2020
Carryall 510 and 710 LSV Maintenance and Service Manual

Zero-Emission Electric Vehicle with QuiQ™ Charger

Manual Number 86753090014
Edition Code C

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 the Carryall 510 LSV and 710 LSV series vehicles, and should be thoroughly reviewed prior to servicing the vehicle. The procedures provided 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 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, vehicle service seminars, 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.

To find your local authorized Club Car dealer, visit www.clubcardealer.com, call 1-800-ClubCar (258–2227), or scan this Quick Response (QR) code to be taken to the Club Car dealer locator. Refer to Figure 1. Download a QR code reader such as RedLaser or Barcode Scanner to your cell phone or tablet.

If you would prefer to write to us, direct your letter to: Club Car LLC, Attention: Marketing Services, P.O. Box 204658, Augusta, Georgia 30917-4658 USA.

Dealer Locator QR Code

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FOREWORD

TECHNICAL PUBLICATION CUSTOMER SATISFACTION ONLINE SURVEY

Let your voice be heard!

Please participate in the Technical Publication customer satisfaction online survey.
This survey takes less than five minutes to complete and your responses will help examine current performance and identify areas for future improvement.

Our top priority is to provide timely, accurate, and user friendly manuals.

The online survey can be found at *http://bit.ly/1w9uFMh* or using the QR Code below.

Online Survey QR Code

⚠ 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 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 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.

CONTENTS

SECTION 1 — SAFETY

SAFETY DETAILS

To ensure the safety of those servicing Club Car vehicles, and to protect the vehicles from possible damage resulting from improper service or maintenance, the procedures in this manual must be followed.

It is important to note that throughout this manual there are statements labeled DANGER, WARNING, or CAUTION. These special statements relate to specific safety issues, and must be read, understood, and heeded before proceeding with procedures. There are statements labeled NOTE, which provide other essential service or maintenance information.

PERSONAL SAFETY

⚠ DANGER

- **A DANGER indicates an immediate hazard that will result in severe personal injury or death. The color associated with Danger is RED.**

⚠ WARNING

- **A WARNING indicates an immediate hazard that could result in severe personal injury or death. The color associated with Warning is ORANGE.**

⚠ CAUTION

- **A CAUTION with the safety alert symbol indicates a hazard or unsafe practice that could result in minor personal injury. The color associated with Caution is YELLOW.**

MACHINE SAFETY

CAUTION

- **A CAUTION without the safety alert symbol indicates a potentially hazardous situation that could result in property damage.**

A CAUTION, without the safety alert symbol, is intended for machine and property safety. It is used throughout this manual followed by specific instructions to prevent machine or property damage. Failure to follow these CAUTION messages could result in machine or property damage.

INFORMATION

NOTE: *Instructions that clarify steps, procedures, or other information in this manual.*

GENERAL WARNINGS

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

⚠ 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.**
- **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.**
- **The driver must possess a valid, unrestricted driver's license issued by the State in which the vehicle will be operated.**
- **The driver and passenger must be restrained at all times with the seat belts provided to help prevent injury in the event of sudden braking or collision.**
- **No more than two people should be on the vehicle at one time. Do not allow people to ride in any part of the vehicle that is not equipped with a seat and a seat belt. Do not allow a third person to sit in the middle of the seat or let a passenger hold a child in his or her lap while the vehicle is moving.**
- **Do not leave children unattended in vehicle at any time.**
- **The vehicle is not designed to meet child seat compatibility requirements. Children requiring a child safety seat must not ride on the vehicle. Comply with state and local laws pertaining to child safety.**
- **Prior to leaving the vehicle unattended or servicing the vehicle, set the park brake, place the Forward/Reverse 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 can 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, can 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.**
- **For vehicles with cargo beds, remove all cargo (including accessories) before raising the bed or servicing the vehicle. If the vehicle is equipped with a prop rod, ensure that it is securely engaged while bed is raised. Do not close bed until all persons are clear of cargo bed area. Keep hands clear of all crush areas. Do not drop cargo bed; lower gently and keep entire body clear. Failure to heed this warning can result in 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.**
- **Ensure battery connections are clean and properly tightened. See Battery Care – Vehicles Equipped with the Single-Point Watering System (SPWS) on page 14-8 or Battery Care – Vehicles Without the Single-Point Watering System (SPWS) on page 14-9.**

WARNING CONTINUED ON NEXT PAGE

⚠ WARNING

- **Place Tow/Run switch in the TOW position before disconnecting or connecting the batteries. Failure to heed this warning can 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 1-3.**
- **Use only 2-gauge (AWG) wires with low-resistance terminals to replace battery wires on the vehicle.**
- **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.**
- **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**

DISABLING THE VEHICLE

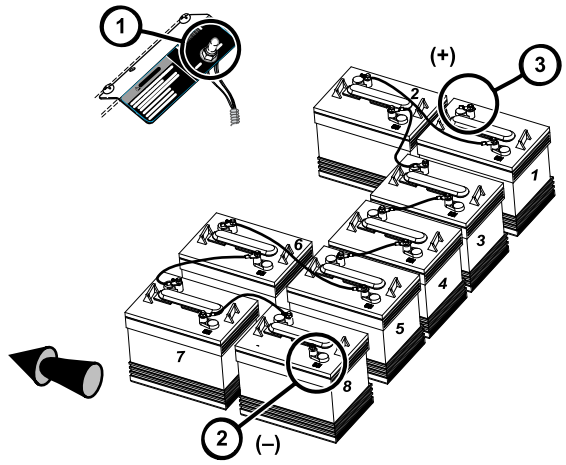
1. Engage park brake to lock wheels.
2. Turn the key switch OFF and remove the key.
3. Place the Forward/Reverse control in the NEUTRAL position.
4. In addition, chock the wheels if servicing or repairing the vehicle.

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 can result in a battery explosion or severe personal injury.
3. Disconnect the batteries, negative (–) cable first, as shown **(Figure 1-1 or Figure 1-2)**.
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 to minimize corrosion.



(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.

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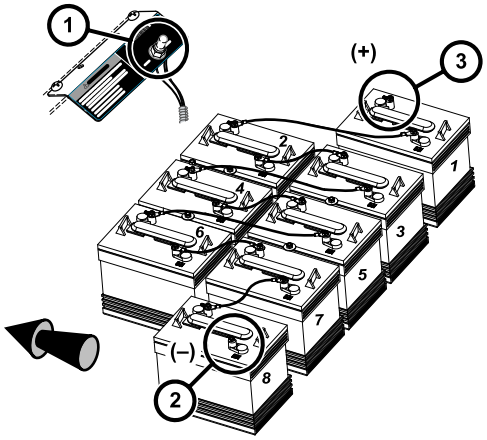
Figure 1-1 Battery Cable Removal – Carryall 510 LSV



(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.

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Figure 1-2 Battery Cable Removal – Carryall 710 LSV

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 1-3)**. 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.

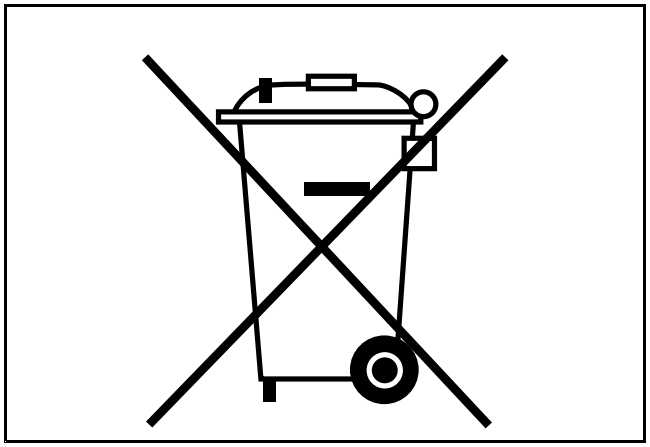

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Figure 1-3 Dispose of Lead-acid Batteries Properly

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.

1. Shield eyes.	3. No smoking, no open flames, no sparks.	5. Battery acid hazard.
2. Read and follow operating instructions.	4. Keep away from children.	6. Explosive gas hazard.
Refer to General Warnings for more information.		

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Figure 1-4 International Safety Symbols on Batteries

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SECTION 2 — VEHICLE SPECIFICATIONS

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VEHICLE SPECIFICATIONS

VEHICLE SPECIFICATIONS – ELECTRIC VEHICLES

SPECIFICATIONS	CARRYALL 510 LSV	CARRYALL 710 LSV
POWER SOURCE	**ELECTRIC**	**ELECTRIC**
Drive motor: Direct drive, 3 Phase AC Induction Motor, 4.4 hp (3.3 kW)	•	•
Transaxle: Double reduction helical gear with 12.3:1 direct drive axle	•	•
Electrical system: 48 volt	•	•
Batteries: High capacity, deep cycle, 6-volt	•	•
Charger: Automatic, 48-volt; UL and CSA listed **See QuiQ Battery Charger Specifications on page 2-3.**	•	•
Controller: 400 amp solid state (AC)	•	•
STEERING/SUSPENSION/BRAKES		
Steering: Self-adjusting rack and pinion	•	•
Suspension: Independent leaf spring with dual hydraulic shocks	•	•
Brakes: 4-wheel hydraulic drum brakes	•	•
Park Brake: Hand operated, mechanical	•	•
BODY/CHASSIS		
Frame/chassis: Twin I-Beam welded aluminum	•	•
Side and rear body: Aluminum	•	•
Front body: ArmorFlex®	•	•
Front body finish: Automotive-grade paint with clear-coat finish	•	•
Tires: DOT rated, 205/65 R10, Premium tread	•	•
DIMENSIONS/WEIGHT		
Overall length: Standard configuration Add for Heavy-Duty Bumper:	118 in (299.7 cm) 1.8 in (4.5 cm)	137.5 in (349.3 cm) 1.8 in (4.5 cm)
Overall width with mirrors:	50.3 in (127.7 cm) 62.6 in (159.0 cm)	50.3 in (127.7 cm) 62.6 in (159.0 cm)
Overall height: At steering wheel	47.1 in (119.6 cm)	47.1 in (119.6 cm)
Overall height: with cab Add for LSV Light:	74.3 in (188.7 cm) 3.75 in (9.5 cm)	74.3 in (188.7 cm) 3.75 in (9.5 cm)
Wheelbase	78.1 in (198.3 cm)	99.1 in (251.7 cm)
Ground clearance	5.6 in (14.2 cm)	5.6 in (14.2 cm)
Front wheel tread	34.6 in (87.8 cm)	34.6 in (87.8 cm)
Rear wheel tread	39.2 in (99.5 cm)	39.2 in (99.5 cm)
Weight: Standard electric vehicle	1656 lb (751 kg)	1765 lb (800 kg)
Speed: Standard maximum	25 mph (40 km/h)	25 mph (40 km/h)

SPECIFICATIONS	CARRYALL 510 LSV	CARRYALL 710 LSV
POWER SOURCE	**ELECTRIC**	**ELECTRIC**
Speed: Economy mode maximum (when equipped with Smart Key)	15 mph (24 km/h)	15 mph (24 km/h)
Outside clearance circle (diameter)	258.5 in (656.5 cm)	313.5 in (796.2 cm)
Turning radius per SAE J 695	121 in (307.3 cm)	151.5 in (384.8 cm)
Intersecting aisle clearance	91.8 in (233.2 cm)	105.8 in (268.7 cm)
Floorboard height	6.7 in (17 cm)	6.7 in (17 cm)
Load bed height	29.5 in (74.9 cm)	29.5 in (74.9 cm)
Load bed size: Box bed inside dimensions	44.2 x 47.5 x 10.5 in (112.2 x 120.6 x 26.6 cm)	64.5 x 47.5 x 10.5 in (163.8 x 120.6 x 26.6 cm)
Load bed size: Flat bed inside dimensions	46.2 x 48.8 in (117.3 x 123.9 cm)	65.5 x 48.8 in (166.4 x 123.9 cm)
Vehicle rated capacity: Level surface only	950 lb (430 kg)	1250 lb (567 kg)
Standard seating capacity	2	2
LIQUID CAPACITIES		
Transaxle	22 fl-oz (0.67 L)	22 fl-oz (0.67 L)
TIRE PRESSURE		
Front and rear	28 to 32 psig (193 to 221 kPa)	28 to 32 psig (193 to 221 kPa)

QUIQ BATTERY CHARGER SPECIFICATIONS

QUIQ BATTERY CHARGER SPECIFICATIONS	
AC INPUT	
AC Voltage – range	85 to 265 VAC (acceptable)
AC Voltage – nominal	120 to 230 VAC
Frequency	45 to 65 Hz
AC Power Factor – nominal	>0.99 @ 120 VAC / >0.98 @ 230 VAC
POWER CONSUMPTION	
AC current (Amps)	Max: 12 Amps Nominal: 9.5 Amps rms @ 120 VAC 5 Amps rms @ 230 VAC
DC OUTPUT	
DC voltage (VDC) – nominal	48 V
DC voltage (VDC) – maximum	68 V
DC current – maximum	18 Amps
Interlock current – maximum	1 Amp
DIMENSIONS/WEIGHT	
Case – Overall length	11 in (28 cm)
Case – Overall width	9.7 in (24.6 cm)
Case – Overall height	4.3 in (11 cm)
Weight – with standard output cord	< 11 lb (< 5 kg)
MOUNTING CONFIGURATION	
Mounting	Onboard

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SECTION 3 — GENERAL INFORMATION

⚠ DANGER

- **See General Warnings, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warnings, Section 1, Page 1-1.**

This manual features Carryall 510 LSV and 710 LSV electric vehicles. These vehicles utilize a DC electrical / AC drive system and onboard Delta-Q QuiQ™ battery chargers.

Throughout this manual, important features unique to each model are highlighted. We urge the owner/operator to read and understand this manual, and to pay special attention to the features specific to their vehicle(s).

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

- Controls and Indicators
- Pre-Operation and Daily Safety Checklist
- Driving Instructions
- Bed Latch
- Prop Rod
- Loading and Unloading
- Towing with a Vehicle
- Transporting on a Trailer
- Subsequent Owner Registration
- Warranties

MODEL IDENTIFICATION

The serial number of each vehicle is printed on a bar code decal mounted below the center dash panel (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.

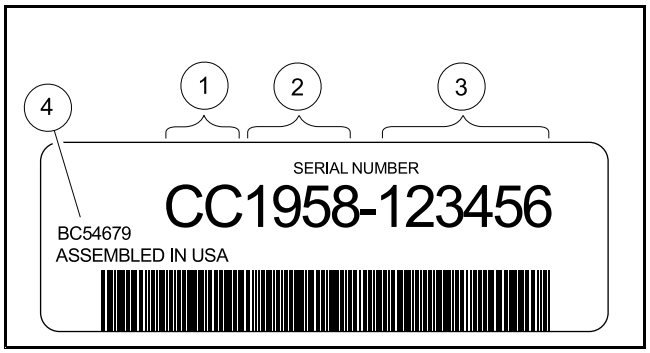

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Figure 3-1 Serial Number Decal

VEHICLE IDENTIFICATION NUMBER (VIN) AND CERTIFICATION LABEL

The vehicle identification number (VIN) is stamped on a plate located on the dash panel. The VIN certification decal is located in the driver's side dash storage area.

STORAGE – ELECTRIC VEHICLES

See General Warnings on page 1-1.

⚠ WARNING

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

⚠ CAUTION

- **Batteries in a low state of charge will freeze at low temperatures.**
- **To avoid exposing electrical components to moisture and subsequent damage, 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 1/2 inch (13 mm) above plates to 1/4 inch (6 mm) below the level indicator **(Figure 14-3)**.

Immediately Prior to Storage, Perform the Following Steps

1. Unload the vehicle so that tires are supporting only the weight of the vehicle.
2. 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 information light are disabled when the Tow/Run switch is in the TOW position.*

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. **See Vehicle Specifications – Electric Vehicles on page 2-1.**
9. Perform semiannual periodic lubrication. **See Periodic Lubrication Schedule on page 10-6.**
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.

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.

RETURNING THE STORED ELECTRIC VEHICLE TO SERVICE

1. If necessary, connect batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**
2. Fully charge batteries.

⚠ 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. **See Vehicle Specifications – Electric Vehicles on page 2-1.**
4. Perform the Pre-Operation and Daily Safety Checklist on page 10-2 and the Performance Inspection on page 10-2.

SECTION 4 — BODY AND TRIM

⚠ DANGER

- **See General Warnings, Section 1, Page 1-1.**

⚠ WARNING

- **See General Warnings, Section 1, Page 1-1.**

CLEANING THE VEHICLE

See General Warnings on page 1-1.

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.**

These vehicles are equipped with painted TPO front bodies and aluminum only rear bodies with black polypropylene rear fender and tailskirt. The cargo beds are steel with aluminum sheet and Rhino Lining®.

The manufacturer does not recommend any type of pressure washing or steam cleaning. Such a process will expose electrical components to moisture. Moisture entering electrical components can result in water damage and subsequent component failure. Normal residential water pressure is adequate for exterior cleaning.

For regular cleaning, use commercially available automotive cleaning solutions with a sponge or soft cloth. The painted finish is the same paint used in automotive applications. Automotive cleaning/polishing products are available at automotive specialty and hardware stores.

Use non-abrasive wax products. Battery acid, fertilizers, tars, asphalt, creosote, paint, or chewing gum should be removed immediately to prevent possible stains.

SEAT CLEANING

Clean seats regularly using 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. **See following NOTE.**

NOTE: *Dispose of waste water properly.*

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. **See following CAUTION.**

CAUTION

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

FRONT BODY REPAIR

See General Warnings on page 1-1.

LIGHT SCRATCHES

1. Clean entire area to be repaired with clean, clear water.
2. Using 1200 grit sandpaper, water-sand entire area of scratch until original scratch is no longer visible, either with finishing sander or wet sanding block. Be sure that sandpaper is centered on sanding pad. Continue to flush with water while sanding, to increase sandpaper life and keep the sanded surface cool. Wipe repaired area dry and visually inspect to be sure that the originial scratch has completely disappeared.
3. Repeat step 2 using 1500 grit sandpaper until all 1200 grit scratches are removed paying close attention to edges.
4. Install a wool cutting pad (3M #5711 or equivalent) on buffer and spread approx 1/2 tsp. (2 mL) of compound (3M #05955 or equivalent). Buff slowly and steadily over small area so as not to heat surface as this may cause warping or melting of plastic. Buff sanded area until all sanding scratches have disappeared. Use as much buffing compound as necessary to achieve this step. If at any time original scratches can be seen, repeat steps 2 and 3 as needed. When all 1500 grit scratches have disappeared, there will be a dull luster over entire area.
5. Install a foam polishing pad (3M #5725 or equivalent) on buffer and repeat step 4 using approx 1/2 tsp. (2 mL) buffing compound (3M #5933 or equivalent). Buff compound off until scratches have disappeared. It may be necessary to apply additional compound to achieve this. The result will be an almost-finished product with a very high luster and very few buffer swirls.
6. Using a clean foam polishing pad (3M #5725 or equivalent) and finish glaze (3M #05937 or equivalent), apply a slightly smaller amount of material than in steps 4 and 5 and buff to desired gloss.
7. Wipe clean with soft, clean cloth. Any dirt on cloth can mar surface.

ABRASIONS AND HAZE

Abrasions and haze can be greatly minimized by performing steps 5 through 7 above.

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 bodies.

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FRONT BODY

See General Warnings on page 1-1.

BRUSHGUARD REMOVAL

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the bolts (1) **(Figure 4-1, Page 4-4)**.
3. Remove the screws (2) and washers (3).
4. Remove the brushguard (4).

BRUSHGUARD INSTALLATION

1. Position the brushguard (4) onto the vehicle **(Figure 4-1, Page 4-4)**.
2. Install the washers (3), screws (2), and bolts (1). Tighten the bolts to 36 ft·lb (49 N·m). Tighten the screws to 25 ft·lb (34 N·m).
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

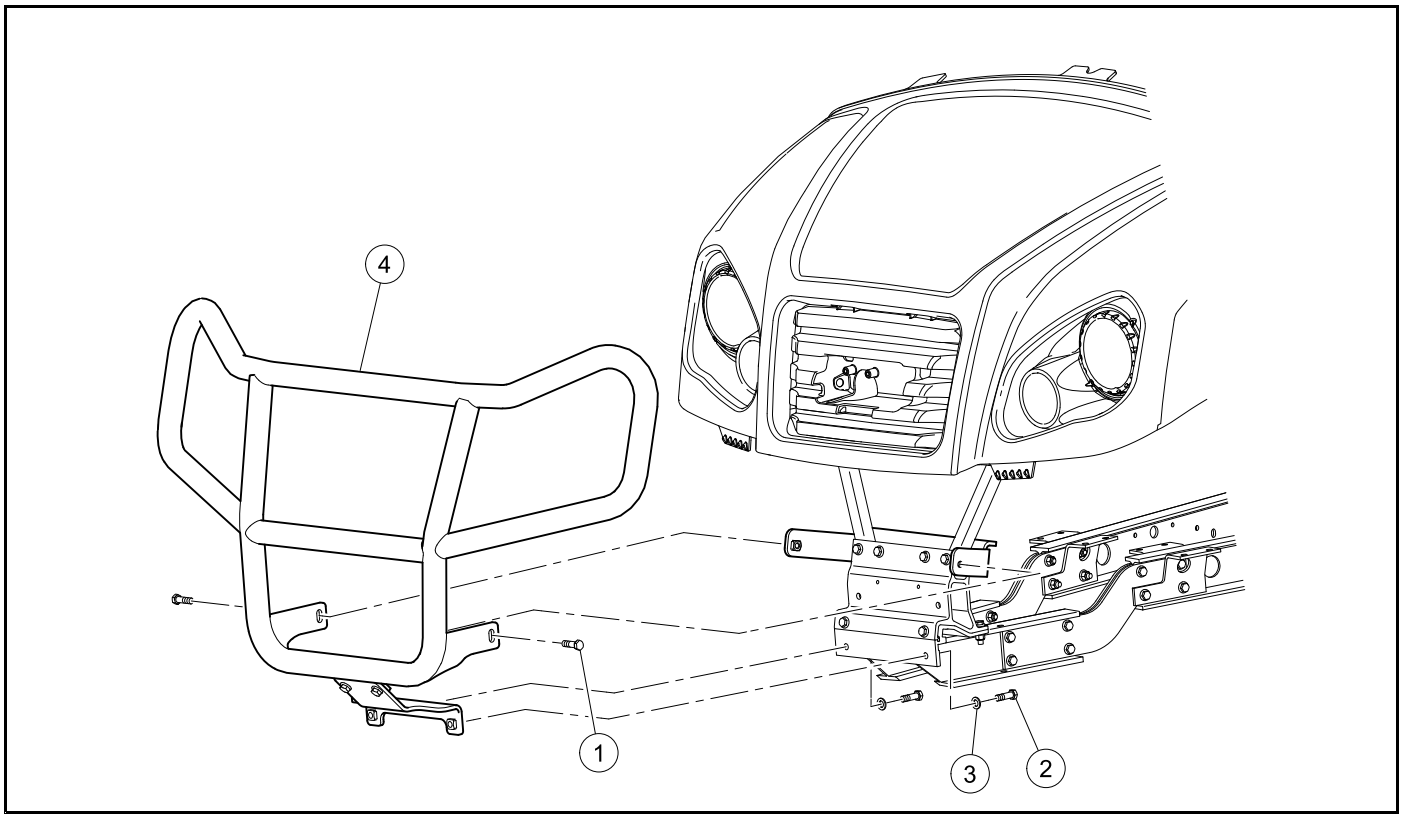

Figure 4-1 Brushguard

COWL REMOVAL

1. Disable the vehicle.
2. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
3. The cowl (1) is secured by tabs (2) located behind the front fenders (3), and under the lip of the dash (4) **(Figure 4-2, Page 4-6)**.
4. Push down and rearward on front fenders to unsnap cowl in two locations.
5. Slide cowl forward until free, then lift out cowl.

COWL INSTALLATION

1. Slide bottom edges of cowl into grooves in front fenders.
2. Ensure the three tabs (2) on cowl install under lip of dash (4). **(Figure 4-2, Page 4-6)**.
3. Ensure sides of cowl (1) assemble between the two ribs on side of dash.
4. Ensure center tab on cowl assembles beneath the rib in the grille.
5. With fenders disengaged from the front bumper, press down on front fenders, line up cowl tabs and fully engage snap tabs.
6. Ensure front corners of cowl are engaged with front fender (3).
7. Engage the front fenders to the body clips under the front bumper.

NOTE: *Ensure that cowl is fully engaged to prevent dislodging during use.*

8. Connect the batteries.**See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
9. Remove tire chocks.

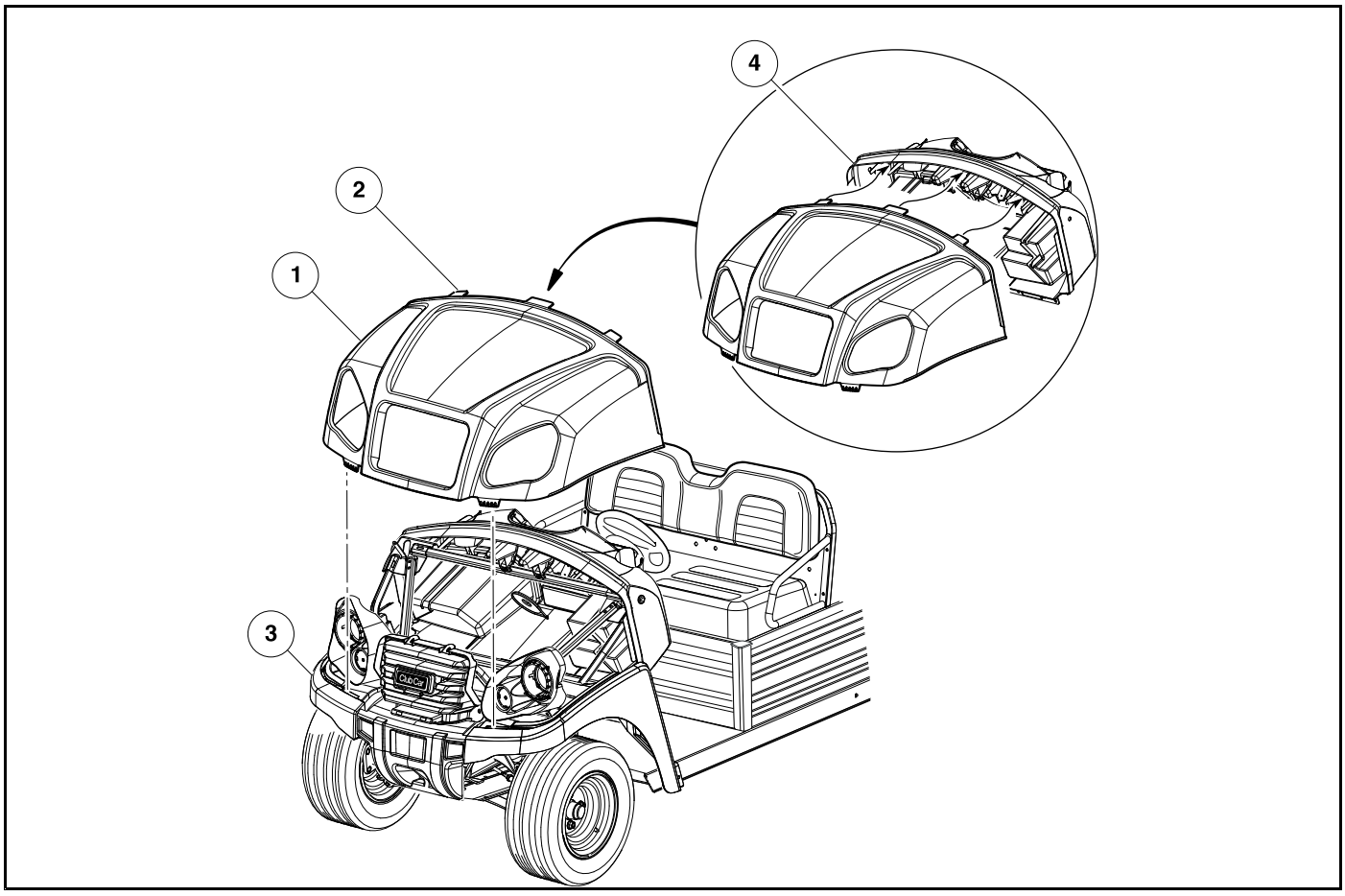

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Figure 4-2 Front Cowl

GRILLE REMOVAL

1. Park vehicle and chock the tires.
2. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
3. Remove HD bumper (if equipped). **See Brushguard Removal, Section 4, Page 4-4.**
4. Remove cowl. **See Cowl Removal on page 4-5.**
5. Loosen and remove the two M6 self-tapping fasteners (1) at the top of grille (7) **(Figure 4-3, Page 4-8)**.
6. Loosen and remove the two lower left and right side bolts (1 and 7) that attach the grille and plastic bumper (6).
7. Remove charger receptacle (if equipped) by removing the three screws that attach the receptacle or disconnect connector (quick connect).

GRILLE INSTALLATION

1. Connect the charger receptacle or connector (quick connect).
2. Install, but do not tighten upper M6 screws. (Do not tighten screws until plastic bumper is installed).
3. Lower grille holes are shared with the front bumper, ensure lower bumper screws are attached first then install grille.
4. Line up upper and lower bolt holes.
5. Install and tighten upper bolts, then lower right and left side bolts.

6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

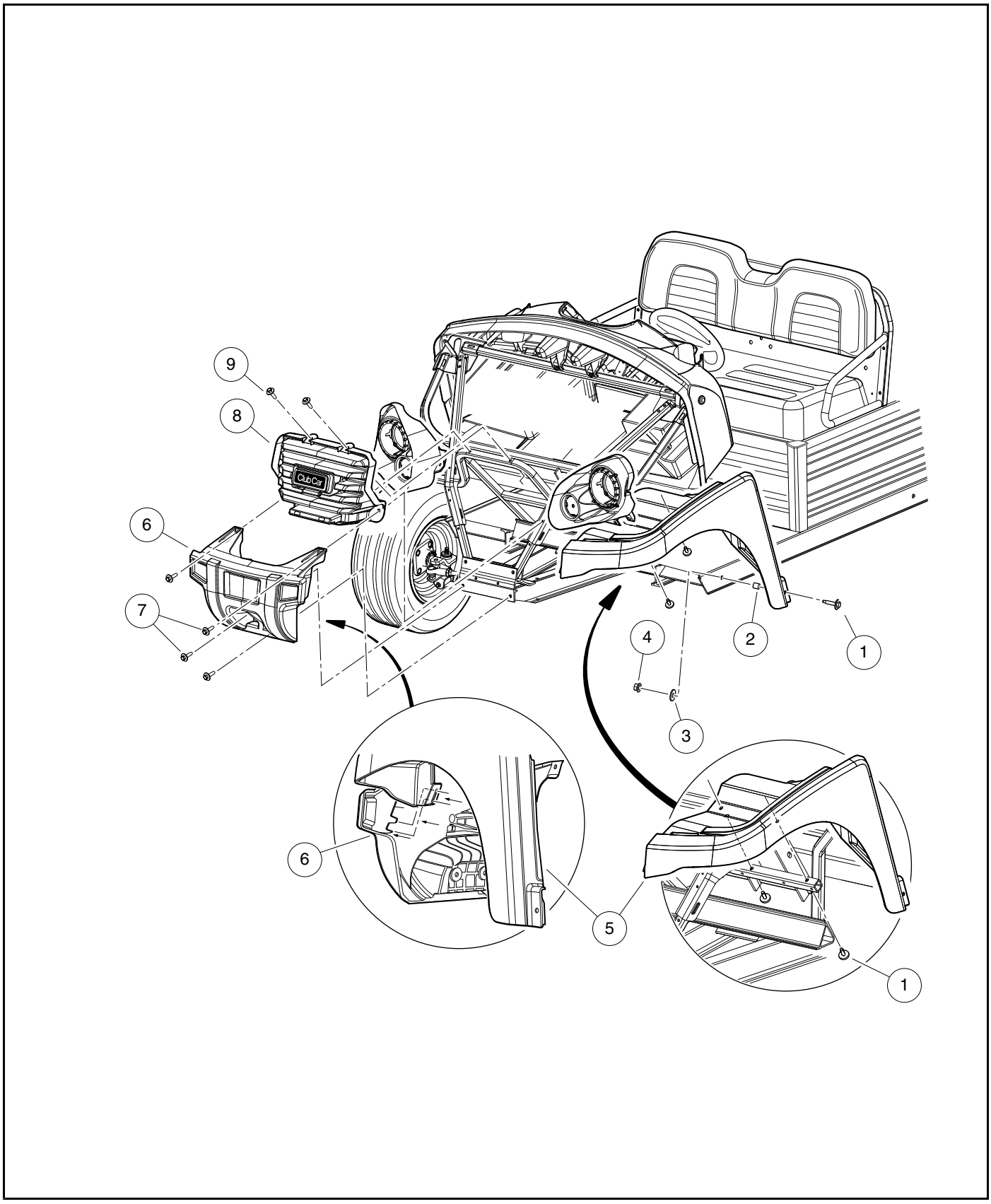

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Figure 4-3 Front Grille, Bumper, and Side Fenders

FRONT BUMPER AND SIDE FENDER REMOVAL

1. Park the vehicle, chock tires.
2. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
3. Remove HD bumper, (if equipped). **See Brushguard Removal on page 4-4.**
4. Remove cowl. **See Front Cowl on page 4-6.**
5. Remove the grille. **See Grille Removal on page 4-6.**
6. Loosen and remove the two upper and lower bolts (7) that attach the bumper to the vehicle frame. Push down and rearward on front fenders near the bumper **(Figure 4-3, Page 4-8)**.
7. Remove front bumper (6).
8. Loosen and remove the inner screws, nuts, and spacers (1, 2, 3, and 4) that attach the side fender to the frame. (repeat procedure on opposite side).
9. Unsnap body clips and remove side fenders (5).

FRONT BUMPER AND SIDE FENDER INSTALLATION

1. Install side fenders (5) by snapping in body clips.
2. Install inner screws, nuts, and spacers (1, 2, 3, and 4) that attach the side fender to the frame.
3. Install front bumper (6).
4. Install the two upper and lower bolts (7) that attach the bumper to the vehicle frame. Push down and rearward on front fenders near the bumper to install.
5. Install the grille. **See Grille Installation, Section 4, Page 4-6.**
6. Install the front cowl. **See Cowl Installation, Section 4, Page 4-5.**
7. Install HD bumper (if equipped). **See Brushguard Installation, Section 4, Page 4-4.**
8. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
9. Remove tire chocks.

INSTRUMENT PANEL REMOVAL

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. From the inside of the dash, press upper snap tabs (1) of the instrument panel inward to release from dash.
4. Then push the instrument panel near the bottom (2) to pop out the lower body clips (be careful not to pry the lower clips off).
5. Pull instrument panel out from the dash panel (2).

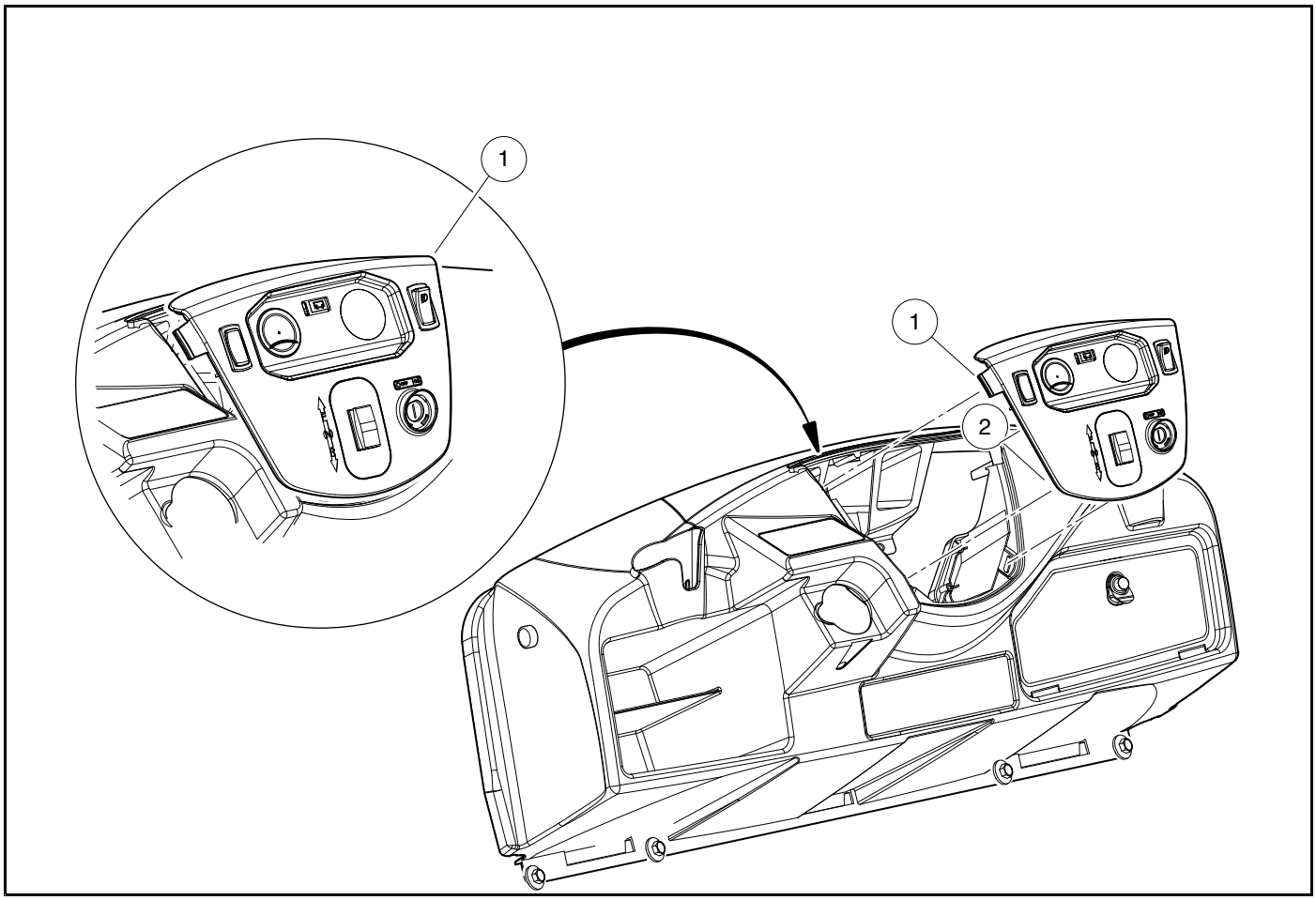

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Figure 4-4 Instrument Panel

INSTRUMENT PANEL INSTALLATION

1. Place upper tab of instrument panel into slot (1).
2. Snap panel into dash while pushing in on the driver and passenger side tabs and sliding the top portion of the panel into place.
3. Snap lower body clips in at each lower corner.
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

DASH REMOVAL

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove cowl. **See Cowl Removal on page 4-5.**
3. Remove steering wheel. **See Steering Wheel Removal, Section 7, Page 7-1.**
4. Disconnect instrument panel wiring.
5. Remove the bolts, and washers (5, 6, 7, 8, and 9) from the top, sides and bottom of the dash (10) **(Figure 4-5, Page 4-11)**.
6. Remove dash assembly.

DASH INSTALLATION

1. Install dash assembly.
2. Install the bolts, and washers (5, 6, 7, 8, and 9) to the top, sides and bottom of dash (10) **(Figure 4-5, Page 4-11)**.
3. Connect instrument panel wiring.
4. Install steering wheel. **See Steering Wheel Installation, Section 7, Page 7-2.**
5. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**
6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

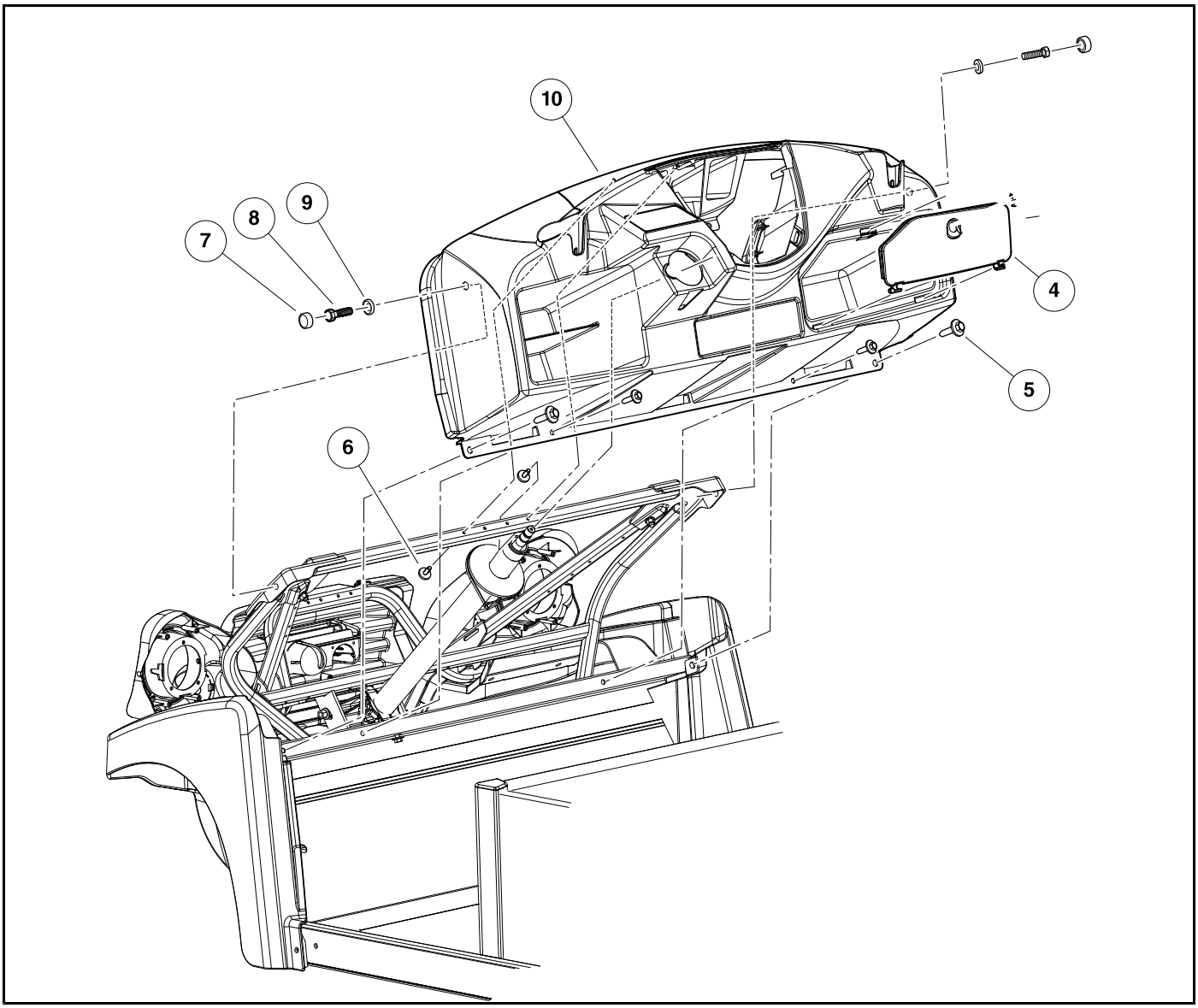

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Figure 4-5 Dash Assembly

CAB

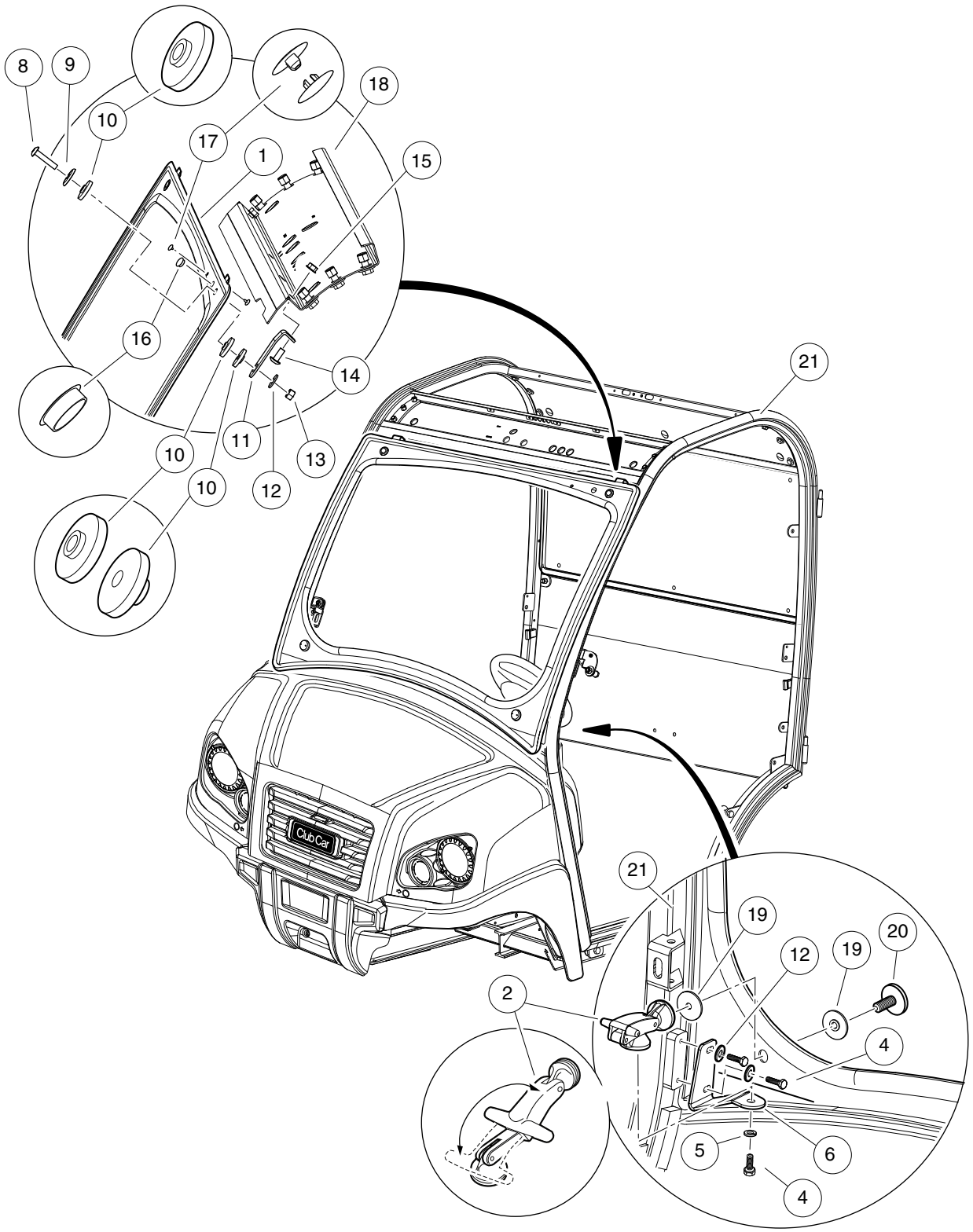

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Figure 4-6 Windshield – Tempered

WINDSHIELD REMOVAL – TEMPERED

1. Turn the key switch to OFF, remove the key, place the Forward/Reverse handle in the NEUTRAL position, engage the park brake, and chock the wheels.
2. Remove wiper assembly. **See Windshield Wiper Removal on page 4-17.**
3. Remove plastic studs (20) and rubber washers (19) that secure bottom of windshield (1) to tee handle assembly (2) **(Figure 4-6)**.
4. Remove flat washers (12), lock nuts (13), rubber washer (10), washer (9), and screws (8) that secure top of windshield (1) to cab frame.
5. Remove windshield (1) from cab.

WINDSHIELD INSTALLATION – TEMPERED

1. Insert one screw (8), one washer (9), and one rubber washer (10) through the upper windshield (1) fastener hole, and two rubber washers (10) on the cab side of the upper windshield fastener hole, as shown **(Figure 4-6)**. Repeat for opposite side.

NOTE: *Installation for the left and right-hand side of the windshield is the same.*

The following steps may require additional personnel.

Ensure that the shoulder for each rubber washer (10) is matched with an insert hole as shown on ***Figure 4-6****.*

Ensure that the windshield is positioned to seal correctly.

2. Position the windshield onto the cab frame using the fastener holes as a guide.
3. Install one flat washer (12) and one lock nut (13) from the cab side of the upper windshield fastener hole. Hand-tighten only. Repeat for opposite side.
4. Secure bottom of windshield to tee handle assembly (2) using two rubber washers (19) and one plastic stud (20). Hand-tighten only. Repeat for opposite side.
5. Ensure windshield seals against the cab.
6. Tighten the hardware the secures the top of the windshield to the window clips (11) to 35 in·lb (4.0 N·m).
7. Tighten the hardware the secures the tee handle assemblies to the windshield.
8. Adjust tee handle mounting so that the tee handles close properly.
9. Tighten the hardware the secures the tee handle mounts to the cab side frames to 15 ft·lb (20.3 N·m).
10. Tighten the hardware the secures the tee handle assemblies to the tee handle mounts to 35 in·lb (4.0 N·m).

DOOR REMOVAL – GLASS

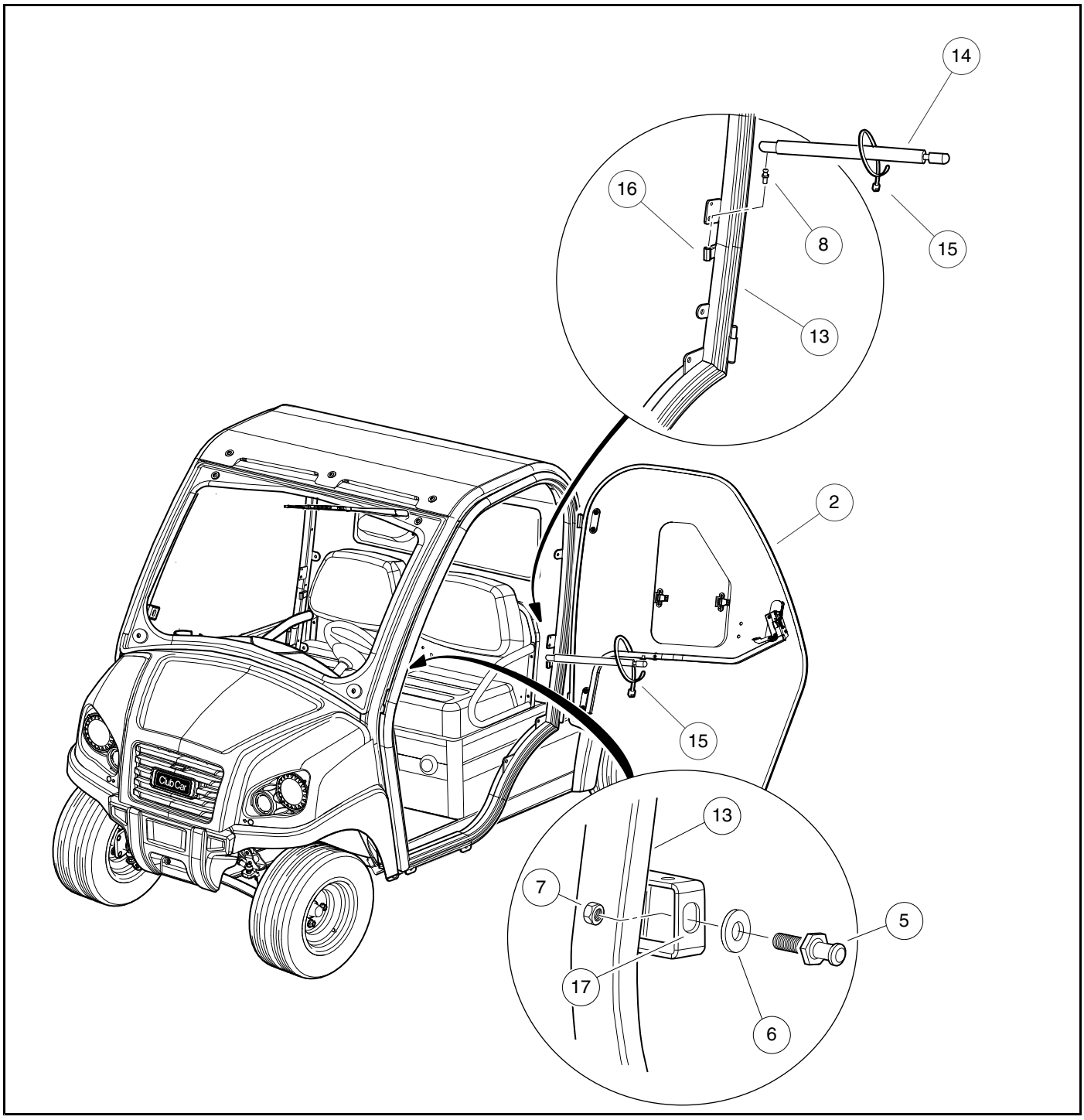

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Figure 4-7 Gas Spring and Door Striker

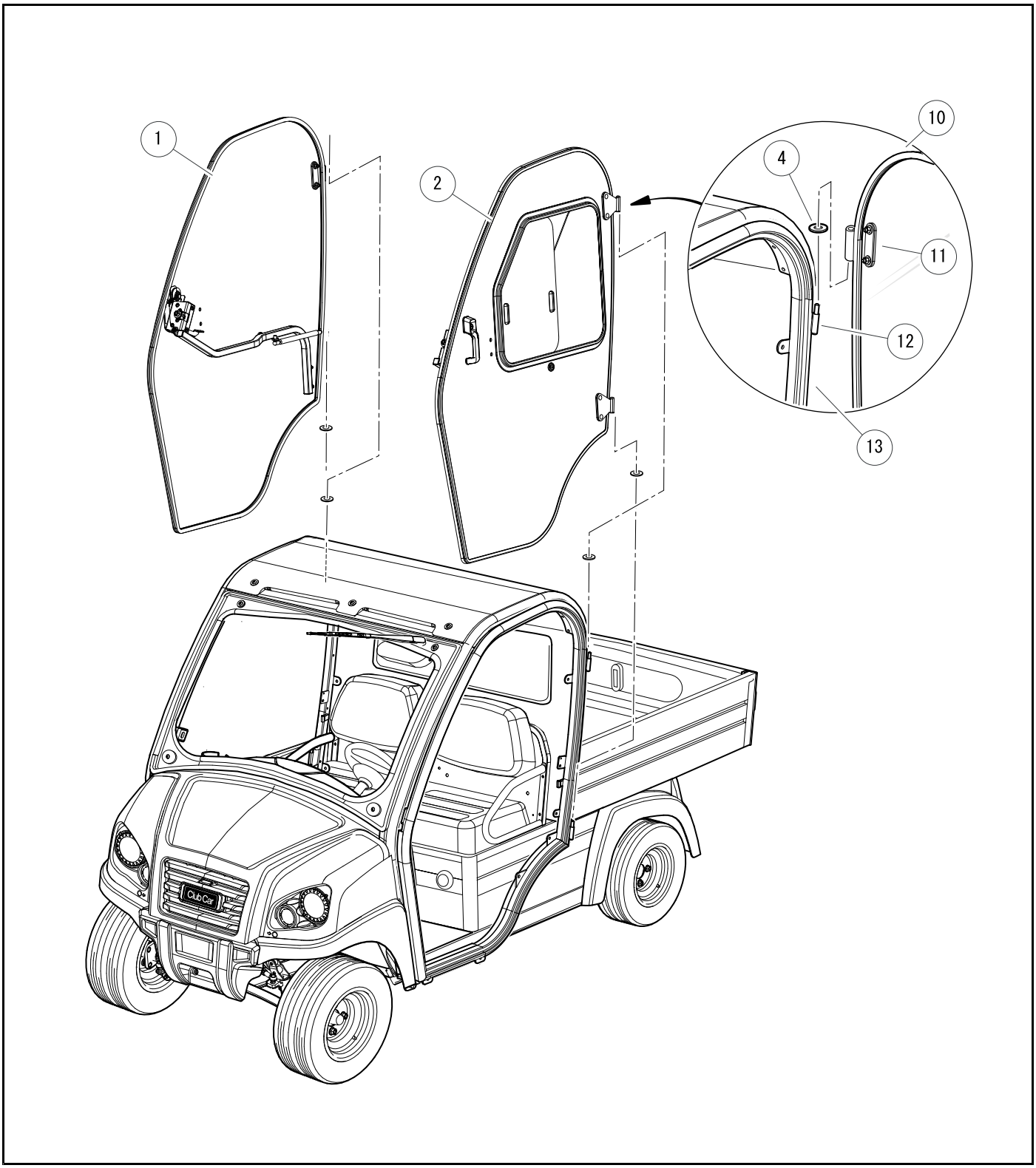

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Figure 4-8 Doors to Hinges

1. Turn the key switch OFF, remove the key, place the Forward/Reverse handle in the NEUTRAL position, engage the park brake, and chock the wheels.

2. Open door (1 or 2) and detach the gas spring (14) from ball studs (8) **(Figure 4-7)**.
3. With door (1 or 2) still open, carefully lift door assembly up and off of the two hinge pins (12) **(Figure 4-8)**.
4. Inspect and replace brass hinge washer (4) if necessary.

DOOR INSTALLATION – GLASS

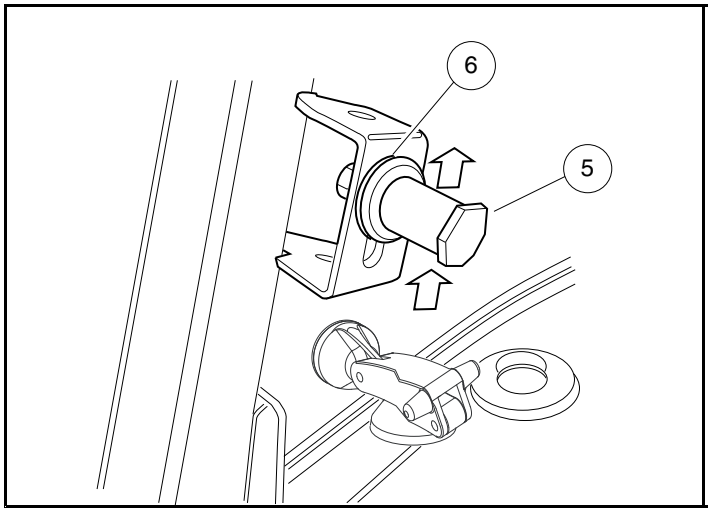

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Figure 4-9 Adjust Door Striker

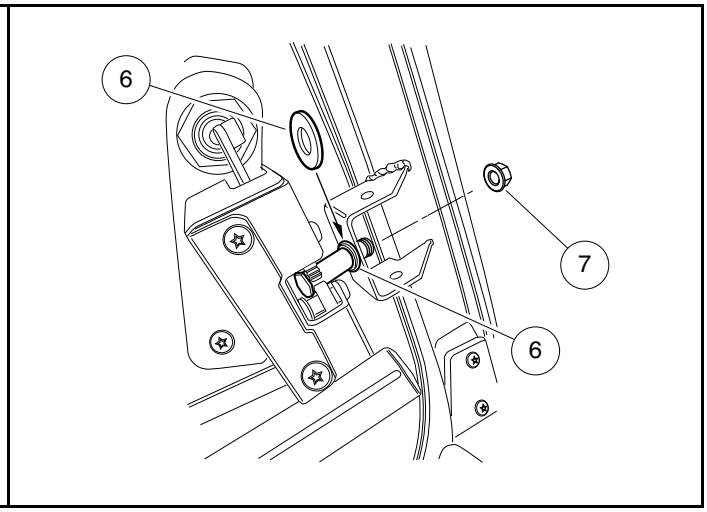

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Figure 4-10 Add Additional Spacer to Striker if Necessary

1. Place one brass hinge washer (4) onto each hinge pin (12) **(Figure 4-8)**.
2. Position the door (1 or 2) slightly higher than the hinge pins, align the door hinges (11) with the hinge pins and slowly slide the door downward onto the hinge pins and brass washers on the side frame (13).
3. Loosen the long striker stud (5), washer (6), and lock nut (7) on the side frame (13) **(Figure 4-9)** and **(Figure 4-8)**.
4. Loosen the four hinge bolts (11) on the door **(Figure 4-8)**.
5. Carefully close the door so the door latches onto the striker (5). This may require an upward force applied to the door as it shuts. **See following NOTE**.

NOTE: *Make sure the door is latched properly. The two-position door rotary latch must be placed in the second (click) inward position to be fully closed.*

6. With the door in the latched position, tighten the door hinge (11) hardware to 40 in·lbs (4.5 N·m).
7. Open the door, lower the striker (5) to align the striker to the door latch. **See following NOTE.**

NOTE: If the striker is not long enough to engage the door latch, remove the striker from the side frame, and add an additional flat steel washer (6) as a spacer between the striker and the side frame (Figure 4-10).

8. Tighten the striker mount hardware to 40 ft·lbs (54.2 N·m).
9. Check the door lock using the door keys. Retain keys for future use.
10. Attach the gas spring (14) to the ball studs (8) **(Figure 4-7)**.

WINDSHIELD WIPER REMOVAL

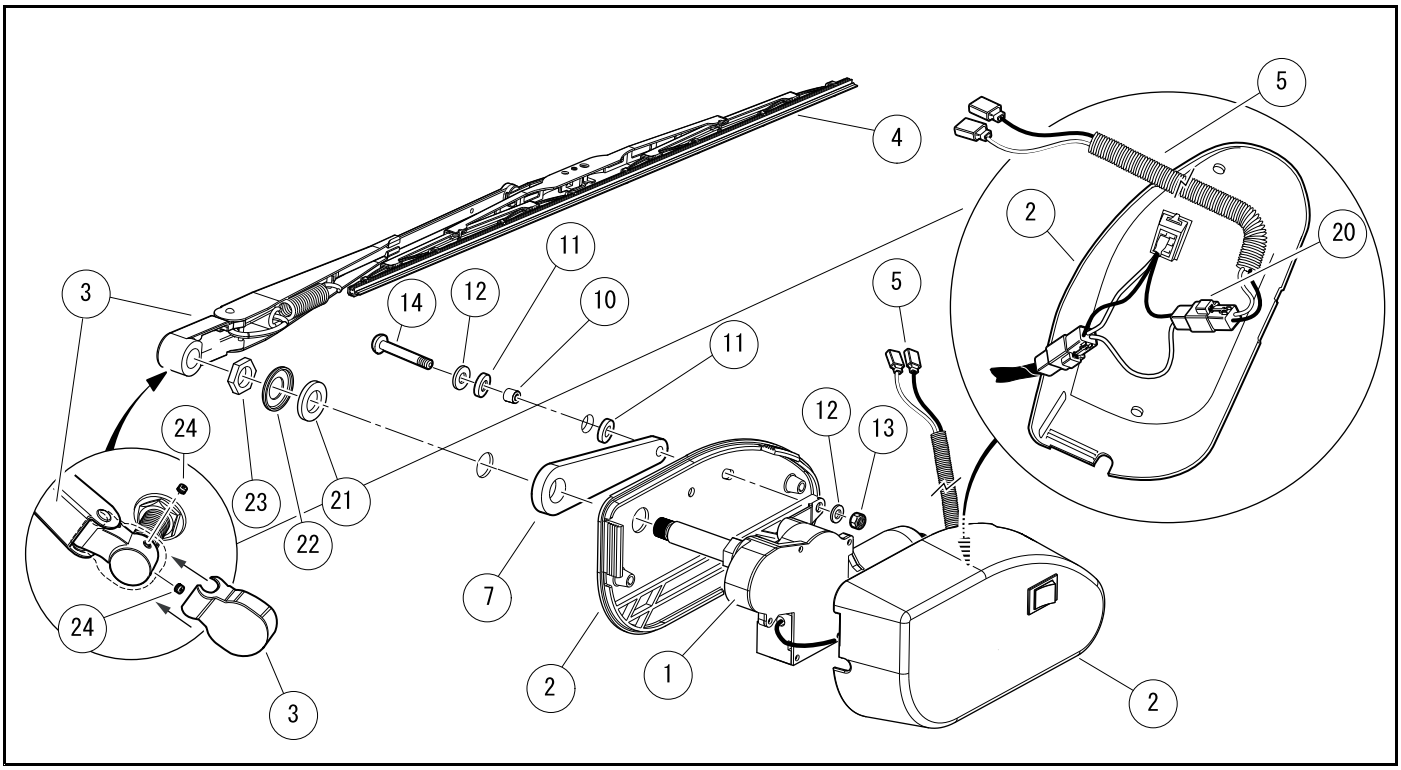

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Figure 4-11 Wiper Motor and Arm Components

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Lift the wiper arm end cover (3) on the base of the wiper arm, remove the two hex allen screws (24), and pull the wiper arm off the shaft **(Figure 4-11)**.
3. Separate the wiper motor cover (2).
4. Disconnect wiring (5 and 20) inside wiper motor cover (2).
5. Loosen the hex nut (23) on the motor shaft.
6. Remove screw (14), washer (12), two rubber washers (11), spacer (10), and lock nut (13) securing motor and rear cover to windshield.
7. Remove hex nut (23), cupped washer (22), nylon washer (21) and remove rear wiper cover (2), spacer (7), and wiper motor (1) from windshield.

WINDSHIELD WIPER INSTALLATION

⚠ WARNING

- **Club Car electric vehicles are designed without a chassis ground. The windshield wiper is physically and electrically isolated from the windshield frame of the vehicle. Failure to maintain this chassis isolation could result in a potential fire hazard.**

NOTE: *The windshield wiper must be installed at the top of the windshield.*

1. Position the rear wiper cover (2) and spacer (7) onto the wiper motor (1) shaft and insert the motor shaft through the windshield using the windshield holes as a guide **(Figure 4-11)**. Secure the shaft with one nylon washer (21), one cupped washer (22), and one hex nut (23).
2. Secure the motor and rear cover to the windshield using one screw (14), one washer (12), two rubber washers (11), one spacer (10), and one lock nut (13). Tighten the screw to 20 in·lbs (2.3 N·m).
3. Tighten the hex nut (23) on the motor shaft to 60 in·lbs (6.8 N·m).
4. Connect the 2-pin male connector of the short jumper harness (5) to the 2-pin female connector (20) on the wiper motor cover (2).
5. Secure the front of the wiper motor cover (2) to the back cover (2).

⚠ WARNING

- **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.**

6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
7. Turn the key switch to the ON position and press the wiper motor switch to the ON and then OFF position. Observe the rotation of the motor shaft and make a mark, if necessary, to help locate the park position **(Figure 4-12)**. Turn key switch to the OFF position. **See following NOTE.**

NOTE: *When the wiper motor is activated, there is an immediate short direction of travel in reverse before the full wiper cycle. The full wiper cycle of the motor will run for a period of time and then stop by itself. This is the parked position.*

If the wiper motor park location is oriented to the wrong side of windshield, the yellow wire from the wiper switch (from under the wiper motor cover) can be relocated to another terminal on the connector to change the park location. If the park position needs to be changed, proceed to step 13.

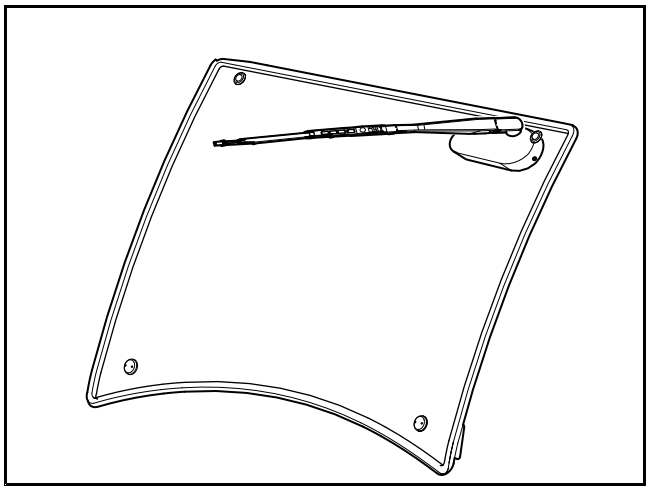

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Figure 4-12 Windshield Wiper Shown In Parked Position

8. Secure the wiper blade to the end of the wiper arm **(Figure 4-11)**.
9. Extend the wiper arm (48) to the dimension shown **(Figure 4-13)** by lifting the tab under the wiper arm, extend the arm, and press the tab to secure the arm.
10. Position the wiper arm onto the wiper motor shaft using the measurements shown **(Figure 4-13)**. Once the end of the wiper blade is in position, push the base of the wiper arm fully onto the motor shaft. Firmly secure the two hex allen screws (24) on the base of the wiper arm to the motor shaft **(Figure 4-11)**.

11. Turn key switch to the ON position and press the wiper motor switch to the ON and then OFF position. Check coverage area and adjust as needed. Turn key switch to the OFF position.

NOTE: *If desired parked position is on the wrong side of the windshield refer to step 13.*

12. Press the wiper arm end cover (3) onto the base of the wiper arm as shown **(Figure 4-11)**.
13.

NOTE: *The wiper arm can be parked in either the driver side or passenger side position, depending on which wire connections are made from the wiper motor switch to the wiper motor connector.*

Turn key switch OFF and remove the key. Separate the wiper motor cover (2) **(Figure 4-11)**.

14. To park the wiper on the driver side, insert yellow wire from switch into the top location of connector.
15. Assemble the wiper motor cover (2).
16. Test the wiper motor to ensure the proper park position.

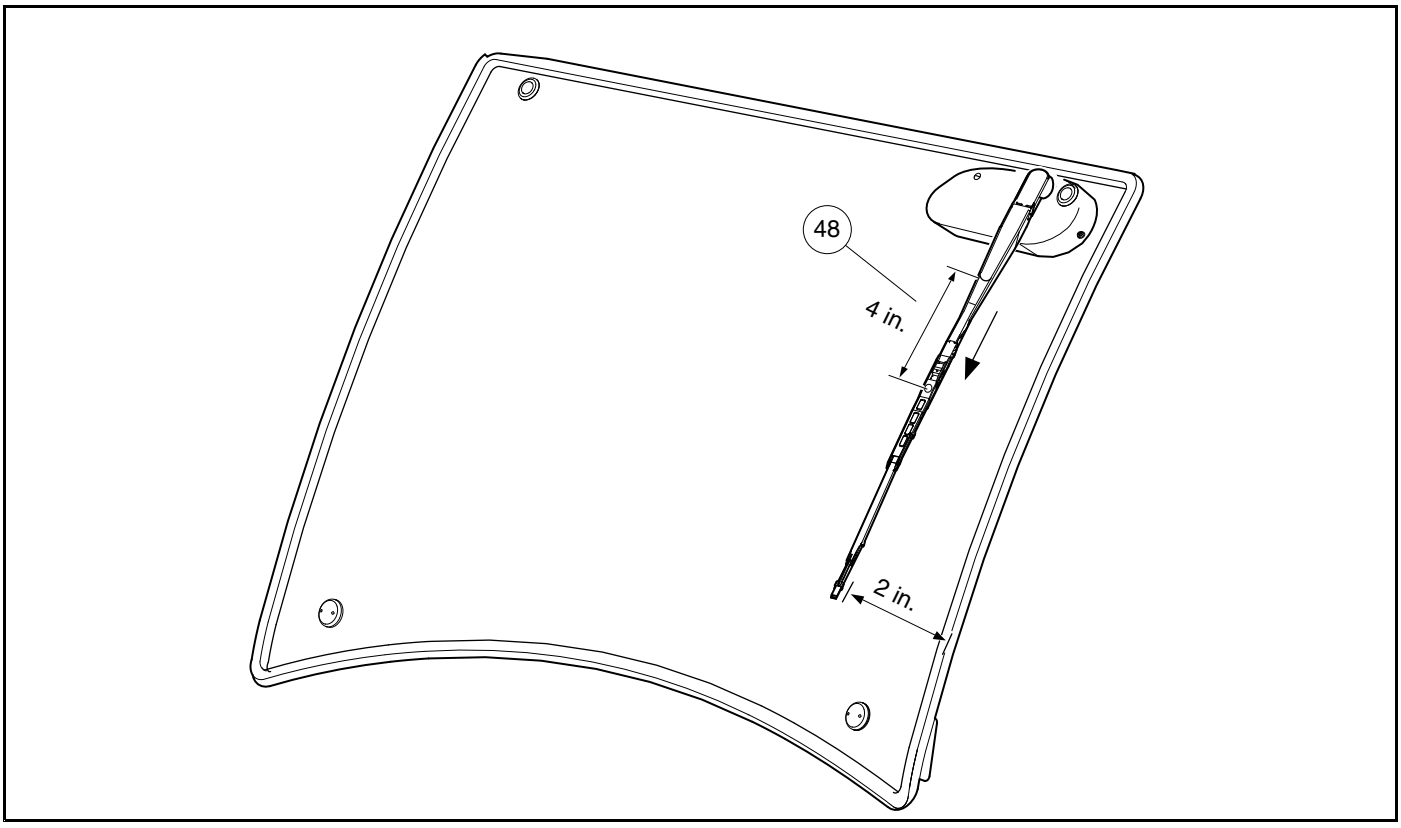

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Figure 4-13 Wiper Arm Measurement

OVERHEAD CONSOLE REMOVAL

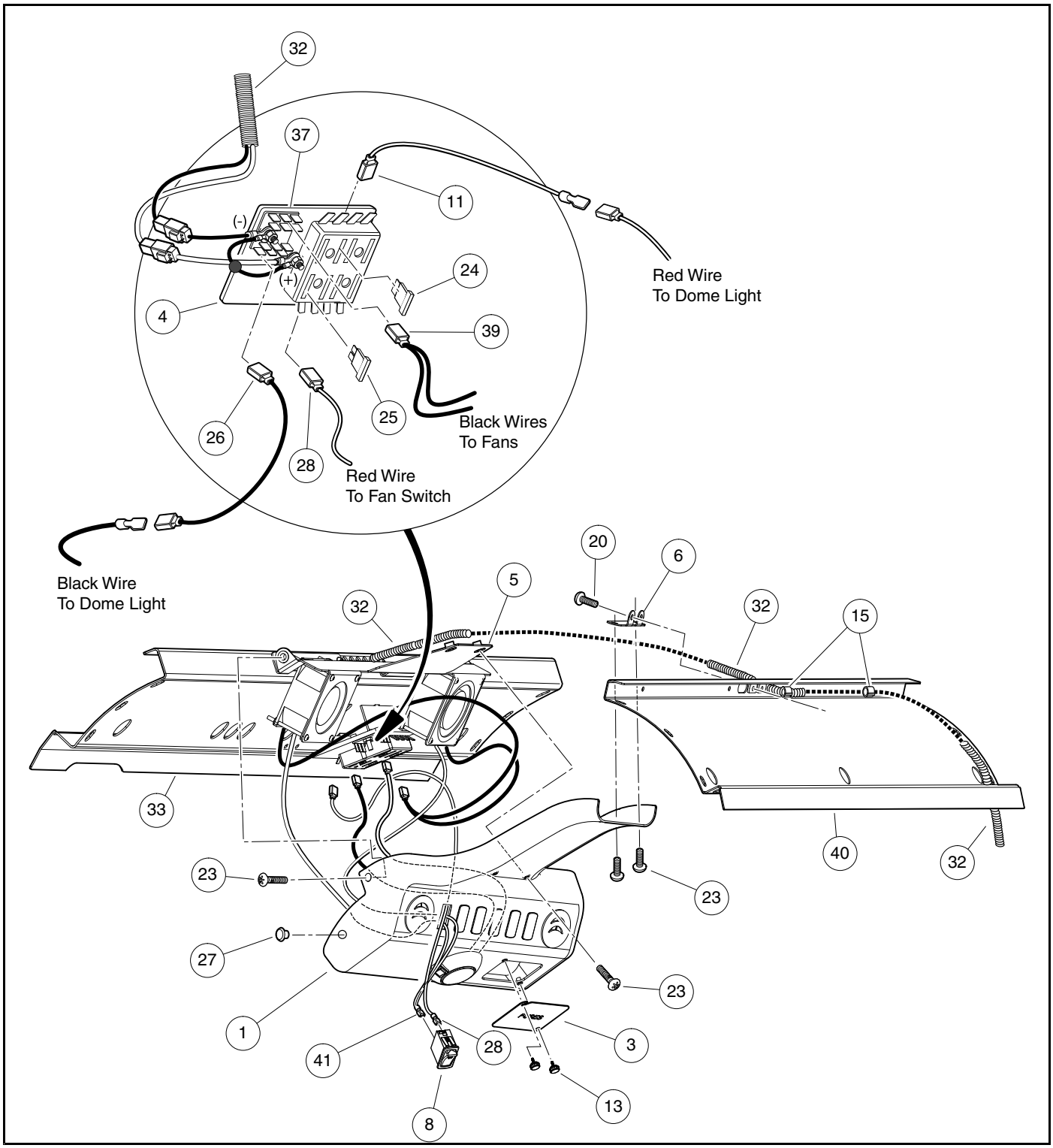

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Figure 4-14 Overhead Console Components – Exploded View

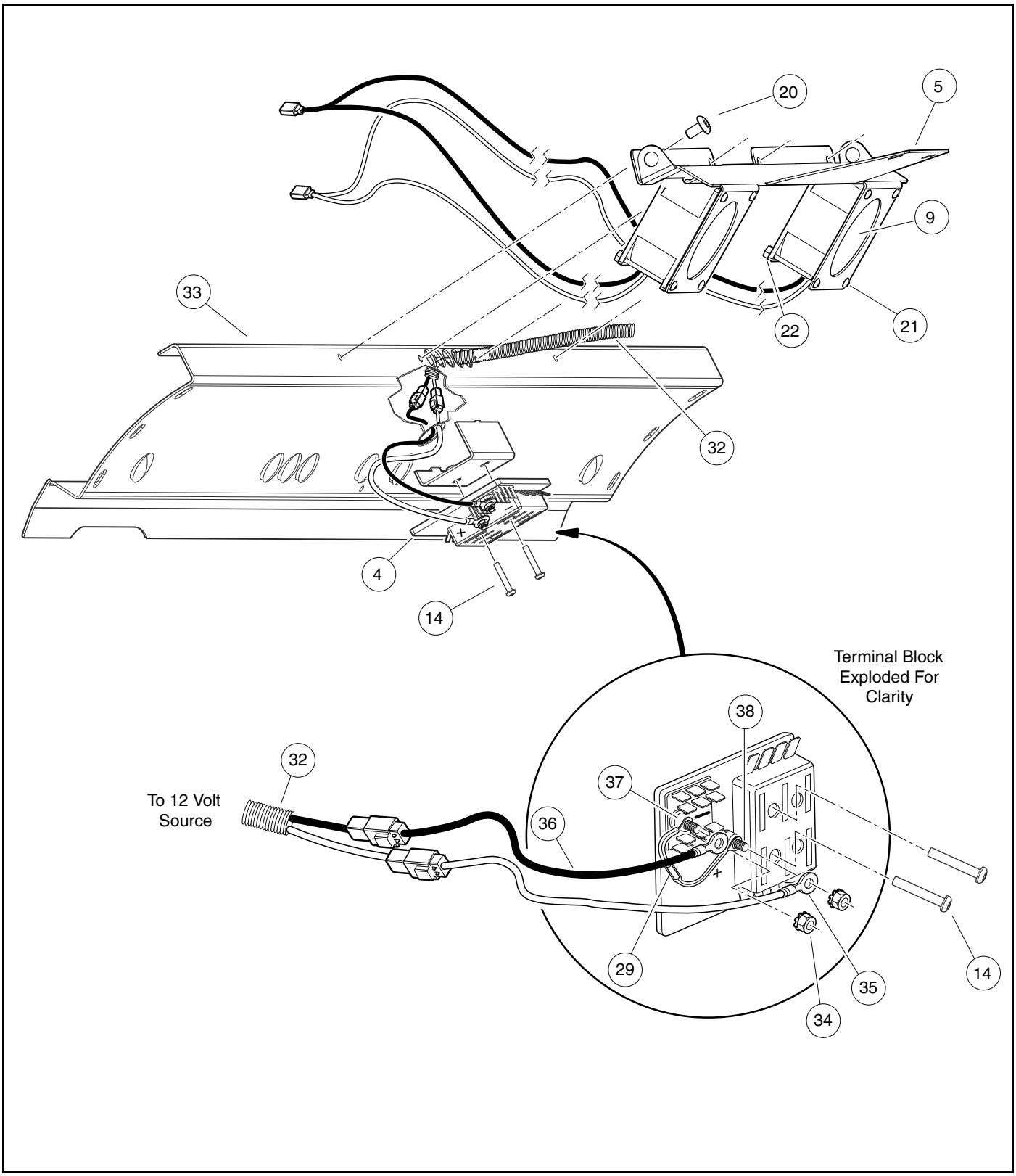

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Figure 4-15 Fuse Holder and Console Fan Assembly – Exploded View

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove two stud knobs (13) securing fuse cover (3) to overhead console cover (1) **(Figure 4-14)**.
3. Remove six screws (23) securing overhead console cover (1) to front and rear console brackets (5 and 6) and lower cover to access wires.
4. Disconnect wiring and remove console cover (1).
5. Disconnect fuse holder wire leads (35 and 36) from cab power harness (32) **(Figure 4-15)**.
6. Remove two screws (14) securing fuse holder (4) to front cross member (33) and remove fuse holder (4).
7. Remove four screws (20) securing front fan bracket (5) and console fan assembly (9) to front cross member (33) and remove bracket (5) and fan assembly (9).

OVERHEAD CONSOLE INSTALLATION

⚠ WARNING

- **Club Car electric vehicles are designed without a chassis ground. Accessories must be physically and electrically isolated from the frame of the vehicle. Failure to maintain this chassis isolation could result in a potential fire hazard.**

1. Position the fuse holder (4) onto the front cross member (33) using the fastener holes for alignment as shown **(Figure 4-15)**.
2. Secure the fuse holder to the front cross member using two screws (14). Tighten the hardware to 10 in·lb (1.1 N·m).
3. Position the front fan bracket and console fan assembly (items 5 and 9) onto the front cross member (33) using the fastener holes for alignment as shown **(Figure 4-15)**.

NOTE: *The console fans are attached to the front fan bracket prior to installation. Air direction is from the front of the console fans where the manufacturer decals are placed. Make sure that the front of the console fans face inside the cab.*

4. Secure the front fan bracket and console fan assembly to the front cross member using four screws (20). Tighten the screws to 7 ft·lb (9.5 N·m).
5. From inside the cab, route the cab power harness (32) with ring terminals (items 35 and 36) through one of the cable holes in the front cross member (33) as shown **(Figure 4-15)**.
6. Remove one hex nut (34) from the ground block terminal (37). Retain the nut for reinstallation.
7. Remove one hex nut from the fuse block terminal (38). Retain the nut for reinstallation.
8. Install capacitor assembly (29) onto fuse holder (4) with one ring terminal on ground block terminal (37) and the other ring terminal on fuse block terminal (38). Orientation does not matter; the capacitor is not polarity sensitive. **See following NOTE.**

NOTE: *To prevent incorrect fan performance, the capacitor assembly (29) must be installed.*

9. Attach the black power harness ring terminal (36) to the ground block terminal (37). Secure the ring terminal using one nut (34). Tighten hardware to 32 in·lb (3.6 N·m).
10. Attach the red power harness ring terminal (35) to the fuse block terminal (38). Secure the ring terminal using one nut (34). Tighten hardware to 32 in·lb (3.6 N·m).
11. From inside the cab, connect the black fan wires (39) to the quick connect on the fuse holder ground block terminal (37) as shown **(Figure 4-14)**.
12. Install the fan rocker switch (8) inside the overhead console cover (1).
13. Connect the red fan wires (41) to the quick connect on the back of the fan rocker switch (8) inside the overhead console cover.

NOTE: *The wire connection made with the rocker switch will support the cover until final installation.*

14. Connect one end of the red fan jumper wire (28) to the quick connect on back of the fan rocker switch. Connect the other end of the red jumper wire (28) to the overhead fan fuse block quick connect on the fuse holder (4).
15. Connect one end of the red dome light jumper wire (11) to the dome light fuse block quick connect on the fuse holder. Connect the other end of the red jumper wire (11) to the red dome light wire (2).
16. Connect one end of the black dome light jumper wire (26) to the quick connect on the fuse holder ground block terminal (37). Connect the other end of the black dome light jumper wire (26) to the black dome light wire (2).
17. Install a 3 amp fuse (25) into the empty overhead console fan fuse location. **See following WARNING.**
18. Install a 1 amp fuse (24) into the empty dome light fuse location.

⚠ WARNING

- **Failure to use properly rated fuse can result in a fire hazard.**

19. Identify the optional equipment needed and install the equipment kit(s) prior to securing the overhead console cover.
20. Position the rear overhead console bracket (6) onto the rear cross member (40) using the fastener holes for alignment as shown **(Figure 4-14)**.
21. Secure the rear overhead console bracket to the rear cross member using two screws (20). Tighten the screws to 7 ft·lb (9.5 N·m).
22. Position the overhead console cover (1) onto the front and rear console brackets (5 and 6) using the fastener holes for alignment as shown **(Figure 4-14)**.
23. Secure the console cover to the brackets using six screws (23). Tighten the screws to 35 in·lb (4.0 N·m).
24. If not installed, position the fuse cover (3) onto the overhead console cover (1). Secure the fuse cover to the overhead console cover using two stud knobs (13). Hand-tighten only.

⚠ WARNING

- **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.**

25. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

TILT BED

See General Warnings on page 1-1.

TILT BED REMOVAL

NOTE: *This procedure requires two people.*

⚠ WARNING

- **Remove all cargo before raising the bed or servicing the vehicle. If the vehicle is equipped with a prop rod, ensure that it is securely engaged while bed is raised. Do not close bed until all persons are clear of cargo bed area. Keep hands clear of all crush areas. Do not drop cargo bed; lower gently and keep entire body clear. Failure to heed this warning could result in severe personal injury or death.**

1. Raise bed and secure prop rod (9) in prop rod track (2). Hold bed securely in an upright position. Remove cotter pin (11) and flat washer (17) from top end of prop rod where prop rod attaches to bed. Remove prop rod (9) from bed and place prop rod between prop rod track (2) and rear body panel. Lower bed onto vehicle frame **(Figure 4-16, Page 4-25)**.
2. Remove two lock nuts (8) from left and right hinge assemblies (C).
3. Apply slight upward pressure (by hand) on the rear of the bed to relieve pressure on the hinges, and remove the hinge bolts (7) from the hinge assemblies.
4. Raise rear edge of bed approximately 6 inches (15.2 cm) and pull bed assembly toward rear of vehicle approximately 3 inches (7.6 cm) to release bed latch assembly (A) from latch plate (B).
5. Lift bed from vehicle.

TILT BED INSTALLATION

NOTE: *This procedure requires two people.*

Lubricate the hinge bolts (7) with light motor oil prior to assembly.

1. Place bed on vehicle. Hold bed at a slight angle (front of bed lower than rear of bed) to vehicle and push front edge of bed onto vehicle frame engaging bed latch assembly (A) with latch plates (B).
2. Install bolt (7) into each hinge assembly.
3. Install a nylon lock nut (8) on each bolt (7) and tighten to 15 ft·lb (21 N·m).
4. Lift bed and insert the prop rod (9) in bed mounting hole. Install a 3/8-inch flat washer (17) and a new cotter pin (11) on prop rod.

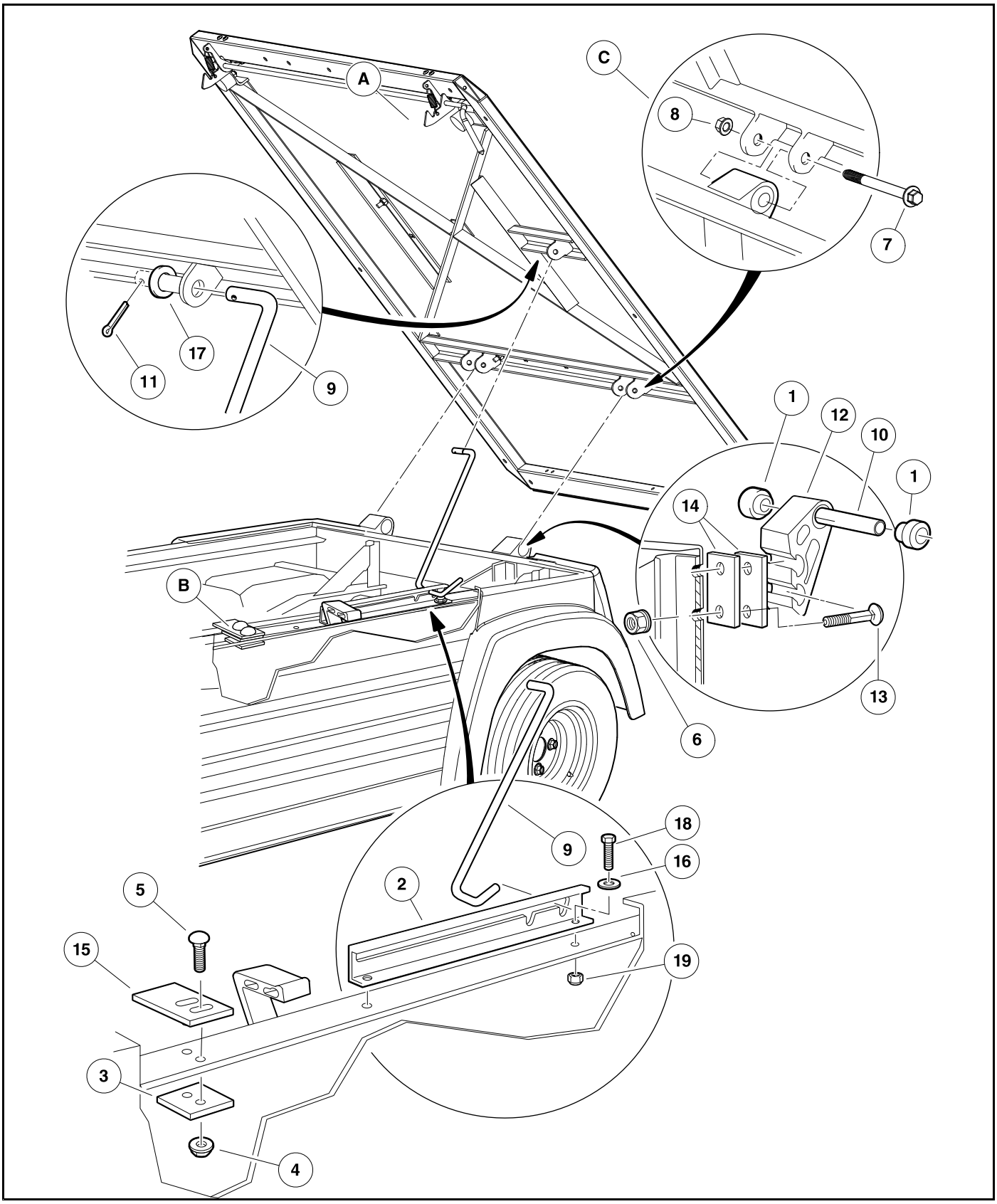

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Figure 4-16 Tilt Bed Mounting

BED LATCH ASSEMBLY REMOVAL

NOTE: *This procedure requires the aid of an assistant.*

1. Park the vehicle and chock the tires.
2. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
3. Raise bed and secure prop rod (9) in prop rod track (2) **(Figure 4-16, Page 4-25)**. **See following WARNING.**

⚠ WARNING

- **Remove all cargo before raising the bed or servicing the vehicle. If the vehicle is equipped with a prop rod, ensure that it is securely engaged while bed is raised. Do not close bed until all persons are clear of cargo bed area. Keep hands clear of all crush areas. Do not drop cargo bed; lower gently and keep entire body clear. Failure to heed this warning could result in severe personal injury or death.**

4. Remove the four bolts (12) and lock nuts (7) that secure the bed latch (6) to the underside of the bed **(Figure 4-17, Page 4-27)**.
5. Remove the bed latch (6) and springs (5).

BED LATCH ASSEMBLY INSTALLATION

1. Install bed latch (6) and springs (5).

NOTE: *Latch assembly needs to sit open exactly as shown* ***(Figure 4-17, Page 4-27)****.*

2. Install the four bolts (12) and lock nuts (7) that secure the bed latch (6) to the underside of the bed. Tighten to 70 to 80 in·lb (8 to 9 N·m).
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
4. Remove tire chocks.

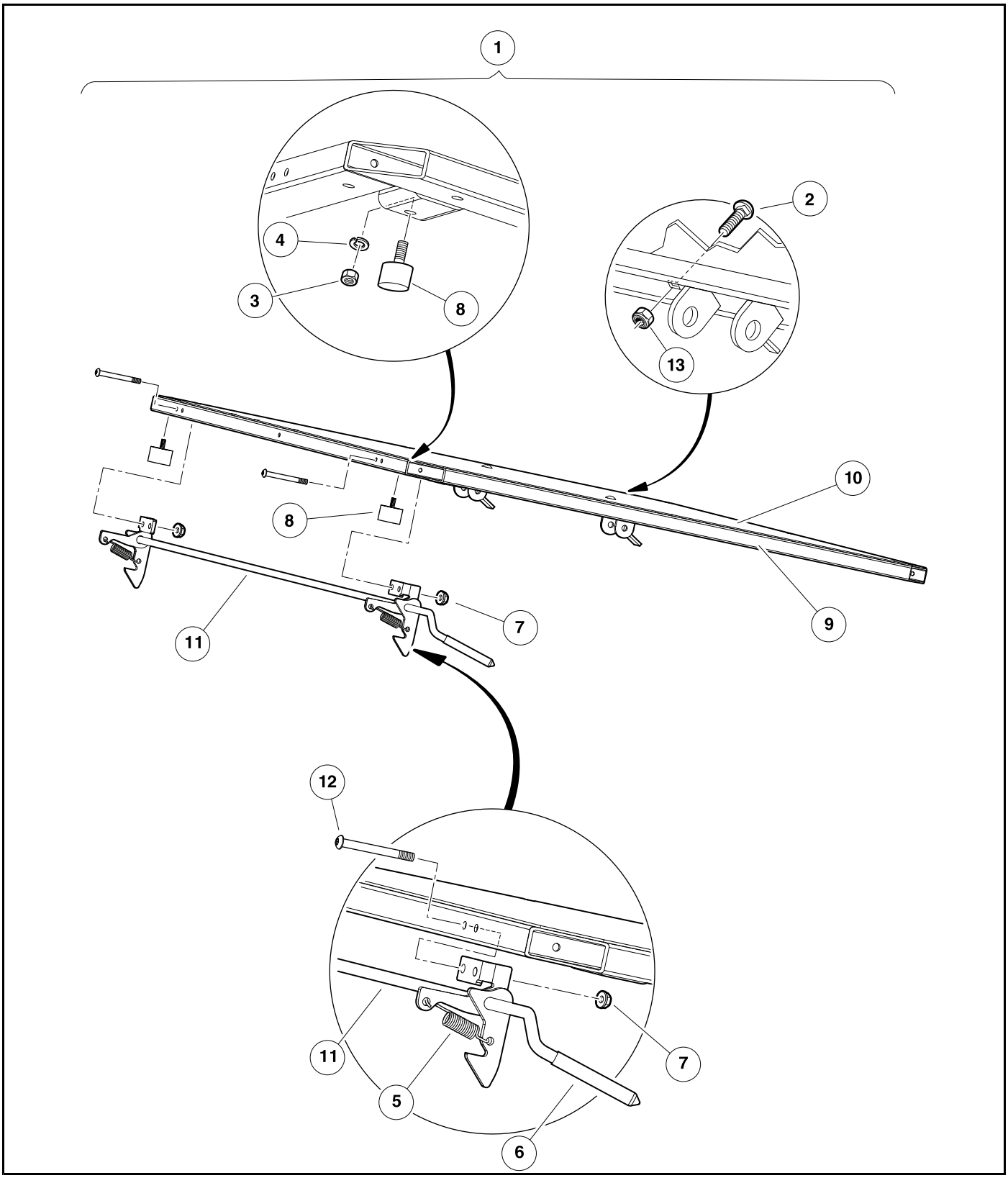

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Figure 4-17 Bed Latch Assembly

REAR FENDERS AND TAILSKIRT

See General Warnings on page 1-1.

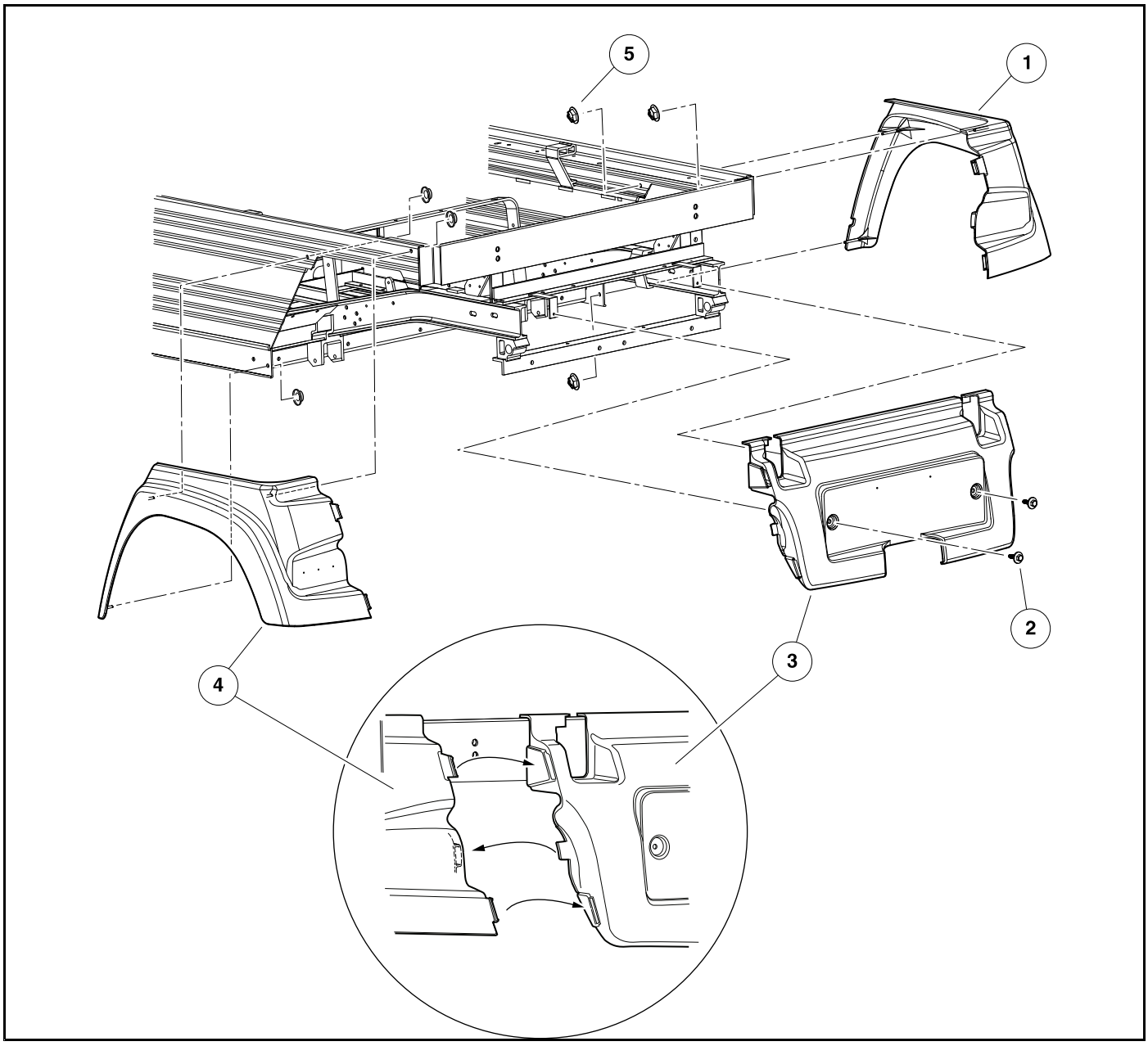

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Figure 4-18 Rear Fender and Tailskirt

REAR FENDER AND TAILSKIRT REMOVAL

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse handle in NEUTRAL and set the park brake. Chock the wheels.
2. Disconnect the battery cables and either discharge the controller or disconnect the spark plug wire(s). **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

3. Remove the tilt bed. **See Tilt Bed Removal on page 4-24.**
4. Disconnect the three taillight wires.
5. Using a 10 mm socket, remove the three fasteners (5) that attach the rear fender (4) to vehicle frame **(Figure 4-18, Page 4-28)**.
6. Using a 10 mm socket, remove the two M6 screws (2) that attach the tailskirt (3) to the vehicle frame.
7. Remove fenders and tailskirt.

REAR FENDER AND TAILSKIRT INSTALLATION

1. Using a 10 mm socket, install the two screws (2) that attach the tailskirt (3) to the vehicle frame **(Figure 4-18, Page 4-28)**. Tighten to 44 in·lb (5 N·m).
2. Using a 10 mm socket, install the three fasteners (5) that attach the rear fender (4) to the vehicle frame. Tighten to 5 in·lb (0.56 N·m). Do not over torque.
3. Connect the taillight wires.
4. Install the two bolts and nuts that secure taillight to the rear fender.
5. Connect the three taillight wires.
6. Install the tilt bed. **See Tilt Bed Installation on page 4-24.**
7. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**

ELECTRIC BED LIFT

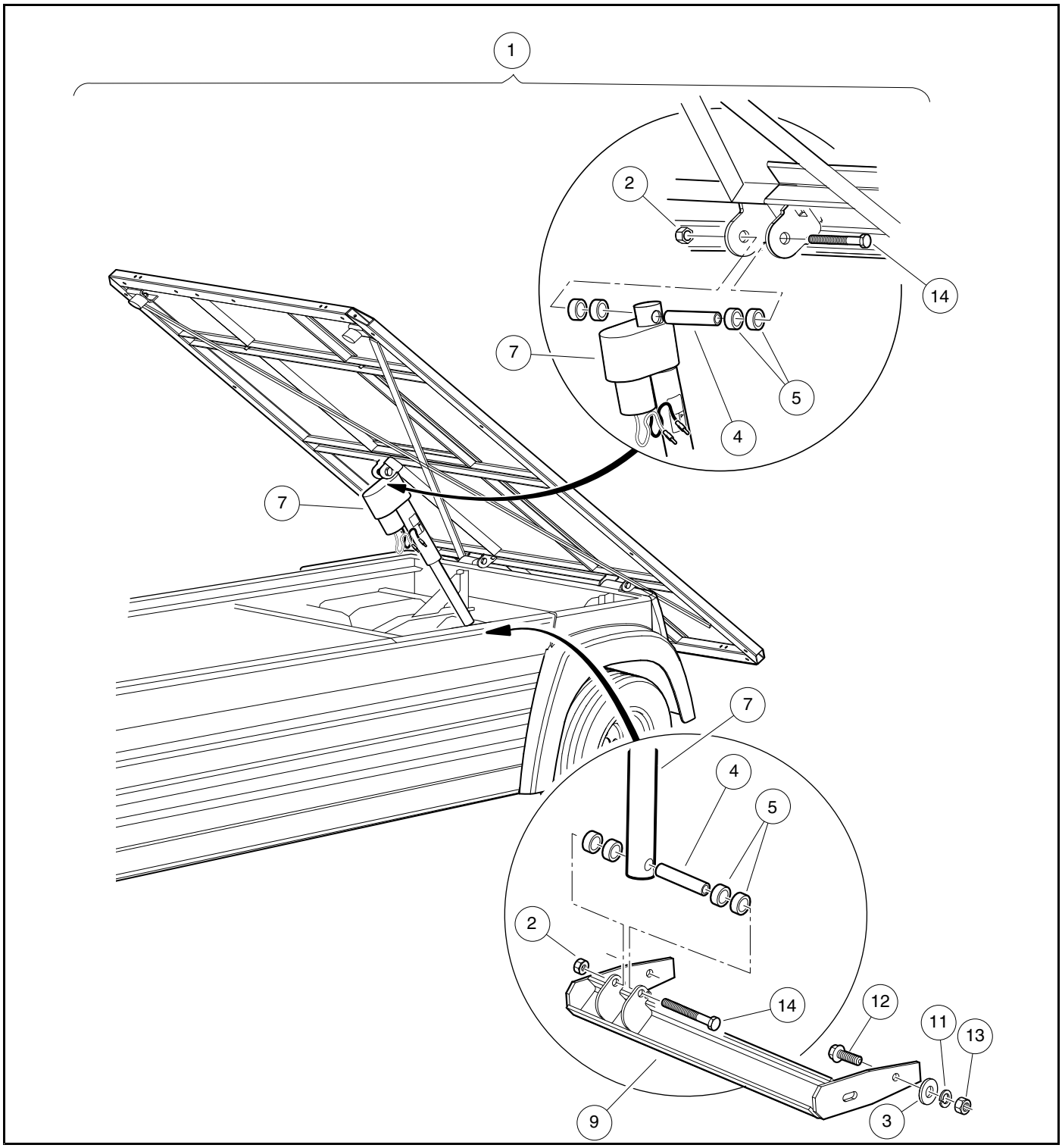

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Figure 4-19 Electric Bed Lift

ELECTRIC BED LIFT REMOVAL

NOTE: *For vehicles equipped with an electric bed lift.*

This procedure requires the aid of an assistant.

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles on page 1-3.**
2. Raise the bed.
3. Disconnect actuator wires.
4. Remove actuator hardware that secures lift (7) **(Figure 4-19, Page 4-30)**.
5. Lower the bed.
6. Remove the hex-head bolts, lock nuts, spacers and bushings (1, 2, 5, 6, 7, and 8) **(Figure 4-20, Page 4-31)**.

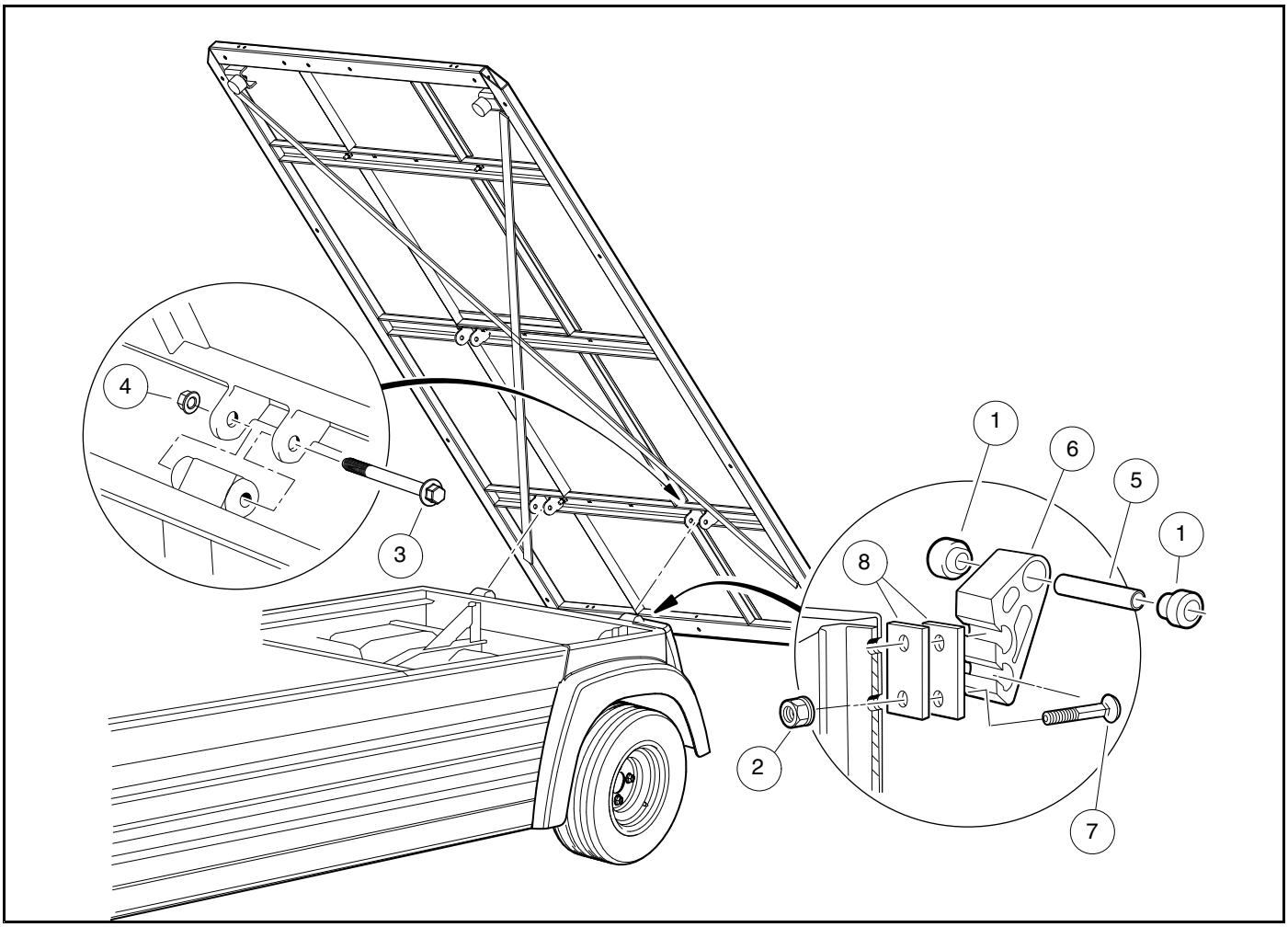

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Figure 4-20 Electric Bed Mounting

ELECTRIC BED LIFT INSTALLATION

1. Install hex-head bolts, lock nuts, spacers and bushings (1, 2, 5, 6, 7, and 8) **(Figure 4-20, Page 4-31)**.
2. Lift bed.

3. Install actuator hardware that secures lift (7) **(Figure 4-19, Page 4-30)**.
4. Connect actuator wires.
5. Lower bed.
6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**

FLOOR MAT

See General Warnings on page 1-1.

FLOOR MAT REMOVAL

1. Remove the brake and accelerator pedals. **See Accelerator and Brake Pedal Group, Section 5, Page 5-1.**
2. Remove the top edge of the floor mat from the overlapping flange under the dash.
3. Lift the mat from the vehicle.

FLOOR MAT INSTALLATION

1. Install mat into vehicle. Ensure mat is laying flat.
2. Install top edge of the floor mat into the overlapping flange under the dash.
3. Install the two screws in the rear body kick plate. Tighten kick-plate screws to 50 in·lb (5.6 N·m).
4. Install the brake and accelerator pedals. **See Accelerator and Brake Pedal Group, Section 5, Page 5-1.**

TRAILER HITCH

See General Warnings, Section 1, Page 1-1.

TRAILER HITCH REMOVAL

1. Remove the tailskirt. **See Rear Fender and Tailskirt Removal on page 4-28.**
2. Where the hitch is mounted to frame, remove two nuts, lockwashers, flat washers, and bolts.
3. Where the hitch is mounted to hitch brace, remove the nut, lockwasher, flat washer, and bolt.
4. Remove hitch from vehicle.

TRAILER HITCH INSTALLATION

1. Mount hitch to hitch brace, install nut, lockwasher, flat washer, and bolt.
2. Install hitch to frame, install two nuts, lockwashers, flat washer, and bolts.
3. Tighten hardware to 15 ft·lb (20.3 N·m).
4. Install tailskirt. **See Rear Fender and Tailskirt Installation, Section 4, Page 4-29.**

SECTION 5 — ACCELERATOR AND BRAKE PEDAL GROUP

5

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

BRAKE PEDAL

See General Warnings on page 1-1.

BRAKE PEDAL REMOVAL

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse switch in NEUTRAL. Chock the wheels.

   Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

2. Place chocks under rear wheels and lift front end of vehicle with a chain hoist or floor jack. Place jack stands under the outer front I-beam of the vehicle frame and lower the vehicle onto the jack stands **(Figure 5-1, Page 5-2)**. **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.**

3. Remove the brake pedal assembly (1).

3.1. Remove the bow tie locking pins (2) and clevis pins (3) from the linkage rods **(Figure 5-2, Page 5-2)**.

3.2. Remove nuts (4), flat washers (5), bolts (6), and mounting blocks (7) **(Figure 5-3, Page 5-3)**. If the mounting blocks (7) show signs of excessive wear, or are damaged, replace with new ones.

3.3. Remove the jam nut (8) and brake stop bumper (9) **(Figure 5-2, Page 5-2)**.

3.4. Lift pedal assembly through the floorboard **(Figure 5-4, Page 5-3)**.

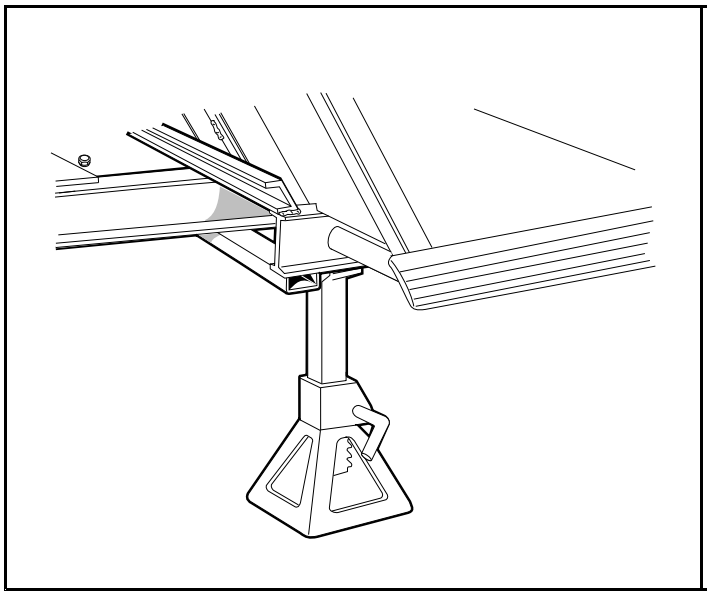

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Figure 5-1 Jack Stand Location on I-Beam

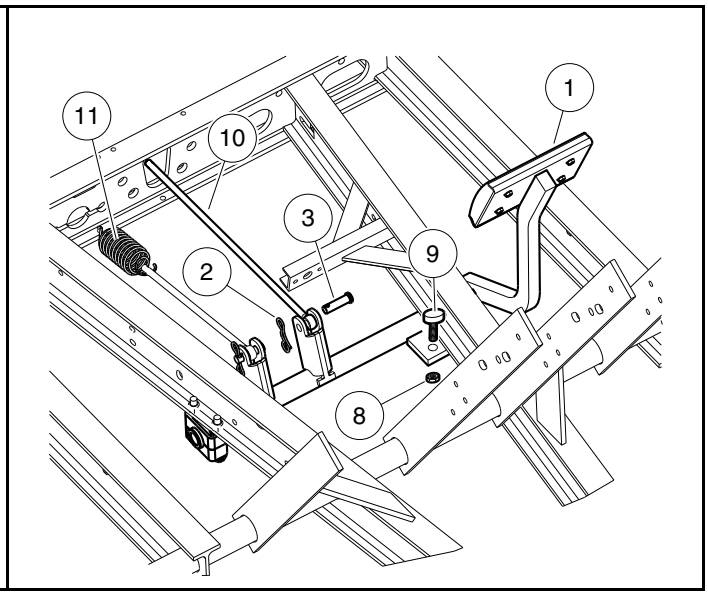

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Figure 5-2 Brake Pedal Mounting – Linkage Rods

BRAKE PEDAL INSTALLATION

1. Insert the brake pedal assembly (1) through the top side of the floorboard **(Figure 5-4, Page 5-3)** and install the brake pedal stop bumper (9) and jam nut (8) **(Figure 5-2, Page 5-2)** but do not tighten.
2. Position and attach brake pedal assembly and mounting blocks (7) with bolts (6), washers (5), and lock-nuts (4). Tighten to 70 in·lb (7.91 N·m) **(Figure 5-3, Page 5-3)**.
3. Attach the linkage rods to the brake pedal assembly (1) and secure with bow tie locking pins (2) and clevis pins (3) **(Figure 5-2, Page 5-2)**.
4. Adjust the brake pedal. **See Brake Pedal Adjustment on page 5-3.**
5. Connect the battery cables, positive (+) post first, and tighten terminals to 110 in·lb (16.3 N·m). Coat terminals with Battery Terminal Protector Spray.
6. Perform all of the brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

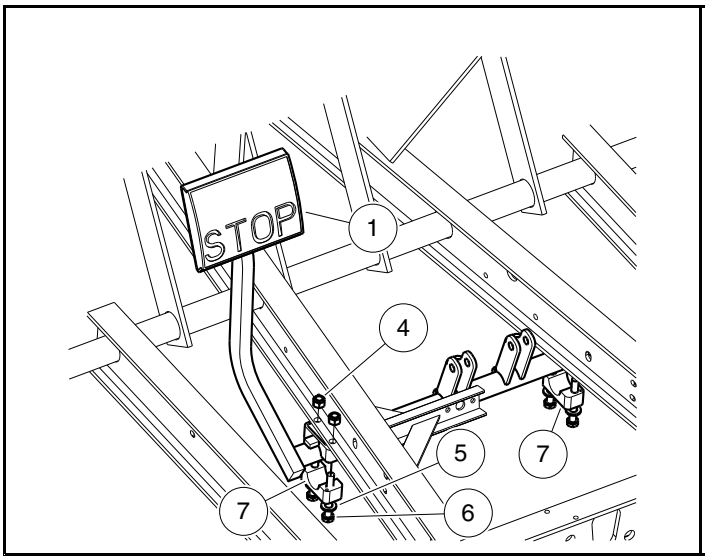

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Figure 5-3 Brake Pedal Mounting Blocks

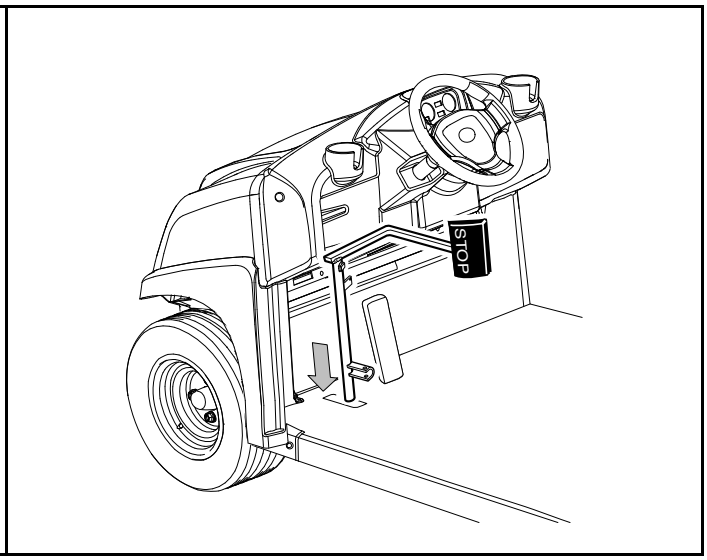

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Figure 5-4 Brake Pedal Weldment Through Floor

BRAKE PEDAL ADJUSTMENT

See General Warnings on page 1-1.

1. Make sure the key switch is OFF and the Forward/Reverse handle is in the NEUTRAL position. Remove the key. Chock the wheels.
2. Remove the bow tie locking pins (2) and clevis pins (3) from the linkage rods **(Figure 5-2, Page 5-2)**.
3. Loosen, but do not remove, the brake stop jam nut (12) **(Figure 5-5, Page 5-3)**.
4. Pull the brake pedal toward the rear of the vehicle until the brake stop bumper (13) will not allow the pedal to travel any further **(Figure 5-6, Page 5-3)**.
5. Holding the brake pedal in this position, measure the distance from the back of the brake pedal to the floorboard. If it is between 5-3/8 inches (136.5 mm) and 5-7/8 inches (149.25 mm), proceed to step 7.

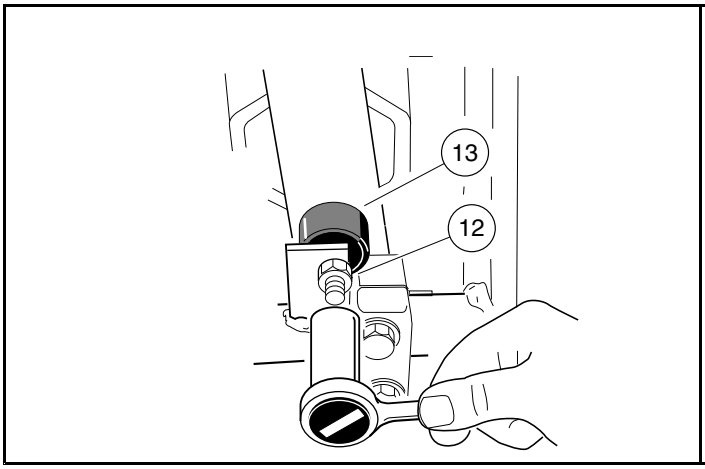

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Figure 5-5 Adjust Brake Pedal Height

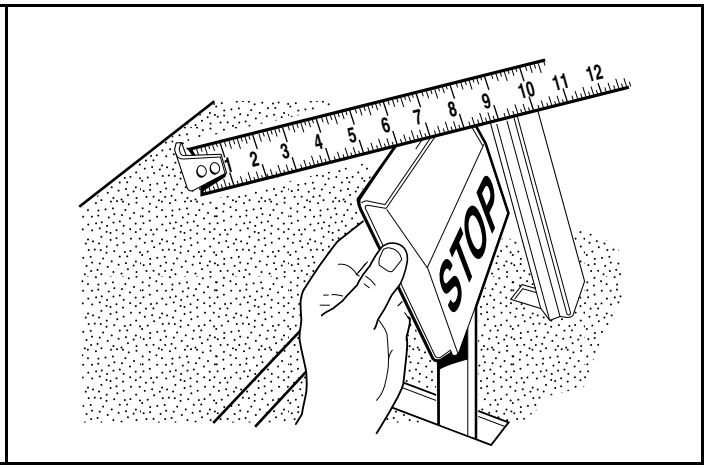

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Figure 5-6 Measure Brake Pedal Height

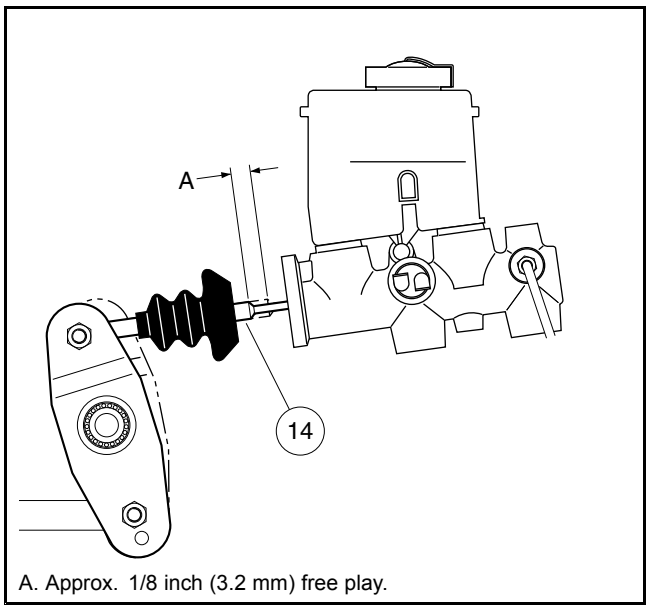
6. Adjust the brake stop bumper (13) down to increase the distance between the pedal and the floorboard or up to decrease the distance **(Figure 5-5, Page 5-3)**. Proper brake pedal height is 5-5/8 inches (±1/4) (142.875 mm (±6.35)) **(Figure 5-6, Page 5-3)**.
7. Tighten the jam nut (12) to 8 ft·lb (9.5 N·m) **(Figure 5-5, Page 5-3)**.
8. Adjust the linkage rod (10) by threading it in or out of the master cylinder clevis until the clevis pin (3) can be attached to the brake pedal assembly (1) **(Figure 5-2, Page 5-2)**. **See following NOTE.**

NOTE: *The spring (11) should not be under tension while the brake pedal is at rest.*

9. Install the bow tie locking pin (2).
10. There should be at least 1/8 inch (3.2 mm) of free play (at the push rod) before the push rod (14) begins to press the master cylinder piston **(Figure 5-7, Page 5-4)**. **See following NOTE.**

NOTE: *Brake pedal free play is the distance the push rod (14) travels before the master cylinder piston is pressed* ***(Figure 5-7, Page 5-4)****.*

11. Perform all brake system inspections to ensure that the hydraulic brake system is adjusted and operating correctly before placing the vehicle into service. **See Hydraulic Brake System Inspection on page 6-7.**



A. Approx. 1/8 inch (3.2 mm) free play.

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Figure 5-7 Push Rod Free Play

ACCELERATOR PEDAL

See General Warnings on page 1-1.

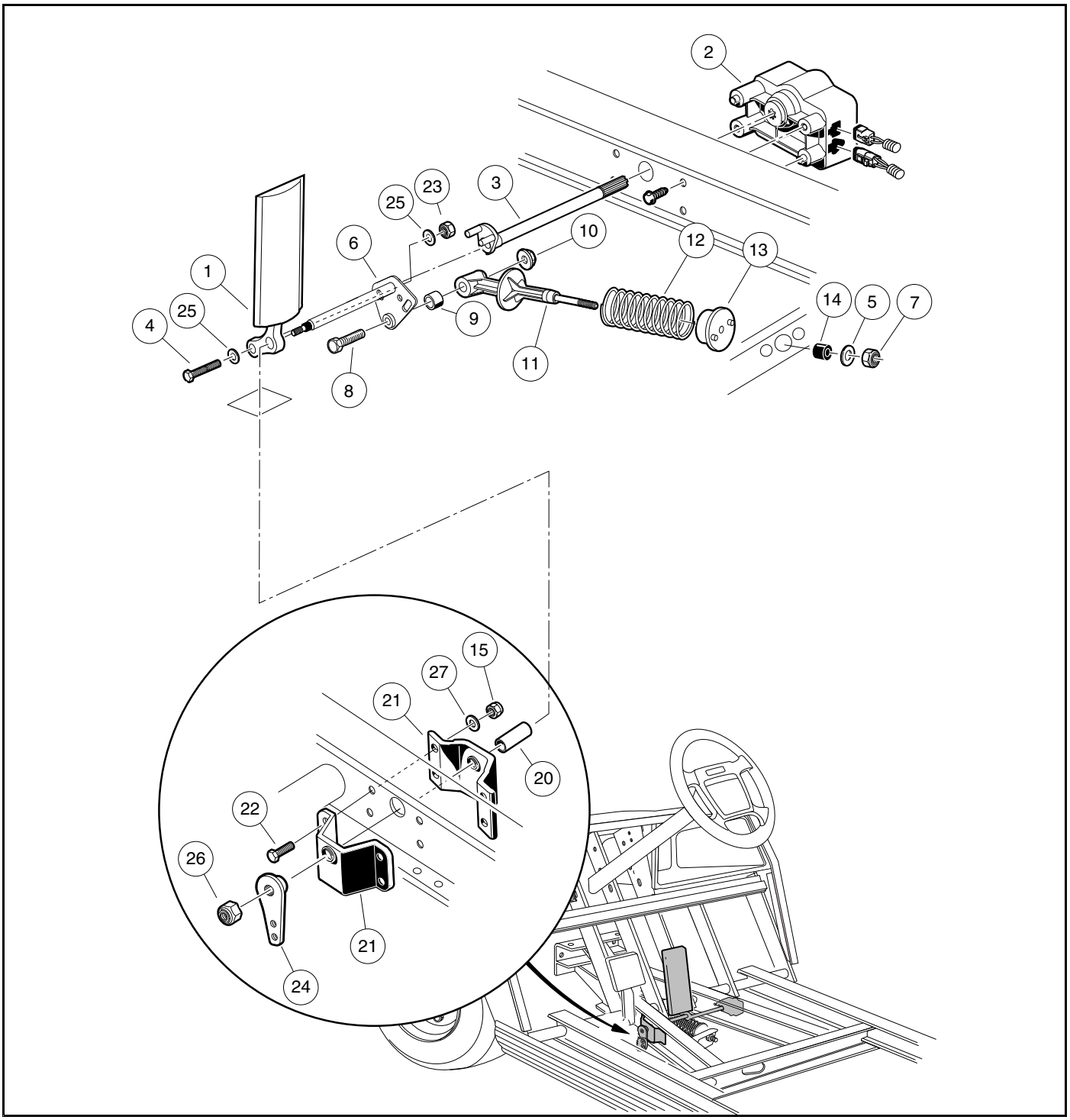

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Figure 5-8 Accelerator Pedal Assembly

ACCELERATOR PEDAL REMOVAL

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse switch in NEUTRAL. Chock the wheels.
2. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
3. Place chocks under the rear wheels and lift the front end of the vehicle with a chain hoist or floor jack. Place jack stands under the outer front I-beam of the vehicle frame and lower the vehicle onto the jack stands **(Figure 5-1, Page 5-2)**.
4. Remove the MCOR (2) and drive bar (3) as instructed **(Figure 5-8, Page 5-5)**. **See MCOR Removal on page 13-5.**
5. Use a 9/16-inch socket and 9/16-inch wrench and remove the nut (23), two washers (25), and bolt (4) securing the accelerator pedal (1) to the pivot rod (6) **(Figure 5-8, Page 5-5)**.
6. Remove the nut (10) and bolt (8) from the accelerator pivot rod (6).
7. Slide the spring retainer (11) off of the accelerator pivot rod (6).
8. Inspect the pivot support bearing (9), inside the spring retainer, for wear and replace if necessary.
9. Remove locknut (26) from the accelerator pivot rod (6).
10. Move the brake pedal slightly and then slide the spacer (24) toward end of accelerator pivot rod, releasing the splined fit between the two. Rotate the spacer (24) and remove from the pivot rod (6).
11. Loosen, but do not remove, the four bolts (22) and locknuts (15).
12. Slide the pivot rod (6) from the accelerator pivot rod supports (21), nylon spacer (20), and accelerator pedal (1). Remove both the pivot rod (6) and the accelerator pedal (1).

NOTE: *The accelerator will release to the top side of the floorboard.*

13. Inspect the accelerator pivot rod support bearings (21) and all parts for wear or damage and replace as necessary **(Figure 5-8, Page 5-5)**.

ACCELERATOR PEDAL INSTALLATION

NOTE: *The following procedure will be easier with the help of an additional person.*

1. If replaced, position the supports (21) on the vehicle frame and loosely install the four bolts (22), washers (27), and locknuts (15) and finger-tighten **(Figure 5-8, Page 5-5)**.
2. With another person, position accelerator pedal (1) through the floorboard and slide the accelerator pivot rod (6) through the upper hole in the pedal, through the nylon spacer (20), and through the two pivot rod supports (21).
3. Tighten bolts (22) to 75 in·lb (8.5 N·m).
4. Install spacer (24), aligning the splined parts, and tighten the nylon locknut (26) to 18 ft·lb (24.5 N·m).
5. Insert bolt (4) through a washer (25) and through the lower hole in the pedal, then through the adjacent slotted hole in the pivot rod (6). Attach the remaining washer (25) and nut (23). Finger-tighten nut. **See Accelerator Pedal Adjustment on page 5-7.**
6. Insert pivot support bearing (9) into spring retainer (11) and onto the boss of the pivot rod plate.
7. Install the bolt (8) through the pivot rod (6) and spring retainer (11). Secure these parts with the nut (10) tightened to 50 in·lb (5.5 N·m) **(Figure 5-8, Page 5-5)**.
8. Install the MCOR (2) and drive bar (3) as instructed. **See MCOR Installation on page 13-5.**
9. Adjust the pedal. **See Accelerator Pedal Adjustment on page 5-7.**
10. Connect the battery cables, positive (+) post first, and tighten terminals to 110 in·lb (12.4 N·m). Coat terminals with Battery Terminal Protector Spray.
11. Perform all of the brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

ACCELERATOR PEDAL ADJUSTMENT

See General Warnings on page 1-1.

1. Measure the distance from the top of the accelerator pedal to the floorboard. If it is within the range of 5-3/4 inches (±1/4) (14.6 cm (±6)) **(Figure 5-9, Page 5-7)**, adjusting the accelerator pedal is not necessary. Tighten the nylon locknut (23) to 26 ft·lb (35.3 N·m) **(Figure 5-8, Page 5-5)** and proceed to step 7. If adjustment is necessary, proceed to step 2.
2. Turn the key switch OFF and remove the key. Place the Forward/Reverse switch in NEUTRAL. Chock the wheels.
3. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
4. Loosen the nut and bolt securing the accelerator pedal to the pivot rod flange **(Figure 5-10, Page 5-7)**.
5. Use an accelerator pedal adjustment tool to make adjustment:

5.1. Clamp the accelerator pedal adjustment tool to the accelerator pedal, with the end marked accelerator pedal height closest to the floorboard **(Figure 5-11, Page 5-8)**.

5.2. Press the accelerator pedal until the end of the tool rests against the floorboard. Hold pedal in position against the floorboard with a rubber strap and tighten nut to 26 ft·lb (35.3 N·m).

6. Use a tape measure to make adjustment.

6.1. Adjust the distance from the floormat to the back of the accelerator pedal to be 5-3/4 inches (±1/4) (14.6 cm (±6)) **(Figure 5-9, Page 5-7)**. Tighten nut to 26 ft·lb (35.3 N·m) **(Figure 5-10, Page 5-7)**.

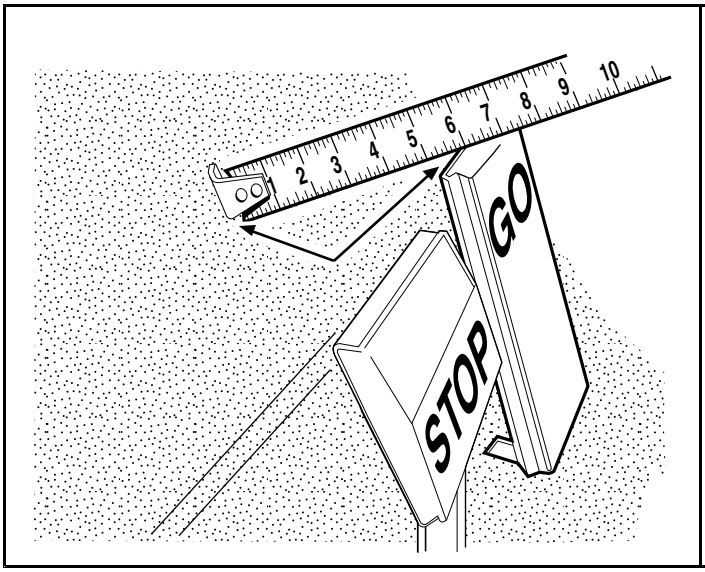

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Figure 5-9 Accelerator Pedal Height

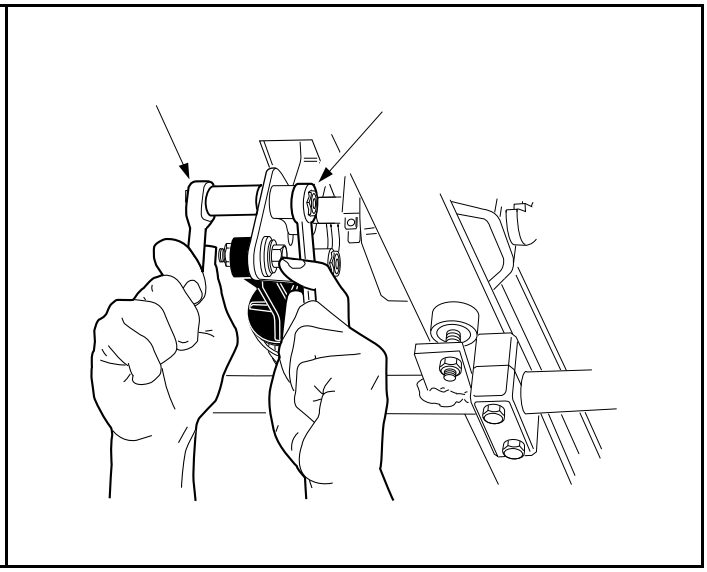

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Figure 5-10 Accelerator Pedal Adjustment

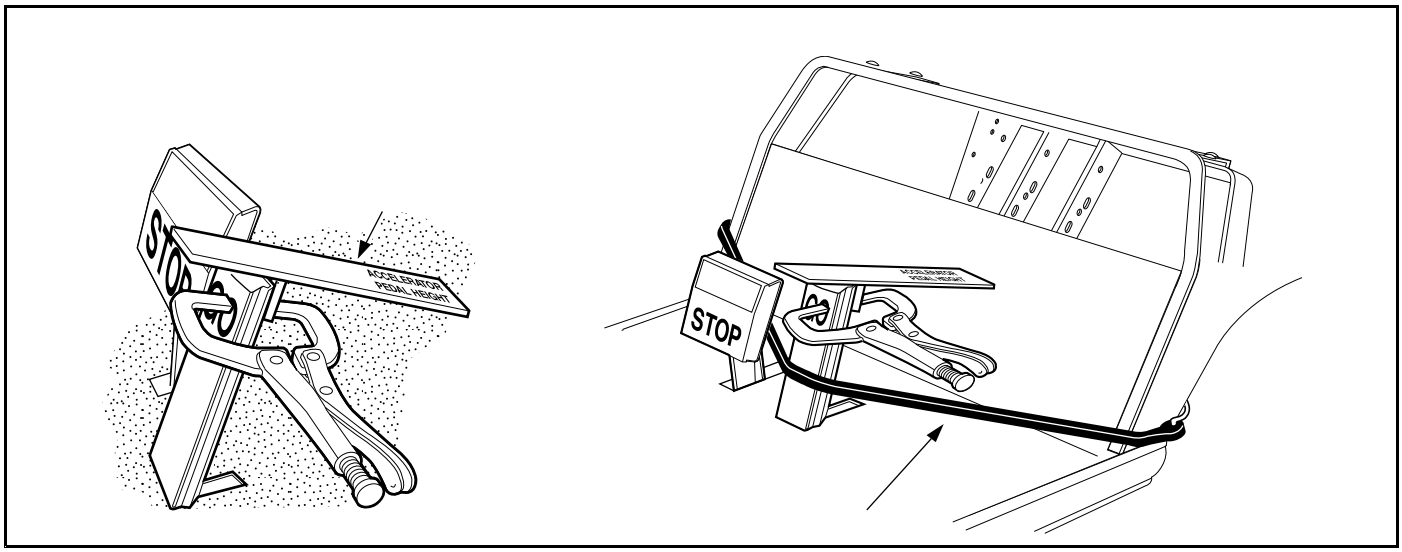

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Figure 5-11 Accelerator Pedal Height Adjustment

7. Connect the battery cables, positive (+) post first, and tighten terminals to 110 in·lb (12.4 N·m). Coat terminals with Battery Terminal Protector Spray.
8. Perform all of the brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

SECTION 6 — BRAKES

GENERAL INFORMATION

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**
- **To perform many of the following procedures, the hydraulic system must be opened. As a result, the brakes must be bled after the correct reinstallation of brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**
- **Prior to servicing hydraulic brakes, thoroughly clean the vehicle, paying particular attention to areas immediately surrounding hydraulic connections, to prevent dirt or debris from entering system.**

Asbestos Dust Warning

- **Some aftermarket brake shoes contain asbestos dust. 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.**

⚠ CAUTION

- **Do not pump the brake pedal without brake fluid in the master cylinder and reservoir.**
- **Worn or damaged brake drums cannot be machined to refinish them. Replace as necessary.**

This vehicle is equipped with self-adjusting, 4-wheel, hydraulic drum brakes at all four wheels with a hand-operated, mechanical park brake.

This section contains procedures for inspection, troubleshooting, removal, installation, maintenance, and regular servicing of the hydraulic brake system. In order to properly service and maintain this brake system, it is necessary to understand the hydraulic circuit and the functions of all components in the system. If any repair or servicing needs to be performed, we recommend that it be performed by an authorized Club Car distributor/dealer using Club Car OEM parts.

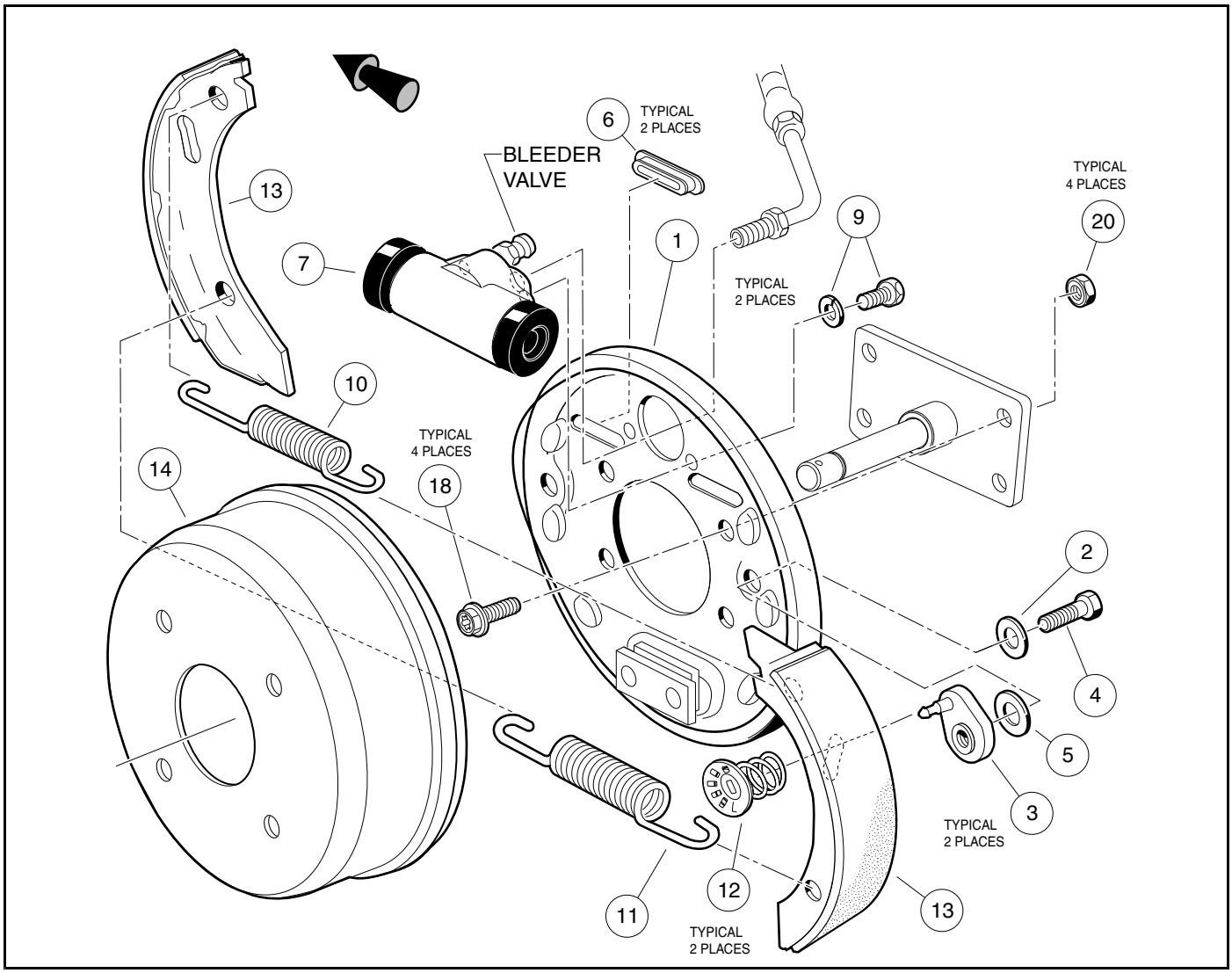

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Figure 6-1 Front Hydraulic Brake Assembly

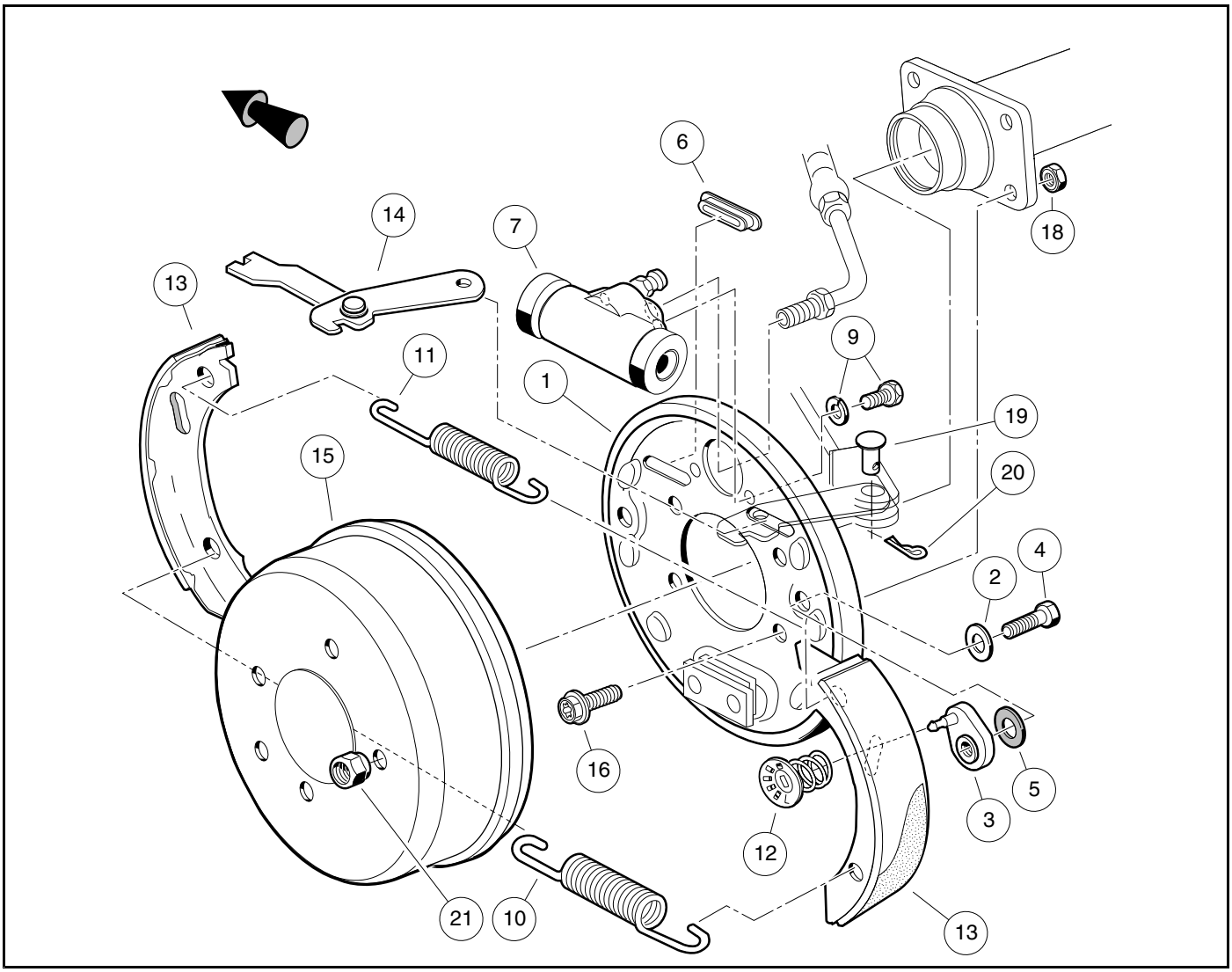

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Figure 6-2 Rear Hydraulic Brake Assembly

TROUBLESHOOTING

HYDRAULIC BRAKE SYSTEM TROUBLESHOOTING

The procedures used in making the checks provided in the following troubleshooting guide can be found in the referenced sections of this maintenance and service manual.

TROUBLESHOOTING GUIDE - HYDRAULIC SYSTEM COMPONENTS		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Low pedal – pedal may go to the floor	Excessive clearance between the drums and shoe linings	Rear - Perform step 4 of Brake Drum Installation on page 6-11.
	Automatic adjusters are not working	Make several forward and reverse brake stops; if the pedal does not come up, replace the automatic adjusters. **See Brake Shoe Adjuster Replacement on page 6-20.**
	Bent or warped brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Leak in the hydraulic system	Check the master cylinder, brake lines and hoses for leaks. Replace all damaged parts and bleed brake system.
	Air in the hydraulic system	**See Bleeding the Hydraulic Brake System on page 6-26.**
	Weak (bulging) brake line	Replace the worn hose. **See Brake Hose Replacement on page 6-21.**
	Improperly adjusted master cylinder push rod	**See Brake Pedal Adjustment on page 5-3.**
Springy or spongy brake pedal – brake pedal has soft, springy, or spongy feel when pressed	Cracked or thin drums	Replace brake drums. **See Brake Drum Removal on page 6-10.**
	Bent or warped brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Poor quality brake fluid or water in fluid	Purge hydraulic fluid and fill with approved DOT 5 (silicone) brake fluid. **See Bleeding the Hydraulic Brake System on page 6-26.**
	Weak (bulging) brake hoses that expand under pressure	Check the master cylinder, brake lines, and hoses for leaks or bulges. Replace all damaged parts.
	Air in the hydraulic system	**See Bleeding the Hydraulic Brake System on page 6-26.**

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE - HYDRAULIC SYSTEM COMPONENTS		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Hard pedal – excessive pedal pressure is required to stop the vehicle	Brake fade	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Grease or brake fluid on the brake shoe linings	Replace hub or axle seal and replace the brake shoes. **See Brake Shoes on page 6-12.**
	Glazed brake shoe linings	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Damaged or warped brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Scored or barrel-shaped brake drums	Replace the brake drums. **See Brake Drum Removal on page 6-10.**
	Clogged hydraulic lines	Replace brake lines as required. **See Brake Hose Replacement on page 6-21.**
	Frozen master cylinder piston or bent rod	Replace master cylinder. **See Master Cylinder Removal on page 6-24.**
Over-aggressive braking	Incorrect or warped brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Grease or brake fluid on the brake shoe linings	Replace hub, axle seal or wheel brake cylinder and replace brake shoes. **See Brake Shoes on page 6-12.**
	Loose or warped brake backing plate	Tighten or replace the back plate and/or hardware.
	Scored or warped brake drums	Replace the brake drums. **See Brake Drum Removal on page 6-10.**
	Corroded master cylinder bore	Replace master cylinder. **See Master Cylinder Removal on page 6-24.**
	Binding brake pedal linkage	Lubricate and adjust. **See Accelerator and Brake Pedal Group, Section 5, Page 5-1.**
Vehicle pulls to one side	Incorrect or warped brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Grease or brake fluid on the brake shoe linings	Replace hub, axle seal or wheel cylinder and replace the brake shoes. **See Brake Shoes on page 6-12.**
	Loose or warped brake backing plate	Tighten or replace the backing plate and/or hardware.
	Scored or warped brake drums	Replace the brake drums. **See Brake Drum Removal on page 6-10.**
	Sticking wheel cylinder piston	Replace the wheel cylinder. **See Wheel Cylinder Replacement on page 6-19.**
	Faulty suspension parts or alignment	**See Steering and Front Suspension Section or Rear Suspension Section.**

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE - HYDRAULIC SYSTEM COMPONENTS		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Pulsating brake pedal	Warped brake drums	Replace the brake drums. **See Brake Drum Removal on page 6-10.**
	Bent wheel	Replace the wheel.
	Bent axle	Replace the axle. **See Transaxle (Type G) Section.**
	Worn or damaged wheel bearings	Replace bearings. **See Steering and Front Suspension Section.**
Decreasing brake pedal travel	Weak or broken brake shoe return springs	Replace return springs.
	Sticking wheel cylinder piston	Replace the wheel cylinder. **See Wheel Cylinder Replacement on page 6-19.**
	Overly adjusted brake adjusters	Adjust brake adjusters. **See Brake Shoe Adjuster Replacement on page 6-20.**
	Improperly adjusted park brake	Adjust park brake. **See Park Brake Adjustment on page 6-31.**
Noise and chatter – squealing, clicking or scraping sound upon brake application	Bent, damaged or incorrect brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Worn out brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Foreign material embedded in brake shoe linings	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Brake drums are cracked or scored	Replace the brake drums. **See Brake Drum Removal on page 6-10.**
	Broken brake shoe return springs or hold down springs	Replace damaged parts.
	Rough, grooved or dry brake shoe edges or backing plate bosses	Lubricate the bosses of the brake backing plate, and/or replace the brake shoes. **See Drum Brake Assembly Inspection and Cleaning on page 6-15. See Brake Shoes on page 6-12.**
All brakes drag	Binding brake pedal	Lubricate and adjust. **See Accelerator and Brake Pedal Group Section.**
	Soft or swollen rubber parts caused by incorrect or contaminated brake fluid	Replace master cylinder. **See Master Cylinder Replacement on page 6-24.**
Rear brakes drag	Binding park brake handle or cables	Adjust or replace park brake handle or cables.
	Improper brake adjustment	Adjust shoes and repair the brake shoe adjusters if necessary. **See Drum Brake Assembly Inspection and Cleaning on page 6-15.**

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE - HYDRAULIC SYSTEM COMPONENTS		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
One brake drags	Weak or broken brake shoe return springs	Replace the return springs.
	Improper brake shoe adjustment	Adjust shoes and repair the brake shoe adjusters if necessary. **See Drum Brake Assembly Inspection and Cleaning on page 6-15.**
	Sticking wheel cylinder pistons	Replace the wheel cylinder. **See Wheel Cylinder Replacement on page 6-19.**
	Swollen wheel cylinder cups	Replace the wheel cylinder and purge the hydraulic system. **See Wheel Cylinder Replacement on page 6-19 and Refilling the Hydraulic System on page 6-28.**
	Bent or warped brake shoes	Replace the brake shoes. **See Brake Shoes on page 6-12.**
	Loose or worn front wheel bearings	Adjust or replace front wheel bearings. **See Steering and Front Suspension Section.**
	Damaged hydraulic hose	Replace brake hoses as required. **See Brake Hose Replacement on page 6-21.**

HYDRAULIC BRAKE SYSTEM INSPECTION

See General Warnings on page 1-1.

The hydraulic brake system and park brake system should be inspected immediately after any service to either of the brake systems.

Brake Pedal Inspection

- When the brakes are applied during vehicle operation, the vehicle should come to a smooth, straight stop. If the vehicle swerves or fails to stop as quickly as it should, have the brake system checked and adjusted as required.
- Apply and release the brake pedal several times. If noise or binding occurs, the brake pedal or hydraulic brake system may require service. Pedal movement should be smooth, and when the pedal is released, it should return quickly and quietly.
- Move the brake pedal from side to side to check for worn parts. Excessive side movement indicates loose or worn pedal mounting parts. If worn parts are found, replace the worn parts and adjust the brake pedal. **See Brake Pedal Adjustment on page 5-3.**
- Apply heavy pressure to the pedal and check for sponginess and excessive pedal travel. The pedal should be firm and the back of the pedal should be a minimum of 2 inches (5.08 cm) from the floor. Brake adjustment must be maintained so the brake pedal cannot be pressed to the floorboard under any circumstance. If the brake pedal feels “spongy,” perform the brake bleeding procedure. **See Bleeding the Hydraulic Brake System on page 6-26.**
- Hold the brake pedal down with medium foot pressure (25 to 35 lb. (11.3 to 15.9 kg)) for 15 seconds. The pedal should not continue dropping when pressed with a steady amount of pressure. If the pedal goes to the floor, inspect the hydraulic system for leaks and repair any worn or damaged components. After repair, bleed the hydraulic brake system. **See Bleeding the Hydraulic Brake System on page 6-26.**

Master Cylinder Inspection

- Inspect the exterior of the master cylinder (1). Replace any leaking components and bleed the hydraulic brake system. **See Bleeding the Hydraulic Brake System on page 6-26.**
- Check the brake fluid level. **See Brake Fluid Level on page 6-9.**

- Remove the reservoir cap and inspect the brake fluid. If the brake fluid is contaminated, purge the brake fluid and refill the hydraulic system. **See Bleeding the Hydraulic Brake System on page 6-26.**
- Check the vent holes in the reservoir cap and clean or replace as necessary.
- Check the diaphragm inside the reservoir cap and replace if damaged.

Brake Hose Inspection

- Inspect the brake lines and fittings for leakage. They must be flexible and free of leaks, cuts, cracks or bulges. Replace as needed. **See Brake Hose Replacement on page 6-21.**
- Turn the steering wheel all the way from left to right and back again. Contact between the brake hoses and any other components, especially the wheels or tires, will damage the brake hoses.
- Check the back side of each brake drum assembly backing plate for signs of brake fluid leakage. If there is evidence of leakage, determine the cause and repair or replace as needed. **See Wheel Cylinder Replacement on page 6-19. Also see Brake Hose Replacement on page 6-21.**

Park Brake Inspection

- Apply moderate pressure to the park brake handle. When latched, the park brake should lock the wheels and hold the vehicle stationary (on incline of 20% or less). If not, adjust the park brake. **See Park Brake Adjustment on page 6-31.**
- Check the park brake cables, equalizer and linkage for damage. The cables should not come in contact with either of the rear wheels or tires.

Brake Drum and Shoe Inspection

- Remove and inspect each brake drum. The drum should not be cracked, warped or have excessive scores or heat checks.
- Inspect the brake shoes. Shoes should not be warped, cracked or have broken welds.
- Check the condition of the brake shoe linings. The brake shoe lining should not be glazed or soiled with grease or brake fluid. There should be a minimum of 1/32-inch (0.8 mm) of usable lining remaining at the thinnest point.

⚠ WARNING

- **Use only approved replacement brake drums designed for your vehicle.**

Brake Assembly Inspection

- Check each wheel cylinder by pulling back the edge of each dust boot **(Figure 6-2, Page 6-3)**. Brake fluid in the boot indicates a leaking wheel cylinder and should be replaced. **See Wheel Cylinder Replacement on page 6-19.**
- Inspect the shoe hold-down parts and springs. Replace damaged items.
- If the brake adjusters (3) are frozen (requiring more than 65 in·lb (7.4 N·m) to turn freely), worn or loose, replace the adjuster assemblies in pairs **(Figure 6-4, Page 6-10)**. **See Brake Shoe Adjuster Replacement, Section 6, Page 6-20.**

BRAKE FLUID LEVEL

The master cylinder is located under the front seat **(Figure 6-3, Page 6-9)**. Raise or remove the seat to check the brake fluid level.

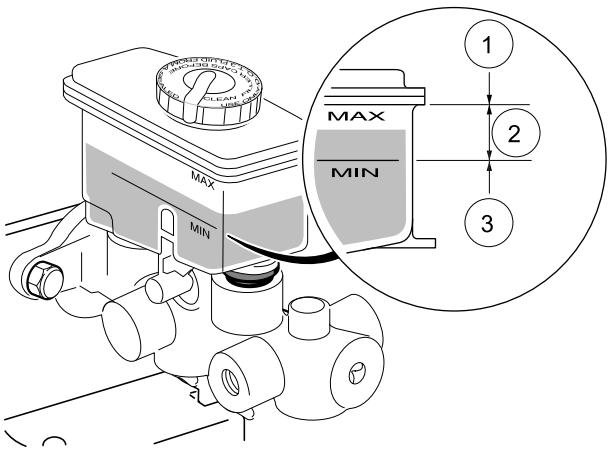
When checking the brake fluid, also inspect the following:

- The presence of brake fluid on the exterior surface of the master cylinder indicates a leak.
- The vent holes in the reservoir cover should be clean and open.
- The reservoir diaphragm should not have holes or other damage.

Brake fluid level should be within 1/4-inch (6 mm) from top of reservoir **(Figure 6-3, Page 6-9)**. Also, brake fluid should be clean with no residue in bottom of reservoir or other evidence of contamination. **See following CAUTION.**

⚠ CAUTION

- **Use only DOT–5 (silicone) brake fluid. Use of any other type brake fluid is not recommended.**



1. Full Level 2. Safe Level 3. Low Level

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Figure 6-3 Brake Fluid Reservoir

BRAKE DRUMS

See General Warnings on page 1-1.

BRAKE DRUM REMOVAL

⚠ WARNING

- **If at any point in this procedure the hydraulic system is opened, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**
- **Worn or damaged brake drums cannot be machined. Replace as necessary.**
- **Use only approved replacement brake drums designed for this vehicle.**

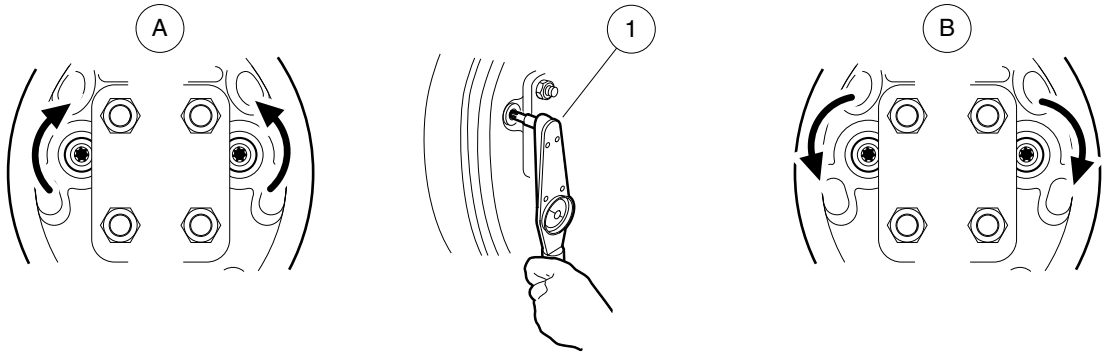
1. Chock tires and loosen lug nuts.
2. Lift vehicle and support on jack stands. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
3. Remove lug nuts and wheel.
4. Pull brake drum straight off brake shoes and hub. If brake drum is difficult to remove, proceed to next step.
5. To remove difficult brake drum:

5.1. Locate the bolt heads of the two brake shoe adjusters on the backing plate.

5.2. Use a torque wrench and a Torx #T-27 driver, or hydraulic brake adjuster, to gently rotate the adjuster bolts and increase the clearance between the brake shoe lining and the brake drum **(Figure 6-4, Page 6-10)**. **See following NOTE.**

NOTE: *If the adjusters require more than 65 in·lb (7.3 N·m) of force to rotate, they must be replaced.* ***See Brake Shoe Adjuster Replacement on page 6-20.***

5.3. While pulling, rotate brake drum back and forth to aid removal.



1. Torque Wrench with Torx #T-27 Driver

A. Rotate adjuster bolts this direction to loosen brake shoes

B. Rotate adjuster bolts this direction to tighten brake shoes

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Figure 6-4 Loosen or Tighten Brake Adjusters

BRAKE DRUM INSTALLATION

NOTE: *Prior to installing the brake drum, inspect the brake lines, hoses, drums and brake assemblies.* ***See Hydraulic Brake System Inspection on page 6-7. See following WARNING.***

⚠ WARNING

- **Use only approved replacement brake drums designed for this vehicle.**

1. Place brake drum (15) over brake shoes and onto hub **(Figure 6-2, Page 6-3)**. **See following NOTE.**

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

2. Use a torque wrench and a Torx #T-27 driver, or hydraulic brake adjuster, and gently rotate the adjuster bolts to increase the clearance between the brake shoe lining and the brake drum **(Figure 6-4, Page 6-10)**. **See following NOTE.**

NOTE: *If the adjusters require more than 65 in·lb (7.3 N·m) of force to rotate, they must be replaced.* ***See Brake Shoe Adjuster Replacement on page 6-20.***

3. Rotate and gently press the brake drum to ensure that the drum is properly seated.
4. With the brake drum properly seated and secured, gently adjust the clearance between the brake shoe lining and brake drum **(Figure 6-4, Page 6-10)**. **See following CAUTION.**

⚠ CAUTION

- **Do not apply more than 65 in·lb (7.3 N·m) of torque to any of the adjuster bolts. Over-tightening the adjuster bolts could result in damage to the brake assembly components or the separation of the bolt (4) from the adjuster (3) (Figure 6-2, Page 6-3).**

5. Install wheel and finger-tighten lug nuts.
6. Lower vehicle and finish tightening lug nuts using a crisscross pattern. **See Wheel Installation on page 8-1.**
7. Perform all of the brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

BRAKE SHOES

See General Warnings on page 1-1.

⚠ WARNING

- **If at any point in this procedure the hydraulic system is opened, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**

BRAKE SHOE REMOVAL

1. Remove the brake drum. **See Brake Drum Removal on page 6-10.**
2. **For front brakes:** Remove wheel hub. **See Front Hub and Wheel Bearings Removal, Section 7, Page 7-17.**.

   For rear brakes: Remove axle shaft. **See Axle Shaft and Oil Seal Removal, Section 17, Page 17-1.**
3. Use pliers or a brake tool to rotate the cup washer and compression spring assembly 90° and remove the cup and spring from each brake shoe **(Figure 6-5, Page 6-12)**. **See following NOTE.**

NOTE: *The brake shoes are under spring tension and can release suddenly when cup and spring assemblies are removed.*

4. Pull brake shoes and tensioning springs from the brake assembly **(Figure 6-6, Page 6-12)**.
5. Repeat steps for opposite brake if replacing brake shoes.

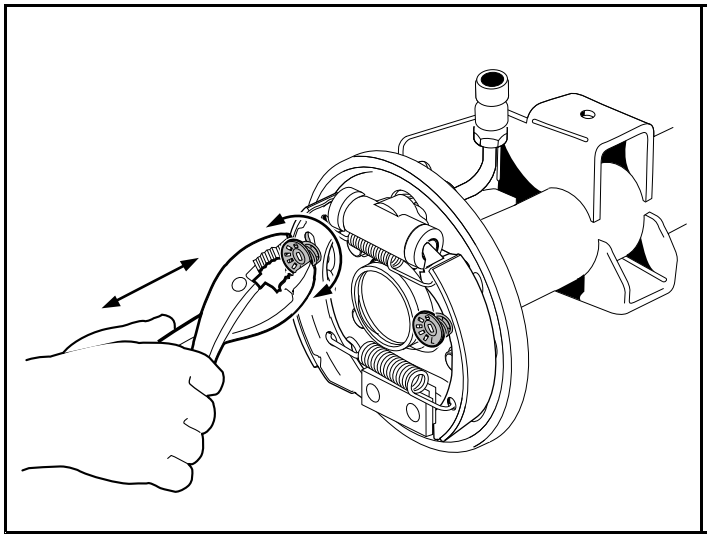

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Figure 6-5 Rotate Rear Spring Cups

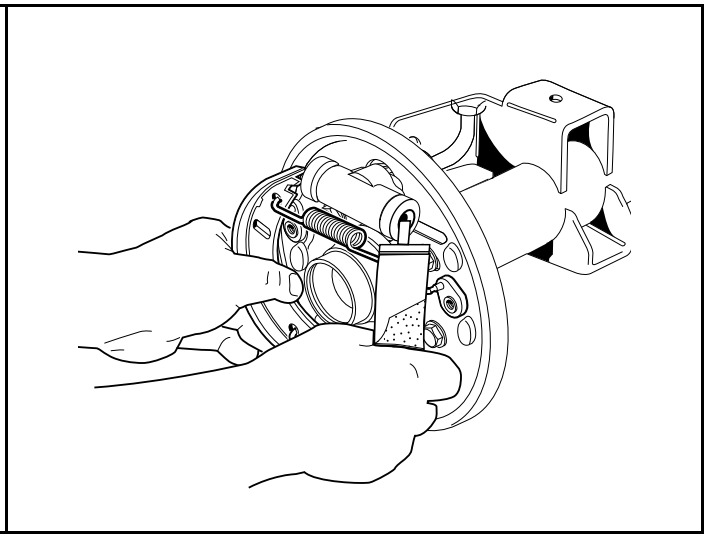

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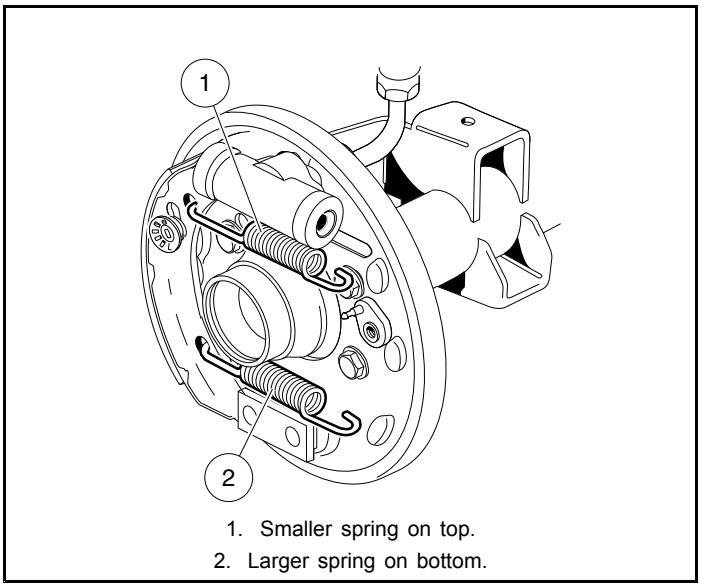
Figure 6-6 Remove Brake Shoes



1. Smaller spring on top.
2. Larger spring on bottom.

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Figure 6-7 Brake Shoe Tensioning Springs

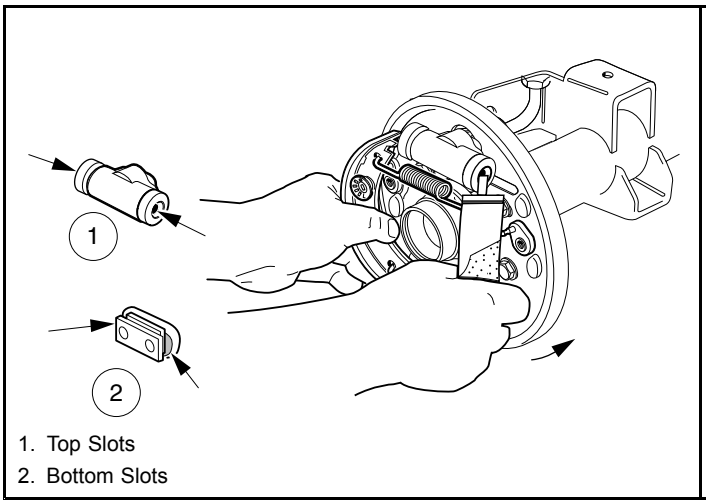
BRAKE SHOE INSTALLATION

⚠ WARNING

- **If at any point in this procedure the hydraulic system is opened, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26. See following NOTE.**

NOTE: *This vehicle uses a pair of identical brake shoes in each brake assembly. Each shoe must be positioned so that the adjuster pin is inserted into the slot of the brake shoe* ***(Figure 6-8, Page 6-14)****.*

1. Install one shoe onto the backing plate, positioning the bottom tip of the shoe into the brake shoe mounting block, and the top tip into the wheel cylinder piston.
2. Compress the spring with the cup washer (12) onto the pin of the adjuster assembly (3) **(Figure 6-2, Page 6-3)** and rotate 90° to secure the brake shoe **(Figure 6-5, Page 6-12)**.
3. Attach the tensioning springs onto the shoe with the smaller spring on top and the larger spring on the bottom **(Figure 6-7, Page 6-13)**.
4. Position the bottom tip of the remaining shoe into the mounting block and the top tip into the slot in the wheel cylinder piston. Attach the free ends of the tensioning springs to the loose shoe and push the shoe into place **(Figure 6-8, Page 6-14)**.
5. Compress the remaining spring and cup washer (12) onto the pin of the adjuster (3) **(Figure 6-2, Page 6-3)** and rotate 90° to secure the brake shoe **(Figure 6-5, Page 6-12)**.
6. After installation, move brake shoes up and down to make sure that they will slide easily approximately 1/4 to 3/8-inch (6.3 to 9.5 mm) without binding **(Figure 6-9, Page 6-14)**.



1. Top Slots
2. Bottom Slots

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Figure 6-8 Brake Shoe Installation

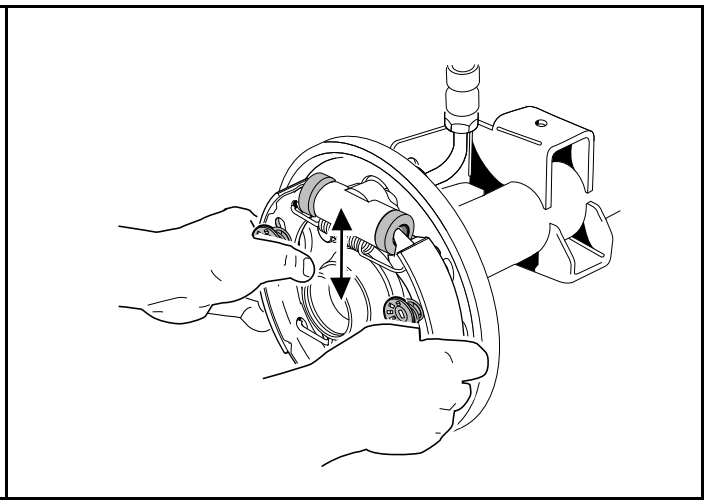

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Figure 6-9 Slide Brake Shoes

7. Repeat steps for opposite brake if replacing brake shoes.
8. **For front brakes:** Install wheel hub. **See Front Hub and Wheel Bearings Installation, Section 7, Page 7-18.**

   For rear brakes: Install axle shaft. **See Axle Shaft and Oil Seal Installation, Section 17, Page 17-4.**
9. Install brake drum(s). **See Brake Drum Installation on page 6-11.**
10. Perform all of the brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

DRUM BRAKE ASSEMBLY INSPECTION AND CLEANING

See General Warnings on page 1-1.

⚠ WARNING

- **If at any point in this procedure the hydraulic system is opened, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**

NOTE: *Factory installed brake shoes have non-asbestos linings. When replacing brake shoes, Club Car, Inc. recommends non-asbestos replacement parts.*

1. Remove brake drum. **See Brake Drum Removal on page 6-10.**
2. Remove brake shoes. **See Brake Shoe Removal on page 6-12.**
3. Clean backing plate and all brake assembly components.
4. Check brake shoe adjusters for proper operation.

4.1. Locate the bolt heads of the two brake shoe adjusters on the back of each brake assembly.

4.2. Use a torque wrench and a Torx #T-27 driver, or hydraulic brake adjuster, and gently rotate the adjuster bolts **(Figure 6-4, Page 6-10)**. **See following NOTE.**

NOTE: *If the adjusters require more than 65 in·lb (7.3 N·m) of force to rotate, they must be replaced.* ***See Brake Shoe Adjuster Replacement on page 6-20.***

5. Check the wheel cylinder for signs of fluid leakage and replace if necessary. **See Wheel Cylinder Replacement on page 6-19.**
6. Check all springs for loss of compression, tension, or damage and replace if necessary.
7. Check backing plate for signs of excessive wear or damage and replace if necessary. **See Drum Brake Assembly Replacement on page 6-17.**
8. Brush a light coat of white lithium NLGI Number 2 grease (Dow Corning BR2-Plus or equivalent) on each of the six raised bosses on the backing plate **(Figure 6-10, Page 6-16)**. **See following WARNING.**

⚠ WARNING

- **Apply grease carefully when performing the following steps. Do not allow any grease to get on the friction surfaces of the brake shoes. Failure to heed this warning could cause diminished brake performance, possibly resulting in property damage or severe personal injury.**

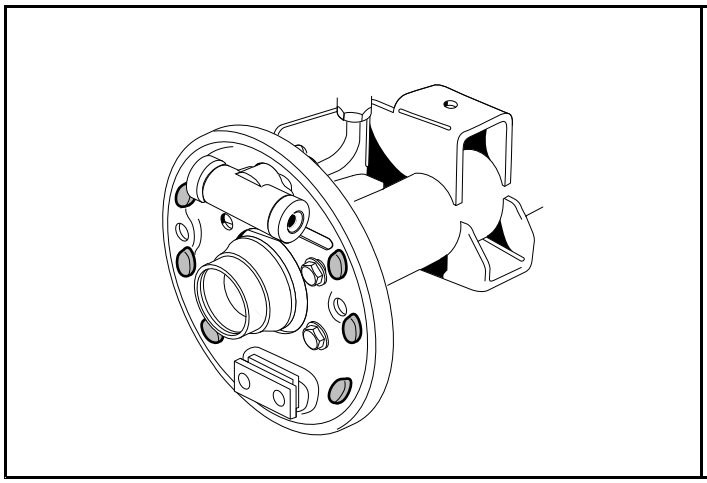

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Figure 6-10 Lubricate Raised Bosses

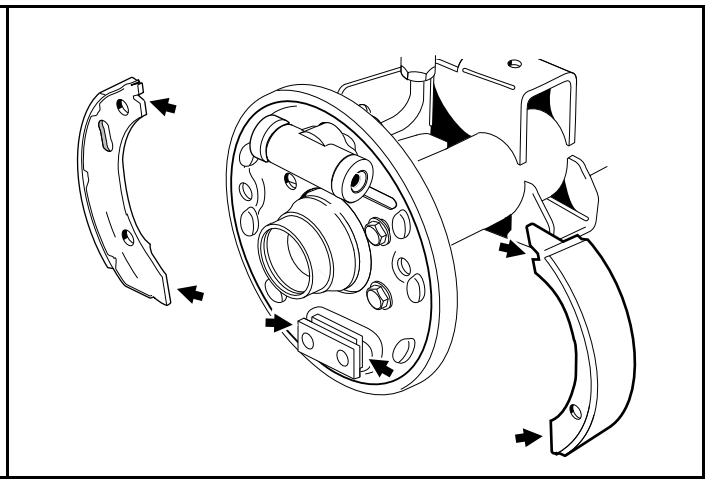

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Figure 6-11 Lubricate Rear Brake Shoe Contact Points

9. Brush a light coat of white lithium NLGI Number 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 **(Figure 6-11, Page 6-16)**. **See preceding WARNING.**
10. Repeat steps for opposite side brake assembly.

DRUM BRAKE ASSEMBLY REPLACEMENT

See General Warnings on page 1-1.

⚠ WARNING

- **To perform this procedure, the hydraulic system must be opened. As a result, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**
- **Worn or damaged brake drums must not be machined. Replace as necessary.**
- **Use only approved replacement brake drums designed for this vehicle.**

DRUM BRAKE ASSEMBLY REMOVAL

1. Remove brake drum. **See Brake Drum Removal on page 6-10.**
2. Remove brake shoes. **See Brake Shoe Removal on page 6-12.**
3. Disconnect park brake cable clevis from wheel brake lever by removing clevis pin (13) and bow tie locking pin (12) **(Figure 6-17, Page 6-29)**.
4. Disconnect brake hose (3) from back of wheel cylinder **(Figure 6-12, Page 6-17)**. **See following NOTE.**

NOTE: *Place a pan under each drum brake assembly to collect the brake fluid.*

Plug each wheel cylinder to prevent debris from entering. Do not allow brake fluid to contact the brake shoes and drum.

5. Place a plastic bag (4) over the hose fitting to keep dirt and debris from entering the hydraulic braking system and secure the hose to the chassis with a wire tie (5) **(Figure 6-13, Page 6-17)**.
6. Use a Torx #T-40 driver and remove the four Torx-head bolts (16), washers (17), and locknuts (18) that secure the backing plate to the axle tube flange **(Figure 6-2, Page 6-3)**.
7. Repeat steps for opposite side if necessary.

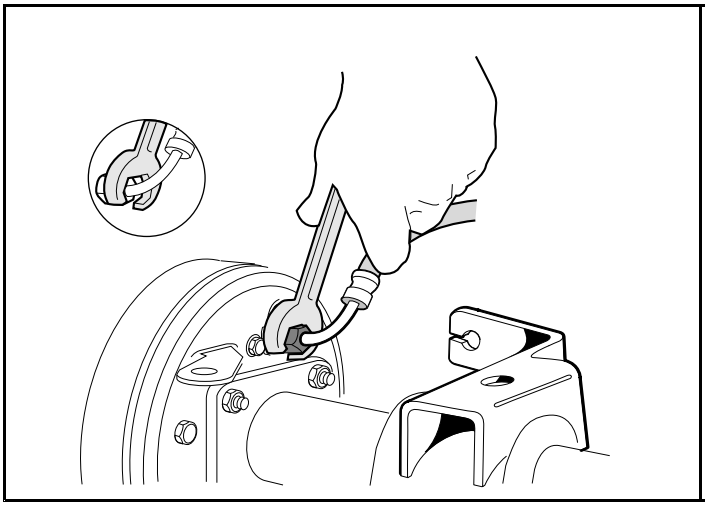

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Figure 6-12 Rear Brake Hose Connection

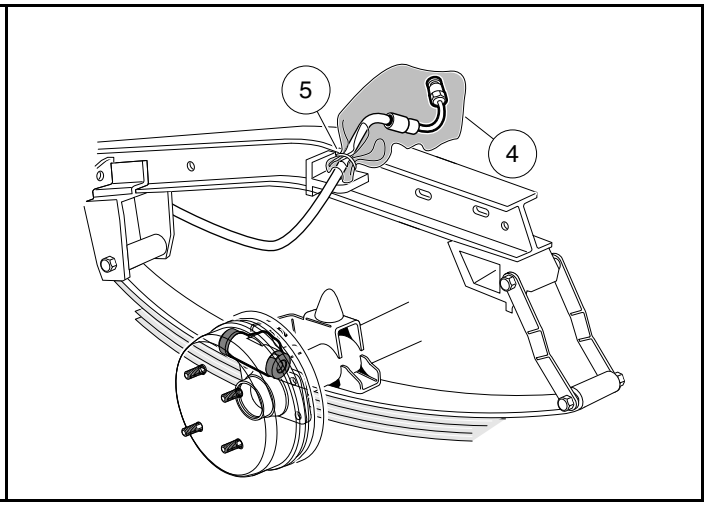

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Figure 6-13 Rear Brake Hose With Plastic Bag

DRUM BRAKE ASSEMBLY INSTALLATION

1. Install the backing plate to the axle tube flange with four new Torx-head bolts (16), washers (17), and locknuts (18) **(Figure 6-2, Page 6-3)**. **See following CAUTION.**

   For front brakes: Tighten all four Torx-head bolts to 24 ft·lb (32.5 N·m).

   For rear brakes: Tighten all four locknuts to 17 ft·lb (23 N·m).

⚠ CAUTION

- **Do not substitute the Torx-head bolts for ordinary hex-head bolts. The Torx-head bolts have a tapered shoulder that is required for proper installation.**

2. Secure brake hose (3) to wheel cylinder **(Figure 6-12, Page 6-17)**. Tighten flare nut fitting to 159 in·lb (18 N·m).
3. Install brake shoes. **See Brake Shoe Installation on page 6-13.**
4. Install brake drum. **See Brake Drum Installation on page 6-11.**
5. Connect park brake cable clevis to wheel brake lever using clevis pin (13) and bow tie locking pin (12) **(Figure 6-17, Page 6-29)**.
6. Repeat steps for opposite side if necessary.
7. Bleed brake system. **See Bleeding the Hydraulic Brake System on page 6-26.**
8. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

WHEEL CYLINDER REPLACEMENT

See General Warnings on page 1-1.

⚠ WARNING

- **To perform this procedure, the hydraulic system must be opened. As a result, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**

WHEEL CYLINDER REMOVAL

1. Remove brake drum. **See Brake Drum Removal on page 6-10.**
2. Remove brake shoes. **See Brake Shoe Removal on page 6-12.**
3. Disconnect brake hose (3) from back of wheel cylinder **(Figure 6-12, Page 6-17)**. **See following NOTE.**

NOTE: *Place a pan under each drum brake assembly to collect the brake fluid.*

Plug each wheel cylinder to prevent debris from entering. Do not allow brake fluid to contact the brake shoes and drum.

4. Place a plastic bag (4) over the hose fitting to keep dirt and debris from entering the hydraulic braking system and secure the hose to the chassis with a wire tie (5) **(Figure 6-13, Page 6-17)**.
5. Remove two bolts (9) and lockwashers that secure wheel cylinder (7) to backing plate (1) and remove cylinder **(Figure 6-2, Page 6-3)**.
6. Repeat steps for opposite side if necessary.

WHEEL CYLINDER INSTALLATION

1. Install wheel cylinder (7) with two new bolts (9) and lockwashers and tighten the two bolts to 120 in·lb (13 N·m).
2. Secure brake hose (3) to wheel cylinder **(Figure 6-12, Page 6-17)**. Tighten flare nut fitting to 159 in·lb (18 N·m).
3. Install brake shoes. **See Brake Shoe Installation on page 6-13.**
4. Install brake drum. **See Brake Drum Installation on page 6-11.**
5. Repeat steps for opposite side if necessary.
6. Bleed brake system. **See Bleeding the Hydraulic Brake System on page 6-26.**
7. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

BRAKE SHOE ADJUSTER REPLACEMENT

See General Warnings on page 1-1.

⚠ WARNING

- **If at any point in this procedure the hydraulic system is opened, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**

BRAKE SHOE ADJUSTER REMOVAL

1. Remove brake drum. **See Brake Drum Removal on page 6-10.**
2. Remove brake shoes. **See Brake Shoe Removal on page 6-12.**
3. Grip adjuster arm (3) with a pair of locking pliers and use a Torx #T-27 driver, or 7/16-inch socket to remove the bolt (4), flat washer (2) and Bellville washer (5) from the backing plate (1) **(Figure 6-2, Page 6-3)**. Remove remaining adjuster and discard all adjuster components (2, 3, 4, and 5) for both assemblies.
4. Clean the backing plate surfaces that contact the adjusters.
5. Repeat steps for opposite side if necessary.

BRAKE SHOE ADJUSTER INSTALLATION

NOTE: *The adjusters must be replaced as pairs using new hardware.*

1. Install bolt (4) and flat washer (2) to the backing plate (1) **(Figure 6-2, Page 6-3)**.
2. Apply a light coat of grease to the Bellville washer (5) and install the washer onto the bolt (4) and against the inside surface of the back plate (1).
3. Carefully apply Loctite 222 to the threaded portion of bolt (4) and attach the adjuster arm (3). Position adjuster so that the brake mounting post is to the top of the back plate.
4. Grip adjuster arm (3) with a pair of locking pliers and tighten the bolt (4) to 115 in·lb (13 N·m).
5. Repeat steps for the remaining adjuster.
6. Install brake shoes. **See Brake Shoe Installation on page 6-13.**
7. Install brake drum. **See Brake Drum Installation on page 6-11.**
8. Repeat steps for opposite side if necessary.
9. Bleed brake system. **See Bleeding the Hydraulic Brake System on page 6-26.**
10. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

BRAKE HOSE REPLACEMENT

See General Warnings on page 1-1.

NOTE: *The brake hoses are provided as assemblies without separating unions other than those at the wheels and master cylinder.*

FRONT BRAKE HOSE REMOVAL

NOTE: *If any portion of the brake hose is damaged, the entire hose assembly must be replaced.*

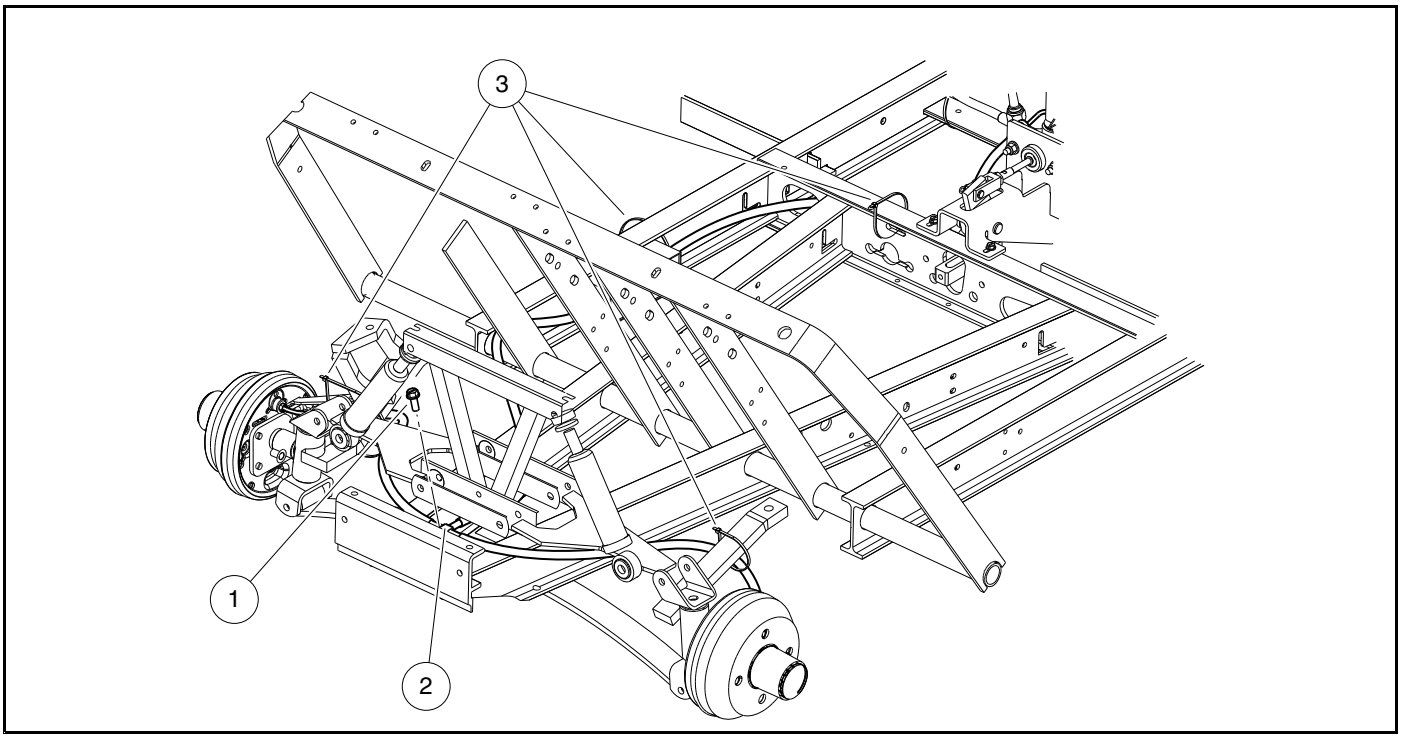

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Figure 6-14 Front Brake Hose Tee and Hose Routing

1. Chock rear tires.
2. Remove seat(s).
3. Use a flare-nut wrench to disconnect front brake hose at master cylinder. **See following NOTE.**

NOTE: *Place a plastic bag around master cylinder to catch brake fluid before brake hose is removed. Once hose is removed, wrap bag around master cylinder to prevent debris from entering brake hose port.*

4. Disconnect front brake hose, using a 3/8 inch wrench, from each front drum brake assembly **(Figure 6-15, Page 6-23)**. **See following NOTE.**

NOTE: *Place a pan under each drum brake assembly to collect brake fluid.*

Plug each wheel cylinder to prevent debris from entering. Do not allow brake fluid to contact brake shoes or drum.

5. Remove bolt (1) securing hose tee (2) to chassis **(Figure 6-14, Page 6-21)**.
6. Cut wire ties (3) securing front brake hose to chassis.

7. Note routing of brake hose assembly for installation. Then, pull hose assembly out the front of the vehicle to remove.

FRONT BRAKE HOSE INSTALLATION

1. Feed new front brake hose assembly through the front of the vehicle and up to the master cylinder following the same route as before.
2. Carefully insert flared end of brake hose into master cylinder and tighten fitting to 159 in·lb (18 N·m).
3. Secure hose tee (2) to chassis and tighten bolt (1) to 123 in·lb (14 N·m) **(Figure 6-14, Page 6-21)**.
4. At original locations, secure front brake hose assembly to chassis with new wire ties.
5. Secure brake hoses to each wheel cylinder. Tighten flare nut fitting to 159 in·lb (18 N·m).
6. Fill master cylinder reservoir and bleed hydraulic system. **See Bleeding the Hydraulic Brake System on page 6-26. See following WARNING.**

⚠ WARNING

- **Ensure hydraulic hoses cannot contact any moving parts that will cause wear and damage.**

7. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7. See preceding WARNING.**
8. Install seat(s).

REAR BRAKE HOSE REMOVAL

NOTE: *If any portion of the brake hose is damaged, the entire hose assembly must be replaced.*

1. Chock front tires.
2. Remove seat(s).
3. Disconnect wires from pressure switch (10) **(Figure 6-16, Page 6-24)**.
4. Use a flare-nut wrench to disconnect rear brake hose at master cylinder. **See following NOTE.**

NOTE: *Place a plastic bag around master cylinder to catch brake fluid before brake hose is removed. Once hose is removed, wrap bag around master cylinder to prevent debris from entering brake hose port.*

5. Disconnect rear brake hose, using a 3/8 inch wrench, from each rear drum brake assembly **(Figure 6-15, Page 6-23)**. **See following NOTE.**

NOTE: *Place a pan under each drum brake assembly to collect brake fluid.*

Plug each wheel cylinder to prevent debris from entering. Do not allow brake fluid to contact brake shoes or drum.

6. Cut wire ties (7) securing rear brake hose(s) to chassis.
7. Note routing of brake hose assembly for installation. Then, pull hose assembly out the rear of the vehicle to remove.

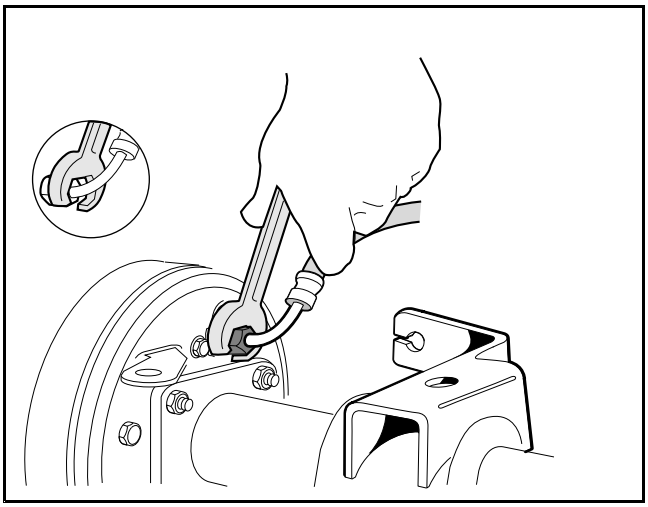

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Figure 6-15 Rear Brake Hose Flare Nut

REAR BRAKE HOSE INSTALLATION

1. Feed new rear brake hose assembly from the rear of the vehicle and up to the master cylinder following the same route as before.
2. Carefully insert flared end of brake hose into master cylinder and tighten fitting to 159 in·lb (18 N·m).
3. At original locations, secure rear brake hose assembly to chassis with new wire ties.
4. Secure brake hoses to each wheel cylinder. Tighten flare nut fitting to 159 in·lb (18 N·m).
5. Connect wires to pressure switch (10) **(Figure 6-16, Page 6-24)**.
6. Fill master cylinder reservoir and bleed hydraulic system. **See Bleeding the Hydraulic Brake System on page 6-26. See following WARNING.**

⚠ WARNING

- **Ensure hydraulic hoses cannot contact any moving parts that will cause wear and damage.**

7. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7. See preceding WARNING.**
8. Install seat(s).

MASTER CYLINDER REPLACEMENT

See General Warnings on page 1-1.

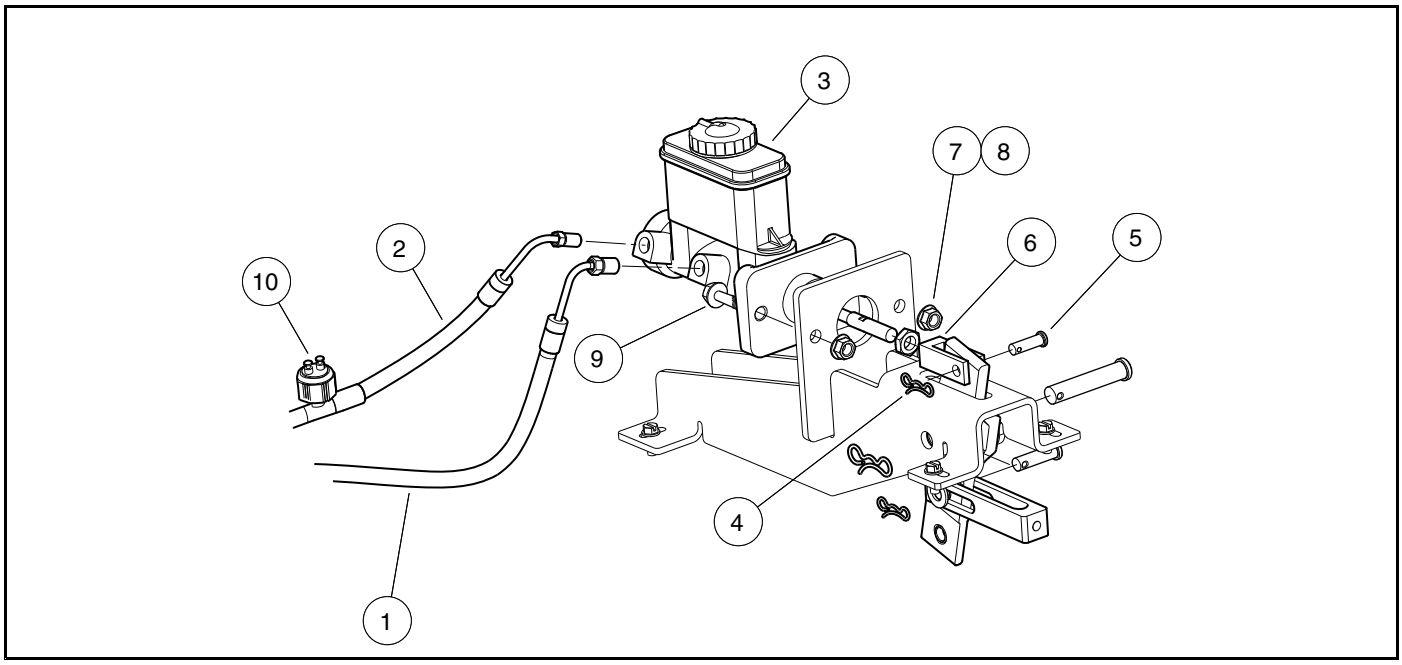

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Figure 6-16 Master Cylinder

MASTER CYLINDER REMOVAL

⚠ WARNING

- **To perform this procedure, the hydraulic system must be opened. As a result, the brakes must be bled after the correct installation of the brake components. Failure to bleed the brakes could result in decreased braking performance due to air being trapped in the hydraulic system. Use only DOT 5 brake fluid. See Bleeding the Hydraulic Brake System on page 6-26.**

1. Chock rear tires.
2. Use a flare-nut wrench to disconnect brake hoses (1 and 2) at master cylinder (3) **(Figure 6-16, Page 6-24)**. **See following NOTE.**

NOTE: *Place a plastic bag around master cylinder to catch brake fluid before brake hose is removed. Once hose is removed, wrap bag around master cylinder to prevent debris from entering brake hose port.*

3. Cover fittings on brake hoses with plastic bags and wire ties to keep any dirt or debris from entering hydraulic brake system.
4. Remove bow tie locking pin (4) and clevis pin (5) from master cylinder push rod clevis (6) **(Figure 6-16, Page 6-24)**.
5. Remove two nylon locknuts (7), flat washers (8), and bolts (9) that secure master cylinder (3) to mounting bracket.

MASTER CYLINDER INSTALLATION

1. Install master cylinder (3) into mounting bracket and secure with bolts (9), flat washers (8), and nylon locknuts (7). Tighten locknuts (7) to 155 in·lb (17.5 N·m) **(Figure 6-16, Page 6-24)**.
2. Attach master cylinder push rod clevis (6) to pedal linkage with clevis pin (5) and bow tie locking pin (4).
3. Carefully insert front brake hose (1) and rear brake hose (2) into master cylinder and tighten fittings to 159 in·lb (18 N·m).
4. Check brake pedal adjustment. **See Brake Pedal Adjustment on page 5-3.**
5. Fill master cylinder reservoir and bleed hydraulic brake system. **See Bleeding the Hydraulic Brake System on page 6-26.**
6. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

BLEEDING THE HYDRAULIC BRAKE SYSTEM

See General Warnings on page 1-1.

⚠ WARNING

- **Do not bleed the brakes in the same manner as a DOT 3 system. Failure to bleed the brakes as instructed in this manual will result in decreased braking performance due to air being trapped in the hydraulic system.**
- **Use only DOT 5 brake fluid to fill the master cylinder. NEVER mix DOT 3, DOT 4, or DOT 5.1 with DOT 5 as it IS NOT compatible.**

The hydraulic system must be free of air. Air enters the hydraulic system whenever the system is opened and will result in a “spongy” brake pedal.

Pressure or vacuum bleeding, with preference given to the pressure bleeding method, is the recommended way to remove air from a brake system filled with DOT 5 silicone brake fluid. If a pressure or vacuum brake bleeding tool is not available, manually bleeding the system can be accomplished when done carefully.

VACUUM BLEEDING OF BRAKES ON A DOT 5 FLUID FILLED SYSTEM

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse switch in NEUTRAL.
2. Check the brake pedal and master cylinder push rod for proper adjustment before the brake system is bled. **See Brake Pedal Adjustment on page 5-3.**
3. Remove the cap from the master cylinder reservoir and top off the master cylinder with fresh DOT 5 silicone brake fluid. **NEVER** mix DOT 3, DOT 4, or DOT 5.1 with DOT 5 as it **IS NOT** compatible.
4. Place, but do not tighten, the cap on the master cylinder reservoir.
5. Chock the front or rear wheels and loosen the lug nuts. Release the park brake and lift the front or rear of the vehicle with a chain hoist or floor jack. **See WARNING “Lift only one end...” in General Warnings on page 1-1.**
6. Place jack stands under the outer front frame, or under the rear axle tubes, and lower onto stands.
7. Connect the vacuum-type brake bleeder to the brake bleeder valves on the back of each of brake assembly.
8. Connect an air hose to the vacuum brake bleeder. The air pressure must be regulated at 12 to 15 psig (82.7 to 103.4 kPa).
9. Press the handle on the brake bleeder to start the vacuum.
10. With the vacuum running, open each of the brake bleeder valves 1/4 turn on the brake assemblies.
11. Monitor the fluid as it flows through the tubes of the vacuum bleeder tool. Continue to run the vacuum until there are no air bubbles in the lines. **See following NOTE.**

NOTE: *Do not allow the brake fluid in the master cylinder reservoir to fall below the MIN level mark at any time during the brake bleeding procedure.*

12. With the vacuum still running, tighten the bleeder valves to 25 in·lb (3 N·m).
13. Allow the handle on the brake bleeder tool to open and turn the vacuum system off.
14. After bleeding, fill the master cylinder reservoir to the MAX level with DOT 5 brake fluid.
15. Tighten the cap on the master cylinder reservoir.
16. Properly label and dispose of the used brake fluid.
17. Inspect brake system. **See Hydraulic Brake System Inspection on page 6-7.**
18. Before a test drive, pump the brake pedal 3 or 4 times. Carefully drive the vehicle and test the function of the brakes. Check the fluid level to ensure no loss of fluid.

MANUAL BLEEDING OF BRAKES ON A DOT 5 FLUID FILLED SYSTEM

Manually bleeding brakes is not done by rapidly applying extreme pressure on the vehicle's master cylinder. It's simply a function of gently moving fluid through the system to displace the air and contaminants that have accumulated.

It is important to have the vehicle sitting level and safely supported on jack stands before the manual bleeding procedure is performed. **See following WARNING.**

⚠ WARNING

- **Do not bleed brakes with only one end of the vehicle raised. To place vehicle on four jack stands, 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 the lifting device to hold vehicle in the raised position. Use approved jack stands of proper weight capacity to support the vehicle.**

The following procedure will enable correct bleeding:

1. Turn the key switch OFF and remove the key. Place the Forward/Reverse switch in NEUTRAL.
2. Check the brake pedal and master cylinder push rod for proper adjustment before the brake system is bled. **See Brake Pedal Adjustment on page 5-3.**
3. Remove the cap from the master cylinder reservoir and top off the master cylinder with fresh DOT 5 silicone brake fluid. **NEVER** mix DOT 3, DOT 4, or DOT 5.1 with DOT 5 as it **IS NOT** compatible.
4. Place, but do not tighten, the cap on the master cylinder reservoir.
5. Chock the front or rear wheels and loosen the lug nuts. Release the park brake and lift the front of the vehicle with a chain hoist or floor jack. **See preceeding WARNING.** Place jack stands under the outer front frame and lower onto stands.
6. Position jack under rear differential and lift rear of vehicle. Ensure the vehicle is not pulled off the front jack stands while lifting the rear. **See following WARNING.** Once vehicle is level, place jack stands under the rear axle tubes and lower onto stands.

⚠ WARNING

- **To prevent possible injury from pulling the vehicle off the front jack stands while lifting the rear, perform the following:**
  - **Position floor jack wheels in the direction the jack will roll as the rear of the vehicle rises.**
  - **Ensure the wheels of the jack are able to roll freely without obstruction.**

7. Start at the brake assembly farthest away from the master cylinder. Attach a clear plastic hose to the bleeder valve and place the other end into a clear container (a clean plastic 16 fl-oz soda bottle works fine) filled with enough brake fluid to cover the end of the hose. This prevents air from being drawn into the caliper during the bleeding process.
8. Have an assistant **SLOWLY** depress and release the brake pedal repeatedly until resistance is encountered when pushing the pedal. **DO NOT VIGOROUSLY PUMP** the brake pedal! Pumping the pedal can aerate the brake fluid in the master cylinder and brake hoses.
9. When resistance is felt at the pedal, have the assistant apply gentle downward pressure on the pedal and hold while slowly opening the bleeder valve, then close the valve fully as the brake pedal reaches the end of its travel. Continue this process until air bubbles no longer come out of the hose that is submerged into the fluid in the bottle. Gently tap the brake assembly and the master cylinder with a plastic-tipped hammer and repeat the bleeding sequence. This will dislodge air bubbles that tend to accumulate, allowing for a more complete bleeding process.
10. Ensure that no brake fluid gets on the brake drums or shoes. If fluid gets on the brake drums, they should be cleaned with brake cleaner. If fluid gets on the shoes, they should be replaced as brake fluid can reduce the brake shoes effectiveness or even break down the friction material.
11. Check the master cylinder fluid level and add fluid if necessary. Always pour fluid into the master cylinder slowly to avoid creating air bubbles in the reservoir. **See following NOTE.**

NOTE: *Do not allow the brake fluid in the master cylinder reservoir to fall below the MIN level mark at any time during the brake bleeding procedure.*

12. Once the brake assembly is bled, tighten the bleeder valve to 25 in·lb (3 N·m), wipe the area of any residual fluid with a clean rag and have the assistant press on the brake pedal to ensure there are no leaks. Normal pedal pressure should be used.
13. Repeat this process at each brake assembly, starting at the next brake assembly farthest from the master cylinder.
14. After bleeding, fill the master cylinder reservoir to the MAX level with DOT 5 brake fluid.
15. Tighten the cap on the master cylinder reservoir.
16. Properly label and dispose of the used brake fluid.
17. Inspect brake system. **See Hydraulic Brake System Inspection on page 6-7.**
18. Before a test drive, pump the brake pedal 3 or 4 times. Carefully drive the vehicle and test the function of the brakes. Check the fluid level to ensure no loss of fluid.

REFILLING THE HYDRAULIC SYSTEM

The brake fluid reservoir is accessible by lifting/removing the front seat. Do not allow the brake fluid level to fall below the MIN line. Use only DOT 5 brake fluid. After purging the brake system and making any necessary repairs, bleed the brakes. Add brake fluid until the system is full and virtually no air bubbles are present in the brake bleeder vacuum tubes. **See Bleeding the Hydraulic Brake System on page 6-26.**

PARK BRAKE SYSTEM

See General Warnings on page 1-1.

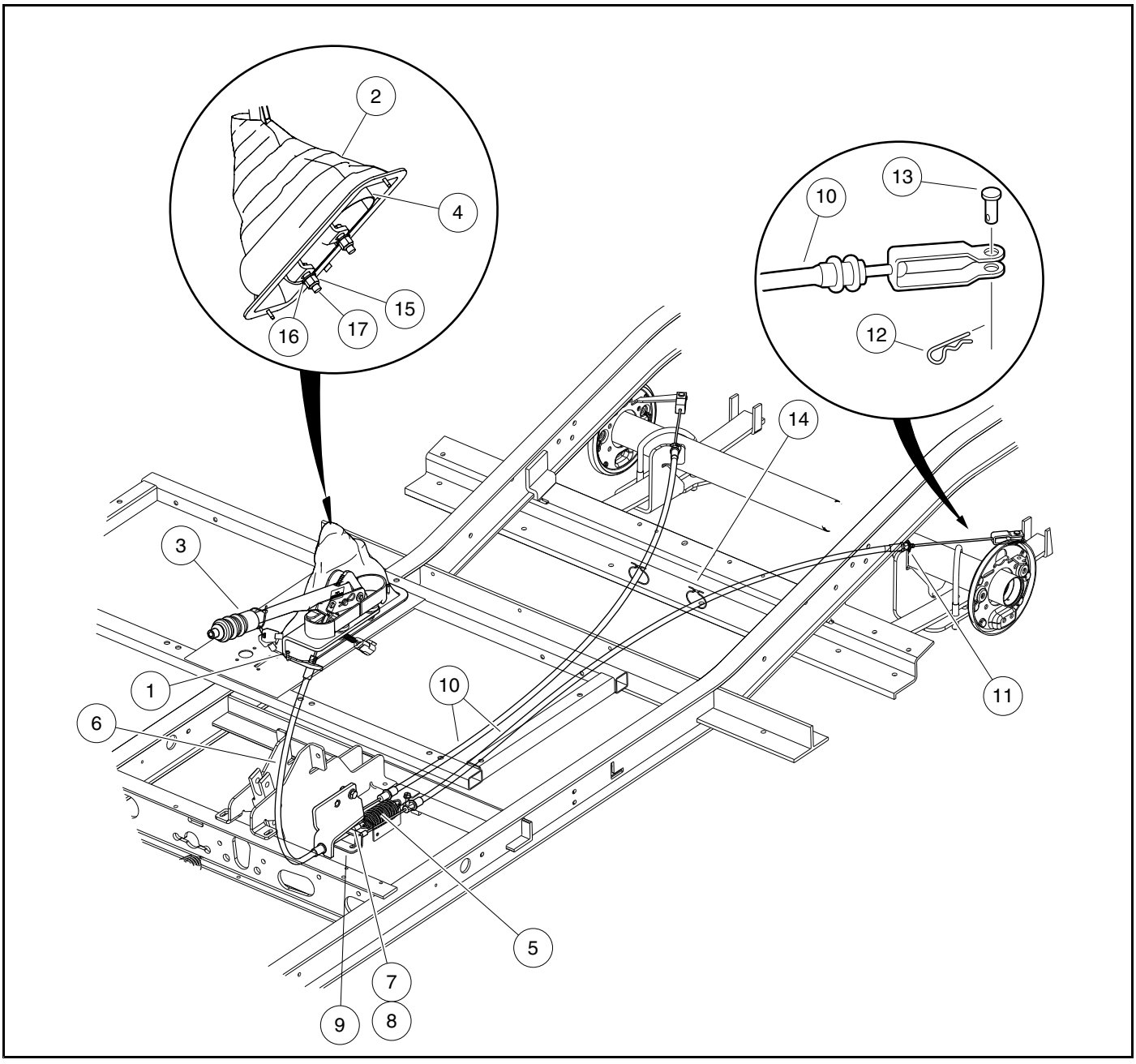

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Figure 6-17 Park Brake System

FRONT PARK BRAKE CABLE REMOVAL

1. Chock wheels and release park brake.
2. Remove two screws (1) that secure park brake boot (2) to seat support **(Figure 6-17, Page 6-29)**.

3. Slide boot (2) off of park brake handle (3).
4. Remove boot shield (4) from park brake handle (3).
5. Disconnect equalizer spring (5).
6. Remove equalizer jam nut (7) and conical nut (8) from cable end.
7. Using brake cable release tool, compress retaining clips on each end of the cable sheathing to release cable from mounting brackets.
8. Disconnect end of front park brake cable (6) from handle (3) and remove front park brake cable (6) from vehicle.

FRONT PARK BRAKE CABLE INSTALLATION

1. Connect end of front park brake cable (6) to handle (3) **(Figure 6-17, Page 6-29)**.
2. Push retaining clips on cable sheathing fully into mounting brackets to secure in place.
3. Install equalizer bracket (9), conical nut (8), and equalizer jam nut (7) onto threaded end of front park brake cable (6).
4. Connect equalizer spring (5).
5. Slide boot shield (4) around park brake handle (3).
6. Slide boot (2) over handle and onto seat support.
7. Attach the boot (2) using two screws (1).
8. Adjust park brake. **See Park Brake Adjustment on page 6-31.**

REAR PARK BRAKE CABLE REMOVAL

1. Loosen equalizer jam nut (7) and conical nut (8) to provide slack in rear park brake cable (10) **(Figure 6-17, Page 6-29)**.
2. Disconnect cable end from keyhole opening in equalizer bracket (9).
3. Using brake cable release tool, compress retaining clips on front end of cable sheathing to release cable from chassis.
4. At rear end of cable, remove e-clip (11), bow tie locking pin (12), and clevis pin (13).
5. Detach rear end of cable sheathing from mounting bracket at leaf spring.
6. Slide cable through hanger (14) and remove rear park brake cable (10) from vehicle.
7. Repeat for other rear park brake cable (10).

REAR PARK BRAKE CABLE INSTALLATION

1. Slide rear park brake cable (10) through hanger (14) **(Figure 6-17, Page 6-29)**.
2. Attach rear end of cable sheathing to mounting bracket at leaf spring and secure with e-clip (11).
3. Connect cable clevis to wheel brake lever using the clevis pin (13) and bow tie locking pin (12).
4. Insert front end of cable through hole in chassis. Push retaining clips on cable sheathing fully into frame crossmember to secure in place.
5. Connect cable end to keyhole opening in equalizer bracket (9).
6. Adjust park brake. **See Park Brake Adjustment on page 6-31.**
7. Repeat for other rear park brake cable (10).

PARK BRAKE HANDLE REMOVAL

1. Disconnect front park brake cable (6). **See Front Park Brake Cable Removal on page 6-29.**

2. Remove locknuts (15), flat washers (16), and bolts (17) from the park brake handle (3) and remove handle from seat support **(Figure 6-17, Page 6-29)**.

PARK BRAKE HANDLE INSTALLATION

1. Attach handle (3) to seat support using bolts (17), flat washers (16), and new locknuts (15) **(Figure 6-17, Page 6-29)**. Tighten locknuts to 108 in·lb (12.2 N·m).
2. Connect front park brake cable (6). **See Front Park Brake Cable Installation on page 6-30.**
3. Adjust park brake. **See Park Brake Adjustment on page 6-31.**
4. Perform all brake system inspections. **See Hydraulic Brake System Inspection on page 6-7.**

PARK BRAKE ADJUSTMENT

CAUTION

- **Perform the following procedure only on level surface. To avoid injury or property damage, ensure that the path of the vehicle is clear before pushing vehicle.**

1. Ensure brake pedal is adjusted correctly. **See Brake Pedal Adjustment on page 5-3.**
2. Chock wheels, release park brake and place Forward/Reverse handle in NEUTRAL position.
3. Loosen equalizer jam nut (7) and the conical nut (8) to provide slack in the rear park brake cables **(Figure 6-17, Page 6-29)**.
4. Use a torque wrench and Torx #T-27 driver, or hydraulic brake adjuster, to gently rotate adjuster bolts to increase or decrease the clearance between brake shoe lining and brake drum **(Figure 6-4, Page 6-10)**. **See following CAUTION.**

CAUTION

- **Do not apply more than 65 in·lb (7.3 N·m) of torque to any of the adjuster bolts. Overtightening of the adjuster bolts could result in damage to the brake cluster components or the separation of the bolt (4) from the adjuster (3) (Figure 6-2, Page 6-3).**

5. With park brake released (handle down), tighten conical nut (8) until significant resistance is observed in front park brake cable in order to fully lock the brakes **(Figure 6-17, Page 6-29)**.
6. Push vehicle by hand. If vehicle moves when pushed, continue tightening conical nut until vehicle can no longer be pushed.
7. Loosen conical nut two full revolutions.
8. Tighten equalizer jam nut (7) against conical nut (8), using double-wrench method, to 55 ft·lb (74.6 N·m).
9. Park brake should now be adjusted so that vehicle will not roll when pushed with park brake latched in the fourth notch (four clicks up).
10. Perform all brake system inspections to ensure that both the hydraulic brake system and the park brake system are adjusted and operating correctly before placing vehicle into service. **See Hydraulic Brake System Inspection on page 6-7.**

Pagination Page

SECTION 7 — STEERING AND FRONT SUSPENSION

7

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

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 1-1.

STEERING WHEEL REMOVAL

1. Disconnect the battery cables and either discharge the controller or disconnect the spark plug wire(s). **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the two mounting screws (1) and plate (2) **(Figure 7-1, Page 7-2)**.
3. Match mark the steering wheel (3) and steering column shaft (4) so when the steering wheel is removed it can be placed back in exactly the same position on steering column shaft.
4. Loosen the steering wheel nut (5) and back it off approximately 1/4 inch (6 mm). Do not remove the nut.
5. Use the steering wheel puller to remove steering wheel.

5.1. Place the puller anvil (6) through the top opening of the steering wheel **(Figure 7-2, Page 7-2)**.

5.2. Insert the anvil feet through the two slots in the base plate (marked “B”) (7) as shown.

5.3. Rotate the anvil screw (8) clockwise until the base plate contacts the bottom of the steering wheel where it attaches to the steering column.

5.4. Use a 1/2-inch drive air impact wrench to tighten the anvil screw (8) until the steering wheel breaks free from the steering shaft.

5.5. Remove the steering wheel puller.

5.6. Remove the steering wheel nut (5) and the steering wheel (3) from the steering column (9) **(Figure 7-1, Page 7-2)**.

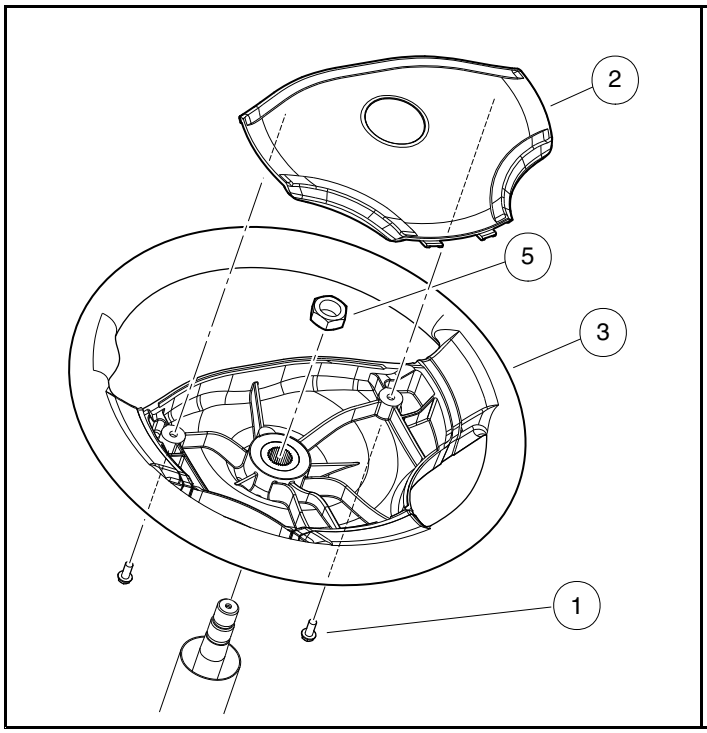

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Figure 7-1 Steering Wheel

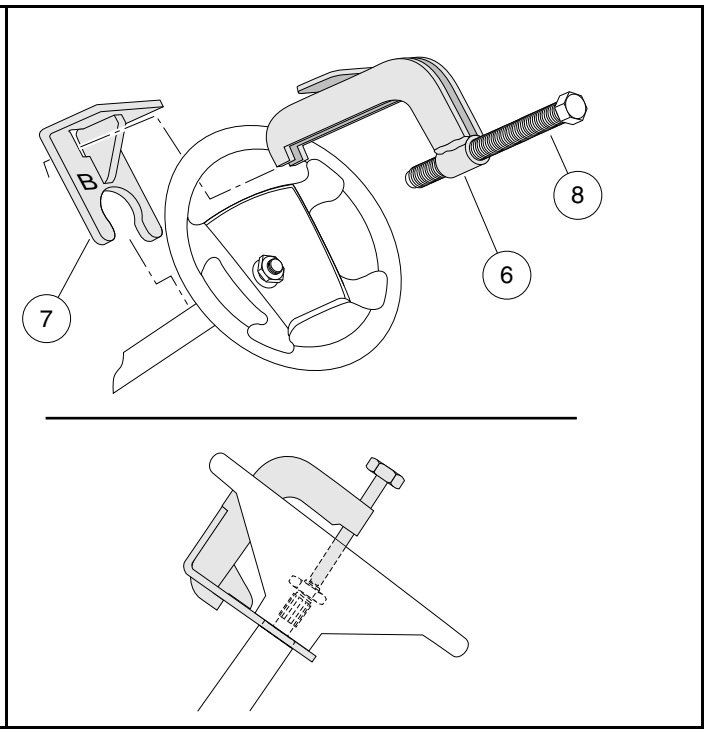

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Figure 7-2 Steering Wheel Puller

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 splines and taper before installing the steering wheel.*

1. Install the steering wheel (3) on the splines of the steering shaft (4). Be sure to align the match marks placed on the wheel and steering column shaft in step 3 above **(Figure 7-1, Page 7-2)**.
2. Install the steering wheel nut (5) and tighten to 156 in·lb (17.6 N·m).
3. Install the plate (2) and screws (1) **(Figure 7-1, Page 7-2)**. Tighten screws to 16 in·lb (1.8 N·m).
4. Connect the battery cables. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

STEERING COLUMN

See General Warnings on page 1-1.

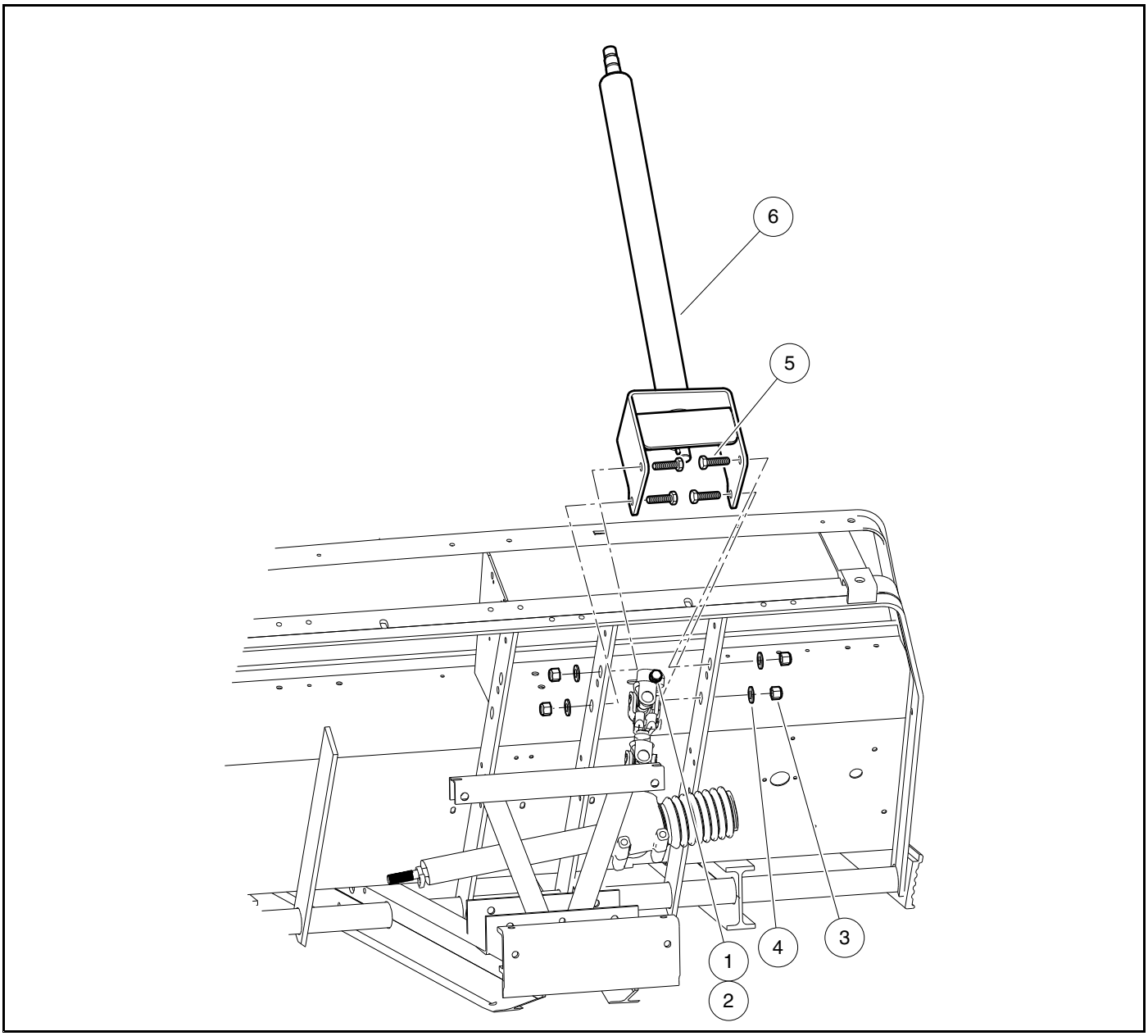

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Figure 7-3 Steering Column Mounting

STEERING COLUMN REMOVAL

1. Remove the steering wheel as previously instructed.
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Remove the upper bolt (1) and lock washer (2) from the universal joint **(Figure 7-3, Page 7-3)**.

4. Remove the nuts (3), washers (4), and bolts (5) securing the steering column (6) to the chassis **(Figure 7-3, Page 7-3)**.
5. Remove the steering column from the vehicle.

STEERING COLUMN DISASSEMBLY

1. While supporting steering column tube (1) on a workbench, remove snap ring (2) from shaft (3) **(Figure 7-4, Page 7-4)**.

NOTE: *Do not allow the steering shaft to slide out of the steering tube when removing the snap ring.*

2. Remove the washer (4), spring (5), and wedge (6).
3. Turn the steering column over and slide the shaft (3) out of the tube to expose the retaining ring (7). Use pliers to twist the retaining ring until it breaks off, then remove the wedge (8).
4. Remove the shaft (3) from the bottom of the tube.
5. Use steering shaft (3) to push bearing seats (9) out from the ends of the steering tube (1).
6. Insert a flat blade screwdriver between the bottom of the outer race of the bearing (10) and the bottom lip of the bearing seat (9) and remove the bearing.

NOTE: *Use new retaining rings and bearings for reassembly.*

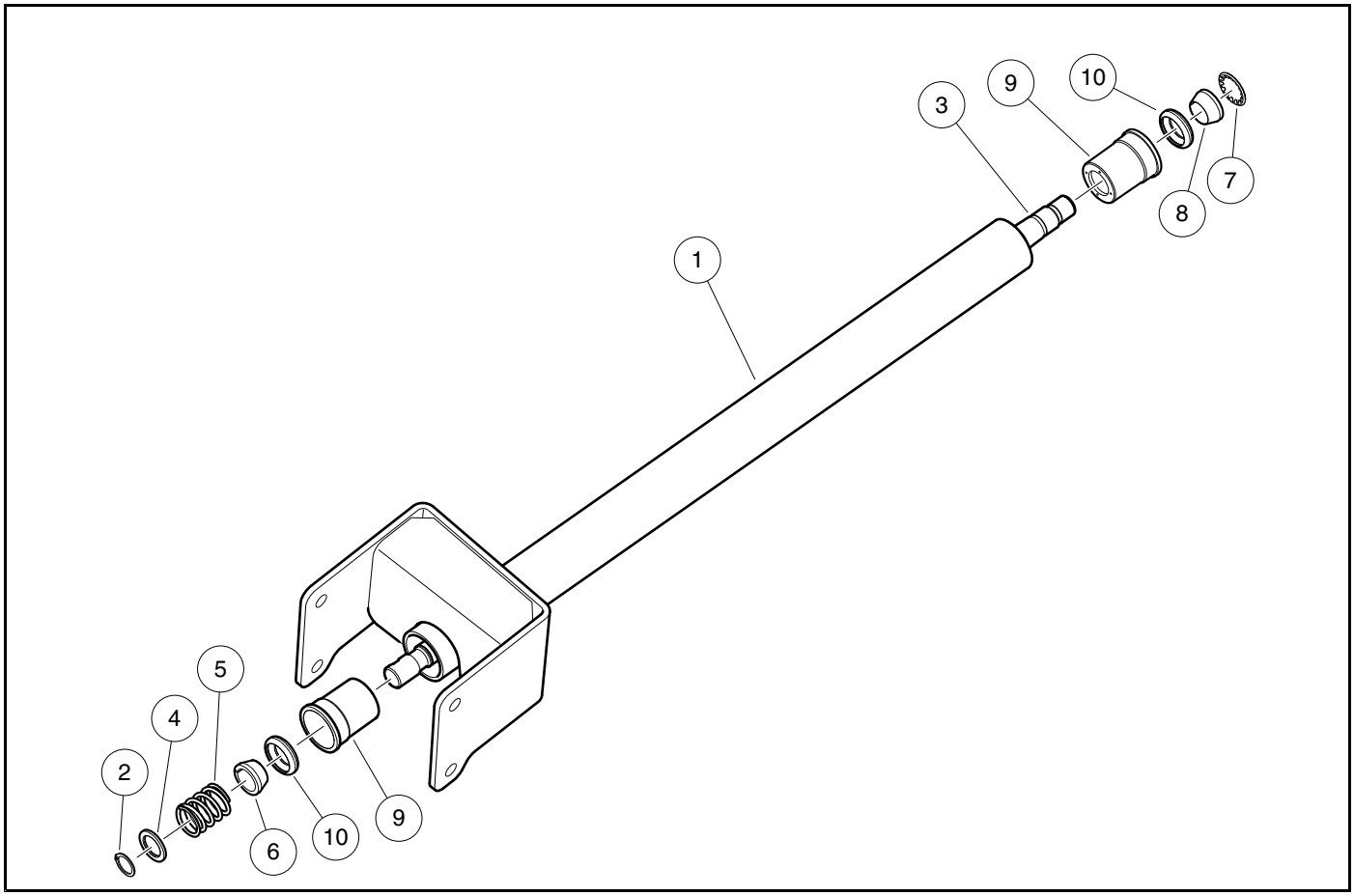

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Figure 7-4 Steering Column – Exploded View

STEERING COLUMN ASSEMBLY

1. Insert bearing seat (18) into both ends of steering tube (20). Place a block of wood on bearing seat and tap lightly on block until bearing seat (18) is fully seated in steering tube (20) **(Figure 7-5, Page 7-5)**.
2. Press the bearing (17) all the way into the bearing seat (18) using a steering column bearing press tool or a metal tube approximately 6 inches (15.2 cm) long with a maximum outer diameter of 1-3/16 inches (3.3 cm) and a minimum inside diameter of 7/8 inch (2.2 cm). Be sure the bearing is installed in the bearing seat as shown **(Figure 7-5, Page 7-5)** so the wedge (16) will ride against the inner race of the bearing.
3. Install the wedge (16), spring (15), washer (14), and snap ring (13) onto the bottom end of the steering shaft (19) **(Figure 7-5, Page 7-5)**.
4. Insert the shaft (19) from the bottom of the steering tube (20) **(Figure 7-5, Page 7-5)**.
5. Turn the assembly over and place the shaft (19) on a bench. Install the wedge (16) and retaining ring (22) onto the top of the shaft **(Figure 7-6, Page 7-5)**. Be sure the prongs on the retaining ring face up and away from the wedge. Use a steering column retaining ring tool to seat the retaining ring to the proper depth. Support end of tube while pressing. If you do not have the recommended tool, use the same tube as was used in step 2 to press the retaining ring onto the top of the shaft. The retaining ring should be pressed onto the shaft until 2 to 2-1/8 inches (5.1-5.4 cm) of the shaft extends from the top of the bearing seat in the steering tube **(Figure 7-6, Page 7-5)**.

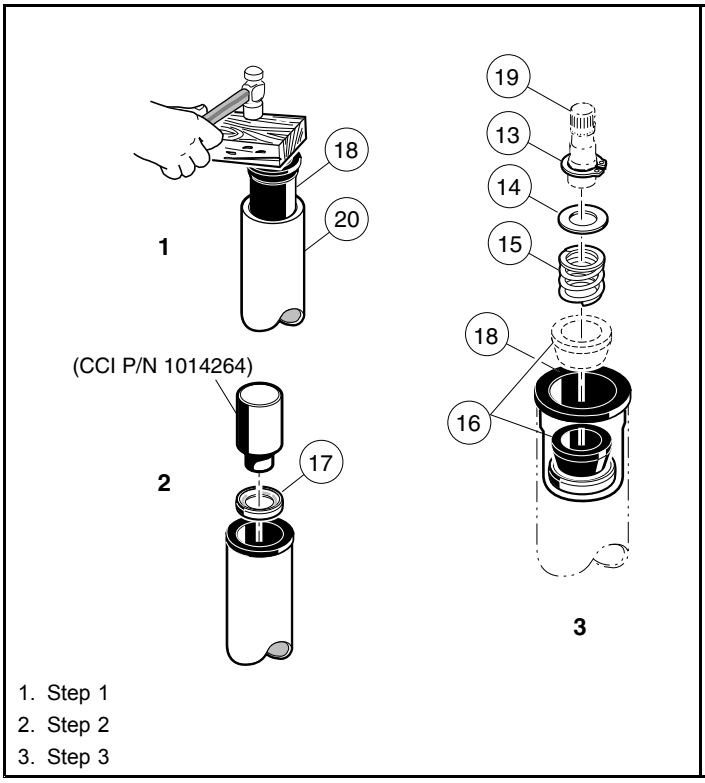

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Figure 7-5 Steering Shaft – Bottom End

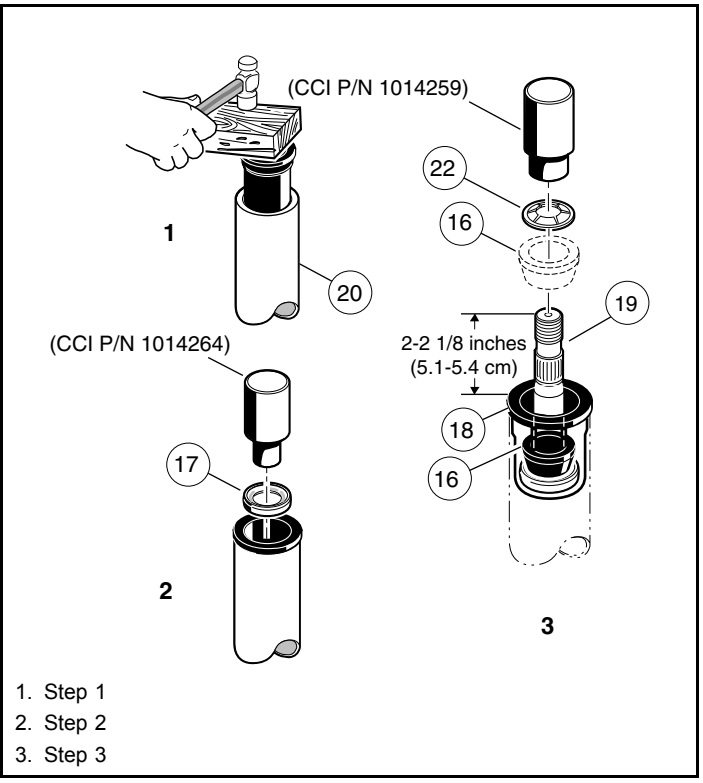

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Figure 7-6 Steering Shaft – Top End

STEERING COLUMN INSTALLATION

1. For ease of assembly and to prevent corrosion, apply a light coat of anti-seize or lubricating compound to both splined ends of the steering shaft.
2. Position the steering column assembly in the vehicle while inserting the steering column shaft into the upper universal joint. The flat portion of the steering shaft spline (3) must be aligned with the bolt hole in the universal joint before sliding the spline into the universal joint **(Figure 7-4, Page 7-4)**. While holding the steering column in place, attach it to the frame using bolts (5) washers (4) and nuts (3) **(Figure 7-3, Page 7-3)**. Thread the nuts onto the bolts but do not tighten them.

3. Install the bolt (1) and lock washer (2) on the upper universal joint and finger tighten **(Figure 7-3, Page 7-3)**.
4. Tighten the four nuts (3) to 18 ft-lb (24.4 N·m).
5. Tighten the bolt (1) on the upper universal joint to 23 ft-lb (31 N·m).
6. Check the other bolts on the universal joint to ensure that they are properly tightened to 23 ft-lb (31 N·m).
7. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**
8. Install the steering wheel. **See Steering Wheel Installation on page 7-2.**

STEERING ADJUSTMENT

See General Warnings on page 1-1.

1. Verify each spindle stop hits its respective A-plate when the steering wheel is turned from lock to lock. If contact does not occur, proceed to step 2.
2. Loosen the nuts (1 and 2) and turn the drag link (3) **(Figure 7-7, Page 7-8)** to adjust the steering so that each spindle stop hits its respective A-plate when the steering wheel is turned from lock to lock. **See following CAUTION.**

⚠ CAUTION

- **The drag link has both left and right-hand threads. The end of the drag link toward the spindle has left-hand threads, and the end toward the rack has right-hand threads. To prevent damage to threaded parts, care should be taken when servicing the drag link.**

3. Once adjustment is complete, tighten the nuts (1 and 2) on the drag link with an open end wrench to 21 ft·lb (28.4 N·m) **(Figure 7-7, Page 7-8)**. **See following CAUTION.**

⚠ CAUTION

- **When tightening the nuts (1 and 2), make sure the drag link (3) does not turn (Figure 7-7, Page 7-8).**

4. Straighten wheels and then turn steering wheel from lock to lock. Wheels should turn smoothly and easily. If steering is not smooth and easy, inspect the following steering assemblies:
   – ball joint (4) **(Figure 7-7, Page 7-8)** and ball joints (6 and 13) **(Figure 7-14, Page 7-13)**
   – spindle bushings (3 and 4) **(Figure 7-15, Page 7-14)**
   – wave washers (20) **(Figure 7-15, Page 7-14)**
   – steering gear assembly (5) **(Figure 7-7, Page 7-8)**
5. Also inspect the following front suspension assemblies:
   – A-Plates (1) **(Figure 7-14, Page 7-13)**
   – urethane bushings (2) **(Figure 7-14, Page 7-13)**
   – leaf springs (6) **(Figure 7-15, Page 7-14)**
6. Replace components as necessary.

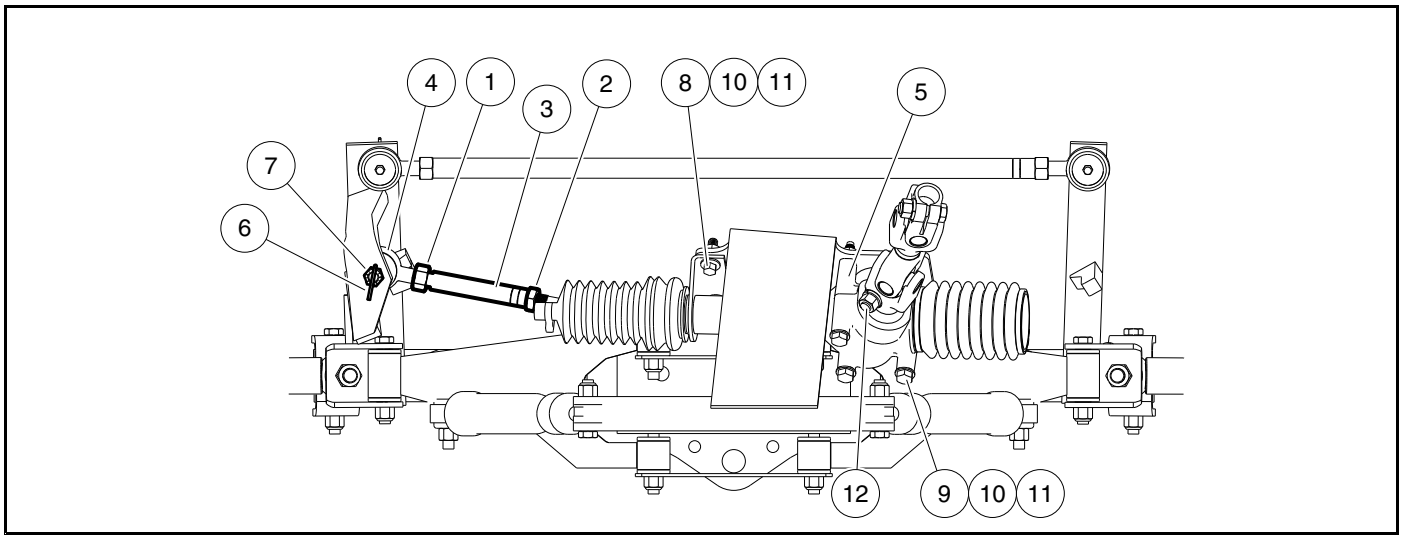

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Figure 7-7 Steering Components

RACK AND PINION

See General Warnings on page 1-1.

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 7-8. 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 7-12.**
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.

RACK AND PINION REMOVAL

1. Remove the front body. **See Front Body on page 4-4.**
2. Remove the cotter pin (6) and ball joint retaining nut (7) **(Figure 7-7, Page 7-8)**.
3. Using a ball joint removal tool, remove the ball joint (4) **(Figure 7-7, Page 7-8)** from the passenger side spindle assembly. **See Figure 7-8, Page 7-9.**

4. Remove the bolts (8 and 9), washers (10), and lock nuts (11) securing the rack assembly to the mounting bracket **(Figure 7-7, Page 7-8)**.
5. Remove the hardware (12) securing the universal joint to the rack assembly, then remove the rack assembly from the vehicle **(Figure 7-7, Page 7-8)**.

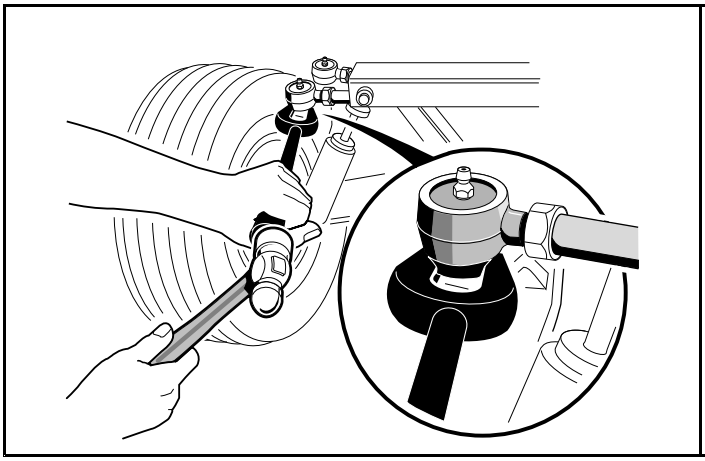

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Figure 7-8 Ball Joint Removal Tool

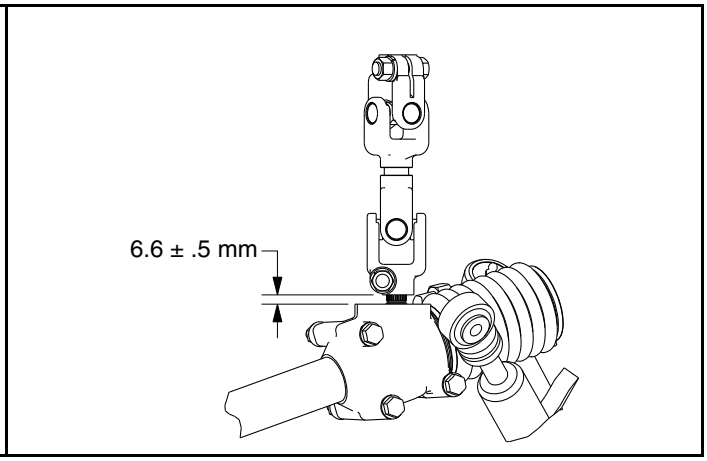

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Figure 7-9 Universal Joint Gap

RACK AND PINION INSTALLATION

1. For ease of assembly and to prevent corrosion, apply a light coat of anti-seize and lubricating compound to the splines of the pinion shaft.
2. Insert the pinion shaft spline into the universal joint and install the hardware (12) in the universal joint but do not tighten **(Figure 7-7, Page 7-8)**.
3. Adjust gap between universal joint and steering gear assembly to dimension shown **(Figure 7-9, Page 7-9)**. Tighten hardware (12) to 23 ft·lb (31 N·m).
4. Position the steering gear assembly on the mounting bracket and secure with bolts (8 and 9), washers (10), and lock nuts (11) **(Figure 7-7, Page 7-8)**. Tighten the lock nuts (11) to 20 ft·lb (27 N·m).
5. Insert the ball joint (4) into the passenger side spindle assembly and secure with ball joint retaining nut (7) **(Figure 7-7, Page 7-8)**. Tighten retaining nut to 23 ft·lb (31 N·m) and install cotter pin (6).
6. Adjust the steering. **See Steering Adjustment on page 7-7.**

TIE ROD AND DRAG LINK

See General Warnings on page 1-1.

TIE ROD AND DRAG LINK REMOVAL

1. Using locking pliers to hold tie rod and drag link, loosen jam nuts (7 and 12) on tie rod ball joints **(Figure 7-14, Page 7-13)** and loosen jam nuts (1 and 2) on the drag link **(Figure 7-7, Page 7-8)**.
2. Remove the cotter pin (6) and ball joint retaining nut (7) **(Figure 7-7, Page 7-8)**.
3. Remove the cotter pins (21) and ball joint retaining nuts (20) **(Figure 7-14, Page 7-13)**.
4. Use a ball joint removal tool to remove ball joints (13 and 6) **(Figure 7-14, Page 7-13)** and (4) **(Figure 7-7, Page 7-8)** from the spindles.
5. Remove the ball joints from the tie rod (11) **(Figure 7-14, Page 7-13)**.
6. Remove drag link (3) from steering gear assembly (5) and ball joint (4) **(Figure 7-7, Page 7-8)**.

TIE ROD AND DRAG LINK INSTALLATION

1. Thread ball joints (6 and 13) into tie rod (11) to a depth of 1/2 inch (12.5 mm) **(Figure 7-14, Page 7-13)**.

⚠ WARNING

- **The ball joints must be threaded into the rod at least 5/16 of an inch (8 mm). Failure to thread ball joints in deep enough may cause a ball joint to separate from the rod during adjustment or while being operated, possibly resulting in loss of vehicle control and severe personal injury.**

⚠ CAUTION

- **The tie rod and drag link have right-hand threads on one end and left-hand threads on the other end. Right-hand threads are identified by a groove in the tie rod or drag link.**

2. Install ball joint ends (6 and 13) into the left and right-hand spindle arms, then install the retaining nuts (20) and cotter pins (21) **(Figure 7-14, Page 7-13)**.
3. Thread the drag link (3) all the way onto the threaded stud of the steering gear assembly (5) (right-hand threads) **(Figure 7-7, Page 7-8)**.
4. Thread the ball joint (4) into the drag link (3) (left-hand threads) to full thread depth.
5. Insert the ball joint (4) into the passenger side spindle assembly and secure with ball joint retaining nut (7). Tighten retaining nut to 23 ft·lb (31 N·m) and install cotter pin (6).
6. Adjust wheel toe-in and steering. **See Toe-in Adjustment on page 7-12 and Steering Adjustment on page 7-7.**

FRONT SUSPENSION

See General Warnings on page 1-1.

LUBRICATION

Five grease fittings are provided (one in each spindle housing, one in the ball joint on each end of the tie rod, and one in the ball joint of the steering drag link). Lubricate these fittings semi-annually with the proper lubricant. **See Periodic Lubrication Schedule on page 10-6.**

⚠ CAUTION

- **To ensure proper lubrication of the front suspension and steering linkages, raise front of vehicle to lubricate. See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-1.**

WHEEL ALIGNMENT

Wheel alignment is limited to equalizing the camber angle of each front wheel and adjusting toe-in of the front wheels. There is also a drag link adjustment to equalize the turning radius in both directions. **See Steering Adjustment on page 7-7.**

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

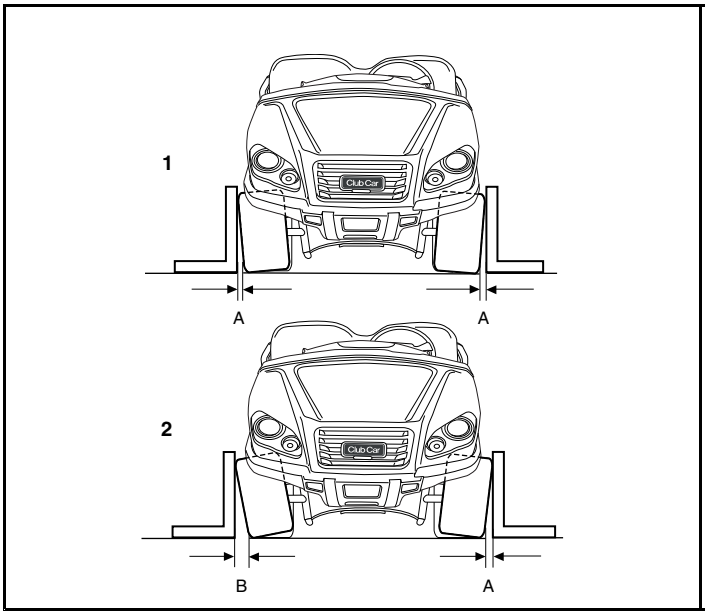

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Figure 7-10 Check Camber

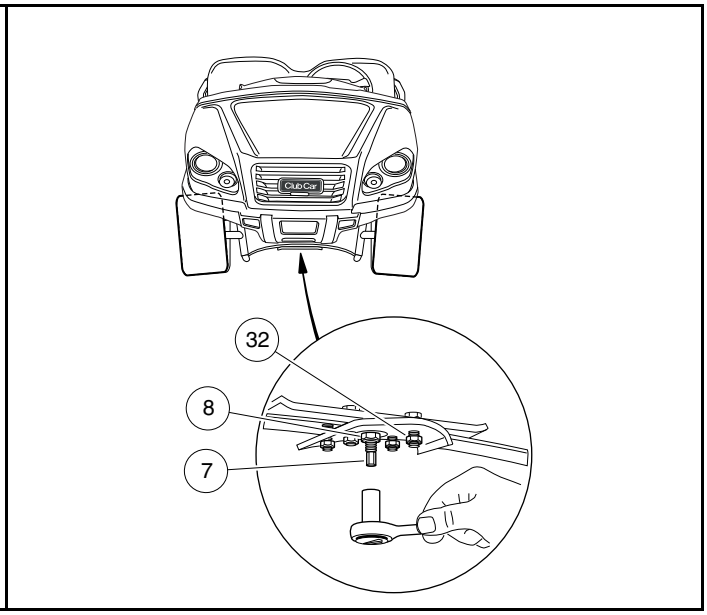

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Figure 7-11 Adjust Camber

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 7-10, Page 7-11)**.
2. Loosen (do not remove) the four bolts (32) that secure the leaf spring (6) to the bottom spring plate (29) **(Figure 7-15, Page 7-14)**. **See also Figure 7-11, Page 7-11.**

3. Loosen (do not remove) the hex nut (8) on the adjustment eccentric (7) **(Figure 7-11, Page 7-11)** in the center of the spring.
4. Use a 7 mm deep well socket to rotate the eccentric **(Figure 7-11, Page 7-11)**.
5. After adjusting camber, tighten the four spring retaining bolts (32) to 23 ft·lb (31 N·m). Then roll the vehicle forward one full tire revolution and recheck the camber. **See also Figure 7-10, Page 7-11.**
6. Tighten the hex nut (8) on the adjustment eccentric (7) to 10 ft·lb (13.5 N·m). **See also Figure 7-11, Page 7-11.**

Toe-in Adjustment

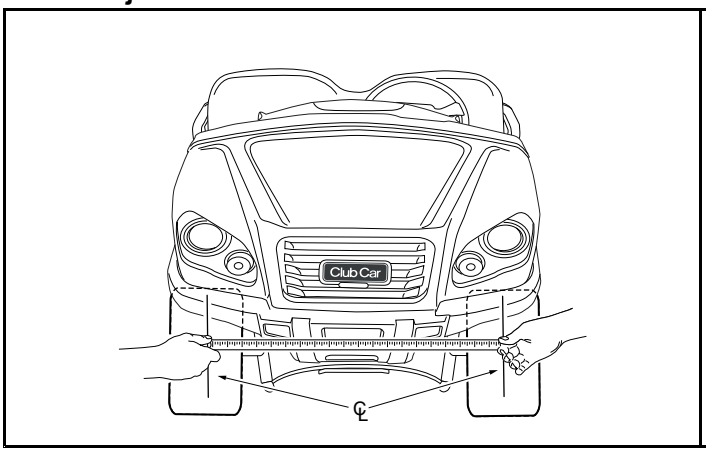

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Figure 7-12 Check Toe-In

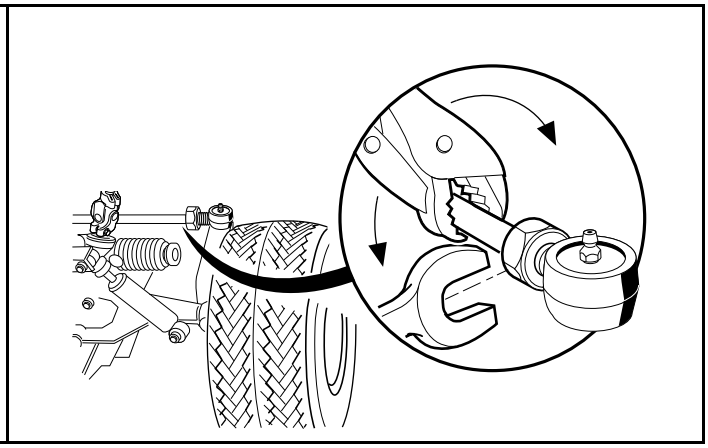

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Figure 7-13 Adjust Toe-In

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 I-beams.
3. Measure the distance between the marks on the rear-facing surfaces of the tires, and then roll the vehicle **forward** one and one-half wheel revolutions until the marks appear on the forward facing surfaces of the tires at about the same height from the floor **(Figure 7-12, Page 7-12)**.
4. Measure the distance between the marks on the forward-facing surfaces of the tires.

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 1/8 to 3/8 of an inch (3.2 to 9.5 mm).
6. If adjustment is necessary, loosen the jam nut on each tie rod ball joint and rotate the tie rod to increase or decrease toe-in **(Figure 7-13, Page 7-12)**. **See following CAUTION.**

⚠ CAUTION

- **The tie rod has right-hand threads on one end and left-hand threads on the other end. Right-hand threads are identified by a groove in the tie rod.**

7. Tighten nuts (loosened in step 6) to 21 ft·lb (28 N·m) and recheck toe-in.
8. 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. **See following NOTE.**

NOTE: *If the minimum turning radius is not the same for both left and right turns, adjust the steering.* ***See Steering Adjustment on page 7-7.***

FRONT SUSPENSION COMPONENTS

See General Warnings on page 1-1.

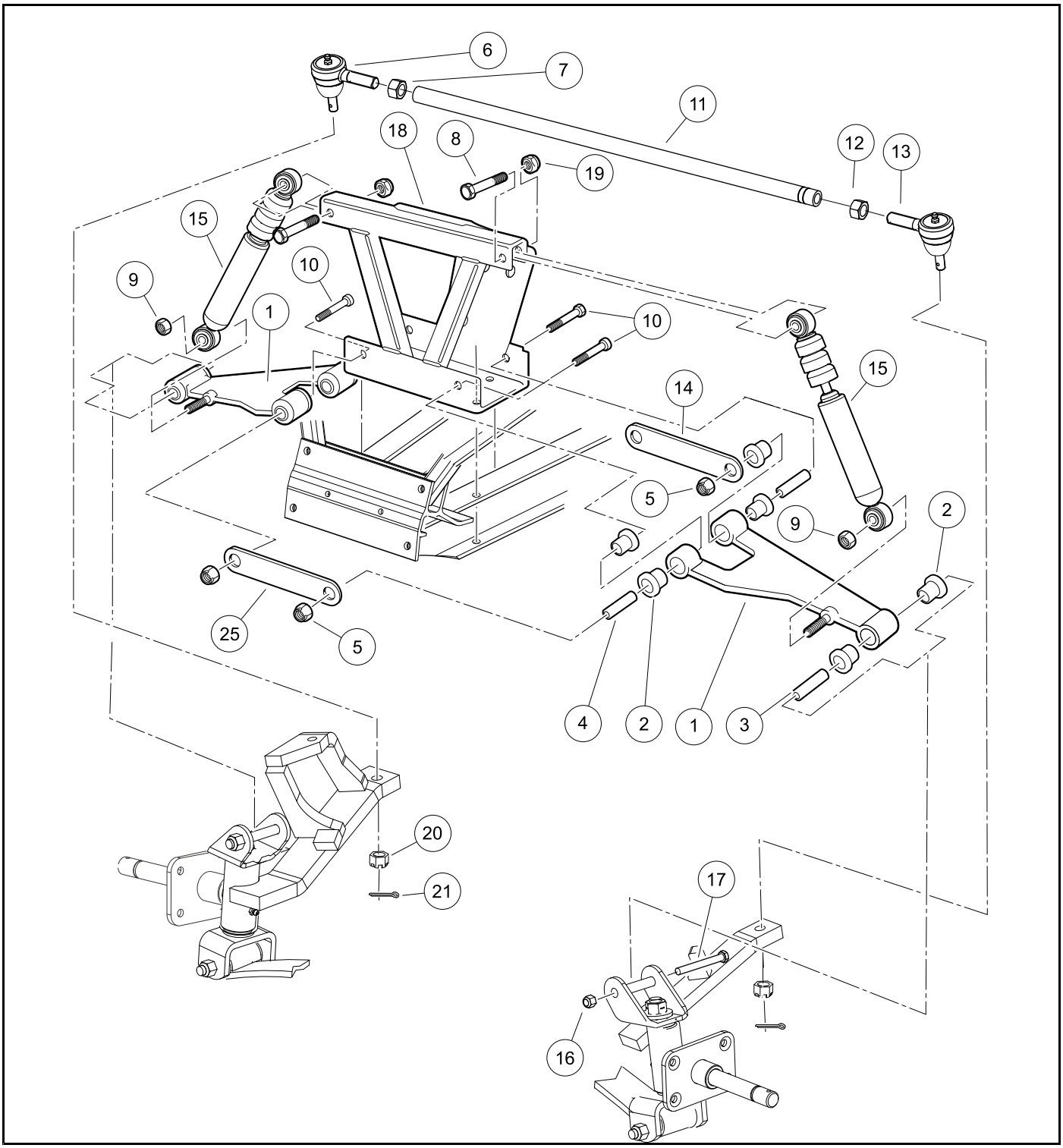

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Figure 7-14 Front Suspension – Upper Portion

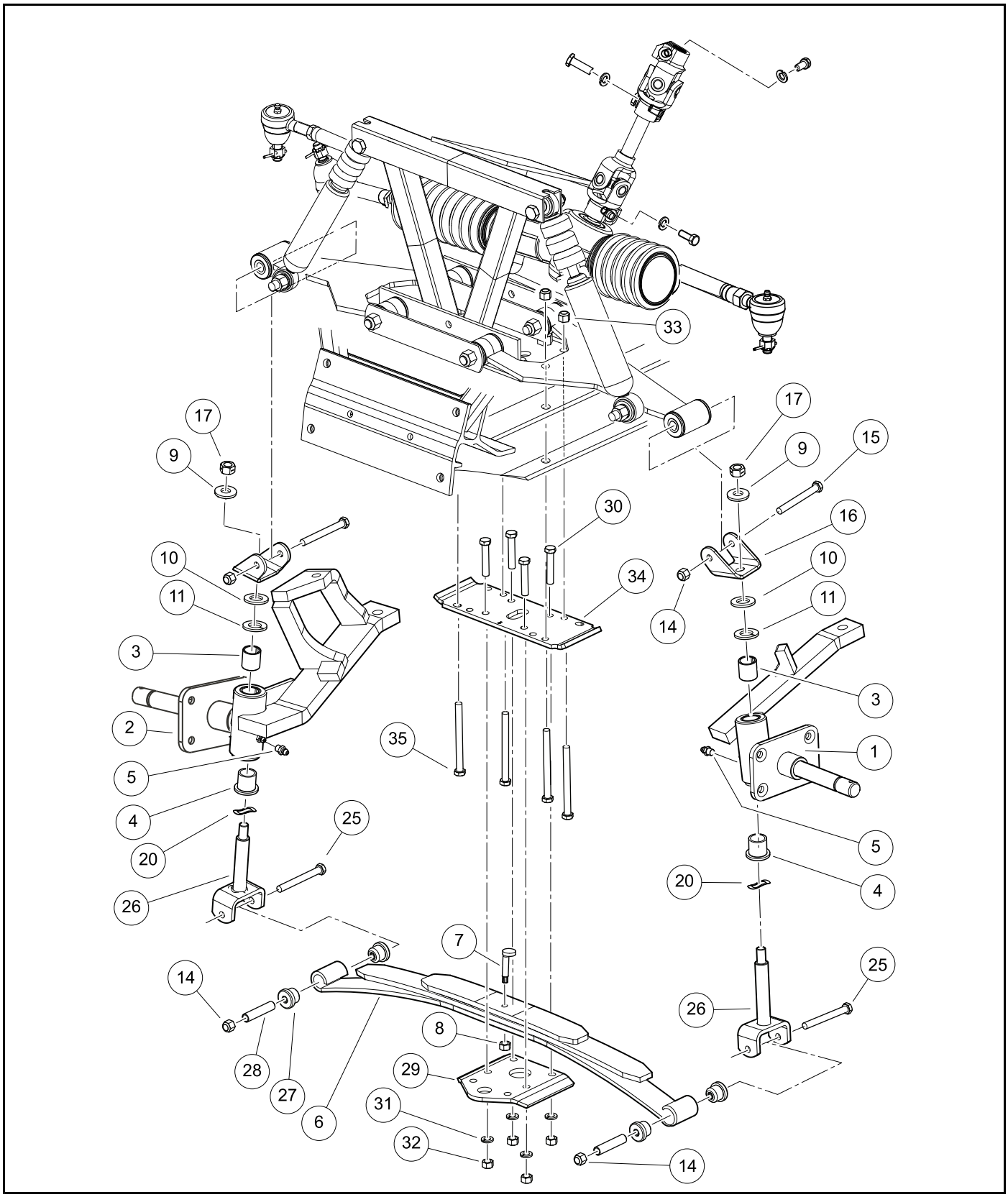

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Figure 7-15 Front Suspension – Lower Portion

LEAF SPRING REMOVAL

1. Loosen lug nuts on both front wheels and raise front of vehicle with a chain hoist or floor jack. Place jack stands under the front cross tube of the vehicle frame and lower the vehicle onto the jack stands.
2. Remove both front wheels.
3. Remove the nuts (14) and bolts (25) from the bottom of each king pin (26) **(Figure 7-15, Page 7-14)**.
4. Remove the four bolts (30), four nuts (32), four lock washers (31), and bottom spring plate (29).
5. Remove leaf spring (6).
6. Check the condition of the urethane bushings (27) and steel sleeves (28). Replace any that are worn or damaged.

LEAF SPRING INSTALLATION

1. Install urethane bushings (27) and steel bushings (28) into leaf spring eyes **(Figure 7-15, Page 7-14)**.
2. Install leaf spring (6), bottom spring plate (29), four bolts (30), four lock washers (31), and four nuts (32). Using a crisscross pattern sequence, tighten nuts to 23 ft·lb (31 N·m).
3. Install spring (6) in king pins (26) with bolts (25) and nuts (14). Tighten to 23 ft·lb (31 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 specified torque. **See Wheels and Tires section.**
6. Adjust camber and toe-in as instructed on page 7-11.

KINGPIN AND STEERING SPINDLE REMOVAL

1. Remove brake assembly from spindle but do not disconnect the brake hose. **See Drum Brake Assembly Removal on page 6-17.**
2. Remove front hub. **See Front Hub and Wheel Bearings Removal on page 7-17.**
3. Remove cotter pins (21) and nuts (20), then remove ball joints (6 and 13) from spindles **(Figure 7-14, Page 7-13)**. Remove drag link ball joint from spindle. **See Tie Rod and Drag Link Removal on page 7-10.**
4. Remove nut (17) and conical washer (9) from top of upper clevis (16) **(Figure 7-15, Page 7-14)**.
5. Raise upper clevis (16) off kingpin (26).
6. Remove the flat washer (10) and thrust washer (11).
7. Slide the spindle (1 or 2) off the kingpin (26).
8. Remove the wave washer (20) and inspect it. If the washer is broken or has a wave bottom to wave crest height dimension of less than 0.040 inch (0.10 cm), it must be replaced.
9. Remove bolt (25) and nut (14) from bottom of kingpin (26) and remove kingpin.
10. Inspect the kingpin and spindle. If either is worn or damaged, it must be replaced.
11. Inspect the bushings (3 and 4). If the bushings are worn or damaged, remove them and press in new ones. **See following NOTE.**

NOTE: *If the bushings are replaced, ream new bushings from 0.750 to 0.752 (19.05 to 19.10 mm) in diameter. The reamer should be long enough to ream both bushings from one direction.*

KINGPIN AND STEERING SPINDLE INSTALLATION

1. Inspect all parts and replace them as necessary.
2. Install the kingpin (26) over the leaf spring eye. Insert the bolt (25) and install the nut (14) **(Figure 7-15, Page 7-14)**. Tighten the bolt to 23 ft·lb (31 N·m).
3. Install the wave washer (20).

4. Install the steering spindle on the kingpin. Then install the thrust washer (11), flat washer (10), upper clevis (16), conical washer (9), and nut (17). Tighten the nut to 62 ft·lb (85 N·m).
5. Attach the ball joints (6 and 13) to the spindle arms **(Figure 7-14, Page 7-13)**. Install and tighten the nut (20) to 23 ft·lb (31 N·m). Install cotter pin (21). If necessary, tighten nut more until slot aligns with hole. Bend each end of cotter pin around nut (20) in opposite directions.
6. Install the drag link ball joint. **See Tie Rod and Drag Link Installation on page 7-10.**
7. Install front hub and wheel. **See Front Hub and Wheel Bearings Installation on page 7-18.**
8. Attach the brake assembly to the spindle. **See Drum Brake Assembly Installation on page 6-18.**

DELTA A-PLATE REMOVAL

1. 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 cross tube of the vehicle frame and lower the vehicle onto the jack stands.
2. Remove wheel.
3. Remove nut (9) from shock absorber (15) at Delta A-Plate (1) **(Figure 7-14, Page 7-13)**.
4. Remove nuts (5 and 16), A-Plate straps (14 and 25), and bolts (10 and 17).
5. Slide shock absorber (15) off A-Plate mounting stud.
6. Remove the Delta A-Plate (1).
7. Inspect the bushings (2) and sleeves (3 and 4) in the Delta A-Plate and replace them if necessary.

DELTA A-PLATE INSTALLATION

1. Install Delta A-Plate in reverse order of removal. Tighten the A-Plate suspension nuts (5 and 16) to 23 ft·lb (31 N·m) **(Figure 7-14, Page 7-13)**.
2. Tighten shock absorber mounting nut (9) to 23 ft·lb (31 N·m).
3. Install wheels and adjust wheel alignment. **See Wheel Alignment on page 7-11.**

SHOCK ABSORBER REMOVAL AND INSPECTION

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 nut (9) from shock absorber (15) at Delta A-Plate (1) **(Figure 7-14, Page 7-13)**.
3. Remove nut (19) and bolt (8) attaching shock absorber (15) to weldment (18).
4. Remove shock absorber.

SHOCK ABSORBER INSTALLATION

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

1. Install the shock absorber (15) by reversing the removal procedure.
2. Tighten the nuts (9 and 19) to 23 ft·lb (31 N·m).

FRONT WHEEL BEARINGS AND HUBS

See General Warnings on page 1-1.

FRONT WHEEL FREE PLAY INSPECTION

1. Raise the front of the vehicle.
2. Using your hands, attempt to rock the wheel and hub assembly back and forth on the spindle. If there is any observable movement of the wheel and hub on the spindle, remove dust cap (1) and cotter pin (2) and then tighten the spindle nut (3) until the bearing (5) fully seats in the bearing race (7) **(Figure 7-16, Page 7-17)**.
3. Loosen spindle nut one cotter pin position. If the hub does not turn freely, loosen spindle nut one more cotter pin position.
4. Install a new cotter pin (2). If movement continues, replace the wheel bearings (5) as required **(Figure 7-16, Page 7-17)**.

FRONT HUB AND WHEEL BEARINGS REMOVAL

1. Remove the front wheels. **See Wheel Removal on page 8-1.**
2. Remove the front wheel hubs.

2.1. Remove dust cover (1), cotter pin (2), spindle nut (3), and flat washer (8) **(Figure 7-16, Page 7-17)**.

2.2. Remove the hub assembly (4) from the spindle shaft **(Figure 7-16, Page 7-17)**.

3. Remove the seal (6) and the bearings (5) from the hub **(Figure 7-16, Page 7-17)**.
4. Inspect the bearing cups (7). If they are worn or pitted, remove the cups by inserting a drift punch from the opposite end of the hub and tapping lightly around them **(Figure 7-16, Page 7-17)**.
5. Clean all parts and inspect them for wear. Replace any damaged or worn parts. **See following NOTE.**

NOTE: *Do not use compressed air to dry wheel bearings after cleaning.*

6. Inspect the surface of the spindle shaft where the seal (6) seats. It should be clean and smooth **(Figure 7-16, Page 7-17)**.

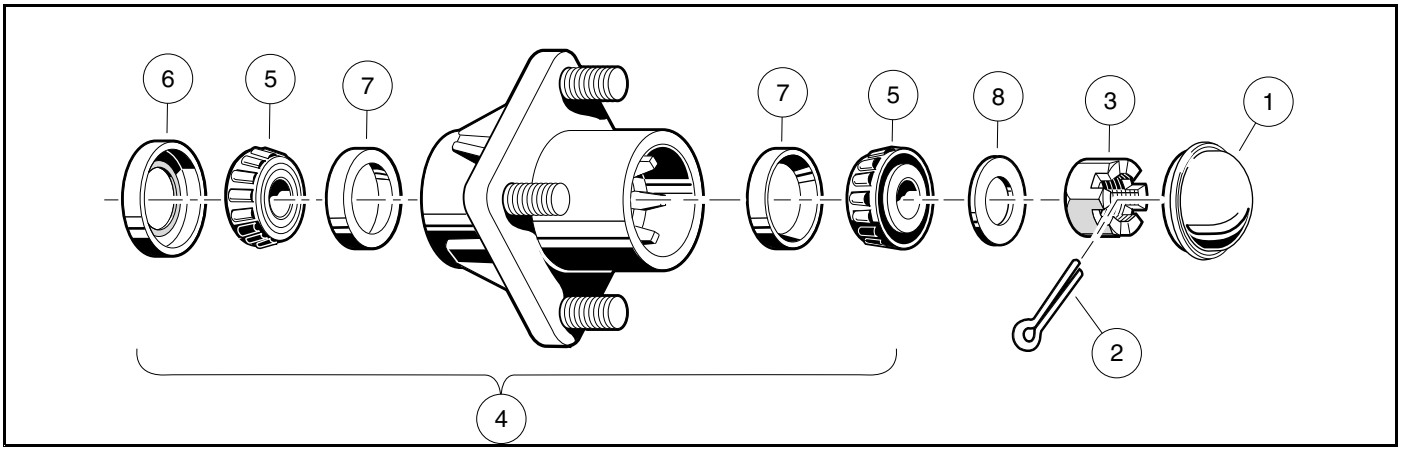

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Figure 7-16 Front Wheel Bearings and Hub

FRONT HUB AND WHEEL BEARINGS INSTALLATION

1. Pack the wheel bearings (5) and hub cavities, and lubricate cups (7) with wheel bearing grease or chassis lube. Make sure the grease is forced between the rollers **(Figure 7-16, Page 7-17)**.
2. If bearing cups (7) were removed, press new ones in squarely against stops in the hub **(Figure 7-16, Page 7-17)**.

NOTE: *Install new cups when new bearings are installed.*

3. Install the wheel bearings (5) into the hub and install a new seal (6), with the metal edge toward the hub **(Figure 7-16, Page 7-17)**. **See following NOTE.**

NOTE: *Apply grease around dust seal inner lip before installation.*

4. Install the hub assembly (4) and flat washer (8) on the spindle and start the spindle nut (3) **(Figure 7-16, Page 7-17)**.
5. Tighten the spindle nut (3) until the hub is hard to turn, then back the nut off until the hub turns freely. Install a new cotter pin (2) **(Figure 7-16, Page 7-17)**. **See following WARNING and NOTE.**

⚠ WARNING

- **Make sure to install and bend the cotter pin. Failure to bend the cotter pin could result in the separation of the wheel hub from the spindle. Loss of vehicle control could result, causing death or severe personal injury.**

NOTE: *When the cotter pins are bent, make sure they do not contact the hub or dust cap.*

6. Check front wheel free play. **See Front Wheel Free Play Inspection on page 7-17.**
7. Install the dust cap (1) **(Figure 7-16, Page 7-17)**.
8. Repeat the procedure for the opposite wheel.
9. Install the wheels and then finger tighten the lug nuts.
10. Lower the vehicle and finish tightening lug nuts, using a crisscross pattern, to specified torque. **See Wheels and Tires section.**

SECTION 8 — WHEELS AND TIRES

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

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 on page 2-1.**
- Keep lug nuts properly tightened. **See Wheel Installation on page 8-1.**
- Keep the front end properly aligned and adjusted.

WHEELS

See General Warnings on page 1-1.

WHEEL REMOVAL

1. Slightly loosen the lug nuts on the wheel to be removed.
2. Raise the end of the vehicle from which the wheel is to be removed. Make sure the wheels are off the ground. **See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-1.**
3. 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.
2. Lower the vehicle and finish tightening the lug nuts, using a crisscross pattern, to 65 ft·lb (88 N·m).

TIRES

See General Warnings on page 1-1.

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 auto supply stores.

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 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. **See Wheel Removal on page 8-1.**
2. 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 8-3, Detail A)**.

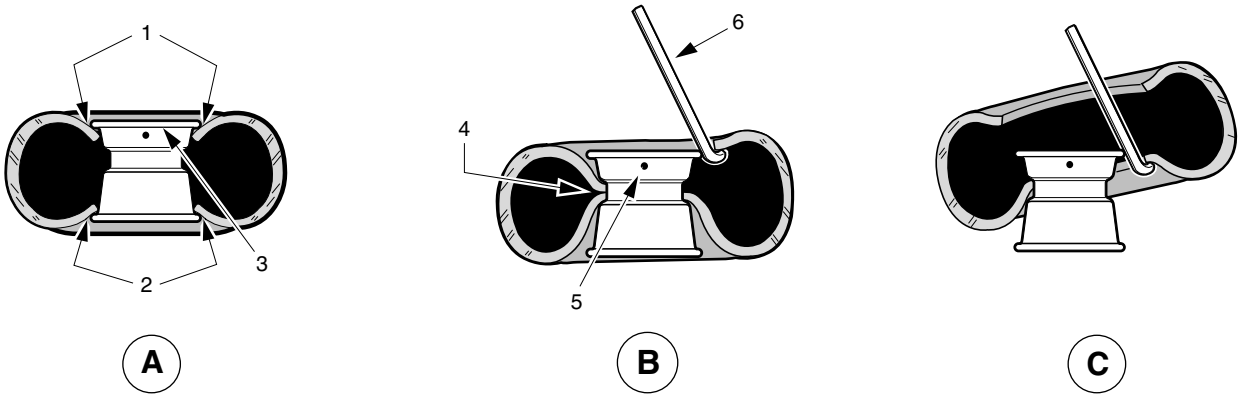
3.2. With the valve stem side of the wheel up, use a tire tool to carefully start the upper bead over the edge of the rim **(Figure 8-1, Page 8-3, Detail B)**. **See following CAUTION.**

CAUTION

- **To avoid damage to the tire, do not use excessive force when starting the bead over the edge of the rim.**

3.3. 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 8-3, Detail C)** and carefully pry the lower bead over the rim flange.

3.4. Once the lower bead is started over the rim flange, the tire can be removed from the rim by hand.



1. Upper Tire Beads 2. Lower Tire Beads 3. Rim Flange 4. Tire Beads Positioned In Rim Well 5. Valve Stem Side Up 6. Tire Tool

Figure 8-1 Tire Removal

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 rim with a wire brush. Wipe away any debris with a clean cloth. **See following NOTE.**

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 the tire so that both beads are on the rim flange narrow bead seats.
6. Place the tire and wheel assembly against a wall in an upright position and push it against the wall while inflating the tire to the recommended pressure. **See Vehicle Specifications on page 2-1.** The three-point contact (wall, floor, and hand) will help ensure that beads snap into place and form a proper seal as the 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 (689.5 kPa). Due to the low pressure requirements of a small tire, over-inflation could be reached almost instantly when using a high pressure air supply. Over-inflation could cause the tire to explode, possibly resulting in personal injury.**

7. Quickly remove the air nozzle and install the valve core.

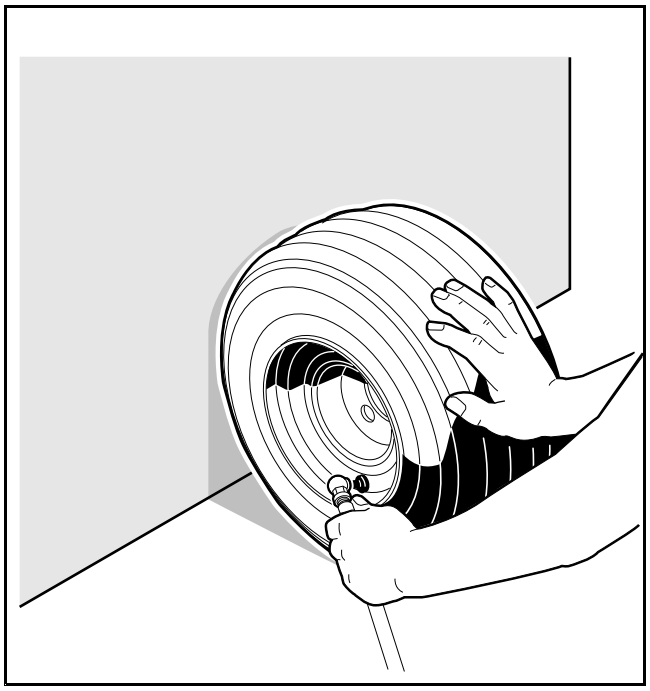


Figure 8-2 Inflate Tire

8. Adjust air pressure in the tire to recommended pressure. **See Vehicle Specifications on page 2-1.**
9. Immerse the wheel and tire assembly in water to make sure there are no leaks.

SECTION 9 — REAR SUSPENSION

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

The rear suspension and powertrain of the vehicle move independently from the vehicle frame. The suspension includes two multi-leaf springs controlled by two hydraulic shock absorbers mounted between the spring mounting plate and the frame.

SHOCK ABSORBERS

See General Warnings on page 1-1.

SHOCK ABSORBER INSPECTION AND REMOVAL

1. Check shock absorbers (14) for damage and fluid leakage around the lower housing of the shock absorber body. Replace damaged or leaking shock absorbers **(Figure 9-1, Page 9-1)** and **(Figure 9-4, Page 9-4)**.
2. To remove a shock absorber (14), remove the nut (1), cup washer (3), and rubber bushing (4) from the upper shock absorber stem. **(Figure 9-4, Page 9-4)**.
3. Remove lower mounting hardware (2) on shock absorber lower mount **(Figure 9-4, Page 9-4)**.
4. Compress the shock absorber to remove it.

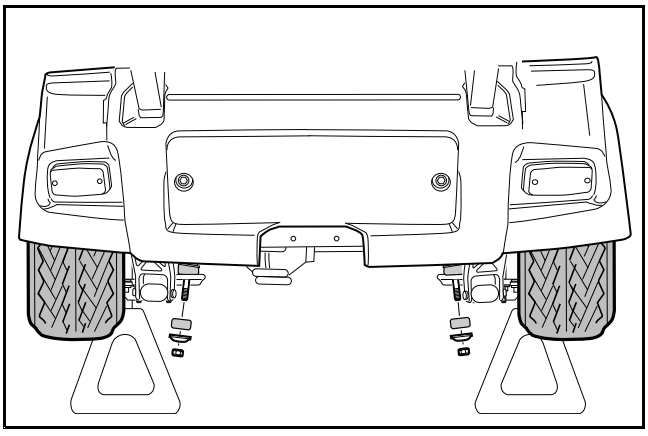


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Figure 9-1 Shock Absorber Removal

SHOCK ABSORBER INSTALLATION

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

NOTE: *Tighten 3/8 hex nut at shock absorber until shock absorber cushions are approximately the same diameter as the retainers. Do not over tighten.*

1. On the upper shock absorber mount, tighten nut (1) until rubber bushing (4) expands to size of cup washer (3) **(Figure 9-4, Page 9-4)**.
2. On the lower shock absorber mount, install mounting hardware. Tighten the nut (1) until the rubber bushing (4) expands to the same diameter as the cup washer (3).

MULTI-LEAF SPRINGS

See General Warnings on page 1-1.

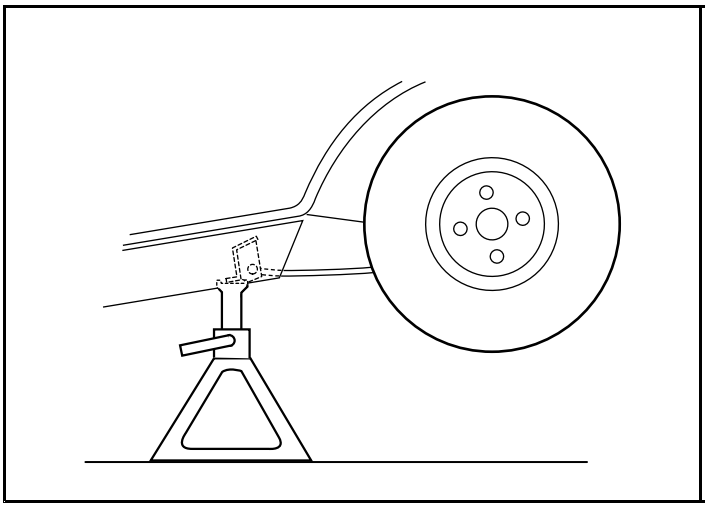
MULTI-LEAF SPRING REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, 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 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 9-2, Page 9-3)**. **See following WARNING.**

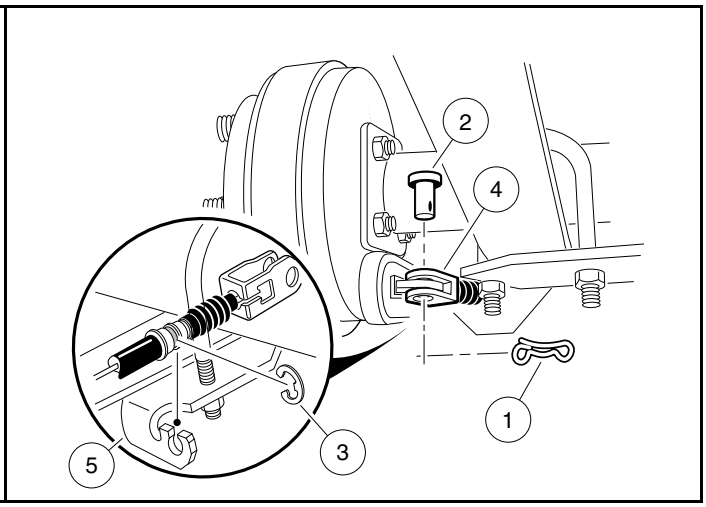
⚠ WARNING

- **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.**

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 tire and wheel assembly on the side from which the spring is to be removed. Thread one lug nut onto a stud on the rear hub. This will keep the brake drum on the hub.
5. Remove lower nut (1), cup washer (3), and rubber bushing (4) from shock absorber (14) **(Figure 9-4, Page 9-4)**.
6. Remove the lock nuts (5) attaching the U-bolt (7) to the shock mount bracket (6 and 12). Do not disconnect brake cable from bracket **(Figure 9-4, Page 9-4)**.
7. Raise axle with floor jack until axle tube is 1 inch (2.5 cm) above spring **(Figure 9-4, Page 9-4)**.
8. Remove bolt (17) and lock nut (9) attaching the leaf spring (15) to the rear shackle (13) **(Figure 9-4, Page 9-4)**.
9. Allow rear of leaf spring (15) to rest on the ground and remove the bolt (17) and lock nut (9) attaching the front of the spring to the vehicle frame **(Figure 9-4, Page 9-4)**. Remove spring from vehicle.
10. Inspect the rubber bushings and steel sleeves in the spring eyes and replace them if they are worn or damaged **(Figure 9-4, Page 9-4)**.



2600-30000-10369
Figure 9-2 Support Vehicle on Jack Stands



1400-18100-10243
Figure 9-3 Disconnect Brake Cable

MULTI-LEAF SPRING INSTALLATION

NOTE: *When installing rear leaf springs, make sure that both springs have identical part numbers.*

NOTE: *Tighten flange bolt (9) after clamp from brake cable has been positioned between nut and frame component.*

1. Install rubber bushings and steel sleeves into leaf spring eyes if bushings were removed **(Figure 9-4, Page 9-4)**.
2. Place front of leaf spring (15) into vehicle frame and insert bolt (17) through frame and leaf spring eye. Install lock nut (9) and tighten to 15 ft·lb (20.3 N·m).
3. Align the other end of leaf spring with the holes in the spring shackles (14). Insert bolt (9) through leaf spring eye and shackles. Install lock nut (10) and tighten to 15 ft·lb (20.3 N·m). Lower axle tube onto leaf spring (18). **See following CAUTION.**

CAUTION

- **When placing axle tube on spring, be sure to position locating bolt on the spring in the locating hole in the axle tube saddle (Figure 9-4, Page 9-4).**

4. Install shock mount bracket (13 and 6) onto locating bolt at bottom center of leaf-spring **(Figure 9-4, Page 9-4)**. **See following NOTE.**

4.1. Install U-bolt (7) and lock nuts (5). Tighten lock nuts to 25 ft·lb (34 N·m) **(Figure 9-4, Page 9-4)**.

5. Install shock absorber. **See Shock Absorber Installation on page 9-1. See following NOTE.**

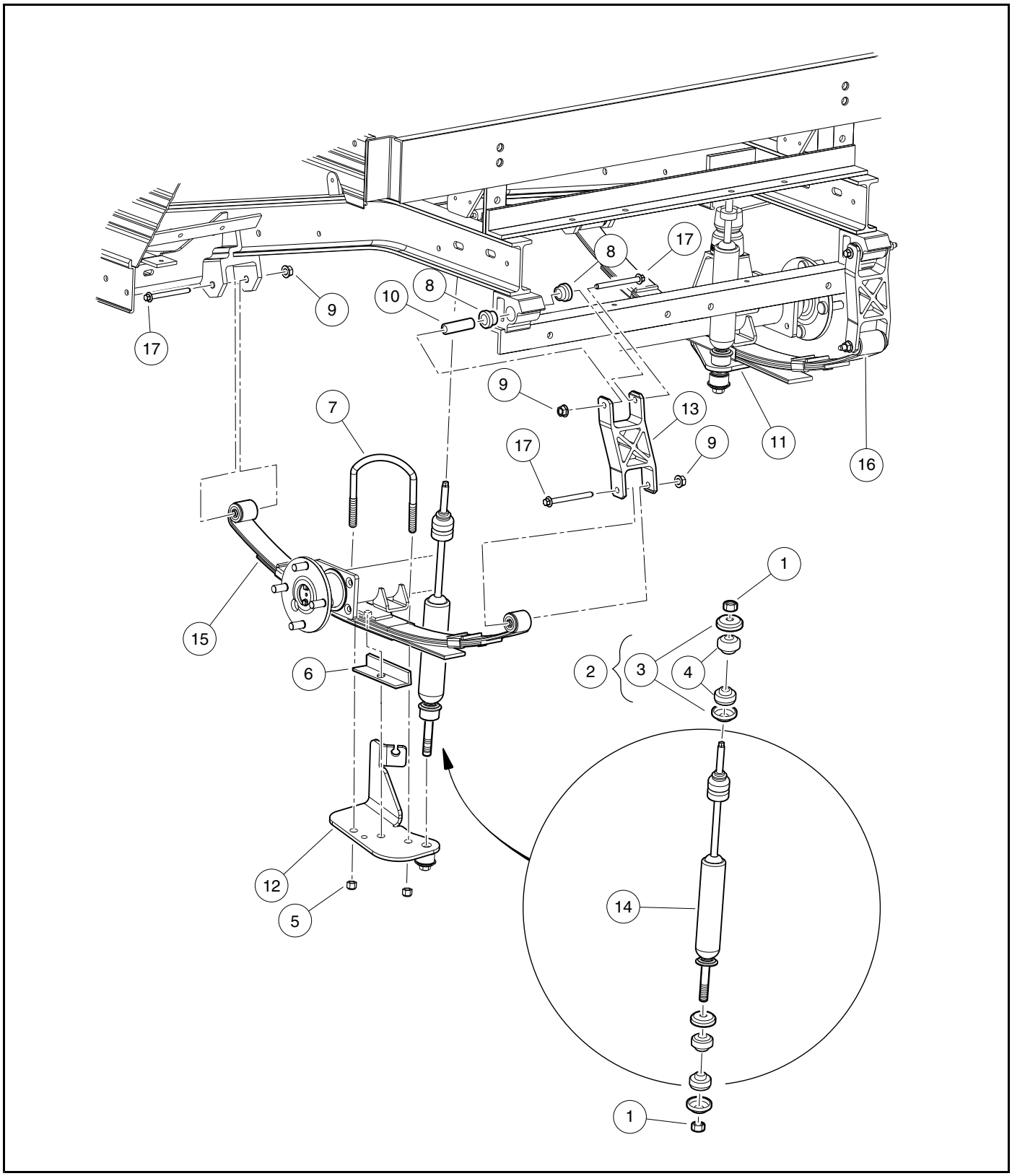


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Figure 9-4 Rear Suspension

SECTION 10 — PERIODIC MAINTENANCE

10

GENERAL INFORMATION

See General Warnings on page 1-1.

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 on page 10-2, the Performance Inspection on page 10-2, and the following *Periodic Service Schedule* and *Periodic Lubrication Schedule* 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.**
- **Hot! Do not attempt to service motor. Attempting to do so could cause severe burns.**
- **Do not work on vehicle powertrain or under the cargo bed when it is loaded.**
- **Do not wear loose clothing or jewelry, such as rings, watches, chains, etc., when servicing the vehicle.**
- **Turn the key switch to OFF, remove the key, place the Forward/Reverse switch in the NEUTRAL position, and chock tires prior to servicing.**
- **Be sure all persons are clear of the vehicle when lifting a cargo bed equipped with a tailgate ramp.**
- **Do not remove prop rod or close bed until all persons are clear of the bed area. Lower the bed gently, keeping entire body clear. do not drop the bed. Failure to follow these instructions could result in severe personal injury.**
- **A hydraulic bed lift system is under pressure. Wear a face shield and use extreme caution when servicing it.**

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 Schedule on page 10-3. Any problems should be corrected by a Club Car distributor/dealer or a trained technician.

- **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 for wear, damage, and proper inflation on a daily basis. **See Vehicle Specifications on page 2-1.**
- **Batteries:** Check electrolyte to ensure that it is at its proper level **(Figure 14-3, Page 14-11)**. Check battery posts. Wires should be tight and free of corrosion. Charge batteries fully before first use of vehicle.
- **Charger cord and plug:** Visually inspect for cracks, loose connections, and frayed wiring.
- **Brakes:** Check brake fluid levels.
- **Performance Inspection:** Inspect as instructed. **See Performance Inspection on page 10-2.**

⚠ WARNING

- **Be sure the plastic has been removed from the seat bottom before operating the vehicle. Failure to do so can 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 Pre-Operation and Daily 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.

- **Forward/Reverse control:** Check for proper operation.
- **Brakes:** Be sure the brakes function properly. When brake pedal is fully pressed under moderate pressure, it should not go more than halfway to the floor, and vehicle should come to a smooth, straight stop. If the brake pedal goes more than halfway to the floor, or if the vehicle swerves or fails to stop, have the brake system checked and adjusted as required. Brake adjustment must be maintained so that the brake pedal cannot be pressed to the floor under any circumstance.
- **Park brake:** Apply moderate pressure to park brake handle. Tension should increase as the handle is pulled. When latched, the park brake should lock the wheels and hold the vehicle stationary (on an incline of 20% or less).
- **Reverse buzzer:** The reverse buzzer should sound as a warning when the Forward/Reverse 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 ride and performance. Have a Club Car distributor/dealer or a trained technician investigate anything unusual.

- **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. Club Car vehicles operate at reduced speed in reverse. When the pedal is released, it should return to the original position and the motor should go into motor braking mode. **See Motor Braking below.**
- **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 limit rolling to 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.

⚠ WARNING

- **Walk-away braking will not limit vehicle speed to 3 mph (4.8 km/h) on 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.

PERIODIC SERVICE SCHEDULE

See General Warnings on page 1-1.

⚠ 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 can result in fire, property damage, severe personal injury, or death.**

NOTE: *If the vehicle is constantly hauling heavy loads or hauling a trailer, these preventive maintenance procedures should be performed more often than recommended in the Periodic Service Schedule.*

Both the Periodic Service Schedules and the Periodic Lubrication Schedules 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 10-2.**
	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)	Check electrolyte level. Add water if necessary. **See page 14-11.**
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. **See Battery Care – Vehicles Equipped with the Single-Point Watering System (SPWS) on page 14-8.**
	Batteries	Wash battery tops and clean terminals with baking soda/water solution.
	Tires	Check air pressure and adjust if necessary. **See Vehicle Specifications – Electric Vehicles on page 2-1.**
	General vehicle	Wash battery compartment and underside of vehicle.
Initial (one-time) inspection by owner or trained technician after six weeks of use	Batteries (For vehicles newly equipped with the SPWS)	For vehicles newly equipped with the SPWS, manually check battery electrolyte levels of all cells to verify correct valve operation. **See page 14-9.**
Semiannual service by trained technician only (or every 50 hours of operation, whichever comes first)	Brake system	Inspect master cylinder, brake lines, and hoses for damage or leakage.
		Check brake cables for damage; replace if necessary.
		Check brake pads and discs; replace if necessary. **See Wheel Brake Assemblies in the maintenance and service manual.**
	Electrical wiring and connections	Check for tightness and damage.
	Forward/Reverse switch	Check condition of contacts and wire connections; make sure connections are tight.
	Front wheel alignment and camber	Check and adjust as required. **See Steering and Front Suspension section in the maintenance and service manual.**
	Motor Controller Output Regulator (MCOR)	Check for loose hardware, cracks, or other damage.

TABLE CONTINUED ON NEXT PAGE

PERIODIC SERVICE SCHEDULE – ELECTRIC VEHICLES		
REGULAR INTERVAL	**SERVICE**	
Annual service by trained technician only (or every 100 hours of operation, whichever comes first)	Batteries (For vehicles equipped with the SPWS)	Manually check battery electrolyte levels of all cells to verify correct valve operation. **See page 14-9.**
	Batteries	If batteries are not performing as expected, see the Batteries section in the maintenance and service manual.
	Safety decals	Check safety decals. Replace if damaged or illegible.

PERIODIC LUBRICATION SCHEDULE

PERIODIC LUBRICATION SCHEDULE – ELECTRIC VEHICLES			
REGULAR INTERVAL	**SERVICE**	**LUBRICATION POINTS**	**RECOMMENDED LUBRICANT**
Semiannually by owner or trained technician (or every 50 hours of operation, whichever comes first)	Brake pedal shaft bearings	1	Dry Moly Lube
	Brake linkage and pivots	2	Dry Moly Lube
	Accelerator pivot rod supports	3	Dry Moly Lube
	Brake slides	4	Dry Moly Lube
	Front suspension	5	Chassis Lube – EP NLGI Grade 2
Annually by trained technician only (or every 100 hours of operation, whichever comes first)	Transaxle: Check/fill to plug level.	6	22 fl-oz (0.67 L) SAE 30 WT. API Class SE, SF, SG Oil (or higher)
	Inspect front wheel bearings (Repack as necessary)	7	Chassis Lube – EP NLGI Grade 2

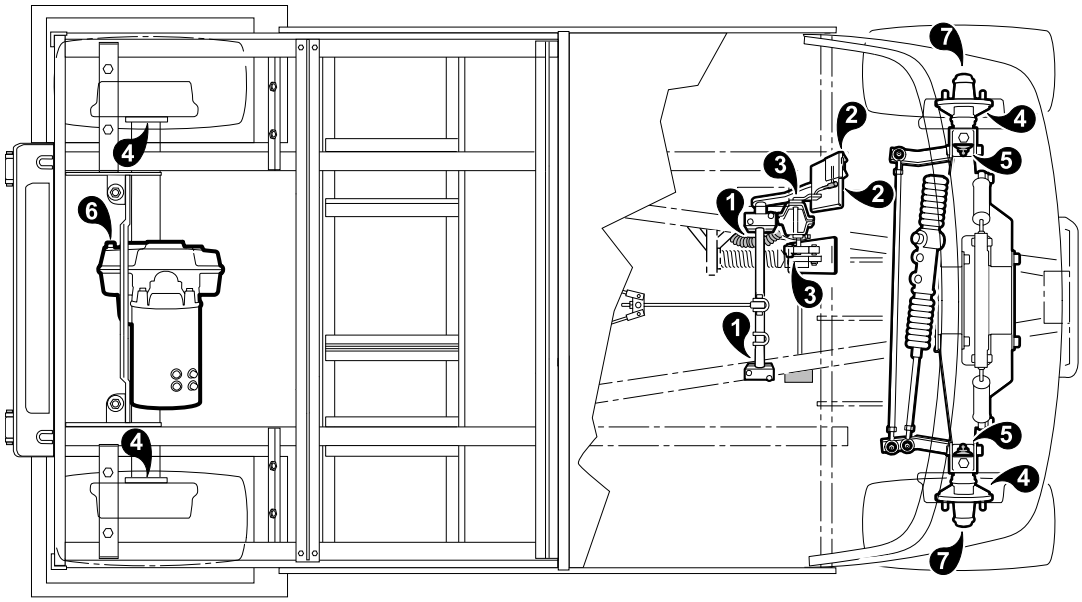

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Figure 10-1 Lubrication Points – Electric Vehicles

SECTION 11 — CONTROLLER DIAGNOSTIC TOOL (CDT)

11

⚠ DANGER

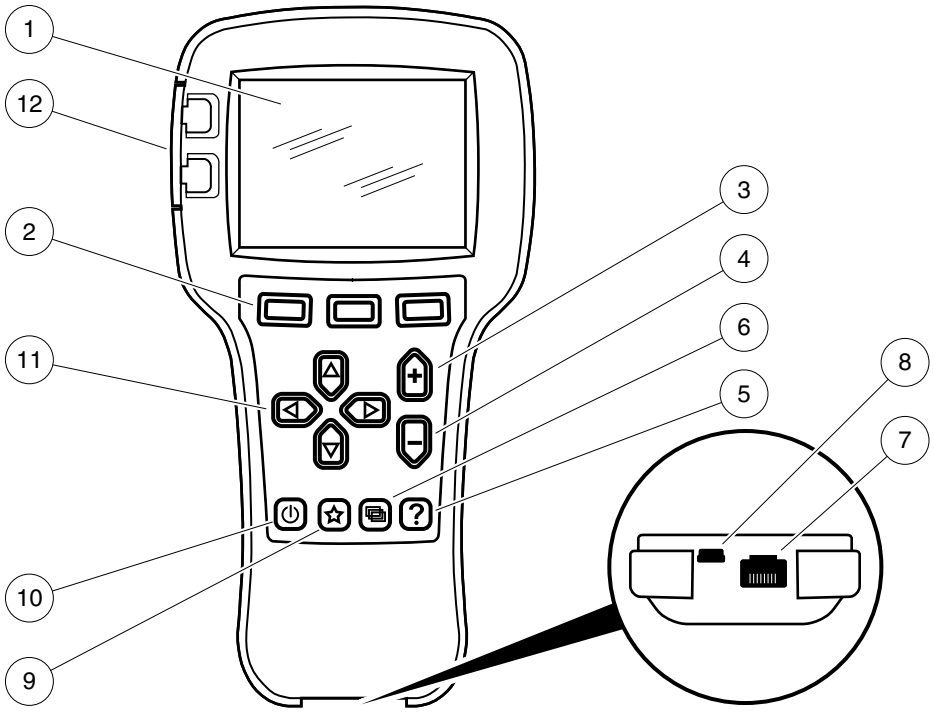
- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

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.*



1. Display Screen	5. Help Button	9. Favorites Button
2. Softkeys	6. Main Menu Button	10. Power Button
3. “+” Key	7. System Port	11. Arrow Keys
4. “–” Key	8. USB Port	12. SD-card Slot

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Figure 11-1 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

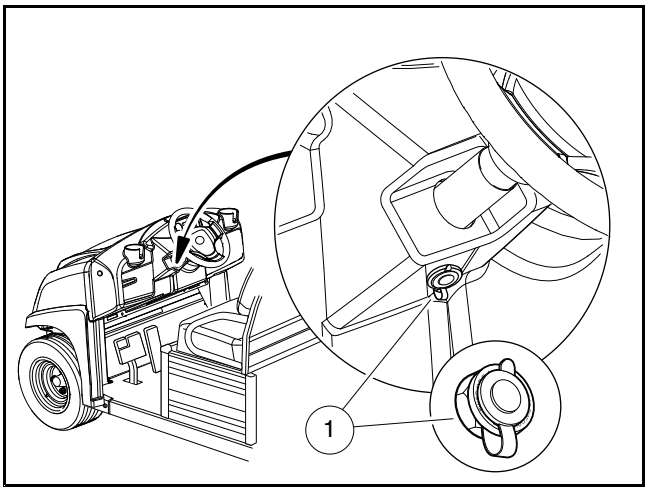

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Figure 11-2 Communication Port Under Instrument Panel

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 11-2, Page 11-3)**.
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 11-18.**

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.**

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 (OS) software version. **See following NOTE.**

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 11-17. 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 (Handheld Programmer) Settings menu; see Plot & Log on page 11-17. For information on creating names, see **Using the Keyboard** in the CDT Owner's Manual.

CLUB CAR

1 – LSV

- **Max Speed** – Defines the maximum allowed vehicle speed at full throttle: 20 to 25 MPH. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value. Note: The maximum allowed vehicle speed is subject to the following Motor Speed Constraints: Electrical Frequency, Encoder Pulses/Revolution and Firmware Max Speed.
- **Fast Accel** – This setting enables or disables the ability of the speed controller to aggressively attempt to match the speed of the motor to the commanded speed.

  This setting enables or disables the ability of the speed controller to aggressively attempt to match the speed of the motor to the commanded speed.

  Determines how aggressively the speed controller attempts to match the speed of the motor to the commanded speed. Larger values provide tighter control. If the gain is set too high, you may experience oscillations as the controller tries to control speed. If it is set too low, the motor may behave sluggishly and be difficult to control.
- **Pedal Up Firm** – This setting enables or disables the ability of the speed controller to use aggressive regenerative braking to slow the vehicle when the accelerator pedal is released.

  This setting enables or disables the ability of the speed controller to use aggressive regenerative braking to slow the vehicle when the accelerator pedal is released.

2 – Carryall

- **Max Speed** – Defines the maximum allowed vehicle speed at full throttle: 3 to 17 MPH. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed Value. Note: The maximum allowed vehicle speed is subject to the following Motor Speed Constraints: Electrical Frequency, Encoder Pulses/Revolution and Firmware Max Speed.
- **Fast Accel** – This setting selects whether the OEM Slow Accel or Fast Accel value (See OEM Tuning menu) is applied. Setting to ON will result in the vehicle reaching top speed sooner.
- **Pedal Up Firm** – This setting enables or disables the ability of the speed controller to use aggressive regenerative braking to slow the vehicle when the accelerator pedal is released.
- **Power Limiting** – This setting enables or disables the power limiting maps that allow performance customization for reduced motor heating and consistent performance over varying battery state-of-charge.

Reverse

- **Reverse Max Speed** – Defines the maximum allowed vehicle speed in reverse at full throttle: 3 to 10 MPH. Partially-applied throttle is scaled proportionately; e.g., 40% applied throttle corresponds to a request for 40% of the set Max Speed value.
- **Reverse Accel** – Defines how quickly the maximum allowed vehicle speed is reached in reverse when throttle is applied: 2.0 to 30.0 seconds.
- **Reverse Pedal Up Decel** – Defines how quickly the vehicle slows down when the throttle is reduced: 1.0 to 30.0 seconds.

Power Limiting

- **PL Base Speed** – Sets the base speed that will be used in the drive limiting map and regen limiting map: 100 to 4000 RPM.
- **PL Delta Speed** – Sets the width of the delta increment that will be used in the drive limiting map and regen limiting map: 50 to 1000 RPM.
- **PL Nominal** – These parameters define the percentage of drive current limit that will be applied at the speeds defined by the base speed and delta speed parameters. The resulting map allows the controller to reduce the drive current as a function of speed. Reducing the power requirements at certain speeds restricts performance. This can be useful for reducing motor heating. It can also be used to keep consistent vehicle power with changing battery state-of-charge: 0 to 100%.
- **PL Base Plus Delta** – See *PL Nominal* above: 0 to 100%.
- **PL Base Plus 2xDelta** – See *PL Nominal* above: 0 to 100%.
- **PL Base Plus 4xDelta** – See *PL Nominal* above: 0 to 100%.
- **PL Base Plus 8xDelta** – See *PL Nominal* above: 0 to 100%.

OEM Tuning

- **Slow Accel** – Defines how quickly the maximum allowed vehicle speed is reached in forward when throttle is applied and the Fast Accel parameter is set to OFF: 1.0 to 30.0 seconds.
- **Fast Accel** – Defines how quickly the maximum allowed vehicle speed is reached in forward when throttle is applied and the Fast Accel parameter is set to ON: 1.0 to 30.0 seconds.
- **Mild Decel** – Defines how quickly the vehicle slows down when the throttle is reduced and the Pedal Up Firm parameter is set to OFF: 1.0 to 30.0 seconds.
- **Firm Decel** – Defines how quickly the vehicle slows down when the throttle is reduced and the Pedal Up Firm parameter is set to ON: 1.0 to 30.0 seconds.

HPD

- **HPD Threshold** – Percentage of throttle input required to set an HPD Fault: 0 to 100%. HPD check is made when the charger input or key input or direction inputs are Off. If the throttle input >25%, an HPD Fault is set. The check on direction is done only after the vehicle has been at rest, so reversing direction with the throttle applied while the vehicle is moving, is allowed.
- **Brake HPD Time** – This defines how long the Brake Pedal can be applied, while the throttle input > 25%, before an HPD fault is declared. A setting of 0.0 turns this portion of the HPD logic off entirely: 0.0 to 2.0 seconds.

Brake

- **Electric Braking** – This defines whether motor braking is commanded when the Brake cylinder pressure switch is closed: ON or OFF.
- **Antiskid Enable** – This detects an ultra-rapid deceleration of motor speed indicating that the wheels may have become locked in a skid condition. The function releases the braking torque briefly to attempt to allow the wheels to spin and regain traction: ON or OFF.
- **BLD Regen Current Upper** – This specifies the level of Motor Braking Current that will result in the Brake Lights being switched ON: 0 to 1000 Ampere. (The Brake Lights will also be switched on when the Brake cylinder pressure switch is detected as closed, indicating the Brake Pedal is being applied.)
- **BLD Regen Current Lower** – Unused: 0 to 1000 Ampere.
- **BLD Min Time** – This defines the time that the Brake Lights will remain lit after the Brake Lights ON conditions are no longer present (i.e. (Motor Braking Current < BLD Regen Current Upper) and Brake Switch Open): 0 to 1000 ms.

EnGage IV

- **EnGage Enable** – This setting enables or disables the EnGage IV which is a microprocessor based instrument panel that can be customized to monitor, display, and control numerous vehicle functions. EnGage IV is not used on this vehicle.

Amp Hours

- **Amp Hour Reset** – 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.
- **AHr Regen Factor** – This defines what percentage of regen current is "credited" towards Amp Hours used: 0 to 100%.
- **AHr External Load** – This defines a value to represent the battery current used by accessories that the controller cannot measure directly (e.g. lights, radio). This value is then added into the Amp Hours used calculation: 0.0 to 100.0 Ampere.

Vehicle Menu

- **MPH to Hz at 30MPH** – This defines the correct frequency to be output to the speedometer (at 30 MPH) to allow vehicle speed to be displayed correctly: 100 to 1000 Hz.

Motor

- **Motor Select** – This parameter references a predefined table of motor parameters for many AC motors: 1, 2, or 3. Factory setting is 2. Consult your local Curtis customer support engineer for information on how to set this parameter based on your application and motor.

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.
- **Voltage Rise Delta** – This defines the minimum rise in Battery Voltage that the controller must detect, after the charger has been plugged in, to determine that the batteries are being charged and output the audible beep pattern: 0.4 to 4.0 volts.

LED Control

- **LED Solid** – This setting enables or disables the Charge Indicator Light to come ON and stay ON when the battery pack reaches a low state of charge (SoC).
- **LED Solid SOC Level** – Use this setting to determine the battery state of charge percentage that will trigger when the Charge Indicator Light comes ON and stays ON.
- **LED Flashing** – This setting enables or disables the Charge Indicator Light to flash ON and OFF when the battery pack reaches a critically low state of charge (SoC).
- **LED Flashing SOC Level** – Use this setting to determine the battery state of charge percentage that will trigger when the Charge Indicator Light flashes ON and OFF.

THROTTLE

NOTE: *All three throttle adjustment parameters; Deadband, Map, and Max, condition the raw throttle voltage into a single % throttle command.*

Forward Deadband

Defines the wiper voltage at the throttle deadband threshold: 0 to 5.00 volts. Increasing the throttle deadband setting will increase the neutral range. This parameter is especially useful with throttle assemblies that do not reliably return to a well-defined neutral point, because it allows the deadband to be defined wide enough to ensure that the controller goes into neutral when the throttle mechanism is released.

Forward Map

Modifies the vehicle's response to the throttle input: 0 to 100%. Setting the throttle map at 50% provides a linear output response to throttle position. Values below 50% reduce the controller output at low throttle settings, providing

enhanced slow speed maneuverability. Values above 50% give the vehicle a faster, more responsive feel at low throttle settings. The map value is the percentage of controller output at half throttle ((deadband + max)/2).

Forward Max

Defines the wiper voltage required to produce 100% controller output: 0 to 5.00 volts. Decreasing the throttle max setting reduces the wiper voltage and therefore the full stroke necessary to produce full controller output. This parameter allows reduced-range throttle assemblies to be accommodated.

Reverse Deadband

This Throttle Reverse parameter is the same as its Throttle Forward counterpart, and applies when the throttle direction is reversed.

Reverse Map

This Throttle Reverse parameter is the same as its Throttle Forward counterpart, and applies when the throttle direction is reversed.

Reverse Max

This Throttle Reverse parameter is the same as its Throttle Forward counterpart, and applies when the throttle direction is reversed.

VEHICLE

Speed to RPM

This parameter affects the vehicle speed displayed in the Monitor » Motor menu **(see Motor on page 11-10)** and also modifies the VCL variable Vehicle_Speed; it does not affect actual vehicle performance. The value entered for Speed to RPM is a conversion factor that scales motor speed to vehicle speed: 10.0 to 3000.0.

KPH to RPM: (G/d)*5.305, where G = gear ratio, d = tire diameter [cm].

MPH to RPM: (G/d)*336.1, where G = gear ratio, d = tire diameter [in].

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.**

⚠ 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:

CLUB CAR

Inputs

- **Throttle** – Indicates the position of the accelerator pedal from 0% (pedal not pressed) to 95 and 100% (pedal fully pressed). This item can be monitored when the key switch is in the ON or OFF position.
- **Throttle Command** – Throttle request to slew rate block: -100 to 100%.
- **Mapped Command** – Mapped throttle request: -100 to 100%.
- **Throttle Voltage** – Voltage at throttle pot wiper (pin 16): 0 to 5.5 volts.
- **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.
- **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.
- **Mode Input** – Indicates what mode the vehicle is being operated in (Mode 1 or Mode 2): ON or OFF.
- **Brake Switch** – Indicates the status of the pressure switch on the master cylinder: ON or OFF.
- **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.
- **Park Brake** – Indicates the status of the park brake: ON or OFF.

- **Temp Sensor Voltage** – Displays the measured voltage of the motor temperature sensor.

Outputs

- **Main Contactor** – Indicates the Driver 1 PWM output (pin 6): ON or OFF.
- **Reverse Buzzer** – Indicates the Driver 4 PWM output (pin 3): 0 to 100%.
- **Dash LED** – Indicates the Driver 2 PWM output (pin 5): 0 to 100%.
- **Brake Light Relay** – Indicates the Driver 3 PWM output (pin 4): 0 to 100%.
- **5 Volts** – Indicates the voltage at +5V output (pin 26): 0 to 6.25 volts.
- **Ext Supply Current** – Indicates the combined current of the external +12V and +5V voltage supplies (pins 25 and 26): 5 to 200 mA.
- **Pot Low** – Indicates the voltage at pot low (pin 18): 0 to 6.25 volts.

Battery

- **Battery Current** – Displays the computed current being drawn from (or returned to) the batteries.
- **BDI** – Battery Display Indicator (BDI) Percent displays the current battery state of charge as a percent: 0 to 100%. It is based on several parameters monitored by the controller.
- **Capacitor Voltage** – Indicates the voltage of controller's internal capacitor bank at B+ terminal: 0 to 105 volts.
- **Pin 1 Voltage** – Indicates the voltage at TOW/RUN switch input (pin 1): 0 to 105 volts.
- **Amp Hours** – Displays total accumulated amp hours removed since initial vehicle start-up.
- **OS Amp Hours** – Displays total accumulated operating system amp hours removed since initial vehicle start-up.

Motor

- **Motor RPM** – Indicates the motor speed in revolutions per minute: -12000 to 12000 RPM.
- **Motor Temperature** – Indicates the temperature sensor readout in the motor: -100 to 300 °C.
- **Encoder A** – Indicates the motor encoder phase A speed in revolutions per minute: 0 to 12000 RPM. This can be used to verify that phase A of the encoder is operating correctly. Encoder A should equal Encoder B in a properly operating motor encoder. Encoder A does not indicate direction.
- **Encoder B** – Indicates the motor encoder phase B speed in revolutions per minute: 0 to 12000 RPM. This can be used to verify that phase B of the encoder is operating correctly. Encoder B should equal Encoder A in a properly operating motor encoder. Encoder B does not indicate direction.

Controller

- **Current RMS** – Indicates RMS current of the controller, taking all three phases into account: 0 to 1000 A.
- **Modulation Depth** – Indicates the percentage of available voltage being used: 0 to 100%.
- **Frequency** – Indicates controller electrical frequency: -300 to 300 Hz.
- **Controller Temperature** – Indicates controller internal temperature: -100 to 300 °C.
- **Main State** – Indicates Main Contactor state.

0 = open	1 = precharge	2 = weldcheck
3 = closingdelay	4 = missingcheck	5 = closed (when Main Enable = On)
6 = delay	7 = arccheck	8 = opendelay
9 = fault	10 = closed (when Main Enable = Off)	

Cutbacks

- **Motor Temp Cutback** – Displays the current available as a result of the motor temperature cutback function: 0 to 100%. A value of 100% indicates no cutback in current.
- **Controller Temp Cutback** – Displays the current available as a result of the controller temperature cutback function: 0 to 100%. A value of 100% indicates no cutback in current.
- **Undervoltage Cutback** – Displays the current available as a result of the undervoltage cutback function: 0 to 100%. A value of 100% indicates no cutback in current.
- **Overvoltage Cutback** – Displays the current available as a result of the overvoltage cutback function: 0 to 100%. A value of 100% indicates no cutback in current.

Vehicle

- **Vehicle Speed** – Indicates the approximate ground speed of the vehicle in miles per hour (MPH).
- **Odometer** – Vehicle distance traveled, in units of miles or km, depending on the setting of the Metric Units parameter. For accurate distance measurements, the Speed to RPM parameter must be set correctly.
- **Distance Since Stop** – Distance traveled by the vehicle starting from a stop. In effect, the vehicle is used as a tape measure. (In other words, if you travel 300 feet forward and then 300 feet in reverse, the distance would be 600.) The distance is continuously updated and will stop (and restart) when Motor_RPM = 0. For accurate distance measurements, the Speed to RPM parameter must be set correctly. Units are meters or feet, depending on the setting of the Metric Units parameter.
- **Distance Fine** – Position measurement. Net distance in both the forward and reverse directions. (In other words, if you travel 20 inches forward and then 20 inches in reverse, the distance would be zero.) The distance is continuously updated and will roll over when the variable goes over the limits. Units are decimeters or inches, depending on the setting of the Metric Units parameter. For accurate distance measurements, the Speed to RPM parameter must be set correctly.

DIAGNOSTICS MENU

CAUTION

- **A failed motor will damage the controller. Always inspect the motor before replacing the controller. See External Motor Testing, Section 16, Page 16-1.**

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 / 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.

SYSTEM FAULTS

NOTE: *The system faults menu displays all of the present faults detected by the speed controller. The faults displayed in this menu are currently active. Once a fault has been detected, it is stored in the memory of the speed controller for display on the fault history menu. Each detected fault is listed only once in the fault history menu, the number of fault occurrances are located in the fault counter section of the monitor menu, even if the fault has occurred multiple times.*

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 speed 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 speed 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 vehicle speed controller should be checked for fault codes before any service is performed.

The speed controller, after detecting a fault, will respond in one or more of the following ways:

1. Reduces vehicle speed to zero

3. Turns off Main Contactor

4. "Limp-Home:" Causes the vehicle to run at half speed

5. Gradually reduces the motor current limit

7. Gradually reduces Regen Current Limit

8. SmartKey functions NOT enabled

9. PASSWORD TRIES count incremented

10. Sets Internal Scaled Throttle Signal to Zero

12. Activates Walk Away function

13. Activates Walk Away beeping immediately

FAULT RECOVERY

See Troubleshooting Guide 2 on page 12-7.

When a fault is detected by the speed controller, the speed 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 immediately after the condition clears or after the accelerator pedal has been cycled (released and pressed again).

FAULT DESCRIPTIONS

The following faults can be detected by the LSV controller and seen under both the *Monitor Menu* and *Diagnostics Menu*:

See Troubleshooting Guide 2 on page 12-7.

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 11-1, Page 11-1)**. 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.

TABLE CONTINUED ON NEXT PAGE

MENU ITEM	DESCRIPTIONS
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 ( ).
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.

TROUBLESHOOTING GUIDE		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Handset display screen is blank	Handset cord and/or adaptor is disconnected	**See Plugging the CDT into the Vehicle on page 11-3.**
	Vehicle batteries – loose terminals or corrosion	Section 14 — Batteries
	Vehicle batteries – improperly wired	Section 14 — Batteries
	Vehicle batteries – batteries failed	Section 14 — Batteries
	Vehicle batteries – batteries not fully charged	Section 14 — Batteries
	Handset cord has failed	Test Procedure 1 – Handset Cord on page 11-19
	Handset cord adaptor has failed	Test Procedure 2 – Handset Cord Adaptor on page 11-20
	CDT port (mounted under instrument panel assembly) has failed	Test Procedure 3 – CDT Port (Located Under Steering Wheel) on page 11-20
	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 Port (Located Under Steering Wheel) on page 11-20
	Speed controller malfunction	Section 12 — Electrical System Troubleshooting
	Handset has failed	Replace handset

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Display screen shows jumbled or undecipherable characters	Speed controller malfunction	Section 12 — Electrical System Troubleshooting
	Handset malfunction	Disconnect the CDT cord from the vehicle. Wait a few seconds and reconnect the handset to the vehicle
	Loose connection at CDT port	Test Procedure 3 – CDT Port (Located Under Steering Wheel) on page 11-20
	Intermittent handset cord failure	Test Procedure 1 – Handset Cord on page 11-19
	Intermittent handset cord adaptor failure	Test Procedure 2 – Handset Cord Adaptor on page 11-20
	Loose vehicle wire harness connections	Test Procedure 3 – CDT Port (Located Under Steering Wheel) on page 11-20
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	Section 14 — Batteries
	Vehicle batteries – improperly wired	Section 14 — Batteries
	Vehicle batteries – batteries failed	Section 14 — Batteries
	Vehicle batteries – batteries not fully charged	Section 14 — Batteries
	Speed controller malfunction	Section 12 — Electrical System Troubleshooting

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

TEST PROCEDURE 1 – Handset Cord

See General Warnings on page 1-1.

1. 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.

2. Place the black (–) probe on each of the pins, one at a time, on the plug on the other end of the cord.
3. 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 1-1.

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 Port (Located Under Steering Wheel)

See General Warnings on page 1-1.

Inspect the CDT port for damage or corrosion.

1. Turn the key switch to the OFF position, place the Forward/Reverse switch in the NEUTRAL position, and lock the park brake.
2. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
3. Check the CDT port mounted under the steering wheel.

3.1. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-9.**

3.2. Disconnect the CDT port four-pin connector from the main wire harness and visually inspect the contacts for damage and corrosion. Inspect the CDT port mounted to the bottom of the dash panel. Repair and replace parts as necessary.

3.3. If no problem is found, connect the four-pin connector and install the center dash panel.

3.4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

3.5. Align the keyed portion of the CDT plug with the CDT port and connect. If the handset fails to function, **see CDT Troubleshooting on page 11-18**.

SECTION 12 — ELECTRICAL SYSTEM TROUBLESHOOTING 12

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

The LSV vehicle uses a 48-volt electrical system with an AC induction motor that is powered by eight, 6-volt, lead-acid batteries and charged by a high-frequency charger. Several additional features include the following:

ACCESSORIES

For powered accessories that need to be controlled by the key switch, use the 12-volt power strip located under the cowl.

CHARGE INDICATOR LIGHT

LSV vehicles with QuiQ Charger system feature a dash mounted charge indicator light that serves two functions: 1) Battery low state of charge warning, and 2) Charging confirmation. The charge indicator light is controlled by pin 5 of the controller. The presence of AC power to the charger is monitored from pin 11.

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 Charger Control, Section 11, Page 11-7.***

KEY DIFFERENCES: LSV SYSTEM WITH QUIQ CHARGER VS. IQ PLUS CHARGER

- Utilizes the 1236-5410 controller (gold label) instead of the 1236-5402.
- The onboard computer (OBC) is no longer used.
- New main wire harness that uses a 10k Ohm pull-up resistor for the charger interlock circuit.
- 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. 8 (8 x 6-volt battery set).
- New battery charge indicator light in the instrument panel that is controlled by pin 5 of the controller. This light is used to confirm when a charge cycle begins and when the battery pack has reached a low state of charge.
- A new controller is used that has data collecting functions previously performed by the OBC.
- The controller tracks amp-hour usage for fleet management and warranty administration.
- No Communication Display Module (CDM) required. Use only the Controller Diagnostic Tool (CDT).
- The CDT will remain ON for approximately 10 minutes when the charger is activated.
- Improved charger and battery state of charge (SoC) status indication.
- Battery charger algorithm can be changed in the field instead of changing an onboard computer (OBC).
- B+ red wire of charger wire harness connects directly to the solenoid to reduce potential corrosion.

FEATURES

- **Motor Braking:** This feature helps to control vehicle downhill speed. When traveling downhill, motor braking engages to maintain speeds proportional to the accelerator pedal position. For example, when the accelerator pedal is fully depressed, motor braking holds the vehicle at the programmed top speed. When the accelerator pedal is fully released, motor braking slows the vehicle to a complete stop.
- **Walk Away Braking:** the walk away braking feature will prevent the vehicle from rolling at more than 1 or 3 mph (1.5 or 4.8 km/h) unless the accelerator is pressed. This prevents the possibility of a parked vehicle (with the park brake disengaged) rolling away too fast to be overtaken on foot. 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.

⚠ WARNING

- **Walk away braking will not limit vehicle speed to 1 mph (1.6 km/h) on very steep grades. Do not operate vehicle on slopes exceeding 20% grades.**

- **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 OBC and 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.
- **High Pedal Detect:** This function prevents unexpected vehicle movement if the key switch is turned ON after the accelerator is pressed or the Forward/Reverse switch is used to change the direction of travel while the vehicle is being driven. The vehicle slowly comes to a controlled stop, then starts to gradually accelerate in the new direction.

  If either situation arises, an *HPD fault* is recorded by the speed controller and will be displayed on an CDT handset in the Diagnostic History menu.

SONIC WELD, DIODE, AND 10K OHM RESISTOR LOCATIONS

See Wiring Diagrams.

TROUBLESHOOTING

The following troubleshooting guides will be helpful in identifying operating difficulties should they occur. Diagnostic information can be obtained in either of two ways: (1) by reading the display on the CDT or (2) by observing the fault codes issued by the Status LEDs. See Summary of LED Display Formats on page 12-7 for a summary of LED display formats. 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 this maintenance and service manual.

TROUBLESHOOTING THE VEHICLE WITH THE CDT

Club Car recommends the use of the CDT handset for troubleshooting vehicles appropriately equipped. Troubleshooting Guide 1 is to be used in conjunction with the CDT handset. Refer to the CDT Owner's Manual 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 3.

If an CDT handset is unavailable, the technician should proceed to Troubleshooting Guide 2. In the event that the vehicle is not functioning properly after completing Troubleshooting Guide 2, the technician should proceed to Troubleshooting Guide 3.

TROUBLESHOOTING GUIDE 1

The following troubleshooting guide is intended for use with an CDT handset. For CDT operating instructions, refer to the CDT Owner's Manual. **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 1 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 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed MCOR	Test Procedure 13 – MCOR Voltage on page 12-33
Diagnostic Menu – THERMAL CUTBACK fault code	Over-adjusted brakes	See Wheel Brake Assemblies Section
	Vehicle is over-loaded or has exceeded its duty cycle	Ensure that vehicle is not over-loaded before returning to operation
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 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed motor speed sensor or failed magnet	**See External Motor Testing on page 16-1.**

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 1		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
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 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed MCOR limit switch	Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26
Monitor Menu – FORWARD INPUT and/or REVERSE INPUT does not indicate the correct reading or Diagnostic Menu – PROC/WIRING fault code	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 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed Forward/Reverse rocker switch	Test Procedure 7 – Forward/Reverse Rocker Switch on page 12-27
Diagnostic Menu – MAIN CONT DNC (main contactor (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 See General Warnings on page 1-1.** Reconnect the batteries and see if the symptom returns.
	Failed controller FET (that powers up solenoid coil)	
	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 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed solenoid	Replace solenoid. **See Solenoid Removal on page 13-12.**
Monitor Menu – KEY INPUT does not indicate ON when key switch is in the ON position	Loose or disconnected wires at key switch terminals or broken wire	Repair and/or connect the quick disconnect terminals to the Forward/Reverse switch
	Loose or disconnected 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed key switch	Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26
Diagnostic Menu – THROTTLE FAULT 1 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 35-pin connector at speed controller or broken wire	Repair and/or connect the 35-pin connector to the speed controller
	Failed MCOR	Test Procedure 13 – MCOR Voltage on page 12-33

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 1		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Diagnostic Menu – HW FAILSAFE (Hardware Failsafe) fault code	Armature drive FET's (field-effect transistors) inside speed controller have failed	Replace the speed controller. **See Speed Controller Removal on page 13-10.**
	Speed controller logic malfunction	Disconnect the batteries and allow the speed controller capacitors to discharge. **See WARNING "To avoid unintentionally starting..." in See General Warnings on page 1-1.** 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 13-12.**
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 See General Warnings on page 1-1.** 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 13-10.**
Diagnostic Menu – MAIN COIL FAULT fault code or Diagnostic Menu – MAIN DROPOUT fault code	Solenoid coil has failed in an open condition or broken wire to solenoid coil	Replace solenoid. **See Solenoid Removal on page 13-12.**
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	Section 14 — Batteries
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

The following troubleshooting guide is intended for use with the Status LED lights found on the speed controller.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes displaying all the currently set faults in a repeating cycle. Each code consists of two digits. The red LED flashes once to indicate that the first digit of the code will follow; the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow; the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Fault menu of the CDT, the words Undervoltage Cutback will be displayed; the real-time battery voltage is displayed in the Monitor menu (“Keyswitch Voltage”).

The controller’s two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
★ (one flash)	☼☼ (two flashes)	★★ (two flashes)	☼☼☼ (three flashes)
(first digit)	(2)	(second digit)	(3)

The numerical codes used by the yellow LED are listed in Troubleshooting Guide 2, which also lists possible fault causes and describes the conditions that set and clear each fault.

Summary of LED Display Formats

The two LEDs have five different display modes, indicating the type of information they are providing.

LED DISPLAY	STATUS
Neither LED illuminated	Controller is not powered on, has a dead battery, or is severely damaged.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure. Cycle KSI (key switch input) to restart.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

Using Troubleshooting Guide 2

Troubleshooting Guide 2 provides the following information on all the controller faults:

- fault code
- fault name as displayed on the programmer’s LCD
- the effect of the fault
- possible causes of the fault
- fault set conditions
- fault clear conditions

Whenever a fault is encountered and no wiring or vehicle fault can be found, shut off KSI (key switch input) and turn it back on to see if the fault clears. If not, shut off KSI and disconnect the 35-pin connector. Check the connector for corrosion or damage, clean it if necessary, and reconnect it.

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** *EFFECT OF FAULT*	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
12	Controller Overcurrent *ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake.*	1. External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective.	*Set:* Phase current exceeded the current ShutdownMainContactor; motor connections. measurement limit. *Clear:* Cycle KSI.
13	Current Sensor Fault *ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake.*	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 3. Controller defective.	*Set:* Controller current sensors have invalid offset reading. *Clear:* Cycle KSI.
14	Precharge Failed *ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake.*	1. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging. 2. See CDT menu Monitor » Battery: Capacitor Voltage.	*Set:* Precharge failed to charge the capacitor bank to the KSI voltage. *Clear:* Cycle Interlock input or use VCL function Precharge().
15	Controller Severe Undertemp *ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Controller is operating in an extreme environment. 2. See CDT menu Monitor » Controller: Temperature.	*Set:* Heatsink temperature below -40°C. *Clear:* Bring heatsink temperature above -40°C, and cycle interlock or KSI.
16	Controller Severe Overtemp *ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Controller is operating in an extreme environment. 2. Excessive load on vehicle. 3. Improper mounting of controller. 4. See CDT menu Monitor » Controller: Temperature.	*Set:* Heatsink temperature above +95°C. *Clear:* Bring heatsink temperature below +95°C, and cycle interlock or KSI.
17	Severe Undervoltage *Reduced drive torque.*	1. Battery Menu parameters are misadjusted. 2. Non-controller system drain on battery. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. See CDT menu Monitor » Battery: Capacitor Voltage. 6. Blown B+ fuse or main contactor did not close.	*Set:* Capacitor bank voltage dropped below the Severe Undervoltage limit (see page 55) with FET bridge enabled. *Clear:* Bring capacitor voltage above Severe Undervoltage limit.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** ***EFFECT OF FAULT***	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
18	Severe Overvoltage *ShutdownMainContactor; ShutdownMotor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Battery Menu parameters are misadjusted. 2. Battery resistance too high for given regen current. 3. Battery disconnected while regen braking. 4. See CDT menu Monitor » Battery: Capacitor Voltage.	*Set:* Capacitor bank voltage exceeded the Severe Overvoltage limit (see page 55) with FET bridge enabled. *Clear:* Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
21	Controller Undertemp Cutback *None, unless a fault action is programmed in VCL.*	1. Controller is performance-limited at this temperature. 2. Controller is operating in an extreme environment. 3. See CDT menu Monitor » Controller: Temperature.	*Set:* Heatsink temperature dropped below -25°C. *Clear:* Bring heatsink temperature above -25°C.
22	Controller Overtemp Cutback *Reduced drive and brake torque.*	1. Controller is performance-limited at this temperature. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle. 4. Improper mounting of controller. 5. See CDT menu Monitor » Controller: Temperature.	*Set:* Heatsink temperature exceeded 85°C. *Clear:* Bring heatsink temperature below 85°C.
23	Undervoltage Cutback *Reduced drive torque.*	1. Normal operation. Fault shows that the batteries need recharging. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Non-controller system drain on battery. 4. Battery resistance too high. 5. Battery disconnected while driving. 6. See CDT menu Monitor » Battery: Capacitor Voltage. 7. Blown B+ fuse or main contactor did not close.	*Set:* Capacitor bank voltage dropped below the Undervoltage limit (see page 55) with the FET bridge enabled. *Clear:* Bring capacitor voltage above the Undervoltage limit.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** *EFFECT OF FAULT*	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
24	Overvoltage Cutback *Reduced brake torque.*	1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking. 5. See CDT menu Monitor » Battery: Capacitor Voltage.	*Set:* Capacitor bank voltage exceeded the Overvoltage limit (see page 55) with the FET bridge enabled. *Clear:* Bring capacitor voltage below the Overvoltage limit.
25	+5V Supply Failure *None, unless a fault action is programmed in VCL.*	1. External load impedance on the +5V supply (pin 26) is too low. 2. See CDT menu Monitor » outputs: 5 volts and Ext Supply Current.	*Set:* +5V supply (pin 26) outside the +5V (±10%) range. *Clear:* Bring voltage within range.
26	Digital Out 6 Overcurrent *Digital Output 6 driver will not turn on.*	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	*Set:* Digital Output 6 (pin 19) current exceeded 15 mA. *Clear:* Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
27	Controller Undertemp Cutback *Digital Output 7 driver will not turn on.*	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	*Set:* Digital Output 7 (pin 20) current exceeded 15 mA. *Clear:* Remedy the overcurrent cause and use the VCL function Set_DigOut() to turn the driver on again.
28	Motor Temp Hot Cutback *Reduced drive torque.*	1. Motor temperature is at or above the programmed Temperature Hot setting, and the requested current is being cut back. 2. Motor Temperature Control Menu parameters are mis-tuned. 3. See CDT menus Monitor » Motor: Temperature and Monitor » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	*Set:* Motor temperature is at or above the Temperature Hot parameter setting. *Clear:* Bring the motor temperature within range.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** ***EFFECT OF FAULT***	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
29	Motor Temp Sensor Fault *MaxSpeed reduced (LOS, Limited Operating Strategy) and motor temperature cutback is disabled.*	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off. 3. See CDT menus Monitor » Motor: Temperature and Monitor » Inputs: Analog2.	*Set:* Motor thermistor input (pin 8) is at the voltage rail (0 or 10V). *Clear:* Bring the motor thermistor input voltage within range.
31	Coil1 Driver Open/Short *ShutdownDriver1.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 1 (pin 6) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
31	Main Open/Short *ShutdownDriver1; ShutdownMotor; ShutdownEMBrake.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Main contactor driver (pin 6) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
32	Coil2 Driver Open/Short *ShutdownDriver2.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 2 (pin 5) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
32	EM Brake Open/Short *ShutdownDriver2; ShutdownThrottle; FullBrake.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Electromagnetic brake driver (pin 5) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
33	Coil3 Driver Open/Short *ShutdownDriver3.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 3 (pin 4) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
34	Coil4 Driver Open/Short *ShutdownDriver4.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 4 (pin 3) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
35	PD Open/Short *ShutdownPD.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Proportional driver (pin 2) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
36	Encoder Fault *Control Mode changed to LOS (Limited Operating Strategy).*	1. Motor encoder failure. 2. Bad crimps or faulty wiring. 3. See CDT menu Monitor » Motor: Motor RPM.	*Set:* Motor encoder phase failure detected. *Clear:* Cycle KSI.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** ***EFFECT OF FAULT***	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
37	Motor Open *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake.*	1. Motor phase is open. 2. Bad crimps or faulty wiring.	*Set:* Motor phase U, V, or W deteected open. *Clear:* Cycle KSI.
38	Main Contactor Welded *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake.*	1. Main contactor tips are welded closed. 2. Motor phase U is disconnected or open. 3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).	*Set:* Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. *Clear:* Cycle KSI.
39	Main Contactor Did Not Close *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake.*	1. Main contactor did not close. 2. Main contactor tips are oxidized, burned, or not making good contact. 3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. 4. Blown B+ fuse.	*Set:* With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. *Clear:* Cycle KSI.
41	Throttle Wiper High *ShutdownThrottle.*	1. Throttle pot wiper voltage too high. 2. See CDT menu Monitor » Inputs: Throttle Pot.	*Set:* Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). *Clear:* Bring throttle pot wiper voltage below the fault threshold.
42	Throttle Wiper Low *ShutdownThrottle.*	1. Throttle pot wiper voltage too low. 2. See CDT menu Monitor » Inputs: Throttle Pot.	*Set:* Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()). *Clear:* Bring throttle pot wiper voltage above the fault threshold.
43	Brake Wiper High *FullBrake.*	1. Brake pot wiper voltage too high. 2. See CDT menu Monitor » Inputs: Brake Pot.	*Set:* Brake pot wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults()). *Clear:* Bring brake pot wiper voltage below the fault threshold.
44	Brake Wiper Low *FullBrake.*	1. Brake pot wiper voltage too low. 2. See CDT menu Monitor » Inputs: Brake Pot.	*Set:* Brake pot wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function Setup_Pot_Faults()). *Clear:* Bring brake pot wiper voltage above the fault threshold.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** *EFFECT OF FAULT*	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
45	Pot Low Overcurrent *ShutdownThrottle;* *FullBrake.*	1. Combined pot resistance connected to pot low is too low. 2. See CDT menu Monitor » Outputs: Pot Low.	*Set:* Pot low (pin 18) current exceeds 10mA. *Clear:* Clear pot low overcurrent condition and cycle KSI.
46	EEPROM Failure *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the CDT, or by loading new software into the controller.	*Set:* Controller operating system tried to write to EEPROM memory and failed. *Clear:* Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	HPD/Sequencing Fault *ShutdownThrottle.*	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See CDT menu Monitor » Inputs.	*Set:* HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. *Clear:* Reapply inputs in correct sequence.
48	Emer Rev HPD *ShutdownThrottle;* *ShutdownEMBrake.*	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	*Set:* At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral. *Clear:* If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.
49	Parameter Change Fault *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake.*	1. This is a safety fault caused by a change in certain CDT parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	*Set:* Adjustment of a parameter setting that requires cycling of KSI. *Clear:* Cycle KSI.
51–67	OEM Faults *(See OEM documentation.)*	1. These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.	*Set:* See OEM documentation. *Clear:* See OEM documentation.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** *EFFECT OF FAULT*	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
68	VCL Runtime Error *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. VCL code encountered a runtime VCL error. 2. See CDT menu Monitor » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	*Set:* Runtime VCL code error condition. *Clear:* Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
69	External Supply Out of Range *None, unless a fault action is programmed in VCL.*	1. External load on the 5V and 12V supplies draws either too much or too little current. 2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. 3. See CDT menu Monitor » Outputs: Ext Supply Current.	*Set:* The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. The two thresholds are defined by the Ext Supply Max and Ext Supply Min parameter settings (page 52). *Clear:* Bring the external supply current within range.
71	OS General *ShutdownMainContactor;* *ShutdownMotor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. Internal controller fault.	*Set:* Internal controller fault detected. *Clear:* Cycle KSI.
72	PDO Timeout *ShutdownInterlock;* *CAN NMT State set to Pre-operational.*	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	*Set:* Time between CAN PDO messages received exceeded the PDO Timeout Period. *Clear:* Cycle KSI.

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 2			
CODE	**PROGRAMMER LCD DISPLAY** *EFFECT OF FAULT*	**POSSIBLE CAUSES**	**SET/CLEAR CONDITIONS**
73	Stall Detect *Control Mode changed to LOS (Limited Operating Strategy).*	1. Stalled motor. 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Problems with power supply for the motor encoder. 5. See CDT menu Monitor » Motor: Motor RPM.	*Set:* No motor encoder movement detected. *Clear:* Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.
87	Motor Characterization Fault *ShutdownMainContactor;* *ShutdownThrottle;* *ShutdownEMBrake;* *ShutdownMotor.*	1. Motor characterization failed because of an Overvoltage or Undervoltage fault, Motor Temperature Sensor fault, or Motor_Temperature > 150°C during the characterization process.	*Set:* Motor characterization failed during the motor characterization process. *Clear:* Cycle KSI.
88	Encoder Characterization Fault *ShutdownMainContactor;* *ShutdownThrottle;* *ShutdownEMBrake;* *ShutdownMotor* *Encoder_Steps set to value = 31.*	1. Encoder characterization failed during the motor characterization process. 2. Motor encoder pulse rate is not a standard value (32, 48, 64, 80 ppr).	*Set:* During the motor characterization process, encoder pulses were detected but the Encoder_Steps were not detected as 32, 48, 64, or 80 ppr. *Clear:* Manually set Encoder_Steps to the correct value for the motor encoder and cycle KSI.
89	Motor Type Fault *ShutdownMainContactor;* *ShutdownThrottle;* *ShutdownEMBrake;* *ShutdownMotor.*	1. The Motor_Type parameter value is out of range.	*Set:* Motor_Type parameter is set to an illegal value. *Clear:* Set Motor_Type to correct value and cycle KSI.
92	EM Brake Failed to Set *Enter Position Hold.*	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	*Set:* After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. *Clear:* Activate the throttle.
93	Limited Operating Strategy (LOS) *Enter LOS control mode.*	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detect Fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	*Set:* Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. *Clear:* Cycle KSI, or if the LOS mode was activated by the Stall Fault, clear LOS by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.
94	Emer Rev Timeout *ShutdownThrottle;* *ShutdownEMBrake.*	1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. 2. The emergency reverse input is stuck On.	*Set:* Emergency Reverse was activated and ran until the EMR Timeout timer expired. *Clear:* Turn the emergency reverse input Off.

TROUBLESHOOTING GUIDE 3

TROUBLESHOOTING GUIDE 3		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Vehicle does not operate	Batteries discharged	Charge batteries
	Improper or poor battery connections	Check vehicle wiring. **See Wiring Diagrams beginning on page .**
	Battery charger AC cord is plugged in – Charger lockout feature has disabled the vehicle	Unplug the battery charger AC cord
	Onboard battery charger failure	Replace battery charger
	Key switch and MCOR limit switch circuit	Check for loose or disconnected wires at key switch and MCOR
	Failed key switch	Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26
	Failed MCOR	Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26, see also Test Procedure 13 – MCOR Voltage on page 12-33.
	Forward/Reverse rocker switch	Test Procedure 7 – Forward/Reverse Rocker Switch on page 12-27
	Solenoid – loose wires	Test Procedure 9 – Solenoid Activating Coil, 48-Volt on page 12-29
	Solenoid – failed coil	Test Procedure 9 – Solenoid Activating Coil, 48-Volt on page 12-29
	Solenoid – failed solenoid diode	Test Procedure 9 – Solenoid Activating Coil, 48-Volt on page 12-29
	Speed controller thermal cutback	Allow controller to cool and ensure that vehicle is not over-loaded before returning to operation
	35-pin connector at speed controller	Check for loose or disconnected wires at the 35-pin connector. **See also Test Procedure 15 – 35-Pin Connector on page 12-36.**
	High pedal detect	Cycle accelerator pedal
	Motor stall	Cycle accelerator pedal
	Motor failure	Section 16 — Motor (Model TRA145)
	Failed Tow/Run switch	Test Procedure 3 – Tow/Run Switch on page 12-22
	Speed controller failure	Replace speed controller. **See Speed Controller Removal on page 13-10.**

TABLE CONTINUED ON NEXT PAGE

TROUBLESHOOTING GUIDE 3		
SYMPTOM	**POSSIBLE CAUSES**	**CORRECTIVE ACTION**
Vehicle runs slowly	Speed sensor disconnected or failed	**See External Motor Testing on page 16-1.**
	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 beginning on page .**
	Batteries discharged	Charge batteries
	MCOR malfunction	Test Procedure 13 – MCOR Voltage on page 12-33
	Motor – loose wires	Inspect and tighten all wire connections at the motor
	Failed motor	Replace motor. Section 16 — Motor (Model TRA145)
	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 13-10.**
	Brakes – improperly adjusted	**See Wheel Brake Assemblies Section.**
	Tires – under-inflated or flat tires	**See Wheels and Tires Section.**
Vehicle operates, but motor braking function does not	Wiring – improperly wired	Check vehicle wiring. **See Wiring Diagrams beginning on page .**
	Speed sensor disconnected or failed	**See External Motor Testing on page 16-1.**
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 7 – Forward/Reverse Rocker Switch on page 12-27
	Motor – improperly wired	Check motor wiring. **See Wiring Diagrams beginning on page .**
	Speed controller – improperly wired or failed speed controller FET	Check vehicle wiring. **See Wiring Diagrams beginning on page .**
Vehicle operates, but battery charger does not charge batteries	Charger interlock failure	Test Procedure 12 – Charger Interlock on page 12-32
	Battery charger connections – loose wires at charger or batteries	Check wire connections and tighten if necessary.
	Battery charger	Section 15 — QuiQ High Frequency Charger

TEST PROCEDURES

Using the following procedures, the entire electrical system can be tested without major disassembly of the vehicle. **See following WARNING.**

⚠ 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.**

TESTING BASICS

- The electric vehicle has two electrical systems powered by the 48-volt battery pack, and are characterized as follows:
  - — The **main system is 48-volts** and used for the powertrain.
  - — The **secondary system is 12-volts** and used for accessories. A DC-DC converter is employed to convert 48-volt battery pack voltage to 12-volts.
- On electric vehicles, the chassis is not electrical ground like it is in a gasoline vehicle. Ground terminal blocks are used; one located on the electrical component mounting plate for the 48-volt main system, and one located under the front cowl for the 12-volt secondary system.
- 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 12-20**.
- 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.**

- The Tow/Run switch powers the key switch, controller, lockout relay, Forward/Reverse switch, 15-amp fuse, and reverse buzzer.
- The key switch powers the MCOR 2-pin circuit, pin 9 of the 35-pin connector, 48-volt solenoid, and the 12-volt power strip via the DC-DC converter.
- When testing controller functions, the Run/Tow switch must be in the RUN position. The TOW position removes power to the controller.
- The MCOR 3-pin circuit, motor speed sensor circuit, and charge indicator light is powered by the controller (with Tow/Run switch in RUN).
- On the electrical component mounting plate, the two 2-amp fuses are powered directly by the batteries via the 48-volt solenoid and sonic-weld 6 and carries BPV to the connected car device and the instrument cluster. No switch is involved.
- On the electrical component mounting plate, the 15-amp fuse is powered by the Run/Tow switch in the RUN position.
- On the electrical component mounting plate, the 20-amp fuse is powered directly by the batteries via the 48-volt solenoid and sonic-weld 6 and carries BPV to the DC-DC converter.
- When testing voltage in the 48-volt system:

— The batteries must remain connected.

— Unless specifically directed to do otherwise in a procedure, connect the black (–) probe of the multimeter to the negative post of battery no. 8 (8 x 6-volt battery set), the B- terminal of the controller, or the ground terminal block located on the electrical component mounting plate, whichever is easier to access.

- When testing voltage in the 12-volt system for Accessories:

— The batteries must remain connected.

— Unplug onboard charger AC cord from electrical outlet.

— The Tow/Run switch must be in the RUN position.

— The key switch must be in the ON position.

— Unless specifically directed to do otherwise in a procedure, connect the black (–) probe of the multimeter to the ground terminal block located under the front cowl.

Index of Test Procedures

1 – Batteries / Voltage Check (BPV)
2 – 48-volt Battery Pack Voltage Under Load
3 – Tow/Run Switch
4 – Fuses
5 – Wire Harness Diodes
6 – Key Switch and MCOR Limit Switch Circuit
7 – Forward/Reverse Rocker Switch
8 – Solenoid Contacts, 48-Volt
9 – Solenoid Activating Coil, 48-Volt
10 – Solenoid, 12-Volt
11 – Relay
12 – Charger Interlock
13 – MCOR Voltage
14 – Motor Speed Sensor
15 – 35-Pin Connector
16 – Reverse Buzzer Control (Pin 3)
17 – Forward and Reverse Input (Pins 22 and 33)
18 – Main Solenoid Control (Pin 6)
19 – Mode Switch (Pin 12)
20 – Reverse Buzzer
21 – Headlight Switch – High Beam
22 – Charge Indicator Light
23 – 4-Pin Connector (for Connected Car Device)
24 – DC-DC Converter
25 – Rear View Camera

TEST PROCEDURE 1 – Batteries / Voltage Check (BPV)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

If battery voltage drops below 34 volts during operation, the vehicle will shut down and give a Low Battery Voltage/Undervoltage fault.

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 14-6.***

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

1. 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 on page 14-1 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

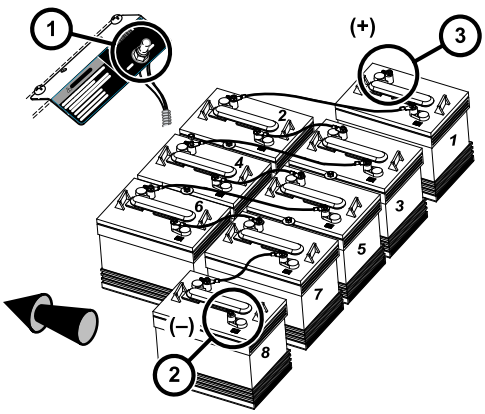
1. If necessary, see Testing Basics on page 12-18.
2. With batteries connected and using a multimeter set to 200 volts DC, place red (+) probe on the positive (+) post of battery no. 1 and the black (–) probe on the negative (–) post of battery no. 8 **(Figure 1-1, Page 1-4) or (Figure 1-2, Page 1-4)**.
3. 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 on page 14-1 for further details on battery testing.**

TEST PROCEDURE 2 – 48-volt Battery Pack Voltage Under Load

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

1. If necessary, see Testing Basics on page 12-18.
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. 8 **(Figure 12-1, Page 12-21)**.



(Viewed from driver side of vehicle)
1. RED probe to battery no. 1 (+).
2. BLACK probe to battery no. 8 (-).

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Figure 12-1 Battery Discharge Test (710 shown)

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 47 and 49 volts while under load.
6. A reading of 32 to 42 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 on page 14-1.

TEST PROCEDURE 3 – Tow/Run Switch

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

If no voltage is coming to the Tow/Run Switch, inspect the 16-gauge pink wire connection at the solenoid and sonic weld 6.

Tow/Run Switch Test with the CDT Handset

1. With the Tow/Run switch in the RUN position, connect the CDT to the vehicle. **See Plugging the CDT into the Vehicle on page 11-3.**
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 is blank, drive the vehicle a short distance to activate the onboard computer.
4. If the vehicle will not operate, proceed to **Tow/Run Switch Test without the CDT Handset**.
5. If the CDT display screen begins to work after the vehicle has been driven, turn the key switch to the OFF position and proceed to step 6; otherwise, perform **Tow/Run Switch Test without the CDT Handset**.
6. With the CDT still connected to the vehicle, place the Tow/Run Switch in the TOW position and wait 90 seconds.
7. If the CDT display screen goes blank, the Tow/Run switch and connecting wires are operating correctly.
8. If the CDT display screen is still active after 90 seconds, the switch has failed closed. Replace the Tow/Run switch. **See Key Switch Removal on page 13-1.**

Tow/Run Switch Test without the CDT Handset

1. Set a multimeter to 200 volts DC. With the batteries connected, and the Tow/Run switch in either the TOW or RUN position, connect the black (–) probe to the negative post of battery no. 8 and connect red (+) probe (with insulation-piercing probe) on the pink wire close to the two-pin connector on the Tow/Run switch.
2. If the reading is 48 to 50 volts, proceed to Step 3. If the voltage reading is 0 volts, check wire continuity from the large post of the solenoid with the pink, 16-gauge wire attached, through sonic weld 6, and to the pink wire side of the Tow/Run switch two-pin connector.
3. Set a multimeter to 200 volts DC and with the batteries connected, connect the black (–) probe to the negative post of battery no. 8 and connect red (+) probe (with insulation-piercing probe) on the light green wire (1) close to the two-pin connector on the Tow/Run switch.
4. With the Tow/Run switch in the RUN position, the reading should be approximately 48 to 50 volts. With the switch in the TOW position, the reading should be approximately 0 volts.
5. If the two-pin connector and pink wire readings are correct, replace the Tow/Run switch.

TEST PROCEDURE 4 – Fuses

See General Warnings on page 1-1.

⚠ WARNING

- **Failure to use properly rated fuse can result in a fire hazard.**

NOTE: *These vehicles predominately use a combination of ATC-style and ATM-style blade fuses. A single AGC-style glass fuse is used for the charger interlock circuit.*

This is a voltage test. It can be performed relatively easily on ATC-style and ATM-style fuses. A voltage test can be performed on the AGC-style glass fuse if insulation-piercing probes are used. Otherwise, the AGC-style will have to be removed to visually inspect or check using a continuity test.

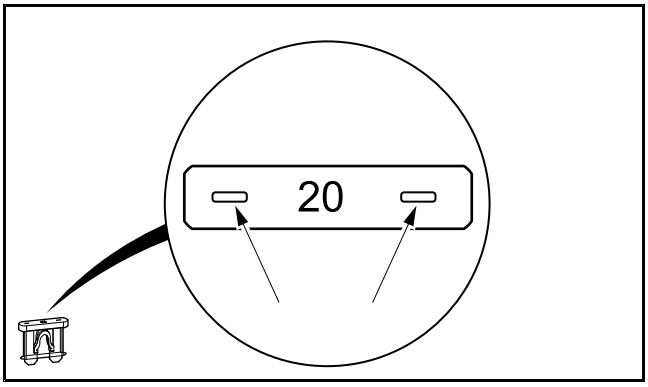

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Figure 12-2 Testing the Fuse

1. If necessary, see Testing Basics on page 12-18.
2. Access the fuses but do not remove them. Fuses are found at the following locations:
   – **On Controller Mounting Plate:** 20-amp fuse to DC-DC converter, 2-amp fuse to connected car device (Guardian/Visage V3 Circuit), 2-amp fuse to dash display, and 15-amp fuse to electric powertrain
   – **Under Floorboard Near MCOR:** 30-amp fuse from DC-DC converter to accessories
   – **Under Front Cowl:** 15-amp fuse to cab, 10-amp fuse to brake lights, horn and turn signals, 7.5-amp fuse to headlights and taillights, 10-amp fuse to 12-volt power strip and power point
   – **On Main Harness Near Controller Mounting Plate:** 30-amp fuse for charger receptacle harness
   – **On Main Harness Near Charger 30-Amp Fuse and 8-Pin Connector:** 1-amp fuse for charger interlock circuit
   – **Inside the Cab Overhead Console:** Various fuses depending on accessory
3. **2-Amp and 15-Amp ATC Fuses On Controller Mounting Plate and 30-Amp ATC Charger Receptacle Fuse:** With the batteries connected and the Tow/Run switch in the RUN position:

3.1. Probe the two, small metal contacts on the top of the fuse **(Figure 12-2, Page 12-23)**.

3.2. Each contact should show BPV.

3.3. If only one side shows BPV, replace fuse.

3.4. If neither side of fuse shows BPV, do the following:
   – Check BPV.
   – Check condition and connection of large red wires at solenoid.

– Check sonic weld_6 in main wire harness.

– For the 15-amp ATC fuse, check Tow/Run switch to make sure it is in RUN position.

– Check if 10-gauge red wire is coming off large post on solenoid.

4. **1-amp AGC Glass Fuse Only:** With the Tow/Run switch in the RUN position:

4.1. Probe the wire on each side of the fuse with insulation-piercing probes.

4.2. Each probe should show 42 to 46 volts.

4.3. If only one side shows voltage, replace fuse.

4.4. If neither side of fuse shows voltage, do the following:

– Check Tow/Run switch to make sure it is in RUN position.

– Check diode 1 in main wire harness.

– Check 10k ohm in main wire harness.

– Check 15-amp ATC fuse on controller mounting plate.

5. **30-Amp ATC Fuse Near MCOR, ATC Fuses in the Overhead Console, and ATM Fuses Under Front Cowl:** With the batteries connected, key switch ON and DC-DC converter operating:

NOTE: *For these fuses only, connect the black probe of the meter to the 12 volt ground terminal block located under the front cowl.*

5.1. Probe the two, small metal contacts on the top of the fuse **(Figure 12-2, Page 12-23)**.

5.2. Each contact should show approximately 12.5 to 13.5 volts.

5.3. If only one side shows 12.5 to 13.5 volts, replace fuse.

5.4. If neither side of fuse shows 12.5 to 13.5 volts, do the following:

– Check 20-amp ATC fuse on controller mounting plate that supplies power to DC-DC converter. If fuse is good, check converter.

– **For ATM Fuses Under Front Cowl:** Check sonic weld_4 in main wire harness.

– Check key switch.

– Check lockout relay.

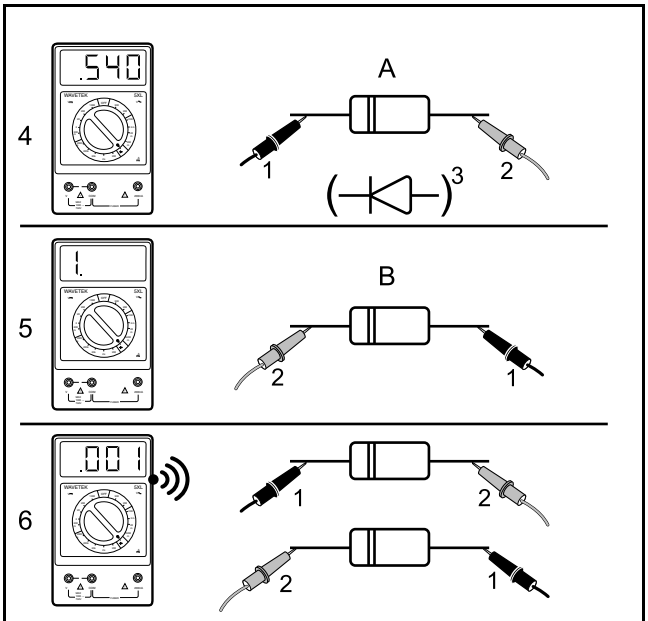
– **For All Fuses Powered by the DC-DC Converter:** Check sonic weld_16 in main wire harness.

TEST PROCEDURE 5 – Wire Harness Diodes

See General Warnings on page 1-1.

A diode is designed to conduct current in one direction only. Depending on the application, diodes are used in the vehicle to control electrical system logic, or to help protect relay and switch contacts from excessive arcing. **See following NOTE.**

NOTE: *If a diode conducts current in both directions, the diode has failed closed. If a diode will not conduct current in either direction, the diode has failed open* ***(Figure 12-3, Page 12-25)****.*



1. VOM Black Lead 2. VOM Red Lead 3. Wiring Diagram Symbol with Diode Stripe Orientation 4. Good Diode (Probe Scenario A) - Conducts Current and Shows Continuity 5. Good Diode (Probe Scenario B) - No Continuity 6. Bad Diode - Meter Beeps In Either Direction (Probe Scenarios A and B)

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Figure 12-3 Basic Diode Information

TEST PROCEDURE 6 – Key Switch and MCOR Limit Switch Circuit

See General Warnings on page 1-1.

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 crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
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. **See Plugging the CDT into the Vehicle on page 11-3.**
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.*

5. 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 pedal group for proper adjustment. **See Accelerator and Brake Pedal Group Section.**

6.2. Check the wiring of the key switch and MCOR.

6.3. 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

1. If necessary, see Testing Basics on page 12-18.
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*.**
3. Place the Tow/Run switch in the RUN position and the Forward/Reverse switch in the NEUTRAL position.
4. **Pin 9 Tan Wire:** Lift bed, remove cover to access the controller. **See following NOTE.**

NOTE: *The easiest way to test the key switch and MCOR Limit Switch is to check the pin 9 tan wire in the 35-pin connector. Pin 9 is the end of this circuit.*

4.1. Locate and connect an insulation-piercing probe to the pin 9 tan wire in the 35-pin connector.

4.2. With the key switch in the OFF position and the accelerator pedal at rest, the tan wire should show zero (0) volts.

4.3. With the key switch in the ON position and the accelerator pedal pressed, the tan wire should show BPV which is KEY INPUT (ON position) to controller.
– If it shows BPV, then the key switch and related wiring is functioning properly.

– If not, first check the key switch.

5. **Key Switch:** Remove instrument panel to access the back of the key switch but do not disconnect wires. **See Instrument Panel Removal, Section 4, Page 4-9.**

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.

6. **MCOR Limit Switch (FOOT INPUT):** Access the MCOR from under the vehicle passenger side.

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. From the MCOR, the blue wire supplies voltage (BPV) to pin 8. If not, replace MCOR. **See MCOR Removal on page 13-5.**

TEST PROCEDURE 7 – Forward/Reverse Rocker Switch

See General Warnings on page 1-1.

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

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. **See Plugging the CDT into the Vehicle, Section 11, Page 11-3.**
3. 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 beginning on page** . Also check the 35-pin connector at the speed controller. **See 35-Pin Connector on page 12-36.**

4. 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. Also check the 35-pin connector at the speed controller. **See 35-Pin Connector on page 12-36.**

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

1. If necessary, see Testing Basics on page 12-18.
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 13-3.**

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 13-3.**

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 13-3.**

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 13-3.**

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 8 – Solenoid Contacts, 48-Volt

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

Unlike other controllers used by Club Car, the pre-charge resistor is internal to the LSV controller.

This solenoid is located on the passenger side of the electrical component mounting plate.

1. If necessary, see Testing Basics on page 12-18.

2. Access the solenoid by removing the speed controller cover. **See Removing the Speed Controller Cover on page 13-7.**
3. 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 between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
4. Turn the key switch to the ON position and place the Forward/Reverse switch in the FORWARD position.
5. Set a multimeter to 200 volts. Place the black (–) probe on the battery no. 8 negative post and place the red (+) probe on the large post with the 2-gauge yellow wire.
6. With the pedal up, the reading should be 9.5 to 10.5 volts. If the voltage is higher, let the car sit for 5 to 10 minutes to allow the capacitors to discharge to 9.5 to 10.5 volts.
7. Press the accelerator pedal. The voltage should read 48 to 50 volts with the pedal pressed. If the voltage does not increase or goes to 0 volts with the pedal pressed, replace the solenoid.

TEST PROCEDURE 9 – Solenoid Activating Coil, 48-Volt

See General Warnings on page 1-1.

NOTE: *This is a resistance test.*

This solenoid is located on the passenger side of the electrical component mounting plate.

1. If necessary, see Testing Basics on page 12-18.
2. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles on page 1-3.**
3. Access the solenoid by removing the speed controller cover. **See Removing the Speed Controller Cover on page 13-7.**
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 180 to 190 ohms should be obtained **(Figure 12-4, Page 12-29)**. If not, replace the solenoid.

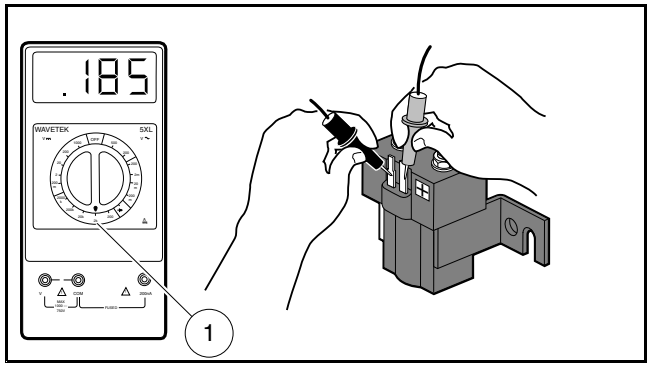

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Figure 12-4 Activating Coil Test

TEST PROCEDURE 10 – Solenoid, 12-Volt

See General Warnings on page 1-1.

NOTE: *This solenoid is used for the defogger/heater system.*

This is a resistance and voltage test.

This solenoid is located in the center of the electrical component mounting plate.

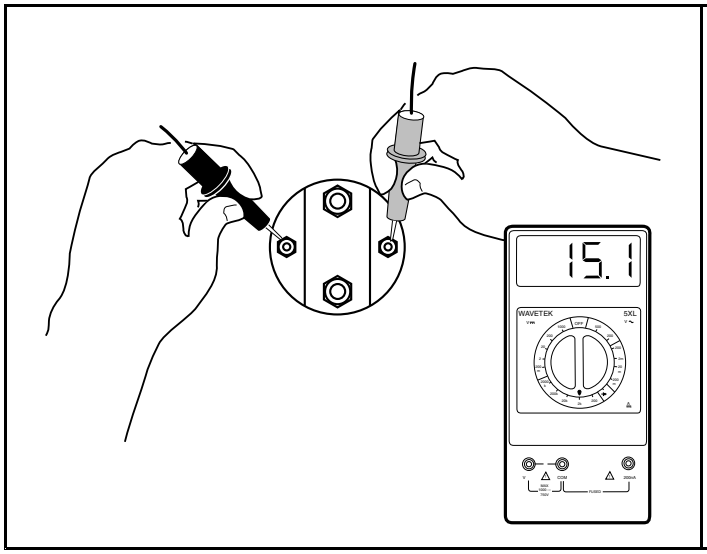

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Figure 12-5 Solenoid Coil Test

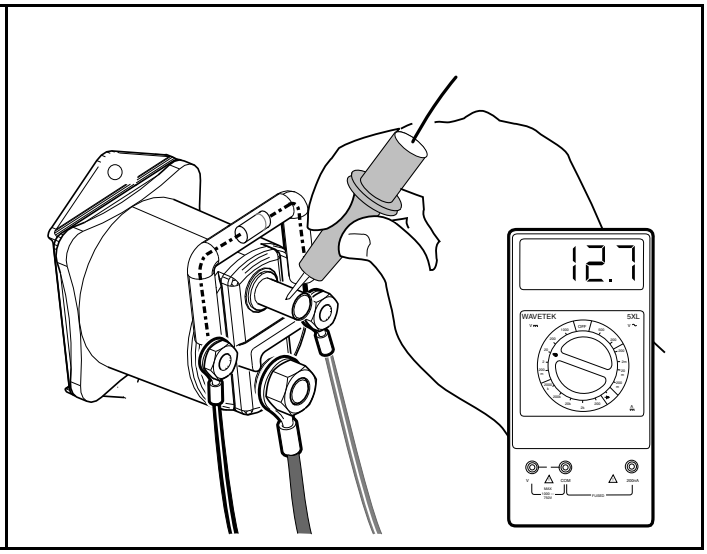

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Figure 12-6 Solenoid Contact Test

1. If necessary, see Testing Basics on page 12-18.
2. Remove the electrical component box cover.
3. Ensure that the wires are connected correctly and are tight. If they are not, rewire or tighten as necessary.
4. **Coil Side:** Note orientation and disconnect wires from both small posts of the solenoid and remove diode. Check resistance across the small posts of the solenoid **(Figure 12-5, Page 12-30)**. The reading should be 14 to 16 ohms. If the reading is not within limits, replace the solenoid.
5. **Contact Side:** Install diode and connect wires to small posts of the solenoid in correct orientation. Tighten the nuts on the small solenoid posts to 22 in·lb (2.5 N·m). Remove the 10-gauge yellow wire from the large post of the solenoid. Cover the other large post.

5.1. Check voltage between the empty large post and the ground strip terminal block under the cowl **(Figure 12-6, Page 12-30)**.
- **With heater switch in the OFF position:** The meter should read no voltage.
- **With heater switch in the ON position:** The solenoid should click and the meter should read output voltage of the DC-DC converter (12.6 to 13.6 volts).

5.2. If the readings are incorrect, replace solenoid. **See Solenoid Removal, Section 13, Page 13-13.**

5.3. If the readings are correct, connect 10-gauge yellow wire to large post and tighten hex nut to 60 in·lb (6.8 N·m).

TEST PROCEDURE 11 – Relay

See General Warnings on page 1-1.

NOTE: *Relays are used in the lockout system, brake lights, backup light, and the "N" neutral indicator light in the instrument cluster.*

Wire terminal location may vary depending on manufacturer of relay.

Three relays are located on the electrical component mounting plate and one relay is located on the back side of the instrument panel.

At electrical component mounting plate: There are two Single Pole-Single Throw relays **(Figure 12-7, Page 12-31)** and one Single Pole-Double Throw relay **(Figure 12-8, Page 12-31)**.

At instrument panel: This is a Single Pole-Double Throw relay **(Figure 12-8, Page 12-31)**.

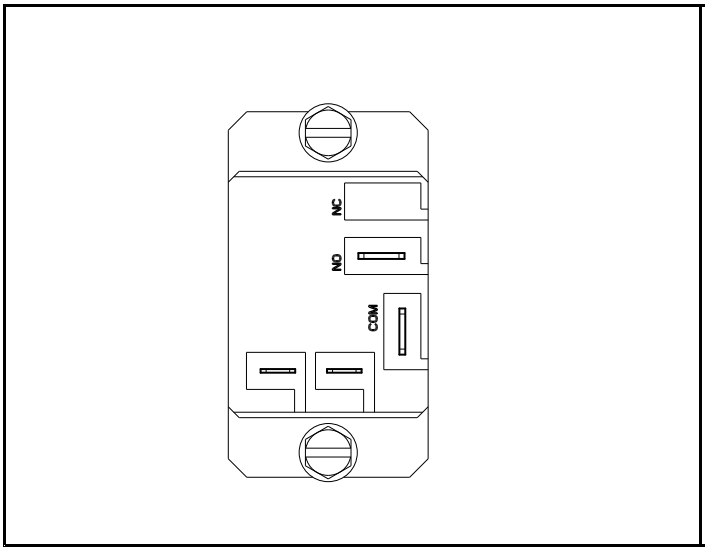

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Figure 12-7 Single Pole-Single Throw Relay

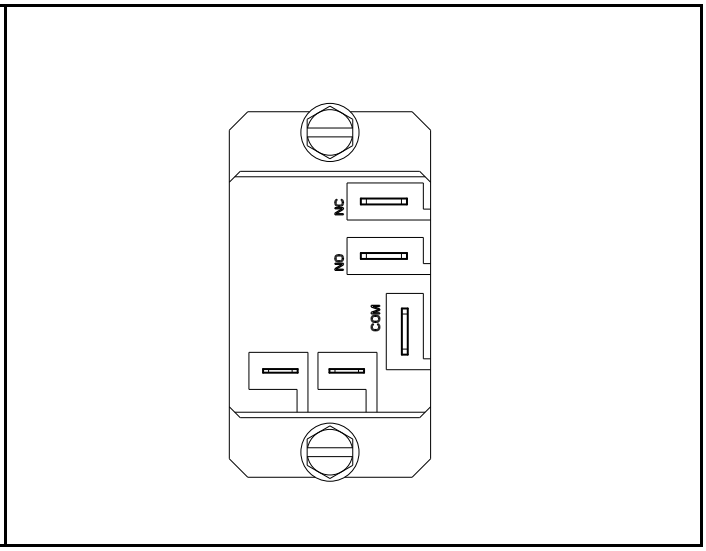

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Figure 12-8 Single Pole-Double Throw Relay

1. **For all relays:** Test for continuity between the two unmarked coil terminals **(Figure 12-7, Page 12-31) or (Figure 12-8, Page 12-31)**.
2. **For all relays:** Test for no continuity between switch terminals COM and NO.
3. **For all relays:** Apply 48-volts to the unmarked coil terminals. The relay should click and show continuity between switch terminals COM and NO.
4. **For Single Pole-Double Throw relays:** Test for continuity between switch terminals COM and NC **(Figure 12-8, Page 12-31)**.
5. **For Single Pole-Double Throw relays:** Apply 48-volts to the unmarked coil terminals. The relay should click and show no continuity between switch terminals COM and NC.

TEST PROCEDURE 12 – Charger Interlock

See General Warnings on page 1-1.

Controller Interlock Function Test with the CDT Handset

1. If necessary, see **See Testing Basics, Section 12, Page 12-18.**.
2. Connect the CDT to the vehicle.
3. Access the Monitor menu and select CHARGER INHIBIT by using the SCROLL DISPLAY buttons. The CDT should indicate OFF.
4. 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 13, Page 13-10.**

Testing the Interlock Circuit

The charger interlock circuit consists of a 48 volt power source through the RUN/TOW switch, sonic welds, a lockout relay, two diodes, a 15-amp fuse, and a 10k ohm resistor. **See following NOTE.** Use the following procedure to test the charger interlock circuit:

NOTE: *The following steps involve testing voltage and resistance.*

1. With batteries connected, place the Tow/Run switch in the RUN position.
2. Remove electronics module cover.
3. **Check 15-amp fuse:** Check the 15-amp fuse located in the electrical component box. It is the fuse that has a pink wire and a light green wire connected to it. **See Test Procedure 4 – Fuses on page 12-23.**
4. **Check power:** Using a multimeter set to 200 volts DC, place red (+) probe (with insulation-piercing probe) on the blue wire (pin 11 of the 35-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 blue wire (pin 11 of the 35-pin connector), place the black (–) probe to the pink 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 .
6. **Check 1-amp fuse:** Remove and check the 1-amp fuse from the yellow fuse holder in onboard charger harness lead.
7. **Check D_1 diode:** Set multimeter to Diode test and check diode 1 (D_1) near onboard charger harness lead. **See Wire Harness Diodes on page 12-25.** Probe between the blue wire (pin 11 of the 35-pin connector) at the controller and the gray wire terminal (pin 4 of the 8-pin connector) of the onboard charger.
8. When finished, install 15-amp fuse.

TEST PROCEDURE 13 – MCOR Voltage

See General Warnings on page 1-1.

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 crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING “Lift only one end...” in General Warnings on page 1-1. 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. **See Plugging the CDT into the Vehicle on page 11-3.**
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 or does not rise to 100%, check the drive bar for wear. If drive bar is not worn, replace MCOR.*

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, check the drive bar for wear. If drive bar is not worn, replace MCOR.
6. If throttle input percentage never reaches 100% in the previous steps, check the drive bar for wear. If drive bar is not worn, replace MCOR.

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*. 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. 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.
7. If reading does not increase as the pedal is pressed, check the drive bar for wear. If drive bar is not worn, replace 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 14 – Motor Speed Sensor

See General Warnings on page 1-1.

NOTE: *The Motor Speed Sensor uses pins 7, 26, 31, and 32 of the 35-pin connector at controller.*
Pin 7: Black/White Wire — Ground
Pin 26: Red Wire — +5 volt power supplied by controller
Pin 31: Red/White Wire — Phase A signal to controller
Pin 32: Red/Green Wire — Phase B signal to controller

Motor Speed Sensor Test without any Tool

⚠ 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. **See Plugging the CDT into the Vehicle, Section 11, Page 11-3.**
3. 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.
5. If the CDT does not indicate ON while the wheels are in motion, proceed to the following procedure.

TEST PROCEDURE 15 – 35-Pin Connector

See General Warnings on page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Disconnect the 35-pin connector from the speed controller **(Figure 12-9, Page 12-36)**. 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 35-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.
4. Check the wire colors of each wire and make sure that the colors for each pin position match the wire colors in the wiring diagram. **See Wiring Diagrams beginning on page .**
5. When connecting the 35-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 35-pin connector. Refer to the following chart for the appropriate procedure for each pin in the 35-pin connector.

If the results of any of the referenced procedures are different 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 on page 12-18.**

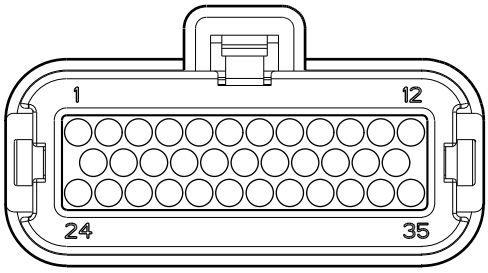

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Figure 12-9 Speed Controller 35-Pin Connector Layout

SPEED CONTROLLER 35-PIN CONNECTOR PINS		
PIN AND WIRE COLOR	**DESCRIPTION**	**TEST PROCEDURE**
Pin 1 – Gray (18-gauge)	TOW/RUN switch input	Test Procedure 3 – Tow/Run Switch on page 12-22
Pin 2 – White (18-gauge)	Speedometer signal	
Pin 3 – Orange/White (18-gauge)	Reverse buzzer	Test Procedure 16 – Reverse Buzzer Control (Pin 3) on page 12-39
Pin 4 – Pink (18-gauge)	Brake light relay output	
Pin 5 – Gray/Black (18-gauge)	Charge Indicator Light (in instrument panel) control	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.

TABLE CONTINUED ON NEXT PAGE

SPEED CONTROLLER 35-PIN CONNECTOR PINS		
PIN AND WIRE COLOR	**DESCRIPTION**	**TEST PROCEDURE**
Pin 6 – Blue/White (18-gauge)	Solenoid coil driver	Test Procedure 18 – Main Solenoid Control (Pin 6) on page 12-41
Pin 7 – Black/White (18-gauge)	I/O ground	
Pin 8 – Yellow/Black (18-gauge)	Motor temperature switch positive (+)	
Pin 9 – Tan (18-gauge)	KEY input	Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26
Pin 10 – Green (18-gauge)	PEDAL input	Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26
Pin 11 – Blue (18-gauge)	OBC enable input (charger interlock)	Test Procedure 12 – Charger Interlock on page 12-32
Pin 12 – Purple (18-gauge)	MODE input	Test Procedure 19 – Mode Switch (Pin 12) on page 12-41
Pin 13 – Light Blue (18-gauge)	Solenoid coil and brake light relay coil return	Test continuity of wire(s) and sonic-weld 8
Pin 14 – Open (no wire)		
Pin 15 – Orange (18-gauge)	Throttle pot high	Test continuity of each wire and perform Test Procedure 13 – MCOR Voltage on page 12-33
Pin 16 – Yellow (18-gauge)	Throttle wiper	Test continuity of each wire and perform Test Procedure 13 – MCOR Voltage on page 12-33
Pin 17 – Open (no wire)		
Pin 18 – Purple/White (18-gauge)	Throttle pot low	Test continuity of each wire and perform Test Procedure 13 – MCOR Voltage on page 12-33
Pin 19 – Open (no wire)		
Pin 20 – Open (no wire)		
Pin 21 – Open (no wire)		
Pin 22 – Brown (no wire)	FORWARD input	Test Procedure 17 – Forward and Reverse Input (Pins 22 and 33) on page 12-40
Pin 23 – Open (no wire)		
Pin 24 – Green/White (18-gauge)	Master cylinder pressure switch input for brake lights	
Pin 25 – Black (18-gauge)	+12 volts (controller communication port supply)	
Pin 26 – Red (18-gauge)	+5 volts (motor speed sensor supply)	Test Procedure 14 – Motor Speed Sensor on page 12-35
Pin 27 – Open (no wire)		
Pin 28 – Red (18-gauge)	Controller serial port tx	
Pin 29 – Yellow (18-gauge)	Controller serial port rx	
Pin 30 – Light Green (18-gauge)	Battery SOC signal to instrument panel	
Pin 31 – Red/White (18-gauge)	Encoder signal A	

TABLE CONTINUED ON NEXT PAGE

SPEED CONTROLLER 35-PIN CONNECTOR PINS		
PIN AND WIRE COLOR	**DESCRIPTION**	**TEST PROCEDURE**
Pin 32 – Red/Green (18-gauge)	Encoder signal B	
Pin 33 – Gray/White (18-gauge)	REVERSE input	Test Procedure 17 – Forward and Reverse Input (Pins 22 and 33) on page 12-40
Pin 34 – Open (no wire)		
Pin 35 – Open (no wire)		

TEST PROCEDURE 16 – Reverse Buzzer Control (Pin 3)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

Pin 3 in the 35-pin connector provides a connection point for the reverse buzzer to the speed controller.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
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 crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
3. Disconnect the 35-pin connector at the speed controller.
4. Place a jumper wire with an alligator clip between the B– terminal of the speed controller (use alligator clip for this connection) and pin 3 (orange/white wire) of the 35-pin connector **(Figure 12-9, Page 12-36)**. **See following CAUTION.**

CAUTION

- **Do not fully insert probes into the 35-pin plug. Doing so can result in a poor connection.**

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in·lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position.
7. The reverse buzzer should sound when the Tow/Run switch is in the RUN position.
8. If any other activity is observed, check the following items:
   – Continuity of the wires in the wire harness
   – Reverse buzzer for proper operation. **See Reverse Buzzer on page 12-42.**
   – Tow/Run switch for proper operation. **See Tow/Run Switch on page 12-22.**

TEST PROCEDURE 17 – Forward and Reverse Input (Pins 22 and 33)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

Pins 22 and 33 in the 35-pin connector provide a connection point for the Forward/Reverse rocker switch to the speed controller. The switch provides a +48 volt signal to the speed controller through pin 22 when the Forward/Reverse switch is in the FORWARD position and provides a +48 volt signal on pin 33 when the Forward/Reverse switch is in the REVERSE position.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
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 crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
3. Disconnect the 35-pin connector at the speed controller.
4. Set a multimeter to 200 volts DC, insert the red (+) probe of the multimeter into pin 22 (brown wire) of the 35-pin connector **(Figure 12-9, Page 12-36)**. **See following CAUTION.** Using an alligator clip, connect the black (–) probe to the B– terminal of the speed controller.

CAUTION

- **Do not fully insert probes into the 35-pin plug. Doing so can result in a poor connection.**

5. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in·lb (12.4 N·m).
6. Place the Tow/Run switch in the RUN position and the Forward/Reverse switch in the NEUTRAL position. The multimeter should indicate zero volts DC at this time.
7. While monitoring the multimeter, place the Forward/Reverse switch in the REVERSE position. The multimeter should still indicate zero volts.
8. Place the Forward/Reverse switch in the FORWARD position. The multimeter should indicate full battery voltage (approximately 48 volts).
9. Insert the red (+) probe of the multimeter into pin 33 (gray/white wire) of the 35-pin connector. Leave the black (–) probe (alligator clip) connected to the B– terminal of the speed controller. **See previous CAUTION.**
10. Place the Forward/Reverse switch in the NEUTRAL position. The multimeter should indicate zero volts DC at this time.
11. While monitoring the multimeter, place the Forward/Reverse switch in the FORWARD position. The multimeter should still indicate zero volts.
12. Place the Forward/Reverse switch in the REVERSE position. The multimeter should indicate full battery voltage (approximately 48 volts).
13. If any other reading is obtained, check the following items:
    – Continuity of the wires, sonic-welds and multi-pin connectors in the wire harness.
    – Forward/Reverse switch for proper operation. **See Forward/Reverse Rocker Switch on page 12-27.**
    – Tow/Run switch for proper operation. **See Tow/Run Switch on page 12-22.**

TEST PROCEDURE 18 – Main Solenoid Control (Pin 6)

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

Pin 6 in the 35-pin connector provides a connection point for the main solenoid coil to the speed controller. The speed controller activates the main solenoid by providing power to the solenoid coil at the appropriate time.

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 crossmember between the spring mount and side stringer, just forward of each rear wheel. **See WARNING "Lift only one end..." in General Warnings on page 1-1.**
2. Set a multimeter to 200 volts DC. Use an alligator clip to connect the red (+) probe to the positive terminal on battery no. 1. With an insulation-piercing probe, connect the black (–) probe to the blue/white wire attached to pin 6 of the 35-pin connector **(Figure 12-9, Page 12-36)**.
3. Place the Tow/Run switch in the RUN position, the Forward/Reverse swith in the FORWARD position, and the key switch in the ON position.
4. With the accelerator pedal pressed, the multimeter should read 48 volts DC. With the pedal up, the multimeter should read 0 volts DC.
5. If the voltage reading is less than 40 volts with the accelerator pedal pressed, replace the controller.
6. If any other activity is observed, check the following items:
   – Continuity of the wires in the wire harness.
   – Tow/Run switch for proper operation. **See Tow/Run Switch on page 12-22.**
   – Key switch for proper operation. **See Key Switch and MCOR Limit Switch Circuit on page 12-26.**
   – Solenoid for proper operation. **See Solenoid Contacts, 48-Volt on page 12-28.**

TEST PROCEDURE 19 – Mode Switch (Pin 12)

NOTE: *This is a voltage test.*

Voltage is supplied to Pin 12 when the vehicle is equipped with the special mode key switch and the Carryall mode is selected.

1. With a multimeter set for 200 volts DC, insert the red (+) probe of the multimeter into pin 12 (purple wire) of the 35-pin connector **(Figure 12-9, Page 12-36)**. **See following CAUTION.** With an alligator clip, connect the black (–) probe to the negative terminal of battery # 8.
2. The reading should be 48 volts. If the reading is zero volts, check the purple wire continuity from the key switch to the 35 pin connector. If there is continuity, replace the key switch. If there is no continuity, repair broken wire.

TEST PROCEDURE 20 – Reverse Buzzer

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-9.**
3. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
4. Place the Tow/Run switch in the RUN position.
5. Set a multimeter to 200 volts DC. Place the black (–) probe on battery no. 8 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).

5.1. If the voltage reading is correct, proceed to step 6.

5.2. If reading is zero volts, check pink wire continuity and Tow/Run switch. **See Tow/Run Switch on page 12-22. See also** Test Procedure 3 – Tow/Run Switch on page 12-22.

5.3. If the continuity readings are not correct, repair or replace the red wire.

5.4. If the continuity readings are correct, proceed to step 6.

6. 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).

6.1. If the voltage reading is correct, replace the reverse buzzer.

6.2. If reading is zero volts, check orange/white wire continuity and connection at Pin 33 in 35-Pin connector.

6.3. If there is no continuity in the orange/white wire, or the Pin 33 terminal in the 35-Pin connector is not properly seated, repair or replace as required.

6.4. If the orange/white wire continuity and 35-pin connector are correct and there is no voltage at the orange wire, replace the controller.

TEST PROCEDURE 21 – Headlight Switch – High Beam

See General Warnings on page 1-1.

NOTE: *The headlight circuit is protected by the 15-amp fuse. Check the fuse before this procedure is performed.* ***See Test Procedure 4 – Fuses on page 12-23.***

This is a voltage test.

1. If necessary, see Testing Basics on page 12-18.
2. Remove instrument panel. **See Instrument Panel Removal on page 4-9.**
3. If connected, unplug onboard charger AC cord from electrical outlet.
4. Ensure Tow/Run switch is in RUN position.
5. Back probe the light green wire in the light switch connector.
6. Connect the black (–) probe of the multimeter to 12-volt ground terminal block.
7. Place key switch in ON position and check voltage. With the light switch in the OFF position, the reading should indicate 0 volts. With the light in the ON position, the reading should indicate 12.6 to 13.6 voltage. If there is no voltage reading, check related wiring and 15-amp fuse. **See Test Procedure 4 – Fuses on page 12-23.** If the wires and fuse show continuity and the readings are still incorrect, replace the switch. **See Headlight Switch Removal, Section 13, Page 13-14.**

TEST PROCEDURE 22 – Charge Indicator Light

See General Warnings on page 1-1.

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.
2. 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 Charger Control, Section 11, Page 11-7.***

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.**

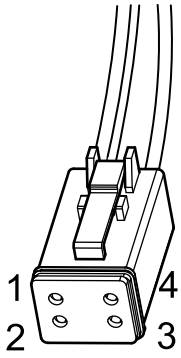
NOTE: *The CDT will still flash ON even with a failed or missing charge indicator light.*

7. If the CDT quickly displays ON but the charge indicator light still does not flash, check the following items:
   – Condition of the gray/black wire terminal in the 35-pin connector.
   – Condition of the 26-pin connector to the instrument cluster.
   – Condition of the 1K Ohm resistor in the main wire harness.
   – Continuity of the wires in the main wire harnesses.
8. If no problems exist in the above items, replace the charge indicator light.

TEST PROCEDURE 23 – 4-Pin Connector (for Connected Car Device)

See General Warnings on page 1-1.

NOTE: *This is a voltage and continuity test.*



Pin 1 – Yellow/Black	Pin 4 – Open (No wire)
Pin 2 – Red/White	Pin 3 – Open (No wire)

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Figure 12-10 4-Pin Connector

1. If necessary, see Testing Basics on page 12-18.
2. Check for continuity between pin 1 (yellow/black wire) **(Figure 12-10, Page 12-45)** and either of the two ground blocks. It should indicate continuity. If not, check sonic weld no. 21.
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.*

TEST PROCEDURE 24 – DC-DC Converter

See General Warnings on page 1-1.

NOTE: *This is a voltage test.*

The DC-DC converter is located under the floorboard; mounted to the passenger-side frame rail. It is activated by the key switch and converts 48-volt power from the entire battery pack to 12-volt power for use by accessories. Power is supplied via the 16-gauge pink wire from the 48-volt solenoid, sonic weld 6, 12-gauge blue wire, 20-amp fuse in fuse block on electrical component mounting plate, and 16-gauge blue wire to converter 3-pin connector.

1. If necessary, see Testing Basics on page 12-18.
2. Locate 30-amp fuse in the 12-volt output red wire from the converter and remove fuse cover.
3. If connected, unplug onboard charger AC cord from electrical outlet.
4. Ensure Tow/Run switch is in RUN position.
5. Place key switch in ON position and check voltage between either of the contacts on the top of the fuse and the ground terminal block located under the front cowl. It should indicate 12.6 to 13.6 volts. If not, check the following:
   - 20-amp fuse in fuse block on the electrical component mounting plate.
   - Key switch.
   - Function of lockout relay.
   - Condition of sonic weld 6.
   - Function of diode 8.
   - Condition of related wiring.
   - Function of Tow/Run circuit components.
   - Function of lockout circuit components.

TEST PROCEDURE 25 – Rear View Camera

See General Warnings on page 1-1.

NOTE: *This is a continuity test.*

1. Make sure that all of the electrical connectors are correctly connected.
2. Set the Run/Tow switch to TOW.
3. Disconnect the rear view camera and rear view camera display from the camera wire harness.
4. Check the continuity of the yellow wire in the camera wire harness.

4.1. If there is continuity, proceed to the next step.

4.2. If there is no continuity, replace the camera harness.

5. Check the continuity of the red, black, and green wires in the camera wire harness.

5.1. If there is continuity, replace the rear view camera and rear view camera display.

5.2. If there is no continuity, replace the camera harness.

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

KEY SWITCH

See General Warnings on page 1-1.

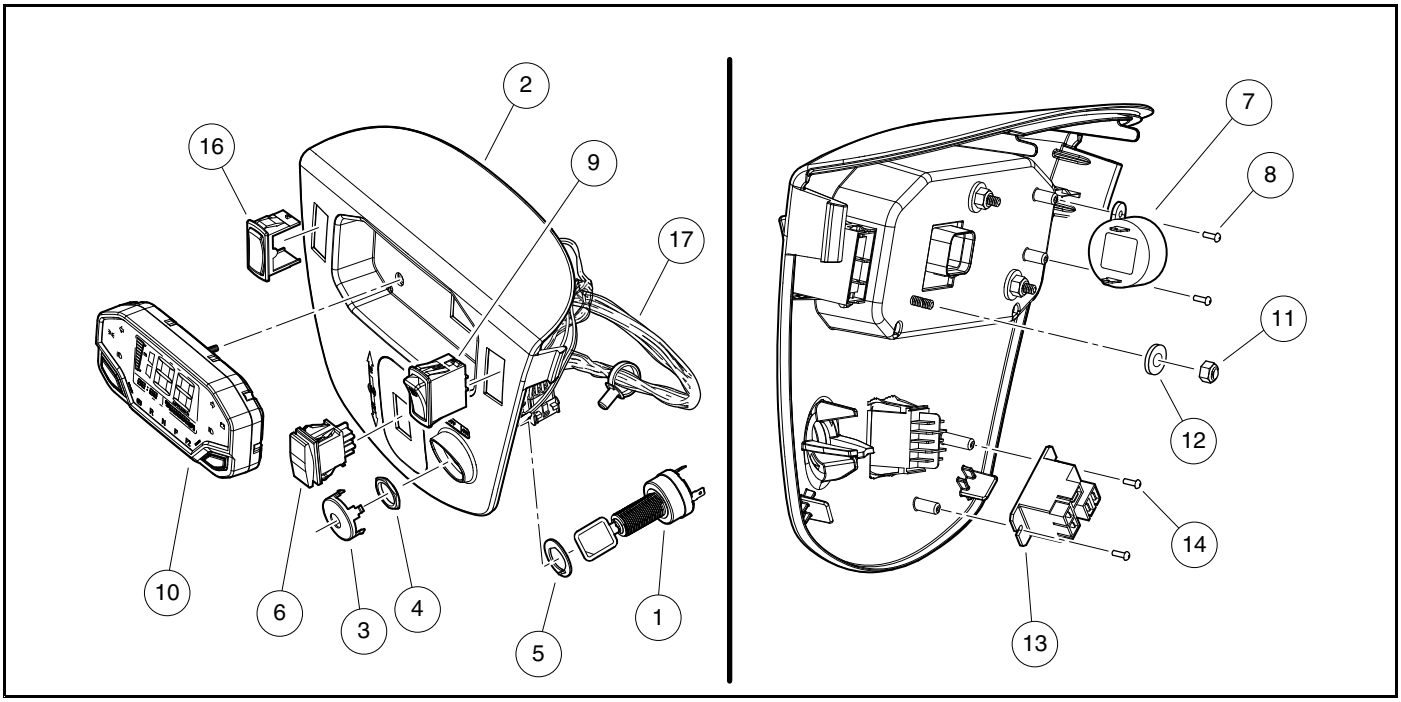

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Figure 13-1 Instrument Panel Components

TESTING THE KEY SWITCH

See Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26.

KEY SWITCH REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove instrument panel. **See Instrument Panel Removal on page 4-9.**

NOTE: *Take care to prevent key switch terminals and wires from touching the metal frame around the dash.*

3. Disconnect the wires from the key switch (1). Do not allow wires to touch.

4. From the back of the instrument panel (2), squeeze the key switch cap (3) retaining tabs and push out the key switch cap **(Figure 13-1, Page 13-1)**. Using a 1-inch socket, hold the key switch (1) and remove the switch retaining nut (4) from the front of the instrument panel (2).

KEY SWITCH INSTALLATION

1. Position the key switch (1) and key switch washer (5) in the instrument panel (2) aligning the locating tab with the slot in the instrument panel **(Figure 13-1, Page 13-1)**. Install and tighten the key switch nut (4) to 35 to 45 in·lb (4 to 5 N·m). Install key switch cap (3) into instrument panel, align the retaining tabs with the slots in the plastic.
2. Refer to the wiring diagram to connect the wires to the key switch terminals.
3. Install instrument panel. **See Instrument Panel Installation on page 4-10.**
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

FORWARD/REVERSE ROCKER SWITCH

See General Warnings on page 1-1.

TESTING THE FORWARD/REVERSE ROCKER SWITCH

See Test Procedure 7 – Forward/Reverse Rocker Switch on page 12-27.

FORWARD/REVERSE ROCKER SWITCH REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-9.**
3. Disconnect the wires from the rocker switch (6) **(Figure 13-1, Page 13-1)**.
4. Press the locking tabs on each end of switch (6) and push switch out of instrument panel (2).

FORWARD/REVERSE ROCKER SWITCH INSTALLATION

1. Press the locking tabs on each end of the rocker switch (6) and push switch into instrument panel (2) **(Figure 13-1, Page 13-1)**.
2. Connect the wires to the rocker switch exactly as shown in the wiring diagram.
3. Install instrument panel. **See Instrument Panel Installation on page 4-10.**
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
5. Place the Tow/Run switch in the RUN position.
6. 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.**

TOW/RUN SWITCH

See General Warnings on page 1-1.

TESTING THE TOW/RUN SWITCH

See Test Procedure 3 – Tow/Run Switch on page 12-22.

TOW/RUN SWITCH REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove Tow/Run switch boot/hex nut (6) **(Figure 13-2, Page 13-4)**.
3. Remove Tow/Run switch (10) and nut (9) from bracket (5).
4. Disconnect the two-pin connector (7) and remove switch.

TOW/RUN SWITCH INSTALLATION

1. Installation is reverse of removal. Make sure groove on switch is aligned with tang on bracket. Tighten Tow/Run switch boot/hex nut (6) to 16 in·lb (1.8 N·m) **(Figure 13-2, Page 13-4)**.
2. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

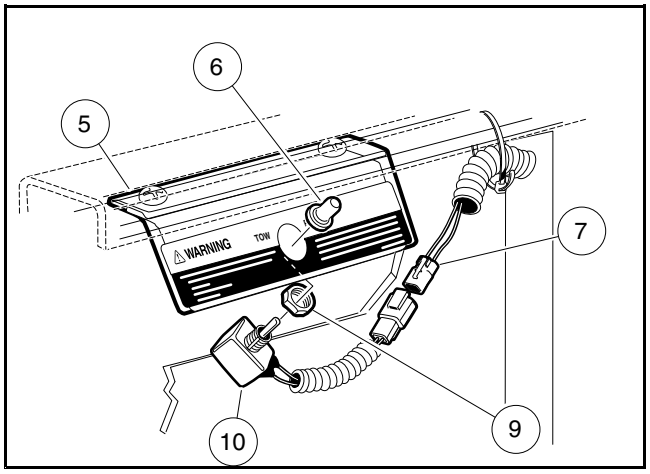

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Figure 13-2 Tow/Run Switch

MOTOR CONTROLLER OUTPUT REGULATOR (MCOR)

See General Warnings on page 1-1.

TESTING THE MCOR

See Test Procedure 13 – MCOR Voltage on page 12-33 and Test Procedure 6 – Key Switch and MCOR Limit Switch Circuit on page 12-26.

MCOR REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Place chocks at rear wheels and lift the front of the vehicle with a chain hoist or floor jack. Place jack stands under the round tube crossmember of the frame to support vehicle.
3. Disconnect the two-pin and three-pin connectors (1) from the MCOR (2) **(Figure 13-3, Page 13-5)**.
4. Remove the two torx screws (3) securing the MCOR (2) to the plastic housing (4) on the chassis.
5. Detach the two tabs from the plastic housing (4) and remove the MCOR (2) from vehicle.

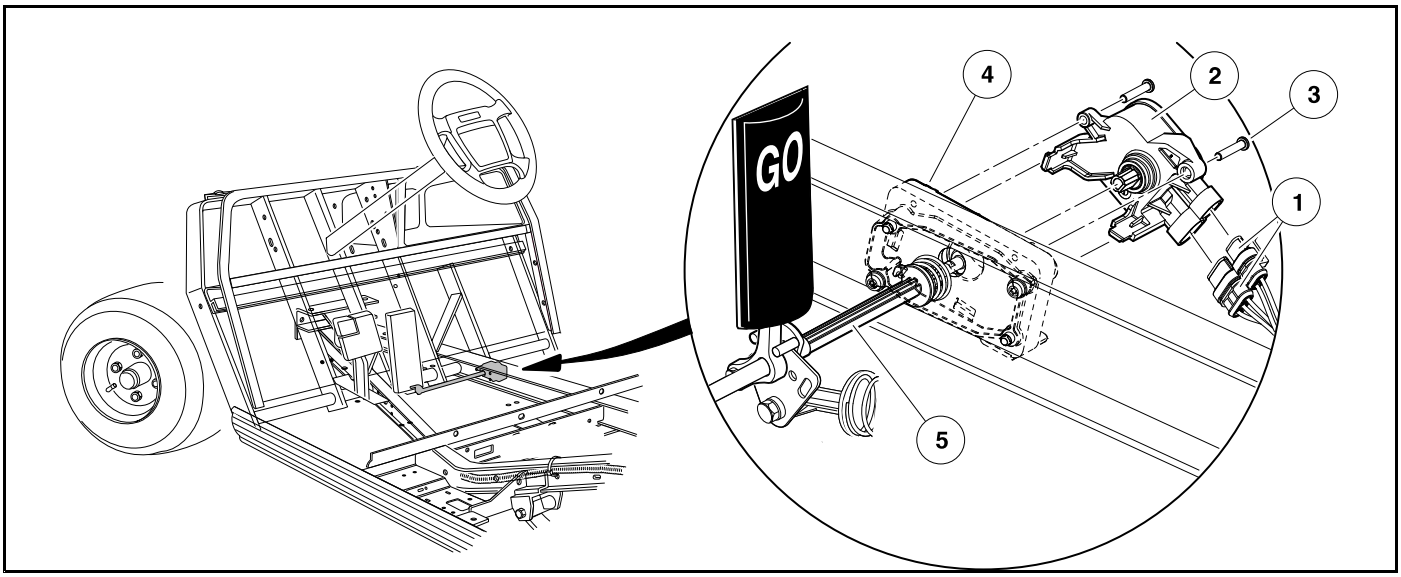

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Figure 13-3 MCOR Mounting

MCOR INSTALLATION

1. Align the two tabs of the MCOR (2) with the slots in the plastic housing (4) on the chassis **(Figure 13-3, Page 13-5)**. Insert the MCOR into the plastic housing (4) until the tabs engage. **See following NOTE.**

NOTE: *Rotate the drive bar (5) back and forth if necessary to align the D-shaped end with the MCOR.*

2. Secure the MCOR (2) to the plastic housing (4) with two torx screws (3). Tighten screws to 12 in·lb (1.4 N·m).
3. Connect the two-pin and three-pin connectors (1) from the wire harness to the MCOR (2).
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

REVERSE BUZZER

See General Warnings on page 1-1.

TESTING THE REVERSE BUZZER

See Test Procedure 20 – Reverse Buzzer on page 12-42.

REVERSE BUZZER REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-9.**
3. Disconnect the 18-gauge pink and orange/white wires from reverse buzzer (7) **(Figure 13-1, Page 13-1)**.
4. Remove the two screws (8) from the reverse buzzer (7). Remove the reverse buzzer from the instrument panel.

REVERSE BUZZER INSTALLATION

1. Install the reverse buzzer (7) in the reverse order of removal. Tighten screws (8) to 4 in·lb (0.45 N·m).
2. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

INSTRUMENT CLUSTER

See General Warnings on page 1-1.

INSTRUMENT CLUSTER REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove instrument panel. **See Instrument Panel Removal on page 4-9.**
3. Disconnect the 26-pin connector from the instrument cluster (10) **(Figure 13-1, Page 13-1)**.
4. From the back of the instrument panel (2), remove nuts (11) and washers (12) and push out the cluster.

INSTRUMENT CLUSTER INSTALLATION

1. Insert instrument cluster (10) into the instrument panel (2) and secure with washers (12) and nuts (11) **(Figure 13-1, Page 13-1)**. Tighten the nuts (11) to 10 in·lb (1.13 N·m).
2. Plug the 26-pin connector into the instrument cluster (10).
3. Install instrument panel. **See Instrument Panel Installation on page 4-10.**
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

SPEED CONTROLLER COVER

REMOVING THE SPEED CONTROLLER COVER

1. Use a flathead screwdriver to pry up the center pieces of the 3 push rivets (1) and remove the rivets **(Figure 13-5, Page 13-11)**.
2. Pull the speed controller cover (2) down and away from the component mounting plate.
3. Lift the curved edges of the speed controller cover out of the slots in the component mounting plate.

INSTALLING THE SPEED CONTROLLER COVER

1. Place the curved edges on the bottom of the speed controller cover (2) into the slots on the component mounting plate.
2. Press the speed controller cover (2) onto the component mounting plate over the speed controller and other electrical components.
3. Install the three push rivets (1) **(Figure 13-5, Page 13-11)**.

RELAYS

See General Warnings on page 1-1.

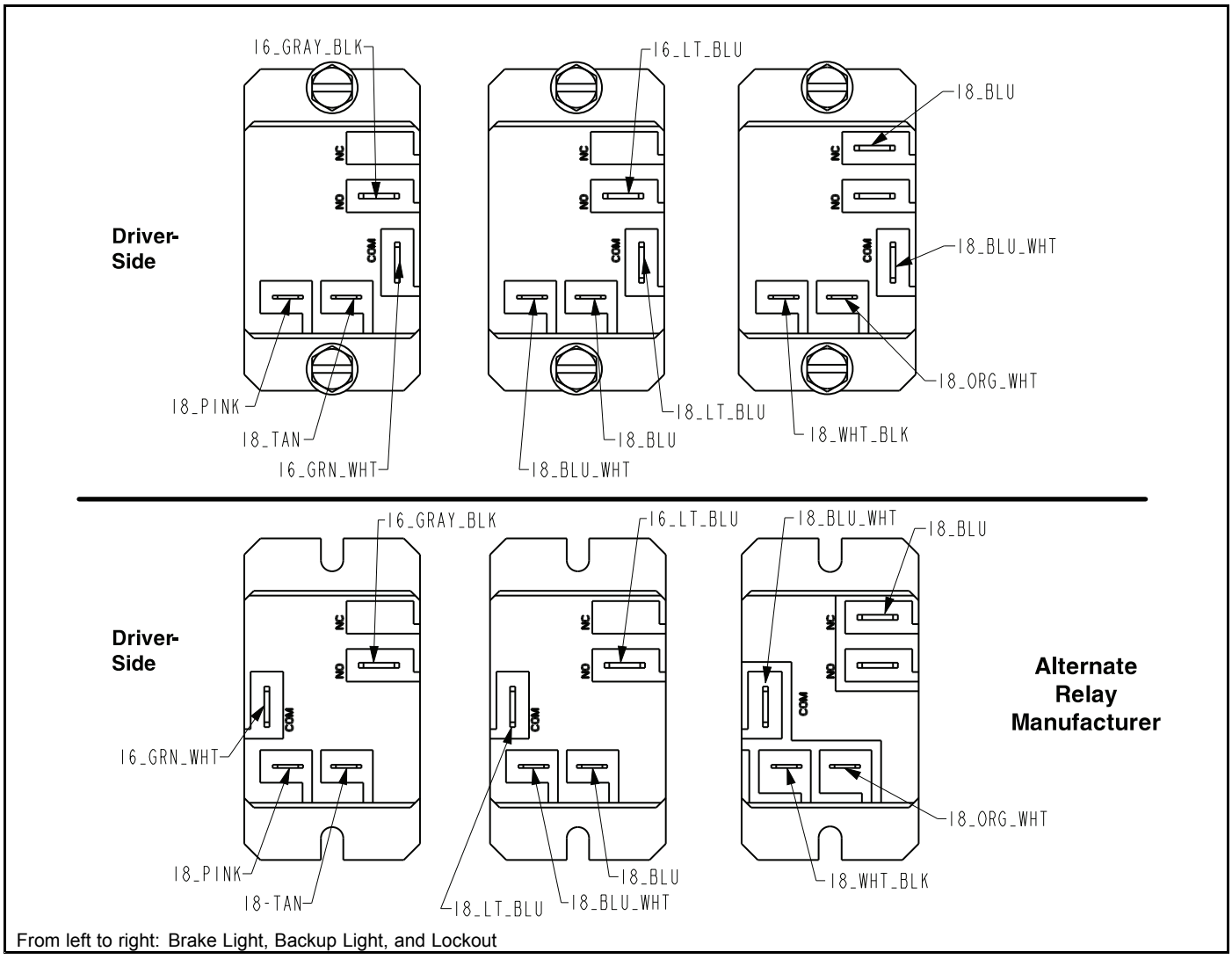
NOTE: *Relays are used in the lockout system, brake lights, backup light, and the "N" neutral indicator light in the instrument cluster.*

Wire terminal location may vary depending on manufacturer of relay.

Three relays are located on the electrical component mounting plate and one relay is located on the back side of the instrument panel.

At electrical component mounting plate: There are two Single Pole-Single Throw relays (3) and one Single Pole-Double Throw relay (4) **(Figure 13-5, Page 13-11)**.

At instrument panel: This is a Single Pole-Double Throw relay (13) **(Figure 13-1, Page 13-1)**.



From left to right: Brake Light, Backup Light, and Lockout

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Figure 13-4 Relay Wiring at Electrical Component Mounting Plate

TESTING THE RELAY

See Test Procedure 11 – Relay on page 12-31.

RELAY REMOVAL – ON INSTRUMENT PANEL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-9.**
3. Disconnect the 18-gauge pink and orange/white wires from relay (13) **(Figure 13-1, Page 13-1)**.
4. Remove the two screws (14) from the relay (13). Remove the relay from the instrument panel.

RELAY INSTALLATION – ON INSTRUMENT PANEL

1. Install the relay (13) in the reverse order of removal. Tighten screws (14) to 4 in·lb (0.45 N·m).
2. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

RELAY REMOVAL – AT ELECTRICAL COMPONENT MOUNTING PLATE

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Remove the speed controller cover (2). **See Removing the Speed Controller Cover on page 13-7.**
3. Disconnect all wires from the relay (3 and/or 4) **(Figure 13-5, Page 13-11)**.
4. Remove the two screws (5) that hold the relay (3 and/or 4) to the component mounting plate and remove the relay from the vehicle.

RELAY INSTALLATION – AT ELECTRICAL COMPONENT MOUNTING PLATE

1. Install the two screws (5) that hold the relay (3 and/or 4) to the component mounting plate and tighten to 9 in·lb (1 N·m) **(Figure 13-5, Page 13-11)**.
2. Connect the wires as shown **(Figure 13-4, Page 13-8)**.
3. Install the speed controller cover (2). **See Installing the Speed Controller Cover on page 13-7.**
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
5. Place the Tow/Run switch in the RUN position.
6. Inspect related vehicle system for proper operation.

SPEED CONTROLLER

See General Warnings on page 1-1.

TESTING THE SPEED CONTROLLER

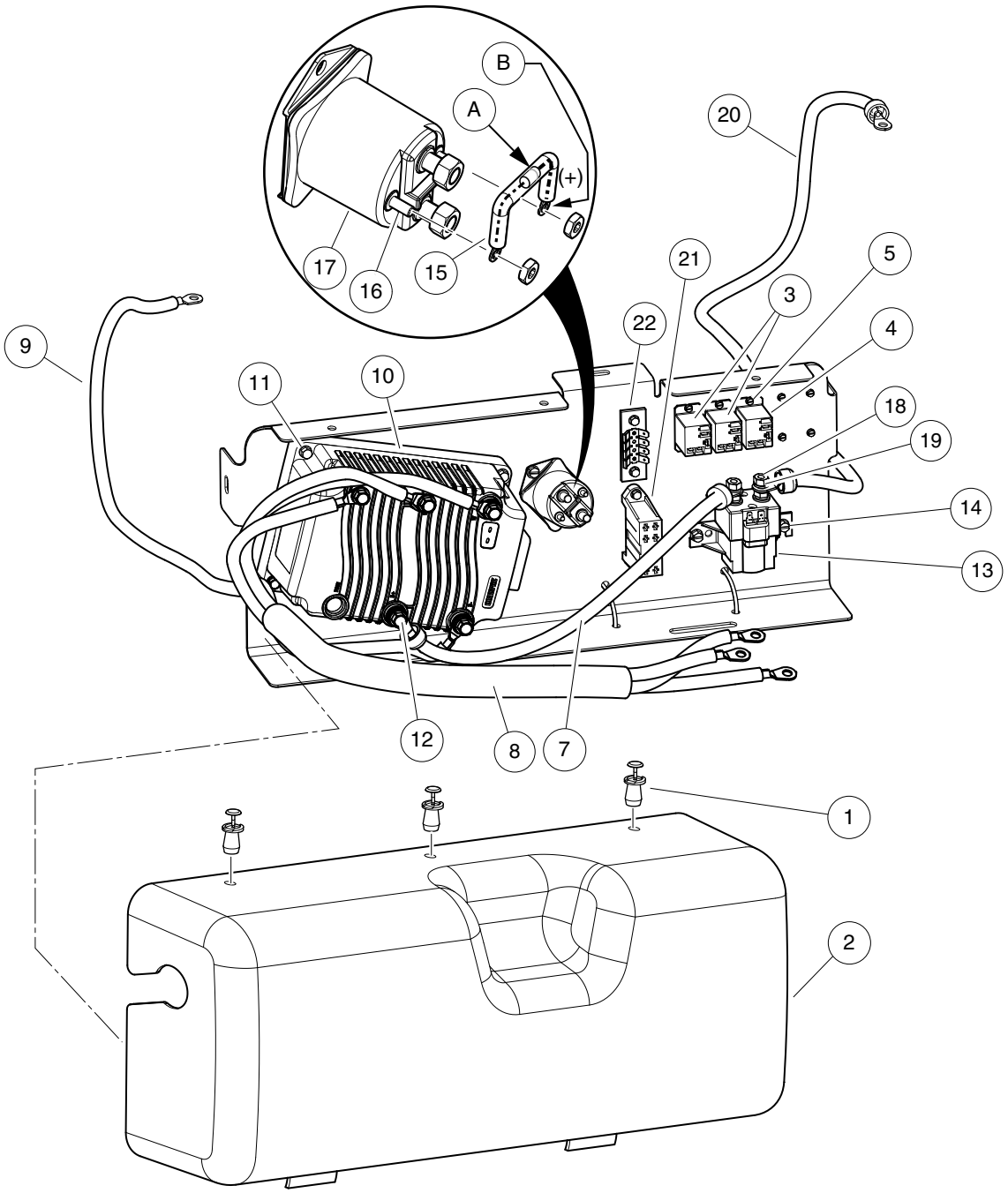
See Test Procedure 15 – 35-Pin Connector on page 12-36.

SPEED CONTROLLER REMOVAL

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Remove the speed controller cover (2). **See Removing the Speed Controller Cover on page 13-7.**
3. Disconnect all heavy gauge wires (7, 8, and 9) and the 35-pin connector from the speed controller (10).
4. Remove the four bolts (11) that hold the speed controller (10) to the component mounting plate and remove the controller from the vehicle.

SPEED CONTROLLER INSTALLATION

1. Install the four bolts (11) that hold the speed controller (10) to the component mounting plate and tighten to 60 in·lb (6.8 N·m) **(Figure 13-5, Page 13-11)**.
2. Install the 35-pin connector and all heavy gauge wires (7, 8, and 9) as illustrated. **See also .** Tighten controller bolts (12), securing the heavy gauge wires, to 9 ft·lb (12.2 N·m).
3. Install the speed controller cover (2). **See Installing the Speed Controller Cover on page 13-7.**
4. Place the Tow/Run switch in the TOW position and connect the battery cables, positive (+) cable first. Tighten battery terminals to 110 in·lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray to minimize corrosion.
5. Place the Tow/Run switch in the RUN position.
6. Inspect the vehicle for proper operation:
   – 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.



2 Ga. Yellow from Motor “U” to Controller “U”
2 Ga. Blue from Motor “V” to Controller “V”
2 Ga. Green from Motor “W” to Controller “W”
2 Ga. Yellow from Solenoid to Controller B+
2 Ga. Black from Battery No. 8 Negative Terminal to Controller B–
10 Ga. Black from Onboard Battery Charger to Controller B–
10 Ga. Black from 48-volt Ground Block to Controller B–
A. Gray Diode Band B. Red Ring Terminal

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Figure 13-5 Speed Controller, Solenoids, Relays and Fuse Block – LSV

SOLENOID, 48-VOLT

See General Warnings on page 1-1.

This solenoid is located on the passenger side of the electrical component mounting plate.

TESTING THE SOLENOID

See Test Procedure 9 – Solenoid Activating Coil, 48-Volt on page 12-29 and Test Procedure 8 – Solenoid Contacts, 48-Volt on page 12-28.

SOLENOID REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the speed controller cover (2). **See Removing the Speed Controller Cover on page 13-7.**
3. Disconnect all wires from the solenoid (13) **(Figure 13-5, Page 13-11)**.
4. Loosen, but do not remove, the two screws (14) that hold the solenoid (13) to the component mounting plate.
5. Lift the solenoid (13) up and off of the component mounting plate.

SOLENOID INSTALLATION

1. Mount solenoid (13) onto component mounting plate with screws (14) **(Figure 13-5, Page 13-11)**.
2. Tighten screws (14) to 50 in·lb (5.6 N·m).
3. Using the wiring diagram, install the wires, washers, and nuts onto the large mounting posts. Tighten nuts to 77 in·lb (8.7 N·m).
4. Install the blue/white and light blue wires onto the small terminals of the solenoid.
5. Install speed controller cover (2). **See Installing the Speed Controller Cover on page 13-7.**
6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

SOLENOID, 12-VOLT

See General Warnings on page 1-1.

NOTE: *This solenoid is used for the defogger/heater system.*

This solenoid is located in the center of the electrical component mounting plate.

TESTING THE SOLENOID

See Test Procedure 10 – Solenoid, 12-Volt on page 12-30.

SOLENOID REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the speed controller cover (2). **See Removing the Speed Controller Cover on page 13-7.**
3. Note orientation of diode (15) connecting the small posts (16) to the 18-gauge wires **(Figure 13-5, Page 13-11)**.
4. Disconnect all the wires from the solenoid (17) and remove diode (15) from small posts.
5. Remove the two screws securing the solenoid (17) in place. Remove the solenoid.

SOLENOID INSTALLATION

1. Mount solenoid (17) onto component mounting plate with screws **(Figure 13-5, Page 13-11)**. Tighten screws to 50 in·lb (5.6 N·m).
2. Install diode (15) onto small posts (16).
3. Connect all wires as indicated.

3.1. Connect the 10-gauge yellow wire to the large post on the solenoid.

3.2. Connect the 10-gauge red wire from the positive (+) battery terminal to the other large post on the solenoid.

3.3. Connect the 18-gauge green/yellow wire to the small post on the solenoid that has the positive (+) end of the diode denoted by a gray stripe or band.

3.4. Connect the 18-gauge black/yellow wire to the other small post on the solenoid.

4. Tighten the hex nuts on the large solenoid posts to 60 in·lb (6.8 N·m). Tighten the nuts on the small solenoid posts to 22 in·lb (2.5 N·m).
5. Install speed controller cover. **See Installing the Speed Controller Cover on page 13-7.**
6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

HEADLIGHT SWITCH

See General Warnings on page 1-1.

TESTING THE LIGHT SWITCH

See Test Procedure 21 – Headlight Switch – High Beam on page 12-43.

HEADLIGHT SWITCH REMOVAL

1. Remove the instrument panel. **See Instrument Panel Removal, Section 4, Page 4-9.**
2. Disconnect the wires from the light switch (9) **(Figure 13-1, Page 13-1)**.
3. Collapse the tabs and push light switch (9) from instrument panel (2).

HEADLIGHT SWITCH INSTALLATION

1. Push light switch (9) into instrument panel (2) **(Figure 13-1, Page 13-1)**.
2. Connect the wires to the light switch (9).
3. Install the instrument panel. **See Instrument Panel Installation on page 4-10.**
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

HEADLIGHTS

See General Warnings on page 1-1.

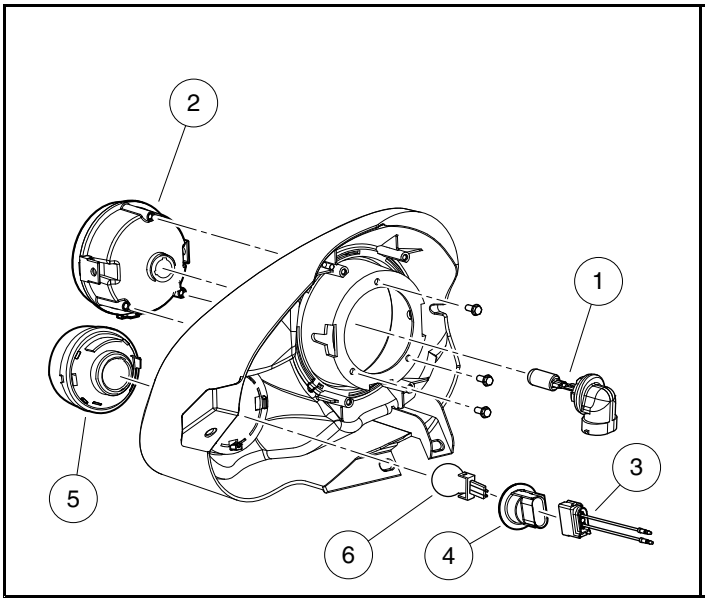

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Figure 13-6 Headlight Bulb – Halogen

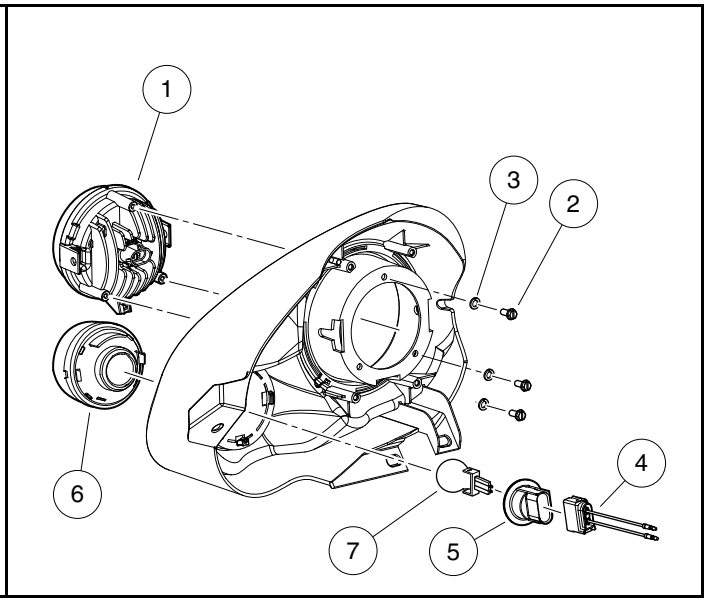

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Figure 13-7 Headlight Bulb – LED

HEADLIGHT BULB REMOVAL – HALOGEN

NOTE: *When handling halogen bulbs, do not touch the glass portion of bulb. Oil from finger tips can cause premature failure of the bulb.*

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Disconnect wire harness from halogen bulb (1) **(Figure 13-6, Page 13-15)**.
4. Rotate halogen bulb (1) in headlight housing (2) and pull bulb out to remove.

HEADLIGHT BULB INSTALLATION – HALOGEN

1. Insert halogen bulb (1) into headlight housing (2) and rotate to lock in place **(Figure 13-6, Page 13-15)**.
2. Connect wire harness to halogen bulb (1).
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**
4. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**

HEADLIGHT BULB REMOVAL – LED

NOTE: *LED headlights do not have replaceable bulbs. The entire headlight must be replaced.*

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Disconnect wire harness from LED headlight (1) **(Figure 13-7, Page 13-15)**.

4. Remove three screws (2) and lock washers (3) and remove LED headlight (1) from bezel.

HEADLIGHT BULB INSTALLATION – LED

1. Insert LED headlight (1) into bezel and secure with three lock washers (3) and screws (2) **(Figure 13-7, Page 13-15)**. Tighten screws (2) to 35 in·lb (4 N·m).
2. Connect wire harness to LED headlight (1).
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**
4. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**

HEADLIGHT BEZEL REMOVAL

1. Disconnect the batteries and discharge the controller. Disconnecting the Batteries – Electric Vehicles on page 1-3
2. Remove the cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Remove the front fenders. **See Front Bumper and Side Fender Removal, Section 4, Page 4-9.**
4. Loosen and remove the M6 self-tapping bolts (2) that attach the bezel (1) to the vehicle frame **(Figure 13-8, Page 13-17)**.

HEADLIGHT BEZEL INSTALLATION

1. Install bezel (1) to vehicle frame **(Figure 13-8, Page 13-17)**.
2. Install the three M6 self-tapping bolts (2) that attach the bezel onto frame. Tighten to 44 in·lb (5 N·m).
3. Install the front fenders. **See Front Bumper and Side Fender Installation, Section 4, Page 4-9.**
4. Install the cowl. **See Cowl Installation, Section 4, Page 4-5.**
5. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

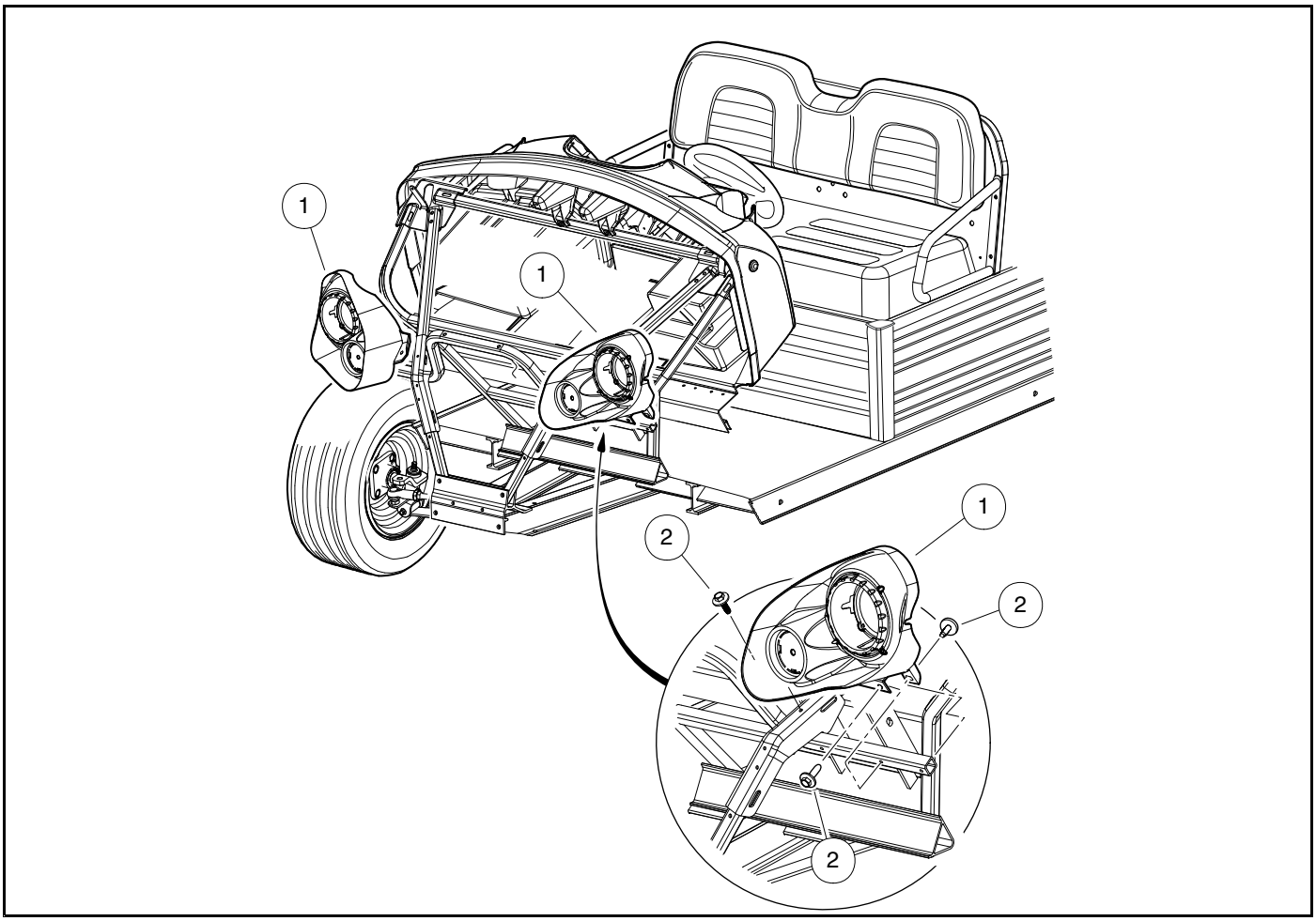

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Figure 13-8 Headlight Bezel Mounting

TURN SIGNAL LIGHTS

See General Warnings on page 1-1.

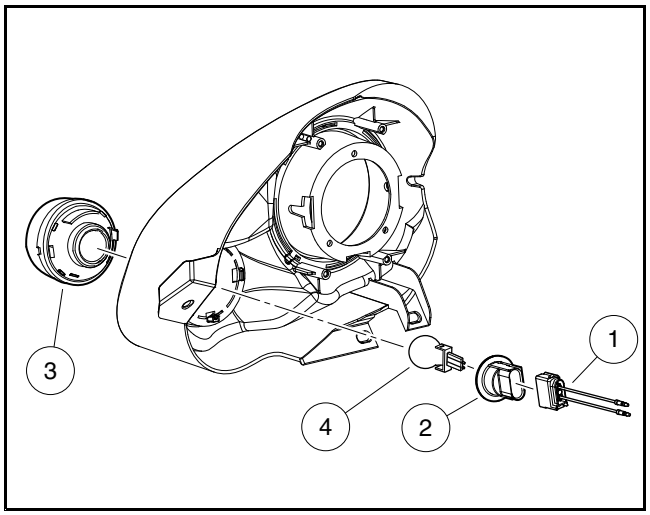

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Figure 13-9 Turn Signal Bulb

TURN SIGNAL BULB REMOVAL

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove cowl. **See Cowl Removal, Section 4, Page 4-5.**
3. Disconnect wire harness plug (1) from bulb socket (2) **(Figure 13-9, Page 13-18)**.
4. Rotate bulb socket (2) and pull to remove from turn signal (3).
5. Pull bulb (4) straight out to remove from socket (2).

TURN SIGNAL BULB INSTALLATION

1. Push bulb (4) straight into socket (2) **(Figure 13-9, Page 13-18)**.
2. Install bulb socket (2) into turn signal (3) and rotate to lock in place.
3. Connect wire harness plug (1) to bulb socket (2).
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**
5. Install cowl. **See Cowl Installation, Section 4, Page 4-5.**

TAILLIGHTS

See General Warnings on page 1-1.

NOTE: *Taillights use LED bulbs that are not replaceable. The entire taillight must be replaced.*

TAILLIGHT REMOVAL

1. Disconnect the batteries. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove two flanged nuts (1) and screws (2) securing taillight assembly (3) to rear fender.
3. Disconnect three wires from wire harness.

TAILLIGHT INSTALLATION

1. Install taillight assembly (3) into rear fender and connect three wires to wire harness.
2. Secure taillight assembly (3) with two screws (2) and flanged nuts (1). Tighten flanged nuts (1) to 20 in·lb (2 N·m).
3. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**

REAR VIEW CAMERA DISPLAY

⚠ WARNING

- **The rear view camera is a secondary aid to a visual check. The rear view camera does not show objects outside of the cameras' field of view, below the bumper, or below the vehicle. The operator must visually make sure that it is safe to back up. Failure to use proper care can cause property damage, serious injury, and death.**

REAR VIEW CAMERA DISPLAY REMOVAL

1. Disable the vehicle.
2. Set the Run/Tow switch to TOW.
3. Remove the cowl.
4. Disconnect the rear view camera display from the camera wire harness.
5. Remove the rubber grommet (1) from the dash panel **(Figure 13-10, Page 13-20)**.

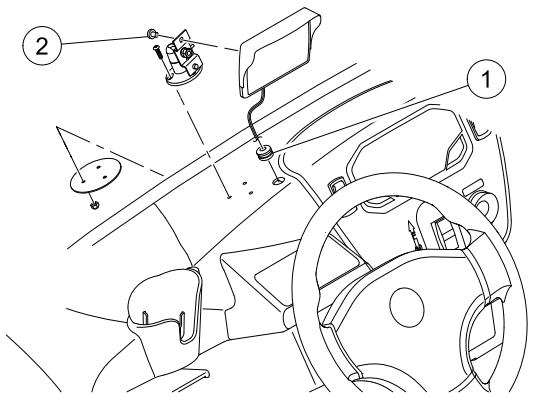


Figure 13-10 Rear View Camera Display

6. Remove the screws (2).
7. Remove the rear view camera display.

REAR VIEW CAMERA DISPLAY INSTALLATION

1. Install the rear view camera display wire through the hole in the dash.
2. Connect the rear view camera display to the camera wire harness.
3. Install the rubber grommet (1) **(Figure 13-10, Page 13-20)**.
4. Install the screws (2). Tighten the screws to 32 in·lb (3.6 N·m).
5. Install the cowl.
6. Set the Run/Tow switch to RUN.

DISPLAY BRACKET REMOVAL

1. Disable the vehicle.
2. Remove the screws (1) **(Figure 13-11, Page 13-21)**.

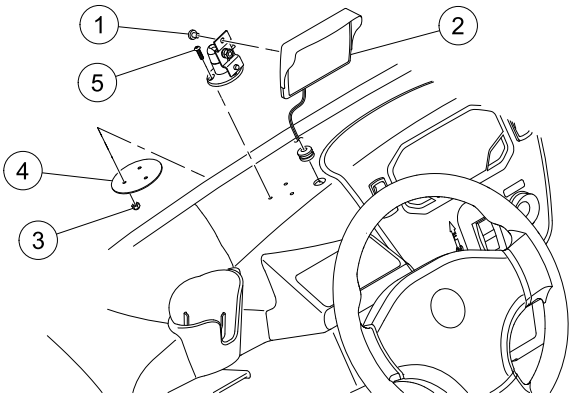


Figure 13-11 Display Bracket

3. Remove the rear view camera display (2) from the display bracket.
4. Remove the instrument panel.
5. Remove the nuts (3), backing plate (4), and screws (5).
6. Remove the display bracket.

DISPLAY BRACKET INSTALLATION

1. Install the display bracket on the cowl.
2. Install the backing plate (4), screws (5), and nuts (3) **(Figure 13-11, Page 13-21)**. Tighten the nuts to 18 in·lb (2 N·m).
3. Install the instrument panel.
4. Install the rear view camera display (2) on the display bracket.
5. Install the screws (1). Tighten the screws to 32 in·lb (3.6 N·m).

REAR VIEW CAMERA

REAR VIEW CAMERA REMOVAL

1. Disable the vehicle.
2. Set the Run/Tow switch to TOW.
3. Disconnect the camera from the camera wire harness.
4. Push the two tabs (1) on the camera and remove from the bracket **(Figure 13-12, Page 13-22)**.

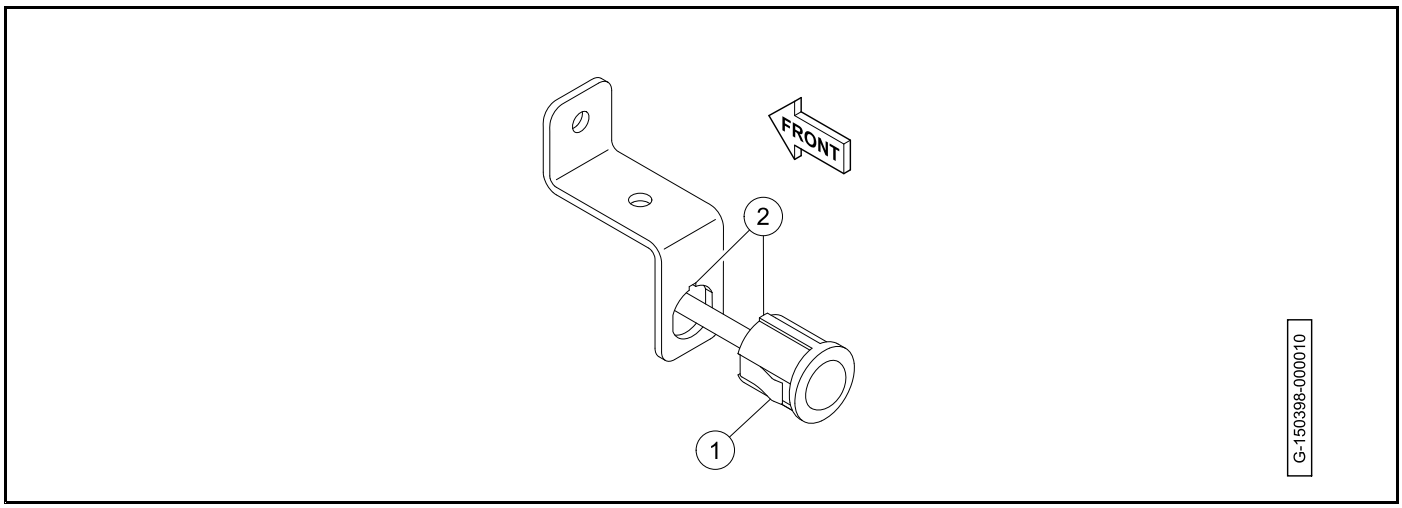


Figure 13-12 Rear View Camera

REAR VIEW CAMERA INSTALLATION

1. Install the camera wires through the bracket.
2. Align the tab (2) on the camera with the slot (2) in the bracket **(Figure 13-12, Page 13-22)**.
3. Install the camera into the bracket.
4. Make sure that the two tabs (1) on the camera engage.
5. Connect the camera to the camera wire harness.
6. Set the Run/Tow switch to RUN.

CARGO BED CAMERA BRACKET REMOVAL

1. Disable the vehicle.
2. Set the Run/Tow switch to TOW.
3. Remove the rear view camera (1) **(Figure 13-13, Page 13-23)**.

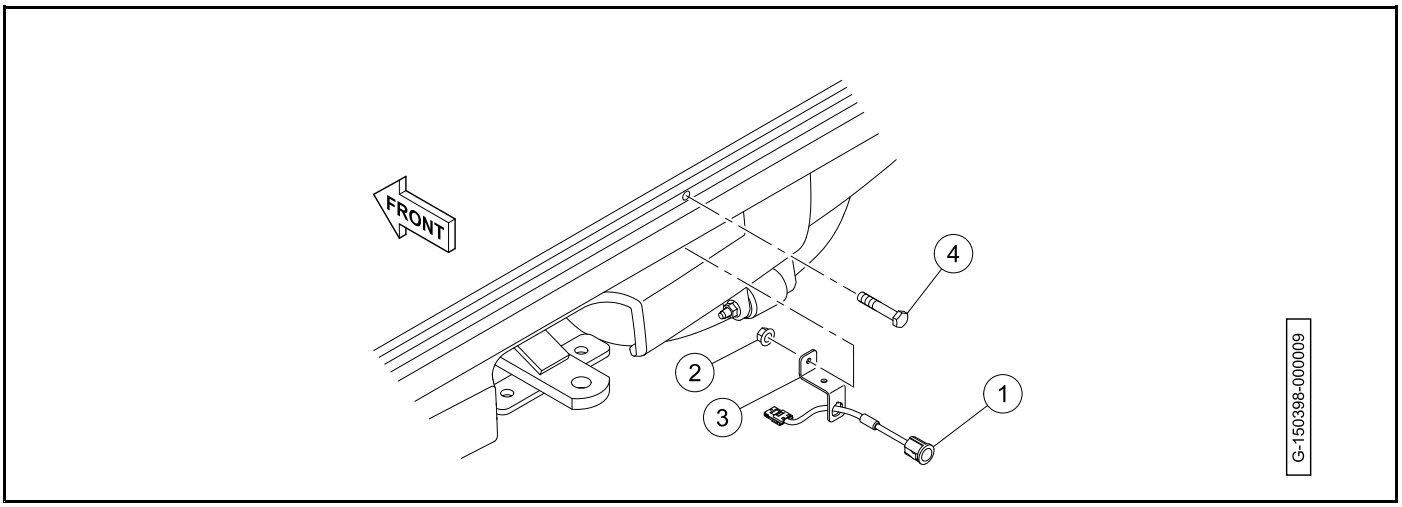


Figure 13-13 Cargo Bed Camera Bracket

4. Remove the tailgate.
5. Remove the nut (2).
6. Remove the camera bracket (3).

NOTE: *For initial setup, a longer bolt (4) will be used to install the camera bracket.*

CARGO BED CAMERA BRACKET INSTALLATION

1. If the tailgate is installed, remove the tailgate.
2. Install the camera bracket (3) on the vehicle **(Figure 13-13, Page 13-23)**.
3. Install the nut (2). Tighten the nut to 12.5 ft·lb (17 N·m).

NOTE: *For Cargo Bed: For initial setup, use the long bolt (4) included with the rear view camera kit.*

4. Install the tailgate.
5. Install the rear view camera (1).
6. Set the Run/Tow switch to RUN.

FLAT BED CAMERA BRACKET REMOVAL

1. Disable the vehicle.
2. Set the Run/Tow switch to TOW.
3. Remove the rear view camera (1) **(Figure 13-14, Page 13-24)**.

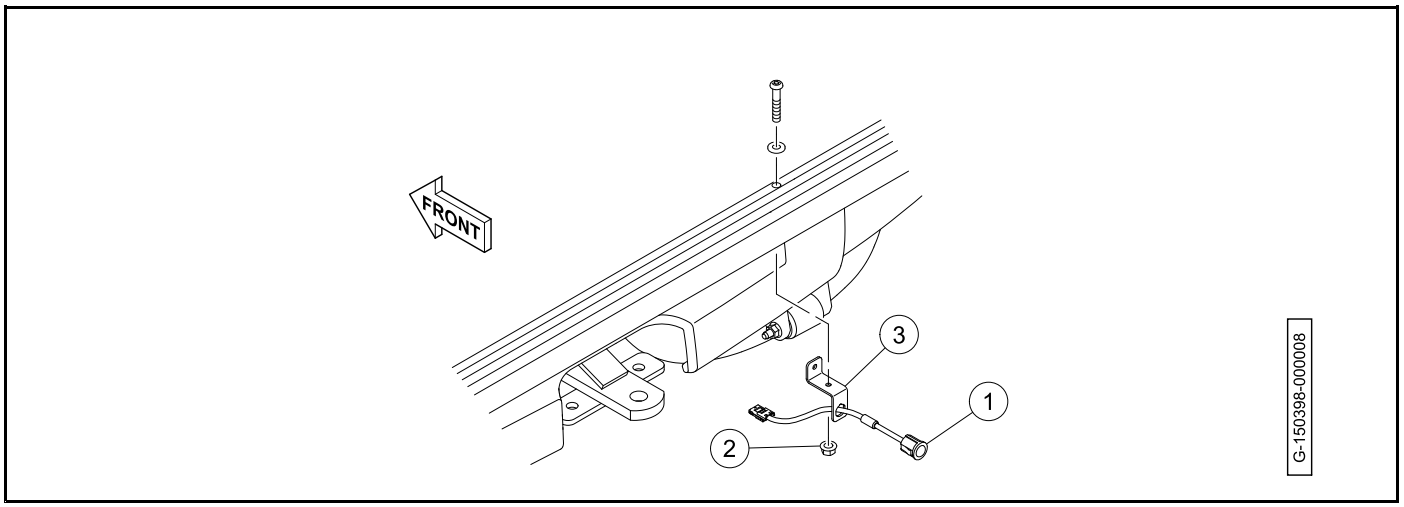


Figure 13-14 Flat Bed Camera Bracket

4. Remove the nut (2).
5. Remove the camera bracket (3).

FLAT BED CAMERA BRACKET INSTALLATION

1. Install the camera bracket (3) on the vehicle **(Figure 13-13, Page 13-23)**.
2. Install the nut (2). Tighten the nut to 12.5 ft·lb (17 N·m).
3. Install the rear view camera (1).
4. Set the Run/Tow switch to RUN.

USB RECEPTACLE

The 5-volt, 2.1 amp USB receptacle supplies electricity to power and charge portable devices. The USB receptacle is not for movement of data.

The USB receptacle will only operate when a shielded USB cord is connected. When the USB receptacle is not in use, remove the shielded USB cord to prevent battery drain.

USB RECEPTACLE REMOVAL

1. Disable the vehicle.
2. Disconnect the batteries and discharge the controller.
3. Remove the cowl.
4. Disconnect the USB red wire from the 12V power point (1) and the main harness red wire (2) **(Figure 13-15)**.

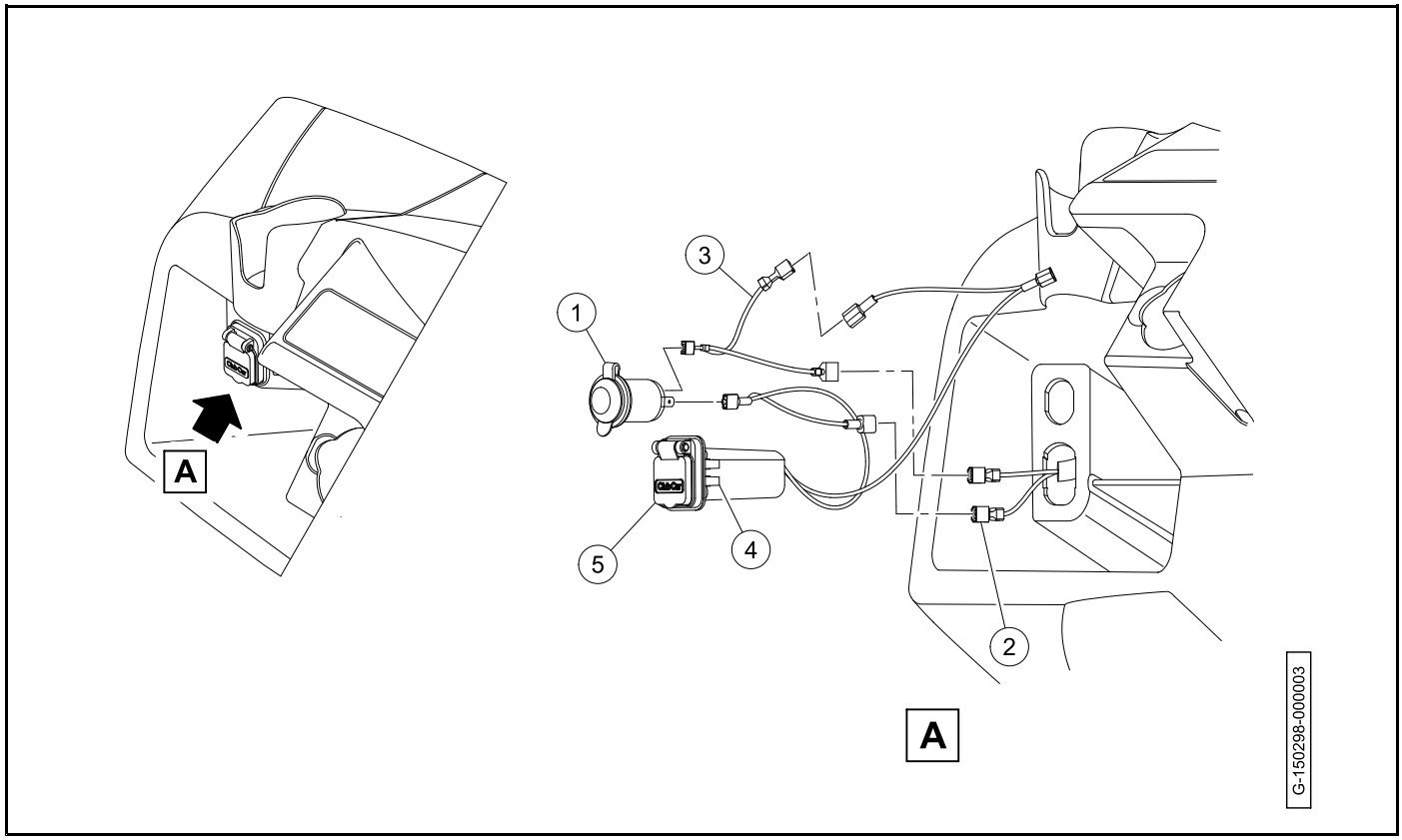


Figure 13-15

5. Disconnect the USB black wire from the jumper wire (3).
6. Push the lock tabs (4) on both sides and remove the USB receptacle (5).

USB RECEPTACLE INSTALLATION

1. Put the USB receptacle wires into the dash.
2. Push the USB receptacle (5) into the dash **(Figure 13-15)**.
3. Make sure that the locking tabs (4) engage.

4. Connect the USB black wire to the jumper wire (3).
5. Connect the USB red wire to the main harness red wire (2) and the 12V power point (1).
6. Install the cowl.
7. Connect the batteries.

SECTION 14 — BATTERIES

14

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

⚠ 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 14-6.**

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 – 6 VOLT

See General Warnings on page 1-1.

OBSERVATION

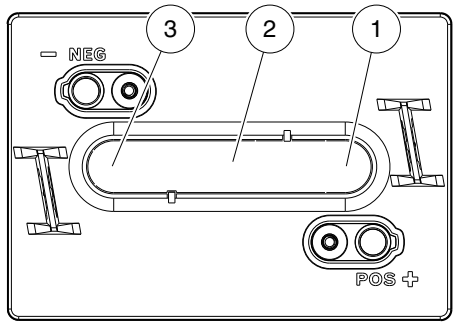
Inspect the battery compartment for the following items:

- 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. 8. Record the reading.

BATTERY CELL NUMBERING



1. Cell 1 (Cell with Positive Post
2. Cell 2 (Cell in center of battery)
3. Cell 3 (Cell with Negative Post)

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Figure 14-1 Battery Cell Numbering – 6 Volt

BATTERY TESTING – 6 VOLT

See General Warnings on page 1-1.

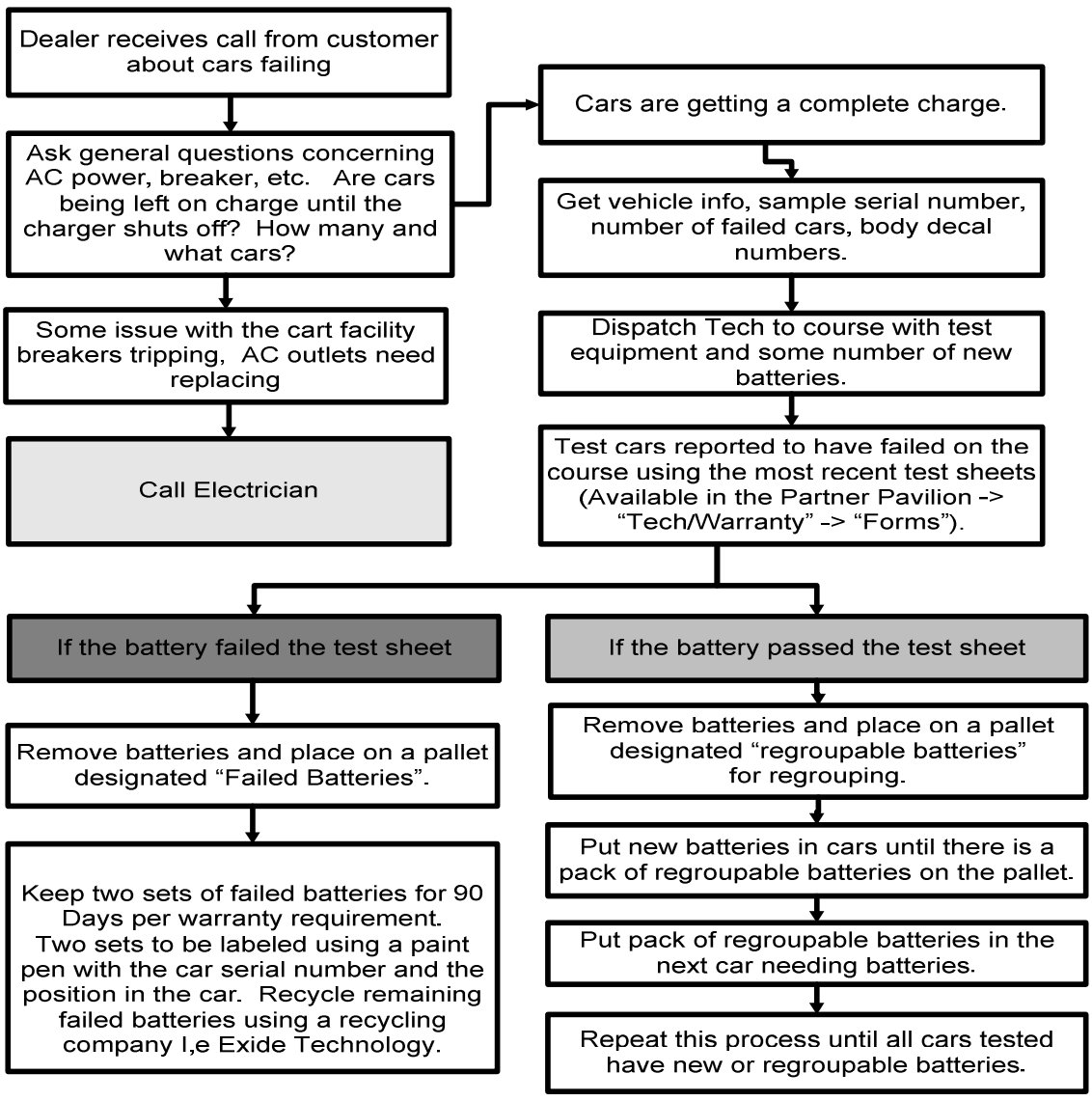
Test procedures not available at time of publication. Refer to any Bulletin that is released concerning testing for Model Year 2015.

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.



CAUTION: To prevent degradation of battery performance and life, never mix batteries of different part numbers or brands/model numbers. Charging algorithms 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 14-2 Battery Regrouping Process Flow

BATTERY REPLACEMENT

See General Warnings on page 1-1.

⚠ 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 1-3.** 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 14-3.**
6. Install regrouped or new batteries in the proper orientation. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.** 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 55 in·lb (6.2 N·m), alternating between hold-down bolts.
7. Install wires in proper sequence. Install black wire to negative post of battery no. 8 (8 x 6-volt battery set) last. **See Connecting the Batteries – Electric Vehicles on page 1-3.**
8. 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 1-1.

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 two deionizer systems: one for vehicles equipped with the Single Point Watering System (SPWS) and one for vehicles without SPWS (used in combination with 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
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	4.0	Slight self-discharge of negative plates

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 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.

  Replacement filters are available from Club Car Service Parts.

- 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:

1. 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.
2. 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 (SPWS)

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. **See following NOTE.**

NOTE: *Dispose of waste water properly.*

2. 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. Tighten hold-down retaining nuts to 55 in·lb (6.2 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 1-3. See following WARNING.**

⚠ WARNING

- **If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so can cause them to overheat during operation and can 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 14-9. See Watering Batteries with the SPWS on page 14-12.**

CAUTION

- **The watering interval must adequately maintain the electrolyte level above the top of the plates (Figure 14-3, Page 14-11).**
- **Water the batteries only AFTER charging.**

NOTE: *Bottled distilled water, with the hand pump 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 Schedule on page 10-3.** 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 (SPWS)

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. **See following NOTE.**

NOTE: *Dispose of waste water properly.*

2. Check the electrolyte level weekly **(Figure 14-3)**. 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.**

⚠ CAUTION

- **Do not overfill the batteries.**

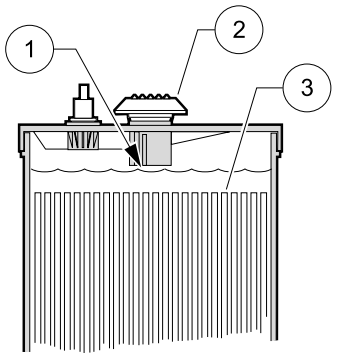
NOTE: *A battery watering gun or bottle is available from your authorized Club Car dealer.*

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. Tighten hold-down retaining nuts to 55 in·lb (6.2 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 1-3. See following WARNING.**

⚠ WARNING

- **If battery wire terminals are damaged or corroded, replace or clean them as necessary. Failure to do so can cause them to overheat during operation and can 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).



1. Level Indicator 2. Cap 3. Plates
Maintain electrolyte level from at least 1/2 inch (13 mm) above plates to 1/4 inch (6 mm) below level indicator.

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Figure 14-3 Electric Battery Electrolyte Level

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 14-14.**

ELECTROLYTE LEVEL

⚠ 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.**

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 14-3, Page 14-11)**. Never allow the electrolyte level to fall below the tops of the plates because this will cause the exposed part of the plate 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 14-5.** 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 14-5.**

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 14-6. 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 14-6.***

WATERING BATTERIES WITH THE SPWS

Checking the Water Flow Rate

1. Connect the water hose with the built-in screen filter (2) to the water faucet (1) **(Figure 14-4)**. **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 or 6 meters), as a decrease in water pressure can 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 14-4)**.
3. Connect the purger (5) to the female coupler (8) on the end of the hose-end assembly **(Figure 14-5)**.

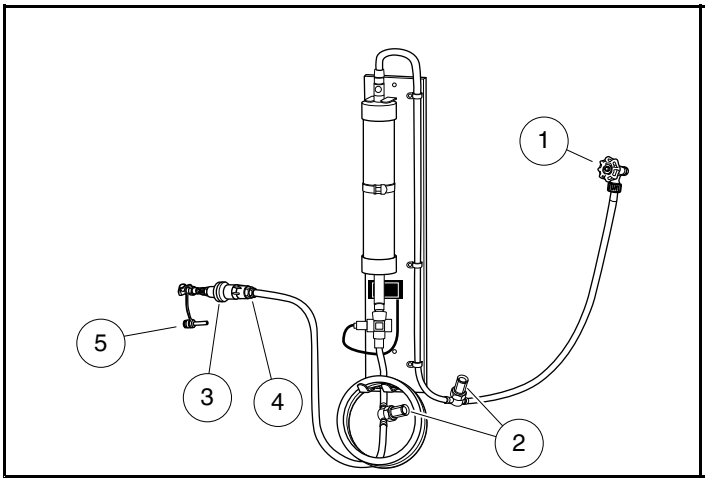

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Figure 14-4 Connecting Hose with Filter to Water Source

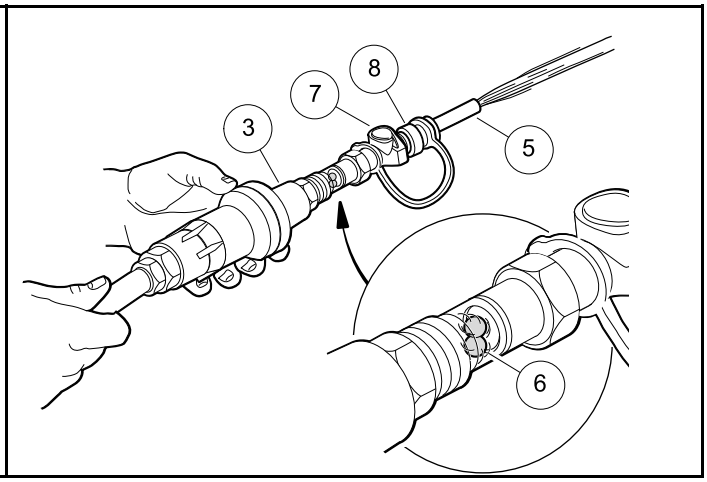

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Figure 14-5 Checking the Water Flow Rate

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 14-6)**, and connect the hose-end assembly (3) **(Figure 14-7)**. The water flow will begin immediately.

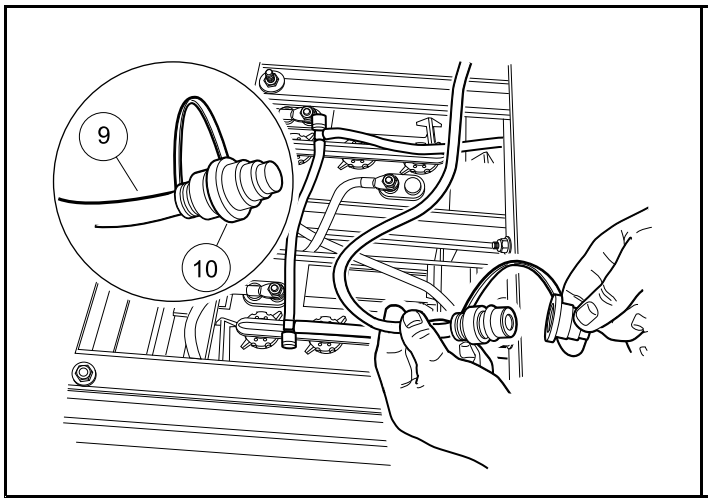

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Figure 14-6 Dust Cap

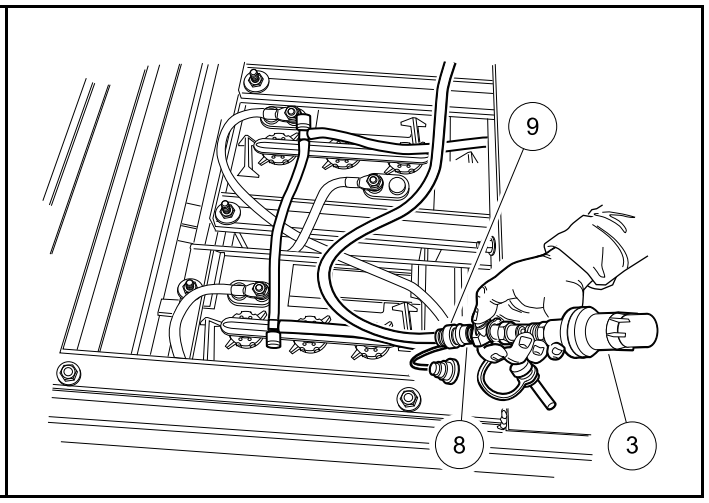

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Figure 14-7 Connecting Hose-end Assembly to Battery Fill Connector

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 14-6)**.
4. Place the battery fill coupling into the space between the batteries and the car body. Leaving the fill coupling on top of the battery bank or tucked between the batteries can result in coupling damage.
5. Turn the water faucet off when finished filling the vehicle(s).

BATTERY STORAGE

See Storage – Electric Vehicles, Section 3, Page 3-2.

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 11, Page 11-9.***

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.

Pagination Page

SECTION 15 — QUIQ HIGH FREQUENCY CHARGER

15

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

This section includes information pertaining to servicing the QuiQ™ high frequency battery charger. Do not attempt to service a battery charger that has not been properly identified. If a charger cannot be properly identified, contact your local authorized Club Car dealer or distributor.

The High Frequency Battery Charger 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. **See Battery Charger Algorithms on page 15-2.**

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.

FEATURES

Charge Interlock

When the AC power cord is inserted into a wall receptacle, the charger locks out the vehicle drive system. This prevents the possibility of driving the vehicle while the charger is plugged in and potentially damaging the vehicle and charger.

Long-Term Storage Charge

This charger is designed to be left connected to AC power during off-season or long-term storage. Be sure to check the charger monthly to ensure the charger is operating correctly during storage. The charger will enter maintenance mode if supported by the charge algorithm or automatically activate if battery voltage drops less than 2.1 volts per cell (24 cells is 50.4 volts) or 30 days have elapsed. To return the vehicle to service, disconnect the AC cord from the wall outlet, wait 15 seconds and then plug the AC cord back in. The charger will activate. Allow the vehicle to complete one full charge cycle before putting it into service.

UL AND CSA LISTING

When operated on a 120 volt / 60 Hz electrical system, this battery charger has been listed by Underwriters Laboratories and by the Canadian Underwriters (thereby meeting the criteria of the Canadian Standards Association).

CE COMPLIANCE

This battery charger is compliant with the EU EMC Directive 2004/108/EC.

IP (INGRESS PROTECTION) RATING

The enclosure of the charger has been tested successfully to EN60529, meeting IP66. The AC supply inlet is rated to IP20, which is suitable for indoor use only. Keep all AC connections clean and dry.

HOW TO IDENTIFY CHARGE ALGORITHM NUMBER

The algorithm numbers offered can be found in **See Battery Charger Algorithms on page 15-2.** The charger can display its algorithm number by initiating Algorithm Display Mode. To enter Algorithm Display Mode, do the following:

1. Disconnect the AC cord from the power outlet.
2. Disconnect the DC connector from the battery charger.
3. Wait for 1 to 1.5 minutes.
4. Connect the AC cord into the power outlet.

4.1. All of the charger lights will turn on and then off.

4.2. The AC on symbol will turn on.

4.3. The current algorithm will display for 11 seconds.

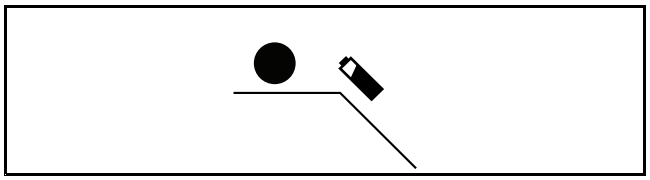

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Figure 15-1 80% Charge Light

5. If the 80% charge light flashes, the current algorithm is 72 **(Figure 15-1)**.

NOTE: *The 80% charge light will flash 7 times, pause, then flash 2times.*

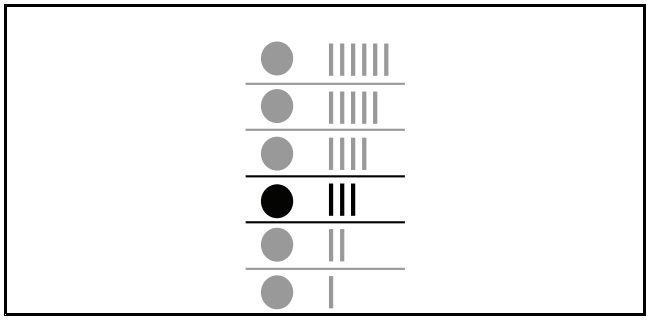

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Figure 15-2 Number 3 Light

6. If the number 3 light flashes, the current algorithm is 3 **(Figure 15-2)**.
7. Disconnect the AC cord from the power outlet.
8. Connect the DC connector.

Battery Charger Algorithms

CHARGER MODEL (PART NUMBER)	ALGORITHM	BATTERY TYPE
912–4854–04	algorithm # 72	JCI
912–4854–04	algorithm # 3	Trojan

HOW TO CHANGE THE ALGORITHM

1. Set the Run/Tow switch to TOW.
2. If equipped, disconnect the DC/DC converter connector (1).

Figure 15-3 DC/DC Converter Connector

3. Disconnect the AC cord (2).

Figure 15-4 AC cord

4. Disconnect the main positive (+) battery wire (3).

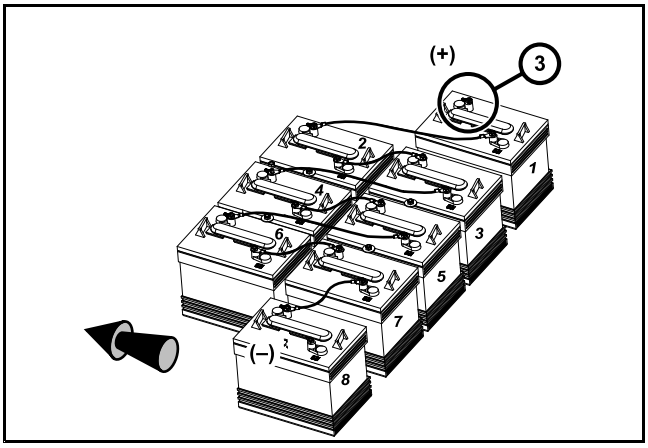

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Figure 15-5 Main Positive Battery Wire

5. Wait for 1 to 1.5 minutes.
6. Connect the AC cord.
7. While the battery charger lights flash, touch the main positive (+) battery wire to the battery post.

7.1. After three seconds, the algorithm display will change to the next algorithm. Continue to touch the main positive (+) battery wire to the battery post until the batteries start to charge.

7.2. When the batteries start to charge, disconnect the main positive (+) battery wire.

8. Disconnect the AC cord.
9. Connect the main positive (+) battery wire.
10. If equipped, connect the DC/DC converter connector.
11. Set the Run/Tow switch to RUN.

THE CHARGE CIRCUIT

The charge circuit consists of the onboard charger, batteries and charger information light **(Figure 15-6, Page 15-4)**.

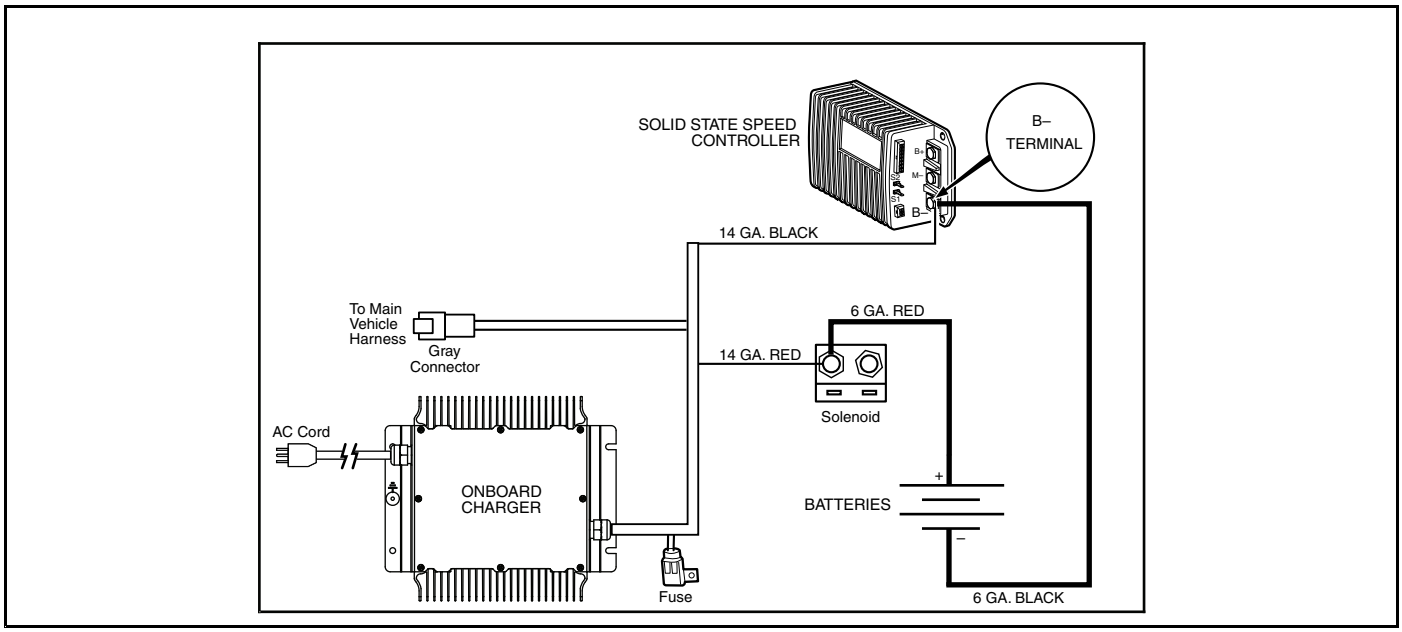

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Figure 15-6 Charge Circuit

ONBOARD CHARGER OPERATION

⚠ 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.**
- **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 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.**
- **Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock; do not use ground adapters or modify plug.**
- **Do not touch uninsulated portion of output connector or uninsulated battery terminals.**
- **Disconnect the AC supply before making or breaking the connections to the battery.**
- **Do not open or disassemble charger.**

DANGER CONTINUED ON NEXT PAGE

⚠ DANGER

- **Do not operate this charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way. Refer all repair work to the manufacturer or qualified personnel.**
- **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**

⚠ WARNING

- **The high frequency battery charger is programmed with an algorithm that matches the type and design specifications of the batteries originally installed in the vehicle. Never use this charger to charge batteries of a different type and design specification. Doing so will damage the non-matching batteries and greatly reduce their life span. If the batteries can not be replaced with the same as original, the charger must be replaced with one that matches the replacement batteries.**
- **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.**
- **Only trained technicians should repair or service the charger. Contact your nearest Club Car distributor/dealer.**
- **Each charger should have its own dedicated 15 or 20 ampere separately protected (circuit breaker or fuse) single phase branch circuit, in accordance with all applicable electrical codes for the location.**
- **Connect the charger AC supply cord to a properly grounded, three-wire outlet of the proper voltage and frequency as 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.**
- **Use only an appropriately sized AC power cord. See AC Power Connection on page 15-8.**
- **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.**
- **Prior to servicing the charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle. See removal procedure in the appropriate maintenance and service manual.**
- **Do not use a battery charger if the cord or plug is damaged in any way. Replace worn or damaged parts immediately. Failure to heed this warning could result in a fire, property damage, severe personal injury, or death.**
- **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.**
- **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 lightening strikes**
- **Ensure battery connections are clean and properly tightened.**

WARNING CONTINUED ON NEXT PAGE

⚠ 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.**
- **Do not wear loose clothing or jewelry such as rings, watches, chains, etc., when servicing the vehicle or battery charger.**
- **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**

CHARGER DISPLAYS

10-LED display on charger:

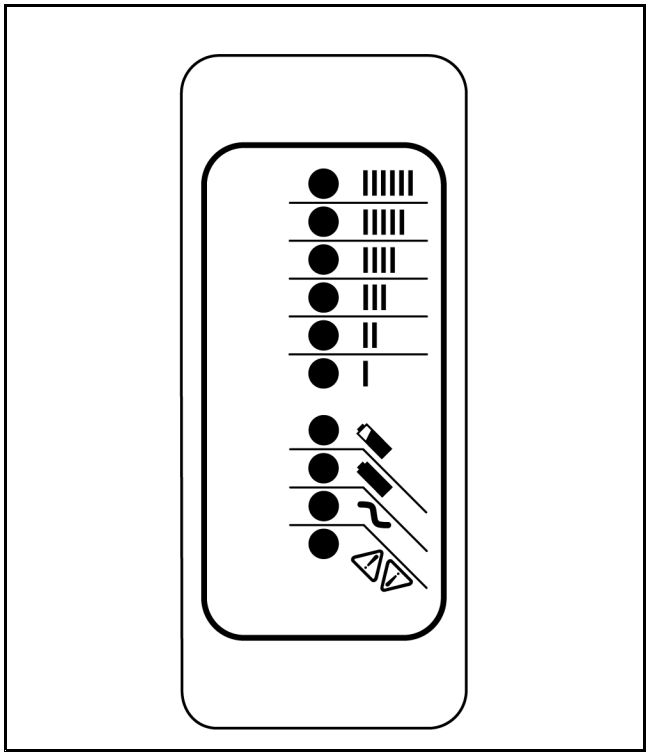

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Figure 15-7 10–LED Display on Charger

LED Color	Icon	Indication (following "Power-On Self Test")	STATUS EXPLANATION
Ammeter (Amber)		Solid:	Displays approximate scale of current output during bulk phase.
		Flashing:	High internal charger temperature. Output reduced. Also displays algorithm #1 through # 6 for 11 seconds if no battery is connected.
80% Charge (Amber)		Solid:	Bulk charge phase complete, 80% charged. In Absorption phase.
		Flashing:	1. With no battery connecte, indicates algorithm # selected by number of flashes. 2. With battery connected, indicates battery being charged.
100% Charge (Green)		Solid:	Charging is complete. Charger in Maintenance Mode.
		Flashing:	Absorption phase complete. In Finish phase
AC on (Amber)		Solid:	AC Power good
		Flashing:	Low AC Voltage. Check voltage and power cord length (refer to guidelines) **See AC Power Connection on page 15-8.**
Fault (Red)		Flashing:	1. Solid Red = Charger Hardware Failure; requires charger to be replaced 2. Flashing Red = Charge Cycle Caution; AC Voltage, DC Voltage, Ambient Temperature, Charge Cycle Timers

AC POWER CONNECTION

CAUTION

- **Charger enclosure may be hot during charging. Use hand protection if handling the charger while charging.**

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.*

Only use one charger on a single 15 amp circuit or the circuit may become overloaded.

To reduce the risk of electric shock, the battery charger must be grounded. The charger is equipped with an AC electric cord with 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 Electric Code and all local codes and ordinances.

The AC power cord must be a three-conductor, no. 12 AWG (American Wire Gauge) or no. 14 SWG (British Standard Wire Gauge), heavy-duty cord with ground, properly wired and in good electrical condition. Keep it as short as possible (no more than 12 feet (3.7 m)). Place all cords so they will not be stepped on, tripped over, or otherwise subject to damage or stress.

CHARGING BATTERIES

NOTE: *Batteries should be put on charge even if they have been used for only a short time, i.e., 10 minutes. The charger is automatic and will turn off when batteries are fully charged. If the charger does not seem to be operating properly, or if the batteries seem weak, contact a local Club Car distributor/ dealer.*

New batteries will not deliver their full range until the vehicle has been driven and recharged from 20 to 50 times.

Vehicles should be restricted to 40 to 50 amp hours of discharge between charges until the batteries have been properly seasoned (20 to 50 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 deep discharging the batteries. Charging between uses will also extend battery life.

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, while cold batteries require more time to fully charge.

1. Insert the onboard charger AC plug into a dedicated and properly wired AC receptacle to begin a charge cycle. **See Battery Charger Algorithms, Section 15, Page 15-2.**

NOTE: *Only connect ONE charger to a single 15 amp circuit or the circuit may become overloaded.*

2. Place the charger AC cord so it will not be stepped on, tripped over, or otherwise subject to damage or stress.
3. Do not place items in the compartment where the battery charger is installed. Provide the charger with adequate ventilation.

After the charger is plugged in, the vehicle's control circuit is locked out, preventing operation of the vehicle, as well as the possibility of subsequent damage to the charger and vehicle.

Once the lockout is actuated, the charger turns on and performs a Power-On Self Test in which the LED lights on the charger flash ON in sequence, the Charger Indicator Light on the dash will flash three times and the reverse buzzer will simultaneously sound three times. If test is successful, charging will start and the ammeter will come on.

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 green battery icon will stop flashing and remain on.

The vehicle's control circuit lockout remains activated until the charger AC plug is disconnected from the AC receptacle.

MAINTENANCE

See General Warnings on page 1-1.

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. 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.**
- **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 clean and dry.
- 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.

TROUBLESHOOTING

See General Warnings on page 1-1.

⚠ DANGER

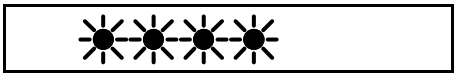
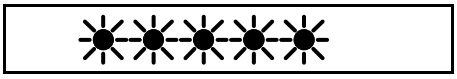
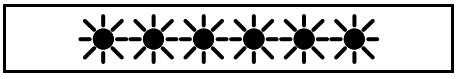
- **Do not touch any wire or component in the battery charger while AC power is present. Failure to heed this warning will result in an electric shock.**

⚠ WARNING

- **Knowledge of battery charger wiring and component terminology is required before attempting any repair (Figure 15-5, Page 15-3).**
- **Prior to servicing the charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle. See Onboard Charger Removal And Installation on page 15-12.**

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

RED FLASHES	CAUSE	SOLUTION
	Battery High Voltage	Ensure battery set is rated 48 volts and composed of 24 cells. **See Battery Voltage Using Multimeter on page 15-11.** If not, replace with correct battery set. Reset charger (interrupt AC power for 15 seconds).
	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 15-11.**If not, replace with correct battery set. Reset charger (interrupt AC power for 15 seconds).
	Charge Timeout caused by battery pack not reaching required voltage. Charger output was reduced due to high temperatures	Check for loose or corroded connections. Check for old or defective batteries. **See Test Procedures on page 15-11.** Operate charger at a lower ambient temperature.
	Check Battery: battery could not be trickle charged up to minimum voltage	Check for shorted or damaged cells. **See Battery Voltage Using Multimeter on page 15-11.**
	Over-Temperature: Charger shut down due to high internal temperature	Check for dirty, obstructed, or damaged cooling fins. Clean if necessary and ensure sufficient cooling air flow. Reset charger (interrupt AC power for 15 seconds).
	Charger Internal Fault	Reset charger (interrupt AC power for 15 seconds). Return to qualified service depot if fault persists.

TEST PROCEDURES

See General Warnings, Section 1, Page 1-1.

Index of Test Procedures

TEST PROCEDURE 1 – Battery Voltage Using Multimeter

See General Warnings on page 1-1.

1. Check battery pack voltage. **See Measuring Voltage of Battery Set, Section 14, Page 14-2.**
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 0.5 volts of the other 7 batteries (for 8 x 6 volt battery set).

TEST PROCEDURE 2 – Battery Condition Using Charger – All Batteries

The easiest way to monitor the condition of a vehicle's batteries is simply to observe the charger display (usually found on the dash) at the end of the charge cycle. After a full charge, disconnect the charger AC plug, wait 30 seconds and reconnect the charger AC plug. The green battery icon will flash quickly and then flash slowly within 10 to 20 minutes, indicating sound, fully charged batteries.

NOTE: *Batteries near the end of their useful lives may not allow the battery charge current to taper and the green battery icon will continue to flash quickly.* ***See Batteries on page 14-1.***

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 green battery icon does not change to a slow flash, the batteries should be tested further using the on-charge voltage test.

TEST PROCEDURE 3 – 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. 8 (for 8 x 6 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.

For 6 volt batteries: If individual batteries read above 7.0 volts and are within 0.5 volt of each other, go to the hydrometer test or discharge test. **See Battery Testing – 6 Volt, Section 14, Page 14-3.** If any battery reads below 7.0 volts and not within 0.5 volts of those batteries above 7.0 volts, replace battery. If readings are below 7.0 volts but within 0.5 volts of each other, the batteries are old.

TEST PROCEDURE 4 – 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 QuiQ Battery Charger Specifications, Section 2, Page 2-3.** 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 5 – Charger DC Circuit Continuity Test

1. Disconnect the AC cord from the wall outlet and the DC cord plug from the charger lead.
2. Check continuity of the DC cord wires from plug pin to large solenoid post (10-gauge red wire) and B- terminal of controller (10-gauge black wire). **See following NOTE.**

NOTE: *The 10-gauge red wire from the charger to the solenoid has an in-line 30-amp fuse.*

3. When finished, connect DC cord plug to the charger lead.

CHARGER REPAIRS

See General Warnings on page 1-1.

NOTE: *The high frequency charger offers no replacement parts. If necessary, the charger must be replaced.* ***See Onboard Charger Removal And Installation on page 15-12.***

ONBOARD CHARGER REMOVAL AND INSTALLATION

See General Warnings on page 1-1.

⚠ WARNING

- **Knowledge of battery charger wiring and component terminology is required before attempting any repair See Troubleshooting on page 15-10.**
- **Prior to servicing the charger, disconnect the AC power supply cord from the wall outlet and remove the battery charger from the vehicle.**

ONBOARD CHARGER REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Remove the wire ties securing the connector to the charger P-clip.
3. Disconnect the all connectors from the charger AC and DC connector.
4. Remove four lock nuts (5) securing charger to charger mounting plate.

5. Remove charger from vehicle.

ONBOARD CHARGER INSTALLATION

1. Install charger onto vehicle.
2. Install the four lock nuts (5) securing charger to charger mounting plate. Tighten to 40 in·lb (5.4 N·m).
3. Connect the AC and DC connector.
4. Connect 8-pin grey connector.
5. Install wire ties to secure connectors to the charger P-clip.
6. Connect the batteries. **See Connecting the Batteries – Electric Vehicles on page 1-3.**

Pagination Page

SECTION 16 — MOTOR (MODEL TRA145)

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

GENERAL INFORMATION

The LSV vehicle is equipped with an air-cooled, 3-Phase, AC Motor. Unlike the DC motors widely used in other vehicles, the AC motor utilizes no brushes or commutator and requires minimal maintenance. This section provides instructions for motor removal and installation. **See following CAUTION.**

CAUTION

- **Disassembly of the motor requires the destructive removal of certain parts which will require replacement for proper motor operation.**

EXTERNAL MOTOR TESTING

The following tests can be performed, using a multimeter or continuity tester, without disassembling the motor.

NOTE: *Tag the motor wires for identification before disconnecting.*

Index of Test Procedures

TEST PROCEDURE 1 – Stator Winding

See General Warnings on page 1-1.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Isolate the motor by disconnecting the six-pin connector and the heavy gauge wires.
3. Check the resistance between each phase as well as each phase to ground.

3.1. The phase to phase resistance should be the same for each combination U-V, V-W, U-W.

3.2. With a multimeter set to 2000 ohms, place black (–) probe on motor housing. Scratch through paint to ensure a good connection. Place red (+) probe on the U, V, and W terminals respectively. Multimeter should indicate open circuit (several Mega-Ohms). If readings are incorrect, motor will need to be replaced. **See Motor Removal on page 16-3.**

TEST PROCEDURE 2 – Speed Sensor

See General Warnings on page 1-1.

The speed sensor is a hall effect device integral to the motor bearing which provides for indication of speed and direction of rotation. The connection to the speed sensor consists of four wires within the six-pin connector.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Isolate the motor by disconnecting the six-pin connector from the vehicle wire harness.
3. Pins 1 (red wire) and 2 (black/white wire) provide 5V from the controller to power the sensor **(Figure 16-1, Page 16-2)**.
4. Pins 3 (red/white wire) and 4 (red/green wire) provide two square wave signals phase shifted by 90 degrees.

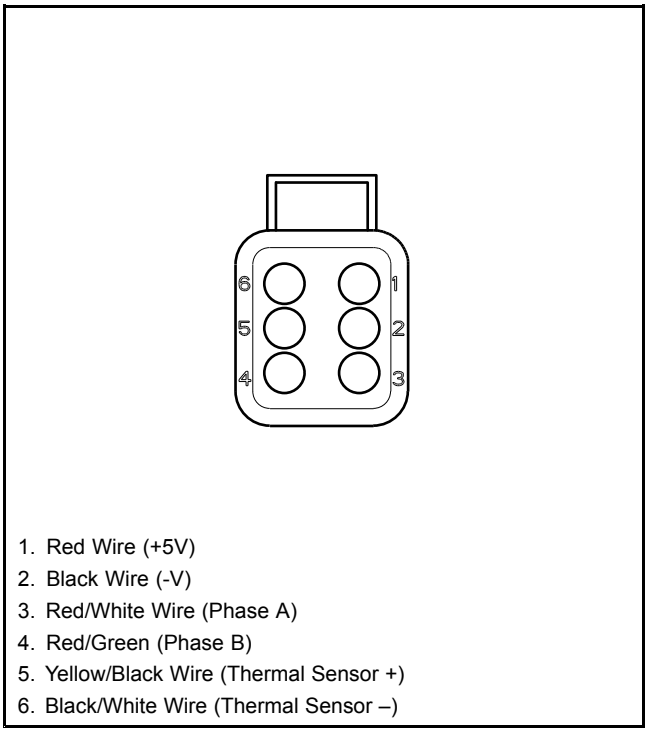


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Figure 16-1 Six-pin Connector Lead from Motor

TEST PROCEDURE 3 – Thermal Sensor

See General Warnings on page 1-1.

The motor is equipped with a thermal sensor embedded in the stator winding. The sensor provides motor temperature to the controller and allows for protection of the motor.

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Isolate the motor by disconnecting the six-pin connector from the vehicle wire harness.
3. Measure the resistance between pin 5 (yellow/black wire) and pin 6 (black/white wire) **(Figure 16-1, Page 16-2)**. The resistance should be in the range of 576 ohms at 25 °C (77 °F).

MOTOR REMOVAL

See General Warnings on page 1-1.

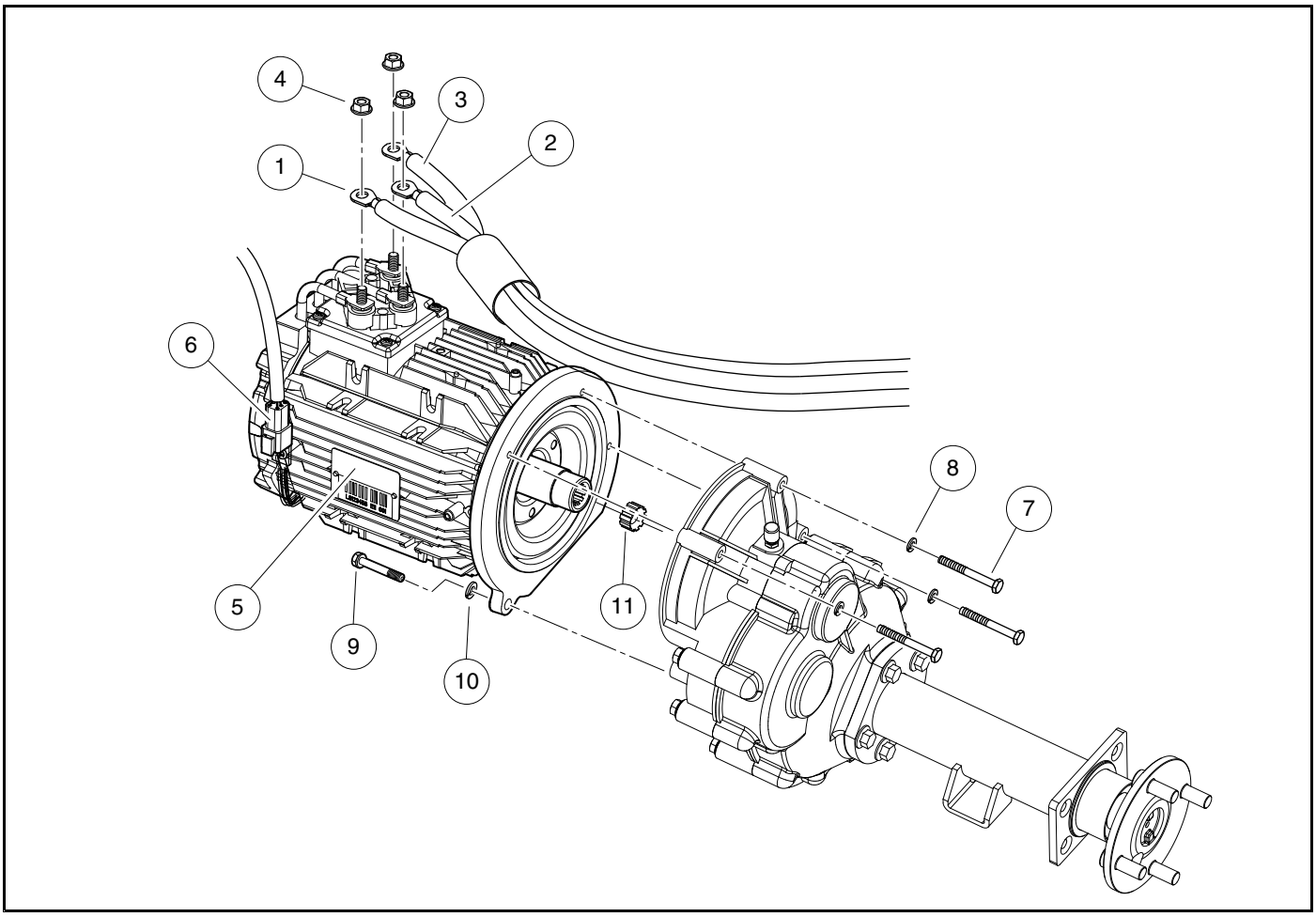

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Figure 16-2 Motor and Wiring

1. Disconnect the battery cables as instructed. **See WARNING "To avoid unintentionally starting..." in General Warnings on page 1-1.**
2. Remove the lock nuts (4) and disconnect the three heavy gauge wires (1, 2, and 3) from the terminals on the motor (5) **(Figure 16-2, Page 16-3)**. Label the wires to ensure proper assembly.
3. Disconnect the 6-pin wire connector (6) from the motor (5).
4. Slightly loosen all the lug nuts on both rear wheels.
5. Place floor jack under transaxle and raise rear of vehicle **(Figure 16-3, Page 16-4)**. 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. **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.**

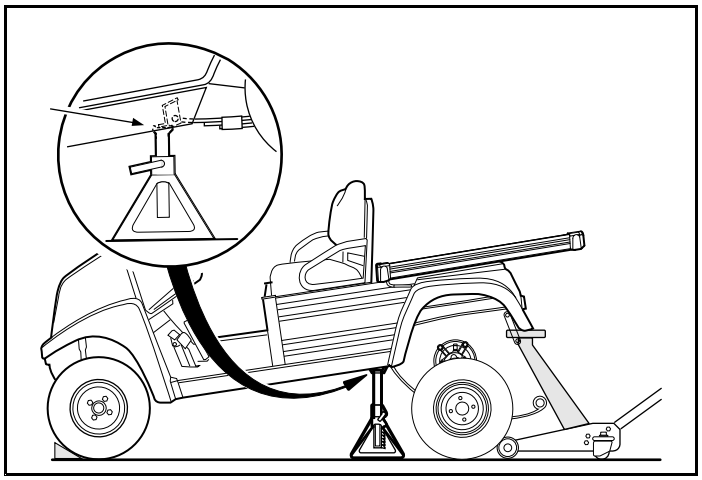

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Figure 16-3 Lift Vehicle and Support on Jack Stands

6. Remove both rear wheels.
7. 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 16-4, Page 16-4)**.
8. Remove the nuts and bolts mounting the rear leaf springs to the shackles **(Figure 16-5, Page 16-4)**.

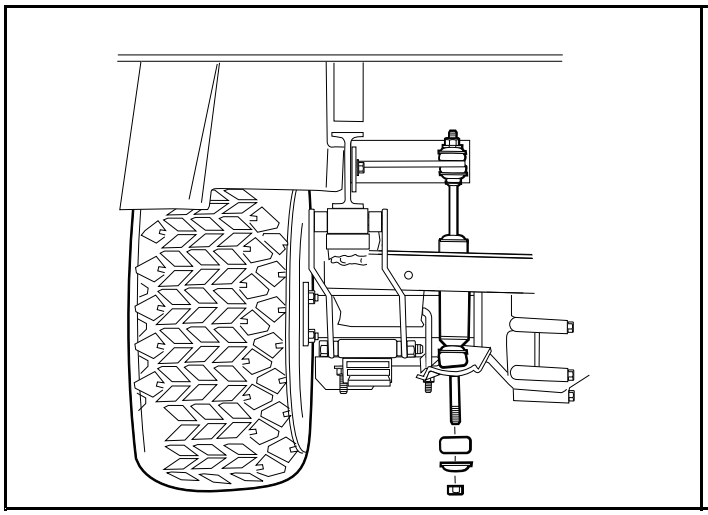

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Figure 16-4 Disconnect Shocks

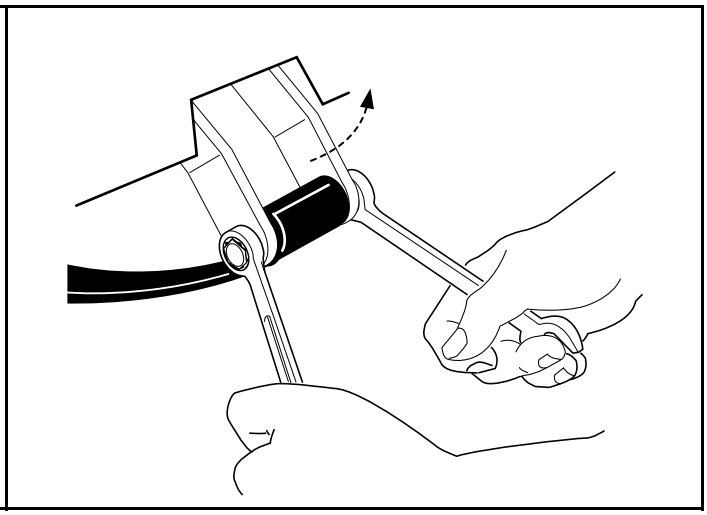

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Figure 16-5 Detach Spring From Shackles

9. 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.
10. Remove the three motor mounting bolts (7) and lock washers (8) securing the motor (5) to the transaxle **(Figure 16-2, Page 16-3)**.

11. Remove the motor positioning bolt (9) and lock washer (10) securing the motor (5) to the transaxle. **See following CAUTION.**

⚠ CAUTION

- **The motor (5) weighs in excess of 60 lb. (27 kg). Be prepared to use a lifting device or have an assistant help remove the motor from the transaxle.**
- **Do not position fingers under motor, or between motor and transaxle, when sliding the motor off of the input shaft. Fingers may get pinched when motor separates from the transaxle housing or when motor disengages the input shaft.**

12. Carefully remove the motor (5) 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 CAUTION.**

MOTOR INSTALLATION

See General Warnings on page 1-1.

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 from tube onto a putty knife as shown **(Figure 16-6, Page 16-6)**.
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 16-7, Page 16-6)**.
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.

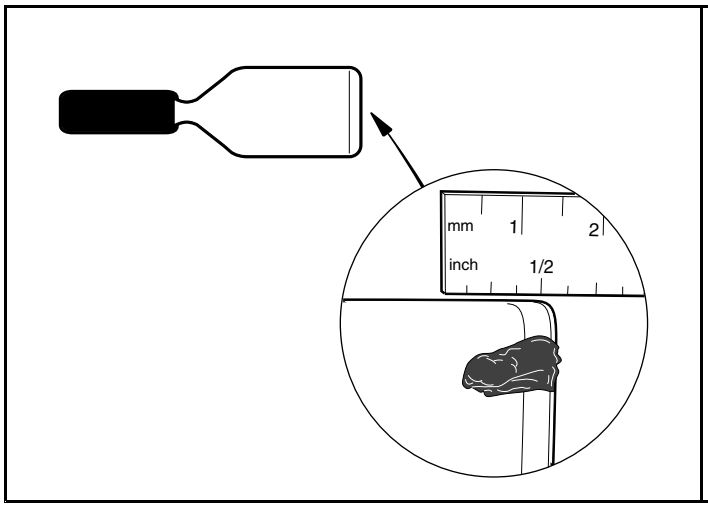


Figure 16-6 Grease on Putty Knife

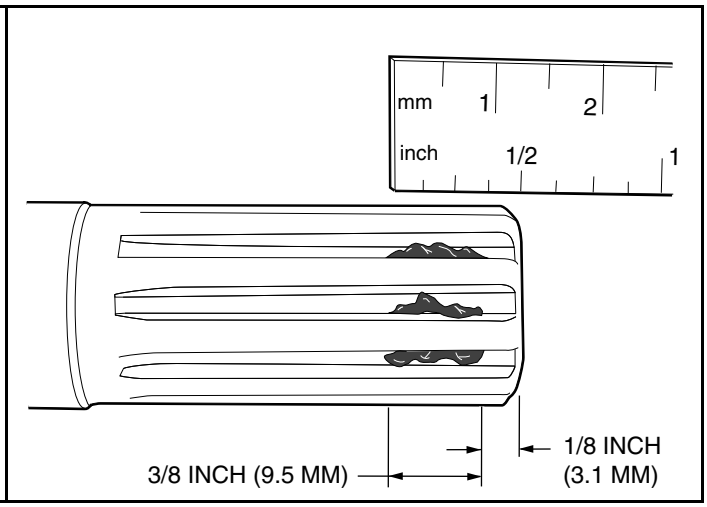


Figure 16-7 Application of Grease to Input Shaft Grooves

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 16-8, Page 16-6)**.

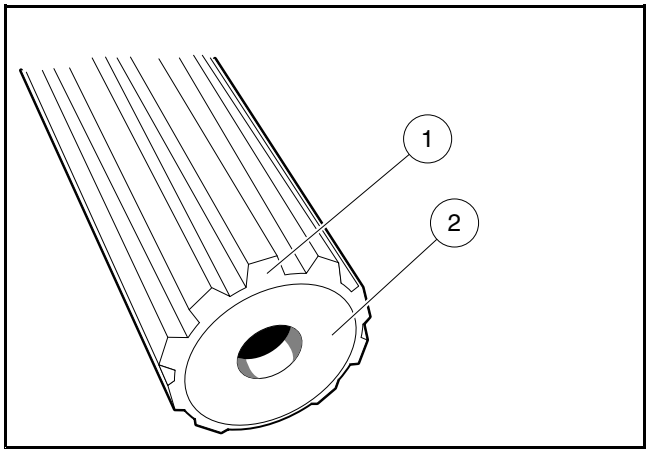


Figure 16-8 Clean Chamfer and Input Shaft End

3. Install motor (5) on transaxle **(Figure 16-2, Page 16-3)**.

3.1. Orient bumper (11) (flat side towards motor; cupped side towards transaxle input shaft) and install into the armature shaft.

3.2. Slide the armature shaft onto the transaxle input shaft.

3.3. Loosely install the four bolts (7 and 9) and lock washers (8 and 10) that secure the motor (5) to the transaxle. Do not tighten.

3.4. Begin finger-tightening the bolts (7 and 9) in the pattern indicated as shown **(Figure 16-9, Page 16-7)**. Continue tightening by hand until the motor (5) is seated against the transaxle housing. **See following CAUTION and NOTE.**

CAUTION

- **Make sure the motor (5) is properly seated against 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.*

3.5. Tighten the middle bolt (3) to 100 in·lb (11 N·m) **(Figure 16-9, Page 16-7)**.

3.6. Tighten the left bolt (2) and right bolt (1) to 100 in·lb (11 N·m).

3.7. Tighten all three bolts (1,2,3) one more time to 100 in·lb (11 N·m).

3.8. Tighten the positioning bolt (4) to 155 in·lb (17.5 N·m).

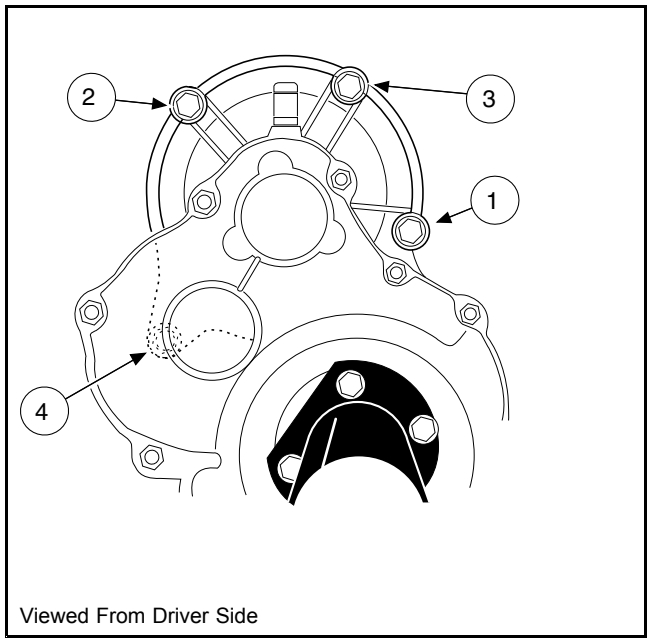


Figure 16-9 Motor Tightening Sequence

3.9. Install the three heavy gauge motor wires (1, 2, and 3), making sure they are connected to the correct motor terminals and that the terminal orientation is correct **(Figure 16-2, Page 16-3)**. Tighten the terminal retaining nuts (4) to 65 in·lb (7.3 N·m).

3.10. Secure the heavy gauge wires with a wire tie so that none of the motor wires will scrub the motor or transaxle when the vehicle is in operation.

3.11. Connect the 6-pin plug (6) from the wire harness to the motor (5).

4. 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.
5. Insert the mounting bolts through the spring shackles and the bushings in the leaf spring eyes and install locknuts. Tighten the bolts to 23 ft·lb (31 N·m). **See Rear Suspension Section.**
6. Install the shock absorbers. Tighten nut until rubber bushing expands to the diameter of the cup washer.
7. If removed, install wheels and finger tighten the lug nuts.
8. Lift vehicle and remove jack stands. Lower vehicle to the floor and tighten lug nuts, using a crisscross pattern, to specified torque. **See Wheels and Tires section.**
9. Place the Tow/Run switch in the TOW position and connect the batteries, positive (+) cable first. Tighten battery terminals to 110 in·lb (12.4 N·m) and coat terminals with Battery Terminal Protector Spray to minimize corrosion.
10. Place the Tow/Run switch in the RUN position.
11. 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.**

⚠ DANGER

- **See General Warnings on page 1-1.**

⚠ WARNING

- **See General Warnings on page 1-1.**

LUBRICATION

See General Warnings on page 1-1.

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 17-5, Page 17-3)**. 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 1-1.

AXLE SHAFT

Axle Shaft and Oil Seal Removal

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
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 1-1.**
3. Remove the rear wheel and brake drum. **See Wheel Brake Assemblies Section and Wheels and Tires Section.**
4. Use 90° internal snap ring pliers to remove the internal retaining ring (1) from the axle tube **(Figure 17-1, Page 17-2)**.
5. Remove the axle (2), 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 to remove the axle seal and adapter ring from the axle tube **(Figure 17-2, Page 17-2)**. **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.*

6.2. Use a press to separate the axle oil seal (15) from the adapter ring (39) **(Figure 17-3, Page 17-2)**. 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 17-5, Page 17-3)**. If the bearing in a Type G transaxle is worn or damaged, the entire axle shaft assembly (1 or 2) must be replaced.

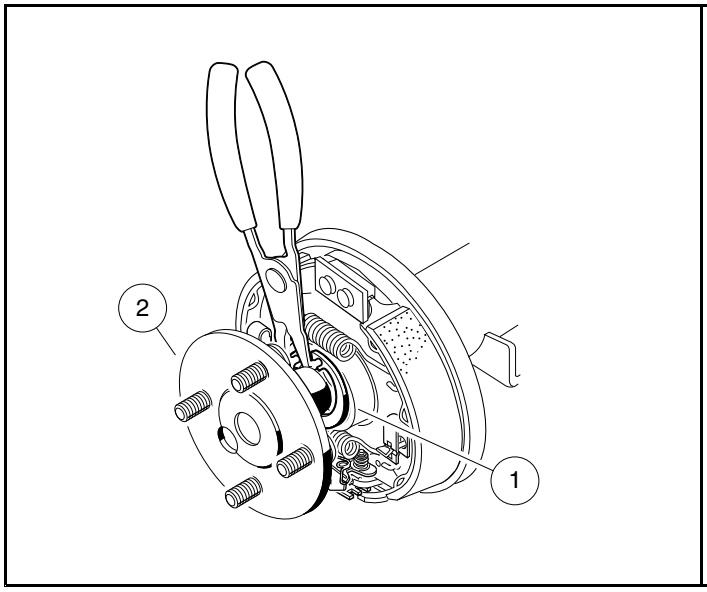


Figure 17-1 Remove Internal Retaining Ring

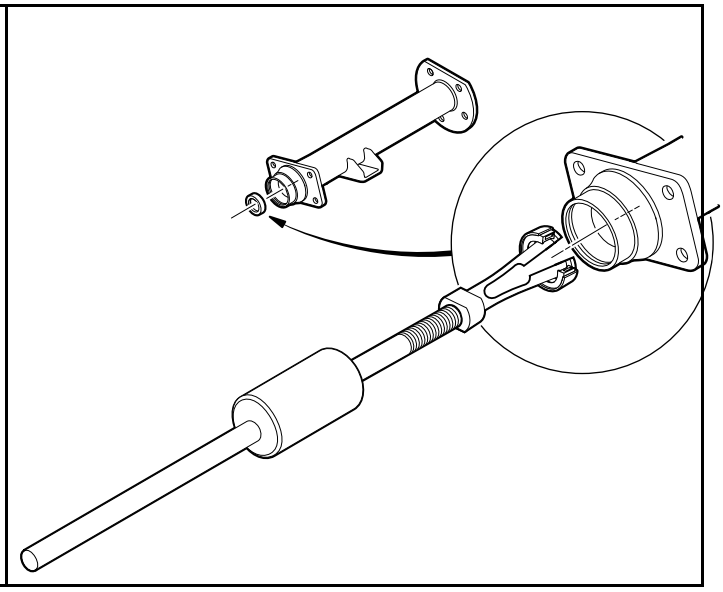
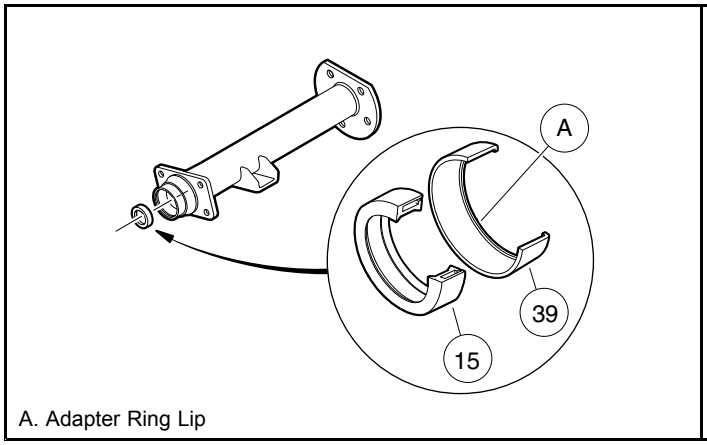


Figure 17-2 Axle Seal and Adapter Ring Removal



A. Adapter Ring Lip

Figure 17-3 Axle Seal and Adapter Ring

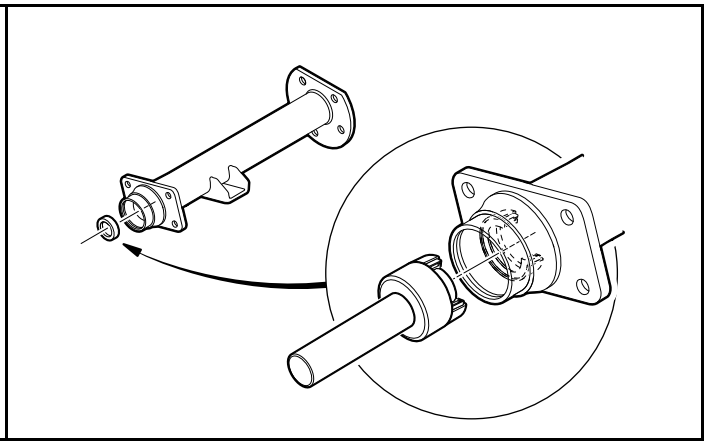


Figure 17-4 Axle Seal and Adapter Ring Installation

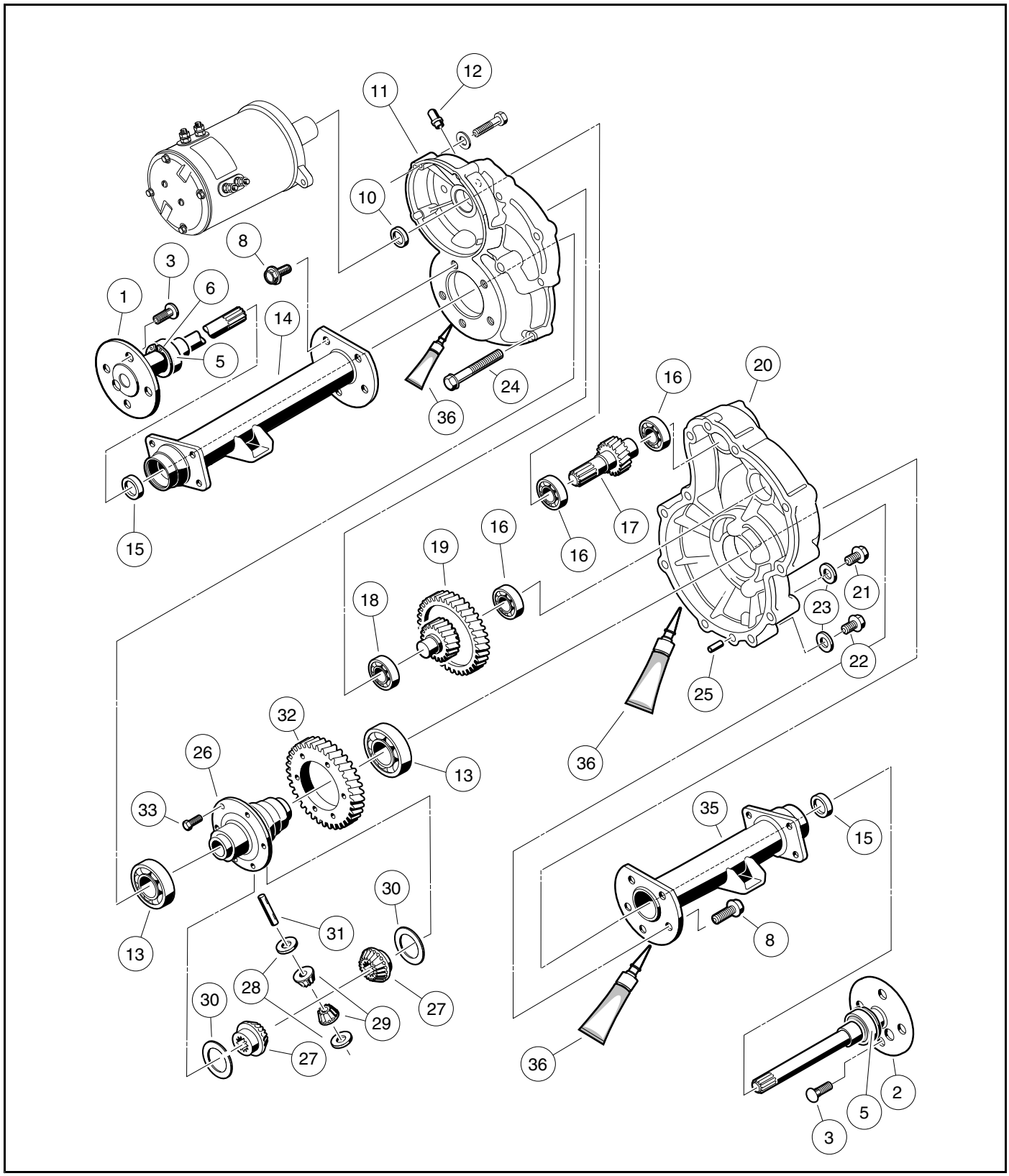


Figure 17-5 Transaxle – Type G

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 17-3, Page 17-2)**.

1.2. Place a new seal (15) in the adapter ring with the seal lip facing toward the adapter ring lip **(Figure 17-3, Page 17-2)**. Use an axle seal tool and mallet to tap it in until it seats firmly in position **(Figure 17-3, Page 17-2)**. 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 17-5, Page 17-3)**.

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 17-4, Page 17-2)**. Use an axle seal tool 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 17-5, Page 17-3)**. 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 17-5, Page 17-3)**. **See following NOTE.**

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 17-5, Page 17-3)**.*

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.**

⚠ 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.
4. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**

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 17-5, Page 17-3)**.

TRANSAXLE

See General Warnings on page 1-1.

TRANSAXLE REMOVAL

1. Disconnect the batteries and discharge the controller. **See Disconnecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
2. Place chocks at the front wheels and slightly loosen lug nuts on both rear wheels.
3. Place a floor jack under the transaxle and raise the rear of the vehicle. Position jack stands under the 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 17-6, Page 17-5)**. **See WARNING "Lift only one end of the vehicle..." in General Warnings on page 1-1.**
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), brake cable clevis pins (2), and cable retaining E-clips (3). Disconnect the brake cables (4) **(Figure 17-7, Page 17-5)**.

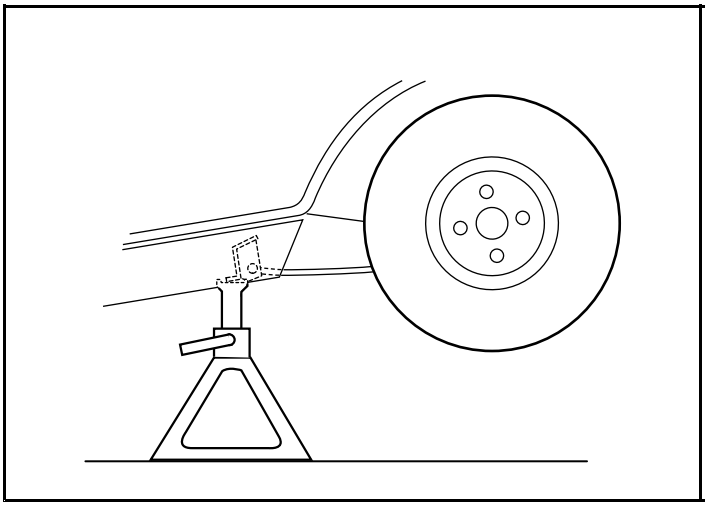


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Figure 17-6 Vehicle Supported on Jack Stands

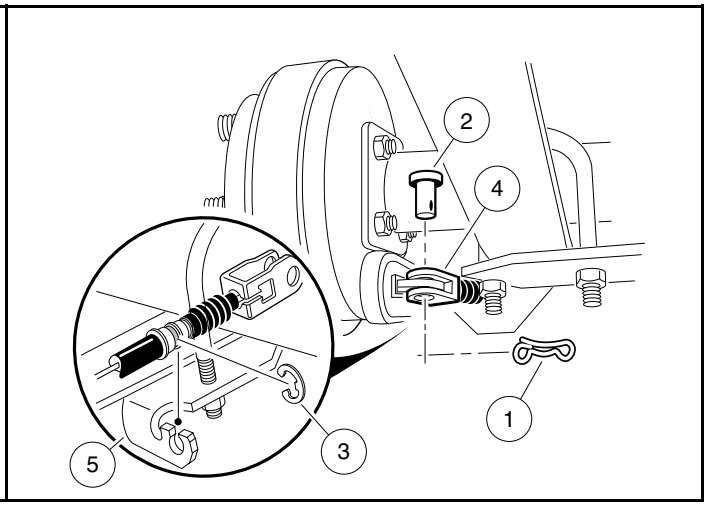

Figure 17-7 Brake Cables

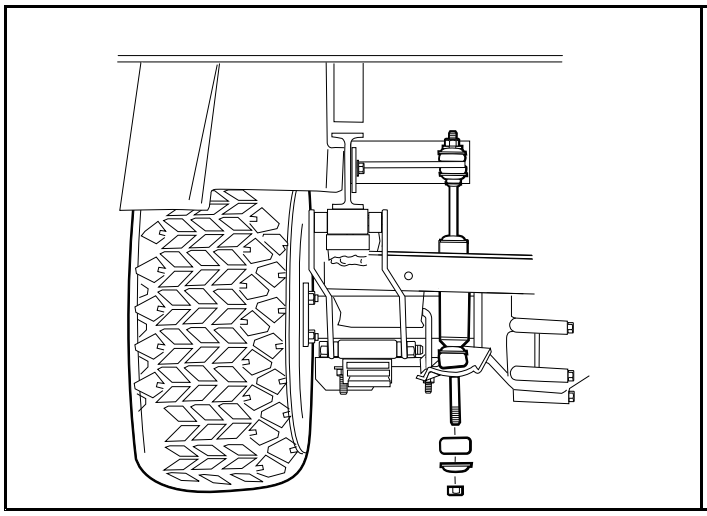

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Figure 17-8 Disconnect Shocks

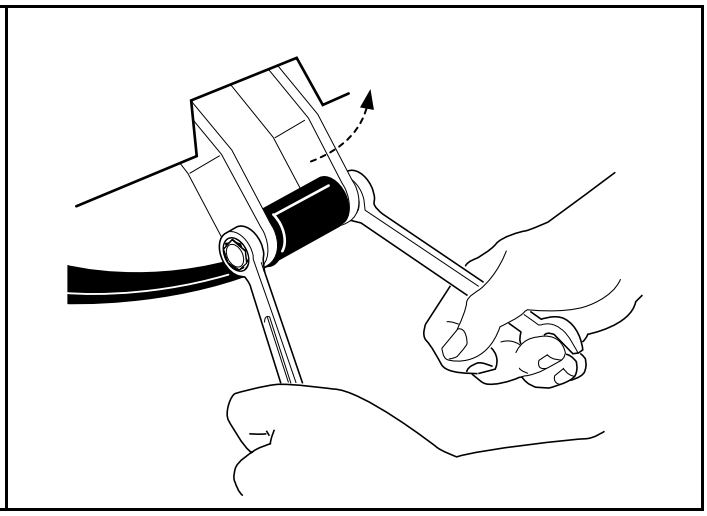

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Figure 17-9 Detach Spring From Shackles

6. Disconnect the shock absorbers from their lower mounts **(Figure 17-8, Page 17-6)**.
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. Rotate shackles up and away from springs **(Figure 17-9, Page 17-6)**.
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 **(Figure 17-11, Page 17-7)** and the motor positioning bolt **(Figure 17-12, Page 17-7)** mounting 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.**

CAUTION CONTINUED ON NEXT PAGE

⚠ CAUTION

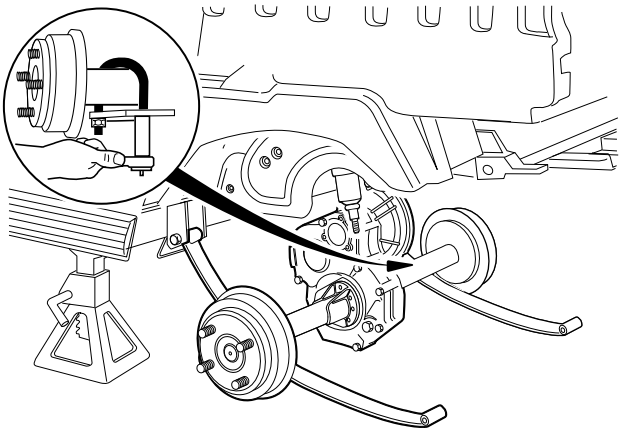

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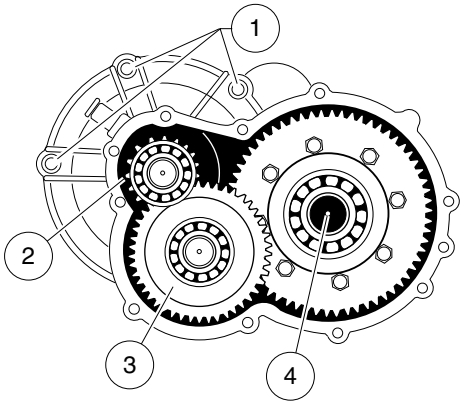
Figure 17-10 Detach Axle From Leaf Springs



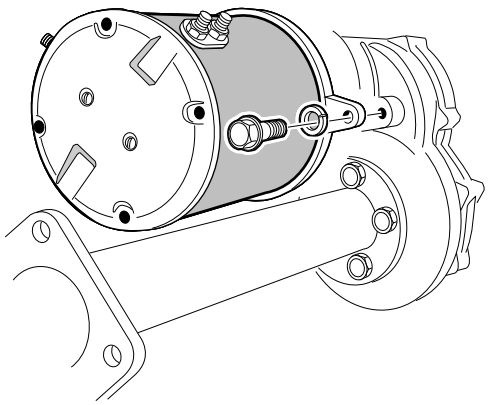
1. **Motor Mounting Bolts**
2. **Input Pinion Gear**
3. **Intermediate Gear Assembly**
4. **Differential Gear Case**

Figure 17-11 Motor Mounting Bolts and Gear Assembly

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.**
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 17-10, Page 17-7)**.
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 17-1. 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 Wheel Brake Assemblies Section.**



Appearance of motor may be different from the motor shown above.

Figure 17-12 Motor Positioning Bolt

TRANSAXLE DISASSEMBLY, INSPECTION, AND ASSEMBLY

See General Warnings on page 1-1.

TRANSAXLE DISASSEMBLY AND INSPECTION

1. To detach axle tubes (14 and 35) from the transaxle housing, remove the bolts (8) **(Figure 17-5, Page 17-3)**.
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.**

4. 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 17-5, Page 17-3)**. **See following CAUTION.**

CAUTION

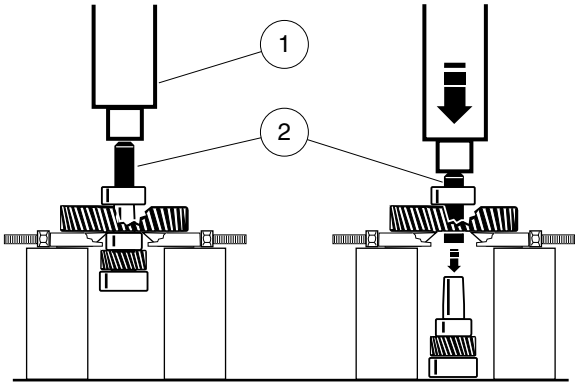
- **Do not damage gears. Use extreme care when handling them.**

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 17-5, Page 17-3)**. **See also Figure 17-13, Page 17-8. 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 17-5, Page 17-3)**. **See also Figure 17-13, Page 17-8.**
7. Press the bearing (18) off the intermediate gear assembly **(Figure 17-5, Page 17-3)**.



1. Press Ram
2. Arbor

Figure 17-13 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 17-5, Page 17-3)**.

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 17-14, Page 17-9)**. Remove the two bolts.

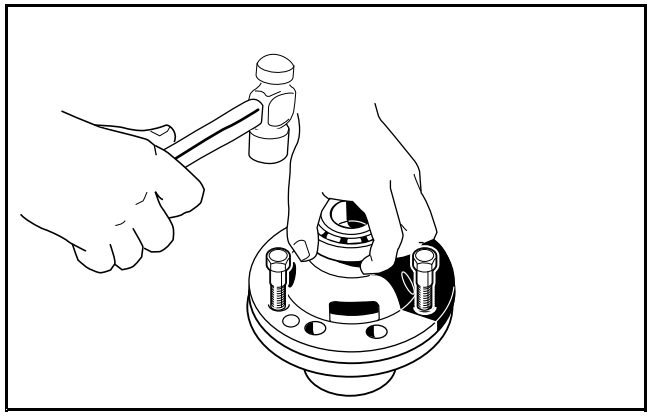


Figure 17-14 Separate Housing

8.4. Remove the differential pin (31) by pushing pin through differential gear case from one side **(Figure 17-5, Page 17-3)**. **See also Figure 17-15, Page 17-9.**

8.5. Remove the idler gears (1 and 2) and thrust plates (3 and 4) **(Figure 17-16, Page 17-9)**.

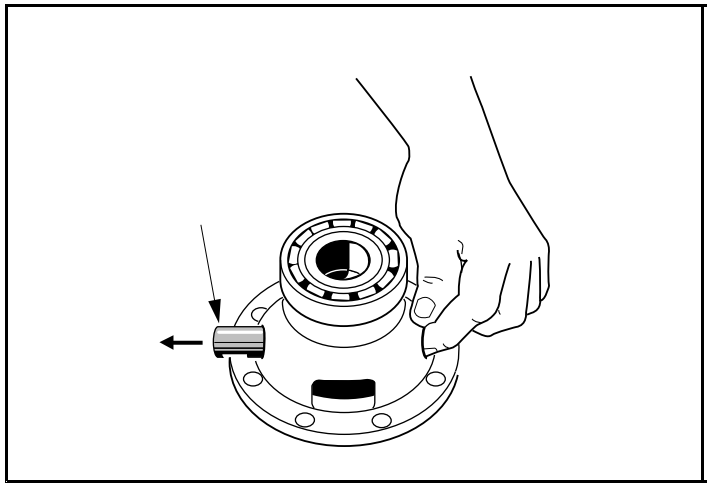


Figure 17-15 Differential Pin

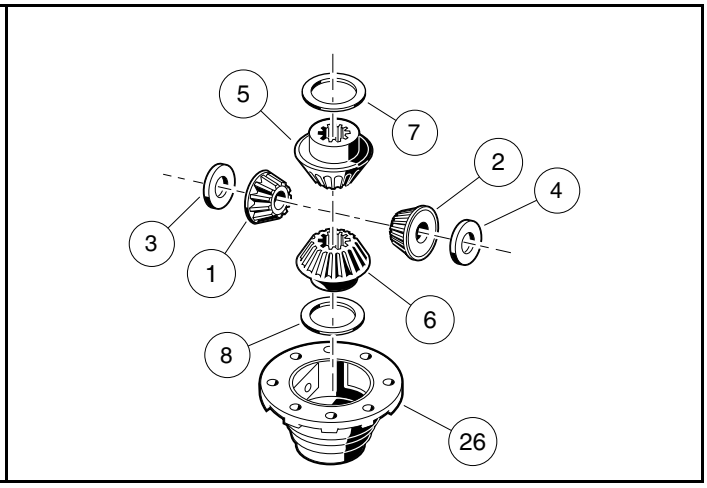


Figure 17-16 Left Differential

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 17-5, Page 17-3)**. 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 17-5, Page 17-3)**.
2. Assemble the differential gear case.

2.1. Install the pin (31) **(Figure 17-5, Page 17-3)**. 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 17-5, Page 17-3)**.
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. 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, the intermediate gear assembly, and the input pinion gear simultaneously. Be sure all bearings are seated properly in the housing. Rotate the input shaft to check for smooth gear operation **(Figure 17-11, Page 17-7)**.
7. Install both dowel pins (25) in the transaxle housing (20) **(Figure 17-5, Page 17-3)**.
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 17-5, Page 17-3)**.

8.3. Install eleven 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 17-5, Page 17-3)**. Tighten the bolts to 37 ft·lb (50.2 N·m).

9. Install the brake assemblies as instructed. **See Wheel Brake Assemblies Section.**
10. Apply a small amount of grease to the lip of the oil seal (15) **(Figure 17-5, Page 17-3)**. **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.**

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), 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 17-5, Page 17-3)**.

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**.

⚠ 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 ounces 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 1-1.

1. 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.
2. 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, lockwashers, 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 16-5.**
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 four motor wires. Tighten the retaining nuts to 65 in·lb (7.3 N·m). Use two wrenches to prevent the posts from turning. **See following NOTE.**

NOTE: *If the motor wires were not tagged when disconnected, refer to the wiring diagram for proper connection.*

7. Insert bolts through the spring shackles and bushings in the leaf spring eyes. Secure bolts with locknuts. Tighten to 15 ft·lb (20.3 N·m).
8. Connect the brake cables using new bow tie pins (1) **(Figure 17-7, Page 17-5)**.
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. **See Wheel Installation, Section 8, Page 8-1.**
13. Connect the batteries. **See Connecting the Batteries – Electric Vehicles, Section 1, Page 1-3.**
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.**
- **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 18 — WIRING DIAGRAMS

18

GENERAL INFORMATION

Wire Description

EXAMPLE: 18_GRN_RED

- 18 = 18 gauge wire
- GRN_RED = Green wire with red stripe

Wire Colors

NOTE: *The following colors will represented as a black wire in the wiring diagrams:*

- *Black*
- *White*
- *Yellow*
- *White with Black Stripe*

Abbreviation	Wire Color
BLK	Black
BLU	Blue
LT BLU	Light Blue
BRN	Brown
GRAY	Gray
GRN	Green
ORG	Orange
PINK	Pink
PUR	Purple
RED	Red
TAN	Tan
WHT	White
YEL	Yellow
BLK_LT_BLUE	Black with Light Blue Stripe
BLK_ORG	Black with Orange Stripe
BLK_PINK	Black with Pink Stripe
BLK_WHT	Black with White Stripe
BLK_YEL	Black with Yellow Stripe
BLU_WHT	Blue with White Stripe
BRN_WHT	Brown with White Stripe
GRN_RED	Green with Red Stripe

TABLE CONTINUED ON NEXT PAGE

GRN_WHT	Green with White Stripe
ORG_BLK	Orange with Black Stripe
ORG_WHT	Orange with White Stripe
PUR_WHT	Purple with White Stripe
RED_GRN	Red with Green Stripe
RED_WHT	Red with White Stripe
RED_YEL	Red with Yellow Stripe
WHT_BLK	White with Black Stripe

MAIN HARNESS MATRIX

Callout Number	Description	Destination
1	To SW_21	Main Harness Continued Wiring Diagram
2	To SW_10	Main Harness Continued Wiring Diagram
3	To SW_1	Main Harness Continued Wiring Diagram
4	To SW_20	Main Harness Continued Wiring Diagram
5	To SW_1	Main Harness Continued Wiring Diagram
6	To SW_20	Main Harness Continued Wiring Diagram
7	To 48V Fuse Block	Main Harness Continued Wiring Diagram
8	To SW_1	Main Harness Continued Wiring Diagram
9	To SW_18	Main Harness Continued Wiring Diagram
10	To SW_19	Main Harness Continued Wiring Diagram
11	To DC to DC Converter	Main Harness Continued Wiring Diagram
12	To Reverse Light Coil	Main Harness Continued Wiring Diagram
13	To 48V Fuse Block	Main Harness Continued Wiring Diagram
14	To 48V Fuse Block	Main Harness Continued Wiring Diagram
15	To 48V Fuse Block	Main Harness Continued Wiring Diagram
16	To Brake Light Relay Switch	Main Harness Continued Wiring Diagram
17	To Brake Light Relay Switch	Main Harness Continued Wiring Diagram
18	To 48V Ground Block	Main Harness Continued Wiring Diagram

MAIN HARNESS CONTINUED MATRIX

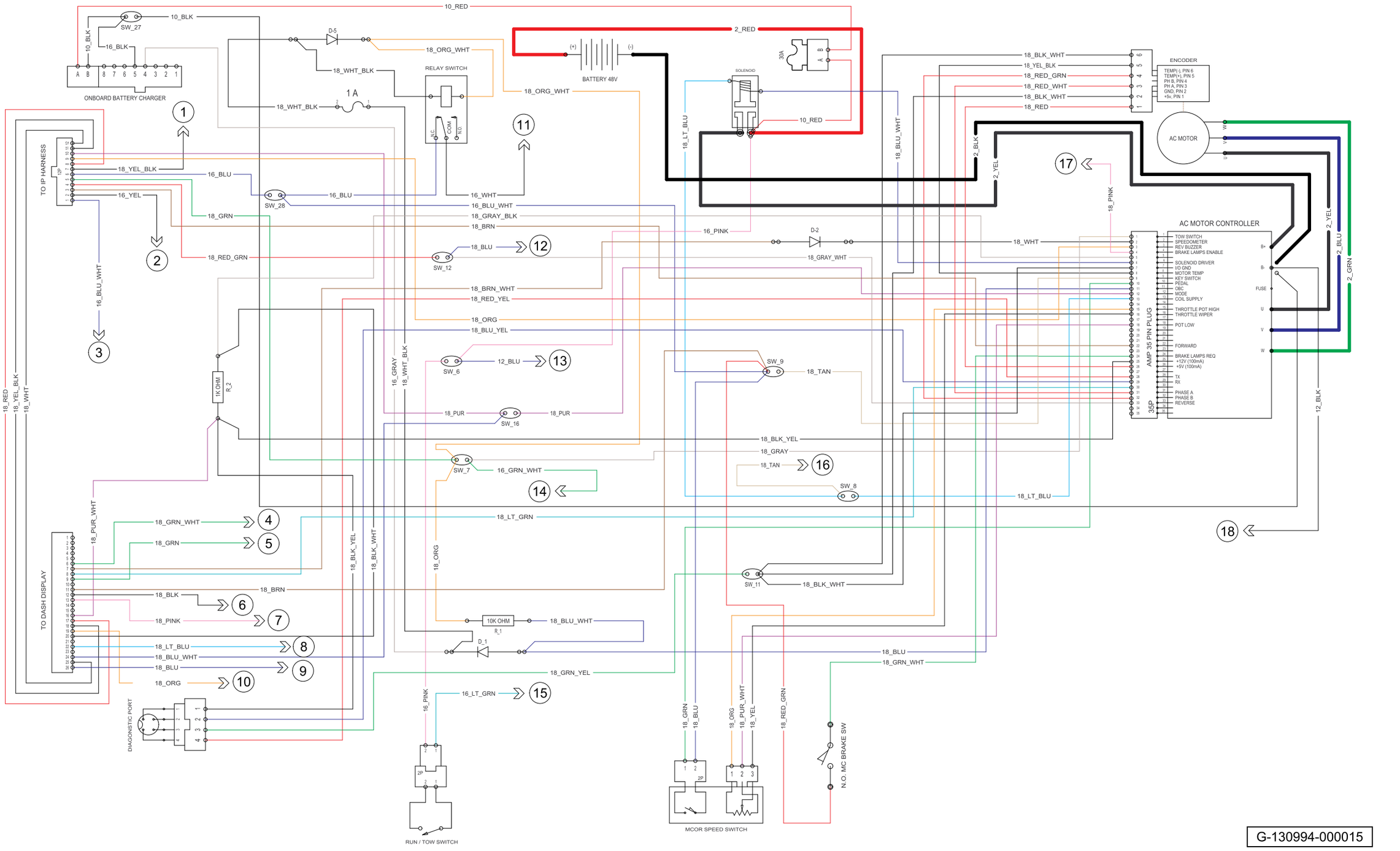
Callout Number	Description	Destination
1	To IP Connector	Main Harness Wiring Diagram
2	To IP Connector	Main Harness Wiring Diagram
3	To IP Connector	Main Harness Wiring Diagram
4	To Dash Display Connector	Main Harness Wiring Diagram
5	To Dash Display Connector	Main Harness Wiring Diagram
6	To Dash Display Connector	Main Harness Wiring Diagram
7	To Dash Display Connector	Main Harness Wiring Diagram
8	To Dash Display Connector	Main Harness Wiring Diagram
9	To Dash Display Connector	Main Harness Wiring Diagram
10	To Dash Display Connector	Main Harness Wiring Diagram
11	To Relay Switch	Main Harness Wiring Diagram
12	To SW_12	Main Harness Wiring Diagram
13	To SW_6	Main Harness Wiring Diagram
14	To SW_7	Main Harness Wiring Diagram
15	To Run/Tow Switch	Main Harness Wiring Diagram
16	To SW_8	Main Harness Wiring Diagram
17	To AC Motor Controller	Main Harness Wiring Diagram
18	To AC Motor Controller B-	Main Harness Wiring Diagram
19	To Rear View Camera Trigger Input	Rear View Camera Harness Wiring Diagram
20	To Rear View Camera Trigger Input	Rear View Camera Harness Wiring Diagram
21	To Rear View Camera Ground	Rear View Camera Harness Wiring Diagram
22	To Battery #3 Negative (-)	Not Applicable
23	To Battery #1 Negative (-)	Not Applicable

REAR VIEW CAMERA HARNESS MATRIX

Callout Number	Description	Destination
1	No Connection. For Villager LSV Only	Not Applicable
2	No Connection. For Villager LSV Only	Not Applicable
3	No Connection. For Villager LSV Only	Not Applicable
19	To Reverse Light Relay Switch	Main Harness Continued Wiring Diagram
20	To CHMSL (Center High-Mount Stop Light)	Main Harness Continued Wiring Diagram
21	To Rear View Camera Jumper Wire	Main Harness Continued Wiring Diagram

Pagination Page

MAIN HARNESS



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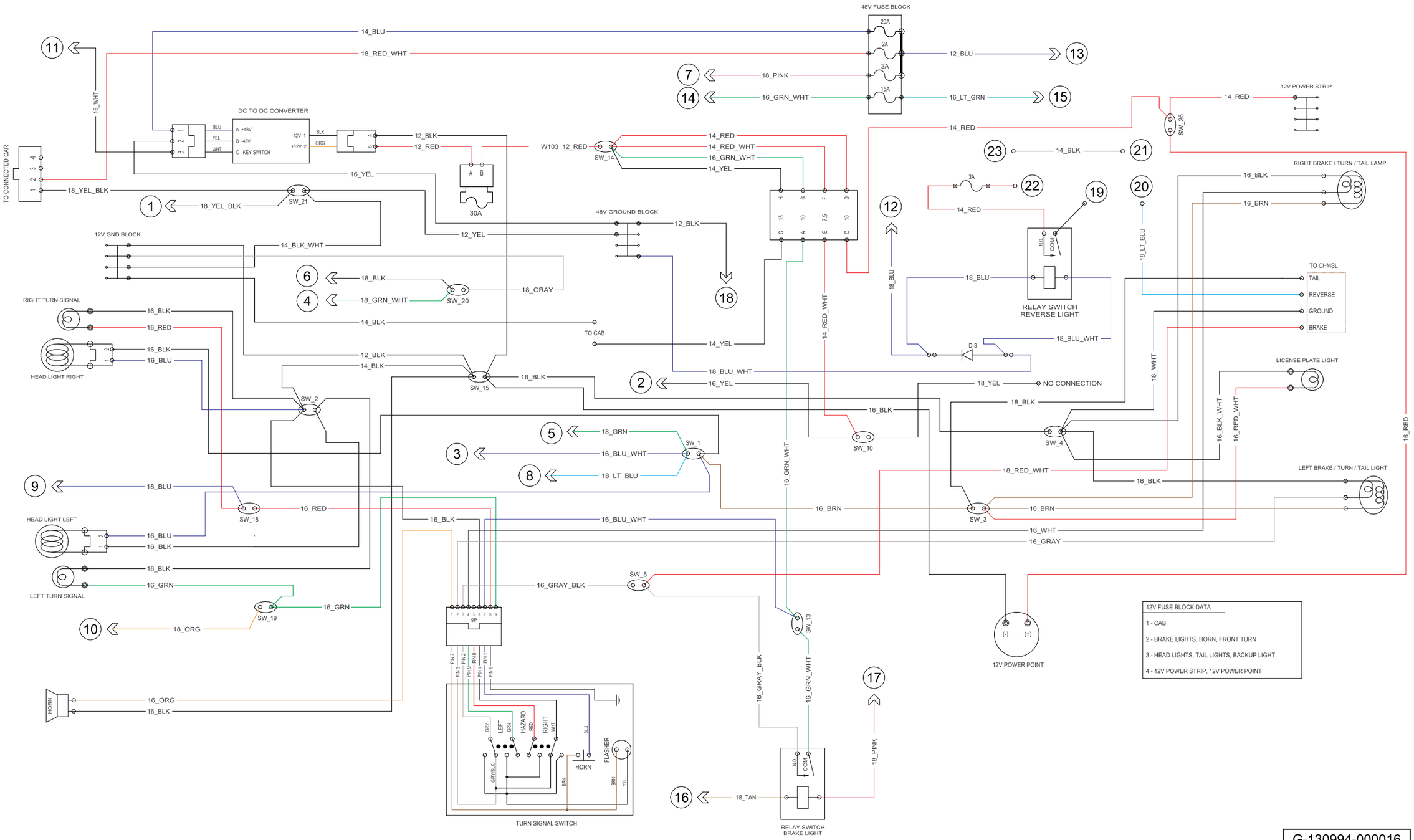
MAIN HARNESS CONTINUED



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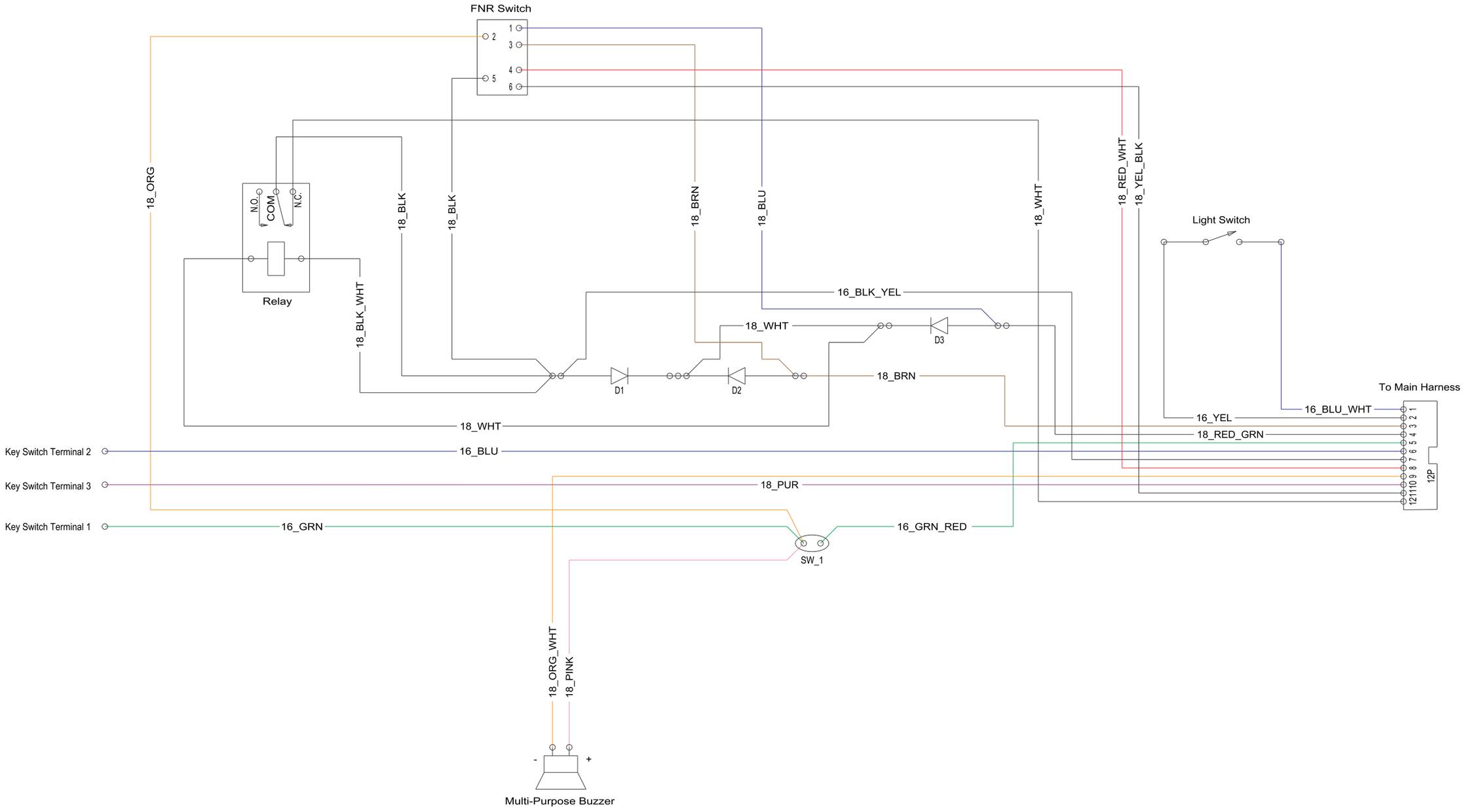
INSTRUMENT PANEL HARNESS



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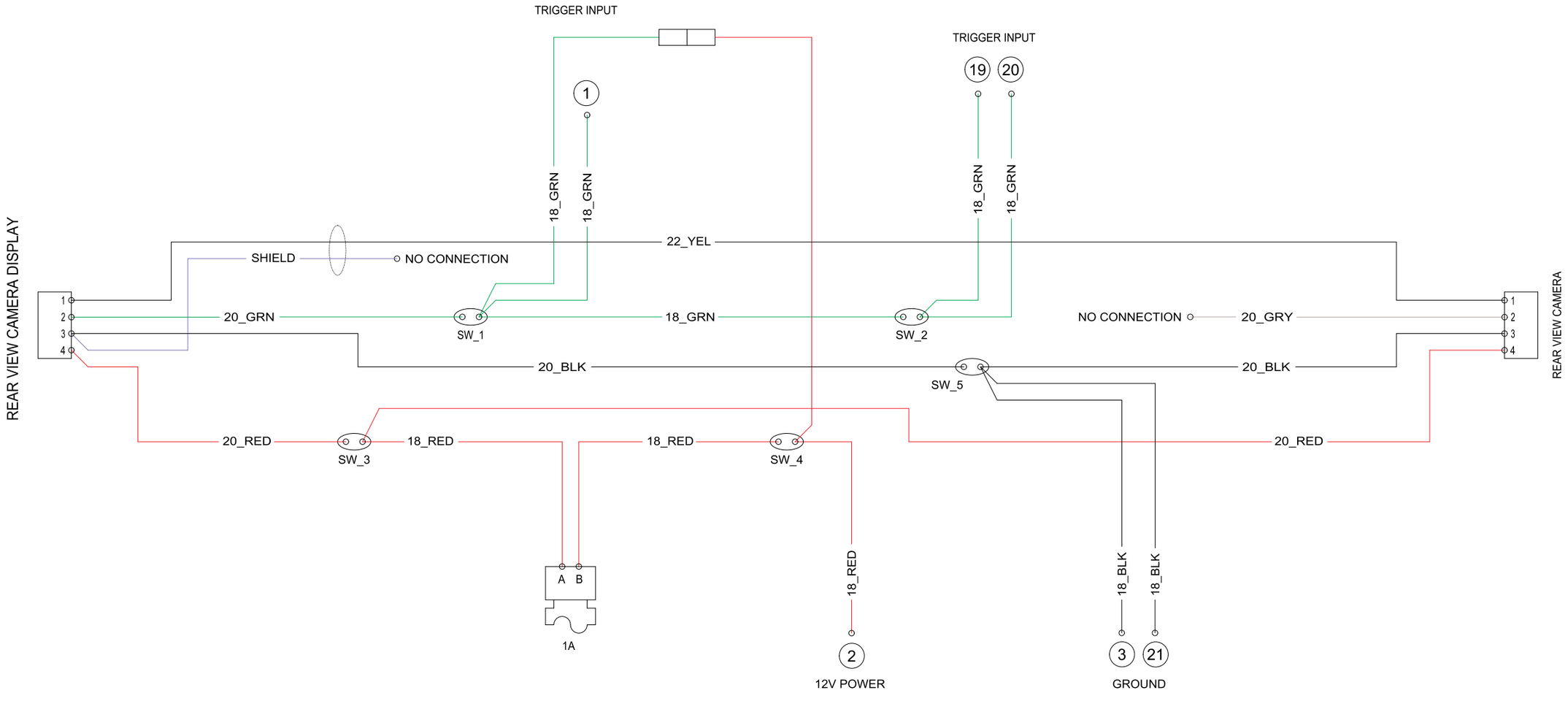
REAR VIEW CAMERA HARNESS



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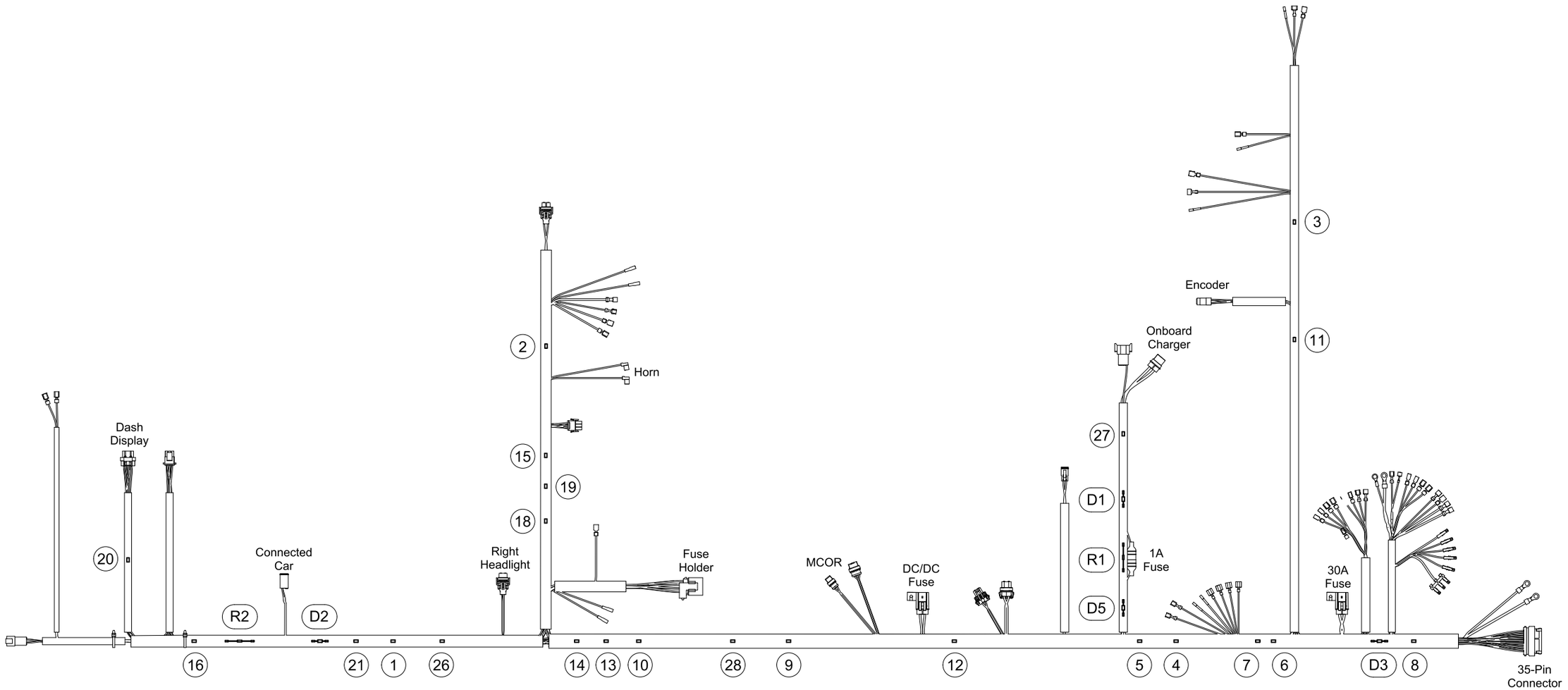
AC ELECTRIC - SONIC WELD AND RESISTOR LOCATIONS



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V

W

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