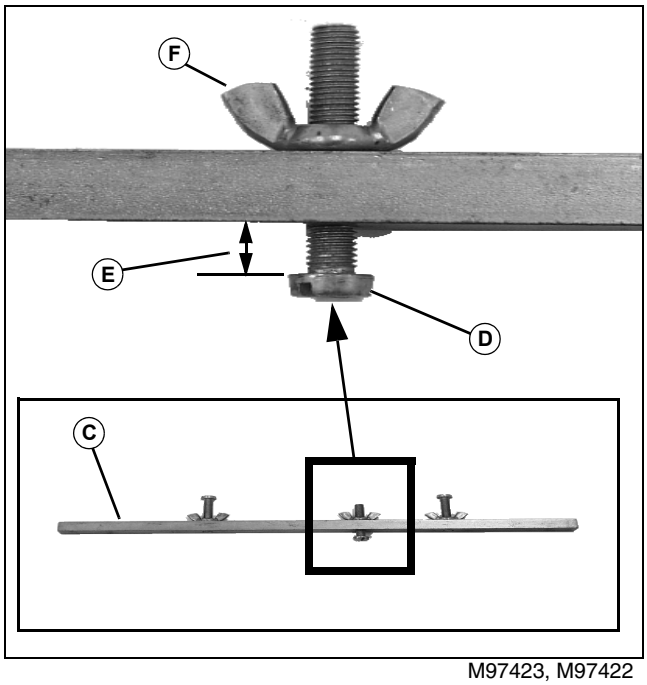
1. Remove cutting unit(s) from machine. See “Remove and Install Cutting Unit” on page 638.

NOTE: Adjusters (A) are connected with cross shaft (B) so turning one side simultaneously turns the other.



MX41226

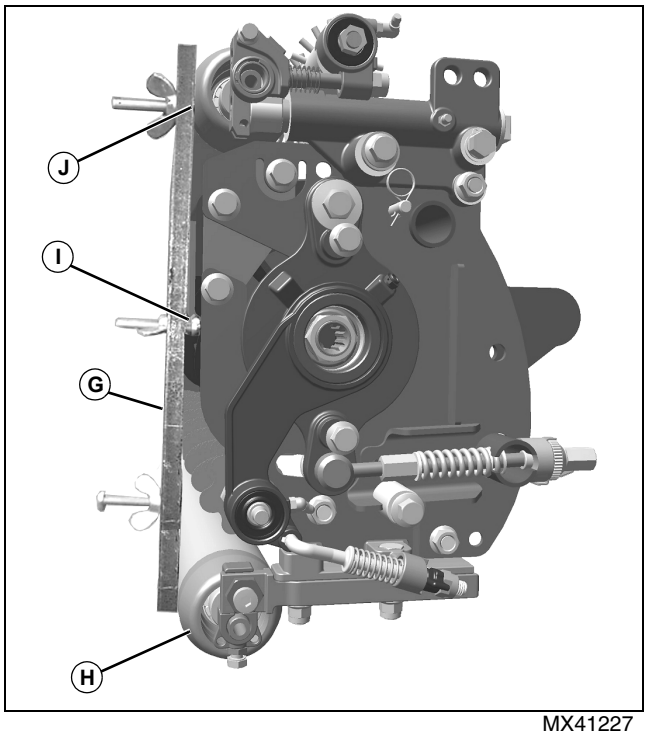
2. Adjust reel-to-bed knife before adjusting HOC.



M97423, M97422

3. On the height-of-cut (HOC) gauge bar (C), set center adjustment bolt head (D) at the desired height of cut (E). Lock wing nut (F).

4. Back out or remove outside adjustment bolts so they do not interfere with adjustment.

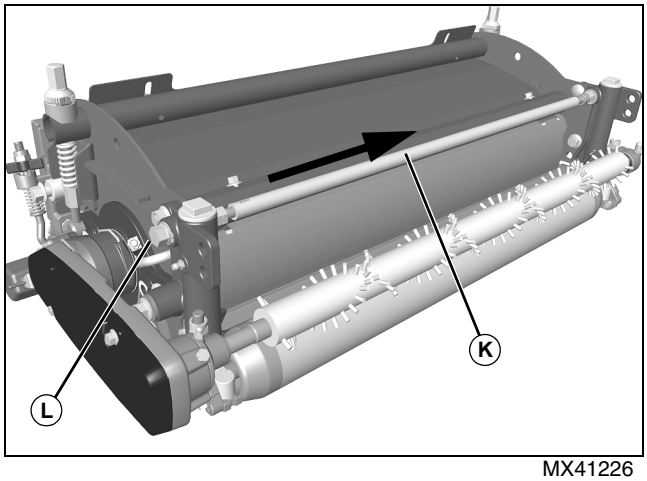


MX41227

5. Rest HOC gauge bar (G) against front roller (H) approximately 51 mm (2 in.) from the end of the bed knife. Set the inside of the bolt head (I) against the edge of the bed knife.

6. Turn HOC adjuster until the rear roller (J) contacts the HOC gauge bar. Repeat for the other side of the cutting reel.

7. Check HOC adjustment setting from side to side and adjust if necessary.



MX41226

8. If side to side HOC adjustment is necessary, pull against spring tension on cross shaft (K) to disconnect it from hex coupling. Remove the cross shaft.

9. Turn adjuster (L) until side to side HOC is equal, and then reinstall cross shaft (K).

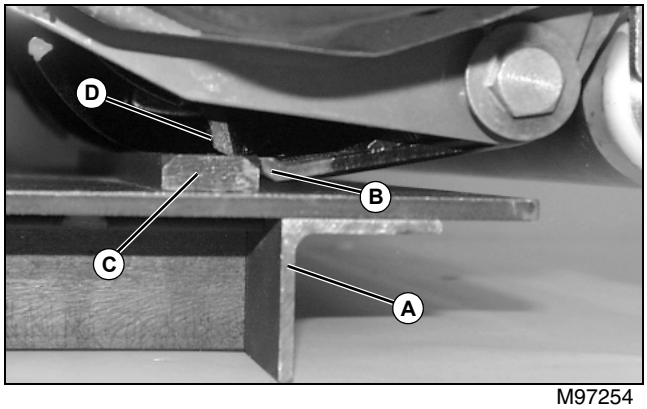
Adjust Front Roller QA-7

Parallelism Adjustment with Bench Plate

Caution: Avoid Injury! Rotating blades are dangerous. Before adjusting or servicing mower:

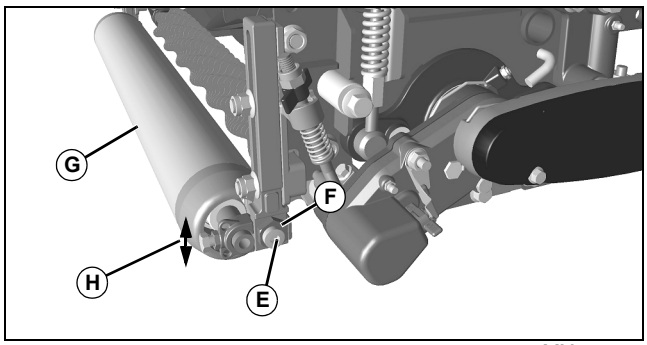
- **Disconnect spark plug wire(s) or battery negative (-) cable to prevent engine from accidentally starting.**
- **Always wear gloves when handling mower blades or working near blades.**

1. Position cutting unit upright on flat surface or workbench.



M97254

2. Set bench plate on a level surface. Set cutting unit on top of bench plate (A). Bed knife (B) must rest firmly against plate stop (C) with cutting reel blade (D) on top of plate stop.



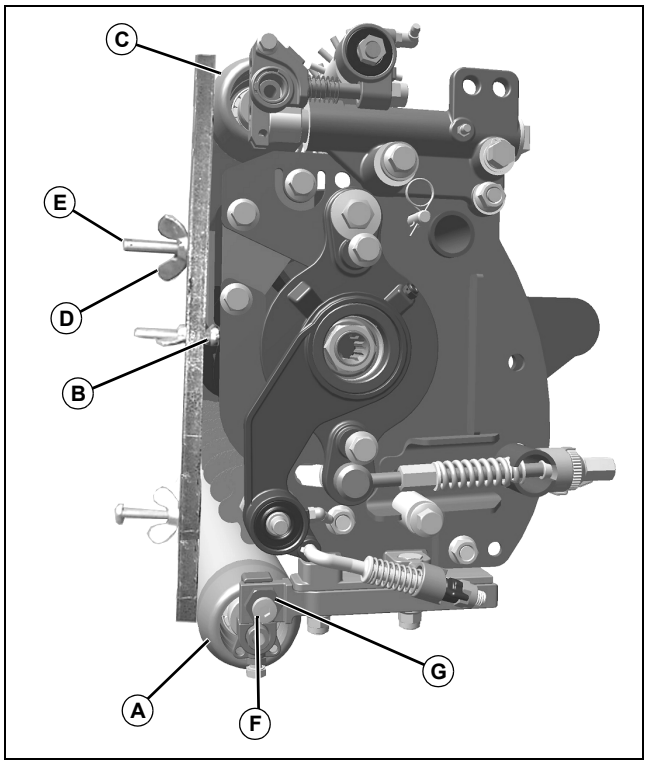
MX41220

3. Loosen socket head cap screw (E) on one of the roller brackets.

4. Rotate eccentric adjuster (F) until the front roller (G) sits flat and parallel with the bench plate. Gap (H) should not exceed 0.050 mm (0.002 in.) maximum.

5. Hold roller eccentric adjuster (F) and tighten socket head cap screw (E).

Parallelism Adjustment with HOC Gauge Bar



MX41227A

1. Position cutting unit upright on flat surface or workbench.

2. Rest HOC gauge bar against front roller (A) approximately 51 mm (2 in.) in from the side end of the bed knife. Set the inside of the bolt head (B) against the edge of the bed knife.

3. Loosen wing nut (D). Turn lower gauge screw (E) clockwise until top of screw makes contact with flat edge of bed knife.

4. Tighten wing nut (D).

5. Hold end of gauge bar against the bottom of rear roller (C).

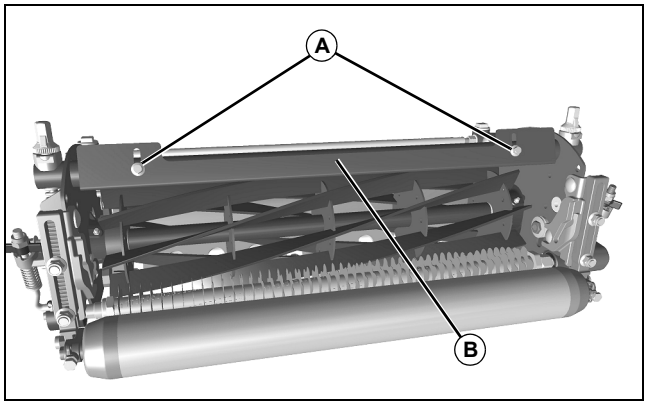
6. Adjust position of front roller:

   - Loosen socket head cap screw (F) and rotate eccentric adjuster (G) until top of lower gauge screw (E) makes contact with the bed knife.

7. Repeat procedure for opposite side.

Adjust Cutting Unit Shield QA-7

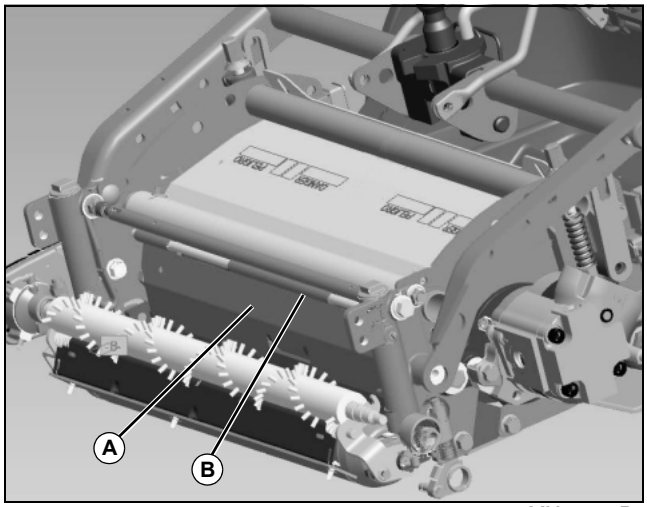
NOTE: Keeping the shield close to the cutting blades improves the performance of the grass catcher in most conditions.



MX41274

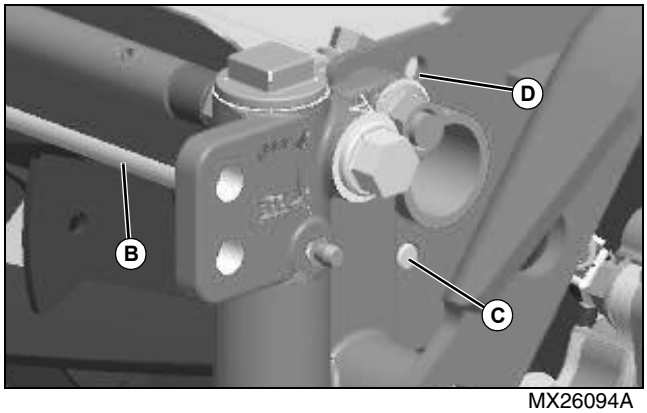
1. Loosen two bolts (A) and locknuts on each side of cutting unit.
2. Raise or lower shield (B) to desired position.
   - Maintain an approximate 1.5 mm (0.06 in.) clearance between the bottom of the shield and the top of the cutting blades.
3. Tighten bolts.

Adjusting Grass Deflector QA-7



MX26095B

1. To change deflector position slide deflector (A) to one side and opposite side rod (B) will slide out.



MX26094A

2. There are three positions for the deflector, completely closed, partially open, and completely open. For completely closed and partially open positions rod (B) needs to be in position (C). For completely open position place rod (B) into position (D).
3. When deflector is in the completely closed position make sure the deflector clips onto the bedknife shoe so no discharge will occur.

Adjust Reel-to-Bed Knife Clearance QA-7

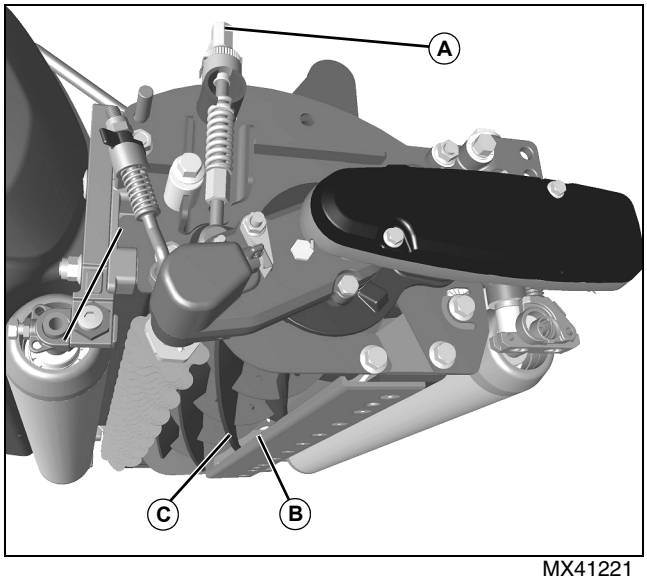
Caution: Avoid Injury! Blades are sharp. Always wear gloves when handling blades or working near blades.

Important: Avoid Damage! Adjust reel to bed knife clearance by lowering and raising the reel evenly.

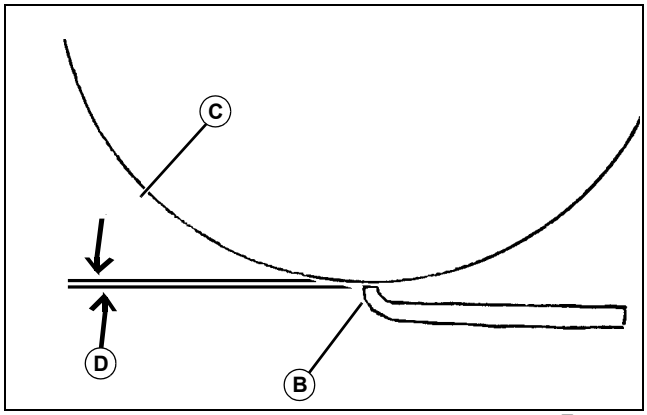
Do not adjust more than one notch on the adjuster bolt at a time, and alternate side to side.

1. Raise reels slightly off the ground to gain access to underside of each reel.
2. Park machine safely. (See “Park Machine Safely” in the Safety section.)

Note: Each notch on the adjustment bolt (A) represents 0.025 mm (0.001 in.) movement of the reel (C).



MX41221



E35559

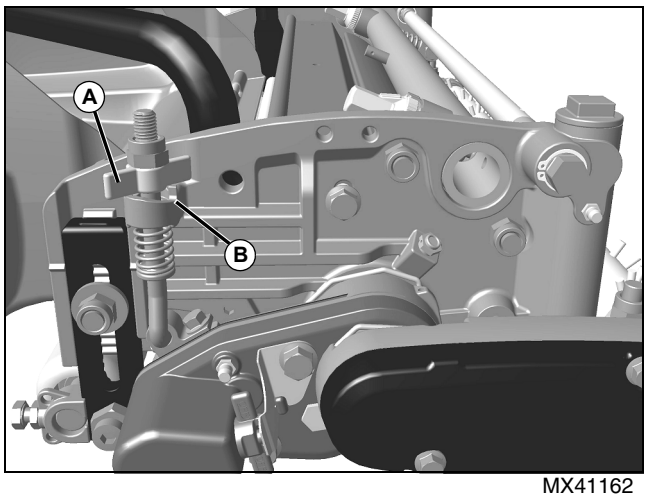
3. Alternately turn adjustment bolts (A) (one on each side) evenly (no more than one notch at a time) until bed knife starts making contact with the reel. Turn adjusters back one click at a time and check reel (C) to bedknife (B) clearance at center of reel (D) with a feeler gauge until clearance measures 0.050 mm (0.002 in.).

4. Check the bed knife-to-reel clearance (D) on the outer left and outer right side of the reel.

5. If clearance measurements cannot be kept within 0.050 mm (0.002 in.) across length of bedknife, you will need to grind the reel and bed knife.

Adjusting Fairway Tender Conditioner

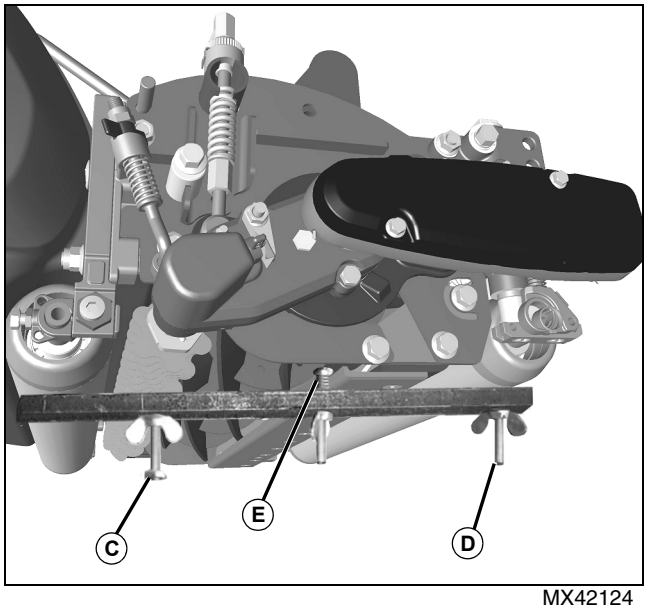
Note: Height Of Cut must be adjusted prior to adjusting the Fairway Tender Conditioner. (See "Adjust Height-of-Cut (HOC) - QA-5 Reel" on page 626.)



MX41162

1. Rotate FTC adjuster wing nuts (A) to lower the FTC to the cutting position. Wings should be at the lowest part of the ramp (B).

2. Position cutting unit to make height of cut adjustment.

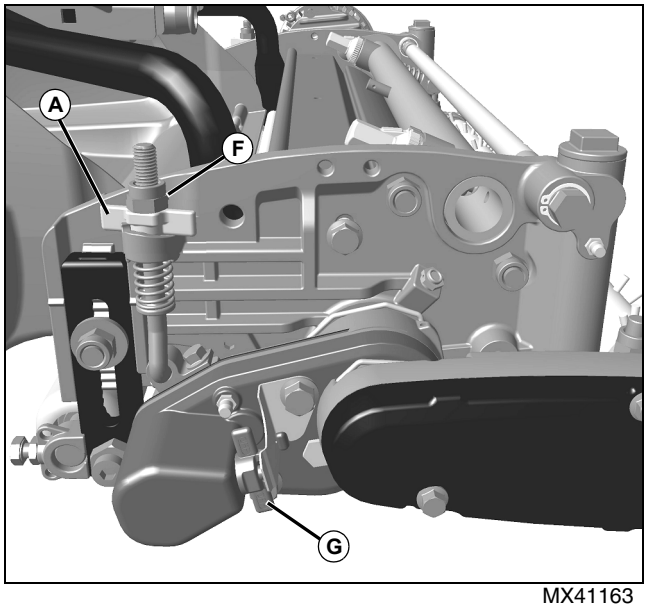


MX42124

3. Set FTC adjustment screw (C) on the gauge bar to the desired operating height.

- Adjustment screw (D) may need to be loosened so that the gauge bar can rest on both the front and rear rollers.

4. Place preset gauge bar on cutting unit. Hook height of cut screw (E) on bed knife. The ends of the bar should rest firmly on the front and rear rollers.



MX41163

5. Turn locknut (F) on each side of the cutting unit to raise or lower FTC roller. Alternate from end to end until the cutting teeth touch the screw on the gauge bar on each side.

6. Remove gauge bar.

7. Rotate FTC adjuster wing nuts (A) to raise or lower conditioner as desired.

Adjust Depth-of-Cut - Vertical Cutting Units

Reason

To set the desired cutting depth.

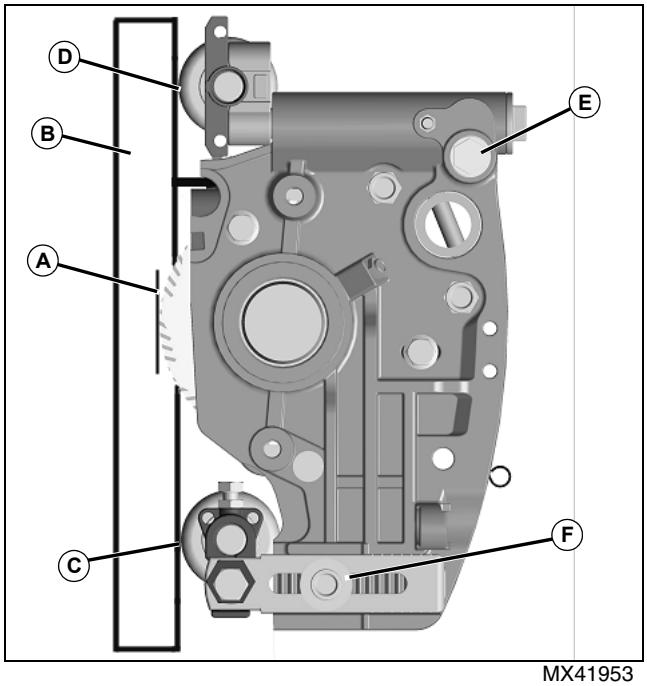
Special or Required Tools

Tool Name	Tool No.	Tool Use
Height-of-Cut Gauge Bar	AMT2978	Used to set desired cutting height.

Procedure

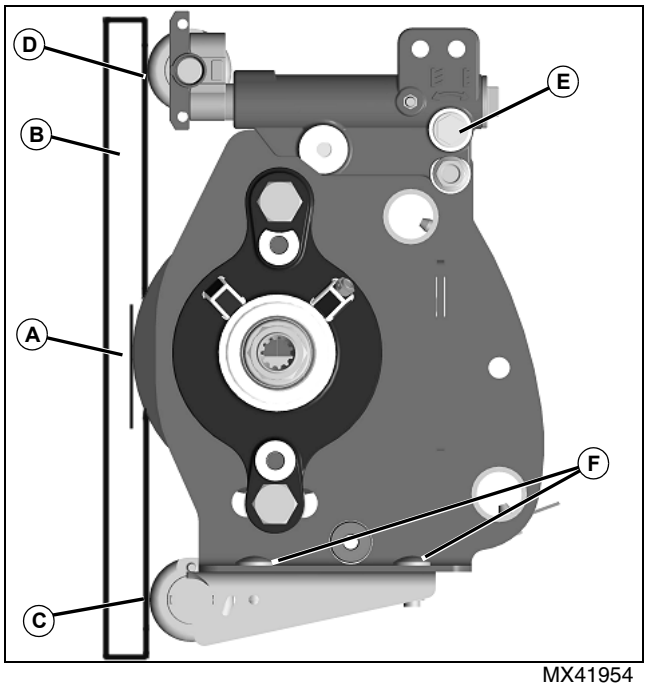
1. Remove cutting units from mower.

2. Place cutting unit on a stable working surface with the front roller facing up.



MX41953

QA-5 Verticut shown



MX41954

QA-7 Verticut shown

3. Mark the desired cutting depth (A) on the gauge bar (B).

4. Place gauge bar across the front and rear rollers (C and D) approximately 50 mm (2 in.) in from the end of the rollers.

5. Turn adjuster (E) until the leading edge of the vertical cutting unit blade aligns with the cutting depth on the gauge bar.

6. Rotate the cutting reel back and forth to ensure the tips

of the cutting blade do not extend past the mark on the gauge bar.

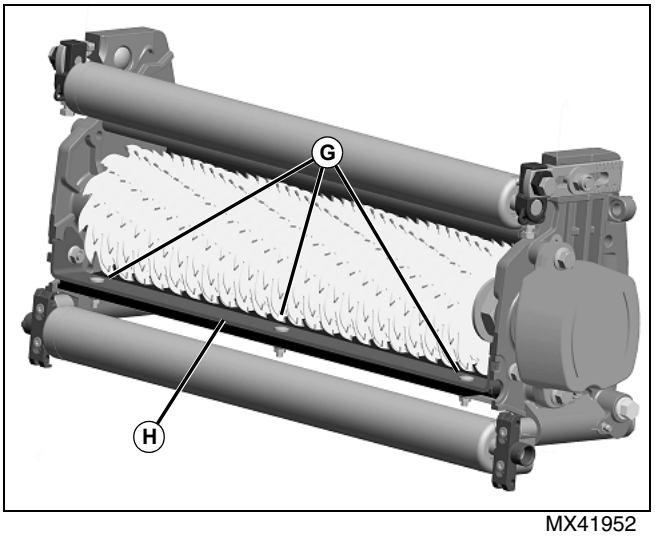
7. If cutting reel can not be adjusted to correct depth it may be necessary to loosen bolts (F) on each side of front roller height adjuster and set depth-of-cut range.

8. Tighten bolts.

Note: Adjustment of flap height will depend on turf conditions.

On short turf, lower flap to prevent material from flying out the rear of the cutting unit.

On turf with a lot of thatch, raise flap to allow the removed thatch to exit out the rear of the cutting unit.



MX41952

9. Loosen three carriage bolts and hex nuts (G).

10.Adjust flap (H) from the bottom of the rollers to specification.

11.Tighten hardware.

Results

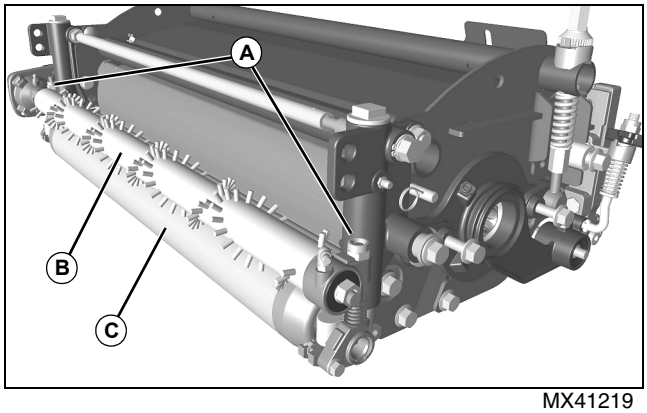
Height-of-cut should be adjusted to desired level, consistently across cutting unit.

Specifications

Vertical Cutting Unit Flap Adjustment . . . . . 13 mm (1/2 in.)

Adjust Rear Roller Power Brush

Note: The brush bristles should just barely clear the full length of the roller. The gap between the brush bristle tips and the roller should be approximately 1 mm (1/32 in.).



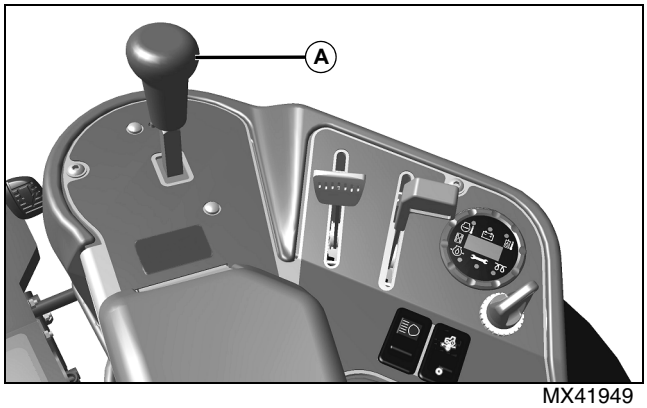
MX41219

1. Loosen or tighten locknuts (A), evenly on both sides to adjust the roller brush (B) bristle tips approximately 1 mm (1/32 in.) away from roller (C).

Adjust Height-of-Cut (HOC) Rotary Deck

Height Adjustment

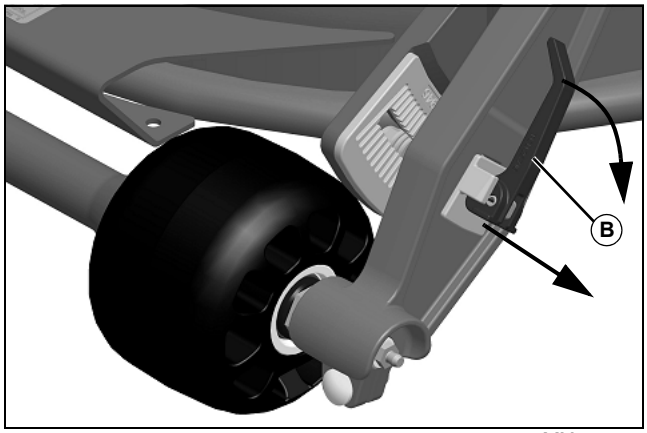
1. Stop machine on level surface.



MX41949

2. Lift cutting units from ground by moving lift-lower lever (A) to the raised position.

3. Lock park brake and stop engine.

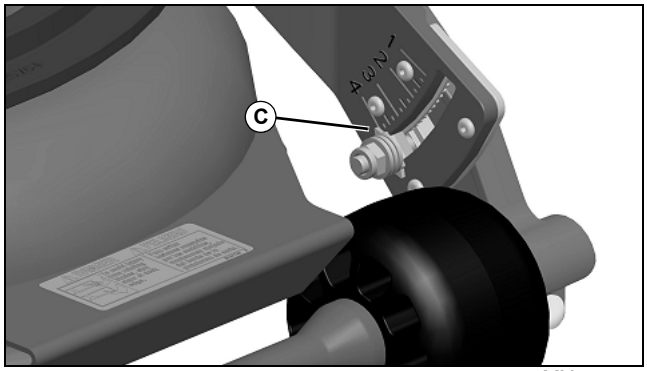


MX41934

4. Pull lever (B) out to from lock position on both sides of

the deck.

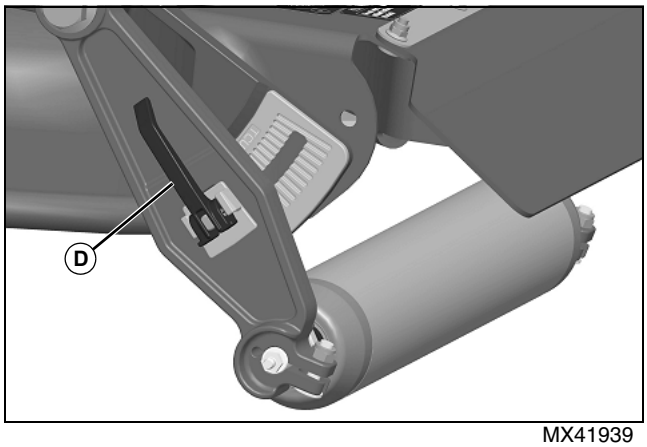
5. Disengage locking teeth by pulling lever outward.



MX41935

6. Once both sides of the roller are disengaged, set to preferred height by sliding height indicator (C) up or down by moving the front axle.

7. Make sure both sides are set to same height . Re-engage locking levers when preferred height is set.



MX41939

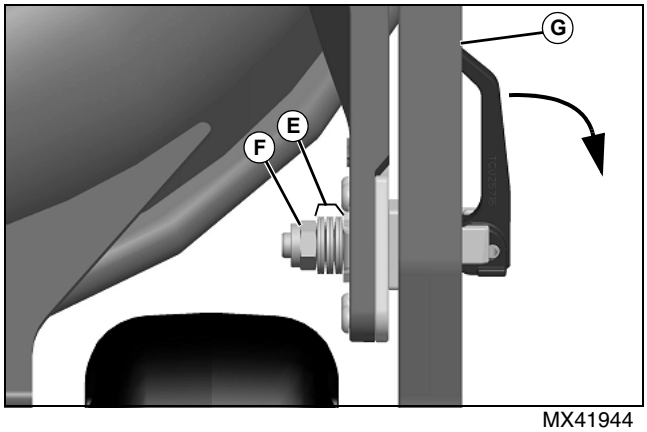
8. Pull lever (D) out to release position on both sides of rotary deck for rear roller.

9. Set rear roller cutting height to same setting as front.

Tension Adjustment

The belleville washers are used to provide tension to the quick release levers. Use this procedure to set quick release lever tension and set compression of cupped belleville washers.

Note: Six belleville washers (E) are used for each height adjuster. The six washers should be arranged in sets of three pairs with the cupped side of the washers facing each other in each pair to act as a compression spring.



MX41944

1. Tighten nut (F) so washers (A) are snugged together and the quick release lever can rotate but is still held in position when set parallel to bracket (G). Do not overtighten nut to compress washers.

2. Repeat as necessary for other height adjusters.

Repair - Reel Units

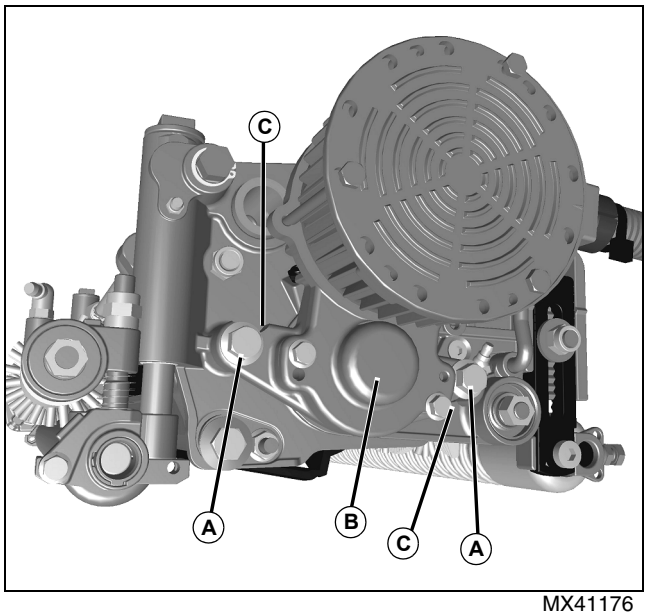
Remove and Install Cutting Unit

Removing and Installing QA-5 Cutting Units

1. Park the machine safely. (See “Park Machine Safely” on page 3.)

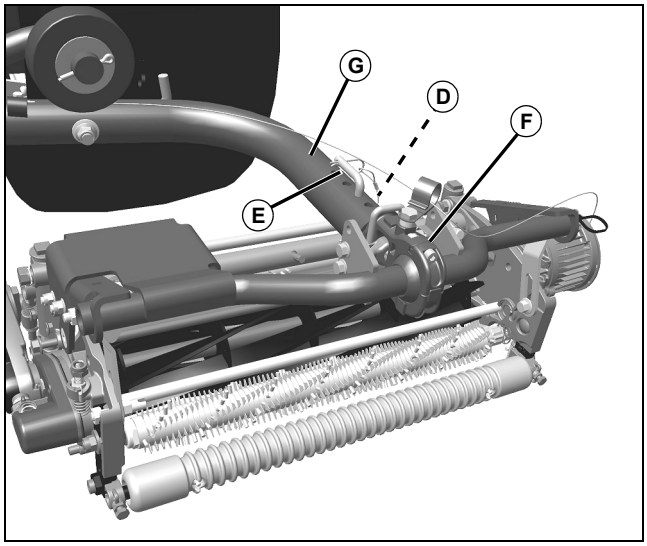
Important: Avoid Damage! Do not roll cutting unit far enough away to place a strain on hydraulic hoses or electrical wiring.

Note: Hybrid units will need to have motor wire harness and tether pulled from J-clamp on the yoke pivot. Then motors need to be placed on platform or on secured location to avoid damage.



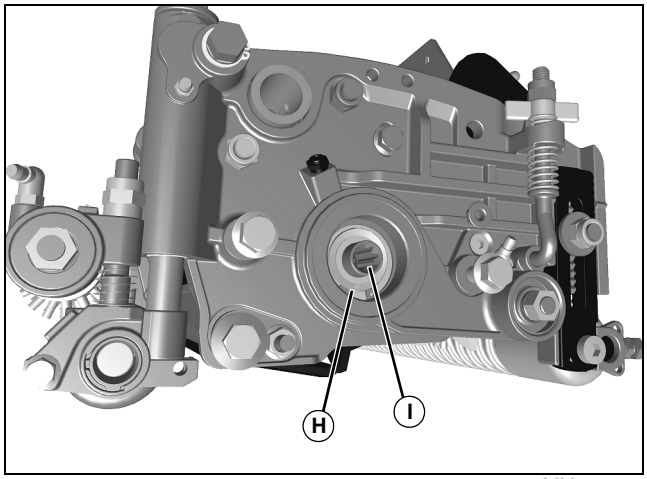
MX41176

2. Loosen two bolts (A), and then rotate and remove motor (B) from housing slots (C).



MX41712

3. Remove lower spring locking pin (D) and pin (E), and roll unit away, disconnecting yoke (F) from lift arm (G).



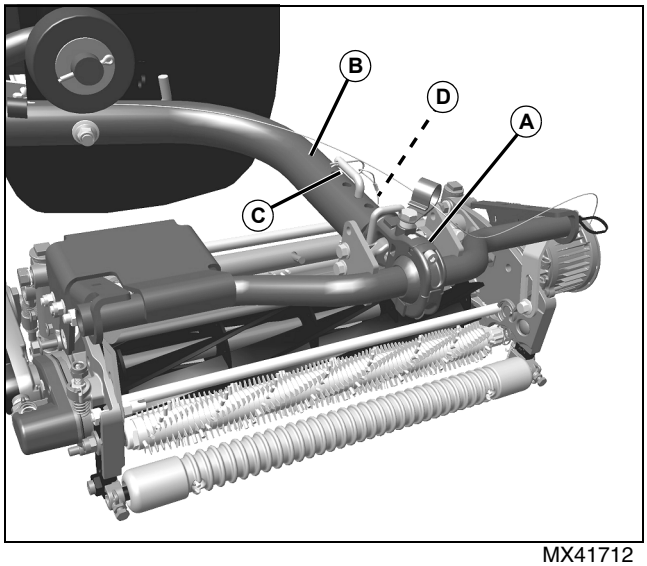
MX41177

4. Inspect inside of reel bearing housing (H) for grease. Add John Deere Special Purpose HD Cornhead Grease to housing if additional lubrication is needed.

5. Check splines (I) for wear. Replace if necessary. Make sure splines are lubricated with grease and splined fitting remains in position on reel shaft.

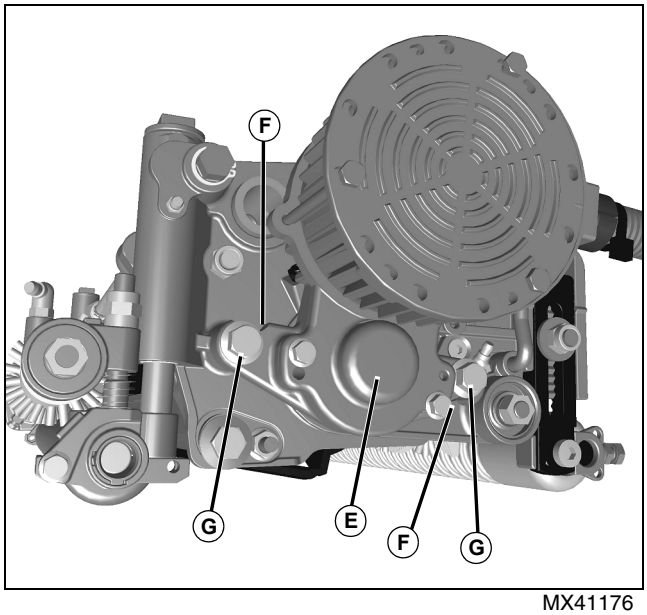
6. Repeat procedure for other cutting units if necessary.

Installing Cutting Units



MX41712

1. Install yoke (A) in lift arm (B).
2. Align yoke pin and lift arm mounting holes.
3. Fasten cutting reel in position with pin (C) and lower spring locking pin (D).

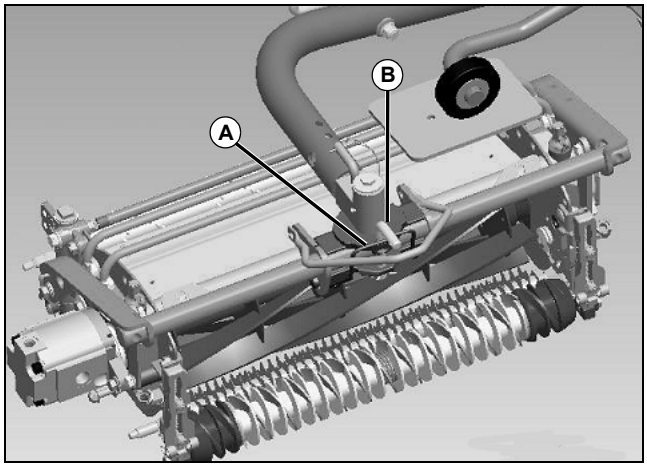


MX41176

4. Install motor (E) onto the reel bearing housing. See “Motor Desired positions 7500-8500 E-Cut Hybrid” on page 641
   - Align reel spline with splined motor drive shaft.
   - Align locking assembly hardware with reel bearing housing slots (F)
   - Tighten assembly bolts (G).
5. Repeat procedure for other cutting units if necessary

Removing and Installing QA-7 Cutting Units

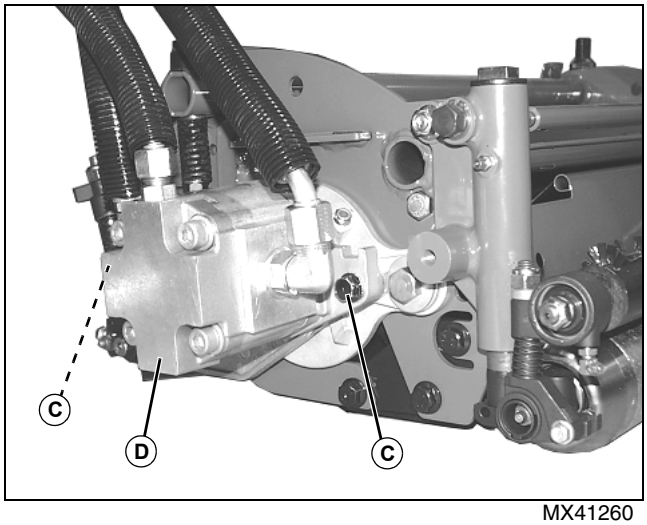
1. Park the machine safely. (See “Park Machine Safely” on page 3.)



MX42126

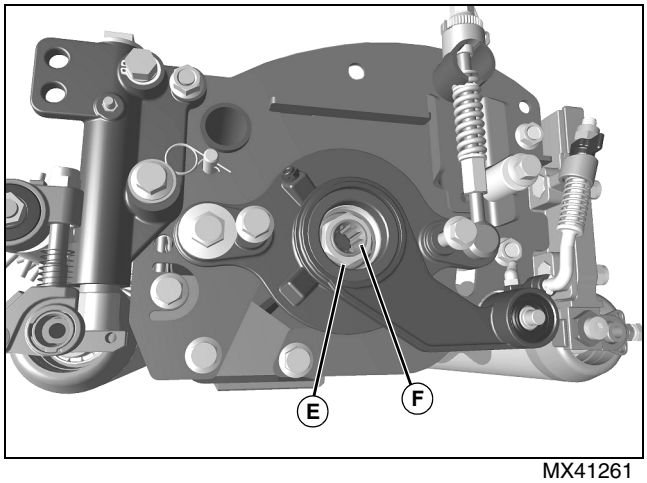
2. Push spring (A) down and remove front pin (B).
3. Pull unit away from the mower.

Note: Disconnect hydraulic hoses only if hydraulic motor is being replaced.

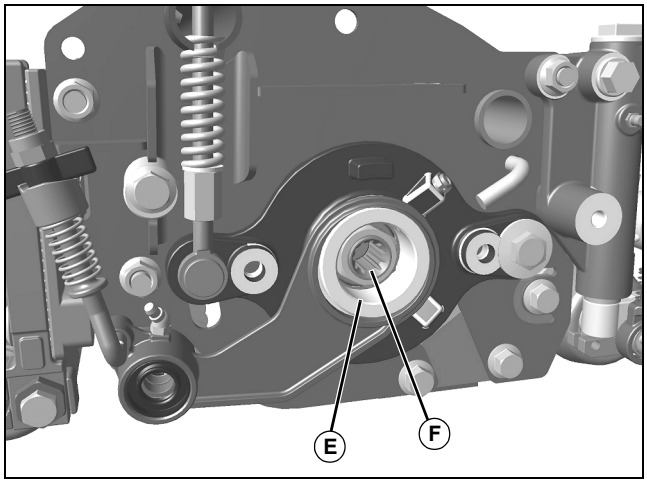


MX41260

4. Loosen two bolts (C), and rotate and remove hydraulic motor (D) from bolts.



MX41261



MX41713

5. Inspect inside of reel bearing housing (E) for grease. Add John Deere Special Purpose HD Cornhead Grease to housing if additional lubrication is needed.

6. Check splines (F) for wear. Replace reel if splines are excessively worn and can't effectively engage motor splines. Make sure splines are lubricated with grease.

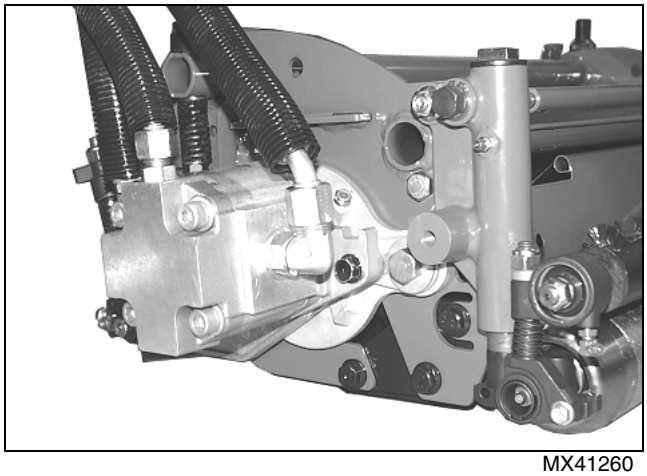
7. Repeat procedure for other cutting units.

Installing Cutting Units

Note: Center cutting unit has two upstop brackets. Right front cutting unit has the steering limiter bracket.

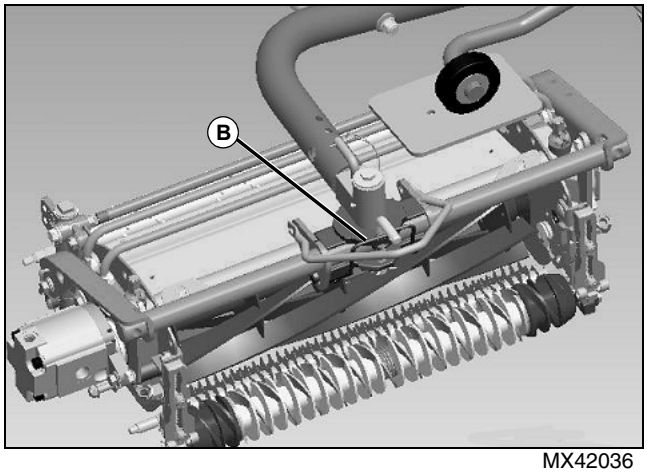
1. Align reel spline with motor drive shaft, and install motor onto the reel bearing housing.

2. Secure assembly with cap screws.



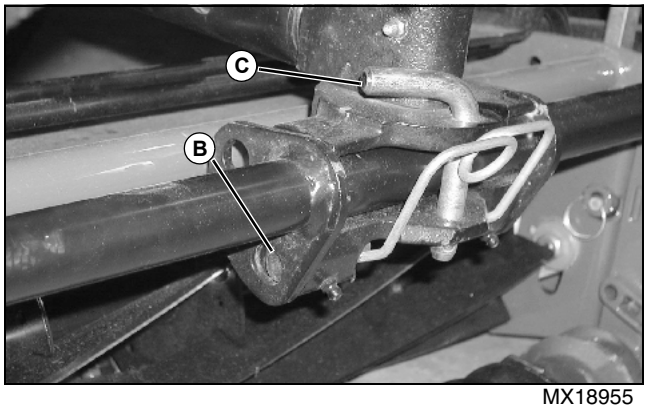
MX41260

3. If the motor was replaced, install three hose hydraulic fittings (A).



MX42036

4. Pull spring (B) down and roll cutting unit into place.

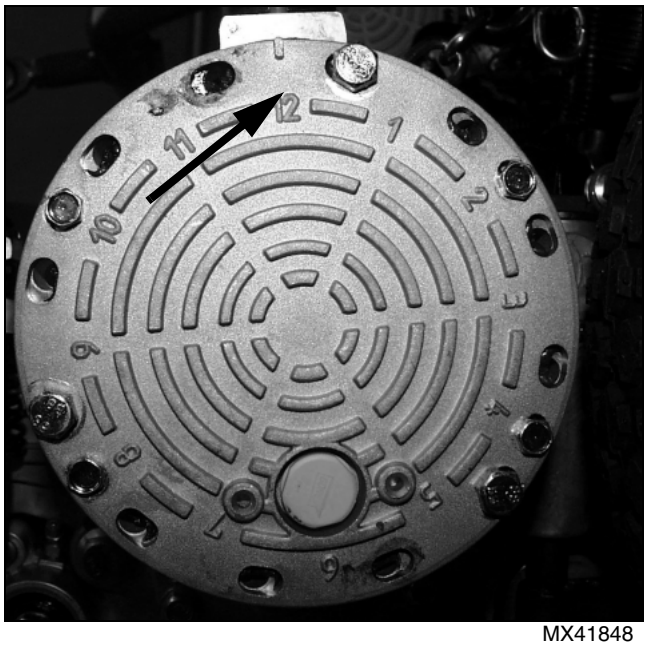


MX18955

5. Align locking pins (C) and release spring (B), to allow locking pins to engage.

6. Insert front pin (D) into place.

Motor Orientation



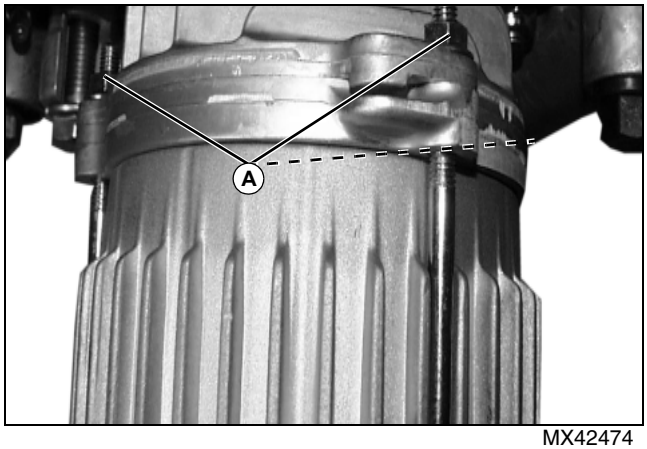
MX41848

The orientation position is determined by the number on the motor which is in the vertical position. Position 12 is shown.

Motor Desired positions 7500-8500 E-Cut Hybrid

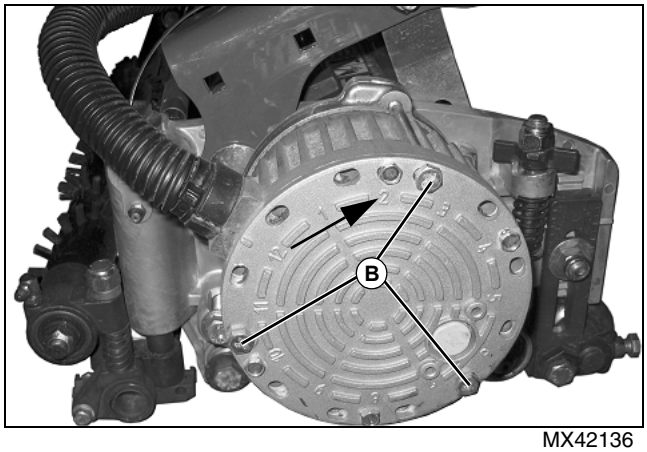
- Rear right reel position 11.
- Rear left reel position 1.
- Front left reel position 12.
- Front right reel position 12.
- Front center reel position 10.

Adjusting Orientation of Motor



MX42474

1. Remove flange nuts (A) on cap screws.



MX42136

Picture Note: Motor shown in position 2

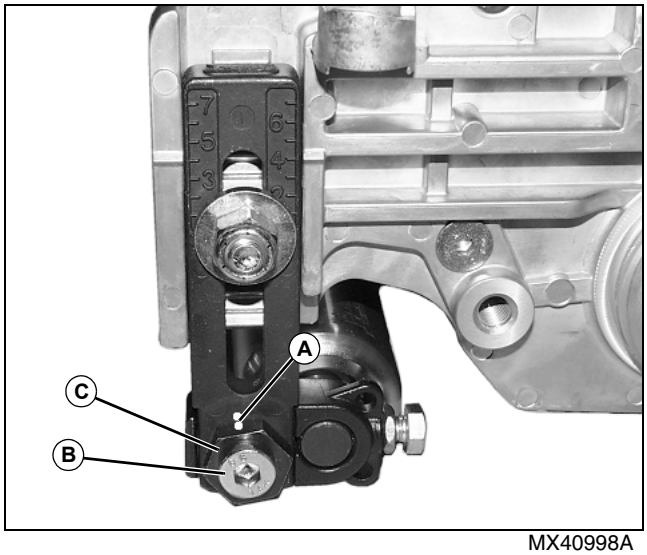
2. Remove cap screws (B) and rotate motor desired number, to vertical position.

3. Install cap screws and flange nuts.

Remove and Install Front Roller - QA-5 Reel

1. Remove cutting units from mower. (See “Remove and Install Cutting Unit” on page 638.)

2. Place cutting unit on a stable working surface with the front roller suspended.



MX40998A

3. Place marks (A) on each eccentric and roller bracket for reassembly purposes.

4. Remove eccentric cap screw (B) and eccentric adjuster (C) on each end of roller.

5. Remove roller and end bracket assembly.

Installation

Installation is done in the reverse order of removal.

Note: Roller brackets are offset. For standard use, the

bracket should be installed on the roller with the offset to the rear of the cutting unit.

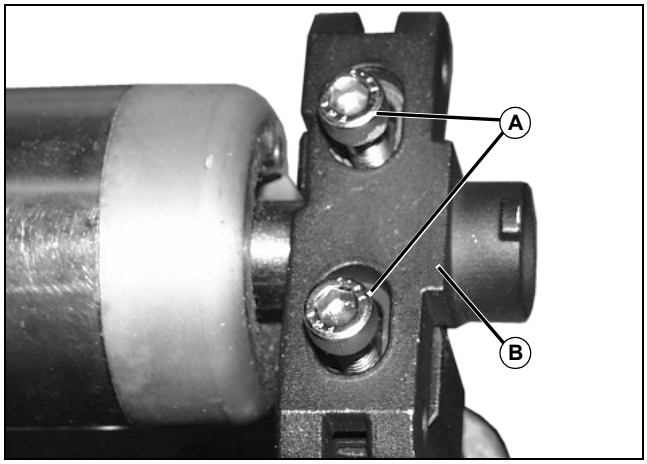
If Fairway Tender Conditioner (FTC) is installed, the bracket should be installed on the roller with the offset to the front of the cutting unit.

- Install roller with eccentrics and cap screws.
- Align marks made during disassembly on eccentrics and brackets.
- Tighten cap screws.
- Check roller height of cut and parallelism adjustments. (See “Adjust Front Roller - QA-5 Reel” on page 627.)

Remove and Install Rear Roller - QA-5 Reel

Removal

1. Remove cutting units from mower. (See “Remove and Install Cutting Unit” on page 638.)
2. Remove roller brush (if equipped).
3. Place cutting unit upside down on a stable working surface (rollers facing up).



MX41005

4. Remove cap screws (A) and caps (B) on both sides of cutting unit.
5. Remove roller.

Installation

1. Install roller bearing spindle shaft into cutting unit.
2. Center rear roller between brackets.
3. Install caps (B) and cap screws (A) on both sides of cutting unit.
4. Tighten cap screws.

Remove and Install Bed Knife - QA-5 Reel

Removal

Caution: Avoid Injury! Blades are sharp and rotate quickly:

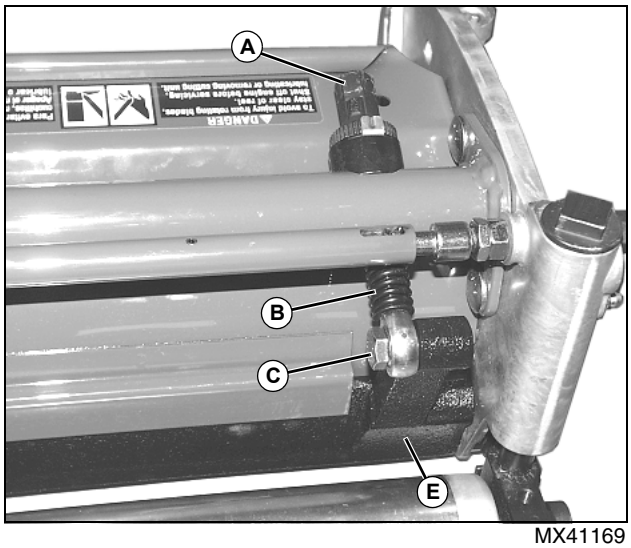
- **Keeps hands and feet away from cutting reels while machine is running.**
- **Always wear gloves while working on cutting reels.**
- **Watch for rotation of cutting reels. Rotating one cutting reel can cause another blade or cutting reel to rotate.**

1. Remove the cutting unit from mower. (See “Remove and

Install Cutting Unit" on page 638.)

2. Position cutting unit with the bottom side down on a flat surface or workbench.

3. Relieve tension from bed knife tension springs on both sides of cutting unit.



MX41169

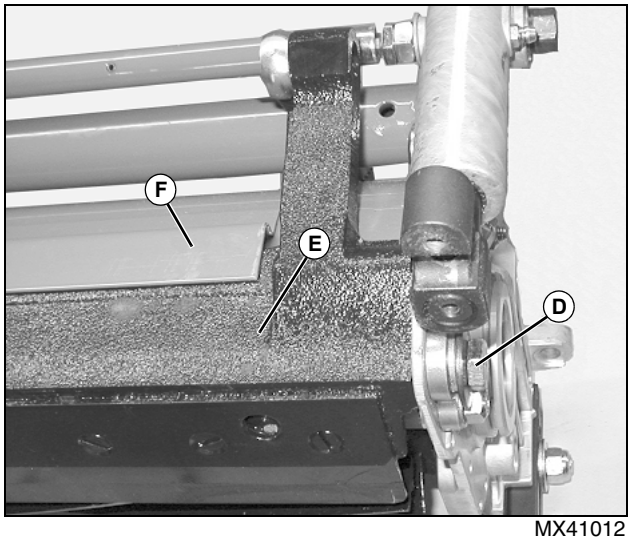
- Turn adjuster (A) on each side equal amounts to compress spring (B) and draw bedknife and shoe away from reel.

4. Remove bolt (C) on each side connecting adjuster link to bed knife shoe.

5. Position cutting unit with bed knife up off of the bench.

Caution: Avoid Injury! Mower parts are sharp! Wear gloves when handling bed knife and reel.

6. Remove rear roller assembly. (See "Remove and Install Rear Roller - QA-5 Reel" on page 642.)



MX41012

7. Remove shoulder bolt and two spring washers (D) from each end of bed knife shoe.

8. Slide bed knife/shoe assembly (E) down out of shield (F) and out of the cutting unit.

9. If original bed knife is to be used again, grind the bed knife. (See "Reel and Bed Knife Grinding" on page 616.)

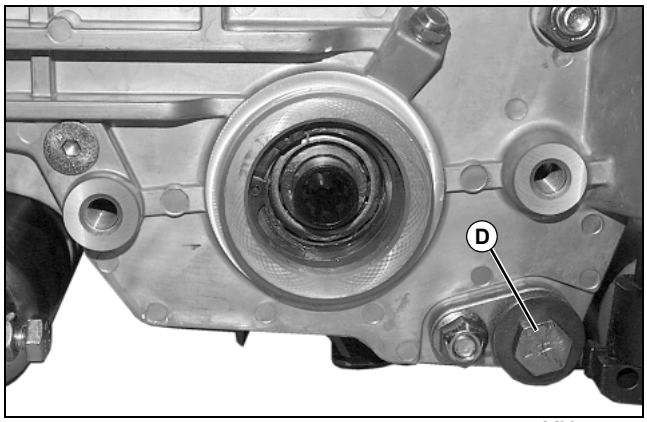
Installation

1. Remove and discard screws attaching bed knife to assembly support.

Note: Remove debris, corrosion, and rust from bottom surface of bed knife support.

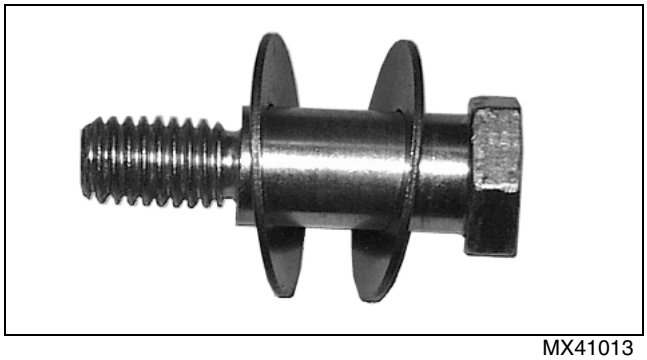
2. Install bed knife using new screws. Alternate tightening by starting with center screws and working out to the ends. Tighten screws to specification.

3. If installing a used bed knife, grind the bed knife. (See "Reel and Bed Knife Grinding" on page 616.)



MX41003

4. Slide bed knife and support assembly into position and secure with bolt (D) on each side.



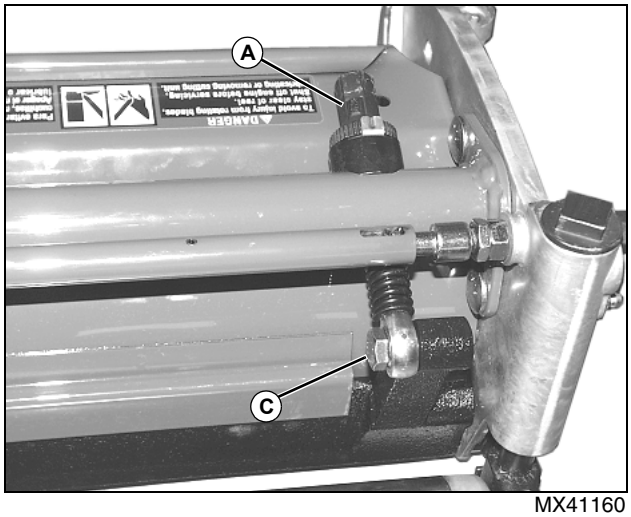
MX41013

- Install shoulder bolt (D) with two spring washers on each side of unit. Make sure outer edges of spring washers touch and inner holes have space between them.
- Tighten hardware to specification.

5. Position cutting unit with bottom side down on flat

surface or workbench.

6. Install each adjustment assembly inside housing mounting bracket.



MX41160

7. Install bolts (C) through adjuster links into bed knife shoe. Tighten hardware to specification.

8. Restore bed knife spring tension by turning hex head bolt (A) clockwise.

9. Install rear roller. (See “Remove and Install Rear Roller - QA-5 Reel” on page 642.)

10.Adjust reel-to-bed knife. (See “Adjust Bed Knife to Reel Clearance QA-5” on page 629.)

11.Set height-of-cut. (See “Adjust Height-of-Cut (HOC) - QA-5 Reel” on page 626.)

12.Backlap reel. (See “Backlapping Procedure” on page 623.)

13.Check height-of-cut and adjust as necessary.

Specifications

Bed Knife Shoulder Bolt Torque . . . . . 55 N•m (40 lb-ft)
Bed Knife Mounting Screw Torque . . . 7 N•m (62 lb-in.)

Remove and Install Reel - QA-5 Reel

Removal

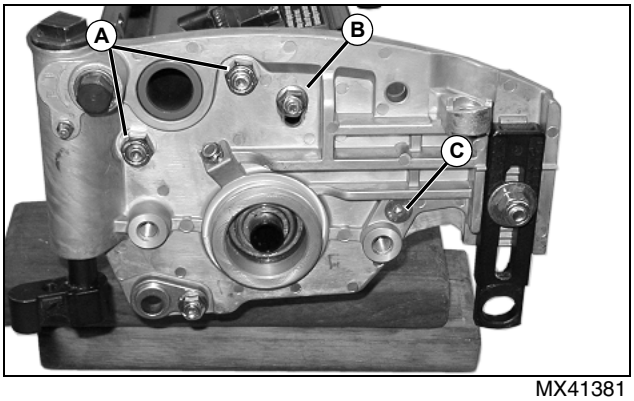
1. Remove cutting units from mower. (See “Remove and Install Cutting Unit” on page 638.)

2. Remove fairway tender conditioner (if equipped). (See “Remove and Install Fairway Tender Conditioner” on page 654.)

3. Remove front and rear rollers. (See “Remove and Install Front Roller - QA-5 Reel” on page 641 and See “Remove and Install Rear Roller - QA-5 Reel” on page 642.)

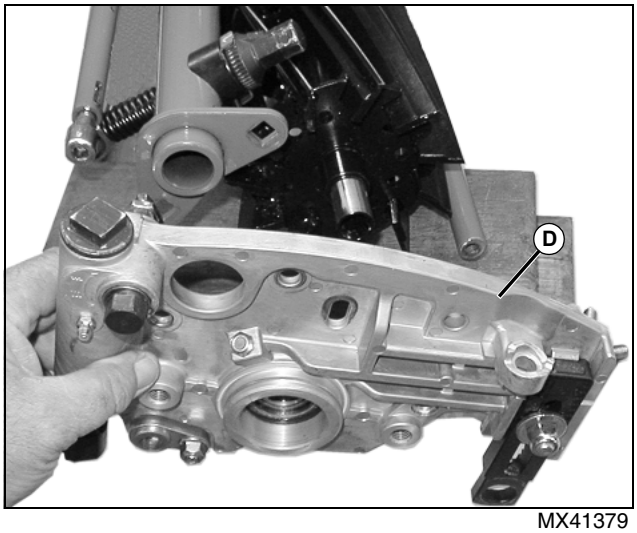
4. Remove bed knife. (See “Remove and Install Bed Knife - QA-5 Reel” on page 642.)

5. Place cutting unit on a stable work surface.



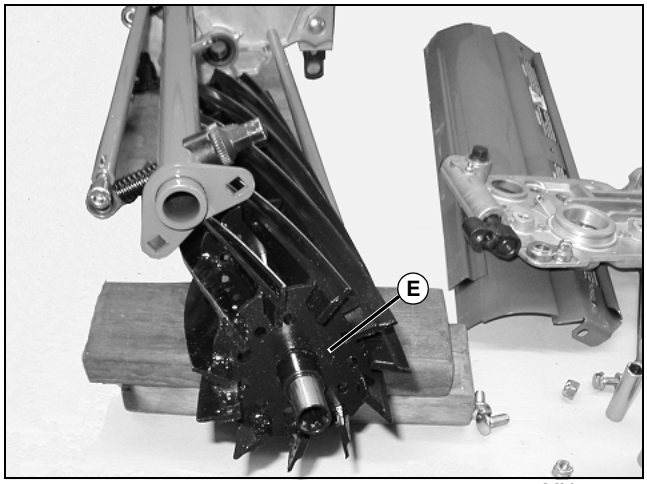
MX41381

6. Remove nuts (A) from the cross pipe, nut and bolt (B) from the shield, and tapered socket head screw (C) from small cross pipe.



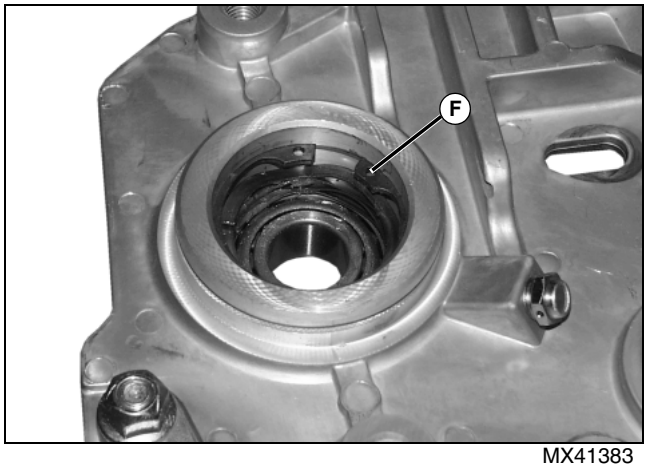
MX41379

7. Remove side assembly (D).



MX41382

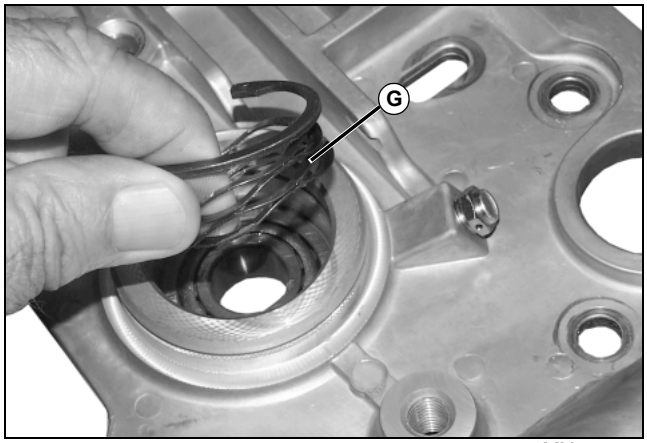
8. Pull reel (E) out from other side assembly.



MX41383

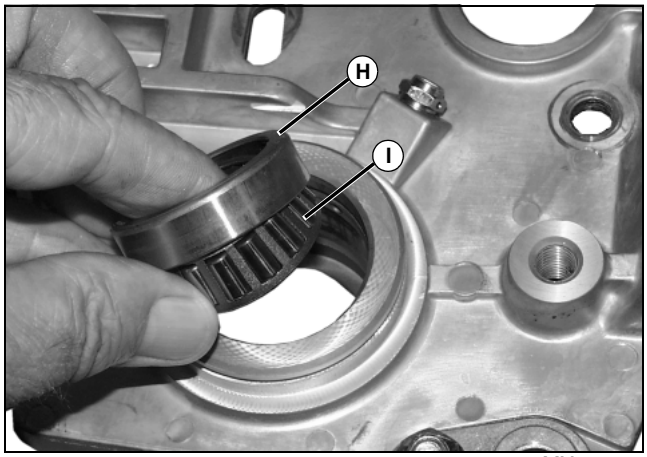
9. Remove snap ring (F).

Note: Wave washer is in left side bearing compartment only. Left side while looking at back of mower.



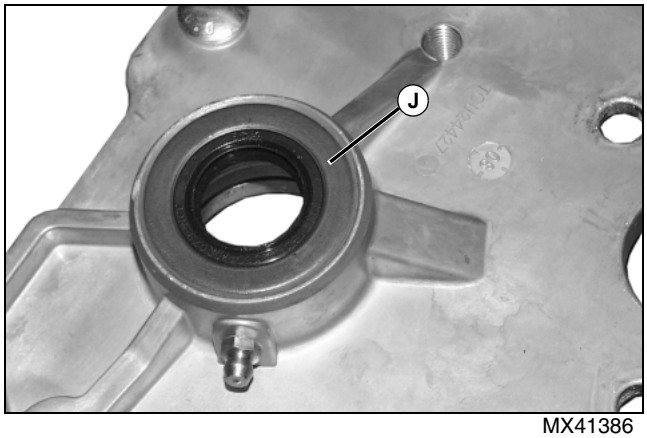
MX41384

10.Remove wave washer (G).



MX41385

11.Remove bearing race (H) and bearing (I)



MX41386

12.Always replace seal (J) when servicing bearings.

13.Clean and inspect all parts. Replace parts as needed.

Installation

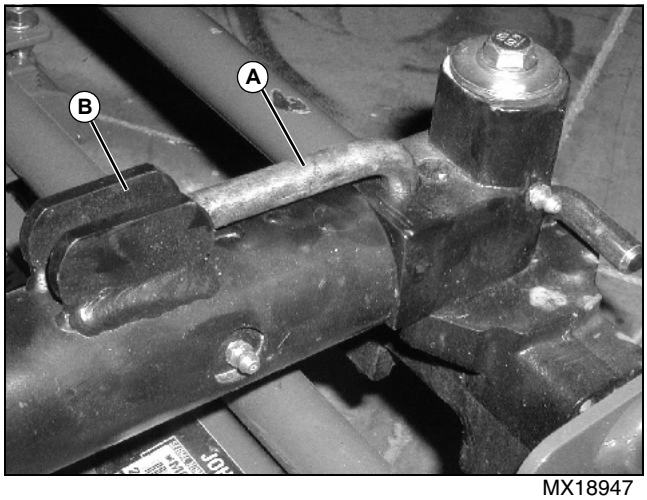
Assembly is done in the reverse order of disassembly.

Rotating Reel Cutting Units

Rotate for Service™ (RFS)

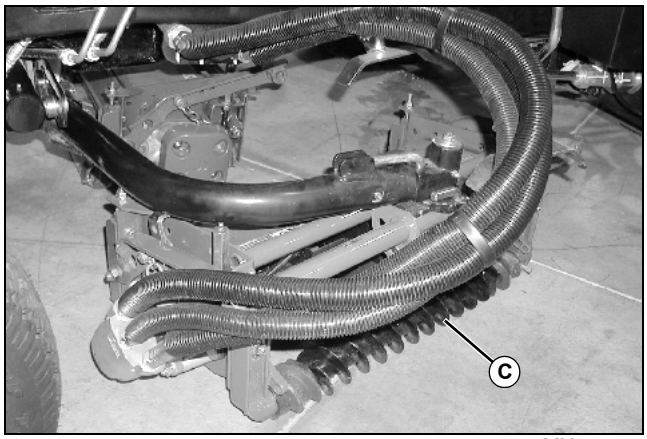
Caution: Avoid Injury! Always use the mower's hydraulic system to raise and rotate the units. DO NOT attempt to rotate units manually. Keep others away from mower during RFS operation to prevent injury.

1. Lock the park brake.
2. Lower mowing units to the ground and stop engine.



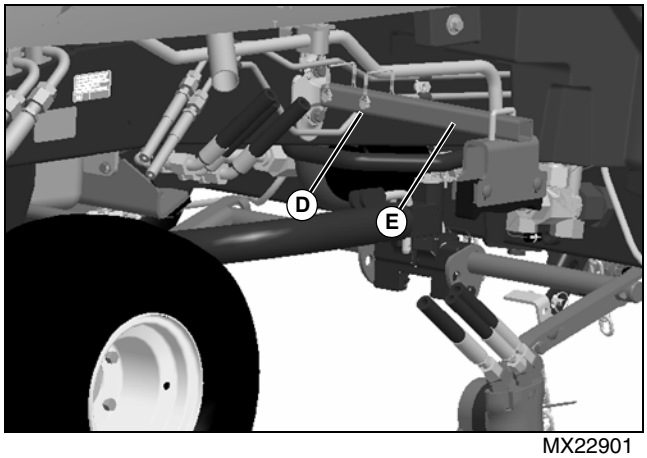
MX18947

3. Pull out pin (A) of rear cutting unit and insert the pin with the short leg in the hole and the long leg in the channel (B).



MX18949

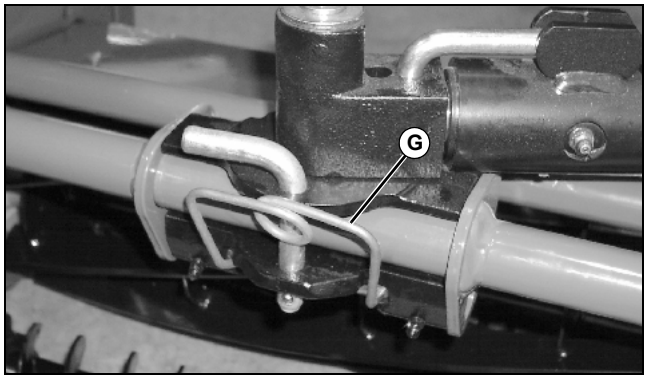
4. Turn the cutting unit (C) outward.
5. Repeat for second rear cutting unit.



MX22901

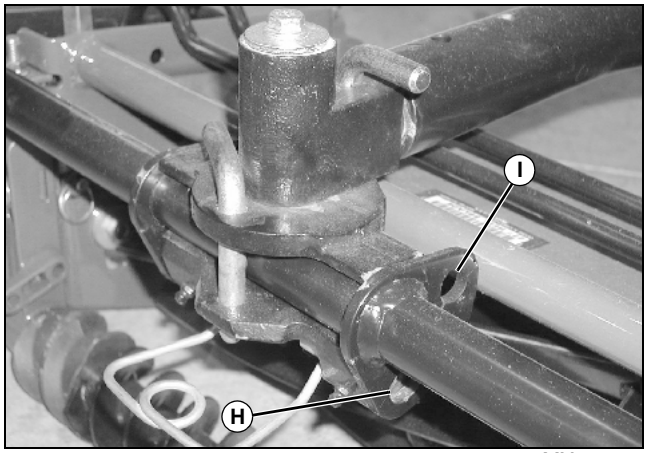
6. Remove pins (D) from rear reel stabilizers (E) and slide stabilizers off the machine.

Caution: Avoid Injury! Units must be on the ground when releasing the spring levers. DO NOT release spring levers with units raised, to prevent injury.



MX10837

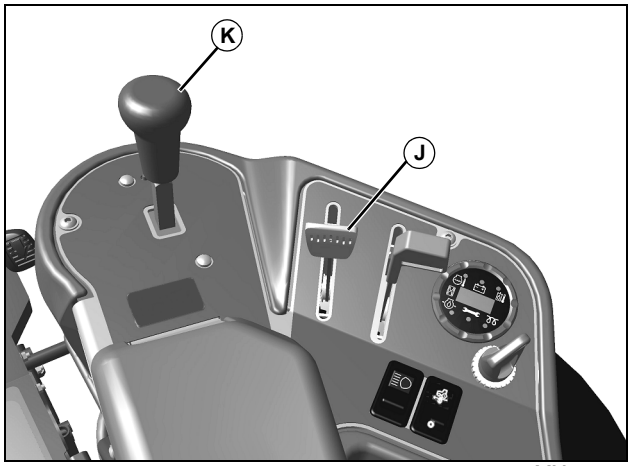
7. Push down spring (G) on each cutting unit until spring holds in down position.



MX18951

8. The unique spring design has two settings: The bottom

hole (H) locks the cutting units in the normal operating position. The top hole (I) locks the cutting unit in forward position to present the blades.



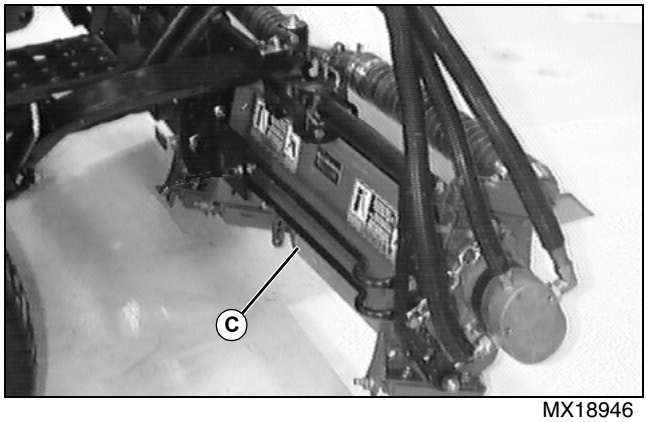
MX41949

9. With the mow-transport lever (J) pulled down to the transport position, start the engine while in the seat.

10.Move the mow-transport lever (J) to the mow position, and pull back the mow-lift lever (K) to raise the cutting units.

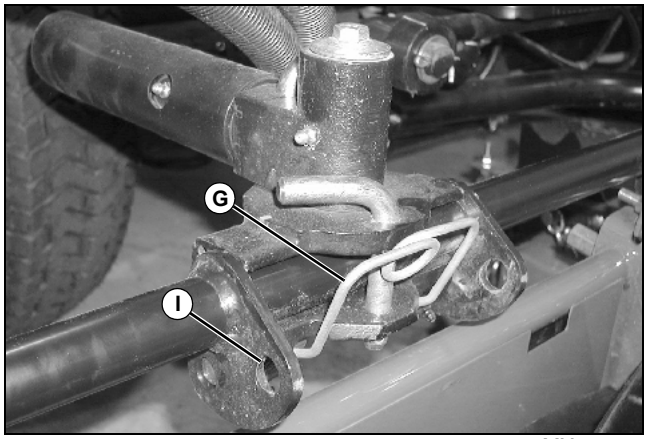
11.Move the mow-transport lever (J) to the transport position.

12.Lock the park brake and shut off the engine.



MX18946

13.The cutting units (C) are pointing up because the retaining pins are not in place.

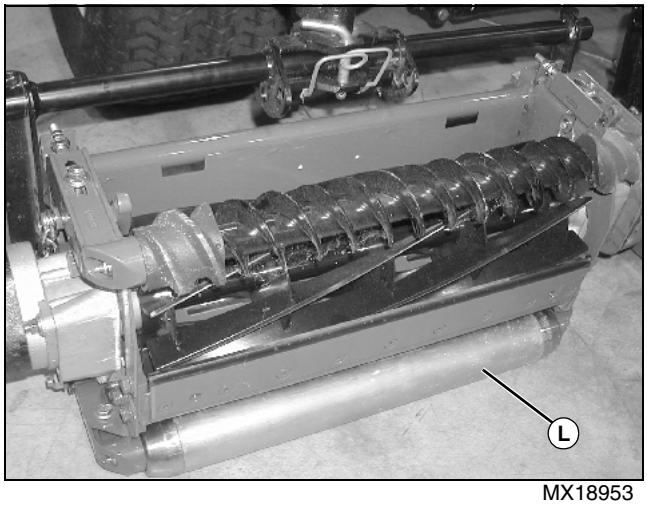


MX18952

14.Pull the spring lever (G) back up to the normal position. Then, pull the cutting unit up by the front roller so the pins align with the top hole (I) and lock the cutting unit in place.

Note: Lock the rear cutting units in place facing to the side.

15.Restart the machine.

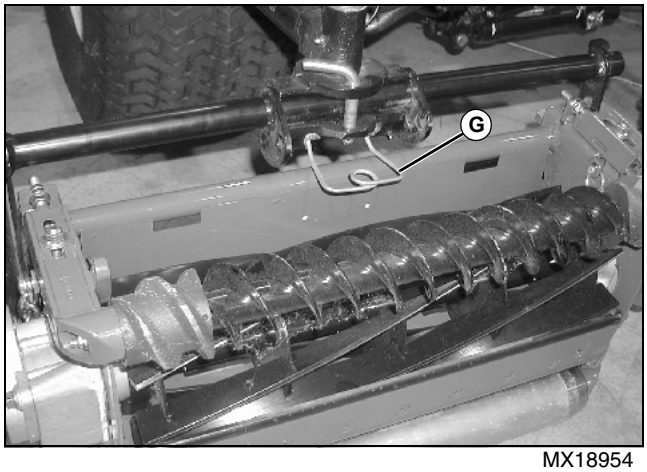


MX18953

16.Lower the cutting units so the back roller (L) is on the floor. This stabilizes the cutting units and takes the load off the lock pins. The cutting units are now ready for servicing.

Preparing Cutting Units for Mowing

Caution: Avoid Injury! Units must be on the ground when releasing the spring levers. DO NOT release spring levers with units raised, to prevent injury.

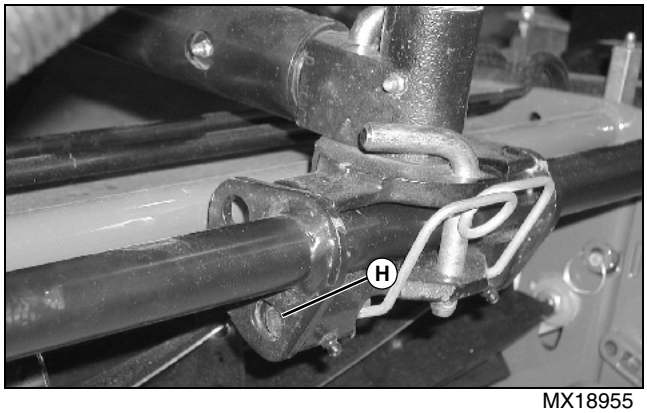


MX18954

1. When finished servicing the cutting units, release the spring levers (G) on all five units.

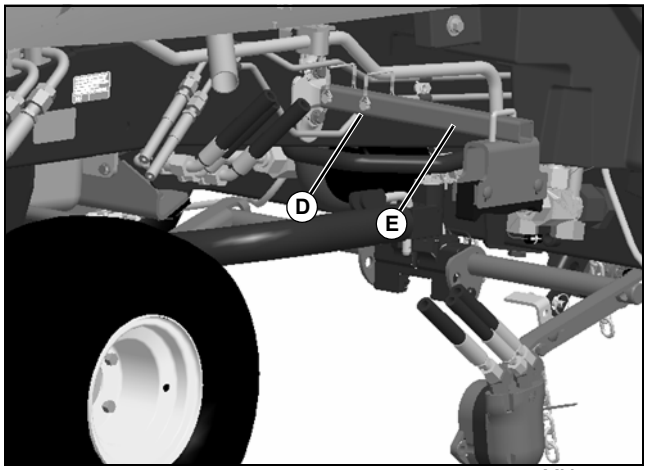
2. Start the machine and pull the lift lever back to raise the cutting units, causing them to hang in their normal free positions.

3. Push the lift lever forward to fully lower the cutting units.



MX18955

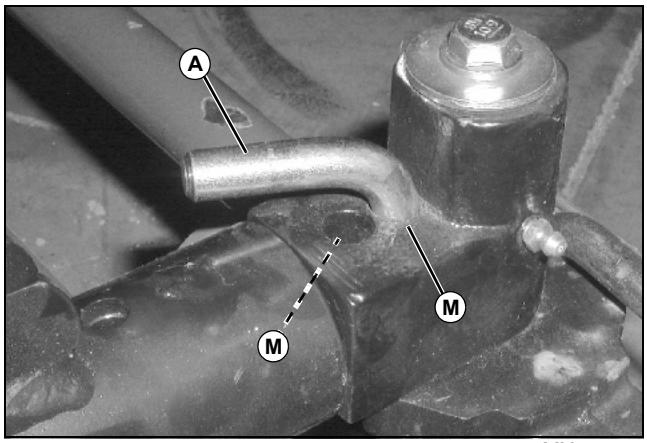
4. Shut off the engine and put the spring levers back up on each cutting unit. Ensure the pins fully lock in place (H).



MX22901

5. Install rear reel stabilizers (E) and (D).

Important: Avoid Damage! Do not install pin in channel except for servicing the rear units.



MX18957

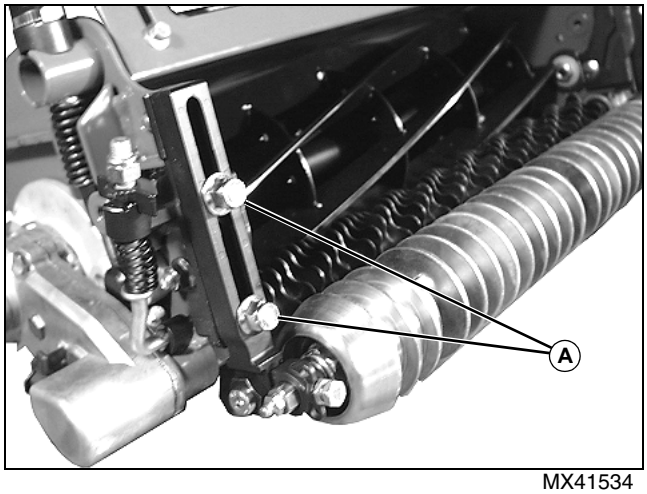
- Fixed steer cutting unit position is where the longer leg of pin (A) is inserted into the front hole (M).
- Normal steer is where pin (A) is inserted into rear hole (N).

Remove and Install Front Roller QA-7

Remove Front Roller Assembly

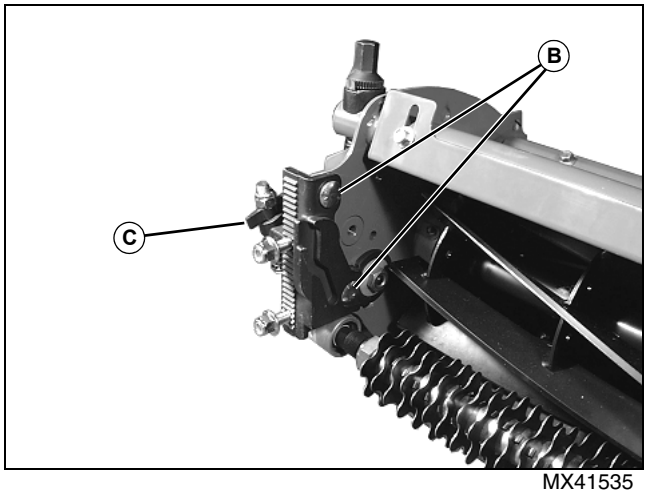
Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.

Note: Reel assembly is shown with optional Fairway Tender Conditioner (FTC) installed. The front roller assembly removal process is similar for reels without this option.



MX41534

1. Remove two lock nuts (A) on each side of the front roller assembly, and remove the assembly from the reel housing.



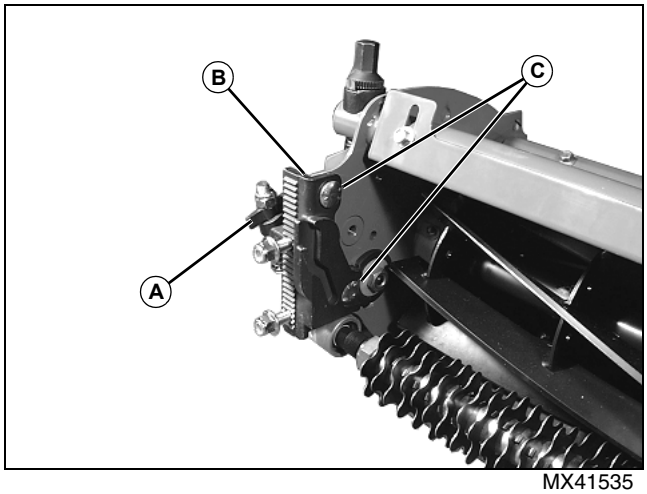
MX41535

2. Remove carriage bolts (B) and lock nuts, and slide height adjuster mechanism (C) outward to release it from the FTC drive housing. Remove roller bracket.

3. Repeat step two on the other roller bracket.

Install Front Roller Assembly

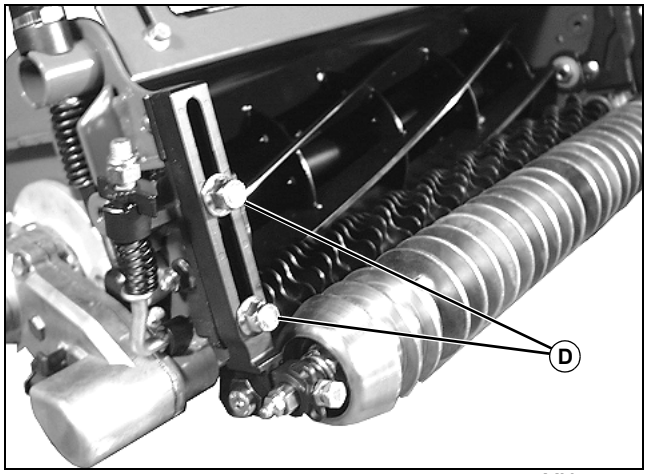
Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.



MX41535

1. Engage height adjuster mechanism (A) in FTC drive housing and position the roller bracket (B) on the reel housing with cap screws pre installed. Install carriage bolts (C) and lock nuts and tighten securely.

2. Repeat step two on the other roller bracket.



MX41534

3. Install front roller assembly on reel housing. Adjust left and right roller assembly brackets for desired initial height and install on reel housing. Secure with two lock nuts (D).

4. Adjust roller to align with bed knife. (See “Adjust Front Roller QA-7” on page 632.)

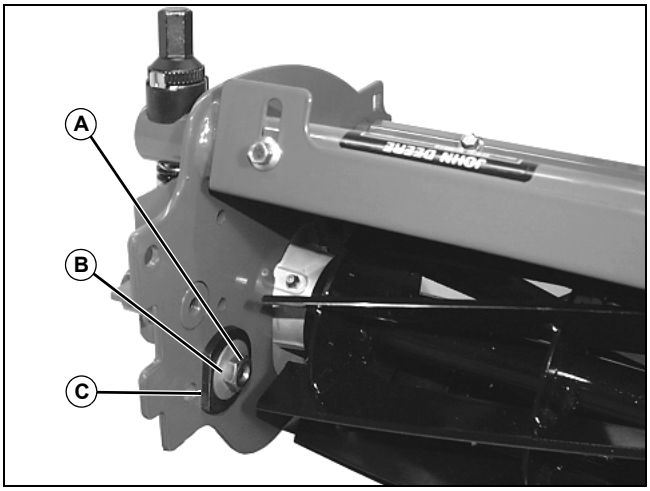
Remove and Install Reel QA-7

Remove Reel

Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.

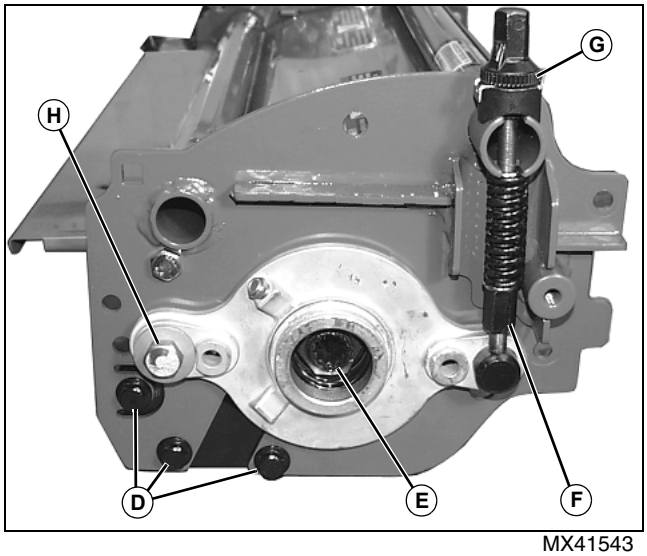
1. Remove front roller assembly from reel housing. (See "Remove and Install Front Roller QA-7" on page 649.)

2. Remove tender conditioner assembly if equipped from reel housing. (See "Remove and Install Fairway Tender Conditioner" on page 654.)



MX41539

3. Remove shoulder nut (A), spring washer (B) and spacer (C) from both sides of reel housing.



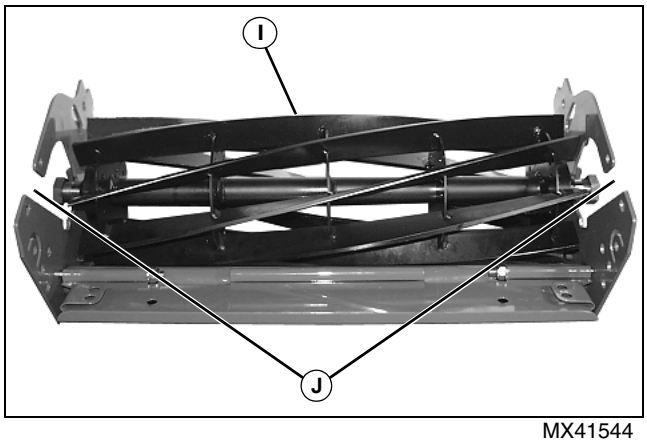
MX41543

4. Remove three cap screws (D) from each side of reel housing and remove bed knife assembly.

5. Remove nut (E) from both reel bearing retainers.

6. Mark position of nuts (F) to aid in reassembling to the same position. Loosen nuts to release spring tension and remove adjuster (G) on both sides of reel housing.

7. Remove shouldered cap screw, two spring washers (H) and lock nut, and remove both reel bearing retainers from reel and housing.

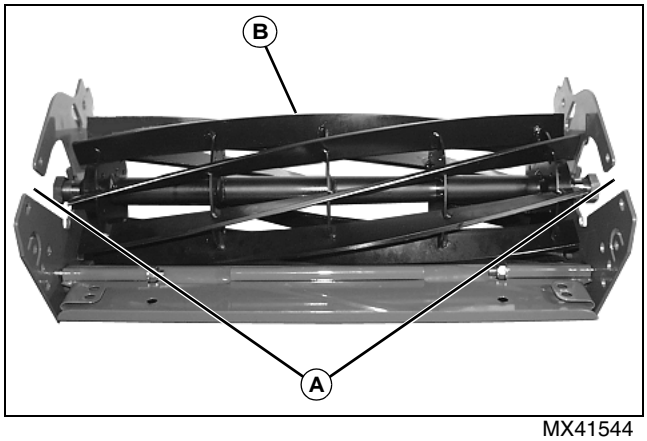


MX41544

8. Invert reel housing and remove reel (I) through slots on each end of housing (J).

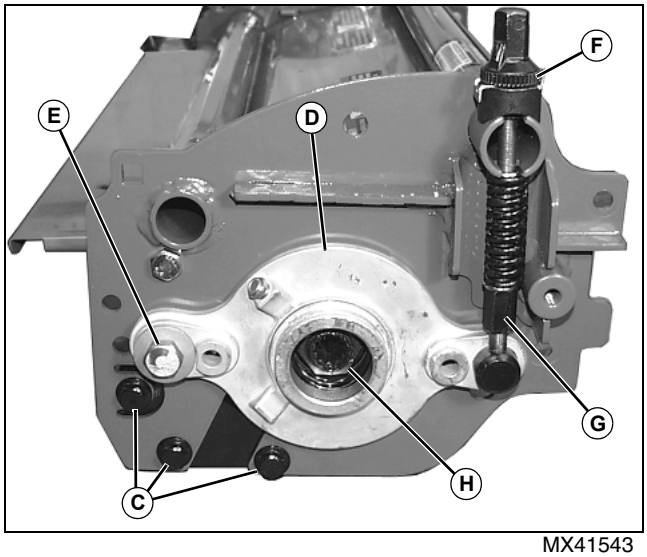
Install Reel

Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.



MX41544

1. Routing the reel shaft ends through the slots (A) in the housing, place the reel (B) in the housing.



MX41543

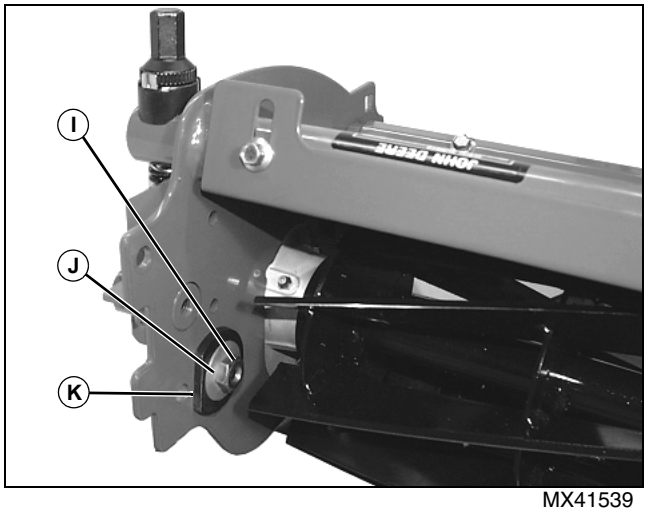
2. Install a reel bearing retainer (D) on the reel shaft and housing and secure with a shouldered cap screw, two spring washers (E) and lock nut.

3. Repeat step 3 for the second bearing retainer.

4. Install the adjuster assembly (F) in the bearing retainer and reel housing. Adjust nuts (F) to hold the reel assembly 25 mm (0.010in.) away from bedknife. Tighten nuts (G) in equal increments to marks made during disassembly.

5. Install nut (H) on both ends of the reel shaft in the bearing retainers and tighten securely.

6. Install the bed knife assembly and secure with three cap screws (C) on each side of reel housing assembly.



MX41539

7. Install shoulder nut (I), spring washer (J) and spacer (K) on both sides of reel housing and tighten securely.

8. Install tender conditioner assembly on reel housing if originally equipped and removed. (See “Remove and Install Fairway Tender Conditioner” on page 654.)

9. Install front roller assembly onto reel housing. (See “Remove and Install Front Roller QA-7” on page 649.)

10. Adjust reel-to-bedknife. See “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.

Remove and Install Bed Knife QA-7

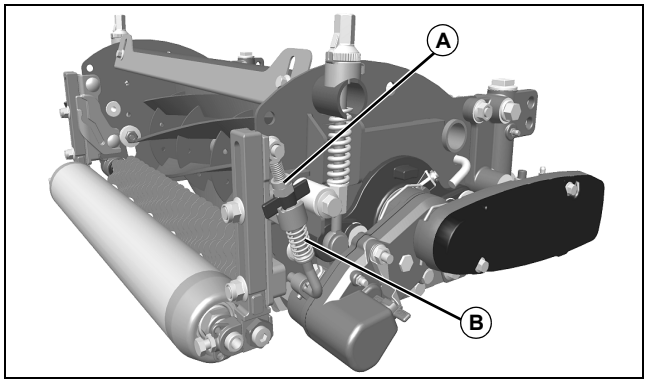
Caution: Avoid Injury! Blades are sharp and rotate quickly:

- Keeps hands and feet away from cutting reels while machine is running.
- Always wear gloves while working on cutting reels.
- Watch for rotation of cutting reels. Rotating one cutting reel can cause another blade or cutting reel to rotate.

Removing Bed Knife

1. Remove the cutting unit from machine.

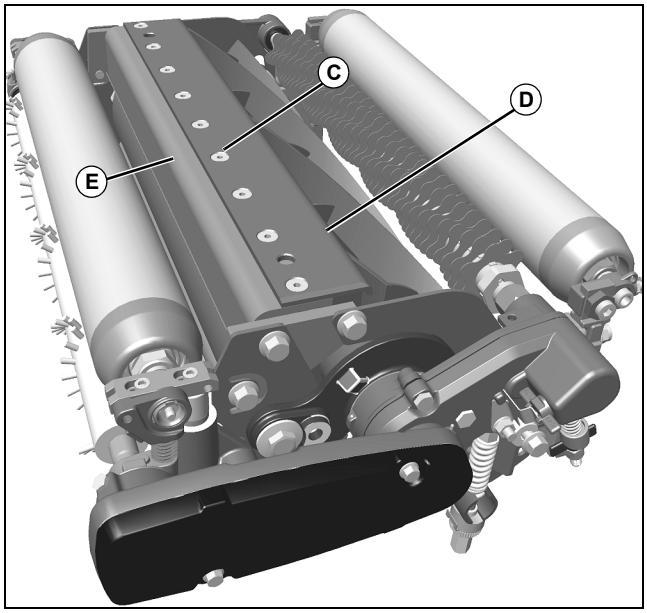
2. Position cutting unit with the bottom side down on a flat surface or workbench.



MX41502

- Turn hex head bolt (A) counterclockwise until spring (B) is completely relaxed. Repeat on opposite side.

3. Rotate cutting unit and position with bottom side up on flat surface or workbench as shown.



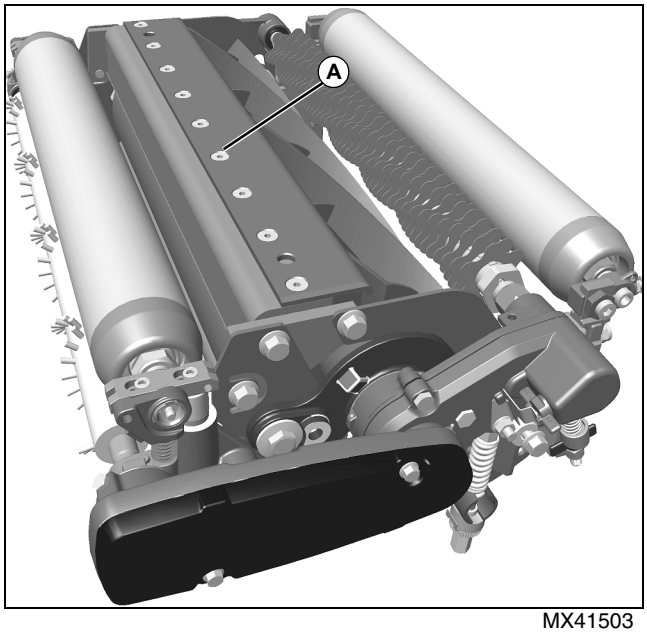
MX41503

4. Remove and discard nine screws (C) attaching bed knife (D) to assembly support (E). Discard bed knife.

5. If original bed knife is to be used again, grind the bed knife. (See “Reel and Bed Knife Grinding” on page 616.)

Installing Bed Knife

NOTE: Remove debris, corrosion, and rust from bottom surface of bed knife support.



MX41503

1. Install bed knife (A) using new screws. Alternate tightening by starting with center screws and working out to the ends. Tighten screws to 7 N•m (62 lb-in).

2. If installing a used bed knife, grind the bed knife. (See “Reel and Bed Knife Grinding” on page 616.)

3. Adjust reel-to-bedknife. (See “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

4. Set height-of-cut. (See “Adjust Height-of-Cut (HOC) QA-7” on page 630.)

5. Backlap reel. (See “Backlapping Procedure” on page 623.)

6. Check height-of-cut and adjust as necessary.

Removing and Installing Bed Knife and Shoe QA-7

Caution: Avoid Injury! Blades are sharp and rotate quickly:

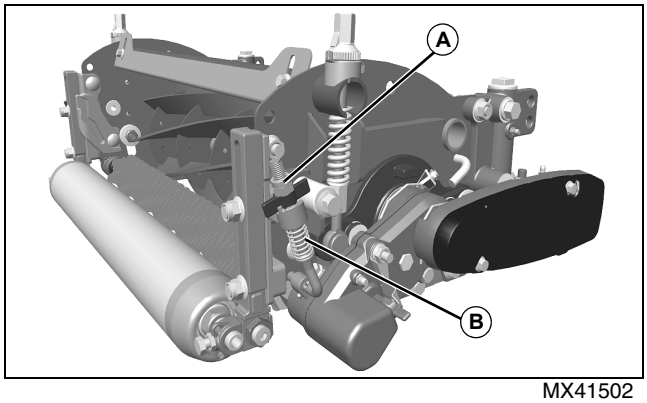
- Keeps hands and feet away from cutting reels while machine is running.
- Always wear gloves while working on cutting reels.
- Watch for rotation of cutting reels. Rotating one cutting reel can cause another blade or cutting reel to rotate.

Removing Bed Knife and Shoe

1. Remove the cutting unit from machine.

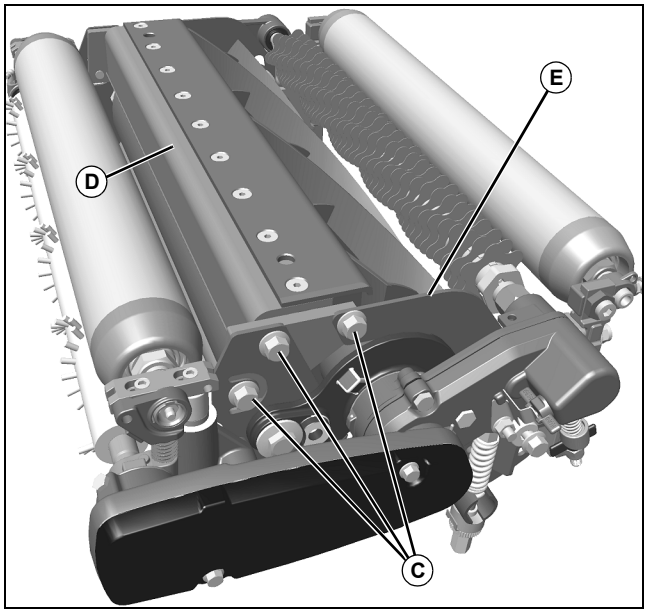
2. Position cutting unit with the bottom side down on a flat surface or workbench.

3. Relieve tension from bed knife tension springs on both sides of cutting unit.



MX41502

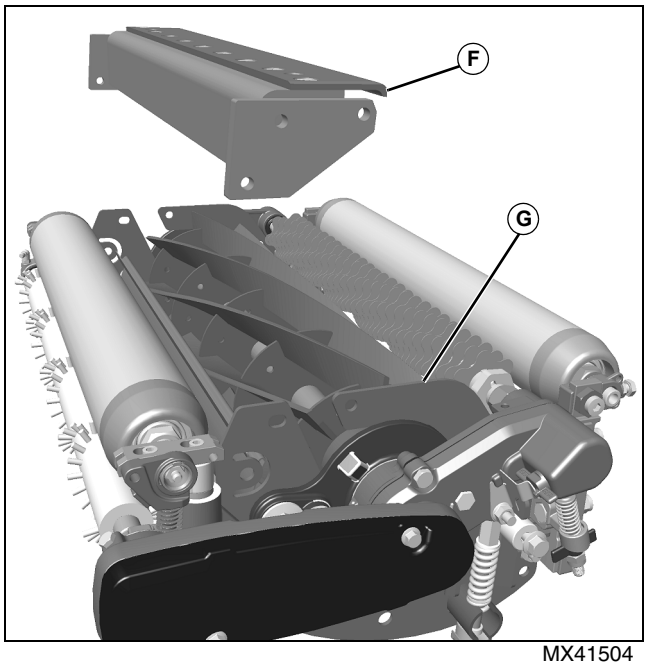
- Turn hex head bolt (A) counterclockwise until spring (B) is completely relaxed. Repeat on opposite side.



MX41503

4. Rotate cutting unit and position with bottom side up on flat surface or workbench as shown.

5. Remove three bolts (C) holding bed knife and shoe assembly (D) to reel frame (E). Repeat on opposite side.



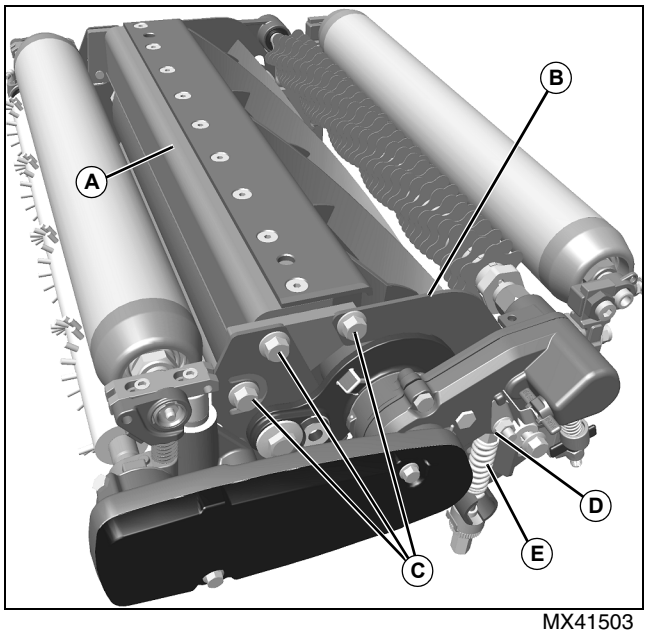
MX41504

6. Remove bed knife and shoe assembly (F) from reel frame (G).

7. Inspect bed knife for wear or damage. Replace bed knife, if necessary. (See “Removing and Installing Bed Knife and Shoe QA-7” on page 652.)

8. If original bed knife is to be used again, grind the bed knife. (See “Reel and Bed Knife Grinding” on page 616.)

Installing Bed Knife and Shoe



MX41503

1. Install bed knife assembly (A) onto reel frame (B), and secure with three bolts (C). Repeat on opposite side. Tighten hardware to 55 N•m (40 lb-ft).

2. Tighten nut (D) to compress spring (E) on adjuster. Repeat on opposite side.

3. Adjust reel-to-bedknife. (See “Adjust Reel-to-Bed Knife Clearance QA-7” on page 633.)

4. Set height-of-cut. (See “Adjust Height-of-Cut (HOC) QA-7” on page 630.)

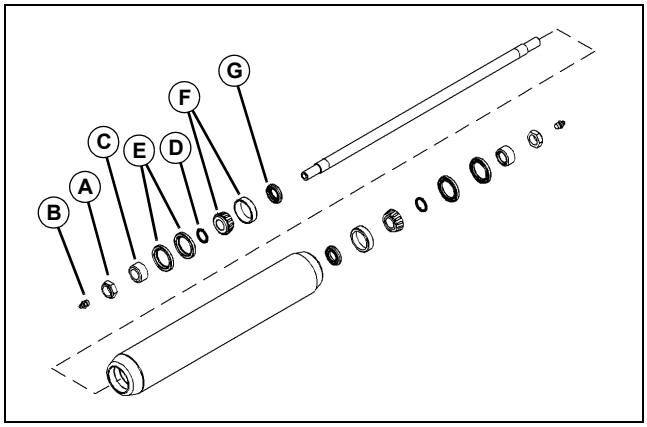
5. Backlap reel. (See “Backlapping Procedure” on page 623.)

6. Check height-of-cut and adjust as necessary.

Repair Front Roller

Disassembly

1. Remove front roller assembly from reel housing. (See “Remove and Install Front Roller - QA-5 Reel” on page 641, or “Remove and Install Front Roller QA-7” on page 649.)



MX20405

2. Remove locknut (A) from both ends of shaft.

3. Remove grease fitting (B) from both ends of shaft.

4. Push shaft through roller to remove.

5. If spacer (C) and O-ring (D) do not come out with shaft, pull out to remove.

6. Remove outer seals (E).

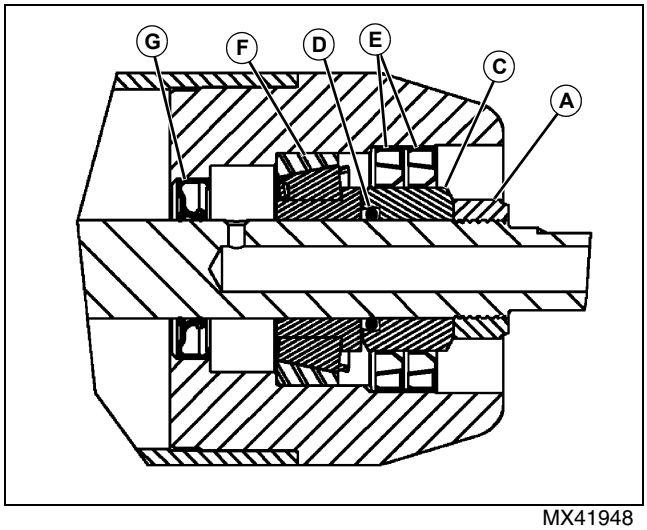
7. Remove bearing and race (F).

8. Remove inner seal (G).

9. Repeat for opposite end of roller if needed.

10. Inspect all components and replace as necessary.

Assembly



MX41948

1. Install inner seal (G) with lip facing out.

2. Pack bearing (F) with TY25083 Golf and Turf Cutting Unit Grease. Install bearing.

Important: Avoid Damage! Install outer seals with lips facing in.

3. Apply TY25083 Golf and Turf Cutting Unit Grease between lips of outer seals. Press outer seals (E) into place.

4. Install shaft in roller and approximately center it lengthwise.

Important: Avoid Damage! Use care not to catch seal lips when installing spacer.

5. Install new O-ring (D) in spacer (C). Apply a light coat of grease to bore of spacer and install with O-ring next to bearing.

6. Repeat for opposite end of roller.

7. Install both locknuts (A) and tighten until end play is gone, yet roller rotates freely.

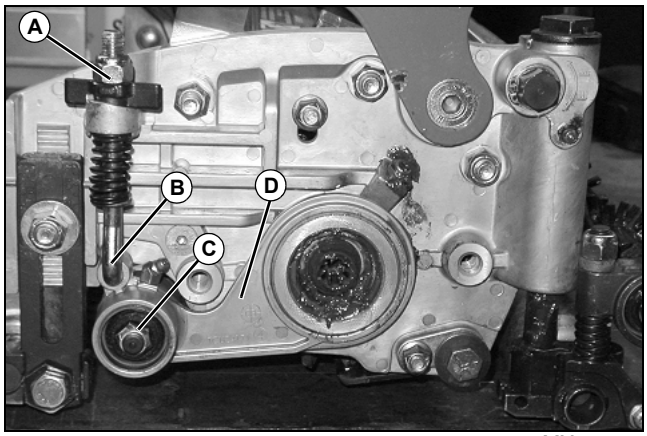
8. Install front roller assembly onto reel housing. (See “Remove and Install Front Roller - QA-5 Reel” on page 641, or “Remove and Install Front Roller QA-7” on page 649.)

Remove and Install Fairway Tender Conditioner

Note: Procedure is the same on OA-5 and QA-7 reels. Photos are from a QA-5 reel.

Remove Fairway Tender Conditioner (FTC)

Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.



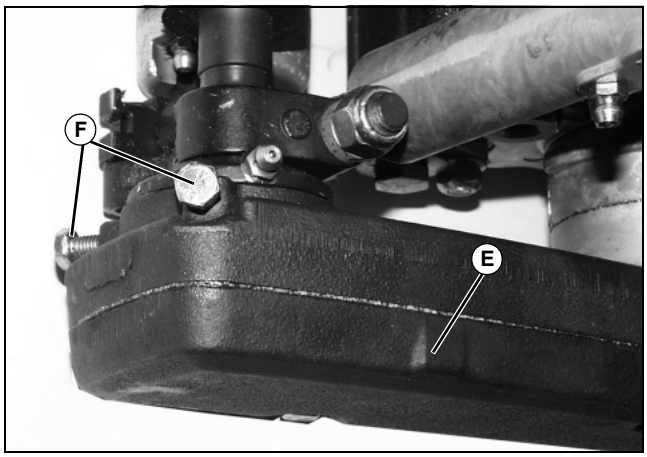
MX41806

1. Remove front roller assembly from reel housing. See “Remove and Install Front Roller - QA-5 Reel” on page 641 or See “Remove and Install Front Roller QA-7” on page 649

2. Remove locknut (A) from conditioner height adjustment rod and disconnect bottom of rod (B) from shaft support bracket (D).

3. Remove lock nut (C) from non-driven side of tender conditioner shaft.

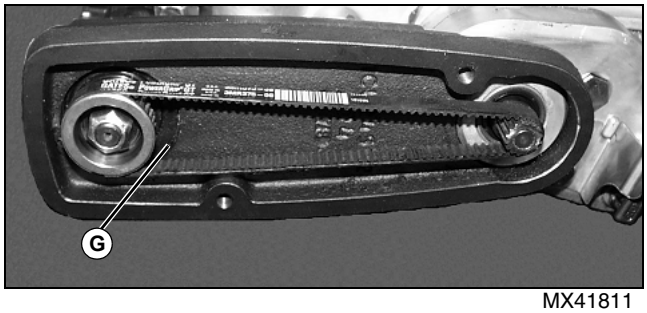
4. Pull shaft support bracket (D) outward and remove from reel housing.



MX41810

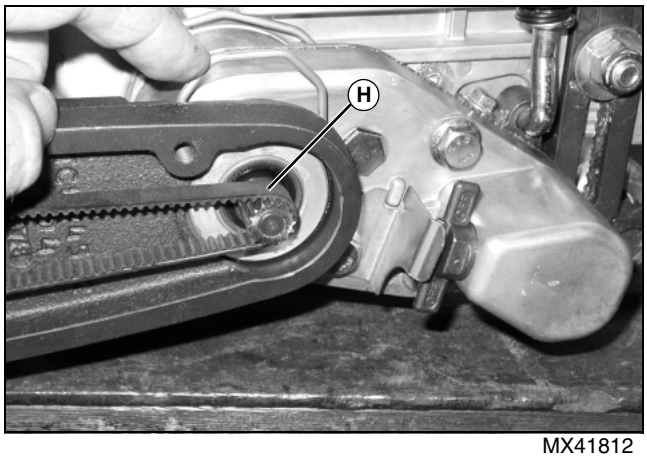
5. Remove two cap screws and belt cover (E).

6. Remove cap screws (F).



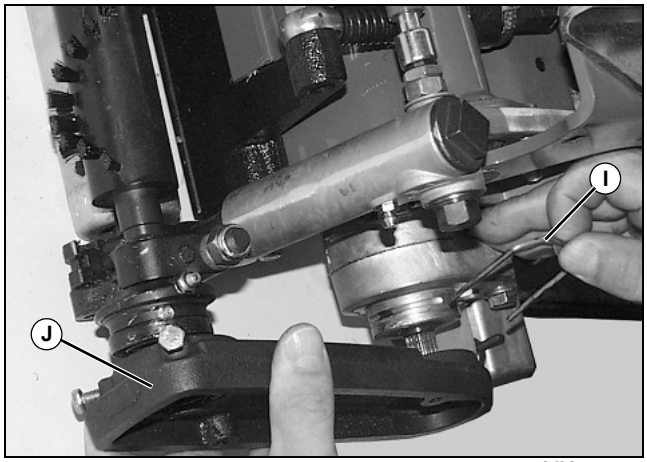
MX41811

7. Turn eccentric (G) from brush side of cover to remove tension from belt.



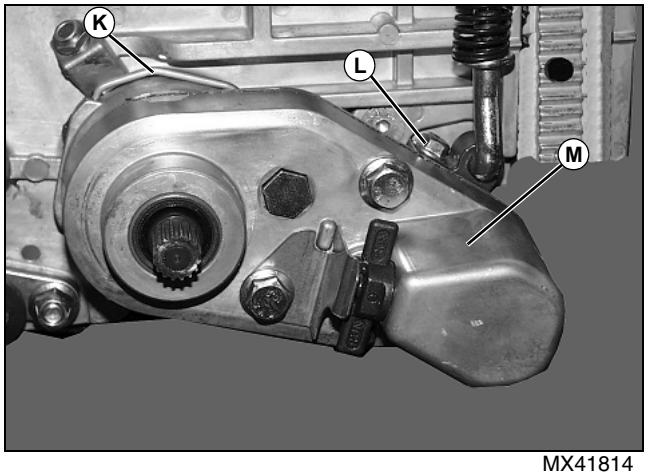
MX41812

8. Remove belt (H).



MX41813

9. Remove retainer clip (I) and belt housing (J).



MX41814

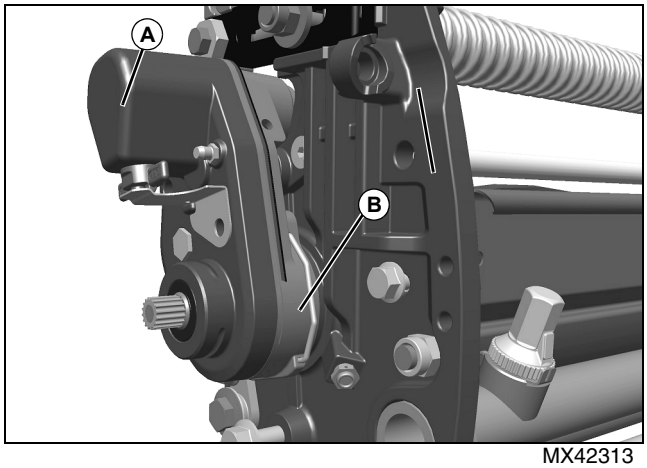
10.Remove retainer clip (K). Remove cap screw (L) and pull drive and conditioner assembly (M) out of reel.

Install Fairway Tender Conditioner (FTC)

Caution: Avoid Injury! Blades are sharp and can cut. Use caution and wear gloves when handling blades or working near blades.

1. Position cutting unit on flat surface or workbench as shown below.

Note: Lubricate male shaft assembly of gearcase with John Deere Special Purpose HD Cornhead Grease before installing onto cutting unit bearing housing.

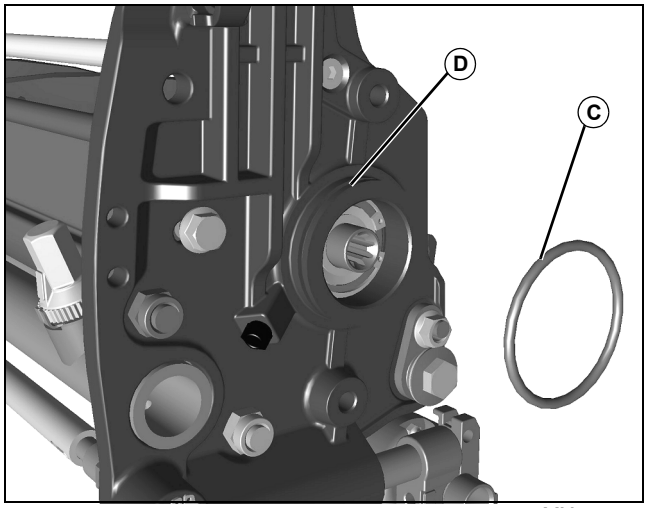


MX42313

2. Install gearcase assembly (A), onto cutting unit, as shown. Carefully engage splined male gearcase input shaft with splined female shaft on end of reel.

Note: Gearcase assembly should be flush with the bearing holder, or U-shaped clip will not seat and secure the assembly properly.

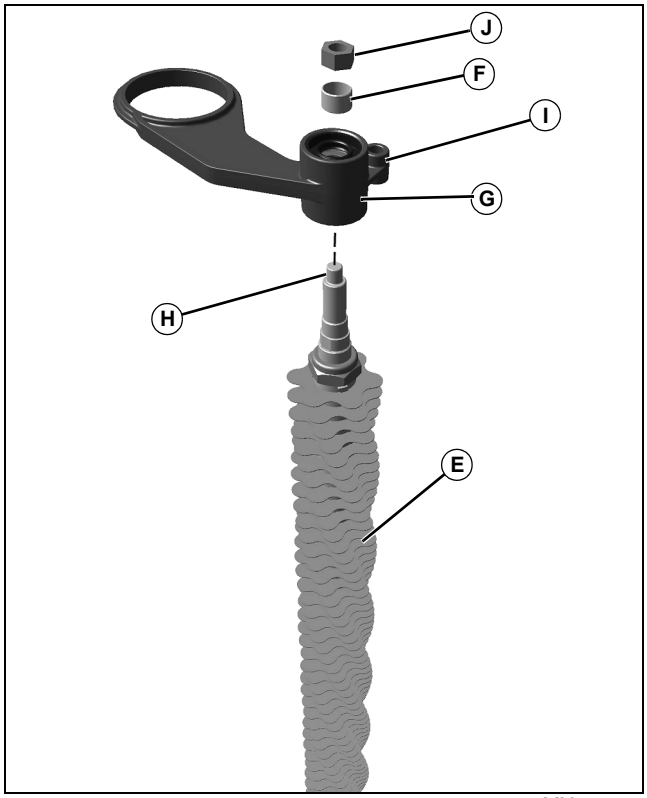
3. Rotate assembly as shown, and install U-shaped clip (B) to secure in a locked position.



MX42314

4. On opposite end, install O-ring (C) onto groove (D) on cutting unit end plate.

Note: Be sure to stand roll shaft (E) vertically and install conditioner idler bracket (G) onto roll shaft first before attaching to drive. (This is done because there are washers in the assembly that seat properly when following this procedure.)



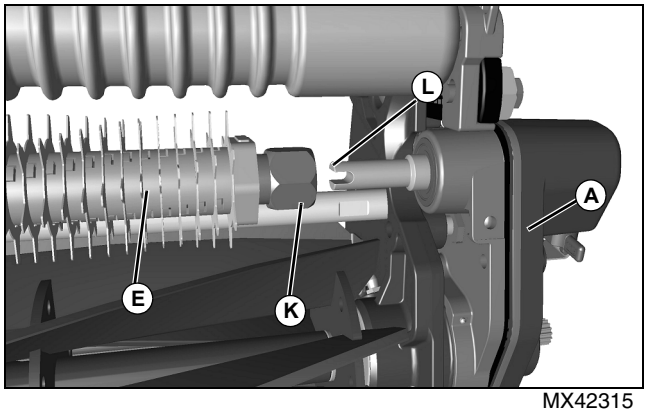
MX42319

5. Wearing gloves, stand roll shaft (E) vertically as shown.

6. Install 15.1 mm (ID) spacer (F) into idler bracket (G), and install idler bracket (G) onto threaded end (H) of roll shaft. Before securing assembly, make certain hole (I) on idler bracket would remain on the top side when installed on both left and right side installations.

7. Secure conditioner idler bracket (G) with M10 locknut (J).

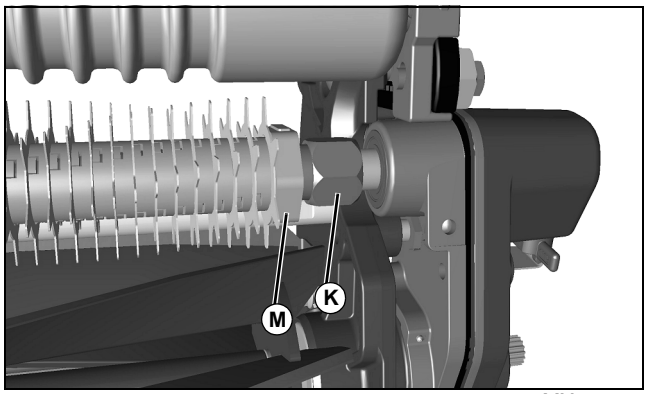
Note: You may need to loosen collet nut (K) before attempting to fit end of roll shaft into gearcase assembly (A) output shaft. Roll shaft should easily slide in place when assembling.



MX42315

8. Install idler bracket onto cutting unit end plate, while simultaneously installing opposite end of roll shaft (E), with

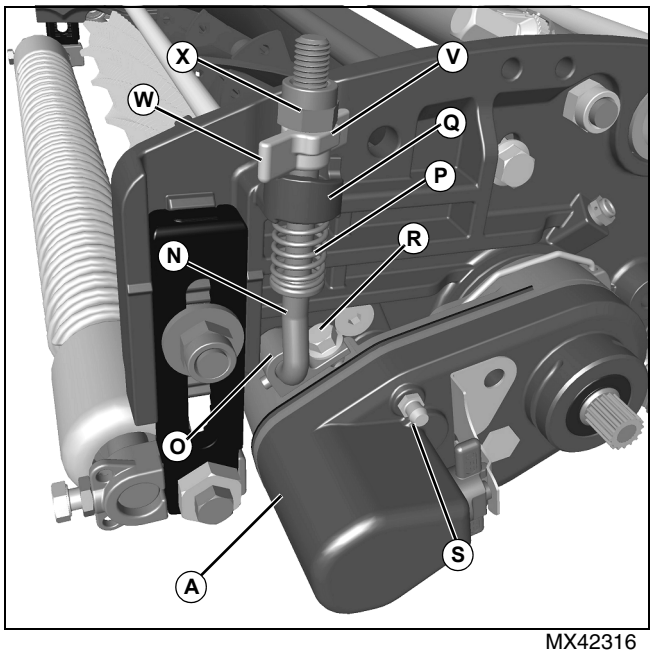
collet nut (K), onto the output shaft of gearcase assembly (A). Make sure roll shaft engages notched end (L) of gearcase assembly output shaft before attempting to secure components.



MX42320

9. Holding a wrench on the large hex blade retainer (M). tighten collet nut (K) to lock conditioner drive to roll shaft. Maintain pressure of roll shaft into conditioner drive for proper alignment when tightening collet nut. Tighten collet nut to 62 N.m (46 lb-ft).

Note: When installing tender conditioner on opposite side, bushing (O) will be installed on opposite side of gearcase assembly (A).



MX42316

Picture Note: Drive side shown.

10.On drive side:

- Install bent end of tensioner rod (N) through bushing (O).
- Install spring (P) onto opposite end of tensioner rod, and then insert tensioner rod through hole in tab (Q) on side of cutting unit frame.
- Install bushing (O) onto gearcase assembly (A) with M6 bolt (R) and M6 locknut.
- Lubricate grease fitting (S) with John Deere Special Purpose HD Cornhead Grease.

11. On driven side:

- Install spring (P) onto long end tensioner rod (N).
- Install long end of tensioner rod (N) through hole in tab (T) on side of cutting unit frame, and then bent end through hole on conditioner idler bracket (G).
- Position grease fitting (U) for access to allow lubrication. Lubricate grease fitting with John Deere Special Purpose HD Cornhead Grease.

Note: Be certain that thicker side (V) of knob (W) is on the top when installing.

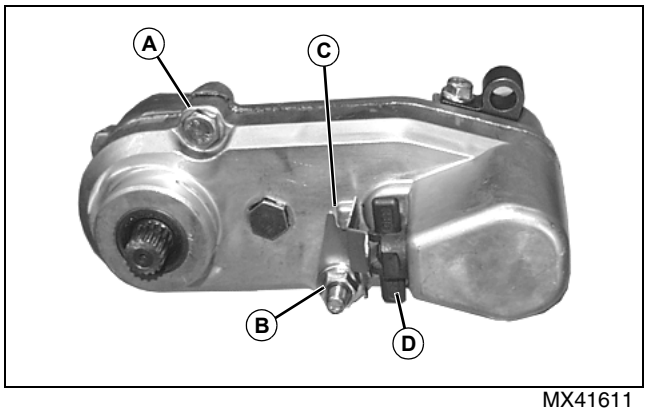
12.On both sides of cutting unit, install knob (W) and M10 nylon insert locknut (X). Do not tighten hardware at this time.

13.See “Adjusting Fairway Tender Conditioner” on page 634

Disassemble and Inspect Fairway Tender Conditioner

Disassembly - Drive

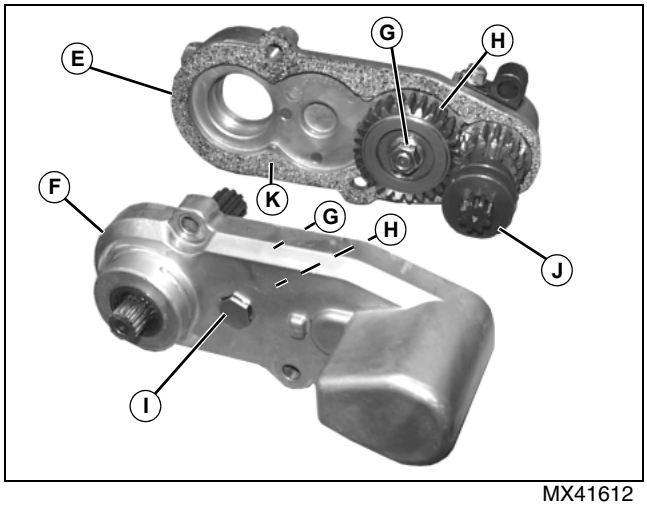
1. Remove FTC drive and shaft assembly from reel housing. (See “Remove and Install Fairway Tender Conditioner” on page 654.)



MX41611

2. Remove cap screw (A), lock nut (B) and cap screw and bracket (C) from drive housing.

3. Pull knob (D) from housing.



MX41612

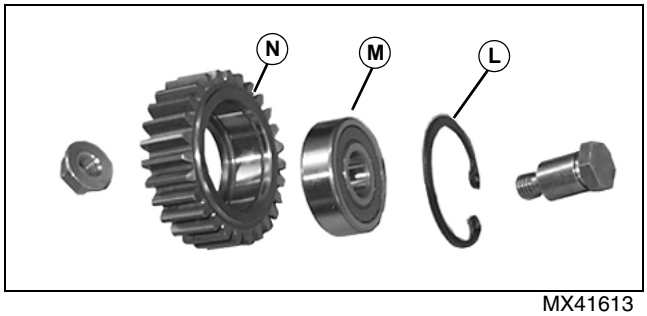
4. Pull inner housing (E) from outer housing (F).

5. Remove lock nuts (G), idler gears (H), and cap screw from each housing.

6. Remove lock nut, gear and cap screw (I) from outer housing (F).

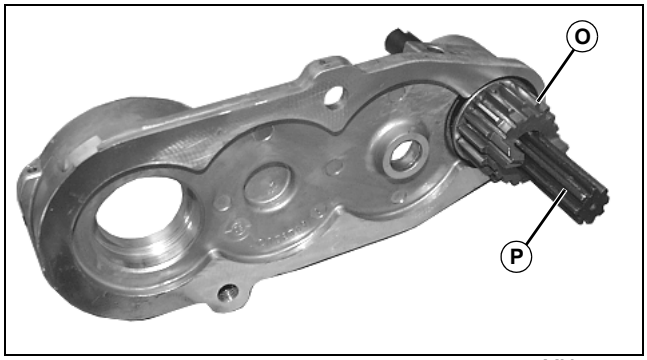
7. Remove shift collar (J) from shaft.

8. Remove gasket (K).



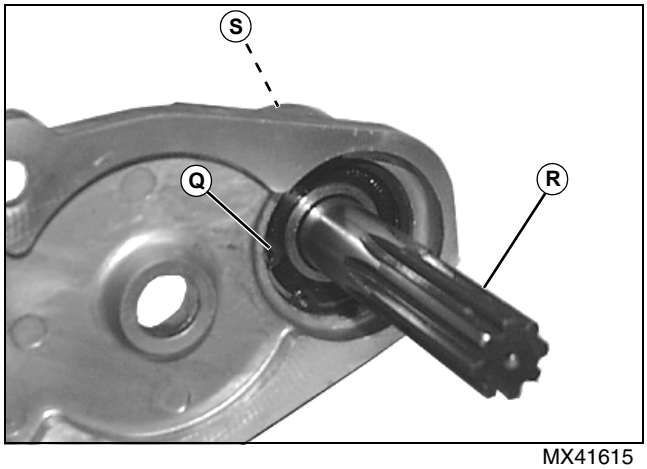
MX41613

9. Remove snap ring (L) and bearing (M) from gears (N) removed in step 5 and 6.



MX41614

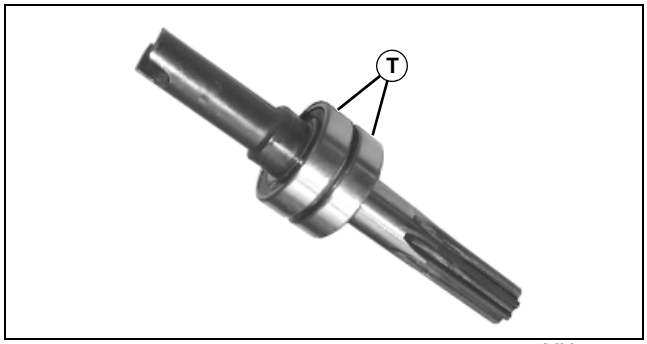
10.Remove driven gear (O) from shaft (P).



MX41615

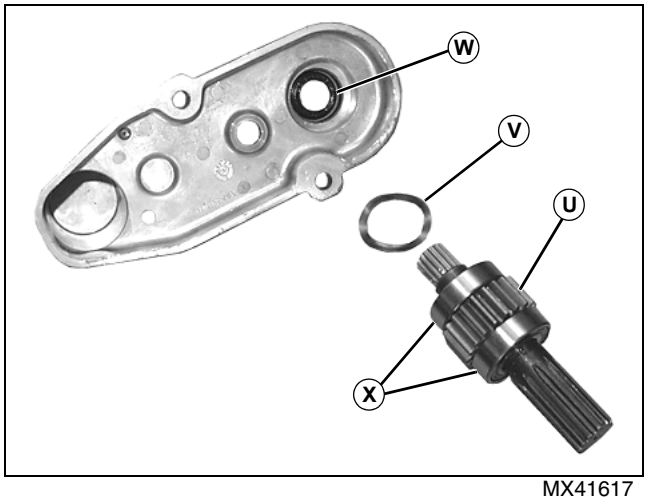
11.Remove snap ring (Q) and pull shaft assembly (R) from housing.

12.Remove seal (S) and E-ring from back side of housing.



MX41616

13.Press bearings (T) from shaft.



MX41617

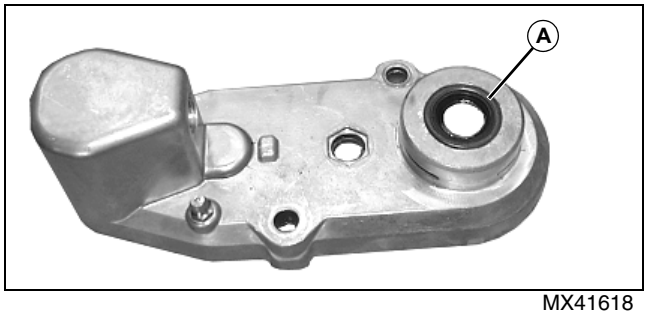
14.Pull shaft assembly (U) and wave spring (V) from housing.

15.Remove seal (W) from housing.

16.Remove bearings (X) from shaft.

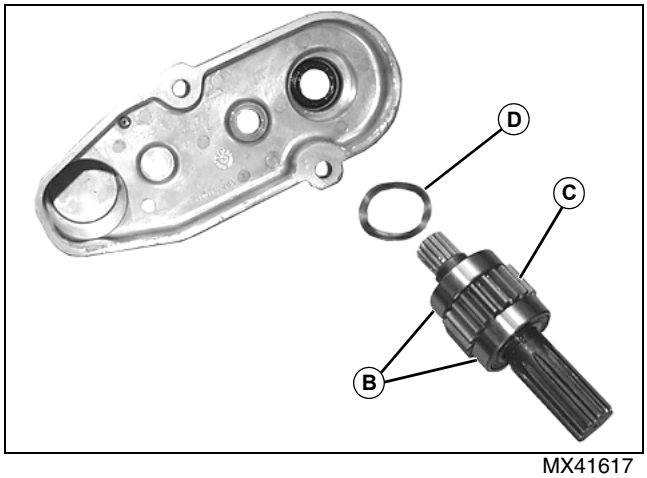
17.Inspect all components and replace as necessary.

Assembly - Drive



MX41618

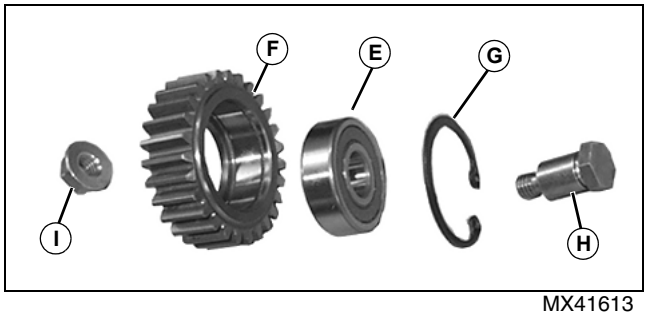
1. Install seal (A) in outer housing with lip facing in.



MX41617

2. Install bearings (B) on shaft (C).

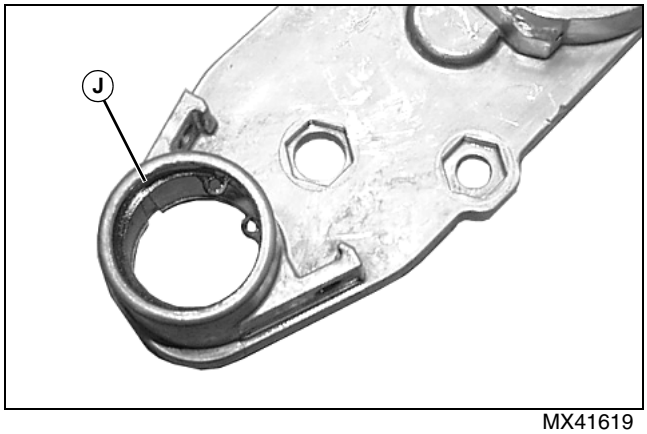
3. Install wave spring (D) and shaft assembly (B, C) in inner housing.



MX41613

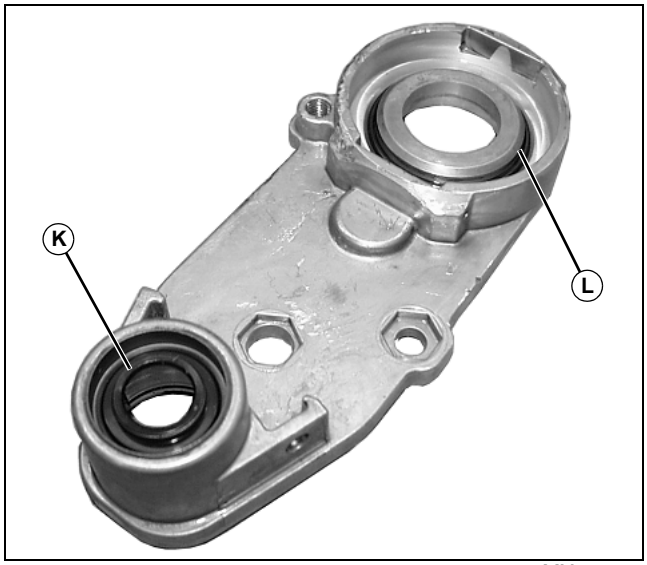
4. Install bearing (E) in gear (F) and secure with E-ring (G).

5. Install gear in outer housing with cap screw (H) and nut (I).



MX41619

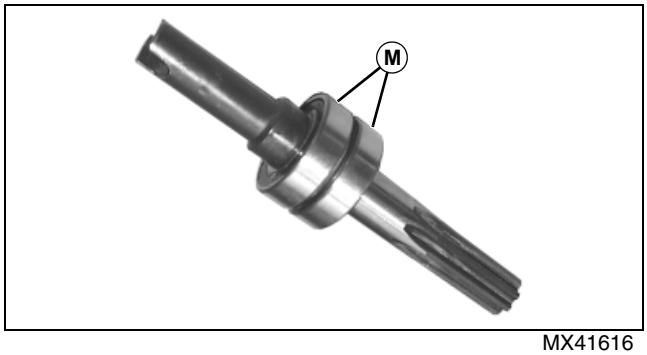
6. Install E-ring (J) in outer groove of inner housing.



MX41620

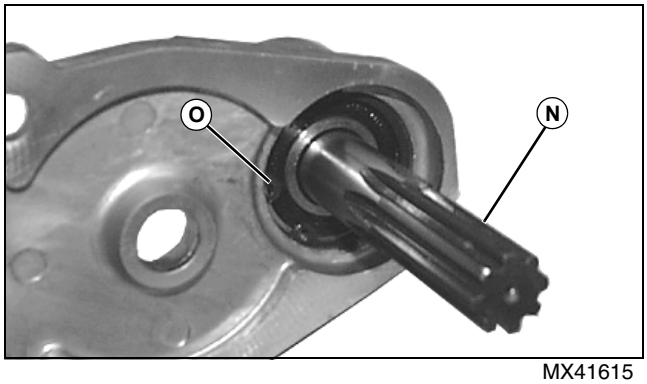
7. Install seal (K) with lip and spring facing out in inner housing.

8. Apply a light coat of grease to housing and install O-ring (L) in housing.



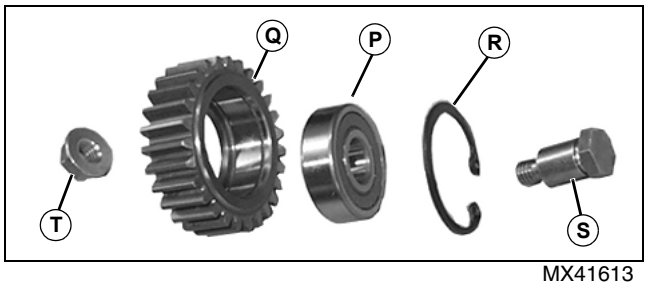
MX41616

9. Install bearings (M) on shaft.



MX41615

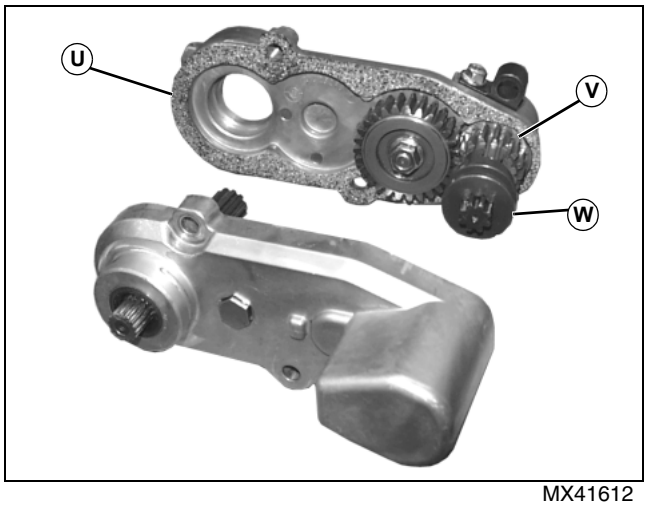
10.Install shaft assembly (N) in housing and secure with E-ring (O).



MX41613

11.Install bearing (P) in gear (Q) and secure with E-ring (R).

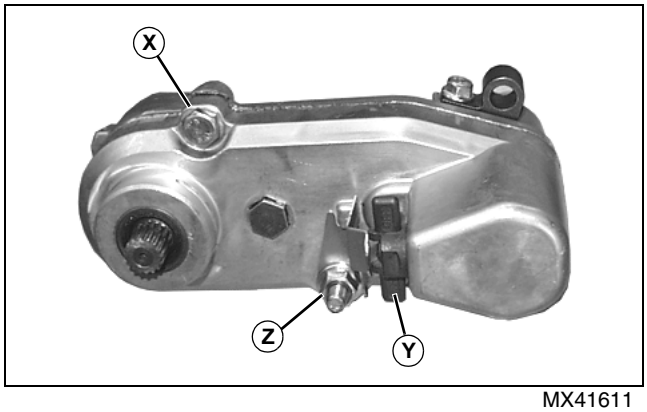
12.Install gear in inner housing with cap screw (S) and nut (T).



MX41612

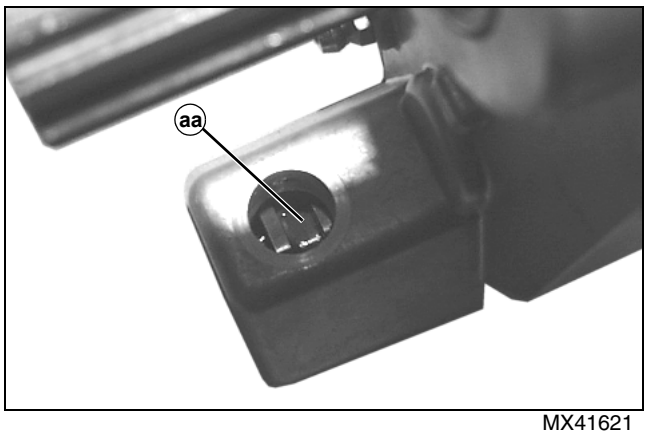
13.Remove backing from adhesive side of gasket (U) and install on inner housing.

14.Install gear (V) and shift collar (W) on shaft. Make sure the shift dogs on the shift collar are facing the shift dogs on the gear.



MX41611

15.Assemble both housings and secure with one cap screw (X).



MX41621

16.Install knob (Y) in housing, ensuring that the pin on the base of the knob engages the shift collar (aa).

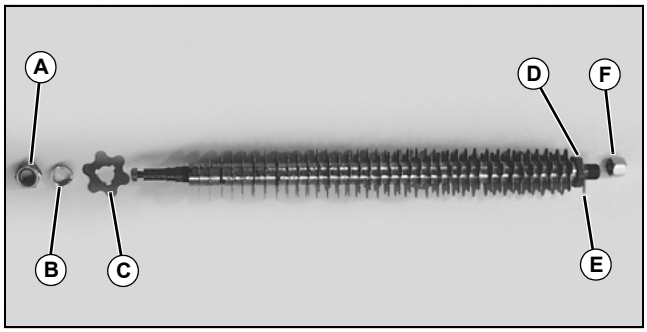
17.Install cap screw, bracket and flange nut (Z) on housing assembly.

18.Grease drive housing through zerk in outer housing with John Deere Golf and Turf Cutting Unit Grease TY25083.

1. Install FTC drive on reel housing. (See “Remove and Install Fairway Tender Conditioner” on page 654.)

Disassembly - Shaft Assembly

1. Remove FTC assembly from reel housing. (See “Remove and Install Fairway Tender Conditioner” on page 654.)



MX41552

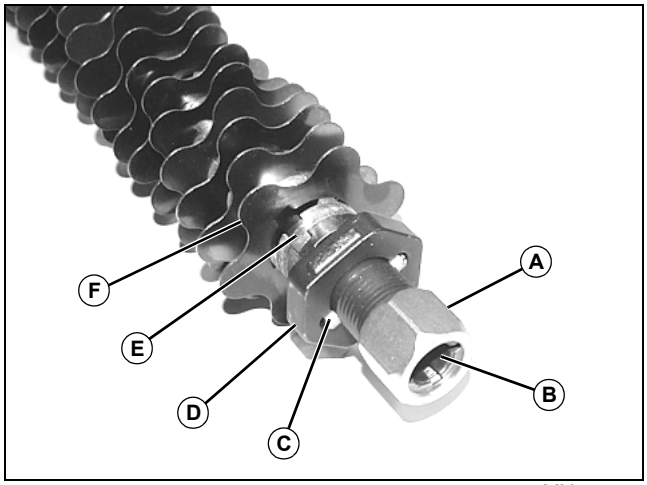
2. Remove nut (A) on end of shaft. The spacers (B) and blade segments (C) can be removed as required.

Note: As nut (A) is loosened, the retainer on the opposite shaft end (D) can move, and its retaining pin can be removed.

3. Remove the compression nut (F) and inner ferrule.

4. Inspect all components and replace as necessary.

Assembly - Shaft Assembly



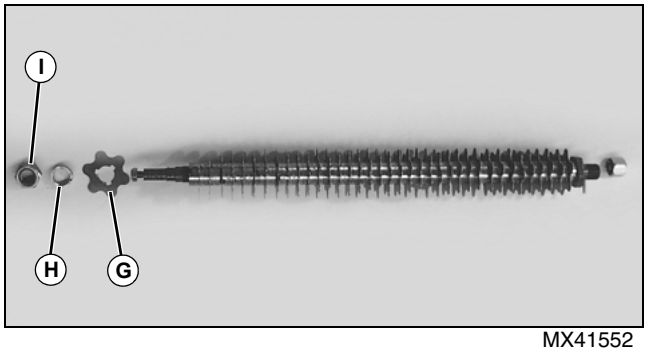
MX41553

1. Loosely install compression nut (A) with inner ferrule (B) on shaft.

2. Insert pin (C) in shaft. Install or index the blade stack retainer (D) over the exposed ends of the pin.

3. Alternately install spacers (E) and blade segments (F) on shaft.

Note: During assembly, ensure that pin (C) does not be dislodged from retainer recess (D).



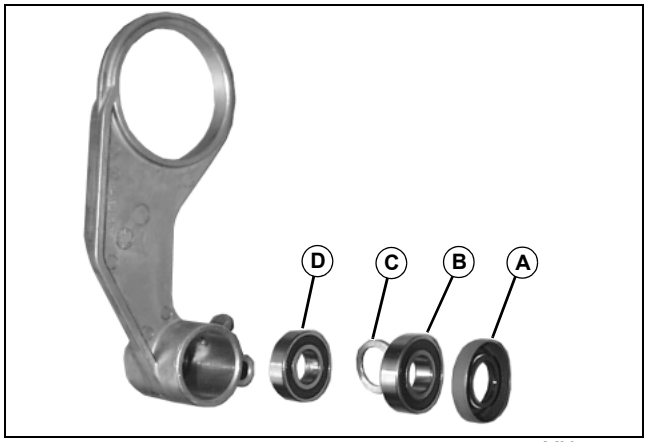
MX41552

4. When all blade segments (G) and spacers (H) are added, install nut (I) and tighten securely.

5. Install FTC shaft on drive assembly/reel housing. (See “Install Fairway Tender Conditioner (FTC)” on page 655.)

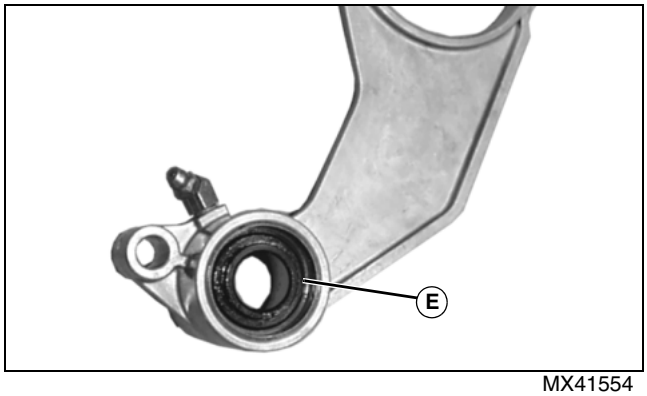
Disassembly - Shaft Support Bracket

1. Remove FTC shaft support bracket from reel housing. (See “Remove and Install Fairway Tender Conditioner” on page 654.)



MX41555

2. Remove seal (A), bearing (B), spacer (C) and bearing (D) from bracket.

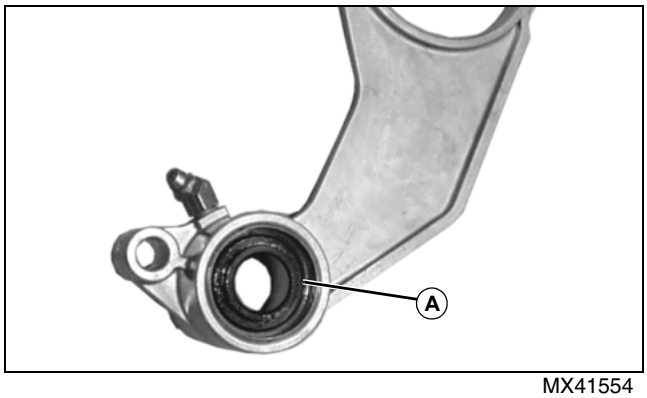


MX41554

3. Remove seal (E).

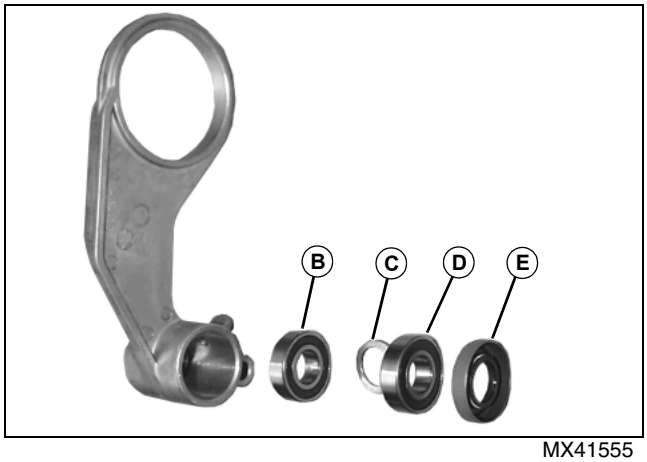
4. Inspect all components and replace as necessary.

Assembly - Shaft Assembly



MX41554

1. Install seal (A) with lip and spring facing out flush into housing.

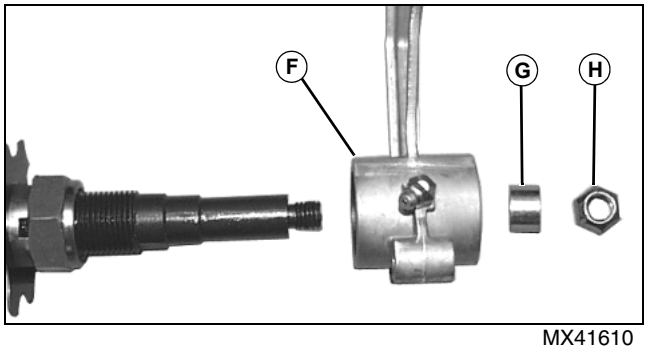


MX41555

2. Install bearing (B), spacer (C), bearing (D) in bracket.

3. Install seal (E) with lip and spring facing out flush into housing.

Note: When assembling FTC bracket (F) to shaft, ensure that bushing (G) is inserted before lock nut (H) is installed.

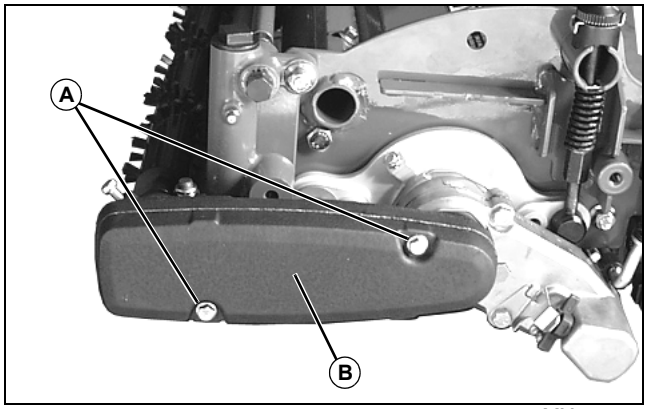


MX41610

1. Install FTC shaft support bracket reel housing. (See “Remove and Install Fairway Tender Conditioner” on page 654.)

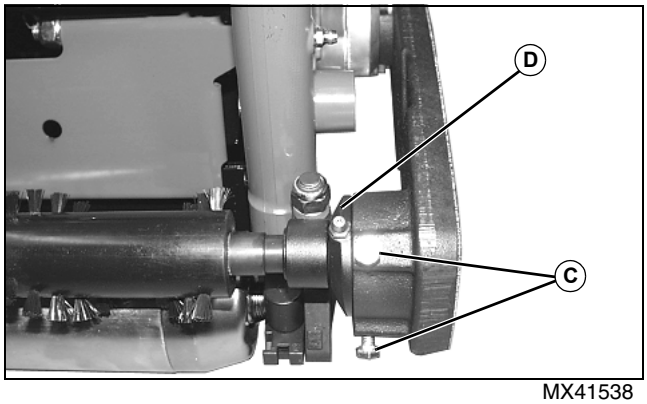
Remove and Install Power Brush

Remove Power Brush



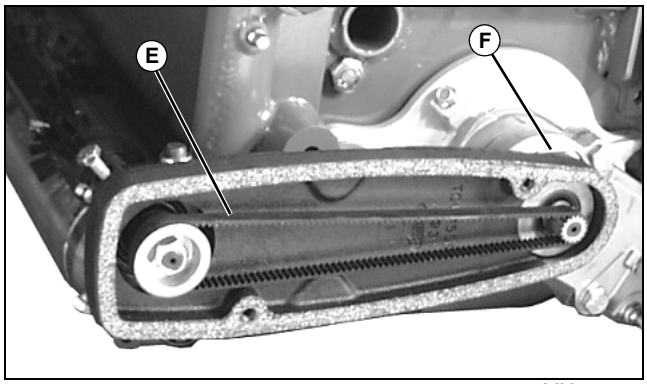
MX41529

1. Remove both hex head bolts (A).
2. Remove drive housing cover (B).



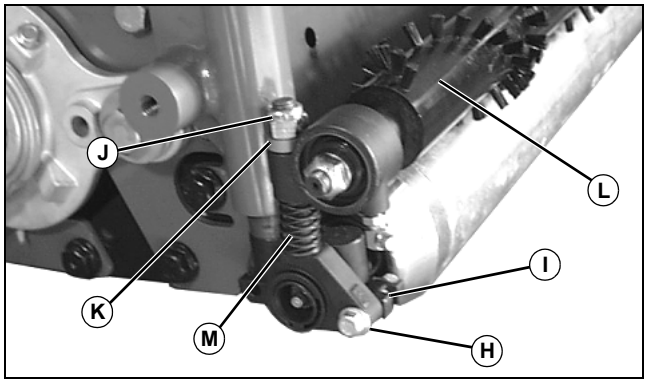
MX41538

3. Loosen two cap screws (C) and rotate top of eccentric housing (D) toward front of reel to loosen drive belt.



MX41530

4. Remove belt (E) from pulley and drive shaft.
5. Remove lock pin (F) from housing.
6. Remove inner drive housing from reel assembly.



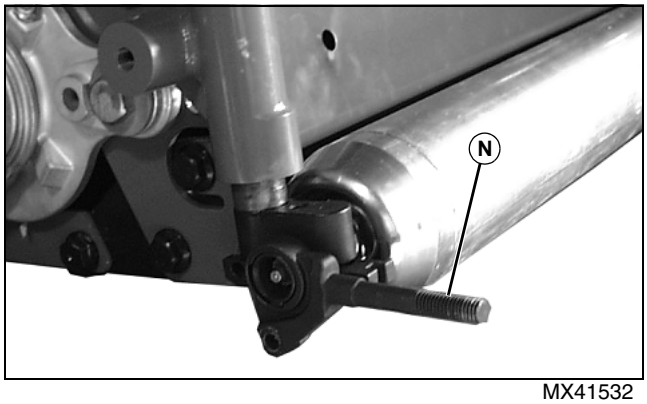
MX41531

7. Remove cap screw (H) and lock nut (I) from non-driven side of brush assembly.

8. Remove lock nut (J) and spacer (K) from both brush support brackets.

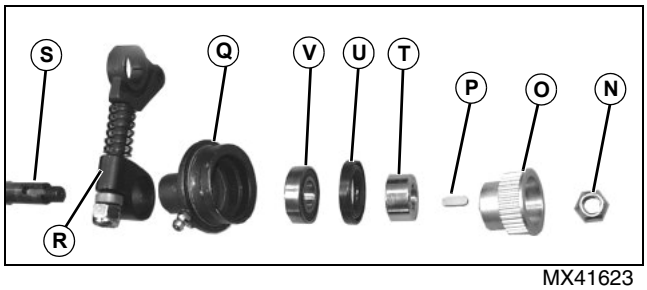
9. Lift brush assembly (L) and remove from reel.

10.Remove wave spring (M) from stud on both brush support brackets.



MX41532

11.Rotate and remove brush support bracket (N) from non-driven side of reel.

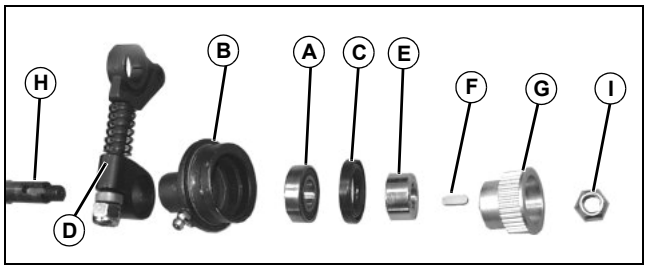


MX41623

12.Remove nut (N), gear (O), key (P), housing (Q) and shaft support bracket (R) from shaft (S).

13.Remove spacer (T), seal (U) and bearing (V) from housing (Q).

Install Power Brush

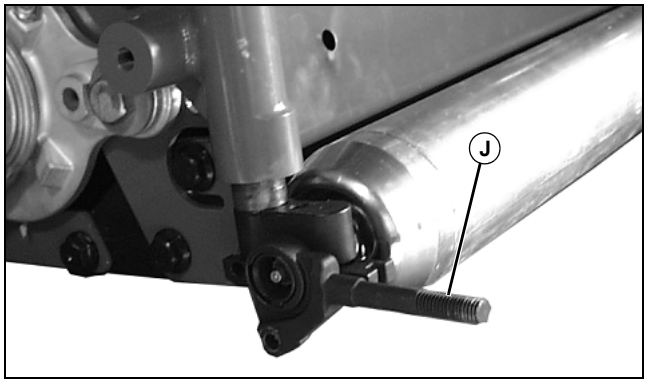


MX41623

1. Install bearing (A) in housing (B).

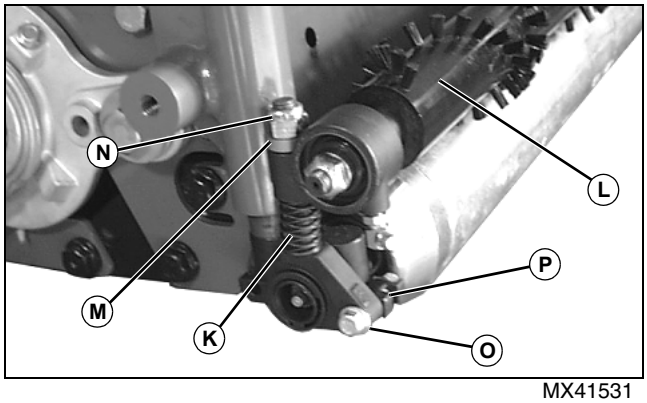
2. Install seal (C) in housing (B) with lip facing out.

3. Install brush support bracket (D), spacer (E), key (F) and gear (G) onto shaft (H), and secure with lock nut (I).



MX41532

1. Install brush support bracket on non-driven side (J) and rotate to a vertical position.



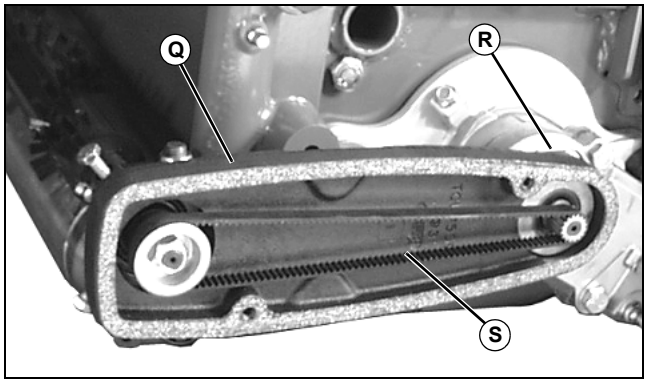
MX41531

2. Install wave spring (K) on stud on both brush support brackets.

3. Install brush assembly (L) on both brush support brackets.

4. Install spacer (M) and lock nut (N) on both brush support brackets. Adjust nut on each side to obtain brush to roller clearance of 0-1 mm (0-0.039 in.).

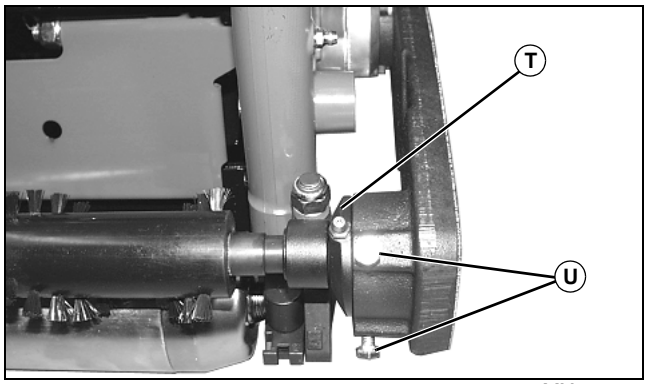
5. Install cap screw (O) and lock nut (P) on support bracket on non-driven side only.



MX41530

6. Install inner drive housing (Q) on reel assembly.

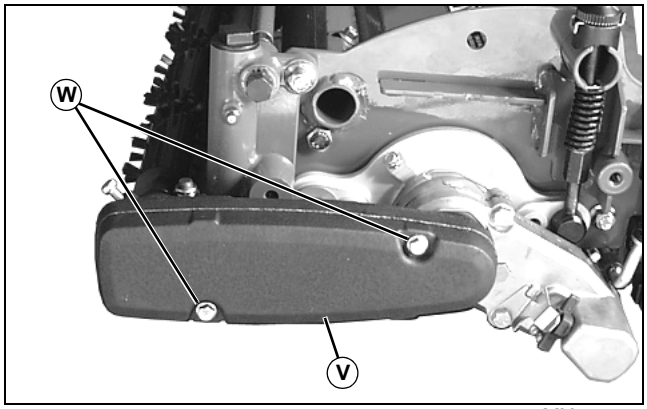
7. Install lock pin (R) in housing and install belt (S) on pulley and drive shaft.



MX41538

8. Rotate top of eccentric housing (T) toward rear of reel to tension drive belt. Tighten cap screws (U) securely.

9. Install new gasket on housing.



MX41529

10.Install drive housing cover (V) with hex head bolts (W) and tighten securely.

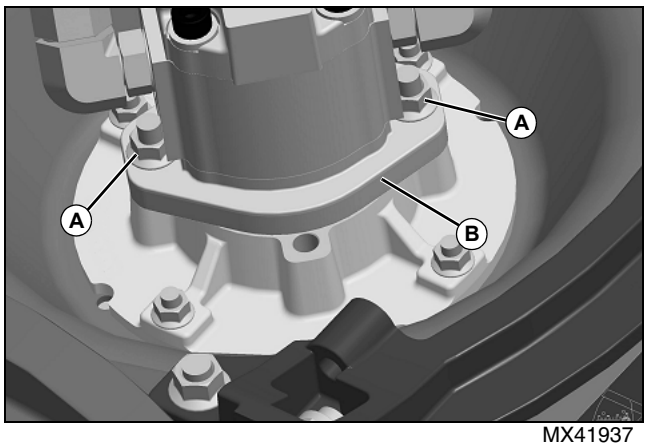
Repair - Rotary Decks

Remove and Install Rotary Decks

Remove

1. Park machine safely. (See “Park Machine Safely” in the Safety section.)
2. Remove blade. (See “Remove and Install Blades” on page 665.)
3. Lower mower deck to the ground.

Note: It is not necessary to disconnect hydraulic lines from hydraulic motor to remove rotary deck.



MX41937

4. Remove two flange nuts (A) and cap screws. Remove hydraulic motor (B) from cutting unit.
5. Remove two cap screws securing cutting unit to lift arm.
6. Slide deck forward, away from mower.

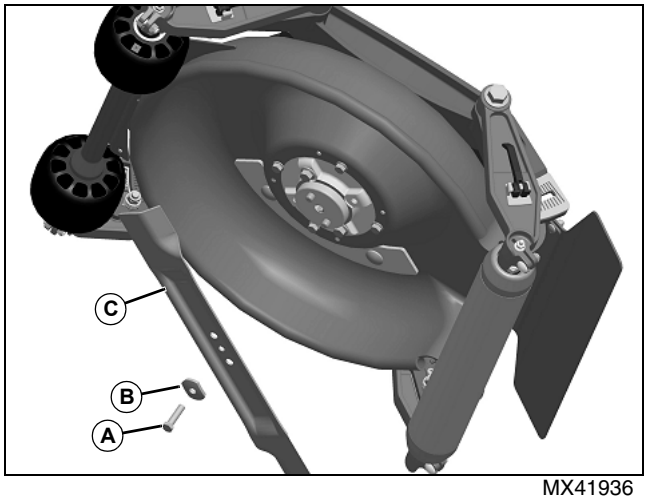
Installation

Installation is done in reverse order.

Remove and Install Blades

Remove

1. Stop machine on a level surface.
2. Lock park brake.
3. Raise mower decks completely.
4. Stop engine and remove the key.
5. Insert a wooden block between end of blade and edge of deck to prevent blade from turning while removing attaching hardware.



MX41936

6. Remove cap screw (A), washer (B), and blade (C) by turning the cap screw counterclockwise.
7. Inspect the blade, hub and attaching components for damage. Replace all damaged parts.
8. Sharpen and balance all blades.

Installation is done in reverse order of removal.

- Tighten blade cap screw to specification.

Specifications

Rotary Deck Blade Cap Screw Torque . . . . . 47.5 N•m (35 lb-ft)

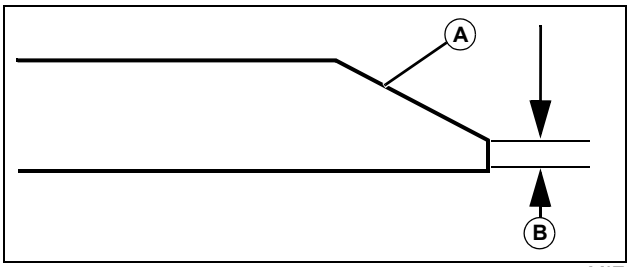
Sharpen Blades

Caution: Avoid Injury! Mower blades are dangerous!

1. Always wear gloves while working on blades.

2. Always wear safety eye protection when grinding.

- Sharpen blades with grinder, hand file, or electric blade sharpener.



MIF

- Keep original bevel (A) when grinding.
- Blade should have 0.40 mm (1/64 in.) cutting edge (B)

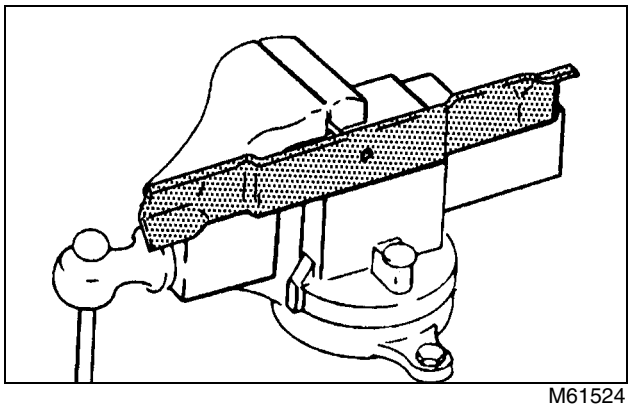
or less.

- Balance blades before installing.

Balance Blades

Caution: Avoid Injury! Mower blades are sharp. Always wear gloves when handling mower blades or working near blades.

1. Clean blade.



M61524

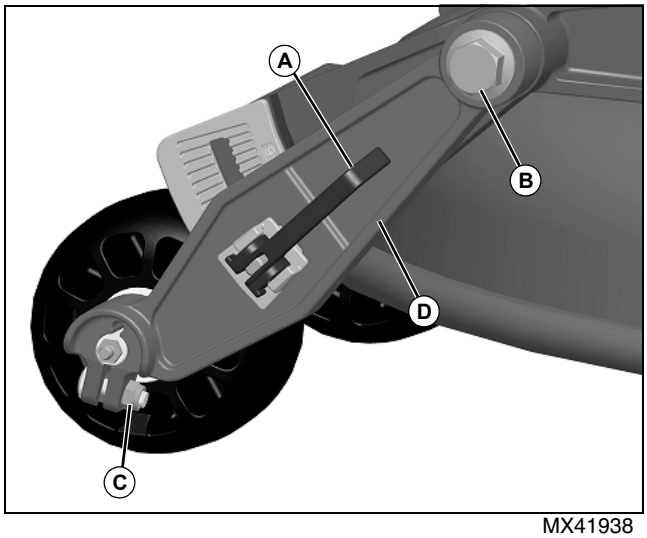
2. Put blade on nail in a vise. Turn blade to horizontal position.

3. Check balance. If blade is not balanced, heavy end of blade will drop.

4. Grind bevel of heavy end. Do not change blade bevel.

Remove and Install Front Rollers

Note: This procedure can be done with mower deck installed on machine or removed.



MX41938

1. Pull quick release lever (A) out on both sides and allow assembly to swing free of adjusters.

2. Remove bolt (B).

3. Loosen locknut (C) on both ends of front roller.

4. Remove bracket (D).

5. Remove shaft and roller assembly from the remaining bracket.

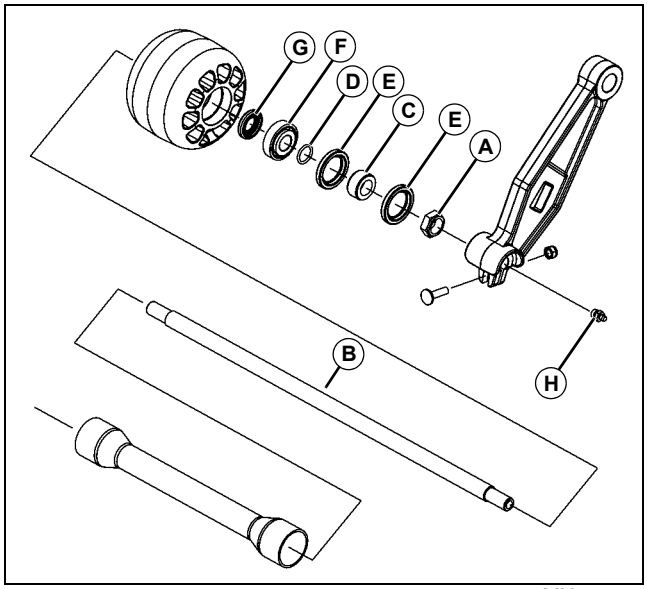
6. Repair as necessary.

Installation is done in the reverse order of removal.

- Center the rollers and axle between the brackets before tightening locknuts.
- Lubricate pivot points.
- Adjust roller height. (See “Adjust Height-of-Cut (HOC) Rotary Deck” on page 636.)

Repair Front Roller Assembly

1. Remove front roller assembly from mower deck. (See “Remove and Install Front Rollers” on page 666.)



MX41946

2. Remove locknut (A) from each end of shaft.

3. Push shaft (B) through roller to remove.

4. If spacer (C) and O-ring (D) do not come out with shaft, pull out to remove.

5. Remove outer seals (E).

6. Remove bearing and race (F).

7. Remove inner seal (G).

8. Remove grease fitting (H) from shaft to clean lubrication passage.

9. Repeat for opposite end of roller if needed.

10. Inspect all parts and replace as necessary.

Assembly is done in the reverse order of disassembly.

- Install roller with the deepest recess facing the end of the shaft.
- Pack bearing (F) with TY25083 Golf and Turf Cutting Unit Grease. Install bearing.
- Install inner seal (G) with lip facing out.

Important: Avoid Damage! Install outer seals with lips facing out.

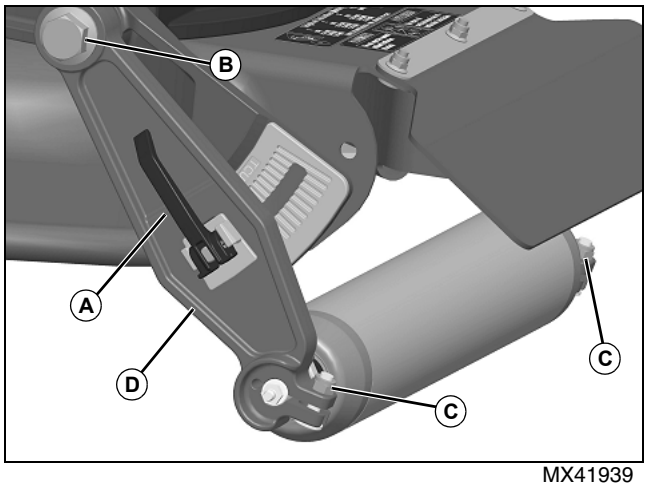
- Apply TY25083 Golf and Turf Cutting Unit Grease between lips of outer seals. Press outer seals (E) into place.
- Install shaft in roller and approximately center it lengthwise.

Important: Avoid Damage! Use care not to catch seal lips when installing spacer.

- Install new O-ring (D) in spacer (C). Apply a light coat of grease to bore of spacer and install with O-ring next to bearing.
- Repeat for opposite end of roller.
- Install both locknuts (A) and tighten until end play is gone, yet roller rotates freely.

Remove and Install Rear Roller

Note: This procedure can be done with mower deck installed on machine or removed.



MX41939

1. Pull quick release lever (A) out on both sides and allow assembly to swing free of adjusters.
2. Remove bolt (B).
3. Loosen locknut (C) on both ends of front roller.
4. Remove bracket (D).
5. Remove shaft and roller assembly from the remaining bracket.
6. Repair as necessary.

Installation is done in the reverse order of removal.

- Center the roller and axle between the brackets before tightening locknuts.
- Lubricate rear roller at both ends.
- Adjust roller height. (See “Adjust Height-of-Cut (HOC) Rotary Deck” on page 636.)

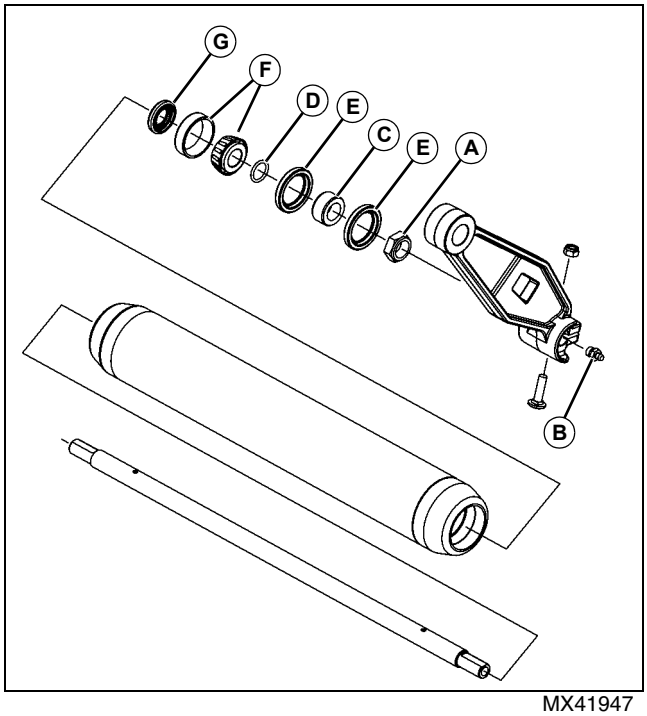
Repair Rear Roller Assembly

Other Material

Part No.	Part Name	Part Use
TY25083	John Deere Golf and Turf Cutting Unit Grease	Used to lubricate roller bearings and seals.

Disassembly

1. Remove rear roller assembly from mower deck. (See “Remove and Install Rear Roller” on page 667.)



MX41947

2. Remove locknut (A) from each end of shaft.
3. Remove grease fitting (B) from each end of shaft.
4. Push shaft through roller to remove.
5. If spacer (C) and O-ring (D) do not come out with shaft, pull out to remove.
6. Remove outer seals (E).

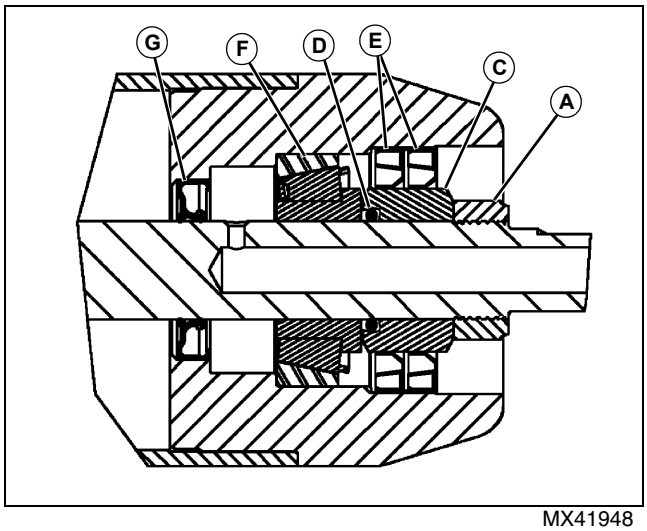
7. Remove bearing and race (F).

8. Remove inner seal (G).

9. Repeat for opposite end of roller if needed.

10. Inspect all components and replace as necessary.

Assembly



MX41948

1. Install inner seal (G) with lip facing out.

2. Pack bearing (F) with TY25083 Golf and Turf Cutting Unit Grease. Install bearing.

Important: Avoid Damage! Install outer seals with lips facing in.

3. Apply TY25083 Golf and Turf Cutting Unit Grease between lips of outer seals. Press outer seals (E) into place.

4. Install shaft in roller and approximately center it lengthwise.

Important: Avoid Damage! Use care not to catch seal lips when installing spacer.

5. Install new O-ring (D) in spacer (C). Apply a light coat of grease to bore of spacer and install with O-ring next to bearing.

6. Repeat for opposite end of roller.

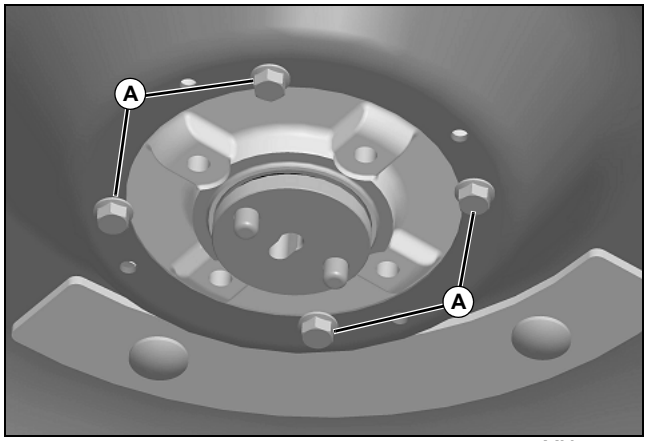
7. Install both locknuts (A) and tighten until end play is gone, yet roller rotates freely.

8. Install roller assembly onto mower deck. (See “Remove and Install Rear Roller” on page 667.)

Remove and Install Spindle Housing

1. Remove hydraulic motor from rotary deck and remove deck from machine. (See “Remove and Install Rotary Decks” on page 665.)

2. Remove blade. (See “Remove and Install Blades” on page 665.)



MX41940

3. Remove four cap screws (A) and remove spindle housing from deck shell.

Installation is done in the reverse order of removal.

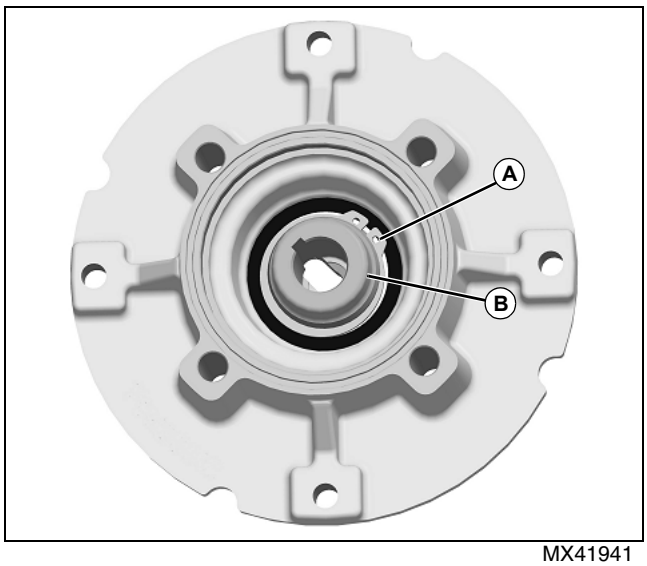
- Tighten spindle housing cap screws to specification.

Specifications

Spindle Housing Cap Screws . . . . . 24 N•m (18 lb-ft)

Repair Spindle

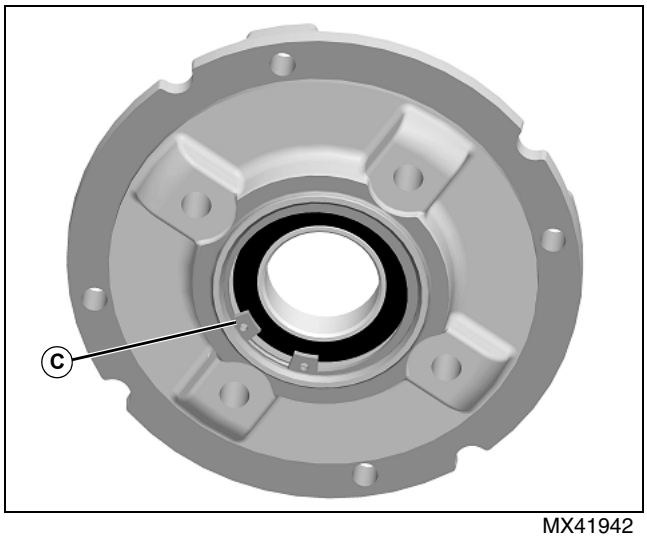
1. Remove spindle housing. (See “Remove and Install Spindle Housing” on page 668.)



MX41941

2. Remove top snap ring (A) from spindle (B).

3. Remove spindle (B) from bearing and housing.



MX41942

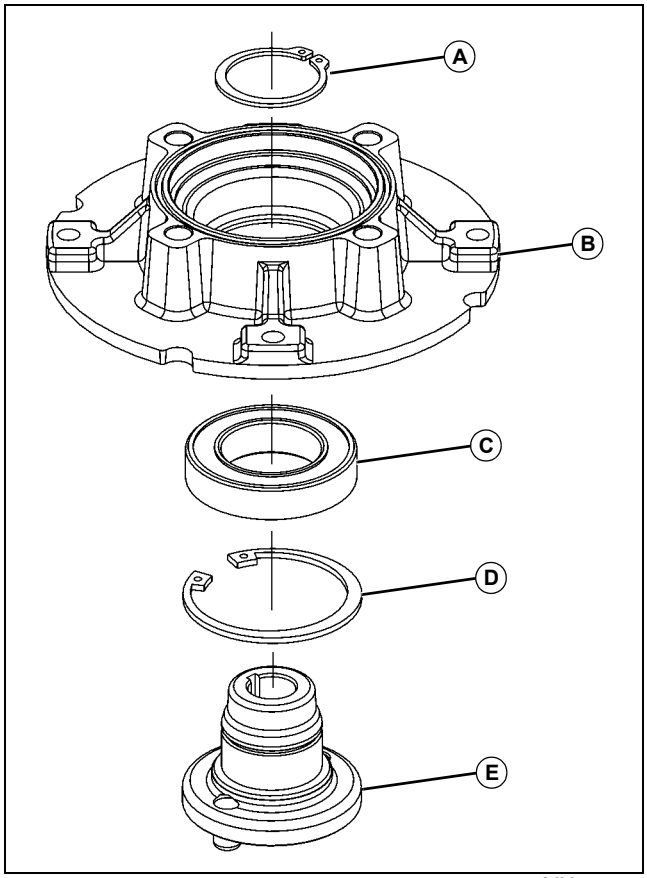
4. Remove snap ring (C) from spindle housing.

Important: Avoid Damage! You must press on outer race of bearing to remove from housing. Pressing on inner race puts all the pressure on the ball bearings and will damage them.

5. Support spindle housing in a press.

6. Using a bearing or bushing driver of the appropriate size, press on inner race of bearing and remove bearing from housing. Discard bearing.

7. Using a bearing and bushing driver of the appropriate size, press bearing into housing, pressing only on the outer race of bearing, until bearing bottoms out in housing.



MX41943

A- Snap Ring
B- Spindle Housing
C- Bearing
D- Snap Ring
E- Spindle

8. Assemble spindle in reverse order of disassembly.

9. Install spindle housing. (See “Remove and Install Spindle Housing” on page 668.)

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