Form No. 19239SL Rev G

Count on it.

Service Manual

Greensmaster® eTriFlex 3360 and 3370

(Model 04580, 04590, and 04591)

Revision History

Revision	Date	Description
A	06/2019	Initial Issue
B	12/2019	Model 04590 information added
C	10/2020	Modify battery file handling, battery storage, and wheel motor controller handling. Added battery service wire harness.
D	02/2021	Modify ID module connections, lithium-ion battery handling, battery specifications, and added fuse kit.
E	03/2021	Update machine fault table, update rear wheel traction motor testing.
F	06/2021	Updated Foldout Drawings.
G	01/2023	Add Model 04591 (HyperCell battery machine) Updated the reel drive, handle, bedknife, groomer drive gearbox, idler plate, groomer reel, height adjuster chapters

Reader Comments

The Toro Company Technical Assistance Center maintains a continuous effort to improve the quality and usefulness of its publications. To do this effectively, we encourage user feedback. Please comment on the completeness, accuracy, organization, usability, and readability of this manual by an e-mail to servicemanuals@toro.com

or Mail to:

Technical Publication Manager, Commercial
The Toro Company
8111 Lyndale Avenue South
Bloomington, MN 55420-1196
Phone: +1 952-887-8495

Preface

This service manual was written expressly for service technicians. Basic shop safety knowledge and mechanical/electrical skills are assumed. The Toro Company has made every effort to make the information in this manual complete and correct.

The purpose of this publication is to provide the service technician with information about troubleshooting, testing, and repairing major systems and components. This manual may also be specified for use on numerous products. Refer to the Table of Contents for a list of the systems and the related topics covered in this manual.

Refer to the machine *Operator's Manual* for additional information about operating, maintaining, and adjusting the machine. Keep a copy of the *Operator's Manuals*, *Installation Instructions*, and *Parts Catalog* for your machine and its accessories with this *Service Manual* for reference. Additional copies of the *Operator's Manuals*, *Installation Instructions* and *Parts Catalogs* are available at www.toro.com.

The Toro Company reserves the right to change the product specifications or this publication without notice.

Service Procedure Icons

The following icons appear throughout this Service Manual to bring attention to specific important details of a service procedure.

Critical Process

This icon is used to highlight:

- installing safety equipment (shields, guards, seat belts, brakes and R.O.P.S. components) that may have been removed
- dimensions or settings that must be maintained for proper machine operation
- a specific fastener tightening sequence
- component orientation that may not be obvious

Critical Torque

This icon is used to highlight an assembly torque requirement that is different than what is recommended in the Standard Torque Tables; refer to Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series) (page 2–8) or Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners) (page 2–10).

Fluid Specifications

This icon is used to highlight fluid specifications and capacities that are less common, and may not appear on the machine service decal or in the machine *Operator's Manual*.

Note: Refer to the service decal on the machine and the machine *Operator's Manual* for commonly used fluid specifications and capacities.

Table of Contents

Additional Reference Materials

Kawasaki FS481V Service Manual

Chapter 1

Safety

Table of Contents

Safety Instructions

DANGER

This safety symbol means danger. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions could cause serious permanent injury, disability, or death.

WARNING

This safety symbol means warning. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions can result in serious injury.

CAUTION

This safety symbol means caution. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions can result in minor to moderate injury.

IMPORTANT

The *Important* notice will give the important instructions which you must follow to prevent damage to the systems or components on the machine.

Note: A **Note** will give the general information about the correct operation, maintenance, service, testing, or repair of the machine.

Think Safety First

Toro Products are evaluated for compliance with existing safety standards and specifications. Although hazard control and accident prevention are partially dependent upon the design and configuration of the machine, hazard control and accident prevention are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death.

WARNING

To reduce the potential of injury or death, comply with the safety instructions in this manual, as well as information found in the *Operator's Manuals* and the Operator and Safety Training Materials found on www.toro.com.

- **Avoid unexpected starting of the engine…**

  Always turn off the engine, remove the key and unplug the 48V battery disconnect before cleaning, adjusting, or repair.

- **Avoid lacerations and amputations…**

  Stay clear of all moving parts whenever the engine is running. Treat all normally moving parts as if they were moving whenever the engine is running or has the potential to start.

- **Avoid burns…**

  Do not touch the engine, muffler, or other components, which may be hot during operation, while the unit is running or shortly after it has been running. Allow the engine, muffler, and other components to cool before working near them.

- **Avoid fires and explosions…**

  Use extreme care in handling fuel. Fuel is flammable and its vapors are explosive.

  – Extinguish all cigarettes, cigars, pipes, and other sources of ignition.

  – Avoid spilling fuel and never smoke while working with any type of fuel or lubricant.

  – Wipe up any spilled fuel or oil immediately.

  – Never remove the fuel cap or add fuel when the engine is running.

  – Always use approved, labeled containers for storing or transporting fuel and lubricants.

  – Do not add or drain fuel in an enclosed space.

  – Do not store the machine or fuel container where there is an open flame, spark, or pilot light, such as on a water heater or other appliance.

- **Avoid asphyxiation…**

  Do not operate an engine in a confined area without proper ventilation.

- **Avoid injury from lead acid batteries…**

  – Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing.

  – Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.

- **Avoid injury from lithium-ion batteries…**
  - Immediately discontinue use of the battery if the battery emits an unusual smell, feels hot, changes color or shape, or appears abnormal in any other way. Move the product or battery to a safe outdoor area away from any building, vehicle, or combustible material. Observe the battery for at least 1 hour to ensure that any reaction has stopped. If the reaction continues, or if any smoke is observed, call your local emergency services immediately.
  - Use only Toro-specified lithium-ion battery packs designed for your machine. Do not mix batteries of any brand or type in Toro products.
  - Use only the Toro-specified lithium-ion charger designed to charge your machine. Do not attempt to use any other battery charger.
  - Do not over-charge or over-discharge lithium-ion batteries.
  - Do not heat, puncture, or open the battery case.
  - Always disconnect the batteries at the battery disconnect provided when servicing products with lithium-ion batteries.
  - Always service lithium-ion batteries with the machine parked near a service door large enough to move the product or battery outside in case of an emergency and keep a fire blanket nearby. Do not use a fire extinguisher on lithium-ion batteries.
- **Avoid injury due to inferior parts…**

  Use only original equipment parts to ensure that important safety criteria are met.
- **Avoid injury to bystanders…**

  Always clear the area of bystanders before starting or testing powered equipment.
- **Avoid injury due to projectiles…**

  Always clear the area of any debris that could be picked up and thrown by the powered equipment.
- **Avoid modifications…**

  Do not alter or modify any part unless it is a factory approved procedure.
- **Avoid unsafe machine operation…**

  Always test the safety interlock system after adjusting or repairing the machine. Refer to the Electrical section in this manual for more information.
- **Avoid electrical shock…**
  - Never touch electrical wires or components while the engine is running. They can be sources of shock.
  - De-energize the system if you are having to do repairs.
  - If testing electrical components, ensure you are working in a dry environment.
  - Do not wear metal jewelry when working on or near electrical components or wiring.
- **Use personal protective equipment…**
  - Tie back long hair, and do not wear loose clothing or jewelry.
  - Use appropriate personal protective equipment (PPE) for protecting yourself from potential hazards in the environment in which you will work.
  - Each process outlined in this manual may need different PPE to protect the service person. Use the proper PPE for the task at hand.

- **Using tools…**
  - All tools should be in proper working order. Do not use tools that are broken or in disrepair.
  - Use the proper tool for the proper application.
- **Using lifts, hoists, and jacks…**
  - All lifts, hoists, and jacks should be used in accordance with the manufacturer information.
  - Inspect lifts, hoists, and jacks prior to use.
  - Do not overload lifts, hoists, and jacks.
  - Do not work under a suspended load.
  - Ensure chock blocks are used on equipment that can move.
  - Use lifts or jacks and jack stands that are rated to support the total weight of the machine and any attachments.
  - Do not rely on jacks to support the machine.
  - If you are unfamiliar with any lifts, hoists or jacks, do not use them until you know how to operate them correctly.
- **Using fire extinguishers…**

  Use the proper class of fire extinguisher in case of fire.

  Ensure fire extinguishers are serviced regularly, and replace any fire extinguishers that are discharged or in use beyond their expiration dates.

WARNING

Do not use a fire extinguisher on lithium-ion batteries. If you observe any smoke, move the product or battery to a safe outdoor area away from any building, vehicle, or combustible material if possible and call your local emergency services immediately. Failure to do so may result in personal injury and property damage.

  - **Class A** fire extinguishers are for ordinary combustible materials such as paper, wood, cardboard, and most plastics. The numerical rating on these types of extinguishers indicates the amount of water it holds and the amount of fire it can extinguish. Geometric symbol (green triangle).
  - **Class B** fire extinguishers are for fires that involve flammable or combustible liquids such as gasoline, kerosene, grease and oil. The numerical rating for class B extinguishers indicates the approximate number of square feet of fire it can extinguish. Geometric symbol (red square).
  - **Class C** fire extinguishers are for fires that involve electrical equipment such as appliances, wiring, circuit breakers and outlets. Never use water to extinguish class C fires - the risk of electrical shock is far too great! Class C extinguishers do not have a numerical rating. The C classification means the extinguishing agent is non-conductive. Geometric symbol (blue circle).
  - **Class ABC** fire extinguishers are a dry chemical type used for multiple purposes. See above descriptions for additional information.

Jacking Instructions

DANGER

Mechanical or hydraulic jacks may fail to support the machine and cause a serious injury.

- **Use jack stands to support the raised machine.**
- **Use only mechanical or hydraulic jacks to lift the machine.**

1. Park the machine on a level surface, lower the cutting units, shut off the engine, remove the key from the key switch and unplug the 48V battery disconnect.
2. Position the jack securely under the desired jacking point:
   - Footstep on the left side of the machine
   - Jack bracket on the right side of the machine
   - Caster fork at the rear of the machine

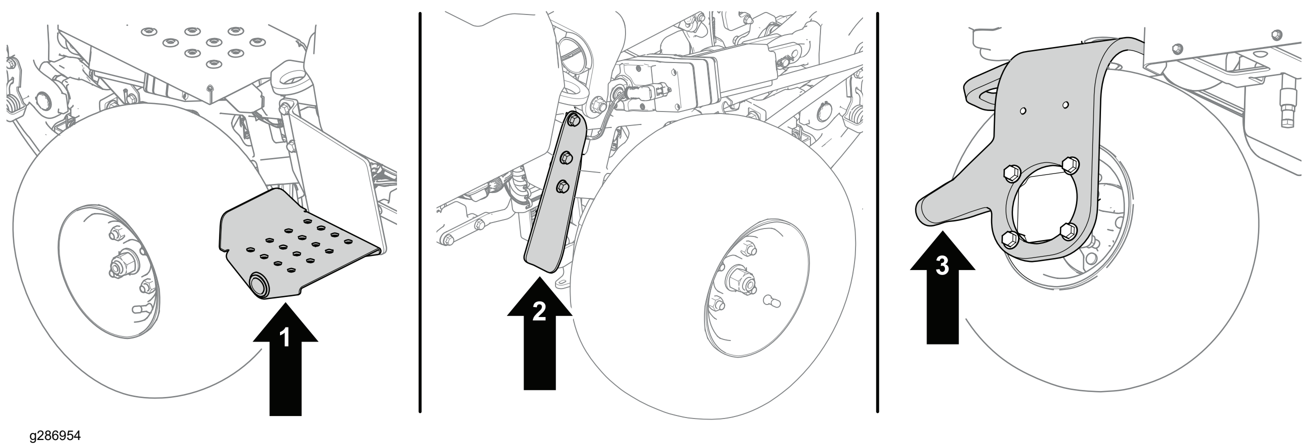


Figure 1

1. Footstep – left front of the machine
2. Jack bracket – right front of the machine
3. Caster fork – rear of the machine

3. After raising the machine, use an appropriate jack stand at the following locations to support the machine.

IMPORTANT

Use two jack stands (one under each battery tray) when supporting the rear of the machine.

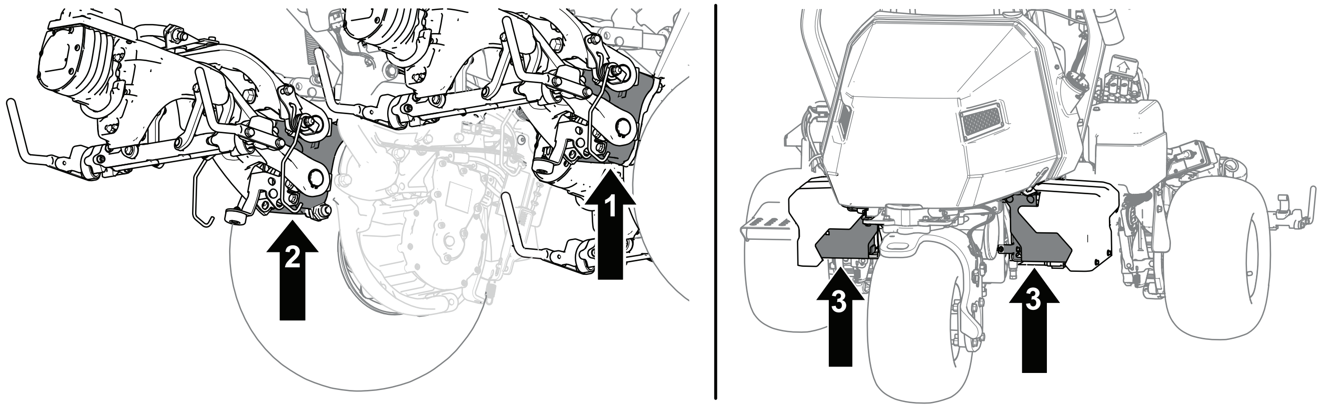


Figure 2

1. Cutting unit pivot mount – supports left front of machine
2. Cutting unit pivot mount – supports right front of machine
3. Battery trays – supports rear of machine

Safety and Instructional Decals

Numerous safety and instructional decals are affixed to the traction unit and the cutting units of the Greensmaster 3360/3370. If any decal becomes illegible or damaged, replace it with a new decal. Part numbers are listed in your *Parts Catalog* and *Operator's Manual*. Order replacement decals from your Authorized Toro Distributor

Chapter 2

Specifications and Maintenance

Table of Contents

Specifications

Overall Dimensions

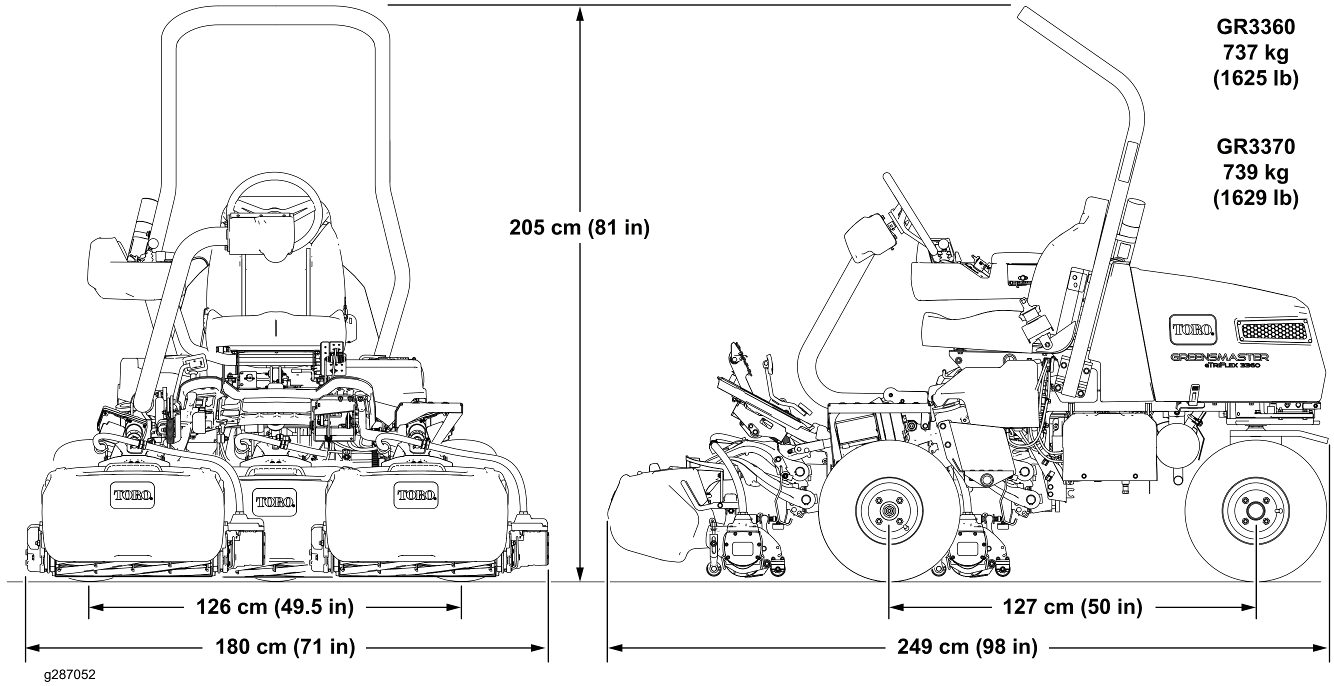


Figure 3

Engine Specifications (Model 04580 only)

Item	Description
Make/Designation	Kawasaki, 4-cycle, V-Twin Cylinder, OHV, Air Cooled, Gasoline Engine - Model FS481V.
Bore x Stroke	73 x 72 mm (2.87 x 2.83 inches)
Total displacement	603 cc^3 (36.8 in^3)
Governor	Mechanical
Carburetor	Single-barrel, float controlled with fixed main jets
Choke	Manual
Fuel Pump	Pulse Type
Fuel	Refer to the *Traction Unit Operator's Manual*
Fuel tank capacity	18.5 L (4.9 US gallons)
Operating RPM (fixed)	2,400 rpm ± 100
Engine oil	Refer to the *Traction Unit Operator's Manual*
Crankcase-oil capacity	1.7 L (1.8 qt) with new filter
Ignition System	Flywheel magneto, transistor type
Spark Plugs	NGK BPR4ES
Spark Plug Gap	0.75 mm (0.030 inches)
Charging System	12 VDC, 15 amp
Engine Weight (dry)	37 kg (82 lb)

Chassis Specifications

Item	Description
Front and Rear tire	Standard = 19 x 10.50 x 8, 4 ply Smooth Optional = 20 x 10 x 8, 4 ply Turf Tread 83 to 110 kPa (12 to 16 psi)
Wheel lug nut torque	95 to 122 N·m (70 to 90 ft-lb)
Front wheel gear box lubricant	385 cc (13 ounces) 80W-90 gear oil (Mobilube HD Plus or equivalent)
Optional 3WD gear box lubricant	1 L (34 ounces) 80W-90 gear oil (Mobilube HD Plus or equivalent)

DPA Cutting Unit Specifications

Item	Description
Frame construction	Precision machined die cast aluminum crossmember with two bolt-on die-cast aluminum side plates.
Reel construction	Reels are 53.3 cm (21 inches) in length and 12.7 cm (5 inch) in diameter. High strength, low alloy steel blades are thru hardened and impact resistant. Reels are available in 8, 11 and 14 blade configurations.
Reel bearings	Two stainless steel ball bearings are press fit onto the reel shaft and retained by a threaded insert. Low drag seals/slingers for added protection with an O-ring sealed counterweight mounting surface. Reel position is maintained by a wave washer with no end play adjustment required.
Reel drive	The reel shaft is 35 mm (1.375 inch) diameter tube with an internally splined threaded nut on each end.
Height-of-cut	Cutting height is adjusted on the front roller by two vertical screws. Standard bench height of cut range is 1.6 to 1.1 mm (0.062 to 0.438 inch) depending on type of bedknife installed. An optional high height-of-cut kit is available to obtain a cut range of 11.1 to 25.4 mm (0.438 to 1.0 inch). Effective HOC may vary depending on turf conditions, type of bedknife, rollers, and attachments installed.
Bedknife and bedbar	Replaceable single edged Edgemax™ bedknife (solid tool steel construction) is standard. Bedknife is fastened to the bedbar with thirteen bedknife screws. A variety of optional bedknives and a more aggressive bedbar are available.
Bedknife adjustment	Dual adjustment (one on each side of the bedbar) with 0.018 mm (0.0007 inch) bedknife movement for each detent.
Rollers	The front roller is a 6.3 cm (2.5 inches) diameter roller that is available in full, wide spaced Wiehle and narrow spaced Wiehle configurations. The rear roller is a 5.1 cm (2 inches) diameter full roller.
Grass shield	Non-adjustable shield with adjustable cut-off bar to improve grass discharge from reel in varying moisture conditions.
Counterbalance weight	A pair of cast iron weights mounted on right side of the cutting unit compensate for the electric reel motor mounted on the left side of the cutting unit.

DPA Cutting Unit Specifications (continued)

Item	Description
Cutting unit weight (approximate)	8 blade* = 32.7 kg (72 lb) 11 blade* = 34 kg (75 lb) 14 blade* = 35 kg (78 lb) *Cutting unit weights do not include a front roller.
Options	Refer to the *Cutting Unit Parts Catalog* or contact your local Authorized Toro Distributor for available cutting unit options.

Universal Groomer Specifications (Optional)

Item	Description
Grooming reel diameter	6 cm (2.375 inches)
Groomer blade type	51 twin tip steel blades with 3/8 inch blade spacing. A groomer brush can be installed in place of a grooming reel.
Groomer mounting	The groomer is mounted to the cutting unit side plates. The drive assembly for the grooming reel is located on the opposite side of the cutting unit from the cutting unit motor.
Groomer height setting	**Mowing:** 0.8 to 15.7 mm (0.030 to 0.620 inch). **HOC range:** 1.5 to 19.1 mm (0.060 to 0.750 inch).
Width-of-groomer	54.6 cm (21.5 inches).
Height adjustment knob	Allows a 0.003 inch (0.08 mm) increment of height adjustment for each click of the adjuster.
Quick-up feature	Allows grooming reel to be raised above the height/depth adjustment for no grooming reel action while mowing.
Groomer drive	The groomer drive assembly is attached to the right side of the cutting unit.
Gear box lubricant	50 cc (1.7 ounces) 80W-90 gear oil (Mobilube HD Plus or equivalent)
Groomer rotation	Forward: the groomer rotates in the same direction as the reel Reverse: the groomer rotates in the opposite direction as the reel Neutral: the groomer does not rotate

Torque Specifications

The recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These torque specifications for the installation and tightening of the fasteners will apply to all the fasteners which do not have a specific requirement identified in this Service Manual. The following factors must be considered when applying the torque: cleanliness of the fastener, use of a thread sealant (e.g., Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature (e.g., Nylock nut), hardness of the surface underneath the head of the fastener, or similar condition which affects the installation.

As noted in the following tables, the torque values should be **reduced by 25% for lubricated fasteners or fasteners with a wet thread locking compound applied** to achieve the similar stress as a dry fastener. The torque values must be reduced when the fastener is threaded into the aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of checking the torque can be performed by marking a line on the fastener (head or nut) and mating part, then back off the fastener 1/4 of a turn. Measure the torque necessary to tighten the fastener until the lines match up.

Calculating the Torque Values When Using a Drive-Adapter Wrench

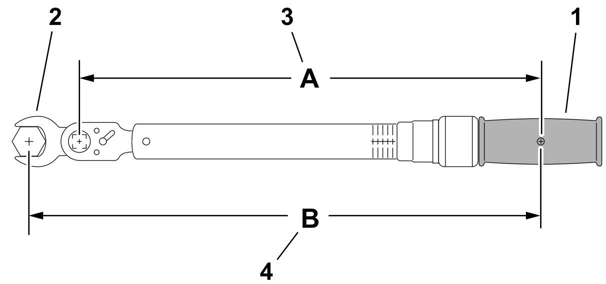


Figure 4

Torque Conversion Factor = A / B

1. Torque wrench
2. Drive-adapter wrench (crowsfoot)
3. A (effective length of torque wrench)
4. B (effective length of torque wrench and drive-adapter wrench)

Using a drive-adapter wrench (e.g., crowfoot wrench) in any position other than 90° and 270° to the frame of the torque wrench will affect the torque value measured by the torque wrench because of the effective length (lever) of the torque wrench changes. When using a torque wrench with a drive-adapter wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Figure 4) to determine proper tightening torque. When using a torque wrench with a drive-adapter wrench, the calculated torque will be lower than the listed torque recommendation.

Example: The measured effective length of the torque wrench (distance from the center of the handle to the center of the square drive) is 457 mm (18 inches).

The measured effective length of the torque wrench with the drive-adapter wrench installed (distance from the center of the handle to the center of the drive-adapter wrench) is 483 mm (19 inches).

The calculated torque conversion factor for this torque wrench with this drive-adapter wrench would be 18/19 = 0.947.

If the listed torque recommendation for a fastener is **103 to 127 N·m (76 to 94 ft-lb)**, the proper torque when using this torque wrench with a drive-adapter wrench would be **98 to 121 N·m (72 to 89 ft-lb)**.

Identifying the Fastener

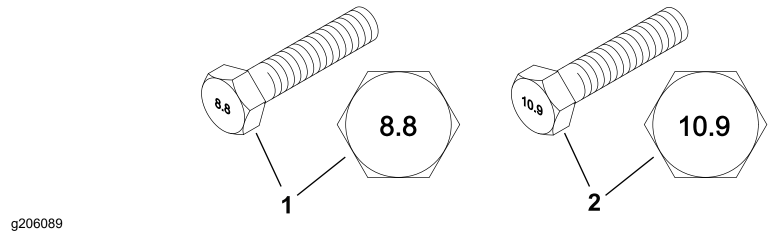


Figure 5
Metric Bolts and Screws

1. Class 8.8
2. Class 10.9

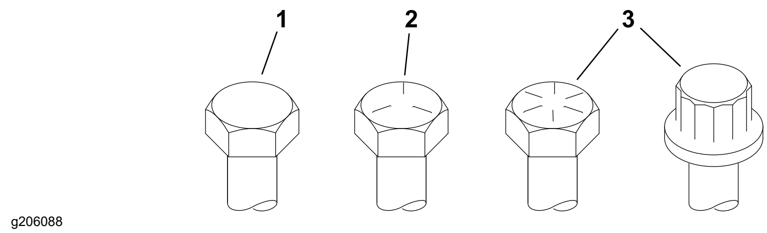


Figure 6
Inch Series Bolts and Screws

1. Grade 1
2. Grade 5
3. Grade 8

Fasteners with a Locking Feature

IMPORTANT

If a fastener with a locking feature or previously applied thread locking compound is reused, clean the fastener threads and apply new thread locker to the fastener during installation.

Locking features are designed to create friction and prevent a fastener from loosening. Locking features can be found on externally or internally threaded fasteners. Common examples are plastic inserts incorporated into the fastener and pre-applied “dry” thread locking compound. Keep in mind, a fastener with a locking feature usually means there will be friction during initial installation and during removal.

Toro recommends replacing fasteners with a locking feature once they have been removed because the effectiveness of the locking feature diminishes with each reuse. If it is necessary to reuse a fastener with a locking feature; apply a thread locking compound (Loctite for example) to the fastener during installation. Use the appropriate strength and type of thread locking compound based on application, fastener size or information found in the product *Operators Manual*, *Service Manual* or *Installation Instructions*.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5 and 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs, and Sems with Regular Height Nuts(SAE J995 Grade 2 or Stronger Nuts)	SAE Grade 5 Bolts, Screws, Studs, and Sems with Regular Height Nuts(SAE J995 Grade 2 or Stronger Nuts)	SAE Grade 8 Bolts, Screws, Studs, and Sems with Regular Height Nuts(SAE J995 Grade 2 or Stronger Nuts)
#6 - 32 UNC	1 to 1.5 N·m (8 to 12 in-lb)	1 to 1.5 N·m (11 to 15 in-lb)	1.5 to 2 N·m (13 to 17 in-lb)	2 to 3 N·m (20 to 26 in-lb)
#6 - 40 UNF			1.5 to 2 N·m (15 to 19 in-lb)	2 to 3 N·m (22 to 28 in-lb)
8 - 32 UNC	1 to 1.5 N·m (11 to 15 in-lb)	2 to 3 N·m (20 to 30 in-lb)	3 to 4 N·m (26 to 33 in-lb)	4 to 5 N·m (36 to 46 in-lb)
#8 - 36 UNF			3 to 4 N·m (27 to 35 in-lb)	4 to 5 N·m (38 to 48 in-lb)
#10 - 24 UNC	2 to 2.5 N·m (16 to 20 in-lb)	3 to 4 N·m (25 to 35 in-lb)	4 to 5 N·m (37 to 47 in-lb)	6 to 7 N·m (54 to 66 in-lb)
#10 - 32 UNF			5 to 6 N·m (43 to 53 in-lb)	7 to 8 N·m (59 to 73 in-lb)
1/4 - 20 UNC	4 to 6 N·m (41 to 55 in-lb)	5 to 7 N·m (46 to 60 in-lb)	10 to 12 N·m (90 to 110 in-lb)	14 to 17 N·m (125 to 155 in-lb)
1/4 - 28 UNF	5 to 7 N·m (46 to 60 in-lb)	6 to 8 N·m (55 to 75 in-lb)	11 to 14 N·m (103 to 127 in-lb)	16 to 20 N·m (143 to 177 in-lb)
5/16 - 18 UNC	11 to 13 N·m (100 to 130 in-lb)	10 to 13 N·m (90 to 120 in-lb)	19 to 25 N·m (175 to– 225 in-lb)	30 to 37 N·m (270 to 330 in-lb)
5/16 - 24 UNF	13 to 17 N·m (121 to 155 in-lb)	13 to 16 N·m (111 to 145 in-lb)	23 to 28 N·m (200 to 250 in-lb)	33 to 40 N·m (292 to 358 in-lb)
3/8 - 16 UNC	19 to 24 N·m (14 to 18 ft-lb)	19 to 24 N·m (14 to 18 ft-lb)	37 to 45 N·m (27 to 33 ft-lb)	51 to 65 N·m (38 to 48 ft-lb)
3/8 - 24 UNF	20 to 26 N·m (15 to 19 ft-lb)	22 to 27 N·m (16 to 20 ft-lb)	42 to 53 N·m (31 to 39 ft-lb)	60 to 76 N·m (44 to 56 ft-lb)
7/16 - 14 UNC	33 to 40 N·m (24 to 30 ft-lb)	33 to 40 N·m (24 to 30 ft-lb)	61 to 74 N·m (45 to 55 ft-lb)	85 to 105 N·m (63 to 77 ft-lb)
7/16 - 20 UNF	35 to 43 N·m (26 to 32 ft-lb)	35 to 43 N·m (26 to 32 ft-lb)	66 to 83 N·m (49 to 61 ft-lb)	94 to 115 N·m (69 to 85 ft-lb)
1/2 - 13 UNC	37 to 45 N·m (27 to 33 ft-lb)	56 to 74 N·m (41 to 55 ft-lb)	90 to 112 N·m (67 to 83 ft-lb)	127 to 157 N·m (94 to 116 ft-lb)
1/2 - 20 UNF	38 to 46 N·m (28 to 34 ft-lb)	62 to 81 N·m (46 to 60 ft-lb)	100 to 125 N·m (74 to 92 ft-lb)	146 to 178 N·m (108 to 132 ft-lb)
5/8 - 11 UNC	75 to 102 N·m (55 to 75 ft-lb)	103 to 135 N·m (76 to 100 ft-lb)	185 to 225 N·m (135 to 165 ft-lb)	390 to 450 N·m (289 to 331 ft-lb)
5/8 - 18 UNF	90 to 115 N·m (65 to 85 ft-lb)	110 to 150 N·m (80 to 110 ft-lb)	205 to 255 N·m (152 to 188 ft-lb)	295 to 355 N·m (216 to 264 ft-lb)
3/4 - 10 UNC	110 to 142 N·m (81 to 105 ft-lb)	165 to 220 N·m (120 to 160 ft-lb)	325 to 395 N·m (238 to 292 ft-lb)	460 to 560 N·m (337 to 413 ft-lb)
3/4 - 16 UNF	135 to 175 N·m (100 to 130 ft-lb)	190 to 285 N·m (140 to 210 ft-lb)	365 to 450 N·m (270 to 330 ft-lb)	510 to 630 N·m (377 to 463 ft-lb)
7/8 - 9 UNC	165 to 215 N·m (120 to 160 ft-lb)	275 to 340 N·m (200 to 250 ft-lb)	525 to 645 N·m (385 to 475 ft-lb)	735 to 895 N·m (540 to 660 ft-lb)
7/8 - 14 UNF	175 to 245 N·m (130 to 180 ft-lb)	315 to 395 N·m (230 to 290 ft-lb)	580 to 710 N·m (427 to 523 ft-lb)	815 to 990 N·m (600 to 730 ft-lb)

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series) (continued)

Note: Reduce the torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant, such as engine oil, or a thread locking compound such as Loctite.

Note: The torque values must be reduced when installing the fasteners into threaded aluminum or brass. The specified torque value should be determined based on the aluminum or base material strength, fastener size, length of thread engagement, etc.

Note: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. The thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners)

Thread Size	Class 8.8 Bolts, Screws, and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)	Class 10.9 Bolts, Screws, and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)
M5 X 0.8	6 to 7 N·m (51 to 63 in-lb)	8 to 10 N·m (70 to 86 in-lb)
M6 X 1.0	10 to 12 N·m (86 to 106 in-lb)	13 to 16 N·m (119 to 147 in-lb)
M8 X 1.25	23 to 28 N·m (17 to 21 ft-lb)	34 to 42 N·m (25 to 31 ft-lb)
M10 X 1.5	46 to 57 N·m (34 to 42 ft-lb)	65 to 80 N·m (48 to 60 ft-lb)
M12 X 1.75	80 to 99 N·m (59 to 73 ft-lb)	112 to 140 N·m (83 to 103 ft-lb)
M16 X 2.0	202 to 248 N·m (149 to 183 ft-lb)	280 to 340 N·m (206 to 252 ft-lb)
M20 X 2.5	395 to 485 N·m (292 to 358 ft-lb)	550 to 670 N·m (404 to 496 ft-lb)

Note: Reduce the torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant, such as engine oil, or a thread sealant, such as Loctite.

Note: The torque values must be reduced when installing the fasteners into threaded aluminum or brass. The specified torque value should be determined based on the aluminum or base material strength, fastener size, length of thread engagement, etc.

Note: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 - 20 UNC	14 to 18 N·m (120 to 160 in-lb)	7 to 9 N·m (61 to 85 in-lb)
5/16 - 18 UNC	20 to 28 N·m (180 to 250 in-lb)	14 to 18 N·m (125 to 165 in-lb)
3/8 - 16 UNC	34 to 61 N·m (25 to 45 ft-lb)	20 to 28 N·m (15 to 21 ft-lb)
1/2 - 13 UNC	81 to 122 N·m (60 to 90 ft-lb)	54 to 81 N·m (40 to 60 ft-lb)

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23 or Type F	
Thread Size	Baseline Torque**
No. 6 - 32 UNC	2 to 3 N·m (15 to 25 in-lb)
No. 8 - 32 UNC	3 to 4 N·m (25 to 35 in-lb)
No. 10 - 24 UNC	4 to 5 N·m (31 to 45 in-lb)
1/4 - 20 UNC	8 to 11 N·m (70 to 100 in-lb)
5/16 - 18 UNC	10 to 14 (90 to 130 in-lb)
3/8 - 16 UNC	11 to 34 (100 to 300 in-lb)

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque*
7/16 - 20 UNF Grade 5	74 to 102 N·m (55 to 75 ft-lb)
1/2 - 20 UNF Grade 5	94 to 122 N·m (70 to 90 ft-lb)
M12 X 1.25 Class 8.8	94 to 122 N·m (70 to 90 ft-lb)
M12 X 1.5 Class 8.8	94 to 122 N·m (70 to 90 ft-lb)

*For steel wheels and non-lubricated fasteners

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque**
	Type A	Type B	
No. 6	18	20	2 to 3 N·m (15 to 25 in-lb)
No. 8	15	18	3 to 4 N·m (25 to 35 in-lb)
No. 10	12	16	4 to 5 N·m (31 to 45 in-lb)
No. 12	11	14	8 to 11 N·m (70 to 100 in-lb)

**The hole size, material strength, material thickness, and material finish must be considered when determining the specified torque values. All the torque values are based on the non-lubricated fasteners.

Conversion Factors

in-lb X 11.2985 = N·cm

ft-lb X 1.3558 = N·m

N·cm X 0.08851 = in-lb

N·m X 0.7376 = ft-lb

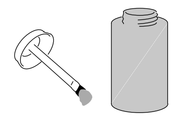
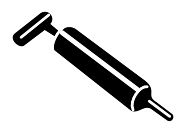
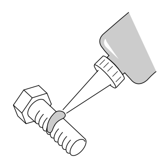
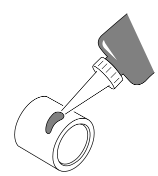
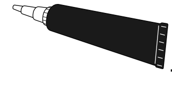
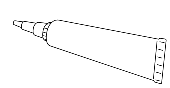
Shop Supplies

The procedures found in this *Service Manual* may recommend the use of commonly used shop supplies (lubricants, sealants, and adhesives). A symbol denoting the use of a shop supply may appear in figures that support a procedure. Always refer to the written procedure for specific information regarding the type and the application of a shop supply.

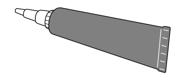
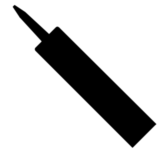
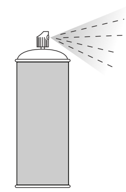
IMPORTANT

Always follow manufacturers instructions when using or storing shop supplies.

Shop Supplies

ANTI-SEIZE LUBRICANT Used to prevent corrosion, galling, and seizure between metal parts. Most often applied to shafts and bores during assembly. Unless otherwise specified, high viscosity regular grade lithium-graphite based anti-seize lubricant should be used.	
GREASE Can be used to pre-fill (pack) bearings, boots, and seals before assembly, ease installation of components during assembly, or fill cavities between moving parts through grease fittings after assembly. Unless otherwise noted, refer to the machine *Operator's Manual* or *Installation Instructions* for grease specifications.	
THREAD LOCKING COMPOUND (thread locker) Used to lock threaded fasteners in position. Available in low, medium and high strength for various size fasteners and applications. Most thread locking compounds are applied immediately prior to fastener installation. Some thread locking compounds use a "Wicking" feature, and can be applied after fastener installation. Most thread locking compounds allow the fastener to be removed with standard tools once cured. High strength thread locking compounds may require applying heat to the fastener and the surrounding area to allow fastener removal. **Note:** Some fasteners have a dry thread locking compound pre-applied (Patch-Loc) so no additional thread locking compound is necessary when installing a "new" fastener. These fasteners are designed to be removed and re-installed only once before applying additional thread locking compound is necessary.	
RETAINING COMPOUND (bearings and sleeves) An adhesive used to secure bearings, bushings, and cylindrical parts into housings or onto shafts. When cured, bearing and sleeve retaining compound fills the gap between mating parts with a hard resin that increases load distribution and protects against corrosion.	
ADHESIVE Used to secure a variety of components immediately prior to assembly. May be recommended for installing new components or when reusing a component that had a pre-applied adhesive such as hood seals, moldings, and weather-stripping.	
THREAD SEALANT Used to seal threaded fittings and sensors from air, fuel, and oil pressure leaks and prevent galling and seizure between threaded parts. A thread sealant in paste firm is preferred over sealant tape. The sealant should remain semi-pliable to allow for component removal with standard tools. Some thread sealants may require the use of a cleaner or primer prior to use.	

Shop Supplies (continued)

GASKET COMPOUND Used to create a seal between mating parts. Gasket compounds may be used with or without the presence of a pre-formed gasket. Gasket compounds may be solvent or silicone based, and cure when exposed to air or designed to cure in an air-less environment (anaerobic). Most gasket compounds are designed to be applied to clean surfaces free of oil, chemical residue and previously used gaskets or gasket compounds.	
SILICONE SEALANT Designed for a broad variety of sealing and bonding requirements, silicone sealants are usually room temperature vulcanizing (RTV) which form a flexible silicone rubber that bonds to a wide variety of smooth or porous materials when cured. Standard silicone sealants are designed to perform in temperatures from -51°F to 232°C (-60°F to 400°F), while high temperature variants can preform in temperatures up to 343°C (650°F).	
AEROSOL PROTECTANT/LUBRICANT Used to coat battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply an aerosol protectant to the connection after you secure the terminal connection. Do Not use an aerosol protectant on small multi-pin electrical connectors. An aerosol lubricant may also be specified. Refer to the specific service procedure for details.	

Special Tools

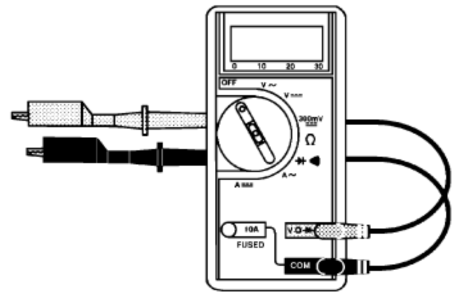
Special tools for servicing Toro Commercial Products are available from your Toro Distributor. Some of these tools may have been supplied with your machine, are available as Toro parts, or may also be available from a local tool supplier.

Multimeter

Obtain this tool locally

The meter can test the electrical components and circuits for current, resistance, or voltage.

Note: Use a digital multimeter when testing the electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode ensures that the excess current is not allowed through the meter. This excess current can damage the circuits that are not designed to carry it.



Battery Terminal Protector

Toro Part No. 107-0392

Use this aerosol spray on the battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply the terminal protector to the connection after you secure the battery cable, ring terminal, or fork terminal.

Dielectric Gel

Toro Part No. 107-0342

Use the dielectric gel to prevent corrosion of unsealed connection terminals. To ensure complete coating of the terminals, liberally apply the gel to the component and wire harness connector, plug the connector into the component, disconnect the connector, apply the gel to both surfaces again, and connect the harness connector to the component again. The connectors must be fully packed with gel for effective results.

Note: Do not use the dielectric gel on the sealed connection terminals as the gel can unseat the connector seals during assembly.

Generator Rotor Tool

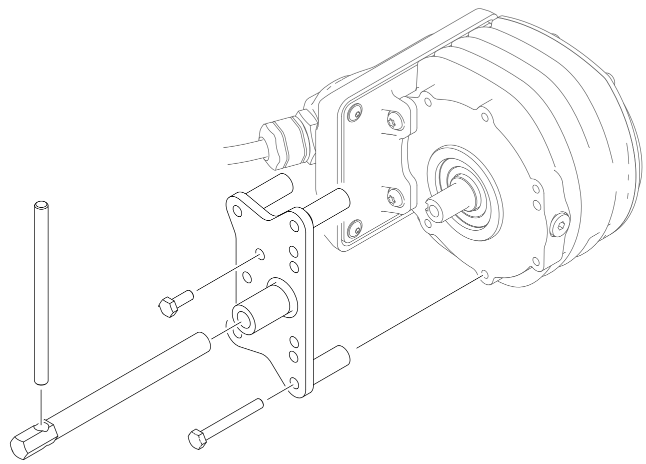
K-Line Part No. TOR6029

The starter/generator rotor tool is recommended to safely remove and install the starter/generator rotor from the housing/stator assembly. The tool includes the base plate, threaded shaft and handle.

3WD Motor Rotor Tool

Toro Part No. 139–8420

The 3WD motor rotor tool is recommended to remove and install the rotor from the optional 3WD motor housing. The tool includes the puller hub, threaded shaft, handle and four screws.

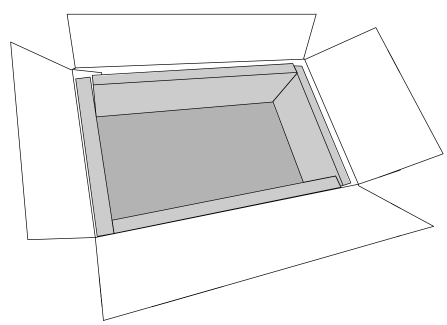


Lithium-Ion Battery Shipping Kit

Toro Part No. 137–9650

Use the original packaging or the battery shipping kit and a certified carrier to ship one of the lithium-ion batteries. The kit includes the appropriate carton, packing, labels, and instructions necessary to confirm to current lithium-ion battery shipping regulations in the USA.

Note: Outside of the USA, contact the appropriate government agency in your country for detailed regulations on shipping the lithium-ion batteries.



Lithium-Ion Battery Service Wire Harness

Toro Part No. 122–1947

Use with Model 04590 machines to identify a failing battery, or determine if the SC8: lithium-ion battery controller or battery interface harness is working correctly.

The lithium–ion battery service wire harness may also be used to bypass a failing battery or battery interface harness, allowing you to move the machine or (depending on distance and battery condition) drive it back to the shop for repair. Try connecting the M/S Samsung service wire harness between the controller and one of the batteries. Then try to turn on the machine.

1. Disconnect the battery interface harness from the BMS and one of the batteries.
2. Connect the battery service wire harness to the BMS and the disconnected battery.
3. Set the key switch to the ON position and move the machine to service.
4. If the machine still does not function, try connecting the battery service wire harness to another battery.

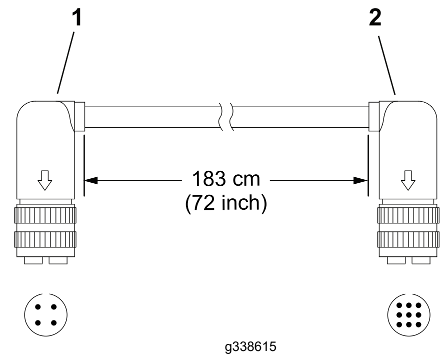


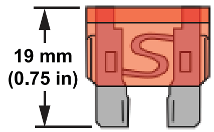
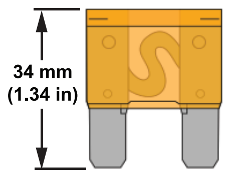
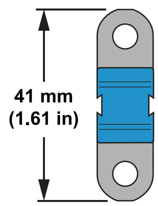
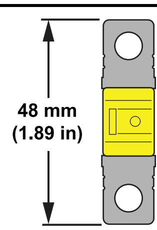
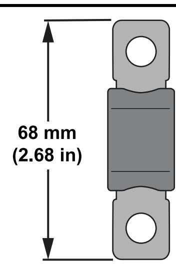
Figure 7

1. 4-Pin battery connector
2. 9–Pin controller Li-ion battery controller connector

Fuse Kit

Toro Part No. 139–8482

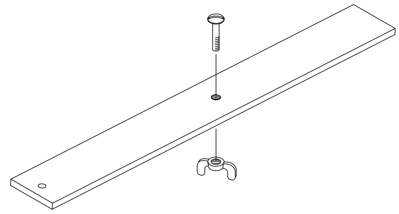
This kit includes an assortment of the different style fuses used on eTriFlex machines.

FUSE TYPE	AMPERAGE/VOLTAGE	PART NUMBER (QTY)
 STANDARD (ATO) Blade Fuse	3A-80V 5A-80V 10A-80V 30A-80V	117-4720 (1) 117-4722 (1) 117-4724 (5) 117-4728 (1)
 MAXI Blade Fuse	35A-58V	122-0255 (3)
 BF1 Fuse	100A-58V	137–7708 (1)
 MIDI Fuse	60A-70V	137–7707 (2)
 MEGA Fuse	150A-70V 175A-70V	137–7722 (1) 139-8414 (1)

Gauge Bar Assembly

Toro Part No. 94–9010

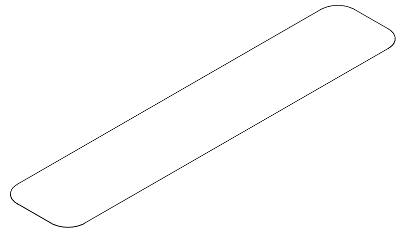
Use the gauge bar to verify height-of-cut adjustment.



Cutting Reel Shim

Toro Part No. 125–5611

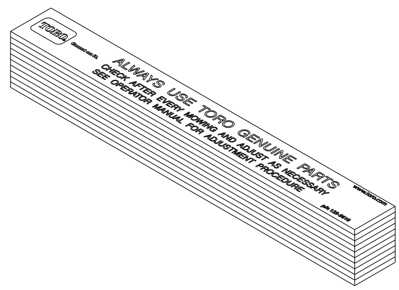
Use the 0.05 mm (0.002 in) shim like a feeler gauge to measure the gap between the reel and the bedknife during reel adjustment.



Cutting Performance Paper

Toro Part No. 125–5610 (300 strips)

Cutting performance paper is used to test the cutting reel performance after adjusting the reel to bedknife clearance.



Reel Drive Shaft

K-Line Part No. TOR4112

Use the drive shaft for rotating the reel during cutting unit adjustment or any time the cutting unit motor is removed.

Reel Thread Repair Taps

15/16–16 Right-Hand Thread – Toro Part No. 137–0926

15/16–16 Left-Hand Thread – Toro Part No. 137–0927

Use to clean or repair the internal threads of cutting unit reels.

Backlapping Brush Assembly

Toro Part No. 29–9100

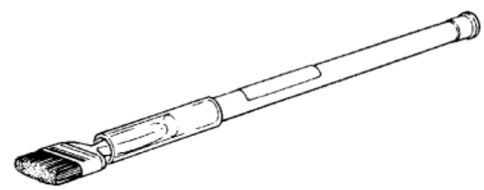
For applying lapping compound to cutting units while keeping hands a safe distance from the rotating reel.

Components for the brush assembly are also available individually.

Brush 36-4310

Handle 29-9080

Handle cap 2410-18



Angle Indicator and Magnetic Mount

Angle Indicator: Toro Part No. 131–6828

Magnetic Mount: Toro Part No. 131–6829

Because the top grind angle on bedknives is critical for edge retention, and therefore after− cut appearance, Toro has developed these service tools for accurately measuring the top grind angle on all bedknives.

Since there can be variations in the mounting surface of the bedbar, it is necessary to grind the bedknife after installing it to the bedbar.

1. Place the angle indicator on the bottom side of the bedknife with the digital display facing you as shown.

2. Press the Alt Zero button on the angle indicator.

3. Remove the angle indicator and place the magnetic mount on the edge of the bedknife so the face of the magnet is flat against the top angle of the bedknife.

4. Place the angle indicator on the mount with the digital display facing you as shown. The angle displayed on the indicator is the current bedknife top angle.

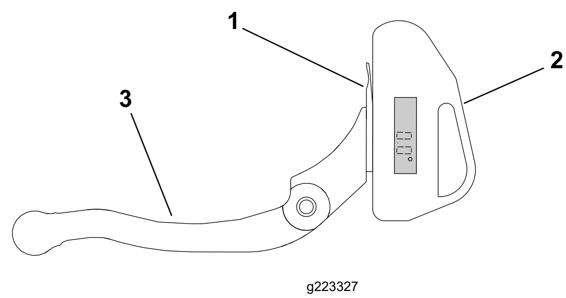


Figure 8

1. Bedknife
2. Angle Indicator
3. Bedbar

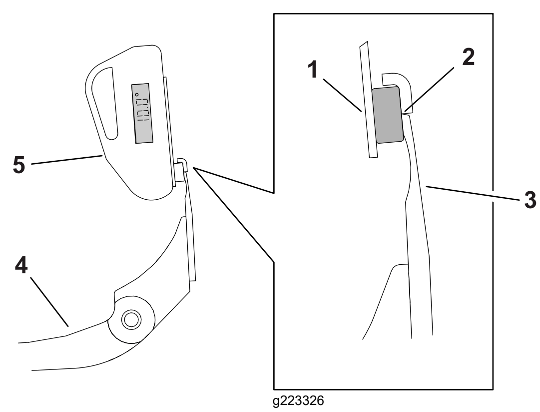


Figure 9

1. Angle indicator surface
2. Magnetic mount
3. Bedknife
4. Bedbar
5. Angle indicator

Bedknife Screw Tool

K-Line Part No. TOR510880A

This screwdriver-type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar.

IMPORTANT

Important: To prevent damage to the bedbar, DO NOT use an air or manual impact wrench with this tool.

Diameter/Circumference Measuring Tape

K-Line Part No. TOR6023

Spring steel measuring tape for accurately measuring the circumference and outside diameter of cutting reel and other spherical components. Tape calibration is in fixed inch readings (no adjustments).

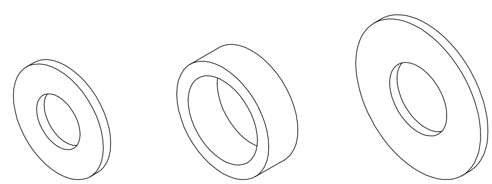
Roller Rebuilding Tools

The following combination of washers and spacers can be used to install bearings and seals into the front and rear rollers (2 each required).

Bearing installation washer: 107-8133 (black)

Seal installation spacer: 107-3505

Seal installation washer: 104-6126 (yellow)



107-8133 **107-3505** **104-6126**

K-Line Part No. TOR4105

As an alternative to using the washers and spacer listed above, this special tool set can be used to install bearings and seals into the front and rear rollers.

Turf Evaluator Tool

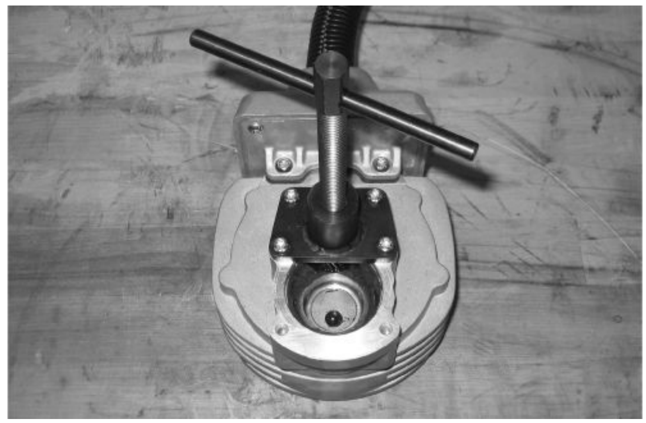
Toro Part No. 04399

Many turf discrepancies are subtle and require closer examination. In these instances, the Turf Evaluator grass viewing tool is helpful. It can assist turf managers and service technicians in determining causes for poor reel mower performance and in comparing the effective height-of-cut of one mowed surface to another. This tool should be used with the Toro Guide to Evaluation Reel Mower Performance and Using the Turf Evaluator (Toro part no. 97931SL) available from a local authorized Toro Distributor.

Cutting Unit Motor Rotor Tool

K-Line Part No. TOR6028

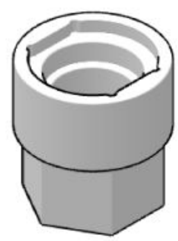
The cutting unit motor rotor tool is recommended to remove and install the rotor from the cutting unit motor housing. The tool includes the puller hub, threaded shaft, handle and four screws.



Drive Shaft Removal Tool

Toro Part No. 137–0920

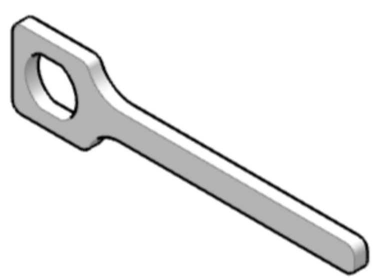
Use to remove the optional Universal Groomer drive shaft from the reel if the drive shaft hex is damaged.



Adapter Wrench

Toro Part No. 137-0921

Use to hold the optional Universal Groomer drive shaft securely when removing or installing the drive adapter.



Syringe – 50cc (2 ounce)

Toro Part No. 137-0872

Aids in accurately filling the optional Universal Groomer gear box with oil.

Chapter 3

Troubleshooting

Table of Contents

The information In this chapter is intended to help troubleshoot machine operation issues. Keep in mind there can be more than one cause for a machine malfunction.

GEARS – The Systematic Approach to Defining, Diagnosing and Solving Problems

1. Gather Information
   - Information reported by the customer
   - Information observed by you
   - Establish the “what, where and when” of the issue
2. Evaluate Potential Causes
   - Consider possible causes of the problem to develop a hypothesis
   - Narrow down the focus of the problem
3. Assess Performance
   - Ensure you have all the necessary tools for testing
   - Test all potential causes of the failure
   - Reevaluate and create a new hypothesis if necessary
4. Repair
   - Return the unit to service by repairing, rebuilding or replacing
5. Solution Confirmation
   - Did the issue go away
   - Was the root cause of the issue correctly repaired
   - Are there any other new symptoms

Operator Advisories

Operator advisories are automatically displayed by the InfoCenter when a machine function is prevented, and additional action is required. Typically, an advisory can be eliminated with a change in machine controls by the operator. For example, if the operator attempts to drive the machine when the manual parking brake is engaged, an advisory is identified on the InfoCenter Display that the manual parking brake needs to be in disengaged. An advisory will not be logged into any fault log. The following table lists each advisory in detail.

Operator Advisories

Advisory Number	Affected Machine Model No.	Advisory Name	Cause	InfoCenter Message | Corrective Action Required
B200A	04580	START DENIED	Starter has been active for 30 seconds	Start Denied | Key held too long
B2013	04580	START DENIED	Fault(s) Active	Start Denied | Resolve active faults
B201B	04580	START DENIED	Starter/Generator not ready	Start Denied | Wait for starter
B2024	04580	ENGINE RPM RESTRICTED	Engine Oil Pressure Low	Engine RPM Restricted | Check Oil
B2152	04580, 04590, 04591	TRACTION DISABLED	Traction not ready	Traction Denied | Wait for traction
B2155	04580, 04590, 04591	TRACTION DISABLED	Parking brake engaged	Traction Denied | Release parking brake
B2159	04580, 04590, 04591	TRACTION DISABLED	Out of seat	Traction Denied | Seat
B215A	04580, 04590, 04591	TRACTION DISABLED	Traction illegally engaged	Traction Denied | Return pedal to neutral
B215B	04580	TRACTION DISABLED	Engine not running	Traction Denied | Start engine
B2162	04580, 04590, 04591	LIFT/LOWER CALIBRATION	Lift/Lower actuator 1 (center/rear) not calibrated	Calibrate Lift/Lower 1
B2163	04580, 04590, 04591	LIFT/LOWER CALIBRATION	Lift/Lower actuator 2 (left) not calibrated	Calibrate Lift/Lower 2
B2164	04580, 04590, 04591	LIFT/LOWER CALIBRATION	Lift/Lower actuator 3 (right) not calibrated	Calibrate Lift/Lower 3
B2116A	04580, 04590, 04591	TRACTION ADVISORY	Traction pedal position sensor needs calibration	Calibrate traction pedal
B2116B	04580, 04590, 04591	TRACTION MOTOR CALIBRATION	Traction motor not calibrated	Calibrate traction motor
B2116C	04580, 04590, 04591	STEERING CENTER CALIBRATION	Steering System – Center not calibrated	Calibrate steering center
B2116D	04580, 04590, 04591	STEERING RANGE CALIBRATION	Steering System – Range not calibrated	Calibrate steering range
B2300	04590, 04591	SYSTEM SHUTDOWN	Battery Fault(s) Active	System Shutdown | Battery fault active
B2301	04590, 04591	MACHINE DISABLED	Battery charger connected	Machine Disabled | Disconnect charger
B2302	04590, 04591	LOW BATTERY		Battery Low | Charge battery

Operator Advisories (continued)

Advisory Number	Affected Machine Model No.	Advisory Name	Cause	InfoCenter Message | Corrective Action Required
B2303	04590, 04591	BATTERY OVERLOAD		Battery Overload | Reduce power draw
B2304	04590, 04591	BATTERY TEMPERATURE LOW		Battery Temp Low | Warm machine
B2305	04590, 04591	BATTERY TEMPERATURE HIGH		Battery Temp High | Cool machine
B2408	04580, 04590, 04591	CUTTING UNIT LOWER DENIED	Function switch in HIGH	Lower Denied | Set function switch to LOW
B2503	04580, 04590, 04591	PTO DENIED	Fault(s) Active	PTO Denied | Resolve active faults
B2509	04580, 04590, 04591	PTO DENIED	Out of seat	PTO Denied | Seat
B250B	04580	PTO DENIED	Engine not running	PTO Denied | Start engine
B2513	04590, 04591	PTO DENIED	Low Battery	PTO Denied | Battery Low
B2550	04580, 04590, 04591	BACKLAP DENIED	Function switch not in NEUTRAL	Backlap Denied | Set function switch to NEUTRAL
B2551	04580, 04590, 04591	BACKLAP DENIED	Parking brake not engaged	Backlap Denied | Engage parking brake
B2553	04580, 04590, 04591	BACKLAP DENIED	Fault(s) Active	Backlap Denied | Resolve active faults
B255C	04580	BACKLAP DENIED	Engine not running	Backlap Denied | Start engine
B2560	04580, 04590, 04591	CLIP SETTINGS OUT OF RANGE	Settings are outside the recommended range	Clip Settings Out of Range | Verify settings
B2704	04580, 04590, 04591	CONTROLLER CHANGED	New controller detected	New Controller Detected | Recycle key

Note: If "Unknown Cause" appears as an advisory description, a controller software issue may exist. If you are unable to clear this type of advisory, contact an Authorized Toro Distributor.

Dialogue Messages

When the machine is being calibrated, dialog messages appear in the InfoCenter. These messages are intended to instruct you through the calibration process. Refer to the following table for a list of each dialog message:

Message Number	InfoCenter Message
1	Return pedal to neutral
4	Move pedal to max forward and hold
5	Max forward calibration passed
9	Max forward calibration failed. Voltage out of spec
13	Move pedal to max reverse and hold
14	Max reverse calibration passed
16	Max reverse calibration failed. Voltage out of spec
17	Calibration failed. Pedal position unknown
18	Return pedal to neutral. Continue?
100	Calibration engaged
101	Calibration complete
102	Cycle key switch
110	Inhibit calibration. Component not responding
111	Inhibit calibration. Component not ready
112	Inhibit calibration. Fault active
113	Inhibit calibration. Not in seat
114	Inhibit calibration. Not in neutral
115	Inhibit calibration. In neutral
116	Inhibit calibration. Pbrake engaged
300	Return pedal to neutral
301	Center steering wheel. Continue?
302	Manually center rear wheel. Continue?
303	Steer rear wheel max left. Continue?
304	Steer rear wheel max right. Continue?
305	Rear wheel center out of range
306	Rear wheel angle out of range
400	Caution: Machine must be on jack stands. Continue?
401	Inhibit calibration. Contactor open
402	Inhibit calibration. Pedal in Neutral
403	Return pedal to neutral
404	Wait for wheels to stop
405	Move pedal to max forward and hold
406	Calibration active. Hold pedal
500	Lift/Lower extend active
501	Lift/Lower retract active
502	Move joystick to lower position
503	Move joystick to raise position

Message Number	InfoCenter Message
504	Is the Cutting Unit installed? Continue?
1100	Traction diagnostic messages enabled
1101	Steering diagnostic messages enabled

Controller Code Table

The table that follows contains the list of controller codes used throughout this manual, and a description of the component code represents.

Controller Code	Component	Controller Code	Component
SC1	InfoCenter	TB1	Toro Leader battery BMS (Model 04591)
SC2	Lift/Lower 1 actuator controller (center)	TB2 and higher	Toro Support battery BMS (Model 04591)
SC3	Lift/Lower 2 actuator controller (left)	T1	Primary controller
SC4	Lift/Lower 3 actuator controller (right)	T2	Cutting Unit 1 motor controller (center)
SC5	Traction 1 motor controller (right)	T3	Cutting Unit 2 motor controller (left)
SC6	Traction 2 motor controller (left)	T4	Cutting Unit 3 motor controller (right)
SC7	Steering motor controller	T5	Traction 3 motor controller (optional)
SC8	Lithium-ion Battery BMS (Model 04590)	T6	Pre–charge controller

Machine Faults

The controllers of the machine generate machine faults to identify an electrical system malfunction (fault) that occurs during machine operation. The fault IDs conform to SAE J2012 standards. When a fault occurs, a red warning light will illuminate and a code for the active fault will appear on the InfoCenter display.

Faults can be viewed using the InfoCenter FAULTS screen. The fault code includes the number of the controller that generated the fault. For example: C1A32:SC7 is a steering motor voltage fault generated by the SC7 (steering motor). “Active” or the time the fault last occurred expressed in machine Key On hours will appear next to the fault. Selecting an individual fault displays the current machine Key On hours for reference, the last time (expressed in Key On hours) the specific fault occurred, the first time (expressed in Key On hours) the specific fault occurred, and the number of times the specific fault has occurred.

Recent non-active faults can be cleared from the Faults screen only after the correct PIN has peen entered at the **Settings > Protected Menus** screen.

Machine Faults

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
B1007	Joystick Raise/Lower Broken	T1	This fault is reported when the joystick lower and joystick raise inputs are active at the same time.	The machine will not be capable of raising or lowering the cutting units, depending on which switch failed.	1. Use the InfoCenter **Diagnostics > Lift/Lower > Inputs** screen to observe joystick switch operation. 2. Test the joystick switches. 3. Inspect and test the joystick wiring and connectors (P01, P04, P05). 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
B1197	Mode Switch Broken **Note:** The Mode Switch may also be referred to as the Function Control Switch	T1	This fault is reported when two or more signals from the mode switch are active at the same time.	Traction is disabled.	1. Use the icons on the InfoCenter main information screen to observe the switch operation. 2. Test the mode switch. 3. Test the switch circuit wiring. The signals begin at connector P43, pins 1, 3, and 6. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C0051	Steering Input Device - Out of Range	SC7	This fault is reported when the steering input device signals are outside the expected range.	Traction is disabled.	1. Use the InfoCenter **Diagnostics > Steering > Inputs** screen to observe the input device operation. 2. Test the steering input device. 3. Test the input device circuit wiring and connector P72.
C0526	Steering Position Sensor - Out of Range	SC7	This fault is reported when the steering position sensor signals are outside the expected range.	Traction is disabled.	1. Use the InfoCenter **Diagnostics > Steering > Inputs** screen to observe the steering position sensor operation. 2. Test the steering position sensor. 3. Test the steering position sensor circuit wiring and connector P69.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C0528	Steering Position Sensor - Not Responding	SC7	This fault is reported when the controller does not see a change in the steering position sensor when comparing steering motor commands and steering sensor movement.	Traction is disabled.	1. Use the InfoCenter **Diagnostics > Steering > Inputs** screen to observe the steering position sensor operation. 2. Test the steering position sensor. 3. Test the steering position sensor circuit wiring and connector P69. 4. Verify rear caster fork movement is not restricted. 5. Verify steering gear box operation.
C0529	Steering Position Sensor Signal Correlation Fault	SC7	This fault is reported when the sum of the 2 signals from the steering position sensor are not correlating correctly.	Traction is disabled.	1. Use the InfoCenter **Diagnostics > Steering > Inputs** screen to observe the steering position sensor operation. 2. Test the steering position sensor. 3. Test the steering position sensor circuit wiring and connector P69.
C1013	Engine On Output - Short to Battery	T1	This fault is reported when low current is detected on the engine control output (Engine On). Indicates a short to a high (+) source.	The short could be to battery voltage or to another signal that is in a high (+) state.	1. Check the engine On output circuit wiring and connectors (P01, P45, P70). 2. Test the engine relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1014	Engine On Output – Overcurrent	T1	This fault is reported when overcurrent is detected on the engine control output (Engine On), indicating a short to ground.		1. Check the engine On output circuit wiring and connectors (P01, P45, P70). 2. Test the engine relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1015	Engine On Output - Open Circuit	T1	This fault is reported when an open circuit is detected on the engine control output (Engine On).		1. Check the engine On output circuit wiring and connectors (P01, P45, P70). 2. Test the engine relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1023	Parking Brake Disengage Output - Short to Battery	T1	This fault is reported when low current is detected on the automatic parking brake disengage output, indicating a short to a high (+) source.	The short could be to battery voltage or to another signal that is in a high (+) state.	1. Check the parking brake disengage output circuit wiring and connectors (P01, P74, P75). 2. Test the parking brake relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1024	Parking Brake Disengage Output - Overcurrent	T1	This fault is reported when Overcurrent is detected on the automatic parking brake disengage output, indicating a short to ground.		1. Check the parking brake disengage output circuit wiring and connectors (P01, P74, P75). 2. Test the parking brake relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1025	Parking Brake Disengage Output - Open Circuit	T1	This fault is reported when an open circuit is detected on the automatic parking brake disengage output.		1. Check the parking brake disengage output circuit wiring and connectors (P01, P74, P75). 2. Test the parking brake relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C10C4	Steering Feedback Output - Overcurrent	T1	This fault is reported when an overcurrent is detected on the steering feedback output, indicating a short to ground.		1. Check the steering feedback output circuit wiring and connectors (P01, P72). 2. Test the steering feedback output circuit wiring to ground. 3. Test the steering input device brake coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C10C5	Steering Feedback Output - Open Circuit	T1	This fault is reported when an open circuit is detected on the steering feedback output.		1. Check the steering feedback output circuit wiring and connectors (P01, P72). 2. Test the steering feedback output circuit wiring. 3. Test the steering input device brake coil. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C10E3	48V Logic Enable Relay Output - Short to Battery	T1	This fault is reported when low current is detected on the logic relay output, Indicating a short to a high (+) source.	The short could be to battery voltage or to another signal that is in a high (+) state.	1. Check the logic relay output circuit wiring and connectors (P01, P47) 2. Test the logic relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C10E4	48V Logic Enable Relay Output - Overcurrent	T1	This fault is reported when an overcurrent is detected on the logic relay output, indicating a short to ground.		1. Check the logic relay output circuit wiring and connectors (P01, P47) 2. Test the logic relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C10E5	48V Logic Enable Relay Output - Open Circuit	T1	This fault is reported when an open circuit is detected on the logic relay output.		1. Check the logic relay output circuit wiring and connectors (P01, P47) 2. Test the logic relay and circuit wiring. 3. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1801	Cutting Unit Motor - High Temp Shutdown	T2, T3, T4	This fault is reported when the cutting unit motor temperature is greater than 130° C (266° F) in the indicated cutting unit.	PTO is disabled.	1. Let the machine cool off. 2. Check the reel to bedknife contact and the condition of the cutting unit. 3. Reduce the reel speed. 4. Reduce the mow speed. 5. Test the 48V ground to the motor. 6. Swap cutting reel motors between cutting units. Replace and reprogram the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
C180C	Cutting Unit Motor - High Temp Warning	T2, T3, T4	This fault is reported when the cutting unit motor temperature is greater than 120° C (248° F) in the indicated cutting unit.	Motor current is limited on a linear basis until the motor temperature drops below 120° C (248° F) or exceeds 130 °C (266 °F).	1. Let the machine cool off. 2. Check the reel to bedknife contact and the condition of the cutting unit. 3. Reduce the reel speed. 4. Reduce the mow speed. 5. Test the 48V ground to the motor. 6. Swap cutting reel motors between cutting units. Replace and reprogram the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1811	Cutting Unit Motor Controller - High Temp Shutdown	T2, T3, T4	This fault is reported when the cutting unit motor controller temperature is greater than 100° C (212° F) in the indicated cutting unit.	PTO is disabled.	1. Let the machine cool off. 2. Check the reel to bedknife contact and the condition of the cutting unit. 3. Reduce the reel speed. 4. Reduce the mow speed. 5. Test the 48V ground to the motor. 6. Swap cutting reel motors between cutting units. Replace and reprogram the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
C181C	Cutting Unit Motor Controller - High Temp Warning	T2, T3, T4	This fault is reported when the cutting unit motor controller temperature is greater than 90° C (194° F) in the indicated cutting unit.	Motor current is limited on a linear basis until the motor controller temperature drops below 90° C (194° F) or exceeds 100° C (210° F).	1. Let the machine cool off. 2. Check the reel to bedknife contact and the condition of the cutting unit. 3. Reduce the reel speed. 4. Reduce the mow speed. 5. Test the 48V ground to the motor. 6. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
C1820	Cutting Unit Motor Speed Sensor - Out of Range	T2, T3, T4	This fault is reported when one of the three cutting unit motor internal hall effect sensors fails in the indicated cutting unit.	Hall effect sensors are used to detect the motor speed. If a sensor fails, the motor will have trouble maintaining speed and may become unstable.	1. Cycle the key switch. 2. If the fault repeats, replace and program the motor (contact an Authorized Toro Distributor for assistance).
C1821	Cutting Unit Motor Speed - High	T2, T3, T4	This fault is reported when the speed of the cutting unit motor is greater than 2,500 RPM in the indicated cutting unit.		1. Cycle the key switch. 2. If the fault repeats, replace and program the motor (contact an Authorized Toro Distributor for assistance).
C1822	Cutting Unit Motor - Stall	T2, T3, T4	This fault is reported when the speed of the cutting unit motor is 0 RPM for more than 3 seconds in the indicated cutting unit.	PTO is disabled.	1. Check the cutting unit and the motor for mechanical resistance. 2. Check the bedknife adjustment and the condition of the reel. 3. Try spinning the motor without a load. If it doesn't spin, replace and program the motor (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1831	Cutting Unit Motor Internal Regulator Voltage - High	T2, T3, T4	This fault is reported when the internal regulator voltage is greater than 15V in the indicated cutting unit.		1. Cycle the key switch. 2. If the fault repeats, replace and program the motor (contact an Authorized Toro Distributor for assistance).
C1832	Cutting Unit Motor Internal Regulator Voltage - Low	T2, T3, T4	This fault is reported when the internal regulator voltage is less than 10V in the indicated cutting unit.	PTO is disabled. **Note:** If this fault is present on multiple cutting unit motors, check the 48V logic relay and connector (P47).	1. Inspect all cutting unit wiring and connectors. 2. Inspect the battery terminals. 3. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
C1841	Cutting Unit Motor Logic Voltage - High	T2, T3, T4	This fault is reported when the 48V logic voltage measures greater than 67.5V in the indicated cutting unit.	PTO is disabled. **Note:** If more than one Logic Voltage - High fault is reported, go to fault U1501 and follow the listed service actions.	1. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance). 2. Inspect the harness connectors at the cutting unit motor for damage, corrosion, debris, and proper alignment of the pins inside the connectors. 3. Test the connectors for 48V with the engine shut off and the key in the On position. 4. Test the power and ground wiring resistance in the harness connectors.
C1842	Cutting Unit Motor Logic Voltage - Low	T2, T3, T4	This fault is reported when the 48V logic voltage measures less than 32V in the indicated cutting unit.	PTO is disabled. **Note:** If more than one Logic Voltage - Low fault is reported, go to fault U1502 and follow the listed service actions.	1. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance). 2. Check the 48V logic power connection to the motor.
C1851	Cutting Unit Motor Bus Voltage - High	T2, T3, T4	This fault is reported when the 48V logic voltage measures greater than 67.5V in the indicated cutting unit.	PTO is disabled. **Note:** If more than one Bus Voltage - High fault is reported, go to fault U1511 and follow the listed service actions.	1. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance). 2. Inspect the harness connectors at the cutting unit motor for damage, corrosion, debris, and proper alignment of the pins inside the connectors. 3. Test the connectors for 48V with the engine shut off and the key in the On position. 4. Test the power and ground wiring resistance in the harness connectors.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1852	Cutting Unit Motor Bus Voltage - Low	T2, T3, T4	This fault is reported when the 48V bus voltage measures less than 32V in the indicated cutting unit.	PTO is disabled. **Note:** If more than one Bus Voltage - Low fault is reported, go to fault U1512 and follow the listed service actions.	1. Test the 48V bus Maxi blade fuse under the left side cover. 2. Check the 2 pin, 48V bus connector of the cutting unit motor. 3. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
C1861	Cutting Unit Motor - Over Current	T2, T3, T4	This fault is reported when an internal over current condition is detected in the indicated cutting unit.	PTO is disabled.	1. Cycle the key switch. 2. If the fault repeats, replace and program the motor (contact an Authorized Toro Distributor for assistance).
C1901	Lift/Lower Motor Controller - High Temp Shutdown	SC2, SC3, SC4	This fault is reported when the temperature is greater than 75° C (167° F) in the indicated actuator.	Lift/Lower is disabled.	1. Check for mechanical resistance in the cutting unit suspension making the actuator work extra hard. 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C190C	Lift/Lower Motor Controller - High Temp Warning	SC2, SC3, SC4	This fault is reported when the temperature is greater than 65°C (149°F) in the indicated actuator.	Lift/Lower speed reduced until the actuator temperature drops below 65° C (149° F) or exceeds 75° C (167° F).	1. Check for mechanical resistance in the cutting unit suspension making the actuator work extra hard. 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C1910	Lift/Lower Motor Speed Sensor - Out of Range	SC2, SC3, SC4	This fault is reported when an internal sensor fails in the indicated actuator.	Lift/Lower is disabled.	1. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. Use the InfoCenter to calibrate the actuator.
C1912	Lift/Lower Motor - Stall	SC2, SC3, SC4	This fault is reported when the maximum allowed current is being drawn by the indicated actuator.	Lift/Lower is disabled for 5 seconds.	1. Check for mechanical resistance in the cutting unit suspension making the actuator work extra hard. 2. Use the InfoCenter to calibrate the actuator. 3. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the actuator.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1919	Lift/Lower Motor - Position Error	SC2, SC3, SC4	This fault is reported when an internal sensor fails in the indicated actuator.	Lift/Lower is disabled.	1. Verify proper power and ground to the actuator. 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C1921	Lift/Lower Motor Logic Voltage - High	SC2, SC3, SC4	This fault is reported when the 48V logic voltage measures greater than 67.5V in the indicated actuator.	Lift/Lower is disabled. **Note:** If more than one Logic Voltage - High faults are reported, go to fault U1501 and follow the listed service actions.	1. Check the logic power connection to the actuator. 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C1922	Lift/Lower Motor Logic Voltage - Low	SC2, SC3, SC4	This fault is reported when the 48V logic voltage measures less than 32V in the indicated actuator.	Lift/Lower is disabled. **Note:** If more than one Logic Voltage - Low faults are reported, go to fault U1502 and follow the listed service actions.	1. Check the logic power connection to the actuator. 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C1931	Lift/Lower Motor Bus Voltage - High	SC2, SC3, SC4	This fault is reported when the 48V bus voltage measures greater than 67.5V in the indicated actuator.	Lift/Lower is disabled. **Note:** If more than one Bus Voltage - High faults are reported, go to fault U1511 and follow the listed service actions.	1. Check the bus power connection to the actuator. 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C1932	Lift/Lower Motor Bus Voltage - Low	SC2, SC3, SC4	This fault is reported when the 48V bus voltage measures less than 32V in the indicated actuator.	Lift/Lower is disabled. **Note:** If more than one Bus Voltage - Low faults are reported, go to fault U1512 and follow the listed service actions.	1. Test the actuator 48V bus standard blade fuse (under seat). 2. Verify power and ground to the actuator. 3. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the actuator.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1941	Lift/Lower Controller - Internal Software Failure	SC2, SC3, SC4	This fault is reported when an internal software failure is detected in the indicated actuator.	Lift/Lower is disabled.	1. Update machine software (contact an Authorized Toro Distributor for assistance). 2. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the actuator.
C1942	Lift/Lower Motor Overload	SC2, SC3, SC4	This fault is reported when 3 or more amps are drawn for more than 10 seconds reaching an overload condition in the indicated actuator.	Lift/Lower is disabled for 30 seconds.	1. Let the actuator rest for 30 seconds. 2. Use the InfoCenter to re-calibrate the actuator. 3. Replace and program the actuator (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the actuator.
C1A01	Steering Motor - High Temp Shutdown	SC7	This fault is reported when the temperature of the motor in the steering motor is greater than 120° C (248° F).	Traction and steering is disabled.	1. Check for binding or restriction of the rear caster fork assembly. 2. Allow the steering motor to cool down. 3. If the fault repeats, replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A11	Steering Motor Controller - High Temp Shutdown	SC7	This fault is reported when the temperature of the controller in the steering motor is greater than 80° C (176° F).	Traction and steering is disabled.	1. Check for binding or restriction of the rear caster fork assembly. 2. Allow the steering motor to cool down. 3. If the fault repeats, replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A20	Steering Motor Speed Sensor - Out of Range	SC7	This fault is reported when a sensor inside the steering motor fails.	Traction and steering is disabled.	1. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1A22	Steering Motor - Stall	SC7	This fault is reported when the steering motor draws too much current for too long (longer than 1 second when the traction speed is higher than 15%, or longer than 5 seconds when the traction speed is lower than 5%).	Traction and steering is disabled.	1. Check for binding or restriction of the rear caster fork assembly. 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A27	Steering Motor Position Error	SC7	This fault is reported when there is a disagreement between the encoder in the steering motor and the steering position sensor.	Traction is disabled.	1. Verify steering position sensor adjustment. 2. Check for binding or restriction of the rear caster fork assembly. 3. Verify proper wiring of the steering position sensor connector (P69). 4. Test the steering position sensor. 5. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 6. Cycle the key switch. 7. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A32	Steering Motor Bus Voltage - Low	SC7	This fault is reported when the steering motor detects that the 48V bus voltage did not reach at least 14V within 3.2 seconds of Key On.	Traction and steering is disabled.	1. Test the steering motor 48V bus standard blade fuse (under seat). 2. Verify proper power and ground to the steering motor connector (P46). 3. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A41	Steering Controller - Over Current	SC7	This fault is reported when a current sensor fails in the steering motor controller.	Traction and steering is disabled.	1. Manually check that the rear caster fork moves easily through its entire range. 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1A55	Steering Motor Phase U - Open Circuit	SC7	This fault is reported when the steering motor controller detects an open circuit on motor phase U.	Traction and steering is disabled.	1. Test the steering motor 48V bus standard blade fuse (under seat) and the power connection to the 48V battery. 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A5C	Steering Motor Phase V - Open Circuit	SC7	This fault is reported when the steering motor controller detects an open circuit on motor phase V.	Traction and steering is disabled.	1. Test the steering motor 48V bus standard blade fuse (under seat) and the power connection to the 48V battery. 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A5D	Steering Motor Phase W - Open Circuit	SC7	This fault is reported when the steering motor controller detects an open circuit on motor phase W.	Traction and steering is disabled.	1. Test the steering motor 48V bus standard blade fuse (under seat) and the power connection to the 48V battery. 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A69	Steering Wheel Sensor - Feedback Noisy	SC7	This fault is reported when the steering motor controller detects electrical noise on the output of the steering input device.	Traction and steering is disabled.	1. Test the steering input device wiring and connector (P72). 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A6C	Steering Controller - Internal Hardware Failure	SC7	This fault is reported when an internal hardware component of the steering motor controller fails.	Traction and steering is disabled.	1. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1A7D	Steering Controller - Internal Software Failure	SC7	This fault is reported when an unexpected steering motor controller software error occurs.	Traction and steering is disabled.	1. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
C1A7E	Steering Motor Software - Hardware Incompatibility	SC7	This fault is reported when the steering motor controller software is not compatible with the hardware.	Traction and steering is disabled.	1. Update machine software (contact an Authorized Toro Distributor for assistance). 2. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
P0524	Oil Pressure Low - Kill Engine	T1	This fault is reported when the engine oil pressure is low for more than 10 seconds while the engine is running.	Engine ETR output shuts off.	1. Check and adjust the engine oil level. 2. Inspect and test the wiring and connectors (P70, pin F to P01, pin 24). 3. Test the engine oil pressure switch. 4. Test the engine lubrication system; refer to the *Kawasaki FS481V Service Manual*.
P058E	Battery - High Temp Shutdown	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when the temperature of one or more Li-ion battery is greater than 70° C (158° F).	While this fault is active, the Li-ion battery controller keeps the battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond when the key switch is turned to the On position.	Allow the machine to cool before operating.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P058F	Battery - Low Temp Shutdown	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when the temperature of one or more Li-ion battery is -20° C (-4° F) or lower.	While this fault is active, the Li-ion battery controller keeps the battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond when the key switch is turned to the On position.	Allow the machine to warm before operating.
P063C	Starter/Generator Logic Voltage - Low	T6	This fault is reported when the starter/generator measures the 48V logic voltage at less than 36V.	PTO and starter/generator is disabled. **Note:** If more than one Logic Voltage - Low fault is reported, go to fault U1502 and follow the listed service actions.	1. Check the logic power to the starter/generator connector (P21). 2. Replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P063D	Starter/Generator Logic Voltage - High	T6	This fault is reported when the starter/generator measures the 48V logic voltage at greater than 65V.	PTO and starter/generator is disabled. **Note:** If more than one Logic Voltage - High fault is reported, go to fault U1501 and follow the listed service actions.	1. Test the starter/generator. 2. Verify that all starter/generator motor-to-controller connections are good. 3. Test the starter/generator (test procedure pending). 4. Replace and program the starter/generator (contact an Authorized Toro Distributor for assistance).
P06E9	Starter/Generator Timeout	T1	This fault is reported when the starter function of the starter/generator was engaged for more than the maximum time permitted.	Starter/Generator is disabled. **Note:** This fault could be caused by the key switch being held in the Start position for more than 15 seconds.	1. Cycle the key switch. 2. Test the key switch.

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0A1B	Traction Controller - Short	SC5, SC6	This fault is reported when either the traction controller FET has shorted, the motor phases have shorted, or the phase wires from the motor to the controller are shorted in the indicated controller.	Traction is disabled.	1. Verify that U, V, and W motor phases are correctly connected. 2. Test each motor phase to ground. 3. Check the phase resistance to 48V bus and 48V ground after the controller capacitor bank has been de-energized. 4. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 5. Cycle the key switch. 6. Use the InfoCenter to calibrate the traction motors. 7. For SC5: Calibrate the traction pedal, then calibrate the traction motors. For SC6: Calibrate the traction motors.
P0A2A	Traction Motor - Temperature Sensor Failure	SC5, SC6	This fault is reported when the temperature sensor is out of the normal operating range in the indicated motor.	Traction performance is limited.	1. Test the wiring to the motor. 2. Replace the motor. 3. Use the InfoCenter to calibrate the traction motors.
P0A2F	Traction Motor - High Temp Warning	SC5, SC6, T5	This fault is reported when the traction motor temperature is greater than: 150° C (302° F) for (SC5, SC6) or 120° C (248° F) for T5.	Traction performance is limited.	1. Reduce the ground speed. 2. Check for mechanical resistance in the wheels that would make the motors work extra hard. 3. Replace the traction motor. For SC5 and SC6, use the InfoCenter to calibrate the traction motors. For T5, program the traction motor (contact an Authorized Toro Distributor for assistance).
P0A36	Starter/Generator - Temperature Sensor Failure	T6	This fault is reported when the starter/generator FET and the motor sensor fail.	PTO and starter/generator is disabled.	Replace and program the starter/generator (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0A3B	Starter/Generator Motor - High Temp Warning	T6	This fault is reported when the starter/generator temperature is greater than 120° C (248° F).	Starter/Generator current is limited on a linear basis until the temperature drops below 120° C (248° F) or exceeds 130° C (266° F). **Note:** This fault is not produced by a bad sensor.	1. Clean the air intake screen on the back of the starter/generator. Be sure the starter/generator is pulling air through the air intake by feeling with your hand or by testing with a piece of paper. 2. Let the machine cool. 3. Reduce the cutting loads by reducing the reel speed or reducing mow speed. 4. Replace the starter/generator motor.
P0A3C	Traction Motor Controller - High Temp Warning	SC5, SC6, T5	This fault is reported when the temperature is greater than 90°C (194° F) in the indicated traction motor controller.	Traction motor current is limited on a linear basis until the temperature drops below 90°C (194° F) or exceeds 100° C (212° F).	1. Reduce the ground speed. 2. Check for mechanical resistance in the wheels that would make the motors work extra hard. 3. For SC5 and SC6: Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). For T5; Replace and program the traction motor assembly (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.
P0A3E	Starter/Generator Controller - High Temp Warning	T6	This fault is reported when the starter/generator controller temperature is greater than 90° C (194° F).	Starter/Generator current is limited on a linear basis until the temperature drops below 90° C (194° F) or exceeds 100° C (212° F). **Note:** This fault is not produced by a bad sensor.	1. Clean the air intake screen on the back of the starter/generator. Be sure the starter/generator is pulling air through the air intake by feeling with your hand or by testing with a piece of paper. 2. Let the machine cool. 3. Reduce the cutting loads by reducing the reel speed or reducing mow speed. 4. Replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0A44	Traction Motor Speed - High	SC5, SC6, T5	This fault is reported when the ground speed is more than the allowed maximum speed of the machine as measured by the indicated traction motor.	Traction is disabled.	1. Inspect the wiring of the speed sensors. 2. Check supply voltage to the speed sensor. 3. Replace the traction motor. For SC5 and SC6, use the InfoCenter to calibrate the traction motors. For T5, program the traction motor (contact an Authorized Toro Distributor for assistance).
P0A54	Traction Motor Controller - Over Current	SC5, SC6, T5	This fault is reported when the current draw exceeds the hardware and software limits of the indicated traction motor.	Traction is disabled.	1. Cycle the key switch to clear the fault. 2. Contact an Authorized Toro Distributor or the Toro Technical Assistance Center and report that this fault occurred.
P0A5A	Starter/Generator Current Sensor Out of Range	T6	This fault is reported when one of the sensors inside the starter/generator controller fails.	PTO and starter/generator is disabled.	1. Cycle the key switch. 2. If the fault repeats, replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P0A5C	Starter/Generator Hardware - DC Over Current	T6	This fault is reported when the starter/generator controller detects an internal overcurrent condition.	PTO and starter/generator is disabled.	1. Cycle the key switch. 2. If the fault repeats, replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P0A80	Battery - Internal Hardware Failure	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when a hardware component in one or more Li-ion batteries has failed.	While this fault is active, the Li-ion battery controller keeps the battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond when the key switch is turned to the On position.	One or more Li-ion batteries are likely damaged. Contact an Authorized Toro Distributor for assistance.
P0AA1	Battery Contactor - Stuck Closed	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when the battery contactor in the Li-ion battery controller is measured to be closed when it should be open.	**Note:** If the contacts are "welded" together, the contactor will not open.	**Model 04590—**the Li-ion battery controller (SC8) is likely damaged. Contact an Authorized Toro Distributor for assistance. **Model 04591—**the discharge FET or charge FET is damaged. Contact an Authorized Toro Distributor for assistance.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0AA2	Battery Contactor - Stuck Open	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when the battery contactor in the Li-ion battery controller is measured to be open when it should be closed.		**Model 04590—**the Li-ion battery controller (SC8) is likely damaged. Contact an Authorized Toro Distributor for assistance. **Model 04591—**the discharge FET or charge FET is damaged. Contact an Authorized Toro Distributor for assistance.
P0AC2	Battery - Over Current	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when a battery cell is supplying too much current for too long. **Note:** This fault can be caused by too much power draw or by a defective Li-ion battery.	While this fault is active, the Li-ion battery controller keeps the battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond when the key switch is turned to the On position.	1. Operate the machine in a reduced power condition (example: disengage the cutting units). 2. Inspect the wiring for the batteries and the battery controller. 3. One or more Li-ion batteries is likely damaged. Contact an Authorized Toro Distributor for assistance.
P0AE4	Hybrid/EV - Contactor Stuck Open	T6	This fault is reported when there is a problem with control of the 48V main contactor – the contactor is open when it should be closed.	PTO, starter/generator, and lift/lower is disabled.	1. Check the voltage across the coil of the main contactor with the key On. It should be approximately 48V and the contactor should be closed (continuity across the contactor terminals) 2. Test the circuit protection diode (across the contactor coil). 3. Test the main contactor.
P0AE5	Hybrid/EV - Contactor Stuck Closed	T6	This fault is reported when there is a problem with control of the 48V main contactor – the contactor is closed when it should be open.	PTO, starter/generator, and lift/lower is disabled.	1. Check the voltage across the coil of the main contactor with the key Off. It should be 0V and the contactor should be open (no continuity across the contactor terminals) 2. Test the circuit protection diode (across the contactor coil). 3. Test the main contactor.
P0AE6	Precharge Failure	T6	This fault is reported when the minimum precharge voltage (38V) was not achieved in the appropriate time.	PTO, starter/generator, and lift/lower is disabled.	Start with a component that may have just blown a fuse and disconnect one cutting unit motor or lift/lower actuator at a time until the fault stops repeating. • The starter/generator or precharge controller must remain connected because it reports this fault. • If one of the cutting unit motors or lift/lower actuators is reporting a COMM fault, that is likely the shorted component.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0AFA	Battery - Low Voltage	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when a Li-ion battery cell voltage was measured to be low. The battery may be recoverable using software or by using the battery charger.	While this fault is active, the Li-ion battery controller keeps the battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond when the key switch is turned to the On position.	1. Charge the batteries. The contactor (Model 04590) or discharge FET (Model 04591) in the Li-ion battery controller should be allowed to close once the battery pack voltage reaches 42V. 2. If the battery pack voltage does not recover, contact an Authorized Toro Distributor for assistance.
P0AFB	Battery - High Voltage	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when a Li-ion battery cell voltage was measured to be high.	While this fault is active, the Li-ion battery controller keeps the battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond when the key switch is turned to the On position.	• If the fault occurred with a full Li-ion battery during a regenerative charge (coasting – traction motors charging battery), everything is likely fine. Cycle the key switch and continue operation. • If the fault occurred when the Li-ion battery state of charge is less than 90%, contact an Authorized Toro Distributor for assistance.
P0C06	Traction Motor Phase Short	SC5, SC6	This fault is reported when two traction motor phases are shorted together but not shorted to ground in the indicated traction motor controller or motor.	Traction is disabled.	1. Verify that the U, V, and W motor phase cables are in the correct order. 2. Check the motor power cables. 3. Replace the traction motor. Use the InfoCenter to calibrate the traction motors. 4. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 5. Cycle the key switch. 6. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0C19	Traction Motor Power Mismatch	SC5, SC6	This fault is reported when the motor is not responding to the power setpoint in the indicated traction motor.	Traction is disabled.	1. Verify that the U, V, and W motor phase cables are in the correct order. 2. Verify the speed feedback sensor (sin-cos) is wired correctly. 3. Use the InfoCenter to calibrate the traction motors. 4. Contact an Authorized Toro Distributor or the Toro Technical Assistance Center and report that this fault occurred.
P0C78	Precharge Failure - Battery	T1, TB	This fault is reported after 30 seconds of unsuccessfully attempting to pre-charge and fully energize its output terminals. The battery will go to sleep after this fault is sent.	The battery contactor is opened. Power cycle required.	1. Cycle power and attempt normal operation. 2. If fault persists, inspect electrical harnesses and batteries for short circuits or significant contamination. Clean as needed. 3. If fault consistently persists on the same battery module, then use serial number in the fault log to identify the affected battery, and replace it.
P0DAB	Battery Series Cell Imbalance	T1, TB	This fault is reported when the battery BMS detects a significant voltage mismatch between internal series cells.	Fault will affect machine run time and ability to achieve a full charge.	1. Cycle power and attempt normal operation. 2. If fault consistently persists on the same battery module, then use serial number in the fault log to visually identify the affected battery, and replace it
P0D2F	Traction Motor Logic Voltage - Low	SC5, SC6, T5	This fault is reported when the traction motor measures the 48V logic voltage at less than: 38V (SC5, SC6) or 32V for T5	Traction is disabled. **Note:** If more than one Logic Voltage - Low fault is reported, go to fault U1502 and follow the listed service actions.	1. Measure the logic voltage at the motor controller to determine whether the voltage is low, or the controller is measuring low. 2. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. For SC5: Use the InfoCenter to calibrate the traction pedal, then calibrate the traction motors. For SC6: Use the InfoCenter to calibrate the traction motors.
P0D30	Traction Motor Logic Voltage - High	SC5, SC6, T5	This fault is reported when the traction motor measures the 48V logic voltage at greater than: 65V (SC5, SC6) or greater than 67.5V for T5	Traction is disabled. **Note:** If more than one Logic Voltage - High fault is reported, go to fault U1501 and follow the listed service actions.	1. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. For SC5: Use the InfoCenter to calibrate the traction pedal, then calibrate the traction motors. For SC6: Use the InfoCenter to calibrate the traction motors.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P0E8E	Traction Motor Bus Voltage - Low	SC5, SC6, T5	The traction motor measures the 48V bus voltage at less than: 38V (SC5, SC6) or 32V for T5	Traction is disabled. **Note:** If more than one Bus Voltage - Low fault is reported, go to fault U1512 and follow the listed service actions.	1. Measure the 48V bus voltage at the motor connector to determine whether the voltage is low, or the controller is measuring low. 2. Test the 60A MIDI fuse for the controller (SC5 fuse under seat, SC6 fuse under left side cover). 3. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. For SC5: Use the InfoCenter to calibrate the traction pedal, then calibrate the traction motors. For SC6: Use the InfoCenter to calibrate the traction motors.
P0E8F	Traction Motor Bus Voltage - High	SC5, SC6, T5	This fault is reported when the traction motor measures the 48V bus voltage at greater than: 65V (SC5, SC6) or greater than 67.5V for T5	Traction is disabled. **Note:** If more than one Bus Voltage - High fault is reported, go to fault U1511 and follow the listed service actions.	1. Measure the voltage at the motor connector to determine whether the voltage is high, or the controller is measuring high. 2. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. For SC5: Use the InfoCenter to calibrate the traction pedal, then calibrate the traction motors. For SC6: Use the InfoCenter to calibrate the traction motors.
P1A01	Battery Charging - High Temp Shutdown	T1, TB	This fault is reported when the cells within the battery exceed the upper charging temperature limit.	The charger is disabled and will recover automatically once temperature is within limits.	1. Let the machine cool before charging. 2. Charge the machine in the shade or in a cooler environment – Battery will begin charging automatically once fault condition no longer exists.
P1A02	Battery Charging- Low Temp Shutdown	T1, TB	This fault is reported when the cells within the battery fall below the lower charging temperature limit.	The charger is disabled and will recover automatically once temperature is within limits.	Charge the machine in a warmer environment – Battery will begin charging automatically once fault condition no longer exists.
P1A11	Battery Charging Voltage - High	T1, TB	This fault is reported when a battery exceeds the upper charging voltage limit.	The charger is disabled.	1. Check the charger for faults. 2. Unplug charger 3. Confirm machine is being charged with an approved charger. Use only chargers approved for this machine.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P1A21	Battery Charging - Over Current	T1, TB	This fault is reported when a battery exceeds the upper charging current limit	The battery contactor is opened. Power cycle required.	1. Unplug the battery charger. 2. Confirm machine is being charged with an approved charger. Use only chargers approved for this machine. 3. If the charger is correct and the fault is still present, replace the charger.
P1A55	Battery ID Pin – Open Circuit	T1, TB	The primary controller never established or lost communication with the Leader battery	This is the jumper that designates the pack as the Leader battery.	1. Cycle the power 2. Check battery and machine harness for loose or damaged wires. 3. If fault is persistent through several charge cycles, battery may need replacement – Contact Toro.
P1501	Traction Motor - High Temp Shutdown	SC5, SC6, T5	This fault is reported when the traction motor temperature is greater than: 170° C (338° F) (SC5, SC6) or greater than 130° C (266 °F) for T5.	Traction is disabled.	1. Reduce ground speed, try to cool the traction motor. 2. Check for mechanical resistance in the wheels that would make the motors work extra hard. 3. Check air pressure in all 3 tires. 4. For SC5 and SC6 only: A. Check the adjustment of the brakes. B. Verify the Steering System – Center Calibration. 5. Replace the traction motor. For SC5 and SC6, use the InfoCenter to calibrate the traction motors. For T5, program the traction motor (contact an Authorized Toro Distributor for assistance).
P1511	Traction Motor Controller - High Temp Shutdown	T5	This fault is reported when the optional 3WD traction motor controller temperature is greater than 100° C (212° F).	Traction is disabled.	1. Reduce ground speed. 2. Check for mechanical resistance in the wheels that would make the motors work extra hard. 3. The T5 controller is part of the motor assembly and is not replaceable separately. Replace and program the traction motor (contact an Authorized Toro Distributor for assistance).
P1520	Traction Motor Speed Sensor - Out of Range	SC5, SC6, T5	This fault is reported when the speed sensor reading is outside the normal operating range in the indicated traction motor.	Traction is disabled.	1. For SC5 and SC6 only: verify the speed feedback sensor (sin-cos) is wired correctly. 2. Replace the traction motor. For SC5 and SC6, use the InfoCenter to calibrate the traction motors. For T5, program the traction motor (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P1522	Traction Motor Speed Sensor - Stall	SC5, SC6, T5	SC5, SC6: This fault is reported when the speed sensor reading in the indicated drive unit indicates a stalled motor. T5: This fault is reported when the speed of the optional rear traction motor is 0 RPM for more than 3 seconds.	Traction is disabled.	1. Check for mechanical resistance in the wheels that would make the motors work extra hard. 2. Check air pressure in all 3 tires. 3. For SC5 and SC6 only: A. Verify the speed feedback sensor (sin-cos) is wired correctly. B. Check the adjustment of the brakes. C. Verify the Steering System – Center Calibration. 4. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 5. Cycle the key switch. 6. For SC5: Use the InfoCenter to calibrate the traction pedal, then calibrate the traction motors. For SC6: Use the InfoCenter to calibrate the traction motors.
P1527	Traction Motor Speed Sensor - Data Invalid	SC5, SC6	This fault is reported when the speed sensor reading is invalid in the indicated traction motor.	Traction is disabled.	1. Verify the speed feedback sensor (sin-cos) is wired correctly. 2. Replace the traction motor. Use the InfoCenter to calibrate the traction motors.
P1529	Traction Motor Speed Sensor - Wrong Direction	SC5, SC6	This fault is reported when the speed sensor shows the motor moving in the wrong direction in the indicated traction motor.	Traction is disabled.	1. Verify the speed feedback sensor (sin-cos) is wired correctly. 2. Test the cables on the U, V, and W phases. 3. Replace the traction motor. Use the InfoCenter to calibrate the traction motors.
P152C	Traction Motor Speed Sensor - Feedback Noisy	SC5, SC6	This fault is reported when the speed sensor feedback is noisy in the indicated traction motor.	Traction is disabled.	1. Test the speed sensor wiring. 2. Check the adjustment of the brakes. 3. Replace the traction motor. Use the InfoCenter to calibrate the traction motors.
P1531	Traction Motor Internal Regulator - Voltage High	T5	This fault is reported when the internal regulator voltage is greater than 15V.	3WD Traction is disabled.	1. Inspect the wiring and connectors (P19, P20). 2. Replace and program the traction motor (contact an Authorized Toro Distributor for assistance).
P1532	Traction Motor Internal Regulator - Voltage Low	T5	This fault is reported when the internal regulator voltage is less than 10V.	3WD Traction is disabled.	1. Inspect the wiring and connectors (P19, P20). 2. Replace and program the traction motor (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P1541	Traction Motor Phase - Voltage High	SC5, SC6	This fault is reported when the motor phase voltage is out-of-range high in the indicated traction motor.	Traction is disabled.	1. Test the cables on the U, V, and W phases. 2. Test the wheel motor contactor 3. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.
P1542	Traction Motor Phase - Voltage Low	SC5, SC6	This fault is reported when the motor phase voltage is out-of-range low in the indicated traction motor.	Traction is disabled.	1. Test the cables on the U, V, and W phases. 2. Test the wheel motor contactor 3. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.
P1554	Traction Motor Contactor Coil - Short Circuit	SC5	This fault is reported when the coil engage output of the controller is shorted.	Traction is disabled.	1. Check the connections between the controller outputs and the motor. 2. Test the traction motor contactor. 3. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate traction pedal first, then the traction motors.
P1555	Traction Motor Contactor Coil - Open Circuit	SC5	This fault is reported when an open circuit is detected on the NMC signal from the controller.	Traction is disabled.	1. Check the connections between the controller outputs and the motor. 2. Test the traction motor contactor. 3. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate traction pedal first, then the traction motors.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P156C	Traction Controller - Internal Hardware Failure	SC5, SC6	This fault is reported when an internal component of the controller fails in the indicated traction motor controller.	Traction is disabled.	1. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.
P156D	Traction Controller - Internal Software Failure	SC5, SC6	This fault is reported when an unexpected software error occurs in the indicated traction motor controller.	Traction is disabled.	1. Reprogram the traction motor controller (contact an Authorized Toro Distributor for assistance). 2. Cycle the key switch. 3. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors. 4. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 5. Cycle the key switch. 6. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.
P156E	Traction Motor Software - Hardware Incompatibility	SC5, SC6	This fault is reported when the software is not compatible with the hardware in the indicated traction motor controller.	Traction is disabled.	1. Update the machine software. 2. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.
P1A01	Battery Charging - High Temp Shutdown	SC8	This fault is reported when a Li-ion battery cell temperature is greater than 60° C (140° F).	Battery contactor in Li-ion battery controller is opened.	1. Allow the machine to cool before charging. 2. Disconnect the charger for 5 seconds and then reconnect. 3. Charge the machine in the shade or a cooler environment.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P1A02	Battery Charging- Low Temp Shutdown	SC8	This fault is reported when a Li-ion battery cell temperature is less than -10° C (14° F).	The Li-ion battery controller will not allow the battery to be charged.	1. Allow the machine to warm before charging. 2. Disconnect the charger for 5 seconds and then reconnect. 3. Charge the machine in a warmer environment.
P1A11	Battery Charging Voltage - High	SC8	This fault is reported when a Li-ion battery cell voltage is greater than the allowed threshold while a battery charger is connected.	The Li-ion battery controller will not allow the battery to be charged.	1. Ensure the correct charger is being used. 2. Disconnect the charger for 5 seconds and then reconnect. 3. Check the charger for faults. 4. Charge the machine with a known good charger or replace the charger.
P1A21	Battery Charging - Over Current	SC8	This fault is reported when a Li-ion battery cell charging current is greater than the allowed threshold while a battery charger is connected.	The Li-ion battery controller will not allow the battery to be charged.	1. Ensure the correct charger is being used. 2. Disconnect the charger for 5 seconds and then reconnect. 3. Check the charger for faults. 4. Charge the machine with a known good charger or replace the charger. 5. Check battery and charger harnesses for corrosion or damage. 6. Contact an Authorized Toro Distributor for assistance.
P1B01	Starter/Generator Motor - High Temp Shutdown	T6	This fault is reported when the starter/generator motor temperature is greater than 130° C (266° F).	PTO and starter/generator is disabled. **Note:** This fault is not produced by a bad sensor.	1. Clean the air intake screen on the back of the starter/generator. Be sure the starter/generator is pulling air through the air intake by feeling with your hand or by testing with a piece of paper. 2. Let the machine cool. 3. Reduce the cutting loads by reducing the reel speed or reducing mow speed. 4. If the fault continues, replace the starter/generator motor.
P1B11	Starter/Generator Controller - High Temp Shutdown	T6	This fault is reported when the starter/generator controller temperature is greater than 100° C (212° F).	PTO and starter/generator is disabled. **Note:** This fault is not produced by a bad sensor.	1. Clean the air intake screen on the back of the starter/generator. Be sure the starter/generator is pulling air through the air intake by feeling with your hand or by testing with a piece of paper. 2. Let the machine cool. 3. Reduce the cutting loads by reducing the reel speed or reducing mow speed. 4. If the fault continues, replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P1B20	Starter/Generator Motor Speed Sensor Out of Range	T6	The hall effect sensors in the starter/generator motor provide an invalid reading.	This fault will not disable any machine functionality.	1. Check the wiring between the starter/generator motor and controller. 2. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance).
P1B21	Starter/Generator Motor Speed - High	T6	This fault is reported when the speed of the starter/generator motor is greater than 3,600 RPM.		1. Check the engine governor if the engine RPM is consistently high. 2. Check the wiring between the starter/generator motor and controller. 3. Replace the starter/generator motor.
P1B2C	Starter/Generator Motor - Stall	T6	This fault is reported when the starter/generator stalls for 3 seconds or more.	PTO and starter/generator is disabled.	1. Verify that the starter/generator can spin freely. 2. Check the wiring between the starter/generator motor and controller. 3. Replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P1B31	Starter/Generator Motor Internal Regulator Voltage - High	T6	This fault is reported when the internal regulator voltage is greater than 18V.	PTO and starter/generator is disabled.	1. Inspect the logic relay and wire harness connectors. 2. Inspect the starter/generator and wire harness connectors. 3. Replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P1B41	Starter/Generator Bus Voltage - High	T6	This fault is reported when the starter/generator measures the 48V bus voltage at greater than 65V.	PTO and starter/generator is disabled. **Note:** If more than one Bus Voltage - High fault is reported, go to fault U1511 and follow the listed service actions.	1. Test the starter generator. 2. Check the wiring between the starter/generator motor and controller. 3. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance).
P1B42	Starter/Generator Bus Voltage - Low	T6	This fault is reported when the starter/generator measures the 48V bus voltage at less than 36V.	PTO and starter/generator is disabled. **Note:** If more than one Bus Voltage - Low fault is reported, go to fault U1512 and follow the listed service actions.	1. Test the starter generator. 2. Check the wiring between the starter/generator motor and controller. 3. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P1B4C	Starter/Generator Hardware Over Voltage	T6	This fault is reported when the voltage protection hardware inside the starter/generator trips.	PTO and starter/generator is disabled.	1. Cycle the key switch. 2. If the fault repeats, replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P1B51	Starter/Generator Hardware Phase Over Current	T6	This fault is reported when the current sensor on phase current indicates an internal short.	PTO and starter/generator is disabled.	1. Cycle the key switch. 2. If the fault repeats, replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P1B6C	Starter/Generator Internal Hardware Failure	T6	This fault is reported when the hardware phase overcurrent and hardware overvoltage trip.	PTO and starter/generator is disabled.	1. Cycle the key switch. 2. If the fault repeats, replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
P210E	Traction Pedal 1 Sensor/Switch Analog vs Analog conflict	SC5	This fault is reported when the traction pedal sensors report different positions.	Traction is disabled.	1. Use the InfoCenter **Diagnostics > Traction > Inputs** screen to observe the traction pedal position sensor operation. 2. Check the wiring to the sensor connector (P36). 3. Check the sensor wiring to the T1: primary controller (P01). 4. Replace the traction pedal position sensor. 5. Use the InfoCenter to calibrate the traction pedal.
P2503	Alternator - Charging Too Low **Note:** The alternator consists of a stator coil, flywheel magnets, and an external voltage regulator	T1	This fault is reported when the TEC senses that the 12V charging system is less than 8.8V.	PTO is disabled.	1. Test the 15A mini blade style fuse in the 12V fuse holder (under the right side cover). 2. Test the circuit wiring and connector (P70). 3. Test the voltage regulator. The regulator output to battery should be approx. 15 VDC at 2,400 RPM. 4. Test the alternator. The alternator output to the regulator should be approx. 21 VAC at 2,400 RPM. 5. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
P2504	Alternator - Charging Too High **Note:** The alternator consists of a stator coil, flywheel magnets, and an external voltage regulator	T1	This fault is reported when the TEC senses that the 12V charging system is greater than 16.3V.		1. Test the circuit wiring and connector (P70). 2. Test the voltage regulator. The regulator output to battery should be approx. 15 VDC at 2,400 RPM. 3. Test the alternator. The alternator output to the regulator should be approx. 21 VAC at 2,400 RPM. 4. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P2530	Key Start/On Correlation Fault	T1	This fault is reported when the key start input is active but the key On input is off.	Machine will shut down since key On input is inactive	1. Use the InfoCenter **Diagnostics > Engine > Inputs** to verify the key On and key start circuit inputs. 2. Check the key switch circuit wiring and connectors (P57, P01). 3. Test the key switch.
P2BE8	Traction Motor Contactor - Open	SC5	This fault is reported when the wheel motor contactor is detected open when it should be closed.	Traction is disabled.	1. Test the wiring connectors (P35 and J13). 2. Test the 60A MIDI fuse for the SC5 controller (under seat). 3. Test the wheel motor contactor. 4. Replace and program the SC5 traction motor controller (contact an Authorized Toro Distributor for assistance). 5. Cycle the key switch. 6. Use the InfoCenter to calibrate the traction pedal first, then the traction motors.
P2BE9	Traction Motor Contactor - Closed	SC5	This fault is reported when the wheel motor contactor is detected closed when it should be open	Traction is disabled.	1. Test the wiring connectors (P35 and J13). 2. Test the main contactor.
P2BEA	Traction Motor Precharge Failure	SC5, SC6	This fault is reported when there is a short on the 48V traction bus, too much resistance, or too much capacitance in the indicated traction motor controller.	Traction is disabled.	1. Check if an external load is installed on the traction 48V bus. If there is, remove it. 2. Replace and program the traction motor controller (contact an Authorized Toro Distributor for assistance). 3. Cycle the key switch. 4. Use the InfoCenter to calibrate the traction motor controller. For SC5, calibrate the traction pedal first, then the traction motors. For SC6, calibrate the traction motors.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U0110	CAN Bus Communication Fault - Traction Motor 1	T1	This fault is reported when the primary controller never establishes or loses communication with the right side traction motor controller (SC5).	Traction is disabled.	1. Test the wiring from the controller to the CAN bus (connector P35). 2. Verify power to the controller. 3. Replace and program the SC5 traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the traction pedal first, then the traction motors.
U0111	CAN Bus Communication Fault - Li-ion Battery controller	TB, T1	This fault is reported when the primary controller never establishes or loses communication with the Li-ion battery controller (SC8).	Machine performance is limited	1. Test the wiring from the Li-ion battery controller to the CAN bus (connector P12). 2. Test the CAN bus wiring through the system interface harness (the adapter cable between the main wire harness connector P12 and the Li-ion battery controller). 3. Verify power and ground to the Li-ion battery controller. 4. Replace and program the Li-ion battery controller (contact an Authorized Toro Distributor for assistance).
U0120	CAN Bus Communication Fault - Starter/Generator	T1	This fault is reported when the primary controller never establishes or loses communication with the starter/generator controller (T6).	PTO and starter/generator is disabled.	1. Test the wiring from the starter/generator controller to the CAN bus (connector P21). 2. Verify power and ground to the starter/generator controller. 3. Replace and program the starter/generator controller (contact an Authorized Toro Distributor for assistance).
U012A	CAN Bus Communication Fault - Precharge Controller	T1	This fault is reported when the primary controller never establishes or loses communication with the precharge controller (T6).	One or more machine functions may be disabled.	1. Test the wiring from the precharge controller to the CAN bus (connector P02). 2. Verify power and ground to the precharge controller (connector P03). 3. Test the 3A standard blade fuse (machine wire harness on left side of the center battery set). 4. Replace the T6: precharge controller (contact an Authorized Toro Distributor for assistance).

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U0131	CAN Bus Communication Fault - Steering	T1	This fault is reported when the primary controller never establishes or loses communication with the steering motor (SC7).	Traction is disabled.	1. Test the wiring from the steering motor to the CAN bus (connector P46). 2. Verify power and ground to the steering motor. 3. Replace and program the steering motor (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the steering system – center first, then the steering system – range.
U0156	CAN Bus Communication Fault - InfoCenter	T1	The primary controller reports this fault if the controller never establishes or loses communication with the InfoCenter.	This fault may also be reported by the InfoCenter if the primary controller loses logic power (includes the 2A fuse on the Logic Pwr connection to pin 40 on the primary controller).	1. Verify power to the T1 primary controller (connector P01). 2. Verify power and ground to the InfoCenter (connector P52). 3. Test the wiring from the InfoCenter to the CAN bus (connector P52). 4. Replace and program the InfoCenter (contact an Authorized Toro Distributor for assistance).
U0292	CAN Bus Communication Fault - Traction Motor 2	T1	This fault is reported when the primary controller never establishes or loses communication with the left side traction motor controller (SC6).	Traction is disabled.	1. Test the wiring from the SC6 controller to the CAN bus (connector P34). 2. Check the power supply (fused) and ground to the controller. 3. Replace and program the SC6 traction motor controller (contact an Authorized Toro Distributor for assistance). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the traction motors.
U029B	CAN Bus Communication Fault - Traction Motor 3	T1	This fault is reported when the primary controller never establishes or loses communication with the optional rear traction motor (T5).	Traction is disabled.	1. Test the wiring from the T5 controller to the CAN bus (connector P19). 2. Check the power supply (fused) and ground to the T5 controller (connector P20) 3. Replace and program the traction motor (contact an Authorized Toro Distributor for assistance).
U0320	Software Version Incompatibility - Steering	T1	This fault is reported when the steering firmware is incompatible.	Machine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U1011	Controller Logic Voltage - High	T1	This fault is reported when the 12V logic circuit voltage is above 16.3V.		1. Test the 48 VDC/12 VDC converter. 2. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U1012	Controller Logic Voltage - Low	T1, T6	This fault is reported when the 12V logic circuit voltage is below 8.8V (T1), or 48V logic circuit voltage is below 32V (T6).	PTO is disabled.	1. If the fault is generated by the T1 primary controller: A. Check the output of the DC-to-DC converter on the InfoCenter. B. Measure the logic voltage at the DC-to-DC converter. C. Measure the logic voltage at the T1 primary controller. D. Test the 48 VDC/12 VDC converter. E. Swap the T1: Primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance). 2. If the fault is generated by the T6 precharge controller: A. Check the power supply (fused) and ground to the T6 precharge controller. B. Replace the T6: precharge controller (contact an Authorized Toro Distributor for assistance).
U1025	TEC (T1 Primary controller) Fuse 5 Failure	T1	This fault is reported when the fuse has failed for outputs 13–16 on the T1: Primary controller.	Connector P01, pin 38, output will not function.	1. Test the 7.5A mini blade style fuse in the 12V fuse holder (under the right side cover). 2. Check the fuse holder circuit wiring and connector (P68).
U110C	Model Number Unknown	T1	This fault is reported when the model number not recognized.	Engine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U1117	Source Address Contention Fault	T1	This fault is reported when the T1 primary controller receives a message from another controller on the CAN bus using the same source address.	Machine is disabled. **Note:** Most often, this fault is caused by installing a controller that was programmed while it was installed in another machine.	Update machine software (contact an Authorized Toro Distributor for assistance).
U111F	Source ID - CU Motor ID Out of Range	T1	This fault is reported when multiple cutting unit motors are reporting the same node ID or address.	PTO is disabled.	1. Inspect for loose wire or connector at the cutting unit motors and the CAN ID module. 2. Test the resistance of the motor ID pin (pin 2 of the 4-pin motor connector). It should be 18k to 20k ohm. 3. Test the CAN ID module.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U1121	48V Devices Offline	T1	This fault is reported when CAN communication between the T1 primary controller and all 48V devices is lost.	PTO and starter/generator is disabled. **Note:** If this fault repeats with one of the 48V Logic Enable faults (C10E3, C10E4, or C10E5) repeating and/or the U1502 48V system Logic Voltage – Low fault repeating, troubleshoot the faults in the following order: 1) C10E3, C10E4, or C10E5 2) U1502 3) U1121	1. Verify that the 48V battery disconnect is connected. 2. Inspect CAN bus isolation module connector for damage and corrosion (P50) 3. Check for 12V at the CAN bus isolation module. 4. Test the CAN bus wiring at connector P50. 5. Verify that 48V logic power is available.
U1122	CAN Bus Communication Fault - CU Motor 1	T1	This fault is reported when the T1: Primary controller never establishes or loses communication with cutting unit 1 (center).	PTO is disabled.	1. Test the wiring from the cutting unit motor controller to the CAN bus (connector P24). 2. Verify 48V logic power to the cutting unit. 3. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
U1123	CAN Bus Communication Fault - CU Motor 2	T1	This fault is reported when the T1: Primary controller never establishes or loses communication with cutting unit 2 (left).	PTO is disabled.	1. Test the wiring from the cutting unit motor controller to the CAN bus (connector P26). 2. Verify 48V logic power to the cutting unit. 3. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).
U1124	CAN Bus Communication Fault - CU Motor 3	T1	This fault is reported when the T1: Primary controller never establishes or loses communication with cutting unit 3 (right).	PTO is disabled.	1. Test the wiring from the cutting unit motor controller to the CAN bus (connector P22). 2. Verify 48V logic power to the cutting unit. 3. Swap cutting reel motors between cutting units. Replace and program the motor if the fault moves to the new position (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U1128	CAN Bus Communication Fault - Lift/Lower Motor 1	T1	This fault is reported when the T1: Primary controller never establishes or loses communication with lift/lower actuator 1 (center).	PTO is disabled.	1. Test the wiring from the actuator to the CAN bus (connector P62). 2. Verify 48V logic power to the actuator. 3. Replace and program the actuator (contact an Authorized Toro Distributor). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the lift/lower actuator.
U1129	CAN Bus Communication Fault - Lift/Lower Motor 2	T1	This fault is reported when the T1: Primary controller never establishes or loses communication with lift/lower actuator 2 (left).	PTO is disabled.	1. Test the wiring from the actuator to the CAN bus (connector P61). 2. Verify 48V logic power to the actuator. 3. Replace and program the actuator (contact an Authorized Toro Distributor). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the lift/lower actuator.
U112A	CAN Bus Communication Fault - Lift/Lower Motor 3	T1	This fault is reported when the T1: Primary controller never establishes or loses communication with lift/lower actuator 3 (right).	PTO is disabled.	1. Test the wiring from the actuator to the CAN bus (connector P59). 2. Verify 48V logic power to the actuator. 3. Replace and program the actuator (contact an Authorized Toro Distributor). 4. Cycle the key switch. 5. Use the InfoCenter to calibrate the lift/lower actuator.
U1170	CAN Bus Communication Fault - Battery Cell Module	SC8, TB (Model 04590); T1, TB (Model 04591)	This fault is reported when the SC8: Li-ion battery controller never establishes or loses communication with one of the Li-ion batteries.	Battery contactor in Li-ion battery controller is opened.	1. Check the battery interface cable between all batteries and the T6: Li-ion battery controller (Model 04590) or between all Support batteries and the Leader battery (Model 04591). 2. One of the Li-ion batteries may be damaged (contact your Authorized Toro Distributor for assistance).
U1140	Host Machine Controller Authentication Failure - Battery	T1, TB	This fault is reported when the Leader battery cannot authenticate the host machine.	This fault will disable the machine. The battery contactor is opened. Power cycle required.	1. Update machine firmware (contact your Authorized Toro Distributor for assistance) 2. If fault persists, contact Toro.
U1301	Software Version Incompatibility - CU Motor 1	T1	This fault is reported when the cutting unit 1 (center) software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U1302	Software Version Incompatibility - CU Motor 2	T1	This fault is reported when the cutting unit 2 (left) software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)
U1303	Software Version Incompatibility - CU Motor 3	T1	This fault is reported when the cutting unit 3 (right) software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)
U1304	Software Version Incompatibility - Lift/Lower Motor 1	T1	This fault is reported when the lift/lower actuator 1 (center) software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)
U1305	Software Version Incompatibility - Lift/Lower Motor 2	T1	This fault is reported when the lift/lower actuator 2 (left) software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)
U1306	Software Version Incompatibility - Lift/Lower Motor 3	T1	This fault is reported when the lift/lower actuator 3 (right) software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)
U1307	Software Version Incompatibility - Starter/Generator	T1	This fault is reported when the starter/generator software is incompatible.	Engine is disabled.	Update machine software (contact your Authorized Toro Distributor for assistance)
U1308	Software Version Incompatibility - Precharge Controller	T1	This fault is reported when the T6 precharge controller software is incompatible	Machine is disabled	Update machine software (contact your Authorized Toro Distributor for assistance)
U130A	Software Version Incompatibility - InfoCenter	T1	This fault is reported when the InfoCenter software is incompatible	Machine is disabled	Update machine software (contact your Authorized Toro Distributor for assistance)
U130B	Software Version Incompatibility - Traction Motor 1	T1	This fault is reported when the right side traction motor controller (SC5) firmware is incompatible.	Machine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U130C	Software Version Incompatibility - Traction Motor 2	T1	This fault is reported when the left side traction motor controller (SC6) firmware is incompatible.	Machine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U130D	Software Version Incompatibility - Traction Motor 3	T1	This fault is reported when the 3WD drive motor (T5) firmware is incompatible.	Machine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U130E	Software Version Incompatibility - Processor Mismatch	SC5, SC6, SC7	This fault is reported when the software is incompatible in the component indicated.	Traction is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U130F	Software Version Incompatibility - Unknown	T1	This fault is reported when the T1: Primary controller has detected an incompatible software version.	Machine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U1311	Software Version Incompatibility - Li-ion Battery Controller	T1	This fault is reported when the Li-ion battery controller (SC8) software is incompatible.	Machine is disabled.	Update machine software (contact an Authorized Toro Distributor for assistance).
U1501	48V System Logic Voltage - High	T1	This fault is reported when three or more components on the machine are reporting a Logic Voltage - High fault.	PTO and the generator function of the starter/generator is disabled. **Note:** This fault may be dependent upon how aggressive the operator is driving the machine. If they are trying to do frequent aggressive braking and/or driving down hills and braking, they may see this fault repeat because this machine uses regenerative braking.	For 3360 machines: 1. Test the starter/generator. 2. Verify that all starter/generator motor-to-controller connections are good. 3. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance). For 3370 machines: • If the fault occurred with already fully charged Li-ion batteries during a regenerative charge (i.e., while the machine is coasting, the traction motors charge the battery pack), everything is likely fine. Cycle the key switch and continue operation. • If the fault occurred immediately after fully charging the Li-ion batteries, verify that the correct battery charger is being used.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U1502	48V System Logic Voltage - Low	T1	This fault is reported when three or more components on the machine are reporting a Logic Voltage - Low fault.	PTO and the generator function of the starter/generator is disabled.	For 3360 machines: 1. Test the 100A BF1 style fuse (under the seat). 2. Test the 5A standard blade fuse (under the seat) 3. Test the 48V batteries with the engine Off. 4. Test the 48V logic relay and wiring. 5. Test the starter/generator. 6. Verify that all starter/generator motor-to-controller connections are good. 7. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance). For 3370 machines: 1. Attempt to charge the batteries. 2. Test the 175A Mega style fuse (behind the left side cover). 3. Test the 5A standard blade fuse (under the seat) 4. Test the 48V batteries with the engine Off. 5. Test the 48V logic relay and wiring. 6. Contact an Authorized Toro Distributor for assistance
U1511	48V System Bus Voltage - High	T1	This fault is reported when three or more components on the machine are reporting a Bus Voltage - High fault.	PTO and the generator function of the starter/generator is disabled.	For 3360 machines: 1. Test the starter/generator. 2. Verify that all starter/generator motor-to-controller connections are good. 3. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance). For 3370 machines: • If the fault occurred with already fully charged Li-ion batteries during a regenerative charge (i.e., while the machine is coasting, the traction motors charge the battery pack), everything is likely fine. Cycle the key switch and continue operation. • If the fault occurred immediately after fully charging the Li-ion batteries, verify that the correct battery charger is being used.

Machine Faults (continued)

Fault ID	Fault Title	Affected Controller	Fault Condition/Circuit Description	Additional Notes	Service Actions
U1512	48V System Bus Voltage - Low	T1	This fault is reported when three or more components on the machine are reporting a Bus Voltage - Low fault.	PTO and the generator function of the starter/generator is disabled.	For 3360 machines: 1. Test the 100A BF1 style fuse (under the seat). 2. Test the 5A standard blade fuse (under the seat) 3. Test the 48V batteries with the engine Off. 4. Test the 48V logic relay and wiring. 5. Test the starter/generator. 6. Verify that all starter/generator motor-to-controller connections are good. 7. Replace and program the starter/generator assembly (contact an Authorized Toro Distributor for assistance). For 3370 machines: 1. Attempt to charge the batteries. 2. Test the 175A Mega style fuse (behind the left side cover). 3. Test the 5A standard blade fuse (under the seat) 4. Test the 48V batteries with the engine Off. 5. Test the 48V logic relay and wiring. 6. Contact an Authorized Toro Distributor for assistance
U1700	Board Internal Error - IPE	T6	This fault is reported when the Inputs or outputs in the T6: precharge controller are not working correctly.	Machine is disabled	1. Test the power and ground at the T6 precharge controller. 2. Test the 3A standard blade fuse (machine wire harness on left side of the center battery set). 3. Replace and program the T6: precharge controller (contact an Authorized Toro Distributor for assistance).
U1701	Board Internal Error - IPE	T1	This fault is reported when the Inputs or outputs in the T1: primary controller are not working correctly.	Machine is disabled	1. Test the 12V battery voltage at the T1 primary controller (connector P01). 2. Swap the T1: primary controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Using the InfoCenter Display for Troubleshooting

The InfoCenter Splash Screen and Main Information Screen can be used to check the operation of various components. The neutral, parking brake, and seat icons represent the switch activity and can be used to verify the switch and its circuit wiring integrity. The battery icon can be used to check battery voltage and circuit wiring integrity.

The Diagnostics − Input and Output screens of the InfoCenter display can be very helpful when troubleshooting machine operation issues. Electrical components and their circuit wiring can be evaluated quickly using the Input screens prior to testing the component individually. The screens can show the current state of the inputs and the outputs required to allow a machine operation to proceed, or report electrical performance (voltage or currant) of a specific component. Refer to InfoCenter Display (page 5–11) for a guide to the various InfoCenter screens.

CAUTION

It may be necessary to start and run the engine, raise and lower the cutting units, or otherwise operate the machine during the troubleshooting process. Make sure the machine is in a well ventilated area and keep away from attachments and moving parts while troubleshooting to prevent personal injury.

Displaying Input and Output Values

If a machine operation is malfunctioning, the following procedure can help identify the component or circuit wiring causing the malfunction.

1. Park machine on a level surface, lower the cutting units if possible and stop engine.
2. Set the key switch to the ON position and navigate to the InfoCenter **Diagnostics > Input** or **Output** Screen for the desired machine function.
3. Manually operate the input component. The component state on the InfoCenter display should alternate ON and OFF or the signal voltage from the component should change as the component is operated. If ON and OFF do not alternate or signal voltage does not change during component operation, the component or its circuit wiring is faulty and should be tested; refer to Testing the Electrical Components (page 5–27) and Appendix A (page A–1).

   Note: – – – means no signal from the input is available on the CAN bus and the input or the CAN bus circuit wiring should be tested.

   When the correct inputs are received by the controllers, the outputs identified on the Output screen should show as ON, or a control amperage is reported. If the inputs are properly positioned and the output remains OFF or the control amperage is not as expected, a problem with controller output power (circuit wiring or fuse) may exist, or the controller software may require reloading or replacement. Contact your Authorized Toro Distributor for assistance.

   A faulty output component will not be identified by the Output screen. The Output screen reflects the actions of the controller, not the component(s) involved in the operation. If all inputs and outputs are correct for the machine operation selected, yet the operation does not function as it should, the output component may be faulty. Test the specific output component and the wiring from the controller to the component; refer to Testing the Electrical Components (page 5–27) and Appendix A (page A–1).

TRACTION (example):

Using the Inputs Screen

- Depress the traction pedal in the forward direction slowly. **Pedal Fwd** should change from OFF to ON, **Pedal Sig 1** voltage should increase, and **Pedal Sig 2** voltage should decrease as the pedal is depressed forward. If not, the traction pedal or its circuit wiring is faulty and should be tested.
- Depress the traction pedal in the reverse direction slowly. **Pedal Rev** should change from OFF to ON, **Pedal Sig 1** voltage should decrease, and **Pedal Sig 2** voltage should increase as the pedal is depressed rearward. If not, the traction pedal or its circuit wiring is faulty and should be tested.
- When the traction pedal is released, the pedal should return to neutral as indicated by both **Pedal Fwd** and **Pedal Rev** being OFF. If not, the traction pedal may require re-calibration.
- **TRXN 1 Logic V**, **TRXN 2 Logic V**, and **TRXN 3 Logic V** (if equipped with optional 3WD) should each display 48V system voltage. If not, an issue with the logic circuit wiring or the logic relay may exist.
- When the vehicle is stationary, **TRXN 1 Speed**, **TRXN 2 Speed**, and **TRXN 3 Speed** (if equipped with optional 3WD) should display 0.0 mph/kph. When the vehicle is traveling in a straight line, the traction speeds displayed should be approximately the same. If not, the traction motors may require re-calibration.
- **TRXN 3 Bus V** (if equipped with optional 3WD) should display 48V system voltage. If not, an issue with the power supply circuit wiring to the optional 3WD motor may exist.

Using the Outputs Screen

Note: An inappropriate output reading may indicate an issue with the controller. Contact your Authorized Toro Distributor for assistance with controller reprogramming or replacement.

• Once the required conditions are satisfied (operator in the seat and manual parking brake disengaged), **Pbrake Release** should be ON, indicating the automatic parking brake is disengaged (brake actuator energized). If the operator raises out of the seat or the manual parking brake is engaged, **Pbrake Release** should be OFF, indicating the automatic parking brake is engaged (brake actuator de-energized). If the output reading is appropriate and the vehicle does not perform correctly, the brake actuator or its circuit wiring may be faulty and should be tested.

Troubleshooting General Operation Problems

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage. Model 04580 machines have a separate batteries for the 12 VDC system and the 48 VDC system.

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components that are used on this machine; refer to the Electrical Schematics in Appendix A (page A–1).

If the machine has any interlock switches that are bypassed, connect the switches for correct troubleshooting and safety.

Power-Up Troubleshooting—Greensmaster 3360 (Model 04580)

Many aspects of machine and component operation are visible using the InfoCenter; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). Machine faults may also appear on the InfoCenter display to assist in troubleshooting.

Problem	Possible Cause	Corrective Action
Nothing happens when the key switch is set to the ON position	A fuse or the circuit wiring is damaged.	Test the 15A fuse located in fuse holder 1 under the right side cover.
		Test the 7.5A fuse located in fuse holder 2 under the right side cover.
	The key switch or circuit wiring is damaged.	Test the key switch.
		The battery cables are corroded or damaged. Clean, repair, or replace the cables as necessary.
	The 12V AGM battery is discharged or damaged.	Charge the battery and replace if necessary.
The engine cranks but does not start.	The fuel level is low.	Fill the fuel tank.
	The fuel pump is damaged.	Test the fuel pump; refer to the Kawasaki engine Service Manual.
	A fuel hose is restricted or damaged.	Repair, or replace the fuel hoses necessary.
	The fuel solenoid or circuit wiring is damaged.	Test the fuel solenoid; refer to the Kawasaki engine Service Manual.
	The engine relay or circuit wiring is damaged (ignition circuit remains grounded).	Test the engine relay and replace if necessary.

Power-Up Events—Greensmaster 3360 (Model 04590)

A series of events occur to power-up the machine prior to operating the steering, traction, lift/lower, and cutting unit functions. The events are explained here to assist with troubleshooting a machine that does not power-up correctly. Many aspects of machine operation are visible for troubleshooting using the InfoCenter; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). Machine faults codes may also appear on the InfoCenter display to assist in troubleshooting. If a machine has an issue that prevents the InfoCenter from powering up, the InfoCenter will not be available to aid in troubleshoot the machine.

Note: The events in bold for steps through 7 must occur to power up the InfoCenter display.

Key Switch in the OFF Position:

- A signal wire from the SC8: Lithium-ion battery controller (BMS) Pack Sig+ terminal provides a low current 48 VDC signal to the key switch D terminal.
- Except for the lithium-ion battery cables, the Pack Sig+ signal wire carries the only live voltage on the machine when the key switch is in the OFF position.

1. **Ensure that the battery-cable connector is plugged into the 60V connector of the machine.**
2. **Key Switch in the ON Position—key switch terminals D and E close, and the Pack Sig+ signal voltage passes through the key switch to the BMS Ignition terminal to wake the BMS.**
3. **The 48V batteries Connect to the Machine—the BMS quickly polls the lithium-ion batteries condition. If the batteries are within specification, the BMS energizes an internal contactor to supply 48V battery power through the supply cables to the 48V battery disconnect.** Listen for the ***"Click"*** from the BMS to quickly confirm internal contactor operation.
4. **The 48V Circuits Energize—48V power passes through the 175A mega fuse located below the battery disconnect.**
   - 48V should be available at the T6: precharge controller Logic input (connector P03 pin 6) to wake-up the precharge controller.
   - 48V should pass through the 5A fuse in the 48V fuse block under the operator's seat and be available at terminal 30 of the logic relay (connector P47 pin 1).
   - 48V bus should pass through the 30A fuse in the 48V fuse block under the operator's seat and be available to power the SC7: steering motor (connector P46 pins 3, 4 and 5). This is the 48V bus power supply for the steering motor controller.
   - 48V power should be available at the main contactor and the traction motor contactor E terminal (left side main terminal).
   - **48V should pass through the 10A fuse in the 48V fuse block under the operator's seat, and 48V is available at voltage converter.**
5. **Voltage Converter and Shutdown Relay—12V should become available at the 48 VDC/12 VDC converter output (connector P07 pin 2).**
   - **12V should pass to 15A fuse in fuse holder 1 the shutdown relay (connector P13, pin 1).**
   - **48V should become available at the shutdown relay coil (connector P13, pin 2).**
   - **12V should pass from the shutdown relay (connector P13, pin 4) to the 15A fuse in 12V fuse holder 1 under the right side cover.**.

6. **Key Switch Ground Circuits—**the key switch terminals B and C close (creating a path to ground).
   - The key switch provides a path to ground for the T6: precharge controller Key Start and Key On inputs (connector P02 pins 1 and 2). These connections allow the precharge controller to start the precharge function.
   - **The key switch provides a path to ground for terminal 85 of the shutdown delay relay (connector P13, pin 2), energizing the relay coil.**
7. **The following 12V power circuits energize:**

   Note: Except for 12V power to the T1: primary controller Logic input, 12V control system power is made available to the machine through the shutdown delay relay.

   - 2A fuse in 12V FUSE-HOLDER 2 (under the right side cover) and Telematics connector (connector P71 pin 2)
   - 10A fuse in 12V FUSE-HOLDER 2 (under the right side cover) and the brake actuator relay terminal 30 (connector P75 pin 1)
   - **7.5A fuse in 12V fuse holder 2 (under the right side cover) and InfoCenter Display (connector P52 pin 2)**
   - 15A fuse in 12V fuse holder 1, through the 2A fuse in 12V fuse holder 1, and to the T1: primary controller Logic input (connector P01 pin 40) to wake-up the primary controller.
   - CAN bus isolation module (connector P50 pin A)
   - Parking brake switch (connector P06 pin A).
   - T1: primary controller PWR 2 and PWR 5 terminals (connector P01 pins 9 and 37)
   - T1: primary controller Key On input (connector P01 pin 25 and 37)
8. **Cutting Unit and Secondary Controller Logic Power—**The T1: primary controller output OUT 1 supplies power to the logic relay. 12V should be available at terminal 85 of the logic relay (connector P47 pin 5) energizing the relay coil.

   The following 48V logic power circuits energize:

   - T2: cutting unit 1 (center) motor controller (connector P24 pin 1)
   - T3: cutting unit 2 (left) motor controller (connector P26 pin 1)
   - T4: cutting unit 3 (right) motor controller (connector P22 pin 1)
   - The optional T5: traction 3 motor controller (connector P19 pin 1)
   - SC2: lift/lower 1 (center) actuator controller (connector P62 pin 2)
   - C3: lift/lower 2 (left) actuator controller (connector P61 pin 2)
   - SC4: lift/lower 3 (right) actuator controller (connector PX59 pin 2)
   - SC7: steering motor/controller (connector P46 pin 15)
9. **Precharge Controller—**The T6: precharge controller supplies precharge power to the following components:
   - T2: cutting unit 1 (center) motor controller
   - T3: cutting unit 2 (left) motor controller
   - T4: cutting unit 3 (right) motor controller
   - Optional T5: traction 3 motor controller

   If precharge is successful, the T1: primary controller sends a CAN message to the T6: precharge controller to close the main contactor.

   - The precharge controller uses the output OUT 2 to provide a path to ground for the main contactor B terminal (right side main terminal), which energizes the contactor coil.

Note: Listen for the ***"Click"*** from the main contactor to quickly confirm contactor operation.

- 48V bus power should be available at the cutting unit motor controllers, the optional 3WD traction motor controller, and at the lift/lower actuator controllers.

10. **Steering and Traction—**If the steering and traction systems are calibrated, the SC5: traction 1 (right) motor controller will close the traction motor contactor.

    - The traction motor controller uses the output NMC to provide a path to ground for the traction motor contactor B terminal (right side main terminal) to energize the contactor coil.

      Note: Listen for the ***"Click"*** from the traction motor contactor to quickly confirm contactor operation.

    - 48V bus power should be available at each of the front traction motor controllers.

Power-Up Troubleshooting—Greensmaster 3370 (Model 04590)

Problem	Possible Cause	Corrective Action
Nothing happens when the key switch is set to the ON position	The 48V battery disconnect is not connected or is connected to the battery charger.	Connect the 48V battery disconnect.
	The lithium-ion battery controller (BMS) is not communicating with all the lithium-ion batteries using the battery interface harness.	Ensure the battery interface harness is not damaged and that all battery interface harness connections are clean and secure.
	The key switch or circuit wiring is damaged.	Test the key switch
	The main fuse or circuit wiring is damaged.	Test the 175A mega fuse located below the battery disconnect.
	The 48V shutdown delay relay fuse or circuit wiring is damaged.	Test the 10A fuse in the 48V fuse block under the operator's seat.
		Check for 48 VDC at the shutdown delay relay (connector P13 pin 5).
		Check for ground at the shutdown delay relay (connector P13 pin 2).
	The 48V 48 VDC/12 VDC converter fuse or circuit wiring is damaged.	Test the 10A fuse in the 48V fuse block under the operator's seat.
		Check for 48 VDC at the 48 VDC/12 VDC converter (connector P07 pin 4).
	The 12V shutdown delay relay fuse or circuit wiring is damaged.	Test the 15A fuse in the 12V fuse holder 1 under the right side cover.
		Check for 12 VDC at the shutdown delay relay (connector P13 pin 1).
	The 12V control system fuse or circuit wiring is damaged.	Test the 7.5A fuse in the 12V fuse holder 2 under the right side cover.
		Check for 12 VDC at the InfoCenter Display (connector P52 pin 2).
	The shutdown delay relay is damaged.	Test the shutdown delay relay and replace if necessary.
	The 48 VDC/12 VDC converter is damaged.	Test the 48 VDC/12 VDC converter and replace if necessary.
	The SC8: lithium-ion battery controller (BMS) is damaged.	Replace and reprogram the lithium-ion battery controller (contact an Authorized Toro Distributor for assistance).

Power-Up Events—Greensmaster 3370 (Model 04591)

A series of events occur to power-up the machine prior to operating the steering, traction, lift/lower, and cutting unit functions. The events are explained here to assist with troubleshooting a machine that does not power-up correctly. Many aspects of machine operation are visible for troubleshooting using the InfoCenter; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). Machine fault codes may also appear on the InfoCenter display to assist in troubleshooting. If a machine has an issue that prevents the InfoCenter from powering up, the InfoCenter will not be available to aid in troubleshoot the machine.

Note: The events in bold for Steps 1 through 7 must occur to power up the InfoCenter display.

Key Switch in the OFF Position—A signal wire from the TB: Leader battery BMS Bat+ Sig Rail terminal provides a low current 48 VDC signal to the key switch D terminal.

Note: Except for the lithium-ion battery cables, the Bat+ Sig Rail signal wire carries the only live voltage on the machine when the key switch is in the OFF position.

1. **Ensure that the battery-cable connector is plugged into the 60V connector of the machine.**
2. **Key Switch in the ON Position—key switch terminals D and E close, and the Bat+ Sig Rail signal voltage passes through the key switch to the BMS Leader battery WAKEUP terminal to wake the BMS.**
   A. **The discharge FET of the Leader battery closes, and 48V power flows to the 175A fuse under the charge port cover.**
   B. **48V power flows from the 175A fuse to the voltage converter.**.
   C. **12V power flows from the voltage converter to the power logic pin of the primary controller.**
3. **The 48V Batteries Connect to the Machine—the primary controller and Leader battery exchange messages, and the Primary Controller signals the Support batteries to close their discharge FETs.**
4. **The 48V Circuits Energize—48V power passes through the 175A mega fuse located below the battery disconnect.**
   - 48V should be available at the T6: precharge controller Logic input (connector P03 pin 6) to wake-up the precharge controller.
   - 48V should pass through the 5A fuse in the 48V fuse block under the operator's seat and be available at terminal 30 of the logic relay (connector P47 pin 1).
   - 48V bus should pass through the 30A fuse in the 48V fuse block under the operator's seat and be available to power the SC7: steering motor (connector P46 pins 3, 4 and 5). This is the 48V bus power supply for the steering motor controller.
   - 48V power should be available at the main contactor and the traction motor contactor E terminal (left side main terminal).
   - **48V should pass through the 10A fuse in the 48V fuse block under the operator's seat, and 48V is available at voltage converter.**
5. **Voltage Converter and Shutdown Relay—12V should become available at the 48 VDC/12 VDC converter output (connector P07 pin 2).**

- **12V should pass to 15A fuse in fuse holder 1 the shutdown relay (connector P13, pin 1).**
- **48V should become available at the shutdown relay coil (connector P13, pin 2).**
- **12V should pass from the shutdown relay (connector P13, pin 4) to the 15A fuse in 12V fuse holder 1 under the right side cover.**.

6. **Key Switch Ground Circuits—**the key switch terminals B and C close (creating a path to ground).
   - The key switch provides a path to ground for the T6: precharge controller Key Start and Key On inputs (connector P02 pins 1 and 2). These connections allow the precharge controller to start the precharge function.
   - **The key switch provides a path to ground for terminal 85 of the shutdown delay relay (connector P13, pin 2), energizing the relay coil.**
7. **The following 12V power circuits energize:**

   Note: Except for 12V power to the T1: primary controller Logic input, 12V control system power is made available to the machine through the shutdown delay relay.

   - 2A fuse in 12V FUSE-HOLDER 2 (under the right side cover) and Telematics connector (connector P71 pin 2)
   - 10A fuse in 12V FUSE-HOLDER 2 (under the right side cover) and the brake actuator relay terminal 30 (connector P75 pin 1)
   - **7.5A fuse in 12V fuse holder 2 (under the right side cover) and InfoCenter Display (connector P52 pin 2)**
   - 15A fuse in 12V fuse holder 1, through the 2A fuse in 12V fuse holder 1, and to the T1: primary controller Logic input (connector P01 pin 40) to wake-up the primary controller.
   - CAN bus isolation module (connector P50 pin A)
   - Parking brake switch (connector P06 pin A).
   - T1: primary controller PWR 2 and PWR 5 terminals (connector P01 pins 9 and 37)
   - T1: primary controller Key On input (connector P01 pin 25 and 37)
8. **Cutting Unit and Secondary Controller Logic Power—**The T1: primary controller output OUT 1 supplies power to the logic relay. 12V should be available at terminal 85 of the logic relay (connector P47 pin 5) energizing the relay coil.

   The following 48V logic power circuits energize:

   - T2: cutting unit 1 (center) motor controller (connector P24 pin 1)
   - T3: cutting unit 2 (left) motor controller (connector P26 pin 1)
   - T4: cutting unit 3 (right) motor controller (connector P22 pin 1)
   - The optional T5: traction 3 motor controller (connector P19 pin 1)
   - SC2: lift/lower 1 (center) actuator controller (connector P62 pin 2)
   - C3: lift/lower 2 (left) actuator controller (connector P61 pin 2)
   - SC4: lift/lower 3 (right) actuator controller (connector PX59 pin 2)
   - SC7: steering motor/controller (connector P46 pin 15)
9. **Precharge Controller—**The T6: precharge controller supplies precharge power to the following components:
   - T2: cutting unit 1 (center) motor controller
   - T3: cutting unit 2 (left) motor controller
   - T4: cutting unit 3 (right) motor controller

- Optional T5: traction 3 motor controller

If precharge is successful, the T1: primary controller sends a CAN message to the T6: precharge controller to close the main contactor.

- The precharge controller uses the output OUT 2 to provide a path to ground for the main contactor B terminal (right side main terminal), which energizes the contactor coil.

  Note: Listen for the ***"Click"***from the main contactor to quickly confirm contactor operation.

- 48V bus power should be available at the cutting unit motor controllers, the optional 3WD traction motor controller, and at the lift/lower actuator controllers.

10. **Steering and Traction—**If the steering and traction systems are calibrated, the SC5: traction 1 (right) motor controller will close the traction motor contactor.

    - The traction motor controller uses the output NMC to provide a path to ground for the traction motor contactor B terminal (right side main terminal) to energize the contactor coil.

      Note: Listen for the ***"Click"*** from the traction motor contactor to quickly confirm contactor operation.

    - 48V bus power should be available at each of the front traction motor controllers.

Power-Up Troubleshooting—Greensmaster 3370 (Model 04591)

Problem	Possible Cause	Corrective Action
Nothing happens when the key switch is set to the On position	The 48V battery disconnect is not connected or is connected to the battery charger.	Connect the 48V battery disconnect.
	The BMS of the Leader battery is not communicating with all the Support battery BMSs using the CAN harnesses.	Ensure the CAN harnesses are not damaged, and that all CAN harness connections at the batteries are clean and secure.
	The key switch or circuit wiring is damaged.	Test the key switch
	The main fuse or circuit wiring is damaged.	Test the 175A mega fuse located below the battery disconnect.
	The 48V shutdown delay relay fuse or circuit wiring is damaged.	Test the 10A fuse in the 48V fuse block under the operator's seat.
		Check for 48 VDC at the shutdown delay relay (connector P13 pin 5).
		Check for ground at the shutdown delay relay (connector P13 pin 2).
	The 48V 48 VDC/12 VDC converter fuse or circuit wiring is damaged.	Test the 10A fuse in the 48V fuse block under the operator's seat.
		Check for 48 VDC at the 48 VDC/12 VDC converter (connector P07 pin 4).
	The 12V shutdown delay relay fuse or circuit wiring is damaged.	Test the 15A fuse in the 12V fuse holder 1 under the right side cover.
		Check for 12 VDC at the shutdown delay relay (connector P13 pin 1).
	The 12V control system fuse or circuit wiring is damaged.	Test the 7.5A fuse in the 12V fuse holder 2 under the right side cover.
		Check for 12 VDC at the InfoCenter Display (connector P52 pin 2).
	The shutdown delay relay is damaged.	Test the shutdown delay relay and replace if necessary.
	The 48 VDC/12 VDC converter is damaged.	Test the 48 VDC/12 VDC converter and replace if necessary.
	The Leader battery BMS is damaged.	Replace the Leader battery and reprogram the machine.

Troubleshooting a Lithium-Ion Battery-Related Fault

Model 04590 Battery Fault

While a battery-related fault is active, the SC8: lithium-Ion battery controller (BMS) keeps its internal battery contactor open, not allowing battery power to go to the machine. As a result, the machine will not respond (the InfoCenter will not display any information) when the key switch is set to the ON position. The Lithium-Ion Battery Service Wire Harness (page 2–16) is available to assist in identifying a failing battery, or determine if the BMS or battery interface harness is working correctly.

1. Disconnect the battery interface wire harness at the lithium-ion battery controller (BMS).

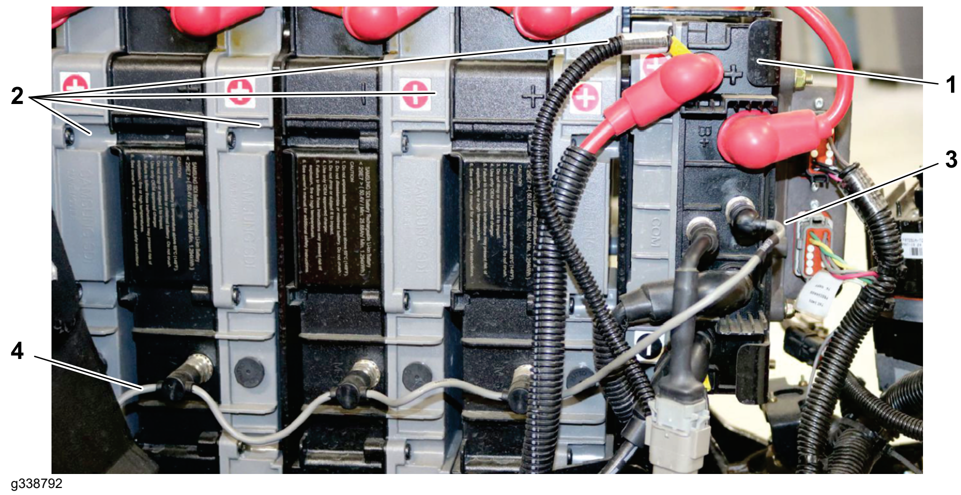


Figure 10

1. Lithium-Ion battery controller (BMS)
2. Batteries (4 of 8 shown)
3. Battery interface harness 9-pin connector (at BMS)
4. Battery interface harness 4-pin connector (at battery)

2. Disconnect the battery interface wire harness from the 4-pin connector on each of the 8 batteries.
3. Connect the 9-pin connector of the battery service wire harness to the battery controller (BMS).
4. Connect the 4-pin connector of the battery service wire harness to one of the batteries.
5. Set the key switch to the ON position.
6. Record the InfoCenter activity (illuminated or not) then set the key switch to the OFF position.
7. Repeat steps 4 – 6 for each of the 8 batteries.
   - If the InfoCenter does not illuminate with one of the batteries but does illuminate with the other 7 batteries, that one battery is likely failing; contact an Authorized Toro Distributor for assistance.
   - If the InfoCenter does not illuminate with any of the 8 batteries, the battery controller (BMS) may be failing, or all the batteries may be too hot or too cold.
   - If the InfoCenter illuminates with each of the 8 batteries, the battery interface wire harness is likely failing.

Troubleshooting a Model 04591 Battery Fault

While a battery-related fault is active, the BMS of an individual battery (Leader or Support) keeps its discharge FET open, not allowing battery power to go to the machine. If the Leader battery cannot close its discharge FET, .most battery faults result in individual batteries not connecting to the 48V bus. If the Leader battery cannot close its discharge FET because of a fault, the InfoCenter will not display information. Contact an Authorized Toro Distributor for assistance.

Aftercut Appearance

There are several factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the cutting unit. It is important to remember that the lower the height-of-cut, the more critical these factors are.

Refer to the *Cutting Unit Operator’s Manual* detailed adjustment procedures. Refer to Chapter 7: DPA Cutting Units (page 7–1) for cutting unit repair information.

Note: For additional information regarding cutting unit troubleshooting, several Reel Mower and Aftercut Appearance General Training Books can be found on the Service Reference Set available from your Authorized Toro Distributor.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
Tire pressure	Check tire pressure of all traction unit tires. Adjust tire pressure as necessary.
Engine RPM and mow speed	For best cutting performance and appearance, the engine should be run at high idle speed while cutting. Check and adjust the high idle speed as necessary; refer to the traction unit *Operator’s Manual*. Use the traction pedal linkage to adjust the actual mow speed; refer to traction unit *Operator’s Manual*.
Reel speed	Use a non-contact tachometer (phototach) to verify reel speed. Make sure that the reel speed setting is correct for the number of blades and mow speed used; refer to the traction unit *Operator’s Manual*.
Bedknife to reel adjustment	Check the bedknife to reel contact daily. The bedknife must have light contact across the entire reel. No contact will dull the cutting edges. Excessive contact accelerates wear of both edges. Quality of cut is adversely affected by both conditions.
Reel and bedknife sharpness	A reel and/or bedknife that has rounded cutting edges or rifling (grooved or wavy appearance) cannot be corrected by tightening the bedknife to reel contact. Grind the reel to remove taper and/or rifling. Grind the bedknife to sharpen and/or remove rifling. The most common cause of rifling is bedknife to reel contact that is too tight. A new bedknife must be ground or backlapped after installation to the bedbar. Refer to Grinding the Bedknife (page 7–12) for grinding information or the traction unit *Operator’s Manual* for backlapping information.
Rear roller level	Reel and rear roller should be parallel for proper cutting performance; refer to Leveling the Rear Roller (page 7–3).
Height-of-cut	Effective or actual height-of-cut depends on the mower weight and turf conditions. Effective height-of-cut will be different than the bench set height-of-cut.
Proper bedknife for height-of-cut desired	If the bedknife is too thick for effective height-of-cut, poor quality of cut will result.
Stability of bedbar	Ensure that the bedbar pivot bolts are securely seated; refer to Bedbar Assembly (page 7–6).
Number of reel blades	Use correct number of blades for clip frequency and optimum height-of-cut range.
Reel bearing condition	Check and replace the reel bearings if necessary; refer to Reel Assembly (page 7–16).

Factors That Can Affect Quality of Cut (continued)

Factor	Possible Problem/Correction
Cutting unit alignment and ground following	Check cutting unit stabilizer springs and suspension ball joints for damage, binding condition, or wear. The ball joint base has a slip fit condition with reference to the suspension, and should be free to rotate. Repair if necessary.
Roller type and condition	A variety of cutting unit rollers are available. Refer to the cutting unit *Parts Manual* for a listing of available accessories, or contact your local Authorized Toro Distributor for additional information. Ensure that the rollers rotate freely. Repair the roller bearings if necessary; refer to Roller Assemblies (page 7–25).
Cutting unit accessories	A variety of cutting unit accessories are available that can be used to enhance aftercut appearance. Refer to the cutting unit *Parts Manual* for a listing of available accessories, or contact your local Authorized Toro Distributor for additional information.

Grooming Performance

There are several factors that can affect the performance of grooming. These factors vary for different golf courses and from green to green. It is important to inspect the turf frequently and vary the grooming practice with turf needs.

IMPORTANT

Improper or overaggressive use of the groomer (e.g., too deep or too frequent grooming) may cause unnecessary stress on the turf leading to severe turf damage. Use the groomer carefully. Read and understand the groomer operation instructions before operating or testing the groomer performance.

It is important to remember that the same factors that affect quality of cut also affect grooming performance.

Variables that Affect the Use and Performance of the Groomer:

1. The growing season and weather conditions.
2. General turf conditions.
3. The frequency of grooming/cutting–number of cuttings per week and how many passes per cutting.
4. The height-of-cut.
5. The grooming depth.
6. The type of grass.
7. The amount of time that a groomer reel has been in use on a particular turf area.
8. The amount of traffic on the turf.
9. The overall turf management program–irrigation, fertilizing, weed control, coring, over-seeding, sand dressing, disease control, and pest control.
10. Stress periods for turf–high temperatures, high humidity, and unusually high traffic.

Universal Groomer Problems (Optional)

Problem	Possible Cause	Corrective Action
The groomer reel does not rotate.	The groomer drive is in neutral.	Engage the groomer drive to forward or reverse.
	The groomer drive gears are damaged or seized.	Repair the groomer drive.
	The drive between the groomer and the reel has separated.	Repair the groomer drive.
The turf is damaged or has uneven grooming.	The groomer is set too aggressively.	Refer to groomer Installation Instructions for groomer set-up information.
	The groomer reel blades are bent, damaged, or missing.	Repair or replace the blades if necessary.
	The groomer reel shaft is bent or damaged.	Replace the groomer reel shaft.
	Grooming depth is not equal on both ends of the groomer reel.	Adjust the depth if necessary. Check and adjust the cutting unit set up (level bed knife to reel, level rear roller to reel, set the height-of-cut, etc.).

Battery Charger Error and Fault Codes (Model 04590)

If a battery charger error or fault appears, additional information may be available by disconnecting the charger, connecting the batteries to the machine, and using the machine InfoCenter to check for any active machine faults.

Problem	Possible Cause	Corrective Action
Codes E-0-0-1, or E-0-4-7	Battery high voltage	Ensure that the battery voltage is correct, and the cable connections are secure.
		Ensure that the battery is in good condition.
Code E-0-0-4	Lithium-ion battery controller (BMS) or battery fault detected	Contact an Authorized Toro Distributor for assistance.
Code E-0-0-7	Battery amp hour limit exceeded	Check all battery cable connections for corrosion or damage. Clean and repair battery connections as necessary.
		Batteries may be deeply discharged. Battery replacement may be necessary.
		Disconnect and connect the charger to the batteries to reset this error.
Code E-0-1-2	Reverse polarity error	Ensure that the battery cables are connected correctly and that the cable connections are clean and secure.
Code E-0-2-3	High AC voltage error (greater than 270 VAC)	Connect the charger to an AC power source that provides stable AC power between 85 - 270 VAC at 45-65 Hz.
Code E-0-2-4	Charger failed to initialize	Disconnect the charger AC input and battery connections for 30 seconds, then reconnect the charger.
Code E-0-2-5	Low AC voltage oscillation error	The charger requires an AC power source that provides stable AC power between 85 - 270 VAC at 45-65 Hz. Confirm the AC power supply capacity and verify AC input cable gauge.
Code E-0-3-7	Re-programming failed	Software upgrade failure or script operation failure. Ensure that the new software is correct.
Codes E-0-2-9, E-0-3-0, E-0-3-2, E-0-4-6, or E-0-6-0	Communication error with battery	Ensure that the connection of the signal wires to each battery is clean and secure.
Codes F-0-0-1, F-0-0-2, F-0-0-3, F-0-0-4, F-0-0-5, F-0-0-6, or F-0-0-7	Internal charger fault	Remove the charger AC connection and battery connection for a minimum of 30 seconds, then reconnect the charger.
		The battery charger may require replacement (contact an Authorized Toro Distributor for assistance).

Battery Charger Error and Fault Codes (Model 04591)

The battery charger for machine Model 04591 does not display errors or fault codes. When battery charging fault codes occur, the InfoCenter of the machine displays the codes.

Engine (Model 04580)

Table of Contents

Additional Reference Materials

Kawasaki FS481V Service Manual

General Information

This chapter provides information about the gasoline engine used in the Greensmaster eTriFlex machine. The general maintenance procedures are described in the engine *Operator's Manual*. Detailed information on engine troubleshooting, testing, disassembly, and assembly is identified in the *Kawasaki FS481V Service Manual*.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the *Kawasaki FS481V Service Manual*. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

Service and repair parts for Kawasaki FS481V engines are supplied through your local Toro Distributor. If no parts list is available, be sure to provide your distributor with the Toro model and serial number along with the engine model and serial number.

Traction Unit Operator's Manual

The traction unit *Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for your machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Kawasaki Owner's Manual

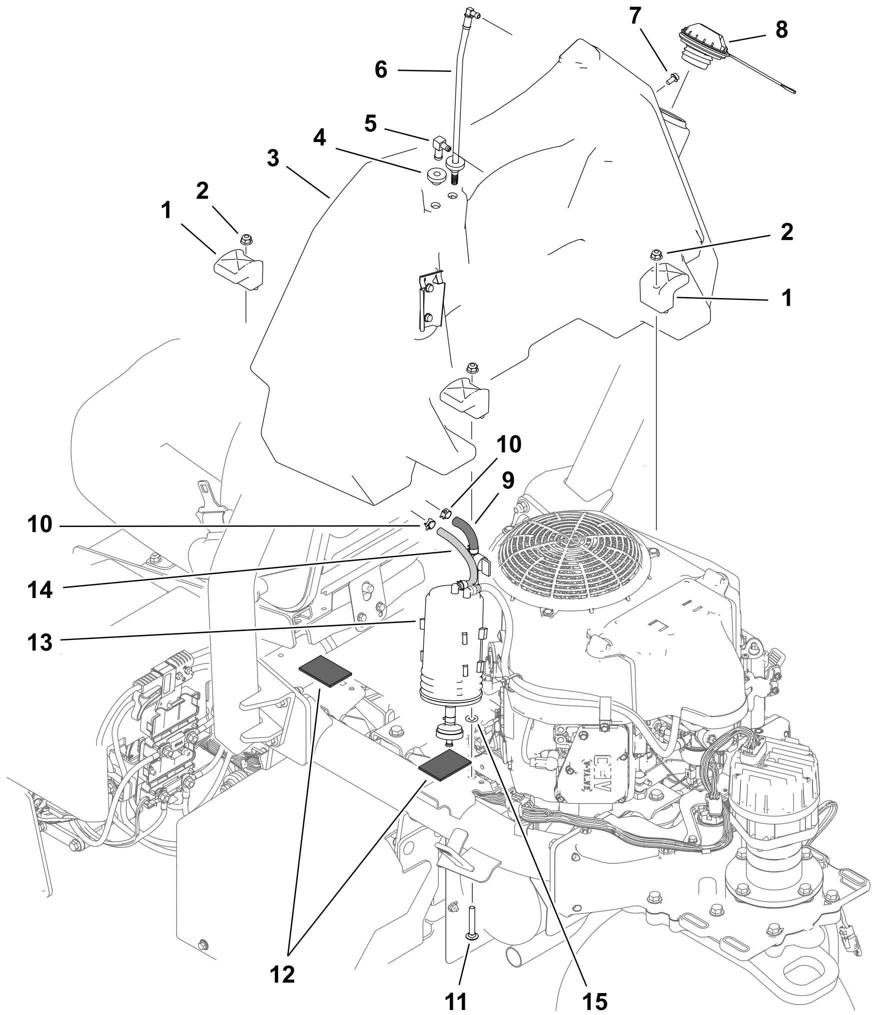
The engine that powers the Greensmaster eTriFlex machine is a Kawasaki Model FS481V engine. A copy of the *Kawasaki FS481V Owner's Manual* is supplied with the machine. Additional copies of the engine Owner's Manual are available for download at www.kawasakienginesusa.com.

Kawasaki Service Manual

The engine that powers the Greensmaster eTriFlex machine is a Kawasaki Model FS481V engine. The *Kawasaki FS481V Service Manual* is available for this engine. Ensure that the correct engine manual is used when servicing the engine on your machine.

Service and Repairs

Fuel Tank



g286303

Figure 11

1. Clamp (4 each)
2. Flange nut (4 each)
3. Fuel tank
4. Bushing (2 each)
5. Vent fitting
6. Standpipe
7. Cap screw
8. Fuel cap
9. Fuel supply hose
10. Hose clamp (2 each)
11. Carriage bolt (4 each)
12. Foam pad (4 each)
13. Carbon canister assembly
14. Fuel vent hose
15. Push nut (4 each)

DANGER

Gasoline is highly flammable and explosive. A fire or an explosion from the fuel can burn you, burn other people, and damage property.

- **Use caution whenever you store or handle gasoline.**
- **Do not smoke while handling gasoline.**
- **Do not fill the fuel tank while the engine is running, while the engine is hot, or when the machine is in an enclosed area.**
- **Always fill the fuel tank outside and wipe up any spilled gasoline before starting the engine.**
- **Store gasoline in a clean, safety-approved container and keep the cap in place.**
- **Use gasoline as an engine fuel only, not for any other purpose.**

CAUTION

The muffler and exhaust manifold may be hot. To avoid possible burns, allow exhaust system to cool before working on the engine.

Removing the Fuel Tank

Refer to Figure 11 for this procedure.

1. Park the machine on a level surface, lower the cutting units, shut off the engine, remove the key from the key switch and unplug the 48V battery disconnect.
2. Open or remove the hood; refer to Removing and Installing the Hood Assembly (page 6–42).
3. Close the fuel shut-off valve.
4. Allow the engine to completely cool.
5. Use a siphon or pump to empty the fuel tank.
6. Disconnect the fuel vent hose and fuel supply hose from the top of the fuel tank.
7. Lift the evaporative control system carbon canister from its bracket on the fuel tank.
8. Remove the four flange nuts and clamps securing the fuel tank to the vehicle frame and remove the fuel tank.
9. Inspect the foam pads at the fuel tank mounts and replace them if damaged.

Installing the Fuel Tank

Refer to Figure 11 for this procedure.

1. Secure the fuel tank to the vehicle frame with the clamps and flange nuts previously removed.
2. Secure the evaporative control system carbon canister in its bracket on the fuel tank.
3. Connect the fuel supply hose to the top of the fuel tank and secure with the hose clamp.
4. Connect the fuel vent hose to the top of the fuel tank and secure with the hose clamp. Make sure that the hose is not kinked or obstructed.

Installing the Fuel Tank (continued)

5. Check the fuel tank position and adjust if necessary:
   A. Install and lower the hood.
   B. The fuel tank should be aligned (square) with the front edge of the hood.
   C. Loosen the fuel tank clamps and adjust the tank position if necessary.
   D. Ensure the engine does not contact the back of the fuel tank and tighten the fuel tank clamp fasteners.
6. Fill the fuel tank with fuel and open the fuel shut-off valve.
7. Connect the 48V battery disconnect.
8. Start the engine and check the fuel system for leaks. Repair any leaks as necessary before returning the machine to service.

Checking the Fuel Lines and Connections

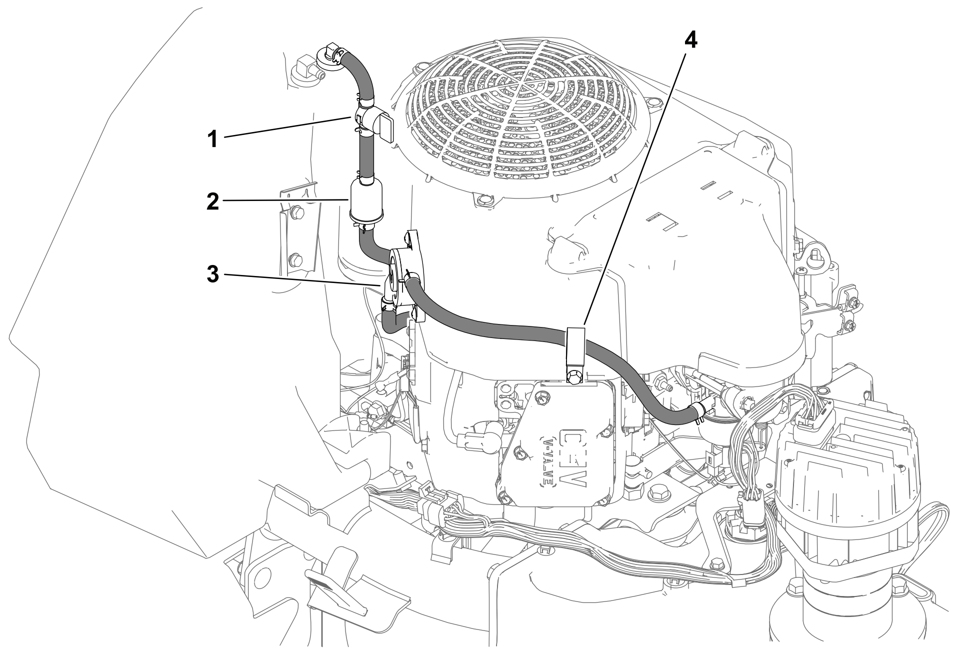


Figure 12

(shown with evaporative control system removed)

1. Fuel shut-off valve
2. Fuel filter
3. Fuel pump
4. Clamp

Check the fuel lines and connections at the scheduled maintenance intervals recommended in the *Traction Unit Operator's Manual*. Check the lines for deterioration, damage, leaks, or loose connections. Replace the hoses, clamps, and fittings as necessary.

Evaporative Control System

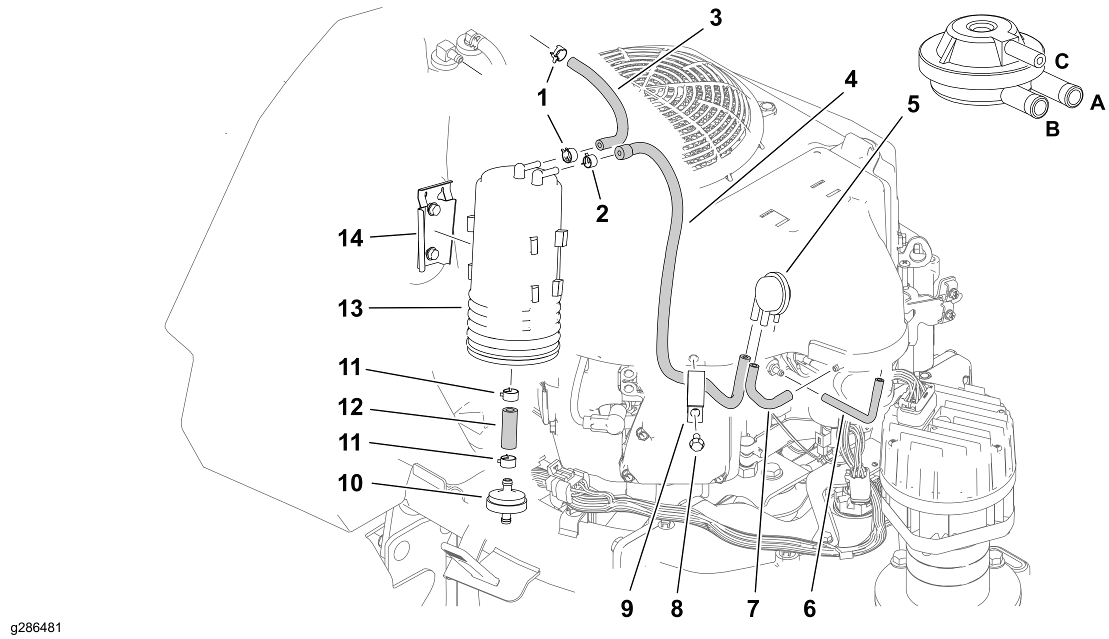


Figure 13

1. Hose clamp (2 each)
2. Hose clamp
3. Vent hose (tank to canister)
4. Vent hose (canister to valve)
5. Vacuum valve
6. Vent hose (valve to intake manifold)
7. Vent hose (valve to intake tube)
8. Cap screw
9. Clamp
10. Fresh air filter
11. Hose clamp (2 each)
12. Vent hose (fresh air filter)
13. Carbon canister
14. Canister bracket

Greensmaster eTriFlex model 04580 machines are equipped with a fuel evaporative control system designed to collect and store evaporative emissions from the fuel tank. The evaporate control system uses a carbon canister and a series of vent hoses to collect these evaporative emissions. The fuel tank uses a non-vented fuel cap. A fuel tank vent fitting is positioned in the top of the tank that allows tank venting through a carbon canister mounted on the fuel tank. Fuel vapors from the fuel tank are vented to the canister and consumed by the engine when the engine is running.

A vacuum control valve located near the air intake tube is used to control evaporative emission flow through the system. The carbon canister is connected to both the fuel tank vent and the vacuum control valve. When the engine is running, engine intake vacuum unseats the vacuum control valve which then allows vapors from the canister to flow to the engine air intake tube. These vapors are then consumed during engine operation. When the engine is not running, evaporative vapors remain in the fuel tank and carbon canister.

Note: If there is restriction in the carbon canister, the fuel tank vent fitting or the vent hose, the fuel tank may distort due to venting issues. If the fuel tank returns to its normal shape when the fuel cap is removed, restriction in the evaporative control system is likely.

1. Inspect the carbon canister and attached hoses for damage or leaks. A damaged or leaking canister should be replaced.
2. Ensure the fresh air filter below the carbon canister is not blocked.
3. Ensure all evaporative control system hoses are not kinked or pinched and are secured at each end with hose clamps.

Evaporative Control System (continued)

4. Test the operation of the vacuum control valve. The valve should open (allow flow between ports A and B) when **21 to 29 mm Hg (0.8 to 1.1 inch Hg)** vacuum is applied to port C.

5. Repair or replace evaporative system components as necessary.

Cooling System

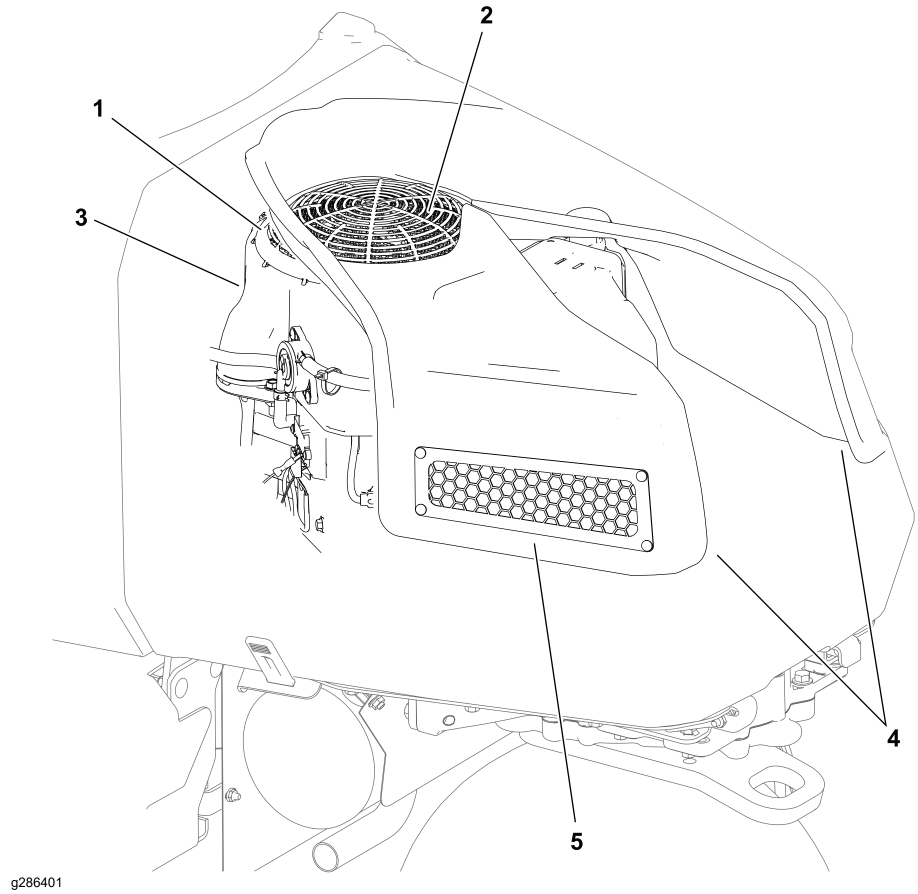


Figure 14

1. Screen guard
2. Rotating screen (under screen guard)
3. Blower housing
4. Air ducts (in hood)
5. Air duct screen (in hood)

IMPORTANT

The engine that powers the eTriFlex model 04580 machine is air-cooled. Operating the engine with dirty or plugged cooling fins, a blocked screen guard or rotating screen, a plugged or dirty blower housing, or plugged intake screens or ducts in the hood may result in the engine overheating and cause engine damage.

To ensure proper engine cooling, make sure the screen guard, rotating screen, cooling fins and other external surfaces of the engine are always kept clean. Perform the following maintenance procedure at the interval specified in the traction unit *Operator's Manual*.

1. Park the machine on a level surface, lower the cutting units, shut off the engine, remove the key from the key switch and unplug the 48V battery disconnect.

Cooling System (continued)

CAUTION

The engine and exhaust system may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the engine.

IMPORTANT

Never clean engine with pressurized water. Water could enter and contaminate the fuel system.

2. Carefully clean the area around the cooling fins on both cylinder heads.
3. Clean the screen guard and blower housing of dirt and debris
4. If necessary, remove the screen guard from the blower housing and clean the rotating screen that is attached to the flywheel.
5. If necessary, remove the blower housing from the engine for complete cooling system cleaning.

IMPORTANT

Never operate engine without the blower housing installed. Overheating and engine damage may result.

6. Make sure rotating screen, blower housing and screen guard are reinstalled to the engine if removed.
7. Clean any debris from the screens and air ducts in the hood.

Exhaust System

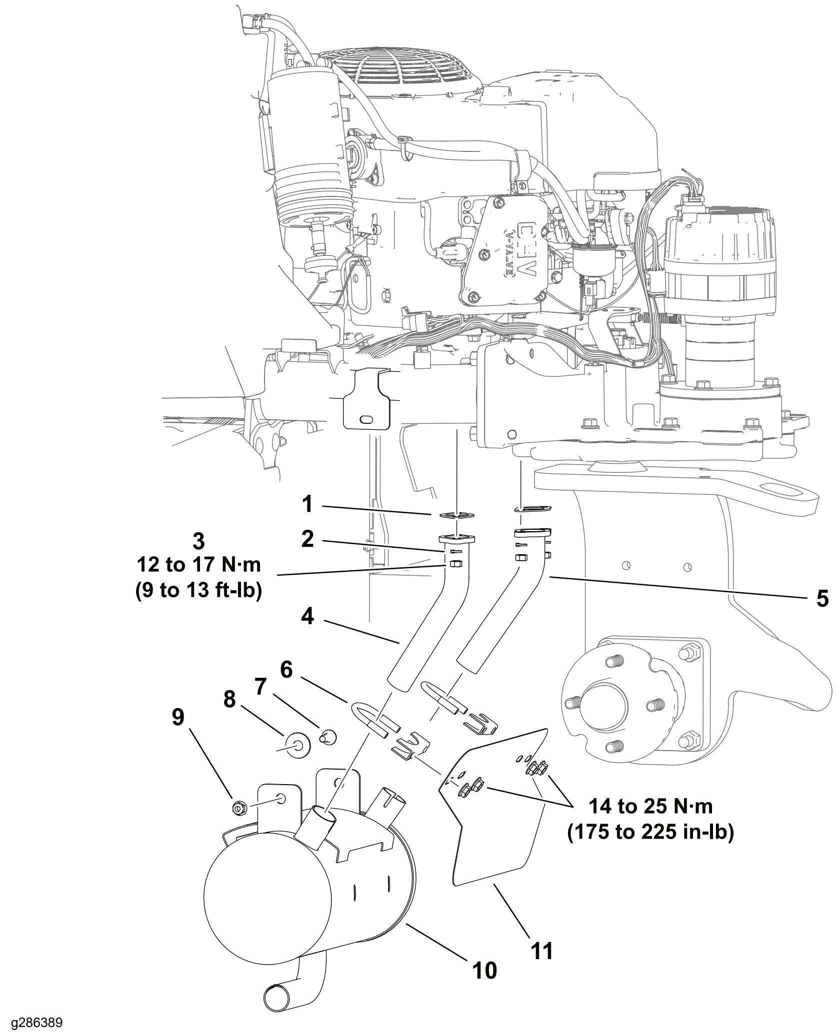


Figure 15

1. Exhaust gasket (2 each)
2. Lock washer (4 each)
3. Hex nut (4 each)
4. Exhaust pipe – LH
5. Exhaust pipe – RH
6. Muffler clamp (2 each)
7. Shoulder screw (2 each)
8. Conical washer (2 each)
9. Flange nut (2 each)
10. Muffler
11. Heat shield

Removing the Exhaust System

CAUTION

The engine and exhaust system may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the engine.

1. Park the machine on a level surface, lower the cutting units, shut off the engine, remove the key from the key switch and unplug the 48V battery disconnect.

Removing the Exhaust System (continued)

2. Remove the hood and rear wheel assembly for additional clearance if desired; refer to Removing and Installing the Hood Assembly (page 6–42) and Removing and Installing the Wheels (page 6–9).
3. Remove the fasteners securing the muffler to the engine frame.
4. Remove the fasteners securing the exhaust pipes to the cylinder heads, and remove the muffler assembly from the machine. Retrieve the two conical washers from the muffler brackets. Retrieve and discard the exhaust gaskets.
5. Continue to dismantle the muffler assembly as needed.
6. Remove any gasket material from the exhaust pipes or cylinder heads.

Installing the Exhaust System

1. Loosely assemble the muffler, exhaust pipes, clamps and heat shield.
2. Use new exhaust gaskets and fit the muffler assembly to the machine.
3. Install all the fasteners used to secure the muffler assembly loosely. Ensure the conical washer is installed between the muffler brackets and the engine frame brackets in the direction shown; refer to Figure 16.

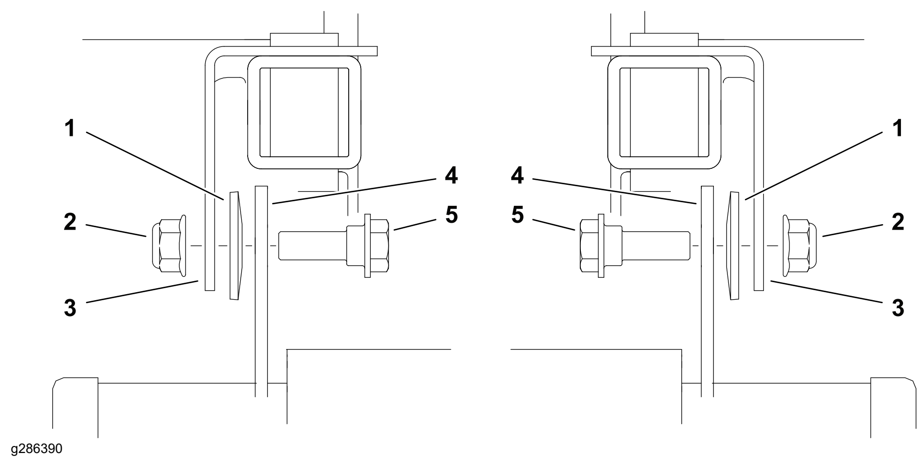


Figure 16

1. Conical washer
2. Flange nut
3. Engine frame bracket
4. Muffler bracket
5. Shoulder screw

---

4. Secure the muffler assembly to the machine:

   A. Tighten the fasteners at the cylinder heads from **12 to 17 N·m (9 to 13 ft-lb)**.

   B. Tighten the muffler clamp fasteners from **14 to 25 N·m (175 to 225 in-lb)**.

   C. Tighten the muffler bracket fasteners.

5. Install the rear wheel assembly; refer to Removing and Installing the Wheels (page 6–9)
6. Install the hood assembly; refer to Removing and Installing the Hood Assembly (page 6–42).

Engine

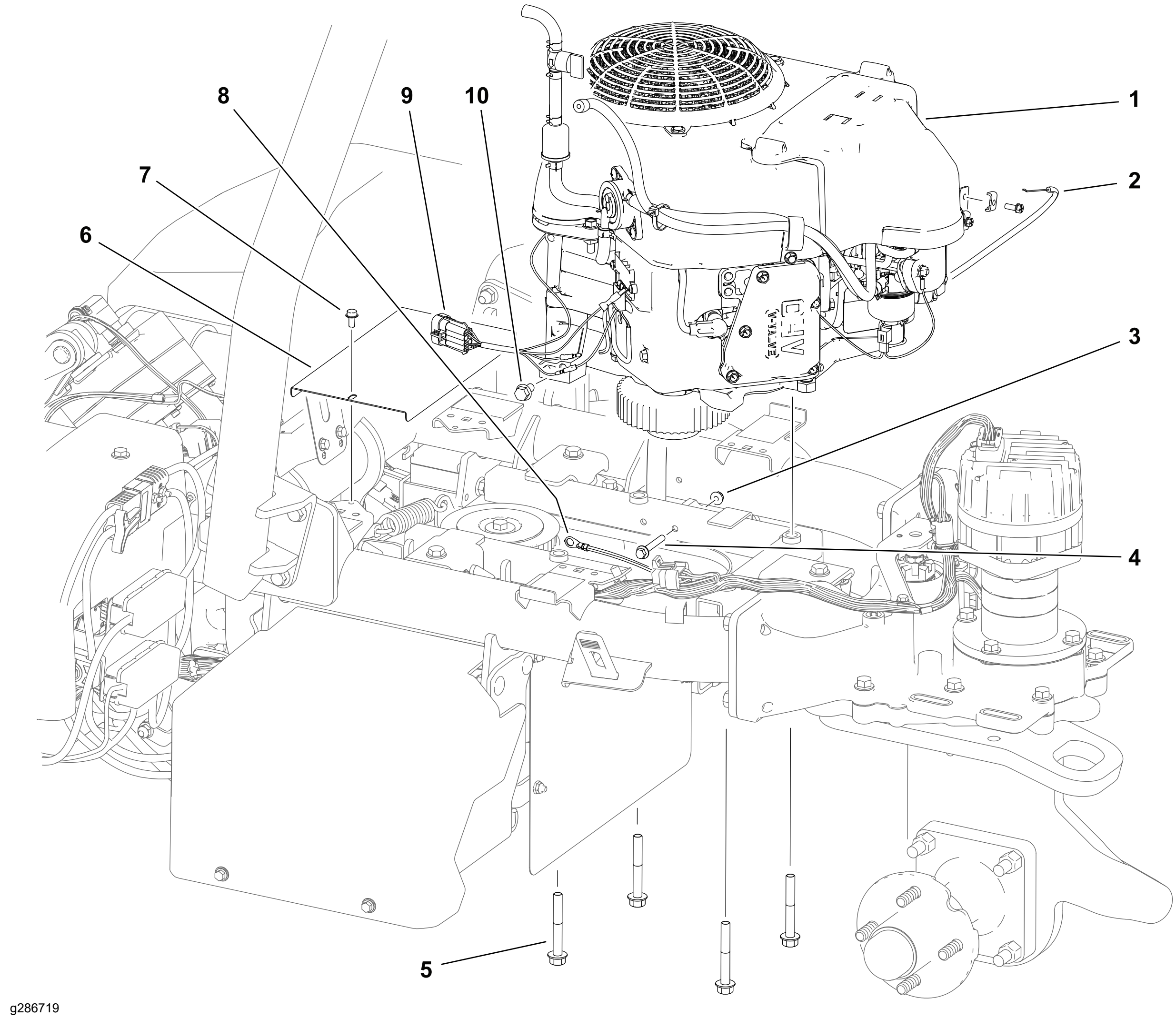


Figure 17

1. Engine assembly
2. Choke cable
3. Flange nut (2 each)
4. Cap screw (2 each)
5. Cap screw (4 each)
6. Pulley cover
7. Cap screw (2 each)
8. Wire harness ground wire (at engine block)
9. Wire harness connector
10. Cap screw (ground)

Removing the Engine

Refer to Figure 17 for this procedure.

1. Park the machine on a level surface, lower the cutting units, shut off the engine, remove the key from the key switch and unplug the 48V battery disconnect.
2. Disconnect the negative (–) battery cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
3. Remove the exhaust system; refer to Removing the Exhaust System (page 4–11).
4. Remove the fuel tank; refer to Removing the Fuel Tank (page 4–5).
5. Remove the evaporative control system carbon canister from the machine.

Removing the Engine (continued)

6. Disconnect the electrical system wiring from the engine:
   - The engine wire harness connector at the main wire harness (left side of engine). Check the engine and the harness connector for damage or corrosion and clean or repair as necessary.
   - The wire harness ground at the engine (near front left engine mount).
7. Disconnect the choke cable from the engine.
8. Remove the clamp securing the engine oil drain hose to the right side battery tray.
9. If the engine is being removed from the machine separately, proceed to step10 of this procedure. If the entire engine frame assembly (including the starter/generator) is being removed:

Removing the Engine (continued)

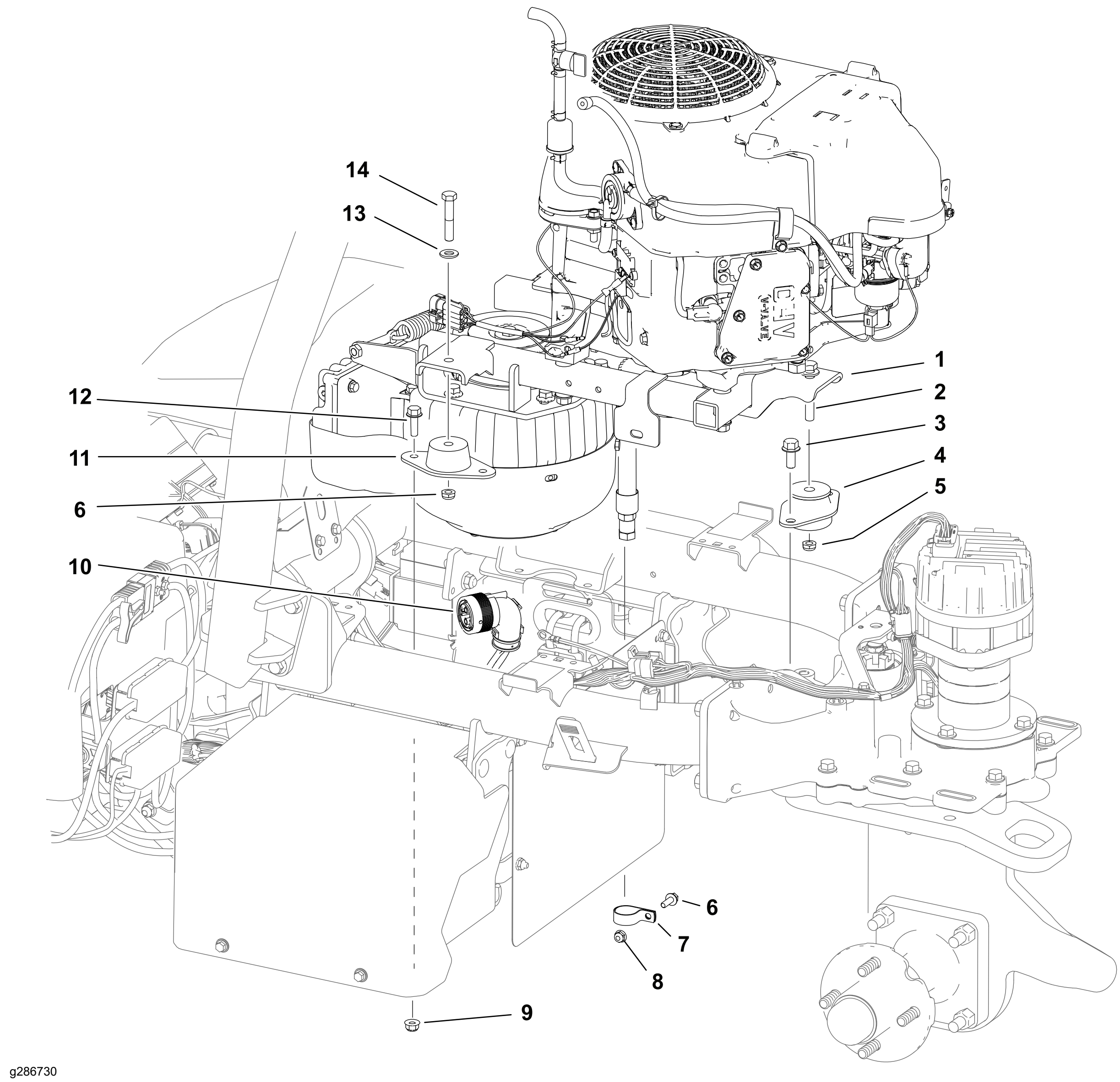


Figure 18

1. Engine frame assembly
2. Cap screw
3. Cap screw (2 each)
4. Isolating mount – rear
5. Lock nut (3 each)
6. Cap screw
7. Clamp
8. Lock nut
9. Flange nut (4 each)
10. Wire harness connector
11. Isolating mount – front (2 each)
12. Cap screw (4 each)
13. Flat washer (3 each)
14. Cap screw (2 each)

A. Disconnect the starter/generator from the machine wire harness. Check the starter/generator and the harness connector for damage or corrosion and clean or repair as necessary.

B. Remove the fasteners securing the engine frame assembly to the 3 isolating mounts.

Removing the Engine (continued)

CAUTION

The engine frame assembly weighs approximately 68 kg (150 lb). Use an appropriate lift to remove the engine frame assembly.

C. Remove the engine frame assembly from the machine.

10. Remove the fasteners securing the drip pan to the engine frame (item 3 and 4 in Figure 17).

11. Remove the starter/generator drive belt:

    A. Tilt the Operator seat forward and remove the pulley cover (item 6 in Figure 17).

    B. Loosen the hex nuts and extend the adjustment pin as far as possible to relax the extension spring.

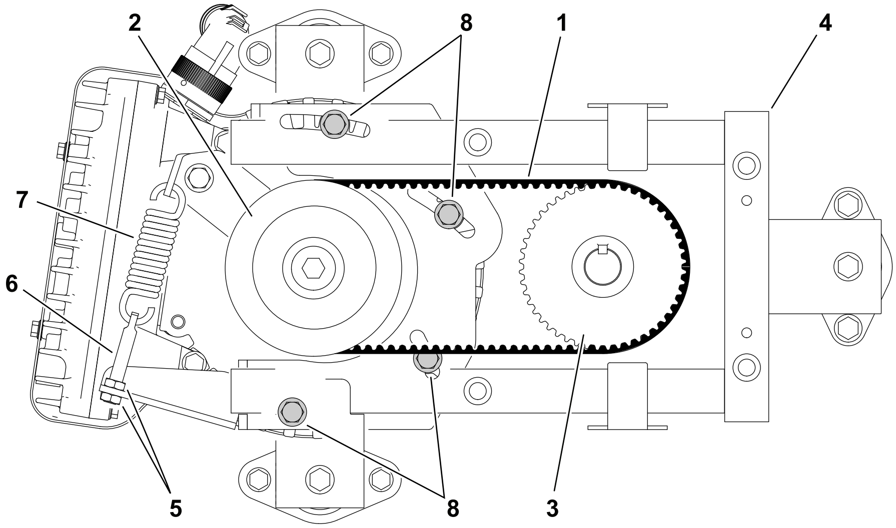


Figure 19

1.	Generator drive belt	5.	Hex nut (2 each)
2.	Generator pulley	6.	Adjustment pin
3.	Engine pulley	7.	Extension spring
4.	Engine frame	8.	Cap screw (4 each)

C. Loosen the 4 cap screws (item 8) securing the starter/generator to the engine frame. Loosen the cap screws only enough to allow the starter/generator to rotate on the engine frame.

D. Rotate the starter/generator clockwise (when viewed from above) and slip the starter/generator drive belt from the engine pulley.

Note: An engine lift lug is included in the machine loose parts kit.

12. Install an engine lift lug to the front of the engine.

Removing the Engine (continued)

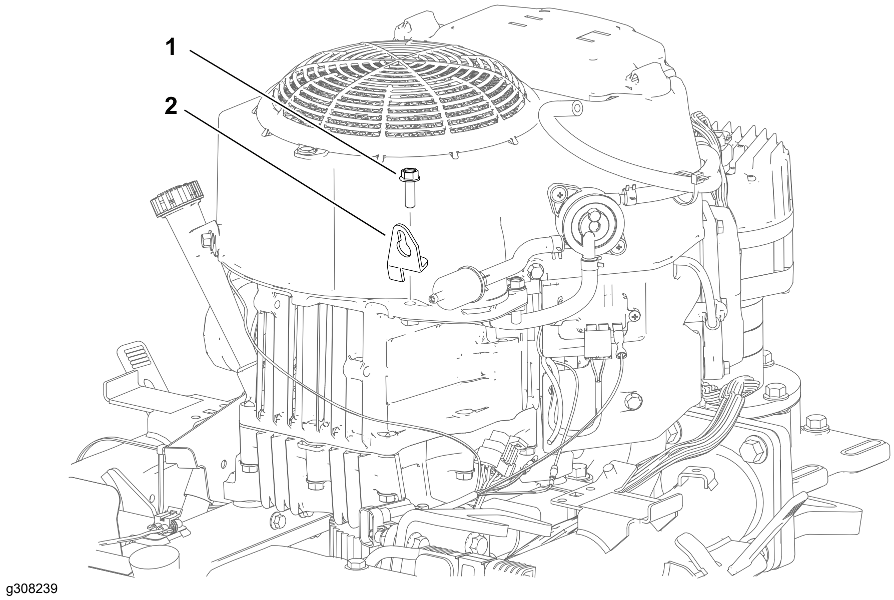


Figure 20

1. Cap screw
2. Front engine lift lug

CAUTION

The engine assembly weighs approximately 42 kg (92 lb). Use an appropriate lift to remove the engine assembly.

13. Remove the 4 fasteners securing the engine to the engine frame and lift the engine from the machine.
14. Continue to disassemble the engine as necessary.

Installing the Engine

Refer to Figure 17 for this procedure.

IMPORTANT

Ensure that all parts removed from the engine during maintenance are installed.

1. If the engine pulley was removed:
   A. Apply anti-seize lubricant to the engine shaft and fit the square key and engine pulley onto the engine shaft. Position the pulley approximately **28 mm (1.1 inch)** from the engine.
   B. Apply a high temperature medium strength thread locking compound (Loctite 2422 or equivalent) to the set screws and tighten from **14 to 18 N·m (120 to 140 in-lb)**.

Installing the Engine (continued)

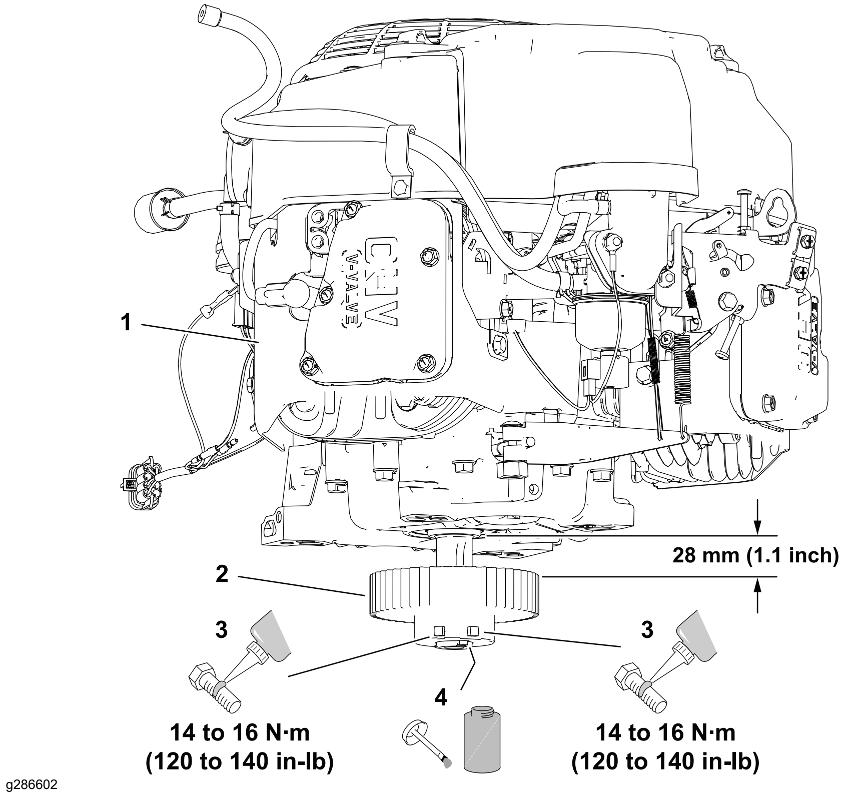


Figure 21

1. Engine
2. Engine pulley
3. Set screw (2 each)
4. Square key

CAUTION

The engine assembly weighs approximately 42 kg (92 lb). Use an appropriate lift to install the engine assembly.

IMPORTANT

Make sure to not damage the engine, fuel or vent hoses, oil drain hose, electrical harnesses, control cables or other parts while installing the engine.

---

2. Secure the engine to the engine frame with the 4 cap screws previously removed.
3. Remove the front engine lift lug and reinstall the fastener used to secure the lift lug to the engine; refer to Figure 20.
4. Secure the drip pan to the engine frame.
5. Fit the starter/generator drive belt over the engine pulley and adjust the drive belt tension; refer to Adjusting the Starter/Generator Drive Belt Tension (Model 04580) (page 5–24).

Installing the Engine (continued)

6. If the engine was removed from the machine separately, proceed to step 8 of this procedure. If the entire engine frame assembly (including the starter/generator) was removed:
   A. Secure the 3 engine frame assembly isolation mounts to the machine with the fasteners previously removed.
   B. Connect the machine wire harness to the starter/generator.
7. Install the clamp securing the engine oil drain hose to the right side battery tray.
8. Connect the choke control cable to the engine:
   A. Set the choke control at the operator control panel to the full choke position.
   B. Connect the choke control cable to the choke lever at the carburetor.
   C. Set the choke lever at the carburetor to the full closed position and secure the cable housing to the engine with the clamp and cap screw previously removed.
9. Connect the electrical system wiring to the engine:
   - The wire harness ground at the engine (near front left engine mount).
   - The engine wire harness connector at the main wire harness (left side of engine).
10. Connect the evaporative control system carbon canister to the engine vent hose.
11. Install the fuel tank; refer to Installing the Fuel Tank (page 4–5).
12. Install the exhaust system; refer to Installing the Exhaust System (page 4–12).
13. Ensure that all the hoses, tubes, and wires are clear of moving parts and secured to their original locations.
14. Connect the negative (–) battery cable at the 12V system battery (model 04580).
15. Check engine oil level and adjust if necessary; refer to traction unit *Operator's Manual*.
16. Operate the machine. Check for proper engine operation. Check for fuel leaks and correct any issues before returning the machine to service.

Chapter 5

Electrical System

Table of Contents

General Information

The *Traction Unit Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for your machine. Refer to the *Traction Unit Operator's Manual* for additional information when servicing the machine.

Traction Unit Operator's Manual and Accessory Installation Instructions

The traction unit *Operator's Manual* and accessory *Installation Instructions* provide information regarding the operation, general maintenance and maintenance intervals for the machine and its accessories. Refer to the traction unit *Operator's Manual* and accessory *Installation Instructions* for additional information.

Kawasaki Engine Electrical Components (Model 04580)

When servicing or troubleshooting the engine electrical components, use the correct engine service manual. Kawasaki engine service manuals are available online and on the Toro Service Reference flash drive.

Electrical Drawings

The electrical schematic and wire harness drawings for the eTriFlex machines are in Appendix A (page A–1).

Electrical System Operation

The eTriFlex machines have 4 different functional subsystems. Each subsystem has components that operate on 12 VDC, and components that operate on 48 VDC. Many of the machine control functions operate on a typical 12 VDC system. The electric traction motors, electric steering motor, electric cutting unit lift/lower actuators, and the electric cutting unit motors operate from the 48 VDC electrical system. The 12 VDC and 48 VDC systems include circuits that support both the logic demands of the various controllers, and the power supply (bus) required for component operation. Refer to Testing the Electrical Components (page 5–27) for detailed information and testing procedures for all the subsystem components.

Traction Subsystem

The traction subsystem and steering subsystem work together to steer the machine. The rear wheel (steering) sets the direction while the two front wheels turn the machine using the Radius Dependent Speed System (RDS). Each front traction motor speed is controlled independently by the RDS. The RDS also helps prevent the front wheels from scrubbing the turf in turns. For the subsystems to function properly, the front traction motors must be calibrated to each other by using the InfoCenter Service>Calibration screen.

The traction subsystem consists of the following components:

- Function Control Switch: A three position switch on the operator's console that allows the operator to select between Neutral and Transport or Mow speed ranges.
- Traction Pedal Position Sensor: A dual hall effect sensor attached to the traction pedal that sends reciprocal signals to the SC5: Traction 1 controller for direction and speed. The two signals are part of a redundant traction safety circuit in the case that one signal fails. For the subsystem to function properly, the traction pedal position sensor must be calibrated for range of motion by using the InfoCenter Service>Calibration screen.
- Front Traction Motor Controllers (2): Each traction motor controller operates and its respective traction motor using a separate interconnect harness.

  SC5: Traction 1 (right side): Is considered the primary traction controller as it controls the precharge function for the traction subsystem, provides the ground path to energize the traction motor contactor, and receives traction pedal sensor signals for traction direction and speed, and reports any traction pedal sensor faults.

  SC6: Traction 2 (left side): Is considered the secondary traction controller as it receives traction pedal sensor signals for traction direction and speed from the SC5: Traction 1 controller.
- Front Traction Motors (2): Are 3 phase 48 VDC electric motors located behind each front wheel and include a separate reduction gear box and disc brake mechanism. The front traction motors receive all operation commands from their respective traction motor controller.
- Optional 3WD Traction Motor: Is designed to assist with traction demands in the forward direction only. The 3WD traction motor is attached to the rear wheel caster fork and includes an integrated controller and reduction gear box.

Steering Subsystem

The steering subsystem components work together to coordinate the position of the steering wheel with the position of the rear caster fork. The Radius Dependent Speed System (RDS) uses steering position information from the steering subsystem to control the traction and cutting unit drive subsystems. The steering subsystem and traction subsystem work together to steer the machine. The rear wheel (steering) sets the direction while the two front wheels turn the machine using the RDS; refer to Traction Subsystem (page 5–4) for additional information.

The steering subsystem consists of the following components:

- Steering Input Device: Connected to the steering wheel, the device converts steering wheel direction and speed of rotation information are not reciprocal signals. Both signals are sent to the SC7: Steering motor controller. The two signals are part of a redundant steering safety circuit in the case that one signal fails. Tactile feedback (controlled by a PWM signal from the T1: primary controller) determines the amount of feed back the operator feels while turning the steering wheel. This feature of the steering input device produces a more natural power steering feel for the operator.
- SC7: Steering Motor: The SC7: Steering motor is attached to a reduction gear box and includes an integrated steering motor controller. The Steering motor receives all of its operation commands from the steering motor controller. The steering motor controller interprets steering position sensor data and broadcasts the information using the CAN bus to SC5: Traction 1 controller to manage front wheel speed, and to the steering input device to determine operator tactile feedback. The steering motor controller is responsible for reporting steering subsystem faults from the steering input device, steering motor, and steering position sensor.
- Steering Position Sensor: A dual hall effect sensor attached to the rear wheel caster fork sends reciprocal signals to the SC7: Steering motor controller. The two signals are part of a redundant steering safety circuit in the case that one signal fails. For the subsystems to function properly, the steering position sensor must be calibrated for center position, and for range of motion by using the InfoCenter Service>Calibration screen.

Lift/Lower Subsystem

The T1: Primary controller receives an input signal from the lift/lower switches and sends a CAN message to the lift/lower actuator controllers to lift or lower the cutting unit lift arms.

The lift/lower subsystem consists of the following components:

- Cutting Unit Lift and Lower Switches “Joystick”: The two identical lift/lower switches are mounted below the joystick and act as inputs to the T1: Primary controller.
- Lift/Lower Actuators (3): Each lift/lower actuator includes an integrated controller and is responsible for operating its respective cutting unit lift arm. The front actuators extend to lower and retract to lift the front lift arms, while the center actuator retracts to lower and extends to lift the center lift arm. Due to differences in mounting orientation and stroke length, each actuator is unique and their position on the machine is not interchangeable. For the subsystem to function properly, each lift/lower actuator must be calibrated separately for range of motion by using the InfoCenter Service>Calibration screen.

Cutting Unit Drive Subsystem

The cutting unit drive subsystem is also part of the Radius Dependent Speed System (RDS). Each cutting unit motor speed is controlled independently by the RDS to maintain a constant clip speed in turns.

The cutting unit drive subsystem consists of the following components:

- Location ID Module: Located under the right side cover, the location ID module is used to identify the three cutting unit motors individually based on the position of the cutting unit on the machine. Individual cutting unit motor location information is necessary for RDS operation, for cutting unit timing (starting and stopping the center cutting unit slightly later than the front cutting units), and for reporting cutting unit motor fault information individually.
- Cutting Unit Motors (3): The cutting unit motors are attached to the left side of each cutting unit and include an integrated controller. The cutting unit motor controllers receive CAN messages from the T1: Primary controller to start and stop the cutting unit motors, as well as set the cutting unit speed and direction of operation (mow or backlap).

12 VDC System Components

The engine electrical components, the machine operation switches, the T1: Primary controller, the InfoCenter display, the CAN bus isolation module, the electric brake actuator, the logic relay coil, and the operator feedback feature of the steering input device are all powered by the 12 VDC system on eTriFlex machines.

- On model 04580 machines, a single 12V AGM battery under the right side cover of the machine, an alternator (stator coil and flywheel magnets), and an external voltage regulator combine to provide the 12 VDC system electrical power. The 12 VDC system is an isolated system; each component has a separate wire leading to a ground provided by the engine block.
- On model 04590 and model 04591 machines, the 48V battery pack and a 48 VDC/12 VDC converter are used to provide the 12 VDC system electrical power. Circuit protection for the 12 VDC system includes two (2) fuse holders under the right side cover of the machine. The 12 VDC system is an isolated system; each component has a separate wire leading to a ground provided by the 48 VDC/12 VDC converter.

48 VDC System Components

The eTriFlex 48 VDC system includes a 48 VDC battery pack, an engine driven starter/generator (model 04580), two front traction motors, a steering input device and a steering motor, three cutting unit lift/lower actuators, three cutting unit motors, a main contactor and a traction motor contactor. An optional rear wheel traction motor and an LED light kit that runs on 48 VDC are also available. Circuit protection for the 48 VDC system includes fourteen fuses in a variety of styles and locations. The 48 VDC system is an isolated system so the vehicle frame is not used for any ground connections in this system. On model 04580 machines, each component has a separate wire leading to a ground bus located at the left side of the machine.

- **Model 04590 machines—**each component has a separate wire leading to the negative (-) terminal of the lithium-ion battery controller (BMS).
- **Model 04591 machines—**each component has a separate wire leading to the negative (-) terminal of the cable lithium-ion battery pack.

A 48V battery disconnect is located behind the left side cover of the machine. Use the 48V battery disconnect to make sure that 48 VDC components do not operate unexpectedly when performing service procedures.

- **Model 04580 machines—**the battery pack is composed of four 12 VDC sealed batteries connected in series to achieve the necessary 48 VDC system voltage. The batteries are maintenance free AGM, valve regulated lead acid batteries.
- **Model 04590 machines—**the battery pack is composed of eight 48 VDC lithium-ion batteries located in one center mounted and two side mounted assemblies. The batteries are connected in parallel and managed by a lithium–ion battery controller (SC8).
- **Model 04591 machines—**the battery stack is composed 2 battery packs located under the hood. The batteries of the upper-battery pack vertically mounted, include the Leader battery and 2 Support batteries. The batteries of the lower-battery pack are horizontally mounted, and are support batteries.

  The batteries are connected in parallel, and managed by their integrated BMSs and the primary controller.

Lithium-ion Battery Controller (Model 04590)

The a Lithium-ion Battery Controller (SC8: Battery) monitors the condition of the eight 48V lithium-ion batteries used to power the machine. The controller is also known as the Battery Management System (BMS). The BMS connects the 48V lithium-ion batteries to the machine during power-up, and disconnects the batteries from the machine during shut down.

Precharge Controller

The Precharge controller (T6: Precharge) limits the inrush of current to the 48V component controllers during the power-up procedure.

Primary Controller

T1: Primary controller uses the CAN bus system to communicate with the secondary controllers. Since the T1: Primary controller (a 12 VDC component) sends and receives information with the starter/generator, traction motors, and the remaining 48 VDC components, the CAN bus needs to communicate with both 12 VDC and 48 VDC systems.

Secondary (Component) Controllers

Control for the components in the 48 VDC system is performed by the following secondary controllers:

Secondary (Component) Controllers (continued)

- **Cutting Unit Motor Controllers—**T2: Cutting Unit 1, T3: Cutting Unit 2, T4: Cutting Unit 3
- **Lift/Lower Actuator Controllers—**SC1: Lift/Lower 1, SC2: Lift/Lower 2, and SC3: Lift/Lower 3
- **Traction Motor Controllers—**SC5: Traction 1 and SC6: Traction 2
- **Steering Motor Controller—**SC7: Steering

Components

CAN Bus Isolation Module

The CAN bus isolation module is included in the system to allow communication between the different voltage controllers while keeping the two electrical systems isolated.

Cutting Unit Lift/Lower Actuators

The three cutting unit lift/lower actuators are CAN message controlled electric linear actuators with an integrated controller, brushless motor, and brake. The InfoCenter Display can be used to monitor the current draw for the lift/lower actuators during machine operation.

Cutting Unit Motors

The three cutting unit motors are identical brushless, permanent magnet motors with an internal gear reduction feature. Each motor has its own on-board controller. The InfoCenter Display can be used to monitor the speed and current draw for the cutting unit motors during machine operation.

Location ID Module

The location ID module is used to identify the location of the three cutting unit controllers and the optional rear traction motor controller. The ID module enables machine operation features such as starting and stopping the center cutting unit slightly later than the front cutting units.

Main Contactor (Model 04580)

The main contactor is used to connect and disconnect the 48V battery pack with the starter/generator, and the cutting unit motor and optional rear traction motor controllers. The starter/generator controller controls the main contactor coil.

Main Contactor (Models 04590 and 04591)

The main contactor is used to connect and disconnect the 48V battery pack with the cutting unit motor and optional rear traction motor controllers. The primary controller controls the main contactor coil.

Starter/Generator (Model 04580)

The starter/generator is a 48 VDC, air cooled, brushless, permanent magnet device. The starter/generator has its own internal inverter and on-board controller. The InfoCenter Display can be used to monitor starter/generator activity during machine operation. The starter/generator also manages the precharge function for model 04580 machines.

Steering Motor

The steering motor is a brushless permanent magnet motor with its own on-board controller and integrated planetary gear box. The InfoCenter Display can be used to monitor the position of the steering motor during machine operation.

Traction Motor Contactor

The traction motor contactor is used to connect the 48 VDC system with the 2 front traction motors. The controller for the right side traction motor determines when the traction motor contactor is engaged.

Traction Motors

The two front traction motors are brushless permanent magnet motors. The motor controllers are separate from the motors and control each motor individually (RH controller controls RH motor and LH controller controls LH motor). The optional rear traction motor is a brushless, permanent magnet motor with its own on-board controller. The InfoCenter Display can be used to monitor the current draw for the traction motors during machine operation.

48V Battery Service Disconnect

CAUTION

Before installing, removing or servicing components in the 48 VDC system (e.g., cutting unit motors, starter/generator), separate the 48V battery disconnect. This will prevent unexpected operation of 48V system components.

The 48V battery disconnect is attached to a bracket behind the left side cover. Unplug the disconnect to make sure that 48 VDC components do not operate unexpectedly. Apply dielectric grease to the contact surfaces of the battery disconnect and plug the battery disconnect back in after service to the 48 VDC system is completed.

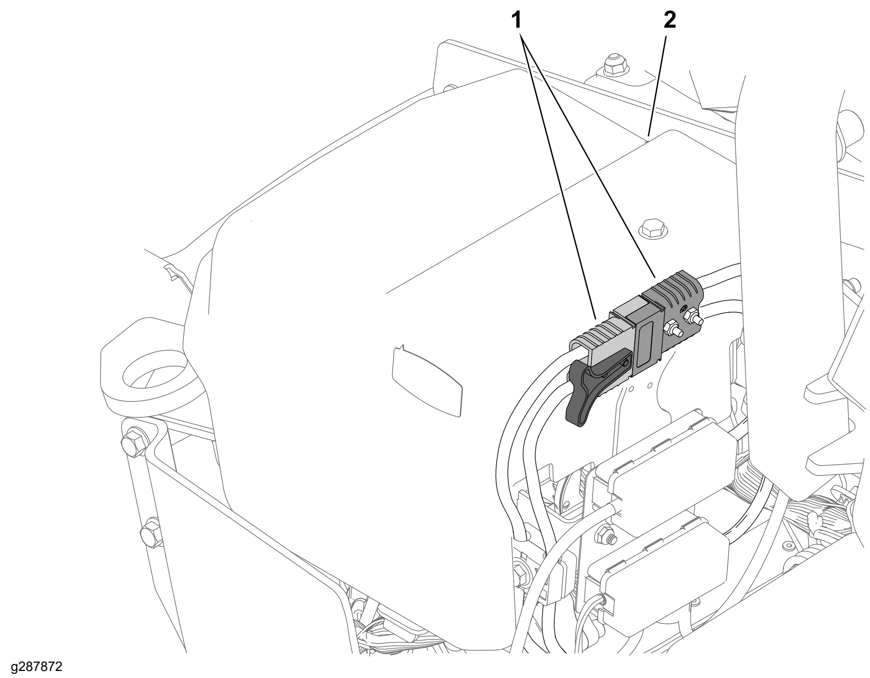


Figure 22

1. 48V power connectors
2. Left side cover

InfoCenter Display

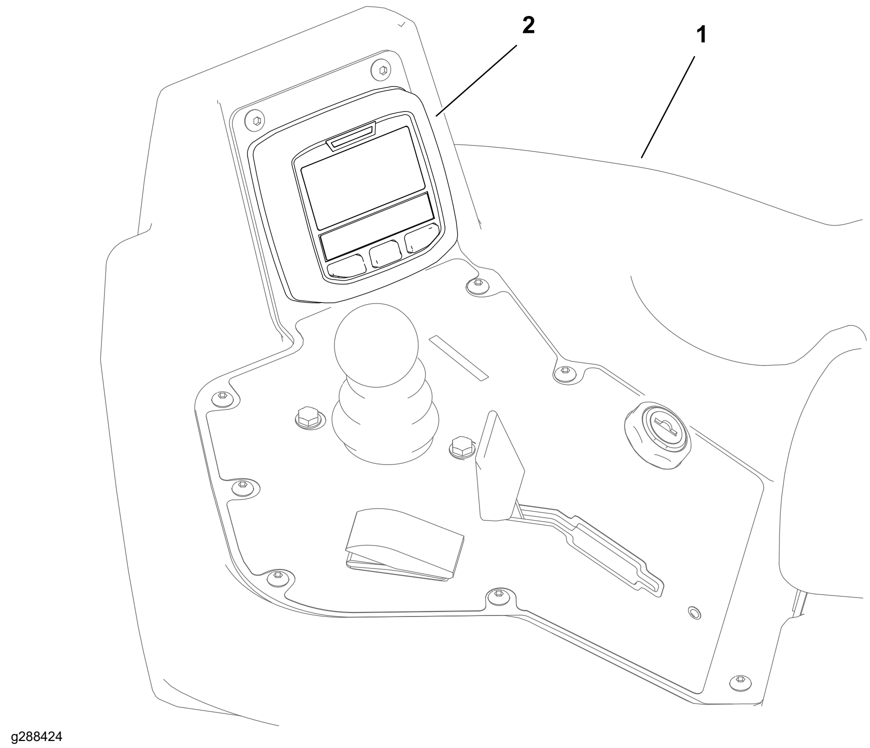


Figure 23

1. Operator's console
2. InfoCenter

The InfoCenter Display is a three button LCD device located on the operator's console. The InfoCenter provides information to the machine operator during machine operation, provides electrical system diagnostic assistance for technicians, and allows access to adjustable machine and attachment settings. Power for the InfoCenter is available when the key switch is in the ON or START position. A 7.5 Amp fuse protects all the key switched circuits, including the InfoCenter power circuit.

The InfoCenter communicates with the other machine controllers on a Controller Area Network (CAN) bus system; refer to CAN Bus Communication (page 5–13) for additional information.

Note: If the InfoCenter display (SC1) is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

InfoCenter Display (continued)

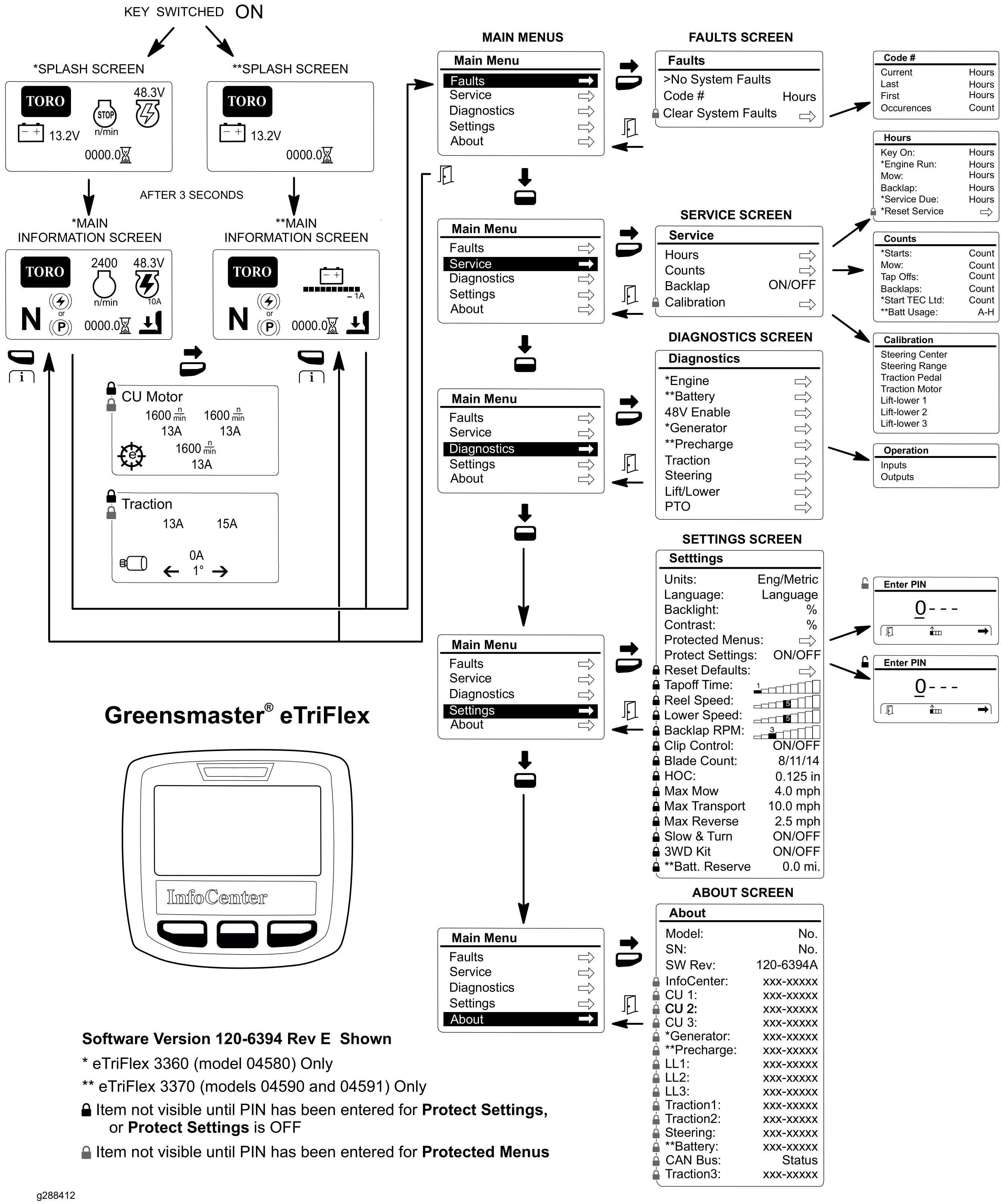


Figure 24

InfoCenter Display Screens – Greensmaster 3360/3370 eTriFlex

CAN Bus Communication

The controllers of the machine communicate with each other on a Controller Area Network (CAN) bus system. Using this network allows full integration of all the different electrical components of the machine, and allowing them to operate together as a multi-tiered system. The integration of the controllers allows the InfoCenter display to access machine settings, to calibrate various machine components, and to assist with electrical system diagnostics. The key switch needs to be in the ON or START position for the components on the network to communicate.

Controllers that operate on 12 VDC connect to the 12V side of the CAN bus (CAN A), while controllers that operate on 48 VDC connect to the 48V side of the CAN bus (CAN B). The two sides of the CAN bus communicate as one network using the CAN bus Isolation Module.

IMPORTANT

Logic voltage must be present at the controller before communication with that controller can occur on the CAN bus.

The entire CAN bus is made up of two specially designed twisted wires. The engineering term for these wires are CAN High (yellow wire) and CAN Low (green wire). A 120 ohm CAN termination resistor is located at each end of CAN A, and at each end of CAN B (4 total). Refer to CAN Bus (page 5–34) for CAN bus testing procedures.

The Toro DIAG electronic control diagnostics service system is available to Authorized Toro Distributors to support machine fault diagnosis and maintenance services of the machine electrical control devices. The Toro DIAG connector is part of the CAN bus and is located at the rear of the console armrest.

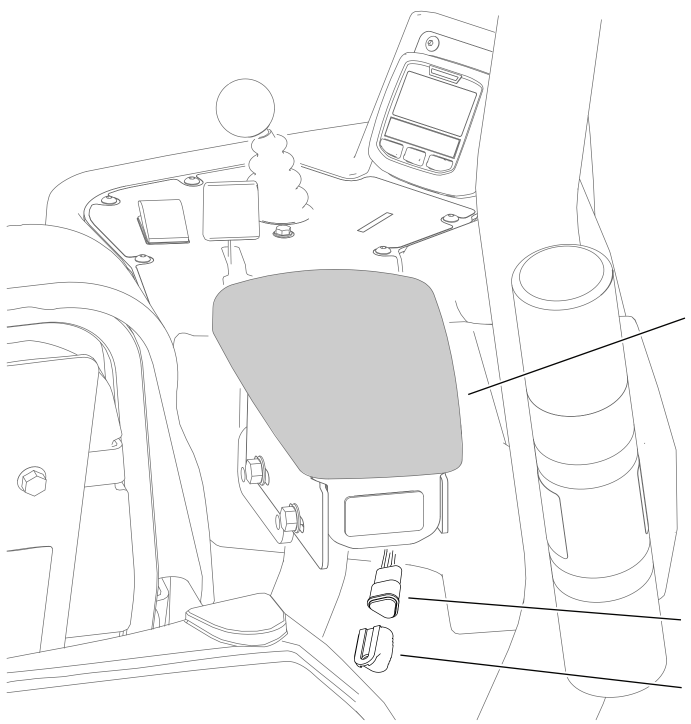


Figure 25

1. Console armrest
2. Toro DIAG connector
3. Connector cover

CAN Bus Communication (continued)

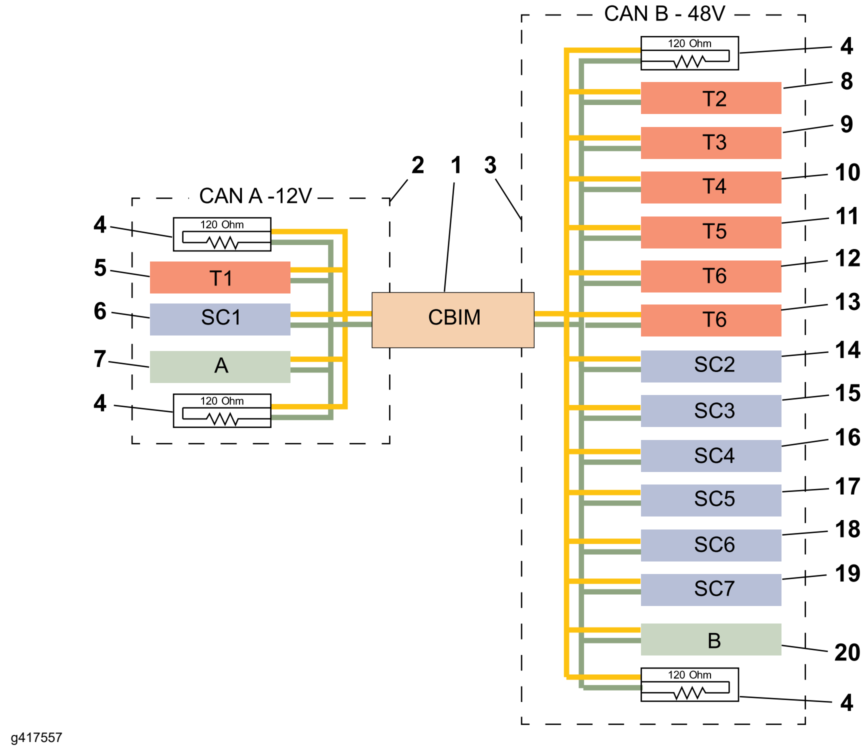
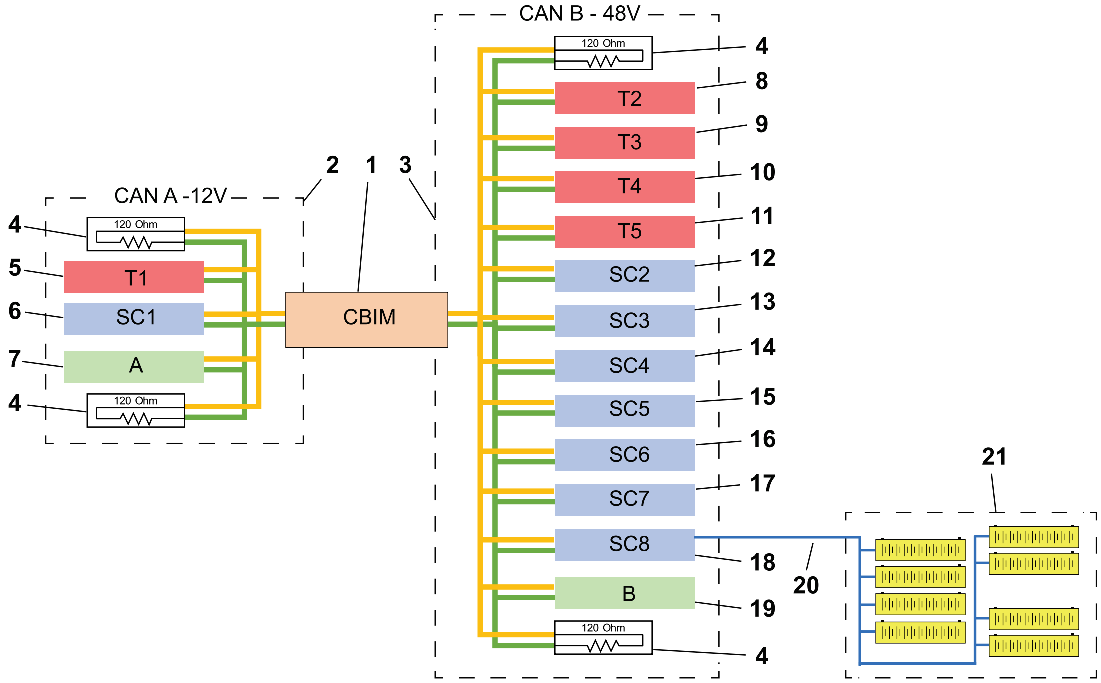


Figure 26

Machine Model 04580

1. CAN bus isolation module
2. CAN A – 12V side
3. CAN B– 48V side
4. CAN bus terminator resistor (4 each)
5. T1: Primary controller
6. SC1: InfoCenter
7. CAN A diagnostic port
8. T2: Cutting Unit 1 motor controller (center)
9. T3: Cutting Unit 2 motor controller (left)
10. T4: Cutting Unit 3 motor controller (right)
11. T5: Traction 3 motor controller (optional)
12. T6: Starter/Generator controller
13. T6: Pre–charge controller
14. SC2: Lift/Lower 1 actuator controller (center)
15. SC3: Lift/Lower 2 actuator controller (left)
16. SC4: Lift/Lower 3 actuator controller (right)
17. SC5: Traction 1 motor controller (right)
18. SC6: Traction 2 motor controller (left)
19. SC7: Steering motor controller
20. CAN B diagnostic port

CAN Bus Communication (continued)



g287505

Figure 27

Machine Model 04590

1. CAN bus isolation module
2. CAN A – 12V side
3. CAN B– 48V side
4. CAN bus terminator resistor (4 each)
5. T1: Primary controller
6. SC1: InfoCenter
7. CAN A diagnostic port
8. T2: Cutting Unit 1 motor controller (center)
9. T3: Cutting Unit 2 motor controller (left)
10. T4: Cutting Unit 3 motor controller (right)
11. T5: Traction 3 motor controller (optional)
12. SC2: Lift/Lower 1 actuator controller (center)
13. SC3: Lift/Lower 2 actuator controller (left)
14. SC4: Lift/Lower 3 actuator controller (right)
15. SC5: Traction 1 motor controller (right)
16. SC6: Traction 2 motor controller (left)
17. SC7: Steering motor controller
18. SC8: Lithium-ion Battery controller
19. CAN B diagnostic port
20. Lithium-ion battery interface
21. Lithium-ion batteries

Note: For model 04590 machines, the SC8: Lithium-ion battery controller (BMS) exists on the CAN bus. Each of the eight lithium-ion batteries communicate with the BMS across the battery pack subnetwork. The BMS then forwards the battery information to the primary controller of the host machine using the CAN bus.

CAN Bus Communication (continued)

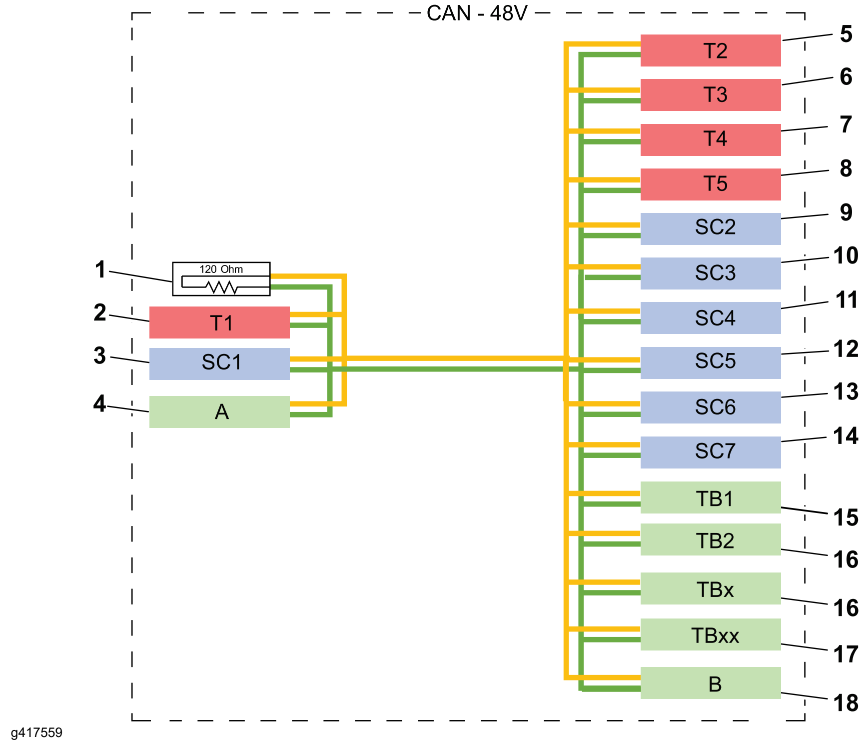


Figure 28

1. CAN bus isolation module
2. CAN A – 12V side
3. CAN B– 48V side
4. CAN bus terminator resistor (4 each)
5. T1: Primary controller
6. SC1: InfoCenter
7. CAN A diagnostic port
8. T2: Cutting Unit 1 motor controller (center)
9. T3: Cutting Unit 2 motor controller (left)
10. T4: Cutting Unit 3 motor controller (right)
11. T5: Traction 3 motor controller (optional)
12. SC2: Lift/Lower 1 actuator controller (center)
13. SC3: Lift/Lower 2 actuator controller (left)
14. SC4: Lift/Lower 3 actuator controller (right)
15. SC5: Traction 1 motor controller (right)
16. SC6: Traction 2 motor controller (left)
17. SC7: Steering motor controller
18. TB1: Leader battery
19. TB2 through TBx: Support batteries
20. CAN B diagnostic port

Note: For model 04591 machines, the BMSs for each of the batteries communicate through the Leader battery, and across the CAN bus to the primary controller of the host machine.

T1: Primary Controller

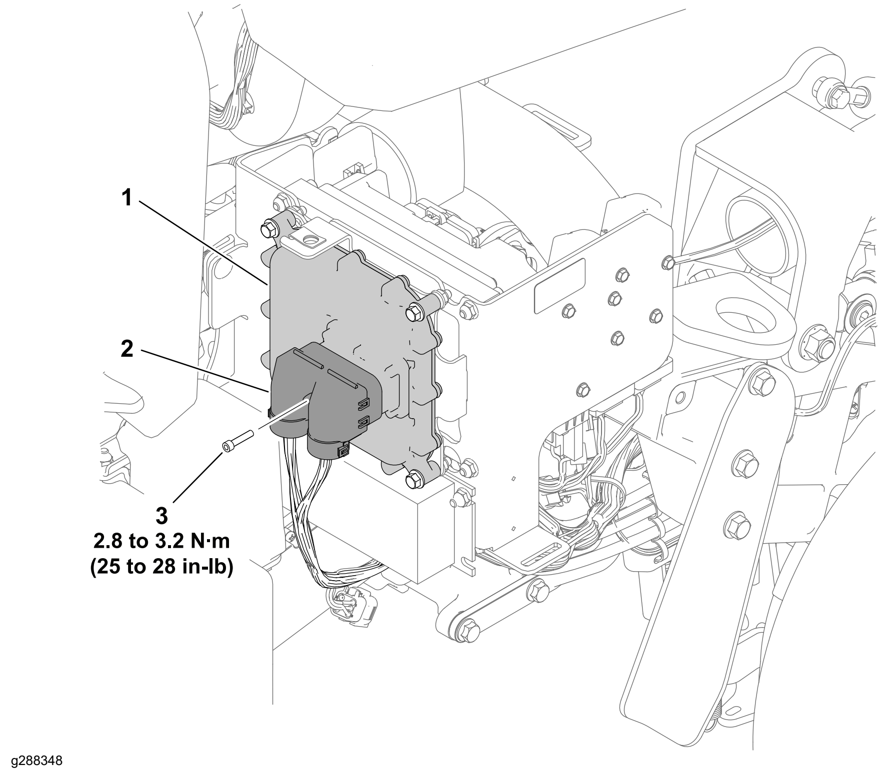


Figure 29

(right side cover removed)

1. Primary controller (T1)
2. Machine harness connector

The eTriFlex machines use a primary controller (T1) to manage machine electrical functions. The primary controller is a TEC 5004 series microcontroller that monitors the condition of various machine switches and sensors (inputs) and directs electrical power to control appropriate machine functions (outputs) based on the state of the inputs. The primary controller is directly responsible for managing the logic relay, the automatic parking brake relay, the operator feedback feature of the steering input device, and the fuel solenoid and engine relay on Greensmaster 3360 and 3370 machines. The status of inputs to the controller as well as outputs from the controller can be monitored with the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). Refer to T1: Primary Controller (page 5–41) for T1: primary controller testing information.

The primary controller communicates with the other machine controllers on a Controller Area Network (CAN) bus system; refer to CAN Bus Communication (page 5–13) for additional information.

Note: If the T1: Primary controller is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

SC8: Lithium-Ion Battery Controller (Model 04590)

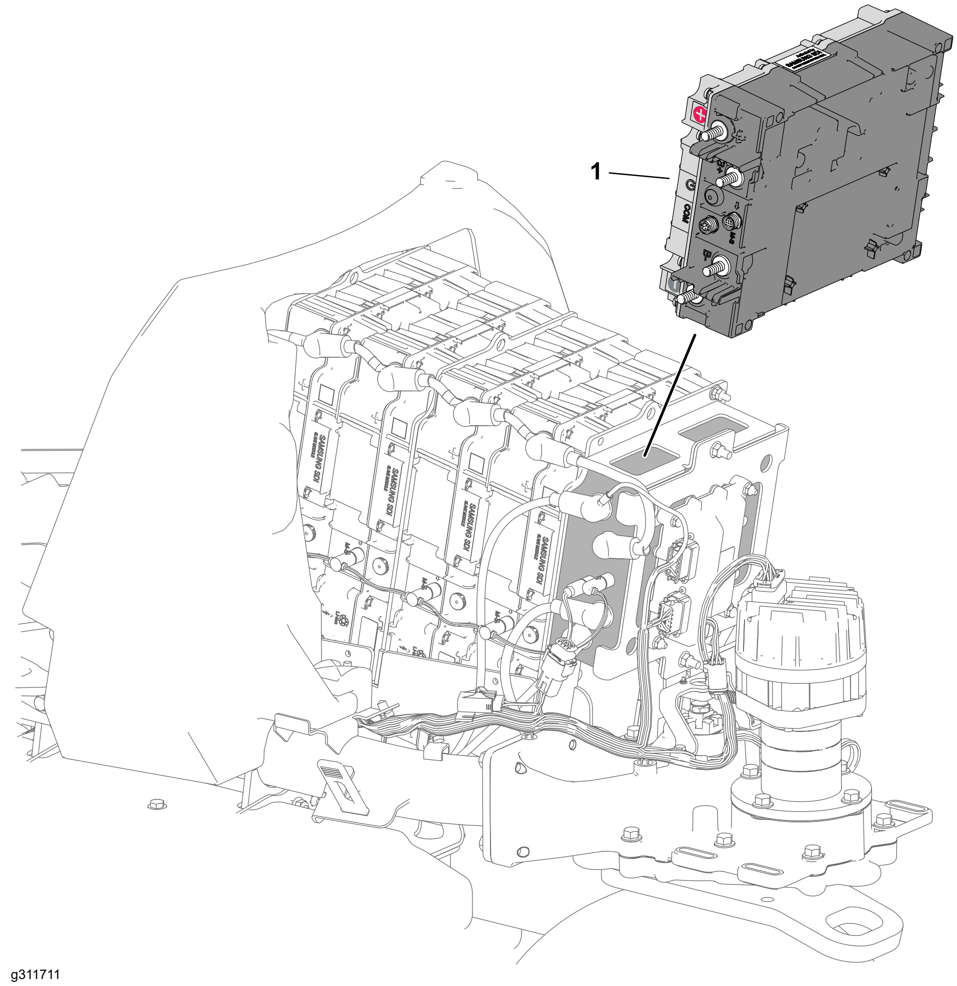


Figure 30
(shown with hood removed)

1. SC8: Lithium–ion battery controller

The eTriFlex 3370 uses a Lithium–ion battery controller or Battery Management System (BMS) to manage the lithium-ion batteries. Each of the eight lithium-ion batteries communicate with the BMS across the battery pack subnetwork using a battery interface harness. The battery interface harness includes a 4-pin connector at each of the batteries and a 9-pin connector at the BMS. The BMS uses the battery pack subnetwork to verify the presence and condition of each of the batteries before allowing battery power to the machine. The BMS is also connected to the CAN bus which allows it to forward battery information to the primary controller of the machine. The BMS is located under the hood, and attached to the back of the center mounted batteries.

The Lithium–ion battery controller:

- Monitors the batteries across the battery pack subnetwork using a battery interface harness.

  Note: All the battery interface harness connections must be corrosion free and securely connected before machine operation can occur.

- Protects the batteries from operating (discharging and charging) outside their safe operating voltage, amperage, and temperature ranges.
- Operates an internal contactor to connect and disconnect the batteries from the machine and the battery charger.

Note: When the key switch is set to the Off position, the BMS delays disconnecting the batteries from the machine for approximately 3 seconds to allow time for all the other machine controllers to shut down.

- Communicates battery information to the primary controller of the machine during operation using a the CAN bus.
- Communicates battery information to the battery charger using the CAN bus.
- Supplies battery pack signal voltage to the key switch.

Note: Except for the lithium-ion battery cables, the only machine circuit with voltage when the key switch is in the OFF position, is the low amperage signal voltage (Pack Sig+) from the BMS to the key switch.

Refer to SC8: Lithium-Ion Battery Controller (Model 04590) (page 5–47) for SC8: lithium-ion battery controller testing information.

IMPORTANT

Do not open the lithium-Ion battery controller. There are no serviceable parts on or in the controller. If you open the controller, you will void the warranty. The controller is protected by tamper-alerting devices.

Note: If the SC8: Lithium-Ion Battery Controller is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

T6: Precharge Controller (Models 04590 and 04591)

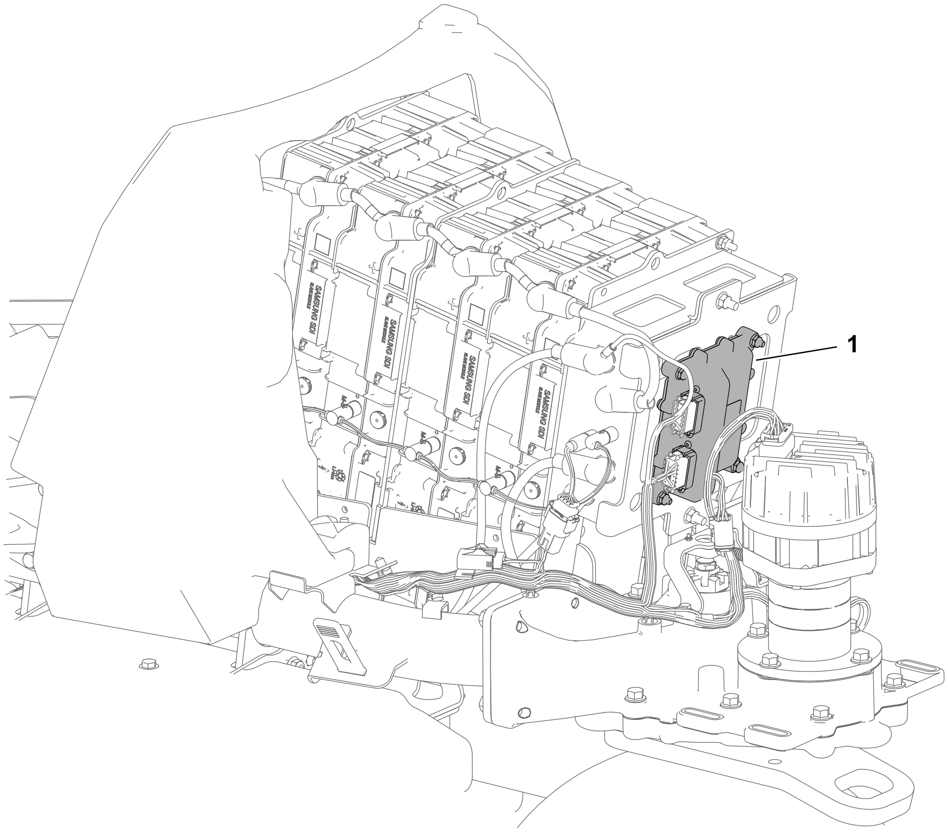


Figure 31
Model 4590 (shown with hood removed)

1. T6: Precharge controller

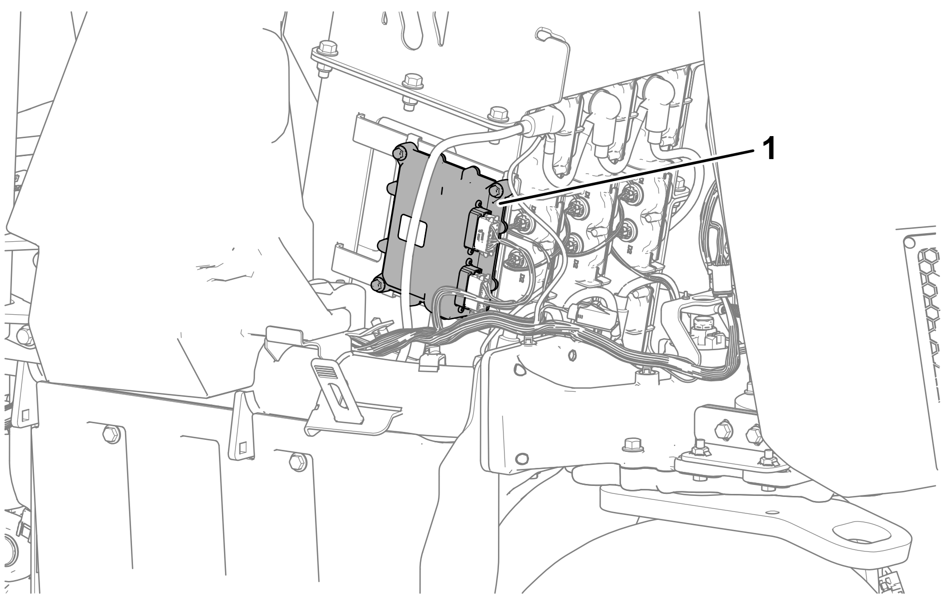


Figure 32
Model 04591

1. T6: Precharge controller

T6: Precharge Controller (Models 04590 and 04591) (continued)

The eTriFlex 3370 uses a TEC 2400 series microcontroller as a precharge controller (T6) to manage the precharge function. Precharge is a preliminary mode which limits the inrush of current during the power-up procedure. This current, if not limited, can cause considerable stress or damage to the 48 VDC system components. Precharge occurs each time the key switch is set to the ON position and lasts for less than a second. Precharging is implemented to increase the lifespan of the electronic components and increase reliability of the 48 VDC system.

When the key switch is set to the ON position, the T1: primary controller energizes the logic relay and power is supplied to the precharge controller precharge input. The precharge controller then supplies a controlled precharge voltage to the reel motors, lift actuators, and optional 3WD traction motor using the precharge output. Once precharge is successful, the T1: primary controller commands the T6: precharge controller using a CAN message to provide a path to ground for the 48 VDC main contactor coil to energize the main contactor (48 VDC power bus). Refer to T6: Precharge Controller (Models 04590 and 04591) (page 5–52) for T6: precharge controller testing information.

The precharge controller communicates with the other machine controllers on a Controller Area Network (CAN) bus system; refer to CAN Bus Communication (page 5–13) for additional information.

Note: If the precharge controller (T6) is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

Electrical System Quick Checks

Testing the 12V Charging System (Model 04580)

Battery Voltage Table

At least 0.50 VDC over the initial battery voltage.	
Initial battery voltage	= 12.30 VDC
Battery voltage after 3 minutes charge	= 12.85 VDC
Difference	= +0.55 VDC

This is a simple test that determines if the 12V charging system is functioning. It tells you if the 12V charging system has an output, but not its capacity.

Tool required: Digital multimeter to set the DC volts.

1. Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post of the 12V system battery and record the battery voltage.

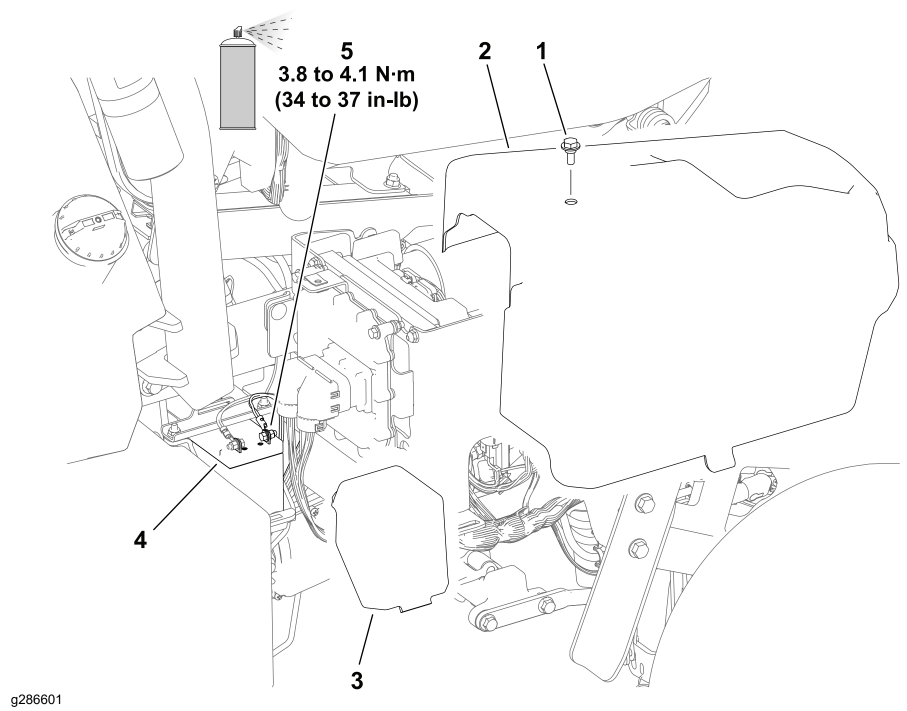


Figure 33

1. Shoulder screw
2. Front right side cover
3. Battery cover
4. 12V system battery
5. Negative (-) terminal

2. Start the engine and allow the engine to run at 2400 rpm for a minimum time of 3 minutes.
3. Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post of the 12V system battery and record the battery voltage.
4. After running the engine for a minimum time of 3 minutes, the battery voltage must be at east 0.50V higher than that of the initial battery voltage.

Note: Depending upon the condition of the battery, its current charge and the battery temperature, the battery voltage increases at different rates as the battery charges.

Refer to the Battery Voltage Table (page 5–22) for an example of a charging system that is functioning.

Checking the Interlock System Operation

CAUTION

The interlock system is for the operator's protection; do not bypass any of the interlock system components. Check the operation of the interlock system daily to assure the system is operating correctly. If an interlock system component is out of adjustment or defective, replace it before operating the machine.

The purpose of the interlock system is to:

- Prevent the machine from moving if an operator is not in the seat, the manual parking brake is engaged, or the function control switch is in the NEUTRAL position.
- Shut off the reels if the function control switch is moved to NEUTRAL or TRANSPORT.

Test the interlock system as follows:

1. Rise from the seat, start the engine, disengage the manual parking brake, move the function-control switch to the MOW or TRANSPORT position, and engage the traction pedal. The machine should not move, if you are not in the seat.
2. Sit in the seat, start the engine, engage the manual parking brake, move the function-control switch to the MOW or TRANSPORT position, and engage the traction pedal. The machine should not move, if the manual parking brake is engaged.
3. Sit in the seat, start the engine, disengage the manual parking brake, move the function control switch to the NEUTRAL position, and engage the traction pedal. The machine should not move, as the function control switch is in the NEUTRAL position.
4. Sit on the seat, move the traction pedal to the NEUTRAL position, move the function control switch to the NEUTRAL position, engage the manual parking brake, start the engine, and move the lift/lower joystick forward to lower the cutting units. The cutting units should lower but not start rotating.

IMPORTANT

Adjust or repair any of the interlock system components as necessary so all the interlock system operations function correctly before operating the machine.

Adjustments

Adjusting the Starter/Generator Drive Belt Tension (Model 04580)

For additional starter/generator service information; refer to Generator Assembly (Model 04580) (page 5–165).

1. Remove the fuel tank; refer to Removing the Fuel Tank (page 4–5).
2. Tilt the operator seat forward and remove the starter/generator pulley cover.
3. Loosen the 4 cap screws (item 2) securing the starter/generator to the engine frame and allow the extension spring to pull the starter/generator counterclockwise to tension the drive belt.

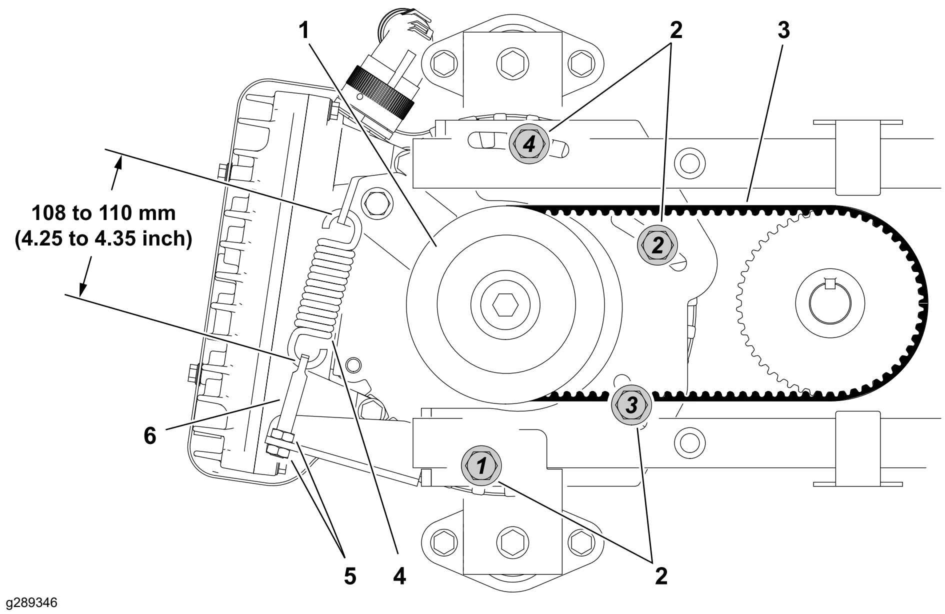


Figure 34

1. Generator pulley
2. Cap screw (4 each)
3. Generator drive belt
4. Extension spring
5. Hex nut (2 each)
6. Adjustment pin

4. Measure the extension spring length. To apply the correct amount of belt tension, the spring must be **108 to 110 mm (4.25 to 4.35 inch)** when measured inside the spring hooks. Adjust the adjustment pin if necessary.
5. Tighten the 4 cap screws securing the starter/generator to the engine frame in the sequence shown.
6. Install the starter/generator pulley cover.
7. Install the fuel tank; refer to Installing the Fuel Tank (page 4–5).

Adjusting the Steering Position Sensor

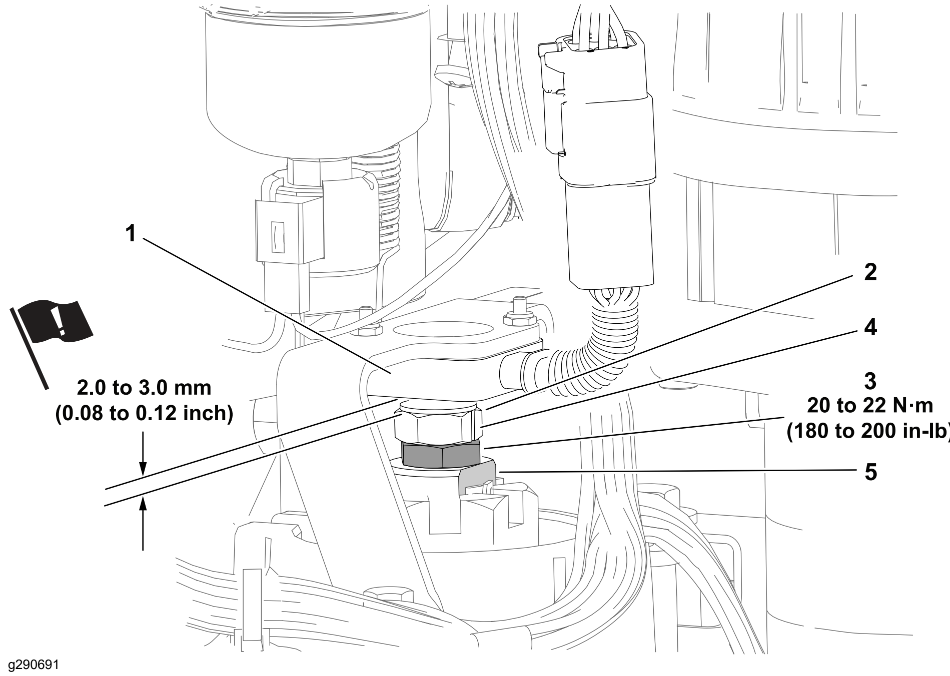


Figure 35

1. Steering position sensor
2. Magnetic bolt
3. Jam nut
4. Slot in magnet bolt
5. Flat on caster fork shaft

The steering position sensor is a two–piece assembly located on top of the rear wheel caster fork shaft. The sensor portion includes 2 analog hall effect sensors. The second piece of the assembly is a bolt with a magnetic head threaded into the caster fork shaft. The steering position sensor follows the rear caster fork movement.

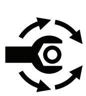
For steering position sensor testing information; refer to Steering Position Sensor (page 5–98).

1. Align the rear caster fork; refer to Aligning the Rear Wheel Caster Fork (page 6–8).

   Note: Be careful not to disturb the rear caster fork alignment while adjusting the steering position sensor.

2. Loosen the jam nut under the magnet bolt.

3. Adjust the magnetic bolt so the slot in the bolt aligns with the flat on the castor fork shaft (straight toward the rear of the machine) and the gap between the top of the bolt and the bottom of the sensor is **2.0 to 3.0 mm (0.08 to 0.12 inch)**.



4. Tighten the jam nut against the caster fork from **20 to 22 N·m (180 to 200 in-lb)** and recheck the gap between the top of the bolt and the bottom of the sensor. Adjust the gap if necessary.

5. Check the rear caster fork alignment and readjust the sensor if necessary.

6. Calibrate the steering system. Calibrate the steering system – center first, then calibrate the steering system – range; refer to Calibrating the Steering System – Center (page 5–100) and Calibrating the Steering System – Range (page 5–100).

Adjusting the Manual Parking Brake Switch

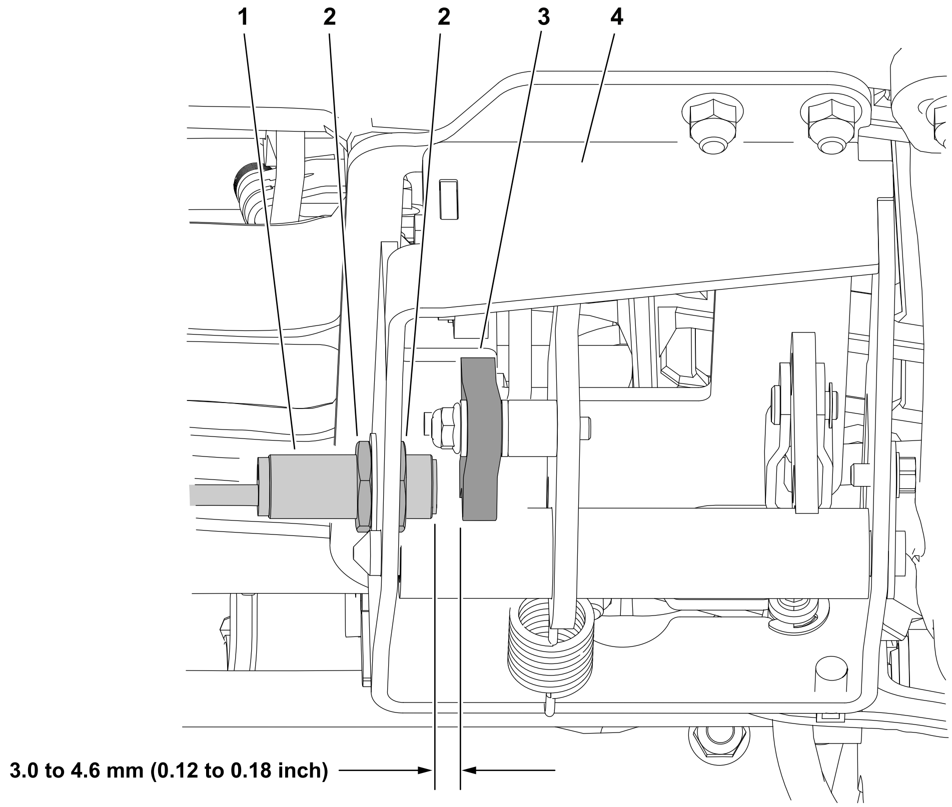


Figure 36

1. Manual parking brake switch
2. Jam nut (2 each)
3. Latch
4. Brake pedal support

The manual parking brake switch is located directly under the brake pedal assembly. The manual parking brake switch is an input to the T1: primary controller. The switch is a normally open proximity switch that closes when the foot actuated parking brake is disengaged (the parking brake latch is near the parking brake switch). The manual parking brake switch is part of the safety interlock system; refer to Checking the Interlock System Operation (page 5–23) for a better understanding of how the switch is used.

For manual parking brake switch testing information; refer to Manual Parking Brake Switch (page 5–86).

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. The gap between the manual parking brake switch and the latch should be from **3.0 to 4.6 mm (0.12 to 0.18 inch)**. If the distance is incorrect:

   A. Loosen the jam nuts that secure switch to the brake pedal support.

   B. Use the jam nuts to move the switch until the correct gap is obtained.

   C. Tighten the jam nuts from **18 to 22 N·m (13 to 16 ft-lb)**.

   D. Test the manual parking brake switch operation using the main information screen of the InfoCenter Display; refer to InfoCenter Display (page 5–11) **(P)** icon.

Testing the Electrical Components

The Greensmaster eTriFlex 3360 and 3370 machines have isolated electrical systems; they do not use the machine frame as ground. Use an unpainted surface of the engine block or an unpainted engine fastener as a ground for testing 12V components unless instructed otherwise. Use the B- terminal of the front traction motor controllers (SC5 or SC6) as a ground for testing 48V components unless instructed otherwise. Depending on which side of the machine is more convenient, remove the right side cover or the left side cover to access a front traction motor controller. Make sure the 48V battery disconnect must be connected.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g., unplug the key switch connector before doing a continuity check of the switch). Always check the item being tested and the harness connector for damage or corrosion and clean or repair as necessary.

IMPORTANT

When testing the electrical components for continuity with a multimeter (ohms setting), ensure that you disconnect the power to the circuit.

Note: For engine component testing information (fuel solenoid, charging system, ignition modules); refer to the *Kawasaki FS481V Service Manual*.

Fuses

Several different style fuses are used on this machine in a variety of amperage and voltage ratings. Most fuses are color coded based on their amperage rating. Always replace fuses with the same style, amperage, and voltage as the original fuse.

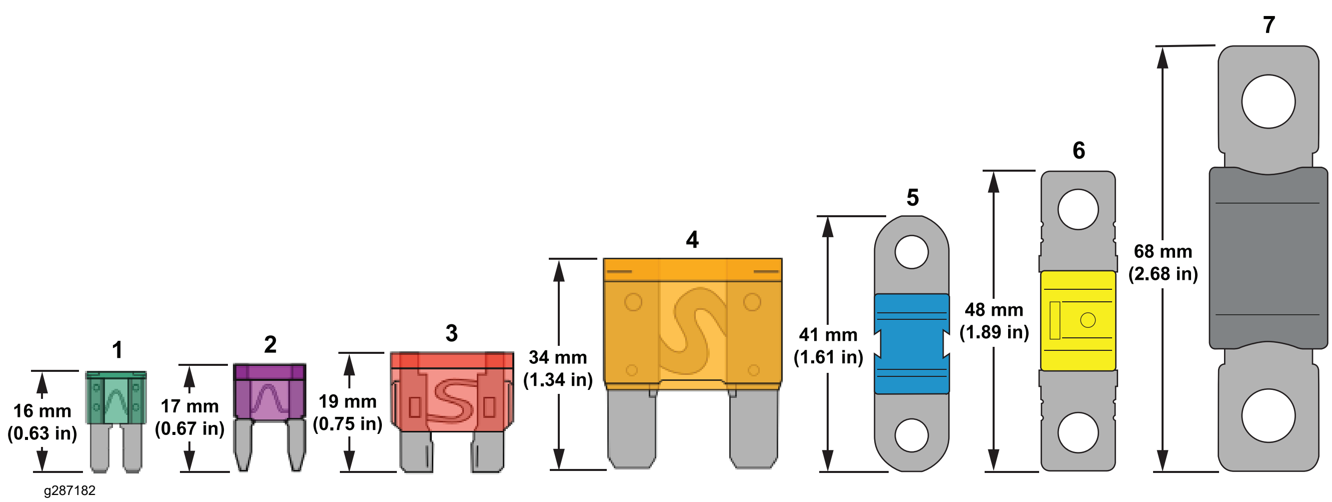


Figure 37

1. Micro blade fuse
2. Mini blade fuse
3. Standard (ATO) blade fuse
4. Maxi blade fuse
5. BF1 fuse
6. MIDI fuse
7. Mega fuse

Identifying the 12 VDC System Fuses and their Functions

A group of fuses used to protect the 12 VDC system are in the 2 covered fuse holders under the right side cover. These are mini blade style fuses.

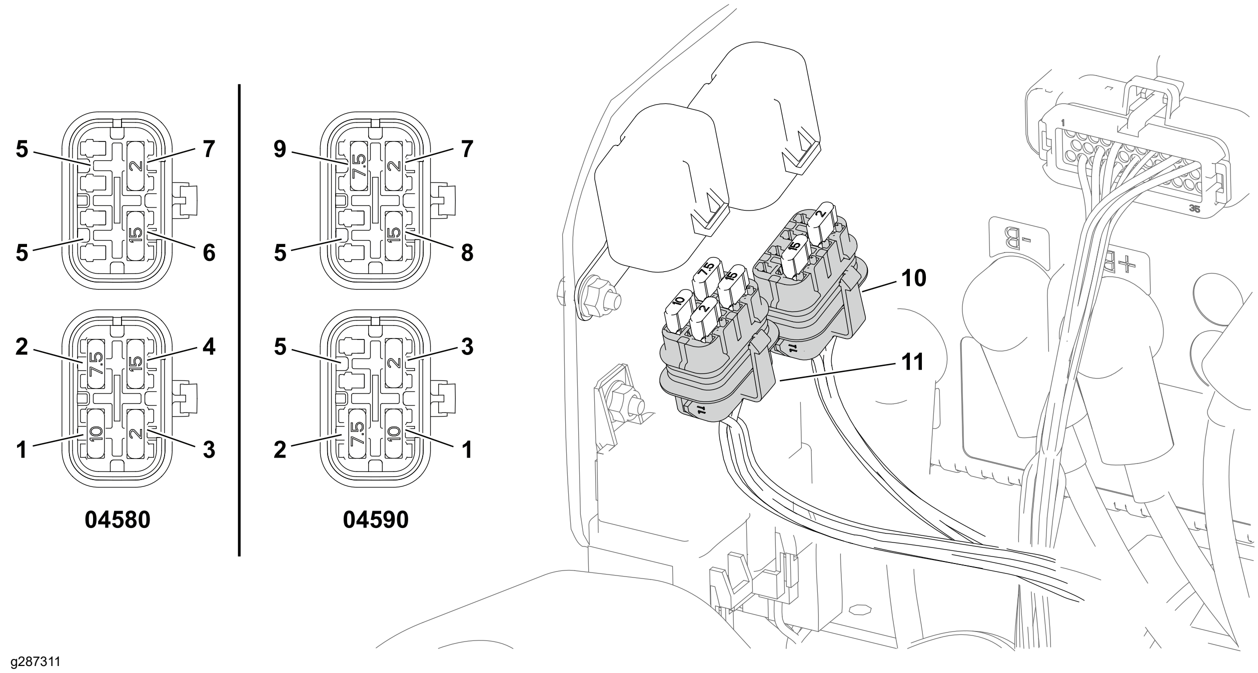


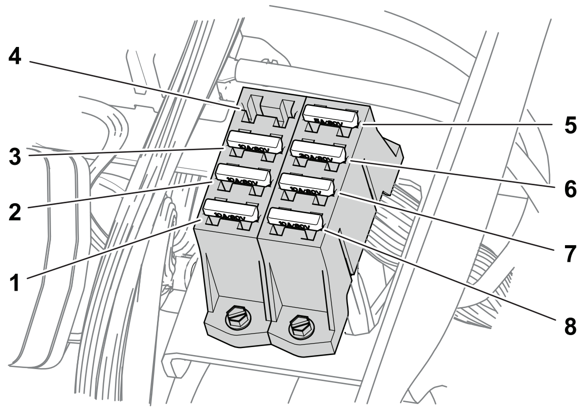
Figure 38

(right side cover removed)

1. 10A fuse – brake actuator relay
2. 7.5A fuse – T1: Primary outputs
3. 2A fuse – telematics connector
4. 15A fuse – 12V system battery charging (model 04580)
5. Open
6. 15A fuse – main (model 04580)
7. 2A fuse – T1: Primary logic
8. 15A fuse – 48 VDC/12 VDC converter (model 04590)
9. 7.5A fuse – spare
10. 12V fuse holder 1
11. 12V fuse holder 2

Identifying the 48 VDC System Fuses and their Functions

A group of fuses used to protect the 48 VDC system are in the open fuse block under the operator's seat. These are standard blade ATO style fuses.



g287256

Figure 39

(seat raised)

1.	10A 80V fuse – SC2:Lift/Lower Actuator 1 (center) power bus	5.	5A 80V fuse – 48V controller logic
2.	10A 80V fuse – SC3:Lift/Lower Actuator 2 (left) power bus	6.	30A 80V fuse – SC7:Steering Motor power bus
3.	10A 80V fuse – SC4:Lift/Lower Actuator 3 (right) power bus	7.	10A 80V fuse – Optional work lights (model 04580) or 48 VDC/12 VDC converter (model 04590)
4.	Open	8.	10A 80V fuse – Optional work lights (model 04590)

On model 04590 machines, an additional 48 VDC fuse located in its own holder on the machine wire harness to the left of the center (rear) battery set. The fuse is used to protect the T6:Precharge controller. This is a standard blade ATO style fuse.

Identifying the 48 VDC System Fuses and their Functions (continued)

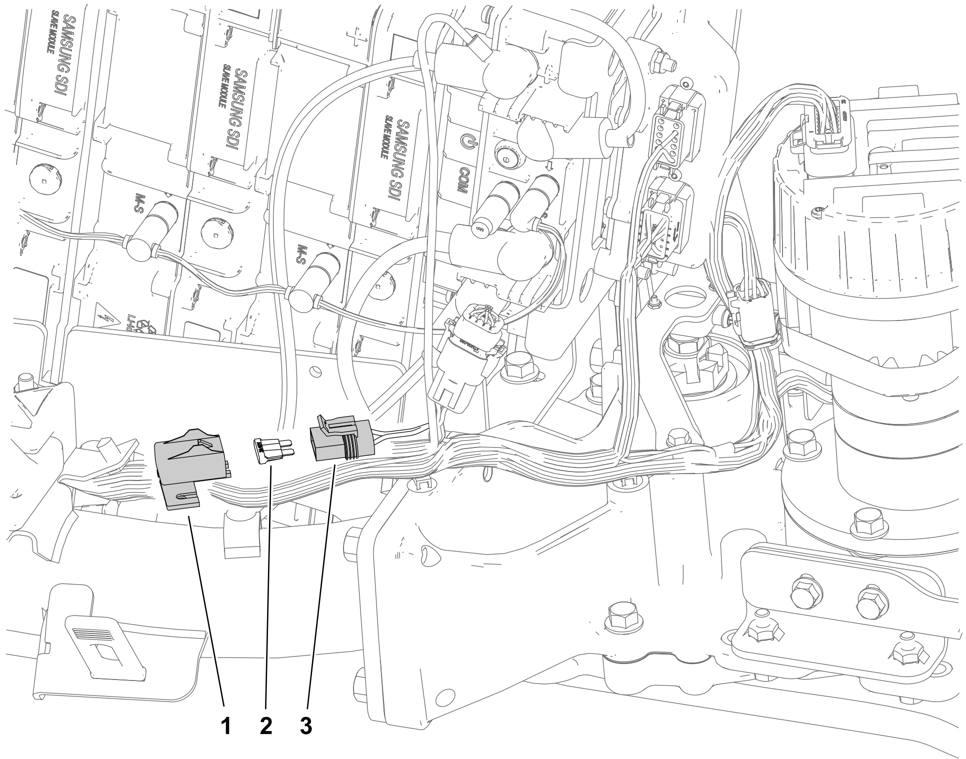


Figure 40
(model 04590 only)

1. Cap
2. 3A 80V fuse – T6:Precharge controller (model 04590)
3. Fuse holder

Identifying the 48 VDC System Fuses and their Functions (continued)

Three fuses are used to protect the 48 VDC cutting unit motors. An additional fuse is used to protect the optional 48 VDC 3WD (rear) traction motor. These are Maxi blade fuses located in a covered fuse block under the left side cover.

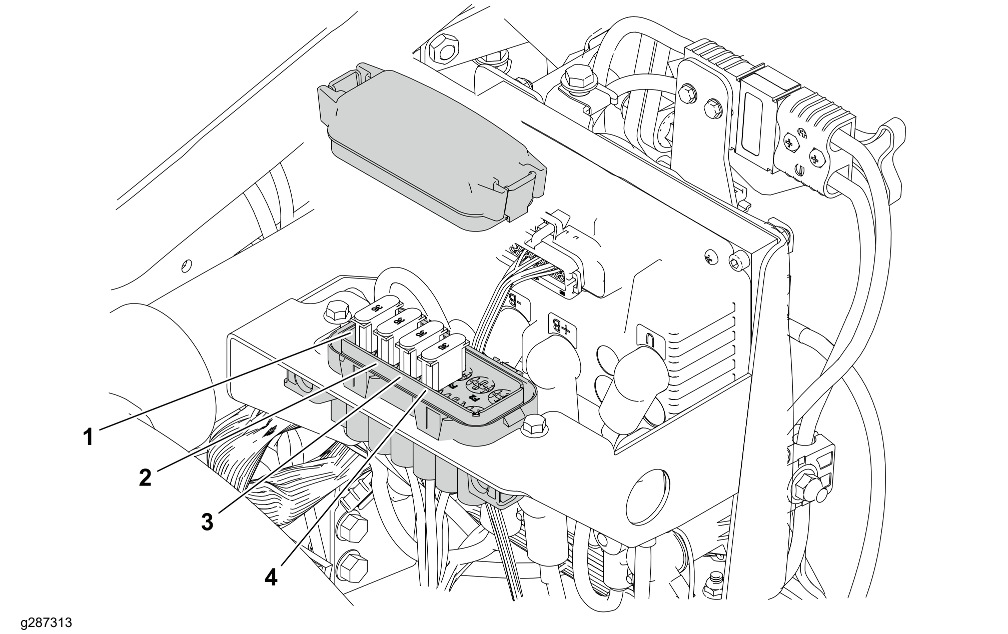


Figure 41
(left side cover removed)

1. 35A 58V fuse – T2:Cutting Unit 1 (center) power bus
2. 35A 58V fuse – T3:Cutting Unit 2 (left) power bus
3. 35A 58V fuse – T4:Cutting Unit 3 (right) power bus
4. 35A 58V fuse – T5:Traction 3 (optional 3WD) power bus

Identifying the 48 VDC System Fuses and their Functions (continued)

Two fuses are used to protect the 48 VDC standard (front) traction motors. These are MIDI style fuses located in separate covered holders. The fuse holder for SC5:Traction 1 (right) is located under the operator seat. The fuse holder for SC6:Traction 2 (left) is located under the left side cover.

On machines with an engine/generator (model 04580), a single fuse is used to protect the starter/generator. This is a BF1 style fuse located in a separate covered holder under the operator seat.

If a MIDI or BF1 style fuse is removed:

1. Tighten the hex nuts that secure the fuse from **2.3 to 2.8 N·m (20 to 25 in-lb)**.
2. Coat the terminals with battery terminal protector Toro Part No. 107-0392 to reduce corrosion.
3. Install the fuse holder cover and secure it with a new cable tie.

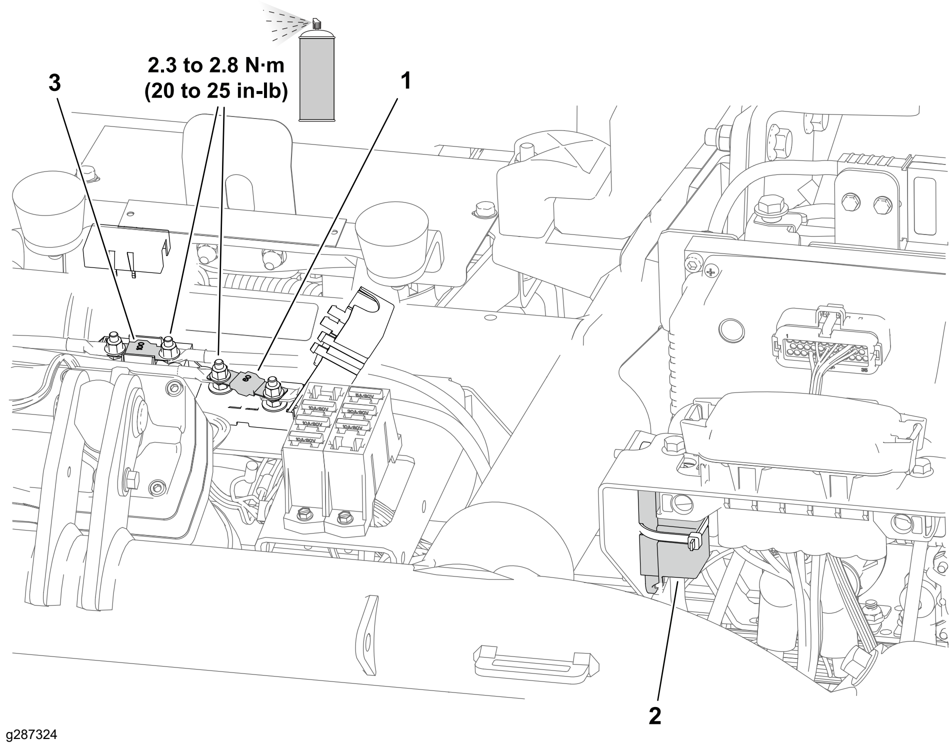


Figure 42

(seat raised and left side cover removed)

1. 60A 70V fuse – SC5: Traction 1 (right) power bus
2. 60A 70V fuse – SC6: Traction 2 (left) power bus
3. 100A 58V fuse – T6: Starter/Generator power bus (model 04580)

For model 04580 machines, the four 12 VDC batteries that make up the 48 VDC battery power supply are protected by a 150A 70V Mega style fuse. For model 04590 machines, the lithium-ion battery pack is protected by a 175A 70V Mega style fuse. The fuse is in a separate covered holder near the 48 VDC battery (main) power disconnect (behind the left side cover).

Identifying the 48 VDC System Fuses and their Functions (continued)

If a Mega style fuse is removed, tighten the hex nuts that secure the fuse from **12 to 17 N·m (9 to 13 ft-lb)**, then coat the terminals with battery terminal protector Toro Part No. 107-0392 to reduce corrosion.

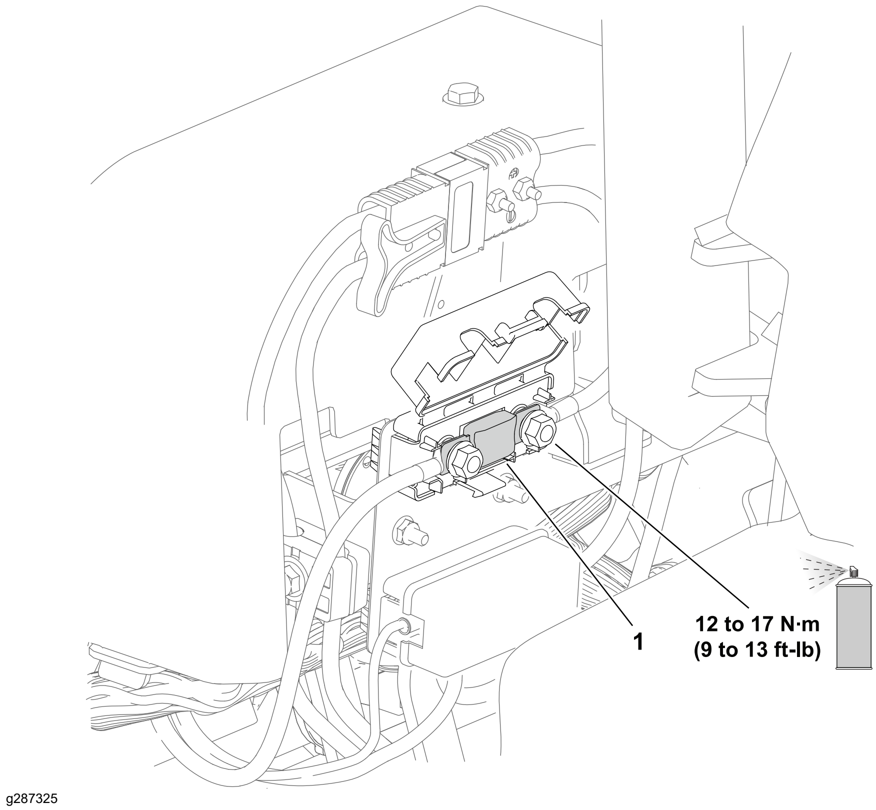


Figure 43

1. 150A 70V fuse (model 04580) or 175A 70V fuse (model 04590)

Testing a Fuse

1. Turn the key switch to the ON position (do not start the engine).
2. With the fuse installed in the fuse holder/block, use a multimeter to check that 12 VDC exists at both terminal test points on the fuse. If 12 VDC exists at 1 of the fuse test points but not at the other, the fuse is damaged.
3. Set the key switch to the OFF position and remove the key from the key switch. Remove the fuse from the fuse holder/block and use a multimeter (ohms setting) to check that the fuse has continuity across the fuse terminals.
4. If the fuse tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

CAN Bus

The machine controllers communicate with each other on a Controller Area Network (CAN) bus system; refer to CAN Bus Communication (page 5–13) for CAN bus operation notes. Controllers that operate on 12 VDC connect to the 12V side of the CAN bus (CAN A), while controllers that operate on 48 VDC connect to the 48V side of the CAN bus (CAN B). A 120 ohm CAN termination resistor is located at each end of CAN A, and at each end of CAN B (4 total); refer to CAN Bus Terminator Resistors (page 5–111).

12V and 48 V CAN Bus (Machine Model 04580)

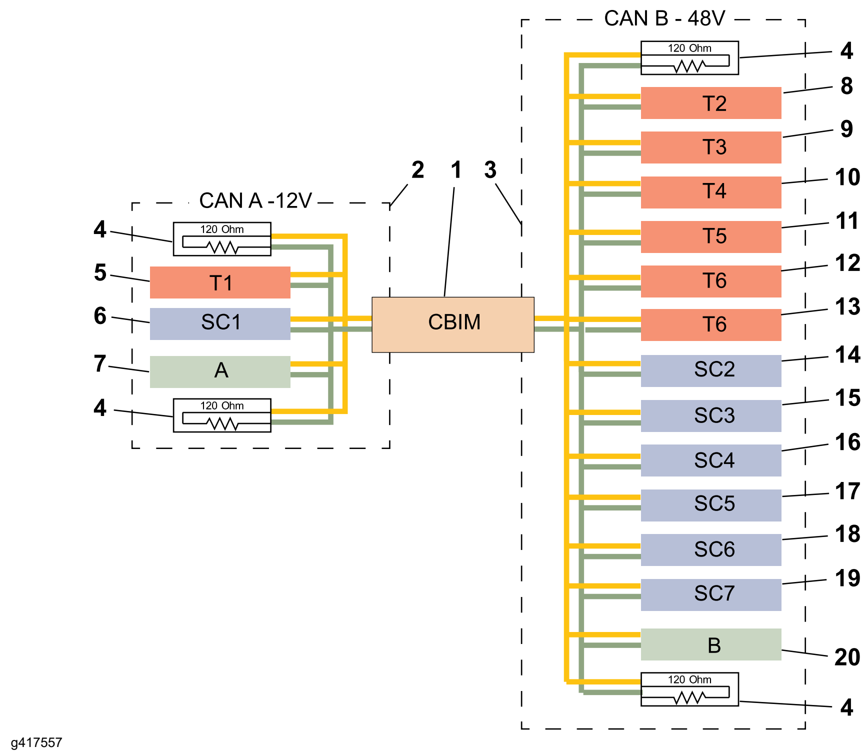


Figure 44

1. CAN bus isolation module
2. CAN A – 12V side
3. CAN B– 48V side
4. CAN bus terminator resistor (4 each)
5. T1: Primary controller
6. SC1: InfoCenter
7. CAN A diagnostic port
8. T2: Cutting Unit 1 motor controller (center)
9. T3: Cutting Unit 2 motor controller (left)
10. T4: Cutting Unit 3 motor controller (right)
11. T5: Traction 3 motor controller (optional)
12. T6: Starter/Generator controller
13. T6: Pre–charge controller
14. SC2: Lift/Lower 1 actuator controller (center)
15. SC3: Lift/Lower 2 actuator controller (left)
16. SC4: Lift/Lower 3 actuator controller (right)
17. SC5: Traction 1 motor controller (right)
18. SC6: Traction 2 motor controller (left)
19. SC7: Steering motor controller
20. CAN B diagnostic port

12V and 48 V CAN Bus (Machine Model 04590)

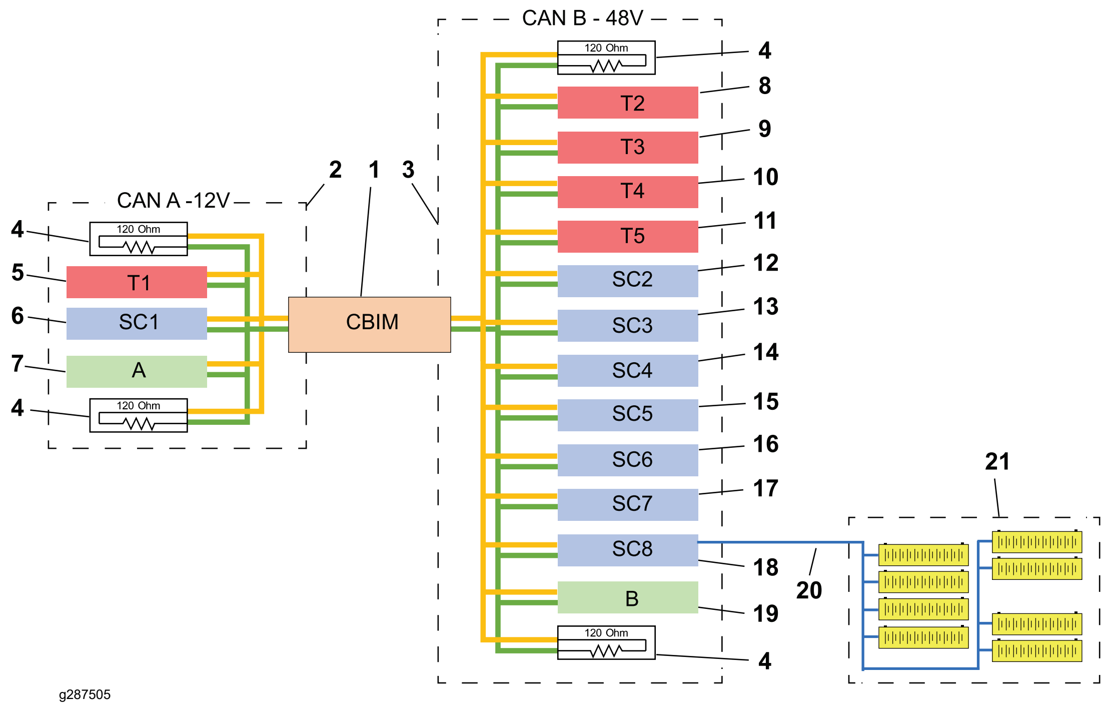


Figure 45

1. CAN bus isolation module
2. CAN A – 12V side
3. CAN B– 48V side
4. CAN bus terminator resistor (4 each)
5. T1: Primary controller
6. SC1: InfoCenter
7. CAN A diagnostic port
8. T2: Cutting Unit 1 motor controller (center)
9. T3: Cutting Unit 2 motor controller (left)
10. T4: Cutting Unit 3 motor controller (right)
11. T5: Traction 3 motor controller (optional)
12. SC2: Lift/Lower 1 actuator controller (center)
13. SC3: Lift/Lower 2 actuator controller (left)
14. SC4: Lift/Lower 3 actuator controller (right)
15. SC5: Traction 1 motor controller (right)
16. SC6: Traction 2 motor controller (left)
17. SC7: Steering motor controller
18. SC8: Lithium-ion Battery controller
19. CAN B diagnostic port
20. Lithium-ion battery interface
21. Lithium-ion batteries

48 V CAN Bus (Machine Model 04591)

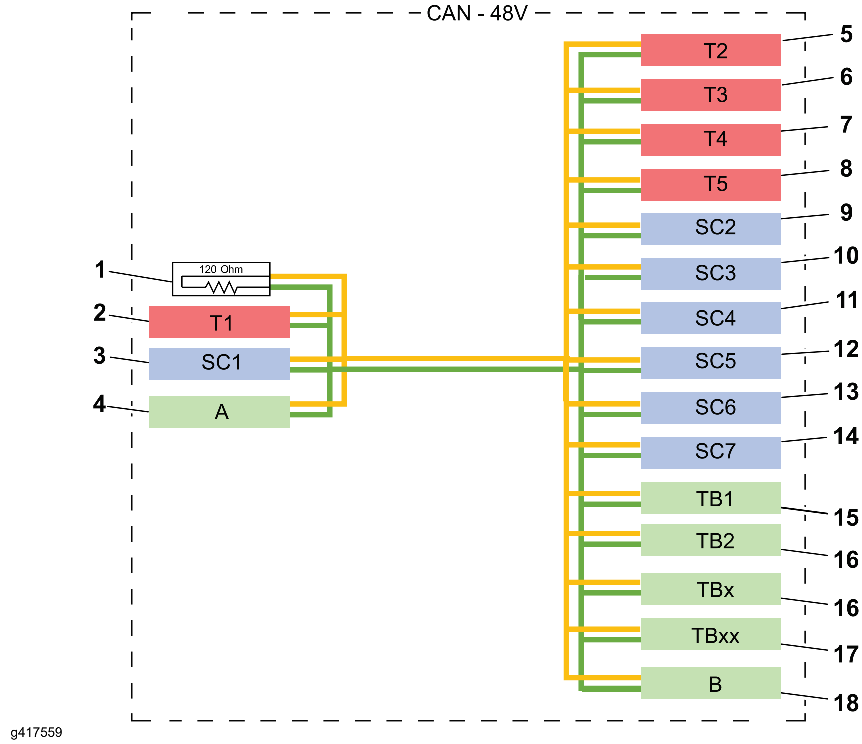


Figure 46

1. CAN bus terminator resistor
2. T1: Primary controller
3. SC1: InfoCenter
4. CAN A diagnostic port
5. T2: Cutting Unit 1 motor controller (center)
6. T3: Cutting Unit 2 motor controller (left)
7. T4: Cutting Unit 3 motor controller (right)
8. T5: Traction 3 motor controller (optional)
9. SC2: Lift/Lower 1 actuator controller (center)
10. SC3: Lift/Lower 2 actuator controller (left)
11. SC4: Lift/Lower 3 actuator controller (right)
12. SC5: Traction 1 motor controller (right)
13. SC6: Traction 2 motor controller (left)
14. SC7: Steering motor controller
15. TB1: Leader battery
16. TB2 through TBx: Support batteries
17. TBxx: last support battery with a 120 Ohm terminating resistor/jumper
18. CAN B diagnostic port

Testing the CAN bus

1. Make sure that key switch is in the OFF position.
2. Remove the right side cover.
3. Locate the CAN bus isolation module and disconnect the machine wire harness connector from the isolation module.

Testing the CAN bus (continued)

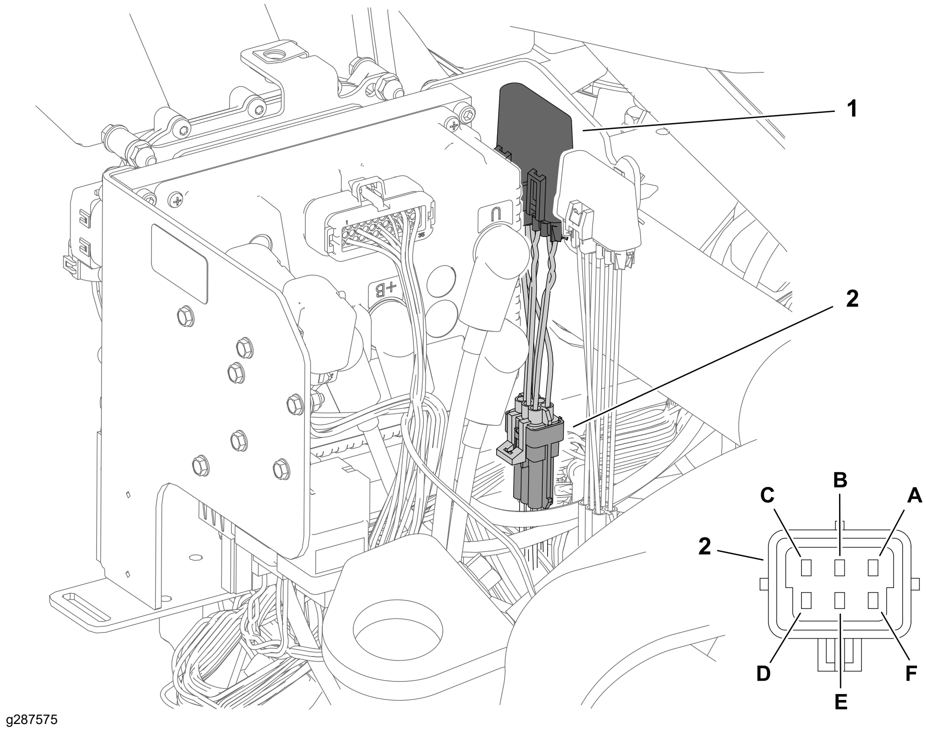


Figure 47

(right side cover removed)

1. CAN bus isolation module
2. Machine wire harness connector

4. Inspect the wiring, inside the wire harness connector, and inside the CAN bus isolation module for damage, corrosion, and the wires are secure to the pins, the pins are secure to the connector, proper fit between all pins and their corresponding sockets. Clean or repair the connector and wiring as necessary.
5. Set the key switch to the ON position.
6. Use a multimeter (DC voltage setting) to check for 12 VDC across terminals A and B of the machine wire harness connector. If no voltage is present, check the wire harness for damage; refer to Appendix A (page A–1).

   Note: There is not a test procedure for the isolation module. Continue testing the remaining components of the CAN bus before replacing the isolation module.
7. Set the key switch to the OFF position.
8. Use a multimeter (ohms setting) to measure and record the resistance of CAN A across the machine wire harness connector terminals C and D, and CAN B across terminals E and F.
   - A reading of 0 to 50 ohms indicates one of the devices (nodes) on the CAN side being tested is faulty; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).
   - A reading of 55 to 65 ohms indicates the CAN side being tested is intact.
   - A reading of 110 to 140 ohms indicates one of the CAN terminator resistors on the CAN side being tested is not connected or damaged; refer to CAN Bus Terminator Resistors (page 5–111).

Testing the CAN bus (continued)

- A reading of 100K to 200k ohms indicates both of the CAN terminator resistors on the CAN side being tested are not connected or damaged; refer to CAN Bus Terminator Resistors (page 5–111).
- A reading of more than 500k ohms indicates damage to the wiring of the CAN side being tested; refer to Appendix A (page A–1).

9. Connect the CAN bus isolation module to the machine wire harness after testing.

Testing Devices (Nodes) on the CAN bus

DEVICE ID	DESCRIPTION	NORMAL RESISTANCE (across CAN + (HI) and CAN – (LOW) terminals)
T1	Primary controller (TEC 5004)	70k to 75k ohms
T2, T3, T4	Cutting Unit motor controllers	150k to 160k ohms
T5	Traction 3 motor controller (optional)	150k to 160k ohms
T6 (04580)	Generator controller (model 04580 only)	150k to 160k ohms
T6 (04590)	Pre–charge controller (model 04590 only)	155k to 165k ohms
SC1	InfoCenter (KanTrak 1700)	2.25k to 2.75k ohms
SC2, SC3, SC4	Lift/Lower actuator controllers	150k to 160k ohms
SC5, SC6	Front traction motor controllers	2.75k to 3.00k ohms
SC7	Steering motor controller	75k to 80k ohms
SC8	Li-ion battery controller (model 04590)	50k to 55k ohms

1. Disconnect the machine wire harness at the device being tested. Check the device and the harness connector for damage or corrosion and clean or repair as necessary.
2. Use a multimeter (ohms setting) to measure and record the resistance across the CAN + (HI) and CAN – (LOW) terminals of the device. Use to the appropriate electrical schematic or wire harness diagram for your machine in to determine the specific device terminals for testing; refer to Appendix A (page A–1).
   - A reading of 0 to 50 ohms indicates the CAN terminals or the CAN transceiver in the device have shorted together. Replace the device as necessary.
   - A reading of more than 500k ohms indicates the CAN terminals or the CAN transceiver in the device have failed (open circuit). Replace the device as necessary.
   - A reading that falls within the resistance range listed for the device should be tested further. Use a multimeter (ohms setting) to measure and record the resistance across the CAN + (HI) terminal and an unpainted surface of the metallic case of the device, and across the CAN – (LOW) terminal and an unpainted surface of the metallic case of the device.

     Note: Devices with a non-metallic case can only be tested across the CAN + (HI) and CAN – (LOW) terminals.

     - A reading of less than 500k ohms indicates the CAN circuit has shorted to ground. Replace the device as necessary.

Testing Devices (Nodes) on the CAN bus (continued)

- A reading of more than 500k ohms indicates the CAN circuit is open and the device being tested is intact.

3. Connect the device to the machine wire harness after testing.

CAN Bus Isolation Module (Models 04580 and 04590)

The CAN bus isolation module is part of the CAN bus. The isolation module brings both sides of the CAN (CAN A – 12 VDC and CAN B – 48 VDC) together so they can communicate as one network. Power for the isolation module is available when the key switch is in the ON or START position. A 7.5 Amp fuse protects all the key switched circuits, including the CAN bus isolation module power circuit. The module plugs into the machine wire harness under the right side cover.

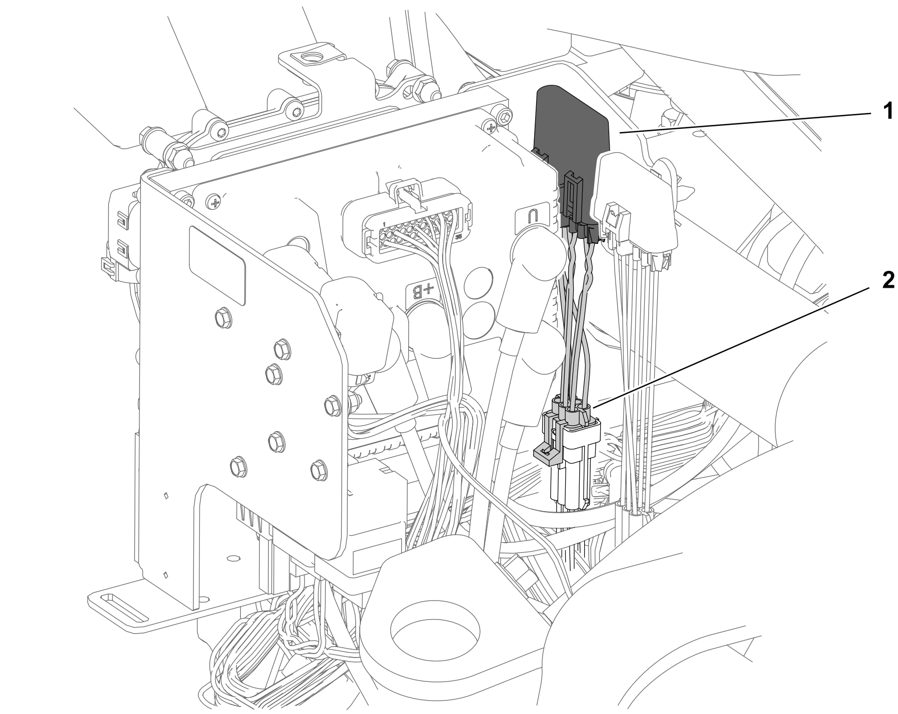


Figure 48

(right side cover removed)

1. CAN bus isolation module
2. Wire harness connector

Testing the CAN bus Isolation Module

There is not a test procedure specifically for the CAN bus isolation module. Test the CAN bus before replacing the isolation module; refer to Testing the CAN bus (page 5–36).

InfoCenter Display

At the time of publication, only the InfoCenter CAN bus transceiver can be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38). There is no additional testing procedure available for the InfoCenter display.

Note: If the InfoCenter display is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

T1: Primary Controller

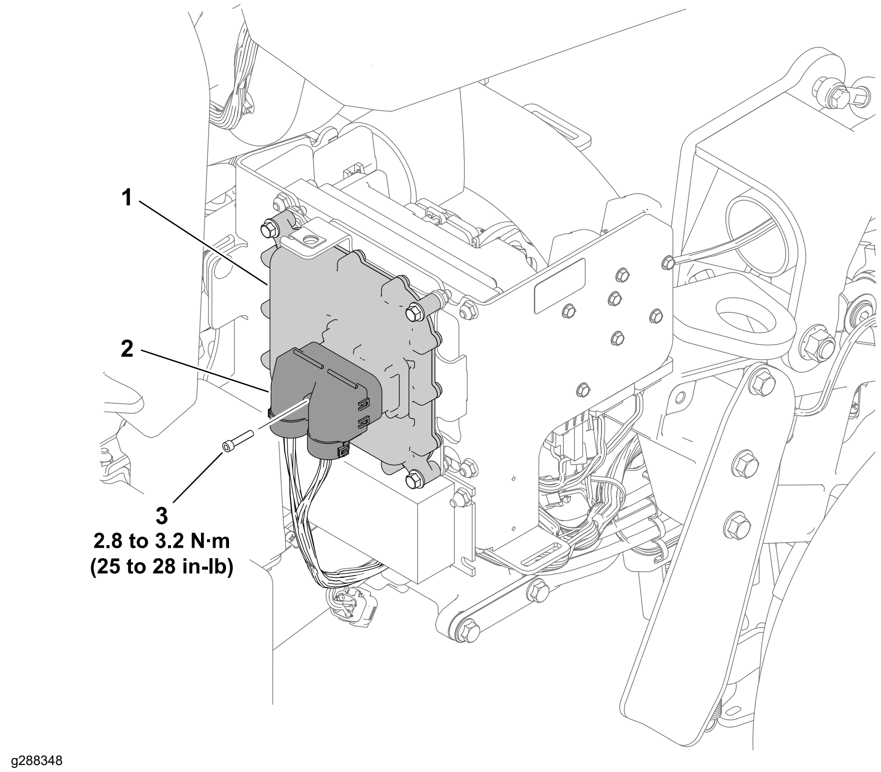


Figure 49

(right side cover removed)

1. T1: Primary controller
2. Machine harness connector
3. Harness connector screw

The eTriFlex machines use a primary controller (T1) to manage machine electrical functions; refer to T1: Primary Controller (page 5–17) for T1: primary controller operation notes. The primary controller is attached to the machine under the right side cover. The logic and memory circuit is protected by a 2 Amp fuse. Power for the primary controller outputs is available when the key switch is in the ON or START position. A 7.5 Amp fuse protects all the key switched circuits, including the primary controller output circuits.

Note: If the primary controller (T1) is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

T1: Primary Controller (continued)

T1: Primary Controller Inputs

INPUT NUMBER	DESCRIPTION
IN 1	Not Used
IN 2	Cutting Unit Raise Switch
IN 3	Cutting Unit Lower Switch
IN 4	Manual Parking Brake Switch
IN 5	Seat Switch
IN 6	Engine Oil Pressure Switch (Model 04580)
IN 7	Function Control Switch – Neutral position
IN 8	Function Control Switch – Mow position
IN 9	Function Control Switch – Transport position
IN 10	Not Used

INPUT NUMBER	DESCRIPTION
IN 11	Not Used
IN 12	Not Used
IN 13	Not Used
IN 14	Not Used
AIN1	Not Used
AIN2	Not Used
AIN3	Not Used
AIN4	Not Used
AIN5	Not Used
AIN6	Not Used

T1: Primary Controller Outputs

OUTPUT NUMBER	DESCRIPTION
OUT 1	Logic Relay
OUT 2	Engine Control (Model 04580)
OUT 3	Automatic Parking Brake Relay
OUT 4	Not Used
OUT 5	Not Used
OUT 6	Not Used
OUT 7	Not Used
OUT 8	Not Used
OUT 9	Not Used

OUTPUT NUMBER	DESCRIPTION
OUT 10	Not Used
OUT 11	Not Used
OUT 12	Not Used
OUT 13	Not Used
OUT 14	Not Used
OUT 15	Not Used
OUT 16	Steering Feedback
OUT LS	Not Used

The machine electrical schematic and wire harness drawings in Appendix A (page A–1) can be used to identify possible circuit problems between the controller and the input or output devices (e.g., switches and relays).

T1: Primary Controller (continued)

IMPORTANT

When testing for wire harness continuity at the connector for the controller, take care to not damage the connector pins with multimeter test leads. If connector pins are enlarged or damaged during testing, connector repair may be necessary for proper machine operation.

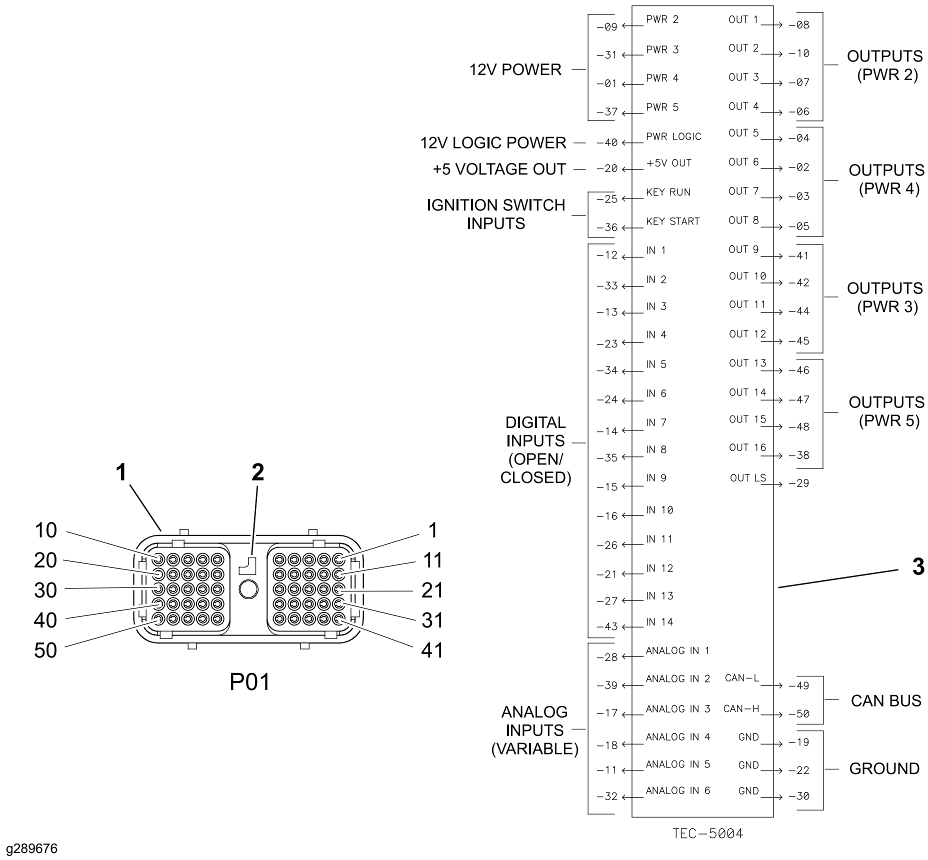


Figure 50

1. Machine wire harness connector P01
2. Tab
3. T1: Primary controller

A 50 pin platform wire harness connector is attached to the controller. The connection terminal function for the controller and the wire harness connector pins are shown above. If the wire harness connector is removed from the T1: primary controller for any reason, tighten the harness connector screw from **2.8 to 3.2 N·m (25 to 28 in-lb)**.

Because of the solid state circuitry built into the controller, there is no method to test the controller directly. A controller may be damaged if an attempt is made to test it with an electrical test device (e.g., digital multimeter or test light).

Starter/Generator (Model 04580)

The starter/generator is a 48 VDC, air cooled, brushless, permanent magnet device. To operate, the starter/generator requires 48V logic power (supplied by the logic relay). The starter/generator supplies power to all the 48V components using the 48V power bus when the main contactor and traction motor contactor are energized. Since the 48V batteries are connected to the 48V power bus, the starter/generator also charges the 48V batteries.

The starter/generator has its own on-board controller. The starter/generator and the T6: starter/generator controller can be replaced separately if necessary. The InfoCenter can be used to monitor starter/generator activity during machine operation; refer to InfoCenter Display (page 5–11).

The starter/generator is not serviceable, and is best tested by using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If the starter/generator controller is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

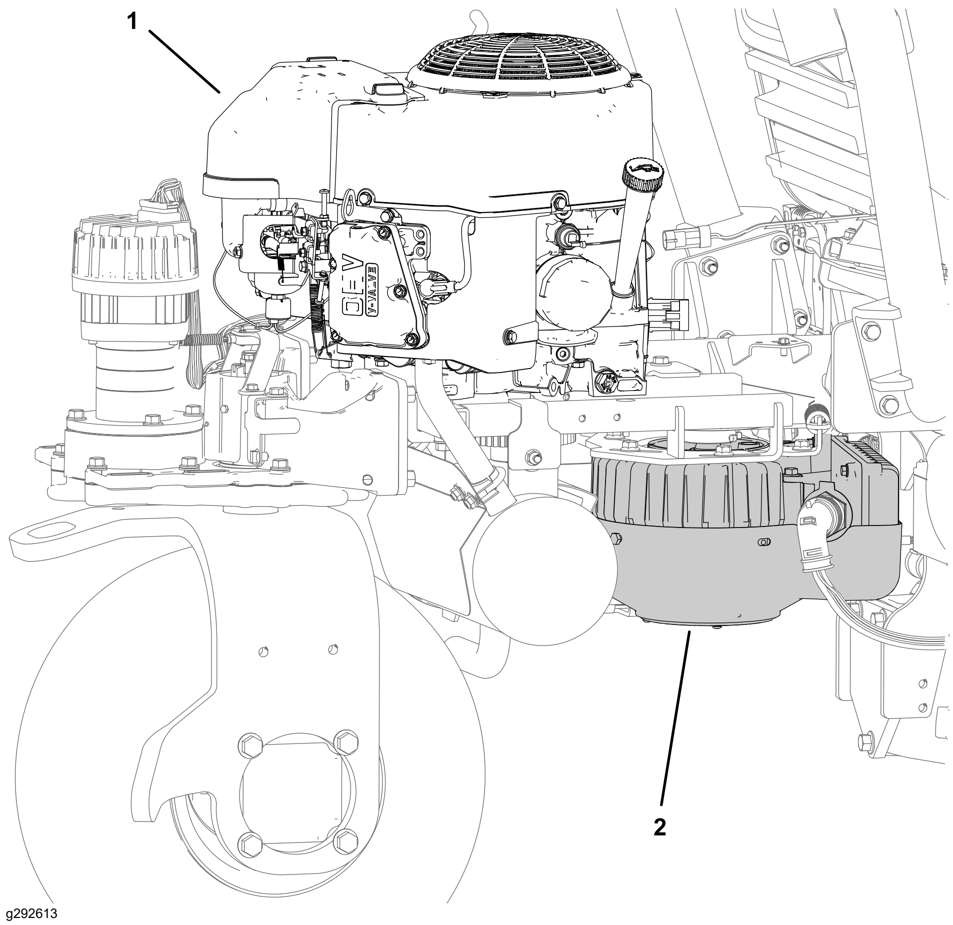


Figure 51

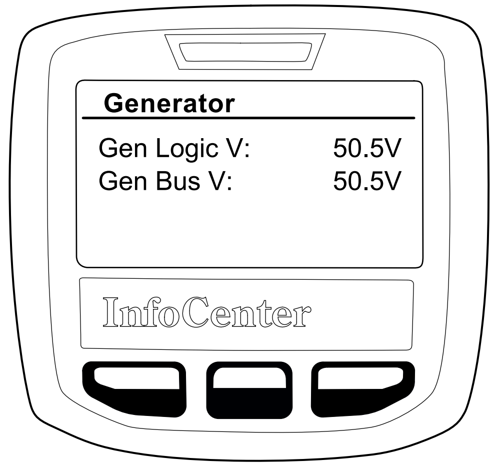
1. Engine
2. Generator

Testing the Starter/Generator

1. Park the machine on a level surface, lower the cutting units, and set the key switch to the OFF position.
2. Engage the manual parking brake and set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.

Testing the Starter/Generator (continued)

4. Access the InfoCenter **Diagnostics > Generator > Inputs** screen.



g292336

Figure 52

48V system voltage should be present at the starter/generator logic circuit **Gen Logic V** and at the starter/generator power bus circuit **Gen Bus V**.

- If – – – appears, the controller is not communicating on the CAN bus.

  Voltage must be present at the controller logic circuit before communication can occur on the CAN bus. If voltage is not present at the logic circuit, the logic circuit is damaged. The circuit wiring should be checked for corrosion or damage and cleaned or repaired as necessary.

  If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The starter/generator controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).

- If 00.0V is present at the starter/generator power bus circuit, the power bus circuit is damaged. The circuit wiring should be checked and repaired as necessary.

5. Access the InfoCenter **Main Information** screen.

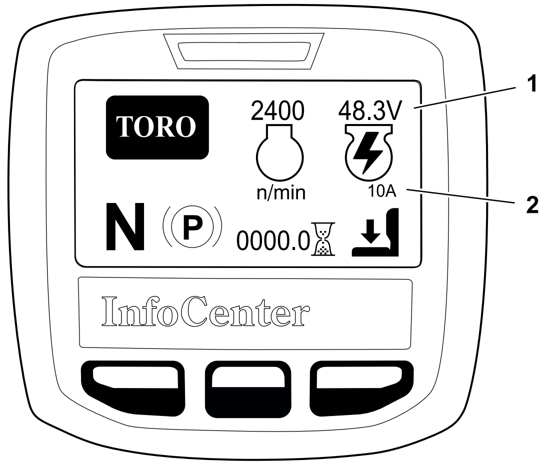


Figure 53

1. System voltage
2. Generator output

6. Start the engine and verify the engine is operating at approximately 2,400 rpm.
   - If the batteries require charging (system voltage below 52V), the generator output should read from 3A to 10A.
   - If the batteries are fully charged (system voltage above 54V), the generator output should read at or near 0A
7. If the InfoCenter diagnostics inputs report normally and the starter/generator output is out of range, repair or replace the starter/generator or starter/generator controller; refer to Generator Assembly (Model 04580) (page 5–165). If the starter/generator controller is replaced, update the machine software; contact an Authorized Toro Distributor.

SC8: Lithium-Ion Battery Controller (Model 04590)

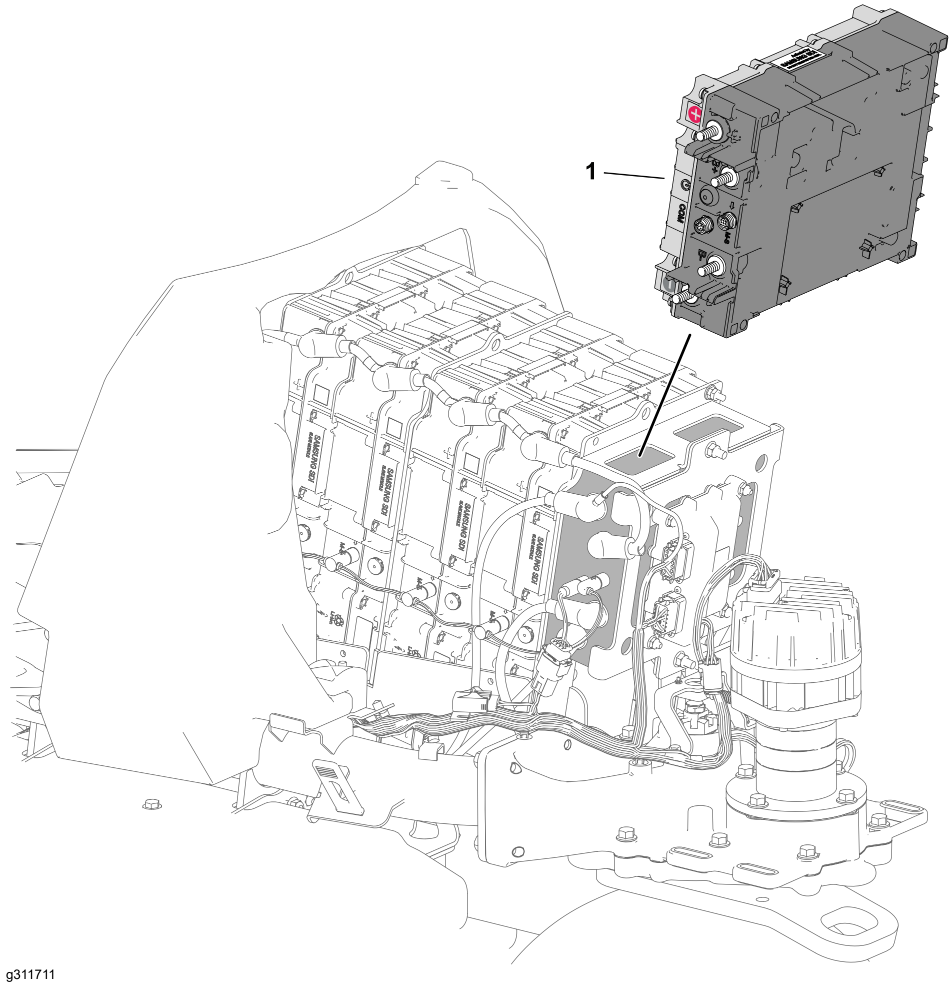


Figure 54
(shown with hood removed)

1. SC8: Lithium–ion battery controller

The eTriFlex 3370 uses a Lithium-ion battery controller or Battery Management System (BMS) to manage the lithium-ion batteries; refer to SC8: Lithium-Ion Battery Controller (Model 04590) (page 5–18) for SC8: lithium-ion battery controller operation notes. The BMS is located under the hood attached to the back of the center mounted batteries.

Note: If the SC8: Lithium-Ion Battery Controller is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

Testing the SC8: Lithium-Ion Battery Controller (Model 04590)

Although there is no method to test the solid state circuitry built into the controller directly, some aspects of the lithium-ion battery controller operation can be tested as follows; refer to Figure 55.

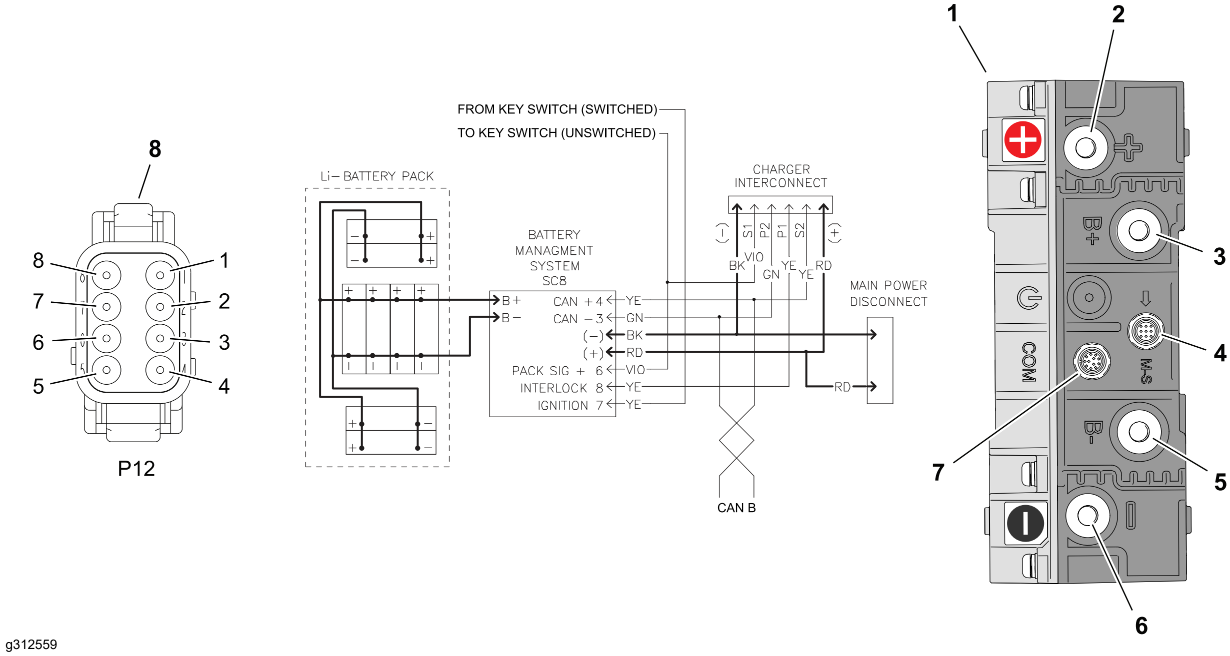


Figure 55

1. Lithium-Ion battery controller (BMS)
2. Positive (+) terminal (power supply positive (+) cable)
3. +B terminal (positive (+) battery cable)
4. M-S terminal (battery interface harness)
5. –B terminal (negative (-) battery cable)
6. Negative (-) terminal (power supply negative (-) cable)
7. COM terminal (machine wire harness)
8. Controller wire harness connector

- With the batteries connected to the BMS, the battery pack voltage can be tested across the BMS +B and –B terminals.
- With the batteries connected to the BMS, signal voltage from the BMS to the key switch can be tested at the controller wire harness connector P12 pin 6 and the BMS B- terminal.
- An audible "Click" should come from the BMS shortly after the key switch is set to the On position. The "Click" sound indicates the contactor inside the BMS has closed and battery power should be available to the machine.
- Once the BMS internal contactor has closed, battery pack voltage can be tested across the BMS positive (+) and negative (–) terminals.
- If CAN bus communication with the controller is suspect, the CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The lithium-ion battery controller CAN bus transceiver can also be tested if necessary using the controller wire harness connector P12 pins 3 and 4; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).

Removing and Installing the SC8: Lithium-Ion Battery Controller (Model 04590)

CAUTION

To prevent accidentally shorting disconnected battery cables across other components or tools, insulate the battery cable terminals with 76 mm (3 inch) lengths of 1/2 inch internal diameter rubber hose immediately after disconnecting the cables.

Removing and Installing the SC8: Lithium-Ion Battery Controller (Model 04590) (continued)

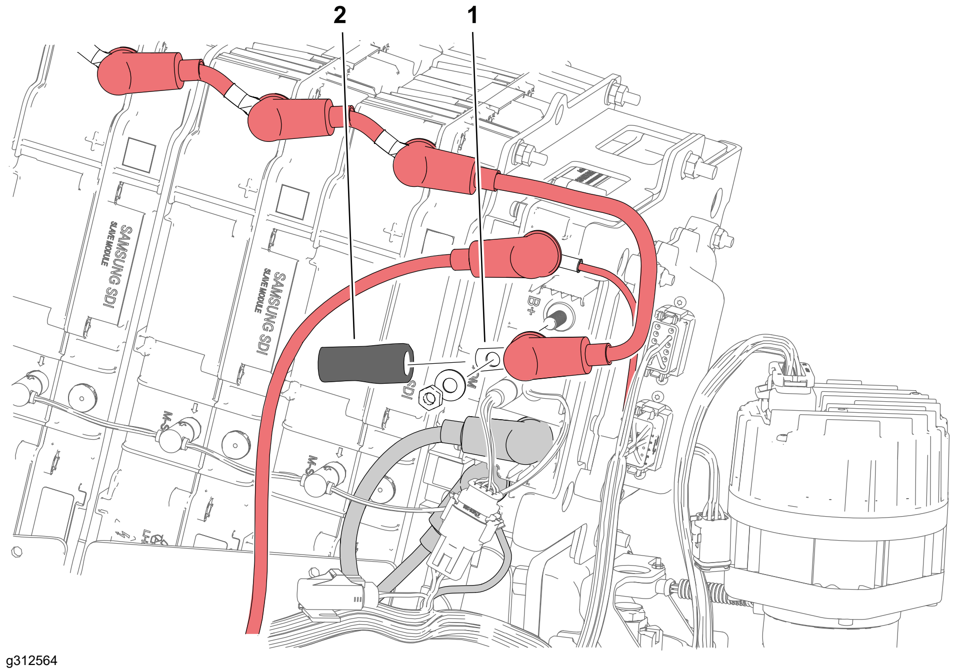


Figure 56

1. Battery cable terminal (typical)
2. 1/2 inch ID rubber hose

CAUTION

Do not open the lithium-Ion battery controller. There are no serviceable parts on or in the lithium-ion battery controller case. If you open the controller case, you will void the warranty. The controller case is protected by tamper-alerting devices. Opening the controller case may result in personal injury and property damage.

---

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Label and disconnect the negative (-) battery cable, positive (+) battery cable from the lithium-ion battery controller –B- and +B terminals.

Removing and Installing the SC8: Lithium-Ion Battery Controller (Model 04590) (continued)

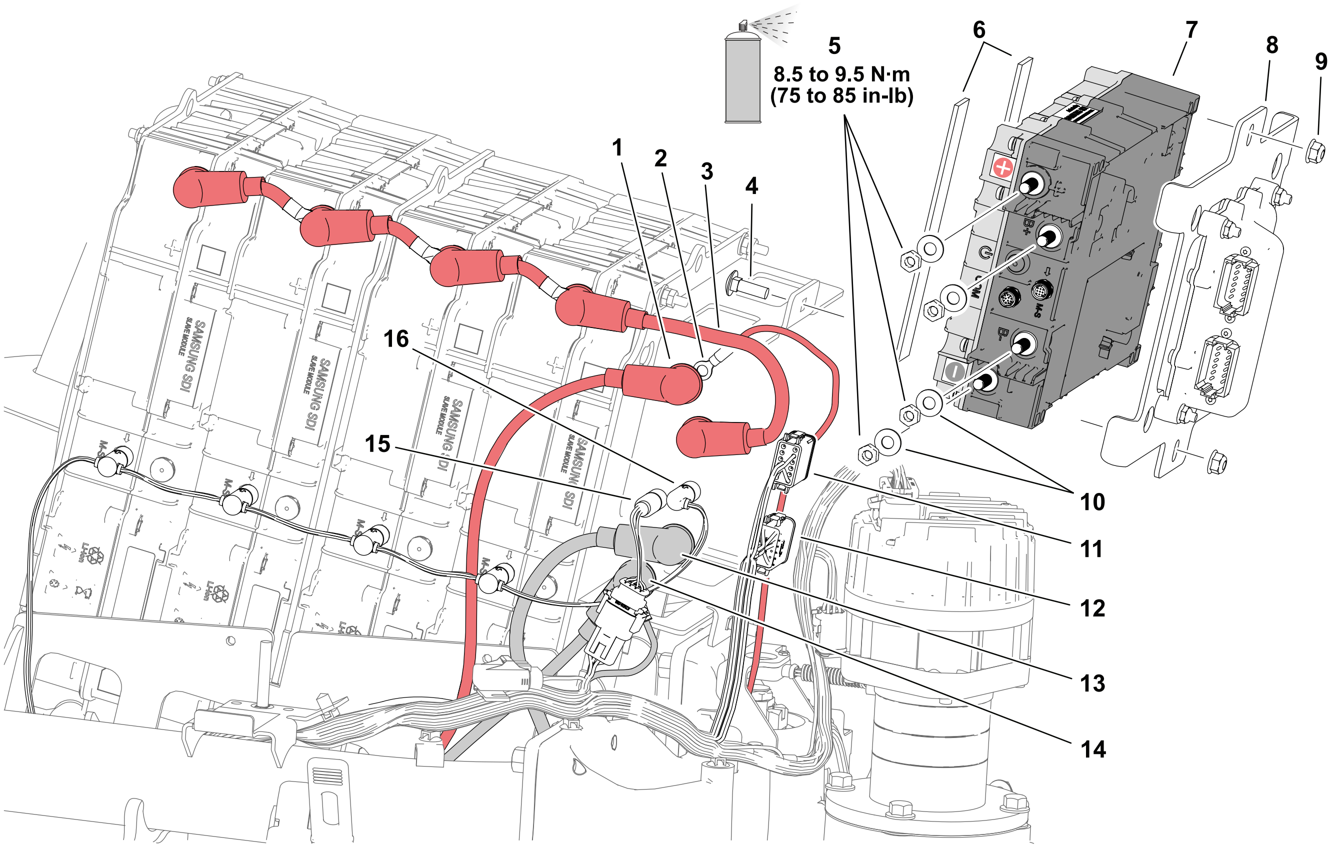


Figure 57

1. Power supply positive (+) cable
2. Machine wire harness positive (+) cable
3. Positive (+) battery cable
4. Carriage bolt (2 each)
5. Hex nut (4 each)
6. Foam strip (2 each)
7. SC8: lithium-ion battery controller (BMS)
8. Controller bracket and T6: precharge controller assembly
9. Flange nut (2 each)
10. Washer (4 each)
11. T6: precharge controller wire harness connector P03 (black)
12. T6: precharge controller wire harness connector P02 (gray)
13. Negative (-) battery cable
14. Power supply negative (-) cable
15. Controller wire harness connector
16. Battery interface harness

4. Label and disconnect the battery interface harness and the machine wire harness connector from the lithium-ion battery controller.
5. Label and disconnect the machine wire harness negative (-) and positive (+) cables from the lithium-ion battery controller negative (–) and positive (+) terminals.
6. Label and remove the power supply negative (-) and positive (+) cables from the lithium-ion battery controller negative (–) and positive (+) terminals.
7. Remove the controller bracket and T6: precharge controller assembly from the battery tray.
8. Remove the SC8: lithium-ion battery controller from the machine.
9. Check the foam strips for damage or wear and replace them if necessary.

Removing and Installing the SC8: Lithium-Ion Battery Controller (Model 04590) (continued)

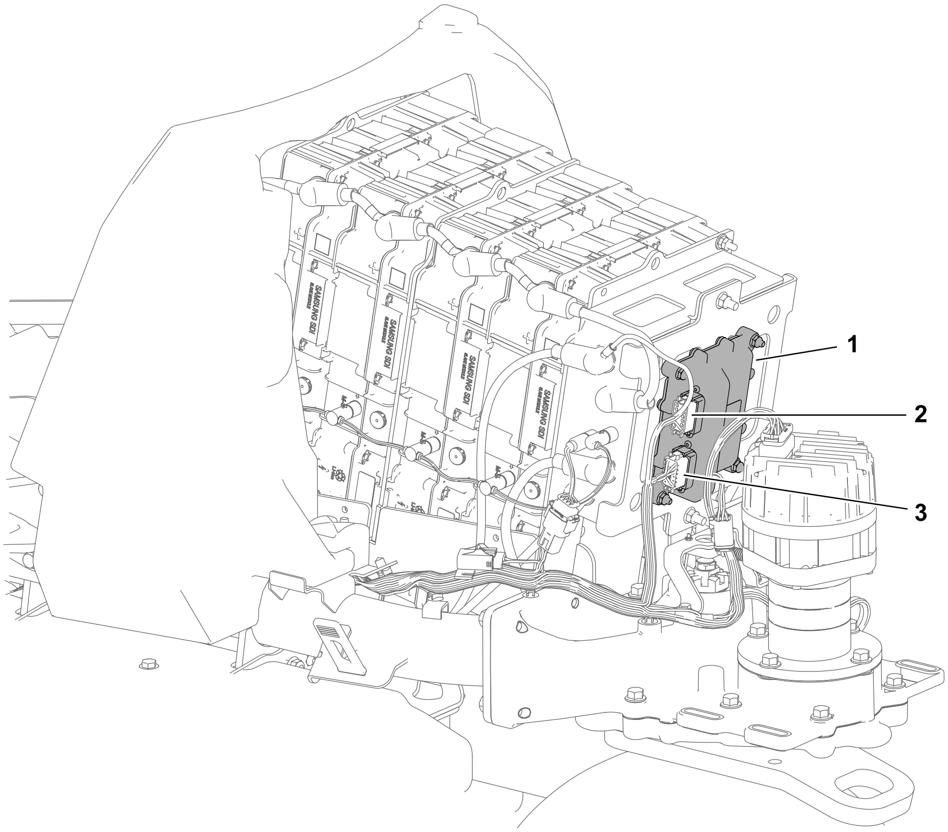
CAUTION

Pay close attention to the lithium-ion battery controller orientation during installation. Ensure that the lithium-ion battery controller is installed in the proper orientation prior to connecting any cables. Failure to do so may result in personal injury and property damage.

10. Install the lithium-ion battery controller in reverse order. Install the controller with the positive (+) terminals upward; refer to Figure 57.

11. Tighten the power supply and battery cable fasteners from **8.5 to 9.5 N·m (75 to 85 in-lb)**, then apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the battery terminals and cable connectors to reduce corrosion.

T6: Precharge Controller (Models 04590 and 04591)



g311004

Figure 58

Machine Model 045690 (shown with hood removed)

1. T6: Precharge controller
2. Machine wire harness connector P03 (black)
3. Machine wire harness connector P02 (gray)

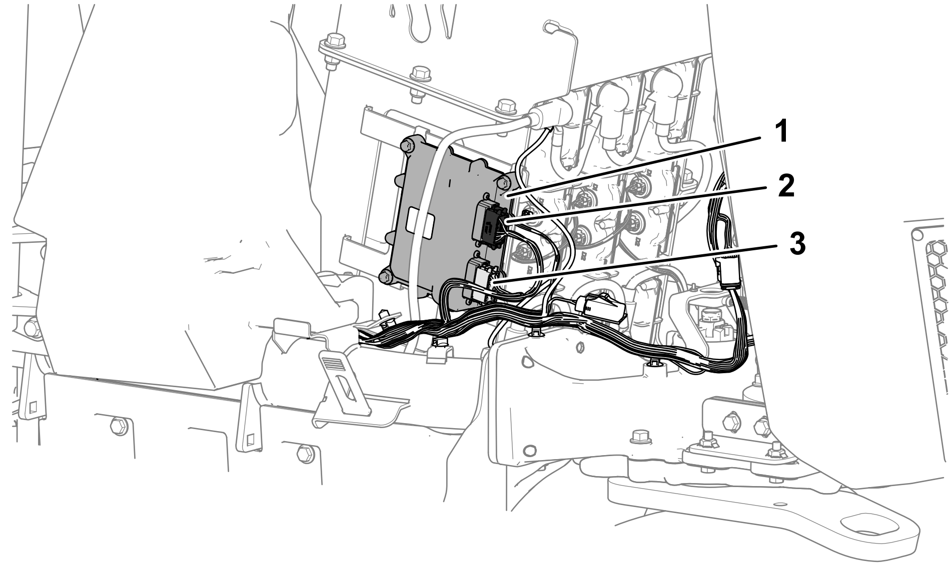


Figure 59

Machine Model 045691

1. T6: Precharge controller
2. Machine wire harness connector P03 (black)
3. Machine wire harness connector P02 (gray)

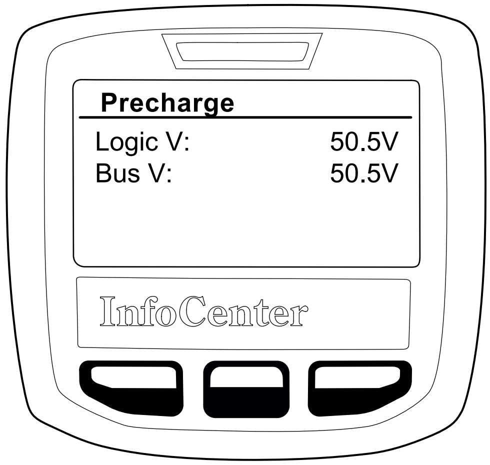
The eTriFlex 3370 uses a TEC 2400 series microcontroller as a precharge controller (T6) to manage the precharge function; refer to T6: Precharge Controller (Models 04590 and 04591) (page 5–20) for T6: precharge controller operation notes. The precharge controller is located under the hood attached to the back of the center mounted battery assembly. Power for the precharge controller logic circuit is available when the key switch is set to the ON position (switched). The logic circuit is protected by a 3 Amp fuse. Power for the precharge controller outputs is available when the logic relay is energized.

Note: If the precharge controller (T6) is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

Testing the T6: Precharge Controller (Models 04590 and 04591)

Although there is no method to test the solid state circuitry built into the controller directly, some aspects of the precharge controller operation are visible using the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45).

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.
4. Access the InfoCenter **Diagnostics > Precharge > Inputs** screen.



g311218

Figure 60

Logic V

- If 48V system voltage is present, the T1: primary controller has energized the logic relay and power is being supplied to the precharge controller precharge input (connector P02 pin 6).
- If – – – appears, the controller is not communicating on the CAN bus. Voltage must be present at the controller logic circuit (connector P03 pin 6) before communication can occur on the CAN bus.

  If voltage is not present at the logic circuit, the logic circuit fuse or logic circuit wiring is damaged. The fuse and circuit wiring should be checked for corrosion or damage and cleaned, repaired, or replaced as necessary.

  If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The precharge controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).
- If 00.0V is present, the logic relay or logic circuit wiring is damaged. The relay and circuit wiring should be checked for corrosion or damage and cleaned, repaired, or replaced as necessary.

Bus V

- If 48V system voltage is present, the main contactor has closed and 48V bus voltage is present at the precharge controller precharge output (connector P02 pin 3). To achieve this, the T1: primary controller has commanded the T6: precharge controller using a CAN message to provide a path to ground (precharge controller OUT 2) for the 48 VDC main contactor coil to energize and close the main contactor . Precharge was successful.
- If 00.0V is present, the main contactor or circuit wiring (including the precharge controller OUT 2 circuit) is damaged. The contactor and circuit wiring should be checked for corrosion or damage and cleaned, repaired, or replaced as necessary.

T6: Precharge Controller Inputs

T6: Precharge Controller Inputs (continued)

INPUT NUMBER	DESCRIPTION
Precharge	Logic Relay Switch On
IN 1	Not Used
IN 2	Not Used
IN 3	Not Used
IN 4	Not Used

INPUT NUMBER	DESCRIPTION
IN 5	Not Used
IN 6	Not Used
IN 7	Not Used
IN 8	Not Used
AIN1	Not Used

T6: Precharge Controller Outputs

OUTPUT NUMBER	DESCRIPTION
OUT 1	Not Used
OUT 2	Main Contactor Coil (ground)
N/C 1	Not Used
N/C 2	Not Used

OUTPUT NUMBER	DESCRIPTION
Precharge	Precharge Voltage to Reel Motors, Lift Actuators, 3WD Traction (opt)
5 VDC OUT	Not Used
12 VDC OUT	Not Used

The machine electrical schematic and wire harness drawings in Appendix A (page A–1) can be used to identify possible circuit problems between the controller and the input or output devices (e.g., switches and relays).

IMPORTANT

When testing for wire harness continuity at the connector for the controller, take care to not damage the connector pins with multimeter test leads. If connector pins are enlarged or damaged during testing, connector repair may be necessary for proper machine operation.

Testing the T6: Precharge Controller (Models 04590 and 04591) (continued)

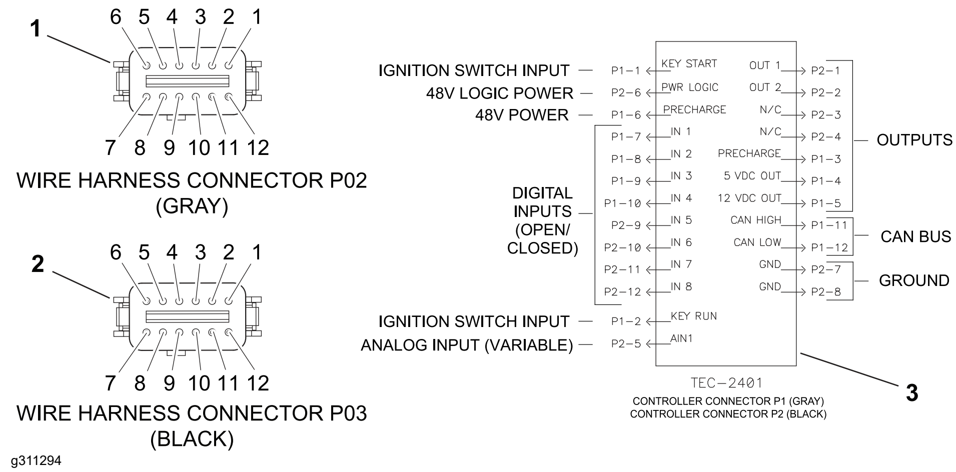


Figure 61

1. Machine wire harness connector P02 (gray)
2. Machine wire harness connector P03 (black)
3. T6: Precharge controller

Two 12 pin wire harness connectors are attached to the controller. The connection terminal function for the controller and the wire harness connector pins are shown above. The connectors are keyed the same. Pay close attention to the wire harness connector color and the controller connector color (gray wire harness connector attaches to gray controller connector).

48 VDC/12 VDC Converter (Models 04590 and 04591)

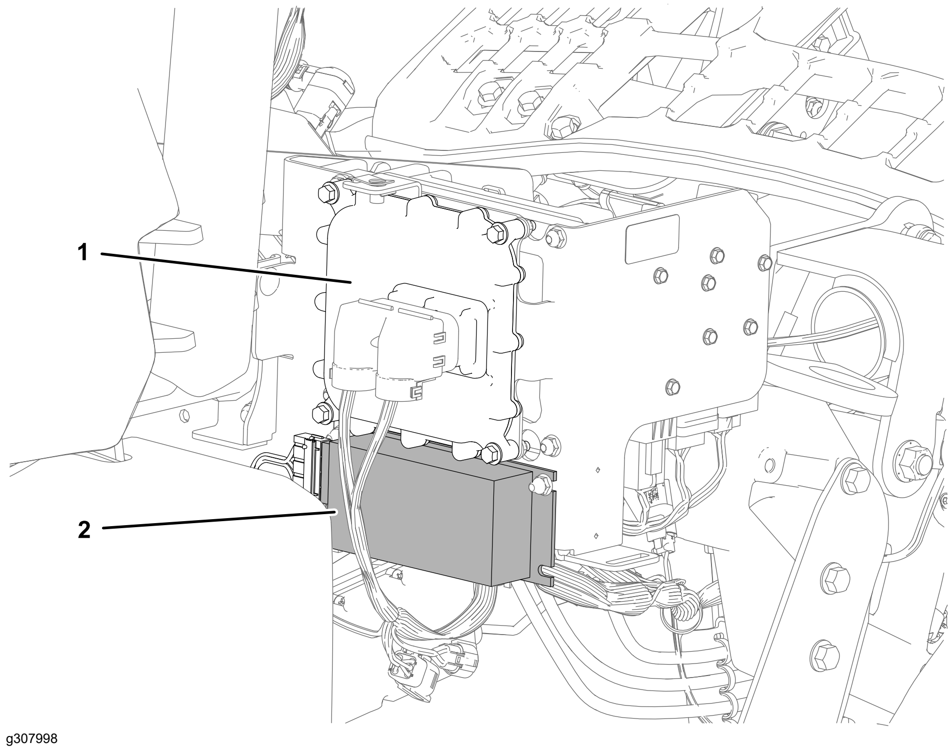


Figure 62

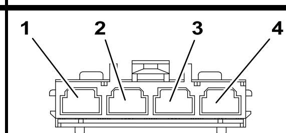
1. T1: Primary Controller
2. 48 VDC/12 VDC Converter

The 48V battery pack and the 48 VDC/12 VDC converter are used to supply the 12 VDC electrical system with power. The 48 VDC/12 VDC converter is located under the right side cover below the T1: primary controller.

Testing the 48 VDC/12 VDC Converter

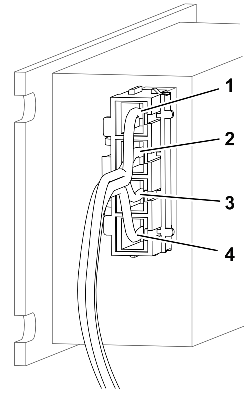
The 48 VDC/12 VDC converter and its circuit wiring can be tested using the InfoCenter splash screen (battery icon); refer to Using the InfoCenter Display for Troubleshooting (page 3–45). If testing determines that the converter and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the switch.
2. Remove the right side cover.
3. Disconnect the 48 VDC/12 VDC converter from the machine wire harness. Check the harness connectors for damage or corrosion and clean or repair as necessary. Use a multimeter (VDC setting) to check the machine wire harness connector.

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	Main	P07	3	Black/White	48 VDC (nominal)	
2	Main	P07	4	Tan		

4. Connect the 48 VDC/12 VDC converter to the machine wire harness. Use a multimeter (VDC setting) to check the machine wire harness connector (from the back of the connector).

Testing the 48 VDC/12 VDC Converter (continued)

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	Main	P07	1	Black	12 VDC (nominal)	
2	Main	P07	2	Red		

5. If testing determines the converter is faulty, replace the converter.
6. If the converter tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

Front Traction Motor Controllers

The front traction motor controllers are separate from the motors, and control each motor individually. The right side controller (SC5: Traction 1) is located under the right side cover, and controls the right side traction motor. The left side controller (SC6: Traction 2) is located under the left side cover, and controls the left side traction motor.

To operate, the front traction motor controllers require 48V logic power (supplied by the logic relay) and require a connection to the 48V power bus (supplied by the traction motor contactor when energized). The traction motor controllers communicate with the primary controller using the CAN bus. Each front traction motor controller passes 48V power along to its respective traction motor as needed. The traction motors themselves are not directly on the CAN bus.

Each traction motor controller includes a red alarm LED located between the motor phase U and V terminals. When the key switch is set to the ON position, the LED should flash once or twice than stop, indicating the controller is receiving power and is properly grounded. If the LED continues to flash, a traction motor controller alarm is active and a specific fault code should appear on the InfoCenter display; refer to Machine Faults (page 3–8).

The traction motor controller is not serviceable, and is best tested by using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If either traction motor controller is replaced, the machine software must be updated; contact an Authorized Toro Distributor for assistance. If the right traction motor controller (SC5) is replaced, the traction pedal must be calibrated and then the front traction motors must be calibrated. If the left traction motor controller (SC6) is replaced, the front traction motors must be calibrated.

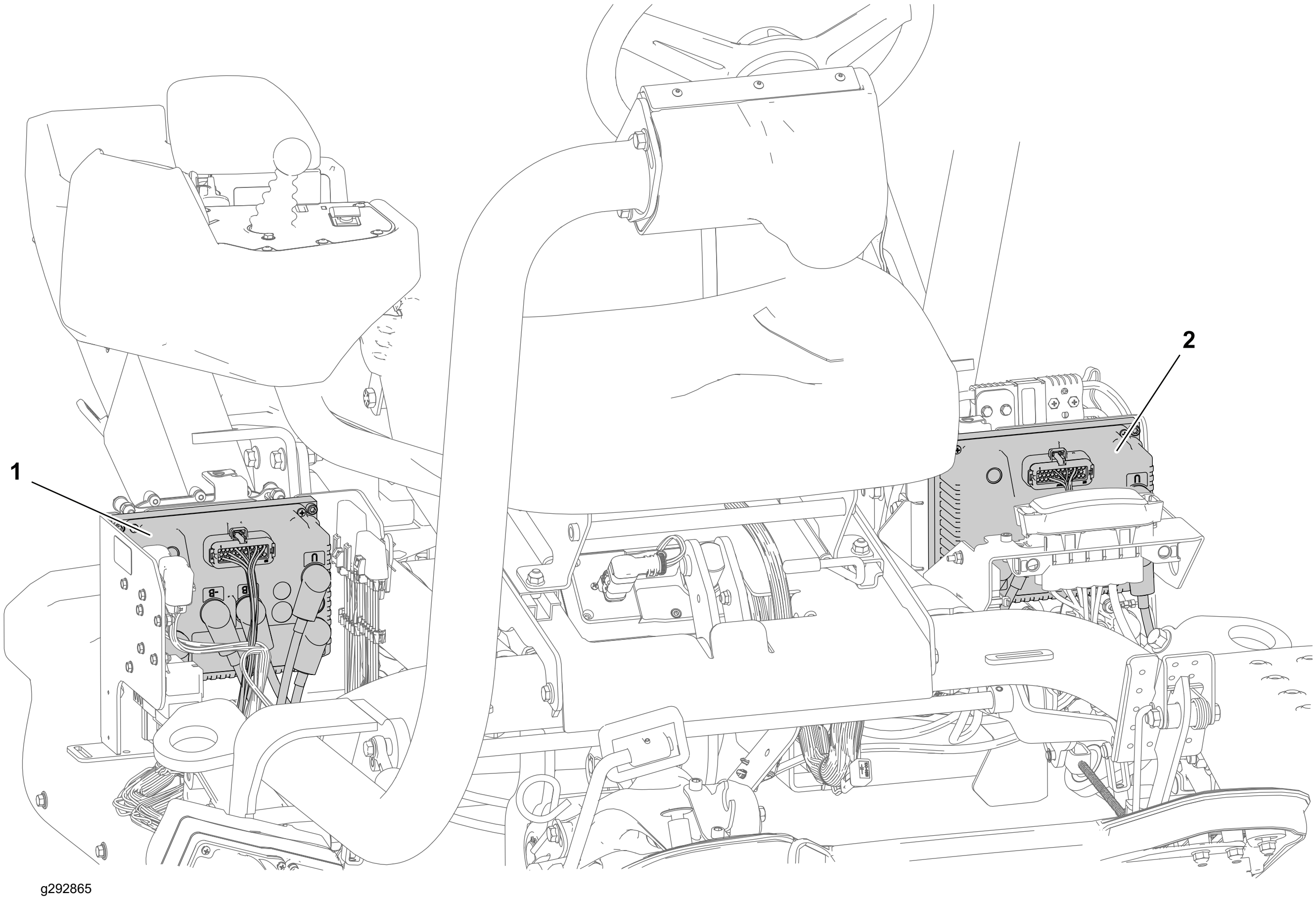


Figure 63

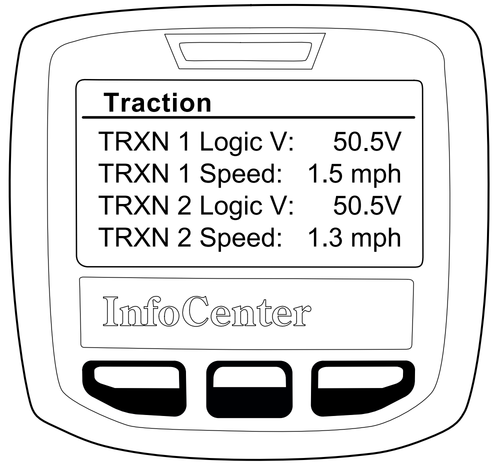
1. SC5: Traction 1 (right side)
2. SC6: Traction 2 (left side)

Testing the Front Traction Motor Controllers

The InfoCenter Display can also be used to monitor the current draw for the traction motors during machine operation. During operation, some variance in the traction motor current draw is expected even when driving straight.

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.
4. Access the InfoCenter **Diagnostics > Traction > Inputs** screen.

Testing the Front Traction Motor Controllers (continued)



g292803

Figure 64

(Machine turning to the left)

5. 48V system voltage should be present at the traction motor controller logic circuit **TRXN # Logic V**.
   - If – – – appears, the controller is not communicating on the CAN bus. Voltage must be present at the controller logic circuit before communication can occur on the CAN bus.

     If voltage is not present at the logic circuit, the logic circuit is damaged. The circuit wiring should be checked for corrosion or damage and cleaned or repaired as necessary.

     If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The traction motor controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).
   - Traction motor speed should be displayed while the traction motors are engaged **TRXN # Speed**. Individual traction motor speed is related to the current turning radius (RDS).

IMPORTANT

Allow the traction motor controller to fully discharge before disconnecting the wire harness or any of the controller cables. Use a digital multimeter to measure the voltage across the controller –B and +B terminals. If the output voltage is greater than 1 VDC, wait 15 minutes and measure the output voltage again. Continue measuring the output voltage until it is less than 1 VDC.

6. Locate the front traction motor controller and disconnect it from the machine wire harness. Check the controller connector and the harness connector for damage or corrosion and clean or repair as necessary. Ensure all the connector pins are equally seated in the connector body.
7. Inspect the front traction motor controller cable connections for damage or corrosion and clean or repair as necessary. Tighten the cable connections from **7.9 to 8.3 N·m (70 to 74 in-lb)**.

Testing the Front Traction Motor Controllers (continued)

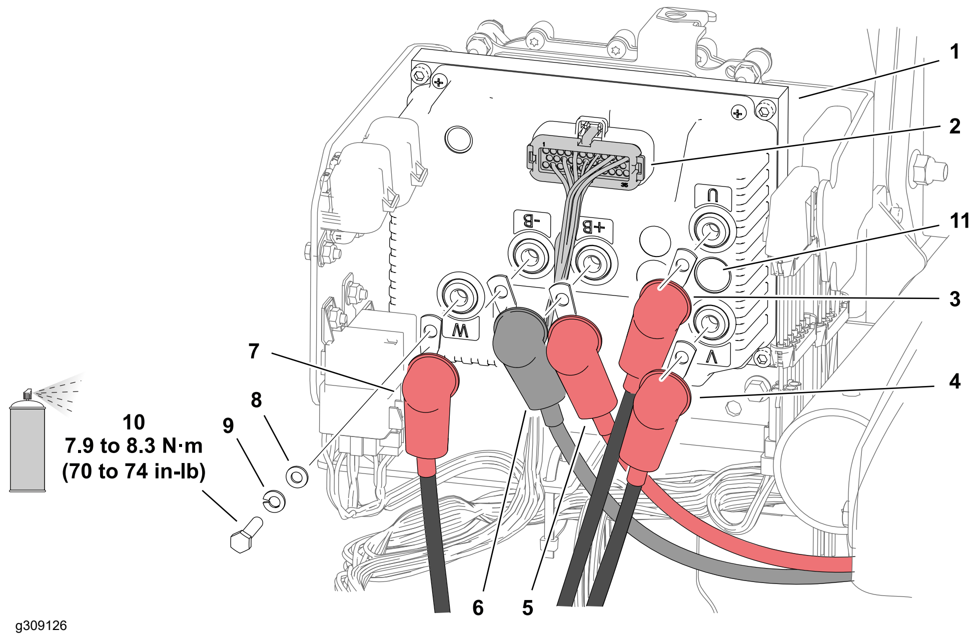


Figure 65

1. Front traction motor controller (SC5: Traction 1 shown)
2. Multi-pin wire harness connector
3. Cable – motor phase (U)
4. Cable – motor phase (V)
5. Cable – battery positive (+)
6. Cable – battery positive (-)
7. Cable – motor phase (W)
8. Washer (5 each)
9. Lock washer (5 each)
10. Cap screw (5 each)
11. Red alarm LED

---

8. If the InfoCenter diagnostics inputs report normally and traction motor operation is an issue, test the traction motor; refer to Front Traction Motor (page 5–64).

Replacing The Traction Motor Controller

1. Disconnect the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

IMPORTANT

Allow the traction motor controller to fully discharge before disconnecting the wire harness or any of the controller cables. Use a digital multimeter to measure the voltage across the controller –B and +B terminals. If the output voltage is greater than 1 VDC, wait 15 minutes and measure the output voltage again. Continue measuring the output voltage until it is less than 1 VDC.

2. Disconnect the harness connector from the front traction motor controller.
3. Label and disconnect the cables from the front traction motor controller.
4. Remove the controller assembly from the machine.
5. Secure the new controller to the machine with the previously removed fasteners and connect the cables to the controller. Tighten the cable connections from **7.9 to 8.3 N·m (70 to 74 in-lb)**.

Replacing The Traction Motor Controller (continued)

6. Connect the wire harness connector to the front traction motor controller.

IMPORTANT

Do not allow aerosol protectant to spray into the front traction motor controller multi-pin connector. Install the wire harness connector or cover the connector before applying spray protectant. Spray protectant can adversely affect the precise fit of a multi-pin connector.

7. Lift the rubber boots from the cable terminals and coat the terminals with battery terminal protector Toro Part No. 107-0392 to reduce corrosion. Fit the rubber boots securely over the terminals.
8. Update the machine software; contact an Authorized Toro Distributor for assistance.
9. Calibrate the traction motor controller; refer to Traction Motor Controller Calibration Requirements (page 5–63).

Traction Motor Controller Calibration Requirements

Right Traction Controller

If the right traction motor controller (SC5) is replaced, the following calibrations must be completed before returning the machine to service:

- **Traction pedal calibration—**refer to Calibrating the Traction Pedal Position Sensor (page 5–97)
- **Front Traction Motor Calibration—**refer to Calibrating the Front Traction Motors (page 5–177)

Left Traction Controller

If the left traction motor controller (SC6) is replaced, the following calibrations must be completed before returning the machine to service:

Front Traction Motor Calibration—refer to Calibrating the Front Traction Motors (page 5–177)

Front Traction Motor

The two front traction motors are brushless permanent magnet motors located directly behind the front wheels. Each motor is attached to an oil filled gear box with an internal disc brake. Each motor includes a rotary encoder to recognize the motor speed. The front motor controllers are separate from the motors and control each motor individually. The right side controller (SC5: Traction 1) controls the right side traction motor and the left side controller (SC6: Traction 2) controls the left side traction motor. The traction motors receive operation power from their respective motor controllers. The traction motors are not directly connected to the CAN bus.

Note: If a front traction motor is removed or replaced for any reason, the front traction motors must be calibrated.

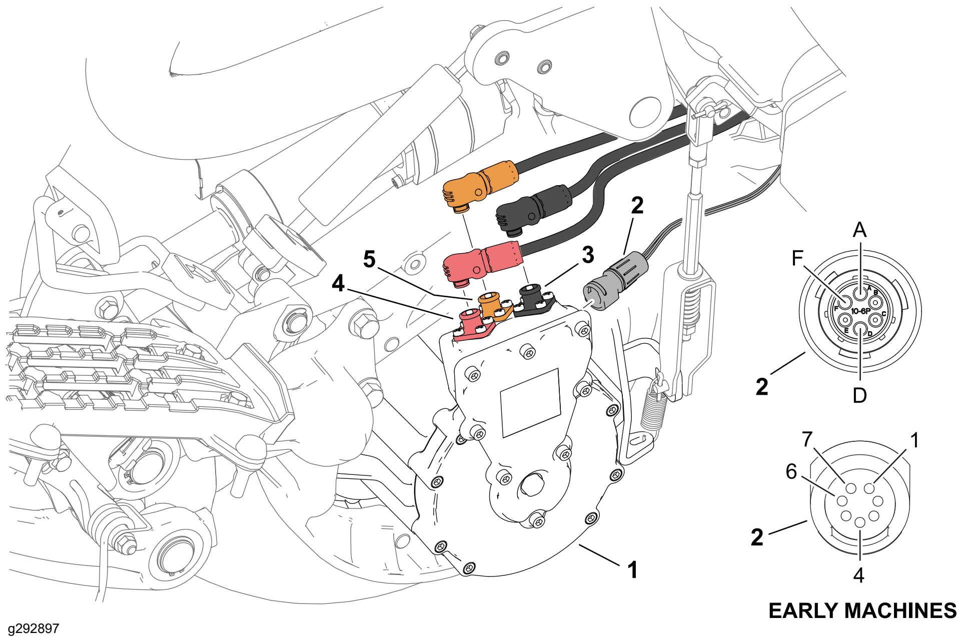


Figure 66

(right side traction motor shown)

1. Traction Motor
2. Wire harness connector
3. Motor terminal – U (black)
4. Motor terminal – W (red)
5. Motor terminal – V (orange)

Testing the Front Traction Motors

The InfoCenter Display can be used to monitor the current draw for the traction motors during machine operation. During operation, some variance in the traction motor current draw is expected even when driving straight.

Perform the steps in Testing the Machine Wire Harness (page 5–65) then the steps in Testing Traction Motor Continuity (page 5–65).

Note: If you suspect that traction motor performance is a problem, do the following **before** testing the traction motor:

- Ensure the tire pressures are in balance.
- Ensure the rear caster fork is in alignment; Aligning the Rear Wheel Caster Fork (page 6–8).

Testing the Front Traction Motors (continued)

- Ensure the brake system is not engaging (dragging) during operation; refer to Adjusting the Brakes (page 6–3).
- Try to calibrate the traction motors; refer to Calibrating the Front Traction Motors (page 5–177).

Testing the Machine Wire Harness

Refer to Figure 66 for this procedure.

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Set the function control switch to the NEUTRAL position.
3. Locate and disconnect the multi-pin machine wire harness connector from the traction motor. Check the motor and the harness connector for damage or corrosion and clean or repair as necessary.
4. Set the key switch to the ON position.
5. Use a multimeter (DC voltage setting) to confirm 12 VDC is present at the wire harness connector terminal 1.
6. Set the key switch to the OFF position.
7. Use a multimeter (ohms setting) to confirm continuity to the 48V ground bus at the machine wire harness connector pins 4, 6 and 7.
8. Repair the machine wire harness if necessary; refer to Appendix A (page A–1).

Testing Traction Motor Continuity

1. Disconnect the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
2. Label the 3 traction motor power cables at the traction motor, then press the release on the side of the connectors and disconnect the cables from the traction motor.
3. Use a multimeter (ohms setting) to confirm continuity across each combination of the motor terminals (black to red, black to orange, orange to red).
4. If the front traction motor fails the test, perform the following procedures:
   - Removing the Front Traction Motor (page 5–176)
   - Installing the Front Traction Motor (page 5–177)
   - Calibrating the Front Traction Motors (page 5–177)

Rear Wheel Traction Motor (Optional 3WD)

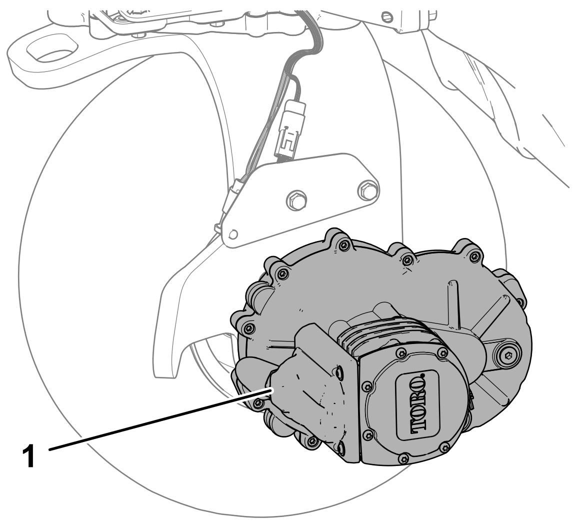
The rear wheel traction motor is a 48 VDC, brushless, permanent magnet motor. The rear wheel traction motor has its own on-board controller (T5).

If a problem exists with the rear wheel traction motor, a fault code may show on the InfoCenter display. Before considering that rear wheel traction motor service work is necessary, check for any existing fault codes that indicate problems with the rear wheel traction motor; refer to Machine Faults (page 3–8). If the rear wheel traction motor is faulty, there will likely be numerous fault codes that are listed by the InfoCenter display.

To operate, the rear wheel traction motor requires 48V logic power (supplied by the logic relay), and a connection to the 48V power bus (supplied by the main contactor when energized).

The traction motor controller is not serviceable, and is best tested by using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If the rear wheel traction motor is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.



g417817

Figure 67

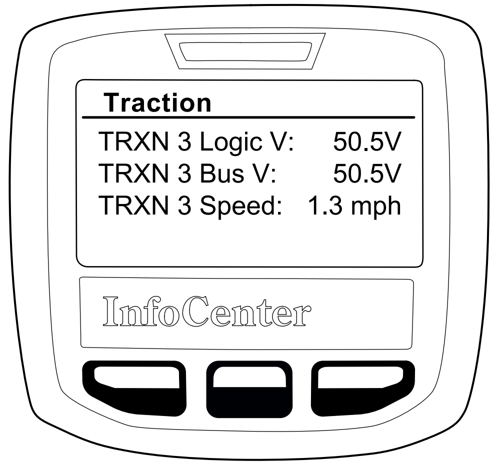
1. Rear wheel traction motor and controller (T5)

Testing the Rear Wheel Traction Motor

The InfoCenter Display can also be used to monitor the current draw for the traction motors during machine operation. During operation, some variance in the traction motor current draw is expected even when driving straight.

1. Park the machine on a level surface, lower the cutting units, and set the key switch to the OFF position.
2. Set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.
4. Access the InfoCenter **Diagnostics > Traction > Inputs** screen.

Testing the Rear Wheel Traction Motor (continued)



g292899

Figure 68

5. 48V system voltage should be present at the traction motor controller logic circuit **TRXN 3 Logic V** and at the rear wheel traction motor power bus circuit **TRXN 3 Bus V**.
   - If – – – appears, the controller is not communicating on the CAN bus. Voltage must be present at the controller logic circuit before communication can occur on the CAN bus.

     If voltage is not present at the logic circuit, the logic circuit is damaged. The circuit wiring should be checked for corrosion or damage and cleaned or repaired as necessary.

     If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The rear wheel traction motor controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).
   - If 00.0V is present at the rear wheel traction motor power bus circuit, the circuit is damaged. The circuit wiring should be checked and repaired as necessary.
   - Rear wheel traction motor speed should be displayed while the traction motor is engaged **TRXN 3 Speed**.
6. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
7. Locate and disconnect the rear wheel traction motor cable electrical connections at the machine wire harness. Check the motor and the harness connector for damage or corrosion and clean or repair as necessary.
8. If rear wheel traction motor removal, installation, disassembly or assembly is required; refer to Rear Traction Motor (Optional) (page 5–178).
9. If the motor tests correctly and a problem still exits, check the rear wheel traction motor circuit wiring; refer to Appendix A (page A–1).
10. After testing is complete, secure the rear wheel traction motor wire harness connectors and connect the 48V battery disconnect.

Steering Input Device

The steering input device is mounted to the steering arm behind the steering wheel. The steering input device includes a hall effect sensor that reports the steering wheel position to the SC7: Steering Motor. The steering input device sensors operate on 5 VDC supplied by the steering motor. The steering input device is not directly connected to the CAN bus.

The steering input device also includes a brake coil which creates drag (feedback) for a more “natural” feel when turning the steering wheel. The brake coil is controlled by a pulse width modulated (PWM) signal from the T1: Primary controller.

The steering input device is not serviceable, and is best tested by using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If the steering input device is removed or replaced for any reason, the steering system – center must be calibrated; refer to Calibrating the Steering System – Center (page 5–100).

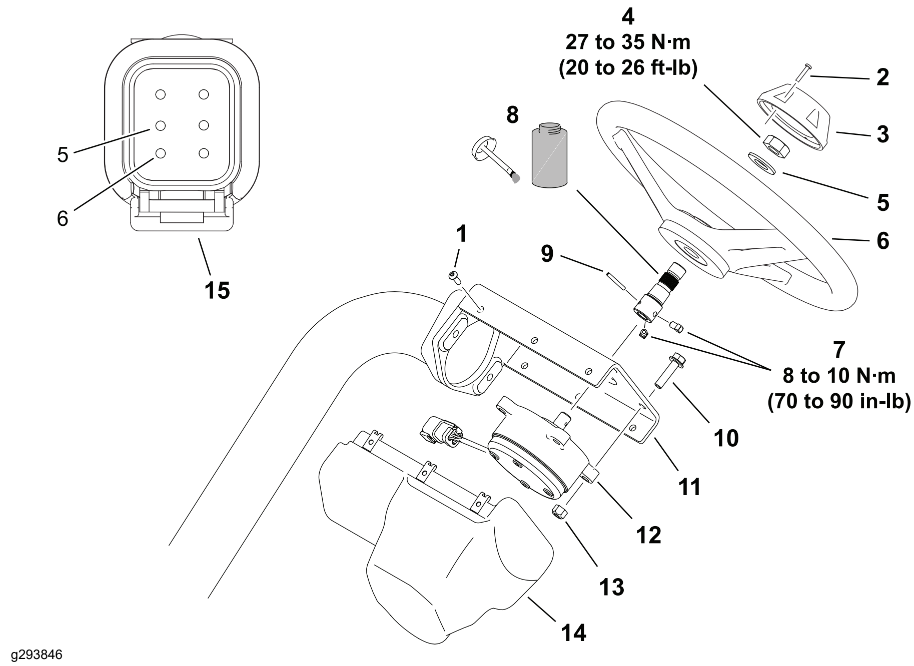


Figure 69

1. Button head screw (6 each)
2. Screw
3. Cap
4. Hex nut
5. Washer
6. Steering wheel
7. Set screw (2 each)
8. Shaft adapter
9. Roll pin
10. Flange head screw (4 each)
11. Steering mount
12. Steering input device
13. Lock nut (4 each)
14. Cover
15. Device wire harness connector

Testing the Steering Input Device

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Engage the manual parking brake and set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.

Testing the Steering Input Device (continued)

4. Access the InfoCenter **Diagnostics > Steering > Inputs** screen.

g293809

Figure 70

5. The steering input device sensor signal voltage characteristics are:
   - **St Wheel Sig 1** and **St Wheel Sig 2** voltages should decrease as you turn the steering wheel to the right (clockwise).
   - **St Wheel Sig 1** and **St Wheel Sig 2** voltages should increase as you turn the steering wheel to the left (counterclockwise).
   - The signal voltage range should be from 0.2V to 4.7V.
   - When the signal voltage reaches either end of the voltage range, the voltage will reset and continue to increase or decrease as you continue to turn the steering wheel.
   - The signal voltage should change from minimum to maximum in approximately one complete revolution of the steering wheel.
   - The difference between the 2 signal voltages should always be approximately 2.5V.
6. Access the InfoCenter **Diagnostics > Steering > Outputs** screen.

g293810

Figure 71
(steering wheel at rest)

Testing the Steering Input Device (continued)

7. **St Wheel Feel** is the amount of current being sent by the T1: Primary controller to the steering input device brake coil, and not necessarily what is being received by the coil. The steering input device brake coil amperage characteristics are:
   - **St Wheel Feel** should be approximately 220 mA when the steering wheel is at rest or turned slowly in either direction.
   - **St Wheel Feel** should be approximately 600 mA when the steering wheel reaches the end of its turning range in either direction.
   - **St Wheel Feel** should vary between 220 and 480 mA when the steering wheel is turned quickly in either direction.
8. Remove the cover from the steering mount.
9. Disconnect the steering input device from the machine wire harness. Check both connectors for corrosion or damage and clean or repair as necessary.
10. Use a multimeter (ohms setting) to measure the resistance of the brake coil across the steering input device connector pins 5 and 6. Resistance should be approximately **10 ohms at 20° C (68° F)**.
11. If the InfoCenter diagnostics inputs and outputs report normally, the brake coil resistance measures correctly, and the steering input device does not function properly, replace the steering device; refer to Steering Arm Assembly (page 6–35).
12. If the steering input device tests correctly and a circuit problem still exists, check the machine wire harness; refer to Appendix A (page A–1).
13. After testing, connect the machine wire harness, install the cover, and calibrate the steering system – center: refer to Calibrating the Steering System – Center (page 5–100).

Steering Motor

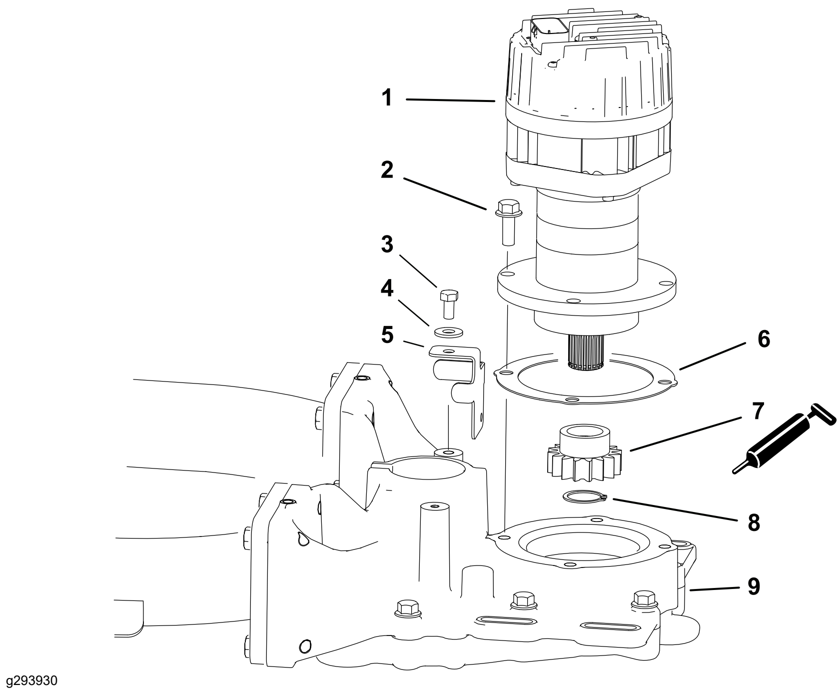


Figure 72

1. Steering motor
2. Flange head screw (4 each)
3. Cap screw
4. Washer
5. Bracket – harness
6. Gasket
7. Pinion gear
8. Retaining ring
9. Steering gear box housing

The steering motor is mounted to the steering gear box housing over the rear wheel caster fork. The steering motor has its own on-board controller (SC7). To operate, the steering motor requires 48V logic power (supplied by the logic relay), a connection to the 48V power bus, and a connection to the CAN bus to send and receive control messages. The steering motor is always connected to the 48V power bus, and is not controlled by the main contactor.

The steering motor is not serviceable, and is best tested using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If the steering motor (SC7) is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance. If the steering motor is replaced or removed for any reason, the steering system must be calibrated. Calibrate the steering system – center first, then calibrate the steering system – range; refer to Calibrating the Steering System – Center (page 5–100) and Calibrating the Steering System – Range (page 5–100).

Testing the Steering Motor

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.
4. Access the InfoCenter **Diagnostics > Steering > Inputs** screen.

Testing the Steering Motor (continued)

g293903

Figure 73

5. 48V system voltage should be present at the steering motor controller logic circuit **Logic Voltage**.

   • If – – – appears, the controller is not communicating on the CAN bus.

   Note: Voltage must be present at the controller logic circuit before communication can occur on the CAN bus.

   If voltage is not present at the logic circuit, the logic circuit is damaged. The circuit wiring should be checked for corrosion or damage and cleaned or repaired as necessary.

   If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage, and cleaned or repaired as necessary. The steering motor controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).

6. Sit in the operator seat and set the key switch to the ON position.

7. Access the InfoCenter **Diagnostics > Steering > Outputs** screen.

g293810

Figure 74

(steering wheel at rest)

- **Mtr Current** should read 0A while the steering motor is stationary.

Testing the Steering Motor (continued)

- Turning the steering wheel in both directions. The current required to move the rear caster wheel should appear next to **Mtr Current** while the steering motor is moving.
- The amount of current required to turn the rear caster wheel should not exceed 6A.

8. Locate the steering motor and disconnect it from the machine wire harness. Check the motor connector and the harness connector for damage or corrosion, and clean or repair as necessary. Ensure all the connector pins are equally seated in the connector body.
9. If the InfoCenter diagnostics inputs and outputs report normally and the steering motor does not function properly, replace the steering motor; refer to Figure 72.
   A. Record the orientation of the steering motor prior to removal.
   B. Remove the fasteners securing the steering motor to the upper steering housing and remove the steering motor. Locate and discard the steering motor gasket.
   C. Remove and replace the retaining ring and the pinion gear from the motor shaft if necessary. Apply a light coating of high temperature grease (Mobil XHP-222 or equivalent) to the pinion gear teeth.
   D. Use a new steering motor gasket, orient the steering motor as previously recorded, and install the steering motor.
   E. Update the machine software; contact an Authorized Toro Distributor.
10. Calibrate the steering system. Calibrate the steering system – center first, then calibrate the steering system – range; refer to Calibrating the Steering System – Center (page 5–100) and Calibrating the Steering System – Range (page 5–100).

Location ID Module

The location ID module is part of the 48 VDC electrical circuit, and is used to identify the 3 cutting unit motors individually. The ID module enables machine operation features such as starting and stopping the center cutting unit slightly later than the front cutting units. The location ID module plugs into the main wire harness under the right side cover.

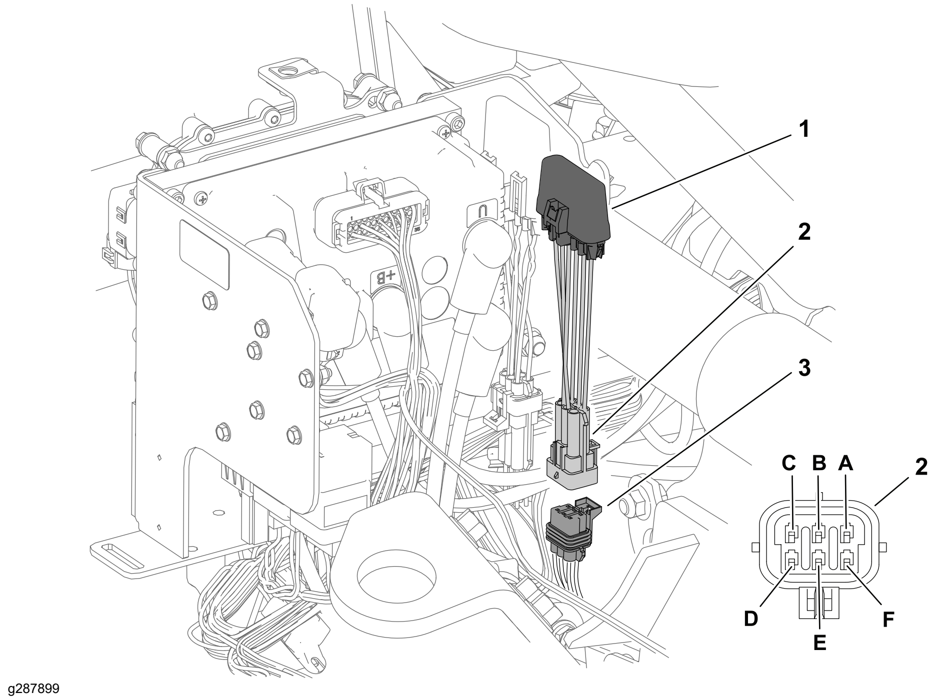


Figure 75

(right side cover removed)

1. Location ID module
2. ID module connector
3. Machine wire harness connector

Testing the Location ID Module

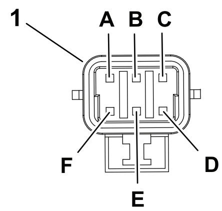
1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10)
3. Remove the right side cover.
4. Locate the location ID module, and disconnect it from the machine wire harness. Check the module and the harness connector for damage or corrosion, and clean or repair as necessary.
5. Use a multimeter (ohms setting) to measure and record the resistance across the ID module connector terminals.

   Note: On early machines, the B terminal was connected to the optional rear wheel traction motor unnecessarily. The B terminal is no longer used on eTriFlex machines.

Testing the Location ID Module (continued)

CONNECTOR TERMINALS	NORMAL RESISTANCE
F and A	14k to 16k ohms
F and C	6k to 7k ohms
F and D	3.5k to 4.5k ohms
F and E	1.4k to 1.8k ohms

6. Replace ID module if testing determines that it is faulty.
7. If the ID module tests correctly and a circuit problem still exists, check the wire harness:
   A. Use a multimeter (ohms setting) to measure and record the resistance across the disconnected machine wire harness connector terminals.



g287900

Figure 76

1. Machine wire harness connector

   B. The resistance across connector terminal F (black/white wire) and each of the terminals C, D, and E should be 18k to 20k ohms.
   C. An incorrect resistance measurement across a pair of terminals indicates damage to the wire harness for that motor circuit. Repair or replace the wiring as necessary; refer to Appendix A (page A–1).
8. Connect the location ID module to the machine wire harness after testing.
9. Connect the 48V battery disconnect.

Cutting Unit Motors

The three cutting unit motors are identical 48 VDC, brushless, permanent magnet motors. Each motor has an own on-board controller (T1: center cutting unit, T2: left cutting unit, T3: right cutting unit). If a problem exists with any cutting unit motor, a fault may have occurred that would be indicated by a fault code on the InfoCenter Display. Before considering that cutting unit motor service work is necessary, check for any existing fault codes that indicate problems with a cutting unit motor; refer to Machine Faults (page 3–8). If a cutting unit motor is faulty, there will likely be multiple fault codes listed in the InfoCenter display.

Because all the cutting unit motors used on the machine are the same, the motors can be exchanged to help troubleshoot a problem. If the problem follows the motor to the new cutting unit, the motor is likely the issue. If the problem remains with the cutting unit, the issue is likely due to the cutting unit or electrical components or wiring specific to that cutting unit.

To operate, the cutting unit motors require 48V logic power (supplied by the logic relay) and a connection to the 48V power bus (supplied by the main contactor when energized).

The cutting unit motor controller is not serviceable, and is best tested by using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If a cutting unit motor is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

Testing the Cutting Unit Motors

The InfoCenter Display can be used to monitor the speed and current draw for the cutting unit motors during machine operation; refer to InfoCenter Display (page 5–11).

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.
4. Access the InfoCenter **Diagnostics > PTO > Inputs** screen.

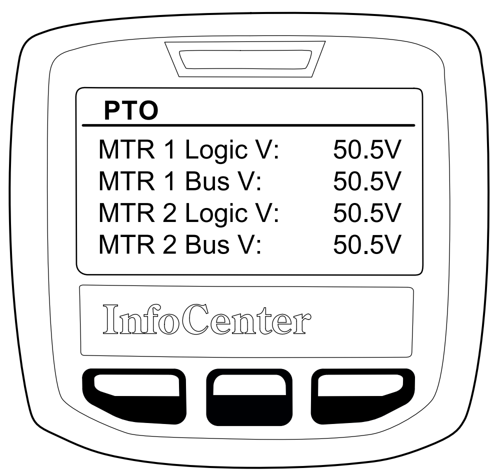


Figure 77

5. 48V system voltage should be present at the cutting unit motor controller logic circuit **MTR # Logic V** and at the cutting unit motor power bus circuit **MTR # Bus V**.

Testing the Cutting Unit Motors (continued)

- If – – – appears, the controller is not communicating on the CAN bus. Voltage must be present at the controller logic circuit before communication can occur on the CAN bus.

  If voltage is not present at the logic circuit, the logic circuit is damaged. The circuit wiring should be checked for corrosion or damage and cleaned or repaired as necessary.

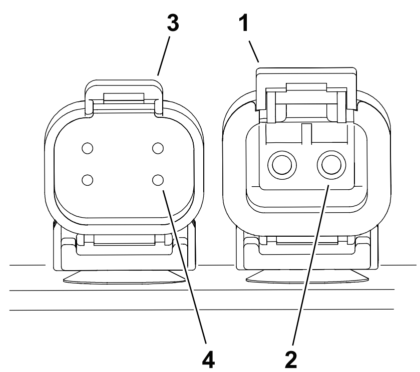
  If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The cutting unit motor controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).

- If 00.0V is present at the cutting unit motor power bus circuit, the circuit is damaged. The circuit wiring should be checked and repaired as necessary.

6. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

7. Locate and disconnect the cutting unit motor cable electrical connections at the machine wire harness for the motor being tested. Check the motor and the harness connector for damage or corrosion and clean or repair as necessary.

8. Use a multimeter (ohms setting) and measure the resistance between the ground terminal (blank wire) and the location ID terminal (T1 = blue wire, T2 = yellow wire, T3 = tan wire). Resistance should be approximately **18.8 K-ohms**.



g289535

Figure 78

1. Cutting unit motor connector – 2 pin
2. Ground terminal
3. Cutting unit motor connector – 4 pin
4. Location ID terminal

---

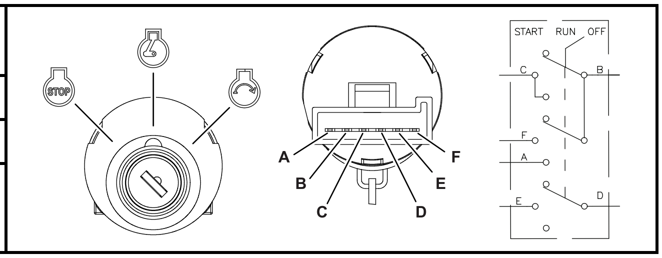
9. If cutting unit motor removal, installation, disassembly or assembly is required; refer to Cutting Unit Motor (page 5–182).

10. If the motor tests correctly and a problem still exits, check the cutting unit motor circuit wiring; refer to Appendix A (page A–1).

11. After testing is complete, secure the cutting unit motor wire harness connectors and connect the 48V battery disconnect.

Key Switch (Model 04580)

POSITION	CLOSED CIRCUITS
OFF	1 + 6, 4 + 5
ON	1 + 3 + 4 + 5 + 6
START	1 + 2 + 4 + 5 + 6



The key switch on the console has three (3) positions − OFF, ON and START. The key switch is an input used by the T1: Primary controller to manage various machine functions.

Testing the Key Switch

The key switch and its circuit wiring can be tested using the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45) **Diagnostics > Engine > Inputs**. If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

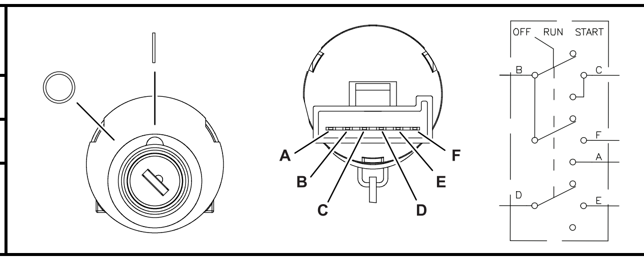
1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
3. Remove the console cover.
4. Disconnect the wire harness connector from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary. Remove the switch from the console if necessary.

   Note: Key switch terminals 1 and 6 are connected internally. Terminals 4 and 5 are also connected internally. These terminals should have continuity regardless of the switch position.

5. Use a multimeter (ohms setting) and the preceding table to determine whether continuity exists between the various terminals for each switch position.
6. Replace the switch if necessary.
7. If the switch tests correctly and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).
8. Install the switch, connect the wire harness and install the console cover after testing.
9. Connect the battery negative (-) cable at the 12V system battery.

Key Switch (Model 04590 and 04591)

POSITION	CLOSED CIRCUITS
OFF	NONE
ON	B + C + F, D + E
START	A + B + C



The key switch on the console has three (3) positions − OFF, ON and START. The START position is not used on these machines. The key switch is used to energize the following components.

Model 04590	T6: Precharge controller and SC8: 48V Battery Controller
Model 04591	T6: Precharge controller

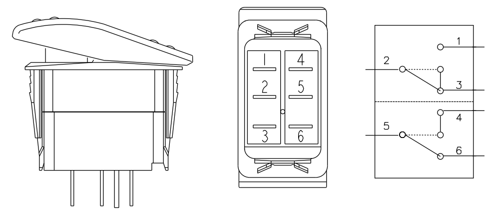
Testing the Key Switch

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Remove the console cover.
4. Disconnect the wire harness connector from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary. Remove the switch from the console if necessary.
5. Use a multimeter (ohms setting) and the preceding table to determine whether continuity exists between the various terminals for each switch position.
6. Replace the switch if necessary.
7. If the switch tests correctly and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).
8. Install the switch, connect the wire harness and install the console cover after testing.
9. Connect the 48V battery disconnect before returning the machine to service.

Function Control Switch

Function Switch Circuit Table

POSITION	CLOSED CIRCUITS
NEUTRAL	1 + 2, 4 + 5
MOW	2 + 3, 4 + 5
TRANSPORT	2 + 3, 5 + 6



The function control switch is located on the operator console. The function control switch allows the operator to select between NEUTRAL (also used for backlapping), MOW (low speed range), and TRANSPORT (high speed range). The function control switch is part of the safety interlock system; refer to Checking the Interlock System Operation (page 5–23) for a better understanding of how the switch is used.

Testing the Function Control Switch

The function control switch and its circuit wiring can be tested using the main information screen of the InfoCenter Display; refer to InfoCenter Display (page 5–11). If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

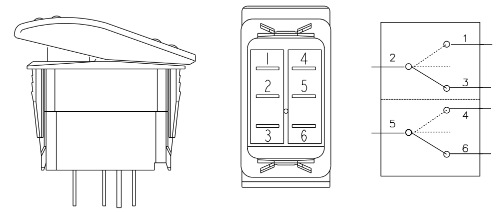
3. Remove the console cover.
4. Disconnect the wire harness connector from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary. Remove the switch from the console if necessary.
5. Use a multimeter (ohms setting) and the Function Switch Circuit Table to determine whether continuity exists between the various terminals for each switch position.
6. Replace the switch if necessary.
7. If the switch tests correctly and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).
8. Install the switch with the flat portion of the rocker toward the rear of the machine. Connect the wire harness and install the console cover after testing.
9. Connect battery power to the machine as follows:

Model 04580	Connect the battery negative (-) cable at the 12V system battery.
Model 04590 and 04591	Connect the 48V battery disconnect.

10. Test the switch functionality before returning the machine to service.

Light Switch (Optional)

POSITION	CLOSED CIRCUITS
FRONT AND REAR FACING LIGHTS ON	1 + 2, 4 + 5
OFF	NONE
REAR FACING LIGHT ON	2 + 3, 5 + 6



The light switch is located on the operator console. Pushing down on the right side of the switch energizes the front and rear facing lights. Pushing down on the left side of the switch energizes the rear facing light.

Testing the Light Switch

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

3. Remove the console cover.
4. Disconnect the wire harness connector from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary. Remove the switch from the console if necessary.
5. Use a multimeter (ohms setting) and the preceding table to determine whether continuity exists between the various terminals for each switch position.
6. Replace the switch if necessary.
7. If the switch tests correctly and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).
8. Install the switch with the flat portion of the rocker toward the right side of the machine. Connect the wire harness and install the console cover after testing.
9. Connect battery power to the machine as follows:

Model 04580	Connect the battery negative (-) cable at the 12V system battery.
Model 04590 and 04591	Connect the 48V battery disconnect.

10. Test the switch functionality before returning the machine to service.

Seat Switch

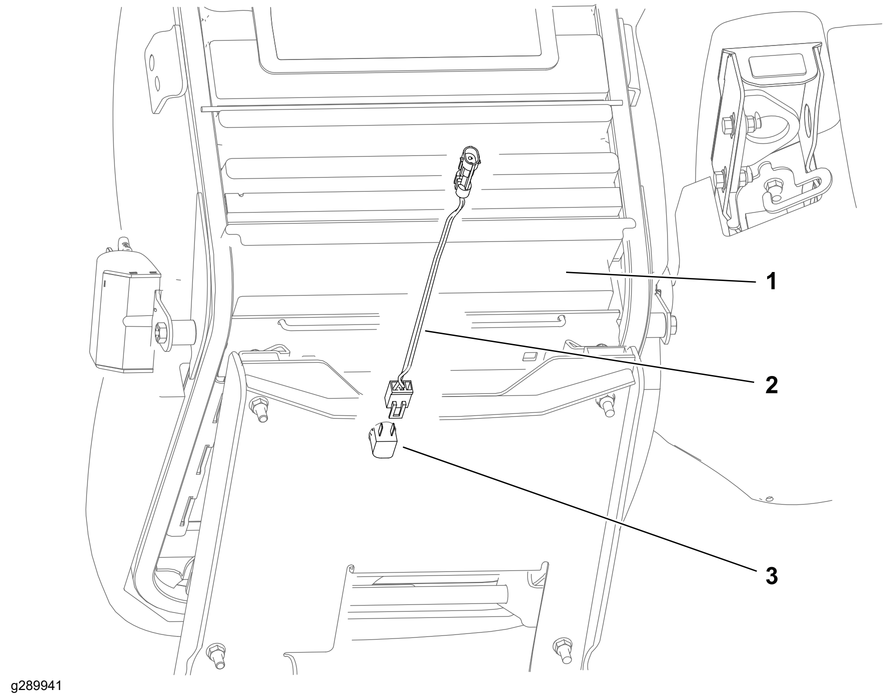


Figure 79

1. Seat assembly
2. Seat switch wire harness
3. Seat switch

The seat switch is a normally open switch that closes when the operator is on the seat. The seat switch and its electrical connector are located directly under the seat. The seat switch is part of the safety interlock system; refer to Checking the Interlock System Operation (page 5–23) for a better understanding of how the switch is used.

Testing the Seat Switch

The seat switch and its circuit wiring can be tested using the main information screen of the InfoCenter Display; refer to InfoCenter Display (page 5–11). If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Raise the seat and disconnect the wire harness connector from the seat switch harness. Check the harness connectors for damage or corrosion and clean or repair as necessary.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch harness terminals.
   A. With no operator in the seat, there should be no continuity between the terminals.
   B. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.
4. Disconnect the seat switch harness from the seat switch and test the seat switch separately if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.
5. Replace the switch or switch harness if necessary. To replace the seat switch:
   A. Detach the rear of the seat base fabric cover.

Testing the Seat Switch (continued)

B. Access the top of the switch by slipping between the seat frame and the seat base foam.

C. Release the switch from underneath and remove the switch.

D. Install the seat switch in the reverse order.

6. If the seat switch and seat switch harness tests correctly and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).

7. Connect the wire harnesses to the switch before returning the machine to service.

Brake Actuator

The eTriFlex machines use a single mechanical brake assembly that is used as a service brake, a manual parking brake, and an automatic parking brake. The service brake and manual parking brake are controlled by a cable connected to pedals at the operator's left foot, while the automatic parking brake is controlled by a 12 VDC electric brake actuator.

When the brake actuator is de-energized, an extension spring extends the actuator and engages the brakes. When the brake actuator is energized, the actuator retracts and disengages the brakes. The brake actuator is energized by the parking brake relay which is controlled by the T1: Primary controller.

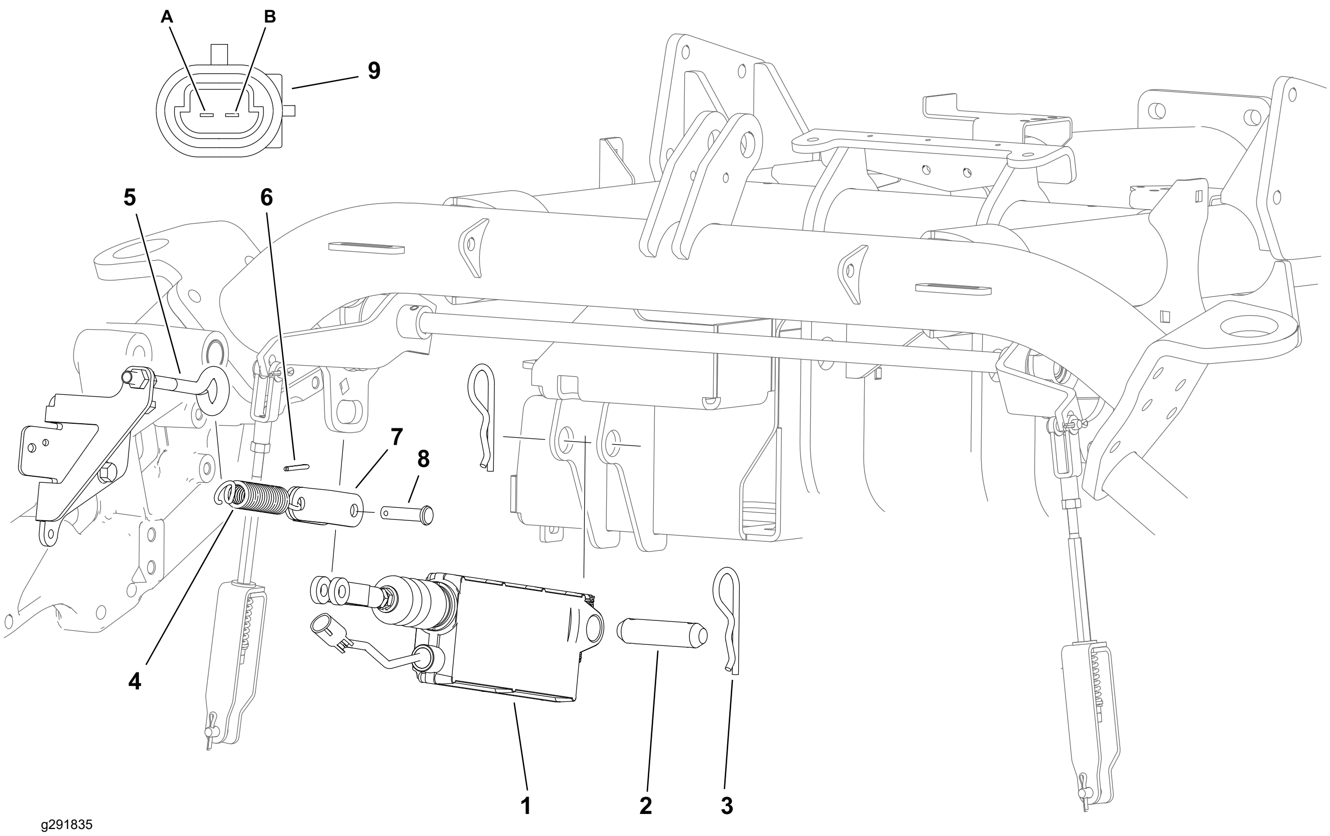


Figure 80

1. Brake actuator
2. Cylinder pin
3. Hair pin (2 each)
4. Extension spring
5. Eye bolt
6. Cotter pin
7. link plate (2 each)
8. Clevis pin
9. Brake actuator connector

Testing the Brake Actuator

The brake actuator and its circuit wiring can be tested using the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45) **Diagnostics > Traction > Outputs**. If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Ensure the parking brake relay is operating correctly; refer to Relays (page 5–101).
3. Engage the manual parking brake.

Testing the Brake Actuator (continued)

4. Disconnect the brake actuator from the machine harness. Check the actuator and the harness connector for damage or corrosion and clean or repair as necessary.
5. Remove the actuator from the machine.
6. Use the cylinder pin to clamp the body of the actuator securely in a vise, and manually extend and retract the actuator rod. The actuator rod should travel approximately 32 mm (1.25 inch) in each direction smoothly.
7. Connect the brake actuator B terminal (green wire) to a 12 VDC power supply, and connect the A terminal (black wire) to ground. The actuator should retract.
8. Connect the brake actuator A terminal (black wire) to a 12 VDC power supply, and connect the B terminal (green wire) to ground. The actuator should extend.
9. Replace the actuator if necessary.
10. If the actuator tests correctly and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).

    Note: 12 VDC should be present at the wire harness connector when the manual parking brake is disengaged, an operator is sitting in the seat, and the key switch is set to the ON position.

11. Install the actuator and adjust the brakes before returning the machine to service; refer to Adjusting the Brakes (page 6–3).

Manual Parking Brake Switch

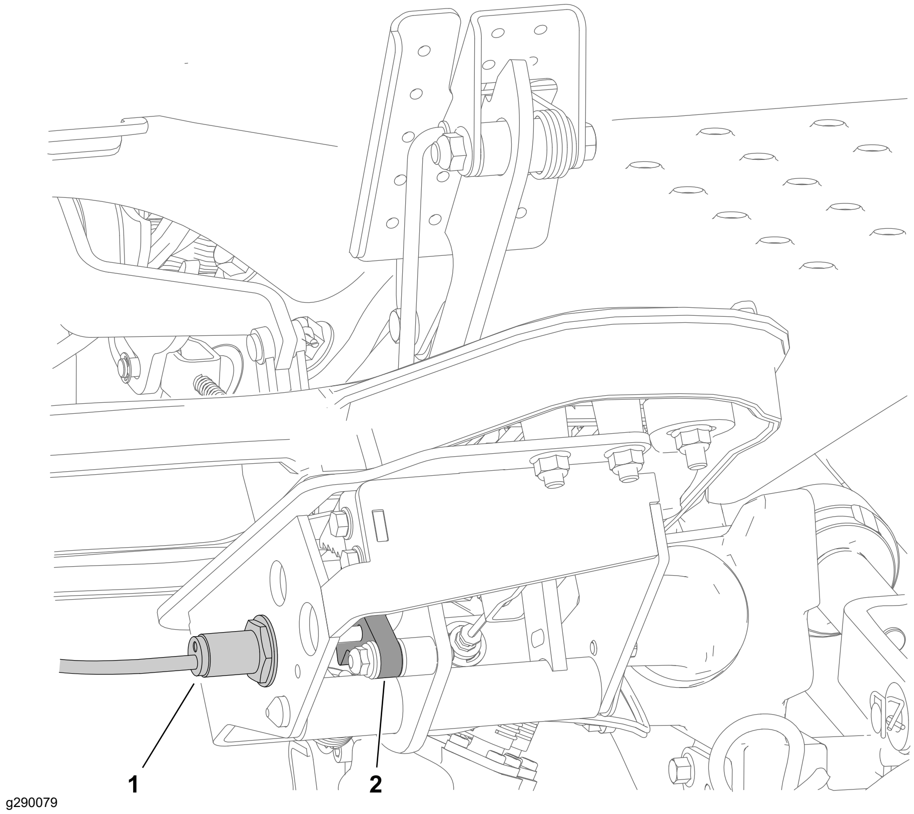


Figure 81
(view from under foot panel)

1. Manual parking brake switch
2. Latch

The switch is located directly under the brake pedal assembly. The manual parking brake switch is an input to the T1: primary controller. The switch is a normally open proximity switch that closes when the foot actuated parking brake is disengaged (the parking brake latch is neal to the parking brake switch). The manual parking brake switch is part of the safety interlock system; refer to Checking the Interlock System Operation (page 5–23) for a better understanding of how the switch is used.

Testing the Manual Parking Brake Switch

The manual parking brake switch and its circuit wiring can be tested using the main information screen of the InfoCenter Display; refer to InfoCenter Display (page 5–40) **(P)** icon. If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Set the key switch to the ON position and check LED on the cable end of the manual parking brake switch. The LED should be illuminated when the manual parking brake is disengaged. The LED should not be illuminated when the manual parking brake is engaged. Set the key switch to the OFF position.
3. If the switch LED does not function correctly:
   A. Check the manual parking brake switch adjustment and adjust if necessary; refer to Adjusting the Manual Parking Brake Switch (page 5–26).

Testing the Manual Parking Brake Switch (continued)

B. Disconnect the machine wire harness from the parking brake switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.

C. Set the key switch to the ON position (do not start the engine) and use a multimeter (DC voltage setting) to verify that the machine wire harness pink wire has system voltage (12 VDC) present. Set the key switch to the OFF position.

D. Use a multimeter (ohms setting) and verify that the machine wire harness black wire is closed to ground (has continuity).

E. Use a multimeter (ohms setting) and verify that the machine wire harness blue wire has continuity at the T1: primary controller connector; refer to Appendix A (page A–1).

4. If the wire harness tests correctly and the switch LED does not function as desired, replace and adjust the manual parking brake switch; refer to Adjusting the Manual Parking Brake Switch (page 5–26).

5. Connect the machine wire harness to the switch before returning the machine to service.

Cutting Unit Lift/Lower Switches

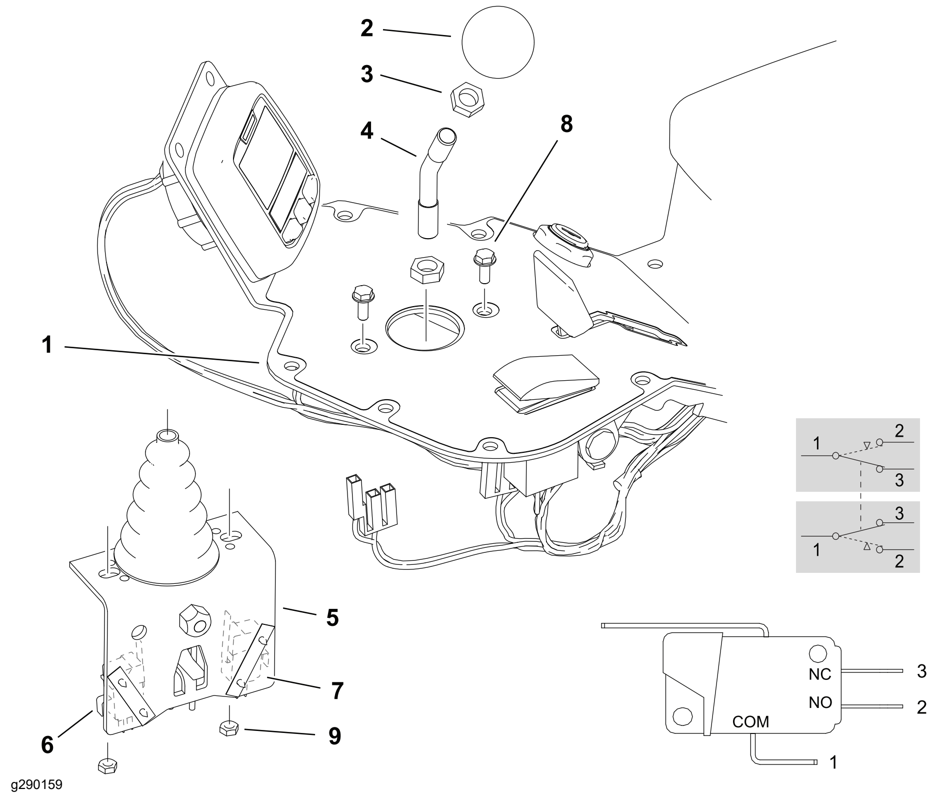


Figure 82

1. Console
2. Knob
3. Jam nut (2 each)
4. Stem
5. Joystick assembly
6. Lower switch
7. Lift switch
8. Cap screw (2 each)
9. Hex nut (2 each)

Raise/Lower Switch Testing Reference

JOYSTICK POSITION	RAISE SWITCH CIRCUIT	LOWER SWITCH CIRCUIT
LIFT	1 + 2	1 + 3
CENTER	1 + 3	1 + 3
LOWER	1 + 3	1 + 2

The 2 cutting unit lift/lower switches are located on the joystick bracket attached to the operator console. The rear switch is used to lower the cutting units and the front switch is used to lift the cutting units. The switches are identical. Each switch includes a common terminal, a normally open terminal and a normally closed terminal. The cutting unit lift/lower switches are part of the safety interlock system; refer to Checking the Interlock System Operation (page 5–23) for a better understanding of how the switches are used.

Testing the Cutting Unit Lift/Lower Switches

The cutting unit lift/lower switches and their circuit wiring can be tested using the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). If testing determines that either switch or the circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting units, set the key switch is in the OFF position and remove the key.

Testing the Cutting Unit Lift/Lower Switches (continued)

2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

3. Remove the console cover; refer to Removing and Installing the Control Console (page 6–38).
4. Disconnect the wire harness from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.
5. Use a multimeter (ohms setting) to determine whether continuity exists between the various terminals for each switch position: refer to the Raise/Lower Switch Testing Reference (page 5–88).
6. Replace the switch if necessary.
7. If the switch tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
8. Connect the wire harness to the switch and install the console cover.
9. Connect battery power to the machine as follows:

Model 04580	Connect the battery negative (-) cable at the 12V system battery.
Model 04590 and 04591	Connect the 48V battery disconnect.

10. Test the switch functionality before returning the machine to service.

Lift/Lower Actuators

Three electric linear actuators are used on eTriFlex machines to lift and lower the cutting units. Each lift/lower actuator is unique and cannot be interchanged with each other. The lift/lower actuators may be referred to by number: #1 = center (rear), #2 = left, #3 = right. The front lift/lower actuators retract to lift the cutting units, while the center (rear) lift/lower actuator extends to lift the cutting unit. Each lift/lower actuator has its own on-board controller. To operate, the lift/lower actuators require 48V logic power (supplied by the logic relay), a connection to the 48V power bus (supplied by the main contactor when energized), and a connection to the CAN bus to send and receive control messages.

The lift/lower actuators are not serviceable, and are best tested by using the information provided on the InfoCenter display as described in the following test procedure. Refer to Appendix A (page A–1) for circuit wiring information.

Note: If a lift/lower actuator (SC2, SC3, or SC4) is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance. If the lift/lower actuator is removed for any reason, the lift/lower actuator must be calibrated; refer to Calibrating the Lift/Lower Actuators (page 5–92).

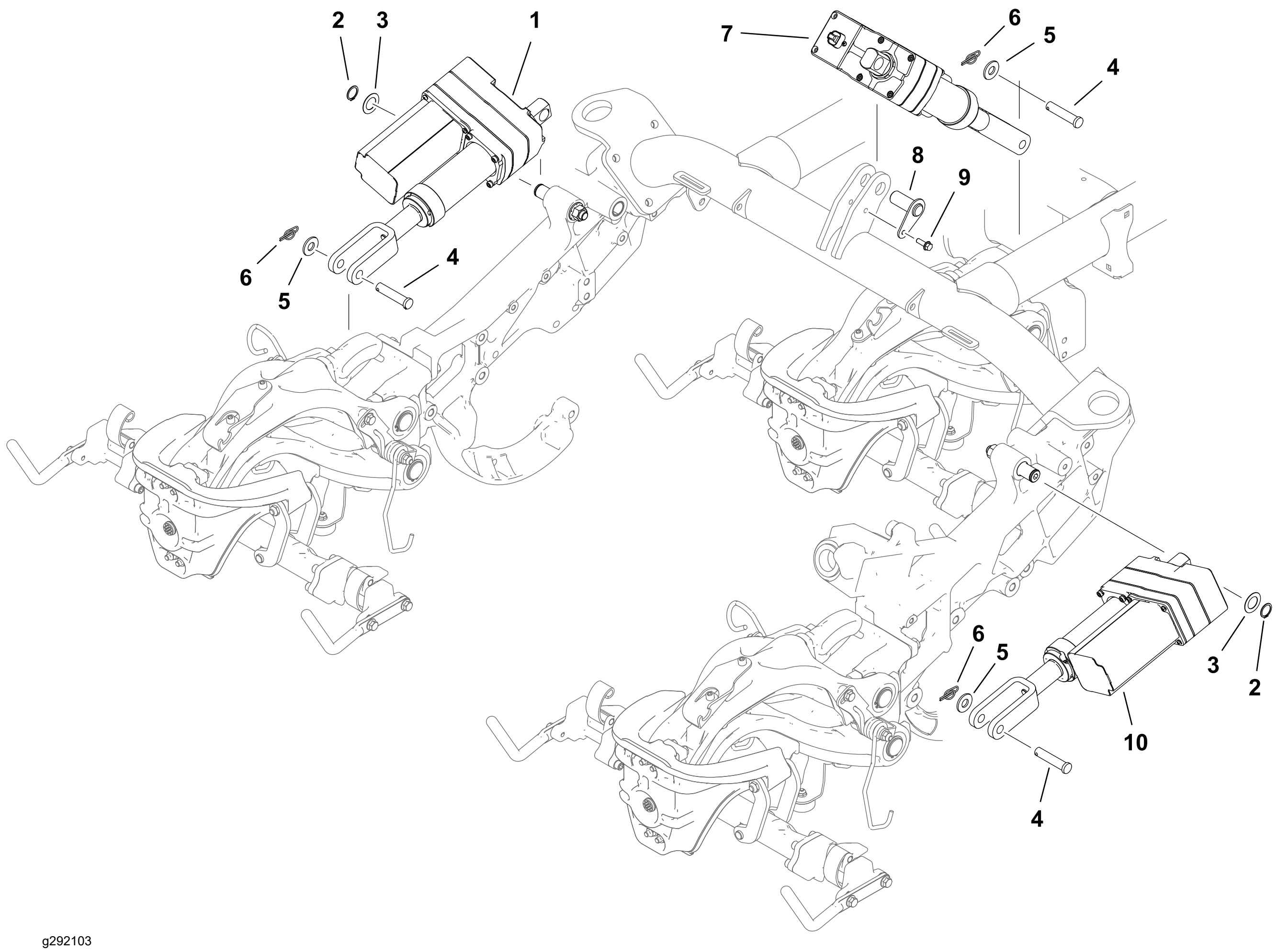
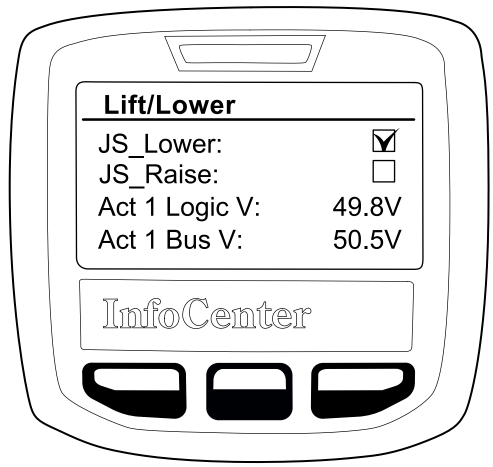


Figure 83

1. Lift/Lower actuator #3 (right)
2. Retaining ring (3 each)
3. Flat washer (3 each)
4. Clevis pin (3 each)
5. Flat washer (3 each)
6. Cotter pin (3 each)
7. Lift/Lower actuator #1 (center/rear)
8. Cap screw
9. Pivot pin
10. Lift/Lower actuator #2 (left)

Testing the Lift/Lower Actuators

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.
2. Engage the manual parking brake and set the function control switch to the NEUTRAL position.
3. Sit in the operator seat and set the key switch to the ON position.
4. Access the InfoCenter **Diagnostics > Lift/Lower > Inputs** screen.



g292214

Figure 84

(joystick in the Lower position)

A. Move the joystick to the LOWER position. A check mark should appear next to **JS_Lower**.

B. Move the joystick to the RAISE position. A check mark should appear next to **JS_Raise**.

C. Test the cutting unit raise and lower switches and their circuit wiring if necessary; refer to Cutting Unit Lift/Lower Switches (page 5–88).

D. 48V system voltage should be present at the actuator logic circuit **Act # Logic V** and at the actuator power bus circuit **Act # Bus V**.

- If – – – appears, the actuator is not communicating on the CAN bus.

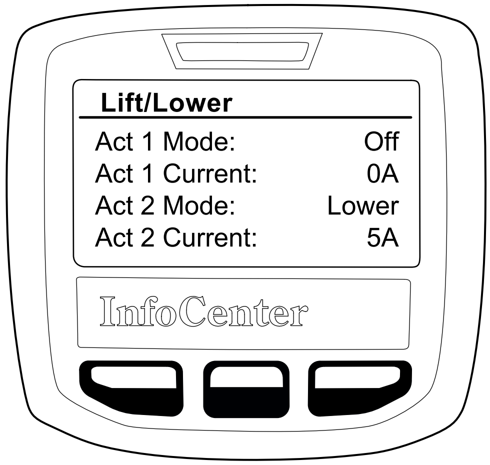
  Voltage must be present at the controller logic circuit before communication can occur on the CAN bus. If voltage is not present at the logic circuit, the logic circuit is damaged. The circuit wiring should be checked for corrosion or damage and cleaned or repaired as necessary.

  If logic voltage is present at the controller, and CAN bus communication is suspect, the CAN bus circuit is damaged. The CAN bus wiring should be checked for corrosion or damage and cleaned or repaired as necessary. The lift/lower controller CAN bus transceiver can also be tested if necessary; refer to Testing Devices (Nodes) on the CAN bus (page 5–38).

- If 00.0V is present at the actuator power bus circuit, the circuit is damaged. The circuit wiring should be checked and repaired as necessary.

5. Sit in the operator's seat set the key switch to the ON position.
6. Access the InfoCenter **Diagnostics > Lift/Lower > Outputs** screen.

Testing the Lift/Lower Actuators (continued)



g292215

Figure 85

(left cutting unit lowering)

- **Act # Mode** should read Off while the actuator is stationary.
- **Act # Current** should read 0A while the actuator is stationary.
- Move the joystick to the LOWER position. Lower should appear next to **Act # Mode** while the actuator is moving. The current required to move the actuator should appear next to **Act # Current** while the actuator is moving.
- Move the joystick to the RAISE position. Raise should appear next to **Act # Mode** while the actuator is moving. The current required to move the actuator should appear next to **Act # Current** while the actuator is moving.

7. If the InfoCenter diagnostics inputs and outputs report normally and the actuator does not function properly, replace the actuator and update the machine software; contact an Authorized Toro Distributor.
8. Calibrate the lift/lower actuator: refer to Calibrating the Lift/Lower Actuators (page 5–92).

Calibrating the Lift/Lower Actuators

1. Sit in the operator seat and set the key switch to the ON position.
2. Access the InfoCenter **Settings > Protected Menus > Enter PIN** screen and enter the machine PIN.
3. Access the InfoCenter **Service > Calibration** screen.
4. Select **Lift-lower** for the actuator being calibrated and follow the on-screen calibration instructions.

   Note: If the calibration procedure fails, try calibrating the item again before continuing to troubleshoot the system.

Engine Oil Pressure Switch (Model 04580)

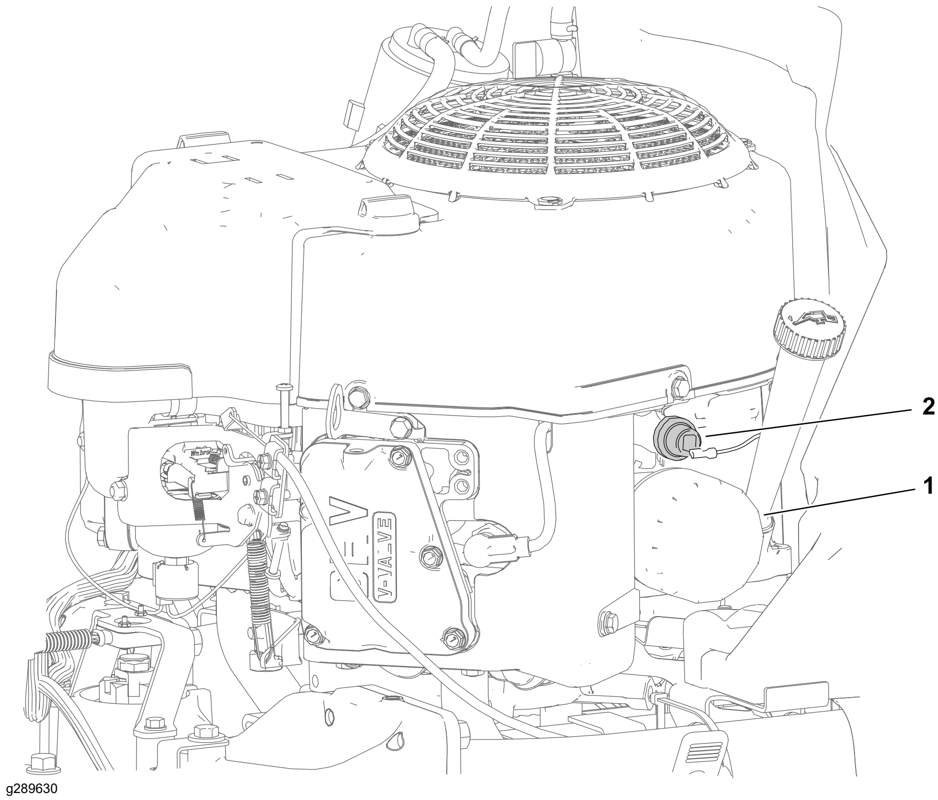


Figure 86

1. Oil filter
2. Engine oil pressure switch

The engine oil pressure switch is located at the right side of the engine near the oil filter. The oil pressure switch is a normally open switch that closes under engine oil pressure.

The condition of the engine oil pressure switch is monitored by the T1: Primary controller. If the oil pressure opens (low oil pressure) for more than 10 seconds while the engine is running, the controller will de-energize the engine control circuit to shut off the engine.

Testing the Engine Oil Pressure Switch

Refer to the *Kawasaki FS481V Service Manual* for information regarding engine lubrication system testing.

The engine oil pressure switch and its circuit wiring can be tested as a T1: Primary input using the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Locate the engine oil pressure switch on the engine and disconnect the wire harness connector from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.
3. Connect a multimeter (ohms setting) to check the continuity of the switch:
   A. With the engine off, there should be no continuity between the switch terminal and the metal switch body.
   B. With the engine running, there should be continuity between the switch terminal and the metal switch body.

Testing the Engine Oil Pressure Switch (continued)

4. Replace the switch as necessary.
5. If the switch tests correctly and a circuit problem still exists, check the machine wire harness; refer to Appendix A (page A–1).
6. After testing, connect the engine wire harness to the switch before returning the machine to service.

Traction Pedal Position Sensor

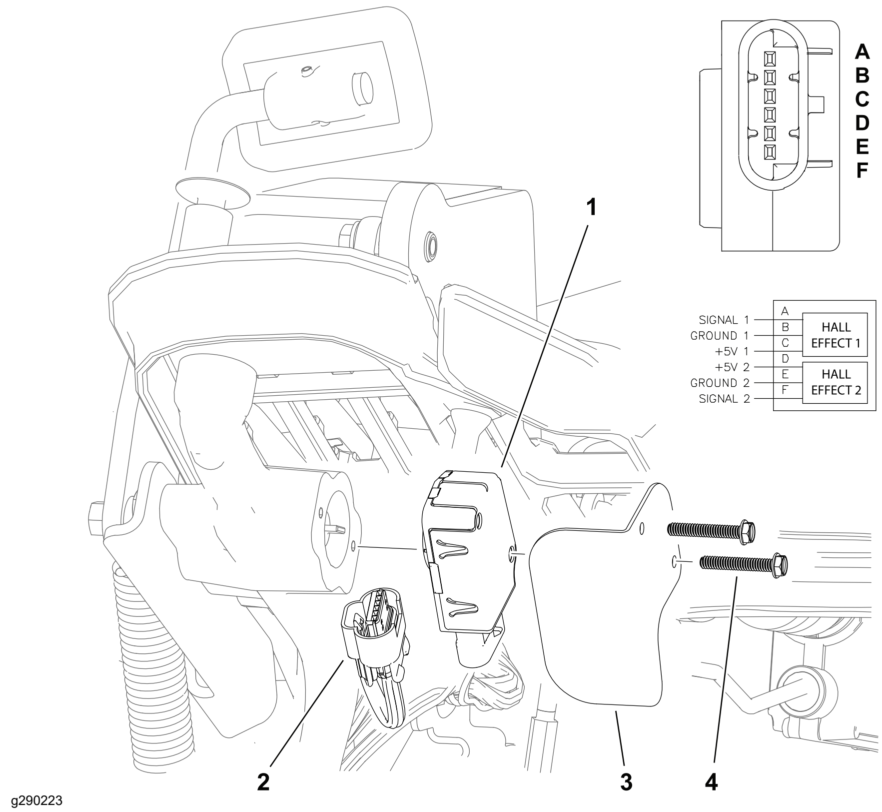


Figure 87

1. Traction pedal position sensor
2. Wire harness connector
3. Shield
4. Screw (2 each)

The traction pedal position sensor is a separate component in the traction pedal assembly. The sensor includes 2 analog hall effect sensors. The traction pedal sensor follows the traction pedal movement.

The sensor operates on 5VDC supplied by the SC5: Traction 1 motor controller (right side). Signal voltage from the pedal sensor (along with information from additional inputs) is used to determine the appropriate current flow to operate the traction motors. The traction pedal position sensor is connected directly to the SC5: Traction 1 motor controller. Traction control messages are sent to the remainder of the traction system motors (including machines with optional 3WD) from the SC5: Traction 1 motor controller using the CAN bus.

The sensor signals are constantly monitored for traction fault detection. If a traction pedal position sensor fault occurs while the machine is moving, the machine will slowly come to a stop. The brake pedal can be used to stop the machine sooner if necessary. A traction pedal position sensor fault will disable traction control until the ignition key is cycled OFF and ON.

The traction pedal position sensor is part of the safety interlock system; refer to Checking the Interlock System Operation (page 5–23) for a better understanding of how the sensor is used.

Note: If a the traction pedal position sensor is replaced or removed for any reason, the sensor must be calibrated; refer to Calibrating the Traction Pedal Position Sensor (page 5–97).

Testing the Traction Pedal Position Sensor

1. Park the machine on a level surface, lower the cutting units and set the key switch to the OFF position.

Testing the Traction Pedal Position Sensor (continued)

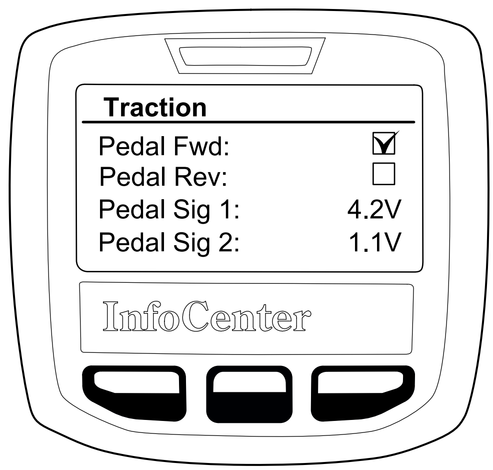
2. Ensure the traction pedal assembly moves from the full forward stop to the full rearward stop.
3. Use the InfoCenter to view the sensor signal voltage:

   Note: While the voltage readings on the InfoCenter indicate the sensor wiring is intact, how the voltage readings change relative to each other and the traction pedal position are very important. While the voltage reading for one signal increases with traction pedal movement, the voltage reading for the other signal should decrease. Also, the total of the Pedal Sig 1 and Pedal Sig 2 voltage readings should add up to about 5.5V.

   A. Sit in the operator seat and set the key switch to the ON position.

   B. Set the function control switch to the NEUTRAL position.

   C. From the InfoCenter Main Menu, select **Diagnostics > Traction > Inputs**.



g290532

Figure 88
(shown with traction pedal fully forward)

   D. Move the traction pedal forward. **Pedal Fwd** should be checked.

   E. Move the traction pedal fully forward. **Pedal Sig 1** should be 3.75 to 4.50 V and **Pedal Sig 2** should be 0.5 to 1.25V.

   F. Move the traction pedal rearward. **Pedal Rev** should be checked.

   G. Move the traction pedal fully rearward. **Pedal Sig 1** should be 0.50 to 1.25 V and **Pedal Sig 2** should be 3.75 to 4.50 V.

   H. Allow the traction pedal to return to the NEUTRAL position. **Pedal Sig 1** and **Pedal Sig 2** should be 2.5 to 3.0 V.

   I. Set the key switch to the OFF position.

4. If any of the sensor readings are out of range, test the traction position sensor:

   A. Disconnect the machine wire harness from the traction pedal position sensor. Check the sensor and the harness connector for damage or corrosion and clean or repair as necessary.

   B. Connect the sensor pins C and D to a 5 VDC power supply, and connect pins B and E to ground.

   C. Using a multimeter (DC voltage setting) with the traction pedal in the NEUTRAL position, 2.5 to 3.0 VDC should be present at both sensor pins A and F.

Testing the Traction Pedal Position Sensor (continued)

D. Using a multimeter (DC voltage setting) with the traction pedal depressed fully forward, 3.75 to 4.50 VDC should be present at sensor pin A and 0.50 to 1.25 VDC should be present at sensor pin F.

E. Using a multimeter (DC voltage setting) with the traction pedal depressed fully rearward, 0.50 to 1.25 VDC should be present at sensor pin A and 2.55 to 3.20 VDC should be present at sensor pin F.

5. Replace the traction pedal position sensor if necessary. Ensure the sensor drive is aligned with the tab on the pedal shaft before tightening the mounting fasteners.
6. If the traction pedal position sensor tests correctly and a circuit problem still exists, check the machine wire harness; refer to Appendix A (page A–1).
7. After testing, connect the machine wire harness and calibrate the traction pedal position sensor; refer to Calibrating the Traction Pedal Position Sensor (page 5–97).

Calibrating the Traction Pedal Position Sensor

1. Sit in the operator seat and set the key switch to the ON position.
2. Access the InfoCenter **Settings > Protected Menus > Enter PIN** screen and enter the machine PIN.
3. Access the InfoCenter **Service > Calibration** screen.
4. Select **Traction Pedal** and follow the on-screen calibration instructions.

   Note: If the calibration procedure fails, try calibrating the item again before continuing to troubleshoot the system.

Steering Position Sensor

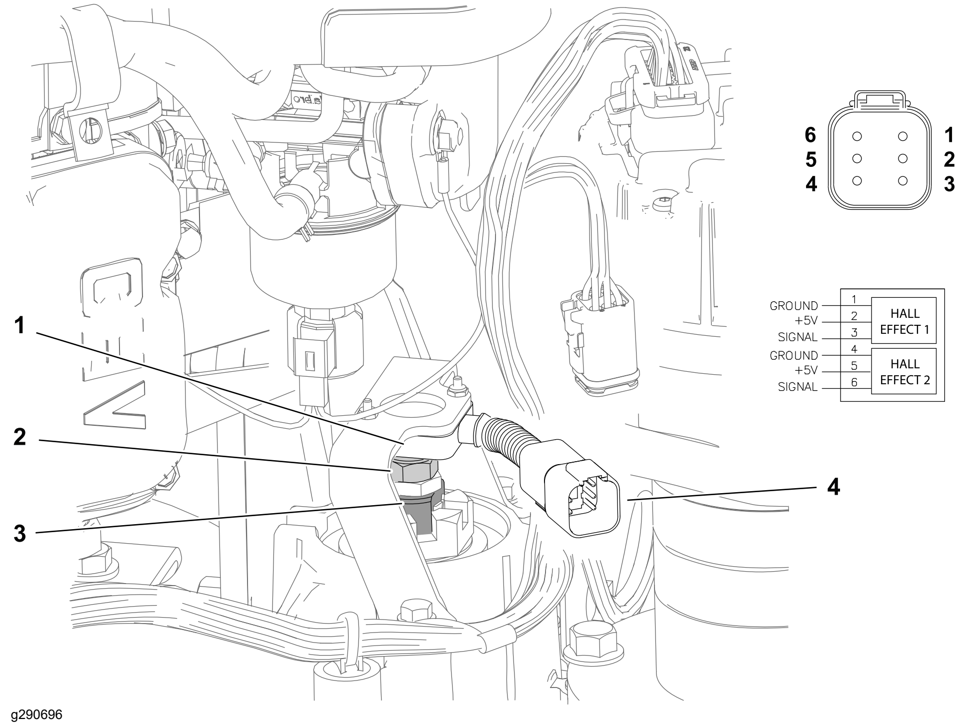


Figure 89

1. Steering position sensor
2. Magnetic bolt
3. Caster fork shaft
4. Sensor harness connector

The steering position sensor is a two-piece assembly located on top of the rear wheel caster fork shaft. The sensor portion includes 2 analog hall effect sensors. The second piece of the assembly is a bolt with a magnetic head threaded into the caster fork shaft. The steering position sensor follows the rear caster fork movement.

The sensor operates on 5VDC supplied by the SC7: Steering motor. Signal voltage from the steering position sensor (along with information from the steering input device) is used by the SC7: Steering motor to determine the appropriate direction and current flow to operate the steering motor. The steering position sensor signals are constantly monitored for steering fault detection. If a steering position sensor fault occurs while the machine is moving, the machine will slowly come to a stop. The brake pedal can be used to stop the machine sooner if necessary. A steering sensor fault will disable the traction system until the ignition key is cycled OFF and ON.

The InfoCenter Display can be used to monitor the direction of the steering position sensor during machine operation.

Note: If the steering position sensor is removed for any reason, the steering system must be calibrated. Calibrate the steering system – center first, then calibrate the steering system – range; refer to Calibrating the Steering System – Center (page 5–100) and Calibrating the Steering System – Range (page 5–100).

Testing the Steering Position Sensor

The steering position sensor and its circuit wiring can be tested using the InfoCenter Display; refer to Using the InfoCenter Display for Troubleshooting (page 3–45). If testing determines that the sensor and circuit wiring are not functioning correctly, proceed with the following test procedure:

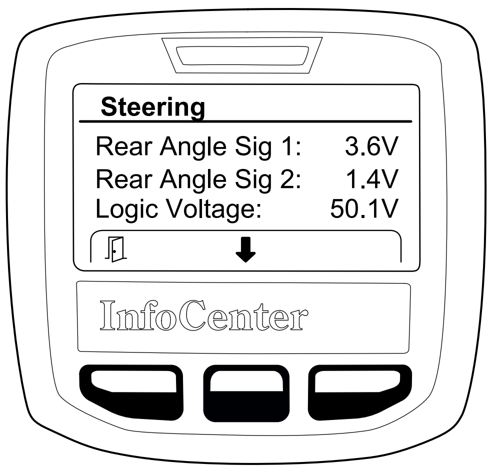
1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Raise and support the rear of the machine; refer to Jacking Instructions (page 1–6).
3. Ensure the rear wheel assembly moves from the full right stop to the full left stop (approximately 50° in either direction).
4. Check the rear caster fork alignment and steering position sensor air gap and adjust if necessary; refer to Adjusting the Steering Position Sensor (page 5–25).
5. **Rear Angle Sig 1** and **Rear Angle Sig 2** report the amount of signal voltage being received from the position sensor at the steering motor. Use the InfoCenter to view the sensor signal voltage:

   Note: While the voltage readings on the InfoCenter indicate the sensor wiring is intact, how the voltage readings change relative to each other and the caster fork position are very important. While the voltage reading for one signal increases with caster fork movement, the voltage reading for the other signal should decrease. Also, the total of the Rear Angle Sig 1 and Rear Angle Sig 2 voltage readings should add up to about 5.5 V.

   A. Sit in the operator seat and set the key switch to the ON position.

   B. Set the function control switch to the NEUTRAL position.

   C. From the InfoCenter Main Menu, select **Diagnostics > Steering > Inputs**.



g290697

Figure 90

(shown with caster fork turned to the left)

   D. Turn the caster fork by hand until it is square with the machine (straight). **Rear Angle Sig 1** and **Rear Angle Sig 2** should be 2.0 – 3.0 V.

   E. Turn the rear caster fork by hand fully to the left (counterclockwise). **Rear Angle Sig 1** should be 3.5 – 4.0 V and **Rear Angle Sig 2** should be 1.0 – 1.5 V.

   F. Turn the rear caster fork by hand fully to the right (clockwise). **Rear Angle Sig 1** should be 1.0 – 1.5 V and **Rear Angle Sig 2** should be 3.5 – 4.0 V.

   G. Set the key switch to the OFF position.

6. If any of the sensor readings are out of range, test the steering position sensor:

Testing the Steering Position Sensor (continued)

A. Disconnect the machine wire harness from the steering position sensor. Check the sensor and the harness connector for damage or corrosion and clean or repair as necessary.

B. Connect sensor connector pins 2 and 5 to a 5 VDC power supply, and connect pins 1 and 4 to ground.

C. Turn the caster fork by hand until it is square with the machine (straight). Using a multimeter (DC voltage setting), 2.0 – 3.0 VDC should be present at both sensor connector pins 3 and 6.

D. Turn the rear caster fork by hand fully to the left (counterclockwise). Using a multimeter (DC voltage setting), 3.7 – 3.9 VDC should be present at sensor connector pin 3 and 1.1 – 1.3 VDC should be present at sensor connector pin 6.

E. Turn the rear caster fork by hand fully to the right (clockwise). Using a multimeter (DC voltage setting), 1.1 – 1.3 VDC should be present at sensor connector pin 3 and 3.7 – 3.9 VDC should be present at sensor connector pin 6.

7. Replace the steering position sensor if necessary.

IMPORTANT

The sensor and the magnetic bolt are matched by the manufacturer and must be replaced as a set.

8. Align the rear caster fork and adjust the sensor air gap; refer to Aligning the Rear Wheel Caster Fork (page 6–8).
9. If the steering position sensor tests correctly and a circuit problem still exists, check the machine wire harness; refer to Appendix A (page A–1).
10. After testing, connect the machine wire harness and calibrate the steering system. Calibrate the steering system – center first, then calibrate the steering system – range; refer to Calibrating the Steering System – Center (page 5–100) and Calibrating the Steering System – Range (page 5–100).

Calibrating the Steering System – Center

1. Sit in the operator seat and set the key switch to the ON position.
2. Access the InfoCenter **Settings > Protected Menus > Enter PIN** screen and enter the machine PIN.
3. Access the InfoCenter **Service > Calibration** screen.
4. Select **Steering Center** and follow the on-screen calibration instructions.

   Note: If the calibration procedure fails, try calibrating the item again before continuing to troubleshoot the system.

Calibrating the Steering System – Range

1. Sit in the operator seat and set the key switch to the ON position.
2. Access the InfoCenter **Settings > Protected Menus > Enter PIN** screen and enter the machine PIN.
3. Access the InfoCenter **Service > Calibration** screen.
4. Select **Steering Range** and follow the on-screen calibration instructions.

   Note: If the calibration procedure fails, try calibrating the item again before continuing to troubleshoot the system.

Relays

Greensmaster eTriFlex machines use several electrical relays. Some of the relays have four (4) terminals and some have five (5) terminals. The number of terminals the relay has determines how the relay should be tested. A tag near the wire harness relay connector can be used to identify each relay.

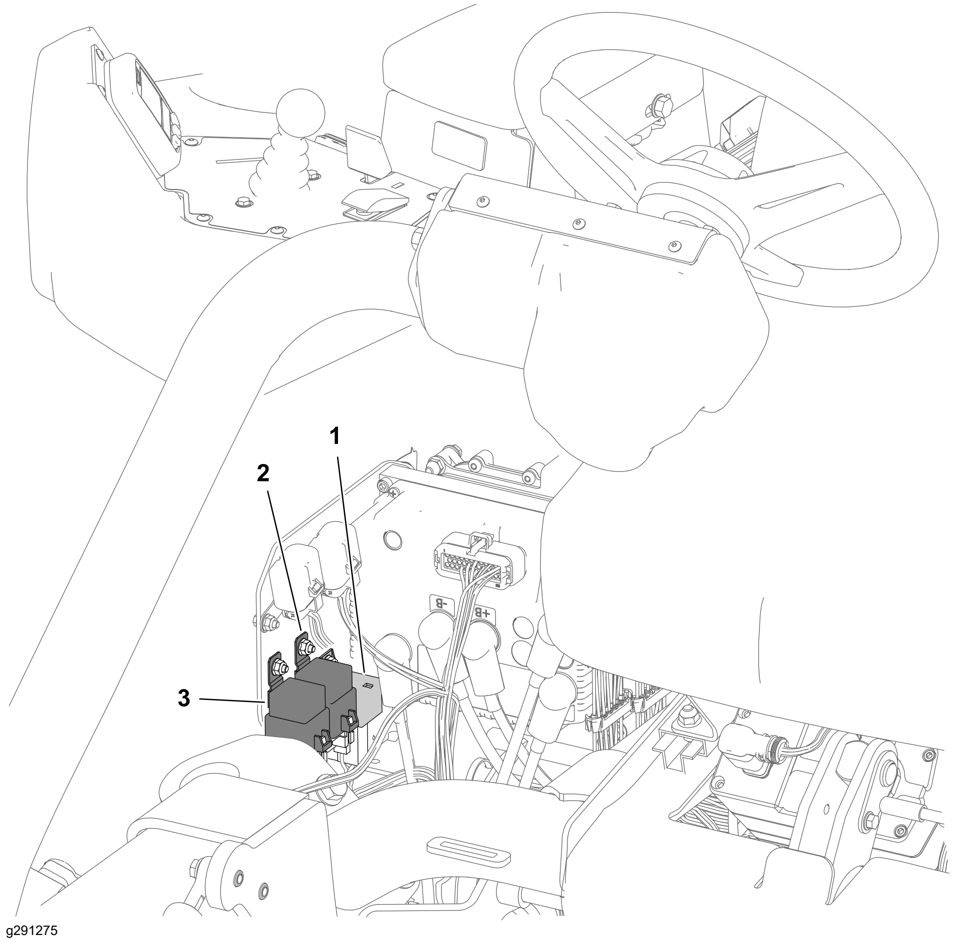


Figure 91

eTriFlex 3360 Model 04580

1. Logic relay
2. Brake actuator relay
3. Engine relay (model 04580)

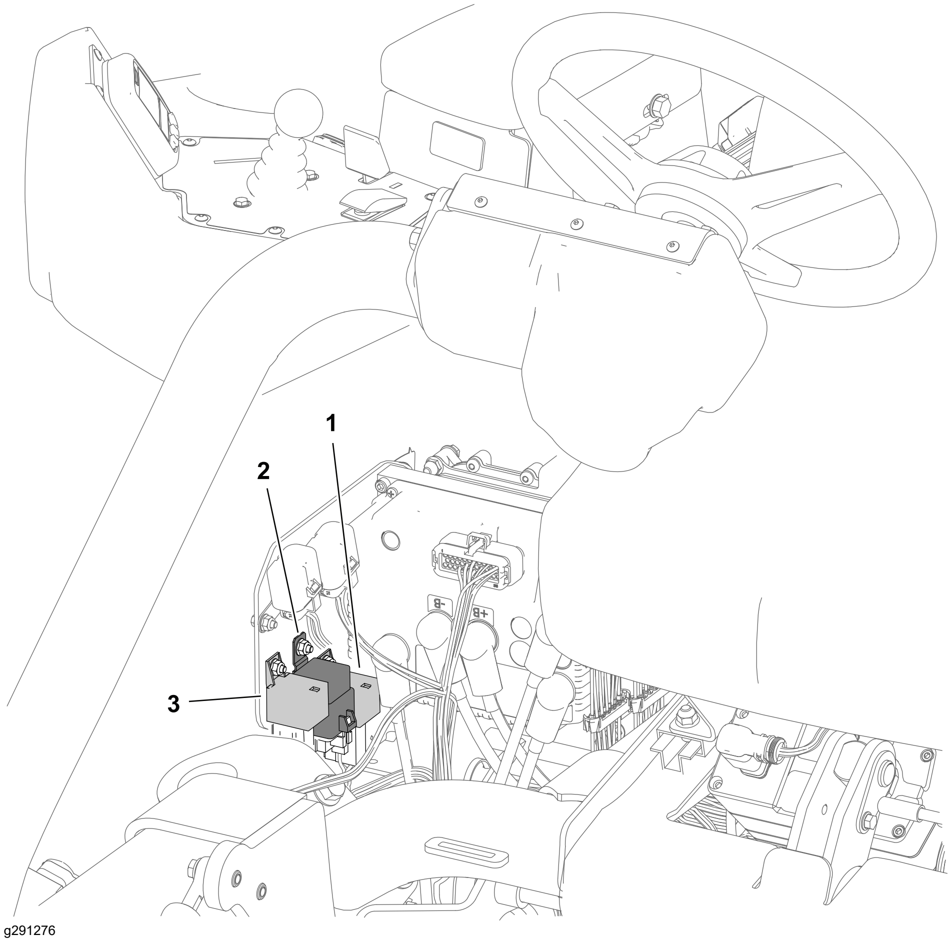
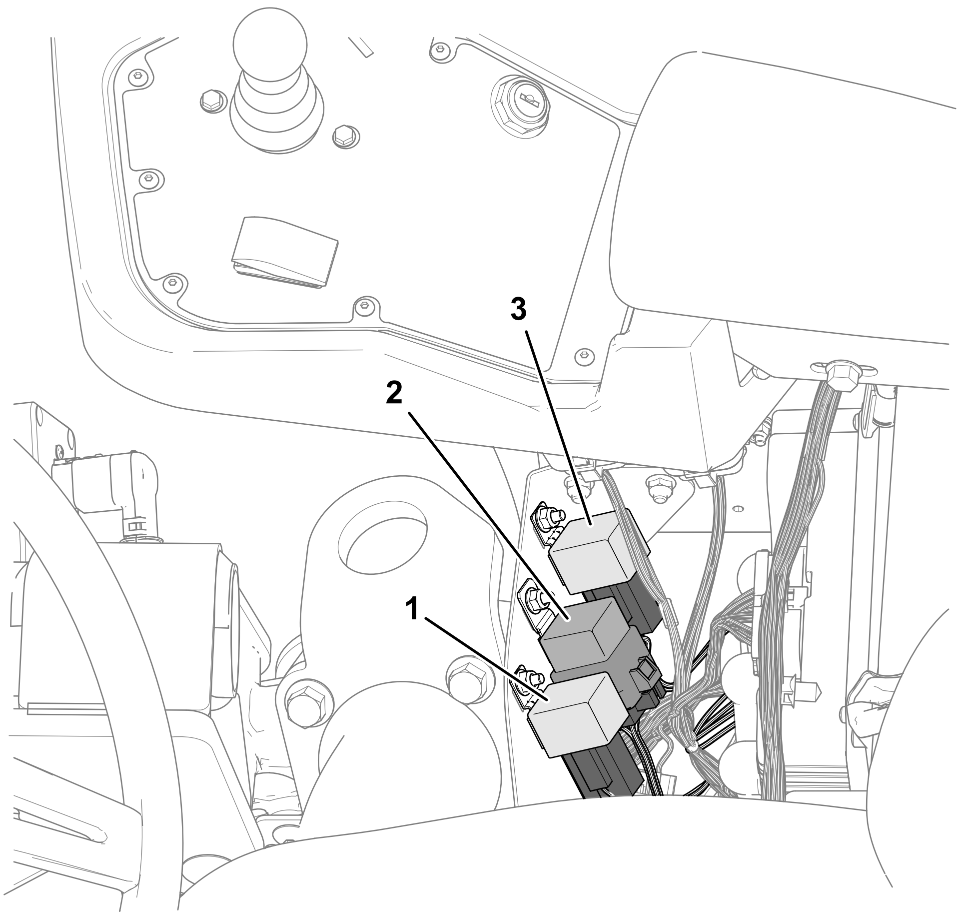


Figure 92
eTriFlex 3370 Model 04590

1. Logic relay
2. Brake actuator relay
3. Shutdown delay relay (model 04590)



g419816

Figure 93

eTriFlex 3370 Model 04591

1. Shutdown delay relay (model 04591)
2. Brake actuator relay
3. Logic relay

The relays are located under the right side cover:

- The logic relay is a 4 terminal relay with a 12V coil.
- The brake actuator relay is a 5 terminal relay with a 12V coil.
- The engine relay (model 04580) is a 5 terminal relay with a 12V coil.
- The shutdown delay relay (models 04590 and 04591) is a 4 terminal relay with a 48V coil.

Identifying the Relays and their Functions

Note: Refer to the Electrical Schematics and Wire Harnesses in Appendix A (page A–1) for additional relay circuit information.

Logic Relay When energized by the T1: primary controller, the logic relay provides 48V power to the logic circuits of all 48 volt controllers (T2 – T6 and SC2 – SC8). T1 and SC1 operate on 12V logic power.

Brake Actuator Relay When energized by the T1: primary controller, the brake actuator relay supplies 12V power to the electric brake actuator to retract. The automatic parking brake disengages when the brake actuator retracts.

Engine Relay (Model 04580) When energized by the T1: primary controller, the engine relay opens the path to ground which allows the engine ignition circuit to function. When de-energized, the engine relay closes the path to ground which interrupts the engine ignition circuit and stops the engine.

Identifying the Relays and their Functions (continued)

Shutdown Delay Relay (Model 04590 and 04591) The shutdown delay relay is energized when the key switch is set to the ON position. When energized, the shutdown delay relay supplies power to the 12V control circuits (manual parking brake switch, T1: primary controller outputs, InfoCenter display, CAN bus isolation module, brake actuator relay switch terminal).

The shutdown delay relay is also used to de-energize the 12V control circuits before the SC8: lithium-ion battery controller (BMS) takes the 48 VDC lithium-ion batteries off-line.

Testing Relays with 4 Terminals

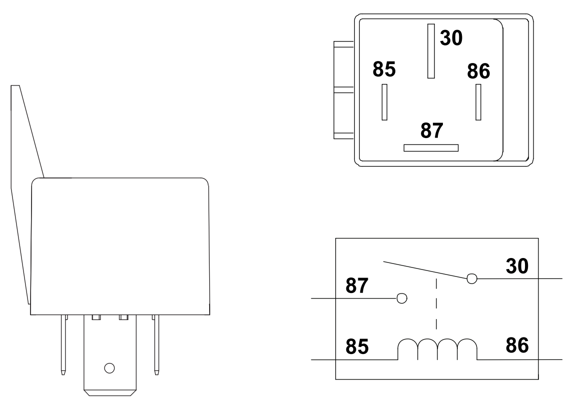
1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

3. Remove the right side cover.
4. Disconnect the wire harness connector from the relay being tested. Check the relay and the harness connector for damage or corrosion and clean or repair as necessary. Remove the relay from the mounting panel.

   Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value for the tested component.

5. Using a multimeter (ohms setting), measure the coil resistance between terminals 85 and 86.



g291282

Figure 94

Relays with 4 terminals

RELAY	COIL RESISTANCE
Logic Relay	12V coil – 68 to 82 ohm
Shutdown Delay Relay (Model 04590)	48V coil – 990 to 1210 ohms

6. Verify infinite resistance (no continuity) exists between terminals 30 and 87.

Testing Relays with 4 Terminals (continued)

7. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85 of the logic relay (12V coil), or +48 VDC to terminal 85 of the shutdown delay relay (48V coil). The relay should make and break continuity between terminals 30 and 87 as +voltage is applied and removed from terminal 85.
8. Replace the relay as necessary.
9. If the relay tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
10. Install the relay and connect the wire harness.
11. Connect battery power to the machine as follows:

Model 04580	Connect the battery negative (-) cable at the 12V system battery.
Model 04590 and 04591	Connect the 48V battery disconnect.

12. Test the relay functionality before returning the machine to service.

Testing Relays with 5 Terminals

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

3. Remove the right side cover.
4. Disconnect the wire harness connector from the relay being tested. Check the relay and the harness connector for damage or corrosion and clean or repair as necessary. Remove the relay from the mounting panel.

   Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value for the tested component.

5. Using a multimeter, verify that coil resistance between terminals 85 and 86 is from 71 to 88 ohms.

Testing Relays with 5 Terminals (continued)

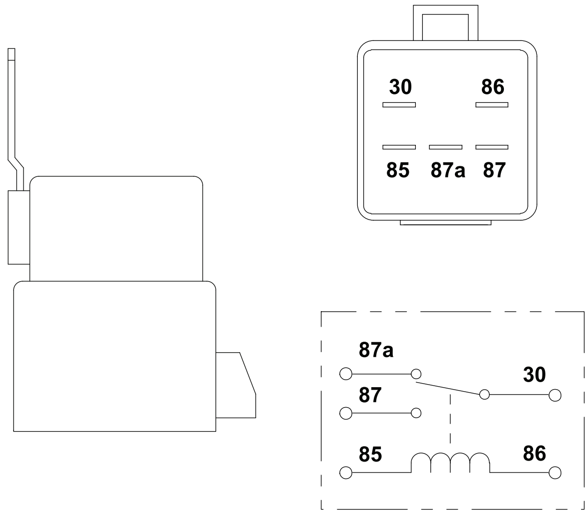


Figure 95

Relays with 5 terminals

---

6. Verify infinite resistance (no continuity) exists between terminals 30 and 87.
7. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +voltage is applied and removed from terminal 85.
8. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.
9. Replace the relay as necessary.
10. If the relay tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
11. Install the relay and connect the wire harness.
12. Connect battery power to the machine as follows:

Model 04580	Connect the battery negative (-) cable at the 12V system battery.
Model 04590 and 04591	Connect the 48V battery disconnect.

13. Test the relay functionality before returning the machine to service.

Contactors

Two contactors are used on eTriFlex machines: the main contactor and the traction motor contactor. Both contactors are located under the left side cover. The main contactor connects the 48V batteries to the 48V power bus for the lift/lower actuators, cutting unit motors, the optional 3WD traction motor, and the starter/generator (model 04580). The steering motor is always connected to the 48V power bus, and is not controlled by the main contactor. The main contactor is energized be the logic relay.

The traction motor contactor connects the 48V batteries to the 48V power bus for the front traction motor controllers. Each front traction motor controller passes 48V power along to its specific traction motor as needed. The traction motor contactor is energized by the traction motor controller SC5: Traction 1.

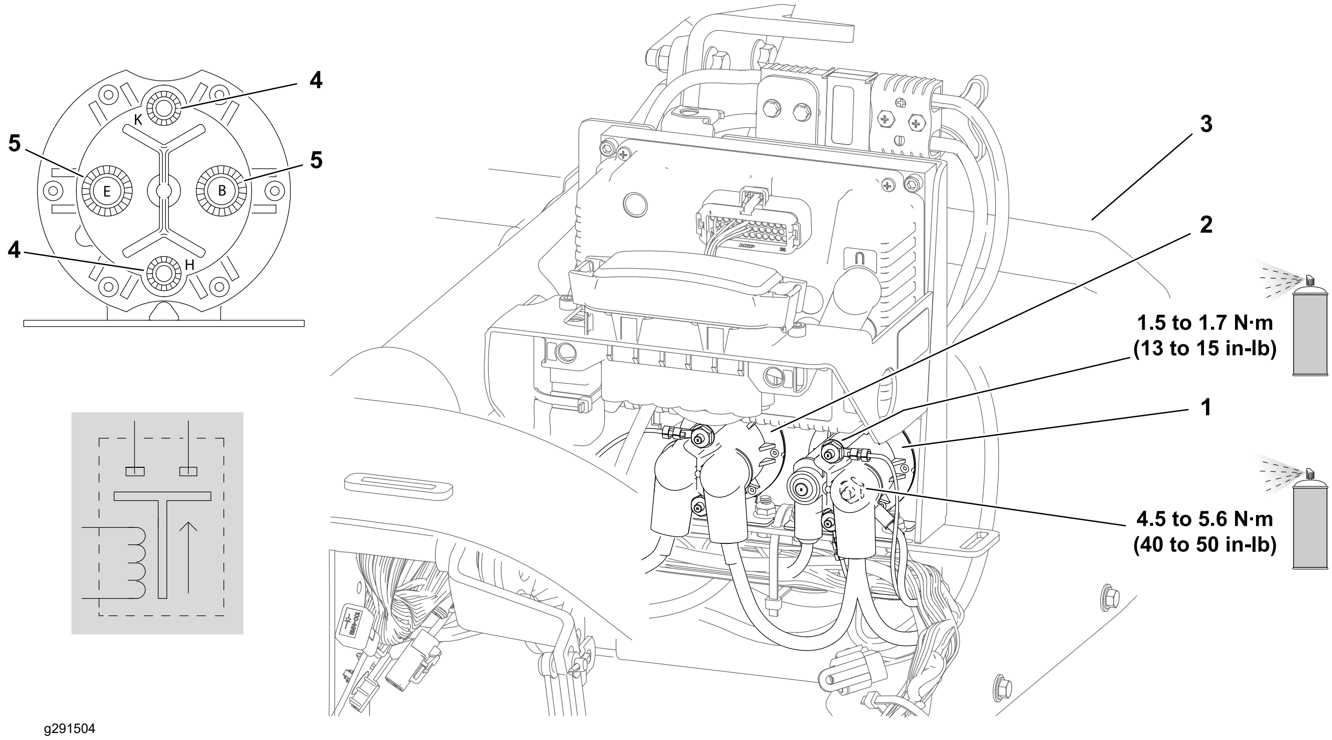


Figure 96

1. Main contactor
2. Traction motor contactor
3. Left side battery box
4. Coil terminals
5. Main terminals

Testing the Contactors

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

3. Remove the left side cover.
4. Record the wire connector locations on the contactor being tested for assembly purposes, and disconnect the harness electrical connectors from contactor. Check the contactor and the harness connectors for damage or corrosion and clean or repair as necessary.

Testing the Contactors (continued)

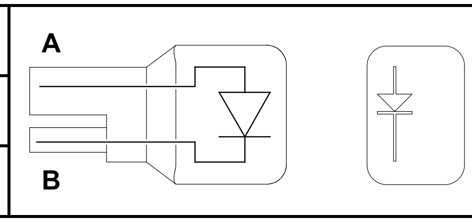
Note: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value for the tested component.

5. Measure the resistance across the contactor coil terminals. Resistance of the coil should be approximately 195 ohms.
6. With the contactor coil not energized, resistance across the contactor main terminals should be infinite ohms.
7. If testing determines that the contactor is faulty, replace the contactor.
8. If the contactor tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
9. After testing, connect the harness electrical connectors to the contactor. Secure the main terminal connectors with flange nuts and tighten the nuts from **4.5 to 5.6 N·m (40 to 50 in-lb)**. Secure the coil terminal connectors with Keps™ nuts, and tighten the nuts from **1.5 to 1.7 N·m (13 to 15 in-lb)**. Apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the contactor terminals and cable connectors to reduce corrosion.
10. Connect battery power to the machine as follows:

Model 04580	Connect the battery negative (-) cable at the 12V system battery.
Model 04590 and 04591	Connect the 48V battery disconnect.

11. Test contactor functionality before returning the machine to service.

Diode Assemblies

Multimeter Red (+) Lead	Multimeter Black (-) Lead	Resistance	
DIODE TERMINAL A	DIODE TERMINAL B	VERY LOW	
DIODE TERMINAL B	DIODE TERMINAL A	VERY HIGH	

Two different diodes are used on the eTriFlex machines. The maximum current allowed through any of the diodes is 6 amps. The diodes can be identified by their black color and diode symbol on the end of the diode body.

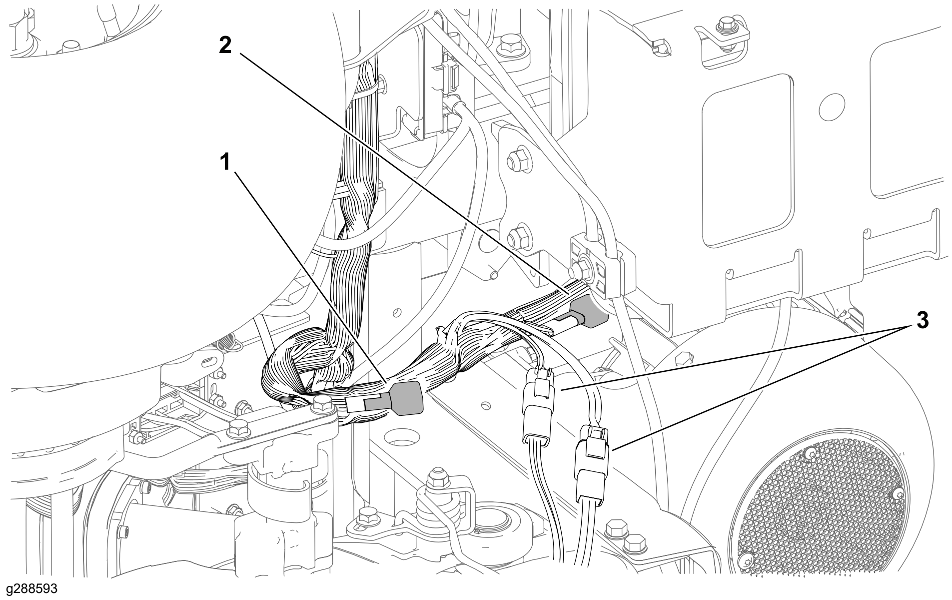


Figure 97

1. Main contactor diode
2. Traction motor contactor diode
3. Center cutting unit motor connectors

- A diode assembly is used for circuit protection from voltage spikes that occur when the main contactor is de−energized. The diode plugs into the machine wire harness near the wire harness connectors for the center cutting unit motor on the left side of the machine.
- A diode assembly is used for circuit protection from voltage spikes that occur when the traction motor contactor is de−energized. The diode plugs into the machine wire harness near the wire harness connectors for the center cutting unit motor on the left side of the machine.

Testing the Diode Assemblies

1. Locate and remove the diode from the wire harness. Check the diode and the harness connector for damage or corrosion and clean or repair as necessary.
2. Use a multimeter to check for voltage drop across the diode terminals (diode test setting). Contact the multimeter red (+) lead to diode terminal A and the black (−) lead to diode terminal B. A reading of less than 0.7 volts should be displayed on the multimeter.

   OR

   Use the table provided and a multimeter (ohms setting) to measure the resistance across the diode terminals.
3. Replace the diode if necessary.

Testing the Diode Assemblies (continued)

4. If the diode tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).

CAN Bus Terminator Resistors

Terminator Resistor Locations—Models 04580 and 04590

The machine controllers communicate with each other on a Controller Area Network (CAN) bus system. Controllers that operate on 12 VDC connect to the 12V side of the CAN bus (CAN A), while controllers that operate on 48 VDC connect to the 48V side of the CAN bus (CAN B). The two sides of the CAN bus communicate as one network using the CAN bus Isolation Module. The entire CAN bus is made up of two specially designed twisted wires. The engineering term for these wires are CAN High (yellow wire) and CAN Low (green wire). A 120 ohm CAN termination resistor is located at each end of CAN A, and at each end of CAN B (4 total). Refer to CAN Bus (page 5–34) for CAN bus testing procedures.

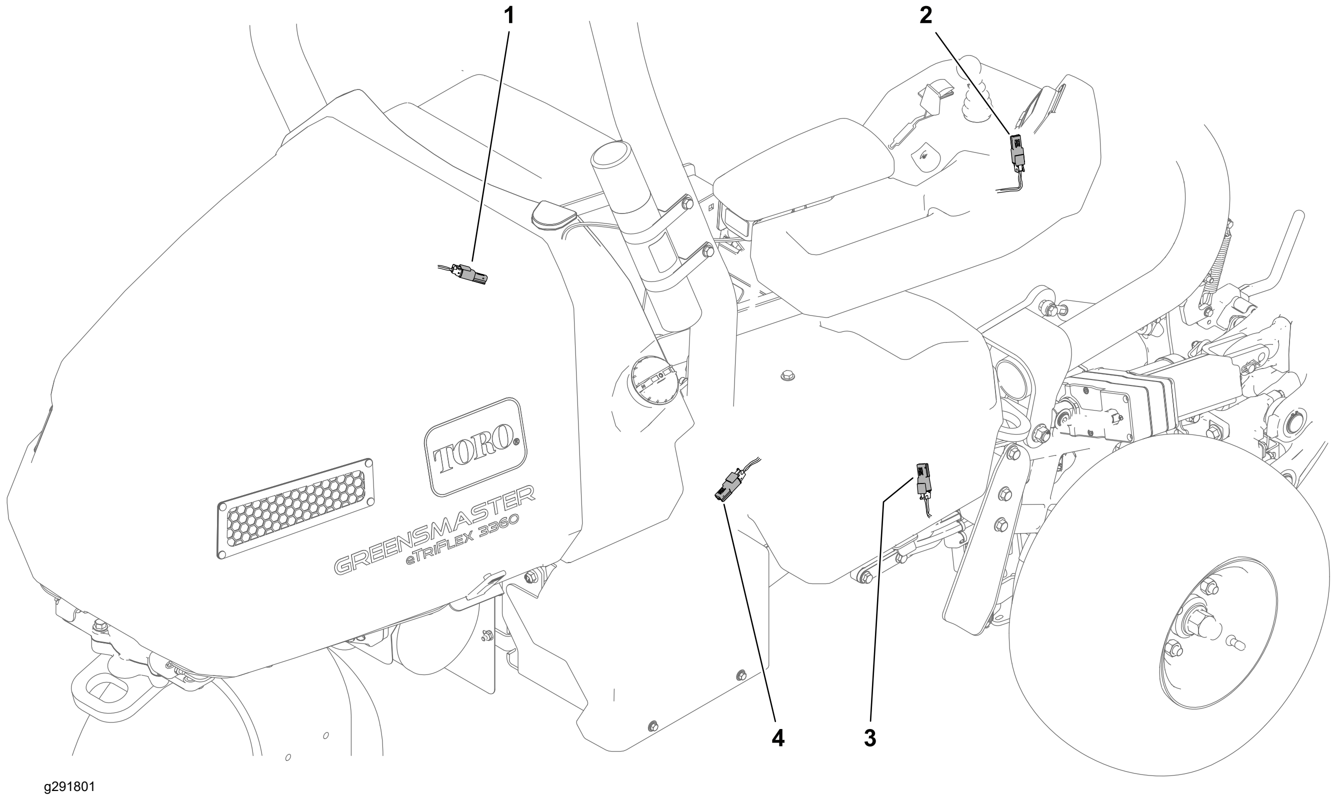


Figure 98

Models 04580 and 04590

1. CAN B termination resistor at connector P60 (lower step—left side of the machine)
2. CAN A termination resistor at connector P66 (console cover)
3. CAN B termination resistor at connector P58 (right electrical cover)
4. CAN A termination resistor at connector P65 (bottom of the machine—left of the brake actuator)

The CAN bus and the termination resistors are part of the machine wire harness.

CAN System	Location	Main Harness Connector Number
CAN A termination resistor	Bottom of the machine to the left of the brake actuator	P65
CAN A termination resistor	Operator’s console under the InfoCenter display	P66

Terminator Resistor Locations—Models 04580 and 04590 (continued)

CAN System	Location	Main Harness Connector Number
CAN B termination resistor	Under the right side cover below the relays.	P58
CAN B termination resistor	Inboard of the step at the left side of the machine	P60

Note: Refer to Appendix A (page A–1) for additional information on the CAN bus wiring.

IMPORTANT

All 4 terminator resistors are required for proper CAN bus operation.

Terminator Resistor Locations—Model 04591

The machine controllers communicate with each other on a Controller Area Network (CAN) bus system. The controllers that communicate across a 48 V CAN bus. The entire CAN bus is made up of two specially designed twisted wires. The engineering term for these wires are CAN High (yellow wire) and CAN Low (green wire). A 120 ohm CAN termination resistor is located at each end of CAN system, 1 in the wire harness, and the other in a battery of the lower battery pack. Refer to Removing the Lower-Battery Pack Cover (page 5–153) for accessing the battery and CAN Bus (page 5–34) for CAN bus testing procedures..

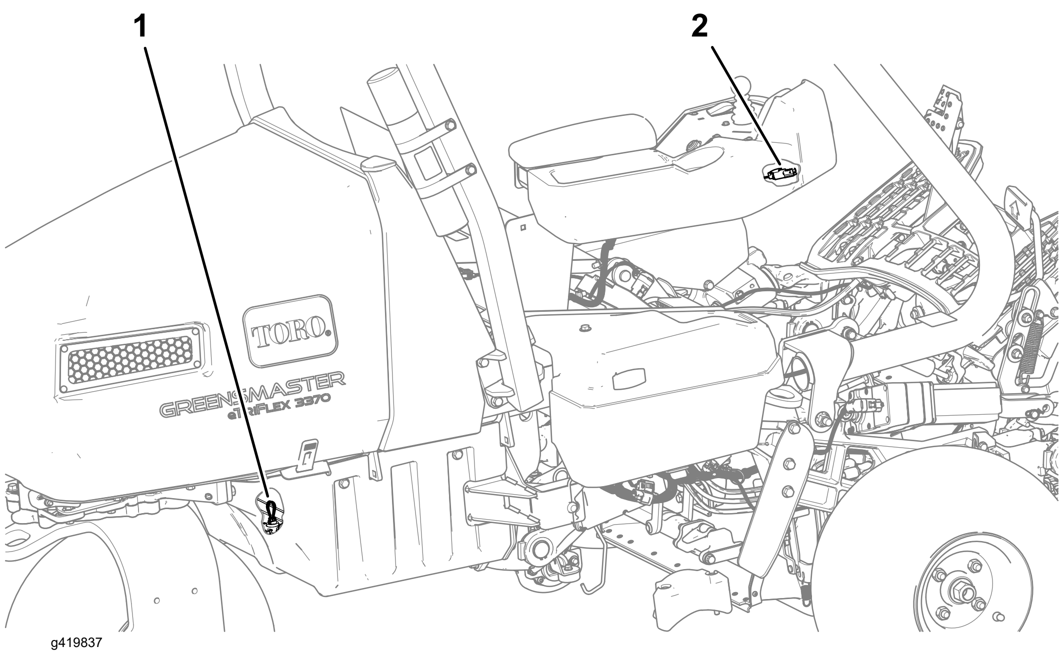


Figure 99

Model 04591

1. CAN termination resistor (lower battery—lower battery pack)
2. CAN termination resistor at connector P66 (console cover)

Terminator Resistor Locations—Model 04591 (continued)

CAN System	Location	Main Harness Connector Number
CAN termination resistor	Operator's console under the InfoCenter display	P66
CAN termination resistor	In the lower battery of the lower battery pack	N/A

Note: Refer to CAN Bus (page 5–34) for additional information on the CAN bus wiring.

IMPORTANT

Both terminator resistors are required for proper CAN bus operation.

Testing the CAN bus Terminator Resistors

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Disconnect battery power from the machine as follows:

Model 04580	Disconnect the battery negative (-) cable at the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
Model 04590 and 04591	Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

3. Locate the CAN bus termination resistor and unplug it for testing. Check the resistor and the harness connector for damage or corrosion and clean or repair as necessary.
   - Terminator Resistor Locations—Models 04580 and 04590 (page 5–111)
   - Terminator Resistor Locations—Model 04591 (page 5–112)
4. Use a digital multimeter (ohms setting) and measure the resistance across the pins of the CAN bus termination resistor. There should be 120 ohms resistance between terminals 1 and 2.

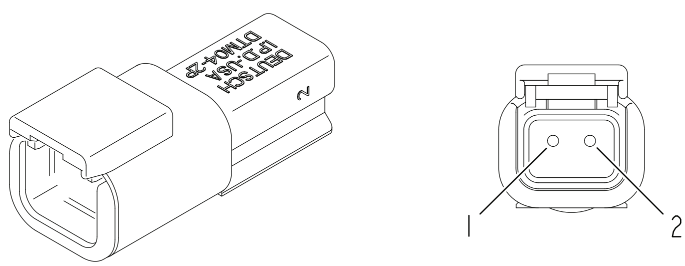


Figure 100

5. If testing determines the termination resistor is faulty, replace the resistor.
6. After testing is complete, make sure the external termination resistor is fully installed into the connector and secured to the wire harness.
7. If the resistors test correctly and a circuit problem still exists, check the remainder of the CAN–bus; refer to Testing the CAN bus (page 5–36), Appendix A (page A–1), or contact an Authorized Toro Distributor for assistance.

Lead Acid Batteries (Model 04580)

Caring for the Lead Acid Batteries (Model 04580)

WARNING

The battery gases are explosive; also, they can cause nausea.

- **Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated place so that the gasses produced while charging can dissipate.**
- **Keep open flames and electrical sparks away from the battery; do not smoke.**
- **Disconnect the charger from the electrical outlet before connecting or disconnecting charger leads to or from the battery posts.**

IMPORTANT

Do not remove fill caps while cleaning.

1. Clean the top of the battery by washing at the terminals with a brush dipped in ammonia or bicarbonate of soda solution. Flush the top surface with water after cleaning.
2. If corrosion occurs at the battery terminals, disconnect the battery cables. Always disconnect the negative (-) cable first. Clean the cable clamps and terminals separately.
3. Tighten the battery cables on the battery terminals to provide a good electrical contact. Apply a coating of Toro Part No. 107-0392 battery terminal protector or a light coat of grease to the terminals to reduce corrosion after you make the connections; refer to Special Tools (page 2–14).

WARNING

Connecting the cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

Ensure that the cables are properly connected to the correct battery posts before operating the machine.

Storing the Lead Acid Batteries (Model 04580)

If you store the machine for more than 30 days:

1. Ensure that the key switch is in the OFF position.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Disconnect the ground (-) cable from the 12V battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
4. Charge the batteries fully before storage; refer to Charging the Lead Acid Batteries (Model 04580) (page 5–120).
5. Store the battery in the appropriate environment:
   - Recommended storage temperatures should be between 10°C to 25°C (50°F and 77°F).
   - Storage at elevated temperatures will result in accelerated rates of self discharge.
   - If temperatures are expected to drop well below freezing for an extended period, remove the batteries from the machine and store the batteries in a warmer environment.

Servicing the Lead Acid Batteries (Model 04580)

Battery Specifications

12V system battery	Type: absorbed glass mat (AGM), valve regulated lead acid (VRLA) Nominal voltage: 12 AH rating: 8 Load Test (maximum discharge current): 120 amps for 5 seconds Length: 15.0 cm (5.9 inches) Width: 6.6 cm (2.6 inches) Height including terminal posts: 10.7 cm (4.2 inches)
48V system batteries – 4 each	Type: absorbed glass mat (AGM), valve regulated lead acid (VRLA) Nominal voltage: 12 AH rating: 33 Load Test (maximum discharge current): 495 amps for 5 seconds Length: 19.6 cm (7.7 inches) Width: 13.2 cm (5.1 inches) Height including terminal posts: 18.3 cm (6.6 inches)

The battery is the heart of the electrical system. With the regular and correct service, the battery life can be extended. Additionally, the battery and electrical component failure can be prevented.

Removing and Installing the 12V System Lead Acid Battery (Model 04580)

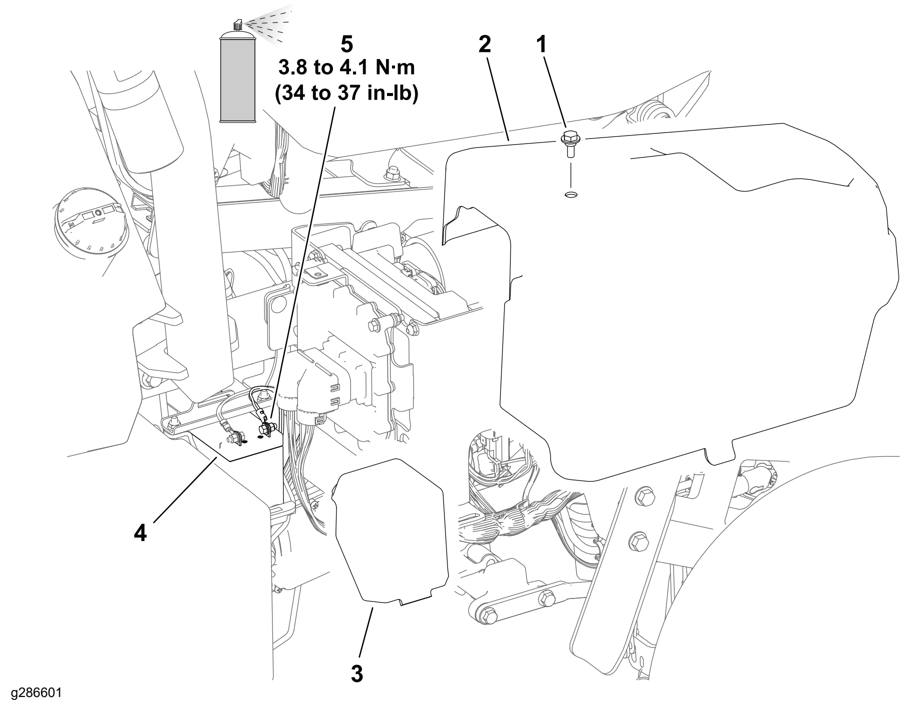


Figure 101

1. Shoulder screw
2. Front right side cover
3. Battery cover
4. 12V battery
5. Negative (-) terminal

IMPORTANT

Be careful when removing the battery cables and ensure that you do not damage the terminal posts or cable connectors.

---

1. Remove the right side cover.
2. Remove the battery cover.
3. Disconnect the ground (-) cable from the battery terminal, then disconnect the positive (+) cable from the battery terminal.
4. Remove the lock nuts, carriage bolts, and the battery clamp.
5. Install the battery in reverse order.
6. Tighten the battery terminal fasteners from **3.8 to 4.1 N·m (34 to 37 in-lb)**, then apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the battery terminals and cable connectors to reduce corrosion.

Removing and Installing the 48V System Lead Acid Batteries (Model 04580)

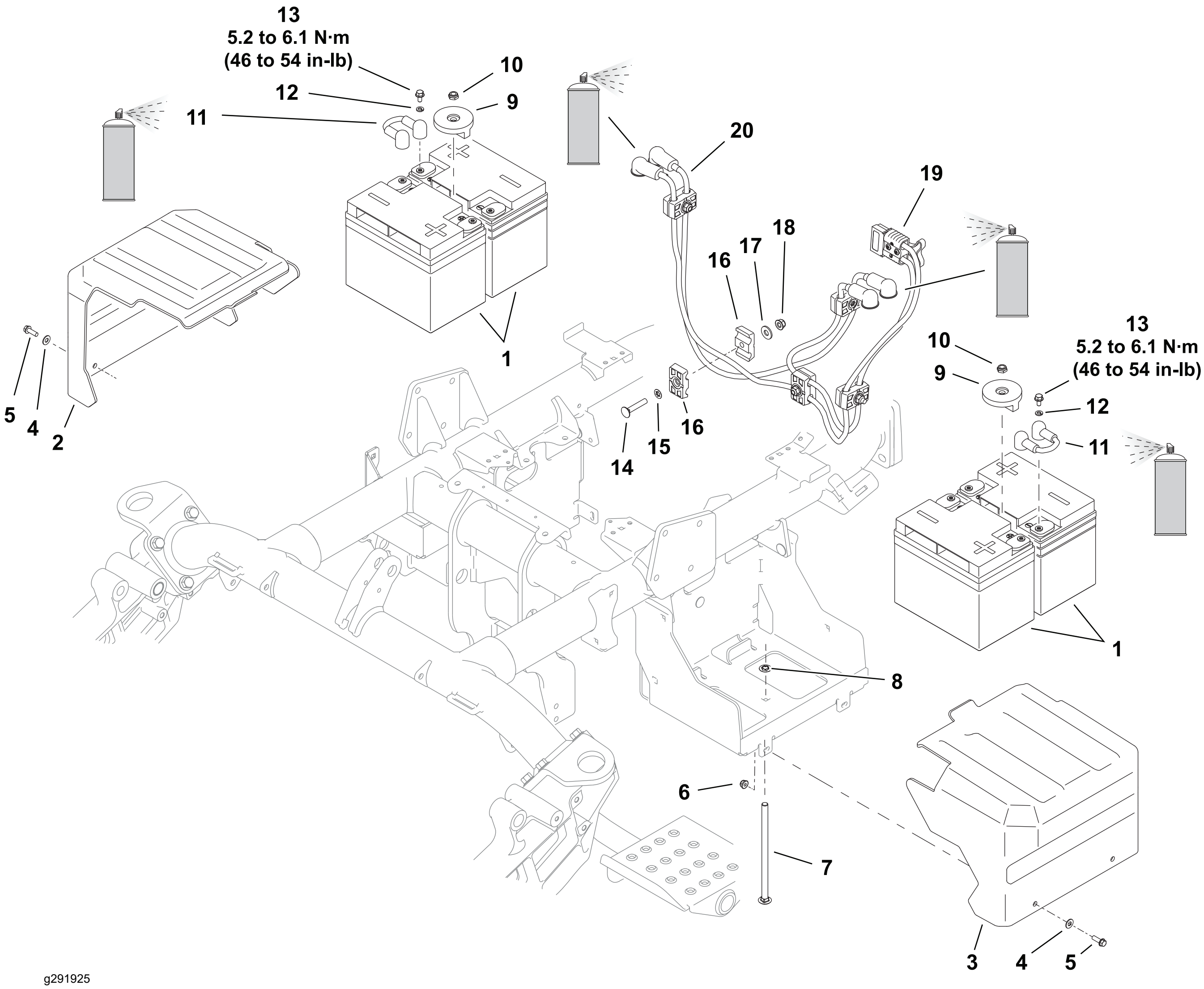


Figure 102

1.	Battery (4 each)	8.	Push nut (2 each)	15.	Retaining ring
2.	Battery cover – RH	9.	Battery hold down (2 each)	16.	Clamp (10 each)
3.	Battery cover – LH	10.	Lock nut (2 each)	17.	Flat washer
4.	Flat washer (4 each)	11.	Jumper cable (2 each)	18.	Flange nut
5.	Flange head screw (4 each)	12.	Lock washer (8 each)	19.	Battery cable assembly
6.	Flange nut (4 each)	13.	Cap screw (8 each)	20.	Battery cable
7.	Carriage bolt (2 each)	14.	Carriage bolt		

Removing and Installing the 48V System Lead Acid Batteries (Model 04580) (continued)

⚠ WARNING ⚠

The battery terminals, metal tools and metal vehicle parts could short together and cause sparks during battery removal and installation. Damaged cables could short against metal vehicle parts and cause sparks. Sparks can cause battery gasses to explode. When removing or installing the batteries, do not allow the battery terminals to short against metal parts of the vehicle. Do not allow metal tools or metal vehicle parts to short between the battery terminals or battery cables. Always keep the battery hold downs in place to protect and secure the batteries.

1. Ensure that the key switch is in the OFF position.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Remove the battery covers.
4. Carefully remove the battery jumper cables from each pair of batteries to open the battery circuit. Do not allow tools or vehicle components to complete the battery circuit during cable removal.
5. Remove the remaining cables from the battery terminals. Position the battery cables away from the battery terminals.
6. Remove the hex nuts and battery hold downs that secure the batteries to the battery trays.
7. Carefully remove the batteries from the machine.
8. If battery cable removal is needed, record the routing of the cables for installation purposes before removing the cables from the machine.
9. Make sure the battery cables, battery terminals and all fasteners are free of corrosion and in good condition.
10. If the battery cables were removed, install the cables as recorded during disassembly. Ensure that the cables are correctly routed through the clamps and that the clamps are secured to the machine.
11. Tighten the battery terminal fasteners from **5.2 to 6.1 N·m (46 to 54 in-lb)**, then apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the battery terminals and cable connectors to reduce corrosion.
12. Secure each pair of batteries with a battery hold down and hex nut.

IMPORTANT

When connecting the batteries in the 48 volt system, make sure that battery polarity is carefully checked. Damage to fuses or other system components can occur if batteries are not connected correctly.

13. Install all the battery cables except the battery jumper cables (item 11). Make sure that the cables are connected to correct battery terminal noting the battery polarity. Tighten the battery terminal cap screws from **5.2 to 4.5 N·m (46 to 54 in-lb)**.

Removing and Installing the 48V System Lead Acid Batteries (Model 04580) (continued)

14. Carefully install the battery jumper cables(item 11)-. Do not allow tools or vehicle components to complete the battery circuit during cable installation. Tighten the battery terminal cap screws from **5.2 to 4.5 N·m (46 to 54 in-lb)**.
15. After you make the connections, apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the battery terminals and cable connectors to reduce corrosion; refer to Battery Terminal Protector (page 2–14). Make sure that all terminal boots are positioned over all cable connections.
16. Install the battery covers before returning the machine to service.

Inspecting, Maintaining, and Testing the Lead Acid Batteries (Model 04580)

1. Clean the batteries with clean water and a towel. Do not use solvents or chemicals to clean the batteries.
2. Check the battery case for cracks. Replace the battery if cracked or leaking.
3. Check the battery terminals and cables for corrosion and clean them as necessary. Use a battery terminal protector to reduce corrosion; refer to Battery Terminal Protector (page 2–14).
4. If the 48V system battery voltage drops below 50 VDC, battery inspection and/or charging may be necessary.
5. Use a digital multimeter (VDC) to measure the voltage of each battery individually.

   Note: This test provides a relative condition of the battery. Load testing of the battery provides additional and more accurate information.

   A. Disconnect the cables from the terminals of the battery being tested.

   B. Measure and record the battery voltage. Refer to the following table to determine charge level of the battery.

Lead Acid Battery Test Table

Voltage Measured	Battery Charge Level
12.68 VDC (or higher)	Fully charged (100%)
12.45 VDC	75% charged
12.24 VDC	50% charged
12.06 VDC	25% charged
11.89 VDC	0% charged

   Note: The voltages listed are measured at 20 C (F).

   If the battery was being charged prior to the measurement, allow the battery voltage to stabilize (wait a few hours) before taking the voltage measurement.

   When testing the 48V system batteries, the voltage should be consistent across all 4 batteries. If the voltage of any of the batteries varies by more than 10%, it indicates a problem with the battery that has the lower voltage.

6. A battery load tester can be used to test individual batteries.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

IMPORTANT

Many locally available battery load testers do not, have any adjustment on the load that is put on the battery. Results received from using load testers should follow the recommendations of the load tester manufacturer.

Refer to the Battery Specifications (page 5–115) for load testing specifications.

Charging the Lead Acid Batteries (Model 04580)

The batteries may be individually charged with a 12V charger rated for operation with absorbed glass mat (AGM), valve regulated lead acid (VRLA) batteries. The voltage of this battery type is slightly lower than flooded lead acid batteries. Maximum charge voltage should be limited to 14.8 VDC. Maximum charge current for the 12V system battery should be limited to 2.4 amps. Maximum charge current for the 48V system batteries should be limited to 9.9 amps.

IMPORTANT

Follow the manufacturer's instructions when using a battery charger.

Operating the machine should charge the 12V system and the 48V system batteries.

Lithium-Ion Batteries (Model 04590 and 04591)

WARNING

Immediately discontinue use of the battery if the battery emits an unusual smell, feels hot, changes color or shape, or appears abnormal in any other way. Move the product or battery to a safe outdoor area away from any building, vehicle, or combustible material. Observe the battery for at least 1 hour to ensure that any reaction has stopped. If the reaction continues, or if any smoke is observed, call your local emergency services immediately. Failure to do so may result in personal injury and property damage.

Use only Toro-specified lithium-ion battery packs designed for your machine. Do not mix batteries of any brand or type in Toro products. Failure to do so may result in personal injury and property damage.

IMPORTANT

A used or damaged lithium-ion battery must be disposed of or recycled in accordance with local and federal regulations. For information on how to properly dispose of lithium-ion batteries, contact your local municipality or recycling facility.

Model 04590

The Greensmaster 3370 Model 04590 is powered by 8 maintenance free lithium-ion batteries. 2 batteries are located under a cover at the right side of the machine, 2 batteries are located under a cover at the left side of the machine, and 4 batteries are located at the center of the machine under the hood.

SC8 Lithium-Ion Battery Controller

Note: SC8 Lithium-Ion Battery Controller is also referred to as the BMS (battery management system) module.

The BMS Module is the controller for the batteries in the 60V DC system. The BMS connects the 60V circuit of the batteries to the 60V bus, and disconnects the battery circuit from the bus. The BMS module controls 60V battery pack voltage to the 60V Bus of the machine. The BMS module controls battery charger voltage to the batteries when charging the battery pack. The BMS module is the only CAN aware device in the battery system; only the BMS communicates with the primary controller of the host machine through the CAN bus system. The batteries communicate with the BMS across the battery pack subnetwork using a battery interface harness. Refer to SC8: Lithium-Ion Battery Controller (Model 04590) (page 5–18) for additional information.

Battery

Each battery consists of a temperature sensor, a serial communication interface, and numerous lithium-ion cells.

Battery Pack

A battery pack physical group of 1 or more batteries. A machine may have 1 or more battery packs. The high-current cables of a battery pack with multiple batteries are wired in parallel.

Model 04591

The Greensmaster 3370 Model 04591 is powered by 5 maintenance free lithium-ion batteries in the battery stack. All batteries are located under the hood. The upper battery pack has 3 batteries, and the lower battery pack has 2 batteries.

Battery

IMPORTANT

The 60V battery and BMS are not serviceable. If either is determined to be worn or damaged, the battery must be replaced. Breaking the tamper-proof seal on a battery case voids any existing warranty that it may have.

Each battery consists of a BMS (battery management system), a temperature sensor, and numerous lithium-ion cells. The BMS of the Leader and BMS of each Support battery independently control charge voltage to the battery and discharge voltage from the battery. Refer to the HyperCell BMS information. for additional information.

Battery Pack

A battery pack physical group of 1 or more batteries. A machine may have 1 or more battery packs. The high-current cables of a battery pack with multiple batteries are wired in parallel.

Battery Stack

A battery stack is comprised of 2 or more battery packs. The high-current cables of the battery packs in a battery stack are wired in parallel.

Leader Battery

Every machine has 1 leader battery. The Leader battery can comprise the only battery in a battery pack, but is more likely to be a member of a multi-battery pack or battery stack.

- Only the BMS of the Leader battery has the direct interface with the primary controller of the machine through the CAN bus.
- The Leader battery communicates with the primary controller of the machine on behalf of itself, the batteries of a battery pack, and the packs of a battery stack.

Support Battery

A Support battery is 1 or more batteries, other than the Leader battery, that comprise a battery pack. The BMS of the Support battery communicate with the host machine by passing CAN bus messages through the series of each upstream support battery, to the Leader battery, across the CAN bus, and to the primary controller of the machine.

Caring for the Lithium-Ion Batteries (Model 04590 and 04591)

When mowing, use the InfoCenter to monitor the state of charge of the lithium-ion battery pack. Consistently operating the machine with a very low state of charge will adversely affect the life of the batteries.

Caring for the Lithium-Ion Batteries (Model 04590 and 04591) (continued)

If problems with the batteries exist, an advisory or fault may be identified on the InfoCenter; refer to InfoCenter Display (page 5–11).

When done using the machine for the day, park the machine in a clean and dry area that is away from direct sunlight and other heat sources. Do not store the machine in a location where the battery temperature could rise above 45°C (113°F). If the battery is regularly subjected to excessive temperatures, the life of the batteries will be reduced.

Charge the batteries when you are finished mowing for the day to ensure that the batteries are fully charged for the next mowing. Lithium-ion batteries do not have a charge memory issue and do not need to be fully discharged before charging them. Ensure that the battery pack is charged with the Toro lithium-ion battery charger that is specially designed for the exact model number of your machine. For best battery life, connect the machine to the battery charger any time the machine is not in use.

Keep the battery covers clean. A dirty battery cover will increase the heat in the battery and will reduce the energy capacity and life of the battery.

Storing the Lithium-Ion Batteries (Model 04590 and 04591)

Do not store the machine in a location where the temperature will drop below -25°C (-13°F) or rise above 45°C (113°F). Because storage temperature will affect the life of the battery pack, avoid storing the machine in temperatures outside of this range. Storage for long periods of time at high temperatures will reduce the life of the battery pack, especially if the pack is stored with a high charge. Where possible, store the machine in a cool (not below freezing) location.

- Storage of 1 to 6 months: Charge or discharge the battery to 50 - 100%. 50% is ideal due to 100% will degrade the battery faster.
- Storage of 6 to 12 months: Charge the battery to 100%.
- Storage of more than 12 months: Check the state of charge. If it is under 50% charging is required.

After charging, disconnect the charger from batteries to prevent minimal drain on the batteries. If charger is left connected to the batteries for an extended period, it will shut off after the batteries are fully charged and will NOT turn back on unless the charger is disconnected and reconnected.

Shipping and Transporting the Lithium-Ion Batteries (Model 04590 and 04591)

The US Department of Transportation and international transportation authorities require that lithium-ion batteries be shipped using special packaging and only be handled by carriers certified to haul them. Use the original packaging whenever possible when shipping lithium-ion batteries in the USA. If the original packaging is damaged or not available, use a Battery Shipping Kit; refer to Lithium-Ion Battery Shipping Kit (page 2–15). Contact the appropriate government body in your country for detailed regulations on shipping the lithium-ion batteries.

In the USA, you are allowed to transport the battery when it is installed on the machine as battery powered equipment, with some regulatory requirements. Contact US Department of Transportation or the appropriate government body in your country for detailed regulations on transporting a machine with lithium batteries installed.

Shipping and Transporting the Lithium-Ion Batteries (Model 04590 and 04591) (continued)

IMPORTANT

Ship a lithium-ion battery in its original packaging or a specially designed Battery Shipping Kit. Failure to ship a lithium-ion battery correctly may result in substantial penalties.

Charging the Lithium-Ion Batteries (Models 04590 and 04591)

WARNING

When charging lithium-ion batteries:

- **Use only the Toro-specified lithium-ion charger designed to charge batteries for the exact model number of your machine. Do not attempt to use any other battery charger.**
- **Charge the lithium-ion batteries together (as a set of eight batteries) through the machine charger interconnect as described in the traction unit *Operator's Manual*.**
- **Do not over-charge or over-discharge the lithium-ion batteries.**

Failure to follow these recommendations may result in personal injury and property damage.

Charge the lithium-ion batteries together (as a set of eight batteries) through the machine charger interconnect as described in the traction unit *Operator's Manual*.

IMPORTANT

If charging an individual lithium-ion battery is necessary, contact an Authorized Toro Distributor for assistance.

Refer to Battery Charger Error and Fault Codes (Model 04590) in Chapter 3 – Troubleshooting for battery charger troubleshooting information. A record of battery charger operation data can be downloaded by inserting a flash drive into the USB port on the battery charger. Forward a copy of the battery charger data file to Toro Service (contact an Authorized Toro Distributor for assistance).

Servicing the Lithium-Ion Batteries (Model 04590)

WARNING

When removing or installing the batteries:

- **Always disconnect the batteries at the battery disconnect provided when servicing products with lithium-ion batteries.**
- **Always service lithium-ion batteries with the machine parked near a service door large enough to move the product or battery outside in case of an emergency. Keep a fire suppression blanket nearby; do not use a fire extinguisher on lithium-ion batteries.**

Failure to follow these recommendations may result in personal injury and property damage.

Removing and Installing the Lithium-Ion Batteries (Model 04590)

WARNING

When removing or installing the batteries:

- **Always disconnect the batteries at the battery disconnect provided when servicing products with lithium-ion batteries.**
- **Always service lithium-ion batteries with the machine parked near a service door large enough to move the product or battery outside in case of an emergency and keep a fire blanket nearby. Do not use a fire extinguisher on lithium-ion batteries.**
- **Do not allow the battery terminals or battery cables to touch any metal parts of the machine.**
- **Do not allow metal tools to short between the battery terminals or battery cables and metal parts of the machine.**
- **Do not attach anything to the battery terminal other than the battery cable or wire harness connector that came with the product.**
- **Always keep the battery retainers and covers in place to protect and secure the batteries.**

Failure to follow these recommendations may result in personal injury and property damage.

CAUTION

To prevent accidentally shorting disconnected battery cables across other components or tools, insulate the battery cable terminals with 76 mm (3 inch) lengths of 1/2 inch internal diameter rubber hose immediately after disconnecting the cables. Failure to do so may result in personal injury and property damage.

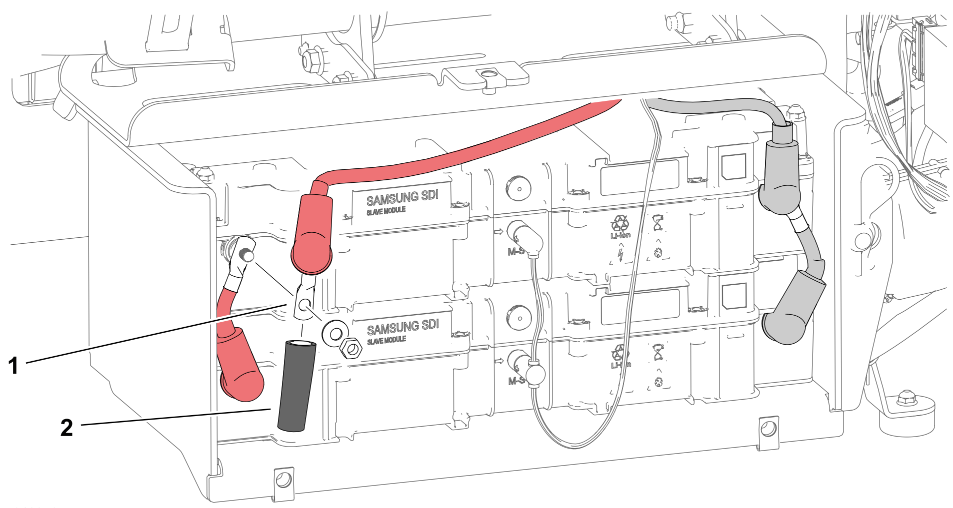


Figure 103

1. Battery cable terminal (typical)
2. 1/2 inch ID rubber hose

Removing and Installing the Lithium-Ion Batteries (Model 04590) (continued)

⚠ CAUTION ⚠

Do not open the lithium-Ion batteries. There are no serviceable parts on or in the lithium-ion battery case. If you open the battery case, you will void the warranty. The battery case is protected by tamper-alerting devices. Opening the battery case may result in personal injury and property damage.

---

1. Park the machine on a level surface near a service door large enough to move the machine or battery outside in case of an emergency. If possible, service the product outside if the product can be removed from the building quickly in the event of an emergency. Engage the manual parking brake, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Open the hood, and remove both side battery covers.
4. Label and disconnect the positive (+) battery cable at the center mounted batteries, and at each set of side mounted batteries; refer to Figure 104.

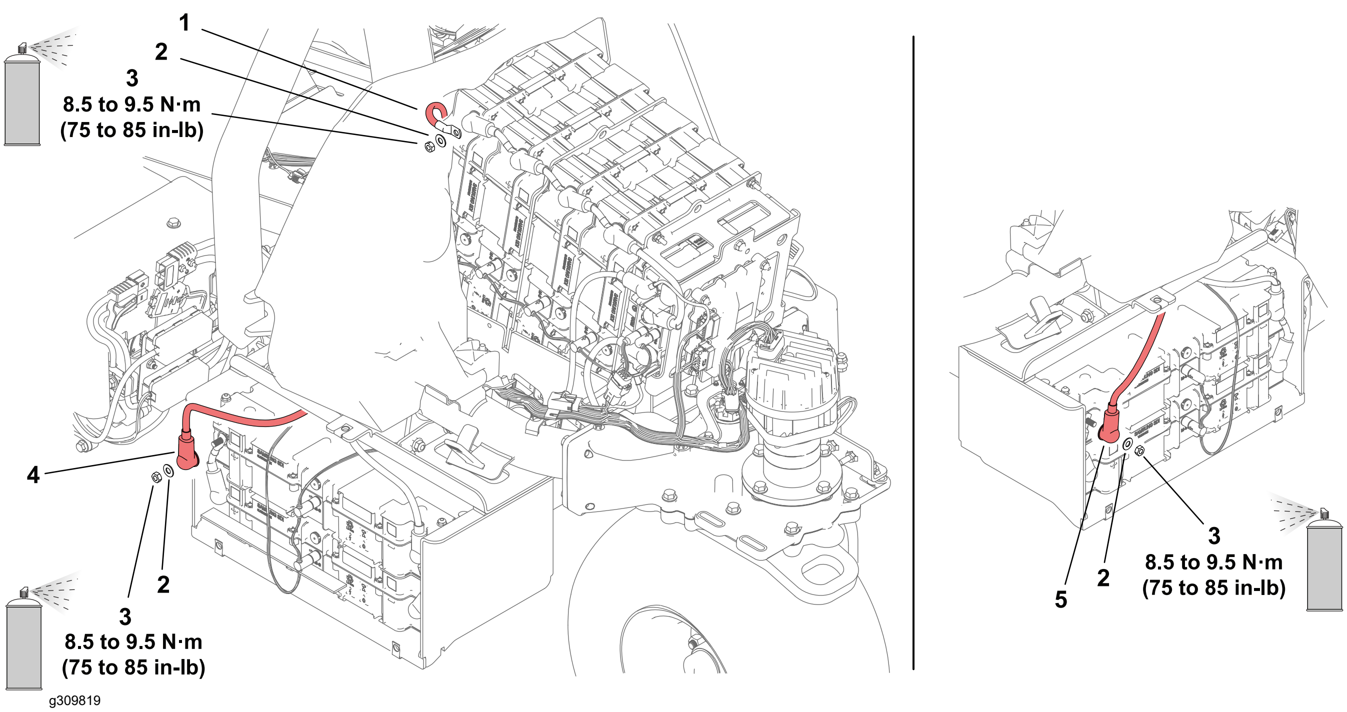


Figure 104

1. Positive (+) battery cable – center
2. Washer
3. Hex nut
4. Positive (+) battery cable – left side
5. Positive (+) battery cable – right side

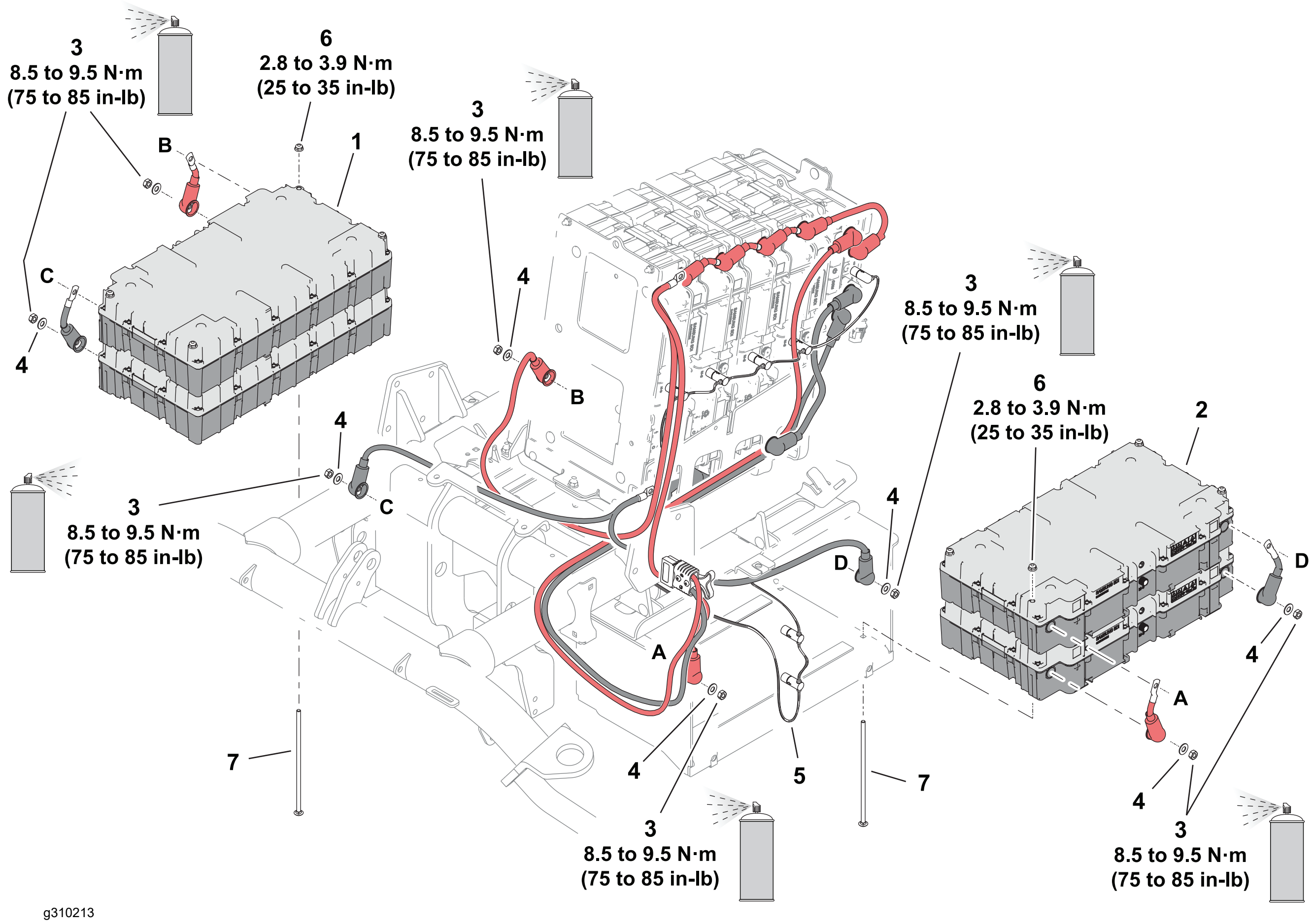


Figure 105

1. Right side mounted battery assembly
2. Left side mounted battery assembly
3. Hex nut
4. Washer
5. Battery interface harness
6. Battery clamp nut (8 each)
7. Carriage bolt (8 each)

5. To remove the side mounted batteries:
   A. Label and disconnect the negative (-) battery cable, positive (+) battery cable, and battery interface harness from both lithium-ion batteries.
   B. Remove the 4 nuts, washers and bolts that secure the batteries to the battery tray.

CAUTION

Each battery weighs approximately 11 kg (24 lbs). When removing, support each battery to prevent it from falling and causing personal injury or damage to the battery.

   C. Carefully remove the side mounted batteries from the battery tray.

Removing and Installing the Lithium-Ion Batteries (Model 04590) (continued)

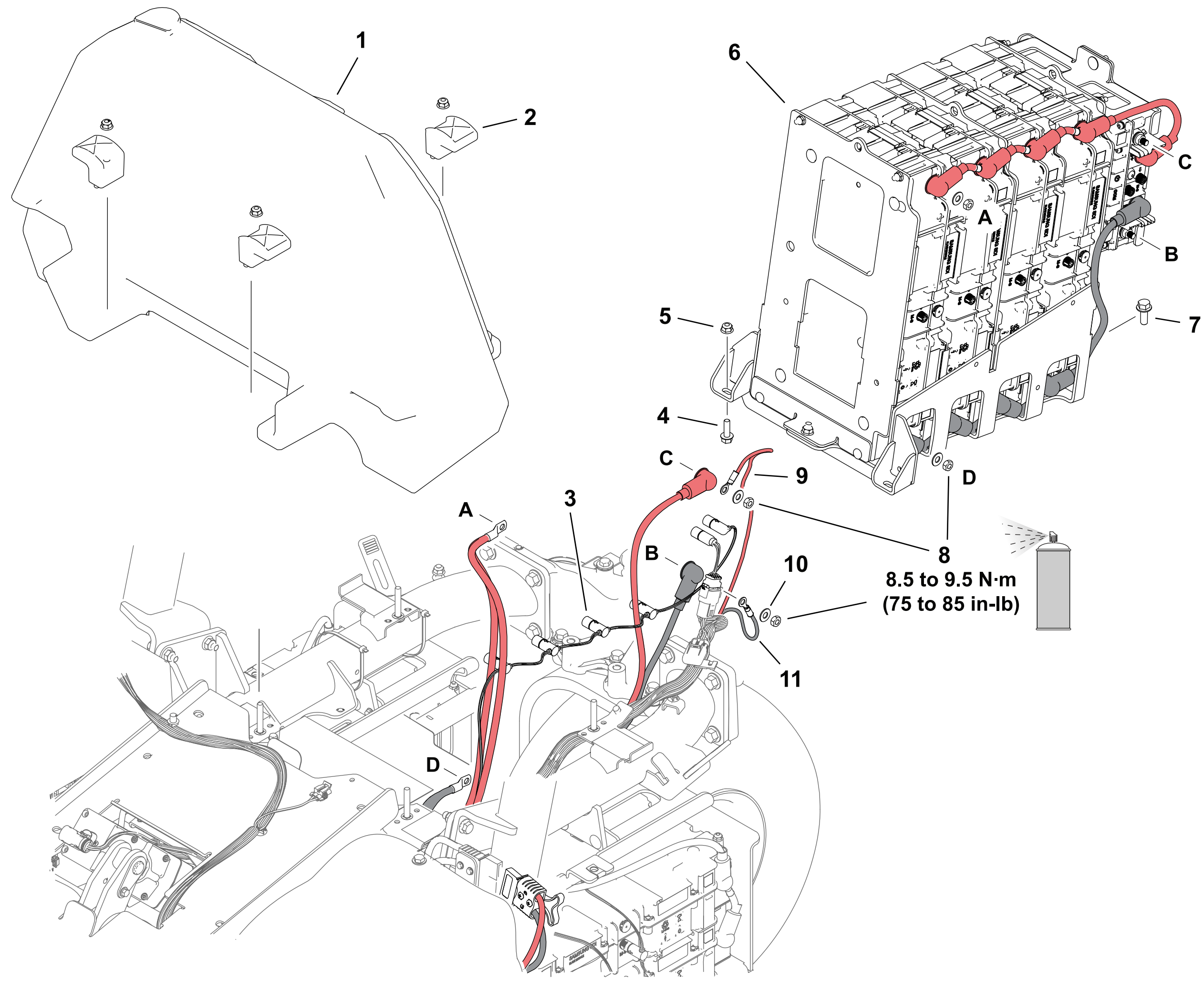


Figure 106

1. Center battery cover
2. Battery cover clamp (4 each)
3. Battery interface harness
4. Flange head screw (2 each)
5. Lock nut (2 each)
6. Center mounted battery assembly
7. Flange head screw (2 each)
8. Hex nut (4 each)
9. Positive (+) wire harness terminal
10. Washer (4 each)
11. Negative (–) wire harness terminal

6. To remove one or more of the center mounted batteries:

   A. Remove the hood; refer to Removing and Installing the Hood Assembly (page 6–42).

   B. Remove the center battery cover.

   C. Label and disconnect the negative (–) battery cable and negative (–) wire harness terminal, and the positive (+) battery cable and the positive (+) wire harness terminal from the SC8: lithium-Ion battery controller (BMS) negative (–) and positive (+) terminals; refer to connections B and C in Figure 106.

   D. Label and disconnect the battery interface harness connectors from each of the center mounted batteries and from the lithium-Ion battery controller (BMS) M-S terminal.

   E. Label and disconnect the machine wire harness connector from the lithium-Ion battery controller (BMS) COM terminal.

Removing and Installing the Lithium-Ion Batteries (Model 04590) (continued)

F. Label and disconnect the machine wire harness connectors from the T6: precharge controller.

G. Remove the 4 fasteners securing the center mounted battery try to the machine.

⚠ CAUTION ⚠

The center mounted battery assembly weighs approximately 67 kg (148 lbs). Use an appropriate lift and the lift points provided to remove the center mounted battery assembly to prevent it from falling and causing personal injury or damage to the battery.

H. Raise the center mounted battery assembly approximately 7.5 cm (3 inch). Label and disconnect the negative (–) battery cable from the bottom of the forward most battery before completely removing the assembly from the machine; refer to connection D in Figure 106.

I. Continue to dismantle the center mounted battery assembly as necessary.

J. Check the foam strips for damage or wear and replace them if necessary.

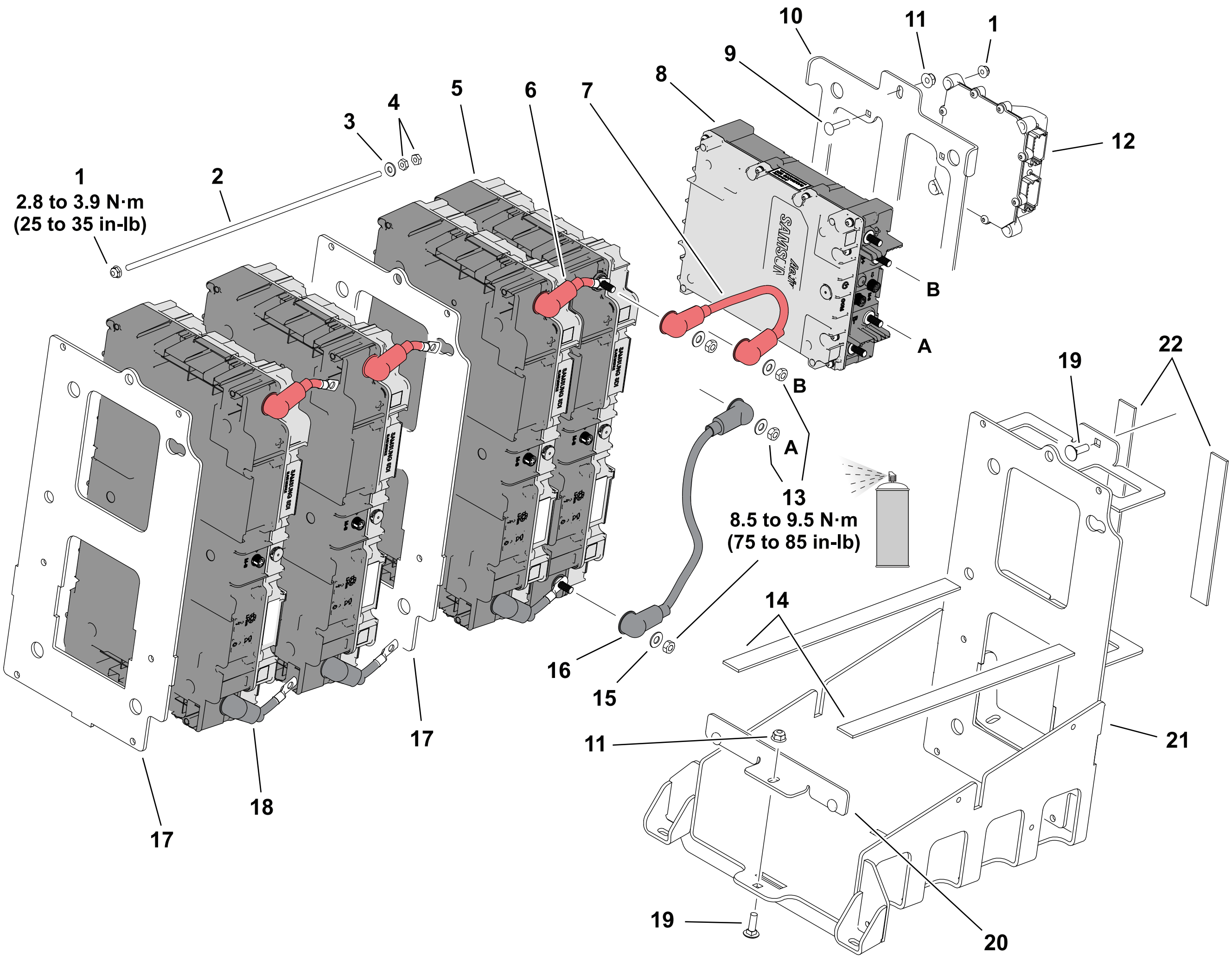


Figure 107

1. Lock nut (6 each)
2. Battery clamp rod (2 each)
3. Flat washer (2 each)
4. Jam nut (4 each)
5. Battery (4 each)
6. Positive (+) battery cable (3 each)
7. Positive (+) battery cable
8. SC8: Lithium-Ion battery controller (BMS)
9. Carriage bolt (4 each)
10. Controller bracket
11. Lock nut (3 each)
12. T6: Precharge controller
13. Hex nut (10 each)
14. Foam strip (2 each)
15. Washer (10 each)
16. Negative (-) battery cable
17. Battery support (2 each)
18. Negative (-) battery cable (3 each)
19. Carriage bolt (3 each)
20. Battery retainer
21. Battery tray
22. Foam strip (2 each)

CAUTION

Pay close attention to the battery orientation during installation. Ensure that each battery is installed in the proper orientation prior to connecting any cables. Failure to do so may result in personal injury and property damage.

7. Install the batteries in reverse order. Install the right side mounted batteries with the positive (+) terminals rearward. Install the left side mounted batteries

with the positive (+) terminals forward. Install the center mounted batteries with the positive (+) terminals upward. Refer to Figure 105 and Figure 107 for additional information.

8. Tighten the battery clamp nuts from **2.8 to 3.9 N·m (25 to 35 in-lb)**.
9. Connect the positive (+) battery cable at the center mounted batteries, and at each set of side mounted batteries; refer to Figure 104.
10. Tighten the battery cable fasteners from **8.5 to 9.5 N·m (75 to 85 in-lb)**, then apply battery terminal protector Toro Part No. 107-0392 or a light layer of grease to the battery terminals and cable connectors to reduce corrosion.
11. Install the side mounted battery covers.

Servicing the Lithium-Ion Batteries (Model 04591)

CAUTION

Do not open the lithium-Ion batteries. There are no serviceable parts on or in the lithium-ion battery case. If you open the battery case, you will void the warranty. The battery case is protected by tamper-alerting devices. Opening the battery case may result in personal injury and property damage.

IMPORTANT

The left battery of the upper battery pack is the Leader battery. The other batteries of the upper and lower battery packs are support batteries.

Preparing the Machine

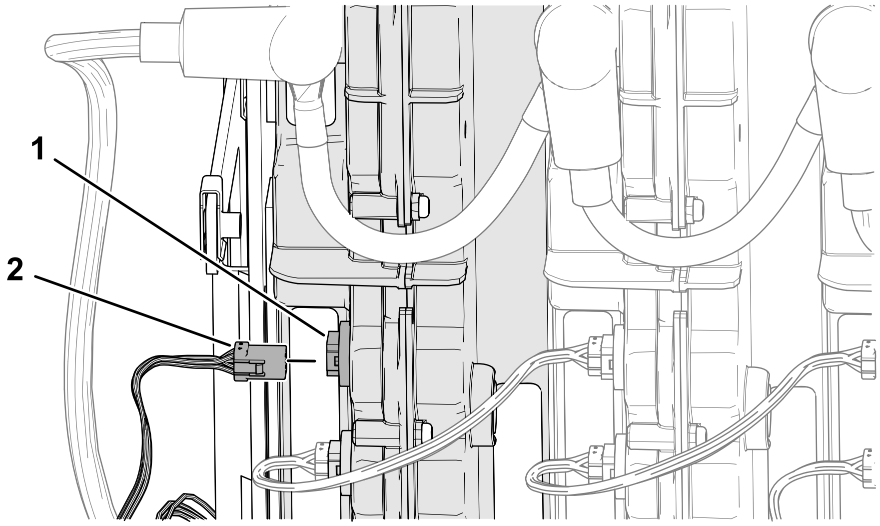
WARNING

When removing or installing the batteries:

- **Always disconnect the batteries at the battery disconnect provided when servicing products with lithium-ion batteries.**
- **Always service lithium-ion batteries with the machine parked near a service door large enough to move the product or battery outside in case of an emergency. Keep a fire suppression blanket nearby; do not use a fire extinguisher on lithium-ion batteries.**

Failure to follow these recommendations may result in personal injury and property damage.

1. Park the machine on a level surface near a service door large enough to move the machine or battery outside in case of an emergency. If possible, service the product outside if the product can be removed from the building quickly in the event of an emergency. Engage the manual parking brake, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Open the hood.
4. At the upper battery pack, unplug the CAN connector of the main harness from the CAN port of the Leader (left) battery.



g420767

Figure 108

1. CAN port—Leader (left) battery
2. CAN connector (main harness)

Removing the Center Battery from the Upper Battery Pack

Removing the Top Strap

1. Prepare the machine for maintenance; refer to Preparing the Machine (page 5–134).
2. Remove the 6 flange head screws and 6 flange locknuts that secure the top strap of the upper battery pack to the base-mount plate.

Removing the Center Battery from the Upper Battery Pack (continued)

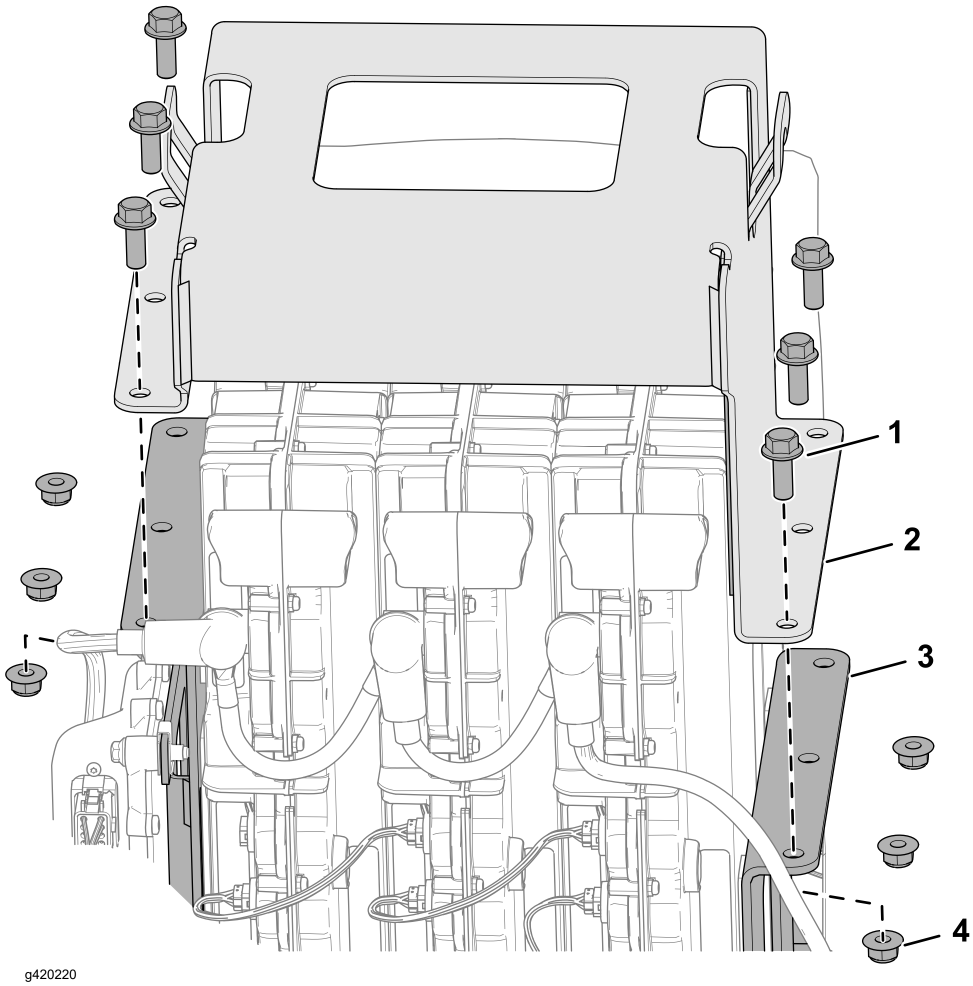


Figure 109

1. Flange head screw
2. Top strap
3. Base-mount plate
4. Flange locknut

Unplugging the CAN Cables

Unplug the 2 CAN harness connectors from the CAN ports of the center battery.

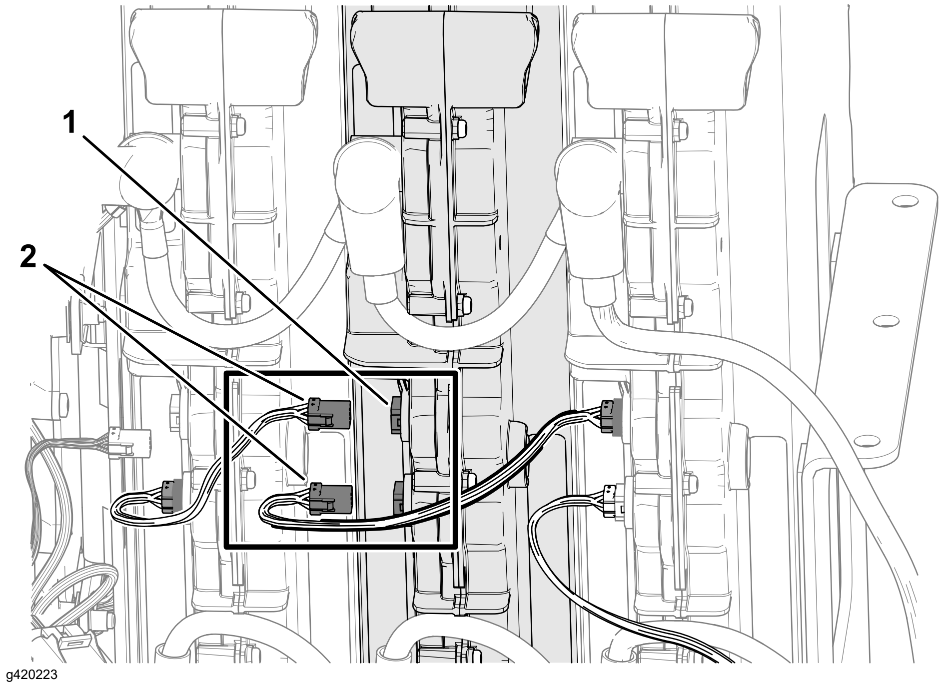


Figure 110

1. CAN port (center battery)
2. CAN harness connectors

Disconnecting the High-Current Cables

WARNING

When removing or installing the batteries:

- **Always disconnect the batteries at the battery disconnect provided when servicing products with lithium-ion batteries.**
- **Always service lithium-ion batteries with the machine parked near a service door large enough to move the product or battery outside in case of an emergency and keep a fire blanket nearby. Do not use a fire extinguisher on lithium-ion batteries.**
- **Do not allow the battery terminals or battery cables to touch any metal parts of the machine.**
- **Do not allow metal tools to short between the battery terminals or battery cables and metal parts of the machine.**
- **Do not attach anything to the battery terminal other than the battery cable or wire harness connector that came with the product.**
- **Always keep the battery retainers and covers in place to protect and secure the batteries.**

Failure to follow these recommendations may result in personal injury and property damage.

CAUTION

To prevent accidentally shorting disconnected battery cables across other components or tools, insulate the battery cable terminals with 76 mm (3 inch) lengths of 1/2 inch internal diameter rubber hose immediately after disconnecting the cables. Failure to do so may result in personal injury and property damage.

1. Slide the red insulator off the positive battery terminal of the center battery.

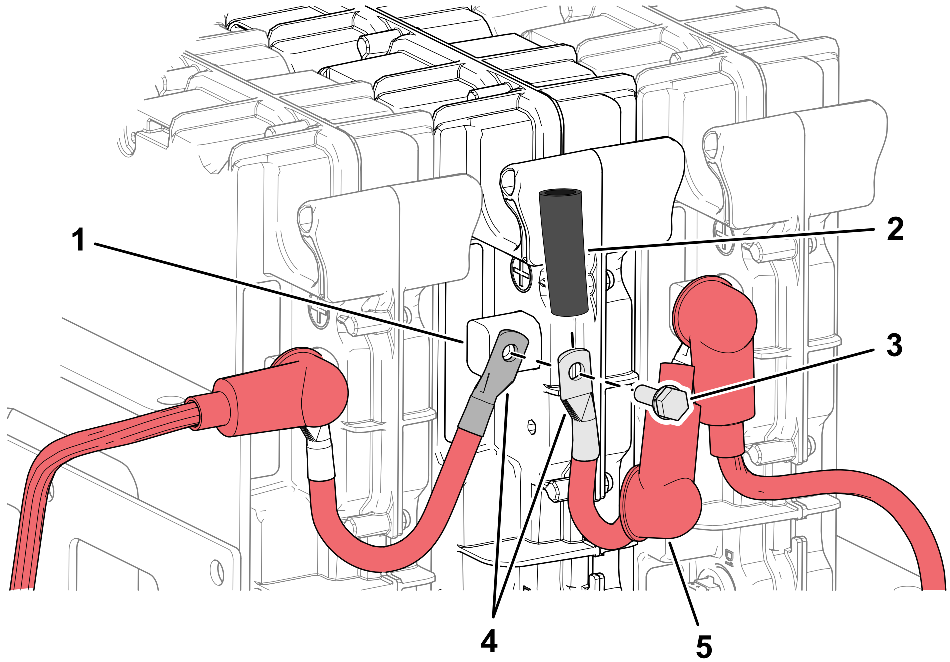
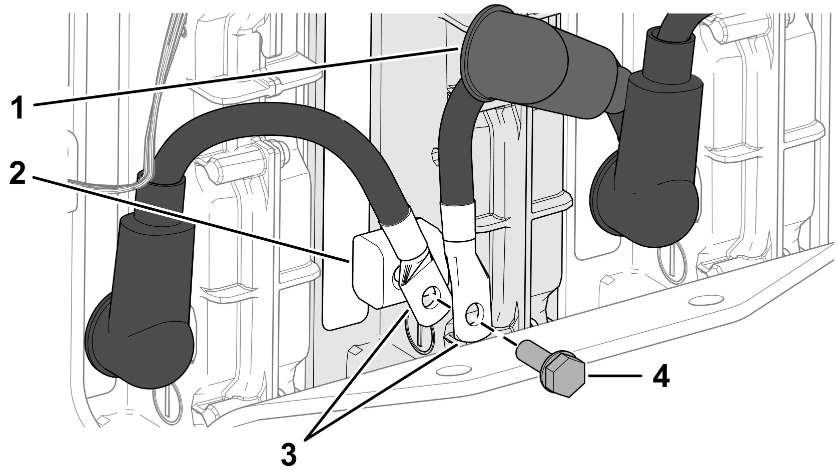


Figure 111

1. Positive battery terminal (center battery)
2. 1/2 inch ID rubber hose
3. Washer-screw
4. Terminals—high-current cables (red)
5. Insulator

2. At the center battery, remove the washer-screw that secures the 2 red high-current cables to the positive battery terminal.
3. Slide the black insulator off the negative battery terminal of the center battery.



g420247

Figure 112

1. Insulator
2. Negative battery terminal (center battery)
3. Black cables
4. Washer-screw

4. Remove the washer-screw that secures the 2 black high-current cables to the negative terminal of the center battery.

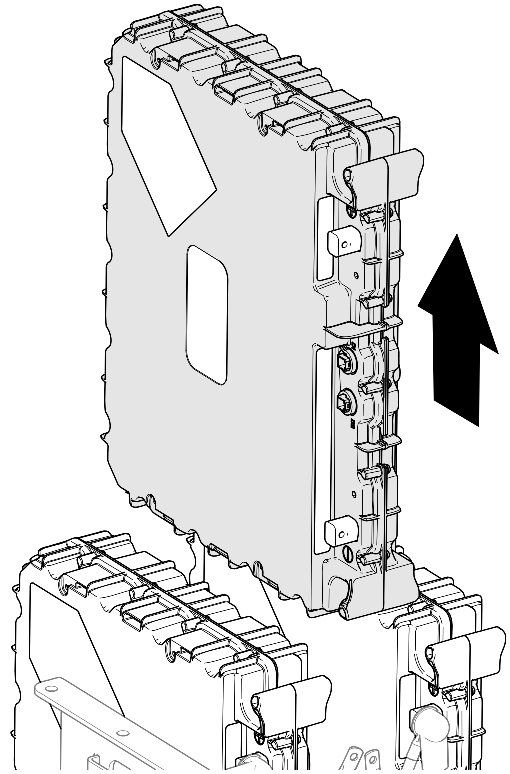
Removing the Center Battery

IMPORTANT

The battery weights approximately 17.8 kg (30.4 lb).

Lift the center battery from the base-mount plate for the upper battery pack.

Removing the Center Battery from the Upper Battery Pack (continued)



g420249

Figure 113

Installing the Center Battery to the Upper Battery Pack

Assembling the Battery to the Machine

IMPORTANT

The battery weights approximately 17.8 kg (30.4 lb).

1. Align the outer batteries so that they are positioned against the left and right sides of the base-mount plate.

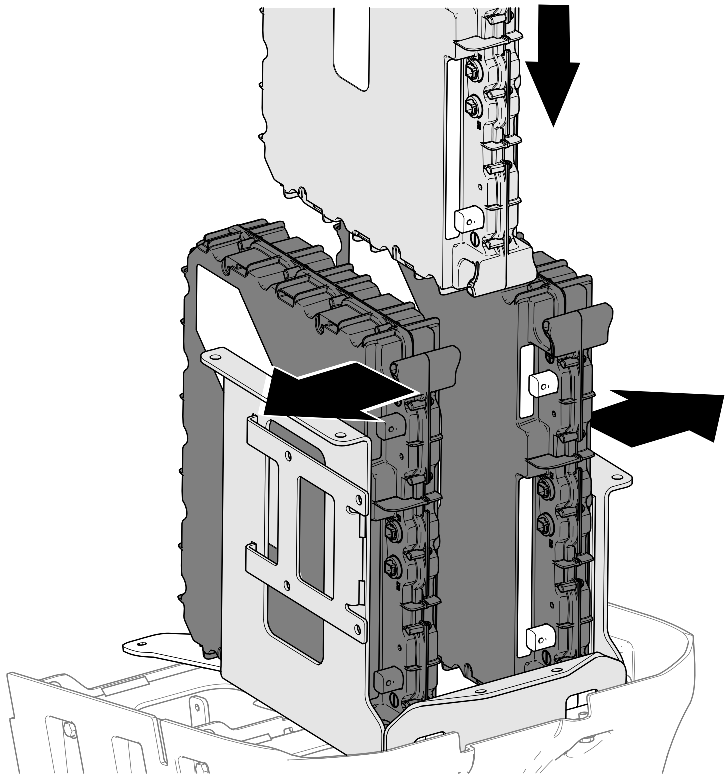


Figure 114

2. Align the center battery so that the battery terminals face rearward, and lower the center battery into the base-mount plate, between the outer batteries.
3. Align the holes in the top strap with the holes in the base-mount plate.
4. Assemble the top strap to the base plate 6 flange head screws and 6 flange locknuts, and tighten the screws and nuts.

Center Battery—Installing the High-Current Cables

IMPORTANT

Use a torque wrench with a 2.3 to 13.6 N·m (20 to 120 in-lb) range when torquing the battery cable or bus bar hardware. Torque wrench accuracy: +/– 5 in-lbs

1. At the center battery, align the terminals of the 2 black high-current cables—18.4 cm (7.25 in) with the negative battery terminal.

Installing the Center Battery to the Upper Battery Pack (continued)

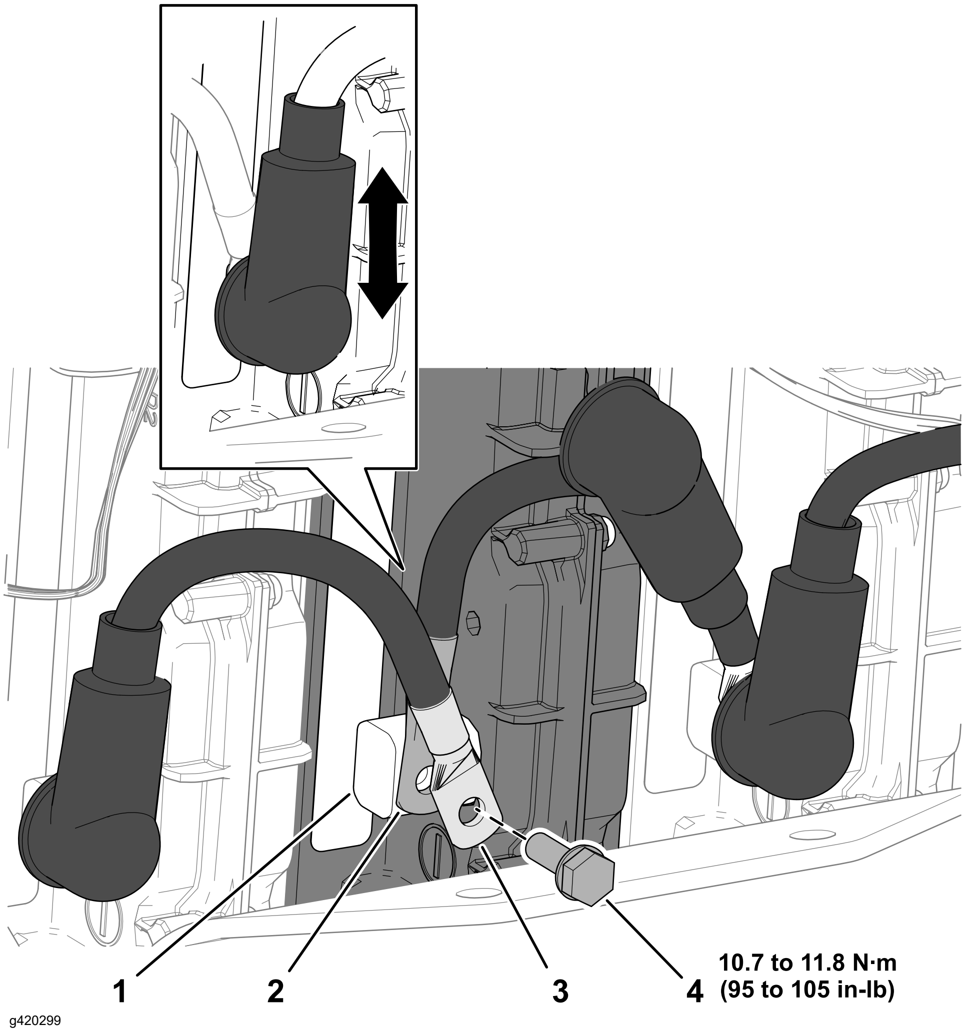


Figure 115

1. Negative terminal (center battery)
2. Black high-current cable 18.4 cm (7.25 in)—insulator slide back
3. Black high-current cable 18.4 cm (7.25 in)—with insulator
4. Washer-screw

2. Loosely assemble the black high-current cables to the negative terminal of the center battery with the washer-screw.
3. Rotate the cable so that the insulator aligns vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
4. Slide the black insulator over the negative battery terminal of the center battery.
5. At the center battery, align the terminals 2 red high-current cables with the positive battery terminal.

Installing the Center Battery to the Upper Battery Pack (continued)

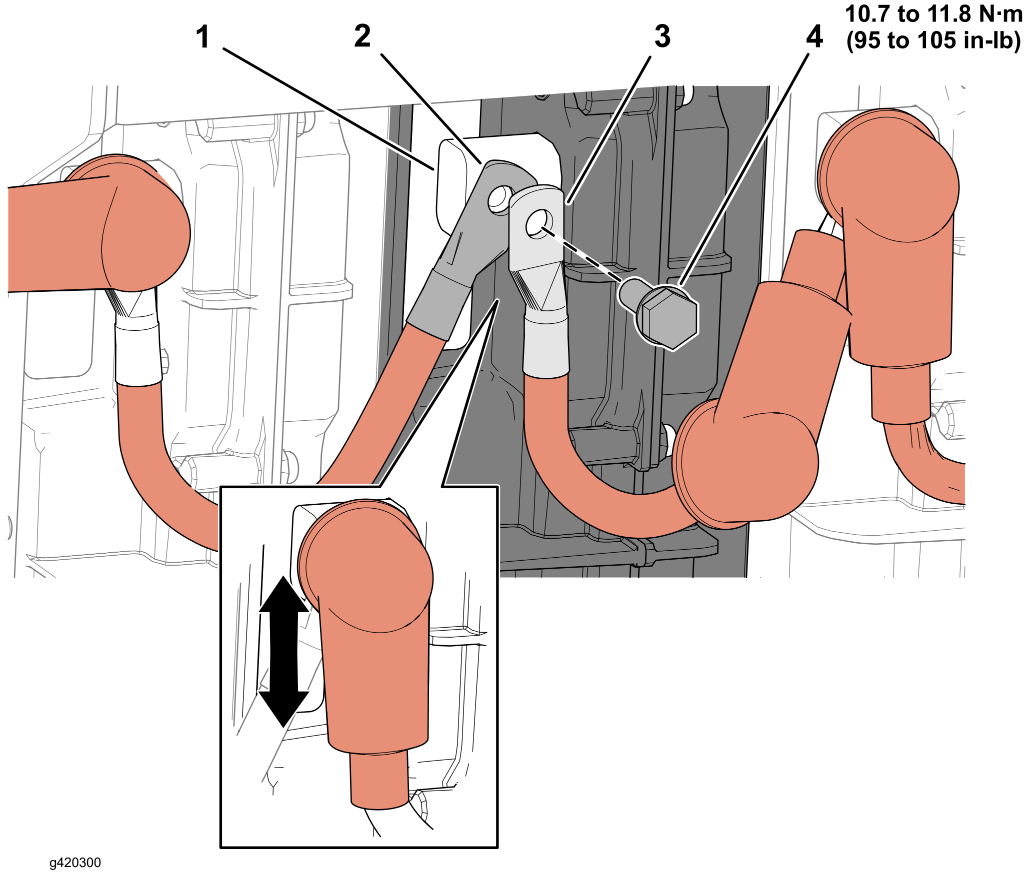


Figure 116

1. Positive terminal (center battery)
2. Red high-current cable 18.4 cm (7.25 in)—with insulator
3. Red high-current cable 18.4 cm (7.25 in)—insulator slide back
4. Washer-screw

6. Loosely assemble the red high-current cables—18.4 cm (7.25 in) to the positive terminal of the center battery with the washer-screw.
7. Rotate the cable so that the insulator aligns vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
8. Slide the red insulator over the positive battery terminal of the center battery.

Finishing the Center Battery Installation

1. Plug the 2 CAN harness 19 cm (7-1/2 in) connectors into the CAN ports of the center battery.

Installing the Center Battery to the Upper Battery Pack (continued)

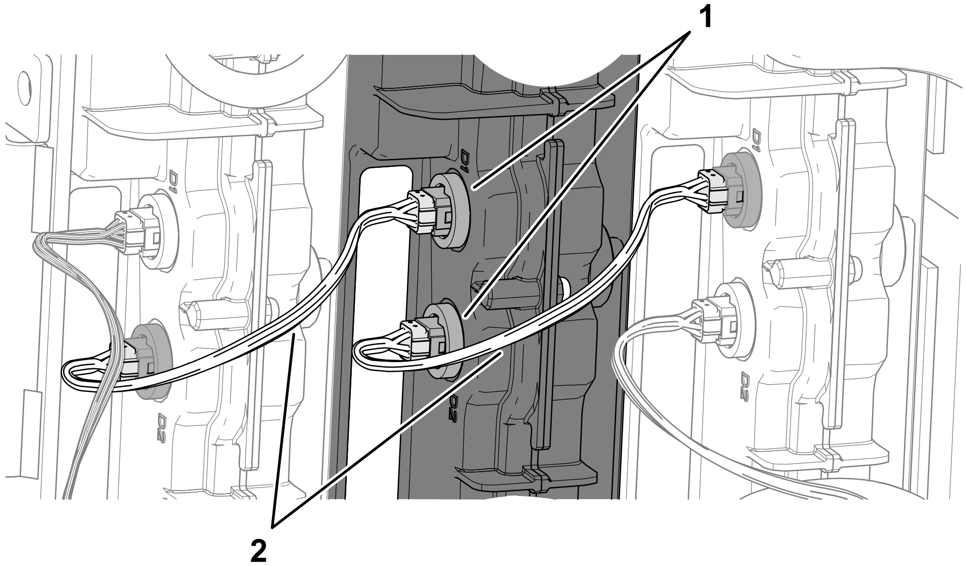


Figure 117

1. CAN ports (center battery)
2. CAN harness 19 cm (7-1/2 in)

---

2. Connect the 48V battery disconnect.
3. If you replace the battery, contact your Authorized Toro Distributor for assistance with programming the machine for the new battery.

IMPORTANT

The machine must be programmed to complete the installation of a replacement battery.

Removing an Outer Battery from the Upper Battery Pack

WARNING

When removing or installing the batteries:

- **Always disconnect the batteries at the battery disconnect provided when servicing products with lithium-ion batteries.**
- **Always service lithium-ion batteries with the machine parked near a service door large enough to move the product or battery outside in case of an emergency and keep a fire blanket nearby. Do not use a fire extinguisher on lithium-ion batteries.**
- **Do not allow the battery terminals or battery cables to touch any metal parts of the machine.**
- **Do not allow metal tools to short between the battery terminals or battery cables and metal parts of the machine.**
- **Do not attach anything to the battery terminal other than the battery cable or wire harness connector that came with the product.**
- **Always keep the battery retainers and covers in place to protect and secure the batteries.**

Failure to follow these recommendations may result in personal injury and property damage.

IMPORTANT

To avoid damaging the battery cushion on the base-mount plate, you must remove the center battery before removing an outer battery.

IMPORTANT

The battery weights approximately 17.8 kg (30.4 lb).

1. Prepare the machine for maintenance; refer to Preparing the Machine (page 5–134).
2. Remove the center battery from the upper battery pack; refer to Removing the Center Battery from the Upper Battery Pack (page 5–135).
3. Unplug the CAN harness connectors from the battery CAN ports as shown in Figure 118:

Removing an Outer Battery from the Upper Battery Pack (continued)

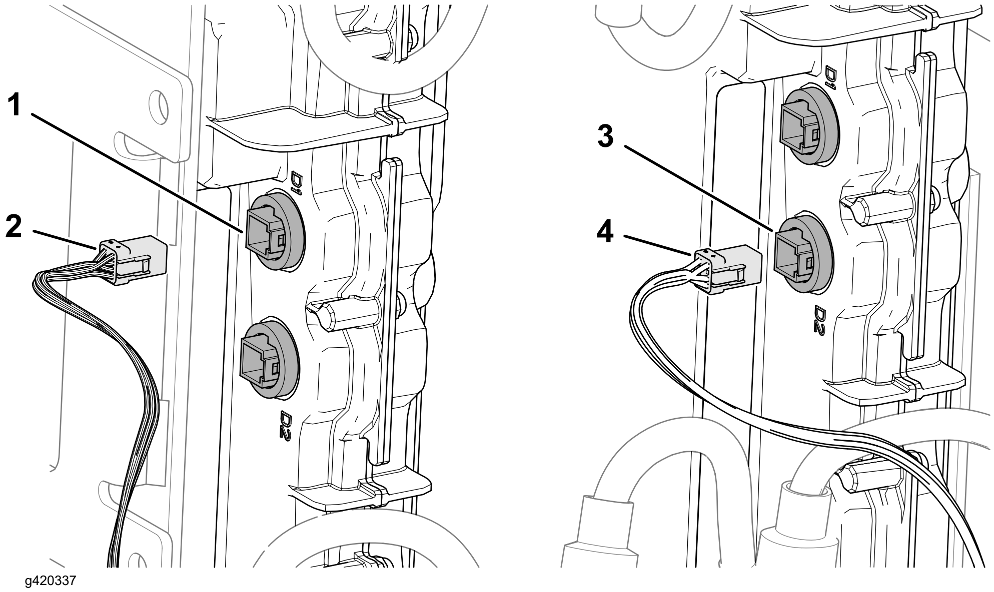


Figure 118

1. Left battery CAN port (upper battery pack)
2. Main harness CAN connector
3. Right battery CAN port (upper battery pack)
4. Pack interconnect CAN Harness

4. Slide the insulator off the positive battery terminals of the battery.

Removing an Outer Battery from the Upper Battery Pack (continued)

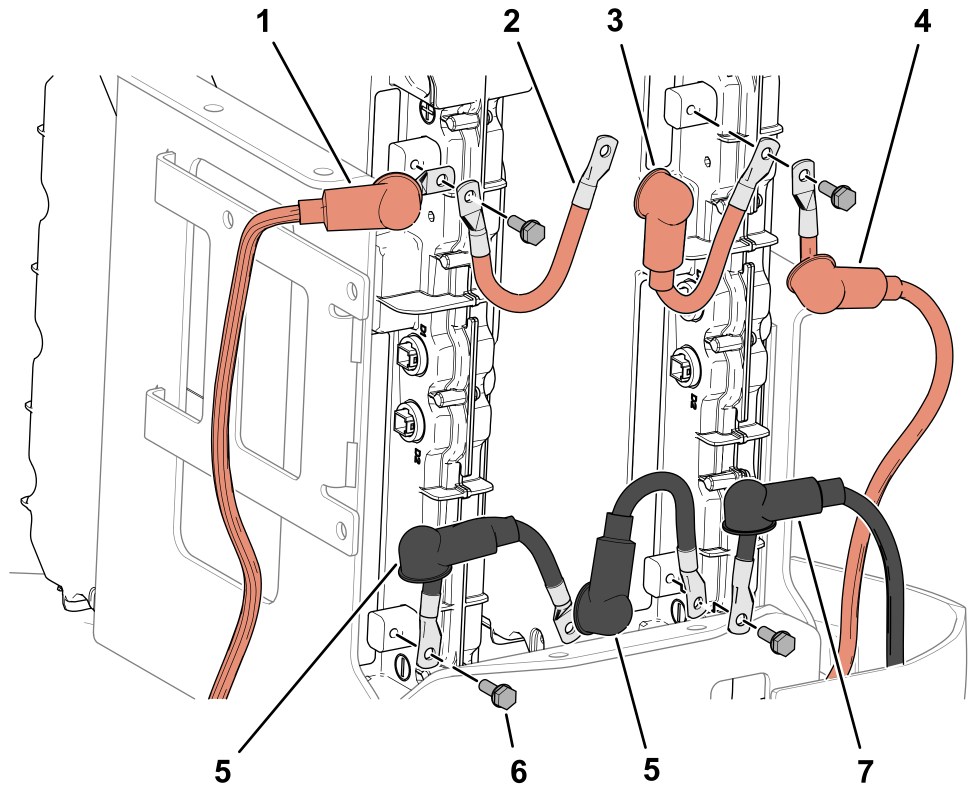


Figure 119

1. Battery disconnect cable (red)—with insulator
2. Red high-current cable 18.4 cm (7.25 in)—no insulator
3. Red high-current cable 18.4 cm (7.25 in)—with insulator
4. Battery interconnect cable (red)—with insulator
5. Black high-current cable 18.4 cm (7.25 in)—with insulator
6. Washer-screw
7. Battery interconnect cable (black)—with insulator

5. Remove the washer-screw that secures the 2 red high-current cable to the positive terminal of the battery.
6. Slide the black insulator off the negative battery terminals of the battery.
7. Remove the washer-screw that secures the 2 black high-current cable to the negative terminal of the battery.
8. Lift the outer battery from the base-mount plate for the upper battery pack.

Installing an Outer Battery to the Upper Battery Pack

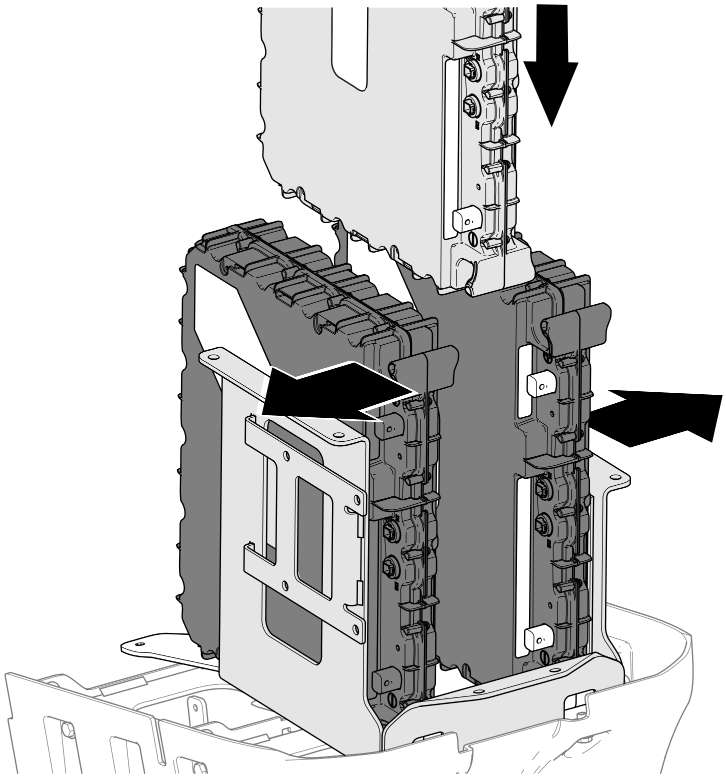
Assembling the Batteries to the Machine

IMPORTANT

The battery weights approximately 17.8 kg (30.4 lb).

1. Align the outer battery so that the battery terminals face rearward, and lower the battery into the base-mount plate.

Installing an Outer Battery to the Upper Battery Pack (continued)



g420261

Figure 120

---

2. Align the outer batteries so that they are positioned against the left and right sides of the base-mount plate.
3. Install the center battery; refer to Installing the Center Battery to the Upper Battery Pack (page 5–140).

Left Battery—Installing the High-Current Cables

1. At the left battery, align the terminal of a black high-current cable 18.4 cm (7.25 in)—with insulator with the negative battery terminal.

Installing an Outer Battery to the Upper Battery Pack (continued)

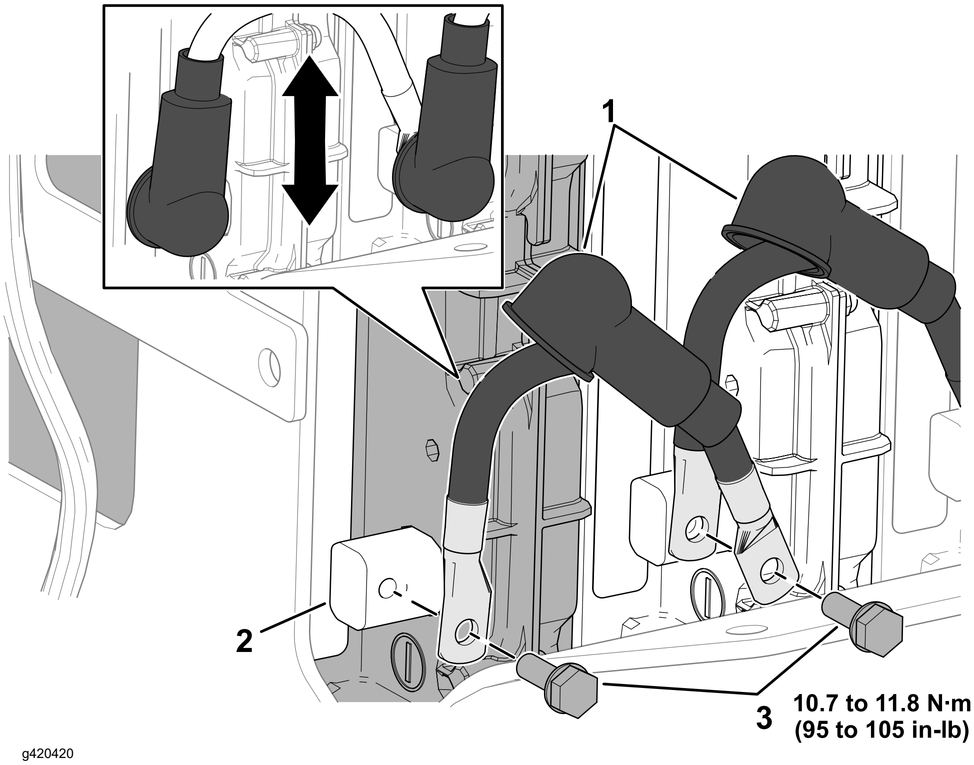


Figure 121

1. Black high-current cable 18.4 cm (7.25 in)—with insulator
2. Negative terminal (left battery)
3. Washer-screw

2. Loosely assemble a black high-current cable 18.4 cm (7.25 in)—with insulator to the negative battery terminal battery with the washer-screw.
3. At the center battery, align the other end of the black high-current cable from step with the negative battery terminal.
4. Align a black high-current cable 18.4 cm (7.25 in)—with insulator with the high-current cable from step and the negative battery terminal of the center battery.
5. Loosely assemble a 2 high-current cables to the negative battery terminal of the center battery with the washer-screw.
6. At the left battery, rotate the high-current cable so that the insulator align vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb**).
7. At the center battery, rotate the high-current cable so that the insulator align vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
8. Slide the 2 black insulators over the negative battery terminals of the left and center batteries.
9. At the left battery, align the terminal of the red battery disconnect cable with the cable with the positive battery terminal.

Installing an Outer Battery to the Upper Battery Pack (continued)

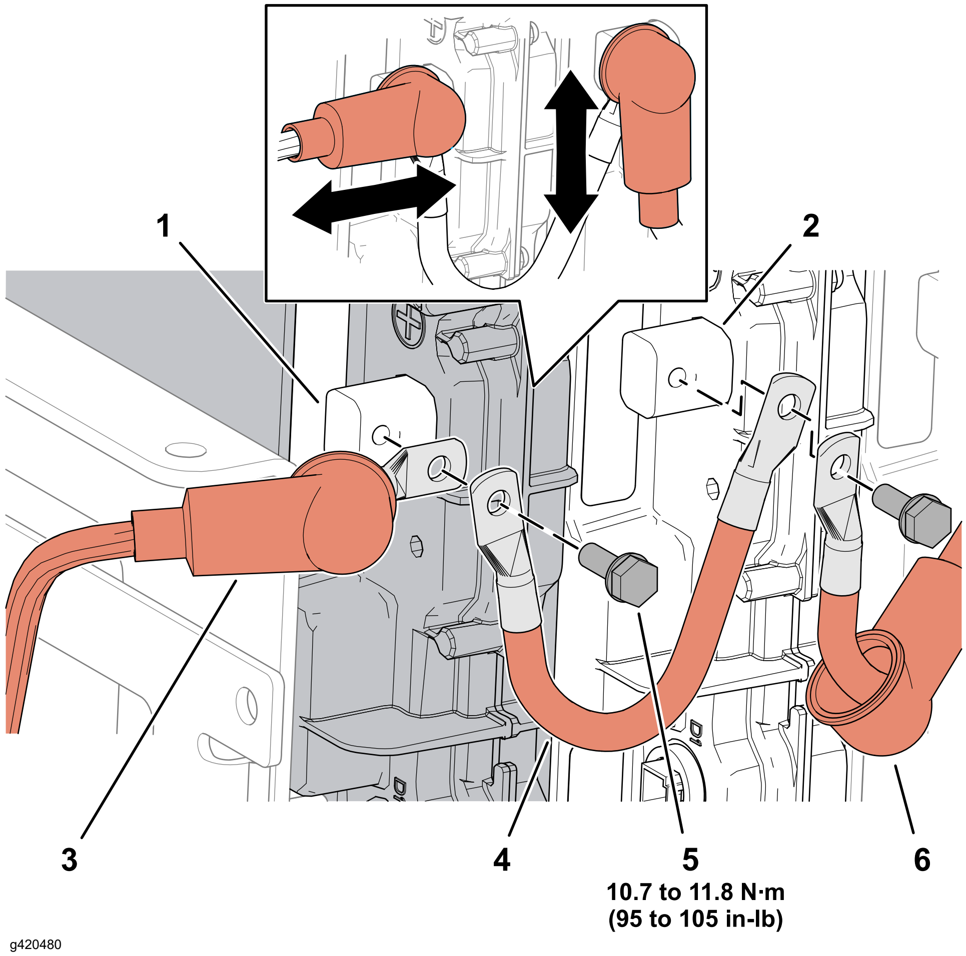


Figure 122

1. Positive terminal (left battery)
2. Positive terminal (center battery)
3. Red battery disconnect cable
4. Red high-current cable 18.4 cm (7.25 in)—without insulator
5. Washer-screw
6. Red high-current cable 18.4 cm (7.25 in)—with insulator

10. Align the terminal of the red high-current cable 18.4 cm (7.25 in)—without insulator with the battery disconnect cable from step and negative battery terminal of the left battery.
11. Loosely assemble the battery disconnect cable and high-current cable to the positive terminal of the left battery with the washer-screw.
12. At the center battery, align the other end of the red high-current cable 18.4 cm (7.25 in)—without insulator from step with the positive battery terminal.
13. Align the terminal of the red high-current cable 18.4 cm (7.25 in)—with insulator from the right battery with the red high-current cable 18.4 cm (7.25 in)—without insulator from step and negative terminal of the center battery.
14. Loosely assemble the high-current cables to the positive terminal of the center battery with the washer-screw.
15. At the left battery, rotate the red battery disconnect cable so that the insulator aligns horizontally when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb**).

Installing an Outer Battery to the Upper Battery Pack (continued)

16. At the center battery, rotate the red high-current cable so that the insulator aligns vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
17. Slide the 2 red insulators over the positive battery terminals of the left and center batteries.

Right Battery—Installing the High-Current Cables

1. At the right battery, align the terminal of a black high-current cable 18.4 cm (7.25 in)—with insulator with the negative battery terminal.

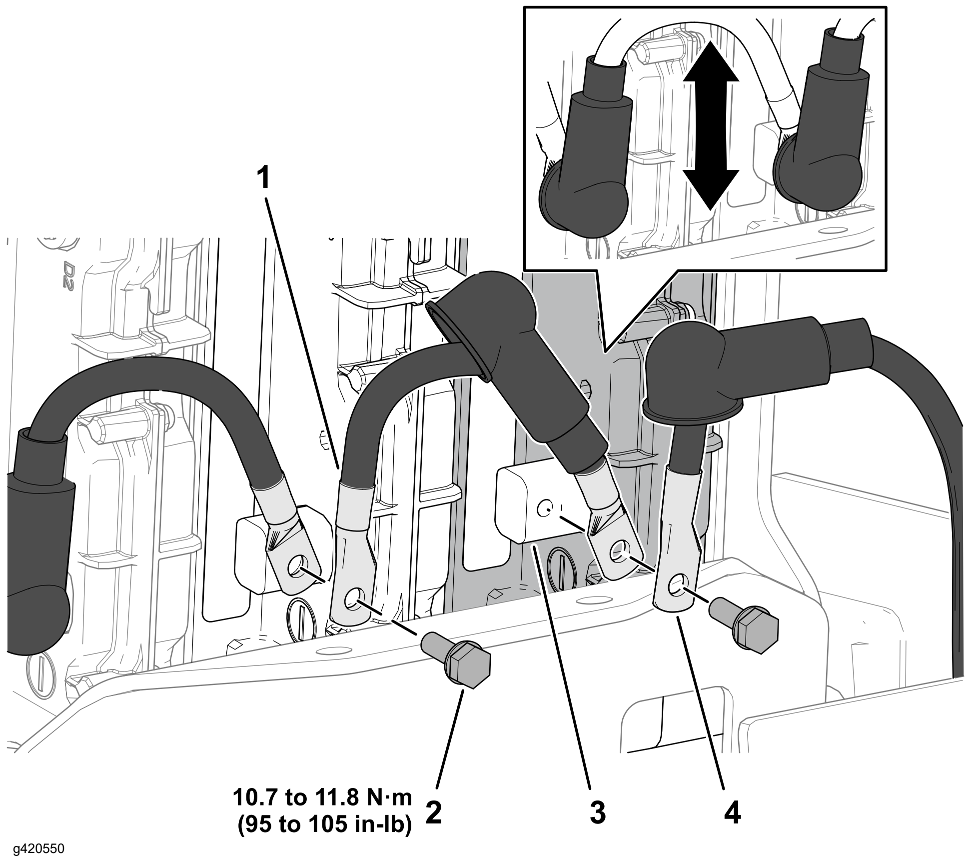


Figure 123

1. Black high-current cable 18.4 cm (7.25 in)—with insulator
2. Washer-screw
3. Negative terminal (right battery)
4. Black pack interconnect cable

---

2. Align the terminal of the black pack interconnect cable with the cable from step and the negative terminal of the battery.
3. Loosely assemble the high-current cable and pack interconnect cable to the negative terminal of the right battery with the washer-screw.
4. At the right battery, rotate the high-current cable so that the insulator align vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
5. At the center battery, rotate the high-current cable so that the insulator align vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.

Installing an Outer Battery to the Upper Battery Pack (continued)

6. Slide the 2 black insulators over the negative battery terminals of the right and center batteries.
7. At the right battery, align the terminal of a red high-current cable 18.4 cm (7.25 in)—with insulator to the positive battery terminal.

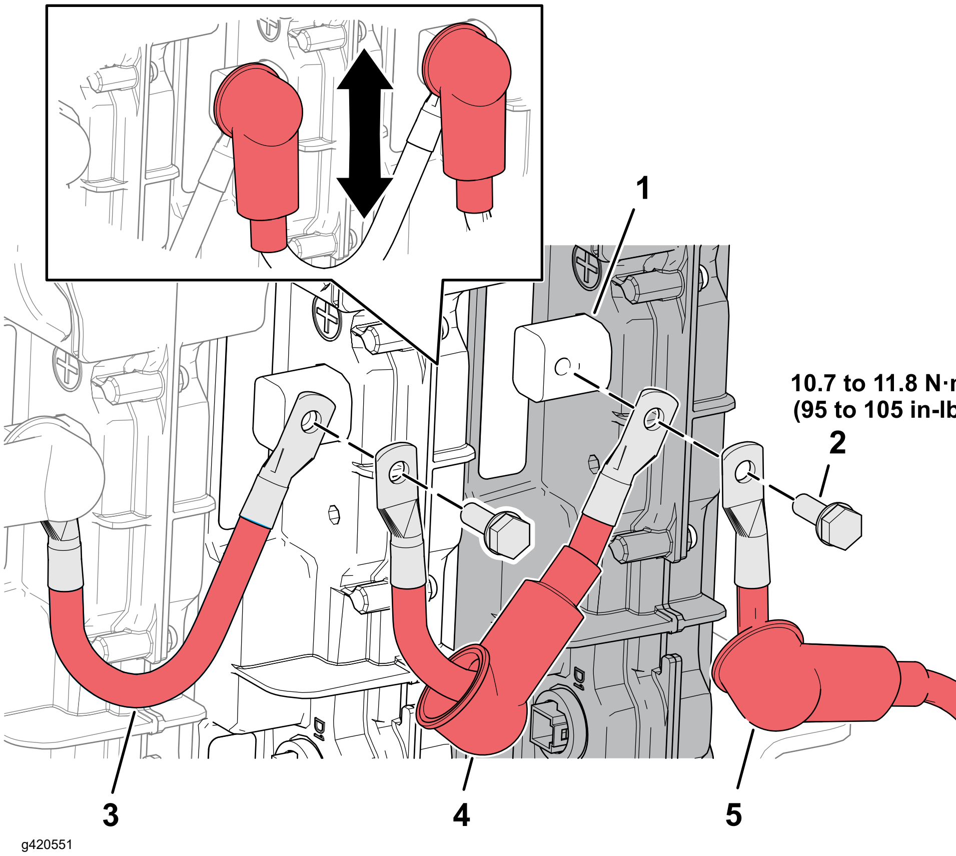


Figure 124

1. Positive terminal (right battery)
2. Washer-screw
3. Red high-current cable 18.4 cm (7.25 in)—without insulator
4. Red high-current cable 18.4 cm (7.25 in)—with insulator
5. Red pack interconnect cable

8. Align the terminal of the red pack interconnect cable to the cable from step and the positive battery terminal.
9. Loosely assemble the high-current cable and pack interconnect cable to the positive terminal of the right battery with the washer-screw.
10. At the center battery, align the terminal of a red high-current cable 18.4 cm (7.25 in)—without insulator to the positive battery terminal.
11. Align the terminal of the red high-current cable 18.4 cm (7.25 in)—without insulator with the cable from step and the positive battery terminal.
12. Loosely assemble the 2 high-current cables to the positive battery terminal of the right battery with the washer-screw.
13. At the right battery, rotate the pack interconnect cable so that the insulator align vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb**).

Installing an Outer Battery to the Upper Battery Pack (continued)

14. At the center battery, rotate the high-current cable so that the insulator align vertically when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.

15. Slide the 2 red insulators over the positive battery terminals of the right and center batteries.

Connecting the CAN Bus Harnesses

Plug the CAN harness connectors into the CAN ports of the batteries as shown in Figure 125:

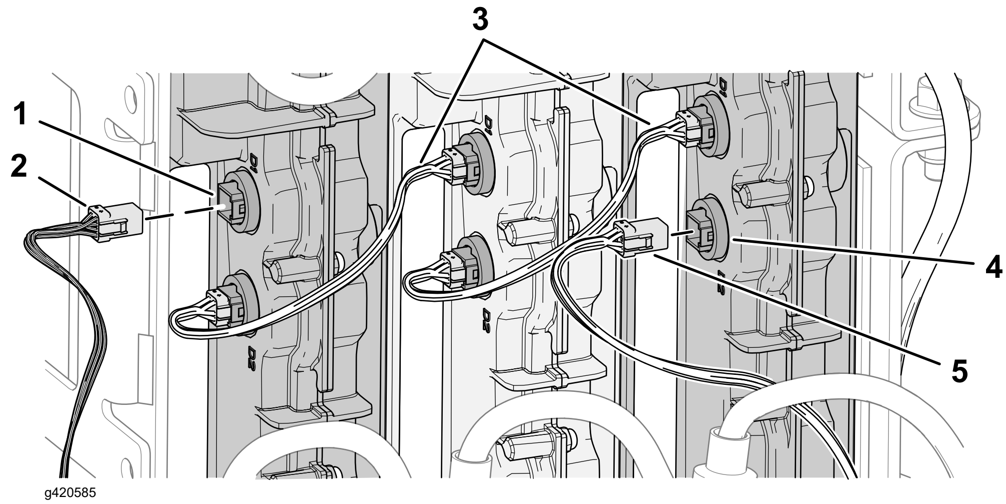


Figure 125

1.	Left battery CAN port (upper battery pack)	3.	CAN harness 19 cm (7-1/2 in)
2.	Main harness CAN connector	4.	Pack interconnect CAN Harness

Finishing the Battery Installation

1. Connect the 48V battery disconnect.
2. If you replace the battery, contact your Authorized Toro Distributor for assistance with programming the machine for the new battery.

IMPORTANT

The machine must be programmed to complete the installation of a replacement battery.

Removing a Battery from the Lower Battery Pack

Removing the Lower-Battery Pack Cover

Remove the 6 flange-head screws that secure the lower-battery pack cover to the upper battery mount and the lower battery mount, and remove the cover from the machine.

Removing a Battery from the Lower Battery Pack (continued)

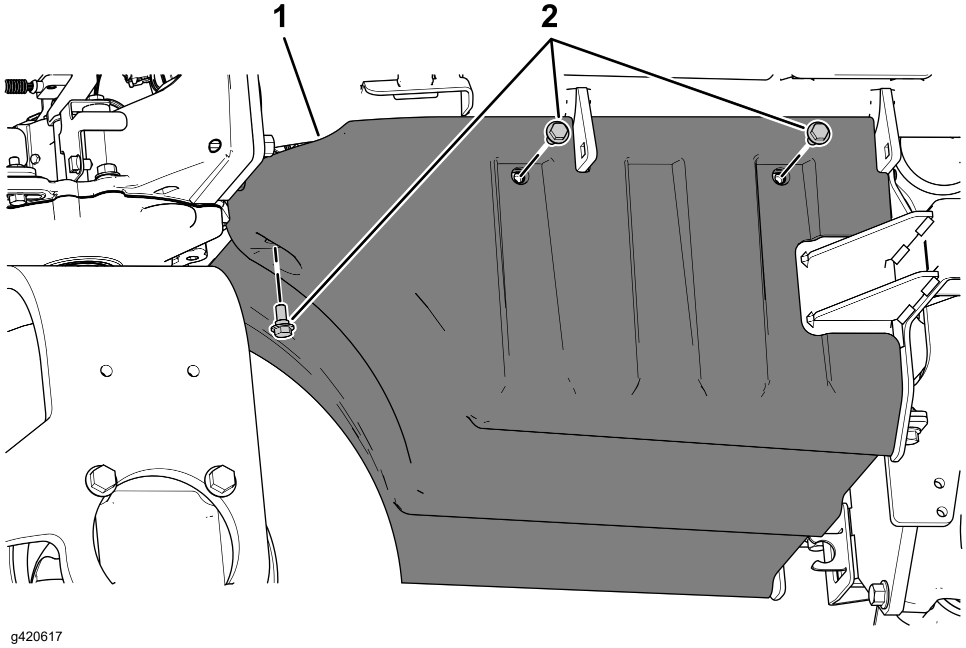


Figure 126

1. Lower-battery pack cover
2. Flange-head screws

Disconnecting the Cables

Note: To remove a battery from the lower battery pack, you must remove the entire lower battery pack from the machine.

1. Prepare the machine for maintenance; refer to Preparing the Machine (page 5–134).
2. Unplug the CAN pack interconnect cable from the CAN port of the upper battery.

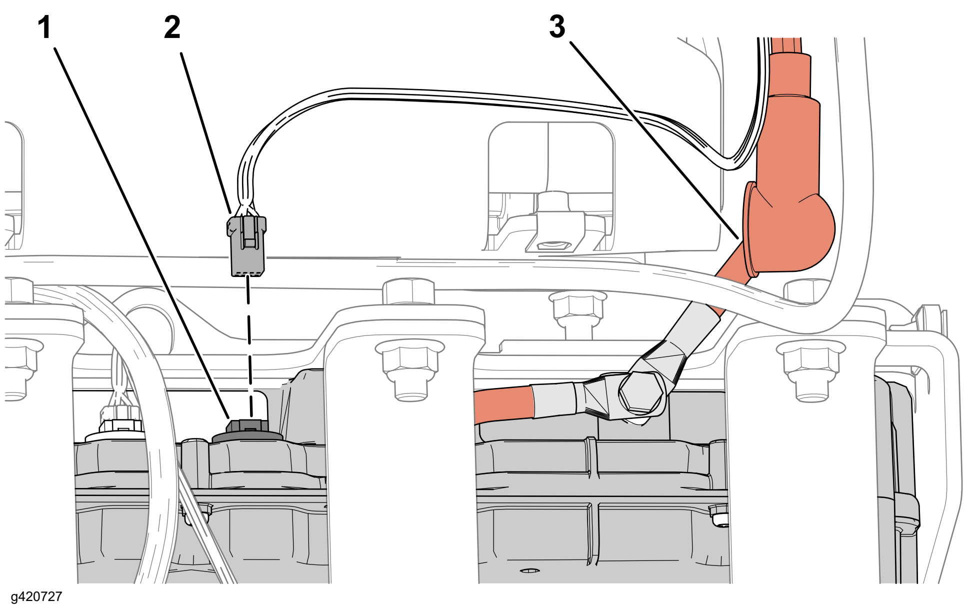


Figure 127

1. CAN port (upper battery)
2. CAN pack interconnect cable
3. Red pack interconnect cable

Removing a Battery from the Lower Battery Pack (continued)

3. At the upper battery, slide the red insulator of the pack interconnect cable off the positive battery terminal.
4. Remove the washer-screw that secures the red pack interconnect cable and the red high-current cable 18.4 cm (7.25 in) to the positive terminal of the upper battery.

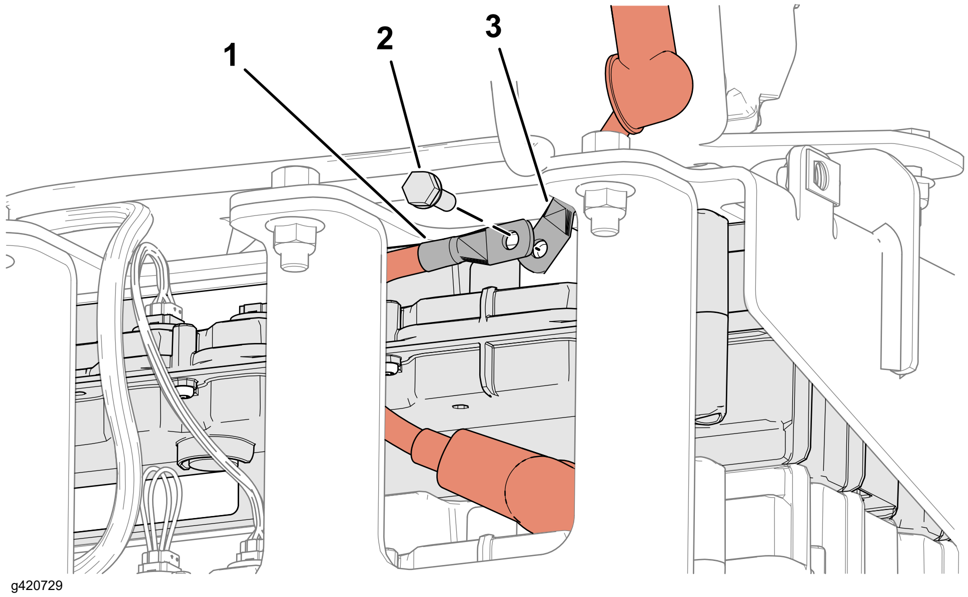


Figure 128

1. Red high-current cable 18.4 cm (7.25 in)—with insulator
2. Washer-screw
3. Red pack interconnect cable

---

5. Slide the black insulator off the negative battery terminal of the upper battery.

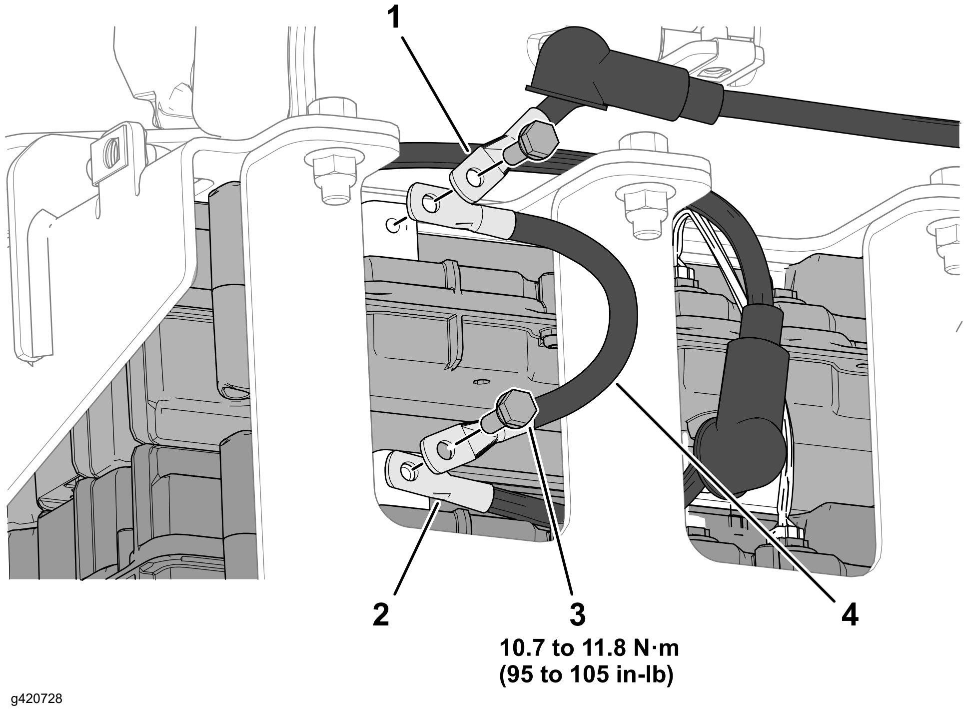


Figure 129

1. Black battery interconnect cable
2. Black high-current cable 18.4 cm (7.25 in)—without insulator
3. Washer-screw
4. Black battery disconnect cable

6. Remove the washer-screw that secures the black battery interconnect cable and the black high-current cable 18.4 cm (7.25 in)—without insulator to the negative terminal of the upper battery.
7. Loosely secure the black high-current cable (no insulator) to the upper battery with the washer-screw.
8. At the lower battery, slide the black insulator off the negative battery terminal.
9. Remove the screw that secures the black battery disconnect cable and the black high-current cable 18.4 cm (7.25 in)—without insulator to the negative terminal of the lower battery.

Lowering the Battery Pack

IMPORTANT

The battery pack and base plate weight approximately 34.1 kg (75.2 lb).

1. Align a floor jack under the center base plate for the lower battery pack.

IMPORTANT

Keep the center of the batteries and base plate aligned to the jack to prevent the batteries from falling.

Removing a Battery from the Lower Battery Pack (continued)

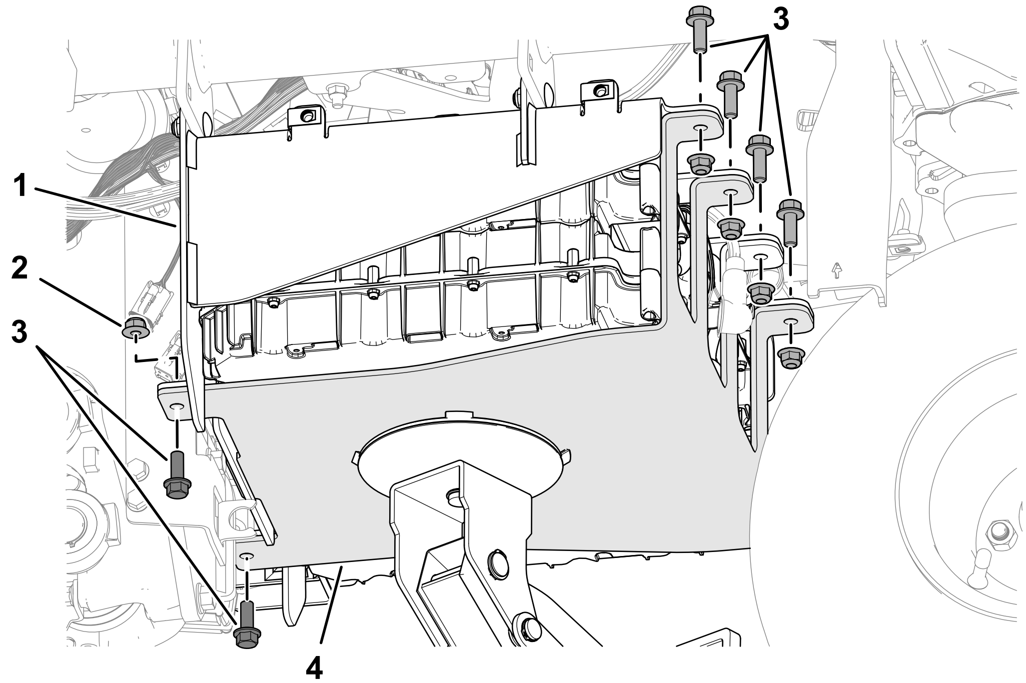


Figure 130

1. Battery mount
2. Flange locknut
3. Flange head screws
4. Base plate

2. Remove the 6 flange head screws and 6 flange locknuts that secure the base plate to the battery mount.
3. Move the batteries, base plate, and jack rearward to disengage the flange of the base plate from the slot in the battery mount.
4. Carefully lower the jack.
5. Place the base plate and batteries on the ground or a sturdy work surface.

Separating the Upper and Lower Batteries

IMPORTANT

If you replace the lower battery of the lower battery pack, unplug the terminating resistor in the CAN port for the battery, and plug the resistor into the CAN port of the new battery.

1. Rotate the batteries so that the battery terminals are aligned to the open end of the base plate.

Removing a Battery from the Lower Battery Pack (continued)

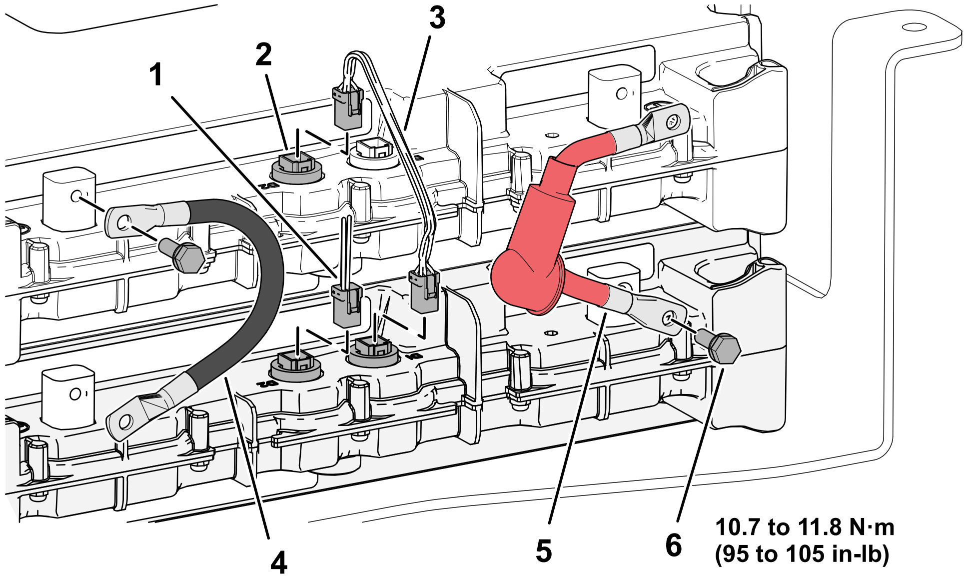


Figure 131

1. Terminating resistor
2. CAN port
3. CAN harness 19 cm (7-1/2 in)
4. Black high-current cable 18.4 cm (7.25 in)—without insulator
5. Red high-current cable 18.4 cm (7.25 in)—with insulator
6. Washer-screw

---

2. Unplug the CAN harness from the CAN ports of the upper and lower batteries.
3. Remove the washer screw securing the black battery cable (no insulator) to the negative terminal of the upper battery.
4. Remove the that secures the red high-current cable 18.4 cm (7.25 in)—with insulator to the positive terminal of the lower battery.
5. Separate the batteries as needed.
6. If you replace the lower battery of the lower battery pack, unplug the terminating resistor in the CAN port for the battery, and plug the resistor into the CAN port of the new battery.

Installing a Battery to the Lower Battery Pack

Assembling the Upper and Lower Batteries

1. Place the battery with the terminating resister on to the base plate with the battery terminals aligned to the open side of the plate.

Installing a Battery to the Lower Battery Pack (continued)

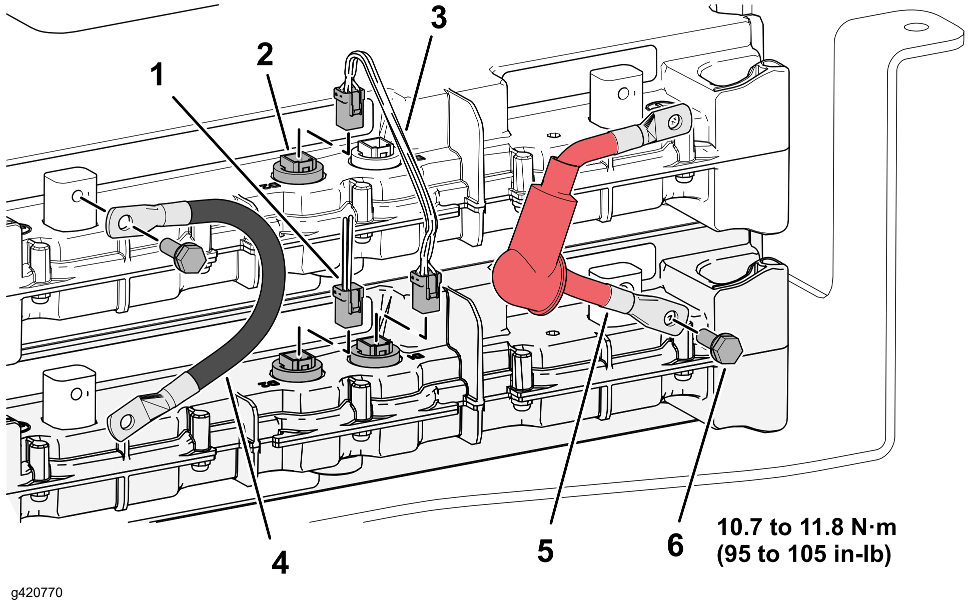


Figure 132

1. Terminating resistor
2. CAN port
3. CAN harness 19 cm (7-1/2 in)
4. Black high-current cable 18.4 cm (7.25 in)—without insulator
5. Red high-current cable 18.4 cm (7.25 in)—with insulator
6. Washer-screw

---

2. At the lower battery, loosely assemble the insulator end of the high-current cable 18.4 cm (7.25 in) to the positive battery terminal of the lower battery with a washer-screw.
3. At the upper battery, loosely assemble the other end of the red high-current cable 18.4 cm (7.25 in) to the positive battery terminal with a washer-screw.
4. Loosely assemble the black high-current cable 18.4 cm (7.25 in)—without insulator to the negative battery terminals of the upper battery and the lower batteries with 2 washer-screws.
5. At the red battery cable for the positive terminal of the lower battery, torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb**).

   Note: Do not torque the other washer-screws.
6. Slide the red insulator over the positive battery terminal of the right battery.
7. Plug the CAN harness into the port connectors of the upper and lower batteries.
8. Rotate the batteries so that the battery terminals are aligned vertical flange base plate, and the batteries and plate are centered.

Assembling the Battery Pack to the Machine

IMPORTANT

The battery pack and base plate weight approximately 34.1 kg (75.2 lb).

---

1. Center the batteries and base plate to the floor jack.

IMPORTANT

Keep the center of the batteries and base plate aligned to the jack to prevent the batteries from falling.

2. Align the batteries, base plate, and jack to the battery mount.
3. Raise the batteries and base plate, and align the flange of the base plate into the slot in the battery mount.

IMPORTANT

Ensure that the batteries do not pinch the black battery disconnect cable and the red pack interconnect cable.

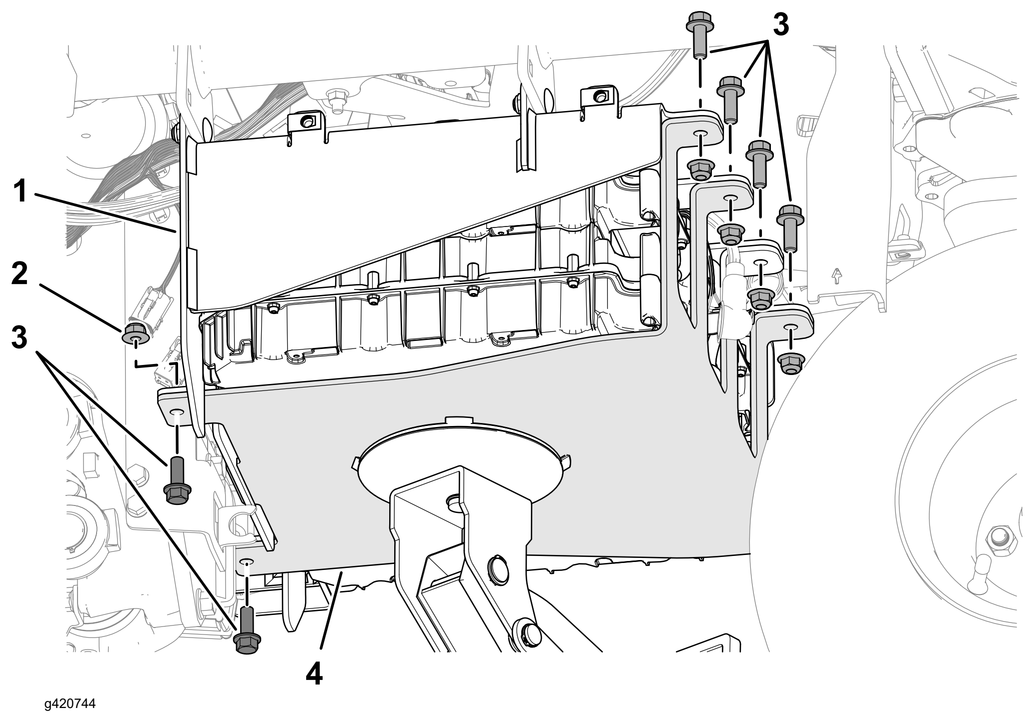


Figure 133

1. Battery mount
2. Flange locknut
3. Flange head screws
4. Base plate

4. Loosely assemble the base plate to the battery mount with the 6 flange head screws and 6 flange locknuts, and
5. Ensure that the batteries are centered in the base plate
6. Tighten the screws and nuts.

Connecting the Cables

1. At the lower battery, remove the washer-screw from the negative terminal.

Installing a Battery to the Lower Battery Pack (continued)

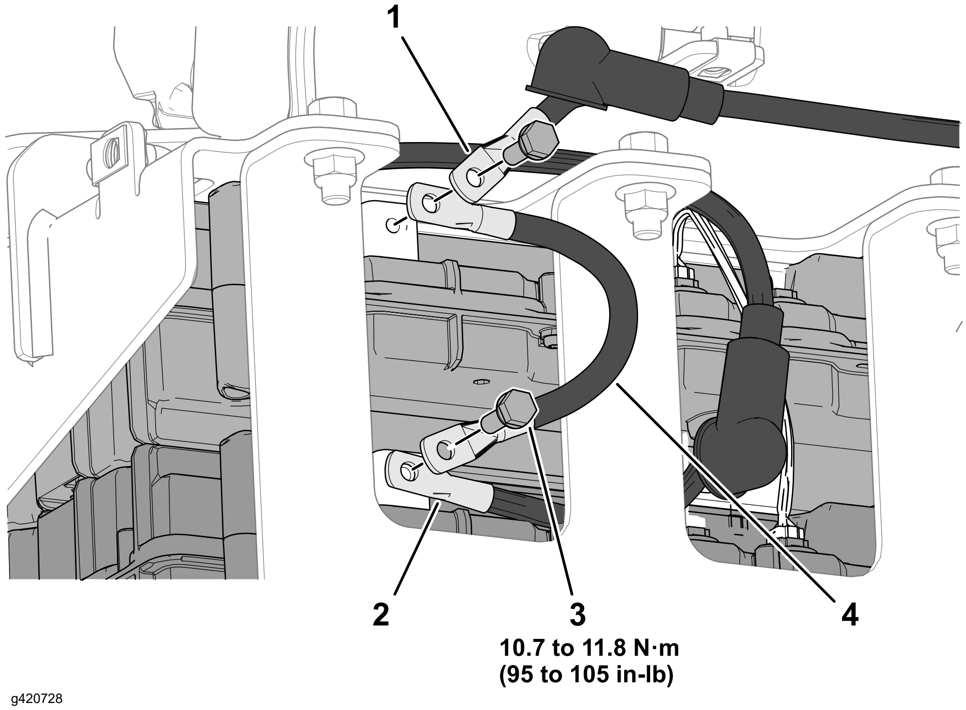


Figure 134

1. Black battery interconnect cable
2. Black battery disconnect cable
3. Washer-screw
4. Black high-current cable 18.4 cm (7.25 in)—without insulator

---

2. Align the terminal of the black battery disconnect cable with negative terminal of the lower battery.
3. Align the terminal of the black high-current cable 18.4 cm (7.25 in)—without insulator with the terminal of the battery disconnect cable and the negative terminal of the lower battery.
4. Loosely assemble the disconnect cable and the high-current cable 18.4 cm (7.25 in) cable to the negative terminal of the battery with a washer-screw.
5. At the upper battery, remove the washer-screw from the negative battery terminal.
6. Align the terminal of the black battery interconnect cable with the terminal of the black high-current cable 18.4 cm (7.25 in)—without insulator and the negative terminal of the upper battery.
7. Loosely assemble the interconnect cable and the high-current cable 18.4 cm (7.25 in)—without insulator to the negative terminal of the battery with a washer-screw.
8. Rotate the disconnect cable so that the insulator aligns horizontally when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
9. Slide the black insulator for the black interconnect cable over the negative battery terminal.
10. Rotate the interconnect cable so that the insulator aligns up and inboard 45º when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.

Installing a Battery to the Lower Battery Pack (continued)

11. Slide the black insulator for the black interconnect cable over the negative battery terminal.
12. At the upper battery, remove the washer-screw from the positive battery terminal.

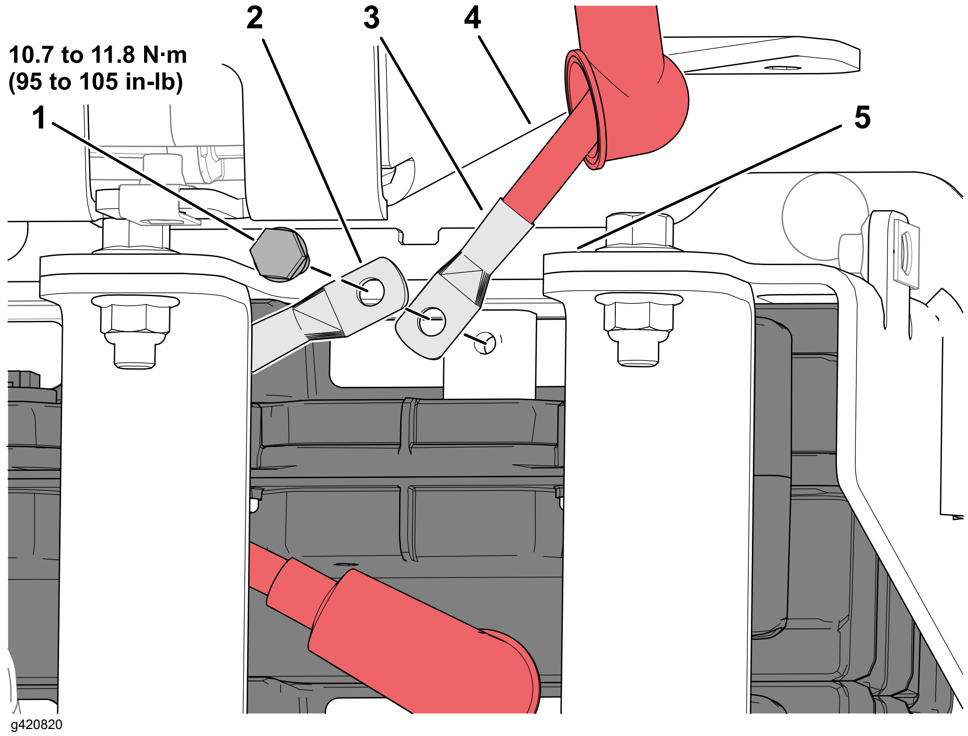


Figure 135

1. Washer-screw
2. Red high-current cable 18.4 cm (7.25 in)—with insulator
3. Red pack interconnect cable
4. Base-mount plate
5. Battery mount

---

13. Align the terminal of the red battery interconnect cable with the terminal of the red high-current cable 18.4 cm (7.25 in)—with insulator and the positive battery terminal of the upper battery.
14. Loosely assemble the red interconnect cable and the red battery cable the positive terminal of the battery with a washer-screw.
15. Rotate the interconnect cable so that the cable and insulator clear the battery mount of the lower battery pack and base-mount plate of the upper battery pack the when installed, and torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
16. Slide the red insulator for the interconnect cable over the positive battery terminal.
17. At the positive terminal of the lower battery, torque the washer-screw to **10.7 to 11.8 N·m (95 to 105 in-lb)**.
18. Slide the red insulator for the batter cable over the positive battery terminal.

Connecting the CAN Bus Harness

Plug the CAN pack interconnect cable into the CAN port of the upper battery.

Installing a Battery to the Lower Battery Pack (continued)

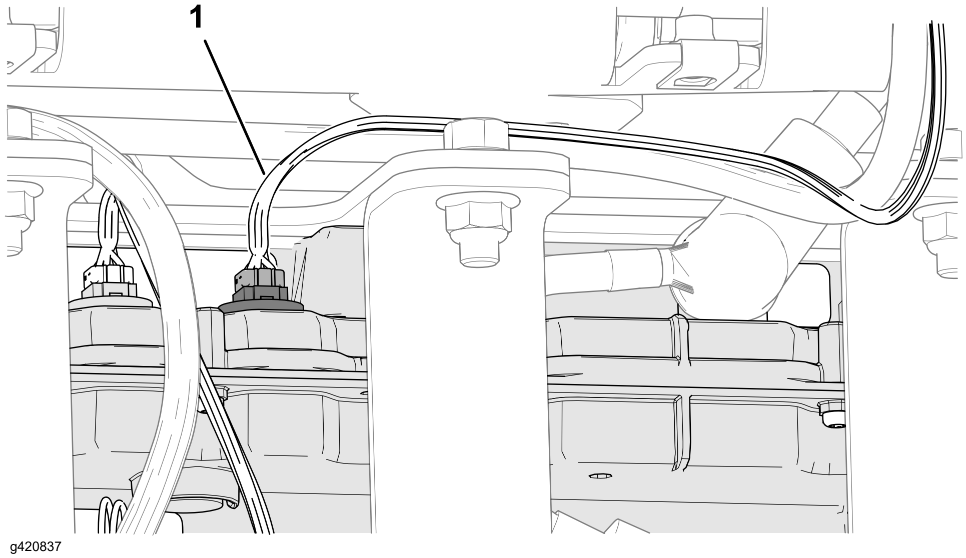


Figure 136

1. CAN pack interconnect cable

Installing the Lower-Battery Pack Cover

1. Align the holes in the lower-battery pack cover with the holes in the upper battery mount and the lower battery mount.

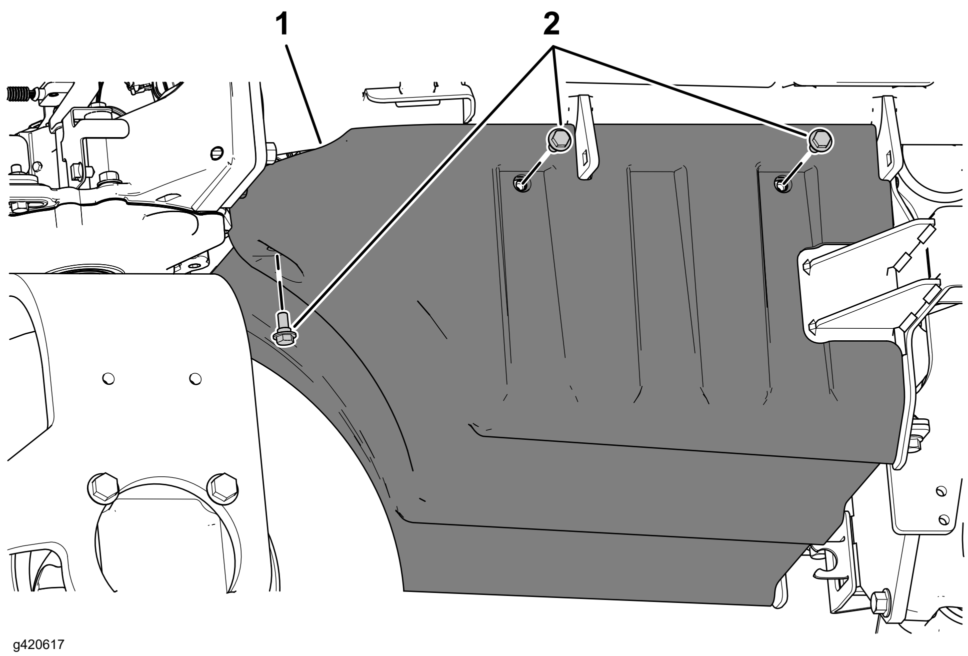


Figure 137

1. Lower-battery pack cover
2. Flange-head screws

2. Assemble the cover to the mounts with the 6 flange-head screws, and tighten the screws.

Finishing the Battery Installation

1. Connect the 48V battery disconnect.

Installing a Battery to the Lower Battery Pack (continued)

2. If you replace the battery, contact your Authorized Toro Distributor for assistance with programming the machine for the new battery.

IMPORTANT

The machine must be programmed to complete the installation of a replacement battery.

Service and Repairs

Generator Assembly (Model 04580)

Note: If the starter/generator controller is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

Replacing the Starter/Generator Drive Belt

1. Remove the fuel tank; refer to Removing the Fuel Tank (page 4–5).
2. Tilt the operator seat forward and remove the starter/generator pulley cover.
3. Loosen the hex nuts and extend the adjustment pin as far as possible to relax the extension spring. Remove the extension spring from the starter/generator spring bracket if necessary.

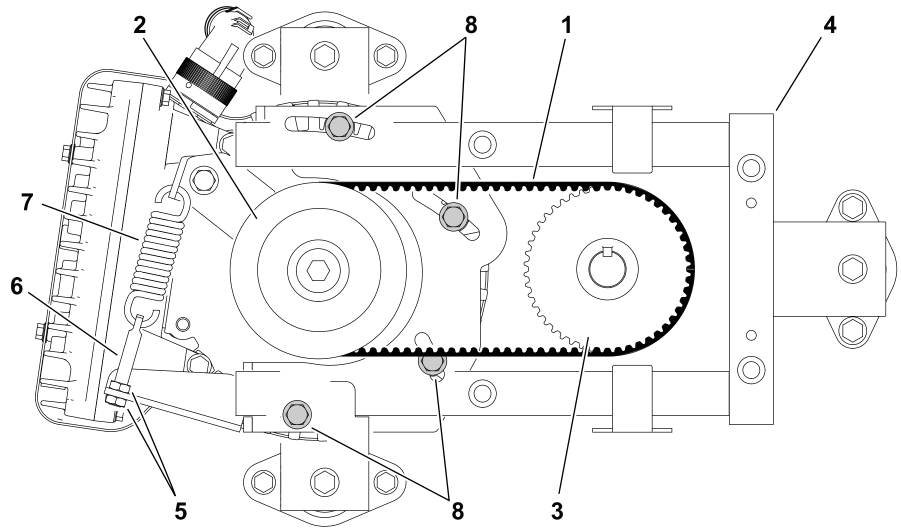


Figure 138

1.	Generator drive belt	5.	Hex nut (2 each)
2.	Generator pulley	6.	Adjustment pin
3.	Engine pulley	7.	Extension spring
4.	Engine frame	8.	Cap screw (4 each)

4. Loosen the 4 cap screws (item 8) securing the starter/generator to the engine frame, then rotate the starter/generator clockwise to loosen and remove the starter/generator drive belt.
5. Install a new starter/generator drive belt. Ensure that the drive belt cogs engage with the teeth in the engine and starter/generator pulleys.
6. Adjust the starter/generator belt tension; refer to Adjusting the Starter/Generator Drive Belt Tension (Model 04580) (page 5–24).

Removing the Starter/Generator Assembly

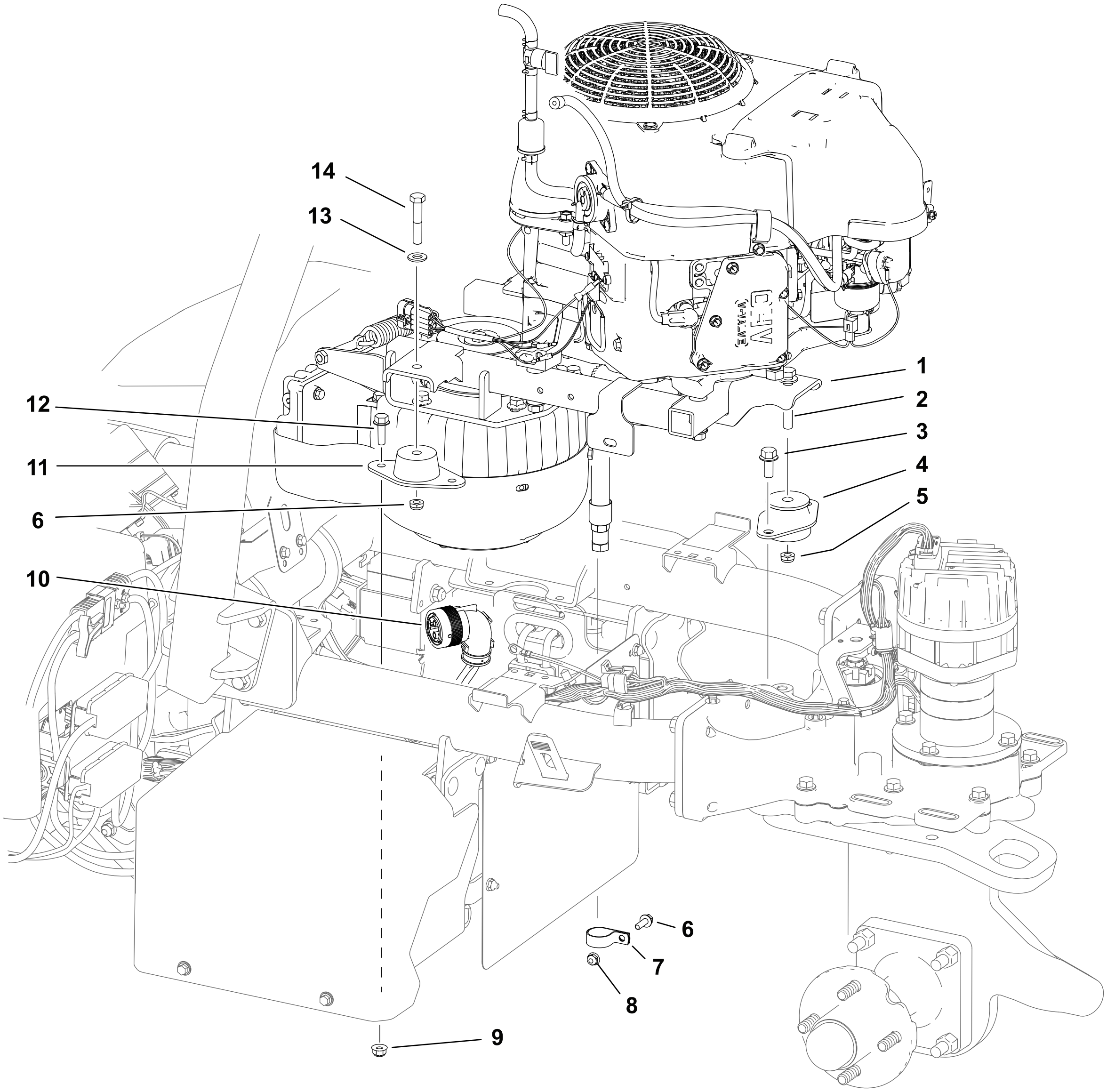


Figure 139

1. Engine frame assembly
2. Cap screw
3. Cap screw (2 each)
4. Isolating mount – rear
5. Lock nut (3 each)
6. Cap screw
7. Clamp
8. Lock nut
9. Flange nut (4 each)
10. Wire harness connector
11. Isolating mount – front (2 each)
12. Cap screw (4 each)
13. Flat washer (3 each)
14. Cap screw (2 each)

Refer to Figure 139 for this procedure

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).
3. Disconnect the negative (–) battery cable from the 12V system battery; refer to Removing and Installing the 12V System Lead Acid Battery (Model 04580) (page 5–116).
4. Remove the exhaust system; refer to Removing the Exhaust System (page 4–11).

5. Remove the fuel tank; refer to Removing the Fuel Tank (page 4–5).
6. Remove the evaporative control system carbon canister from the machine.
7. Disconnect the electrical system wiring from the engine:
   - The engine wire harness connector at the main wire harness (left side of engine). Check the engine and wire harness connector for damage or corrosion and clean or repair as necessary.
   - The wire harness ground at the engine (near front left engine mount).
8. Disconnect the choke cable from the engine.
9. Remove the clamp securing the engine oil drain hose to the right side battery tray.
10. Disconnect the starter/generator from the machine wire harness. Check the starter/generator and the harness connector for damage or corrosion and clean or repair as necessary.
11. Tilt the operator seat forward and remove the starter/generator pulley cover.
12. Remove the fasteners securing the engine frame assembly to the 3 isolating mounts.

CAUTION

The engine frame assembly weighs approximately 68 kg (150 lb). Use an appropriate lift to remove the engine frame assembly.

13. Remove the engine frame assembly from the machine.
14. Loosen the hex nuts and extend the adjustment pin as far as possible to relax the extension spring. Remove the extension spring from the starter/generator spring bracket.

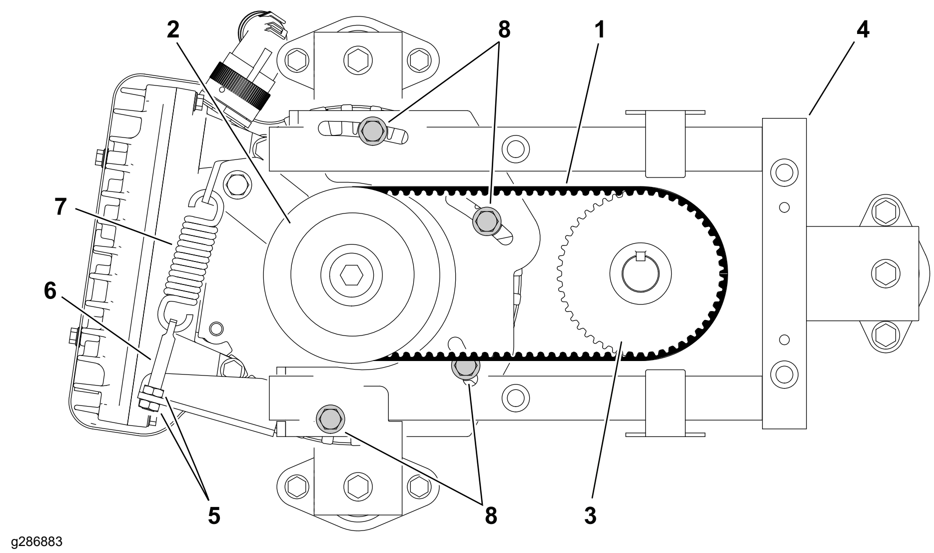


Figure 140

1.	Generator drive belt	5.	Hex nut (2 each)
2.	Generator pulley	6.	Adjustment pin
3.	Engine pulley	7.	Extension spring
4.	Engine frame	8.	Cap screw (4 each)

Removing the Starter/Generator Assembly (continued)

15. Loosen the 4 cap screws (item 8) securing the starter/generator to the engine frame, then rotate the starter/generator clockwise to loosen the starter/generator drive belt.
16. Remove the fasteners and the starter/generator from the engine frame.

Disassembling the Starter/Generator

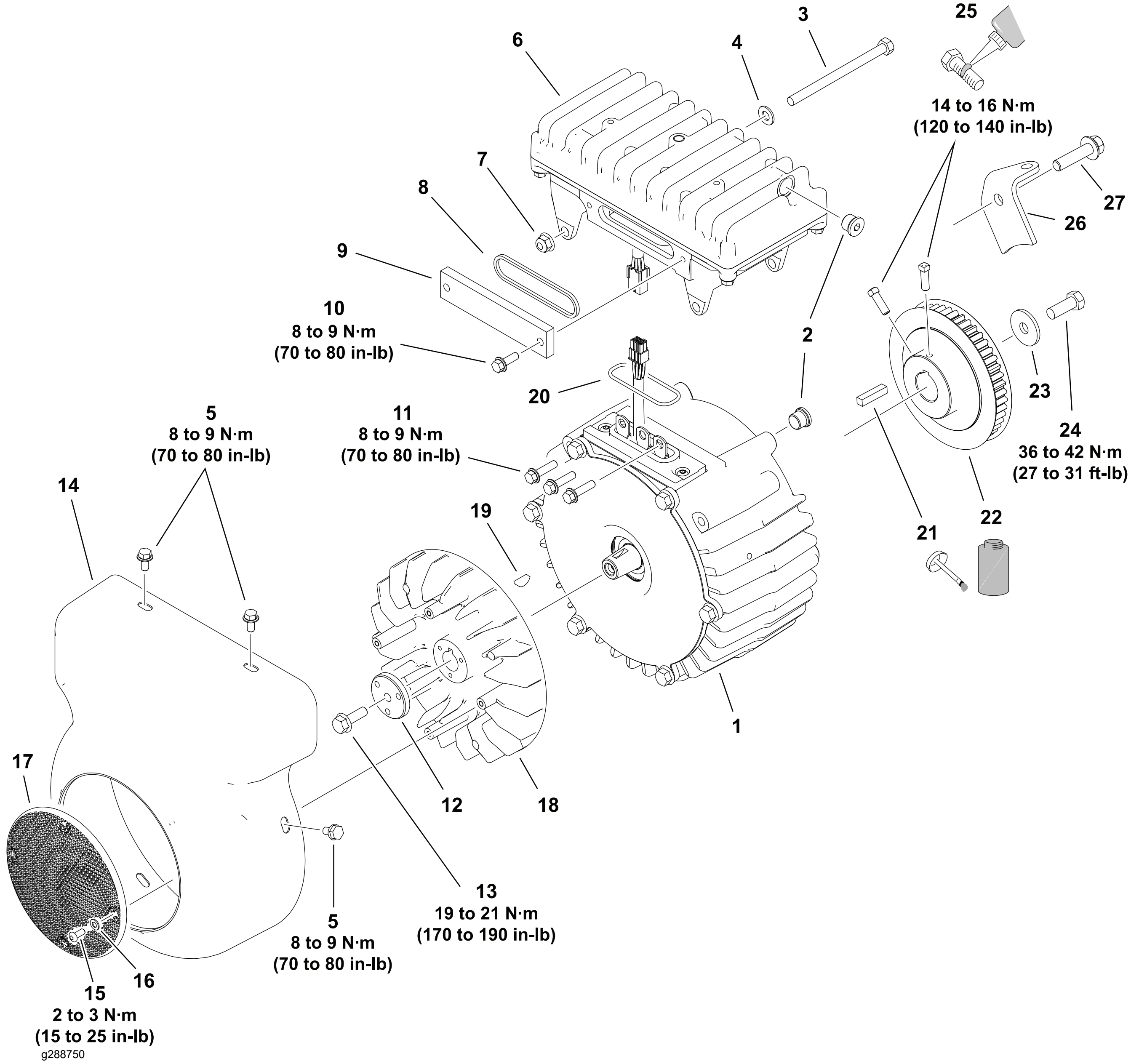


Figure 141

1. Generator assembly
2. Plug (2 each)
3. Cap screw (2 each)
4. Flat washer (2 each)
5. Washer head screw (6 each)
6. Controller assembly
7. Flange nut (2 each)
8. Cover gasket
9. Access cover
10. Washer head screw (2 each)
11. Flange head screw (3 each)
12. Collar
13. Flange head screw
14. Generator cover
15. Torx screw (4 each)
16. Flat washer (4 each)
17. Rotating screen
18. Generator fan
19. Woodruff key
20. O−ring
21. Square key
22. Generator pulley
23. Washer
24. Cap screw
25. Square head set screw (2 each)
26. Spring bracket
27. Flange head screw

Refer to Figure 141 for this procedure.

1. Remove the starter/generator cover from the starter/generator assembly.
2. Remove rotating screen from the starter/generator fan.

Disassembling the Starter/Generator (continued)

3. Remove the access cover (item 9) and the cover gasket from the controller. Discard the cover gasket.
4. Record the position of the connectors and the wire harnesses for assembly purposes. Carefully remove the starter/generator and controller harness connectors from the controller opening and unplug the connectors.
5. Remove the three flange head screws (item 11) that secure the starter/generator stator conductors to the controller connectors.
6. Remove the fasteners that secure the controller to the starter/generator assembly. Lift the controller from the starter/generator. Remove and discard the O-ring (item 20).

   Note: If controller damage exists, controller replacement is necessary. Internal controller components are not available separately. If the starter/generator controller is replaced, the machine software must be updated; contact an Authorized Toro Distributor for assistance.
7. Remove the starter/generator fan:
   A. Remove the flange head screw and the collar from the starter/generator shaft.
   B. To prevent damage to the starter/generator shaft threads, install a plain washer in the center hole of the starter/generator fan to protect the starter/generator shaft threads before removing the starter/generator fan.

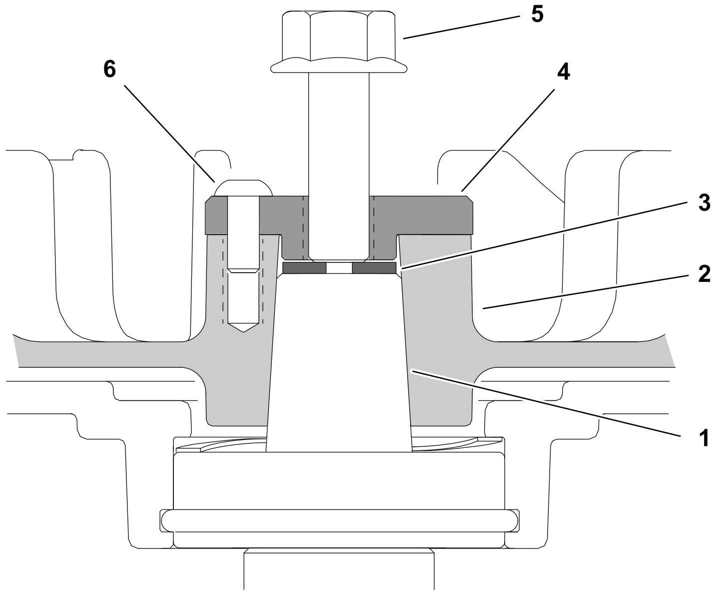


Figure 142

1.	Generator shaft	4.	Collar
2.	Generator fan	5.	3/8-16 x 1 inch cap screw
3.	Plain washer	6.	Screw (3 each)

   C. Install the collar on the starter/generator fan with three of the rotating screen screws previously removed.
   D. Thread a 3/8-16 x 1 cap screw into the collar.
   E. Support fan to prevent it from falling and tighten the cap screw to remove the fan.
   F. Locate and retrieve the woodruff key.
8. Remove the starter/generator pulley. Locate and retrieve the square key.

Disassembling the Starter/Generator (continued)

9. Remove the spring bracket from the starter/generator housing.

   Note: If the starter/generator housing/stator requires replacement, the starter/generator assembly must be replaced. The starter/generator housing/stator is not available separately.

10. Continue to disassemble the starter/generator if necessary:

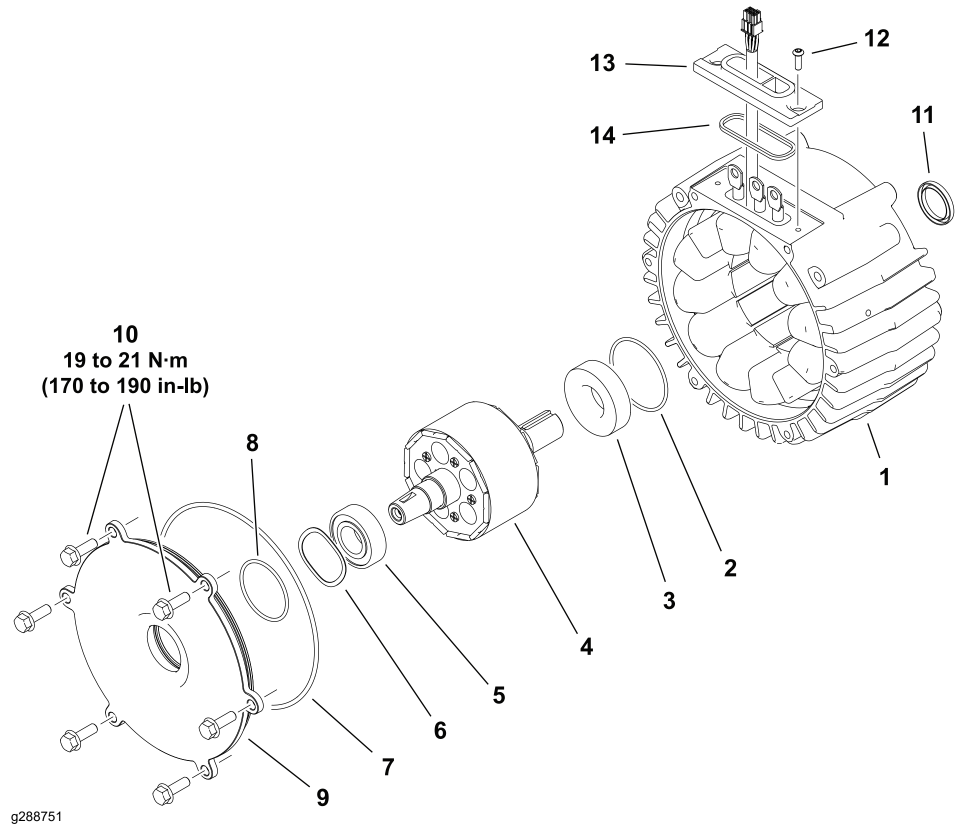


Figure 143

1. Housing/stator assembly
2. O−ring
3. Bearing
4. Rotor assembly
5. Bearing
6. Wave washer
7. O−ring
8. O−ring
9. Cover
10. Flange screw (6 each)
11. Lip seal
12. Screw (2 each)
13. Isolator
14. Gasket

Use of the starter/generator rotor tool part number TOR6029 is recommended for this procedure; refer to Generator Rotor Tool (page 2–15).

IMPORTANT

When servicing the starter/generator, use a clean workspace with a non-metal surface. The starter/generator rotor includes very powerful magnets that can cause the rotor to move unexpectedly if working on a metal surface. Also, any metallic debris that gets attracted to the rotor can damage the starter/generator after assembly.

Disassembling the Starter/Generator (continued)

A. Remove the six flange head screws that secure the cover to the housing/stator assembly. Do not remove the cover.

B. Secure the base plate of the starter/generator rotor tool (part number TOR6029) to the drive side of the starter/generator housing/stator with three 3/8–16 X 3 inch cap screws.

g289007

Figure 144

1. Generator housing/stator assembly (drive side)
2. Generator rotor tool base plate
3. Generator rotor tool shaft

C. Install the rotor tool shaft into the base plate and turn it in against the rotor shaft.

CAUTION

The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Be cautious during rotor removal to prevent component damage or personal injury.

D. Turn the rotor tool shaft to push the rotor and cover assembly from the housing/stator assembly. Support the rotor to prevent it from falling during removal.

E. Remove the cover from the rotor assembly. Remove the O-rings and the wave washer from the cover. Discard the O-rings.

F. Remove and discard the O-ring and lip seal from the bearing bore in the housing.

G. If necessary, remove and discard the bearings from the rotor.

H. If necessary, remove the isolator and gasket from the housing/stator assembly. Discard the gasket.

11. Inspect the starter/generator components for wear or damage. Replace components or complete starter/generator assembly if necessary.

Assembling the Starter/Generator

Refer to Figure 141 for this procedure.

1. Make sure that all the starter/generator components are clean before assembly.
2. Assembly the starter/generator internal components:
   A. If the bearings were removed from the rotor assembly, install new bearings onto the rotor shaft. Make sure the new bearings are fully pressed onto rotor shaft.

   B. If the isolator was removed, lubricate a new gasket with dielectric lubricant and install it to the isolator. Fit the isolator to the housing assembly so the stator conductors and stator harness pass through the isolator.

   C. Lubricate a new O-ring with dielectric lubricant and install it into the groove in the housing/stator bearing bore.

   D. Apply a light coating of grease to the inside of a new lip seal and install the seal in the housing/stator.

   E. Lubricate the new O-rings with dielectric lubricant and install the O-rings into the grooves in the cover. Place the wave washer in the cover bearing bore and fit the rotor assembly into the cover.

   F. Secure the base plate of the starter/generator rotor tool to the drive side of the starter/generator housing/stator with three 3/8–16 X 3 inch cap screws.

   G. Install the rotor tool shaft into the base plate and turn it in so the end of the shaft prevents the rotor body from entering the housing/stator assembly.

CAUTION

The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Be cautious during rotor installation to prevent component damage or personal injury.

   H. While supporting the rotor and cover assembly, slowly turn the rotor tool shaft to allow the rotor to be drawn into the housing/stator assembly. Once the rotor and cover assembly is fully seated in the housing/stator assembly, remove the rotor tool base plate.

   I. Secure the cover to the housing with the six flange head screws and tighten the screws from **19 to 21 N·m (170 to 190 in−lb)**.

   J. Make sure that rotor rotates before continuing with starter/generator assembly.

3. Install the spring bracket (item 26).
4. Install the starter/generator pulley:
   A. Apply anti-seize lubricant to the rotor shaft and fit the square key and starter/generator pulley onto the rotor shaft.

   B. Install the flat washer and cap screw (item 24) and tighten the screw from **36 to 42 N·m (27 to 31 ft−lb)**

   C. Apply a high temperature medium strength thread locking compound (Loctite 2422 or equivalent) and tighten the square head set screws (item 25) from **14 to 16 N·m (120 to 140 in−lb)**.

Assembling the Starter/Generator (continued)

5. Install the starter/generator fan:

   A. Make sure that tapered surfaces of the rotor shaft and the fan are thoroughly clean.

   B. Position the woodruff key into the rotor shaft and install the starter/generator fan.

   C. Install the collar and flange head screw (item 13). Tighten the screw from **19 to 21 N·m (170 to 190 in−lb)**.

6. Lubricate a new O-ring (item 20) with dielectric lubricant and install it into the groove on the isolator.

7. Install the controller:

   A. Lower the controller onto the starter/generator and route both controller and starter/generator harness connectors out the opening in the controller.

   B. Loosely install the three flange head screws that secure the starter/generator stator conductors to the controller connectors. Make sure that the flange head screws do not pinch the electrical harnesses.

   C. Secure the controller to the starter/generator housing with the fasteners previously removed.

   D. Tighten the three flange head screws (item 11) to **8 to 9 N·m (70 to 80 in−lb)**.

   E. Apply dielectric lubricant to the harness connectors and plug the starter/generator connector into the controller connector. Insert harnesses and connectors to the side of the three terminals in the controller.

8. Lubricate a new cover gasket (item 8) with dielectric lubricant and install the gasket into the groove in the access cover. Secure the cover to the controller and tighten the screws from **8 to 9 N·m (70 to 80 in−lb)**.

9. Install the rotating screen and tighten the screws from **2 to 3 N·m (15 to 25 in−lb)**.

10. Install the starter/generator cover and tighten the cover screws from **8 to 9 N·m (70 to 80 in−lb)**.

Installing the Starter/Generator Assembly

Note: If the starter/generator controller (T6) is replaced for any reason, system software needs to be reloaded; contact an Authorized Toro Distributor for assistance.

Refer to Figure 139 for this procedure.

1. Secure the starter/generator to the engine frame assembly with the 4 cap screws previously removed. Do not tighten the cap screws.
2. Install the starter/generator drive belt over the starter/generator and engine pulleys.
3. Connect the extension spring to the starter/generator spring bracket and the adjustment pin.
4. Adjust the starter/generator belt tension; refer to Adjusting the Starter/Generator Drive Belt Tension (Model 04580) (page 5–24).
5. Secure the 3 engine frame assembly isolation mounts to the machine with the fasteners previously removed.

Installing the Starter/Generator Assembly (continued)

6. Connect the machine wire harness to the starter/generator.
7. Install the clamp securing the engine oil drain hose to the right side battery tray.
8. Connect the choke control cable to the engine:
   A. Set the choke control at the operator control panel to the full choke position.
   B. Connect the choke control cable to the choke lever at the carburetor.
   C. Set the choke lever at the carburetor to the full closed position and secure the cable housing to the engine with the clamp and cap screw previously removed.
9. Connect the electrical system wiring to the engine:
   - The wire harness ground at the engine (near front left engine mount).
   - The engine wire harness connector at the main wire harness (left side of engine).
10. Connect the evaporative control system carbon canister to the engine vent hose.
11. Install the fuel tank; refer to Installing the Fuel Tank (page 4–5).
12. Install the exhaust system; refer to Installing the Exhaust System (page 4–12).
13. Ensure that all the hoses, tubes, and wires are clear of moving parts and secured to their original locations.
14. Connect the negative (–) battery cable at the 12V system battery.
15. Check engine oil level and adjust if necessary; refer to traction unit *Operator's Manual*.
16. If the starter/generator controller is new, update the machine software; contact an Authorized Toro Distributor for assistance.
17. Operate the machine. Check for proper starter/generator operation. Check for fuel leaks and correct any issues before returning the machine to service.

Front Traction Motor

The front traction motors can be replaced separate from the front traction gear box. The front traction gear box can be removed or installed before or after the motor is removed from the machine; refer to Front Traction Gear Box (page 6–11).

If the front traction motor is replaced for any reason, the traction motors must be calibrated; refer to Calibrating the Front Traction Motors (page 5–177).

For front traction motor testing information; refer to Front Traction Motor (page 5–64).

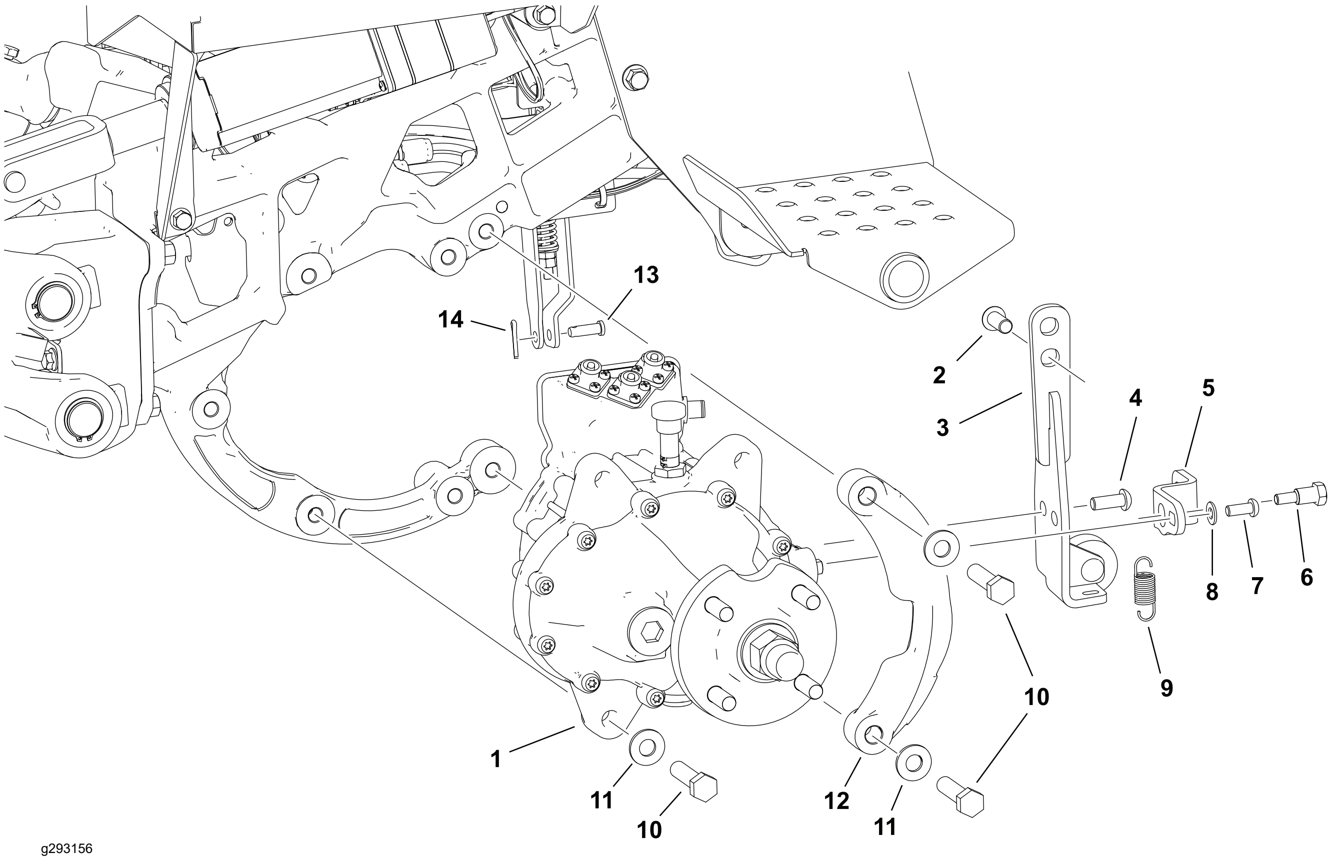


Figure 145

(shown with front traction gear box attached)

1. Traction motor and gear box assembly
2. Button head cap screw (2 each)
3. Arm – LH
4. Button head cap screw (2 each)
5. Brake lever – LH
6. Shoulder bolt
7. Button head screw
8. Washer
9. Extension spring
10. Cap screw (6 each)
11. Thrust washer (6 each)
12. Support link
13. Clevis pin
14. Cotter pin

Removing the Front Traction Motor

Refer to Figure 145 for this procedure.

1. Unplug the 48V battery; refer to 48V Battery Service Disconnect (page 5–10).
2. Remove the front wheel; refer to Removing and Installing the Wheels (page 6–9).
3. Disconnect the multi-pin wire harness connector and the 3 power cables from the motor. Check the motor, harness connector and cable terminals for damage or corrosion and clean or repair as necessary.

Removing the Front Traction Motor (continued)

4. Remove the cotter pin and clevis pin securing the brake linkage to the brake lever. Discard the cotter pin.
5. Remove the extension spring from the brake lever.
6. Remove the fasteners that secure the brake lever from the traction motor assembly.
7. Remove the fasteners securing the arm (item 3) to the frame and the traction motor, and remove the arm.
8. Remove the 2 fasteners and washers securing the support link to the frame.
9. Remove the 4 fasteners and washers securing the traction motor to the frame and remove the traction motor.

Installing the Front Traction Motor

Refer to Figure 145 or this procedure.

1. Assemble the traction motor to the frame with the 4 fasteners and washers, and torque the fasteners to 91 to 113 N·m (67 to 83 ft-lb).
2. Assemble the support link to the frame with the 2 fasteners and washers, and torque the fasteners to 91 to 113 N·m (67 to 83 ft-lb).
3. Assemble the arm (item 3) to the frame and the traction motor with the fasteners.
4. Assemble the brake lever to the arm and traction motor with the fasteners.
5. Install the extension spring between the brake lever and the arm.
6. Align the holes in the brake linkage to the brake lever, and secure the linkage to the lever with the clevis pin and a new cotter pin.
7. Plug the wire harness connector into the motor.
8. Install the 3 power cables to the motor.
9. Install the front wheel, and torque the lug nuts to 109 to 122 N·m (80 to 90 ft-lb).
10. Plug the 48V battery into the machine; refer to 48V Battery Service Disconnect (page 5–10).
11. Calibrate the traction motors before returning the machine to service; refer to Calibrating the Front Traction Motors (page 5–177).

Calibrating the Front Traction Motors

1. Sit in the operator seat and set the key switch to the ON position.
2. Access the InfoCenter **Settings > Protected Menus > Enter PIN** screen and enter the machine PIN.
3. Access the InfoCenter **Service > Calibration** screen.
4. Select **Traction Motor** and follow the on-screen calibration instructions.

   Note: If the calibration procedure fails, try calibrating the item again. Ensure the entire brake assembly is operating properly before continuing to troubleshoot the system; refer to Checking the Brake Adjustment (page 6–3).

Rear Traction Motor (Optional)

The optional rear traction motor is attached to the rear wheel gear box cover. The rear wheel gear box must be removed and disassembled to access the motor mounting fasteners.

If the rear traction motor is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

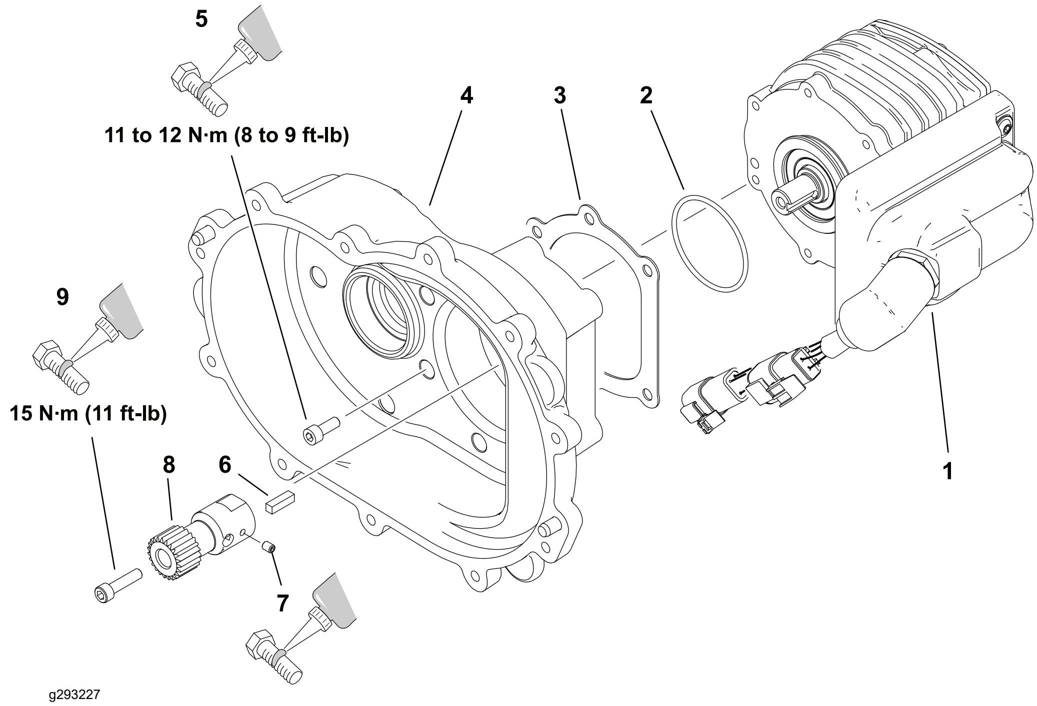


Figure 146

1. 3WD traction motor
2. O-ring
3. Gasket
4. Gear box cover
5. Socket head screw (6 each)
6. Square key
7. Set screw
8. Spur gear
9. Socket head cap screw

Removing the Rear Traction Motor

Refer to Figure 146 for this procedure.

1. Remove and disassemble the 3WD gear box assembly; refer to Rear Wheel Gear Box (Optional 3WD) (page 6–19).
2. Remove the 6 fasteners securing the motor to the cover and remove the motor.
3. Remove and discard the motor gasket and O-ring.
4. Remove the spur gear and square key from the motor shaft if necessary.

Disassembling the Rear Traction Motor

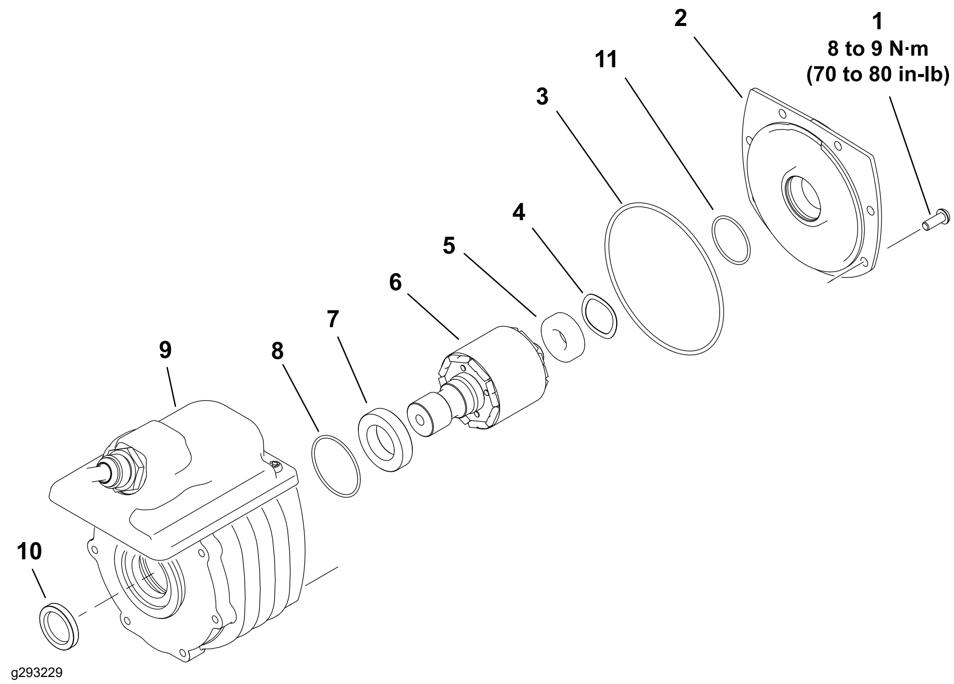


Figure 147

1. Cap screw (6 each)
2. Motor cover
3. O-ring
4. Wave washer
5. Bearing
6. Rotor
7. Bearing
8. O-ring
9. Housing assembly
10. Lip seal
11. O-ring

Note: If the motor housing, stator, controller or cable is damaged, 3WD traction motor replacement is necessary as these components are not available separately.

Use of the motor rotor tool part number TOR6028 is recommended for this procedure; refer to Cutting Unit Motor Rotor Tool (page 2–21).

IMPORTANT

When servicing the 3WD traction motor, use a clean workspace with a non-metal surface. The motor rotor includes very powerful magnets that can cause the rotor to move unexpectedly if working on a metal surface. Also, any metallic debris that gets attracted to the rotor can damage the motor after assembly.

Refer to Figure 147 for this procedure.

1. Inspect the 3WD traction motor cable for wear or damage. replace cable components or complete 3WD traction motor assembly if necessary.
2. Carefully remove and discard the lip seal from the housing assembly.
3. Remove the six cap screws that secure the motor cover to rear of motor housing. Do not remove the motor cover.
4. Secure the base plate of the motor rotor tool (Toro part number 139–8420) to the housing with four M6 – 1.0 X 50 cap screws.

Disassembling the Rear Traction Motor (continued)

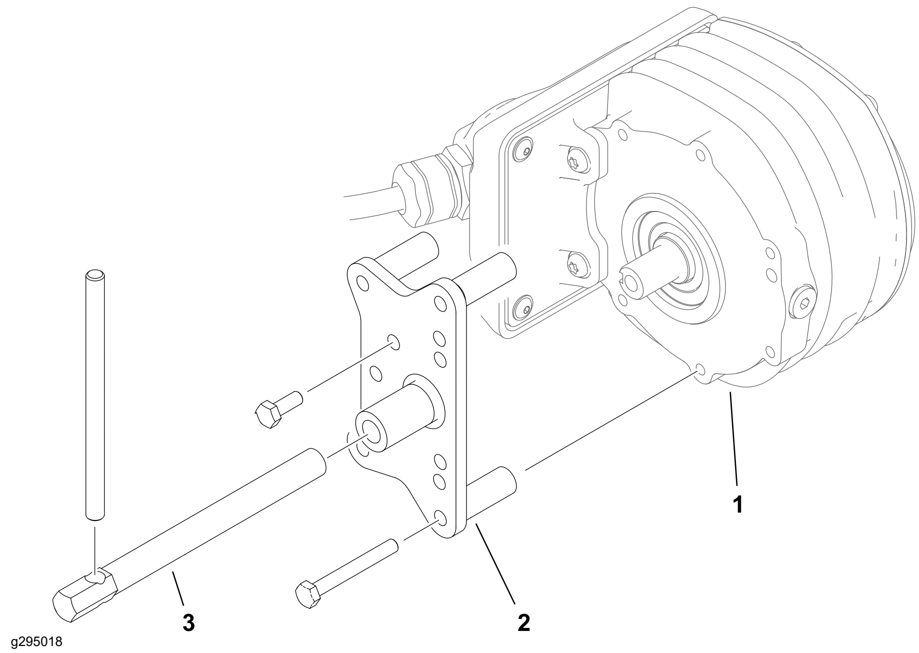


Figure 148

1. 3WD traction motor housing
2. Motor rotor tool base plate
3. Motor rotor tool shaft

---

5. Install the rotor tool shaft into the base plate and turn it in against the rotor shaft.

CAUTION

The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Be cautious during rotor removal to prevent component damage or personal injury.

---

6. Turn the rotor tool shaft to push the rotor and cover assembly from the housing assembly. Support the rotor to prevent it from falling during removal.
7. Remove the motor cover and wave washer from the rotor assembly.
8. Remove and discard the O-rings from the motor cover.
9. Remove and discard the O-ring from the motor housing.
10. If necessary, remove and discard the bearings from the rotor.
11. Inspect the 3WD traction motor components for wear or damage. Replace components or complete 3WD traction motor assembly if necessary.

Assembling the Rear Traction Motor

Refer to Figure 147 or this procedure.

1. Make sure that motor components are cleaned before assembly.
2. If the bearings were removed from the rotor, install new bearings. Make sure the new bearings are fully pressed onto the rotor shaft.
3. Lubricate a new O-ring with dielectric lubricant and install it into the groove in the housing bearing bore.

Assembling the Rear Traction Motor (continued)

4. Lubricate new O-rings with dielectric lubricant and install the O-rings into the grooves in the motor cover. Place the wave washer in the cover bearing bore and fit the rotor assembly into the cover.
5. Secure the base plate of the motor rotor tool to the housing with four M6 – 1.0 X 50 cap screws.
6. Install the rotor tool shaft into the base plate and turn it in so the end of the shaft prevents the rotor body from entering the housing assembly.

IMPORTANT

The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Be cautious during rotor installation to prevent component damage or personal injury.

7. While supporting the rotor and cover assembly, slowly turn the rotor tool shaft to allow the rotor to be drawn into the housing assembly. Once the rotor and cover assembly is fully seated in the housing, remove the rotor tool base plate.
8. Secure the cover to the housing with the six cap screws and tighten the screws from **8 to 9 N·m (70 to 80 in−lb)**.
9. Make sure that rotor rotates without binding before installing the motor assembly.

Installing the Rear Traction Motor

Refer to Figure 146 for this procedure.

1. If previously removed, install the square key and spur gear on the motor shaft.
   A. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the socket head cap screw (item 9) and tighten the screw to **15 N·m (11 ft-lb)**.
   B. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the set screw (item 7) and tighten the set screw.
2. Use a new O-ring and new gasket and fit the 3WD traction motor to the gear box cover.
3. Install the fasteners securing the motor to the cover and tighten the fasteners from **11 to 12 N·m (8 to 9 ft-lb)**.
4. Assemble and install the 3WD gear box assembly; refer to Rear Wheel Gear Box (Optional 3WD) (page 6–19).
5. If the 3WD traction motor was replaced, update the machine software; contact an Authorized Toro Distributor for assistance.

Cutting Unit Motor

If a cutting unit motor is replaced for any reason, the machine software must be updated; contact an Authorized Toro Distributor for assistance.

Removing the Cutting Unit Motor

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove key from the key switch.
2. Unplug the 48V battery disconnect; refer to 48V Battery Service Disconnect (page 5–10).

IMPORTANT

When removing the cutting unit motor, take care to not damage the cable. The cable is not available as a replacement part.

---

3. Remove the cutting unit motor from the cutting unit; refer to the traction unit *Operators Manual*.
4. Remove and discard the O-ring from the cutting unit motor flange.
5. Inspect the cutting unit threaded insert splines for wear. Replace the inserts if necessary; refer to Reel Assembly (page 7–16).
6. Locate the cutting unit motor cable connections at the machine wire harness for the motor that is to be removed, and disconnect the 2 connectors. Check the motor and the harness connector for damage or corrosion and clean or repair as necessary.
7. Locate and loosen the bulkhead nuts (2 per motor cable) that secures the cutting unit motor cable to the bulkhead brackets on the machine.
8. Loosen the motor cable bulkhead nuts and remove the cable bulkheads from the bulkhead brackets (2 per motor cable).
9. Remove the cutting unit motor and cable from the machine.

Disassembling the Cutting Unit Motor

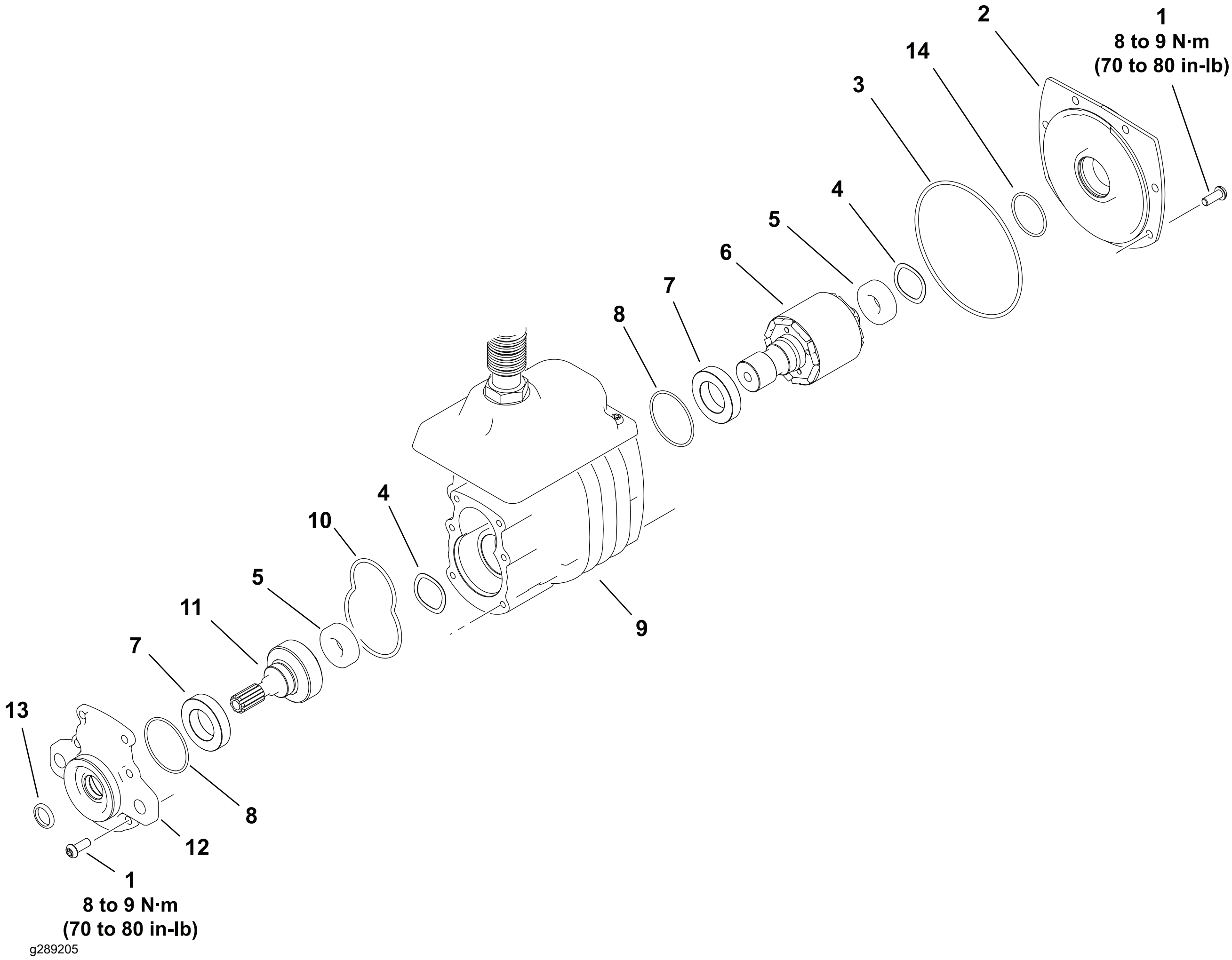


Figure 149

1. Cap screw (12 each)
2. Motor cover
3. O-ring
4. Wave washer (2 each)
5. Bearing (2 each)
6. Rotor
7. Bearing (2 each)
8. O-ring (2 each)
9. Housing assembly
10. O-ring
11. Output gear
12. Gear box cover
13. Lip seal
14. O-ring

Note: If the motor housing, stator, controller or cable is damaged, cutting reel motor replacement is necessary as these components are not available separately.

Use of the cutting unit motor rotor tool part number TOR6028 is recommended for this procedure; refer to Cutting Unit Motor Rotor Tool (page 2–21).

IMPORTANT

When servicing the cutting unit motor, use a clean workspace with a non-metal surface. The motor rotor includes very powerful magnets that can cause the rotor to move unexpectedly if working on a metal surface. Also, any metallic debris that gets attracted to the rotor can damage the motor after assembly.

Refer to Figure 149 for this procedure.

Disassembling the Cutting Unit Motor (continued)

1. Inspect the cutting unit motor cable for wear or damage. replace cable components or complete cutting unit motor assembly if necessary.

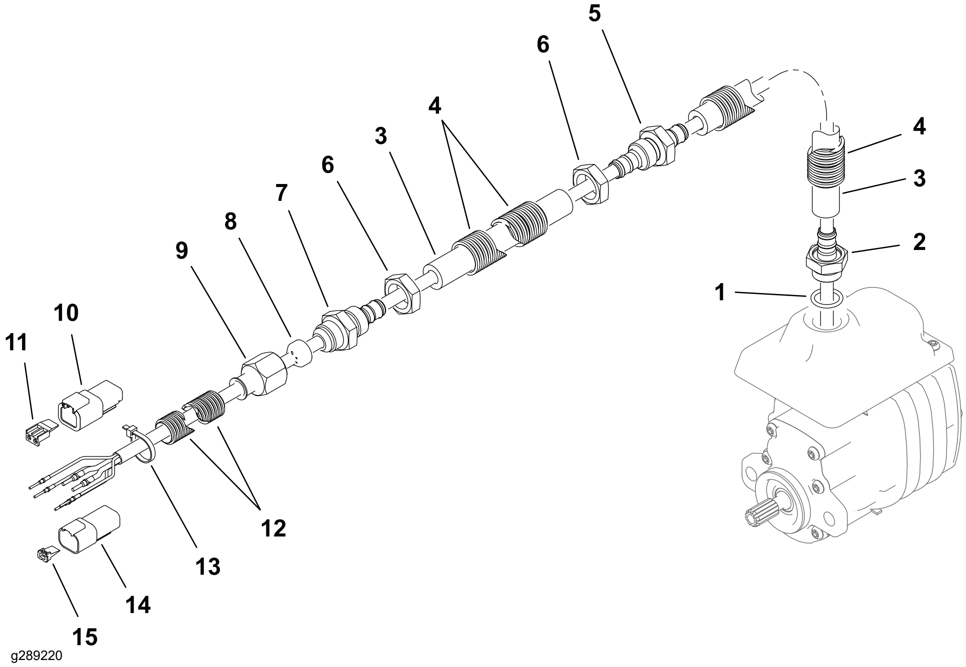
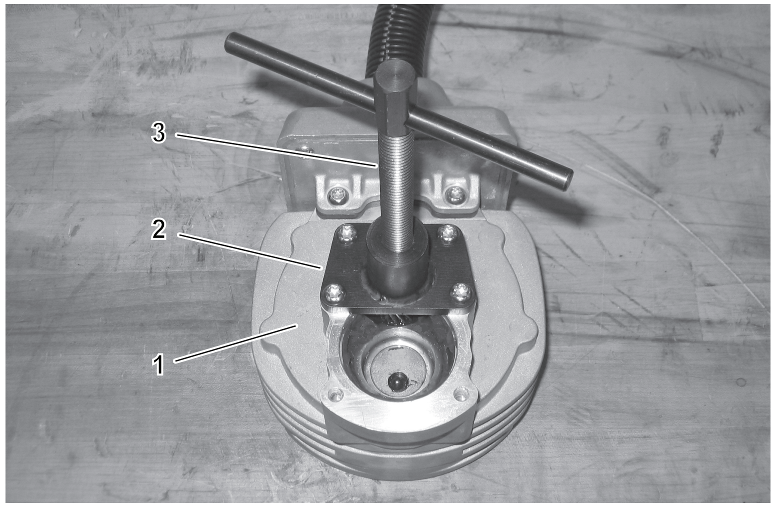


Figure 150

1. O-ring
2. Barb fitting
3. Hose
4. Convoluted tubing – 0.88 inch
5. Bulkhead fitting
6. Bulkhead nut (2 each)
7. Bulkhead fitting
8. Ferrule
9. Ferrule nut
10. Connector – 2 pin
11. Wedge – 2 pin
12. Convoluted tubing – 0.63 inch
13. Cable tie (4 each)
14. Connector – 4 pin
15. Wedge – 4 pin

2. Remove the 6 cap screws that secure the gear box cover to the front of the motor housing.
3. Carefully slide the gear box cover from the front of the motor.
4. Remove and discard the O-rings from the gear box cover.
5. Carefully remove and discard the lip seal from the gear box cover.
6. Slide the output gear assembly from the motor housing and retrieve the wave washer.
7. Remove the six cap screws that secure the motor cover to rear of motor housing. Do not remove the motor cover.
8. Secure the base plate of the cutting unit motor rotor tool (part number TOR6028) to the gear box side of the motor with four M6 – 1.0 X 16 cap screws.

Disassembling the Cutting Unit Motor (continued)



g289233

Figure 151

1. Cutting unit motor housing (gear box side)
2. Motor rotor tool base plate
3. Motor rotor tool shaft

9. Install the rotor tool shaft into the base plate and turn it in against the rotor shaft.

CAUTION

The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during removal. Be cautious during rotor removal to prevent component damage or personal injury.

10. Turn the rotor tool shaft to push the rotor and cover assembly from the housing assembly. Support the rotor to prevent it from falling during removal.
11. Remove the motor cover and wave washer from the rotor assembly.
12. Remove and discard the O-rings from the motor cover.
13. Remove and discard the O-ring from the motor housing.
14. If necessary, remove and discard the bearings from the output gear and rotor.
15. Inspect the cutting unit motor components for wear or damage. Replace components or complete cutting unit motor assembly if necessary.

Assembling the Cutting Unit Motor

Refer to Figure 149 or this procedure.

1. Make sure that motor components are cleaned before assembly.
2. If the bearings were removed from the rotor or the output gear, install new bearings. Make sure the new bearings are fully pressed onto rotor or output gear shaft.
3. Lubricate a new O-ring with dielectric lubricant and install it into the groove in the housing bearing bore.
4. Lubricate new O-rings with dielectric lubricant and install the O-rings into the grooves in the motor cover. Place the wave washer in the cover bearing bore and fit the rotor assembly into the cover.

Assembling the Cutting Unit Motor (continued)

5. Secure the base plate of the cutting unit motor rotor tool to the gear box side of the housing with four M6 – 1.0 X 16 cap screws.
6. Install the rotor tool shaft into the base plate and turn it in so the end of the shaft prevents the rotor body from entering the housing assembly.

IMPORTANT

The rotor magnets are very powerful and can cause the rotor to shift position very rapidly during installation. Be cautious during rotor installation to prevent component damage or personal injury.

7. While supporting the rotor and cover assembly, slowly turn the rotor tool shaft to allow the rotor to be drawn into the housing assembly. Once the rotor and cover assembly is fully seated in the housing, remove the rotor tool base plate.
8. Secure the cover to the housing with the six cap screws and tighten the screws from **8 to 9 N·m (70 to 80 in−lb)**.
9. Make sure that rotor rotates without binding before continuing with motor assembly.
10. Place the wave washer into the housing bore for output gear bearing.
11. Fill the output gear area of the motor housing with **15 ml (0.5 oz)** of NLGI grade 00 grease.
12. Slide the output gear assembly into the housing. Make sure that output gear teeth mesh with rotor gear.
13. Apply a light coating of grease to the inside of a new lip seal and install the seal in the gear box cover. Press the lip seal into the gear box cover until it is flush with the cover surface. The inner lip of the seal should be toward the inside of the motor.

Assembling the Cutting Unit Motor (continued)

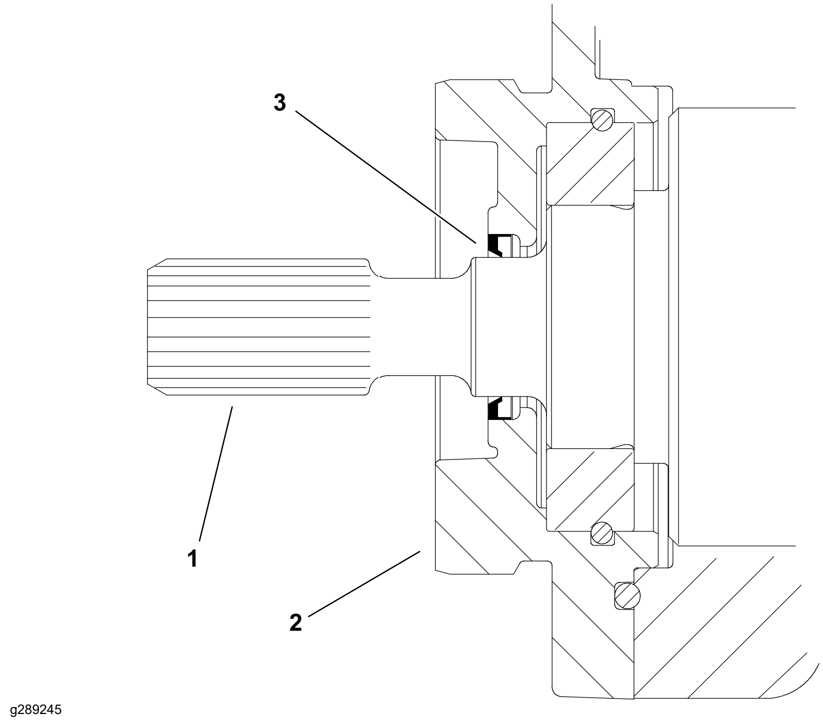


Figure 152

1. Output gear
2. Gear box cover
3. Lip seal

---

14. Lubricate new O-rings with dielectric lubricant and install the O-rings into the grooves in the gear box cover.

IMPORTANT

The output shaft splines can be sharp; be careful not to damage the lip seal when installing the gear box cover.

---

15. Carefully install the gear box cover and secure it with the six cap screws previously removed. Tighten the screws from **8 to 9 N·m (70 to 80 in- lb)**.

Installing the Cutting Unit Motor

1. Install a new O-ring to the flange of the cutting unit motor.
2. Coat the splines of the cutting unit motor shaft with No. 2 multipurpose lithium base grease.
3. Install the cutting unit motor to the cutting unit; refer to the traction unit *Operators Manual*.
4. Position the cutting unit motor cable into the bulkhead brackets on the machine (2 per motor cable) and tighten the bulkhead nuts.
5. Connect the two cutting unit motor cable connectors to the machine wire harness and connect the 48V battery .
6. If the cutting unit motor is new, update the machine software; contact an Authorized Toro Distributor for assistance.

Chapter 6

Chassis

Table of Contents

General Information

The traction unit *Operator's Manual* and optional accessory *Installation Instructions* provide information regarding the operation, general maintenance procedures, and maintenance intervals for your machine. Refer to the traction unit *Operator's Manual* and optional accessory *Installation Instructions* for additional information when servicing the machine.

Adjustments

Adjusting the Brakes

The eTriFlex machines use a single mechanical brake assembly that can be used as a service brake, a manual parking brake, and an automatic parking brake. The service brake and manual parking brake are controlled by a cable connected to pedals at the operator's left foot, while the automatic parking brake is controlled by the 12 VDC electric brake actuator. The brake system engages 2 brake calipers (located between each front traction motor and front traction gear box).

Checking the Brake Adjustment

1. Park the machine on a level surface, set the key switch to the OFF position and disengage the manual parking brake.
2. Check each brake rod assembly for a gap between the washer and the brake rod. A gap indicates the electric brake actuator has fully engaged each brake. The gap should be approximately **3.3 mm (0.13 inch)**. If no gap exists at one or both brake rod assemblies, adjust the brake linkage; refer to Adjusting the Brake Linkage (page 6–4).

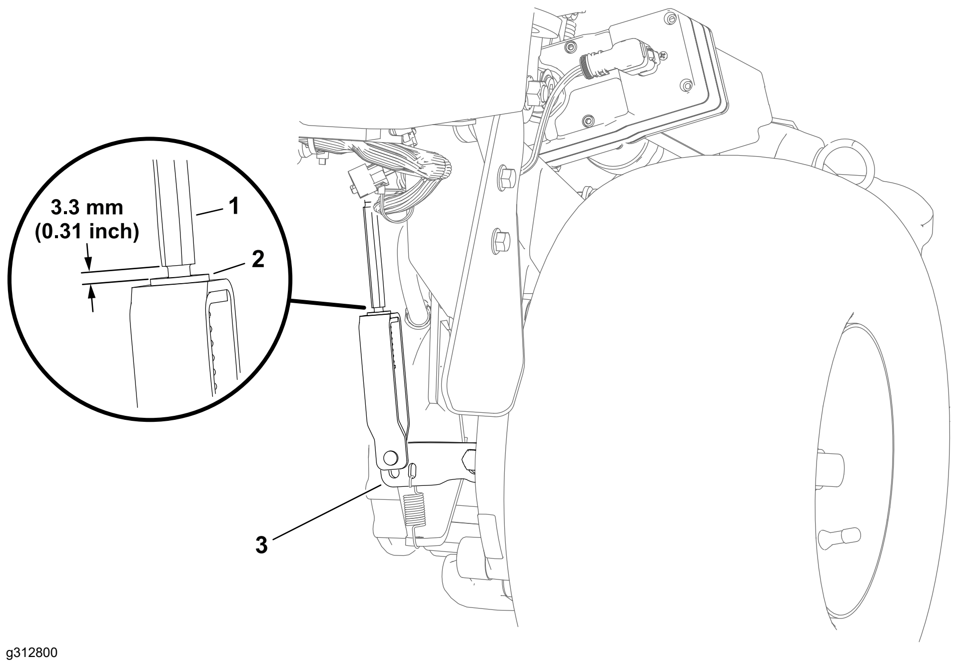


Figure 153

1. Brake rod
2. Washer
3. Brake lever

3. Have an assistant sit in the operator's seat and set the key switch to the ON position.
4. Ensure the brake lever (item 3 in Figure 153) at each wheel motor can be moved by hand. A small amount of brake lever movement indicates the actuator has fully released each brake. If no movement exists at one or both brake levers, adjust the brake linkage; refer to Adjusting the Brake Linkage (page 6–4).
5. Set the key switch to the OFF position.
6. Observe each brake rod assembly while engaging the manual parking brake. The gap between the washer and the brake rod should increase when the manual parking brake is applied. The increased gap indicates the manual parking brake is creating slightly move brake holding force than the automatic

parking brake. If the gaps do not increase when the manual parking brake is engaged, adjust the brake cable: refer to Adjusting the Brake Cable (page 6–6).

Adjusting the Brake Linkage

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Loosen the hex nuts and adjust the eye bolt as far as possible to relax the extension spring. Remove the spring.

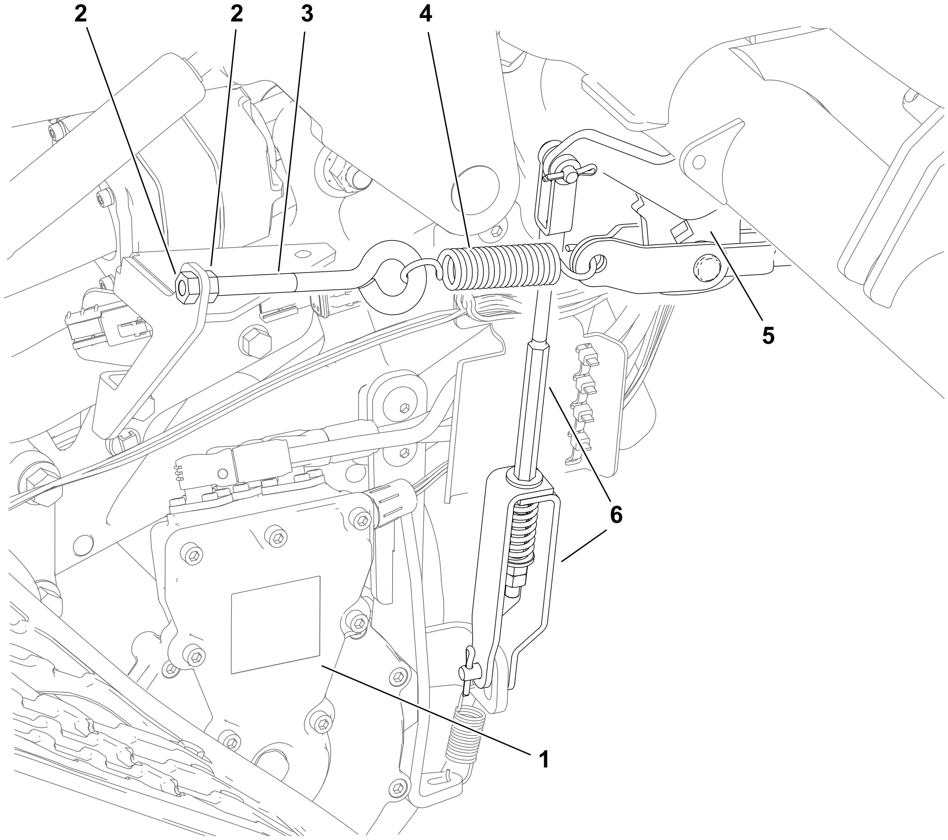


Figure 154

1. Front traction motor – RH
2. Hex nut (2 each)
3. Eye bolt
4. Extension spring
5. Upper brake arm – RH
6. Brake rod assembly

3. Use the 3/8 inch square drive hole in the right side upper brake arm to fully retract the brake actuator.
4. If either brake rod assembly was removed, repaired, or replaced:

   A. Check the brake rod assembly and adjust as necessary:

      B. Set the spring length to **36 to 40 mm (1.44 to 1.56 inch)** and tighten the jam nuts.

      C. Set the overall length to **282 to 285 mm (11.11 to 11.23 inch)** and tighten the clevis nut.

Adjusting the Brake Linkage (continued)

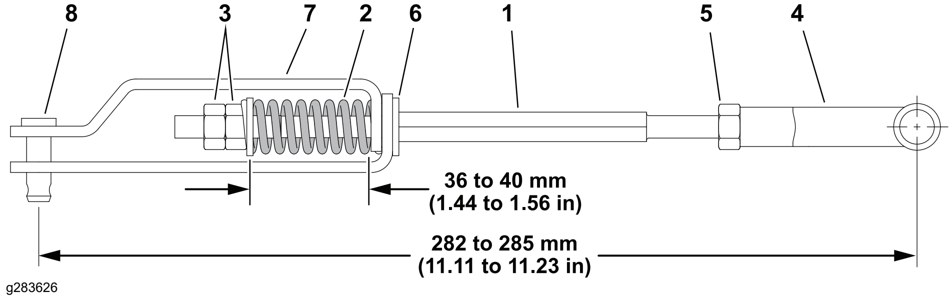


Figure 155

1. Brake rod
2. Brake rod spring
3. Jam nut (2 each)
4. Upper brake rod clevis
5. Clevis nut
6. Washer
7. Lower brake rod clevis
8. Clevis pin

D. Use new cotter pins and install the brake rod assembly to the upper brake arms only.

5. Remove the cotter pin and clevis pin from the lower brake rod clevis. Discard the cotter pin.

IMPORTANT

Adjust each brake rod individually.

6. Loosen the hex nut at the upper brake rod clevis and adjust the brake rod so the hole in the lower brake rod clevis is just below the top of the slot in the brake lever.

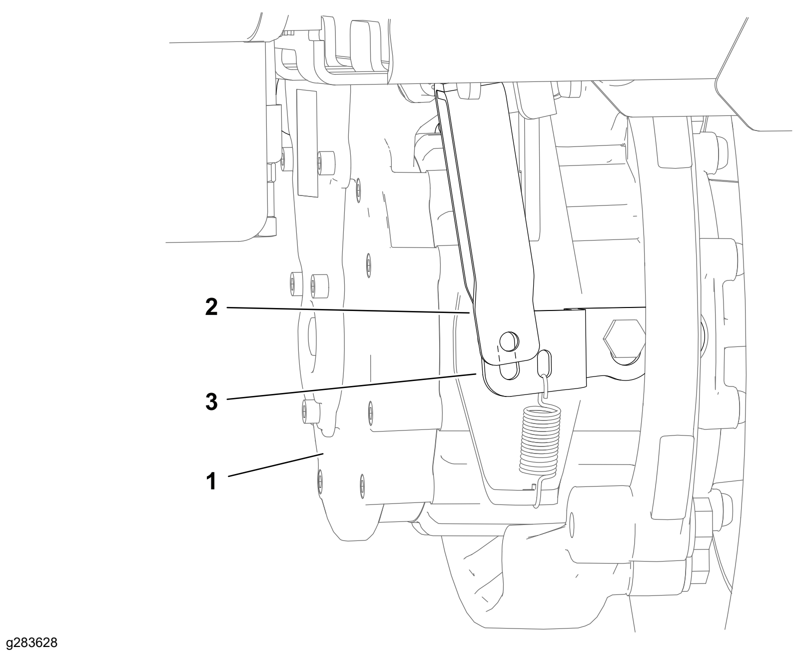


Figure 156
(view from rear)

1. Front traction motor – RH
2. Lower brake rod clevis
3. Brake lever

Adjusting the Brake Linkage (continued)

7. Ensure the flat side of the lower brake rod clevis is toward the traction motor and install the clevis pin with a new cotter pin.
8. Adjust the brake cable; refer to Adjusting the Brake Cable (page 6–6).

Adjusting the Brake Cable

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Loosen the hex nuts and adjust the eye bolt as far as possible to relax the extension spring. Remove the spring.

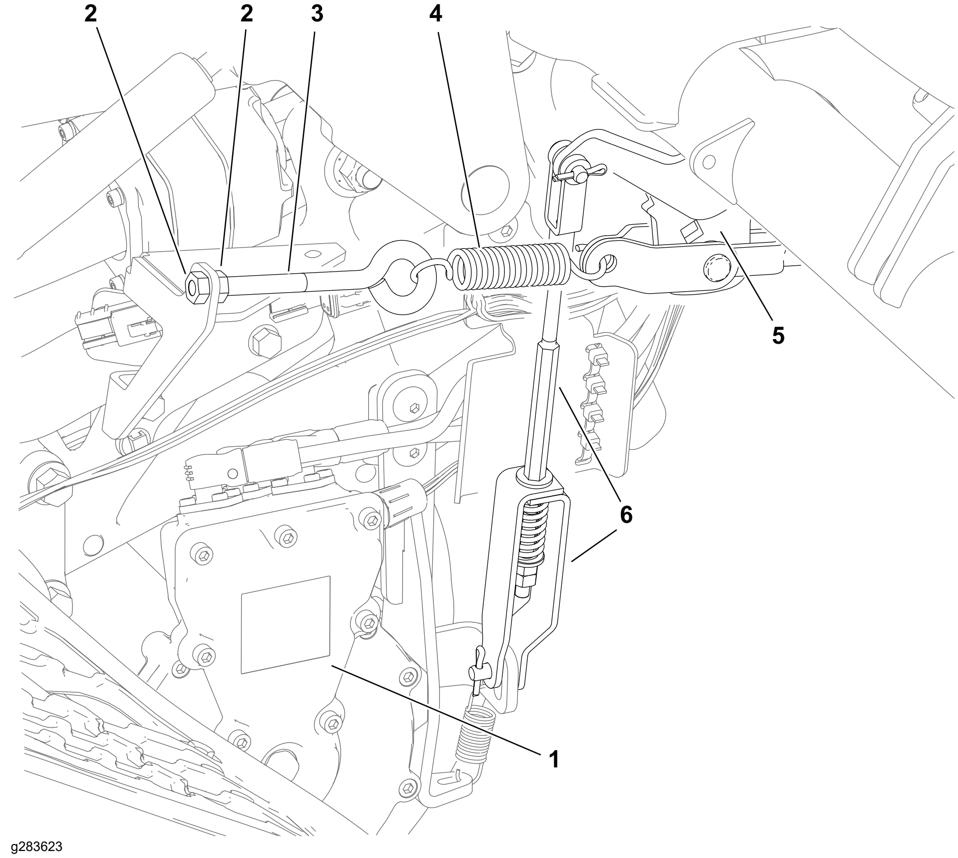


Figure 157

1. Front traction motor – RH
2. Hex nut (2 each)
3. Eye bolt
4. Extension spring
5. Upper brake arm – RH
6. Brake rod assembly

3. Use the 3/8 inch square drive hole in the right side upper brake arm to fully retract the brake actuator.

IMPORTANT

The brake cable must not restrict the brake actuator from fully retracting.

4. Loosen the brake cable adjuster jam nuts and adjust the cable until only a small amount of free play exists in the brake pedal. Tighten the adjuster jam nuts.

Adjusting the Brake Cable (continued)

5. Use the 3/8 inch square drive hole in the right side upper brake arm to fully extend the brake actuator.

6. The gap between the brake actuator rod nut and the actuator clevis nut should be **3.3 to 3.8 mm (0.13 to 0.15 inch)** and the clevis pin holes should be parallel to the ground. Loosen the clevis nut and adjust the clevis if necessary.

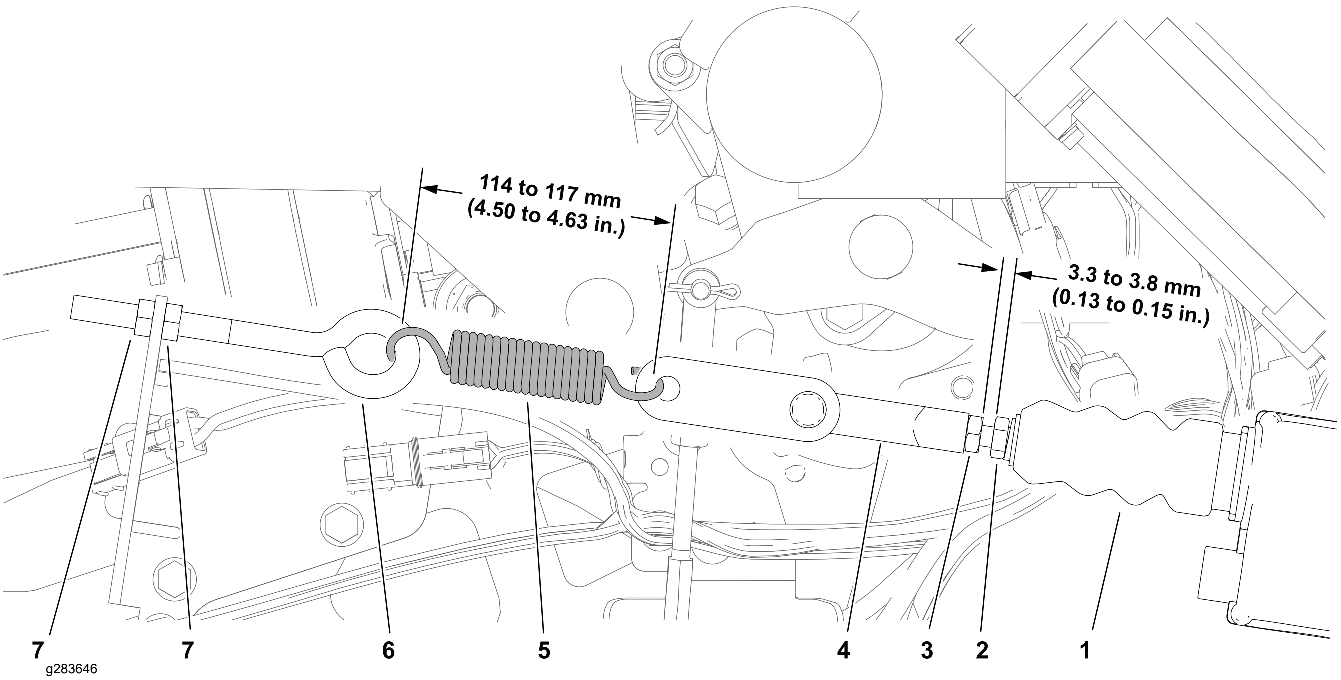


Figure 158

1. Brake actuator
2. Rod nut
3. Clevis nut
4. Clevis
5. Extension spring
6. Eye bolt
7. Hex nuts (2 each)

---

7. Install the extension spring and adjust the eye bolt until the extension spring is **114 to 117 mm (4.50 to 4.63 inch)** inside the spring hooks. Tighten the eye bolt hex nuts.

8. Check the brake adjustment; refer to Checking the Brake Adjustment (page 6–3).

Aligning the Rear Wheel Caster Fork

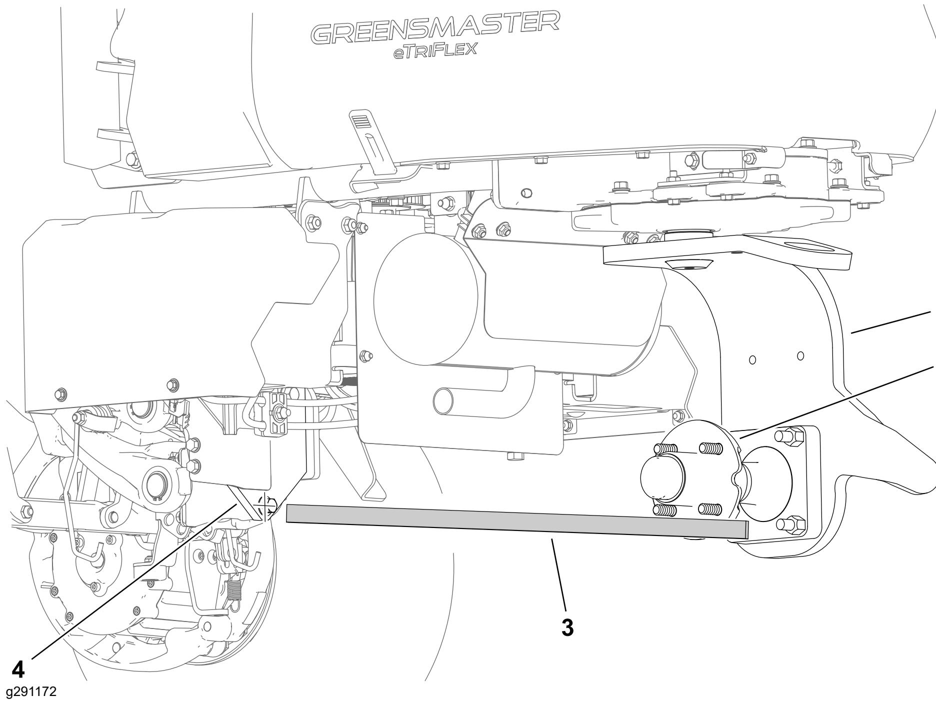


Figure 159

1. Rear caster fork
2. Wheel Hub
3. Straight edge
4. Center (rear) cutting unit suspension mount plate

---

1. Remove the rear wheel; refer to Removing and Installing the Wheels (page 6–9).
2. Clamp a straight edge to the rear wheel hub flange.
3. Rotate the caster fork by hand until the straight edge aligns with the lower mounting bolt on the center (rear) cutting unit suspension mount plate.
4. Adjust the steering position sensor; refer to Adjusting the Steering Position Sensor (page 5–25).

Service and Repairs

Wheels and Tires

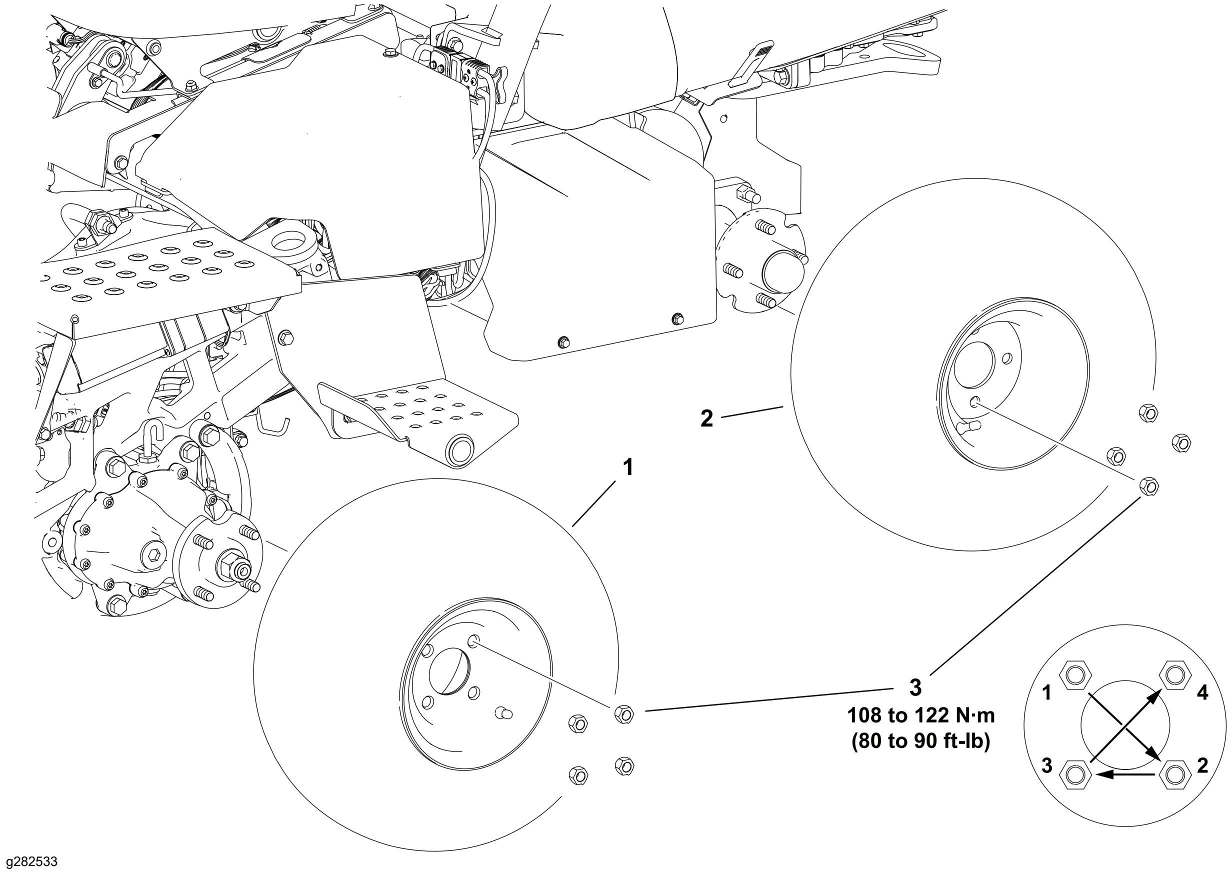


Figure 160

1. Front wheel assembly (2 each)
2. Rear wheel assembly
3. Lug nut (4 each wheel)

Removing and Installing the Wheels

1. Raise the machine off the ground; refer to Jacking Instructions (page 1–6).
2. Remove and install the wheel and tire assemblies as necessary.
3. Tighten the wheel lug nuts in a crossing pattern from **95 to 122 N·m (70 to 90 ft-lb)**.

Front Wheel Hubs

Removing and Installing the Front Wheel Hubs

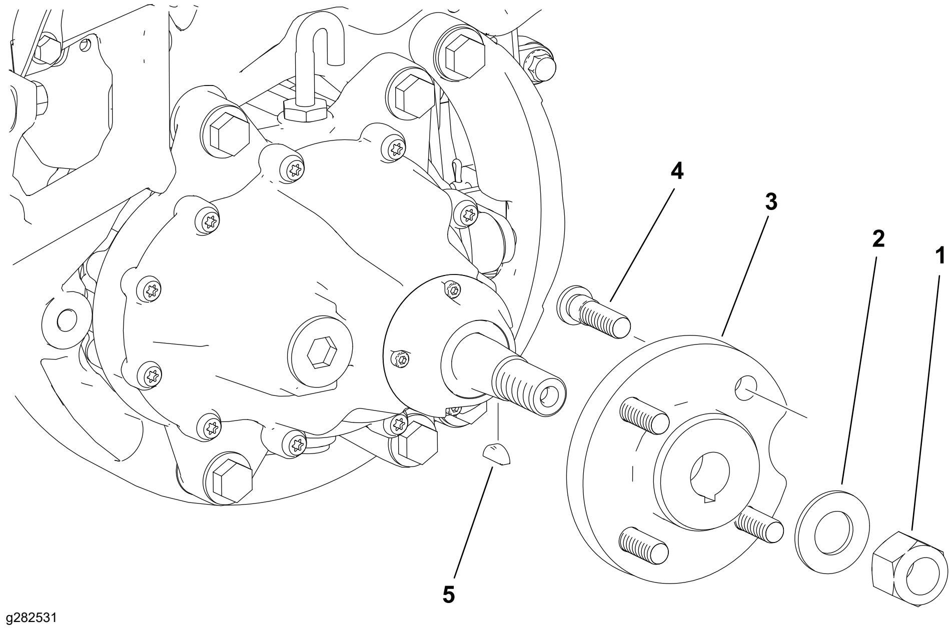


Figure 161

1. Lock nut
2. Hardened washer
3. Hub
4. Drive stud (4 each hub)
5. Woodruff key

1. Loosen but do not remove the front hub nut.
2. Raise the machine and remove the front wheel; refer to Jacking Instructions (page 1–6).

IMPORTANT

DO NOT hit the front wheel hub or gear box assembly with a hammer during front hub removal. Hammering the assembly may damage to the gear box.

3. Make sure that the front hub lock nut is loosened at least two revolutions. Use a 3-jaw puller to loosen the front hub assembly from the gear box shaft.
4. Remove the wheel hub lock nut, hardened washer, and the wheel hub. Locate and retrieve the woodruff key.
5. Use a press to replace the drive studs as necessary. Ensure that the drive stud flange is pressed fully to the hub surface.
6. Clean the hub and motor shaft tapers.
7. Install the woodruff key, front hub, hardened washer, and lock nut.
8. Lower the machine to the ground and tighten the front hub nut from **237 to 305 N·m (175 to 225 ft-lb)**.

Front Traction Gear Box

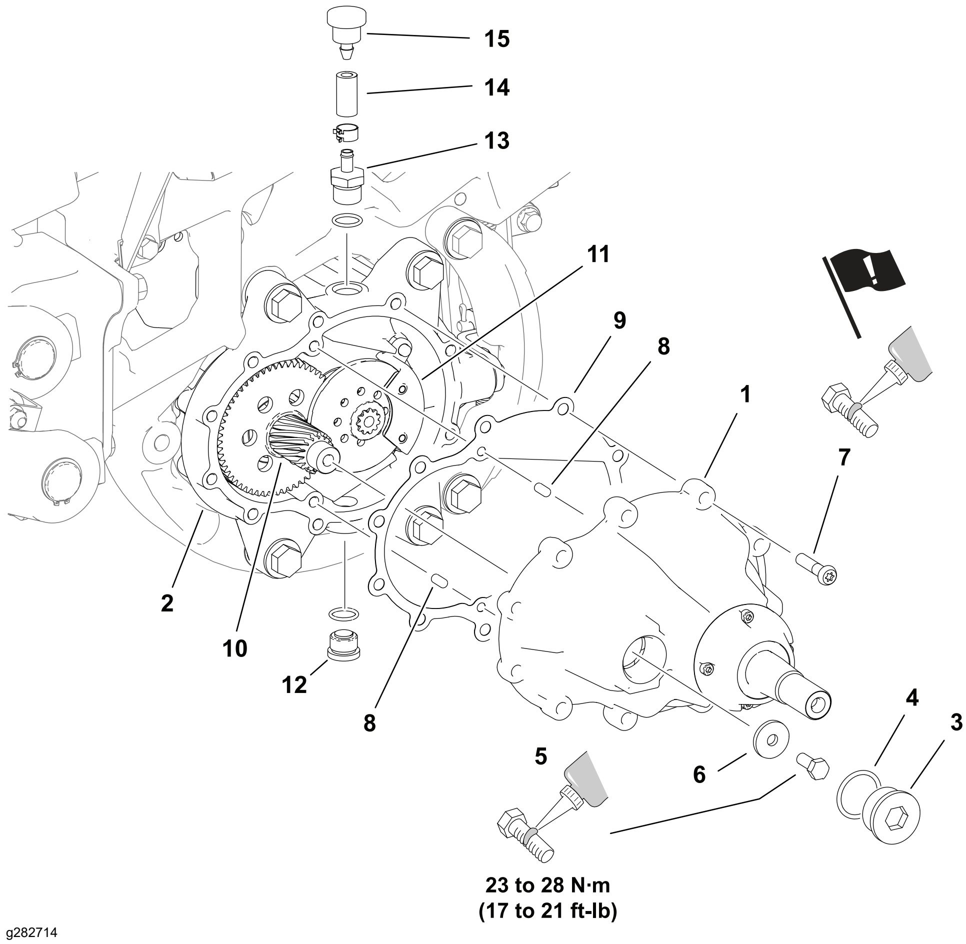


Figure 162

1. Front traction gear box assembly
2. Front traction motor assembly
3. Plug
4. O-ring
5. Cap screw
6. Washer
7. Cap screw (10 each)
8. Dowel pin (2 each)
9. Gasket
10. Countershaft assembly
11. Brake caliper
12. Drain plug
13. Barb fitting
14. Hose
15. Vent

Removing the Front Traction Gear Box

Refer to Figure 162 for this procedure.

1. Remove the front wheel; refer to Removing and Installing the Wheels (page 6–9).
2. Remove the front wheel hub; refer to Removing and Installing the Front Wheel Hubs (page 6–10).
3. Remove the drain plug (item 12) and allow the gear box to drain. Remove and discard the drain plug O-ring.
4. Remove the plug (item 3). Remove and discard the O-ring.
5. Remove the cap screw (item 5) and the washer.
6. Remove the 10 cap screws securing the gear box to the motor assembly. Remove the gear box and discard the gasket.

Removing the Front Traction Gear Box (continued)

7. Locate and retrieve the 2 dowel pins.
8. Use a new O-ring and install the drain plug.

Installing the Front Traction Gear Box

Refer to Figure 162 for this procedure.

1. Remove any residual gasket material from the gear box and wheel motor gasket surfaces.
2. Fit the dowel pins and a new gasket in position and install the gear box.
3. Apply a medium strength thread locking compound (Loctite 243 or equivalent) to the 10 cap screws (item 7) and install them loosely.

   A. Tighten the cap screws in a crossing pattern from **10 to 12 N·m (90 to 110 in-lb)**.

   B. Tighten the cap screws in a crossing pattern from **18 to 22 N·m (160 to 200 in-lb)**.

   C. Retighten the cap screws in a clockwise pattern from **18 to 22 N·m (160 to 200 in-lb)**.
4. Apply a medium strength thread locking compound (Loctite 243 or equivalent) to the cap screw (item 5). Install the washer and cap screw, then tighten the cap screw from **23 to 28 N·m (17 to 21 ft-lb)**.
5. Apply a light coating of grease to a new O-ring and install it on the plug (item 3), then install the plug.
6. Remove the vent fitting (item 13) and fill the gear box with **385 cc (13 ounces)** of 80W-90 gear oil (Mobilube HD Plus 80W-90 or equivalent). Install the vent fitting.
7. Install the front wheel hub; refer to Removing and Installing the Front Wheel Hubs (page 6–10).
8. Install the front wheel; refer to Removing and Installing the Front Wheel Hubs (page 6–10).
9. Test traction operation and check for leaks before returning the machine to service.

Front Traction Gear Box Service

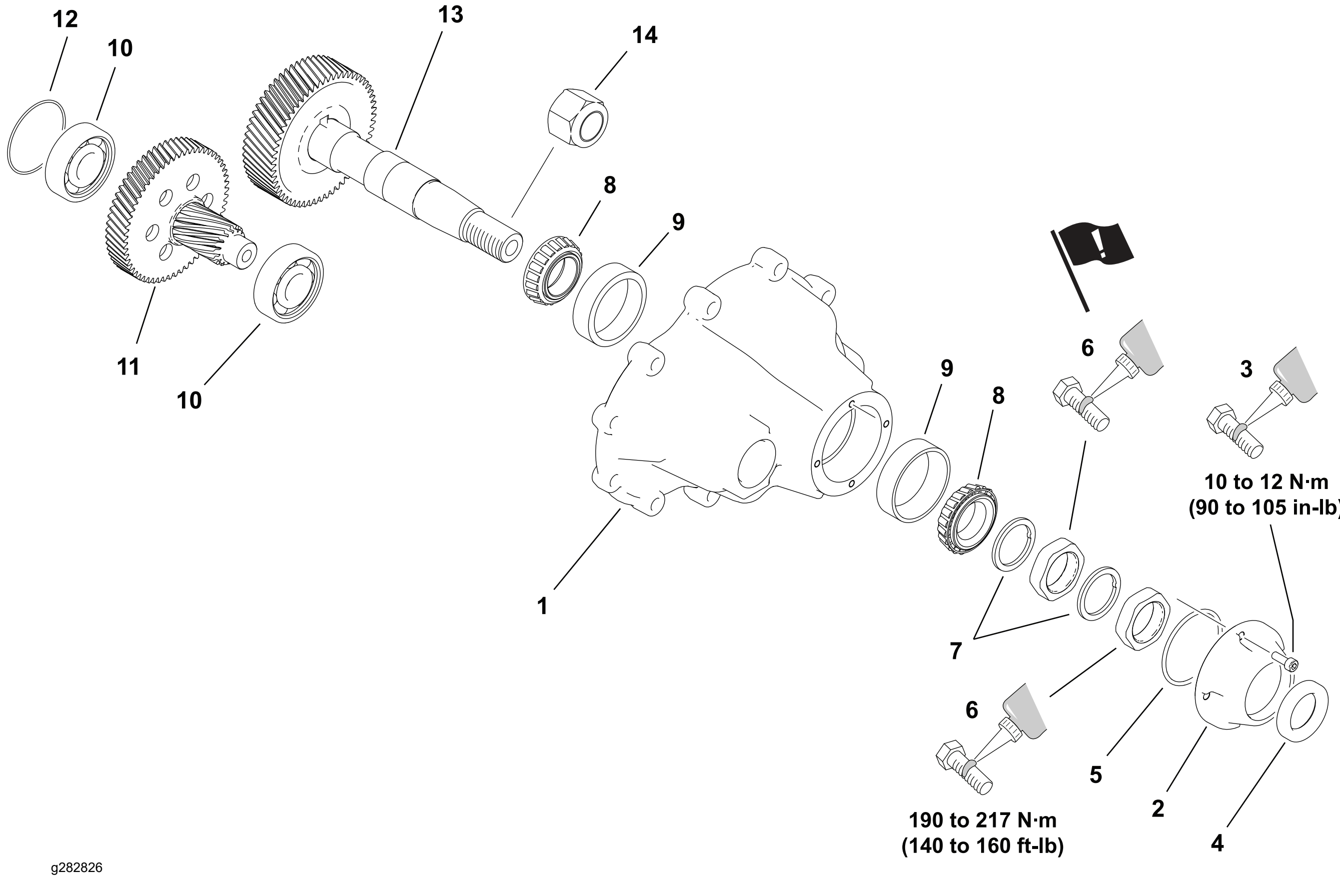


Figure 163

1. Gear box housing
2. Nose cover
3. Cap screw (4 each)
4. Lip seal
5. O-ring
6. Jam nut (2 each)
7. Tab washer (2 each)
8. Bearing cone (2 each)
9. Bearing cup (2 each)
10. Roller bearing (2 each)
11. Countershaft assembly
12. O-ring
13. Output shaft assembly
14. Wheel hub lock nut

Servicing the Front Traction Gear Box

1. Remove the front wheel gear box from the machine; refer to Removing the Front Traction Gear Box (page 6–11).
2. Remove the brake caliper; refer to Servicing the Brake Caliper (page 6–28).
3. Remove the nose cover. Discard the lip seal and O-ring.
4. Loosen and remove the jam nuts and tab washers from the output shaft assembly.
5. Remove the output shaft from the gear box housing and retrieve the outer bearing cone.
6. Press the bearing cups, and roller bearing from the gear box housing. Press the inner bearing cone from the output shaft assembly. Press the roller bearing from the countershaft assembly.
7. Clean and inspect all parts for wear or damage.
8. Press new bearing cups (item 9) into the housing. Ensure each bearing cup is fully seated in the housing bore.
9. Press a new countershaft roller bearing (item 10) into the housing. Ensure the bearing is fully seated in the housing bore.

10. Press a new inner bearing cone onto the output shaft. Ensure the bearing cone is flush against the output gear.
11. Press a new roller bearing onto the countershaft assembly behind the countershaft gear. Ensure the bearing is flush against the countershaft gear.
12. Install the output shaft assembly.
    A. Position the output shaft assembly in the gear box housing and install the outer bearing cone.
    B. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the shaft threads and install one tab washer and the inner jam nut.

    Note: Temporarily install the front wheel hub lock nut on the end of the output shaft, and use an accurate torque wrench to install the output shaft.

    C. Tighten the inner jam nut until **0.5 to 1.0 N·m (5 to 9 in-lb)** is required to rotate the output shaft.
    D. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the shaft threads and install the second tab washer and the outer jam nut.
    E. Hold the inner jam nut and tighten the outer jam nut from **190 to 217 N·m (140 to 160 ft-lb)**.
    F. Ensure the torque required to rotate the output shaft is still **0.5 to 1.0 N·m (5 to 9 in-lb)**. Loosen and reset the jam nuts if necessary.
13. Install a new lip seal in the nose cover and apply a light coating of grease to the seal lip.
14. Apply a light coating of grease to a new O-ring and install it on the nose cover.
15. Install the nose cover.
16. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the cap screws (item 3). Install the nose cover and cap screws, then tighten the cap screws from **10 to 12 N·m (90 to 105 in-lb)**.
17. Install a new O-ring (item 12) in the countershaft bearing bore of the motor assembly and install the countershaft assembly.
18. Install the brake caliper; refer to Servicing the Brake Caliper (page 6–28).
19. Install the front wheel gear box to the machine; refer to Installing the Front Traction Gear Box (page 6–12).

Rear Wheel Hub (Standard)

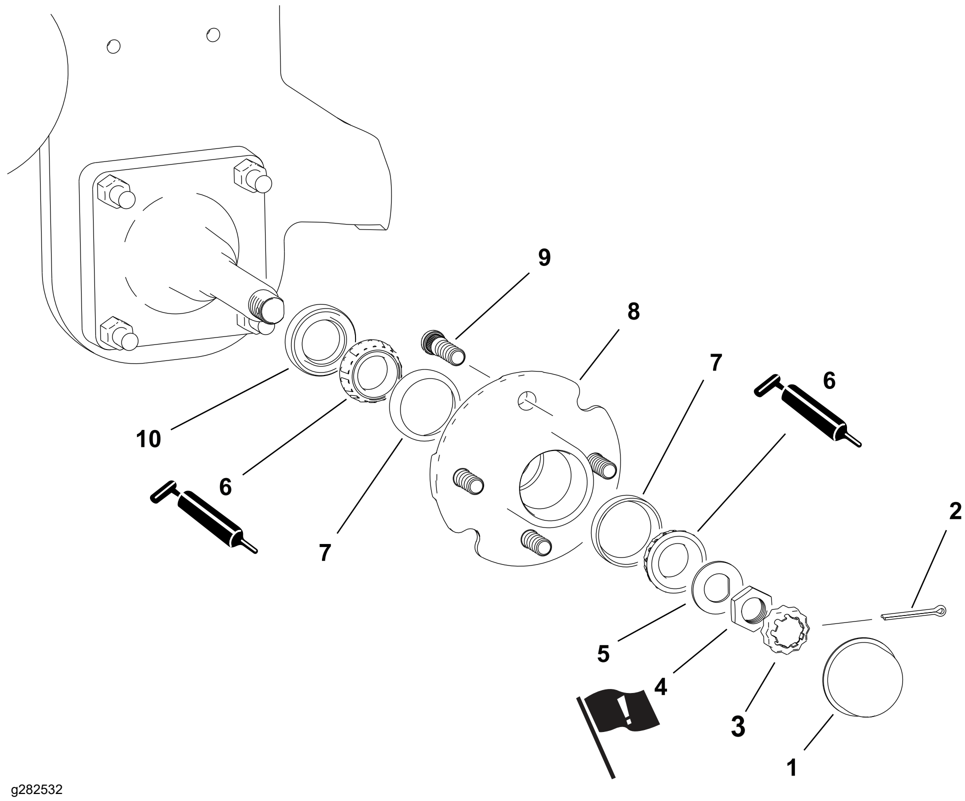


Figure 164

1. Dust cap
2. Cotter pin
3. Nut retainer
4. Nut
5. Spindle washer
6. Bearing cone (2 each hub)
7. Bearing cup (2 each hub)
8. Hub assembly
9. Drive stud (4 each hub)
10. Lip seal

Disassembling the Rear Wheel Hub and Bearings (Standard)

Refer to Figure 164 for the following procedure.

1. Raise the machine and remove the rear wheel; refer to Jacking Instructions (page 1–6).
2. Carefully remove the dust cap from the wheel hub.
3. Remove and discard the cotter pin from the axle spindle.
4. Remove the nut retainer, nut, and spindle washer that secure the wheel hub to the spindle. Slide the wheel hub with the bearings from the spindle.
5. Disassemble the wheel hub as follows:

   Note: Ensure that you do not damage the hub bore.

   A. Remove and discard the oil seal from the wheel hub.

   B. Remove the bearing cones from both sides of the wheel hub. Clean the inner surface of the wheel hub.

   C. Clean and inspect the wheel bearing cups and cones. Check the bearing cones and cups for wear, pitting, or other damage. Replace the parts that are worn or damaged.

   D. Use a press to replace the drive studs as necessary. Ensure that the drive stud flange is pressed fully to the hub surface.

Disassembling the Rear Wheel Hub and Bearings (Standard) (continued)

6. Clean and inspect the axle spindle for wear or damage. Replace the spindle if necessary.

Assembling the Rear Wheel Hub and Bearings (Standard)

Refer to Figure 164 for the following procedure.

1. Assemble the wheel hub as follows:

   A. If the bearing cups were removed from the wheel hub, press the inner and outer cups into the wheel hub until they seat against the wheel hub shoulder.

   Note: Use high temperature grease (Mobil XHP-222 or equivalent).

   B. Fill the wheel hub approximately 50% full of grease.

   C. Pack both bearing cones with grease. Install greased inner bearing cone into the cup on inboard side of the wheel hub.

   IMPORTANT

   The oil seal should be pressed in so that it is flush with the end of the wheel hub. The lip of the oil seal must be toward the inner bearing.

   D. Lubricate the inside of new oil seal and press it into the wheel hub.

   Note: Ensure that you do not damage the oil seal in the wheel hub.

2. Install the wheel hub onto the axle spindle.
3. Install greased outer bearing cone, spindle washer, and nut onto the spindle shaft.
4. While rotating the wheel hub by hand, torque the nut to **8.5 to 20.3 N·m (75 to 180 in-lb)** to seat bearings. Loosen the nut until it is away from the spindle washer and the wheel hub has end-play. Finally, while rotating the wheel hub, tighten the nut to **1.7 to 2.3 N·m (15 to 20 in-lb)**.
5. Install the nut retainer and a new cotter pin to secure the nut. Install the dust cap.
6. Install the wheel assembly; refer to Removing and Installing the Wheels (page 6–9).

Rear Wheel Hub (Optional 3WD)

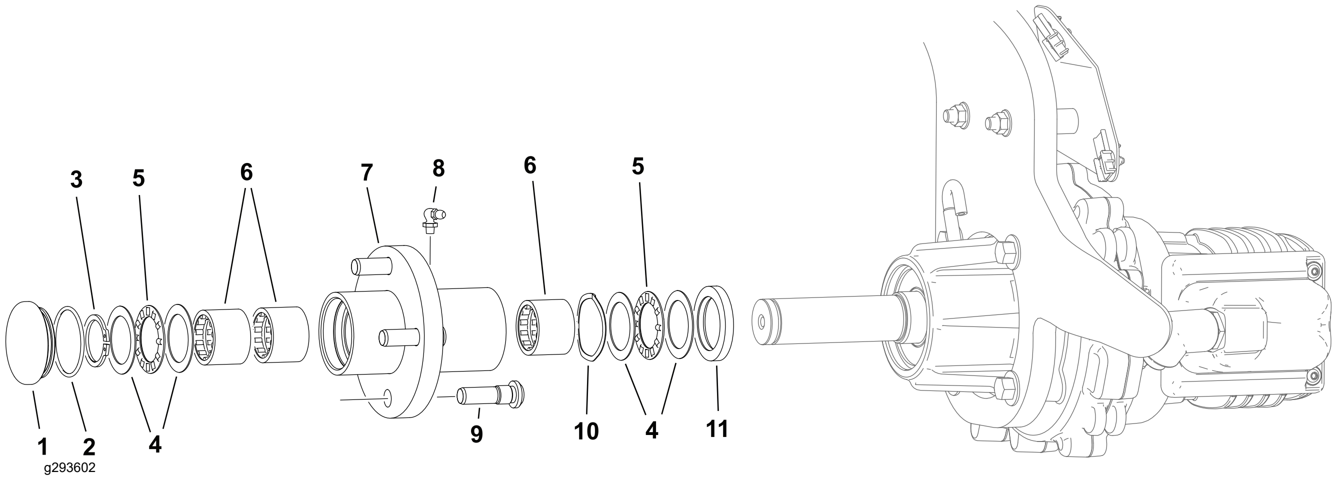


Figure 165

1. Dust plug
2. O-ring
3. Retaining ring
4. Thrust washer (4 each)
5. Thrust bearing (2 each)
6. Roller clutch (3 each)
7. Hub
8. Grease fitting
9. Drive stud (4 each)
10. Wave washer
11. Lip seal

Removing and Installing the Rear Wheel Hub

1. Remove the rear wheel; refer to Removing and Installing the Wheels (page 6–9).
2. Remove the dust plug from the hub assembly. Inspect the dust plug O-ring and replace as necessary.
3. Remove the retaining ring and twist the hub assembly off the shaft in a counterclockwise (forward) direction.
4. Install the rear wheel hub in the reverse order.
5. When properly installed, the hub should rotate freely in the counterclockwise (forward) direction, and engage with the rear wheel gear box shaft when rotated in the clockwise (reverse) direction.
6. Grease the hub fitting with high temperature grease (Mobil XHP-222 or equivalent) before returning the machine to service.

Servicing the Rear Wheel Hub

1. Remove the inner lip seal, thrust washers, thrust bearings, and wave washer from the hub assembly.
2. Clean and inspect all the hub components and replace them as necessary.
3. If bearing replacement is necessary:

IMPORTANT

The roller clutches are designed to roll in one direction and lock in the other (unidirectional). Pay attention to the roller clutch orientation when replacing the roller clutches. The roller clutches must be installed with the white roller cage of the roller clutch toward the inside (lip seal) of the hub.

Servicing the Rear Wheel Hub (continued)

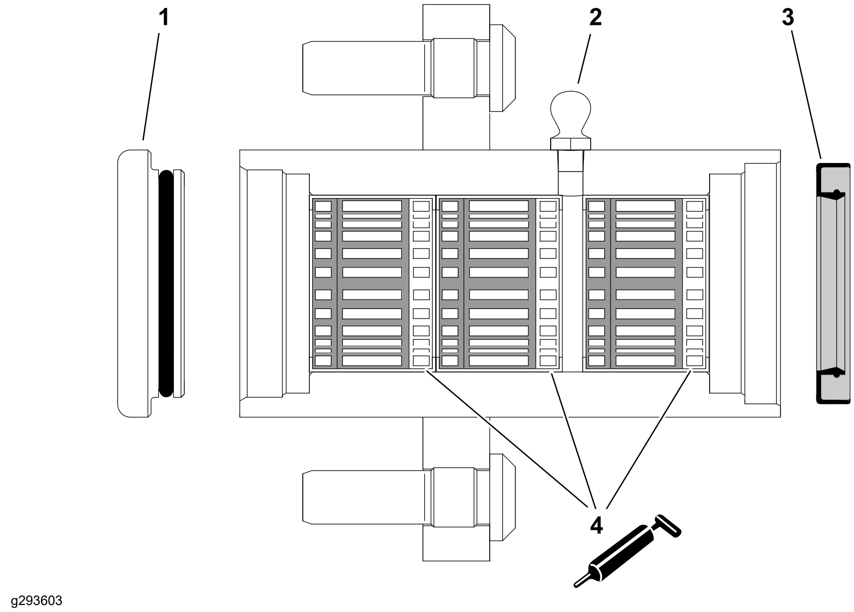


Figure 166

1. Dust cap (outside of hub)
2. Grease fitting and passage
3. Lip seal (inside of hub)
4. Roller clutch – white roller cage

A. Press the old roller clutches from the hub.

B. Press one new roller clutch from the inside of the hub. The white roller cage of the roller clutch must be toward the inside (lip seal) of the hub. The roller clutch should rest just below the inner shoulder of the hub and not block the grease passage.

C. Press two new roller clutches from the outside of the hub. The white roller cage of each roller clutch must be toward the inside (lip seal) of the hub. The roller clutches should rest just below the inner shoulder of the hub and not block the grease passage.

D. Apply a thin layer of high temperature grease (Mobil XHP-222 or equivalent) to the inside of each roller clutch.

4. Install the wave washer in the inner hub bore.
5. Apply a thin layer of high temperature grease (Mobil XHP-222 or equivalent) to the thrust bearings and install the thrust bearings and thrust washers as shown in Figure 165.
6. Install the inner lip seal in the inner hub bore. Apply a thin layer of grease to the lip of the seal.

Rear Wheel Gear Box (Optional 3WD)

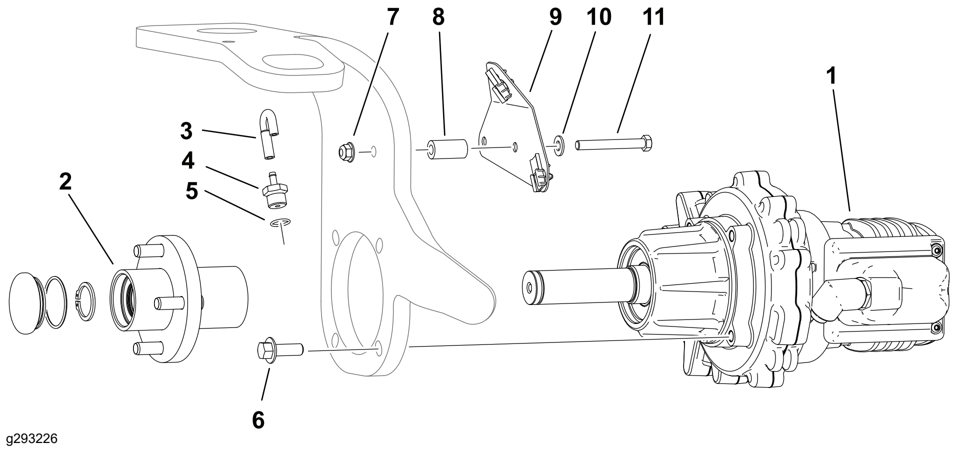


Figure 167

1. Rear wheel gear box and motor assembly
2. Rear wheel hub assembly
3. Vent hose
4. Vent fitting
5. O-ring
6. Flange head screw (4 each)
7. Flange nut (2 each)
8. Spacer (2 each)
9. Harness bracket
10. Flat washer (2 each)
11. Cap screw (2 each)

Removing and Installing the Rear Wheel Gear Box

Refer to Figure 167 for this procedure.

1. Remove the rear wheel; refer to Removing and Installing the Wheels (page 6–9).
2. Remove the lower plug and drain the oil from the gear box. Inspect the plug O-ring and replace as necessary.
3. Unplug the 48V battery; refer to 48V Battery Service Disconnect (page 5–10).
4. Locate the 3WD traction motor connections to the machine wire harness and disconnect the 2 connectors. Check the motor and the harness connector for damage or corrosion and clean or repair as necessary.
5. Remove the rear wheel hub from the 3WD traction motor; refer to Rear Wheel Hub (Optional 3WD) (page 6–17).
6. Remove the vent hose and fitting from the motor and gear box assembly. Inspect the vent fitting O-ring and replace as necessary.
7. Remove the 4 fasteners securing the gear box to the caster fork and remove the motor and gear box assembly.
8. Install the motor and gear box assembly in reverse order.
9. Fill the gear box with approximately **1 L (34 oz)** of 80W-90 gear oil (to the bottom of the level plug) before returning the machine to service.

Servicing the Rear Wheel Gear Box

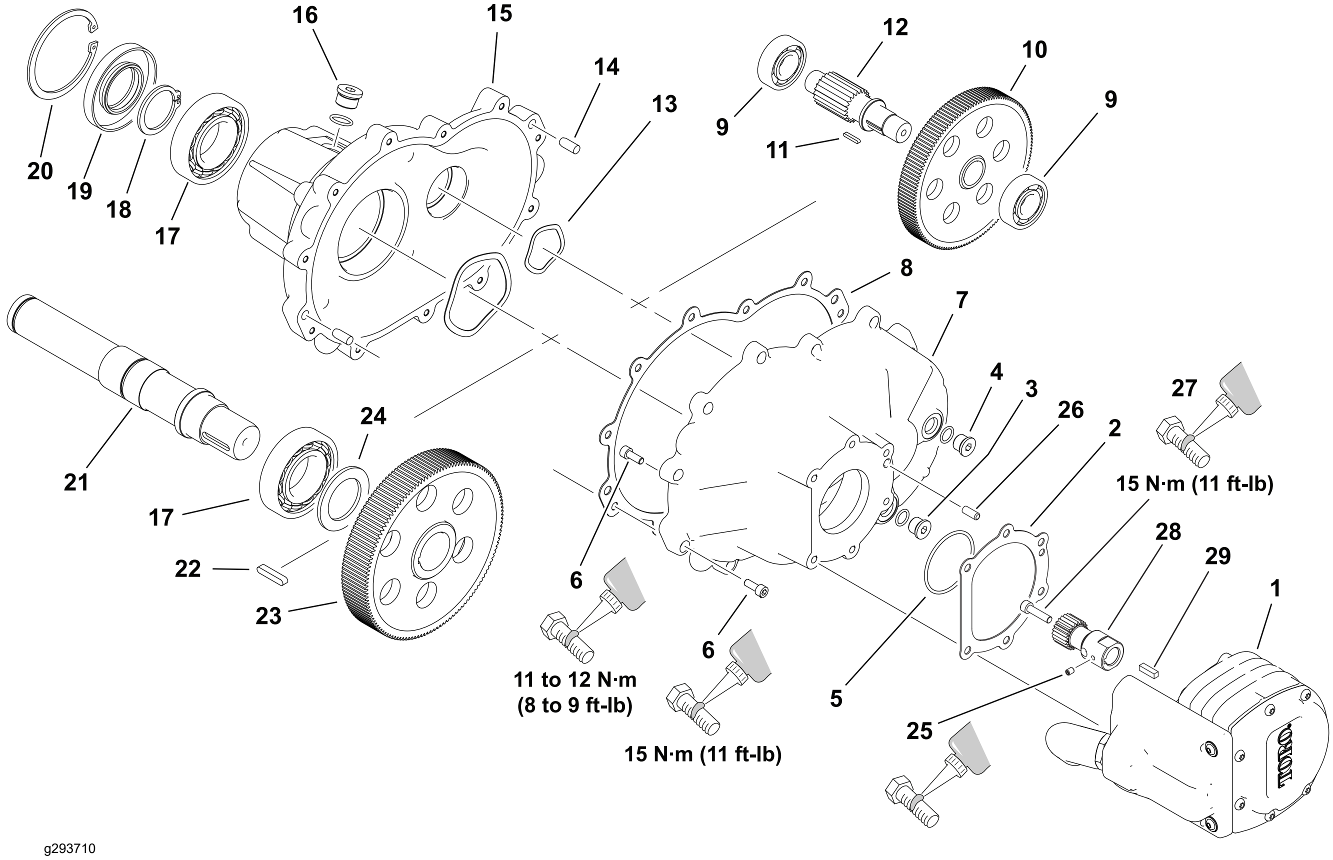


Figure 168

1. Rear traction motor
2. Gasket
3. Plug – drain
4. Plug – level
5. O-ring
6. Socket head screw (17 each)
7. Gear box cover
8. Gasket
9. Bearing (2 each)
10. Gear – 137 T
11. Key
12. Spur gear
13. Wave washer
14. Dowel pin (2 each)
15. Gear box housing
16. Plug – fill
17. Bearing (2 each)
18. Retaining ring
19. Lip seal
20. Retaining ring
21. Axle shaft
22. Key
23. Gear 133 T
24. Washer
25. Set screw
26. Dowel pin
27. Socket head screw
28. Gear 23 T
29. Square key

Note: The drive shaft seal can be replaced without removing or disassembling the gear box.

1. Remove the rear wheel gear box from the machine; refer to Removing and Installing the Rear Wheel Gear Box (page 6–19).
2. Remove the fasteners and separate the gear box cover and motor assembly from the gear box housing.
3. Remove and discard the gear box housing gasket. Locate and retrieve the 2 dowel pins.
4. Remove the spur gear assembly from the housing. Locate and retrieve the wave washer.
5. Remove the retaining ring and lip seal from the housing. Discard the lip seal.
6. Remove the retaining ring from the axle shaft and remove the axle shaft assembly from the housing. Locate and retrieve the wave washer.

Servicing the Rear Wheel Gear Box (continued)

7. Remove the rear traction motor if necessary; refer to Rear Traction Motor (Optional) (page 5–178).
8. Inspect and replace all the gearbox components as necessary. Ensure all bearings are pressed fully against their respective shoulders.
9. Assemble the gear box in reverse order. Use a new axle shaft seal and housing gasket. Tighten the gear box cover fasteners in a crossing pattern to **15 N·m (11 ft-lb)**.

Traction Pedal Assembly

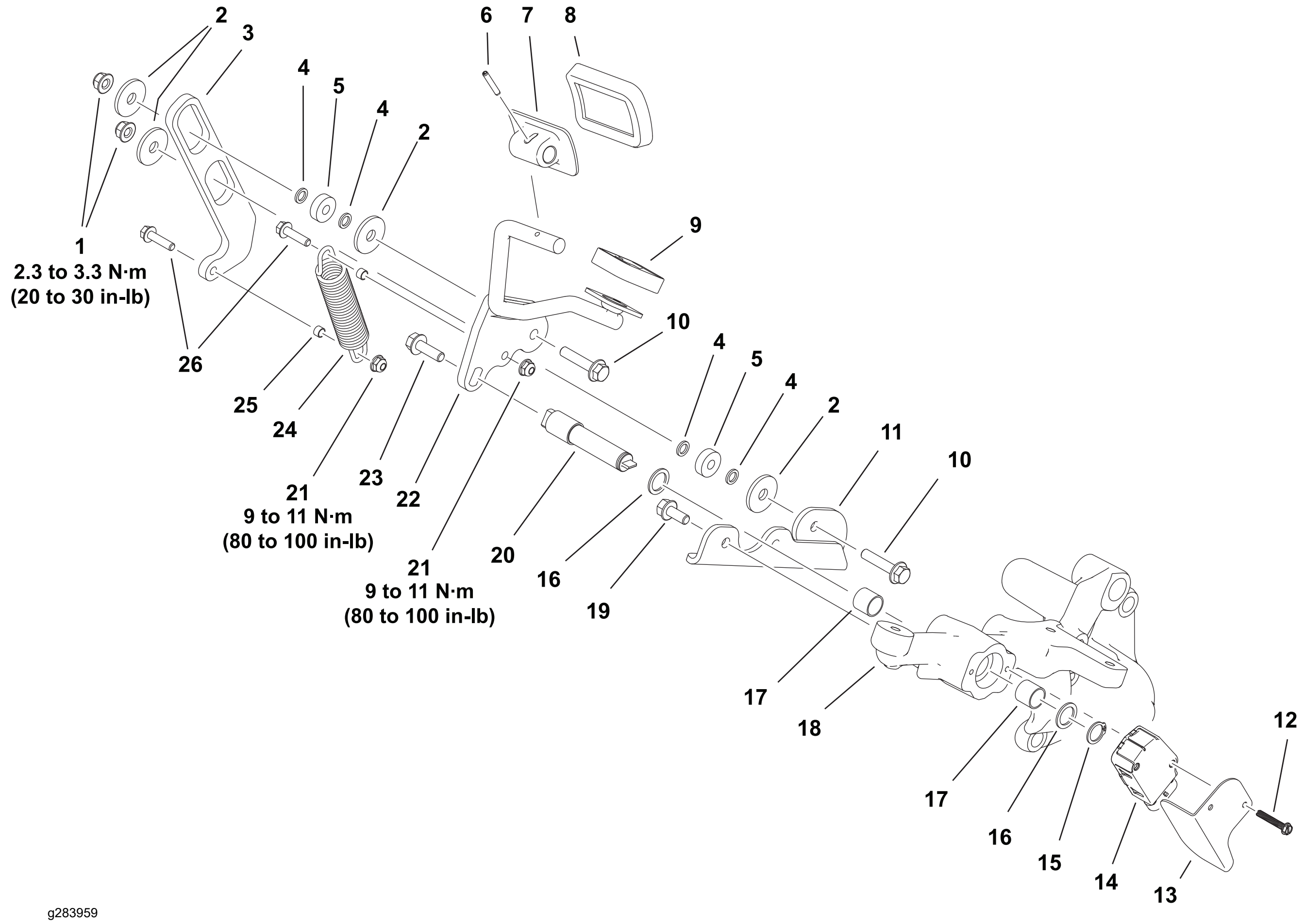


Figure 169

1. Flange nut (2 each)
2. Washer (4 each)
3. Connecting link
4. Bearing spacer (4 each)
5. Bearing (2 each)
6. Roll pin
7. Pedal – forward
8. Pad – forward
9. Pad – reverse
10. Flange head screw (2 each)
11. Motion control bracket
12. Screw (2 each)
13. Sensor shield
14. Traction position sensor
15. Retaining ring
16. Washer (2 each)
17. Bushing (2 each)
18. Platform support – RH
19. Flange head screw (2 each)
20. Pedal shaft
21. Flange nut (2 each)
22. Traction pedal
23. Flange head screw
24. Extension spring
25. Spacer (2 each)
26. Flange head screw (2 each)

Remove, repair, or replace the traction pedal components as necessary.

IMPORTANT

Ensure the traction pedal moves freely from stop to stop, and returns to the NEUTRAL position when released. Calibrate the traction pedal position sensor after assembly; refer to Calibrating the Traction Pedal Position Sensor (page 5–97).

For traction pedal position sensor testing information; refer to Traction Pedal Position Sensor (page 5–95).

Brake Assembly

The eTriFlex machines use a single mechanical brake assembly that can be used as a service brake, a manual parking brake, and an automatic parking brake. The service brake and manual parking brake are controlled by a cable connected to pedals at the operator's left foot, while the automatic parking brake is controlled by a 12 VDC electric brake actuator. The brake system engages 2 brake calipers (located between each front traction motor and front traction gear box).

Automatic Parking Brake: When the key switch is in the OFF position, or when the key switch is in the ON or START position and the operator is not in the operator seat, a large extension spring keeps the brakes engaged. When the key switch is in the ON or START position and the operator is in the operator seat, the electric brake actuator pulls against the spring (retracts) and disengages the brakes.

For brake actuator testing information; refer to Brake Actuator (page 5–84).

Replacing the Brake Cable

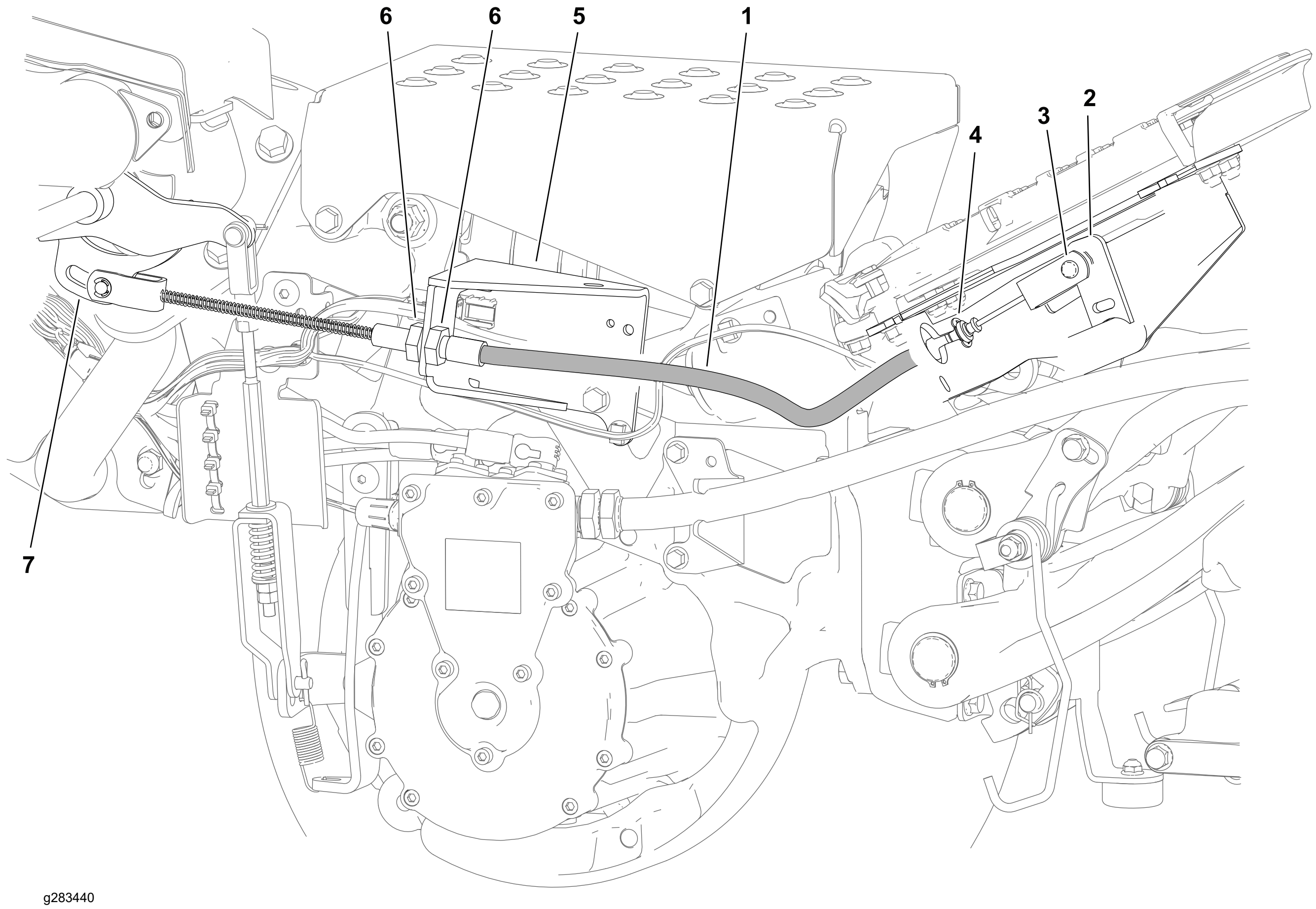


Figure 170

1. Brake cable
2. Brake pedal
3. Retaining ring
4. Retaining ring
5. Adjuster bracket
6. Adjuster jam nut (2 each)
7. Upper brake arm – LH

---

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Ensure the manual parking brake is released.
3. Disconnect the brake cable from the brake pedal and pedal support (remove 2 retaining rings).

Replacing the Brake Cable (continued)

4. Loosen the 2 adjuster jam nuts at the brake adjuster and remove the cable from the adjuster bracket.
5. Disconnect the brake cable from the left side brake arm.
6. Install the new cable in the reverse order.
7. Adjust the brake cable; refer to Adjusting the Brake Cable (page 6–6).

Removing and Installing the Brake Linkage

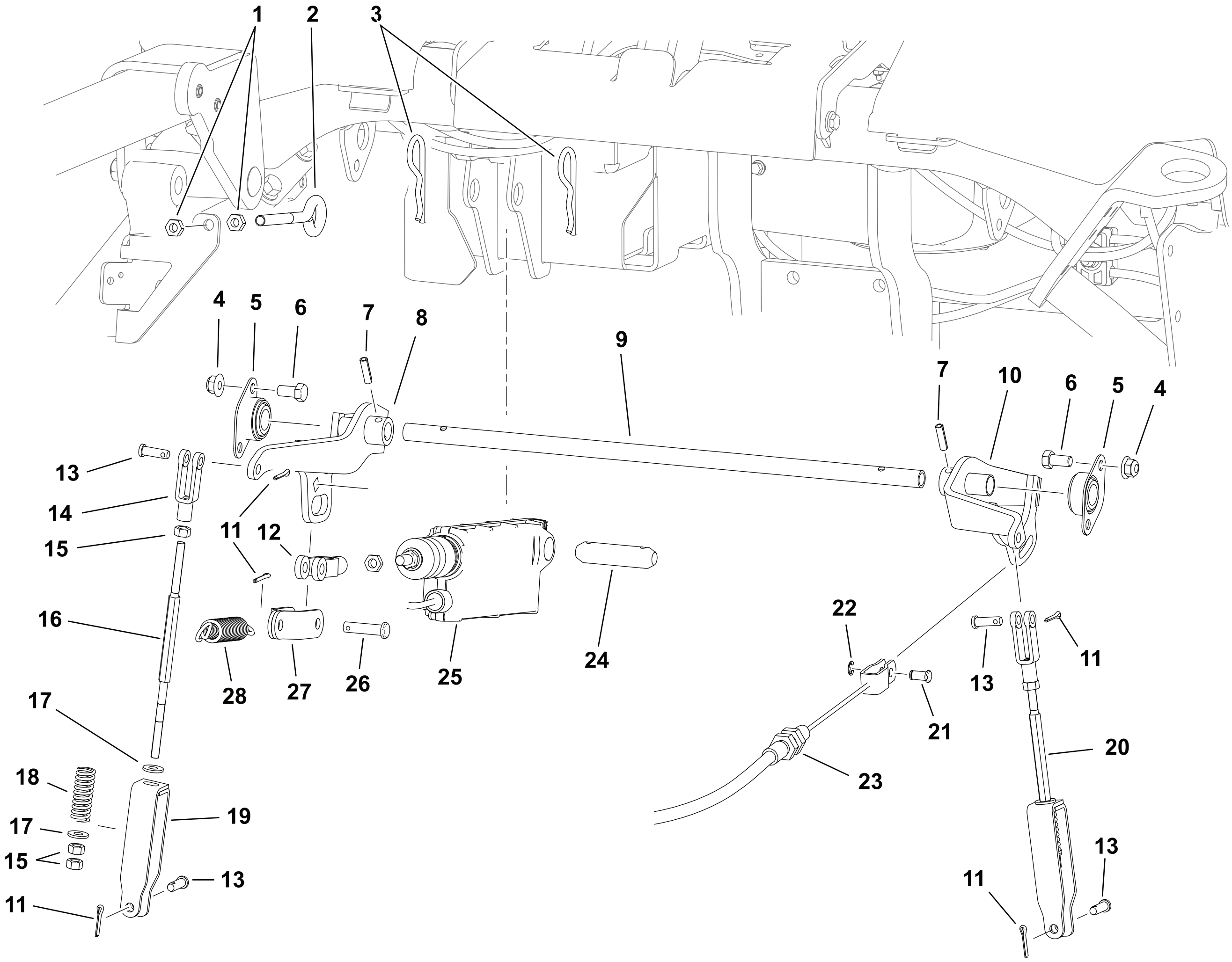


Figure 171

1. Hex nut (2 each)
2. Eye bolt
3. Hair pin (2 each)
4. Flange nut (4 each)
5. Bearing (2 each)
6. Cap screw (4 each)
7. Roll pin (2 each)
8. Upper brake arm – RH
9. Brake shaft
10. Upper brake arm – LH
11. Cotter pin (5 each)
12. Clevis – actuator
13. Clevis pin (2 each rod)
14. Upper clevis – brake rod
15. Hex nut (3 each rod)
16. Brake rod
17. Washer (2 each rod)
18. Spring
19. Lower clevis – brake rod
20. Brake rod assembly (2 each)
21. Clevis pin
22. Retaining ring
23. Brake cable
24. Pin – actuator
25. Electric brake actuator
26. Clevis pin
27. Link
28. Extension spring

Removing and Installing the Brake Linkage (continued)

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Loosen the hex nuts and adjust the eye bolt as far as possible to relax the extension spring. Remove the spring.
3. Use the 3/8 inch square drive hole in the right side upper brake arm (item 8) to fully retract the brake actuator.
4. Disconnect the actuator clevis (item 12) from the link and brake shaft assembly. Discard the cotter pin.
5. Remove the brake rod assemblies (item 20) from the machine. Discard the cotter pins.
6. Disconnect the brake cable from the left side brake arm.
7. Remove the fasteners securing the brake shaft bearings (item 5) to the machine, and remove the bearings and shaft as an assembly.
8. Repair or replace the brake linkage components as necessary.
9. Secure the brake shaft and bearing assembly to the machine.
10. Connect the brake cable to the left side brake arm.
11. Use a new cotter pin and connect the actuator clevis to the link and brake shaft assembly.
12. Use new cotter pins and install the brake rod assemblies to the brake arms only.
13. Adjust the brake linkage; refer to Adjusting the Brake Linkage (page 6–4).

Removing and Installing the Brake Pedals

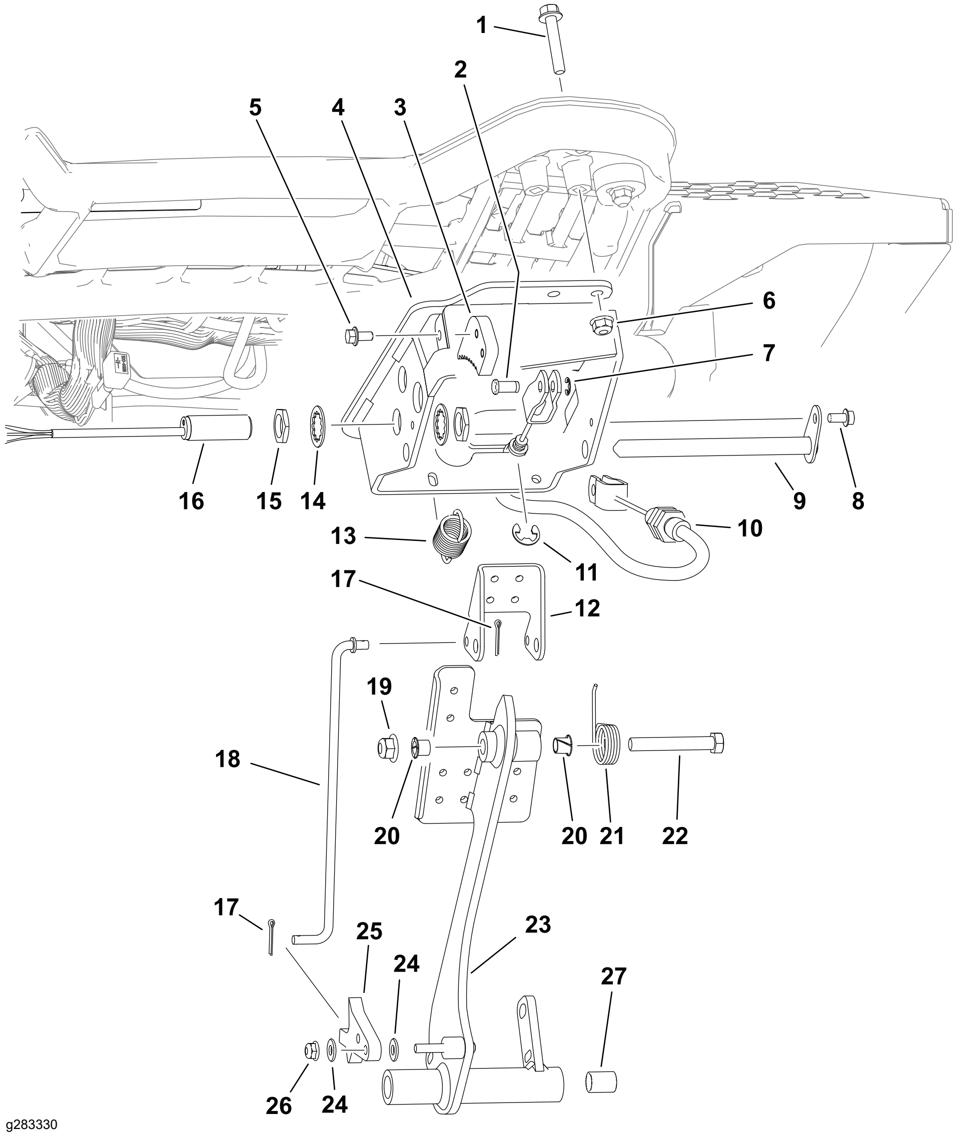


Figure 172

1. Cap screw (3 each)
2. Clevis pin
3. Brake pawl
4. Pedal support
5. Cap screw (2 each)
6. Flange nut (3 each)
7. Retaining ring
8. Cap screw
9. Pivot
10. Brake cable
11. Retaining ring
12. Park pedal
13. Extension spring
14. Lock washer (2 each)
15. Adjuster jam nut (2 each)
16. Manual parking brake switch
17. Cotter pin (2 each)
18. Rod – pawl
19. Flange nut
20. Nylon bushing (2 each)
21. Torsion spring
22. Cap screw
23. Brake pedal
24. Washer (2 each)
25. Detent
26. Flange nut
27. Bushing (2 each)

---

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.

Removing and Installing the Brake Pedals (continued)

2. Disconnect the brake cable from the brake pedal and pedal support (remove 2 retaining rings).

   Note: Record the location of any cable ties securing the wire harness to the machine, and replace them during assembly.

3. Disconnect the manual parking brake switch from the machine wire harness. Check the switch and the harness connector for damage or corrosion and clean or repair as necessary.
4. Remove the 3 fasteners securing the brake pedal support to the left platform, and remove the assembly from the machine.
5. Repair or replace the brake pedal components as necessary.
6. Ensure the park pedal (item 12) moves freely with the torsion spring.
7. Check and adjust the manual parking brake switch if necessary; refer to Adjusting the Manual Parking Brake Switch (page 5–26).
8. Secure the brake pedal assembly to the platform.
9. Connect the brake switch to the machine wire harness and secure the wiring to the machine.
10. Install the brake cable with the 2 retaining rings previously removed. Adjust the brake cable; refer to Adjusting the Brake Cable (page 6–6).

Servicing the Brake Caliper

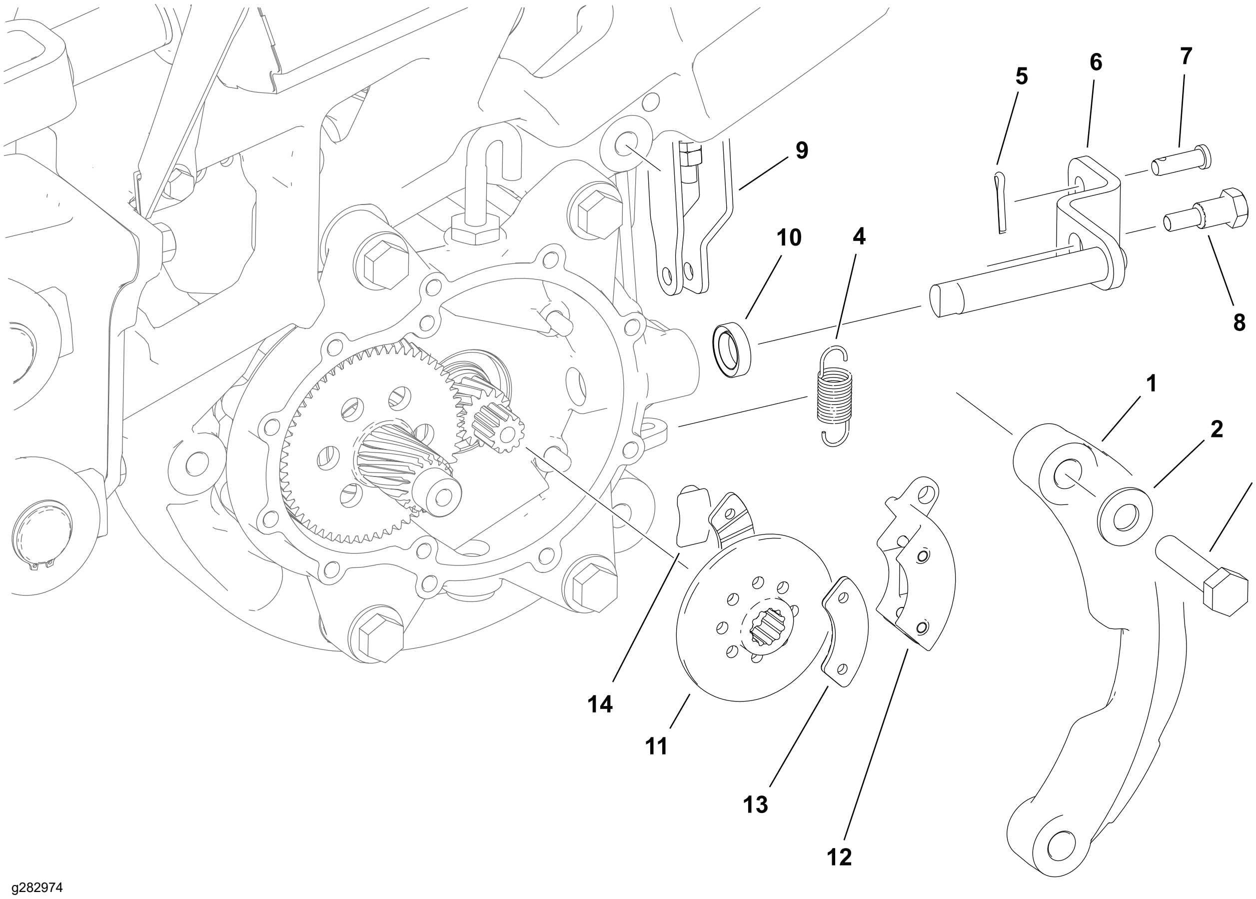


Figure 173

1.	Support link	6.	Brake lever and shaft	11.	Brake rotor
2.	Washer (2 each)	7.	Clevis pin	12.	Brake caliper
3.	Cap screw (2 each)	8.	Shoulder bolt	13.	Brake pad (2 each)
4.	Return spring	9.	Clevis	14.	Brake block
5.	Cotter pin	10.	Lip seal		

1. Remove the front traction gear box; refer to Removing the Front Traction Gear Box (page 6–11).
2. Loosen the hex nuts and adjust the eye bolt as far as possible to relax the extension spring. Remove the spring.
3. Use the 3/8 inch square drive hole in the right side upper brake arm (item 8) to fully retract the brake actuator.
4. Remove the support link (item 1).
5. Remove the brake return spring.
6. Remove the cotter pin and the clevis pin from the clevis to disconnect the brake linkage from the brake lever. Discard the cotter pin.
7. Remove the shoulder bolt (item 8) securing the brake lever to the wheel motor housing.
8. Remove the brake lever and shaft from the wheel motor housing.
9. Slide the brake rotor and brake caliper assembly from the motor housing.
10. Clean and inspect the parts for wear or damage.
    - **The minimum brake pad thickness is 2.8 mm (0.110 inch)**.

Servicing the Brake Caliper (continued)

- **The minimum brake rotor thickness is 4.6 mm (0.180 inch)**.

11. Inspect the lever shaft seal (item 10) and replace it if necessary. Apply a coating of grease to the seal lip.
12. Assemble and install the brake caliper and rotor into the motor housing as an assembly.
13. Install the brake lever and shaft, then secure the assembly in position with the shoulder bolt.
14. Fit the brake linkage clevis over the brake lever. Use a new cotter pin and install the clevis pin and cotter pin to secure the brake linkage.
15. Install the brake return spring.
16. Install the link support.
17. Install the front traction gear box; refer to Installing the Front Traction Gear Box (page 6–12).
18. Adjust the brake linkage; refer to Adjusting the Brake Linkage (page 6–4).

Rear Wheel Caster Fork

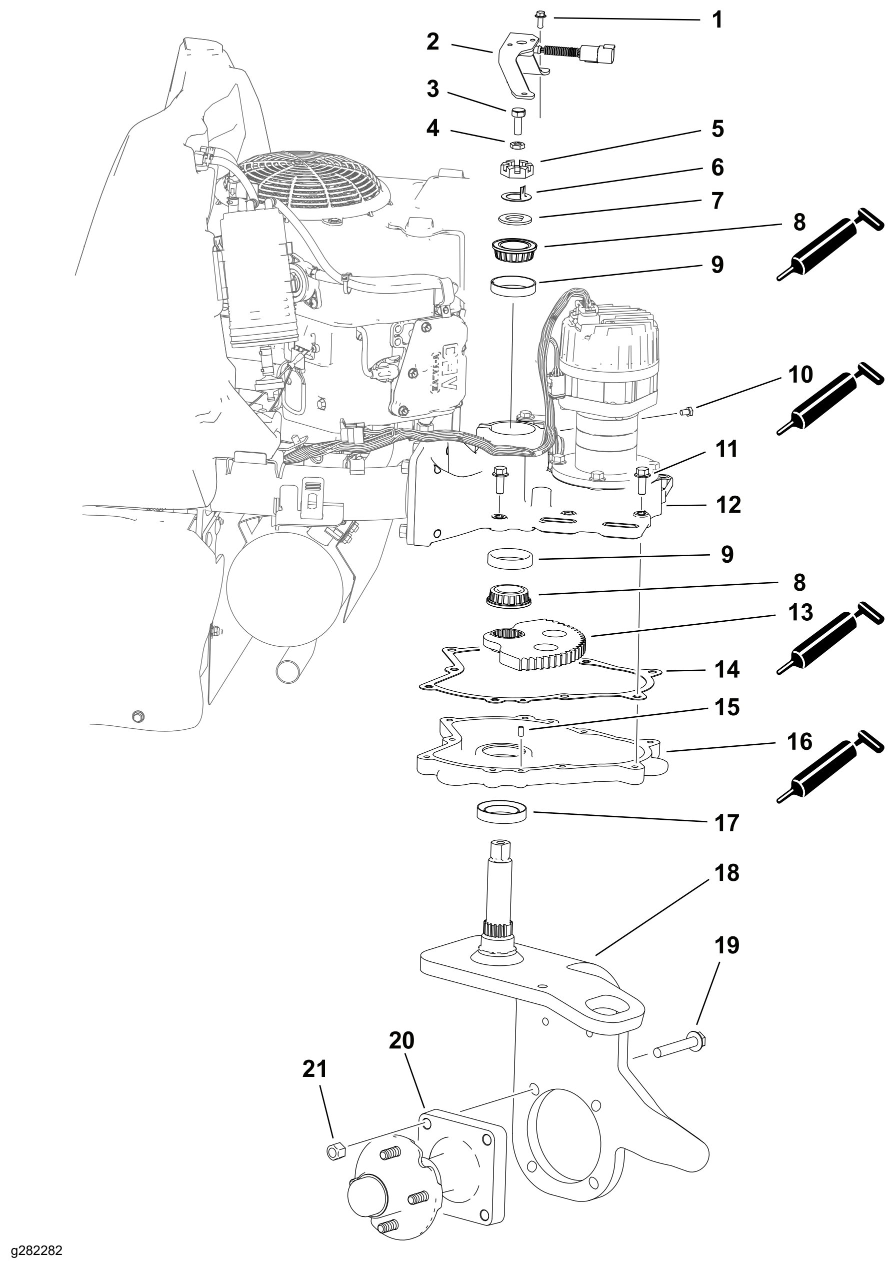


Figure 174

1. Cap screw (2 each)
2. Steering position sensor and bracket
3. Magnetic carrier bolt
4. Jam nut
5. Castle nut
6. Tang washer
7. Washer
8. Bearing cone (2 each)
9. Bearing cup (2 each)
10. Plug
11. Flange head screw (9 each)
12. Upper steering housing
13. Sector gear
14. Gasket
15. Dowel pin (2 each)
16. Lower steering housing
17. Lip seal
18. Caster fork
19. Flange head screw
20. Rear wheel spindle
21. Hex hut (4 each)

For steering position sensor testing information; refer to Steering Position Sensor (page 5–98).

Removing the Rear Wheel Caster Fork

Refer to Figure 174 for this procedure.

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Remove the rear wheel; refer to Removing and Installing the Wheels (page 6–9).
3. Remove the 4 fasteners securing the rear wheel spindle or the rear wheel gear box to the castor fork; refer to Removing and Installing the Rear Wheel Gear Box (page 6–19) for 3WD machines.
4. Remove the hood; refer to Removing and Installing the Hood Assembly (page 6–42).
5. Remove the steering position sensor bracket with the sensor attached.
6. Remove the magnetic carrier bolt and jam nut from the caster shaft.
7. Remove the 9 flange head screws (item 11) that secure the lower steering housing.
8. Fold the locking tang (item 6) free of the castle nut.
9. Support the caster fork and remove the castle nut, tang washer, and washer. Discard the tang washer.
10. Lower the caster fork from the machine with the lower steering housing and sector gear attached.
11. Remove the lower bearing cone, sector gear, and lower steering housing from the caster fork. Locate and retrieve the upper bearing cone.
12. Locate and discard the steering housing gasket. Remove any gasket material from the upper or lower steering housing. Remove and discard the seal in the lower steering housing.
13. Inspect the upper and lower bearing cups in the frame for wear or damage and replace them if necessary.

Installing the Rear Wheel Caster Fork

Refer to Figure 174 for this procedure.

1. If the bearing cups were removed from the frame, press new cups into the frame making sure that they are fully seated against the shoulder of the frame housing.
2. Press a new seal in the lower steering housing. Apply a small amount of grease on the inner lip of the new seal.
3. Being careful not to damage the new seal, fit the lower steering housing over the caster shaft.

   Note: Use a high temperature grease (Mobil XHP-222 or equivalent) for the caster fork bearings and the steering housing.

4. Fit the sector gear over the caster shaft and coat the sector gear and steering motor pinion gear teeth with grease.
5. Carefully fill the lower housing with **88 to 118 cc (3 to 4 ounces)** of grease. Clean any grease from the housing gasket surface with solvent if necessary.
6. Pack the bearing cones with grease and fit the lower bearing cone over the caster shaft.
7. Verify the location of the 2 dowel pins and place a new housing gasket in position.
8. Support the caster assembly and raise it into position against the upper steering housing. Secure the lower steering housing with the 9 flange head screws previously removed.

9. Install the upper bearing cone, washer, a new tang washer, and the castle nut on the caster shaft.

10. Remove the caster support and while rotating the caster fork by hand, torque the castle nut to **8.5 to 20.3 N·m (75 to 180 in-lb)** to seat the bearings. Support the caster fork and loosen the nut until it is away from the washer and the caster shaft has end-play. Finally, remove the caster support and while rotating the caster fork, tighten the castle nut to **1.7 to 2.3 N·m (15 to 20 in-lb)**.

11. Secure the castle nut by bending the washer tang into the castle nut.

12. Remove plug (item 10) from upper steering housing and install a grease fitting (Toro part 302−5 or equivalent). Lubricate the steering housing until grease is seen at the upper bearing. Wipe up any excess grease.

13. Install the magnetic carrier bolt and jam nut all the way into the caster shaft finger tight.

14. Install the steering position sensor bracket with the sensor attached.

15. Install the 4 fasteners securing the rear wheel spindle or the rear wheel gear box to the castor fork; refer to Removing and Installing the Rear Wheel Gear Box (page 6–19) for 3WD machines.

16. Align the caster fork and adjust the steering position sensor; refer to Aligning the Rear Wheel Caster Fork (page 6–8).

17. Install the rear wheel; refer to Removing and Installing the Wheels (page 6–9).

18. Install the hood; refer to Removing and Installing the Hood Assembly (page 6–42).

Steering Housing

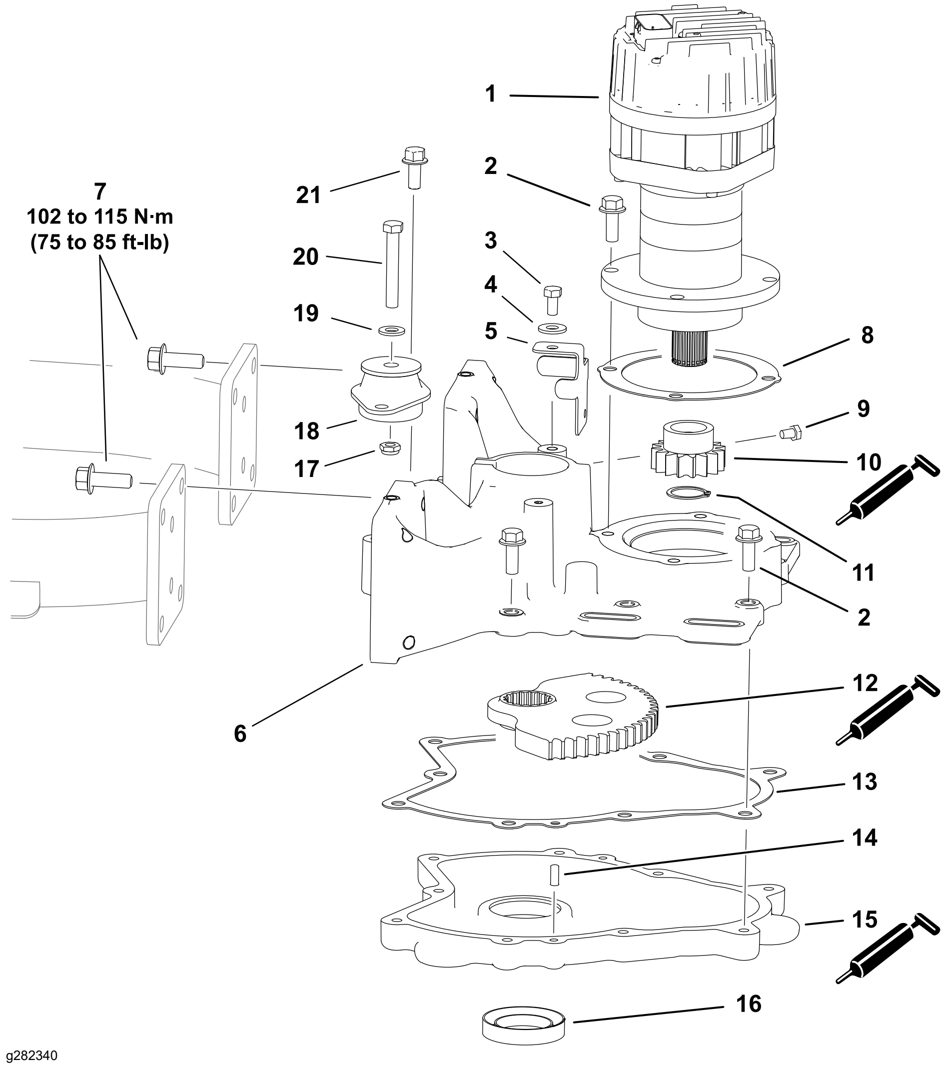


Figure 175

1. Steering motor
2. Flange head screw (13 each)
3. Cap screw
4. Washer
5. Bracket – harness
6. Upper steering housing
7. Flange head screw (8 each)
8. Gasket
9. Plug
10. Pinion gear
11. Retaining ring
12. Sector gear
13. Gasket
14. Dowel pin (2 each)
15. Lower steering housing
16. Lip seal
17. Lock nut
18. Engine mount
19. Washer
20. Cap screw
21. Flange head screw (2 each)

Removing and Installing the Steering Gear Box

Refer to Figure 175 for this procedure.

1. Remove the caster fork; refer to Rear Wheel Caster Fork (page 6–30).
2. Record the orientation of the steering motor prior to removal. Remove the fasteners securing the steering motor to the upper steering housing and remove the steering motor. Locate and discard the steering motor gasket.

Removing and Installing the Steering Gear Box (continued)

3. Remove the lock nut, cap screw (item 20) and washer from the center of the rear engine frame mount.
4. Support the rear of the engine frame and remove the upper steering housing from the machine frame.
5. Remove additional items from the upper steering housing as needed.
6. Install the upper steering housing in reverse order. Tighten the fasteners securing the upper steering housing to the machine frame from **102 to 115 N·m (75 to 85 ft-lb)**.
7. Use a new steering motor gasket, orient the steering motor as previously recorded (as shown), and install the steering motor.

Steering Arm Assembly

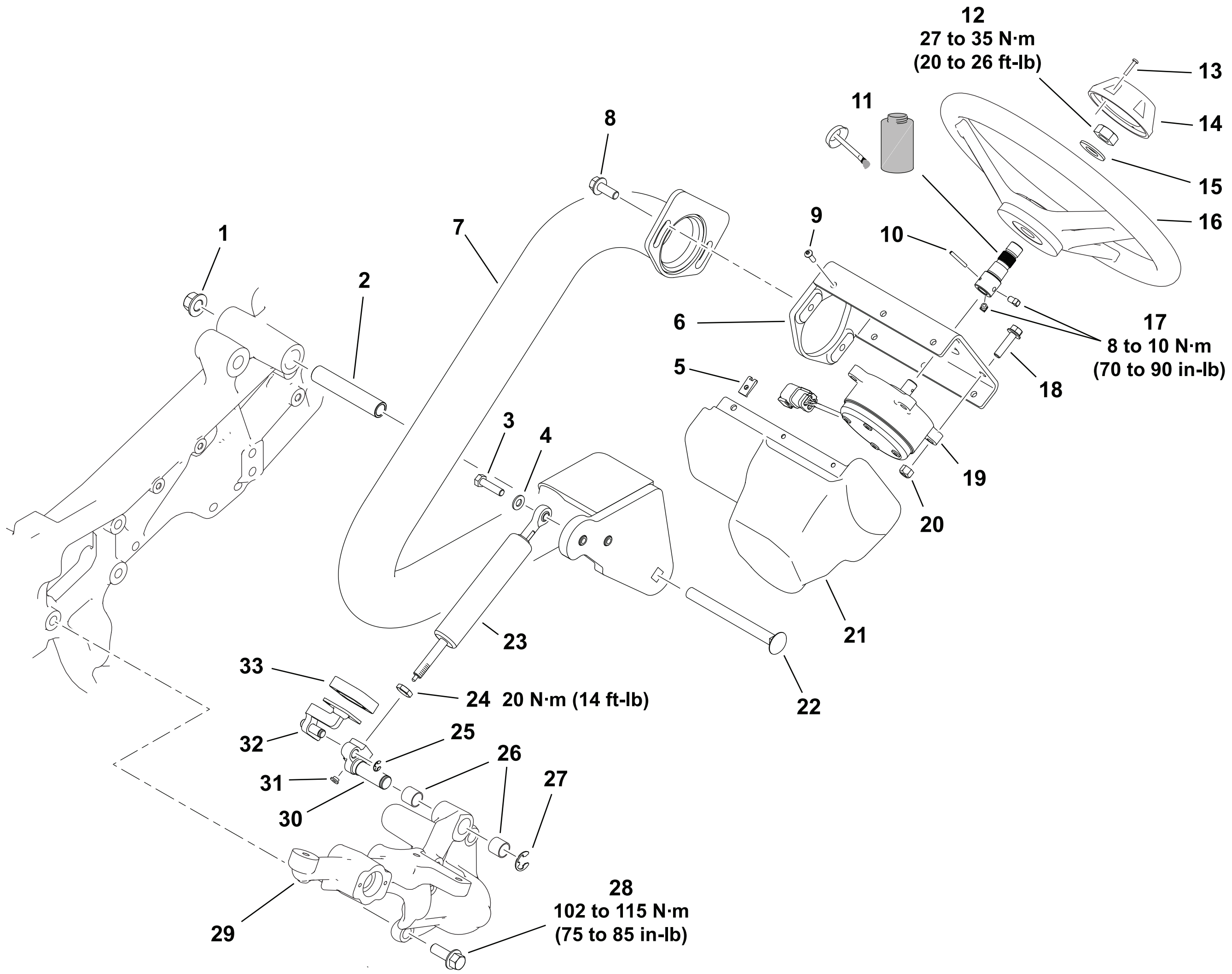


Figure 176

1. Flange nut
2. Spacer
3. Cap screw
4. Flat washer
5. Speed nut (6 each)
6. Steering mount
7. Steering arm
8. Flange head screw (2 each)
9. Button head screw (6 each)
10. Roll pin
11. Shaft adapter
12. Hex nut
13. Screw
14. Cap
15. Washer
16. Steering wheel
17. Set screw (2 each)
18. Flange head screw (4 each)
19. Steering input device
20. Lock nut (4 each)
21. Cover
22. Carriage bolt
23. Gas cylinder
24. Jam nut
25. Retaining ring
26. Bushing
27. Retaining ring
28. Flange head screw (3 each)
29. Platform support – RH
30. Pivot lever
31. Flange bushing
32. Pivot pedal
33. Pedal pad

If the steering input device is replaced, the steering system – center must be calibrated; refer to Calibrating the Steering System – Center (page 5–100).

For steering input device testing information; refer to Testing the Steering Input Device (page 5–68).

Removing the Steering Arm

Refer to Figure 176 for this procedure.

Removing the Steering Arm (continued)

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Remove the cover (item 21) and disconnect the steering input device from the machine wire harness. Check the steering input device and the harness connector for damage or corrosion and clean or repair as necessary.

   Note: The steering wheel, steering input device, and steering mount may be removed from the steering arm as an assembly if desired. Record the position of the steering mount for assembly.
3. Remove the steering input device if necessary:
   A. Remove the screw securing the cap to the steering wheel.
   B. Remove the hex nut and flat washer securing the steering wheel to the shaft.
   C. Use a suitable puller to remove the steering wheel from the steering input device.
   D. Remove the fasteners securing the steering input device to the steering mount and remove the steering input device.

   Note: If the steering input device is being replaced, remove or replace the shaft adapter (item 11). The shaft adapter is secured to the steering input device with a roll pin and 2 set screws. Discard the roll pin.
4. Record the position of the steering mount (item 6) for assembly and remove if necessary.

CAUTION

The gas cylinder is always under high pressure. Avoid pressing the gas cylinder release pin while either end of the cylinder are not secured to the machine. Do not open the gas cylinder.

5. Remove the gas cylinder:
   A. Remove the retaining ring and the pivot pedal (item 32).
   B. Support the steering arm assembly.
   C. Remove the fasteners securing the gas cylinder at the steering arm.
   D. Remove the retaining ring (item 27) then remove the pivot lever and gas cylinder as an assembly.
   E. Loosen the jam nut and separate the gas cylinder from the pivot lever if necessary.
6. Remove the fasteners securing the steering arm to the chassis and remove the steering arm.
7. Inspect the steering arm pivot spacer (item 2) and the pivot lever bushings (item 26) and (item 31) for wear, and replace if necessary.

Installing the Steering Arm

Refer to Figure 176 for this procedure.

1. If the right side platform support (item 29) was removed from the machine, tighten the support fasteners from **102 to 115 N·m (75 to 85 ft-lb)**.
2. Secure the steering arm to the chassis.

Installing the Steering Arm (continued)

CAUTION

The gas cylinder is always under high pressure. Avoid pressing the gas cylinder release pin while either end of the cylinder are not secured to the machine. Do not open the gas cylinder.

3. Install the gas cylinder:
   A. If previously removed, fully thread the end of the gas cylinder into the pivot lever.
   B. Install the pivot lever and gas cylinder as an assembly then install the retaining ring (item 27).
   C. Install the fasteners securing the gas cylinder at the steering arm, then tighten the gas cylinder jam nut to **20 N·m (14 ft-lbs)**.
   D. Install the pivot pedal (item 32) and the retaining ring.
4. If previously removed, install the steering mount in the position recorded.
5. Install the steering input device:
   A. If previously removed, install the shaft adapter (item 11) to the steering input device by pressing a new roll pin and installing 2 set screws. Tighten each set screw from **8 to 10 N·m (70 to 90 in-lb)**.

   IMPORTANT

   The lower right mounting hole of the steering mount is larger to accept an alignment feature on the steering input device body. Ensure the steering input device is properly aligned with the steering mount before installing the steering input device.

   B. Install the steering input device using the fasteners previously removed.
   C. Apply a light coating of anti-seize lubricant to the splines of the shaft adapter and install the steering wheel.
   D. Install the flat washer and lock nut, then tighten the lock nut from **27 to 35 N·m (20 to 26 ft-lb)**.
   E. Install the steering wheel cap and screw.
6. Connect the steering input device to the machine wire harness and install the cover (item 21).
7. Calibrate the steering system – center; refer to Calibrating the Steering System – Center (page 5–100).

Control Console

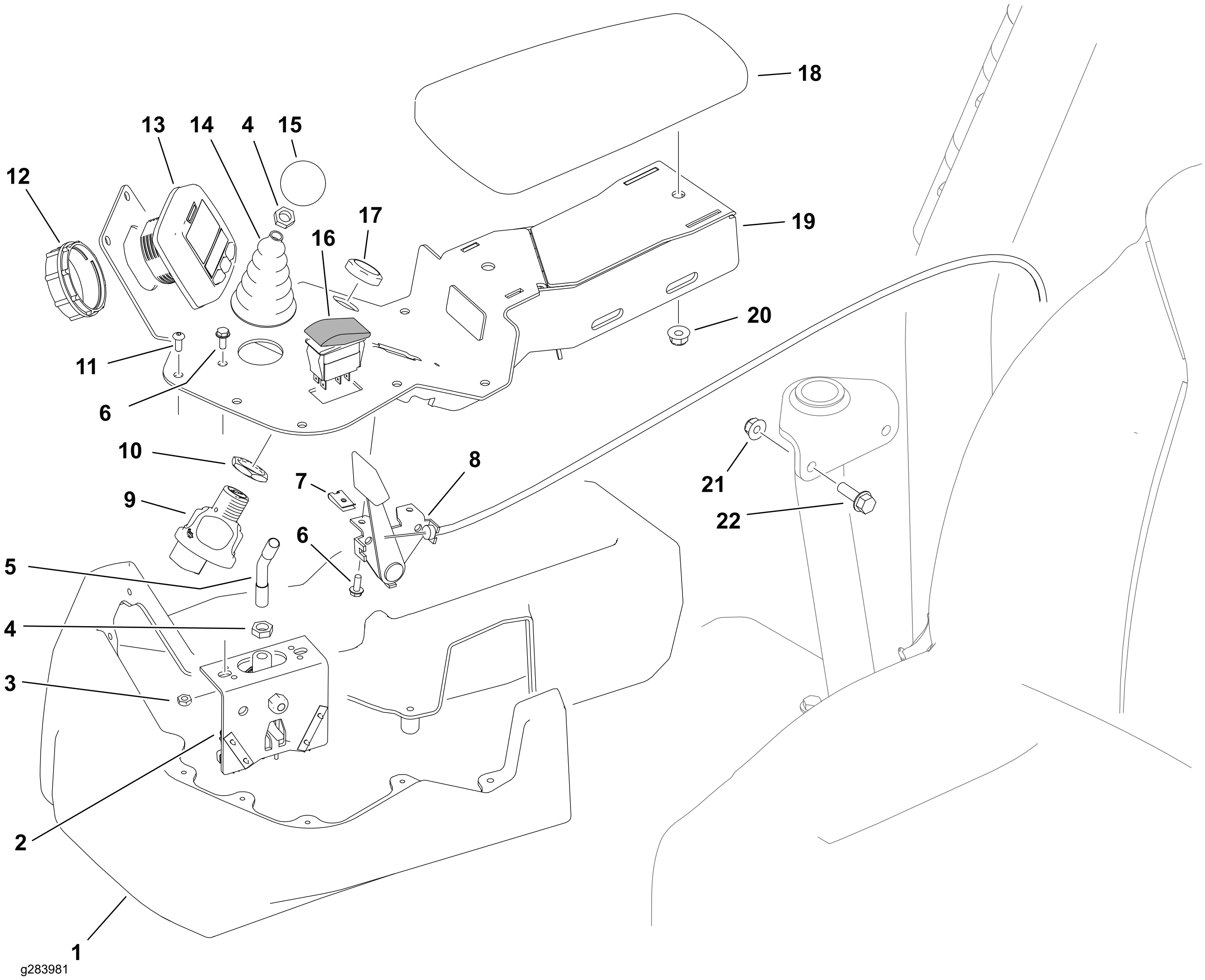


Figure 177

1. Console cover
2. Joystick assembly
3. Lock nut (2 each)
4. Jam nut (2 each)
5. Joystick stem
6. Flange head screw (4 each)
7. Speed nut (2 each)
8. Choke control
9. Key switch
10. Jam nut
11. Button head screw (10 each)
12. Collar
13. InfoCenter display
14. Boot
15. Knob
16. Function control switch
17. Panel nut
18. Arm rest
19. Console
20. Flange nut (2 each)
21. Flange nut (2 each)
22. Flange head screw (2 each)

For console switch testing information; refer to Testing the Electrical Components (page 5–27).

Removing and Installing the Control Console

Refer to Figure 177 for this procedure.

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Remove the 10 button head screws (item 11) from the console and remove the console cover.
3. Record the location of any cable ties and disconnect the machine wire harness connector to remove the InfoCenter or any switches as necessary.

Removing and Installing the Control Console (continued)

Check the InfoCenter, switches, and the harness connectors for damage or corrosion and clean or repair as necessary.

4. Record the location of any cable ties and disconnect the choke control cable at the engine. Remove the choke control knob before removing the choke control.
5. Remove the 2 fasteners securing the console to the support and remove the console.
6. Install the console and console components in reverse order.

   Note: Align joystick stem toward seat during assembly. Install function control switch as shown in Figure 177.

Platform Assembly

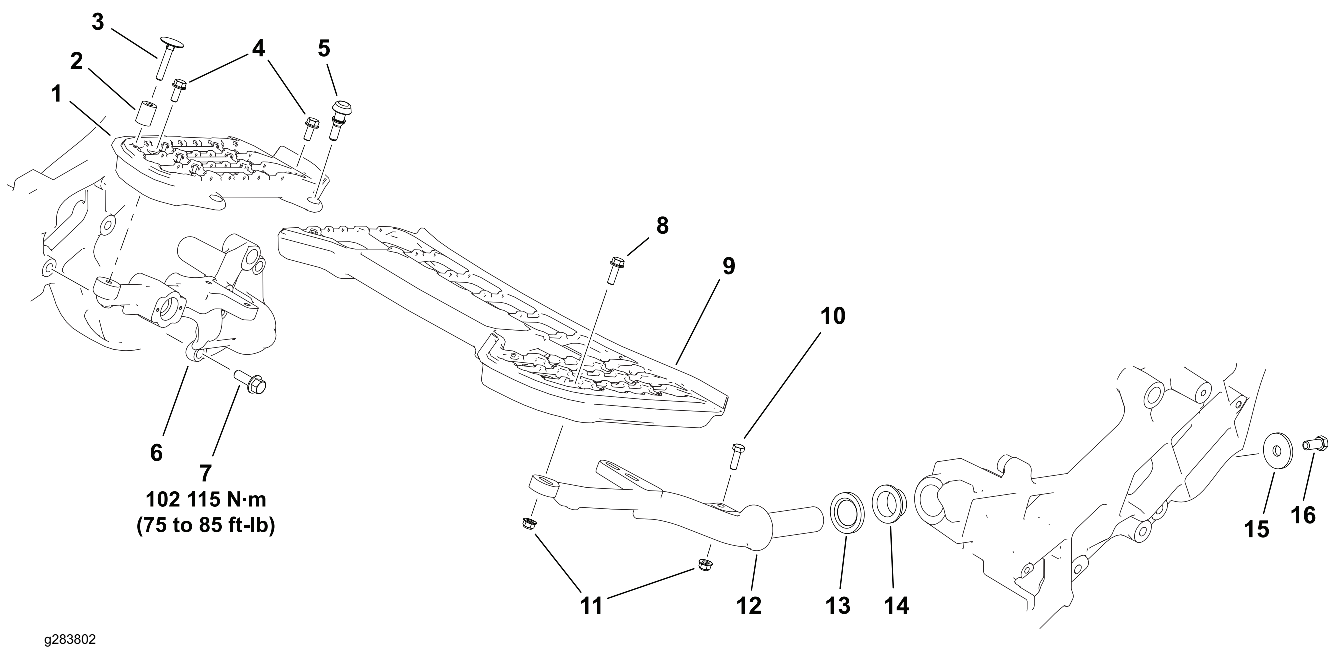


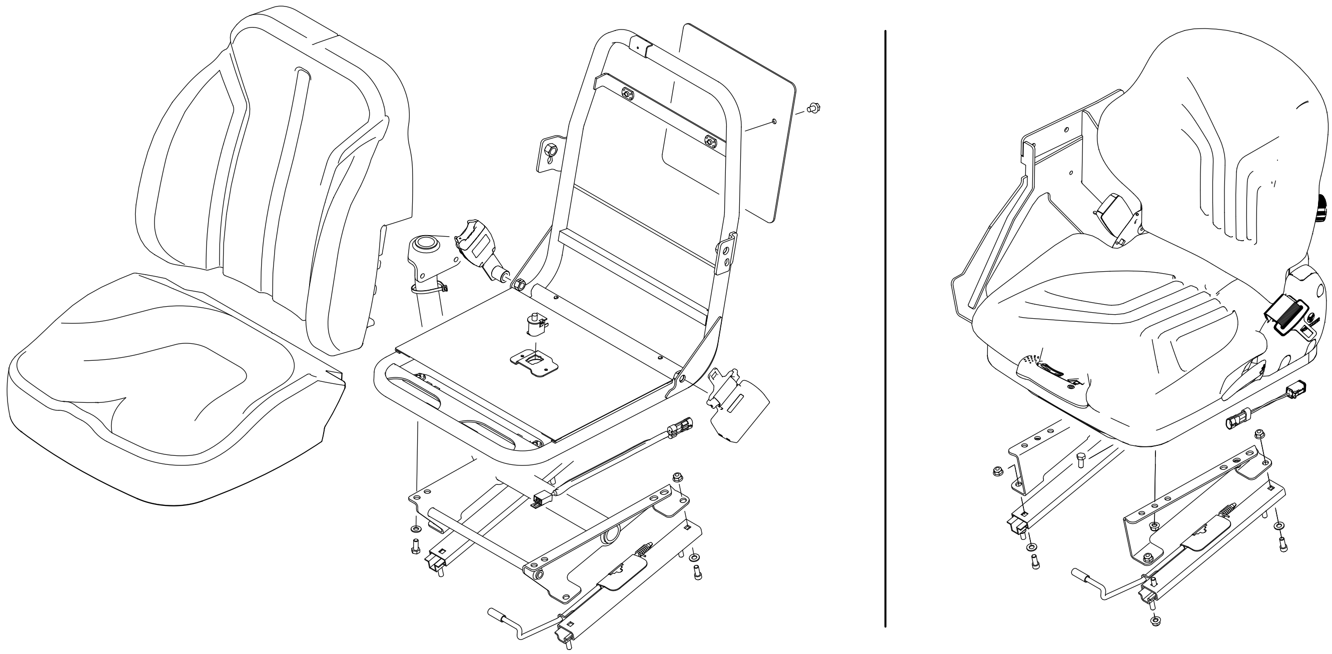
Figure 178

1. Platform – RH
2. Spacer
3. Pedal stop screw
4. Flange head screw (3 each)
5. Rubber bumper (2 each)
6. Platform support – RH
7. Flange head screw (3 each)
8. Flange head screw (3 each)
9. Platform – LH
10. Cap screw
11. Flange nut (4 each)
12. Platform support – LH
13. Thrust washer
14. Flange bushing (2 each)
15. Washer
16. Cap screw

---

1. Align the platforms with each other before tightening the fasteners.
2. If the right side platform support (item 6) was removed from the machine, tighten the support fasteners from **102 to 115 N·m (75 to 85 ft-lb)**.
3. Ensure the left platform can open and close without interference before returning the machine to service.

Operator's Seat



Standard Seat 04508

Premium Seat 04729

g308438

Figure 179

A standard seat (model 04508) and a premium seat (model 04729) is available for the Greensmaster 3360/3370 machines. Refer to the specific seat *Installation Instructions* and *Parts Catalog* available at www.Toro.com for additional information.

Frame Assembly

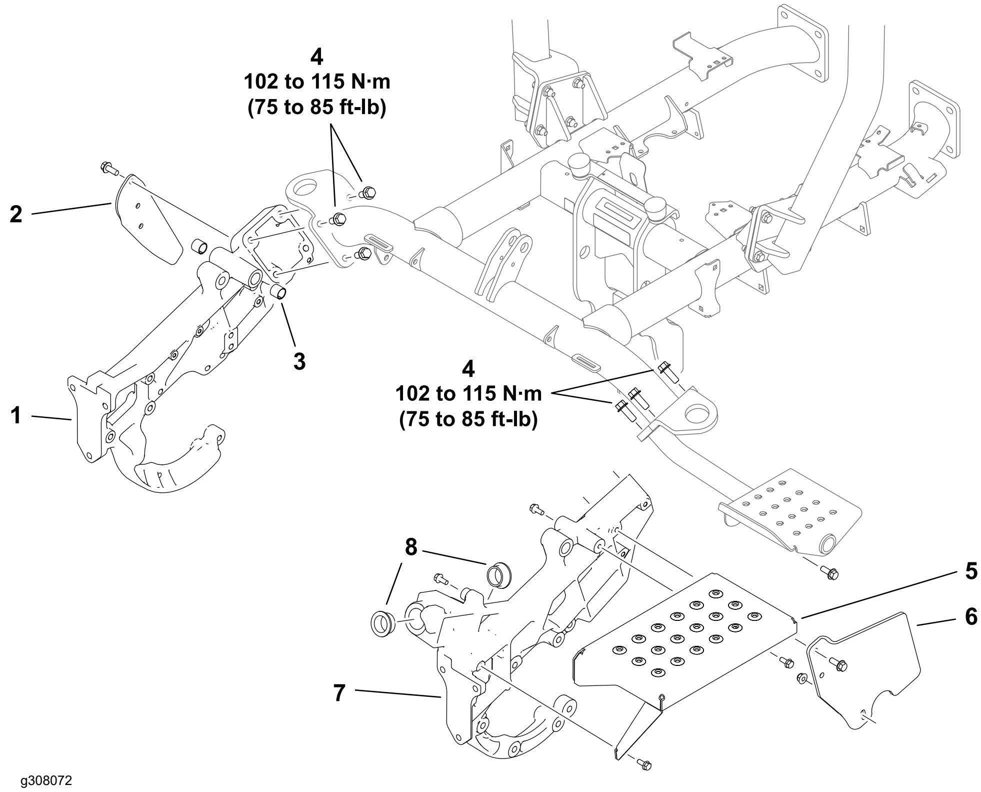


Figure 180

1. Side casting – RH
2. Jack bracket
3. Bushing (2 each)
4. Cap screw (8 each)
5. Step
6. Step bracket
7. Side casting – LH
8. Bushing (2 each)

If the side castings were removed from the machine, tighten the cap screws (Item 4) from **102 to 115 N·m (75 to 85 ft-lb)**.

Hood Assembly

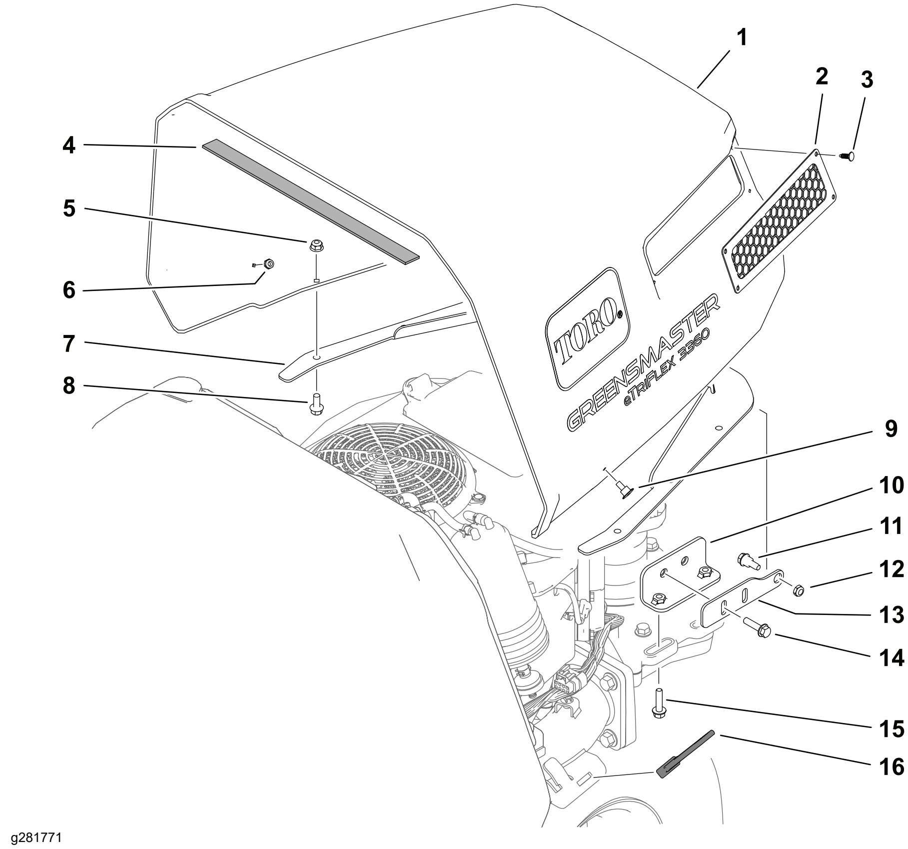


Figure 181

1. Hood
2. Screen (2 each)
3. Panel fastener (8 each)
4. Foam strip
5. Flange nut (6 each)
6. Lock nut (2 each)
7. Hinge bracket
8. Flange head screw (6 each)
9. Shoulder screw (2 each)
10. Hood bracket (2 each)
11. Shoulder bolt (2 each)
12. Lock nut (2 each)
13. Hinge bracket (2 each)
14. Flange head screw (4 each)
15. Flange head screw (4 each)
16. Hold down strap (2 each)

The hood brackets and hinge brackets are adjustable upward, downward, forward and rearward individually. Adjust the hood brackets as needed to allow the hood to rest squarely on the fuel tank.

Removing and Installing the Hood Assembly

Refer to Figure 181 for this procedure.

1. Park the machine on a level surface, set the key switch to the OFF position and remove the key.
2. Open the hood and mark the location of the hood brackets (item 10) on the upper steering housing.
3. Close the hood and remove the 4 fasteners securing the hood brackets to the upper steering housing (item 15). Remove the hood.
4. To install the hood:

   A. Place the hood in position on the machine.

   B. Install the hood bracket fasteners (item 15) finger tight.

Removing and Installing the Hood Assembly (continued)

C. Open the hood and align the brackets with the markings made during removal, or adjust the hood brackets as needed to allow the hood to rest squarely along the top and sides of the fuel tank.

D. Tighten the bracket fasteners.

Cutting Unit Suspension Assembly

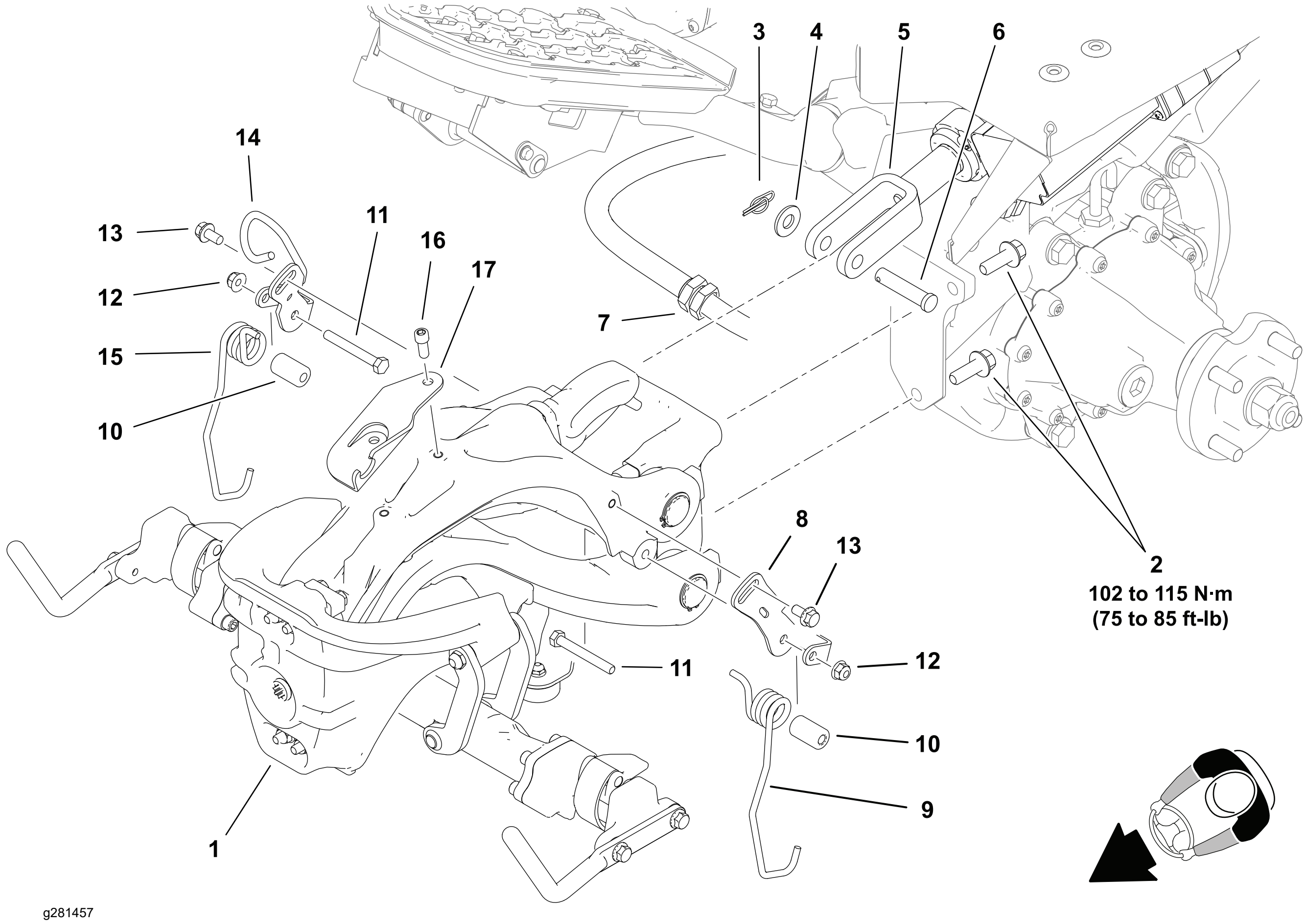


Figure 182

1. Suspension assembly (3 each)
2. Flange screw (3 each suspension)
3. Cotter pin (3 each)
4. Washer (3 each)
5. Lift/Lower actuator
6. Clevis pin (3 each)
7. Motor cable bulkhead (3 each)
8. Spring retainer – left (3 each)
9. Stabilizer spring – left (3 each)
10. Spacer (6 each)
11. Cap screw (6 each)
12. Flange nut (6 each)
13. Flange head screw (6 each)
14. Spring retainer – right (3 each)
15. Stabilizer spring – right (3 each)
16. Socket head screw (6 each)
17. Cable bracket – front (2 each)

Three (3) identical cutting unit suspension assemblies are used on Greensmaster eTriFlex machines. The cutting unit attaches to the crossarm assembly which is attached to the front of the cutting unit suspension assembly. The crossarm assembly can be serviced with the suspension assembly attached to the machine; refer to Cutting Unit Suspension Crossarm Assembly (page 6–50).

For additional lift/lower actuator information; refer to Lift/Lower Actuators (page 5–90).

Removing the Cutting Unit Suspension Assembly

Refer to Figure 182 for this procedure.

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Remove the grass basket.
3. Remove the cutting unit; refer to the traction unit *Operator's Manual*.

Removing the Cutting Unit Suspension Assembly (continued)

4. If a front suspension assembly will be removed from the machine, remove the front wheel; refer to Wheels and Tires (page 6–9).
5. Loosen the bulkhead nut that secures the cutting unit motor cable to the bracket on the suspension assembly, and separate the cable from the bracket.
6. Remove the fasteners securing the lift/lower actuator to the cutting unit suspension.
7. Support the cutting unit motor away from the suspension assembly.

⚠ CAUTION ⚠

The suspension assembly weighs approximately 30 kg (65 lbs). Support the suspension assembly when removing it to prevent it from falling and causing personal injury.

8. Support the suspension assembly and remove the 3 flange head screws that secure the assembly to the machine. Remove the suspension assembly.

Servicing the Cutting Unit Suspension Assembly

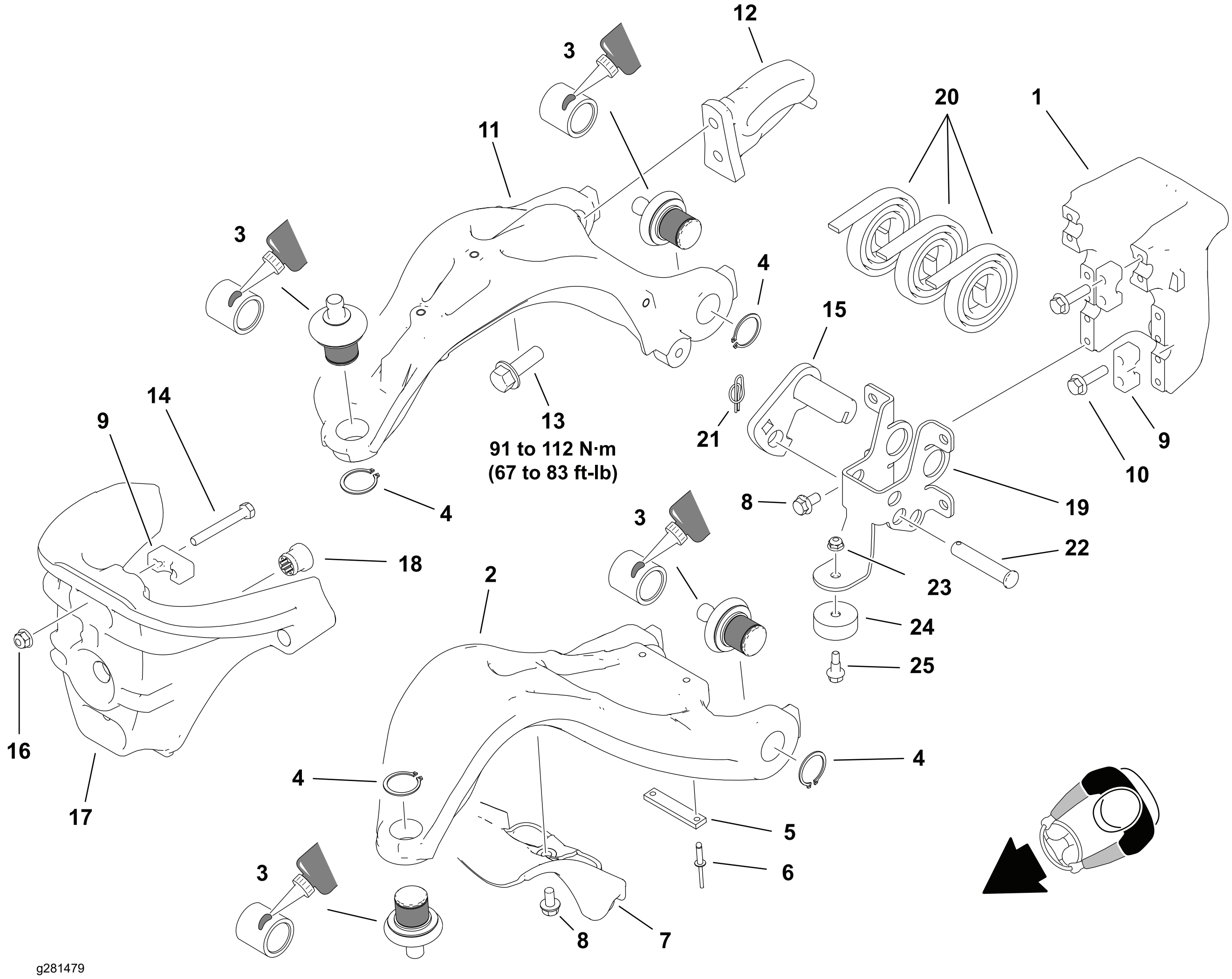


Figure 183

1. Pivot mount
2. Lower A−arm
3. Ball joint (6 each)
4. Retaining ring (6 each)
5. Striker plate
6. Pop rivet (2 each)
7. Steering stop
8. Flange head screw (5 each)
9. Ball joint clamp (6 each)
10. Flange head screw (8 each)
11. Upper A−arm
12. Lift plate
13. Flange head screw (2 each)
14. Cap screw (4 each)
15. Counterbalance tensioner
16. Flange nut (4 each)
17. Steering head
18. Grommet
19. Counterbalance bracket
20. Counterbalance spring (3 each)
21. Cotter pin
22. Clevis pin

The cutting unit suspension assembly can be serviced on or off the machine.

1. Park the machine on a level surface, lower the cutting units, set the key switch to the OFF position and remove the key.
2. Remove the grass basket.
3. Remove the cutting unit; refer to the traction unit *Operator's Manual*.

CAUTION

The counterbalance springs are under heavy load . Disassemble the counterbalance mechanism carefully to avoid personal injury.

Servicing the Cutting Unit Suspension Assembly (continued)

4. Remove tension from the counterbalance mechanism:

   A. Use 3/8 inch drive breaker bar in the square hole of the counterbalance tensioner to hold tensioner in place.

   B. Record the position of the clevis pin (item 22), then remove the cotter pin and clevis pin from the counterbalance bracket and allow the tensioner to relax.

5. Replace worn or damaged components as necessary:

   A. The ball joints were installed in the A-arms with a medium strength retaining compound (Loctite 609 or equivalent). It may be necessary to heat the A-arm around the ball joint for removal. Clean the ball joint housing and the A−arm bore with solvent and allow to dry. Apply a medium strength retaining compound to the ball joint housing before installation.

   B. If a ball joint clamp (item 9) is removed, ensure the raised boss in the clamp bore fits in the groove of the ball joint stud before securing the clamp.

   C. If the lift plate (item 12) is removed, tighten the lift plate mounting fasteners from **91 to 112 N·m (67 to 83 ft−lb)**.

CAUTION

The counterbalance springs are under heavy load . Assemble the counterbalance mechanism carefully to avoid personal injury.

6. Use a 3/8 inch drive breaker bar in the square hole of the counterbalance tensioner to raise the tensioner. Install the clevis in the position recorded during disassembly. Install the cotter pin, relax the tensioner, and remove the breaker bar.

   Note: The default counterbalance setting for eTriFlex machines has the clevis pin passing under the counterbalance tensioner and the middle hole of the counterbalance bracket.

Servicing the Cutting Unit Suspension Assembly (continued)

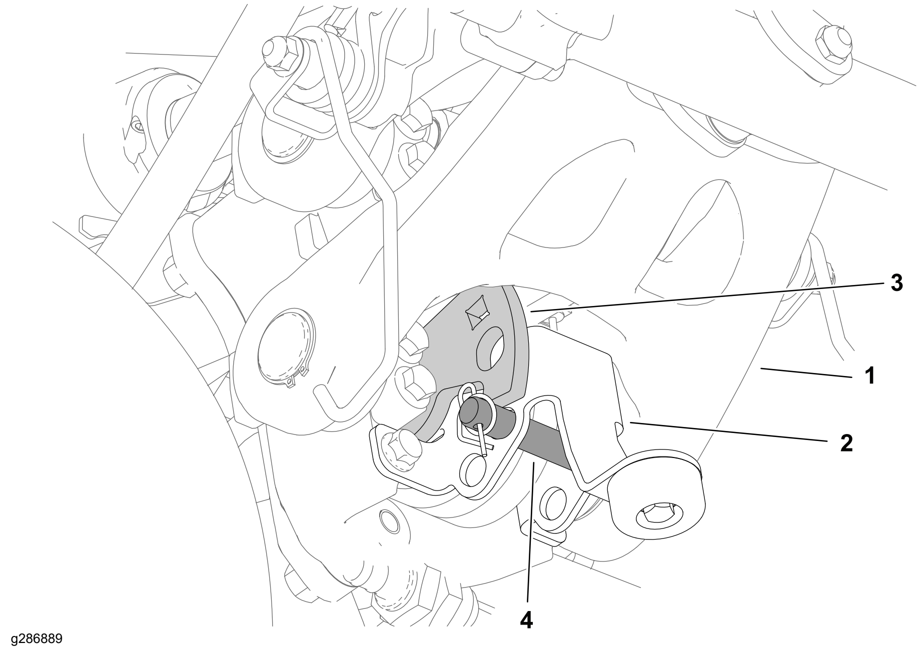


Figure 184

1. Lower A arm
2. Counterbalance bracket
3. Counterbalance tensioner
4. Clevis pin

7. Install the cutting unit; refer to the traction unit *Operators Manual*.
8. Install the grass basket.

Installing the Cutting Unit Suspension Assembly

Refer to Figure 182 for this procedure.

1. Ensure all suspension components are correctly assembled.
2. Secure the suspension assembly to the machine with the 3 flange head screws previously removed. Tighten the screws from **102 to 115 N·m (75 to 85 ft-lb)**.
3. Install the front wheel if previously removed; refer to Removing and Installing the Wheels (page 6–9).
4. If the stabilizer springs are removed, support the suspension assembly so the spring bracket mounting hole is centered in the spring bracket slot **approximately 145 mm (5.72 inch)** from the rear of the pivot mount (this is the cutting unit transport position). Then, position the bracket so the center of the spring end is **222 mm (8.74 inch)** from the rear of the pivot mount. Secure the spring bracket in position with the flange head screw.

Installing the Cutting Unit Suspension Assembly (continued)

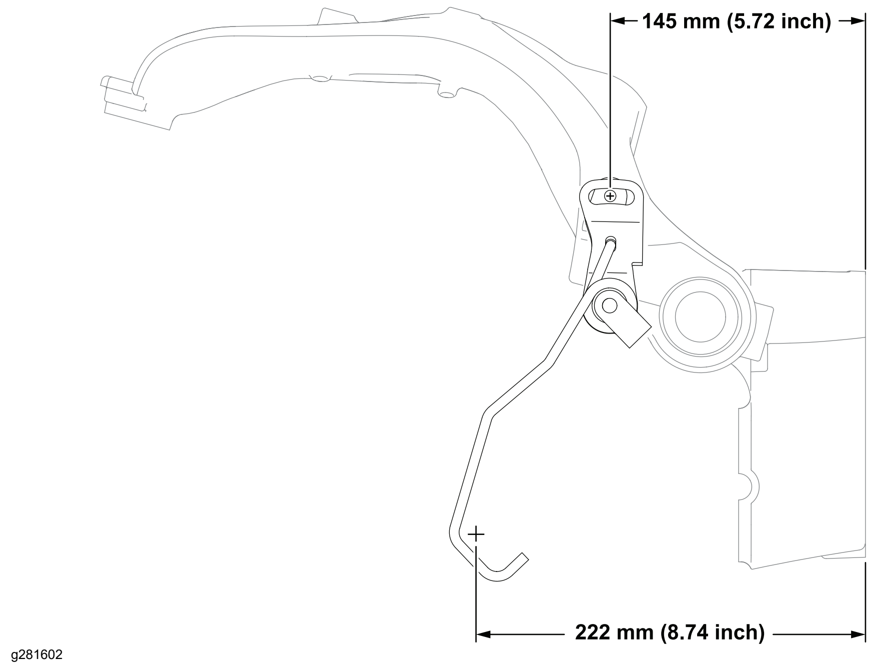


Figure 185

1. Stabilizer spring
2. Spring bracket
3. Rear of pivot mount

Note: To reduce the chance of turf damage when the cutting unit is lowered, properly adjusted stabilizer springs should square the cutting unit with the machine as the cutting unit is raised. Adjust the stabilizer springs if necessary.

5. Move the cutting unit motor to its storage location at the front of the suspension assembly.
6. Fit the cutting unit motor cable into the bracket on the suspension assembly, and secure the cable with the bulkhead nut.
7. Install the cutting unit; refer to the traction unit *Operators Manual*.
8. Install the grass basket.

Cutting Unit Suspension Crossarm Assembly

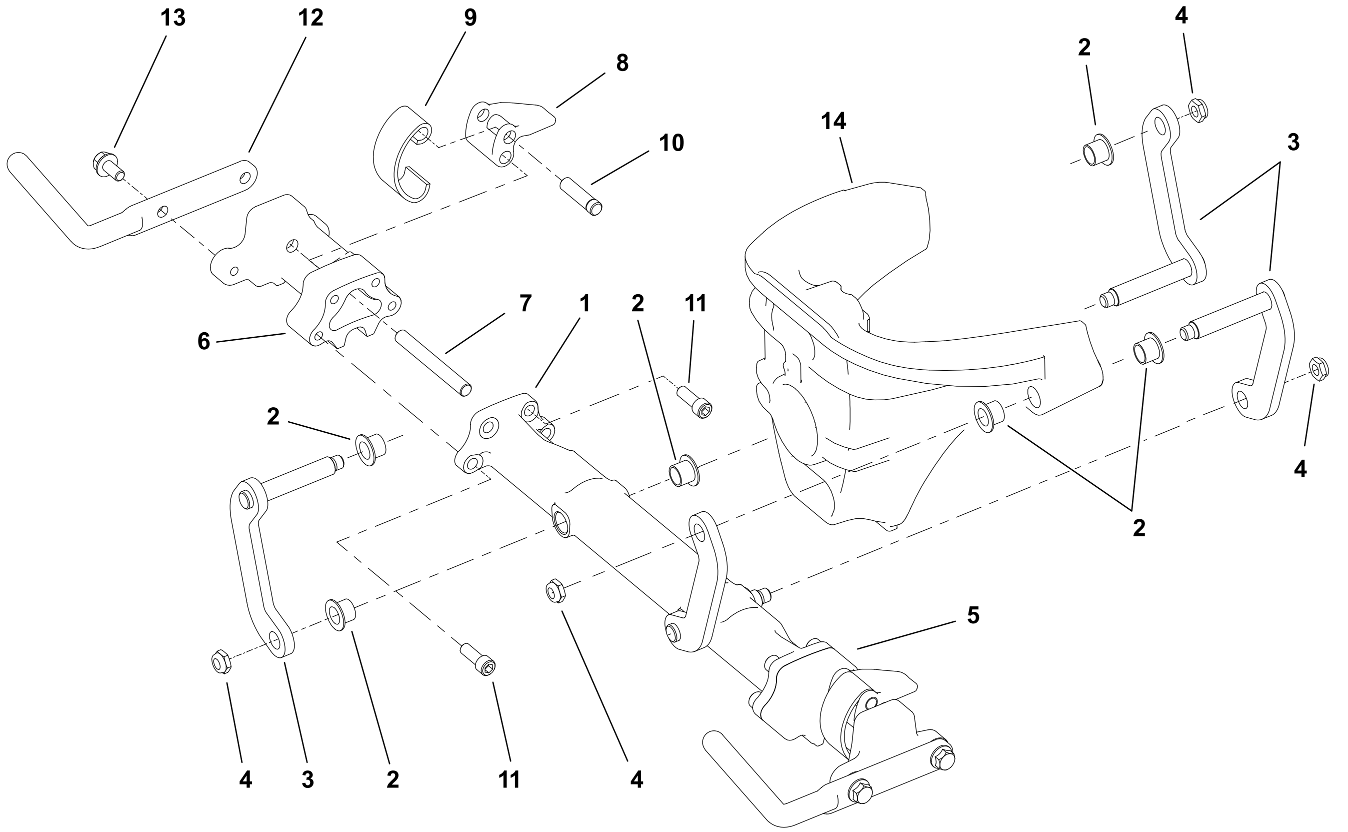


Figure 186

1. Crossarm
2. Flange bushing (8 each)
3. Link (4 each)
4. Lock nut (4 each)
5. LH crossarm mount
6. RH crossarm mount
7. Pivot pin (2 each)
8. Lever (2 each)
9. Spring (2 each)
10. Pivot pin (2 each)
11. Socket head screw (8 each)
12. Basket horn (2 each)
13. Flange head screw (4 each)
14. Suspension steering head

Three (3) identical cutting unit suspension assemblies are used on Greensmaster eTriFlex machines. The cutting unit attaches to the crossarm assembly which is attached to the front of the cutting unit suspension assembly.

Remove the cutting unit before servicing the crossarm assembly; refer to the traction unit *Operator's Manual*.

Chapter 7

DPA Cutting Units

Table of Contents

General Information

Cutting Unit Operator's Manual

The *Cutting Unit Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for the cutting units on your machine. Additionally, if optional kits have been installed on the cutting units (e.g., groomer or rear roller brush), the *Installation Instructions* for the kit includes set-up, operation and maintenance information. Refer to the *Cutting Unit Operator's Manual* and the kit *Installation Instructions* for additional information when servicing the cutting units.

Supporting the Cutting Unit when Servicing

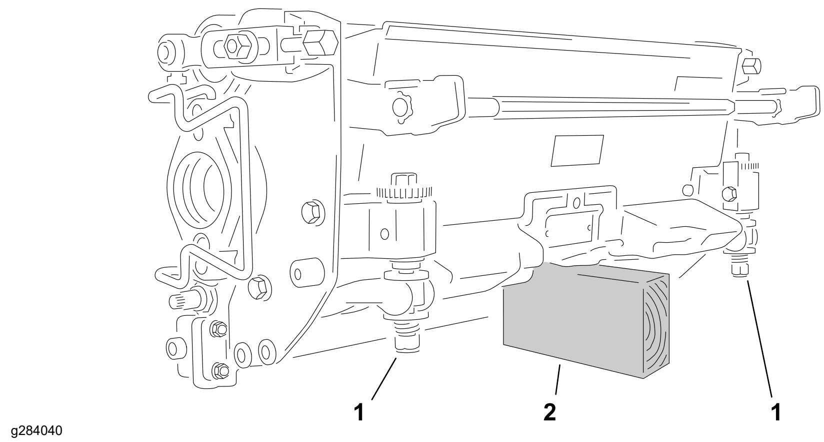


Figure 187

1. Bedbar adjuster screws
2. Support

Whenever you have to tip the cutting unit to expose the bedknife or cutting reel, support the rear of the cutting unit making sure the back of the bedbar adjuster screws are not resting on the work surface.

Adjustments

DPA Cutting Unit Characteristics

CAUTION

Never install or work on or near a cutting unit or cutting unit suspension with the engine running. Always set the key switch to the OFF position and remove the key before working on or near a cutting unit.

The dual point adjust (DBA) bedknife-to-reel adjustment system incorporated in this cutting unit simplifies the adjustment procedure needed to deliver optimum mowing performance. The precise adjustment possible with this design gives the necessary control to provide a continual self-sharpening action. This feature maintains sharp cutting edges, assures good quality of cut and greatly reduces the need for routine backlapping. In addition, the rear roller positioning system allows for various height-of-cut ranges and aggressiveness of cut selections.

If a cutting unit is determined to be out of adjustment, complete the following procedures in the specified order to adjust the cutting unit properly.

1. Adjust the bedknife to reel contact; refer to the *Cutting Unit Operator's Manual*.

   Note: If one of the cutting unit side plates is removed during cutting unit service or maintenance, check to make sure the rear roller is level (parallel to the reel) before adjusting the rear roller; refer to Leveling the Rear Roller (page 7–3).

2. Determine desired height-of-cut range and adjust the rear roller as needed, refer to the *Cutting Unit Operator's Manual*.
3. Adjust the height-of-cut; refer to the *Cutting Unit Operator's Manual*.
4. Adjust the cut-off bar; refer to the *Cutting Unit Operator's Manual*

Leveling the Rear Roller

The precision machined components of the cutting unit frame keep the rear roller and cutting reel in alignment (parallel). If the side plates are disassembled a limited amount of side plate adjustment is possible to make sure that the rear roller and cutting reel remain parallel.

Note: Use a pie tape to measure the reel diameter taper; service limit 0.25 mm (0.01 inch). Leveling the rear roller of a cutting unit with a reel that exceeds the reel diameter taper limit is not recommended.

1. Make sure the cutting unit bedknife is properly adjusted to the reel; refer to the *Cutting Unit Operator's Manual*.
2. Place the assembled cutting unit on a cutting unit bench plate so at least three of the reel blades contact the bench plate rib.

Leveling the Rear Roller (continued)

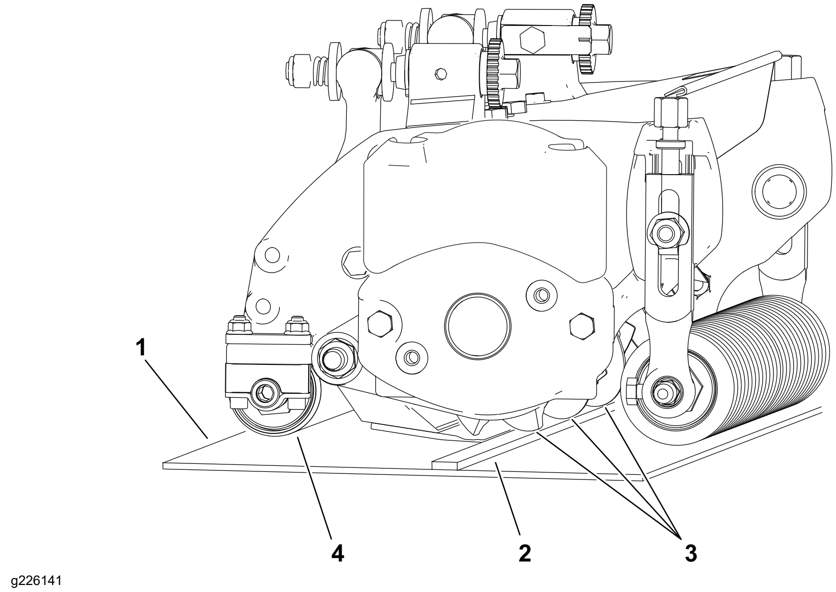


Figure 188

1. Bench plate
2. Bench plate rib
3. Reel blade contacting rid
4. Rear roller

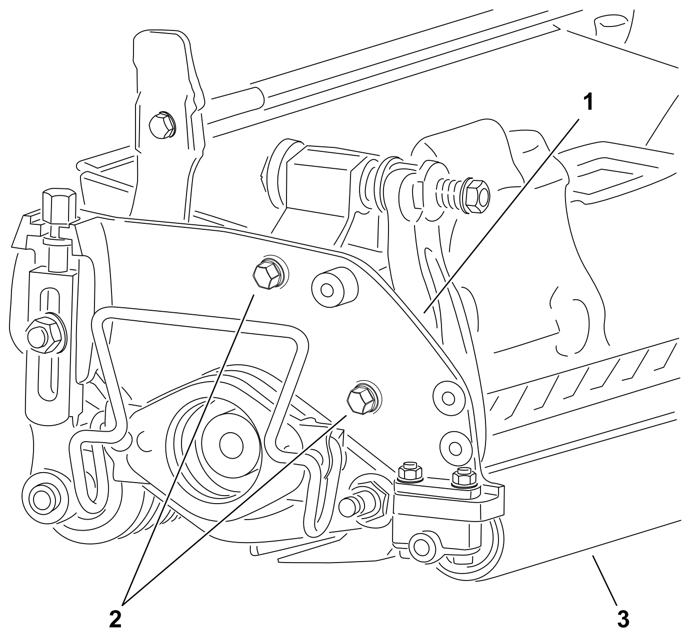
3. Check if the rear roller is parallel to the cutting reel by trying to fit a **0.13 mm (0.005 in)** shim between the rear roller and the bench plate at each end of rear roller. Rotate the roller and recheck the clearance at each end a few times to account for any roller run-out. If the shim will pass under the roller through entire rotation of the roller, the rear roller is not parallel to the reel, or is high on one side and an adjustment should be made.

   Note: If the cutting unit has an optional rear roller adjustment kit (eccentric roller shaft bushing), loosening the cutting unit side plate should not be necessary. Adjust the rear roller by loosening the rear roller clamp fasteners and rotating the eccentric bushing as necessary; refer to the kit *Installation Instructions* for additional information.

4. Loosen, but do not remove, the two shoulder bolts that secure the side plate to the frame on the side of the cutting unit where the rear roller is high (not contacting the bench plate).

   Note: It may be necessary to remove the upper counterweight to access the shoulder bolts for the left side plate.

Leveling the Rear Roller (continued)



g284061

Figure 189

1. Side plate
2. Shoulder bolt (2 each)
3. Rear roller

---

5. Adjust the position of the side plate so the rear roller contacts the bench plate at both ends, making the rear roller parallel to the reel. Tighten the shoulder bolts from **24 to 27 N·m (210 to 240 in-lb)**.

6. Recheck the clearance between the rear roller and the bench plate. If necessary, loosen and adjust second side plate on the side of the cutting unit where the rear roller is low (contacting the bench plate).

7. Complete the cutting unit set-up and adjustment procedure.

Service and Repairs

Bedbar Assembly

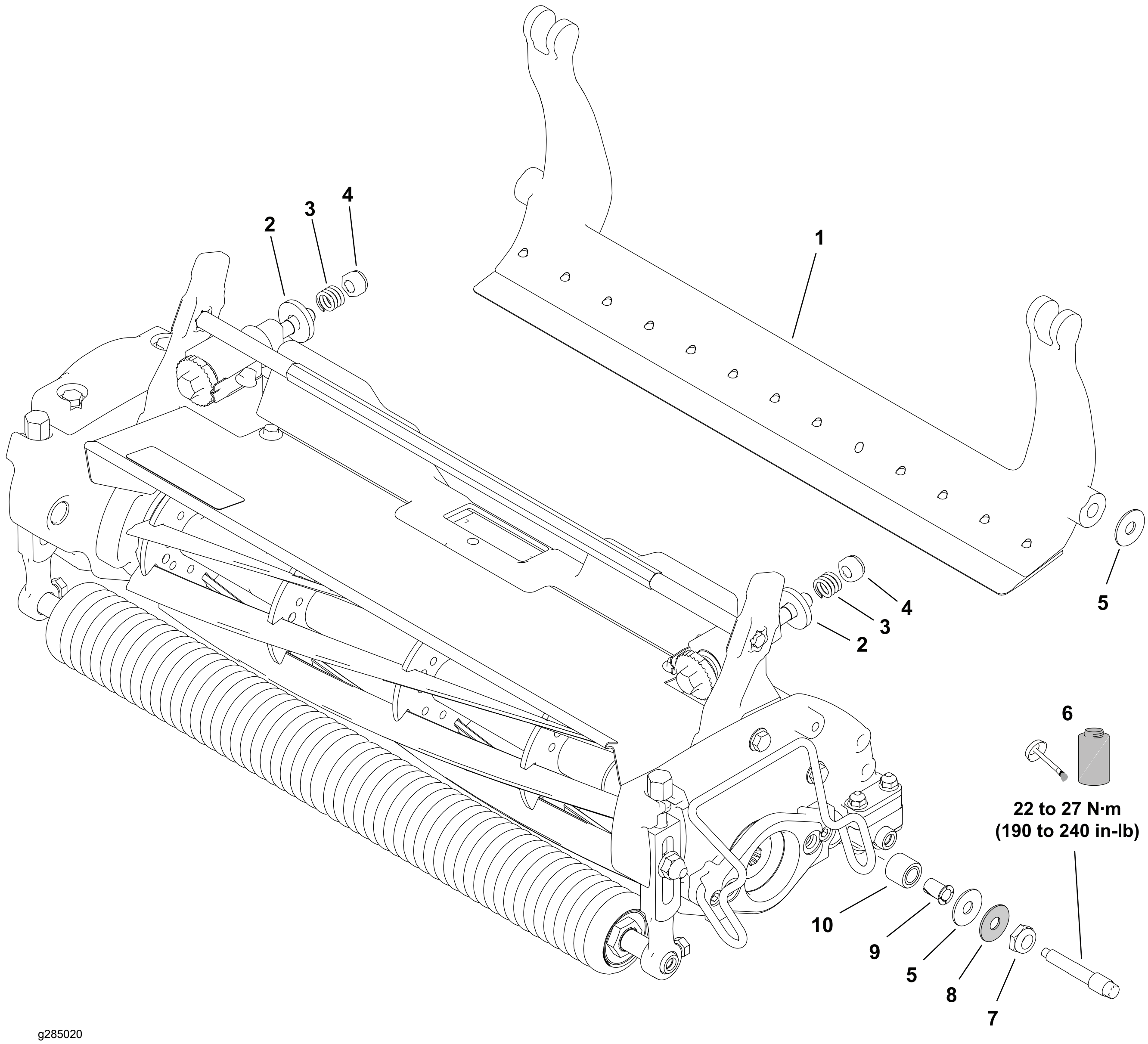


Figure 190

1. Bedbar assembly
2. Washer (2 each)
3. Compression spring (2 each)
4. Lock nut (2 each)
5. Plastic washer (4 each)
6. Bedbar pivot bolt (2 each)
7. Lock nut (2 each)
8. Metal washer (2 each)
9. Nylon bushing (2 each)
10. Rubber bushing (2 each)

Removing the Bedbar

Refer to Figure 190 for this procedure.

1. Remove the cutting unit from the machine and place the cutting unit on a flat work surface.
2. Loosen the lock nuts (item 4) on the end of each bedbar adjuster screw until the washers (item 2) are loose.

Removing the Bedbar (continued)

3. Tip the cutting unit to expose the bedknife and support the rear of the cutting unit; refer to Supporting the Cutting Unit when Servicing (page 7–2).
4. Loosen the lock nuts (item 7) on each bedbar pivot bolt.
5. Remove the two bedbar pivot bolts, two metal washers and four plastic washers from the cutting unit side plates.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.

6. Remove the bedbar assembly from the cutting unit.
7. Inspect the nylon bushings and rubber bushings in the side plates for wear or damage. Replace the bushings if necessary.

Installing the Bedbar

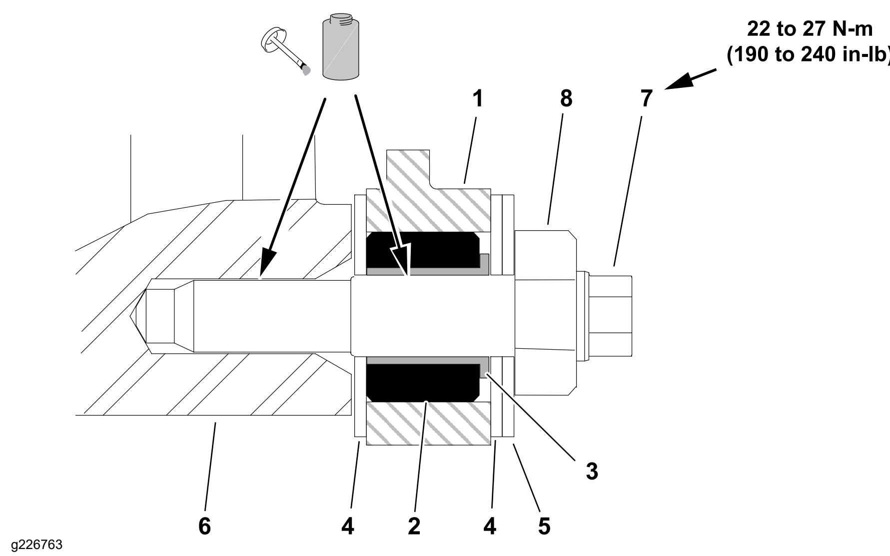


Figure 191

1. Side plate
2. Rubber bushing
3. Nylon bushing
4. Plastic washer (2 each)
5. Metal washer
6. Bedbar
7. Bedbar pivot bolt
8. Lock nut

Refer to Figure 191 for this procedure.

1. If rubber bushing was removed from either side plate, apply grease to outside surface of new bushing and install into side plate. The bushing should be installed flush with the inside surface of the side plate.
2. If removed, install the nylon bushings with flange facing outward.
3. Apply anti-seize lubricant to the threads and shank of each bedbar pivot bolt.

Installing the Bedbar (continued)

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when handling the bedbar.

Note: If a new bedknife is attached to the bedbar, there may be interference between the bedknife and the reel when installing the bedbar. Turn the bedbar adjusting screws counterclockwise to increase bedknife clearance if necessary.

4. Position the bedbar into the cutting unit. Make sure that the top of each bedbar arm is between the washer and adjuster screw flange.

IMPORTANT

When installing the washers, make sure that the plastic washers are positioned against the side plate.

5. Slide one metal washer and then one plastic washer onto each bedbar pivot bolt.
6. Position one plastic washer between the bedbar and the inside of each side plate.
7. Install the bedbar pivot bolt assemblies. Make sure the washers are not caught on the threads of the pivot bolts. Tighten each bedbar pivot bolt from **22 to 27 N·m (190 to 240 in-lb)**.

IMPORTANT

Do not over tighten the lock nuts as this can distort the side plates and affect reel bearing alignment. When the lock nut is correctly tightened, the inside washers may be loose.

8. Tighten both lock nuts (item 8 in Figure 191) until the outside washers do not have any end play, but you can still rotate the them.
9. Tighten the lock nut (item 4 in Figure 190) on each bedbar adjuster assembly until the adjuster spring is fully compressed, then loosen the lock nut 1/2 turn.
10. Adjust the bedknife to reel contact; refer to the *Cutting Unit Operator's Manual*.

Removing the Bedbar Adjuster

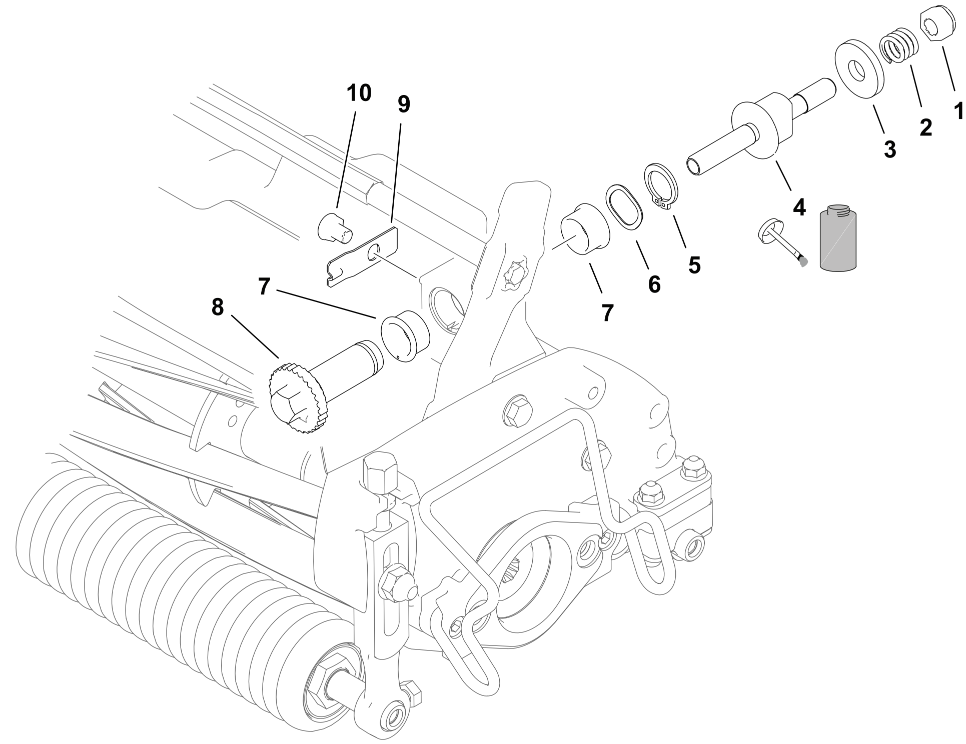


Figure 192

1. Lock nut
2. Compression spring
3. Washer
4. Bedbar adjuster screw
5. Retaining ring
6. Wave washer
7. Flange bushing (2 each)
8. Bedbar adjuster shaft
9. Detent
10. Cap screw

---

1. Remove bedbar; refer to Removing the Bedbar (page 7–6).
2. Remove the lock nut, compression spring and washer from the bedbar adjuster screw.

   Note: The bedbar adjuster shaft has left-hand threads.
3. Unscrew the bedbar adjuster shaft from the bedbar adjuster screw.
4. Remove the retaining ring and wave washer from the adjuster shaft and remove the adjuster shaft.
5. Inspect the flange bushings in the cutting unit side plate and replace them if necessary.
6. Inspect the detent and replace it if necessary.

Installing the Bedbar Adjuster

1. If previously removed, secure the detent to the side plate.
2. If previously removed, align the key on the flange bushings to the slots in the cutting unit frame and install.
3. Slide adjuster shaft into flange bushings and secure with wave a washer and a retaining ring.

   Note: The bedbar adjuster shaft has left-hand threads.
4. Apply anti-seize lubricant to the threads of the bedbar adjuster screw that fit into adjuster shaft (the left hand threads) and thread the bedbar adjuster screw into the adjuster shaft.

Installing the Bedbar Adjuster (continued)

5. Install the washer, spring and lock nut onto the adjuster screw.
6. Install the bedbar; refer to Installing the Bedbar (page 7–7).

Bedknife

Removing the Bedknife

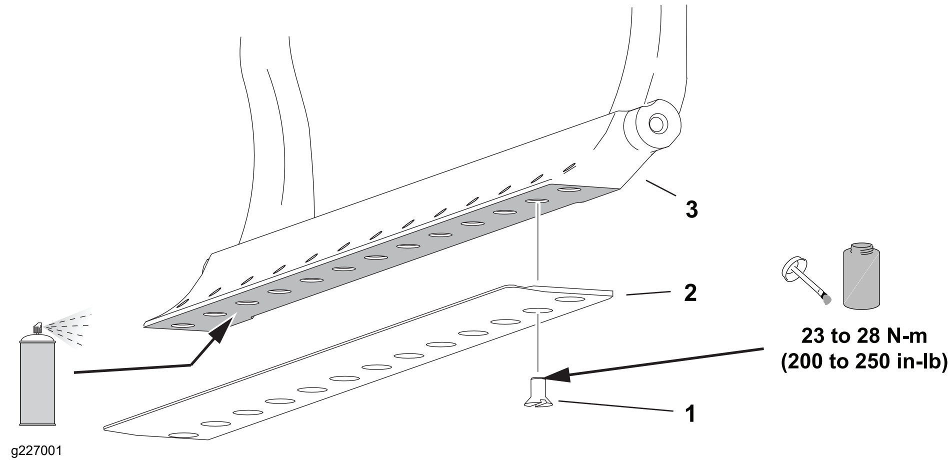


Figure 193

1. Bedknife screw (13 used)
2. Bedbar
3. Bedknife

1. Remove the bedbar from the cutting unit; refer to Removing the Bedbar (page 7–6).
2. Remove screws from bedbar using a socket wrench and bedknife screw tool; refer to Bedknife Screw Tool (page 2–20). Discard the screws. Remove bedknife from the bedbar.
3. Refer to Grinding the Bedknife (page 7–12) for additional information.

Installing the Bedknife

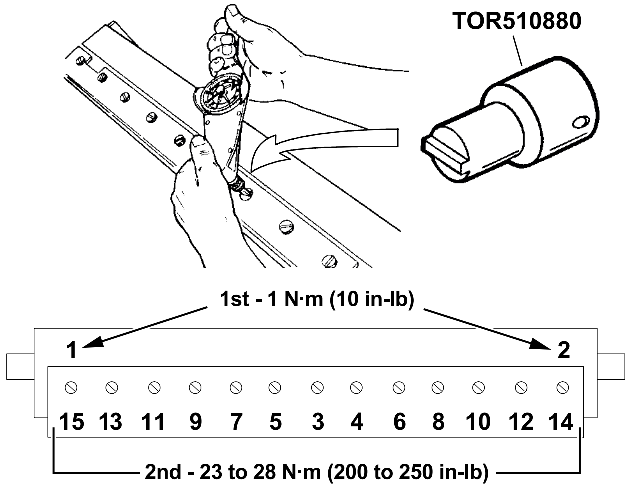
1. Use a scraper to remove all rust, scale and corrosion from the bedbar surface under the bedknife. Lightly oil the bedbar surface before installing the bedknife.
2. Make sure that screw threads in bedbar (5/16-18UNC-2A) are clean.
3. Use new screws to secure bedknife to bedbar. Apply anti-seize lubricant to the threads of new screws. Do not apply anti-seize lubricant to the taper of the screw heads.
4. Install all screws but do not tighten.

IMPORTANT

Do not use an impact wrench to tighten screws into the bedbar.

5. Using a torque wrench and bedknife screw tool, tighten the 2 outer screws to **1 N-m (10 in-lb)**.

Installing the Bedknife (continued)



g226894

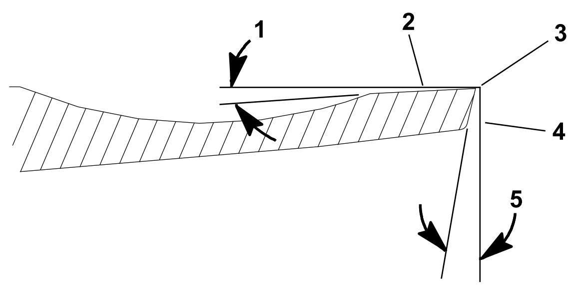
Figure 194

6. Working from the center of the bedknife toward each end, tighten screws from **23 to 28 N-m (200 to 250 in-lb)**.
7. After installing the bedknife to bedbar, grind the bedknife.

Grinding the Bedknife

Bedknife Grinding Specifications

Standard Bedknife Relief Angle	3° minimum
Fairway Bedknife Relief Angle	3° minimum
Extended Bedknife Relief Angle	7° minimum
Front Angle Range	13° to 17°



g207289

Figure 195

1. Top angle
2. Top surface
3. Remove burr
4. Front surface
5. Front angle

Since there can be variations in the mounting surface of the bedbar, it is necessary to grind the bedknife after installing it to the bedbar. Follow the bedknife grinding specifications provided; refer to Bedknife Grinding Specifications (page 7–12). Grind only enough so the top surface of the bedknife is true; refer to Figure 195.

IMPORTANT

Do Not grind the bedknife below the service limit. Operating the cutting unit with the bedknife below the service limit may result in poor after-cut appearance and reduce the structural integrity of the bedknife.

The bedknife service limit occurs when the reel contacts the back of the bedknife scallop during operation; refer to Figure 196. Check for reel contact marks at the back of the bedknife scallop prior to grinding. The bedknife service limit may also occur when the bottom of the bedknife scallop is reached when grinding the bedknife.

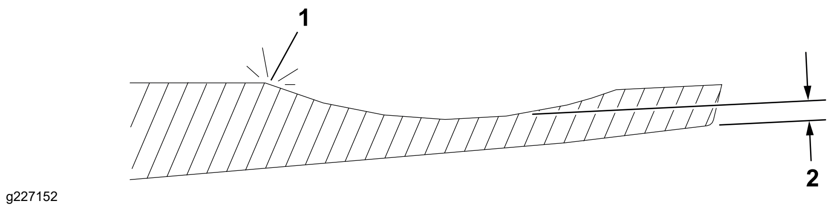


Figure 196

1. Service limit (reel contacts back of bedknife scallop during operation)
2. Service limit (bottom of bedknife scallop reached when grinding)

When grinding the bedknife, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder. **Also, clean and dress grinding stone often during the grinding process.**

IMPORTANT

EdgeMax® bedknives are extremely hard. Using a diamond grinding wheel is recommended to prevent overheating or damaging the bedknife edge while grinding.

Because the top grind angle on bedknives is critical for edge retention, and therefore after−cut appearance, Toro has developed special service tools for accurately measuring the top grind angle on all bedknives; refer to Angle Indicator and Magnetic Mount (page 2–19).

1. Use Toro General Service Training Book, Reel Mower Basics (part no. 09168SL) and grinder manufacturer's instructions for bedknife grinding information.
2. After grinding the bedknife, install the bedbar assembly in the cutting unit; refer to Installing the Bedbar (page 7–7).

   Note: Always adjust the cutting unit after grinding the reel and/or bedknife; refer to the Cutting Unit *Operator's Manual*. If a properly adjusted cutting unit does not cut paper cleanly after grinding, the grind angle may be incorrect. To extend the cutting unit performance by allowing the reel and the bedknife to hold their edge longer, an additional adjustment may be required after the first few minutes of operation as the reel and bedknife conform to each other.

Troubleshooting Bedknife Grinding

Perform this troubleshooting procedure is a newly ground bedknife does not cut test paper at the center of the knife.

Troubleshooting Bedknife Grinding (continued)

1. Place a .002 inch shim (Part No. 140-5531) between the outer most left and right magnets and the bedbar-bedknife assembly when placing it in the grinder (Figure 197).

   Note: If a bedknife does not cut paper more than 2 inches from each end, place the shims on the inner magnets instead of the outer magnets.

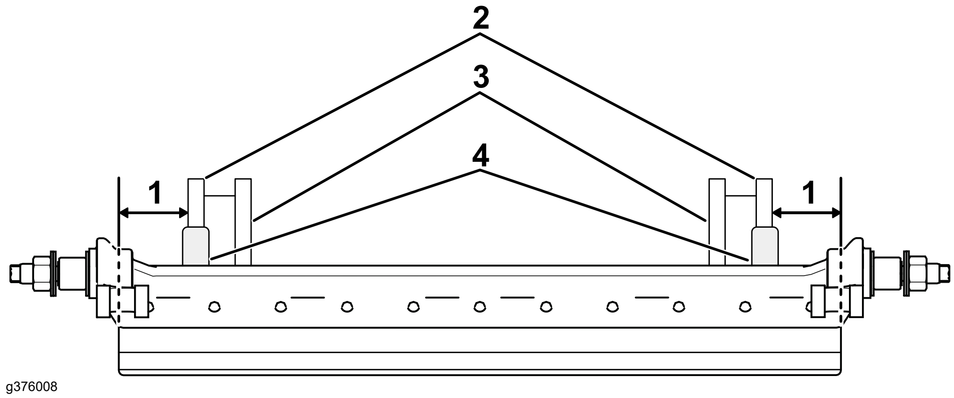


Figure 197

1. 1 inch between the outer edge of the bedknife and the outer magnet
2. Outer magnets
3. Inner magnets
4. .002 inch shim (Part No. 140-5531)

2. Ensure that you are following the grinder manufacturer instructions and grind the bedknife.
3. In most cases the outside of each outer magnet should be 1 inch (25 mm) from the outside edge of the bedknife.
4. Remove the bedbar-bedknife assembly from the grinder.
5. If you have a precision flat granite surface plate, check the bedbar-bedknife; refer to Checking the Bedknife on a Granite Surface Plate (page 7–14).
6. Install the bedbar-bedknife assembly to the cutting unit and adjust the cutting unit; refer to your Cutting Unit Operator's Manual.
7. Test the cut across the entire length of the bedknife, if the paper does not cut across the entire length, complete this procedure again with an additional shim installed on each magnet (maximum of 4 shims total).

   Note: If a properly adjusted cutting unit does not cut the test paper cleanly across the entire length of the bedbar-bedknife after grinding, check the grind angle to be sure it is ground to the bedknife grinding specification; refer to Bedknife Grinding Specifications (page 7–12).

   Note: If there are still gaps after grinding with 2 shims at either the outer or inner magnets (maximum of 4 shims total), there may be a separate issue; contact the Technical Assistance Center.

Checking the Bedknife on a Granite Surface Plate

1. Place bedbar-bedknife assembly on a precision flat granite surface plate with the cutting-edge down. Look for visible light between the granite and the bedknife, or use a shim to test for .002 inch or greater gaps (Figure 198).

Checking the Bedknife on a Granite Surface Plate (continued)

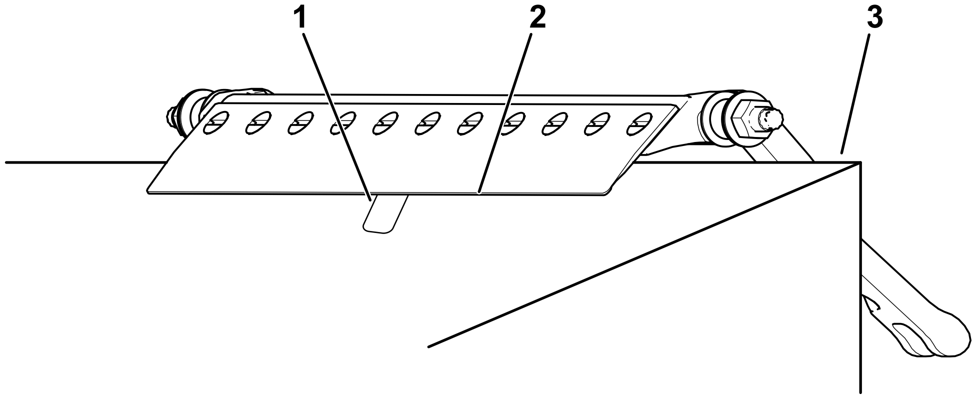


Figure 198

1. Shim (.002 inch) to test for gaps
2. Inspect the surface between the bedknife and granite for light
3. Granite surface plate

---

2. If there is a gap that the shim fits through, or light shows between the granite and the cutting edge after grinding with 1 shim, regrind the bedknife with an additional shim installed (maximum of 4 shims total, 2 per magnet); refer to Grinding the Bedknife (page 7–12).

Reel Assembly

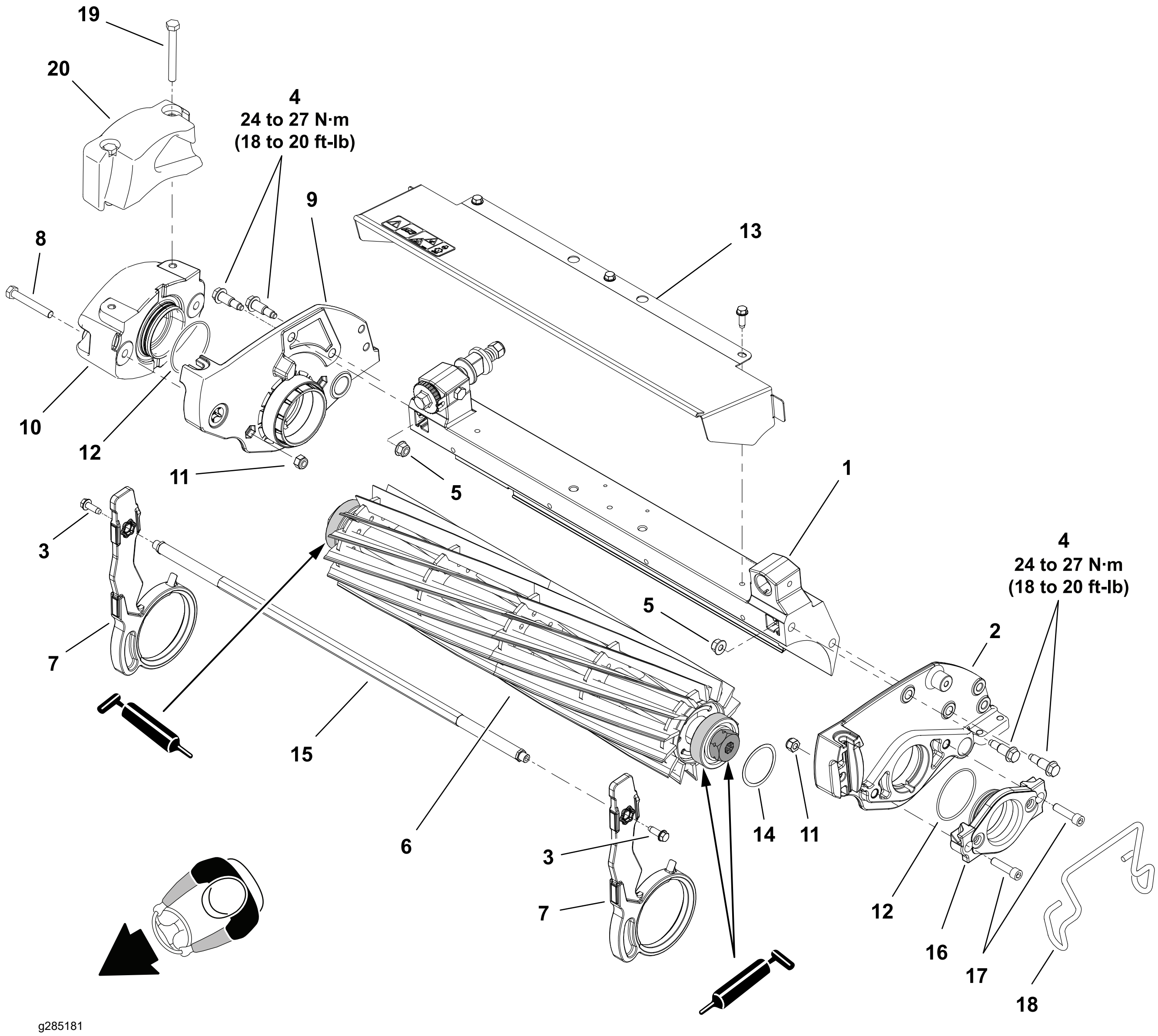


Figure 199

1.	Crossmember	8.	Cap screw (2 each)	15.	Crosslink
2.	Side plate – LH	9.	Side plate – RH	16.	Electric motor adapter
3.	Flange head screw (2 each)	10.	Counterweight	17.	Socket head screw (2 each)
4.	Shoulder bolt (4 each)	11.	Hex nut (4 each)	18.	Motor clamp
5.	Flange nut (4 each)	12.	O-ring (2 each)	19.	Cap screw (2 each)
6.	Reel assembly	13.	Grass shield	20.	Counterweight
7.	Pitch arm (2 each)	14.	Flat wire spring		

Removal of the cutting reel requires removal of the left or right side plate from the cutting unit frame. The opposite side plate does not have to be removed from the frame to service the cutting reel.

Removing the Reel Assembly

Refer to Figure 199 for this procedure.

1. Remove the cutting unit from the machine and place the cutting unit on a flat work surface.

2. If the cutting unit is equipped with an optional groomer or rear roller brush, remove the drive components for those options from cutting unit. Refer to Removing the Gear Box Assembly (page 8–5), and/or Rear Roller Brush (Optional) (page 7–32) for additional information.
3. Remove the fasteners that secure the counterweights to the left side plate, and remove the counterweights. Remove and discard the O-ring.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when removing the cutting reel.

IMPORTANT

If the reel bearings or seals are being replaced, the reel nuts must be removed. Use the following procedure to restrain the reel and loosen the reel nuts before removing the rollers.

4. Loosen the reel nuts:
   A. Tip up the cutting unit to access the bottom of the reel.

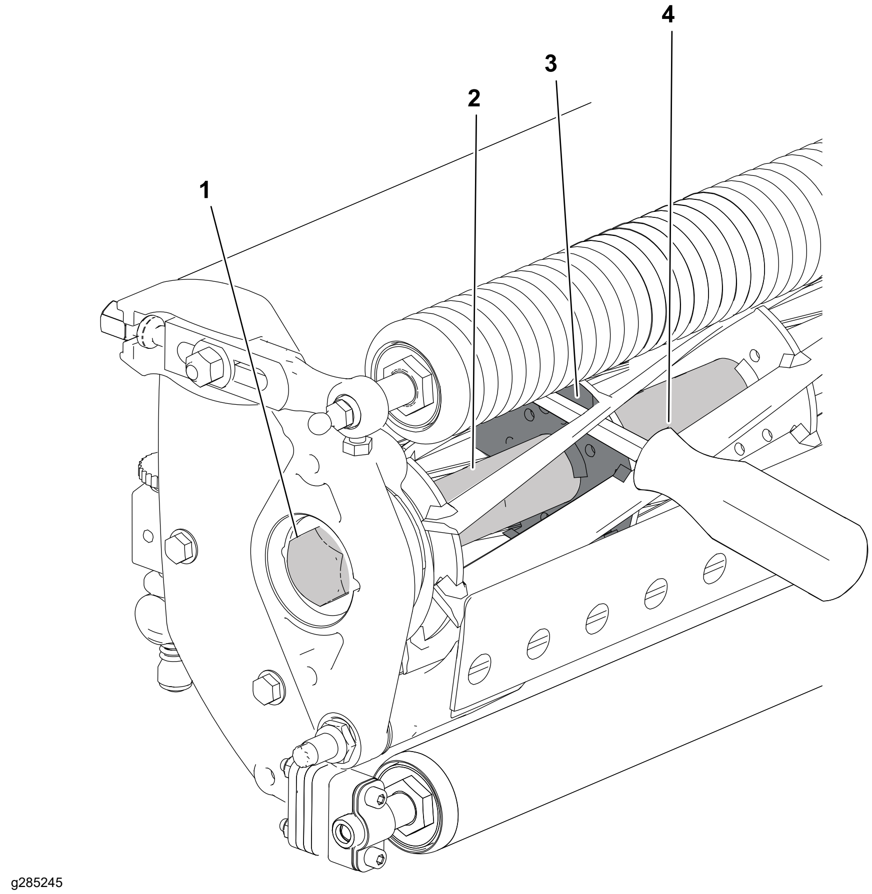


Figure 200

1. Reel nut (right end shown)
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

Removing the Reel Assembly (continued)

B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the reel nut being loosened.

IMPORTANT

The reel nut on the left end of the cutting reel has a black finish and has left-hand threads. The reel nut on the right end of the cutting reel has a silver finish and has right-hand threads.

D. Rest the handle of the pry bar against the front roller and loosen the reel nut closest to the pry bar.

E. Position the pry bar in the same manner on the opposite end of the reel and loosen the remaining reel nut.

F. Tip the cutting unit back onto its rollers.

5. Remove the bedbar; refer to Removing the Bedbar (page 7–6).
6. Remove the front roller; refer to Removing the Front Roller (page 7–25).
7. Remove the rear roller; refer to Removing the Rear Roller (page 7–26).
8. Remove the fasteners that secure the crosslink (item 15) to pitch arms and remove the crosslink.
9. Support the cutting reel to prevent it from shifting or falling and remove the two shoulder bolts and two flange nuts that secure either side plate to the cutting unit frame. Remove the side plate from the cutting unit.
10. Carefully slide the cutting reel assembly (with seals, bearings and reel nuts) from the opposite side plate. Retrieve the flat wire spring from the reel bearing bore of the left side plate.
11. Thoroughly clean any grease and corrosion from the reel bearing bores in the side plates. Inspect side plates and pitch arms for wear or damage and replace components if needed.
12. Inspect the remaining cutting unit components for corrosion, wear, or damage and replace the components as necessary.

Inspecting the Reel Assembly

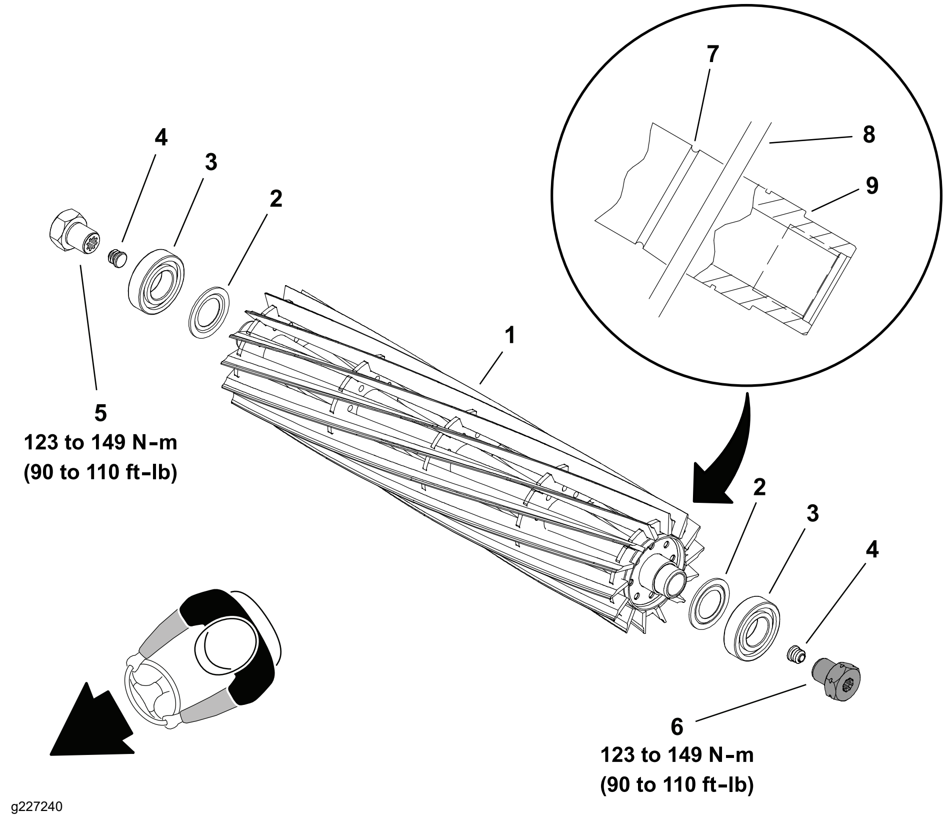


Figure 201

1. Cutting reel
2. Flocked seal (2 each)
3. Bearing (2 each)
4. Plug (2 each)
5. reel nut (right hand thread)
6. Reel nut (black – left hand thread)
7. Groove indication left hand threads
8. Left-most reel spider
9. Bearing shoulder

---

1. Remove the reel nuts from the cutting reel. Check the splines in the reel nuts for excessive wear or distortion and replace them if necessary.

   Note: Reels+™ is a line of replacement reels (with the seals and bearings pre-assembled) that arrive ready for installation into the cutting unit. Contact your local Toro Distributor for additional information.

2. Press the bearings and slide the seals from the reel shaft. Discard the seals and inspect the reel bearings to ensure that they spin freely and have a minimal amount of axial play.

3. Inspect the reel:

   A. Place the reel shaft ends in V-blocks and check the reel shaft for distortion.

   B. Check the threads in the ends of the reel shaft. A right-hand thread and left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–18).

   C. Check the reel blades for bending or cracking.

   D. Check the service limit of the reel diameter; refer to Preparing the Reel for Grinding (page 7–22).

   E. Replace the reel if damage is evident.

Inspecting the Reel Assembly (continued)

IMPORTANT

The seal must be installed with the flocked side of the seal toward the bearing.

4. Slide the new flocked seals and press the bearings onto the reel shaft until they contact the shoulder of the reel shaft.

   Note: The reel nut on the left end of the cutting reel has a black finish and has left-hand threads. The left end of the cutting reel shaft is identified with a groove cut just inside of the left-most reel spider. The reel nut on the right end of the cutting reel has a silver finish and has right-hand threads.

5. Install the reel nuts finger tight.

Installing the Reel Assembly

Refer to Figure 199 for this procedure.

1. Position the cutting unit on a flat work area.
2. If previously removed; attach the right side plate to the cutting unit frame. Tighten the shoulder bolts from **24 to 27 N·m (18 to 20 ft-lb)**.
3. Install the right side pitch arm.

CAUTION

Contact with the reel, bedknife or other cutting unit parts can result in personal injury. Use heavy gloves when installing the cutting reel.

4. Apply a thin coat of grease to the outside of the cutting reel bearings and carefully slide the cutting reel assembly into the right side plate. Make sure that the reel bearing is fully seated in the side plate, and that the real nut on the left (exposed) end of the cutting reel has a black finish.
5. Place the flat wire spring into the bearing bore of the left side plate. Install the left side pitch arm and carefully slide the left side plate and pitch arm onto the cutting reel assembly as far as possible.
6. Install the shoulder bolts and flange nuts that secure the left side plate to the cutting unit frame. Tighten the shoulder bolts from **24 to 27 N·m (18 to 20 ft-lb)**.
7. Install the rear roller; refer to Installing the Rear Roller (page 7–27).
8. Install the front roller; refer to Installing the Front Roller (page 7–25).
9. Install the bedbar assembly; refer to Installing the Bedbar (page 7–7).
10. Tighten the reel nuts:

    A. Insert a long-handled pry bar (3/8 x 12 inch with a screwdriver handle recommended) through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

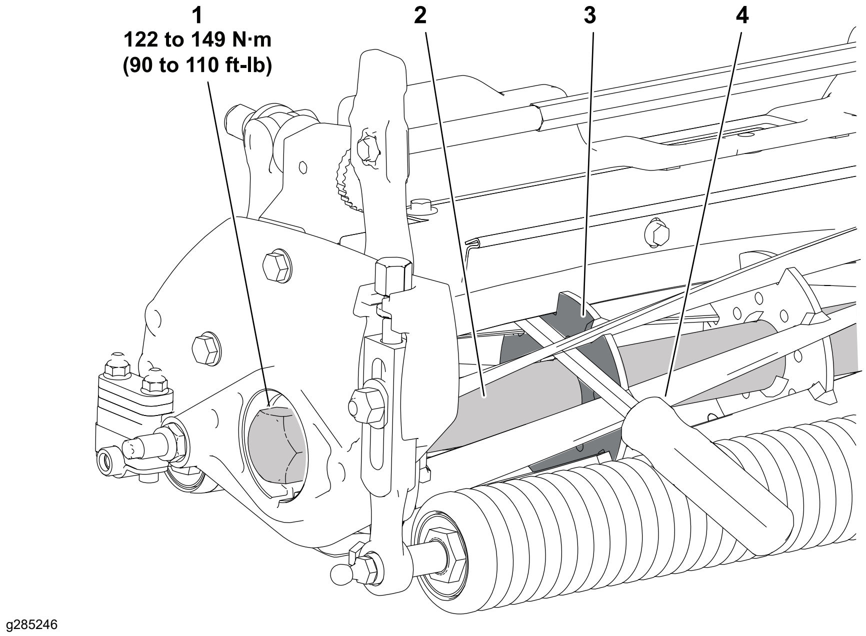


Figure 202

1. Reel nut (right end shown)
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

B. Move the pry bar against the weld side of the reel support plate closest to the reel nut being tightened.

IMPORTANT

The reel nut on the left end of the cutting reel has a black finish and has left-hand threads. The reel nut on the right end of the cutting reel has a silver finish and has right-hand threads.

C. Rest the handle of the pry bar against the front roller and tighten the reel nut closest to the pry bar. Tighten the reel nut from **123 to 149 N·m (90 to 110 ft-lb)**.

D. Position the pry bar in the same manner on the opposite end of the reel and tighten the remaining reel nut.

E. Fill the reel nut splines with high temp Mobil XHP−222 grease or equivalent.

11. Check to make sure the rear roller and cutting reel are parallel; refer to Leveling the Rear Roller (page 7–3).

12. Install a new O-ring on the counterweight assembly and secure the counterweights to the right side plate with the fasteners previously removed.

Installing the Reel Assembly (continued)

13. If the cutting unit is equipped with an optional groomer or optional rear roller brush, install the components for those options. Refer to Installing the Gear Box Assembly (page 8–11), and Rear Roller Brush (Optional) (page 7–32) for additional information.

Preparing the Reel for Grinding

Reel Grinding Specifications

Reel Diameter New (D)	128.5 mm (5.06 inch)
Reel Diameter Service Limit	114.3 mm (4.50 inch)
Reel Diameter Taper Limit (D1 – D2)	0.25 mm (0.01 inch)
Blade Land Width	0.8 to 1.2 mm (0.03 to 0.05 inch)
Blade Relief Angle	30° ±2°
Reel Shaft Diameter	34.9 mm (1.375 inch)

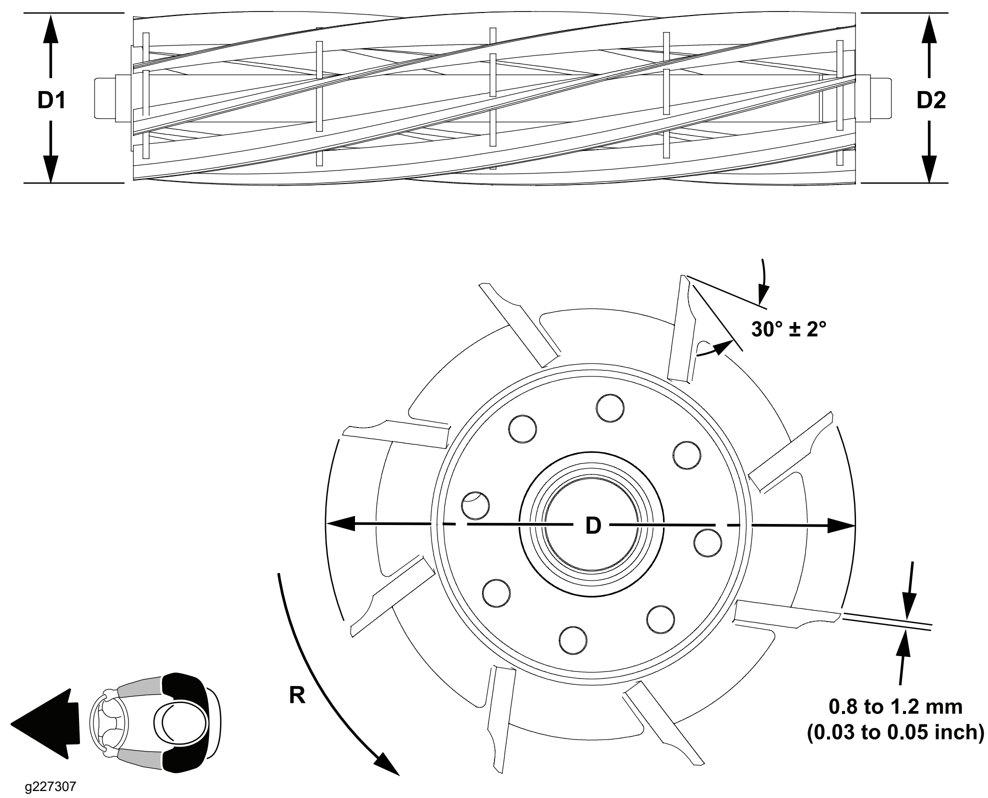


Figure 203
(R = Direction of Rotation)

Before grinding a cutting reel, make sure that all the cutting unit components are in good condition. Depending on the type of grinder used, faulty cutting unit components can affect the grinding results. When grinding, be careful to not overheat the cutting reel blades. Remove small amounts of material with each pass of the grinder.

Follow reel grinder manufacturer's instructions to grind cutting reel to Toro specifications; refer to Reel Grinding Specifications (page 7–22). Additional reel grinding information can be found in the *Cutting Unit Operator's Manual*. An additional resource is the Toro Basics Series Training Book, Reel Mower

Preparing the Reel for Grinding (continued)

Basics (part no. 09168SL) found on the Service Reference Set available from your Authorized Toro Distributor.

Relief grind the reel blades to the minimum blade land width if the reel blade land width exceeds the service limit. Spin grind the reel to establish the specified blade land width or to restore the reel's cylindrical shape.

Note: Always adjust the cutting unit after grinding the reel and/or bedknife; refer to the *Cutting Unit Operator's Manual*. To extend the cutting unit performance by allowing the reel and the bedknife to hold their edge longer, an additional adjustment may be required after the first few minutes of operation as the reel and bedknife conform to each other.

Electric Cutting Unit Motor Adapter

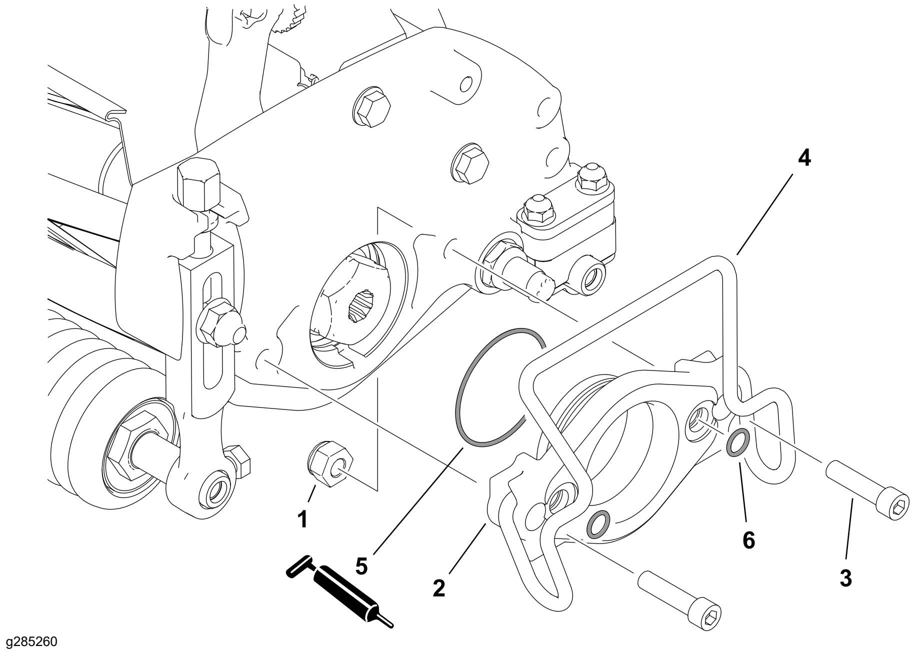


Figure 204

1. Hex nut (2 each)
2. Motor adapter
3. Socket head screw (2 each)
4. Motor clamp
5. O-ring
6. O-ring (2 each)

Removing and Installing the Cutting Unit Motor Adapter

Refer to Figure 204 for this procedure.

1. Remove the electric motor from the cutting unit and move it to the storage location at the front of the cutting unit suspension.
2. Remove the motor adapter from the cutting unit side plate.

   Note: The lock nuts are captured in the back side of the side plate.
3. Remove the large O-ring and the 2 small O-rings from the motor adapter. Discard the large O-ring.
4. Lubricate a new, large O-ring with grease and install in on the motor adapter.
5. Install the 2 small O-rings in the motor adapter without lubrication. Ensure the O-rings are correctly positioned in the motor adapter grooves.
6. Install the motor adapter to the cutting unit side plate and install the electric cutting unit motor.

Roller Assemblies

Removing the Front Roller

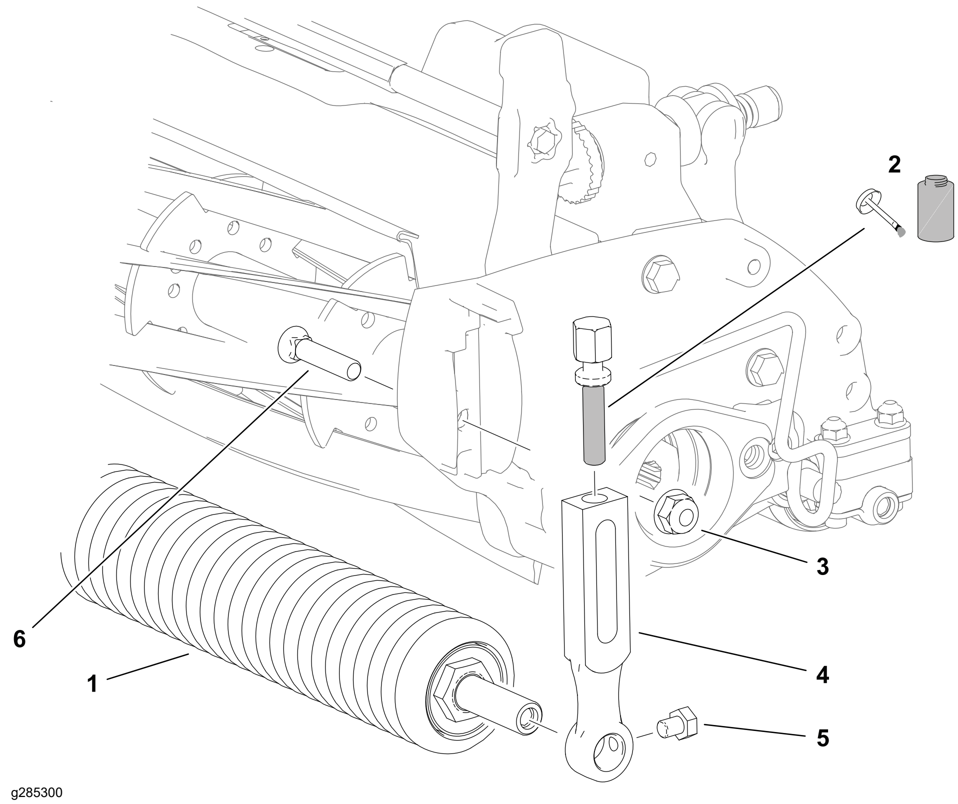


Figure 205

1. Front roller assembly
2. Height-of-cut screw (2 each)
3. Lock nut (2 each)
4. Height-of-cut arm (2 each)
5. Pinch bolt (2 each)
6. Plow bolt (2 each)

Refer to Figure 205 for this procedure.

1. Remove the cutting unit from the machine and place it on a level work surface. Use an appropriate support to raise the front roller off the work surface.
2. Loosen the pinch bolts that secure the front roller shaft to the front height-of-cut arms.
3. Remove the lock nut, height-of-cut washer and plow bolt that secures one of the height-of-cut arms to the cutting unit side plate and remove the height-of-cut arm.
4. Slide the front roller assembly from the remaining height-of-cut arm.
5. Remove the remaining height-of-cut arm from the cutting unit if necessary.

Installing the Front Roller

Refer to Figure 205 for this procedure.

1. Place the cutting unit on a level work surface. Use an appropriate support to raise the front of the cutting unit off the work surface.
2. Inspect the condition of both height-of-cut screws and replace them if necessary. Apply anti-seize lubricant to the threads of a new height-of-cut screw.

   Note: When installing the height-of-cut arms, make sure tab of the side plate fits between the head and the washer of the height-of-cut screw.

Installing the Front Roller (continued)

3. Secure one of the height-of-cut arms to the side plate with a plow bolt, height-of-cut washer and lock nut. The tab on the height-of-cut washer should be oriented downward and fit into the slot of the height-of-cut arm.
4. Slide the front roller shaft into the height-of-cut arm attached to the cutting unit.
5. Slide the remaining height-of-cut arm onto the other end of roller shaft. Secure the remaining height-of-cut arm to the side plate with a plow bolt, height-of-cut washer and lock nut.
6. Center the front roller in the cutting unit and tighten the pinch bolts that secure the front roller shaft to the height-of-cut arms.
7. Adjust the cutting unit height-of-cut; refer to the *Cutting Unit Operator's Manual*.

Removing the Rear Roller

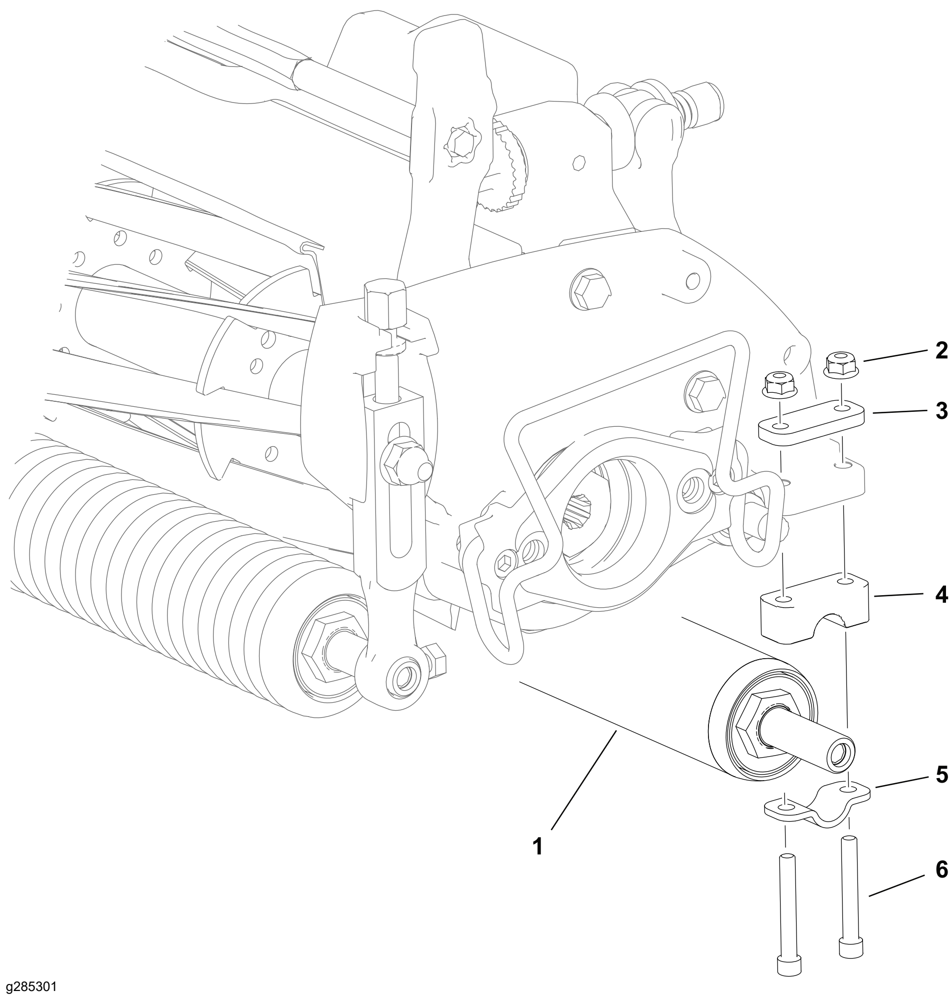


Figure 206

1. Rear roller assembly
2. Flange nut (2 each)
3. Shim
4. Spacer
5. Shaft retainer
6. Socket head screw (2 each)

Refer to Figure 206 for this procedure.

1. Remove the cutting unit from the machine and place it on a level work surface. Place blocks under the bedbar to raise the rear roller off the work surface.

Removing the Rear Roller (continued)

2. Loosen the flange nuts that secure the rear roller retainer assemblies (flange nuts, socket head screws, shaft retainer, spacer and shims) to the cutting unit.

   Note: On cutting units equipped with the optional High Height-of-Cut Kit, there will be additional roller shims installed between the rear roller and the cutting unit side plate.

3. Remove one of the rear roller retainer assemblies.
4. Slide the rear roller assembly from the remaining retainer assembly.
5. Remove the remaining retainer assembly from the cutting unit if necessary.

Installing the Rear Roller

Refer to Figure 206 for this procedure.

1. Place the cutting unit on a level work surface. Place blocks under the bedbar to raise the rear of the cutting unit off the work surface.

   Note: Refer to the *Cutting Unit Operator's Manual* to determine the number of shims required for the desired height-of-cut range.

2. If previously removed, install one of the rear roller retainer assemblies (flange nuts, socket head screws, shaft retainer, spacer and shims) to the cutting unit.
3. Slide the rear roller shaft into the retainer assembly attached to the cutting unit.
4. Install the remaining rear roller retainer assembly.
5. Center the rear roller in the cutting unit and tighten the flange nuts at each of the retainer assemblies.
6. Check to make sure the rear roller and the cutting reel are parallel; refer to Leveling the Rear Roller (page 7–3).

Disassembling the Roller

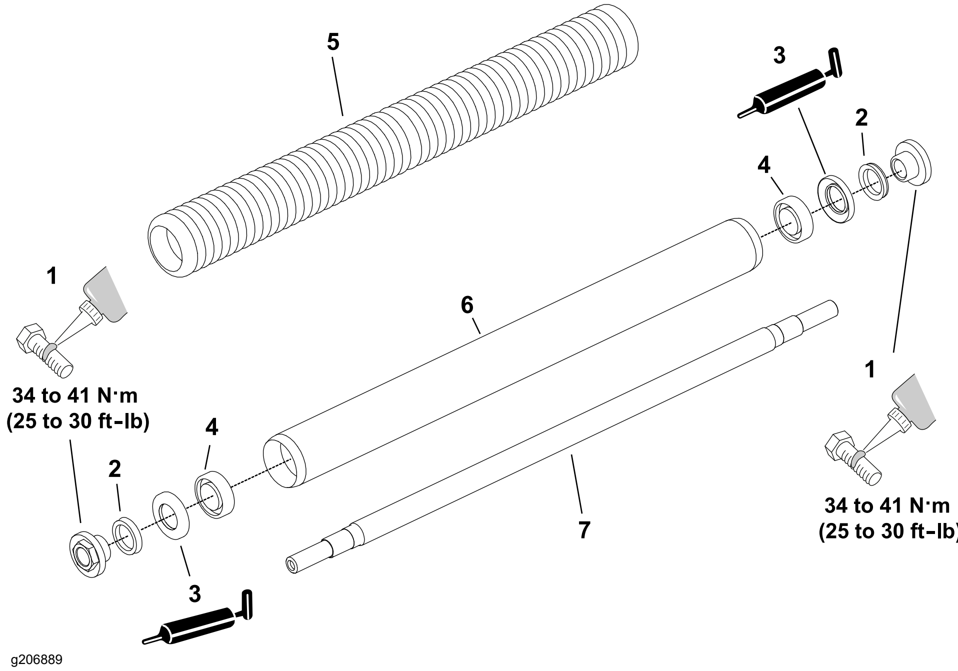


Figure 207

1. Bearing lock nut
2. V-ring
3. Seal
4. Ball bearing
5. Wiehle roller
6. Smooth roller
7. Roller shaft

---

1. To hold the roller shaft stationary while removing the bearing lock nut, install a 3/8-24 UNF 2B screw with a jam nut into the threaded end of the roller shaft and tighten the jam nut against the roller shaft. Remove the bearing lock nuts.
2. Carefully inspect the seating surface and threads of the bearing lock nuts and replace them if damaged.
3. Remove and discard the V-rings.
4. Loosely secure the roller assembly in a bench vise and lightly tap on the roller shaft to remove the seals and bearings. Discard the seals.
5. Clean and carefully remove any corrosion from the bearing cavities of the roller.

Assembling the Roller

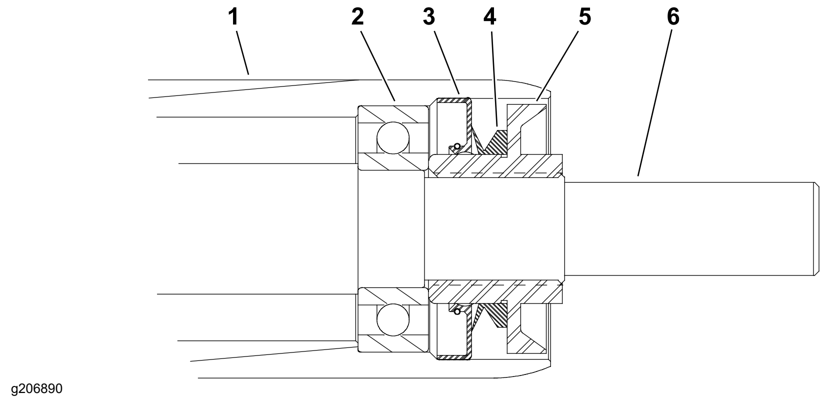


Figure 208

1. Roller
2. Ball bearing
3. Seal
4. V-ring
5. Bearing lock nut
6. Roller shaft

Note: Special tools are required to assemble the rollers; refer to Roller Rebuilding Tools (page 2–20). The following procedure describes the assembling the rollers using the set of assembly washers and spacers.

1. Place the roller shaft into the roller.

IMPORTANT

If the bearing lock nuts are being replaced, use the original lock nuts for installing the bearings and seals, if possible, to preserve the patch lock feature of the new lock nuts. Use the new nuts only after the bearings and seals have been installed.

2. Position a new bearing, the black assembly washer, and a bearing lock nut onto each end of the roller shaft.

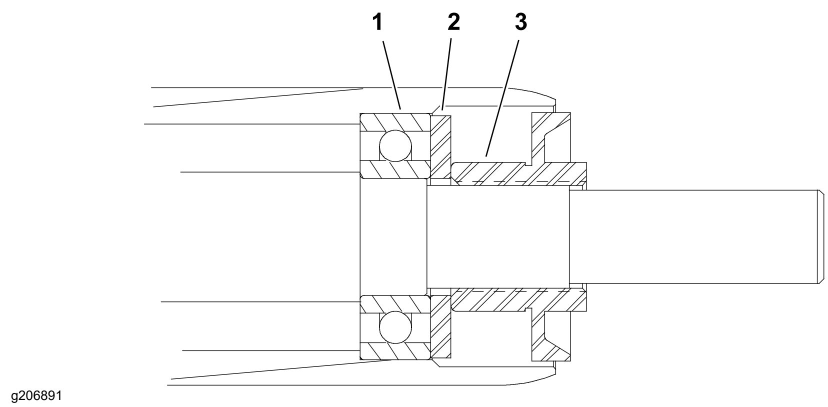


Figure 209

1. Bearing
2. Black assembly washer
3. Bearing lock nut

3. Tighten the bearing lock nuts until both bearings are seated in the roller.
4. Remove the bearing lock nuts and the black assembly washers.

Assembling the Roller (continued)

IMPORTANT

Failure to grease bearing lock nut before seal installation may result in seal damage.

5. Fill the seal 75 to 90% full with #2 grease, and apply a coating of grease to the underside of the bearing lock nut to prevent damaging the seal damage during installation. Carefully fit a seal onto each bearing lock nut.

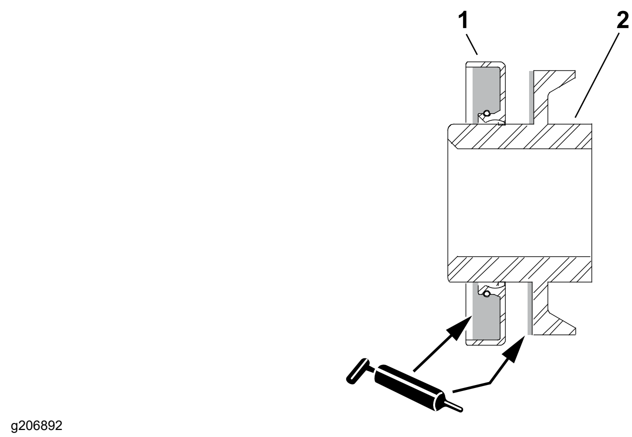


Figure 210

1. Seal
2. Bearing lock nut

6. Install a bearing lock nut with seal onto each end of the roller shaft. Tighten the bearing lock nuts until they bottom against the bearings. Remove the bearing lock nuts and clean away any grease.

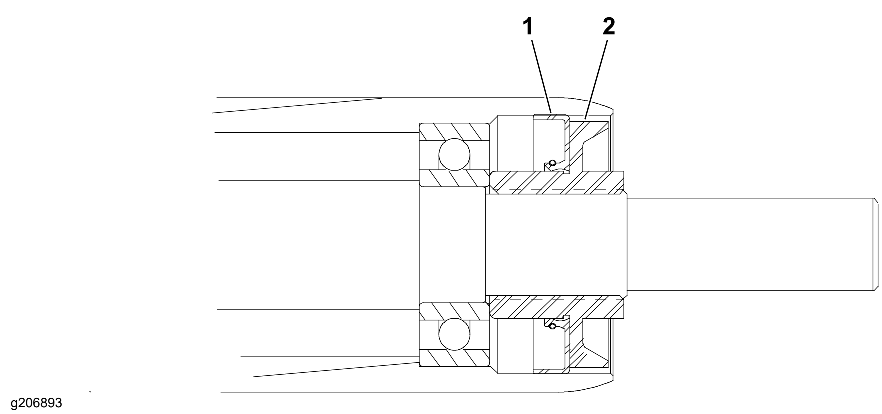


Figure 211

1. Seal
2. Bearing lock nut

7. Position an assembly spacer and yellow assembly washer on each end of the roller shaft.

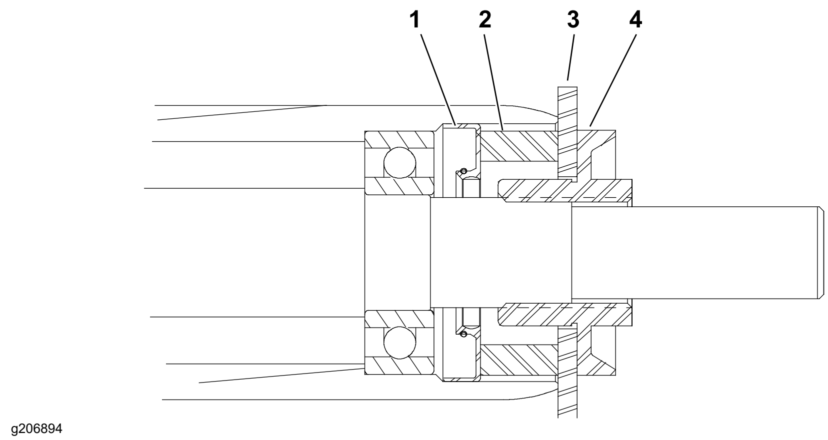


Figure 212

1. Seal
2. Assembly spacer
3. Yellow assembly washer
4. Bearing lock nut

8. Tighten the bearing lock nuts until the yellow assembly washers bottom out against the roller housing. Remove the bearing lock nuts, assembly washers, and assembly spacers.

   Note: The V-rings should be installed without any lubrication.

9. Carefully fit a dry V-ring onto each bearing lock nut.

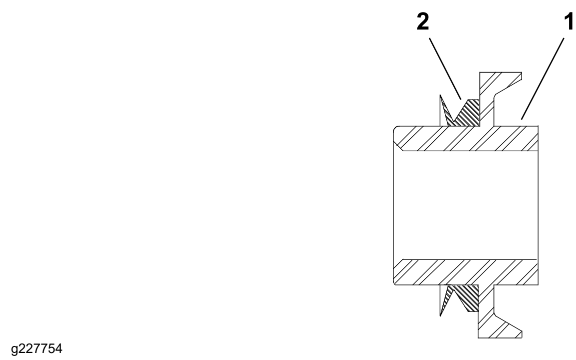


Figure 213

1. Bearing lock nut
2. V-ring

10. Lubricate the lips of the installed seals with #2 general purpose grease.

    Note: If an original bearing lock nut is being used, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.

11. Install the bearing lock nut with V-ring onto each end of the roller shaft. Tighten the lock nuts to **34 to 41 N·m (25 to 30 ft-lb)**.

Rear Roller Brush (Optional)

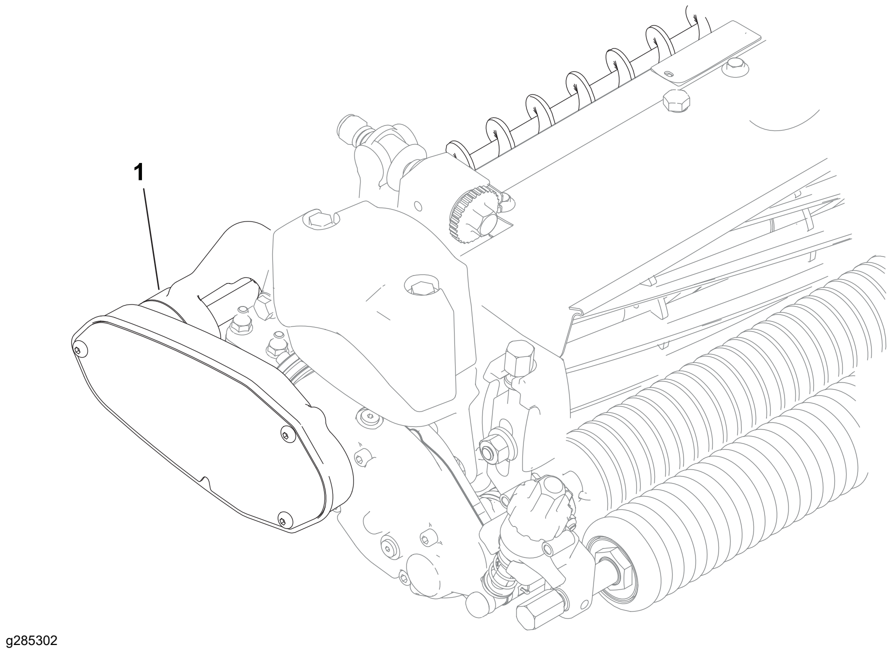


Figure 214
(shown with Universal Groomer installed)

1. Rear roller brush assembly

Note: The *Installation Instructions* for the rear roller brush kit has detailed information regarding assembly and adjustment. Use the *Installation Instructions* along with this *Service Manual* when servicing the rear roller brush.

For eTriFlex machines, the drive components for the rear roller brush are located on the right side of the cutting unit (opposite from the electric cutting unit motor).

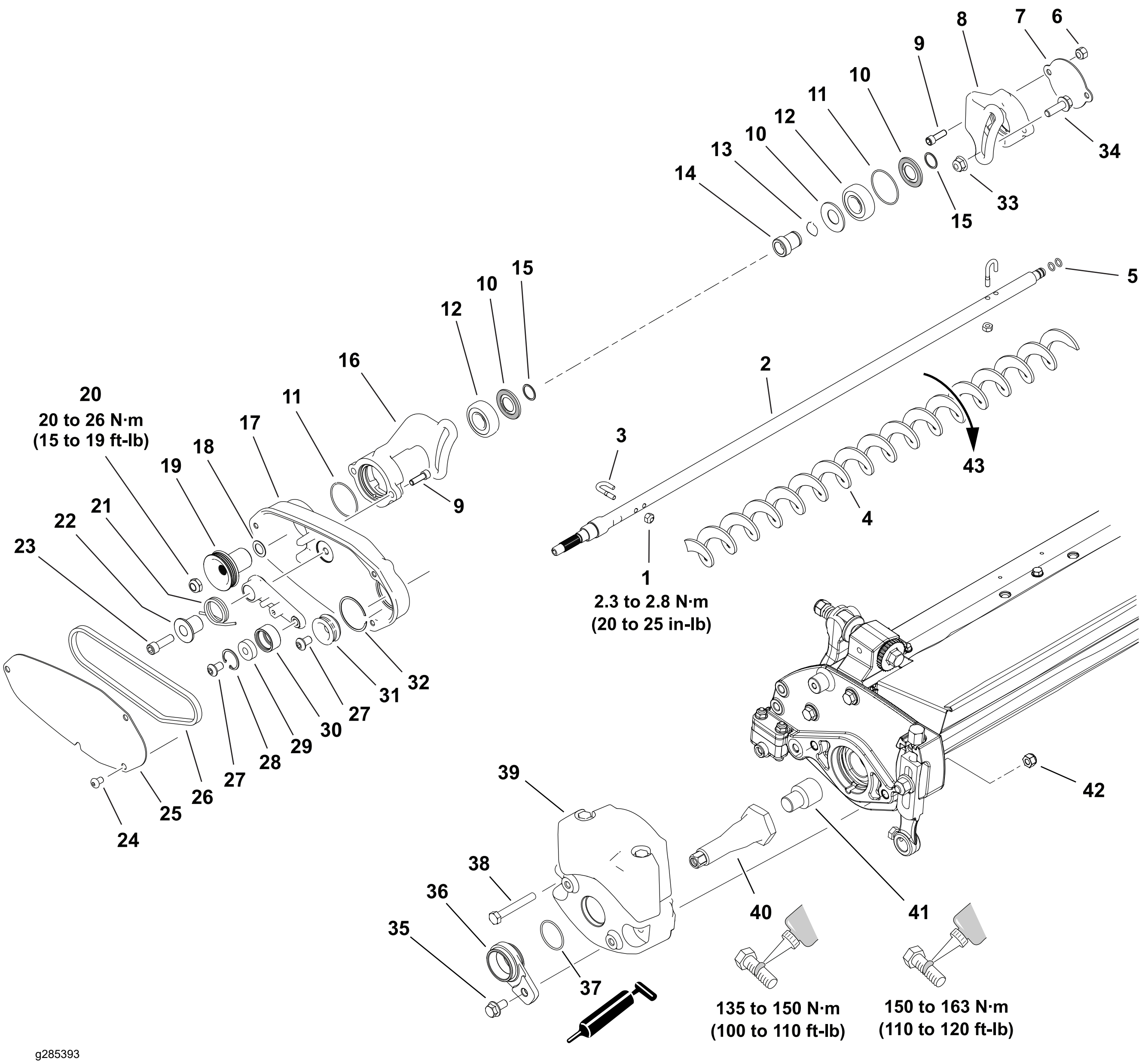


Figure 215

(shown without Universal Groomer installed)

1. Lock nut (2 each)
2. Brush shaft
3. J-bolt (2 each)
4. Brush element
5. O-ring (2 each)
6. Lock nut (2 each)
7. Cover
8. Bearing bracket RH
9. Socket head screw (4 each)
10. Flocked seal (3 each)
11. O-ring (2 each)
12. Bearing (2 each)
13. Retaining ring
14. Collar
15. Retaining ring (2 each)
16. Bearing bracket LH
17. Drive housing
18. Spacer (as required)
19. Driven pulley
20. Lock nut
21. Torsion spring
22. Idler bushing
23. Socket head screw
24. Socket head screw (3 each)
25. Cover
26. Drive belt
27. Socket head screw (2 each)
28. Retaining ring
29. Bearing
30. Idler pulley
31. Drive pulley
32. Retaining ring
33. Flange nut (4 each)
34. Flange head screw (4 each)
35. Flange head screw
36. Adapter housing (used without groomer)
37. O-ring
38. Cap screw (2 each)
39. Counterweight assembly
40. Drive shaft (used without groomer)
41. Drive adapter – silver (used without groomer)
42. Lock nut (2 each)
43. Direction of brush rotation

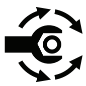
CAUTION

Contact with the reel or other cutting unit parts can result in personal injury. Use heavy gloves when handling the cutting reel.

Replacing the Roller Brush Element

Refer to Figure 215 for this procedure.

1. Remove the cutting unit from the machine and place it on a level work surface.
2. Remove the RH bearing bracket assembly.
3. Remove the brush element from the shaft.
4. Slide the new brush element onto the shaft while rotating the brush.



5. Install the J-bolts and lock nuts making sure the threaded portion of the J-bolts are installed on the outside of the brush element. Tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.
6. Apply a thin coating of grease to the O-rings on the brush shaft and install the RH bearing bracket.

IMPORTANT

If brush to roller contact is incorrect, brush operation will be adversely affected.

7. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the bearing brackets as necessary.

Drive and Support Components

Note: The drive shaft assemble is used on cutting units with a rear roller brush but without a universal groomer drive.

Refer to Figure 215 for this procedure.

1. Disassemble the roller brush components as necessary. Retrieve and discard the adapter housing O-ring (machines without a universal groomer).
2. Clean and inspect all components for wear or damage and replace as necessary.
3. If the drive shaft and drive adapter (items 40 or 41) require replacement (machines without a universal groomer):
   A. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

Drive and Support Components (continued)

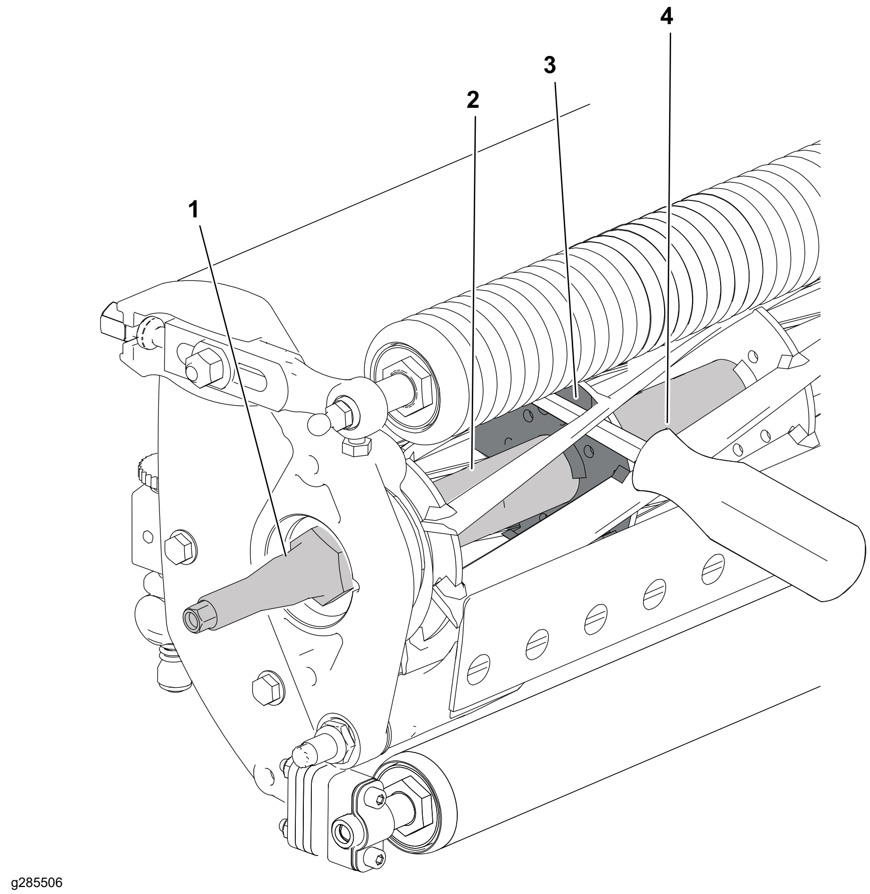


Figure 216

1. Drive shaft assembly (rear roller brush adapter kit)
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

B. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

C. Move the pry bar against the weld side of the reel support plate closest to the rear roller brush drive shaft.

D. Rest the handle of the pry bar against the front roller and use the large hex (1.375 inch) to loosen the drive shaft assembly.

E. Tip the cutting unit back onto its rollers.

F. Clean the threads in the end of the reel shaft. A right-hand thread and left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–18).

G. Assemble the drive shaft and drive adapter (machines without a universal groomer) with a medium strength thread locking compound (Loctite 243 or equivalent) and tighten from **150 to 163 N·m (110 to 120 ft-lb)**.

H. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

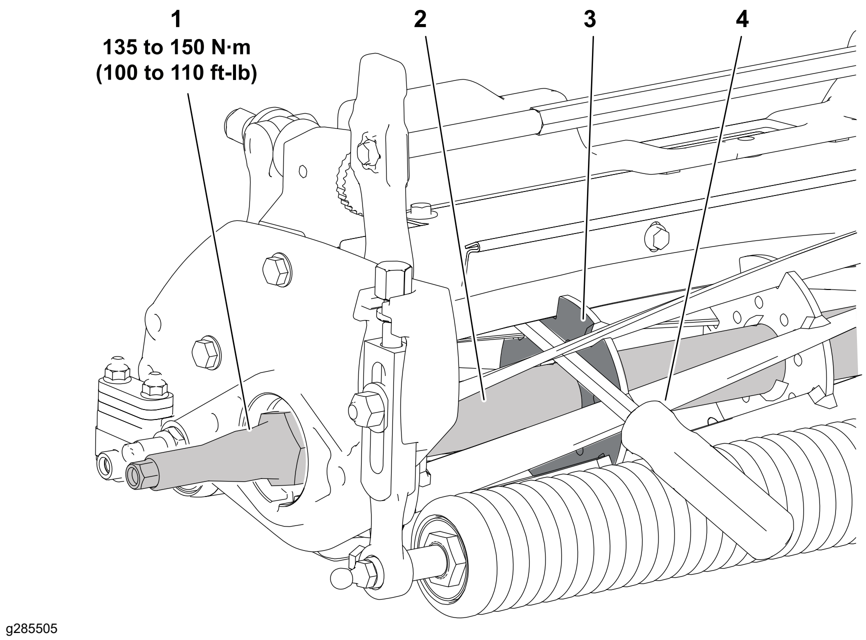


Figure 217

1. Drive shaft assembly (rear roller brush adapter kit)
2. Reel shaft
3. Weld side of reel support plate
4. Pry bar

I. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

J. Rest the handle of the pry bar against the front roller. Use the large hex (1.375 inch) and tighten the drive shaft from **135 to 150 N·m (100 to 110 ft-lb)**.

Note: The screw used to secure the adapter housing has a locking feature to prevent the screw from loosening. If the original screw is being re-used, apply a medium strength thread locker (Loctite #242 or equivalent).

4. Apply a light coating of grease to a new O-ring and install the adapter housing (machines without a universal groomer).
5. Install the drive housing and LH bearing bracket.
6. Apply a thin coating of grease to the O-rings on the brush shaft and fit the RH bearing bracket over the brush shaft.

   Note: Install all flocked seals with the flocked surface against the bearing.

7. Install a flocked seal and the retaining ring onto the brush shaft.
8. Install the brush and RH bearing bracket assembly.
9. Install the drive pulley.

IMPORTANT

The brush drive belt may fail prematurely if the pulleys are not properly aligned.

10. Using a straight edge, determine the number of spacers necessary under the driven pulley to align the pulleys. Tighten the lock nut securing the driven pulley from **20 to 26 N·m (15 to 19 ft-lb)**.

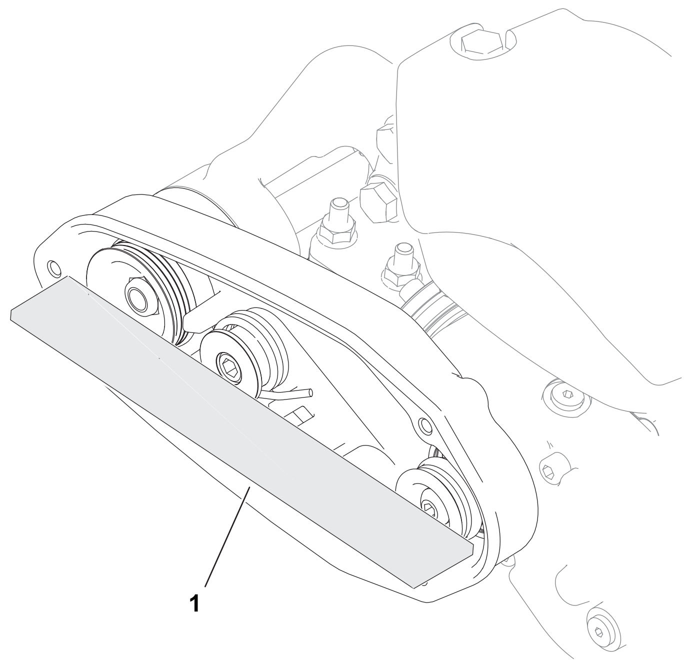


Figure 218

(Shown with Universal Groomer installed)

1. Straight edge

11. Install and adjust the drive belt and install the cover.

IMPORTANT

If brush to roller contact is incorrect, brush operation will be adversely affected.

12. Check that the roller brush is parallel to the rear roller within **0.25 mm (0.010 inch) clearance to light contact**. Adjust the bearing brackets as necessary.

Universal Groomer (Optional)

Table of Contents

General Information

Installation Instructions

The *Installation Instructions* for the groomer provides information regarding the set-up, operation, general maintenance procedures, and maintenance intervals for the groomer assembly on your Greensmaster machine. Refer to the *Installation Instructions* for additional information when servicing the groomer assembly.

Service and Repairs

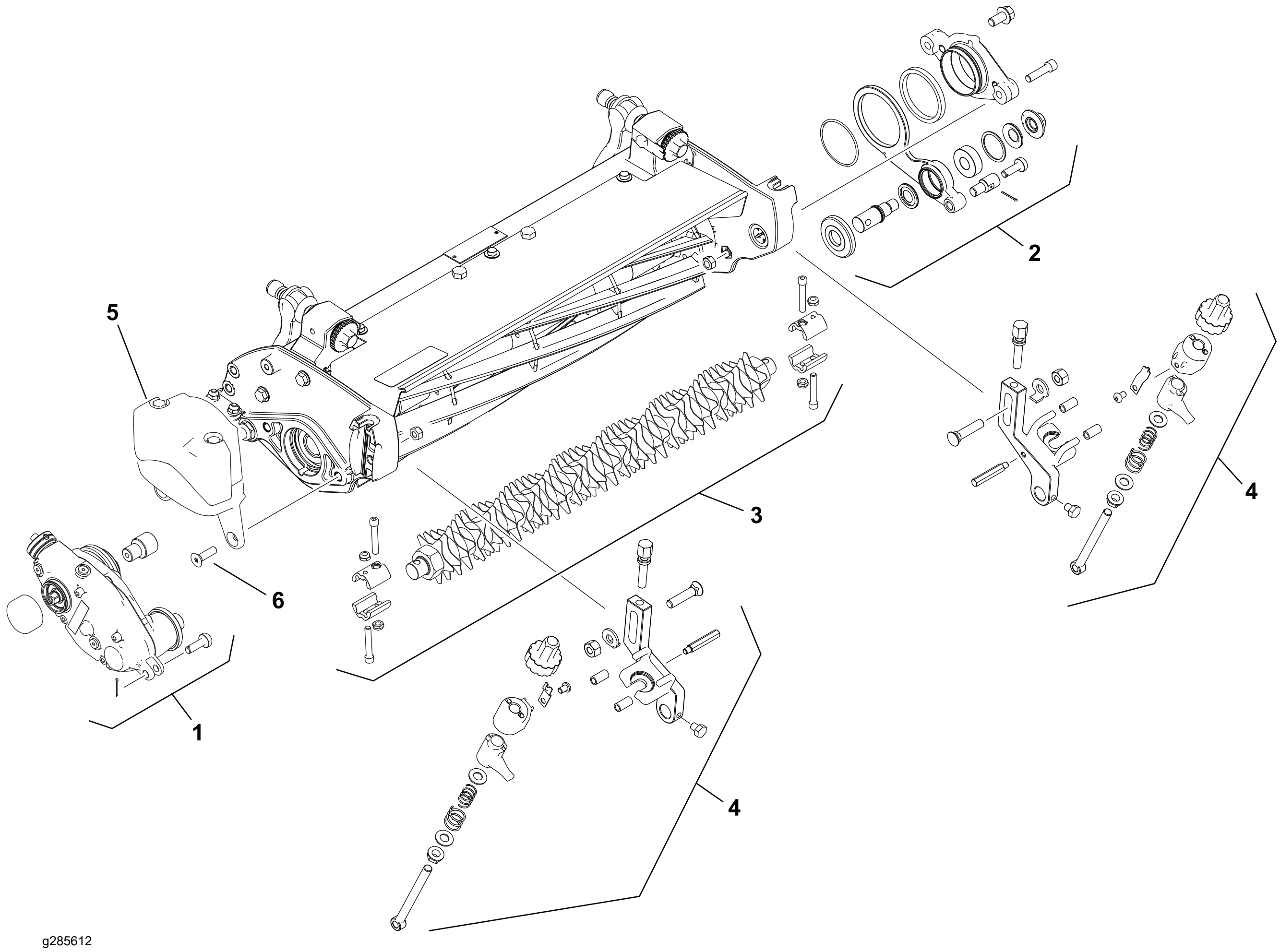


Figure 219

1. Gear box assembly
2. Idler assembly
3. Groomer reel
4. Height adjuster assembly (2 each)
5. Counterweight assembly
6. Flat head screw (2 each)

CAUTION

Never work on the groomer with the key switch in the ON or START position. Always set the key switch to the OFF position, remove the key from the switch and wait for all machine movement to stop before working on the groomer.

The Gear Box Assembly

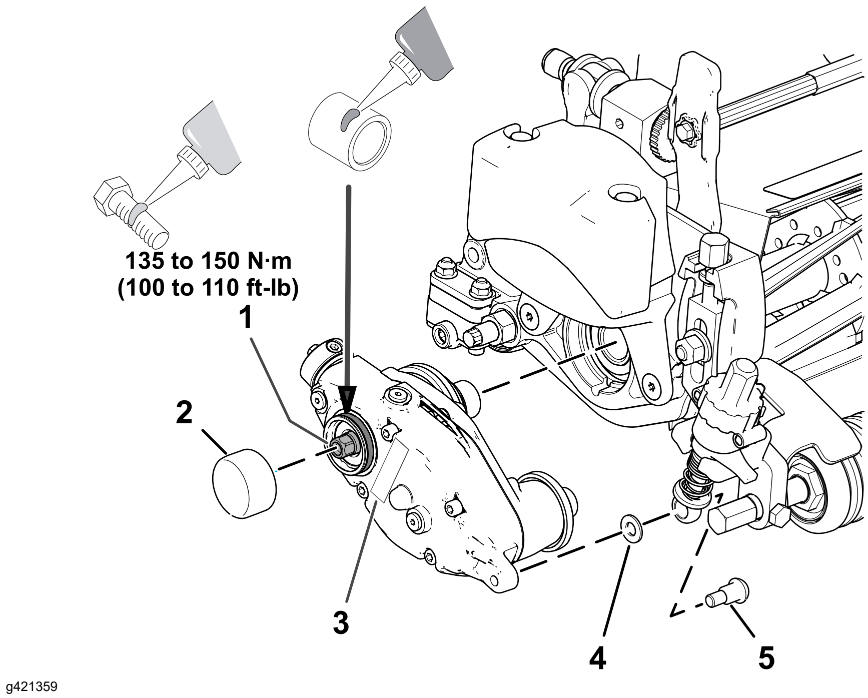
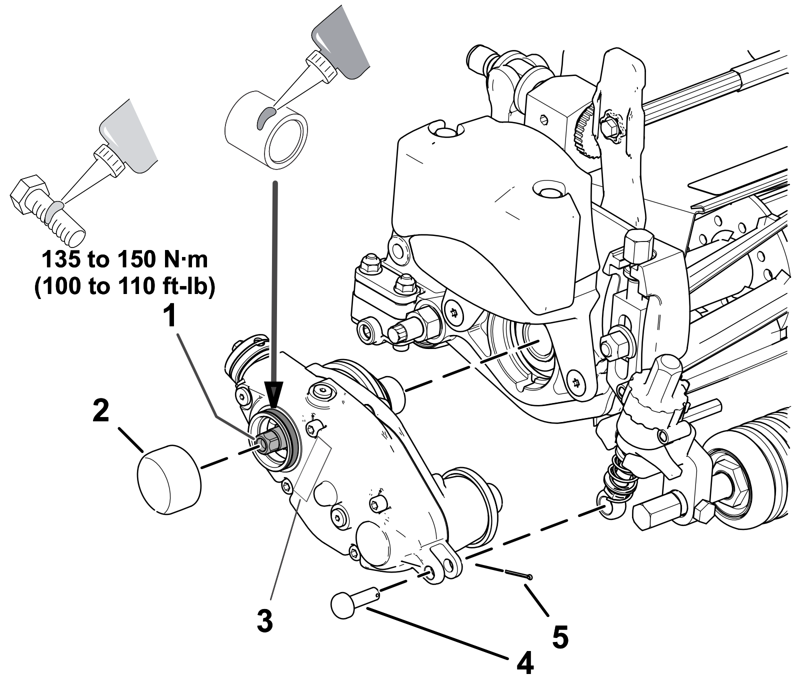


Figure 220

Single-Lug Gearbox

1. Input shaft
2. Cap
3. Gear box assembly
4. Washer (hardened(
5. Shoulder screw



g421358

Figure 221

2-Lug Gearbox

1. Input shaft
2. Cap
3. Gear box assembly
4. Adjuster pin
5. Cotter pin

The groomer gear box assembly is located on the opposite side of the cutting unit from the cutting unit motor. The groomer gear boxes for eTriFlex machines are installed on the right side of the cutting unit.

Removing the Gear Box Assembly

Refer to Figure 221 for this procedure.

1. Remove the cutting unit from the machine and place it on a level work surface.
2. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 8–16).
3. Remove the drive shield, or, if the cutting unit is equipped with an optional powered rear roller brush, remove the rear roller brush drive assembly to service the groomer drive; refer to Rear Roller Brush (Optional) (page 7–32).
4. Install a 5/16–18 X 5/8 inch square head set screw (Toro Part No. 1-803022) in the end of the drive shaft and tighten to **13 N·m (120 in-lb)**; refer to Figure 222.
5. Remove the cotter pin and clevis pin from the height adjustment rod at the front of the groomer gear box. Discard the cotter pin.
6. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

Removing the Gear Box Assembly (continued)

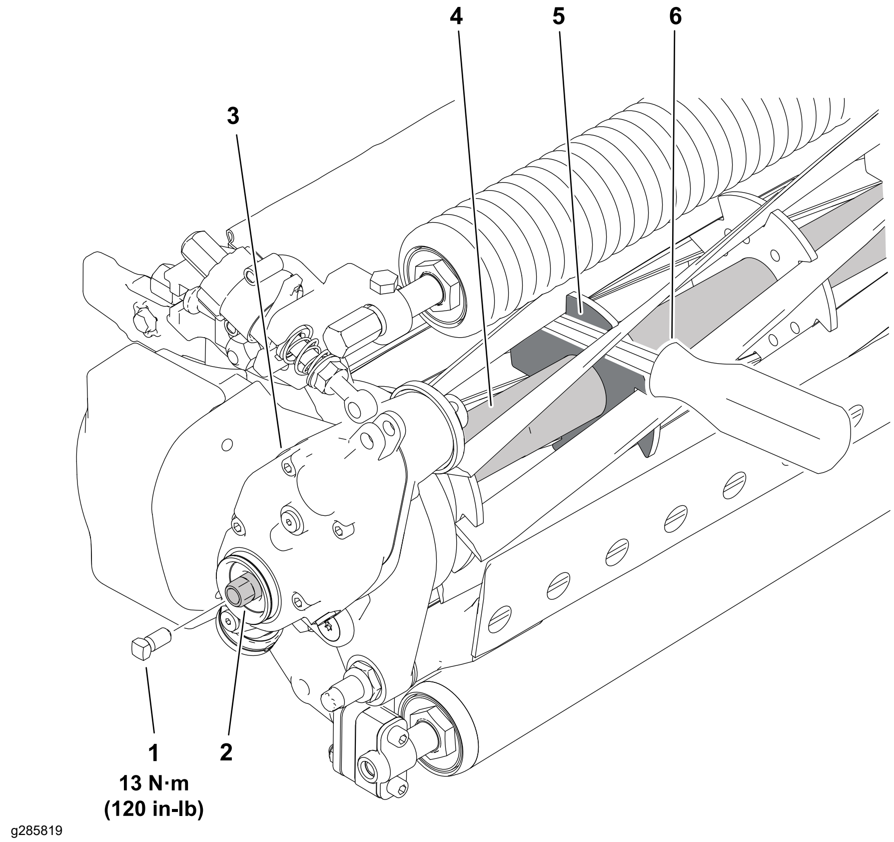


Figure 222

1. 5/16–18 X 5/8 inch square head set screw
2. Input shaft assembly
3. Groomer gear box assembly
4. Reel shaft
5. Weld side of reel support plate
6. Pry bar

7. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

8. Move the pry bar against the weld side of the reel support plate closest to the groomer gear box.

IMPORTANT

You must use a 6-point socket with a heavy wall to remove the gear box from the reel. Do not use an impact wrench. Groomer gear boxes installed on the right side of the cutting unit use a standard right hand thread; turn the drive shaft counterclockwise to remove the gear box.

Removing the Gear Box Assembly (continued)

9. Rest the handle of the pry bar against the front roller and turn the drive shaft counterclockwise to loosen it from the reel. Continue to unscrew the drive shaft and remove the gear box from the cutting unit.
10. If the hex head on the end of the drive shaft is damaged during removal:
    A. Remove the drain/fill plug and drain the oil from the gear box.

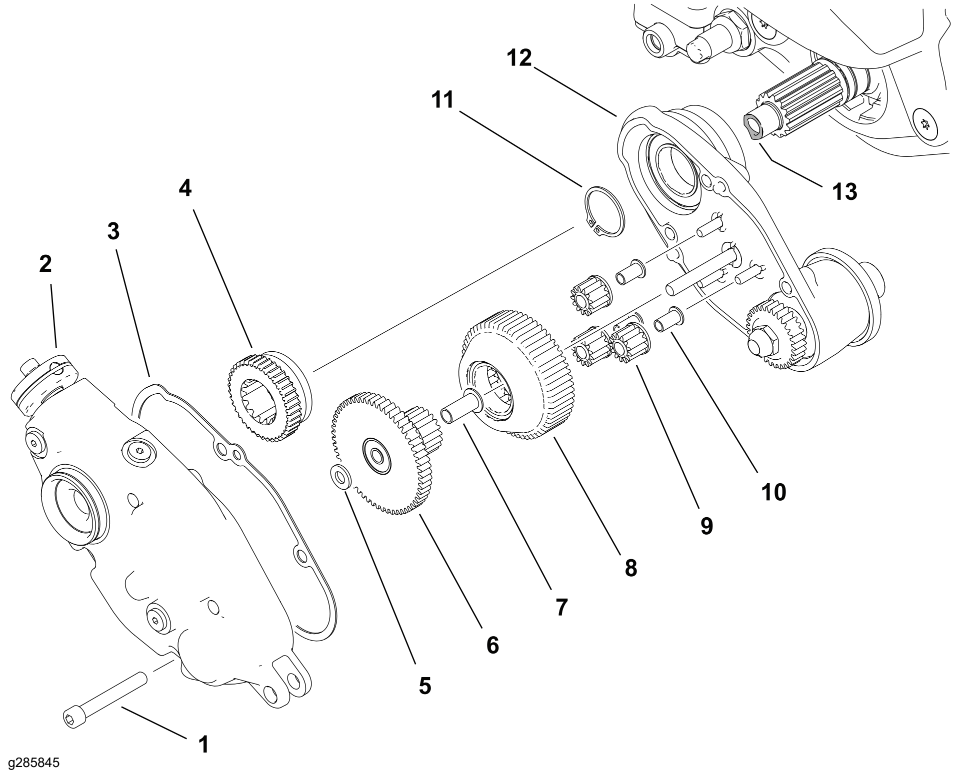


Figure 223

1. Socket head screw (4 each)
2. Gear box cover assembly
3. Cover gasket
4. Driven gear
5. Thrust washer
6. Ring gear
7. Flange bushing
8. Sun gear
9. Planet gear (3 each)
10. Flange bushing (3 each)
11. Retaining ring
12. Gear box housing assembly
13. Damaged drive shaft

B. Remove the 4 socket-head screws and remove the gear box cover assembly and driven gear. Remove and discard the cover gasket.

C. Slide the thrust washer, ring gear and bushing from the gear box housing.

D. Slide the sun gear, and planet gears and bushings from the pins on the gear box housing.

E. Remove the retaining ring from the drive shaft.

F. Slide the groomer housing assembly from the drive shaft.

G. Tip up the cutting unit to access the bottom of the reel to remove the drive shaft assembly.

Removing the Gear Box Assembly (continued)

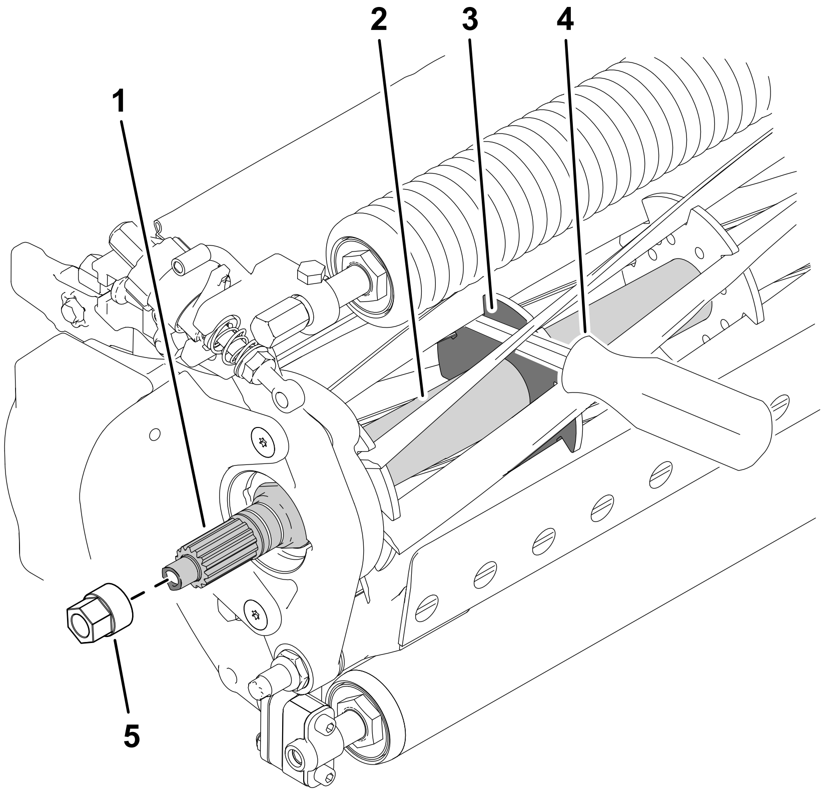


Figure 224

1. Damaged input shaft assembly
2. Drive shaft removal tool
3. Reel shaft
4. Weld side of reel support plate
5. Pry bar

H. Insert a long-handled pry bar (3/8 x 12 inch with screwdriver handle recommended) through the bottom of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

IMPORTANT

To avoid grinding the reel, do not contact the cutting edge of any blade with the pry bar as this may damage the cutting edge and/or cause a high blade.

I. Move the pry bar against the weld side of the reel support plate closest to the drive shaft assembly.

J. Use the drive shaft removal tool on the large flats of the drive shaft assembly; refer to Drive Shaft Removal Tool (page 2–21).

K. Rest the handle of the pry bar against the front roller and turn the drive shaft counterclockwise to loosen it from the reel.

11. Tip the cutting unit back onto its rollers.
12. Clean the threads in the end of the reel shaft. A right-hand thread and left-hand thread tap is available to clean or repair the threads if necessary; refer to Reel Thread Repair Taps (page 2–18).

Servicing the Gear Box

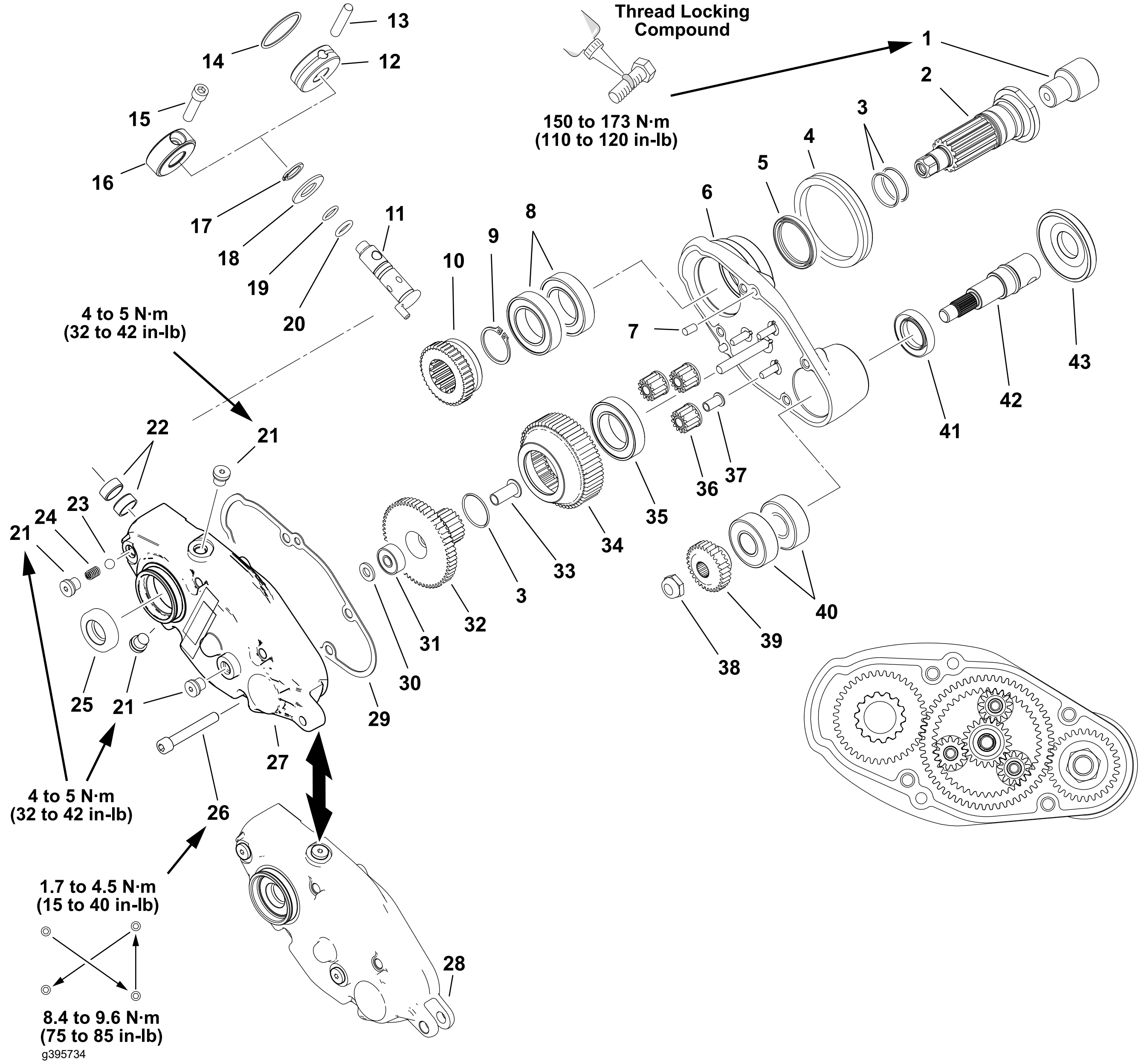


Figure 225

1.	Drive adapter	12.	Knob (2-lug gearbox)	23.	Detent ball	34.	Ring gear
2.	Input shaft	13.	Pin (2-lug gearbox)	24.	Detent spring	35.	Bearing
3.	O-ring (3 each)	14.	O-ring (2-lug gearbox)	25.	Oil seal	36.	Planet gear (3 each)
4.	V-ring	15.	Socket-head screw	26.	Socket-head screw(4 each)	37.	Flange bushing (3 each)
5.	Oil seal	16.	Knob (single-lug gearbox)	27.	Single-lug gearbox cover	38.	Lock nut
6.	Gearbox housing	17.	Retaining ring	28.	2-lug groomer gearbox cover	39.	Driver gear
7.	Dowel pin (2 each)	18.	Thrust washer	29.	Gasket	40.	Bearing (2 each)
8.	Ball bearing (2 each)	19.	O-ring	30.	Thrust washer	41.	Oil seal
9.	Retaining ring	20.	O-ring	31.	Ball bearing	42.	Driven shaft
10.	Driver gear	21.	Drain/fill plug (4 each)	32.	Sun gear	43.	Shield
11.	Actuator shaft	22.	Straight bushing (2 each)	33.	Flange bushing		

Servicing the Gear Box (continued)

1. Remove the drain/fill plug and drain the oil from the gearbox, and drain the oil.
2. Remove the 4 socket-head screws and separate the gearbox cover and housing. Remove and discard the cover gasket.
3. Remove the thrust washer, sun gear, ring gear, and planet gears from the pins on the gearbox housing.
4. Continue to disassemble the gearbox as necessary.

CAUTION

Use the large 34.9 mm (1-3/8 inch) flats on the drive shaft to prevent it from rotating when removing or installing the drive adapter.

***Do Not* use the 12.7 mm (1/2 inch) hex head of the drive shaft when removing or installing the drive adapter—drive shaft damage may occur.**

---

5. If the drive adapter requires replacement, apply medium strength thread locking compound (Loctite 243 or equivalent) to the internal threads of the groomer gearbox drive shaft. Allow the thread locking compound to cure for 15 minutes before continuing this procedure.

   Note: A special tool is available to hold the drive shaft if necessary; refer to Special Tools (page 2–14).

6. Torque the drive adapter to **150 to 163 N·m (110 to 120 ft-lb)**. Allow the thread locking compound to cure for 15 minutes before continuing this procedure.
7. Carefully clean all the gasket material from the gearbox housing and cover.
8. Inspect the V-ring, seals, bearings, gears, and bushings in the gearbox assembly. Replace the damaged or worn components as necessary.
9. If the bearings for the sun gear, ring gear, or the gearbox housing are replaced, press the bearing all the way to shoulder of the bore.
10. If the flange bushings are replaced, ensure that the flange bushing is fully seated against the part.
11. Assembly the gearbox.
    - Ensure that all the retaining rings and O-rings are fully seated in the ring groove during assembly.
    - Lubricate the seal lips and O-rings before installing the shafts.
    - Lubricate the planet gear and sun gear pins in the gearbox housing with the gear oil prior to installing the gears.
12. Clean the gasket surface on the gearbox housing and cover with the solvent and install new gasket.
13. Ensure that the trust washer is assembled to the pin that supports the ring gear and sun gear, and the washer is located between the sun-gear bearing and the gearbox cover.
14. Fit the gearbox cover over dowel pins and install the 4 socket-head screws. Tighten the screws from **1.7 to 4.5 N·m (15 to 40 in-lb)**. In an alternating cross pattern, torque the screws from 8.4 to 9.6 N·m (75 to 85 in-lb).

Servicing the Gear Box (continued)

15. If removed, lubricate the O-rings for the drain/fill plug with Mobile XHP-222 or an equivalent grease.

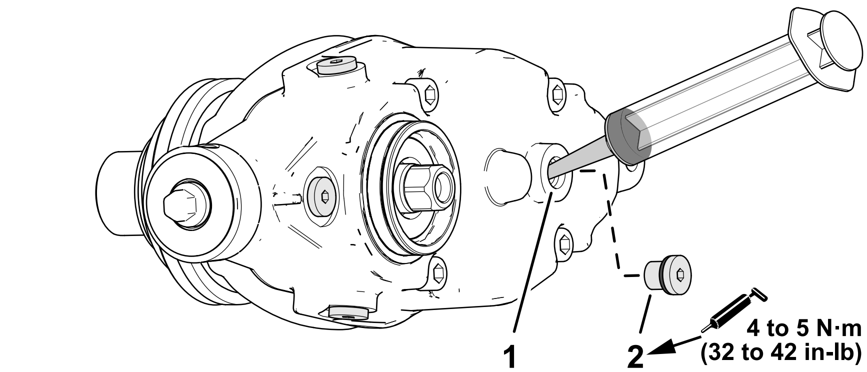


Figure 226

1. Gearbox cover
2. Drain/fill plug

---

16. Install all the plugs into the gearbox cover, except for the plug for the face of the cover (located between the 4 socket-head screws). Torque the plugs to **4 to 5 N·m (32 to 42 in-lb)**.

17. Add **50 ml (1.7 fluid ounces)** 80W-90 gear oil into the gearbox through the hole in the face of the cover.

18. Install drain/fill plug into the hole in the face of gearbox cover, and tighten the plug to **4 to 5 N·m (32 to 42 in-lb)**.

19. Operate the groomer gearbox by hand to check for proper operation prior to installation.

Installing the Gear Box Assembly

Refer to Figure 221 for this procedure.

1. Apply medium strength thread locking compound (Loctite 243 or equivalent) to the threads in the reel and allow the thread locking compound to cure for 15 minutes before continuing this procedure.
2. Insert a long-handled pry bar through the front of the cutting unit. The pry bar should pass between the top of the reel shaft and the backs of the reel blades so that the reel will not move.

Installing the Gear Box Assembly (continued)

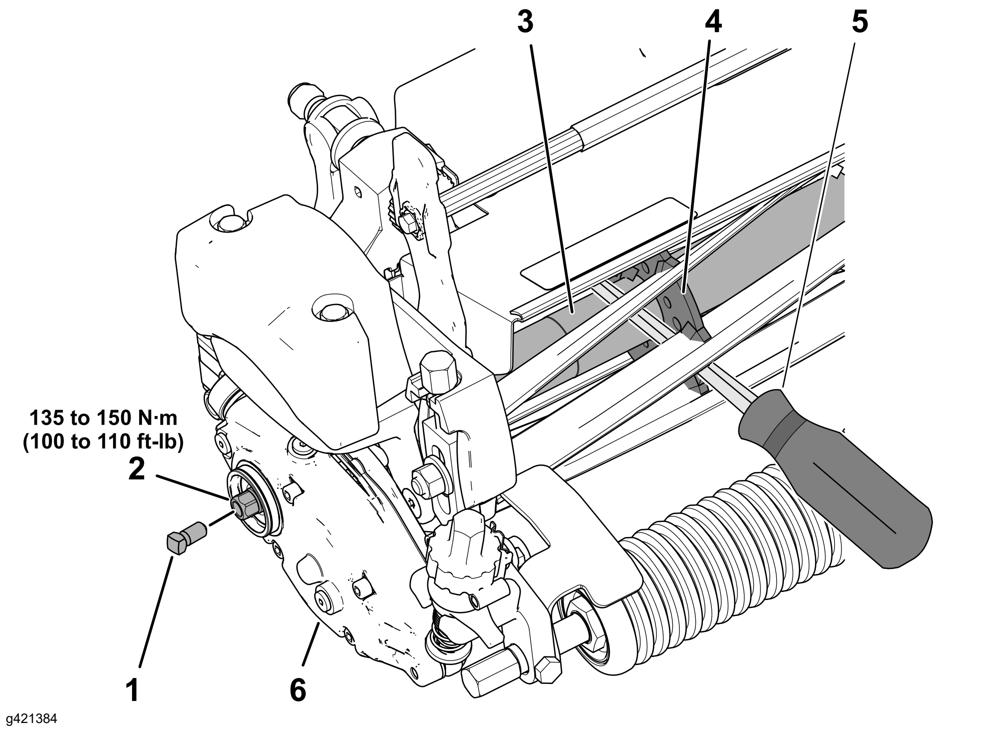


Figure 227

Single-lug gearbox shown, 2-lug gearbox is similar

1. 5/16–18 X 5/8 inch square head set screw
2. Input shaft assembly
3. Reel shaft
4. Weld side of reel support plate
5. Pry bar
6. Groomer gear box assembly

3. Move the pry bar against the weld side of the reel support plate closest to the gear box assembly and rest the handle of the pry bar against the front roller.
4. Position the gear box assembly against the cutting unit and turn the drive shaft assembly clockwise until it is seated against the reel.

IMPORTANT

You must use a 6-point socket with a heavy wall to install the gear box to the reel. Do not use an impact wrench. Groomer gear boxes installed on the right side of the cutting unit use a standard right hand thread; turn the drive shaft clockwise to install the gear box.

5. Tighten the drive shaft assembly from **135 to 150 N·m (100 to 110 ft-lb)**.
6. Remove the square head set screw from the end of the drive shaft.
7. Install the clevis pin and a new cotter pin to secure the height adjustment rod to the front of the groomer gear box.
8. Apply a retaining compound (Loctite 609 or equivalent) to the lip of the drive housing and install the drive shield, or, if the cutting unit is equipped with an optional powered rear roller brush, install the rear roller brush drive assembly; refer to Rear Roller Brush (Optional) (page 7–32).
9. Install the groomer reel assembly; refer to Installing the Groomer Reel (page 8–18).

The Idler Assembly

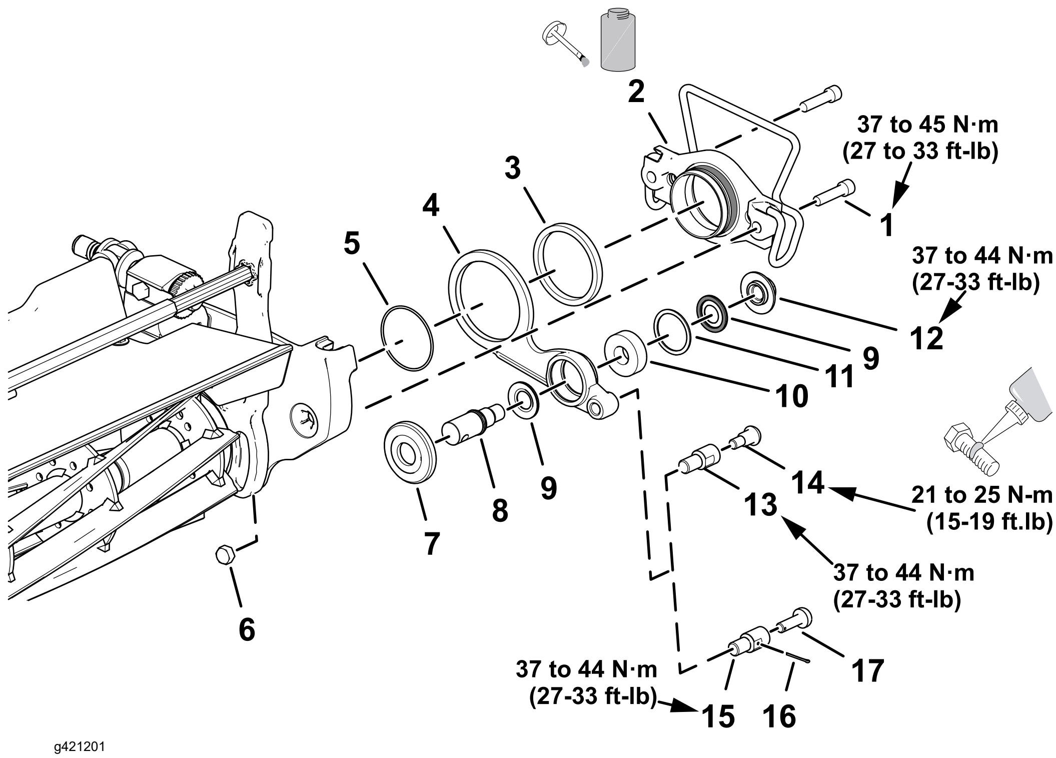


Figure 228

1. Socket-head screw (2 each)
2. Motor adapter
3. Bushing
4. Idler arm
5. O-ring
6. Lock nut (2 each)
7. Shield
8. Stub shaft
9. Flocked seal (2 each)
10. Bearing
11. Retaining ring
12. Flange nut
13. Spring pin (with a 2-lug groomer gearbox)
14. Adjuster pin (with a 2-lug groomer gearbox)
15. Spring pin—drilled (with a single-lug groomer gearbox)
16. Cotter pin (with a single-lug groomer gearbox)
17. Adjuster pin (with a single-lug groomer gearbox)

The groomer idler assembly is located at the opposite side of the groomer gear box.

Removing the Idler Assembly

1. Remove the cutting unit from the machine and place it on a level work surface.
2. Remove the groomer reel assembly; refer to Removing the Groomer Reel (page 8–16).
3. Remove the spring pin as follows:
   - **Cutting units with a Single-Lug Groomer Gearbox:** remove the shoulder screw and hardened washer that secure the eye bolt to the spring pin of the idler plate.
   - **Cutting units with a 2-Lug Groomer-Drive Gearbox:** remove the cotter pin and adjuster pin that secure the eye bolt to the spring pin of the idler plate.

     Note: Discard the cotter pin.

Removing the Idler Assembly (continued)

4. Remove the two socket-head screws that secure the motor adapter to the cutting unit, and remove the adapter and idler assembly. Remove and discard the O-ring and lock nuts.

   Note: Use a new O-ring and lock nuts when assembling the adapter and idler assembly.

5. If needed, remove the spring pin from the idler plate.
6. Inspect the shields, bearing, and bushing in the idler assembly. Replace any components that are worn or damaged.

Installing the Idler Assembly

1. If the shields, bearing, or bushing were removed from the idler plate, install new components as follows:

   A. Press the bushing into the idler plate until the bushing is centered in the bore.

   B. Press the bearing into the idler plate so that the bearing contacts the shoulder in bore, and secure the bearing with the retaining ring.

   C. Assemble the 2 bearing shields to the idler plate with flocked side of shield toward the bearing.

   D. Check the idler plate orientation (left side of the cutting unit), and insert the stub shaft (item 8 in Figure 228) through shields and bearing. Use the through hole in the shaft to prevent it from rotating, and torque the flange nut to **37 to 45 N·m (27 to 33 ft-lb)**.

   E. If the spring pin was removed from the idler arm, install the spring pin and torque it to **37 to 45 N·m (27 to 33 ft-lb**).

2. Fit a new O-ring to the motor adapter.
3. Apply anti-seize lubricant to the outside diameter of the motor adapter and position the idler arm over the adapter.
4. Use new lock nuts and secure the motor adapter and idler arm to the cutting unit side plate.
5. Assemble the motor adapter and idler arm to the cutting unit with the 2 socket head screws, and torque them to **37 to 45 N·m (27 to 33 ft-lb**).
6. Assemble the eye bolt of the groomer adjuster to the idler plate (Figure 228) as follows:

   - **Cutting Units with a Single-Lug Groomer Gearbox**

     A. Apply a coat of medium-duty thread-locking compound to the shoulder screw.

     B. Assemble the eye bolt to the spring pin of the idler plate with the shoulder screw. Torque the shoulder screw to 16.3 to 20.3 N·m (12 to 15 ft-lb).

   - **Cutting units with a 2-Lug Groomer-Drive Gearbox:** assemble the eye bolt to spring pin of the idler plate with the adjuster pin and cotter pin.

Installing the Idler Assembly (continued)

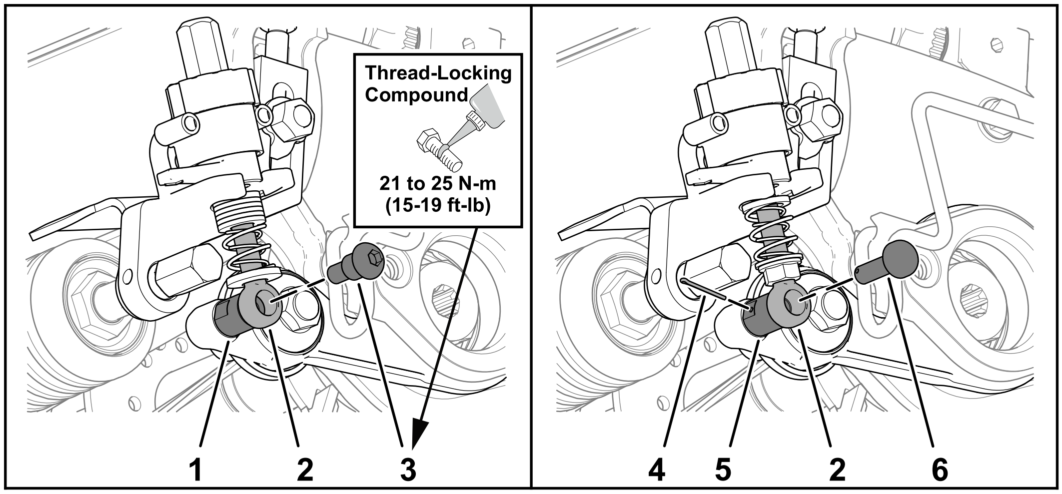


Figure 229

1. Spring pin (idler plate)—threaded (with a single-lug groomer gearbox)
2. Eye bolt
3. Shoulder screw
4. Cotter pin
5. Spring pin (idler plate)—cross drilled (with a 2-lug groomer gearbox)
6. Adjuster pin

7. Install the groomer reel assembly; refer to Installing the Groomer Reel (page 8–18).

The Groomer Reel

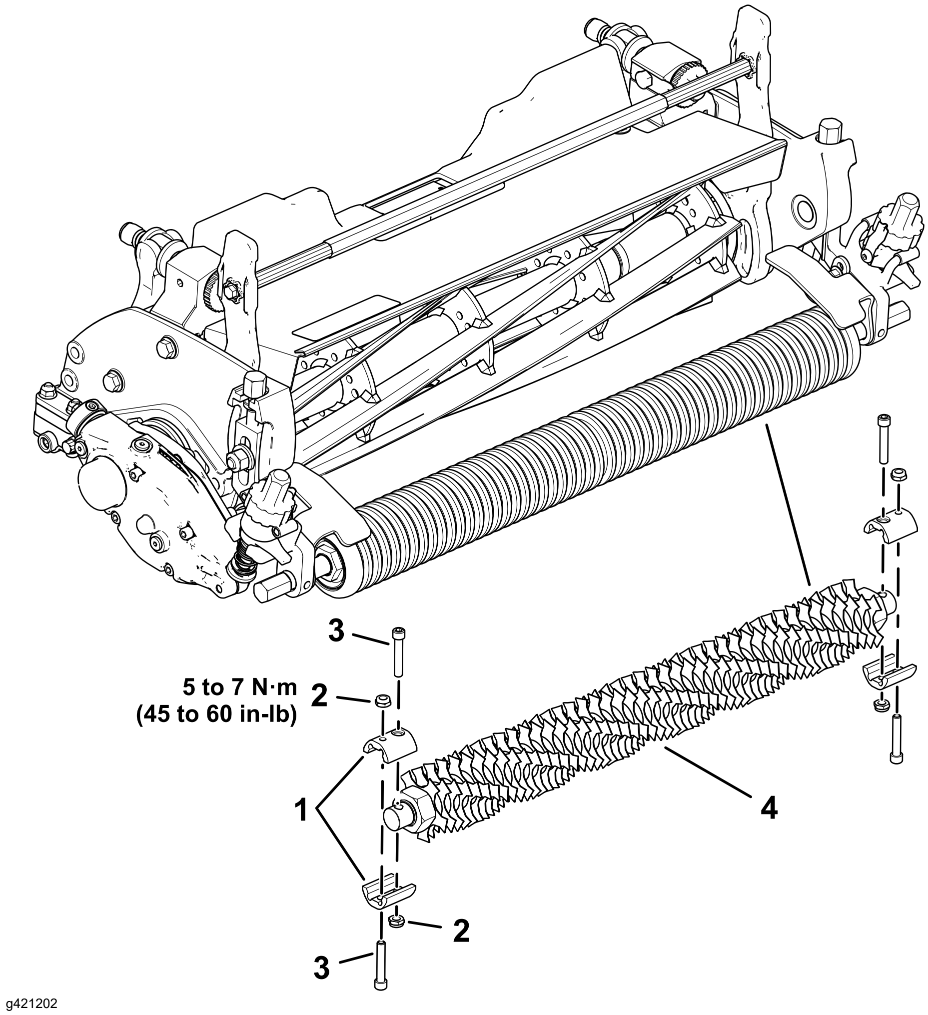


Figure 230

1. Shaft clamp (4 each)
2. Jam nut (4 each)
3. Bolt (4 each)
4. Groomer reel

Remove the groomer reel to replace individual groomer blades or replace the shaft. The groomer reel can be reversed to provide additional blade life.

Removing the Groomer Reel

1. Park the machine on a clean and level surface, lower the cutting units, set the key switch to the OFF position and remove the key from the key switch.

CAUTION

Contact with the reel or other cutting unit parts can result in personal injury.

Use heavy gloves when handling the groomer reel.

---

2. Carefully remove the 4 jam nuts, 4 bolts, and 4 shaft clamps that secure the groomer reel to the output and stub shafts.
3. Lift the groomer reel from the cutting unit.

Removing the Groomer Reel (continued)

4. Inspect the shields, stub shaft, driven shaft and shaft bearings for wear or damage and replace components as necessary; refer to The Gear Box Assembly (page 8–4) and The Idler Assembly (page 8–13).

Servicing the Groomer Reel

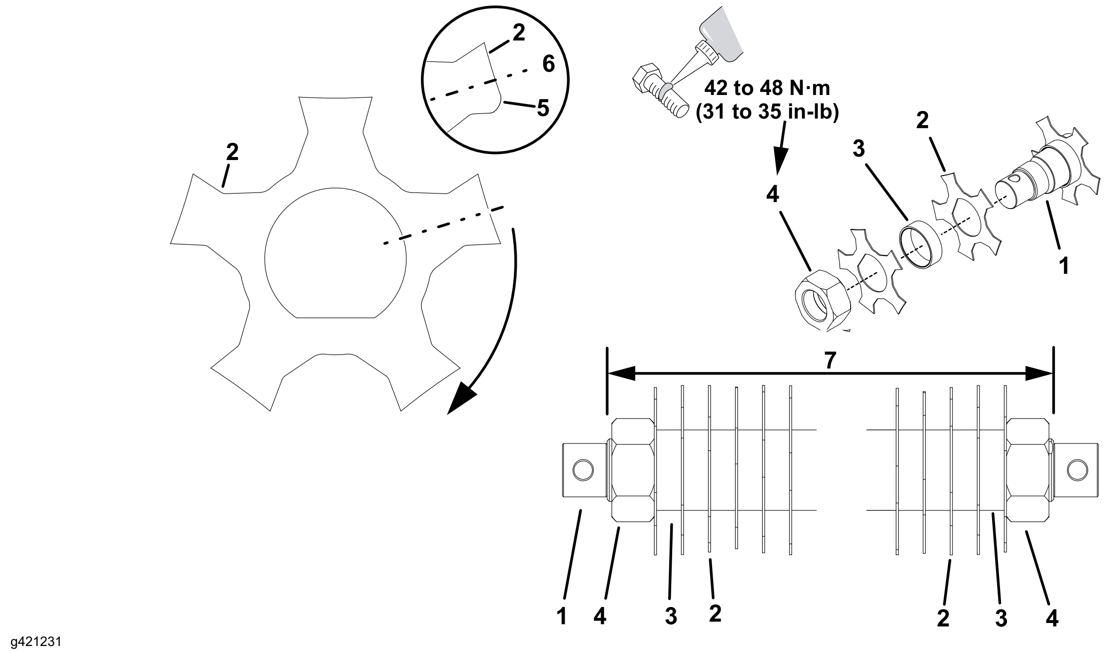


Figure 231

1. Groomer reel shaft
2. Groomer blade (40 each)
3. Spacer (39 each)
4. Locknut (2 each)
5. Rounded edge
6. Midpoint
7. Centered on shaft

Inspect the groomer reel blades frequently for any damage and wear. Straighten the bent blades. Either replace the worn blades or reverse the individual blades to put the sharpest blade edge forward. The blades that are rounded to the midpoint of the blade tip must be reversed or replaced for best groomer performance.

1. Park the machine on a clean and level surface, lower the cutting unit, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the groomer reel from the cutting unit; refer to Removing the Groomer Reel (page 8–16).
3. Remove the lock nut from either end of the groomer reel shaft.
4. Remove the blades and from the groomer shaft. If necessary, remove second lock nut from the shaft.
5. Inspect and replace worn or damaged components.
6. Assemble the groomer reel as follows:

   Note: New lock nuts have an adhesive patch to prevent the lock nut from loosening. If a used lock nut is being installed, apply a medium strength thread locker (Loctite #242 or equivalent) to the threads of the lock nut.

   A. Install a lock nut on one end of the groomer reel shaft.

   B. Install a groomer blade against the lock nut.

Servicing the Groomer Reel (continued)

C. Install the remaining spacers and blades in an alternating manner making sure that all blades are separated by a spacer.

D. When all the blades have been installed, install the second lock nut onto the shaft. Center the blades and spacers on the shaft by adjusting the lock nuts.

E. Use the through holes in shaft to prevent the shaft from rotating and tighten the second lock nut to **42 to 48 N·m (31 to 35 ft-lb)**. After tightening the lock nut, the spacers should not be free to rotate, and the groomer blades should be centered on the shaft.

7. Install the groomer reel back onto the cutting unit; refer to Installing the Groomer Reel (page 8–18).

Installing the Groomer Reel

1. Position the cutting unit on a level surface. If the cutting unit is attached to the traction unit, lower the cutting unit, set the key switch to the OFF position and remove the key from the key switch.
2. Position the groomer reel between the groomer driven and stub shafts.
3. Secure the groomer reel to the cutting unit with the 4 jam nuts, 4 bolts, and 4 shaft clamps. Tighten the bolts from **5 to 7 N·m (45 to 60 in-lb)**.
4. Check the groomer reel height and mower height-of-cut settings and adjust as necessary.

Single-Lug Groomer Gearbox and Idler Plate

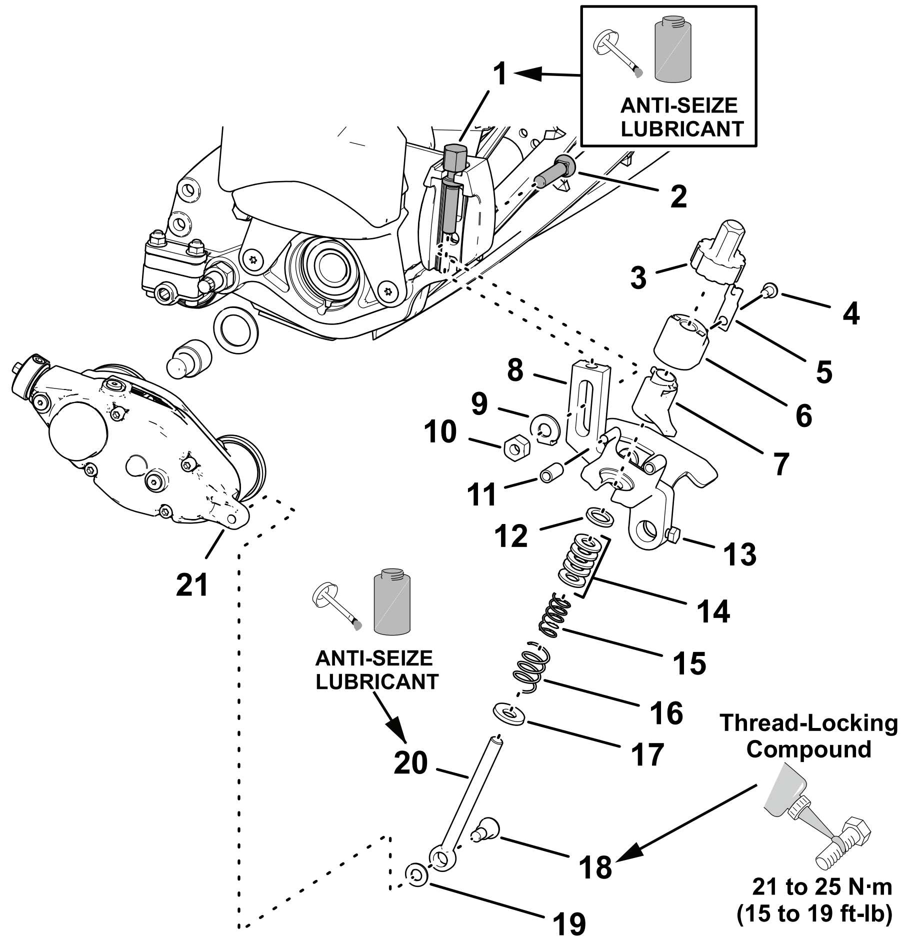


Figure 232

1. Height of cut screw
2. Plow bolt
3. Height adjuster knob
4. Screw
5. Detent spring
6. Quick up cover
7. Quick up handle
8. Groomer height of cut arm
9. Height of cut washer
10. Lock nut
11. Bumper
12. Washer 20.6 x 14.3 mm (0.813 x 0.563 inch)
13. Lock screw
14. Shim washers
15. Compression spring (inner)
16. Compression spring (outer)
17. Belleville washer
18. Eye bolt
19. Shoulder screw
20. Hardened washer
21. Single-lug groomer gearbox

Note: Early universal groomers used 2 non-adjustable compression springs on eye bolts for the 2-lug gearbox and idler plate. The single-lug gearbox and idler plate assemblies are the current groomer drive configuration, and use shim washers to preload the springs; refer to Figure 231.

Disassembling the Height Adjuster

1. Disconnect the battery; refer to 48V Battery Service Disconnect (page 5–10).
2. Remove the cutting unit from the machine; refer to the *Operator's Manual*.

Disassembling the Height Adjuster (continued)

3. Remove the shoulder screws and hardened washers that secure the eye bolts to the lugs of the groomer gearbox and the idler plate.
4. Loosen the lock screws that secure the front roller to the height-of-cut arms.
5. Remove the lock nuts, height of cut washers, and plow bolts that secure the height-of-cut arms to the cutting unit side plates, and remove the height adjusters and front roller from the cutting unit.
6. Remove the height-of-cut bolts from the groomer height of cut arms.
7. Disassemble the height adjuster assembly as necessary.
8. Clean all the components and inspect for wear or damage. Replace all the worn or damaged components.

Assembling the Height Adjuster

1. Apply anti-seize lubricant to the upper threads of the adjustment rod and lower threads of the height adjusters.
2. Assemble the height-of-cut bolts to the height-of-cut arms.
3. If both the height of cut arms are removed, align 1 height-of-cut arm and height-of-cut bolt to the cutting unit side plate.
4. Loosely assemble the height-of-cut arm to the side plate with the plow bolt, plow bolt, height of cut washer, and lock nut. Do not tighten the flange lock nut.
5. Loosely assemble the front roller shaft to the height-of-cut arm.
6. Assemble the other height of cut bracket to the front roller shaft. Assemble height-of-cut arm and height-of-cut bolt to the cutting unit side plate.
7. Assemble the height-of-cut arm to the side plate with the plow bolt, plow bolt, height of cut washer, and lock nut. Tighten the 2 lock nuts and 2 plow bolts finger tight.
8. Adjust the height-of-cut bolts so that the height-of-cut arm are the same.
9. Center the front roller between the height-of-cut arms, and tighten the lock screws in the height-of-cut arms.
10. Align the hardened washers between the eye bolts to the groomer gearbox and idler arm lugs, and loosely assemble the eye bolts and washers to the gearbox and idler plate lugs with the shoulder screws.
11. Adjust the cutting unit height-of-cut; refer to *Cutting Unit Operators Manual*.
12. Adjust the groomer reel height; refer to *Universal Groomer Drive Kit Installation Instructions*.
13. Ensure that both groomer quick up handles are in the OPERATING position.

Assembling the Height Adjuster (continued)

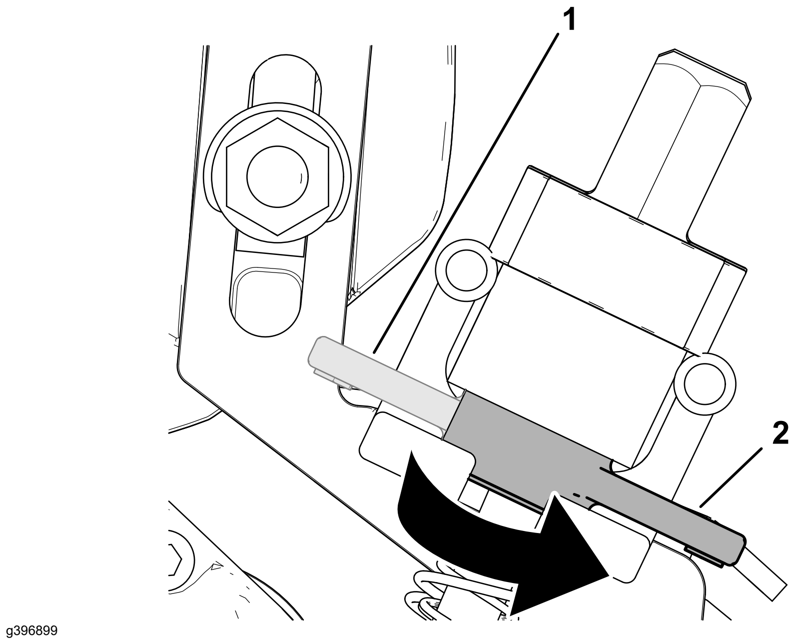


Figure 233

1. Transport position
2. Operating position

14. Measure the distance between the washers (the current spring length) as shown in

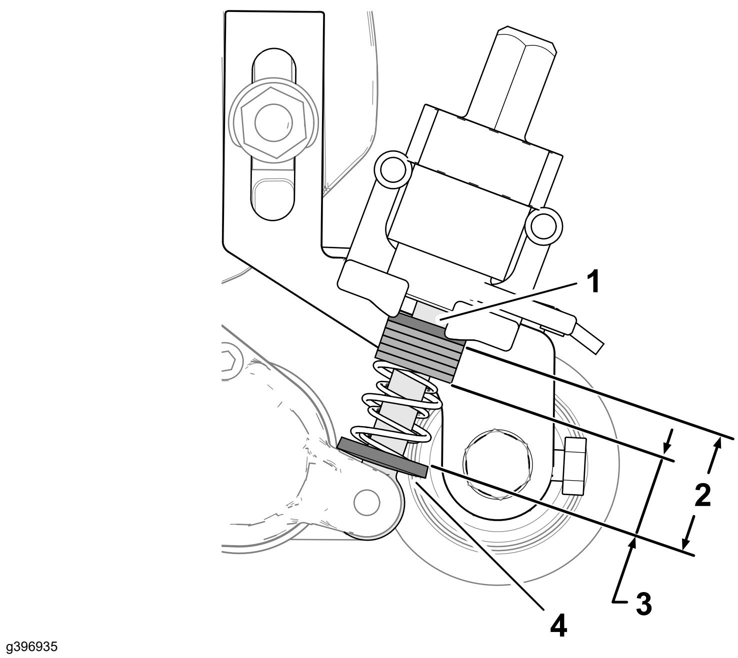


Figure 234

1. Top washer
2. Original spring length (distance between top and bottom washers)
3. Desired spring length with optional washers—19 mm (0.75 inch)
4. Belleville washer

15. Subtract the desired (.75 inch or 19 mm) spring length from the current spring length, and divide this difference by 0.06 inches to determine how many shim washers you need to add to achieve the desired spring length.

Assembling the Height Adjuster (continued)

16. Repeat steps 14 and 15.
17. Remove the eye bolts and hardened washers from the groomer gearbox and idler arm lugs, and adjust the shim washers as you calculated in step 15.
18. Apply medium strength thread locking compound to the threads of the shoulder screws.
19. Align the hardened washers between the eye bolts to the groomer gearbox and idler arm lugs, and loosely assemble the eye bolts and washers to the gearbox and idler plate lugs with the shoulder screws.

The Height Adjuster Assembly

2-Lug Groomer Gearbox and Idler Plate

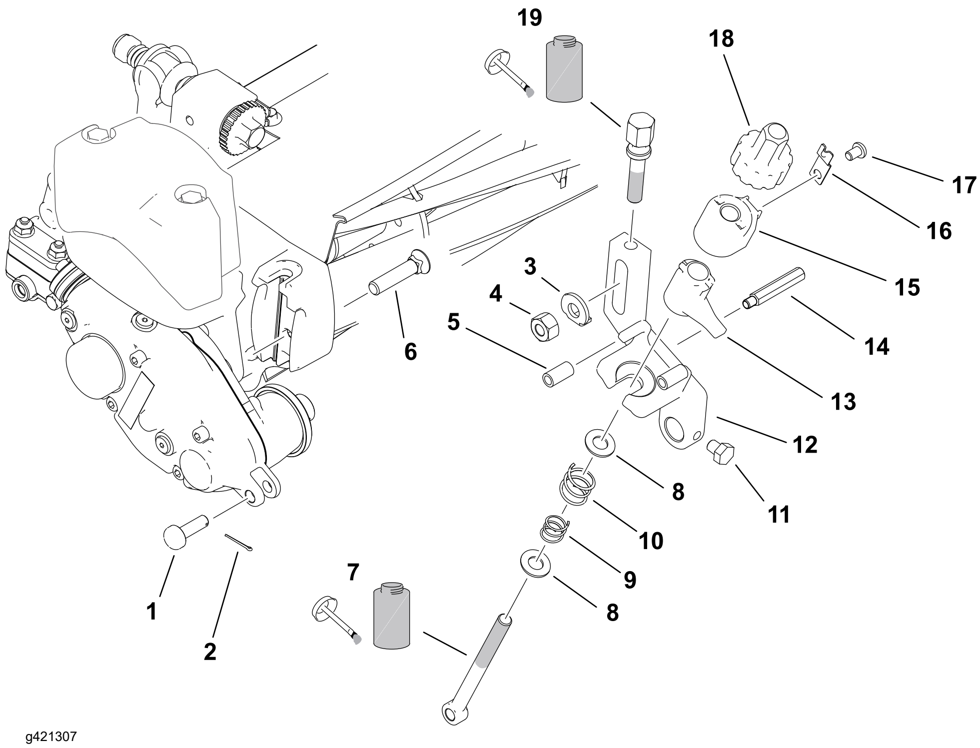


Figure 235

1.	Adjuster pin	8.	Washer (hardened)	15.	Quick up cover
2.	Cotter pin	9.	Compression spring (inner)	16.	Detent spring
3.	Height of cut washer	10.	Compression spring (outer)	17.	Screw
4.	Lock nut	11.	Washer 20.6 x 14.3 mm (0.813 x 0.563 inch)	18.	Height adjuster knob
5.	Bumper	12.	Lock screw	19.	Height of cut screw
6.	Plow bolt	13.	Quick up handle		
7.	Eye bolt	14.	Groomer pin		

Note: Early universal groomers used 2 non-adjustable compression springs on eye bolts for the 2-lug gearbox and idler plate. The single-lug gearbox and idler plate assemblies are the current groomer drive configuration, and use shim washers to preload the springs; refer to .

Disassembling the Height Adjuster

1. Disconnect the battery; refer to 48V Battery Service Disconnect (page 5–10).
2. Remove the cutting unit from the machine; refer to the *Operator's Manual*.
3. Remove the cotter pin and adjuster pin that secure the eye bolts to the lugs of the groomer gearbox and the idler plate.
4. Loosen the lock screws that secure the front roller to the height-of-cut arms.
5. Remove the lock nuts, height of cut washers, and plow bolts that secure the height-of-cut arms to the cutting unit side plates, and remove the arms from the cutting unit.
6. If needed, remove the height-of-cut bolts from the groomer height of cut arms.

Disassembling the Height Adjuster (continued)

7. Disassemble the height adjuster assembly as necessary.
8. Clean all the components and inspect for wear or damage. Replace all the worn or damaged components.

IMPORTANT

If the cutting unit is equipped with an eyebolt and flange nut used to adjust the spring pretension for the height of groom adjuster, replace the flange nut with washers to eliminate premature hardware wear.

Assembling the Height Adjuster

1. Apply anti-seize lubricant to the upper threads of the eye bolts and lower threads of the height-of-cut bolts.
2. Assemble an eye bolt to each of the height-of-cut arms with a hardened washers, and inner and outer springs below the slot in the arms, and the quick up handle, quick up cover, and height adjuster knob above the slots.
3. Apply anti-seize lubricant to the upper threads of the adjustment rod and lower threads of the height adjusters. Assemble the height adjuster assembly.
4. Assemble the height-of-cut bolts to the height-of-cut arms.
5. If both the height of cut arms are removed, align 1 height-of-cut arm and height-of-cut bolt to the cutting unit side plate.
6. Loosely assemble the height-of-cut arm to the side plate with the plow bolt, plow bolt, height of cut washer, and lock nut. Do not tighten the flange lock nut.
7. Loosely assemble the front roller shaft to the height-of-cut arm.
8. Assemble the other height of cut bracket to the front roller shaft. Assemble height-of-cut arm and height-of-cut bolt to the cutting unit side plate.
9. Assemble the height-of-cut arm to the side plate with the plow bolt, plow bolt, height of cut washer, and lock nut. Tighten the 2 lock nuts and 2 plow bolts finger tight.
10. Adjust the height-of-cut bolts so that the height-of-cut arm are the same.
11. Center the front roller between the height-of-cut arms, and tighten the lock screws in the height-of-cut arms.
12. Secure the eye bolts to the groomer gearbox and idler arm lugs with the adjuster pin and cotter pin.
13. Adjust the cutting unit height-of-cut; refer to *Cutting Unit Operators Manual*.
14. Adjust the groomer reel height; refer to *Universal Groomer Drive Kit Installation Instructions*.
15. Ensure that both groomer quick up handles are in the OPERATING position.

Assembling the Height Adjuster (continued)

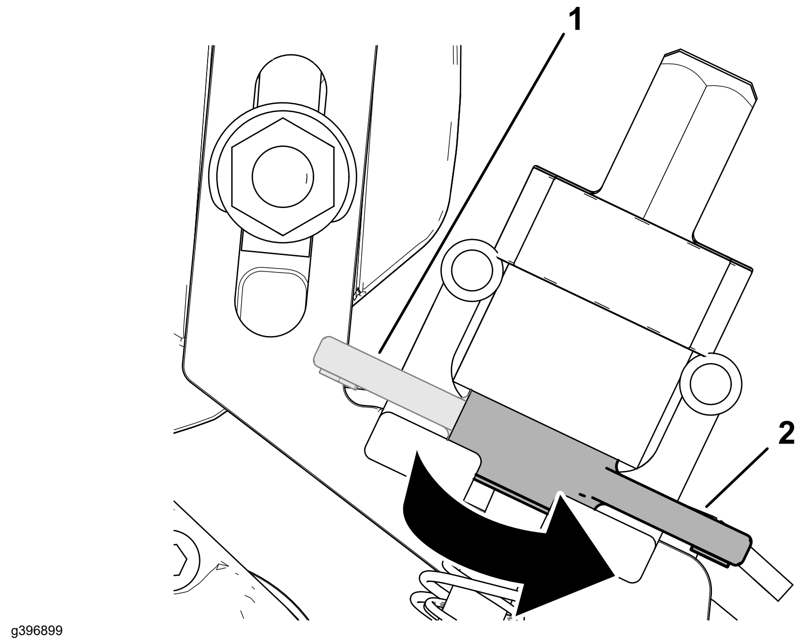


Figure 236

1. Transport position
2. Operating position

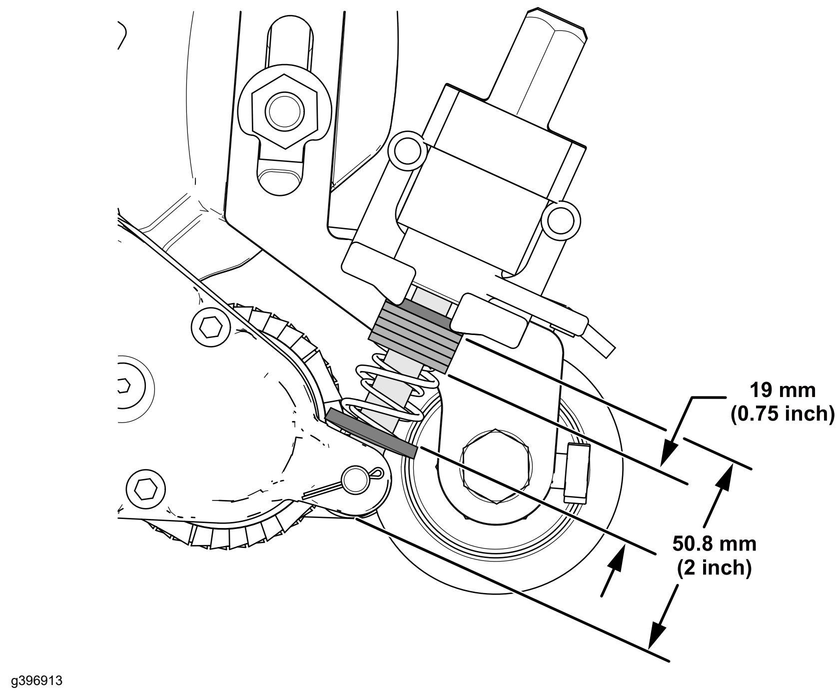


Figure 237

16. Add or remove washers on the groomer eye bolts until the springs are compressed to **19 mm (0.75 inch)**.

The Grooming Brush (Optional)

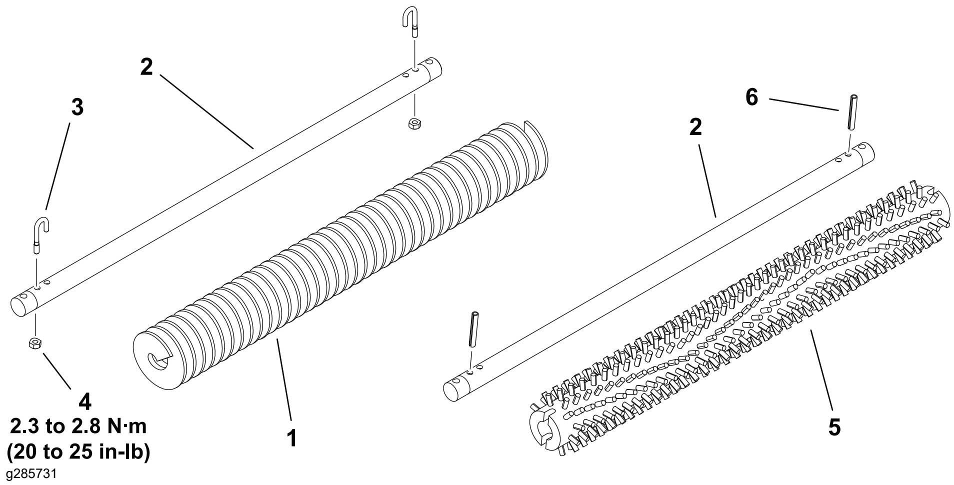


Figure 238

1. Spiral brush
2. Brush shaft
3. J-bolt (2 each)
4. Lock nut (2 each)
5. Grooming brush
6. Roll pin (2 each)

The optional grooming brush attaches to the groomer in place of the groomer reel. The grooming brush is removed and installed from the groomer in the same manner as the groomer reel; refer to The Groomer Reel (page 8–16).

The grooming brush element or shaft can be serviced separately.

To remove the spiral grooming brush from the shaft, remove the lock nut and J-bolt from both ends of the brush assembly and slide the brush from the shaft. When assembling the spiral brush to the shaft, make sure that the J-bolts are installed with the threaded portion on the outside of the brush and tighten the lock nuts from **2.3 to 2.8 N·m (20 to 25 in-lb)**.

Appendix A

Foldout Drawings

Table of Contents

Electrical Drawing Designations

Note: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g., SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

ABBREVIATION	COLOR
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on the Toro machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g., R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

Wire Size

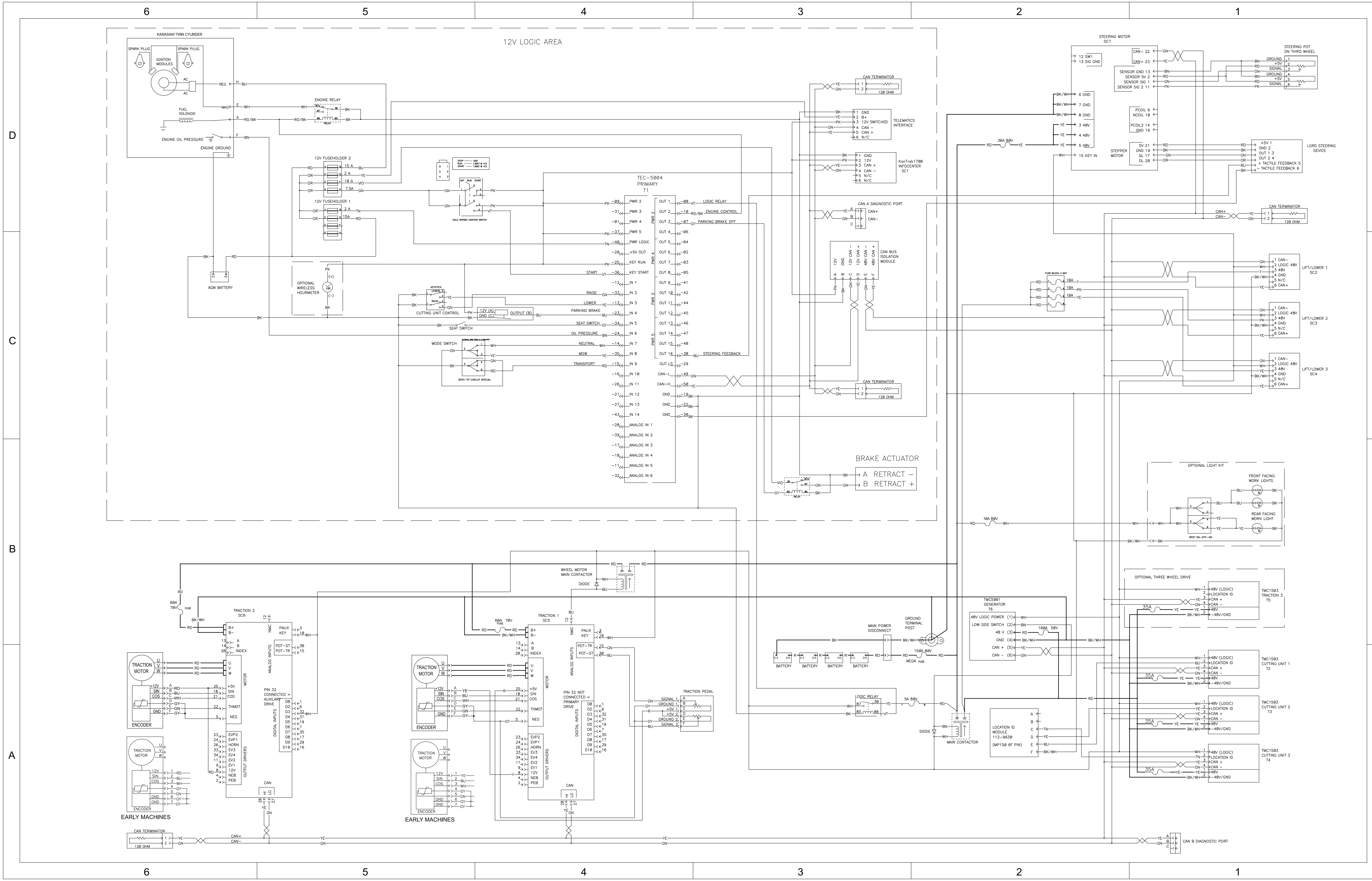
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

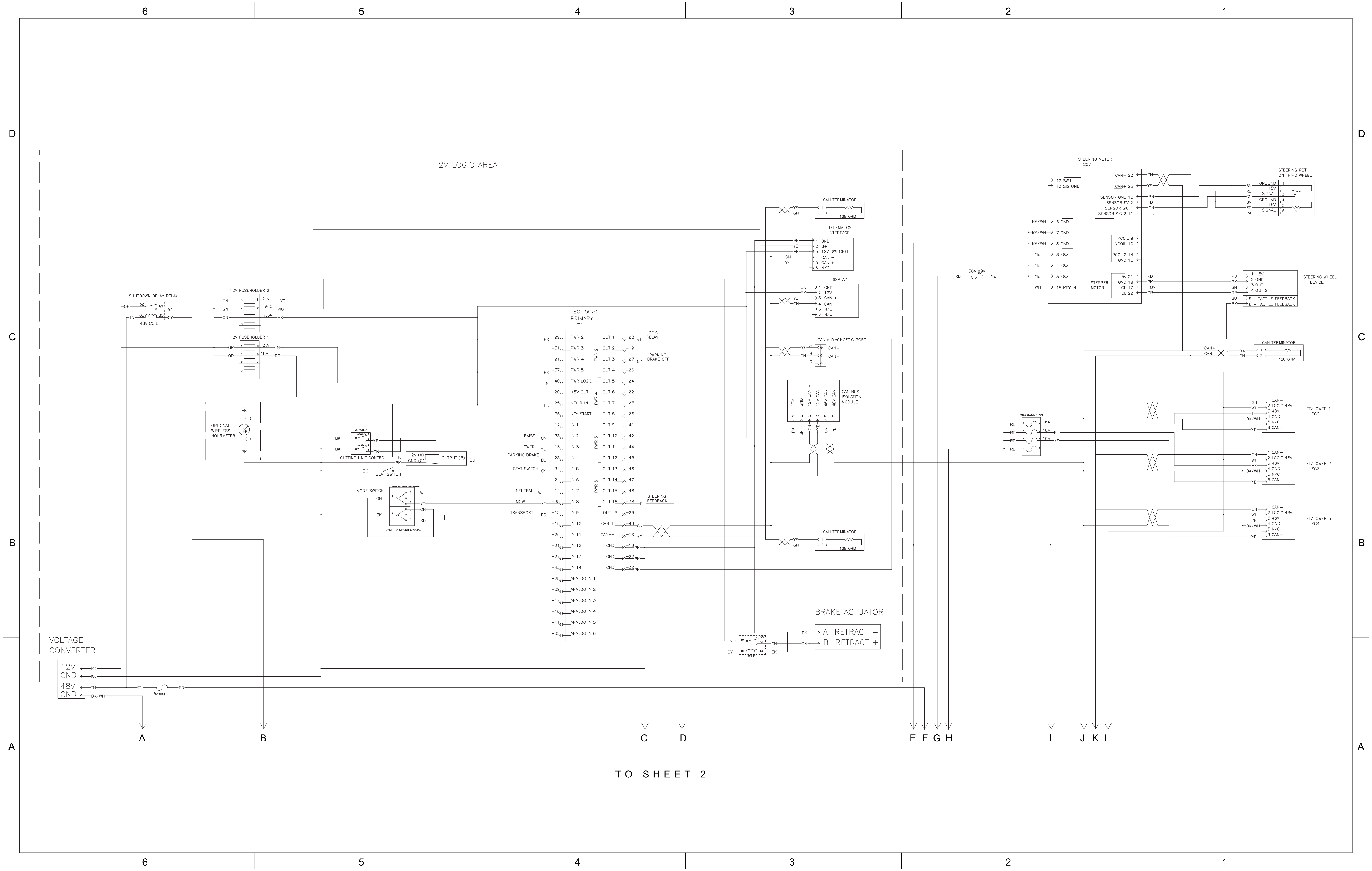
Examples:

- 16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator
- 050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

AWG Equivalents for Metric Wire		
Diagram Label	**Metric Size**	**AWG Equivalent**
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

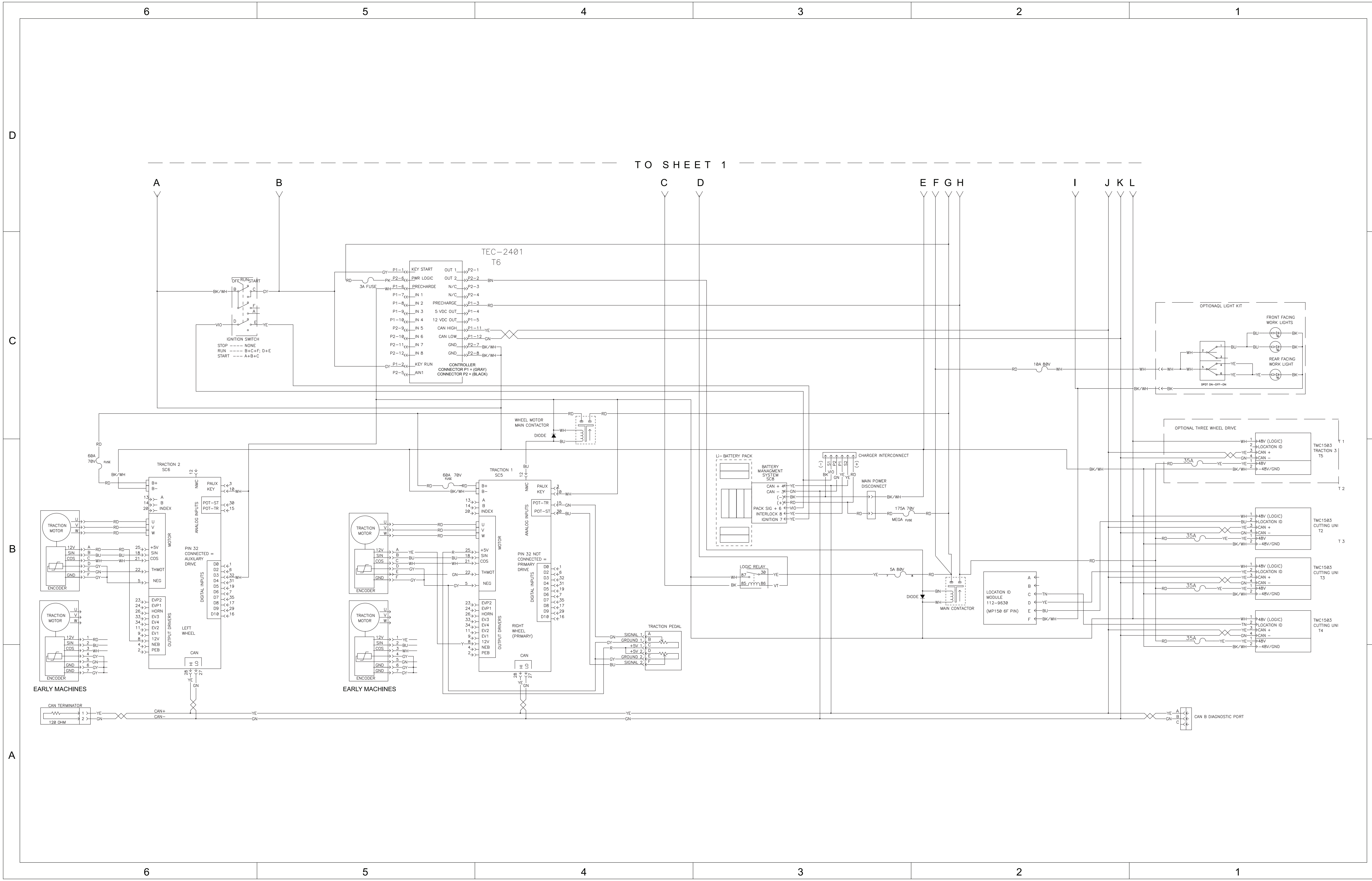
Electrical Schematic – 04580



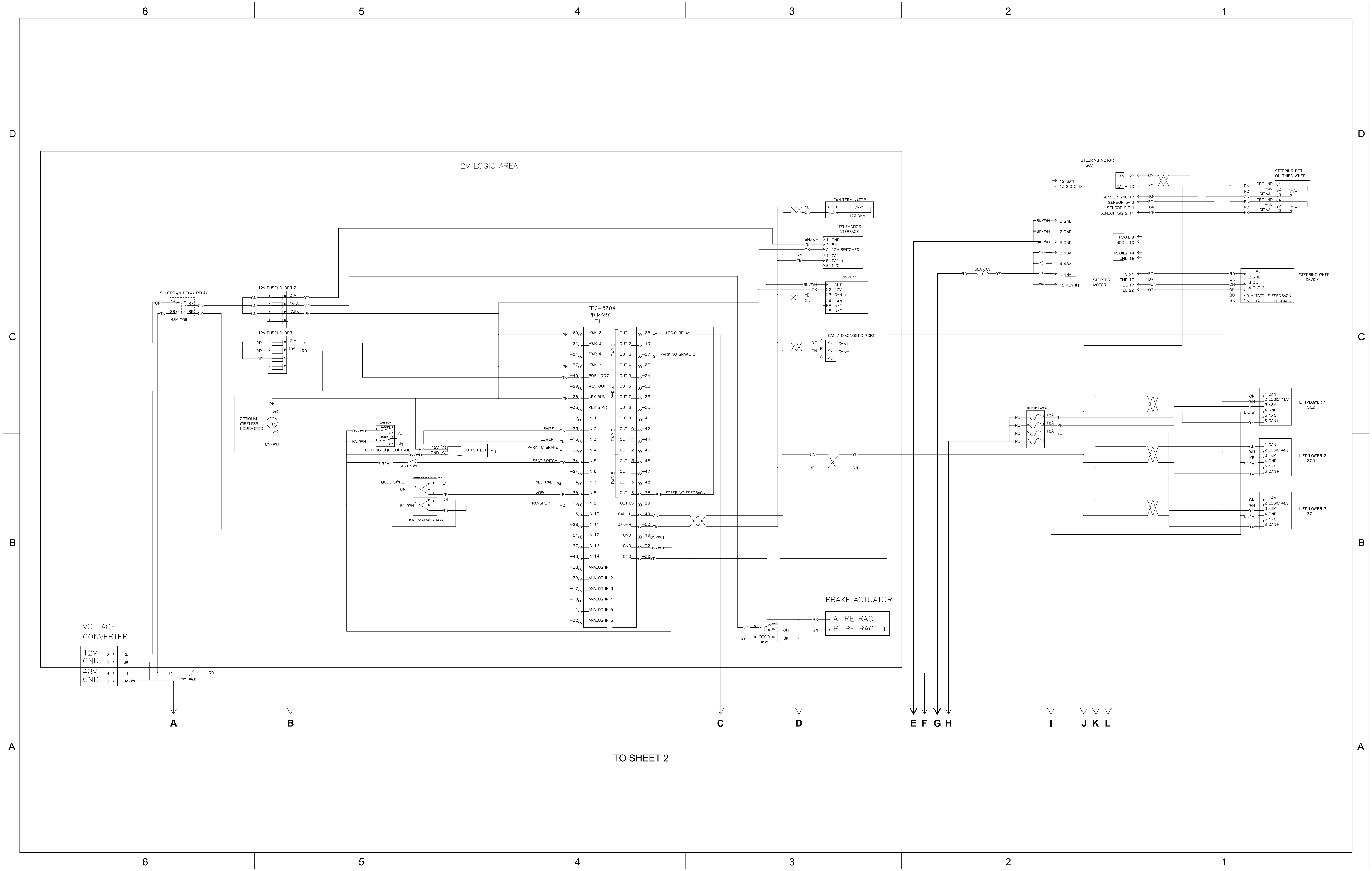

12V LOGIC AREA
TEC-5004
PRIMARY
T1
STEERING MOTOR
SC7
BRAKE ACTUATOR
VOLTAGE
CONVERTER
TO SHEET 2
A
B
C
D
E F G H
I
J K L

g309035

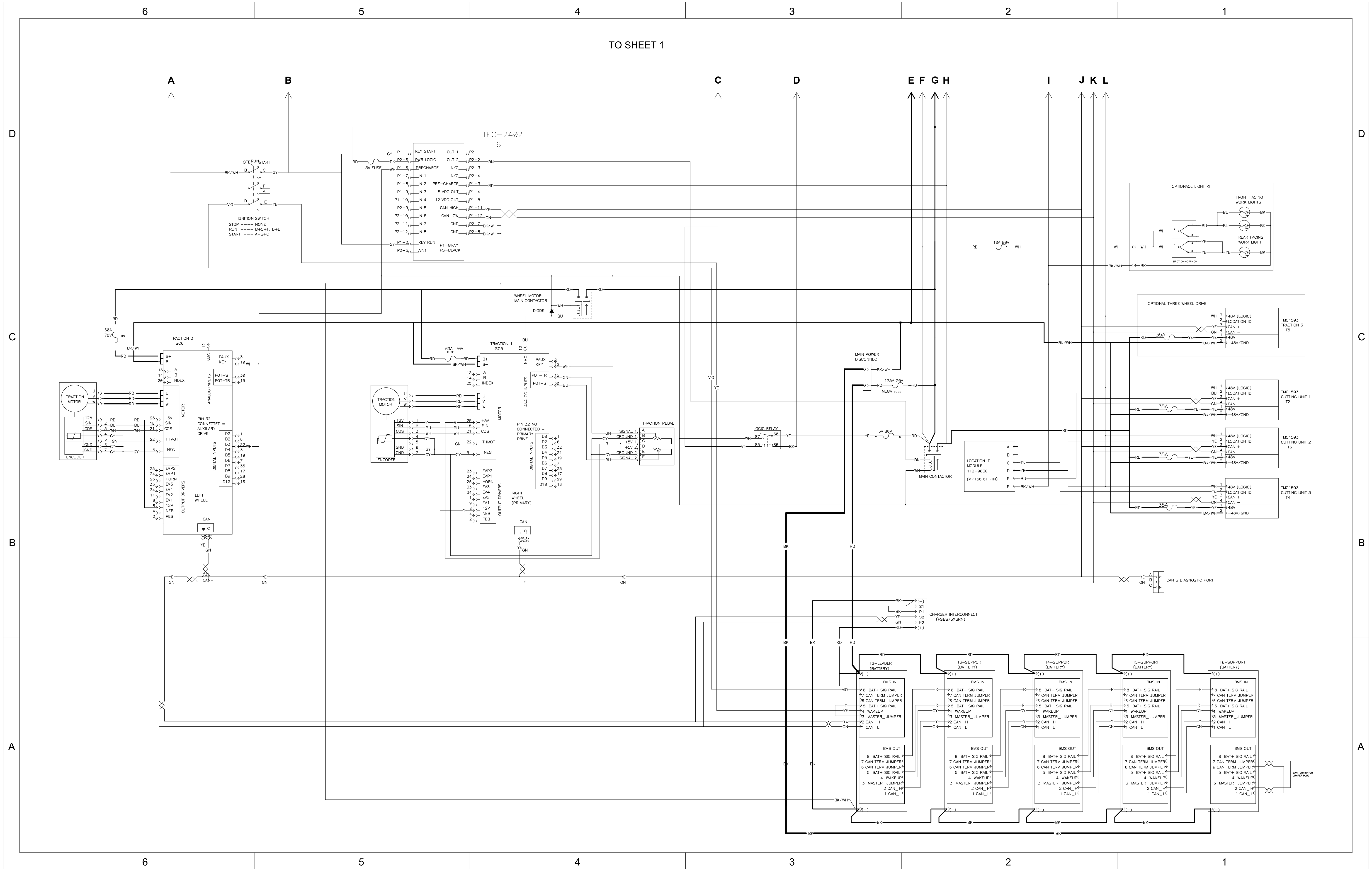
Electrical Schematic – 04590 (continued)



g309036

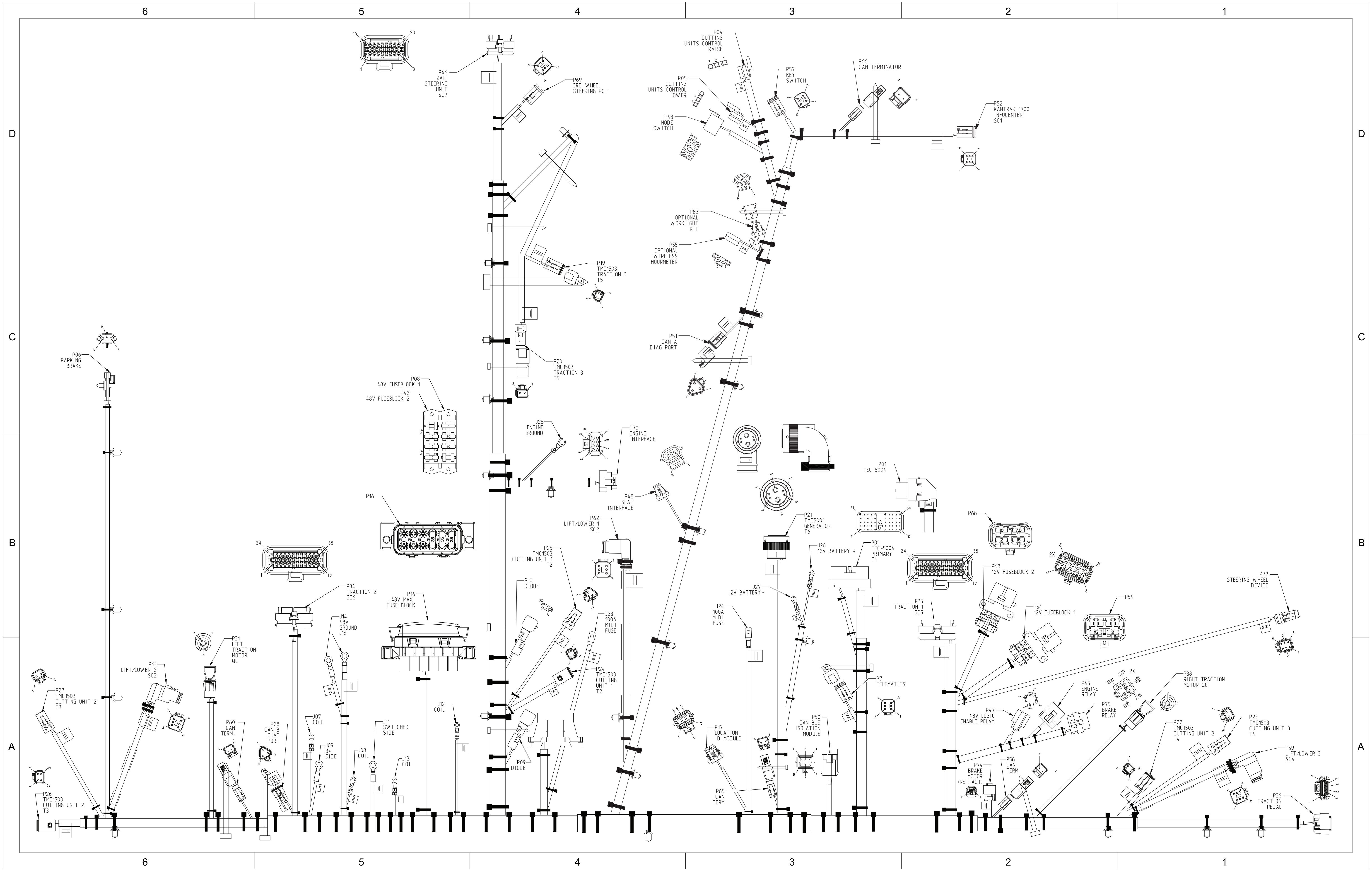

12V LOGIC AREA
SHUTDOWN DELAY RELAY
48V COIL
12V FUSEHOLDER 2
12V FUSEHOLDER 1
OPTIONAL WIRELESS HOURMETER
TEC-5004 PRIMARY T1
CUTTING UNIT CONTROL
SEAT SWITCH
MODE SWITCH
LOGIC RELAY
PARKING BRAKE OFF
STEERING FEEDBACK
RAISE
LOWER
PARKING BRAKE
NEUTRAL
MOW
TRANSPORT
CAN TERMINATOR
TELEMATICS INTERFACE
DISPLAY
CAN A DIAGNOSTIC PORT
BRAKE ACTUATOR
A RETRACT –
B RETRACT +
VOLTAGE CONVERTER
12V
GND
48V
GND
10A FUSE
STEERING MOTOR SC7
STEPPER MOTOR
STEERING POT ON THIRD WHEEL
STEERING WHEEL DEVICE
30A 80V
FUSE BLOCK 4 WAY
LIFT/LOWER 1 SC2
LIFT/LOWER 2 SC3
LIFT/LOWER 3 SC4
A
B
C
D
E
F
G
H
I
J
K
L
TO SHEET 2
g421755

Electrical Schematic – 04591



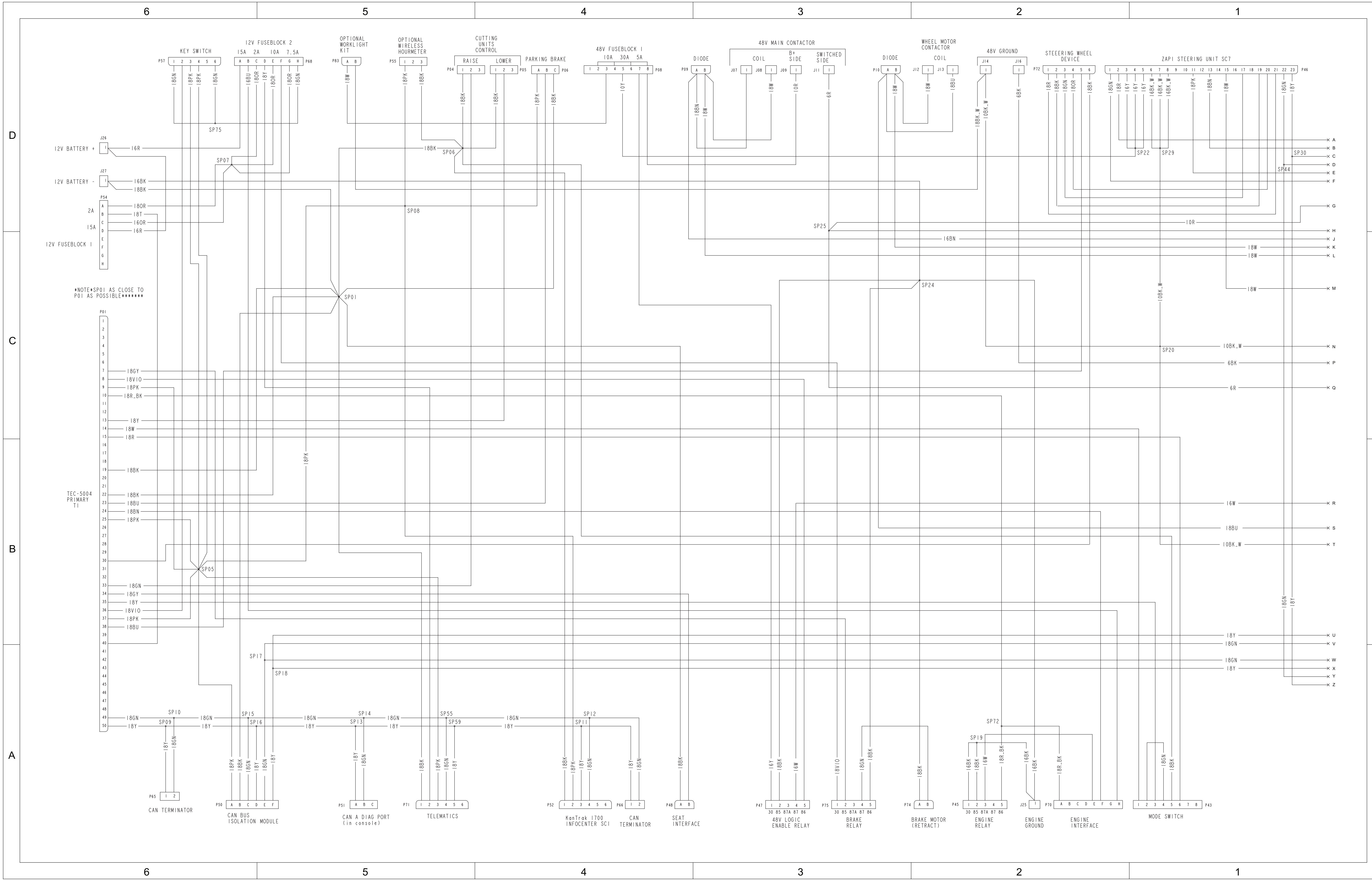
g421756

Wire Harness Drawing – 04580 (Serial number below 409000000)

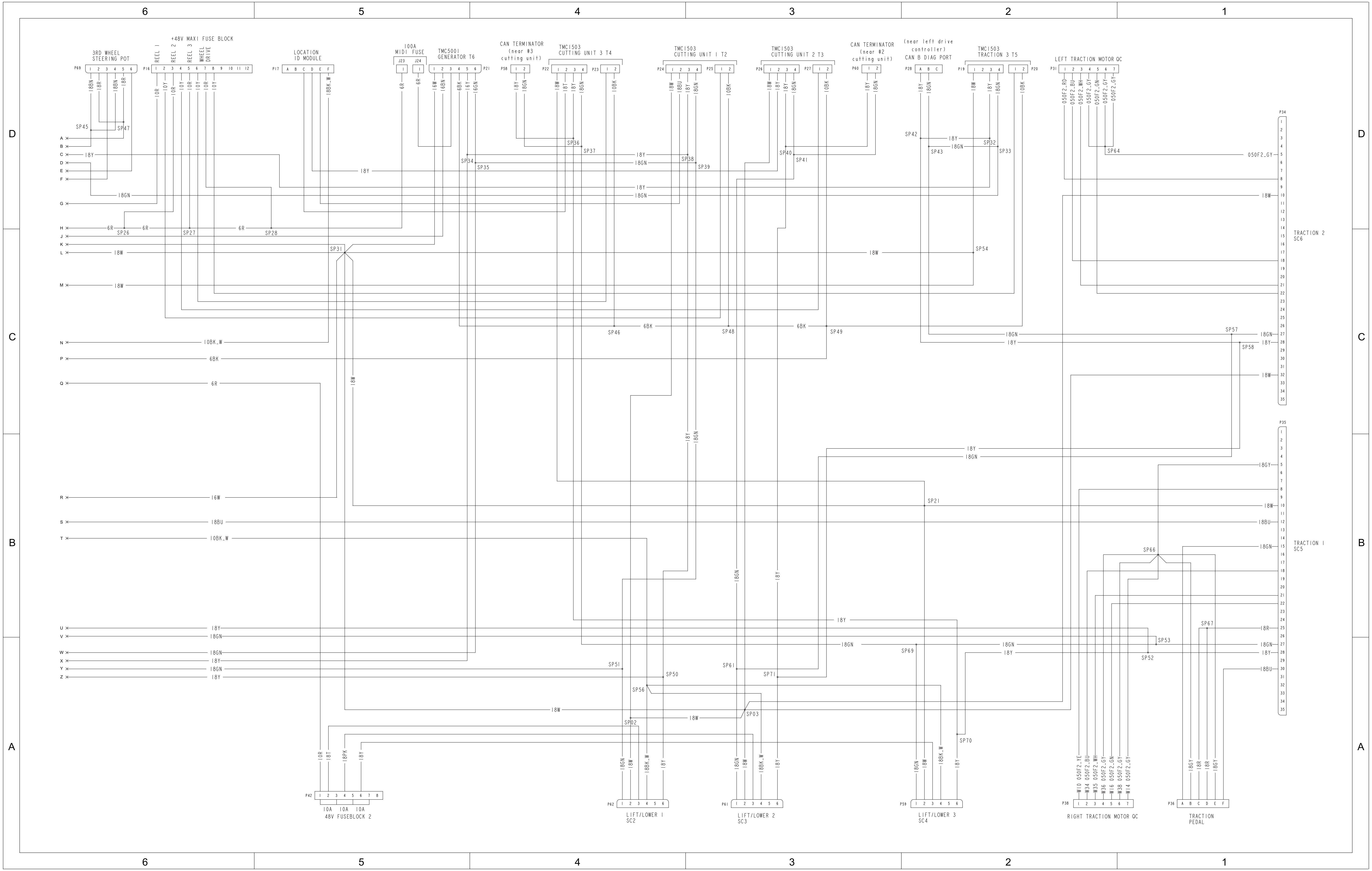


g287361

Wire Harness Diagram – 04580 (Serial number below 409000000)

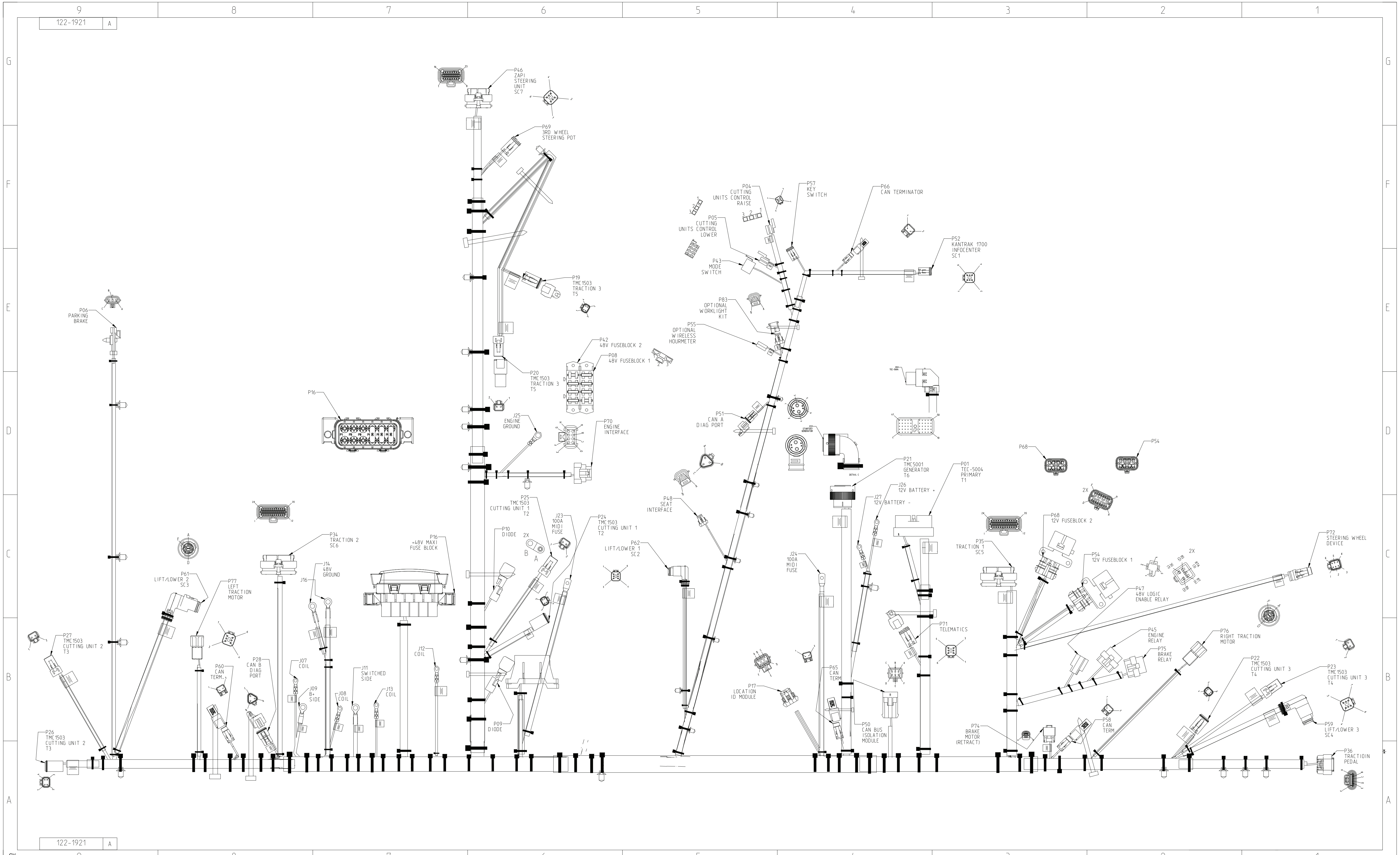


g293957


3RD WHEEL STEERING POT
+48V MAXI FUSE BLOCK
LOCATION ID MODULE
100A MIDI FUSE
TMC5001 GENERATOR T6
CAN TERMINATOR (near #3 cutting unit)
TMC1503 CUTTING UNIT 3 T4
TMC1503 CUTTING UNIT 1 T2
TMC1503 CUTTING UNIT 2 T3
CAN TERMINATOR (near #2 cutting unit)
(near left drive controller) CAN B DIAG PORT
TMC1503 TRACTION 3 T5
LEFT TRACTION MOTOR QC
TRACTION 2 SC6
TRACTION 1 SC5
10A 10A 10A 48V FUSEBLOCK 2
LIFT/LOWER 1 SC2
LIFT/LOWER 2 SC3
LIFT/LOWER 3 SC4
RIGHT TRACTION MOTOR QC
TRACTION PEDAL

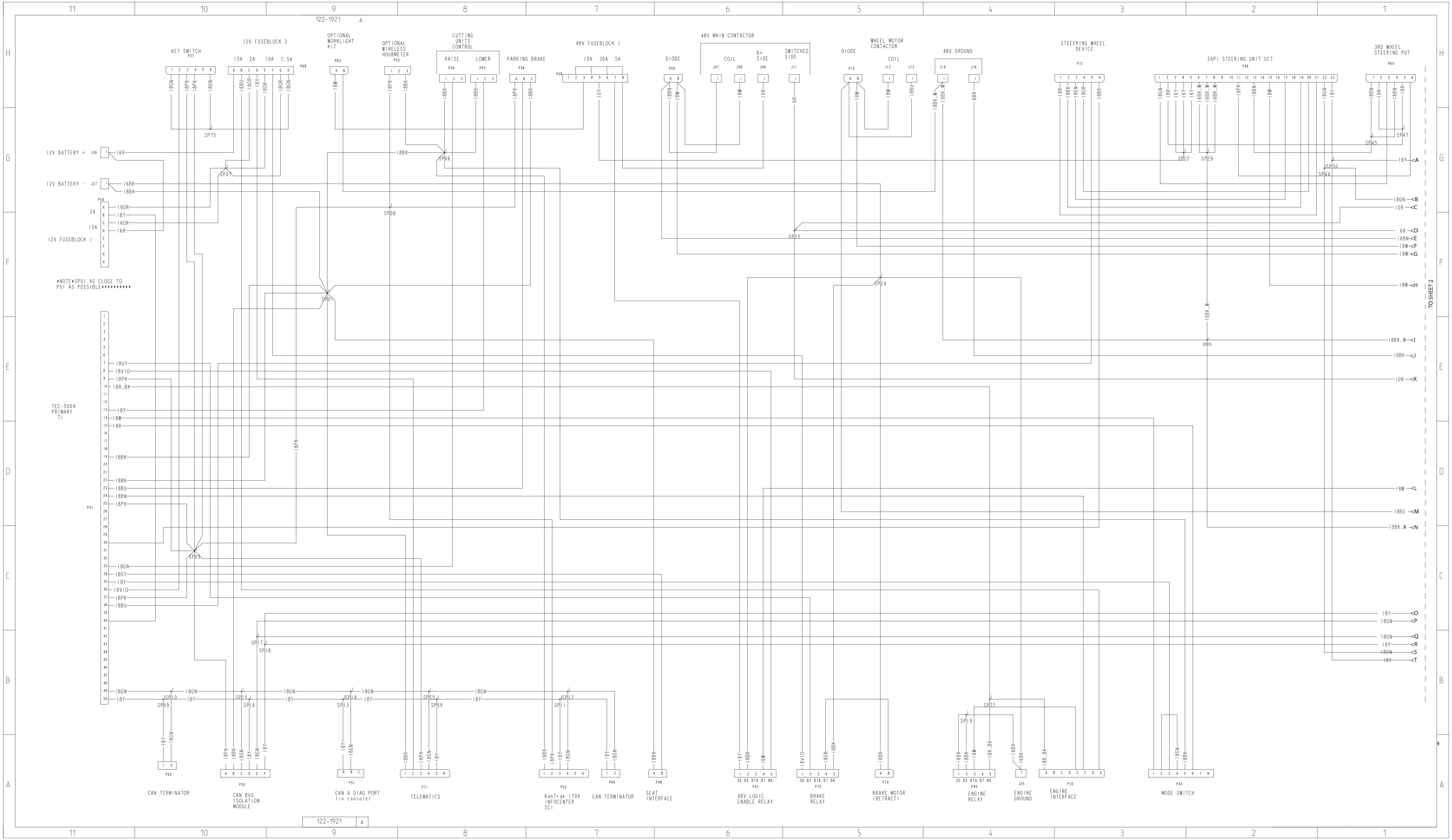
g293958

Wire Harness Drawing – 04580 (Serial number above 409000000)

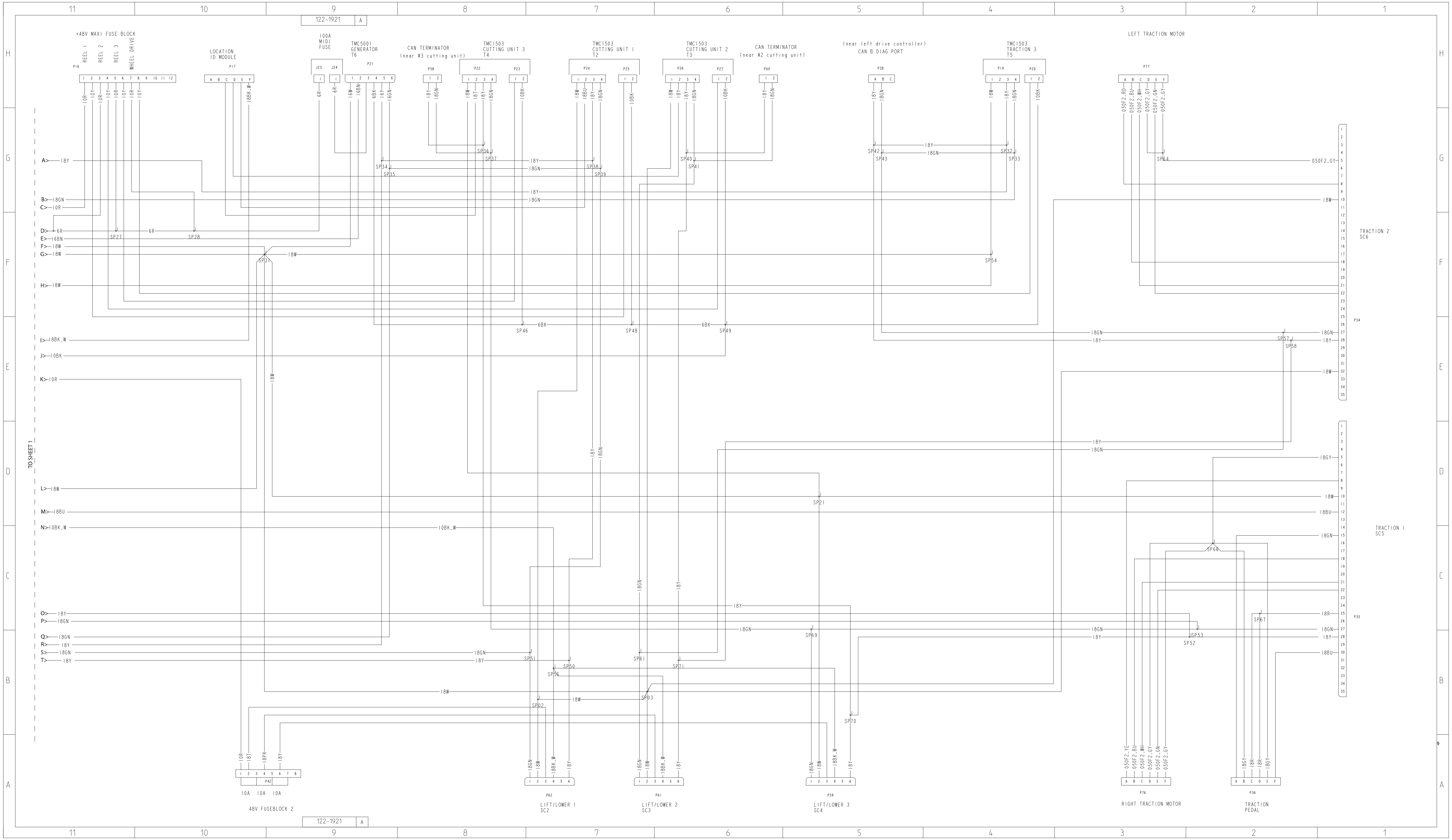


g363332

Wire Harness Diagram – 04580 (Serial number above 409000000)



Wire Harness Diagram – 04580 (Serial number above 409000000) (continued)

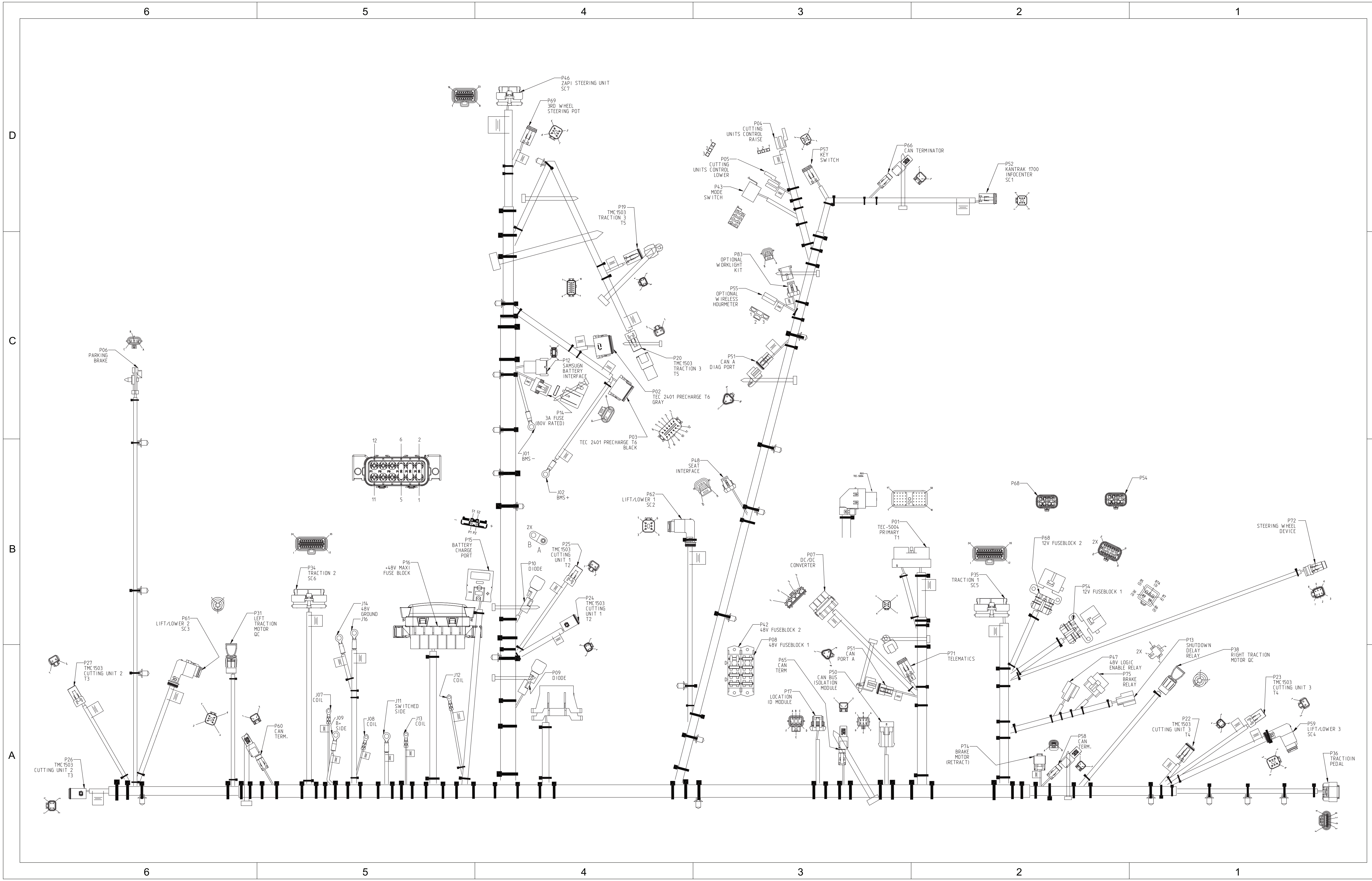


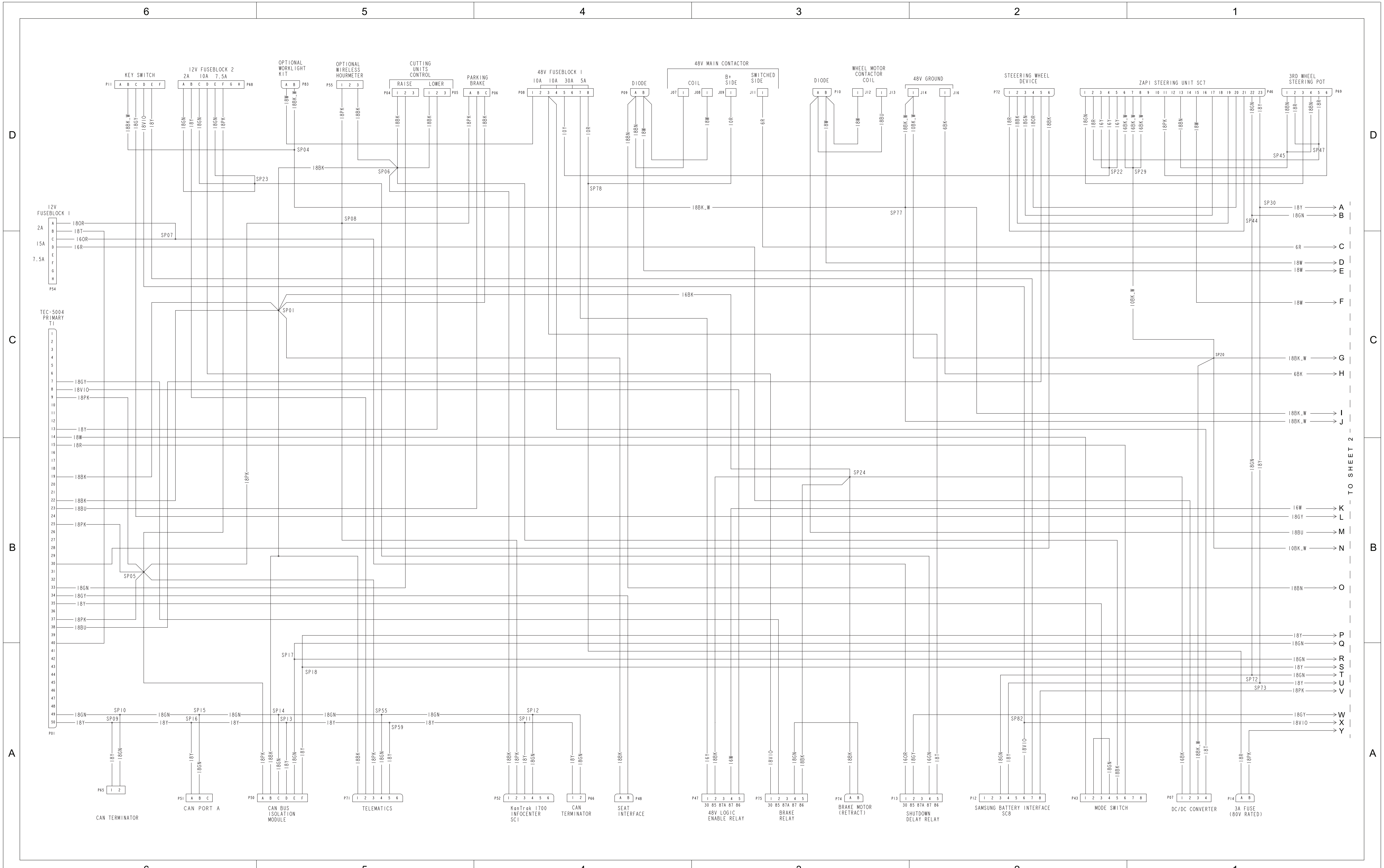
g363334

This page is intentionally left blank

g326106

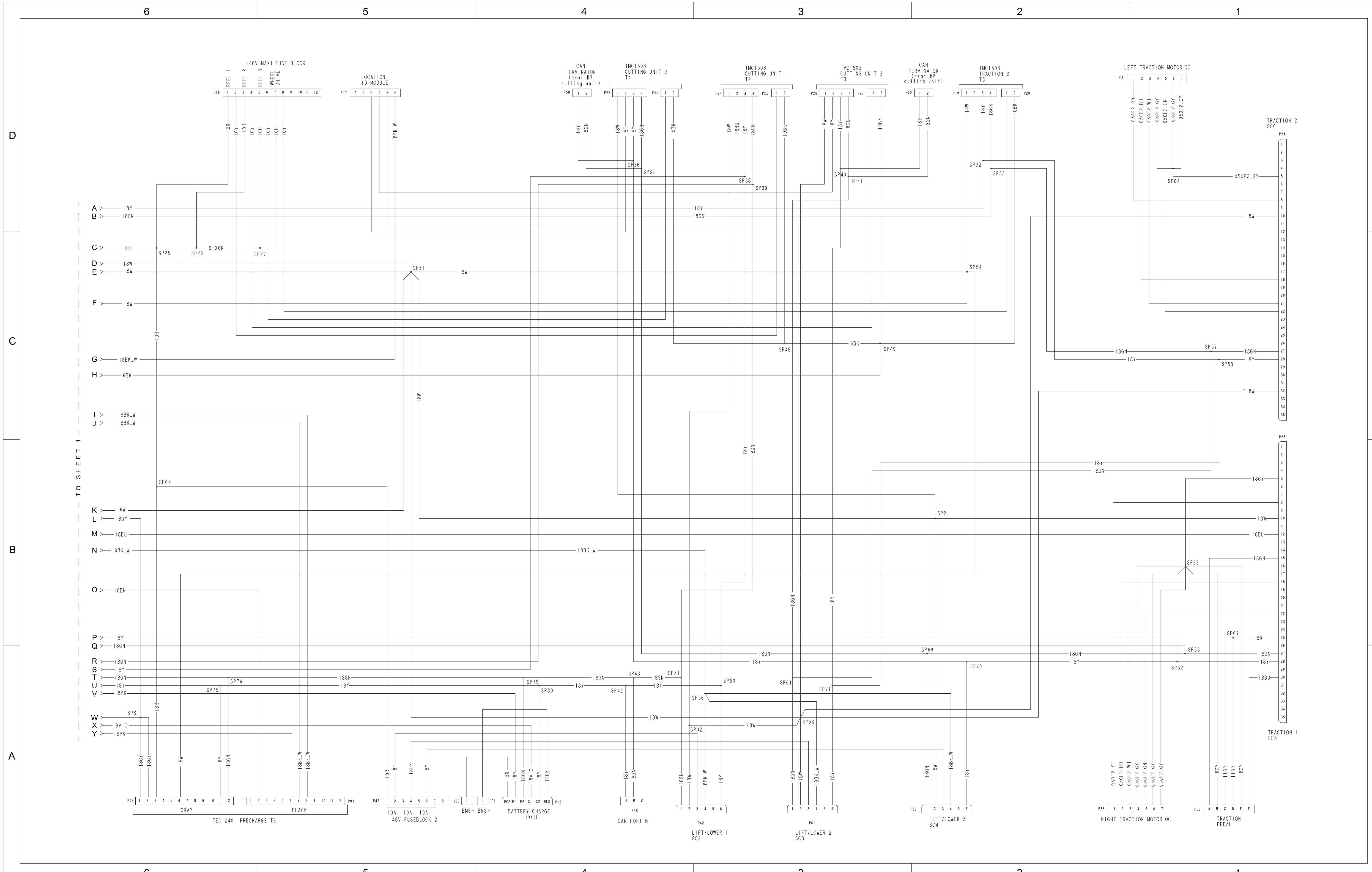
Wire Harness Drawing – 04590




KEY SWITCH
12V FUSEBLOCK 2
OPTIONAL WORKLIGHT KIT
OPTIONAL WIRELESS HOURMETER
CUTTING UNITS CONTROL
RAISE
LOWER
PARKING BRAKE
48V FUSEBLOCK 1
48V MAIN CONTACTOR
COIL
B+ SIDE
SWITCHED SIDE
DIODE
WHEEL MOTOR CONTACTOR COIL
48V GROUND
STEEERING WHEEL DEVICE
ZAPI STEERING UNIT SC7
3RD WHEEL STEERING POT
12V FUSEBLOCK 1
TEC-5004 PRIMARY
TO SHEET 2
CAN TERMINATOR
CAN PORT A
CAN BUS ISOLATION MODULE
TELEMATICS
KanTrak 1700 INFOCENTER SC1
CAN TERMINATOR
SEAT INTERFACE
48V LOGIC ENABLE RELAY
BRAKE RELAY
BRAKE MOTOR (RETRACT)
SHUTDOWN DELAY RELAY
SAMSUNG BATTERY INTERFACE SC8
MODE SWITCH
DC/DC CONVERTER
3A FUSE (80V RATED)

g309032

Wire Harness Diagram – 04590

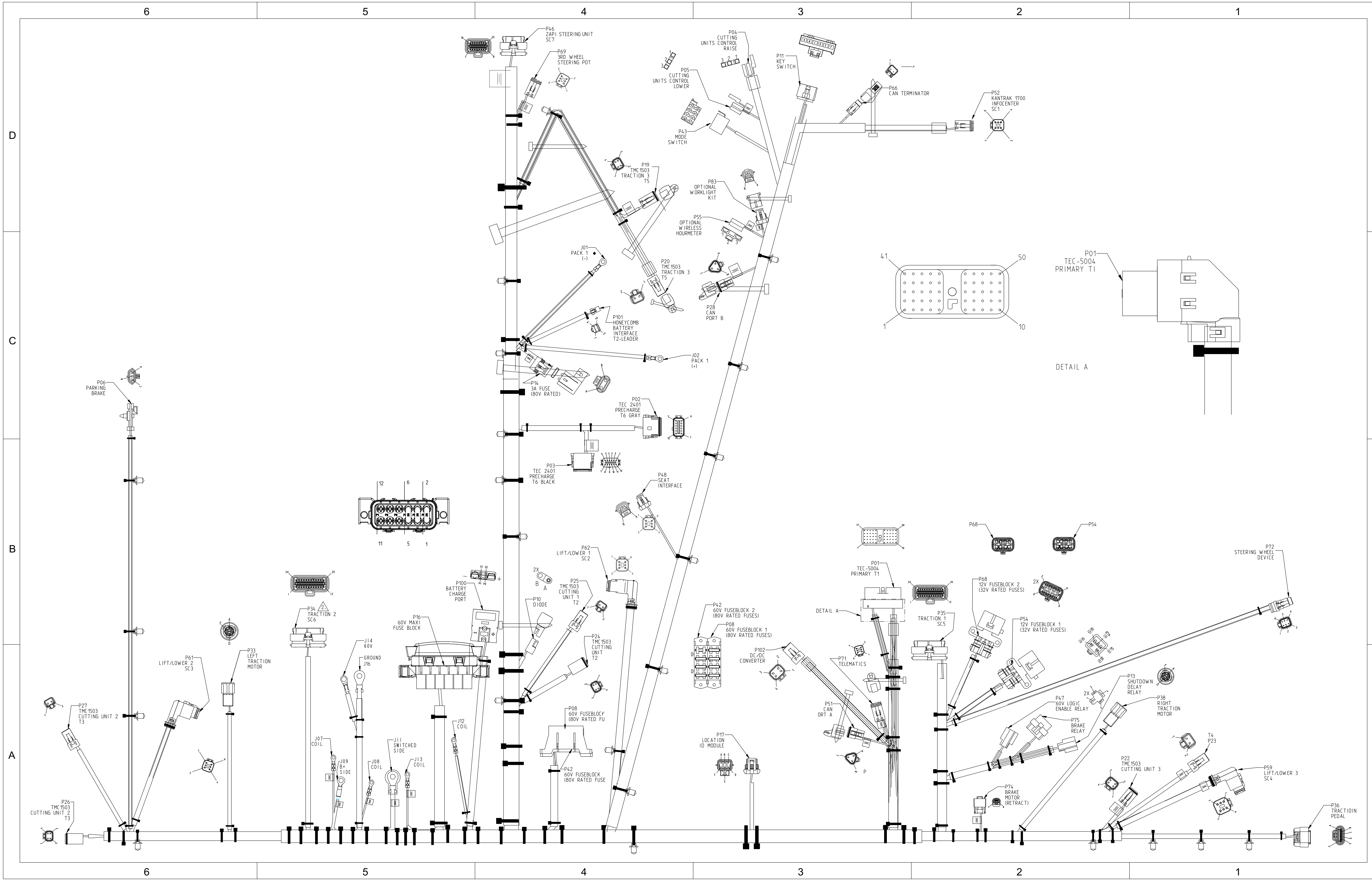


g309033

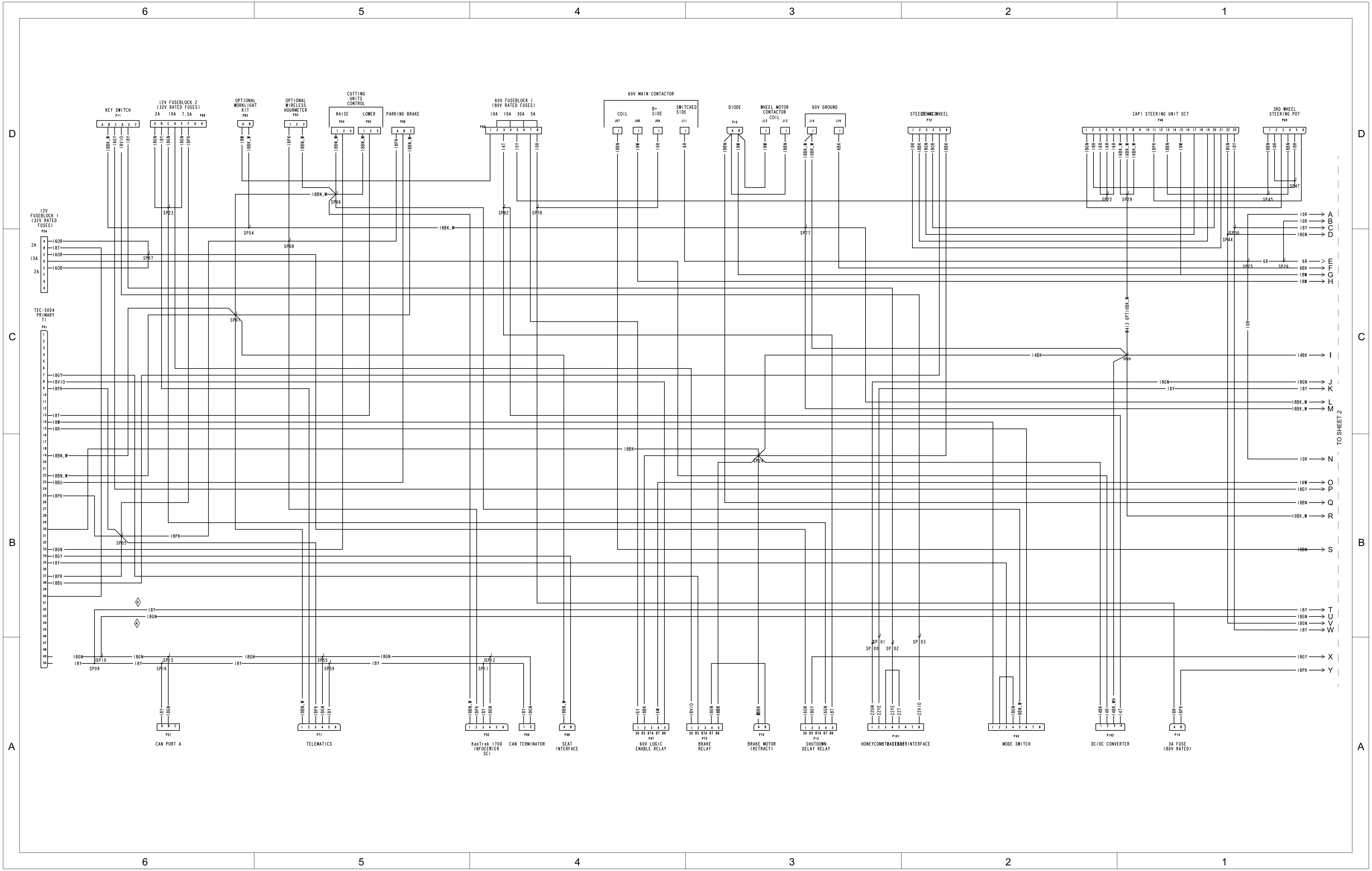
This page is intentionally left blank

g326106

Wire Harness Drawing – 04591

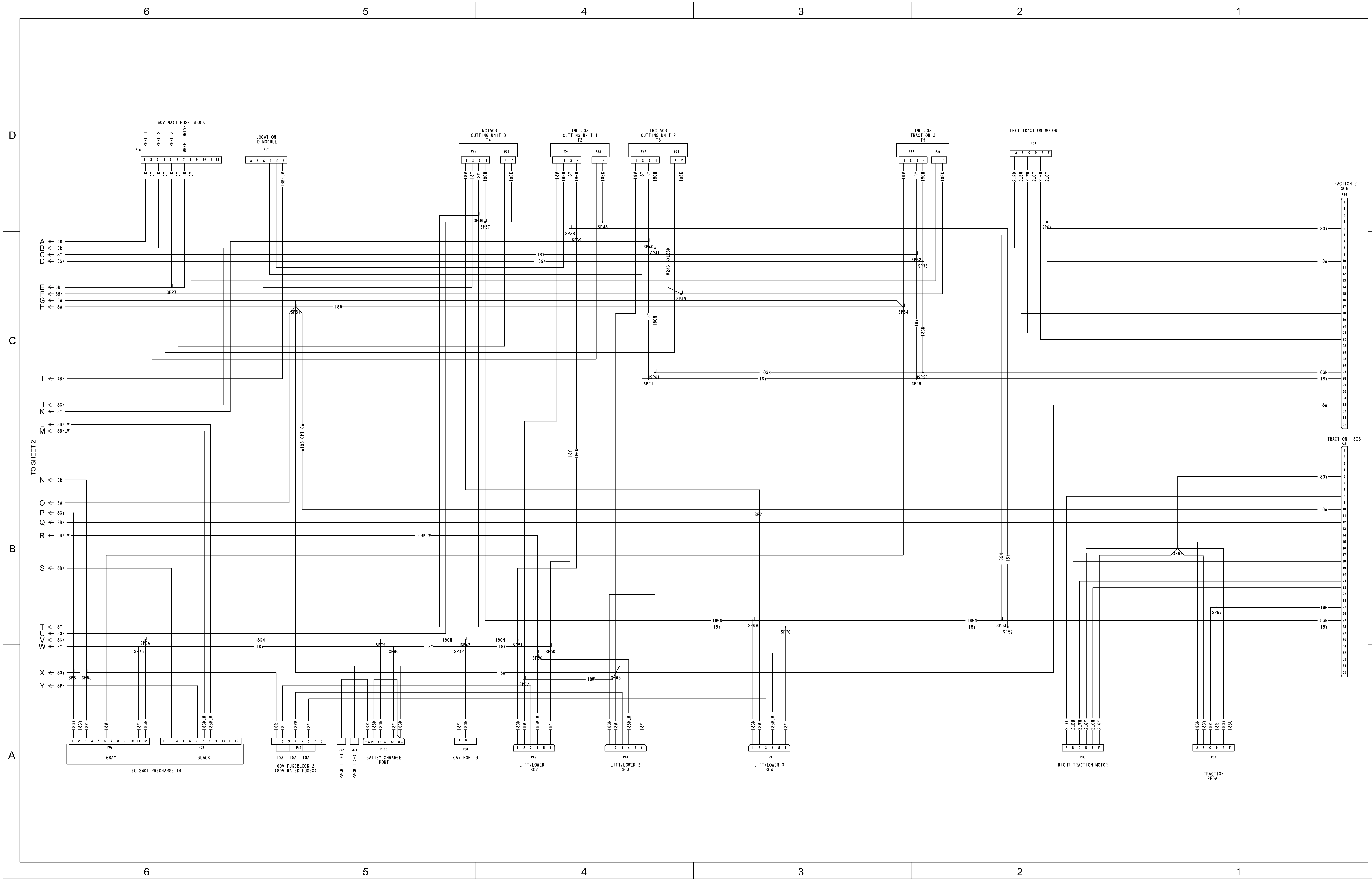


g421757



, Drawing 122-2788 Rev A, Sheet 1 of 2

Wire Harness Diagram – 04591



g422053

Count on it.