

2015 Precedent Golf Car Maintenance and Service Manual



Gasoline Vehicle with Kawasaki FE350 Engine Electric Vehicle with ERIC Charging System Gasoline Vehicle with Subaru EX40 Engine

FOREWORD

Club Car vehicles are designed and built to provide the ultimate in performance efficiency; however, proper maintenance and repair are essential for achieving maximum service life and continued safe and reliable operation.

This manual provides detailed information for the maintenance and repair of 2015 Precedent electric and gasoline-powered vehicles, and should be thoroughly reviewed prior to servicing the vehicle. The procedures provided herein must be properly implemented, and the DANGER, WARNING, and CAUTION statements must be heeded.

This manual was written for the trained technician who already possesses knowledge and skills in electrical and mechanical repair. If the technician does not have such knowledge and skills, attempted service or repairs to the vehicle may render the vehicle unsafe. For this reason, Club Car advises that all repairs and/or service be performed by an authorized Club Car distributor/dealer representative or by a Club Car factory-trained technician.

It is the policy of Club Car, LLC to assist its distributors and dealers in continually updating their service knowledge and facilities so they can provide prompt and efficient service for vehicle owners. Regional technical representatives, periodic service bulletins, maintenance and service manuals, and other service publications also represent Club Car's continuing commitment to customer support.

Club Car offers a full line of training and continuing education classes for technicians who want to learn more about our products. For more information, contact your local dealer or Club Car's Technical Services department for a list of upcoming classes.

This manual covers all aspects of typical vehicle service; however, unique situations sometimes occur when servicing a vehicle. If it appears that a service question is not answered in this manual, please contact your nearest authorized Club Car dealer or distributor for assistance. You may also write to us at: Club Car, LLC, P.O. Box 204658; Augusta, GA 30917–4658 USA, Attention: Technical Services.

WARNING

- Read Safety on page 1-1 before attempting any service on the vehicle.
- Before servicing vehicle, read complete section(s) and any referenced information that may be relevant to the service or repair to be performed.

NOTE: This manual represents the most current information at the time of publication. Club Car, LLC is continually working to further improve its vehicles and other products. These improvements may affect servicing procedures. Any modification and/or significant change in specifications or procedures will be forwarded to all Club Car dealers and will, when applicable, appear in future editions of this manual.

Club Car, LLC reserves the right to change specifications and designs at any time without notice and without the obligation of making changes to units previously sold.

There are no warranties expressed or implied in this manual. See the limited warranty found in the vehicle owner's manual or write to Club Car, LLC, P.O. BOX 204658, Augusta, Georgia 30917-4658 USA, Attention: Warranty Department.

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SAFETY DETAILS

WARNING

• This owner's manual should be read completely before attempting to drive or service the vehicle. Failure to follow the instructions in this manual could result in property damage, severe personal injury, or death.

It is important to note that some vital statements throughout this manual and on the decals affixed to the vehicle are preceded by the words DANGER, WARNING, or CAUTION. For your protection, we recommend that you take special notice of these safety precautions. Safety precautions are essential and must be followed.

Throughout this manual and on the operation and safety decals affixed to the vehicle, the words "golf car" and "vehicle" are used interchangeably. "Golf car" is defined in the Notice of this manual and no other representation is stated or implied.

If any of the operation or safety decals on the vehicle become damaged, have been removed or cannot be easily read, they should be replaced immediately to avoid possible property damage, personal injury, or death. Contact your distributor/dealer.

▲ DANGER

A DANGER indicates an immediate hazard that will result in severe personal injury or death.

A WARNING

· A WARNING indicates an immediate hazard that could result in severe personal injury or death.

A CAUTION

 A CAUTION with the safety alert symbol indicates a hazard or unsafe practice that could result in minor personal injury.

CAUTION

 A CAUTION without the safety alert symbol indicates a potentially hazardous situation that could result in property damage. General Warnings SAFETY

GENERAL WARNINGS

The following safety statements must be heeded whenever the vehicle is being operated, repaired, or serviced. Vehicle feature identification information is also included. Other specific safety statements appear throughout this manual and on the vehicle.

A DANGER

- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.
- Gasoline Flammable! Explosive! Do not smoke. Keep sparks and flames away from the vehicle and service area. Service only in a well-ventilated area.
- Do not operate engine in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- The vehicle will not provide protection from lightning, flying objects, or other storm-related hazards. If caught in a storm while driving a Club Car vehicle, exit the vehicle and seek shelter in accordance with applicable safety guidelines for your location.

▲ WARNING

- Follow the procedures exactly as stated in this manual, and heed all DANGER, WARNING, and CAUTION statements in this manual as well as those on the vehicle and battery charger.
- Children requiring a child safety seat must not ride in vehicle.
- · Do not leave children unattended on vehicle.
- Prior to leaving the vehicle unattended or servicing the vehicle, set the park brake, place the Forward/Reverse handle or switch in the NEUTRAL position, turn the key switch to the OFF position, and remove the key. Chock the wheels when servicing the vehicle.
- Improper use of the vehicle or failure to properly maintain it could result in decreased vehicle performance, severe personal injury, or death.
- Any modification or change to the vehicle that affects the electrical system, stability or handling
 of the vehicle, or increases maximum vehicle speed beyond factory specifications, could result in
 severe personal injury or death.
- Check the vehicle for proper location of all vehicle safety and operation decals and make sure they are in place and are easy to read.
- Only trained technicians should service or repair the vehicle or battery charger. Anyone doing even simple repairs or service should have knowledge and experience in electrical and mechanical repair. The appropriate instructions must be used when performing maintenance, service, or accessory installation.
- Wear safety glasses or approved eye protection when servicing the vehicle or battery charger. Wear a full face shield and rubber gloves when working on or near batteries.
- Do not wear loose clothing or jewelry such as rings, watches, chains, etc., when servicing the vehicle or battery charger.

WARNING CONTINUED ON NEXT PAGE

A WARNING

• Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.

Electric vehicles only:

- Place Tow/Run switch in the TOW position before disconnecting or connecting the batteries. Failure to heed this warning could result in a battery explosion or severe personal injury.
- To avoid unintentionally starting an electric vehicle, disconnect the batteries and discharge the controller. See Disconnecting the Batteries – Electric Vehicles on page 1-5.

Gasoline vehicles only:

- To avoid unintentionally starting a gasoline vehicle, disconnect the battery and spark plug wire. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- Frame ground Do not allow tools or other metal objects to contact frame when disconnecting battery cables or other electrical wiring. Do not allow a positive wire to touch the vehicle frame, engine, or any other metal component.

DISABLING THE VEHICLE

- 1. Set the park brake.
- 2. Turn the key switch OFF and remove the key.
- 3. Place the Forward/Reverse control in the NEUTRAL position.
- 4. In addition, chock the wheels if servicing or repairing the vehicle.

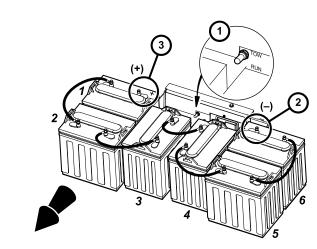
LOW MAINTENANCE BATTERY: DISCONNECTING THE BATTERY - GASOLINE VEHICLES

- 1. Disable the vehicle. See Disabling the Vehicle on page 1-3.
- 2. Disconnect the battery cables, negative (–) cable first, as shown (Figure 1-2).
- 3. Disconnect the spark plug wire(s) from the spark plug(s).

LOW MAINTENANCE BATTERY: CONNECTING THE BATTERY – GASOLINE VEHICLES

- 1. Connect the battery cables, positive (+) cable first.
- 2. Tighten battery terminals to 80 in·lb (9 N·m).
- 3. Coat terminals with Battery Terminal Protector Spray (CC P/N 1014305) to minimize corrosion.
- Connect the spark plug wire(s) to the spark plug(s).

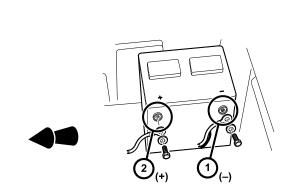
General Warnings SAFETY



(Viewed from driver side of vehicle)

- 1. Place TOW/RUN Switch in TOW before disconnecting or connecting battery cables.
- 2. Remove negative battery cable.
- 3. Remove positive battery cable.

Connect battery cables in reverse order.



(Viewed from driver side of vehicle)

- 1. Remove negative battery cable.
- 2. Remove positive battery cable.

Connect battery cables in reverse order.

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Figure 1-1 Battery Cable Removal – Electric Vehicles 6x8-Volt Battery Configuration

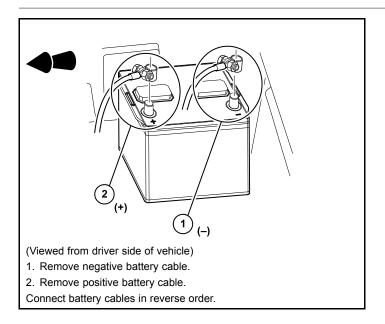
Figure 1-2 Low Maintenance Battery: Battery Cable Removal - Gasoline Vehicles

NO MAINTENANCE BATTERY: DISCONNECTING THE BATTERY- GASOLINE VEHICLES

- Disable the vehicle. See Disabling the Vehicle on page 1-3.
- Disconnect the battery cables, negative (–) cable first, as shown (Figure 1-3).
- Disconnect the spark plug wire(s) from the spark plug(s).

NO MAINTENANCE BATTERY: CONNECTING THE BATTERY- GASOLINE VEHICLES

- Connect the battery cables, positive (+) cable first. 1.
- Tighten battery terminals to 41 in·lb (4.3 N·m). 2.
- Coat terminals with Battery Terminal Protector Spray (CC P/N 1014305) to minimize corrosion.
- Connect the spark plug wire(s) to the spark plug(s).



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Figure 1-3 No Maintenance Battery: Battery Cable Removal-Gasoline Vehicles

DISCONNECTING THE BATTERIES - ELECTRIC VEHICLES

- 1. Disable the vehicle. See Disabling the Vehicle on page 1-3.
- 2. Place Tow/Run switch in the TOW position before disconnecting or connecting the batteries. Failure to heed this warning could result in a battery explosion or severe personal injury.
- 3. Disconnect the batteries, negative (–) cable first, as shown (Figure 1-1).
- 4. After disconnecting the batteries, wait 90 seconds for the controller capacitors to discharge.

CONNECTING THE BATTERIES - ELECTRIC VEHICLES

- 1. Ensure the Tow/Run switch is in the TOW position.
- 2. Connect the battery cables, positive (+) cable first.
- 3. Tighten battery terminals to 110 in·lb (12.4 N·m).
- 4. Coat terminals with Battery Terminal Protector Spray (CC P/N 1014305) to minimize corrosion.

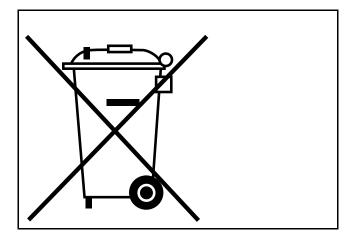
General Warnings SAFETY

RECYCLING LEAD-ACID BATTERIES

WARNING

 Lead-acid batteries contain lead (Pb), other metals, acids and other compounds. If improperly handled, they can contaminate both water and soil, causing environmental damage and personal injury.

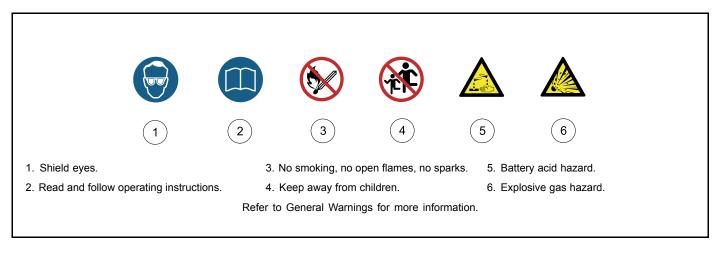
Lead-acid batteries are identified by the symbol shown below and should be properly recycled (Figure 1-4). They cannot be disposed as municipal waste and must be collected separately. Responsibility for environmental protection must be shared, not only by the manufacturers of the batteries, but by people who use the batteries as well. Please contact your nearest Club Car dealer or distributor for information on how to properly recycle your batteries.



1403.eps
Figure 1-4 Dispose of Lead-acid Batteries Properly

INTERNATIONAL SAFETY SYMBOLS ON BATTERIES

Anyone using, repairing, or servicing the vehicle must understand and heed the safety symbols on the vehicle battery or batteries.



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Figure 1-5 International Safety Symbols on Batteries

VEHICLE SPECIFICATIONS - ELECTRIC AND SUBARU EX40

SPECIFICATIONS	TWO- PASSENGER ELECTRIC VEHICLE	TWO- PASSENGER GASOLINE VEHICLE	FOUR- PASSENGER ELECTRIC VEHICLE	FOUR- PASSENGER GASOLINE VEHICLE
POWER SOURCE				
Drive motor: Direct drive, 48 volts DC, shunt-wound, 3.1 hp	•		•	
Transaxle: Double reduction helical gear with 12.3:1 direct drive axle	•		•	
Electrical system: 48-volts DC, reduced speed reverse	•		•	
Batteries: High capacity, deep cycle	•		•	
Charger: E.R.I.C. Automatic, 48-volt; UL and CSA listed See E.R.I.C. Battery Charger Specifications on page 2-5.	•		•	
Battery: 12-volt, Low Maintenance or No Maintenance		•		•
Engine: 4 cycle, OHC, 404 cc, 14 Horsepower (10.4 kW) rated engine @ 3600 RPM (per SAE J 1940), single cylinder, air cooled, with splash lubrication system		•		•
Fuel system: Electronic fuel injection (EFI), high-pressure rotary fuel pump with 10 micron fuel filter		•		•
Governor: Automatic ground speed sensing, internally geared in transaxle		•		•
Ignition: Digital CDI with electronic RPM limiter		•		•
Transaxle: Precision helical gears, forward/reverse with neutral position (11.47:1 forward; 15.63:1 reverse), with optional limited slip differential		•		•
Torque converter: Automatic, variable-speed, dry type		•		•
Electrical system: 12-volt, 500 cca at 0 °F (-17.8 °C), 650 cca at 32 °F (0 °C). 105-minute reserve capacity		•		•
Torque converter: Automatic, variable speed, dry type		•		•

TABLE CONTINUED ON NEXT PAGE

SPECIFICATIONS	TWO- PASSENGER ELECTRIC VEHICLE	TWO- PASSENGER GASOLINE VEHICLE	FOUR- PASSENGER ELECTRIC VEHICLE	FOUR- PASSENGER GASOLINE VEHICLE	
STEERING/SUSPENSION/BRAKES					
Steering: Self-adjusting rack and pinion	•	•	•	•	
Suspension: Front and rear tapered mono-leaf springs with dual hydraulic shocks	•	•	•	•	
Brakes: Dual rear wheel self-adjusting brakes with cast iron drums and single brake pedal with automatic-release park brake	•	•	•	•	
BODY/CHASSIS					
Frame/Chassis: Aluminum and composite	•	•	•	•	
Front and rear body: Dupont Surlyn® Reflections	•	•	•	•	
Body finish: High-gloss molded-in color	•	•	•	•	
Tires: 18 x 8.5 – 8 tubeless, 4 ply rated	•	•	•	•	
Lug- Nut Torque Values: Front and Rear tires	55 ft·lb (±5.0) (67.8 to 81.3 N·m)				
DIMENSIONS/WEIGHT			_	_	
Overall length	91.5 in. (232 cm)	91.5 in. (232 cm)	104 in. (264 cm)	104 in. (264 cm)	
Overall width	47.25 in. (120 cm)	47.25 in. (120 cm)	47.25 in. (120 cm)	47.25 in. (120 cm)	
Overall height (with canopy)	68.5 in. (174 cm)	68.5 in. (174 cm)	71 in. (180 cm)	71 in. (180 cm)	
Overall height (at steering wheel)	48.0 in. (122 cm)	48.0 in. (122 cm)	48.0 in. (122 cm)	48.0 in. (122 cm)	
Wheelbase	65.5 in. (166 cm)	65.5 in. (166 cm)	65.5 in. (166 cm)	65.5 in. (166 cm)	
Ground clearance	4.5 in. (11 cm)	4.5 in. (11 cm)	4.5 in. (11 cm)	4.5 in. (11 cm)	
Front wheel tread	34.5 in. (88 cm)	34.5 (88 cm)	34.5 in. (88 cm)	34.5 (88 cm)	
Rear wheel tread	38.6 in. (98 cm)	38.6 in. (98 cm)	38.6 in. (98 cm)	38.6 in. (98 cm)	
Weight (standard electric vehicle with canopy, with batteries)	909 lb (412.5 kg)		1024 lb (464.5 kg)		
Weight (standard gasoline vehicle with canopy, with battery, without fuel)	651 lb (295 kg) 768 lb (348 kg)				
Forward speed	12 to 15 mph (19 to 24 km/h)				
Curb clearance circle (diameter)	17 ft - 4 in. (528 cm)	17 ft - 4 in. (528 cm)	17 ft - 4 in. (528 cm)	17 ft - 4 in. (528 cm)	
Standard seating capacity	2	2	4	4	
LIQUID CAPACITIES					
Transaxle	22 fl-oz (0.67 L)		22 fl-oz (0.67 L)		
Engine crankcase		40 fl-oz (1.2 L)		40 fl-oz (1.2 L)	
Transaxle		22 fl-oz (0.67 L)		22 fl-oz (0.67 L)	

TABLE CONTINUED ON NEXT PAGE

SPECIFICATIONS	TWO- PASSENGER ELECTRIC VEHICLE	TWO- PASSENGER GASOLINE VEHICLE	FOUR- PASSENGER ELECTRIC VEHICLE	FOUR- PASSENGER GASOLINE VEHICLE
Fuel tank		5.9 gal (22.3 L)		5.9 gal (22.3 L)
TIRE PRESSURE				
Front and rear	18 to 20 psig (124 to 138 kPa)	18 to 20 psig (124 to 138 kPa)	18 to 20 psig (124 to 138 kPa)	18 to 20 psig (124 to 138 kPa)
NOISE AND VIBRATION		_	_	_
Drive-by noise level to operator Test method: EN 12053:2001	68.5 dBA Uncertainty: 2 dBA	75.5 dBA Uncertainty: 4 dBA	68.5 dBA Uncertainty: 2 dBA	75.5 dBA Uncertainty: 4 dBA
Vibration at driver's seat Test method: EN 13059:2002	0.6 m/s² Uncertainty: 0.114 m/s²	Unknown at time of print	0.8 m/s ² Uncertainty: 0.072 m/s ²	Unknown at time of print

Vehicle Specifications – Kawasaki FE350

SPECIFICATIONS	TWO- PASSENGER GASOLINE VEHICLE	FOUR- PASSENGER GASOLINE VEHICLE
POWER SOURCE	_	_
Engine: 4-cycle OHV, 351 cc, 10.4 Engine Horsepower (7.8 kW) rated @ 3600 RPM (per SAE J1349), single-cylinder, air-cooled, with pressure lubrication system	•	•
Fuel system: Side-draft carburetor with float bowl, fixed jets, fuel filters, and impulse fuel pump	•	•
Governor: Automatic ground-speed sensing, internally geared in unitized transaxle	•	•
Ignition: Transistor electronic ignition with electronic RPM limiter	•	•
Unitized transaxle: Fully synchronized forward and reverse with neutral and reduced speed reverse (11.8:1 forward, 17.1:1 reverse)	•	•
Torque converter: Automatic, variable-speed, dry type	•	•
Electrical system: 12 volt, 500 cca at 0 °F (-17.8 °C), 650 at 32 °F (0 °C). 105-minute reserve capacity and 35-amp charging capacity	•	•
STEERING/SUSPENSION/BRAKES	-	•
Steering: Self-adjusting rack and pinion	•	•
Suspension: Front and rear tapered mono-leaf springs with dual hydraulic shocks	•	•
Brakes: Dual rear wheel self-adjusting brakes with cast iron drums and single brake pedal with automatic-release park brake	•	•
BODY/CHASSIS	_	
Frame/Chassis: Aluminum and composite	•	•
Front and rear body: Dupont Surlyn® Reflections	•	•
Body finish: High-gloss molded-in color	•	•

TABLE CONTINUED ON NEXT PAGE

SPECIFICATIONS	TWO- PASSENGER GASOLINE VEHICLE	FOUR- PASSENGER GASOLINE VEHICLE
Tires: 18 x 8.5 – 8 tubeless, 4 ply rated	•	•
DIMENSIONS/WEIGHT		
Overall length	91.5 in. (232 cm)	104 in. (264 cm)
Overall width	47.25 in. (120 cm)	47.25 in. (120 cm)
Overall height (with canopy)	68.5 in. (174 cm)	71 in. (180 cm)
Overall height (at steering wheel)	48.0 in. (122 cm)	48.0 in. (122 cm)
Wheelbase	65.5 in. (166 cm)	65.5 in. (166 cm)
Ground clearance	4.5 in. (11 cm)	4.5 in. (11 cm)
Front wheel tread	34.5 (88 cm)	34.5 (88 cm)
Rear wheel tread	38.6 in. (98 cm)	38.6 in. (98 cm)
Weight (standard gasoline vehicle with canopy, with battery, without fuel)	651 lb. (295 kg)	768 lb. (348 kg)
Forward speed		
Curb clearance circle (diameter)	17 ft - 4 in. (528 cm)	17 ft - 4 in. (528 cm)
Standard seating capacity	2	4
LIQUID CAPACITIES		
Engine crankcase (without filter)	32 oz (0.95 L)	32 oz (0.95 L)
Engine crankcase (with filter)	38 oz (1.12 L)	38 oz (1.12 L)
Unitized transaxle	27 oz (0.8 L)	27 oz (0.8 L)
Fuel tank	6.7 gallons (25.4 L)	6.7 gallons (25.4 L)
TIRE PRESSURE		
Front and rear	12 to 14 psig (83 to 96 kPa)	18 to 20 psig (124 to 138 kPa)
NOISE AND VIBRATION		
Drive-by noise level to operator Test method: EN 12053:2001	70.9 dBA Uncertainty: 2 dBA	70.9 dBA Uncertainty: 2 dBA
Vibration at driver's seat Test method:EN 13059:2002	0.8 m/s ² Uncertainty: 0.096 m/s ²	0.8 m/s ² Uncertainty: 0.087 m/s ²

E.R.I.C. BATTERY CHARGER SPECIFICATIONS

E.R.I.C. BATTERY CHARGER SPECIFICATIONS	
MODEL NUMBER	IC650-048-CC
AC INPUT	1
AC voltage	100 to 240 VAC
Frequency	50 / 60 Hz
POWER CONSUMPTION	
Maximum AC input current (amps)	7.5
DC OUTPUT	-
Rated DC voltage (VDC)	48
Maximum DC voltage (VDC)	72
Maximum DC output current (amps)	13.5
DIMENSIONS/WEIGHT	
Case – overall length	9.9 in (25.2 cm)
Case – overall width	7.3 in (18.6 cm)
Case – overall height	3.1 in (8 cm)
AC cord length (standard length)	6 ft (183 cm)
DC cord length (standard length)	9 ft (274 cm)
Weight	6.5 lb (3 kg)
MOUNTING CONFIGURATION	
Mounting: Set on shelf; mount under shelf, on wall or ceiling; or hang securely from ceiling: any orientation.	•

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

Important features unique to the different models covered in this manual are highlighted. Club Car, LLC recommends the owner/operator read and understand this manual and pay special attention to features specific to their vehicle(s).

Refer to the owner's manual provided with the vehicle for information on the following topics:

- Pre-Operation and Daily Safety Checklist
- · Controls and Indicators
- · Driving Instructions
- Towing
- Transporting on a Trailer
- Subsequent Owner Registration
- Warranties

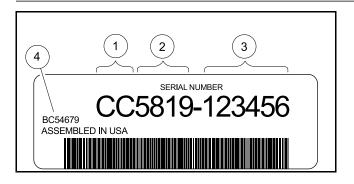
MODEL IDENTIFICATION

The serial number of each vehicle is printed on a bar code decal mounted either below the passenger side cup holder or above the accelerator or brake pedal (Example: CC5819–123456) (Figure 3-1).

The two letters (1) at the beginning of the serial number indicate the vehicle model. The following four digits (2) indicate the model year and production week during which the vehicle was built. The six digits (3) following the hyphen represent the unique sequential number assigned to each vehicle built within a given model year. **See following NOTE.**

NOTE: Have the vehicle serial number available when ordering parts or making inquiries.

Build Code: The build code (4) is a five-digit number that appears on the vehicle serial number decal. The build code exists to enable the user to identify the correct owner's manual for a vehicle. This owner's manual is valid for the build code range indicated on the back cover of this owner's manual.



2843.eps

Figure 3-1 Serial Number Decal

SAFETY COMMITTEE

If the golf car is to be rented or is part of a fleet, we strongly recommend that a safety committee be appointed. One of the main concerns of this committee should be the safe operation of the golf cars.

This should include at a minimum:

- · Where golf cars should be driven.
- Ensuring that proper warnings of driving hazards are displayed and visible. See below for list of signs available from Club Car Service Parts Department.
- · Who should and who should not drive golf cars.
- · Instructing first time drivers.
- · Maintaining golf cars in a safe driving condition
- · How various rules are to be enforced.

The safety committee should include all these items and such others as the committee feels necessary or appropriate.

3

STORAGE - ELECTRIC VEHICLE

See General Warnings on page 1-2.

A WARNING

- Turn the key switch to the OFF position, remove the key, and leave the Forward/Reverse switch in the NEUTRAL position during storage. Place Tow/Run switch in the TOW position. This is to prevent unintentionally starting the vehicle or a fire hazard.
- Do not attempt to charge frozen batteries or batteries with bulged cases. Discard the battery. Frozen batteries can explode.

A CAUTION

- Batteries in a low state of charge will freeze at low temperatures.
- To avoid exposing electrical components to moisture and subsequent damages, do not use any type of pressure washing or steam cleaning equipment to wash the vehicle.

PREPARING THE ELECTRIC VEHICLE FOR EXTENDED STORAGE

Check Battery Water Levels Two Weeks Prior to Storage

Check water levels at least two weeks prior to winter storage to ensure proper mixing of water and electrolyte. Note that it takes approximately five charge cycles with a minimum of 10 amp hours removed after each charge to properly mix the water with electrolyte. Do NOT water batteries immediately prior to storage because this will not provide sufficient charge time to mix the water with the electrolyte. Freezing can occur when batteries are stored in this condition.

1. Check the water levels in each battery cell. If water is required, fill the cells to cover the plates, charge the batteries, and then use distilled water to fill each cell to the correct level. Electrolyte level should be from 0.5 inch (13 mm) above plates to 0.25 inch (6 mm) below the level indicator (Figure 21-3).

Immediately Prior to Storage, Perform the Following Steps

- 1. Unload the vehicle so that tires are supporting only the weight of the vehicle.
- Turn the key switch to the OFF position, remove the key, and leave the Forward/Reverse switch in the NEUTRAL position during storage.
- 3. If so installed, turn off all accessories, including GPS units, fans, etc.
- 4. Place the Tow/Run switch in the TOW position.

NOTE: All functions of the dash-mounted charge indicator light are disabled when the Tow/Run switch is in the TOW position.

If Visage or Guardian units are installed on vehicles and remote monitoring will be used during the storage period, make sure the Tow/Run switch remains in the RUN position rather than in the TOW position required for all other vehicles during storage.

- 5. Batteries should be clean and free of corrosion. Wash tops and terminals of batteries with a solution of baking soda and water; use 1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water. Rinse solution off batteries. Do not allow this solution to enter the batteries. Let the terminals dry and then coat them with Battery Terminal Protector Spray.
- 6. Tighten all battery cable connections to 110 in lb (12.4 N·m).
- 7. Store vehicle in a cool, dry place. This will minimize battery self-discharge.
- 8. Adjust tires to recommended tire pressure.
- 9. Perform semiannual periodic lubrication.
- 10. Thoroughly clean front body, rear body, seats, battery compartment, and underside of vehicle.
- 11. Do not engage the park brake. Chock the wheels to prevent the vehicle from rolling.

NOTE: It is recommended that the vehicles be plugged in and the electrolyte level maintained throughout the storage period. If any of the following conditions exist, however, then disconnect the batteries for storage: 1) The charger cannot remain plugged in, 2) AC power will not be available during extended storage, or 3) Electrolyte levels will not be maintained. To disconnect batteries for storage, go to step 13.

- 12. To keep batteries fully charged during storage:
 - 12.1. Plug the battery charger into the car. Leave battery chargers plugged in during storage. The charger will automatically activate when necessary.
 - 12.2. Check the electrolyte level and charger function monthly to ensure that proper operation is maintained. The charger is functioning properly if the blue light is ON and the triangular light is OFF.

CAUTION

- Be sure to check the batteries and charger monthly to maintain correct battery water level and to ensure the charger is operating correctly during storage.
- 13. If disconnecting the batteries for storage, disconnect B negative (-) battery cable and secure it in a way that ensures the cable will not come into contact with battery terminal.

3

RETURNING THE STORED ELECTRIC VEHICLE TO SERVICE

- 1. If necessary, connect batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 2. Fully charge batteries.

A WARNING

- Do not attempt to charge frozen batteries or batteries with bulged cases. Discard the battery. Frozen batteries can explode.
- 3. Adjust tires to recommended tire pressure.
- 4. Perform the **See Pre-Operation and Daily Safety Checklist on page 10-1.** Perform the Performance Inspection on page 10-2.

STORAGE - GASOLINE VEHICLE

See General Warnings on page 1-2.

▲ DANGER

- Do not attempt to drain fuel when the engine is hot or while it is running.
- Be sure to clean up any spilled gasoline before operating the vehicle.
- Store fuel in an approved fuel container only. Store in a well-ventilated area away from sparks, open flames, heaters, or heat sources.
- · Keep fuel out of the reach of children.
- · Do not siphon fuel from the vehicle.

WARNING

 Turn the key switch to the OFF position, remove the key, and leave the Forward/Reverse handle in the NEUTRAL position during storage. This is to prevent unintentionally starting the vehicle or a fire hazard.

A CAUTION

Batteries in a low state of charge will freeze at low temperatures.

PREPARING THE GASOLINE VEHICLE FOR EXTENDED STORAGE

- 1. Unload the vehicle so that tires are supporting only the weight of the vehicle.
- 2. Store vehicle in a cool, dry place. This will minimize battery self-discharge. If the battery appears to be weak, have it charged by a trained technician. Use an automotive-type 12-volt battery charger rated at 10 amps or less.
- Seal the fuel tank.
 - 3.1. Fill fuel tank, and, following manufacturer's directions, add a commercially available fuel stabilizer (such as Sta-Bil®).
 - 3.2. Disconnect fuel vent line from fuel tank vent nipple.
 - 3.3. Plug the fuel tank vent nipple so that it is air tight. We recommend using a slip-on vinyl cap.

NOTE: It is not necessary to drain the fuel line.

- 4. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3. See No Maintenance Battery: Disconnecting the Battery- Gasoline Vehicles on page 1-4.
- Battery should be clean and free of corrosion. Wash top and terminals of battery with a solution of baking soda and water (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse solution off battery. Do not allow this solution to enter the battery. Let the terminals dry and then coat them with Battery Terminal Protector Spray (CC P/N 1014305).

- 6. To protect the engine, remove spark plug and pour 0.5 fl-oz (14.2 mL) of SAE 10 weight oil into the engine through the spark plug hole. Rotate engine crankshaft by hand several times and then install the spark plug and tighten it to 18 ft-lb (24.5 N·m).
- 7. Adjust tires to recommended tire pressure. See Vehicle Specifications Electric and Subaru EX40 on page 2-1.
- 8. Perform semiannual periodic lubrication. See Periodic Lubrication Schedules on page 10-11.
- 9. Thoroughly clean front body, rear body, seats, engine compartment, and underside of vehicle.
- 10. Do not engage the park brake. Chock the wheels to prevent the vehicle from rolling.

RETURNING THE STORED GASOLINE VEHICLE TO SERVICE

- 1. Restore the fuel systems to operation.
 - 1.1. Remove the plug from the fuel tank vent.
 - 1.2. Connect the vent tube to the fuel tank vent.
- Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3. See No Maintenance Battery: Connecting the Battery- Gasoline Vehicles on page 1-4.
- 3. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Crank the engine until fuel is pumped into the fuel injector and fuel lines and the engine starts. Turn the engine off and return the neutral lockout switch to the OPERATE position. **See following NOTE**.

NOTE: Due to the oil added to the engine in preparation for storage, engine may smoke excessively for a short time when it is run for the first time after storage.

- 4. Adjust tires to recommended tire pressure. See Vehicle Specifications Electric and Subaru EX40 on page 2-1.
- 5. Perform the Pre-Operation and Daily Safety Checklist on page 10-1 and the Performance Inspection on page 10-2.

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

CLEANING THE VEHICLE

See General Warnings on page 1-2.

CAUTION

- Do not use detergents or cleaning solvents that contain ammonia, aromatic solvents, or alkali materials on body panels or seats.
- Do not allow battery acid to drip on body panels. Battery acid will cause permanent damage. Wash spilled battery acid from body panels immediately.

Club Car Precedent vehicles are equipped with Surlyn® front and rear bodies. Use only commercially available automotive cleaners with a sponge or soft cloth for normal cleaning. A garden hose at normal residential water pressure is adequate.

Club Car does not recommend any type of pressure washing or steam cleaning. Such a process (especially if the vehicle has a Surlyn® rear body that is removed) will expose electrical components to moisture. Moisture entering electrical components can result in water damage and subsequent component failure.

Use non-abrasive wax products. Do not use abrasive leveling or rubbing compounds; these will permanently dull the gloss. Battery acid, fertilizers, tars, asphalt, creosote, paint, or chewing gum should be removed immediately to prevent possible stains. **See following CAUTION and NOTE.**

CAUTION

- Use of leveling or rubbing compounds will permanently dull finish of vehicle.
- Do not apply wax products to the black plastic material of the front and rear underbody, the front bumper, or the textured area of the rear beauty panel marked "NO STEP." Wax will cause these surfaces to become discolored.

NOTE: Dispose of waste water properly.

SEAT

To preserve seat appearance, clean regularly with mild soap or detergent applied with a sponge or soft cloth. Use a soft bristle brush to clean areas that are especially soiled. Use the following guidelines:

Light Soiling: A solution of 10% liquid dish soap and warm water applied with a soft, damp cloth is recommended. A soft bristle brush may be used if necessary. Wipe off any residue with a water dampened cloth.

Difficult Stains: Dampen a soft, white cloth with a solution of 10% household bleach (sodium hypochlorite) and 90% water. Rub gently to remove stain, then rinse with a water dampened cloth to remove bleach concentration.

More Difficult Stains: Perform previous procedure using full-strength bleach, or allow bleach to puddle on affected area for approximately 30 minutes. Rinse with a water dampened cloth to remove any remaining bleach concentration.

CAUTION

• To prevent damage to the vehicle when removing difficult stains or heavy soiling, remove the seat bottom from the vehicle first.

FRONT AND REAR BODY REPAIR

See General Warnings on page 1-2.

STRESS LINES OR STREAKS

Repeatedly flexing the Surlyn® body can cause white stress lines or streaks in the finish. To remove them:

- 1. Hold a heat gun 12 inches (30 cm) away from the affected area, with the gun on its lowest heat setting.
- 2. Slowly wave the heat gun back and forth over the affected area until the streak fades.
- 3. It may be necessary to move the gun closer to the body to fade the streak, but under no circumstance should the gun be held closer than 6 inches (15 cm) to the body. **See following CAUTION.**

CAUTION

Holding the heat gun too close to the body could melt the body or damage the finish.

MINOR IMPACT DAMAGE/DEFORMATIONS

Minor impact damage to a Surlyn® body can be repaired using a procedure similar to the one used to remove stress lines. To remove deformations resulting from minor impact damage:

- 1. Hold a heat gun 12 inches (30 cm) away from the affected area, with the gun on its lowest heat setting.
- 2. Periodically remove the heat gun and bend the body, using a push block, in the opposite direction of the deformation.
- 3. Continue heating and bending the body until the original shape returns. Under no circumstance should the gun be held closer than 6 inches (15 cm) to the body. **See preceding CAUTION.**

MINOR SCRATCHES AND SURFACE BLEMISHES

For minor scratches or blemishes in the Surlyn® body that do not penetrate the finish:

- Thoroughly clean the affected area using a strong, non-abrasive detergent and hot water, then clean with Ultra-Kleen® Solvent Cleaner to remove any oil-based contaminants.
- Lightly buff imperfection with a clean soft cloth or buff pad. Do not use any kind of rubbing (abrasive) compound on body assemblies.
- 3. Wax the entire body part to restore luster and weather protection.

GOUGES, PUNCTURES, TEARS, LARGE SCRATCHES, AND ABRASIONS

Touch-up is not recommended. Replace the entire body part or have it repaired by a professional paint and body repair shop with experience repairing Surlyn® bodies.

FRONT BODY

See General Warnings on page 1-2.

FRONT BODY REMOVAL

- 1. Remove the four screws (2) and pull the brow cap (1) from the brow and fascia assembly (4) (Figure 4-1, Page 4-4).
- 2. Pull the front beauty panel (3) up and away from the brow and fascia assembly (4), disengaging the snap tabs.
- 3. If the vehicle is equipped with a canopy, loosen the canopy support cover then loosen, but do not remove, the front canopy support bolts. If there is no canopy, remove the non-canopy cover.
- Remove the five screws (8) and lift the brow and fascia assembly (4) from the front underbody.
- 5. Remove the five screws (7) to separate the front fascia (6) from the brow (5).

FRONT BODY INSTALLATION

- 1. Install fascia (6) to brow (5) with five screws (7). Tighten screws to 40 in·lb (4.5 N·m) (Figure 4-1, Page 4-4).
- 2. Install brow and fascia assembly (4) to front underbody with five screws (8). Tighten screws to 31 in·lb (3.5 N·m).
- 3. Install front beauty panel (3) over brow (5). Tabs on the forward edge of the front beauty panel should fit into slots between the fascia and the brow.
- Position brow cap (1) to cover the edge of both the brow (5) and the front beauty panel (3). Secure brow cap (1) with four screws (2). Tighten screws to 25 in lb (2.8 N·m).

Front Body BODY AND TRIM

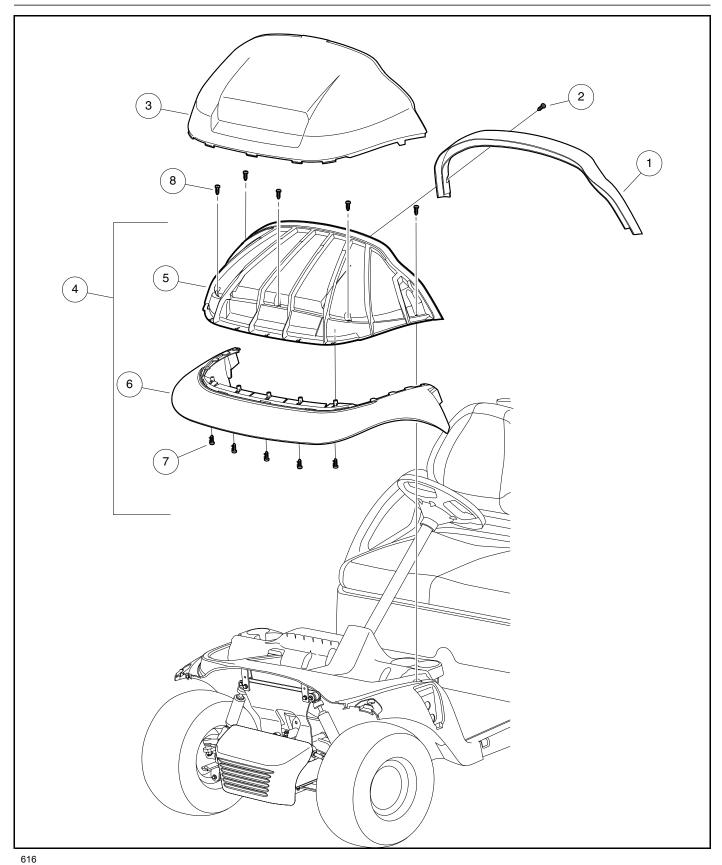


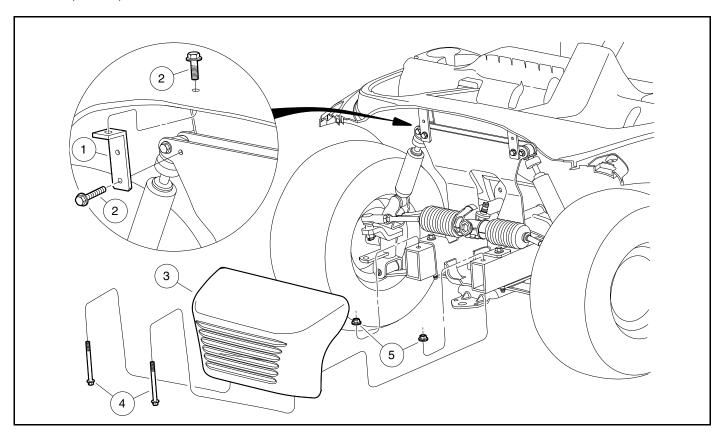
Figure 4-1 Front Body

BODY AND TRIM Front Bumper

FRONT BUMPER

The underbody bracket (1) connects the front suspension to the front underbody (Figure 4-2, Page 4-5). Each bracket is secured in place by two taptite screws (2) tightened to 13 ft·lb (17.6 N·m).

The front bumper (3) is attached to the vehicle frame rails by nuts (5) and bolts (4). The nuts are tightened to 13.3 ft-lb ($18 \text{ N} \cdot \text{m}$).



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Figure 4-2 Bracket and Front Bumper

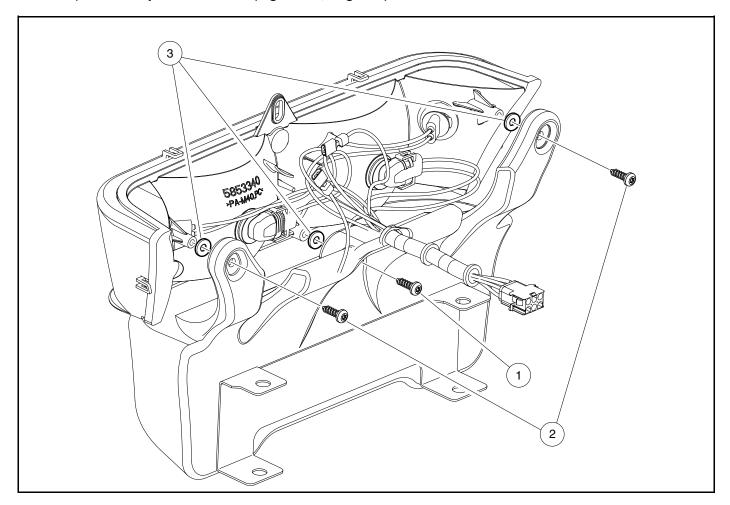
HEADLIGHT ADJUSTMENT

Headlights are available as an accessory on this vehicle. To raise or lower the headlight beam, washers can be added to the mounting hardware between the headlight and the bumper assembly.

See General Warnings on page 1-2.

AIMING THE HEADLIGHT BEAM

- 1. Park the vehicle on a level surface 5 feet away from, and facing a vertical surface such as a garage door or wall.
- 2. On the vertical surface, mark a 24 inch (61 cm) long, horizontal line 15-1/2 inches (39.4 cm) above the ground directly in front of the vehicle.
- 3. Turn on headlight. Take note where the beam strikes the vertical surface in relation to the marked horizontal line. To raise the beam, add washers (size M6) to the lower mounting screw (1). To lower the beam, add washers to both upper screws. Tighten screws to 66 in·lb (7.5 N·m). While it is possible to add washers with the headlight/bumper assembly mounted to the vehicle, these adjustments may be easier if the headlight/front bumper assembly is unbolted first (Figure 4-3, Page 4-6).



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Figure 4-3 Headlight Aiming

INSTRUMENT PANEL

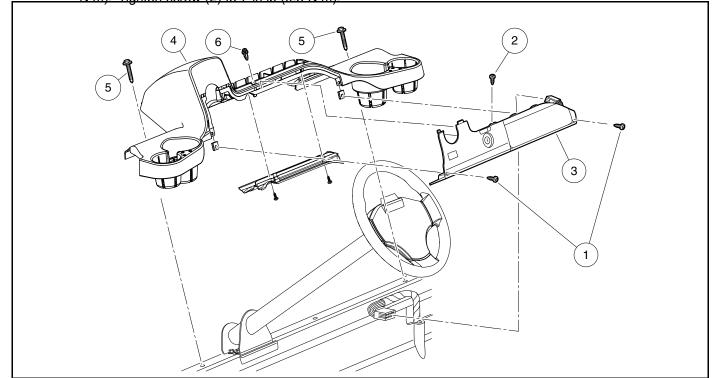
See General Warnings on page 1-2.

INSTRUMENT PANEL REMOVAL

- 1. Remove two screws (1) at sides and one screw (2) on top of instrument panel (3) (Figure 4-4, Page 4-7).
- 2. Tilt instrument panel up to release it from the dash assembly (4).
- 3. Disconnect the electrical connector on the passenger side of the instrument panel (3) and remove the panel.
- 4. Remove two screws (5) and plastic rivet (6) and remove dash assembly (4) from vehicle.

INSTRUMENT PANEL INSTALLATION

- 1. Position dash assembly (4) on vehicle. Make sure tabs on the forward edge engage to front underbody. Secure assembly in place with two screws (5) and plastic rivet (6) (Figure 4-4, Page 4-7). Tighten screws to 8.8 ft·lb (12 N·m).
- 2. Install the instrument panel.
 - 2.1. Connect the electrical connector on the instrument panel to the harness connector.
 - 2.2. Position the instrument panel (3) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 2.3. Secure instrument panel to the dash assembly with screws (1 and 2). Tighten screws (1) to 22 in·lb (2.5 N·m). Tighten screw (2) to 7 in·lb (0.8 N·m).



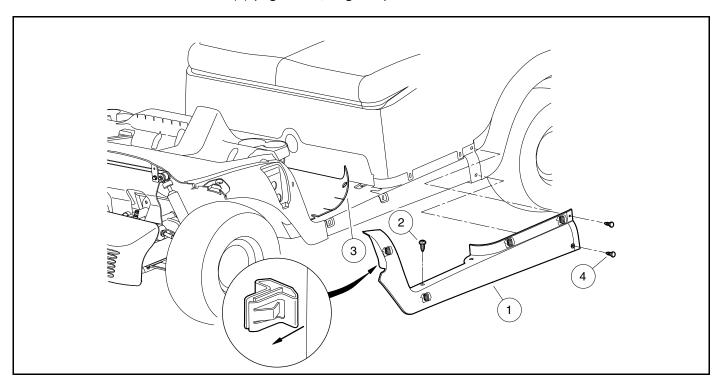
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Figure 4-4 Instrument Panel

FLOOR MAT AND RETAINERS

See General Warnings on page 1-2.

The floor mat retainers secure the floor mat to the vehicle and also provide a clean appearance to the side of the vehicle. Normally, if only the floor mat (3) needs to be removed, the screws (2) must be removed to allow the floor mat to be slid from beneath the retainers (1) (Figure 4-5, Page 4-8).



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Figure 4-5 Floor Mat Retainer

FLOOR MAT RETAINER REMOVAL

- 1. Remove screws (2) from top of retainer (1) (Figure 4-5, Page 4-8).
- 2. Remove push rivets (4) from rear corners of retainer.
- 3. Carefully pull on retainer to separate the trim clips from their respective slots. Trim clips do not normally need to be removed from the retainer.

FLOOR MAT RETAINER INSTALLATION

- 1. Position the retainer on the vehicle and press firmly to engage the trim clips to the vehicle (Figure 4-5, Page 4-8).
- 2. Ensure the floor mat is properly positioned beneath the top flange of the retainer and loosely install two screws (2).
- 3. Install two push rivets (4) at the rear corners of the retainer.
- 4. Tighten screws (2) to 4.4 ft·lb (6.0 N·m).

KICK PLATE AND CHARGER RECEPTACLE BEZEL

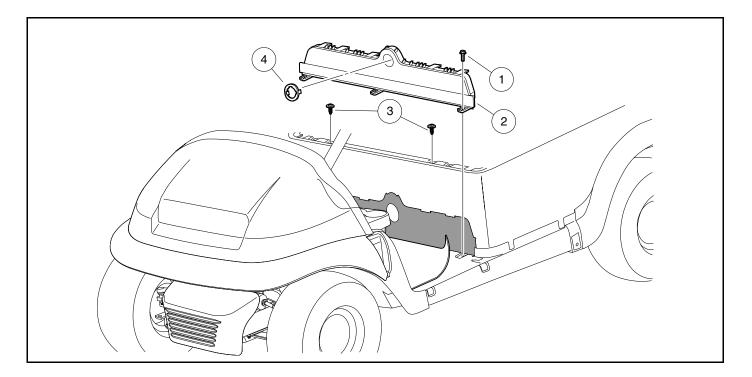
See General Warnings on page 1-2.

KICK PLATE AND CHARGER RECEPTACLE BEZEL REMOVAL

- 1. If charger bezel (4) requires removal, use charger bezel tool (P/N 102562401) to remove bezel from the kick plate (Figure 4-6, Page 4-9).
- 2. Remove floor mat. See Floor Mat and Retainers on page 4-8.
- 3. Remove three screws (1) that hold the kick plate (2) to the vehicle.
- 4. Remove the two front screws (3) that hold the beauty panel to the vehicle. Raise the forward portion of the rear beauty panel to disengage it from the tabs on the upper portion of the kick plate.
- 5. Remove kick plate from vehicle.

KICK PLATE AND CHARGER RECEPTACLE BEZEL INSTALLATION

- 1. Position the kick plate (2) on the vehicle and secure with three screws (1) **(Figure 4-6, Page 4-9)**. Ensure front lower edge of rear beauty panel mates with the kick plate. Tighten screws to 3.3 ft·lb (4.5 N·m).
- 2. Install two front screws (3) to secure the rear beauty panel. Tighten screws to 3.7 ft·lb (5 N·m).
- 3. Install floor mat. See Floor Mat and Retainers on page 4-8.
- 4. Snap charger bezel (4) in place on the kick plate.



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Figure 4-6 Kick Plate and Charger Receptacle Bezel

KICK PLATE AND CHOKE BUTTON BEZEL

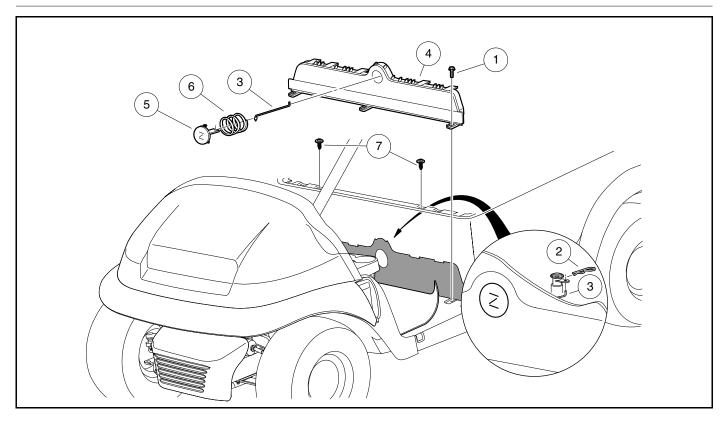
See General Warnings on page 1-2.

KICK PLATE AND CHOKE BUTTON REMOVAL

- 1. Access the inside of the fuel bucket and disconnect hair spring cotter pin (2) from choke rod (3). Remove rod from the choke (Figure 4-7, Page 4-11).
- 2. Remove floor mat. See Floor Mat and Retainers on page 4-8.
- 3. Remove three screws (1) that hold the kick plate (4) to the vehicle.
- 4. Remove the two front screws (7) that hold the beauty panel to the vehicle. Raise the forward portion of the rear beauty panel to disengage it from the tabs on the upper portion of the kick plate.
- 5. Remove kick plate from vehicle.
- 6. Disengage the choke rod (3) from the button (5).
- 7. Press in on the tabs on the top and bottom of button (5) to free the button from the kick plate. Remove button (5) and spring (6).

KICK PLATE AND CHOKE BUTTON INSTALLATION

- 1. Place spring (6) in kick plate (4) and orient the tabs on the button (5) with the slots in the kick plate. Press in the button until it snaps in place in the kick plate (Figure 4-7, Page 4-11).
- 2. Insert the tabbed end of the choke rod (3) into the rear slot on the button (5).
- Position the kick plate (4) on the vehicle and secure with three screws (1). Ensure front lower edge of rear beauty panel mates with the kick plate. Tighten screws to 3.3 ft-lb (4.5 N·m).
- 4. Insert choke rod (3) through the choke actuator. Secure the rod with hair spring cotter pin (2).
- 5. Install two front screws to secure the rear beauty panel. Tighten screws to 3.7 ft·lb (5 N·m).
- Install floor mat. See Floor Mat and Retainers on page 4-8.

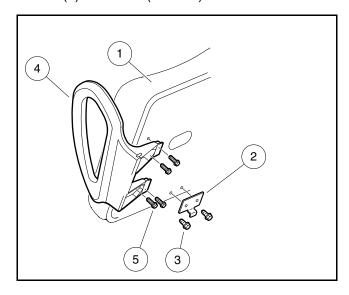


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Figure 4-7 Kick Plate and Choke Button

SEAT BOTTOM

The seat bottom (1) is secured to the vehicle with two hinges (2) **(Figure 4-8, Page 4-11)** that hook into slots in the body. When replacing the hinges (2), tighten screws (3) to 75 in·lb (8.5 N·m). When replacing hip restraints (4), tighten screws (5) to 65 in·lb (7.3 N·m).



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Figure 4-8 Seat Bottom, Hinge and Hip Restraint

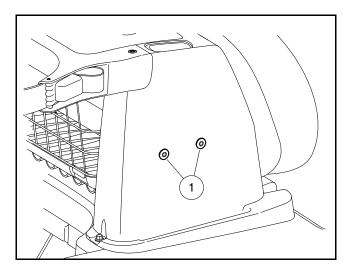
REAR BODY - TWO-PASSENGER VEHICLES

See General Warnings on page 1-2.

UNIVERSAL ACCESSORY MOUNTING

NOTE: The Structural Accessory Module (SAM) uses clearance holes for accessories to attach to the canopy support located inside the SAM.

The Structural Accessory Module (SAM) includes two mounting locations on both the driver side and the passenger side (Figure 4-9, Page 4-12). These serve as common attachment points (1) for various accessories. Accessories that can be mounted on the SAM include single or dual sand bottles, sand bucket, and the club cleaner.



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Figure 4-9 Universal Accessory Mounting

SEAT BACK AND STRUCTURAL ACCESSORY MODULE (SAM)

SAM Removal

- If the vehicle has a canopy, the rear upright supports must be removed from the SAM.
- 2. Remove four bolts (4) to release the SAM (3) from the vehicle (Figure 4-10, Page 4-13).

SAM Installation

Position the SAM (3) over its mounting holes and secure with four screws (4). Tighten screws to 71 in lb (8 N·m).

Seat Back

The seat back (1) is secured to the SAM (3) with two screws (2) (Figure 4-10, Page 4-13). When replacing the backrest, tighten screws (2) to 51 in·lb (5.8 N·m).

Bag Rack Removal

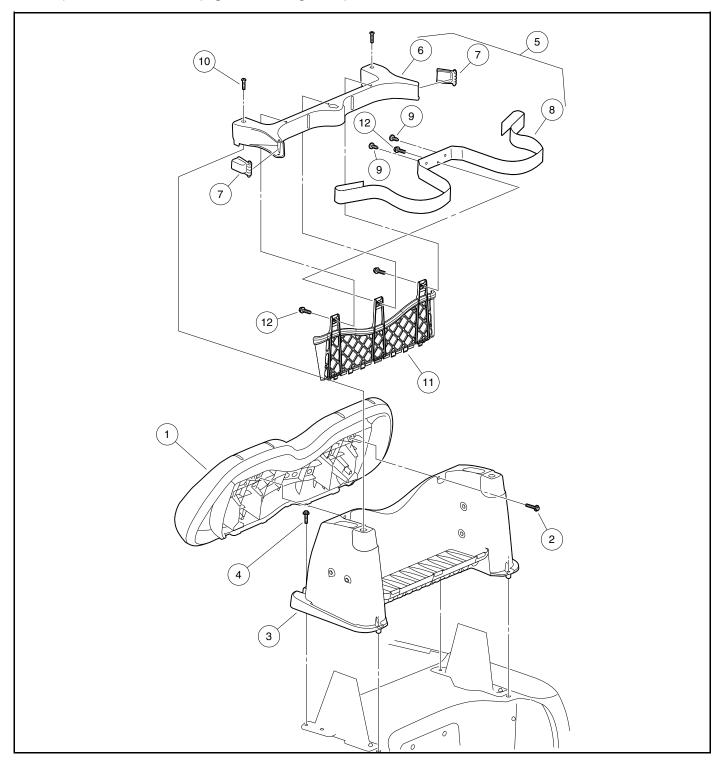
- 1. Remove two screws (10) to release the bag hoop (6) and related components from the SAM (3) (Figure 4-10, Page 4-13).
- 2. Bag strap (8) may be released by removing two plastic barrel connectors (9) and one screw (12).
- 3. Bag strap buckles (7) may be snapped out of bag hoop (6).

Bag Rack Installation

Installation is the reverse of removal. Tighten screw (12) to 31 in·lb (3.5 N·m) and screws (10) to 53 in·lb (6 N·m).

Sweater Basket

The sweater basket (11) is secured to the bag hoop assembly by three screws (12). Tabs on the upper edge of the basket align with holes in the bag hoop (6) for installation purposes. Tighten screws (12) to 31 in·lb (3.5 N·m) for molded-plastic sweater basket (**Figure 4-10**, **Page 4-13**).



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Figure 4-10 Seat Back, Bag Rack and SAM

REAR BODY COMPONENTS (TWO-PASSENGER)

Rear Beauty Panel Removal

- 1. Remove SAM. See SAM Removal on page 4-12.
- Remove one screw (3) from each canopy support bracket (1 and 2) (Figure 4-11, Page 4-15). Remove canopy supports.
- 3. Remove four screws (13) attaching the rear beauty panel (12).
- 4. Remove two screws (14) and remove Forward/Reverse switch housing (15) from vehicle.
- 5. Disconnect electrical wires from the Forward/Reverse switch (16).
- 6. Disengage the two body clips (17) under the rear of the beauty panel from the slots in the rear underbody (4).
- 7. Lift rear beauty panel (12) from vehicle.

Rear Beauty Panel Installation

- 1. Install rear beauty panel (12) on vehicle. Make sure body clips (17) on the rear of the beauty panel engage the slots in the rear underbody (4) **(Figure 4-11, Page 4-15)**. Secure beauty panel in place with four screws (13). Tighten screws to 44 in·lb (5 N·m).
- 2. Connect the three wires to the Forward/Reverse switch (16) as shown.
- 3. Position the Forward/Reverse switch housing (15) on the front of beauty panel (12) and secure with two screws (14). Tighten screws to 20 in·lb (2.3 N·m).
- 4. Position canopy support brackets (1 and 2) on vehicle and secure each with one screw (3). Tighten screws to 53 in·lb (6 N·m).

Access Panel

Access panel (6) is secured to the rear underbody (4) with two push rivets (7) (Figure 4-11, Page 4-15).

Rear Underbody Removal

- 1. Remove four screws (5) attaching the rear underbody (4) to vehicle (Figure 4-11, Page 4-15).
- 2. Lift the rear edge of the rear underbody (4) until the front portion slides out from beneath the front underbody. Remove the rear underbody from the vehicle.

Rear Underbody Installation

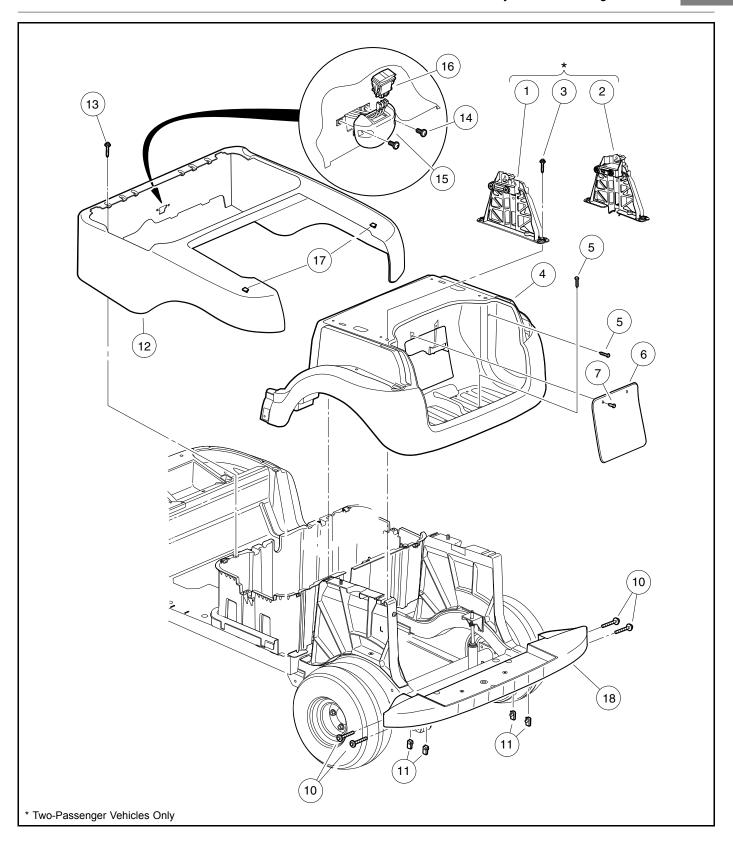
Install rear underbody (4) on the vehicle (Figure 4-11, Page 4-15). Install four screws (5) to secure the underbody to the vehicle. Tighten screws (5) to 71 in·lb (8 N·m).

Rear Crossmember Removal

Remove bolts (10) to release rear crossmember (18) from vehicle (Figure 4-11, Page 4-15).

Rear Crossmember Installation

Position rear crossmember (18) on vehicle and secure with bolts (10) **(Figure 4-11, Page 4-15)**. Bolts (10) thread into J-clips (11) attached to the inner-frame rail. Tighten bolts to 56 in·lb (6.35 N·m) for two-passenger vehicles or 123 in·lb (14 N·m) for four-passenger vehicles.



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Figure 4-11 Rear Body Components

REAR BODY - FOUR-PASSENGER VEHICLES

See General Warnings on page 1-2.

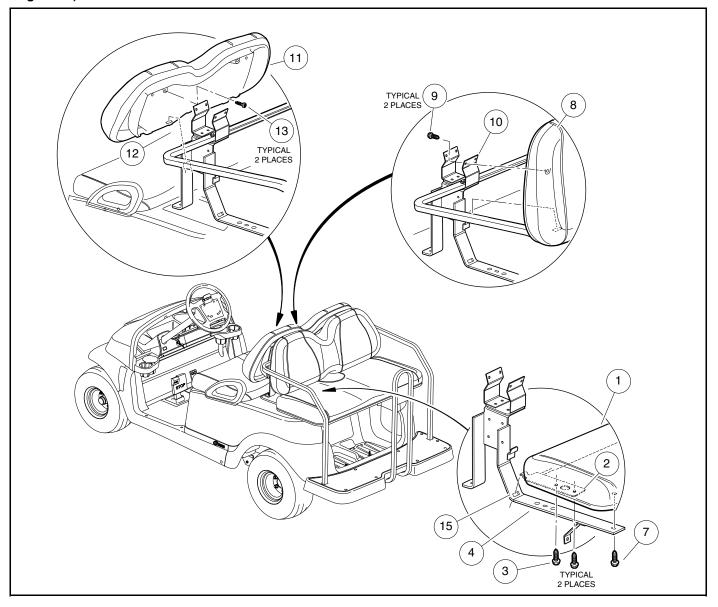
SEAT BACKS

Seat Back Removal

Remove screws (9 or 13) securing seat back (8 or 11) to seat support and remove the seat back (Figure 4-12, Page 4-16).

Seat Back Installation

Secure seat back (8 or 11) to seat support with screws (9 or 13). Tighten screws to 51 in·lb (5.8 N·m) (Figure 4-12, Page 4-16).



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Figure 4-12 Seats (Four-Passenger Vehicles)

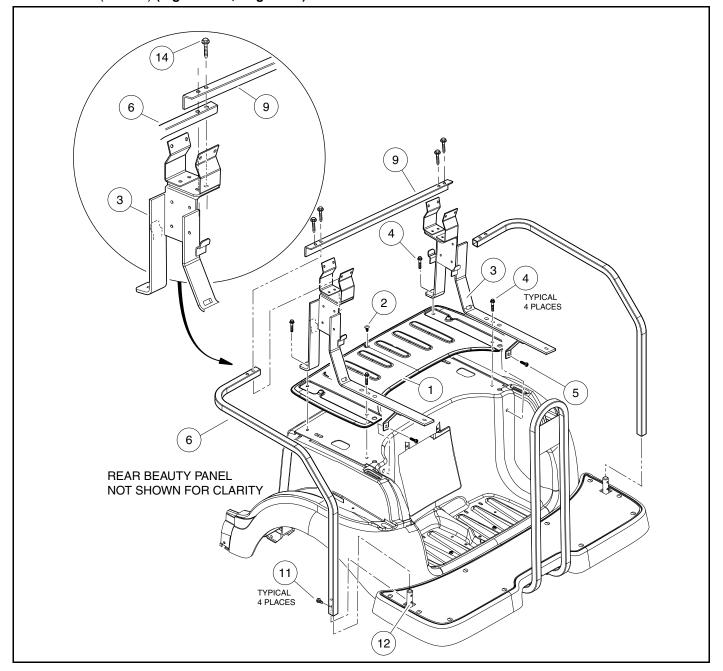
SEAT SUPPORT

Seat Support Removal

- 1. Remove screws (11 and 14) securing the rear hip restraints (6) and remove the hip restraints from the vehicle (Figure 4-13, Page 4-17).
- 2. Remove the screws (5) and bolts (4) from the seat supports (3) and remove the seat supports from the vehicle.

Seat Support Installation

- 1. Install in the reverse order of removal.
- 2. Tighten bolts (4) to 155 in·lb (17.5 N·m). Tighten screws (5) to 71 in·lb (8 N·m). Tighten bolts (11 and 14) to 159 in·lb (18 N·m) (Figure 4-13, Page 4-17).



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Figure 4-13 Seat Supports (Four-Passenger Vehicles)

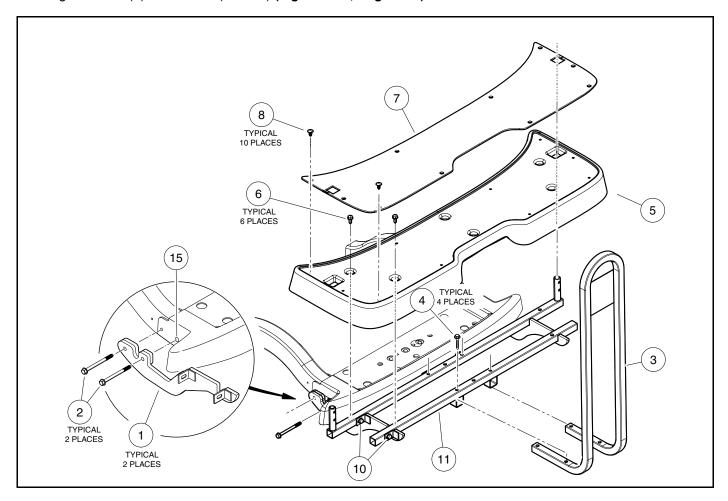
FOOT DECK

Foot Deck Removal

- 1. Remove screws (11 and 14) securing the rear hip restraints (6) and remove the hip restraints from the vehicle (Figure 4-13, Page 4-17).
- Remove the four bolts (2) securing the foot deck (1) to the vehicle frame (Figure 4-14, Page 4-18).

Foot Deck Installation

- Install foot rest in reverse order of removal.
- Tighten bolts (2) to 123 in·lb (14 N·m) (Figure 4-14, Page 4-18).



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Figure 4-14 Foot Deck (Four-Passenger Vehicles)

REAR BODY COMPONENTS (FOUR-PASSENGER)

Rear Beauty Panel Removal

- 1. Remove seat support. See Seat Support Removal on page 4-17.
- 2. Remove four screws (13) attaching the rear beauty panel (12) (Figure 4-11, Page 4-15).
- 3. Remove two screws (14) and remove Forward/Reverse switch housing (15) from vehicle.
- 4. Disconnect electrical wires from the Forward/Reverse switch (16).
- Disengage the two body clips (17) under the rear of the beauty panel from the slots in the rear underbody (4). 5.
- Lift rear beauty panel (12) from vehicle.

Rear Beauty Panel Installation

- Install rear beauty panel (12) on vehicle. Make sure body clips (17) on the rear of the beauty panel engage the slots in the rear underbody (4) (Figure 4-11, Page 4-15). Secure beauty panel in place with four screws (13). Tighten screws to 44 in·lb (5 N·m).
- 2. Connect the three wires to the Forward/Reverse switch (16) as shown.
- 3. Position the Forward/Reverse switch housing (15) on the front of beauty panel (12) and secure with two screws (14). Tighten screws to 20 in·lb (2.3 N·m).
- 4. Install seat support. See Seat Support Installation on page 4-17.

Access Panel

Access panel (6) is secured to the rear underbody (4) with two push rivets (7) (Figure 4-11, Page 4-15).

Rear Underbody Removal

- 1. Remove four screws (5) attaching the rear underbody (4) to vehicle (Figure 4-11, Page 4-15).
- 2. Lift the rear edge of the rear underbody (4) until the front portion slides out from beneath the front underbody. Remove the rear underbody from the vehicle.

Rear Underbody Installation

Install rear underbody (4) on the vehicle (Figure 4-11, Page 4-15). Install four screws (5) to secure the underbody to the vehicle. Tighten screws (5) to 71 in·lb (8 N·m).

CANOPY - TWO-PASSENGER

See General Warnings on page 1-2.

CAUTION

• To prevent damage to the canopy, do not remove the canopy supports (3, 7, and 10) from the vehicle without first removing the canopy (1) (Figure 4-15, Page 4-20).

TWO-PASSENGER CANOPY REMOVAL

- 1. Remove the two nuts (9) and two bolts (8) from the canopy (1) and each front canopy support (7 and 10) (Figure 4-15, Page 4-20).
- 2. Remove the nuts (5) and bolts (4) from the canopy (1) and each rear support (3).
- 3. Lift canopy (1) away from front canopy supports (7 and 10) and rear supports (3).
- 4. Remove screws (14) securing front canopy support covers to front body.
- 5. Slide canopy support covers (12 and 13) up front canopy supports (7 and 10) to gain access to bolts (11).
- 6. Remove two bolts (11) from each front canopy support (7 and 10) and remove canopy supports from the vehicle.
- 7. Remove bolt (6) from each rear support (3) and pull rear supports from vehicle.

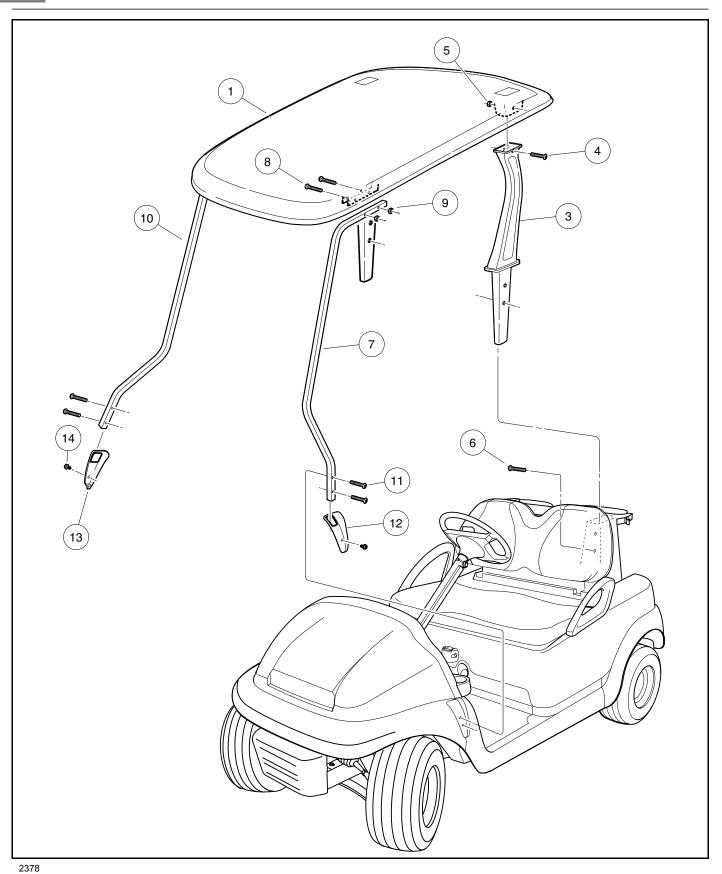


Figure 4-15 Precedent Two-Passenger Canopy

TWO-PASSENGER CANOPY INSTALLATION

- 1. Install the front canopy supports.
 - 1.1. Ensure the front supports are properly oriented to the correct side of the vehicle as shown (Figure 4-15, Page 4-20). The lower profile of each support follows the profile of the vehicle. If the supports are placed on the wrong side of the vehicle, they will not follow the vehicle's profile.
 - 1.2. Align the holes in the lower portion of each front support (7 and 10) with the corresponding holes in the vehicle. Insert two bolts (11) through each front support into the threaded holes in the vehicle. The bolts are color-coded with gold thread lock. Only finger-tighten the bolts at this time.
 - 1.3. Slide the covers (12 and 13) over the front supports. The covers are marked DRIVER and PASS to identify them as going on the driver side or passenger side respectively. Do not install the screws (14) yet.
- 2. Insert the two rear canopy supports (3) into the openings on the top of the Structural Accessory Module (SAM).
- 3. From the inside of the basket, insert bolt (6) through the basket wall and into each support. The bolts are color-coded with blue thread-lock. Finger-tighten the bolts to avoid cross-threading the threads in the supports. **See following CAUTION.**

CAUTION

- Using tools to thread the bolts could prevent proper feel of the bolt as it captures the female threads in the support. This could result in damage to the components.
- 4. Position the canopy on top of the front and rear supports. Ensure that the front supports are properly positioned between the molded tabs on the underside of the canopy and that the molded protrusions at the rear of the canopy extend into the top of the rear supports.
- 5. Secure the canopy to the front supports with four bolts (8) and lock nuts (9). Use two bolts on each support, inserting the bolts from the inside. Tighten the lock nuts to 50 in·lb (5.6 N·m).
- 6. Secure the canopy to the rear supports with two bolts (4) and locknuts (5). Tighten the lock nuts to 50 in·lb (5.6 N·m).
- 7. At the rear supports (3), tighten the two bolts (6) to 88 in·lb (10 N·m).
- 8. At the front supports (7 and 10), tighten the four bolts (11) to 18.4 ft·lb (25 N·m).
- 9. Position each cover (12 and 13) over its respective support. A hole in each cover should be aligned with a corresponding hole in the support. Secure the cover to the support with a screw (14). Tighten the screws (14) to 31 in·lb (4.6 N·m).

CANOPY - FOUR-PASSENGER

See General Warnings on page 1-2.

CAUTION

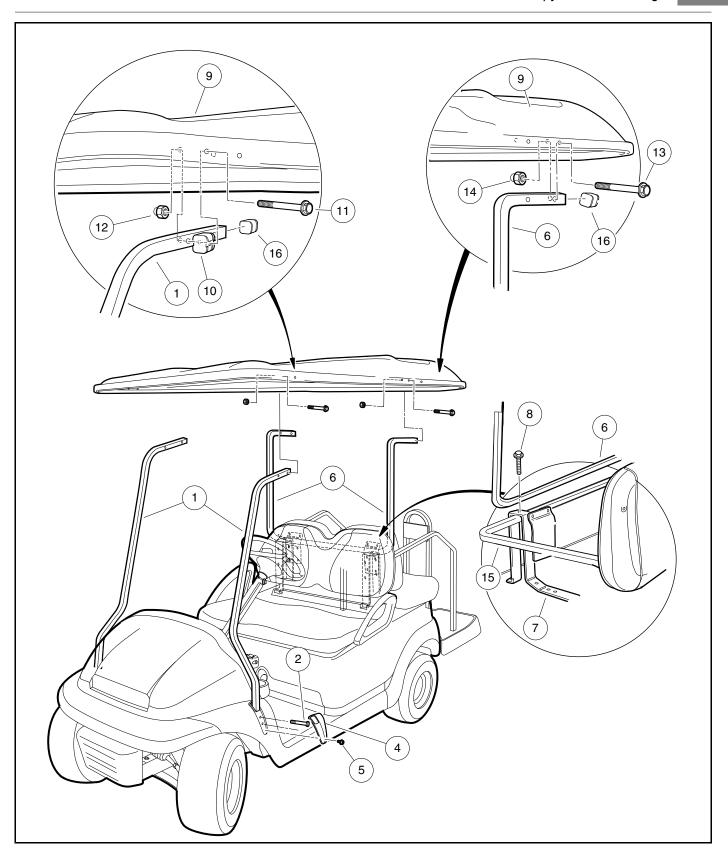
• To prevent damage to the canopy, do not remove the canopy supports (1 and 6) from the vehicle without first removing the canopy (9) (Figure 4-16, Page 4-23).

FOUR-PASSENGER CANOPY REMOVAL

- 1. Remove the two nuts (12), two bolts (11), and spacers (10) from the canopy (9), and each front canopy support (1) (Figure 4-16, Page 4-23).
- 2. Remove the nuts (14) and bolts (13) from the canopy (9) and the rear support (6).
- 3. Lift canopy (9) away from front canopy supports (1) and rear support (6).
- 4. Remove screws (5) securing front canopy support covers to front body.
- 5. Slide canopy support covers (4) up front canopy supports (1) to gain access to bolts (2).
- 6. Remove two bolts (2) from each front canopy support (1) and remove the canopy supports from the vehicle.
- 7. Remove two bolts (8) from the rear support (3) and remove rear support from vehicle.

FOUR-PASSENGER CANOPY INSTALLATION

- 1. Install the front canopy supports.
 - 1.1. Ensure the front supports are properly oriented to the correct side of the vehicle as shown (**Figure 4-16**, **Page 4-23**). The lower profile of each support follows the profile of the vehicle. If the supports are placed on the wrong side of the vehicle, they will not follow the vehicle's profile.
 - 1.2. Align the holes in the lower portion of each front support (1) with the corresponding holes in the vehicle. Insert two bolts (2) through each front support into the threaded holes in the vehicle. The bolts are color-coded with gold thread lock. Only finger-tighten the bolts at this time.
 - 1.3. Slide the front support covers (4) over the front supports (1). The covers are marked DRIVER and PASS to identify them as going on the driver side or passenger side respectively. Do not install the screws (5) yet.
- 2. Remove the two bolts that secure the hip restraint (15) to the seat supports (7).
- 3. Align the rear canopy support (6) with the top of the seat supports (7) and secure with two bolts (8) as shown. Tighten the hardware to 124 in·lb (14 N·m).
- 4. Secure the front of the canopy (9) to the front supports (1) with four spacers (10), bolts (11), and cap-nuts (12). Tighten the hardware to 10 ft·lb (13.6 N·m).
- 5. Secure the rear of the canopy (9) to the rear canopy support (6) with four bolts (13) and cap-nuts (14). Tighten the hardware to 10 ft·lb (13.6 N·m).
- 6. Tighten the four bolts (2) installed in step 1.2 to 18 ft·lb (25 N·m).
- 7. Secure each front support cover (4) with one screw (5). Tighten the hardware to 31 in·lb (4.6 N·m).



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Figure 4-16 Precedent Four-Passenger Canopy

CANOPY (MONSOON VERSION) - FOUR-PASSENGER

See General Warnings on page 1-2.

CAUTION

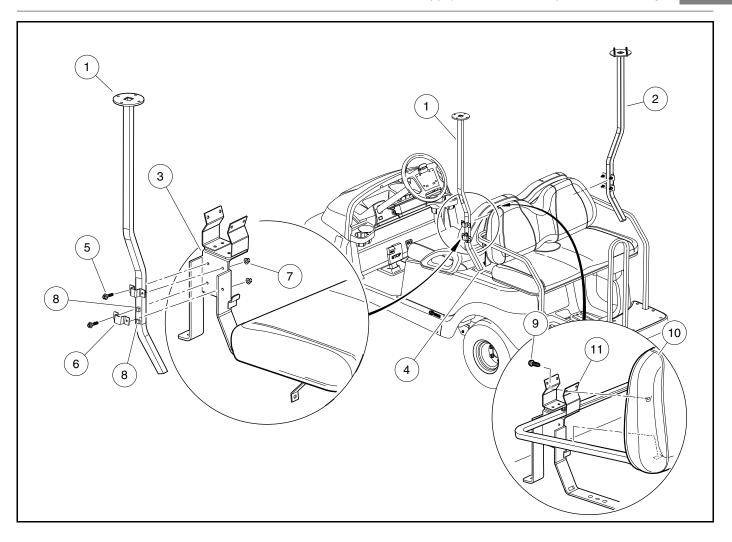
• To prevent damage to the canopy, do not remove the canopy supports (1, 2, 8 and 9) from the vehicle without first removing the canopy (13) (Figure 4-19, Page 4-27).

MONSOON CANOPY REMOVAL

- 1. Remove the two flanged lock nuts (17), four rubber faced conical washers (20), and two bolts (15) from the canopy (13) at each front strut (8 and 9) (Figure 4-19, Page 4-27).
- 2. Remove the four bolts (18) from the canopy (13) at each rear drain strut (1 and 2).
- 3. Lift canopy (13) off the canopy struts.
- 4. Remove screws (12) securing front strut covers (11) to front body.
- 5. Slide front strut covers (11) up front canopy supports (8 and 9) to gain access to bolts (10).
- 6. Remove two bolts (10) from each front strut (8 and 9) and remove the struts from the vehicle.
- 7. Remove the four nuts (7) and four bolts (5) securing each rear drain strut (1 and 2) and remove the struts from the vehicle (Figure 4-17, Page 4-25).

MONSOON CANOPY INSTALLATION

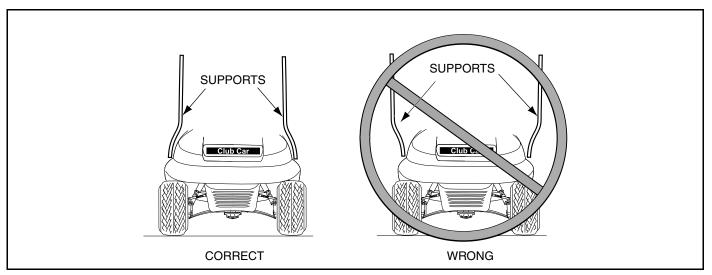
- 1. Secure the rear canopy supports.
 - 1.1. Position each rear canopy support (1 and 2) to the side of the seat support assembly (3) as shown (**Figure 4-17**). Make sure the bottom of the strut is in the hole (4) in the rear body to allow for water drainage.
 - 1.2. Loosely secure each rear drain strut (1 and 2) to the seat support assembly with two hat brackets (6), four M6x1 x 25 hex head bolts (5), and four M6 nylon lock nuts (7). Make sure the lower hat bracket (6) is between the two locating tabs (8) on each rear strut. Finger tighten the hardware at this time.



K-00834

Figure 4-17 Secure Rear Drain Struts to Seat Supports

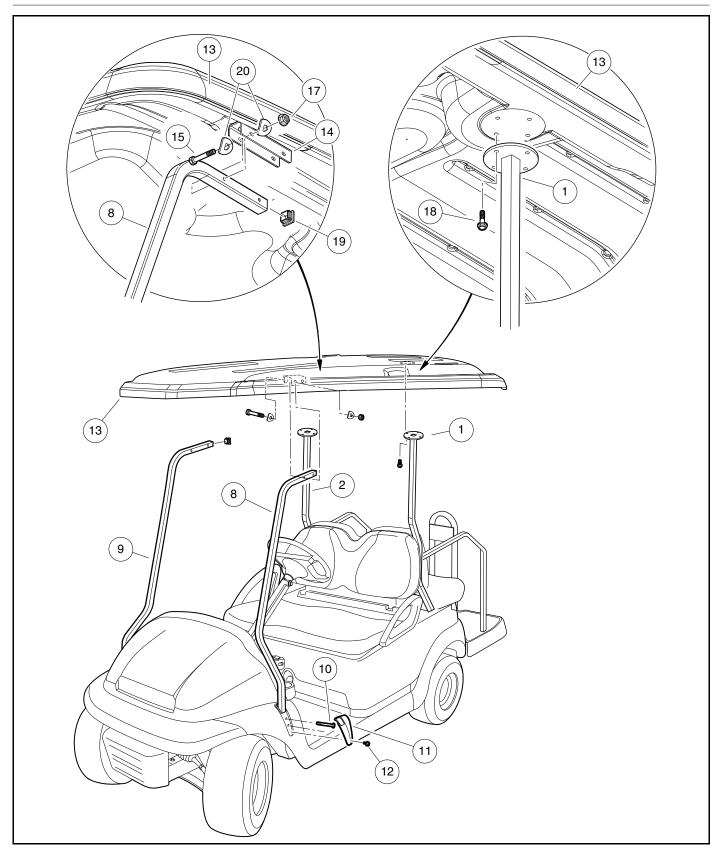
- Attach the front struts.
 - 2.1. Ensure the front struts are properly oriented to the correct side of the vehicle as shown (**Figure 4-18**). The lower profile of each support follows the profile of the vehicle. If the struts are placed on the wrong side of the vehicle, they will not follow the vehicle's profile.
 - 2.2. Align the holes in the lower portion of each front strut (8 and 9) with the corresponding holes in the vehicle **(Figure 4-19)**. Insert two M8-1.25 x 65 torx button-head bolts (with nylon patch) (10) through each front strut into the threaded holes in the vehicle. Only finger-tighten the bolts at this time.
 - 2.3. Slide the front strut covers (11) over the front struts (8 and 9). The covers are marked DRIVER and PASS to identify them as going on the driver side or passenger side respectively (Figure 4-19). Do not install the M6 hex-head screws (12) yet.



K-00504

Figure 4-18 Properly Orient the Front Supports

- 3. With the aid of an assistant, position the canopy (13) to the top of the front struts (8 and 9) and rear drain struts (1 and 2).
- 4. Secure the front canopy brackets (under the canopy) (14) to the front struts (8 and 9) with four grey M6x1 x 45 hex head bolts (15), eight rubber faced conical washers (20), and four M6 flanged nylon lock nuts (17). Tighten the hardware to 80 in·lb (9 N·m).
- 5. Secure the rear of the canopy (13) to each rear drain strut (1 and 2) with four M6-1.0 x 25 flanged head bolts (18). Tighten the hardware to 80 in·lb (9 N·m).
- 6. At the bottom of each front strut (8 and 9), tighten the two M8-1.25 x 65 torx button-head bolts (10) to 18.4 ft·lb (25 N·m).
- 7. Secure each front strut cover (11) with one M6 hex-head screw (12). Tighten the hardware to 31 in·lb (3.5 N·m).
- 8. Secure the tube plugs (19) into the end of each front strut (8 and 9).
- 9. At the bottom of each rear drain strut (1 and 2), secure the four M6-1x25 bolts (5) and M6 nylon locknuts (7) to 80 in lb (9 N·m) (Figure 4-17).
- 10. Reinstall the rear facing seat back (10) to the seat back supports (11) with the two retained M6-1x30 bolts (9) and tighten to 51 in·lb (5.8 N·m).



K-00835

Figure 4-19 Secure Canopy

A DANGER

See General Warnings on page 1-2.

WARNING

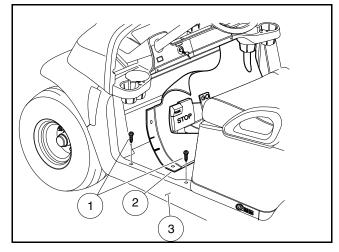
• See General Warnings on page 1-2.

PEDAL GROUP - ELECTRIC VEHICLE

See General Warnings on page 1-2.

PEDAL GROUP REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove screws (1). Pull floor mat retainer (3) away from the vehicle (Figure 5-1, Page 5-1).
- 3. Pull floor mat (2) over the pedal group to gain access to the pedal group hardware.



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Figure 5-1 Pedal Group Access

- 4. Remove fastener (10) and lift off cover plate (7) (Figure 5-2, Page 5-2).
- 5. Loosen jam nuts (4 and 5) on each side of turnbuckle (6).

NOTE: Nut (4) has a left-hand thread.

- 6. Loosen turnbuckle (6) until the threaded rod (8) from the pedal group (11) is free of the turnbuckle (Figure 5-2, Page 5-2).
- 7. Remove two screws (2) on the driver side of the pedal group and two screws (1) on the passenger side of the pedal group.
- 8. Disconnect the wire harness (12) from the MCOR (13).

9. Lift pedal group from vehicle.

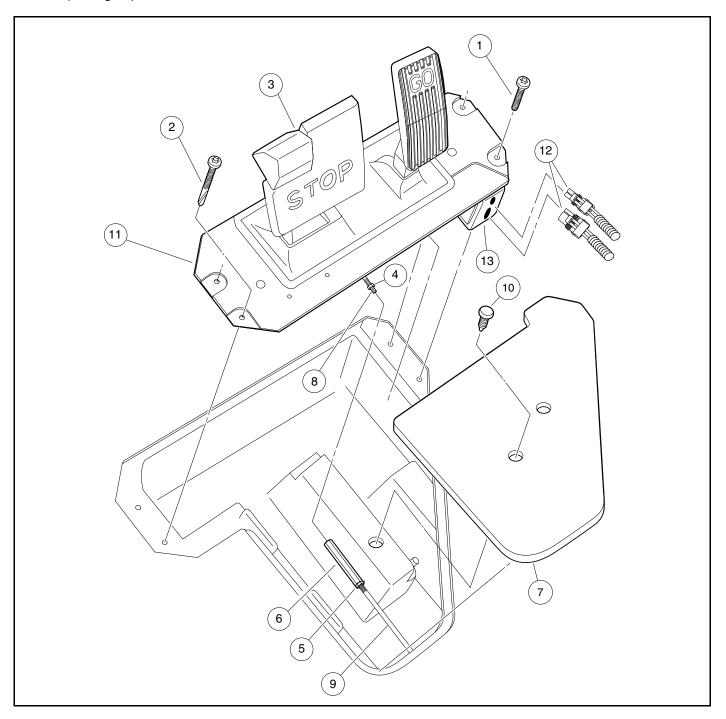


Figure 5-2 Pedal Group - Electric Vehicle

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MCOR

The pedal group for the Precedent electric vehicle includes a Motor Controller Output Regulator (MCOR) mounted on the side of the pedal group. The MCOR detects the position of the GO pedal and sends a corresponding voltage to the motor controller. **For more information see the following procedures:**

- Test Procedure 11 MCOR Voltage on page 19-27
- Test Procedure 5 Key Switch and MCOR Limit Switch Circuit on page 19-21
- MCOR Removal on page 20-7
- MCOR Installation on page 20-7

PEDAL GROUP INSTALLATION

- 1. Connect the wire harness (12) to the MCOR (13) (Figure 5-2, Page 5-2).
- 2. Position the pedal group in vehicle and secure with two screws (2) on the driver side and two screws (1) on the passenger side. Tighten driver side screws (2) to 97 in·lb (11 N·m). Tighten passenger side screws (1) to 18 in·lb (2 N·m).
- 3. Remove the turnbuckle (6) and apply Loctite[®] 242 to the threaded ends of both the rod from the pedal group (8) and the brake actuator rod (9). Connect the rods using the turnbuckle (6).
- 4. Adjust the brake cable equalizer tension. See Brake Cable Equalizer Adjustment on page 6-10.
- 5. Place floor cover plate (7) over the floor opening and secure with fastener (10) (Figure 5-2, Page 5-2).
- 6. Install the floor mat (2) over the pedal group. Make sure tabs on floor mat sides are beneath the sill (3). Tighten screws (1) to 53 in·lb (6 N·m) (Figure 5-1, Page 5-1).
- 7. Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

PEDAL GROUP - GASOLINE VEHICLE

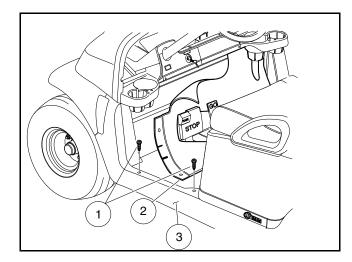
See General Warnings on page 1-2.

PEDAL GROUP REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove screws (1). Pull floor mat retainer (3) away from the vehicle (Figure 5-3, Page 5-4).
- 3. Pull floor mat (2) over the pedal group to gain access to the pedal group hardware.
- 4. Remove fastener (10) and lift off cover plate (7) (Figure 5-4, Page 5-5).
- 5. Loosen jam nuts (4 and 5) on each side of turnbuckle (6).

NOTE: Nut (4) has a left-hand thread.

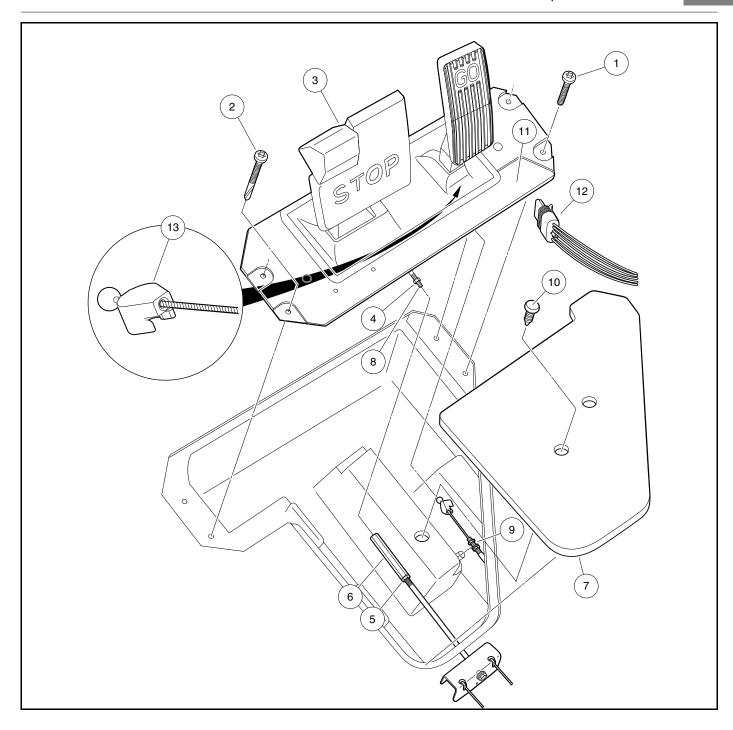
6. Loosen turnbuckle (6) until the threaded rod (8) from the pedal group (11) is free of the turnbuckle (Figure 5-4, Page 5-5).



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Figure 5-3 Pedal Group Access

- 7. Loosen two nuts (9) on the accelerator cable and lift the cable from its mounting bracket.
- 8. Remove two screws (2) on the driver side of the pedal group and two screws (1) on the passenger side of the pedal group.
- 9. Disconnect six-pin connector (12) from throttle position sensor.
- 10. Release the end of the accelerator cable (13) from the pedal group.
- 11. Lift pedal group from vehicle.



2518a

Figure 5-4 Pedal Group - Gasoline Vehicle

THROTTLE POSITION SENSOR

The pedal group for the Precedent vehicle includes a throttle position sensor mounted on the side of the accelerator pedal assembly. The throttle position sensor detects the position of the accelerator pedal and sends a voltage to the solenoid and forward/reverse limit switches. The throttle position sensor itself is not intended to be replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced. **See Accelerator Pedal Removal on page 5-6.**

PEDAL GROUP INSTALLATION

1. Connect the end of the accelerator cable to the pedal group (Figure 5-4, Page 5-5). See following CAUTION.

CAUTION

- Make sure the accelerator cable is properly seated to the pedal group.
- 2. Connect the wire harness (12) to the throttle position sensor (Figure 5-4, Page 5-5).
- 3. Position the pedal group in vehicle and secure with two screws (2) on the driver side and two screws (1) on the passenger side. Tighten driver side screws (2) to 97 in·lb (11 N·m). Tighten passenger side screws (1) to 18 in·lb (2 N·m).
- 4. Remove the turnbuckle (6) and apply Loctite® 242 to the threaded ends of both the rod from the pedal group (8) and the brake actuator rod (9). Connect the rods using the turnbuckle (6). Ensure the ends of the brake cables do not slip out of the brake equalizer during this procedure.
- 5. Adjust the brake cable equalizer tension. See Brake Cable Equalizer Adjustment on page 6-10.
- 6. Place floor cover plate (7) over the floor opening and secure with fastener (10) (Figure 5-4, Page 5-5).
- 7. Install the floor mat (2) over the pedal group. Make sure tabs on floor mat sides are beneath the sill (3). Tighten screws (1) to 53 in lb (6 N·m) (Figure 5-3, Page 5-4).
- 8. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

DEBRIS SHIELDS

Debris shields on the top face of the pedal group prevent excessive debris from contacting the moving parts of the pedal group. Both shields (4 and 5) are held in place by tabs that snap into the pedal group mounting plate (Figure 5-5, Page 5-8).

ACCELERATOR PEDAL REMOVAL

- 1. Remove pedal group from vehicle. See Pedal Group Removal on page 5-1. See Pedal Group Removal on page 5-4.
- 2. Electric Vehicle: Remove the MCOR. See MCOR Removal on page 20-7.
- Remove debris shields (4 and 5) (Figure 5-5, Page 5-8).
- 4. Remove four screws (13) securing accelerator pedal assembly (7) to pedal group mounting plate and pull accelerator pedal assembly through bottom of pedal group mounting plate.

ACCELERATOR PEDAL INSTALLATION

- 1. Insert accelerator pedal assembly (7) through bottom of pedal group mounting plate and secure with four screws (13) **(Figure 5-5, Page 5-8)**.
- 2. Tighten screws (13) to 38 in·lb (4.3 N·m)

- 3. Install debris shields (4 and 5).
- 4. Electric Vehicle: Install the MCOR. See MCOR Installation on page 20-7.
- 5. Install pedal group in vehicle. See Pedal Group Installation on page 5-3. See Pedal Group Installation on page 5-6.

BRAKE PEDAL REMOVAL

- 1. Remove pedal group from vehicle. See Pedal Group Removal on page 5-1. See Pedal Group Removal on page 5-4.
- 2. Remove debris shields (4 and 5) (Figure 5-5, Page 5-8).
- 3. Remove four screws (12) securing brake pedal assembly (8) to pedal group mounting plate and pull brake pedal assembly through bottom of pedal group mounting plate.

BRAKE PEDAL INSTALLATION

- 1. Insert brake pedal assembly (8) through bottom of pedal group mounting plate and secure with four screws (12) (Figure 5-5, Page 5-8).
- 2. Tighten screws (12) to 100 in·lb (11.3 N·m)
- 3. Install debris shields (4 and 5).
- 4. Install pedal group in vehicle. See Pedal Group Installation on page 5-3. See Pedal Group Installation on page 5-6.

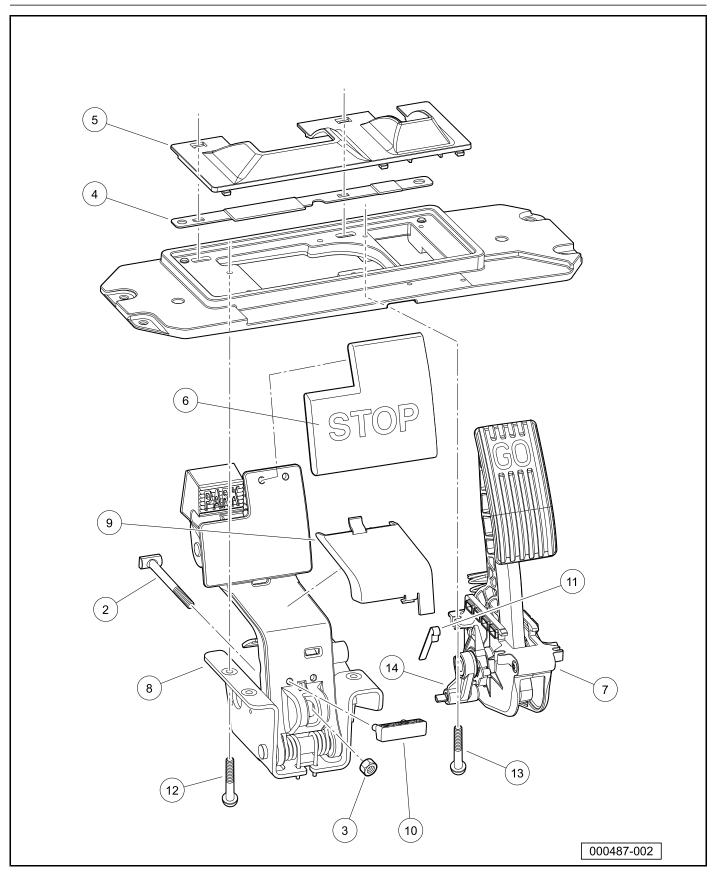


Figure 5-5 Accelerator Pedal Assembly and Brake Pedal Assembly

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

Asbestos Dust Warning

Some aftermarket brake shoes contain asbestos fiber, and asbestos dust is created when these brake
mechanisms are handled. Wear approved eye and respiratory protection when disassembling and
cleaning brake mechanisms. Inhalation of asbestos could result in severe personal injury or death. Do
not use compressed air or aerosol sprays to clean the brake mechanism. Clean brake mechanism
using the negative pressure enclosure/hepa vacuum system or low pressure/wet cleaning method per
OSHA/29 CFR - 1910.1001.

GENERAL INFORMATION

Precedent Golf Cars are equipped with self-adjusting, mechanically-expanding shoe, drum brakes on each rear wheel.

BRAKE SHOE REMOVAL

See General Warnings on page 1-2. See also Asbestos Dust Warning on page 6-1.

- 1. Electric Vehicle: Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5. Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Place chocks at the front wheels. Loosen, but do not remove, lug nuts on rear wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle. **See WARNING "Lift only one end..." in General Warnings on page 1-2.**
- 3. Gain access to the pedal group by removing the floor mat and access panel. See Pedal Group Removal on page 5-1.
- 4. Loosen the two jam nuts (1 and 3) on either side of turnbuckle (2) **(Figure 6-1, Page 6-2)**. Note that the forward jam nut (1) is a left-hand thread. Thread each nut approximately 1/2 inch (12.7 mm) away from the turnbuckle.
- 5. Loosen turnbuckle (2) to release tension on the equalizer bracket (4) that pulls on the heads of the brake cables.
- 6. Remove the rear wheels and then the brake drums. If the brake drums were easily removed, proceed to step 8.

▲ CAUTION

Worn or damaged brake drums cannot be machined to refinish them. Replace as necessary.

NOTE: When servicing vehicles with severely worn brake shoes and when the drums cannot be removed by normal methods, proceed to step 7 to minimize damage to the brake cluster and brake components.

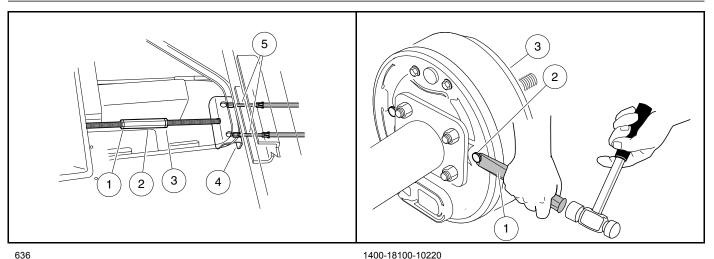


Figure 6-1 Loosen Turnbuckle

Figure 6-2 Shoe Retainer Pins

- 7. Remove brake drums and badly worn brake shoes.
 - 7.1. On the back of each brake cluster assembly, locate the heads of two brake shoe retainer pins. It may be necessary to remove sealant material around the head of each pin.
 - 7.2. Insert a 1/2 inch x 5/8 inch cold chisel (1) under the head (2) of each pin and shear them off as illustrated (Figure 6-2, Page 6-2). This will release the shoes from the backing plate, allowing them to pivot away from the inside of the brake drum (3), which should then allow the brake drum to be pulled free. After completing step 8, skip step 9.

NOTE: Although step 8 allows easier access to the brake shoes, it is not imperative to do so in order to remove the brake shoes.

8. For electric vehicles: Remove the axle shaft.

For gasoline vehicles: Remove the wheel hub assembly. See Rear Hub Removal, Section 31, Page 31-4.

9. Using needle nose pliers, turn the clip retainer pin (1) 90° to remove the shoe retainer clip (2) **(Figure 6-4, Page 6-4)**.

▲ CAUTION

• The brake shoes are under pressure and can release suddenly when brake shoe retainers are removed.

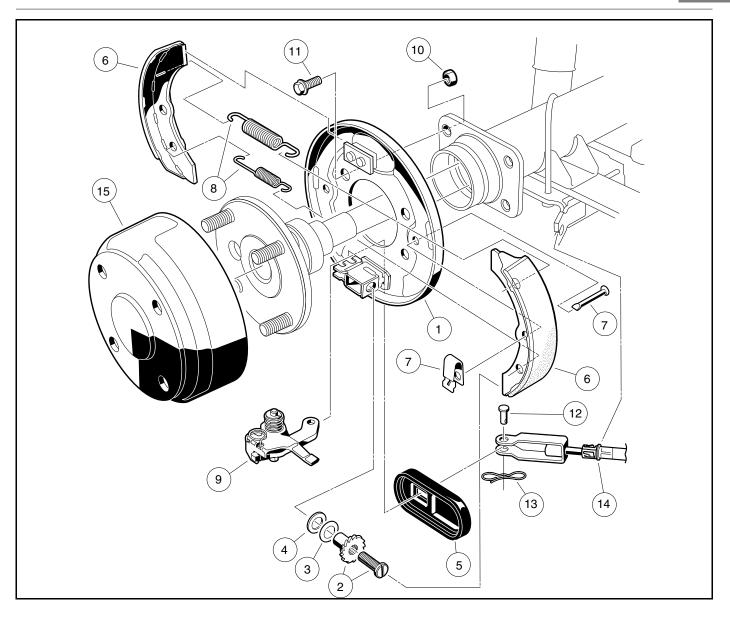
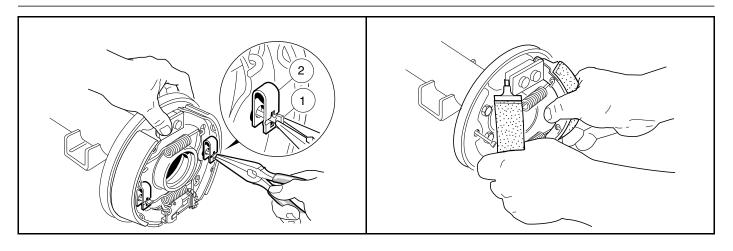


Figure 6-3 Self-adjusting Wheel Brake Assembly

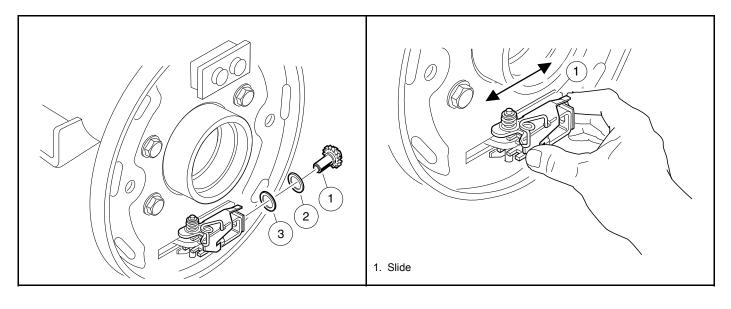
- 10. Grasp both brake shoes and pull them, together with the springs, out of the brake assembly as shown (**Figure 6-5**, **Page 6-4**).
- 11. Remove adjuster wheel (1) with two washers (2 and 3) from the backing plate (Figure 6-6, Page 6-4).



1400-18100-10222

Figure 6-4 Remove Shoe Retainer Clip

1400-17700-10225
Figure 6-5 Remove Brake Shoes



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Figure 6-6 Remove Adjuster Wheel

Figure 6-7 Lubricate Slide

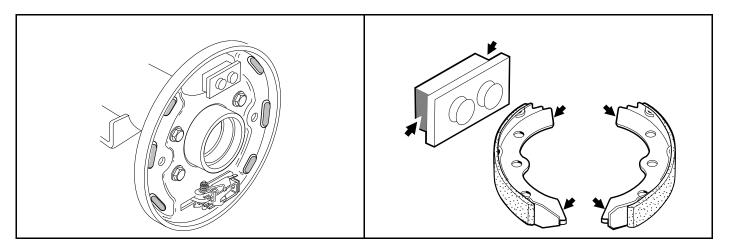
BRAKE ASSEMBLY CLEANING

See General Warnings on page 1-2. See also Asbestos Dust Warning on page 6-1.

- 1. Carefully clean the brake backing plate and all of its mechanical components.
- 2. Remove the rubber boot from backing plate and wipe with a clean damp cloth.
- 3. Lubricate the slide (1) with dry moly lubricant (P/N 1012151) (Figure 6-7, Page 6-4). After lubricating, work slide back and forth against backing plate to ensure that it slides smoothly and easily. Install rubber boot onto backing plate.

WARNING

- Apply grease carefully when performing the following steps. Do not allow any grease to get onto the
 friction surfaces of the brake shoe pads or the brake drum. Failure to heed this warning could cause
 diminished brake performance, possibly resulting in property damage or severe personal injury.
- Use a small brush to carefully apply a light coat of white lithium NLGI #2 grease (Dow Corning® BR2-Plus or equivalent) on each of the six raised bosses on the brake backing plate (Figure 6-8, Page 6-5). See preceding WARNING.
- 5. Use a small brush to carefully apply a light coat of white lithium NLGI #2 grease (Dow Corning® BR2-Plus or equivalent) to each end of both brake shoes and into the slots in the brake shoe mounting block as shown (Figure 6-9, Page 6-5). See preceding WARNING.



2734 Figure 6-8 Apply Grease On Bosses

Figure 6-9 Apply Grease To Brake Shoes and Slots

- 6. Use a small brush to carefully apply a light coat of white lithium NLGI #2 grease (Dow Corning® BR2-Plus or equivalent) to the brake adjuster assembly, adjuster wheel shoe slots, and the shaft of the adjuster wheel as shown (Figure 6-10, Page 6-6). See preceding WARNING.
- 7. Install the adjuster wheel (1) and two washers (2 and 3) into the adjuster assembly (Figure 6-6, Page 6-4).

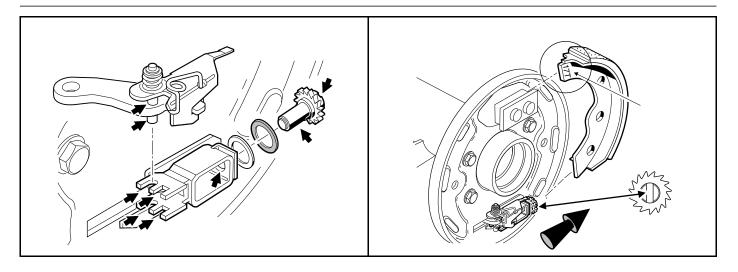


Figure 6-10 Apply Grease To Brake Adjuster

Figure 6-11 Install Adjuster Wheel, Trailing Shoe

BRAKE SHOE INSTALLATION

See General Warnings on page 1-2. See also Asbestos Dust Warning on page 6-1.

1. Turn the adjusting wheel screw so that the shoe slot is vertical, then position the trailing shoe in the slots in the shoe mounting block and adjuster assembly (Figure 6-11, Page 6-6). See following NOTE.

NOTE: The trailing shoe has 17T stamped into the tip of the shoe flange (Figure 6-11, Page 6-6). The leading shoe is stamped 17L. When installing the shoes, the stamping on both shoes should be oriented to the top of the brake assembly. When installing the shoes on the passenger side of the vehicle, the side of the trailing shoe flange marked 17T should be facing out and be visible. On the driver side, the 17L on the leading shoe should be facing out and be visible.

When installed on the backing plate, the **leading** shoe (stamped 17L) is **always** oriented toward the **rear** of the vehicle.

- 2. Install the shoe retainer clip, using pliers to compress the clip (1) while turning the retainer pin (2) into position (Figure 6-12, Page 6-7).
- 3. Attach the springs onto the trailing shoe already installed. Then hold the leading shoe next to the trailing shoe, correctly oriented, and attach the springs to it (Figure 6-13, Page 6-7).

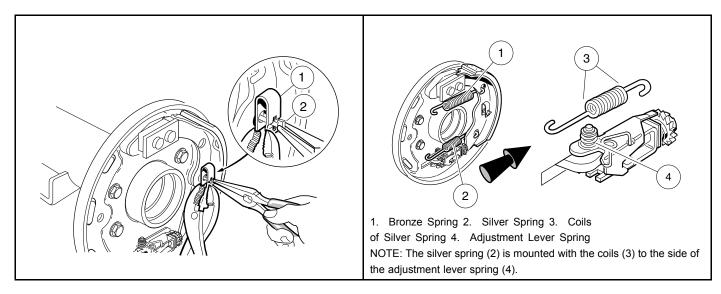


Figure 6-12 Install Trailing Shoe Retainer Clip

2738 Figure 6-13 Attach Springs

- 4. While maintaining spring attachment on both shoes, position tips of leading shoe (1) in the mounting slots and then push shoe into place. Hold shoe in position and install retaining clip (Figure 6-14, Page 6-8).
- 5. After the shoes are installed, move them together up and down and side to side to make sure that they will easily slide approximately 1/4 to 3/8 inch (6.3 to 9.5 mm) without binding (Figure 6-15, Page 6-8).

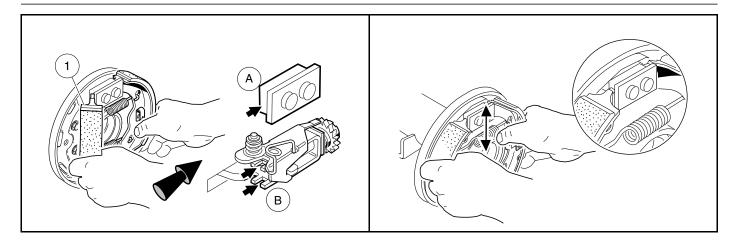
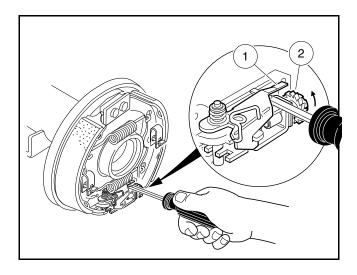


Figure 6-14 Install Leading Shoe

Figure 6-15 Check Shoe Positions

6. Place a flatblade screwdriver under the adjusting arm (1) and raise the arm off of the adjusting wheel (2). While holding the arm (1) up, turn the wheel (2) upward until it stops (Figure 6-16, Page 6-8). Remove the screwdriver.

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Figure 6-16 Set Adjusting Wheel

7. For electric vehicles: Install the axle shaft.

For gasoline vehicles: Install the wheel hub assembly. See Rear Hub Installation, Section 31, Page 31-4.

8. Install the brake drum, and make sure that it is properly seated. See following NOTE.

NOTE: If drum installation is difficult, the brake shoes may need to be adjusted vertically in the mounting slots.

- 9. After the drum is installed, make sure the axle and drum turn freely and then install the wheel. **See Wheel Installation on page 8-1.**
- 10. Remove the turnbuckle (2) and apply Loctite® 242 to the threaded ends of both the rod from the pedal group (6) and the brake actuator rod (5) **(Figure 6-18, Page 6-13)**. Connect the rods using the turnbuckle. Ensure the ends of the brake cables do not slip out of the brake equalizer during this procedure.
- 11. Adjust brake cable equalizer. See Brake Cable Equalizer Adjustment on page 6-10.

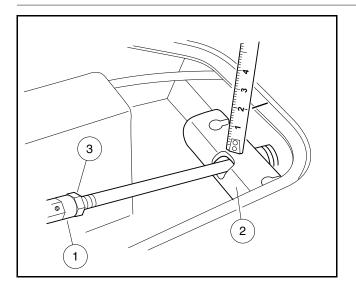


Figure 6-17 Equalizer Adjustment

BRAKE CABLE EQUALIZER ADJUSTMENT

See General Warnings on page 1-2. See also Asbestos Dust Warning on page 6-1.

- 1. After maintenance on the brake system is complete, lower the vehicle onto the floor. With the brake pedal in the full up or at rest position, adjust the turnbuckle (1) until the proper brake tension is achieved (Figure 6-17, Page 6-9). The turnbuckle is properly adjusted when the distance from the top of the equalizer (2) to the upper flange surface is 2 inches (±1/16) (51 mm (±1.6)).
- 2. Ensure that both threaded rods are visible in the witness holes of the turnbuckle (1) before the jam nuts (3) are tightened.
- 3. Snug the front and rear jam nuts to their respective surfaces, then back the nuts off 1/4 to 3/8 inch (6.4 to 9.5 mm) and apply Loctite® 242 on the threads for both front and rear jam nuts.
- 4. Tighten the rear jam nut first to 208 in·lb (23.5 N·m), then tighten the front jam nut to 208 in·lb (23.5 N·m). **See following WARNING.** For optimal performance, drive the vehicle and apply the brakes approximately 20 times to burnish the shoes, center the clusters, and adjust the brake mechanism.

WARNING

- Reduced braking force could result if the jam nuts are not tightened in the proper sequence.
- 5. Once steps 2 and 4 are complete, recheck the 2-inch specification listed in step 1. If the measurement has not changed, the adjustment is complete. If the measurement has changed, perform steps 1 through 4 again.
- 6. Replace access panel and floor mat.
 - 6.1. Place floor cover plate (7) over the floor opening and secure with fastener (10) (Figure 5-2, Page 5-2).
 - 6.2. Install the floor mat (2) over the pedal group. Make sure tabs on floor mat sides are beneath the sill (3). Tighten screws (1) to 53 in·lb (6 N·m) (Figure 5-1, Page 5-1).

BRAKE CLUSTER REMOVAL AND INSTALLATION

See General Warnings on page 1-2. See also Asbestos Dust Warning on page 6-1.

BRAKE CLUSTER REMOVAL

- Electric Vehicle: Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Place chocks at the front wheels and loosen the lug nuts on the rear wheels. Lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Gain access to the pedal group by removing the floor mat and access panel. **See Pedal Group Removal** on page 5-1.
- 4. Loosen the two jam nuts (1 and 3) on either side of turnbuckle (2) **(Figure 6-1, Page 6-2)**. Note that the forward jam nut (1) is a left-hand thread. Thread each nut approximately 1/2 inch (12.7 mm) away from the turnbuckle.
- 5. Loosen turnbuckle (2) to release tension on the equalizer bracket (4) that pulls on the heads of the brake cables.
- 6. Remove lug nuts and rear wheels and then the brake drums.
- **NOTE:** When servicing vehicles with self-adjusting brakes with badly worn brake shoes and when the drums cannot be removed by normal methods, perform Step 7 of **Brake Shoe Removal on page 6-1**, then continue with this procedure.
 - Although step 7 below allows easier access to the brake shoes, it is not imperative to do so in order to remove the brake shoes.
- 7. For electric vehicles: Remove the axle shaft.
 - For gasoline vehicles: Remove the wheel hub assembly. See Rear Hub Removal, Section 31, Page 31-4.
- 8. Remove bow tie locking pin (13) and clevis pin (12) from brake cable (Figure 6-3, Page 6-3).
- 9. Remove four bolts (11) and lock nuts (10) that mount the brake assembly to the transaxle (Figure 6-3, Page 6-3).
- 10. Remove brake assembly from transaxle.

BRAKE CLUSTER INSTALLATION

1. Install in reverse order of disassembly. Use new bow tie locking pins when installing brake cables.

A CAUTION

- Before installing axle shaft, clean any residual oil from the exposed end of the axle tube and from the oil seal area.
- 2. Be sure bolts (11) (P/N 101884801) and new lock nuts (10) (P/N 1013924) are used to mount the brake assembly (Figure 6-3, Page 6-3).
- 3. Tighten nuts to 17 ft-lb (23.0 N·m). If torquing the bolt heads, torque to 30 ft-lb (40.6 N·m).
- 4. For electric vehicles: Install the axle shaft.

For gasoline vehicles: Install the wheel hub assembly. See Rear Hub Installation, Section 31, Page 31-4.

- 5. Tighten lug nuts on rear wheels, using a crisscross pattern, to 55 ft·lb (74.6 N·m). **See Wheel Installation on page 8-1.**
- 6. Adjust the brakes. See Brake Cable Equalizer Adjustment on page 6-10.

BRAKE CABLE REMOVAL AND INSTALLATION

See General Warnings on page 1-2. See also Asbestos Dust Warning on page 6-1.

BRAKE CABLE REMOVAL

1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**

Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

- 2. Place chocks at the front wheels.
- 3. Gain access to the pedal group by removing the floor mat and access panel. See Pedal Group Removal on page 5-1.
- 4. Loosen the two jam nuts (1 and 3) on either side of turnbuckle (2) **(Figure 6-18, Page 6-13)**. Note that the forward jam nut (1) is a left-hand thread. Thread each nut approximately 1/2 inch (12.7 mm) away from the turnbuckle.
- 5. Loosen turnbuckle (2) until the bolt (5) is free of the turnbuckle.

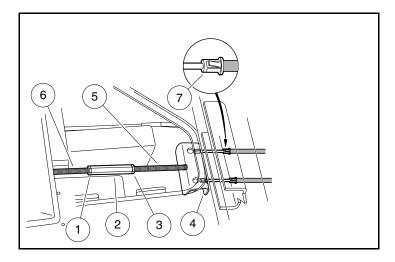


Figure 6-18 Loosen Brake Cables

- 6. Rotate the bolt (5) and equalizer bracket (4) to the upright position then slip the cable heads out of the bracket.
- Remove nut (1) from the bolt (2) that secures front of the leaf spring (Figure 6-20, Page 6-14). Do not remove bolt (2).
- 8. Remove the mounting tab (3) of the brake cable from the bolt.
- 9. Using brake cable release tool (P/N 102555501), compress the retaining clips (7) on the end of the cable housing enough to slide the cable end out of the hole in the frame (Figure 6-18, Page 6-13).
- 10. Remove bow tie locking pin (1) and the clevis pin (2) from the brake lever on each wheel and pull the clevis (3) away from the lever. (Figure 6-19, Page 6-14).
- 11. Using brake cable release tool (P/N 102555501), compress the retaining clips on the end of the cable housing enough to slip the cable end out of the bracket (4) and remove the brake cable from the vehicle.

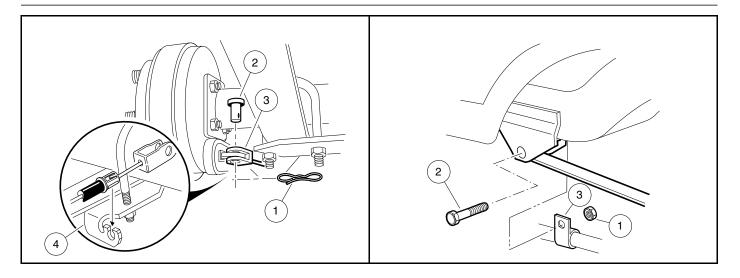


Figure 6-19 Disconnect Cables at Rear Brakes

652 Figure 6-20 Brake Cable Mounting Tab

BRAKE CABLE INSTALLATION

NOTE: The driver-side and passenger-side brake cables are not interchangeable. The driver-side cable is shorter than the passenger-side cable. Make sure the correct cable is used on the correct side.

Be sure to orient the cable so that the clevis end goes to the wheel rather than to the equalizer bracket.

- 1. Insert the end of the new brake cable through the hole in the frame (**Figure 6-18**, **Page 6-13**). Push on the cable housing so the clips on the housing ends secure the housing in the hole.
- 2. Hold the bolt (5) and the equalizer bracket (4) in the upright position and slip the cable head through the hole on top of the bracket. Pivot the equalizer to the horizontal position to capture the cable heads in the equalizer.
- 3. Insert the rear cable housing into the shock mount bracket (4) (Figure 6-19, Page 6-14). Push the cable housing end into the bracket to ensure the clips on the housing end secure the cable in position.
- 4. At the rear wheel brake, connect the cable to the brake actuator arm using new clevis pin (2) and new bow tie locking pin (1) (Figure 6-19, Page 6-14).
- 5. Place tab (3) on cable housing over the forward leaf spring mounting bolt (2) (Figure 6-20, Page 6-14). Install nut (1). Tighten nut to 18.4 ft·lb (25 N·m).
- 6. Adjust the brakes. See Brake Cable Equalizer Adjustment on page 6-10.

A DANGER

See General Warnings on page 1-2.

WARNING

See General Warnings on page 1-2.

GENERAL INFORMATION

Steering is controlled through a rack and pinion steering assembly that is connected by a steering column to a steering wheel. No manual adjustment to the rack and pinion gear assembly is required. A spring loaded self-adjusting mechanism is incorporated into the assembly.

STEERING WHEEL

See General Warnings on page 1-2.

STEERING WHEEL REMOVAL

1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**

Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

2. Rotate steering wheel to a straight ahead position.

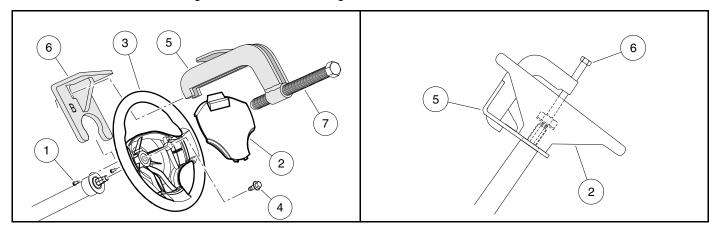
NOTE: Do not turn steering again until wheel has been installed.

- 3. Remove two screws (1) securing cover (2) to steering wheel (3) (Figure 7-1, Page 7-2).
- 4. Loosen and remove the steering wheel retaining bolt (4).
- 5. Remove the steering wheel. **See following NOTE.**

NOTE: The steering wheel has a tapered hex fitting. A steering wheel puller (CC P/N 102061201) may be required to remove the steering wheel.

- 5.1. Place the puller anvil (5) through the top opening of the steering wheel (Figure 7-1, Page 7-2).
- 5.2. Insert the anvil feet through the two slots in the base plate (marked "B") (6).
- 5.3. Rotate the anvil screw (7) clockwise until the base plate (6) contacts the bottom of the steering wheel (3) at the steering column (Figure 7-2, Page 7-2).
- 5.4. Use a 1/2-inch drive air impact wrench to tighten the anvil screw (7) until the steering wheel releases from the steering shaft.

5.5. Remove the steering wheel from the steering column.



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Figure 7-1 Steering Wheel Removal

Figure 7-2 Steering Wheel Puller

STEERING WHEEL INSTALLATION

NOTE: To minimize corrosion and to make future removal of the steering wheel easier, apply a small amount of oil or anti-seize compound to steering shaft before installing the steering wheel.

2520

- 1. Install the steering wheel (3) on the hex portion of the steering shaft. Align the hex fitting of the wheel with the steering column shaft (Figure 7-1, Page 7-2).
- 2. Install steering wheel retaining bolt (4) and tighten to 37 ft·lb (50 N·m).
- 3. Place cover (2) onto steering wheel and secure with two screws (1). Tighten screws to 15 in·lb (1.7 N·m).
- 4. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

STEERING COLUMN

See General Warnings on page 1-2.

STEERING COLUMN REMOVAL

 Electric Vehicle: Disconnect the batteries and discharge the controller. See Disconnecting the Batteries – Electric Vehicles on page 1-5.

Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

- 2. Remove the steering wheel. See Steering Wheel Removal on page 7-1.
- 3. Remove the dash insert, instrument panel, dash assembly, and front bumper. See Section 4 Body and Trim.
- 4. Remove the bolt (11) that secures the steering column universal joint to the pinion shaft of the steering gear (Figure 7-3, Page 7-3).
- 5. Remove the four bolts (10) that secure the steering column to the frame.
- 6. Remove the steering column from the vehicle.

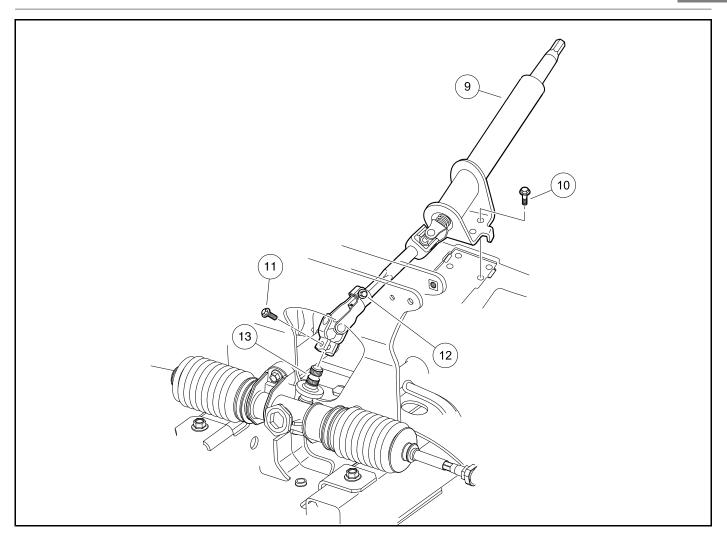


Figure 7-3 Steering Column

STEERING COLUMN INSTALLATION

- 1. For ease of assembly and to prevent corrosion, apply a light coat of anti-seize or lubricating compound to the splined stud extending from the steering gear.
- 2. Insert the end of the steering column with the universal joint through the front underbody. Install universal joint onto pinion shaft of steering gear. Loosely install bolt (11). Do not tighten until steering column is mounted to frame in step 3 (Figure 7-3, Page 7-3).
- 3. Align the holes in the steering column mounting bracket with holes in the vehicle frame. Secure column to frame with four bolts (10). Tighten bolts to 18.4 ft·lb (25 N·m).
- 4. Tighten universal joint bolt (11) to 18.4 ft·lb (25 N·m). Verify the upper universal joint bolt (12) torque is 18.4 ft·lb (25 N·m).
- 5. Install front bumper, dash assembly, dash insert, and instrument panel. See Section 4 Body and Trim.
- 6. Install steering wheel. See Steering Wheel Installation on page 7-2.
- 7. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

RACK AND PINION

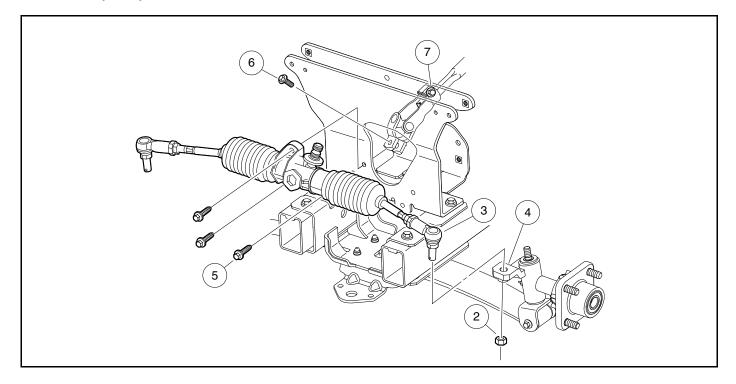
See General Warnings on page 1-2.

CAUTION

 Front impacts that bend tie rods and/or drag links can possibly damage internal steering gear components. See Rack and Pinion Inspection on page 7-4. The manufacturer recommends inspecting the rack and pinion and replacing if damaged.

RACK AND PINION INSPECTION

- 1. Look for obvious damage to the chassis, where the rack and pinion is mounted, and the rack and pinion housing. Particularly check the housing for broken mounting points.
- 2. Compare the toe-in against the specification. See Toe-in Adjustment on page 7-7.
- 3. If obvious visible damage is found, such as a bent tie rod, check the steering gear for abnormal free-play, noise, binding or clunking while it is under a load. With the steering system fully assembled and all four tires on the ground/floor, turn the steering wheel from stop to stop. While turning, feel for any binding, clunking or tight/loose spots. Listen for unusual noises. Replace the rack and pinion as an assembly if any is found.
- 4. In the event of an known impact and obvious visible damage is not found in the method described above, disconnect the tie rods and/or drag links from the spindles. Turn the steering wheel from stop to stop. While turning, feel for any binding or tight/loose spots. Listen for unusual noises. Replace the rack and pinion as an assembly if any is found.



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Figure 7-4 Rack and Pinion Removal

RACK AND PINION REMOVAL

1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**

Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

- 2. Remove the front bumper as instructed. See Section 4 Body and Trim.
- 3. Remove the tie rod end retaining nuts (2) (Figure 7-4, Page 7-4).
- 4. Remove the tie rod ends (3) from the spindle assemblies.
- 5. Remove the three bolts (5) from the steering rack and pinion assembly mounting bracket.
- 6. Remove the upper bolt (7) from the universal joint, then remove the rack and pinion assembly and universal joint from the vehicle.

RACK AND PINION INSTALLATION

- 1. To minimize corrosion, apply a light coat of anti-seize lubricating compound to the end of the steering column shaft.
- 2. Simultaneously slide the universal joint over the square end of the steering column shaft and position the assembly over the mounting holes in the chassis.
- 3. Install three screws to secure the assembly to the chassis. Tighten screws to 22 ft·lb (30 N·m).
- 4. Install the upper universal joint bolt (7) and tighten to 18.4 ft·lb (25 N·m) (Figure 7-4, Page 7-4).
- 5. Install the tie rod ends (3) into the left- and right-hand spindle tabs (4), and then install the retaining nuts (2) (Figure 7-4, Page 7-4). See following WARNING.

A WARNING

- Do not operate vehicle until toe-in is adjusted and ball joints are secured.
- 6. Adjust the toe-in. See Toe-in Adjustment on page 7-7.
- 7. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 8. Test drive vehicle before returning it to service.

FRONT SUSPENSION

See General Warnings on page 1-2.

LUBRICATION

Two grease fittings are provided (one in each spindle housing). Lubricate these fittings at the recommended interval with the proper lubricant. See Periodic Lubrication Schedules on page 10-11.

CAUTION

• To ensure proper lubrication, raise front of vehicle to lubricate. See General Warnings on page 1-2.

WHEEL ALIGNMENT

Wheel alignment is limited to equalizing the camber angle of each front wheel and adjusting toe-in of the front wheels.

NOTE: Prior to making any front suspension adjustments, inspect components for wear or damage and repair or replace as necessary.

Camber Adjustment

- 1. Check each front wheel with a framing square. At the floor (or ground), there should be an equal amount of space between each tire and the framing square (Figure 7-5, Page 7-7).
- 2. Loosen, but do not remove, the four bolts (17) that secure the leaf spring (13) to the bottom spring plate (16) (Figure 7-11, Page 7-13). See also Figure 7-6, Page 7-7.
- 3. Loosen, but do not remove, the hex nut (8) on the adjustment eccentric (7) (Figure 7-6, Page 7-7) in the center of the spring. See also Figure 7-11, Page 7-13.
- 4. Use a 7 mm deep well socket to rotate the eccentric (Figure 7-6, Page 7-7).
- 5. After adjusting camber, use a crisscross pattern to tighten the four spring retaining bolts (17) (Figure 7-11, Page 7-13) to 37 ft·lb (50 N·m). Then roll the vehicle forward one full tire revolution and recheck the camber. See also Figure 7-5, Page 7-7.
- 6. Tighten the hex nut (8) on the adjustment eccentric (7) to 10 ft·lb (13.5 N·m) (Figure 7-6, Page 7-7). See also Figure 7-11, Page 7-13.

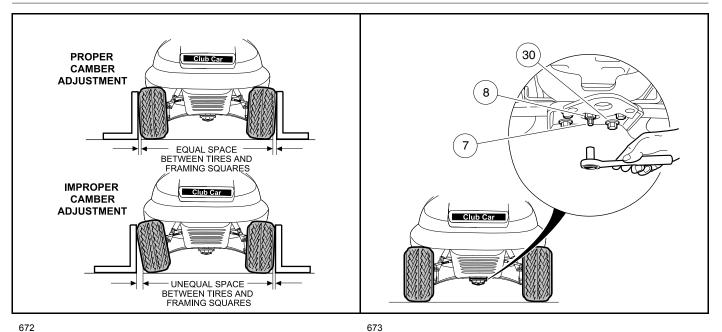


Figure 7-5 Check Camber

Figure 7-6 Adjust Camber

Toe-in Adjustment

- 1. On a level surface, roll the vehicle forward, then stop. Make sure the front wheels are pointed straight ahead. Do not turn the steering wheel again during this procedure.
- 2. On each front tire, mark (as closely as possible) the center of the tread face that is oriented toward the rear of the vehicle. The marks should be even with the bottom surfaces of the vehicle frame.
- 3. Measure the distance between the marks on the rear-facing surfaces of the tires, and then roll the vehicle forward one and a half wheel revolutions until the marks appear on the forward facing surfaces of the tires at about the same height from the floor (Figure 7-7, Page 7-7).

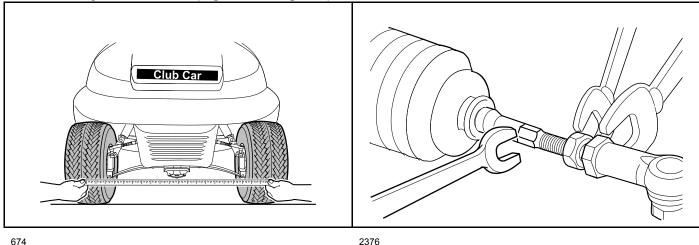


Figure 7-7 Check Toe-In

Figure 7-8 Adjust Toe-In

4. Measure the distance between the marks on the forward-facing surfaces of the tires (Figure 7-7, Page 7-7).

NOTE: The front measurement must be less than the rear measurement.

- 5. Subtract the measurement on the front of the tires from the measurement on the rear of the tires. The difference is the toe-in. Proper toe-in is 3/8 inch (±1/8) (9.5 mm (±3.2)).
- 6. If adjustment is necessary, proceed as follows:
 - 6.1. Loosen the jam nuts on both ends of each drag link (Figure 7-8, Page 7-7).

- 6.2. Rotate both of the drag links equally. To increase the toe-in, rotate both drag links counterclockwise. To decrease the toe-in, rotate both drag links clockwise. Maintain an equal distance from the ball joint to the end of the threads on each drag link (Figure 7-9, Page 7-8).
- 6.3. Tighten jam nuts to 26 ft·lb (35 N·m).
- 6.4. Check the toe-in, and repeat the adjustment procedure if necessary.
- 6.5. After toe-in adjustment is made and with wheels in the straight ahead position, the steering wheel should be at the center of its travel. There should be equal travel to the left and right.

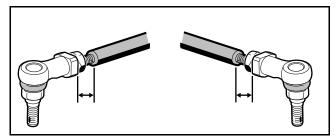


Figure 7-9 Adjust Both Drag Links To An Equal Distance

FRONT SUSPENSION COMPONENTS

See General Warnings on page 1-2.

TIE ROD END REMOVAL

- 1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Loosen jam nuts (13) to allow later rotation of the tie rod ends (12) (Figure 7-10, Page 7-12).
- 3. Remove the and retaining nuts (14).
- 4. Lift male thread of tie rod from the hole in the spindle tab.
- 5. Remove the tie rod ends from the steering gear.
- To minimize corrosion, apply a light coat of anti-seize lubricating compound to the threads where the tie rod ends are installed.

TIE ROD INSTALLATION

1. Thread tie rod ends (12) onto steering gear to a depth of 1/2 inch (12.5 mm) (Figure 7-10, Page 7-12).

WARNING

- The tie rod ends must be threaded into the rod at least 5/16 of an inch (8 mm). Failure to thread deep enough may cause tie rod ends to separate from the rod during adjustment or while being operated, possibly resulting in loss of vehicle control and severe personal injury.
- 2. Install tie rod ends (12) into the spindle tabs. Install the retaining nuts (14) (Figure 7-10, Page 7-12).
- 3. Adjust wheel toe-in. See Toe-in Adjustment on page 7-7.

4. Electric Vehicle: Connect batteries. See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-5.

Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery – Gasoline Vehicles on page 1-3.

LEAF SPRING REMOVAL

- 1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Loosen lug nuts on both front wheels and raise front of vehicle with a chain hoist or floor jack. Place jack stands under the aluminum rails of the vehicle frame just aft of the front suspension. Lower the vehicle onto the jack stands. See General Warnings on page 1-2.
- 3. Remove both front wheels.
- 4. Remove the bolts (8) from the bottom of each kingpin (7) (Figure 7-11, Page 7-13).
- 5. Remove the four bolts (17) and bottom spring plate (16).
- 6. Remove leaf spring (13).
- 7. Check the condition of the urethane bushings (15) and steel sleeves (14). Replace any that are worn or damaged.

LEAF SPRING INSTALLATION

- 1. Install urethane bushings (15) and steel sleeves (14) into leaf spring eyes (Figure 7-11, Page 7-13).
- 2. Install leaf spring (13), bottom spring plate (16), and four bolts (17). Using a crisscross pattern sequence, tighten bolts to 37 ft·lb (50 N·m).
- 3. Install spring in kingpins (7) with bolts (8). Tighten to 30 ft·lb (41 N·m).
- 4. Install the wheels and finger tighten the lug nuts.
- 5. Lower the vehicle and finish tightening lug nuts (using a crisscross pattern) to 55 ft·lb (74.6 N·m).
- 6. Adjust camber and toe-in. See Wheel Alignment on page 7-6.
- 7. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

Gasoline Vehicle: Connect battery and spark plug wire(s). **See Low Maintenance Battery: Connecting the Battery – Gasoline Vehicles on page 1-3.**

KINGPIN AND STEERING SPINDLE REMOVAL

- 1. Electric Vehicle: Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the front hub. See Front Hub Removal on page 7-14.
- 3. Remove retaining nuts (14), then remove tie rod ends (12) from the tabs on the spindles (Figure 7-10, Page 7-12).
- 4. Remove the nut (1) from the top of the kingpin (7) (Figure 7-11, Page 7-13).
- 5. Raise the upper clevis from the kingpin.

- 6. Slide the spindle (3) off the kingpin (7).
- 7. Remove the wave washer (6) and inspect it. If the washer is broken or has a wave bottom to wave crest height dimension of less than 0.040 inch (1 mm), it must be replaced.
- 8. Remove bolt (8) from bottom of kingpin (7) and remove kingpin.
- 9. Inspect the kingpin and spindle. If either is worn or damaged, it must be replaced.
- 10. Inspect the bushings (4). If the bushings are worn or damaged, remove them and press in new ones. **See following NOTE.**

NOTE: New bushings (4) may not fit the kingpin (7) after installing them into the spindle (3). Ream new bushings as required.

10.1. After installing new bushings (4), ream bushings to 0.753 inch (±0.0005) (19.13 mm (±0.013)).

KINGPIN AND STEERING SPINDLE INSTALLATION

- 1. Inspect all parts and replace them as necessary.
- 2. Install the kingpin (7) over the leaf spring eye. Insert the bolt (8) **(Figure 7-11, Page 7-13)**. Tighten the bolt to 30 ft·lb (41 N·m).
- 3. Install the wave washer (6) on the kingpin.
- 4. Install the steering spindle on the kingpin. Place upper clevis over the kingpin threads and install nut (1). Tighten the nut to 70 ft·lb (95 N·m).
- 5. Attach the tie rod ends (12) to the spindle tabs, then install and tighten the nuts (14) to 70 ft·lb (95 N·m) (Figure 7-10, Page 7-12).
- 6. Install front hub and wheel. See Hub Installation on page 7-14.
- 7. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

CONTROL ARM REMOVAL

 Electric Vehicle: Disconnect the batteries and discharge the controller. See Disconnecting the Batteries – Electric Vehicles on page 1-5.

Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

- 2. Loosen lug nuts on both front wheels and raise front of the vehicle with a chain hoist or floor jack. Place jack stands under the front aluminum rails of the vehicle frame and lower the vehicle onto the jack stands.
- 3. Remove wheel.
- 4. Remove bolts (17) and move rack and pinion to allow clearance for bolt (19) (Figure 7-10, Page 7-12).
- Remove bolts (11 and 19).
- 6. Remove the control arm (6).
- 7. Inspect the bushings (7) and sleeves (8 and 9) in the control arm and replace them if necessary.

CONTROL ARM INSTALLATION

- 1. Install the control arm in reverse order of removal. Tighten the control arm bolts (11 and 19) to 30 ft·lb (41 N·m) (Figure 7-10, Page 7-12). Tighten three rack and pinion mounting bolts (17) to 22 ft·lb (30 N·m)
- 2. Install the wheels and adjust the wheel alignment as instructed on page 7-6.
- 3. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

SHOCK ABSORBER REMOVAL

- 1. Inspect the shock absorbers for fluid leakage at the point where the shaft enters the shock absorber body. Leaking shock absorbers should be replaced.
- 2. Remove the upper bolt (18) (Figure 7-10, Page 7-12).
- 3. Remove the lower bolt (10).
- 4. Remove the shock absorber.

SHOCK ABSORBER INSTALLATION

NOTE: When installing shock absorbers, make sure front shocks have identical part numbers.

- 1. Install the shock absorber by reversing the removal procedure.
- 2. Tighten the bolts to 16 ft·lb (21 N·m).

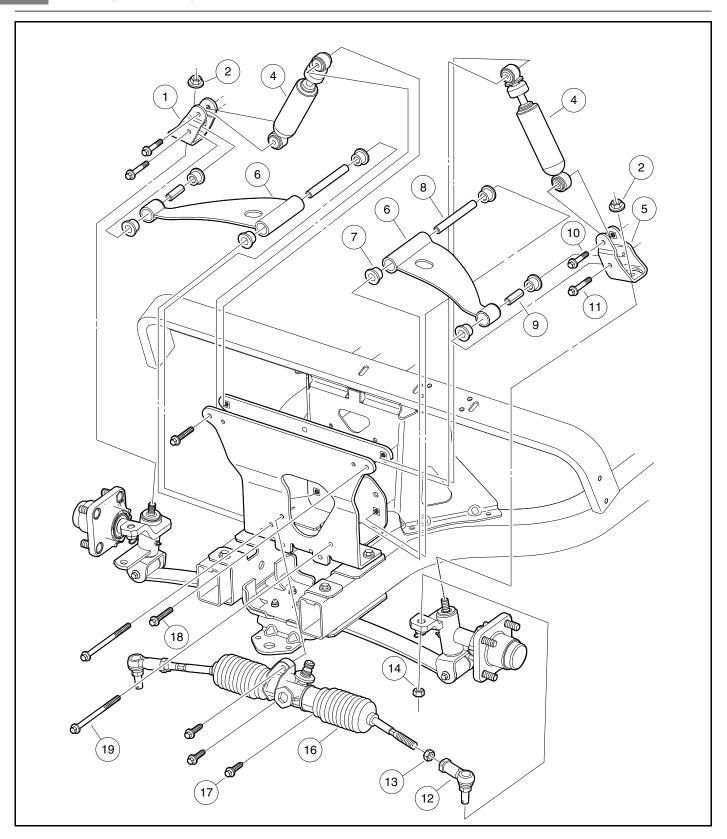
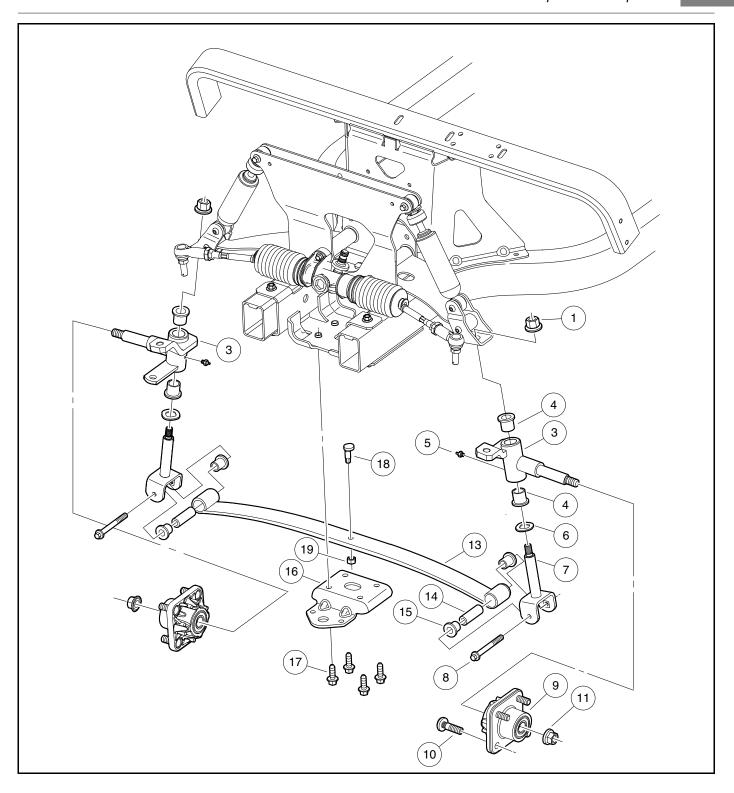


Figure 7-10 Upper Front Suspension Assembly



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Figure 7-11 Lower Front Suspension Assembly

FRONT WHEEL BEARINGS AND HUBS

See General Warnings on page 1-2.

NOTE: The front wheel bearings are pressed into the spindle and are not serviceable. If excessive free-play is detected the entire hub should be replaced.

FRONT WHEEL FREE PLAY INSPECTION

- 1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Raise the front of the vehicle.
- 3. Use your hands to attempt to rock the wheel and hub assembly back and forth on the spindle. Movement of the wheel and hub on the spindle indicates that the hub bearing is worn; therefore, the hub assembly must be replaced. See Front Hub Removal on page 7-14.

FRONT HUB REMOVAL

- 1. Remove the front wheels. See Wheel Removal on page 8-1.
- 2. Remove dust cap (12) and lock nut (11) (Figure 7-11, Page 7-13).
- 3. Slide the hub assembly (9) off of the spindle shaft (3).
- 4. Lightly sand spindle shaft to clean away any light rust.
- 5. Inspect the surface of the spindle shaft for surface damage. It should be clean and smooth. If severe pitting from rust or corrosion has occurred, replace the spindle assembly. See Kingpin and Steering Spindle Removal on page 7-9.

HUB INSTALLATION

- 1. Clean and apply a light coat of anti-seize lubricant to the spindle shaft (3).
- 2. Slide the hub assembly (9) onto the spindle shaft (Figure 7-12, Page 7-15).
- 3. Install a new flanged lock nut (11) and tighten to 50 ft·lb (68 N·m).
- 4. Rotate the hub. The hub should rotate smoothly without binding, side play, or any indication of rough spots.
- 5. Repeat the procedure for the opposite wheel.
- 6. Install wheels and finger-tighten lug nuts.
- 7. Lower the vehicle and finish tightening lug nuts, using a crisscross pattern, to 55 ft·lb (74.6 N·m).
- Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.
 - Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

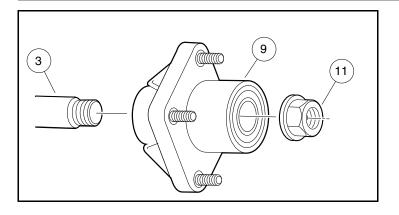


Figure 7-12 Front Wheel Hub

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

Maximum tire life and good vehicle handling qualities are directly related to proper wheel and tire care.

- Keep tires properly inflated. See Vehicle Specifications Electric and Subaru EX40.
- · Keep lug nuts properly tightened.
- · Keep the front end aligned and adjusted.

WARNING

• Tires affect vehicle handling. When selecting a replacement tire, use only original equipment or comparable tires.

WHEELS

See General Warnings on page 1-2.

WHEEL REMOVAL

- 1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Slightly loosen the lug nuts on the wheel to be removed.
- 3. Raise the end of the vehicle from which the wheel is to be removed. Make sure that the wheels are off the ground. See General Warnings on page 1-2.
- 4. Remove the lug nuts and remove the wheel.

WHEEL INSTALLATION

1. Install wheel(s) and tighten the lug nuts, using a crisscross pattern, until they are snug.

8 Tires WHEELS AND TIRES

- Lower the vehicle and finish tightening lug nuts, using a crisscross pattern, to 55 ft·lb (74.6 N·m).
- 3. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

TIRES

See General Warnings on page 1-2.

TIRE REMOVAL

NOTE: Tire must be removed or installed from the valve stem side of the rim.

- 1. Remove the tire and wheel assembly from the vehicle as instructed above.
- Remove the valve cap and valve core and allow air to escape from the tire.
- 3. If possible, use a tire machine to remove the tire from the rim.
 - 3.1. If a tire machine is not available, loosen both tire beads by applying pressure to the tire side walls and pushing the tire bead away from the rim flange and into the rim well (Figure 8-1, Page 8-2, Detail A).
 - 3.2. With the valve stem side of the wheel up, use a tire tool to carefully start the upper bead over the edge of the wheel rim (Figure 8-1, Page 8-2, Detail B).

CAUTION

- To avoid damage to the tire, do not use excessive force when starting the bead over the edge of the rim.
- 4. When top bead is free of the rim, pull the bead from the bottom side of the rim up into the upper part of the rim well. Insert the tire tool under the lower bead as shown (**Figure 8-1**, **Page 8-2**, **Detail C**) and carefully pry the lower bead over the rim flange.
- 5. Once the lower bead is started over the rim flange, the tire can be removed from the rim by hand.

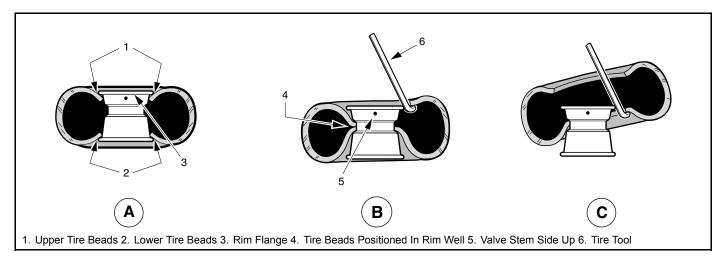


Figure 8-1 Tire Removal

Tires 8

TIRE REPAIR

- 1. Determine the location and cause of the air leak:
 - 1.1. Remove the wheel. See Wheel Removal on page 8-1. Inflate the tire to no more than 20 psig (138 kPa).
 - 1.2. Immerse the tire in water and then mark the point where bubbles are formed by escaping air.
 - 1.3. Determine the cause of the air leak. See following NOTE.

NOTE: An air leak could be due to a punctured casing, faulty valve core, improperly seated valve stem, or improperly seated tire bead.

Small holes in the casing can be plugged using a standard automotive tubeless tire repair kit available at your local Club Car dealer.

2. When the cause of the air leak has been determined, remove tire from the rim and repair as required. **See Tire Removal on page 8-2.**

TIRE INSTALLATION

WARNING

- While mounting or inflating tire, keep hands, fingers, etc. from exposed areas between the tire bead and rim.
- 1. Clean both tire beads to remove dirt or other foreign matter.
- 2. Where the tire beads seat, clean the wheel rim with a wire brush. Wipe away any debris with a clean cloth.

NOTE: Because tubeless tires require a perfect seal in order to seat, keeping the tire and rim clean is very important.

- 3. Apply a liberal amount of tire-mounting lubricant (soap and water solution) to both tire beads and rim flanges.
- 4. Install the tire on the rim from the valve stem side. If there is no tire machine available, use a rubber mallet and tire iron.
- 5. Remove the valve core, and position tire so that both beads are on the rim flange narrow bead seats.
- 6. Place tire and wheel assembly against wall in upright position and push it against wall while inflating tire to 30 to 35 psig (207 to 242 kPa). The three-point contact (wall, floor, and hand) will help ensure that beads snap into place and form a proper seal as tire is inflated (**Figure 8-2, Page 8-4**). **See following WARNING.**

WARNING

- Do not use a compressed air source with pressure over 100 psig (689 kPa). Due to low pressure requirements of a small tire, over-inflation could be reached almost instantly with a high pressure air supply. Over-inflation could cause tire to explode, possibly resulting in severe personal injury.
- 7. Quickly remove the air nozzle and install the valve core.
- 8. Adjust air pressure in tire to recommended pressure. See Vehicle Specifications Electric and Subaru EX40.
- 9. Immerse the wheel and tire assembly in water to make sure there are no leaks.

8 Tires WHEELS AND TIRES

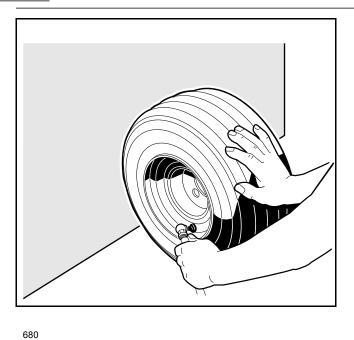


Figure 8-2 Inflate Tire

A DANGER

See General Warnings on page 1-2.

A WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

The rear suspension and powertrain of the vehicle move independently from the vehicle frame. It consists of two leaf springs controlled by two shock absorbers mounted between the springs and the vehicle frame.

SHOCK ABSORBERS

See General Warnings on page 1-2.

SHOCK ABSORBER REMOVAL AND INSPECTION

- 1. Check shock absorbers (7) for damage or fluid leakage at the point where the shaft enters the shock absorber body. Replace damaged or leaking shock absorbers (Figure 9-3, Page 9-4 or Figure 9-4, Page 9-6).
- 2. To remove a shock absorber, remove the nut (5), cup washer (9), and rubber bushings (10) from the stem at the top of the shock absorber.
- 3. Remove the nut (5), cup washer (9), and rubber bushings (10) from lower mounting stem.
- 4. Compress the shock absorber to remove it.

SHOCK ABSORBER INSTALLATION

- 1. To install, reverse the removal procedure.
- 2. On the upper and lower shock absorber mounting stems, tighten the nuts until the rubber bushing expands to the size of the cup washer.

LEAF SPRINGS (TWO-PASSENGER VEHICLES)

See General Warnings on page 1-2.

LEAF SPRING REMOVAL (TWO-PASSENGER VEHICLES)

- 1. **Electric Vehicle:** Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-5.**
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Loosen, but do not remove, lug nuts on tire and wheel assembly on the side from which the spring is to be removed. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember forward of the spring mounting tabs. Lower the vehicle to let the jack stands support the vehicle (Figure 9-1, Page 9-3). See following WARNING.

A WARNING

- Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.
- 3. Place a floor jack under the transaxle differential casing to support, but not lift, the drivetrain. Raise it just enough to relieve tension on the shock absorbers without compressing them.
- 4. Remove the tire and wheel assembly on the side from which the spring is to be removed.
- 5. Remove the bow tie locking pin (1) and the clevis pin (2) at the brake lever and brake cable connection, and remove cable end (3) from the brake lever (Figure 9-2, Page 9-3). Detach the brake cable from the shock mount bracket (4). See Brake Cable Removal, Section 6, Page 6-13.
- 6. Remove the nut (5), cup washer (9), and rubber bushings (10) from the lower mounting stem of the shock absorber (Figure 9-3, Page 9-4).
- 7. Remove the nuts (13) and the U-bolt (11) securing the spring to the transaxle. Remove the shock mount bracket (15) and the U-bolt.
- 8. Remove the bolt (17) and nut (2) attaching the rear of the spring to the shackle (1).
- 9. Remove the nut (2) and bolt (17) attaching the front of the spring to the vehicle frame and remove the spring.
- 10. Inspect the bushings (4) and sleeves (3) in the spring eyes and replace them if they are worn or damaged.

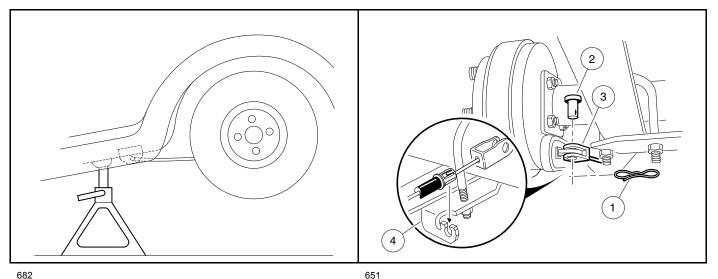


Figure 9-1 Support Vehicle on Jack Stands

Figure 9-2 Disconnect Brake Cable

LEAF SPRING INSTALLATION (TWO-PASSENGER VEHICLES)

1. To install the springs, reverse the removal procedure. See following CAUTION.

▲ CAUTION

- When positioning the spring on the transaxle, be sure to insert the locating bolt on the spring in the locating hole in the transaxle saddle.
- 2. Tighten the nuts on the U-bolts to 25 ft·lb (34 N·m) and tighten nuts (2) on spring mounting bolts (17) to 18.5 ft·lb (25 N·m) (Figure 9-3, Page 9-4).
- 3. Install tire and wheel assembly. See Wheel Installation, Section 8, Page 8-1.
- 4. Electric Vehicle: Connect batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

 Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

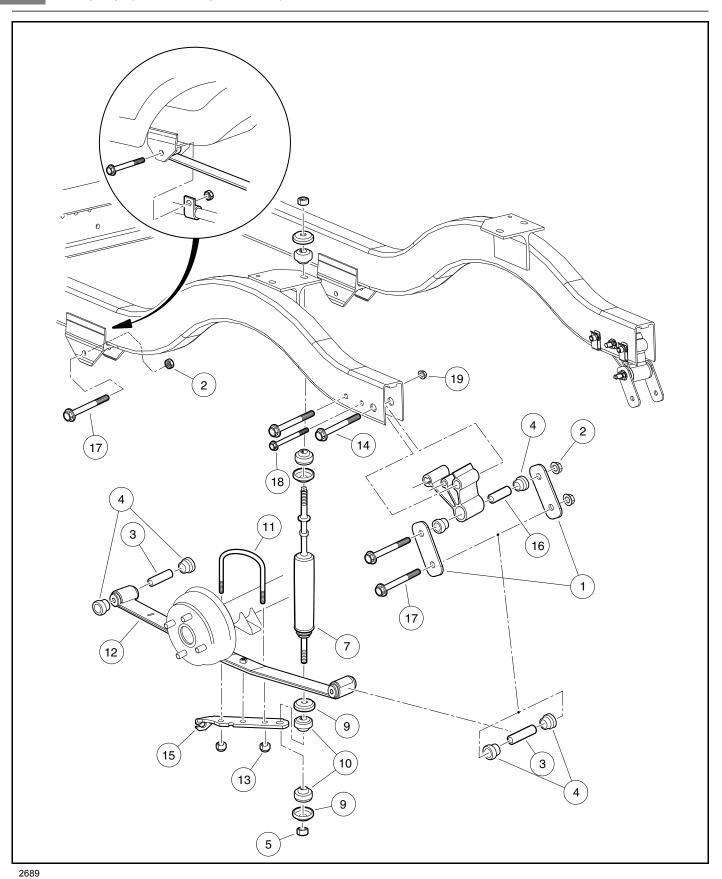


Figure 9-3 Rear Suspension Assembly and Mounting (Two-Passenger Vehicles)

LEAF SPRINGS (FOUR-PASSENGER VEHICLES)

See General Warnings on page 1-2.

LEAF SPRING REMOVAL (FOUR-PASSENGER VEHICLES)

- Electric Vehicle: Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
 - Gasoline Vehicle: Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Loosen, but do not remove, lug nuts on tire and wheel assembly on the side from which the spring is to be removed. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame crossmember forward of the spring mounting tabs. Lower the vehicle to let the jack stands support the vehicle (Figure 9-1, Page 9-3). See following WARNING.

A WARNING

- Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.
- 3. Place a floor jack under the transaxle differential casing to support, but not lift, the drivetrain. Raise it just enough to relieve tension on the shock absorbers without compressing them.
- 4. Remove the tire and wheel assembly on the side from which the spring is to be removed.
- 5. Remove the bow tie locking pin (1) and the clevis pin (2) at the brake lever and brake cable connection, and remove cable end (3) from the brake lever (Figure 9-2, Page 9-3). Detach the brake cable from the shock mount bracket (4). See Brake Cable Removal, Section 6, Page 6-13.
- 6. Remove the nut (5), cup washer (9), and rubber bushings (10) from the lower mounting stem of the shock absorber (Figure 9-4, Page 9-6).
- 7. Remove the nuts (13) and the U-bolt (11) securing the spring and jounce bumper to the transaxle. Remove the shock mount bracket (15), jounce bumper bracket (20), and the U-bolt (11).
- 8. Remove the bolt (17) and nut (2) attaching the rear of the spring to the shackle (1).
- 9. Remove the nut (2) and bolt (17) attaching the front of the spring to the vehicle frame and remove the spring.
- 10. Inspect the bushings (4) and sleeves (3) in the spring eyes and replace them if they are worn or damaged.

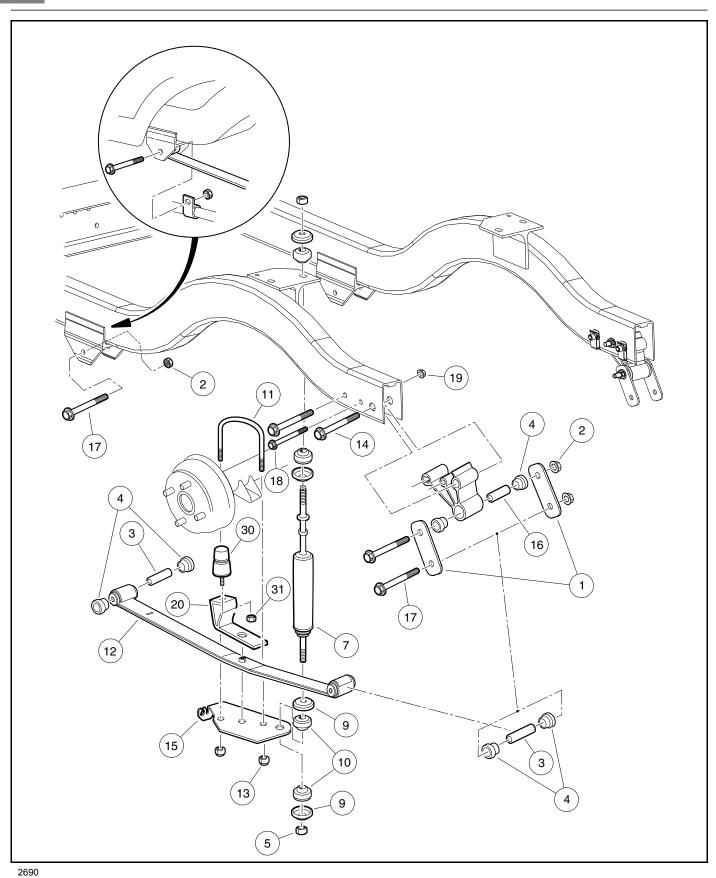


Figure 9-4 Rear Suspension Assembly and Mounting (Four-Passenger Vehicles)

LEAF SPRING INSTALLATION (FOUR-PASSENGER VEHICLES)

1. To install the springs, reverse the removal procedure. See following CAUTION.

A CAUTION

- When positioning the spring on the transaxle, be sure to insert the locating bolt on the spring in the locating hole in the transaxle saddle.
- 2. Tighten the nuts on the U-bolts to 25 ft·lb (34 N·m) and tighten nuts (2) on spring mounting bolts (17) to 18.5 ft·lb (25 N·m) (Figure 9-4, Page 9-6).
- 3. Install tire and wheel assembly. See Wheel Installation, Section 8, Page 8-1.
- 4. **Electric Vehicle:** Connect batteries. **See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.**
 - Gasoline Vehicle: Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

GENERAL INFORMATION

To ensure trouble-free vehicle performance, it is very important to follow an established preventive maintenance program. Regular and consistent vehicle maintenance can prevent vehicle downtime and expensive repairs that can result from neglect. Any vehicle not functioning correctly should be removed from use until it is properly repaired. This will prevent further damage to the vehicle and avoid the possibility of injury due to unsafe conditions.

Contact your local Club Car distributor/dealer to perform all repairs and semiannual and annual periodic service.

PRE-OPERATION AND DAILY SAFETY CHECKLIST

Each Club Car vehicle has been thoroughly inspected and adjusted at the factory; however, upon receiving your new vehicle(s), you should become familiar with its controls, indicators, and operation. Carefully inspect each vehicle to ensure that it is in proper working condition before accepting delivery.

Use the following checklist as a guide to inspect the vehicle. This checklist should be used daily to ensure that the vehicle is in proper working condition and in conjunction with the Performance Inspection on page 10-2, and the Periodic Service Schedules on page 10-4. Any problems should be corrected by a Club Car distributor/dealer or a trained technician.

Any vehicle not functioning correctly should be removed from use until it is properly repaired. This will prevent further damage to the vehicle and avoid the possibility of injury due to unsafe conditions.

All Vehicles

- General: All the parts should be in place and properly installed. Be sure that all nuts, bolts, and screws are tight.
- Safety and information decals: Check to ensure that all safety and information decals are in place.
- Tires: Visually inspect tires for wear, damage, and proper inflation on a daily basis. See Vehicle Specifications Electric and Subaru EX40 on page 2-1.
- Performance Inspection: Inspect as instructed. See Performance Inspection on page 10-2.

Electric Vehicles

- Batteries: Check electrolyte to ensure that it is at its proper level (Figure 21-3, Page 21-10). Check battery posts. Wires should be tight and free of corrosion. Charge batteries fully before first use of vehicle.
- Charger cord, plug, and receptacle: Visually inspect for cracks, loose connections, and frayed wiring.

WARNING

• Be sure the plastic has been removed from the seat bottom before operating the vehicle. Failure to do so may result in a fire, property damage, personal injury, or death.

Gasoline Vehicles

- Low Maintenance Battery: Check electrolyte to ensure it is at the proper level (Figure 12-31, Page 12-29). Check battery posts. Wires should be tight and free of corrosion and battery should be fully charged.
- No Maintenance Battery: Check battery posts. Wires should be tight and free of corrosion and battery should be fully charged. (Figure 26-23, Page 26-25)

- Engine: Check for proper engine oil level.
- Fuel: Check fuel level. See Fueling Instructions Gasoline Vehicles on page 28-24. Check fuel tank, lines, cap, pump, fuel filters, and fuel injector for fuel leakage.

WARNING

• Be sure the plastic has been removed from the seat bottom before operating the vehicle. Failure to do so may result in a fire, property damage, personal injury, or death.

PERFORMANCE INSPECTION

After you have familiarized yourself with the vehicle controls and have read and understood the driving instructions, take the vehicle for a test drive.

Use the following checklist in conjunction with the Daily Pre-Operation and Safety Checklist as a guide to inspect the vehicle and check daily for proper operation. Any problems should be corrected by a Club Car distributor/dealer or a trained technician.

All Vehicles

- Forward/Reverse switch: Check for proper operation.
- **Brakes:** Be sure the brakes function properly. When brake pedal is pressed using moderate pressure, the vehicle should come to a smooth, straight stop. If the vehicle swerves or fails to stop, stops abruptly, or makes a grinding or squeaking noise, have the brake system checked and adjusted as required. Continued, moderate brake pedal pressure should be able to lock the wheels, but using lesser pressure should also permit a slow, gradual deceleration.
- Park brake: When latched, the park brake should lock the wheels and hold the vehicle stationary (on an incline of 20% or less). It should release when either the accelerator or brake pedal is pressed.
- Reverse buzzer: The reverse buzzer will sound as a warning when the Forward/Reverse handle or switch is in the REVERSE position.
- Steering: The vehicle should be easy to steer and should not have any play in the steering wheel.
- **General:** Listen for any unusual noises such as squeaks or rattles. Check the vehicle's ride and performance. Have a Club Car distributor/dealer or a trained technician investigate anything unusual.

Electric Vehicles

- Accelerator: With the key switch in the ON position and the Forward/Reverse switch in the FORWARD position, as the accelerator pedal is pressed, the motor should start and the vehicle should accelerate smoothly to full speed. When the pedal is released it should return to the original position. All Club Car vehicles operate at reduced speed in reverse.
- Walk Away Braking: With the vehicle parked on level ground and the park brake disengaged, place the Tow/Run switch in the RUN position and attempt to push the vehicle. Motor braking should engage and cause resistance to rolling ((moving at no more than 1 to 3 mph) (1.6 to 4.8 km/h)) with the Forward/Reverse switch in any position. When walk away motor braking is engaged, the reverse buzzer should emit a distinct pattern of beeps. See following WARNING.

WARNING

- Walk Away Braking will not limit vehicle speed to 3 mph (4.8 km/h) on very steep grades. Do not
 operate vehicle on slopes exceeding 20% grades.
- Motor Braking: Accelerate down an incline with the accelerator pedal fully pressed. When the vehicle reaches maximum programmed speed, motor braking should engage and limit the vehicle to its maximum programmed speed. On very steep grades, the vehicle may slightly exceed its maximum programmed speed, requiring the use of

the brake pedal. Also, travel downhill with the accelerator pedal partially pressed. Motor braking should limit speed to less than top speed and maintain speeds proportional to the accelerator pedal position. On a level surface, accelerate the vehicle to full speed and then release the accelerator pedal. Motor braking should smoothly slow the vehicle to a complete stop or else allow the vehicle to coast freely, depending on the selected controller setting.

Gasoline Vehicles

- Accelerator: With the key switch in the ON position and the Forward/Reverse switch in the FORWARD position, as the accelerator pedal is pressed, the engine should start and the vehicle should accelerate smoothly to full speed. When the pedal is released it should return to the original position. All Club Car vehicles operate at reduced speed in reverse.
- Governor: Check maximum speed of the vehicle. The vehicle should operate at 12 to 15 mph (19 to 24 km/h) on a level surface.

NOTE: The 12 to 15 mph (19 to 24 km/h) is for fleet golf cars. There is an optional 19 mph (30 km/h) speed kit available for non-fleet golf cars, these vehicles should be set between 18.5 and 19.5 mph (29.7 and 31.3 km/h).

MAINTENANCE

See General Warnings on page 1-2.

To ensure trouble-free vehicle performance, it is very important to follow an established preventive maintenance program. Regular and consistent vehicle maintenance can prevent vehicle downtime and expensive repairs that can result from neglect. Use the Pre-Operation and Daily Safety Checklist beginning on page 10-2, the Performance Inspection, and the following Periodic Service Schedules and Periodic Lubrication Schedules to keep the vehicle in proper working condition.

Any vehicle not functioning correctly should be removed from use until it is properly repaired. This will prevent further damage to the vehicle and avoid the possibility of injury due to unsafe conditions.

Contact your local Club Car distributor/dealer to perform all repairs and semiannual and annual periodic service.

▲ WARNING

- If any problems are found during scheduled inspection or service, do not operate the vehicle until repairs are made. Failure to make necessary repairs could result in fire, property damage, severe personal injury, or death.
- Only trained technicians should service or repair the vehicle or battery charger. Anyone doing even simple repairs or service should have knowledge and experience in electrical and mechanical repair. The appropriate instructions must be used when performing maintenance, service, or accessory installation.

Electric vehicles:

- Hot! Do not attempt to service hot motor. Attempting to do so could cause severe burns.
- To avoid unintentionally starting the vehicle, disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.

Gasoline vehicles:

- Moving parts: Do not attempt to service gasoline vehicle while the engine is running.
- Hot! Do not attempt to service hot engine or exhaust system. Failure to heed this warning could result in severe burns.

WARNING CONTINUED ON NEXT PAGE

A WARNING

- To avoid unintentionally starting the vehicle, disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3. See No Maintenance Battery: Disconnecting the Battery- Gasoline Vehicles on page 1-4.
- Frame ground Do not allow tools or other metal objects to contact frame when disconnecting batteries or other electrical wiring. Never allow a positive wire to touch the vehicle frame, engine, or other metal component.

PERIODIC SERVICE SCHEDULES

▲ WARNING

- Service, repairs, and adjustments must be made per instructions in the maintenance and service manual.
- If any problems are found during scheduled inspection or service, do not operate the vehicle until repairs are made. Failure to make necessary repairs could result in fire, property damage, severe personal injury, or death.

NOTE: If the vehicle is constantly subjected to heavy use or severe operating conditions, the preventive maintenance procedure should be performed more often than recommended in the periodic service and lubrication schedules.

Both the Periodic Service Schedule and Periodic Lubrication Schedule must be followed to keep vehicle in optimum operating condition.

PERIODIC SERVICE SCHEDULE – ELECTRIC VEHICLES			
REGULAR INTERVAL	SERVICE		
Daily service by owner	Pre-Operation and Daily Safety Checklist	See Pre-Operation and Daily Safety Checklist on page 10-1.	
	Performance Inspection	See Performance Inspection on page 10-2.	
	Batteries	Charge batteries (after each daily use only).	
Weekly service by owner	Batteries (For vehicles NOT equipped with the Single-Point Watering System and Low Maintenance Batteries)	Check electrolyte level. Add water if necessary.	

PERIODIC SERVICE SCHEDULE – ELECTRIC VEHICLES			
REGULAR INTERVAL	SERVICE		
Monthly service by owner or trained technician	Batteries (For vehicles equipped with the Single-Point Watering System). Water monthly or according to the established watering interval.	Water the batteries. Observe that water flow occurs and no water overflows from any cell.	
	Batteries	Wash battery tops and clean terminals with baking soda/water solution. Apply Battery Terminal Protector Spray (CC P/N 1014305) to battery terminals.	
	Tires	Check air pressure and adjust if necessary. See Vehicle Specifications – Electric and Subaru EX40 on page 2-1.	
	General vehicles	Thoroughly wash vehicle including the underside.	
Initial (one-time) inspection by owner or trained technician after six weeks of use	Batteries (For vehicles newly equipped with the Single Point Watering System)	For vehicles newly equipped with the SPWS, manually check battery electrolyte levels of all cells to verify correct valve operation. See page .	
Semiannual service by trained technician		Check brake shoes; replace if necessary.	
only (every 50 hours of operation or 100 rounds of golf)		Lubricate brake system per Lubrication Schedule.	
	Brake system	Check brake cables for damage; replace if necessary.	
		Check brake cable equalizer adjustment; adjust if necessary.	
	Electrical wiring and connections	Check for tightness and damage; replace if necessary.	
	Front wheel alignment and camber	Check and adjust as required. See Section 7 – Steering and Front Suspension in the appropriate maintenance and service manual.	
Annual service by owner or trained technician (every 100 hours of operation or	Batteries (For vehicles equipped with the Single Point Watering System)	Manually check battery electrolyte levels of all cells to verify correct valve operation. See page .	
200 rounds of golf)	Safety decals	Check safety decals. Replace if damaged or illegible.	

PERIODIC SERVICE SCHEDULE – ELECTRIC VEHICLES			
REGULAR INTERVAL	SERVICE		
Annual service by trained technician only (every 100 hours of operation or 200 rounds of golf)	Batteries	If batteries are not performing as expected, see Batteries in the maintenance and service manual.	
	Pedal group	Lubricate all rotating joints. See Periodic Lubrication Schedules on page 10-11.	
	General vehicle	Check for loose hardware; tighten if necessary. Refer to the appropriate maintenance and service manual.	

REGULAR INTERVAL	SERVICE		
Daily service by owner	Pre-Operation and Daily Safety Checklist	See Pre-Operation and Daily Safety Checklist on page 10-1.	
	Performance Inspection	See Performance Inspection on page 10-2.	
		Check engine oil level; change if necessary. Properly dispose of used oil. See Periodic Lubrication Schedules on page 10-11.	
Monthly service by owner or trained technician	Engine	Check engine cooling air intake; clean if necessary. Visually inspect the unshrouded area around engine exhaust for grass and debris, and clean if necessary.	
	Tires	Check air pressure and adjust as necessary. See Vehicle Specifications – Electric and Subaru EX40 on page 2-1.	
	General vehicle	Wash engine compartment and underside of vehicle. Do not wash engine when hot.	
	Battery	Clean terminals and wash dirt from casing; Apply Battery Terminal Protector Spray (CC P/N 1014305) to battery terminals; For Low Maintenance battery check electrolyte level. See Battery – Gasoline Vehicles on page 12-28.	
Semiannual service by trained technician	Front wheel alignment and camber	Check and adjust if necessary. See Section 7 – Steering and Front Suspension in the appropriate maintenance and service manual.	
only (every 50 hours of operation or every 100 rounds of golf)	Electrical wiring and connections	Check for tightness and damage; replace if necessary.	
		Check brake shoes; replace if necessary.	
		Lubricate brake system per Lubrication Schedule.	
	Brake system	Check brake cables for damage; replace if necessary.	
		Check brake cable equalizer adjustment; adjust if necessary.	

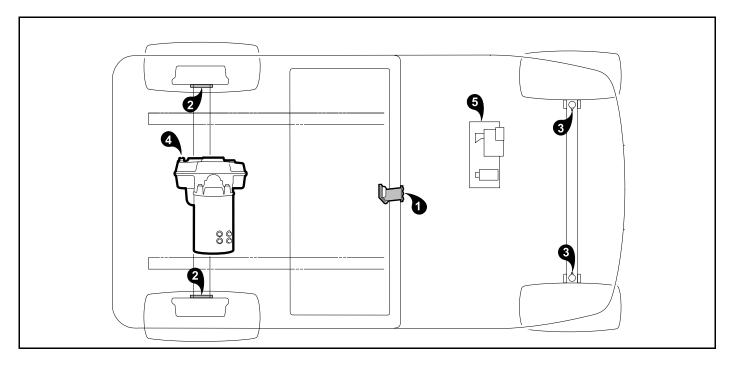
PERIODIC SERVICE SCHEDULE - SUBARU EX40 GASOLINE VEHICLES			
REGULAR INTERVAL	SERVICE		
		Check for leaks around gaskets, fill plugs, etc.	
	Engine	Inspect, clean and regap spark plug; replace if necessary.	
		Check air filter element; replace if necessary.	
Annual service by trained technician only (every 100 hours of operation or every 200 rounds of golf)	Engine air intake system	Check clamps for tightness; check hose for cracks.	
	Pedal group	Lubricate all rotating joints. See Periodic Lubrication Schedules on page 10-11.	
	General vehicle	Check for loose hardware; tighten if necessary. Refer to the appropriate maintenance and service manual.	
	Safety decals	Check safety decals. Replace if damaged or illegible.	
Two year service by trained technician only (every 200 hours of operation or every 400 rounds of golf)	Engine	Check and adjust valve lash as needed.	

PERIODIC SERVICE SCHEDULE – KAWASAKI FE350 GASOLINE VEHICLES				
REGULAR INTERVAL	SERVICE			
Daily service by owner	Pre-Operation and Daily Safety Checklist	See Pre-Operation and Daily Safety Checklist in the appropriate Owner's Manual		
Daily service by Owner	Performance Inspection	See Performance Inspection in the appropriate Owner's Manual		
		Check engine oil level; change if necessary. Properly dispose of used oil. See Periodic Lubrication Schedules on page 10-11.		
Monthly service by owner or trained technician	Engine	Check engine cooling air intake; clean if necessary. Visually inspect the unshrouded area around engine exhaust for grass and debris, and clean if necessary.		
	Tires	Check air pressure and adjust as necessary. See Vehicle Specifications – Electric and Subaru EX40 on page 2-1.		
	General vehicle	Wash engine compartment and underside of vehicle. Do not wash engine when hot.		
	Battery	Clean terminals and wash dirt from casing; Apply Battery Terminal Protector Spray (CC P/N 1014305) to battery terminals; check electrolyte level. See Battery – Gasoline Vehicles on page 12-28.		
	Front wheel alignment and camber	Check and adjust if necessary. See Steering and Front Suspension section.		
Semiannual service by trained technician only (every 50 hours of operation or every	Electrical wiring and connections	Check for tightness and damage; replace if necessary.		
100 rounds of golf)		Check brake shoes; replace if necessary.		
		Lubricate brake system per Lubrication Schedule.		
	Brake system	Check brake cables for damage; replace if necessary.		
		Check brake cable equalizer adjustment; adjust if necessary.		
		Check for leaks around gaskets, fill plugs, etc.		
	Engine	Inspect, clean and regap spark plug; replace if necessary.		
Annual service by trained technician only (every 100 hours of operation or every 200		Check air filter element; replace if necessary.		
rounds of golf)	Engine air intake system	Check clamps for tightness; check hose for cracks.		
	Pedal group	Lubricate all rotating joints. See Periodic Lubrication Schedules on page 10-11.		

PERIODIC SERVICE SCHEDULE - KAWASAKI FE350 GASOLINE VEHICLES			
REGULAR INTERVAL	SERVICE		
	General vehicle	Check for loose hardware; tighten if necessary. Refer to the appropriate maintenance and service manual.	
	Safety decals	Check safety decals. Replace if damaged or illegible.	
Two year service by trained technician only (every 200 hours of operation or every 400 rounds of golf)	Fuel filters	Replace. Dispose of used filters properly.	

PERIODIC LUBRICATION SCHEDULES

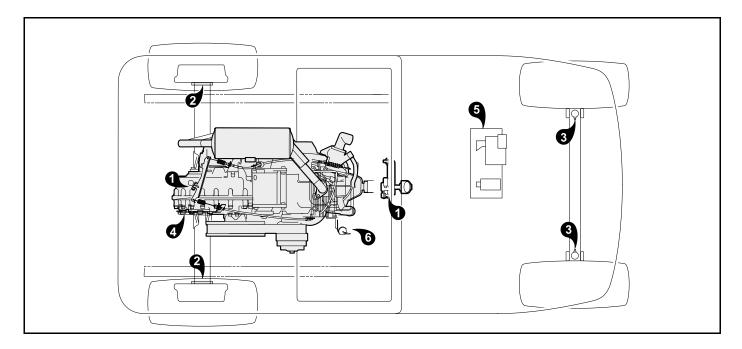
PERIODIC LUBRICATION SCHEDULE – ELECTRIC VEHICLES			
REGULAR INTERVAL	SERVICE	LUBRICATION POINTS	RECOMMENDED LUBRICANT
Semiannually by owner or	Charger receptacle	•	WD-40®
trained technician (every 50 hours of operation or 100 rounds of golf)	Brake system, per maintenance and service manual.	2	Dry Moly Lube (CC P/N 1012151), white lithium grease NLGI #2
	Front suspension (two fittings)	3 ~	Chassis Lube - EP NLGI Grade 2
Annually by trained technician only (every 100 hours of operation or 200 rounds of golf)	Check/fill transaxle to plug level	•	22 fl-oz (0.67 L) SAE 30 WT. API Class SE, SF, or SG Oil (or higher)
	Pedal group (as required)	5 ~	Dupont™ Performance Dry Multi-Use Lubricant



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Figure 10-1 Lubrication Points - Electric Vehicles

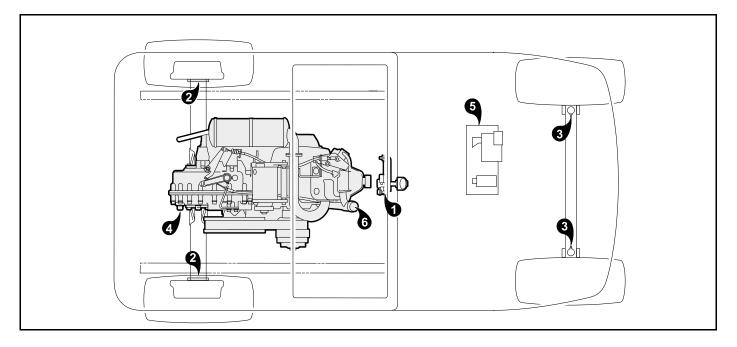
PERIODIC LUBRICATION SCHEDULE – SUBARU EX40 GASOLINE VEHICLES				
REGULAR INTERVAL	SERVICE LUBRICATION POINTS		RECOMMENDED LUBRICANT	
	Shifter cable pivots	•	Dry Moly Lube (CC P/N 1012151)	
Semiannually by owner or trained technician (every 50 hours of operation or every 100 rounds of golf)	Brake system, per maintenance and service manual.	2	Dry Moly Lube (CC P/N 1012151), white lithium grease NLGI #2	
	Front suspension (two fittings)	3 ⁄	Chassis Lube - EP NLGI Grade 2	
Annually by trained technician only (every 100 hours of	Transaxle: Check/fill to plug level	4	22 fl-oz (0.67 L) SAE 30 WT. API Class SE, SF, SG Oil (or higher)	
operation or every 200 rounds of golf)	Pedal group (as required)	5	Dupont™ Performance Dry Multi-Use Lubricant	
First change 100 hours – additional change every 200 hours of operation or annually, whichever comes first	Change engine oil	6	40 fl-oz (1.2 L) 10W-30 or 5W-30 grade SE or higher. See also Figure 27-3, Page 27-5.	



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Figure 10-2 Lubrication Points – Gasoline Vehicles

PERIODIC LUBRICATION SCHEDULE – KAWASAKI FE350 GASOLINE VEHICLES			
REGULAR INTERVAL	SERVICE	LUBRICATION POINTS	RECOMMENDED LUBRICANT
Semiannually by owner or	Shifter cable pivots	•	Dry Moly Lube (CC P/N 1012151)
trained technician (every 50 hours of operation or every 100 rounds of golf)	Brake system, per maintenance and service manual.	2	Dry Moly Lube (CC P/N 1012151), white lithium grease NLGI #2
	Front suspension (two fittings)	3	Chassis Lube - EP NLGI Grade 2
Annually by trained technician only (every 100 hours of operation or every 200 rounds of golf)	Check/fill unitized transaxle to plug level	4	27 oz (0.8 L) 80-90 WT. API Class GL-3 or 80-90 WT. AGMA Class EP Gear Lube
	Pedal group (as required)	5	Dupont™ Performance Dry Multi-Use Lubricant
First change 100 hours – additional change every 200 hours of operation (or every 400 rounds of golf), or annually, whichever comes first	Change engine oil and oil filter (dispose of properly)	6	32 oz (0.95 L) without filter; 38 oz (1.12 L) with filter



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Figure 10-3 Lubrication Points - Gasoline Vehicles

▲ DANGER

See General Warnings on page 1-2.

A WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

This section contains the information required to correctly troubleshoot the vehicle. A troubleshooting guide is provided for general troubleshooting. In addition to troubleshooting, this section contains general information on the electrical system and the circuits of the electrical system.

TROUBLESHOOTING GUIDE

The following troubleshooting guide will be helpful in identifying operating difficulties should they occur. The guide includes the symptom, probable cause(s) and suggested checks. The procedures used in making these checks can be found in the referenced sections in this maintenance and service manual.

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REFER TO
Engine does not start easily.	Spark plug is partially fouled or in poor condition	See Section 13 – Engine – Kaw. FE350.
	Spark plug wire is damaged or loose	See Section 13 – Engine – Kaw. FE350.
	Loose wire connection at ignition coil or RPM limiter	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
	Intermittent ignition coil failure	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
	Low cylinder compression	See Section 13 – Engine – Kaw. FE350.
	Water or dirt in the fuel system and/or carburetor; dirty or clogged fuel filter	See Section 14 – Fuel System – Kaw. FE350.
	Carburetor improperly adjusted	See Section 14 – Fuel System – Kaw. FE350.
	Starter/generator belt is slipping	Belt Tension Adjustment on page 12-11

SYMPTOM	ROUBLESHOOTING GUIDE	
STMPTOM	POSSIBLE CAUSES	REFER TO
Engine starts but does not run smoothly.	Spark plug is fouled or in poor condition	See Section 13 – Engine – Kaw. FE350.
	Spark plug wire is damaged or loose	See Section 13 – Engine – Kaw. FE350.
	Intermittent ignition coil failure	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
	Water or dirt in the fuel system and/or carburetor; dirty or clogged fuel filter	See Section 14 – Fuel System – Kaw. FE350.
	Fuel pump malfunction; fuel pressure to carburetor too low	See Section 14 – Fuel System – Kaw. FE350.
	Fuel tank is empty	See Section 14 – Fuel System – Kaw. FE350.
	Fuel line or filters clogged	See Section 14 – Fuel System – Kaw. FE350.
	Fouled spark plug	See Section 13 – Engine – Kaw. FE350.
	Spark plug wire damaged or loose	See Section 13 – Engine – Kaw. FE350.
Engine turns but fails to start.	Loose wire connection at ignition coil	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
	Ignition coil failed	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
	Engine flooded with fuel as result of excess choking	Refer to the appropriate owner's manual. See Choke.
	Kill circuit grounded	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 5 – Throttle Position Sensor (TPS), 15 – Key Switch (Engine Kill Circuit), 16 – Engine Kill Wire
	Fuel pump malfunction or failure	See Section 14 – Fuel System – Kaw. FE350.
Engine overheats.	Fan screen is partially blocked or plugged	See Section 13 – Engine – Kaw. FE350.
	Governor is improperly adjusted	See Section 14 – Fuel System – Kaw. FE350.
	Carburetor is too lean; check main jet size	See Section 14 – Fuel System – Kaw. FE350.
Engine pre-ignites.	Excessive carbon deposits on piston head or in combustion chamber	See Section 13 – Engine – Kaw. FE350.
	Spark plug heat range is incorrect	See Section 13 – Engine – Kaw. FE350.
	Unsuitable or contaminated fuel	See Section 14 – Fuel System – Kaw. FE350.

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REFER TO
	Exhaust valve is restricted with carbon deposit	See Section 13 – Engine – Kaw. FE350.
	Muffler or exhaust pipe restricted with carbon or other substance	See Section 15 – Exhaust System – Kaw. FE350.
	Ignition coil failed	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
Loss of engine power.	Air filter is dirty or clogged	Fuel System – Kaw. FE350 on page 14-1
Loss of engine power.	Governor is improperly adjusted	Fuel System – Kaw. FE350 on page 14-1
	Throttle linkage out of adjustment	Fuel System – Kaw. FE350 on page 14-1
	Low cylinder compression	See Section 13 – Engine – Kaw. FE350.
	Spark plug failed	See Section 13 – Engine – Kaw. FE350.
	Restricted fuel flow	Fuel System – Kaw. FE350 on page 14-1
	Torque converter is not backshifting properly	See Section 16 – Torque Converter – Kaw. FE350.
	Incorrect plug	See Section 13 – Engine – Kaw. FE350.
	Spark plug wire is damaged	See Section 13 – Engine – Kaw. FE350.
	Unsuitable fuel, or incorrect (rich) fuel mixture	Fuel System – Kaw. FE350 on page 14-1
Spark plug fouls repeatedly.	Ignition coil failed	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. Test Procedures 13 – <i>Ignition Spark</i> and 14 – <i>Ignition Coil</i>
	Dirt entering combustion chamber	Check intake system for leaks. Fuel System – Kaw. FE350 on page 14-1
	Rings are heavily worn, low cylinder pressure	See Section 13 – Engine – Kaw. FE350.
Carburetor floods.	Inlet valve or seat is leaking, dirty, worn, or damaged	Fuel System – Kaw. FE350 on page 14-1
	Float is damaged and filled with fuel	Fuel System – Kaw. FE350 on page 14-1
	Float needle valve not functioning properly	Fuel System – Kaw. FE350 on page 14-1
	Carburetor vent is clogged	Fuel System – Kaw. FE350 on page 14-1

SYMPTOM	POSSIBLE CAUSES	REFER TO
	Neutral lockout cam is in the wrong position	Test Procedure 7 – Neutral Lockout Limit Switch on page 11-19
	Fuse is blown	Test Procedure 2 – Fuse on page 11-14
	Battery is dead	Test Procedure 1 – Battery on page 11-12
	Starter control circuit is not operating	Test Procedure 8 – Starter/Generator (Starter Function) on page 11-20
	Starter/generator failed	Test Procedure 8 – Starter/Generator (Starter Function) on page 11-20
Starter fails to operate.	Starter solenoid failed	Test Procedure 6 – Solenoid on page 11-18
curtor faile to operate.	Throttle position sensor failed	Test Procedure 5 – Throttle Position Sensor (TPS) on page 11-17
	Key switch failed	Test Procedure 4 – Key Switch (Starter Circuit) on page 11-16
	Neutral lockout limit switch failed	Test Procedure 7 – Neutral Lockout Limit Switch on page 11-19
	Loose or broken wire in starter/generator circuit	See Section 12 – Electrical Components – Kaw. FE350.
	Cylinder and/or crankcase flooded with fuel	Fuel System – Kaw. FE350 on page 14-1
Starter/Generator does not charge battery.	Loose or broken wire in starter/generator circuit	Test Procedure 10 – Starter/Generator (Generator Function) on page 11-21
	Generator field coil is shorted	Test Procedure 10 – Starter/Generator (Generator Function) on page 11-21
	Brushes are worn or commutator is dirty	See Section 12 – Electrical Components – Kaw. FE350.
	Starter/generator belt is loose or slipping	Belt Tension Adjustment on page 12-11
	Voltage regulator failed	Test Procedure 11 – Voltage Regulator on page 11-22
	Battery failed	Test Procedure 1 – Battery on page 11-12
Transmission does not engage or disengage smoothly.	Transmission shifter linkage is binding or is out of adjustment	See Section 17 – Unitized Transaxle (for Kaw. FE350).
	Idle RPM setting is set too high	Fuel System – Kaw. FE350 on page 14-1
	Insufficient (low) level of lubricant or wrong type of lubricant in transmission	See Section 17 – Unitized Transaxle (for Kaw. FE350).
	Internal gears are damaged or worn	See Section 17 – Unitized Transaxle (for Kaw. FE350).
	Synchronizer rings are worn, damaged or jammed	See Section 17 – Unitized Transaxle (for Kaw. FE350).

TROUBLESHOOTING GUIDE		
SYMPTOM	POSSIBLE CAUSES	REFER TO
	Engine mounting nuts or bolts are loose	See Section 13 – Engine – Kaw. FE350.
	Snubber on frame is worn or damaged	See Section 13 – Engine – Kaw. FE350.
	Misaligned muffler mounting clamp	See Section 15 – Exhaust System – Kaw. FE350.
	Damaged drive belt or starter belt	See Section 16 – Torque Converter – Kaw. FE350.
Excessive vehicle vibration.	Damaged drive clutch	See Section 16 – Torque Converter – Kaw. FE350.
	Damaged driven clutch	See Section 16 – Torque Converter – Kaw. FE350.
	Damaged starter/generator pulley	See Section 12 – Electrical Components – Kaw. FE350.
	RPM setting is incorrect	Engine RPM Adjustment on page 14-9
Torque converter does not shift smoothly.	Drive belt is worn, cracked, glazed, or frayed	See Section 16 – Torque Converter – Kaw. FE350.
	Drive clutch malfunction	See Section 16 – Torque Converter – Kaw. FE350.
	Driven clutch malfunction	See Section 16 – Torque Converter – Kaw. FE350.
	Governor is sticking	See Section 17 – Unitized Transaxle (for Kaw. FE350).
Engine won't stop running.	Kill circuit wire is disconnected from the ignition coil	Test Procedure 12 – Disconnected Kill Wire on page 11-23
	Key switch failure	See Section 11 – Troubleshooting and Electrical System – Kaw. FE350. , Test Procedures 4 – Key Switch (Starter Circuit), 5 – Throttle Position Sensor (TPS)
	Carburetor is too lean; check main and pilot jet sizes	Fuel System – Kaw. FE350 on page 14-1
	Carburetor throttle stop screw out of adjustment	Fuel System – Kaw. FE350 on page 14-1

WIRING DIAGRAMS - THROTTLE POSITION SENSOR (TPS)

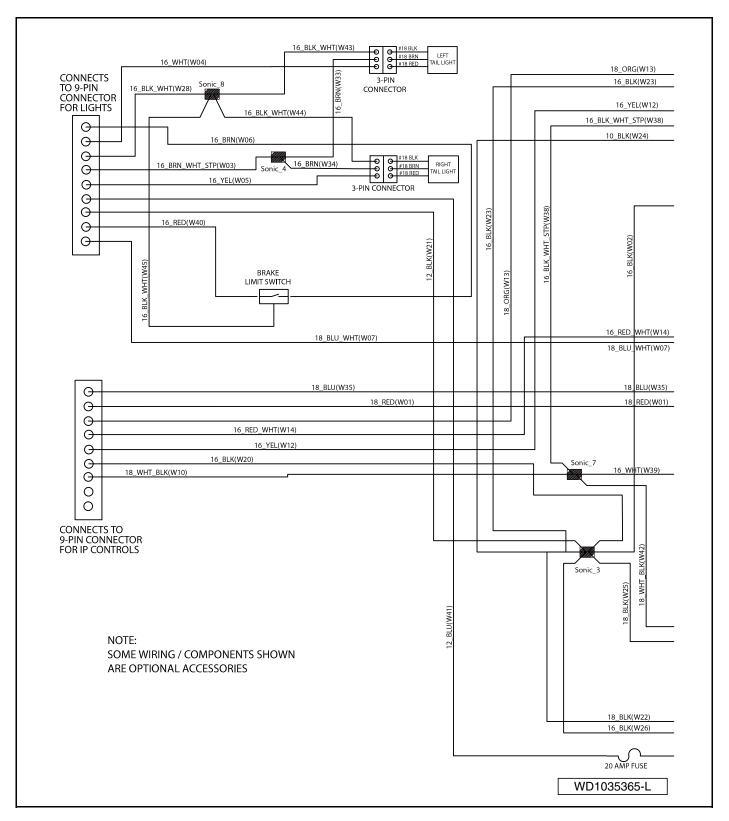


Figure 11-1 Wiring Diagram - Precedent Gasoline Vehicle with TPS

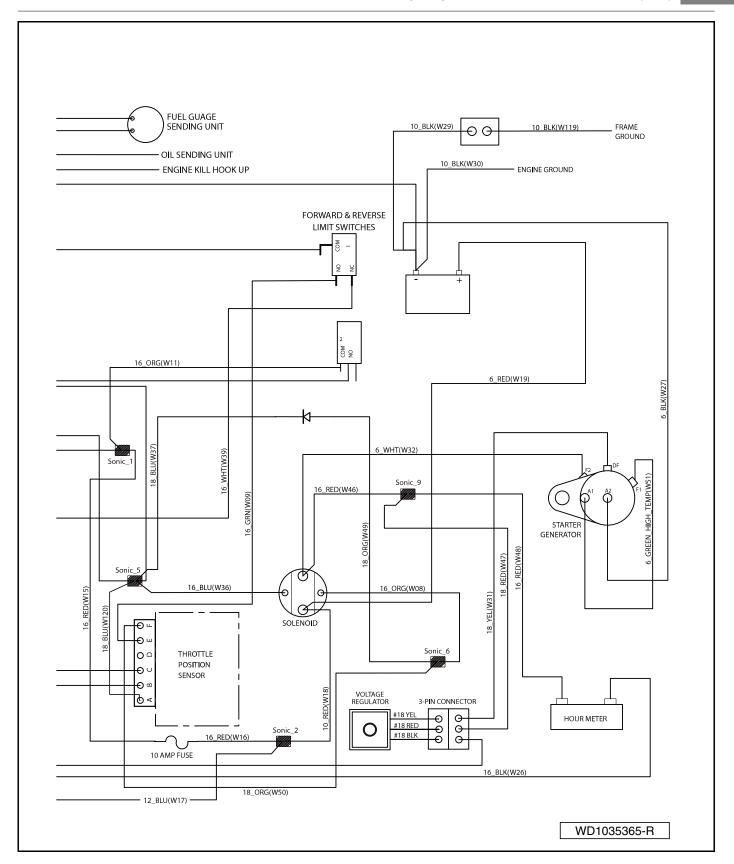


Figure 11-2 Wiring Diagram - Precedent Gasoline Vehicle with TPS

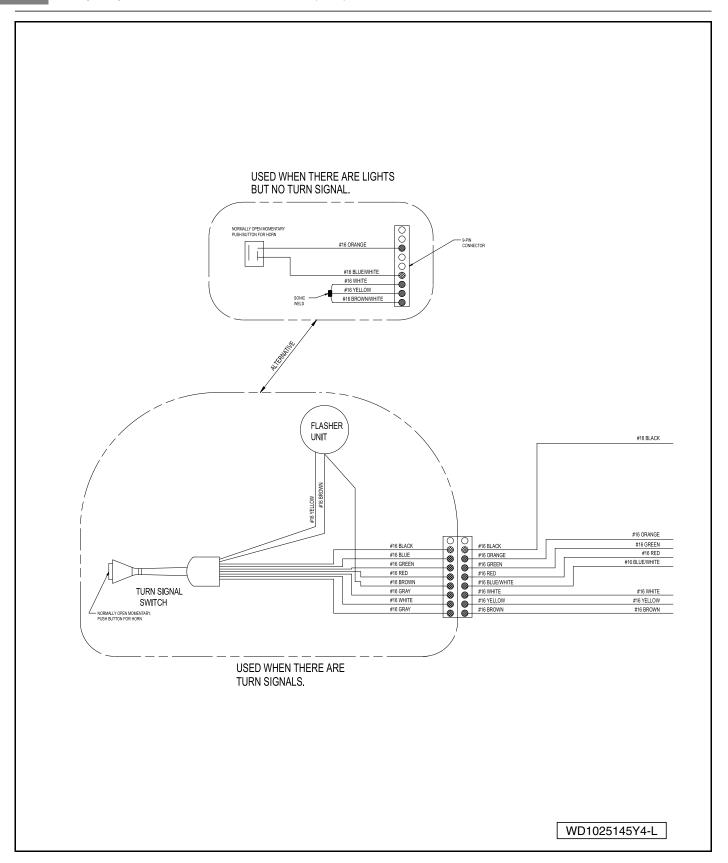


Figure 11-3 Precedent Gasoline Vehicle Accessory Wiring Diagram (Optional)

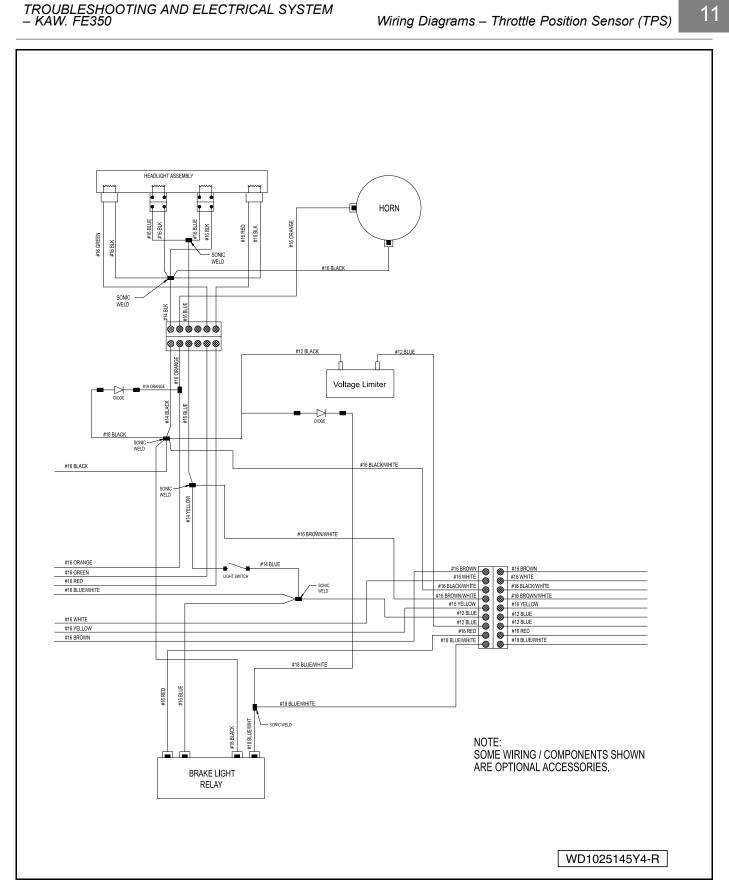


Figure 11-4 Precedent Gasoline Vehicle Accessory Wiring Diagram (Optional)

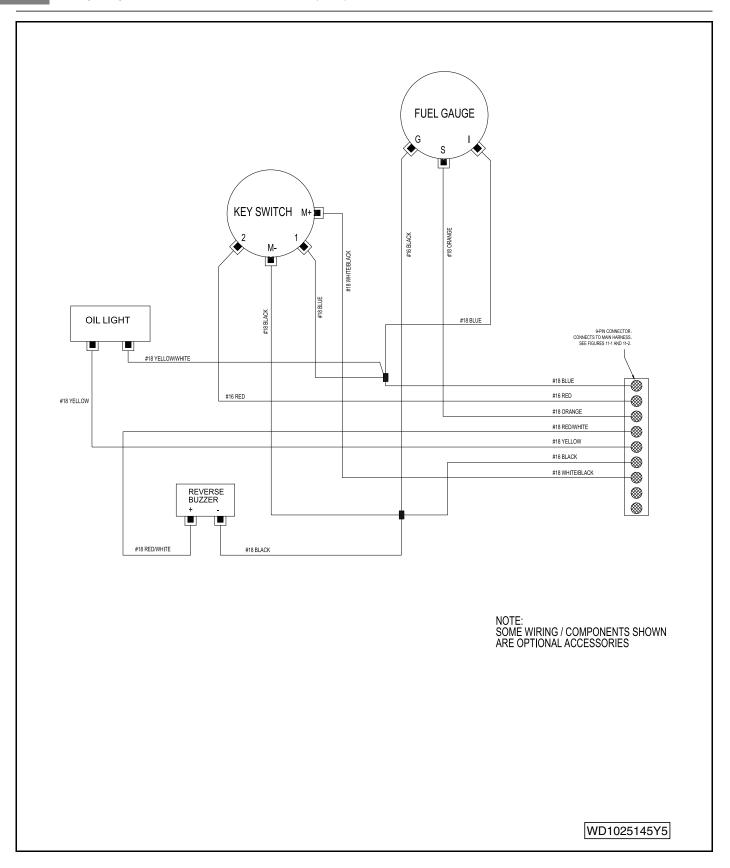


Figure 11-5 Precedent Gasoline Vehicle Instrument Panel Wiring Diagram

ELECTRICAL SYSTEM

The electrical system on the gasoline vehicle is 12 volts DC with negative (–) ground to frame, and consists of nine circuits that are easily identified:

- Starter Circuit
- Generator Circuit
- · Engine Ignition Circuit
- · Engine Kill Circuit
- · Reverse Buzzer Circuit
- · Low Oil Warning Light Circuit
- Neutral Lockout Circuit
- · Fuel Gauge and Sending Unit Circuit
- Hour Meter Circuit

Recognizing and understanding the function of each of these circuits will help to quickly isolate the source of an electrical problem. Use the troubleshooting flow charts in the circuit testing section to find the proper test procedure to correct the electrical problem.

TEST PROCEDURES

Index of Test Procedures

- 1 Battery
- 2 Fuse
- 3 Ground Cables
- 4 Key Switch (Starter Circuit)
- 5 Throttle Position Sensor (TPS)
- 6 Solenoid
- 7 Neutral Lockout Limit Switch
- 8 Starter/Generator (Starter Function)
- 9 Wire Continuity
- 10 Starter/Generator (Generator Function)
- 11 Voltage Regulator
- 12 Disconnected Kill Wire
- 13 Ignition Spark
- 14 Ignition Coil
- 15 Key Switch (Engine Kill Circuit)
- 16 Engine Kill Wire
- 17 Reverse Buzzer Limit Switch
- 18 Reverse Buzzer
- 19 Oil Level Sensor
- 20 Low Oil Warning Light
- 21 Neutral Lockout Cam
- 22 Battery Test (Under Load)
- 23 Fuel Level Sending Unit
- 24 Fuel Gauge

25 - Hour Meter

TEST PROCEDURE 1 – Battery

See General Warnings on page 1-2.

A DANGER

- Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working around a battery.
- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.
- Battery Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing.
 Antidotes:
 - External: Flush with water. Call a physician immediately.
 - Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.
 - Eyes: Flush with water for 15 minutes. Call a physician immediately.

NOTE: The battery must be properly maintained and fully charged in order to perform the following test procedures. Battery maintenance procedures, including watering information and allowable mineral content, can be found in the Electrical Components section of this manual. **See Battery on page 12-27.**

- Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Check for loose or corroded battery terminal connections. Remove the negative (–) cable first and clean, tighten, and replace connections as necessary.

Hydrometer Test

A hydrometer (P/N 1011478) measures the specific gravity. The greater the specific gravity, the greater the state of charge of the battery. A fully charged battery should read between 1.250 and 1.280 at 80 °F (27 °C). Never add acid to the battery to obtain a higher specific gravity (Figure 11-7, Page 11-13).

A CAUTION

Do not allow battery acid from battery caps or hydrometer to drip onto the body. Battery acid will
cause permanent damage. Wash off immediately.

Performing the Hydrometer Test

- 1. Be sure that the battery has sufficient water to cover the plates by approximately 1/2 inch (12.7 mm) and is fully charged prior to beginning the test. If water must be added, recharge the battery before performing the hydrometer test (Figure 11-6, Page 11-13).
- Remove the vent cap.
- Using a battery thermometer (P/N 1011767), record the electrolyte temperature of a center cell.
- 4. Squeeze the rubber bulb of the hydrometer and insert into the cell. Slowly release the bulb, drawing electrolyte up into the glass tube of the hydrometer.

- 5. When the float rises off the bottom, adjust the electrolyte level so that the float rides free of the bottom but does not strike the bottom of the rubber bulb. Remove the hydrometer from the cell and release the pressure from the bulb.
- 6. Hold the hydrometer vertically, ensuring that the float is not contacting the sides of the glass tube. Hold the hydrometer at eye level and read the scale at the level of electrolyte (Figure 11-7, Page 11-13).
- 7. Record the reading.
- 8. Return the electrolyte to the cell from which it was taken. Replace vent cap.

9. Repeat steps 2 through 8 on all cells.

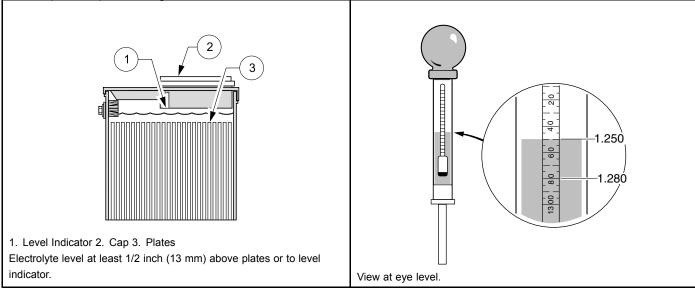


Figure 11-6 Battery Electrolyte Level

717

Figure 11-7 Hydrometer Test

Hydrometer Calibration

Most hydrometers are calibrated to read correctly at 80 $^{\circ}$ F (27 $^{\circ}$ C). The readings obtained as described above must be corrected for temperature. For each 10 $^{\circ}$ F (5.6 $^{\circ}$ C) above 80 $^{\circ}$ F (27 $^{\circ}$ C), add 0.004 to the reading. For each 10 $^{\circ}$ F (5.6 $^{\circ}$ C) below 80 $^{\circ}$ F (27 $^{\circ}$ C), subtract 0.004 from the reading.

Interpreting the Results of the Hydrometer Test

The approximate state of charge can be determined by referring to the following table:

SPECIFIC GRAVITY (TEMPERATURE CORRECTED)	APPROXIMATE STATE OF CHARGE
1.250 to 1.280	100%
1.220 to 1.240	75%
1.190 to 1.210	50%
1.160 to 1.180	25%

If the difference between the cells is 0.020 or more, the low cell should be suspected. It may require a catch-up charge or it may be a weak cell. When the variations between cells reach 0.050 or more, the battery should be replaced.

Voltage Test

Take a voltage reading with a multimeter set to 20 VDC by placing the red (+) probe on the positive (+) battery post and the black (–) probe on the negative (–) battery post. If it shows less than 12.4 volts, or if the lowest specific gravity reading from the Hydrometer Test is less than 1.225, recharge the battery. If battery voltage is greater than 12.4 volts and specific gravity is greater than 1.225, the problem is not with the battery. If the battery does not reach 12.4 volts, or if the specific gravity of a cell is still less than 1.225 after charging, replace the battery. **See following NOTE.**

NOTE: A fully charged battery that is in good condition should have a specific gravity of at least 1.225 in all cells, and the difference in the specific gravity of any two cells should be less than 50 points. Open circuit voltage should be at least 12.4 volts.

Load Test

- 1. Connect a 160-ampere load tester to the battery posts.
- Turn the switch on the load tester to the ON position.
- Read the battery voltage after the load tester has been turned on for 15 seconds. Compare the battery's voltage reading with the following table. Make sure you have the correct ambient temperature.

IF TEMPERATURE IS	MINIMUM CRANKING VOLTAGE
70 °F (20 °C and above)	9.6 V
60 °F (16 °C)	9.5 V
50 °F (10 °C)	9.4 V
40 °F (4 °C)	9.3 V
30 °F (-1 °C)	9.1 V
20 °F (-7 °C)	8.9 V
10 °F (-12 °C)	8.7 V
0 °F (-18 °C)	8.5 V

If the battery is found to be good, or if the electrical problem continues after the battery has been replaced with a good one, test the electrical circuits.

TEST PROCEDURE 2 - Fuse

See General Warnings on page 1-2.

The fuse (red 10 amp) is located in the wiring harness (Figure 11-8, Page 11-15).

- Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the cover from in-line fuse.
- 3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- Remove fuse to be tested from the fuse holder. See Fuse Removal on page 12-16.
- Connect the probes of a multimeter, set to 200 ohms, to the fuse terminals. The reading should be continuity. If there is no continuity, determine and repair the cause of the fuse failure. Replace the fuse with a properly rated new one.

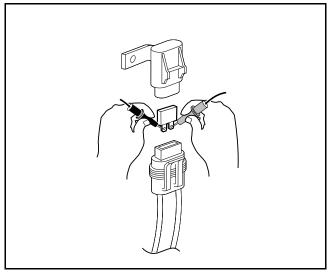


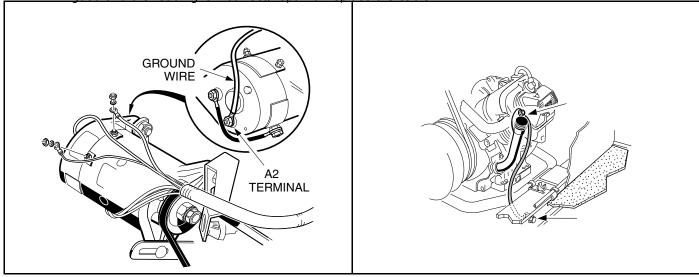
Figure 11-8 Fuse

TEST PROCEDURE 3 – Ground Cables

See General Warnings on page 1-2.

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Check the starter/generator ground cable.
 - 2.1. Set the multimeter to 200 ohms. Place the red (+) probe on the A2 terminal of the starter/generator and place the black (–) probe on the vehicle frame (Figure 11-9, Page 11-15). The reading should be continuity. If there is no continuity, clean and tighten cable connections. If the connections are good, repair or replace the cable.
- Check the engine ground cable.

3.1. Place the red (+) probe of the multimeter on the ground cable terminal end located on the oil filler bracket on the engine (Figure 11-10, Page 11-15). Place the black (–) probe on the vehicle frame. The reading should be continuity. If the reading is incorrect, clean and tighten cable connections. If the connections are good and the reading is incorrect, repair or replace the cable.



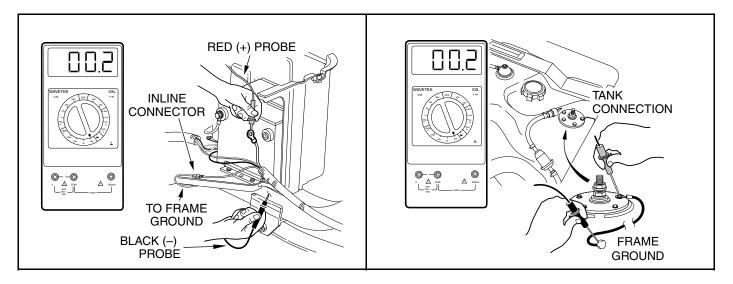
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Figure 11-9 Starter/Generator Ground Cable Test

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Figure 11-10 Engine Ground Cable Test

- 4. Check the battery ground cable.
 - 4.1. Four 10-gauge black wires are crimped together and connected to the negative (–) battery post. One of these wires is connected via a single position in-line connector to the frame. The frame connection should be clean and tight. Visual inspection of the connection on the frame is very difficult. The best check for tightness is to pull on the black cable. If the cable moves at the connection end, disassemble the frame connection and clean the bolt, ring terminal, and nut. Reinstall the frame connection.
 - 4.2. Set the multimeter to 200 ohms. Place the red (+) probe on the unconnected end of the 6-gauge black cable, and place the black (–) probe on the vehicle frame (Figure 11-11, Page 11-16). The reading should be continuity. If the reading is incorrect, ensure that terminal connections are clean and tight. If the connections are good and the reading is incorrect, check that the in-line connector is secure, repair or replace the cable.
- 5. Check the fuel tank ground.
 - 5.1. A 16-gauge wire runs from the fuel tank to the wire harness where it is sonically welded to the other ground wires. Check the ground connection at the fuel tank.
 - 5.2. Set the multimeter to 200 ohms. Place the red (+) probe on the terminal for the fuel tank ground connection, and place the black (–) probe on the vehicle frame (Figure 11-12, Page 11-16). The reading should be continuity. If there is no continuity, clean and tighten all cable connections. If the connections are good, repair or replace the cable.



2420 Figure 11-11 Battery Ground Cable Test

Figure 11-12 Fuel Tank Ground

TEST PROCEDURE 4 – Key Switch (Starter Circuit)

See General Warnings on page 1-2.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel assembly. See Key Switch Removal on page 12-14.
- Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 4. Insert the key and turn the switch to ON. Place the red (+) probe of the multimeter on the No. 2 terminal and the black (–) probe on the No. 1 terminal of the key switch. The reading should be continuity. If the reading is incorrect, replace the key switch (Figure 11-13, Page 11-17).

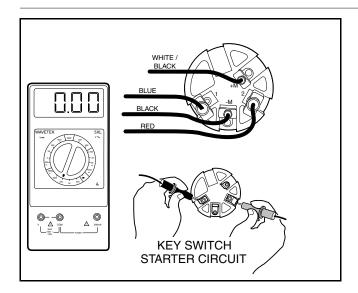


Figure 11-13 Test Key Switch – Engine Starter Circuit

TEST PROCEDURE 5 – Throttle Position Sensor (TPS)

The throttle position sensor performs the function of two limit switches: the accelerator pedal limit switch and the kill limit switch. This sensor is sealed and is not to be repaired or replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced. **See Accelerator Pedal Removal on page 5-6.** The sensor is joined to the main wire harness through a six-pin connector. Tests for the sensor are found in the following two procedures.

Accelerator Pedal Limit Switch Function

See General Warnings on page 1-2.

The green and orange wires connect to the accelerator pedal limit switch function of the throttle position sensor. This is the normally open (NO) portion of the circuit used to energize the starter solenoid.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect the spark plug wire from the spark plug.
- 3. Disconnect white/black wire bullet connector located on the front of engine (Figure 11-22, Page 11-24).
- 4. With battery connected and using a multimeter set to the diode test function (ç), attach the red (+) lead to the orange wire at the starter solenoid and the black (-) lead to the green wire at the limit switch located on the Forward/Reverse shifter assembly. **See following NOTE.**

NOTE: It may be necessary to partially pull the green wire from the switch terminal to attach the black lead.

- 5. Turn the key switch to the ON position. With accelerator pedal at rest in the fully raised position, the meter should indicate an over limit (no continuity) condition.
- 6. Press the accelerator to engage the starter and engine. With accelerator pedal pressed, the meter should indicate approximately 1.0 volt. If either reading is incorrect, replace the accelerator pedal assembly. **See Accelerator Pedal Removal on page 5-6.**

Kill Limit Switch Function

See General Warnings on page 1-2.

The black and white/black wires connect to the kill limit switch function of the throttle position sensor. This is the normally closed (NC) portion of the circuit used to ground the ignition and shut the engine off when the pedal is released.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- Disconnect white/black wire bullet connector located on the front of engine (Figure 11-22, Page 11-24).
- Disconnect the spark plug wire from the spark plug.
- 4. With battery connected and using a multimeter set to the diode test function (ç), attach the red (+) lead to the negative (–) battery terminal and the black (-) lead to the white wire at the limit switch located on the Forward/Reverse shifter assembly. **See following NOTE.**

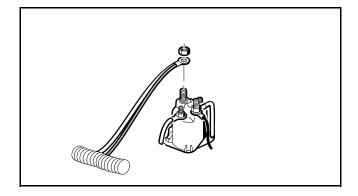
NOTE: It may be necessary to partially pull the white wire from the switch terminal to attach the black lead.

- 5. Turn the key switch to the ON position. With accelerator pedal at rest in the fully raised position, the meter should indicate approximately 1.0 volt.
- 6. Press the accelerator to engage the starter and engine. With accelerator pedal pressed, the meter should indicate an over limit (no continuity) condition. If either reading is incorrect, replace the accelerator pedal assembly. **See Accelerator Pedal Removal on page 5-6.**

TEST PROCEDURE 6 - Solenoid

See General Warnings on page 1-2.

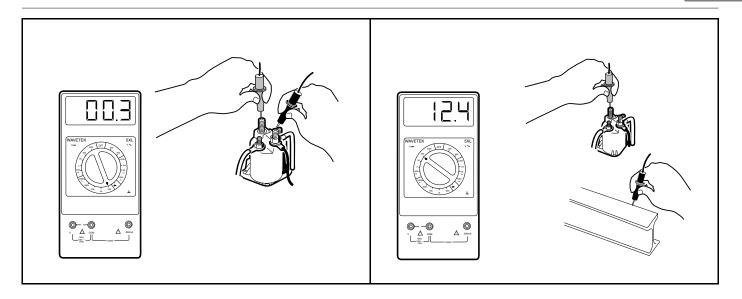
- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 3. Set a multimeter to 200 ohms. Place the red (+) probe on one of the small posts of the solenoid and place the black (–) probe on the other small post. The reading should be 14 to 16 ohms. If the reading is not within limits, replace the solenoid.
- 4. Remove the 10-gauge white wire (crimped with a 16-gauge red wire) from the large post of the solenoid. Do not allow the wires to touch the frame or other components of the vehicle (Figure 11-14, Page 11-18).



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Figure 11-14 Solenoid Wire Removal

5. Set the multimeter to 200 ohms. Connect the red (+) probe to one of the large posts of the solenoid and connect the black (–) probe to the other large post (Figure 11-15, Page 11-19).



2425 Figure 11-15 Solenoid Continuity Test

Figure 11-16 Solenoid Ground Test

6. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery – Gasoline Vehicles on page 1-3.

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- 7. Place the Forward/Reverse handle in NEUTRAL, and place the neutral lockout cam in the MAINTENANCE position. Turn the key switch to the ON position. With the accelerator in the UP position, the reading on the multimeter should be no continuity. Press the accelerator pedal and listen for the solenoid click. There should be continuity. If either reading is incorrect, replace the solenoid.
- 8. With the Forward/Reverse handle still in NEUTRAL and the neutral lockout cam in the MAINTENANCE position, set the multimeter to 20 volts DC and place the red (+) probe on the large post that does not have wires connected to it. Place the black (–) probe on the vehicle frame. Turn key switch to the ON position, press accelerator pedal, and listen for solenoid click. The meter should read full battery voltage. If the reading is incorrect, replace the solenoid (Figure 11-16, Page 11-19).
- 9. Disconnect the 10-gauge black cables from the negative (–) post of the battery before reconnecting the wires to the solenoid.

TEST PROCEDURE 7 - Neutral Lockout Limit Switch

See General Warnings on page 1-2.

This switch is located on the Forward/Reverse switch assembly. There is a black wire, a green wire, and a white wire connected to this limit switch.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Check for proper wiring and tight connections.
- 3. Set the multimeter to 200 ohms. Place the red (+) probe of the multimeter on the common (COM) terminal of the limit switch. Place the black (–) probe on the normally open (NO) terminal of the switch. Without the lever pressed, the reading should be no continuity. Press the lever, and the reading should be continuity. If either reading is incorrect, replace the limit switch (Figure 11-17, Page 11-20).

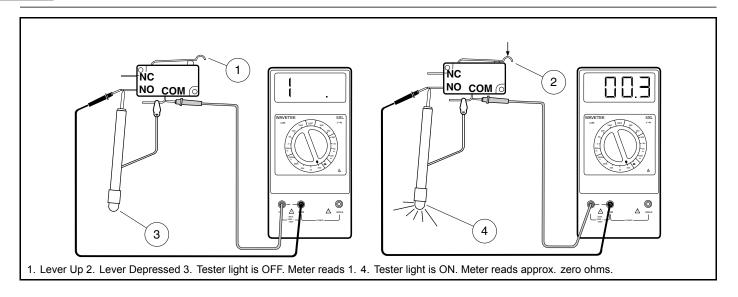


Figure 11-17 Test Neutral Lockout Switch

4. Check to be sure the lobes on the cam are pressing the neutral lockout limit switch as the Forward/Reverse handle is being shifted. The limit switch should make an audible click as it is pressed. If it does not, check for wear on the cam lobes. Be sure the cam snaps fully back into place. If the cam lobes still do not activate the limit switch, replace the cam.

TEST PROCEDURE 8 – Starter/Generator (Starter Function)

See General Warnings on page 1-2.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Ensure that wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 3. Disconnect the wires from all the terminals on the starter/generator. Then place the black (–) probe of a multimeter, set to 200 ohms, on the starter/generator housing (scratch through the paint to ensure a good ground). While holding the black (–) probe against the housing, place the red (+) probe (one at a time) on the A1, A2, F1, F2 and DF terminals respectively (Figure 11-18, Page 11-21). The readings should be no continuity. If the readings are incorrect, the starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Section 12 Electrical Components Kaw. FE350.
 - An incorrect reading from A1 or A2 terminal indicates three possible problems: 1) a grounded A1 or A2 terminal, 2) a grounded wire in the brush area, or 3) a grounded armature/commutator.
 - If the F1 or F2 reading is incorrect, it indicates a possible grounded F1 or F2 terminal or a grounded field coil.
 - If the DF reading is incorrect, it indicates a possible grounded DF terminal or a grounded field coil.
- 4. Disconnect the ground wire from the A2 terminal and the green wire from the A1 terminal on the starter/generator.

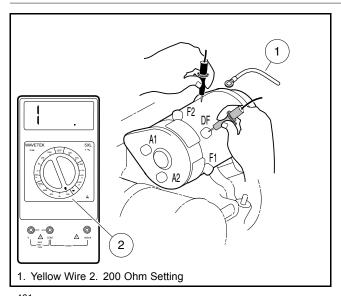


Figure 11-18 Check Terminal Continuity – Model G425419 shown

- 5. Using a multimeter set to 200 ohms, place the red (+) probe on the A1 terminal and the black (–) probe on the A2 terminal. The reading should be continuity. If the reading is incorrect, a possible open or poor contact in a brush assembly and/or open armature windings may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Section 12 Electrical Components Kaw. FE350.
- 6. With the wires still disconnected, using a multimeter set on 200 ohms, place the red (+) probe on the F1 terminal and the black (–) probe on the F2 terminal. The reading should be between approximately 0.1 and 0.3 ohms. If the reading is incorrect, a possible open field coil or bad connections at terminals may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Section 12 Electrical Components Kaw. FE350.
- 7. With the wires still disconnected, using a multimeter set on 200 ohms, place the red (+) probe on the DF terminal and the black (–) probe on the F1 terminal. The reading should be between 4.5 and 5.5 ohms. If the reading is incorrect, a possible grounded DF terminal and/or grounded field coil may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Section 12 Electrical Components Kaw. FE350.

TEST PROCEDURE 9 – Wire Continuity

See General Warnings on page 1-2.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. To test a wire for continuity, disconnect either end from the electrical component it is attached to.
- 3. Set the multimeter to 200 ohms and place the red (+) probe on the terminal at one end of the wire. Place the black (–) probe on the other terminal end of the wire. The reading should be continuity. If the reading is incorrect, repair or replace the wire.

TEST PROCEDURE 10 – Starter/Generator (Generator Function)

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test proc edure.

1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.

- 2. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 3. Disconnect the yellow wire from the DF terminal on the starter/generator. Cover the connector on the yellow wire to make sure the yellow wire will not short to ground. Then, using a jumper wire, ground the DF terminal to the A2 terminal (Figure 11-19, Page 11-22).
- 4. Using a multimeter set to 20 volts DC, place the red (+) probe on the positive (+) post of the battery, and place the black (–) probe on the negative (–) post. Turn the key switch to ON position, press the accelerator pedal to start the engine and run it at full governed speed. The reading should show the voltage rising on the meter. If the voltage rises above 15.3 volts DC, test the voltage regulator. See Test Procedure 11 Voltage Regulator on page 11-22. If the voltage does not rise, a tear-down inspection of the starter/generator will be necessary. See Section 12 Electrical Components Kaw. FE350.
- 5. Connect the yellow wire to the DF terminal on the starter/generator.

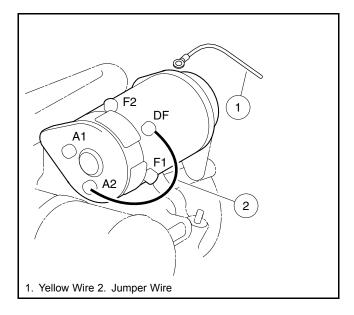


Figure 11-19 Jumper Wire Ground DF to A2 – Model G425419 shown

TEST PROCEDURE 11 - Voltage Regulator

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- Check the engine RPM setting to ensure that it is correctly adjusted. See Engine RPM Adjustment on page 14-9.
- 4. With the battery in good condition and fully charged, run the engine for several minutes to bring the voltage regulator to operating temperature.
- 5. Turn the key switch to OFF, killing the engine. Using a multimeter set to 20 volts DC, place the red (+) probe on the large post of the solenoid with the red and white wires crimped together from the voltage regulator attached. Place the black (–) probe on the negative (–) battery post (Figure 11-20, Page 11-23). Turn the key switch to the ON position. Press the accelerator to start the engine and run it at full governed speed. If the reading is between 14.7 and 15.3 volts, the regulator is good. If the reading is lower than 14.7 volts but rising steadily, check battery condition. See Test Procedure 1 Battery on page 11-12. If the reading is lower than 14.7 volts and not rising, and the starter/generator is good; or if the reading is over 15.3 volts and continues to rise, replace voltage regulator. See Voltage Regulator Removal on page 12-13.

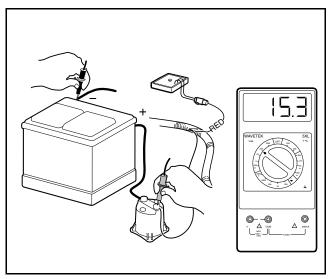


Figure 11-20 Voltage Regulator Test

TEST PROCEDURE 12 - Disconnected Kill Wire

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout cam in the MAINTENANCE position. Chock the wheels.
- 2. Disconnect the engine kill white/black wire (Figure 11-22, Page 11-24).
- 3. Start the engine in a well ventilated area.
 - Turn the key switch to the ON position. Press the accelerator pedal to start the engine.
- 4. If the engine begins to run, test the engine kill circuit for a shorted wire or other failed components in the engine kill circuit. See Key Switch (Engine Kill Circuit) on page 11-28. See following WARNING.

▲ WARNING

- When the white/black engine kill wire is disconnected, the engine will not stop running after the
 accelerator pedal is released. It will be necessary to pull and hold the choke handle until the engine
 stops running.
- 5. If the engine does not run, proceed to Test Procedure 13 Ignition Spark on page 11-24.

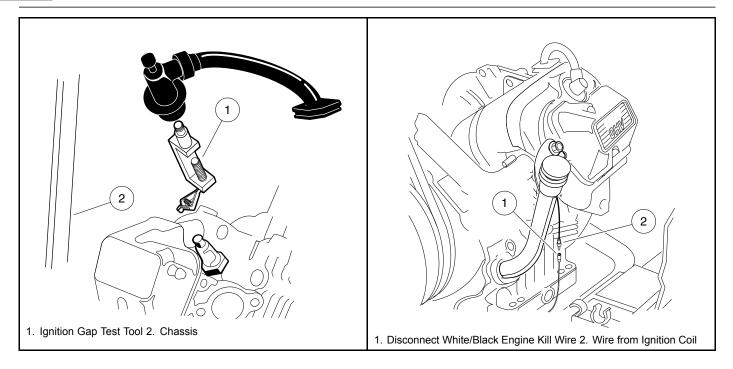


Figure 11-21 Ignition Spark Test

Figure 11-22 White/Black Engine Kill Wire

TEST PROCEDURE 13 - Ignition Spark

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

1. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout cam in the MAINTENANCE position. Chock the wheels.

- 2. Remove the plug wire from the spark plug. Using an ignition spark gap test tool (Thexton 404® or equivalent), check for correct spark (Figure 11-21, Page 11-24).
 - 2.1. Adjust the tester probes to approximately 18,000 volts (18 kV) setting (SE *Small Engine Setting* on the Thexton 404 tool). Connect the tester to the spark plug wire, and connect the alligator clip to a solid engine ground.
 - 2.2. Start the engine. There should be a strong blue spark between the probes of the spark gap tester. If there is no spark, or if the spark is a faint yellow or red color, test components of the ignition circuit. **See Ignition Coil on page 11-25.**
- 3. If the spark gap tester tool indicates a strong blue spark, it is possible the spark plug has failed internally. Check the spark plug gap. The gap should be set at 0.027 to 0.031 inch (0.69 to 0.79 mm). If the gap is correct, replace the spark plug with a new part and test the engine for proper operation.

TEST PROCEDURE 14 – Ignition Coil

See General Warnings on page 1-2.

The following test procedures will properly detect a coil that has failed in most cases; in rare cases however, some ignition coils can fail to operate at normal (warmer) operating temperatures. If the ignition coil has tested okay in the vehicle and on the bench, but fails to operate reliably, replace the coil with a known good coil and operate the engine for several minutes to ensure that the coil functions at normal operating temperature. If the new coil functions properly, keep the new coil in the circuit.

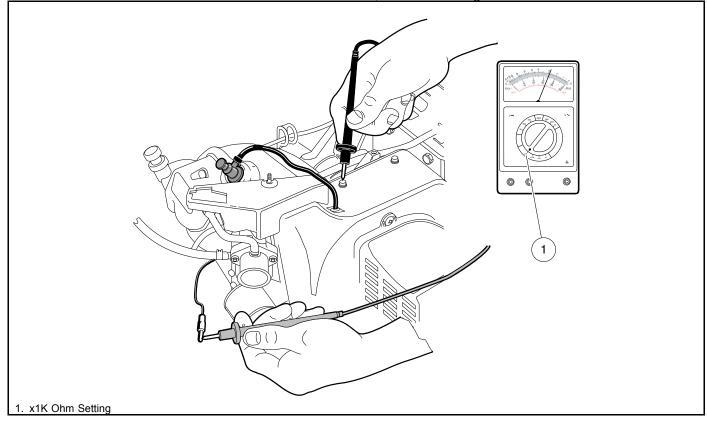
NOTE: An analog ohm meter set to the x1K scale must be used for this test. A digital ohm meter will not provide the correct results.

Resistance value ranges given in these tests reflect a tolerance of ±40%.

Please note that these values are rough standard and it is impossible to reach an exact conclusion with the resistance reading.

Ignition Coil - In Vehicle Test

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. Using an analog multimeter set to x1k ohms, measure the primary coil resistance.
 - 2.1. Disconnect the bullet terminal at the front of the engine (Figure 11-22, Page 11-24). Place the red (+) probe of the meter on the male bullet terminal of the wire connecting to the ignition coil under the fan housing, and place the black (–) probe on a clean unpainted surface of the engine or frame (Figure 11-23, Page 11-25).
 - 2.2. If the resistance is not between 5.5k to 12.7k ohms, bench test the ignition coil.



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Figure 11-23 Primary Coil Resistance – In Vehicle Test

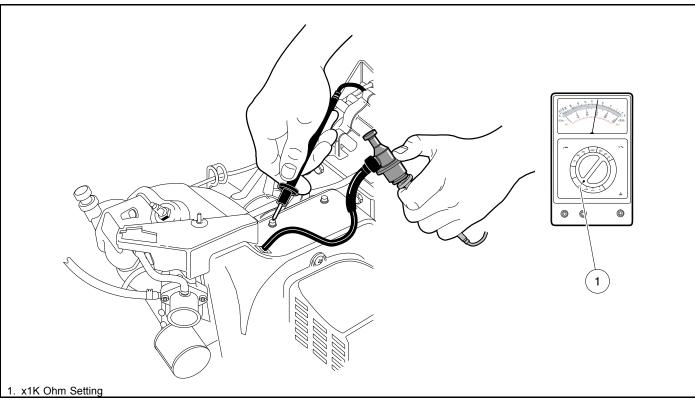


Figure 11-24 Secondary Coil Resistance - In Vehicle Test

- 3. Using an analog multimeter set to x1k ohms, measure the resistance of the secondary coil and spark plug cap together.
 - 3.1. Place the red (+) probe of the meter into the end of the spark plug cap that normally connects to the spark plug and place the black (-) probe on a clean unpainted surface of the engine or frame (Figure 11-24, Page 11-26).
 - 3.2. If the resistance is between 8.6k to 20.2k ohms, the secondary coil and spark plug cap are within acceptable limits; proceed to step 5. If the resistance is not between 8.6k to 20.2k ohms, the spark plug cap and secondary coil must be tested independently from each other.
- 4. Test the spark plug cap separately from the secondary coil.
 - 4.1. Remove the rubber gasket (1) on the plug cap (2) by rolling back the gasket onto the spark plug wire (3) (Figure 11-25, Page 11-27).
 - 4.2. Remove the cap from the wire by turning the cap counterclockwise three or four revolutions while gently pulling it off the wire (Figure 11-26, Page 11-27).

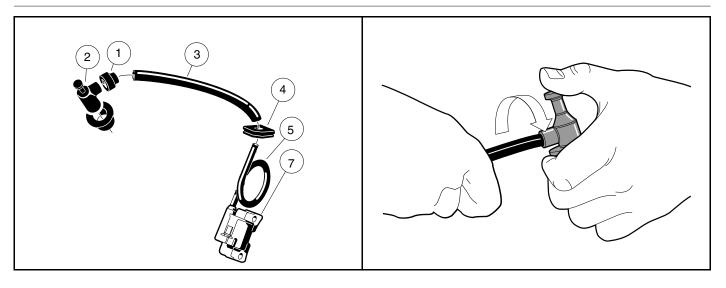
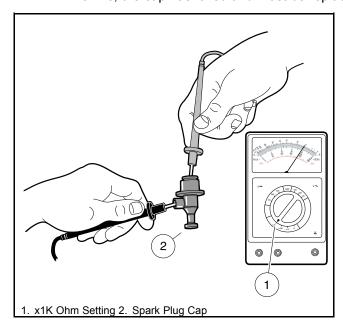


Figure 11-25 Ignition Coil and Cap

Figure 11-26 Spark Plug Cap Removal

4.3. Using an analog multimeter set to x1k ohms, place the red (+) probe of the multimeter into the end of the spark plug cap that normally connects to the spark plug and place the black (–) probe into the end of the cap with the internal screw (Figure 11-27, Page 11-27). If the resistance is not between 4.5k to 6.0k ohms, the cap has failed and must be replaced.



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Figure 11-27 Spark Plug Cap Test

5. If the preceding tests indicate that the ignition coil resistance readings are within acceptable ranges, but the coil fails to function properly, proceed to the following bench test procedures.

Ignition Coil – Bench Test

- 1. Remove the coil from the engine. See Ignition Coil Removal on page 12-24.
- 2. Using an analog multimeter set to x1k ohms, measure the primary coil resistance.
 - 2.1. Place the black (–) probe of the meter on the terminal on the ignition coil (1), and place the red (+) probe on the core (2) (Figure 11-28, Page 11-28).

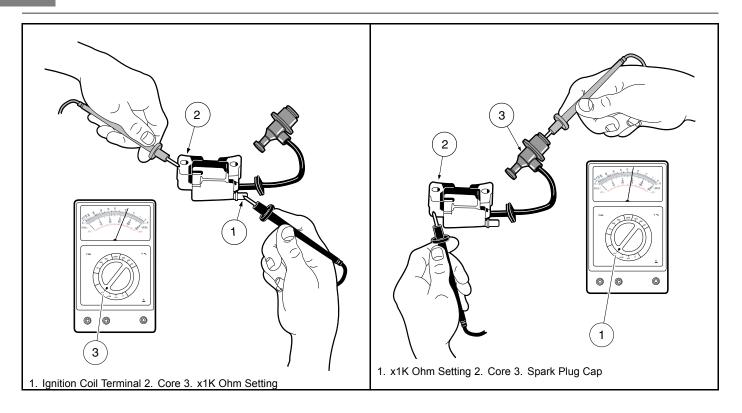


Figure 11-28 Primary Coil Resistance – Bench Test

Figure 11-29 Secondary Coil and Cap Resistance – Bench Test

- 2.2. If the resistance is not between 5.5k to 12.7k ohms, replace the ignition coil.
- 3. Using an analog multimeter set to x1k ohms, measure the resistance of the secondary coil and spark plug cap together.
 - 3.1. Place the red (+) probe of the meter into the end of the spark plug cap (3) that normally connects to the spark plug and place the black (-) probe on the core (2) (Figure 11-29, Page 11-28).
 - 3.2. If the resistance is between 8.6k to 20.2k ohms, the secondary coil and spark plug cap are within acceptable limits; proceed to step 5. If the resistance is not between 8.6k to 20.2k ohms, the spark plug cap and secondary coil must be tested independently from each other.
- 4. If not previously tested, test the spark plug cap separately from the secondary coil.
 - 4.1. Remove the rubber gasket (1) on the plug cap (2) by rolling back the gasket onto the spark plug wire (3) (Figure 11-25, Page 11-27).
 - 4.2. Remove the cap from the wire by turning the cap counterclockwise three or four revolutions while gently pulling it off the wire (Figure 11-26, Page 11-27).
 - 4.3. Using a multimeter set to 20k ohms, place the red (+) probe of the multimeter into the end of the spark plug cap that normally connects to the spark plug and place the black (–) probe into the end of the cap with the internal screw (Figure 11-27, Page 11-27). If the resistance is not between 4.5k to 6.0k ohms, the cap has failed and must be replaced. Proceed to the next step with the spark plug cap still removed.
- 5. If the preceding tests indicate that the ignition coil resistance readings are within acceptable ranges, but the coil fails to function properly, replace the ignition coil and cap.

TEST PROCEDURE 15 – Key Switch (Engine Kill Circuit)

See General Warnings on page 1-2.

 Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

- 2. Remove the instrument panel assembly. See Key Switch Removal on page 12-14.
- 3. Disconnect wires from the (+M) and (-M) terminals of the key switch.
- 4. Place the red (+) probe on the (+M) terminal and the black (–) probe on the (-M) terminal. With the key switch OFF, the reading should be continuity. With the key switch ON, the reading should be no continuity. If either reading is incorrect, replace the key switch (Figure 11-30, Page 11-29).
- 5. Connect wires to key switch. Make sure wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 6. Install instrument panel in reverse order of removal.

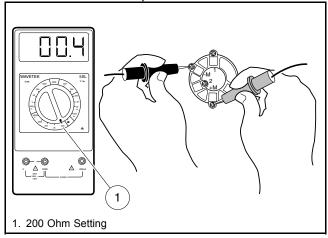


Figure 11-30 Key Switch Test - Engine Kill Circuit

TEST PROCEDURE 16 – Engine Kill Wire

See General Warnings on page 1-2.

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. Disconnect white/black wire bullet connector located at the front of the engine (Figure 11-22, Page 11-24).
- 3. Connect red (+) probe of multimeter to the male bullet terminal on the white/black wire and connect the black (–) probe to the vehicle frame.
- 4. Turn the key switch ON, place the Forward/Reverse handle in FORWARD, and press the accelerator pedal. There should be no continuity. If there is continuity, check for worn insulation on the white/black wire that may be allowing the engine kill wire to ground to the frame.

TEST PROCEDURE 17 – Reverse Buzzer Limit Switch

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

The reverse buzzer limit switch is located on the Forward/Reverse shifter; red/white and orange wires are connected to it.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Move the Forward/Reverse handle to REVERSE and listen for an audible click from the limit switch. If there is no click, check the switch for proper alignment and switch arm movement.
- 3. If the switch is being activated but the buzzer does not function, place the red (+) probe of the multimeter on one terminal and the black (–) probe on the other terminal of the limit switch. Without the lever pressed, the reading

should be no continuity. Press the lever and the reading should be continuity. If either reading is incorrect, replace the limit switch. See Reverse Buzzer Limit Switch Removal on page 12-20.

TEST PROCEDURE 18 - Reverse Buzzer

See General Warnings on page 1-2.

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel. See Key Switch Removal on page 12-14.
- Check for proper wiring and tight connections. Using a multimeter, individually check for continuity through each wire that connects to the reverse buzzer. See Wiring Diagrams Throttle Position Sensor (TPS) on page 11-6. If the buzzer will not function when properly wired, replace the buzzer. See Reverse Warning Buzzer Removal on page 12-19.

TEST PROCEDURE 19 - Oil Level Sensor

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, turn the key switch to the OFF position, disconnect the spark plug wire, and chock the wheels.
- 2. Ensure that the low oil warning light and all connecting wires are functioning correctly. See Test Procedure 20 Low Oil Warning Light on page 11-30.
- 3. Drain the engine oil into an approved container and properly dispose of used oil.
- 4. Turn the key switch ON, closing the circuit. The low oil warning light should illuminate. If the low oil warning light does not illuminate, the oil level sensor needs to be replaced. **See Oil Level Sensor on page 12-27.**
- 5. Install a new oil filter and fill the engine with new oil before returning the vehicle to service.

TEST PROCEDURE 20 - Low Oil Warning Light

See General Warnings on page 1-2.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- Remove the instrument panel assembly. See Key Switch Removal on page 12-14.
- 3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary (Figure 11-5, Page 11-10).
- 4. Disconnect the yellow wire (to the oil level sensor) from the terminal on the low oil warning light. Using an alligator clip jumper wire, connect the low oil warning light terminal to the vehicle frame. Connect the red (+) battery cable to the positive (+) battery post, then attach the black (–) cable to the negative (–) battery post.
- 5. Turn the key switch ON. The low oil warning light should illuminate. If it does not, check continuity between the yellow/white wire connection on the low oil warning light and the blue wire connection at the key switch. If there is no continuity in the wire, correct the problem. Then test the key switch. See Test Procedure 4 Key Switch (Starter Circuit) on page 11-16. If the yellow/white wire and the key switch test okay, then replace the low oil warning light.

TEST PROCEDURE 21 - Neutral Lockout Cam

See General Warnings on page 1-2.

Check to be sure the lobes on the cam are pressing the neutral lockout limit switch lever as the Forward/Reverse handle is being shifted. The limit switch should make an audible click as it is pressed. If it does not, check for wear on the cam lobes. Be sure the cam has snapped fully back into place. If the cam lobes still do not activate the limit switch, replace the cam.

TEST PROCEDURE 22 – Battery Test (Under Load)

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Set a multimeter to 20 volts DC and place the red (+) probe on the F2 (white wire) terminal on the starter/generator. Place the black (-) probe on the negative (-) battery post.
- 3. Place battery under load.
 - 3.1. Turn the key switch to the ON position, leave the Forward/Reverse shifter in the NEUTRAL position and press the accelerator pedal (with the accelerator pedal pressed, the battery is under load).
- 4. If the voltage reading is over 9.6 volts, with an electrolyte temperature of 70 °F (21 °C), check the starter/generator. **See following NOTE.**

NOTE: The voltage reading listed is for electrolyte at 70 °F (21 °C). At lower electrolyte temperatures the voltage reading will be lower.

- 5. If the reading is below 9.6 volts, with an electrolyte temperature of 70 °F (21 °C), check the battery. **See Test Procedure 1 Battery on page 11-12.**
- 6. If the reading is zero, there may be no continuity across the large posts of the solenoid. **See Test Procedure 6 Solenoid on page 11-18.**
- 7. If all of the test results are good and the voltage reading is zero, there may be a broken or damaged 6-gauge white wire from the solenoid to the starter/generator. See Test Procedure 8 Starter/Generator (Starter Function) on page 11-20.

TEST PROCEDURE 23 – Fuel Level Sending Unit

See General Warnings on page 1-2.

▲ WARNING

- To avoid the possibility of fire or explosion, make sure the fuel tank cap is securely in place while performing this test procedure.
- 1. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect the orange wire from the center post of the fuel level sending unit.
- 3. With a multimeter set to 2 k ohms, place the red (+) probe of the multimeter on the center post of the sending unit. Place the black (–) probe on the ground connection of the sending unit (Figure 11-31, Page 11-32).

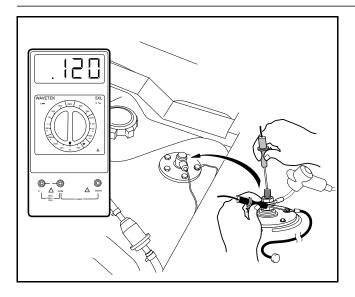


Figure 11-31 Fuel Level Sending Unit Test

4. The following resistance readings (in ohms) should be obtained depending on the position of the float inside the fuel tank. The resistance reading will vary according to the exact position of the float. The chart below may be used as a guideline to determine if the fuel level sending unit is operating correctly. Make sure the float is at the surface of the fuel in the tank.

FLOAT POSITION	RESISTANCE READING	FUEL GAUGE READINGS
Lower position (tank empty)	250 ±10 ohms	Empty
Center position (tank half full)	120 ±20 ohms	Half full
Upper position (tank full)	33.5 ±6 ohms	Full

- 5. If the readings are within the specifications listed above, the fuel level sending unit is working properly. If the readings are incorrect, the fuel level sending unit has failed and the fuel tank must be replaced. **See Fuel Tank Removal on page 14-18.**
- 6. If the readings are correct and the fuel gauge does not function correctly, check the continuity of the orange wire from the fuel level sending unit to the fuel gauge. Leave the battery disconnected while checking continuity. Also check the continuity of the blue wire from the fuel gauge to the key switch, and the black ground wires at the fuel level sending unit and at the fuel gauge. **See Fuel Gauge Removal on page 12-22.**
- 7. If the readings are correct according to the position of the float, but give an incorrect reading on the fuel gauge, test the fuel gauge. **See Test Procedure 24 Fuel Gauge on page 11-32.**

TEST PROCEDURE 24 - Fuel Gauge

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- Remove the dash assembly to gain access to the back of the fuel gauge. See Key Switch Removal on page 12-14.
- 2. Disconnect the orange wire from the fuel gauge.
- 3. Set a multimeter to 20 volts DC and place the red (+) probe of the multimeter on the positive (+) post of the battery. Place the black (-) probe on the negative (-) post of the battery. Record the voltage reading.
- 4. Set a multimeter to 20 volts DC and place the red (+) probe of the multimeter on the (G) terminal of the fuel gauge with the blue wire. Place the black (–) probe on the (S) terminal of the fuel gauge with the black wire (Figure 11-32, Page 11-33).

- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 6. Turn the key switch ON. The voltage reading should be the same as the battery voltage reading recorded earlier. If not, check the continuity of the blue and black wires (Figure 11-32, Page 11-33).
- 7. The orange wire should remain disconnected for this step. With the black probe still on the terminal (S) of the fuel gauge, place the red (+) probe of the multimeter on the (I) terminal of the fuel gauge. The voltage reading should be the same as the full battery voltage reading obtained in step 4. If the reading is incorrect, replace fuel gauge (Figure 11-33, Page 11-33).

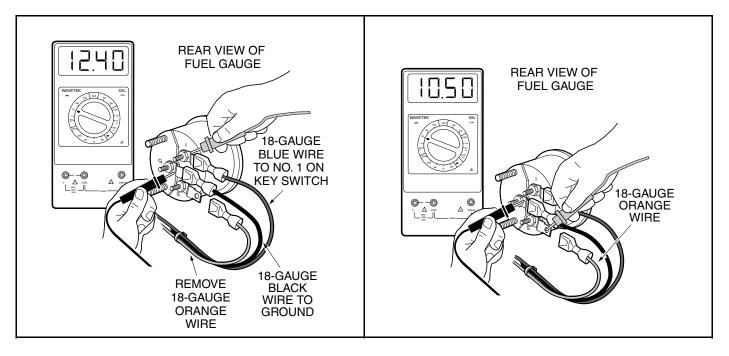


Figure 11-32 Fuel Gauge Test

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Figure 11-33 Fuel Gauge Voltage Test

TEST PROCEDURE 25 - Hour Meter

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Turn the key switch to ON and record the current hour meter reading.
- Press and hold the accelerator pedal to run the engine for at least six minutes (the meter records in six-minute increments). See following DANGER.

A DANGER

- Do not operate vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- 4. If the reading does not change after six minutes, then replace the hour meter.

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

STARTER/GENERATOR

TESTING THE STARTER/GENERATOR

See Test Procedure 8 – Starter/Generator (Starter Function) on page 11-20 and Test Procedure 10 – Starter/Generator (Generator Function) on page 11-21.

STARTER/GENERATOR REMOVAL

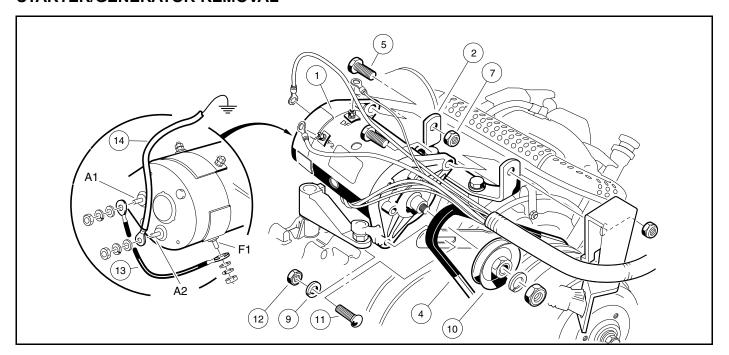


Figure 12-1 Starter/Generator Removal

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the access panel on the vehicle.
- 3. Mark and disconnect the wires from the starter/generator (1). Loosen the two pivot nuts (7) and bolts (5) (Figure 12-1, Page 12-1).

- 4. Remove the mounting/adjustment nut (12), washer (9) and bolt (11). Lower the starter/generator and remove the belt (4) from the pulley (10).
- 5. Support the starter/generator so that when the pivot bolts are removed the starter/generator will not fall to the ground. Remove the two pivot nuts (7) and bolts (5) from the mounting bracket.
- 6. Remove the starter/generator.

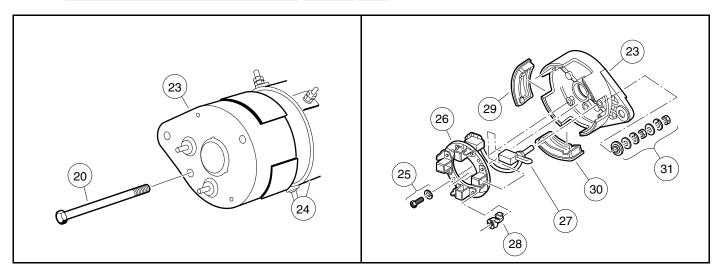
DISASSEMBLY OF THE STARTER/GENERATOR TO SERVICE THE BRUSHES

1. Remove brush covers (29 and 30). **(Figure 12-3, Page 12-2)**. Pull back each brush spring and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover. **(Figure 12-6, Page 12-4)**. **See following NOTE.**

NOTE: If the brushes are not removed, contact between the brushes and commutator as the commutator end cover is being removed or installed could damage the brushes.

- 2. Remove the two bolts (20) and pull commutator end cover (23) free of starter/generator housing (24) (Figure 12-2, Page 12-2).
- 3. Remove terminal hardware (31), screws and lock washers (25), brush holder assembly (26), brush springs (28), and brushes (27). Make note of the routing of the brushes and wires between the brush holder assembly and the inside of the commutator end cover for later reassembly (Figure 12-3, Page 12-2). See following NOTE.

NOTE: Clean and inspect the armature/commutator and the bearings. See Disassembly of the Starter/Generator to Service the Armature/Commutator on page 12-4.



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Figure 12-2 Commutator End Cover

Figure 12-3 Brush Covers and Brushes

BRUSH INSPECTION AND REPLACEMENT

- Visually inspect brushes. Replace brushes that are cracked or severely chipped.
- 2. Check the length of each brush. If the overall length of any brush is less than 0.79 inch (20 mm), replace all four brushes (Figure 12-4, Page 12-3).

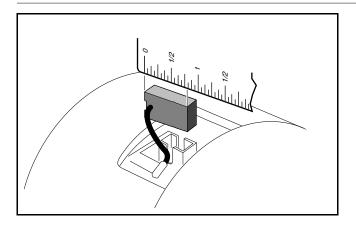


Figure 12-4 Inspect Brushes

BRUSH SPRING INSPECTION AND REPLACEMENT

- 1. Visually inspect springs. Replace all four springs if any spring is discolored from heat (straw or bluish in color).
- 2. Install the four brushes (27) into their holders and insert the four brush springs (28) (Figure 12-3, Page 12-2). Insert the brush wiring terminal studs through the commutator end cover (23) and assemble using the terminal hardware (31). Route the brush wiring between the brush holder assembly (26) and the inside of the commutator end cover cover (23) and assemble using the screws and lock washers (25). Using a spring scale, test brush spring tension. If any spring has a tension less than 14.8 ounce-force (ozf) (0.42 kilogram-force (kgf)), replace all four springs (Figure 12-5, Page 12-3). See following CAUTION.

A CAUTION

 When checking brush spring tension, do not push springs beyond the point they would normally be if there were new brushes installed. Exerting excessive force or pushing brush springs beyond their normal maximum extension point will damage springs.

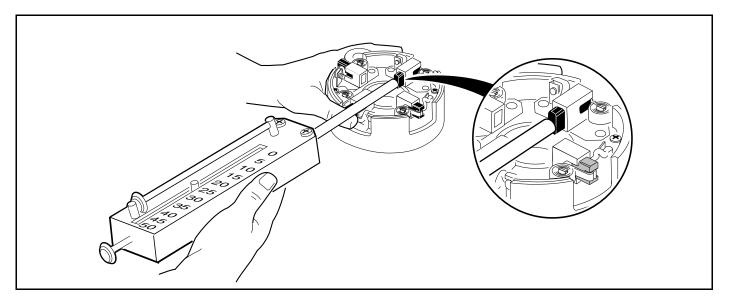
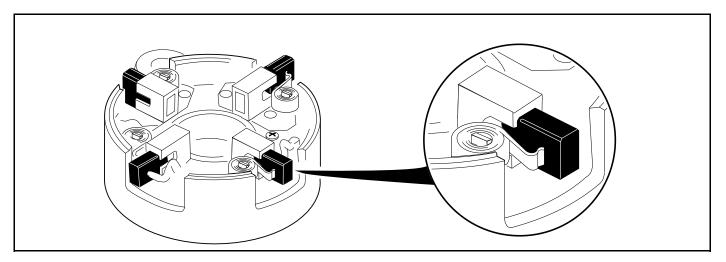


Figure 12-5 Brush Spring Tension Test

STARTER/GENERATOR ASSEMBLY

- To prevent contact between the brushes and commutator as the commutator is installed, and possible damage
 to the brushes, pull back each brush spring and pull the brushes back from the center of the commutator end
 cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center
 of the cover (Figure 12-6, Page 12-4).
- 2. Install the commutator end cover (23) onto the armature shaft. Orient the commutator end cover with the field coil housing as shown. Install two M5 x 20 mm bolts (20) and tighten to 60 in lb (6.8 N·m) (Figure 12-2, Page 12-2).
- 3. Push the brushes down into the holders. Position springs so that brushes are being held against the commutator. Install the brush cover (30) that has the drain hole in it next to the A2 terminal. Install the remaining three brush covers (29) in the openings in the commutator end cover (23) (Figure 12-3, Page 12-2).



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Figure 12-6 Pull Brushes Away from Center of the Commutator End Cover

DISASSEMBLY OF THE STARTER/GENERATOR TO SERVICE THE ARMATURE/COMMUTATOR

- 1. Remove the commutator end cover to prevent damage to the brushes and armature. See Disassembly of the Starter/Generator to Service the Brushes on page 12-2.
- To separate armature and output end cover assembly from the field coil housing, first remove the two securing bolts (43). Carefully remove armature and output end cover assembly from the field coil housing so components are not damaged.
- 3. To separate armature (33) from output end cover (36), remove nut (41), lock washer (40), pulley (39). It may be necessary to use the wedge attachment tool (P/N 1012812) to remove the pulley from the shaft.
- 4. Remove the internal retaining ring (32) to release the bearing (35) and armature (33) from the output end cover (36). **(Figure 12-7, Page 12-5)**.

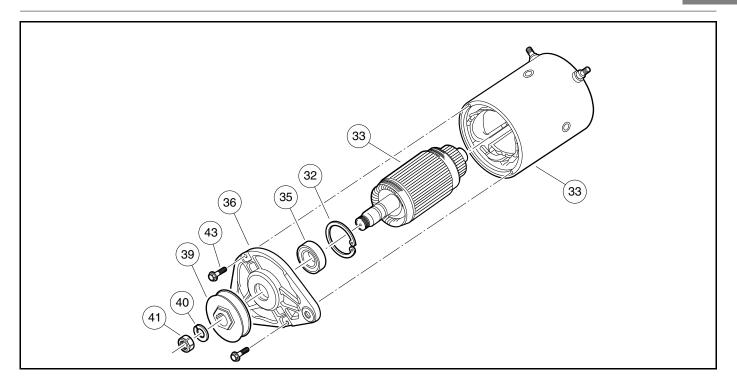


Figure 12-7 Output End Cover Assembly, Armature and Housing

BEARING CLEANING AND INSPECTION

- 1. Using a clean cloth, wipe the carbon dust from the two bearings. Inspect bearings by spinning them by hand and checking for both axial (A) and radial (B) play (Figure 12-8, Page 12-5).
- 2. Replace the bearing if it is noisy, does not spin smoothly, or has excessive play. Check the bearings and replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing. Bearings should be replaced if there is extensive wear or pitting on the balls or on the rolling surfaces. Do not remove the bearings unless they are to be replaced.

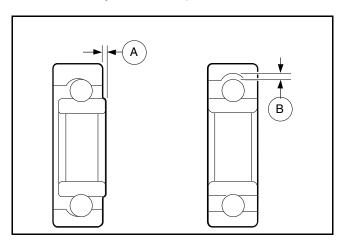
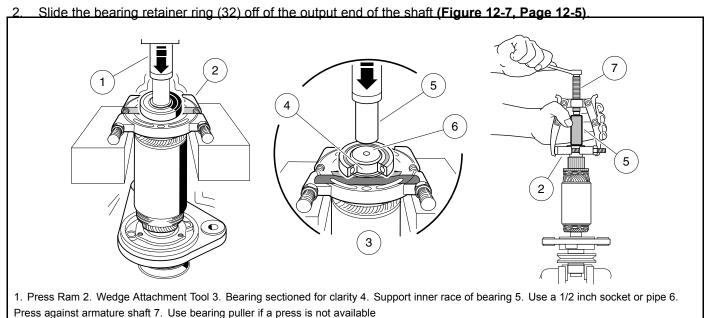


Figure 12-8 Bearing Play Inspection

BEARING REMOVAL

Place the wedge attachment tool (P/N 1012812) between the bearing and the armature. Make sure the wedge
attachment tool is supporting the inner race of the bearing. If a press is not available, secure a bearing puller (P/N
1012811) to the wedge attachment tool and pull the bearing off of the end of the armature shaft. Support the
armature so that it will not drop when the bearing is removed (Figure 12-9, Page 12-6).



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Figure 12-9 Bearing Removal

FIELD COIL ASSEMBLY

Replace entire field coil housing assembly if coils, pole shoes or terminals are damaged. (Figure 12-10, Page 12-7).

VISUAL INSPECTION OF ARMATURE

Obvious defects can be seen by examining the armature. If an armature has frayed or charred insulation, broken wires or thrown solder, it is obvious without testing that it should be replaced. Faults seen during the visual inspection can aid in diagnosing the original cause of the failure. Items to look for are listed below.

- · Burned, charred, or cracked insulation
- · Improperly cured varnish
- · Thrown solder
- Flared armature windings
- · Worn, burned, or glazed commutator
- · Loose or raised commutator bars
- · Bruised or damaged armature core laminations
- · Worn armature bearing or shaft
- · Dirty or oily commutator

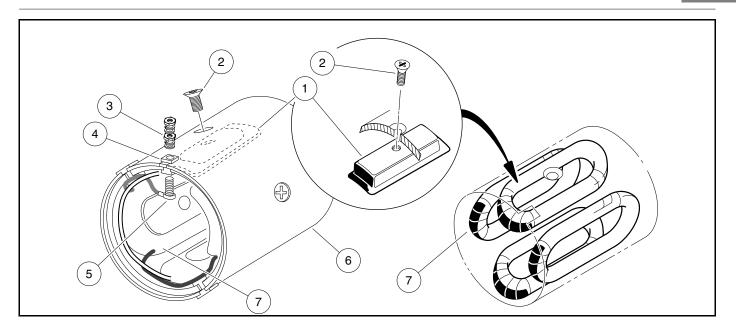
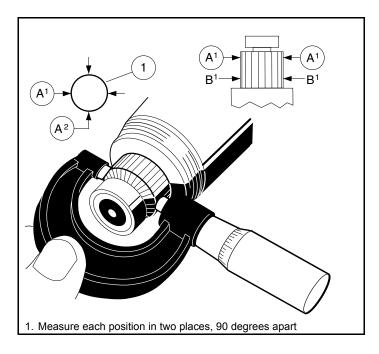


Figure 12-10 Field Coil Assembly

COMMUTATOR CLEANING AND INSPECTION



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Figure 12-11 Inspect Commutator

1. Clean the carbon dust, dirt and oil from the commutator. Visually inspect the commutator for worn, burned or glazed areas. Check for loose or raised commutator bars. Slight roughness of the commutator can be polished away with 400-grit (or finer) sandpaper. **See following CAUTION.**

A CAUTION

- Do not use emery cloth on the commutator. Particles of emery are conductive and may short-circuit the commutator bars. Do not use oil or lubricants on the commutator or brushes.
- 2. Using a micrometer, measure the outside diameter at two points along the commutator. If the commutator outside diameter is less than 1.60 inches (40.6 mm), replace the armature and bearings (Figure 12-11, Page 12-7).

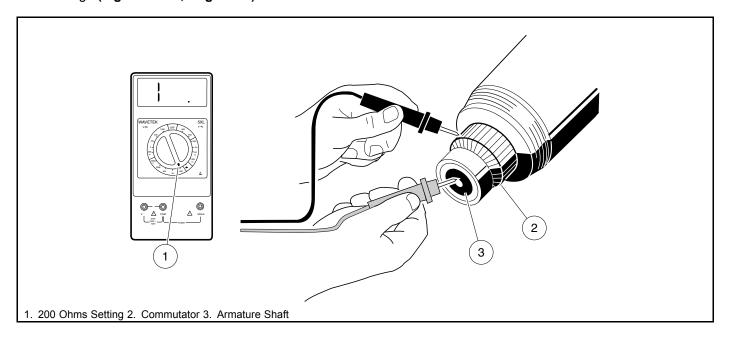
ARMATURE GROUND TEST

CAUTION

· Do not submerge armature in solvent.

NOTE: Before testing, wipe the armature with a clean cloth and remove carbon dust and metal particles from between commutator bars.

Using a multimeter set on 200 (ohms), place the positive (+) probe on the commutator bars and the negative (–) probe on the armature core. The reading should be no continuity. If the reading is incorrect, replace the armature and the two bearings (Figure 12-12, Page 12-8).



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Figure 12-12 Armature Ground Test

VISUAL INSPECTION OF FIELD COILS

If the insulation on the field coils appears blackened or charred, the serviceability of the coils is questionable. Burned or scorched coil insulation indicates the starter/generator has overheated due to overloads or grounded or shorted coil windings. Be sure the insulators are tight in the housing.

STARTER/GENERATOR REWORK

Any rework must be performed by a qualified technician. Starter/generator service specifications are listed in

the following table.

ITEM	SERVICE LIMIT
Commutator diameter (minimum)	1.60 in. (41 mm)
Concentric with armature shaft within	0.002 in. (0.051 mm)
Minimum commutator diameter for reslotting	1.65 in. (42 mm)
Undercut (Commutator must have a minimum diameter of 1.65 in (42 mm) for reslotting):	0.050 in. (1.3 mm)
Dielectric strength	500 VAC for one minute
Armature insulation resistance	0.2M (ohms) at 500 VDC
Starter field coil resistance	0.006 to 0.01 ohms
Generator field coil resistance	4.5 to 5.5 ohms

STARTER/GENERATOR ASSEMBLY

- 1. Slide the bearing retainer (32) onto the output end of the armature shaft (33) (Figure 12-7, Page 12-5).
- 2. Press a new ball bearing (35) onto the output end of the armature (Figure 12-7, Page 12-5). Press a new ball bearing onto the commutator end of the armature shaft. See following CAUTION.

CAUTION

- To prevent damage to the retainer, use care while pressing new bearing onto the output end of the shaft.
- · Press against the inner race of the new bearing until it is fully seated.
- 3. Install the drive end cover (36) onto the armature. Secure the bearing retainer ring (32) (Figure 12-7, Page 12-5).
- 4. Slide the housing with field coils over the armature. Use the tapped mounting holes to align housing to the cover, rotate and orient as shown.

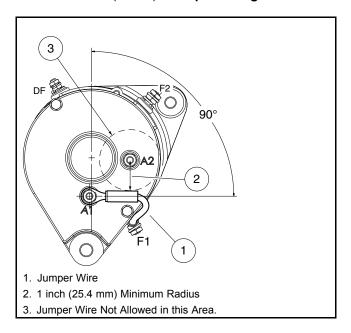
NOTE: The terminal insulators should be on the commutator end of the housing.

- 5. To prevent contact between the brushes and commutator as the commutator cover is installed, and possible damage to the brushes, lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover (Figure 12-6, Page 12-4).
- 6. Install the commutator end cover (23) onto the armature shaft. Use the tapped mounting holes to align housing to the cover, rotate and orient as shown. Install the two M6 x 180 mm bolts (20) and tighten to 60 in·lb (6.8 N·m) (Figure 12-2, Page 12-2).
- 7. Push the brushes down into the holders. Place springs into the notches in the brushes. Install the brush cover (30) that has the drain hole in it next to the A2 terminal. Install the remaining three brush covers (29) in the openings in the commutator end cover (23) (Figure 12-3, Page 12-2).
- 8. Install the belt pulley (39) onto the shaft, and install the lock washer (40) and M14 nut (41). Tighten the nut to 30 ft·lb (40.7 N·m) (Figure 12-7, Page 12-5).
- 9. Install the A1 to F1 terminal jumper wire on the starter/generator.
 - 9.1. Loosely attach wire, flat washers, lock washers, and nuts onto each terminal.

9.2. Orient wire at A1 to be 1 inch (25.4 mm) away from A2 terminal as shown and tighten nut to 44 in·lb (5 N·m) (Figure 12-13, Page 12-10). See following NOTE.

NOTE: Secure bottom nut of terminal with wrench before tightening top nut.

9.3. Form wire against starter housing as shown and allow terminal at F1 to self-orient. Tighten nut to 44 in·lb (5 N·m). **See preceding NOTE.**



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Figure 12-13 A1 to F1 Terminal Jumper Wire Routing

STARTER/GENERATOR INSTALLATION

- 1. Install two 3/8-inch hex-head pivot bolts (5) into the mounting bracket with the heads of the bolts facing toward the driver-side of the vehicle. Position the starter/generator in the mounting bracket so that the bolts will go through the starter/generator before going through the bracket. Install a lock nut (7) onto each bolt. Tighten to finger tight (Figure 12-14, Page 12-11).
- 2. Install the adjustment bolt (11) through the adjusting bracket (4) and then through the starter/generator. Install a lock washer (9) and 5/16-inch nut (12) onto the end of the adjustment bolt (11). Tighten to finger tight.
- 3. Install the belt (3), then tighten the mounting bolts. See Belt Tension Adjustment on page 12-11.
- 4. Connect the yellow wire from the voltage regulator to the DF terminal on the starter/generator. Install a flat washer, lock washer, and nut onto the terminal. Tighten the nut to 18 in·lb (2.0 N·m).
- 5. Install the white wire from the solenoid to the F2 terminal on the starter/generator. Install the black wire from the frame to the A2 terminal on the starter/generator. Install a flat washer, lock washer and nut onto each terminal, and tighten the nut to 45 in·lb (5.1 N·m). Bundle and tie wrap excess wire.
- 6. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

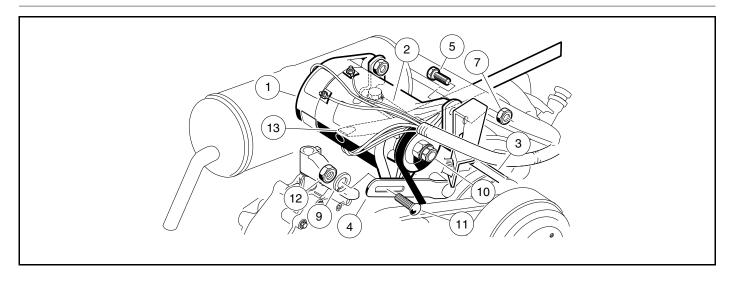


Figure 12-14 Starter/Generator Installation

BELT TENSION ADJUSTMENT

Belt tension should be checked periodically. If the belt slips when starter/generator motor operates, adjust belt to correct tension.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the access panel on the vehicle.
- 3. Make sure the two pivot bolts (5) on the mounting bracket are finger tight. The carriage bolt (11) and hex nut (12) are to be finger tight also (Figure 12-14, Page 12-11).
- 4. Push the starter/generator down so it is at the lowest point of its adjustment travel. With the starter/generator belt in place around the drive clutch pulley, install the starter/generator belt (3) around the pulley (10) on the end of the starter/generator.
- 5. Position a pry bar (13) between the top of the starter/generator mounting bracket (2) and the underside of the starter/generator by passing the pry bar under the exhaust header.
- 6. While holding the pry bar, measure the belt tension using a Krikit® gauge (1) (available at NAPA® Auto Parts stores), or equivalent. Proper tension for a new starter/generator belt should be 120 pound-force (lbf) (54.4 kilogram-force (kgf)) or 70 lbf (31.8 kgf) for an existing belt (Figure 12-15, Page 12-12).
- 7. While maintaining the tension, tighten the adjustment nut (12) to 144 in·lb (16.3 N·m). Tighten the two pivot bolts (5) and hex nuts (7) to 23 ft·lb (31.2 N·m) (Figure 12-14, Page 12-11). See following CAUTION.

A CAUTION

- Remove pry bar before starting engine.
- 8. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

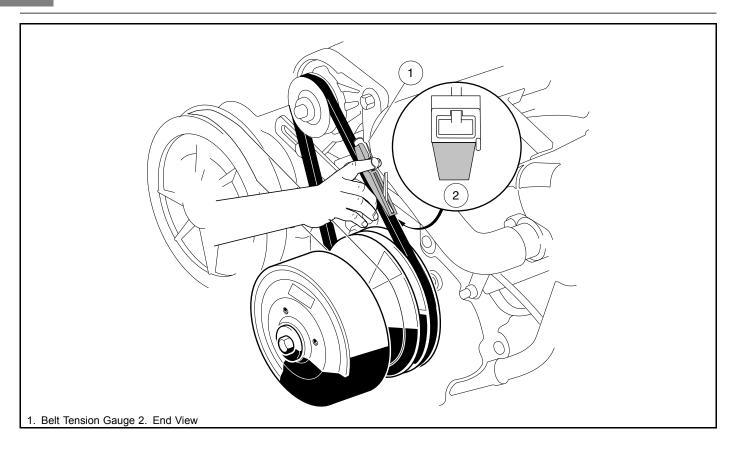


Figure 12-15 Belt Tension Gauge

VOLTAGE REGULATOR

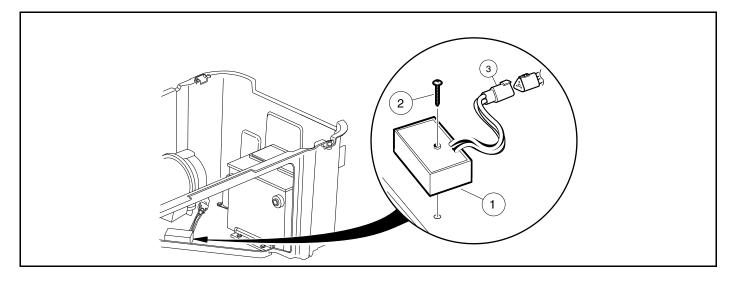
See General Warnings on page 1-2.

TESTING THE VOLTAGE REGULATOR

See Test Procedure 11 – Voltage Regulator on page 11-22.

VOLTAGE REGULATOR REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect the voltage regulator connector (3) from the wire harness (Figure 12-16, Page 12-13).
- 3. Remove the voltage regulator mounting screw (2) and remove the voltage regulator (1).



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Figure 12-16 Voltage Regulator

VOLTAGE REGULATOR INSTALLATION

- 1. Position the voltage regulator (1) and install the mounting screw (2) (Figure 12-16, Page 12-13). Tighten screw to 23 in·lb (2.6 N·m).
- 2. Connect the voltage regulator three-pin connector (3) to the wire harness.
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 4. Place Forward/Reverse handle in NEUTRAL and place the neutral lockout cam in the MAINTENANCE position. Start the engine and check regulator for proper functioning as described in the voltage regulator test procedure. See Test Procedure 11 Voltage Regulator on page 11-22.

KEY SWITCH

See General Warnings on page 1-2.

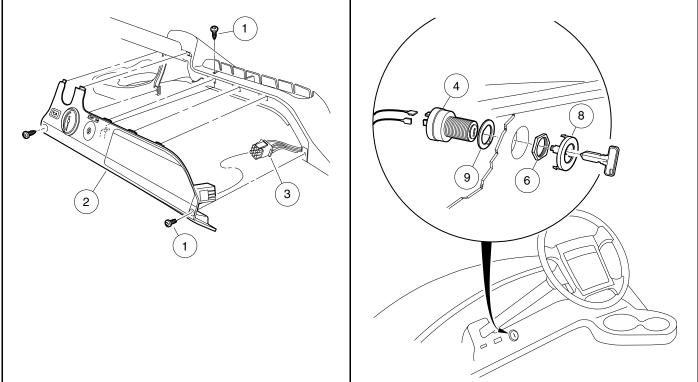
TESTING THE KEY SWITCH

See Test Procedure 15 – Key Switch (Engine Kill Circuit) on page 11-28. See also Test Procedure 4 – Key Switch (Starter Circuit) on page 11-16.

KEY SWITCH REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery -Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel.
 - 2.1. Remove three screws (1) from the instrument panel (2) (Figure 12-17, Page 12-14).
 - 2.2. Rotate the instrument panel up and away from the dash to disengage the tabs at the top of the instrument panel.

2.3. Disconnect the electrical connector (3) to the instrument panel.



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Figure 12-17 Instrument Panel Removal

Figure 12-18 Key Switch

- Disconnect the wires from the key switch. 3.
- From the back of the instrument panel, push down on the retaining tabs surrounding the key switch (4) and remove the key switch cap (8). Hold the key switch and remove the switch retaining nut (6) from the outside of the instrument panel (Figure 12-18, Page 12-14).

KEY SWITCH INSTALLATION

- 1. Reverse removal procedures to install key switch in the instrument panel. Connect wires to key switch.
- 2. Install the instrument panel.
 - 2.1. Connect the electrical connector (3) (Figure 12-17, Page 12-14).
 - 2.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 2.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

SOLENOID

See General Warnings on page 1-2.

TESTING THE SOLENOID

See Test Procedure 6 – Solenoid on page 11-18.

SOLENOID REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect all the wires from the solenoid.
- Remove the two screws securing the solenoid in place.
- 4. Remove the solenoid.

SOLENOID INSTALLATION

- 1. Install the solenoid in the vehicle. Use two screws to secure the solenoid and tighten to 14 in lb (1.6 N·m).
- 2. Connect the ring terminal with the 10-gauge white wire and the 16-gauge red wire on a large post on the solenoid. See Wiring Diagrams Throttle Position Sensor (TPS) on page 11-6.
- 3. Connect the ring terminal with the two 10-gauge red wires to the other large post on the solenoid. **See Wiring Diagrams Throttle Position Sensor (TPS) on page 11-6.**
- 4. Connect the 16-gauge blue wire from the main harness to a small post on the solenoid.
- 5. Connect the 16-gauge orange wire from the main harness to the other small post on the solenoid. **See Wiring Diagrams Throttle Position Sensor (TPS) on page 11-6.**
- 6. Tighten the hex nuts on the large solenoid posts to 55 in·lb (6.2 N·m). Tighten the nuts on the small solenoid posts to 22 in·lb (2.5 N·m).
- 7. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

FUSE

See General Warnings on page 1-2.

TESTING THE FUSE

See Test Procedure 2 - Fuse on page 11-14.

FUSE REMOVAL

- 1. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove cover from fuse holder.
- Remove the fuse from the fuse holder.

FUSE INSTALLATION

Install the fuse. See following WARNING.

▲ WARNING

- If a fuse is blown, determine the cause of the failure and make necessary repairs before installing a new fuse. Use the appropriately rated fuse; if a fuse with a higher amp rating is used, damage to the vehicle electrical system may occur.
- 2. Install the cover on the fuse holder.
- 3. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

LIMIT SWITCHES

ACCELERATOR PEDAL LIMIT SWITCH

See General Warnings on page 1-2.

Testing the Accelerator Pedal Limit Switch

See Test Procedure 5 - Throttle Position Sensor (TPS) on page 11-17.

The accelerator pedal limit switch is housed inside the throttle position sensor. The throttle position sensor itself is not intended to be replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced.

KILL LIMIT SWITCH

See General Warnings on page 1-2.

Testing the Kill Limit Switch

See Test Procedure 5 – Throttle Position Sensor (TPS) on page 11-17.

The kill limit switch is housed inside the throttle position sensor. The throttle position sensor itself is not intended to be replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced.

NEUTRAL LOCKOUT LIMIT SWITCH

See General Warnings on page 1-2.

Testing the Neutral Lockout Limit Switch

See Test Procedure 7 – Neutral Lockout Limit Switch on page 11-19.

Neutral Lockout Limit Switch Removal

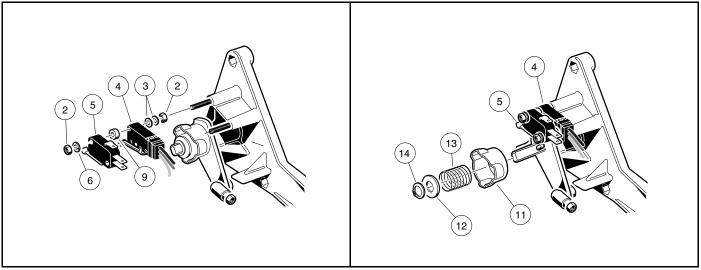
- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect the wires from the neutral lockout limit switch (5) located on the back of the Forward/Reverse shifter assembly (Figure 12-19, Page 12-17).
- 3. Remove two nuts (2) and washers (6) from the neutral lockout limit switch (5) and slide the neutral lockout limit switch off of the screws.

Neutral Lockout Limit Switch Installation

Install the neutral lockout limit switch (5) with two washers (6) and two nuts (2) (Figure 12-19, Page 12-17).
 Tighten to 5 in lb (0.6 N·m). Place the Forward/Reverse handle in REVERSE to make sure that both switches actuate. See following CAUTION.

CAUTION

• Do not overtighten the retaining nuts. If the nuts are overtightened, limit switches could be damaged.



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Figure 12-19 Neutral Lockout and Reverse Buzzer Limit
Switches

2435 Figure 12-20 Neutral Lockout Cam

- Connect the black wire to common (COM) terminal, the green wire to the normally open (NO) terminal and the white wire to the normally closed (NC) terminal of the neutral lockout limit switch (Figure 12-19, Page 12-17).
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 4. Place the Forward/Reverse handle in NEUTRAL. The neutral lockout cam should be in the OPERATE position. Make sure everyone is clear of the vehicle. Turn the key switch ON. The engine should not crank when pressing the accelerator. If the engine does crank, turn the key switch OFF and re-adjust the shift linkage.
- 5. Test drive the vehicle in both forward and reverse for proper operation.

NEUTRAL LOCKOUT CAM

See General Warnings on page 1-2.

If the cam lobes have worn to the point where they will no longer activate the neutral lockout limit switch, the cam must be replaced.

TESTING THE NEUTRAL LOCKOUT CAM

See Test Procedure 21 - Neutral Lockout Cam on page 11-31.

NEUTRAL LOCKOUT CAM REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- Remove the external snap ring (14) (Figure 12-20, Page 12-17).
- 3. Remove the plastic washer (12) and the spring (13).
- 4. Remove the cam (11).

NEUTRAL LOCKOUT CAM INSTALLATION

- 1. Install the cam (11) (Figure 12-20, Page 12-17).
- 2. Install the spring (13) and the plastic washer (12).
- Install the external snap ring (14) onto the shaft. Be sure the snap ring is installed in the groove on the shaft.
- 4. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

REVERSE WARNING BUZZER

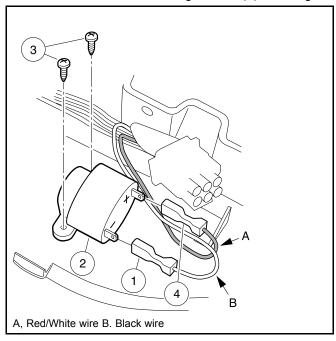
See General Warnings on page 1-2.

TESTING THE REVERSE WARNING BUZZER

See Test Procedure 18 - Reverse Buzzer on page 11-30.

REVERSE WARNING BUZZER REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel. See Key Switch Removal on page 12-14.
- 3. Disconnect the wires from the reverse warning buzzer (2) (Figure 12-21, Page 12-19).
- Remove the two mounting screws (3) securing the buzzer to the instrument panel.



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Figure 12-21 Reverse Buzzer

REVERSE WARNING BUZZER INSTALLATION

- 1. Install the screws (3) through the buzzer bracket tabs and tighten to 3.5 in·lb (0.40 N·m) (Figure 12-21, Page 12-19).
- 2. Connect the black wire (1) from the wire harness to the negative (–) terminal on the buzzer.
- 3. Connect the red/white wire (4) from the wire harness to the positive (+) terminal on the buzzer.
- 4. Install the instrument panel.
 - 4.1. Connect the electrical connector (3) (Figure 12-17, Page 12-14).
 - 4.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 4.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 6. Shift the Forward/Reverse handle to the REVERSE position. The buzzer should sound.

Reverse Buzzer Limit Switch

REVERSE BUZZER LIMIT SWITCH

See General Warnings on page 1-2.

TESTING THE REVERSE BUZZER LIMIT SWITCH

See Test Procedure 17 – Reverse Buzzer Limit Switch on page 11-29.

REVERSE BUZZER LIMIT SWITCH REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery -Gasoline Vehicles on page 1-3.
- 2. Disconnect the wires from the reverse buzzer limit switch (4) located on the back of the Forward/Reverse assembly (Figure 12-19, Page 12-17).
- Remove the nuts (2) and washers (6) from the neutral lockout limit switch (5) and slide the neutral lockout limit switch off of the screws. Do not disconnect the wires.
- 4. Remove the spacers (9) from the reverse buzzer limit switch (4) and slide the reverse buzzer limit switch off the screws.

REVERSE BUZZER LIMIT SWITCH INSTALLATION

- Install the reverse buzzer limit switch (4), and then install two spacers (9) against the limit switch (Figure 12-19, Page 12-17).
- Install the neutral lockout limit switch (5) with two washers (6) and two nuts (2). Tighten to 5 in lb (0.6 N·m). See following CAUTION.

CAUTION

- Do not overtighten the retaining nuts. If the nuts are over tightened, limit switches could be damaged.
- Place the Forward/Reverse handle in REVERSE and make sure that both switches actuate.
- 4. Connect the orange wire to the common (COM) terminal and the red/white wire to the normally open (NO) terminal of the reverse buzzer limit switch (4) (Figure 12-19, Page 12-17).
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 6. Shift the Forward/Reverse handle to the REVERSE position. The buzzer should sound.

LOW OIL WARNING LIGHT

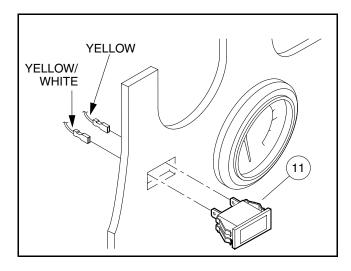
See General Warnings on page 1-2.

TESTING THE LOW OIL WARNING LIGHT

See Test Procedure 20 - Low Oil Warning Light on page 11-30.

LOW OIL WARNING LIGHT REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel. See Key Switch Removal on page 12-14.
- 3. Disconnect the wires from the low oil warning light (11) (Figure 12-22, Page 12-21).
- 4. Press the retaining tabs and remove the low oil warning light from the instrument panel.



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Figure 12-22 Low Oil Warning Light

LOW OIL WARNING LIGHT INSTALLATION

- 1. Push a new unit into hole in instrument panel until plastic tabs engage (Figure 12-22, Page 12-21).
- 2. Connect yellow and yellow/white wires from the wire harness to the low oil warning light.
- 3. Install the instrument panel.
 - 3.1. Connect the electrical connector (3) (Figure 12-17, Page 12-14).
 - 3.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 3.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).
- 4. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

FUEL GAUGE

See General Warnings on page 1-2.

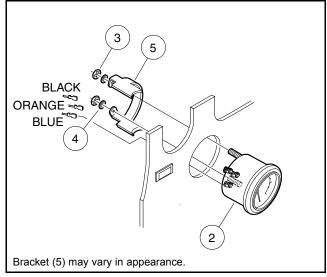
With the key switch in the OFF position, the fuel gauge reads empty. When the key switch is turned to ON, the fuel gauge becomes active.

TESTING THE FUEL GAUGE

See Test Procedure 24 - Fuel Gauge on page 11-32.

FUEL GAUGE REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel. See Key Switch Removal on page 12-14.
- 3. Disconnect the three wires from the fuel gauge (Figure 12-23, Page 12-22).
- 4. Remove the two hex nuts (3) and lock washers (4) from the threaded studs on the back of the gauge (2). Remove the mounting bracket (5) from the back side of the fuel gauge and remove the gauge from the instrument panel.



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Figure 12-23 Fuel Gauge Installation

FUEL GAUGE INSTALLATION

- Install a new fuel gauge into hole in instrument panel until flange seats against panel (Figure 12-23, Page 12-22).
- Slide the mounting bracket (5) onto the two threaded studs on the fuel gauge and secure with two lock washers
 (4) and two hex nuts (3). Tighten to 2.5 in·lb (0.28 N·m). Place one drop of Loctite® on each hex nut. Do not allow Loctite® to come into contact with the fuel gauge casing.
- 3. Connect the blue wire from the wire harness to the (I) terminal, the orange wire from the wire harness to the (S) terminal, and the black wire from the wire harness to the (G) terminal. See Wiring Diagrams Throttle Position Sensor (TPS) on page 11-6.
- 4. Install the instrument panel.

- 4.1. Connect the electrical connector (3) (Figure 12-17, Page 12-14).
- 4.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
- 4.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 22 in·lb (2.5 N·m).
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

FUEL LEVEL SENDING UNIT

See General Warnings on page 1-2.

The fuel level sending unit is an integral part of the fuel tank and should never be removed. Thoroughly test the fuel level sending unit before replacing the fuel tank.

TESTING THE FUEL LEVEL SENDING UNIT

See Test Procedure 23 - Fuel Level Sending Unit on page 11-31.

HOUR METER

See General Warnings on page 1-2.

TESTING THE HOUR METER

See Test Procedure 25 - Hour Meter on page 11-33.

The hour meter displays the number of hours of use in increments of 0.1 hour.

HOUR METER REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect the wires from the hour meter (1) (Figure 12-24, Page 12-24).
- 3. Remove screw (2) to release bracket (3).
- 4. Remove keeper (4) from hour meter to release meter (1) from bracket (3).

HOUR METER INSTALLATION

1. Install a new hour meter into bracket (3) and secure it by sliding the keeper (4) onto it (Figure 12-24, Page 12-24).

- Connect wires to the hour meter.
- Position bracket (3) on the vehicle and secure in place with screw (2).

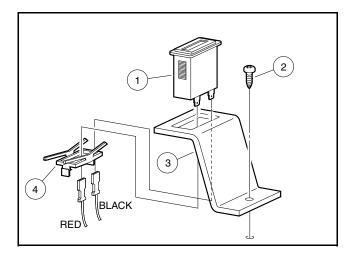


Figure 12-24 Hour Meter Installation

IGNITION COIL

See General Warnings on page 1-2.

TESTING THE IGNITION COIL

See Test Procedure 13 – Ignition Spark on page 11-24 and Test Procedure 14 – Ignition Coil on page 11-25.

IGNITION COIL REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery -Gasoline Vehicles, Section 1, Page 1-3.
- 2. Remove seat to access engine compartment.
- Remove the muffler. See Muffler Removal on page 15-1.
- Cut the wire tie holding the wire harness to the stiffener (1) and remove the bolts (2) and nuts (3) securing the stiffener to the mounting plate (4) (Figure 12-25, Page 12-25).
- 5. Remove the pan-head bolts (5) securing the fan shroud (8) to the fan housing (9) (Figure 12-26, Page 12-25).
- Loosen, but do not remove, the three bolts (6) attaching the fan housing as shown. 6.
- Remove the remaining four bolts (10) attaching the fan housing as shown (Figure 12-26, Page 12-25), then while opening the housing, detach the spark plug wire grommet (4) from the housing (Figure 12-28, Page 12-26).
- Disconnect the 18-gauge black wire (12) from the spade terminal on the ignition coil (11) and remove the coil by removing two bolts (10) (Figure 12-27, Page 12-25).

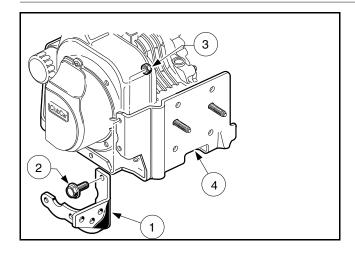
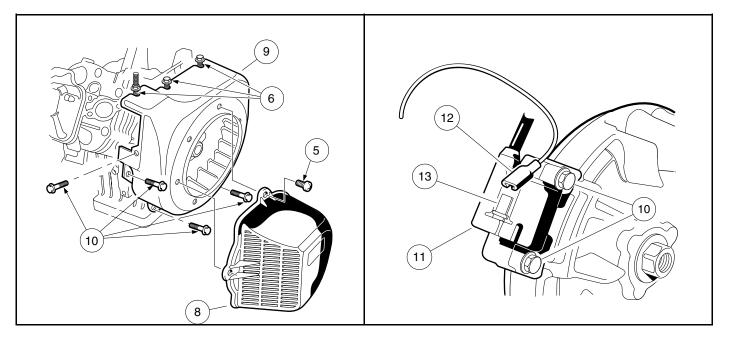


Figure 12-25 Stiffener Removal



50

Figure 12-26 Fan Housing Removal

510

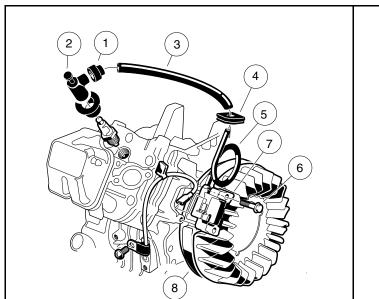
Figure 12-27 Ignition Coil Removal

IGNITION COIL INSTALLATION

NOTE: If a new ignition coil is being installed, the spark plug cap, gasket, protector tube and grommet must be removed from the old coil and installed on the new coil. See steps 1 through 8 for procedures to remove and install these existing parts.

If the existing ignition coil will be remounted, proceed to step 9.

- 1. Remove the rubber gasket (1) on the plug cap (2) by rolling back the gasket onto the spark plug wire (Figure 12-28, Page 12-26).
- 2. Remove the cap (2) from the wire by turning the cap counterclockwise three or four revolutions while gently pulling it off the wire.



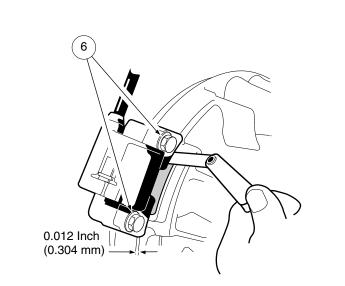


Figure 12-28 Clean Grommet

Figure 12-29 Mount Ignition Coil Using Feeler Gauge

Remove the gasket (1) and protector tube (3) from the old coil. See following NOTE.

NOTE: Moisten the spark plug wire with water to make gasket removal and installation easier.

- 4. Remove the grommet (4) from the old spark plug wire. Clean the grommet and place it on the new spark plug wire (5).
- Install the protector tube onto the new wire.
- 6. Slide the gasket onto the end of the new spark plug wire.
- 7. Install the cap on the new coil spark plug wire by rotating it clockwise three or four revolutions while applying light pressure on the cap.
- 8. Install the gasket (1) on the cap (2).
- 9. Position the ignition coil (7) onto the cast mounting bosses on the engine crankcase and tighten the two mounting bolts (6) to finger-tight at this time.
- 10. Rotate the flywheel (8) until the magnet is positioned directly under the ignition coil. Use a 0.012 inch (0.304 mm) bronze feeler gauge to set the air gap between the ignition coil and the flywheel magnet. Tighten the two mounting bolts (6) to 30 in·lb (3.4 N·m) (Figure 12-29, Page 12-26).
- 11. Connect the 18-gauge black wire to the spade terminal on the coil.
- 12. Position the fan housing close to the engine crankcase and slide the plug wire grommet into the notch on the housing.
- 13. When installing fan housing, make sure the top front corner of the housing is above the upper cylinder shroud. The front edge of the fan housing should be behind the lower cylinder shroud. Align the slots in the housing with the flanged bolts loosened earlier.
- 14. Install the four remaining flange bolts that secure the fan housing to the engine crankcase. Tighten all seven mounting bolts to 90 in lb (10.2 N·m) (Figure 12-26, Page 12-25).
- 15. Install the stiffener with four hex-head bolts and lock nuts. Tighten the hardware to 23 ft·lb (30.5 N·m).
- 16. Install the fan shroud with four pan-head bolts (5). Tighten to 50 in lb (5.7 N·m) (Figure 12-26, Page 12-25).
- 17. Secure the wire harness to the stiffener with a wire tie. Place the wire tie through the lower hole at the back of the stiffener (Figure 12-25, Page 12-25).

A CAUTION

- · Make sure wire harness is routed and secured away from the muffler.
- 18. Install the muffler. See Muffler Installation on page 15-1.
- 19. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

OIL LEVEL SENSOR

See General Warnings on page 1-2.

TESTING THE OIL LEVEL SENSOR

See Test Procedure 19 – Oil Level Sensor on page 11-30.

OIL LEVEL SENSOR REMOVAL

See Oil Level Sensor Removal on page 13-6.

OIL LEVEL SENSOR INSTALLATION

See Oil Level Sensor Installation on page 13-6.

BATTERY

See General Warnings on page 1-2.

▲ DANGER

- Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working around a battery.
- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.
- Battery Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing.
 Antidotes:

DANGER CONTINUED ON NEXT PAGE

A DANGER

- External: Flush with water. Call a physician immediately.
- Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.
- Eyes: Flush with water for 15 minutes. Call a physician immediately.

GENERAL INFORMATION

Club Car gasoline vehicles are equipped with 12-volt, low-maintenance batteries. When changing a 12-volt battery in any Club Car gasoline-powered vehicle, the same size battery with adequate amperage ratings should be used as a replacement.

Club Car recommends a group 70, side-post battery (P/N 1012328), with a 650 cranking amp rating at 32 °F (0 °C) (500 CCA at 0 °F (-17.8 °C)) and a reserve capacity of at least 105 minutes. The group 70 classification indicates battery size: 8-1/4 inches W x 6-1/2 inches D x 7-1/4 inches H (21.0 cm W x 16.5 cm D x 18.4 cm H). It is important to use the proper size to ensure that the battery clamp will fit correctly.

Testing the Battery

See Test Procedure 1 – Battery on page 11-12.

BATTERY - GASOLINE VEHICLES

See General Warnings on page 1-2.

A DANGER

- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.
- · Tools, wires, and metal objects can cause sparks when shorted across a battery.
- · Follow all instructions carefully when working with batteries.
- · Charge battery in a well-ventilated area only.
- Battery Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing.
 Antidotes:
 - External: Flush with water. Call a physician immediately.
 - Internal: Drink large quantities of milk or water followed with milk of magnesia or vegetable oil. Call a physician immediately.
 - Eyes: Flush with water for 15 minutes. Call a physician immediately.

WARNING

Do not jump start a dead battery using another battery and jumper cables.

The battery in the Club Car gasoline vehicle is a 12-volt, low maintenance battery that requires infrequent watering (Figure 12-30).

Any corrosion around the positive (+) or negative (-) terminals should be washed off with a solution of baking soda and water (1 cup (237 mL) per 1 gallon (3.8 L) of water). Rinse solution off the battery. Do not allow this solution to enter battery. Be sure terminals are tight. Let the terminals dry and then spray them with Battery Terminal Protector Spray (CC P/N 1014305). See Low Maintenance Battery: Connecting the Battery - Gasoline Vehicles on page 1-3. See preceding and following WARNINGS.

A WARNING

 If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so may cause them to overheat during operation and could result in fire, property damage, or personal injury.

Be sure battery clamp is properly tightened. Tighten to 144 in lb (16 N·m). A loose battery clamp may allow the battery to become damaged from vibration or jarring.

If battery appears weak, have it charged by a trained technician. The battery should never be left discharged any

longer than absolutely necessary (do not leave discharged overnight).

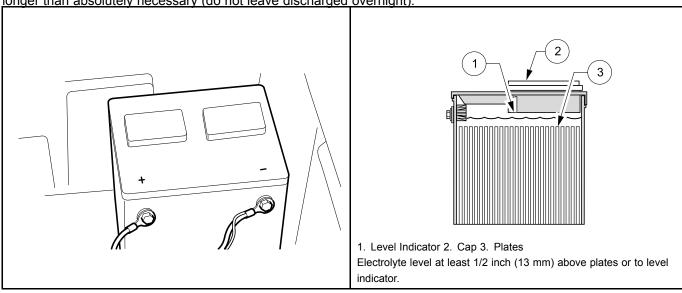


Figure 12-30 Gasoline Vehicle Battery

Figure 12-31 Electrolyte Level for Battery

PREVENTIVE MAINTENANCE

To keep the battery in good operating condition, follow these steps on a regular basis.

- 1. Any corrosion build-up on or around the battery should be removed immediately. Post connections should be clean and tight. Any frayed or worn wires should be replaced. After all cables have been connected and properly tightened to 20 ft lb (27.1 N·m), coat terminals with Battery Terminal Protector Spray (P/N 1014305) to prevent future corrosion.
- The battery should be kept clean and dry to minimize self-discharge. Any dirt, grime or acid spillage should be removed. Wash the battery with a bristle brush using water and bicarbonate of soda (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse with water. Do not allow solution to enter battery through the vent cap holes. See Self-Discharge on page 12-30.
- 3. Maintain proper water level. See Water Level on page 12-30.

- Check battery periodically to see that it is in a full state of charge. See Charging the Battery on page 12-31.
- Keep battery hold-down clamp tight. See Vibration Damage on page 12-30.

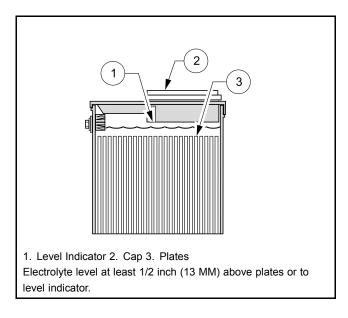
SELF-DISCHARGE

Dirt and battery acid can provide a path for a small current draw that slowly discharges the battery. To minimize self-discharge, the battery should always be kept clean.

Hot weather also has an effect on a battery's self-discharge rate. The higher the temperature, the quicker a battery will discharge. In hotter climates the battery should be checked more often. When storing the battery, keep in a cool place. See Battery Storage on page 12-32.

WATER LEVEL

The water level should be checked semi-annually to be sure water is at the proper level (Figure 12-32, Page 12-30). Never allow the water level to fall below the tops of the plates because this will cause the exposed part of the plate to become permanently inactive. Check the water level more frequently in hot weather or when the battery becomes old.



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Figure 12-32 Battery Water Level

VIBRATION DAMAGE

The battery hold-down clamp should always be tight enough to keep the battery from bouncing. Battery life may be severely shortened if the clamp is too loose. Excessive vibration shortens the life of the battery. It may also cause acid to leak out of the vent caps and corrosion to build up on surrounding metal parts. The acid which is lost reduces the capacity of the battery and cannot be replaced.

MINERAL CONTENT

For the longest battery life, distilled water should be used in the battery; however, if tap water is going to be used, contact your local water department to be sure mineral contents are below the levels listed in the following table. **See following NOTE.**

NOTE: Contact your local water department for mineral content analysis.

IMPURITY	ALLOWABLE CONTENT (PARTS PER MILLION)		
Suspended matter	Trace		
Total solids	100.0		
Calcium and Magnesium Oxides	40.0		
Iron	5.0		
Ammonia	8.0		
Organic matter	50.0		
Nitrates	10.0		
Nitrites	5.0		
Chloride	5.0		

BATTERY REMOVAL

See General Warnings on page 1-2. See also DANGER on page 12-27.

- 1. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the battery hold-down clamp from the battery.
- 3. Lift the battery from the vehicle. See following WARNING.

▲ WARNING

Keep the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a
45° angle in any direction can allow a small amount of electrolyte to leak out of the vent hole. Do not
exceed this 45° angle when lifting, carrying or installing battery. The battery acid could cause severe
personal injury when accidentally coming in contact with the skin or eyes, and could damage clothing.

CHARGING THE BATTERY

See General Warnings on page 1-2. See also DANGER on page 12-27.

- 1. Charge the battery using an automotive type 12-volt battery charger. Follow all warnings and procedures supplied by the battery charger manufacturer.
- 2. Attach the positive (+) charger cable to the positive (+) battery post.
- 3. Attach the negative (–) charger cable to the negative (–) battery post.
- 4. The battery may be charged with a slow charge (3 to 10 amps) or a fast charge (20 to 30 amps). Charge until the specific gravity reaches 1.250. **See following WARNING.**

A WARNING

- If the battery case feels hot (approximately 125 °F (52 °C) or more), emits gases, or fluid boils from vents, stop charging immediately. Failure to stop charging battery when any of these conditions are present could result in an explosion, personal injury and/or damage to the battery.
- Do not disconnect the DC leads and battery when the charger is on. The resulting arcing between the DC leads and battery post could cause an explosion.
- If the charger must be stopped, disconnect the AC supply cord from the wall outlet before disconnecting the DC leads from the battery. Allow the battery to cool to room temperature and resume charging battery at a lower amp rate.

BATTERY INSTALLATION

See General Warnings on page 1-2. See also DANGER on page 12-27.

- 1. Place the battery into the vehicle. Make sure the battery posts are facing the engine.
- 2. Secure the battery to the vehicle with the clamp. Install two screws and tighten to 31 in·lb (3.5 N·m).
- 3. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

BATTERY STORAGE

See General Warnings on page 1-2. See also DANGER on page 12-27.

- Keep the battery clean and free of corrosion. See Preventive Maintenance on page 12-29.
- 2. The battery cables should be disconnected from the battery so the battery can be connected to the charger. The battery can be left in the vehicle.
- 3. Fully charge the battery prior to storage.
- 4. Store in a cool area. The colder the area in which the battery is stored, the less the battery will self-discharge. A battery stored at 0 °F (-17.8 °C) will discharge very little over a four-month period. A battery stored at 80 °F (27 °C) will have to be recharged every few weeks.
- 5. Check the state of charge periodically. A battery that is discharged and left in a cold environment can freeze and crack. If the specific gravity drops below 1.220, the battery should be recharged. **See following WARNING.**

A WARNING

- If the battery is frozen or the container is bulged, discard battery. A frozen battery can explode.
- 6. The frequency of recharging required depends on the temperature of the storage area, but it is recommended that the battery be monitored for state of charge every month. Also, if the storage area is unheated in a cold climate and recharging is required, it is recommended that the area be heated to at least 60 °F (16 °C) prior to charging. The battery will not charge effectively in cold temperatures for the same reasons that it does not discharge as rapidly in cold temperatures.

CHARGING A DEAD BATTERY

See General Warnings on page 1-2. See also DANGER on page 12-27.

The vehicle is equipped with a starter/generator. The generator is not designed to charge a dead battery. If the vehicle battery has become discharged, it must be charged using a properly rated automotive type charger.

▲ WARNING

• Do not jump-start a dead battery using another battery and jumper cables.

GROUND CABLES

See General Warnings on page 1-2.

TESTING THE GROUND CABLES

See Test Procedure 3 - Ground Cables on page 11-15.

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

See General Warnings on page 1-2.

This vehicle is powered by a 4-cycle, overhead valve, single cylinder, air-cooled engine. The S26 engine is identified by labelling on the blower housing and has mechanical lifters as opposed to a hydraulically-lifted valve train. The engine has an oil reservoir (crankcase) similar to automobiles, trucks, aircraft, heavy equipment, machinery and other applications designed for reliable heavy-duty service. The engine has two major component assemblies: the cylinder assembly and the crankcase assembly. **See following NOTE.**

NOTE: Engine rotation is clockwise as viewed from the clutch side of the engine.

This section contains information for removing and replacing the engine. For complete instruction on engine disassembly, repair, rebuilding, and reassembly, see your authorized dealer.

BEFORE SERVICING

Carefully read the applicable information and instructions before beginning engine service. Diagrams, DANGER, WARNING, CAUTION and NOTE statements and detailed descriptions have been included wherever necessary. Anyone attempting engine service should have knowledge and experience in small engine service and repair.

ENGINE ROTATION

When turning the crankshaft by hand, always turn it clockwise as viewed from the clutch side of the engine. This will ensure proper adjustments.

SPARK PLUG

Spark plugs are selected to suit specific engine design and vehicle operating conditions. The spark plug (P/N AM1232301) is designed to give maximum life and efficient combustion of fuel. The spark gap should be set between 0.027 to 0.031 inch (0.69 to 0.79 mm).

Spark Plug Removal

See General Warnings on page 1-2.

A CAUTION

· Before removal and disassembly, clean the engine.

Remove all dirt from plug base in the cylinder head before removing plug. Use a 13/16-inch deep well socket wrench or 13/16-inch spark plug wrench to loosen the plug.

Spark Plug Cleaning, Inspection and Repair

Examine the plug (Figure 13-1, Page 13-2). The deposits on the plug base and electrode are an indication of the correct heat range and efficiency as well as a guide to the general condition of the engine, fuel and air mixture and ignition system. If all of the above conditions are proper, the spark plug should be a light brown color. There should be no bridging between the electrode and base. The electrode should not be eroded. Black color, excessive carbon, and/or a wet plug indicates that the fuel is too rich. White, burned or melted electrodes indicate the fuel is too lean or pre-igniting. Oily deposits on the plug electrode are an indication of worn rings, valve guides, cylinder wall, etc. Also examine the spark plug wire. Remove rubber boot and inspect internal spring for damage. Inspect spark plug wire for damage and be sure spring coil is securely attached to spark plug. See following WARNING.

WARNING

Remove spark plug wire to avoid accidental start up of the engine when servicing vehicle. To avoid
ignition of fuel and serious personal injury or death, never try to start the engine with plug removed
from engine.

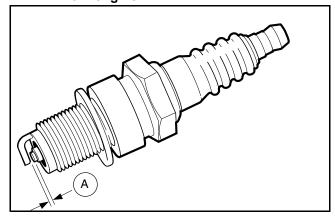


Figure 13-1 Spark Plug

Testing the Spark Plug

Check the sparking ability of a cleaned and properly gapped plug on a sparking comparator if possible. Spark should be blue and strong and able to jump a 5/16-inch (8 mm) gap.

Setting the Spark Gap

- 1. Pass a contact point file between the electrodes to produce flat, parallel surfaces to facilitate accurate gauging.
- 2. Use a wire type gauge. Bend the outside or ground electrode so only a slight drag on the gauge is felt when passing it between the electrode. Never make an adjustment by bending the center electrode. Set gap (A) between 0.027 to 0.031 inch (0.69 to 0.79 mm) (Figure 13-1, Page 13-2).

Spark Plug Installation

NOTE: Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in cylinder head threads with penetrating oil and clean the threads with a tap if necessary.

Use a high temperature, anti-seize lubricant on the threads of the spark plug to reduce friction when installing a new plug, and reduce "gauling" and thread seizing for future replacements.

Install the spark plug by threading it in until finger tight, then tighten the spark plug to 20 ft·lb (27 N·m).

CYLINDER HEAD

See General Warnings on page 1-2.

GENERAL INFORMATION

Test cylinder compression using a standard compression tester. Low compression would normally indicate a problem in the cylinder assembly such as defective rings, gaskets, etc. At a cranking speed of 550 to 600 RPM, the compression should be 156 to 185 psig (1075.6 to 1275.5 kPa). **See Engines and Transaxles Manual for inspection and repair.**

BREATHER VALVE (REED VALVE)

General Information

The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. The breather has a reed valve which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one-way reed valve blocks return flow and therefore maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expands into the rocker chamber. In the rocker chamber most oil separates from the air and drains back to the crankcase. The air passes through a tube and vents to the intake manifold. See Engines and Transaxles Manual for inspection and repair.

VALVE CLEARANCE CHECK AND ADJUSTMENT

- 1. Check and adjust clearance when the engine is cold.
- 2. Turn the crankshaft until the piston is at the top of the compression stroke.
- 3. Using a feeler gauge (1), measure the clearance (2) between the adjuster screw (3) and the top of the valve stem (4) **(Figure 13-2, Page 13-4 and Figure 13-3, Page 13-4)**.
- 4. If necessary, loosen the lock nut (3) and turn the adjuster (6) up or down to adjust the clearance to 0.005 inch (0.127 mm) for both intake and exhaust (Figure 13-2, Page 13-4).
- 5. While keeping the adjuster from turning with the screw holder (5) (P/N 1016413), tighten the lock nut (3) to 90 in·lb (10 N·m).
- 6. Recheck the clearance on both valves.

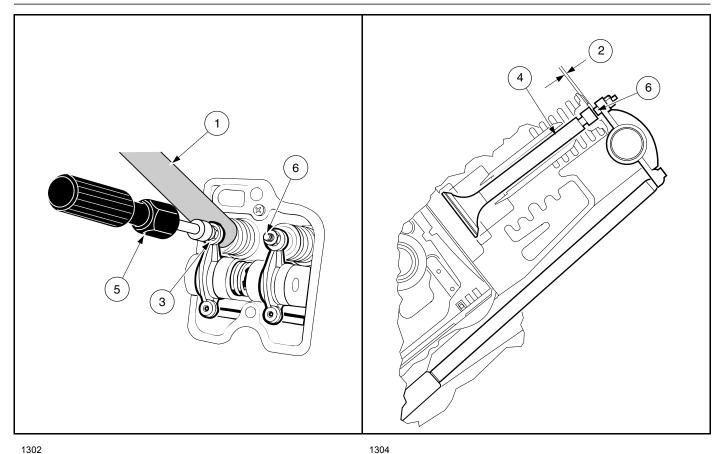


Figure 13-2 Measure Valve Clearance

Figure 13-3 Valve Clearance

CRANKCASE

See General Warnings on page 1-2.

ENGINE REMOVAL

To perform repairs on crankcase components, remove engine from the vehicle. See following CAUTION.

▲ CAUTION

- Before removal and disassembly, clean the engine.
- 1. Remove the powertrain. See Unitized Transaxle Removal on page 17-10.See following NOTE.

NOTE: The crankshaft has left-hand threads at the clutch mounting hole.

- 2. Remove starter/generator. See Starter/Generator on page 12-1.
- 3. Remove drive clutch. See Drive Clutch Removal on page 16-4 and preceding NOTE.
- 4. Remove muffler. See Muffler Removal on page 15-1.
- 5. Remove engine mounting hardware (items 1, 2, 5, and 6) (Figure 13-6, Page 13-6).
- 6. Lift engine from the mounting plate.

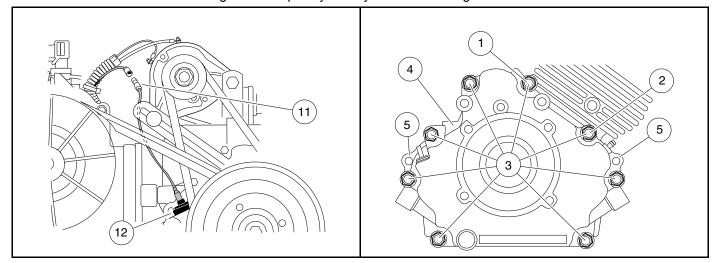
7. Remove crankcase oil drain plug and filler tube. Tip the engine slightly to allow all of the oil to drain from the crankcase. Dispose of engine oil properly.

CRANKCASE COVER REMOVAL

- 1. Remove yellow jumper wire (11) from cord connector (12) (Figure 13-4, Page 13-5).
- 2. Remove nuts and clamps at two-ended bolts (1 and 2) (Figure 13-5, Page 13-5).
- 3. Remove eight bolts (3) and remove the crankcase cover (4). See following NOTE.

NOTE: If the crankcase cover sticks, tap lightly with a plastic mallet on alternate sides near the dowel pins (5) (**Figure 13-5**, **Page 13-5**).

4. Remove the crankcase cover gasket completely. It may stick to the flanged surface of the crankcase.



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Figure 13-4 Oil Level Sensor Wire

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Figure 13-5 Crankcase Cover

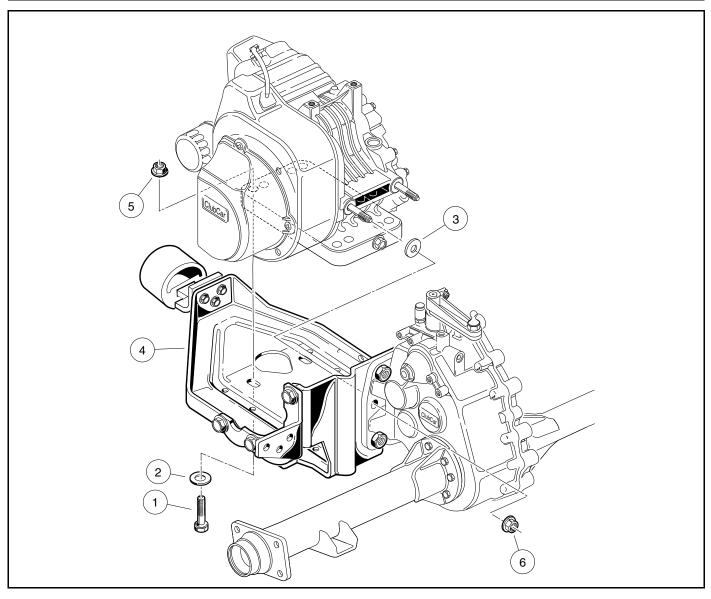


Figure 13-6 Engine Mounting Plate

OIL LEVEL SENSOR

Testing the Oil Level Sensor

See See Oil Level Sensor on page 11-30.

Oil Level Sensor Removal

- 1. If not already removed, remove crankcase cover. See Crankcase Cover Removal on page 13-5.
- 2. Disconnect the oil level sensor wire (2) from the cord connection (1) (Figure 13-7, Page 13-7).
- 3. Remove the screw (3) from the wire clamp (4).
- 4. Remove the two mounting screws from the inside of the crankcase cover and remove the oil level sensor and bracket.
- 5. If necessary, remove the three screws (7) that hold the sensor to the bracket (5).

Oil Level Sensor Installation

1. If the oil level sensor was removed from the bracket, install sensor (6) into bracket (5) and secure with three screws (7) (Figure 13-7, Page 13-7). Tighten to 17 in lb (1.9 N·m).

- 2. Position the sensor and bracket on inside of crankcase and install two mounting screws.
- 3. Connect sensor wire (2) to cord connector (1).
- 4. Install screw (3) through wire clamp and into crankcase cover. Tighten to 30 in·lb (3.4 N·m).

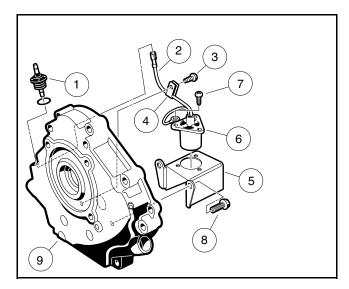
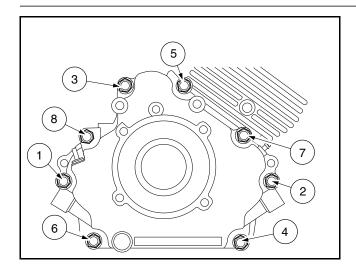


Figure 13-7 Oil Level Sensor

CRANKCASE COVER INSTALLATION

▲ CAUTION

- Before assembly, make sure parts are clean.
- · Do not reuse the gasket. Install a new one.
- Install and tighten crankcase cover bolts as instructed. Failure to do so could cause the cover to become warped.
- 1. Clean the gasket surfaces on the crankcase cover to fit a new gasket during installation and inspect the oil seal for wear and damage.
- 2. Install crankcase cover. Using HANDS ONLY, seat cover completely against the crankcase. If the cover will not seat, the camshaft is not installed correctly.
- Install and finger tighten evenly the eight cover mounting bolts.
- 4. Tighten the cover mounting bolts in two steps. First, in the sequence shown, tighten all eight bolts to approximately 130 in lb (14 N·m). Then, repeating the sequence, tighten them to 250 in lb (28.2 N·m) (Figure 13-8, Page 13-8).
- 5. Connect the yellow jumper wire (11) to the cord connector (12) (Figure 13-4, Page 13-5).



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Figure 13-8 Crankcase Cover Installation

IGNITION COIL AND FLYWHEEL

See General Warnings on page 1-2.

IGNITION COIL AND FLYWHEEL REMOVAL

- 1. Loosen three screws (2) and remove the remaining four screws (1) attaching the flywheel housing as shown, then remove the housing (Figure 13-9, Page 13-8).
- 2. Disconnect the ignition coil (11) from its primary lead wire at the connector (12). Remove the two bolts (10) and take out the ignition coil (Figure 13-10, Page 13-8).

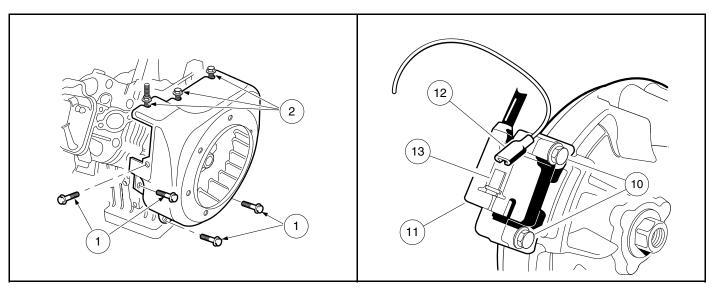


Figure 13-9 Flywheel Housing

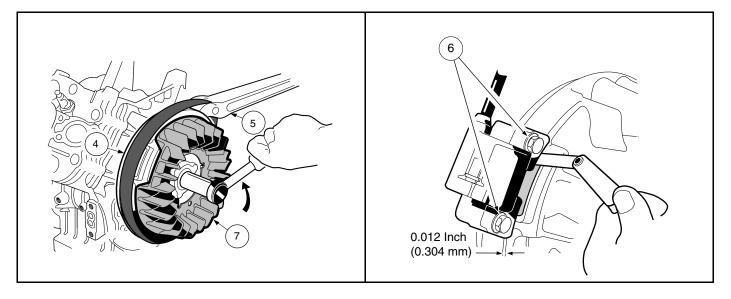
Figure 13-10 Ignition Coil

3. Hold the flywheel (4), not the fan (7), with a strap wrench (5) and, using a 25 mm socket, remove the flywheel nut (and flat washer) by turning it counterclockwise (Figure 13-11, Page 13-9). See following CAUTION.

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A CAUTION

- The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.
- Do not damage the fan blades with the strap wrench. Do not place screwdriver or pry bar in the fan blades.
- 4. Remove the flywheel with a puller (P/N 1016627).
- 5. Remove the flywheel key from its groove.



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Figure 13-11 Flywheel Nut

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Figure 13-12 Adjust Ignition Coil Air Gap

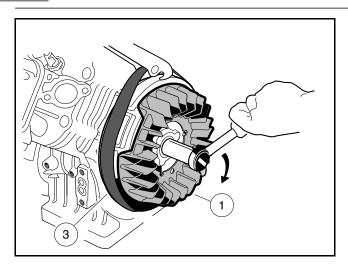
FLYWHEEL INSTALLATION

- 1. Insert the flywheel key into the keyway in the crankshaft. Then align the keyway in the flywheel to the key and push the flywheel and fan assembly onto the crankshaft until it seats. Install flat washer and nut finger tight.
- 2. Use a strap wrench (3) to keep the flywheel and fan assembly (1) from turning while tightening the flywheel nut to 63 ft·lb (85.4 N·m) (Figure 13-13, Page 13-10). See following CAUTION.

▲ CAUTION

- The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.
- Be careful not to damage the fan blades. Use a strap wrench to hold flywheel. Do not place screwdriver or pry bar between fan blades.
- 3. Install the fan housing and tighten the screws to 90 in lbs (10 N·m).

Engine Installation ENGINE – KAW. FE350



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Figure 13-13 Fan and Flywheel Installation

IGNITION COIL INSTALLATION

- 1. Installation is the reverse of removal.
- 2. While tightening the two bolts (6), use a bronze feeler gauge to adjust the ignition coil air gap to 0.012 inch (0.304 mm) (Figure 13-12, Page 13-9).
- 3. Tighten the two ignition coil bolts to 30 in·lb (3.4 N·m).

CRANKCASE COVER INSTALLATION

See Crankcase Cover Installation on page 13-7.

ENGINE INSTALLATION

See General Warnings on page 1-2.

- 1. Place engine onto engine mounting plate and tighten the mounting hardware (1, 2, and 5) to 13 ft·lb (17.7 N·m). Tighten nuts (6) to 17 ft·lb (23.1 N·m) (Figure 13-6, Page 13-6).
- 2. Install drive clutch. See Drive Clutch Installation on page 16-12.
- 3. Install drive belt. See Drive Belt Installation on page 16-3.
- 4. Install muffler. See Muffler Installation on page 15-1.
- 5. Install starter/generator and belt. See Starter/Generator on page 12-1.
- Install the powertrain. See Unitized Transaxle Installation on page 17-18.
- 7. Install oil drain plug in the crankcase and tighten to 20 ft·lb (27.1 N·m). Apply a light film of oil on the seal of a new oil filter and install the filter on the crankcase. Fill the crankcase to the proper level with the correct type of oil. This engine should be regarded as a new engine for next scheduled oil change. See Section 10 Periodic Maintenance.
- 8. Check all hardware for proper torque/tightness.
- 9. Check engine oil level.
 - 9.1. With vehicle on level surface, remove dip stick and clean with cloth (Figure 13-14, Page 13-11).

- 9.2. Reinsert dip stick until fully seated.
- 9.3. Oil must be in the SAFE LEVEL range.

A CAUTION

· Do not overfill with oil.

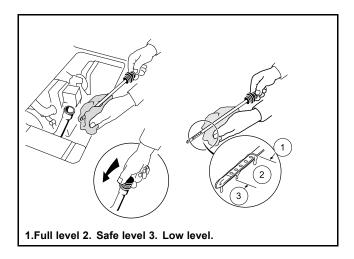


Figure 13-14 Check Engine Oil Level

- 10. Install a new or cleaned spark plug, gapped between 0.027 to 0.031 inch (0.69 to 0.79 mm), and connect plug wire to plug.
- 11. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 12. Adjust the engine RPM setting. See Engine RPM Adjustment on page 14-9.
- 13. Test-drive vehicle to ensure all systems are functional and correctly adjusted.

TORQUE SPECIFICATIONS

ITEM	SIZE	LIMITS	
Cylinder head bolts	M8	220 in·lb (24 N·m)	
Valve clearance adjustment nuts	M5	90 in·lb (10 N·m)	
Connecting rod bolts (coat threads with engine oil)	M7	180 in·lb (20 N·m)	
Flywheel retaining nut	M18	100 ft·lb (135 N·m)	
Crankcase cover to block bolts	M8	22 ft·lb (31 N·m)	
Starter/Generator bracket to block bolts	M8	200 in·lb (23 N·m)	
Oil drain plug	M14	20 ft·lb (27.1 N·m)	
Fan housing screws	M6	90 in·lb (10 N·m)	
Fan shroud screws	M6	25 in·lb (2.8 N·m)	
Bolts marked with "4" (when used with nuts)	M8 M6 M5	130 in·lb (15 N·m) 50 in·lb (5.9 N·m) 30 in·lb (3.4 N·m)	

ADJUSTMENTS AND SETTINGS

ITEM	LIMITS
Spark plug gap (standard)	0.027 to 0.031 in. (0.69 to 0.79 mm)
Ignition coil air gap (standard)	0.012 in. (0.304 mm)
Compression pressure (min.)	128 psig (883 kPa)
Cylinder head-gasket surface flatness (max.)	0.002 in. (0.05 mm)
Valve clearance (exhaust, intake) when engine is cold	0.005 in. (0.127 mm)
Engine RPM	2900 (±30) RPM

A DANGER

See General Warnings on page 1-2.

A WARNING

See General Warnings on page 1-2.

GENERAL INFORMATION

The engine is equipped with a float bowl type carburetor with fixed jets that require no adjustment. The carburetor atomizes the fuel, mixes it with air, and feeds the combustible mixture into the cylinder.

NOTE: To ensure proper fuel supply hose installation, a nylon washer was added to act as a positive stop early in Model Year 2013. It is placed onto the fuel inlet nipple of the carburetor before the fuel supply hose is attached and secured with the screw clamp. The nylon washer keeps the hose and clamp correctly located only on the fuel inlet, rather than on the carburetor body.

CARBURETOR

See General Warnings on page 1-2.

Before suspecting the carburetor as the cause of poor engine performance, make sure the fuel and ignition systems are in proper operating condition. Check the following items:

- Spark plug and gap condition. See Spark Plug Cleaning, Inspection and Repair on page 13-2.
- Air filter element. See Air Filter on page 14-13.
- Fuel filter. See Fuel Filter on page 14-15.
- Choke and air intake system (for restriction of air flow). See Choke and Air Intake System on page 14-10.
- Fuel pump. See Fuel Pump on page 14-17.
- Fuel lines (from fuel tank to filter to pump to carburetor). See Fuel Lines on page 14-21.
- Exhaust system (for restrictions). See Section 15 Exhaust System Kaw. FE350.

If the carburetor floods or leaks fuel at the float bowl gasket or carburetor vent tube, the fuel inlet valve could be worn or dirty. Another cause of this condition may be a damaged float that has filled with fuel and sinks.

For elevations above 3000 feet (914.4 m), main jets other than standard operate more effectively. The following chart lists the elevation ratings for various jet sizes. No adjustment is required for the pilot jet. If the vehicle idles roughly, turn the pilot air screw out until the vehicle idles smoothly.

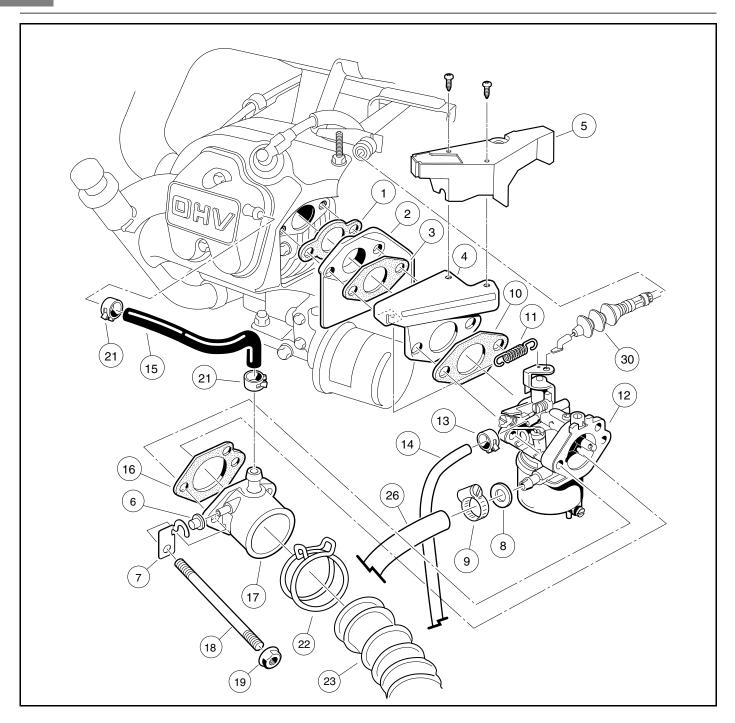


Figure 14-1 Carburetor Mounting

MAIN JET ELEVATION/SIZE CHART

KAWASAKI FE350	CARBURETOR NUMBER	JET SIZE		
ENGINE Model/Revision		0 TO 3300 FT. (0 TO 1000 M)	3300 TO 9900 FT. (1000 TO 3000 M)	9900 FT. AND HIGHER (3000 M AND HIGHER)
AS02, BS02 AS03, CS03, DS03	32282	85	82	80
	32337			
BS03	32478			
AS10 to FS10 AS11 to FS11 AS23 AS24	32571			
	32642			
	32740			
	42051			
AS26 to current	42081			
AS27 to current	42082	82	80	78

CHANGING THE MAIN JET

See General Warnings on page 1-2.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the carburetor.
 - 2.1. Turn fuel shut-off valve on fuel tank to the closed (OFF) position (Figure 14-13, Page 14-22).
 - 2.2. Loosen the intake air hose clamp (22) and disconnect the intake air hose (23) at the carburetor end only (Figure 14-1, Page 14-2).
 - 2.3. Remove the governor guard (5).
 - 2.4. Disconnect the governor cable (30) from the carburetor.
 - 2.5. Disconnect the carburetor vent line (14).
 - 2.6. Disconnect the fuel supply line (26) at the carburetor end only. Temporarily plug the end of the fuel line to prevent fuel leakage.
 - 2.7. Remove the carburetor retaining nuts (19), intake pipe (17), and carburetor (12). See following NOTE.

NOTE: Note the orientation of the gasket (16), between the carburetor intake pipe (17) and the carburetor body (12) so that it can be replaced in the same orientation (**Figure 14-1, Page 14-2**).

When removing the carburetor body, the throttle return spring (11) must be disconnected. Note its proper orientation so that it can be replaced in the same orientation.

The carburetor must be kept upright during removal.

- 3. Position the carburetor with the drain screw (11) over a catch basin (Figure 14-4, Page 14-4).
- 4. Turn the carburetor bowl drain screw counterclockwise two or three turns and drain all the fuel from the bowl into the catch basin (**Figure 14-2**, **Page 14-4**). Tighten the drain screw to 10 in·lb (1.1 N·m). Return fuel to the fuel tank or dispose of properly.
- 5. Mark the body of the carburetor and the carburetor fuel bowl with an indelible ink marker so that, after removal, the bowl can be installed again in the same position (**Figure 14-3, Page 14-4**).

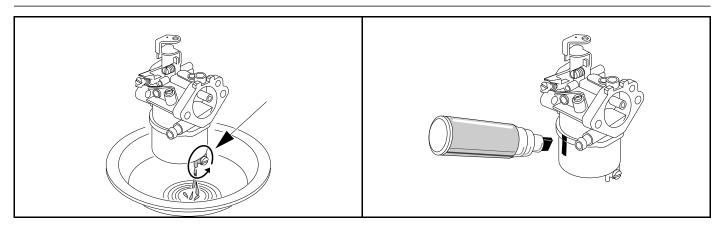


Figure 14-2 Drain Bowl

Figure 14-3 Mark Carburetor and Bowl for Alignment

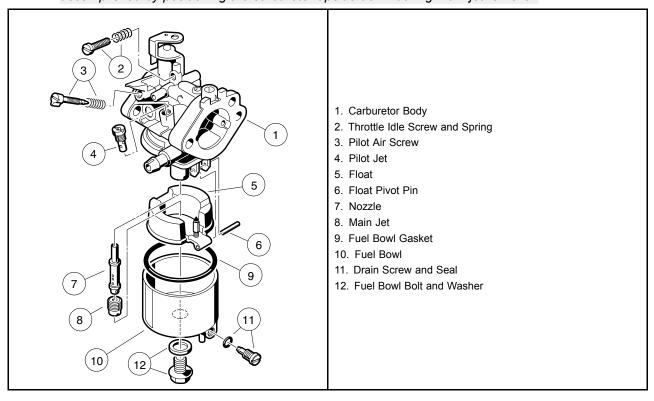
6. Remove the carburetor fuel bowl retaining screw and washer (12), then remove the fuel bowl (10) and clean it with a nonflammable solvent (Figure 14-4, Page 14-4). See following NOTE.

NOTE: Make sure the fuel bowl gasket (9) remains properly seated in the carburetor body when the fuel bowl is removed.

During normal operation, the fuel bowl retains the float pivot pin (6). Make sure that the float pivot pin does not fall out of the carburetor body after the fuel bowl is removed.

7. Remove the main jet (8) from the carburetor body and discard it (Figure 14-4, Page 14-4). See following NOTE.

NOTE: Make sure the fuel nozzle (7) does not fall out of the carburetor body after removal of the main jet. This is best accomplished by positioning the carburetor upside down during main jet removal.



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Figure 14-4 Carburetor Components

- 8. Select the proper size main jet. **See Main Jet Elevation/Size Chart on page 14-3.** Check the size designation on the jet to make sure it is the correct part.
- Install the new main jet and tighten it to 12 in lb (1.4 N·m). See following CAUTION and NOTE.

A CAUTION

Do not remove the valve/spring assembly from the float assembly. Doing so will damage the spring.

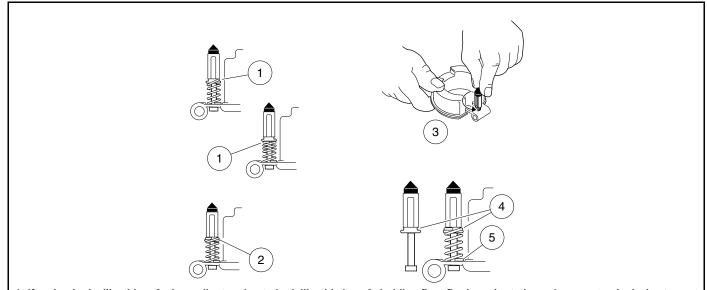
NOTE: Inspect the main jet nozzle (7), and pilot jet (4) to ensure they are free from contamination (**Figure 14-4**, **Page 14-4**). Replace any part that is clogged with contamination. Replace the float if it is damaged, or if the float valve is damaged or worn. Examine the float valve/spring assembly to make sure the spring is installed correctly (**Figure 14-5**, **Page 14-5**).

10. Install the fuel bowl. Make sure that it is positioned properly by aligning the marks applied in step 4. **See following CAUTION.**

A CAUTION

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 Make sure the fuel bowl is properly seated against the carburetor fuel bowl gasket, and the gasket is not pinched.



1. If spring looks like this... 2. then adjust spring to look like this by... 3. holding float firmly and rotating valve counterclockwise to seat spring in seat of float bowl 4. Check for coil located in groove above both ears. 5. Check for spring seated in recess of float.

Figure 14-5 Inspect Float Valve/Spring Assembly – Adjust If Required

- 11. Install the fuel bowl retaining screw and tighten it to 61 in lb (6.9 N·m).
- 12. Write the size of the main jet on the fuel bowl with an indelible ink marker. This should be written in a location that will be visible when the carburetor is installed on the engine.
- 13. Install the carburetor on the engine (Figure 14-1, Page 14-2).
 - 13.1. Attach the throttle return spring (11) to the carburetor and then to the throttle bracket (4) just before positioning the carburetor and securing it to the engine.
 - 13.2. Install the intake pipe gasket (16) (check for proper orientation) and intake pipe (17).
 - 13.3. Install the carburetor retaining nuts (19) and tighten them to 50 in·lb (5.7 N·m).
- 14. Place nylon washer (8) onto fuel inlet of carburetor and then connect fuel supply line (26). Tighten screw clamp (9) to 9 in·lb (1.0 N·m) (Figure 14-1, Page 14-2).

- 15. Install carburetor vent line (14) and clamp (13).
- 16. Install the governor cable (30).
- 17. Install the governor guard (5), flat washer and nylon lock nut. Tighten to 30 in·lb (3.4 N·m).
- 18. Install the intake hose (23) and secure with hose clamp.

NOTE: Make sure the intake hose is not twisted during installation.

- 19. Turn fuel shut-off valve to the ON position (Figure 14-13, Page 14-22).
- 20. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 21. Test drive the vehicle.

ENGINE CONTROL LINKAGE

See General Warnings on page 1-2.

GENERAL INFORMATION

For proper vehicle operation, it is important the accelerator pedal, governor linkage, and throttle adjustments are done correctly and in the proper sequence. **See following CAUTION.**

CAUTION

· Improper adjustment can result in poor vehicle performance and/or damage to the engine components.

GROUND SPEED

NOTE: If possible, the manufacturer recommends measuring ground speed when setting engine RPM.

This vehicle should reach a ground speed of at least 12.5 mph (20.1 km/h). If the ability to measure vehicle ground speed is not available, the closest engine RPM setting to achieve 12.5 mph (20.1 km/h) is 2750 RPM.

GOVERNOR CABLE

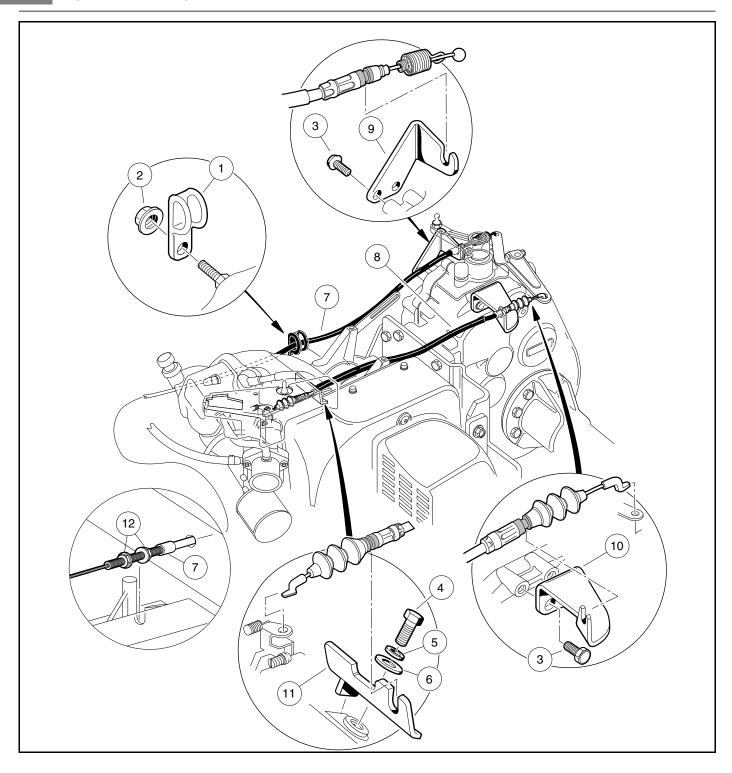
Governor Cable Removal

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the governor guard (5) (Figure 14-1, Page 14-2).
- 3. Release the governor cable (8) from brackets (10 and 11) (Figure 14-6, Page 14-8).
- 4. Remove the ends of cable (8) from the governor lever arm and the carburetor and remove the cable from the vehicle.

Governor Cable Installation and Adjustment

 Insert the ends of cable (8) into the respective holes on the carburetor and the governor lever arm (Figure 14-6, Page 14-8).

- 2. Press on the cable (8) to snap it in place in brackets (10 and 11).
- 3. With the governor lever arm loose on the governor shaft, use a 1/8-inch (3.2 mm) punch or scratch awl to turn the governor arm shaft counterclockwise until it stops. Then pull the governor lever arm rearward until the carburetor throttle is in the "wide open throttle" (WOT) position.
- 4. While holding the arm and shaft in the fully counterclockwise position, tighten the governor arm lever nut to 36 in·lb (4.0 N·m).
- 5. Check engine RPM adjustment. See Engine RPM Adjustment on page 14-9.



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Figure 14-6 Governor and Accelerator Cables

ACCELERATOR CABLE

Accelerator Cable Removal

1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles on page 1-3.

- 2. Access the pedal group and remove accelerator cable from the pedal group. See Pedal Group Removal on page 5-4.
- 3. Loosen the two lock nuts (12) that secure the accelerator cable to the vehicle (Figure 14-6, Page 14-8).
- 4. Release the accelerator cable housing from bracket (9).
- 5. Release the end of accelerator cable from the governor lever arm and remove the cable from vehicle.

Accelerator Cable Installation

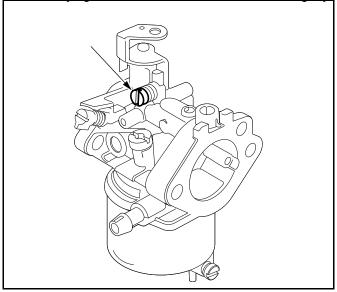
- 1. Insert the accelerator cable through the hole in the frame and feed it towards the pedal group. Connect the accelerator cable to the pedal group. See Pedal Group Gasoline Vehicle on page 5-4.
- 2. Connect the end of the accelerator cable (7) to the governor lever arm (Figure 14-6, Page 14-8).
- 3. Press on the cable (7) to snap it in place in bracket (9).
- 4. Adjust two lock nuts (12) to remove excess slack in the accelerator cable. Finger-tighten the two lock nuts.
- 5. Before tightening the cable housing lock nuts make sure the engine RPM adjustment is correct. **See Engine RPM Adjustment on page 14-9.**

CLOSED THROTTLE OR IDLE ADJUSTMENT

When the accelerator pedal is released, the engine will stop. Therefore, it is not possible to measure or set idling speed under normal vehicle operating conditions. Set throttle valve as follows:

1. Loosen the Throttle Idle Screw so that it is not touching the throttle lever (Figure 14-7, Page 14-9).

. Slowly tighten the Throttle Idle Screw until it lightly touches the throttle lever, then tighten it an additional 3/4 turn.



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Figure 14-7 Throttle Idle Screw

ENGINE RPM ADJUSTMENT

A DANGER

- Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- 1. If the governor is adjusted, proceed to step 2; otherwise, adjust the governor. See Governor Cable Installation and Adjustment on page 14-6.

- Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 3. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and place the neutral lockout cam in the MAINTENANCE position.
- 4. Connect a tachometer (P/N 1016112) to the spark plug lead.
- 5. With the tachometer connected, and the engine at normal operating temperature, check high speed RPM. With the accelerator pedal pressed to the floor, the tachometer should read 2900 RPM (±30).
- 6. To **reduce** RPM, adjust the two lock nuts (12) to move the cable housing toward the rear of the vehicle until the specified RPM is reached **(Figure 14-6, Page 14-8)**. To **increase** RPM, adjust the two lock nuts (12) to move the cable housing forward until the specified RPM is reached.
- 7. Be sure both lock nuts are locked against the bracket and then check the RPM again. If the RPM needs to be adjusted, repeat step 6.
- 8. If more adjustment is required than the cable housing will allow, make sure the spring on the other end of the accelerator cable is properly positioned. Excessive belt and torque converter wear can also prevent proper RPM adjustment. Check them for excessive wear. See Section 16 Torque Converter Kaw. FE350.
- 9. Check vehicle ground speed. See Governor Cable on page 14-6.

ENGINE BACKFIRE

If the pedal-start Kawasaki FE350 engine is "backfiring", it is most likely a *lean backfire* originating in the exhaust system due a lean fuel/air mixture. A lean backfire has the following characteristics:

- Occurs in the exhaust
- Generally occurs after pedal is reapplied
- · Sounds range from a soft 'pffft' to a loud pop. Engines can exhibit a wide range of the sound.

To eliminate engine backfire, the carburetor pilot air screw and throttle idle screw must be adjusted.

Pilot Air Screw Adjustment

Adjust pilot air screw (3) (Figure 14-4, Page 14-4) out (counterclockwise) until it hits the stop (1/4 to 1/2 turn). No tools are needed.

Throttle Idle Screw Adjustment

- 1. If throttle idle screw (2) (Figure 14-4, Page 14-4) is still at factory setting:
 - 1.1. Back throttle idle screw out (counterclockwise) 1/4 to 3/8 turn.
 - 1.2. Ensure the throttle idle screw is still in contact with throttle when pedal is up.
- 2. If throttle idle screw (2) is not at factory setting or if not sure:
 - 2.1. Back throttle idle screw out (counterclockwise) until screw is not touching throttle.
 - 2.2. Slowly adjust throttle idle screw in (**clockwise**) until screw just touches throttle. This can be accomplished by gently holding throttle closed while adjusting screw. Go to next step when throttle just begins to move.
 - 2.3. Adjust throttle idle screw in (clockwise) an addition 1/8 to 1/4 turn.
- Check the engine RPM setting to ensure that it has not been altered. See Engine RPM Adjustment on page 14-9.

CHOKE AND AIR INTAKE SYSTEM

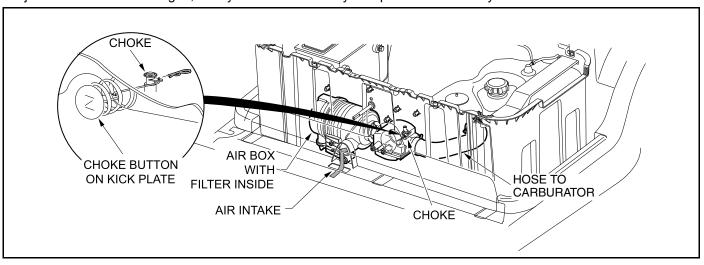
See General Warnings on page 1-2.

GENERAL INFORMATION

The choke and air intake system is a simple mechanism requiring very little or no maintenance. The system consists of a choke assembly mounted at the center of the kick plate. An air filter housing draws clean, cool air from beneath the vehicle via an opening between the kick plate and the fuel bucket. The air passes through an air filter, through the choke assembly, and through a hose to the carburetor. (Figure 14-8, Page 14-11)

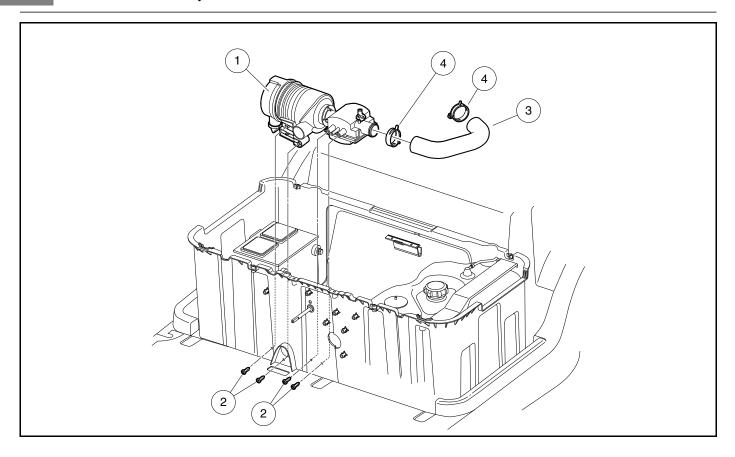
The choke system aids in starting the engine in cold weather. When starting a cold engine, the spring loaded choke cover is pushed in by hand. This restricts the air flow, creating a "fuel rich" mixture in the carburetor. The choke cover is held in until the engine starts, and then is released. The air flow to the engine is no longer restricted, and the engine operates normally.

The choke assembly is adjusted at the factory and does not require field adjustment; however, if the choke assembly is subjected to abuse or damaged, it may become necessary to replace the assembly.



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Figure 14-8 Air Intake and Choke



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Figure 14-9 Air Intake Mounting

CHOKE BUTTON

The choke button actuates the choke mechanism via a rod that connects to the button and the choke (Figure 14-8, Page 14-11). Pressing in the button actuates the choke. A spring clip attaches the rod to the choke. If the choke button requires service, the kick plate must be removed. See Kick Plate and Choke Button Bezel on page 4-10.

AIR INTAKE COMPONENTS REMOVAL

- 1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Access the engine compartment.
- 3. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 4. Hose (3) may be removed by removing the clamps (4) at the choke and the carburetor (Figure 14-9, Page 14-12).
- 5. The air intake assembly (1) is secured to the fuel bucket with four screws (2). Access to the screws requires that the kick plate be removed. **See Kick Plate and Choke Button Bezel on page 4-10.**

AIR INTAKE COMPONENTS INSTALLATION

WARNING

- Intake hose is made from a special fire retardant neoprene material. Use of any hose that does not meet CCI specifications could create a fire hazard.
- 1. Position air intake assembly (1) inside the fuel bucket (Figure 14-9, Page 14-12). Secure intake assembly with four screws (2). Tighten screws to 2.7 ft·lb (3.5 N·m).
- 2. Install hose (3) and secure one end to the air intake assembly (1) and one end to the carburetor. Install clamps (4) to secure the hose in place.
- 3. Install kick plate and choke button. See Kick Plate and Choke Button Bezel on page 4-10.

AIR FILTER

General Information

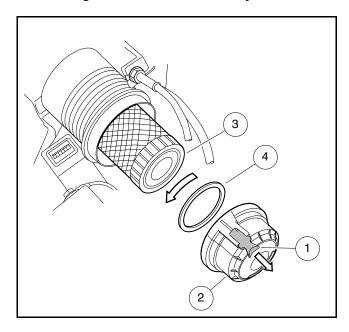
The air filter should be checked every year or 100 hours. More frequent service may be required in extremely dirty operating environments. Need for immediate servicing will be indicated by a loss of power, sluggish acceleration, or an engine which runs roughly with excessive black exhaust smoke.

Air Filter Replacement

- 1. Access the engine compartment.
- 2. Pull the yellow tab (1) on the air filter cover (2) away from the air filter housing (Figure 14-10, Page 14-14).
- 3. Rotate the cover counterclockwise to approximately the 10 o'clock position to release the internal locking tabs. Remove the cover.
- 4. Remove the air filter (3) and dispose of properly.
- 5. Using a clean cloth, wipe away any dust or dirt from inside the air filter housing. Remove all dirt build-up around the inside lip of the housing or the cover will not seal properly.
- 6. Install new air filter, inserting the open end into the housing first.
- 7. Check that the air intake gasket (4) is in place in the cover (2) and oriented correctly with the coated side of the gasket facing toward the air filter housing.
- 8. Place the cover (2) over the housing. Press firmly to engage the seals and rotate the cover clockwise until the yellow tab is at the 11 o'clock position.
- 9. Press in the yellow tab (1) to lock the cover on the housing. See following CAUTION.

CAUTION

- Engine damage will occur if the air filter cover is not properly secured.
- · If air filter housing is extremely dirty, clean thoroughly.
- Use only Club Car replacement air filters (P/N 102558201) or equivalent. The use of other air filters could result in engine damage. If the air filter is too small, the cover will seat before the filter can seal, leaving space for dirt to pass into the engine on all sides of the element. This will damage the engine and void the warranty.



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Figure 14-10 Air Filter

FUEL FILTER

See General Warnings on page 1-2.

GENERAL INFORMATION

Fuel is supplied to the fuel pump and carburetor through flexible lines. An in-line filter is installed between the fuel tank and the fuel pump (**Figure 14-11**, **Page 14-16**). The filter, fuel lines, and the fuel tank vent should be inspected periodically for leaks.

The fuel filter should be replaced when necessary, but under no circumstance should the period of time between filter changes exceed two years or 200 hours.

FUEL FILTER REMOVAL

- 1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Access the engine compartment.
- 3. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 4. To prevent fuel drainage, turn the fuel shut-off valve (5) on the fuel tank (1) (Figure 14-11, Page 14-16) to the closed (OFF) position (Figure 14-13, Page 14-22).
- 5. Remove the clamps (6) and fuel lines (9 and 10) from the filter (7) and plug the fuel lines (Figure 14-11, Page 14-16).

FUEL FILTER INSTALLATION

CAUTION

- Fuel filter is marked with flow direction arrows. Make sure that the filter is installed with arrows pointing in the direction of fuel flow from tank to the fuel pump.
- 1. Install the fuel filter (7) in the fuel line. Use new clamps (6) (Figure 14-11, Page 14-16).
- 2. Turn the fuel shut-off valve to the ON position (Figure 14-13, Page 14-22).
- 3. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 4. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and place the neutral lockout cam in the MAINTENANCE position. Start the engine and check for fuel leaks. **See following DANGER.**

A DANGER

- Repair all fuel leaks before operating the vehicle.
- 5. Place the neutral lockout cam in the OPERATE position.

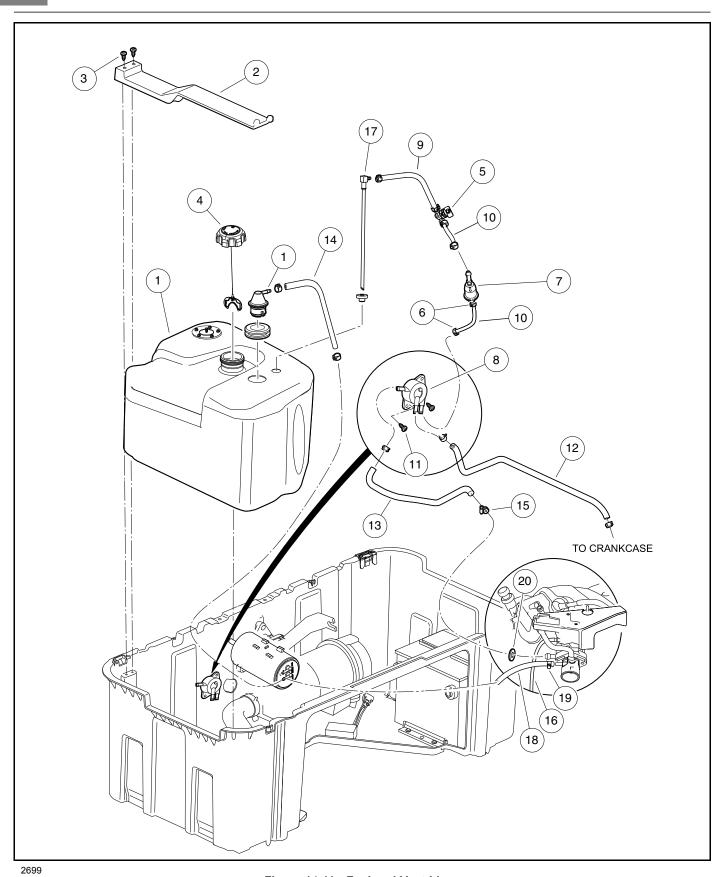


Figure 14-11 Fuel and Vent Lines

FUEL PUMP

See General Warnings on page 1-2.

NOTE: The fuel pump is plastic and cannot be disassembled for repair.

GENERAL INFORMATION

The gasoline vehicle is equipped with an impulse fuel pump. If the fuel pump is not operating properly, perform the following tests:

- · Make sure all hose clamps are tight.
- · Inspect the impulse line and fuel lines for damage or clogging.
- Make sure the air vent on the fuel pump is not clogged with dirt.
- · Make sure the fuel filter is not clogged.

FUEL PUMP REMOVAL

- 1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Turn fuel shut-off valve to the closed (OFF) position (Figure 14-13, Page 14-22).
- 4. Disconnect impulse hose (12) from fuel pump (8) (Figure 14-11, Page 14-16).
- 5. Disconnect the fuel hoses (10 and 13) from the pump and plug hoses to prevent fuel leakage. **See following WARNING.**

A WARNING

- Carefully drain any fuel remaining in the pump into an approved container. Add drained fuel back into fuel tank or dispose of properly.
- 6. Remove hardware (11) and fuel pump (8).

FUEL PUMP INSTALLATION

NOTE: This gasoline vehicle complies with the California Air Resources Board (CARB) evaporative emissions regulations when equipped with MARK 4 DAYPERM C-U-06-030 or AVON GREENBAR G-05-018 fuel hose (CC P/N 102865101). To remain in compliance with California regulations, replace any fuel hose on this vehicle with Club Car P/N 102865101 having 'DAYPERM C-U-06-030' or 'AVON GREENBAR G-05-018' printed on the hose, or equivalent.

- 1. Secure fuel pump (8) to vehicle with hardware (11) and tighten to 40 in lb (4.5 N·m) (Figure 14-11, Page 14-16).
- 2. Connect fuel hoses (10 and 13) to fuel pump (8) and secure with clamps. Route the fuel lines as shown.

NOTE: Be sure to connect the fuel line (10), that comes from the fuel filter (7), to the inlet nipple on the pump (8). Direction of fuel flow is indicated by the arrows on the fuel pump (**Figure 14-11, Page 14-16**).

- 3. Connect the impulse hose (12) to the fuel pump (8) and secure with clamp.
- 4. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- Turn the fuel shut-off valve to the open position (Figure 14-13, Page 14-22).
- 6. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout cam in the MAINTENANCE position. **See following DANGER.**

- · Repair all fuel leaks before operating the vehicle.
- 7. Start the engine and check for fuel leaks. If the fuel pump leaks, it must be replaced.
- If no leaks are found, place the neutral lockout cam in the OPERATE position (Figure 17-2).

FUEL TANK

See General Warnings on page 1-2.

GENERAL INFORMATION

The vehicle is equipped with a high impact plastic, 6.7 gallon (25.4 L) fuel tank.

A WARNING

• If the fuel tank is damaged, replace it. Do not attempt to repair it. See the following tank removal and disposal procedure.

CAUTION

• Add only unleaded fuel to the tank. Do not put oil in the fuel tank.

FUEL TANK REMOVAL

- Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout cam in the MAINTENANCE position.
- 2. Turn fuel shut-off valve to the closed (OFF) position and run the engine until fuel remaining in the carburetor, fuel pump, and fuel lines is used up and the engine stalls (**Figure 14-13**, **Page 14-22**).
- 3. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 4. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 5. Return the neutral lockout cam to the OPERATE position.
- 6. Loosen, but do not remove, the carburetor drain screw (11) and drain fuel remaining in the carburetor bowl into an approved container (Figure 14-4, Page 14-4). Retighten carburetor drain screw.

7. Using a siphon with a suction device, siphon all fuel out of the tank and into an approved container. **See following DANGER and WARNING.**

A DANGER

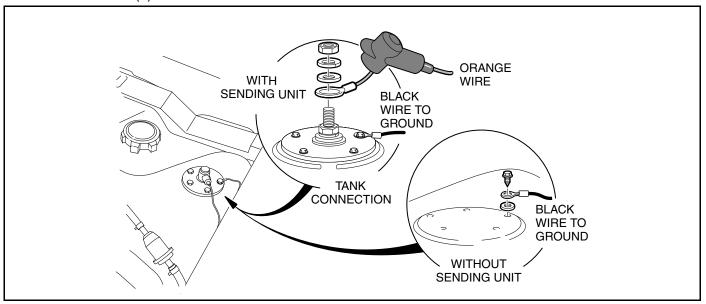
 Gasoline – Flammable! Explosive! Do not smoke. Keep sparks and flames away from the vehicle and service area. Service only in a well-ventilated area.

WARNING

- Do not attempt to siphon fuel using a hose that does not have a built-in suction device.
- · Do not attempt to siphon fuel using your mouth.
- 8. If vehicle is equipped with a fuel gauge, disconnect the black wire and orange wire from the fuel level sending unit on the tank (Figure 14-12, Page 14-19). Do not remove the lower nut on the center stud of the sending unit. If vehicle is not equipped with a fuel level sending unit, disconnect black ground wire. See following WARNING.

WARNING

- · Make sure the key switch is off before disconnecting wiring.
- 9. Remove the vent tube (14) and fuel line (9) from the fuel tank (Figure 14-11, Page 14-16).
- 10. Remove two screws (3) holding the forward end of the fuel tank hold-down (2). Lift up on the forward end of the hold-down and release the rear end from the fuel bracket.
- 11. Lift the fuel tank (1) out of the vehicle.



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Figure 14-12 Fuel Level Sending Unit

FUEL TANK DISPOSAL

- 1. Remove the cap from the tank. Thoroughly rinse the cap with water. The cap may be discarded or kept as a spare.
- 2. In a well-ventilated area, flush the fuel tank with water to remove any remaining fuel.
- 3. In a well-ventilated area, set the tank upside down so that the water can drain out of it. To make sure that the tank dries completely, allow the tank to sit for 24 hours. **See following CAUTION.**

A CAUTION

• Dispose of wastewater and fuel tank in accordance with local, state, and federal laws and ordinances.

FUEL TANK STORAGE

- 1. Remove the cap from the tank and thoroughly rinse it with water.
- 2. In a well-ventilated area, flush the fuel tank with water to remove any remaining fuel.
- In a well-ventilated area, set the tank upside down so that the water can drain out of it. To make sure that the tank dries completely, allow the tank to sit for 24 hours.
- 4. Store the tank upside down, with the cap installed, in a well-ventilated area.

FUEL TANK INSTALLATION

- 1. Place the fuel tank in the vehicle.
- Secure the tank with the fuel tank hold-down (2) (Figure 14-11, Page 14-16).
 - 2.1. Insert the tabs on the rear of the hold-down into the slots on the back of the fuel bucket.
 - 2.2. Pivot hold-down to place the front edge over mounting holes. Install two screws (2) to secure the hold-down. Tighten screws to 31 in·lb (3.5 N·m).
- 3. Connect the vent tube (14) to the fuel tank vent (Figure 14-11, Page 14-16).
- 4. Connect the fuel line (9) to the fuel tank shut-off valve (5). Use new clamps (6) (Figure 14-11, Page 14-16).
- 5. If vehicle is equipped with fuel level sending unit, connect the black wire from the fuel gauge to one of the fuel level sending unit screws. Connect the orange wire to the center stud and install the flat washer, lock washer, and nut. Tighten to 18 in·lb (2.0 N·m). Slide the rubber boot over the stud (Figure 14-12, Page 14-19). If not equipped with fuel level sending unit, connect black wire to ground screw on fuel tank. Tighten to 18 in·lb (2.0 N·m).

WARNING

- Static electricity on fuel tank can cause arching and ignite fuel vapors. Ensure that ground wire is properly connected.
- 6. Add fuel to the tank.
- 7. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 8. Ensure that the wheels are chocked, the Forward/Reverse handle is in the NEUTRAL position, and that the neutral lockout cam is in the MAINTENANCE position.
- 9. Check to be sure the fuel shut-off valve on top of the fuel tank is in the open (ON) position (Figure 14-13, Page 14-22).
- Turn the key switch to the ON position and press the accelerator pedal to start the engine. See following DANGER.

A DANGER

- Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- After installing the fuel tank and adding fuel, carefully check all fuel lines and connections for leaks. Repair any fuel leaks before operating the vehicle.

- 11. Allow the engine to run for a few minutes to ensure that the fuel lines are full of fuel.
- 12. Inspect each fuel line for leaks.
 - 12.1. Check all of the fuel line clamps at the carburetor, fuel filter, fuel pump, and fuel tank for leaks.
 - 12.2. Inspect each fuel line to ensure that the lines are not cracked, cut, or worn.

FUEL LINES

See General Warnings on page 1-2.

The fuel lines must be properly routed, and all hose clamps must be tight. The fuel lines should be kept clean. **See following WARNING.**

▲ WARNING

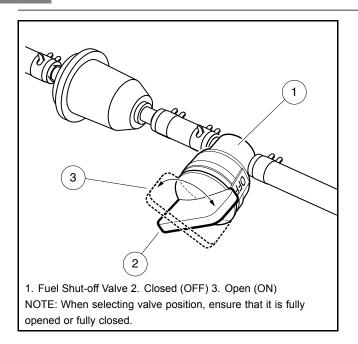
- Make sure fuel lines are the correct length and are properly routed. Failure to heed this warning could result in a fire due to damaged fuel lines.
- Fuel line (9) runs directly from the fuel tank to the fuel filter (7). The fuel filter has an arrow indicating fuel flow direction (Figure 14-11, Page 14-16).
- Fuel line (10) runs directly from the fuel filter to the fuel inlet of the fuel pump.
- Fuel line (13) runs directly from the fuel outlet of the fuel pump to the carburetor.

Small spring steel band clamps are used on all hose connections except at the carburetor. A screw band clamp (15) should be used at the carburetor along with a 0.31 inch (7.9 mm) nylon flat washer (20).

FUEL SHUT-OFF VALVE

See General Warnings on page 1-2.

The fuel shut-off valve is located on top of the fuel tank. The fuel shut-off valve should always be turned to the closed (OFF) position during vehicle storage, towing or trailering (**Figure 14-13**, **Page 14-22**). Unless the engine will be run as part of a procedure, the fuel shut-off valve should also be closed (OFF) before performing maintenance or service procedures.



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Figure 14-13 Fuel Shut-off Valve

FULLY OPEN POSITION

The valve's open position differs from standard valve configurations. For the valve to be fully open, it must be turned approximately 120° from the closed (OFF) position (until it cannot be turned any further). If the valve becomes partially closed, the engine will not run properly due to fuel starvation (**Figure 14-13**, **Page 14-22**).

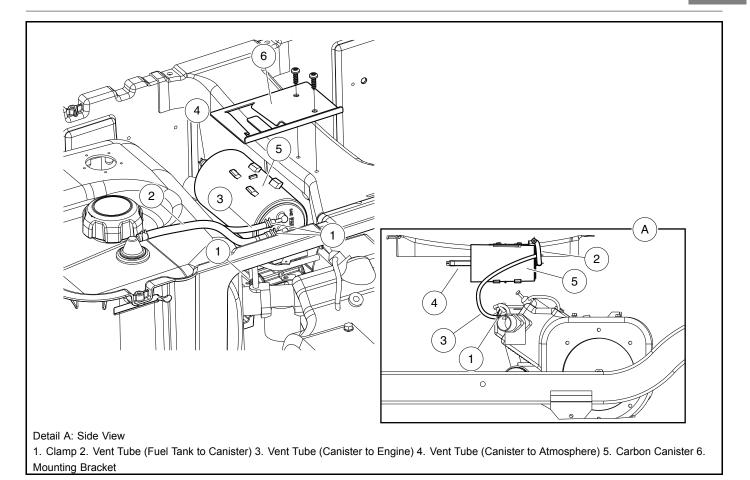
CARBON CANISTER

▲ WARNING

• If the carbon canister is damaged, only use an OEM (Club Car) replacement that is specifically designed and approved for use on this vehicle. Do not attempt to repair it. See the following canister removal procedure.

CARBON CANISTER REMOVAL

- 1. Disable the vehicle. See Disabling the Vehicle on page 1-3.
- 2. Raise or remove seat bottom from vehicle.
- 3. Remove hose clamps (1), securing three hoses (2, 3, and 4) to canister (5), and disconnect hoses (Figure 14-14, Page 14-23).
- 4. Push or pull canister from mounting bracket (6).



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Figure 14-14 Carbon Canister, Hoses and Routing

CARBON CANISTER INSTALLATION

- 1. Align canister mounting tabs with slots in mounting bracket (6) and push canister (5) into bracket (Figure 14-14, Page 14-23). Force it in until fully seated.
- 2. Attach hoses (2, 3, and 4) to appropriate locations on carbon canister and secure with hose clamps (1).
- 3. Install and/or lower seat bottom.

• See General Warnings on page 1-2.

A WARNING

• See General Warnings on page 1-2.

MUFFLER

MUFFLER REMOVAL

A WARNING

- Hot! Do not attempt to service hot engine or exhaust system. Failure to heed this warning could result in severe burns.
- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the muffler clamp (6) from the muffler (1) and clamp bracket (2) (Figure 15-1, Page 15-2).
- 3. Remove the hex-head cap screw (7), lock washer (8), and flat washer (9) from mounting bracket. Retain the governor cable bracket (13).
- 4. Remove the hex nuts (10) and lock washers (11) from the manifold.
- 5. Remove the muffler (1) from the vehicle.

MUFFLER INSTALLATION

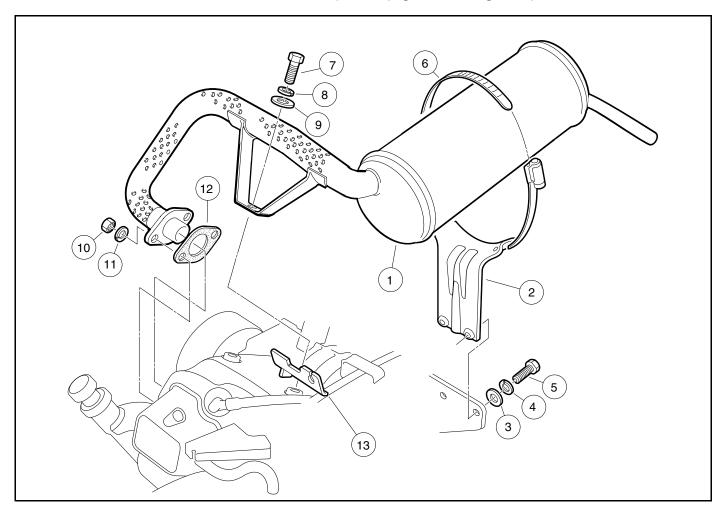
NOTE: Any time the muffler is removed from the vehicle, install a new muffler clamp (6) (CC P/N 1017689) and muffler gasket (12) FE350 (CC P/N 1016904) (Figure 15-1, Page 15-2).

- 1. Loosely secure muffler (1) to muffler bracket (2) with clamp (6).
- 2. Place a new gasket (12) on the cylinder block exhaust stud bolts.
- 3. Attach muffler manifold with lock washers (11) and hex nuts (10) and finger tighten.
- 4. Loosely secure muffler (1), mounting bracket, and governor cable bracket (13) using hex-head cap screw (7), lock washer (8), and flat washer (9).
- 5. Tighten manifold hex nuts (10) to 11 ft·lb (14.9 N·m).
- 6. Tighten the hex cap screw (7) to 14 ft·lb (18.9 N·m).
- 7. Tighten the muffler clamp (6) to 40 in·lb (4.5 N·m).

NOTE: Removing and installing the governor cable bracket may change the RPM setting. **See Engine RPM Adjustment on page 14-9.**

- 8. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 9. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout cam in the MAINTENANCE position (**Figure 17-1**, **Page 17-2**).
- 10. Start the engine and check for exhaust leaks and proper engine operation. See following DANGER.

- Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- 11. Return the neutral lockout cam to the OPERATE position (Figure 17-2, Page 17-2).



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Figure 15-1 Exhaust System

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

The torque converter consists of a drive clutch, a driven clutch, and a drive belt. The drive clutch, which is mounted to the engine, is in the open position when the engine is at idle. At this point, the belt is riding at a low position (smaller diameter) on the drive clutch. The driven clutch is mounted on the transaxle. It is in the closed position, and the drive belt is riding at a high position (large diameter) on it when the engine is at idle.

At the point of clutch engagement, the speed ratio of the drive clutch to the driven clutch is 3.5 to 1. This ratio provides excellent starting and low-speed torque.

As engine speed increases, centrifugal force on internal weights close the drive clutch, pushing the belt up to a higher position on the clutch (increasing the diameter of the belt loop). As the diameter of the belt loop increases at the drive clutch, the driven clutch is forced open as the diameter of its belt loop decreases. At governed top speed, the ratio of driven clutch to driven clutch is 0.92 to 1.

On steep grades, or when the vehicle is heavily loaded, higher torques are achieved through the use of a torque-sensing ramp device on the driven clutch. This device overcomes the force of the centrifugal weights to close the driven clutch and open the drive clutch, thus increasing axle torque with little or no change in engine RPM.

The engine and torque converter rotate clockwise as viewed from the clutch side of the engine.

To provide optimum performance for the OHV engine and powertrain, the vehicle uses a pair of tuned clutches.

To properly assemble and disassemble the torque converter, the following tools should be used:

- Torque Converter Tool Kit (P/N 1014510) (Figure 16-1, Page 16-2).
- Scribe or small pick (not included in torque converter tool kit).

TROUBLESHOOTING

See General Warnings on page 1-2.

Maintaining proper adjustment of the engine and governor, as well as the torque converter, is essential to the troubleshooting process. If these adjustments are within specifications and, when climbing a steep hill, the engine begins to lose RPM before the drive belt reaches the top of the driven clutch, there is a torque converter problem.

If the torque converter is not operating properly, perform the following steps:

- 1. Check the governor and throttle settings. See Engine Control Linkage on page 14-6.
- 2. Inspect the driven clutch for dirt and dust buildup on its component parts. Clean the driven clutch with water to remove any dust or dirt, then drive the vehicle and check for proper operation.
- 3. If cleaning the driven clutch does not solve the problem, disassemble and thoroughly clean all parts of the drive clutch. Be sure to clean the plastic drive buttons (10) (Figure 16-7, Page 16-7).

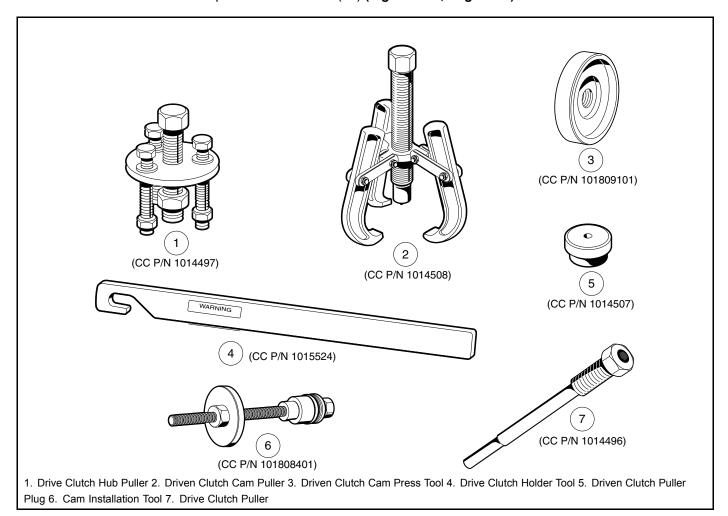


Figure 16-1 Torque Converter Tool Kit

DRIVE BELT

See General Warnings on page 1-2.

The drive belt should be inspected semiannually for wear and (or) glazing. If it is excessively worn, frayed, or glazed, replace the belt.

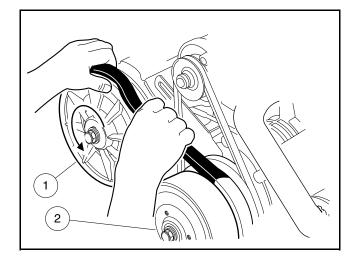
As the drive belt wears, the engine RPM will increase to compensate for the change in torque converter ratio. This will keep the vehicle's maximum ground speed correct. **See Section 2 – Vehicle Specifications.**

DRIVE BELT REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Grasp the belt midway between the drive (2) and driven (1) clutches. Lift upward on the belt to force the sheaves of the DRIVEN clutch apart, then roll the belt off the DRIVEN clutch by rotating the clutch counterclockwise (Figure 16-2, Page 16-3). See following CAUTION.

A CAUTION

- Make sure fingers are not underneath the belt when rolling the belt off the driven clutch.
- 3. Remove the belt from the drive clutch.



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Figure 16-2 Drive Belt Removal

DRIVE BELT INSTALLATION

- 1. Position the new belt on the drive clutch, then start the belt over the top of the driven clutch.
- 2. With the belt started onto the driven clutch, rotate the driven clutch counterclockwise and roll the belt over the driven clutch sheaves and onto the clutch.
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

DRIVE CLUTCH

See General Warnings on page 1-2.

A CAUTION

• Be very careful when handling the clutches. A clutch that has been dropped will not be properly balanced. If either clutch is dropped, assume that it is damaged and replace it.

DRIVE CLUTCH REMOVAL

- 1. Remove the drive belt as instructed. See Drive Belt Removal on page 16-3.
- 2. Loosen the starter/generator mounting and adjusting hardware and then remove the starter belt. See WARNING "Moving parts! Do not..." in General Warnings on page 1-2.

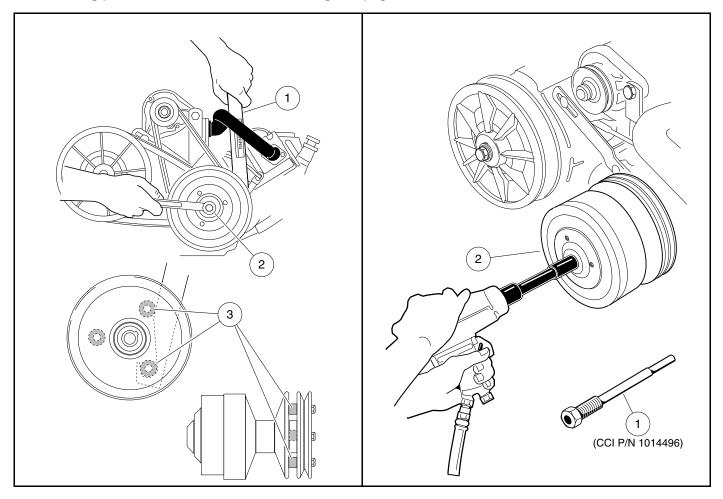


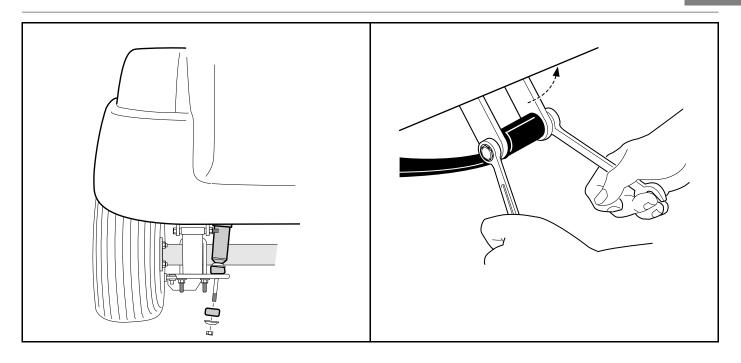
Figure 16-3 Loosen Retaining Bolt

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Figure 16-4 Drive Clutch Removal

- 3. Remove the lower shock mounting hardware from both rear shocks (Figure 16-5, Page 16-5).
- 4. Place chocks at the front wheels and lift the rear of the vehicle just enough to relieve tension from leaf springs, then remove the bolts securing the leaf springs to the shackles (**Figure 16-6**, **Page 16-5**).

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767 Figure 16-5 Shock Absorbers

Figure 16-6 Rear Shackle

5. Raise the rear of the vehicle enough to allow the centerline of the drive clutch to drop below the frame rails for access to the bolt securing the drive clutch. Place jack stands beneath the frame rails just forward of the spring mounts. **See following WARNING.**

WARNING

 Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.

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6. Remove the drive clutch retaining bolt (17) and mounting washer (19) (Figure 16-7, Page 16-7). See also Figure 16-3, Page 16-4. See following NOTE.

NOTE: On Kawasaki FE-series engines, the drive clutch mounting bolt has left-hand threads.

- 6.1. Use the drive clutch holder tool (1) while tightening or loosening the drive clutch retaining bolt (2) **(Figure 16-3, Page 16-4)**.
- 6.2. Hook drive clutch holder tool (1) on boss (3) of pulley located behind drive clutch and push against the adjacent boss with holder.
- 7. Lubricate the threaded portion of the clutch puller tool (1) with a light oil and thread the clutch puller tool into the female thread of the drive clutch (Figure 16-4, Page 16-4).
- 8. Support the drive clutch with your hand and use a 1/2-in. drive air wrench to tighten the clutch puller tool. The tool will bottom out in the crankshaft and force the drive clutch (2) free of the crankshaft.
- 9. Remove clutch puller tool from drive clutch.

A CAUTION

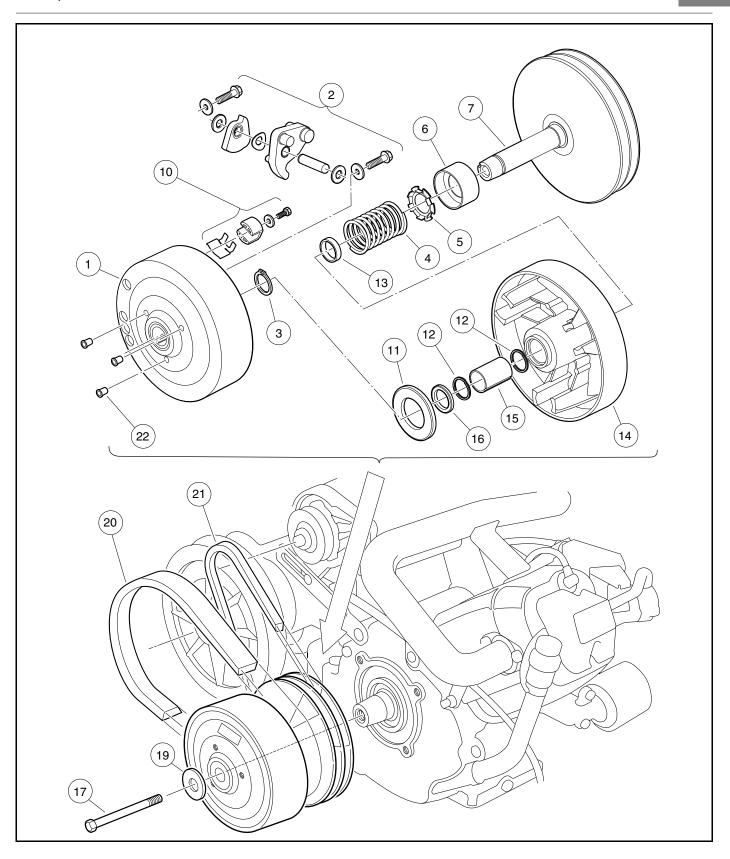
• Do not hit or tap the clutch with a hammer. Do not pry the clutch. These actions will damage the clutch.

DRIVE CLUTCH CLEANING AND INSPECTION

1. Use a dry, lint-free cloth to clean clutch parts.

A CAUTION

- Do not lubricate the drive clutch. Lubricants attract dirt and dust, which interfere with proper clutch operation.
- Use only a dry cloth to lightly wipe the shaft of the fixed face assembly (7) (Figure 16-7, Page 16-7). Do not use a brush or steel wool. These will damage the surface of the shaft.
- Do not use solvents. Solvents will damage the lubricating characteristics of the bushings.
- 2. Inspect the belt contact surfaces of the clutch sheaves for wear. If any area of a sheave contact surface has wear of 0.060 inch (1.52 mm) or more, the clutch should be replaced.



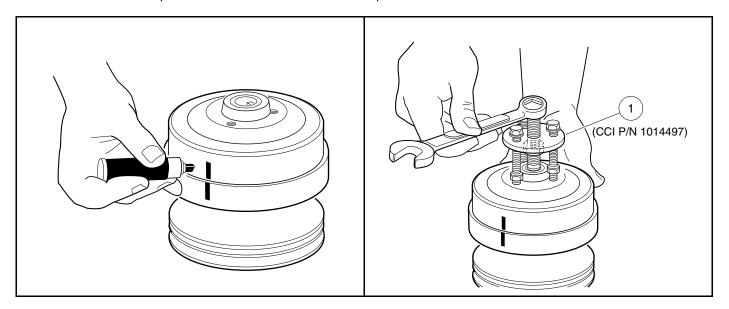
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Figure 16-7 Drive Clutch Assembly

DRIVE CLUTCH DISASSEMBLY

A CAUTION

- The drive clutch is balanced as an assembly. Before disassembly, make match marks on the drive clutch hub and on the moveable face assembly so they can be reassembled in the same positions (Figure 16-8, Page 16-8).
- 1. Make match marks on the drive clutch hub and on the moveable face casting (Figure 16-8, Page 16-8).
- 2. Remove the drive clutch hub (1) (Figure 16-7, Page 16-7):
 - 2.1. Remove the three plugs (22) from the clutch puller attachment holes (Figure 16-7, Page 16-7).
 - 2.2. Thread the center bolt of the Drive Clutch Hub Puller (1) (P/N 1014497) into clutch until the stop nut touches the clutch, then back the bolt out one-half turn (Figure 16-9, Page 16-8).
 - 2.3. Thread the three small bolts of the puller (1) into corresponding holes in the clutch. Tighten bolts evenly, making sure the face of the puller plate is parallel to the face of the clutch **(Figure 16-9, Page 16-8)**.
 - 2.4. Unscrew the puller center bolt out of the clutch to pull drive clutch hub off.



598 Figure 16-8 Mark Drive Clutch Hub

Figure 16-9 Remove Drive Clutch Hub

- 3. Remove the thrust washer (11) from the moveable face (14) (Figure 16-7, Page 16-7).
- 4. Remove the drive buttons (3) by removing the screws (1), flat washers (2), and drive button take-up springs (4) as shown (Figure 16-10, Page 16-9).

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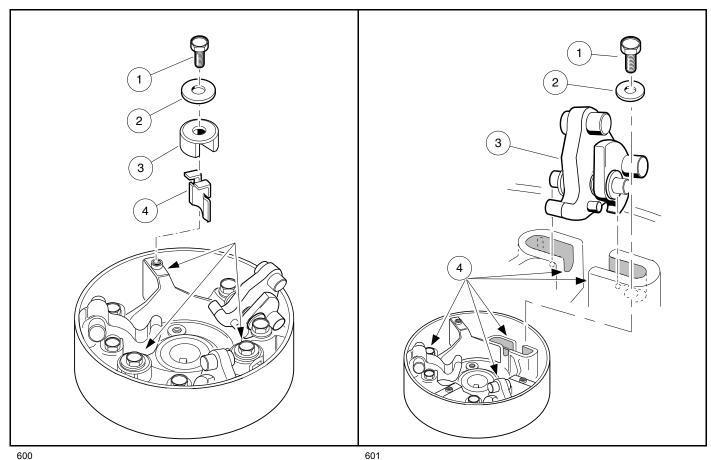


Figure 16-10 Drive Button Mounting

Figure 16-11 Weight Position

- 5. Remove the clutch weights:
 - 5.1. Remove the screws (1) and flat washers (2) attaching the weights (3) as shown (Figure 16-11, Page 16-9).
 - 5.2. Pull the weight assemblies (3), with pins, from slots (4) in the clutch. See following NOTE.

NOTE: Before removing, note the orientation of the wave washer (1) and secondary weight (2) on the primary weight (3) (Figure 16-12, Page 16-9).

5.3. Remove the plastic washers, weights (2 and 3) and wave washer (1) from the pin (4). Retain all parts.

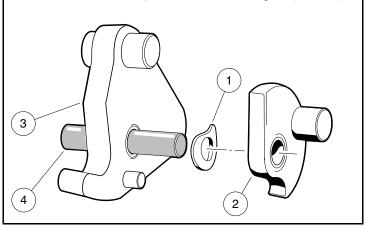


Figure 16-12 Primary and Secondary Weights, Wave Washer and Pin

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6. Remove the retaining ring (3) from the shaft of the fixed face assembly (7) and slide the moveable face (14) off the shaft (Figure 16-7, Page 16-7). See following NOTE.

NOTE: If the moveable face is removed from the hub of the fixed face, the spiral back-up rings (12) must be replaced with new ones (**Figure 16-7**, **Page 16-7**).

- 7. Remove the spacer (16), and spring (4) and retainer (5). The spring retainer can be removed from the spring if necessary (Figure 16-7, Page 16-7).
- 8. If necessary, remove idler bearing (2). Use a press (1) and bearing puller (3) to remove the bearing from the fixed face assembly (4) (Figure 16-13, Page 16-10). See following NOTE.

NOTE: Do not remove the idler bearing unless it needs to be replaced. If idler bearing is removed, replace it with a new bearing.

9. Use a scribe or small pick to remove the spiral backup rings (12) from each end of the bore in the fixed face assembly (Figure 16-7, Page 16-7). See also Figure 16-14, Page 16-10. Discard the rings.

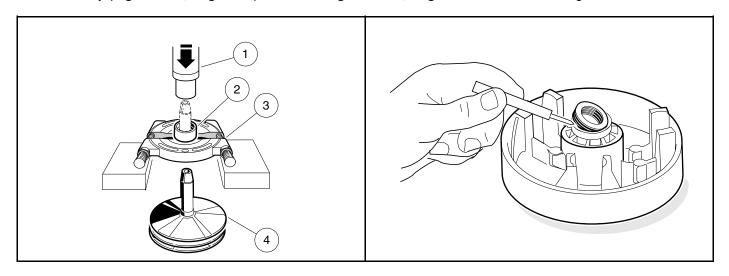


Figure 16-13 Remove Idler Bearing

Figure 16-14 Spiral Back-up Rings

INSPECTION OF DRIVE CLUTCH PARTS

Inspect the idler bearing (6) for smooth rotation or seal damage (Figure 16-7, Page 16-7). See following NOTE.

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NOTE: It is normal for a small amount of grease to be present at the edge of seal.

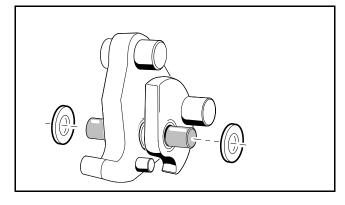
- 2. Inspect the bore of the moveable face assembly (14) for scarring or wear. The moveable face assembly must be replaced if the bore is worn to a diameter of 0.883 inch (22.4 mm) or larger (Figure 16-7, Page 16-7).
- 3. Inspect the steel shaft (7) on the fixed face assembly. There should be no measurable wear anywhere on the shaft. Replace the shaft if it is worn, scratched, or damaged.
- 4. Inspect the thrust washer (11) for wear. If it is worn more than 0.030 inch (0.76 mm), turn it over or replace it with a new one.
- 5. Inspect the primary weights (2) and the hub casting for wear. If the primary weights show signs they are touching the casting, the tips of the weights have worn beyond specification and they must be replaced.
- 6. Inspect the pins on the primary weights (2). There should be no measurable wear. Replace them if they are worn, scratched, or damaged.
- 7. Inspect the drive belt pulley sheaves for excessive wear or damage. If the sheaves are excessively worn or damaged, replace the entire fixed face drive assembly.

DRIVE CLUTCH ASSEMBLY

- 1. Press idler bearing (6) onto the shaft of the fixed face assembly (7). Press on the inner race of the bearing only. Make sure that the cup side of bearing is facing away from the fixed face (Figure 16-7, Page 16-7).
- 2. Using needle nose pliers, install the spring retainer (5) onto the spring (4).
- 3. Install the spring (4) and retainer (5) into the cup of the idler bearing (6).
- 4. Install the spacer (13) onto the shaft of the fixed face.
- 5. Install a new spiral backup ring (12) in each end of the bore of the moveable face assembly (14).
- 6. Install the moveable face assembly (14) onto the shaft of the fixed face assembly (7).

CAUTION

- To avoid damaging the spiral back-up rings, be very careful when installing the moveable face.
- 6.1. Rotate the moveable face assembly clockwise while installing it onto the shaft.
- 6.2. Install the retaining ring (3) (Figure 16-7, Page 16-7).
- 7. Install the primary weights (3) on the mounting pins (4) (Figure 16-12, Page 16-9).
- 8. Install a wave washer (1) on each mounting pin (4). Make sure that the concave side of the washer faces the side of the primary weight (3) with the small guide pin protruding from it (Figure 16-12, Page 16-9).
- 9. Install the secondary weights (2) onto the mounting pins (4) with the weight pins on the secondary weights pointing away from the primary weights (3). The wave washers should be between the primary and secondary weights (Figure 16-12, Page 16-9).
- 10. Install white plastic flat washers on each end of the mounting pin and push them against the outside surfaces of the weights. Center the weights and washers on the mounting pin (Figure 16-15, Page 16-11).
- 11. Install the weight assemblies into the slots (4) in the hub casting (Figure 16-11, Page 16-9). Make sure the mounting pin protrudes an equal amount on each side of the weights when the assemblies are in position (Figure 16-15, Page 16-11).



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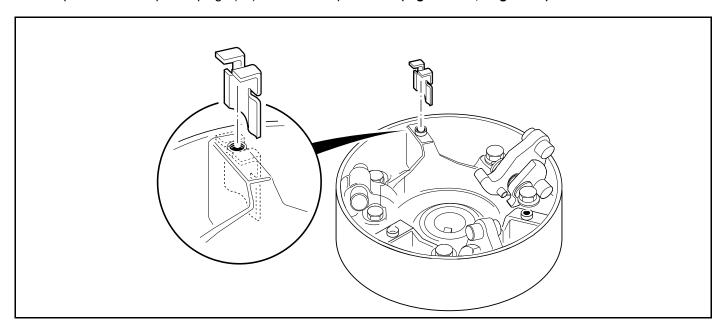
Figure 16-15 Install White Washers

12. Install the 1/4-20 bolts and washers (2) and tighten them to 10 ft·lb (13 N·m) (Figure 16-7, Page 16-7). See following NOTE.

NOTE: Make sure there is at least a (minimum) gap of 0.020 inch (0.51 mm) between each end of the mounting pin and the mounting bolt.

- 13. Install three drive button take-up springs.
 - 13.1. Install each spring on right-hand side of the three button mounting posts (when looking into the interior of the clutch drive hub, and with the rib at a twelve o'clock position) as shown (Figure 16-16, Page 16-12).

- 16 Drive Clutch
 - 14. Compress each take-up spring and install the drive button over the rib and take-up spring (Figure 16-10, Page 16-9).
 - 15. Install a no. 10-24 button retaining screw with flat washer through each button and into the rib. Tighten the screws to 34 in·lb (3.8 N·m) (Figure 16-11, Page 16-9).
 - 16. Install the thrust washer (11) onto the moveable face assembly (Figure 16-7, Page 16-7).
 - 17. Install the hub assembly (8) on the moveable face assembly and align the match marks made before disassembling the clutch. Press the hub assembly on by hand.
 - 18. Replace the three plastic plugs (22) into the hole protectors (Figure 16-7, Page 16-7).



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Figure 16-16 Correct Orientation of Drive Button Take-up Springs

DRIVE CLUTCH INSTALLATION

1. Place the drive clutch assembly on the crankshaft taper. Position the mounting washer (19) on the bolt (17) and start the bolt into the crankshaft (Figure 16-7, Page 16-7). See following NOTE.

NOTE: The drive clutch retaining bolt has left-hand threads. The manufacturer recommends replacing the drive clutch retaining bolt (PN 103345701) when installing the drive clutch. If a new bolt is not available, clean the threads of the original bolt and apply Loctite® 242 to the threaded end prior to installation.

- 2. Tighten the drive clutch retaining bolt (17) to 25 ft·lb (33.9 N·m) (Figure 16-7, Page 16-7).
- 3. Install the starter/generator belt and adjust belt tension as instructed. **See Belt Tension Adjustment on page 12-11.** Tighten the starter/generator mounting hardware to 23 ft·lb (31.2 N·m) and the adjusting hardware to 13 ft·lb (17.6 N·m).
- 4. Lower vehicle to the height required to position the leaf springs in the mounting shackles. Install the mounting bolts and lock nuts. Tighten lock nuts to 15 ft·lb (20.3 N·m) (Figure 16-17, Page 16-13).
- 5. Position shocks in the shock mounts and install cushions, mounting washers, and nuts (**Figure 16-18, Page 16-13**). Tighten nuts until cushions expand to be the same diameter as the mounting washers.

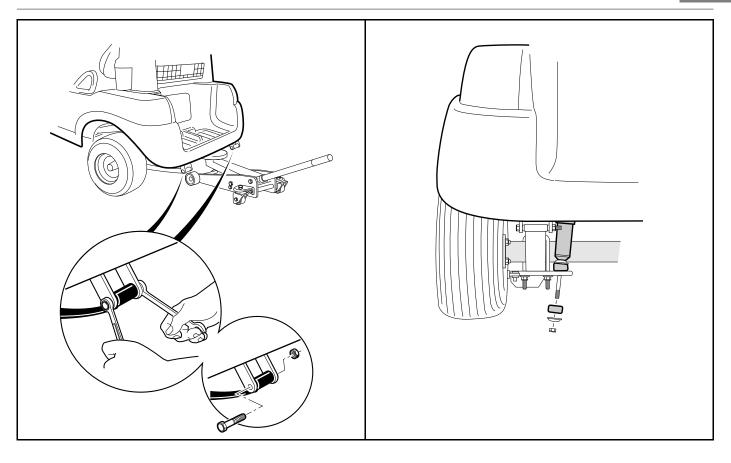


Figure 16-17 Leaf Spring and Shackles

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Figure 16-18 Shock Absorbers

- 6. Lower vehicle and remove the lifting device.
- 7. Install the drive belt as instructed. See Drive Belt Installation on page 16-3.
- 8. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 9. Drive the vehicle and check for proper operation.

DRIVEN CLUTCH

See General Warnings on page 1-2.

DRIVEN CLUTCH REMOVAL

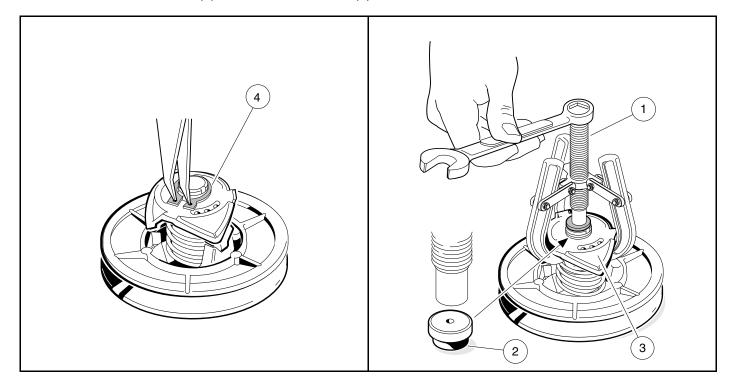
- 1. Remove the drive belt as instructed. See Drive Belt Removal on page 16-3.
- 2. Remove the bolt (11) and mounting washer (12) from the clutch shaft (Figure 16-21, Page 16-15).
- 3. Grasp the driven clutch assembly and slide it off the shaft.
- 4. Leave the key (9) in the keyway.

DRIVEN CLUTCH DISASSEMBLY

 Using external snap ring pliers, remove the retaining ring (4) (Figure 16-19, Page 16-14). See following WARNING.

A WARNING

- Do not place fingers under the cam when removing the cam. The moveable face may spin when the cam buttons release from the cam ramps, resulting in severe personal injury.
- 2. Insert a puller plug (2) (P/N 1014507) (Figure 16-20, Page 16-14) into the shaft bore and use a driven clutch cam puller (1) (P/N 1014508) to remove the cam (3) from the fixed face shaft (Figure 16-21, Page 16-15).
- 3. Remove the spring (5) (Figure 16-21, Page 16-15).
- Retain the key (3).
- 5. Slide the moveable face (7) off the fixed face shaft (8).



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Figure 16-19 Remove Retaining Ring

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Figure 16-20 Driven Clutch Disassembly

DRIVEN CLUTCH INSPECTION

- 1. Inspect the cam (4) for excessive wear. Replace it if necessary (Figure 16-21, Page 16-15).
- 2. Inspect the drive buttons (6) for excessive wear. Replace if necessary. To remove the drive buttons, remove the socket-head cap screws and then the buttons.
- 3. Inspect the smooth surface on the fixed and moveable face assemblies. Assemblies must be replaced if surfaces are worn more than 0.060 inch (1.5 mm).
- 4. Inspect the bronze bearing in the moveable face. If the bearing bore diameter is more than 1.384 inch (35.15 mm), the entire moveable face assembly must be replaced.
- 5. Inspect the shaft of the fixed face assembly. There should be no noticeable wear. Replace the shaft if it is worn, scratched or damaged.

DRIVEN CLUTCH ASSEMBLY

- 1. Place the three drive buttons (6) in position. Apply one drop of Loctite® 222 to each of the socket-head cap screws and then install and tighten them to 8 in·lb (0.9 N·m) (Figure 16-21, Page 16-15).
- 2. Slide the moveable face assembly (7) onto the fixed face shaft (8).
- 3. Place the end of the spring (5) into the hole in the moveable face assembly.

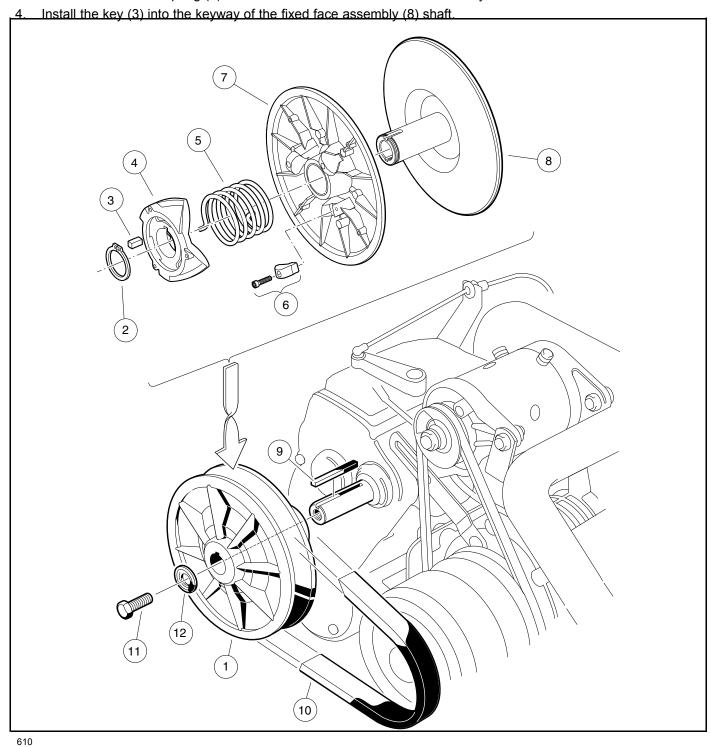


Figure 16-21 Driven Clutch Assembly

- Driven Clutch
 - Holding the cam (4) in position for assembly on the shaft, install the other end of the spring (5) into the center spring hole of the cam. Rotate the cam until the keyway is aligned with the key (3) on the fixed face assembly, and then start the cam onto the shaft approximately 1/4 to 3/8 inch (6.3 to 9.5 mm).
 - 5.1. Press Assembly Process:
 - 5.1.1. Place the clutch assembly in a press and position the cam press tool (P/N 101809101) on the cam as shown (Figure 16-22, Page 16-16).
 - 5.1.2. Hold the fixed face assembly (3) and rotate the moveable face assembly (1) one-third turn clockwise, then press the cam (2) onto the fixed face assembly (Figure 16-22, Page 16-16).
 - 5.1.3. Install the retaining ring (2) (Figure 16-21, Page 16-15). See following NOTE.

NOTE: The retaining ring can be reused if the O.D. does not exceed 1.607 inches (40.82 mm); otherwise, it must be replaced with a new ring (P/N 1014080).

5.1.4. While holding onto the cam, tap the end of the fixed face shaft lightly with a plastic mallet until the cam seats against the retaining ring. See following CAUTION.

A CAUTION

· Do not use a metal hammer to tap the fixed face hub. A metal hammer will damage the shaft.

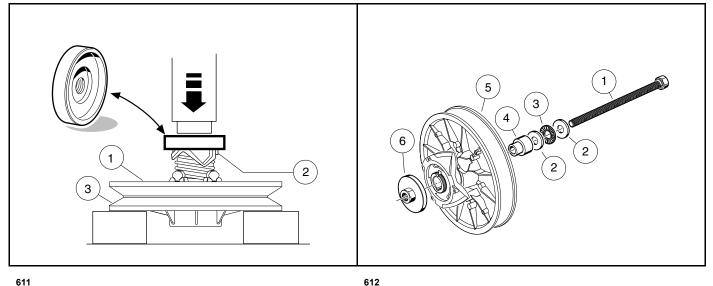


Figure 16-22 Cam Press Tool

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Figure 16-23 Cam Installation Tool

5.2. Field Assembly Process:

NOTE: This process is for field assembly requirements where hydraulic and pneumatic press equipment is not available. Use the cam installation tool (P/N 101808401) for this process.

- 5.2.1. With the clutch loosely assembled, set the edge of the clutch body (5) on a clean, flat surface (Figure 16-23, Page 16-16).
- 5.2.2. Assemble the threaded bolt (1) through the washer (2), the thrust bearing assembly (3), the second washer (2), and the hub guide (4).

NOTE: It is very important that the bolt, washers, and thrust bearing assembly be assembled in the order described and shown.

5.2.3. Slide the bolt (1) through the clutch body (5) until the threaded bolt, washers, bearing, and hub guide are against the fixed face hub (Figure 16-23, Page 16-16).

- 5.2.4. Hold the clutch assembly and cam installation tool together and place the fixed face down on spaced blocks (Figure 16-22, Page 16-16).
- 5.2.5. Place the cam press hub (6) onto the cam installation bolt and thread it down onto the cam hub, centering the press hub onto the cam hub.
- 5.2.6. Hold the fixed face assembly of the clutch (5) and rotate the moveable face of the clutch one-third turn clockwise.
- 5.2.7. Use two wrenches, and hold the bolt head while tightening the cam press hub (6) pressing the cam onto the keyed shaft. Advance the press hub until it is firm against the shaft end.
- 5.2.8. Remove the cam press hub (6) and installation tool, and install the retaining ring.

NOTE: The retaining ring can be reused if the O.D. does not exceed 1.607 inches (40.82 mm); otherwise, it must be replaced with a new ring (P/N 1014080).

DRIVEN CLUTCH INSTALLATION

1. To install the driven clutch, reverse the removal procedure. Make sure that the washer (12) is mounted with the flat portion of the washer against the driven clutch (Figure 16-21, Page 16-15). Secure with a new bolt (11). See following NOTE.

NOTE: The bolt (11) must be replaced with a new bolt (P/N 102242101) containing a locking patch that will prevent the bolt from loosening.

- 2. Tighten the bolt (11) to 18 ft·lb (24.4 N·m).
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

SECTION 17 – UNITIZED TRANSAXLE (FOR KAW. FE350)

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

The vehicles addressed in this manual are equipped with heavy-duty, fully-synchronized Unitized Transaxles manufactured by either Kawasaki or Graziano. The unitized transaxle utilizes fully-synchronized internal gearing to change vehicle direction. Because the unitized transaxle is used to reverse vehicle direction, the engine, drive clutch, belt, and driven clutch rotate in the same direction; therefore, the engine and clutches are not subjected to reversing loads. This reduces maintenance requirements on the engine and clutches. With the unitized transaxle, power is transferred from the engine through the drive clutch, the drive belt, the driven clutch, and then through the unitized transaxle to the wheels.

This section contains information for removing and replacing the unitized transaxle. For complete instruction on unitized transaxle disassembly, repair, rebuilding, and reassembly, see the Engines and Drivetrain Components, Repair and Rebuild Manual (P/N 102396501).

SHIFTER LEVER

A shifter lever, connected to a shifter arm, is used to change the gears to one of three shift positions: FORWARD (F), NEUTRAL (N), or REVERSE (R) (Figure 17-3, Page 17-3). Bring the vehicle to a complete stop before changing FORWARD or REVERSE direction.

NEUTRAL LOCKOUT

During normal vehicle operation, the neutral lockout feature prevents the engine from running when the Forward/Reverse handle is in the NEUTRAL position. If a vehicle is started in FORWARD or REVERSE and then shifted to NEUTRAL, the engine will stop running.

For the convenience of the trained technician, there is a neutral lockout cam (yellow knob) located on the back of the Forward/Reverse shifter, inside the engine compartment. If the neutral lockout cam is pulled out approximately 3/8 inch (10 mm) and then rotated one-half turn until it snaps into place, the cam will be in the MAINTENANCE position (Figure 17-1, Page 17-2). When the switch is in the MAINTENANCE position, it will allow the technician to run the engine in the NEUTRAL position to perform certain maintenance and/or repair functions. With the cam in this position, the vehicle will not operate if the Forward/Reverse handle is placed in either the FORWARD or REVERSE position. See following WARNING and NOTE.

WARNING

• With the cam in the MAINTENANCE position and the engine running, the vehicle may move suddenly if the Forward/Reverse handle is shifted or accidentally bumped. To prevent this, chock the front and rear wheels and firmly set the park brake before servicing or leaving the vehicle.

NOTE: Be sure to return the cam to the OPERATE position (**Figure 17-2**) after servicing the vehicle, or it will not run with the Forward/Reverse handle in either the FORWARD or REVERSE position.

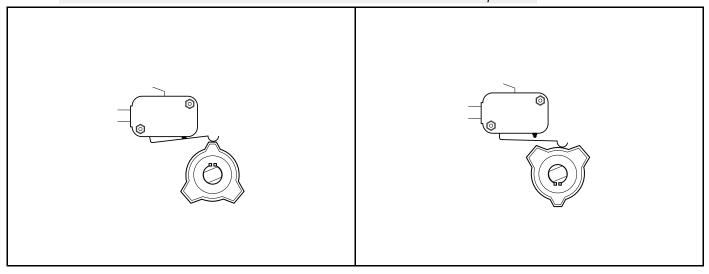


Figure 17-1 Neutral Lockout – Maintenance

Figure 17-2 Neutral Lockout - Operate

GOVERNOR SYSTEM

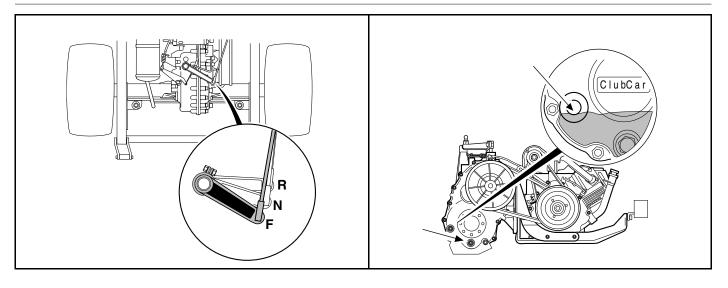
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The governor system regulates vehicle ground speed. It is mounted inside the unitized transaxle and is driven by transaxle gears. If any of the governor linkages are removed in order to service other components, readjustment of the governor linkage is required. **See Governor Cable Installation and Adjustment on page 14-6.**

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UNITIZED TRANSAXLE SERVICE

The unitized transaxle is extremely durable and should require very little service under normal operating conditions. The only service required is to maintain proper lubricant level. **See Periodic Lubrication Schedules on page 10-11.** Under normal operating conditions, adjustment to the system should not be required.



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Figure 17-3 Shifter Positions (Top View)

Figure 17-4 Lubricant Level (should be level with bottom of hole) and Drain Plug

TOOLS REQUIRED FOR THIS SECTION

Hydraulic floor jack (or chain hoist)	12 to 18 in. straight edge	17 mm socket, 3/8-in. drive
Jack stands (2) (one ton capacity)	Small ball peen hammer (10 oz.)	7/16-in. combination wrench
Hydraulic press	Plastic or rubber mallet	1/2-in. combination wrench
Bench vise	Ratchet wrench, 3/8-in. drive	9/16-in. combination wrench
Standard slip joint pliers	Torque wrench, 3/8-in. drive	11/16-in. combination wrench (2)
External snap ring pliers (0.070 in. tip)	3/8-in. Socket, 3/8-in. drive	17 mm combination wrench
External snap ring pliers (0.047 in. tip)	7/16-in. Socket, 3/8-in. drive	Small flat blade screwdriver
90° Internal snap ring pliers (0.090 in. tip)	10 mm Combination wrench	Medium flat blade screwdrivers (2)
Feeler gauge	1/2-in. Socket, 3/8-in. drive	No. 2 phillips-head screwdriver
16-in. rolling head prybar	9/16-in. Socket, 3/8-in. drive	1/4-in. nut driver
Small punch or scratch awl	5/8-in. Socket, 3/8- in. drive	5/16-in. nut driver
1/4-in. diameter drift or metal rod	12 mm Socket, 3/8-in. drive	Small knife or wire snippers
Bearing puller wedge attachment (P/N 1012812)	Axle seal tool (P/N 1014162)	Governor gear shaft installation tool (P/N 101933101)
10 mm socket, 3/8-in drive	Internal snap ring pliers (P/N 1012560)	Brake cable removal tool (P/N 102555501)
13 mm combination wrench		

LUBRICATION

There are two oil port plugs located on the right (driven clutch) side of the unitized transaxle (Figure 17-4, Page 17-3). When the vehicle is on a level surface, use the upper plug as a lubricant level indicator. Lubricant level should be even with the bottom of level indicator hole. Use the lower plug for draining. When draining lubricant, remove both plugs to allow the lubricant to drain faster. Clean and reinstall the drain plug and gasket before filling the transaxle with new lubricant. Use a funnel when filling the transaxle through the lubricant level indicator hole. Fill with 27 fl-oz (0.8 L) 80-90 WT. API class GL or 80-90 WT. AGMA class 5 EP gear lubricant (or until lubricant begins to run out of the level indicator hole). Tighten the plug to 20 ft·lb (27.1 N·m).

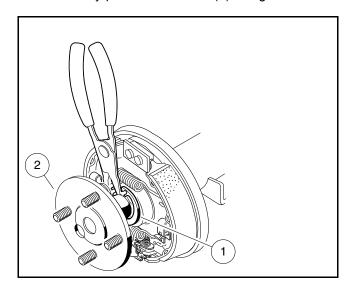
AXLE BEARING AND SHAFT - KAWASAKI

See General Warnings on page 1-2.

Removal of the unitized transaxle is not required for servicing or replacing axle shafts, axle bearings, or axle shaft oil seals. If the unitized transaxle is to be removed from the vehicle, do not remove the wheels, axle shafts, or axle tubes first. Instructions for removing the unitized transaxle from the vehicle begin on page 17-10.

AXLE SHAFT AND OIL SEAL REMOVAL

- Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- Loosen the lug nuts on the wheel to be removed.
- 4. Place chocks at the front wheels and lift the rear of the vehicle with a floor jack. Then place jack stands under the axle tubes to support the vehicle. See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-2.
- 5. Remove the rear wheel and brake drum.
- 6. Use 90° internal snap ring pliers (0.090 inch (2.28 mm) tip) to remove internal retaining ring (1) from axle tube (Figure 17-5, Page 17-4).
- 7. Carefully pull the axle shaft (2) straight out of the axle tube (Figure 17-5, Page 17-4).



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Figure 17-5 Retaining Ring

8. Position a 16-inch (40 cm) rolling head prybar (Figure 17-6, Page 17-5) under the inside lip of the seal and pull the oil seal out (Figure 17-7, Page 17-5). See following CAUTION.

CAUTION

 Do not scar or damage the inside surfaces of the tube when removing the oil seal. A damaged tube might have to be replaced.

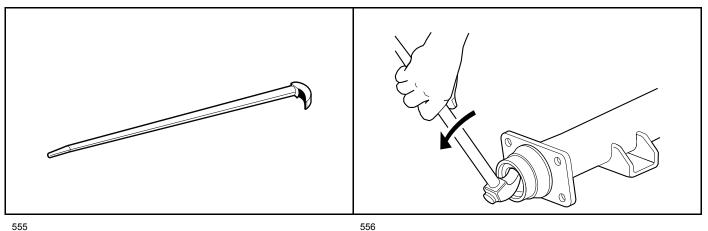


Figure 17-6 Rolling Head Prybar

Figure 17-7 Seal Lip

- 9. Inspect the axle shaft assembly to be sure the bearing (71) and collar (73) have not slipped and are still seated against the shoulder on the axle shaft (**Figure 17-8**, **Page 17-6**).
- 10. Inspect the bearing. If the bearing is damaged or worn, replace it.

AXLE BEARING

Axle Bearing Removal

1. Use external retaining ring pliers (0.047 inch (1.19 mm) tip) to remove the retaining ring (74). Place a bearing puller wedge attachment (P/N 1012812) on the axle shaft between the wheel mounting flange and the bearing (Figure 17-8, Page 17-6). See also Figure 17-9, Page 17-8.See following CAUTION.

CAUTION

- Do not tighten the bearing puller wedge attachment against the axle shaft. This could damage the axle shaft when pressing the bearing and collar off.
- 2. Press the bearing (71) and collar (73) off together (Figure 17-8, Page 17-6). See also Figure 17-9, Page 17-8. See following NOTE.

NOTE: It may be necessary to heat the collar to remove it.

Do not remove the large axle retaining ring (70) from the axle (Figure 17-8, Page 17-6). Since the inner diameter of the retaining ring (70) is smaller than the outer diameter of the bearing (71), the ring must be in place on the axle before a new bearing and collar are pressed on.

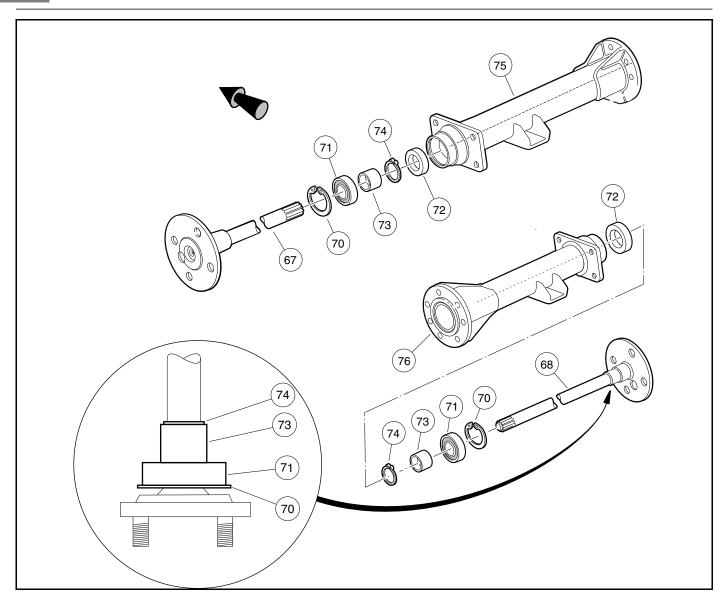


Figure 17-8 Differential Gear Case and Axle Tubes

Axle Bearing Installation

- 1. Ensure that the retaining ring (70) is loosely placed on the axle shaft. See preceding NOTE.
- 2. Install a new axle bearing (71) on axle (67 or 68). Push bearing onto axle until bearing is flush against axle shoulder (Figure 17-8, Page 17-6).
- 3. Apply two drops of Loctite® 271 to inside of the collar. See following CAUTION.

A CAUTION

- Apply Loctite® 271 to the inside of the collar only, not to the shaft, so that the Loctite® will be pushed
 away from the bearing as the collar and bearing are pressed on. If Loctite® gets on or in the bearing,
 the bearing must be replaced.
- The collar should be removed no more than two times. If a collar is removed a third time, the shaft and collar will not fit properly.

- 4. Place a new sealed bearing (71) on shaft (67 or 68) (Figure 17-8, Page 17-6).
- 5. Install collar (73) onto axle shaft. Place axle assembly on bearing puller wedge attachment and press collar onto axle.
- 6. Place the bearing puller wedge attachment against collar and press both bearing and collar onto shaft. **See following CAUTION.**

A CAUTION

- If the bearing was removed from the shaft, replace it with a new one.
- Do not tighten the bearing puller wedge attachment against the axle shaft. This could damage the axle shaft when the bearing and collar are pressed on.
- 7. Use external snap ring pliers (0.047 inch (1.19 mm) tip) to install collar retaining ring (74) (Figure 17-8, Page 17-6).

AXLE SHAFT AND OIL SEAL INSTALLATION

- 1. Clean bearing and seal seats in axle tube (75 or 76) (Figure 17-8, Page 17-6).
- 2. Place a new oil seal (72) in axle tube with seal lip facing inside of the axle tube (Figure 17-8, Page 17-6). Use an axle seal tool (P/N 1014162) to press it in until it seats firmly in position (Figure 17-10, Page 17-8). See following NOTE.

NOTE: The new seal can be installed by tapping the axle seal tool with a mallet.

A CAUTION

- Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft.
- 3. Clean the axle shaft and splines and then insert the shaft, splined end first, through the seal and into the axle tube. Be careful not to damage the seal. Then advance the shaft through the inner bearing and rotate it to align the shaft splines with the splined bore of the differential side gear. Continue advancing the shaft until the bearing seats against the axle tube shoulder.
- 4. Install the bearing retaining ring (70) in the axle tube (Figure 17-8, Page 17-6). See also Figure 17-5, Page 17-4.
- 5. Place a 1/4 to 3/8 inch (6 to 10 mm) diameter rod against the retaining ring and tap lightly at four to five locations to ensure it is properly seated. **See following WARNING.**

▲ WARNING

• Be sure bearing retaining ring is properly seated in its groove. If ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result in severe personal injury or death.

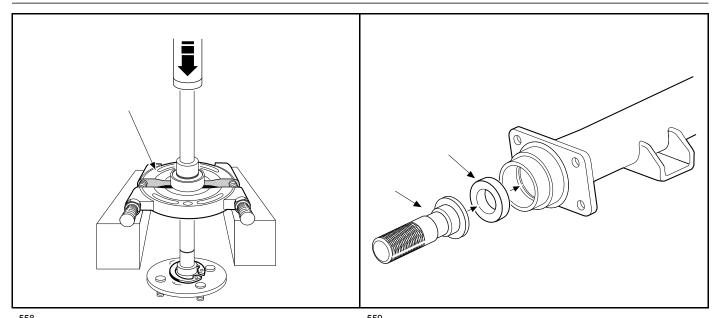


Figure 17-9 Press Bearing and Collar From Shaft Using Bearing Puller Wedge Attachment

Figure 17-10 Axle Seal and Seal Tool

AXLE BEARING AND SHAFT - GRAZIANO

See General Warnings on page 1-2.

AXLE SHAFT AND OIL SEAL REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Place chocks at the front wheels. Loosen lug nuts on rear wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Remove the rear wheel and brake drum. See Section 6 Wheel Brake Assemblies. See Section 8 Wheels and Tires.
- 4. Use 90° internal snap ring pliers to remove the internal retaining ring (1) from the axle tube (**Figure 17-11**, **Page 17-9**).
- 5. Remove the axle shaft (2), retaining ring, and bearing assembly by pulling the axle shaft straight out of the housing.
- 6. If necessary, remove the axle oil seal and adapter ring.
 - 6.1. Use a bearing puller (P/N 1016417) to remove the axle seal and adapter ring from the axle tube (Figure 17-12, Page 17-9). See following CAUTION and NOTE.

CAUTION

Do not scar or damage the inside surfaces of the tube when removing the oil seal and adapter ring. A
damaged tube might have to be replaced.

NOTE: Do not discard the adapter ring. If the adapter ring is lost or damaged, the axle tube will have to be replaced. Varying rear axle configurations have been installed on vehicles. If replacing axle tubes, take note of individual axle tube lengths to ensure proper fit.

- 6.2. Use a press to separate the axle oil seal (15) from the adapter ring (39) **(Figure 17-13, Page 17-9)**. Retain the adapter ring and discard the oil seal.
- 7. Inspect the axle shaft assembly to be sure the bearing and collar have not slipped and are still seated against the shoulder on the axle shaft.
- 8. Inspect bearing. If the bearing in a Graziano transaxle is worn or damaged, the entire axle shaft assembly must be replaced.

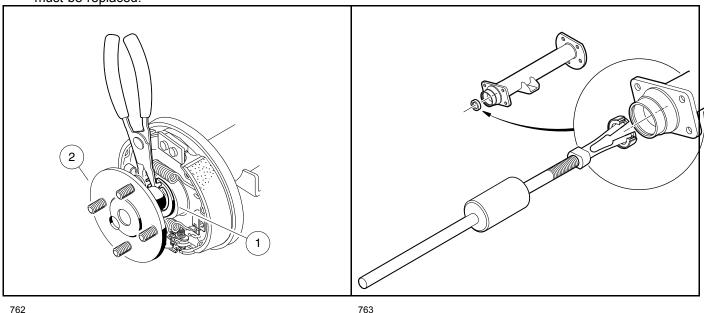


Figure 17-11 Remove Internal Retaining Ring

Figure 17-12 Axle Seal and Adapter Ring Removal

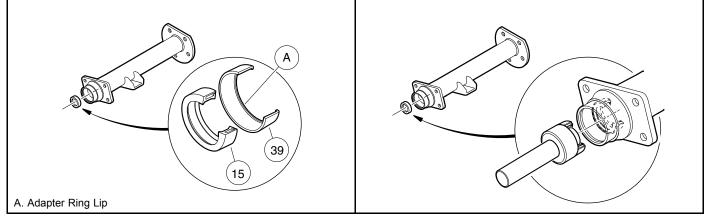


Figure 17-13 Axle Seal and Adapter Ring

Figure 17-14 Axle Seal and Adapter Ring Installation

AXLE BEARING

Do not remove the axle bearing from a Graziano axleshaft. If bearing is worn or damaged, the entire axleshaft assembly must be replaced.

AXLE SHAFT AND OIL SEAL INSTALLATION

- 1. If previously removed, install a new oil seal.
 - 1.1. Clean seal seat in the adapter ring (39) (Figure 17-13, Page 17-9).

- 1.2. Place a new seal (15) in the adapter ring with the seal lip facing toward the adapter ring lip (Figure 17-13, Page 17-9). Use an axle seal tool (P/N 1014162) and mallet to tap it in until it seats firmly in position. A hydraulic press may also be used with the axle seal tool.
- 1.3. Clean adapter ring seat(s) in the axle tube.
- 1.4. Apply Loctite® 603 to the outer diameter of the adapter ring.
- 1.5. Place the oil seal and adapter ring assembly into the axle tube with the seal lip facing away from the bearing (Figure 17-14, Page 17-9). Use an axle seal tool (P/N 1014162) and mallet to tap it in until it seats firmly in position. See following CAUTION.

CAUTION

- Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft to prevent oil from coming in contact with brakes.
- 2. Install the rear axle into the transaxle. See following NOTE.
 - 2.1. Insert the shaft, splined end first, through the seal and into the axle tube. Be careful not to damage the seal on the inside of the axle tube hub. Advance the shaft through to the bearing on the shaft, then rotate it to align the shaft splines with the splined bore of the differential side gear. Continue advancing the shaft until the bearing on the axle is firmly seated within the axle tube hub seat.
 - 2.2. Use a pair of snap ring pliers to install the retaining ring (1) inside axle tube hub so that it seats against the axle bearing assembly and into the machined slot in the inside wall of the axle tube hub (Figure 17-11, Page 17-9).

NOTE: If the retaining ring, axle bearing, or sleeve must be replaced, the entire axle shaft assembly must be replaced.

2.3. Place a 1/4 to 3/8-inch (6 to 10 mm) diameter rod against the retaining ring and tap lightly at four to five locations around the retaining ring to ensure it is properly seated. **See following WARNING.**

WARNING

- Be sure the retaining ring is properly seated in its groove. If the ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result, causing severe personal injury or death.
- 3. If a new oil seal was installed, allow 24 hours before operating the vehicle to allow the Loctite® 603 to fully cure.

UNITIZED TRANSAXLE REMOVAL

See General Warnings on page 1-2.

- Turn the key switch to the OFF position and remove the key, and place the Forward/Reverse handle in the NEUTRAL position.
- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- Close the fuel shut-off valve on fuel tank (Figure 14-13, Page 14-22).
- 4. Detach all wires, hoses, etc. connecting the powertrain to the vehicle.
 - 4.1. Disconnect the carburetor vent tube from the carburetor (Figure 17-15, Page 17-11).
 - 4.2. Disconnect the air intake hose from the carburetor (Figure 17-16, Page 17-11).

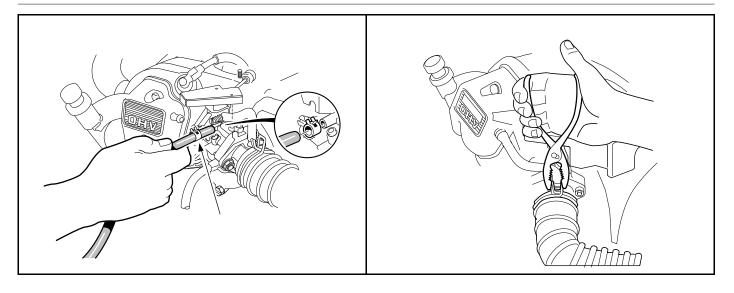
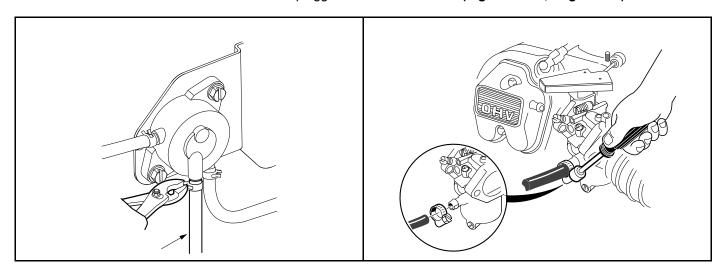


Figure 17-15 Carburetor Vent Tube

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Figure 17-16 Air Intake Hose

- 4.3. Disconnect impulse line from fuel pump (Figure 17-17, Page 17-11).
- 4.4. Loosen the hose clamp and then disconnect the fuel line from the carburetor. To prevent spilling fuel, the disconnected end of the line can be plugged with a 1/4-inch bolt (Figure 17-18, Page 17-11).



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Figure 17-17 Impulse Line

Figure 17-18 Fuel Line

- 4.5. Disconnect the throttle cable from the pedal group. See Pedal Group Removal on page 5-4. Loosen the cable mounting nuts (1) and ensure the cable can move freely through the hole in the frame (Figure 17-19, Page 17-12).
- 4.6. Remove retaining nut and disconnect the engine ground wire from the oil filler tube mounting bracket (Figure 17-20, Page 17-12).

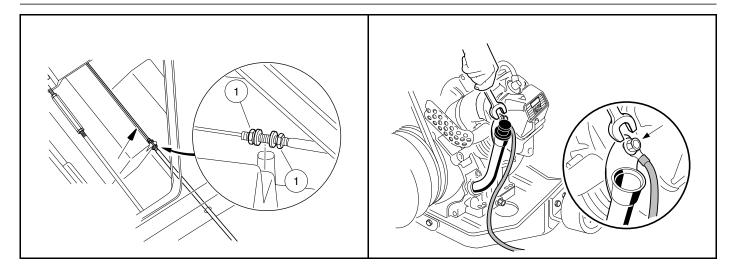


Figure 17-19 Throttle Cable Mounting

Figure 17-20 Engine Ground Wire

4.7. Use a screwdriver or flat blade to snap the shifter cable rod end (1) from the shifter arm (2) on the unitized transaxle. Compress the retaining clips (3) on the cable anchor and push the cable through the shifter bracket (Figure 17-21, Page 17-12).

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4.8. Mark for identification and then disconnect the 6-gauge white wire (F2 post), 6-gauge black ground wire (A2 post), and 16-gauge yellow wire (DF post) from starter/generator (Figure 17-22, Page 17-12).

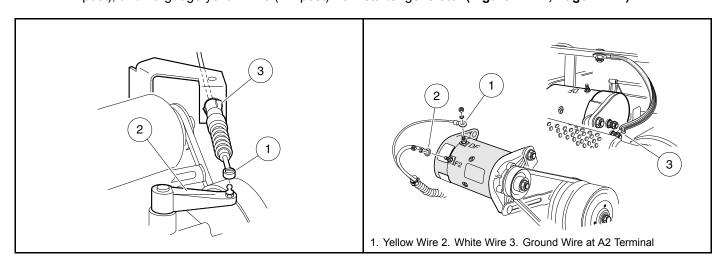


Figure 17-21 Shifter Cable (Top View)

Figure 17-22 Generator Wires - Model 114-01-4005 shown

- 4.9. Disconnect the engine oil level sensor wire (18-gauge yellow) at the connector just to the rear of the starter/generator (Figure 17-23, Page 17-13).
- 4.10. Disconnect the engine kill switch wire (18-gauge white/black) from the bullet connector at the lower right front of the engine (Figure 17-24, Page 17-13).
- 4.11. Cut away the wire ties securing the engine kill wire at the lower right front of the engine (below the exhaust header), the wire harness at the governor cable bracket, and the wire harness to the plate beneath the muffler.

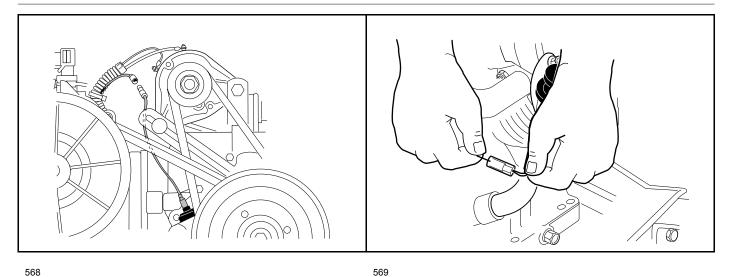


Figure 17-23 Oil Level Sensor Jumper Wire

Figure 17-24 Ignition Kill Wire

5. Disconnect the brake cables. Remove bow tie locking pins (1) and brake cable clevis pins (2) and using tool (P/N 1025555) compress tangs on cable end and remove cable from bracket (4) (Figure 17-25, Page 17-13).

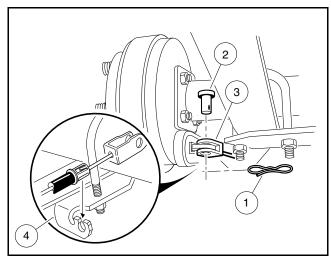
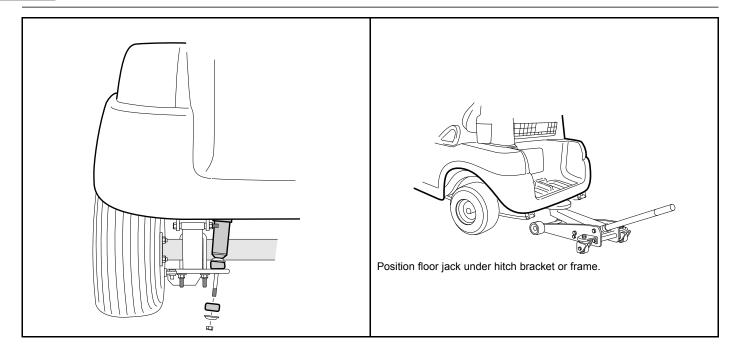


Figure 17-25 Brake Cable (Rear View)

- 6. Remove the lower shock mounting hardware from both rear shocks (Figure 17-26, Page 17-14).
- 7. Position a floor jack under the rear of the vehicle (Figure 17-27, Page 17-14).



767 Figure 17-26 Shock Absorbers

Figure 17-27 Floor Jack Positioned Under Vehicle

- 8. Raise vehicle just enough to relieve tension from leaf springs, then remove the bolts securing the leaf springs to the shackles (Figure 17-28, Page 17-14).
- 9. Remove the bolts securing the leaf springs to their front mounts (Figure 17-29, Page 17-14).

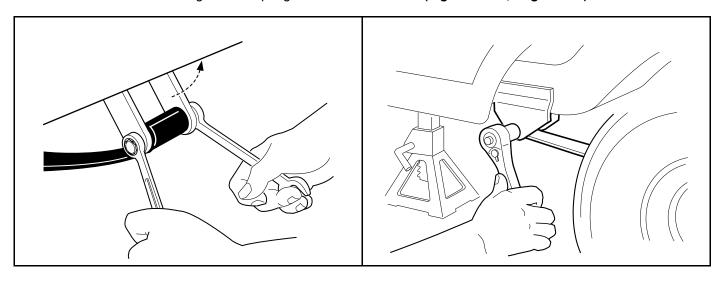


Figure 17-28 Rear Shackles

Figure 17-29 Spring Retainer Bolts

10. Continue raising vehicle until frame is higher than the top of the unitized transmission (enough to allow transaxle and engine to be rolled under and out of vehicle) (Figure 17-30, Page 17-15).

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11. Position jack stands, adjusted to support the vehicle at this height, under the aluminum frame rails forward of the spring mounts. Lower the floor jack to allow the jack stands to support the vehicle (Figure 17-31, Page 17-15).

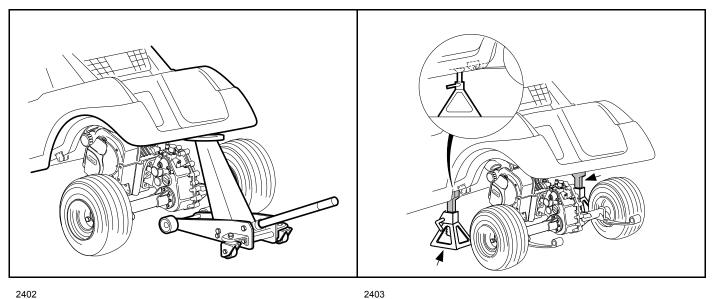


Figure 17-30 Raise Vehicle

Figure 17-31 Position Jack Stands On Both Sides of Frame

- 12. Pull the floor jack from beneath the vehicle and move it away.
- 13. Carefully lift the snubber (1) out of the snubber bracket (2) in the vehicle frame and lower it to the floor (**Figure 17-32**, **Page 17-15**). The powertrain should be completely disconnected from the vehicle and resting on the floor.
- 14. Grasp the ends of the leaf springs at the rear of the vehicle and roll the powertrain out from under the vehicle (Figure 17-33, Page 17-15).

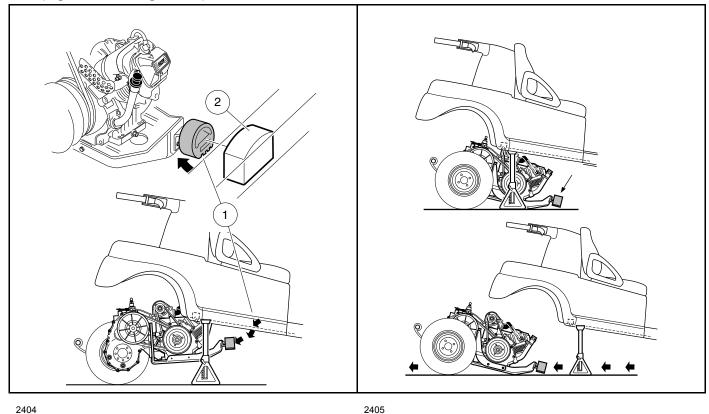


Figure 17-32 Snubber and Bracket

Figure 17-33 Remove Powertrain

15. Place blocks under the engine pan so they will completely support the engine and keep it **level to the floor** (Figure 17-34, Page 17-16). See following NOTE.

NOTE: Place the blocks so they will support the engine when the transaxle is detached and moved away from the engine.

16. Remove the drive belt.

16.1. Grasp belt midway between drive and driven clutch and pull up on belt to force the driven clutch sheaves apart. Roll the belt counterclockwise while pulling it off driven clutch (**Figure 17-35**, **Page 17-16**).

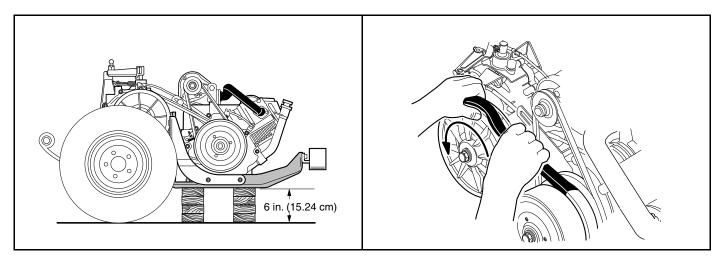


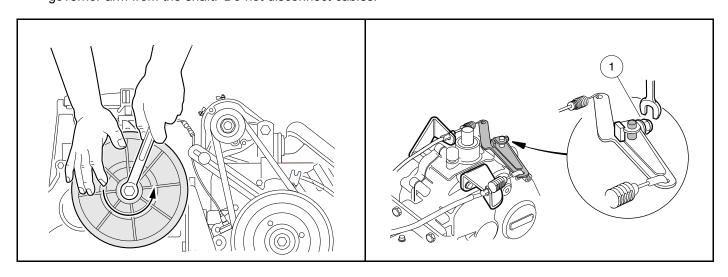
Figure 17-34 Position Powertrain on Wood Blocks

Figure 17-35 Remove Drive Belt

17. Remove the driven clutch retaining bolt and remove the driven clutch from the unitized transaxle (**Figure 17-36**, **Page 17-16**).

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18. Loosen, but do not remove, the governor arm retaining bolt (1) **(Figure 17-37, Page 17-16)**. Remove the governor arm from the shaft. Do not disconnect cables.



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Figure 17-36 Driven Clutch

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Figure 17-37 Governor Arm

- 19. Remove screws (1) securing the governor cable bracket to transaxle (Figure 17-38, Page 17-17).
- 20. Remove screws (1) securing the accelerator cable bracket to transaxle (Figure 17-39, Page 17-17).

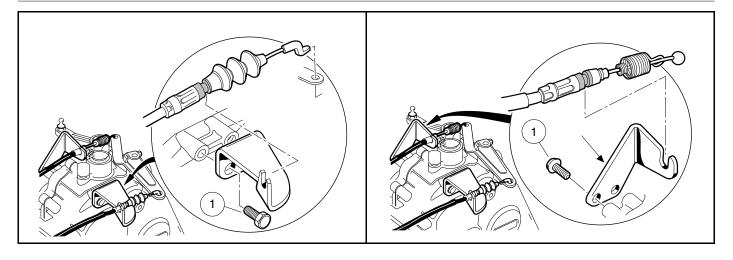


Figure 17-38 Governor Cable Bracket

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Figure 17-39 Accelerator Cable Bracket

- 21. Remove the six bolts mounting the unitized transaxle to the engine.
 - 21.1. Remove four transaxle mounting bolts and flat washers (one at each corner of the transaxle mounting plate) (Figure 17-40, Page 17-17).
 - 21.2. Remove two middle transaxle mounting nuts from the engine block studs.
- 22. Remove leaf springs, wheels and brake assemblies from the transaxle.

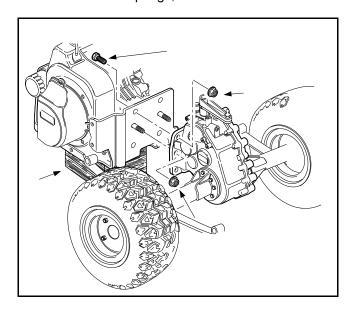


Figure 17-40 Transaxle Mounting

UNITIZED TRANSAXLE INSTALLATION

See General Warnings on page 1-2.

- 1. Install the wheels. See Wheel Installation, Section 8, Page 8-1.
- 2. Install the leaf springs. See Rear Suspension on page 9-1.
- 3. Position the transaxle mounting plate on the two mounting studs at the rear of the engine, and then install the two mounting nuts finger tight (Figure 17-41, Page 17-18).
- 4. Install the remaining four mounting bolts, four flat washers, and four nuts (one bolt and nut at each corner of the mounting plate) finger tight.
- 5. Tighten the four corner nuts (with bolts) to 23 ft·lb (31.2 N·m). Tighten the two center nuts (on the engine block studs) to 17 ft·lb (23.1 N·m) (Figure 17-41, Page 17-18).
- 6. Install the accelerator cable bracket on transaxle case. Tighten the mounting screws to 134 in·lb (15.1 N·m) (Figure 17-39, Page 17-17).

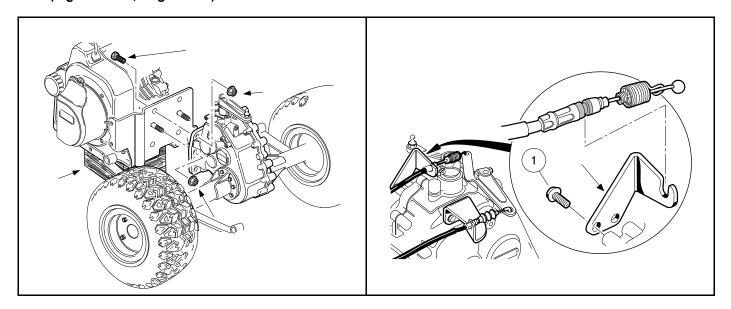


Figure 17-41 Transaxle Mounting

2407 Figure 17-42 Governor Arm

- 7. Install the governor cable bracket on transaxle case. Tighten the mounting screws to 134 in·lb (15.1 N·m) (Figure 17-38, Page 17-17).
- 8. Install governor lever arm on governor shaft (Figure 17-42, Page 17-18).
 - 8.1. With the governor lever arm loose on the governor shaft, turn the governor arm shaft counterclockwise until it stops. Then pull the governor lever arm rearward until the carburetor throttle is in the "wide open throttle" (WOT) position (Figure 17-42, Page 17-18).
 - 8.2. While holding the arm and shaft in the fully counterclockwise position, tighten the governor arm lever nut to 35 in·lb (4.0 N·m) (Figure 17-42, Page 17-18).
- 9. Install the key onto the input shaft (Figure 17-43, Page 17-19).
- 10. Position the driven clutch on the transaxle input shaft and install the washer (yellow side facing out) and mounting bolt. Tighten the mounting bolt to 14 ft·lb (19.0 N·m) (Figure 17-43, Page 17-19).
- 11. Install the drive belt. See Drive Belt Installation, Section 16, Page 16-3.
- 12. Remove the blocks from under the engine and roll the powertrain into position under the vehicle. Then lift the front of the powertrain and place the snubber into the snubber bracket in the vehicle frame (Figure 17-44, Page 17-19).

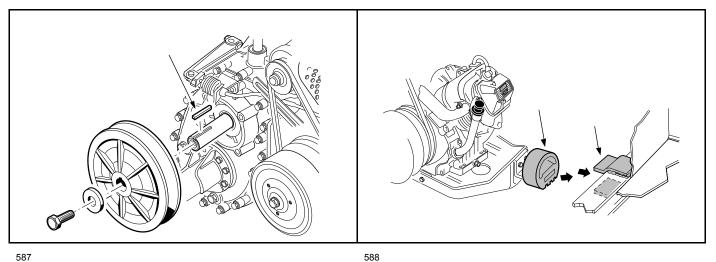


Figure 17-43 Driven Clutch and Key

Figure 17-44 Snubber and Bracket

- 13. Position the floor jack under the rear frame crossmember and raise the jack high enough to support the vehicle (Figure 17-45, Page 17-19). Make sure the vehicle is stable on the jack, then remove the jack stands.
- 14. After the jack stands are removed, lower the vehicle to approximately its normal height. Position the leaf springs in the front spring mounts and install the bolts and lock nuts. Ensure the brackets on the brake cables are placed over the bolts before the lock nuts are installed. Tighten to 15 ft·lb (20.3 N·m).
- 15. Adjust the vehicle height with the floor jack to position the leaf springs for mounting in the shackles. Install the mounting bolts and lock nuts (**Figure 17-46**, **Page 17-19**). Tighten lock nuts to 18.5 ft·lb (25 N·m).

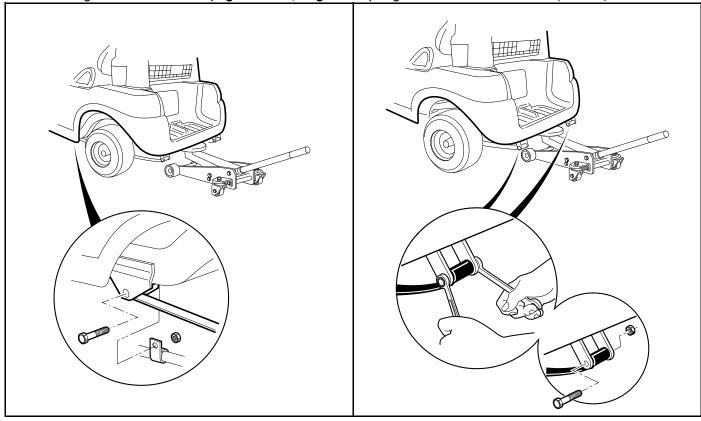
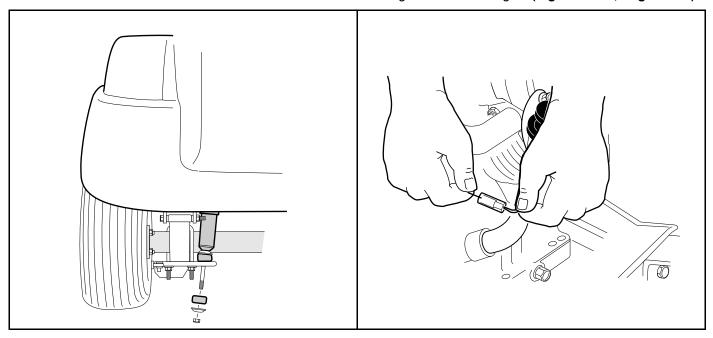


Figure 17-45 Leaf Springs

Figure 17-46 Leaf Springs and Shackles

16. Position shocks in the shock mounts and install cushions, mounting washers and nuts (Figure 17-47, Page 17-20). Tighten nuts until cushions expand to be the same diameter as the mounting washers.

- 17. Connect brake cables. See Brake Cable Installation on page 6-14.
- 18. Route the engine kill switch wire (18-gauge white/black) through the same retainers that hold the accelerator cable. Connect the wire to the bullet connector at the lower right front of the engine (Figure 17-48, Page 17-20).



767 Figure 17-47 Shock Absorber

Figure 17-48 Ignition Kill Wire

- 19. Connect the oil level sensor wire (18-gauge yellow) to the jumper wire (Figure 17-49, Page 17-20).
- 20. Connect the 6-gauge white wire to the F2 post, the 6-gauge black ground wire to the A2 post and tighten both wires to 48 in·lb (5.4 N·m). Connect the 16-gauge yellow wire to the DF post on the starter/generator and tighten to 30 in·lb (3.4 N·m) (Figure 17-50, Page 17-20).

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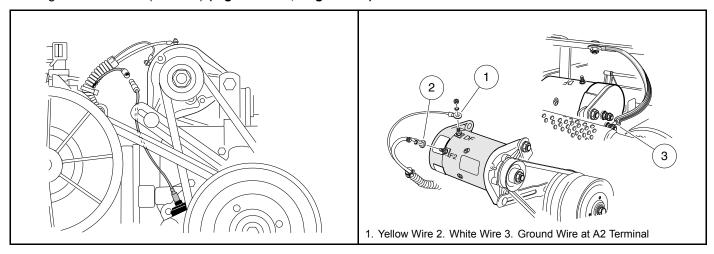
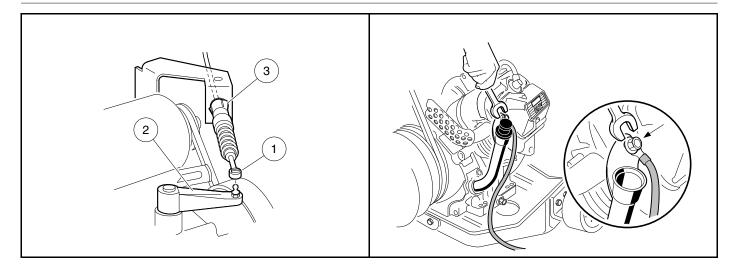


Figure 17-49 Oil Level Sensor Jumper wire

Figure 17-50 Starter/Generator – Model 114-01-4005 shown

- 21. Route shifter cable through the shifter cable bracket. Ensure the cable boot is properly positioned through the bracket. The clips on the boot should hold the cable in place. Connect shifter cable rod end to the shifter arm (Figure 17-51, Page 17-21).
- 22. Attach the ground wire to the mounting screw on the oil filler tube mounting bracket and tighten to 50 in·lb (5.7 N·m) (Figure 17-52, Page 17-21).



2399 Figure 17-51 Connect Shifter Cable

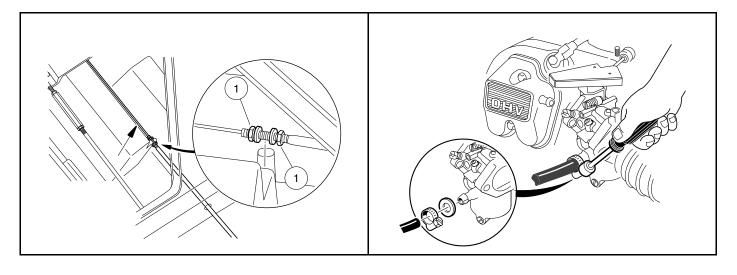
Figure 17-52 Engine Ground Wire

23. Insert the accelerator cable through the hole in the frame and connect the accelerator cable to the pedal group as described in Pedal Group – Gasoline Vehicle on page 5-4. Position the accelerator cable in the mounting brackets in the vehicle base and adjust mounting nuts (1) to remove all slack in the wire portion of the cable. Tighten mounting nuts to 23 in·lb (2.6 N·m) (Figure 17-53, Page 17-21).

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24. Remove the 1/4-inch bolt from the fuel line and connect the fuel line to the carburetor and secure with a screw-type hose clamp (Figure 17-54, Page 17-21). See following NOTE. Tighten screw clamp to 9 in lb (1.0 N·m).

NOTE: Ensure the nylon washer is in place on fuel inlet nipple prior to connecting the fuel line to the carburetor.



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Figure 17-53 Connect Cable

2398

Figure 17-54 Connect Fuel Line

- 25. Connect the impulse line to the fuel pump and secure it with the hose clamp (Figure 17-55, Page 17-22).
- 26. Connect air intake hose to carburetor and secure hose clamp (Figure 17-56, Page 17-22).

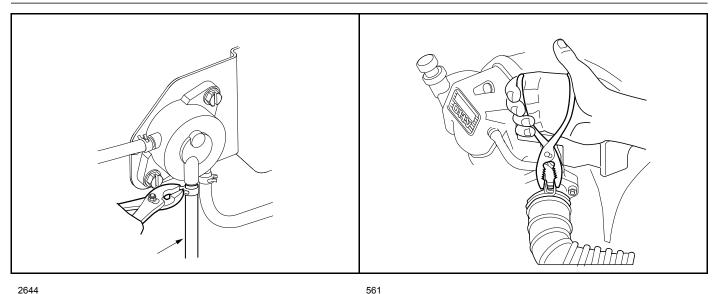
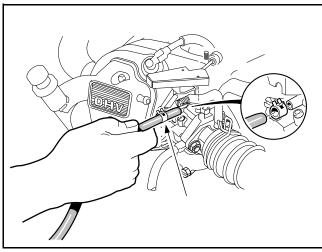


Figure 17-55 Impulse Line

Figure 17-56 Air Intake Hose

27. Connect carburetor vent tube to carburetor and secure with hose clamp (Figure 17-57, Page 17-22).



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Figure 17-57 Carburetor Vent Tube

- 28. Install transaxle drain plug and tighten to 21 ft·lb (28.5 N·m).
- 29. Fill transaxle with 27 fl-oz (0.8 L) 80-90 Wt. API class GL-3 or 80-90 WT. AGMA class EP gear lube. Install and tighten the level indicator hole plug to 21 ft-lb (28.5 N·m).
- 30. Ensure that all wiring is secured properly. See following WARNING.

A WARNING

- If wires are removed or replaced make sure wiring and wiring harness is properly routed and secured to vehicle frame. Failure to properly route and secure wiring could result in vehicle malfunction, property damage or personal injury.
- 31. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 32. Turn the fuel shut-off valve on top of the fuel tank to the open position (Figure 14-13, Page 14-22).
- 33. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout cam in the MAINTENANCE position. **See following DANGER.**

A DANGER

- · Repair all fuel leaks before operating the vehicle.
- 34. Start the engine and check for fuel leaks. If the fuel pump leaks, a rebuild kit must be installed to replace all gaskets and diaphragms.
- 35. Place the neutral lockout cam in the OPERATE position.
- 36. Adjust the engine RPM setting. See Engine RPM Adjustment on page 14-9.

FORWARD/REVERSE SHIFTER CABLE

See General Warnings on page 1-2.

If the Forward/Reverse shifter cable is damaged in any way, it must be replaced.

FORWARD/REVERSE SHIFTER CABLE REMOVAL

NOTE: Before removing cable, note cable routing and positions of wire ties or other devices securing the cable to the vehicle. When installed, cable must be routed and secured as it was originally.

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Loosen lock nut (26) where the cable attaches to the shifter (Figure 17-58, Page 17-24). Push in the end of the ball joint socket (27) to release the cable from the ball stud (17).
- 3. Loosen retaining nuts (28) to release cable from bracket (10).
- 4. Release the wire tie (25) that is clipped to the bucket and secure the cable.
- 5. Use a screwdriver or flat blade to pry cable end off the stud on the lever arm.
- 6. Compress clips on boot enough to push boot through the cable bracket (24). Remove cable from vehicle.

FORWARD/REVERSE SHIFTER CABLE INSTALLATION

- 1. From the Forward/Reverse shifter, route the cable toward the passenger side of the vehicle so it lies against the side of the front body, turns 90° and passes over the battery, through the opening to the engine, and through the cable bracket to the shifter arm (Figure 17-58, Page 17-24). Make sure cable does not touch muffler.
- 2. Place cable in bracket (10) and secure in position with two retaining nuts (28). Tighten retaining nuts to 43 in·lb (4.9 N·m).
- 3. Attach ball joint socket (27) to stud (17) on shifter. Tighten lock nut (26) to 43 in·lb (4.9 N·m).
- 4. Position cable near the clip and secure it with wire tie (25).
- 5. Push cable boot through cable bracket (24). Clips on boot should snap in place to secure the cable in position.
- 6. Place end of cable over stud on lever arm. Push down on cable end to snap the cable onto the stud.

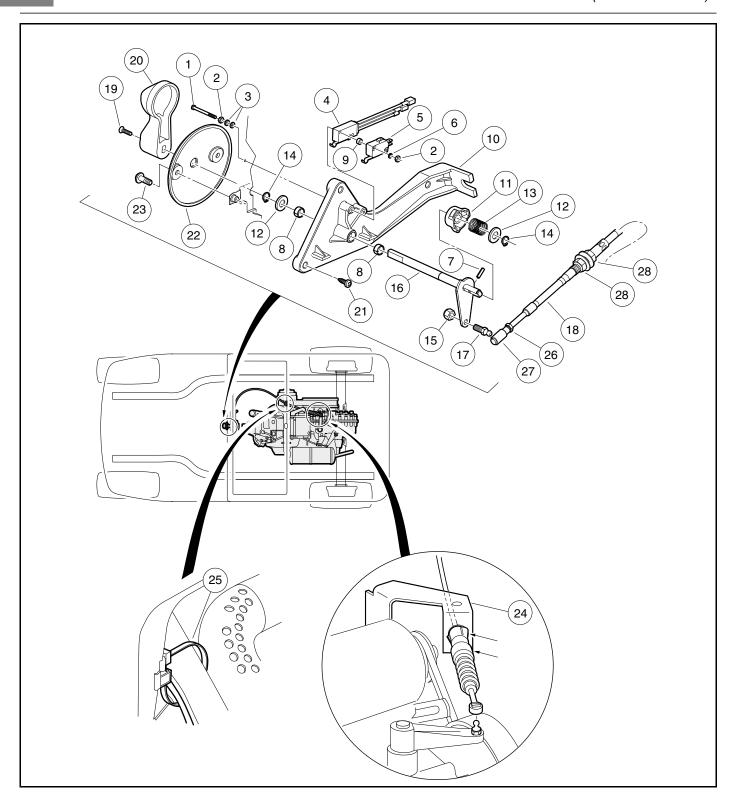


Figure 17-58 Forward/Reverse Shifter Cable

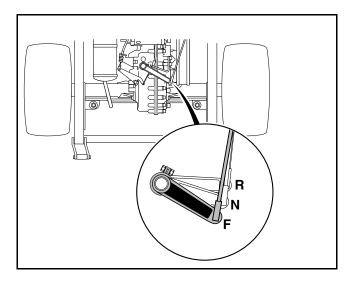
FORWARD/REVERSE SHIFTER CABLE ADJUSTMENT

With the shifter lever of the unitized transaxle in the NEUTRAL position (Figure 17-58, Page 17-24), the Forward/Reverse handle (20) should be straight up. For minor adjustments, the lock nut (26) may be loosened and the ball joint socket (27) rotated to get the proper adjustment. **See following CAUTION.**

A CAUTION

• Be sure threads of cable are engaged in ball joint socket at least 1/4 inch (6.35 mm). If ball joint socket comes loose from the cable, the Forward/Reverse shifter will not operate properly.

For major adjustments, the cable retaining nuts (28) must be loosened and adjusted. When the cable is properly adjusted, with the Forward/Reverse handle (20) (Figure 17-58, Page 17-24) in the NEUTRAL position, the shift lever of the transaxle will also be in the NEUTRAL position (Figure 17-59, Page 17-25). Retighten nuts at the Forward/Reverse assembly to 43 in·lb (4.9 N·m).



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Figure 17-59 Forward/Reverse Shifter Positions

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

NOTE: The information presented in this section addresses the following:

- The Controller Diagnostic Tool (CDT) handheld programmer which replaced the IQDM series 2 handset.
- How to use the CDT to troubleshoot the vehicle and to adjust controller parameters that affect vehicle behavior.
- The Excel controller with OS version 34 or version 35. The OS version can be viewed in the System Info menu of the CDT. See System Info on page 18-5.

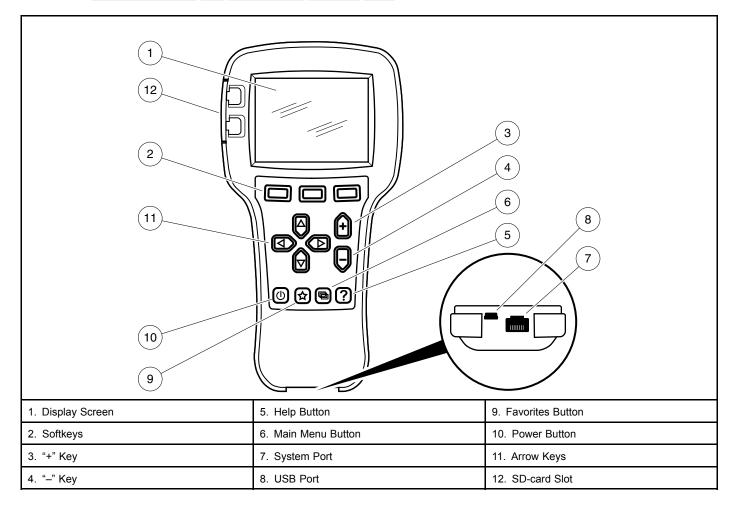


Figure 18-1 CDT Overview

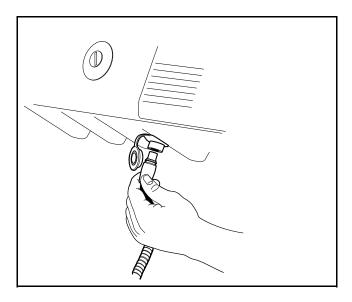
GENERAL INFORMATION

The CDT is used to adjust and save parameter settings of the controller, monitor real-time data, and perform diagnostics and troubleshooting of the electric vehicle.

FEATURES

- Batteries: Two AA batteries provide power for the CDT's real-time clock and they allow for use of the CDT when not connected to a vehicle.
- Convenient parameter adjustment: You can easily adjust a wide range of parameters to customize vehicle performance. These settings can then be saved as a unique .cpf (Cab Provisioning Format) file and stored. Multiple .cpf files can be stored and restored as needed.
- **Diagnostics and troubleshooting:** Existing faults as well as all the accumulated faults in the system's fault history file are listed in clear language. Suggestions for clearing each fault are also provided.
- Help function: Help screens give descriptions of adjustable parameters, monitored variables, and faults.
- **PC interface:** Files can be downloaded from a PC (onto an Secure Digital (SD) card or into the programmer directly through its USB connector) for installation into the controller.
- Plot and Log: The plot and log programs allow you to look at variables over time, either in graphical format or as data files you can upload in a spreadsheet program, such as Microsoft Excel.
- Real-time monitoring: Values of monitored data variables are displayed in easy-to-read formats.
- **SD-card support:** An SD card provides additional memory capacity. This is where any screenshots you take will be stored. SD cards can be used to deliver software upgrades, and can be used in multiple programmers to install identical software.
- Softkeys: Three versatile softkeys provide multiple functions, depending on context.
- **Update**: The handheld programmer can update its own software.

PLUGGING THE CDT INTO THE VEHICLE



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Figure 18-2 Communication Port Under Instrument Panel

- 1. Connect one end of the cable to the port located on the bottom of the CDT.
- 2. Connect the cable adaptor to the CDT cable.
- 3. Find the communication port on the vehicle (Figure 18-2, Page 18-3).
- 4. Remove the dust cap from the communication port.
- 5. Align the keyed portion of the plug with the communication port and insert plug into port.

INTRODUCTORY DISPLAY

Immediately after the CDT is connected to the vehicle, it begins loading controller information. During this time, the loading status is shown as a percentage, the CDT's software version is given, and status/information icons appear in the upper right corner. Once loading is complete, the screen displays the Main Menu.

NOTE: If the Power button is used to turn ON the handset and the handset is not connected to a vehicle, the message "No System Detected" will be displayed.

In the event that the handset does not display any information, or the screen is difficult to read, refer to the CDT troubleshooting procedures. **See CDT Troubleshooting on page 18-27.**

QUICK REFERENCE GUIDE - EXCEL WITH ERIC CHARGING SYSTEM

OPER	ATION:
Change screen contrast for better viewing by selecting the following: HPI	P Settings, Backlight
Preset Favorites: Select a frequently viewed screen, press "Add to" softk	ey, highlight "Favorites", press "Select" softkey.
CONTROLL	ER FAULTS:
Anti Tamper: If car is not equipped with Visage, make sure Control	Main Driver Off: Replace controller.
Mode is set to zero (0).	
Current Sense Fault: Clear the Fault History in CDT. If fault does not	Main Driver On: Replace controller.
return and car operates normally, do not replace controller. If fault	
remains in System Faults, or Fault History after clearing, and car will not	
operate, replace controller.	
FLD Missing: Check in order: orange or blue wire broke or disconnected	Main Driver Overcurrent: Replace controller.
at motor/controller, short in motor. If good, replace controller.	·
High Speed WalkAway: This is a symptom, not a cause. Most likely	Main Dropout: Solenoid or any component before it in circuit could be at
due to driver error. If not, check speed sensor on motor and key switch	fault. Check components from key switch to solenoid and connections.
for proper operation.	,
HPD: Check throttle %. If at zero (0), is a driver issue.	Main Dropout 2: Symptom more than the cause; see other faults that
7. 2. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3. 3.	accompany Main Dropout 2.
HW Failsafe: Replace controller.	Main Weld: Replace solenoid. If it doesn't correct fault of car running at
THE ANSWER REPUBLIC CONTROLL.	half speed, check accessory wiring.
Incorrect Password: Incorrect code being entered into controller, check	Motor Stall: If car moves freely, issue not with vehicle, operator error.
code A,B,C.	Motor Stant. If car moves freely, issue not with vehicle, operator error.
Lockout Fault: This is a symptom, not a cause. Inspect and test the	Overveltage: Centrallar reads 72 valts or mare: it's a symptom, not a
	Overvoltage: Controller reads 72 volts or more; it's a symptom, not a
charger interlock circuit. If no problems are found in the charger interlock	cause. See other faults that accompany OV.
circuit, replace the controller.	Current Courses. Check coursetters replace around course
Low Battery Voltage: Check Battery Voltage Under a Load less than 34	Speed Sensor: Check connection; replace speed sensor.
volts; could be a symptom, not a cause.	
Low SOC (State of Charge): This is a symptom, not a cause. Controller only acknowledges it happened and counts the number of occurrences.	Thermal Cutback: Controller heatsink rises above 185° F (85° C); increased resistance causes issue.
Charge batteries.	Therefore For to Describe MOOD follows are former additional discuss of the
M (Main) Coil Open: Broken or disconnected coil wire (B+ or B-), a	Throttle Fault: Possible MCOR failure; perform additional diagnostic if
defective solenoid coil. Replace solenoid.	car is running.
M- Shorted: Replace controller.	
WHEN CDT IS NOT COMMUNICATING WITH CONTR	ROLLER, CHECK THE FOLLOWING COMPONENTS:
The main connection port is corroded. Plug directly into the controller.	The battery pack voltage is below 32 volts. Check pack voltage to see if
See Figure 18-4 on page 18-30.	it is above 32 volts.
The DC cord is plugged into the car for more than 10 minutes. Unplug	Grey wire (pin # 9) to controller (16-pin connector) is loose or broken.
DC Cord.	, , , , , , , , , , , , , , , , , , , ,
The charger interlock circuit has failed. Check for voltage on Light Blue	15 Amp fuse in the harness has failed (Precedent Car only).
wire in pin 5 of 16-pin connector. See Test Procedure 10 – Charger	,
Interlock on page 19-26.	
Tow/Run switch is in "Tow" position. Switch to "Run" position.	Sonic weld(s) in Tow switch circuit failed (wire harnesses vary; see
Town Carl Carlot To It Town position. Owner to Truit position.	wiring schematic for that model car)
The Tow circuit has failed. Check Tow switch, 16-pin connector, and	The controller has failed.
The Tow Grount has railed. Officer Tow Switch, To-pin confidently, and	THE CONTROLLET Has falled.

SYSTEM INFO

The System Info menu is accessed by using the arrow keys to highlight System Info and pressing the Select softkey to activate the menu.

The System Info selection displays information pertaining to the controller. The information provided from this menu selection includes:

MODEL NUMBER

Displays the model number of the controller.

SERIAL NUMBER

Displays the serial number of the controller.

HARDWARE VERSION

Displays the controller hardware version. See following NOTE.

NOTE: This manual covers hardware version 5.

PROTOCOL VERSION

Displays the controller protocol version.

PARAM BLOCK VERSION

Displays a number that represents the default parameter settings at time of manufacture.

MFG DATE CODE

Displays the date the controller was manufactured.

OS VERSION

Displays the controller operating system software version. See following NOTE.

NOTE: This manual spans OS version 34 and version 35.

SM VERSION

Displays the version number of the Start Manager software in the controller.

VCL APP VERSION

Displays the version number of the Vehicle Control Language application software in the controller.

PARAMETERS

The *Parameters* menu is accessed by using the arrow keys to highlight *Parameters* and pressing the *Select* softkey to activate the menu.

The Parameters menu is where you can view and modify the settings of the controller's adjustable parameters. Navigate through this complex menu using the arrow keys, +/- keys, and softkeys. **The parameters displayed will depend on the access level of the handset.**

Be aware when changing parameter settings, the new values replace the earlier values. If you make adjustments that you don't like, and wish you could return to the earlier values, you cannot do this unless you have written down those earlier settings (which is unlikely) or unless you have saved them. To save your parameter settings, use the "Save .cpf File" function in the Programming menu; see Plot & Log on page 18-26. Your parameter settings will then be saved in a .cpf file. You can save as many .cpf files as you desire, and you can create unique names for them. If you prefer, each .cpf can automatically be given a name consisting of the date and time when it was created; see the "Text for save as" item in the HHP menu; see Plot & Log on page 18-26. For information on creating names, see **Using the Keyboard** in the CDT Owner's Manual.

SETTINGS

Speed Setting

The vehicle's top speed can be changed by selecting values 1 through 3. If a value of 4 is displayed for the speed setting, a special access code has been entered to place the vehicle in "private speed mode." A speed setting of 4 cannot be selected with the *speed setting* menu item. For additional information on speed setting 4, refer to *Code A*, *Code B*, *and Code C*. **See Code A**, **Code B**, **and Code C on page 18-9.**

SPEED SETTING	DESCRIPTION	VEHICLE SPEED
1	Commercial speed	8.0 mph (12.9 km/h)
2	Slow golf speed	11.4 mph (18.3 km/h)
3	Normal golf speed	Typical 14.8 mph (23.8 km/h). See S3 FWD Speed on page 18-7.
4	Private speed mode	19.2 mph (30.9 km/h)

NOTE: Present speed values for each speed setting may be observed in the Monitor menu. **See Vehicle Speeds** on page 18-14.

Fast Accel

Fast accel (fast acceleration) is an option that can be enabled or disabled. With fast accel turned on, the vehicle will accelerate at a noticeably faster rate. With this feature turned off, the vehicle speed will gradually increase, even if the accelerator is quickly pressed to the floor. Turn the feature on or off by pressing "+" or "-" on the change value button.

Pedal Up Mode

Three options exist for *pedal up mode* (motor braking). When the accelerator pedal is released, motor braking will slow the vehicle to "near zero speed" when pedal up motor braking is enabled (option 1 or 2). If pedal up motor braking is disabled (option 0), the vehicle will coast to a stop when the accelerator pedal is released. **See following NOTE.**

Change the settings of the Pedal Up Mode by pressing "+" or "-" on the change value button.

NOTE: Pedal Up Mode does not affect top vehicle speed. When the vehicle is going down an incline, the motor braking function will activate to prevent the vehicle from exceeding the speed setting defined in the Program menu, regardless of Pedal Up Mode setting (0,1, or 2). **See Speed Setting on page 18-6.**

When going down an incline with the accelerator pedal partially pressed, the motor braking function will activate to assist the operator in maintaining a speed less than the top speed setting. For example, if the vehicle is going down an incline with the accelerator pedal pressed half way, the motor braking function will activate to assist the operator in maintaining a speed approximately half of the speed setting defined in the Program Menu.

PEDAL UP MODE SETTING	MODE	OPERATION DESCRIPTION
0	Off	Pedal up motor braking is disabled
1	Mild pedal up	Mild pedal up motor braking
2	Aggressive pedal up	Aggressive pedal up motor braking

Speed Cal

The *speed cal* (speed calibration) menu item allows the user to fine tune the vehicle speed. This feature cannot be used to increase the vehicle speed. The range for speed calibration is 0 to 30. Each time the number is increased, the top speed will be decreased by 0.1 mph (0.16 km/h). The top vehicle speed will be determined by the *speed setting* menu item and the speed calibration setting. For example, if the speed setting is set for a value of 2 (11.4 mph (18.3 km/h)), and the speed calibration is set for 5, the total top speed of the vehicle should be approximately 10.9 mph (17.5 km/h).

NOTE: The SPEED CAL function will not be necessary in most golf applications since the speed setting 3 is finely adjustable with S3 FWD SPEED. **See S3 FWD Speed on page 18-7.**

S3 FWD Speed

The *s3 fwd speed* option allows for adjustability of the SPEED 3 speed setting. From the factory, *s3 fwd speed* will be set to one of 4 options: 12.4, 13.2, 14.0 and 14.8 mph (20.0, 21.3, 22.6 and 23.8 km/h, respectively). The default *s3 fwd speed* is 14.8 mph (23.8 km/h). The *s3 fwd speed* may be adjusted with the handset from 11.4 to 14.8 mph (18.3 to 23.8 km/h) in 0.1 mph (0.16 km/h) increments. The speed value chosen for *s3 fwd speed* may also be observed in the monitor menu. **See Vehicle Speeds on page 18-14.**

To fine tune vehicle top speed in normal golf speed range (12.4 to 14.8 mph (20.0 to 23.8 km/h)):

- 1. Access the *program* menu, then the *speed setting* menu with the navigation keys.
- 2. Select Speed Setting 3 with the change value buttons.
- 3. Access the *program* menu and the *s3 fwd speed* menu with the navigation keys.
- 4. Use the change value buttons to select desired speed.

Control Mode

The *control mode* option is used to configure the 1515 controller for different modes of speed control operation. Four modes are available:

• 0 = Standard: Uses maximum speeds defined by the *S1* through *S4 Fwd Speed*, *Rev Speed* and *Speed Cal* parameters.



- 1 = LIN (Local Interconnect bus) (i.e. Guardian or Visage): Uses maximum speeds assigned to a particular location or area as defined by the fleet operator; however, these defined speeds can not override maximums set in the S1 through S4 Fwd Speed, Rev Speed and Speed Cal parameters.
- 2 = ES-Protocol (UpLink): Uses maximum speeds assigned to a particular location or area as defined by the fleet operator; however, these defined speeds can not override previously set values from other control mode options. To avoid this, after changing the control mode to 2, cycle power to the controller by placing the Tow/Run Switch in the TOW position for 30 seconds. Then return it to RUN.
- 3 = Deterrent Demo Mode: Uses maximum speeds defined by the deterrent demo setting to demonstrate the automatic speed control features of Guardian and UpLink. See Deterrent Demo on page 18-8.

Anti-Tamper

The anti-tamper setting defines maximum speed if the Anti-Tamper fault is triggered (e.g. controller is disconnected from the Guardian or Visage system). These speeds can only be activated if the Control Mode option is set to 1 (Guardian/Visage) and are intended to be a deterrent. Factory default setting is 1.

- 0 = OFF; uses controller configured speed (S1 through S4 Fwd Speed, Rev Speed and Speed Cal parameters) even if the Anti-Tamper fault is triggered
- 1 = 2 mph
- 2 = 0 mph
- 3 = 7 mph

Deterrent Demo

The deterrent demo setting defines maximum speed of Control Mode 3.

- 0 = Controller configured speed (S1 through S4 Fwd Speed, Rev Speed and Speed Cal parameters)
- 1 = 10 mph
- 2 = 7 mph
- 3 = 2 mph

Excel Braking

The excel braking menu item allows the user to turn this function ON or OFF. With it ON, the vehicle maintains the regen motor braking "feel" of the Excel system. With it OFF, regen motor braking is less aggressive and the vehicle mimics the "feel" of the IQ system.

For example: A Pedal Up Mode setting of 2 = 150 amps of regen motor braking. Setting Excel Braking to ON increases regen by 30 amps for a total of 180 amps and a more aggressive braking action.

WalkAway Deterrent

The walkaway deterrent menu item allows the user to turn this function ON or OFF. Walkaway deterrent is triggered by the High Speed WalkAway fault. With it ON, the reverse buzzer will sound immediately upon the key switch being turned OFF at speeds above 2 mph. With it OFF, the buzzer will cycle on and off at a higher frequency (7.5 Hz vs. 2.5 Hz).

Battery Type

The battery type menu item is intended to be used with Guardian/Visage so that the type of battery could be determined and displayed when remotely monitoring vehicles.

Charger Control

Beep Option

The Beep Option controls use of the reverse buzzer to sound a confirmation that charging has started: 0 = OFF, 1 = 1 beep, 2 = 3 beeps. From the factory, the Beep Option will be set to 2.

AMP HOURS

Reset Trip Amp Hours

The reset trip amp hours menu item allows the user to reset counter to zero (0). To reset, set to ON and then immediately back to OFF. To review or validate, proceed to Amp Hours Display on page 18-13 under the Monitor Menu.

ACCESS CODES

Code A, Code B, and Code C

The code entries are used to place the vehicle in "private speed mode", speed setting code 4. Each vehicle has a unique code for placing the vehicle in this mode. A vehicle programmed for "private speed mode", speed setting 4, does not conform to ANSI Z130.1 – American National Standard for Golf Cars – Safety and Performance Specifications because it is capable of speeds in excess of 15 mph (24.1 km/h). For more information on this feature, contact your local Club Car distributor or dealer.

NOTE: If controller is replaced, the information below must be entered into the new controller. See Speed Controller Installation, Section 20, Page 20-11.

VEHICLE ID

Vehicle Date of Manufacture

Four digit number programmed by vehicle manufacturer. Example: 1401 represents Model Year 2014, week 1.

Vehicle S/N

Six digit number programmed by vehicle manufacturer.

Vehicle Decal

Decal number ranging from 0 to 999 and programmed by vehicle manufacturer.

MONITOR MENU

The *Monitor* menu is accessed by using the arrow keys to highlight *Monitor* and pressing the *Select* softkey to activate the menu.

All information in the *Monitor* menu is updated in real time, allowing the trained technician to troubleshoot the vehicle by monitoring the handset as the key switch is cycled, Forward/Reverse switch is activated, etc. **See following NOTE.**

NOTE: Values appearing in these menus represent approximate measurements made by the controller and may differ from measurements made by external instruments.

Since the *Monitor* menu is updated while the vehicle is in operation, the trained technician has the ability to monitor the status of several components in conditions or locations where a problem with vehicle performance has been reported. **See following WARNING.**

A WARNING

The vehicle operator should not monitor the handset while the vehicle is in motion. A technician
can monitor the handset while traveling as a passenger in the vehicle. Failure to heed this warning
could result in severe personal injury or death.

The following parameters can be monitored in real time with the handset from the *Monitor* menu:

BATT VOLTAGE

Displays the current battery voltage at the speed controller.

V_{MIN} I

Displays volts (minimum) at a certain amperage. This is a setting parameter used with the Low SOC (State of Charge) detection fault.

SIGNED BATTERY CURRENT

While driving the vehicle, this displays either the current being pulled out of the batteries or the current being returned to the batteries during regenerative motor braking. It has a range from negative (–) 300 amps to positive (+) 300 amps.

BDI PERCENT

Battery Discharge Indicator (BDI) Percent displays the current battery state of charge as a percent. It is based on several parameters monitored by the controller.

SPEED

Vehicle speed in mph.

THROTTLE

Indicates the position of the accelerator pedal from 0% (pedal not pressed) between 95 and 100% (pedal fully pressed). This item can be monitored when the key switch is in the ON or OFF position.

TEMPERATURE

Displays the temperature (in degrees Celsius) of the speed controller heatsink. During normal operating conditions, the heatsink temperature should be below 185 °F (\pm 9) (85 °C (\pm 5)). **See following NOTE.**

NOTE: Anything that adds resistance (i.e. improper brake adjustment, low air pressure in tires, low battery voltage, etc.) can cause the operating current to be higher than normal. This higher current increases the temperature of the speed controller heatsink.

ARM CURRENT

Displays the motor armature current (in amperes).

FIELD CURRENT

Displays the motor field current (in amperes).

ARMATURE PWM

Displays motor armature PWM (pulse width modulation). The range of pulse width modulation is 0% to 100%. When the vehicle is operating at full speed, the pulse width modulation should be at 100%.

FIELD PWM

Displays motor field PWM (pulse width modulation). The range of pulse width modulation is 0% to 100%. When the vehicle is in operation, the pulse width modulation will fluctuate in response to the terrain and throttle input.

SPEED PULSES

The *speed pulses* menu item displays the activity of the motor speed sensor. With the key switch in the OFF position, the Forward/Reverse switch in the NEUTRAL position, and the vehicle at rest, the handset should indicate that speed pulses are off. When the vehicle is gently pushed a short distance, the handset should indicate that speed pulses are on.

FOOT INPUT

Indicates the status of the MCOR (Motor Controller Output Regulator) internal limit switch: on or off. When the accelerator pedal is unpressed, the handset should indicate that the limit switch is off. When the accelerator pedal is pressed and the key switch is in the ON position, the display should indicate that the limit switch is on.

KEY INPUT

Displays the position of the key switch: OFF or ON.

FORWARD INPUT

With the Forward/Reverse switch in the NEUTRAL or REVERSE position, the handset should indicate that the forward input is off. When the Forward/Reverse switch is placed in the FORWARD position, the handset should indicate that the forward input is on.

REVERSE INPUT

With the Forward/Reverse switch in the NEUTRAL or FORWARD position, the handset should indicate that the reverse input is off. When the Forward/Reverse switch is placed in the REVERSE position, the handset should indicate that the reverse input is on.

MODE SWITCH INPUT

This menu is reserved for possible future use and has no application at this time.

CHARGER INHIBIT

Displays charger connection. When the charger is connected and the controller does not drive (inhibited), the handset indicates ON. When the charger is not connected and the controller is allowed to drive, the handset indicates OFF.

MAIN CONT DRIVER

Displays the present solenoid (main contactor) state. When the controller energizes the solenoid coil, the handset indicates ON. When the controller de-energizes the solenoid coil, the handset indicates OFF.

LED DRIVER

Displays the present state of pin 11 in the controller 16-pin connector that operates the charge indicator light on the dash. When pin 11 is activated, power is provided to the light and the handset indicates that the LED Driver is ON. When pin 11 is not activated, the handset indicates that the LED Driver is OFF.

PASSWORD TRIES (OEM ACCESS LEVEL ONLY)

A password is required to place the vehicle in "private speed mode" (speed setting 4). The speed controller will log unsuccessful and unauthorized attempts to place the speed controller in "private speed mode". If repeated attempts are unsuccessful, the speed controller will permanently lock out access to "private speed mode". In the event that "private speed mode" is locked out, the controller must be removed and shipped to Club Car before it can ever be placed in "private speed mode". **See Code A, Code B, and Code C on page 18-9.**

ODOMETER

Displays approximate distance travelled in miles.

BDI INFO

Load Line SOC

Load Line SOC is the state of charge estimation based upon battery voltage during a defined discharge current (between 50 and 60 amps).

Load Line Valid

Load Line Valid is an indication (Load Line Valid = 1) that the discharge current is between 50 and 60 amps.

BDI Int Factor

BDI Int Factor is an auto-adjusting correction factor for estimating state of charge based upon the difference between the currently estimated state of charge and the Load Line SOC.

Open Circuit Voltage Start

Open Circuit Voltage Start is the voltage, as determined by the controller, following a cycle of the Run/Tow switch or coming out of sleep mode.

Open Circuit SOC Start

Open Circuit SOC Start is the estimated state of charge following a cycle of the Run/Tow switch or coming out of sleep mode.

BATTERY MONITOR

These menu items reset every time the vehicle is charged.

Lowest Battery Voltage

Displays the lowest battery pack voltage reached since the last charge.

I Batt at Lowest Volts

Displays the current through the controller at the lowest battery pack voltage.

Highest Battery Voltage

Displays the highest battery pack voltage after being charged.

CHARGING TOTALS

These menu items accumulate totals for the life of the vehicle.

Completed Charges

Displays the number of completed charge cycles.

Interrupted Charges

Displays the number of interrupted charge cycles.

Storage Charges

Displays the number of storage charge cycles.

AMP HOURS DISPLAY

Signed Battery Current

While driving the vehicle, this displays either the current being pulled out of the batteries or the current being returned to the batteries during regenerative motor braking. It has a range from negative (–) 300 amps to positive (+) 300 amps.

Amp Hours

Displays total accumulated amp hours removed from batteries since initial vehicle start-up.

Regen Amp Hours

Displays total accumulated amp hours returned to the batteries from regenerative braking since initial vehicle start-up.

Charge Amp Hours

Displays amp hours removed from batteries since the last charge.

Charge Regen Amp Hours

Displays amp hours returned to the batteries from regenerative braking since the last charge.

Trip Amp Hours

Displays amp hours removed from batteries since trip amp hours was reset. See Reset Trip Amp Hours on page 18-9.

Trip Regen Amp Hours

Displays amp hours returned to the batteries from regenerative braking since trip amp hours was reset.

LIN

Relates to communication between the controller and the Guardian/Visage device (if equipped).

Charger

Additional

VEHICLE SPEEDS

Press right arrow to display programmed speeds for each speed setting. See Code A, Code B, and Code C on page 18-9.

PEDAL COUNTERS

Accumulates accelerator pedal usage.

FAULT COUNTERS

The Fault Counters indicate how many times each fault type has been recorded since the last clearing of fault history. **See following Faults Menu section.**

FAULT COUNT ODOMETERS

The Fault Count Odometers indicate the odometer reading associated with the last occurrence of each fault type. Will indicate 0.0 (miles) if the fault occurred before the last clearing of fault history.

DIAGNOSTICS MENU

CAUTION

• A failed motor will damage the controller. Always inspect the motor before replacing the controller. See External Motor Testing, Section 23, Page 23-1.

NOTE: The software is subject to frequent updates, and this manual may span many versions. Be aware that some faults listed in this manual may not display in the CDT, indicating older software.

Sometimes the fault circuits catch a temporary event that is not a true fault in the system. It is good practice to turn the control system OFF and back ON again to see if the fault clears by itself.

The *Diagnostics* menu is accessed by using the arrow keys to highlight *Diagnostics* and pressing the *Select* softkey to activate the menu. Under the Diagnostics menu are two folders: *Present Errors* and *Fault History*.

Faults displayed in the *Diagnostics* menu will aid the trained technician in troubleshooting the vehicle. Faults displayed often indicate which components in the electrical system need to be tested.

Since the *Diagnostics* menu is updated while the vehicle is in operation, the trained technician has the ability to monitor the occurrence of faults in conditions or locations where a problem with vehicle performance has been reported. **See following WARNING.**

▲ WARNING

• The vehicle operator should not monitor the handset while the vehicle is in motion. A technician can monitor the handset while traveling as a passenger in the vehicle. Failure to heed this warning could result in severe personal injury or death.

PRESENT ERRORS FOLDER

The Fault History folder displays all existing faults in chronological order. An item in this folder can only be removed by remedying the fault. As long as the fault exists, it will be included in the Present Errors folder. The "number" in the upper right corner of the screen indicates the number of present faults and which fault is highlighted. Example: "1/3" means the first of three total faults is highlighted.

FAULT HISTORY FOLDER

The Fault History folder displays all of the faults detected by the controller since the last time the fault history has been cleared. The faults displayed in this folder may or may not be currently active. Once a fault has been detected, it is stored in the memory of the controller for display on the Fault History folder. Each detected fault is listed only once, even if the fault has occurred multiple times. You can clear the entire contents of this folder to allow a fresh Fault History to be started.

CAUSES OF FAULTS

Some common causes of faults are:

- · Loose, broken, or disconnected wires or connectors
- · Failed components
- Improper adjustment or installation of electrical or mechanical components (examples: brake adjustment, improper MCOR installation)
- · Improper wiring of electrical components

As shown above, there are many possible causes for faults to occur, and the controller has a programmed reaction to each fault that is based on the fault currently detected. The technician should be familiar with the detected faults and the controller's reactions to faults to ensure a proper diagnosis.

An example of a possible mis-diagnosis of a vehicle due to a fault: If the three-pin speed sensor wire has been disconnected, the controller will detect a *speed sensor* fault. When a *speed sensor* fault is detected, the controller responds to the fault by limiting the vehicle speed to 1/2 of its normal top speed. If the technician reaches the conclusion that the vehicle is running slowly because batteries are heavily discharged, he has made an improper diagnosis of the problem.

The controller should be checked for fault codes before any service is performed.

After detecting a fault, the controller will respond in one or more of the following ways:

- · A. Reduce vehicle speed to zero by reducing armature current
- · B. Reduce vehicle speed to zero by reducing field current to zero
- · C. Turn off the solenoid
- D. Cause the vehicle to run at slow speed
- E. Gradually reduce the armature current limit
- F. Quickly reduce the armature current until speed sensor pulses occur
- G. Reduce field current and beep reverse buzzer at a fast rate
- H. Limits vehicle speed per Anti-Tamper setting
- · J. Adds the occurrence to the fault counter
- · K. Activates a warning device
- · L. Locks out Private Speed Mode

CONTROLLER FAULT	CONTROLLER RESPONSE	VEHICLE RESPONSE
HW FAILSAFE	A, B, C	Vehicle comes to a stop
THROTTLE FAULT	A, C	Vehicle comes to a stop
SPEED SENSOR	D	Vehicle runs at slow speed
MAIN WELDED	D	Vehicle runs at slow speed
MAIN DRIVER ON	A, B	Vehicle comes to a stop
MAIN DRIVER OFF	A, C	Vehicle comes to a stop
MAIN COIL OPEN	A	Vehicle comes to a stop
FIELD MISSING	A, B, C	Vehicle comes to a stop
HPD	A	Vehicle comes to a stop
OVERVOLTAGE	A, B, G	Vehicle slows and beeps
LOW BATTERY VOLTAGE	E	Top speed is reduced
THERMAL CUTBACK	E	Top speed is reduced
MOTOR STALL	J	None
MAIN DROPOUT (1 and 2)	A, C	Vehicle comes to a stop
MAX PASSWORD TRIES	L	Vehicle continues to only reach a top speed determined by the Speed Setting
INCORRECT PASSWORD	J	None
MAIN DRIVER OVERCURRENT	A, B	Vehicle comes to a stop
CURRENT SENSE FAULT	A, B, C	Vehicle comes to a stop
M- SHORTED	A, B, C	Vehicle comes to a stop
ANTI-TAMPER	Н	Top speed is reduced
HIGH SPEED WALKAWAY	J, K	Vehicle beeps
LOCKOUT FAULT	J	None
LOW SOC	J, K	Charge indicator light ON

FAULT RECOVERY

When a fault is detected by the controller, the controller will attempt to recover from the fault and resume normal operation. In the case of an intermittent problem, such as a loose wiring connection, the controller **may** be able to recover and operate normally for a while, but the problem should be repaired before placing the vehicle in service. Depending on the type of fault, the controller will attempt to recover either immediately after the condition clears or after the accelerator pedal has been cycled (released and pressed again).

CONTROLLER FAULT	CONTROLLER ATTEMPTS TO RECOVER
HW FAILSAFE	When key switch is cycled
THROTTLE FAULT	When condition clears
SPEED SENSOR	When condition clears
MAIN WELDED	When condition clears
MAIN DRIVER ON	When condition clears
MAIN DRIVER OFF	When accel. pedal is cycled
MAIN COIL OPEN	When accel. pedal is cycled
FIELD MISSING	When accel. pedal is cycled
HPD	When accel. pedal is cycled
OVERVOLTAGE	When condition clears
LOW BATTERY VOLTAGE	When condition clears
THERMAL CUTBACK	When condition clears
MOTOR STALL	When condition clears
MAIN DROPOUT (1 and 2)	When accel. pedal is cycled
MAX PASSWORD TRIES	When Tow/Run switch is cycled
INCORRECT PASSWORD	When Tow/Run switch is cycled
MAIN DRIVER OVERCURRENT	When condition clears
CURRENT SENSE FAULT	Within controller
M- SHORTED	When key switch is cycled
ANTI-TAMPER	When condition clears
HIGH SPEED WALKAWAY	When condition clears
LOCKOUT FAULT	When condition clears
LOW SOC	When condition clears

FAULT DESCRIPTIONS

The following faults can be detected by the Excel System controller and seen under both the *Monitor Menu* and *Diagnostics Menu*:

INCORRECT PASSWORD (OEM ACCESS LEVEL ONLY)

Each vehicle has a password in the form of a unique set of codes used to place the vehicle in "private speed mode". If a set of codes has been entered incorrectly, the *incorrect password* fault is declared. For additional information on codes, refer to Code A, Code B, and Code C. See Code A, Code B, and Code C on page 18-9. See also Password Tries (OEM Access Level Only) on page 18-12.

MAX PASSWORD TRIES (OEM ACCESS LEVEL ONLY)

The max password tries fault is declared when the incorrect password fault has been declared several times. In the event that the max password tries fault is indicated, the speed controller must be removed and shipped to Club Car before it can ever be placed in "private speed mode". See Code A, Code B, and Code C on page 18-9. See also Password Tries (OEM Access Level Only) on page 18-12.

THROTTLE FAULT

If the MCOR (Motor Controller Output Regulator) voltage is less than 0.20 volts or greater than 4.80 volts, the controller detects a *throttle fault*.

What it means: If the voltage seen by the controller coming out of the MCOR is not within specified limits, this fault occurs and the controller de-energizes the solenoid coil. Perform additional diagnostic if vehicle is running. **What to do:** Replace MCOR. **See following NOTE.**

NOTE: Newer controllers may, infrequently, read voltages above or below limits and give a false fault.

LOW BATTERY VOLTAGE (UNDERVOLTAGE)

If the battery voltage falls below 34 volts $\pm 5\%$, the *low battery voltage* fault is detected by the speed controller. **What it means:** Could be a symptom, not a cause. Voltage coming into the controller is at, or less than, 34 volts. **What to do:** Check battery voltage under a load.

OVERVOLTAGE

If the speed controller detects that the battery voltage is too high (68.4 to 75.6 volts DC), the *overvoltage* fault is detected.

What it means: This is a symptom that occurs when the controller sees 72 or more volts. Reverse Buzzer beeps when fault occurs and the car will freewheel.

What to do: Check to see if car has been towed without being put into "Tow" mode. Check charger relay because, in Excel vehicles, bypassing the relay in the charger could cause the controller to read an overvoltage fault. Note too that Excel vehicles, on hilly courses, may see this fault if the driver turns the key switch off while the vehicle is in motor braking mode.

THERMAL CUTBACK

If the controller heatsink temperature is found to be in excess of 185 °F (\pm 9) (85 °C (\pm 5)) or below –13 °F (\pm 9) (–25 °C (\pm 5)), the *thermal cutback* fault is detected.

What it means: Heatsink temperature rises above 185 °F (85 °C).

What to do: Monitor Heatsink Temp, battery voltage, brakes dragging, car under extreme loads, low or no air pressure in tire(s).

ANTI-TAMPER FAULT

If communication with the Visage or Guardian unit is interrupted, the controller registers an *anti-tamper fault*. **What it means:** This is a symptom, not a cause. The controller is set to communicate with a Visage or Guardian unit and it is unable to.

What to do: Clear the Fault History in the CDT. Ensure wiring is connected and inspect for damaged wires. If the vehicle is not or no longer going to be equipped with these services, change Control Mode setting to zero (0).

HPD

The *HPD* (High Pedal Detect) fault is detected if the accelerator pedal is already depressed when the key switch is turned to the ON position. This fault is also detected if the accelerator pedal is pressed when the selected direction is changed by pressing the Forward/Reverse switch. This fault, when not caused by the operator, can indicate that the pedal limit switch has failed closed.

What it means: The pedal is depressed before the key switch and/or the FNR is switched on. This is a safety control and the controller must see the pedal engaged last in the following sequence: key switch first, FNR second, and then pedal last.

What to do: Check throttle percentage and, if at 0, issue is driver error.

MAIN DRVR OVERCURRENT

If the current on the relay driver exceeds 120 mA, or the current on the solenoid driver exceeds 6 A, a *main driver* overcurrent fault is detected.

LOCKOUT FAULT

If the controller receives a signal that the charger interlock is activated while the vehicle is being driven, the controller registers a *lockout fault* and may prevent the vehicle from operating.

What it means: This is a symptom, not a cause. The controller should only see charger interlock activated when the charger's DC cord (external charger) is connected to the vehicle or AC cord (onboard charger) is connected to an AC outlet. One possible cause is failure of the 10k ohm resistor in the charger interlock circuit.

What to do: Clear the Fault History in the CDT. If the fault does not return and the car operates normally, do not replace the controller. If the fault continues to occur, inspect and test the charger interlock circuit. See Test Procedure 10 – Charger Interlock on page 19-26. If the 10k ohm resistor has failed, replace resistor. If no problems are found in the charger interlock circuit, replace the controller.

LOW SOC

If the controller sees that the battery pack has reached a low state of charge (SOC), the controller registers a *low SOC fault*.

What it means: This is a symptom, not a cause. The controller records the number of times this occurs. What to do: Charge batteries. If fault occurs more frequently than normal, test battery pack. See Section 21 – Batteries: Electric Vehicle with ERIC Charging.

MAIN WELDED

If the speed controller detects that the solenoid contacts are welded closed, a *main welded* fault is detected. **What it means:** The solenoid contact is welded closed and will not dropout when pedal is released, or key switch is turned to OFF, or FNR is switched to N.

What to do: Replace solenoid. If vehicle continues to operate at half speed, check accessory wiring.

HIGH SPEED WALKAWAY

If the controller receives a signal to activate walk away braking while the vehicle is moving at a speed greater than 2 mph (3.2 km/h), the controller registers a *high speed walkaway fault*.

What it means: This is a symptom, not a cause. The key switch was turned to OFF while the vehicle was coasting faster than 2 mph (3.2 km/h).

What to do: Most likely, this is due to driver error. If not, check speed sensor on motor and key switch for proper operation.

SPEED SENSOR

If the speed controller does not detect pulses from the speed sensor while the controller outputs power (greater than 75% armature PWM) to the motor, a *speed sensor* fault is detected.

What it means: Speed sensor is not working. Check connection.

What to do: Replace speed sensor.

MAIN DRIVER ON

If the field-effect transistor (FET) that controls the closing of the solenoid contacts is found to be energized when it should not be, a *main driver on* fault is detected by the speed controller.

What it means: The controller FET controlling the energizing of the solenoid is on (or energized) when it should not be. This causes main contactors to stay engaged. Pin 12 provides ground for the solenoid coil when FORWARD, REVERSE, KEY, or FOOT INPUT is present at the controller. If the ground continues to be present once either KEY, FOOT, FORWARD or REVERSE INPUT is removed, *main driver on* is detected.

What to do: Replace controller.

MAIN COIL OPEN

If the speed controller determines that the solenoid is not closing as a result of a solenoid coil failure, a *main coil open fault* is detected.

What it means: An open circuit in the solenoid coil. It could be in either the ground side or B+ side of the circuit.

What to do: Check for a broken or disconnected blue wire on the B+ side of the solenoid coil, a broken or disconnected blue/white wire on the B- side of the solenoid coil, a broken coil wire inside the solenoid which would result in zero ohms resistance reading, a defective coil which could result in very low coil resistance (usually less than 40 ohms; large solenoids should read 180 to 190 ohms; small solenoids 200 to 250 ohms), a broken blue/white wire at the 16-pin controller plug or its terminal is loose in the 16-pin plug.

MAIN DROPOUT (1 OR 2)

If the controller detects that the solenoid contacts have opened while the vehicle is in operation, a main dropout fault is detected.

What it means: Occurs when the solenoid coil losses ground causing the main contact to lose connection. With Main Dropout 2, the solenoid drops out while the vehicle is in regen/motor braking. Main Dropout 2 is usually a symptom more than a cause.

What to do: Check the following components: key switch, MCOR, batteries, battery cables, FNR, solenoid coil, solenoid contacts, and controller 16-pin connector.

MOTOR STALL

If the motor current is high and there is no movement of the vehicle wheels for a short period of time, a motor stall is detected by the speed controller. This fault can be caused by an operator holding the vehicle on a hill by depressing the accelerator pedal instead of the brake pedal.

What it means: This fault appears anytime current is running to the motor and no movement of the armature is registered.

What to do: In most cases this is an operator issue holding the vehicle on an incline with the accelerator pedal, not the brake pedal. See following NOTE.

NOTE: In rare cases, it could be a controller or drivetrain issue. If the vehicle rolls, the drivetrain is okay. Check to see if Armature Current spikes to 250 amps when accelerator pedal is pressed. If so, replace controller.

MAIN DRIVER OFF

If the FET that controls the closing of the solenoid is **not** energized when it should be, a *main driver off* fault is detected by the speed controller.

What it means: This is the exact opposite of main driver on. The controller FET controlling the energizing of the solenoid is off (or not energized) when it should be.

What to do: Replace controller.

CURRENT SENSE FAULT

What it means: If there are problems with the armature current sensor circuitry, a current sense fault is detected and the controller de-energizes the solenoid coil.

What to do: Clear the Fault History in the CDT. If the fault does not return and the car operates normally, do not replace the controller. If the fault remains in System Faults or Fault History after clearing and the car will not operate, replace the controller.

M- SHORTED

If an uncontrolled current path is detected from the motor to B- (bypassing the MOSFETs), an M- shorted fault is detected.

FLD (FIELD) MISSING

If the speed controller is operating at a duty cycle of greater than 90% (almost full speed) and the field current is less than 3 amps, a *field missing* fault is detected by the speed controller.

CAUTION

 A failed motor will ruin a controller. If a new controller is installed in a vehicle with a bad motor, the bad motor will blow the field FET in the new controller. Always check the motor before replacing a controller when a FLD Missing fault is shown.

What it means: Not necessarily a controller issue.

What to do: Check in this order: connections and continuity of orange and blue motor field wires, short in motor, and then controller. See External Motor Testing, Section 23, Page 23-1.

HW FAILSAFE

The armature drive FETs (field effect transistors) regulate the armature current. If the speed controller detects a failure of the armature drive FETs or circuitry, a *hardware failsafe* fault is detected.

What it means: A catastrophic failure internal to the controller on either the power board or the logic board.

What to do: Check motor before replacing controller.

FAULT HISTORY

The fault history menu can be useful in determining the cause of a vehicle problem; however, the fault history alone should not be the factor that determines when a component is replaced. Some faults detected by the speed controller are not the result of a failed component, and are instead the result of vehicle operator error. If a fault appears in the fault history menu, the trained technician should attempt to determine when and where the fault has occurred. For example, if the motor stall fault is present in the fault history, the trained technician may be able to determine the location on the course where an operator has held the vehicle on a hill by using the accelerator pedal.

CLEAR FAULT HISTORY

After a repair has been made, the fault history should be cleared. This will enable the trained technician to properly troubleshoot the vehicle in the future, in the event that another problem occurs. It is recommended that the fault history be cleared in order to avoid the replacement of a component that caused a fault in the past, but has been replaced and is now functioning correctly. For example, if the MCOR (Motor Controller Output Regulator) was disconnected and the speed controller detected a fault code associated with the throttle, the fault history should be cleared so that any future problem is not diagnosed incorrectly as a throttle problem. **See Fault History Folder on page 18-15.**

PROGRAMMING

The *Programming* menu is accessed by using the arrow keys to highlight *Programming* and pressing the *Select* softkey to activate the menu.

The *Programming* menu selection allows the user to save and restore parameter settings files (.cpf files). These files contain controller information and are saved to the internal memory or SD card. Once saved, they can be used for future reference or emailed when the CDT or SD card is connected to a PC. For information on how to save and restore these files, refer to the manual supplied with the CDT.

CLONING

Use the "Restore .cpf File" function to clone a controller with a saved .cpf file stored in the CDT. If using an OEM-level CDT, after you highlight a stored .cpf file and choose "Restore," a pop-up window will ask whether you want to enable Advanced Cloning ("Yes"/"No") using the softkeys. This choice is not offered in the User-level CDT. Without Advanced Cloning (if you select "No"), an OEM-level CDT will restore only those parameters up to and including OEM level. Advanced Cloning ("Yes") restores all parameters, including those at a higher level. This makes a true clone by copying parameters that cannot be seen at the OEM level. It is recommended to enable Advanced Cloning.

FAVORITES

The *Favorites* menu is accessed by pressing the Favorites key (9) **(Figure 18-1, Page 18-1)**. This menu can also be accessed by using the arrow keys to highlight *Favorites* and pressing the *Select* softkey to activate the menu. Return to the Main Menu at any time by pressing the Main Menu key (6).

The *Favorites* menu selection consists of the custom set of items you have created. Typically, you will want to include the parameters you most frequently adjust, along with the monitor items you most frequently check. This way you can go directly to these items more easily than by navigating through the entire Parameters and Monitor menus.

Any item or folder in the Parameters or Monitor menu can be added to Favorites. Once added, it can be renamed if desired. When you add a ready-made folder from the Parameters or Monitor menu, the folder icon will appear in the Favorites menu with a star on it. Although you can rename a ready-made folder, you are not allowed to rename any of the items within that folder. You can also create folders of your own to hold specific sets of items; these folders will be indicated with the usual folder icon. You may want to create a folder for each type of vehicle or application, or for each customer.

HHP SETTINGS

The *HHP Settings* menu is accessed by using the arrow keys to highlight *HHP Settings* and pressing the *Select* softkey to activate the menu.

The *HHP Settings* menu selection allows the user to adjust the appearance of the screen displays, adjust several aspects of the handheld programmer's functionality, and displays information pertaining to the handset.

MENU ITEM	DESCRIPTIONS
Access Level	The Access Level of the programmer can be set to its own level or to any lower level: OEM, Dealer, Service, User. Setting the Access Level to a lower level allows you to see what a person with that level programmer would see. For example, a dealer could set the Access Level to User, to see what a person with a User-level programmer would see.
Language	You can select English, Deutsch, Français, Italiano, or Español for the screen text.
Left Handed Soft Keys	Selecting "Yes" for Left Handed Soft Keys reverses the position of items in the softkey text line, to make the keys more convenient for left-handed people.
Backlight	Here you can set the brightness of the programmer's LCD display—from 100% to 20%, in 5% increments.
Keytone	You can choose between several tones to sound each time you press a key, or you can turn the keytone Off for silent programmer operation.
Auto Poweroff (battery)	You can set the idle time before the programmer will automatically power off when it is powered by its own batteries (i.e., when the control system is not running, or when the programmer is not connected to the control system).
Auto Poweroff (ext)	You can set the idle time before the programmer will automatically power off when it is being powered by the controller.
Exit menus with left arrow	The left-arrow key () is used to navigate backwards within menus. When set to Yes, you can use the left-arrow key to leave the presently displayed screen and return to the next higher (i.e., previous) screen; using the left-arrow key will eventually return you to the Main Menu. When set to No, you must use the appropriate softkeys (Exit, Cancel) and the Main Menu key () to leave the present screen and reach the Main Menu. You may find this setting preferable if you use the table screens frequently, as it eliminates any possible confusion caused by the left-arrow key having two functions: moving one cell to the left, and exiting the table altogether.
Enable Screenshot	The Yes/No setting of this item determines whether the programmer will allow screenshots to be taken; see Section 14 for a description of this function. When set to "No," if you attempt to take a screenshot—by pressing the Power key () followed by the Favorites key ()—the power command is ignored and the screen jumps to the Favorites menu in response to the Favorites key command.
Show only empty battery	A battery icon showing the state-of-charge of the programmer's battery can be displayed in the upper right corner of the screen. If you do not want the icon to be displayed except as a warning when the battery is empty, set this to "Yes."
Text for save as	When you create a new .cpf file, the field at the top of the keyboard screen is either blank ("No text") or is automatically filled with the date and time in this format: YYYY_MM_DD_HHMM ("Date/Time").
Keyboard help text	When set to On, every time you enter the keyboard screen a pop-up explains how to use the keyboard. When set to Off, no pop-up appears as you enter the keyboard screen, but you can still use the Help key (?) at any time.
Remember Last View	When set to On, when you select a menu from the Main Menu screen, you will be returned to the screen you were on before you last exited that menu. When set to Off, each time you select a menu from the Main Menu screen, you will go to the selected root menu. It does not matter what you did the last time you used that menu.
Delete Cache File	This item is different from the other HHP items, because it is a procedure instead of an adjustable setting. The first time you connect the programmer to a system, menu cache files are created. If you encounter problems when connecting, you can delete the cache files and retry connecting. To delete the cache files, select this item and press the right-arrow key ().

MENU ITEM	DESCRIPTIONS
Date & Time	This folder contains eight items. Show Date/Time in header. The date and time are typically displayed at the top of the Main Menu screen. However, if you do not use batteries in the handheld programmer and there is no real-time clock in the connected control system, you can set this item to "Off," since it would not provide accurate information. 12h/24h. Here you can select the format used to display the time. Date Format. Several options are available: the year appearing first or last, and the month appearing before the day or the day appearing before the month. Year, Month, Day, Hour, and Minute allow you to set the date and the time for your time zone.
About	This folder contains information about the programmer similar to what is shown in the System Info menu for each of the modules in the control system: model number, software version, hardware version, serial number, etc.

PLOT & LOG

The Plot & Log menu selection allows the user, with the Plot program, to plot real-time variables on the CDT display screen; or, with the Log program, to create a log file of variable values to view later in a spreadsheet program on a PC.

The first step is to add the desired items to the Plot Variable List or the Log Variable List. While in the Monitor menu or Parameters menu, highlight an item and press the "Add to" softkey. In the next screen, highlight Plot or Log and press the "Select" softkey to view the list. To add the item to the list, press the "Add" softkey followed by the "Finish" softkey; you can include up to five items. To remove an item from a Variable List, select it and press the "Delete" softkey.

PLOT

In the Plot Variables list, a colored circle beside each variable shows the color that will be used to represent that variable in the plot. The colors are in a fixed order. If you want to use specific colors for specific variables, use the "Move Down" and "Move Up" softkeys to achieve the desired combinations. Use the left-arrow key to return to the Plot & Log menu. To open the plotting program, highlight Plot and press the right-arrow key. The vertical axis is always used for the variables being plotted, and the horizontal axis is always used for time. For On/Off items, On = 1 and Off = 0 on the plot. Press the "Start" softkey to begin plotting data. Press the "Stop" softkey to stop plotting data and freeze the plot. You have the option of pressing the "Start" softkey to resume the plot.

LOG

To create a log of the items in your Log Variable List, highlight Log and press the right-arrow key. Then, in the "Start Logging" window, press the "OK" softkey. Select the location where you want to save the .xls file, and after pressing the "Save As" softkey and naming the .xls file, press the "OK" softkey. The display will now show the Plot & Log menu with a flashing red dot next to Log, indicating that logging is in progress. To stop logging, press the right-arrow key, and then in the "Stop Logging" screen, press the "OK" softkey.

CDT TROUBLESHOOTING

In the event that the handset does not function as described in this manual, the following troubleshooting guide should be studied and the referenced test procedures should be performed to troubleshoot the handset.

	<u> </u>	
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
	Handset cord and/or adaptor is disconnected	See Plugging the CDT into the Vehicle on page 18-3.
	Vehicle batteries – loose terminals or corrosion	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.
	Vehicle batteries – improperly wired	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.
	Vehicle batteries – batteries failed	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.
	Vehicle batteries – batteries not fully charged	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.
	Handset cord has failed	Test Procedure 1 – Handset Cord on page 18-28
Handset display screen is blank	Handset cord adaptor has failed	Test Procedure 2 – Handset Cord Adaptor on page 18-28
	CDT port (mounted under instrument panel assembly) has failed	Test Procedure 3 – CDT Ports on page 18-29
	Contrast Setting is too light	See Backlight under HHP Settings menu
	Controller is in power-down mode (vehicle unused and not charged for 72 hours)	Connect charger or drive the vehicle a short distance and reconnect the handset to the vehicle
	Charger has been connected and charging for more than 10 minutes	Disconnect charger, wait 30 seconds and reconnect charger
	Loose vehicle wire harness connections	Test Procedure 3 – CDT Ports on page 18-29
	Speed controller malfunction	See Section 19 – Excel System Troubleshooting: with ERIC Charging.
	Handset has failed	Replace handset
Display screen shows jumbled or undecipherable characters	Speed controller malfunction	See Section 19 – Excel System Troubleshooting: with ERIC Charging.
	Handset malfunction	Disconnect the CDT cord from the vehicle. Wait a few seconds and reconnect the handse to the vehicle
	Loose connection at CDT port	Test Procedure 3 – CDT Ports on page 18-29
	Intermittent handset cord failure	Test Procedure 1 – Handset Cord on page 18-28
	Intermittent handset cord adaptor failure	Test Procedure 2 – Handset Cord Adaptor on page 18-28
	Loose vehicle wire harness connections	Test Procedure 3 – CDT Ports on page 18-29

TROUBLESHOOTING GUIDE			
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION	
Handset is "locked-up" – buttons do not respond	Handset malfunction	Disconnect the CDT cord from the vehicle. Wait a few seconds and reconnect the handset to the vehicle	
	Vehicle batteries – loose terminals or corrosion	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.	
	Vehicle batteries – improperly wired	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.	
	Vehicle batteries – batteries failed	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.	
	Vehicle batteries – batteries not fully charged	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.	
	Speed controller malfunction	See Section 19 – Excel System Troubleshooting: with ERIC Charging.	

CONNECTION TESTS

WARNING

· If wires are removed or replaced, make sure wiring and wire harness is properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction, property damage, personal injury, or death.

Index of Test Procedures

- 1 Handset Cord
- 2 Handset Cord Adaptor
- 3 CDT Ports

TEST PROCEDURE 1 - Handset Cord

See General Warnings on page 1-2.

- Using a multimeter set for 200 ohms, place the red (+) probe into one of the terminals on the end of the cord with the square plug.
- Place the black (–) probe on each of the pins, one at a time, on the plug on the other end of the cord.
- The multimeter should indicate continuity on only one pin. If any other reading is obtained, the cord must be replaced.
- 4. Repeat the procedure three more times, each time with the red (+) probe inserted into a different terminal on the end of the cord with the square plug.

TEST PROCEDURE 2 – Handset Cord Adaptor

See General Warnings on page 1-2.

The procedure for testing the handset cord adaptor is similar to the cord test.

- 1. Using a multimeter set for 200 ohms, place the red (+) probe into one of the terminals on the end of the adapter with the square plug.
- 2. Place the black (–) probe on each of the pins, one at a time, on the other plug of the adaptor.
- 3. The multimeter should indicate continuity on only one pin. If any other reading is obtained, the adaptor must be replaced.
- 4. Repeat the procedure three more times, each time with the red (+) probe inserted into a different terminal on the end of the adaptor with the square plug.

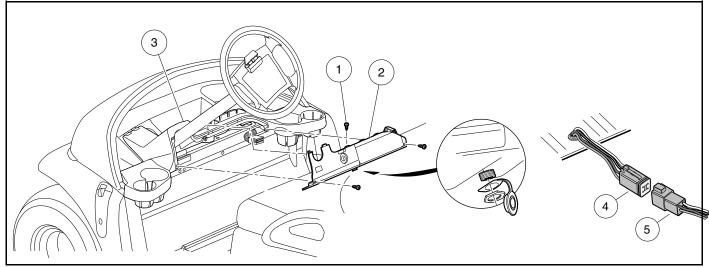
TEST PROCEDURE 3 - CDT Ports

Inspect the CDT ports for damage or corrosion.

CDT PORT (LOCATED UNDER INSTRUMENT PANEL)

See General Warnings on page 1-2.

- 1. Turn the key switch to the OFF position, place the Forward/Reverse rocker switch in the NEUTRAL position, and lock the park brake.
- 2. Place the Tow/Run switch in the TOW position, disconnect the batteries, negative (–) cable first, and wait 90 seconds for the controller capacitors to discharge. **See General Warnings on page 1-2.**
- 3. Check the CDT port mounted under the instrument panel.
 - 3.1. Remove the three screws (1) that secure the instrument panel assembly (2) to the dash assembly (3) (Figure 18-3, Page 18-29).



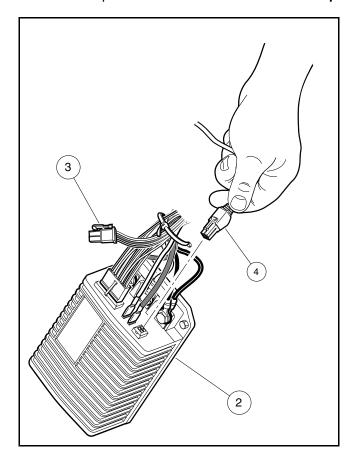
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Figure 18-3 Instrument Panel Assembly Removal and CDT Port Connection

- 3.2. Disconnect the four-pin connectors (4 and 5) and visually inspect the contacts for damage and corrosion. Inspect the CDT port, mounted under the instrument panel assembly (2). Repair and replace parts as necessary.
- 3.3. If no problem is found, connect the four-pin connectors and install the instrument panel assembly.
- 3.4. Install the three screws (1) that secure the instrument panel assembly (2) to the dash assembly (3) (Figure 18-3, Page 18-29).
- 4. Check the CDT port on the controller.
 - 4.1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
 - 4.2. Remove electronics module cover. See Speed Controller Removal, Section 20, Page 20-11.

4.3. Connect CDT to controller.

- 4.3.1. Disconnect the square four-pin connector (3) from the controller.
- 4.3.2. Connect the handset cord to the handset.
- 4.3.3. Connect the other end of the handset cord (without the adapter) (4) to the four-pin connector of the controller (2) (Figure 18-4, Page 18-30).
- 4.3.4. Connect the vehicle batteries, positive (+) cable first.
- 4.3.5. If the handset functions when connected directly to the controller, the adapter plug or vehicle wire harness should be thoroughly tested. See Test Procedure 2 - Handset Cord Adaptor on page **18-28.** See Section 19 – Excel System Troubleshooting: with ERIC Charging.
- 4.4. Replace electronics module cover. See Speed Controller Installation, Section 20, Page 20-11.



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Figure 18-4 CDT Connector On Controller

SECTION 19 – EXCEL SYSTEM TROUBLESHOOTING: WITH ERI

▲ DANGER

See General Warnings on page 1-2.

A WARNING

- See General Warnings on page 1-2.
- · Shorting of battery terminals can cause personal injury or death.
 - Do not place component mounting plate directly on top of batteries when removing or installing plate.
 - Remove plate from vehicle completely.

GENERAL INFORMATION

The Excel vehicle with ERIC Charging system uses a 48-volt electrical system with a shunt-wound, 3.1 hp motor that is powered by six 8-volt lead-acid batteries and charged by a high-frequency charger. The Excel vehicle with ERIC Charging system includes several additional features.

ACCESSORIES

For powered accessories that need to be controlled by the key switch, use the gray wire with a female bullet connector located behind the instrument panel.

CHARGE INDICATOR LIGHT

Excel vehicles with ERIC Charging system feature a dash mounted charge indicator light (below the steering column) that serves two functions: 1) Battery low state of charge warning, and 2) Charging confirmation. The charge indicator light is controlled by pin 11 of the controller.

Battery Low State of Charge Warning

- The light comes on and remains solid when the battery state of charge falls below 20%.
- The light begins flashing when the battery state of charge falls below 10%.

Charging Confirmation

• The light will flash three times and the reverse buzzer simultaneously will sound three times to indicate a battery charging session has begun. **See following NOTE.**

NOTE: The number of flashes and beeps can vary depending on the Beep Option setting. **See Beep Option**, **Section 18, Page 18-8.**

ATTRIBUTES OF THE EXCEL SYSTEM

- · Excel is used in Precedent models only.
- Excel utilizes the 1515 controller instead of the 1510A.
- The Excel 1515 controller uses half-bridge technology allowing cooler operating temperatures and increased motor braking.
- The Excel minimum motor braking speed has been lowered to almost zero.
- Excel has higher energy output during regenerative braking due to the lowered minimum motor braking speed.
- The Excel accelerator pedal has more control of downhill speed.
- The programmed speed of the Excel vehicle can now range from 5 to 19.2 mph (8 to 30.8 kph) with fine adjustments in 0.1 mph (0.16 kph) increments.
- · Excel provides mileage readings.
- Excel has more diagnostics available.
- Excel offers the ability to change software. See Section 18 Controller Diagnostic Tool (CDT).

KEY DIFFERENCES: EXCEL WITH ERIC CHARGING SYSTEM VS. POWERDRIVE CHARGERS

- Utilizes the 1515-5206 controller (white in color) instead of the 1515-5201 (gray in color).
- New main wire harness for Precedent (which is not compatible with vehicles using PowerDrive chargers) that uses a 10k Ohm pull-up resistor for the charger interlock circuit (charger plug lockout pin pulls Lo to lockout the vehicle, and the 10k resistor pulls Hi once charger plug is removed to enable the vehicle). In addition, the three throttle circuit resistors are now internal to the controller.
- New B- wire assembly, which replaces the one integral to the onboard computer (OBC). With the OBC gone, the New B- wire assembly is needed to connect the B- terminal of the controller to the negative (-) post of battery no. 6 (6 x 8-Volt battery set).
- New battery charge indicator light in the instrument panel. This light is an LED and is used to confirm when a charge cycle begins and when the battery pack has reached a low state of charge.
- New instrument panel wire harness (not compatible with vehicles using PowerDrive chargers)
- A new controller is used that has data collecting functions previously performed by the OBC. Pin 11 in the 16-pin connector is now utilized to operate the charge indicator light in the instrument panel. In addition, the controller has mounting slots instead of holes for easier replacement.
- An expanded Monitor menu for Controller Diagnostic Tool (CDT): Charge Cycle, Amp-Hours, Faults, and Diagnostics.
- The controller tracks amp-hour usage for fleet management and warranty administration.
- No Communication Display Module (CDM) required. Use only the CDT.
- The CDT will remain ON for approximately 10 minutes when the charger is connected.
- Improved charger and battery state of charge (SOC) status indication.
- Battery charger algorithm is programmable in the field via a USB flash drive or laptop computer instead of changing onboard computer (OBC).
- B+ red wire of charger wire harness now connects directly to the solenoid to reduce potential corrosion.

FEATURES

- Shunt-Wound Motor: The shunt-wound motor, unlike a series motor, is designed so that the speed controller is able to vary the amount of current passing through the field coils independently from the current passing through the armature.
- Motor Braking: Under certain conditions a shunt-wound motor also has the ability to act as an electrical brake to slow the vehicle. There are two features of the Excel electrical system that will activate the motor braking function: Walk Away Braking and Motor Braking (adjustable with the CDT handset).
- Walk Away Braking: This feature prevents the vehicle from rolling away uncontrolled should the driver park on a slope and leave the vehicle without locking the park brake. The vehicle will roll at about 1 to 3 mph (1.5 to 4.8 km/h). If the walk away braking function remains engaged for two seconds or more, a warning buzzer will sound to alert the driver that motor braking has been activated.

A WARNING

- Walk Away Braking will not limit vehicle speed to 3 mph (4.8 km/h) on very steep grades. Do not
 operate vehicle on slopes exceeding 20% grades.
- **Motor Braking:** When going down an incline with the accelerator pedal partially pressed, the motor braking function will activate to assist the operator in maintaining a speed less than the speed setting. For example, if the vehicle is going down an incline with the accelerator pedal pressed half way, the motor braking function will activate to assist the operator in maintaining a speed approximately half of the speed setting defined in the Program Menu.
- Regenerative Braking: When motor braking is activated, the vehicle motor acts as a generator, slowing the vehicle as it creates energy that is used to charge the batteries.
- Tow/Run Switch: When the Tow/Run switch is in the RUN position, the vehicle will function normally. When the switch is in the TOW position, power to the controller is shut off, disabling the vehicle operating circuit and walk away braking, allowing the vehicle to be towed.
- Motor Protection Circuit: The operator should never attempt to hold the vehicle on an incline by pressing the accelerator pedal instead of the brake pedal, as motor overheating could result. By reducing the current to the motor during such an occurrence, the motor protection circuit reduces the possibility of motor damage. When this situation arises, a *motor stall fault* is recorded by the speed controller and will be displayed on an CDT handset in the Diagnostic History menu. See Motor Stall on page 18-22.
- **High Pedal Detect:** This function prevents unexpected vehicle movement if the key switch is turned ON after the accelerator is pressed. The vehicle will not move until the accelerator is released and pressed again. When this situation arises, a *HPD fault* is recorded by the speed controller and will be displayed on an CDT handset in the Diagnostic History menu. **See HPD on page 18-20.**

WIRING DIAGRAMS

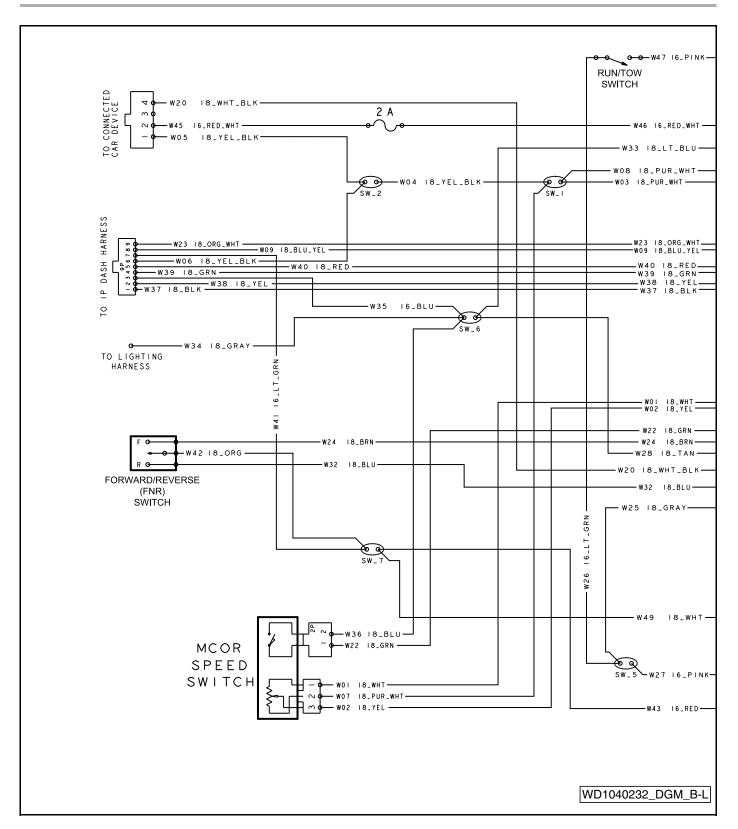


Figure 19-1 Wiring Diagram – Excel System with ERIC Charging

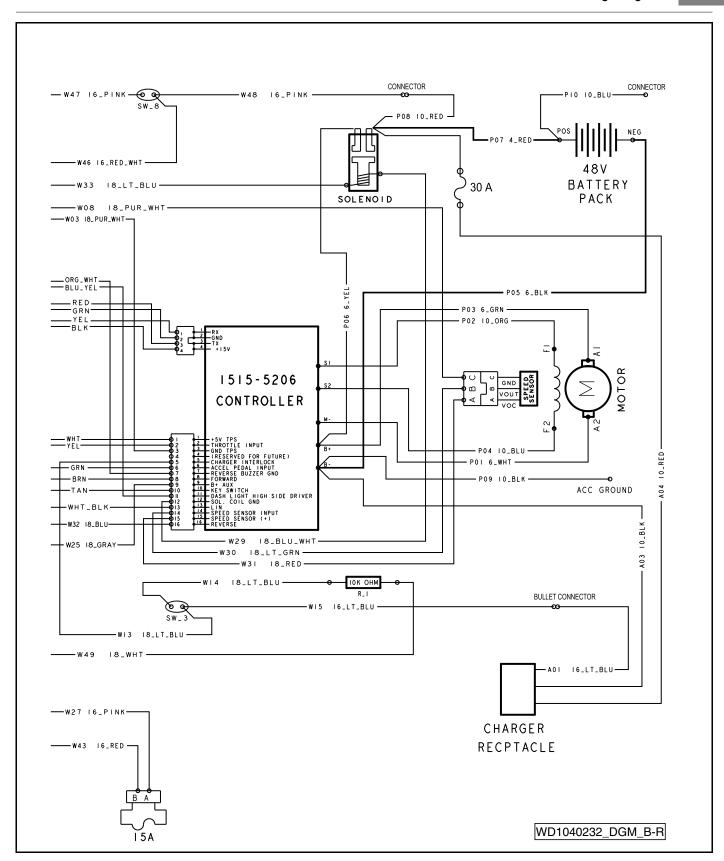


Figure 19-2 Wiring Diagram – Excel System with ERIC Charging (Continued)

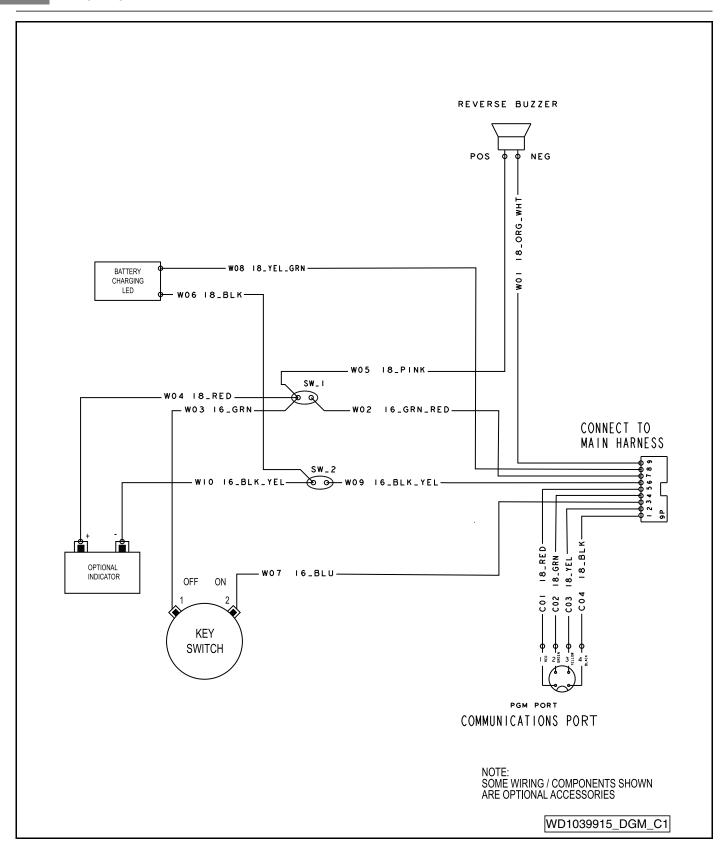


Figure 19-3 Instrument Panel Wiring Diagram - Precedent with ERIC Charging

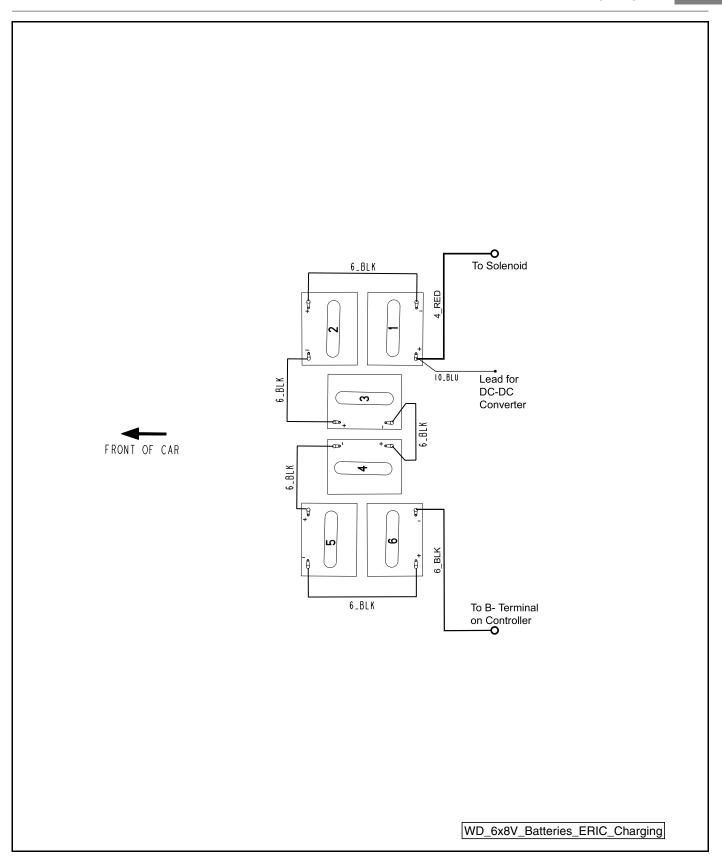


Figure 19-4 Battery Wiring Diagram - Precedent with ERIC Charging

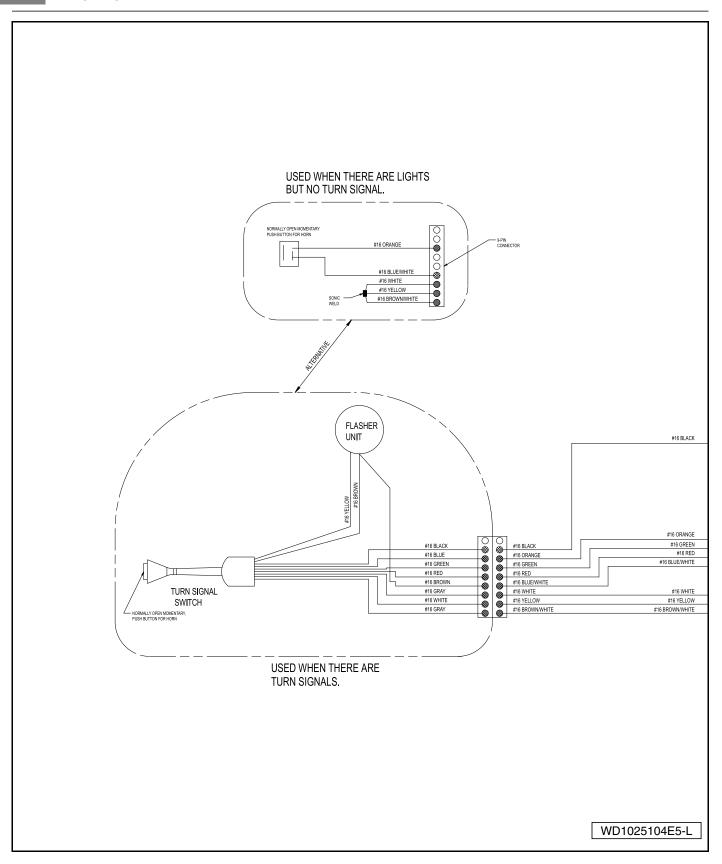


Figure 19-5 Precedent Electric Vehicle Accessory Wiring Diagram

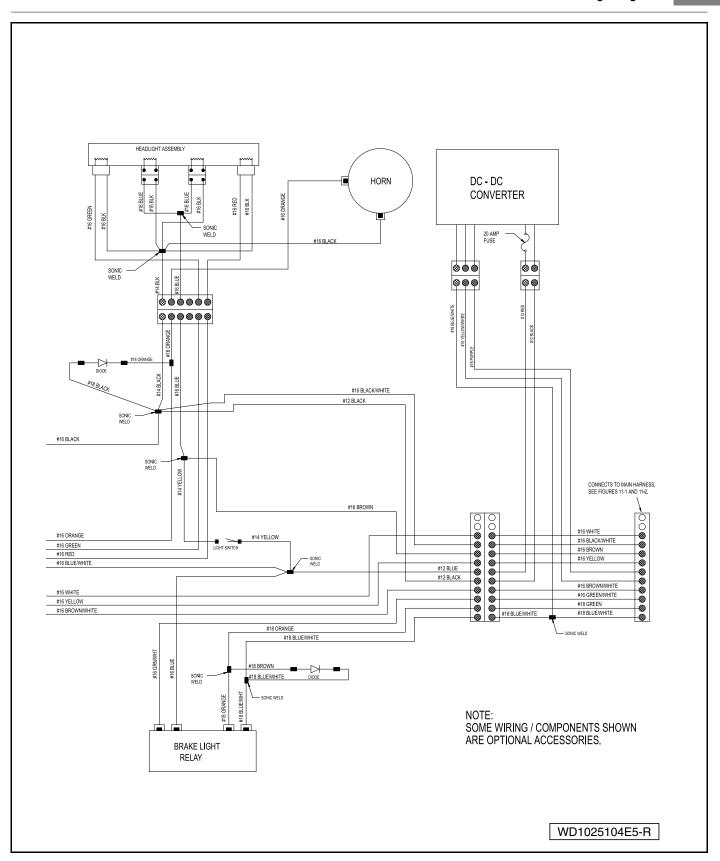
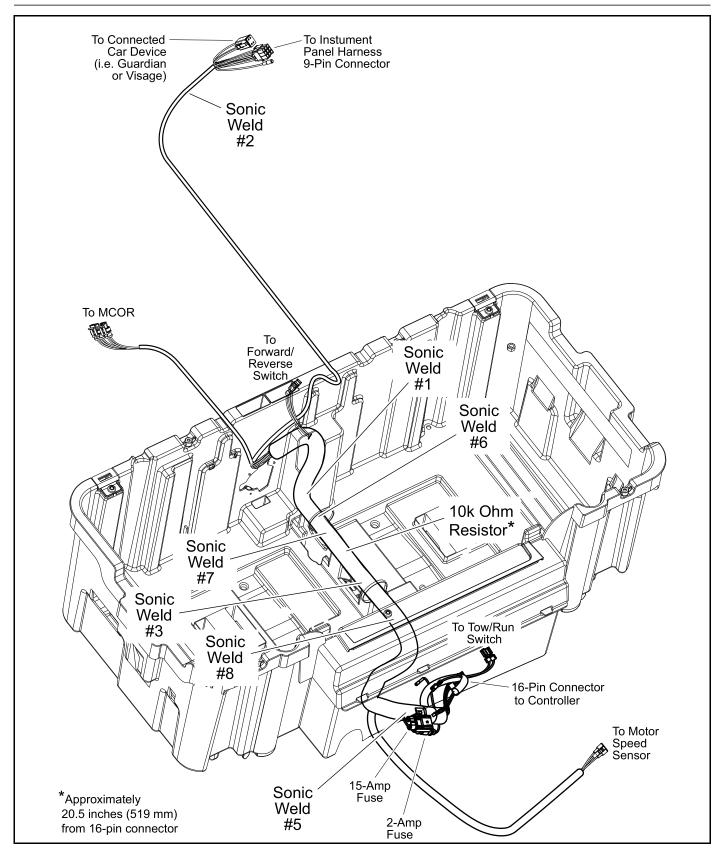


Figure 19-6 Precedent Electric Vehicle Accessory Wiring Diagram (Continued)



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Figure 19-7 Sonic Weld and 10k Ohm Resistor Locations (Approximate)

TROUBLESHOOTING

The following troubleshooting guides will be helpful in identifying operating difficulties should they occur. The guides include the symptom, probable cause(s) and suggested checks. The procedures used for making these checks can be found in the referenced sections of this maintenance and service manual.

TROUBLESHOOTING THE VEHICLE WITH THE CDT

Club Car recommends the use of the CDT handset for troubleshooting vehicles equipped with the Excel electrical system. Troubleshooting Guide 1 is to be used in conjunction with the CDT handset. **See Controller Diagnostic Tool (CDT) on page 18-1** for operating instructions. **See following WARNING.**

▲ WARNING

• The vehicle operator should not monitor the CDT while the vehicle is in motion. A technician can monitor the CDT while traveling as a passenger in the vehicle. Failure to heed this warning could result in severe personal injury or death.

In the event that the vehicle is not functioning properly after completing Troubleshooting Guide 1, the technician should proceed to Troubleshooting Guide 2.

If an CDT handset is unavailable, the technician should proceed to Troubleshooting Guide 2.

TROUBLESHOOTING GUIDE 1

The following troubleshooting guide is intended for use with an CDT handset. See following NOTE.

NOTE: Before troubleshooting the vehicle, check the diagnostic history from the Special Diagnostics Menu. Note any fault codes.

TROUBLESHOOTING GUIDE 1		
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Monitor Menu – THROTTLE % value does not increase as the accelerator pedal is pressed or Diagnostic Menu – THROTTLE FAULT fault code	Loose or disconnected three-pin connector at the MCOR or broken wire	Repair and/or connect the three-pin connector to the MCOR
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed MCOR	Test Procedure 11 – MCOR Voltage on page 19-27
Monitor Menu – TEMPERATURE °C indicates that temperature is above 85 °C (145 °F) or Diagnostic Menu – THERMAL CUTBACK fault code	Over-adjusted brakes	Section 6 – Wheel Brake Assemblies
	Vehicle is overloaded	Ensure that vehicle is not overloaded before returning to operation
Monitor Menu – ARM PWM value does not reach 100% when vehicle is at full speed	Failed MCOR	Test Procedure 11 – MCOR Voltage on page 19-27

TROUBLESHOOTING GUIDE 1		
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Monitor Menu – SPEED PULSES menu item indicates that speed pulses are OFF when the vehicle is in motion or Diagnostic Menu – SPEED SENSOR fault code	Loose or disconnected motor speed sensor or broken wire	Repair and/or connect the three-pin connector to the motor speed sensor
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed motor speed sensor	Test Procedure 12 – Motor Speed Sensor on page 19-29
Monitor Menu – FOOT INPUT menu item indicates that the MCOR internal limit switch is always ON or always OFF.	Loose or disconnected two-pin connector at the MCOR or broken wire	Repair and/or connect the two-pin connector to the MCOR
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed MCOR	Test Procedure 5 – Key Switch and MCOR Limit Switch Circuit on page 19-21
Monitor Menu – FORWARD INPUT and/or REVERSE INPUT does not indicate the correct reading	Loose or disconnected Forward/Reverse rocker switch (quick disconnect terminals) or broken wire	Repair and/or connect the quick disconnect terminals to the Forward/Reverse switch
	Loose or disconnected Forward/Reverse rocker switch (three-pin connector) or broken wire	Repair and/or connect the three-pin connector from the Forward/Reverse switch to the wire harness
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed Forward/Reverse rocker switch	Test Procedure 6 – Forward/Reverse Rocker Switch on page 19-22
Monitor Menu – MAIN CONT DRIVER (solenoid) does not indicate ON when the solenoid should be activated. or Diagnostic Menu – MAIN CONT DNC (main contactor in solenoid did not close) fault code	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. See WARNING "To avoid unintentionally starting" in General Warnings on page 1-2. Reconnect the batteries and see if the symptom returns.
	Loose, broken, or disconnected wire(s) at solenoid or B+ speed controller terminal	Repair and/or connect the loose or disconnected wire(s)
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed solenoid	Replace solenoid. See Solenoid Removal on page 20-13.
	Loose or disconnected wires at key switch terminals or broken wire	Repair and/or connect the quick disconnect terminals to the Forward/Reverse switch
Monitor Menu – KEY INPUT does not indicate ON when key switch is in the ON position	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed key switch	Test Procedure 5 – Key Switch and MCOR Limit Switch Circuit on page 19-21

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Diagnostic Menu – THROTTLE FAULT fault code	Loose or disconnected three-pin connector at the MCOR or broken wire	Repair and/or connect the three-pin connector to the MCOR
	Loose or disconnected 16-pin connector at speed controller or broken wire	Repair and/or connect the 16-pin connector to the speed controller
	Failed MCOR	Test Procedure 11 – MCOR Voltage on page 19-27
	Armature drive FETs (field-effect transistors) inside speed controller have failed	Replace the speed controller. See Speed Controller Removal on page 20-11.
Diagnostic Menu – HW FAILSAFE (Hardware Failsafe) fault code	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. See WARNING "To avoid unintentionally starting" in General Warnings on page 1-2. Reconnect the batteries and see if the symptom returns.
Diagnostic Menu – MAIN WELDED (main solenoid contacts welded) fault code	solenoid contacts have failed closed	Replace solenoid. See Solenoid Removal on page 20-13.
Diagnostic Menu – MAIN DRIVER ON or MAIN DRIVER OFF fault code	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. See WARNING "To avoid unintentionally starting" in General Warnings on page 1-2. Reconnect the batteries and see if the symptom returns.
	Failure of the FET that controls the solenoid coil	Replace the speed controller. See Speed Controller Removal on page 20-11.
Diagnostic Menu – MAIN COIL FAULT fault code or Diagnostic Menu – MAIN DROPOUT (1 or 2) fault code	Solenoid coil has failed in an open condition	Replace solenoid. See Solenoid Removal on page 20-13.
	Loose or disconnected motor field coil wires at motor or speed controller or broken wire	Repair and/or connect the field coil wires
Diagnostic Menu – FIELD MISSING fault code	Failure of the motor field windings	See Section 23 – Motor (Model EJ8-4001A): Electric Vehicle.
	Failure of the FETs that control field current	Replace the speed controller. See Speed Controller Removal on page 20-11.
Diagnostic Menu – HPD (high pedal detect) fault code	Operator error	Train operators to fully remove foot from accelerator pedal before turning key switch to the ON position or changing the selected direction with the Forward/Reverse switch
Diagnostic Menu – LOW BATTERY fault code	Batteries require charging	Place batteries on battery charger and allow them to fully charge
	Improperly maintained or failed batteries	See Section 21 – Batteries: Electric Vehicle with ERIC Charging.
Diagnostic Menu – MOTOR STALL fault code	Operator error	Train operators to use the brake to hold the vehicle on a hill, rather than holding the vehicle on a hill using the accelerator pedal

TROUBLESHOOTING GUIDE 2

In the event that the vehicle is not functioning properly after completing Troubleshooting Guide 1, use Troubleshooting Guide 2.

If an CDT handset is unavailable, use Troubleshooting Guide 2.

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
	Batteries – batteries discharged	Charge batteries
	Batteries – battery connections	Check vehicle wiring. See Wiring Diagrams on page 19-4.
	Battery charger is connected to the vehicle – charger interlock feature has disabled the vehicle	Disconnect the battery charger from the vehicle
	Charger interlock failure	Test Procedure 10 – Charger Interlock on page 19-26
	Key switch and MCOR limit switch circuit	Check for loose or disconnected wires at key switch and MCOR
	Failed key switch	Test Procedure 5 – Key Switch and MCOR Limit Switch Circuit on page 19-21
	Failed MCOR	Test Procedure 5 – Key Switch and MCOR Limit Switch Circuit on page 19-21. See also Test Procedure 11 – MCOR Voltage on page 19-27.
	Forward/Reverse rocker switch	Test Procedure 6 – Forward/Reverse Rocker Switch on page 19-22
Vehicle does not operate	Solenoid – loose wires	Test Procedure 7 – Solenoid Activating Coil on page 19-24
	Solenoid – failed coil	Test Procedure 7 – Solenoid Activating Coil on page 19-24
	Speed controller thermal cutback	Allow controller to cool and ensure that vehicle is not over-loaded before returning to operation
	16-pin connector at speed controller	Check for loose or disconnected wires at the 16-pin connector. See also Test Procedure 15 – 16-Pin Connector on page 19-32.
	High pedal detect	Cycle accelerator pedal
	Motor stall	Cycle accelerator pedal
	Motor Failure	See Section 23 – Motor (Model EJ8-4001A): Electric Vehicle.
	Speed controller failure	Replace speed controller. See Speed Controller Removal on page 20-11.
	Motor – motor connections	Check for loose or disconnected wires
	Speed controller – Motor and power connections	Check for loose or disconnected wires

SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION
Vehicle runs slowly	Speed sensor disconnected or failed	Test Procedure 12 – Motor Speed Sensor on page 19-29
	Incorrect speed setting	To change the programmed top speed of the vehicle, an CDT handset must be used
	Wiring – improperly wired	Check vehicle wiring. See Wiring Diagrams on page 19-4.
	Batteries – batteries discharged	Charge batteries
	MCOR malfunction	Test Procedure 11 – MCOR Voltage on page 19-27
	Motor – loose wires	Inspect and tighten all wire connections at the motor.
	Failed motor	Replace motor. See Motor Removal on page 23-4.
	Vehicle is over-loaded	Ensure that vehicle is not over-loaded before returning to operation.
	Speed controller failure	Replace speed controller. See Speed Controller Removal on page 20-11.
	Brakes – improperly adjusted	See Section 6 – Wheel Brake Assemblies.
	Tires – under-inflated or flat tires	See Section 8 – Wheels and Tires.
Vehicle operates but has points in pedal travel where it does not maintain speed nor accelerate	MCOR malfunction	Test Procedure 11 – MCOR Voltage on page 19-27
Vehicle reaches top speed before 100% pedal travel is reached	Speed controller – failed throttle resistor(s)	Replace speed controller. See Speed Controller Removal on page 20-11.
Vehicle operates, but motor braking function does not	Wiring – improperly wired	Check vehicle wiring. See Wiring Diagrams on page 19-4.
	Speed sensor disconnected or failed	Test Procedure 12 – Motor Speed Sensor on page 19-29
Vehicle will run in forward, but not in reverse or will run in reverse but not forward	Forward/Reverse rocker switch – improperly wired	Test Procedure 6 – Forward/Reverse Rocker Switch on page 19-22
	Motor – improperly wired	Check motor wiring. See Wiring Diagrams on page 19-4.
	Speed controller – improperly wired or failed speed controller FET	Check vehicle wiring. See Wiring Diagrams on page 19-4.
Vehicle operates, but battery charger does not charge batteries	Charger interlock failure	Test Procedure 10 – Charger Interlock on page 19-26
	Battery charger connections – loose plug or wires at charger, receptacle or batteries	Check wire connections and tighten if necessary.
	Battery charger	See Section 22 – Battery Charger: for ERIC Charging System.

TEST PROCEDURES

Using the following procedures, the entire electrical system can be tested without major disassembly of the vehicle.

A WARNING

• If wires are removed or replaced, make sure wiring and wire harness is properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction, property damage, personal injury, or death.

For many tests, the electronics module cover must be removed to gain access to the various components that are mounted on the component mounting plate. See Electronics Module Cover on page 20-5. See following WARNING.

WARNING

- Shorting of battery terminals can cause personal injury or death.
 - Do not place component mounting plate directly on top of batteries when removing or installing plate.
 - Remove plate from vehicle completely.

After test procedures are completed, be sure to replace the cover. See Electronics Module Cover on page 20-5. See following CAUTION.

CAUTION

- Exposure to water may damage electronic components.
 - Do not operate vehicle without the cover properly installed.
 - Do not direct a water stream in area of the cover.

TESTING BASICS

- To use the CDT, the Tow/Run switch must be in the RUN position. The Tow/Run switch provides power to the logic board and power board inside the controller.
- Battery Pack Voltage (BPV) will be referenced throughout the test procedures. BPV is accessed in Test Procedure
 1 Batteries / Voltage Check (BPV) on page 19-17.
- The Tow/Run switch powers the key switch, controller, Forward/Reverse switch, 15-amp fuse, and reverse buzzer.
- The key switch powers the MCOR 2-pin circuit, Forward/Reverse switch, solenoid, and the female bullet connector (W34 shown on **(Figure 19-1)**.
- The MCOR 3-pin circuit, motor speed sensor circuit, the communication point for the car device (white/black wire in position 13 of the 16 pin connector), and charge indicator light is powered by the controller (with Tow/Run switch in RUN).
- The 2-amp fuse is powered directly by the batteries via the solenoid and carries BPV to the connected car device. No switch is involved.
- The term "back-probe" refers to probing the side of a connector that the wire enters. This is usually done when the connector must remain connected to a device. **See following CAUTION.**

CAUTION

- Be careful not to damage the wire or terminal when back-probing.
- When testing voltage, the batteries must remain connected.
- When testing voltage, unless specifically directed to do otherwise in a procedure, connect the black (–) probe of the multimeter to the negative post of battery no. 6 (6 x 8-Volt battery set) or the B- terminal of the controller, whichever is easier to access.
- When testing controller functions, the Run/Tow switch must be in the RUN position. The TOW position removes power to the controller.
- Several test can be performed by accessing components through the access panel in the rear body. If greater
 access is required, the two center batteries can be removed and the component mounting plate leaned forward;
 place the two center batteries on the floorboard and reconnect two of the existing battery cables. Use a third,
 "service only" cable that is long enough to connect the two batteries just for troubleshooting.

Index of Test Procedures

- 1 Batteries / Voltage Check (BPV)
- 2 48-Volt Battery Pack Voltage Under Load
- 3 Tow/Run Switch
- 4 15-Amp Fuse
- 5 Key Switch and MCOR Limit Switch Circuit
- 6 Forward/Reverse Rocker Switch
- 7 Solenoid Activating Coil
- 8 Pre-Charge Resistor
- 9 Solenoid Continuity
- 10 Charger Interlock
- 11 MCOR Voltage
- 12 Motor Speed Sensor
- 13 A1 and A2 Motor Voltage
- 14 Voltage at Charger Receptacle Red Wire Socket
- 15 16-Pin Connector
- 16 Reverse Buzzer
- 17 Charge Indicator Light
- 18 4-Pin Connector (for Connected Car Device)

TEST PROCEDURE 1 - Batteries / Voltage Check (BPV)

See General Warnings on page 1-2.

NOTE: This is a voltage test.

The batteries must be properly maintained and fully charged in order to perform the following test procedures. Battery maintenance procedures, including watering information and allowable mineral content, can be found in the Battery section of this manual. **See Battery Care on page 21-6.**

The battery voltage can be displayed with the CDT handset. If an CDT handset is not available, proceed to **Batteries** / **Voltage Check without the CDT Handset**.

Batteries / Voltage Check with the CDT Handset

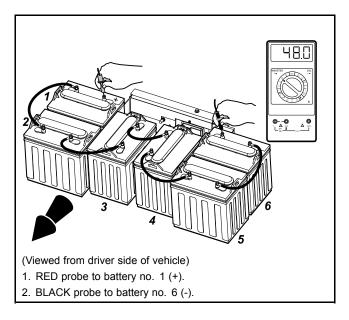
- Connect the CDT to the vehicle.
- 2. Access the Monitor menu and select BATT VOLTAGE by using the SCROLL DISPLAY buttons. The CDT should indicate at least 48 volts. **See following NOTE.** If not, check for loose battery connections or a battery

installed in reverse polarity. Refer to Batteries: Electric Vehicle with ERIC Charging on page 21-1 for further details on battery testing.

NOTE: The voltage displayed through the CDT shows what the controller thinks it sees. If the controller is not operating properly, it may display a different voltage from what the battery pack voltage (BPV) really is. Always compare and confirm with readings obtained using a multimeter in the following procedure.

Batteries / Voltage Check without the CDT Handset

- 1. If necessary, see Testing Basics on page 19-16.
- 2. With batteries connected and using a multimeter set to 200 volts DC, place red (+) probe on the positive (+) post of battery no. 1 and the black (–) probe on the negative (–) post of battery no. 6 (Figure 19-8, Page 19-18).
- The multimeter should indicate at least 48 volts. If not, check for loose battery connections or a battery installed in reverse polarity. Refer to Batteries: Electric Vehicle with ERIC Charging on page 21-1 for further details on battery testing.



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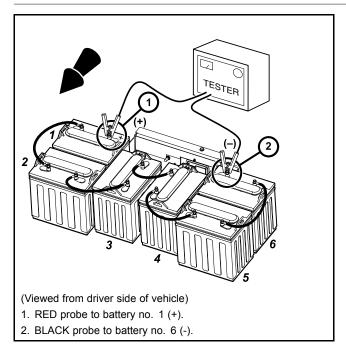
Figure 19-8 Battery Voltage Test

TEST PROCEDURE 2 – 48-Volt Battery Pack Voltage Under Load

See General Warnings on page 1-2.

NOTE: This is a voltage test.

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Be sure the batteries are fully charged and that the electrolyte level is correct in all cells.
- 3. Connect the tester leads to the positive (+) post of battery no.1 and negative (-) post of battery no. 6 (Figure 19-9, Page 19-19).



2500-30100-10411

Figure 19-9 Battery Discharge Test

- 4. Turn the discharge machine on and record the voltage reading of battery pack while under load.
- 5. A fully charged set of batteries in good condition should read between 46 and 49 volts while under load.
- 6. A reading of 32 to 46 volts indicates discharged or failed batteries. Each battery should be checked with a multimeter while under load. **See following NOTE.**

NOTE: If a 48-volt set of batteries is down in the 32 to 38 volt range, the discharge machine will activate but it will think it is testing a 36-volt battery set.

- 7. A reading of 31.5 volts or less will not activate discharge machine. If the voltage of the batteries is below 32 volts, the batteries are deeply discharged or have failed.
- 8. Recording the battery pack voltage reading while under load provides a more accurate diagnosis of the condition of the batteries. When the discharge machine is ON, it places the battery pack under load and many times can help determine if one or more batteries in the set have failed. Testing battery voltage while the batteries are not under load will not always indicate the true condition of the batteries. For more information about the batteries, refer to Batteries: Electric Vehicle with ERIC Charging on page 21-1.

TEST PROCEDURE 3 – Tow/Run Switch

See General Warnings on page 1-2.

NOTE: This is a voltage test.

If no voltage is coming to the Tow/Run Switch, inspect the red-to-pink wire spade connection at the solenoid.

Tow/Run Switch Test with the CDT Handset

- 1. With the Tow/Run switch in the RUN position, connect the CDT to the vehicle.
- 2. Immediately after the CDT is connected to the vehicle, the screen should display a copyright notice and the CDT model number.
- 3. If the CDT display screen remains blank, the CDT port has failed. In this case, disconnect the CDT from the port and connect it directly to the controller (Figure 18-4, Page 18-30).

- If the CDT display screen begins to work, proceed to step 5; otherwise, perform the following procedure, Tow/Run Switch Test without the CDT Handset.
- 5. With the CDT still connected to vehicle, place Tow/Run Switch in TOW position.
- 6. If the CDT display screen goes blank, the Tow/Run switch and connecting wires are operating correctly.
- If the CDT display screen is still active, the switch has failed closed. Replace the Tow/Run switch. See Tow/Run Switch Removal on page 20-6.

Tow/Run Switch Test without the CDT Handset

WARNING

- The key switch should be placed in the OFF position and left in the OFF position for the duration of this test.
- 1. If necessary, see Testing Basics on page 19-16.
- 2. Access the Tow/Run switch but do not disconnect wires.
- 3. With the Tow/Run switch in the RUN position:
 - 3.1. The pink wire should show BPV coming to the switch.
 - 3.2. The light green wire should also show BPV. If it shows less than 5 volts, the switch has failed OPEN and must be replaced.
- 4. With the Tow/Run switch in the TOW position:
 - 4.1. The light green wire should show less than 5 volts. If it still shows BPV, the switch has failed CLOSED and must be replaced.

TEST PROCEDURE 4 – 15-Amp Fuse

See General Warnings on page 1-2.

NOTE: This is a voltage test.

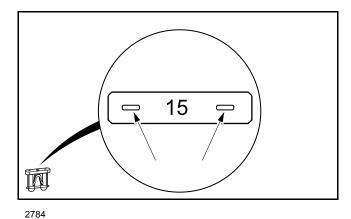


Figure 19-10 Testing the Fuse

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Access the 15-amp fuse but do not remove it.
- 3. With the Tow/Run switch in the RUN position:
 - 3.1. Probe the two, small metal contacts on the top of the fuse (Figure 19-10, Page 19-20).
 - 3.2. Each contact should show BPV.
 - 3.3. If the red wire side does not show BPV, replace fuse.

3.4. If the pink wire side does not show BPV, make sure Tow/Run switch in the RUN position. If it is in RUN, inspect Tow/Run switch, red-to-pink wire spade connector near the solenoid, and sonic welds 5 and 8.

TEST PROCEDURE 5 - Key Switch and MCOR Limit Switch Circuit

See General Warnings on page 1-2.

NOTE: This is a voltage test.

The MCOR provides FOOT INPUT to the controller.

The key switch provides KEY INPUT to the controller.

Key Switch and MCOR Limit Switch Circuit Test with the CDT Handset

- 1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 2. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
- 3. Connect the CDT to the vehicle.
- 4. Test the key switch.
 - 4.1. Access the Monitor menu and select KEY INPUT by using the SCROLL DISPLAY buttons. The CDT should indicate OFF when the key switch is in the OFF position.
 - 4.2. While monitoring the CDT display screen, turn the key switch to the ON position. The CDT should indicate ON.
 - 4.3. If the CDT does not indicate that KEY INPUT is ON when the key switch is in the ON position, proceed to the following procedure, **Key Switch and MCOR Limit Switch Circuit Test without the CDT Handset**. If the key switch functions as described, proceed to the following step. **See following NOTE**.

NOTE: The key switch MUST function properly in order to test the MCOR limit switch with the CDT handset.

- Test the MCOR limit switch.
 - 5.1. Select FOOT INPUT on the Monitor menu by using the SCROLL DISPLAY buttons on the CDT.
 - 5.2. The CDT should indicate that FOOT INPUT is OFF when the accelerator pedal is not pressed, regardless of the key switch position.
 - 5.3. With the key switch in the ON position, press the accelerator pedal. The CDT should indicate that FOOT INPUT is ON when the accelerator pedal is pressed.
- 6. If any reading is obtained that is not described in steps 4 and 5, perform the following steps:
 - 6.1. Check the wiring of the key switch and MCOR. See Wiring Diagrams, Section 19, Page 19-4.
 - 6.2. Check the continuity of the key switch wires and the MCOR limit switch wires.
- 7. If the problem was not found, proceed to the following procedure, **Key Switch and MCOR Limit Switch Circuit Test without the CDT Handset**.

Key Switch and MCOR Limit Switch Circuit Test without the CDT Handset

- 1. If necessary, see Testing Basics on page 19-16.
- Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Place the Tow/Run switch in the RUN position and the Forward/Reverse switch in the NEUTRAL position.
- 4. Pin 6 Green Wire: Access the controller by removing the access panel in the rear body. See following NOTE.

NOTE: The easiest way to test the key switch and MCOR Limit Switch is to check the pin 6 green wire in the 16-pin connector. Pin 6 is the end of this circuit.

- 4.1. Locate and connect an insulation-piercing probe to the pin 6 green wire in the 16-pin connector.
- 4.2. With the key switch in the OFF position and the accelerator pedal at rest, the green wire should show zero (0) volts.
- 4.3. With the key switch in the ON position and the accelerator pedal pressed, the green wire should show BPV which is FOOT INPUT to controller.
 - If it shows BPV, then the key switch, MCOR and related wiring is functioning properly.
 - If not, first check the key switch and then the MCOR limit switch.
- **Key Switch:** Remove instrument panel to access the back of the key switch but do not disconnect wires. See Key Switch Removal, Section 20, Page 20-1.
 - 5.1. With the key switch in the OFF position:
 - The green wire should show BPV coming to the switch.
 - The blue wire should show zero (0) volts. If it shows BPV, the switch has failed CLOSED and must be replaced.
 - 5.2. With the key switch in the ON position:
 - The blue wire should show BPV passing through the key switch to the MCOR. If it does not show BPV. the switch has failed OPEN and must be replaced.
- MCOR Limit Switch (FOOT INPUT): Remove floormat and cover plate to access the MCOR. See Pedal Group Removal on page 5-4.
 - 6.1. With the key switch in the ON position:
 - With an insulation-piercing probe, check voltage of the blue wire in the MCOR 2-pin connector. It should show BPV coming to the MCOR. If not, check wiring.
 - With an insulation-piercing probe, check voltage of the green wire in the MCOR 2-pin connector. It should show zero (0) volts with the accelerator pedal at rest. Press the accelerator pedal and the green wire should show BPV passing through the MCOR to the controller for FOOT INPUT. If not, replace MCOR. See MCOR Removal on page 20-7.

TEST PROCEDURE 6 – Forward/Reverse Rocker Switch

See General Warnings on page 1-2.

NOTE: This is a voltage test.

The Forward/Reverse Switch provides FORWARD INPUT and REVERSE INPUT to the controller.

If the controller sees both FORWARD INPUT and REVERSE INPUT at the same time, the reverse buzzer will sound in all FNR positions and the vehicle will not operate in either direction. Common causes of this include corrosion across the contacts inside the switch, water inside the switch, or a switch that has failed CLOSED.

Forward/Reverse Rocker Switch Test with the CDT Handset

- Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
- 2. Connect the CDT to the vehicle.
- Test FORWARD INPUT.
 - 3.1. Access the Monitor menu and select FORWARD INPUT by using the SCROLL DISPLAY buttons. The CDT should indicate OFF when the Forward/Reverse switch is in the NEUTRAL or REVERSE position.
 - 3.2. Place the Forward/Reverse switch in the FORWARD position. The CDT should indicate that FORWARD INPUT is ON. If the CDT indicates any other reading, check vehicle wiring. See Wiring Diagrams on

Test REVERSE INPUT.

- 4.1. Access the Monitor menu and select REVERSE INPUT by using the SCROLL DISPLAY buttons. The CDT should indicate OFF when the Forward/Reverse switch is in the NEUTRAL or FORWARD position.
- 4.2. Place the Forward/Reverse switch in the REVERSE position. The CDT should indicate that REVERSE INPUT is ON. If the CDT indicates any other reading, check vehicle wiring. See Wiring Diagrams on page 19-4. Also check the 16-pin connector at the speed controller. See Test Procedure 15 16-Pin Connector on page 19-32.
- 5. If the CDT displays readings other than those described above and the wiring is found to be correct, proceed to the following procedure, **Forward/Reverse Rocker Switch Test without the CDT Handset**.

Forward/Reverse Rocker Switch Test without the CDT Handset

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Place the Tow/Run switch in the RUN position and the Forward/Reverse switch in the NEUTRAL position.
- 3. Remove Forward/Reverse switch from its housing by carefully prying up each side with a small, flat-tip screwdriver.
- 4. Back-probe the following three wires connected to the Forward/Reverse switch in each position:

4.1. Orange Wire

 The orange wire provides power to the switch and should show BPV coming to the switch in all three positions.

If the orange wire does not show BPV, check the 15-amp fuse, Tow/Run switch, red-to-pink wire spade terminal connection and related wiring.

4.2. Brown Wire

- The brown wire should show BPV in FORWARD.
- The brown wire should show zero (0) volts in NEUTRAL and REVERSE

If the brown wire shows voltage in NEUTRAL, the switch may have corrosion across the contacts or the switch has failed CLOSED and must be replaced. **See Forward/Reverse Rocker Switch Removal on page 20-3.**

If the brown wire does not show BPV in FORWARD, the switch may have corrosion on the contact or the switch has failed OPEN and must be replaced. **See Forward/Reverse Rocker Switch Removal on page 20-3.**

4.3. Blue Wire

- The blue wire should show BPV in REVERSE.
- The blue wire should show zero (0) volts in NEUTRAL and FORWARD.

If the blue wire shows voltage in NEUTRAL, the switch may have corrosion across the contacts or the switch has failed CLOSED and must be replaced. **See Forward/Reverse Rocker Switch Removal on page 20-3.**

If the blue wire does not show BPV in REVERSE, the switch may have corrosion on the contact or the switch has failed OPEN and must be replaced. **See Forward/Reverse Rocker Switch Removal on page 20-3.**

5. When installing the Forward/Reverse switch into its housing, orient the three wire terminals towards the front of the vehicle (i.e. biased closer to the front of the switch housing and farther from the rear body).

TEST PROCEDURE 7 - Solenoid Activating Coil

See General Warnings on page 1-2.

NOTE: This is a resistance test.

Be aware that one of two different solenoids may be found on the vehicle. Visually, the production solenoid is smaller than the service replacement. On the labels, the larger service replacement solenoid has SOL0605 and the smaller production solenoid has SOL5006. Internally, specifications and test results differ between the two.

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 3. Access the solenoid by removing the electronics module cover. See Electronics Module Cover on page 20-5.
- 4. Remove the two small wire terminals from the solenoid.
- 5. Place red (+) probe of the multimeter on the positive (+) solenoid terminal. Place the black (–) probe on the other small solenoid terminal.
 - A reading of 200 to 250 ohms should be obtained for factory-installed solenoids (Figure 19-11, Page 19-24). If not, replace the solenoid.
 - A reading of 180 to 190 ohms should be obtained for service replacement solenoids (Figure 19-12, Page 19-24). If not, replace the solenoid.

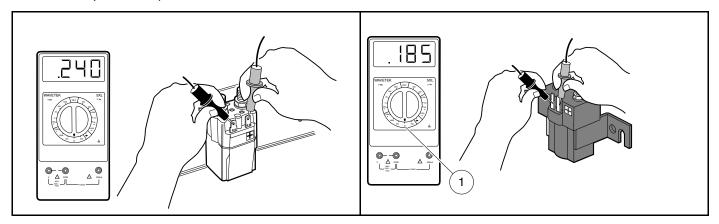


Figure 19-11 Activating Coil Test – Factory-installed Solenoid

2500-20000-10283

Figure 19-12 Activating Coil Test – Service Replacement
Solenoid

TEST PROCEDURE 8 – Pre-Charge Resistor

See General Warnings on page 1-2.

NOTE: This is a resistance test.

- If necessary, see Testing Basics on page 19-16.
- 2. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 3. Access the solenoid by removing the access panel in the rear body.
- 4. Measure resistance between the two large posts of the solenoid. The reading should be approx. 250 Ohms. If not, replace the pre-charge resistor using most of the steps found in **Solenoid Removal on page 20-13**.
- Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

TEST PROCEDURE 9 – Solenoid Continuity

See General Warnings on page 1-2.

Solenoid Continuity Test with the CDT Handset

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Connect the CDT to the vehicle.
- 4. Access the Monitor menu and select MAIN CONT DRIVER by using the SCROLL DISPLAY buttons. The CDT should indicate OFF.
- 5. Turn the key switch to the ON position and place the Forward/Reverse switch in the FORWARD position.
- 6. Press the accelerator pedal. When the controller energizes the solenoid coil, the CDT should indicate ON. If not, check the KEY, FORWARD, REVERSE and FOOT INPUTS to the controller. See Wiring Diagrams on page 19-4. Also check the 16-pin connector at the speed controller. See Test Procedure 15 16-Pin Connector on page 19-32.
- 7. If the CDT displays readings other than those described above and the wiring is found to be correct, proceed to the following procedure, **Solenoid Continuity Test without the CDT Handset**.

Solenoid Continuity Test without the CDT Handset

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- Disconnect the 6-gauge yellow wire and pre-charge resistor from large post of solenoid. See following NOTE.

NOTE: When disconnecting heavy gauge wires from solenoid, use a second wrench on the lower nut of the terminal post to hold post steady, preventing damage to the solenoid.

If the pre-charge resistor is not disconnected, the meter will read approx. 250 Ohms.

- 5. Check for continuity between the two large posts of the solenoid. The reading should be no continuity. If continuity is found, the solenoid has failed CLOSED and must be replace. **See Solenoid Removal on page 20-13.**
- 6. Reconnect the 6-gauge yellow wire and pre-charge resistor to the solenoid and secure with washer and nut. Tighten nut to 77 in·lb (8.7 N·m).
- 7. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

WARNING

- Keep people and equipment clear from rotating rear wheels. Do not allow persons under the car.
 Contact with rotating rear wheels could result in serious personal injury.
- 8. Change the multimeter to measure resistance.
- Place the Tow/Run switch in the RUN position, turn the key switch to the ON position, place the Forward/Reverse
 rocker switch in the FORWARD position, and press the accelerator pedal. The rear tire should rotate and
 the multimeter should show a change in resistance. If not, replace the solenoid. See Solenoid Removal on
 page 20-13.

TEST PROCEDURE 10 - Charger Interlock

See General Warnings on page 1-2.

Controller Interlock Function Test with the CDT Handset

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Connect the CDT to the vehicle.
- Access the Monitor menu and select CHARGER INHIBIT by using the SCROLL DISPLAY buttons. The CDT should indicate OFF.
- 4. For external charger: Insert the charger DC cord into the vehicle's charger receptacle.

For onboard charger: Insert the onboard charger AC plug into an AC outlet.

- 5. In a few seconds, the CDT should indicate ON and the vehicle can no longer be driven. If not, check the KEY, FORWARD, REVERSE and FOOT INPUTS to the controller.
 - If the CDT does not indicate ON, check circuit wiring and DC plug connection. See the following procedure
 Testing the Interlock Circuit.
 - If the CDT does indicate ON, but the vehicle can still be driven, replace the controller. See Speed Controller Removal, Section 20, Page 20-11.

Testing the Interlock Circuit

The charger interlock circuit consists of a 48V power source through the RUN/TOW switch, three sonic welds, a 15-amp fuse, a 10k Ohm resistor, a bullet connector, the charger receptacle blue wire and DC plug. **See following NOTE.** Use the following procedure to test the charger interlock circuit:

NOTE: The following steps involve testing voltage and resistance.

At the charger end of the DC cord, the black wire and blue wire are crimped together in the same fork terminal. This closes the circuit once the DC cord plug is inserted into the charger receptacle.

- With batteries connected, place the Tow/Run switch in the RUN position.
- Remove electronics module cover. See Electronics Module Cover Removal, Section 20, Page 20-5.
- 3. Check 15-amp fuse: See Test Procedure 4 15-Amp Fuse on page 19-20.
- 4. **Check power:** Using a multimeter set to 200 volts DC, place red (+) probe (with insulation-piercing probe) on the light blue wire (pin 5 of the 16-pin connector) and black (–) probe on B- terminal of controller. The reading should be approximately 42 to 46 volts. If the reading is not approximately 42 to 46 volts, proceed to check the 10k Ohm resistor. If the reading is approximately 42 to 46 volts, check continuity of circuit wires.
- 5. **Check 10k Ohm resistor:** Set multimeter to 20k Ohms. Remove the 15-amp fuse. With the red (+) probe (with insulation-piercing probe) still on the light blue wire (pin 5 of the 16-pin connector), place the black (–) probe to the red wire terminal in the 15-amp fuse holder. The reading should be approximately 10.0k Ohms. If the reading is not approximately 10.0k Ohms, replace the resistor or main wire harness (**Figure 19-7, Page 19-10**).
- 6. **Check continuity:** Set multimeter to Continuity test. With the red (+) probe (with insulation-piercing probe) still on the light blue wire (pin 5 of the 16-pin connector), place the black (–) probe in the blue wire terminal of the charger receptacle. The meter should beep to indicate continuity. If not, check bullet connector of blue wires.
 - Next, probe from the pink wire terminal in the 15-amp fuse holder to the large solenoid post with the red wires attached. The meter should beep to indicate continuity. If not, verify Tow/Run switch is in RUN and check the red-to-pink wire spade connector near the solenoid.
 - If the meter does not indicate continuity, check and repair related connections, Tow/Run switch and wiring. If necessary, replace affected wire harness, charger receptacle or Tow/Run switch.
- 7. When finished, install 15-amp fuse and fuse cover.

TEST PROCEDURE 11 - MCOR Voltage

See General Warnings on page 1-2.

NOTE: This is a voltage test.

The accelerator position, which is proportional to the MCOR voltage, can be displayed with the CDT handset. If an CDT handset is not available, proceed to **MCOR Voltage Test without the CDT Handset**.

The following are potential MCOR symptoms:

- Vehicle will not drive due to no FOOT INPUT to the controller.
- Vehicle will not reach top speed because MCOR does not reach 100% throttle position.
- · Vehicle does not maintain speed nor will it accelerate due to MCOR having a "dead-spot" in its pedal travel.
- The voltage signal from the MCOR randomly or sporadically fluctuates with pedal at rest, during pedal travel and with pedal fully pressed.

MCOR Voltage Test with the CDT Handset

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2. See also following WARNING.

WARNING

- The key switch should be placed in the OFF position and left in the OFF position for the duration
 of this test.
- 2. Connect the CDT to the vehicle.
- 3. Access the Monitor menu and select THROTTLE % by using the SCROLL DISPLAY buttons.
- 4. The CDT should indicate 0% with the pedal not pressed. While monitoring the CDT display screen, slowly press the accelerator pedal. As the pedal is pressed, the CDT should indicate a steady, incremental rise from 0% (pedal not pressed) to 100% (pedal fully pressed). **See following NOTE.**

NOTE: Observe closely to see if throttle input percentage randomly or sporadically fluctuates with pedal at rest, during pedal travel and with pedal fully pressed. If it fluctuates, the MCOR is defective and must be replaced.

- 5. If the MCOR passes the previous test, press and hold the accelerator pedal to the floor. By hand, gently move the pedal from side to side and see if the throttle input percentage fluctuates from 100%. If it fluctuates, the MCOR is defective and must be replaced.
- 6. If throttle input percentage does not reach 100% in the previous steps, proceed to **MCOR Voltage Test without** the CDT Handset.

MCOR Voltage Test without the CDT Handset

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2. See also following WARNING.

A WARNING

- The key switch should be placed in the OFF position and left in the OFF position for the duration of this test.
- 2. With the batteries connected, place Tow/Run switch in RUN. Using a multimeter set to 200 volts DC, place red (+) probe on battery no. 1 positive post and place black (–) probe (with insulation-piercing probe) on the purple/white wire at a point close to the three-pin connector at the MCOR. The reading should be approximately 48 to 50 volts (full battery voltage).
- 3. If reading is zero volts, check the purple/white wire continuity from the three-pin connector at the MCOR to the 16-pin connector at the speed controller. Check terminal positions in three-pin connector at the MCOR and the 16-pin connector. If all of the continuity readings are correct and the connectors are wired correctly, replace the speed controller.
- 4. With multimeter set to 20 volts DC, place the black (–) probe on battery no. 6 (6 x 8-Volt battery set) negative post and the red (+) probe (with insulation-piercing probe) on the white wire at a point close to the three-pin connector at the MCOR. The reading should be approximately 4.65 volts.
- 5. If reading is zero volts, check the white wire continuity from the three-pin connector at the MCOR to the 16-pin connector at the speed controller. Check terminal positions in three-pin connector at the MCOR and the 16-pin connector. If all of the continuity readings are correct and the connectors are wired correctly, replace the speed controller.
- 6. With multimeter set to 20 volts DC, place the black (–) probe on battery no. 6 (6 x 8-Volt battery set) negative post and the red (+) probe (with insulation-piercing probe) on the yellow wire at a point close to three-pin connector at the MCOR. The reading should be zero (0) volts with the pedal up. Slowly press the accelerator pedal and note the readings on the multimeter. As the pedal is pressed, the reading should increase until it reaches approximately 4.65 volts when the pedal is fully pressed.
- If reading does not increase as the pedal is pressed, replace the MCOR. See following NOTE.

NOTE: Observe closely to see if voltage randomly or sporadically fluctuates with pedal at rest, during pedal travel and with pedal fully pressed. If it fluctuates, the MCOR is defective and must be replaced.

TEST PROCEDURE 12 - Motor Speed Sensor

See General Warnings on page 1-2.

Motor Speed Sensor Test without any Tool

A CAUTION

- Perform the following procedure only on a level surface. To avoid injury or property damage, ensure that the path of the vehicle is clear before pushing vehicle.
- 1. Place the Forward/Reverse switch in the REVERSE position to verify reverse buzzer is functioning properly. If not, repair or replace the buzzer.
- 2. With Tow/Run switch in the RUN position, turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
- 3. Slowly push the vehicle a short distance (about 3 feet (1 meter)). The reverse buzzer should sound and motor braking should engage while the vehicle is rolling.
- 4. If the reverse buzzer does not sound and motor braking does not engage while the vehicle is rolling, replace the Motor Speed Sensor.

Motor Speed Sensor Test with the CDT Handset

CAUTION

- Perform the following procedure only on a level surface. To avoid injury or property damage, ensure that the path of the vehicle is clear before pushing vehicle.
- 1. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
- 2. Connect the CDT to the vehicle.
- Access the Monitor menu and select SPEED PULSES by using the SCROLL DISPLAY buttons. The CDT should indicate OFF when the vehicle is at rest.
- 4. While monitoring the CDT display screen, slowly push the vehicle a short distance (about 3 feet (1 meter)). The CDT should indicate ON for speed sensor pulses while the wheels are in motion.
- If the CDT does not indicate ON while the wheels are in motion, proceed to the following procedure.

Motor Speed Sensor Test without the CDT Handset

NOTE: This is a voltage test.

- 1. Turn the key switch to the OFF position and place the Forward/Reverse switch in the NEUTRAL position.
- 2. With batteries connected, disconnect the three-pin connector at the motor speed sensor.
- Check voltage at purple/white wire:
 - 3.1. Using a multimeter set to 200 volts DC, place the red (+) probe on the battery no. 1 positive post and place the black (–) probe on the purple/white wire terminal socket in the three-pin connector. The voltage reading should be 48 to 50 volts (full battery voltage).
 - 3.2. If the reading is zero volts, check the continuity of the purple/white wire from the 16-pin connector at the speed controller to the three-pin connector at the motor speed sensor. If the continuity is correct, replace the speed controller.
- Check voltage at the red motor speed sensor wire:

- 4.1. With Tow/Run switch in the RUN position and using a multimeter set to 20 volts DC, place the black (–) probe on the battery no. 6 (6 x 8-Volt battery set) negative post and place red (+) probe on red wire terminal socket in three-pin connector. The voltage reading should be approximately 15 to 16 volts.
- 4.2. If the voltage reading is zero volts, check the continuity of the red wire from the 16-pin connector at the speed controller to the three-pin connector at the motor speed sensor. If the wire continuity is correct, replace the speed controller.
- 4.3. If the reading is below 14 volts, replace the speed controller.
- 4.4. If the voltage reading is correct, proceed to the following step.
- 5. Check voltage at the light green wire:
 - 5.1. Using a multimeter set to 20 volts DC, place the black (–) probe on the battery no. 6 (6 x 8-Volt battery set) negative post and place the red (+) probe on the light green wire female terminal in the three-pin connector at the motor speed sensor. The voltage reading should be from 4.60 to 4.90 volts.
 - 5.2. If the voltage is zero volts, check the continuity of the light green wire from the 16-pin connector at the speed controller to the three-pin connector at the motor speed sensor. If the continuity is correct, replace the speed controller.
 - 5.3. If reading is below 3.50 volts, check the continuity of the wires and plug and replace the speed controller if necessary.
- 6. Reconnect the three-pin connector at the motor speed sensor. Using a multimeter set to 20 volts DC, place the black (–) probe on the battery no. 6 (6 x 8-Volt battery set) negative post and place the red (+) probe (with insulation-piercing probe) on the green wire between the three-pin connector and the motor speed sensor.
 - 6.1. Raise one rear wheel off ground. Slowly turn the rear wheel to rotate the motor armature. As the armature rotates, the voltage reading should alternate from zero to approximately 4.85 volts. The voltage reading will fluctuate from zero to 4.85 volts and back to zero four times for each revolution of the motor armature.

NOTE: The voltage reading of 4.85 is an approximate reading. The actual reading may vary from 4.50 to 5.00 volts.

- 6.2. Replace the speed sensor if any of the following results occur:
 - There is no voltage reading.
 - The voltage reading is not above 3.50.
 - The voltage reading does not fluctuate as the motor is turned.

TEST PROCEDURE 13 – A1 and A2 Motor Voltage

See General Warnings on page 1-2.

NOTE: This is a voltage test.

1. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Position jack stands under the frame rails just forward of each spring mount. See WARNING "Lift only one end..." in General Warnings on page 1-2. See also following WARNING.

A WARNING

- Keep people and equipment clear from rotating rear wheels. Do not allow persons under the car. Contact with rotating rear wheels could result in serious personal injury.
- 2. With the batteries connected and using a multimeter set to 200 volts DC, place the black (–) probe on the A2 motor terminal (white wire) and connect the red (+) probe to the A1 (green wire) motor terminal.
- 3. With Tow/Run switch in the RUN position, place the Forward/Reverse switch in the FORWARD position, turn key switch to the ON position and slowly press accelerator pedal.

4. As the accelerator pedal is pressed, the voltage reading should increase from approximately 5 volts RMS when the MCOR limit switch closes, to approximately 48 volts RMS with the accelerator pedal fully pressed. **See following NOTE.**

NOTE: Voltage can vary depending on controller speed setting as well as which zone a Guardian equipped vehicle is located.

Example: Speed setting 1 may only read 30 volts.

- 4.1. If there is no voltage reading, check the MCOR. See MCOR Voltage on page 19-27. Also check the continuity of the large posts of the solenoid. See Solenoid Continuity on page 19-25.
- 4.2. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 4.3. Check continuity on A1 and A2 motor terminal posts and continuity of the F1 and F2 motor terminal posts. Also, check continuity of all motor wires. See Section 23 Motor (Model EJ8-4001A): Electric Vehicle.

TEST PROCEDURE 14 – Voltage at Charger Receptacle Red Wire Socket

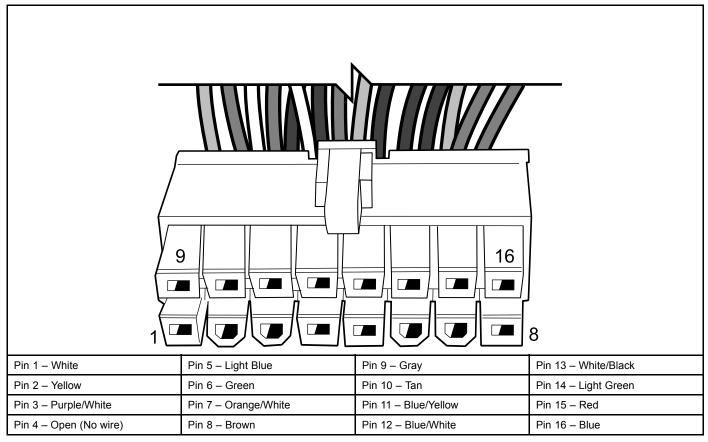
See General Warnings on page 1-2.

NOTE: This is a voltage test.

- 1. If necessary, see Testing Basics on page 19-16.
- 2. Probe the charger receptacle socket connected to the red, 10-gauge wire. The reading should be BPV.
- 3. If the reading is zero volts, check the following items:
 - The 30-amp fuse (located near solenoid) in the 10-gauge red wire of the charger receptacle harness.
 - Continuity of the 10-gauge red wire from the solenoid to the receptacle socket.
 - Continuity of the 6-gauge red wire from the positive post of battery no. 1 to the solenoid.
- 4. If the reading is less than BPV, inspect related wiring and connections for tightness, damage and corrosion.

TEST PROCEDURE 15 - 16-Pin Connector

See General Warnings on page 1-2.



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Figure 19-13 Pin And Wire Color

Inspection and General Information

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- Disconnect the 16-pin connector from the speed controller. Inspect terminal ends inside plug to ensure they are in position and seated in plug housing. If any terminals look like they are not pushed all the way into the connector, gently push the terminals until they are firmly seated in the 16-pin connector. After each terminal has been pushed into the housing, gently pull on the wire to ensure it is locked into place.
- 3. Check wires in the plug to make sure none are broken at the terminal pin crimp. Repair or replace as required.
- Check the wire colors of each wire and make sure that the colors for each pin position match the wire colors as shown in Figure 19-13, Page 19-32.
- When connecting the 16-pin connector to the controller, push plug into controller receptacle with enough force to lock plug into place. An audible click will be heard when plug is properly seated to the controller.

A procedure is provided for testing each of the wires in the 16-pin connector. For testing, wires have been grouped together based on purpose as either controller input or controller output. Tests vary whether the 16-pin must be connected or disconnected from the controller to get the appropriate result.

If 16-pin must be disconnected:

1. Keep the 16-pin connector disconnected from the controller.

- 2. With Tow/Run switch in the TOW position, reconnect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 3. Place the Tow/Run switch in the RUN position and then check the appropriate wires.

If 16-pin must be connected:

- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Connect the 16-pin connector to the controller. See following NOTE.

NOTE: When connecting the 16-pin connector to the controller, push plug into controller receptacle with enough force to lock plug into place. An audible click will be heard when plug is properly seated to the controller.

- 3. With Tow/Run switch in the TOW position, reconnect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 4. Place the Tow/Run switch in the RUN position and then check the appropriate wires.

Refer to the following tables. Each table contains the following information:

- What function the wire performs.
- Whether or not the 16-pin connector must remain connected during the test.
- The appropriate test result for each pin.

If results differ from those described in the procedure, check the continuity of the wires in the wire harness and test the connected components with the appropriate test procedures. **See Index of Test Procedures.**

Testing Controller Inputs

CONTROLLER INPUTS	PERFORM TEST WITH 16-PIN CONNECTED TO CONTROLLER? (IF YES, BACK-PROBE TO TEST)	TEST PROCEDURE
THROTTLE INPUT Pin 2 – Yellow	Yes	Range of zero (0) volts (with accelerator pedal at rest) to 4.65 volts (with accelerator pedal fully pressed) from MCOR 3-pin circuit
GROUND FOR PINS 1 AND 15 Pin 3 – Purple/White	Yes	BPV measured between solenoid post with red wires and pin 3
CHARGER INTERLOCK INPUT Pin 5 – Light Blue	Yes	Approx. 42 to 46 volts (can vary depending on BPV) with charger disconnected. See Test Procedure 10 – Charger Interlock on page 19-26.
FOOT INPUT Pin 6 – Green	No	BPV from MCOR limit switch (Key switch must be ON)
REVERSE BUZZER INPUT Pin 7 – Orange/White	No	BPV from Reverse Buzzer with Tow/Run switch in RUN (Key switch either ON or OFF)
FORWARD INPUT Pin 8 – Brown	No	BPV from Forward/Reverse switch in FWD (Key switch either ON or OFF)
B+ INPUT Pin 9 – Gray Powers the controller logic and power boards.	No	BPV from Tow/Run switch in RUN

TABLE CONTINUED ON NEXT PAGE

CONTROLLER INPUTS	PERFORM TEST WITH 16-PIN CONNECTED TO CONTROLLER? (IF YES, BACK-PROBE TO TEST)	TEST PROCEDURE
KEY SWITCH INPUT Pin 10 – Tan	No	BPV from Key switch in ON
SOLENOID INPUT Pin 12 – Blue/White	No	BPV from Solenoid Activating Coil (result of Key switch in ON)
SPEED SENSOR INPUT Pin 14 – Light Green	Yes	Alternates from zero (0) to approx. 4.85 volts depending on speed sensor position. Rotate rear wheel to see voltage switch (Key switch either ON or OFF)
REVERSE INPUT Pin 16 – Blue	No	BPV from Forward/Reverse switch in REV (Key switch either ON or OFF)

Testing Controller Outputs

CONTROLLER OUTPUTS	PERFORM TEST WITH 16-PIN CONNECTED TO CONTROLLER? (IF YES, BACK-PROBE TO TEST*)	TEST PROCEDURE
THROTTLE OUTPUT Pin 1 – White Supplies approximately 5 volts in MCOR 3-pin circuit.	Yes	4 to 5 volts measured between pin 1 and B- terminal on controller (Key switch either ON or OFF)
CHARGE INDICATOR LIGHT OUTPUT Pin 11 – Blue/Yellow Supplies a positive (+), controlled current source to power the charge indicator light on the instrument panel.	Yes* Do not back-probe for this test.	Start a charging session. After a few seconds, light should flash. Can also be seen under LED Driver in the Monitor menu of the CDT.
CONNECTED CAR OUTPUT Pin 13 – White/Black Supplies approximately 13 volts to the Guardian/Visage unit.	Yes	Approximately 13 volts measured between pin 1 and B- terminal on controller (Key switch either ON or OFF)
SPEED SENSOR OUTPUT Pin 15 – Red Supplies approximately 15 to 16 volts to the motor speed sensor.	Yes	Approximately 15 to 16 volts measured between pin 1 and B- terminal on controller (Key switch either ON or OFF)

TEST PROCEDURE 16 – Reverse Buzzer

See General Warnings on page 1-2.

NOTE: This is a voltage test.

- 1. If necessary, see Testing Basics on page 19-16.
- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 3. Remove the instrument panel. See Key Switch Removal, Section 20, Page 20-1.
- 4. Disconnect the orange/white and pink wires from the reverse buzzer.

- 5. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 6. Place the key switch in the OFF position and the Tow/Run switch in the RUN position.
- 7. Using a multimeter set to 200 volts DC, place the black (–) probe on battery no. 6 (6 x 8-Volt battery set) negative post and place the red (+) probe on the pink wire terminal end that was disconnected from the reverse buzzer. The reading should be approximately 48 volts (full battery voltage).
 - 7.1. If the voltage reading is correct, proceed to step 7.
 - 7.2. If reading is zero volts, check wire continuity, 9-pin connector, 15-amp fuse and Tow/Run switch. **See Test Procedure 3 Tow/Run Switch on page 19-19.**
 - 7.3. If the continuity readings are not correct, repair or replace the pink wire.
 - 7.4. If the continuity readings are correct, proceed to step 7.
- 8. Place the Forward/Reverse switch in REVERSE. Using a multimeter set to 200 volts DC, place the black (–) probe on the orange/white wire terminal end (that was disconnected from the reverse buzzer) and place the red (+) probe on battery no. 1 positive post. The reading should be approximately 48 volts (full battery voltage).
 - 8.1. If the voltage reading is correct, replace the reverse buzzer.
 - 8.2. If reading is zero volts, check orange/white wire continuity and connection at Pin 7 in 16-Pin connector.
 - 8.3. If there is no continuity in the orange/white wire, or the pin 7 terminal in the 16-pin connector is not properly seated, repair or replace as required.
 - 8.4. If the orange/white wire continuity and 16-Pin connector are correct and there is no voltage at the orange wire, replace the controller.

TEST PROCEDURE 17 - Charge Indicator Light

See General Warnings on page 1-2.

- 1. With batteries connected, Tow/Run switch in the RUN position and the key switch in the OFF position, connect charger DC cord to vehicle.
- In a few seconds, the light will flash three times and the reverse buzzer simultaneously will sound three times to indicate charging has begun. See following NOTE.

NOTE: The number of flashes and beeps can vary depending on the Beep Option setting. **See Beep Option, Section 18, Page 18-8.**

- 3. If charge indicator light does not flash three times, disconnect charger DC cord from vehicle and connect an CDT to the vehicle.
- 4. Access the Monitor menu and select LED Driver by using the SCROLL DISPLAY buttons. The CDT should indicate OFF.
- 5. Reconnect charger DC cord to vehicle.
- 6. In a few seconds, the CDT should quickly display ON just once while the dash-mounted charge indicator light flashes three times. **See following NOTE.**

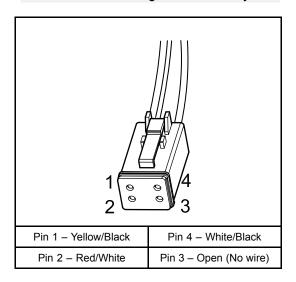
NOTE: The CDT will still flash ON even with a failed or missing charge indicator light.

- 7. If the CDT quickly displays ON but the charge indicator light still does not flash, check the following items:
 - Condition of the blue/yellow wire terminal in the 16-pin connector.
 - Condition of the 9-pin connector behind instrument panel.
 - Condition of the yellow/green wire terminal in the instrument panel wire harness.
 - Continuity of the wires in the wire harnesses.
- 8. If no problems exist in the above items, replace the charge indicator light.

TEST PROCEDURE 18 – 4-Pin Connector (for Connected Car Device)

See General Warnings on page 1-2.

NOTE: This is a voltage and continuity test.



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Figure 19-14 4-Pin Connector

- If necessary, see Testing Basics on page 19-16.
- 2. Check for continuity between pin 1 (yellow/black wire) (Figure 19-14, Page 19-36) and pin 3 (purple/white wire) of the 16-pin connector. It should indicate continuity. If not, check sonic welds no. 1 and no. 2.
- 3. Probe pin 2 (red/white wire). It should show BPV. If not, check 2-amp fuse. See following NOTE.

NOTE: The red/white wire has BPV with the Run/Tow switch in either position.

4. Probe pin 4 (white/black wire). It should show approximately 13 volts supplied by the controller. If not, check wiring and then controller. **See following NOTE.**

NOTE: The white/black wire only has voltage with the Run/Tow switch in the RUN position.

If pin 4 has no voltage, the controllers LIN (Local Interconnect bus) may have failed. The vehicle can be driven if it is not used with Guardian or Visage and will not show any symptoms. Otherwise, Guardian or Visage will disable the vehicle until communication is restored.

SECTION 20 – ELECTRICAL COMPONENTS: ELECTRIC VEHICL WITH ERIC CHARGING

A DANGER

See General Warnings on page 1-2.

WARNING

See General Warnings on page 1-2.

KEY SWITCH

See General Warnings on page 1-2.

TESTING THE KEY SWITCH

See the appropriate troubleshooting section for the type of electrical system used in the vehicle. See Test Procedure 5 – Key Switch and MCOR Limit Switch Circuit on page 19-21.

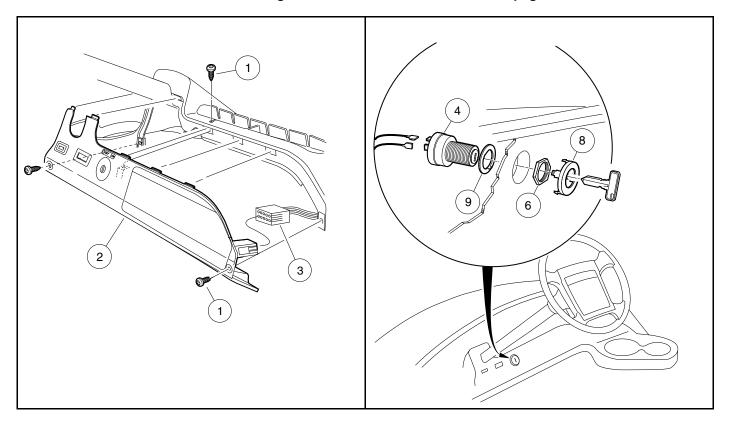
KEY SWITCH REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove the instrument panel (Figure 20-1, Page 20-2).
 - 2.1. Remove three screws (1) from the instrument panel (2).
 - 2.2. Rotate the instrument panel up and away from the dash to disengage the tabs at the top of the panel.
 - 2.3. Disconnect the electrical connector (3) to the instrument panel.
- 3. Disconnect the wires from the key switch.
- 4. From the back of the instrument panel, push down on the retaining tabs surrounding the key switch (4) and remove the key switch cap (8). Hold the key switch and remove the switch retaining nut (6) from the outside of the instrument panel (Figure 20-2, Page 20-2).

KEY SWITCH INSTALLATION

- 1. Position the key switch and flat washer (9) in the instrument panel, then install and tighten the switch retaining nut (6) to 40 in·lb (4.5 N·m). Install key switch cap (8) in center dash (Figure 20-2, Page 20-2).
- 2. Connect the blue and green wires to the key switch terminals. Either orientation is correct. See 19-4.
- 3. Install the instrument panel.
 - 3.1. Connect the electrical connector (3) (Figure 20-1, Page 20-2).
 - 3.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.

- 3.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).
- 4. Connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.



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Figure 20-1 Instrument Panel Removal

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Figure 20-2 Key Switch

CHARGE INDICATOR LIGHT

See General Warnings on page 1-2.

TESTING THE CHARGE INDICATOR LIGHT

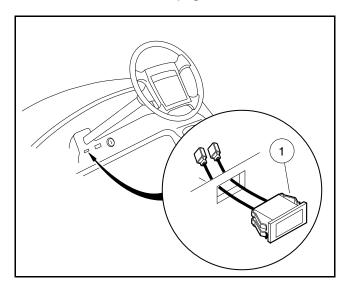
See Test Procedure 17 - Charge Indicator Light on page 19-35.

CHARGE INDICATOR LIGHT REMOVAL

- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove instrument panel. See Key Switch Removal on page 20-1.
- Disconnect the wires at the warning light.
- 4. Press the two retaining tabs (1) and remove the light from the center dash (Figure 20-3, Page 20-3).

CHARGE INDICATOR LIGHT INSTALLATION

- 1. Install in reverse order of removal.
- 2. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.



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Figure 20-3 Charge Indicator Light

FORWARD/REVERSE ROCKER SWITCH

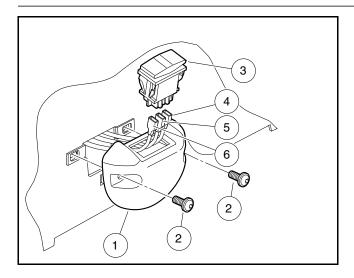
See General Warnings on page 1-2.

TESTING THE FORWARD/REVERSE ROCKER SWITCH

See Test Procedure 6 - Forward/Reverse Rocker Switch on page 19-22.

FORWARD/REVERSE ROCKER SWITCH REMOVAL

- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove two screws (2) that hold Forward/Reverse rocker switch housing (1) to the vehicle (Figure 20-4, Page 20-4).
- 3. Remove the three wires from the rocker switch.
- 4. Press in on the locking tabs on each side of switch (3), and push switch out of housing.



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Figure 20-4 Forward/Reverse Rocker Switch

FORWARD/REVERSE ROCKER SWITCH INSTALLATION

- 1. Route the three wires through bezel. Connect the blue (4), orange (5) and brown (6) wires to the rocker switch (3), exactly as shown in **(Figure 20-4, Page 20-4)**.
- 2. Orient the rocker switch (3) so the terminals are towards the front of the housing (1). Push rocker switch (3) into housing (1).
- 3. Place the housing in position on the body and install the two screws (2). Tighten to 20 in·lb (2.3 N·m).
- 4. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 5. Place the Tow/Run switch in the RUN position.
- 6. Inspect the vehicle for proper operation.

A WARNING

- Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.
- Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
- Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.

ELECTRONICS MODULE COVER

See General Warnings on page 1-2.

The electronics module cover needs to be removed to gain access to the speed controller, Tow/Run switch, and solenoid.

ELECTRONICS MODULE COVER REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove the two plastic rivets (1) that secure the access panel (2) to the vehicle (Figure 20-5, Page 20-6).
- 3. Remove cover (5) by first releasing the four tabs (3) from the matching holes in the hood of the battery bucket. Then, maneuver the cover to release the two hooks (4) that secure the cover to the battery bucket.

CAUTION

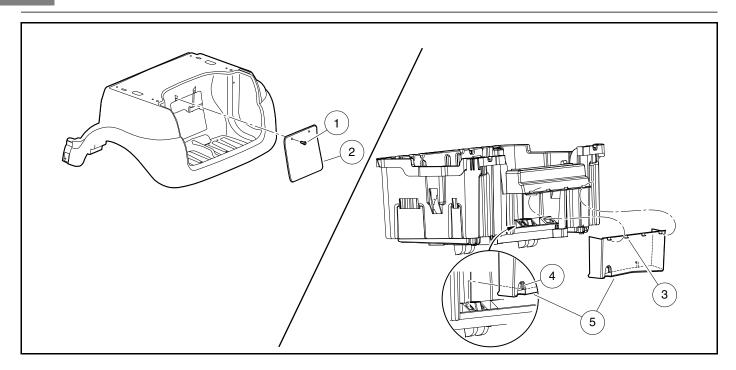
• Be careful not to break the two hooks (4) on the bottom of the cover. Push the bottom of the cover up to release the hooks before pulling cover away from battery bucket.

ELECTRONICS MODULE COVER INSTALLATION

- 1. Install cover (5) by first hooking the four tabs (3) into the matching holes in the hood of the battery bucket (**Figure 20-5**, **Page 20-6**). Then, use the two hooks (4) to secure the cover to the battery bucket.
- 2. Place access panel (2) on vehicle and secure with the two plastic rivets (1). See following CAUTION.

CAUTION

- Exposure to water may damage electronic components.
 - Do not operate vehicle without this cover properly installed.
 - Do not direct water stream in the area of the cover.
- 3. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.



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Figure 20-5 Access and Remove Electronics Module Cover

TOW/RUN SWITCH

See General Warnings on page 1-2.

TESTING THE TOW/RUN SWITCH

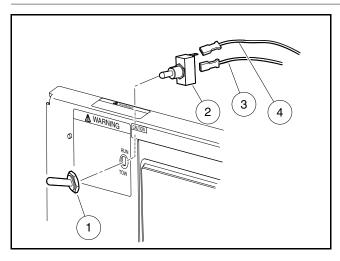
See Test Procedure 3 – Tow/Run Switch on page 19-19.

TOW/RUN SWITCH REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove the electronics module cover to access back side of the Tow/Run switch (2). See Electronics Module Cover Removal on page 20-5.
- 3. Remove Tow/Run switch boot/hex nut (1) (Figure 20-6, Page 20-7).
- 4. Remove Tow/Run switch (2) from electronics module and disconnect the pink wire (3) and light green wire (4).

TOW/RUN SWITCH INSTALLATION

- Installation is reverse of removal. Make sure flat on switch is aligned with flat part of D-shaped hole in electronics module (Figure 20-6, Page 20-7). Tighten Tow/Run switch boot/hex nut (1) to 16 in lb (1.8 N·m).
- Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries -Electric Vehicles on page 1-5.



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Figure 20-6 Tow/Run Switch

MOTOR CONTROLLER OUTPUT REGULATOR (MCOR)

See General Warnings on page 1-2.

TESTING THE MCOR

See Test Procedure 11 – MCOR Voltage on page 19-27 and Test Procedure 5 – Key Switch and MCOR Limit Switch Circuit on page 19-21.

MCOR REMOVAL

- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove pedal group. See Pedal Group Removal, Section 5, Page 5-1.
- 3. Disconnect the two-pin and three-pin connectors from the MCOR.
- 4. Remove the T25 torx screw securing the MCOR to the pedal group.
- 5. Detach the two tabs from the accelerator pedal and remove the MCOR from vehicle.

MCOR INSTALLATION

1. Align the two tabs of the MCOR (2) with the slots in the accelerator pedal on the pedal group. Insert the MCOR into the accelerator pedal until the tabs engage. **See following NOTE.**

NOTE: Rotate the pedal back and forth if necessary to align the D-shaped end of shaft with the MCOR.

- 2. Secure MCOR to pedal group with T25 torx screw. Tighten screw to 19 in·lb (2.1 N·m).
- 3. Connect the two-pin and three-pin connectors from the wire harness to the MCOR.
- 4. Install the pedal group. See Pedal Group Installation on page 5-3.
- 5. Connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

REVERSE BUZZER

See General Warnings on page 1-2.

TESTING THE REVERSE BUZZER

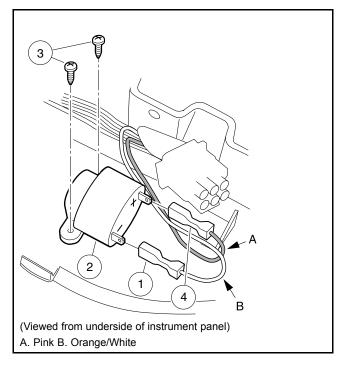
See 19-34.

REVERSE BUZZER REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove instrument panel. See Key Switch Removal on page 20-1.
- 3. Disconnect the 18-gauge pink and orange/white wires from reverse buzzer.
- Remove the two screws from the reverse buzzer. Remove the reverse buzzer from the dash panel.

REVERSE BUZZER INSTALLATION

- Install the reverse buzzer in the reverse order of removal. Pink wire must be connected to the positive terminal. Tighten screws to 4 in·lb (0.45 N·m).
- 2. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.



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Figure 20-7 Reverse Buzzer

ELECTRONICS MODULE

See General Warnings on page 1-2.

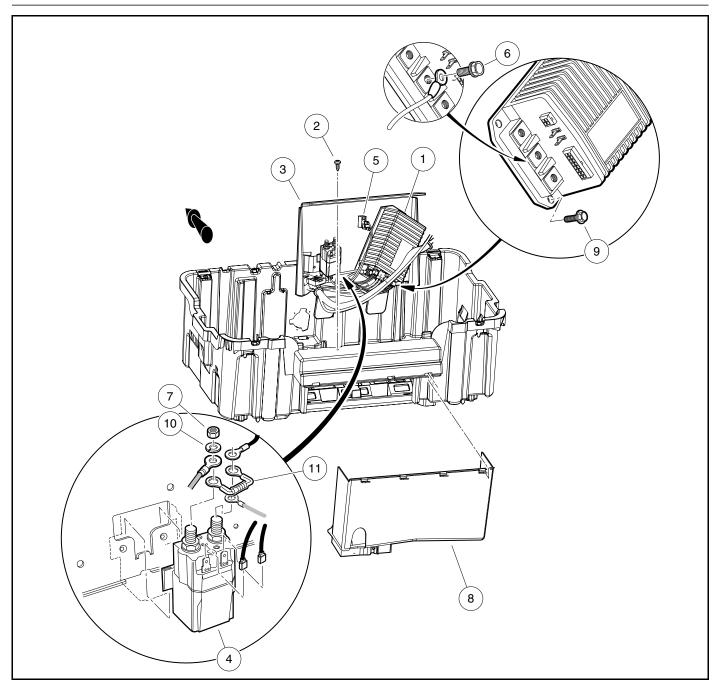
While it is not necessary to remove the electronics module from the vehicle, access to individual components may be easier with the module removed.

ELECTRONICS MODULE REMOVAL

- 1. Disconnect the batteries and discharge the controller (1). See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove the batteries from the vehicle to provide enough room to access the controller (1) (Figure 20-8, Page 20-10). See Battery Replacement on page 21-5.
- 3. Remove the bolt (2) that secures the electronics module (3) to the battery bucket.
- 4. Pull electronics module (3) forward and disconnect the heavy gauge wires from the controller (1) and solenoid (4).
- 5. Disconnect the 16-pin connector, 4-pin connector, and spade connectors from the controller (1).
- 6. Disconnect the spade connectors on the front of the solenoid (4).
- 7. Disconnect the two wires from Tow/Run switch (5).
- 8. Lift the electronics module (3) from the vehicle. **See following WARNING.**

WARNING

- · Shorting of battery terminals can cause personal injury or death.
 - Do not place component mounting plate directly on top of batteries when removing or installing plate.
 - Remove plate from vehicle completely.



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Figure 20-8 Controller and Solenoid Removal

ELECTRONICS MODULE INSTALLATION

- 1. Return electronics module (3) to its location in vehicle but leave it tilted forward.
- 2. Complete connections to the controller (1), the Tow/Run switch (5) and the solenoid (4) per the electrical schematics. **See Wiring Diagrams on page 19-4.**
- 3. Tighten bolts (6) on the controller to 108 in lb (12.2 N·m).
- 4. Tighten nuts (7) on the solenoid to 6.4 ft·lb (8.7 N·m).
- 5. Set electronics module in place and secure with bolt (2) **(Figure 20-8, Page 20-10)**. Tighten bolt to 40 in·lb (4.5 N·m).

- 6. Install the batteries and battery cables in their original locations. See Battery Replacement on page 21-5.
- 7. Place the Tow/Run switch (5) in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 8. Place the Tow/Run switch (5) in the RUN position.
- 9. Inspect the vehicle for proper operation. See following WARNINGS.

WARNING

- Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.
- Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
- Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL
 position.

SPEED CONTROLLER

See General Warnings on page 1-2.

TESTING THE SOLID STATE SPEED CONTROLLER

See Test Procedure 13 – A1 and A2 Motor Voltage on page 19-30.

SPEED CONTROLLER REMOVAL

- 1. Disconnect the batteries and discharge the controller (1). See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove the electronics module cover (8) to access the controller (1). See Electronics Module Cover Removal on page 20-5.
- 3. Disconnect the heavy gauge wires from the controller by removing the three screws (6) (Figure 20-8, Page 20-10).
- 4. Disconnect the 16-pin connector, 4-pin connector, and spade connectors from the controller (1).
- 5. Remove the one self-tapping screw (9) nearest the B- terminal of the controller. Loosen the remaining two self-tapping screws (9) that secure the controller and remove controller from vehicle.

SPEED CONTROLLER INSTALLATION

- 1. Install controller (1) on the two self-tapping screws (9). Install third self-tapping screw (9) and tighten to 5.5 ft·lb (7.5 N·m) (Figure 20-8, Page 20-10).
- 2. Connect the 16-pin connector, 4-pin connector, and spade connectors to the controller (1).
- 3. Connect the heavy gauge wires to the controller (1) per the electrical schematics. **See Wiring Diagrams on page 19-4.** Tighten terminal screws (6) on the controller to 108 in·lb (12.2 N·m).

- 20 Solenoid
 - 4. Return electronics module cover (8) to its original location. See Electronics Module Cover Installation on page 20-5.
 - 5. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
 - 6. Place the Tow/Run switch in the RUN position.
 - 7. If vehicle is equipped with the Guardian SVC system, perform the following additional steps for proper setup.
 - 7.1. Connect an CDT to the CDT port on the vehicle.
 - 7.2. Select Program, Settings, Control Mode and set the value to 1.
 - 7.3. Select Program, Settings, Anti Tamper and set the value to 0.
 - 7.4. Select Program, Vehicle ID, Vehicle S/N and enter the last six digits of the vehicle serial number.

NOTE: The speed for scrolling values may be increased by utilizing the bookmark keys (yellow buttons) in combination with the data inc/dec key (+/-).

- 7.5. Select Program, Vehicle ID, Vehicle Decal and enter the number on the Vehicle Number Decal.
- 7.6. Select *Program, Vehicle ID, Vehicle Date of Manufacture* and enter the number on the model year and week from the vehicle serial number.
- 7.7. Select *Information, Software Version* and verify the value is 13 or higher. If not, contact a Club Car Technical Representative.
- 7.8. Place the Tow/Run switch in the TOW position for 30 seconds. Then return it to RUN.
- 8. Inspect the vehicle for proper operation.

WARNING

- Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.
- Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
- Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL
 position.

SOLENOID

See General Warnings on page 1-2.

The solenoid is located on the rear side of the electronics module.

TESTING THE SOLENOID

See Test Procedure 7 – Solenoid Activating Coil on page 19-24 and Test Procedure 9 – Solenoid Continuity on page 19-25.

SOLENOID REMOVAL

- Disconnect the batteries and discharge the controller (1). See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove the electronics module cover (8) to access the solenoid (4). See Electronics Module Cover Removal on page 20-5.
- 3. Disconnect the heavy gauge wires from the solenoid (4) by removing the nuts (7) and washers (10) (Figure 20-8, Page 20-10).
- 4. Disconnect the spade connectors from the solenoid (4).
- 5. Slide solenoid (4) up to disengage the mounting tabs and remove from mounting plate.

SOLENOID INSTALLATION

- 1. Slide solenoid (4) into mounting plate (Figure 20-8, Page 20-10).
- 2. With resistor (11) in place as shown, connect the four wires to the appropriate solenoid terminals. **See Wiring Diagrams on page 19-4.** Tighten the nuts (7) that secure the heavy-gauge yellow and red wires to 72 to 84 in·lb (8 to 9.5 N·m).
- 3. Return electronics module cover (8) to its original location. See Electronics Module Cover Installation on page 20-5.
- 4. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

CHARGER RECEPTACLE

See General Warnings on page 1-2.

The charger cord, plug, and receptacle are wear items and should be inspected daily. Visually inspect them for cracks, loose connections, and frayed wiring; they must be replaced when worn or damaged. If charger plug or receptacle show signs of corrosion or the plug is difficult to insert or remove, the receptacle contacts and plug terminals should be cleaned with a good electrical contact cleaner or lightly sprayed with WD-40® brand spray lubricant. The plug should then be inserted and removed several times to ensure ease of insertion, ease of removal, and good electrical contact.

TESTING THE CHARGER RECEPTACLE

See Test Procedure 14 – Voltage at Charger Receptacle Red Wire Socket on page 19-31. See also the appropriate battery charger maintenance and service manual.

CHARGER RECEPTACLE INSPECTION

Inspect the receptacle for cracks, loose connections and frayed wiring.

NOTE: Disassembly of the charger receptacle, for the purpose of removal or installation, is not recommended.

CHARGER RECEPTACLE REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Remove kick plate. See Kick Plate and Charger Receptacle Bezel on page 4-9.
- 3. Remove the 10-gauge red wire from the solenoid.
- 4. Disconnect the 10-gauge black wire from the controller B- terminal.
- 5. Disconnect the light blue wire from main harness at the bullet connector.
- Remove the three screws (1) that secure the charger receptacle (2) to the bucket.

CHARGER RECEPTACLE INSTALLATION

- 1. Insert the wires through the hole in the bucket.
- 2. Insert receptacle (2) into bucket.
- Install the three screws (1) that secure the receptacle to the bucket. Tighten screws to 16 in lb (1.8 N·m).
- 4. Connect 10-gauge red wire to solenoid. Tighten nut 72 to 84 in lb (8 to 9.5 N·m).
- 5. Connect 10-gauge black wire to controller B- terminal. Tighten bolt to 108 in lb (12.2 N·m).
- 6. Connect light blue wire to main harness at bullet connector with light blue wire.
- 7. Install kick plate. See Kick Plate and Charger Receptacle Bezel on page 4-9.
- 8. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

A DANGER

See General Warnings on page 1-2.

WARNING

See General Warnings on page 1-2.

A DANGER

- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service
 area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and
 rubber gloves when working on or near batteries.
- Charge batteries in a well-ventilated area only. Batteries emit hydrogen while being charged. Hydrogen is an explosive gas and must never exceed a level of 2% of the air.
- Battery Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing.
 Antidotes:
 - External: Flush with water. Call a physician immediately.
 - Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.
 - Eyes: Flush with water for 15 minutes. Call a physician immediately.

WARNING

- Wear safety glasses or approved eye protection when servicing the vehicle or battery charger. Wear a full face shield and rubber gloves when working on or near batteries.
- Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.
- Ensure battery connections are clean and properly tightened. See Battery Care on page 21-6.

CAUTION

On all vehicles, turn off all accessories before charging batteries.

NOTE: Recycle or dispose of discarded batteries in accordance with local, state, and federal regulations.

GENERAL INFORMATION

The batteries supplied with an electric vehicle are different from those supplied with an automobile. The outward appearance of these two batteries is similar, but the operating characteristics are very different. The electric vehicle battery is a deep-cycle battery, and the automotive battery is a "starting, lighting, and ignition" (SLI) battery. They should never be substituted for one another.

BATTERY TESTING BASICS - 8 VOLT

See General Warnings on page 1-2.

OBSERVATION

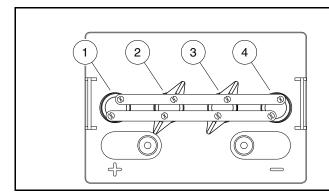
Inspect the battery compartment for the following items:

- · Rusted, corroded, or broken battery posts
- · Rusted, corroded, loose or broken wires
- · Low or overfilled electrolyte levels
- · Cracked, punctured, or bulging battery cases
- · Loose, over-tightened, missing, or improperly placed battery hold-downs
- · Incorrect orientation of batteries (i.e. terminal posts)
- Poor, fair, or proper cleanliness of batteries
- · Added electric accessories
- Use of a single-point watering system (SPWS)

MEASURING VOLTAGE OF BATTERY SET

Set the multimeter to 200 volts DC. Place the red (+) probe on the positive (+) post of battery no. 1 and the black (–) probe on the negative (–) post of battery no. 6. Record the reading.

BATTERY CELL NUMBERING



- 1. Cell 1 (Cell with Positive Post)
- 2. Cell 2 (Cell adjacent to Positive Post)
- 3. Cell 3 (Cell adjacent to Negative Post)
- 4. Cell 4 (Cell with Negative Post)

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Figure 21-1 Battery Cell Numbering - 8 Volt

BATTERY TESTING - 8 VOLT

See General Warnings on page 1-2.

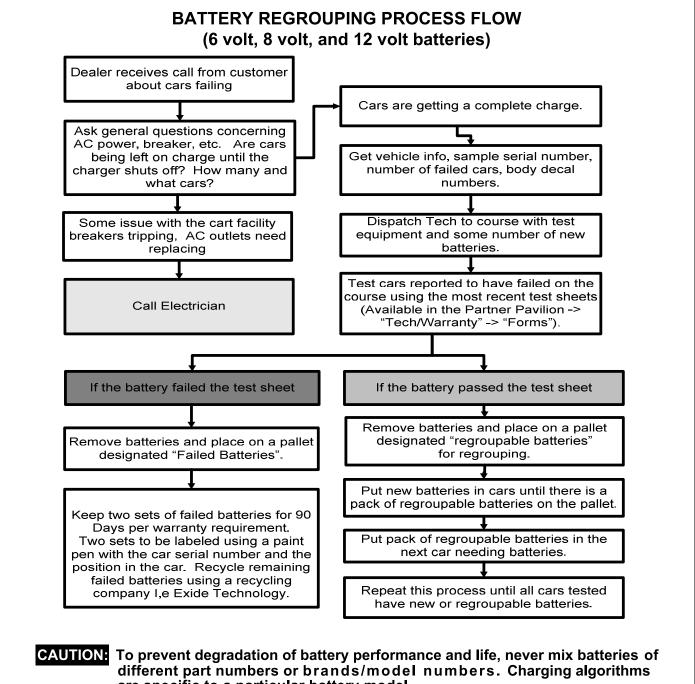
Test procedures not available at time of publication. Refer to any Bulletin that is released concerning testing for Model Year 2015.

BATTERY REGROUPING

CAUTION

To prevent degradation of battery performance and life, never mix batteries of different part numbers
or brands/model numbers. Anytime a different model of battery is used, the charging algorithm must
be changed to match it. For vehicles with PowerDrive charger, the vehicles' onboard computer must
be changed to one that is specific to the battery installed. For vehicles with high-frequency charger
(e.g. ERIC or QuiQ), the charger must be reprogrammed with the appropriate algorithm specific to
the battery installed.

Regrouping is now Club Car's standard battery replacement method. Regrouping is the practice of placing batteries of similar condition together in one vehicle. For example, if there was an issue with the batteries in two cars and the battery test indicated three failed batteries in each car, after removing the failed batteries, there will be six good batteries remaining. Install the six remaining good batteries together in one car and install NEW batteries in the other car. We recommend regrouping batteries in as many cars as possible at a given opportunity to minimize mixing old and new batteries together in one battery pack. A training video for regrouping is available to view in the Partner Pavilion under "Tech/Warranty" and then "Training Videos". Contact your regional Tech Support person to assist you in the regrouping process if needed.



are specific to a particular battery model.

- 1. Install all new batteries or all regroupable batteries of the same brand and model or part number; do not mix new with regroupable except for the last car regrouped.
- 2. Accurate and accumulative Amp Hours are required for Warranty claims. Make sure to have battery lights on hand to replace ones that may be defective so you can capture every car's Amp Hour reading.

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Figure 21-2 Battery Regrouping Process Flow

BATTERY REPLACEMENT

See General Warnings on page 1-2.

▲ WARNING

- · Wear steel-toe shoes when replacing batteries.
- To prevent electrolyte leakage from the battery vents, batteries must be kept in an upright position. Tipping a battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out the vent hole. Do not exceed this 45° angle when lifting, carrying, or installing batteries. Battery acid can cause severe personal injury to skin or eyes, and can damage clothing.
- When replacing batteries in the Single Point Watering System, place the battery cap from the new replacement battery onto the used battery being removed from the car. Important safety warnings on the battery cap must remain with the battery after it has been removed from the car

CAUTION

- To prevent degradation of battery performance and life, never mix batteries of different part numbers
 or brands/model numbers. Anytime a different model of battery is used, the charging algorithm must
 be changed to match it. For vehicles with PowerDrive charger, the vehicles' onboard computer must
 be changed to one that is specific to the battery installed. For vehicles with high-frequency charger
 (e.g. ERIC or QuiQ), the charger must be reprogrammed with the appropriate algorithm specific to
 the battery installed.
- 1. Before removing batteries, note the orientation of the batteries and the connecting wires. Disconnect the battery cables and discharge the controller as instructed. **See Disconnecting the Batteries Electric Vehicles on page 1-5.** Remove remaining wires and batteries.
- 2. Visually inspect the new batteries for any damage that may have occurred in transit. New batteries will not deliver their full capabilities until they have been discharged and recharged 50 to 70 times. To obtain the maximum service life from new batteries, restrict vehicles with new batteries to one hour of operation between charges for the first two months vehicle is in service. Batteries should be fully charged before first use of new vehicle, before first use of a vehicle after storage, and before use each day.
- 3. If the battery cables are to be reused, inspect them for broken or frayed wires, damaged terminals, or worn insulation. Remove any corrosion on the connectors. A solution of baking soda and water (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water) does an excellent job of neutralizing and removing the corrosion. Be careful not to allow the baking soda solution to enter the battery.
- 4. Check and clean the battery rack and hold-downs. The nuts and bolts on the hold-downs may corrode. It is therefore advised they be cleaned periodically and replaced as necessary.
- 5. Regroup batteries as required. See Battery Regrouping on page 21-3.
- 6. Install regrouped or new batteries in the proper orientation (Figure 1-1, Page 1-4). Install battery hold-downs. The hold-downs should be tight enough so batteries do not move while vehicle is in motion, but not so tight as to crack or buckle battery case. Tighten hold-down retaining nuts to 72 in·lb (8.1 N·m), alternating between hold-down bolts.
- 7. Install wires in proper sequence. Install black wire to negative post of battery no. 6 (6 x 8-Volt battery set) last. See Connecting the Batteries Electric Vehicles on page 1-5.
- 8. If replacement batteries have a different part number than the batteries removed, either replace the vehicles' onboard computer or reprogram the high-frequency charger. **See preceding CAUTION.**
- 9. Give the batteries a full charge prior to operation. This ensures all the batteries are fully charged and the cells are equalized prior to use.

BATTERY CARE

See General Warnings on page 1-2.

WATER QUALITY

Water purity is the most important factor in the performance and life span of the vehicle batteries. Club Car is, therefore, placing increased importance on battery water quality.

Outlined below are four battery watering procedures, grouped into two categories: Preferred and Alternate methods. Club Car recommends the use of a deionizer or distilled water. Alternate methods of reverse osmosis or tap water are allowable but should be avoided since water quality can change from day to day depending on additives, water main leaks, etc.

Preferred Methods

- **Distilled Water**: Distilled water is the most common type of water used in batteries. Distilled water is created by boiling water, collecting the steam, and allowing the steam to condense back into water. The distilling process results in water that is free of minerals that can lead to the degradation of battery performance and life.
- **Deionized Water:** Deionized water is created by inducing electrically charged resins that attract and bind to sodium, calcium, iron, copper, chloride, and bromide ions. The result of this electrical filtering is purified water, which contains little to no mineral ions. To make sure the deionized water remains at a high quality, replace the filter in the deionizer per the manufacturer's recommendations.
- **Deionized Systems:** The Service Parts Department at Club Car offers one deionizer system: for vehicles equipped with the Single Point Watering System (SPWS), CC P/N 105166801; for vehicles without SPWS, CC P/N 105166801 (used in combination with AM10818 Battery Watering Nozzle Gun).

Alternate Methods

- Reverse Osmosis: Reverse osmosis involves forcing water through a membrane that allows water to pass while
 trapping solids. The choice of membrane used determines the amount of solids or impurities that get trapped and
 hence the purity quality of the filtered water. In addition, the usage frequency of the membrane can also contribute
 to the filtered water quality. Due to the variance in water quality consistency, Club Car recommends the use of
 the deionizer or distilled water.
- Tap Water: While the use of tap water without filtering is an alternate method of battery watering, its use should be limited due to the levels of dissolved minerals and chemicals that can degrade battery performance and life. If unfiltered tap water is used, regular water analyses must be conducted to check for impurities. The following chart lists the maximum allowable minerals, solids, and contaminates in parts per million and their impact on battery performance. Water testing, however, is expensive, and water quality can change from day to day depending on additives, water main leaks, etc. Due to the cost and labor of performing water quality tests, Club Car recommends the use of distilled water or a deionizer.

IMPURITY	ALLOWABLE CONTENT (PARTS PER MILLION)	EFFECTS OF IMPURITY	
Suspended matter	Trace	N/A	
Total solids	100.0	N/A	
Organic and volatile matter	50.0	Corrosion of positive plates	
Ammonia	8.0	Slight self-discharge of both plates	
Antimony	5.0	Self-discharge, reduces life, lower on-charge voltage	
Arsenic	0.5	Self-discharge, can form poisonous gas	

TABLE CONTINUED ON NEXT PAGE

IMPURITY	ALLOWABLE CONTENT (PARTS PER MILLION)	EFFECTS OF IMPURITY
Calcium	40.0	Increase of positive plate shedding
Chloride	5.0	Loss of capacity in plates, greater loss in positive plates
Copper	5.0	Increased self-discharge, lower on-charge voltage
Iron	3.0	Increased self-discharge, lower on-charge voltage
Magnesium	40.0	Reduced life
Nickel	None allowed	Intense lowering of on-charge voltage
Nitrates	10.0	Increased sulfation of negative plate
Nitrites	5.0	Plate corrosion, loss of capacity, reduced life
Platinum	None allowed	Violent self-discharge, lower on-charge voltage
Selenium	2.0	Positive plate shedding
Zinc	Zinc 4.0	

DEIONIZER

Deionizer systems for SPWS configured fleets became standard with Model Year 2014 fleet golf orders.

Regular Maintenance

This system requires regular preventative maintenance on at least a quarterly basis.

• Check all screens and/or filters on water supplies. Clean or replace all filters / line strainers as necessary. Failure to do so can cause a reduction in the water pressure and flow rates needed to operate the system properly. A filter screen can be found on the inlet of all regulators, and a line strainer on all supply hoses. Be sure to replace the deionizer filter cartridge as indicated by the water quality light. The CC P/N 105166801 Deionizer system has a battery-powered, water quality light. Deionizer filters have a limited life cycle and are disposable. Life cycle of the filter will vary based on incoming water quality and water usage. If the deionizer system is equipped with a water quality light, press the button to check. Replace filter immediately if the red light comes ON indicating service is required.

The following replacement filter is available from Club Car Service Parts:

- Use filter P/N 104005901 for Deionizer Systems P/N's 105166801, 104006001, and AM10974.
- Use filter P/N AM10975 for Deionizer System P/N AM10974.

NOTE: The filter P/N AM10975 will be sold to depletion. After this part becomes unavailable, use the filter P/N 104005901 for Deionizer System P/N AM10974.

- Inspect the condition of all tubing, connections, and couplers. Make sure that all parts are in good working condition, secure, leak free, and properly connected. The coupler must have an O-ring and the dust cover properly attached.
- Clean optical indicator of the water quality light. If the optical indicator is dirty, clean it by wiping with a cloth.

Decals

Starting December 2013, new decals were installed on the deionizer wall bracket and the deionizer filter. The blue, deionizer wall bracket decal is a Filter Replacement Record Log. The yellow filter decal is a Fleet Inspection Record

Log. Use these decals to record filter replacement activity and fleet inspection activity. For convenience, both decals have a QR code for ordering replacement filters.

Seasonal Maintenance

Water supplies must be drained and stored in an empty state if they will be exposed to freezing temperatures. Failure to do so can cause permanent damage.

Single point watering systems will require seasonal maintenance if vehicles are taken out of service or put into storage for a period of 6 weeks or longer. To prepare the SPWS, ensure the feed tube and coupler are on top of battery. Then, use the following steps to bring vehicle back into service:

- After the batteries have been fully charged/equalized, connect the system to its water supply for 3 to 5 seconds, then disconnect regardless of whether or not the batteries are completely full.
- Return the vehicle to normal operation.
- 3. Place the vehicle back into its regular watering schedule, waiting at least one week until next watering.

BATTERY CARE – VEHICLES EQUIPPED WITH THE SINGLE-POINT WATERING SYSTEM

To keep batteries in good working condition, follow this maintenance program on a regular basis:

1. Keep the batteries clean and free of corrosion. Wash tops and terminals of batteries with a solution of baking soda and water; use 1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water. Rinse solution off of the batteries. Do not allow this solution to enter the battery. Be sure terminals are tight. Let the terminals dry and then coat with Battery Terminal Protector Spray (CC PN 1014305). See following NOTE.

NOTE: Dispose of waste water properly.

The battery hold-downs should be tight enough so that the batteries do not move while the vehicle is in motion. but not so tight as to crack or buckle the battery case. For 8-volt batteries, tighten hold-down retaining nuts to 106 in lb (12 N·m). The terminal connections should be clean and tight, and any worn insulation or frayed wires should be replaced. Tighten battery terminals to proper torque. See Connecting the Batteries - Electric Vehicles on page 1-5. See following WARNING.

WARNING

- · If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so may cause them to overheat during operation and could result in fire, property damage, or personal injury.
- 3. After use, charge the batteries. The batteries should never be left discharged any longer than absolutely necessary (do not leave discharged overnight).
- 4. Water the batteries monthly or according to the watering interval. See Establishing the Watering Interval for New Vehicles on page 21-9. See Watering Batteries with the SPWS on page 21-11.

CAUTION

- The watering interval must adequately maintain the electrolyte level above the top of the plates. See Figure 21-3.
- Water the batteries only AFTER charging.

NOTE: Bottled distilled water, with the hand pump, CC PN 104006101, is recommended for private consumer SPWS applications.

Establishing the Watering Interval for New Vehicles

If you do not already have a battery watering interval for your vehicles, manually check the battery water level weekly to establish the correct watering interval. Thereafter, water batteries according to the established interval. During periods of heavy use, add additional watering as required.

Single-Point Watering System (SPWS) Maintenance

1. For vehicles newly equipped with the Single-Point Watering System, the initial electrolyte level check on all battery cells verifies that all the valves in the SPWS are functioning correctly. See Periodic Service Schedules on page 10-4. If a valve fails to open, the cell will eventually dry out. The initial one-time inspection of all cells will identify any occurrence of a valve that fails to open. If a valve fails to close, it will become evident due to the cell overflowing during routine watering. Either failure scenario is rare, but should be monitored in the initial inspection and during routine watering sessions. Replace malfunctioning valves to ensure maximum battery life. See following CAUTION.

CAUTION

- · After checking the electrolyte, fully tighten the battery caps to prevent electrolyte leakage.
- 2. After the initial six-week inspection, manually check the electrolyte level at least once per year, particularly after long-term storage or any other period of vehicle inactivity. **See preceding CAUTION.**

BATTERY CARE – VEHICLES WITHOUT THE SINGLE-POINT WATERING SYSTEM

To keep batteries in good working condition, follow this maintenance program on a regular basis:

1. Keep the batteries clean and free of corrosion. Wash tops and terminals of batteries with a solution of baking soda and water; use 1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water. Rinse solution off of the batteries. Do not allow this solution to enter the battery. Be sure terminals are tight. Let the terminals dry and then coat with Battery Terminal Protector Spray (CC PN 1014305). **See following NOTE.**

NOTE: Dispose of waste water properly.

 Check the electrolyte level weekly (Figure 21-3). Add water only after charging unless the electrolyte level is below the top of the plates. In this case, add just enough water to cover the plates, charge, and then check the level again. Never charge batteries if plates are exposed above electrolyte level. For best battery life, add only distilled water. See following CAUTION and NOTE.

▲ CAUTION

· Do not overfill the batteries.

NOTE: A battery watering gun or bottle (CC P/N AM10818) is available from your authorized Club Car dealer.

3. The battery hold-downs should be tight enough so that the batteries do not move while the vehicle is in motion, but not so tight as to crack or buckle the battery case. For 8-volt batteries, tighten hold-down retaining nuts to 106 in·lb (12 N·m). The terminal connections should be clean and tight, and any worn insulation or frayed wires should be replaced. Tighten battery terminals to proper torque. See Connecting the Batteries – Electric Vehicles on page 1-5. See following WARNING.

A WARNING

- If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so may cause them to overheat during operation and could result in fire, property damage, or personal injury.
- 4. After use, charge the batteries. The batteries should never be left discharged any longer than absolutely necessary (do not leave discharged overnight).

SELF-DISCHARGE

Contaminants on dirty batteries can provide a path for a small current draw that can slowly discharge batteries, thus wasting valuable energy. To prevent self-discharge, batteries should always be kept clean. Hot weather also has an effect on a battery's self-discharge rate. The higher the temperature, the quicker a set of batteries will discharge. In hotter climates, batteries should be checked more often. When storing batteries, keep in a cool place. **See Battery Storage on page 21-13.**

ELECTROLYTE LEVEL

A CAUTION

• Do not allow battery acid from battery caps or hydrometer to drip onto the front or rear body of the vehicle. Battery acid will cause permanent damage. Wash immediately.

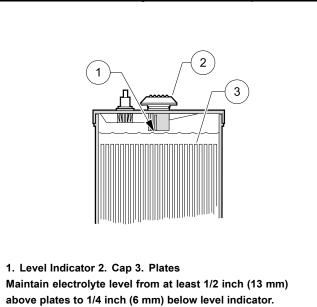


Figure 21-3 Battery Electrolyte Level

Add water only after charging unless the electrolyte is below the level of the plates. If the electrolyte level is below the level of the plates, add just enough water to cover the plates and then charge the batteries. After charging, fill with water to the level indicator. Filling a battery to the level indicator before charging will result in overfilling because the electrolyte level will rise during charging and some of the electrolyte may bubble out of the cap. This reduces the battery's capacity and corrodes the metal parts around it.

The electrolyte level should be checked weekly to be sure electrolyte is at its proper level (Figure 21-3, Page 21-10). Never allow the electrolyte level to fall below the tops of the plates because this will cause the exposed part of the plate

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to become permanently inactive. For best results, use a battery watering gun to add water to batteries. Check the electrolyte level more frequently in hot weather or when batteries are old.

VIBRATION DAMAGE

The battery hold-downs should always be tight enough to keep the battery from bouncing. Battery life may be severely shortened if the battery hold-downs are too loose. **See step 6. of Battery Replacement on page 21-5.** Excessive vibration causes the plates to shed prematurely and shortens the life of the battery. It may also cause acid to leak out of the vent caps and corrosion to build up on surrounding metal parts. The acid which is lost reduces the capacity of the battery and cannot be replaced. Battery hold-downs should NOT be so tight as to crack or buckle the battery case. This may cause leaks which would dry out a cell or cause internal short circuits. **See Battery Replacement on page 21-5.**

SINGLE POINT WATERING SYSTEM (SPWS)

▲ WARNING

 When replacing batteries in the Single Point Watering System, place the battery cap from the new replacement battery onto the used battery being removed from the car. Important safety warnings on the battery cap must remain with the battery after it has been removed from the car

CAUTION

- Water the batteries only AFTER charging.
- Use water that meets the quality standards shown on page 21-6. Maximize battery life by removing ions and heavy metals from water with the use of a single point watering system deionizer. A deionizer for vehicles with SPWS, Club Car Part Number 105166801 is available from Service Parts (DC powered water quality indicator light). Replacement cartridge: 104005901. Bottled distilled water, with hand pump, Club Car Part Number 104006101, is recommended for private consumer applications.

INITIAL MAINTENANCE OF THE SPWS

After six weeks of operation, remove the valves from the batteries and manually check the battery water level to ensure that the SPWS is not leaving any cells dry. This initial electrolyte level check on all the battery cells verifies that all the valves in the SPWS are functioning correctly. If a valve fails to open, the cell will eventually dry out. The initial one-time inspection of all cells will identify any occurrence of a valve that fails to open. If a valve fails to close, it will become evident due to the cell overflowing during routine watering. Either failure scenario is rare, but should be monitored in the initial inspection and during routine watering sessions. Replace malfunctioning valves to ensure maximum battery life. After the initial six-week inspection, manually check the battery water levels at least once per year, particularly after winter storage or any other period of vehicle inactivity. **See following NOTE.**

NOTE: For the longest battery life, be sure the mineral contents of the water meet the minimum requirements as stated in the vehicle's appropriate maintenance and service manual. **See Battery Care on page 21-6.**

WATERING BATTERIES WITH THE SPWS

Checking the Water Flow Rate

 Connect the water hose with the built-in screen filter (2) to the water faucet (1) (Figure 21-4). See following CAUTION.

CAUTION

- Make sure the screen filter is clean.
- Do not use a longer garden hose than provided with the System (20 feet), as a decrease in water pressure could overfill the batteries and damage the refill system.
- 2. Before screwing the hose-end assembly (3) onto the opposite end of the water hose, check the screen filter (4) inside the end of the assembly to make sure it is clean (Figure 21-4).
- 3. Connect the purger (5) to the female coupler (8) on the end of the hose-end assembly (Figure 21-5).

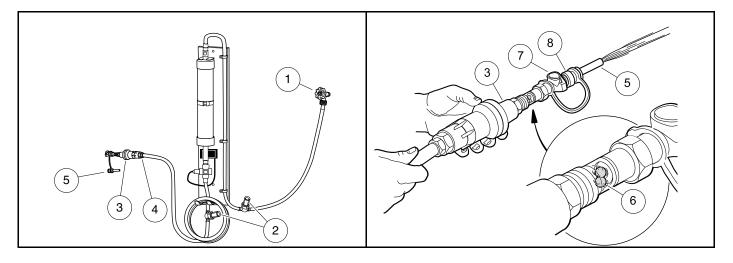


Figure 21-4 Connecting Hose with Filter to Water Source

Figure 21-5 Checking the Water Flow Rate

4. Completely open the water faucet until the water flows out of the hose-end assembly (3), and note the movement of the red flow indicator balls (6). **See following NOTE.**

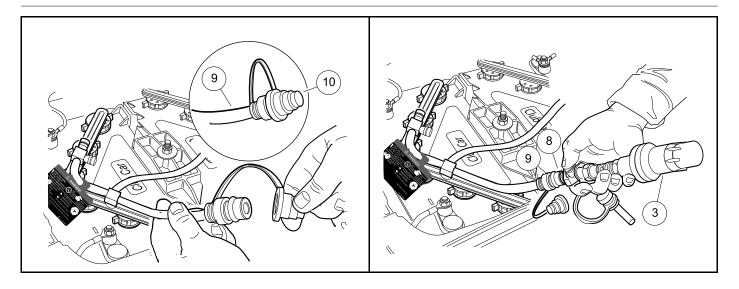
NOTE: This step also eliminates any trapped air from the water hose.

The water flow rate must be at least 2 gallons per minute (7.6 L per minute) and the water pressure must be no more than 100 psig (689.5 kPa) when static (no flow) for the SPWS to function properly.

- 5. Check the water quality light on the deionizer to make sure the light is green in color, indicating acceptable water quality. If the light indicates unacceptable water quality, the cartridge must be replaced.
- 6. After ensuring adequate water flow rate and water quality, press the grey button (7) on the end of the female coupler (8) to disconnect the purger from the pressure regulator.

Refilling the Batteries

1. Locate the battery fill coupling (9) on the driver side of the battery compartment, remove the dust cover (10) from the male connector (Figure 21-6), and connect the hose-end assembly (3) (Figure 21-7). The water flow will begin immediately.



70 Figure 21-6 Dust Cap

Figure 21-7 Connecting Hose-end Assembly to Battery
Fill Connector

2. The red flow indicator balls should swirl, indicating that the batteries are being filled. See following CAUTION.

CAUTION

- If at any time water overflows from the batteries, immediately stop the refill process, disconnect the pressure regulator from the battery fill coupling, and call for service.
- 3. When the red flow indicator balls stop moving, immediately press the grey button to disconnect the hose-end assembly from the battery fill coupling (9), and squeeze the dust cover (10) to lightly secure it to the male connector of the battery fill coupling (Figure 21-6).
- 4. Place the battery fill coupling into the space between the battery bucket and the car body. Leaving the fill coupling on top of the battery bank or tucked between the batteries and the battery bucket can result in coupling damage.
- 5. Turn the water faucet off when finished filling the vehicle(s).

BATTERY STORAGE

FLEET ROTATION

Rotate vehicle usage. It is very hard on batteries if the last vehicles in at night are the first ones out in the morning. Spread the workload evenly, giving all vehicles the same amount of use. This will keep your fleet in balance and will not overwork certain sets of batteries. **See following NOTE.**

NOTE: When vehicles are being rotated, the CDT (Controller Diagnostic Tool) can be a very helpful service tool. Monitoring the value of the Odometer or Amp-Hours with the CDT simplifies vehicle usage scheduling. **See Monitor Menu, Section 18, Page 18-9.**

DEEP-DISCHARGE

Never discharge batteries to the point the vehicle will no longer operate. This will considerably shorten the cycle life of the batteries, and may permanently damage the batteries. It is possible the batteries will not accept a charge if they are completely discharged. The deeper the discharge, the harder it is on the batteries. For this reason, it is recommended that electric vehicle batteries be charged after each use (provided the charge cycle will not be interrupted and the charger will be allowed to shut off automatically). Placing the batteries on charge after each use reduces the depth of discharge and prolongs battery life.

EARLY EXCESSIVE DISCHARGING

When vehicle batteries are new, they do not reach their full capacity until they have been discharged and recharged 50 to 70 times. If they are excessively discharged early in their life, their effective service life will be shortened. It is advisable to limit the use of any vehicle with new batteries for at least the first four weeks and then gradually increase their range.

See General Warnings on page 1-2.

A DANGER

- The charging area must be ventilated. Hydrogen level in the air must never exceed 2%. The total volume of air in the charging area must be changed at least five times per hour. Exhaust fans should be located at the highest point of the roof. Contact a local HVAC engineer.
- Do not charge the vehicle batteries with the vehicle covered or enclosed. Any enclosure or cover should be removed or unzipped and pulled back when batteries are being charged. An accumulation of hydrogen gas could result in an explosion.

▲ WARNING

- Only trained technicians should repair or service the charger. Contact your nearest Club Car distributor/dealer.
- This appliance is not intended for use by persons (including children) with reduced physical, sensory
 or mental capabilities, or lack of experience and knowledge, unless they have been given supervision
 or instruction concerning use of the appliance by a person responsible for their safety. Children
 should be supervised to ensure that they do not play with the appliance.
- Do not operate the charger if it has received a sharp blow, was dropped, or otherwise damaged in any way.
- · Have worn, cut, or damaged power cords or wires replaced immediately.
- Do not connect a stationary charger to the receptacle if the charger cord, plug, or the vehicle receptacle is broken, damaged, or does not make a good electrical connection. Fire or personal injury can result. Have a qualified technician replace the damaged parts.
- Do not use near fuels, grain dust, solvents, thinners, or other flammables. Chargers can ignite flammable materials and vapors.
- Do not expose to rain or any liquid. Keep the charger dry.
- When the charger is on, the charger DC cord may be disconnected from the vehicle receptacle slowly.
 Jerking or pulling the DC cord out quickly could cause arcing and burning that could damage the plug and receptacle and could cause batteries to explode.
- Do not cover the charger cooling fins. Do not allow clothing, blankets, or other material to cover the charger. The fins dissipate heat and protect the charger from overheating.
- Cooling fins will become hot during charging. Do not touch. Use the handle.

CAUTION

- The high-frequency battery charger was specifically designed for use with the high-frequency charging system. Do not use the high-frequency battery charger with other operating systems, and do not use other charger models with high-frequency charging system vehicles.
- The battery charger provided with this vehicle is approved for use only with the battery type
 originally shipped with the vehicle. Using a different battery type (different brand, different capacity,
 etc.) can cause under or overcharging and subsequent battery damage unless the charger is first
 reprogrammed with a new charging algorithm. Club Car only recommends OEM replacement batteries.
 Contact your authorized Club Car dealer/distributor with any questions about battery and charger
 compatibility or algorithm updates.

GENERAL INFORMATION

NOTE: This charger has no internals to service or repair. It only has a few external repairs that can be performed. If an internal component needs repair, the charger must be replaced.

Because the charger has a storage charge feature that automatically checks and recharges the batteries as necessary, the charger can remain plugged to the vehicle throughout the storage period.

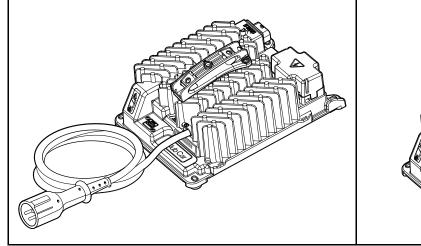
Key Differences between ERIC Chargers and PowerDrive Chargers

- Programmable in the field instead of changing onboard computer (OBC).
- Ability to fully update software via USB flash drive or laptop computer instead of changing OBC.
- DV/DT charge termination instead of Amp-Hour Returned charge termination.
- Communication Display Module (CDM) is not used. Only an CDT is needed for data.
- The CDT will remain ON when the charger is connected.
- Only PD+ 8-volt batteries are approved for use with this high-frequency charging system at this time. Other
 batteries have not been approved. When other batteries are approved, the charger can be updated with the
 appropriate algorithm using the USB port.

This section includes information, troubleshooting and service procedures pertaining to the external high-frequency battery charger (model number IC0650-048-CC) and onboard high-frequency battery charger (model number IC0650-048-COMM). Do not attempt to service a battery charger that has not been properly identified. If a charger cannot be properly identified, contact your local Club Car dealer or distributor.

How To Identify A Vehicle That Uses This High-Frequency Charger

- Vehicles that use the external (shelf), high-frequency battery charger can be easily identified by the combination of the serial number starting with JE, JF, JH, JJ, JN, JW, or JX and a charger DC cord receptacle in the kick plate.
- Vehicles that use the onboard, high-frequency battery charger can be easily identified by the battery charger and cord reel located on the underside of the rear-facing seat bottom and no charger DC cord receptacle in the kick plate.



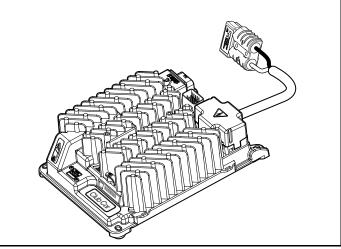


Figure 22-1 High-Frequency Battery Charger – External

COV-1482 Figure 22-2 High-Frequency Battery Charger – Onboard

The high-frequency battery charger is automatic and has no external controls. It functions as an integral part of the vehicles' electrical system and will not work with other electric vehicles. The charger is programmed with a specific charge algorithm that is appropriate to the specific battery type used in the vehicle. When the charger is connected,

there is a 2 to 5 second delay before charging begins. When the AC cord is connected, the charger performs a start-up self-test (all three charger status indicators on the front of the charger flash ON at the same time).

The charger supplied with the electric vehicle resolves the most common problems associated with battery charging. The charger utilizes sophisticated charge termination criterion to shut off automatically, preventing the possibility of either undercharging or overcharging. The charger accomplishes this by monitoring battery voltage, charge current, charge time and using strict dV/dt termination criterion.

Batteries should never be left in a discharged state, as this too affects the internal components and can reduce the capacity of the battery. The batteries should be charged every day they are used. However, the batteries should not be charged if they have not been used.

USB SERVICE PORT

The ERIC charger has a USB port for use by Club Car authorized technicians for data transfer, reconfiguration, and updates. Keep the USB port cover in place when the port is not in use. **See USB Service Port Cleaning and Care on page 22-12.**

UL AND CSA LISTING

High-frequency charging system battery chargers have been listed by UL and by the Canadian Underwriters and meet the criteria of the Canadian Standards Association.

CE COMPLIANCE

This battery charger is compliant with the EU EMC Directive 2004/108/EC.

PLUG AND RECEPTACLE

The charger cord, plug, and receptacle are wear items and should be inspected daily. Visually inspect for cracks, loose connections, frayed wiring or bent pins; they must be immediately replaced when worn or damaged. Do not attempt to straighten a bent pin. If charger plug or receptacle show signs of corrosion or the plug is difficult to insert or remove, check for bent pins, then clean the receptacle contacts and plug terminals with a good electrical contact cleaner or light coating of WD-40® brand spray lubricant. The plug should then be inserted and removed several times to ensure ease of insertion, ease of removal, and good electrical contact.

▲ DANGER

- To prevent fire, immediately replace battery charger DC cord plug and receptacle if the following conditions exist:
 - Plug pins have worn nickel plating and copper is exposed.
 - Plug requires an inordinate amount of force to insert into receptacle, especially if accompanied by a "grinding" feel.

A WARNING

- If pins are bent, the plug must be replaced immediately. The plug is not serviceable. Do not attempt to repair the plug or straighten bent pins.
- Disconnect the AC cord prior to lubricating the plug and receptacle.

NOTE: If the warning tag has been damaged or removed from the DC cord, have it replaced immediately.

CHARGER POWER CONNECTION FUSE

The charger receptacle harness has an in-line, 30-amp fuse located near the solenoid.

CHARGER INTERLOCK

External Charger: While the charger DC cord is plugged into the vehicle, the vehicle control circuit is locked out, preventing operation of the vehicle, as well as the possibility of consequent damage to the charger and the vehicle. **Onboard Charger:** While the charger AC cord is plugged into an electrical outlet, the vehicle control circuit is locked out, preventing operation of the vehicle, as well as the possibility of consequent damage to the charger and the vehicle.

AC INPUT VOLTAGE DETECTION

The high-frequency charger automatically detects the AC input voltage and will operate at full power if the voltage is within the 100 to 240 VAC range. The charger also will function outside of that range down to 85 VAC and up to 270 VAC although charging times will be longer. Outside of the 85 to 270 VAC range, the charger will not operate.

THERMAL CUTBACK

The charger operates at full power in ambient temperatures between -40 °F (-40 °C) and 104 °F (40 °C). The charger also will function outside of that range although charging times will be longer.

CHARGE INDICATOR LIGHT

Excel System vehicles with ERIC Charging system feature a dash mounted charge indicator light (below the steering column) that serves two functions: 1) Battery low state of charge warning, and 2) Charging confirmation. The charge indicator light is controlled by pin 11 of the controller.

Battery Low State of Charge Warning

- The light comes on and remains solid when the battery state of charge falls below 20%.
- The light begins flashing when the battery state of charge falls below 10%.

Charging Confirmation

• The light will flash three times and the reverse buzzer simultaneously will sound three times to indicate a battery charging session has begun. **See following NOTE.**

NOTE: The number of flashes and beeps can vary depending on the Beep Option setting. **See Beep Option**, **Section 18, Page 18-8**.

CHARGER STATUS INDICATORS

The indicator lights on the charger provides information concerning charger status.

LIGHT	STATUS		STATUS EXPLANATION
	Solid red		Charger error. Reset charger power. See Resetting Power – External Charger on page 22-14.
<u> </u>	Flashing orange		Charger unable to complete charge.
		Solid green	Charging is complete. Bettery peak is fully charged
		Solid green	Charging is complete. Battery pack is fully charged.
		Flashing green	Charging is in progress. Battery pack has reached a high state of charge.
		Solid green	onarging to in progress. Battery pask has reastined a high state of onarge.
		Off	Observing in in suppose Pattern and the NOT weaked a bight state of
		Flashing green	Charging is in progress. Battery pack has NOT reached a high state of charge.
	Solid blue		AC power to charger is present.

LONG-TERM STORAGE

High-frequency chargers are designed to be left connected with AC power to the charger during off-season or long-term storage.

EXTERNAL CHARGER MOUNTING

WARNING

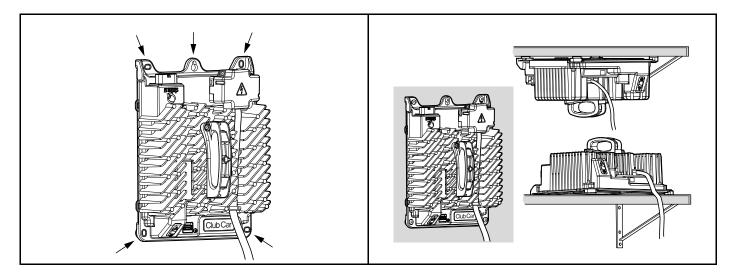
- Make sure the charger is securely mounted. Do not hang the charger by its handle.
- Place all cords so they will not be stepped on, tripped over, or otherwise subjected to damage or stress.

CAUTION

- Do not mount the charger in exceptionally hot locations, such as on a tin exterior wall with southern or western exposure, with chargers stacked together and especially with heatsinks next to each other, etc.
- · Charger must not be subjected to water spray.

Use the mounting holes to secure the charger (**Figure 22-3**). Position the charger so that is has adequate ventilation and the charger status indicator panel is visible. The charger can be mounted in any orientation (right-side up, upside down, etc.) provided the cooling fins are unobstructed it has adequate ventilation (**Figure 22-4**).

To help ensure optimal charge times, mount the charger in an area where ambient temperatures during charging remain below 104 °F (40 °C). **See Thermal Cutback on page 22-4.**

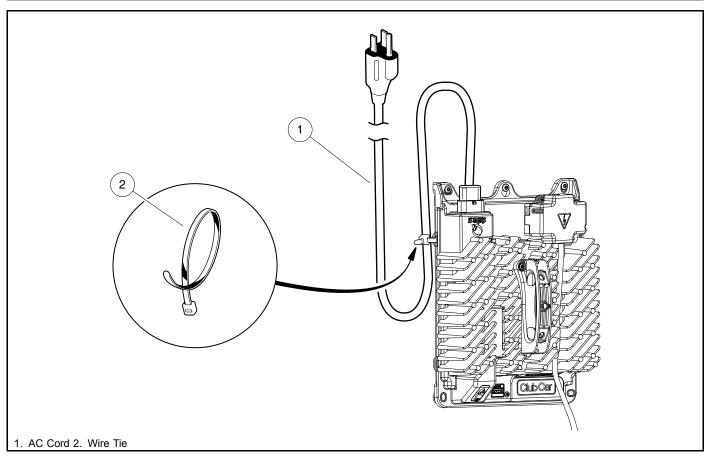


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Figure 22-3 Charger Mounting Holes

Figure 22-4 Examples of Charger Mounting Orientation

When installing charger, incorporate a "drip loop" in the AC cord to prevent water from running down the cord and into the AC cord receptacle on the charger (Figure 22-5, Page 22-7).



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Figure 22-5 AC Cord Drip-Loop Example

AC POWER CONNECTION

▲ WARNING

- Install surge arrestors on incoming AC power lines. Surge arrestors will help protect electrical components in the charger and on the vehicle from all but direct or close lightning strikes.
- Two high-frequency chargers can share a circuit, which should be a dedicated 15 or 20 ampere separately protected (circuit breaker or fuse) single-phase branch circuit that complies with all applicable electrical codes for the location.
- Connect the charger AC supply cord to a properly grounded, three-wire outlet within the voltage and frequency range shown on the charger.
- Do not use an adapter to plug the charger with a three-prong plug into a two-prong outlet. Improper connection of the equipment-grounding conductor can result in a fire or an electrical shock.
- Place all cords so they will not be stepped on, tripped over, or otherwise subjected to damage or stress.

NOTE: Make sure that the AC cord provided with your charger has the proper AC plug for your location. If it does not, contact your Club Car representative to obtain the proper cord or plug.

Two of these high-frequency chargers can be used on a dedicated 15 or 20 ampere, single-phase branch circuit. This high-frequency charger caps current draw at 6 amps and will operate at full power if the voltage is within the 100 to

240 VAC and 50 to 60 Hz ranges. The charger also will function outside of those ranges (down to 85 VAC and 40 Hz, up to 270 VAC and 70 Hz) although charging times will be longer. Outside of the 85 to 270 VAC and 40 to 70 Hz ranges, the charger will not operate.

To reduce the risk of electric shock, the battery charger must be grounded. The charger is equipped with an AC electric cord having an equipment-grounding conductor and a grounding type plug. The AC plug must be connected to an appropriate receptacle that is properly installed and grounded in accordance with the National Electrical Code and all local codes and ordinances.

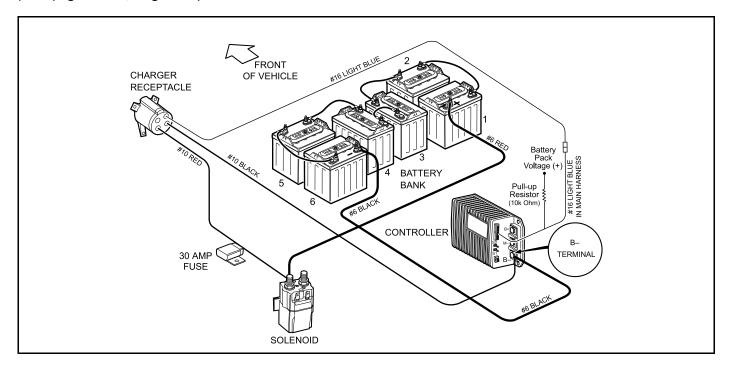
The use of an extension cord with the charger should be avoided. If one must be used, heed the following WARNING.

WARNING

 An extension cord or electrical outlet must accept a three-prong plug. The extension cord should be a three-wire No. 12 AWG (American Wire Gauge) or no. 14 (British Standard Wire Gauge), and be as short as possible (no more than 12 feet (3.7 m). The use of an improper extension cord could result in fire or an electrical shock.

THE CHARGE CIRCUIT

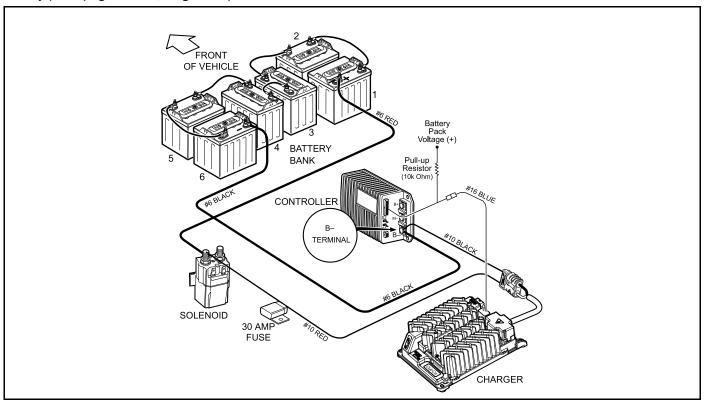
External Charger: The charge circuit consists of the charger receptacle, interlock wire, controller, solenoid and battery pack (Figure 22-6, Page 22-8).



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Figure 22-6 Charge Circuit – External High-Frequency Charger

Onboard Charger: The charge circuit consists of the charger receptacle, interlock wire, controller, solenoid and battery pack (Figure 22-7, Page 22-9).



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Figure 22-7 Charge Circuit - Onboard High-Frequency Charger

CHARGER OPERATION

CHARGING BATTERIES

See Dangers and Warnings beginning on page 22-1.

WARNING

- Be sure all wire connections at the receptacle are clean and tight.
- Do not rock or bend the plug. To connect the charger plug to the vehicle receptacle, grasp the plug handle and push the plug straight into the receptacle (Figure 22-8, Page 22-11).
- Do not pull on the DC cord (Figure 22-9, Page 22-11). Do not twist, rock or bend the plug. To disconnect the charger plug from the vehicle receptacle, grasp the plug by the handle and pull the plug straight out of the receptacle.
- Do not connect a charger to the receptacle if the charger cord, plug, or the vehicle receptacle is broken, damaged in any manner, or does not make a good electrical connection. Fire or personal injury can result. Have it replaced by a qualified service person immediately. Failure to follow these instructions could result in damage to the charger cord, the plug, and (or) the vehicle receptacle.

WARNING CONTINUED ON NEXT PAGE

A WARNING

- Do not attempt to charge frozen batteries or batteries with bulged cases. Discard the battery in accordance with all environmental laws or return to an authorized Club Car dealer. Frozen batteries can explode.
- Do not use a charger if any of the following conditions exist:
 - The plug is too loose or does not make a good connection.
 - The plug and receptacle feel hotter than normal during charge.
 - The plug pins or receptacle contacts are bent or corroded.
 - The plug, receptacle, or cords are cut, worn, have any exposed wires or are damaged in any way.
- Using the charger with any of the above symptoms could result in a fire, property damage, personal injury, or death.

CAUTION

- · On all vehicles, turn off all accessories before charging batteries.
- The battery charger provided with this vehicle is approved for use only with the battery type
 originally shipped with the vehicle. Using a different battery type (different brand, different capacity,
 etc.) can cause under or overcharging and subsequent battery damage unless the charger is first
 reprogrammed with a new charging algorithm. Club Car only recommends OEM replacement batteries.
 Contact your authorized Club Car dealer/distributor with any questions about battery and charger
 compatibility or algorithm updates.

NOTE: Unlike the PowerDrive family of chargers, battery pack voltage does not have to be above 32 volts for charging to begin.

When temperatures fall below 65 °F (18.3 °C), batteries charged in unheated areas should be placed on charge as soon as possible after use. Batteries are warmest immediately after use, and cold batteries require more time to fully charge.

Batteries should be put on charge even if they have been used for only a short period (9 holes of golf or 10 minutes).

Because the charger has a storage charge feature that automatically checks and recharges the batteries as necessary, the charger can remain plugged to the vehicle throughout the storage period.

Vehicles should be restricted to 40 to 50 amp hours of discharge (or 36 holes of golf) between charges until the batteries have been properly seasoned (50 to 70 charge cycles). For maximum battery life, Club Car recommends that electric vehicles always be recharged after 40 to 50 amp hours of discharge or each night in order to avoid deeply discharging the batteries. To detect amp-hour discharge, use the CDT diagnostic tool (CC P/N 102248803).

Battery Charging Procedure

 External Chargers: With the charger DC cord disconnected from the vehicle charger receptacle, insert the charger AC plug into a dedicated and properly wired AC outlet. Connect a maximum of two chargers per dedicated circuit.

Onboard Chargers: Insert the onboard charger AC plug into a dedicated and properly wired AC outlet to begin a charge cycle. Connect a maximum of two chargers per dedicated circuit.

- 2. **External Chargers:** Insert the charger DC cord plug into the vehicle receptacle to begin a charge cycle. When inserting the plug, align the raised guide on the plug with the guide slot in the receptacle and push straight in slowly **(Figure 22-8, Page 22-11)**.
- 3. **External Chargers:** The charger will turn on two to five seconds later, after the charger interlock function activates. The charger interlock remains activated and prevents operation of the vehicle until the DC cord is disconnected from the vehicle. **See following NOTE.**

Onboard Chargers: The charger will turn on two to five seconds later, after the charger interlock function activates. The charger interlock remains activated and prevents operation of the vehicle until the AC cord is disconnected from the AC outlet. **See following NOTE**.

NOTE: The dash-mounted charge indicator light will flash three times and the reverse buzzer simultaneously will sound three times to indicate charging has begun. The number of flashes and beeps can vary depending on the Beep Option setting. **See Beep Option, Section 18, Page 18-8.**

- 4. The charger monitors battery voltage, charge current and charge time to determine when the batteries are properly charged. The charger will shut off by itself and the entire battery-shaped green light will stop flashing and remain on. As long as the charger is allowed to shut off by itself, the batteries will be fully charged. Overcharging and undercharging will normally be prevented.
- 5. If the charger does not seem to be operating properly, or if the batteries seem weak, see Charger Troubleshooting on page 22-13. If troubleshooting does not solve the issue, contact your local Club Car distributor/dealer.

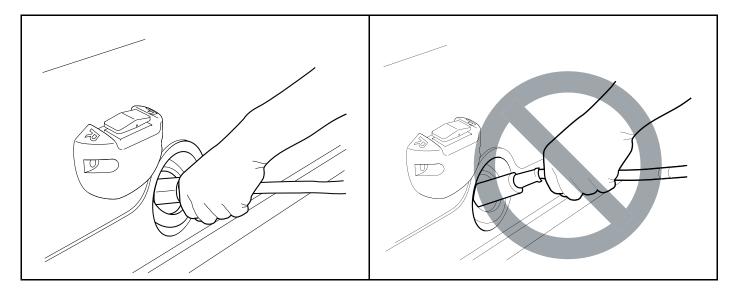


Figure 22-8 Correct Insertion of External Charger DC Plug Figure

Figure 22-9 Incorrect Removal of External Charger DC Plug

CHARGER MAINTENANCE

See General Warnings on page 1-2.

To ensure trouble-free performance, it is very important to follow an established preventive maintenance program. Regular and consistent maintenance can prevent vehicle downtime and expensive repairs that can result from neglect.

Any charger not functioning correctly should be removed from use until it is properly repaired. This will prevent further damage to the vehicle and avoid the possibility of injury due to unsafe conditions.

To perform all periodic service, see Periodic Maintenance on page 10-1.

To perform all troubleshooting, see Charger Troubleshooting on page 22-13.

To perform all repairs, see External Charger Repairs on page 22-19 or Onboard Charger Repairs on page 22-22.

A WARNING

- If any problems are found during scheduled inspection or service, do not operate the vehicle until repairs are made. Failure to make necessary repairs could result in fire, property damage, severe personal injury, or death.
- Do not wear loose clothing or jewelry, such as rings, watches, chains, etc., when servicing the charger.
- Do not expose charger to oil, dirt, mud or direct heavy water spray when cleaning vehicle.
- · Keep all AC connections and the USB port clean and dry.
- Keep all cooling fins clean.
- If the detachable input power supply cord set is damaged, replace with a cord that meets the following criteria:

For North America:	UL or CSA listed/approved detachable cord, 3 conductor, 16AWG minimum, and rated SJT; terminating in a grounding type IEC 60320 C14 plug rated 250V, 13A minimum.
For all other countries:	Safety approved detachable cord, 3 conductor, 1.5mm²; minimum, rated appropriately for industrial use. The cord set must be terminated on one end with a grounding type input connector appropriate for use in the country of destination and, on the other end, an output grounding type IEC 60320 C14 plug.

USB SERVICE PORT CLEANING AND CARE

Depending on environmental conditions, such as coastal locations, open-air storage facilities, possible contamination in the USB port could result, preventing connectivity. If a poor connection is experienced, cleaning the USB port located in the front of the charger with an approved electrical contact cleaner will restore the connection. Always reinstall the USB port dust cover after cleaning and use.

After cleaning, preventative maintenance of the USB port should include applying dielectric grease into the port cavity or applying Corrosion Block ® Corrosion Preventative to help prevent any reoccurance of contamination.

CHARGER TROUBLESHOOTING

See General Warnings on page 1-2.

A DANGER

• Do not touch any wire or component in the battery charger while AC power is present. Failure to heed this warning will result in an electric shock.

A WARNING

- Knowledge of battery charger wiring and component terminology is required before attempting any repair. See The Charge Circuit on page 22-8.
- Prior to servicing the external charger, disconnect the DC plug from the vehicle charger receptacle and the AC power supply cord from the wall outlet.
- Prior to servicing the onboard charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle. See Onboard Charger Repairs on page 22-22.

NUMBERING VEHICLES AND CHARGERS

Return the vehicles to the same charger each night if possible. If the vehicles are put in a storage facility at random and a vehicle dies while in use and testing shows the batteries are sound, then the problem is most likely with the charger. However, finding the problem charger may prove to be quite time consuming. Numbering the vehicles and the chargers and returning each vehicle to its designated charger each night can significantly reduce the amount of time spent troubleshooting a problem.

USB SERVICE PORT

NOTE: The triangular charge status light doubles as the USB light. Flashing green means data transfer from the USB is occurring. Solid green means data transfer is complete.

Use the USB service port for charging algorithm updates, software updates and troubleshooting.

To use the port, pull the cover from the port and insert a USB flash drive.

To update charger: With update file already on flash drive, insert drive into charger and let charger find file and update itself.

To download from charger: Insert an empty flash drive into charger and let charger write charge history file to it. When finished, reinstall the cover.

INCOMING AC SERVICE

Make sure the incoming AC line service is sufficient. If circuit breakers are tripping, fuses blow during the night or the charger does not give the required starting rate when sound batteries are put on charge, an AC line problem exists. The electrical service to the vehicle storage facility should be sufficient to deliver adequate voltage and current to each charger with all the chargers turned on. If not, consult your local power company or electrical contractor.

TERMINAL BLOCK COVER

The terminal block cover prevents water exposure and prevents a short across the terminals, which will blow the 30-amp fuse in the charger receptacle wire harness.

RESETTING POWER - EXTERNAL CHARGER

The triangular status indicator light on the charger comes on in a solid red state to communicate a significant charger hardware or software failure. **See Charger Status Indicators on page 22-5.** Before replacing the charger, however, reset the charger in case the failure was caused by a temporary situation. To reset charger power, take the following steps:

- 1. Unplug the DC cord from the vehicle.
- 2. Unplug the AC cord from the AC power source.
- 3. Wait for the red light to go off, wait 30 seconds, then plug the AC cord into the AC power source.
- 4. When the blue AC status indicator light comes on, connect the DC cord to the vehicle.
- If the triangular status indicator light comes on, contact your Club Car dealer. If the light does not come back on, attempt to charge the car as usual.

RESETTING POWER - ONBOARD CHARGER

The triangular status indicator light on the charger comes on in a solid red state to communicate a significant charger hardware or software failure. **See Charger Status Indicators on page 22-5.** Before replacing the charger, however, reset the charger in case the failure was caused by a temporary situation. To reset charger power, take the following steps:

- 1. Unplug the AC cord from the AC power source.
- 2. Disconnect the DC cord under the rear-facing seat.
- 3. Wait for the red light to go off, wait 30 seconds, then plug the AC cord into the AC power source.
- 4. When the blue AC status indicator light comes on, reconnect the DC cord under the rear-facing seat.
- 5. If the triangular status indicator light comes on, contact your Club Car dealer. If the light does not come back on, attempt to charge the vehicle as usual.

CHARGER TROUBLESHOOTING INDICATORS

If a fault occurs, count the number of red flashes (on the charger or dash) between pauses and refer to the table below:

HIGH-FREQUENCY BATTERY CHARGER TROUBLESHOOTING GUIDE				
CHECK STATUS INDICATOR LIGHT	STATUS	STATUS EXPLANATION	POSSIBLE CAUSES (check in order shown)	SOLUTIONS
		AC power to charger is NOT present.	1. AC cord connection	Unplug and inspect AC cord. Reconnect and attempt to charge again.
			AC power supply was shut off	Verify AC power is present and charge again. See AC Power and Continuity Test of AC Circuit on page 22-17.
	OFF		AC circuit breaker is tripped	Reset AC circuit breaker and charge again.
			Improper AC outlet voltage	Test AC outlet voltage and correct if necessary. See AC Power and Continuity Test of AC Circuit on page 22-17.
			5. Failed AC plug or cord	Replace cord. See AC Power and Continuity Test of AC Circuit on page 22-17.
		Charger unable to complete charge. (Usually not related to charger itself. Something occurred to prevent the charger from completing the charge. Check external factors first.)	Erroneous event (an unknown variable; something occurred to the charger or vehicle that was not the fault of either)	Reset charger power. See Resetting Power – External Charger on page 22-14. Reconnect DC cord to vehicle. If status goes away, continue using charger.
	Flashing orange		Battery high voltage	Ensure battery set is rated 48 volts and composed of 24 cells. See Battery Voltage Using Multimeter on page 22-16. If not, replace with correct battery set. Reset charger power. See Resetting Power – External Charger on page 22-14.
			3. Battery low voltage	Ensure battery set is rated 48 volts and composed of 24 cells. Also, check the voltage of each individual battery. See Battery Voltage Using Multimeter on page 22-16. If not, replace with correct battery set. Reset charger power. See Resetting Power – External Charger on page 22-14.
			Charge timeout caused by battery pack not reaching required	Check for loose or corroded connections. Check for old or defective batteries. See Test Procedures on page 22-16.
			voltage.	
			5. Bad battery pack	Test battery pack health. Look for shorted or damaged cells. See Battery Condition Using Charger on page 22-17. See also Batteries: Electric Vehicle with ERIC Charging on page 21-1.
			6. AC voltage out-of-range	Test and inspect incoming AC power. See AC Power and Continuity Test of AC Circuit on page 22-17.
			7. Ambient temperature too hot (above 104 °F (40 °C))	Check for dirty, obstructed, or damaged cooling fins. Clean if necessary and ensure sufficient cooling air flow. Chargers stacked on top of or located too close to each other. Move chargers farther apart. If issue continues, wait for ambient temperature to cool or relocate charger to a cooler environment.
			8. Ambient temperature too cold (below -40 °F (-40 °C))	Wait for ambient temperature to warm or relocate charger to a warmer environment.

TABLE CONTINUED ON NEXT PAGE

HIGH-FREQUENCY BATTERY CHARGER TROUBLESHOOTING GUIDE				
			9. Bad DC connection	Inspect charger receptacle, receptacle harness connections and DC cord connection to charger. See DC Plug and Receptacle on page 22-16. See Charger DC Circuit Continuity Test on page 22-18.
			10. Corroded or loose connections	Clean or tighten connections.
	Solid red	Charger error	Charger abnormality	Reset charger power. See Resetting Power – External Charger on page 22-14. Reconnect DC cord to vehicle. If status goes away, proceed to charge again. See Charger Output Test on page 22-18. If status occurs again during the next charge cycle, attempt to charge with another identical charger. If charge is successful, proceed to step 2. If status occurs again, troubleshoot the AC power supply, vehicle and battery pack.
			2. Charger internal fault	Replace charger.

TEST PROCEDURES

See General Warnings on page 1-2.

When the upper green light is flashing, indicating the charger is in finish charge, it is okay to begin a battery discharge test if so desired.

Index of Test Procedures

- 1 Battery Voltage Using Multimeter
- 2 DC Plug and Receptacle
- 3 Battery Condition Using Charger
- 4 On-Charge Battery Voltage Using Charger And Multimeter
- 5 AC Power and Continuity Test of AC Circuit
- 6 Charger DC Circuit Continuity Test
- 7 Charger Output Test

TEST PROCEDURE 1 – Battery Voltage Using Multimeter

- Check battery pack voltage. See Measuring Voltage of Battery Set, Section 21, Page 21-2.
- 2. Normal no-load voltage should be between 50 and 52 volts for a fully charged battery set. Normal no-load voltage of an individual battery should not be less than 0.7 volts of the other 5 batteries (for 6 x 8-volt battery set).

TEST PROCEDURE 2 – DC Plug and Receptacle

- 1. Check the DC plug and the vehicle charger receptacle for damage, dirt, corrosion, bent pins or any condition that might prevent a sound electrical connection. See Plug and Receptacle on page 22-3.
- Inspect the receptacle contacts to ensure that they are not damaged and they are firmly seated within the receptacle. See Plug and Receptacle on page 22-3.
- 3. Check the wire connections from the charger receptacle.
 - 3.1. Verify that the 10-gauge red wire from the charger receptacle is connected to the large post of solenoid with 6-gauge red wire (Figure 22-6, Page 22-8).
 - 3.2. Verify that the 10-gauge black wire from the charger receptacle is connected to the B- terminal of controller.

- 3.3. Verify that the 16-gauge light blue wire from the charger receptacle is connected to the light blue wire bullet connector from the main wire harness.
- 4. With batteries connected, DC cord disconnected, and using a multimeter set to 200 volts DC, place the black (–) probe in the charger receptacle socket connected to the black 10-gauge wire and place the red (+) probe in the charger receptacle socket connected to the red 10-gauge wire. The reading should be 48 to 50 volts (full battery voltage).
- 5. If the reading is not 48 to 50 volts, check the following items:
 - The 30-amp fuse (located near solenoid) in the 10-gauge red wire of the charger receptacle harness.
 - Continuity of the 10-gauge red wire from the solenoid to the receptacle socket.
 - Continuity of the 6-gauge red wire from the positive post of battery no. 1 to the solenoid.

TEST PROCEDURE 3 – Battery Condition Using Charger

The easiest way to monitor the condition of a vehicle's batteries is simply to observe the Charger Status Indicators on the charger at the end of the charge cycle. After a full charge, disconnect the charger DC plug, wait 30 seconds and reconnect the charger DC plug. The battery-shaped status indicator will be green with the upper half flashing at first and then stay on continuously within 10 to 20 minutes, indicating sound, fully charged batteries. **See Charger Status Indicators on page 22-5.**

NOTE: Batteries near the end of their useful lives may not allow the battery charge current to taper and the upper half of the battery-shaped status indicator will continue to flash. See Section 21 – Batteries: Electric Vehicle with ERIC Charging.

Continued poor performance may indicate a problem in the vehicle electrical system, brakes or battery charger. If the problem is not found in the vehicle or charging system, proceed to the on-charge voltage test. If the upper half of the battery-shaped status indicator does not stop flashing, the batteries should be tested further using the on-charge voltage test.

TEST PROCEDURE 4 – On-Charge Battery Voltage Using Charger And Multimeter

When the batteries are fully charged, disconnect the charger DC plug. Wait 20 to 30 seconds and reconnect the DC plug to restart the charger. After 5 minutes, use a multimeter to check and record the voltage of the battery set as well as the individual batteries. Set the multimeter to 200 volts DC. Place the red (+) probe on the positive (+) post of battery no. 1 and the black (–) probe on the negative (–) post of battery no. 6 (for 6 x 8-volt battery set). Record reading. Then set multimeter to 20 volts DC and place the red (+) probe on the positive (+) post and the black (–) probe at the negative (–) post of each battery. Record the readings.

The on-charge voltage for the set should be between 56.0 volts and 63.0 volts depending on the age and state of charge of the batteries being tested.

Old batteries may have enough capacity left to last several more months.

TEST PROCEDURE 5 – AC Power and Continuity Test of AC Circuit

- 1. Disconnect AC cord from the wall outlet and DC plug from the vehicle receptacle.
- 2. Check the AC line fuse or circuit breaker in the storage facility.
- 3. With a multimeter set to 500 volts AC, check incoming AC voltage. Insert multimeter test probes into AC wall outlet; voltage should be between 85 and 270 volts. See AC Input Voltage Detection on page 22-4. If proper voltage is not present, have building wiring checked by a licensed electrical contractor.

- 4. If the charger will not power ON, check AC cord connections.
- 5. If the charger is connected correctly, check continuity of the AC cord wires.

TEST PROCEDURE 6 – Charger DC Circuit Continuity Test

- 1. Disconnect the AC cord from the wall outlet and the DC cord from the vehicle charger receptacle.
- 2. Remove DC terminal block cover. See Terminal Block Cover Removal on page 22-23.
- 3. Note polarity and loosen screws securing DC cord wires. Pull wires from DC terminals on charger.
- 4. Check continuity of the DC cord wires from plug pin to fork terminal.
- 5. When finished, attach DC cord white wire to positive terminal (+) and black wire to negative terminal (–) with torx screws. **See following NOTE.** Tighten torx screws to 39.8 in·lb (4.5 N·m).

NOTE: The positive symbol (+) and negative symbol (–) are molded into the terminal block for easy identification.

6. Install terminal block cover. See Terminal Block Cover Installation on page 22-20.

TEST PROCEDURE 7 – Charger Output Test

Without a Meter: Connect DC cord and start a charge cycle. If buzzer sounds three times, then charger is functioning. Both a confirmed connection with the charger and a rise in battery pack voltage are required for buzzer to sound three times. **See following NOTE.**

NOTE: The number of flashes and beeps can vary depending on the Beep Option setting. **See Beep Option**, **Section 18, Page 18-8.**

With a Meter: A clamp meter can be used to measure current in the red battery cable (connected to the positive (+) post of battery no. 1) while charging. Current can reach just over 13-amps at the beginning of a charge session and taper down to approximately 5-amps near the end.

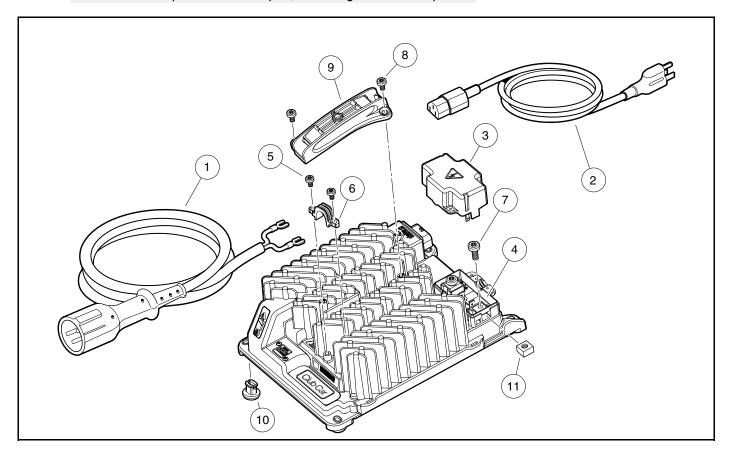
EXTERNAL CHARGER REPAIRS

See General Warnings on page 1-2.

▲ WARNING

- Knowledge of battery charger wiring and component terminology is required before attempting any repair (Figure 22-6, Page 22-8).
- Prior to servicing the charger, disconnect the DC plug from the vehicle charger receptacle and the AC cord from the AC outlet.

NOTE: This charger has no internals to service or repair. It only has a few external repairs that can be performed. If an internal component needs repair, the charger must be replaced.

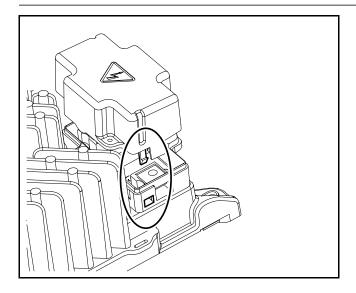


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Figure 22-10 External High-Frequency Charger Components

TERMINAL BLOCK COVER REMOVAL

- 1. Disconnect DC cord (1) from vehicle.
- 2. Disconnect AC cord (2) from AC outlet.
- 3. Push in mounting tabs (Figure 22-11, Page 22-20) to release cover (3) from terminal block (4).



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Figure 22-11 Terminal Block Cover Mounting Tabs

TERMINAL BLOCK COVER INSTALLATION

▲ WARNING

- The terminal block cover (3) on the DC terminal block (4) must be installed properly to comply with UL code. This cover prevents water exposure and prevents a short across the DC terminals.
- 1. Align cover (3) with terminal block (4) and push onto block until tabs lock into place.

DC CORD AND STRAIN RELIEF REMOVAL

- 1. Disconnect DC cord (1) from vehicle.
- 2. Disconnect AC cord (2) from AC outlet.
- 3. Remove two torx screws (5) securing strain relief (6) to charger.
- 4. Remove terminal block cover (3). See Terminal Block Cover Removal on page 22-19.
- 5. Remove torx screw (7) securing each DC cord wire to terminal block (4).

DC CORD AND STRAIN RELIEF INSTALLATION

 Attach DC cord white wire to positive terminal (+) and black wire to negative terminal (-) with torx screws (7). See following NOTE. Tighten screws (7) to 39.8 in lb (4.5 N·m).

NOTE: The positive symbol (+) and negative symbol (–) are molded into the terminal block for easy identification.

- 2. Install terminal block cover (3). See Terminal Block Cover Installation on page 22-20.
- 3. Secure strain relief (6) to charger with torx screws (5). Tighten screws (5) to 27 in·lb (3.1 N·m).

HANDLE REMOVAL

Remove torx screws (8) securing handle (9) to charger.

HANDLE INSTALLATION

Place handle (9) onto charger and seat it onto mounting bosses of charger. See following NOTE.

NOTE: The handle (9) features locating tabs to aid installation.

Secure handle (9) to charger with two torx screws (8). Tighten screws (8) to 39.8 in lb (4.5 N·m).

FOOT REMOVAL

- 1. Disconnect DC cord (1) from vehicle.
- 2. Disconnect AC cord (2) from AC outlet.
- 3. If mounted, detach charger from shelf or wall.
- 4. Squeeze barbs on back side of foot (10) and push foot out of charger mounting tab. Repeat for other feet if necessary.

FOOT INSTALLATION

- 1. Push foot (10) into hole in charger mounting tab until the barbs come through and secure foot in place.
- 2. If required, mount charger to shelf or wall. See External Charger Mounting on page 22-6.

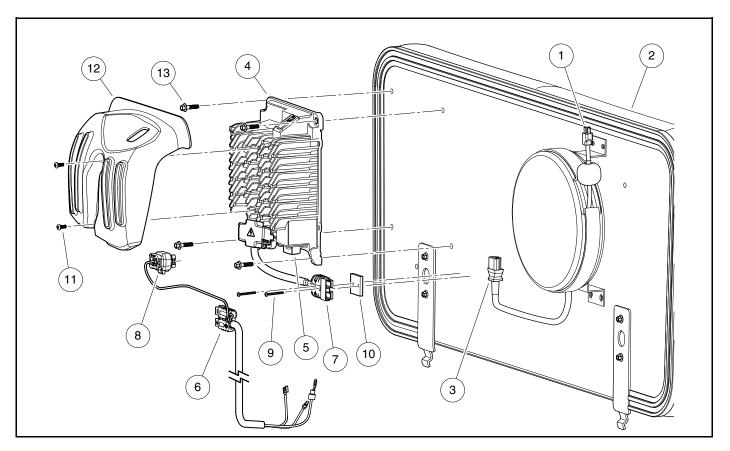
ONBOARD CHARGER REPAIRS

WARNING

- Knowledge of battery charger wiring and component terminology is required before attempting any repair (Figure 22-7, Page 22-9).
- Prior to servicing the charger, disconnect the DC plug from the vehicle charger receptacle and the AC cord from the AC outlet.

NOTE: The onboard charger is available on four-passenger vehicles and is located on the underside of the rear-facing seat.

This charger has no internals to service or repair. It only has a few external repairs that can be performed. If an internal component needs repair, the charger must be replaced.



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Figure 22-12 Onboard High-Frequency Charger Mounting

ONBOARD CHARGER REMOVAL

- 1. If connected, disconnect AC cord (1) from AC outlet (Figure 22-12, Page 22-22).
- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 3. Lift rear-facing seat bottom (2) and support in the raised position.
- 4. Disconnect AC cord reel lead (3) from onboard charger (4). Retain sleeve (5).

- 5. Disconnect DC charging harness (6) from onboard charger DC cord (7).
- 6. Disconnect 14-pin plug (8) from onboard charger (4).
- 7. Remove two torx screws (9) securing DC cord connector (7) to seat bottom (2). Retain insulator (10).
- 8. Remove two torx screws (11) securing charger shield (12) to onboard charger (4).
- 9. Remove four bolts (13) securing onboard charger (4) to seat bottom (2).

ONBOARD CHARGER INSTALLATION

- 1. Using existing mounting holes, secure onboard charger (4) to seat bottom (2) with four bolts (13) **(Figure 22-12, Page 22-22)**. Tighten bolts (13) to 53 in lb (6 N·m).
- 2. Secure charger shield (12) to charger with two torx screws (11). Tighten screws (11) to 39.8 in·lb (4.5 N·m).
- 3. Using existing mounting holes, secure DC cord connector (7) and insulator (10) to seat bottom (2) with two screws (9). Tighten screws (9) to 11 in·lb (1.25 N·m).
- 4. Connect 14-pin plug (8) to onboard charger (4).
- 5. Connect DC charging harness (6) to onboard charger DC cord (7).
- 6. Ensure sleeve (5) is in place on charger's AC socket and connect lead (3) from AC cord reel to onboard charger (4).
- 7. Lower rear-facing seat bottom (2).
- 8. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

TERMINAL BLOCK COVER REMOVAL

- 1. Disconnect AC cord from AC outlet.
- 2. Disconnect DC cord (1) at connector mounted under seat (Figure 22-13, Page 22-24).
- 3. Push in mounting tabs (Figure 22-11, Page 22-20) to release cover (2) from terminal block (3).

TERMINAL BLOCK COVER INSTALLATION

A WARNING

- The terminal block cover (2) on the DC terminal block (3) must be installed properly to comply with UL code. This cover prevents water exposure and prevents a short across the DC terminals.
- 1. Align cover (2) with terminal block (3) and push onto block until tabs lock into place (Figure 22-13, Page 22-24).

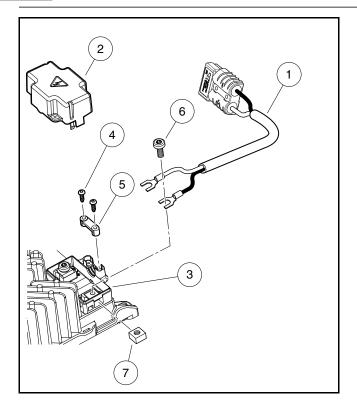


Figure 22-13 Terminal Block Cover, DC Cord and Strain Relief – Onboard Charger

DC CORD AND STRAIN RELIEF REMOVAL

- 1. Disconnect AC cord from AC outlet.
- 2. Disconnect DC cord (1) at connector mounted under seat (Figure 22-13, Page 22-24).
- 3. Remove terminal block cover. See Terminal Block Cover Removal on page 22-23.
- 4. Remove two torx screws (4) securing strain relief (5) to terminal block (3) (Figure 22-13, Page 22-24).
- 5. Remove torx screw (6) securing each DC cord wire to terminal block (3).

DC CORD AND STRAIN RELIEF INSTALLATION

1. Attach DC cord red wire to positive terminal (+) and black wire to negative terminal (–) with torx screws (6) (Figure 22-13, Page 22-24). See following NOTE. Tighten screws (6) to 39.8 in lb (4.5 N·m).

NOTE: The positive symbol (+) and negative symbol (–) are molded into the terminal block for easy identification.

- 2. With DC cord (1) seated properly in the terminal block (3), place strain relief (5) over cord and secure with two torx screws (4). Tighten screws (4) to 7.5 in·lb (0.85 N·m).
- 3. Install terminal block cover. See Terminal Block Cover Installation on page 22-23.

DC CHARGING HARNESS REMOVAL

1. If connected, disconnect AC cord from AC outlet.

- 2. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 3. Lift rear-facing seat bottom and support in the raised position.
- 4. Disconnect DC charging harness from onboard charger DC cord.
- 5. Disconnect 14-pin plug from onboard charger.
- 6. Remove access panel and electronics module cover. See Electronics Module Cover Removal, Section 20, Page 20-5.
- 7. Disconnect blue wire from main wire harness at bullet connector.
- 8. Disconnect 10-gauge black wire from controller B- terminal.
- 9. Disconnect 10-gauge red wire from solenoid.

DC CHARGING HARNESS INSTALLATION

- 1. Connect 10-gauge red wire to solenoid. Tighten nut 72 to 84 in lb (8 to 9.5 N·m).
- 2. Connect 10-gauge black wire to controller B- terminal. Tighten bolt to 108 in lb (12.2 N·m).
- 3. Connect blue wire to main wire harness at bullet connector with light blue wire.
- 4. Install electronics module cover and access panel. See Electronics Module Cover Installation, Section 20, Page 20-5. See following NOTE.

NOTE: Route DC charging harness through notch in access panel.

- 5. Connect 14-pin plug to onboard charger.
- 6. Connect DC charging harness to onboard charger DC cord.
- 7. Lower rear-facing seat bottom.
- 8. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.

A DANGER

See General Warnings on page 1-2.

A WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

The vehicle is equipped with a 48-volt DC, shunt-wound, reversible traction motor. The shunt-wound motor is designed for use in Excel System vehicles. Club Car recommends that motors requiring major repair be sent to a qualified motor repair shop; however, there are many relatively simple tasks that can be performed by a technician with general knowledge and experience in electric motor repair.

EXTERNAL MOTOR TESTING

The following tests can be performed without disassembling the motor using a multimeter or continuity tester.

NOTE: Observe the following before testing the motor:

- This is only testing continuity.
- Tag the motor wires for identification before disconnecting.
- Remove motor wire from one of the "A" terminals and one of the "F" terminals if testing while motor is in vehicle.
- When disconnecting wires from motor terminals, use a second wrench on the lower nut of the terminal
 post to hold post steady.
- Scrape a small amount of paint from motor housing (ground) and use this location when testing motor terminals to electrical ground.

Index of Test Procedures

- 1 Internal Short Circuits
- 2 Armature Circuit Open
- 3 Field Circuit Open

MOTOR TERMINALS	CONTINUITY TEST RESULT	
A1 to A2 F1 to F2	Continuity	
A1 to F1 A1 to F2	No Continuity	

TABLE CONTINUED ON NEXT PAGE

MOTOR TERMINALS	CONTINUITY TEST RESULT	
A2 to F1 A2 to F2	No Continuity	
A1 to Ground A2 to Ground	No Continuity	
F1 to Ground F2 to Ground	No Continuity	

TEST PROCEDURE 1 – Internal Short Circuits

See General Warnings on page 1-2.

- 1. Place vehicle on a level surface.
- 2. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles, Section 1, Page 1-5.
- 3. Disconnect wires from terminals on motor using two wrenches to prevent posts from turning.
- 4. With a multimeter set to 200 ohms, place black (–) probe on motor housing. Scratch through paint to ensure a good connection. Place red (+) probe on A1, A2, F1, and F2 terminals respectively while rolling the vehicle slowly to rotate the armature. Multimeter should indicate no continuity between the motor housing and all individual terminals. If readings indicate continuity, motor will need to be removed from the vehicle and repaired by a qualified technician. See Motor Removal on page 23-4.
 - 4.1. An incorrect reading from the A1 or A2 terminal indicates three possible problems: a grounded A1 or A2 terminal, a grounded wire in the brush area, or a grounded armature/commutator. An incorrect reading for the F1 or F2 terminal indicates a possible grounded F1 or F2 terminal or field coil.
- 5. If readings are correct, reconnect the motor wires. See Motor Installation on page 23-15.
- 6. Connect the batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

TEST PROCEDURE 2 – Armature Circuit Open

See General Warnings on page 1-2.

- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles, Section 1, Page 1-5.
- 2. Disconnect wires from the A1 and A2 terminals on the motor using two wrenches to prevent posts from turning. Set a multimeter to 200 ohms and place the red (+) probe on the A1 terminal and black (–) probe on the A2 terminal. The multimeter should indicate continuity. If the reading is incorrect, a possible open or poor contact in a brush assembly and/or open armature windings may be the cause. The motor will need to be removed from the vehicle and repaired by a qualified technician. See Motor Removal on page 23-4.
- 3. If reading is correct, reconnect the motor wires. See Motor Installation on page 23-15.
- 4. Connect the batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

TEST PROCEDURE 3 – Field Circuit Open

See General Warnings on page 1-2.

- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles, Section 1, Page 1-5.
- 2. Disconnect wires from the F1 and F2 terminals on the motor using two wrenches to prevent posts from turning. Set a multimeter to 200 ohms and place the red (+) probe on the F1 terminal and the black (–) probe on the F2 terminal. The multimeter should indicate continuity. If the reading is incorrect, a possible open field coil or

bad connections at the terminals may be the cause. The motor will need to be removed from the vehicle and repaired by a qualified technician. **See Motor Removal on page 23-4.**

- 3. If reading is correct, reconnect the motor wires. See Motor Installation on page 23-15.
- 4. Connect the batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.

MOTOR

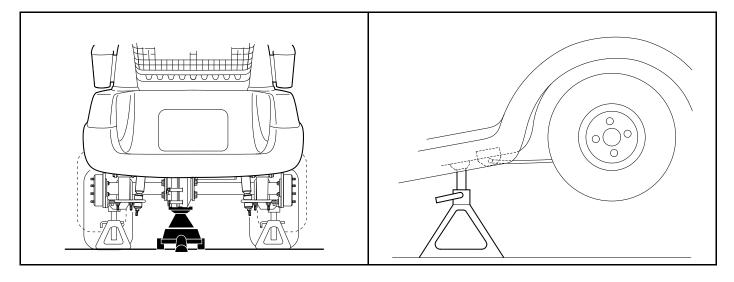
See General Warnings on page 1-2.

MOTOR REMOVAL

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles, Section 1, Page 1-5.
- 2. Disconnect wires from the terminals on the motor using two wrenches to prevent posts from turning. Label the wires to ensure proper reconnection.
- 3. Slightly loosen all the lug nuts on both rear wheels.
- 4. Place floor jack under transaxle and raise rear of vehicle (Figure 23-1, Page 23-4) then place jack stands under frame crossmember between the spring mount and the side stringer, just forward of each rear wheel. Lower the vehicle to let the jack stands support the vehicle (Figure 23-2, Page 23-4). See following WARNING.

WARNING

 Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.



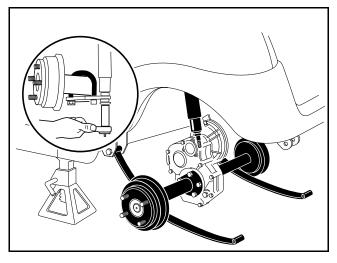
729 Figure 23-1 Lift Vehicle with Floor Jack

Figure 23-2 Vehicle Supported on Jack Stands

- 5. Remove both rear wheels.
- 6. Remove the nut, cup washer, and bushing from the bottom side of the shock absorber. Compress the shock absorber (pushing upwards) to move it out of the way (Figure 23-3, Page 23-5).

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- 7. Remove the nuts and bolts mounting the rear leaf springs to the shackles.
- 8. To gain easier access to the motor, lower the transaxle as low as it will go. If more room is needed, remove the jack from beneath the transaxle and allow the springs to rest on the floor (Figure 23-3, Page 23-5).



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Figure 23-3 Lower Axle

9. Remove the bolts and lock washers that secure the motor to the transaxle (Figure 23-24, Page 23-17). See following CAUTION.

A CAUTION

- Do not position fingers under motor when sliding motor off of the input shaft in step 9. Fingers may get pinched when motor disengages.
- 10. Carefully slide the motor away from the transaxle until the motor spline disengages the input shaft and remove the motor from the vehicle.





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Figure 23-4 Speed Sensor Magnet

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Figure 23-5 End Cap

MOTOR DISASSEMBLY

- 1. Before beginning disassembly, place match marks on the motor end cap and motor frame.
- 2. Remove speed sensor and magnet.
 - 2.1. Remove the two screws (25) that secure the speed sensor (10) to the end cap (11) **(Figure 23-15, Page 23-12)**.

- Motor
 - 2.2. Remove the screw securing the magnet to the armature shaft (Figure 23-4, Page 23-5).
 - 2.3. Inspect the speed sensor magnet. See Speed Sensor Magnet Inspection on page 23-11.
- 3. Loosen, but do not remove, the two screws securing the end cap to the motor frame (Figure 23-5, Page 23-5).





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Figure 23-6 End Cap Disengagement

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Figure 23-7 End Cap Removal

- Orient the motor so that the splined end of the armature is facing down. 4.
- Inspect the area where the end cap mates with the motor frame. If the end cap appears to be loose where it connects to the motor frame, proceed to step 6; otherwise, disengage the end cap from the motor frame using the following procedure:
 - 5.1. With the end cap bolts loose (about 1/4 inch (6.3 mm) between the end cap and the head of the bolt), place a socket on the head of the bolt. See following CAUTION.

CAUTION

- · Ensure that there is sufficient thread engagement of the end cap bolts before proceeding. Performing the procedure without having adequate thread engagement could damage the motor frame, end cap, or end cap bolts.
- 5.2. Gently tap each bolt, alternating between blows, until the end cap and motor frame become disengaged (Figure 23-6, Page 23-6).
- 6. Remove the two end cap bolts.
- Remove the end cap and armature from the motor frame (Figure 23-7, Page 23-6).
- Inspect the brush springs for proper tension. See Motor Brush, Spring, and Terminal Insulator Inspection on 8. page 23-10.
- Remove the armature from the end cap bearing. See following CAUTION and NOTE.

A CAUTION

 Removing the armature from the end cap requires two people: one to operate the press, and another to hold the armature. Failure to heed this CAUTION could result in personal injury and/or damage to the armature resulting from an unsupported armature falling after it becomes disengaged from the end cap bearing.

NOTE: Replacement of the end cap bearing is recommended if the armature is removed.

- 9.1. Place the end cap in a press with the armature facing down.
- 9.2. Place a bearing press tool with an outer diameter smaller than that of the armature shaft between the press ram and the armature shaft (**Figure 23-8**, **Page 23-7**).
- 9.3. Have an assistant support the armature while the press is activated.
- 10. Inspect the armature for wear and damage. See Armature Inspection and Testing on page 23-8.
- 11. Inspect the motor frame and field windings. See Motor Frame and Field Windings Inspection on page 23-10.
- 12. Remove the brush rigging.
 - 12.1. Mark the brush terminal posts (A1 and A2).
 - 12.2. Remove the two nuts securing the brush terminals (A1 and A2) to the end cap (Figure 23-9, Page 23-7).
 - 12.3. Remove the two screws and the brush rigging to the end cap (Figure 23-10, Page 23-8).
- 13. Inspect the terminal insulators. See Terminal Insulator Inspection on page 23-10.
- 14. Remove the bearing from the end cap.
 - 14.1. Remove the retaining ring that secures the bearing in the end cap (Figure 23-11, Page 23-8).
 - 14.2. Use an arbor press to remove the bearing from the end cap.
- 15. Inspect the bearing for wear and damage. See Bearing Inspection on page 23-11.





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Figure 23-8 Armature Removal

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Figure 23-9 A1 and A2 Terminals





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Figure 23-10 Brush Rigging

Figure 23-11 Bearing Retaining Ring

MOTOR COMPONENT TESTING AND INSPECTION

See General Warnings on page 1-2.

ARMATURE INSPECTION AND TESTING

- 1. Remove the motor from the vehicle. See Motor Removal on page 23-4.
- 2. Remove the end cap and armature by performing steps 1 through 7 of Motor Disassembly on page 23-5.

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Visual Inspection

- Burned, charred or cracked insulation
- · Improperly cured varnish
- · Thrown solder
- Flared armature windings
- · Damaged armature core laminations
- · Worn, burned or glazed commutators
- · Dirty or oily commutators
- · Raised commutator bars
- · Worn armature bearing or shaft

A dirty or oily commutator should be cleaned and wiped dry. Abnormalities identified during the inspection can help determine original cause of failure. Slight roughness of the commutator can be polished smooth with 400 grit or finer sandpaper. **See following CAUTION and NOTE.**

CAUTION

• Do not use emery cloth to polish the commutator. Particles of emery are conductive and may short-circuit the commutator bars. Do not use oil or lubricants on the commutator or brushes.

NOTE: Oil on the commutator may indicate a faulty transaxle input shaft oil seal.

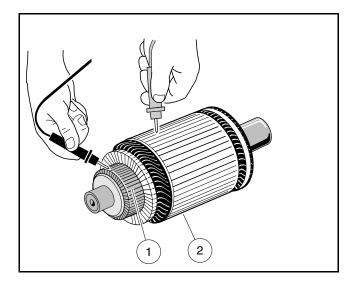
Armature Ground Test

CAUTION

· Do not submerge the armature in solvent.

NOTE: Before testing the armature, wipe it clean with a clean cloth. Remove any carbon dust and metal particles from between the commutator bars.

1. With a multimeter set to 200 ohms, place one probe on the commutator (1) and the other on the armature core (2). The multimeter should indicate no continuity (Figure 23-12, Page 23-9). If the reading is incorrect, replace the armature.



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Figure 23-12 Armature Test

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MOTOR FRAME AND FIELD WINDINGS INSPECTION

- Remove the motor from the vehicle. See Motor Removal on page 23-4.
- 2. Remove the and cap and armature by performing steps 1 through 7 of Motor Disassembly on page 23-5.
- Burned or scorched insulation on the field windings indicates the motor has overheated due to overloads or grounded or shorted coil windings. If the insulation on the field windings is scorched, replace the motor or the stator shell assembly.

MOTOR BRUSH, SPRING, AND TERMINAL INSULATOR INSPECTION

Brush Spring Tension Test

- 1. Remove the motor from the vehicle. See Motor Removal on page 23-4.
- 2. Remove the end cap and armature by performing steps 1 through 7 of Motor Disassembly on page 23-5.
- 3. Inspect the brush springs (14) **(Figure 23-15, Page 23-12)**. Replace springs that are discolored from heat (light gold or blue tinted).
- Test the brush springs for proper tension.
 - 4.1. Place a C-shaped steel plate on a scale.
 - 4.2. Place the end of the C-shaped plate so that it is between the spring and the brush as shown (**Figure 23-13**, **Page 23-11**).
 - 4.3. Gently pull the scale to obtain the spring tension reading. See following CAUTION.

CAUTION

- When checking brush spring tension, do not over-extend the spring. Using excessive force will damage the spring.
- 4.4. Replace springs which require a force of less than 35 ozf (0.99 kgf) (Figure 23-13, Page 23-11). See following NOTE.

NOTE: When installing new brushes, remove and replace brushes one at a time. This method ensures the terminals and brushes will be properly positioned in the rigging. Refer to **Motor Assembly on page 23-13** for brush installation.

When replacing brushes, replace all four brushes. Never replace only two.

Install the brushes in the same rigging 180° apart from each other.

Brush Inspection

- Remove the motor from the vehicle. See Motor Removal on page 23-4.
- 2. Remove the end cap and armature by performing steps 1 through 7 of Motor Disassembly on page 23-5.
- 3. Inspect the brushes (13) for damage or excessive wear (Figure 23-15, Page 23-12). Replace brushes if required. See preceding NOTE.
- 4. Use dial calipers or a micrometer to measure the brush length. The minimum-allowable brush length is 0.62 inches (16 mm). Replace the set of brushes as required. **See preceding NOTE.**

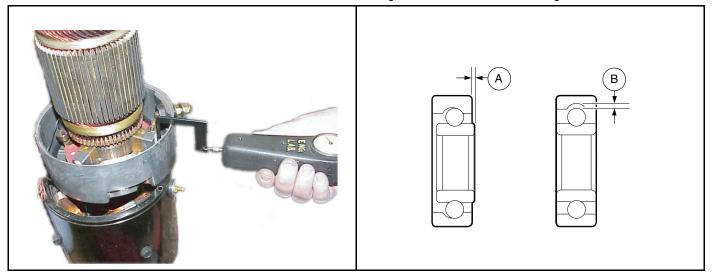
Terminal Insulator Inspection

- 1. Remove the motor from the vehicle. See Motor Removal on page 23-4.
- 2. Remove the terminal insulators by performing steps 1 through 12 of Motor Disassembly on page 23-5.
- 3. Inspect the insulators (4 and 6) for cracks or other damage (Figure 23-15, Page 23-12). Replace insulators as required.

Bearing Inspection

NOTE: Replacement of the end cap bearing is highly-recommended if the end cap is removed from the motor. The following procedure is provided as a guideline for determining general bearing failure.

- 1. Remove the motor from the vehicle. See Motor Removal on page 23-4.
- 2. Remove the bearing by performing steps 1 through 14 of Motor Disassembly on page 23-5.
- 3. Use a clean cloth to wipe the carbon dust off of the bearing. Inspect the bearing by spinning it by hand and checking for both axial (A) and radial (B) play (Figure 23-14, Page 23-11).
- 4. Replace the bearing if it is noisy, does not spin smoothly, or has excessive play. Check the bearing and replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing.



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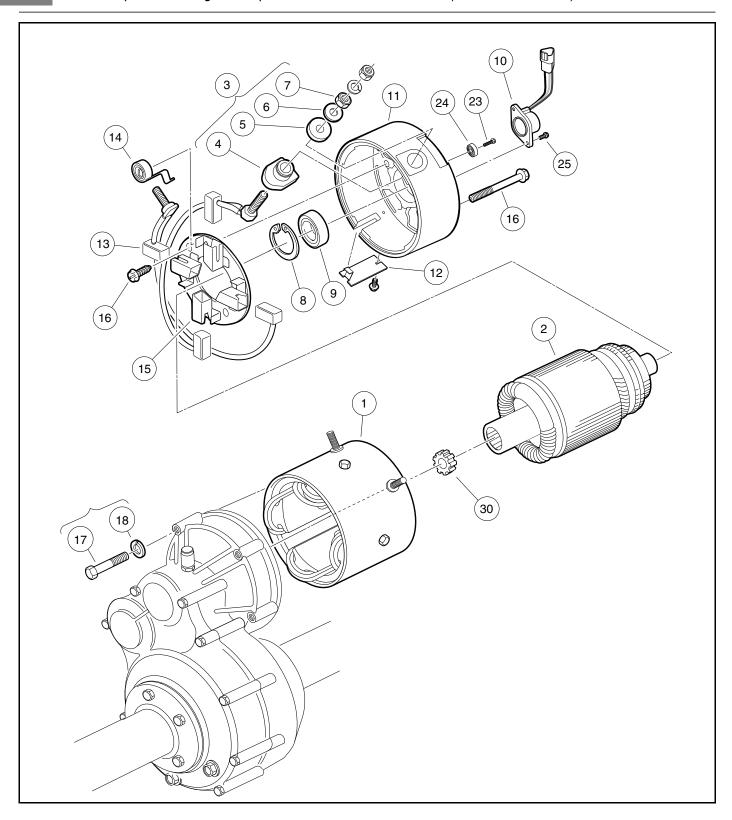
Figure 23-13 Brush Spring Tension Test

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Figure 23-14 Bearing Inspection

Speed Sensor Magnet Inspection

Inspect the speed sensor magnet (24) for rust, wear, and cracks (Figure 23-15, Page 23-12). Replace the magnet if necessary.



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Figure 23-15 Electric Motor (EJ8-4001A)

RECONDITIONING THE MOTOR

See General Warnings on page 1-2.

Motor reconditioning must be performed by a qualified motor repair technician. The use of proper tools and procedures is absolutely essential for successful motor reconditioning.

MOTOR SPECIFICATIONS

Any rework must be performed by a qualified technician. Motor service specifications are listed in the following table.

ITEM	SERVICE LIMIT
Commutator diameter (minimum)	2.80 in. (71.10 mm)
Commutator concentric with armature shaft within	0.003 in. (0.08 mm)
Bar to bar runout should not exceed	0.005 in. (0.013 mm)
Undercut of segment insulator after machining commutator	0.040 in. (1.0 mm)
Armature resistance at 75 °F (24 °C)	0.012 ohms between bar 1 and bar 15
Field coil resistance at 75 °F (24 °C)	1.75 ohms

MOTOR ASSEMBLY

See General Warnings on page 1-2.

- 1. Replace the bearing.
 - 1.1. Use an arbor press to install a new bearing into the end cap. To help avoid damaging the bearing, apply pressure only to the outer race when installing the bearing.
 - 1.2. Install the retaining ring to secure the bearing (Figure 23-11, Page 23-8).
- 2. Install the brushes and brush rigging. See following NOTE.

NOTE: When installing new brushes, remove and replace brushes one at a time. This method ensures the terminals and brushes will be properly positioned in the rigging.

When replacing brushes, replace all four brushes. Never replace only two.

Install the brushes in the same rigging 180° apart from each other.

- 2.1. Insert the brushes into the brush rigging as shown (Figure 23-16, Page 23-14).
- 2.2. Insert the two terminal posts through insulators (4) in the end cap (11) wall at the A1 and A2 positions (Figure 23-15, Page 23-12).
- 2.3. Place external insulators (5) and washers (6) on each terminal post, and secure terminal with nuts (7). Tighten nuts (7) to 100 in·lb (11.3 N·m). Ensure that the terminal posts do not rotate when tightening the nuts (Figure 23-15, Page 23-12).
- 2.4. Secure the brush rigging to the end cap with two screws. Tighten the screws to 25 in·lb (2.8 N·m) (Figure 23-10, Page 23-8).
- 2.5. One at a time, push the brushes back until they are completely retracted into their mounting slots and the spring pressure holds them in the retracted position as shown (Figure 23-17, Page 23-14).





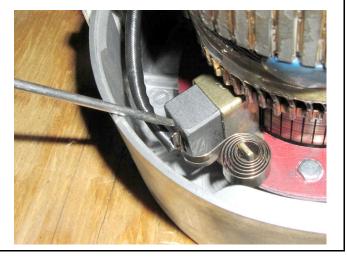


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Figure 23-16 Brush Rigging

Figure 23-17 Retracted Brushes





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Figure 23-18 Armature Installation

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Figure 23-19 Brush Setting

With the brushes retracted, use an arbor press to press the armature shaft into the end cap bearing (Figure 23-18, Page 23-14). See following CAUTION.

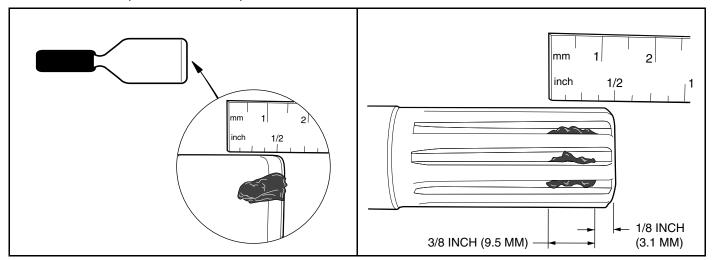
CAUTION

- Make sure the brushes are held back. Do not allow the brushes to support the weight of the commutator. The brushes can be easily damaged by this weight.
- 4. Gently press each brush with a small screwdriver until the spring rests on the end of each brush as shown (Figure 23-19, Page 23-14).
- Align the match marks on the end cap and the motor frame (1) and secure with two bolts (16) (Figure 23-15, 5. Page 23-12). Tighten bolts to 130 in lb (14.7 N·m).
- Install the speed sensor magnet (24) with screw (23). Tighten to 65 in lb (7.3 N·m). 6.
- 7. Install the speed sensor (10) with screws (25). Tighten to 20 in·lb (2.2 N·m).
- Make sure the armature turns freely. If it does not turn freely, disassemble the motor to find the problem.

MOTOR INSTALLATION

See General Warnings on page 1-2.

- 1. Clean the transaxle input shaft.
 - 1.1. Spray the input shaft thoroughly with CRC® Brakleen™ or equivalent brake cleaner degreaser.
 - 1.2. Wipe input shaft with a clean cloth.
 - 1.3. Inspect the grooves of the input shaft and remove any remaining debris.
 - 1.4. Repeat steps 1.1 through 1.3 until input shaft is clean.
- 2. Lubricate the transaxle input shaft.
 - 2.1. Squeeze approximately 1/2 inch (1.3 cm) of moly-teflon lubricant (CC P/N 102243403) from tube onto a putty knife as shown (Figure 23-20, Page 23-15).
 - 2.2. Rotate wheels to rotate input shaft.
 - 2.3. Apply motor coupling grease evenly to the rotating input shaft starting at approximately 1/8 inch (3.1 mm) from the end of the shaft and working back toward the transaxle (away from the end of the shaft) (Figure 23-21, Page 23-15).
 - 2.4. The grease should be evenly distributed in the grooves to a width of approximately 3/8 inch (9.5 mm).
 - 2.5. Use a flat screwdriver to clean the grease out of one of the grooves and allow air to escape when the motor is pushed onto the input shaft.



741 Figure 23-20 Grease on Putty Knife

Figure 23-21 Application of grease to Input Shaft Grooves

- 2.6. Check the chamfer (1) and end (2) of the input shaft to ensure these areas are completely clean of grease as shown (Figure 23-22, Page 23-16).
- 3. Install the molded bumper.
 - 3.1. With the flat side toward the bottom of the coupling and the cupped side toward the transaxle input shaft, install the molded bumper (30) into the motor coupling (Figure 23-15, Page 23-12). See following NOTE.

NOTE: The motor coupling and the new molded bumper must be free of grease and debris.

- 3.2. Ensure that the installed bumper is seated at the bottom of the coupling.
- 4. Install motor on transaxle.
 - 4.1. Slide the motor coupling onto the transaxle input shaft. See following NOTE.

NOTE: The coupling will push any excess grease on the input shaft along the shaft toward the transaxle.

When the motor is pushed onto the input shaft, the motor housing will not bottom out against the transaxle housing (Figure 23-15, Page 23-12). There will be approximately 1/16 inch (1.6 mm) gap between the motor adapter ring and transaxle housing as shown (Figure 23-23, Page 23-16).

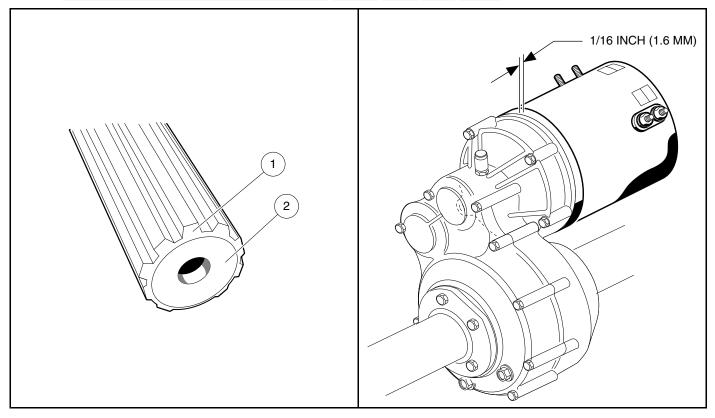


Figure 23-22 Clean Chamfer and Input Shaft End

Figure 23-23 Gap at Motor and Transaxle

- 4.2. Loosely install the three bolts and lock washers that secure the motor to the transaxle (Figure 23-24, Page 23-17). Do not tighten.
- 4.3. Begin finger-tightening the bolts (1, 2, and 3) in the sequence indicated. Continue tightening by hand until the motor is seated in the transaxle housing. See following CAUTION and NOTE.

CAUTION

Make sure the motor is properly seated in the transaxle housing.

NOTE: Failure to install and tighten the motor mounting bolts in the proper sequence and to the proper tightness may result in motor noise during operation.

- 4.4. Tighten the center bolt (3) to 100 in lb (11.3 N·m).
- 4.5. Tighten the left and right bolts (1 and 2) to 100 in lb (11.3 N·m).
- 4.6. Retighten all three bolts (1, 2 and 3) to 100 in·lb (11.3 N·m).
- 4.7. Install the motor wires, making sure they are connected to the correct motor terminals and that the terminal orientation is correct. See page 19-4. Hold the bottom nut of stud with wrench and tighten the terminal retaining nuts. For 5/16 inch (8mm) diameter studs, tighten the nuts to 100 in lb (11 N·m). For 1/4 inch (6.3mm) diameter studs, tighten the nuts to 45 in lb (5.0 N·m).
- 4.8. Secure the white, orange, green, and blue wires with a wire tie so that none of the motor wires will scrub the motor or transaxle when the vehicle is in operation.
- 4.9. Connect the three-pin speed sensor wire to the vehicle wire harness.

- 5. If using a chain hoist, lower the vehicle and guide the leaf springs into the shackles. If using a floor jack, raise the transaxle until the leaf springs can be guided into the shackles.
- 6. Insert the mounting bolts through the spring shackles and the bushings in the leaf spring eyes and install lock nuts. Tighten the bolts to 23 ft·lb (31 N·m). See Leaf Spring Installation (Two-Passenger Vehicles) on page 9-3. See Leaf Spring Installation (Four-Passenger Vehicles) on page 9-7.
- 7. Install the shock absorbers. Tighten nut until rubber bushing expands to the diameter of the cup washer.
- 8. If removed, install wheels and finger tighten the lug nuts.
- 9. Lift vehicle and remove jack stands. Lower vehicle to the floor and tighten lug nuts, using a crisscross pattern, to 55 ft·lb (74.6 N·m).
- 10. Connect the batteries. See Connecting the Batteries Electric Vehicles, Section 1, Page 1-5.
- 11. Place the Tow/Run switch in the RUN position.
- 12. Inspect the vehicle for proper operation. See following WARNING.

WARNING

- Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.
- Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
- Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.

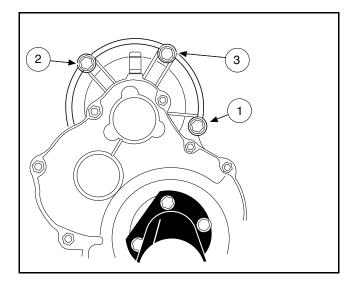


Figure 23-24 EJ8–4001A Motor Mounting Bolts and Tightening Sequence

A DANGER

See General Warnings on page 1-2.

WARNING

See General Warnings on page 1-2.

LUBRICATION

See General Warnings on page 1-2.

There are two plugs located on the lower half of the transaxle housing. The upper plug (21) (as viewed when the vehicle is on a level surface) is used as a lubricant level indicator (Figure 24-5, Page 24-3). When the vehicle is parked on a level surface, the lubricant level should be even with the bottom of the hole. The lower plug (22) is for draining the lubricant. When draining the lubricant, the upper plug should be removed so the lubricant will drain faster. Be sure the drain plug is installed before filling. See following NOTE.

NOTE: Recycle or dispose of used oil or lubricant in accordance with local, state, and federal regulations.

AXLE BEARING AND SHAFT

See General Warnings on page 1-2.

AXLE SHAFT

Axle Shaft and Oil Seal Removal

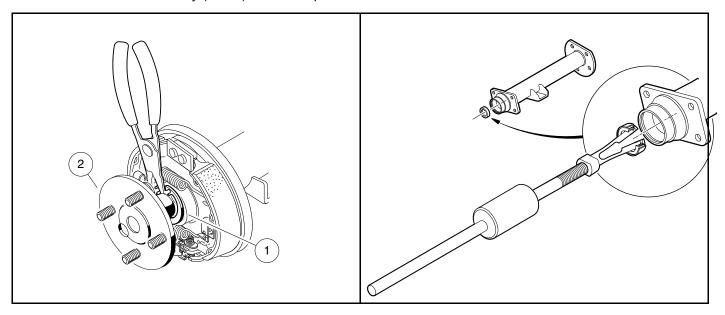
- 1. Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Place chocks at the front wheels. Loosen lug nuts on rear wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the axle tubes to support the vehicle. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Remove the rear wheel and brake drum. See Section 6 Wheel Brake Assemblies. See Section 8 Wheels and Tires.
- 4. Use 90° internal snap ring pliers to remove the internal retaining ring (6) from the axle tube (Figure 24-5, Page 24-3). See also Figure 24-1, Page 24-2.
- 5. Remove the axle, retaining ring, and bearing assembly by pulling the axle straight out of the housing.
- 6. If necessary, remove the axle oil seal and adapter ring.
 - 6.1. Use a bearing puller (P/N 1016417) to remove the axle seal and adapter ring from the axle tube (Figure 24-2, Page 24-2). See following CAUTION and NOTE.

CAUTION

• Do not scar or damage the inside surfaces of the tube when removing the oil seal and adapter ring. A damaged tube might have to be replaced.

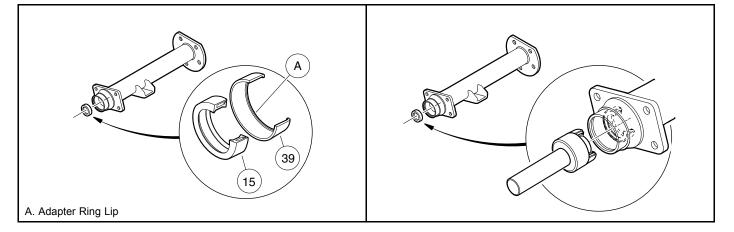
NOTE: Do not discard the adapter ring. If the adapter ring is lost or damaged, the axle tube will have to be replaced. Varying rear axle configurations have been installed on vehicles. If replacing axle tubes, take note of individual axle tube lengths to ensure proper fit.

- 6.2. Use a press to separate the axle oil seal (15) from the adapter ring (39) (Figure 24-3, Page 24-2). Retain the adapter ring and discard the oil seal.
- 7. Inspect the axle shaft assembly to be sure the bearing and collar have not slipped and are still seated against the shoulder on the axle shaft.
- 8. Inspect bearing (5) **(Figure 24-5, Page 24-3)**. If the bearing in a Type G transaxle is worn or damaged, the entire axle shaft assembly (1 or 2) must be replaced.



762 Figure 24-1 Remove Internal Retaining Ring

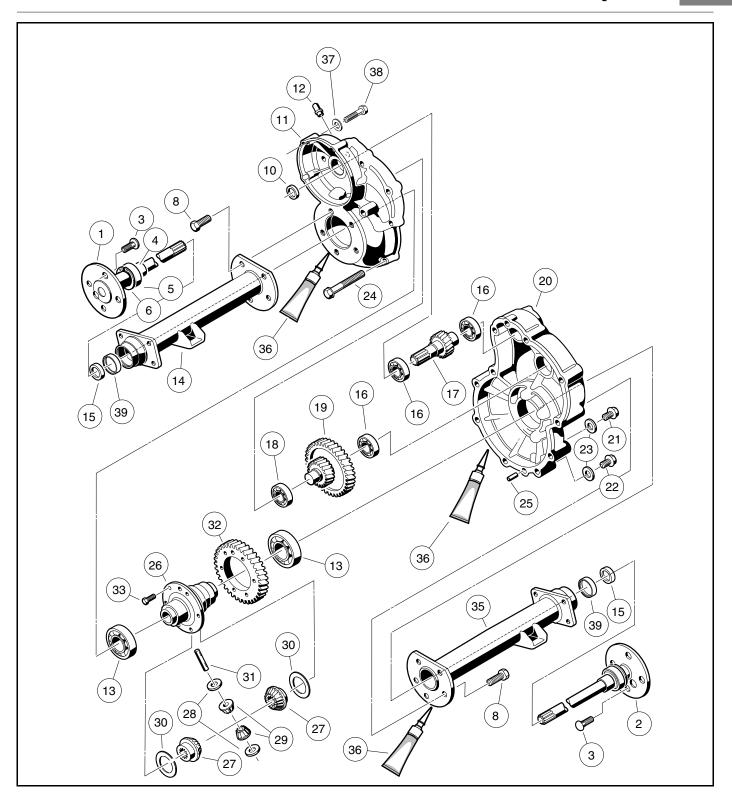
Figure 24-2 Axle Seal and Adapter Ring Removal



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Figure 24-3 Axle Seal and Adapter Ring

Figure 24-4 Axle Seal and Adapter Ring Installation



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Figure 24-5 Transaxle - Type G

Axle Shaft and Oil Seal Installation

- 1. If previously removed, install a new oil seal.
 - 1.1. Clean seal seat in the adapter ring (39) (Figure 24-3, Page 24-2).
 - 1.2. Place a new seal (15) in the adapter ring with the seal lip facing toward the adapter ring lip (Figure 24-3, Page 24-2). Use an axle seal tool (P/N 1014162) and mallet to tap it in until it seats firmly in position (Figure 24-3, Page 24-2). A hydraulic press may also be used with the axle seal tool.
 - 1.3. Clean adapter ring seat(s) in the axle tube (14 or 35) (Figure 24-5, Page 24-3).
 - 1.4. Apply Loctite® 603 to the outer diameter of the adapter ring.
 - 1.5. Place the oil seal and adapter ring assembly into the axle tube with the seal lip facing away from the bearing (Figure 24-4, Page 24-2). Use an axle seal tool (P/N 1014162) and mallet to tap it in until it seats firmly in position. See following CAUTION.

CAUTION

- Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft to prevent oil from coming in contact with brakes.
- 2. Install the rear axle into the transaxle. See following NOTE.
 - 2.1. Insert the shaft, splined end first, through the seal and into the axle tube. Be careful not to damage the seal on the inside of the axle tube hub. Advance the shaft through to the bearing on the shaft, then rotate it to align the shaft splines with the splined bore of the differential side gear (27) (Figure 24-5, Page 24-3). Continue advancing the shaft until the bearing on the axle is firmly seated within the axle tube hub seat.
 - 2.2. Use a pair of snap ring pliers to install the retaining ring (6) inside axle tube hub so that it seats against the axle bearing assembly and into the machined slot in the inside wall of the axle tube hub (**Figure 24-5**, **Page 24-3**).

NOTE: If the retaining ring (6), axle bearing (5), or sleeve (4) must be replaced, the entire axle shaft assembly (1 or 2) must be replaced (Figure 24-5, Page 24-3).

2.3. Place a 1/4 to 3/8-inch (6 to 10 mm) diameter rod against the retaining ring and tap lightly at four to five locations around the retaining ring to ensure it is properly seated. **See following WARNING.**

A WARNING

- Be sure the retaining ring is properly seated in its groove. If the ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result, causing severe personal injury or death.
- 3. If a new oil seal was installed, allow 24 hours before operating the vehicle to allow the Loctite® 603 to fully cure.

AXLE BEARING

Do not remove the axle bearing (5) from a Type G transaxle. If bearing is worn or damaged, the entire axle assembly (1 or 2) must be replaced (Figure 24-5, Page 24-3).

TRANSAXLE REMOVAL

See General Warnings on page 1-2.

- Disconnect the batteries and discharge the controller. See Disconnecting the Batteries Electric Vehicles on page 1-5.
- 2. Place chocks at the front wheels and slightly loosen lug nuts on both rear wheels. See WARNING "Lift only one end..." in General Warnings on page 1-2.
- 3. Place a floor jack under the transaxle and raise the rear of the vehicle. Position jack stands under the aluminum frame rails forward of the spring mount. Lower the vehicle to let the jack stands support the vehicle (Figure 24-6, Page 24-5). See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-2.
- 4. Remove the rear wheels, then thread one lug nut onto a stud on each rear hub. This will keep the brake drums on the hubs.
- 5. Remove the bow tie pins (1) and brake cable clevis pins (3). Use tool (P/N 102555501) to compress tangs on cable end and remove cable end from bracket (4) (Figure 24-7, Page 24-5).

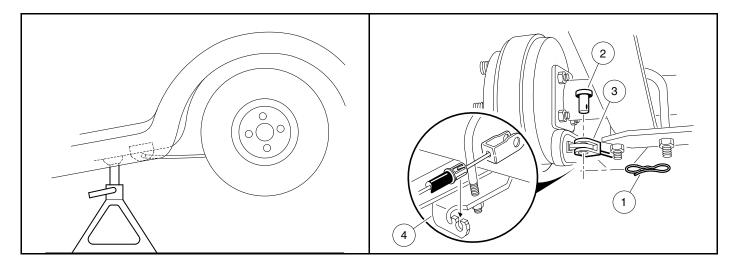


Figure 24-6 Vehicle Supported on Jack Stands

Figure 24-7 Brake Cable

- 6. Disconnect the shock absorbers from their lower mounts (Figure 24-8, Page 24-6).
- 7. Disconnect the four motor wires. Use two wrenches to prevent the post from turning.
- 8. With a floor jack supporting the transaxle, remove lower spring shackle nuts and bolts. Position shackles so they are clear of springs (Figure 24-9, Page 24-6).

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- 9. If a chain hoist was used to raise the vehicle, lift the vehicle high enough to permit easy access and clearance for removal of the motor. If a floor jack was used to raise the vehicle, lower the transaxle enough to permit easy access and clearance for removal of the motor.
- 10. Remove the three motor mounting bolts (1) (Figure 24-11, Page 24-6) securing the motor to the transaxle. See following CAUTION.

▲ CAUTION

- Do not position fingers under motor when sliding motor off of the input shaft. Fingers may get pinched when motor disengages.
- 11. Carefully remove the motor from the transaxle. Slide the motor away from the transaxle until the motor spline becomes disengaged from the input shaft, then lift motor out. **See preceding WARNING.**

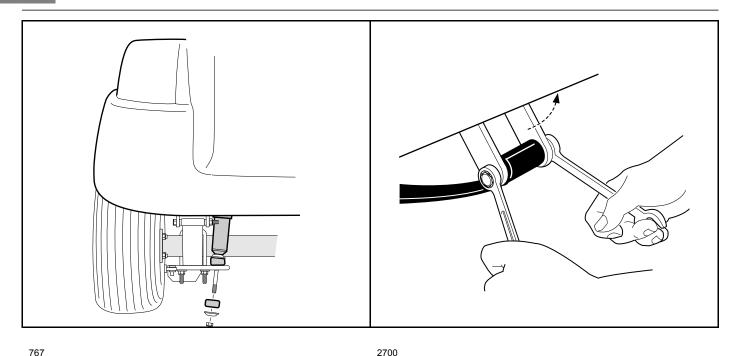
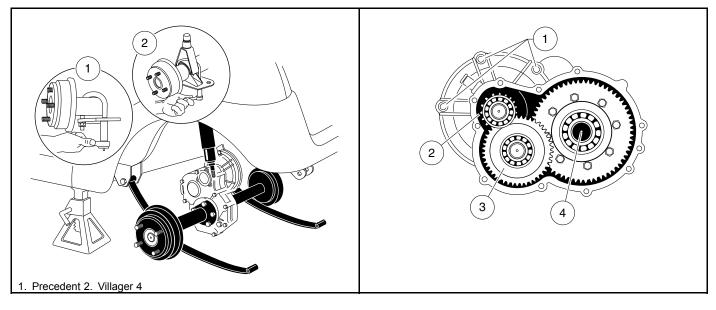


Figure 24-8 Disconnect Shocks

- Figure 24-9 Shackles
- 12. If a floor jack was used, pull floor jack from beneath the transaxle and allow the springs to rest on the floor.
- 13. Remove the U-bolts attaching the transaxle to the leaf springs (Figure 24-10, Page 24-6).
- 14. Carefully lift each end of the transaxle off its positioning pin (on the leaf spring) and slide the transaxle to the rear and out of the vehicle.
- 15. Drain the lubricant from the transaxle and remove the axle shafts. See Axle Shaft and Oil Seal Removal on page 24-1. See following NOTE.

NOTE: Recycle or dispose of used oil or lubricant in accordance with local, state, and federal regulations.

16. Remove the brake assemblies if required. See Brake Cluster Removal on page 6-11.



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Figure 24-10 Leaf Springs

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Figure 24-11 Motor Mounting Bolts

TRANSAXLE DISASSEMBLY, INSPECTION, AND ASSEMBLY

See General Warnings on page 1-2.

TRANSAXLE DISASSEMBLY AND INSPECTION

- 1. To detach axle tubes (14 and 35) from the transaxle housing, remove the bolts (8) (Figure 24-5, Page 24-3).
- 2. Remove 11 bolts (24) that hold housing together.
- 3. Pull the halves of the housing (11 and 20) apart. If necessary, tap lightly on the spline of the input pinion (17). **See following CAUTION.**

CAUTION

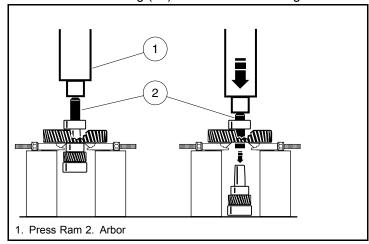
- To prevent damage to the housing mating seal surfaces, use caution when separating halves.
- Remove input pinion gear (17) by pulling gear out while rocking intermediate gear assembly (19). Lift intermediate
 gear assembly and differential gear case unit out simultaneously (Figure 24-5, Page 24-3). See following
 CAUTION.

CAUTION

- · Do not damage gears. Use extreme care when handling them.
- 5. Use a bearing puller or arbor press to remove bearings (16) from the input pinion gear. If the oil seal (10) is damaged, replace it (Figure 24-5, Page 24-3). See also Figure 24-12, Page 24-7. See following CAUTION.

CAUTION

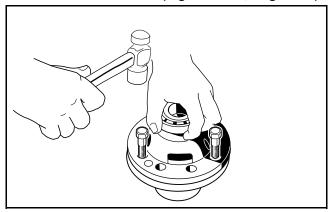
- Do not reuse bearings after removing them. Replace bearings with new ones.
- 6. To disassemble the intermediate gear assembly, press off together the bearing (16) and the gear (19) (Figure 24-5, Page 24-3). See also Figure 24-12, Page 24-7.
- Press the bearing (18) off the intermediate gear assembly (Figure 24-5, Page 24-3).



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Figure 24-12 Intermediate Gear Assembly

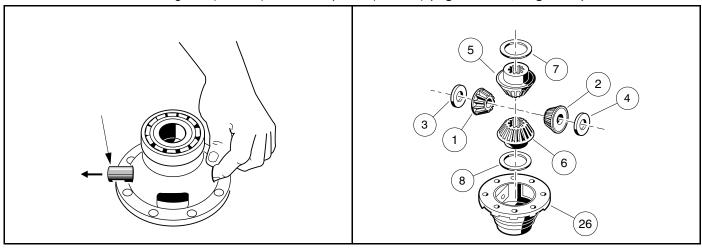
- 8. Disassemble the differential gear case:
 - 8.1. Remove the hex bolts (33) and the ring gear (32) from the differential case (Figure 24-5, Page 24-3).
 - 8.2. Remove the ring gear.
 - 8.3. Separate the differential gear case housing. If necessary, install two of the hex bolts (removed previously in step 8.1.) into the differential gear unit and, while holding the unit slightly above the work area, lightly tap the bolt heads (**Figure 24-13**, **Page 24-8**). Remove the two bolts.



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Figure 24-13 Separate Housing

- 8.4. Remove the differential pin (31) by pushing pin through differential gear case from one side (Figure 24-5, Page 24-3). See also Figure 24-14, Page 24-8.
- 8.5. Remove the idler gears (1 and 2) and thrust plates (3 and 4) (Figure 24-15, Page 24-8).



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Figure 24-14 Differential Pin

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Figure 24-15 Left Differential

- 8.6. Remove the differential gears (5 and 6) and thrust plates (7 and 8).
- 8.7. Inspect the bearings (13) of the differential case (26) and replace them if they are damaged (Figure 24-5, Page 24-3). To remove them, press them off. See following CAUTION.

CAUTION

- · Do not reuse bearings after removing them. Replace bearings with new ones.
- 9. Inspect parts for wear or damage. Any worn or damaged parts should be replaced. See following NOTE.

NOTE: Damaged or worn gears should be replaced as sets.

TRANSAXLE ASSEMBLY

CAUTION

- Do not press against the bearing outer race.
- · The housing and all parts must be wiped clean and dry before reassembly.
- 1. If bearings (13) were removed during disassembly, install new bearings using an arbor press (Figure 24-5, Page 24-3).
- 2. Assemble the differential gear case.
 - 2.1. Install the pin (31) (Figure 24-5, Page 24-3). Apply a small amount of oil to all thrust plates and to both ends of the pin.
 - 2.2. Install the hex bolts (33) and output gear (32). Tighten bolts to 58 ft·lb (78.6 N·m).
- 3. Press a new bearing (18) onto the intermediate gear assembly (Figure 24-5, Page 24-3).
- 4. Press new bearing (16) onto input pinion gear (17).
- 5. Apply grease to the lip of the new oil seal (10) and install the seal using a transaxle pinion seal tool (P/N 1014161). The lip of the oil seal should face the inside of the transaxle housing. Make sure the seal is firmly seated.
- 6. Install the differential assembly (4), the intermediate gear assembly (3), and the input pinion gear (2) simultaneously. Be sure all bearings are seated properly in the housing. Rotate the input shaft to check for smooth gear operation (Figure 24-11, Page 24-6).
- 7. Install dowel pin(s) (25) (if originally installed) in the transaxle housing (20) (Figure 24-5, Page 24-3).
- 8. Install left half of transaxle housing:
 - 8.1. Place a 1/8-inch (3 mm) bead of Three Bond liquid gasket on mating surface of housing.
 - 8.2. Install left half of transaxle housing (20) (Figure 24-5, Page 24-3).
 - 8.3. Install bolts (24) in the case housing and tighten to 19 ft·lb (25.7 N·m). Type G transaxles have no shims or gasket.
 - 8.4. Install axle tube (14 and 35) with bolts (8) (Figure 24-5, Page 24-3). Tighten the bolts to 37 ft·lb (50.2 N·m).
- 9. Install the brake assemblies as instructed. See Brake Cluster Installation on page 6-11.
- 10. Apply a small amount of grease to the lip of the oil seal (15) (Figure 24-5, Page 24-3). See following CAUTION.

A CAUTION

- Clean any residual oil from the exposed end of the axle shaft and from the oil seal area prior to installing the axle shaft to prevent oil from coming in contact with brakes.
- 11. Install the rear axle onto the transaxle.
 - 11.1. Insert the splined end of the axle shaft into the axle tube. Be careful not to damage the seal on the inside of the axle tube hub. Advance the shaft through to the bearing on the shaft, and rotate it to align the shaft splines with the splined bore of the differential gear. Continue advancing the shaft until the bearing on the axle is firmly seated within the axle tube hub seat.
 - 11.2. Using 90° internal snap ring pliers (0.090 tip) (P/N 1012560), attach the internal retaining ring into the axle tube hub so that it seats against the axle bearing assembly and into the machined slot in the inside wall of the axle tube hub (Figure 24-5, Page 24-3).
 - 11.3. Place a 1/4 to 3/8-inch (6 to 10 mm) diameter rod against the retaining ring and tap lightly at four or five locations to ensure it is properly seated. **See following WARNING.**

A WARNING

- Be sure retaining ring is properly seated in its groove. If ring is not properly installed, the axle assembly will separate from the transaxle and damage the axle assembly and other components. Loss of vehicle control could result in severe personal injury or death.
- 12. Make sure the drain plug (22) is installed in the transaxle and tightened to 23 ft·lb (31 N·m). Fill the transaxle, through the level indicator hole, with 22 fl-oz of SAE 30 API Class SE, SF, or SG oil (a higher grade may also be used). Install and tighten the level indicator plug (21) to 23 ft·lb (31 N·m).

TRANSAXLE INSTALLATION

See General Warnings on page 1-2.

- If using a chain hoist, raise the vehicle and place transaxle in position on the jack stands. If using a floor jack, lower the jack stands to their lowest settings and place the transaxle in position on the jack stands.
- Align the center hole in the saddle of the transaxle with the pilot bolt in the leaf spring assembly.
- 3. Install the two U-bolts, jounce bumper mount (if required), and spacers, lock washers, and nuts. Tighten the nuts to 25 ft·lb (34 N·m). Tighten the U-bolt nuts so an equal amount of thread is visible on each leg of the bolt.
- 4. Install the motor. See Motor Installation on page 23-15.
- 5. If using a chain hoist, lower the vehicle while guiding the leaf springs into the rear spring shackles. If using a floor jack, raise the differential while guiding the leaf springs into the rear spring shackles. Then raise the jack stands to support the transaxle.
- 6. Connect the motor wires, making sure they are connected to the correct motor terminals and that the terminal orientation is correct. Hold the bottom nut of stud with wrench and tighten the terminal retaining nuts. For 5/16 inch (8mm) diameter studs, tighten the nuts to 100 in·lb (11 N·m). For 1/4 inch (6.3mm) diameter studs, tighten the nuts to 45 in·lb (5.0 N·m). **See following NOTE.**

NOTE: If the motor wires were not tagged when disconnected, refer to the wiring diagram for proper connection. **See Wiring Diagrams on page 19-4.**

- 7. Insert bolts through the spring shackles and bushings in the leaf spring eyes. Secure bolts with lock nuts. Tighten to 18.5 ft·lb (25 N·m).
- 8. Connect the brake cables using new bow tie pins (1) (Figure 24-7, Page 24-5).
- 9. Install the shock absorbers. Tighten shock absorber retaining nuts until the rubber bushings expand to the same size as the cup washers.
- 10. Install the rear wheels and finger-tighten the lug nuts.
- 11. Lift the vehicle and remove the jack stands.
- 12. Lower vehicle and tighten the lug nuts, using a crisscross pattern, to 55 ft·lb (74.6 N·m).
- 13. Place the Tow/Run switch in the TOW position and connect the batteries. See Connecting the Batteries Electric Vehicles on page 1-5.
- 14. Inspect the vehicle to check for proper operation. See following WARNING.

WARNING

 Make sure that the vehicle operates in the forward direction when the Forward/Reverse switch is in the FORWARD position.

WARNING CONTINUED ON NEXT PAGE



WARNING

- Make sure that the vehicle operates in the reverse direction when the Forward/Reverse switch is in the REVERSE position. The reverse buzzer will sound as a warning when the Forward/Reverse switch is in REVERSE.
- Make sure that the vehicle does not operate when the Forward/Reverse switch is in the NEUTRAL position.

SECTION 25 – TROUBLESHOOTING AND ELECTRICAL SYSTEN – SUBARU EX40

▲ DANGER

See General Warnings on page 1-2.

WARNING

See General Warnings on page 1-2.

GENERAL INFORMATION

A WARNING

• To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help avoid installing it in the gray port.

This section contains the information required to correctly troubleshoot the EFI gas vehicle. In addition to troubleshooting, this section contains general information on the electrical system and the circuits of the electrical system.

ACCESSORIES

For certain powered accessories, use the 9-pin connector located behind the instrument panel.

LOW OIL WARNING LIGHT

NOTE: When the key switch is placed in the ON position, the Low Oil Warning Light will illuminate for approximately 3 seconds as a bulb check function.

If the Low Oil Warning Light comes ON due to low oil level, and oil is added to correct the issue, the Low Oil Warning Light will still remain ON. Cycle the key switch OFF and ON to reset the Low Oil Warning Light.

The gasoline vehicle is equipped with a low oil warning light (4), located at the top of the instrument panel. If the warning light comes on, oil should be checked and added to the engine as necessary before continuing to use the vehicle. **See following CAUTION.** The vehicle should never be driven when the low oil warning light remains on. If the warning light goes on and off, the vehicle may be driven, but oil should be added at the first opportunity. The light will flash repeatedly to indicate a possible problem with the electronic fuel injection (EFI) system. If the oil level is correct and the warning light stays on, have a trained technician check the vehicle.

CAUTION

• Failure to add oil immediately when the low oil warning light stays on may result in permanent engine damage.

GROUND LOCATIONS

Electrical grounds are located at the following areas:

- At the Battery: The starter/generator, voltage regulator, ECU, throttle position sensor and fuel pump module all connect to the main wire harness and goes to the B– battery terminal.
- Between Engine and Battery: The engine and chassis each have a separate lead that connects to the main wire harness and goes to the B– battery terminal.
- Top of Fuel Tank: The fuel tank has a lead that connects to the main wire harness and goes to the B- battery terminal.

FEATURES OF THE ELECTRONIC FUEL INJECTION (EFI) SYSTEM

- Open-loop system (i.e. oxygen sensor not used)
- · Controls fuel pump, fuel injector, oil lamp
- · Inputs: Manifold Absolute Pressure (MAP), engine block temperature, ignition timing
- · Blink fault codes through the Low Oil Warning Lamp
- · Separate EFI wire harness
- The ECU and throttle body/fuel injector assembly are matched pairs

TROUBLESHOOTING GUIDE

The following troubleshooting guides will be helpful in identifying operating difficulties should they occur. The guides include the symptom, probable cause(s) and suggested checks. The procedures used in making these checks can be found in the referenced sections of the maintenance and service manual.

ECU ERROR CODES (DISPLAYED BY THE LOW OIL WARNING LIGHT)

Failure Mode Table – When Ignition Is Initially Switched ON

DISPLAY MODE	CONDITION	LAMP CONTROL
Blink Code	No Failure	Step 1: Lamp ON Two Seconds
		Step 2: Lamp OFF Four Seconds
		Step 3: Lamp OFF
	Detect Failure	Step 1: Lamp ON Two Seconds
		Step 2: Lamp OFF Four Seconds
		Step 3: Display Blink Code

Failure Mode Table - After Ignition Has Been In ON Position (i.e. During Use of Vehicle)

DISPLAY MODE	CONDITION	LAMP CONTROL	
Blink Code	No Failure	Step 1: Lamp OFF	
	Detect Failure	Step 1: Lamp OFF Four Seconds	
		Step 2: Display Blink Code	

Error Codes - ECU

BLINK CODE	CODE DESCRIPTION	CORRECTIVE ACTION	
21	Low Battery Voltage	Check battery voltage. Charge/replace battery as necessary.	
22	MAP Sensor: Open or Shorted Connection	Check connector at ECU & Throttle module. If connection is made and no corrosion is present, replace ECU and Throttle Module.	
23	Temperature Sensor: Open or Shorted Connection	Check connector at ECU & Throttle module. If connection is made and no corrosion is present, replace ECU and Throttle Module.	
31	Fuel Pump: Open Connection	Check fuel pump and fuel system. Check electrical connections at ECU, Throttle module and fuel pump.	
41	Fuel Injector: Open Connection	Check connector at ECU & Throttle module. If connection is made and no corrosion is present, replace ECU and Throttle Module.	
51	Ignition Pulse: Open Connection	Check spark plug, coil, ECU. Replace failed components.	

NOTE: If codes 22, 23, and 41 blink in-sequence, the gray plug is disconnected from the ECU.

If no codes blink, the black plug is disconnected from the ECU.

GASOLINE POWERTRAIN

TROUBLESHOOTING GUIDE			
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION	
	Spark plug is partially fouled or in poor condition	Clean or replace	
	Spark plug is damaged or loose	Replace or tighten	
	Incorrect spark plug gap	Adjust gap	
Engine does not start easily.	Spark plug wire is damaged or loose	Replace or reconnect	
	Loose or bad wire connection at ignition coil, EFI sensors, or ECU	Test Procedures 14 – Ignition Spark or 15 – Ignition Coil or 4 – EFI System (ECU and Sensors)	
	Intermittent ignition coil failure	Test Procedures 14 – <i>Ignition Spark</i> and 15 – <i>Ignition Coil</i>	
	Low fuel level in fuel tank	Refill	
	Fuel line pinched or clogged	Clean or replace	
	Poor fuel quality or contaminated fuel	Replace	

SYMPTOM POSSIBLE CAUSES CORRECTIVE ACTION				
STMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION		
	Fuel pump malfunction; fuel pressure to throttle body too low	See Section 28 – Fuel System – Subaru EX40.		
	Water or dirt in the fuel system and/or throttle body/fuel injector; dirty or clogged fuel filter	See Section 28 – Fuel System – Subaru EX40.		
	Throttle body dirty or improperly adjusted	Clean or adjust. See Section 28 – Fuel System – Subaru EX40.		
	Low cylinder compression	See Section 27 – Engine – Subaru EX40.		
	Cylinder head bolts not tighten properly	Check and retighten. See Section 27 – Engine – Subaru EX40.		
	Intake or exhaust valve not sealing	Repair. See Section 27 – Engine – Subaru EX40.		
	Incorrect valve clearance	Adjust. See Section 27 – Engine – Subaru EX40.		
	Vacuum leak	Retighten hardware or replace gasket(s)		
	Starter/generator belt is slipping	Belt Tension Adjustment on page 26-11		
	Spark plug is fouled or in poor condition	See Section 27 – Engine – Subaru EX40.		
	Spark plug wire is damaged or loose	See Section 27 – Engine – Subaru EX40.		
Engine starts but does not run smoothly	Intermittent ignition coil failure	Test Procedures 14 – Ignition Spark and 15 – Ignition Coil		
Engine starts but does not run smoothly.	Water or dirt in the fuel system and/or throttle body/fuel injector; dirty or clogged fuel filter	See Section 28 – Fuel System – Subaru EX40.		
	Fuel pump malfunction; fuel pressure to throttle body too low	See Section 28 – Fuel System – Subaru EX40.		
	Fuel tank is empty	See Section 28 – Fuel System – Subaru EX40.		
	Fuel line or filter clogged	See Section 28 – Fuel System – Subaru EX40.		
	Fouled spark plug	See Section 27 – Engine – Subaru EX40.		
	Spark plug wire damaged or loose	See Section 27 – Engine – Subaru EX40.		
Engine turns but fails to start.	Loose or bad wire connection at ignition coil, EFI sensors, or ECU	Test Procedures 14 – Ignition Spark or 15 – Ignition Coil or 4 – EFI System (ECU and Sensors)		
	Ignition coil failed	Test Procedures 14 – Ignition Spark and 15 – Ignition Coil		
	Kill circuit grounded	Test Procedures and 6 – Key Switch (Engine Kill Circuit)		
	Fuel pump malfunction or failure	See Section 28 – Fuel System – Subaru EX40.		

TROUBLESHOOTING GUIDE				
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION		
	Fan screen is partially blocked or plugged	See Section 27 – Engine – Subaru EX40.		
	Governor is improperly adjusted	See Section 28 – Fuel System – Subaru EX40.		
Casina averbacta	Excessive back pressure in exhaust	Check and clean or replace		
Engine overheats.	Fuel/air mixture is too lean; check EFI	See Section 28 – Fuel System – Subaru EX40.		
	Overloading	Reduce to rated load		
	Poor quality engine oil	Replace		
	Excessive carbon deposits on piston head or in combustion chamber	See Section 27 – Engine – Subaru EX40.		
Engine pre-ignites.	Spark plug heat range is incorrect	See Section 27 – Engine – Subaru EX40.		
	Unsuitable or contaminated fuel	See Section 28 – Fuel System – Subaru EX40.		
	Exhaust valve is restricted with carbon deposit	See Section 27 – Engine – Subaru EX40.		
	Muffler or exhaust pipe restricted with carbon or other substance	See Section 29 – Exhaust System – Subaru EX40.		
	Ignition coil failed	Test Procedures 14 – Ignition Spark and 15 – Ignition Coil		
	Air filter is dirty or clogged	See Section 28 – Fuel System – Subaru EX40.		
Loss of engine power.	Governor is improperly adjusted	See Section 28 – Fuel System – Subaru EX40.		
	Throttle linkage out of adjustment	See Section 28 – Fuel System – Subaru EX40.		
	Low cylinder compression	See Section 27 – Engine – Subaru EX40.		
	Spark plug failed	See Section 27 – Engine – Subaru EX40.		
	Restricted fuel flow	See Section 28 – Fuel System – Subaru EX40.		
	Torque converter is not backshifting properly	See Section 30 – Clutches – Subaru EX40.		
	Incorrect plug	See Section 27 – Engine – Subaru EX40.		
	Spark plug wire is damaged	See Section 27 – Engine – Subaru EX40.		
	Unsuitable fuel, or incorrect (rich) fuel mixture	See Section 28 – Fuel System – Subaru EX40.		
Spark plug fouls repeatedly.	Ignition coil failed	Test Procedures 14 – <i>Ignition Spark</i> and 15 – <i>Ignition Coil</i>		
	Dirt entering combustion chamber	Check intake system for leaks. See Section 28 – Fuel System – Subaru EX40.		
	Rings are heavily worn, low cylinder pressure	See Section 27 – Engine – Subaru EX40.		

	CORRECTIVE ACTION	
Neutral lockout switch is in the MAINTENANCE position	Place switch in the OPERATE position.	
Fuse is blown	Test Procedure 2 – Fuses	
Battery is dead	Test Procedure 1 – Battery	
Starter control circuit is not operating	Test Procedure 5 – Key Switch (Start Circuit)	
Starter/generator failed	Test Procedure 12 – Starter/Generator (Starter Function)	
Starter solenoid failed	Test Procedure 8 – Solenoid	
Accelerator pedal limit switch failed	Test Procedure 7 – Throttle Position Sensor (TPS)	
Key switch failed	Test Procedure 5 – Key Switch (Start Circuit)	
Neutral lockout limit switch failed	Test Procedure 10 – Neutral Lockout Limit Switch – Pedal-Start Vehicles Only	
Loose or broken wire in starter/generator circuit	See Section 26 – Electrical Components – Subaru EX40. Starter/Generator on page 26-1	
Cylinder and/or crankcase flooded with fuel	See Section 28 – Fuel System – Subaru EX40.	
Loose or broken wire in the starter/ generator circuit	Test Procedure 11 – Starter/Generator (Generator Function)	
Generator field coil is shorted	Test Procedure 11 – Starter/Generator (Generator Function)	
Brushes are worn or commutator is dirty	See Section 26 – Electrical Components – Subaru EX40. Starter/Generator on page 26-1	
Starter/generator belt is loose or slipping	See Section 26 – Electrical Components – Subaru EX40. Belt Tension Adjustment on page 26-11	
Voltage regulator failed	Test Procedure 13 – Voltage Regulator	
Battery failed	Test Procedure 1 – Battery	
Transmission shifter linkage is binding or is out of adjustment	See Section 31 – Transaxle, Fuji ED65 (for Subaru EX40).	
Insufficient (low) level of lubricant or wrong type of lubricant in transmission	See Section 31 – Transaxle, Fuji ED65 (for Subaru EX40).	
Internal gears are damaged or worn	See Section 31 – Transaxle, Fuji ED65 (for Subaru EX40).	
Dog clutch jammed or broken	See Section 31 – Transaxle, Fuji ED65 (for Subaru EX40).	
	Fuse is blown Battery is dead Starter control circuit is not operating Starter/generator failed Starter solenoid failed Accelerator pedal limit switch failed Key switch failed Neutral lockout limit switch failed Loose or broken wire in starter/generator circuit Cylinder and/or crankcase flooded with fuel Loose or broken wire in the starter/ generator circuit Generator field coil is shorted Brushes are worn or commutator is dirty Starter/generator belt is loose or slipping Voltage regulator failed Battery failed Transmission shifter linkage is binding or is out of adjustment Insufficient (low) level of lubricant or wrong type of lubricant in transmission Internal gears are damaged or worn	

TROUBLESHOOTING GUIDE			
SYMPTOM	POSSIBLE CAUSES	CORRECTIVE ACTION	
	Engine mounting nuts or bolts are loose	See Section 27 – Engine – Subaru EX40.	
	Snubber on frame is worn or damaged	See Section 27 – Engine – Subaru EX40.	
	Loose muffler mounting hardware	See Section 29 – Exhaust System – Subaru EX40.	
Excessive vehicle vibration.	Damaged drive belt or starter belt	See Section 30 – Clutches – Subaru EX40.	
EXOCOGIVE VEHICLE VISITATION.	Damaged drive clutch	See Section 30 – Clutches – Subaru EX40.	
	Damaged starter/generator pulley	See Section 26 – Electrical Components – Subaru EX40. Starter/Generator on page 26-1	
	RPM setting is incorrect	See Section 28 – Fuel System – Subaru EX40. Engine RPM Adjustment on page 28-11	
	Drive belt is worn, cracked, glazed, or frayed	See Section 30 – Clutches – Subaru EX40.	
Clutches do not shift smoothly.	Drive clutch malfunction	See Section 30 – Clutches – Subaru EX40.	
Citatories do not shint shibotiny.	Governor is sticking	See Section 31 – Transaxle, Fuji ED65 (for Subaru EX40).	
	Kill circuit wire is disconnected from the ignition coil	Test Procedure	
Engine won't stop running.	Accelerator pedal linkage out of adjustment causing engine kill limit switch not to activate	See Section 28 – Fuel System – Subaru EX40.	
	Fuel mixture is too lean; check EFI	See Section 28 – Fuel System – Subaru EX40.	
	Throttle stop screw out of adjustment at governor arm	See Section 28 – Fuel System – Subaru EX40.	

WIRING DIAGRAMS

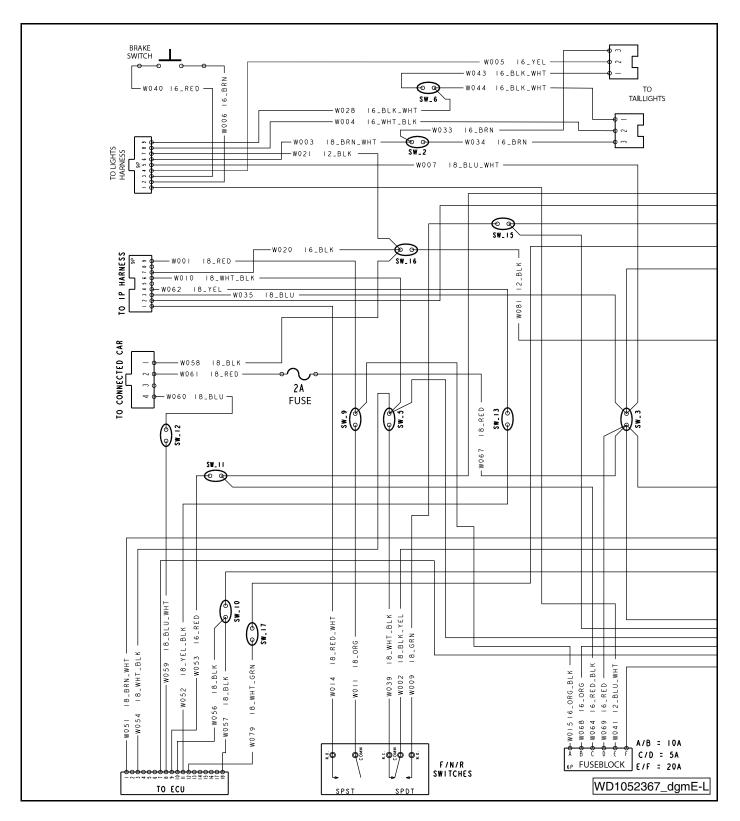


Figure 25-1 Wiring Diagram for Precedent EFI Gasoline Vehicle

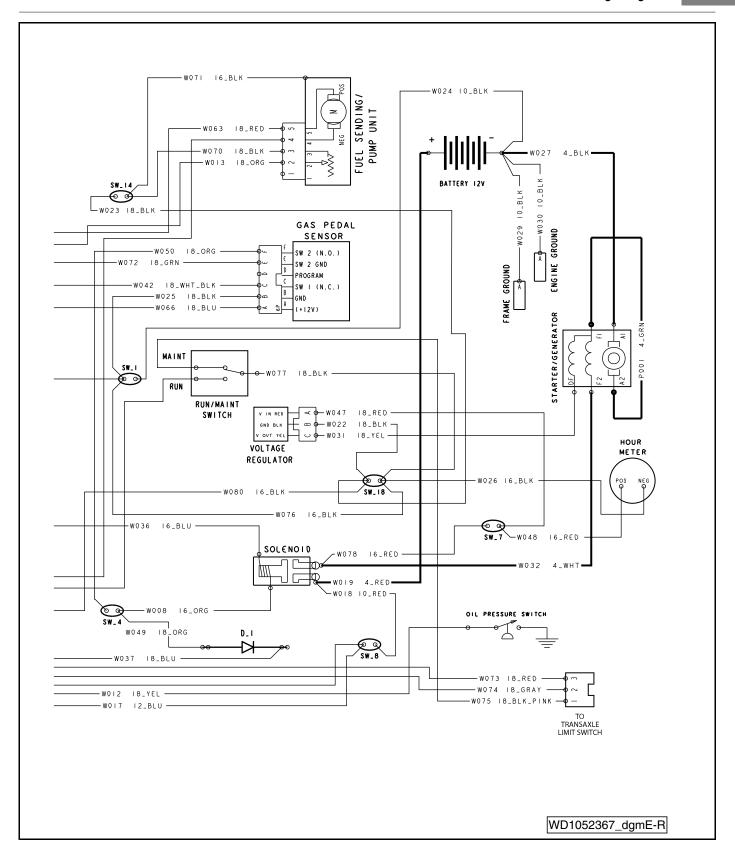


Figure 25-2 Wiring Diagram for Precedent EFI Gasoline Vehicle - Continued

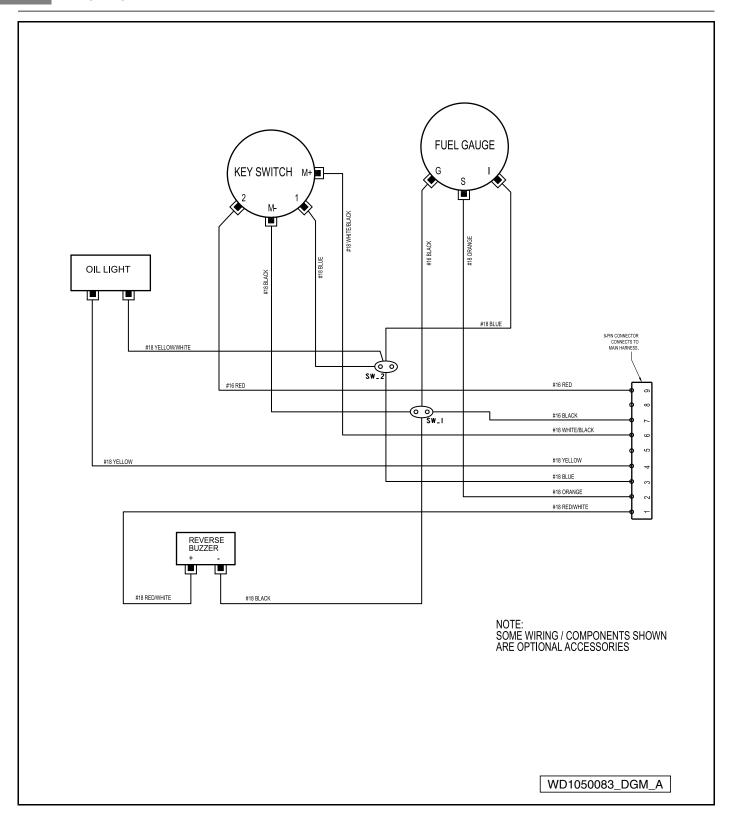


Figure 25-3 Wiring Diagram - Instrument Panel

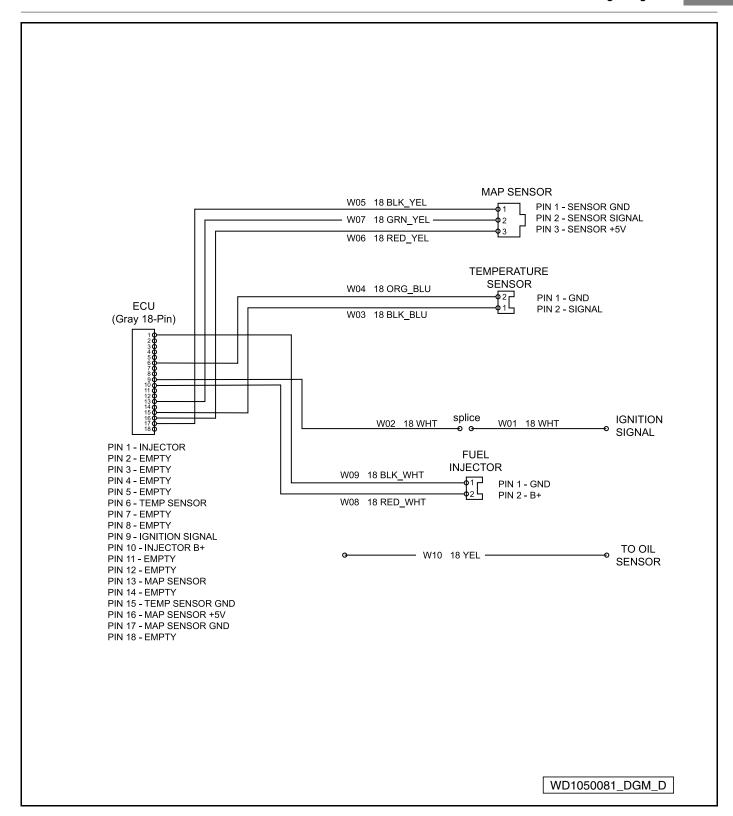


Figure 25-4 Wiring Diagram - EFI and Engine

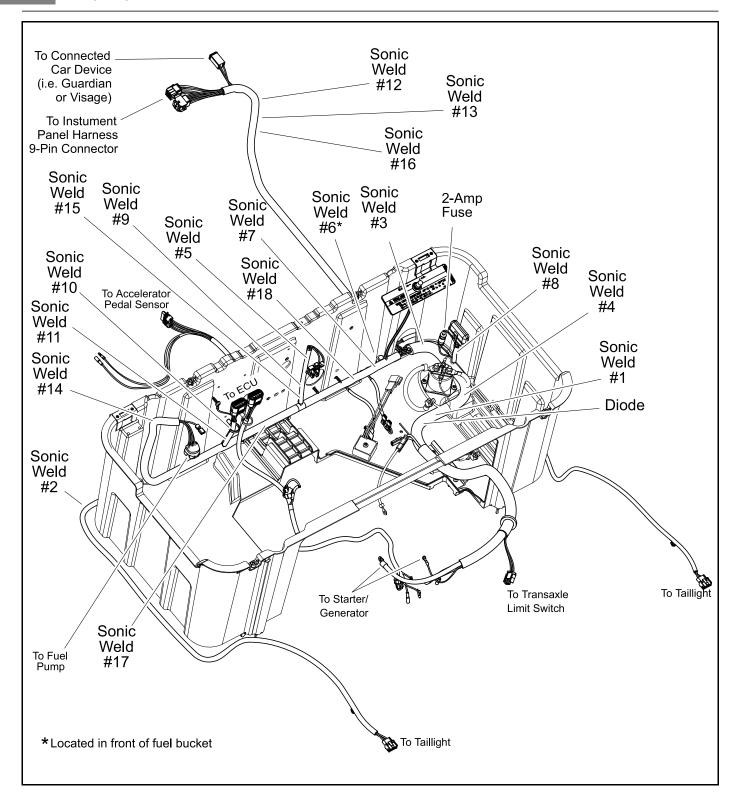


Figure 25-5 Sonic Weld and Diode Locations (Approximate) - Precedent EFI

ELECTRICAL SYSTEM

The electrical system on the gasoline vehicle is 12 volts DC with negative (–) ground to frame, and consists of the following circuits that are easily identified:

- · Starter Circuit
- · Generator Circuit
- Electronic Fuel Injection Circuit
- Engine Ignition Circuit
- Engine Kill Circuit
- · Reverse Buzzer Circuit
- · Low Oil Warning Light Circuit
- Neutral Lockout Circuit
- Fuel Pump Circuit
- · Fuel Gauge and Sending Unit Circuit
- · Hour Meter Circuit
- · Lighting Circuit

Recognizing and understanding the function of each of these circuits will help to quickly isolate the source of an electrical problem. Use the appropriate test procedure to correct the electrical problem. See Test Procedures on page 25-14.

For a complete wiring diagram, see Wiring Diagram for Precedent EFI Gasoline Vehicle on page 25-8.

TEST PROCEDURES

Using the following procedures, the entire electrical system can be tested without major disassembly of the vehicle.

▲ WARNING

• If wires are removed or replaced, make sure wiring and wire harness is properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction, property damage, personal injury, or death.

For some tests, the electrical component box cover must be removed to gain access to the various components that are mounted inside the component box. **See following WARNING.**

WARNING

Shorting of battery terminals can cause personal injury or death.

After test procedures are completed, be sure to replace the cover. See following CAUTION.

CAUTION

• Exposure to water and the elements may damage electrical components. Do not operate vehicle without the cover properly installed.

TESTING BASICS

- Battery voltage will be referenced throughout the test procedures. Battery voltage is accessed in Test Procedure 1

 Battery on page 25-16.
- The MAINTENANCE/OPERATE switch, in the MAINTENANCE position, grounds and kills the ignition if the FNR shifter is placed in FORWARD or REVERSE.
- The key switch powers the ECU, fuel pump, solenoid, lights, and the connected car device.
- The 2-amp fuse is powered by the key switch via the 10-amp ATM fuse and carries battery voltage to the connected car device.
- The term "back-probe" refers to probing the side of a connector that the wire enters. This is usually done when the connector must remain connected to a device. An alternative method is to use an insulation-piercing probe. **See following CAUTION.**

CAUTION

- · Be careful not to damage the wire or terminal when back-probing.
- When testing voltage, the battery must remain connected.
- When testing voltage, unless specifically directed to do otherwise in a procedure, connect the black (–) probe of the multimeter to chassis ground.
- When testing resistance or continuity, turn off power to the circuit being measured and discharge any capacitor(s). The presence of voltage can cause inaccurate readings.

Index of Test Procedures

- 1 Battery
- 2 Fuses
- 3 Ground Cables
- 4 EFI System (ECU and Sensors)
- 5 Key Switch (Start Circuit)
- 6 Key Switch (Engine Kill Circuit)
- 7 Throttle Position Sensor (TPS)
- 8 Solenoid
- 9 Maintenance/Operate Switch Pedal-Start Vehicles
- 10 Neutral Lockout Limit Switch Pedal-Start Vehicles Only
- 11 Starter/Generator (Generator Function)
- 12 Starter/Generator (Starter Function)
- 13 Voltage Regulator
- 14 Ignition Spark
- 15 Ignition Coil
- 16 Reverse Buzzer and Reverse Buzzer Limit Switch
- 17 Low Oil Warning Light (LED)
- 18 Oil Level Sensor
- 19 Battery Test (Under Load)
- 20 Fuel Pump
- 21 Fuel Level Sending Unit
- 22 Fuel Gauge
- 23 Hour Meter
- 24 4-Pin Connector (for Connected Car Device)

TEST PROCEDURE 1 – Battery

See General Warnings on page 1-2.

A DANGER

- Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working near a battery.
- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.
- Battery Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:
 - External: Flush with water. Call a physician immediately.
 - Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.
 - Eyes: Flush with water for 15 minutes. Call a physician immediately.

NOTE: The battery must be properly maintained and fully charged in order to perform the following test procedures.

Battery maintenance procedures, including watering information and allowable mineral content, can be found in section Electrical Components – Subaru EX40 on page 26-1 of this manual. See Battery on page 26-25.

- 1. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
- 2. Check for loose or corroded battery terminal connections. Remove the negative (–) cable first and clean, tighten, and replace connections as necessary.

Hydrometer Test

A hydrometer (CC P/N 1011478) measures the specific gravity. The greater the specific gravity, the greater the state of charge of the battery. A fully charged battery should read between 1.250 and 1.280 at 80 °F (27 °C). Never add acid to the battery to obtain a higher specific gravity (Figure 25-6, Page 25-17).

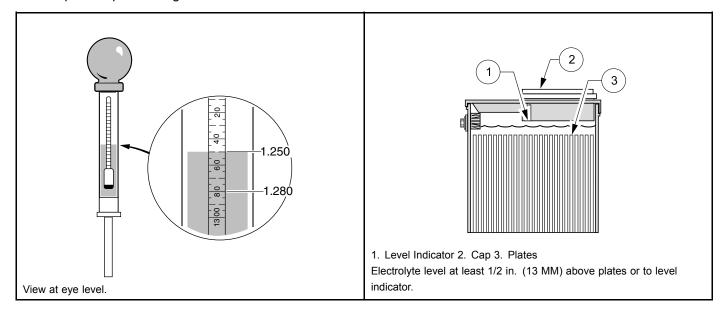
A CAUTION

• Do not allow battery acid from battery caps or hydrometer to drip onto the body. Battery acid will cause permanent damage. Wash off immediately.

Performing the Hydrometer Test

- 1. Be sure that the battery has sufficient water to cover the plates by approximately 1/2 in. (12.7 mm) and is fully charged prior to beginning the test. If water must be added, recharge the battery before performing the hydrometer test (Figure 25-7, Page 25-17).
- Remove the vent cap.
- Using a battery thermometer (CC P/N 1011767), record the electrolyte temperature of a center cell.
- 4. Squeeze the rubber bulb of the hydrometer and insert into the cell. Slowly release the bulb, drawing electrolyte up into the glass tube of the hydrometer.
- 5. When the float rises off the bottom, adjust the electrolyte level so that the float rides free of the bottom but does not strike the bottom of the rubber bulb. Remove the hydrometer from the cell and release the pressure from the bulb.

- 6. Hold the hydrometer vertically, ensuring that the float is not contacting the sides of the glass tube. Hold the hydrometer at eye level and read the scale at the level of electrolyte (Figure 25-6, Page 25-17).
- 7. Record the reading.
- 8. Return the electrolyte to the cell from which it was taken. Replace vent cap.
- 9. Repeat steps 2 through 8 on all cells.



717 Figure 25-6 Hydrometer Test

Figure 25-7 Battery Electrolyte Level

Hydrometer Calibration

Most hydrometers are calibrated to read correctly at 80 °F (27 °C). The readings obtained as described above must be corrected for temperature. For each 10 °F (5.6 °C) above 80 °F (27 °C), add 0.004 to the reading. For each 10 °F (5.6 °C) below 80 °F (27 °C), subtract 0.004 from the reading.

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Interpreting the Results of the Hydrometer Test

The approximate state of charge can be determined by referring to the following table:

SPECIFIC GRAVITY (TEMPERATURE CORRECTED)	APPROXIMATE STATE OF CHARGE
1.250 to 1.280	100%
1.220 to 1.240	75%
1.190 to 1.210	50%
1.160 to 1.180	25%

If the difference between the cells is 0.020 or more, the low cell should be suspected. It may require a catch-up charge or it may be a weak cell. When the variations between cells reach 0.050 or more, the battery should be replaced.

Voltage Test

1. Take a voltage reading with a multimeter set to 20 VDC by placing the red (+) probe on the positive (+) battery post and the black (–) probe on the negative (–) battery post. If it shows less than 12.4 volts, or if the lowest specific gravity reading from the Hydrometer Test is less than 1.225, recharge the battery. If battery voltage is greater than 12.4 volts and specific gravity is greater than 1.225, the problem is not with the battery. If the battery does not reach 12.4 volts, or if the specific gravity of a cell is still less than 1.225 after charging, replace the battery. See following NOTE.

NOTE: A fully charged battery that is in good condition should have a specific gravity of at least 1.225 in all cells, and the difference in the specific gravity of any two cells should be less than 50 points. Open circuit voltage should be at least 12.4 volts.

Load Test

- 1. Connect a 160-ampere load tester to the battery posts.
- Turn the switch on the load tester to the ON position. 2.
- Read the battery voltage after the load tester has been turned ON for 15 seconds. Compare the battery's voltage reading with the following table. Make sure you have the correct ambient temperature.

IF TEMPERATURE IS	MINIMUM CRANKING VOLTAGE
70 °F (20 °C and above)	9.6 V
60 °F (16 °C)	9.5 V
50 °F (10 °C)	9.4 V
40 °F (4 °C)	9.3 V
30 °F (-1 °C)	9.1 V
20 °F (-7 °C)	8.9 V
10 °F (-12 °C)	8.7 V
0 °F (-18 °C)	8.5 V

If the battery is found to be good, or if the electrical problem continues after the battery has been replaced with a good one, test the electrical circuits.

TEST PROCEDURE 2 – Fuses

See General Warnings on page 1-2.

A WARNING

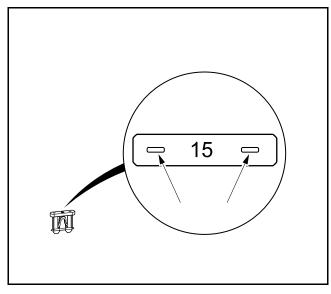
Failure to use properly rated fuse can result in a fire hazard.

NOTE: This vehicle uses three ATM-style blade fuses. A single ABC-style glass fuse is used for the Guardian/Visage 4-pin connector that is labeled "V3 circuit" on the harness.

This is a voltage test. It can be performed relatively easily on ATM-style fuses. A voltage test can be performed on the ABC-style glass fuse if insulation-piercing probes are used. Otherwise, the ABC-style will have to be removed to visually inspect or check using a continuity test.

ATM-style blade fuses are located on the main wire harness in front of the battery.

The ABC-style glass fuse is located on the main wire harness adjacent to the ATM-fuse holder.



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Figure 25-8 Testing ATM-style Blade Fuse

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Access the fuse but do not remove it.
- 3. **20-amp and 10-amp ATM Fuses Only:** With the battery and solenoid connected:
 - 3.1. Probe the two, small metal contacts on the top of the fuse (Figure 25-8, Page 25-19).
 - 3.2. Each contact should show battery voltage.
 - 3.3. If only one side shows battery voltage, replace fuse.
 - 3.4. If neither side of a fuse shows battery voltage, inspect the following locations:
 - Check condition and connection of large red wires at solenoid.
 - Check sonic weld_8 in main wire harness.
- 4. **5-amp ATM Fuse Only:** With the key switch in the ON position:

- 4.1. Probe the two, small metal contacts on the top of the fuse (Figure 25-8, Page 25-19).
- 4.2. Each contact should show battery voltage.
- 4.3. If only one side shows battery voltage, replace fuse.
- 4.4. If neither side of a fuse shows battery voltage, inspect the following locations:
 - Check the 10-amp fuse.
 - Check the key switch.
 - Check sonic weld_3 in main wire harness.
- 5. **2-amp ABC Glass Fuse Only:** With the key switch in the ON position:
 - 5.1. Probe the wire on each side of the fuse with insulation-piercing probes.
 - 5.2. Each probe should show battery voltage.
 - 5.3. If only one side shows battery voltage, replace fuse.
 - 5.4. If neither side of a fuse shows battery voltage, inspect the following locations:
 - Check the 10-amp fuse.
 - Check the key switch.
 - Check sonic weld_3 in main wire harness.

TEST PROCEDURE 3 – Ground Cables

See General Warnings on page 1-2.

NOTE: This is a continuity test for the main ground wire(s) of the vehicle. An additional ground wire is located on top of the fuel tank.

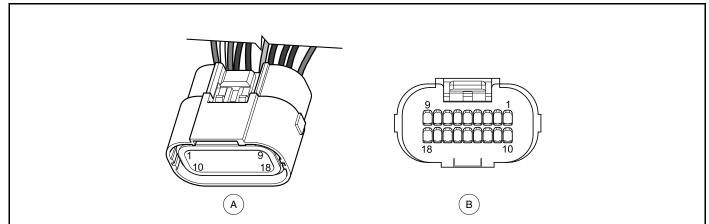
- 1. If necessary, see Testing Basics on page 25-14.
- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Check the following wires and cables for clean, tight connections and continuity:
 - Check the starter/generator ground cable (black wire) from A1 terminal to chassis or engine.
 - Check the engine ground cable from engine block to negative (-) main harness lead disconnected from battery.
 - Check the chassis ground cable from frame rail to negative (-) main harness lead disconnected from battery.
 - Disconnect voltage regulator from main harness. Check from black wire in 3-pin connector to negative (-)
 main harness lead disconnected from battery. This will test sonic weld _18 and sonic weld _1 in the main
 wire harness.
- 4. The reading should be continuity. If the reading is incorrect, clean and tighten cable connections. If the connections are good and the reading is incorrect, repair or replace the wire or cable.

TEST PROCEDURE 4 – EFI System (ECU and Sensors)

See General Warnings on page 1-2.

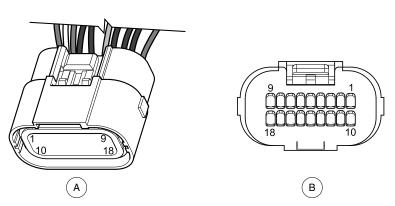
A WARNING

• This procedure involves testing voltage, resistance and continuity. If necessary, see Testing Basics on page 25-14.



18-PIN CONNECTOR (GRAY AND BLACK): A. ECU SIDE OF CONNECTOR B. WIRE ENTRY SIDE OF CONNECTOR

PIN I.D.	CONNECTOR COLOR	FUNCTION	TEST TYPE & PROBE BETWEEN LOCATIONS	TEST RESULT	CONDITION
1	Gray	Fuel Injector Control	Resistance: ECU Gray Pin 1 (Black/White) and ECU Gray Pin 10 (Red/White)	Approx. 12 ohms	Key OFF or ON
6	Gray	Engine Temperature Sensor Input	Resistance: ECU Gray Pin 6 (Orange/Blue) and ECU Gray Pin 15 (Black/Blue)	Approx. 11.5 kOhms @ 70 °F (21 °C) Resistance decreases as temperature rises.	Key OFF
9	Gray	Ignition Coil Input	Resistance: ECU Gray Pin 9 (White) and Ground	Approx. 10.1 kOhms	Key OFF
10	Gray	Fuel Injector Positive (+) Voltage from ECU	Voltage: ECU Gray Pin 10 (Red/White) and Ground	Battery Voltage	Plug connected to ECU and Key ON
13	Gray	MAP Sensor Input	Voltage: ECU Gray Pin 13 (Green/Yellow) and Ground	Approx. 3.9 volts @ sea level & engine OFF / 3.0 volts engine running. Voltage decreases as pressure decreases.	Key ON and engine running
15	Gray	Engine Temperature Sensor Ground	Continuity: ECU Gray Pin 15 (Black/Blue) and Ground	Meter should beep	Key OFF
16	Gray	MAP Sensor Reference Voltage (+5)	Voltage: ECU Gray Pin 16 (Red/Yellow) and ECU Gray Pin 17 (Black/Yellow)	Approx. 5 volts	Key ON



18-PIN CONNECTOR (GRAY AND BLACK): A. ECU SIDE OF CONNECTOR B. WIRE ENTRY SIDE OF CONNECTOR

	18-PIN CONNECTOR (GRAY AND BLACK): A. ECU SIDE OF CONNECTOR B. WIRE ENTRY SIDE OF CONNECTOR				
PIN I.D.	CONNECTOR COLOR	FUNCTION	TEST TYPE & PROBE BETWEEN LOCATIONS	TEST RESULT	CONDITION
			Continuity: ECU Gray Pin 17 (Black/Yellow) and Ground	Meter should beep	Key OFF
17	Gray	MAP Sensor Ground	Voltage: ECU Gray Pin 17 (Black/Yellow) and Battery (+) Terminal	-Battery Voltage	Key OFF
1	Black	Fuel Pump Input	Voltage: ECU Black Pin 1 (Black/White) and ECU Black Pin 10 (Black)	Battery Voltage (after pump stops running)	Key ON
				Meter should beep	Key OFF
3	Black	Ignition OFF Input	Continuity: ECU Black Pin 3 (White/Black) and Ground	Meter should NOT beep	Key ON
7	Black	Low Oil Sensor Input	Resistance: ECU Black Pin 7 (Yellow) and Ground	Approx. 2.3 kOhms	Key OFF
8	Black	Connected Car Link	Voltage: ECU Black Pin 8 (Blue) and Ground	11.8 volts	Key ON
9	Black	B+ Input	Voltage: ECU Black Pin 9 (Red) and ECU Black Pin 10 (Black)	Battery Voltage	Key ON
		Ground for ECU	Continuity: ECU Black Pin 10 (Black) and Ground	Meter should beep	Key OFF
10	Black	Power	Voltage: ECU Black Pin 10 (Black) and Battery (+) Terminal	-Battery Voltage	Key OFF
11	Black	Diagnosis (low oil) Lamp Control	Voltage: ECU Black Pin 11 (Yellow) and Ground	Less than 1 Volt initially. 7 to 8 volts after lamp is OFF.	Key ON
					Key OFF with:
12	Black	Foot Input	ot Input Continuity: ECU Black Pin 12 (White/Black) and Black Pin 18 (Black)	Meter should beep	Accel. Pedal UP
			TITI TO (DIACK)	Infinity	Accel. Pedal DOWN
		Cround for ECL	Continuity: ECU Black Pin 18 (Black) and Ground	Meter should beep	Key OFF
18	Black	Ground for ECU Housing	Voltage: ECU Black Pin 18 (Black) and Battery (+) Terminal	-Battery Voltage	Key OFF

TEST PROCEDURE 5 - Key Switch (Start Circuit)

See General Warnings on page 1-2.

NOTE: This is a voltage test.

The key switch provides power and KEY INPUT to the ECU.

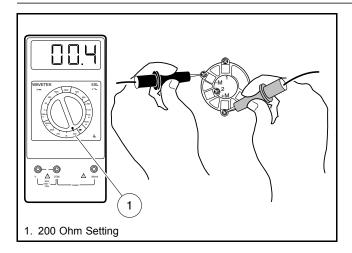
- 1. If necessary, see Testing Basics on page 25-14.
- 2. Remove instrument panel to access the back of the key switch but do not disconnect wires. **See Instrument Panel Removal, Section 4, Page 4-7.**
- 3. With the key switch in the OFF position:
 - The red wire should show battery voltage coming to the switch.
 - The blue wire should show zero (0) volts. If it shows battery voltage, the switch has failed CLOSED and must be replaced.
- 4. With the key switch in the ON position:
 - The blue wire should show battery voltage passing through the key switch to a sonic weld in the instrument panel harness, the 9-pin connector, sonic weld_3, the 5-amp fuse, the solenoid, and the 4-pin connected car plug. If it does not show battery voltage, the switch has failed OPEN and must be replaced.

TEST PROCEDURE 6 – Key Switch (Engine Kill Circuit)

See General Warnings on page 1-2.

NOTE: This is a continuity test.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Remove the instrument panel. See Instrument Panel Removal, Section 4, Page 4-7.
- 4. Disconnect wires from the (+M) and (-M) terminals of the key switch (Figure 25-9, Page 25-24).
- 5. Place the red (+) probe on the (+M) terminal and the black (–) probe on the (–M) terminal. With the key switch OFF, the reading should be continuity. With the key switch ON, the reading should be no continuity. If either reading is incorrect, replace the key switch.
- 6. Connect wires to the key switch. Make sure wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 7. Install dash panel in reverse order of removal.



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Figure 25-9 Key Switch Test - Engine Kill Circuit

TEST PROCEDURE 7 – Throttle Position Sensor (TPS)

The throttle position sensor performs the function of two limit switches: the accelerator pedal limit switch and the kill limit switch. This sensor is sealed and is not to be repaired or replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced. **See Accelerator Pedal Removal on page 5-6.** The sensor is joined to the main wire harness through a six-pin connector. Tests for the sensor are found in the following two procedures.

Accelerator Pedal Limit Switch Function

See General Warnings on page 1-2.

The green and orange wires connect to the accelerator pedal limit switch function of the throttle position sensor. This is the normally open (NO) portion of the circuit used to energize the starter solenoid.

NOTE: Keep the battery connected while performing this test procedure.

- Place the neutral lockout switch in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect the spark plug wire from the spark plug.
- 3. Disconnect gray 18-pin connector from ECU.
- 4. With battery connected and using a multimeter set to the diode test function (ç), attach the red (+) lead to the orange wire at the starter solenoid and the black (-) lead to the green wire at the limit switch located on the Forward/Reverse shifter assembly. **See following NOTE**.

NOTE: It may be necessary to partially pull the green wire from the switch terminal to attach the black lead.

- 5. Turn the key switch to the ON position. With accelerator pedal at rest in the fully raised position, the meter should indicate an over limit (no continuity) condition.
- Press the accelerator to engage the starter and engine. With accelerator pedal pressed, the meter should indicate approximately 1.0 volt. If either reading is incorrect, replace the accelerator pedal assembly. See Accelerator Pedal Removal on page 5-6.

Kill Limit Switch Function

See General Warnings on page 1-2.

The black and white/black wires connect to the kill limit switch function of the throttle position sensor. This is the normally closed (NC) portion of the circuit used to ground the ignition and shut the engine off when the pedal is released.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout switch in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect gray 18-pin connector from ECU.
- 3. Disconnect the spark plug wire from the spark plug.
- 4. With battery connected and using a multimeter set to the diode test function (ç), attach the red (+) lead to the negative (–) battery terminal and the black (-) lead to the white/black wire at the limit switch located on the Forward/Reverse shifter assembly. **See following NOTE.**

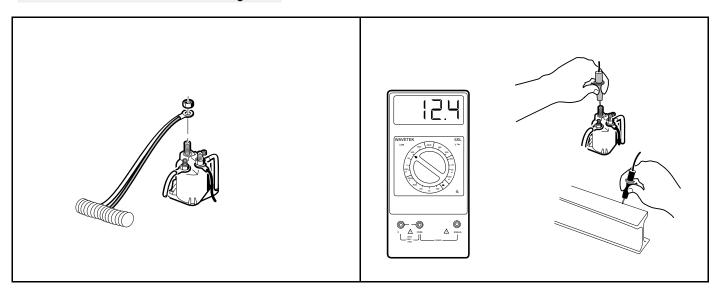
NOTE: It may be necessary to partially pull the white/black wire from the switch terminal to attach the black lead.

- 5. Turn the key switch to the ON position. With accelerator pedal at rest in the fully raised position, the meter should indicate approximately 1.0 volt.
- 6. Press the accelerator to engage the starter and engine. With accelerator pedal pressed, the meter should indicate an over limit (no continuity) condition. If either reading is incorrect, replace the accelerator pedal assembly. See Accelerator Pedal Removal on page 5-6.

TEST PROCEDURE 8 - Solenoid

See General Warnings on page 1-2.

NOTE: This is a resistance and voltage test.



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Figure 25-10 Solenoid Wire Removal

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Figure 25-11 Solenoid Ground Test

- If necessary, see Testing Basics on page 25-14.
- 2. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 3. **Coil Side:** Check resistance across the small posts of the solenoid. The reading should be 14 to 16 ohms. If the reading is not within limits, replace the solenoid.
- 4. Contact Side: Remove the heavy-gauge white wire and 16-gauge red wire from the large post of the solenoid (Figure 25-10, Page 25-26). Do not allow the wires to touch the frame or other components of the vehicle. Cover the other large post.
 - 4.1. Place Forward/Reverse handle in the NEUTRAL position, neutral lockout switch in the MAINTENANCE position, and key switch in the ON position.
 - 4.2. Check voltage between the empty large post and ground (Figure 25-11, Page 25-26).
 - With accelerator pedal in the UP position: The meter should read no voltage.
 - With accelerator pedal pressed: The solenoid should click and the meter should read battery voltage.
 - 4.3. If the readings are incorrect, replace solenoid. See Solenoid Removal, Section 26, Page 26-16.

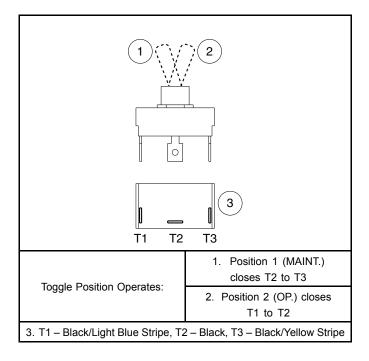
TEST PROCEDURE 9 - Maintenance/Operate Switch - Pedal-Start Vehicles

See General Warnings on page 1-2.

NOTE: This is a continuity test.

The Maintenance/Operate Switch is also known as the Neutral Lockout Switch.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Remove wires from switch (Figure 25-12, Page 25-27).
- 3. With switch in position 1 (MAINTENANCE):
 - 3.1. Check for no continuity between terminals T1 and T2.
 - 3.2. Check for continuity between terminals T2 and T3.
- 4. With switch in position 2 (OPERATE):
 - 4.1. Check for no continuity between terminals T2 and T3.
 - 4.2. Check for continuity between terminals T1 and T2.



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Figure 25-12 Maintenance/Operate Switch Test – for Pedal-Start Vehicles

- 5. If switch:
 - 5.1. does not work as stated in previous steps, replace switch.
 - 5.2. does work as stated and the MAINTENANCE/OPERATE modes still do not work:
 - Check the limit switches.
 - Check continuity of the wires involved.

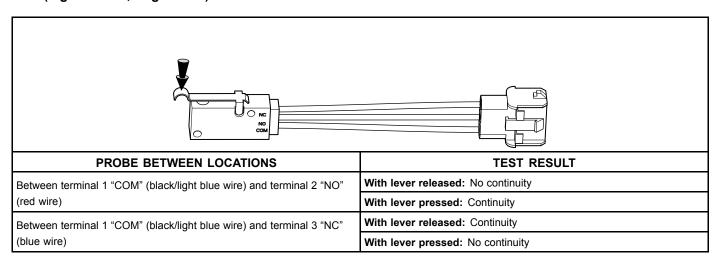
TEST PROCEDURE 10 - Neutral Lockout Limit Switch - Pedal-Start Vehicles Only

See General Warnings on page 1-2.

NOTE: This is a continuity test.

This switch is located on the transaxle. A black/light blue wire, a red wire, and a blue wire are connected to this limit switch with a 3-pin connector.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- At transaxle, disconnect neutral lockout limit switch three-wire lead from main wire harness.
- 4. Check to be sure the cam lobe on the shift lever is pressing the neutral lockout limit switch as the Forward/Reverse shifter is being shifted. The limit switch should make an audible click as it is pressed. If it does not, check for wear on the cam lobe and replace shift lever if necessary.
- 5. Check the following terminals for no continuity with the lever released and continuity with the lever engaged (Figure 25-13, Page 25-28):



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Figure 25-13 Neutral Lockout Limit Switch Test

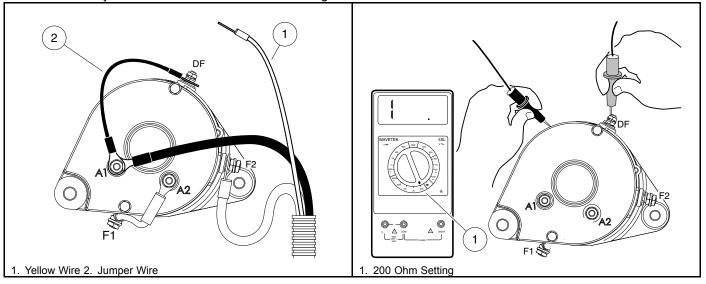
 If switch does not work as stated in previous step, replace switch. See Neutral Lockout Limit Switch Removal, Section 26, Page 26-15.

TEST PROCEDURE 11 – Starter/Generator (Generator Function)

See General Warnings on page 1-2.

NOTE: This is a voltage test.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
- 3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 4. Disconnect yellow wire from DF terminal on starter/generator. Cover terminal on yellow wire to make sure it will not short to ground. Then, using a jumper wire, ground DF terminal to A1 terminal (Figure 25-14, Page 25-29).
- 5. Using a multimeter set to 20 volts DC, place the red (+) probe on the positive (+) post of the battery, and place the black (–) probe on the negative (–) post. Start the engine and run it at full governed speed. The reading should show the voltage rising on the meter. If the voltage rises above 15.3 volts DC, test the voltage regulator. See Voltage Regulator on page 25-31. If the voltage does not rise, a tear-down inspection of the starter/generator will be necessary. See Starter/Generator Removal on page 26-1.
- 6. Remove jumper wire.
- 7. Reconnect yellow wire to DF terminal on starter/generator.



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Figure 25-14 Jumper Wire Ground - DF to A1

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Figure 25-15 Check Starter Terminal Continuity

TEST PROCEDURE 12 – Starter/Generator (Starter Function)

See General Warnings on page 1-2.

NOTE: Observe the following before testing the starter/generator:

- · This is only testing continuity.
- Tag the starter/generator wires for identification before disconnecting.
- Remove starter/generator wire from one of the "A" terminals and one of the "F" terminals if testing while starter/generator is in vehicle.
- When disconnecting wires from starter/generator terminals, use a second wrench on the lower nut of the terminal post to hold post steady.

 Scrape a small amount of paint from starter/generator housing (ground) and use this location when testing motor terminals to electrical ground.

MOTOR TERMINALS	CONTINUITY TEST RESULT
A1 to A2 F1 to F2	Continuity
A1 to F1 A1 to F2	No Continuity
A2 to F1 A2 to F2	No Continuity
A1 to Ground A2 to Ground	No Continuity
F1 to Ground F2 to Ground	No Continuity

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Disconnect the wires from all the terminals on the starter/generator. Then place the black (–) probe of a multimeter, set to 200 ohms, on the starter/generator housing (scratch through the finish to ensure a good ground). While holding the black (–) probe against the housing, place the red (+) probe (one at a time) on the A1, A2, F1, F2 and DF terminals respectively (Figure 25-15, Page 25-29). The readings should be no continuity. If the readings are incorrect, the starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Starter/Generator Removal on page 26-1.
 - An incorrect reading from the A1 or A2 terminal indicates three possible problems: 1) a grounded A1 or A2 terminal, 2) a grounded wire in the brush area, or 3) a grounded armature/commutator.
 - If the F1 or F2 reading is incorrect, it indicates a possible grounded F1 or F2 terminal or a grounded field coil.
 - If the DF reading is incorrect, it indicates a possible grounded DF terminal or a grounded field coil.
- 4. Using a multimeter set to 200 ohms, place the red (+) probe on the A1 terminal and the black (–) probe on the A2 terminal. The reading should be continuity. If the reading is incorrect, a possible open or poor contact in a brush assembly and/or open armature windings may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Starter/Generator Removal on page 26-1.
- 5. With the wires still disconnected, using a multimeter set on 200 ohms, place the red (+) probe on the F1 terminal and the black (–) probe on the F2 terminal. The reading should be between approximately 0.1 and 0.3 ohms. If the reading is incorrect, a possible open field coil or bad connections at terminals may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Starter/Generator Removal on page 26-1.
- 6. With the wires still disconnected, using a multimeter set to 200 ohms, place the red (+) probe on the DF terminal and the black (–) probe on the F1 terminal. The reading should be between 4.5 and 5.5 ohms. If the reading is incorrect, a possible grounded DF terminal and/or grounded field coil may be the cause. The starter/generator will need to be removed from the vehicle and disassembled by a qualified technician. See Starter/Generator Removal on page 26-1.

Ensure that wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.

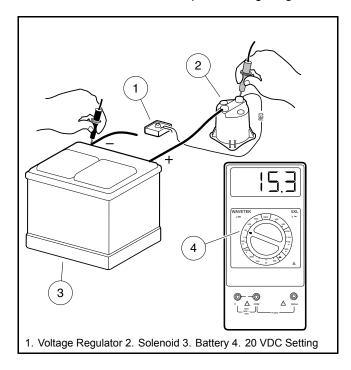
TEST PROCEDURE 13 - Voltage Regulator

See General Warnings on page 1-2.

NOTE: This is a voltage test.

Keep the battery connected while performing this test procedure.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
- 3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
- 4. Check the engine RPM setting to ensure that it is adjusted correctly. **See Engine RPM Adjustment on page 28-11.**
- 5. With the battery in good condition and fully charged, run the engine for several minutes to bring the voltage regulator to operating temperature.
- 6. Turn the key switch to the OFF position, killing the engine. Using a multimeter set to 20 volts DC, place the red (+) probe on the large post of the solenoid with the red wire from the voltage regulator attached. Place the black (–) probe on the negative (–) battery post (Figure 25-16, Page 25-31). Turn the key switch to the ON position. Press the accelerator to start the engine and run it at full governed speed. If the reading is between 14.7 and 15.3 volts, the regulator is good. If the reading is lower than 14.7 volts but rising steadily, check battery condition. If the reading is lower than 14.7 volts and not rising, and the starter/generator is good; or if the reading is over 15.3 volts and continues to rise, replace voltage regulator. See Voltage Regulator Removal, Section 26, Page 26-12.



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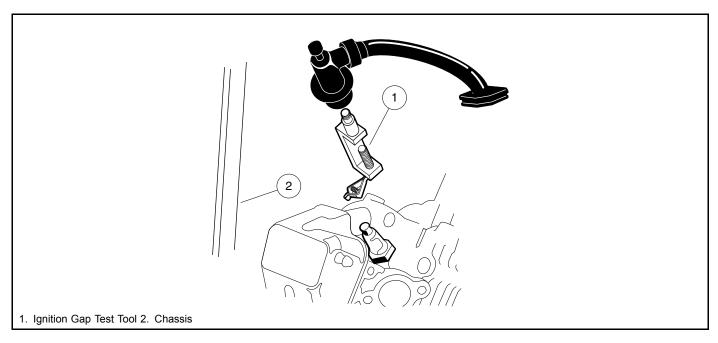
Figure 25-16 Voltage Regulator Test

TEST PROCEDURE 14 – Ignition Spark

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- If necessary, see Testing Basics on page 25-14.
- 2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
- 3. Remove the plug wire from the spark plug. Using an ignition spark gap test tool (Thexton 404® or equivalent), check for correct spark (Figure 25-17, Page 25-32).
 - 3.1. Adjust the tester probes to approximately 18,000 volts (18 kV) setting (SE *Small Engine Setting* on the Thexton 404 tool). Connect the tester to the spark plug wire, and connect the alligator clip to a solid engine ground.
 - 3.2. Start the engine. There should be a strong blue spark between the probes of the spark gap tester. If there is no spark, or if the spark is a faint yellow or red color, test components of the ignition circuit. **See Ignition Coil on page 25-33.**
- 4. If the spark gap tester tool indicates a strong blue spark, it is possible the spark plug has failed internally. Check the spark plug gap. The gap should be set at 0.024 to 0.028 in. (0.6 to 0.7 mm). If the gap is correct, replace the spark plug with a new part and test the engine for proper operation.



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Figure 25-17 Ignition Spark Test

TEST PROCEDURE 15 – Ignition Coil

See General Warnings on page 1-2.

NOTE: This is a resistance test.

The following test procedures will properly detect a coil that has failed in most cases; however, in rare cases, some ignition coils can fail to operate at normal (warmer) operating temperatures. If the ignition coil has tested okay in the vehicle and on the bench, but fails to operate reliably, replace the coil with a known good coil and operate the engine for several minutes to ensure that the coil functions at normal operating temperature. If the new coil functions properly, keep the new coil in the circuit.

NOTE: Resistance value ranges given in these tests reflect a tolerance of ±40%.

Please note that these values are rough standard and it is impossible to reach an exact conclusion with the resistance reading.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. At engine, access white wire in ECU wire harness that connects to ignition coil lead at back of engine.
- 4. Using a multimeter set to 200k ohms, measure resistance between the following locations listed in table below.

IGNITION COIL TERMINALS	TEST RESULT
White Signal Wire to Ground	9 to 11 kOhms
White Signal Wire to Spark Plug Cap	17 to 20 kOhms
Spark Plug Cap to Ground	8 to 13 kOhms

TEST PROCEDURE 16 - Reverse Buzzer and Reverse Buzzer Limit Switch

See General Warnings on page 1-2.

NOTE: Reverse Buzzer: This is a voltage test.

Reverse Buzzer Limit Switch: This is a continuity test.

A reverse buzzer is mounted on the back side of the instrument panel. On some models, another reverse buzzer is also mounted on a bracket at the left rear of the vehicle. The reverse buzzer is powered by the 10-amp ATM fuse located on the main wire harness in front of the engine.

The reverse buzzer limit switch is located on the Forward/Reverse shifter. Red/white and orange wires are connected to it.

- 1. If necessary, see Testing Basics on page 25-14.
- To test the front reverse buzzer, remove instrument panel. See Instrument Panel Removal, Section 4, Page 4-7.
- 3. Check for proper wiring and tight connections.
- 4. Check that battery voltage is present in the red/white wire at buzzer.
- 5. Place the Forward/Reverse handle in the REVERSE position. The buzzer should sound. If not, check limit switch in the next steps.
- 6. Disconnect black wire from buzzer.
- 7. With Forward/Reverse handle still in the REVERSE position, there should be continuity between the black wire and ground. With Forward/Reverse handle still in the FORWARD position, there should be no continuity. If either reading is incorrect, replace limit switch. See Reverse Buzzer Limit Switch Removal, Section 26, Page 26-20.
- If limit switch is operating properly, replace buzzer. See Reverse Warning Buzzer Removal, Section 26, Page 26-18.

TEST PROCEDURE 17 – Low Oil Warning Light (LED)

See General Warnings on page 1-2.

NOTE: This is a voltage test.

When the key switch is placed in the ON position, the Low Oil Warning Light will illuminate for approximately 3 seconds as a bulb check function.

- 1. If low oil warning light does not illuminate for approximately 3 seconds when the key switch is placed in the ON position, proceed with the steps below.
- 2. If necessary, see Testing Basics on page 25-14.
- 3. Remove the instrument panel. See Instrument Panel Removal, Section 4, Page 4-7.
- 4. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary. **See Wiring Diagrams on page 25-8.**
- 5. With key switch in ON position, test for battery voltage at yellow/white wire to low oil warning light. If no voltage, check key switch. See Key Switch (Start Circuit) on page 25-23.
- 6. If battery voltage is present, use a test lead to ground the yellow wire terminal of low oil warning light. Light should illuminate. If not, replace low oil warning light.

TEST PROCEDURE 18 - Oil Level Sensor

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

This procedure requires the oil to be drained from the engine.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Place the Forward/Reverse handle in the NEUTRAL position, the neutral lockout switch in the MAINTENANCE position, turn the key switch to the OFF position, disconnect the spark plug wire, and chock the wheels.
- 3. Ensure that the low oil warning light and all connecting wires are functioning correctly. See Low Oil Warning Light (LED) on page 25-34.
- 4. Drain the engine oil into an approved container and properly dispose of used oil.
- 5. Turn the key switch ON, closing the circuit. The low oil warning light should illuminate. If the low oil warning light does not illuminate, the oil level sensor needs to be replaced. See Oil Level Sensor Removal on page 27-12.
- 6. Fill the engine with new oil before returning the vehicle to service. **See Engine Oil Gasoline Vehicle on page 27-2.**

TEST PROCEDURE 19 – Battery Test (Under Load)

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Place the Forward/Reverse handle in the NEUTRAL position and the neutral lockout switch in the MAINTENANCE position. Chock the wheels.
- 3. Set a multimeter to 20 volts DC and place the red (+) probe on the F2 (white wire) terminal on the starter/generator. Place the black (–) probe on the negative (–) battery post.
- 4. Turn the key switch to the ON position, leave the Forward/Reverse shifter in the NEUTRAL position and press the accelerator pedal (with the accelerator pedal pressed, the battery is under load).
 - 4.1. If the voltage reading is over 9.6 volts, with an electrolyte temperature of 70 °F (21 °C), check the starter/generator. **See following NOTE.**

NOTE: The voltage reading listed is for electrolyte at 70 °F (21 °C). At lower electrolyte temperatures the voltage reading will be lower.

- 5. If the reading is below 9.6 volts, with an electrolyte temperature of 70 °F (21 °C), check the battery. **See Battery on page 25-16.**
 - 5.1. If the reading is zero, there may be no continuity across the large posts of the solenoid. **See Solenoid** on page 25-26.
- 6. If all of the test results are good and the voltage reading is zero, there may be a broken or damaged heavy-gauge white wire from the solenoid to the starter/generator. See Starter/Generator (Starter Function) on page 25-29.

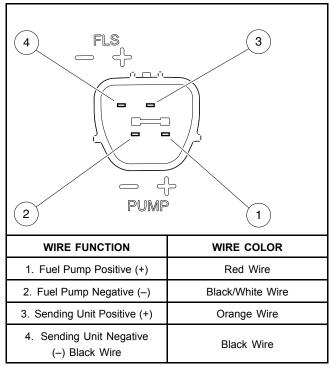
TEST PROCEDURE 20 - Fuel Pump

See General Warnings on page 1-2.

WARNING

 To avoid the possibility of fire or explosion, make sure the fuel tank cap is securely in place while performing this test procedure.

NOTE: This is a voltage and resistance test.



3031

Figure 25-18 Fuel Pump Module Terminals

Voltage to Pump

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect the 5-pin connector from the top of the fuel pump module.
- 3. Check that battery voltage is present between ground and the red wire of the 5-pin connector immediately after the key switch is placed in the ON position.

NOTE: The fuel pump and low oil warning light operate for a few seconds when key switch is turned to the ON position; it stops if no engine RPM is detected by the ECU.

4. If no voltage, check key switch. See Key Switch (Start Circuit) on page 25-23.

Pump

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Disconnect the 5-pin connector from the top of the fuel pump module.
- 4. Probe between pin (1) and pin (2) terminals in module (Figure 25-18, Page 25-36).

- 4.1. The reading should be approximately 2 to 5 ohms. If the reading indicates no resistance, the fuel pump has failed and the fuel pump module must be replaced. **See Fuel Pump Module Removal on page 28-17.**
- 4.2. If the reading is correct and the fuel pump does not function correctly, check the continuity of the red wire from the fuel pump to the red wire of the black 18-pin ECU connector. This red wire contains sonic weld 11. Leave the battery disconnected while checking continuity. Also, check the continuity of the black/white wire from the fuel pump to the black/white wire of the black 18-pin ECU connector.

TEST PROCEDURE 21 – Fuel Level Sending Unit

See General Warnings on page 1-2.

WARNING

• To avoid the possibility of fire or explosion, make sure the fuel tank cap is securely in place while performing this test procedure.

NOTE: This is a resistance test.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Disconnect the 5-pin connector from the top of the fuel pump module.
- 4. Probe between pin (3) and pin (4) terminals in module (Figure 25-18, Page 25-36).
- 5. The following resistance readings (in ohms) should be obtained depending on the position of the float inside the fuel tank. The resistance reading will vary according to the exact position of the float. The chart below may be used as a guideline to determine if the fuel level sending unit is operating correctly. Make sure the float is at the surface of the fuel in the tank.

FLOAT POSITION	RESISTANCE READING	FUEL GAUGE READINGS
Lower position (tank empty)	250 ohms (±10)	Empty
Center position (tank half full)	141 ohms (±8)	Half full
Upper position (tank full)	33.3 ohms (±6)	Full

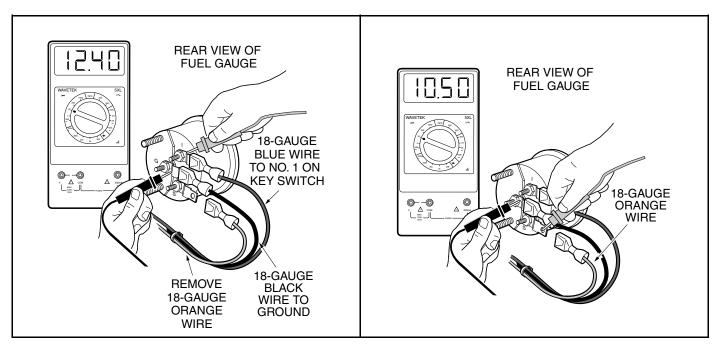
- 6. If the readings are within the specifications listed above, the fuel level sending unit is working properly. If the readings are incorrect, the fuel level sending unit has failed and the fuel pump module must be replaced. **See Fuel Pump Module Removal on page 28-17.**
- 7. If the readings are correct and the fuel gauge does not function correctly, check the continuity of the orange wire from the fuel level sending unit to the orange wire on the fuel gauge/hour meter. Leave the battery disconnected while checking continuity. Also check the continuity of the blue wire from the fuel gauge/hour meter to the blue wire on the key switch, and the black ground wires at the fuel level sending unit and at the fuel gauge/hour meter.
- 8. If the readings are correct according to the position of the float, but give an incorrect reading on the fuel gauge, test the fuel gauge. **See Fuel Gauge on page 25-38.**

TEST PROCEDURE 22 - Fuel Gauge

See General Warnings on page 1-2.

NOTE: This is a voltage test.

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
- 3. Remove the instrument panel to gain access to the back of the fuel gauge. See Key Switch Removal on page 26-14.
- 4. Disconnect the orange wire from the fuel gauge.
- 5. Set a multimeter to 20 volts DC and place the red (+) probe of the multimeter on the blue wire terminal of the fuel gauge. Place the black (–) probe on the black wire terminal of the fuel gauge (Figure 25-19, Page 25-38).
- 6. Turn the key switch ON. The voltage reading should be battery voltage. If not, check the continuity of the blue and black wires (Figure 25-19, Page 25-38).
- 7. The orange wire should remain disconnected for this step. With the black probe still on the black wire terminal of the fuel gauge, place the red (+) probe of the multimeter on the terminal for the orange wire. The voltage reading should be battery voltage or less depending on fuel level. If the reading is incorrect, replace fuel gauge (Figure 25-20, Page 25-38).



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2429 Figure 25-19 Fuel Gauge Test

Figure 25-20 Fuel Gauge Voltage Test

TEST PROCEDURE 23 – Hour Meter

See General Warnings on page 1-2.

NOTE: Keep the battery connected while performing this test procedure.

- 1. Place the neutral lockout cam in the MAINTENANCE position, put the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Turn the key switch to ON and record the current hour meter reading.
- 3. Press and hold the accelerator pedal to run the engine for at least six minutes (the meter records in six-minute increments). **See following DANGER.**

A DANGER

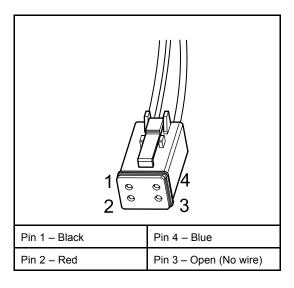
- Do not operate vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- 4. If the reading does not change after six minutes, then replace the hour meter.

TEST PROCEDURE 24 – 4-Pin Connector (for Connected Car Device)

See General Warnings on page 1-2.

NOTE: This is a voltage and continuity test.

The Connected Car Device 4-pin connector is used for Guardian/Visage and is labeled "V3 circuit" on the main wire harness.



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Figure 25-21 4-Pin Connector

- 1. If necessary, see Testing Basics on page 25-14.
- 2. Check for continuity between pin 1 (black wire) (Figure 25-21, Page 25-40) and pin 18 (black wire) of the black 18-pin connector on the ECU. It should indicate continuity. If not, check sonic welds no. 4, 10, and 14.
- 3. Probe pin 2 (red wire). It should show battery voltage with the key switch in the ON position. If not, check 2-amp fuse near ATM fuse holder. **See following NOTE.**

NOTE: The red wire only has battery voltage with the key switch in the ON position.

4. Probe pin 4 (blue wire). It should show approximately 11.8 volts supplied by pin 8 (blue/white wire) of the black 18-pin connector on the ECU. If not, check wiring and then ECU. **See following NOTE.**

NOTE: The blue wire only has voltage with the key switch in the ON position.

If pin 4 has no voltage, the ECU LIN (Local Interconnect bus) may have failed. The vehicle can be driven if it is not used with Guardian or Visage and will not show any symptoms. Otherwise, Guardian or Visage will disable the vehicle until communication is restored.

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

STARTER/GENERATOR

See General Warnings on page 1-2.

TESTING THE STARTER/GENERATOR

See Test Procedure 12 – Starter/Generator (Starter Function) on page 25-29.

See Test Procedure 11 - Starter/Generator (Generator Function) on page 25-29.

STARTER/GENERATOR REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. Place the neutral lockout switch in the MAINTENANCE position. Access the engine compartment by removing the seat or raising the cargo bed.
- 3. Disconnect the wires from the starter/generator (1) (Figure 26-13, Page 26-10).
- 4. Loosen the pivot nuts (7) and bolts (5) (Figure 26-12, Page 26-9).
- 5. Remove the adjustment nut (4), washer (6) and adjustment bolt (1) **(Figure 26-12, Page 26-9)**. Lower the starter/generator and remove the belt (2) from the pulley.
- 6. Support the starter/generator so that when the pivot bolts (5) are removed the starter/generator will not fall. Remove the two pivot nuts (7) and bolts (5) from the mounting bracket.
- 7. Remove the starter/generator.

DISASSEMBLY OF THE STARTER/GENERATOR TO SERVICE THE BRUSHES

1. Remove the two bolts (20) and pull commutator end cover (23) free of starter/generator housing (24) (Figure 26-1, Page 26-2). See following NOTE.

NOTE: If the brushes are not removed, contact between the brushes and commutator as the commutator end cover is being removed or installed could damage the brushes. Lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover (**Figure 26-5**, **Page 26-3**).

2. Remove brush covers (29 and 30), screws (25) and lock washers (26), brush springs (28), and brushes (27) (Figure 26-2, Page 26-2). See following NOTE.

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NOTE: To clean and inspect the armature/commutator and the bearings, see Disassembly of the Starter/Generator to Service the Armature/Commutator on page 26-4.

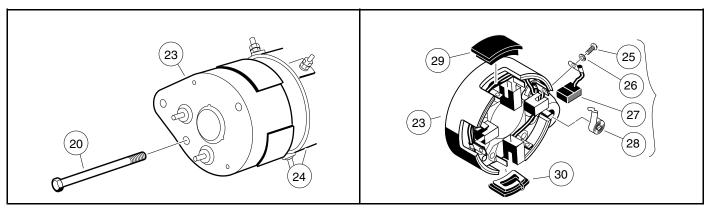


Figure 26-1 Commutator End Cover

Figure 26-2 Brush Covers and Brushes

BRUSH INSPECTION AND REPLACEMENT

- 1. Visually inspect brushes. Replace brushes that are cracked or severely chipped.
- 2. Check the wear line on the side of the brush. If the end of the brush is within 1/16 inch (1.6 mm) of the wear line, replace all four brushes (Figure 26-3, Page 26-2).

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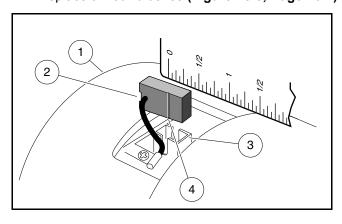


Figure 26-3 Inspect Brushes

BRUSH SPRING INSPECTION AND REPLACEMENT

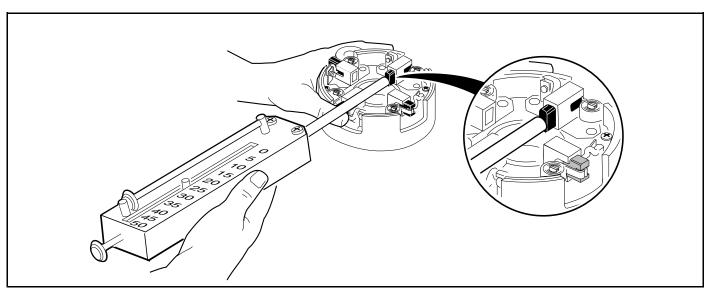
- 1. Visually inspect springs. Replace all four springs if any spring is discolored from heat (straw or bluish in color).
- Install the four brushes (27) into their holders and insert the four brush springs (28) (Figure 26-2, Page 26-2).
 Using a spring scale, test brush spring tension. If any spring has a tension less than 24 ozf (0.68 kgf), replace all four springs (Figure 26-4, Page 26-3). See following CAUTION.

A CAUTION

 When checking brush spring tension, do not push springs beyond the point they would normally be if there were new brushes installed. Exerting excessive force or pushing brush springs beyond their normal maximum extension point will damage springs.

CAUTION CONTINUED ON NEXT PAGE

A CAUTION

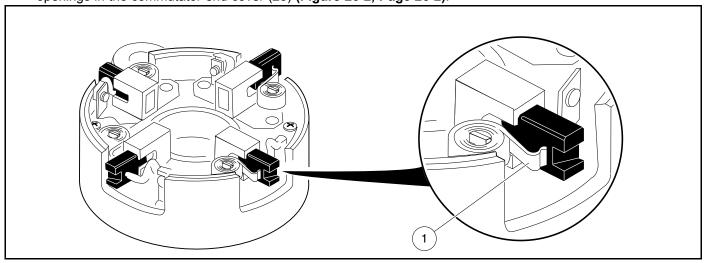


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Figure 26-4 Brush Spring Tension Test

STARTER/GENERATOR ASSEMBLY

- 1. Connect the brush wires to the holders using four lock washers (26) and four screws (25), making sure the crossover leads are connected also. Tighten the screws to 31 in lb (3.5 N·m) (Figure 26-2, Page 26-2).
- 2. To prevent contact between the brushes and commutator as the commutator is installed, and possible damage to the brushes, lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover (Figure 26-5, Page 26-3).
- 3. Install the commutator end cover (23) onto the armature shaft. Align the locating pin with the pin hole in the cover. Install two M6 x 180 mm bolts (20) and tighten to 100 in·lb (11.3 N·m) (Figure 26-1, Page 26-2).
- 4. Push the brushes down into the holders. Position springs into the notches in the brushes. Install the brush cover (30) that has the drain hole in it next to the A2 terminal. Install the remaining three brush covers (29) in the openings in the commutator end cover (23) (Figure 26-2, Page 26-2).

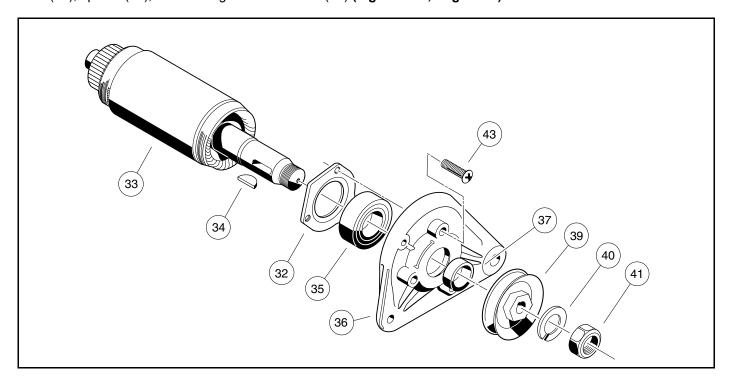


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Figure 26-5 Pull Brushes Away From Center of the Commutator End Cover

DISASSEMBLY OF THE STARTER/GENERATOR TO SERVICE THE ARMATURE/COMMUTATOR

- 1. If the brushes are not removed, contact between the brushes and commutator as the commutator end cover is being removed or installed could damage the brushes.
 - 1.1. Lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover (Figure 26-5, Page 26-3).
- 2. Remove the two bolts (20), and pull commutator end cover (23) free of the starter/generator housing (24) (Figure 26-1, Page 26-2).
- 3. To separate armature (33) from output end cover (36), remove nut (41), lock washer (40), pulley (39), shaft key (34), spacer (37), and bearing retainer screws (43) (Figure 26-6, Page 26-4).

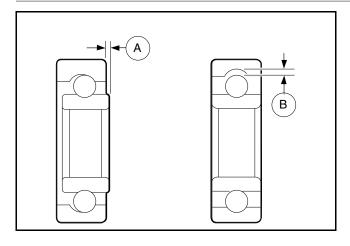


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Figure 26-6 Armature and Output End Cover Assembly

BEARING CLEANING AND INSPECTION

- 1. Using a clean cloth, wipe the carbon dust from the two bearings. Inspect bearings by spinning them by hand and checking for both axial (A) and radial (B) play (Figure 26-7, Page 26-5).
- 2. Replace the bearing if it is noisy, does not spin smoothly, or has excessive play. Check the bearings and replace if rusted, worn, cracked, or if there is an abnormal color change in the metal of the bearing. Bearings should be replaced if there is extensive wear or pitting on the balls or on the rolling surfaces. Do not remove the bearings unless they are to be replaced.

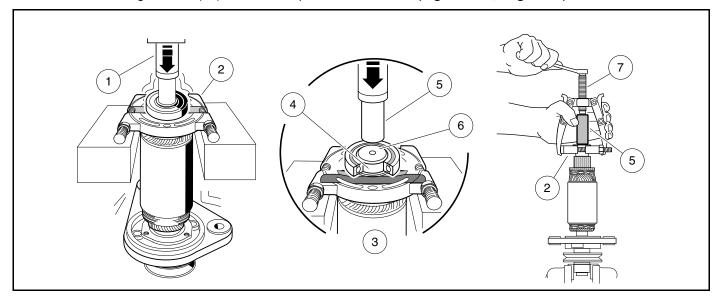


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Figure 26-7 Bearing Play Inspection

BEARING REMOVAL

- 1. Place the wedge attachment tool (CC P/N 1012812) between the bearing and the armature. Make sure the wedge attachment tool is supporting the inner race of the bearing. If a press is not available, secure a bearing puller (CC P/N 1012811) to the wedge attachment tool and pull the bearing off of the end of the armature shaft. Support the armature so that it will not drop when the bearing is removed (Figure 26-8, Page 26-5).
- 2. Discard the bearings.
- 3. Slide the bearing retainer (32) off of the output end of the shaft (Figure 26-6, Page 26-4).



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Figure 26-8 Bearing Removal

FIELD COIL REMOVAL

1. Remove the retaining nut from each field coil terminal and slide the insulator out of the slots in the housing. Remove the four pole pieces screws from the housing. Remove the four pole pieces from inside the housing. Remove the field coils from the inside of the housing (Figure 26-9, Page 26-6). See following NOTE.

NOTE: Do not remove the insulators or the field coils unless an electrical test indicates that it is necessary (Figure 26-9, Page 26-6). See Starter/Generator (Starter Function) on page 25-29.

VISUAL INSPECTION OF ARMATURE

Obvious defects can be seen by examining the armature. If an armature has frayed or charred insulation, broken wires or thrown solder, it is obvious without testing that it should be replaced. Faults seen during the visual inspection can aid in diagnosing the original cause of the failure. Items to look for are listed below.

- · Burned, charred, or cracked insulation
- · Improperly cured varnish
- · Thrown solder
- · Flared armature windings
- · Worn, burned, or glazed commutator
- · Loose or raised commutator bars
- · Bruised or damaged armature core laminations
- · Worn armature bearing or shaft

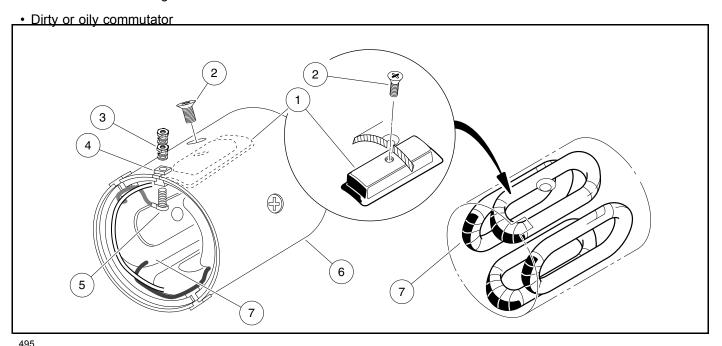


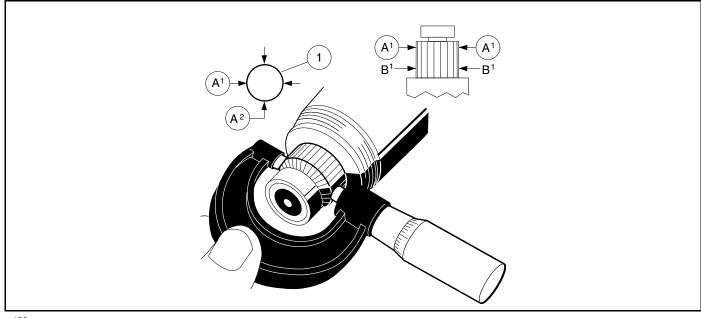
Figure 26-9 Field Coil Assembly

COMMUTATOR CLEANING AND INSPECTION

1. Clean the carbon dust, dirt and oil from the commutator. Visually inspect the commutator for worn, burned or glazed areas. Check for loose or raised commutator bars. Slight roughness of the commutator can be polished away with 400 grit (or finer) sandpaper. **See following CAUTION.**

A CAUTION

- Do not use emery cloth on the commutator. Particles of emery are conductive and may short-circuit the commutator bars. Do not use oil or lubricants on the commutator or brushes.
- 2. Using a micrometer, measure the outside diameter at two points along the commutator. If the commutator outside diameter is less than 1.535 inches (39 mm), replace the armature and bearings (Figure 26-10, Page 26-7).



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Figure 26-10 Inspect Commutator

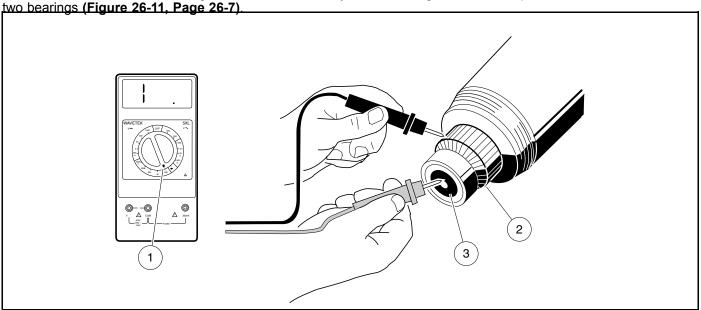
ARMATURE GROUND TEST

▲ CAUTION

• Do not submerge armature in solvent.

NOTE: Before testing, wipe the armature with a clean cloth and remove carbon dust and metal particles from between commutator bars.

Using a multimeter set on 200 ohms, place the positive (+) probe on the commutator bars and the negative (–) probe on the armature core. The reading should be no continuity. If the reading is incorrect, replace the armature and the



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Figure 26-11 Armature Ground Test

VISUAL INSPECTION OF FIELD COILS

If the insulation on the field coils appears blackened or charred, the serviceability of the coils is questionable. Burned or scorched coil insulation indicates the starter/generator has overheated due to overloads or grounded or shorted coil windings. Be sure the insulators are tight in the housing.

STARTER/GENERATOR REWORK

Any rework must be performed by a qualified technician. Starter/Generator service specifications are listed in the following table.

ITEM	SERVICE LIMIT	
ommutator diameter (minimum) 1.535 in. (39 mm)		
Concentric with armature shaft within	0.002 in. (0.051 mm)	
Limit depth of cut when machining commutator	0.007 in. (0.2 mm)	
If undercut of segment insulator is less than 0.016 inch (0.406 mm), then it should be undercut to:	0.031 in. (0.8 mm)	
Dielectric strength	500 VAC for one minute	
ture insulation resistance 0.2M ohms at 500 VDC		
Starter field coil resistance	0.006 to 0.01 ohms	
Generator field coil resistance	4.5 to 5.5 ohms	

STARTER/GENERATOR ASSEMBLY

- 1. Place the field coil into the housing. The two insulators that look alike fit into the slots next to the F1 and F2 markings on the outside of the housing. The insulator that looks different slides into the slot next to the DF marking.
- 2. After the insulators are seated in the slots, install the threaded terminals through the wire connectors and then through the insulators. Install a flat washer, lock washer and nut onto each threaded terminal on the outside of the housing. Tighten nuts to 47.5 in·lb (5.4 N·m) (Figure 26-9, Page 26-6).

A CAUTION

- Route the field terminal wires so that they will not contact the armature.
- 3. Install the four pole pieces into the housing. Use the four screws to secure pole pieces to the inside of the housing to retain the field wires. Tighten screws to 9 ft·lb (12.2 N·m) (Figure 26-9, Page 26-6).
- 4. Slide the bearing retainer onto the output end of the armature shaft (33) so that it will hold the outside of the bearing (35) only.
- 5. Press a new ball bearing (35) onto the output end of the armature (Figure 26-6, Page 26-4). Press a new ball bearing onto the commutator end of the armature shaft. See following CAUTION.

A CAUTION

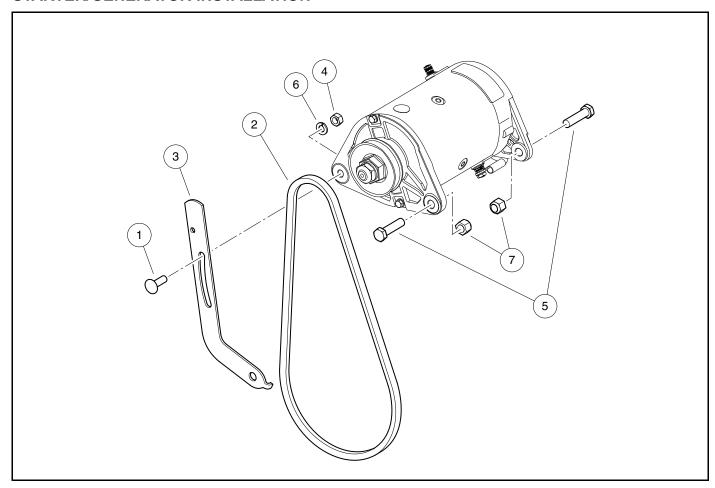
- To prevent damage to the retainer, use care while pressing new bearing onto the output end of the shaft.
- Press against the inner race of the new bearing until it is fully seated.

- 6. Install the output end cover (36) onto the armature. Secure the bearing retainer (32) to the cover and tighten the screws (43) to 39 in·lb (4.4 N·m) (Figure 26-6, Page 26-4).
- 7. Slide the housing with field coils over the armature. Use the locating pin to align housing to the cover.

NOTE: The terminal insulators should be on the commutator end of the housing.

- 8. To prevent contact between the brushes and commutator as the commutator cover is installed, and possible damage to the brushes, lift the brush springs out of the notches in the brushes and pull the brushes back from the center of the commutator end cover. The springs will rest on the sides of the brushes and help prevent them from sliding towards the center of the cover (Figure 26-5, Page 26-3).
- 9. Install the commutator end cover (23) onto the armature shaft. Align the locating pin with the pin hole in the cover. Install the two M6 x 180 mm bolts (20), and tighten to 100 in lb (11.3 N·m) (Figure 26-1, Page 26-2).
- 10. Push the brushes down into the holders. Place springs into the notches in the brushes. Install the brush cover (30) that has the drain hole in it next to the A2 terminal. Install the remaining three brush covers (29) in the openings in the commutator end cover (23) (Figure 26-2, Page 26-2).
- 11. Slide the spacer (37) onto the end of the shaft. Insert the shaft key (34) into the shaft. Install the belt pulley (39) onto the shaft, and install the lock washer (40) and M14 nut (41). Tighten the nut to 28 ft·lb (38.0 N·m) (Figure 26-6, Page 26-4).

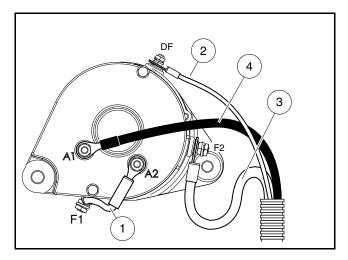
STARTER/GENERATOR INSTALLATION



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Figure 26-12 Starter/Generator Installation

- Install the green wire (1) from the F1 terminal to the A2 terminal on the starter/generator (Figure 26-13, Page 26-10). Install a flat washer, lock washer, and nut onto each terminal and tighten to 48 in lb (5.4 N·m).
- Position the starter/generator over the mounting bracket so that the bolts will go through the starter/generator before going through the bracket. Install pivot bolts (5) with the heads of the bolts facing as shown (Figure 26-12, Page 26-9). Install lock nuts (7) finger-tight.
- Install the adjustment bolt (1) through the adjusting bracket (3) and then through the starter/generator. Install a lock washer (6) and nut (4) onto adjustment bolt (1) finger-tight (Figure 26-12, Page 26-9).
- Install the belt (2), then tighten the mounting bolts. See Belt Tension Adjustment on page 26-11.
- Connect the yellow wire (2) from the voltage regulator to the DF terminal on the starter/generator (Figure 26-13, Page 26-10). Install a flat washer, lock washer, and nut onto the terminal. Tighten the nut to 31 in lb (3.5 N·m).
- Install the white wire (3) from the solenoid to the F2 terminal on the starter/generator (Figure 26-13, Page 26-10). Install the black wire (4) from the frame to the A1 terminal on the starter/generator. Install a flat washer, lock washer and nut onto each terminal, and tighten the nut to 48 in lb (5.4 N·m).
- 7. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

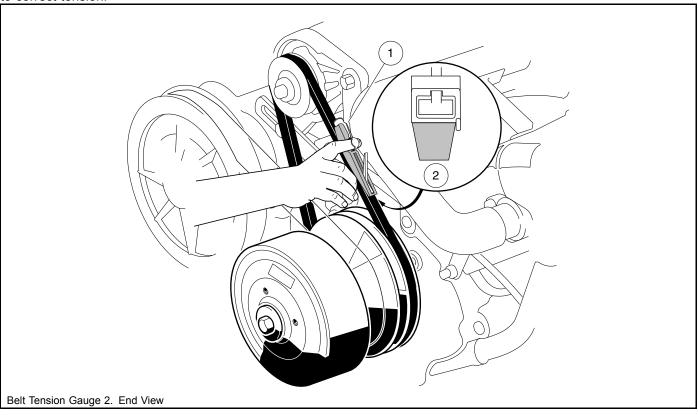


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Figure 26-13 Starter/Generator Wiring

BELT TENSION ADJUSTMENT

Belt tension should be checked periodically. If the belt slips when starter/generator motor operates, adjust belt to correct tension.



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Figure 26-14 Belt Tension Gauge

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. Remove the seat to access engine compartment. See Section 4 Body and Trim.
- 3. Make sure the two pivot bolts (5) on the mounting bracket are finger-tight. The carriage bolt (1) and hex nut (4) are to be finger-tight also (Figure 26-12, Page 26-9).
- 4. Push the starter/generator down so it is at the lowest point of its adjustment travel. With the starter/generator belt in place around the drive clutch pulley, install the starter/generator belt (2) around the starter/generator pulley.
- 5. Position a pry bar between the top of the starter/generator mounting bracket and the underside of the starter/generator by passing the pry bar under the exhaust header.
- 6. While holding the pry bar, measure the belt tension using a Krikit® gauge (1) (available at NAPA® Auto Parts stores), or equivalent (**Figure 26-14**, **Page 26-11**). Proper tension for a new starter/generator belt (2) should be 120 lb (534 N) or 70 to 100 lb (311 to 445 N) for an existing belt.
- 7. While maintaining the tension, tighten the adjustment nut (4) to 144 in·lb (16.3 N·m). Tighten the two pivot bolts (5) and hex nuts (7) to 23 ft·lb (31.2 N·m) (Figure 26-12, Page 26-9). See following CAUTION.

CAUTION

- Remove pry bar before starting engine.
- 8. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

VOLTAGE REGULATOR

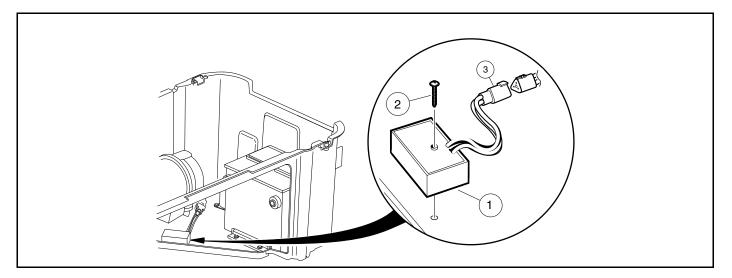
See General Warnings on page 1-2.

TESTING THE VOLTAGE REGULATOR

See Test Procedure 13 – Voltage Regulator on page 25-31.

VOLTAGE REGULATOR REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery -Gasoline Vehicles on page 1-3.
- 2. Disconnect the voltage regulator connector (3) from the wire harness (Figure 26-15, Page 26-12).
- Remove the voltage regulator mounting screw (2) and remove the voltage regulator (1).



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Figure 26-15 Voltage Regulator

VOLTAGE REGULATOR INSTALLATION

- Position the voltage regulator (1) and install the mounting screw (2) (Figure 26-15, Page 26-12). Tighten screw to 23 in·lb (2.6 N·m).
- Connect the voltage regulator three-pin connector (3) to the wire harness.
- Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- Place Forward/Reverse handle in NEUTRAL and place the neutral lockout cam in the MAINTENANCE position. Start the engine and check regulator for proper functioning as described in the voltage regulator test procedure. See Test Procedure 13 - Voltage Regulator on page 25-31.

ENGINE CONTROL UNIT (ECU)

CAUTION

• The Engine Control Unit (ECU) and Throttle Body are to be purchased as one unit. They are matched pairs with matching serial numbers. Do not mix an ECU with another Throttle Body of a different serial number. Doing so violates emissions standards and warranty.

The ECU is located in the engine compartment.

TESTING THE ENGINE CONTROL UNIT

See Test Procedure 4 – EFI System (ECU and Sensors) on page 25-21.

ENGINE CONTROL UNIT REMOVAL

- Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove ECU mounting plate bolts.
- 3. Disconnect gray and black wire connectors.

ENGINE CONTROL UNIT INSTALLATION

WARNING

- To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help prevent accidentally installing it in the gray port.
- 1. Mount ECU to plate with bolts and tighten to 60 in lb (6.8 N·m).
- 2. Install gray connector to the gray port on the ECU. See preceding WARNING.
- 3. Install black connector to the black port on the ECU.
- 4. Connect the battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

KEY SWITCH

See General Warnings on page 1-2.

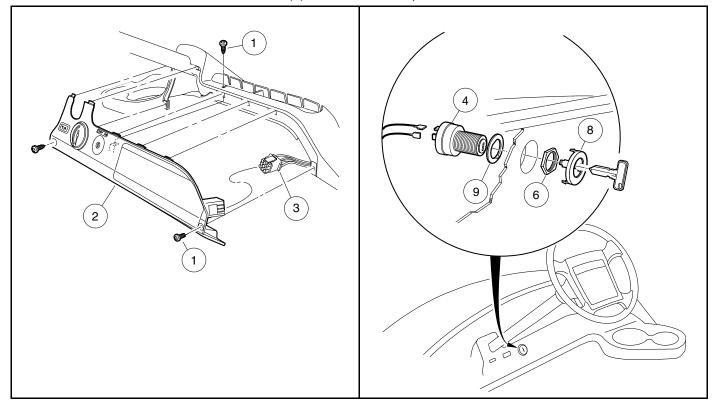
TESTING THE KEY SWITCH

See Test Procedure 5 - Key Switch (Start Circuit) on page 25-23.

See Test Procedure 6 - Key Switch (Engine Kill Circuit) on page 25-23.

KEY SWITCH REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel.
 - 2.1. Remove three screws (1) from the instrument panel (2) (Figure 26-16, Page 26-14).
 - 2.2. Rotate the instrument panel up and away from the dash to disengage the tabs at the top of the instrument panel.
 - 2.3. Disconnect the electrical connector (3) to the instrument panel.



2433 Figure 26-16 Instrument Panel Removal

Figure 26-17 Key Switch

- 3. Disconnect the wires from the key switch.
- 4. From the back of the instrument panel, push down on the retaining tabs surrounding the key switch (4) and remove the key switch cap (8). Hold the key switch and remove the switch retaining nut (6) from the outside of the instrument panel (Figure 26-17, Page 26-14).

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KEY SWITCH INSTALLATION

- 1. Reverse removal procedures to install key switch in the instrument panel. Connect wires to key switch.
- 2. Install the instrument panel.
 - 2.1. Connect the electrical connector (3) (Figure 26-16, Page 26-14).
 - 2.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 2.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).

3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery – Gasoline Vehicles on page 1-3.

MAINTENANCE/OPERATE SWITCH

TESTING THE MAINTENANCE/OPERATE SWITCH

See Test Procedure 9 - Maintenance/Operate Switch - Pedal-Start Vehicles on page 25-27.

MAINTENANCE/OPERATE SWITCH REMOVAL

- 1. Disconnect the battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Using a 5/8 inch (16 mm) wrench, remove maintenance/operate boot/hex nut.
- 3. Remove maintenance/operate switch from bracket.
- 4. Disconnect the three spade terminals and remove switch.

MAINTENANCE/OPERATE SWITCH INSTALLATION

- 1. Connect the three spade terminals (Figure 25-12, Page 25-27).
- 2. Make sure groove switch is aligned with tang on bracket and install switch. Tighten maintenance/operate switch boot/hex nut to 16 in·lb (1.8 N·m).
- 3. Connect the battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

NEUTRAL LOCKOUT LIMIT SWITCH

See General Warnings on page 1-2.

TESTING THE NEUTRAL LOCKOUT LIMIT SWITCH

See Test Procedure 10 - Neutral Lockout Limit Switch - Pedal-Start Vehicles Only on page 25-28.

NEUTRAL LOCKOUT LIMIT SWITCH REMOVAL

- 1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Disconnect the 3-wire connector from the neutral lockout limit switch (1) located on the transaxle.

4. Remove two nuts (3) and washers (4) from the neutral lockout limit switch (1) and slide the limit switch off of the screws.

NEUTRAL LOCKOUT LIMIT SWITCH INSTALLATION

1. Install the limit switch (1) with washers (4) and nuts (3) and tighten to 5 in·lb (0.6 N·m). Move the Forward/Reverse handle to make sure the switch actuates. **See following CAUTION.**

A CAUTION

- Do not overtighten the retaining nuts. If the nuts are overtightened, limit switches could be damaged.
- 2. Connect the 3-wire connector to the neutral lockout limit switch lead.
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 4. Test drive the vehicle in both forward and reverse for proper operation.

SOLENOID

See General Warnings on page 1-2.

TESTING THE SOLENOID

See Test Procedure 8 - Solenoid on page 25-26.

SOLENOID REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect all the wires from the solenoid.
- 3. Remove the two screws securing the solenoid in place.
- 4. Remove the solenoid.

SOLENOID INSTALLATION

- Install the solenoid in the vehicle. Use two screws to secure the solenoid and tighten to 14 in lb (1.6 N·m).
- 2. Connect the ring terminal with the 10-gauge white wire and the 16-gauge red wire on a large post on the solenoid. **See Wiring Diagrams on page 25-8.**
- 3. Connect the ring terminal with the two 10-gauge red wires to the other large post on the solenoid. **See Wiring Diagrams on page 25-8.**
- Connect the 16-gauge blue wire from the main harness to a small post on the solenoid.

- 5. Connect the 16-gauge orange wire from the main harness to the other small post on the solenoid. **See Wiring Diagrams on page 25-8.**
- 6. Tighten the hex nuts on the large solenoid posts to 55 in·lb (6.2 N·m). Tighten the nuts on the small solenoid posts to 22 in·lb (2.5 N·m).
- 7. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

FUSE

See General Warnings on page 1-2.

ATM-style blade fuses are located on the main wire harness in front of the battery.

The ABC-style glass fuse is located on the main wire harness adjacent to the ATM-fuse holder.

TESTING THE FUSE

See Test Procedure 2 – Fuses on page 25-19.

FUSE REMOVAL

- Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. ATM Fuses Only: Remove fuse holder cover.

ABC Fuse Only: Open in-line fuse holder.

3. Remove the fuse.

FUSE INSTALLATION

Install the fuse. See following WARNING.

WARNING

- If a fuse is blown, determine the cause of the failure and make necessary repairs before installing a new fuse. Use the appropriately rated fuse; if a fuse with a higher amp rating is used, damage to the vehicle electrical system may occur.
- 2. ATM Fuse Only: Install the fuse holder cover.

ABC Fuse Only: Assemble in-line fuse holder.

3. Connect battery. See Low Maintenance Battery: Connecting the Battery – Gasoline Vehicles, Section 1, Page 1-3.

ACCELERATOR PEDAL LIMIT SWITCH

See General Warnings on page 1-2.

TESTING THE ACCELERATOR PEDAL LIMIT SWITCH

See Test Procedure 7 – Throttle Position Sensor (TPS) on page 25-24.

The accelerator pedal limit switch is housed inside the throttle position sensor. The throttle position sensor itself is not intended to be replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced.

KILL LIMIT SWITCH

See General Warnings on page 1-2.

TESTING THE KILL LIMIT SWITCH

See Test Procedure 7 - Throttle Position Sensor (TPS) on page 25-24.

The kill limit switch is housed inside the throttle position sensor. The throttle position sensor itself is not intended to be replaced. If sensor is determined to need replacing through test procedures found in this manual, the accelerator pedal assembly must be replaced.

REVERSE WARNING BUZZER

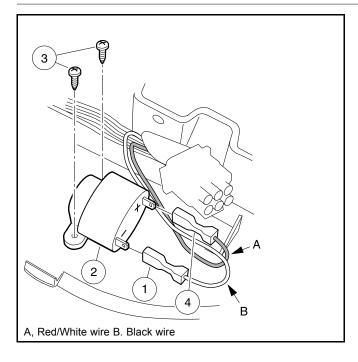
See General Warnings on page 1-2.

TESTING THE REVERSE WARNING BUZZER

See Test Procedure 16 – Reverse Buzzer and Reverse Buzzer Limit Switch on page 25-34.

REVERSE WARNING BUZZER REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel. See Key Switch Removal on page 26-14.
- 3. Disconnect the wires from the reverse warning buzzer (2) (Figure 26-18, Page 26-19).
- Remove the two mounting screws (3) securing the buzzer to the instrument panel.



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Figure 26-18 Reverse Buzzer

REVERSE WARNING BUZZER INSTALLATION

- 1. Install the screws (3) through the buzzer bracket tabs and tighten to 3.5 in·lb (0.40 N·m) (Figure 26-18, Page 26-19).
- 2. Connect the black wire (1) from the wire harness to the negative (–) terminal on the buzzer.
- 3. Connect the red/white wire (4) from the wire harness to the positive (+) terminal on the buzzer.
- 4. Install the instrument panel.
 - 4.1. Connect the electrical connector (3) (Figure 26-16, Page 26-14).
 - 4.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 4.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 6. Shift the Forward/Reverse handle to the REVERSE position. The buzzer should sound.

REVERSE BUZZER LIMIT SWITCH

See General Warnings on page 1-2.

TESTING THE REVERSE BUZZER LIMIT SWITCH

See Test Procedure 16 – Reverse Buzzer and Reverse Buzzer Limit Switch on page 25-34.

REVERSE BUZZER LIMIT SWITCH REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect the wires from the reverse buzzer limit switch (4) located on the back of the Forward/Reverse assembly (Figure 12-19, Page 12-17).
- 3. Remove the nuts (2) and washers (6) from the neutral lockout limit switch (5) and slide the neutral lockout limit switch off of the screws. Do not disconnect the wires.
- 4. Remove the spacers (9) from the reverse buzzer limit switch (4) and slide the reverse buzzer limit switch off the screws.

REVERSE BUZZER LIMIT SWITCH INSTALLATION

- 1. Install the reverse buzzer limit switch (4), and then install two spacers (9) against the limit switch (Figure 12-19, Page 12-17).
- 2. Install the neutral lockout limit switch (5) with two washers (6) and two nuts (2). Tighten to 5 in·lb (0.6 N·m). See following CAUTION.

CAUTION

- Do not overtighten the retaining nuts. If the nuts are over tightened, limit switches could be damaged.
- Place the Forward/Reverse handle in REVERSE and make sure that both switches actuate.
- 4. Connect the orange wire to the common (COM) terminal and the red/white wire to the normally open (NO) terminal of the reverse buzzer limit switch (4) (Figure 12-19, Page 12-17).
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 6. Shift the Forward/Reverse handle to the REVERSE position. The buzzer should sound.

LOW OIL WARNING LIGHT

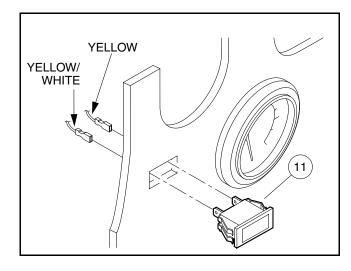
See General Warnings on page 1-2.

TESTING THE LOW OIL WARNING LIGHT

See Test Procedure 17 – Low Oil Warning Light (LED) on page 25-34.

LOW OIL WARNING LIGHT REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Remove the instrument panel. See Key Switch Removal on page 26-14.
- 3. Disconnect the wires from the low oil warning light (11) (Figure 26-19, Page 26-21).
- 4. Press the retaining tabs and remove the low oil warning light from the instrument panel.



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Figure 26-19 Low Oil Warning Light

LOW OIL WARNING LIGHT INSTALLATION

- 1. Push a new unit into hole in instrument panel until plastic tabs engage (Figure 26-19, Page 26-21).
- 2. Connect yellow and yellow/white wires from the wire harness to the low oil warning light.
- 3. Install the instrument panel.
 - 3.1. Connect the electrical connector (3) (Figure 26-16, Page 26-14).
 - 3.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
 - 3.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 1.8 ft·lb (2.5 N·m).
- 4. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

FUEL GAUGE

See General Warnings on page 1-2.

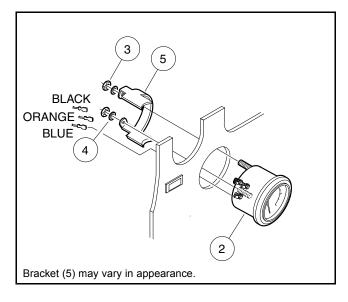
With the key switch in the OFF position, the fuel gauge reads empty. When the key switch is turned to ON, the fuel gauge becomes active.

TESTING THE FUEL GAUGE

See Test Procedure 22 - Fuel Gauge on page 25-38.

FUEL GAUGE REMOVAL

- Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery -Gasoline Vehicles on page 1-3.
- Remove the instrument panel. See Key Switch Removal on page 26-14. 2.
- Disconnect the three wires from the fuel gauge (Figure 26-20, Page 26-22).
- Remove the two hex nuts (3) and lock washers (4) from the threaded studs on the back of the gauge (2). Remove the mounting bracket (5) from the back side of the fuel gauge and remove the gauge from the instrument panel.



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Figure 26-20 Fuel Gauge Installation

FUEL GAUGE INSTALLATION

- 1. Install a new fuel gauge into hole in instrument panel until flange seats against panel (Figure 26-20, Page 26-22).
- Slide the mounting bracket (5) onto the two threaded studs on the fuel gauge and secure with two lock washers (4) and two hex nuts (3). Tighten to 2.5 in lb (0.28 N·m). Place one drop of Loctite® on each hex nut. Do not allow Loctite® to come into contact with the fuel gauge casing.
- 3. Connect the blue wire from the wire harness to the (I) terminal, the orange wire from the wire harness to the (S) terminal, and the black wire from the wire harness to the (G) terminal. See Wiring Diagrams on page 25-8.
- 4. Install the instrument panel.
 - 4.1. Connect the electrical connector (3) (Figure 26-16, Page 26-14).

- 4.2. Position the instrument panel (2) on the dash assembly. Make sure tabs on upper edge properly engage with the corresponding slots on the dash assembly. Ensure that there are no wires exposed or pinched during positioning.
- 4.3. Secure instrument panel to the dash assembly with three screws (1). Tighten screws to 22 in lb (2.5 N·m).
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.

FUEL LEVEL SENDING UNIT

See General Warnings on page 1-2.

The fuel level sending unit is an integral part of the fuel pump module and is not replaceable. Thoroughly test the fuel level sending unit before replacing the fuel pump module.

TESTING THE FUEL LEVEL SENDING UNIT

See Test Procedure 21 – Fuel Level Sending Unit on page 25-37.

HOUR METER

See General Warnings on page 1-2.

The hour meter displays the number of hours of use in increments of 0.1 hour.

TESTING THE HOUR METER

See Test Procedure 23 – Hour Meter on page 25-39.

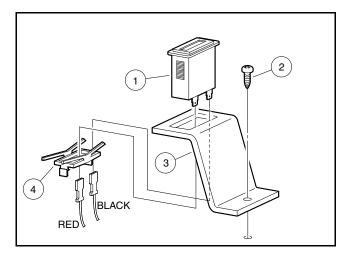
HOUR METER REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 2. Disconnect the wires from the hour meter (1) (Figure 26-21, Page 26-24).
- 3. Remove screw (2) to release bracket (3).
- 4. Remove keeper (4) from hour meter to release meter (1) from bracket (3).

HOUR METER INSTALLATION

- 1. Install a new hour meter into bracket (3) and secure it by sliding the keeper (4) onto it (Figure 26-21, Page 26-24).
- 2. Connect wires to the hour meter.

3. Position bracket (3) on the vehicle and secure in place with screw (2).



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Figure 26-21 Hour Meter Installation

OIL LEVEL SENSOR

See General Warnings on page 1-2.

TESTING THE OIL LEVEL SENSOR

See Test Procedure 18 - Oil Level Sensor on page 25-35.

OIL LEVEL SENSOR REMOVAL

See Oil Level Sensor Removal on page 27-12.

OIL LEVEL SENSOR INSTALLATION

See Oil Level Sensor Installation on page 27-12.

BATTERY

See General Warnings on page 1-2.

A DANGER

- Due to the danger of an exploding battery, wear a full face shield and rubber gloves when working on or near batteries.
- Battery Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service
 area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and
 rubber gloves when working on or near batteries.
- Tools, wires, and metal objects can cause sparks when shorted across a battery.
- · Follow all instructions carefully when working with batteries.
- · Charge battery in a well-ventilated area only.
- Battery Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:
 - External: Flush with water. Call a physician immediately.
 - Internal: Drink large quantities of milk or water followed with milk of magnesia or vegetable oil. Call a physician immediately.
 - Eyes: Flush with water for 15 minutes. Call a physician immediately.

▲ WARNING

Do not jump start a dead battery using another battery and jumper cables.

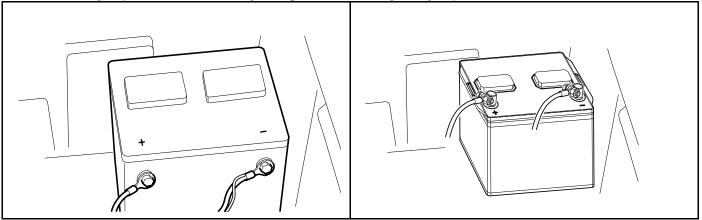


Figure 26-22 Low Maintenance - Gasoline Vehicle Battery

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Figure 26-23 No Maintenance - Gasoline Vehicle Battery

GENERAL INFORMATION – LOW MAINTENANCE BATTERY

See preceding DANGER and WARNING statements.

Gasoline vehicles may be equipped with 12-volt, low maintenance battery that requires infrequent watering. When changing a 12-volt battery in any gasoline-powered vehicle, the same size battery with adequate amperage ratings should be used as a replacement.

A group 70, side-post battery (CC P/N 103496801), with a 525 cold cranking amp rating and a reserve capacity of at least 80 minutes is recommended. The group 70 classification indicates battery size: 8-1/4 inches W x 6-1/2 inches D x 7-1/4 inches H (21.0 cm W x 16.5 cm D x 18.4 cm H). It is important to use the proper size to ensure that the battery clamp will fit correctly.

GENERAL INFORMATION - NO MAINTENANCE BATTERY

See preceding DANGER and WARNING statements.

Gasoline vehicles may be equipped with 12-volt, no maintenance battery that does not require watering. When changing a 12-volt battery in any gasoline-powered vehicle, the same size battery with adequate amperage ratings should be used as a replacement.

A group 26, top-post battery (CC P/N 105237301), with a 525 cold cranking amp rating and a reserve capacity of at least 80 minutes is recommended. The group 26 classification indicates battery size: 8 inches W x 6-1/2 inches D x 7 inches H (20.3 cm W x 16.6 cm D x 17.8 cm H). It is important to use the proper size to ensure that the battery clamp will fit correctly.

TESTING THE BATTERY

See Test Procedure 1 – Battery on page 25-16.
See Test Procedure 19 – Battery Test (Under Load) on page 25-35.

PREVENTIVE MAINTENANCE – LOW MAINTENANCE BATTERY ONLY

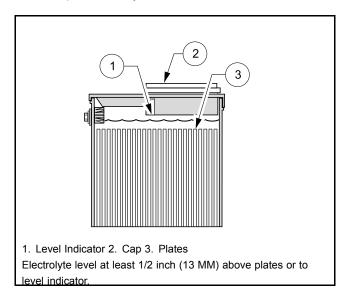
1. To keep the battery in good operating condition, remove any corrosion immediately. Post connections should be clean and tight. Any frayed or worn wires should be replaced. After all cables have been connected and properly tightened to 144 in lb (16 N·m), coat terminals with Battery Terminal Protector Spray (CC P/N 1014305) to prevent future corrosion. See preceding WARNINGS and following CAUTION.

CAUTION

- If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so may cause them to overheat during operation and could result in a fire, property damage, or personal injury.
- 2. The battery should be kept clean and dry to prevent self-discharge. Any dirt, grime or acid spillage should be removed. Wash the battery with a bristle brush using water and bicarbonate of soda (1 cup (237 mL) baking soda per 1 gallon (3.8 L) of water). Rinse with water. Do not allow solution to enter battery through the vent cap holes. See Self-Discharge on page 26-27.
- 3. Maintain proper water level. See Water Level Low Maintenance Battery on page 26-27.
- 4. Check battery periodically to see that it is in a full state of charge. See Charging the Battery on page 26-29.
- 5. Keep battery hold-down clamp tight. See Vibration Damage on page 26-27.

WATER LEVEL - LOW MAINTENANCE BATTERY

The water level should be checked semi-annually to be sure water is at its proper level (Figure 26-24, Page 26-27). Never allow the water level to fall below the tops of the plates because this will cause the exposed part of the plate to become permanently inactive. Check the water level more frequently in hot weather or when the battery becomes old.



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Figure 26-24 Electrolyte Level for Low Maintenance Battery

SELF-DISCHARGE

Dirt and battery acid can provide a path for a small current draw that slowly discharges the battery. To prevent self-discharge, the battery should always be kept clean.

Hot weather also has an effect on a battery's self-discharge rate. The higher the temperature, the quicker a battery will discharge. In hotter climates, therefore, the battery should be checked more often. When storing the battery, keep in a cool place. **See Battery Storage on page 26-30.**

VIBRATION DAMAGE

The battery hold-down clamp should always be tight enough to keep the battery from bouncing. Battery life may be severely shortened if the clamp is too loose. Excessive vibration shortens the life of the battery. It may also cause acid to leak out of the vent caps and corrosion to build up on surrounding metal parts. The acid that is lost reduces the capacity of the battery and cannot be replaced.

MINERAL CONTENT - LOW MAINTENANCE BATTERY ONLY

For the longest battery life, distilled water should be used in the battery. However, if tap water is going to be used, contact your local water department to be sure mineral contents are below the levels listed in the following table. **See following NOTE.**

NOTE: Contact your local water department for mineral content analysis.

IMPURITY	ALLOWABLE CONTENT (PARTS PER MILLION)	EFFECTS OF IMPURITY	
Suspended matter	Trace	_	
Total solids	100.0	_	
Calcium	40.0	Increase of positive shedding	
Magnesium	40.0	Reduced life	
Iron	3.0	Increased self-discharge at both plates, lower on-charge voltage	
Ammonia	8.0	Slight self-discharge of both plates	
Organic matter	50.0	Corrosion of positive plate	
Nitrates	10.0	Increased sulfation at negative	
Nitrites	5.0	Corrosion at both plates, loss of capacity, reduced life	
Chloride	5.0	Loss of capacity in both plates, greater loss in positive	
Color	Clear and "White"	_	
Antimony	5.0	Self-discharge by local action, reduces life, lower on-charge voltage	
Arsenic	0.5	Self-discharge, can form poisonous gas at negative	
Copper	5.0	Increased self-discharge, lower oncharge voltage	
Nickel	None Allowed	Intense lowering of on-charge voltage	
Platinum	None Allowed	Violent self-discharge, lower on-charge voltage	
Selenium	2.0	Positive shedding	
Zinc	4.0	Slight self-discharge at negative	

BATTERY REMOVAL

See General Warnings on page 1-2. Also see DANGER at beginning of Battery topic.

- Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the wheels.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Remove the battery hold-down clamp from the battery.
- 4. Lift the battery from the vehicle. See following WARNING.

▲ WARNING

• Keep the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out of the vent hole. Do not exceed this 45° angle when lifting, carrying or installing battery. The battery acid could cause severe personal injury when accidentally coming in contact with the skin or eyes, and could damage clothing.

CHARGING THE BATTERY

See General Warnings on page 1-2. Also see DANGER at beginning of Battery topic.

- 1. Charge the battery using an automotive type 12-volt battery charger. Follow all warnings and procedures supplied by the battery charger manufacturer.
- 2. Attach the positive (+) charger cable to the positive (+) battery post.
- 3. Attach the negative (-) charger cable to the negative (-) battery post.
- 4. The battery may be charged with a slow charge (3 to 10 amps) or a fast charge (20 to 30 amps). Charge until the specific gravity reaches 1.250. **See following WARNING.**

A WARNING

- If the battery case feels hot (approximately 125 °F (52 °C) or more), emits gases, or fluid boils from vents, stop charging immediately. Failure to stop charging battery when any of these conditions are present could result in an explosion, personal injury and/or damage to the battery.
- Do not disconnect the charger DC leads from the battery when the charger is on. The resulting arcing between the DC leads and battery post could cause an explosion.
- If the charger must be stopped, disconnect the AC supply cord from the wall outlet before disconnecting the DC leads from the battery. Allow the battery to cool to room temperature and resume charging battery at a lower amp rate.

BATTERY INSTALLATION

See General Warnings on page 1-2. Also see DANGER at beginning of Battery topic.

- 1. Place the battery into the vehicle with the battery posts facing the engine.
- 2. Secure the battery to the vehicle with the clamp and install screws and tighten to 31 in·lb (3.5 N·m). A loose battery clamp may allow the battery to become damaged from vibration or jarring.

3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery – Gasoline Vehicles, Section 1, Page 1-3.

BATTERY STORAGE

See General Warnings on page 1-2. Also see DANGER at beginning of Battery topic.

- 1. Keep the battery clean and free of corrosion.
- 2. The battery cables should be disconnected from the battery so the battery can be connected to the charger. The battery can be left in the vehicle. Disconnect the negative (–) cable first. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Fully charge the battery prior to storage.
- 4. Store in a cool, dry area. The colder the area in which the battery is stored, the less the battery will self-discharge. A battery stored at 0 °F (-17.8 °C) will discharge very little over a four-month period. A battery stored at 80 °F (27 °C) will have to be recharged every few weeks.
- 5. Check the state of charge periodically. A battery that is discharged and left in a cold environment can freeze and crack. If the specific gravity drops below 1.220, the battery should be recharged. **See following WARNING.**

WARNING

- If the battery is frozen or the container is bulged, discard battery. A frozen battery can explode.
- 6. The frequency of recharging required depends on the temperature of the storage area, but it is recommended that the battery be monitored for state of charge every month. Also, if the storage area is unheated in a cold climate and recharging is required, it is recommended that the area be heated to at least 60 °F (16 °C) prior to charging. The battery will not charge effectively in cold temperatures for the same reasons that it does not discharge as rapidly in cold temperatures.

CHARGING A DEAD BATTERY

See General Warnings on page 1-2. Also see DANGER at beginning of Battery topic.

The vehicle is equipped with a starter/generator. The generator is not designed to charge a dead battery. If the vehicle battery has become discharged, it must be charged using a properly rated automotive type charger. **See following WARNING.**

A WARNING

Do not jump-start a dead battery using another battery and jumper cables.

GROUND CABLES

NOTE: Verify that all cables (fuel tank, engine, battery, starter/generator and voltage regulator) are connected securely.

TESTING THE GROUND CABLES

See Test Procedure 3 – Ground Cables on page 25-20.

A DANGER

See General Warnings on page 1-2.

WARNING

See General Warnings on page 1-2.

GENERAL INFORMATION

See General Warnings on page 1-2.

This vehicle is powered by a Subaru EX40, high-compression, chain driven, overhead cam engine. The engine offers a heavy-duty construction featuring cast iron cylinder liner for longer life, dual ball bearing crankshaft support, low oil level sensor and heavy-duty air cleaner system, to name a few characteristics. **See following NOTE.**

NOTE: Engine rotation is counterclockwise as viewed from the clutch side of the engine.

This section contains information for removing and replacing the engine. For complete instruction on engine disassembly, repair, rebuilding, and reassembly, see your authorized dealer.

Test cylinder compression using a standard compression tester. Low compression would normally indicate a problem in the cylinder assembly such as defective rings, gaskets, etc. Compression should be:

At a normal cranking speed of 1050 to 1100 RPM, the compression should typically be approximately 167 psig (1151 kPa). This value could vary slightly depending on wear of components affecting compression.

See the Subaru EX40 Engine Repair and Rebuild Manual for complete teardown, rebuild and repair information.

BEFORE SERVICING

Carefully read the applicable information and instructions before beginning engine service. Diagrams, DANGER, WARNING, CAUTION and NOTE statements and detailed descriptions have been included wherever necessary. Anyone attempting engine service should have knowledge and experience in small engine service and repair.

ENGINE ROTATION

When turning the crankshaft by hand, always turn it counterclockwise as viewed from the clutch side of the engine.

TORQUE SPECIFICATIONS

ITEM	SIZE	TORQUE	
Flywheel retaining nut	M18	80 ft·lb (110 N·m)	
Crankcase cover to block bolts	M8	250 in·lb (28.3 N·m)	
Cylinder head bolts	M10	1st Step New head and bolts: 159 in·lb (18 N·m)	2 nd Step New head and bolts: 336 in·lb (38 N·m)
		Used head and bolts: 159 in·lb (18 N·m)	Used head and bolts: 265 in·lb (30 N·m)
	M8	159 in·lb (18 N·m)	2 nd step not needed
Connecting rod bolts	M8	221 in·lb (25 N·m)	
Spark plug	13/16 in. (21 mm) plug socket	New: 120 in·lb (13.5 N·m)	
		Re-tightening: 216 in lb (24.5 N·m)	
Exhaust flange nuts	M8	177 in·lb (20 N·m)	
Ignition coil	M6	71 in·lb (8 N·m)	
Oil sensor	M6	80 in·lb (9 N·m)	
Oil drain plug	M14	18 ft·lb (24.4 N·m)	
Fan housing screws	M6	90 in·lb (10 N·m)	
Fan cover screws	M6	25 in·lb (2.8 N·m)	
Bolts marked with "4" (when used with nuts)	M8 M6 M5	130 in·lb (15 N·m) 50 in·lb (5.9 N·m) 30 in·lb (3.4 N·m)	

ADJUSTMENTS AND SETTINGS

ITEM	VALUES
Spark plug gap	0.024 to 0.028 in. (0.6 to 0.7 mm)
Valve clearance – Intake & Exhaust (cold)	0.0047 to 0.0059 in. (0.12 to 0.15 mm)
Ignition coil air gap	0.012 to 0.020 in. (0.3 to 0.5 mm)
Compression pressure:	167 psig (1151 kPa) Allowable Lower Pressure: 120 psig (827 kPa)

ENGINE OIL - GASOLINE VEHICLE

Even though the low oil warning light on the dash should illuminate if oil level becomes low, engine oil level should be checked monthly. Vehicle should be on a level surface when checking oil. Do not overfill with oil.

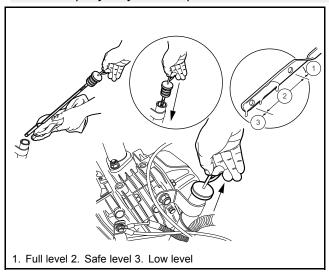
Engine Oil Level Check

 Remove the oil level dipstick from the oil filler tube, and wipe oil off dipstick (Figure 27-1). See following CAUTION.

CAUTION

- · Do not remove dipstick while engine is running.
- 2. Check oil by fully inserting the dipstick into the oil filler tube and immediately removing it.
- 3. If the oil level is at or below the low level mark on the dipstick gauge, add oil until the level is between low and full levels (safe level).
- 4. Insert the dipstick into the oil filler tube. See following NOTE.

NOTE: Properly recycle or dispose of used oil in accordance with local, state, and federal regulations.



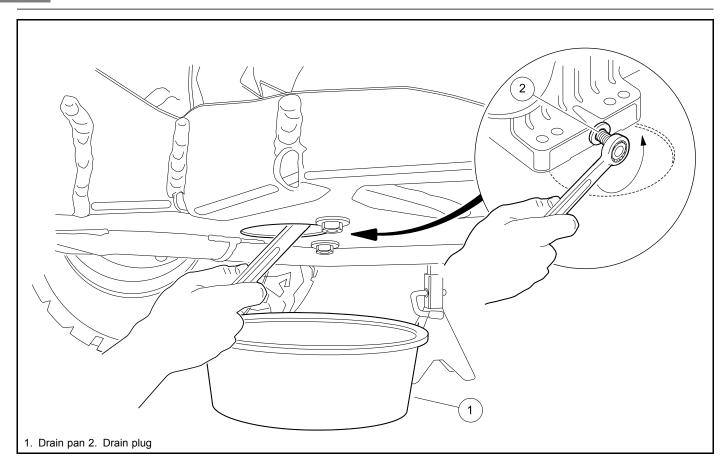
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Figure 27-1 Engine Oil Level Check

Engine Oil Change

Engine oil should be changed after the first 100 hours of operation. After that, it should be changed every 200 hours of operation or annually, whichever comes first.

- 1. Turn the key switch to the OFF position, then remove the key. Place the Forward/Reverse handle in the NEUTRAL position. Chock the front wheels.
- 2. Access the engine compartment and place the Maintenance/Operate switch in the MAINTENANCE position.
- 3. Disconnect battery and spark plug wire. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 4. Position a pan designed for oil changes under the drain plug (1) (Figure 27-2).



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Figure 27-2 Engine Oil Drain Plug and Pan

Use a 14 mm socket or wrench to remove the drain plug, turning it counterclockwise, and allow the engine oil to drain into the pan. See following WARNING.

A WARNING

- Do not attempt to change engine oil when the engine is hot or even warm. Engine oil can cause skin burns.
- Wear safety glasses or approved eye protection when servicing the vehicle. Wear rubber gloves when handling oil drain plug and oil drain pan.
- 6. Clean the oil drain plug threads with solvent to remove oil and oil residue. Make sure that the compression washer remains on the drain plug.
- 7. Use a 14 mm socket or wrench and replace the oil drain plug, turning it clockwise, and tighten to 18 ft·lb (24.4 N·m).
- 8. Remove the dipstick and add engine oil into the dipstick port. Use a funnel or pour spout to direct the oil into the dipstick port. The engine requires 40.5 fl-oz (1.2 L) of oil per change. 10W-30 or 5W-30 grade SE or higher is recommended. Refer to oil viscosity guidelines for selection of oil grade (Figure 27-3). Replace the dipstick.

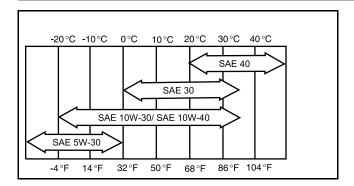


Figure 27-3 Oil Viscosity Chart

- 9. Connect battery and spark plug wire. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles on page 1-3.
- 10. With the Forward/Reverse handle in the NEUTRAL position and the Maintenance/Operate switch in the OPERATE position, start and run the engine for a few minutes. Observe the drain plug from under the vehicle and watch for oil leaks. If leaks appear, begin with step 1 and repeat the appropriate steps as needed to correct the problem.
- 11. Remove the dip stick and check the engine oil as a final step. Replace the dip stick.

SPARK PLUG

Spark plugs are selected to suit specific engine design and vehicle operating conditions. The spark plug (CC P/N 105017801) is designed to give maximum life and efficient combustion of fuel. The spark gap should be set from 0.024 to 0.028 in. (0.6 to 0.7 mm).

Spark Plug Removal

See General Warnings on page 1-2.

▲ CAUTION

· Before removal and disassembly, clean the engine.

Remove all dirt from plug base in the cylinder head before removing plug. Use a 13/16 in. (21 mm), deep well socket with ratchet or spark plug wrench to loosen the plug.

Spark Plug Cleaning, Inspection and Repair

Examine the plug (Figure 27-4, Page 27-6). The deposits on the plug base and electrode are an indication of the correct heat range and efficiency as well as a guide to the general condition of the engine, fuel and air mixture and ignition system. If all of the above conditions are proper, the spark plug should be a light brown color. There should be no bridging between the electrode and base. The electrode should not be eroded. Black color, excessive carbon, and/or a wet plug indicates that the fuel is too rich. White, burned or melted electrodes indicate the fuel is too lean or pre-igniting. Oily deposits on the plug electrode are an indication of worn rings, valve guides, cylinder wall, etc. Also examine the spark plug wire. Remove rubber boot and inspect internal spring for damage. Inspect spark plug wire for damage and be sure spring coil is securely attached to spark plug. See following WARNING.

▲ WARNING

Remove spark plug wire to avoid accidental start up of the engine when servicing vehicle. To avoid
ignition of fuel and serious personal injury or death, never try to start the engine with plug removed
from engine.

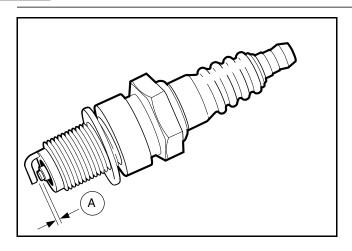


Figure 27-4 Spark Plug

Testing the Spark Plug

Check the sparking ability of a cleaned and properly gapped plug on a sparking comparator if possible. Spark should be blue and strong and able to jump a 5/16-in. (8 mm) gap.

Setting the Spark Gap

- 1. Pass a contact point file between the electrodes to produce flat, parallel surfaces to facilitate accurate gauging.
- 2. Use a wire type gauge. Bend the outside or ground electrode so only a slight drag on the gauge is felt when passing it between the electrode. Never make an adjustment by bending the center electrode. Set gap (A) from 0.024 to 0.028 in. (0.6 to 0.7 mm) (Figure 27-4, Page 27-6).

Spark Plug Installation

NOTE: Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in cylinder head threads with penetrating oil and clean the threads with a tap if necessary.

Use a high temperature, anti-seize lubricant on the threads of the spark plug to reduce friction when installing a new plug, and reduce "gauling" and thread seizing for future replacements.

Install the spark plug by threading it in until finger tight, then tighten the spark plug to the following torque:

• New: 120 in·lb (13.5 N·m).

• Re-tightening: 216 in lb (24.5 N·m).

BREATHER

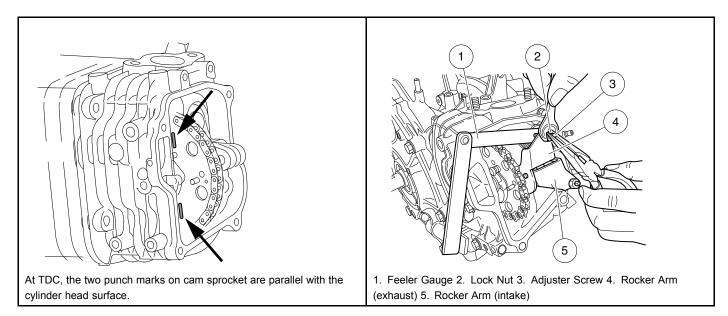
The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. The breather has a reed valve which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one-way reed valve blocks return flow and therefore maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expands into the rocker chamber. In the rocker chamber most oil separates from the air and drains back to the crankcase. The air passes through a tube and vents to the intake manifold.

VALVE CLEARANCE CHECK AND ADJUSTMENT

NOTE: Check and adjust clearance when the engine is cold.

- 1. If equipped, remove air deflector from top of engine.
- 2. Remove rocker cover.
- 3. Turn the crankshaft until the piston is at top dead center of the compression stroke (Figure 27-5, Page 27-7).
- 4. Using a feeler gauge (1), measure the clearance between the adjuster screw (3) and the top of the valve stem (Figure 27-6, Page 27-7).
- 5. If necessary, loosen the lock nut (2) and turn the adjuster (3) up or down to adjust the clearance to 0.0047 in. (0.12 mm) for both intake and exhaust. Once clearance is correct, tighten the lock nut (2) to 52 in·lb (6 N·m).
- 6. After adjusting valve clearances, rotate the crankshaft several full revolutions and verify that the intake and exhaust valve clearance are still correct.



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Figure 27-5 Top Dead Center (TDC) - EX40 Engine

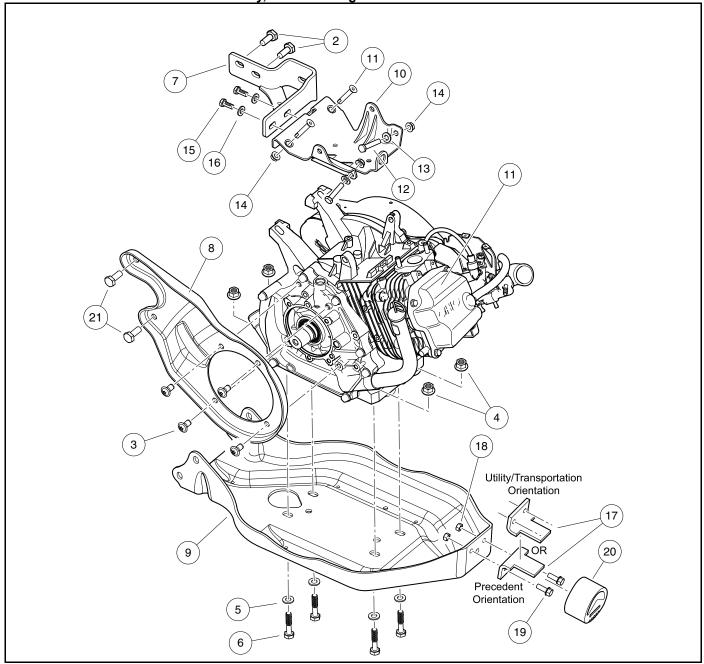
Figure 27-6 Setting Valve Clearance – EX40 Engine

ENGINE REMOVAL

See General Warnings on page 1-2.

A CAUTION

· Before removal and disassembly, clean the engine.



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Figure 27-7 EX40 Engine and Mounting Brackets

1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery – Gasoline Vehicles, Section 1, Page 1-3.

- 2. For some vehicles, the engine (1) can be removed by lifting it up and out of the chassis. For other vehicles, it is easier to remove the entire powertrain assembly first. If removing powertrain, see Transaxle Removal on page 31-9.
- 3. If equipped, remove air deflector from top of engine.
- 4. Disconnect governor cable and P-clamp, air intake hose, fuel line, wire harness connectors, ground cable, and accelerator cable P-clamp. See Fuel System Subaru EX40, Section 28, Page 28-1.
- 5. Remove starter/generator and belt. See Starter/Generator Removal, Section 26, Page 26-1.
- 6. Remove drive clutch. See Drive Clutch Removal, Section 30, Page 30-5.
- 7. Remove muffler. See Muffler Removal, Section 29, Page 29-1.
- 8. Remove engine mounting hardware (2, 3, 4, 5, and 6) from muffler bracket (7), clutch plate (8), and engine pan (9) (Figure 27-7, Page 27-8).
- 9. Lift engine (1) from engine pan (9). See following NOTE.

NOTE: The engine weighs approximately 54 lb (24.5 kg).

- 10. Remove crankcase oil drain plug and drain all oil from crankcase. Dispose of engine oil properly.
- 11. If replacing engine (1), remove starter/generator mounting weldment (10) and retain for installation on new engine. See following NOTE.

NOTE: If replacing engine and throttle body, the ECU must also be replaced. Throttle bodies and ECU's are matched pairs.

ENGINE INSTALLATION

See General Warnings on page 1-2.

- 1. If replacing engine (1), install starter/generator mounting weldment (10) on engine with screws (11), bolts (12), washers (13), and locknuts (14) (Figure 27-7, Page 27-8). Tighten locknuts (14) only finger-tight at this time.
- 2. Install oil drain plug and tighten to 18 ft·lb (24.4 N·m).
- 3. Place engine (1) onto engine pan (9) and secure with mounting hardware (4, 5, and 6). Leave flange nuts (4) loose at this time.
- 4. Install clutch plate (8) with screws (3) and bolts (21). Leave screws (3) and bolts (21) loose at this time.
- 5. Install bolts (2) through muffler bracket (7) into transaxle but do not tighten.
- Tighten hardware in the following order:
 - 6.1. Tighten screws (3) to 23 ft·lb (31 N·m).
 - 6.2. Tighten bolts (21) to 50 ft·lb (68 N·m).
 - 6.3. Tighten bolts (2) to 50 ft·lb (68 N·m).
 - 6.4. Tighten flange nuts (4) to 33 ft·lb (40.6 N·m).
- 7. Install drive clutch. See Drive Clutch Installation, Section 30, Page 30-11.
- 8. Install muffler. See Muffler Installation, Section 29, Page 29-1.
- 9. Install starter/generator and belt. See Starter/Generator Installation, Section 26, Page 26-9.
- 10. If necessary, install powertrain. See Transaxle Installation, Section 31, Page 31-12.
- 11. Connect air intake hose, fuel line, wire harness connectors, ground cable and governor cable. See Fuel System Subaru EX40, Section 28, Page 28-1.
- 12. If equipped, install air deflector on top of engine.
- 13. Secure accelerator cable and governor cable P-clamps to engine. Tighten P-clamp bolts to 36 in·lb (4.0 N·m).
- 14. Check all hardware for proper torque/tightness.

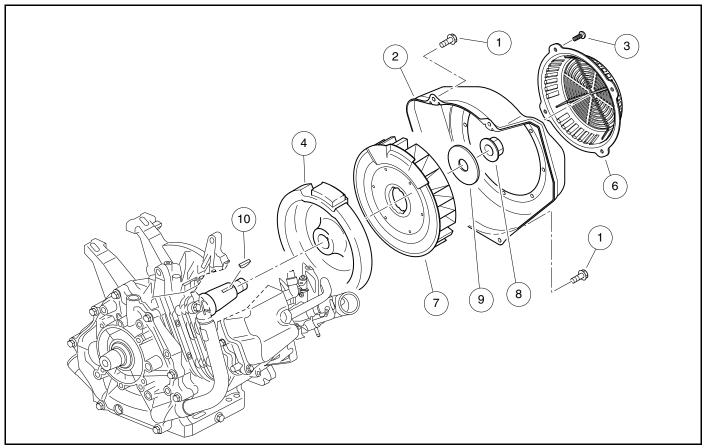
15. Fill engine to proper level with correct type of oil. See Engine Oil – Gasoline Vehicle, Section 27, Page 27-2.

A CAUTION

- · Do not overfill with oil.
- 16. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 17. Adjust the engine RPM setting. See Engine RPM Adjustment on page 28-11.
- 18. Test-drive vehicle to ensure all systems are functional and correctly adjusted.

FLYWHEEL

See General Warnings on page 1-2.



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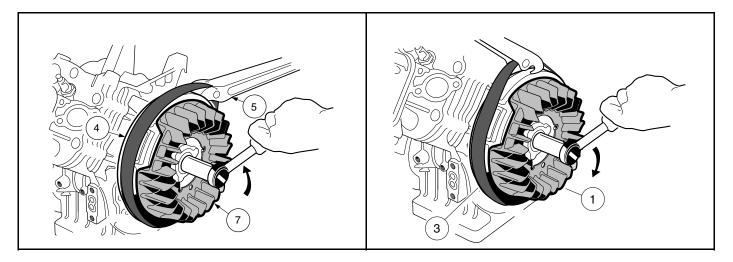
Figure 27-8 Flywheel, Fan and Fan Housing - EX40

FLYWHEEL REMOVAL

- 1. Remove screws (1) and fan housing (2) (Figure 27-8, Page 27-10).
- 2. Hold flywheel (4) only, not fan (7), with strap wrench (5) and use a 24 mm socket to remove flywheel nut (8) and flat washer (9) by turning it counterclockwise (Figure 27-9, Page 27-11). See following CAUTION.

A CAUTION

- The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.
- Do not damage the fan blades with the strap wrench. Do not place screwdriver or pry bar in the fan blades.
- 3. Temporarily install flywheel nut (8) onto end of crankshaft to protect threads and to prevent flywheel (4) from falling off while being pulled.
- 4. Detach flywheel (4) from crankshaft with a large, two-jaw puller.
- 5. Remove flywheel nut (8) and flywheel (4) from crankshaft.
- 6. Remove woodruff key (10) from groove in crankshaft.



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Figure 27-9 Flywheel Nut Removal

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Figure 27-10 Fan and Flywheel Installation

FLYWHEEL INSTALLATION

- 1. Wipe off any oil on tapered portions of crankshaft and flywheel (4) (Figure 27-8, Page 27-10).
- 2. Insert woodruff key (10) into keyway of crankshaft. Then align groove in flywheel (4) to woodruff key (10) and push flywheel onto crankshaft until it seats. Install and fan (7), flat washer (9), and nut (8) finger-tight.
- 3. Use a strap wrench (3) to keep flywheel and fan assembly (1) from turning while tightening flywheel nut to 80 ft·lb (110 N·m) (Figure 27-10, Page 27-11). See following CAUTION.

A CAUTION

- The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.
- Be careful not to damage the fan blades. Use a strap wrench to hold flywheel. Do not place screwdriver
 or pry bar between fan blades.
- 4. Install fan housing (2) and tighten screws (1) to 90 in lb (10 N·m) (Figure 27-8, Page 27-10).

OIL LEVEL SENSOR

TESTING THE OIL LEVEL SENSOR

See Oil Level Sensor on page 25-35.

OIL LEVEL SENSOR REMOVAL

- 1. Drain oil from engine. See Engine Oil Gasoline Vehicle, Section 27, Page 27-2.
- 2. Remove flywheel. See Flywheel Removal on page 27-10.
- 3. Remove bolt (1) securing oil sensor wire clamp (2) to engine.
- 4. Disconnect oil level sensor wire (3) from wire harness (Figure 27-11, Page 27-12).
- 5. Remove two bolts (4) securing oil sensor (5) in engine.
- 6. Pull oil level sensor (5) out of engine.

OIL LEVEL SENSOR INSTALLATION

- Lubricate oil level sensor o-ring with oil and carefully insert sensor (5) into engine until fully seated.
- 2. Secure sensor (5) to engine with two bolts (4) and tighten to 80 in lb (9 N·m) (Figure 27-11, Page 27-12).
- 3. Connect oil level sensor wire (3) to wire harness.
- 4. Secure oil sensor wire (3) with clamp (2) and bolt (1). Tighten bolt to 80 in·lb (9 N·m).
- 5. Install flywheel and fan shroud. See Ignition Coil Removal on page 27-13.
- 6. Fill engine to proper level with correct type of oil. See Engine Oil Gasoline Vehicle, Section 27, Page 27-2.

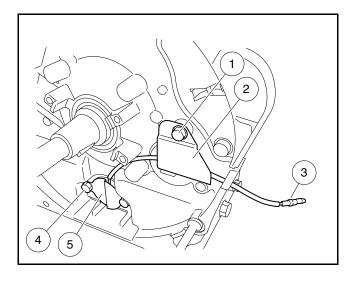


Figure 27-11 Oil Level Sensor – EX40

IGNITION COIL

See General Warnings on page 1-2.

TESTING THE IGNITION COIL

See Test Procedure 14 – Ignition Spark on page 25-32 and Test Procedure 15 – Ignition Coil on page 25-33.

IGNITION COIL REMOVAL

- 1. Remove screws (1) and fan housing (2) (Figure 27-8, Page 27-10).
- 2. Disconnect ignition coil primary lead wire (12) from spade terminal (13) on ignition coil (11) **(Figure 27-12, Page 27-13)**.
- 3. Remove two bolts (10) and pull ignition coil (11) from engine.

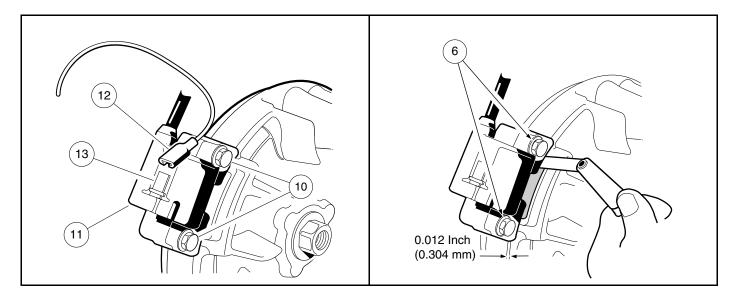


Figure 27-12 Ignition Coil

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Figure 27-13 Adjust Ignition Coil Air Gap

IGNITION COIL INSTALLATION

- 1. Position ignition coil (11) onto engine and tighten two mounting bolts (10) finger-tight at this time (Figure 27-12, Page 27-13).
- 2. Rotate flywheel until its magnet is positioned directly under ignition coil (11). Use a bronze feeler gauge to set air gap between ignition coil and flywheel magnet from 0.012 to 0.020 in. (0.3 to 0.5 mm) (Figure 27-13, Page 27-13).
- 3. Tighten ignition coil bolts (6) to 71 in·lb (8 N·m).
- 4. Connect ignition coil primary lead wire (12) to terminal (13) on coil (Figure 27-12, Page 27-13).

SNUBBER

See General Warnings on page 1-2.

NOTE: The snubber is installed on the gasoline vehicle only.

SNUBBER REMOVAL

- 1. Support the powertrain with a floor jack under the engine pan (1) so that the snubber (2) is raised slightly and does not rest on the vehicle frame (Figure 27-14, Page 27-14).
- 2. Remove the two bolts (3) and two lock nuts (4) securing the snubber bracket (5) to the engine pan (1).
- 3. Slide snubber (2) and bracket (5) assembly toward battery to remove it from vehicle.
- 4. Slide snubber (2) off bracket (5).

SNUBBER INSTALLATION

- Slide snubber (2) onto bracket (5) (Figure 27-14, Page 27-14).
- 2. Install bracket and snubber assembly onto engine pan (1).
- 3. Tighten lock nuts (4) from 20 to 25 ft·lb (27.1 to 33.9 N·m).

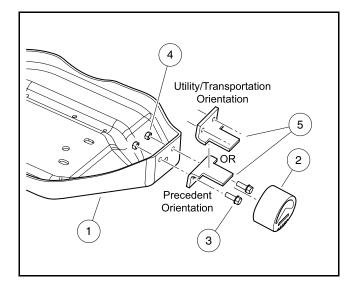


Figure 27-14 Snubber

A DANGER

See General Warnings on page 1-2.

A WARNING

- See General Warnings on page 1-2.
- Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 28-2.
- To prevent damage to the ECU, never mix the black and gray connectors that attach to it. The black connector is tethered to the ECU mounting plate to help prevent accidentally installing it in the gray port.

GENERAL INFORMATION

The engine is equipped with a throttle body/fuel injector assembly that is controlled by an ECU and requires no adjustment. The ECU monitors engine conditions through inputs from a Manifold Absolute Pressure (MAP) sensor, engine block temperature sensor and ignition timing.

EFI SYSTEM FEATURES/SPECIFICATIONS

NOTE: This manual covers ECU software version F6i33051.

- The ECU and throttle body/fuel injector assembly are matched pairs and are not available separately
- Fuel pump and low oil warning light operates for a few seconds when key switch is turned to the ON position; it stops if no engine RPM is detected by the ECU
- The ECU blinks fault codes through the Low Oil Warning Lamp
- · In-tank fuel pump
- Return-less system
- High fuel pressure system (36 to 38 psig (250 to 260 kPa))
- · Controls fuel pump, fuel injector, and oil lamp
- Automatic altitude compensation
- Flow: 16 L per hour minimum @ 12-volts/36 psig (250 kPa)
- · Current draw: 2-amps maximum
- · Throttle Body Bore: 31 mm diameter
- Open-loop system (i.e. oxygen sensor not used)
- · Separate EFI wire harness
- · Fail-safe function

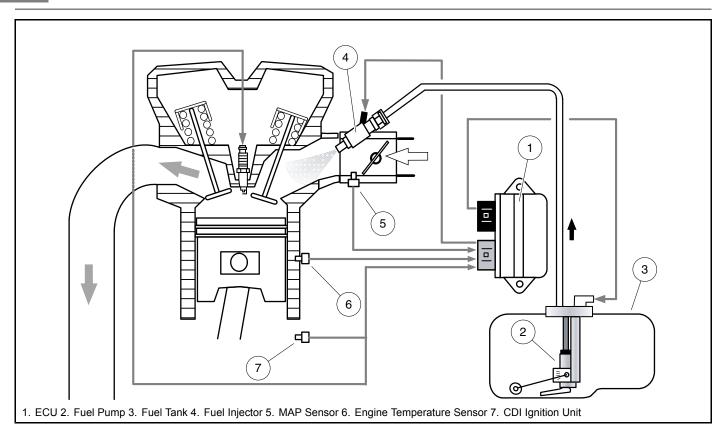


Figure 28-1 EFI System Components

RELIEVING FUEL PRESSURE

In the event that servicing the EFI fuel system necessitates removal of the fuel delivery hose, extreme caution must be exercised. The fuel system is under high pressure even with the engine not running. Disconnecting any part of the fuel delivery system, without first depressurizing the system, will result in a sudden release of pressurized gasoline at the connection. To prevent possible serious injury or death, fuel pressure must be relieved before disconnecting or removing the pump, hose and throttle body.

Either of these suggested procedures MUST be followed before attempting ANY service work on the EFI fuel system. Following these will relieve any pressure in the fuel hose prior to opening the fuel system.

TO RELIEVE FUEL PRESSURE

- · Shut off engine, disconnect battery, and wait 15 minutes or more to allow pressure to dissipate.
 - or –
- Unplug fuel pump module at fuel tank and crank engine for 5 seconds to start reducing fuel pressure. Pause and repeat an additional 5 seconds to allow pressure to dissipate.

NOTE: To absorb any residual fuel the may be present in the fuel hose, place a rag or towel around the hose at the end being disconnected.

THROTTLE BODY

See General Warnings on page 1-2.

Before suspecting the throttle body as the cause of poor engine performance, make sure the fuel and ignition systems are in proper operating condition. Check the following items:

- Spark plug and gap condition. See Spark Plug on page 27-5.
- · Air filter element. See Air Filter on page 28-12.
- Air intake system (for restriction of air flow). See Air Intake System on page 28-12.
- Exhaust system (for restrictions). See Exhaust System Subaru EX40 on page 29-1.
- Fuel pump. See Fuel Pump Module on page 28-17.
- Fuel line. See Fuel Line on page 28-15.
- Fuel pickup screen or filter. See Fuel Filter on page 28-23.

THROTTLE BODY REMOVAL

See General Warnings on page 1-2.

- 1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. If equipped, remove air deflector from top of engine.
- 4. If necessary, remove fuel tank to increase access to the throttle body (1). See Fuel Tank Removal, Section 28, Page 28-20.
- 5. Clean the throttle body (1) and surrounding area (Figure 28-2, Page 28-4).
- 6. Disconnect breather hose (2) from air intake adapter (3).
- 7. Disconnect governor cable from bracket (4).
- 8. Disconnect fuel injector and MAP sensor.
- 9. Remove spring clamps securing fuel line (6) and vent hose (5) to throttle body (1) and disconnect vent hose (5).
- 10. Disconnect fuel line (6) and drain into an appropriate container. **See following WARNING.** Temporarily plug fuel line to prevent fuel leakage.

A WARNING

- Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 28-2.
- Carefully drain any fuel into an approved container. Add drained fuel back into fuel tank or dispose
 of properly.
- 11. Loosen air intake hose clamp and disconnect air intake hose.
- 12. Remove two flange nuts (7) and slide air intake adapter (3), bracket (4), gaskets (8), insulator (9), and throttle body (1) off threaded studs.

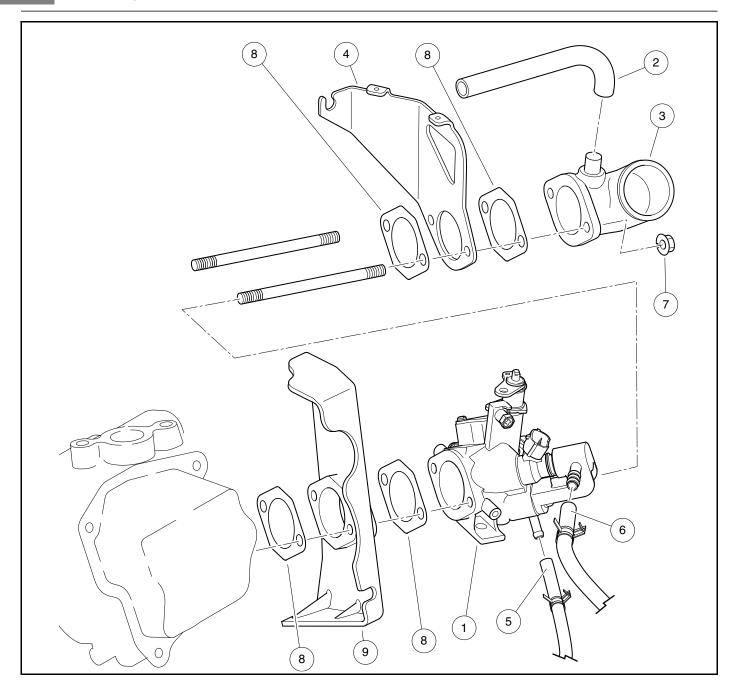


Figure 28-2 Throttle Body – Exploded View

THROTTLE BODY INSTALLATION

See General Warnings on page 1-2.

- 1. Install throttle body (1) and its related components onto threaded studs in order as shown (Figure 28-2, Page 28-4).
- 2. Install two flange nuts (7) and tighten to 53 to 71 in·lb (6 to 8 N·m).
- 3. Connect fuel line (6) and vent hose (5). Secure with spring clamps.
- 4. Connect fuel injector and MAP sensor.
- 5. Connect governor cable to bracket (4).
- 6. Connect breather hose (2) to air intake adapter (3).
- 7. Connect air intake hose and secure with hose clamp.
- 8. If removed, install fuel tank. See Fuel Tank Installation, Section 28, Page 28-21.
- 9. If equipped, install air deflector on top of engine.
- 10. Clean spilled and remove any drained gasoline from the area.
- 11. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 12. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position (Figure 31-1, Page 31-1).
- 13. Turn the key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

A DANGER

- · Repair all fuel leaks before returning the vehicle to service.
- 14. If no leaks are found, place the neutral lockout switch in the OPERATE position (Figure 31-1, Page 31-1).
- 15. Test drive vehicle to ensure proper operation.

ENGINE CONTROL LINKAGES

See General Warnings on page 1-2.

A DANGER

- To ensure the vehicle does not run over you while you disconnect or adjust the accelerator push rod, do the following:
 - Turn key switch OFF and remove key, place Forward/Reverse handle in the NEUTRAL position, and chock the wheels prior to servicing the vehicle.
 - Disconnect battery cables, negative (-) cable first.
 - Disconnect the spark plug wire from the spark plug.
 - See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

GENERAL INFORMATION

For proper vehicle operation, it is important the accelerator cable, governor linkage, and throttle adjustments are done correctly and in the proper sequence. **See following CAUTION.**

A CAUTION

· Improper adjustment can result in poor vehicle performance and/or damage to the engine components.

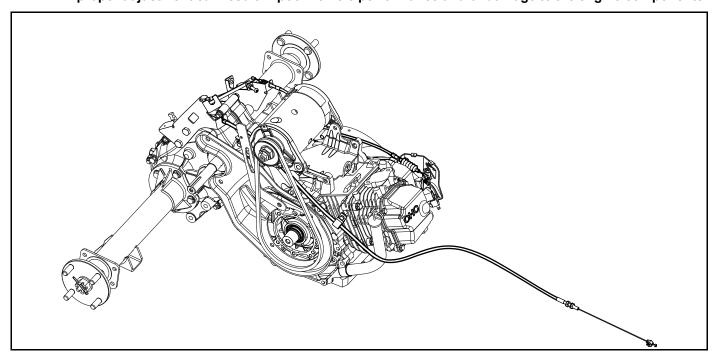


Figure 28-3 Engine Control Linkages – Precedent EFI vehicles

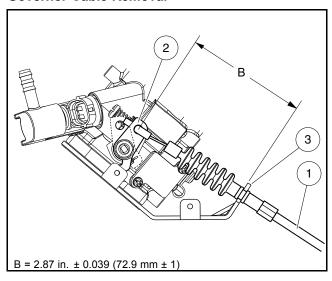
GROUND SPEED

NOTE: If possible, the manufacturer recommends measuring ground speed when setting engine RPM.

This vehicle should reach the forward ground speed specified in **Section 2 – Vehicle Specifications**. **See How to Measure Ground Speed on page 28-10.**

GOVERNOR CABLE

Governor Cable Removal



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Figure 28-4 Governor Cable At Throttle Body and Power Limiter Screw Gap Adjustment

- 1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. At engine:
 - 3.1. If equipped, remove air deflector from top of engine.
 - 3.2. Disconnect "Z" fitting of governor cable (1) from throttle lever (2) (Figure 28-4, Page 28-7).
 - 3.3. Unsnap governor cable (1) from throttle body bracket (3).
- 4. At transaxle:
 - 4.1. Disconnect "Z" fitting of governor cable (1) from governor arm (4) (Figure 28-5, Page 28-8).
 - 4.2. Loosen jam nuts at governor bracket (5) and remove cable (1) from vehicle.

Governor Cable Installation and Adjustment

- 1. At engine:
 - 1.1. Snap governor cable (1) into throttle body bracket (3) (Figure 28-4, Page 28-7).
 - 1.2. Connect "Z" fitting of governor cable (1) to throttle lever (2).
 - 1.3. If equipped, install air deflector on top of engine.
- 2. At transaxle:
 - 2.1. Slide bellows off threaded end of cable housing, separate jam nuts and place threaded end into governor bracket (5) (Figure 28-5, Page 28-8).
 - 2.2. Finger-tighten jam nuts.

- 2.3. Push bellows back onto threaded end of cable housing.
- 2.4. Connect "Z" fitting of governor cable (1) to governor arm (4).
- 3. Loosen adjustment screw jam nuts (6 and 10) and back off throttle stop screw (7) and power limiter screw (11) several turns (Figure 28-6, Page 28-8).
- Rotate governor arm (4) counterclockwise until it stops and hold in this position (Figure 28-6, Page 28-8).
- 5. Adjust governor cable jam nuts until throttle lever (2) is at "wide open throttle" (WOT) (Figure 28-4, Page 28-7) and tighten the governor cable jam nuts to 36 in·lb (4.0 N·m).
- 6. While still holding this position, adjust power limiter screw (11) (Figure 28-6, Page 28-8) to set distance (B) at 2.87 in. (±0.039) (1.4 mm (±1)) as shown (Figure 28-4, Page 28-7) between throttle lever (2) and throttle body bracket (3). Tighten limiter screw jam nut (10) to 36 in·lb (4.0 N·m).
- 7. Release governor arm (4) to return to "idle" position.
- 8. Adjust gap (A) between governor arm (4) and throttle stop screw (7) to 0.055 in. (±0.039) (1.4 mm (±1)) as shown (Figure 28-6, Page 28-8). Tighten stop screw jam nut (6) to 36 in·lb (4.0 N·m).

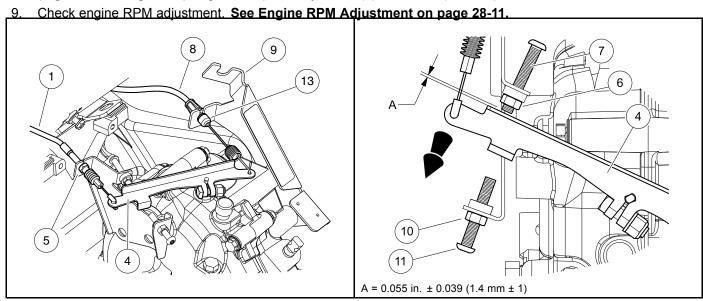


Figure 28-5 Governor and Accelerator Cables At Governor Arm

Figure 28-6 Throttle Stop Screw Gap

ACCELERATOR CABLE

Accelerator Cable Removal

1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.

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- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. At transaxle:
 - Unhook spring fitting of accelerator cable (8) from governor arm (4) (Figure 28-5, Page 28-8).
 - 3.2. Unsnap accelerator cable (8) from FNR/accelerator cable bracket (9).
- 4. At pedal group:
 - 4.1. Access the pedal group and disconnect accelerator cable clip from the accelerator pedal. **See Pedal Group Removal on page 5-4.**
 - 4.2. Loosen jam nuts securing accelerator cable to underbody and remove accelerator cable (9) from vehicle (Figure 5-4, Page 5-5).

Accelerator Cable Installation

1. At transaxle:

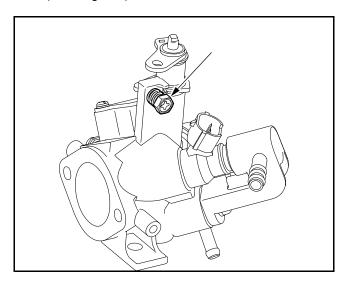


- 1.1. Hook spring fitting of accelerator cable (8) to governor arm (4) (Figure 28-5, Page 28-8).
- 1.2. Snap accelerator cable (8) into FNR/accelerator cable bracket (9).
- 1.3. Push dust shield (13) onto end of cable housing.
- 2. At pedal group:
 - 2.1. Insert the accelerator cable through the hole in the frame and feed it towards the pedal group. Connect the accelerator cable to the pedal group. See Pedal Group Gasoline Vehicle on page 5-4.
 - 2.2. Separate jam nuts (9) on cable and place threaded end into slot in underbody (Figure 5-4, Page 5-5). Tighten jam nuts finger-tight.
 - 2.3. Before tightening the cable jam nuts, make sure the engine RPM adjustment is correct. **See Engine RPM Adjustment on page 28-11.**
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

CLOSED THROTTLE OR IDLE ADJUSTMENT - PEDAL-START VEHICLES

When the accelerator pedal is released, the engine will stop. Therefore, it is not possible to measure or set idling speed under normal vehicle operating conditions. Set throttle valve as follows:

- 1. Loosen the throttle body idle screw so that it is not touching the throttle lever (Figure 28-7, Page 28-10).
- 2. Slowly tighten the idle screw until it lightly touches the throttle lever, then tighten it an additional 1 whole turn (360 degrees).



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Figure 28-7 Idle Screw

HOW TO MEASURE GROUND SPEED

Best Method

An easy way to check ground speed is by using a GPS device or smartphone application (app). If these are not available, use the alternate method below.

Alternate Method (Calculated)

Ground speed is easily determined by a known distance travelled, divided by the amount of time it took to travel that known distance (*Rate = Distance/Time*).

- Establish a known distance to travel (example: 100 ft. (30.5 m) in a safe location using cones or other type of marker.
- 2. Drive vehicle and bring to maximum speed before reaching the first cone.
- Using a stopwatch, record the amount of time it takes to travel from the first cone to the second cone at maximum speed.
- 4. With distance and time determined, calculate ground speed:
 - 4.1. Rate in seconds: Divide distance (100 ft (30.5 m)) by time (5 seconds) = 20 ft/sec (6.1 m/sec).
 - 4.2. **Convert seconds to hour:** Multiply 20 ft/sec (6.1 m/sec) by 3600 (the number of seconds in an hour) = 72000 ft/hour (21960 m/hour)
 - 4.3. Convert to MPH: Divide 72000 ft/hour by 5280 (number of ft in 1 mile) = 13.64 miles/hour
 - Convert to KPH: Move the decimal point over three places; 21960 m/hour = 21.96 km/hour

ENGINE RPM ADJUSTMENT

A DANGER

- Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.
- 1. If governor is adjusted, proceed to step 2; otherwise, adjust governor. See Governor Cable Installation and Adjustment on page 28-7.
- 2. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Measure vehicle ground speed. See How to Measure Ground Speed on page 28-10.
- 4. Compare measured ground speed with forward ground speed specified in **Section 2 Vehicle Specifications**.
- 5. If adjustment is necessary, use the following procedures:
 - 5.1. To **reduce** RPM, adjust the two jam nuts (9) to move the accelerator cable housing toward the rear of the vehicle until specified ground speed is reached **(Figure 5-4, Page 5-5)**. **See Section 2 Vehicle Specifications.**
 - 5.2. To **increase** RPM, adjust the two jam nuts to move the accelerator cable housing forward until specified ground speed is reached.
 - 5.3. Be sure both jam nuts are locked against the underbody and check ground speed again. If ground speed needs to be adjusted, repeat previous step. **See following NOTE.**

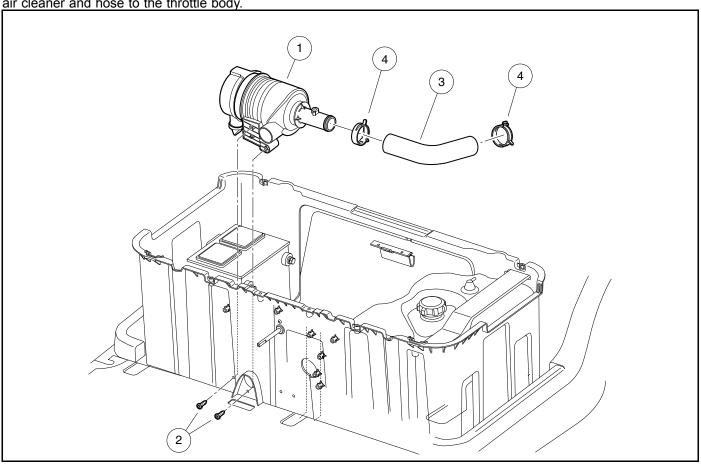
NOTE: If more adjustment is required than the cable housing will allow, make sure the spring fitting on the other end of the accelerator cable is properly installed. Excessive drive belt and clutch wear can also prevent proper ground speed adjustment. Check them for excessive wear. **See Section 30 – Clutches – Subaru EX40.**

AIR INTAKE SYSTEM

See General Warnings on page 1-2.

GENERAL INFORMATION

The air intake system is a simple mechanism requiring very little or no maintenance. The system consists of an air cleaner (1) and air hose (3) mounted under the seat (Figure 28-8, Page 28-12). The air cleaner draws clean, cool air from beneath the vehicle via an opening between the kick plate and the fuel bucket. The air passes through the air cleaner and hose to the throttle body.



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Figure 28-8 Air Intake System - Precedent with EFI

AIR FILTER

The air filter should be checked every year or 100 hours. More frequent service may be required in extremely dirty operating environments. Need for immediate servicing will be indicated by a loss of power, sluggish acceleration, or an engine which runs roughly with excessive black exhaust smoke.

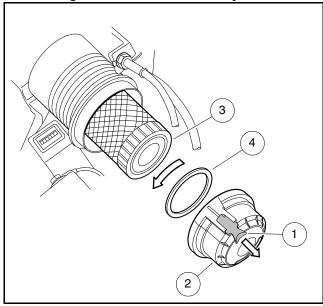
Air Filter Replacement

- 1. Access the engine compartment.
- Pull the yellow tab (1) on the air filter cover (2) away from the air cleaner (Figure 28-9, Page 28-13).
- 3. Rotate the cover counterclockwise to approximately the 10 o'clock position to release the internal locking tabs. Remove the cover.

- 4. Remove the air filter (3) and dispose of properly.
- 5. Using a clean cloth, wipe away any dust or dirt from inside the air cleaner. Remove all dirt build-up around the inside lip of the air cleaner housing or the cover will not seal properly.
- 6. Install new air filter, inserting the open end into the air cleaner housing first.
- 7. Check that the air intake gasket (4) is in place in the cover (2) and oriented correctly with the coated side of the gasket facing toward the air cleaner housing.
- 8. Place the cover (2) over the air cleaner housing. Press firmly to engage the seals and rotate the cover clockwise until the yellow tab is at the 11 o'clock position.
- 9. Press in the yellow tab (1) to lock the cover on the air cleaner. See following CAUTION.

CAUTION

- Engine damage will occur if the air filter cover is not properly secured.
- · If air cleaner is extremely dirty, clean thoroughly.
- Use only Club Car replacement air filters (P/N 102558201) or equivalent. The use of other air filters
 could result in engine damage. If the air filter is too small, the cover will seat before the filter can
 seal, leaving space for dirt to pass into the engine on all sides of the element. This will damage the
 engine and void the warranty.



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Figure 28-9 Air Filter

AIR INTAKE SYSTEM REMOVAL

- Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Access the engine compartment.
- 3. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles on page 1-3.
- 4. Hose (3) may be removed by removing the clamps (4) at the air cleaner (1) and the throttle body **(Figure 28-8, Page 28-12)**.
- 5. The air cleaner (1) is secured to the fuel bucket with screws (2). Access to the screws requires that the kick plate be removed. See Section 4 Body and Trim.

AIR INTAKE SYSTEM INSTALLATION

WARNING

- Intake hose (3) is made from a special fire retardant neoprene material. Use of any hose that does not meet Club Car, LLC specifications could create a fire hazard.
- 1. Position air cleaner (1) inside the fuel bucket (Figure 28-8, Page 28-12). Secure with screws (2). Tighten screws to 2.7 ft·lb (3.5 N·m).
- 2. Install hose (3) and secure one end to the air cleaner (1) and one end to the throttle body. Install clamps (4) to secure the hose in place.
- 3. Install kick plate. See Section 4 Body and Trim.

FUEL LINE

See General Warnings on page 1-2.

NOTE: This EFI gasoline vehicle is equipped with SAEJ30R9 fuel hose rated for high-pressure systems. Always replace the fuel line on this vehicle with approved Club Car replacement part. Do not attempt to repair, patch or splice the fuel line.

The fuel line must be properly routed from the fuel tank to the throttle body. A small, spring steel band clamp is used on the fuel line connection at the throttle body and must be tight. A plastic, dual-locking connector is used at the fuel tank. **See following WARNING.**

WARNING

- Make sure fuel line is the correct length and properly routed. Failure to heed this warning could result in damage to fuel line and fire.
- Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 28-2.

FUEL LINE REMOVAL

- 1. Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Clean the top of the fuel tank and fuel pump module.
- 4. At engine:
 - 4.1. Remove spring clamp securing fuel line to throttle body.
 - 4.2. Disconnect fuel line and drain into an appropriate container. See following WARNING.

WARNING

- Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 28-2.
- Carefully drain any fuel into an approved container. Add drained fuel back into fuel tank or dispose
 of properly.
- 5. At fuel tank:
 - 5.1. Disengage clip as shown (Figure 28-10, Page 28-16).
 - 5.2. Push in tab to unlock connector and pull fuel line from nipple on fuel pump module and remove line from vehicle.

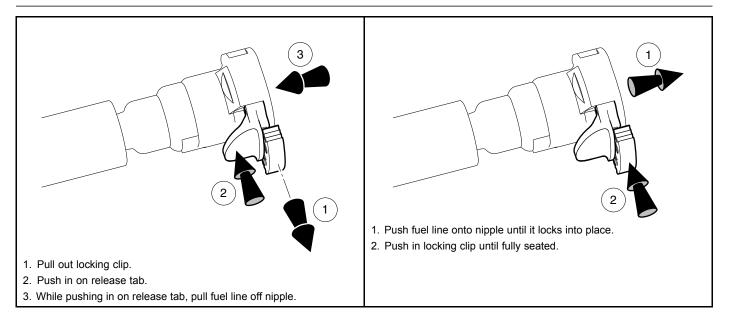


Figure 28-10 Fuel Line Connector - To Disconnect

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Figure 28-11 Fuel Line Connector - To Connect

FUEL LINE INSTALLATION

- 1. At fuel tank:
 - 1.1. Clean the nipple on top of fuel pump module.
 - 1.2. Push fuel line fully onto nipple until it locks in place (Figure 28-11, Page 28-16).
 - 1.3. Engage locking clip by pushing in until fully seated and completely prevents the line from being pulled off nipple.
- 2. At engine:
 - Connect fuel line to throttle body and secure with spring clamp. See following DANGER.

▲ DANGER

- Ensure line is connected properly to avoid a leak that can cause a fire.
- 3. Clean spilled and remove any drained gasoline from the area.
- Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 5. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position (Figure 31-1, Page 31-1).
- Turn the key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

A DANGER

- · Repair all fuel leaks before returning the vehicle to service.
- 7. If no leaks are found, place the neutral lockout switch in the OPERATE position (Figure 31-1, Page 31-1).

Fuel Pump Module

FUEL PUMP MODULE

See General Warnings on page 1-2.

GENERAL INFORMATION

NOTE: The fuel pump and fuel level sending unit themselves are not replaceable. If necessary, the fuel pump module must be replaced as an assembly.

The fuel pump module can be disassembled to replace the fuel filter.

The EFI gasoline vehicle is equipped with an electric fuel pump. The fuel pump is protected by a filter and pickup screen.

FUEL PUMP MODULE REMOVAL

- Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Clean the top of the fuel tank and fuel pump module (1) (Figure 28-12, Page 28-19).
- 4. With a marker pen, make a mark across the top of the module (1) and onto the tank to note orientation before removal.
- 5. Disconnect wire harness plug (2).
- 6. Disconnect the fuel line (3) and drain into an appropriate container. See Fuel Line Removal on page 28-15. See following WARNING.

WARNING

- Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 28-2.
- · Carefully drain any fuel remaining in the hose or pump module into an approved container. Add drained fuel back into fuel tank or dispose of properly.
- 7. Loosen fuel tank retaining strap (4) to allow tank to move and provide access to all of the fuel pump module hardware (5).
- 8. Remove hardware (5) securing hold down ring (6) and ground wire (7) to fuel tank.
- 9. Lift fuel pump module (1) out of fuel tank and drain into an appropriate container. Discard fuel module o-ring (8). See preceding WARNING and following NOTE.

NOTE: If equipped with a fuel level sending unit, carefully maneuver module so as to avoid damaging the float arm mechanism.

FUEL PUMP MODULE INSTALLATION

- 1. Clean the groove on top of fuel tank.
- 2. Place new fuel module o-ring (8) into groove on top of fuel tank (Figure 28-12, Page 28-19).

 Lower fuel pump module (1) into fuel tank noting correct orientation marked before removal. See following NOTE and CAUTION.

NOTE: If equipped with a fuel level sending unit, carefully maneuver module so as to avoid damaging the float arm mechanism.

CAUTION

- Ensure o-ring stays seated in place during fuel pump module installation.
- 4. Install hold down ring (6) and ground wire (7) with hardware (5) and tighten in a crisscross pattern to 66 in·lb (7.5 N·m). See following WARNING.

WARNING

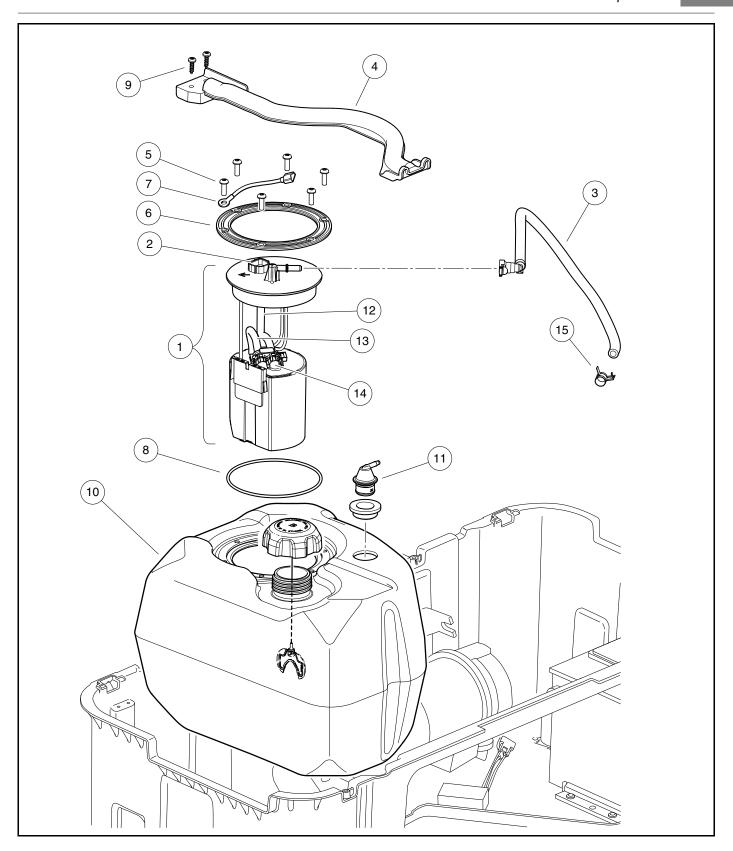
- Always install ground wires during reassembly.
- 5. Tighten fuel tank retaining strap screw (9) to 26.5 in·lb (3 N·m).
- 6. Connect fuel line (3) to fuel pump module (1). See Fuel Line Installation on page 28-16. See following DANGER.

A DANGER

- Ensure line is connected properly to avoid a leak that can cause a fire.
- 7. Connect wire harness plug (2) to fuel pump module (1).
- 8. Clean spilled and remove any drained gasoline from the area.
- 9. Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 10. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position (Figure 31-1, Page 31-1).
- 11. Turn key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

A DANGER

- Repair all fuel leaks before returning the vehicle to service.
- 12. If no leaks are found, place the neutral lockout switch in the OPERATE position (Figure 31-1, Page 31-1).



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Figure 28-12 Fuel System (Precedent) - Exploded View

FUEL TANK

See General Warnings on page 1-2.

GENERAL INFORMATION

The vehicle is equipped with a high impact, plastic fuel tank.

WARNING

• If the fuel tank is damaged, replace it. Do not attempt to repair it. See the following tank removal and disposal procedure.

A CAUTION

· Add only unleaded fuel to the tank. Do not put oil in the fuel tank.

NOTE: This gasoline vehicle complies with the California Air Resources Board (CARB) and EPA evaporative emissions regulations when equipped with SAEJ30R9 1/4 in (6.3 mm) fuel vent hose (CC P/N 102865101) and 3/16 in (4.78 mm) fuel vent hose (CC P/N 1015137). To remain in compliance with California and EPA regulations, replace any fuel vent hose on this vehicle with Club Car P/N's 102865101, 1015137, or equivalent.

FUEL TANK REMOVAL

- Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position.
- 2. Turn key switch to OFF position and remove key.
- 3. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 4. Clean the top of the fuel tank (10) and fuel pump module (1) (Figure 28-12, Page 28-19).
- Remove gas cap and siphon all fuel from tank into an approved container. See following DANGER and WARNING.

A DANGER

• Gasoline – Flammable! Explosive! Do not smoke. Keep sparks and flames away from the vehicle and service area. Service only in a well-ventilated area.

WARNING

- Do not attempt to siphon fuel using a hose that does not have a built-in suction device.
- · Do not attempt to siphon fuel using your mouth.
- 6. Disconnect wire harness plug (2) from fuel pump module (1).
- 7. Disconnect vent hose from fuel tank vent (11).
- 8. Disconnect the fuel line (3) from the fuel pump module (1) and drain into an appropriate container. See Fuel Line Removal on page 28-15. See following WARNING.

WARNING

- Fuel may be under pressure. Use extreme caution when disconnecting fuel line to prevent the spray of fuel onto hot engine. See Relieving Fuel Pressure on page 28-2.
- Carefully drain any fuel remaining in the hose or pump module into an approved container. Add drained fuel back into fuel tank or dispose of properly.
- 9. Disconnect fuel pump module ground wire (7).
- 10. Remove screws (9) holding the forward end of the fuel tank retainer (4). Lift up on the forward end of the retainer (4) and unhook the rear end from the fuel bucket.
- 11. Lift the fuel tank (10) from vehicle

FUEL TANK DISPOSAL

- 1. Remove gas cap and fuel pump module from tank. See Fuel Pump Module Removal on page 28-17. The cap may be discarded or kept as a spare.
- 2. In a well-ventilated area, flush the fuel tank with water to remove any remaining fuel.
- 3. In a well-ventilated area, set the tank upside down so that the water can drain out of it. To make sure that the tank dries completely, allow the tank to sit for 24 hours. **See following CAUTION.**

A CAUTION

• Dispose of wastewater and fuel tank in accordance with local, state, and federal laws and ordinances.

FUEL TANK STORAGE

- 1. Remove gas cap and fuel pump module from tank. See Fuel Pump Module Removal on page 28-17.
- 2. In a well-ventilated area, flush the fuel tank with water to remove any remaining fuel.
- 3. In a well-ventilated area, set the tank upside down so that the water can drain out of it. To make sure that the tank dries completely, allow the tank to sit for 24 hours.
- 4. Completely drain gas from fuel pump module and allow to module to dry.
- 5. After module is completely dry, install in fuel tank. See Fuel Pump Module Installation on page 28-17.
- 6. Store the tank upside down, with the cap installed, in a well-ventilated area.

FUEL TANK INSTALLATION

NOTE: This gasoline vehicle complies with the California Air Resources Board (CARB) and EPA evaporative emissions regulations when equipped with SAEJ30R9 1/4 in (6.3 mm) fuel vent hose (CC P/N 102865101) and 3/16 in (4.78 mm) fuel vent hose (CC P/N 1015137). To remain in compliance with California and EPA regulations, replace any fuel vent hose on this vehicle with Club Car P/N's 102865101, 1015137, or equivalent.

- 1. Place fuel tank (10) in vehicle.
- 2. Secure tank with retainer (4).
 - 2.1. Insert the tabs on the rear of the retainer (4) into the slots on the back of the fuel bucket (Figure 28-12, Page 28-19).

- 2.2. Pivot retainer (4) to place the front edge over mounting holes. Install screws (9) to secure the retainer. Tighten screws to 31 in·lb (3.5 N·m).
- Connect fuel pump module ground wire (7) to main wire harness. See following WARNING.

WARNING

- · Always install ground wires during reassembly.
- 4. Connect fuel line (3) to fuel pump module (1). See Fuel Line Installation on page 28-16. See following DANGER.

A DANGER

- Ensure line is connected properly to avoid a leak that can cause a fire.
- 5. Connect wire harness plug (2) to fuel pump module (1).
- Clean spilled and remove any drained gasoline from the area.
- Connect battery. See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- Add fuel to tank.
- Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position (Figure 31-1, Page 31-1).
- 10. Turn key switch to the ON position and check for fuel leaks. Repeat as necessary to build fuel pressure. Any leaks found must be fixed.

A DANGER

- Repair all fuel leaks before returning the vehicle to service.
- 11. If no leaks are found, place the neutral lockout switch in the OPERATE position (Figure 31-1, Page 31-1).

FUEL FILTER

See General Warnings on page 1-2.

GENERAL INFORMATION

The fuel filter is located in the fuel tank. It is part of the fuel pump module assembly and should last the life of the vehicle; however, it is replaceable if the need should arise. In addition, the module assembly features a fuel pickup screen to catch larger particles before entering the fuel filter.

FUEL FILTER REMOVAL

- Turn the key switch to the OFF position and remove the key, place the Forward/Reverse handle in the NEUTRAL position, and chock the wheels.
- 2. Disconnect battery. See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Remove fuel pump module (1). See Fuel Pump Module Removal on page 28-17.
- 4. Disconnect flex hoses (12 and 13) from filter (14) (Figure 28-12, Page 28-19).
 - 4.1. Pull hose retainer clip straight up and out of filter (14). Do not discard clip.
 - 4.2. Pull flex hoses (12 and 13) straight out of filter inlet and outlet.
- 5. Remove filter (14) from module (1) and dispose of properly.

FUEL FILTER INSTALLATION

▲ CAUTION

Fuel filter flex hoses are keyed to aid proper installation into fuel pump module.

NOTE: The fuel filter is keyed to the fuel pump module to prevent incorrect assembly.

The inlet and outlet flex hoses are keyed to the fuel filter ports to prevent incorrect assembly.

- 1. Orient fuel filter (14) and insert into fuel pump module (1) until fully seated (Figure 28-12, Page 28-19).
- 2. Connect flex hoses (12 and 13) to the fuel filter (14).
 - 2.1. Orient flex hoses (12 and 13) with matching port in filter (14) and push each hose end straight into filter until fully seated.
 - 2.2. Push hose retainer clip straight into filter (14) until fully seated.
- 3. Install fuel pump module (1). See Fuel Pump Module Installation on page 28-17.
- 4. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 5. Place the Forward/Reverse handle in the NEUTRAL position, chock the wheels, and the neutral lockout switch in the MAINTENANCE position (Figure 31-1, Page 31-1).
- 6. Start the engine and check for fuel leaks. See following DANGER.

A DANGER

- · Repair all fuel leaks before operating the vehicle.
- 7. If no leaks are found, place the neutral lockout switch in the OPERATE position (Figure 31-1, Page 31-1).

FUELING INSTRUCTIONS - GASOLINE VEHICLES

See General Warnings on page 1-2.

A DANGER

- · Turn the key switch to the OFF position before fueling.
- Do not pour fuel into the fuel tank when the engine is hot or while it is running.
- To avoid electric arc caused by static electricity, the fuel storage/pumping device must be grounded. If the pump is not grounded, the vehicle must be grounded to the pump before and during the fueling operation.
- If the vehicle has an all-weather enclosure installed, be sure the fuel tank is properly vented as shown (Figure 28-13, Page 28-25).
- To avoid the possibility of fire, clean up any spilled fuel before operating the vehicle.

A CAUTION

- Use unleaded gasoline only.
- · Whenever possible, avoid using oxygenated and blended fuels.
- Do not use any fuel with an alcohol content that exceeds 10% by volume (such as E15 and E85).
 Ethanol is an alcohol that readily absorbs moisture, causing corrosion of fuel system components. It
 also damages neoprene and other plastic and rubber components. Use of these fuels in this vehicle
 will void the warranty.
- Do not repeatedly attempt to start a vehicle when the fuel pump is dry (no gas in tank). Doing so can damage the fuel pump.

NOTE: Whenever possible, avoid using oxygenated fuels and fuels that are blended with alcohol.

Vehicles to be stored for extended periods should be prepared for storage as instructed. See Preparing the Gasoline Vehicle for Extended Storage on page 3-6.

- 1. Turn the key switch to the OFF position before fueling.
- 2. Do not pour fuel into the fuel tank when the engine is hot or while it is running.
- 3. Remove the fuel cap located on the passenger-side panel and fill the fuel tank with fresh unleaded gasoline only. **See preceding CAUTION and NOTE.**
- 4. Replace fuel cap on tank. Ensure that cap is tightened securely (tighten until it clicks).

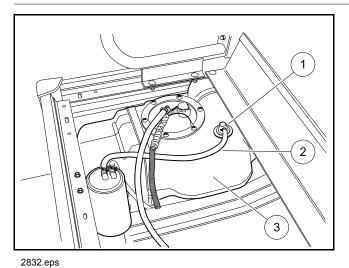


Figure 28-13 Fuel Tank

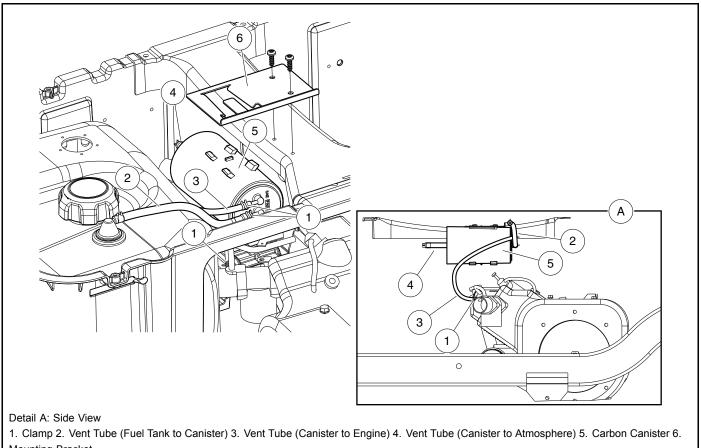
CARBON CANISTER

▲ WARNING

• If the carbon canister is damaged, only use an OEM (Club Car) replacement that is specifically designed and approved for use on this vehicle. Do not attempt to repair it. See the following canister removal procedure.

CARBON CANISTER REMOVAL

- 1. Disable the vehicle. See Disabling the Vehicle on page 1-3.
- 2. Raise or remove seat bottom from vehicle.
- 3. Remove hose clamps (1), securing three hoses (2, 3, and 4) to canister (5), and disconnect hoses (Figure 28-14, Page 28-26).
- 4. Push or pull canister from mounting bracket (6).



Mounting Bracket

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Figure 28-14 Carbon Canister, Hoses and Routing

CARBON CANISTER INSTALLATION

- 1. Align canister mounting tabs with slots in mounting bracket (6) and push canister (5) into bracket (Figure 28-14, Page 28-26). Force it in until fully seated.
- 2. Attach hoses (2, 3, and 4) to appropriate locations on carbon canister and secure with hose clamps (1).
- Install and/or lower seat bottom.

A DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

MUFFLER

MUFFLER REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. If equipped, remove air deflector from top of engine.
- 3. Remove the locknut (1) securing the muffler (2) to its mounting bracket (Figure 29-1, Page 29-3).
- 4. Remove the hex nuts (3) and lock washers (4) at the cylinder head and remove muffler (2) from vehicle.

MUFFLER INSTALLATION

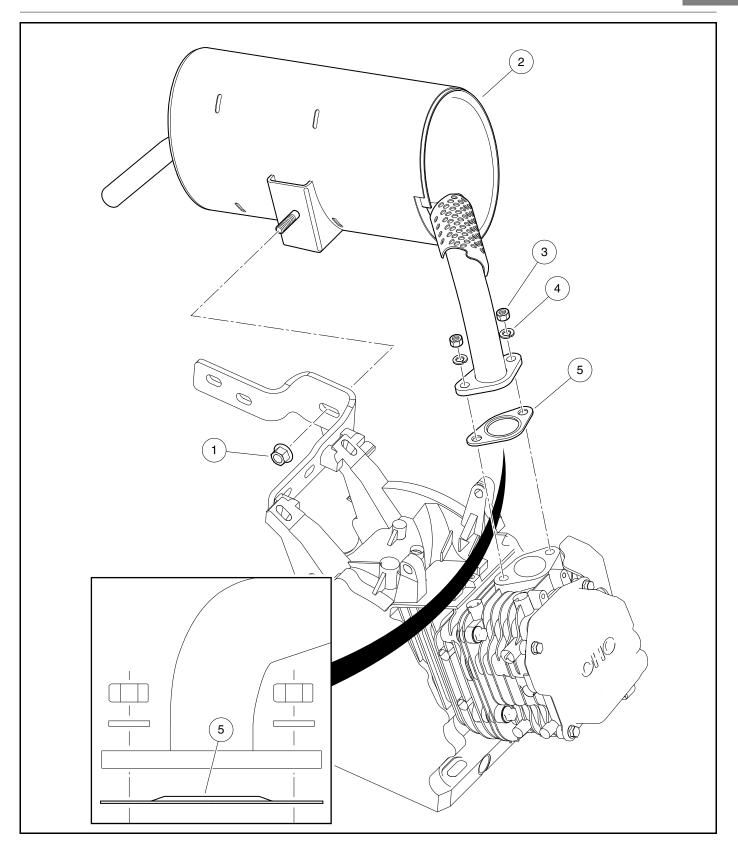
NOTE: Any time the muffler is removed from the vehicle, install a new exhaust gasket (5) (CC P/N 103993601).

- 1. Replace exhaust gasket (5) on the cylinder head exhaust port studs with a new gasket (Figure 29-1, Page 29-3). Orient gasket (5) with raised section of gasket up against the flange of the muffler.
- 2. Place muffler (2) into position and loosely secure it to mounting bracket with locknut (1) and to cylinder head with lock washers (4) and hex nuts (3).
- 3. Tighten hardware in the following order:
 - 3.1. At the mounting bracket, tighten locknut (1) to 34 ft·lb (46 N·m).
 - 3.2. At the cylinder head, tighten passenger-side hex nut (3) to 15 ft·lb (20 N·m).
 - 3.3. At the cylinder head, tighten driver-side hex nut (3) to 15 ft·lb (20 N·m).
- 4. If equipped, install air deflector on top of engine.
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 6. Place the shifter handle in NEUTRAL, the neutral lockout switch in MAINTENANCE, and chock the wheels.
- 7. Start the engine and check for exhaust leaks and proper engine operation. See following DANGER.

A DANGER

• Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.





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Figure 29-1 Exhaust System

▲ DANGER

See General Warnings on page 1-2.

WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

The torque converter consists of a drive clutch, a driven clutch, and a drive belt. The drive clutch, which is mounted to the engine, is in the open position when the engine is at idle. At this point, the belt is riding at a low position (smaller diameter) on the drive clutch. The driven clutch is mounted on the transaxle. It is in the closed position, and the drive belt is riding at a high position (large diameter) on it when the engine is at idle.

At the point of clutch engagement, the speed ratio of the drive clutch to the driven clutch provides excellent starting and low-speed torque.

As engine speed increases, centrifugal force on internal weights close the drive clutch, pushing the belt up to a higher position on the clutch (increasing the diameter of the belt loop). As the diameter of the belt loop increases at the drive clutch, the driven clutch is forced open as the diameter of its belt loop decreases.

On steep grades, or when the vehicle is heavily loaded, higher torques are achieved through the use of a torque-sensing ramp device on the driven clutch. This device overcomes the force of the centrifugal weights to close the driven clutch and open the drive clutch, thus increasing axle torque with little or no change in engine RPM.

The engine and torque converter rotate counter-clockwise as viewed from the clutch side of the engine.

To provide optimum performance for the engine and powertrain, the vehicle uses a pair of tuned clutches.

To properly assemble and disassemble the torque converter, the following tools should be used:

- Clutch Tools (Figure 30-1, Page 30-2).
- Scribe or small pick (not included with clutch tools).

TROUBLESHOOTING

See General Warnings on page 1-2.

Maintaining proper adjustment of the engine and governor, as well as the torque converter, is essential to the troubleshooting process. If these adjustments are within specifications and, when climbing a steep hill, the engine begins to lose RPM before the drive belt reaches the top of the driven clutch, there is a torque converter problem.

If the torque converter is not operating properly, perform the following steps:

1. Check the governor and throttle settings. See Engine Control Linkages on page 28-6.

- 2. Inspect the driven clutch for dirt and dust buildup on its component parts. Clean the driven clutch with water to remove any dust or dirt, then drive the vehicle and check for proper operation.
- 3. If cleaning the driven clutch does not solve the problem, disassemble and thoroughly clean all parts of the drive clutch. Be sure to clean the plastic drive buttons (7) (Figure 30-3, Page 30-4).

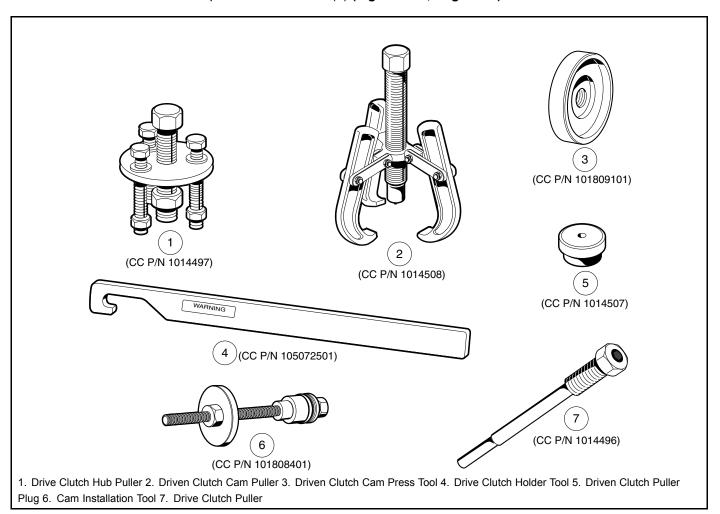


Figure 30-1 Clutch Tools

Drive Belt 30

DRIVE BELT

See General Warnings on page 1-2.

The drive belt should be inspected semiannually for wear and (or) glazing. If it is excessively worn, frayed, or glazed, replace the belt.

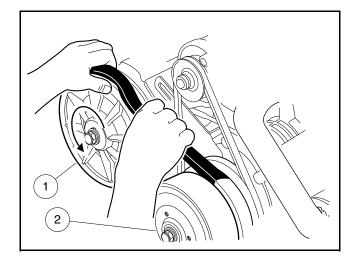
As the drive belt wears, the engine RPM will increase to compensate for the change in torque converter ratio. This will keep the vehicle's maximum ground speed correct. **See Section 2 – Vehicle Specifications.**

DRIVE BELT REMOVAL

- 1. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 2. Grasp the belt midway between the drive (2) and driven (1) clutches. Lift upward on the belt to force the sheaves of the driven clutch (1) apart, then roll the belt off the driven clutch by rotating the clutch counterclockwise (Figure 30-2, Page 30-3). See following CAUTION.

A CAUTION

- · Make sure fingers are not underneath the belt when rolling the belt off the driven clutch.
- 3. Remove the belt from the drive clutch (2).



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Figure 30-2 Drive Belt Removal

DRIVE BELT INSTALLATION

- 1. Position the new belt on the drive clutch (2), then start the belt over the top of the driven clutch (1).
- 2. With the belt started onto the driven clutch (1), rotate the driven clutch counterclockwise and roll the belt over the outer, moveable sheave.
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

DRIVE CLUTCH

See General Warnings on page 1-2.

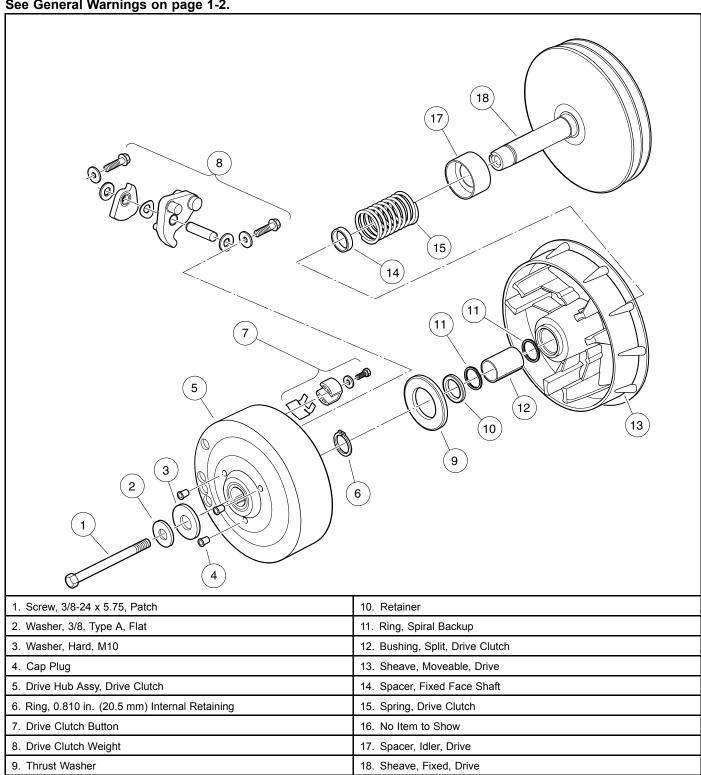


Figure 30-3 Drive Clutch - Exploded View

A CAUTION

• Be very careful when handling the clutches. A clutch that has been dropped will not be properly balanced. If either clutch is dropped, assume that it is damaged and replace it.

DRIVE CLUTCH REMOVAL

1. Remove the drive belt as instructed. See Drive Belt Removal on page 30-3.

2. Loosen starter/generator mounting and adjusting hardware and remove starter belt. See WARNING "Moving nortal Do not." in Conoral Warnings on page 1.2

parts! Do not..." in General Warnings on page 1-2.

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Figure 30-4 Loosen Retaining Bolt

Figure 30-5 Drive Clutch Removal

3. Place chocks at the front wheels and lift the rear of the vehicle with a chain hoist or floor jack. Place jack stands under the chassis to support the vehicle. The weight of the powertrain will allow the centerline of the drive clutch to drop below the frame I-beam for access to the bolt securing the drive clutch. **See following WARNING.**

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▲ WARNING

 Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes. 4. Remove the drive clutch retaining bolt (1) and mounting washers (2 and 3) (Figure 30-3, Page 30-4). See also Figure 30-4, Page 30-5. See following NOTE.

NOTE: On Subaru EX40 engines, the drive clutch mounting bolt has right-hand threads.

- 4.1. Use the drive clutch holder tool (1) while tightening or loosening the drive clutch retaining bolt (2) (Figure 30-4, Page 30-5).
- 4.2. Hook drive clutch holder tool (1) on boss (3) of pulley located behind drive clutch and push against the adjacent boss with holder.
- 5. Lubricate the threaded portion of the clutch puller tool (1) with a light oil and thread the clutch puller tool into the female thread of the drive clutch (Figure 30-5, Page 30-5).
- 6. Support the drive clutch with your hand and use a 1/2-in. drive air wrench to tighten the clutch puller tool. The tool will bottom out in the crankshaft and force the drive clutch (2) free of the crankshaft.
- 7. Remove clutch puller tool from drive clutch.

A CAUTION

Do not hit or tap the clutch with a hammer. Do not pry the clutch. These actions will damage the clutch.

DRIVE CLUTCH CLEANING AND INSPECTION

1. Use a dry, lint-free cloth to clean clutch parts.

A CAUTION

- Do not lubricate the drive clutch. Lubricants attract dirt and dust, which interfere with proper clutch operation.
- Use only a dry cloth to lightly wipe the shaft of the fixed sheave (18) (Figure 30-3, Page 30-4). Do not use a brush or steel wool. These will damage the surface of the shaft.
- Do not use solvents. Solvents will damage the lubricating characteristics of the bushings.
- 2. Inspect the belt contact surfaces of the clutch sheaves for wear. If any area of a sheave contact surface has wear of 0.060 in. (1.52 mm) or more, the clutch should be replaced.

DRIVE CLUTCH DISASSEMBLY

A CAUTION

- The drive clutch is balanced as an assembly. Before disassembly, make match marks on the drive clutch hub and on the moveable sheave so they can be reassembled in the same positions (Figure 30-6, Page 30-7).
- 1. Make match marks on the drive clutch hub and on the moveable face (Figure 30-6, Page 30-7).
- 2. Remove the drive clutch hub (5) (Figure 30-3, Page 30-4):
 - 2.1. Remove the three plugs (4) from the clutch puller attachment holes.

- 2.2. Thread the center bolt of the Drive Clutch Hub Puller (1) (CC P/N 1014497) into clutch until the stop nut touches the clutch, then back the bolt out one-half turn (Figure 30-7, Page 30-7).
- 2.3. Thread the three small bolts of the puller into corresponding holes in the clutch. Tighten bolts evenly, making sure the face of the puller plate is parallel to the face of the clutch (**Figure 30-7, Page 30-7**).
- 2.4. Unscrew the puller center bolt out of the clutch to pull drive clutch hub off.

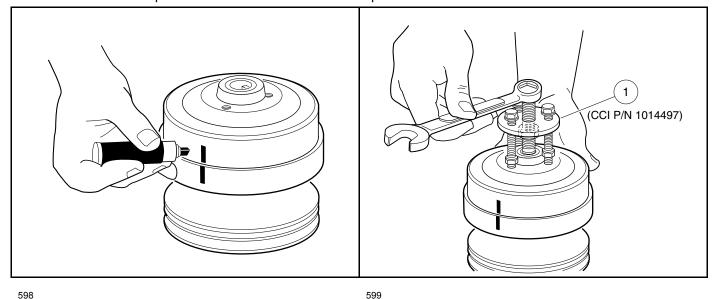


Figure 30-6 Mark Drive Clutch Hub

Figure 30-7 Remove Drive Clutch Hub

- 3. Remove the thrust washer (9) from the moveable sheave (13) (Figure 30-3, Page 30-4).
- 4. Remove the drive buttons (3) by removing the screws (1), flat washers (2), and drive button take-up springs (4) as shown **(Figure 30-8, Page 30-8)**.

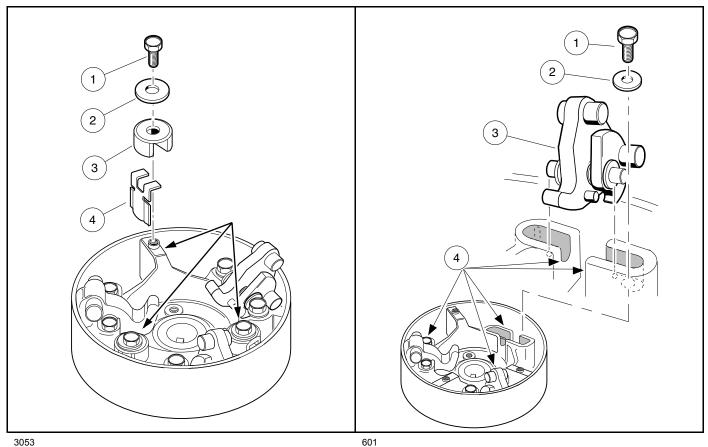


Figure 30-8 Drive Button Mounting

Figure 30-9 Weight Position

- 5. Remove the clutch weights:
 - 5.1. Remove the screws (1) and flat washers (2) attaching the weights (3) as shown (Figure 30-9, Page 30-8).
 - 5.2. Pull the weight assemblies (3), with pins, from slots (4) in the clutch. See following NOTE.

NOTE: Before removing, note the orientation of the wave washer (1) and secondary weight (2) on the primary weight (3) (Figure 30-10, Page 30-8).

5.3. Remove the plastic washers, weights (2 and 3) and wave washer (1) from the pin (4). Retain all parts.

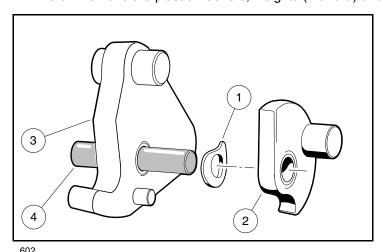
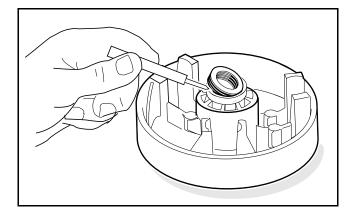


Figure 30-10 Primary and Secondary Weights, Wave Washer and Pin

6. Remove the retaining ring (6) from the shaft of the fixed sheave (18) and slide the moveable sheave (13) off the shaft (Figure 30-3, Page 30-4). See following NOTE.

NOTE: If the moveable sheave is removed from the hub of the fixed sheave, the spiral back-up rings (11) must be replaced with new rings (**Figure 30-3, Page 30-4**).

- 7. Remove the spacer (14) and spring (15) (Figure 30-3, Page 30-4).
- 8. Use a scribe or small pick to remove the spiral backup rings (11) from each end of the bore in the fixed sheave (Figure 30-3, Page 30-4). See also Figure 30-11, Page 30-9. Discard the rings.



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Figure 30-11 Spiral Back-up Rings

INSPECTION OF DRIVE CLUTCH PARTS

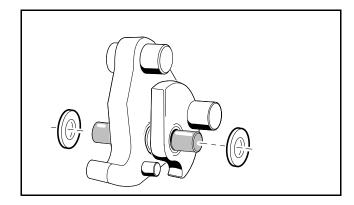
- 1. Inspect the idler spacer (17) for smoothness (Figure 30-3, Page 30-4).
- 2. Inspect the bore of the moveable sheave (13) for scarring or wear. The moveable sheave must be replaced if the bore is worn to a diameter of 0.883 in. (22.4 mm) or larger (Figure 30-3, Page 30-4).
- 3. Inspect the steel shaft on the fixed sheave (18). There should be no measurable wear anywhere on the shaft. Replace the shaft if it is worn, scratched, or damaged.
- 4. Inspect the thrust washer (9) for wear. If it is worn more than 0.030 in. (0.76 mm), turn it over or replace it with a new one.
- 5. Inspect the primary weights (8) and the hub casting for wear. If the primary weights show signs they are touching the casting, the tips of the weights have worn beyond specification and they must be replaced.
- 6. Inspect the pins on the primary weights (8). There should be no measurable wear. Replace them if they are worn, scratched, or damaged.
- 7. Inspect the drive belt pulley sheaves for excessive wear or damage. If the sheaves are excessively worn or damaged, replace the entire fixed sheave.

DRIVE CLUTCH ASSEMBLY

- 1. Install the spring (15) into the cup of the idler spacer (17).
- 2. Install the spacer (14) onto the shaft of the fixed sheave.
- 3. Install a new spiral backup ring (11) in each end of the bore of the moveable sheave (13).
- 4. Install the moveable sheave (13) onto the shaft of the fixed sheave (18).

A CAUTION

- To avoid damaging the spiral back-up rings, be very careful when installing the moveable sheave.
- 4.1. Rotate the moveable sheave clockwise while installing it onto the shaft.
- 4.2. Install the retaining ring (6) (Figure 30-3, Page 30-4).
- Install the primary weights (3) on the mounting pins (4) (Figure 30-10, Page 30-8).
- Install a wave washer (1) on each mounting pin (4). Make sure that the concave side of the washer faces the side
 of the primary weight (3) with the small guide pin protruding from it (Figure 30-10, Page 30-8).
- 7. Install the secondary weights (2) onto the mounting pins (4) with the weight pins on the secondary weights pointing away from the primary weights (3). The wave washers should be between the primary and secondary weights (Figure 30-10, Page 30-8).
- 8. Install white plastic flat washers on each end of the mounting pin and push them against the outside surfaces of the weights. Center the weights and washers on the mounting pin (Figure 30-12, Page 30-10).
- Install the weight assemblies into the slots (4) in the hub casting (Figure 30-9, Page 30-8). Make sure the
 mounting pin protrudes an equal amount on each side of the weights when the assemblies are in position
 (Figure 30-12, Page 30-10).



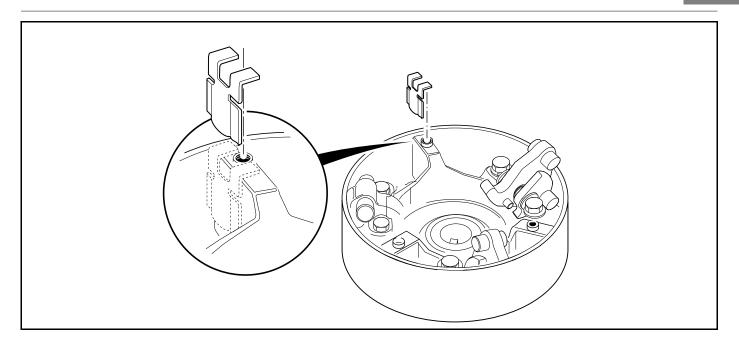
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Figure 30-12 Install White Washers

10. Install the 1/4-20 bolts (1) and washers (2) and tighten them to 10 ft·lb (13 N·m) (Figure 30-9, Page 30-8). See following NOTE.

NOTE: Make sure there is at least a (minimum) gap of 0.020 in. (0.51 mm) between each end of the mounting pin and the mounting bolt.

- 11. Install three drive button take-up springs.
 - 11.1. Install each spring on right-hand side of the three button mounting posts (when looking into the interior of the clutch drive hub, and with the rib at a twelve o'clock position) as shown (Figure 30-13, Page 30-11).
- 12. Compress each take-up spring and install the drive button over the rib and take-up spring (Figure 30-8, Page 30-8).
- 13. Install a drive button retaining bolt (1) with flat washer (2) through each button (3) and into the rib. Tighten the bolts to 34 in·lb (3.8 N·m) (Figure 30-8, Page 30-8).
- 14. Install the thrust washer (9) onto the moveable sheave (13) (Figure 30-3, Page 30-4).
- 15. Install the hub assembly (5) on the moveable sheave (13) and align the match marks made before disassembling the clutch. Press the hub assembly on by hand.
- 16. Replace the three plastic plugs (4) into the holes (Figure 30-3, Page 30-4).



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Figure 30-13 Correct Orientation of Drive Button Take-up Springs

DRIVE CLUTCH INSTALLATION

1. Place the drive clutch assembly on the crankshaft taper. Position the mounting washers (2 and 3) on the bolt (1) and start the bolt into the crankshaft (Figure 30-3, Page 30-4). See following NOTE.

NOTE: The drive clutch retaining bolt has right-hand threads. The manufacturer recommends replacing the drive clutch retaining bolt (CC PN 103976101) when installing the drive clutch. If a new bolt is not available, clean the threads of the original bolt and apply Loctite® 242 to the threaded end prior to installation.

- 2. Tighten the drive clutch retaining bolt (1) to 35 ft·lb (47.5 N·m) (Figure 30-3, Page 30-4).
- 3. Install the starter/generator belt and adjust belt tension as instructed. See Belt Tension Adjustment, Section 26, Page 26-11.
- 4. Install the drive belt as instructed. See Drive Belt Installation on page 30-3.
- 5. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 6. Drive the vehicle and check for proper operation.

DRIVEN CLUTCH

See General Warnings on page 1-2.

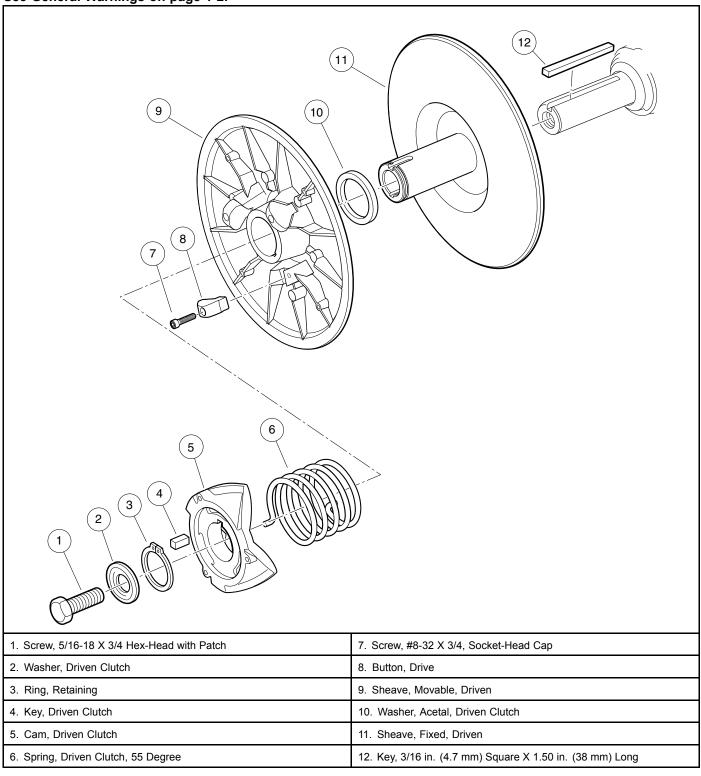


Figure 30-14 Driven Clutch - Exploded View

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DRIVEN CLUTCH REMOVAL

- 1. Remove the drive belt as instructed. See Drive Belt Removal on page 30-3.
- 2. Remove the bolt (1) and mounting washer (2) from the transaxle input shaft (Figure 30-14, Page 30-12).
- 3. Grasp the driven clutch assembly and slide it off the shaft.
- 4. Leave the key (12) in the keyway.

DRIVEN CLUTCH DISASSEMBLY

A CAUTION

- The driven clutch is balanced as an assembly. Before disassembly, make match marks on the driven clutch fixed sheave and moveable sheave so they can be reassembled in the same positions.
- 1. Make match marks on the driven clutch fixed sheave and on the moveable sheave to maintain balance upon reassembly.
- Using external snap ring pliers, remove the retaining ring (4) (Figure 30-15, Page 30-14). See following WARNING.

WARNING

- Do not place fingers under the cam when removing the cam. The moveable face may spin when the cam buttons release from the cam ramps, resulting in severe personal injury.
- 3. Insert a puller plug (2) (CC P/N 1014507) (Figure 30-16, Page 30-14) into the shaft bore and use a driven clutch cam puller (1) (CC P/N 1014508) to remove the cam (3) from the fixed sheave.
- 4. Remove the spring (6) (Figure 30-14, Page 30-12).
- 5. Retain the key (4).
- 6. Slide the moveable sheave (9) off the fixed sheave (11).

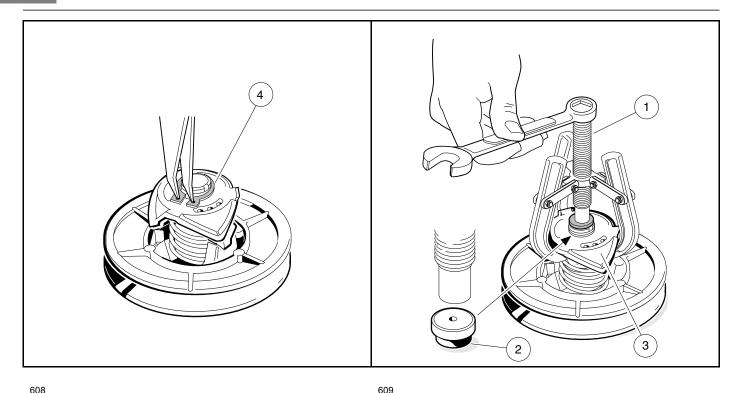


Figure 30-15 Remove Retaining Ring

Figure 30-16 Driven Clutch Disassembly

DRIVEN CLUTCH INSPECTION

- 1. Inspect the cam (5) for excessive wear (Figure 30-14, Page 30-12). Replace it if necessary.
- 2. Inspect the drive buttons (8) for excessive wear. Replace if necessary. To remove the drive buttons (8), remove the socket-head cap screws (7) and then the buttons.
- 3. Inspect the smooth surface on the fixed and moveable sheaves. Sheaves must be replaced if surfaces are worn more than 0.060 in. (1.5 mm).
- 4. Inspect the bronze bearing in the moveable sheave. If the bearing bore diameter is more than 1.384 in. (35.15 mm), the entire moveable sheave must be replaced.
- 5. Inspect the shaft of the fixed sheave. There should be no noticeable wear. Replace the fixed sheave if it is worn, scratched or damaged.

DRIVEN CLUTCH ASSEMBLY

- 1. Place the three drive buttons (8) in position. Apply one drop of Loctite® 222 to each of the socket-head cap screws (7) and then install and tighten them to 8 in·lb (0.9 N·m) (Figure 30-14, Page 30-12).
- 2. Slide the acetal washer (10) and moveable sheave (9) onto the fixed sheave (11).
- 3. Place the end of the spring (6) into the hole in the moveable sheave (9).
- 4. Install the key (4) into the keyway of the fixed sheave (11) shaft.
- 5. Holding the cam (5) in position for assembly on the shaft, install the other end of the spring (6) into the center spring hole of the cam. Rotate the cam until the keyway is aligned with the key (4) on the fixed sheave, and then start the cam onto the shaft approximately 1/4 to 3/8 in. (6.3 to 9.5 mm).

5.1. Press Assembly Process:

5.1.1. Place the clutch assembly in a press and position the cam press tool (CC P/N 101809101) on the cam (2) as shown (Figure 30-17, Page 30-15).

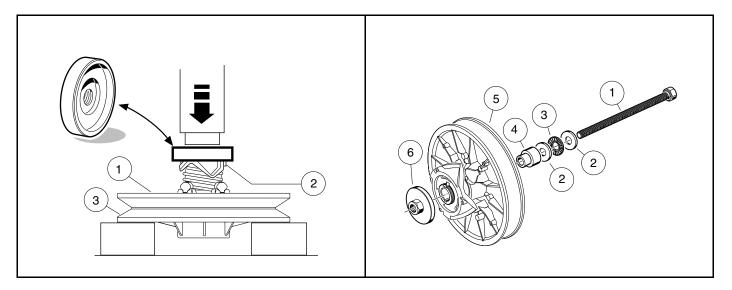
- 5.1.2. Hold the fixed sheave (3) and rotate the moveable sheave (1) one-third turn counterclockwise, then press the cam (2) onto the fixed sheave (Figure 30-17, Page 30-15). The match marks made before disassembly should now align.
- 5.1.3. Install the retaining ring (4) (Figure 30-15, Page 30-14). See following NOTE.

NOTE: The retaining ring (4) can be reused if the O.D. does not exceed 1.607 in. (40.82 mm); otherwise, it must be replaced with a new ring (CC P/N 1014080).

5.1.4. While holding onto the cam, tap the end of the fixed sheave lightly with a plastic mallet until the cam seats against the retaining ring (4). **See following CAUTION.**

CAUTION

Do not use a metal hammer to tap the fixed sheave. A metal hammer will damage the shaft.



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Figure 30-17 Cam Press Tool

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Figure 30-18 Cam Installation Tool

5.2. Field Assembly Process:

NOTE: This process is for field assembly requirements where hydraulic and pneumatic press equipment is not available. Use the cam installation tool (CC P/N 101808401) for this process.

- 5.2.1. With the clutch loosely assembled, set the edge of the clutch body (5) on a clean, flat surface (Figure 30-18, Page 30-15).
- 5.2.2. Assemble the threaded bolt (1) through the washer (2), the thrust bearing assembly (3), the second washer (2), and the hub guide (4).

NOTE: It is very important that the bolt, washers, and thrust bearing assembly be assembled in the order described and shown.

- 5.2.3. Slide the bolt (1) through the clutch body (5) until the threaded bolt, washers, bearing, and hub guide are against the fixed sheave (**Figure 30-18**, **Page 30-15**).
- 5.2.4. Hold the clutch assembly and cam installation tool together and place the fixed sheave down on spaced blocks (Figure 30-17, Page 30-15).
- 5.2.5. Place the cam press hub (6) onto the cam installation bolt and thread it down onto the cam hub, centering the press hub onto the cam hub.

- 5.2.6. Hold the fixed sheave of the clutch (5) and rotate the moveable sheave of the clutch one-third turn counterclockwise (Figure 30-18, Page 30-15). The match marks made before disassembly should now align.
- 5.2.7. Use two wrenches and hold the bolt head (1) while tightening the cam press hub (6) to press the cam onto the keyed shaft. Advance the press hub (6) until it is firm against the shaft end.
- 5.2.8. Remove the cam press hub (6) and installation tool.
- 5.2.9. Install the retaining ring (4) (Figure 30-15, Page 30-14).

NOTE: The retaining ring (4) can be reused if the O.D. does not exceed 1.607 in. (40.82 mm); otherwise, it must be replaced with a new ring (CC P/N 1014080).

DRIVEN CLUTCH INSTALLATION

 To install the driven clutch, reverse the removal procedure. Make sure that the washer (2) is mounted with the flat portion of the washer against the driven clutch (Figure 30-14, Page 30-12). Secure with a new bolt (1). See following NOTE.

NOTE: The bolt (1) must be replaced with a new bolt (CC P/N 102242101) containing a locking patch that will prevent the bolt from loosening.

- Tighten the bolt (1) to 18 ft·lb (24.4 N·m).
- 3. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

A DANGER

See General Warnings on page 1-2.

A WARNING

• See General Warnings on page 1-2.

GENERAL INFORMATION

The vehicles addressed in this manual are equipped with heavy-duty transaxles. The transaxle utilizes internal gearing to change vehicle direction. Because the transaxle is used to reverse vehicle direction, the engine, drive clutch, belt, and driven clutch rotate in the same direction; therefore, the engine and clutches are not subjected to reversing loads. This reduces maintenance requirements on the engine and clutches. With the transaxle, power is transferred from the engine through the drive clutch, the drive belt, the driven clutch, and then through the transaxle to the wheels.

SHIFTER LEVER

A shifter lever, connected to a shifter arm, is used to change the gears to one of three shift positions: FORWARD (F), NEUTRAL (N), or REVERSE (R). Bring the vehicle to a complete stop before changing FORWARD or REVERSE direction.

NEUTRAL LOCKOUT

For the convenience of the trained technician, there is a neutral lockout switch located on the seat support panel under the seat (**Figure 31-1**, **Page 31-1**). The neutral lockout switch has two positions, MAINTENANCE and OPERATE, which are clearly marked.

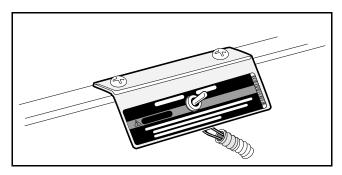


Figure 31-1 MAINTENANCE/OPERATE Switch

Pedal-Start Vehicles

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During normal vehicle operation, the neutral lockout switch in the OPERATE position prevents the engine from running when the Forward/Reverse handle is in the NEUTRAL position. If a vehicle is started in FORWARD or REVERSE and then shifted to NEUTRAL, the engine will stop running.

When the switch is in the MAINTENANCE position, it will allow the technician to run the engine in the NEUTRAL position to perform certain maintenance and/or repair functions. With the switch in this position, the vehicle will not operate if the Forward/Reverse handle is placed in either the FORWARD or REVERSE position. **See following WARNING and NOTE.**

WARNING

• With the switch in the MAINTENANCE position and the engine running, the vehicle may move suddenly if the Forward/Reverse handle is shifted or accidentally bumped. To prevent this, chock the front and rear wheels and firmly set the park brake before servicing or leaving the vehicle.

NOTE: Be sure to return the switch to the OPERATE position after servicing the vehicle, or it will not run with the Forward/Reverse handle in either the FORWARD or REVERSE position.

GOVERNOR SYSTEM

The governor system regulates vehicle ground speed. It is mounted inside the transaxle and is driven by transaxle gears. If any of the governor linkages are removed in order to service other components, readjustment of the governor linkage is required. **See Governor Cable Installation and Adjustment on page 28-7.**

TRANSAXLE SERVICE

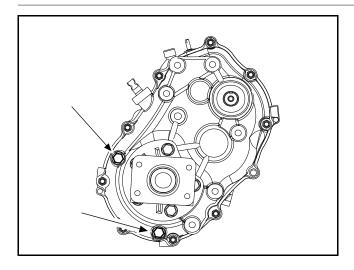
The transaxle is extremely durable and should require very little service under normal operating conditions. The only service required is to maintain proper lubricant level. **See Lubrication on page 31-2.** Under normal operating conditions, adjustment to the system should not be required.

LUBRICATION

There are two oil port plugs located on the right (driven clutch) side of the transaxle (Figure 31-2, Page 31-3). When the vehicle is on a level surface, use the upper plug as a lubricant level indicator. Lubricant level should be even with the bottom of level indicator hole. Use the lower plug for draining.

Oil Change - Transaxle

- 1. When draining transaxle oil, remove both plugs to allow the oil to drain faster.
- 2. Clean and reinstall the drain plug and gasket before filling the transaxle with new lubricant. Tighten drain plug to 17 ft·lb (23 N·m).
- Use a funnel when filling the transaxle through the lubricant level indicator hole. Fill with 67.6 fl-oz (2 L) 80-90 WT. API class GL or 80-90 WT. AGMA class 5 EP gear lubricant (or until lubricant begins to run out of the level indicator hole).
- 4. Install upper plug and gasket and tighten to 17 ft·lb (23 N·m).



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Figure 31-2 Lubricant Level Plug and Drain Plug

TOOLS REQUIRED FOR THIS SECTION

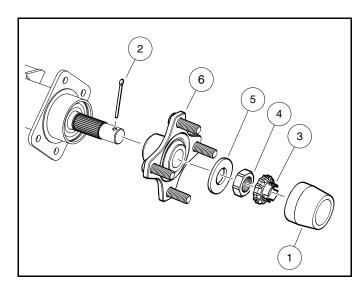
Hydraulic floor jack (or chain hoist)	Torque wrench, 3/8-in. drive	1/2-in. combination wrench
Jack stands (2) (one ton capacity)	3/8-in. socket, 3/8-in. drive	9/16-in. combination wrench
Standard slip joint pliers	7/16-in. socket, 3/8-in. drive	Small flat blade screwdriver
External snap ring pliers (.0.047- in. tip)	1/2-in. socket, 3/8-in. drive	Medium flat blade screwdrivers (2)
90° Internal snap ring pliers (0.090-in. tip)	9/16-in. socket, 3/8-in. drive	No. 2 phillips-head screwdriver
16-in. rolling head prybar	5/8-in. socket, 3/8- in. drive	1/4-in. nut driver
Plastic or rubber mallet	Axle seal tool (CC P/N 1014162)	5/16-in. nut driver
Ratchet wrench, 3/8-in. drive	7/16-in. combination wrench	

REAR HUBS

REAR HUB REMOVAL

- Turn the key switch to the OFF position and remove the key, and place the Forward/Reverse handle in the NEUTRAL position.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Place chocks at the front wheels and loosen lug nuts on both rear wheels.
- 4. Remove the rubber dust cap (1).
- 5. Remove and discard the cotter pin (2) (Figure 31-3, Page 31-4).
- 6. Remove nut locking cap (3) and loosen the hub nut (4) on the axle shaft.
- 7. Lift and support the rear of vehicle.
- 8. Remove the lug nuts and wheel.
- 9. Slide brake drum off hub.
- 10. Remove hub nut (4) and large flat washer (5) and pull hub (6) off axle shaft. See following NOTE.

NOTE: If the hub (6) does not slide easily off the axle shaft, use a two or four-jaw wheel puller to remove the hub.



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Figure 31-3 Rear Hub Exploded View

REAR HUB INSTALLATION

1. Inspect brake shoes for wear and replace if necessary. See Wheel Brake Assemblies section.

NOTE: If brake shoes are replaced on one side, replace the opposite side also.

- 2. Clean the splines and threaded portion of the axle shaft.
- 3. Apply anti-seize compound to both the axle shaft splines and hub (6) splines. See following CAUTION.

CAUTION

- Do not allow anti-seize compound to contact the brake drum or shoes.
- 4. Slide hub (6) onto axle shaft (Figure 31-3, Page 31-4).
- 5. Install the large flat washer (5) onto the threaded portion of the axle.
- 6. Install hub nut (4) and advance the nut to the large flat washer.
- 7. Install brake drum onto hub.
- 8. Install the tire and wheel and finger-tighten the lug nuts.
- 9. Lower the rear of the vehicle.
- 10. Tighten the hub nut (4) to 147 ft·lb (200 N·m) initially. If possible, position the locking cap (3) on hub nut (4) and install new cotter pin (2). If necessary, tighten hub nut (4) further (177 ft·lb (240 N·m) max.) until the locking cap (3) and new cotter pin (2) can be installed.
- 11. Deform cotter pin (2) as shown (Figure 31-4, Page 31-5). Either way is acceptable. No part of the cotter pin (2) should protrude beyond the perimeter of the locking cap (3).
- 12. Install rubber dust cap (1).
- 13. Tighten lug nuts to 65 ft·lb (88 N·m) using a crisscross pattern.
- 14. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

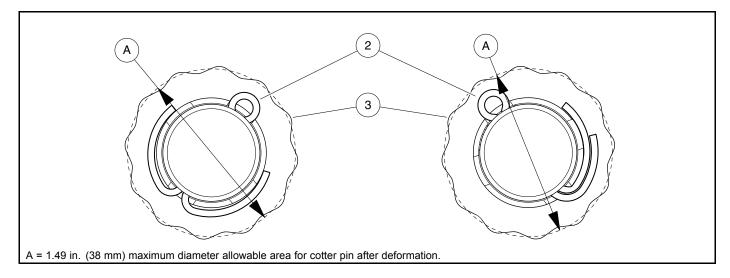


Figure 31-4 Cotter Pin Deformation



AXLE TUBES, AXLE SHAFTS AND WHEEL BEARINGS

Removal of the transaxle is not required for servicing or replacing axle shafts, axle bearings, or axle shaft oil seals. If the transaxle is to be removed from the vehicle, do not remove the wheels, axle shafts, or axle tubes first. Instructions for removing the transaxle from the vehicle begin on page 31-9.

NOTE: The axle shaft oil seals (7) are located in the transaxle gearcase (4), not the axle tubes (2) **(Figure 31-5, Page 31-6)**. The axle tubes must be removed in order to replace these oil seals.

AXLE TUBE AND AXLE SHAFT REMOVAL

See General Warnings, Section 1, Page 1-2.

The transaxle has two axle shafts. If only a tube or shaft is to be serviced, it can be done one side at a time without removing the transaxle.

- 1. Clean debris from drain plug and area around it at the bottom of the transaxle. Drain oil. Install plug after draining.
- 2. If removing entire transaxle from vehicle, remove the transaxle and clean it in preparation for disassembly. See Transaxle Removal on page 31-9. See following NOTE.

NOTE: After cleaning, move transaxle to a clean location before disassembly.

- 3. If removing only one axle tube or shaft from vehicle, clean that tube and hub in preparation for disassembly.
- 4. Remove hub. See Rear Hub Removal on page 31-4.
- 5. Remove the five flange-head bolts (1) securing axle tube (2) to transaxle (Figure 31-5, Page 31-6).
- 6. Avoiding damage caused by dragging splines across lip of oil seal (7) in transaxle gearcase, carefully pull axle tube (2) and shaft (3) from transaxle.

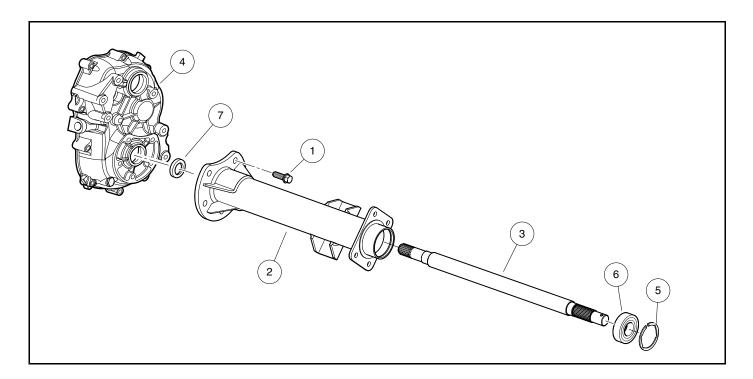


Figure 31-5 Axle Tube, Shaft, Bearing and Oil Seal

AXLE TUBE AND AXLE SHAFT INSTALLATION

1. Clean mating surfaces of axle tube (2) flange and transaxle gearcase (4). Also clean the threads of the five axle tube mounting holes in the gearcase. **See following CAUTION.**

CAUTION

- If necessary. clean each mounting hole with a thread tap (M10 x 1.25 pitch) before installing flange bolts.
- 2. Clean and lubricate the oil seal (7) in the transaxle gearcase (4) with oil (Figure 31-5, Page 31-6).
- 3. Clean inner end of axle shaft (3). Avoiding damage caused by dragging splines across lip of oil seal (7) in transaxle gearcase (4), carefully install axle shaft (3) and tube (2). **See following NOTE.**

NOTE: It may be necessary to rotate each shaft (3) slightly to engage the splines in the differential.

- 4. Secure axle tube (2) to gearcase (4) with flange bolts (1). Use a crisscross pattern to tighten flange bolts to 28 ft·lb (38 N·m).
- 5. Install hub. See Rear Hub Installation on page 31-4.
- 6. If entire transaxle was removed from vehicle, install transaxle. See Transaxle Installation on page 31-12.
- 7. Refill transaxle with appropriate type and volume of oil. See Oil Change Transaxle on page 31-2.

REAR WHEEL BEARING REMOVAL

- 1. Remove hub. See Rear Hub Removal on page 31-4.
- 2. Remove axle tube (2) from transaxle. See Axle Tube and Axle Shaft Removal on page 31-6.
- 3. Remove the snap ring (5) that is in front of the bearing (6) and discard (Figure 31-5, Page 31-6).
- 4. Drive axle shaft (3) and bearing (6) from outer end of axle tube (2) as an assembly.
- 5. Use a puller to remove bearing (6) from axle shaft (3). See following CAUTION.

CAUTION

• To prevent damaging the threads on end of axle shaft (3), install hub nut to cover initial threads prior to using puller.

REAR WHEEL BEARING INSTALLATION

- 1. Press new bearing (6) onto axle shaft (3) until fully seated.
- 2. Clean inside axle tube (2) where new bearing (6) will sit and lightly lubricate the bore (Figure 31-5, Page 31-6).
- 3. Using an appropriate sized bearing driver that fits the outer race, drive in bearing/shaft assembly (3 and 6) until fully seated in tube (2).
- 4. Install new snap ring (5).
- 5. Install axle tube (2). See Axle Tube and Axle Shaft Installation on page 31-7.
- 6. Install hub. See Rear Hub Installation on page 31-4.



AXLE SHAFT OIL SEAL REMOVAL

The rear axle tubes (2) must be unbolted from the transaxle to replace oil seals (7) (Figure 31-5, Page 31-6).

- 1. Clean debris from drain plug and area around it at the bottom of the transaxle. Drain oil. Install plug after draining.
- 2. Remove axle tube (2) from gearcase (4) (Figure 31-5, Page 31-6). See Axle Tube and Axle Shaft Removal on page 31-6.
- 3. Pull oil seal (7) from gearcase (4).

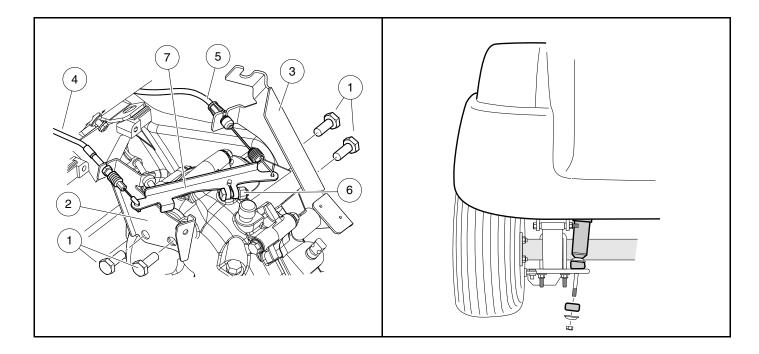
AXLE SHAFT OIL SEAL INSTALLATION

- 1. Clean bore in gearcase (4) where new oil seal (7) will sit (Figure 31-5, Page 31-6).
- 2. Using an appropriate sized seal driver, drive in new oil seal (7) until 0.0393 in. (1 mm) below surface, not fully seated.
- 3. Clean end of axle shaft (3) and carefully install axle tube (2) to avoid damaging new oil seal (7) with splines of axle shaft. See Axle Tube and Axle Shaft Installation on page 31-7.
- 4. Refill transaxle with appropriate type and volume of oil. See Oil Change Transaxle on page 31-2.

TRANSAXLE REMOVAL

See General Warnings on page 1-2.

- 1. Turn the key switch to the OFF position and remove the key, and place the Forward/Reverse handle in the NEUTRAL position.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Place chocks at the front wheels and loosen lug nuts on both rear wheels.
- Disconnect air intake hose, vent hose, and fuel line from throttle body and accelerator cable from electrical component box. See Fuel System – Subaru EX40, Section 28, Page 28-1.
- 5. Disconnect gray 18-pin connector from ECU.
- 6. Disconnect engine ground cable lead from main wire harness.
- 7. **Pedal-Start Vehicles Only:** Disconnect 3-wire plug from limit switch on transaxle.
- 8. Disconnect three wires of main wire harness from starter/generator (Figure 26-13, Page 26-10).
- 9. Loosen jam nuts (1) securing shifter cable (2) to FNR/accelerator cable mounting bracket. Then, remove bowtie clip (3) to disconnect shifter cable end (4) from transaxle shift lever (5) and set shifter cable (2) aside (Figure 31-15, Page 31-13).
- 10. Remove bolts (1) securing governor cable bracket (2) and FNR/accelerator cable bracket (3) to transaxle (Figure 31-6, Page 31-9). Do not disconnect cables (4 and 5).
- 11. Unhook governor cable (4) and accelerator cable (5) from the governor arm (7).

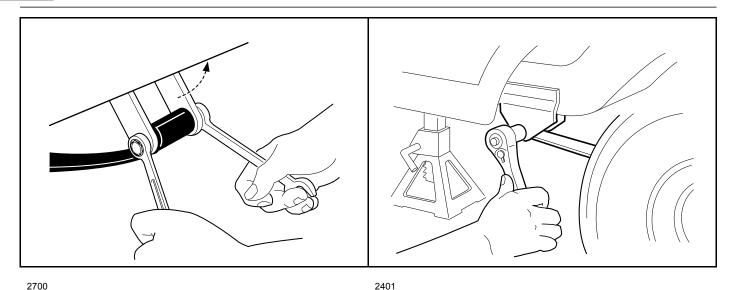


3059 Figure 31-6 Governor Arm, Cable and Brackets

Figure 31-7 Disconnect Shock Absorbers

- 12. Disconnect brake cables from brake assemblies. See Wheel Brake Assemblies section.
- 13. Remove lower shock mounting hardware from both rear shocks (Figure 31-7, Page 31-9).





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Figure 31-9 Disconnect Front of Leaf Spring

- 14. Position floor jack under rear crossmember of chassis or trailer hitch mount (if equipped) (Figure 31-10, Page 31-10). See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-2.
- 15. Raise vehicle just enough to relieve weight on leaf springs, then remove bolts securing leaf springs to shackles (Figure 31-8, Page 31-10).
- 16. Remove bolts securing front of leaf springs (Figure 31-9, Page 31-10).

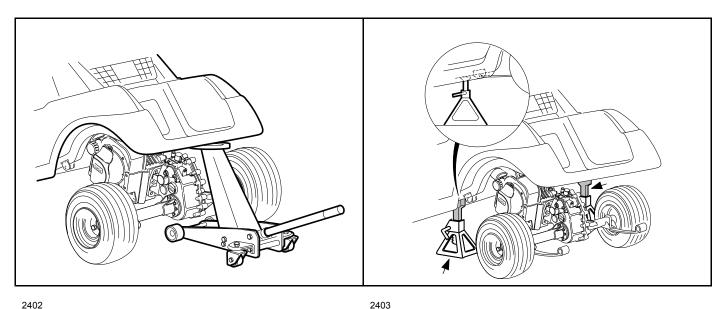


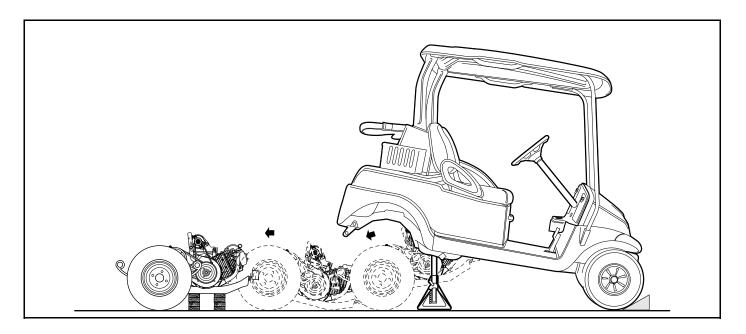
Figure 31-10 Raise Vehicle

Figure 31-11 Position Jack Stands On Both Sides of

- 17. Continue raising vehicle until chassis is higher than the top of the transaxle (i.e. enough to allow powertrain to be rolled out from under vehicle) (Figure 31-10, Page 31-10). Position jack stands, adjusted to support the vehicle at this height, under the frame crossmember between the leaf spring mounts and side stringers, just forward of each rear wheel (Figure 31-11, Page 31-10). Lower the floor jack to allow the jack stands to support the vehicle.
- 18. Remove floor jack from beneath vehicle.
- 19. Grasp ends of leaf springs at rear of vehicle and carefully pull the powertrain until snubber at front of engine pan is free of the chassis. Gently lower front of powertrain to the floor (Figure 31-12, Page 31-11). The powertrain should be completely disconnected from vehicle and resting on floor.
- 20. Roll powertrain out from under vehicle.

21. Place blocks under the engine pan so they will completely support the engine and keep it **level to the floor** (Figure 31-12, Page 31-11). See following NOTE.

NOTE: Place the blocks so they will support the engine when the transaxle is detached and moved away from the powertrain.



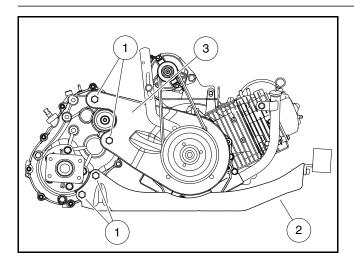
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Figure 31-12 Remove Powertrain and Place Wood Blocks Under Engine Pan

- 22. Remove oil drain plug and drain all oil from transaxle. Dispose of gear oil properly.
- 23. Remove driven clutch. See Driven Clutch Removal, Section 30, Page 30-13.
- 24. Remove eight bolts (1) total that secure transaxle to powertrain (Figure 31-13, Page 31-12) at the following locations:
 - Four bolts (1) at engine pan (2).
 - Two bolts (1) at clutch plate (3).
 - Two bolts (1) at muffler bracket.
- 25. Roll transaxle from engine pan (2). See following NOTE.

NOTE: The transaxle weighs approximately 58 lb (26.2 kg).

26. If replacing transaxle, remove leaf springs, wheels, hubs and brake assemblies and retain for installation on new transaxle. See Rear Suspension section. See Wheel Brake Assemblies section.



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Figure 31-13 Transaxle Mounting Bolts

TRANSAXLE INSTALLATION

See General Warnings on page 1-2.

- 1. Installation is reverse of removal procedure. When attaching transaxle to powertrain, initially install the eight bolts (1) finger-tight (Figure 31-13, Page 31-12). Then, tighten fasteners in the following order:
 - 1.1. Tighten the two bolts (1) at clutch plate (3) to 50 ft·lb (68 N·m).
 - 1.2. Tighten the four bolts (1) at engine pan (2) to 50 ft·lb (68 N·m).
 - 1.3. Tighten the two bolts (1) at muffler bracket to 50 ft·lb (68 N·m).
 - 1.4. Tighten the governor cable bracket (2) and FNR/accelerator cable bracket (2) bolts to 50 ft·lb (68 N·m) (Figure 31-6, Page 31-9).
 - 1.5. Tighten leaf spring hardware to 19 ft lb (26 N·m) at chassis and shackle. See Rear Suspension section.
 - 1.6. Tighten lower nuts of shock absorbers until cushions expand to be the same diameter as the mounting washers.
 - 1.7. Tighten transaxle drain plug to 17 ft·lb (23.5 N·m).
- 2. Fill transaxle with appropriate type and volume of oil. See Oil Change Transaxle on page 31-2.
- 3. Ensure that all wires and cables are secured properly with wire ties. See following WARNING.

WARNING

- If wires and cables are removed or replaced make sure they are properly routed and secured to vehicle frame. Failure to properly route and secure wires and cables could result in vehicle malfunction, property damage or personal injury.
- 4. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 5. Check governor adjustment and correct if necessary. See Governor Cable Installation and Adjustment, Section 28, Page 28-7.
- Check engine RPM setting. Adjust if necessary. See Engine RPM Adjustment, Section 28, Page 28-11.

SHIFTER CABLE

See General Warnings on page 1-2.

If the Forward/Reverse shifter cable is damaged in any way, it must be replaced.

SHIFTER CABLE REMOVAL

NOTE: Before removing cable, note cable routing and positions of wire ties or other devices securing the cable to the vehicle. When installed, cable must be routed and secured as it was originally.

- 1. Turn the key switch to the OFF position and remove the key. Place the Forward/Reverse handle in the NEUTRAL position and chock the wheels.
- 2. Disconnect battery and spark plug wire(s). See Low Maintenance Battery: Disconnecting the Battery Gasoline Vehicles, Section 1, Page 1-3.
- 3. Push the cable end socket (1) off the stud (3) on the Forward/Reverse shifter handle (Figure 31-14, Page 31-13).
- 4. Press in tangs (4) anchoring shifter cable (2) to chassis and push out of mounting hole.
- 5. Loosen jam nuts (1) securing shifter cable (2) to FNR/accelerator cable bracket (3) (Figure 31-15, Page 31-13). Then, remove bowtie clip (3) to disconnect shifter cable end (4) from transaxle shift lever (5).
- 6. Cut wire ties securing shifter cable to chassis.
- 7. Make note of cable routing, then remove shifter cable from vehicle.

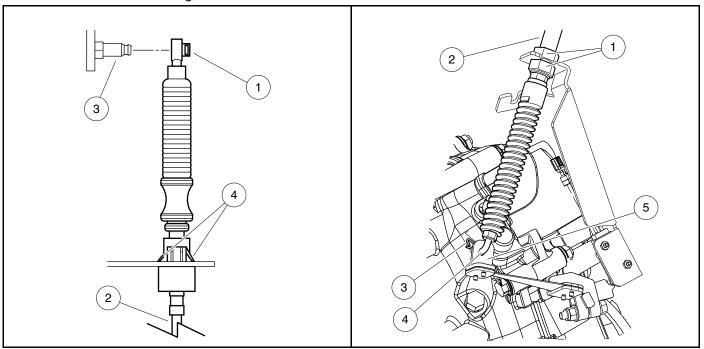


Figure 31-14 Shifter Cable at FNR Handle

Figure 31-15 Shifter Cable at Transaxle

SHIFTER CABLE INSTALLATION

- 1. Install shifter cable (2), routing it exactly as it was originally, from Forward/Reverse shifter handle to transaxle.
- 2. Place rear of cable (2) in FNR/accelerator cable bracket with a jam nut (1) on each side of bracket (Figure 31-15, Page 31-13). Tighten jam nuts (1) to 22 ft·lb (29.8 N·m).

- 3. Hook shifter cable end (4) into transaxle shift lever (5) and secure with bowtie clip (3).
- 4. Feed front of cable (2) through its mounting hole and push the plastic anchor into hole until tangs (4) snap into place (Figure 31-14, Page 31-13).
- 5. Snap cable end socket (1) onto stud (3) of Forward/Reverse shifter handle.
- 6. Secure shifter cable along chassis with wire ties if required.
- 7. Connect battery and spark plug wire(s). See Low Maintenance Battery: Connecting the Battery Gasoline Vehicles, Section 1, Page 1-3.

SHIFTER CABLE ADJUSTMENT

Cable is properly adjusted when both the Forward/Reverse handle and shift lever on transaxle are in the NEUTRAL position at the same time.

To adjust, the jam nuts (6) at the FNR/accelerator cable bracket must be loosened and moved forward or backward as required (Figure 31-15, Page 31-13). Tighten jam nuts (6) to 22 ft·lb (29.8 N·m).

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