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TORO®

Count on it.

Service Manual

Groundsmaster® 3200, 3300 and 3310

(Models 31900, 31901, 31902, 31903, 31907 and 31909)

Revision History

Revision	Date	Description
A	2/2020	Initial release.
B	10/2020	Cutting unit trim height adjustment, update PTO drive belt.
C	4/2021	Add optional slope sensor information.
D	6/2021	Updated Engine chapter.

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 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. The Toro Company has made every effort to make the information in this manual complete and correct.

Refer to the traction unit and cutting unit *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 Catalogs* 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.

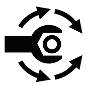
Service Procedure Icons

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) (page 2–10) and Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners) (page 2–12).

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.

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Additional Reference Materials

Yanmar Service Manual for 3TNV80F engines
Yanmar Service Manual for 3TNV88 engines
Yanmar Troubleshooting Manual for 3TNV88 engines
Yanmar Service Manual for 3TNV88C engines
Yanmar Troubleshooting Manual for 3TNV88C engines
Danfoss LPV Axial Piston Pump Service Manual
Danfoss LPV Axial Piston Pump Repair Manual
Parker Torqmotor™ Service Procedure (TF, TG, TH, and TL Series)
Danfoss OSPM Steering Unit Service Manual
Sanden SD Compressor Service Guide

Safety

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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 and remove the key from the key switch before cleaning, adjusting, or making repairs.

- **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 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 due to inferior parts…**

Think Safety First (continued)

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 making adjustments or repairs on 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 that you are working in a dry environment.
  - Do not wear metal jewelry when working on or near electrical components or wiring.
- **Avoid contact with pressurized hydraulic fluid...**
  - Release all pressure in the hydraulic system before performing any work on the system.
  - Keep your body and hands away from pin-hole leaks or nozzles that eject hydraulic fluid under high pressure. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. Use cardboard or paper to find hydraulic leaks; never use your hands. **If hydraulic fluid is injected into your skin, the fluid damage to your body must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.**
- **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 over load lifts, hoists, and jacks.
  - Do not work under a suspended load.

Think Safety First (continued)

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

- **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.**
- **Do not use the cutting unit or implement as a jacking point.**

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Block the 2 wheels not being raised with chocks to prevent the machine from moving.
3. Position the jack securely under the desired jack point:
   - Front = Position the jack securely under the frame tube just behind the front wheel.
   - Rear = Position the jack securely under the frame directly in front of the rear axle.

   After raising the machine, use an appropriate jack stand under the machine frame to support the machine.

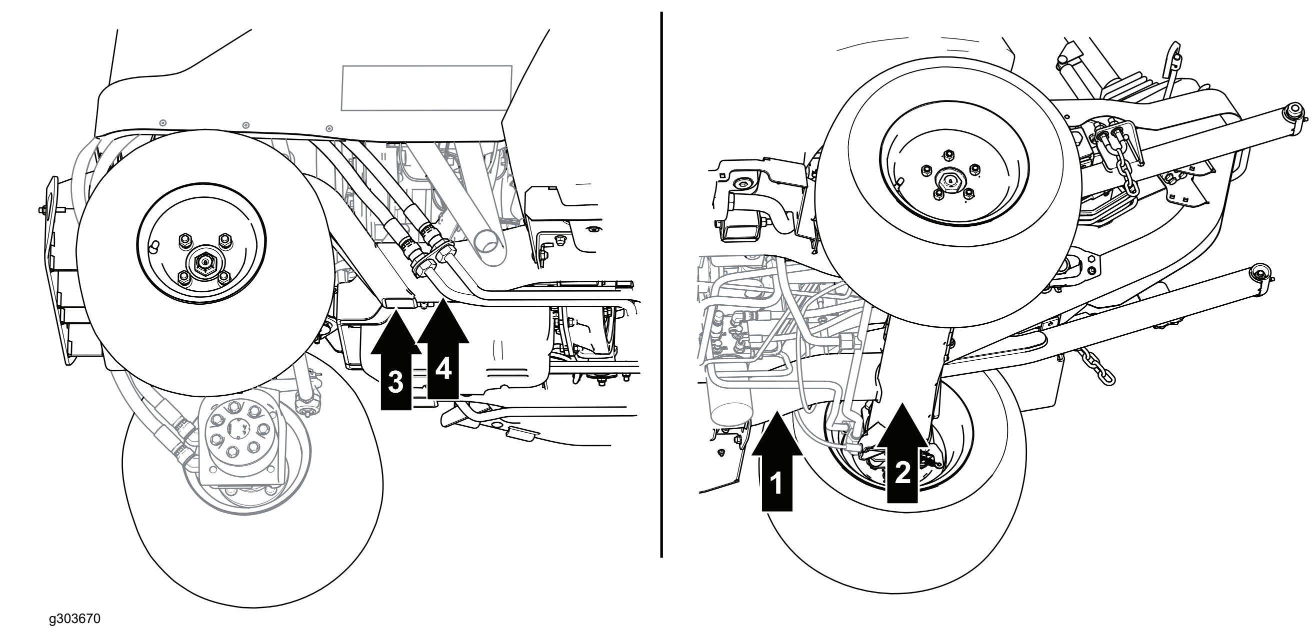

Figure 1

1. Jack point – front
2. Jack stand point – front
3. Jack point – rear
4. Jack stand point – rear

IMPORTANT

Use two jack stands when supporting the machine.

Safety and Instructional Decals

Numerous safety and instruction decals are affixed to the traction unit and cutting units of the Groundsmaster 3200/3300. 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

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Specifications

Overall Dimensions

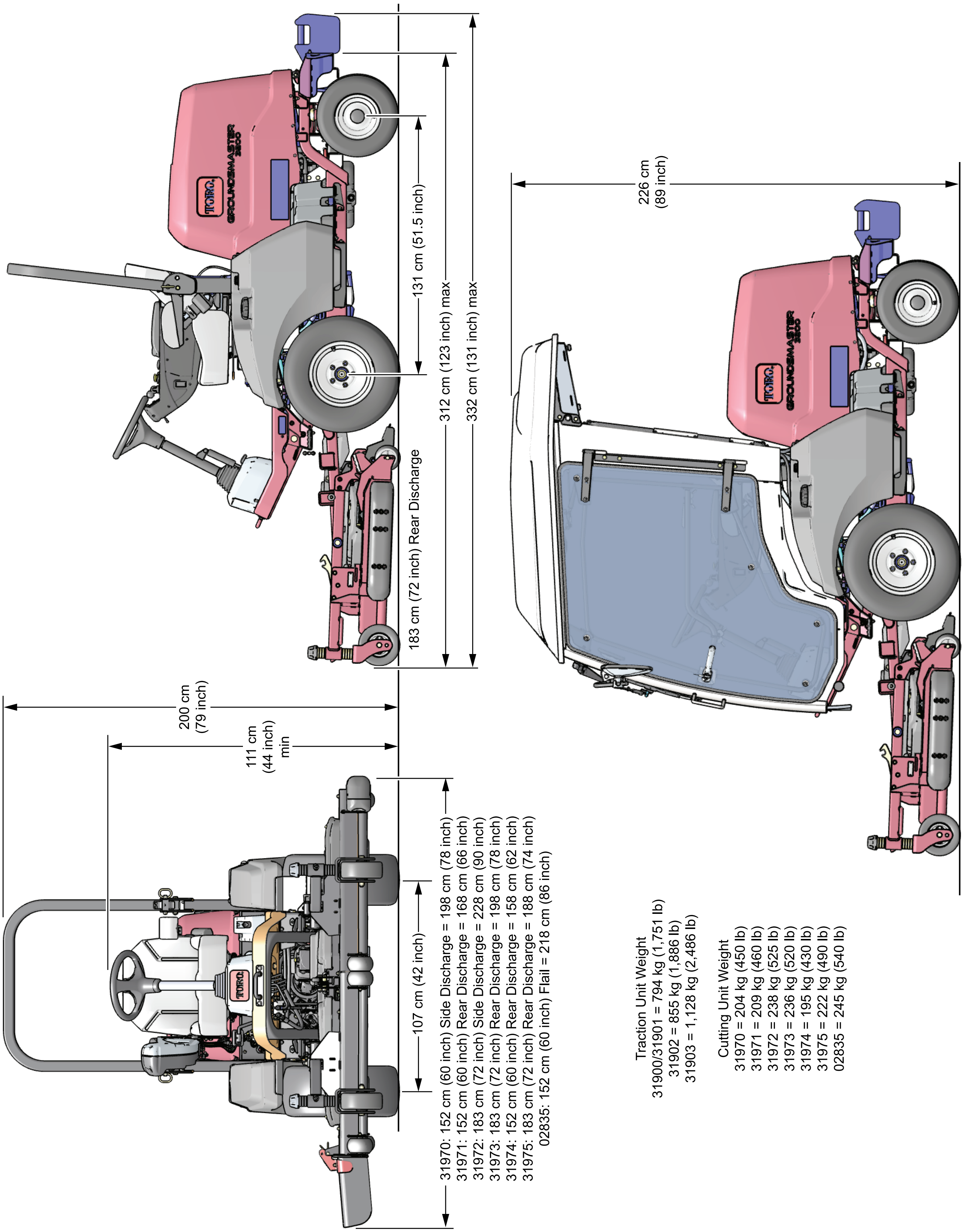


Figure 2

Engine (Model 31900 & 31901)

Item	Description
Make/Designation	Yanmar 3TNV80F: 4-cycle, 3 cylinder water cooled diesel. EPA Tier 4 compliant.
Bore	80 mm (3.15 inches)
Stroke	84 mm (3.31 inches)
Total displacement	1,267 cm^3 (77.31 in^3)
Firing order	1 (flywheel end) - 3 (fan end) - 2
Compression Ratio	19:1
Fuel	Diesel or Biodiesel fuel (up to B7)
Fuel tank capacity	45.4 L (12 US gallons)
Fuel injection pump	Yanmar Supply Pump
Fuel injector nozzle	Throttle type
Governor	Centrifugal-all speed governor
Low idle (no load)	1,150 to 1,250 rpm
High idle (no load)	3,200 to 3,250 rpm
Engine oil	API CJ-4 or higher; refer to the traction unit *Operator's Manual* for additional engine oil information
Crankcase-oil capacity	3.4 L (3.6 US qt)
Oil pump	Gear driven trochoid type
Coolant capacity	6.6 L (7 US qt)
Alternator/Regulator	12 VDC, 40 A
Engine weight (dry)	135 kg (298 lb)

Engine (Model 31902 & 31903)

Item	Description
Make/Designation	Yanmar Model 3TNV88C-DTR: 4-Cycle, 3 cylinder water cooled diesel. EPA Tier 4 compliant.
Bore	88 mm (3.465 inches)
Stroke	90 mm (3.543 inches)
Total displacement	1,642 cm^3 (100.2 in^3)
Firing order	1 (flywheel end) - 3 (fan end) - 2
Compression Ratio	23:1
Fuel	Diesel or Biodiesel fuel (up to B7)
Fuel tank capacity	45.4 L (12 US gallons)
Fuel injection pump	Yanmar Supply Pump
Fuel injector nozzle	Common Rail with Direct Injection
Governor	Electronic-all speed
Low idle (no load)	1,350 to 1,450 rpm
High idle (no load)	3,100 to 3,200 rpm
Engine oil	API CJ-4 or higher; refer to the traction unit *Operator's Manual* for additional engine oil information

Engine (Model 31902 & 31903) (continued)

Item	Description
Crankcase-oil capacity	5.2 L (5.5 US qt) with Filter
Oil pump	Gear driven trochoid type
Coolant capacity	7.6 L (8 US qt)
Alternator/Regulator	12 VDC 55 A
Engine weight (dry)	188 kg (414 lb)

Engine (Model 31907 & 31909)

Item	Description
Make/Designation	Yanmar 3TNV88-BDTR: 4-Cycle, 3 cylinder water cooled diesel. EPA Tier 2 compliant.
Bore	88 mm (3.465 inches)
Stroke	90 mm (3.543 inches)
Total displacement	1,642 cm^3 (100.2 in^3)
Firing order	1 (flywheel end) - 3 (fan end) - 2
Compression Ratio	23:1
Fuel	Diesel or Biodiesel fuel (up to B7)
Fuel tank capacity	45.4 L (12 US gallons)
Fuel injection pump	Yanmar Supply Pump
Fuel injector nozzle	Throttle type
Governor	Centrifugal-all speed governor
Low idle (no load)	1,150 to 1,250 rpm
High idle (no load)	3,200 to 3,250 rpm
Engine oil	API CJ-4 or higher; refer to the traction unit *Operator's Manual* for additional engine oil information
Crankcase-oil capacity	6.6 L (7 US qt)
Oil pump	Gear driven trochoid type
Coolant capacity	7.6 L (8 US qt)
Alternator/Regulator	12 VDC, 40 A
Engine Weight (dry)	161 kg (355 lb)

Hydraulic System

Item	Description
Piston (traction) pump Maximum pump displacement (per revolution)	Danfoss, LPV variable displacement closed circuit axial piston pump 34.9 cm^3 (2.13 in^3)
Traction circuit relief pressure (forward and reverse)	24,993 kPa (3625 psi)
Charge Pump Maximum pump displacement (per revolution)	Casappa positive displacement gear type pump 5.6 cm^3 (0.34 in^3)

Hydraulic System (continued)

Item	Description
Charge circuit relief	896 kPa (130 psi)
Front Wheel Motor Displacement (per revolution)	Parker Torqmotor TG Series Model 31900/31901 – 280 cm^3 (17.1 in^3) Model 31902/31903/31907/31909 – 240 cm^3 (14.5 in^3)
Rear Wheel Motor Displacement (per revolution)	Parker Torqmotor TL Series Model 31901 – 240 cm^3 (14.5 in^3 Model 31902/31903/31907/31909 – 195 cm^3 (11.9 in^3)
Steering valve Displacement (per revolution)	Danfoss Steering Unit, Type OSPM 100 cm^3 (6.1 in^3)
Steering circuit relief pressure	7239 to 7502 kPa (1050 to 1088 psi)
Lift circuit relief pressure	1379 kPa (200 psi)
Hydraulic filter	10 Micron spin-on cartridge type with 413 kPa (60 psi) relief
Hydraulic fluid	Refer to the *Traction Unit Operator's Manual*
Hydraulic reservoir capacity	Minimum – 18.9 L (5 US gallons) Maximum – 45.4 L (12 US gallons)

Chassis

Item	Description
Front tire	
Models 31900, 31901 (24 hp machines)	23 x 10.5 – 12, 4 ply Turf Master @ 137 kPa (20 psi)
Models 31902, 31903, 31907, 31909 (37 hp machines)	24 x 12 – 12, 4 ply Turf Master @ 137 kPa (20 psi)
Rear tire	
Model 31900 (2WD machines)	16 x 6.5 – 8, 4 ply Turf Master @ 193 kPa (28 psi)
Models 31901, 31902, 31903, 31907, 31909 (4WD machines)	18 x 9.5 – 8, 4 ply Turf Master @ 137 kPa (20 psi)
Wheel fastener torque	Front = 95 to 122 N·m (70 to 90 ft-lb) Rear (2WD) = 183 to 224 N·m (135 to 165 ft-lb) Rear (4WD) = 95 to 122 N·m (70 to 90 ft-lb)
Steering wheel mounting nut	28 to 35 N·m (20 to 26 ft-lb)

Cutting Unit

Item	Description
Rotary blade bolt torque	
Standard series cutting unit (models 31974, and 31975)	68 to 81 N·m (50 to 60 ft-lb)
Groundsmaster series cutting unit (models 31970, 31971, 31972, and 31973)	135 to 149 N·m (100 to 110 ft-lb)
Caster wheels	
Rotary cutting unit	8 x 3.5 – 4, 4 ply smooth semi-pneumatic
F60 Flail cutting unit	8 x 3.5 – 4, 4 ply smooth pneumatic @ 276 kPa (40 psi)
Rotary cutting unit gearbox lubricant	petroleum or synthetic SAE 80W–90 gear lube 283 ml (12 oz) capacity

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

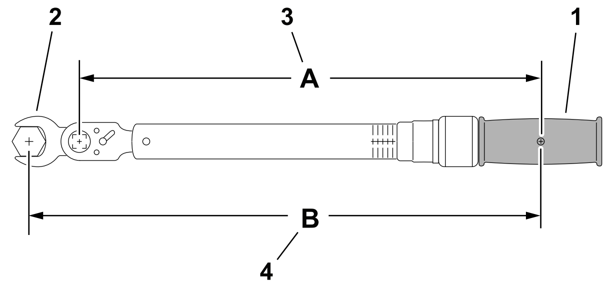


Figure 3

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 3) 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

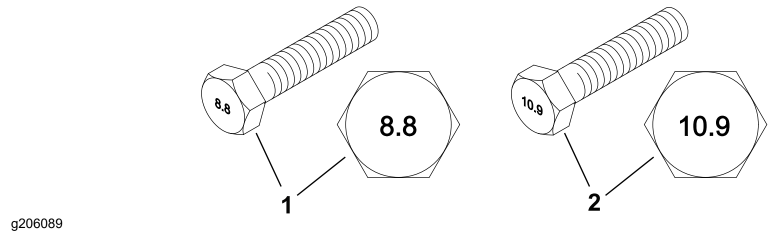


Figure 4
Metric Bolts and Screws

1. Class 8.8
2. Class 10.9

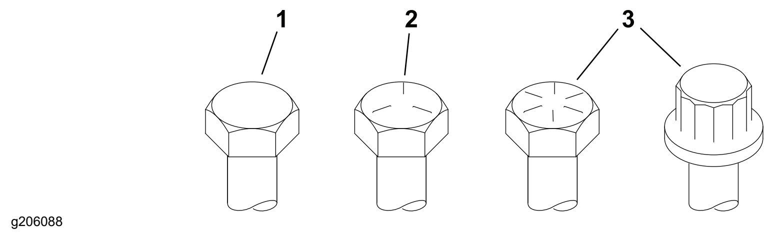


Figure 5
Inch Series Bolts and Screws

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)

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) (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. Fasteners with a factory applied “dry” thread locking compound are not considered lubricated and should be tightened to the standard torque value unless otherwise noted.

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 locking compound such as Loctite. Fasteners with a factory applied “dry” thread locking compound are not considered lubricated and should be tightened to the standard torque value unless otherwise noted.

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

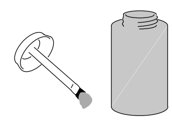
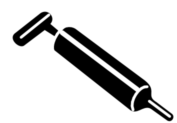
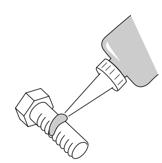
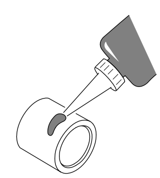
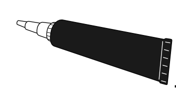
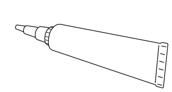
Shop Supplies

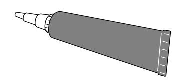
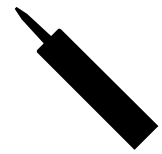
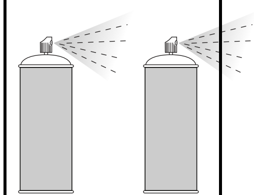
The procedures found in this *Service Manual* may recommend the use of commonly used shop supplies (lubricants, sealants, and adhesives). A symbol denoting the use of a shop supply may appear in figures that support a procedure. Always refer to the written procedure for specific information regarding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

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 Most commonly used to coat battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply an areosol protectant to the connection after you secure the terminal connection. Do Not use an areosol protectant on small multi-pin electrical connectors. An areosol lubricant may also be specified. Refer to the specific service procedure for details.	

Special Tools

You can order these special tools from your Toro Distributor. Some tools may also be available from a local tool supplier.

Hydraulic Pressure Testing Kit

K–Line Part No. TOR47009

Use this kit to take various pressure readings for diagnostic tests. Quick disconnect fittings are provided to attach directly to the mating fittings on the machine test ports without the tools. A high-pressure hose is given for remote readings. Contains 1 each: 6,900 kPa (1,000 psi), 34,500 kPa (5,000 psi), and 69,000 kPa (10,000 psi) gauges.

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57 LPM (15 GPM) Hydraulic Tester Kit

K–LinePart No. TOR214678

Use this tester to test the hydraulic circuits and components for flow and pressure capacities. The tester flow measurement maximum is 57 LPM (15 GPM). This tester includes the following:

Inlet Hose – This hose connects the system circuit to the inlet side of the hydraulic tester.

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 5 to 55 LPM (1 to 15 GPM).

Outlet Hose – A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.

Fittings – An assortment of hydraulic fittings are included with this kit.

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150 LPM (40 GPM) Hydraulic Tester

K–Line Part No. AT40002

Use this tester to test the hydraulic circuits and components for flow and pressure capacities. The tester flow measurement maximum is 151 LPM (40 GPM). This tester includes the following:

Load Valve – Turn the valve to restrict the flow to create a simulated working load in the circuit.

Pressure Gauge – A glycerine filled pressure gauge 0 to 34,500 kPa (0 to 5,000 psi) to provide operating circuit pressure.

Flow Meter – This meter measures the actual fluid flow in the operating circuit with a gauge rated at 20 to 150 LPM (4 to 40 GPM).

Note: This tester does not include any hydraulic hoses or fittings; refer to Hydraulic Hose Kit Toro Part No. TOR6007 and Hydraulic Test Fitting Kit Tor Part No. TOR4079.

Hydraulic O-Ring Kit

Toro Part No. 117-2727

This kit includes O-rings in a variety of sizes for the face seal and port seal hydraulic connections. To help prevent a hydraulic leak, replace the O-rings when you open the hydraulic connection.

Hydraulic Hose Kit

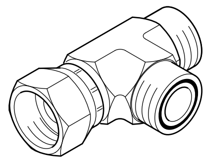
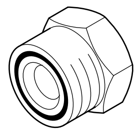
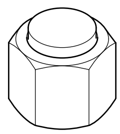
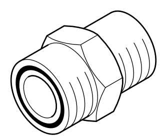
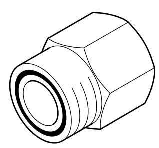
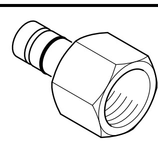
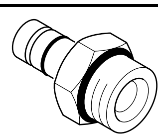
K–Line Part No. TOR6007

This kit includes the fittings and hoses that are used to connect high flow hydraulic filter kit (TOR6011) to the machine hydraulic traction system components.

Hydraulic Test Fitting Kit

K–Line Part No. TOR4079

This kit includes a variety of O-ring face seal fittings to let you connect the test gauges into the system.

FITTING TYPE	SIZE	PART NUMBER
 SWIVEL NUT RUN TEE (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–3 TOR4079–12 TOR4079–4 TOR4079–5
 PLUG (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–13 TOR4079–14 TOR4079–15 TOR4079–16
 CAP (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13–16–16) 10 ORFS (1–14)	TOR4079–17 TOR4079–18 TOR4079–19 TOR4079–20
 UNION (1 each)	6 ORFS (11/16–16) to 8 SAE-ORB (3/4–16) 8 ORFS (13–16–16) to 8 SAE-ORB (3/4–16) 10 ORFS (1–14) to 8 SAE-ORB (3/4–16)	TOR4079–8 TOR4079–9 TOR4079–2
 REDUCER (1 each)	10 ORFS (1–14) to 8 SAE-ORB (3/4–16) 12 ORFS (1 3/16–12) to 8 SAE-ORB (3/4–16)	TOR4079–7 TOR4079–6
 TEST CONNECTOR – FEMALE THREAD (2 each)	4 ORFS (9/16–18) 6 ORFS (11/16–16) 8 ORFS (13/16–16) 10 ORFS (1–14)	TOR4079–10 TOR4079–11 TOR4079–21 TOR4079–1
 TEST CONNECTOR – MALE THREAD (2 each)	4 SAE-ORB (7/16–20) 1/8 NPTF	TOR4079–22 TOR4079–23

High Flow Hydraulic Filter Kit

K–Line Part Number: TOR6011

The high flow hydraulic filter kit is designed with large flow (150 L/minute or 40 gallons/minute) and high pressure (34,500 kPa or 5,000 psi) capabilities. This kit provides for bi-directional filtration which prevents filtered unwanted material from entering into the circuit regardless of the flow direction.

If a component failure occurs in the closed loop traction circuit, contamination from the damaged part will remain in the circuit until you remove it. Install a high flow hydraulic-fluid filter into the circuit when you connect the hydraulic test gauges in order to test the traction circuit components or after you replace a failed traction circuit component (e.g., piston pump or wheel motor). This filter removes contamination from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

Note: This kit does not include the hydraulic hoses; refer to Hydraulic Hose Kit (page 2–17).

Note: The replacement filter element is Toro Part No. TOR6012. The filter element canister tightening torque is **34 N·m (25 ft-lb)**.

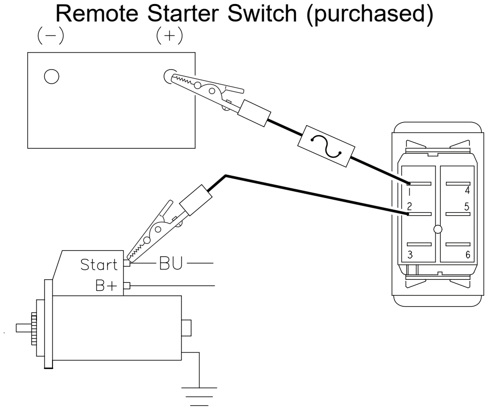
Remote Starter Switch

After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, drive motor), it is necessary to prime the hydraulic pumps. A remote starter switch can be used for this purpose. A remote starter switch can be purchased locally or fabricated as follows.

Remote Starter Switch (purchased)

IMPORTANT: When using a remote starter switch, it is highly recommended to include a 20 amp in−line fuse between the battery and switch connector for circuit protection.

A remote stater switch can also be constructed using Toro switch #106−2027, a length of 14 gauge wire, a 20 amp in−line fuse, two (2) alligator clips and necessary connectors. Connecting the wire to switch terminals 1 and 2 will allow the momentary switch contacts to be used for the remote starter switch.



Remote Starter Switch (fabricated)

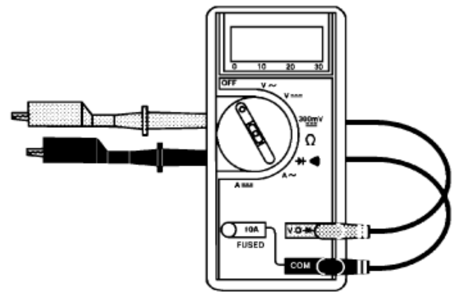
Note: For information on using the remote starter switch to prime the hydraulic pumps, refer to Priming the Hydraulic Pumps (page 5–60).

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 Only. Apply the gel to the component and wire harness connector liberally 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.

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 that 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 TDM display/controller 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 parking brake is engaged, an advisory is identified on the TDM display/controller that the 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	Advisory Name	Cause	InfoCenter Message/Corrective Action Required
B2004	START DENIED	PTO Switch Engaged	Start Denied | Disengage PTO
B005	START DENIED	Out Of Seat And Parking Brake Disengaged	Start Denied | Sit down or set Pbrake
B008	START DENIED	Traction Pedal Engaged	Start Denied | Traction pedal to neutral
B200A	START DENIED	Starter Has Been Active For 30 Seconds	Start Denied | Key held too long
B2015	START DENIED	Deck Switch Engaged	Start Denied | Disengage deck switch
B2024	ENGINE RPM RESTRICTED	Engine Oil Pressure Low	Engine RPM Restricted | Check Oil
B2027	ENGINE SHUTDOWN	Engine Too Hot	Engine Shutdown | Check cooling system
B2028	ENGINE DERATE	Engine Too Hot	Engine Derate | Check cooling system
B2029	ENGINE RPM RESTRICTED	Out Of Seat	Engine Shutdown | Must be seated
B202F	ENGINE SHUTDOWN	Parking Brake Engaged	Engine Shutdown | Disengage parking brake
B2409	DECK LOWER DENIED	Out Of Seat	Lower Denied | Must be seated
B2422	DECK RAISE DENIED	Engine Not Running	Raise Denied | Start engine
B2424	DECK RAISE DENIED	Out Of Seat And Parking Brake Disengaged	Raise Denied | Sit down or set Pbrake
B2504	PTO DENIED	Engine Oil Pressure Low	PTO Denied | Check oil
B2507	PTO DENIED	Engine too hot	PTO Denied | Check cooling system
B2509	PTO DENIED	Out of seat	PTO Denied | Must be seated
B250A	PTO DENIED	No Decks Floating	PTO Denied | Lower decks
B250B	PTO DENIED	Engine Not Running	PTO Denied | Start engine
B2705	INVALID MODEL OR SERIAL NUMBER	Unknown Cause	Invalid Model or Serial Number | Reprogram Software
B2800	REGEN STATUS	Regen Complete	Regen Complete
B2801	REGEN REQUIRED	Inhibit Active	Regen Required. Remove Inhibit
B2802	REGEN REQUIRED	Low Exhaust Temp	Set Engine to full throttle. Regen Required.
B2804	PARKED REGEN REQUIRED	Engine Requested	Parked Regen Required. See Service Menu.
B2805	PTO DISABLED	Parked Regen Required	Parked Regen Required. PTO denied.
B2807	PTO DISABLED	Recovery Regen Required	Recovery Regen Required. PTO denied.
B280A	REGEN STATUS	Regen Failed	Regen Failed

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.

Machine and Engine Faults

Machine Faults

Machine faults are generated by the TDM display/controller to identify an electrical system malfunction (fault) that occurs during machine operation. The fault IDs conform to SAE J2012 standards. When a fault occurs, the bi-color LED on the TDM display/controller panel will flash red and a code for the active fault will appear along the bottom of the TDM display/controller screen. If more than one fault is active, their codes will scroll across the bottom of the TDM display/controller screen one-by-one. Depending on the severity of the fault, a STOP icon may also be displayed.

Recent faults can be viewed via the TDM display/controller screen. A code appears after each fault indicating which controller generated the fault. For example: C14C5:T1 is a PTO fault generated by the T1: TDM

Machine Faults

Fault ID	Fault Title	Fault Condition/Circuit Description	Additional Notes	Service Actions
B1027	Speed Increase/Decrease Switch Broken	The speed increase and speed decrease Inputs are active at the same time.	Speed increase/decrease is disabled.	1. Test the speed increase/decrease switch. 2. Check the wire harness connectors (P100, P106) for damage or corrosion and clean or repair if necessary. 3. Test the circuit wiring. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
B105D	Cutting unit Raise/Lower Switch Broken	The cutting unit raise and deck lower Inputs are active at the same time.	Cutting unit raise/lower is disabled.	1. Test the cutting unit raise/lower switch. 2. Check the wire harness connectors (P100, P33) for damage or corrosion and clean or repair if necessary. 3. Test the circuit wiring. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1013	Engine Run Output - Short to Battery	Low current detected on the engine run output circuit. 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 wire harness connectors for damage or corrosion and clean or repair if necessary. • Model 31900/01/07/09 (P100, P19, P202, P203) • Model 31902/03 (P100, P19, P53, P55, P01) 2. Test the engine run output circuit wiring. 3. Test the engine run output circuit components. • Model 31900/01/07/09 (start interlock relay, fuel pump, fuel solenoid) • Model 31902/03 (start interlock relay, fuel pump, alternator) 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Machine Faults (continued)

Fault ID	Fault Title	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1014	Engine Run Output - Short to Ground/Overcurrent	Overcurrent detected in engine run output circuit, indicating a short to ground.		1. Check the wire harness connectors for damage or corrosion and clean or repair if necessary. • Model 31900/01/07/09 (P100, P19, P202, P203) • Model 31902/03 (P100, P19, P53, P55, P01) 2. Test the engine run output circuit wiring. 3. Test the engine run output circuit components. • Model 31900/01/07/09 (start interlock relay, fuel pump, fuel solenoid) • Model 31902/03 (start interlock relay, fuel pump, alternator) 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1015	Engine Run Output - Open Circuit	Open circuit detected on engine run output circuit.		1. Check the wire harness connectors for damage or corrosion and clean or repair if necessary. • Model 31900/01/07/09 (P100, P19, P202, P203) • Model 31902/03 (P100, P19, P53, P55, P01) 2. Test the engine run output circuit wiring. 3. Test the engine run output circuit components. • Model 31900/01/07/09 (start interlock relay, fuel pump, fuel solenoid) • Model 31902/03 (start interlock relay, fuel pump, alternator) 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1413	Solenoid Valve 1 (SV1) - Short to Battery	Low current detected on the SV1 output circuit. 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 wire harness connectors (P100, P31) for damage or corrosion and clean or repair if necessary. 2. Test the SV1 output circuit wiring. 3. Test the SV1 valve solenoid and cartridge valve. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Machine Faults (continued)

Fault ID	Fault Title	Fault Condition/Circuit Description	Additional Notes	Service Actions
C1414	Solenoid Valve 1 (SV1) - Short to Ground/Overcurrent	Overcurrent detected in SV1 output circuit, indicating a short to ground.		1. Check the wire harness connectors (P100, P31) for damage or corrosion and clean or repair if necessary. 2. Test the SV1 output circuit wiring. 3. Test the SV1 valve solenoid and cartridge valve. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1415	Solenoid Valve 1 (SV1) - Open Circuit	Open circuit detected on SV1 output circuit.		1. Check the wire harness connectors (P100, P31) for damage or corrosion and clean or repair if necessary. 2. Test the SV1 output circuit wiring. 3. Test the SV1 valve solenoid and cartridge valve. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1423	Solenoid Valve 2 (SV2) - Short to Battery	Low current detected on the SV2 output circuit. 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 wire harness connectors (P100, P32) for damage or corrosion and clean or repair if necessary. 2. Test the SV2 output circuit wiring. 3. Test the SV2 valve solenoid and cartridge valve. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1424	Solenoid Valve 2 (SV2) - Short to Ground/Overcurrent	Overcurrent detected in SV2 output circuit, indicating a short to ground.		1. Check the wire harness connectors (P100, P32) for damage or corrosion and clean or repair if necessary. 2. Test the SV2 output circuit wiring. 3. Test the SV2 valve solenoid and cartridge valve. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C1425	Solenoid Valve 2 (SV2) - Open Circuit	Open circuit detected on SV2 output circuit.		1. Check the wire harness connectors (P100, P32) for damage or corrosion and clean or repair if necessary. 2. Test the SV2 output circuit wiring. 3. Test the SV2 valve solenoid and cartridge valve. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).

Machine Faults (continued)

Machine Faults (continued)

Fault ID	Fault Title	Fault Condition/Circuit Description	Additional Notes	Service Actions
C14C3	PTO - Short to Battery	Low current detected on the PTO output circuit. 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 wire harness connectors for damage or corrosion and clean or repair if necessary. • Model 31900/01/07/09 (P100, P07, P106) • Model 31902/03 (P100, P07, P108) 2. Test the PTO output circuit wiring. 3. Test the PTO clutch and TVS diode. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14C4	PTO - Short to Ground/Overcurrent	Overcurrent detected in PTO output circuit, indicating a short to ground.		1. Check the wire harness connectors for damage or corrosion and clean or repair if necessary. • Model 31900/01/07/09 (P100, P07, P106) • Model 31902/03 (P100, P07, P108) 2. Test the PTO output circuit wiring. 3. Test the PTO clutch and TVS diode. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
C14C5	PTO - Open Circuit	Open circuit detected on PTO output circuit.		1. Check the wire harness connectors for damage or corrosion and clean or repair if necessary. • Model 31900/01/07/09 (P100, P07, P106) • Model 31902/03 (P100, P07, P108) 2. Test the PTO output circuit wiring. 3. Test the PTO clutch and TVS diode and replace if necessary. 4. Swap the TDM controller with a known-good unit (contact an Authorized Toro Distributor for assistance).
P0115	Engine Coolant Temp Sensor - Open Circuit	Open circuit detected on engine coolant temp sensor circuit.		1. Check the wire harness connectors (P100, J05) for damage or corrosion and clean or repair if necessary. 2. Check the sensor wiring to the TDM controller. 3. Test the temperature sender and replace if necessary.
P0117	Engine Coolant Temp Sensor - Short to Ground	Short to ground detected on engine coolant temp sensor circuit.		1. Check the wire harness connectors (P100, J05) for damage or corrosion and clean or repair if necessary. 2. Check the sensor wiring to the TDM controller. 3. Test the temperature sender and replace if necessary.

Machine Faults (continued)

Machine Faults (continued)

Fault ID	Fault Title	Fault Condition/Circuit Description	Additional Notes	Service Actions
P06E9	Starter Timeout	Starter has been engaged continuously for more than 30 seconds.	Starter is disabled.	1. Verify the key switch is not stuck in the start position. 2. Check the wire harness connector (P26) for damage or corrosion and clean or repair if necessary. 3. Test key switch and replace if necessary.
P100C	Engine Coolant Temperature Above Threshold - PTO Disabled	Engine coolant temperature has exceeded 105° C (221° F)	PTO is disabled.	1. Allow the engine to cool. 2. Check the fan condition and operation. 3. Clear the air flow screens and passages. 4. Check the coolant level and condition, adjust and replace the coolant if necessary. 5. Check the temperature sender wiring and connector. • Model 31900/01/07/09 (P100, J05) • Model 31902/03 (P01, P240, Yanmar engine wire harness at the temperature sender). 6. Test temperature sender and replace if necessary.
P100D	Engine Coolant Temperature Above Threshold - Engine Shut Down	Engine coolant temperature has exceeded 115° C (239° F)	Engine is shut down.	1. Allow the engine to cool. 2. Check the fan condition and operation. 3. Clear the air flow screens and passages. 4. Check the coolant level and condition, adjust and replace the coolant if necessary. 5. Check the temperature sender wiring and connector. • Model 31900/01/07/09 (J05) • Model 31902/03 (P01, P240, Yanmar engine wire harness at the temperature sender). 6. Test temperature sender and replace if necessary.
P2530	Key Start/Run Correlation Fault	Key start input is active but the key run input is inactive.	Machine will shut down since key run input is inactive.	1. Test fuse F3 in fuse block 1 (10A) and replace if necessary. 2. Check the wire harness connector (P26, P100) for damage or corrosion and clean or repair if necessary. 3. Test the circuit wiring between fuse F3 in fuse block 1 (10A) and the TDM controller. 4. Test the key switch and replace if necessary.

Machine Faults (continued)

Machine Faults (continued)

Fault ID	Fault Title	Fault Condition/Circuit Description	Additional Notes	Service Actions
U0100	CAN Bus Communication Fault - Engine	TDM controller never established communication or lost communication with engine ECU.	One or more machine functions disabled.	1. Check power supply to engine ECU. A. Test the in-line fuse at harness connector P86 (10A). B. Test engine ECU supply and ground circuit wiring. 2. Test the CAN bus.
U0125	CAN Bus Communication Fault - Slope Sensor	The TDM controller established communication then lost communication with the slope sensor.		1. Check power to the slope sensor. • Test the in-line fuse (2A) in connector P03 of the slope sensor harness and replace if necessary. • Verify power to the slope sensor (connector P02 of the slope sensor harness). 2. Check the slope sensor harness connectors (P02, P03) for damage or corrosion and clean or repair if necessary. 3. Test the CAN bus. 4. Replace the slope sensor.
U0432	Configuration Error - Slope Sensor	TDM controller determines the slope sensor was not configured correctly.		1. Check the slope sensor harness connectors (P02, P03) for damage or corrosion and clean or repair if necessary. 2. Cycle the key switch. 3. If the fault repeats, reprogram the machine (contact your Authorized Toro Distributor for assistance).
U1117	Source Address Contention Fault	TDM controller received 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 your Authorized Toro Distributor for assistance).
U1710	Calibration Error	The slope sensor module determines the slope sensor calibration procedure was not able to be completed successfully.		1. Calibrate the slope sensor. 2. Replace the slope sensor.

Engine Faults (Models 31902 and 31903)

Engine faults are generated by the by the Yanmar engine Electronic Control Unit (ECU) to identify an electrical system malfunction (fault) pertaining to the engine during operation. The fault IDs conform to SAE J2012 standards. When a fault occurs a code for the active fault will appear along the bottom of the TDM display/controller screen. If more than one fault is active, their codes will scroll across the bottom of the TDM display/controller screen one-by-one. Depending on the severity of the fault, a STOP icon may also be displayed.

Recent faults can be viewed via the TDM display/controller. A code appears after each fault indicating which controller generated the fault. For example: P1455:EN is a DPF pressure sensor fault generated by the Yanmar engine ECU. Refer to the *Yanmar TNV (Tier 4) Series Troubleshooting Manual* for engine fault information.

Using the TDM Display/Controller Screens for Troubleshooting

The TDM display/controller Main Information Screens can be used to check the operation of various components. The neutral, parking brake, cutting unit lift/lower, seat, and glow plug (model 31902 and 31903) 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 when the engine is not running, and to check charging system activity and circuit wiring integrity when the engine is running.

The TDM display/controller Diagnostics>Input/Output screens can be very helpful when troubleshooting machine operation issues. Electrical components and their circuit wiring can be evaluated quickly using the Input/Output screens prior to testing the component individually. The Input/Output screens show the current state of the inputs and the outputs required to allow the machine cutting unit lift/lower, PTO, and engine operation to proceed. Refer to TDM Display/Controller (page 6–3) for a guide to the various TDM display/controller screens.

CAUTION

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

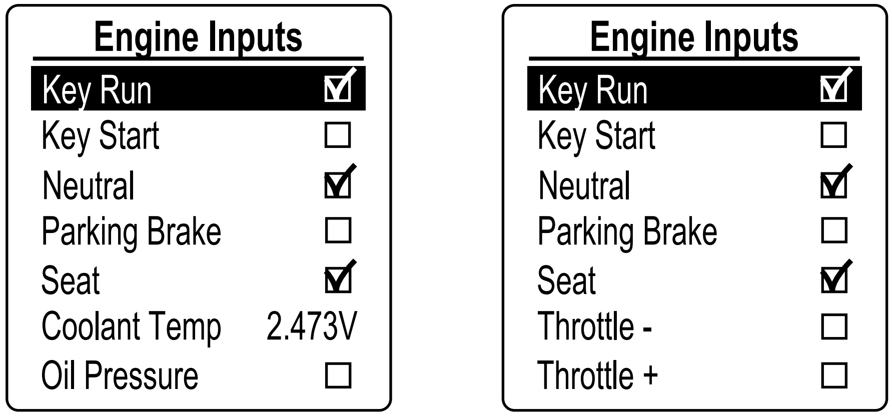
If a machine operation is malfunctioning, the following procedure can help identify the component or circuit wiring causing the malfunction.

1. Park machine on a level surface, lower the cutting unit (or attachment) if possible and stop engine.
2. Set the key switch to the RUN position.
3. Use the screen select button to navigate to the TDM display/controller Diagnostics> Input/Output>Input screen for the desired machine operation. Engine has been selected for this example.

   Manually operate the input component. The component state on the input display should alternate ON (check-mark in box) and OFF (empty box) as the component is cycled. If ON and OFF do not alternate on the input display while operating the component, the component or its circuit wiring is faulty and should be tested; refer to Testing the Electrical Components (page 6–9).

   As an example; the neutral input should display ON (checked) while the traction pedal is at rest. The input should display OFF (empty box) when the traction pedal is pressed in either the forward or reverse direction. The input should display ON (checked box) when the traction pedal is released. Based on the input check boxes shown in this example (refer to Figure 6):

   - the traction pedal is in Neutral
   - the operator is sitting in the seat while testing the traction pedal
   - the parking brake is disengaged
   - the engine is not running



Model 31900, 31901, 31907 and 31909 — Model 31902 and 31903

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Figure 6

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4. Use the screen select button to navigate to the TDM display/controller Diagnostics> Input/Output>Output screen for the desired machine operation. Engine has been selected for this example.

   When the correct inputs are received by the controller, the output identified on the Output screen should show as ON (check-mark in box). If the inputs are functioning properly and in the correct position for the operation to occur, and the output remains OFF (empty box), the controller software may require reloading or replacement. Contact your Authorized Toro Distributor for assistance with controller reprogramming or replacement.

   As an example; if the traction pedal is in neutral and parking brake is engaged or an operator is in the seat, the OK Run output display should come ON (check-mark in box). With the OK Run output display ON, the engine is allowed to crank when the key switch is set to the START position (refer to Figure 7).

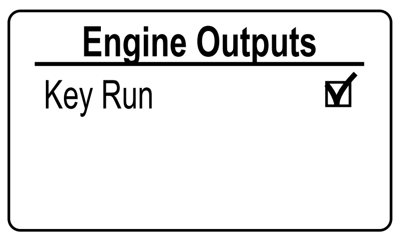

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Figure 7

Note: If the Oil Pressure input does not display ON within 10 seconds after the engine has started, or if the Coolant Temp input voltage goes below 0.153V for 10 seconds (model 31900, 31901, 31907 and 31909 only), the OK Run output display should go OFF (empty box) and the engine should stop.

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 6–9).

Troubleshooting – Hydraulic

The following tables contain suggestions that can be used to solve performance issues specific to the hydraulic system. The suggestions are not all-inclusive. There can be more than 1 cause for a machine malfunction.

Review the hydraulic schematic found in Appendix A (page A–1) and information on the hydraulic system operation in the Hydraulic Flow Diagrams (page 5–13). This information will be useful during the hydraulic troubleshooting process.

Refer to Testing the Hydraulic System (page 5–22) for precautions and specific hydraulic test procedures.

General Hydraulic System Problems

Problem	Possible Cause	Corrective Action
Hydraulic fluid is leaking from the system.	The fitting(s), hose(s), or tube(s) are loose or damaged.	Secure or replace loose or damaged hydraulic connections.
	The O-ring(s) or seal(s) are missing or damaged.	Install a new O-ring(s) or seal(s).
The hydraulic fluid foams excessively causing fluid leakage from the hydraulic tank breather.	The hydraulic fluid level in the hydraulic tank is low.	Adjust the hydraulic fluid level.
	The hydraulic system has a wrong type of fluid.	Replace the hydraulic fluid.
	Note: Refer to the traction unit *Operator's Manual* for hydraulic fluid specifications.	
	The incompatible hydraulic fluids are mixed in the system.	Replace the hydraulic fluid.
	There is water in the hydraulic system.	Replace the hydraulic fluid.
	The pump suction line has an air leak.	Replace the pump suction line.

General Hydraulic System Problems (continued)

Problem	Possible Cause	Corrective Action
The hydraulic system operates hot (exceeds 95° C (203° F).	The traction system pressure is high due to load or dragging brakes.	Inspect brake operation and service or adjust if necessary.
	The hydraulic fluid level in the hydraulic tank is low.	Adjust the hydraulic fluid level.
	The suction filter or suction line is damaged, loose, or clogged.	Secure, clean or replace the suction filter or suction line.
	The hydraulic fluid is contaminated or the fluid viscosity is too light.	Replace the hydraulic fluid.
	Note: Refer to the traction unit *Operator's Manual* for hydraulic fluid specifications.	
	The hydraulic fluid cooler is damaged or plugged.	Repair or replace the hydraulic fluid cooler.
	The fluid cooler air flow is obstructed.	Verify cooling fan operation and remove debris from in and around the fluid cooler.
	The traction pump bypass valve is open or damaged.	Close or replace the traction pump bypass valve.
	The charge pressure is low (steering and lift circuit performance is also affected).	Verify charge pressure; refer to Testing the Traction Circuit – Charge Pressure in the Hydraulic System chapter of this manual.
	The traction pump is worn or damaged.	Verify traction pump operation; refer to Testing the Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure Test in the Hydraulic System chapter of this manual.
	The wheel motor(s) is worn or damaged.	Verify wheel motor operation; refer to Testing the Traction Circuit – Wheel Motor Efficiency in the Hydraulic System chapter of this manual.
	Note: If a traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.	

Traction System Problems

Problem	Possible Cause	Corrective Action
The traction response is sluggish.	The hydraulic fluid is very cold.	Allow the hydraulic fluid to warm by safely operating the machine at rest.
	The hydraulic fluid level in the hydraulic tank is low.	Adjust the hydraulic fluid level.
	The traction control linkage is incorrectly adjusted, binding, or damaged.	Inspect traction linkage operation and service or adjust if necessary.
	The traction pump bypass valve is open or damaged.	Close or replace the traction pump bypass valve.
	Engine speed is low.	Increase the engine speed.
	The traction pump relief valves are leaking or damaged.	Clean or repair the piston (traction) pump relief valves.
	The charge pressure is low (steering and lift circuit performance is also affected).	Verify charge pressure; refer to Testing the Traction Circuit – Charge Pressure in the Hydraulic System chapter of this manual.
	The traction pump is worn or damaged.	Verify traction pump operation; refer to Testing the Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure Test in the Hydraulic System chapter of this manual.
	The wheel motor(s) is worn or damaged.	Verify wheel motor operation; refer to Testing the Traction Circuit – Wheel Motor Efficiency in the Hydraulic System chapter of this manual.
	Note: If a traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.	
The machine travels too far before stopping when the traction pedal is released.	Traction pedal linkage out of adjustment, restricted, or damaged.	Inspect traction linkage operation and service or adjust if necessary.
Neutral is difficult to find or unit operates in one direction only (forward or reverse).	The traction pump bypass valve is open or damaged.	Close or replace the traction pump bypass valve.
	The traction pump relief valves are leaking or damaged.	Clean or repair the piston (traction) pump relief valves.
	The traction pump is worn or damaged.	Verify traction pump operation; refer to Testing the Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure Test in the Hydraulic System chapter of this manual.

Traction System Problems (continued)

Problem	Possible Cause	Corrective Action
No traction exists in either direction.	The hydraulic fluid level in the hydraulic tank is low (other hydraulic circuit performance is affected as well).	Adjust the hydraulic fluid level.
	The traction pump bypass valve is open or damaged.	Close or replace the traction pump bypass valve.
	The traction pump charge relief valve is leaking or damaged.	Clean or repair the charge relief valve.
	The traction pump relief valves are leaking or damaged.	Clean or repair the piston (traction) pump relief valves.
	The charge pressure is low (steering and lift circuit performance is also affected).	Verify charge pressure; refer to Testing the Traction Circuit – Charge Pressure in the Hydraulic System chapter of this manual.
	The traction pump is worn or damaged.	Verify traction pump operation; refer to Testing the Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure Test in the Hydraulic System chapter of this manual.
	The wheel motor(s) is worn or damaged.	Verify wheel motor operation; refer to Testing the Traction Circuit – Wheel Motor Efficiency in the Hydraulic System chapter of this manual.
	Note: If a traction circuit component has internal wear or damage, it is possible that the other traction components are also damaged.	

Steering System Problems

Problem	Possible Cause	Corrective Action
Steering is sluggish, operates poorly or is inoperative.	Steering components (e.g. rod ends, steering cylinder, steering stops) are worn or binding.	Inspect steering components and repair or replace if necessary.
		Verify and adjust rod end and steering stop lengths and adjust if necessary.
	The charge pressure is low (steering and lift circuit performance is also affected).	Verify charge pressure; refer to Testing the Traction Circuit – Charge Pressure in the Hydraulic System chapter of this manual.
		Verify gear pump (P2) performance; refer to Testing the Steering and Lift Circuit – Gear Pump (P2) Flow and Circuit Relief Valve in the Hydraulic System chapter of this manual.
	Relief valve (R4) in the steering control valve is faulty.	Verify relief valve (R4) operation; refer to Testing the Steering and Lift Circuit – Steering Cylinder and Circuit Relief Valve in the Hydraulic System chapter of this manual.
	Steering control valve is worn or damaged.	Rebuild or replace the steering control valve.
Turning steering wheel turns wheels in the wrong direction.	Hydraulic hoses to the steering cylinders are connected incorrectly.	Correct hydraulic hose connections.
Gear pump (P2) are noisy from cavitation (steering, traction charge, and lift circuit performance is affected).	The hydraulic fluid level in the hydraulic tank is low (other hydraulic circuit performance is affected as well).	Adjust the hydraulic fluid level.
	The suction filter or suction line is damaged, loose, or clogged.	Secure, clean or replace the suction filter or suction line.

Cutting Unit (or attachment) Lift/Lower Problems

Problem	Possible Cause	Corrective Action
Lift cylinders will not raise or raise slowly.	Engine speed is too low.	Increase engine speed.
	Lift arms are binding, worn or damaged.	Inspect lift components and repair or replace if necessary.
	The hydraulic fluid level in the hydraulic tank is low (other hydraulic circuit performance is affected as well).	Adjust the hydraulic fluid level.
	An electrical problem exists in the solenoid valve (SV1) circuit.	Test the solenoid valve coil (SV1) and replace if necessary.
		Test the machine wire harness solenoid valve (SV1) circuit.
	Solenoid valve (SV1) in the main manifold is stuck, leaking or faulty.	Clean the solenoid valve and replace the seals.
		Replace the solenoid valve if necessary.
	Relief valve (R4) in the steering control valve is faulty.	Verify relief valve (R4) operation; refer to Testing the Steering and Lift Circuit – Steering Cylinder and Circuit Relief Valve in the Hydraulic System chapter of this manual.
	Lift cylinder circuit pressure is low (traction charge and steering circuits affected as well).	Verify charge pressure; refer to Testing the Traction Circuit – Charge Pressure in the Hydraulic System chapter of this manual.
		Verify gear pump (P2) performance; refer to Testing the Steering and Lift Circuit – Gear Pump (P2) Flow and Circuit Relief Valve in the Hydraulic System chapter of this manual.
Lift cylinders raise but will not stay up. **NOTE:** Lift cylinders cannot provide an absolutely perfect seal. The lift arms will eventually lower if left supporting an attachment in the raised position during storage.	Solenoid valve (SV2) in the main manifold is stuck, leaking or faulty.	Clean the valve and replace the seals.
		Replace the valve if necessary.
	A lift cylinder is leaking internally.	Test and repair or replace the lift cylinder if necessary.
Lift cylinders will not lower.	An electrical problem exists in the solenoid valve (SV2) circuit.	Test the solenoid valve coil (SV2) and replace if necessary.
		Test the machine wire harness solenoid valve (SV2) circuit.
	Solenoid valve (SV2) in the main manifold is stuck, leaking or faulty.	Clean the solenoid valve and replace the seals.
		Replace the solenoid valve if necessary.

Troubleshooting – Electrical

⚠ CAUTION ⚠

Remove all the jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

Pay attention to the TDM display/controller screens. Use the main information screen icons and the operator's advisories to help troubleshoot electrical issues. For the 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 and Wire Harness Drawings/Diagrams in Appendix A (page A–1).

Note: Use the TDM display/controller Diagnostics>Deck/PTO/Engine>Input and Output screens when troubleshooting an electrical problem when possible; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12).

Starting Problems

Problem	Possible Cause	Corrective Action
Nothing happens when you attempt to start the engine.	The battery is discharged.	Charge and test the battery or replace if necessary.
	The battery cables are loose, corroded, or damaged.	Clean the battery terminals (posts).
		Clean the terminals at the ends of the battery cables.
		Inspect the battery cables and repair or replace them if necessary.
	The fuse FB1-F1 (15 A) is damaged.	Test the fuse and replace if necessary.
	The fusible link harness at the engine starter motor is damaged.	Test the fusible link harness and replace if necessary.
	The start interlock relay is damaged.	Test the start interlock relay and replace if necessary.
	The key switch is damaged.	Test the key switch and replace if necessary.
	The starter solenoid is damaged.	Test the starter solenoid and replace if necessary.
	The TDM display/controller is damaged.	Check the TDM display/controller Diagnostics>Engine>Outputs – OK Run.
		Check the TDM display/controller and wire harness connector for corrosion or damaged pins.
		Reprogram or replace the TDM display/controller; contact an Authorized Toro Distributor for assistance.
	Engine ECU is damaged (models 31902 and 31903).	Check the engine ECU and wire harness connector for corrosion or damaged pins.
		Reprogram or replace the Engine ECU; contact an Authorized Toro Distributor for assistance.
The starter solenoid "Clicks", but the engine does not crank.	The battery is discharged.	Charge and test the battery or replace if necessary.
	The battery cables are loose, corroded, or damaged.	Clean the battery terminals (posts).
		Clean the terminals at the ends of the battery cables.
		Inspect the battery cables and repair or replace them if necessary.
	The starter solenoid or starter motor is damaged.	Test the starter solenoid and starter motor and replace if necessary.
	The starter mounting bolts are loose or corroded (insufficient ground).	Remove, clean, apply medium strength thread locking compound and install the mounting bolts. Tighten the bolts to the specified torque.

Starting Problems (continued)

Problem	Possible Cause	Corrective Action
The engine cranks, but does not start.	The fuel tank is empty.	Fill the fuel tank.
	The engine and/or fuel can be too cold.	Move the machine to a heated environment and allow the engine and fuel to warm.
	The fuel filter is plugged.	Check the fuel filter and replace if necessary.
	The fuel pump or circuit wiring is damaged.	Test the fuel pump and replace if necessary.
	The fuel solenoid pull coil relay is damaged (model 31900, 31901, 31907 and 31909).	Test the relay and replace if necessary.
	The engine fuel solenoid is damaged (model 31900, 31901, 31907 and 31909).	Test the fuel solenoid and replace if necessary; refer to the Yanmar Service Manual and Troubleshooting Manual for the engine.
	The glow plug switch is damaged (models 31900, 31901, 31907 and 31909).	Test the glow plug switch and replace if necessary.
	The glow plug relay is damaged.	Test the relay and replace if necessary.
	The glow plugs are damaged.	Test the glow plugs and replace if necessary; refer to the Yanmar Service Manual and Troubleshooting Manual for the engine.
	The engine or fuel system is malfunctioning.	Test the engine fuel system; refer to the Yanmar Service Manual and Troubleshooting Manual for the engine.
	Engine ECU is damaged (models 31902 and 31903).	Check the engine ECU and wire harness connector for corrosion or damaged pins.
		Reprogram or replace the Engine ECU; contact an Authorized Toro Distributor for assistance.
The engine cranks (but should not) when the engine control inputs (neutral switch, parking brake, PTO switch and seat switch) are out of position.	The switch is out of adjustment or damaged.	Adjust the switch position when possible (neutral switch only).
		Test the switch and replace if necessary.
	The TDM display/controller is damaged.	Check the TDM display/controller Diagnostics>Engine>Inputs.
		Check the TDM display/controller and wire harness connector for corrosion or damaged pins.
		Reprogram or replace the TDM display/controller; contact an Authorized Toro Distributor for assistance.
The engine starts, but stops when the key switch is released from the START position.	The key switch or circuit wiring is damaged.	Test the key switch and replace if necessary.

General Run and Transport Problems

Problem	Possible Cause	Corrective Action
The engine shuts off during operation, but it is able to start again.	The machine was operated on a slope with a low fuel level.	Fill the fuel tank.
	The engine temperature sender is damaged.	Test the engine temperature sender; refer to the Yanmar Service Manual and Troubleshooting Manual for the engine.
	The fuel pump or circuit wiring is damaged.	Test the fuel pump and replace if necessary.
	The key switch or circuit wiring is damaged.	Test the key switch and replace if necessary.
	The TDM display/controller is damaged.	Check the TDM display/controller Diagnostics>Engine>Outputs – OK Run while operating the machine.
		Check the TDM display/controller and wire harness connector for corrosion or damaged pins.
		Reprogram or replace the TDM display/controller; contact an Authorized Toro Distributor for assistance.
	Engine ECU is damaged (models 31902 and 31903).	Check the engine ECU and wire harness connector for corrosion or damaged pins.
		Reprogram or replace the Engine ECU; contact an Authorized Toro Distributor for assistance.
The battery does not charge.	The engine alternator belt is loose or damaged.	Adjust the alternator belt tension or replace if necessary.
	The battery is damaged.	Charge and test the battery or replace if necessary.
	A loose, corroded, or broken wire(s) exist in the charging circuit.	Test the circuit wiring and repair or replace if necessary.
	The alternator is damaged.	Test the alternator; refer to the Yanmar Service Manual and Troubleshooting Manual for the engine.
	The fusible link harness at the alternator is damaged.	Test the fusible link harness and replace if necessary.

Cutting Unit (or attachment) Problems

Problem	Possible Cause	Corrective Action
The PTO shaft will not engage (or disengage).	An electrical problem exists in the electric PTO clutch circuit.	Check the TDM display/controller Diagnostics>PTO>Inputs and Outputs while operating the machine.
		Test the PTO switch and replace if necessary.
		Test the PTO clutch coil and replace if necessary.
		Check PTO clutch air gap and adjust or replace if necessary.
The cutting unit (or attachment) does not lift.	Lift arms are binding, worn or damaged.	Inspect lift components and repair or replace if necessary.
	An electrical problem exists in the solenoid valve (SV1) circuit.	Check the TDM display/controller Diagnostics>Deck>Inputs and Outputs while operating the machine.
		Test the solenoid valve coil (SV1) and replace if necessary.
		Test the machine wire harness solenoid valve (SV1) circuit.
	A hydraulic issue exists in the lift/lower hydraulic circuit.	Refer to Troubleshooting – Hydraulic
The cutting unit (or attachment) does not lower.	Lift arms are binding, worn or damaged.	Inspect lift components and repair or replace if necessary.
	An electrical problem exists in the solenoid valve (SV2) circuit.	Check the TDM display/controller Diagnostics>Deck>Inputs and Outputs while operating the machine.
		Test the solenoid valve coil (SV2) and replace if necessary.
		Test the machine wire harness solenoid valve (SV2) circuit.
	A hydraulic issue exists in the lift/lower hydraulic circuit.	Refer to Troubleshooting – Hydraulic

Factors That Can Affect Quality of Cut

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

Remember that the effective or actual height-of-cut depends on the cutting unit weight, tire pressures, hydraulic counterbalance settings, and turf conditions.

Factor	Possible Problem/Correction
Maximum governed engine speed	Check that the engine is running at the correct high-idle speed. Always mow at high engine speed.
Blade speed	All the cutting unit blades should rotate at the same speed.
Tire pressure	Check the air pressure of all the traction unit tires. Adjust to the pressures specified in the traction unit *Operator's Manual*. Ensure that the rotary cutting unit semi-pneumatic caster wheel tires are not worn or damaged to the point they do not hold air. For Model 02835 flail mower, check the air pressure of the pneumatic caster wheel tires. Adjust to the pressure specified in the flail mower *Operator's Manual*.
Blade condition	Sharpen the blades if their cutting edges are dull or nicked. Inspect the blade sail for wear or damage. Replace the blade if necessary.
Mower housing condition	Ensure that the cutting chamber is in good condition. Keep the underside of the deck clean. The unwanted material buildup can reduce the cutting performance.
Height-of-cut	Adjust the deck as specified in the cutting unit *Operator's Manual*. The effective (actual) height-of-cut may be different than the bench set height-of-cut.
Cutting deck alignment and ground following	Check the lift arms for wear, damage, or binding. Also, inspect for bent or damaged pivot shafts.
Roller and castor wheel operation	All rollers and caster wheels should rotate freely. Replace the bearings if they are worn or damaged.
Grass conditions	Mow when the grass is dry for best cutting results. Also, remove only 2.5 cm (1 inch) or 1/3 of the grass blade when cutting.
Machine traction speed	Mowing at too fast of a traction speed will result in poor after cut appearance and missed patches of grass.

Engine

Table of Contents

Additional Reference Materials

Yanmar Service Manual for 3TNV80F engines
Yanmar Service Manual for 3TNV88 engines
Yanmar Troubleshooting Manual for 3TNV88 engines
Yanmar Service Manual for 3TNV88C engines
Yanmar Troubleshooting Manual for 3TNV88C engines

General Information

This chapter gives information about specifications and repair of the Yanmar diesel engine used in the Groundsmaster 3200/3300 machines. The general maintenance procedures are described in the Toro traction unit *Operator's Manual*. Detailed information on engine troubleshooting, testing, disassembly, and assembly is identified in the *Yanmar Service Manual* and the *Yanmar Troubleshooting Manual*.

Additionally, some engine repair procedures are described in this manual. The described adjustments and repairs require tools which are commonly available in many service shops. Special tools are described in the *Yanmar 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 the Yanmar engines are supplied through your Authorized Toro Distributor. If the parts list is not available, provide your distributor with the Toro model and serial number of your machine as well as the Yanmar engine model and serial numbers.

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 traction unit *Operator's Manual* for additional information when servicing the machine.

Yanmar Service and Troubleshooting Manuals

The engine that powers the Groundsmaster 3200 (model 31900 and 31901) is a Yanmar 3TNV80F. The engine that powers the Groundsmaster 3300/3310 (model 31902 and 31903) is a Tier-4 compliant Yanmar 3TNV88C-DTR. The engine that powers the Groundsmaster 3300/3310 (model 31907 and 31909) is a Tier-4i compliant Yanmar 3TNV88-BDTR. *Yanmar Engine Service Manuals* are available for these engines. Additionally, *Yanmar Engine Troubleshooting Manuals* are available for the Tier-4 compliant 3TNV88C-DTR and the Tier-4i compliant 3TNV88-BDTR engines. Ensure that the correct engine manuals are used when servicing the engine on your machine.

Engine Electronic Control Unit (ECU) (Models 31902 and 31903)

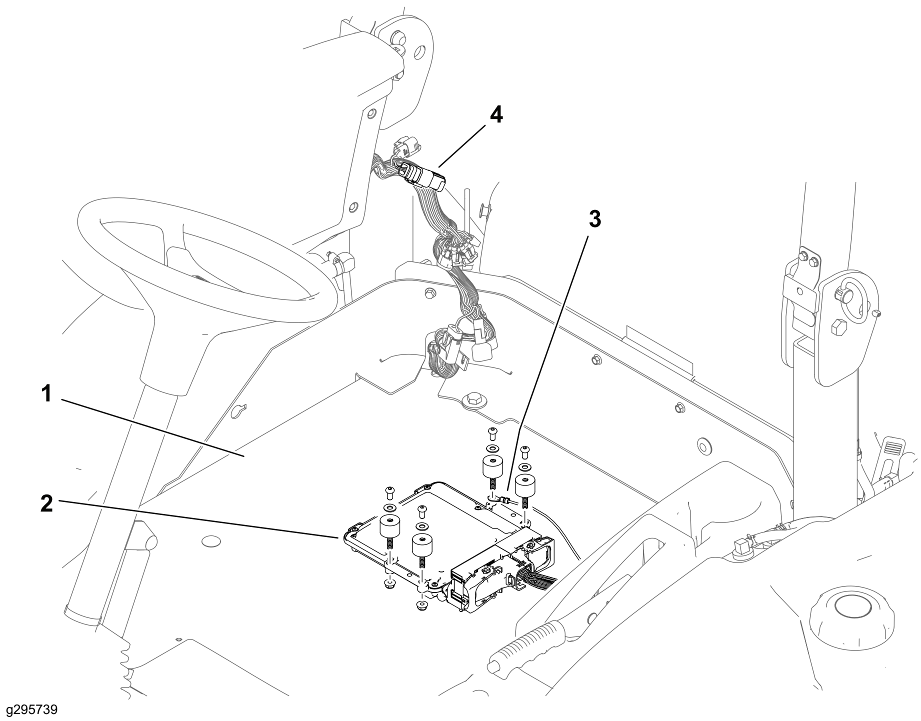


Figure 8

1. Operator's platform
2. Engine ECU
3. Engine ECU ground wire
4. Yanmar SA-D connector

The Yanmar engine that powers the Groundsmaster 3300/3310 (model 31902 and 31903) uses an Electronic Control Unit (ECU) for engine management. The TDM display/controller and the Yanmar Engine Control Unit (ECU) used on the Groundsmaster 3300/3310 machine communicate with each other on a Controller Area Network (CAN) bus system. All wire harness electrical connectors should be plugged into the ECU before the machine key switch is moved from the OFF position to either the ON or START position. The engine ECU is attached to the underside of the operator's platform.

A variety of engine electrical components (e.g. ECU, fuel injectors, EGR sensor, exhaust DPF sensor, etc.) are identified and matched in the engine ECU program. If engine electrical components are replaced on the engine, the Yanmar SmartAssist–Direct tool (SA-D) must be used to update the ECU program to ensure that the engine operates correctly. The Yanmar SA-D connector is located behind the operator's console.

Engine Electronic Control Unit (ECU) (Models 31902 and 31903) (continued)

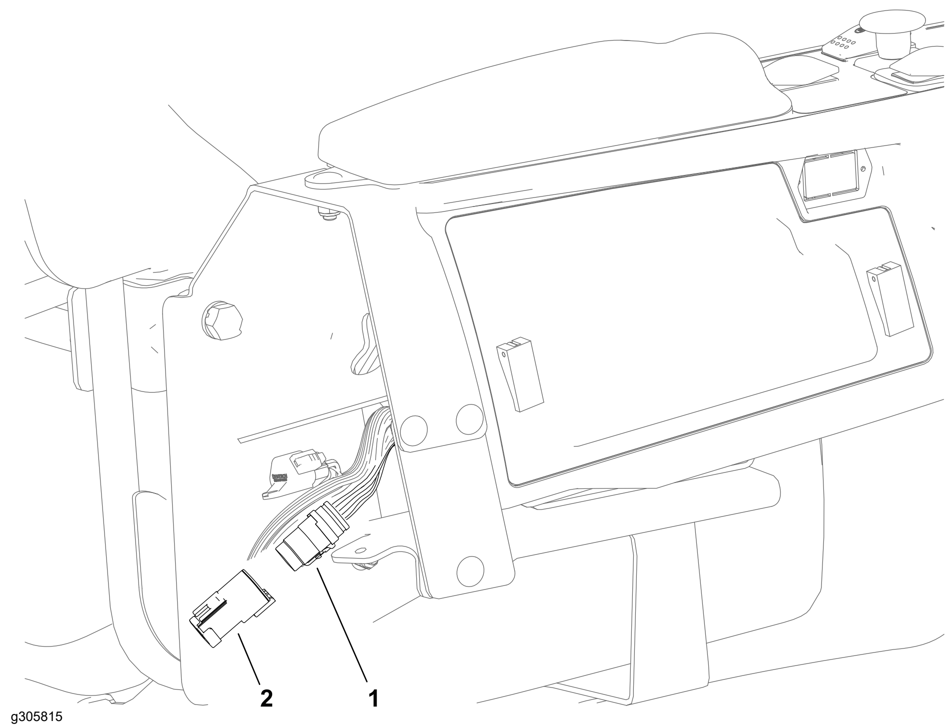


Figure 9

1. Yanmar SA-D connector
2. Cover

If the engine ECU identifies that an engine problem exists, an engine fault will appear on the TDM display/controller screen and the engine speed may be reduced or the engine might stop. The *Yanmar Troubleshooting Manual* and the Yanmar SmartAssist–Direct tool (SA-D) should be used to provide assistance in identifying the cause of the problem and the repairs that may be necessary. Contact your Toro distributor for assistance in Yanmar engine troubleshooting.

IMPORTANT

Do not disconnect the engine ECU for 60 seconds after the machine key switch is turned off. The engine ECU may remain energized even though the key switch is in the OFF position.

Note: A ground wire is used to ground the ECU to the battery. The ground wire is captured by one of the ECU mounting screws and is secured to the negative (-) battery terminal.

Yanmar Engines

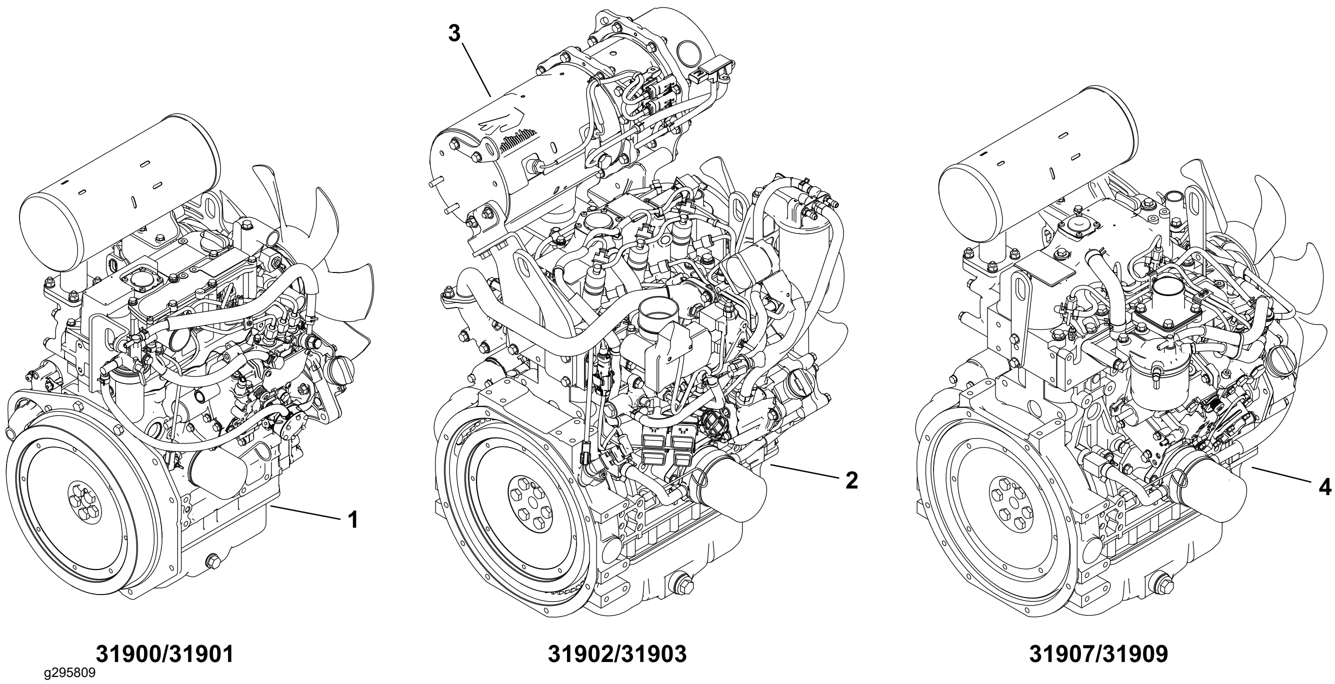


Figure 10

1. Yanmar 3TNV80F engine
2. Yanmar 3TNV88C-DTR engine
3. Diesel particulate filter (DPF)
4. Yanmar 3TNV88-BDTR engine

The engine that powers the Groundsmaster 3200 (model 31900 and 31901) is a Yanmar 3TNV80F. The engine that powers the Groundsmaster 3300/3310 (model 31902 and 31903) is a Tier-4 compliant Yanmar 3TNV88C-DTR. The engine that powers the Groundsmaster 3300/3310 (model 31907 and 31909) is a Yanmar 3TNV88-BDTR.

The engine used on Groundsmaster 3300 machine is a Yanmar TNV series diesel engine that complies with EPA Tier 4F emissions regulations. The engines (for models 31902 and 31903) include an electronic control unit (ECU), an exhaust gas recirculation valve (EGR) and a diesel exhaust particulate filter (DPF).

The ECU combines numerous engine sensors, monitor and control the engine operation for optimum performance. During the operation of the engine, if conditions warrant, the engine ECU may generate an engine fault. Use the Toro Display Module (TDM display/controller) to identify the engine fault; refer to the *Yanmar Troubleshooting Manual*, or contact an Authorized Toro Distributor for assistance.

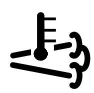
Diesel Particulate Filter

The diesel particulate filter (DPF) used on Yanmar Tier 4F compliant engine is designed to breakdown the hazardous elements in the exhaust and prevent the discharge of unburned fuel or oil known as particulate matter or soot. The DPF includes a Diesel Oxidation Catalyst (DOC), a Soot Filter (SF), 2 temperature sensors and a pressure differential sensor. Additional information regarding the Diesel Particulate Filter can be found in the *Yanmar Operational Manual - Industrial Engines TNV* supplied with your machine.

Regeneration

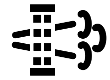
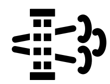
The engine ECU monitors the exhaust pressure before and after the soot filter in the DPF to determine if soot is accumulating. If soot is accumulating during normal engine operation, the pressure differential will increase. The increase in pressure will signal the engine to begin a process called regeneration. Regeneration increases the exhaust temperature and the length of time the engine operates at a higher than normal exhaust temperature, incinerating the built up soot and turning it into ash. The different types of regeneration used are listed in order based on the amount of particulate matter in the soot filter (least to most). The length of time the engine will operate at a higher than normal exhaust temperature to burn out the soot is also related to the amount of particulate matter in the soot filter.

Types of regeneration that are performed automatically (while the machine is operating)

Type	Conditions	Description
Passive	Occurs during normal operation of the machine at high engine speed or high engine load	The DPF processes high heat exhaust gasses, oxidizing harmful emissions and incinerating soot to ash. Passive regeneration occurs as part of normal engine operation. The display screen does not display an icon during passive regeneration. While operating the machine, run the engine at full-engine speed and high load when possible to promote DPF regeneration.
Assist	Occurs because of prolonged operation at low engine speed, low engine load, or when the engine ECU detects the soot filter is becoming obstructed.	The engine ECU adjusts the exhaust intake throttle to raise the exhaust temperature. The display screen does not display an icon during assist regeneration.
Reset	Occurs every 100 hours of engine operation Occurs after an assist regeneration if the engine ECU determines the assist regeneration did not sufficiently reduce the soot level	 The display screen displays the high exhaust temperature icon. The engine ECU adjusts the exhaust intake throttle and the injector timing to raise the exhaust temperature. Do not shut off the engine or reduce the engine speed while the reset regeneration is processing.

Regeneration (continued)

Types of regeneration that are performed manually (while the machine is stationary)

Type	Conditions	Description
Parked	Occurs when exhaust back pressure in the DPF increases due to continued soot buildup. May occur because the InfoCenter was set to inhibit reset regeneration and machine operation continued, adding more soot to the DPF after a reset regeneration was requested. May be caused by prolonged operation at low engine speed, low engine load, or the use of incorrect fuel or engine oil. Can be initiated when prompted by the engine ECU or manually after a minimum of 50 hours of engine operation.	 The display screen displays the stationary regeneration icon. Manually initiate a parked regeneration as soon as possible. A parked regeneration will take approximately 30 to 60 minutes and should not be started with less than 1/4 tank of fuel. The machine must remain stationary (cannot be operated) during the entire parked regeneration process.
Recovery	Occurs when exhaust back pressure in the DPF increases due to soot buildup reaching a critical level. May occur because parked regeneration requests were ignored and machine operation continued, adding more soot to the DPF after a parked regeneration was requested. Can only be initiated when prompted by the engine ECU.	 The display screen displays the stationary regeneration icon. Manually initiate a recovery regeneration as soon as possible. A recovery regeneration will take approximately 3 hours and should not be started with less than 1/2 tank of fuel. The machine must remain stationary (cannot be operated) during the entire recovery regeneration process.

Refer to the traction unit *Operator's Manual* for additional DPF regeneration information, and instructions for using the InfoCenter DPF Regeneration Menus.

Soot Accumulation

If the types of regenerations that are performed automatically (while the machine is operating) are not allowed to complete, soot will continue to accumulate in the soot filter. When enough soot accumulates, the engine ECU will generate an engine fault to prompt a parked or recovery regeneration. In addition to an engine fault appearing on TDM display/controller screen, the engine output power will be reduced.

Ash Accumulation

Ash is a result of the regeneration processes. The lighter ash is discharged through the exhaust system, while the heavier ash collects in the soot filter. When enough ash accumulates in the soot filter, the engine ECU will generate an engine fault to prompt servicing the DPF. In addition to an engine fault appearing on the TDM display/controller screen, the engine output power will be reduced.

Service and Repairs

Air Cleaner Assembly

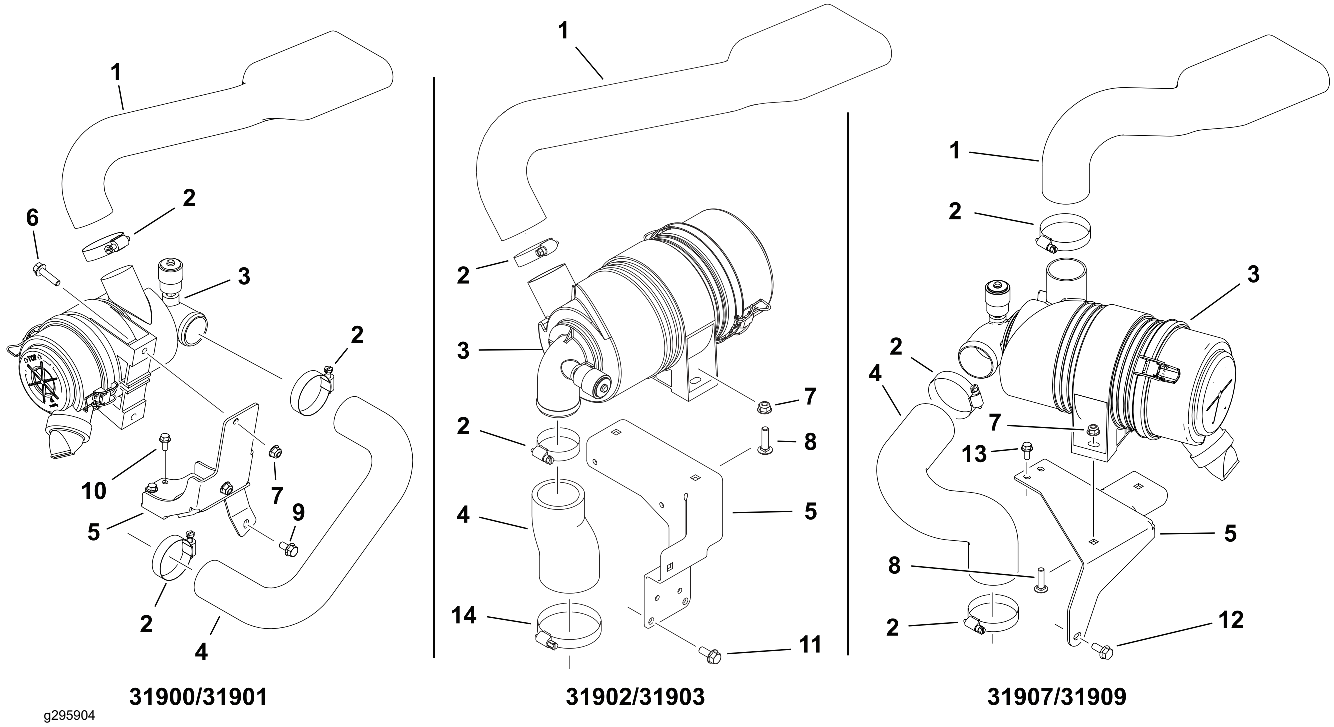


Figure 11

1. Air intake hose
2. Hose clamp (3 each)
3. Air cleaner assembly
4. Intake hose
5. Mounting bracket
6. Cap screw (2 each)
7. Flange nut (2 each)
8. Carriage bolt (2 each)
9. Cap screw (3 each)
10. Cap screw (2 each)
11. Cap screw (3 each)
12. Cap screw
13. Cap screw (2 each)
14. Hose clamp

Removing the Air Cleaner Assembly

Refer to Figure 11 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the **Off** position and remove the key from the key switch.
2. Raise the hood.
3. Remove the air cleaner components if necessary.
4. Refer to Traction Unit Operator's Manual for air cleaner service and maintenance procedures.
5. Examine the air cleaner housing and cover for wear and damage that could cause possible air leaks. Replace components if necessary.
6. Examine the air intake hoses for wear or damage and replace the hoses if necessary.

Installing the Air Cleaner Assembly

Refer to Figure 11 for this procedure.

IMPORTANT

Any leaks in the air cleaner system will allow the dirt into the engine and will cause serious engine damage. Ensure that all air cleaner components are in good condition and are properly secured during assembly.

1. Assemble the air cleaner if necessary.

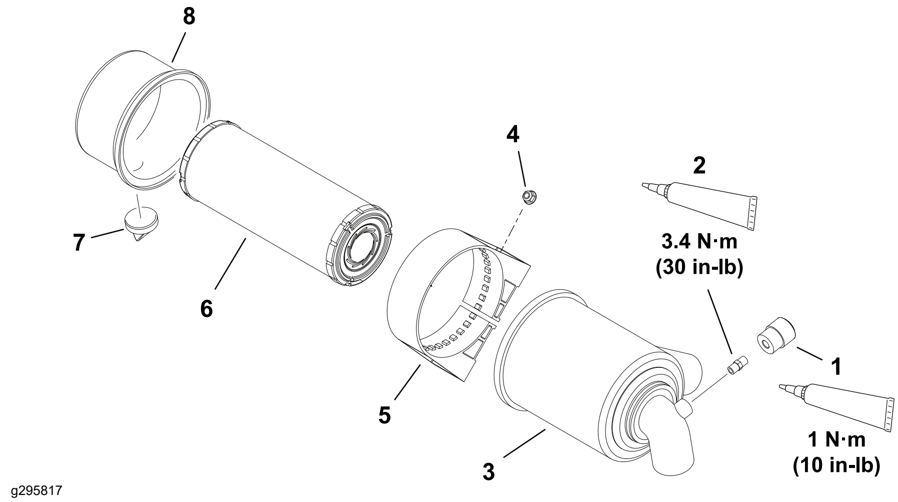


Figure 12

1. Service indicator	5. Air cleaner bracket
2. Pipe nipple	6. Air filter element
3. Air cleaner housing	7. Vacuator valve
4. Flange nut (2 each)	8. Air cleaner cover

   A. If the service indicator or pipe nipple were replaced:
      - Apply sealant to the threads of the nipple and install the nipple in the air cleaner housing. Tighten the nipple to **3.4 N·m (30 in-lb)**.
      - Apply sealant to the threads of the nipple and install the service indicator to the nipple. Tighten the service indicator to **1 N·m (10 in-lb)**.

   B. Ensure that the vacuator valve is pointed downward after installation.

2. Assemble the remaining air cleaner components if necessary.

Exhaust System

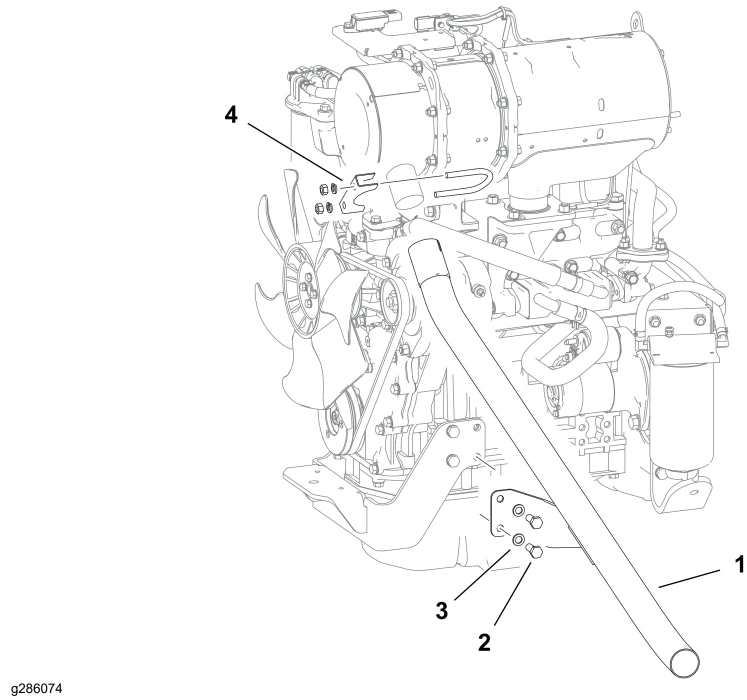


Figure 13
(Model 31902/31903 shown)

1. Exhaust tube
2. Bolt (2 each)
3. Lock washer (2 each)
4. Clamp

The engine that powers the Groundsmaster 3300 (Models 31902 and 31903) machine is equipped with an exhaust system that includes a Diesel Particulate Filter (DPF). The DPF includes a Diesel Oxidation Catalyst (DOC), a Soot Filter (SF), temperature sensors, and a pressure differential sensor. The DPF is kept clean through a series of regeneration processes that are controlled by the engine ECU; refer to Diesel Particulate Filter (page 4–5).

Reconditioning of Soot Filter (SF) may be necessary over the life of the machine which will require exhaust system disassembly. Soot filter reconditioning should be done by a company that has the necessary equipment. Contact your Toro Distributor for information on reconditioning the soot filter.

The Diesel Oxidation Catalyst (DOC) has a service life expectancy and requires replacement at recommended intervals. Replacement of the DOC will require exhaust system disassembly.

Information about the diesel-particulate filter (DPF) operation and maintenance can be found in the *Yanmar TNV (Tier 4) Series Service Manual* and the *Yanmar TNV (Tier 4) Series Troubleshooting Manual*.

Removing and Installing the Exhaust System

Refer to Figure 13 for this procedure.

Removing and Installing the Exhaust System (continued)

⚠ CAUTION ⚠

A hot engine and exhaust system can cause burns.

Allow the exhaust system components to cool before working on or near them.

---

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the **Off** position and remove the key from the key switch.
2. Raise the hood and allow the exhaust system to cool before servicing the exhaust system components.
3. Remove and install the exhaust system components if necessary.
   - Do not reuse exhaust gaskets. Clean any remaining gasket material from the gasket surfaces and install a new gasket during assembly. Do not use any type of gasket sealant on exhaust gaskets or gasket surfaces.
   - Ensure that all exhaust system connections are free of debris or damage that may cause an exhaust leak.

Radiator

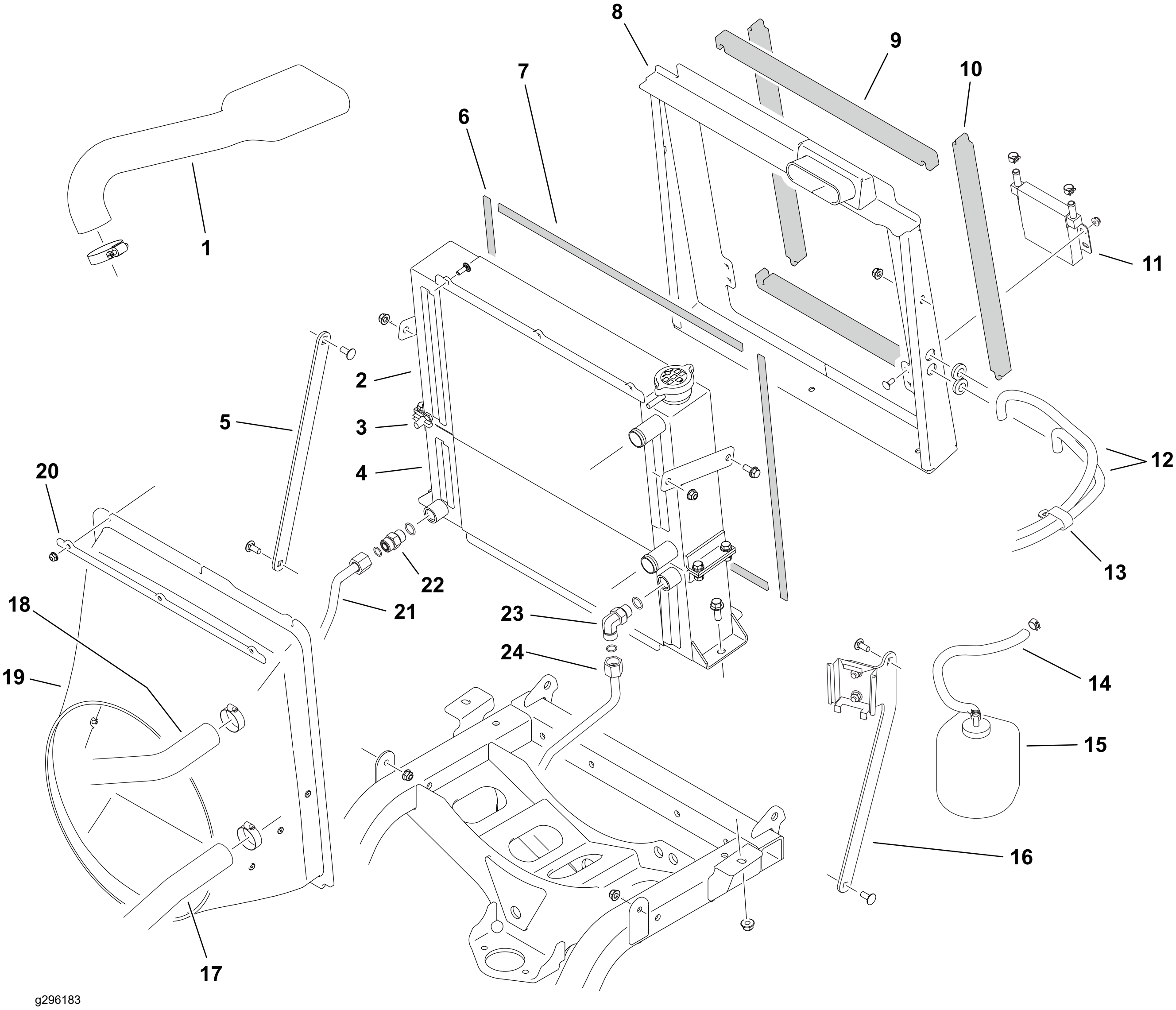


Figure 14

1. Air cleaner intake hose
2. Radiator/hydraulic fluid cooler (radiator)
3. Coolant drain valve
4. Radiator/hydraulic fluid cooler (fluid cooler)
5. Support bracket – RH (non-cab version shown)
6. Radiator foam (2 each)
7. Radiator foam (2 each)
8. Radiator shroud assembly
9. Foam seal (2 each)
10. Foam seal (2 each)
11. Fuel cooler (31902/31903)
12. Fuel hoses (31902/31903)
13. Clamp (31902/31903)
14. Coolant reservoir hose
15. Coolant reservoir
16. Support bracket – LH
17. Radiator hose (lower)
18. Radiator hose (upper)
19. Fan shroud
20. Shroud retainer bracket
21. Hydraulic tube assembly
22. Hydraulic fitting – straight
23. Hydraulic fitting – elbow
24. Hydraulic tube assembly

The radiator on your Groundsmaster 3200/3300 is combined with the hydraulic fluid cooler. The radiator and hydraulic fluid cooler should be removed from the machine as an assembly. If desired, the radiator and hydraulic fluid cooler may be separated once the assembly is removed from the machine.

Removing the Radiator and Hydraulic Fluid Cooler

DANGER

If the radiator or engine is hot, pressurized hot coolant can escape and cause burns.

Do not open the radiator cap or drain the coolant when the radiator or engine is hot.

WARNING

Ethylene-glycol antifreeze is poisonous.

Keep the coolant away from children and pets.

Keep the coolant in a labelled container.

Discard the coolant in accordance with local hazardous waste ordinances.

Refer to Figure 14 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the **Off** position and remove the key from the key switch.
2. Remove the hood; refer to .
3. Remove the air cleaner intake hose.
4. Disconnect the coolant overflow hose from the radiator and remove the coolant reservoir and hose from the machine.
5. Remove the windshield washer fluid reservoir (if equipped) and remove the support bracket from the right side of the radiator assembly.
6. Use the drain valve on the right side of the radiator and drain the coolant from radiator.
7. Remove the support bracket from the left side of the radiator assembly.
8. For model 31902/31903 machines, disconnect the fuel hoses from the fuel cooler and pass the hoses out through the radiator shroud; refer to Fuel System (page 4–16). Remove the clamp securing the fuel hoses to the radiator.
9. Disconnect the upper and lower radiator hoses from the radiator. Cover or plug the disconnected coolant hoses to prevent contamination.
10. Refer to General Precautions for Removing and Installing the Hydraulic System Components (page 5–52), then drain the fluid cooler by disconnecting the hydraulic lines from the cooler.
11. Cover or plug the openings in the hydraulic fluid cooler and radiator to prevent contamination from entering the systems.
12. Remove the fasteners that secures the radiator assembly to the frame and remove the radiator assembly from the machine.
13. Disassemble the radiator and hydraulic fluid cooler assembly if necessary.
    - Inspect the foam seals on both sides of the radiator shroud for wear or damage and replace them if necessary.
    - If necessary, remove the hydraulic fittings from the hydraulic fluid cooler and discard the O-rings.

Installing the Radiator and Hydraulic Fluid Cooler

Refer to Figure 14 for this procedure.

1. Lubricate new O-rings and place them onto the hydraulic fittings. If previously removed, install the fittings into the cooler ports using alignment marks made during removal; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
2. If previously removed:
   - Clamp the radiator shroud to the radiator assembly before securing the shroud to the radiator assembly.
   - Secure the fuel cooler to the radiator shroud.
   - Install the fan shroud to the radiator assembly.
3. Position the radiator assembly to the frame and secure the radiator assembly with the fasteners previously removed.
4. Remove the covers and plugs from the openings in the radiator and the hydraulic fluid cooler and the disconnected coolant and hydraulic lines that were installed during removal.
5. Connect the hydraulic lines to the hydraulic fluid cooler.
6. Install the windshield washer fluid reservoir (if equipped) and install the support bracket to the right side of the radiator assembly.
7. Connect the upper and lower radiator hoses to the radiator and secure the hoses with the hose clamps.
8. Install the support bracket to the left side of the radiator assembly.
9. For model 31902/31903 machines, pass the fuel hoses through the radiator shroud and connect the fuel hoses to the fuel cooler. Install the clamp securing the fuel hoses to the radiator.
10. Install the coolant reservoir on the support bracket and secure the overflow hose to the radiator with a hose clamp.
11. Install the air cleaner intake hose.
12. Ensure that the radiator drain valve is closed and fill radiator and coolant reservoir with coolant; refer to the traction unit *Operator’s Manual*.
13. Add hydraulic fluid to the hydraulic reservoir if necessary; refer to the traction unit Operator’s Manual.
14. Start the engine and check for coolant and hydraulic fluid leaks. Repair any leaks as required.
15. Continue to run the engine to obtain the operating temperature. Check the coolant and hydraulic fluid levels and adjust if necessary before returning the machine to service.
16. Install the hood; refer to Removing and Installing the Hood (page 7–24).

Fuel System

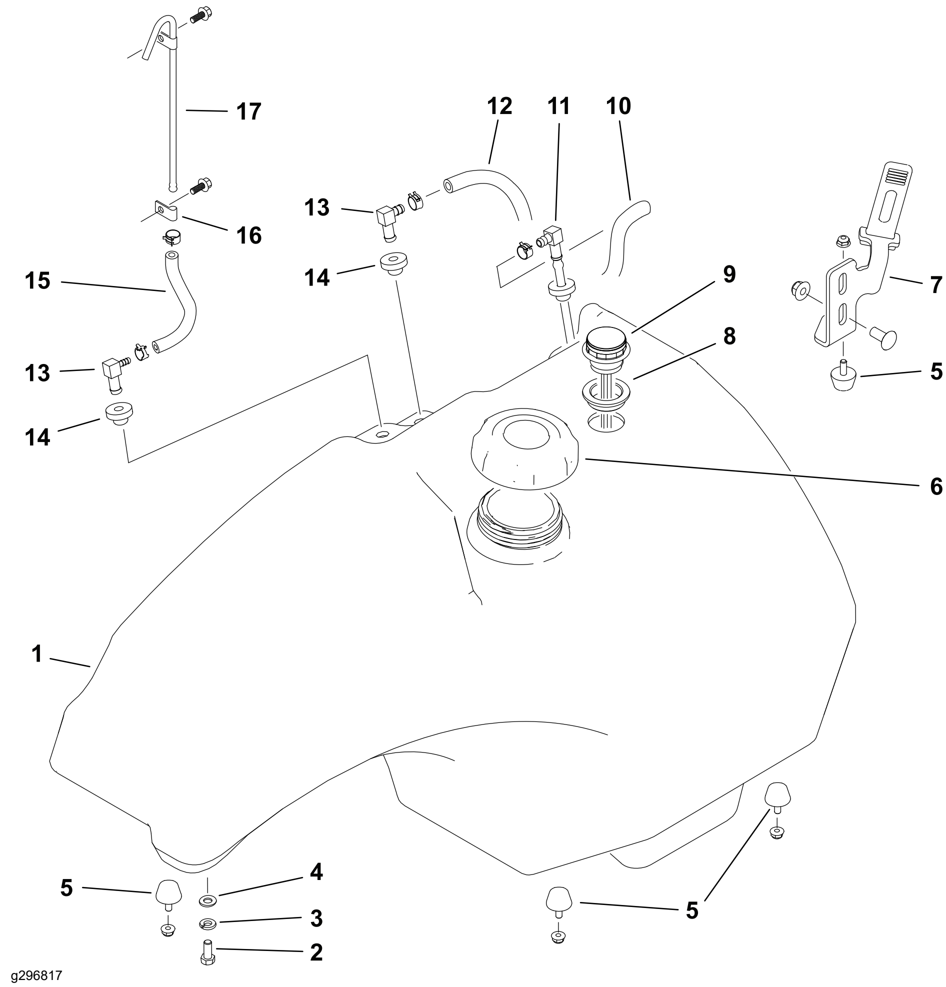


Figure 15

1. Fuel tank
2. Cap screw
3. Lock washer
4. Flat washer
5. Bumper (4 used)
6. Fuel cap
7. Bracket, hold down
8. Seal
9. Fuel level gauge
10. Fuel hose, supply
11. Stand pipe
12. Fuel hose, return
13. Barb fitting (2 used)
14. Grommet (3 used)
15. Fuel hose, vent
16. Clamp (2 used)
17. Tube, vent

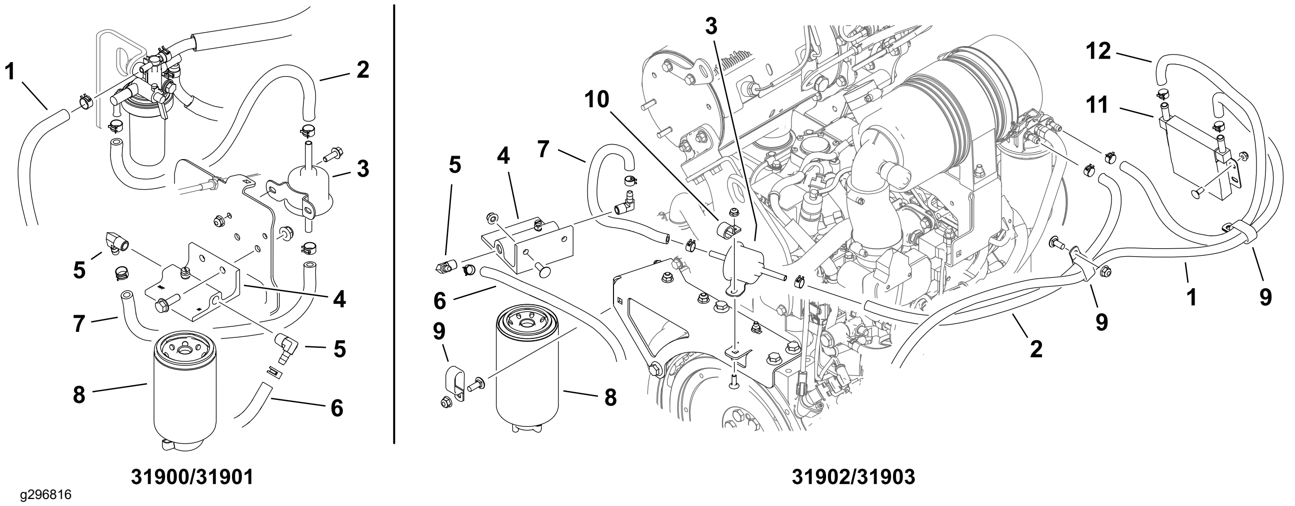


Figure 16

1.	Fuel hose, return	5.	Elbow fitting (2 each)	9.	Clamp (3 each)
2.	Fuel hose, pump to filter	6.	Fuel hose, supply	10.	Clamp
3.	Fuel pump	7.	Fuel hose, separator to pump	11.	Fuel cooler
4.	Separator head	8.	Separator element	12.	Fuel hose, filter to cooler

The fuel system includes a fuel tank with a mechanical fuel level gauge on the left side of the machine, a fuel/water separator, a low pressure electric fuel pump, and a fuel filter and mechanical high pressure fuel injection pump located on the engine. Model 31902/31903 machines include a fuel cooler located in front of the radiator and hydraulic fluid cooler assembly. For testing procedures for the low pressure electric fuel pump; refer to Testing the Fuel Pump (page 6–50).

⚠ DANGER ⚠

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

Checking the Fuel Lines and Connections

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 if necessary; refer to Figure 16.

Priming the Fuel System

The fuel system needs to be primed before starting the engine for the first time, after running out of fuel, or after fuel system maintenance (e.g., draining the fuel/water separator, replacing the fuel filter or disconnecting a fuel hose).

Priming the Fuel System (continued)

IMPORTANT

Do not turn the key switch to the START position to prime the fuel system.

To prime the fuel system:

1. Ensure that the fuel tank has fuel in it.
2. Allow the electric fuel pump to prime the fuel system by turning the key switch to the RUN position for 10 to 15 seconds. Cycle the key switch and repeat if necessary.
3. Check the fuel system for leaks before returning the machine to service.

Removing and Installing the Fuel Tank

Refer to Figure 15 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the **Off** position and remove the key from the key switch.
2. Empty the fuel tank through the filler neck.
3. Open the hood and remove the left side hold down bracket from the ROPS.
4. Remove the battery cover.
5. Remove the cap screw (item 2) from under the front of the fuel tank.

IMPORTANT

To prevent damage to the fuel hoses, cable ties and clamps may be used to secure the hoses to the machine components. Record the location of all cable ties and clamps that are removed from the machine so they can be properly replaced.

6. Label the fuel hoses for assembly purposes. Loosen the hose clamps and disconnect the hoses from the fuel tank.
7. Cover or plug the fuel hoses or fitting openings to prevent contamination from entering the fuel system.
8. Remove the fuel tank from the machine.
9. Inspect the 4 rubber bumpers that support the fuel tank for damage or wear and replace them if necessary.
10. Inspect the 3 rubber grommets that support the fuel fittings for damage or wear and replace them if necessary.
11. To install the fuel tank, follow this procedure in reverse order.
12. If the elbow fittings are removed from the fuel/water separator head, apply thread sealant to the fittings when installing.

Engine

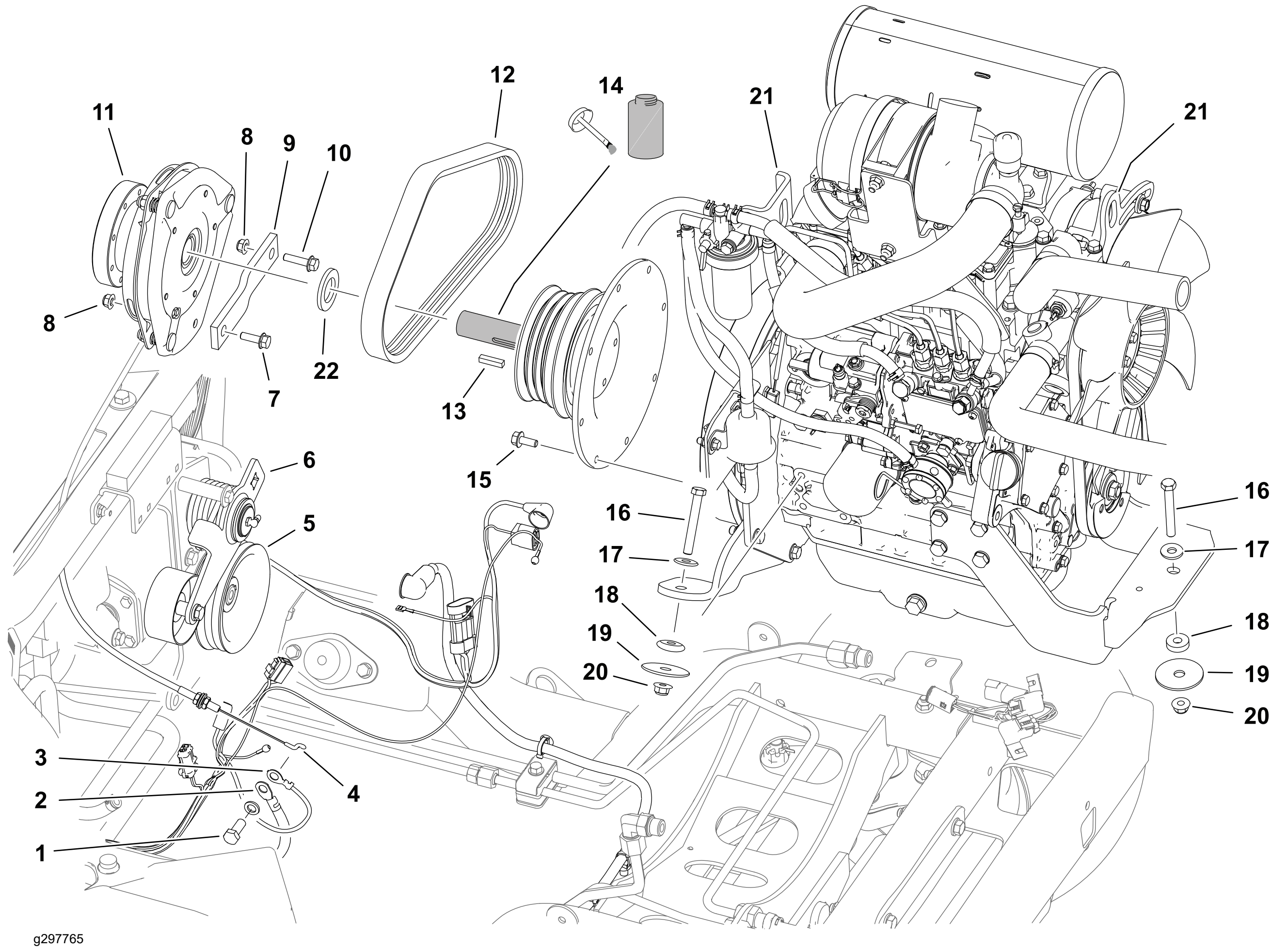


Figure 17

(model 31900 and 31901 shown)

1. Cap screw
2. Negative (-) battery cable
3. Wire harness ground
4. Throttle cable (model 31900 and 31901 only)
5. Pump pulley
6. Drive belt idler arm
7. Cap screw
8. Flange nut (2 each)
9. PTO clutch stop strap
10. Cap screw
11. PTO clutch
12. Pump drive belt
13. Square key
14. Stub shaft
15. Cap screw (8 each)
16. Cap screw (3 each)
17. Flat washer (3 each)
18. Spacer (3 each)
19. Snubbing washer (3 each)
20. Flange nut (3 each)
21. Engine lift lugs
22. Washer

Removing the Engine

Refer to Figure 17 for this procedure.

1. Remove the radiator and hydraulic fluid cooler; refer to Removing the Radiator and Hydraulic Fluid Cooler (page 4–14).
2. Remove the exhaust tube; refer to Removing and Installing the Exhaust System (page 4–11).
3. Disconnect the fuel supply hose from the fuel/water separator, and the fuel return hose from the fuel tank; refer to Fuel System (page 4–16).
4. Remove the fuel/water separator assembly from its support bracket.

5. On model 31900 and 31901 machines; disconnect the throttle cable at the engine.

IMPORTANT

Mark or tag the various electrical connections during removal if necessary to assure proper assembly.

To prevent damage to the electrical wire harnesses, cable ties and clamps may be used to secure wire harnesses to the machine. Record the location of all cable ties and clamps that are removed from the machine during engine removal so that they can be properly replaced during installation.

6. Disconnect all of the electrical connections at the engine.

   On the left side of the engine:

   - Fuel pump
   - Fuel solenoid (model 31900 and 31901 only)
   - Oil pressure switch
   - Glow plugs
   - Coolant temperature sender (model 31900 and 31901 only)
   - DPF pressure sensor (model 31902, 31903, 31907 and 31909 only)
   - 2 DPF temperature sensors (model 31902, 31903, 31907 and 31909 only)
   - 4 engine wire harness connectors (model 31902, 31903, 31907 and 31909 only)

   On the right side of the engine:

   - Fusible link connector
   - Starter solenoid
   - Alternator connector
   - Alternator stud (model 31900 and 31901)

7. Remove the fasteners securing the wire harness ground and battery negative (-) cable to the engine block (lower front left corner).
8. Use a 1/2 inch square drive on the hydraulic pump drive belt idler arm to relieve the belt tension and remove the belt from the pump pulley.
9. Disconnect the cutting unit drive shaft at the PTO clutch.
10. Remove the PTO clutch stop strap.

CAUTION

Make sure that the hoist or lift used to remove the engine can properly support the engine. The engine assembly weighs approximately:

- **Model 31900 and 31901 = 150 kg (330 lbs)**
- **Model 31902 and 31903 = 204 kg (450 lbs)**
- **Model 31907 and 31909 = 172 kg (380 lbs)**

Removing the Engine (continued)

11. Connect a suitable hoist or lift to the front and rear lift tabs on the engine. On model 31902 and 31903 machines, do not allow the lift chains or straps to contact the DPF.
12. Remove the 3 lock nuts, snubbing washers, spacers and cap screws securing the engine mounts to the engine brackets.

CAUTION

Use 1 person to operate the lift or hoist while the other person guides the engine from the machine.

IMPORTANT

When removing the engine ensure that you do not damage the engine, fuel hoses, hydraulic lines, electrical harnesses or other parts.

13. Carefully raise the engine from the machine moving it toward the rear of the machine.
14. Check the condition of the motor mounts and replace if necessary. Ensure that the battery negative (-) cable is secured to one of the front left motor mount fasteners.
15. Continue to disassemble the engine if necessary.
16. Cover or plug all engine openings to prevent contaminants from entering the engine.

Installing the Engine

Refer to Figure 17 for this procedure.

IMPORTANT

Ensure that all parts are removed from the engine during maintenance or overhaul are correctly installed on the engine.

1. If front engine mount brackets were removed from the engine, tighten the bracket to engine fasteners from **46 to 57 N·m (34 to 42 ft-lb)**.
2. Apply anti-seize lubricant to the stub shaft before installing the square key and PTO clutch.
3. Place the pump drive belt in position on the stub shaft.

⚠ CAUTION ⚠

Make sure that the hoist or lift used to install the engine can properly support the engine. The engine assembly weighs approximately:

- **Model 31900 and 31901 = 150 kg (330 lbs)**
- **Model 31902 and 31903 = 204 kg (450 lbs)**
- **Model 31907 and 31909 = 172 kg (380 lbs)**

4. Connect a suitable hoist or lift to the front and rear lift tabs on the engine. On model 31902 and 31903 machines, do not allow the lift chains or straps to contact the DPF.

⚠ CAUTION ⚠

Use 1 person to operate the lift or hoist while the other person guides the engine into the machine.

IMPORTANT

When installing the engine ensure that you do not damage the engine, fuel hoses, hydraulic lines, electrical harnesses or other parts.

5. Carefully lower the engine into the machine moving it toward the front of the machine.
6. Install the 3 lock nuts, snubbing washers, spacers and cap screws securing the engine mounts to the engine brackets.
7. Install the PTO clutch stop strap.
8. Connect the cutting unit drive shaft at the PTO clutch.
9. Use a 1/2 inch square drive on the hydraulic pump drive belt idler arm and install the pump drive belt on the pump pulley.

   Note: Make sure that the engine and frame ground surfaces are free from corrosion, oil and paint.

10. Install the fasteners securing the wire harness ground and battery negative (-) cable to the engine block (lower front left corner).

    A. Torque the engine ground bolt to **7.7 to 8.6 N·m (68 to 76 in-lb)** and apply a coat of terminal protector.

    B. Torque the frame ground bolt to **19.7 to 25.4 N·m (175 to 225 in-lb)** and apply a coat of terminal protector.

11. Connect all of the electrical connections previously removed from the engine.
12. On model 31900 and 31901 machines; connect the throttle cable at the engine.
13. Install the fuel/water separator assembly on its support bracket.
14. Connect the fuel supply and return hoses.

Installing the Engine (continued)

15. Install the exhaust tube; refer to Removing and Installing the Exhaust System (page 4–11).
16. Install the radiator and hydraulic fluid cooler; refer to Installing the Radiator and Hydraulic Fluid Cooler (page 4–15).
17. Ensure that all the wires, fuel lines, hydraulic hoses, and cables are clear of moving parts and secured to their original locations.
18. Check the engine-oil level and adjust if necessary.
19. Prime the fuel system; refer to Priming the Fuel System (page 4–17).
20. Start the engine and check for coolant, hydraulic fluid, and fuel leaks. Repair any leaks as required.
21. Continue to run the engine to obtain the operating temperature. Check the coolant and hydraulic fluid levels and adjust if necessary before returning the machine to service.

Chapter 5

Hydraulic System

Table of Contents

Additional Reference Materials

Danfoss LPV Axial Piston Pump Service Manual
Danfoss LPV Axial Piston Pump Repair Manual
Parker Torqmotor™ Service Procedure (TF, TG, TH, and TL Series)
Danfoss OSPM Steering Unit Service Manual

General Information

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.

Relieving Pressure from the Hydraulic System

Release all the pressure in the hydraulic system before you work on the hydraulic system.

Note: If you park the machine on an incline or slope, the pressure in the traction circuit does not release.

1. Park the machine on a level surface.
2. Lower the cutting unit completely (float).
3. Turn the key switch to the OFF position and allow the engine to stop.
4. Move the traction pedal in both the FORWARD and REVERSE direction.
5. Turn the steering wheel in both the LEFT and the RIGHT directions.

Towing the Traction Unit

IMPORTANT

If towing limits are exceeded, severe damage to the hydraulic pump may occur.

If it becomes necessary to tow or push the machine, the traction pump must be set to bypass hydraulic fluid. Move the machine at a speed below **4.8 kph (3 mph)**, and for a very short distance. If the machine needs to be moved more than a short distance, the machine should be transported on a trailer.

1. Access the bypass valve from under the machine.

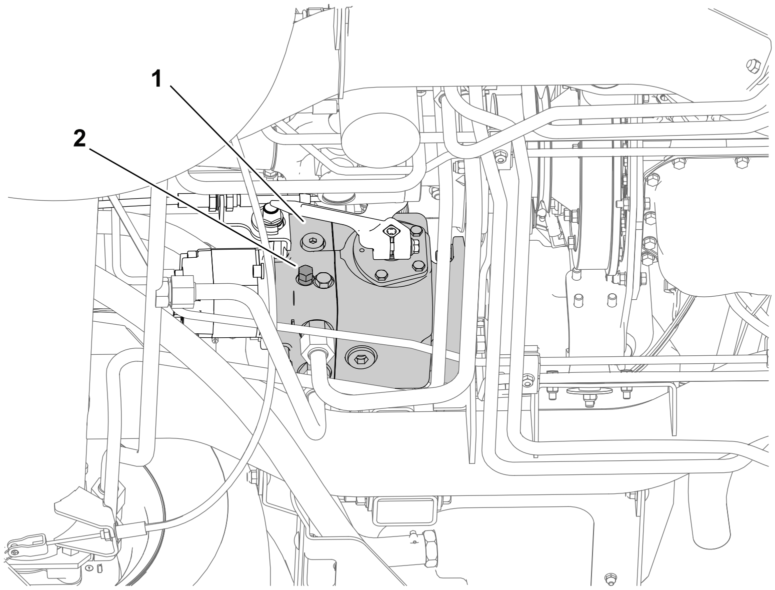


Figure 18

1. Traction pump
2. Bypass valve

2. Use an 11/16” box end wrench to loosen the bypass valve, then open the valve 3 revolutions maximum.

IMPORTANT

Do not start or run the engine when the valve is set to the bypass position.

3. After towing and before starting the engine, tighten the bypass valve to **20 N·m (15 ft-lb)**.

Traction Circuit Component Failure

The traction circuit of the Groundsmaster 3200/3300 machines is a closed loop system that includes the hydraulic pump and hydraulic wheel motors. If a component in the traction circuit should fail, unwanted material and contamination from the damaged component will circulate throughout that traction circuit. This contamination can damage other components in that circuit. The contamination must be removed as soon as possible to prevent additional component failure.

The recommended method to remove contamination from the traction circuit is to temporarily install a Toro high flow hydraulic-fluid filter into the circuit; refer to High Flow Hydraulic Filter Kit (page 2–19). If a traction circuit failure is suspect, the filter should be installed before connecting hydraulic test gauges to test traction circuit components or after replacing a failed traction circuit component. The filter will ensure that contaminates are removed from the closed-loop traction circuit and thus, prevent additional component damage. Refer to Filtering the Closed-loop Traction Circuit (page 5–57) for additional information on using the Toro high flow hydraulic filter.

Note: If traction circuit contamination exists, the traction pump case drain could allow contaminates to enter the hydraulic tank.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure would be to disassemble, drain and thoroughly clean all the components, the hydraulic tank, and the hydraulic tubes and hoses in the traction circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional circuit component failures.

Hydraulic Hoses

The hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions, in addition to mishandling during operation and maintenance. These conditions can cause damage to the hose or deterioration to the hose material. Some hoses are more susceptible to these conditions than others. Examine all of the hydraulic hoses of the machine frequently and replace or repair them if necessary. Hoses that move during normal machine operation should be replaced every 2 years. Check hydraulic hoses for the following signs of deterioration or damage:

- Hydraulic hoses should not be hard, cracked, cut, abraded, charred, leaking, or otherwise damaged.
- Hydraulic hoses should not be kinked, crushed, flattened, or twisted.
- Hydraulic hose covers should not be blistered, soft, degraded, or loose.
- Hydraulic hose fittings should not be cracked, damaged, or badly corroded.

WARNING

Release all pressure in the hydraulic system before performing any work on the system.

- **Keep your body and hands away from pin-hole leaks or nozzles that eject hydraulic fluid under high pressure.**
- **Do not use your hands to search for leaks; use a piece of paper or cardboard.**
- **Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury.**
- **If hydraulic fluid is injected into your skin, the fluid damage to your body must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.**

When you replace a hydraulic hose, ensure that the hose is straight (not twisted) before you tighten the fittings. Observe the imprint (layline) on the hose to do this. Using two wrenches, hold the hose straight with 1 wrench and tighten the hose swivel nut onto the fitting with the other wrench; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).

Note: If the hose has an elbow at one end, tighten the swivel nut on the elbow end before you tighten the nut on the straight end of the hose.

For more hydraulic hose information, refer to the Toro Basics Series Training Book *Hydraulic Hose Servicing* (Part No. 94813SL).

Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting)

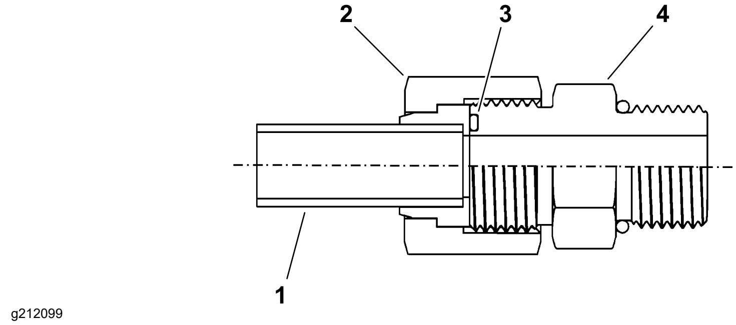


Figure 19

1. Tube or hose
2. Swivel nut
3. O-ring
4. Fitting body

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1. Ensure that all the threads, the sealing surfaces of the hose/tube, and the fitting are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the face seal O-ring when you open the connection. Ensure that the O-ring is installed and correctly seated in the groove of the fitting. Lightly lubricate the O-ring with clean hydraulic fluid.
3. Align the hose/tube against the body of the fitting so that the flat face of the hose/tube sleeve fully touches the O-ring in the fitting (Figure 19).
4. Use your hand to thread the swivel nut onto the fitting. While you hold the hose/tube in alignment with a wrench, use a torque wrench to tighten the swivel nut to the recommended torque value within the specified range of torque values; refer to the Hose/Tube Installation Torque Table (page 5–7). This procedure to tighten the swivel nut requires a drive-adapter wrench (e.g., crowfoot wrench).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–8).

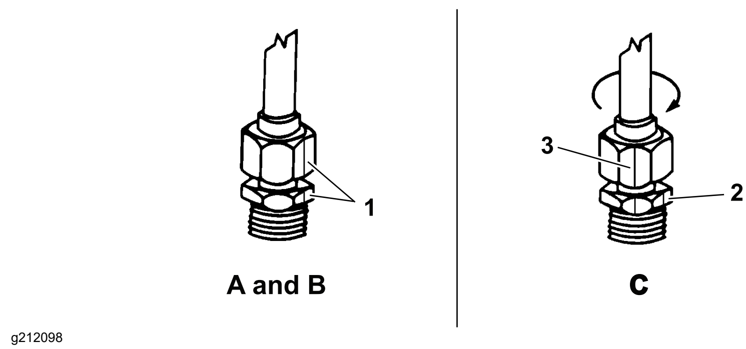

Figure 20

1. Mark nut and fitting body
2. Initial position
3. Final position

Hose/Tube Installation Torque Table

Fitting Dash Size	Hose/Tube Side Thread Size (inch)—threads per inch)	Installation Torque
4	9/16—18	25 – 29 N·m (18 – 22 ft-lb)
6	11/16—16	37 – 44 N·m (27 – 33 ft-lb)
8	13/16—16	51 – 63 N·m (37 – 47 ft-lb)
10	1—14	82 – 100 N·m (60 – 74 ft-lb)

Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (continued)

Hose/Tube Installation Torque Table (continued)

Fitting Dash Size	Hose/Tube Side Thread Size (inch)—threads per inch)	Installation Torque
12	1–3/16—12	116 – 142 N·m (85 – 105 ft-lb)
16	1–7/16—12	150 – 184 N·m (110 – 136 ft-lb)
20	1–11/16—12	190 – 233 N·m (140 – 172 ft-lb)

Flats From Wrench Resistance Table

Size	FFWR
4 (1/4 inch nominal hose or tubing)	1/2 – 3/4
6 (3/8 inch)	1/2 – 3/4
8 (1/2 inch)	1/2 – 3/4
10 (5/8 inch)	1/2 – 3/4
12 (3/4 inch)	1/3 – 1/2
16 (1 inch)	1/3 – 1/2

5. If a torque wrench is not available or if space at the swivel nut prevents the use of a torque wrench, use the alternative procedure Flats From Wrench Resistance (FFWR) given below:

   A. Use a wrench to tighten the swivel nut onto the fitting until you feel light resistance with the wrench—approximately **3.4 N·m (30 in-lb)**.

   B. Put a mark on the swivel nut and body of the fitting (item 1 Figure 20). If connecting a hose, hold the hose in alignment with a wrench to prevent the hose from turning.

   C. Use a wrench to tighten the nut to the correct Flats From Wrench Resistance (compare items 2 and 3 in Figure 20).

Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings)

Installing a Non-Adjustable Fitting

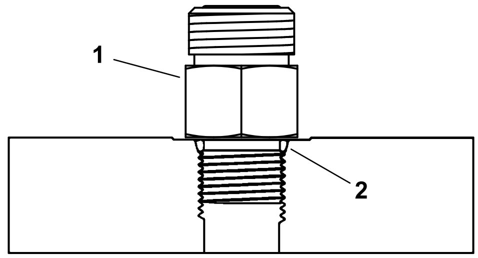

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Figure 21

1. Fitting
2. O-ring

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1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.

IMPORTANT

Before tightening the fitting, determine the material used for the port the fitting is being installed in. Installing a fitting into an aluminum port requires reducing the installation torque.

4. Install the fitting into the port, then use a torque wrench and socket to tighten the fitting to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 5–11).

   Note: It may be necessary to use a drive-adapter wrench (e.g., crowfoot wrench) to install a hydraulic fitting; refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–8).

5. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the Flats From Finger Tight (FFFT) procedure given below:

   A. Install the fitting into the port and tighten the fitting down full length until finger-tight.

   B. If the port material is steel, tighten the fitting to the listed value; refer to the Flats From Finger Tight (FFFT) Table (page 5–11).

   C. If the port material is aluminum, tighten the fitting to 60% of the listed value; refer to the Flats From Finger Tight (FFFT) Table (page 5–11).

Installing an Adjustable Fitting

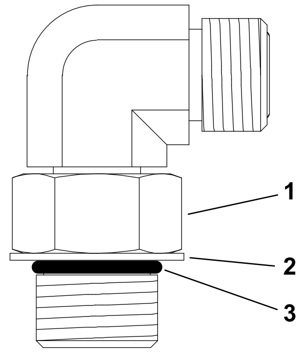

Figure 22

1. Locknut
2. Back-up washer
3. O-ring

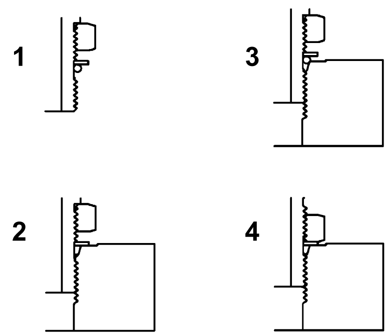

Figure 23

1. Step 1: clearance the lock nut
2. Step 2: seat the back-up washer
3. Step 3: align the fitting
4. Step 4: tighten the lock nut

1. Ensure that all the threads, the sealing surfaces of fitting, and the component port are free of burrs, nicks, scratches, or unwanted material.
2. To help prevent a hydraulic leak, replace the O-ring when you open the connection.
3. Lightly lubricate the O-ring with clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.
4. Turn back the lock nut as far as possible. Ensure that the back-up washer is not loose and it is pushed up as far as possible (Step 1 in Figure 23).
5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 23).
6. If the adjustable fitting needs to align with another component, rotate the fitting counterclockwise until it is aligned to the desired position (Step 3 in Figure 23). Do not rotate the adjustable fitting more than 1 turn counterclockwise.

IMPORTANT

Before tightening the fitting, determine the material used for the port the fitting is being installed in. Installing a fitting into an aluminum port requires reducing the installation torque.

7. Tighten the fitting lock nut (Step 4 in Figure 23):

Installing an Adjustable Fitting (continued)

A. Hold the fitting in the correct alignment with a wrench and use a torque wrench and tighten the lock nut to the recommended torque value within the specified range of torque values; refer to the Fitting Installation Torque Table (page 5–11). This tightening procedure requires a drive-adapter wrench (e.g., crowfoot wrench); refer to Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–8).

B. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, hold the fitting in the correct alignment with a wrench and tighten the lock nut with a second wrench.

C. If the port material is steel, tighten the fitting to the listed Flats From Finger Tight (FFFT) value; refer to the Flats From Finger Tight (FFFT) Table (page 5–11).

D. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT value; refer to the Flats From Finger Tight (FFFT) Table (page 5–11).

Fitting Installation Torque Table

Fitting Dash Size	Fitting Port Side Thread Size (inch(es)—threads per inch)	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16—20	21 – 25 N·m (15 – 19 ft-lb)	13 – 15 N·m (9 – 11 ft-lb)
5	1/2—20	25 – 29 N·m (18 – 22 ft-lb)	15 – 20 N·m (11 – 15 ft-lb)
6	9/16—18	47 – 56 N·m (34 – 42 ft-lb)	28 – 35 N·m (20 – 26 ft-lb)
8	3/4—16	79 – 97 N·m (58 – 72 ft-lb)	48 – 58 N·m (35 – 43 ft-lb)
10	7/8—14	135 – 164 N·m (99 – 121 ft-lb)	82 – 100 N·m (60 – 74 ft-lb)
12	1–1/16—12	182 – 222 N·m (134 – 164 ft-lb)	110 – 134 N·m (81 – 99 ft-lb)
14	1–3/16—12	217 – 265 N·m (160 – 196 ft-lb)	131 – 160 N·m (96 – 118 ft-lb)
16	1–5/16—12	274 – 336 N·m (202 – 248 ft-lb)	165 – 202 N·m (121 – 149 ft-lb)
20	1–5/8—12	335 – 410 N·m (247 – 303 ft-lb)	202 – 248 N·m (149 – 183 ft-lb)

Flats From Finger Tight (FFFT) Table

Size	FFFT
4 (1/4 inch nominal hose or tubing)	0.75 – 1.25
6 (3/8 inch)	1.25 – 1.75
8 (1/2 inch)	1.25 – 1.75
10 (5/8 inch)	1.25 – 1.75
12 (3/4 inch)	1.25 – 1.75
16 (1 inch)	1.25 – 1.75

Hydraulic Schematics

The hydraulic schematics for the Groundsmaster 3200/3300 machines are located in Appendix A (page A–1).

Hydraulic Flow Diagrams

Traction Circuit

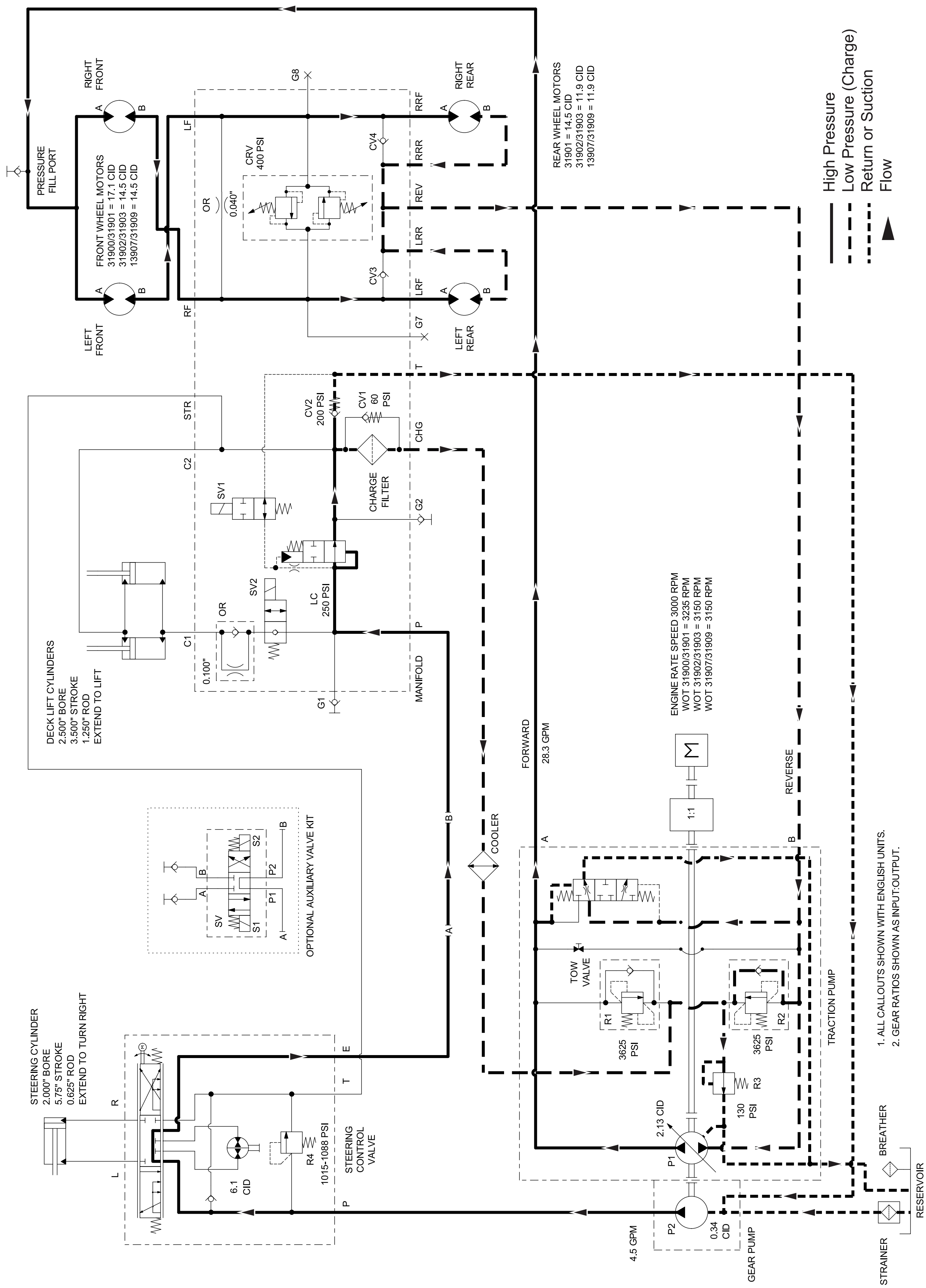

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Figure 24

Traction Circuit Diagram (Forward)

The hydraulic traction circuit is a closed loop system consisting of a variable displacement hydraulic piston (traction) pump and a series of hydraulic wheel motors. The hydraulic fluid passes through the hydraulic manifold on its way to and from the wheel motors. The traction pump is driven by the engine via a multi-row V-belt. V-belt tension is controlled automatically by a spring loaded idler.

Forward Direction

Pushing the top of the traction pedal angles the piston (traction) pump (P1) swash plate to create a flow of oil. This oil flow is directed to the wheel motors via a hydraulic tube to drive the front wheels in the forward direction. Forward traction pressure is limited to 25,000 kPa (3625 psi) by the forward traction relief valve (R1) located in the traction pump.

The angle of the swash plate determines the stroke of the pump pistons and therefore the volume of hydraulic fluid flow and ultimately traction speed. When the traction pedal is pressed a small amount, the swash plate angle is slight resulting in low pump output and lower traction speed. When the traction pedal is pressed fully, the pump swash plate angle is dramatic providing maximum pump output and maximum traction speed.

For 2WD machines, the hydraulic fluid flows from the front wheel motors and passes through the hydraulic manifold. A control orifice in the hydraulic manifold (OR at manifold port OR) equalizes traction system pressure to reduce tire scuffing when turning. Hydraulic fluid exits the manifold and returns to the variable displacement pump. Hydraulic fluid is continuously pumped through the closed loop traction circuit as long as the traction pedal is pressed forward.

For 4WD machines, the hydraulic fluid flows from the front wheel motors and passes through the hydraulic manifold. A control orifice (OR at manifold port OR) and a bidirectional relief valve (CRV) in the hydraulic manifold equalize traction system pressure to reduce tire scuffing when turning. Check valves in the hydraulic manifold allow the rear wheel motors to over-run during tight turns. Hydraulic fluid exits the manifold and returns to the variable displacement pump. Hydraulic fluid is continuously pumped through the closed loop traction circuit as long as the traction pedal is pressed forward.

The piston (traction) pump is equipped with a case drain to allow normal internal leakage to be removed from the pump. The piston pump also includes a flushing valve that bleeds off a small amount of hydraulic fluid from the low pressure side of the circuit for cooling of the closed loop traction circuit. The case drain and flushing valve are connected to the hydraulic reservoir. The charge system replenishes oil that is bled from the traction circuit by the case drain and the flushing valve.

Gear pump (P2) supplies oil flow for the steering circuit and lift circuit, and also provides a constant supply of charge oil to the closed loop traction circuit. Gear pump flow beyond the needs of the steering, lift, and charge circuits exits the manifold. A check valve (CV2) in the manifold may open to provide an additional path for charge circuit fluid to exit the manifold. This feature protects the oil cooler from high pressure when the oil is cold. The hydraulic fluid returning from the manifold provides most of the fluid for the gear pump (P2). The remainder of the fluid necessary is supplied through the suction filter and suction hose from the hydraulic reservoir.

The charge oil provides lubrication for traction circuit components and also replenishes traction circuit oil that is lost due to internal leakage and cooling (flushing) in the traction circuit. Charge pump flow is directed to the low pressure side of the closed loop traction circuit. Charge pressure is limited by the charge relief valve (R3) located in the piston (traction) pump to 896 kPa (130 psi).

Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, the flow through the circuit is reversed. Pushing the bottom of the traction pedal rotates the piston (traction) pump swash plate to create a flow of oil. This oil is directed through the hydraulic manifold and on to the front wheel motors to drive the wheels in the reverse direction. Reverse traction pressure is limited to 25,000 kPa (3625 psi) by the reverse traction relief valve (R2) located in the piston (traction) pump.

For 4WD machines, check valves in the hydraulic manifold allow the hydraulic fluid to bypass the rear wheel motors. The rear wheels do not provide traction in reverse.

Hydraulic fluid flowing from the wheel motors returns to the piston (traction) pump and is continuously pumped through the closed loop traction circuit as long as the traction pedal is pushed rearward.

The charge circuit and flushing valve function the same in reverse as they do in the forward direction.

Steering Circuit

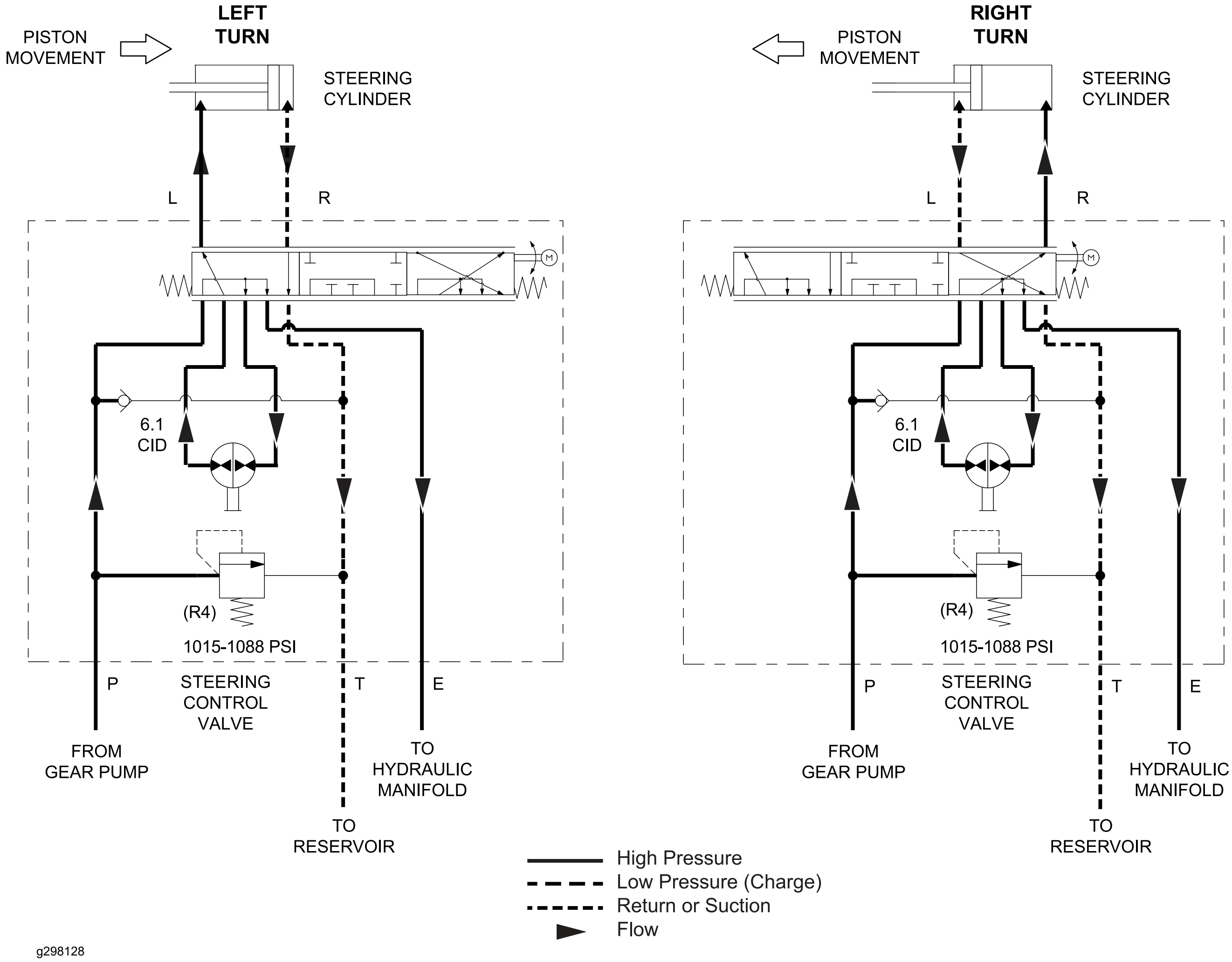

Figure 25

Steering Circuit Diagram

Gear pump (P2) supplies oil flow for the steering circuit and lift circuit, and also provides a constant supply of charge oil to the closed loop traction circuit. The pump output flows to the steering control valve before supplying the lift and charge circuit needs so that the steering circuit has priority. The steering circuit pressure is limited to 7,000 to 7,500 kPa (1,015 to 1,088 psi) by relief valve (R4) located in the steering control valve.

When the steering wheel is not being turned and the engine is running (hydraulic pump input shaft rotating), gear pump flow enters the steering control valve at the P port and by-passes the rotary meter and steering cylinder. Flow leaves the steering control valve through the E port and is directed to the lift manifold to supply the lift and charge circuits.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that the flow goes through the bottom of the spool. Flow entering the steering control valve at the P port passes through the rotary meter and is directed out the L port. Pressure retracts the steering cylinder for a left turn. The rotary meter ensures that the fluid flow to the cylinder is proportional to amount of steering wheel rotation. The fluid leaving the steering cylinder flows back through the spool valve, then out the T port, through the hydraulic manifold, and back to the gear pump (P2).

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that the flow goes through the top of the spool. Flow entering the steering control valve at the P port passes through the rotary meter and is directed out port R. Pressure extends the steering cylinder for a right turn. The rotary meter ensures that the fluid flow to the cylinder is proportional to the amount of steering wheel rotation. The fluid leaving the steering cylinder flows back through the spool valve, then out the T port, through the hydraulic manifold, and back to the gear pump (P2).

Lift Circuit

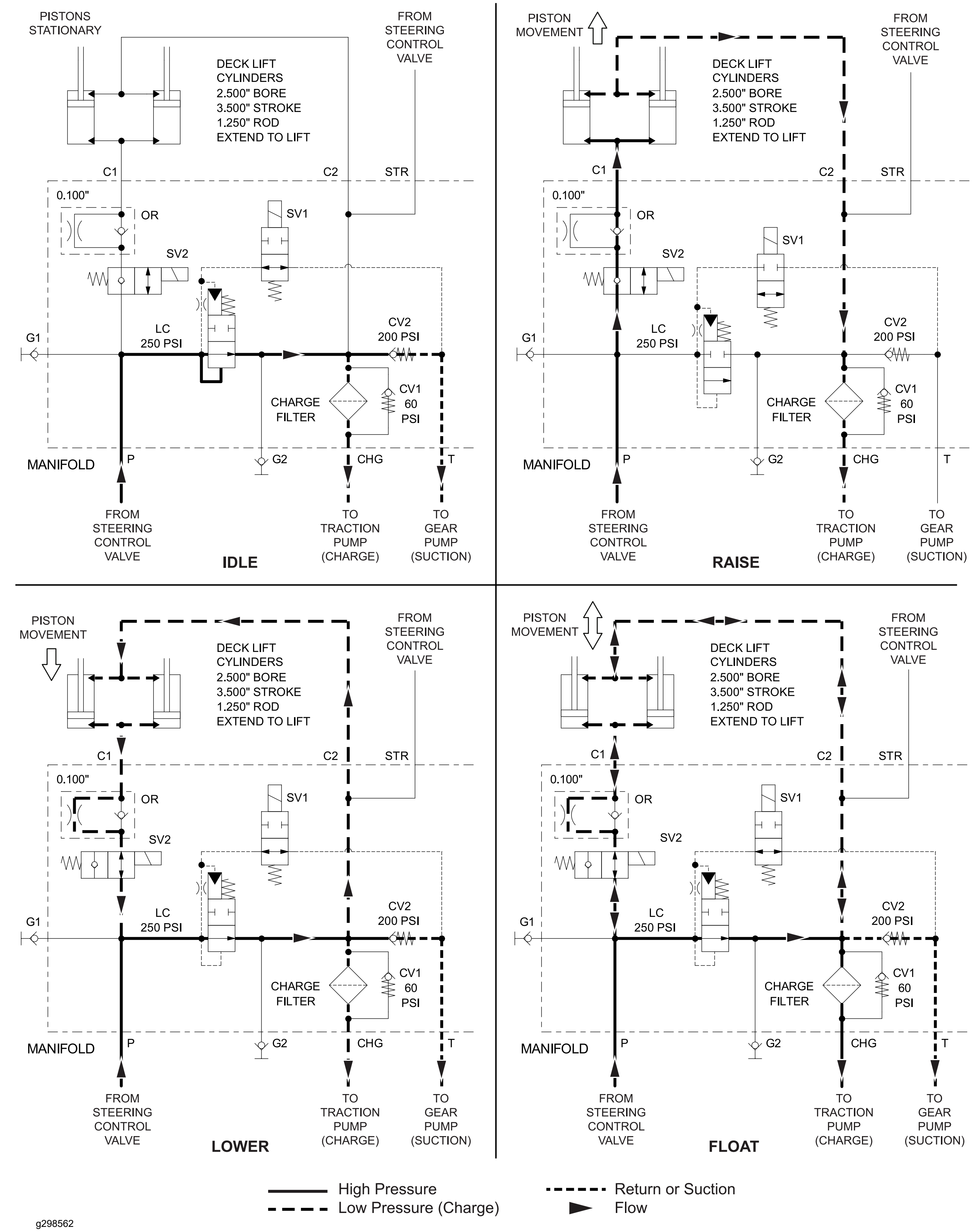

Figure 26

Lift Circuit Diagram

Gear pump (P2) supplies oil flow for the steering circuit and lift circuit, and also provides a constant supply of charge oil to the closed loop traction circuit. The pump output flows to the steering control valve before supplying the lift and charge circuit needs so that the steering circuit has priority.

Cutting Unit (or Implement) Idle

When the lift system is not actively raising, lowering, or floating (idle), fluid flow enters the hydraulic manifold at the P port. Hydraulic pressure will try and raise the lift arms until the pressure opens logic cartridge LC and provides a fluid path to exit the manifold. When the logic cartridge opens is controlled by adjusting the logic cartridge to the desired weight transfer (counterbalance). Refer to the traction unit *Operator's Manual* for additional counterbalance adjustment information.

Raising the Cutting Unit (or Implement)

When the lift switch is set to the Raise position, solenoid valve SV1 is energized, holding logic cartridge LC closed. Hydraulic flow is directed through de-energized solenoid valve SV2 to the front (cap end) of the lift cylinders. The hydraulic pressure against the cylinder pistons extends the lift cylinders. At the same time, the pistons push the hydraulic fluid in the lift cylinders out and to the hydraulic manifold. The extending lift cylinders cause the cutting unit (or implement) to raise. When the cylinders reach the end of their stroke, or if the lift arms are prevented from raising, the relief valve (R4) in the steering control valve opens and directs the hydraulic flow through the manifold and back to the gear pump (P2) until the lift switch is released. The lift circuit pressure is limited to 7,000 to 7,500 kPa (1,015 to 1,088 psi). A check valve in solenoid valve SV2 prevents the cylinders from lowering.

Lowering the Cutting Unit (or Implement)

When the lift switch is set to the LOWER position, solenoid valve SV2 is energized to open a path for fluid trapped at the front (cap end) of the lift cylinder pistons to escape. The weight of the cutting unit (or implement) causes the cylinders to retract and lower the lift arms. The speed which the cylinders lower is controlled by a check orifice (OR at manifold port C1). The escaping fluid combines with the remainder of the flow from the gear pump (P2) to pass through the open logic cartridge (LC) and exit the manifold. As the cylinders retract, the cylinder pistons draw hydraulic fluid from the hydraulic manifold into the rear (rod end) of the lift cylinders.

Floating the Cutting Deck (or Implement)

As the cutting unit moves over terrain with changing elevation, the lift arms are allowed to move up and down (float). The lift cylinders are allowed to extend and retract if necessary when floating. After the cutting unit is fully lowered, solenoid valve SV2 remains energized to hold a path open for fluid at the front (cap end) of the lift cylinder piston to flow in either direction if necessary. Hydraulic fluid is allowed to flow from the manifold to and from the rear (rod end) of the lift cylinders as well.

Auxiliary Valve Circuit (Optional)

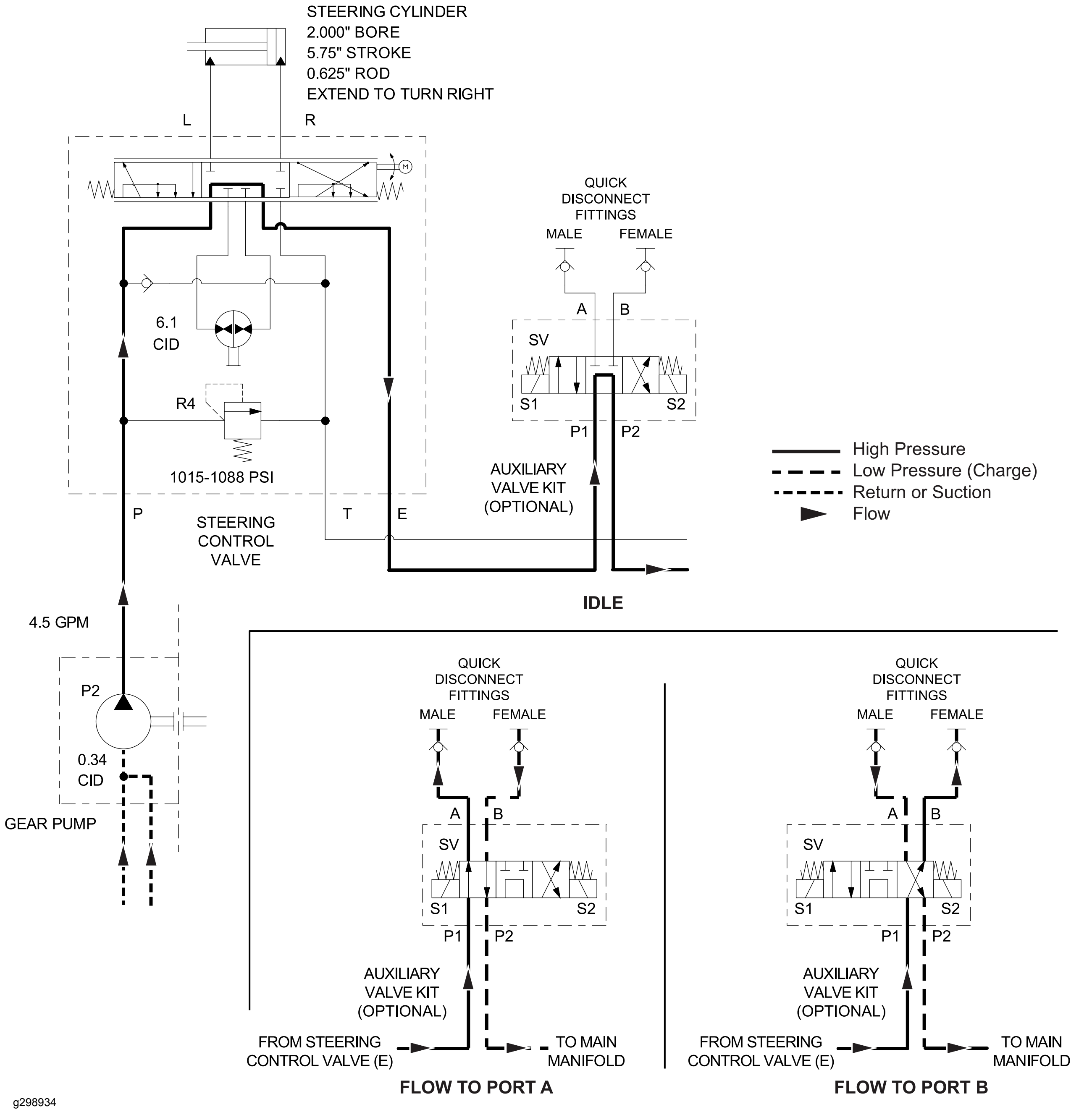

Figure 27

Auxiliary Valve Circuit Diagram

An auxiliary valve kit is available to support the hydraulic needs of various attachments. The kit includes a 3 position cartridge style solenoid valve (SV) in a separate manifold. The valve has 2 coils (S1 and S2). The auxiliary valve manifold is located near the front of the machine under the operator floor plate.

Gear pump (P2) supplies oil flow for the steering circuit, optional auxiliary valve circuit, lift circuit, and also provides a constant supply of charge oil to the closed loop traction circuit. The pump output flows to the steering control valve before supplying the lift, auxiliary valve, and charge circuit needs so that the steering circuit has priority.

Auxiliary Valve Circuit (Optional) (continued)

When the auxiliary valve control switch is in the idle position, the valve allows hydraulic fluid to pass through the auxiliary valve manifold, out port P2, and on to the main hydraulic manifold. When the auxiliary valve control switch is set to the left position, solenoid S1 is energized and fluid flow is directed to the A port of the auxiliary valve manifold (male quick disconnect fitting). When the auxiliary valve control switch is set to the right position, solenoid S2 is energized and fluid flow is directed to the B port of the auxiliary valve manifold (female quick disconnect fitting).

When the hydraulic component controlled by the auxiliary valve reaches the end of its stroke, or if the component is prevented from moving, the relief valve (R4) in the steering control valve opens and directs the hydraulic flow through the main manifold and back to the gear pump (P2) until the auxiliary valve control switch is released. The auxiliary valve circuit pressure is limited to 7,000 to 7,500 kPa (1,015 to 1,088 psi).

Testing the Hydraulic System

The most effective procedure to isolate the problems in the hydraulic system is to use hydraulic test equipment, such as pressure gauges and flow meters in the circuits during different operational checks; refer to Special Tools (page 2–16).

WARNING

Opening the hydraulic system without releasing pressure from the system will cause the hydraulic fluid to escape, causing possible injury.

Before you disconnect the hydraulic components or work on the hydraulic system, release the pressure in the system; refer to Relieving Pressure from the Hydraulic System (page 5–3).

WARNING

Hydraulic fluid escaping under pressure can penetrate skin and cause injury.

- **Keep your body and hands away from pin-hole leaks or nozzles that eject hydraulic fluid under high pressure.**
- **Do not use your hands to search for leaks; use a piece of paper or cardboard.**
- **Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury.**
- **If hydraulic fluid is injected into your skin, the fluid damage to your body must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.**

CAUTION

Failing to use gauges having the recommended pressure (kPa/psi) rating could damage the gauge and cause personal injury from contact with hot, leaking hydraulic fluid.

Use gauges with the recommended pressure rating as listed in the test procedures.

IMPORTANT

Before performing the hydraulic tests, check all obvious areas, such as fluid supply, filter, binding linkages, loose fasteners, or improper adjustments before you assume that a hydraulic component is the source of the problem.

IMPORTANT

Use 2 people to perform all the tests, with 1 person in the seat and the other to read and record the test results.

1. Use the following resources to assist with hydraulic system troubleshooting.
   - The Hydraulic Schematic in Appendix A (page A–1)
   - Hydraulic Flow Diagrams (page 5–13)
   - General and system specific troubleshooting tables in Chapter 3 – Troubleshooting.
2. Always wear the eye protection when you performing hydraulic system tests.
3. Clean the machine fully before you disconnect or disassemble the hydraulic components.

   Note: Cleanliness is required whenever you work on the hydraulic equipment. Contamination causes wear on hydraulic components.
4. To prevent hydraulic system contamination, put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.
5. The engine must be in good operating condition. Use the TDM display/controller screen to verify and monitor engine RPM when performing a hydraulic test. Engine speed can affect the accuracy of the test readings. Use the information below when performing hydraulic system tests. If engine RPM is above or below the specified speed during a test, you will need to adjust the expected hydraulic performance parameters (aprox. 3% per 100 engine rpm at full throttle)

IMPORTANT

Hydraulic component output volume relates directly to engine RPM. For every 100 engine rpm the following component output volumes will change by the volume listed.

   - Traction Pump (P1): 100 engine RPM = 3.85 liters (118 ounces) of hydraulic fluid displaced per minute
   - Gear Pump (P2): 100 engine RPM = 0.6 liters (19 ounces) of hydraulic fluid displaced per minute.
6. When you use a hydraulic tester (pressure and flow), ensure that the inlet and outlet hoses are properly connected and not reversed to prevent damaging the hydraulic tester or components.
7. When you use a hydraulic tester (pressure and flow), open the tester load valve fully before you start the engine to reduce the possibility of damaging the components.
8. Install the hydraulic fittings by hand and ensure that they are not cross-threaded before you tighten them with a wrench.
9. Position any test hoses away from parts that may move during the test procedure.
10. After you connect the test equipment, check the hydraulic-fluid level in the hydraulic tank and ensure that the fluid level is correct.
11. Perform all the hydraulic tests with the hydraulic fluid at normal operating temperature.
12. Record the results of all hydraulic tests performed.

Hydraulic Test Selection

Before beginning any hydraulic test, identify if the problem is related to the traction circuit, steering circuit, or lift circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

If a traction circuit problem exists, consider performing one or more of the following tests: Charge Pressure, Wheel Motor Efficiency, and/or Traction Pump (P1) Flow and Relief Valve.

If a steering, optional auxiliary valve, or lift circuit problem exists, consider performing one or more of the following tests: Steering Relief Valve (RV4) Pressure Test, Steering Cylinder Test, Lift Cylinder Test, and/or Gear Pump (P2) Flow Test.

Note: Adjusting the weight transfer of the cutting unit or attachment may help to diagnose lift circuit problems; refer to the traction unit *Operator's Manual*.

Testing the Traction Circuit – Charge Pressure

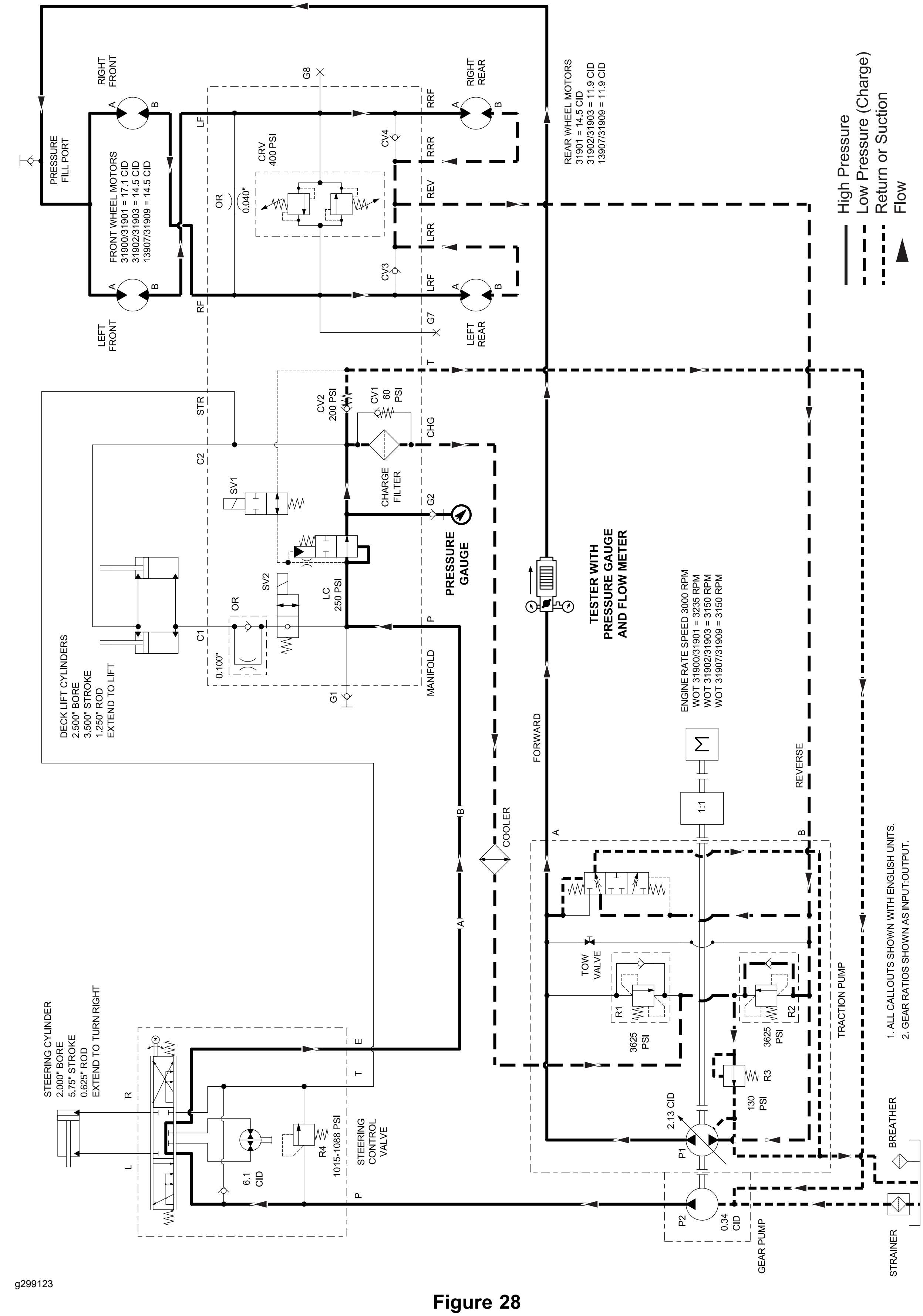

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Figure 28

Traction Circuit – Charge Pressure

Test Procedure

The charge pressure test is the first in a series of tests recommended to determine traction circuit performance. A charge pressure drop of more than 20% when a moderate load is placed on the piston (traction) pump indicates an internal leak in the piston (traction) pump. Reduced charge pressure may also indicate a faulty relief valve (R4) in the steering control unit. Continued unit operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Pressure Gauge (accurate below 300 psi) with hose and quick disconnect coupling
- Flow meter with pressure gauge that has at least a 114 L/minute (30 gallons/minute) capacity.
- 2 Hydraulic Hoses

1. Park the machine on a level surface, lower the cutting unit (or attachment), and set the key switch to the OFF position.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 5–22).
3. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position; refer to Adjusting the Traction System for Neutral (page 5–50). Also, ensure that the hydraulic pump is at full stroke when traction pedal is pressed fully in forward position.
4. Connect a hydraulic pressure gauge to the diagnostic fitting at the main hydraulic manifold G2 port.

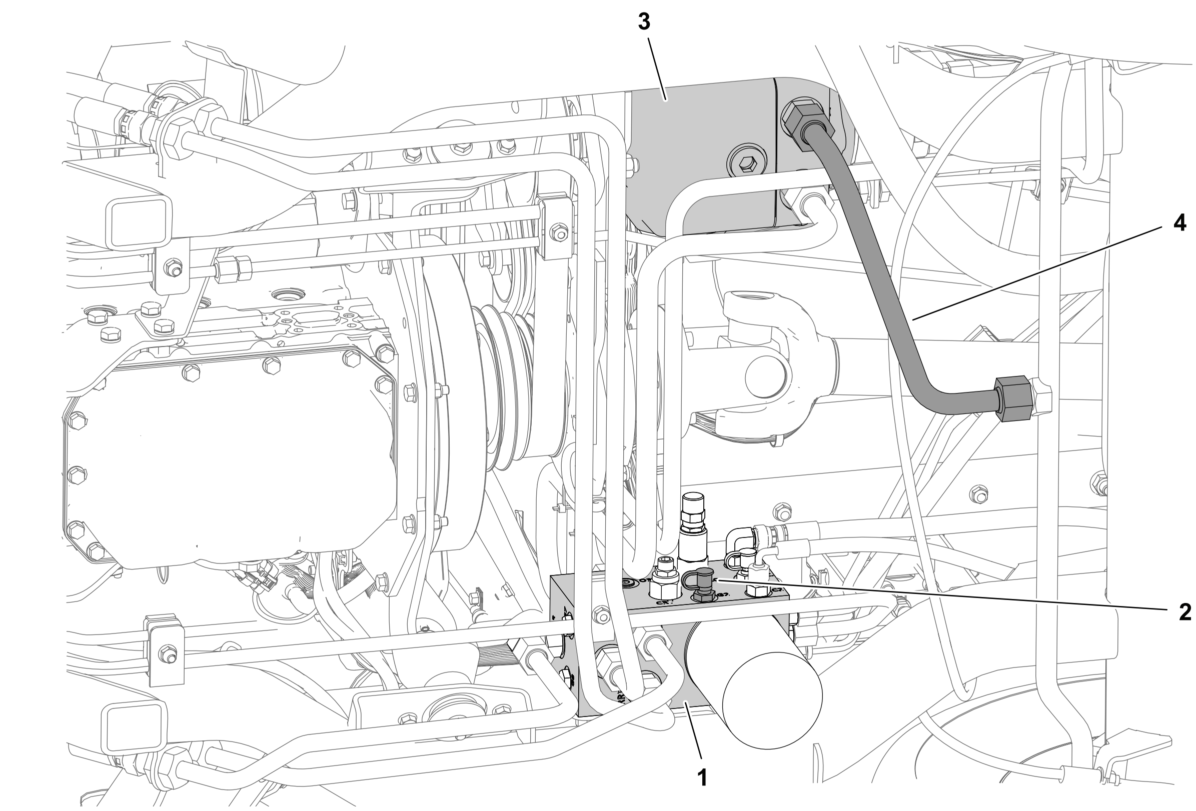


Figure 29

1. Main hydraulic manifold
2. Diagnostic fitting – G2 port
3. Hydraulic pump (P1)
4. Hydraulic tube

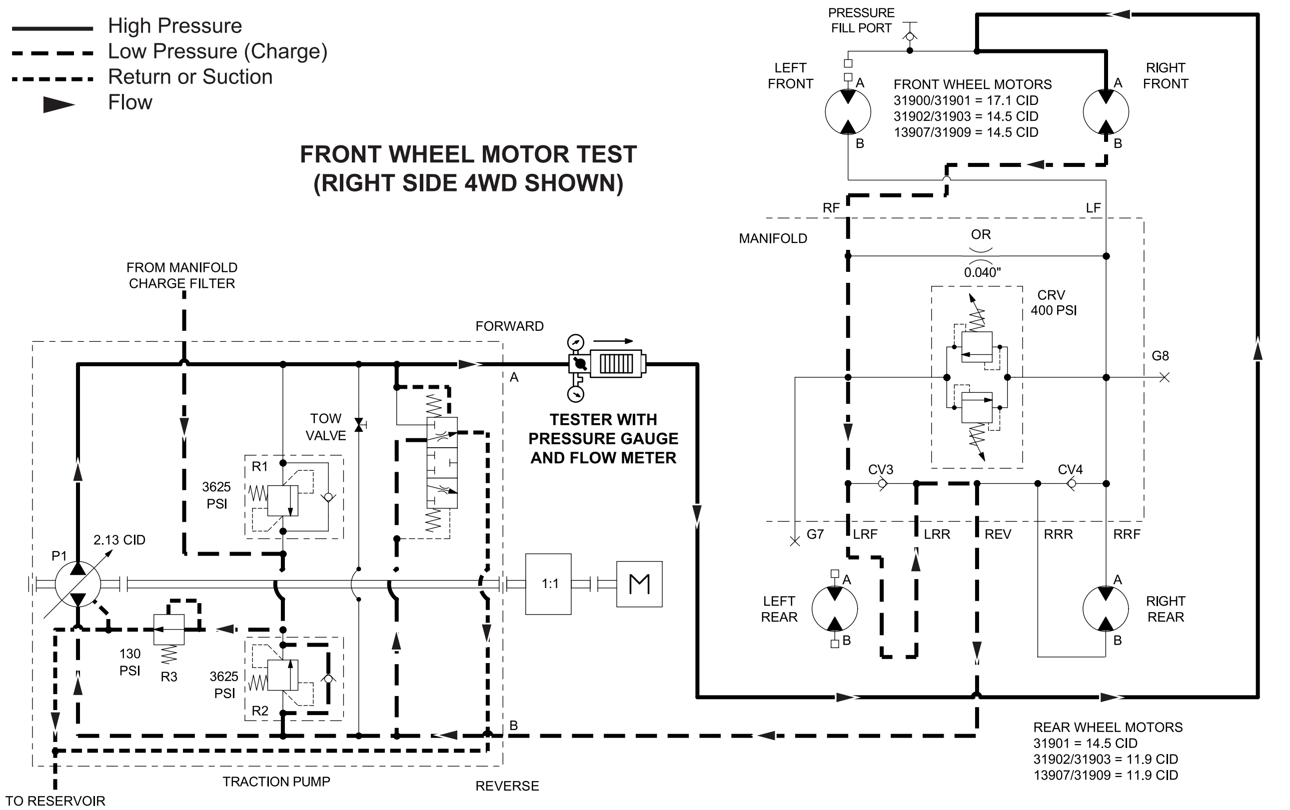
5. Clean the fittings and the hydraulic tube shown; refer to Figure 29.
6. Remove the hydraulic tube and use 2 hydraulic hoses to install the tester to the exposed fittings. Make sure the tester is installed in the correct flow direction (toward the wheel motors) and the tester flow control valve is fully open.
7. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing.
8. Block the wheels with chocks to prevent the wheel rotation during testing.
9. Start the engine and run it at low-idle speed. Correct any hydraulic fluid leaks at the test connections before continuing the test.
10. Start the engine and move the throttle to the full speed:
    - Model 31900 and 31901 = **3235 rpm**
    - Model 31902 and 31903 = **3150 rpm**
    - Model 31907 and 31909 = **3235 rpm**
11. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
12. Use the TDM display/controller screen to verify the engine speed.
13. Record the reading on the pressure gauge at the G2 port of the main manifold (not the pressure gauge on the flow meter). The charge pressure (without load) should read **895 to 1035 kPa (130 to 150 psi)**. If the charge relief pressure specification is not met, consider the following:
    A. The hydraulic pump charge relief valve (R3) is damaged. Replace or repair the hydraulic pump charge relief valve; refer to Servicing the Traction (piston) Pump (P1) (page 5–73).
    B. Gear pump (P2) is faulty (steering and lift circuit performance will also be affected). Test gear pump (P2) flow; refer to Testing the Steering and Lift Circuit – Gear Pump (P2) Flow and Circuit Relief Valve (page 5–40).
    C. Sit in the operator's seat, release the parking brake, and apply a load to the traction pump by slowly depressing the forward traction pedal until **6895 to 10342 kPa (1000 to 1500 PSI)** is reached on the flow meter pressure gauge.
14. Record reading on pressure gauge at the G2 port of the main manifold (not the pressure gauge on the flow meter).
15. Release the traction pedal, move the throttle to low speed and set the key switch to the OFF position.
16. Charge pressure (under load) should not drop more than 20% when compared to charge pressure (without load) recorded in step 13.

    If specifications are not met, leave the test equipment installed and perform the Piston (traction) Pump (P1) Flow and Relief Pressure Test as described in Testing the Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure (page 5–37).
17. After testing:
    A. Remove the hydraulic hoses and tester.
    B. Install the hydraulic tube previously removed.
    C. Disconnect the pressure gauge from the diagnostic fitting at the main manifold.
    D. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.

Test Procedure (continued)

E. Start the engine and check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Testing the Traction Circuit – Wheel Motor Efficiency



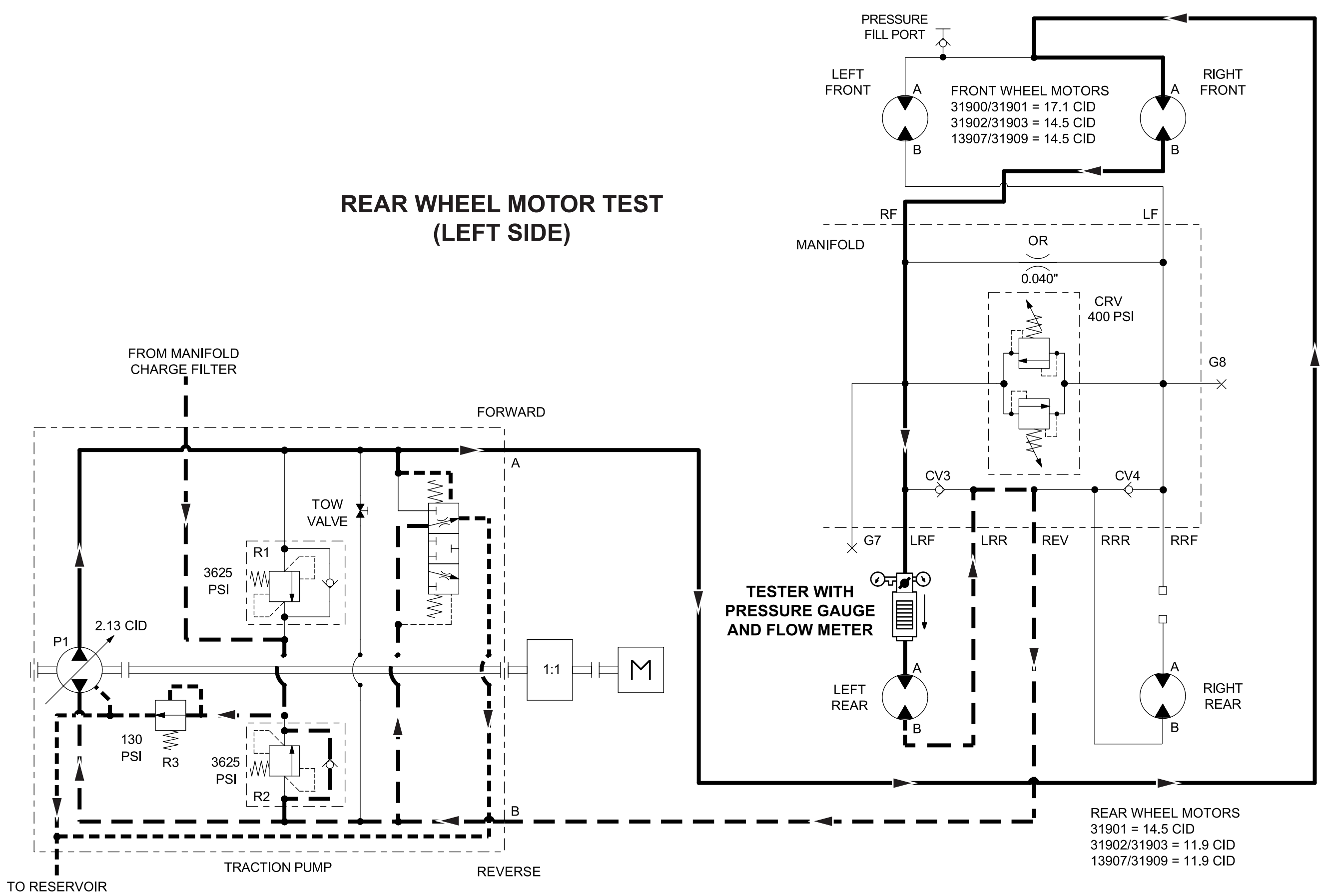


Figure 30

Traction Circuit – Wheel Motor Efficiency

Wheel motor efficiency is the second in a series of tests recommended to determine traction circuit performance. Too much hydraulic fluid flow through a single stationary wheel motor under load indicates an internal leak in the wheel motor. A worn wheel motor is less efficient. Eventually, enough fluid by−pass will cause the wheel motor to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

There are moments during wheel motor operation (geroller position) when fluid flow through the motor is less restricted. If a wheel motor is tested in this position, the test results will be higher should not be used to determine wheel motor efficiency. Test wheel motors in three (3) different wheel positions to obtain accurate test results. Record test readings for all three (3) wheel positions and use the average for the final test result.

Special Equipment Required:

- Flow meter with pressure gauge that has at least a 57 L/minute (15 gallons/minute) capacity.
- 2 Hydraulic Hoses

IMPORTANT

Refer to Traction Circuit Component Failure (page 5–5) for information regarding the importance of removing contamination from the traction circuit.

1. Park the machine on a level surface, lower the cutting unit (or attachment), and set the key switch to the OFF position.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 5–22).
3. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position; refer to Adjusting the Traction System for Neutral (page 5–50). Also, ensure that the hydraulic pump is at full stroke when traction pedal is pressed fully in forward position.
4. Attach a heavy chain to the rear of the machine frame and an immovable object to prevent the machine from moving during testing. Remove as much slack in the chain as possible.
5. Block the wheel being tested with a chock to prevent the wheel from rotating during testing.

Test Procedure – Front Wheel Motor

To accurately test a front wheel motor on a 2WD machine, the front wheel motor not being tested must be disconnected from the traction circuit.

To accurately test a front wheel motor on a 4WD machine, the front wheel motor not being tested and the rear wheel motor on the opposite side of the front motor being tested must be disconnected from the traction circuit.

1. Clean the fittings and the hydraulic tube shown; refer to Figure 31.

Test Procedure – Front Wheel Motor (continued)

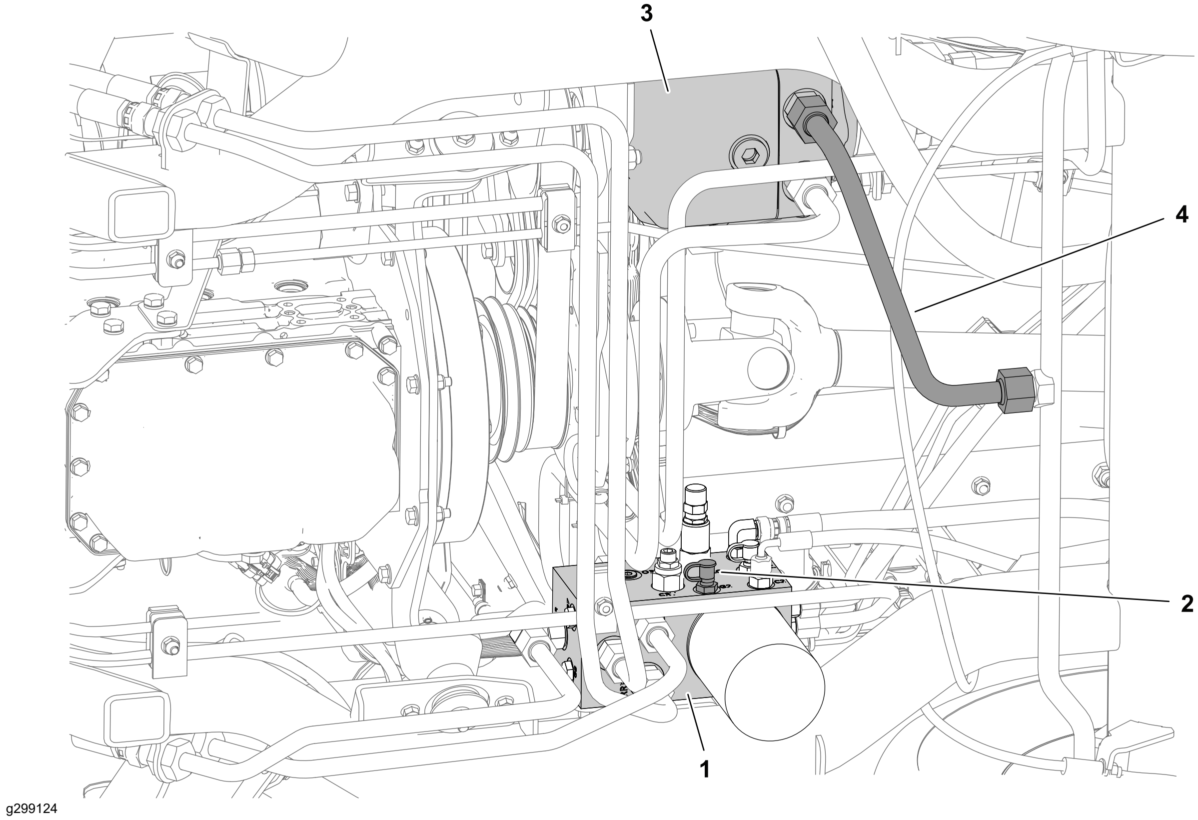


Figure 31

1. Hydraulic pump (P1)
2. Hydraulic tube

2. Remove the hydraulic tube and use 2 hydraulic hoses to install the tester to the exposed fittings. Make sure the tester is installed in the correct flow direction (toward the wheel motors) and the tester flow control valve is fully open.

   Note: Remove and reinstall the wheel to access the wheel motor hydraulic connections if necessary.

3. Clean and disconnect the hydraulic line from the A port of the front wheel motor that is not being tested.

Test Procedure – Front Wheel Motor (continued)

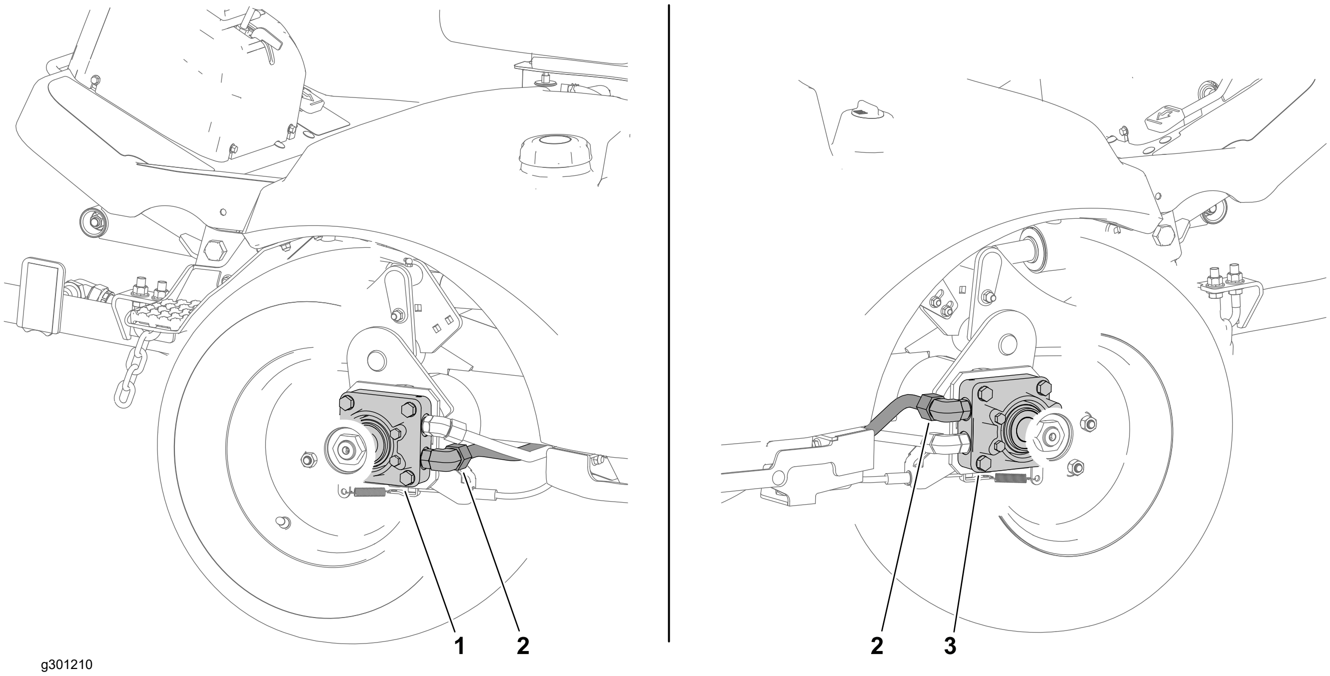


Figure 32

1. Front left wheel motor
2. Front right wheel motor
3. A port

4. Cap the disconnected hydraulic line with a hydraulic ORFS cap, and plug the port of the disconnected wheel motor with a hydraulic ORFS plug.
5. Disconnect the rear wheel motor on the opposite side of the front motor being tested from the traction circuit:

   Clean the bulkhead and hose fittings on the side of the machine.

Test Procedure – Front Wheel Motor (continued)

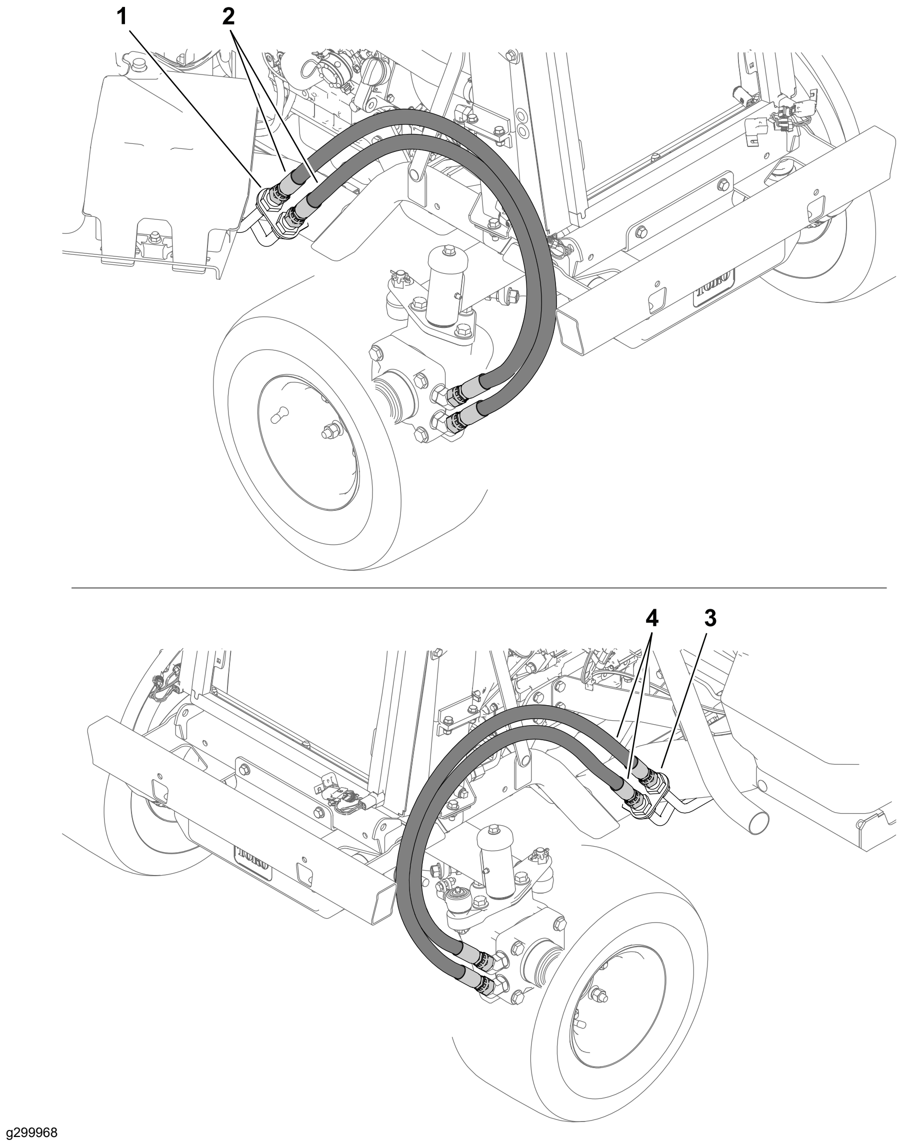


Figure 33

1. Left side bulkhead fitting
2. Left rear wheel motor hydraulic hoses
3. Right side bulkhead fitting
4. Right rear wheel motor hydraulic hoses

A. Disconnect both hydraulic hoses from the bulkhead fitting.

B. Plug the disconnected motor hoses with hydraulic ORFS plugs.

C. Install one end of a test hose to one of the exposed bulkhead fittings, and the other end of the same hose to the remaining exposed bulkhead fitting.

6. Start the engine and run it at low-idle speed. Correct any hydraulic fluid leaks at the test connections before continuing the test.
7. Start the engine and move the throttle to the full speed:
   - Model 31900 and 31901 = **3235 rpm**
   - Model 31902 and 31903 = **3150 rpm**
   - Model 31907 and 31909 = **3235 rpm**
8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Use the TDM display/controller screen to verify the engine speed.

Test Procedure – Front Wheel Motor (continued)

10. Slowly press the traction pedal in the forward direction until **6,900 kPa (1,000 psi)** is displayed on the tester pressure gauge. Ensure that the front wheel is not rotating and record the flow meter reading.
11. Release the traction pedal, shut off the engine, rotate the front wheel being tested 90° Test again and record the flow meter reading.
12. Release the traction pedal, shut off the engine, rotate the front wheel being tested 180° Test again and record the flow meter reading.
13. Use the average of the 3 flow meter readings to judge the front wheel motor performance. Testing of wheel motor leakage in the 3 different wheel positions will provide the most accurate test results. The flow through a stationary front wheel motor should be:
    - Model 31900 and 31901 = less than **4 L/minute (1 gallons/minute)**
    - Model 31902, 31903, 31907 and 31909 = less than **3.4 L/minute (0.9 gallons/minute)**
14. If specifications are not met, replace or repair the worn wheel motor; refer to Wheel Motors (page 5–82) or Wheel Motor Service (page 5–86).
15. After testing:
    A. Remove the hydraulic hoses and tester.

    B. Remove all caps and plugs and connect all hydraulic lines and hoses.

    C. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.

    D. Start the engine and check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Test Procedure – Rear Wheel Motor

To accurately test a rear wheel motor, the front wheel motors must be allowed to rotate.

1. Raise and support both front wheels; refer to Jacking Instructions (page 1–6).
2. Raise the hood.
3. Clean the bulkhead and hose fittings on each side of the machine.

Test Procedure – Rear Wheel Motor (continued)

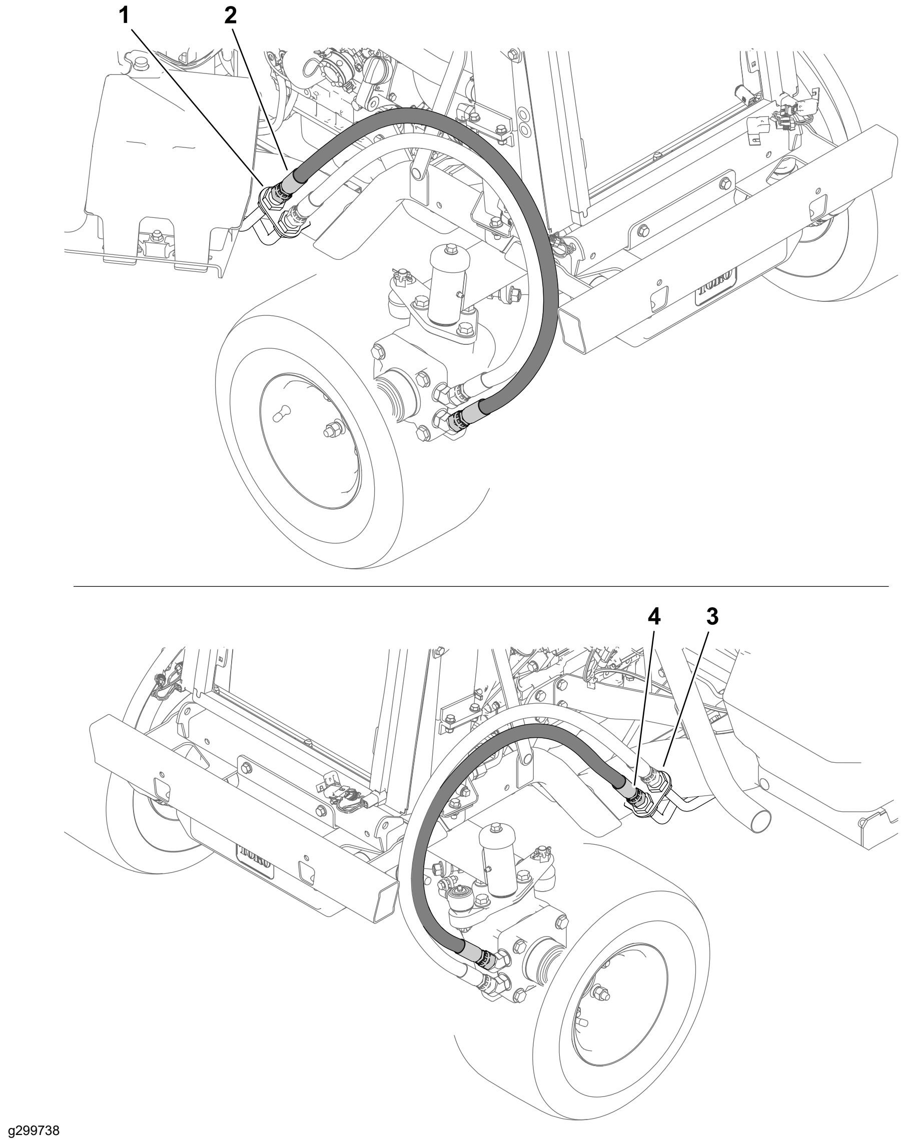


Figure 34

1. Left side bulkhead fitting	3. Right side bulkhead fitting
2. Left rear wheel motor supply hose	4. Right rear wheel motor supply hose

4. Disconnect the rear wheel motor supply hose for the motor being tested and install a hydraulic tester with a pressure gauge and flow meter in series between the disconnected hydraulic hose and the rear wheel motor. Ensure that the tester flow control valve is fully open.
5. Disconnect the rear wheel motor supply hose for the motor not being tested. Cap the disconnected bulkhead fitting with a hydraulic ORFS cap, and plug the disconnected hose with a hydraulic ORFS plug.
6. Start the engine and run it at low-idle speed. Correct any hydraulic fluid leaks at the test connections before continuing the test.
7. Start the engine and move the throttle to the full speed:
   - Model 31901 = **3235 rpm**
   - Model 31902 and 31903 = **3150 rpm**
   - Model 31907 and 31909 = **3235 rpm**

Test Procedure – Rear Wheel Motor (continued)

8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Use the TDM controller/display screen to verify the engine speed.
10. Slowly press the traction pedal in the forward direction until **6,900 kPa (1,000 psi)** is displayed on the tester pressure gauge. Ensure that the rear wheel is not rotating and record the flow meter reading.
11. Release the traction pedal, shut off the engine, rotate the front wheel being tested 90° Test again and record the flow meter reading.
12. Release the traction pedal, shut off the engine, rotate the front wheel being tested 180° Test again and record the flow meter reading.
13. Use the average of the 3 flow meter readings to judge the front wheel motor performance. Testing of wheel motor leakage in the 3 different wheel positions will provide the most accurate test results. The flow through a stationary front wheel motor should be:
    - Model 31901 = less than **3.4 L/minute (0.9 gallons/minute)**
    - Model 31902, 31903, 31907 and 31909 = less than **2.8 L/minute (0.7 gallons/minute)**
14. If specifications are not met, replace or repair the worn wheel motor; refer to Wheel Motors (page 5–82) or Wheel Motor Service (page 5–86).
15. After testing:
    A. Remove the hydraulic hose and tester.
    B. Remove all caps and plugs and connect all hydraulic lines and hoses.
    C. Remove the jack stands and lower the machine to the ground.
    D. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.
    E. Start the engine and check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Testing the Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure

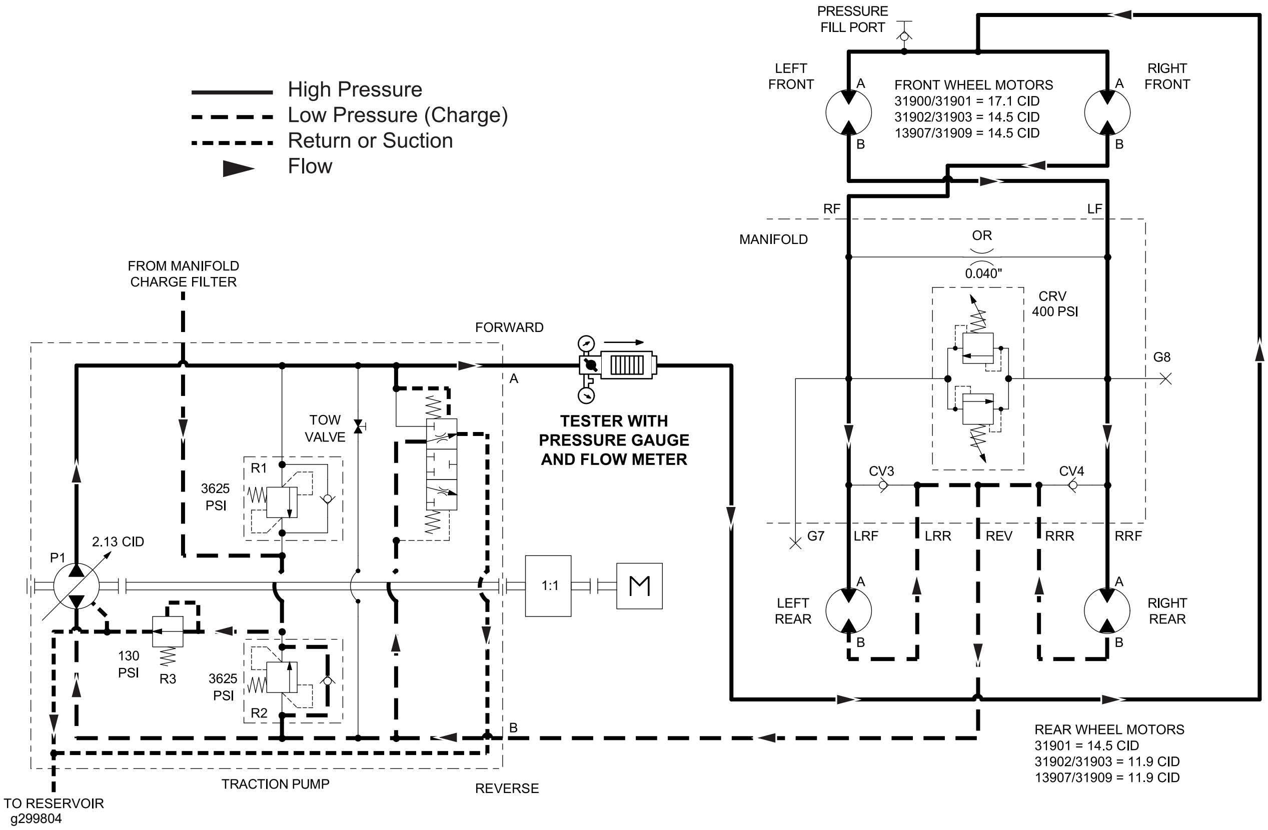


Figure 35

Traction Circuit – Piston (traction) Pump (P1) Flow and Relief Pressure

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The hydraulic pump (P1) flow test is the third in a series of tests recommended to determine the traction circuit performance. This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 12% indicates an internal leak or malfunctioning relief valve in the hydraulic pump. The final traction circuit test is verifying the hydraulic pump forward direction relief valve (R1) operation. A worn hydraulic pump or malfunctioning relief valve is less efficient. Eventually, enough fluid bypass will cause the unit to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Flow meter with pressure gauge that has at least a 114 L/minute (30 gallons/minute) capacity.
- 2 Hydraulic Hoses

Test Procedure

1. Raise the machine so all 4 wheels are off the ground and free to rotate; refer to Jacking Instructions (page 1–6).
2. Read and adhere to the information provided in Testing the Hydraulic System (page 5–22).
3. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position; refer to Adjusting the Traction System for Neutral (page 5–50). Also, ensure

that the hydraulic pump is at full stroke when traction pedal is pressed fully in forward position.

4. Clean the fittings and the hydraulic tube shown; refer to Figure 36.

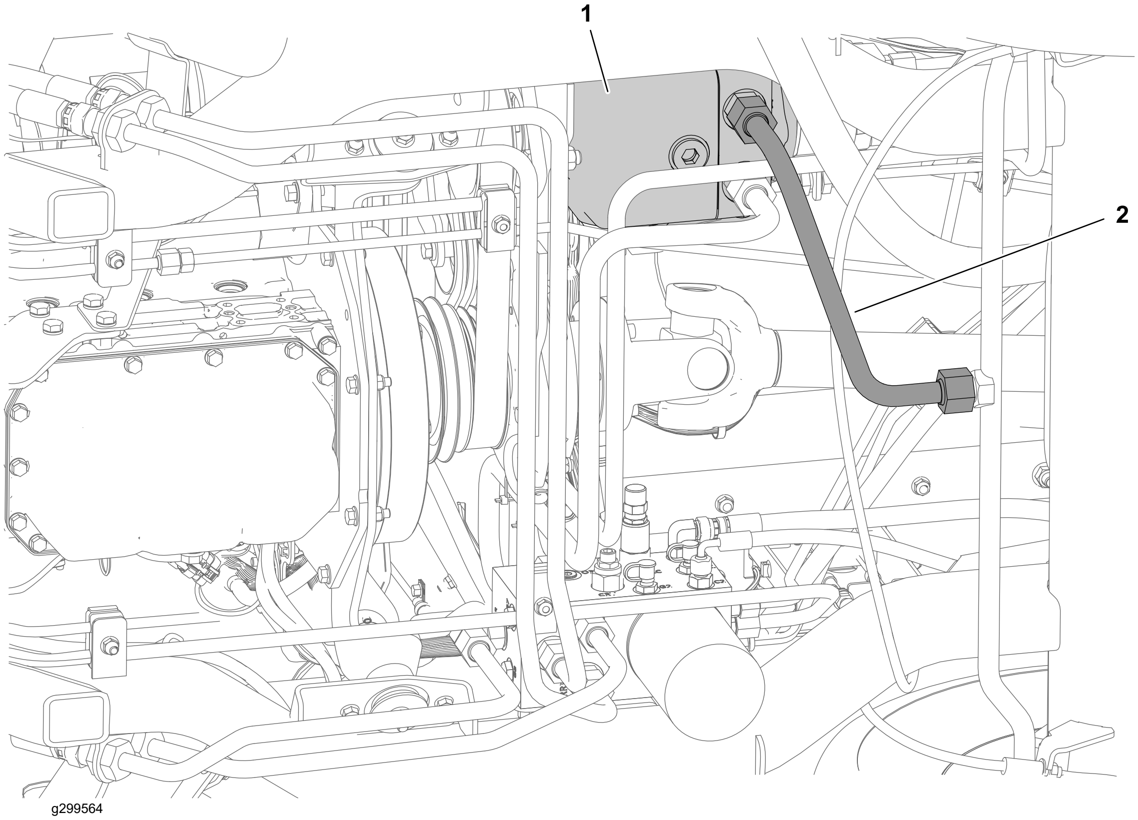

Figure 36

1. Hydraulic pump (P1)
2. Hydraulic tube

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5. Remove the hydraulic tube and use 2 hydraulic hoses to install the tester to the exposed fittings. Make sure the tester is installed in the correct flow direction (toward the wheel motors) and the tester flow control valve is fully open.
6. Start the engine and run it at low-idle speed. Correct any hydraulic fluid leaks at the test connections before continuing the test.
7. Start the engine and move the throttle to the full speed:
   - Model 31900 and 31901 = **3235 rpm**
   - Model 31902 and 31903 = **3150 rpm**
   - Model 31907 and 31909 = **3235 rpm**
8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
9. Use the TDM display/controller screen to verify the engine speed.

CAUTION

Use extreme caution when performing this test. The traction unit wheels will be rotating during the test.

---

10. Verify the pump flow at No Load as follows:

Test Procedure (continued)

A. Slowly press the traction pedal to fully FORWARD position.

B. Unrestricted pump output should be approximately:

- Model 31900 and 31901 = **107 L/minute (28.3 gallons/minute)**
- Model 31902 and 31903 = **104 L/minute (27.6 gallons/minute)**
- Model 31907 and 31909 = **107 L/minute (28.3 gallons/minute)**

C. Release the traction pedal and record the tester pressure and flow readings.

11. Verify the pump flow Under Load as follows:

A. Slowly press the traction pedal to fully FORWARD position.

B. Apply an additional load of **8,274 to 12,410 kPa (1,200 to 1,800 psi)** by slowly closing the flow meter.

C. Release the traction pedal and record the tester pressure and flow readings under load.

12. Verify the traction relief valve (R1) operation as follows:

A. With the traction pedal in the NEUTRAL position, fully close the flow meter flow control valve.

B. Slowly press the traction pedal toward the FORWARD position.

C. The system pressure should reach **25,682 to 26,096 kPa (3,725 to 3,785 psi)** before the relief valve opens. Record the tester pressure reading.

Note: The relief valve setting is **22,925 kPa (3,625 psi)**. An additional **690 to 1,100 kPa (100 to 160 psi)** is necessary to overcome system charge pressure before the relief valve opens.

D. Release the traction pedal, open the flow control valve fully, move the throttle to low speed, and set the key switch to the OFF position.

13. If the relief pressure can not be met or is greater than specified, the traction relief valve is damaged and should be replaced.

14. The under load test flow reading (step 11) should not drop more than 12% when compared to the no load test flow reading (step 10). A difference of more than 12% (Under Load > No Load X 0.88) may indicate the hydraulic pump is worn and should be replaced or repaired; refer to Piston (traction) Pump (P1) (page 5–70) or Servicing the Traction (piston) Pump (P1) (page 5–73).

15. After testing:

A. Remove the hydraulic hoses and tester.

B. Install the hydraulic tube previously removed.

C. Remove the jack stands and lower the machine to the ground.

D. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.

E. Start the engine and check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Testing the Steering and Lift Circuit – Gear Pump (P2) Flow and Circuit Relief Valve

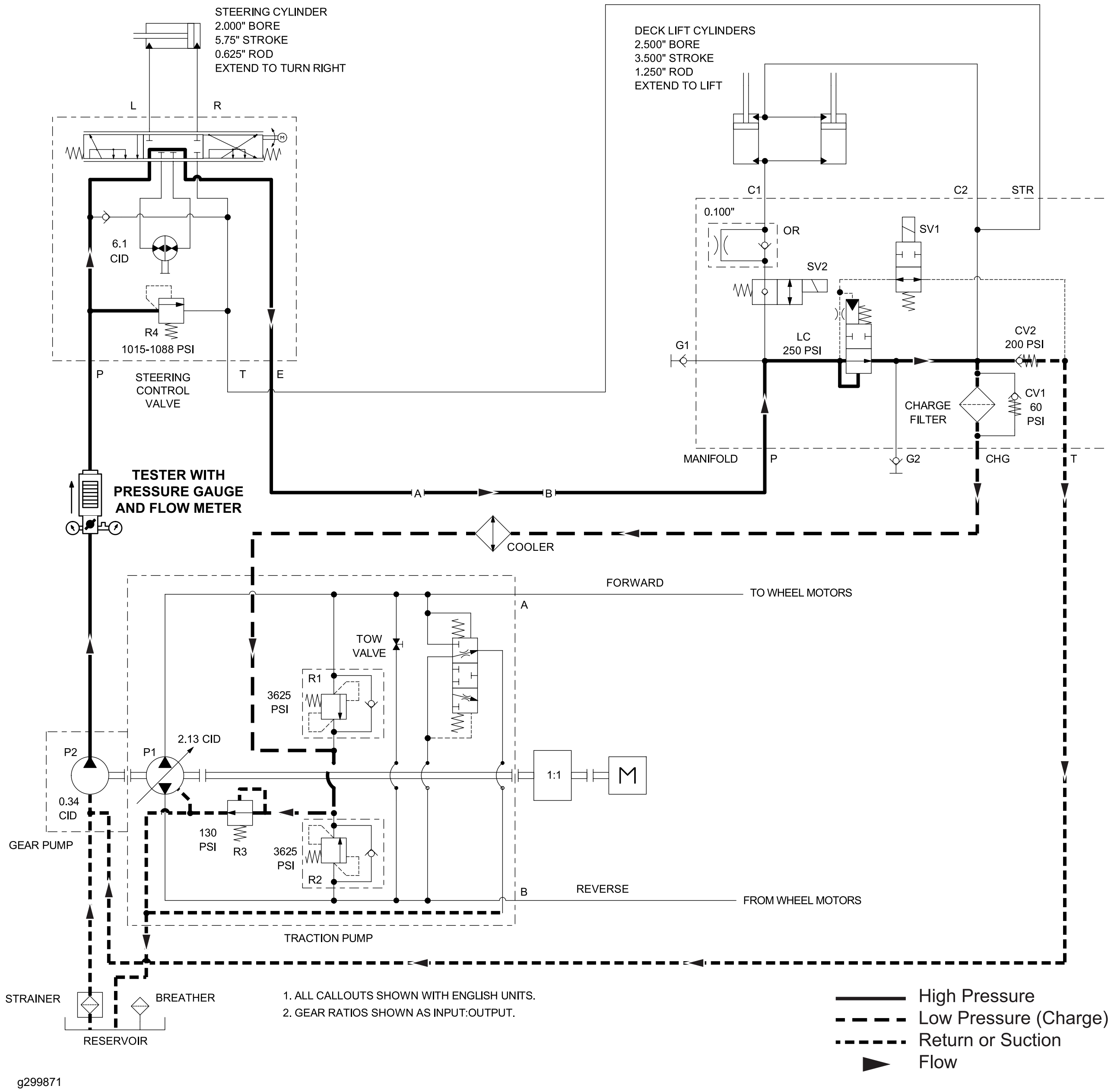

Figure 37

Gear Pump (P2) Flow and Circuit Relief Valve

Gear pump (P2) is designed to satisfy both steering cylinder and lift cylinder needs simultaneously (at full speed throttle). The Gear Pump (P2) Flow Test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than 15% indicates the gears and wear plates in the pump have worn. Continued operation with a worn pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

The relief valve for the steering and lift circuit is integrated into the steering control valve. If both steering and lift operations perform poorly, perform the gear pump (P2) flow test and the circuit relief valve test.

If machine steering is sluggish or otherwise performs poorly, refer to Testing the Steering and Lift Circuit – Steering Cylinder and Circuit Relief Valve (page 5–45).

If cutting unit lift operation is unsatisfactory, check lift control cartridge valve (SV2) and/or lift cylinders; refer to Cartridge Valve Service (page 5–93) and/or Testing the Steering and Lift Circuit – Lift Cylinder Internal Leakage (page 5–47).

Special Equipment Required:

- Flow meter with pressure gauge that has at least a 16 L/minute (5 gallons/minute) capacity.
- 2 Hydraulic Hoses

Test Procedure

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, and set the key switch to the OFF position.
2. Read and adhere to the information provided in Testing the Hydraulic System (page 5–22).
3. Ensure that the traction pedal is correctly adjusted for the NEUTRAL position; refer to Adjusting the Traction System for Neutral (page 5–50).
4. Clean the fittings and the hydraulic tube at the gear pump shown; refer to Figure 38.

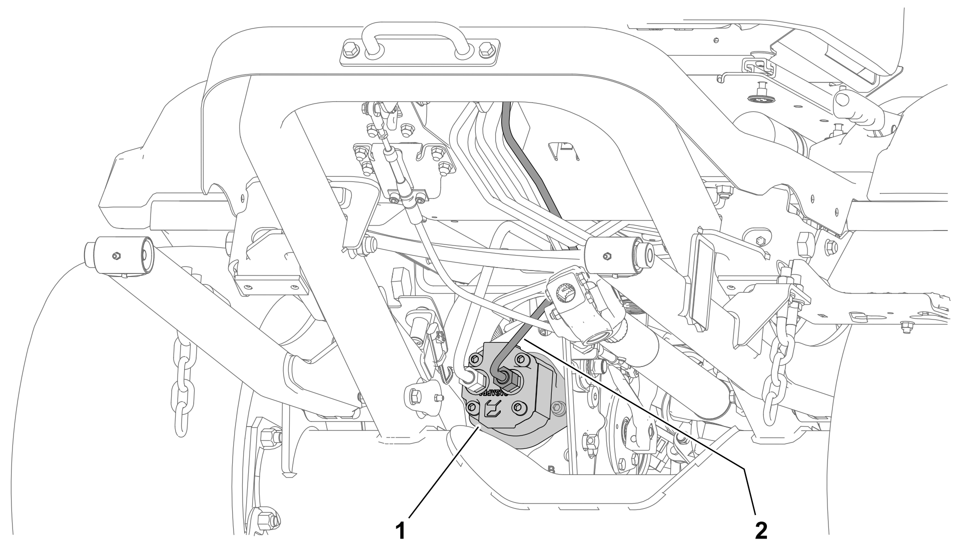

Figure 38

1. Hydraulic pump (P2)
2. Hydraulic tube

5. Remove the steering cover fasteners and raise the steering cover.
6. Clean the fittings and the hydraulic tube at the steering control valve P port shown; refer to Figure 39.

Test Procedure (continued)

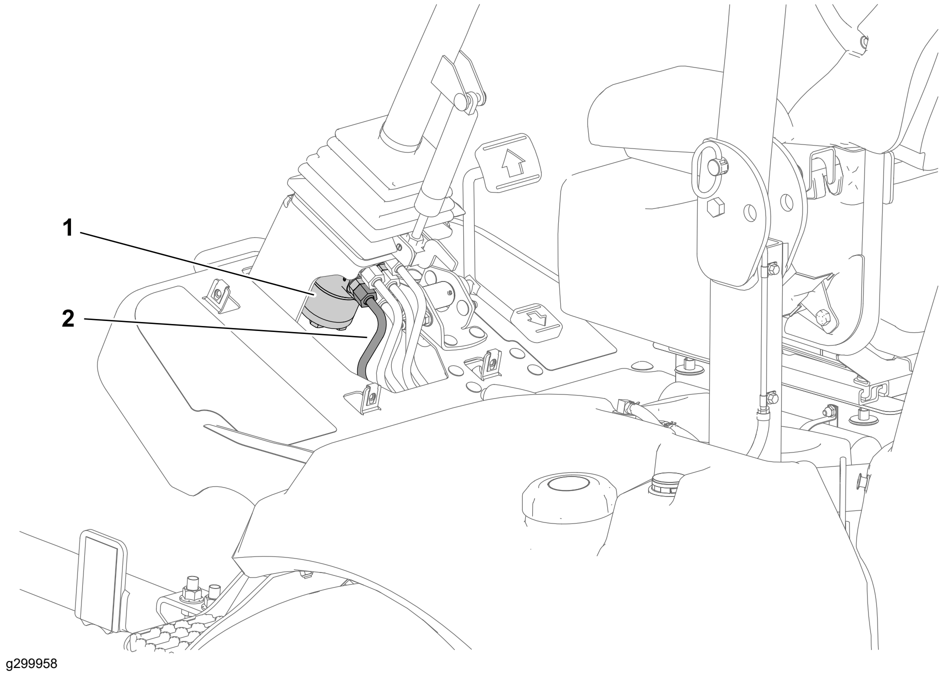

Figure 39

(steering cover raised)

1. Steering control valve
2. Hydraulic tube – P port

7. Remove the hydraulic tube and use 2 hydraulic hoses to install the tester to the exposed fittings. Make sure the tester is installed in the correct flow direction (toward the steering control valve) and the tester flow control valve is fully open.
8. Start the engine and run it at low-idle speed. Correct any hydraulic fluid leaks at the test connections before continuing the test.
9. Start the engine and move the throttle to the full speed:
   - Model 31900 and 31901 = **3235 rpm**
   - Model 31902 and 31903 = **3150 rpm**
   - Model 31907 and 31909 = **3235 rpm**
10. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
11. Use the TDM display/controller screen to verify the engine speed.
12. Verify the pump flow at No Load as follows:
    A. Unrestricted pump output should be approximately:
       - Model 31900 and 31901 = **17 L/minute (4.5 gallons/minute)**
       - Model 31902 and 31903 = **16 L/minute (4.2 gallons/minute)**
       - Model 31907 and 31909 = **17 L/minute (4.5 gallons/minute)**

    B. Record the tester pressure and flow readings at no load.
13. Verify the pump flow at Under Load as follows:

Test Procedure (continued)

CAUTION

Do not close tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the circuit relief valve. Pump damage can occur if the fluid flow is completely restricted by fully closing the tester flow control valve.

A. Monitor the tester pressure gauge carefully while slowly closing the flow control valve until **5,516 kPa (800 psi)** is obtained on the tester pressure gauge.

B. Record the tester pressure and flow readings under load.

14. Verify the steering and lift circuit relief valve (R4) operation as follows:

A. Open the tester flow control valve fully.

CAUTION

When performing the test, do not allow the tester pressure to exceed 8300 kPa (1400 PSI).

IMPORTANT

Hold steering wheel at full lock and hold the lift/lower switch at full raise only long enough to obtain a system pressure reading.

B. Open the circuit relief valve via the steering system. Watch the pressure gauge on the tester and turn the steering wheel completely in one direction. The circuit relief valve should open just after the rear wheel gets to the full lock position. Record the pressure at which the relief valve opens.

C. Open the circuit relief valve via the lift system. Watch the pressure gauge on the tester and set the lift/lower switch to the LIFT position. Momentarily hold the switch with the cutting unit fully raised causing the circuit relief valve to open. Record the pressure at which the relief valve opens.

15. Move the throttle to low speed position and set the key switch to the OFF position.

16. The under load test flow reading (step 13) should not drop more than 15% when compared to the no load test flow reading (step 12). A difference in flow of more than 15% (Under Load > No Load X 0.85) may indicate:

A. A restriction in the pump inlet line.

B. The charge pump is worn and should be replaced or repaired; refer to Gear Pump (P2) (page 5–75) or Gear Pump (P2) Service (page 5–78).

17. The circuit relief valve pressure should be **7000 to 7500 kPa (1015 to 1088 PSI)**. If the relief pressure can not be met or is greater than specified, the steering control valve is damaged and should be replaced or repaired; refer to Steering Control Valve (page 5–95) or Steering Control Valve Service (page 5–97).

18. After testing:

A. Remove the hydraulic hoses and tester.

Test Procedure (continued)

B. Install the hydraulic tube previously removed.

C. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.

D. Start the engine and check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Testing the Steering and Lift Circuit – Steering Cylinder and Circuit Relief Valve

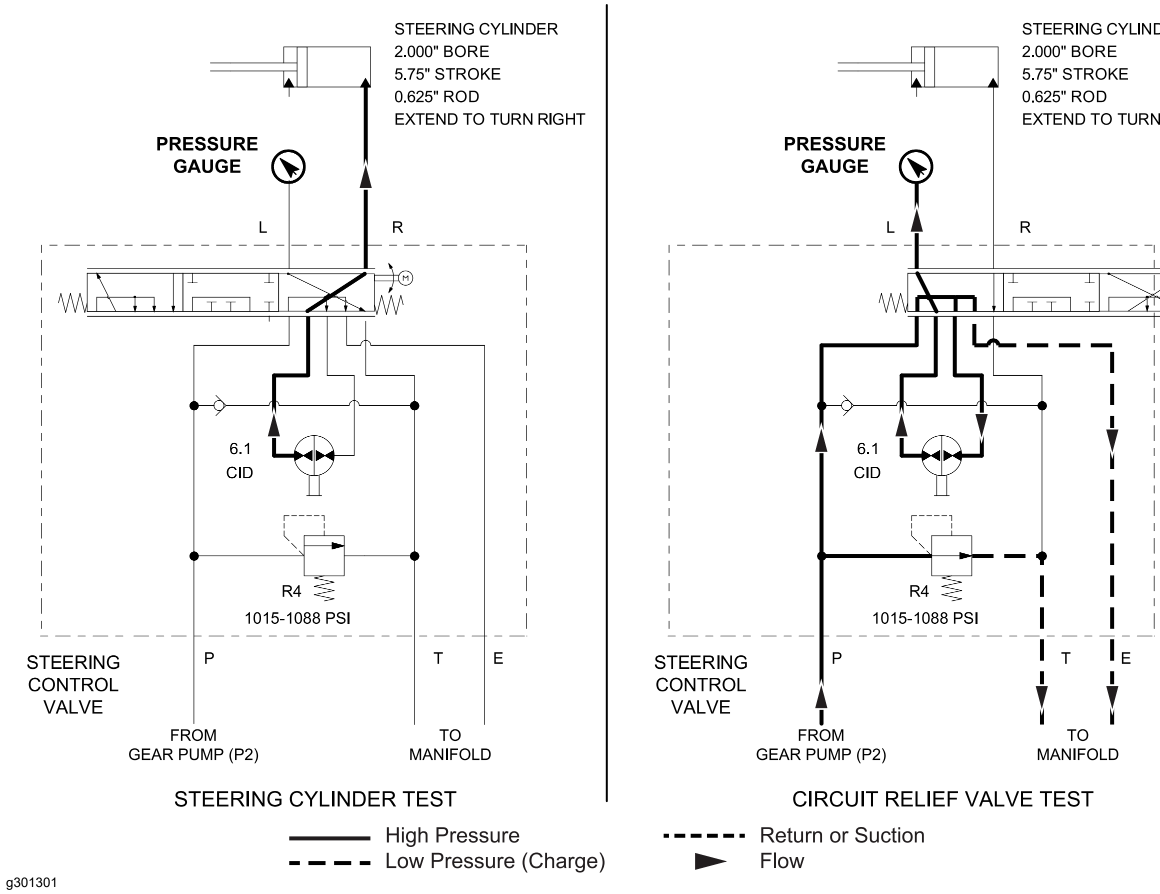

Figure 40

Steering Cylinder and Circuit Relief Valve

Unit steering performance will be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, extra weight on the vehicle, and/or binding of the steering linkage or spindles. Ensure that these conditions are checked and functioning properly before proceeding with any steering system hydraulic testing.

Note: The relief valve for the steering circuit is integrated into the steering control valve.

Test Procedure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for at least 10 minutes.
2. Drive the machine slowly in a figure eight on a flat level surface.
   A. There should be no shaking or vibration in the steering wheel or rear wheels.
   B. The steering wheel movements should be followed immediately by a corresponding rear wheel movement without the steering wheel continuing to turn.
3. Stop the unit with the engine running. Turn the steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.
   A. The steering control valve should respond to each steering wheel movement.

Test Procedure (continued)

B. When steering wheel is released, steering control valve should return to the neutral position with no additional turning.

4. If a steering problem is suspect, determine if the steering cylinder or circuit relief valve is damaged using the following procedure:

A. Park the machine on a level surface, lower the cutting unit (or attachment), and engage the parking brake.

B. With the engine running, turn the steering wheel to the right (clockwise) until the steering cylinder rod is fully extended and set the key switch to the OFF position.

C. Read and adhere to the information provided in Testing the Hydraulic System (page 5–22).

D. Clean the hydraulic fitting and hose end at the rod end of the steering cylinder and disconnect the hydraulic hose.

E. Install a pressure gauge at the end of the disconnected hose.

F. With the engine not running, continue turning the steering wheel to the right (clockwise). Monitor the hydraulic fluid at the open fitting on the steering cylinder as the steering wheel is turned to the right.

G. Start the engine and run it at low-idle speed. Check for hydraulic fluid leaks and correct before continuing the test.

H. Set the engine speed to approximately 2,000 rpm. Use the TDM display/controller screen to check that the engine speed is correct.

IMPORTANT

Turn the steering wheel to the left only long enough to get a system pressure reading. Turning the steering wheel to the left for an extended period may damage the steering control valve.

I. Monitor the pressure gauge carefully when turning the steering wheel for a left turn (counterclockwise).

J. The system pressure should be approximately **7,000 to 7,500 kPa (1,015 to 1,088 psi)** as the relief valve opens.

K. Return the steering wheel to the NEUTRAL position, set the key switch to the OFF position, and record the test results.

5. If the hydraulic fluid comes out of the fitting while turning the steering wheel to the right, the steering cylinder has internal leakage and should be replaced or repaired; refer to Steering Cylinder (page 5–98) or Steering Cylinder Service (page 5–101).

6. If the relief valve pressure specification is not met, replace or repair the steering control valve; refer to Steering Control Valve (page 5–95) or Steering Control Valve Service (page 5–97).

7. After testing:

A. Connect all hydraulic hoses.

B. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.

C. Start the engine and operate the steering system. Check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Testing the Steering and Lift Circuit – Lift Cylinder Internal Leakage

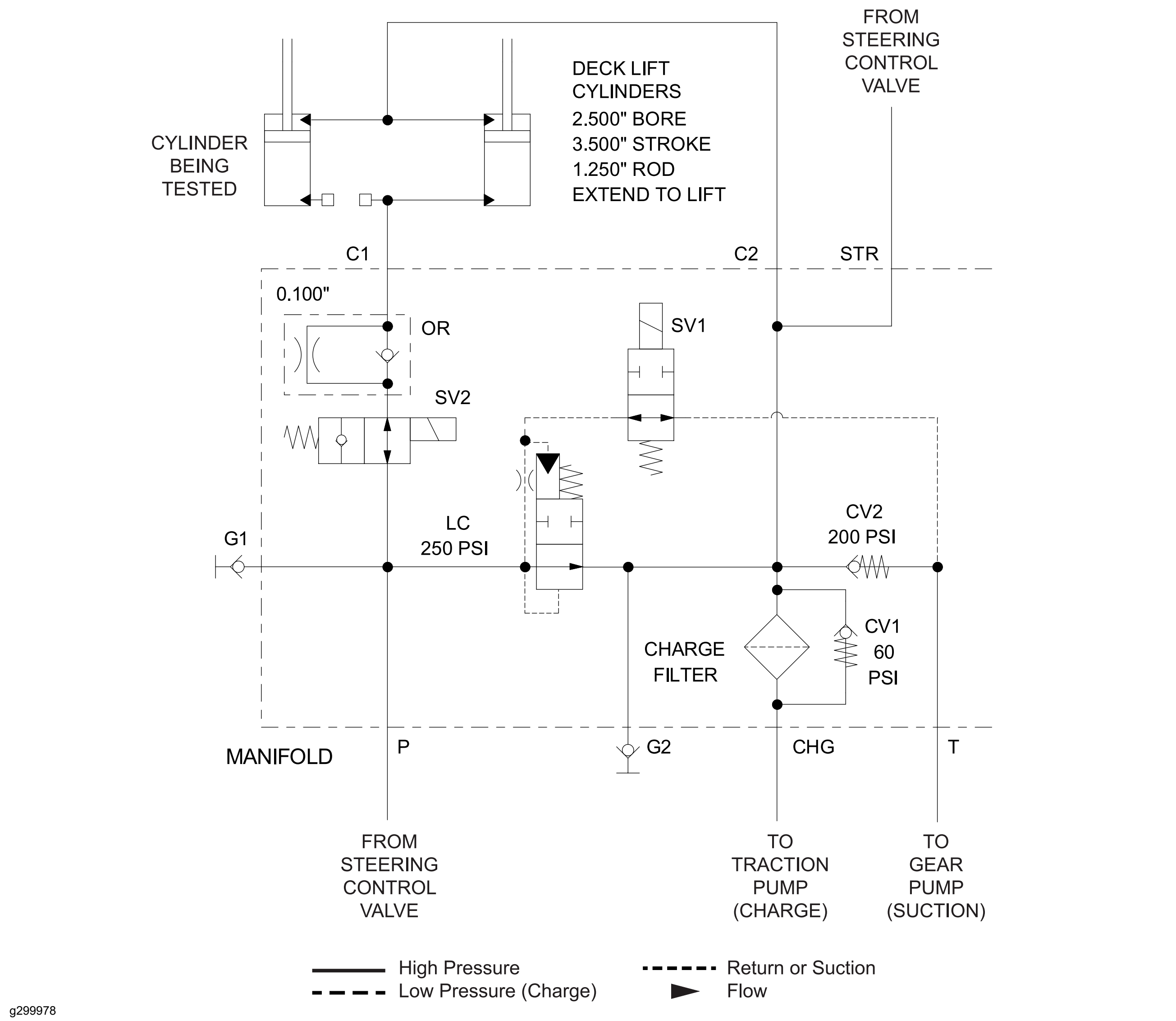

Figure 41

Lift Cylinder Internal Leakage

Perform the lift cylinder internal leakage test if you identify a cutting unit lift or lower problem. This test determines if the lift cylinder being tested is damaged. When performing the lift cylinder internal leakage test, the cutting unit should be attached to the lift arms. Each lift cylinder must be tested individually.

The raise/lower circuit operation can be affected by the lift cylinder binding, extra weight on the cutting unit, and/or binding of the lift components. Ensure that these items are checked before performing the lift cylinder internal leakage test.

Note: The relief valve for the lift circuit is integrated into the steering control valve.

Test Procedure

1. Park the machine on a level surface, raise the cutting unit, engage the parking brake, and set the key switch to the OFF position.
2. Use a jack to support the cutting unit and prevent it from lowering. This removes the load from the lift cylinders and relieves the lift cylinder hydraulic pressure.

Test Procedure (continued)

3. Raise the front of the operator platform to access the lift cylinder hydraulic fittings: refer to Figure 42.
   A. Remove the steering cover fasteners and raise the steering cover.
   B. Remove the front tie-down bracket.
   C. Raise the hood and remove the hood support bracket (item 4).
   D. Remove the parking brake cover.
   E. Remove the 2 fasteners (item 10) securing the fire wall to the frame.
   F. Remove the 6 fasteners (items 6 and 11) securing the operator platform assembly to the frame.
   G. Raise and support the front of the operator platform assembly.

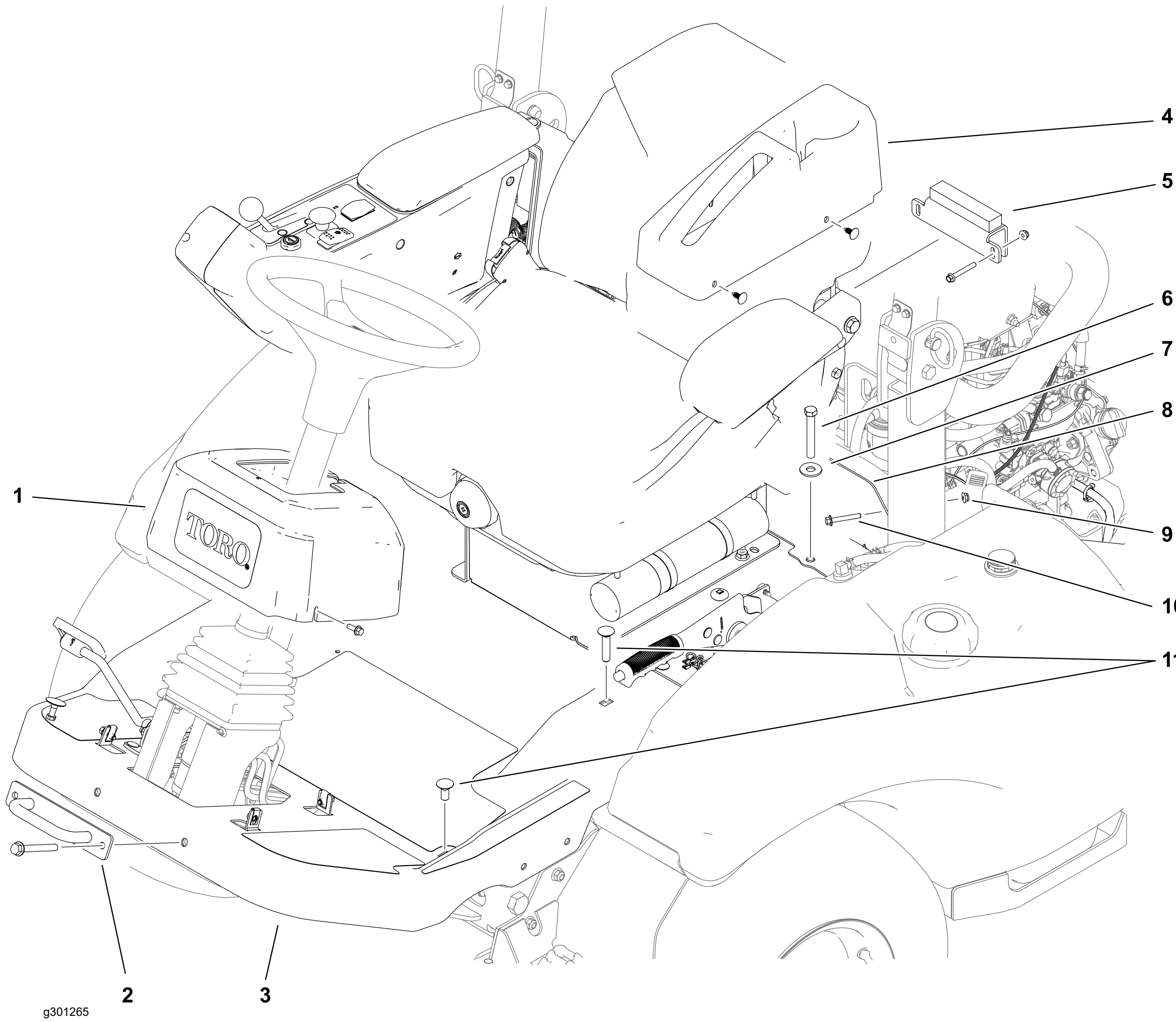

Figure 42

1. Steering cover
2. Front tie-down bracket
3. Operator platform assembly
4. Parking brake cover
5. Hood support bracket
6. Cap screw (2 each)
7. Flat washer (2 each)
8. Fire wall
9. Flange nut (2 each)
10. Cap screw (2 each)
11. Carriage bolt (4 each)

Test Procedure (continued)

4. Clean and disconnect the hydraulic hose fitting at the elbow fitting near the barrel end (front) of the lift cylinder being tested.
5. Cap the disconnected fitting with a hydraulic ORFS cap, and plug the disconnected hose with a hydraulic ORFS plug.
6. Remove the block or jack stand supporting the cutting unit, then lower and remove the jack.
7. Sit in the operator's seat and set the key switch to the ON position. Press and hold the lift/lower switch in the LOWER position.
8. The capped lift cylinder should be able to support the cutting unit for a short period (long enough for the machine to move from one area of the work site to another during operation).
9. Release the lift/lower switch and set the key switch to the OFF position.
10. If the lift cylinder allows the cutting unit to lower too quickly, replace or repair the lift cylinder; refer to Lift Cylinder (page 5–102) or Lift Cylinder Service (page 5–104).
11. Use a jack to raise the cutting unit and lift arms slightly. Support the cutting unit with blocks or jack stands to prevent it from lowering. This removes the load from the lift cylinders and relieves the lift cylinder hydraulic pressure.
12. Remove the hydraulic ORFS cap and plug and connect the hydraulic hose.
13. Repeat the test for the remaining lift cylinder.
14. After testing:

    A. Connect all hydraulic hoses.

    B. Lower and secure the operator's platform and fire wall with the previously removed fasteners and brackets.

    C. Check and adjust the level of the hydraulic fluid in the hydraulic reservoir; refer to the traction unit *Operator's Manual*.

    D. Start the engine and operate the lift cylinders. Check for any hydraulic fluid leaks. Repair hydraulic leaks if necessary before returning the machine to service.

Adjustments

Adjusting the Traction System for Neutral

The traction pedal must return to the NEUTRAL position when released from either the forward or reverse position. The machine must not creep in either direction on level ground when in the traction pedal is in the NEUTRAL position. Adjust the traction system for neutral as follows:

1. Park the machine on a level surface, lower the cutting unit (or attachment) and set the key switch to the OFF position.

WARNING

Review and follow the Jacking Instructions (page 1–6) before lifting the machine.

2. Raise both front wheels for 2WD machines, or all 4 wheels for 4WD machines off the floor and support the machine.
3. Loosen the lock nut on the traction (piston) pump adjustment cam.

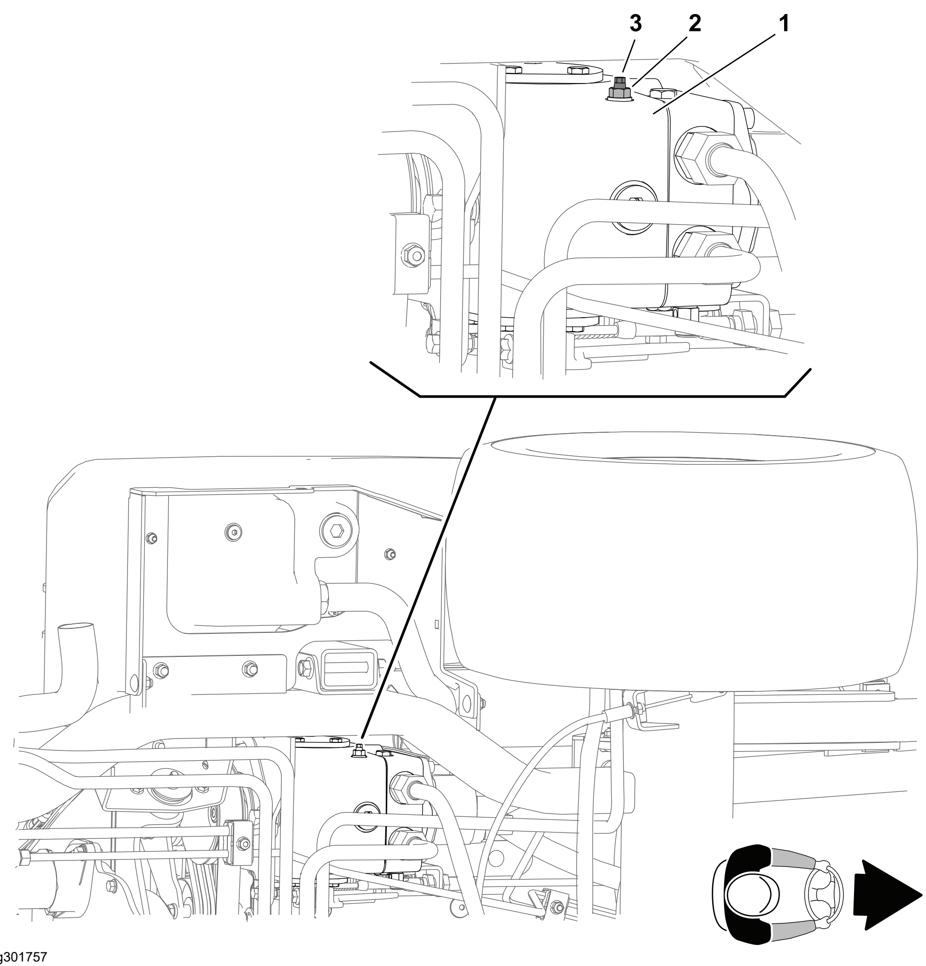

Figure 43

1. Traction (piston) pump
2. Lock nut
3. Adjustment cam

4. Start the engine and rotate the cam in either direction until the wheels stop rotating.

Adjusting the Traction System for Neutral (continued)

5. Tighten the locknut to secure the adjustment.
6. Set the key switch to the OFF position.
7. With the traction pedal in the NEUTRAL position, measure the air gap between the face of the neutral switch and the pump lever and adjust if necessary; refer to Adjusting the Traction Neutral Switch (page 6–29).
8. When finished, remove the jack stands and lower the machine to the ground.
9. Test the machine for proper traction system operation before returning the machine to service.

Service and Repairs

General Precautions for Removing and Installing the Hydraulic System Components

Before Repairing or Replacing the Components

1. Before removing any parts from the hydraulic system, park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Clean the machine before you disconnect, remove, or disassemble the hydraulic components.

   Note: Cleanliness is necessary whenever you work on the hydraulic equipment. Ensure that you clean the hydraulic components, hoses, connections, and fittings.
3. Label all the disconnected hydraulic lines and hoses for proper installation after repairs are completed.
4. Record the position of the hydraulic fittings (especially elbow fittings) on the hydraulic components before removal.

   Note: Mark the parts, if necessary before removal and ensure that they are aligned properly when installing the hydraulic fittings, hoses, and tubes.

WARNING

Before disconnecting or doing any work on the hydraulic system, release all the pressure in the system; refer to Relieving Pressure from the Hydraulic System (page 5–3).

5. The hydraulic fluid may be hot. Be careful when you loosen and remove the hydraulic system components.
6. Install clean caps or plugs on the hydraulic lines, hydraulic fittings, and components that are left open or exposed to prevent hydraulic system contamination. Cap or plug the opening as soon as the opening is exposed.

After Repairing or Replacing the Components

1. Check the hydraulic-fluid level in the hydraulic tank and add correct quantity of fluid if necessary. Use the hydraulic fluids that are specified in the traction unit *Operator's Manual*.

IMPORTANT

Drain and fill the hydraulic tank and change the oil filter if the component failure is severe or the system is contaminated; refer to the traction unit *Operator's Manual*.

2. Lubricate the O-rings and seals with clean hydraulic fluid before installing the hydraulic components.
3. Remove all the caps or plugs from the hydraulic tubes, hydraulic fittings, and components before connecting them.
4. Use proper tightening procedures when installing the hydraulic hoses and fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal

After Repairing or Replacing the Components (continued)

Fitting) (page 5–7) and Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).

5. After you complete the repairs, check the control linkages or cables for proper adjustment, binding, or broken parts.
6. Whenever hydraulic fluid has been drained from the pumps (system drain, flush, or pump removal/installation) it is important to properly prime the hydraulic pumps, refer to Priming the Hydraulic Pumps (page 5–60).
7. After you disconnect or replace any hydraulic components, operate the machine functions slowly until the air is out of the system; refer to Charging the Hydraulic System (page 5–62).
8. Check for hydraulic-fluid leaks. Shut off the engine and repair leaks if necessary.

Checking the Hydraulic Lines and Hoses

WARNING

Hydraulic fluid escaping under pressure can penetrate skin and cause injury.

- **Ensure that all hydraulic-fluid hoses and lines are in good condition and all hydraulic connections and fittings are tight before applying pressure to the hydraulic system.**
- **Keep your body and hands away from pin-hole leaks or nozzles that eject high-pressure hydraulic fluid.**
- **Use a piece of cardboard or paper to find hydraulic leaks.**
- **Release all pressure in the hydraulic system before performing any work on the system.**
- **Seek immediate medical attention if hydraulic fluid is injected into your skin.**

IMPORTANT

Check the hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, and hose deterioration. Repair the damaged hydraulic lines and hoses before operating the machine.

Flushing the Hydraulic System

IMPORTANT

If a component failure occurs in the traction circuit; refer to Filtering the Closed-loop Traction Circuit (page 5–57) for additional information.

IMPORTANT

Flush the hydraulic system whenever there is a severe component failure or the system is contaminated (for example, the fluid appears milky, black, or contains metal particles).

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).

CAUTION

Flush the hydraulic system with the hydraulic fluid as warm as possible, but to prevent additional system damage, Do Not operate a machine with contaminated hydraulic fluid to warm the fluid before draining.

IMPORTANT

Follow all local codes and regulations when recycling or disposing the hydraulic fluid and filters.

3. Drain the hydraulic tank into a suitable container; refer to the traction unit *Operator's Manual*.
4. Drain the hydraulic system hoses, tubes, lift cylinders and other components from low points in the system.
5. Remove and replace the hydraulic-fluid filter; refer to the traction unit *Operator's Manual*.
6. Inspect and clean hydraulic tank. Remove the hydraulic tank if necessary; refer to Hydraulic Tank (page 5–64).
7. Connect all the hydraulic hoses, tubes, and components that were disconnected while draining the system; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).

IMPORTANT

Using other hydraulic fluids could damage the hydraulic system. Use the hydraulic fluids that are specified in the traction unit *Operator's Manual*.

Flushing the Hydraulic System (continued)

8. Fill the hydraulic tank with the correct type and quantity of new hydraulic fluid; refer to the traction unit *Operator's Manual*.
9. Prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 5–60).
10. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Filtering the Closed-loop Traction Circuit

Filtering of a closed−loop hydraulic system after a major component failure (e.g. traction (piston) pump or wheel motor) is required to prevent debris from transmitting throughout the system. If a filtering tool is not used (to ensure that the system is clean), repeat failures and subsequent damage to other hydraulic components in the system will occur. To effectively remove contamination from the closed−loop traction circuit, use of a Toro bidirectional high flow hydraulic filter and hydraulic hose kit is recommended; refer to High Flow Hydraulic Filter Kit (page 2–19).

1. Park machine on a level surface, lower the cutting unit (or attachment), set the key switch to the OFF position and remove the key from the key switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).

WARNING

Review and follow the Jacking Instructions (page 1–6) before lifting the machine.

3. Raise both front wheels for 2WD machines, or all 4 wheels for 4WD machines off the floor and support the machine.
4. Install the hydraulic filter directly upstream of the new component to prevent system contamination from entering and damaging the new component.
   A. If the traction (piston) pump or a front wheel motor was replaced, thoroughly clean both ends of the hydraulic tube shown in Figure 44, then remove the hydraulic tube from the machine.

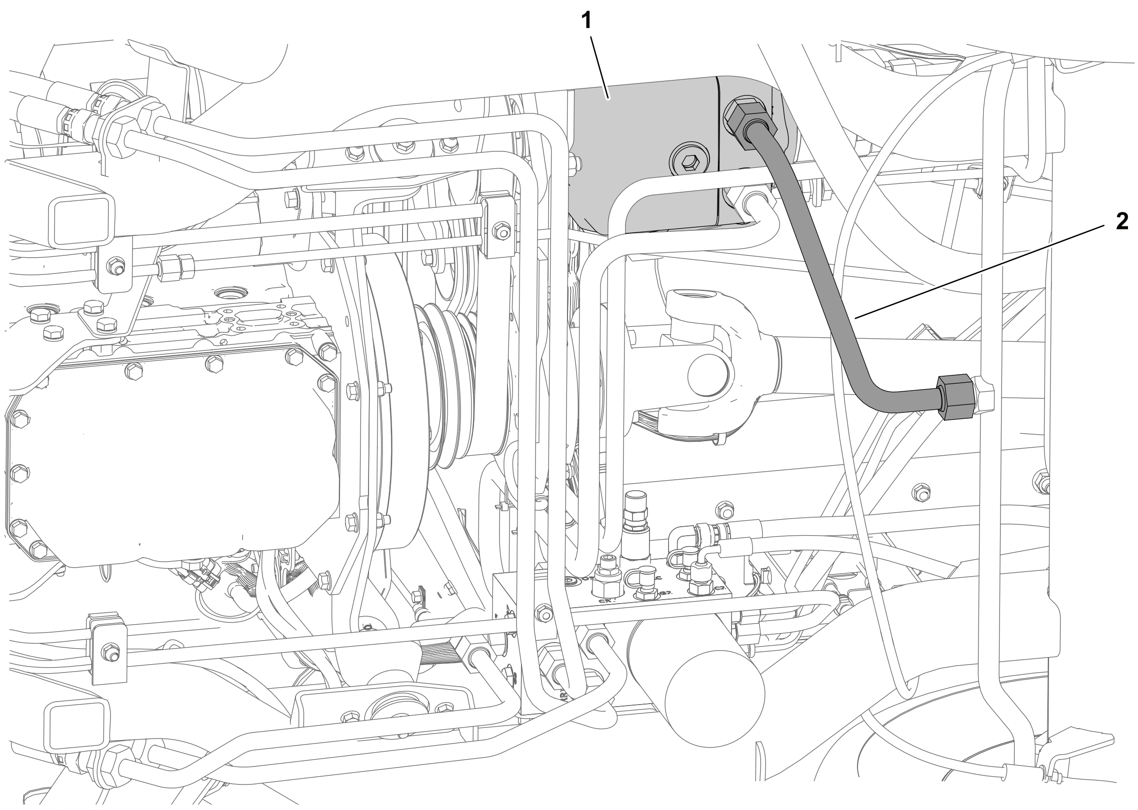

Figure 44

1. Traction (piston) Pump
2. Hydraulic tube

Filtering the Closed-loop Traction Circuit (continued)

B. If a rear wheel motor was replaced, thoroughly clean the junction of the bulkhead fitting and hydraulic hose as shown in Figure 45, then disconnect the hose from the bulkhead fitting.

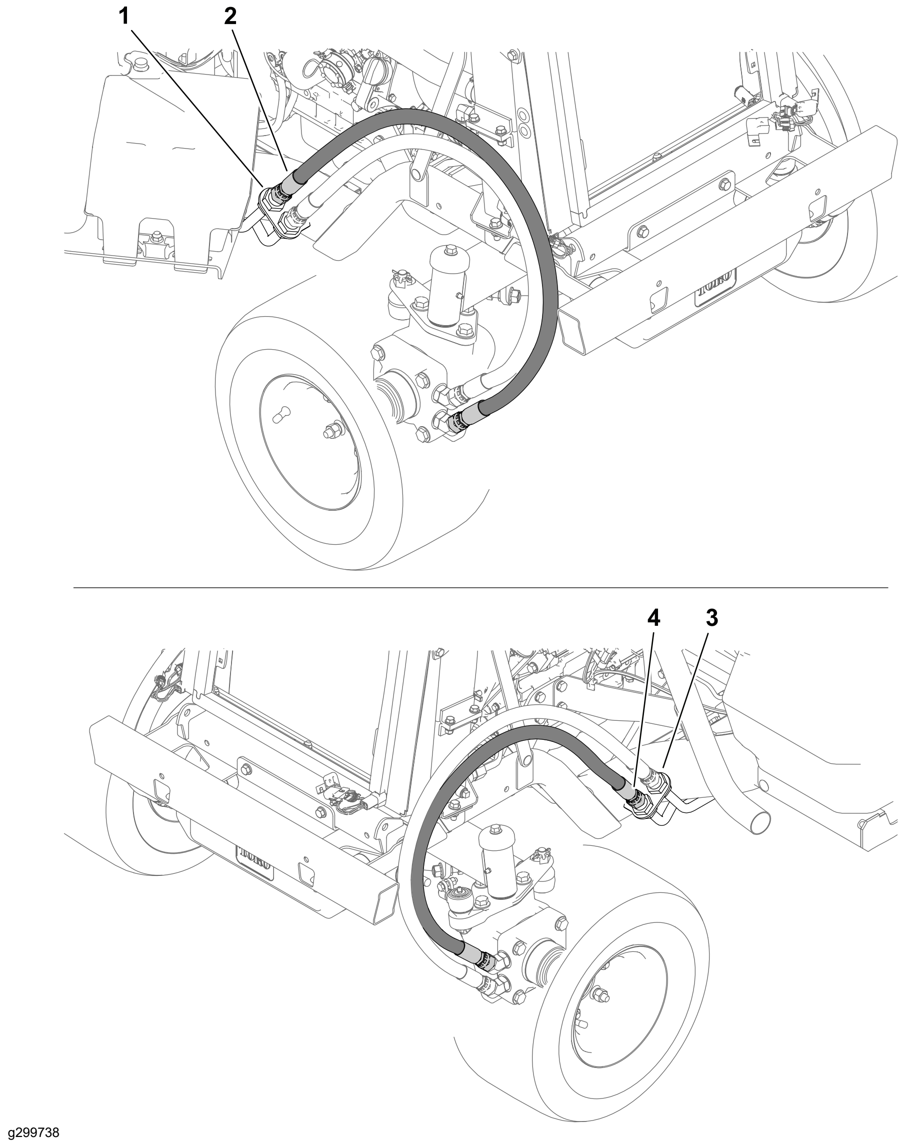

Figure 45

1. Left side bulkhead fitting
2. Left rear wheel motor supply hose
3. Right side bulkhead fitting
4. Right rear wheel motor supply hose

IMPORTANT

If using a hydraulic filter that is not bidirectional, install the filter with the flow direction toward the traction pump for a traction pump failure, and toward the wheel motors for a wheel motor failure.

5. Connect the Toro high flow hydraulic filter in series between the disconnected fittings and tube or hose. Use the hydraulic hose kit to connect the filter to the machine if necessary; refer to Hydraulic Hose Kit (page 2–17). Ensure that all hydraulic connections are properly tightened.

6. Fill the hydraulic tank with the correct type and quantity of new hydraulic fluid; refer to the traction unit *Operator's Manual*.
7. Start engine and run at low idle speed. Check for and correct any hydraulic leaks before proceeding.

CAUTION

Use extreme caution when performing this test. The traction unit wheels will be rotating during the test.

IMPORTANT

While engaging the traction circuit, monitor the indicator on the high flow hydraulic filter. If the indicator shows red, either reduce the pressure on the traction pedal or reduce the engine speed to decrease the hydraulic flow through the filter.

8. With the engine running at low-idle speed, slowly move the traction pedal to the reverse direction for a traction (piston) pump failure, or to the forward direction for a wheel motor failure to allow flow through the traction circuit and high-flow filter. Keep the traction circuit engaged for 5 minutes while gradually increasing the traction pedal pressure and the engine speed. Monitor the filter indicator to ensure that the green color is showing during the operation.

IMPORTANT

If you are using a filter that is not the Toro high flow filter that is bi-directional, do not press the traction pedal in the opposite direction. If the flow is reversed when using a filter that is not bi-directional, unwanted material from the filter will again enter the traction circuit.

9. When using a high flow bi-directional filter, alternately move the traction pedal in opposite directions with the engine running at high-idle speed. While monitoring the filter indicator, continue this process for 5 more minutes.
10. Shut off the engine and remove the key from the key switch.
11. Remove the high flow hydraulic filter and hydraulic hose kit from the machine. Flush clean and install the hydraulic tube preciously removed, or connect the disconnected hydraulic hose. Ensure that you properly tighten the hydraulic tube or hose; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
12. Lower the machine to the ground.
13. Check the hydraulic fluid level in the tank and adjust if necessary; refer to the traction unit *Operator's Manual*.
14. Operate the machine and check for leaks before returning the machine to service.

Priming the Hydraulic Pumps

Whenever hydraulic fluid has been drained from the pumps (system drain, flush, or pump removal/installation) it is important to properly prime the hydraulic pumps. Priming the hydraulic pumps ensures that the gear pumps and piston (traction) pump have sufficient fluid while charging the hydraulic system. The pumps can be primed by using a remote starter switch to crank the engine which allows the pump to prime; refer to Remote Starter Switch (page 2–19).

IMPORTANT

If the traction (piston) pump was rebuilt or replaced, make sure the pump housing is at least half full of clean hydraulic fluid after installation.

1. Make sure all hydraulic connections are properly tightened.
2. Set the key switch to the OFF position and remove the key from the key switch.
3. Check the hydraulic fluid level in the hydraulic tank and add the correct type and quantity of fluid if necessary; refer to the traction unit *Operator's Manual*.
4. Remove the battery cover and raise the hood.

   Note: A blue wire connects to the starter motor solenoid B+ terminal; refer to Figure 46. It is not necessary to remove this blue wire from the solenoid terminal to connect the remote starter switch.

5. Connect the remote starter switch electrical leads to the starter motor solenoid B+ terminal and positive post of the battery.

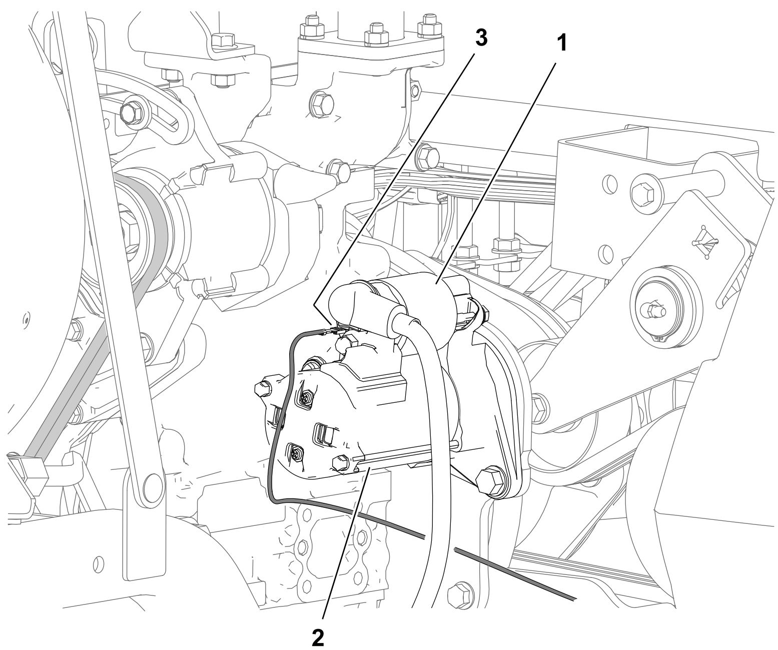

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Figure 46

Starter B+ Terminal (typical)

1. Starter solenoid
2. Starter motor
3. B+ terminal

6. Connect the remote starter switch electrical leads to the starter motor solenoid B+ terminal and positive post of the battery.

Priming the Hydraulic Pumps (continued)

7. Engage the remote starter switch and crank the starter for 15 seconds to prime the hydraulic pump. Wait for 30 seconds to allow the starter motor and starter solenoid to cool. Repeat the cranking procedure for the second time.
8. Disconnect the remote starter switch leads from the machine.
9. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Charging the Hydraulic System

IMPORTANT

Air must be purged from the hydraulic system to reduce the chance of component damage.

When initially starting the hydraulic system with new or rebuilt components such as wheel motors, pumps, or cylinders, it is important that the hydraulic system is charged properly to remove air from the system.

IMPORTANT

Flush the hydraulic system whenever there is a severe component failure or the system is contaminated; refer to Flushing the Hydraulic System (page 5–55).

1. Park the machine on a level surface and set the key switch to the OFF position.
2. Ensure that all of the hydraulic connections are secured tightly.
3. Ensure that the hydraulic tank is full. Add the correct quantity and type of hydraulic fluid if necessary; refer to the traction unit *Operator's Manual*.
4. If the traction (piston) or gear pump was replaced or repaired, prime the hydraulic pumps; refer to Priming the Hydraulic Pumps (page 5–60).

WARNING

Review and follow the Jacking Instructions (page 1–6) before lifting the machine.

5. Raise the front wheels of 2WD machines, or all of the wheels for 4WD machines off the floor and support the machine with jack stands.
6. Make sure the traction pedal is in neutral., then start the engine and let it idle at low speed. The hydraulic pumps should pick up hydraulic fluid and fill the hydraulic system. If there is no indication of the system filling within 30 seconds, stop the engine and determine the cause.

IMPORTANT

Check hydraulic tank fluid level frequently while charging the system and add fluid if necessary.

7. After the hydraulic system starts to show the signs of fill, operate the deck lift switch until the lift cylinders move in and out several times.
8. If the cylinders do not move after 15 seconds or the pump emits abnormal sounds:
   A. Immediately set the key switch to the OFf position.
   B. Make sure the hydraulic fluid filter or the suction line is not loose.
   C. Check for incorrect hose routing.
   D. Ensure that the suction line is not blocked.
   E. Make sure the charge relief valve (R3) is not damaged or blocked open.

Charging the Hydraulic System (continued)

F. Test gear pump (P2) for damage.

9. Turn the steering wheel in both directions so that the steering cylinder moves in and out several times.
10. Operate the traction pedal in the forward and reverse directions. Make sure the wheels are turning in the proper direction. If the traction (piston) pump or a wheel motor was replaced or rebuilt, operate the traction circuit slowly for 10 minutes.
11. Ensure that the traction pedal returns to the NEUTRAL position when released. and adjust if necessary; refer to Adjusting the Traction System for Neutral (page 5–50).
12. Lower the machine to the ground.
13. Operate the machine by gradually increasing its work load to full over a 10 minute period.
14. Stop the machine, check the hydraulic components for leaks and tighten any loose connections.
15. Check and adjust the fluid level in the hydraulic tank if necessary; refer to the traction unit *Operator's Manual*.

    Note: If new fluid shows any signs of contamination, flush the hydraulic system again until the fluid is clean; refer to Flushing the Hydraulic System (page 5–55).

Hydraulic Tank

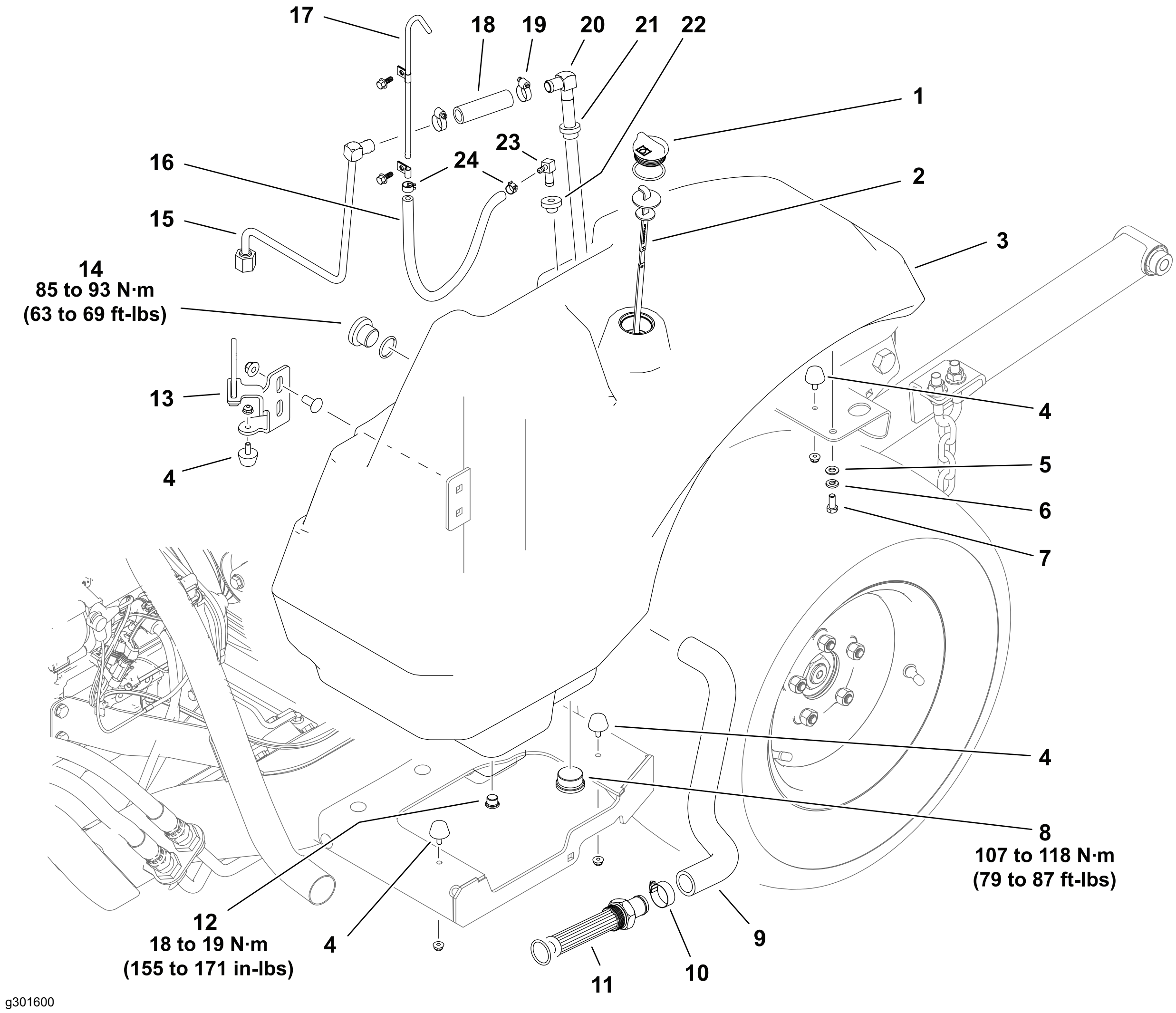

Figure 47

1. Cap	9. Hose – suction	17. Tube – vent
2. Dipstick	10. Hose clamp	18. Hose
3. Hydraulic tank	11. Suction filter	19. Hose clamp (2 each)
4. Rubber bumper (4 each)	12. Drain plug w/o-ring	20. Drop tube
5. Flat washer	13. Hold down bracket	21. Grommet
6. Lock washer	14. Plug w/o-ring	22. Grommet
7. Cap screw	15. Hydraulic tube – return	23. Barb fitting
8. Plug w/o-ring	16. Hose – vent	24. Hose clamp (2 each)

Removing and installing the Hydraulic Tank

Refer to Figure 47 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Empty the hydraulic tank through the drain plug at the bottom of the tank. Use a new O-ring and install the plug when finished to prevent contamination from entering the hydraulic system.
3. Open the hood and remove the right side hold down bracket from the ROPS.

4. Remove the cap screw (item 7) from under the front of the hydraulic tank.

IMPORTANT

To prevent damage to the hydraulic hoses and tubes, cable ties and clamps may be used to secure the hoses and tubes to the machine components. Record the location of all cable ties and clamps that are removed from the machine so they can be properly replaced.

5. Label the hydraulic hoses for assembly purposes. Loosen the hose clamps and disconnect the hoses from the hydraulic tank.
6. Cap or plug the hydraulic fittings and hoses to prevent contamination from entering the hydraulic system.
7. Remove the hydraulic tank from the machine.
8. Inspect the 4 rubber bumpers that support the hydraulic tank for damage or wear and replace them if necessary.
9. Inspect the 2 rubber grommets that support the hydraulic fittings for damage or wear and replace them if necessary.
10. If the large plugs were removed from the tank, use new O-rings and tighten the large plug on the side of the tank from **85 to 93 N·m (63 to 69 ft-lbs)**, and the large plug on the bottom of the tank from **107 to 118 N·m (79 to 87 ft-lbs)**.
11. To install the hydraulic tank, follow this procedure in reverse order.
12. Tighten the drain plug from **18 to 19 N·m (155 to 171 in-lb)**.
13. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Hydraulic Fluid Cooler

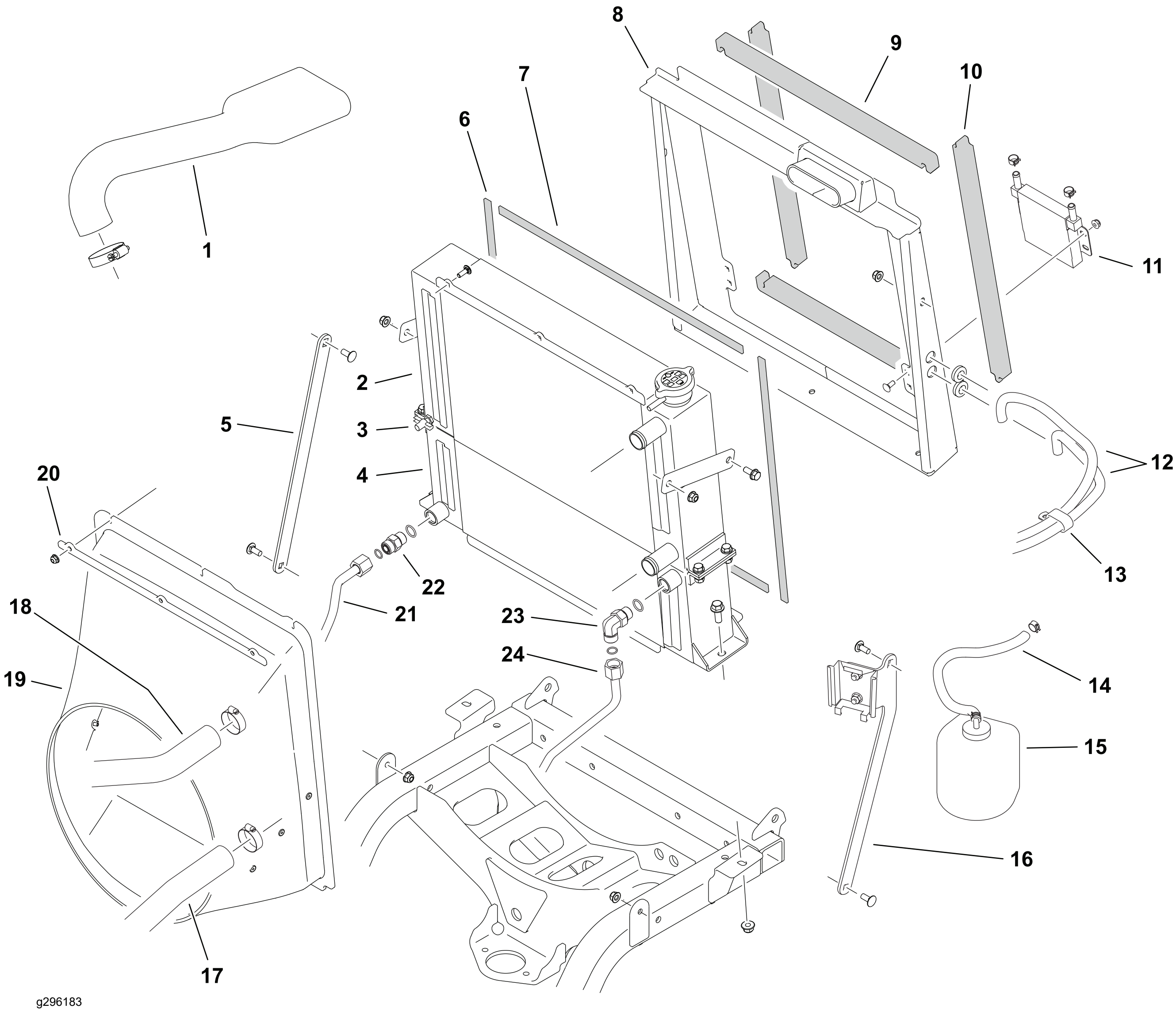

Figure 48

1.	Air cleaner intake hose	9.	Foam seal (2 each)	17.	Radiator hose (lower)
2.	Radiator/hydraulic fluid cooler (radiator)	10.	Foam seal (2 each)	18.	Radiator hose (upper)
3.	Coolant drain valve	11.	Fuel cooler (31902/31903)	19.	Fan shroud
4.	Radiator/hydraulic fluid cooler (fluid cooler)	12.	Fuel hoses (31902/31903)	20.	Shroud retainer bracket
5.	Support bracket – RH (non-cab version shown)	13.	Clamp (31902/31903)	21.	Hydraulic tube assembly
6.	Radiator foam (2 each)	14.	Coolant reservoir hose	22.	Hydraulic fitting – straight
7.	Radiator foam (2 each)	15.	Coolant reservoir	23.	Hydraulic fitting – elbow
8.	Radiator shroud assembly	16.	Support bracket – LH	24.	Hydraulic tube assembly

The hydraulic fluid cooler on your Groundsmaster 3200/3300 is combined with the radiator. The procedure for removing and installing the radiator and hydraulic fluid cooler as an assembly are provided; refer to Radiator (page 4–13). If desired, the radiator and hydraulic fluid cooler may be separated once the assembly is removed from the machine.

Traction Pump Drive

Replacing the Traction Pump Drive Belt

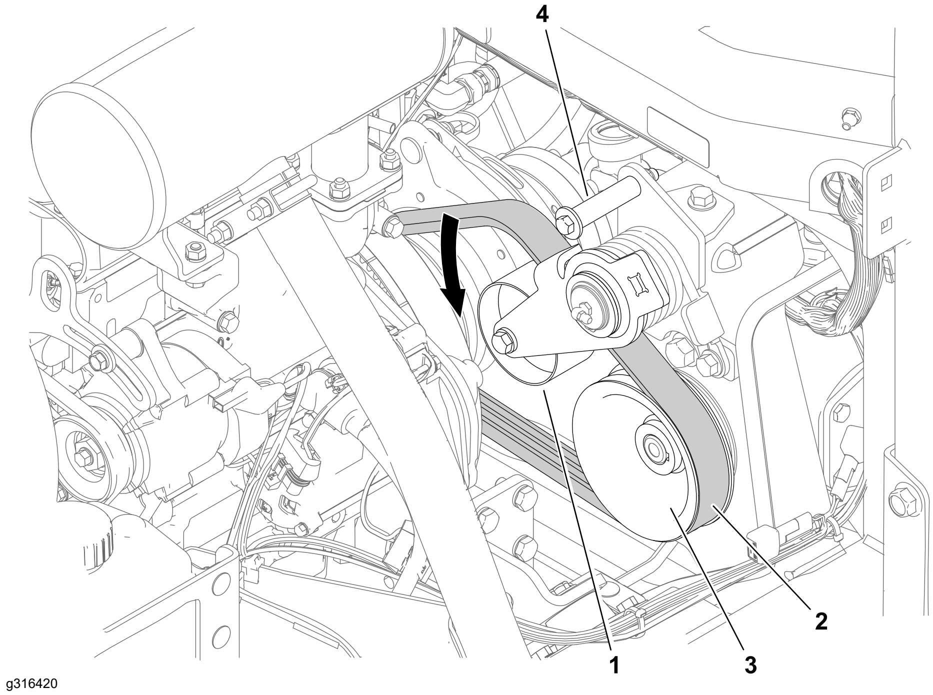

Figure 49

1.	Idler arm	3.	Pump pulley
2.	Drive belt	4.	Idler arm stop

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Raise the hood.
3. Use a 1/2 inch square drive on the hydraulic pump drive belt idler arm to relieve the belt tension. Remove the belt from the idler pulley and allow the idler arm to rest against the stop.
4. Remove the drive belt from the pump pulley
5. Disconnect the cutting unit drive shaft at the PTO clutch.
6. Remove the clutch stop strap from the PTO clutch.
7. Guide the belt over the PTO clutch and out of the machine.
8. To install the new drive belt, follow this procedure in reverse order.

Removing and Installing the Traction Pump Drive Assembly

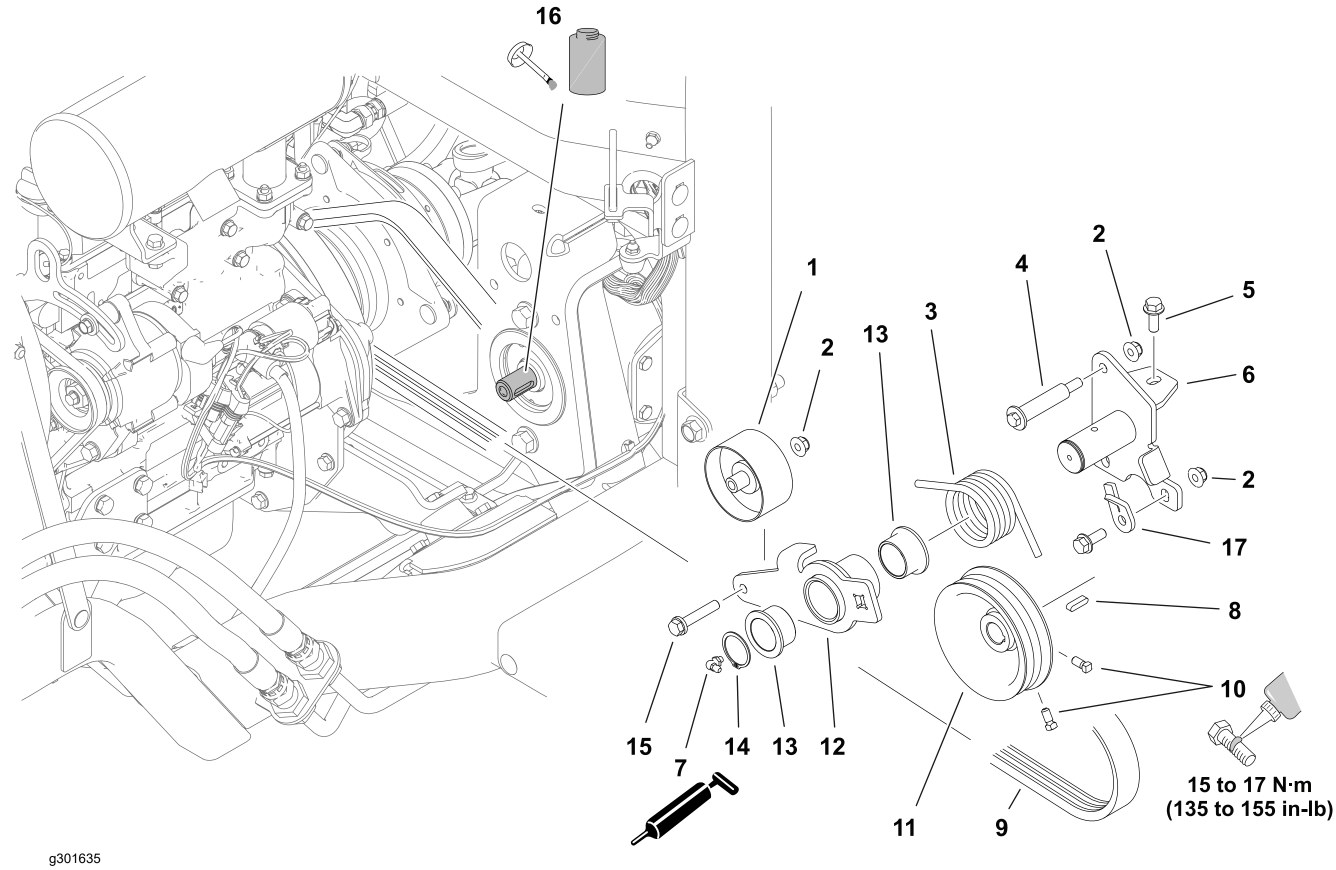

Figure 50

1. Idler pulley
2. Flange lock nut (5 each)
3. Torsion spring
4. Shoulder bolt
5. Cap screw (3 each)
6. Idler pivot
7. Grease fitting
8. Key
9. Drive belt
10. Square head set screw (2 each)
11. Pump pulley
12. Idler arm
13. Flange bushing (2 each)
14. Retaining ring
15. Cap screw
16. Pump shaft
17. Spring retainer tab

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Raise the hood.
3. Use a 1/2 inch square drive on the hydraulic pump drive belt idler arm to relieve the belt tension and remove the belt from the pump pulley.
4. Allow the idler arm to rest with no spring load.
5. Disassembly the pump drive components if necessary.
6. Inspect the drive belt, idler arm bushings, and idler pulley (bearings) and replace if necessary.
7. If the pump pulley is removed:
   A. Install the key and apply a thin coat of anti-seize lubricant to the pump shaft before installing the pump pulley.
   B. Align the pulley with the drive belt grooves on the engine stub shaft.
   C. Use medium strength thread locker on the pulley set screws and tighten the set screws from **15 to 17 N·m (135 to 155 in-lb)**.

Removing and Installing the Traction Pump Drive Assembly (continued)

8. Grease the idler pivot shaft with Mobil high-temp XHP-222 grease or equivalent before and after assembly.

Piston (traction) Pump (P1)

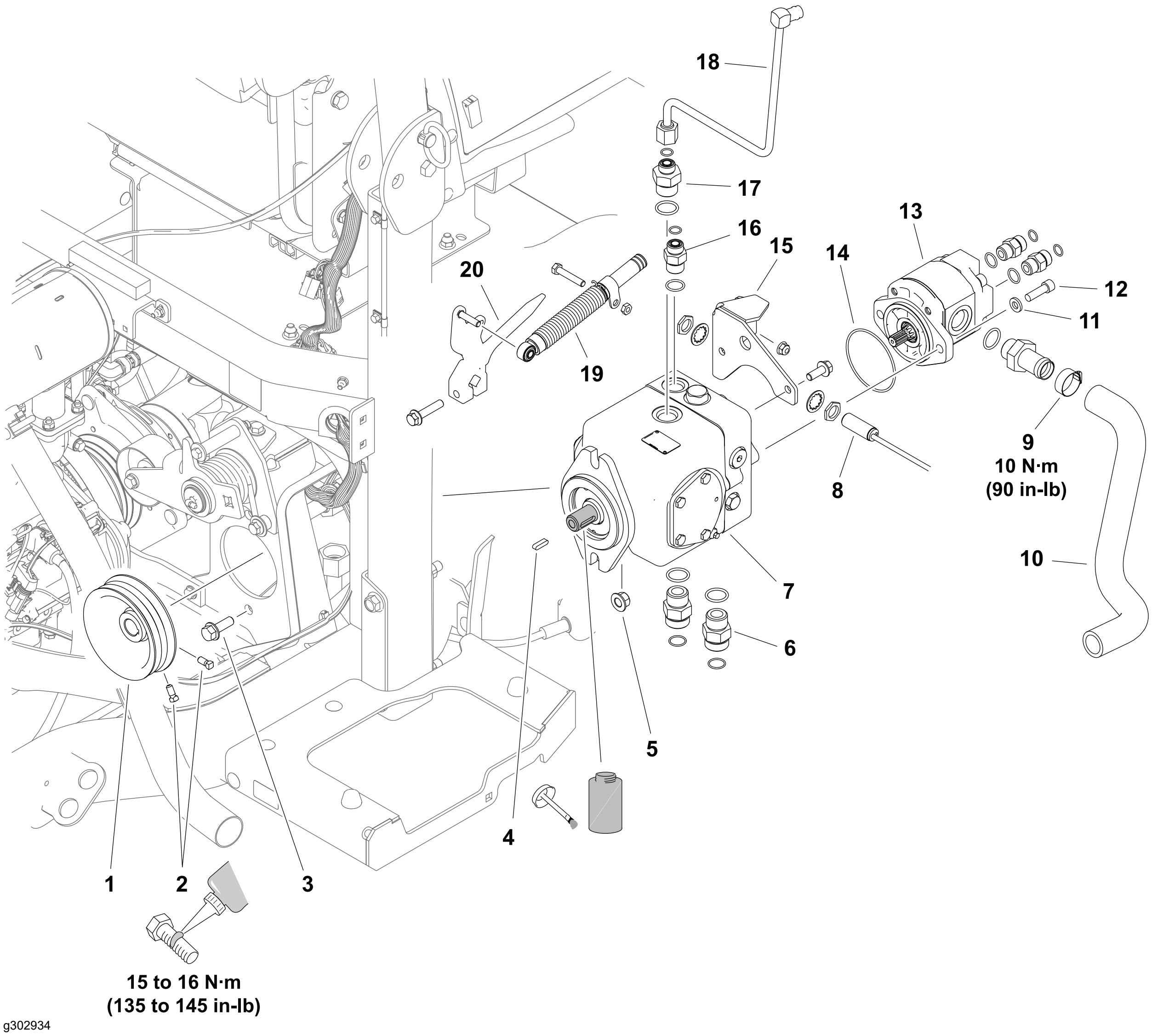

Figure 51

1. Pump pulley
2. Square head set screw (2 each)
3. Cap screw (2 each)
4. Key
5. Flange nut (2 each)
6. Straight fitting (2 each)
7. Traction (piston) pump
8. Neutral switch
9. Hose clamp
10. Suction hose
11. Washer (2 each)
12. Cap screw (2 each)
13. Gear pump
14. O-ring
15. Bracket
16. Straight fitting
17. Straight fitting
18. Return tube
19. Damper
20. Pump lever

Removing the Traction (piston) Pump

Note: The gear pump (P2) can be removed separately or with the traction (piston) pump; refer to Removing the Gear Pump (page 5–75).

Refer to Figure 51 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), set the key switch to the OFF position and remove the key from the key switch.
2. Remove the front left wheel; refer to Removing and Installing the Wheels (page 7–5).

Removing the Traction (piston) Pump (continued)

3. Remove the hydraulic tank; refer to Removing and installing the Hydraulic Tank (page 5–64).
4. Remove the traction pump drive belt from the pump pulley and remove the pump pulley from the pump; refer to Traction Pump Drive (page 5–67).
5. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
6. Clean the hydraulic pump and all hydraulic connections to prevent hydraulic system contamination.
7. For assembly purposes, label all the hydraulic connections.
8. Disconnect the hoses and tubes from the fittings on the hydraulic pump(s) and allow the hydraulic lines to drain into a suitable container.
9. Install clean caps or plugs on the openings of pump and disconnected lines to prevent contamination.
10. Disconnect the traction cable ball joint from the pump lever. Loosen the traction cable jam nuts and remover the cable from the cable bracket; refer to Traction Pedal, Cable, and Control Assembly (page 7–11).
11. Disconnect the wire harness connector from the traction neutral switch.

IMPORTANT

The total weight of the traction pump and gear pump assembled is approximately 31 kg (68 lb).

Use a lift or hoist that can support the weight of the pump assembly before removing the pump mounting bolts.

12. Remove the fasteners securing the pump(s) to the machine and carefully remove the pump(s) out the right side of the machine.
13. If not previously removed, separate the gear pump from the traction pump; refer to Removing the Gear Pump (page 5–75).
14. If necessary, remove the traction control assembly from the traction pump; refer to Removing and Installing the Traction Control Components (page 7–11).
15. If necessary, remove the hydraulic fittings from the pump. Record the locations and orientations of the fittings for assembly purposes.
16. Remove and discard all the O-rings from the hydraulic hoses, tubes, and fittings that were disconnected or removed.

Installing the Traction (piston) Pump

Refer toFigure 51 for this procedure.

1. If previously removed, secure the traction control components to the traction pump; refer to Removing and Installing the Traction Control Components (page 7–11).
2. If previously removed, secure the gear pump to the traction pump; refer to Installing the Gear Pump (page 5–76).
3. Lubricate new O-rings and place them onto the fittings. If previously removed, install the fittings into the pump ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
4. Carefully lower the pump assembly into the machine and secure the pump with the previously removed fasteners.

Installing the Traction (piston) Pump (continued)

5. Apply a thin layer of anti-seize lubricant to the traction pump drive shaft and keyway. Install the key and pump drive pulley. Align the pump pulley with the engine pulley.

6. Apply medium strength thread locking compound to the pulley set screws and tighten the set screws from **15 to 16 N·m (135 to 145 in-lb)**.

7. Fit the pump drive belt over the pulleys and idler.

8. Remove the caps and plugs from the hydraulic fittings and hydraulic lines then install the hydraulic lines to the piston pump and the gear pump; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7). Tighten the gear pump suction hose clamp to **10 N·m (90 in-lb)**.

9. Connect the traction cable to the cable bracket and the pump lever; refer to Traction Pedal, Cable, and Control Assembly (page 7–11).

10. Connect the neutral switch to the machine wire harness.

11. Install the hydraulic tank; refer to Removing and installing the Hydraulic Tank (page 5–64).

12. Install the front right wheel; refer to Removing and Installing the Wheels (page 7–5).

13. Prime the hydraulic pump; refer to Priming the Hydraulic Pumps (page 5–60).

14. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Servicing the Traction (piston) Pump (P1)

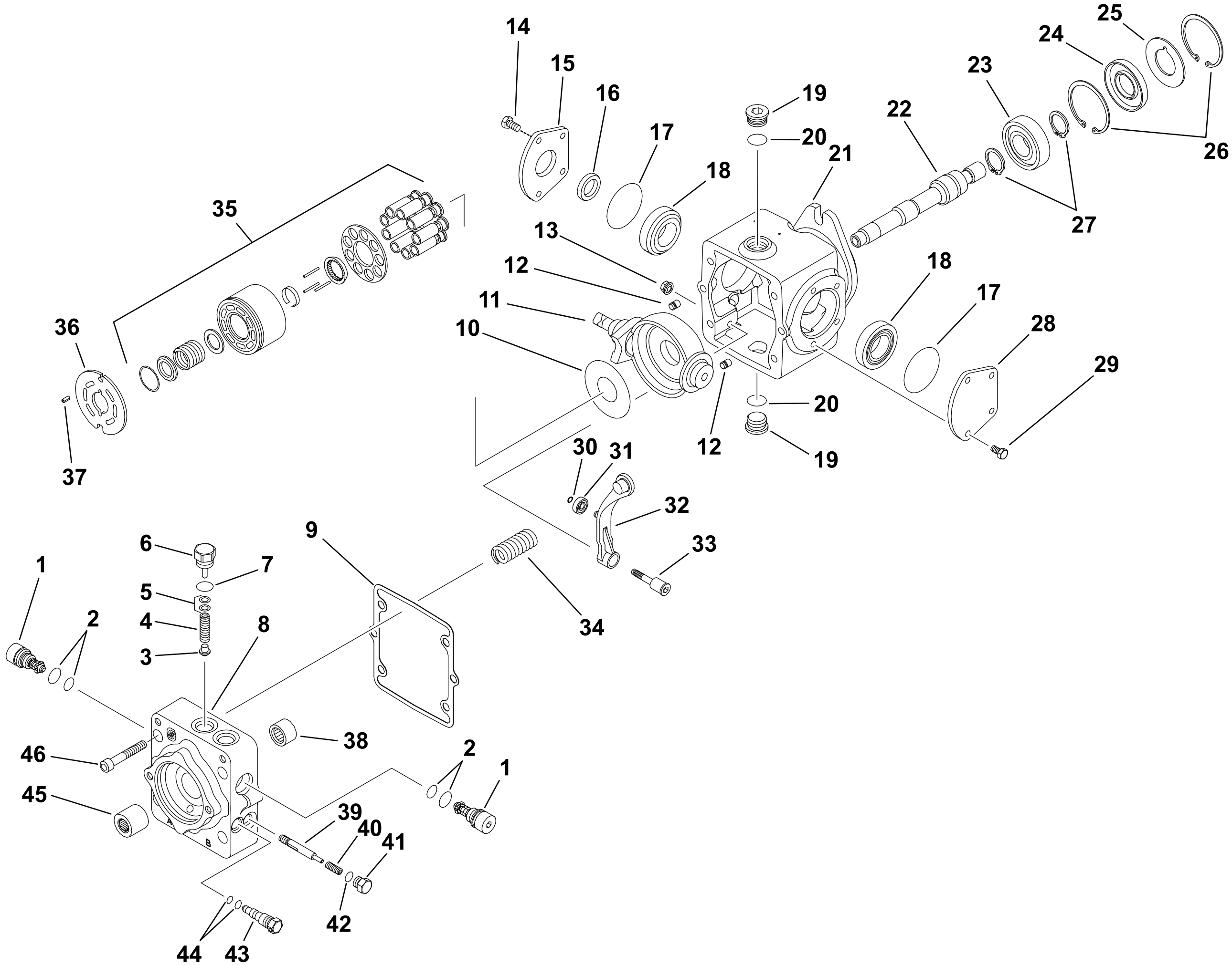

Figure 52

1. Relief valve (2 each)
2. Seal kit (2 each)
3. Charge relief poppet
4. Spring
5. Shim kit
6. Charge relief plug
7. O-ring
8. End cap
9. End cap gasket
10. Thrust plate
11. Swash plate
12. Pin (2 each)
13. Seal nut
14. Screw (4 each)
15. Trunnion cover
16. Seal
17. O-ring (2 each)
18. Bearing (2 each)
19. Plug (2 each)
20. O-ring (2 each)
21. Traction pump housing
22. Auxiliary shaft
23. Ball bearing
24. Seal
25. Backup washer
26. Retaining ring (2 each)
27. Retaining ring (2 each)
28. Trunnion cover
29. Screw (4 each)
30. Retaining ring
31. Bearing
32. Neutral return arm
33. Neutral return pivot
34. Spring
35. Cylinder block kit
36. Valve plate
37. Slotted pin
38. Needle bearing
39. Loop flushing spool
40. Spring
41. Plug
42. O-ring
43. Bypass valve
44. Seal kit
45. Coupling
46. Screw (4 each)

Note: For the traction (piston) pump repair information; refer to the Danfoss LPV Closed Circuit Axial Piston Pumps Repair Instructions and Service Manual.

Servicing the Traction (piston) Pump (P1) (continued)

IMPORTANT

If a traction (piston) pump failure occurs, refer to Traction Circuit Component Failure (page 5–5)for information regarding the importance of removing contamination from the traction circuit.

Gear Pump (P2)

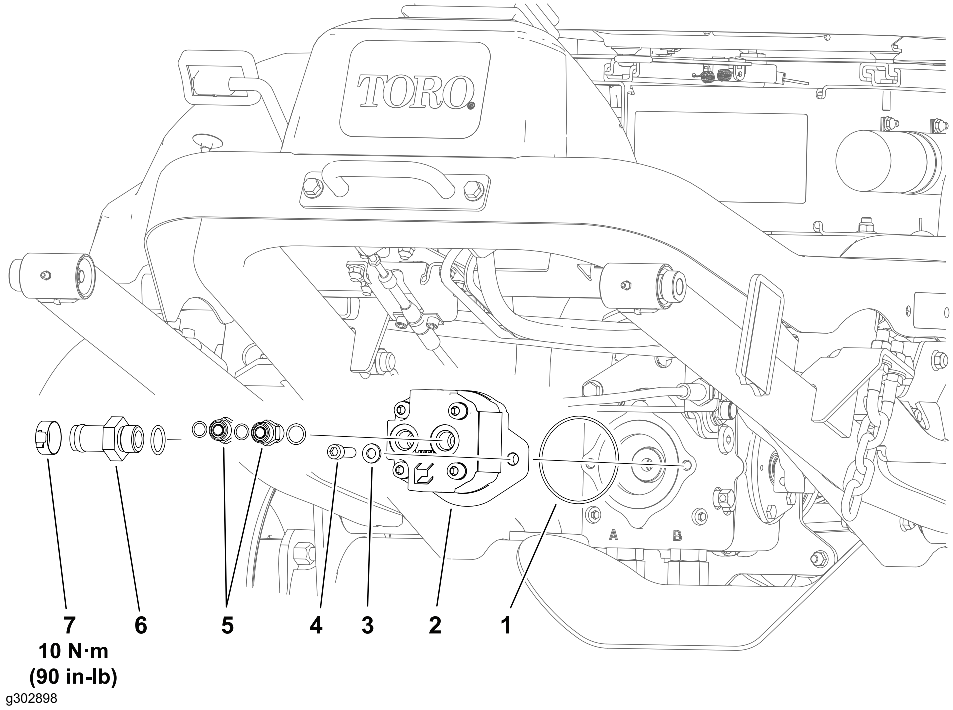

Figure 53

1. O-ring
2. Gear pump
3. Washer (2 each)
4. Cap screw (2 each)
5. Straight fitting
6. Barb fitting – suction
7. Hose clamp

Removing the Gear Pump

Note: The gear pump (P2) can be removed separately or with the traction (piston) pump; refer to Removing the Traction (piston) Pump (page 5–70).

Refer to Figure 53 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), set the key switch to the OFF position and remove the key from the key switch.
2. Empty the hydraulic tank through the drain plug at the bottom of the tank. Use a new O-ring and install the plug when finished to prevent contamination from entering the hydraulic system. Tighten the drain plug from **18 to 19 N·m (155 to 171 in-lb)**.
3. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
4. Clean the hydraulic pump and all hydraulic connections to prevent hydraulic system contamination.
5. For assembly purposes, label all the hydraulic connections.
6. Disconnect the hoses and tubes from the fittings on the hydraulic pump and allow the hydraulic lines to drain into a suitable container.
7. Install clean caps or plugs on the openings of pump and disconnected lines to prevent contamination.
8. Remove the fasteners securing the gear pump to the traction (piston) pump and separate the gear pump from the traction pump. Locate and discard the O-ring between the pumps.

Removing the Gear Pump (continued)

A case drain exists in the traction (piston) pump and a suction port is near the input shaft of the gear pump. When the gear pump is removed from the traction pump, install plugs into the case drain and suction ports to prevent the pumps from draining.

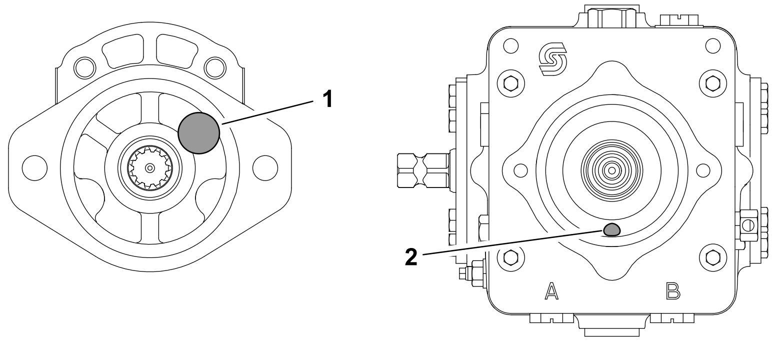

Figure 54

1. Traction pump (P1) case drain
2. Gear pump (P2) suction port

9. If necessary, remove the hydraulic fittings from the pump. Record the locations and orientations of the fittings for assembly purposes.
10. Remove and discard all the O-rings from the hydraulic hoses, tubes, and fittings that were disconnected or removed.

Installing the Gear Pump

Refer to Figure 53 for this procedure.

1. Lubricate new O-rings and place them onto the fittings. If previously removed, install the fittings into the pump ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).

IMPORTANT

A case drain exists in the piston (traction) pump and a suction port is near the input shaft of the gear pump (Figure 54). Before the gear pump is installed, ensure that any plugs placed in either of these ports are removed. Failure to remove the plugs will cause excessive pressure in the piston pump and damage the seals. Also, before securing the gear pump to piston pump, fill the piston pump housing with clean hydraulic fluid through case drain hole.

2. Apply clean petroleum jelly or light grease to a new O-ring (item 1 Figure 53) and position the O-ring onto the gear pump flange.
3. Align the gear pump shaft and slide the gear pump into the traction pump coupler.
4. Secure the gear pump to the piston pump with the previously removed fasteners.
5. Remove the caps and plugs from the hydraulic fittings and hydraulic lines then install the hydraulic lines to the piston pump and the gear pump; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7). Tighten the gear pump suction hose clamp to **10 N·m (90 in-lb)**.
6. Prime the hydraulic pump; refer to Priming the Hydraulic Pumps (page 5–60).

Installing the Gear Pump (continued)

7. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Gear Pump (P2) Service

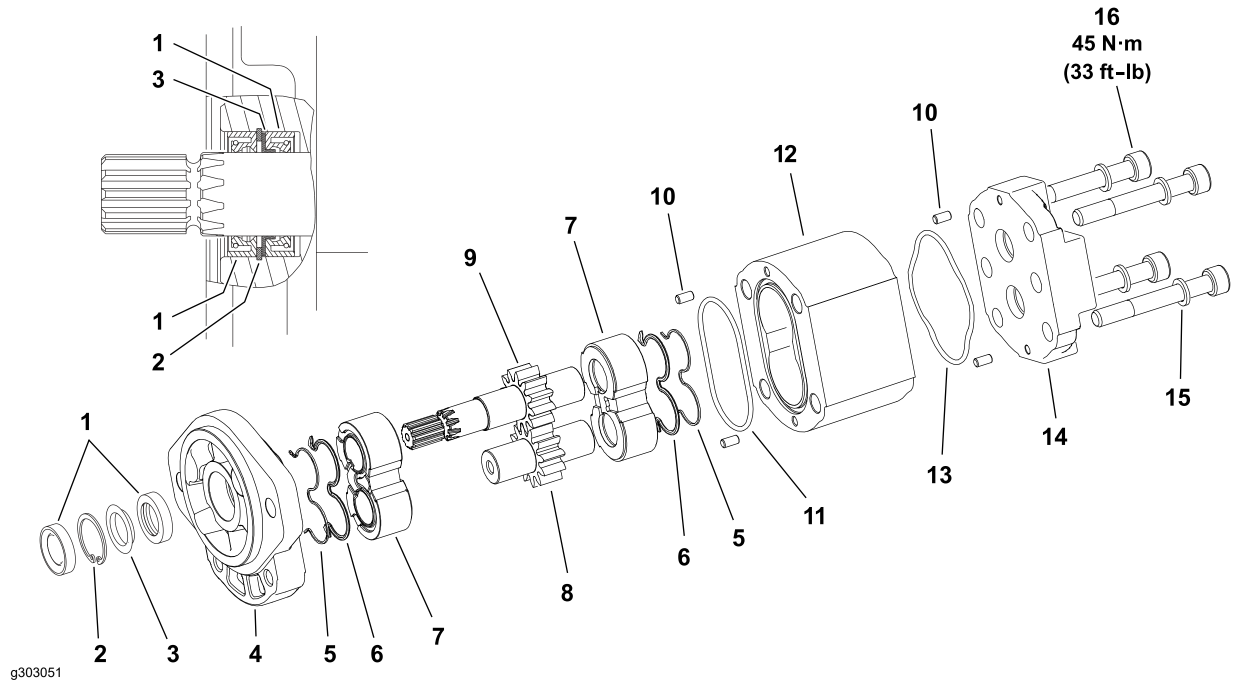

Figure 55

1.	Shaft seal (2 each)	7.	Thrust plate (2 each)	13.	Seal
2.	Retaining ring	8.	Driven gear	14.	Rear cover
3.	Backup washer	9.	Drive shaft	15.	Washer (4 each)
4.	Front cover	10.	Dowel pin (4 each)	16.	Cap screw (4 each)
5.	Uni-ring (2 each)	11.	Seal		
6.	Pressure seal (2 each)	12.	Body		

If items other than the pump seals are worn or damaged, the gear pump must be replaced as a complete assembly. Individual gears, housings and thrust plates are not available separately. Disassemble, inspect, and assemble the gear pump for cleaning, inspection and seal replacement only.

Disassembling the Gear Pump

1. Plug the pump ports and thoroughly clean the exterior of the pump with cleaning solvent. Make sure the work area is clean.
2. Use a marker to make diagonal lines across the gear pump sections for assembly purposes.

Disassembling the Gear Pump (continued)

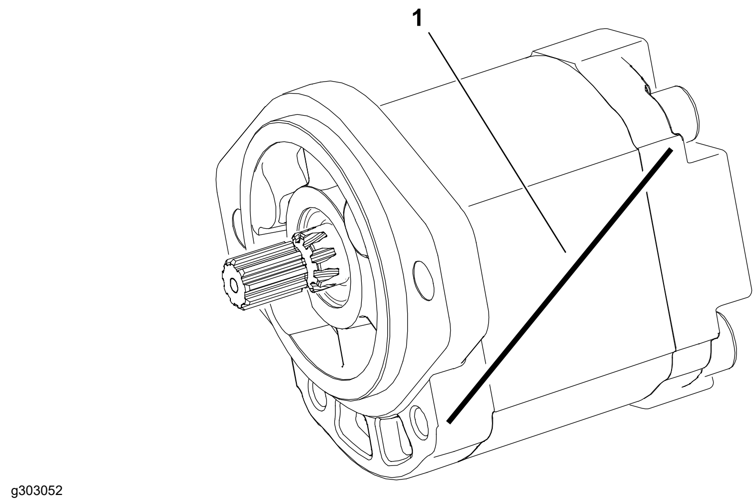

Figure 56

1. Marker line

IMPORTANT

Use caution when clamping gear pump in a vise to avoid distorting any pump components.

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3. Secure the front cover of the pump in a vise with the drive shaft pointing down.
4. Loosen the four (4) cap screws that secure the pump section to the front cover.
5. Remove the pump from the vise and remove the fasteners.

   Note: Be careful to not drop parts or disengage gear mesh when separating pump sections.

6. Support the pump assembly and gently tap the pump bodies with a soft face hammer to loosen the pump section.

IMPORTANT

Mark the relative positions of the gear teeth and the thrust plates so they can be reassembled in the same position. Do not touch the gear surfaces as residue on hands may be corrosive to gear finish.

---

7. Remove the thrust plates and the seals. Before removing the gear set, apply marking dye to the mating teeth to retain the ”timing”. Pump efficiency may be affected if the teeth are not installed in the same position during assembly.

Inspecting the Gear Pump

If internal parts are found to be worn or damaged, gear pump replacement is necessary.

1. Remove any nicks and burrs from all parts with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.
3. Inspect the drive gear and driven gear for the following:
   A. The gear shafts should be free of rough surfaces and excessive wear at the thrust plate points and sealing areas.
   B. The gear teeth should be free of excessive scoring and wear.
   C. Inspect each gear face edge for sharp edges or burrs. Remove sharp edges or burrs from the gear faces with emery cloth.

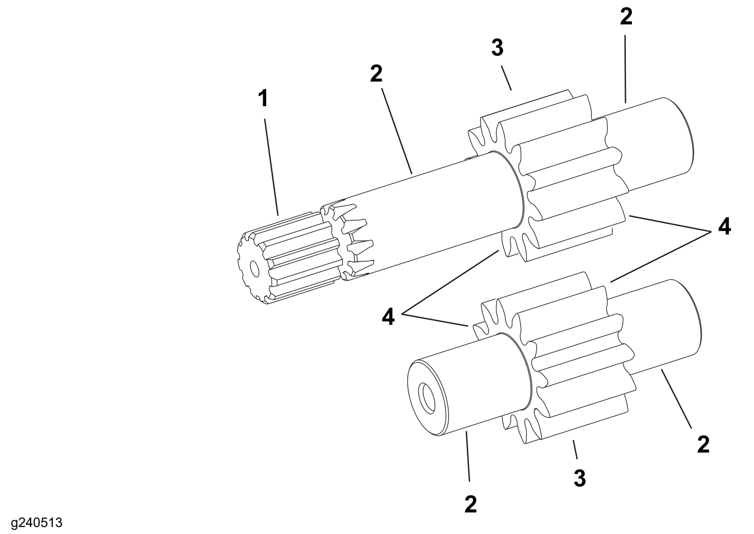

Figure 57

1. Gear shaft spline
2. Gear shaft
3. Gear teeth
4. Gear face edge

4. Inspect the thrust plates for the following:
   A. The bearing areas should not have excessive wear or scoring.
   B. The face of the thrust plates that are in contact with the gears should be free of wear, roughness or scoring.
   C. The thickness of the thrust plates should be equal.
5. Inspect the front cover and the rear cover for damage or wear.

Assembling the Gear Pump

Refer to Figure 55 for this procedure.

When assembling the pump, check the marker line on each part to make sure the parts are properly aligned during assembly. When assembling the pump, check the marker line on each part to make sure the parts are properly aligned during assembly.

1. Lubricate the body seals, pressure seals, uni-rings and the thrust plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.
2. Install new seals, the backup washer, and the retaining ring in the front cover.

Assembling the Gear Pump (continued)

3. Place the front flange, seal side down, on a flat surface.
4. Assemble the gear pump as follows:
   A. Install the pressure seals, flat side outward, into the grooves in the thrust plates. Follow by carefully placing the uni-rings, flat side outward, between the pressure seals and the grooves in the thrust plate.
   B. Apply a light coating of petroleum jelly to the exposed side of the front flange.
   C. Lubricate the drive shaft/gear with clean hydraulic oil. Insert the drive end of the drive shaft through the thrust plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the pump. Fit the drive shaft/gear into the front cover.
   D. Lubricate the idler shaft/gear with clean hydraulic oil. Align the gear teeth position markings made during disassembly and install the idler gear shaft into the front thrust plate and front cover. Apply a light coating of clean hydraulic oil to the gear faces.
   E. Install the rear thrust plate with the pressure seal side up and the open side of the pressure seal pointing to the inlet side of the pump.
   F. Install the dowel pins in the body.
   G. Apply a light coating of petroleum jelly to the new body seals and body seal grooves in the body. Install the new body seals into the body.

IMPORTANT

Do not dislodge the seals during installation.

   H. Align the marker lines and slide the body over the gear assembly.
5. Install the dowel pins in the flange.
6. Align the marker lines and install the flange over the shaft ends.
7. Install dowel pins in rear cover.
8. Align the marker lines and slide the rear cover over the shaft ends.
9. Install the 4 cap screws with washers and hand tighten.
10. Place the front cover of the pump into a vise with soft jaws and alternately tighten the cap screws to **45 N·m (33 ft-lb)**.
11. Place a small amount of clean hydraulic oil in the pump inlet and rotate the drive shaft clockwise one revolution. If any binding is noted, disassemble the pump and check for assembly problems.

Wheel Motors

Front Wheel Motors

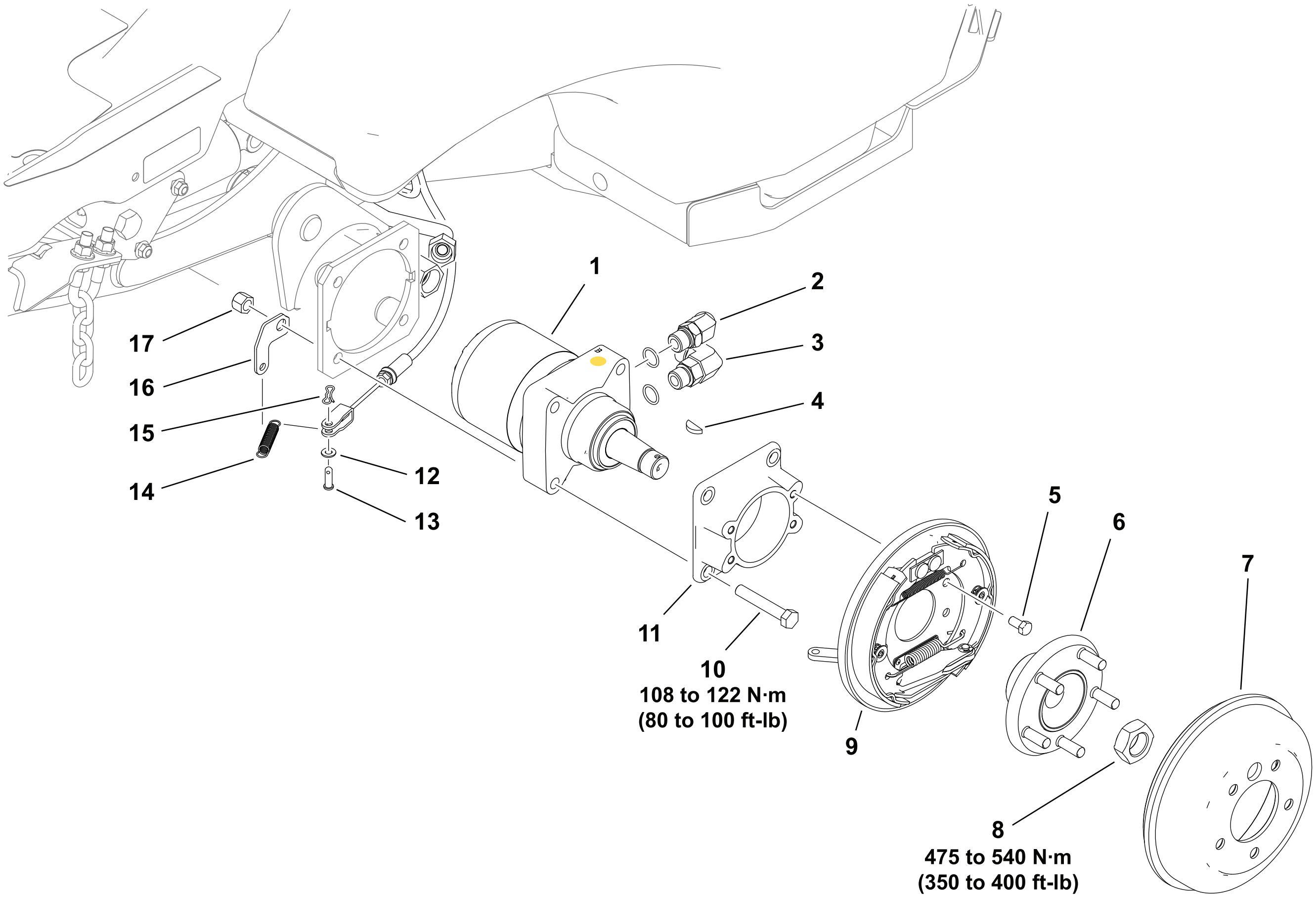

Figure 58

1.	Front wheel motor	7.	Brake drum	13.	Clevis pin
2.	Elbow fitting	8.	Wheel hub nut	14.	Return spring
3.	Elbow fitting	9.	Brake plate assembly	15.	Cotter pin
4.	Woodruff key	10.	Cap screw (4 each)	16.	Spring clip
5.	Cap screw (4 each)	11.	Brake adapter	17.	Lock nut (4 each)
6.	Wheel hub	12.	Washer		

Removing the Front Wheel Motors

Refer to Figure 58 for this procedure.

1. Remove the front wheel; refer to Removing and Installing the Wheels (page 7–5).
2. Disengage the parking brake and remove the brake return spring, cotter pin, clevis pin and washer that attach the brake cable to the brake actuator lever.
3. Remove the brake drum.
4. Use a torque multiplier and remove the wheel hub nut.
5. Use a wheel hub puller for a 114 mm (4.5 inch) bolt circle and remove the wheel hub and woodruff key.
6. Remove the brake plate assembly from the machine.
7. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).

Front Wheel Motors (continued)

8. Clean the hydraulic tube ends and fittings on the wheel motor to prevent contaminants from entering into the hydraulic system.
9. Label and remove the hydraulic tubes from the fittings on the wheel motor. Allow the tubes to drain into a suitable container.
10. Install clean caps and plugs on the hydraulic tubes and fittings to prevent system contamination.
11. Record the wheel motor location (mark the wheel motor) prior to removal.
12. Record the location of the spring clip (item 16) for assembly purposes.
13. Support the wheel motor and remove the fasteners, spring clip, and brake adapter from the machine.
14. Remove the wheel motor from the machine.
15. If the hydraulic fittings are to be removed from the wheel motor, mark the fitting orientation for assembly purposes. Remove the fittings from the wheel motor and discard the O-rings from the fittings.

Installing the Front Wheel Motors

IMPORTANT

Because of the internal differences in the wheel motors, do not interchange the wheel motors on the machine (e.g., do not put the right motor on the left side of the machine). If necessary, use the traction unit *Parts Catalog* and part number on the wheel motor to identify the right and left motors. The left side wheel motors are identified with a yellow dot on the motor housing near the B port.

Refer to Figure 58 for this procedure.

1. If the hydraulic fittings were removed from the wheel motor, lubricate and install new O-rings to the fittings. Align and install the fittings into the wheel motor ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
2. Fit the wheel motor and brake adapter to the frame and install the previously removed fasteners.
3. Install the spring clip and tighten the fasteners from **108 to 122 N·m (80 to 100 ft-lb)**.
4. Remove the caps and plugs then connect the hydraulic tubes to the wheel motor fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
5. Install the brake plate assembly with the previously removed fasteners.

IMPORTANT

Before installing the wheel hub, clean the tapers of the wheel hub and wheel motor shaft. Ensure that the tapers are free of grease, oil, rust, and dirt. Do not use anti-seize lubricant, when you install the wheel hub.

Do not use the locknut previously removed to attach the wheel hub to the wheel motor.

Front Wheel Motors (continued)

6. Clean the tapers of the wheel hub and wheel motor shaft and install the woodruff key and wheel hub.
7. Install a new wheel hub nut. Use a torque multiplier and tighten the nut from **475 to 540 N·m (350 to 400 ft-lb)**.
8. Install the brake drum.
9. Connect the brake cable to the brake actuator lever with the previously removed fasteners and install the brake return spring.
10. Install the front wheel; refer to Removing and Installing the Wheels (page 7–5).
11. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).
12. Check and adjust the parking brake as necessary before returning the machine to service; refer to the traction unit *Operator's Manual*.

Rear Wheel Motors (4WD models)

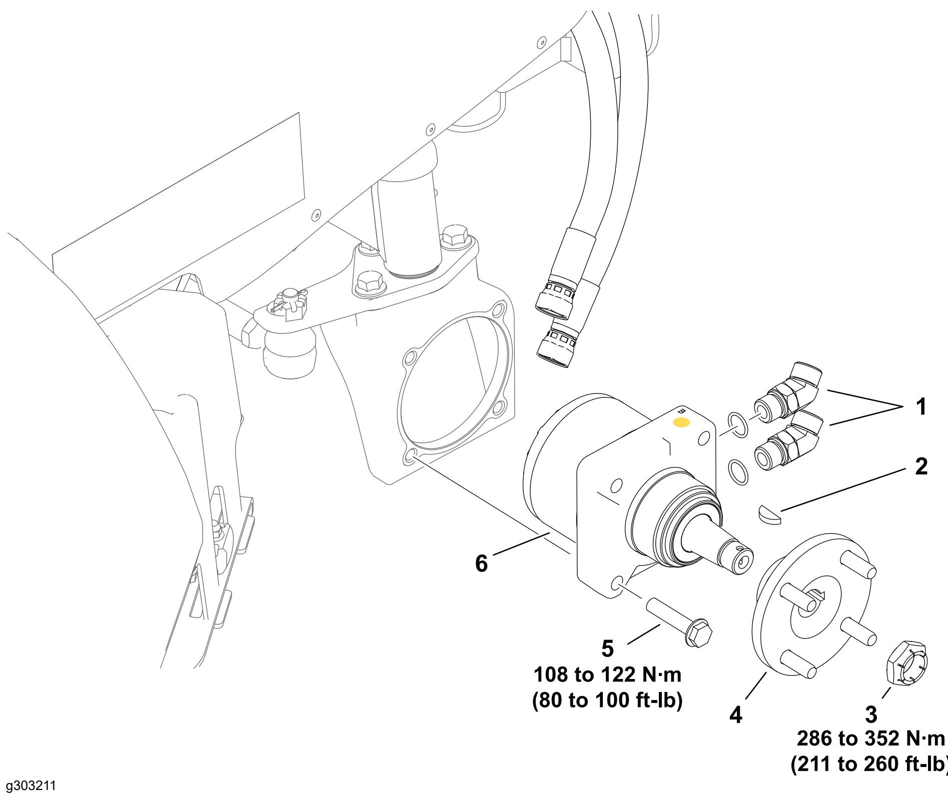

Figure 59

1. Elbow fitting (2 each)
2. Woodruff key
3. Wheel hub nut
4. Wheel hub
5. Cap screw
6. Rear wheel motor

Removing the Rear Wheel Motors

Refer to Figure 59 for this procedure.

1. Remove the rear wheel; refer to Removing and Installing the Wheels (page 7–5).

Rear Wheel Motors (4WD models) (continued)

2. Use a wheel hub puller for a 108 mm (4.25 inch) bolt circle and remove the wheel hub and woodruff key.
3. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
4. Clean the hydraulic hose ends and fittings on the wheel motor to prevent contaminants from entering into the hydraulic system.
5. Label and remove the hydraulic hoses from the fittings on the wheel motor. Allow the hoses to drain into a suitable container.
6. Install clean caps and plugs on the hydraulic hoses and fittings to prevent system contamination.
7. Record the wheel motor location (mark the wheel motor) prior to removal.
8. Remove the fasteners and wheel motor from the machine.
9. If the hydraulic fittings are to be removed from the wheel motor, mark the fitting orientation for assembly purposes. Remove the fittings from the wheel motor and discard the O-rings from the fittings.

Installing the Rear Wheel Motors

IMPORTANT

Because of the internal differences in the wheel motors, do not interchange the wheel motors on the machine (e.g., do not put the right motor on the left side of the machine). If necessary, use the traction unit *Parts Catalog* and part number on the wheel motor to identify the right and left motors. The left side wheel motors are identified with a yellow dot on the motor housing near the B port.

Refer to Figure 59 for this procedure.

1. If the hydraulic fittings were removed from the wheel motor, lubricate and install new O-rings to the fittings. Align and install the fittings into the wheel motor ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
2. Fit the wheel motor to the spindle and install the previously removed fasteners. Tighten the cap screws from **108 to 122 N·m (80 to 100 ft-lb)**.
3. Remove the caps and plugs then connect the hydraulic hoses to the wheel motor fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
4. Clean the tapers of the wheel hub and wheel motor shaft and install the woodruff key and wheel hub. Tighten the wheel hub lock nut from **286 to 352 N·m (211 to 260 ft-lb)**.
5. Install the rear wheel; refer to Removing and Installing the Wheels (page 7–5).
6. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Wheel Motor Service

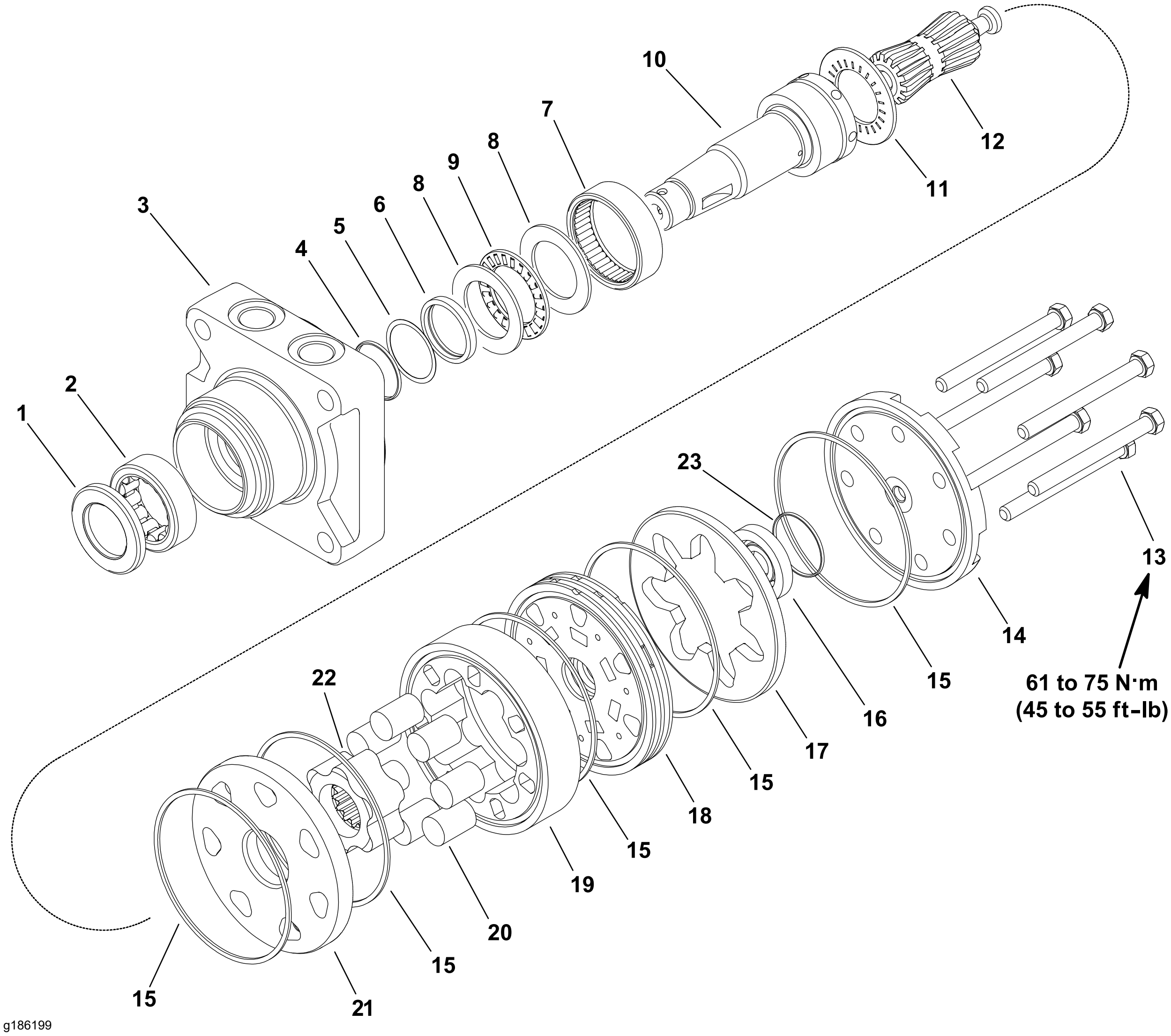

Figure 60

1. Dirt and water seal
2. Outer bearing
3. Housing
4. Back-up ring
5. Back-up washer
6. Shaft seal
7. Inner bearing
8. Thrust washer (2 each)
9. Thrust bearing
10. Coupling shaft
11. Thrust bearing
12. Drive link
13. Bolt (7 each)
14. End cover
15. Body seal (5 each)
16. Commutator
17. Commutator ring
18. Manifold
19. Stator
20. Vane (7 each)
21. Wear plate
22. Rotor
23. Commutator ring

The wheel motors used on Groundsmaster 3200/3300/3310 machines are Parker Torqmotor™ motors of the same basic design with minor differences. The front wheel motors are TG series motors, and the rear wheel motors are TL series motors. The motor displacements vary between models. The right side wheel motors have a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motors are identified with a yellow dot on the motor housing near the B port.

For the wheel motor repair procedures; refer to the Parker Torqmotor™ Service Procedure (TF, TG, TH, and TL Series).

Wheel Motor Service (continued)

IMPORTANT

If a wheel motor fails; refer to Traction Circuit Component Failure (page 5–5) for information regarding the importance of removing contamination from the traction circuit.

Hydraulic Manifold

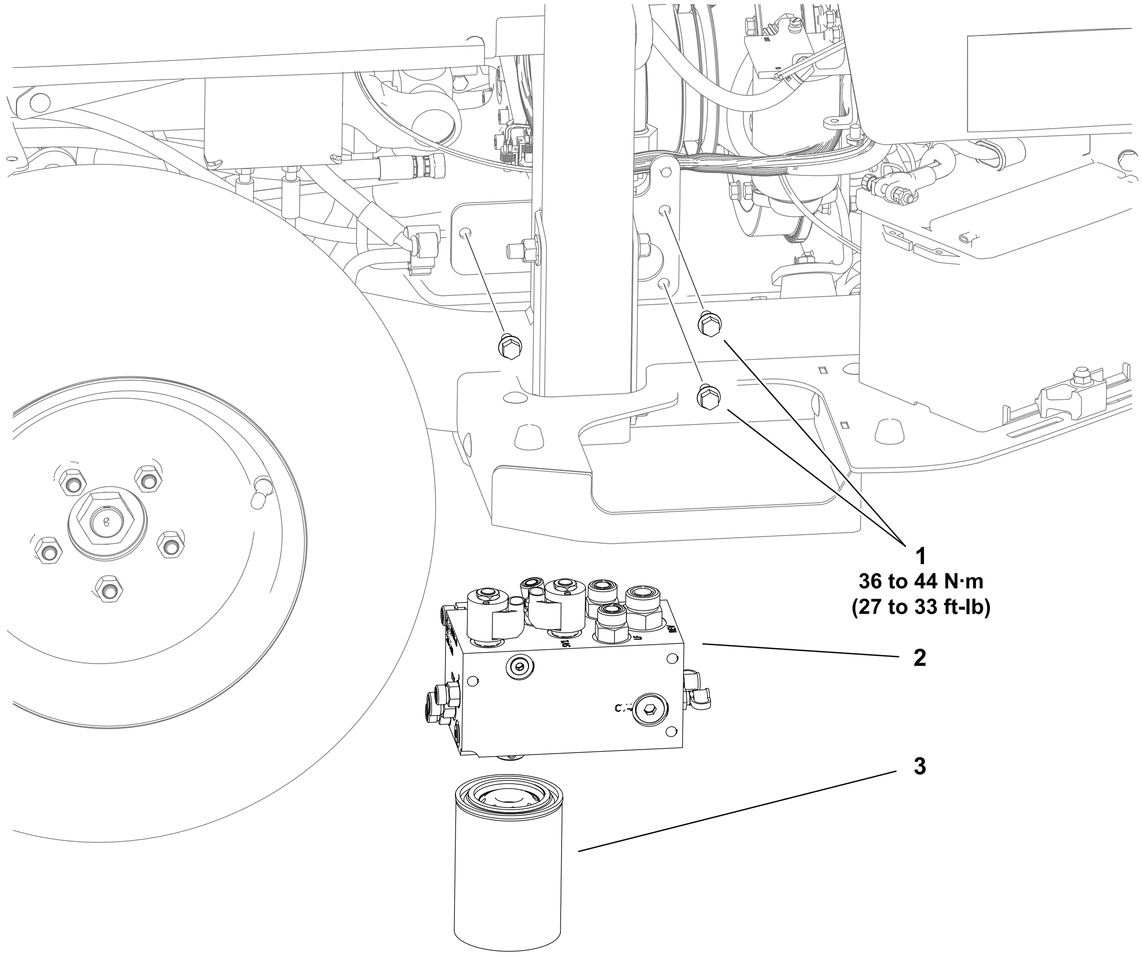

Figure 61

1. Cap screw (3 each)
2. Hydraulic manifold assembly
3. Hydraulic fluid filter

Removing the Hydraulic Manifold

Refer to Figure 61 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the fuel tank from the machine; refer to Removing and Installing the Fuel Tank (page 4–18).
3. Empty the hydraulic tank through the drain plug at the bottom of the tank. Use a new O-ring and install the plug when finished to prevent contamination from entering the hydraulic system. Tighten the drain plug from **18 to 19 N·m (155 to 171 in-lb)**.
4. Remove and discard the hydraulic fluid filter.
5. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
6. Clean the hydraulic tube ends, hose ends, and fittings on the manifold to prevent contaminants from entering into the hydraulic system.

Removing the Hydraulic Manifold (continued)

7. Label and remove the hydraulic tubes and hoses from the fittings on the manifold. Allow the tubes and hoses to drain into a suitable container.
8. Install clean caps and plugs on the hydraulic tubes, hoses, and fittings to prevent system contamination.
9. Label and disconnect the wire harness connectors from the solenoid valves.
10. Support the manifold assembly, remove the fasteners and lower the manifold assembly from the machine.
11. Dismantle the manifold assembly if necessary; refer to Hydraulic Manifold Service (page 5–90).

Installing the Hydraulic Manifold

Refer to Figure 61 for this procedure.

1. Ensure that all manifold components are properly installed prior to installing the manifold into the machine; refer to Hydraulic Manifold Service (page 5–90).
2. Fit the manifold to the machine and secure it with the previously removed fasteners. Tighten the cap screws from **36 to 44 N·m (27 to 33 ft-lb)**.
3. Remove the caps and plugs then connect the hydraulic tubes and hoses to the manifold fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
4. Connect the wire harness connectors to the solenoid valves.
5. Install a new hydraulic fluid filter:
   A. Fill the filter with hydraulic fluid and lubricate the filter gasket with hydraulic fluid.
   B. Ensure that the filter-mounting area is clean and screw the filter on until the gasket contacts the manifold.
   C. Tighten the filter an additional 1/2 turn.
6. Install the fuel tank; refer to Removing and Installing the Fuel Tank (page 4–18).
7. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Hydraulic Manifold Service

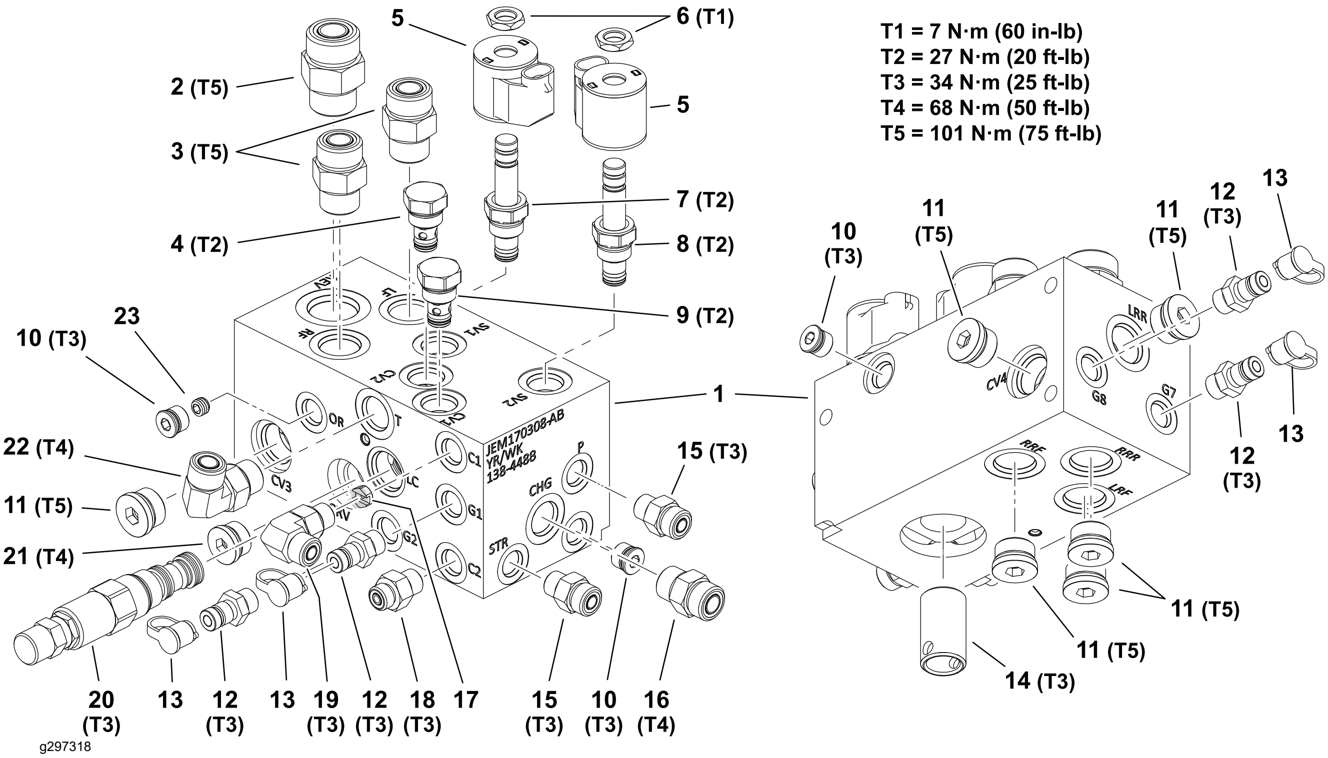

Figure 62

(2WD Manifold – Model 31900)

1. Manifold block
2. Straight fitting
3. Straight fitting (2 each)
4. Check valve – CV2
5. Solenoid coil (2 each)
6. Coil nut (2 each)
7. Solenoid valve – SV1
8. Solenoid valve – SV2
9. Check valve – CV1
10. #6 zero-leak plug with O-ring (3 each)
11. #10 zero-leak plug with O-ring (6 each)
12. Diagnostic fitting (4 each)
13. Cap (4 each)
14. Filter nipple
15. Straight fitting (2 each)
16. Straight fitting
17. Check orifice – 0.100 inch – C1
18. Straight fitting
19. Elbow fitting
20. Logic cartridge – LC
21. #8 zero-leak plug with O-ring
22. Elbow fitting
23. Control orifice – 0.040 inch – OR

Hydraulic Manifold Service (continued)

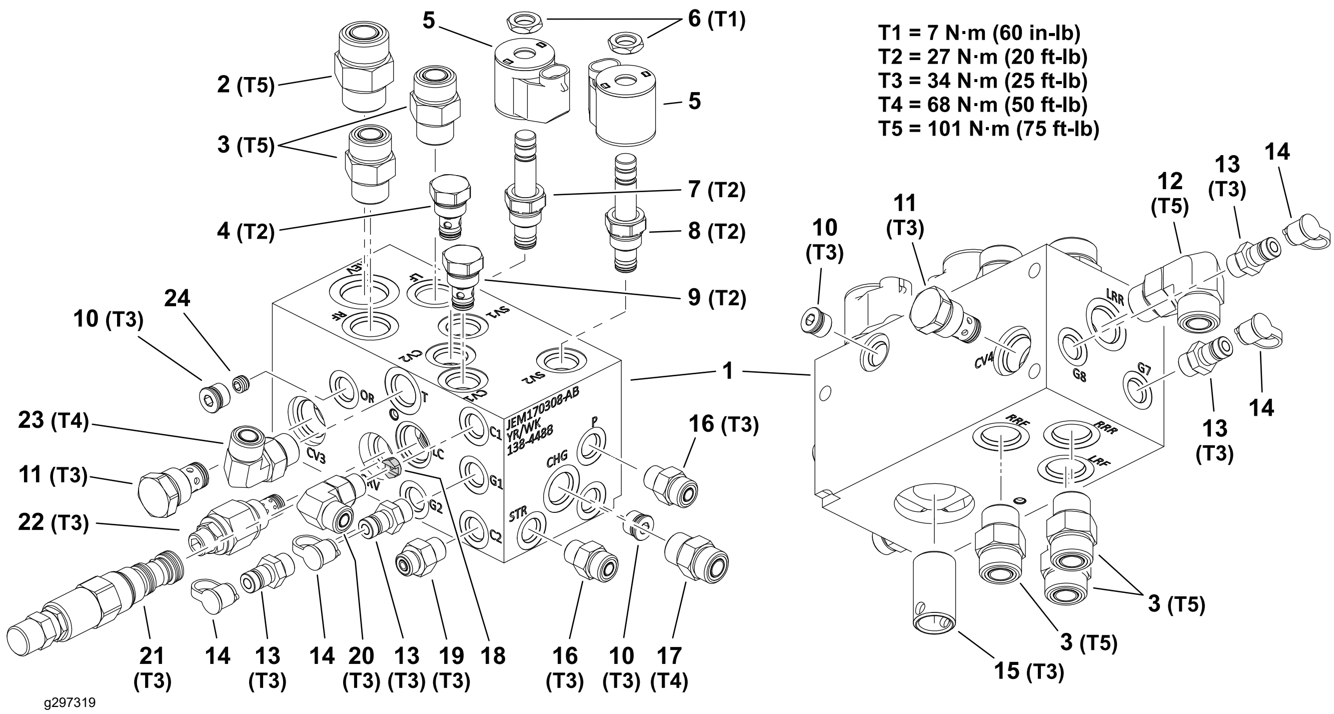

Figure 63

(4WD Manifold – Models 31901/31902/31903/31907/31909)

1. Manifold block
2. Straight fitting
3. Straight fitting (5 each)
4. Check valve – CV2
5. Solenoid coil (2 each)
6. Coil nut (2 each)
7. Solenoid valve – SV1
8. Solenoid valve – SV2
9. Check valve – CV1
10. #6 zero-leak plug with O-ring (3 each)
11. Check valve – CV3/CV4
12. Elbow fitting
13. Diagnostic fitting (4 each)
14. Cap (4 each)
15. Filter nipple
16. Straight fitting (2 each)
17. Straight fitting
18. Check orifice – 0.100 inch – C1
19. Straight fitting
20. Elbow fitting
21. Logic cartridge – LC
22. Bi-directional relief valve – CRV
23. Elbow fitting
24. Control orifice – 0.040 inch – OR

The ports on the manifold are marked for easy identification of components and connections. Example: P is the pressure connection port from the steering control valve and SV1 is the location for the lift/lower solenoid valve; refer to the hydraulic schematic in Appendix A (page A–1) to identify the function of the hydraulic lines and cartridge valves at each port.

For cartridge valve service procedures, refer to Cartridge Valve Service (page 5–93).

The hydraulic manifold include several zero−leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero−leak plugs also have an O−ring as a secondary seal. If removing a zero−leak plug is necessary, lightly rap the plug head using a punch and hammer before using a hex wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. Tighten the plugs to the torque value provided.

IMPORTANT

A removable check orifice exists under the fitting in the C1 port, and a removable control orifice exists under the plug in the OR port of the hydraulic manifold. If the fitting or plug is removed, remove the orifice for cleaning and label its position for assembly purposes.

If the hydraulic fittings are to be removed from the manifold:

1. Mark the fitting orientation for assembly purposes.
2. Remove the fittings from the manifold and discard the O-rings.
3. Lubricate and install new O-rings to the fittings.
4. Align and install the fittings into the manifold and tighten the fittings to the specified torque; refer to Figure 62 or Figure 63.

Cartridge Valve Service

Note: For solenoid style cartridge valve coil testing information; refer to Hydraulic Solenoid Valve Coils (page 6–59).

Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52) prior to removing hydraulic system components.

1. Park the machine on a level surface. Lower the cutting unit, engage the parking brake, stop the engine and remove the key from the key switch.
2. Ensure that the manifold is clean before you remove the cartridge valve from the manifold.
3. Remove the cartridge valve:
   A. For solenoid style valves, disconnect the wire harness connector and remove the nut that secures the solenoid coil to the cartridge valve. Carefully slide the coil off the valve.

   IMPORTANT

   Handle the cartridge valve carefully. Slight bending or distortion of the stem tube can cause binding and malfunction. When removing the cartridge valve from the manifold, ensure that the deep well socket fully engages the valve base.

   B. Use a deep socket wrench to remove the cartridge valve from the manifold.
4. Record the correct location of the O-rings, the sealing rings, and the back-up rings. Remove and discard the seal kit from the cartridge valve.
5. Visually inspect the manifold port and the cartridge valve:
   A. Check for damaged threads on the cartridge valve and in the manifold block.
   B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.
   C. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing valve malfunction.

CAUTION

Use eye protection such as goggles when using compressed air.

Note: Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves.

6. Clean the cartridge valve.
   A. For non-solenoid operated valves: Submerge the valve in clean mineral spirits to flush out contamination. If the valve design allows, use a non–metallic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Clean and dry the cartridge valve with compressed air.
   B. For solenoid operated valves: Temporarily install the solenoid on the cartridge valve and connect a 12 volt power source to the solenoid. While energized, flush out any contamination with a nonflammable aerosol brake cleaner. De-energize the solenoid. Repeat the flush

Cartridge Valve Service (continued)

while energized procedure 5 or 6 times. Remove the solenoid from the cartridge.

7. Install the cartridge valve:

   A. Lubricate the new O-rings and the backup rings of the seal kit with clean hydraulic fluid and install them on the cartridge valve. The O-rings and the backup rings must be arranged correctly on the cartridge valve for proper operation and sealing; refer to notes taken during the seal removal.

IMPORTANT

Use care when installing the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction. Make sure that deep well socket fully engages the valve base.

   B. Lubricate the threads on the cartridge valve with clean hydraulic fluid. Thread the cartridge valve carefully into the correct manifold port. The valve should thread in easily without binding.

   C. Tighten the cartridge valve using a deep well socket to the torque specification shown.

   D. For solenoid valves, slide the solenoid coil onto the cartridge valve. Tighten the coil nut to the torque specification shown.

8. If a problem still exists, remove the valve and clean it again or replace the valve.

Steering Control Valve

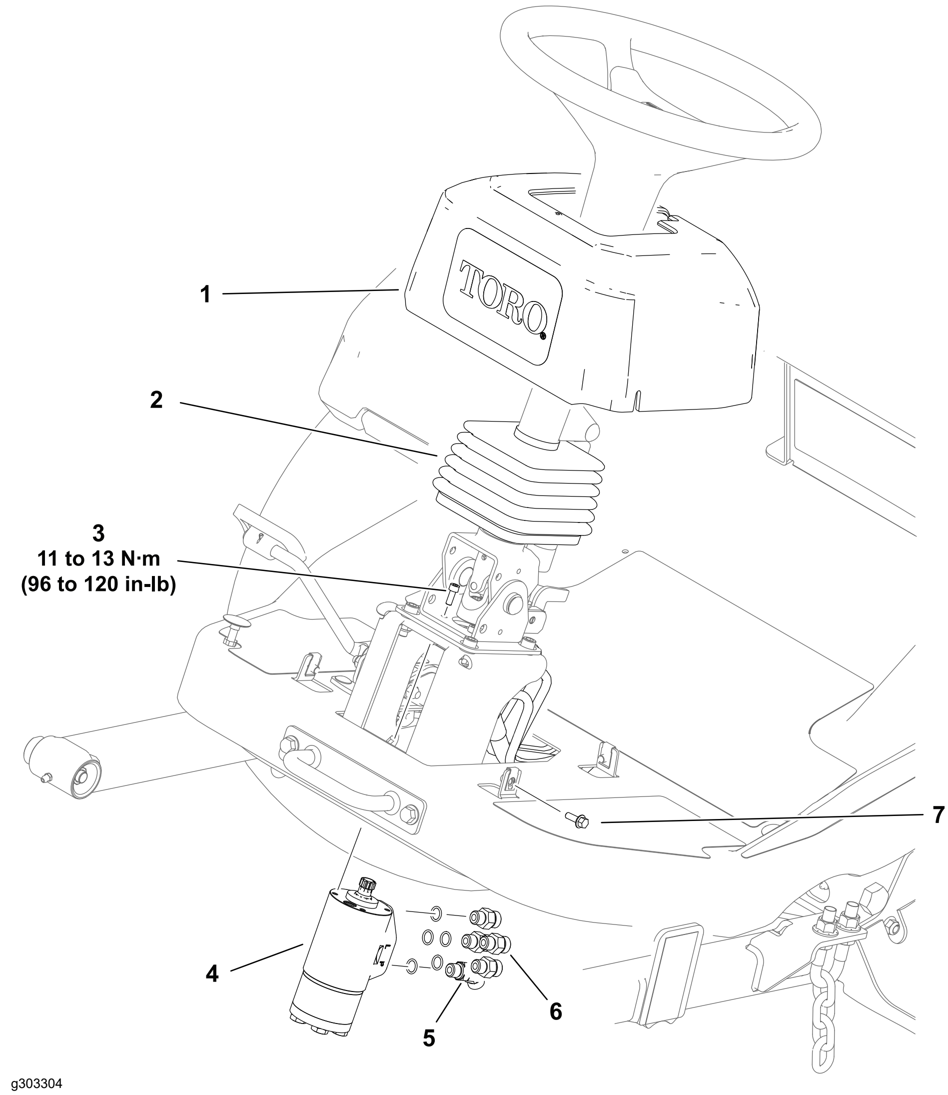

Figure 64

1. Steering cover
2. Rubber boot
3. Cap screw (4 each)
4. Steering control valve
5. Elbow fitting
6. Straight fitting (4 each)

Removing the Steering Control Valve

1. Park the machine on a level surface, lower the cutting unit (or implement), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the steering cover fasteners and raise the steering cover.
3. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
4. Clean the hydraulic tube ends, and fittings on the control valve to prevent contaminants from entering into the hydraulic system.
5. Label and remove the hydraulic tubes from the fittings on the control valve. Allow the tubes to drain into a suitable container.
6. Install clean caps and plugs on the hydraulic tubes and fittings to prevent system contamination.

Removing the Steering Control Valve (continued)

7. Support the steering control valve to prevent it from falling during removal.
8. Raise the rubber boot at the base of the steering column, then loosen and remove the 4 fasteners securing the steering control valve to the steering column.
9. Slide the steering control valve from the steering column, and remove the steering control valve from the machine.
10. If necessary, remove the hydraulic fittings from the steering control valve and discard the O-rings.

Installing the Steering Control Valve

1. If the hydraulic fittings were removed from the steering control valve, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings to the steering control valve; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
2. Apply anti-seize lubricant to the splines of the steering control valve input shaft.
3. Slide the steering control valve onto the steering column. Secure the steering control valve to the steering column with the previously removed fasteners and tighten the fasteners from **11 to 13 N·m (96 to 120 in-lb)**.
4. Install the rubber boot to the base of the steering column.
5. Remove the caps and plugs then connect the hydraulic tubes to the control valve fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
6. Install the steering cover.
7. Charge the hydraulic system; refer to Charging the Hydraulic System (page 5–62).

Steering Control Valve Service

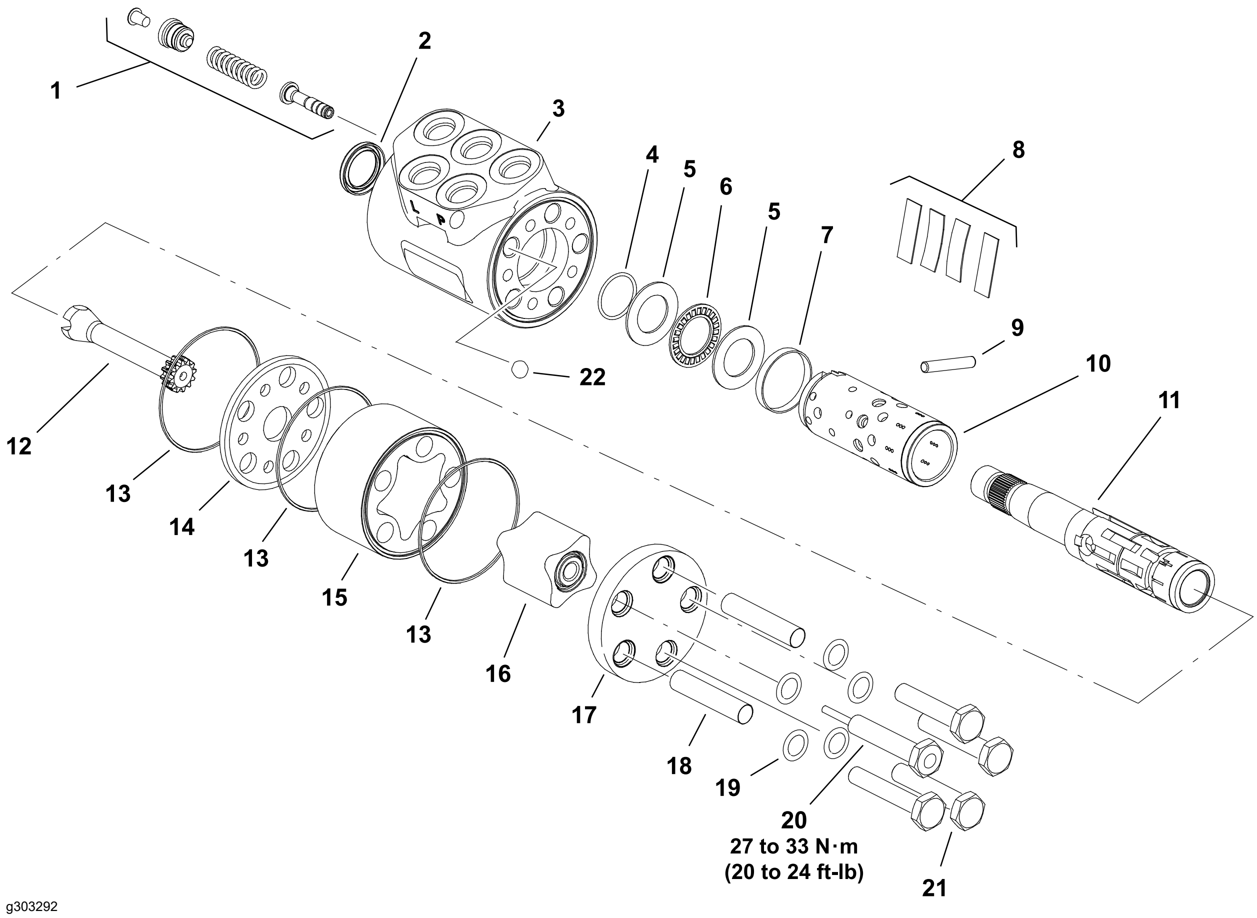

Figure 65

1. Relief valve assembly
2. Dust seal ring
3. Steering valve housing
4. Shaft seal
5. Thrust washer
6. Bearing race
7. Ring
8. Spring set
9. Cross pin
10. Sleeve
11. Spool
12. Cardan shaft
13. O-ring
14. Distributor plate
15. Outer gearwheel
16. Inner gearwheel
17. End cover
18. Tube (2 each)
19. Washer (5 each)
20. Pin bolt
21. Cap screw (4 each)
22. Ball

For the steering control valve repair procedures; refer to the Danfoss Steering Unit Type OSPM Service Manual.

Steering Cylinder

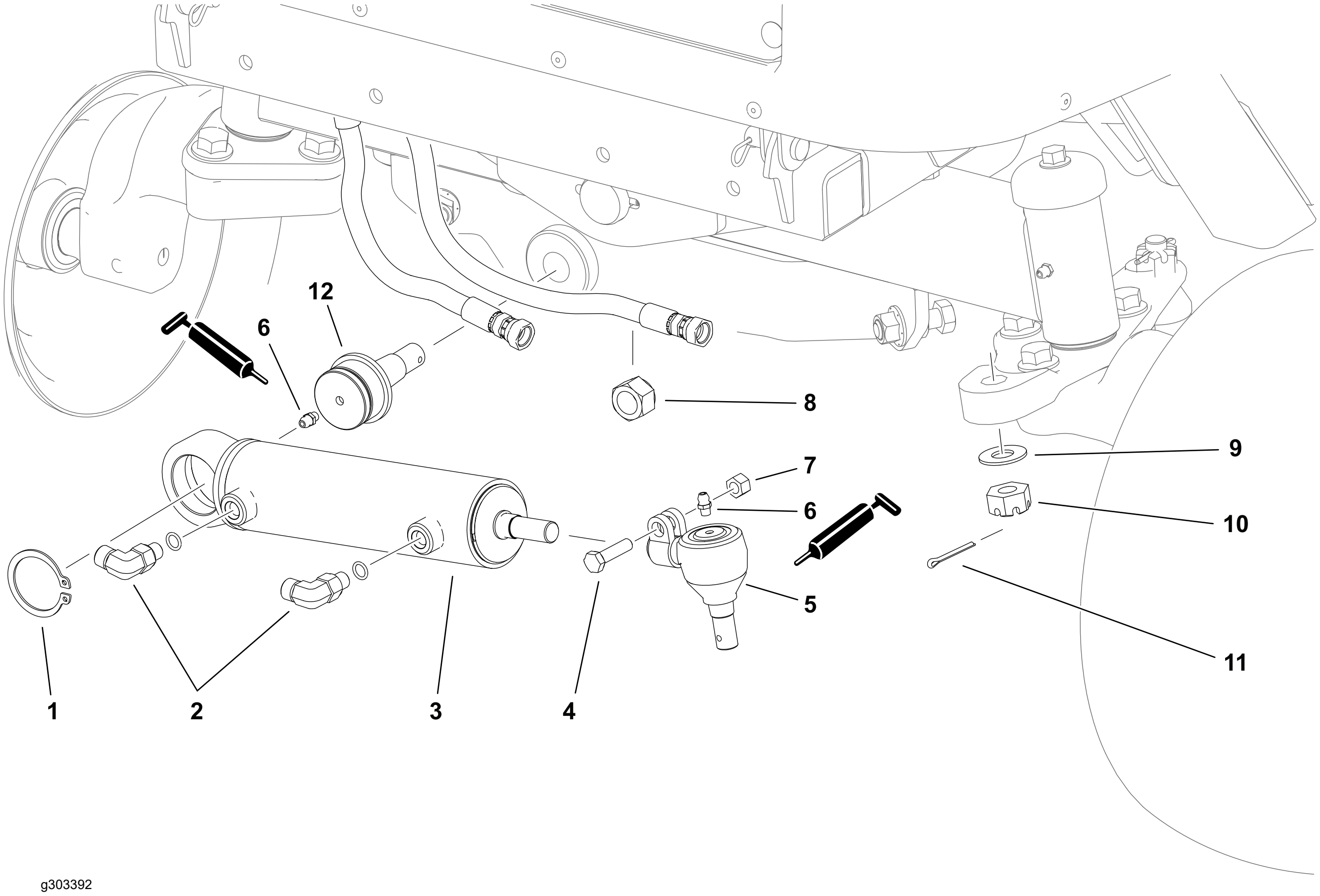

Figure 66

(shown with rear bumper removed)

1. Retaining ring
2. Elbow fitting (2 each)
3. Steering cylinder
4. Cap screw
5. Ball joint – rod end
6. Grease fitting (2 each)
7. Lock nut
8. Lock nut
9. Washer
10. Slotted nut
11. Cotter pin
12. Ball joint – barrel end

Removing the Steering Cylinder

Refer to Figure 66 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
3. Clean the fitting and hydraulic hose connections before disconnecting the hydraulic hoses to prevent system contamination.
4. Disconnect the hydraulic hoses. Cap the fittings and plug the hoses to prevent system contamination.
5. Remove the fasteners from the cylinder ball joints. Discard the cotter pin.
6. Use a suitable tool (pickle fork) to separate the ball joints from the rear axle and the right rear wheel spindle.
7. Inspect the cylinder ball joint boots and replace the ball joints if necessary.

Removing the Steering Cylinder (continued)

8. If the hydraulic fittings are to be removed from the cylinder, mark the fitting orientation for assembly purposes and remove the fittings from the cylinder. Discard the O-rings from the fittings.

Installing the Steering Cylinder

Refer to Figure 66 for this procedure.

1. If previously removed, press the barrel end ball joint into the cylinder and install the rod end ball joint at the position shown.

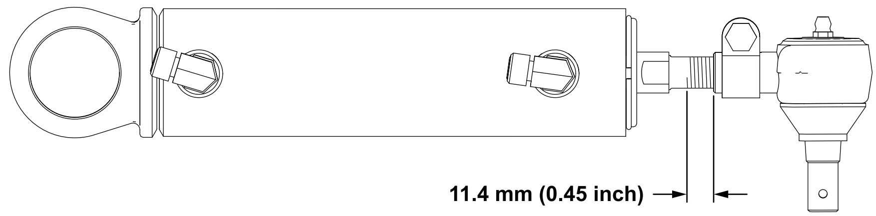

Figure 67

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2. If the hydraulic fittings were removed from the cylinder, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings in the marked orientation; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
3. Install the steering cylinder in the machine with the previously removed fasteners. Secure the slotted nut with a new cotter pin.
4. Remove the caps and plugs then connect the hydraulic tubes to the cylinder fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
5. Lubricate the cylinder ball joint grease fittings.
6. Operate the steering cylinder. Check for hydraulic leaks and correct if necessary.
7. Adjust the steering cylinder rod length and the steering stop bolts:
   A. Loosen the jam nuts on each steering stop bolt and turn the stop bolts into the axle as far as possible.
   B. Start the engine and turn the steering wheel to full left turn. Set the key switch to the OFF position.
   C. Loosen the steering cylinder rod end ball joint clamp and turn the steering cylinder shaft in or out until the gap between the left drag link and the steering stop bolt is **1.5 to 4.6 mm (0.60 to 0.18 inch)**.

Installing the Steering Cylinder (continued)

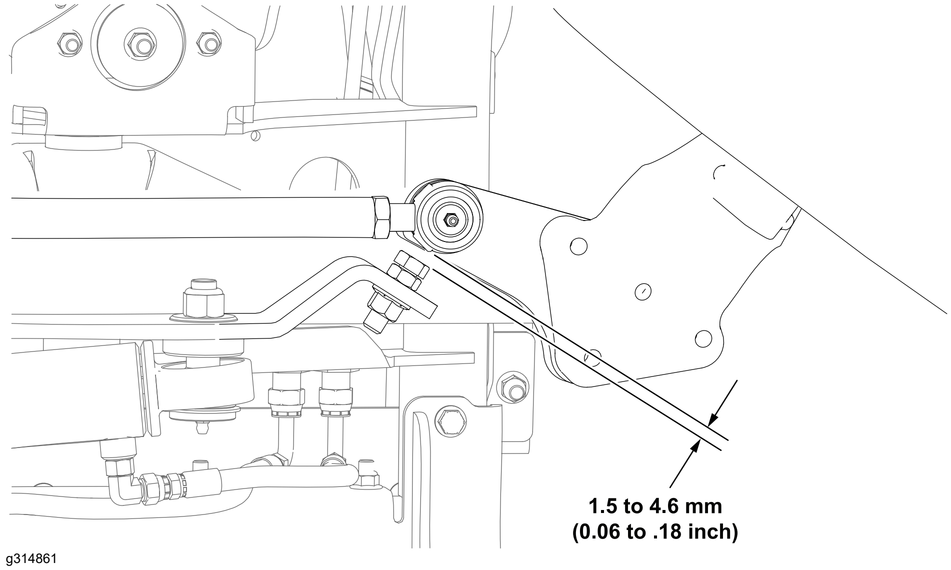


Figure 68

D. Start the engine and turn the steering wheel to full right turn. Set the key switch to the OFF position.

E. Adjust the right steering stop bolt until it contacts the right drag link.

F. Tighten the steering stop bolt jam nuts and the steering cylinder rod end ball joint clamp.

8. Check the hydraulic fluid level and adjust if necessary before returning the machine to service.

Steering Cylinder Service

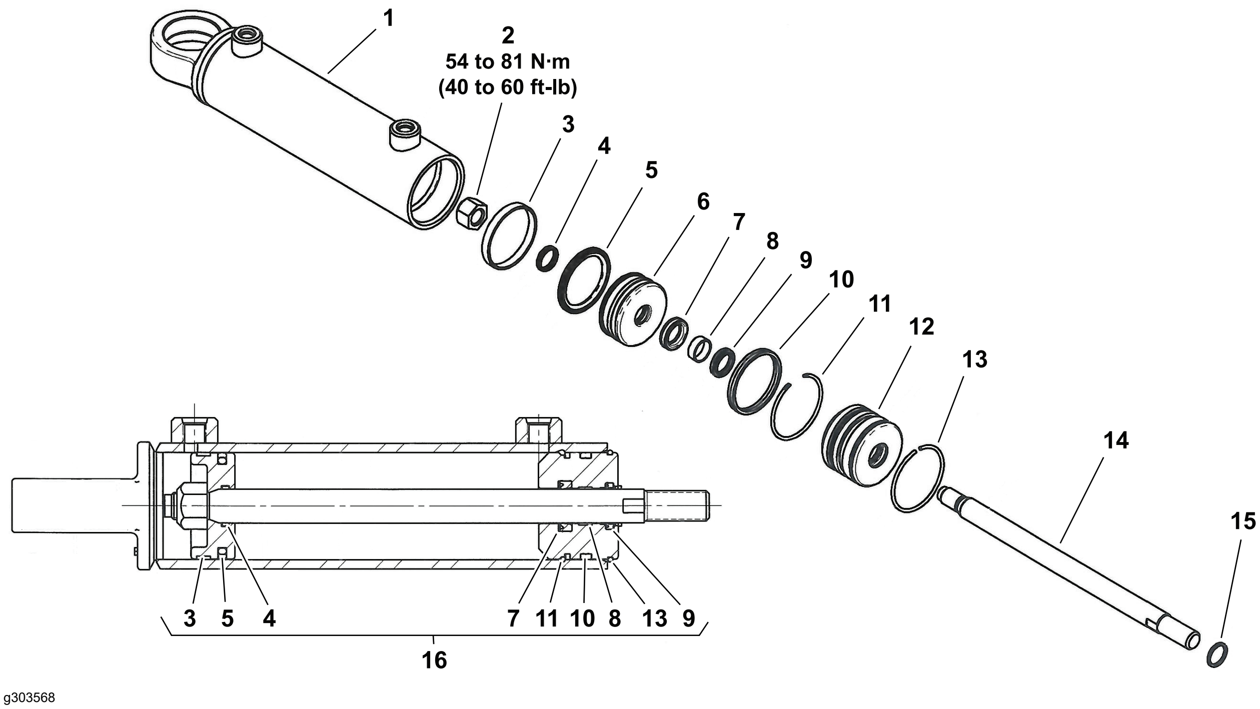


Figure 69

1. Barrel
2. Lock nut
3. Piston wear ring
4. Rod seal
5. Piston seal
6. Piston
7. Rod seal
8. Rod wear ring
9. Rod wiper
10. Dual seal
11. Internal retaining ring
12. Cylinder head
13. External retaining ring
14. Rod
15. Wiper seal mask
16. Repair kit

If items other than the cylinder seals are worn or damaged, the cylinder must be replaced as a complete assembly. Disassemble, inspect, and assemble the cylinder for inspection and seal replacement only.

The cylinder repair kit includes special tools required to replace the cylinder seals. Refer to the detailed instructions included with the repair kit, and view the instructional video *How to Repair a Wire Ring Cylinder* found at http://www.monarchindustries.com/lion-hydraulics/media prior to servicing the cylinder.

Lift Cylinder

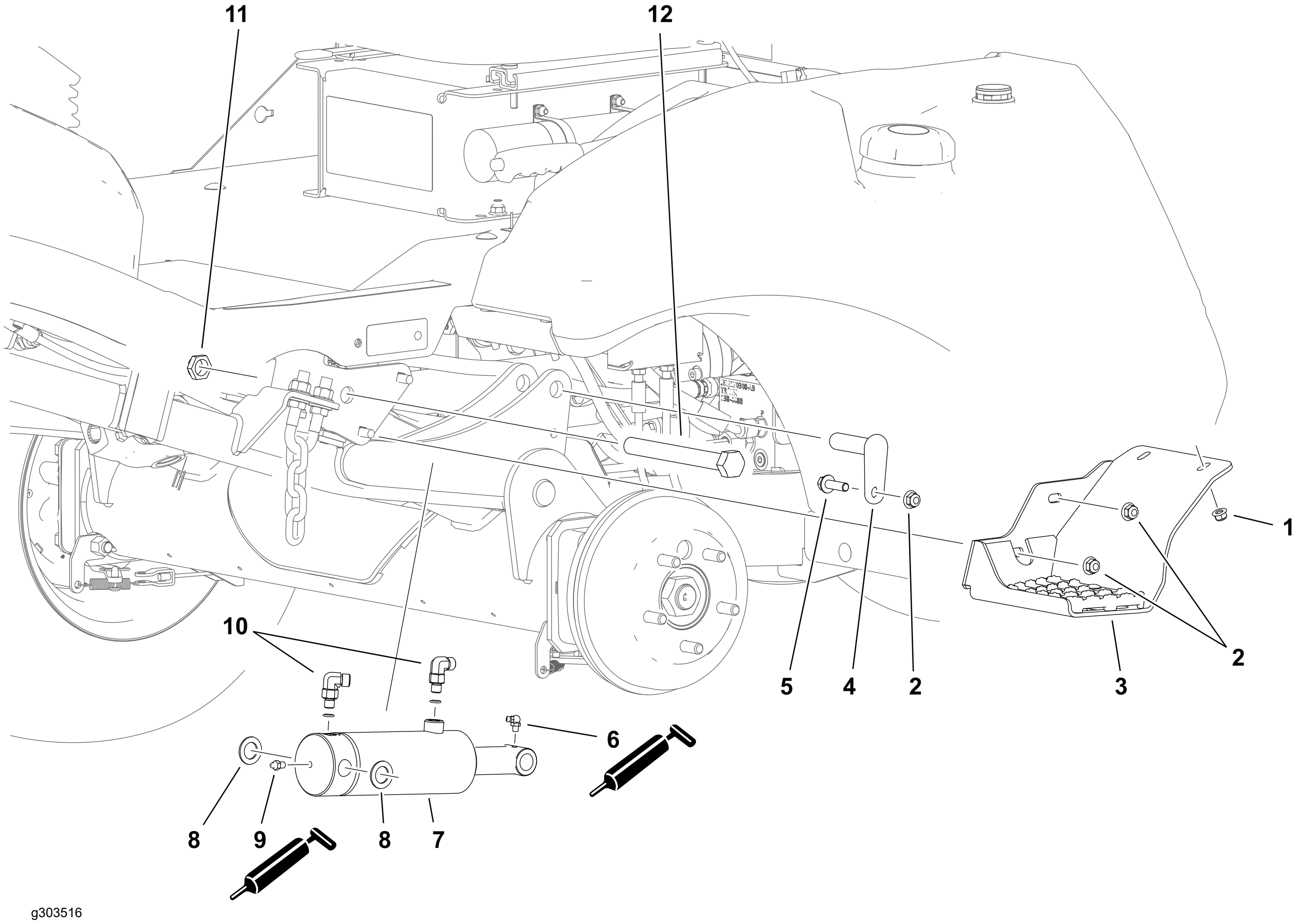


Figure 70

1.	Flange nut (2 each)	5.	Cap screw	9.	Grease fitting
2.	Flange nut (3 each)	6.	Grease fitting	10.	Elbow fitting (2 each)
3.	Step	7.	Lift cylinder	11.	Lock nut
4.	Pivot pin	8.	Nylon washer (2 each)	12.	Pivot bolt

Removing the Lift Cylinder

Refer to Figure 70 for this procedure.

1. Remove the front wheel to access the lift cylinder pivot pins; refer to Removing and Installing the Wheels (page 7–5).
2. To access the left lift cylinder, remove the step assembly.
3. Support the cutting unit or lift arm.
4. Remove the nut, pivot bolt, and nylon washers securing the barrel end of the cylinder to the frame.
5. Remove the pivot pin securing the rod end of the cylinder to the lift arm and lower the cylinder to access the hydraulic fittings.
6. Read and adhere to the information provided in General Precautions for Removing and Installing the Hydraulic System Components (page 5–52).
7. Clean the fitting and hydraulic hose connections before disconnecting the hydraulic hoses to prevent system contamination.
8. Disconnect the hydraulic hoses. Cap the fittings and plug the hoses to prevent system contamination.

Removing the Lift Cylinder (continued)

9. If the hydraulic fittings are to be removed from the cylinder, mark the fitting orientation for assembly purposes and remove the fittings from the cylinder. Discard the O-rings from the fittings.

Installing the Lift Cylinder

Refer to Figure 70 for this procedure.

1. If the hydraulic fittings were removed from the cylinder, lubricate new O-rings with clean hydraulic fluid, position the O-rings to the fittings, and install the fittings in the marked orientation; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
2. Remove the caps and plugs then connect the hydraulic tubes to the cylinder fittings; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
3. Install the pivot pin securing the rod end of the cylinder to the lift arm.
4. Install the nylon washers, pivot bolt, and nut securing the barrel end of the cylinder to the frame.
5. Lubricate the cylinder pivot grease fittings.
6. Operate the lift cylinder. Check for hydraulic leaks and correct if necessary.
7. Install the step if previously removed.
8. Install the front wheel; refer to Removing and Installing the Wheels (page 7–5).
9. Check the hydraulic fluid level and adjust if necessary before returning the machine to service.

Lift Cylinder Service

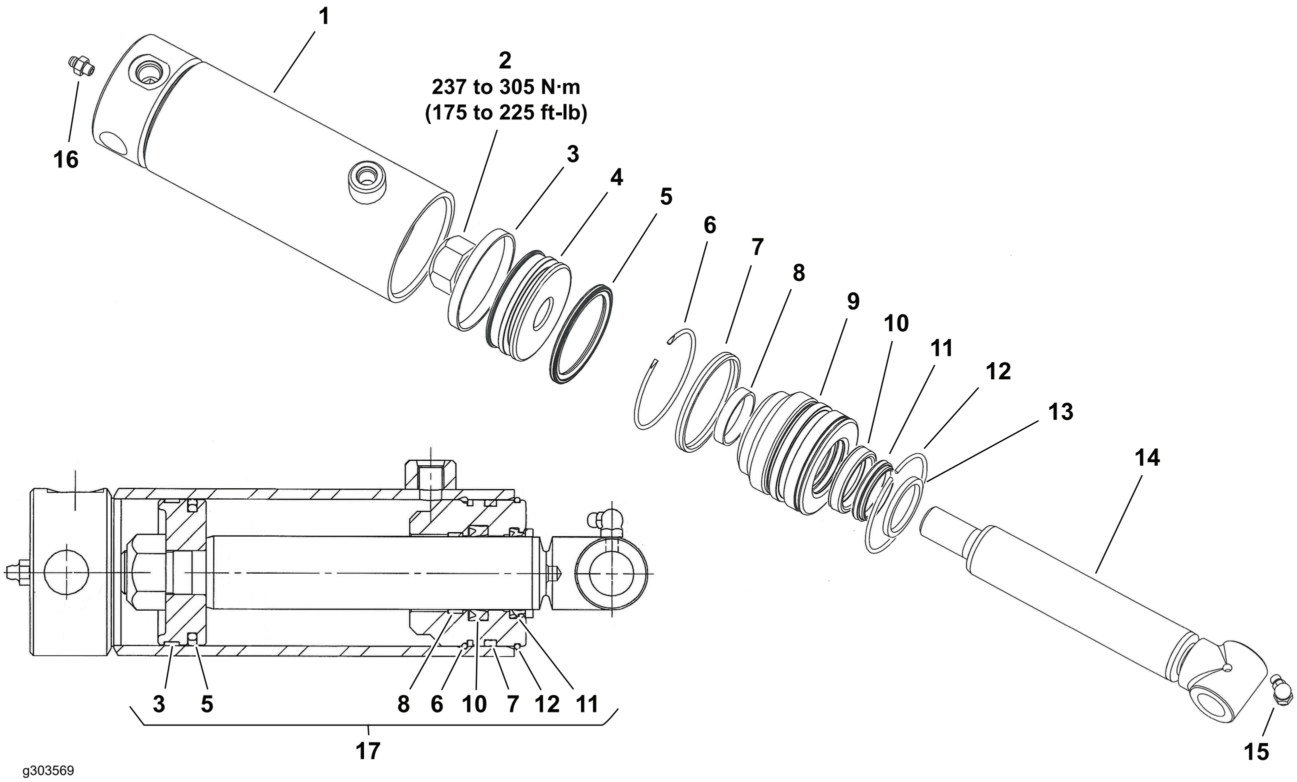


Figure 71

1. Barrel
2. Lock nut
3. Piston wear ring
4. Piston
5. Piston seal
6. Internal retaining ring
7. Dual seal
8. Rod wear ring
9. Cylinder head
10. Rod seal
11. Rod wiper
12. External retaining ring
13. Wiper seal mask
14. Rod
15. Grease fitting
16. Grease fitting
17. Repair kit

If items other than the cylinder seals are worn or damaged, the cylinder must be replaced as a complete assembly. Disassemble, inspect, and assemble the cylinder for inspection and seal replacement only.

The cylinder repair kit includes special tools required to replace the cylinder seals. Refer to the detailed instructions included with the repair kit, and view the instructional video *How to Repair a Wire Ring Cylinder* found at http://www.monarchindustries.com/lion-hydraulics/media prior to servicing the cylinder.

Auxiliary Hydraulic Valve Manifold (optional)

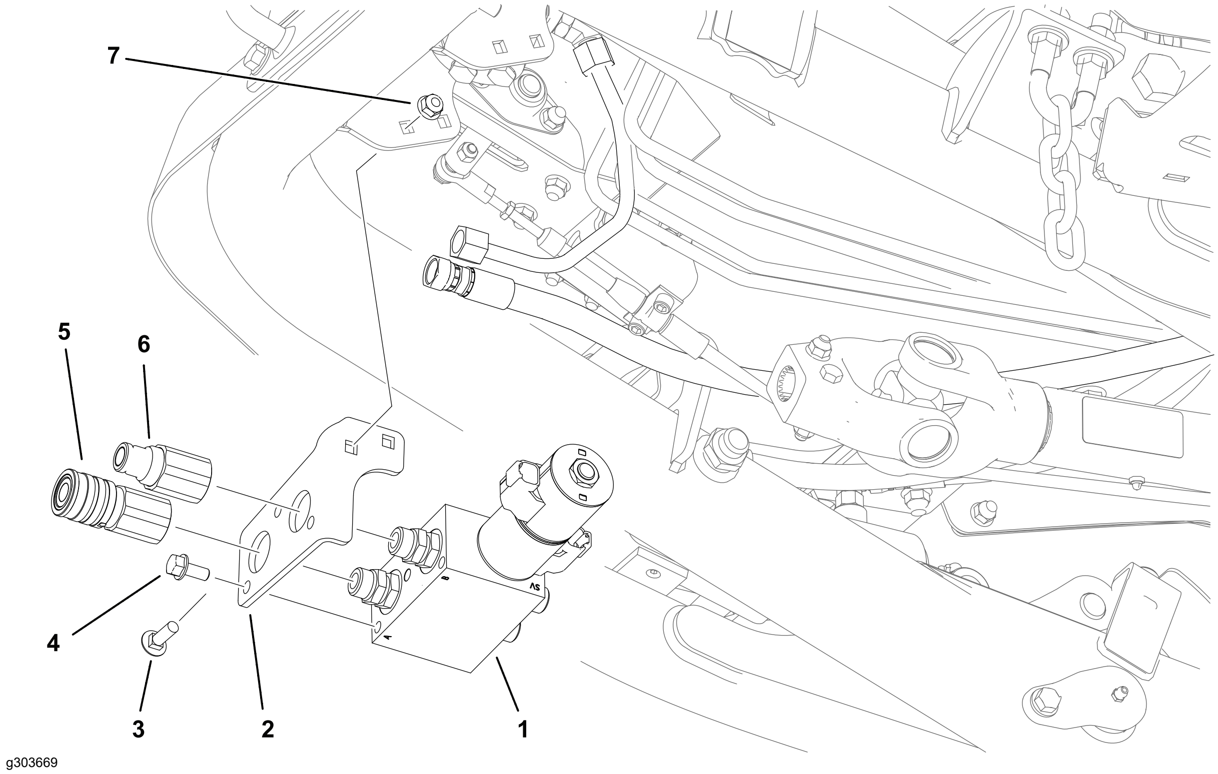


Figure 72

1. Valve manifold assembly
2. Bracket
3. Carriage bolt (2 each)
4. Cap screw (3 each)
5. Quick disconnect fitting – female
6. Quick disconnect fitting – male
7. Lock nut (2 each)

An optional auxiliary hydraulic valve kit is available. The kit is intended to expand the hydraulic capability for front mounted attachments. The kit includes a dual coil cartridge style solenoid valve controlled by a panel mounted switch. The cartridge valve manifold is located at the front right side of the machine under the operator platform.

Removing and Installing the Auxiliary Hydraulic Valve Manifold

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Label and disconnect wire harness connectors from the cartridge valve solenoids.
3. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold, hose connections, and fittings.
4. Label and disconnect the hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings to prevent system contamination.
5. Remove the fasteners securing the manifold bracket to the machine and remove the manifold assembly.
6. Install the manifold in reverse order.
7. Remove the caps and plugs from the fittings and hoses. Properly connect the hydraulic lines to the manifold; refer to Installing Hydraulic Hoses and Tubes (O-Ring Face Seal Fitting) (page 5–7).
8. Connect the wire harness connectors to the cartridge valve solenoids.

Removing and Installing the Auxiliary Hydraulic Valve Manifold (continued)

9. Operate the auxiliary valve. Check for hydraulic leaks and correct if necessary.
10. Check the hydraulic fluid level and adjust if necessary before returning the machine to service.

Servicing the Auxiliary Hydraulic Valve Manifold

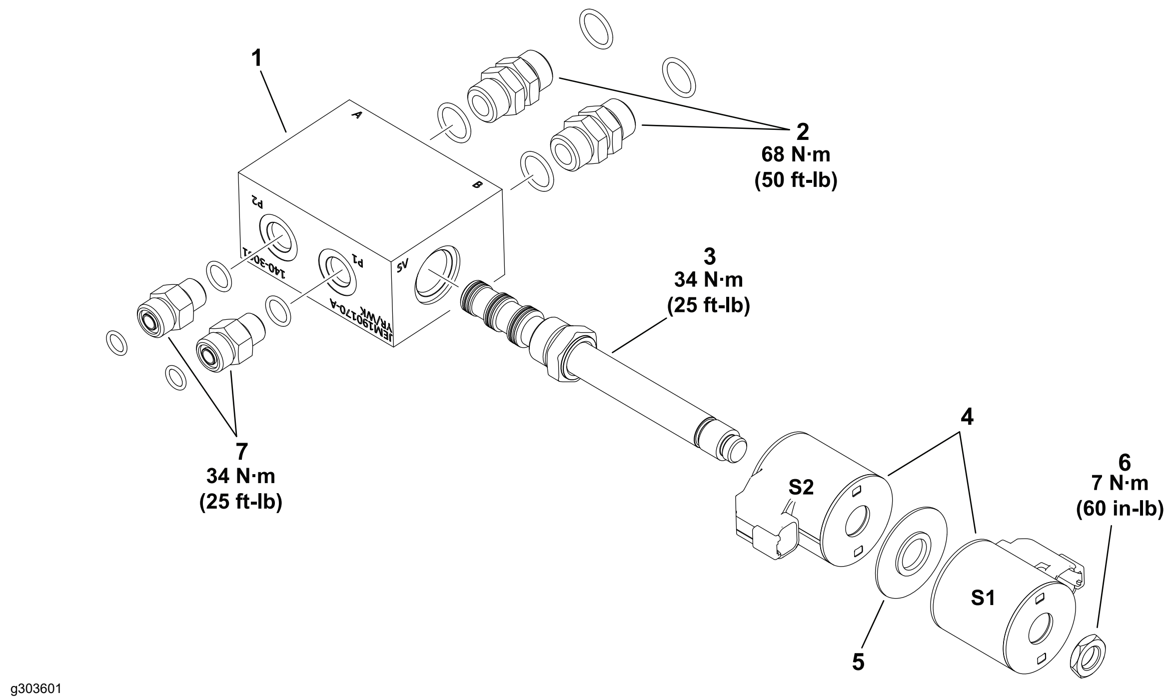


Figure 73

1. Manifold
2. Union fitting (2 each)
3. Cartridge valve
4. Solenoid coil (2 each)
5. Coil spacer
6. Coil nut
7. Straight fitting (2 each)

The ports on the manifold are marked for easy identification of components and connections; refer to the hydraulic schematic in Appendix A (page A–1) to identify the function of the cartridge valve and hydraulic lines at each port.

For cartridge valve service procedures, refer to Cartridge Valve Service (page 5–93).

1. Mark the fitting orientation to allow for correct assembly and remove the quick disconnect fittings.
2. Remove the manifold bracket.
3. If hydraulic fittings are to be removed from the manifold, mark the fitting orientation to allow for correct assembly. Remove the fittings from the manifold and discard the O−rings.
4. Lubricate new O-rings and place them onto the fittings. If previously removed, install the fittings into the valve ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fittings) (page 5–9).
5. Install the manifold bracket and quick disconnect fittings.

Chapter 6

Electrical System

Table of Contents

General Information

IMPORTANT

Before performing any welding on the machine, turn the key switch to the OFF position. To prevent damage to the machine electrical system, disconnect the ground (-) cable to the frame when welding on the frame.

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.

Yanmar Engine Electrical Components

When servicing or troubleshooting the engine electrical components (including the coolant temperature sender, the oil pressure switch, and the fuel solenoid for models 31900, 31901, 31907 and 31909 machines), use the correct engine service manual and troubleshooting manual. Yanmar engine service and troubleshooting manuals are available online, on the Toro Service Reference flash drive, and in print from your authorized Toro Distributor.

TDM Display/Controller

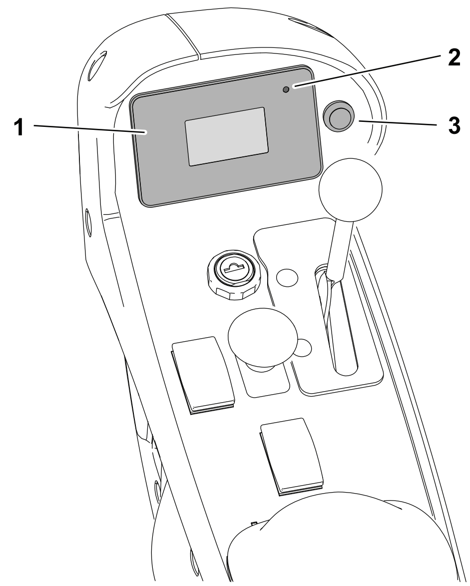


Figure 74

1. TDM display/controller
2. Bi-color LED indicator
3. Display screen select button

The TDM display/controller is an LCD device located on the operator's console that presents operating hours and engine coolant temperature for all models, and electrical system voltage, engine RPM for models 31902 and 31903. The display will also present active machine and engine faults.

The display screen select button located next to the TDM is used to select the various display screens. Press the screen select button once, press and hold the button, or press the button twice quickly to navigate around the display screens.

A bi-color LED is incorporated into the TDM display/controller panel. The LED is green during normal operation and flashes red when an active machine or engine fault is present. Power for the TDM is available when the main power relay is energized (key switch is in the ON or START position). A 15 Amp fuse (FB1–F4) protects the TDM power circuit.

The TDM display/controller is also a 2001 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 status of inputs to the controller can be monitored with the TDM display/controller screens; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12).

The TDM display/controller, the Yanmar Engine Control Unit (ECU)(models 31902 and 31903), and the optional controllers (future attachments) used on the Groundsmaster 3200/3300/3310 machines communicate with each other on a Controller Area Network (CAN) bus system.

Note: If the TDM display/controller is replaced for any reason, system software needs to be reloaded (contact an Authorized Toro Distributor for assistance).

TDM Display/Controller (continued)

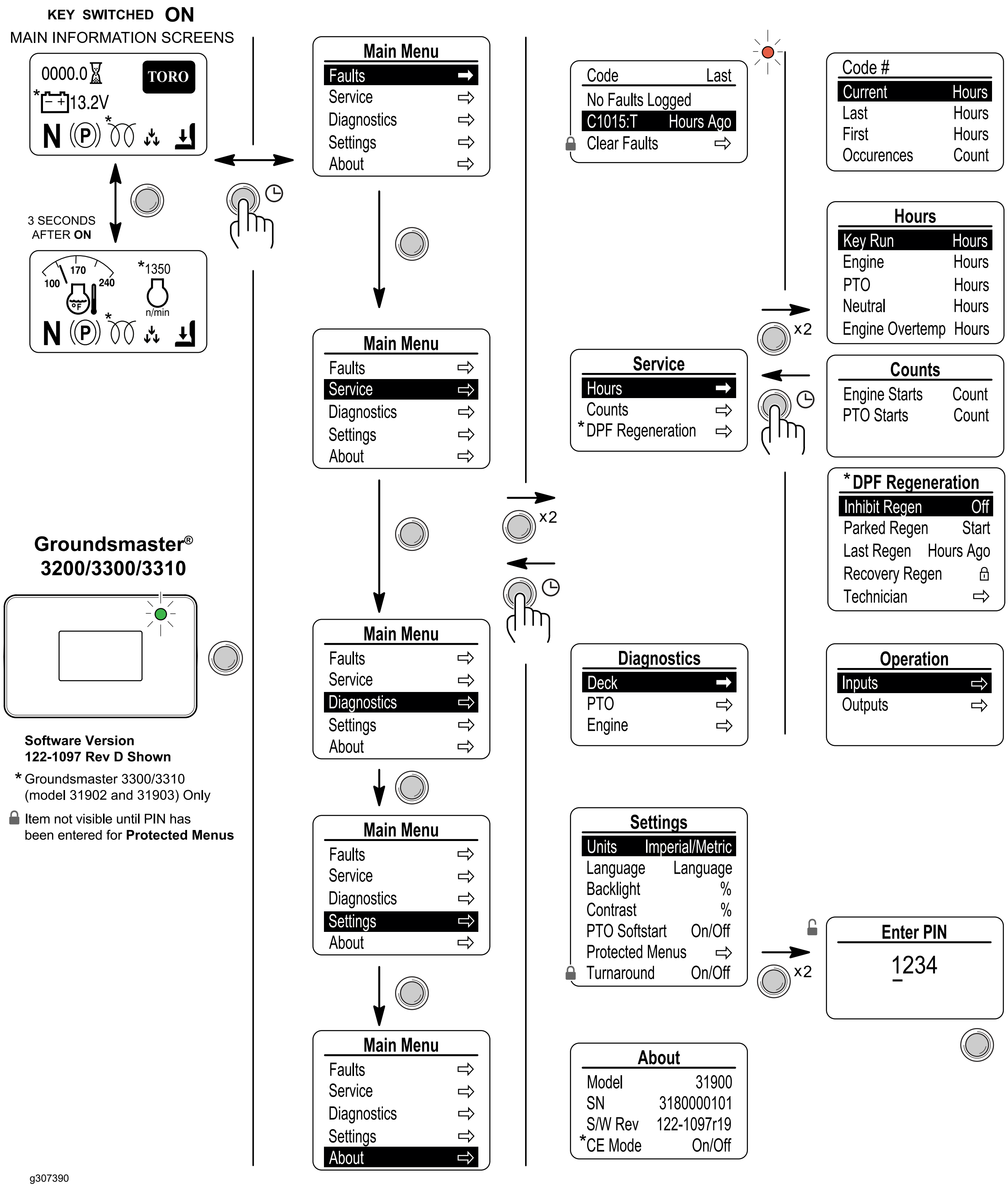


Figure 75

TDM Display/Controller Screens

CAN bus Communications

The machine controllers 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, allowing them to operate together as one. The CAN bus system reduces the number of electrical components and connections used on the machine and allows the number of wires in the wire harness to be significantly reduced.

For model 31900, 31901, 31907 and 31909 machines, the TDM controller is the only controller on the CAN bus presently. For model 31902 and 31903 machines, the TDM controller and the Yanmar engine ECU are the only controllers on the CAN bus presently. Additional controllers (for attachments) may be added to the CAN bus in the future through the expansion port connector and/or the telematics connector.

Each of the components that is controlled by the CAN bus link only needs four (4) wires to operate and communicate to the system: CAN High, CAN Low, power and ground. The key switch needs to be in the RUN or START position for the components on the network to be activated.

Two specially designed, twisted wires form the CAN bus. These wires provide the data pathways between the components on the network. The engineering term for these cables are CAN High and CAN Low. The CAN bus wires are red/white (CAN-High) and black/white (CAN Low). At each end of the CAN bus is a 120 ohm termination resistor; refer to CAN bus Terminator Resistors (page 6–56).

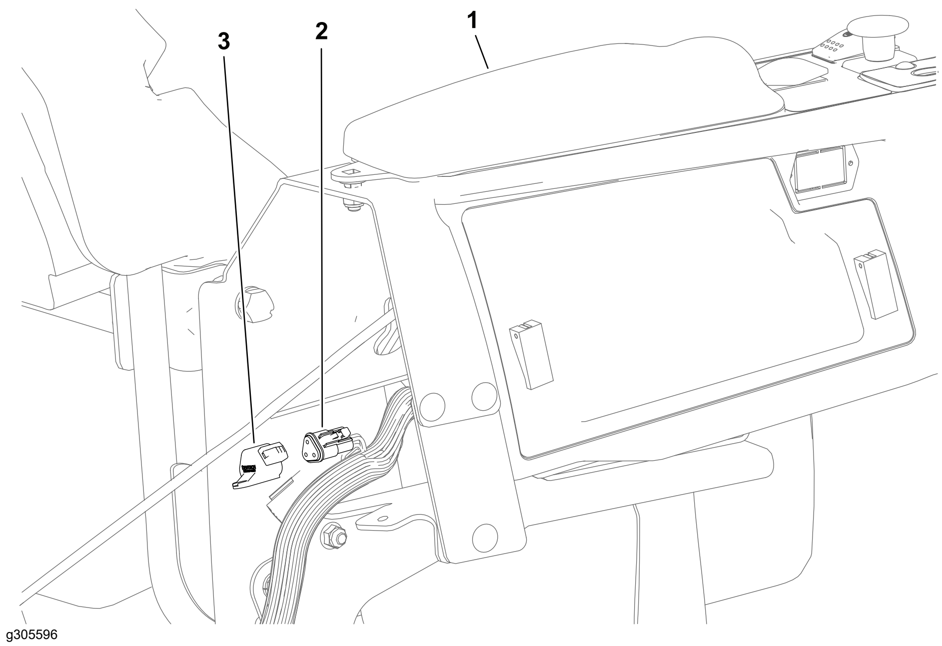


Figure 76

1. Operator's console
2. DIAG connector
3. Cover

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 located at the rear of the operator's console.

Electrical Schematics and Wire Harness Drawings/Diagrams

The electrical schematics and wire harness drawings for the Groundsmaster 3200/3300/3310 machine are located in Appendix A (page A–1).

Electrical System Quick Checks

Testing the Charging System

The Groundsmaster 3200/3300/3310 machines use a single 12 Volt maintenance free battery mounted on the left side of the machine behind the fuel tank. The battery is charged by either a 40 Amp (models 31900/31901) or 55 Amp (Models 31902/31903/31907/31909) 12 volt alternator mounted to the engine, which is driven by a single row V-belt.

Use the TDM display/controller screen to monitor the 12 Volt electrical system. It will tell you if the charging system has an output, but not its capacity.

1. Check to make sure each alternator drive belt is not loose, worn or damaged.
2. Turn the key switch to the ON position and set the TDM display/controller screen to view the voltmeter (battery icon).
3. Record the initial system voltage.
4. Start the engine and warm the engine to normal operating temperature.
5. Set the engine RPM to 2300 RPM.
6. Turn on all additional system loads (e.g. lights, blower).
7. The system voltage should be at least 0.5 volt higher then the initial voltage recorded in step 3.
8. If the charging system performance is less than desired, refer to the Yanmar Service Manual or Troubleshooting Manual for additional information.

Checking the Operation of the Interlock Switches

CAUTION

Do not disconnect safety switches. They are for the operator's protection. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

The Groundsmaster 3200/3300/3310 machines are equipped with a TDM controller that monitors interlock switch operation. If all of the interlock switches necessary to allow a specific machine operation are not in their desired position, an Operator's Advisory may appear on the TDM display/controller screen; refer to Operator Advisories (page 3–3).

The machine interlocks include:

- Operator seat switch
- Parking brake switch
- Traction neutral switch
- PTO switch
- Lift/lower switch
- Cutting unit high trim height switch
- Engine oil pressure switch
- Engine coolant temperature sender

Testing of the individual interlock switches is included in Testing the Electrical Components (page 6–9).

Testing the Electrical Components

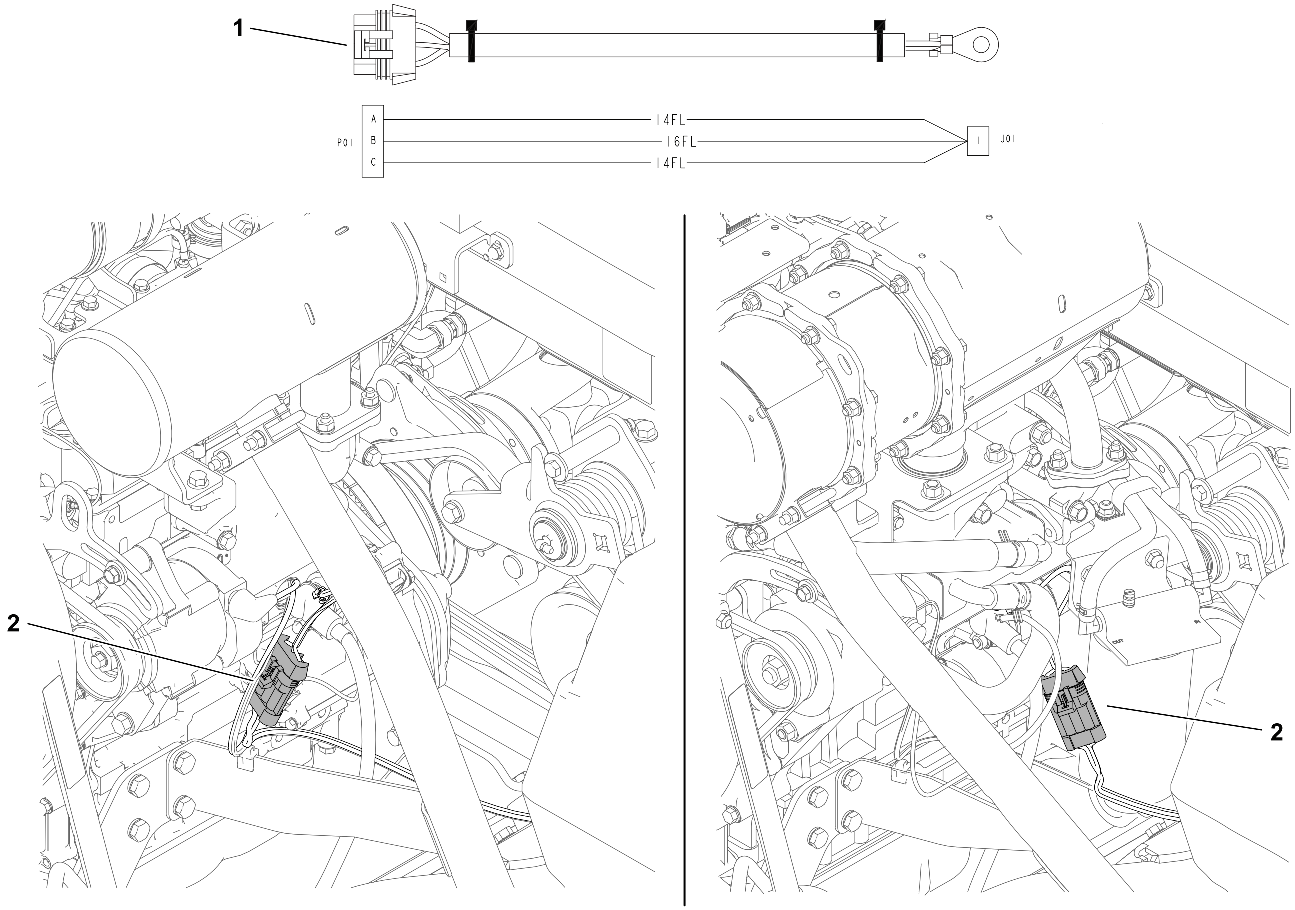
For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g., unplug the key switch connector before doing a continuity check of the switch). Always check the item being tested and the harness connector for damage or corrosion and clean or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

Note: Refer to the appropriate Yanmar engine Service manual or Troubleshooting Manual for your machine for additional electrical component repair information.

IMPORTANT

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

Fusible Link Harness



Groundsmaster 3200 | Groundsmaster 3300/3310

g304898

Figure 77

1. Fusible link harness
2. Fusible link harness connector

The Groundsmaster 3200/3300/3310 machines use 3 fusible links for circuit protection. These fusible links are located in a harness that connects the battery positive cable to the machine wire harness. If any of these links fail, current to the protected circuit stops; refer to Appendix A (page A–1) for additional circuit information.

Testing the Fusible Link Harness

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the negative battery cable from the battery terminal, and then disconnect the positive cable from the battery; refer to Removing and Installing the Battery (page 6–69).
3. Locate and unplug the fusible link connector from the machine wire harness (right side of engine). Check the harness connectors for damage or corrosion and clean or repair if necessary.
4. Use a multimeter to ensure that the continuity exists between each pin in the fusible link harness connector and the fusible link harness ring terminal.
5. If any of the fusible links are open, replace the fusible link harness.

Testing the Fusible Link Harness (continued)

Note: Do not replace individual fusible link conductors of the fusible link harness. If any of the harness links are open (failed), replace the entire fusible link harness.

6. After you complete the testing, ensure that the fusible link harness connectors are correctly attached to the starter and machine wire harness. Connect the positive battery cable to the battery terminal and then connect the negative cable to the battery.

Fuses

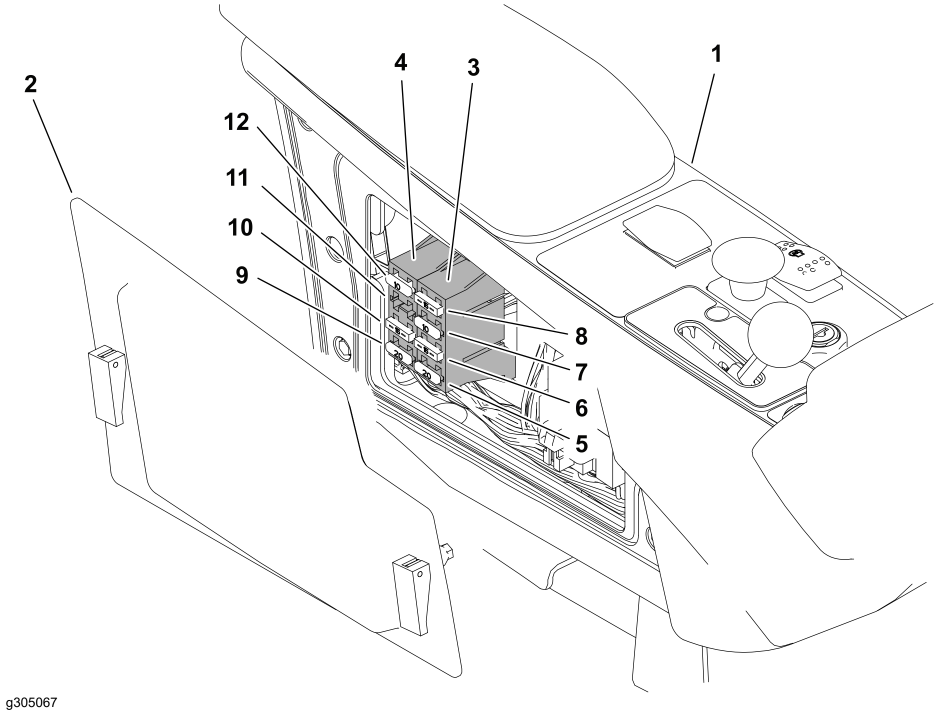


Figure 78

1. Operator's control console	7. Fuse FB1-F3
2. Access cover	8. Fuse FB1-F4
3. Fuse block 1	9. Fuse FB2-F1
4. Fuse block 2	10. Fuse FB2-F2
5. Fuse FB1-F1	11. Fuse FB2-F3
6. Fuse FB1-F2	12. Fuse FB2-F4

Most of the individual control circuits are protected by a variety of fuses found in the main fuse blocks located in the operator's control console. A number of in-line fuses are integrated into the machine wire harness; refer to **In-line Fuses** (page 6–13). Machines with a cab include additional control circuits protected by fuses found in the cab power supply harness and in the cab fuse block located in the cab control panel. Machines with optional lighting kits include additional control circuits protected by fuses found in a fuse block located in the steering column control pod, and in the lighting kit wire harness. Refer to Appendix A (page A–1) for specific circuit information.

Fuse Identification and Function

Main Fuse Blocks

- FB1-F1: (models 31900 and 31901 = 20 Amp, models 31902, 31903, 31907 and 31909 = 15 Amp) supplies unswitched power to the key switch.
- FB1-F2: (models 31900 and 31901 = 15 Amp, models 31902, 31903, 31907 and 31909 = 10 Amp) supplies switched power to the TDM controller Key Start circuit and the start interlock relay switch.
- FB1–F3: (10 Amp) supplies switched power to the TDM controller Key Run circuit.
- FB1–F4: (15 Amp) supplies switched power to the TDM controller logic and output circuits.
- FB2–F1: (20 Amp) supplies switched power to the glow relay coil, the alternator IG circuit, the fuses FB1–F3 and FB1–F4, the cutting unit raise limit switch, the traction neutral switch, the expansion port, the telematics

connector, the optional wireless hour meter and the optional USB charger port.

- FB2–F2: (15 Amp) supplies switched power to the optional air ride seat.
- FB2–F3: (open slot) available to supply power to accessories.
- FB2–F4: (models 31900, 31901, 31902 and 31907 = open slot, models 31903 and 31909 = 10 Amp) supplies switched power to cab.

In-line Fuses

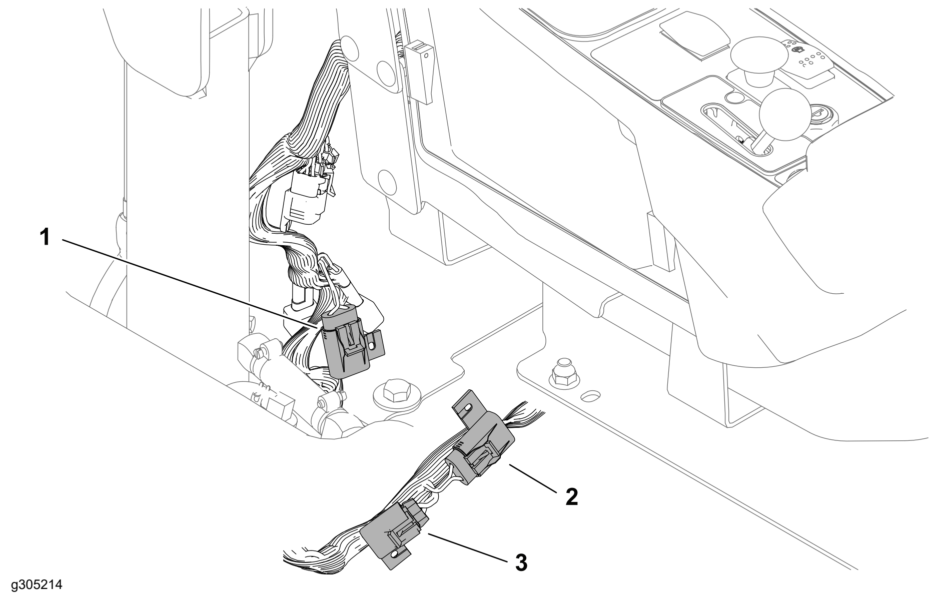


Figure 79

1. Fuse – telematics connector
2. Fuse – expansion port
3. Fuse – engine ECU (models 31902 and 31903)

- Located above the operator's platform in right rear corner: (10 Amp) supplies unswitched power to the telematics connector.
- Located below the operator's platform in right rear corner: (10 Amp) supplies unswitched power to the expansion port.
- Located below the operator's platform in right rear corner: (10 Amp) supplies unswitched power to the engine ECU (models 31902 and 31903).

Cab Power Supply Harness (models 31903 and 31909)

Fuse Identification and Function (continued)

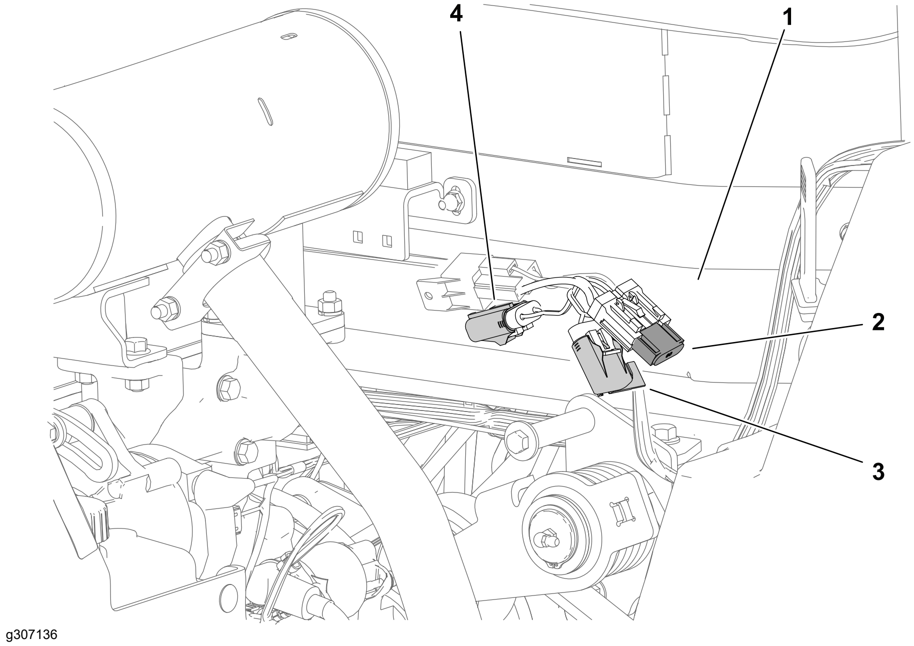


Figure 80

1. Frame crossmember
2. Maxi fuse – main cab power circuits (models 31903 and 31909)
3. Fuse – hazard lights (optional)
4. Fuse – radio (optional)

- Located along the frame crossmember in front of the engine: (60 Amp Maxi fuse) supplies unswitched power to the cab power circuits via the cab power relay.
- Located along the frame crossmember in front of the engine: (15 Amp) supplies unswitched power to the optional hazard light circuit.
- Located along the frame crossmember in front of the engine: (10 Amp) supplies unswitched power to an optional radio.

Cab Fuse Block (models 31903 and 31909)

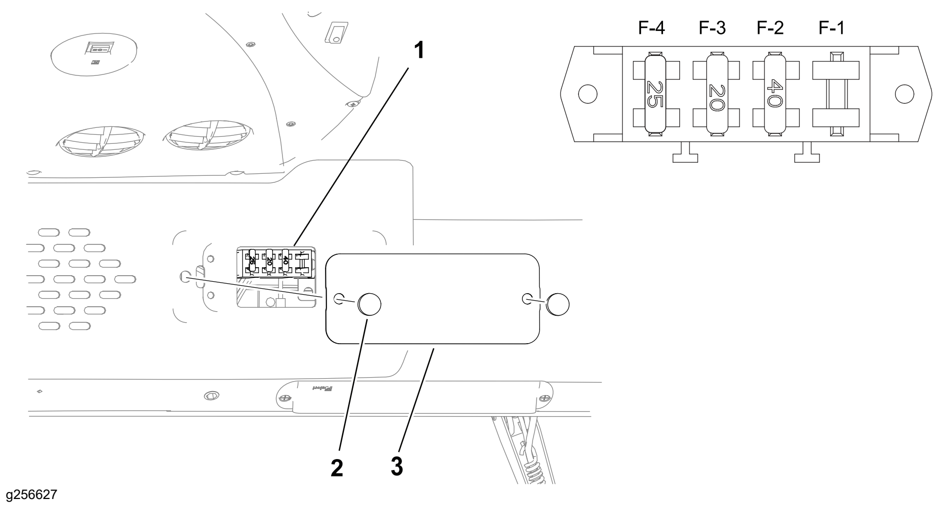


Figure 81

1. Cab fuse block
2. Knob (2 each)
3. Access panel

Fuse Identification and Function (continued)

- Fuse F-1 (open slot) supplies switched power available for optional equipment.
- Fuse F-2 (40 Amp) supplies switched power to the mixing box blower, the defroster blower and the dome light.
- Fuse F-3 (20 Amp) supplies switched power to the windshield wipers and washer pump.
- Fuse F-4 (25 Amp) supplies switched power to the condenser fans and compressor clutch.

Road Light Kit (Optional) – Fuse Block

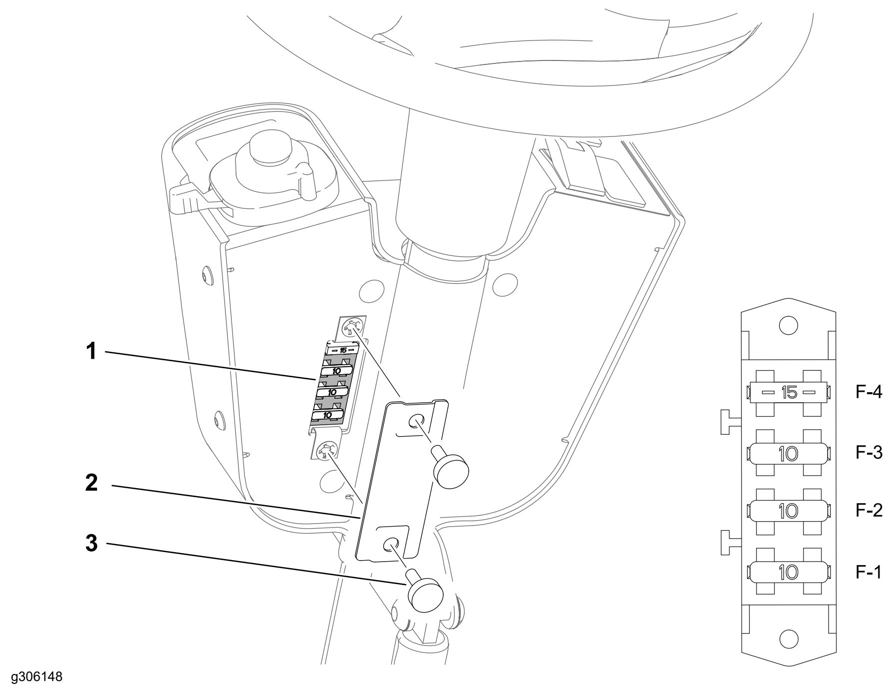


Figure 82

1. Control pod fuse block
2. Access panel
3. Knob (2 each)

- Fuse F-1 (10 Amp) supplies switched power to the work lights.
- Fuse F-2 (10 Amp) supplies switched power to the beacon.
- Fuse F-3 (10 Amp) supplies switched power to the road lights.
- Fuse F-4 (15 Amp) supplies switched power to the horn.

Road Light Kit (Optional) – Harness

Fuse Identification and Function (continued)

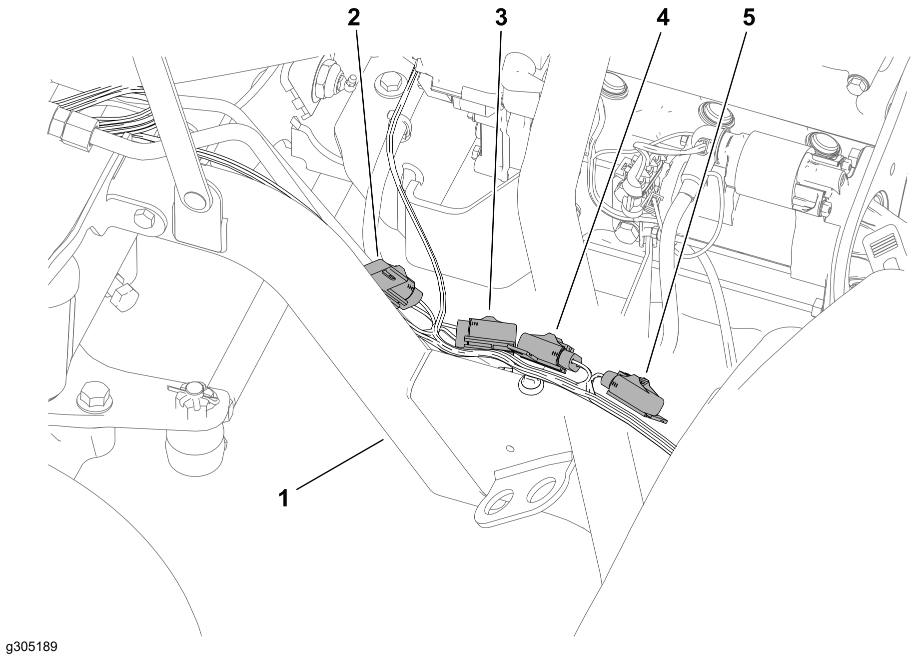


Figure 83

1. Right side frame rail
2. Fuse – RH tail light
3. Fuse – RH brake/turn
4. Fuse – LH brake/turn
5. Fuse – LH tail light

Four (5 Amp) fuses are integrated into the optional turn signal/hazard wire harness. Each fuse is in a separate covered fuse holder. The fuses are located along the right side frame rail near the exhaust pipe.

Testing the Fuses

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the fuse from the fuse block or fuse holder for testing. Check the fuse, fuse block or fuse holder for damage or corrosion and clean or repair if necessary.
3. Use a multimeter (ohms setting) and test the fuse for continuity across the fuse terminals.
4. Replace the fuse if testing determines that it is damaged.
5. If the fuse tests correctly and a circuit problem still exists, check the wire harness(es); refer to Appendix A (page A–1).

CAN bus

The machine controllers 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, allowing them to operate together as one. The CAN bus system reduces the number of electrical components and connections used on the machine and allows the number of wires in the wire harness to be significantly reduced.

For model 31900, 31901, 31907 and 31909 machines, the TDM controller is the only controller on the CAN bus presently. For model 31902 and 31903 machines, the TDM controller and the Yanmar engine ECU are the only controllers on the CAN bus presently. Additional controllers (for attachments) may be added to the CAN bus in the future through the expansion port connector and/or the telematics connector.

Each of the components that is controlled by the CAN bus link only needs four (4) wires to operate and communicate to the system: CAN High, CAN Low, power and ground. The key switch needs to be in the RUN or START position for the components on the network to be activated.

Two specially designed, twisted wires form the CAN bus. These wires provide the data pathways between the components on the network. The engineering term for these cables are CAN High and CAN Low. The CAN bus wires are red/white (CAN-High) and black/white (CAN Low). At each end of the CAN bus is a 120 ohm termination resistor; refer to CAN bus Terminator Resistors (page 6–56).

Testing the CAN bus

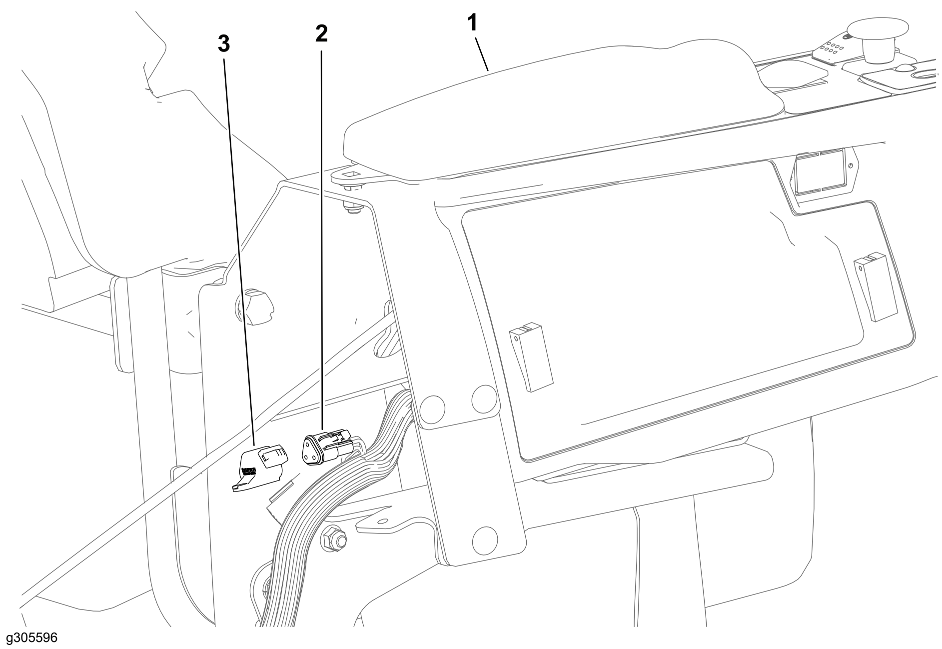


Figure 84

1. Operator's console
2. DIAG connector
3. Cover

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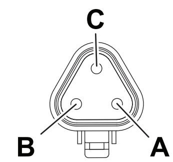
1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. The Toro DIAG connector is part of the CAN bus and is located at the rear of the operator's console. Remove the connector cover from the machine wire harness and use a multimeter (ohms setting) to check the Toro DIAG connector.

Testing the CAN bus (continued)

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	Main	P37	A	Red/White	54 to 66 ohms	
2	Main	P37	B	Black/White		

Note: A reading of 120 ohms indicates one of the CAN bus terminator resistors is not connected or damaged

Refer to CAN bus Terminator Resistors (page 6–56) and/or Appendix A (page A–1) for additional information. If necessary, contact an Authorized Toro Distributor for assistance.

3. Install the connector cover after testing.

TDM Display/Controller

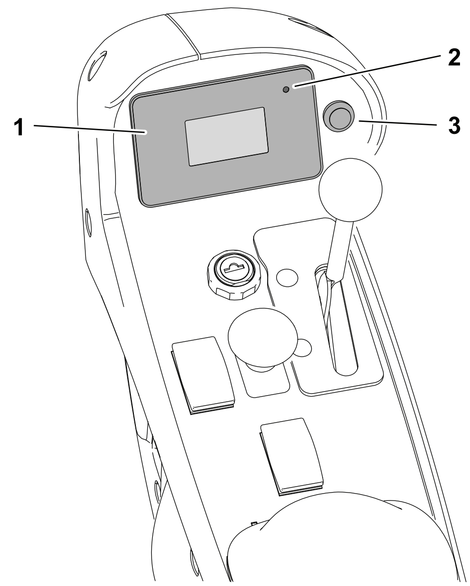


Figure 85

1. TDM display/controller
2. LED fault active indicator
3. Display screen select button

The TDM display/controller is an LCD device located on the operator's console that presents operating hours, engine coolant temperature, electrical system voltage, engine RPM, and active faults. The display screen button located next to the TDM is used to select the various display screens. A red LED active fault indicator is also part of the TDM display/controller. Refer to TDM Display/Controller (page 6–3) for a complete explanation of the TDM features. Power for the TDM is available when the main power relay is energized (key switch is in the ON or START position). A 15 Amp fuse (FB1–F4) protects the TDM power circuit.

The TDM display/controller is also a 2001 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 status of inputs to the controller can be monitored with the TDM display/controller screens; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12).

The TDM display/controller, the Yanmar Engine Control Unit (ECU) (models 31902 and 31903), and the optional controllers (future attachments) used on the Greensmaster 3200/3300/3310 machines communicate with each other on a Controller Area Network (CAN) bus system.

TDM Display/Controller Inputs

TDM Display/Controller (continued)

TDM Display/Controller Inputs (continued)

INPUT NUMBER	DESCRIPTION
IN 1	Key Switch – Start
IN 2	PTO Switch
IN 3	Cutting Unit Lift Lower Switch – Lower
IN 4	Cutting Unit Lift Lower Switch – Lift
IN 5	Parking Brake Switch
IN 6	Seat Switch

INPUT NUMBER	DESCRIPTION
IN 7	Traction Neutral Switch
AIN 1	Cutting Unit High Trim Height Switch
AIN 2	Model 31900, 31901, 31907 and 31909 = Oil Pressure Switch Model 31902 and 31903 = Throttle Switch – Decrease Speed
AIN 3	Model 31900, 31901, 31907 and 31909 = Engine Coolant Temperature Sender Model 31902 and 31903 = Throttle Switch – Increase Speed
AIN 4	Display Screen Select Button

TDM Display/Controller Outputs

OUTPUT NUMBER	DESCRIPTION
OUT 1	PTO Clutch
OUT 2	Model 31900, 31901, 31907 and 31909 = Start Interlock Relay (coil), Fuel Pump, and Fuel Stop Solenoid (hold coil) Model 31902 and 31903 = Start Interlock Relay (coil) and Engine ECU (start signal)
OUT 3	Hydraulic Solenoid Valve SV1 (cutting unit lift)
OUT 4	Hydraulic Solenoid Valve SV2 (cutting unit lower)

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.

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.

TDM Display/Controller (continued)

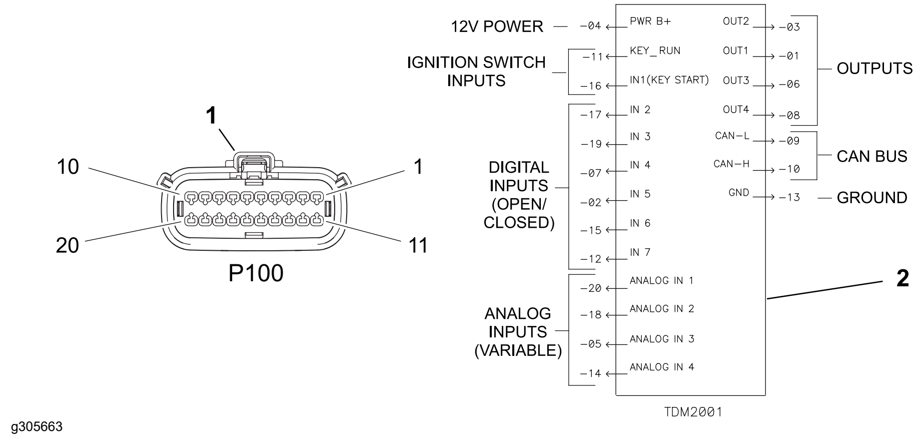


Figure 86

1. Main wire harness connector P100
2. TDM display/controller

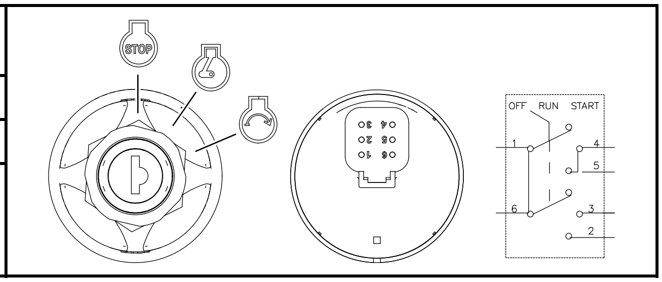
A 20 pin wire harness connector is attached to the controller. The connection terminal function for the controller and the wire harness connector pins are shown above. Check the module and the harness connector for damage or corrosion and clean or repair if necessary.

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).

Note: If the TDM display/controller is replaced for any reason, system software needs to be reloaded (contact an Authorized Toro Distributor for assistance).

Key Switch

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



The key switch is located on the operator's console and has 3 positions: OFF, RUN, and START. The key switch is an input used by the TDM display/controller to manage various machine functions.

Testing the Key Switch

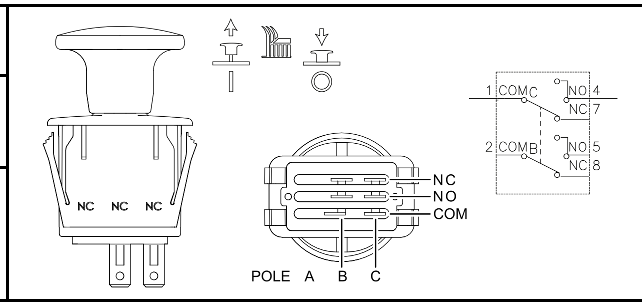
The key switch and its circuit wiring can be tested using the TDM display/controller; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator's console covers; refer to Removing and Installing the Operator's Console Covers (page 7–23)
4. Disconnect the wire harness connector from the switch and remove the switch from the console if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch and connect the wire harness after testing.
9. Install the console covers.
10. Connect the battery negative (-) cable at the battery.

PTO Switch

POSITION	CLOSED CIRCUITS
OFF (DOWN)	COM B + NC B COM C+ NC C
ON (UP)	COM B + NO B COM C+ NO C



The power take off (PTO) switch is located on the operator’s console. This switch is pulled up to engage the PTO shaft and pushed down to disengage the PTO shaft.

The TDM display/controller monitors the position of the PTO switch. Using information from the PTO switch and other inputs, the TDM controller energizes the electric PTO clutch coil to engage the PTO shaft.

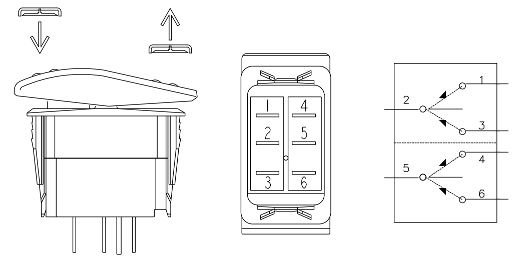
Testing the PTO Switch

The PTO switch and its circuit wiring can be tested using the TDM display/controller; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). 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 unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator’s console covers; refer to Removing and Installing the Operator’s Console Covers (page 7–23).
4. Disconnect the wire harness connector from the switch and remove the switch from the console if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch and connect the wire harness after testing.
9. Install the console covers.
10. Connect the battery negative (-) cable at the battery.

Lift/Lower Switch

POSITION	CLOSED CIRCUITS
LOWER	2 + 3, 5 + 6
NEUTRAL	NONE
LIFT	2 + 1, 5 + 4



The lift/lower switch is a momentary switch located on the operator's console. When the front of the switch is depressed, the lift arms will lower. When the rear of the switch is depressed, the lift arms will lift. When raising the lift arms, the lift arms will remain in position if the switch is released. The engine must be running to allow the lift arms to be raised.

The TDM display/controller monitors signals from the lift/lower switch. When the front of the switch is depressed, the TDM display/controller energizes solenoid valve coil SV1 causing the valve to shift and the lift cylinder to extend to raise the lift arms. When the rear of the switch is depressed, the TDM display/controller energizes solenoid valve coil SV2 causing the valve to shift allowing the hydraulic fluid in the lift cylinder to escape. The weight of the cutting unit (or attachment) retracts the lift cylinder to lower the lift arms.

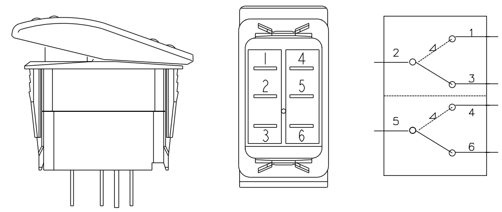
Testing the Lift/Lower Switch

The lift/lower switch and its circuit wiring can be tested using the TDM display/controller; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). 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 unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator's console covers; refer to Removing and Installing the Operator's Console Covers (page 7–23).
4. Disconnect the wire harness connector from the switch and remove the switch from the console if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch and connect the wire harness after testing.
9. Install the console covers.
10. Connect the battery negative (-) cable at the battery.

Glow Plug Switch (Model 31900, 31901, 31907 and 31909)

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



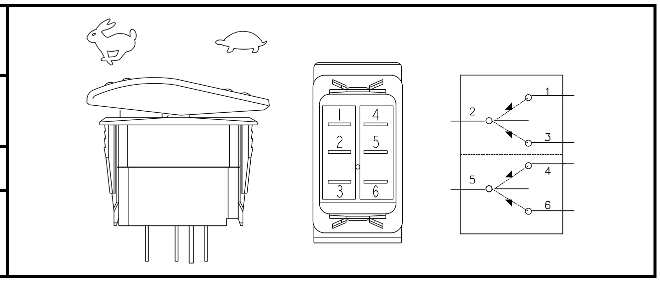
The glow plug switch is located on the operator’s console. The glow relay and the glow plugs are energized as long as the front of the switch is depressed.

Testing the Glow Plug Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator’s console covers; refer to Removing and Installing the Operator’s Console Covers (page 7–23).
4. Disconnect the wire harness connector from the switch and remove the switch from the console if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch and connect the wire harness after testing.
9. Install the console covers.
10. Connect the battery negative (-) cable at the battery.

Throttle Switch (Model 31902 and 31903)

POSITION	CLOSED CIRCUITS
INCREASE SPEED	2 + 3, 5 + 6
NEUTRAL	NONE
DECREASE SPEED	2 + 1, 5 + 4



The throttle switch is a momentary switch located on the operator's console. When the front of the switch is depressed, the engine speed (RPM) will increase. When the rear of the switch is depressed, the engine speed (RPM) will decrease. Refer to the engine specification tables in Chapter 2 (page 2–1) for the minimum and maximum engine RPM for specific Groundsmaster 3200/3300/3310 machines.

The TDM display/controller monitors signals from the throttle switch. The TDM display controller communicates the increase/decrease requests to the Yanmar engine ECU via the CAN network.

Testing the Throttle Switch

The throttle switch and its circuit wiring can be tested using the TDM display/controller; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). 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 unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator's console covers; refer to Removing and Installing the Operator's Console Covers (page 7–23).
4. Disconnect the wire harness connector from the switch and remove the switch from the console if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch and connect the wire harness after testing.
9. Install the console covers.
10. Connect the battery negative (-) cable at the battery.

Seat Switch

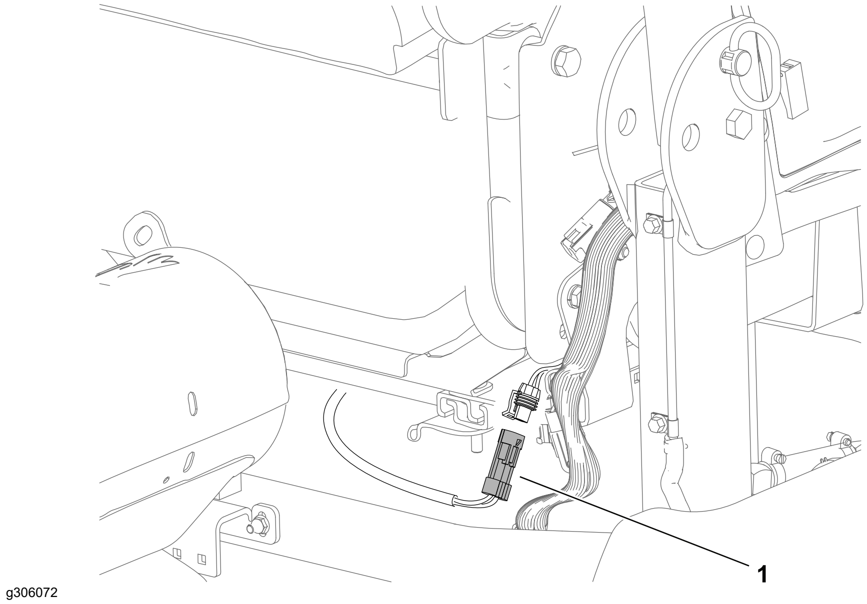


Figure 87

1. Seat switch harness connector

The seat switch is normally open and closes when the operator is on the seat. The seat switch is located directly under the seat cushion. Testing the switch can be done without removing the seat by disconnecting the seat switch wire harness from the machine wire harness.

The TDM display/controller monitors the position of the seat switch. The seat switch is part of the machine safety interlock system. Using the seat switch position (open or closed) and a variety of other inputs, the TDM display/controller manages a variety of machine functions.

Testing the Seat Switch

The seat switch and its circuit wiring can be tested using the TDM display/controller main information screens (seat icon); refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). 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 unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the wire harness connector from the seat switch harness. Check the harness connectors for damage or corrosion and clean or repair if 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, 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. Test the seat switch harness and seat switch separately if necessary:
   A. Remove the seat from the seat box.

Testing the Seat Switch (continued)

B. Disconnect the seat switch harness from the seat switch. Check the switch and the harness connectors for damage or corrosion and clean or repair if necessary.

C. Use a multimeter (ohms setting) and check the continuity of the switch harness.

D. Use a multimeter (ohms setting) and check the continuity of the switch; refer to step 3 of this procedure.

5. Replace the switch or switch harness if necessary. To replace the seat switch:

   A. Detach the rear of the seat base fabric cover (seat with suspension system).

   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 testing is correct and the circuit problem still exists, check the machine wire harness; refer to Appendix A (page A–1).

7. Connect the wire harnesses to the switch and test the seat switch operation before returning the machine to service.

Traction Neutral Switch

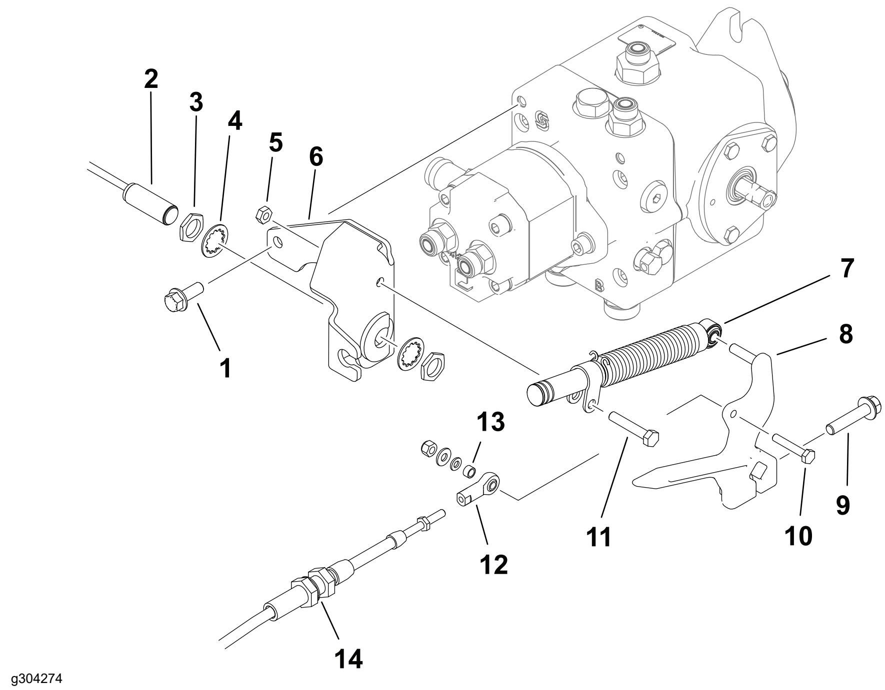


Figure 88

1.	Cap screw (2 each)	8.	Pump lever
2.	Neutral switch	9.	Pinch bolt
3.	Jam nut (2 each)	10.	Cap screw (2 each)
4.	Lock washer (2 each)	11.	Cap screw
5.	Lock nut	12.	Ball joint
6.	Support bracket	13.	Spacer – 5 mm (0.21 inch)
7.	Damper	14.	Traction cable

The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the neutral position. The switch mounts to a bracket on the traction (piston) pump. The sensing element for the traction neutral switch is the traction pump lever that is secured to the pump control arm. When the traction control linkage is in the NEUTRAL position, the pump lever will be near the switch face and the switch will be closed. When the traction linkage moves toward Forward or Reverse, the pump lever moves away from the switch face and the switch opens.

With the key switch in the RUN position, the LED on the cable end of the neutral switch should be illuminated when the traction system is in the NEUTRAL position. Use a small mirror to view the LED if necessary.

The TDM display/controller monitors the position of the traction neutral switch. The traction neutral switch is part of the machine safety interlock system. Using the traction neutral switch position (open or closed) and a variety of other inputs, the TDM display/controller manages a variety of machine functions.

Adjusting the Traction Neutral Switch

1. Check and adjust traction system neutral position; refer to Adjusting the Traction System for Neutral (page 5–50).

IMPORTANT

To prevent damage to the traction neutral switch, make sure that nothing contacts the switch face during operation or adjustment. Do not scratch the face of the neutral switch.

2. When the traction lever is in the NEUTRAL position, the clearance between the face of the neutral switch and the pump lever should be from **2.4 to 2.5 mm (0.09 to 0.10 inch)**.

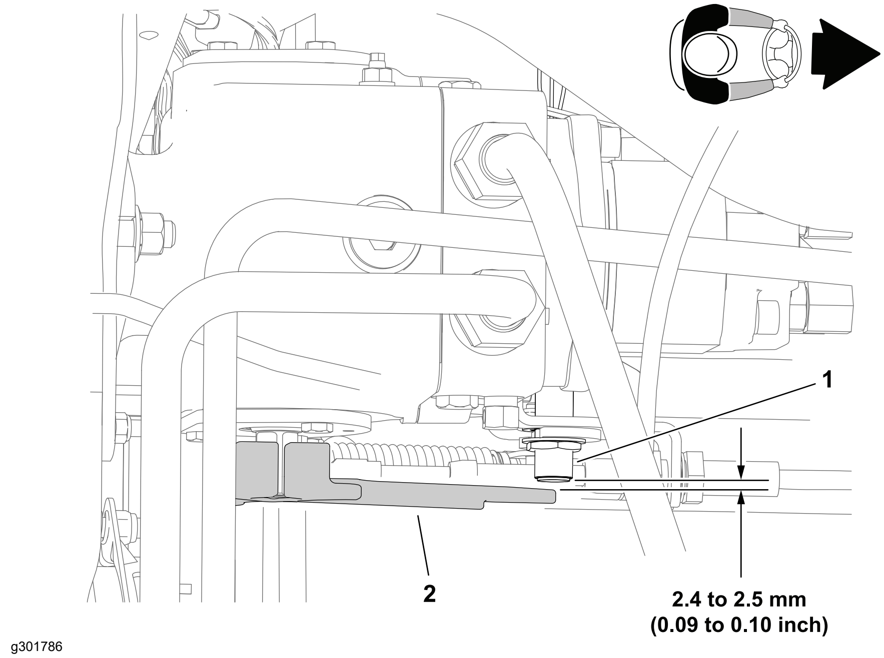
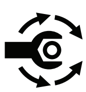


Figure 89

1. Neutral switch
2. Pump lever



3. If the clearance is incorrect, loosen the jam nuts that secure neutral switch to the bracket. Use the jam nuts to move the switch to the correct position. Tighten the jam nuts from **18.4 to 22.4 N·m (162 to 198 in- lb)**. Re-check the switch to lever clearance and adjust if necessary.

4. After adjusting the neutral switch, use the TDM display/controller screen to verify that neutral switch and circuit wiring are functioning correctly.

Testing the Traction Neutral Switch

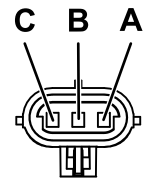
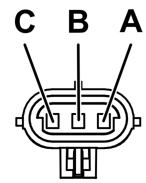
The traction neutral switch and its circuit wiring can be tested using the TDM display/controller main information screens (neutral icon); refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). If testing determines that the switch and circuit wiring are not functioning correctly, proceed with the following test procedure:

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.

2. Ensure that the traction neutral switch is correctly adjusted; refer to Adjusting the Traction Neutral Switch (page 6–29).

Testing the Traction Neutral Switch (continued)

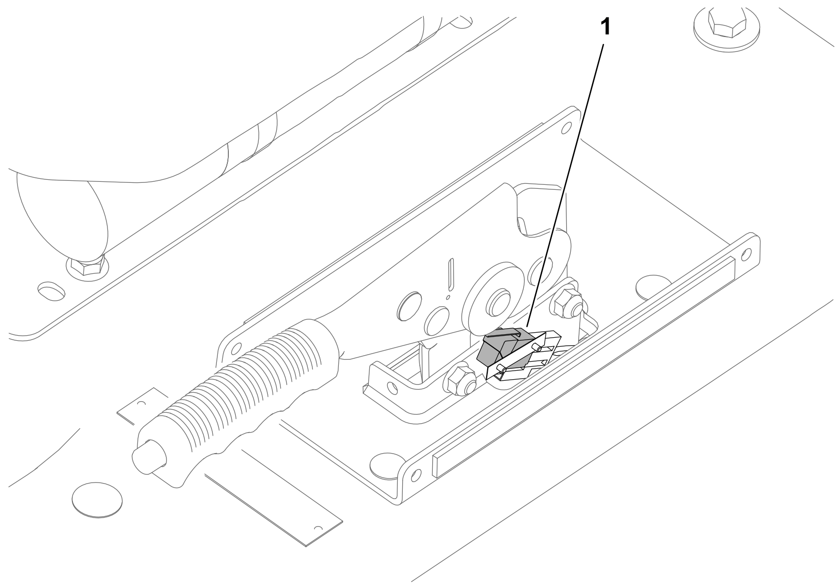
3. Disconnect the traction neutral switch from the machine wire harness. Check the harness connectors for damage or corrosion and clean or repair if necessary. Use a multimeter (ohms setting) to check the machine wire harness connector.

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	Main	P40	C	Black	Less than 2 ohms	 g034018
2	Chassis Ground					
1	Main	P40	A	Pink	12 VDC with key switch in the RUN position (do not start engine)	 g034018
2	Chassis Ground					

4. If the harness wires test correctly and the sensor LED does not function, replace the traction neutral sensor. Connect the traction neutral switch to the machine wire harness and adjust the sensor after installation; refer to Adjusting the Traction Neutral Switch (page 6–29).

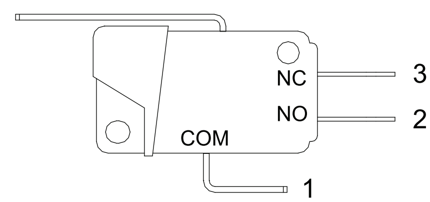
5. Operate the machine and test the traction neutral switch operation before returning the machine to service.

Parking Brake Switch



g306071

Figure 90

POSITION	CLOSED CIRCUITS	
ENGAGED (brake lever up)	1 + 3	
DISENGAGED (brake lever down)	1 + 2	

The parking brake switch is located under the brake lever cover on the left side of the brake lever. A set of normally closed contacts in the switch are opened when the parking brake is disengaged (brake lever down). Only two (2) of the switch terminals are used in the parking brake switch circuit.

The TDM display/controller monitors the position of the parking brake switch. The parking brake switch is part of the machine safety interlock system. Using the parking brake switch position (open or closed) and a variety of other inputs, the TDM display/controller manages a variety of machine functions.

Testing the Parking Brake Switch

The parking brake switch and its circuit wiring can be tested using the TDM display/controller main information screens (brake icon); refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). 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 unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the 4 panel fasteners and remove the parking brake lever cover from the machine.
3. Disconnect the machine wire harness from the switch. Check the switch and the harness connector for damage or corrosion and clean or repair if necessary.
4. Use a multimeter (ohms setting) to determine whether continuity exists between the various terminals for each switch position.

Testing the Parking Brake Switch (continued)

5. Replace the switch if necessary.
6. If the parking brake switch testing is correct and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).
7. Connect the wire harness connector and test the parking brake switch operation before returning the machine to service.
8. Install the parking brake lever cover.

Cutting Unit High Trim Height Switch

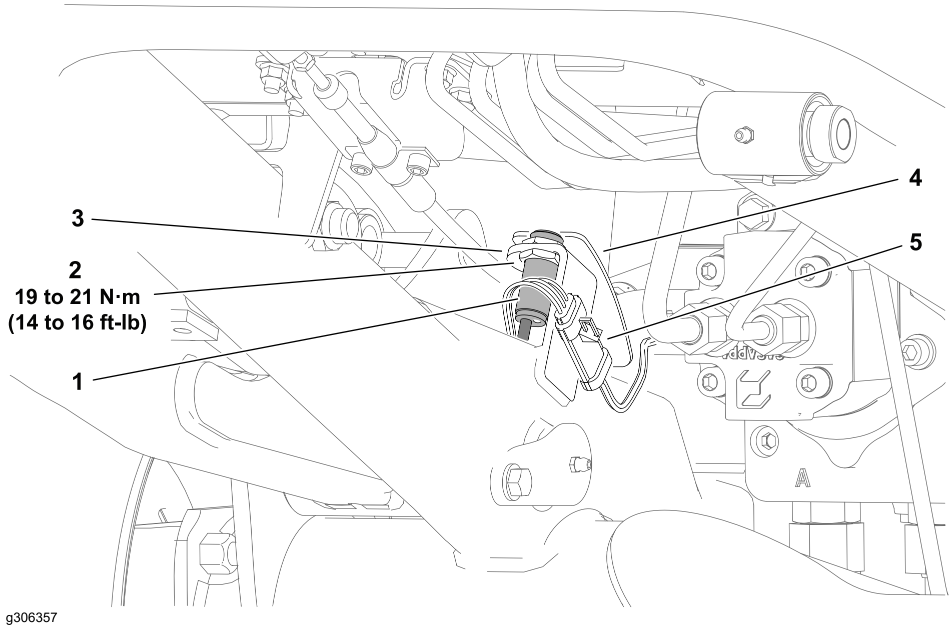


Figure 91

1. Cutting unit high trim height switch
2. Jam nut (2 each)
3. Switch bracket
4. Sensing plate
5. Wire harness connector

The cutting unit high trim height switch is a normally open proximity switch that closes when the lift arms are lowered. The switch mounts to a bracket on the machine frame behind the right front wheel. The sensing element for the high trim height switch is the sensing plate that is secured to the right side lift arm. When the lift arm is in the lowered position, the sensing plate will be near the switch face and the switch will be closed. When the lift arm is raised, the sensing plate moves away from the position switch face and the switch opens.

With the key switch in the RUN position, the LED on the cable end of the high trim height switch should be illuminated when the lift arm is in the lowered position. Use a small mirror to view the LED if necessary.

The TDM display/controller monitors the position of the high trim height switch. Using the high trim height switch position (open or closed) and a variety of other inputs, the TDM display/controller manages a variety of machine functions.

Adjusting the Cutting Unit High Trim Height Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake and set the key switch to the OFF position.
2. The cutting unit high trim height switch should have a **6 mm (0.24 in)** clearance between the center of the sensing eye of the switch and the sensing plate.

Adjusting the Cutting Unit High Trim Height Switch (continued)

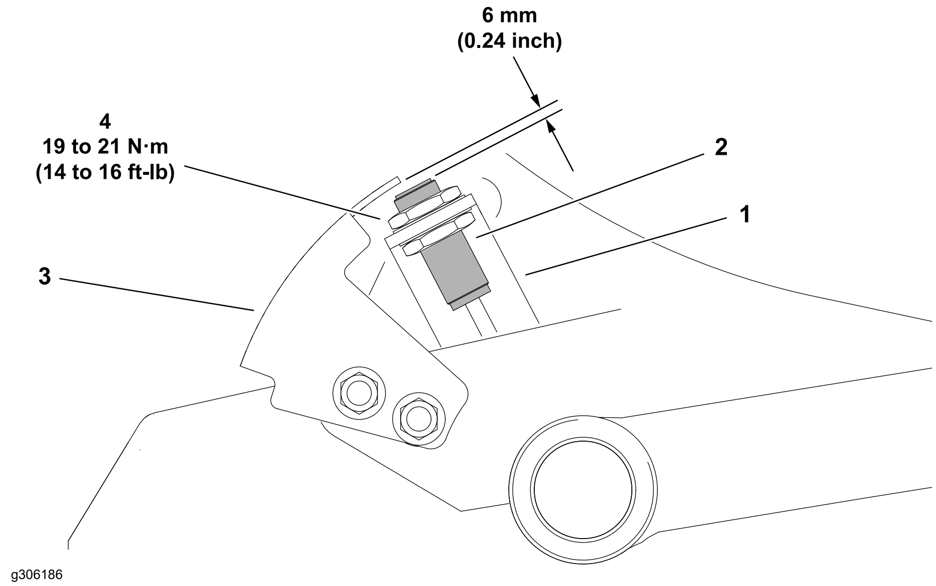


Figure 92

1. Switch bracket (on frame)
2. High trim height switch
3. Sensing plate (on lift arm)
4. Jam nut (2 each)

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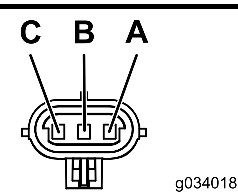
3. If necessary, loosen the lock nuts securing the switch to the switch bracket and set the switch so the correct clearance exists between the target eye and the sensing plate. Tighten the switch lock nuts from **19 to 21 N·m (14 to 16 ft−lb)**. Re-check the switch to sensing plate clearance and adjust if necessary.

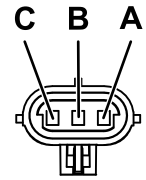
Testing the Cutting Unit High Trim Height Switch

The cutting unit high trim height switch and its circuit wiring can be tested using the TDM display/controller; refer to Using the TDM Display/Controller Screens for Troubleshooting (page 3–12). 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 unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Ensure that the high trim height switch is properly adjusted; refer to Adjusting the Cutting Unit High Trim Height Switch (page 6–34).
3. Disconnect the high trim height switch from the machine wire harness. Check the harness connectors for damage or corrosion and clean or repair if necessary. Use a multimeter (ohms setting) to check the machine wire harness connector.

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	Main	P102	C	Black	Less than 2 ohms	
2	Chassis Ground					

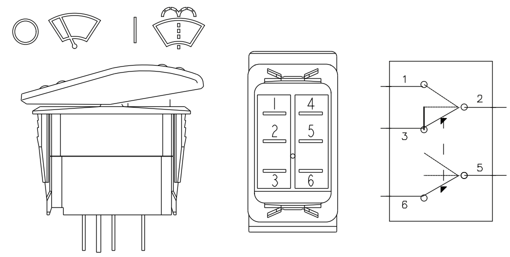
Testing the Cutting Unit High Trim Height Switch (continued)

1	Main	P102	A	Pink	12 VDC with key switch in the RUN position (do not start engine)	 g034018
2	Chassis Ground					

4. If the harness wires test correctly and the switch LED does not function, replace the high trim height switch. Connect the high trim height switch to the machine wire harness and adjust the switch after installation; refer to Adjusting the Cutting Unit High Trim Height Switch (page 6–34).
5. Operate the machine and test the high trim height switch operation before returning the machine to service.

Windshield Washer/Wiper Switch (Model 31903 and 31909)

POSITION	CLOSED CIRCUITS
OFF	1 + 2
WIPER	2 + 3
WASHER	2 + 3, 5 + 6



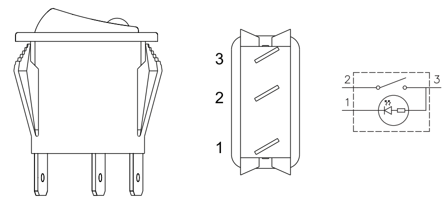
The windshield washer/wiper switch is located in the cab control panel cover. The windshield washer/wiper switch controls the operation of the windshield wiper and the washer pump. The windshield washer/wiper switch receives power from fuse F−3 (20 Amp) in the cab fuse block.

Testing the Windshield Washer/Wiper Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the switch plate from the control panel cover.
3. Disconnect the wire harness electrical connector from the windshield wiper/washer switch. Check the switch and the harness connector for damage or corrosion and clean or repair if necessary.
4. Use a multimeter (ohms setting) and the preceding table to determine whether continuity exists between the various terminals for each switch position.
5. Replace the windshield wiper/washer switch if necessary.
6. If the windshield wiper/washer switch testing is correct and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).
7. Connect the wire harness to the windshield wiper/washer switch.
8. Install the switch plate.

Air Conditioning On/Off Switch (Model 31903 and 31909)

POSITION	CLOSED CIRCUITS
OFF	NONE
ON	1+ 2 + 3

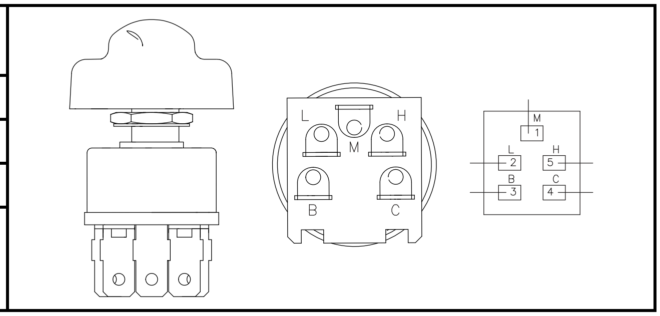


Testing the Air Conditioning On/Off Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery.
3. Remove the roof from the cab.
4. Disconnect the wire harness connectors from the switch and remove the switch from the AC control panel 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch, connect the wire harness, inspect and repair the roof seals as necessary, and install the roof after testing.
9. Connect the battery negative (-) cable at the battery.

Fan Speed Switch (Model 31903 and 31909)

POSITION	CLOSED CIRCUITS
OFF	NONE
LOW	B + C + L
MED	B + C + M
HIGH	B + C + H



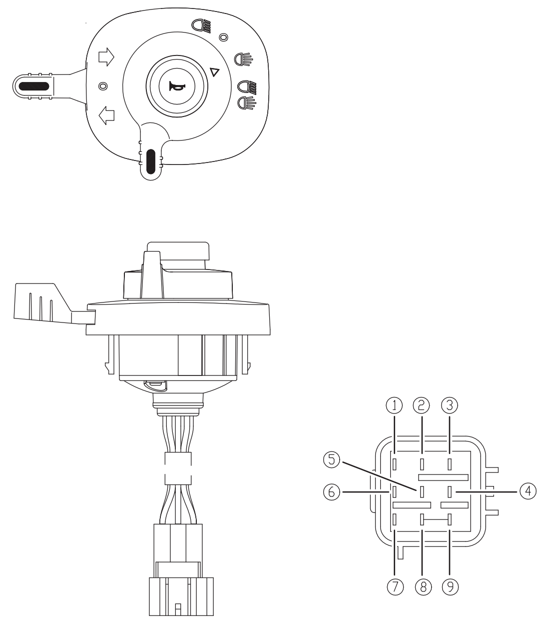
The fan speed switch is located in the cab headliner. The switch is used to select the fan speed (off, low, medium, or high). The fan speed switch receives power from fuse F−2 (40 Amp) in the cab fuse block.

Testing the Fan Speed Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the roof from the cab.
4. Disconnect the wire harness connector from the switch and remove the switch from the control panel if necessary. Check the switch and the harness connector for damage or corrosion and clean or repair 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 wire harnesses; refer to Appendix A (page A–1).
8. Install the switch, connect the wire harness, inspect and repair the roof seals if necessary, and install the roof after testing.
9. Connect the battery negative (-) cable at the battery.

Multifunction Switch (Optional)

POSITION	CLOSED CIRCUITS
ALL OFF	NONE
HORN	4 + 8
ROAD LIGHTS	1 + 9
WORK LIGHTS	3 + 9
ROAD and WORK LIGHTS	1 + 3 + 9
TURN SIGNALS (Turn Right)	2 + 6
TURN SIGNALS (Turn Left)	2 + 7



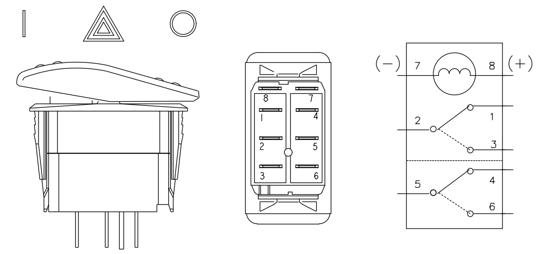
The multifunction switch is used to control the optional work lights, road lights, turn signals, and horn. The switch is located in the optional steering column control pod.

Testing the Multifunction Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. To access the switch, remove the cover from the steering column control pod.
4. Disconnect the machine wire harness connector from the multifunction switch. Check the switch and the harness connector for damage or corrosion and clean or repair 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 testing determines that the switch is damaged.
7. If the switch testing is correct and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
8. After you complete the testing, connect the machine wire harness connector to the switch and install the control pod cover.

Hazard Switch (Optional)

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

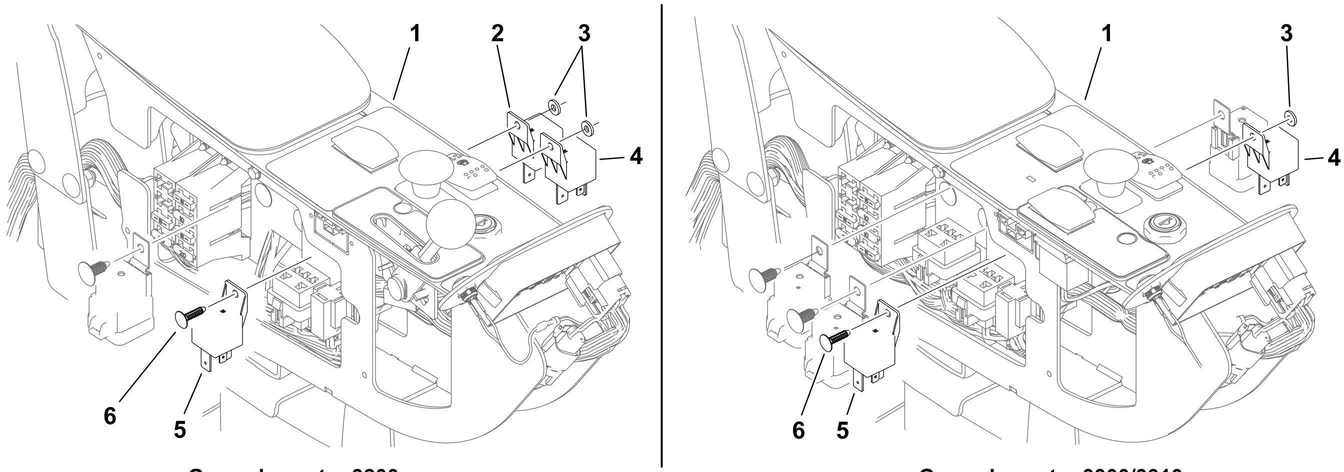


The optional hazard switch is located on the steering column control pod. When the forward end of the hazard switch is depressed, power is sent to the flasher module to illuminate the hazard lights (switch light illuminated). The hazard lights will continue to flash until the switch is returned to the OFF (rearward) position. The hazard switch receives power from a 15 Amp fuse located in the cab power supply harness (along the frame crossmember in front of the engine).

Testing the Hazard Switch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the battery negative (-) cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the steering column control pod cover.
4. Disconnect the wire harness electrical connector from the hazard switch. Check the switch and the harness connector for damage or corrosion and clean or repair 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 hazard switch if necessary.
7. If the hazard switch testing is correct and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).
8. Connect the wire harness to the hazard switch.
9. Install the control pod cover.

Relays with 4 Terminals

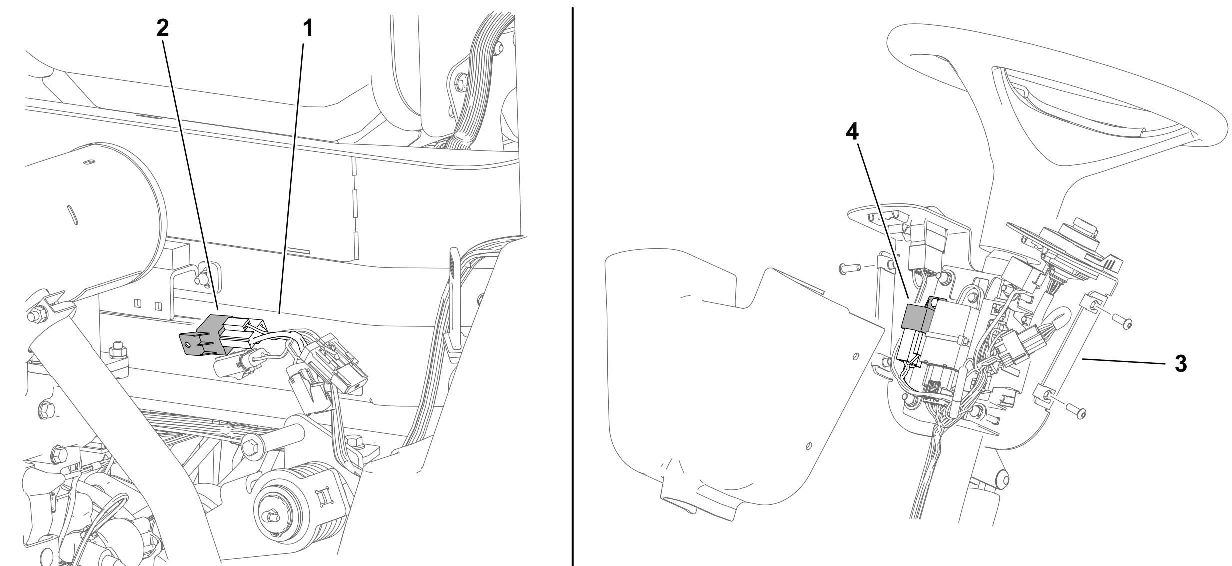


Groundsmaster 3200 | Groundsmaster 3300/3310

g304775

Figure 93

1. Operator's console
2. Relay – fuel solenoid pull coil
3. Washer
4. Relay – main power
5. Relay – glow plug
6. Panel fastener



Groundsmaster 3310 | Optional

g306841

Figure 94

1. Frame crossmember
2. Cab power relay
3. Steering column control pod (optional)
4. Horn relay (optional)

The Groundsmaster 3200 machine uses 3 identical relays that have 4 terminals. The Groundsmaster 3300/3310 machines use 2 identical relays that have 4 terminals. The relays are located in the operator's console. A tag near the wire harness relay connector can be used to identify each relay.

Groundsmaster 3310 machines have an additional 4 terminal relay used to control the cab control circuits located along the frame crossmember in front of the engine.

An additional 4 terminal relay is part of the optional horn kit and is located in the steering column control pod.

Relays with 4 terminals:

- The main power relay supplies power to the fuses (and all of the circuits protected by the fuses) in fuse block 2; refer to Fuse Identification and Function (page 6–12). The main power relay is energized when the key switch is in the RUN or START position.
- The glow plug relay supplies power to the engine glow plugs. For model 31900 and 31901 machines; the glow plug relay is energized while the glow switch is pressed. For model 31902 and 31903 machines, the glow relay is energized by the Yanmar engine ECU.
- The pull coil relay supplies power to the pull coil of the engine fuel solenoid (models 31900 and 31901 only). The pull coil relay is energized by the start interlock relay and the delay timer.
- The cab power relay supplies power to the cab control circuits of Groundsmaster 3310 machines.
- The horn relay supplies power to the optional horn.

Testing Relays with 4 Terminals

Refer to Figure 93 and Figure 94 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the ground cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator's console covers; refer to Removing and Installing the Operator's Console Covers (page 7–23).
4. Locate the relay that is to be tested and disconnect the wire harness connectors from the relay. Check the relay and the harness connector for damage or corrosion and clean or repair if necessary.

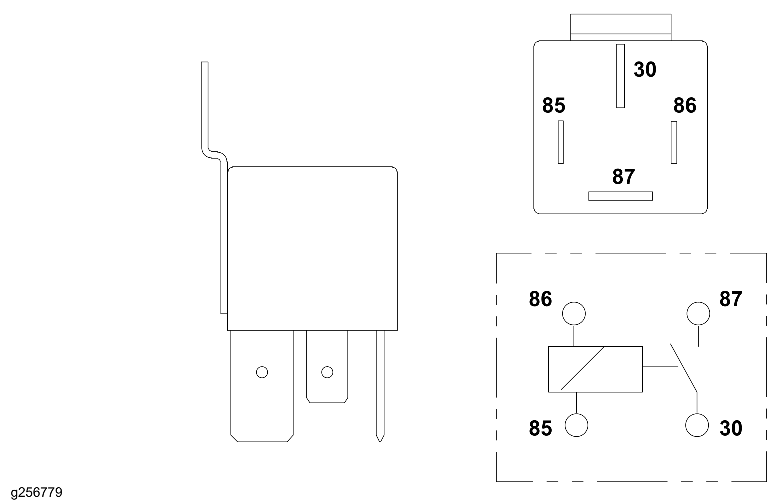


Figure 95
Relay with 4 terminals

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 coil resistance between terminals 85 and 86. Resistance should be between 70 and 100 ohms.

Testing Relays with 4 Terminals (continued)

6. Connect the multimeter (ohms setting) leads to relay terminals 30 and 87. The ground terminal 85 and apply +12 VDC to terminal 86. The relay should make and break continuity between the terminals 30 and 87 as +12 VDC is applied and removed from terminal 86.
7. Verify infinite resistance (no continuity) exists between terminals 30 and 87.
8. Connect the 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 +12 VDC is applied and removed from terminal 85.
9. Replace the relay if necessary.
10. If the relay testing is correct and a circuit problem still exists, check the main wire harness; refer to Appendix A (page A–1).
11. Connect the wire harness electrical connectors to the relay after you complete the testing.
12. Connect the wire harness, install any items removed to access the relay, and connect the battery ground cable.

Relays with 5 Terminals

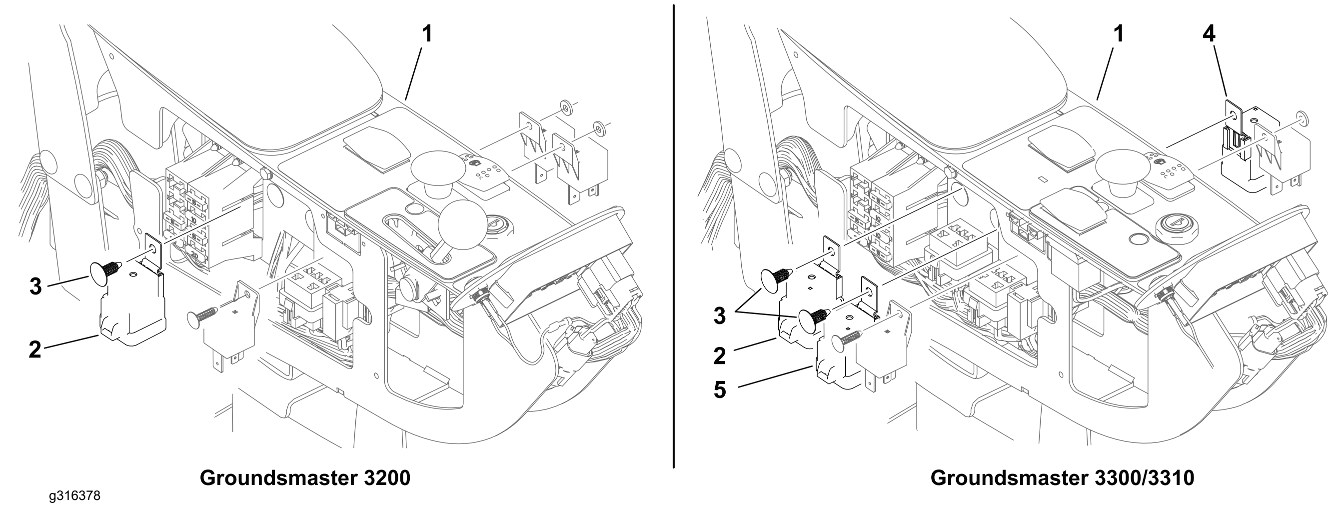


Figure 96

1. Operator's console
2. Relay – start interlock
3. Panel fastener
4. Relay – EGR valve
5. Relay – start

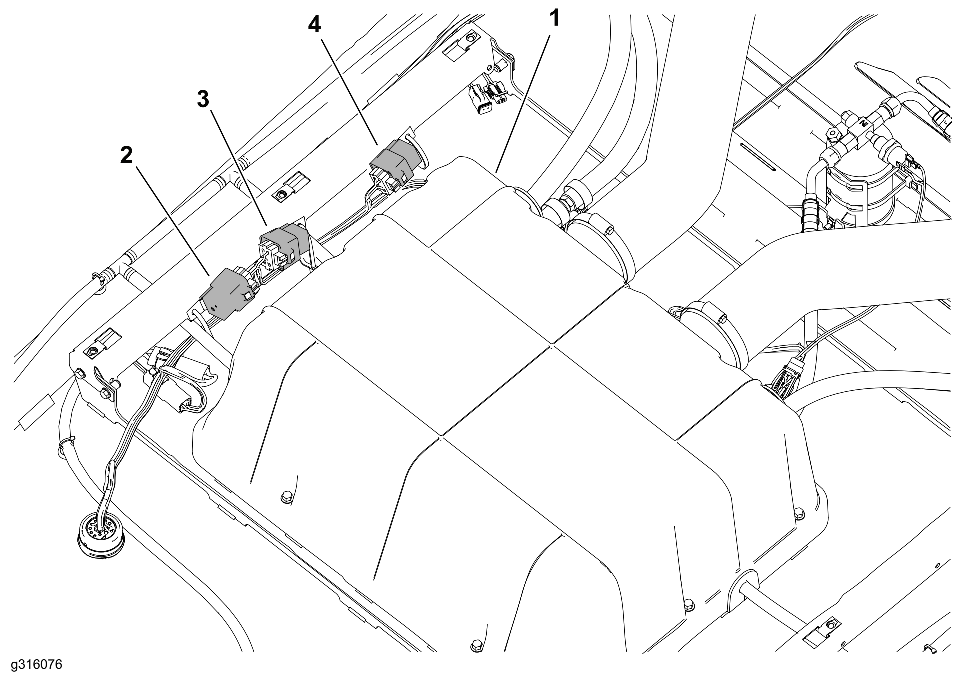


Figure 97

1. AC/Heat assembly
2. AC condenser fans relay
3. AC switch signal relay
4. AC clutch relay

The Groundsmaster 3200 machine uses one relay that has 5 terminals. The Groundsmaster 3300/3310 machines use 3 identical relays that have 5 terminals. The relays are located in the operator's console. A tag near the wire harness relay connector can be used to identify each relay.

Groundsmaster 3310 machines have three additional 5 terminal relays used to control the air conditioning (AC) system located under the cab cover.

Relays with 5 terminals:

- The start interlock relay is used to send the OK to Start signal to the engine. For model 31900 and 31901 machines, the start interlock relay sends power to the engine starter solenoid and the engine fuel solenoid via the delay timer. For model 31902 and 31903 machines, the start interlock relay sends power to the engine ECU. The start interlock relay is energized by the TDM.

- The Exhaust Gas Recirculation (EGR) relay is used to provide current to the engine EGR valve (models 31902 and 31903 only). The EGR relay is energized by the Yanmar engine ECU.
- The start relay supplies power to the engine starter (models 31902 and 31903 only). The start relay is energized by the Yanmar engine ECU.
- The AC condenser fans relay provides current to both of the condenser fans and the AC clutch relay (models 31903 and 31909 only). The AC condenser fans relay is energized by the air conditioning system thermostat.
- The AC switch signal relay is part of the standard cab rooftop harness, but is not used on Groundsmaster 3310 machines.
- The AC clutch relay and the AC condenser fans relay must be energized to engage the compressor clutch (models 31903 and 31909 only). The AC clutch relay is energized by the thermostat as long as the minimum AC system pressure exists (AC pressure switch closed).

Testing Relays with 5 Terminals

Refer to Figure 96 and Figure 97 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the ground cable at the battery; refer to Removing and Installing the Battery (page 6–69).
3. Remove the operator's console covers; refer to Removing and Installing the Operator's Console Covers (page 7–23).
4. Locate the relay that is to be tested and disconnect the wire harness connectors from the relay. Check the relay and the harness connector for damage or corrosion and clean or repair if necessary.

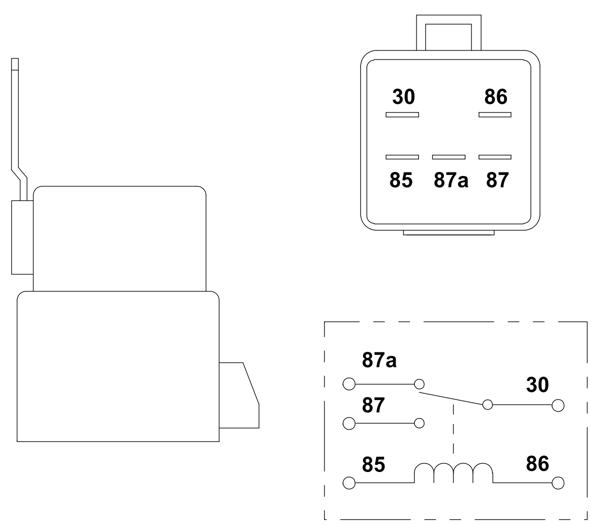


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Figure 98

Relay with 5 terminals

Testing Relays with 5 Terminals (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. Using a multimeter, verify that coil resistance between terminals 85 and 86 is from 71 to 88 ohms.
6. 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 +12 VDC is applied and removed from terminal 85.
7. 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.
8. Replace the relay if 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. Connect the wire harness, install any items removed to access the relay, and connect the battery ground cable.

PTO Clutch

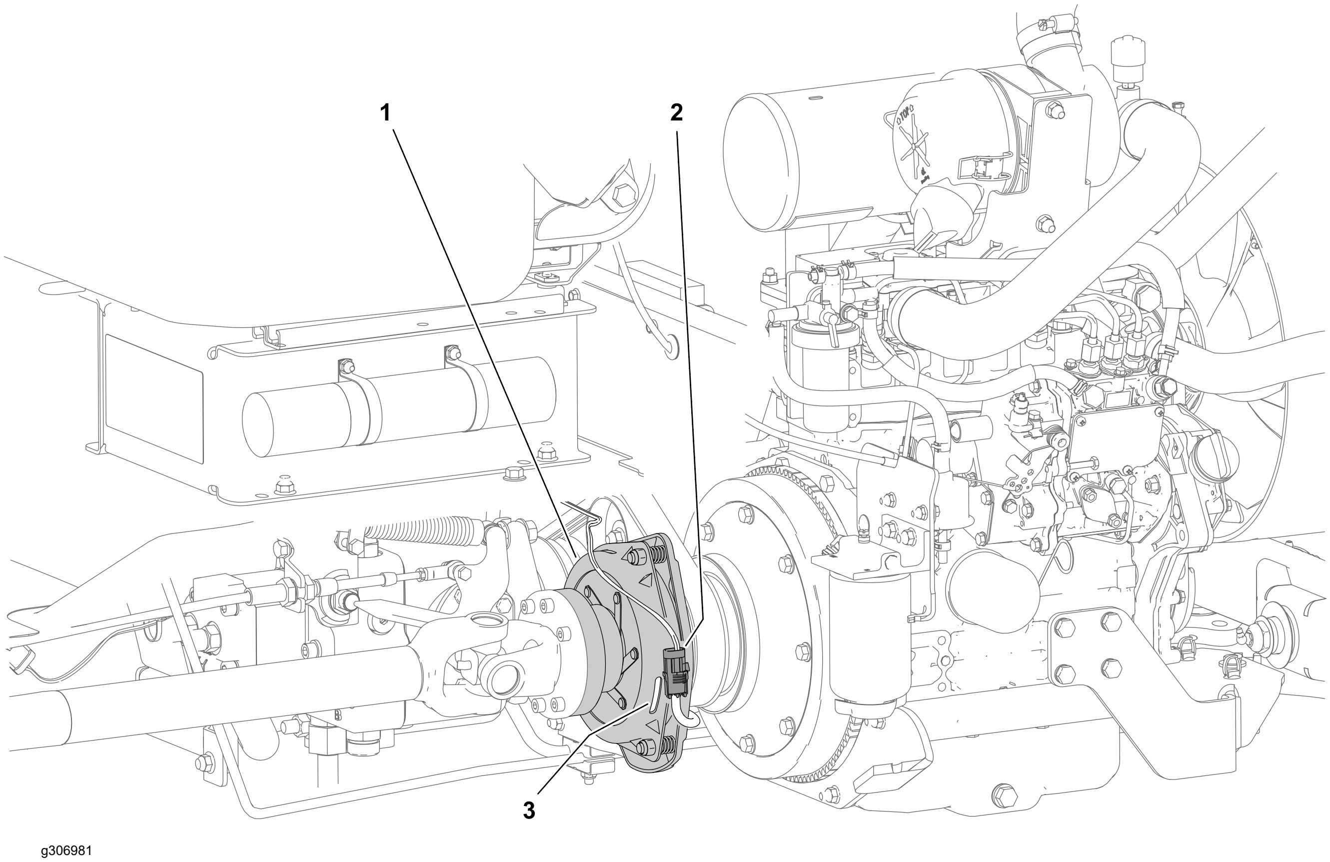

Figure 99

1. PTO clutch
2. Wire harness connector
3. Access slot (3 each)

An electric clutch is used to engage the PTO. The electric clutch is mounted on the engine crankshaft and engages when current is applied to the clutch coil. The clutch also incorporates a magnetic brake to stop clutch rotation when the clutch is de-energized. For PTO clutch adjustment information, refer to Adjusting the PTO Clutch (page 7–4).

Testing the PTO Clutch

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Unplug the clutch electrical connector from the machine wire harness. Check the harness connectors for damage or corrosion and clean or repair if necessary.

   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 of the component you are testing to obtain an accurate reading.

3. Use a multimeter (ohms setting), check the clutch coil resistance across the two clutch connector terminals. The coil resistance should be approximately **2.2 ohms when tested at 20°C (68°F)**. Check that there is no continuity between either of the clutch terminals and the clutch frame.
4. Apply 12 VDC to the terminals of the PTO electric clutch. The coil should energize and the clutch should engage.

Testing the PTO Clutch (continued)

5. Replace the clutch if necessary; refer to Removing and Installing the PTO Clutch (page 7–21).
6. After testing, connect the clutch electrical connector to the machine wire harness.

Fuel Pump

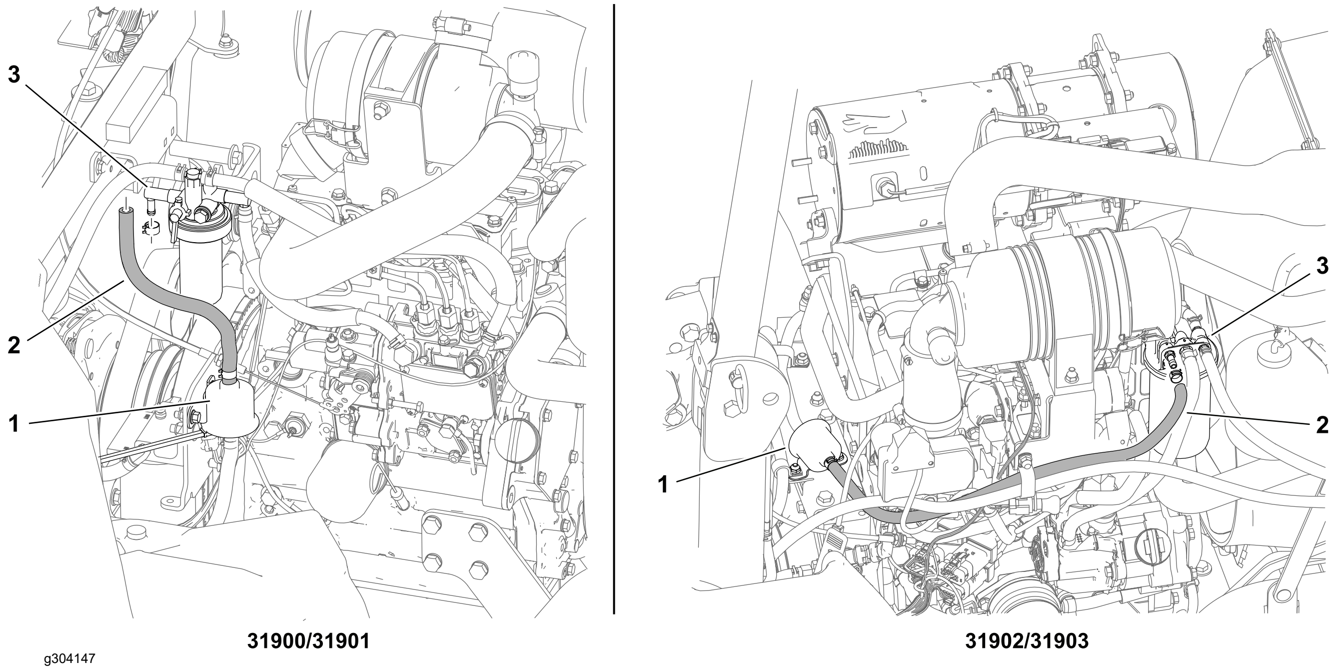

Figure 100

1. Fuel pump
2. Fuel hose (disconnected)
3. Engine fuel filter

Fuel Pump Specifications

Pump Capacity	700 ml (23.5 fluid ounces) per minute
Pressure	22.8 kPa (3.3 psi)
Current Draw	0.9 amp

Testing the Fuel Pump

The fuel pump used on the Groundsmaster 3200/3300/3310 machines is attached to the support bracket at the front of the engine. Testing the fuel pump involves measuring the amount of fuel an unrestricted pump can deliver over a set period of time.

Refer to Figure 100 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake and set the key switch to the OFF position.
2. Ensure that the fuel hoses attached to the fuel pump are free of obstructions.
3. Drain the fuel/water separator; refer to the traction unit *Operator's Manual*. Verify separator element age and condition and replace if necessary.

   Note: Since the fuel/water separator is upstream of the fuel pump, the condition of the fuel/water separator will influence fuel pump performance.
4. Check the fuel pump harness connectors for damage or corrosion and clean or repair if necessary.
5. Disconnect the fuel hose coming from the fuel pump at the engine fuel filter.

IMPORTANT

When testing the fuel pump output, do not turn the key switch to the START position.

6. Hold the disconnected end of the fuel hose in a 0.95 liter (1 quart) graduated cylinder and set the key switch to the RUN position for 30 seconds. The pump should deliver approximately **350 ml (11.8 ounces) in 30 seconds** of fuel. Replace the fuel pump if necessary.
7. After testing, connect the fuel hoses and secure with hose clamps.
8. Prime the fuel system; refer to Priming the Fuel System (page 4–17).

Transient Voltage Suppression (TVS) Diode

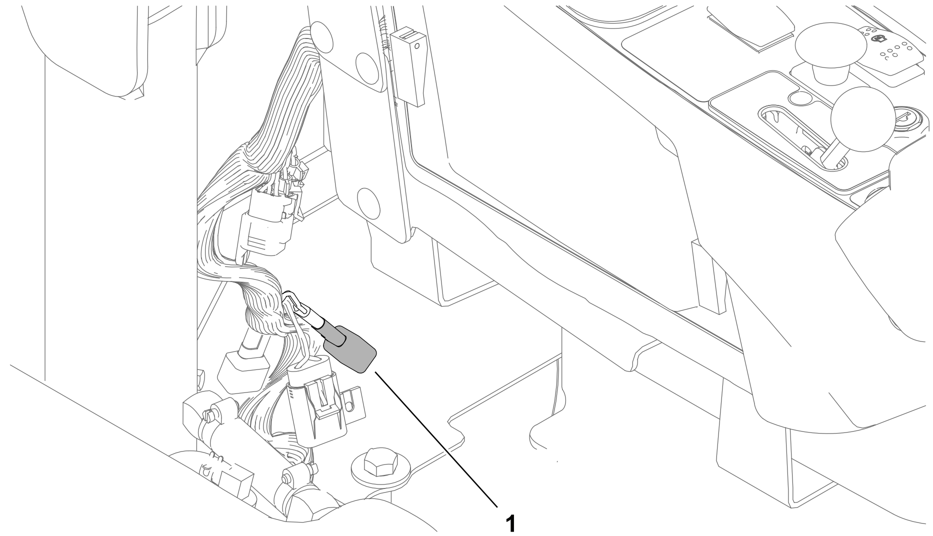

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Figure 101

1. TVS diode

A transient voltage suppression (TVS) diode assembly is used to protect the electrical system components from power surges created by energizing and de-energizing the PTO clutch coil. The TVS diode plugs into the main wire harness above the right rear corner of the operator's platform. The TVS diode can be identified by its yellow color and TVS diode symbol on the end of the diode body.

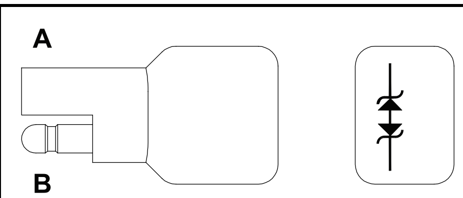
If the TVS diode fails, it may cause a short in the circuit. This type of failure would cause fuse FB1–F4 to blow. Test the TVS diode if fuse FB1–F4 blows repeatedly.

If the TVS diode fails, it may cause an open circuit. This type of failure could damage the TDM controller output for the PTO clutch. Test the TVS diode if the PTO clutch coil does not energize or de-energize correctly.

Testing the Transient Voltage Suppression (TVS) Diode

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Locate and remove the TVS diode from the wire harness. Check the diode and the diode holder for damage or corrosion and clean or repair if necessary.
3. Use the table provided and a multimeter (ohms setting) to measure the resistance across the diode terminals.

Multimeter Red (+) Lead	Multimeter Black (-) Lead	Desired Resistance
DIODE TERMINAL A	DIODE TERMINAL B	VERY LOW
DIODE TERMINAL B	DIODE TERMINAL A	VERY LOW



4. If testing determines the TVS diode is faulty, replace the diode.
5. If the TVS diode tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. After testing is complete, make sure the TVS diode is fully installed into the connector and secured to the wire harness.

Diode Assemblies (Model 31902 and 31903)

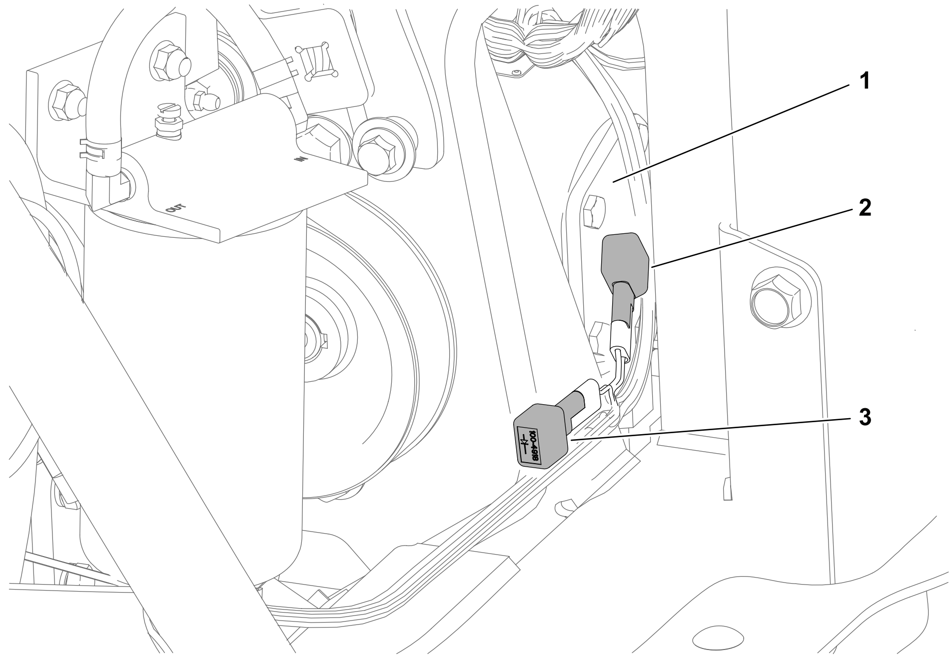


Figure 102

(shown with hydraulic tank removed)

1. Traction pump
2. Diode at connector P57 (starter)
3. Diode at connector P56 (EGR)

Two (2) different diodes are used on the Groundsmaster 3300/3310 (model 31902 and 31903) 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. The diodes plug into the main wire harness on the right side frame rail near the traction pump.

- A diode assembly (at main wire harness connector P57) is used for circuit protection from voltage spikes that occur when the starter solenoid is de−energized.
- A diode assembly (at main wire harness connector P56) is used to protect the engine ECU from reverse polarity in the EGR relay circuit.

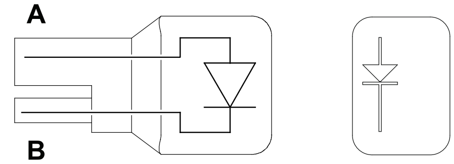
Testing the Diode Assemblies

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Locate and remove the diode from the wire harness. Check the diode and the diode holder for damage or corrosion and clean or repair if necessary.
3. 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.

Testing the Diode Assemblies (continued)

Multimeter Red (+) Lead	Multimeter Black (-) Lead	Resistance	
DIODE TERMINAL A	DIODE TERMINAL B	VERY LOW	
DIODE TERMINAL B	DIODE TERMINAL A	VERY HIGH	

4. If testing determines the diode is faulty, replace the diode.
5. If the diode tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. After testing is complete, make sure the diode is fully installed into the connector and secured to the wire harness.

Resistor Assemblies

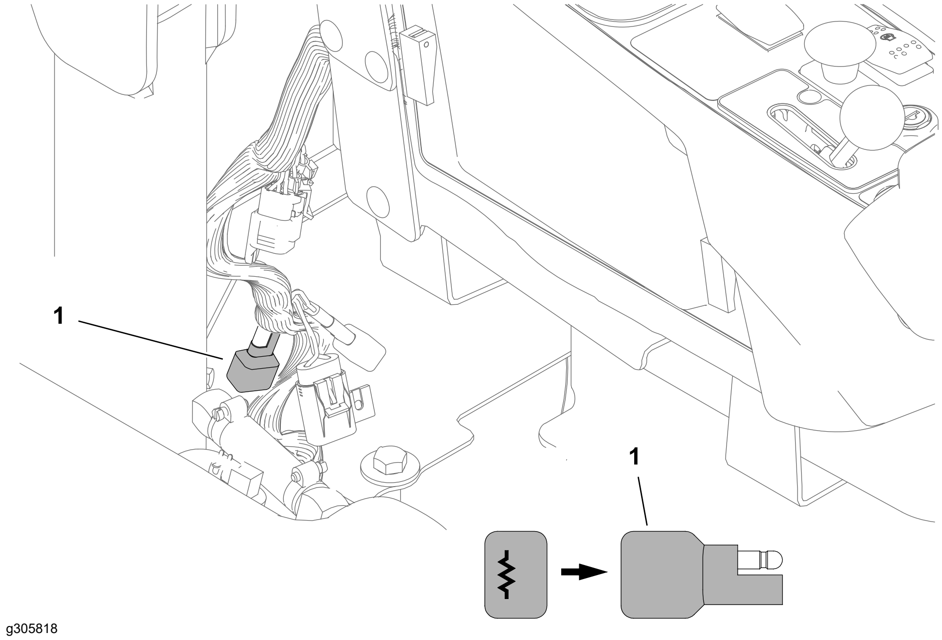


Figure 103

1. 75 ohm resistor

A 75 ohm resistor assembly is used for proper key switch (start circuit) operation. The resistor plugs into the main wire harness above the right rear corner of the operator's platform. The resistor can be identified by its gray color and resistor symbol on the end of the resistor body.

Testing the Resistor Assembly

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the resistor from the wire harness. Check the resistor and the resistor holder for damage or corrosion and clean or repair if necessary.
3. Measure the resistance across the resistor terminals using a digital multimeter (ohms setting). The resistance across the terminals should be at or near the resistors rated resistance.
4. If testing determines the resistor is faulty, replace the resistor.
5. If the resistor tests correctly and a circuit problem still exists, check the wire harnesses; refer to Appendix A (page A–1).
6. After testing is complete, make sure the resistor is fully installed into the connector and secured to the wire harness.

CAN bus Terminator Resistors

System communication between various electrical components on the Groundsmaster 3200/3300/3310 machines is accomplished on a CAN bus communications network. Two specially designed, twisted wires form the CAN bus. These wires provide the data pathways between the components on the network. The engineering term for these cables are CAN High and CAN Low. The CAN bus wires are red/white (CAN High) and black/white (CAN Low). A 120 ohm termination resistor is located at each end of the CAN–bus.

For model 31900, 31901, 31907 and 31909 machines, one of the CAN bus terminator resistors is located at the rear of the operator's console and one of the CAN bus terminator resistors is located at the front of the operator's console under the console cover. Both of the CAN bus terminator resistors are (external) and are replaceable separately.

For model 31902 and 31903 machines, one of the CAN bus terminator resistors is located at the front of the operator's console under the console cover (external) and is replaceable separately. The second CAN bus termination resistor is part of the Yanmar engine ECU (integrated) and can be tested as part of the CAN bus wiring. The integrated termination resistor is not replaceable separately.

Note: Refer to Appendix A (page A–1) for additional information on the CAN bus wiring.

Testing the CAN bus Terminator Resistors

External Resistors

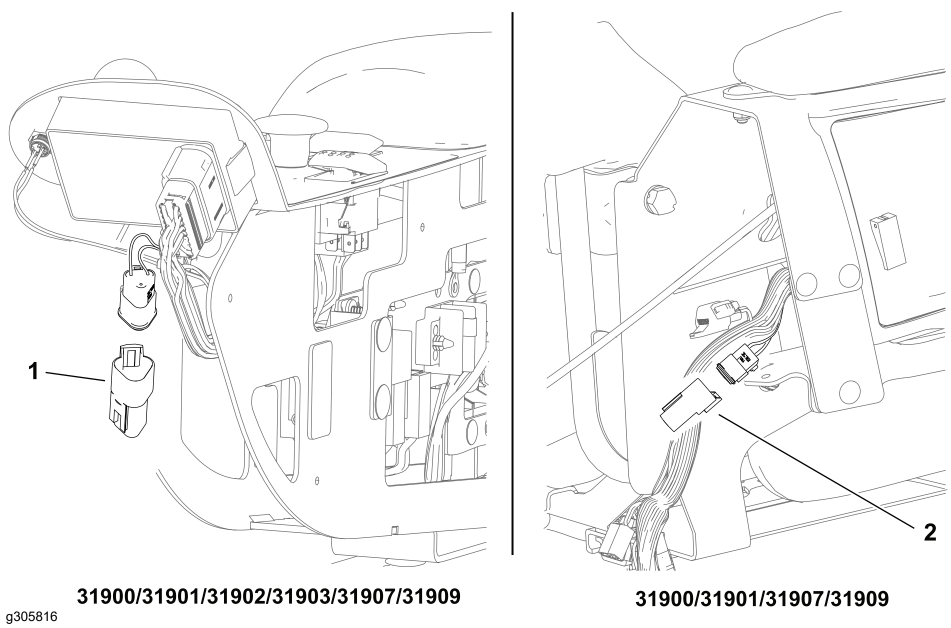


Figure 104

1. CAN bus terminator resistor at connector P35
2. CAN bus terminator resistor at connector P111 (models 31900, 31901, 31907 and 31909)

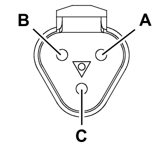
---

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the operator's console covers if necessary; refer to Removing and Installing the Operator's Console Covers (page 7–23).
3. Disconnect the CAN bus terminator resistor from the machine wire harness and use a multimeter (ohms setting) to check the resistor. Check the

Testing the CAN bus Terminator Resistors (continued)

resistor and the resistor holder for damage or corrosion and clean or repair if necessary.

Note: The insulator wedge in the external termination resistor is blue for identification purposes. There also is a center keyway to prevent the termination resistor from plugging into the wrong wire harness connector.

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	CAN bus Terminator Resistor	Resistor at connector P35 or P111	A	N/A	120 ohms	
2			B			

4. If testing determines the external termination resistor is faulty, replace the resistor.
5. After testing is complete, make sure the external terminator resistor is fully installed into the connector and secured to the wire harness.
6. Install the operator's console covers if previously removed.

Internal Resistors

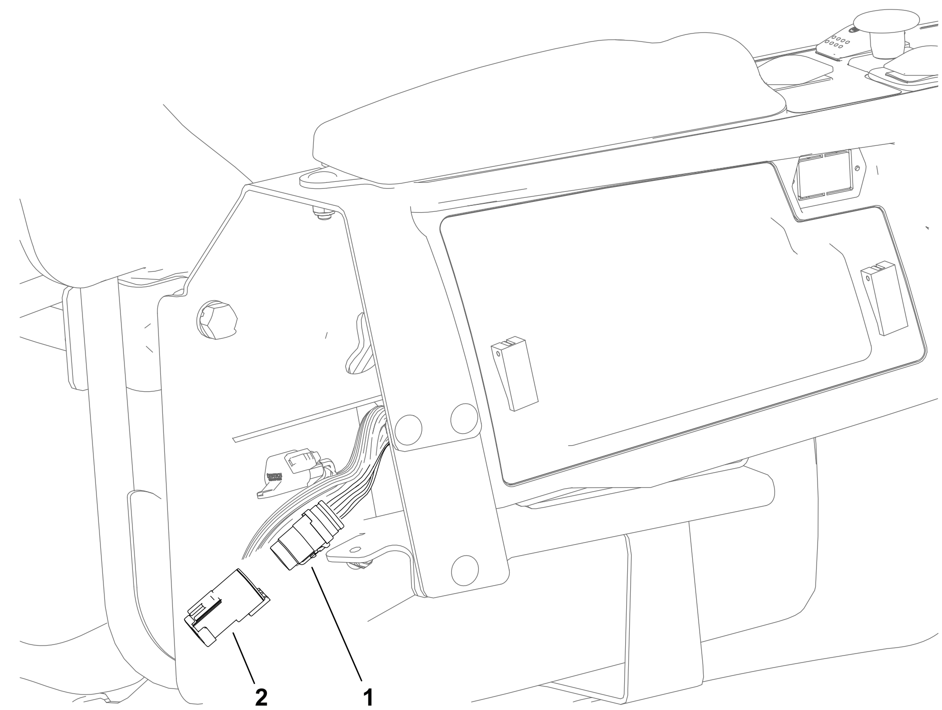


Figure 105

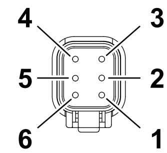
1. Yanmar SA-D connector
2. Cover

---

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the operator's console covers; refer to Removing and Installing the Operator's Console Covers (page 7–23).
3. Disconnect the external CAN bus terminator resistor from the machine wire harness at the front of the operator's console.

Testing the CAN bus Terminator Resistors (continued)

4. Remove the cover from the Yanmar SA-D connector located behind the operator's console. Use a multimeter (ohms setting) to check the wire harness.

Location	Harness	Connector	Pin	Wire Color	Expected Reading	Connector Graphic
1	Main	P20	2	Red/White	120 ohms	
2	Main	P20	3	Black/White		

5. If testing determines the integrated termination resistor is faulty, replace the engine ECU; contact an Authorized Toro Distributor for assistance.
6. After testing is complete, install the SA-D connector cap, and make sure the external terminator resistor is fully installed into the connector and secured to the wire harness.
7. Install the operator's console covers if previously removed.

Hydraulic Solenoid Valve Coils

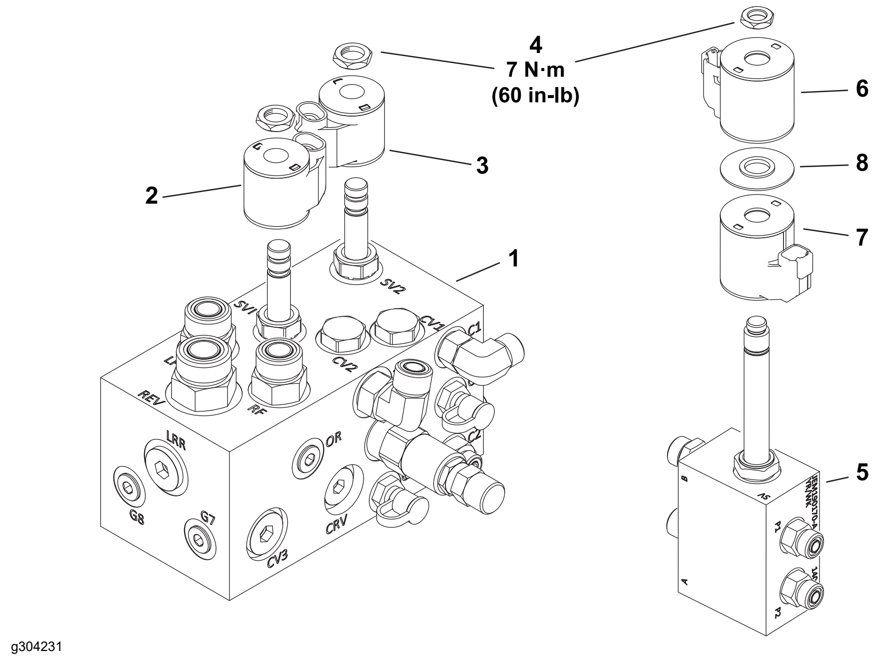


Figure 106

1. Main hydraulic manifold
2. Valve SV1 coil (raise)
3. Valve SV2 coil (lower)
4. Coil nut
5. Auxiliary hydraulic valve manifold (optional)
6. Auxiliary valve coil S1
7. Auxiliary valve coil S2
8. Coil spacer

Electric coil actuated hydraulic valves are used on the main manifold and the optional Auxiliary Hydraulic Valve manifold. When the coil or the coil relay is energized by the TDM, the hydraulic valve shifts to control hydraulic flow.

To assist in troubleshooting, identical replaceable solenoid coils can be exchanged. If the problem follows the coil, the coil is likely at fault. If the problem remains unchanged, something other than the coil is the likely problem source (e.g. switch, circuit wiring, hydraulic problem).

Testing the Hydraulic Solenoid Valve Coils

Typically, a failed solenoid coil will either be shorted (very low or no resistance) or open (infinite resistance).

1. Locate the hydraulic solenoid valve coil to be tested and disconnect the wire harness connector from the coil. Check the harness connectors and solenoid coils for damage or corrosion and clean or repair if necessary.

   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 of the component you are testing to obtain an accurate reading.

2. Using a multimeter (ohms setting), measure the resistance between the two (2) connector terminals on the solenoid coil. The resistance for the solenoid coils is identified below:

   A. The coils of solenoid valves SV1 and SV2 on the main hydraulic manifold are the same. Resistance of these coils should be approximately **8.8 ohms when tested at 20° C (68° F)**.

Testing the Hydraulic Solenoid Valve Coils (continued)

   B. The coils of solenoid valves SV1 and SV2 on the optional auxiliary hydraulic valve manifold are the same. Resistance of these coils should be approximately **7.1 ohms when tested at 20° C (68° F)**.

3. Replace solenoid valve coils if necessary:

   A. Remove the nut from the hydraulic valve.

   B. Slide the solenoid coil from the valve.

   C. Clean any corrosion or dirt from the valve stem.

   D. Install the coil and the nut onto the valve and tighten nut to **7 N·m (60 in-lb)**.

4. If the solenoid coil resistance is correct and a circuit problem still exists, check the wire harness; refer to Appendix A (page A–1).

5. After testing is completed, connect the wire harness connector to the solenoid coil.

Slope Sensor (Optional)

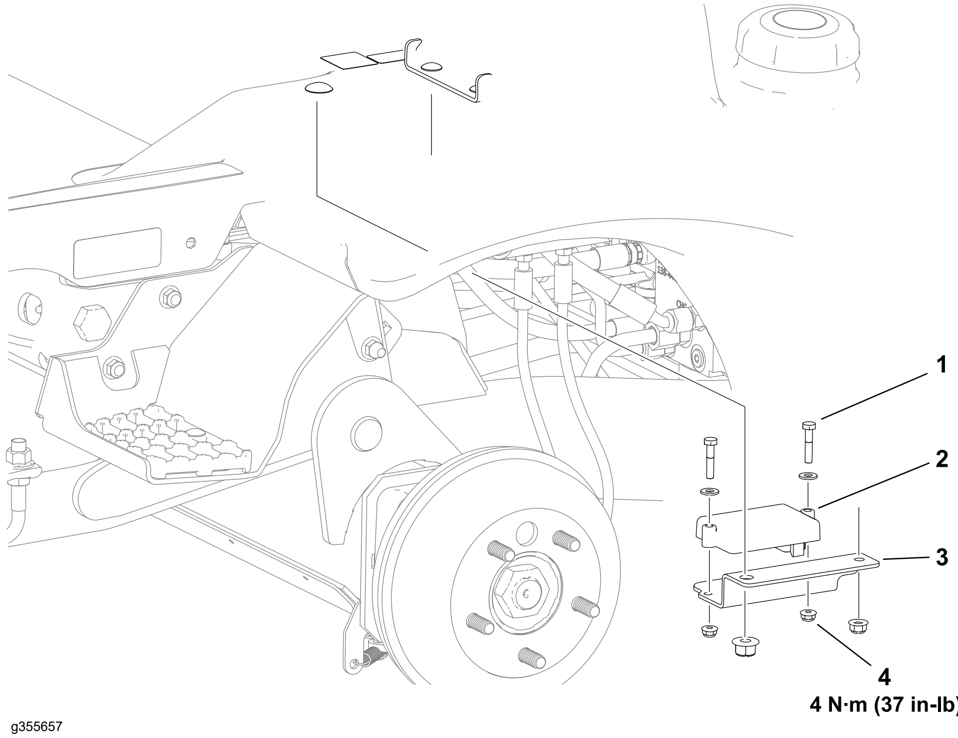


Figure 107

1. Cap screw (2 each)
2. Slope sensor module
3. Sensor bracket
4. Flange nut (2 each)

The optional slope sensor module is located under the operator platform near the fuel tank. Once installed, the optional slope sensor module is constantly monitored by the TDM during operation via the CAN bus. Switched and unswitched power for the slope sensor is provided through the machine expansion port. In addition to the 10 Amp fuse in the machine wire harness protecting the unswitched power supply to the expansion port, an additional 2 Amp fuse is included in the slope sensor wire harness to protect the slope sensor module. The slope sensor cannot be tested directly, but will generate a number of machine faults if the sensor fails to perform as expected; refer to Machine Faults (page 3–5).

Calibrating the Slope Sensor

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake and set the key switch to the OFF position.
2. Raise the hood to access the calibration connectors (left side of the lower panel behind the operator seat).

Calibrating the Slope Sensor (continued)

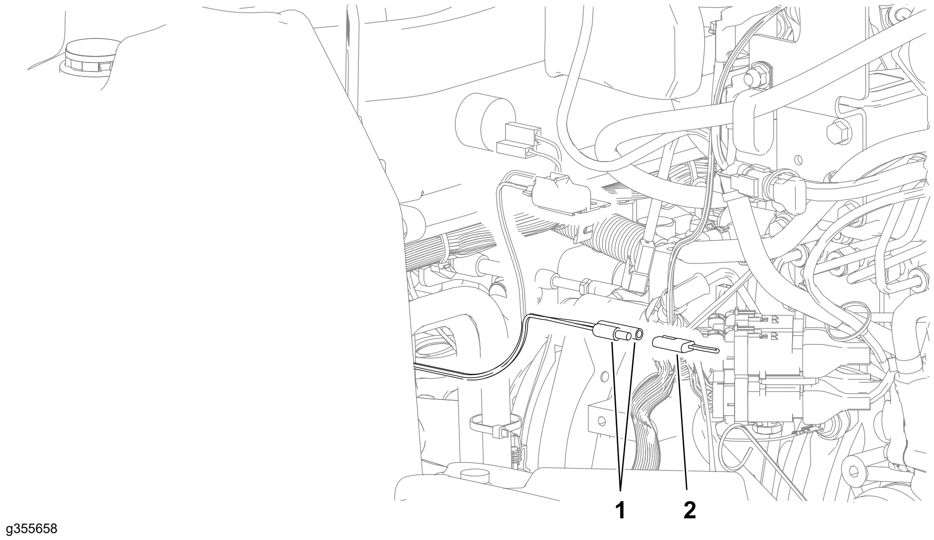


Figure 108

1. Calibration connectors
2. Plug

3. Remove the plug from the calibration connectors and connect the calibration connectors together as shown; refer to Figure 109.

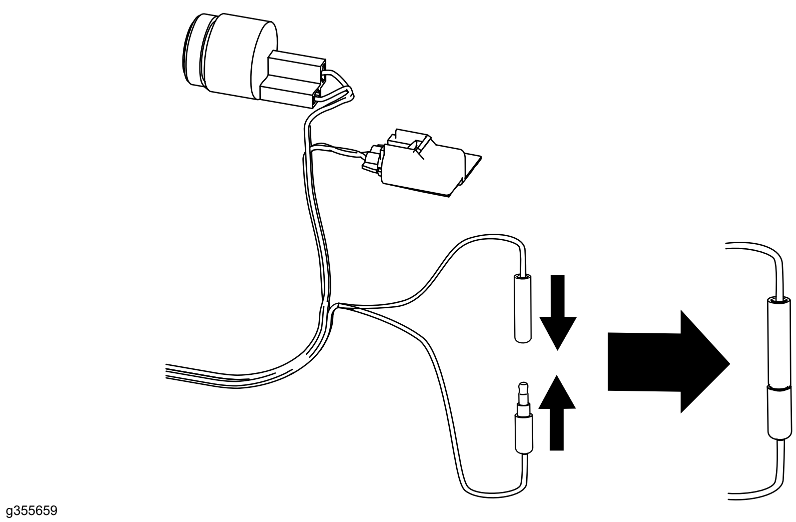


Figure 109

4. Set the key switch to the ON position, but do not start the engine.
5. The TDM display should show **Slope Sensor Calibrating**.

   Note: The LED light on the TDM display is solid green as the sensor calibrates.

6. When the TDM display shows **Slope Sensor Calibrated**, set the key switch to the OFF position.
7. Disconnect the calibration connectors and install the plug onto the connectors.
8. Test the slope sensor operation before returning the machine to service.

Removing and Installing the Slope Sensor

Refer to Figure 107 for this procedure.

Removing and Installing the Slope Sensor (continued)

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the left front wheel; refer to Removing and Installing the Wheels (page 7–5).
3. Disconnect the wire harness from the slope sensor module.
4. Check the harness connector and sensor module for damage or corrosion and clean or repair if necessary.
5. Remove the slope sensor module and sensor bracket assembly from the machine. Separate the sensor module from the bracket if necessary.
6. When installing the slope sensor module, tighten the fasteners that secure the sensor module to the sensor bracket to **4 N·m (37 in-lb)**.
7. Secure the sensor and bracket to the machine and connect the wire harness.
8. Calibrate the slope sensor; refer to Calibrating the Slope Sensor (page 6–61).

Slope Sensor Alarm (Optional)

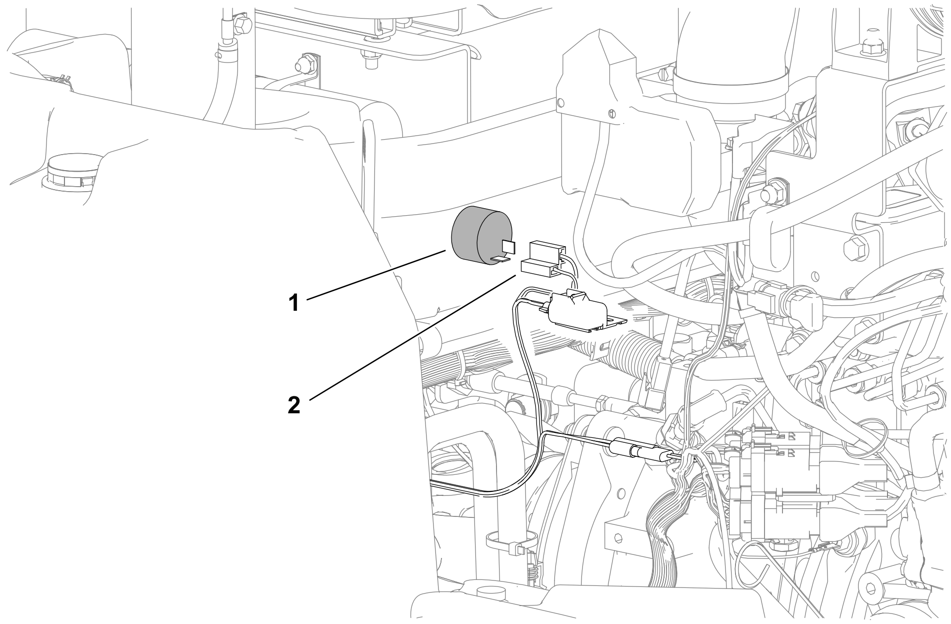


Figure 110

1. Audible alarm
2. Wire harness connector

The audible alarm sounds to notify the operator when the machine is operating on a steep slope; proceed to a more shallow slope. Electrical current for the alarm is provided as an output from the slope sensor module. The audible alarm is located on the left side of the lower panel behind the operator seat.

Testing the Slope Sensor Alarm

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake and set the key switch to the OFF position.
2. Raise the hood to access audible alarm and disconnect the machine wire harness from the alarm.
3. Check the harness connector and audible alarm for damage or corrosion and clean or repair if necessary.

IMPORTANT

Make sure to observe polarity on the alarm terminals when testing. Damage to the alarm may result from an improper connection.

4. Correctly connect 12VDC power to the terminals as shown. The alarm should sound. Replace the alarm if necessary.

Testing the Slope Sensor Alarm (continued)

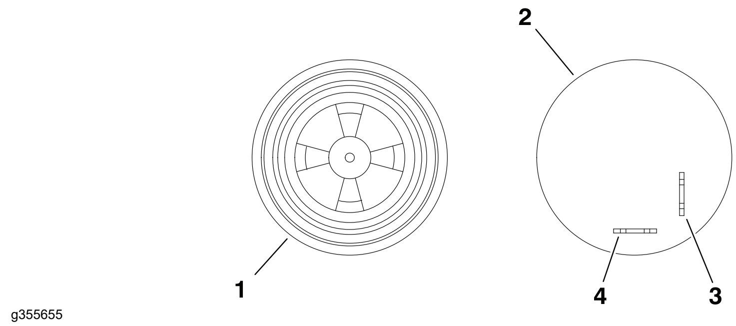


Figure 111

1. Front view
2. Rear view
3. Positive (+) terminal
4. Negative (−) terminal

5. Reconnect the machine wire harness to the alarm.

Service and Repairs

Note: For engine component repair information, see the appropriate Yanmar Service Manual or Troubleshooting Manual for your machine.

Caring for the Battery

WARNING

- **Wear safety goggles and rubber gloves when working with electrolyte.**
- **Charge battery in a well ventilated place so gasses produced while charging can dissipate.**
- **Since the gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke.**
- **Nausea may result if the gases are inhaled.**
- **Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.**

1. When using a maintainable battery, the battery-electrolyte must be kept at the proper level.
2. The top of the battery must be kept clean.
3. If the machine is stored in a location where the temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where the temperatures are cool.
4. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

   IMPORTANT

   Do not remove fill caps while cleaning.

   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

   B. Coat battery posts and cable connectors with Toro Part No. 107-0392 battery terminal protector or petroleum jelly to prevent corrosion.

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.

5. Tighten the battery cables on the battery terminals to provide a good electrical contact.
6. If corrosion occurs at the battery terminals, disconnect the battery cables. Always disconnect the negative (-) cable first. Clean the cable clamps and terminals separately. Connect the battery cables. Always connect the positive (+) cable first. Apply a coating of Toro Part No. 107-0392 battery

Caring for the Battery (continued)

terminal protector or a light coat of petroleum jelly to the terminals to reduce corrosion after you make the connections.

7. Check the battery-electrolyte level every 25 operating hours and every 30 days if machine is in storage.

   Note: Do not fill the cells above the fill line.

8. Maintain the cell level with the distilled or demineralized water.

Storing the Battery

If you store the machine for more than 30 days:

1. Remove the battery and charge it fully; refer to Charging the Battery (page 6–72).
2. Store the battery:
   - on a shelf or on the machine
   - with cables disconnected if stored on the machine
   - in a cool atmosphere to avoid quick deterioration of the battery charge
   - in an environment that will not be below freezing for an extended period

Servicing the Battery

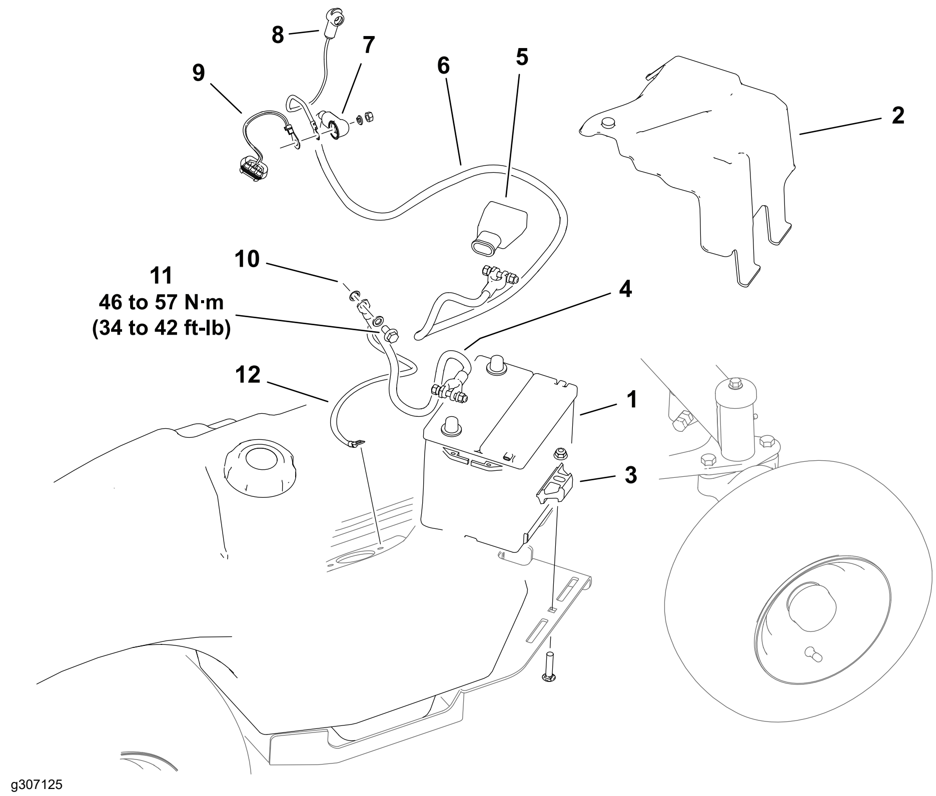


Figure 112

1. Battery
2. Battery cover
3. Battery clamp
4. Negative (-) cable
5. Boot
6. Positive (+) cable
7. Starter connection
8. Alternator cable
9. Fusible link harness
10. Engine ground connection
11. Cap screw
12. Chassis ground connection

Battery Specifications

Battery-electrolyte specific gravity	Fully Charged: 1.25 to 1.28 at 27°C (80°F) Discharged: less than 1.24
Battery specifications	BCI Group 26 540 CCA at -18°C (0°F) Reserve Capacity of 80 minutes at 27°C (80°F)
Battery dimensions (including terminal posts and caps)	Length 22.4 cm (8.8 inches) Width 13.2 cm (6.6 inches) Height 18.3 cm (8.0 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.

CAUTION

Battery-electrolyte is corrosive and can burn skin and eyes and damage clothing.

While working with the batteries, use extreme caution to avoid splashing or spilling of the electrolyte. Always wear the safety goggles and a face shield while working with batteries.

Removing and Installing the Battery

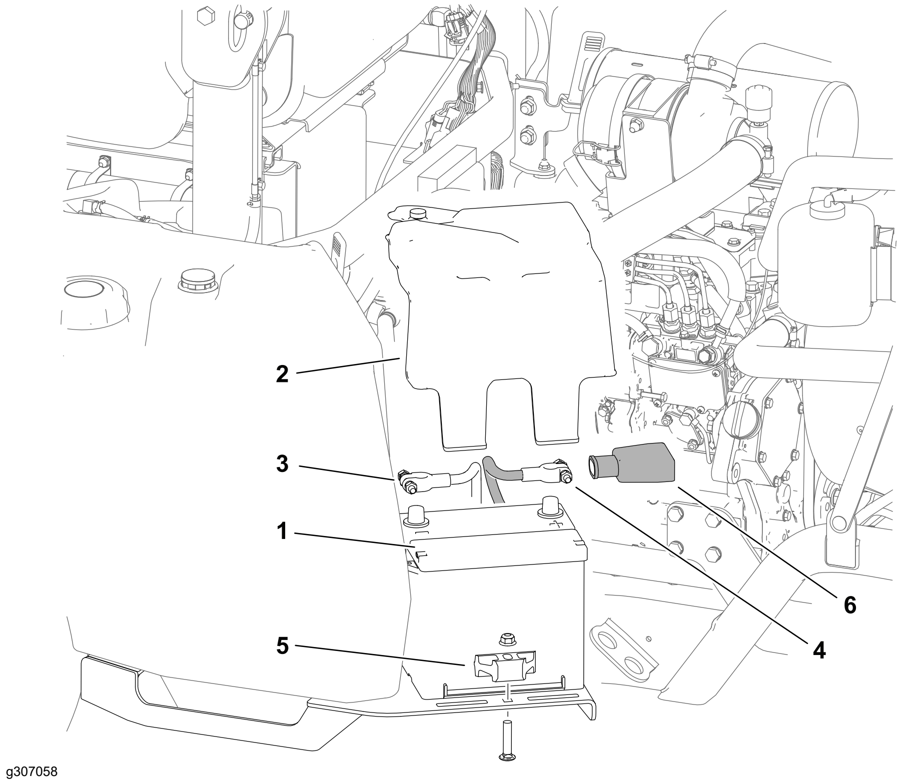


Figure 113

1. Battery
2. Battery cover
3. Negative (-) battery cable
4. Positive (+) battery cable
5. Battery hold down clamp
6. Rubber boot

IMPORTANT

Be careful when removing the battery cables and ensure that you do not damage the terminal posts or cable connectors.

1. Ensure that the key switch and all accessories are in the OFF position.
2. Open the hood.
3. Loosen the knob and remove the battery cover from the machine.
4. Disconnect the negative (-) cable from the battery terminal, then disconnect the positive (+) cable from the battery terminal.
5. Remove the fasteners and the battery hold down clamp.
6. Make sure that the battery filler caps are secure (if applicable) and remove the battery from the battery tray.

Removing and Installing the Battery (continued)

7. Clean the battery tray. Neutralize and refinish any damaged areas of the battery tray.
8. Inspect the battery cables and connectors for damage and corrosion. Clean, repair, or replace the battery cables and connectors if necessary.
9. Install the battery in the reverse order:

IMPORTANT

To prevent possible electrical problems, install only a fully charged battery.

   A. Connect the positive (+) cable connector onto the positive (+) battery terminal.

   B. Connect a digital multimeter (set to A) between the negative (-) battery post and the negative (-) cable connector. Ensure that the reading is less than 0.1 A. A reading of more than 0.1 A usually indicates a damaged switch, a shorted circuit, or grounded wire. Identify and repair the electrical faults before returning the machine to service.

   C. Connect the negative (-) cable connector to the negative (-) battery terminal. The cable clamp must be parallel to the edge of the battery before securing the clamp.

10. After you make the connections, apply battery terminal protector Toro Part No. 107-0392 or a light layer of petroleum jelly to the battery terminals and cable connectors.
11. Make sure that the rubber boots are in place over the positive cable end at the battery post and at the starter.

Inspecting, Maintaining, and Testing the Battery

Temperature Correcting Specific Gravity

Cell Temperature	100°F
Cell Specific Gravity	1.245
38°C minus 27°C equals 11.0°C (100°F minus 80°F equals 20°F)	
11°C multiply by 0.004/5.5°C equals 0.008 (20°F multiply by 0.004/10°F equals 0.008)	
ADD (conversion above)	0.008
Correction to 27°C (80°F)	1.253

Minimum Voltage

Minimum Voltage	Battery-Electrolyte Temperature	
9.6	70°F (and up)	21°C (and up)
9.5	60°F	15°C
9.4	50°F	10°C
9.3	40°F	4°C
9.1	30°F	-1°C

8.9	20°F	-7°C
8.7	10°F	-12°C
8.5	0°F	-18°C

1. Inspect the battery as follows:
   A. Check for cracks. Replace the battery if cracked or leaking.
   B. Check the battery terminals for corrosion. Use the wire brush to clean corrosion from the posts.

IMPORTANT

Before cleaning the battery, tape or block the vent holes of the filler caps and ensure that the caps are secure.

   C. Check for the signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post, or overfilling. Also, check the battery case for dirt and oil. Clean the battery with a solution of baking soda (sodium bicarbonate) and water, then rinse it with clean water.
   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

IMPORTANT

Make sure the area around the battery caps is clean before opening the caps.

   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all the cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 A for 15 minutes to allow sufficient mixing of the electrolyte.
2. Perform the hydrometer test of the battery-electrolyte.

IMPORTANT

Make sure the area around the battery caps is clean before opening the caps.

   A. Use a hydrometer to measure the specific gravity of each cell. Pull the electrolyte in and out of the hydrometer barrel before taking a reading to warm-up the hydrometer. At the same time, take the temperature of the cell.
   B. Temperature correct each cell reading. For each 6°C (10°F) above 27°C (80°F) add 0.004 to the specific gravity reading. For each 6°C (10°F) below 27°C (80°F) subtract 0.004 from the specific gravity reading; refer to Temperature Correcting Specific Gravity (page 6–70).
   C. If the difference between the highest and lowest cell specific gravity is 0.050 or more or the lowest cell specific gravity is less than 1.225, charge the battery.

Inspecting, Maintaining, and Testing the Battery (continued)

D. Charge at the rate and time given in Battery Charge Rate (page 6–72) or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell being less than 0.050. If you can not meet these charging conditions, replace the battery.

3. Do a high-discharge test with an adjustable load tester. This is a very reliable means of testing a battery as it simulates the battery cold-cranking capacity. A commercial battery load tester is required to do this test.

CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals before testing the battery. If the voltage is less than 12.0 VDC, charge the battery before continuing the test.

B. If you charge the battery, apply a 150 A load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Ensure that the battery terminals are free of corrosion.

D. Measure the electrolyte temperature of the center cell.

E. Connect a battery load tester to the battery terminals following the manufacturer's instructions. Connect a digital multimeter to the battery terminals

F. Apply a test load of 1/2 the cold cranking amperage rating of the battery; refer to Battery Specifications (page 6–68).

G. Take a test voltage reading while still under load after 15 seconds, then immediately remove the load.

H. Use Minimum Voltage (page 6–70) to determine the minimum voltage for the center cell electrolyte temperature reading.

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Charging the Battery

Battery Charge Level

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

Battery Charge Rate

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%

80 or less	3.8 hrs @ 3 A	7.5 hrs @ 3 A	11.3 hrs @ 3 A	15 hrs @ 3 A
81 to 125	5.3 hrs @ 4 A	10.5 hrs @ 4 A	15.8 hrs @ 4 A	21 hrs @ 4 A
126 to 170	5.5 hrs @ 5 A	11 hrs @ 5 A	16.5 hrs @ 5 A	22 hrs @ 5 A
171 to 250	5.8 hrs @ 6 A	11.5 hrs @ 6 A	17.3 hrs @ 6 A	23 hrs @ 6 A
above 250	6 hrs @ 10 A	12 hrs @ 10 A	18 hrs @ 10 A	24 hrs @ 10 A

To minimize damage to the battery and allow the battery to charge fully, use the following slow charging procedure. You can accomplish this charging procedure with a constant current battery charger that is available locally.

IMPORTANT

Follow the manufacturer's instructions when using a battery charger.

Note: Using the specific gravity of the battery cells is the most accurate procedure of determining the battery condition.

1. Use Battery Charge Level (page 6–72) to determine the battery charge level from the specific gravity of the battery cells or open circuit voltage.
2. Use the manufacturer's battery charger instructions or Battery Charge Rate (page 6–72) to determine the charging time and rate.

CAUTION

Charging a frozen battery can cause explosion and can cause personal injury. Let the battery warm to 15°C (60°F) before connecting to a charger.

- **Charge the battery in a well-ventilated place to dissipate the gases produced from the charging.**
- **These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke.**
- **Inhaling the battery gases can cause nausea.**
- **Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery terminals.**

3. Follow the battery charger manufacturer's instructions, connect the charger cables to the battery terminals. Ensure that you make a good connection
4. Charge the battery following the manufacturer's instructions.
5. Occasionally check the temperature of the battery-electrolyte. If the temperature is more than 52°C (125°F) or the electrolyte is violently gassing or spewing, lower the charge rate or temporarily stop charging the battery.
6. Beginning three hours before the end of the scheduled charge, measure the specific gravity of a battery cell once per hour.

   Note: The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for 3 consecutive readings.

Chassis

Table of Contents

General Information

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.

Adjustments

Adjusting the Parking Brake

Refer to the traction unit *Operator's Manual* for this procedure.

Adjusting the Traction Cable

1. Check the traction system for NEUTRAL and adjust if necessary; refer to Adjusting the Traction System for Neutral (page 5–50).
2. Loosen the traction pedal stop bolt jam nuts and lower the traction pedal stop bolt.
3. Depress the traction pedal fully forward. The traction pedal and pedal hub should not contact the stop bolt or any part of the machine, ensuring the traction pump is at its full forward displacement. Adjust the traction cable ball joint slightly if necessary.
4. With the traction pedal fully forward, extend the pedal stop bolt to contact the traction pedal.
5. Release the traction pedal and extend the pedal stop bolt an additional 1/2 turn before locking the stop bolt in position with the jam nuts.

Adjusting the Tie Rod Length (Rear Wheel Toe-In)

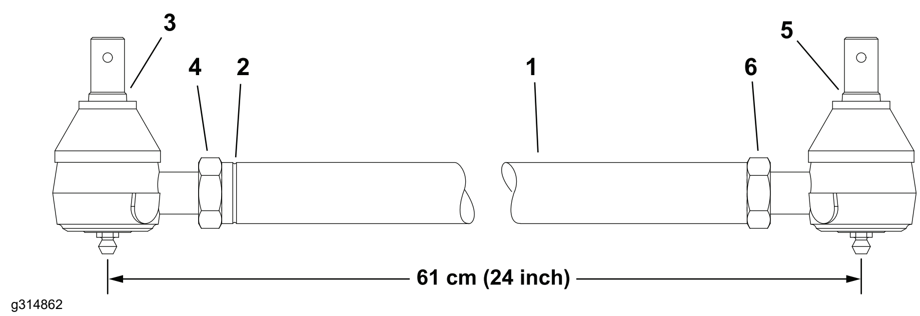


Figure 114

1. Tie rod
2. Groove (LH thread end)
3. Rod end – LH thread
4. Jam nut – LH thread
5. Rod end – RH thread
6. Jam nut – RH thread

---

1. Check the tie rod assembly length as shown in Figure 114.

   Note: One of the tie rod ends and its jam nut have left hand threads. The left hand threaded components are indicated by a groove near the end of the tie rod.

2. Loosen the jam nuts and adjust the tie rod length as necessary. Tighten the jam nuts to **122 N·m (90 ft-lb).**.

Adjusting the PTO Clutch

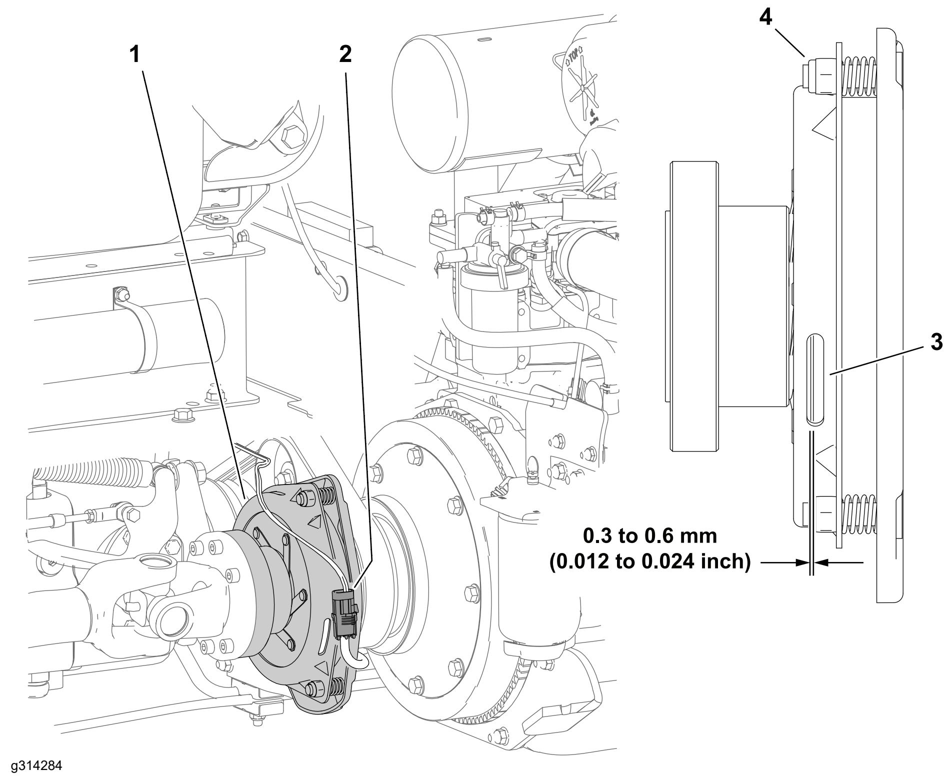


Figure 115

1. PTO clutch
2. Wire harness connector
3. Access slot (3 each)
4. Locknut (3 each)

---

1. Use the access slots in the clutch cover to measure the gap between the clutch rotor and the armature. The gap should be **0.3 to 0.6 mm (0.012 to 0.024 inch)** at all the 3 access slots.
2. If the gap is incorrect, loosen or tighten the 3 locknuts to achieve the correct gap at each access slot.

Service and Repairs

Wheels

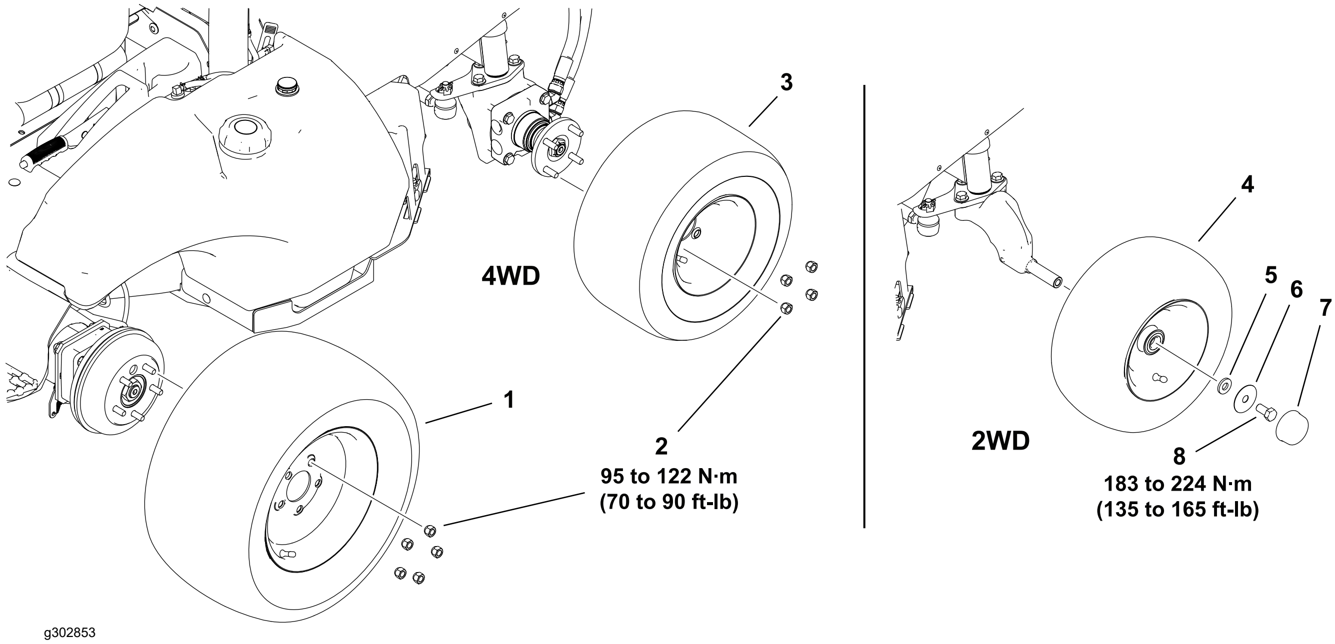


Figure 116

1. Front wheel and tire – all models
2. Lug nut (as required)
3. Rear wheel and tire – 4WD models
4. Rear wheel and tire – 2WD models
5. Flat washer
6. Washer
7. Cap
8. Cap screw

Removing and Installing the Wheels

1. Park the machine on a level surface, lower the cutting unit (or attachment), set the key switch to the OFF position and remove the key from the key switch.
2. Loosen, but do not remove the fasteners (lug nuts or cap screws) that secure the wheel being removed to the machine.

IMPORTANT

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–6).

3. Raise the machine until the wheel to be removed is off the ground. Support the machine with appropriate jack stands.
4. Remove the fasteners that secure the wheel being removed to the machine, and remove the wheel.
5. Fit the wheel to the machine and install the fasteners (lug nuts or cap screws) snugly.
6. Remove the jack stands and lower the machine to the ground.

Removing and Installing the Wheels (continued)

⚠ WARNING ⚠

Failure to maintain proper torque could result in failure or loss of wheel and may result in personal injury.

Maintain the proper torque of the wheel fasteners.

Tighten lug nuts evenly in a crossing pattern.

7. Tighten the wheel fasteners to the specified torque; refer to the specifications table for Chassis (page 2–5).

8. Check and adjust the tire pressures; refer to the specifications table for Chassis (page 2–5).

Servicing the 2WD Rear Wheels/Hubs

The wheel/hub replacement parts are not currently available separately. Replace the entire wheel/hub assembly if necessary.

Parking Brakes

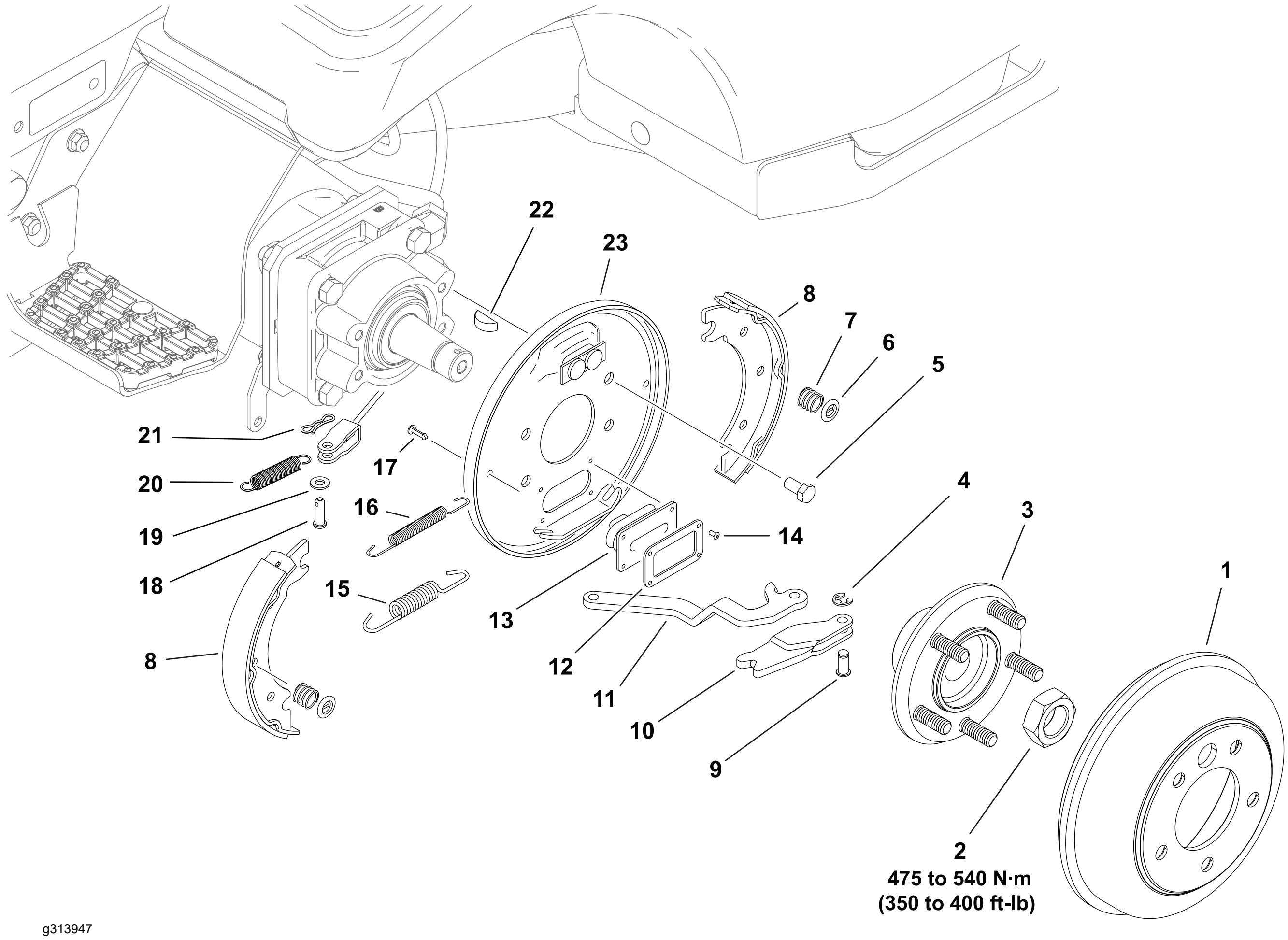


Figure 117

1.	Brake drum	9.	Clevis pin	17.	Hold down pin (2 each)
2.	Wheel hub nut	10.	Brake actuator	18.	Clevis pin
3.	Wheel hub	11.	Brake actuator lever	19.	Washer
4.	Retaining ring	12.	Retainer plate	20.	Return spring
5.	Cap screw (4 each)	13.	Dust boot	21.	Cotter pin
6.	Hold down cup (2 each)	14.	Rivet (4 each)	22.	Woodruff key
7.	Hold down spring (2 each)	15.	Spring – actuator	23.	Brake plate
8.	Brake shoe	16.	Spring – pivot		

Disassembling the Parking Brakes

Refer to Figure 117 for this procedure.

1. Remove the front wheel; refer to Removing and Installing the Wheels (page 7–5).
2. Disengage the parking brake and remove the brake return spring, cotter pin, clevis pin and washer that attach the brake cable to the brake actuator lever.
3. Remove the brake drum.
4. The brake shoes can be serviced without removing the wheel hub. If brake plate removal is necessary:
   A. Use a torque multiplier and remove the wheel hub nut. Discard the locknut.

Disassembling the Parking Brakes (continued)

B. Use a wheel hub puller for a 114 mm (4.5 inch) bolt circle and remove the wheel hub and woodruff key.

C. Remove the 4 fasteners securing the brake assembly to the brake adapter.

5. Remove the brake shoe springs, hold down cups, hold down springs, and hold down pins to remove the brake shoes.

Assembling the Parking Brakes

Refer to Figure 117 for this procedure.

1. Clean all the parts. Use a wire brush to remove rust and unwanted material from the brake parts before installation.
2. Visually examine the brake shoes and contact surfaces of the brake drum for excessive wear. Replace the parts that are worn and damaged.
3. Lightly lubricate the brake shoe pivot points with high-temperature grease.
4. Install the brake shoes, hold downs, and springs.
5. If the brake plate was removed:

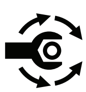
   A. Install the brake plate assembly with the previously removed fasteners.

IMPORTANT

Before installing the wheel hub, clean the tapers of the wheel hub and wheel motor shaft. Ensure that the tapers are free of grease, oil, rust, and dirt. Do not use anti-seize lubricant, when you install the wheel hub.

Do not use the locknut previously removed to attach the wheel hub to the wheel motor.

   B. Clean the tapers of the wheel hub and wheel motor shaft and install the woodruff key and wheel hub.



   C. Install a new wheel hub nut. Use a torque multiplier and tighten the nut from **475 to 540 N·m (350 to 400 ft-lb)**.

6. Install the brake drum.
7. Connect the brake cable to the brake actuator lever with the previously removed fasteners and install the brake return spring.
8. Check and adjust the brakes as necessary before returning the machine to service; refer to the traction unit *Operators Manual*.
9. Install the front wheel; refer to Removing and Installing the Wheels (page 7–5).

Replacing the Parking Brake Cables

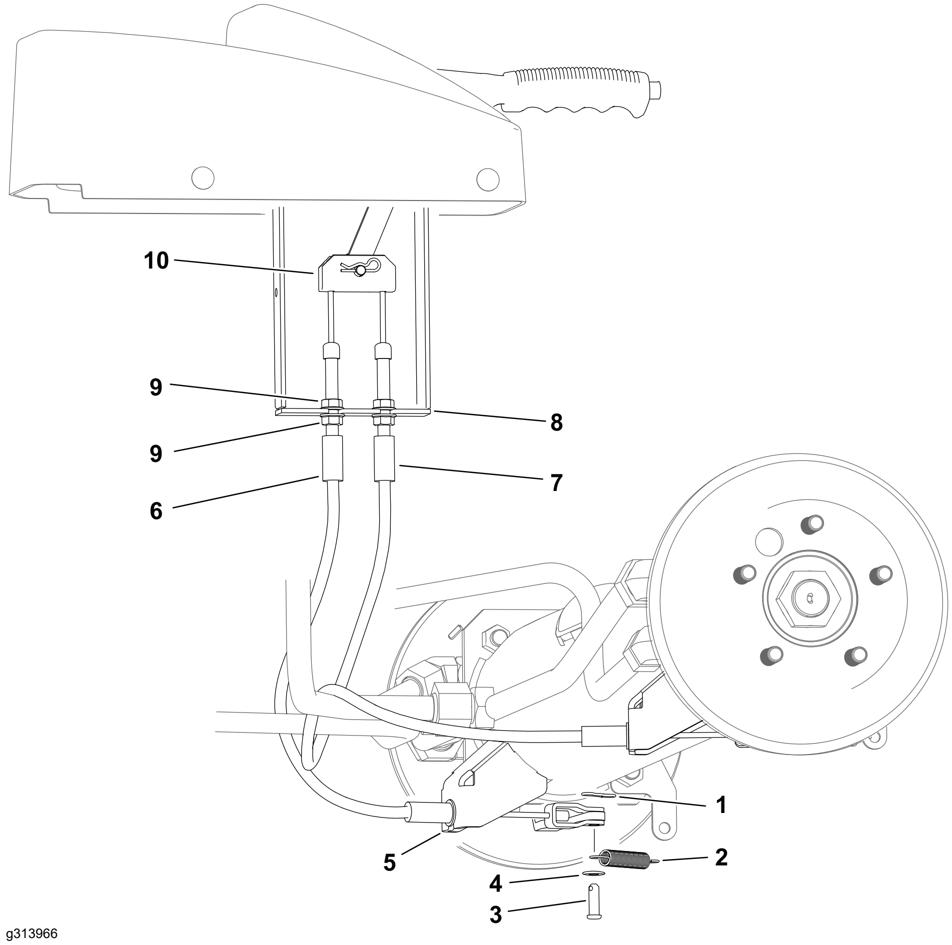


Figure 118

1.	Cotter pin	6.	Brake cable – left
2.	Return spring	7.	Brake cable – right
3.	Clevis pin	8.	Brake cable bracket – brake lever
4.	Washer	9.	Jam nut
5.	Brake cable bracket – wheel motor	10.	Equalizer bracket

Refer to Figure 118 for this procedure.

1. Park the machine on a level surface, lower the cutting deck, shut off the engine, and remove the key from the key switch. Ensure that the parking brake is not engaged.
2. Disengage the parking brake and remove the brake return spring, cotter pin, clevis pin and washer that attach the brake cable to the brake actuator lever.
3. Loosen the flange nuts that secure the brake cable to the brake cable bracket near the wheel motor and remove the cable from the bracket.
4. Loosen the flange nuts that secure the brake cable to the bracket below the brake lever and remove the cable from the bracket.
5. Remove the brake cable ends from the equalizer bracket.
6. Record the location of cable ties and routing of the brake cable for assembly purposes. Remove the brake cable from the machine.
7. Disassemble any additional brake linkage components as necessary. Repair or replace the components that are worn or damaged.

Replacing the Parking Brake Cables (continued)

8. Using the notes recorded during brake cable removal, route and secure the brake cable through the machine.

   Note: The longer (right side) cable should pass over the top of one of the wheel motor hydraulic tubes mid way between the wheel motors.

9. Fit the lower end of the cable housing into the bracket near the wheel motor and tighten the cable nut.
10. Connect the brake cable to the brake actuator lever with the previously removed fasteners and install the brake return spring.
11. Position the jam nuts at the upper end of the cable housing as shown; refer to Figure 119.

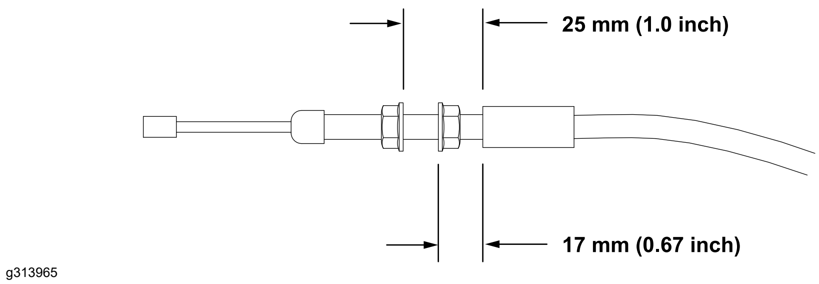


Figure 119

12. Ensure that the brake lever is completely disengaged (down) and fit the cable end into the equalizer bracket the cable housing into the bracket below the brake lever. The cables should push the bottom jam nut upward against the bracket.
13. Pull down on both cable housings a few times to remove any slack in the assembly. The bottom jam nut should move away from the bracket when the housing is pulled.
14. Pull the cable housing down firmly by hand and adjust the bottom jam nut until it contacts the bracket. Perform this step on both cables individually.

    Note: Applying 18 to 29 kg (40 to 65 lbs) force to the parking brake lever should raise the parking brake lever to the last locking position (just short of fully extended).

15. Tighten the jam nuts.

Traction Pedal, Cable, and Control Assembly

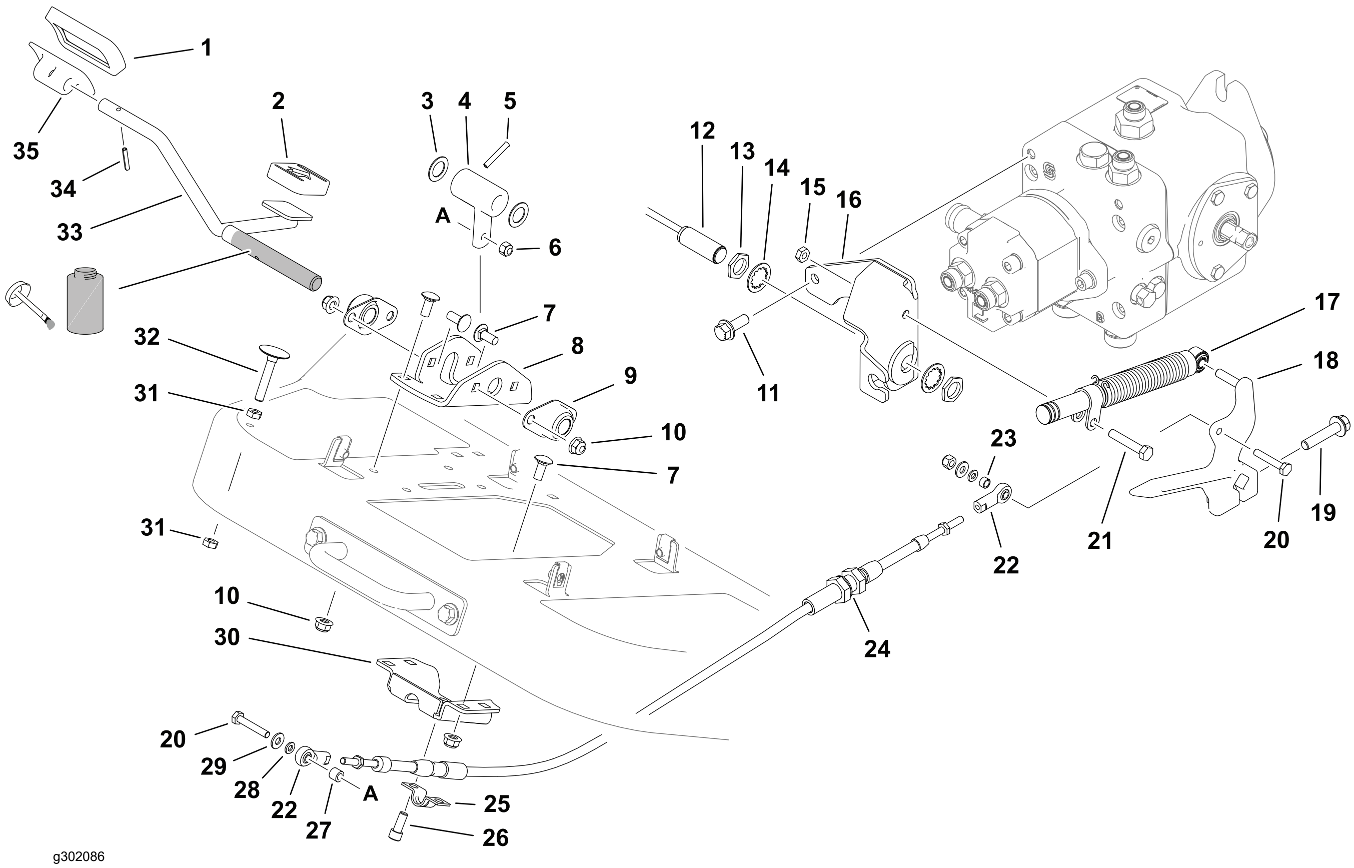


Figure 120

1.	Pad – forward	13.	Jam nut (2 each)	25.	Clamp
2.	Pad – reverse	14.	Lock washer (2 each)	26.	Socket head screw (2 each)
3.	Plastic washer (2 each)	15.	Lock nut	27.	Spacer – 9 mm (0.35 inch)
4.	Pedal hub	16.	Support bracket	28.	Washer (2 each)
5.	Roll pin	17.	Damper	29.	Washer (2 each)
6.	Lock nut (2 each)	18.	Pump lever	30.	Cable bracket
7.	Carriage bolt (12 each)	19.	Pinch bolt	31.	Lock nut (2 each)
8.	Pedal bracket	20.	Cap screw (2 each)	32.	Pedal stop bolt
9.	Bearing (2 each)	21.	Cap screw	33.	Traction pedal
10.	Flange nut (12 each)	22.	Ball joint (2 each)	34.	Roll pin
11.	Cap screw (2 each)	23.	Spacer – 5 mm (0.21 inch)	35.	Forward pedal
12.	Neutral switch	24.	Traction cable		

Removing and Installing the Traction Control Components

Remove and install the traction control components as necessary.

1. Apply anti-seize lubricant to the traction pedal shaft during assembly.
2. If the traction cable is being replaced:
   A. Install the ball joints on the cable ends at the location shown; refer to Figure 121.

Removing and Installing the Traction Control Components (continued)

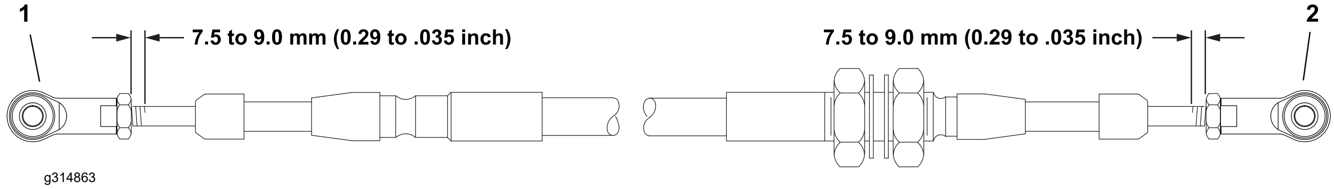


Figure 121

1. Pedal end
2. Pump end

B. Attach the ball joints to the pump lever and the traction pedal hub.

C. Fit the cable housing into the support bracket with a flat washer and a jam nut on each side of the bracket. Center the cable housing threads on the bracket and tighten the jam nuts.

D. Clamp the traction cable to the cable bracket below the operator's platform.

E. Check the traction pedal operation and adjust the traction cable before returning the machine to service; refer to Adjusting the Traction Cable (page 7–3).

3. After assembly, make sure that the traction (piston) pump is properly adjusted for the NEUTRAL position (the machine must not creep in either direction on level ground when the traction pedal is in the NEUTRAL position); refer to Adjusting the Traction System for Neutral (page 5–50).

Steering Column

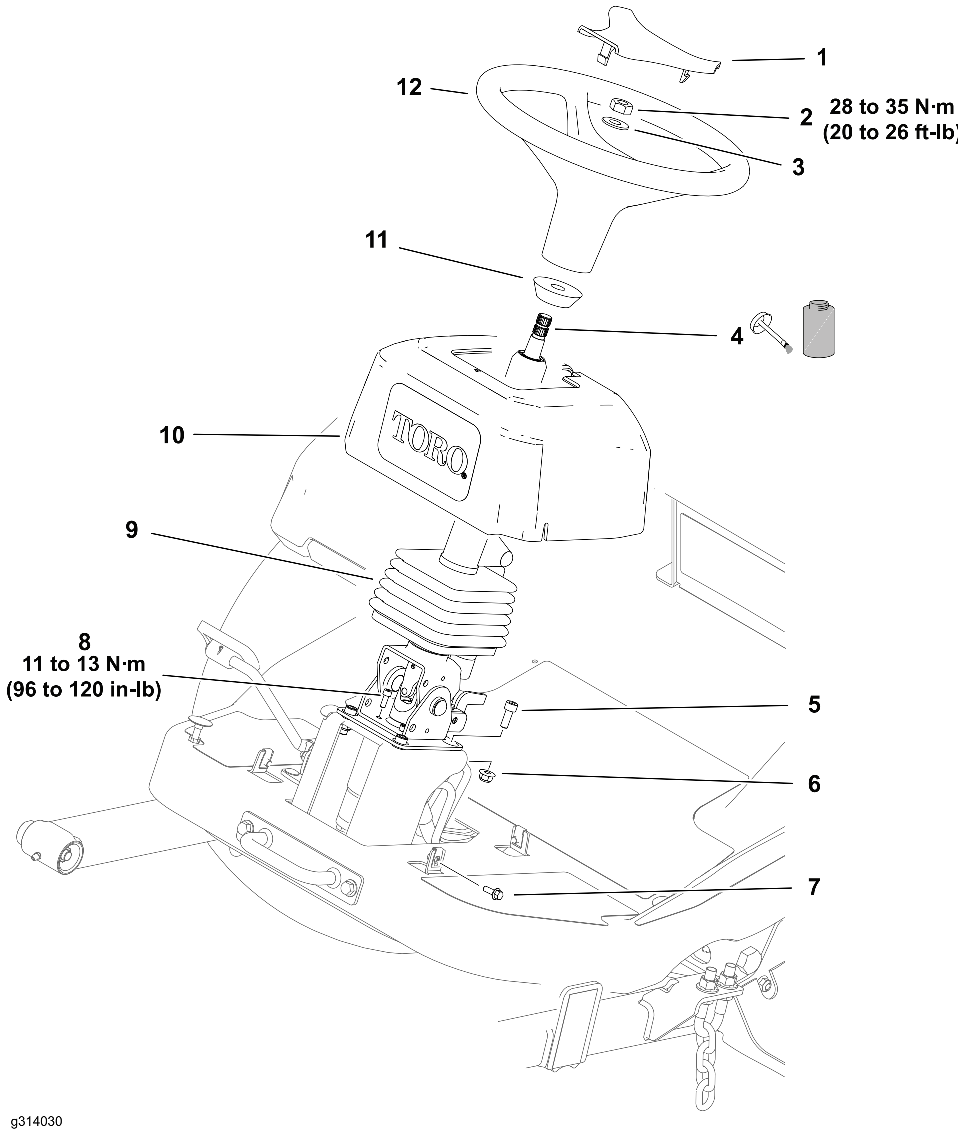


Figure 122

1. Steering wheel cover
2. Locknut
3. Flat washer
4. Steering column
5. Cap screw (4 each)
6. Lock nut (4 each)
7. Cap screw (4 each)
8. Cap screw (4 each)
9. Rubber bellows
10. Steering cover
11. Foam collar
12. Steering wheel

Removing the Steering Column

1. Park the machine on a level surface, engage the parking brake, lower the cutting unit (or attachment), set the key switch to the OFF position and remove the key from the key switch.
2. Carefully remove the steering wheel cover from the steering wheel.
3. Remove the locknut and flat washer that secure the steering wheel to the steering column.
4. Use a suitable puller to remove the steering wheel from the steering tower assembly. Remove the foam collar.
5. Remove the steering cover fasteners and the steering cover.

Removing the Steering Column (continued)

6. Slide the rubber bellows up the steering column to get access to the fasteners that secure the steering column to the machine.

   Note: Do not allow the steering control valve to hang from the hydraulic lines.

7. Support the steering control valve and remove the 4 fasteners securing the steering control valve to the steering column.
8. Remove the 4 fasteners securing the steering column to the machine frame and slide the steering column from the steering control valve.
9. Disassemble the steering column assembly as necessary; refer to Figure 123.

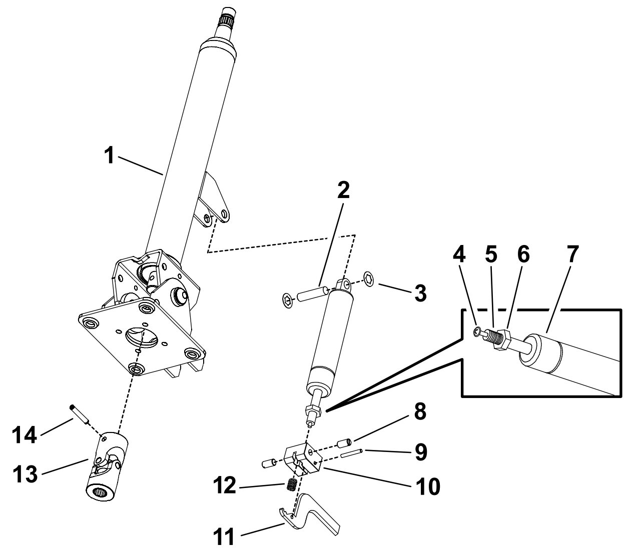


Figure 123

1.	Steering column	8.	Bolt (2 each)
2.	Pin	9.	Pin
3.	Lock washer (2 each)	10.	Pedal block
4.	Release pin	11.	Pedal
5.	Cylinder shaft	12.	Spring
6.	Jam nut	13.	Universal joint
7.	Cylinder	14.	Pin

Installing the Steering Column

1. Assemble the steering column; refer to Figure 123.
2. After assembly, ensure that the release pin on the end of the cylinder shaft is positioned against the pedal. The jam nut on the cylinder shaft can be used to adjust the location of the release pin.
3. Install the steering tower using Figure 122 as a guide.
4. Tighten the fasteners securing the steering control valve to the steering column from **11 to 13 N·m (96 to 120 in-lb)**.
5. Install the steering cover.
6. Apply a small amount of anti-seize lubricant to the splines of the steering column and install the foam collar and the steering wheel.

Installing the Steering Column (continued)

7. Secure the steering wheel to the steering column assembly with the flat washer and lock nut. Tighten the lock nut from **28 to 35 N·m (20 to 26 ft-lb)**.

8. Install the steering wheel cover.

Rear Axle and Spindles

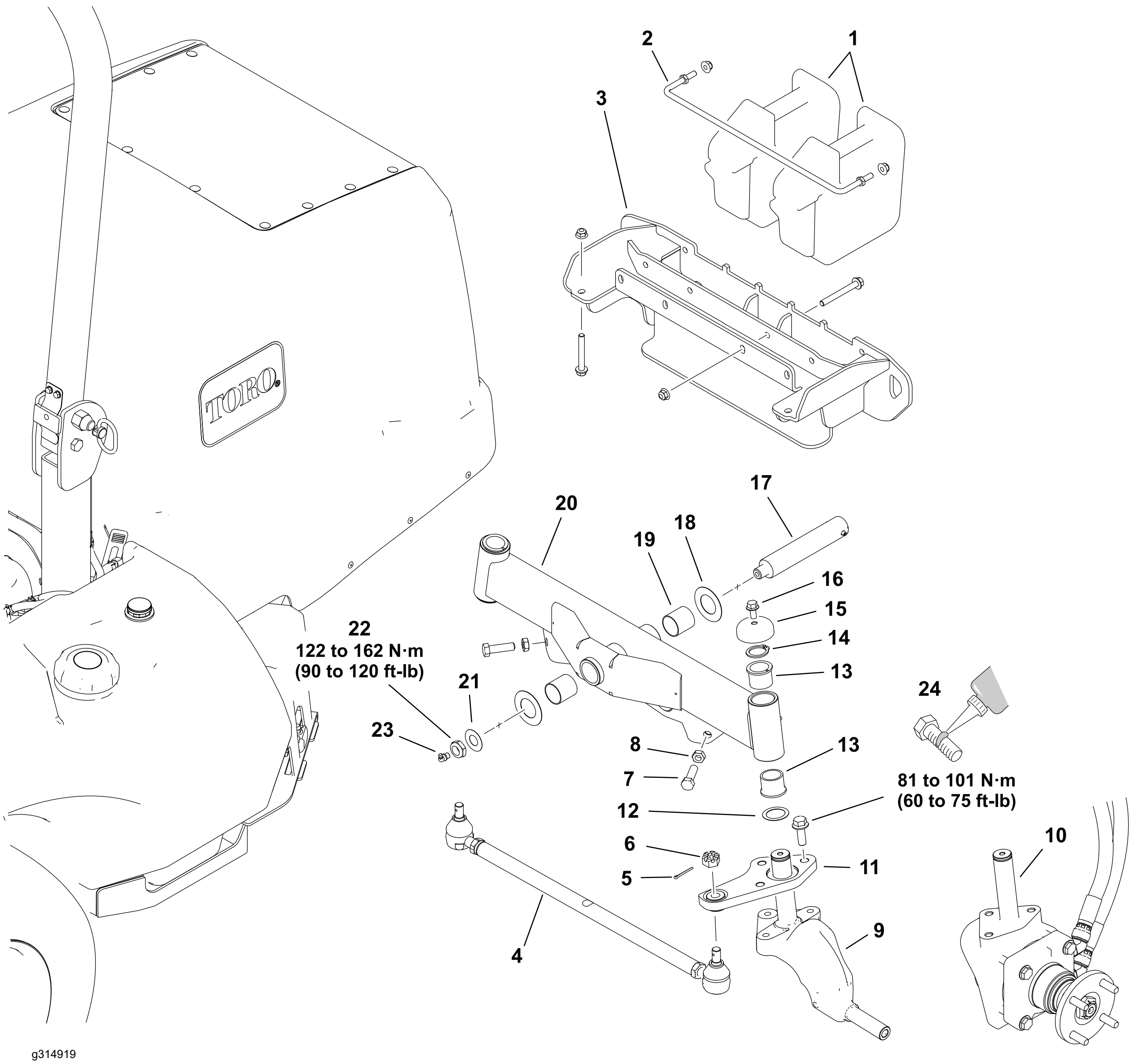


Figure 124

1. Weight
2. Weight lock
3. Rear bumper
4. Tie rod assembly
5. Cotter pin (2 each)
6. Slotted nut (2 each)
7. Steering stop bolt (2 each)
8. Jam nut (2 each)
9. Rear wheel spindle 2WD
10. Rear wheel spindle 4WD
11. Drag link (2 each)
12. Thrust washer (2 each)
13. Flange bushing (4 each)
14. Retaining ring (2 each)
15. Cap (2 each)
16. Cap screw (2 each)
17. Pivot pin
18. Thrust washer (2 each)
19. Sleeve bushing (2 each)
20. Rear axle
21. Thrust washer
22. Lock nut
23. Grease fitting
24. Cap screw – 1.25 inch long

Removing the Rear Axle

Refer to Figure 124 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.

Removing the Rear Axle (continued)

2. Remove any weights from the rear bumper and remove the rear bumper from the machine.
3. Remove the steering cylinder; refer to Removing the Steering Cylinder (page 5–98).
4. Raise and support the rear of the machine; refer to Jacking Instructions (page 1–6).
5. Remove the rear wheels; refer to Removing and Installing the Wheels (page 7–5).
6. Remove the cotter pins and slotted nuts that secure the tie rod ends to the drag links. Discard the cotter pins.
7. Use a suitable tool (pickle fork) to separate the tie rod ends from the drag links and remove the tie rod assembly.

IMPORTANT

On 4WD machines, do not allow the rear wheel spindles and hydraulic motors to hang from the hydraulic hoses unsupported.

8. Remove the rear wheel spindles from the axle.
9. Remove the grease fitting from the axle pivot pin.
10. Remove the lock nut and thrust that secures the axle pivot pin to the rear frame.

    Note: Several washers are installed between the axle pivot tube and the rear frame. Before removing the axle pivot pin, note the location of the washers.

11. Support the rear axle, remove the axle pivot pin, and remove the axle from the machine. Locate and retrieve the pivot pin thrust washers.

Servicing the Rear Axle

The rear axle must be held in place snugly by the axle pivot pin. The rear wheel spindle pivot shafts must fit snugly in the rear axle. Excessive movement of the axle in the frame, or the spindle pivot shafts in the axle (characterized by erratic steering) may indicate worn pivot bushings.

1. Remove the rear axle from the machine; refer to Removing the Rear Axle (page 7–16).
2. Thoroughly clean and inspect all of the rear axle components. Replace or repair worn or damaged components if necessary.
3. Use a bushing removal tool to extract the bushings from the rear axle. Take care to not damage the axle bore during bushing removal. Clean the axle bore to remove all dirt and foreign material.
4. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the axle. Press axle pivot pin bushings flush with the axle tube. Press the wheel spindle shaft bushings into the axle until the bushing flange contacts the axle.
5. Install the rear axle; refer to Installing the Rear Axle (page 7–17).

Installing the Rear Axle

Refer to Figure 124 for this procedure.

1. Position the axle to the rear frame. Install one thrust washer between the front of the axle and the machine frame, and one thrust washer between the

Installing the Rear Axle (continued)

rear of the axle and the machine frame. Slide the axle pivot pin through the frame, washers, and axle.

2. Ensure that the roll pin in the axle pivot pin is seated in the slots of the machine frame and secure the pivot pin with the thrust washer and locknut. Tighten the lock nut from **122 to 162 N·m (90 to 120 ft-lb)**. Ensure that axle pivots freely after the lock nut is tightened.

3. Install the grease fitting in the axle pivot pin.

4. Place a thrust washer onto the rear wheel spindle pivot shaft and install the spindles. Ensure the spindle cap screws are 1.25 inch in length, then apply medium strength thread locking compound to the cap screws and tighten from **81 to 101 N·m (60 to 75 ft-lb)**.

5. Install the tie rod assembly:

   A. Check the tie rod assembly length; refer to Adjusting the Tie Rod Length (Rear Wheel Toe-In) (page 7–3).

   B. Clean the tapers of the tie rod ends and the tapered sockets in the drag link arms.

   C. Fit the tie rod ends into the drag links, tighten the slotted nuts and install new cotter pins.

6. Install the rear wheels; refer to Removing and Installing the Wheels (page 7–5).

7. Remove the jack stands and lower the machine to the ground.

8. Install the steering cylinder and adjust the steering cylinder rod length and the steering stop bolts; refer to Installing the Steering Cylinder (page 5–99).

9. Install the rear bumper assembly, any previously removed weights, and the weight lock.

10. Lubricate the rear axle pivot, rear spindle pivot shafts, tie rod ends, and steering cylinder ends through the grease fittings provided; refer to the traction unit *Operator's Manual*.

11. Check steering operation before returning the machine to service.

PTO Shaft

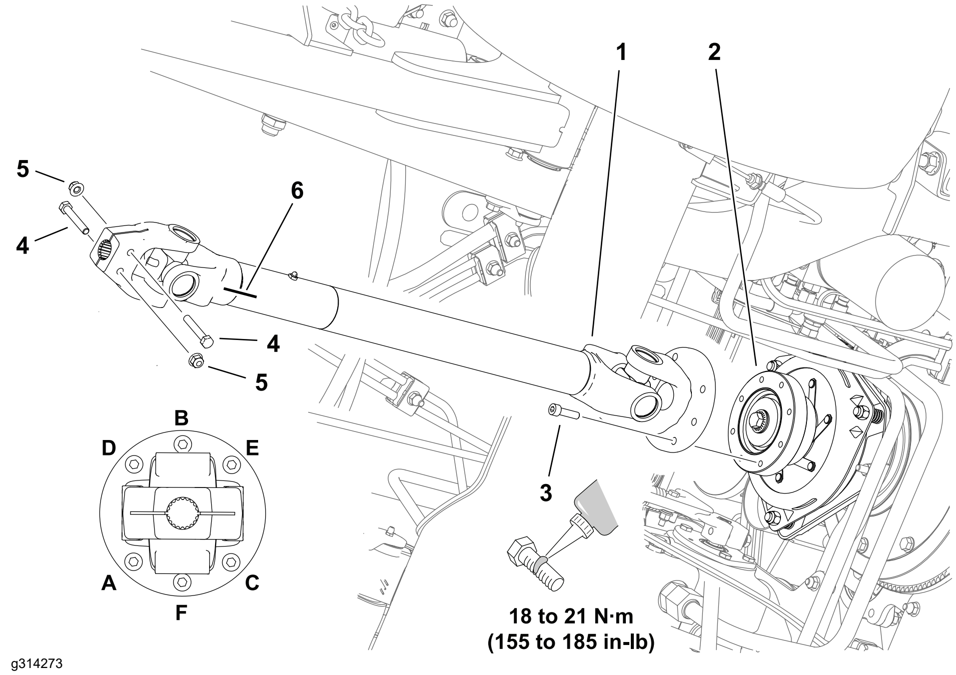


Figure 125

1. PTO shaft
2. PTO clutch
3. Cap screw (6 each)
4. Cap screw (2 each)
5. Lock nut (2 each)
6. Alignment mark

Removing and Installing the PTO Shaft

IMPORTANT

To maintain correct shaft balance, clearly mark the PTO shaft across the slip shaft and the slip tube prior to disassembly.

1. Remove the cutting unit from the machine; refer to the cutting unit *Operator's Manual*.
2. Remove the 6 cap screws from the PTO shaft flange at the PTO clutch and remove the shaft from the machine.
3. When installing the PTO shaft flange at the PTO clutch, apply medium strength thread locking compound to the cap screws and tighten from **18 to 21 N·m (155 to 185 in-lb)** in a star pattern.
4. Install the cutting unit to the machine; refer to the cutting unit *Operator's Manual*.
5. Lubricate the PTO shaft grease fittings before returning the machine to service; refer to the *Traction Unit Operator's Manual*.

IMPORTANT

Ensure that the markings on the slip shaft and slip tube are aligned when the PTO shaft is assembled. Misalignment of the shaft and tube will result in shortened shaft bearing life and may cause unnecessary vibration during cutting unit (or implement) operation.

Servicing the PTO Shaft Cross and Bearing

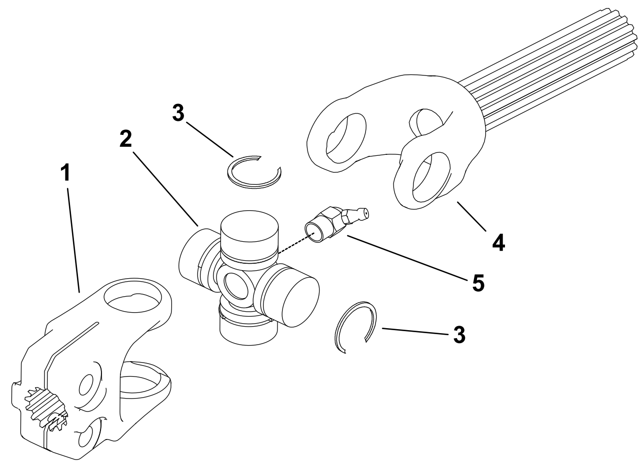


Figure 126

1. End yoke
2. Cross and bearing kit
3. Snap ring (4 each)
4. Shaft yoke
5. Grease fitting

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1. Remove the PTO shaft from the machine; refer to Removing and Installing the PTO Shaft (page 7–19).
2. Remove the snap rings that secure the bearings in the yokes.

IMPORTANT

Support the yokes when removing and installing the bearings to prevent damage.

3. Use a press to remove the cross and bearings from the yokes. Clean the PTO shaft yokes.
4. Install new cross and bearings as follows:
   A. Apply a thick layer of grease to the bearing bores in the end yoke and shaft yoke.
   B. Press 1 bearing partially into the yoke.
   C. Insert the cross into the yoke and bearing.
   D. Hold the cross in alignment and press the bearing in until it hits the yoke.
   E. Install the snap ring into the yoke groove to secure installed bearing.
   F. Place second bearing into the yoke bore and onto the cross shaft. Press the bearing into the yoke and secure with the snap ring.
   G. Repeat the procedure for the other yoke.
   H. Apply grease to the cross until it comes out of all the 4 bearing cups.
5. Ensure that the assembled joint moves without any binding. Lightly rap the yoke lugs with a soft-faced hammer to remove slight binding. If binding continues, disassemble the joint to identify the source of binding.
6. Install the PTO shaft to the machine; refer to Removing and Installing the PTO Shaft (page 7–19).

PTO Clutch

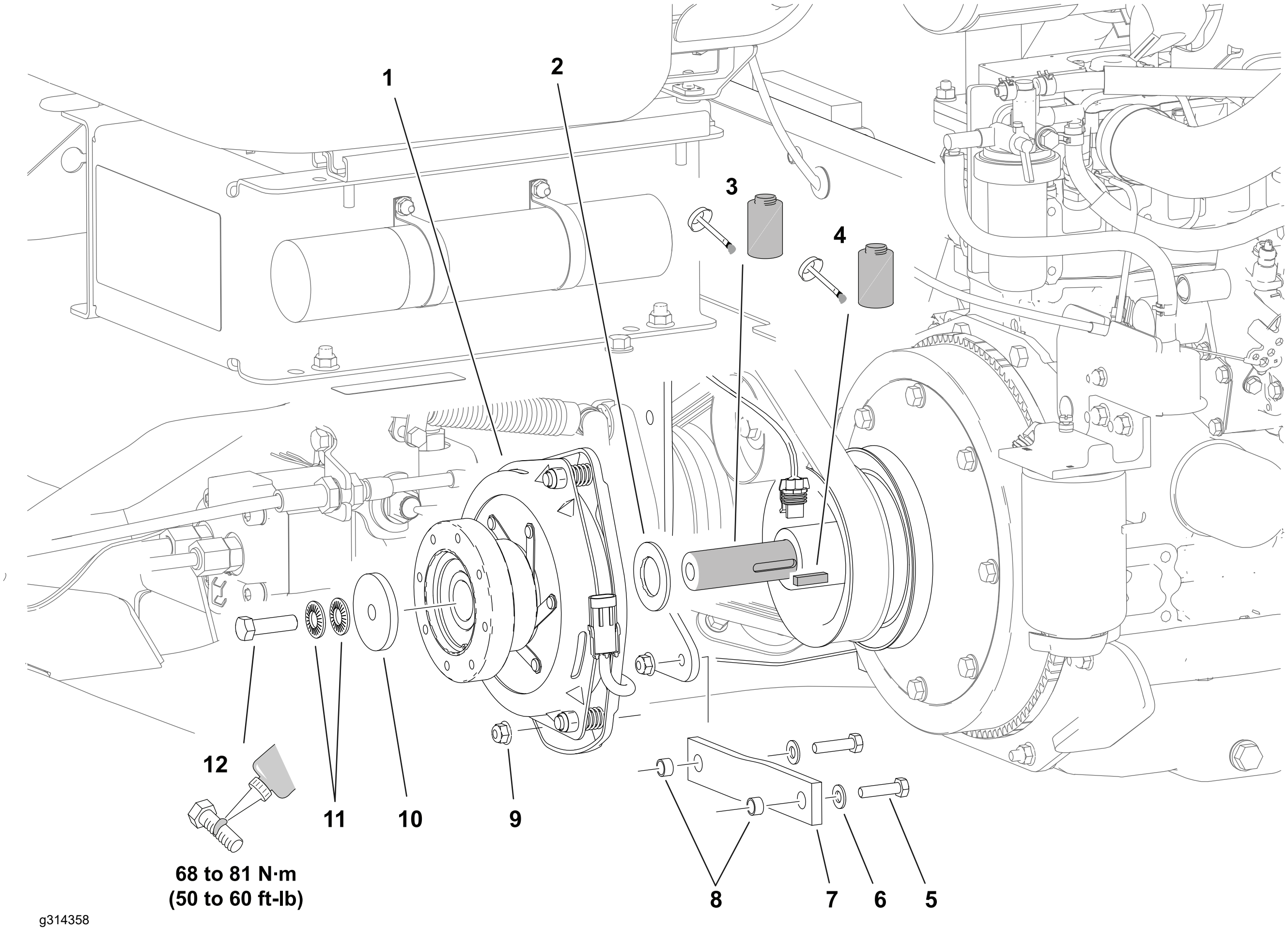

Figure 127

1. PTO clutch
2. Washer
3. Stub shaft
4. Square key
5. Cap screw (2 each)
6. Washer (2 each)
7. Stop strap
8. Spacer (2 each)
9. Lock nut (2 each)
10. Spacer
11. Spring washer
12. Cap screw

For PTO clutch testing and adjustment procedures, refer to Testing the PTO Clutch (page 6–48) and Adjusting the PTO Clutch (page 7–4).

Removing and Installing the PTO Clutch

1. Remove the PTO shaft; refer to Removing and Installing the PTO Shaft (page 7–19).
2. Record the position of the cable ties securing the wire harness near the clutch and unplug the clutch harness connector from the machine wire harness.
3. Remove the clutch stop strap. Locate and retrieve the spacers from the stop strap.
4. Remove the cap screw, spring washers, and the spacer that secure the clutch to the stub shaft.
5. Slide the clutch from the stub shaft. Locate and retrieve the square key and the washer from the stub shaft.
6. Apply anti-seize lubricant to the stub shaft and key, then install the washer and key on the stub shaft.
7. Fit the PTO clutch onto the stub shaft.

Removing and Installing the PTO Clutch (continued)

8. Use medium strength thread locking compound and install the spacer, spring washers, and the cap screw securing the clutch to the stub shaft. Tighten the cap screw from **68 to 81 N·m (50 to 60 ft-lb)**.
9. Install the clutch stop strap. Ensure that the spacers are in the stop strap and that the strap is tight against the clutch flange.
10. Connect the PTO clutch to the machine wire harness and secure the harness to the machine with cable ties.
11. Install the PTO shaft; refer to Removing and Installing the PTO Shaft (page 7–19).

Operator’s Console

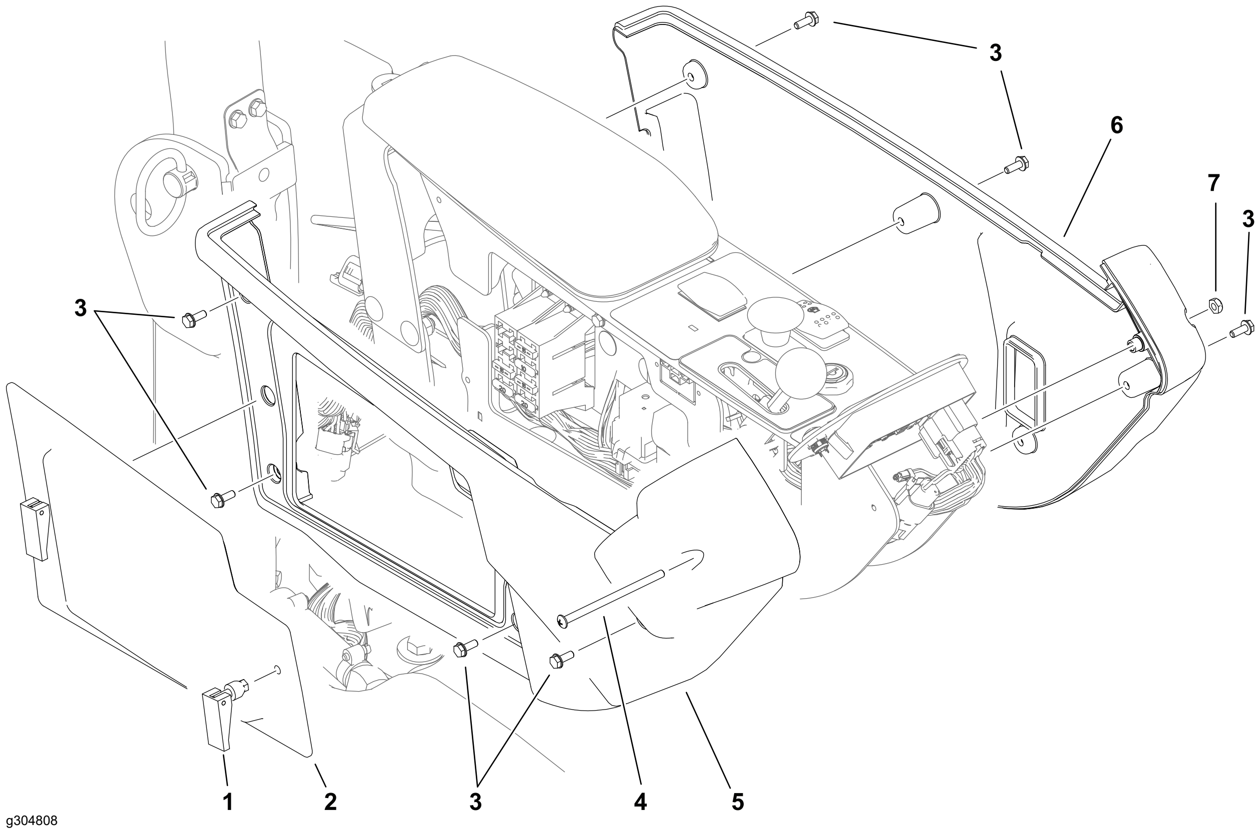

Figure 128

(models 31900 and 31901 shown)

1. Swell latch (2 each)
2. Access cover
3. Cap screw (10 each)
4. Screw
5. Cover – right side
6. Cover – left side
7. Nut

Removing and Installing the Operator’s Console Covers

Refer to Figure 128 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the access panel from the right side of the operator’s console.
3. Remove the long screw at the front of the console near the TDM display/controller screen (item 4).
4. Remove the remaining fasteners and the console covers if necessary.
5. Install the console covers in the reverse order.

Hood

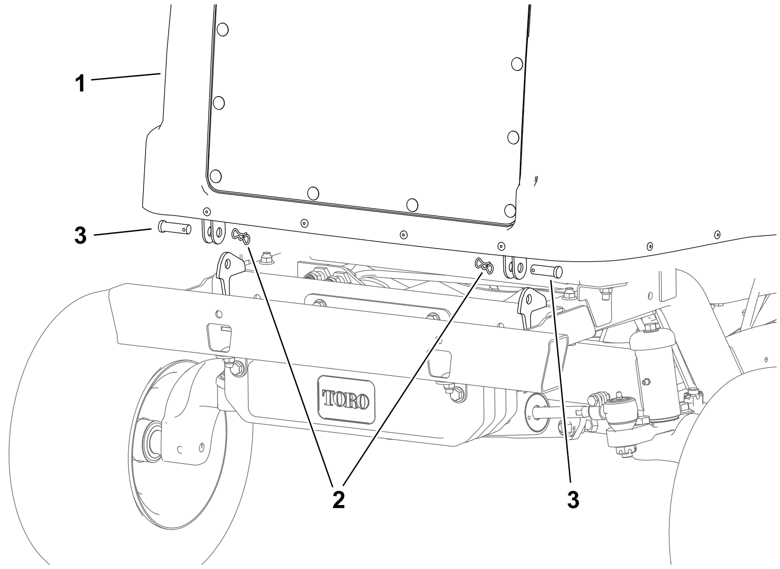

Figure 129

1. Hood assembly
2. Hair pin (2 each)
3. Clevis pin (2 each)

Removing and Installing the Hood

Refer to Figure 129 for this procedure.

1. With the hood closed, remove the hair pins and clevis pins from the hood hinges.
2. Lift the hood assembly from the machine.
3. Install the hood in the reverse order.
4. Adjust the bracket to contact the front of the hood when the rear of the hood contacts the cooler shroud seal.

Removing and Installing the Hood (continued)

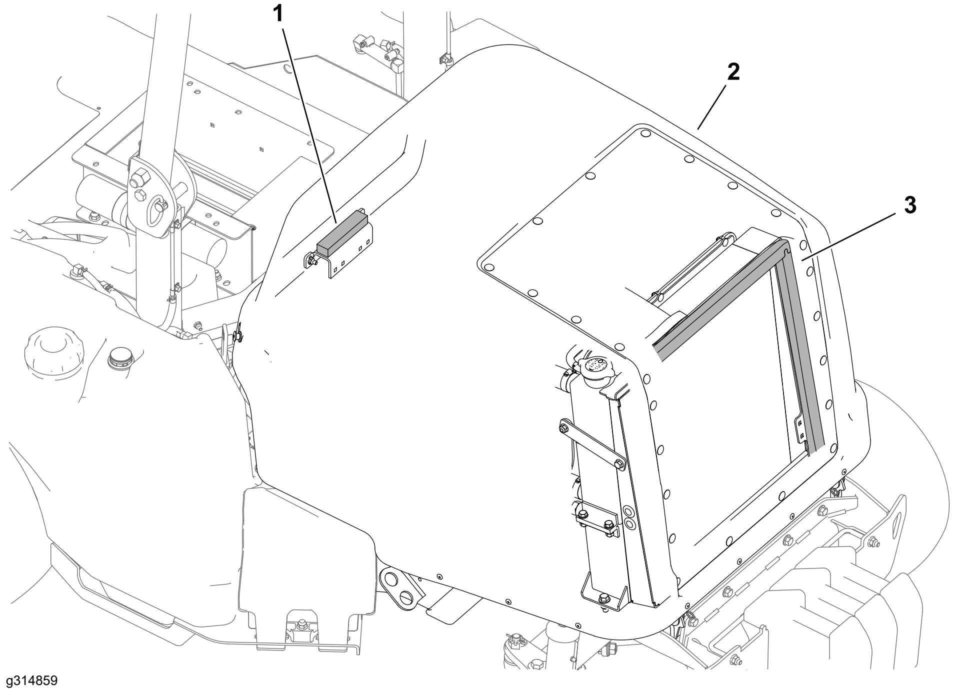

Figure 130

1. Support bracket
2. Hood
3. Cooling shroud

Operator Seat

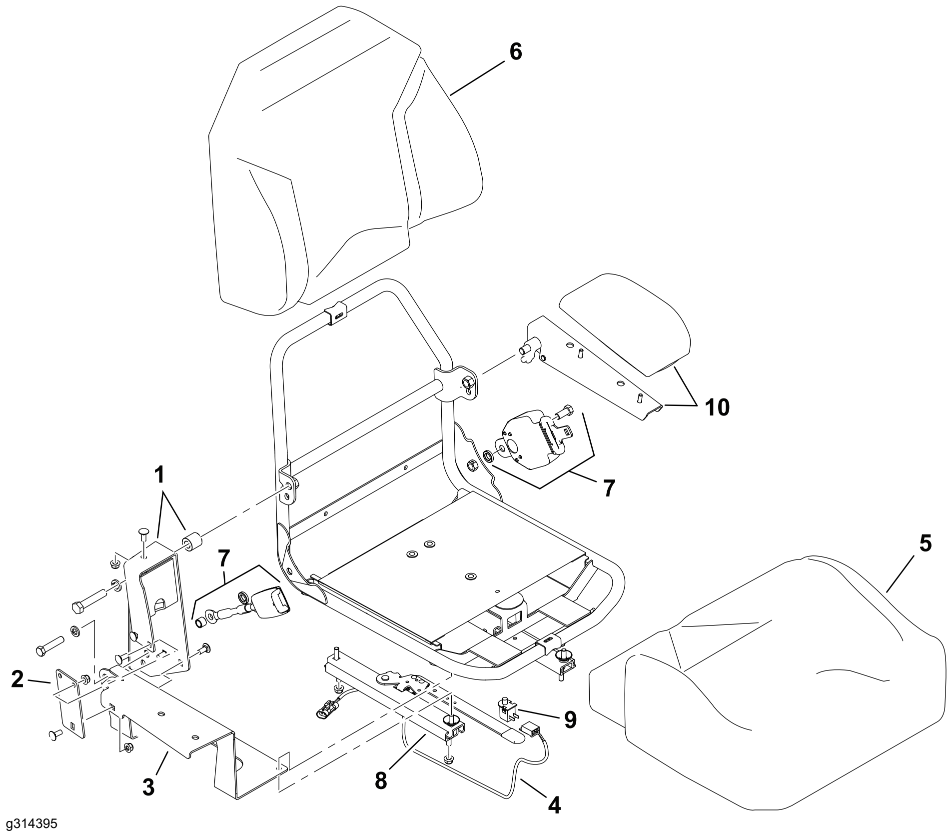

Figure 131

(standard seat shown – model 31980)

1. Console mount kit
2. Bracket kit
3. Lower console mount
4. Seat switch harness
5. Cushion cover
6. Back cover
7. Seat belt kit
8. Seat track kit
9. Seat switch
10. Armrest kit

Standard seat (model 31980), mechanical suspension seat (model 31981), and air ride suspension seat (model 31982) are available for the Groundsmaster 3200/3300 machines. For additional seat switch information, refer to Seat Switch (page 6–27). For additional seat suspension information, refer to Mechanical Suspension Seat (Model 31981) (page 7–28) or Air Ride Suspension Seat (Model 31982) (page 7–29).

Removing and Installing the Operator Seat

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the electrical connector from the seat switch. On air ride seat suspension systems, disconnect the electrical connector from the air compressor.
3. Remove the fasteners securing the seat tracks to the seat box.
4. Remove the seat assembly from the machine.
5. Repair or replace the seat or seat components as necessary.
6. Secure the seat tracks to the seat box.

Removing and Installing the Operator Seat (continued)

7. Connect the electrical connector to the seat switch. On air ride seat suspension systems, connect the electrical connector to the air compressor.

8. Test the seat switch operation before returning the machine to service.

Mechanical Suspension Seat (Model 31981)

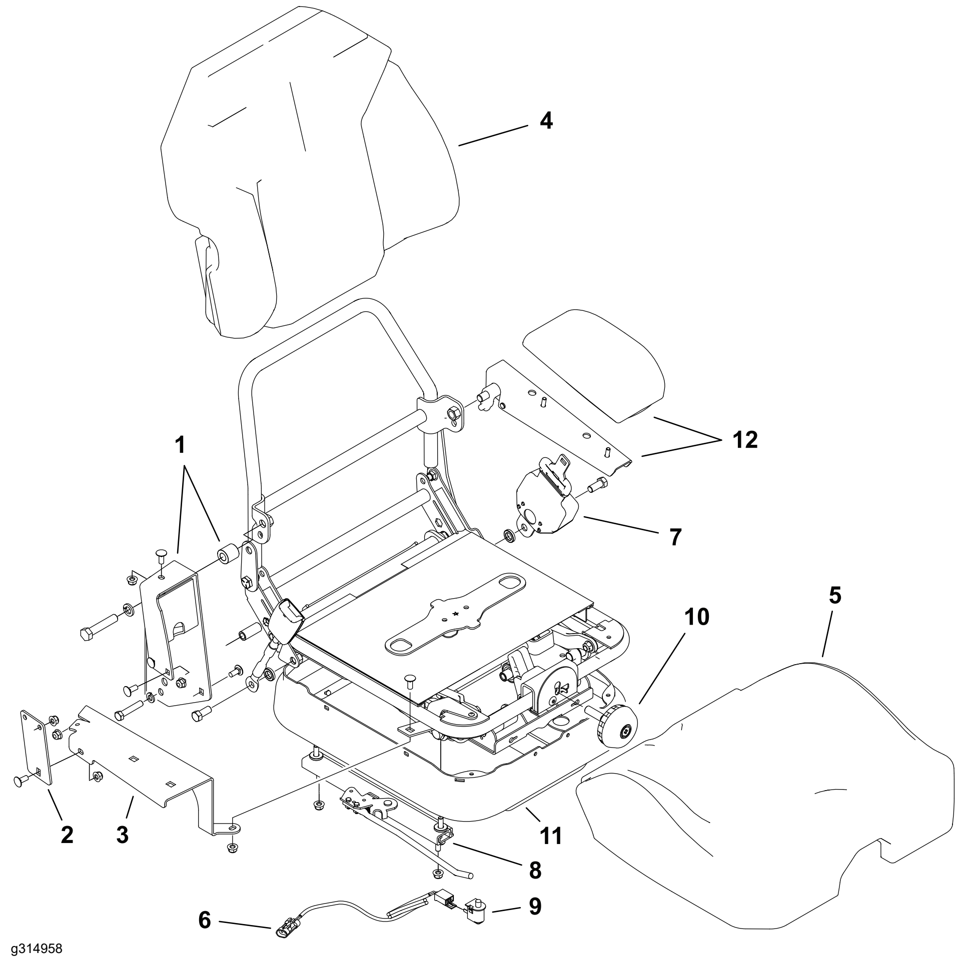

Figure 132

1. Upper console mount kit
2. Bracket kit
3. Lower console mount
4. Back cover
5. Cushion cover
6. Seat switch harness
7. Seat belt kit
8. Seat track kit
9. Seat switch
10. Weight adjust knob
11. Bellows
12. Armrest kit

Air Ride Suspension Seat (Model 31982)

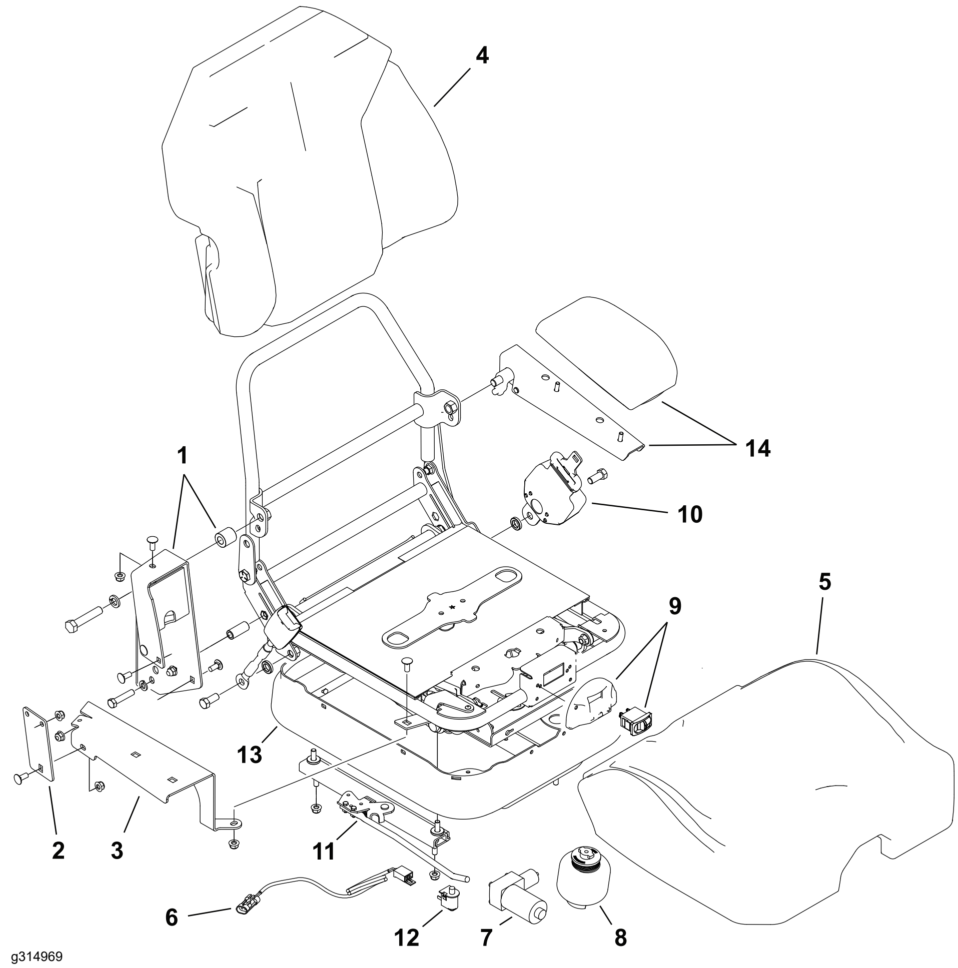

Figure 133

1.	Upper console mount kit	8.	Air bag kit
2.	Bracket kit	9.	Air valve kit
3.	Lower console mount	10.	Seat belt kit
4.	Back cover	11.	Seat track kit
5.	Cushion cover	12.	Seat switch
6.	Seat harness (2 pieces)	13.	Bellows
7.	Air compressor kit	14.	Armrest kit

Lift Arms

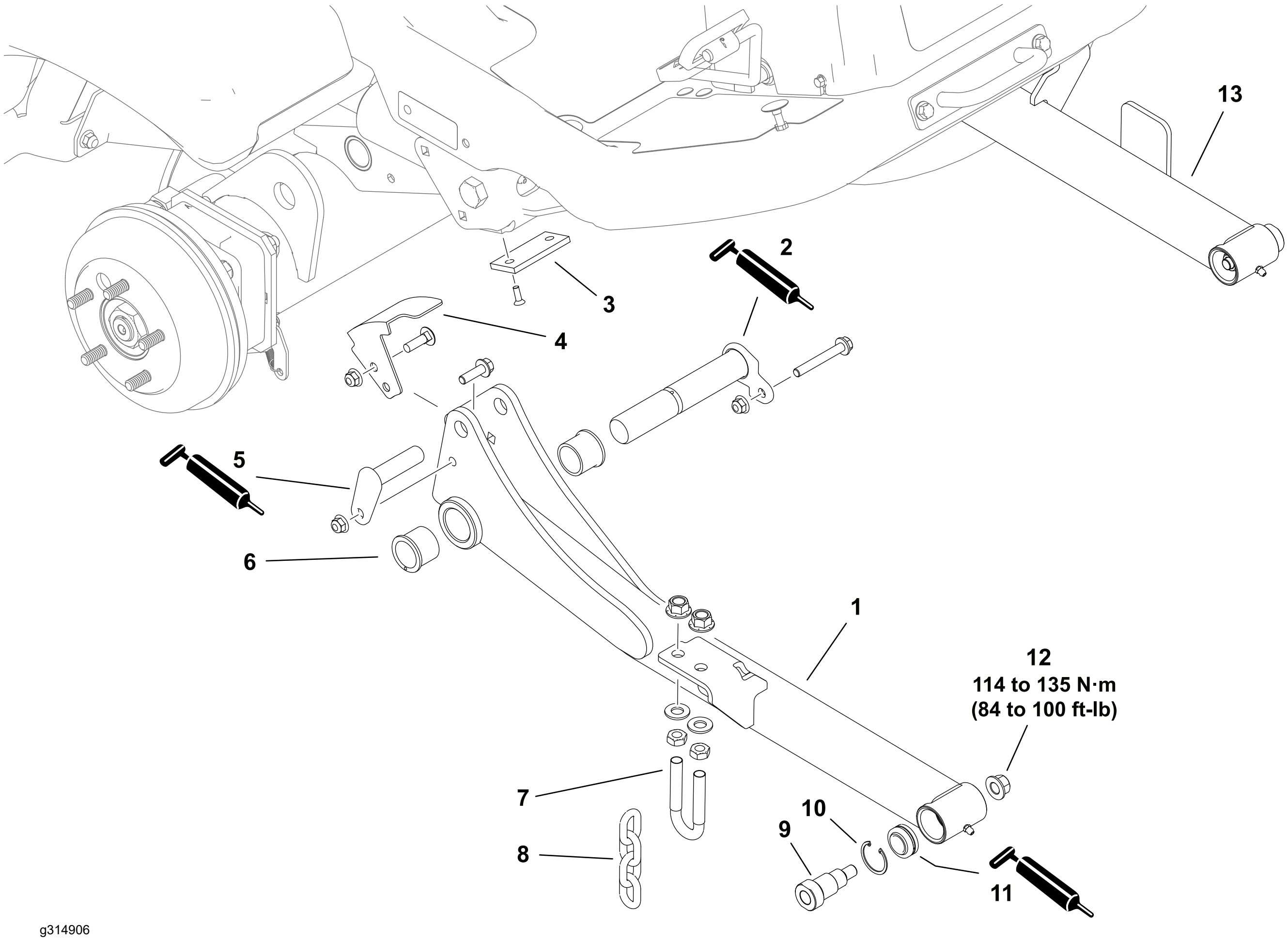

Figure 134

1. Lift arm – left
2. Lift arm pivot pin
3. Bumper pad
4. Switch sensing plate
5. Lift cylinder pivot pin
6. Flange bushing (2 each)
7. U-bolt (2 each)
8. Height of cut (HOC) chain (2 each)
9. Shoulder bolt
10. Retaining ring
11. Spherical bearing
12. Flange nut
13. Lift arm – right

Note: The spherical bearings at the cutting unit end of the lift arms have a light press fit and can be replaced without removing the lift arms from the machine.

Removing the Lift Arms

1. Remove the cutting unit from the machine; refer to the cutting unit *Operator's Manual*.
2. Remove the front wheel next to the lift arm being removed; refer to Removing and Installing the Wheels (page 7–5).
3. Support the lift arm and the lift cylinder and remove the pin from the rod end of the cylinder. Do not allow the cylinder to hang my the hydraulic hoses.

IMPORTANT

Do not contact or scratch the face of the cutting unit high trim height switch when working near the switch.

Removing the Lift Arms (continued)

4. When removing the right side lift arm, carefully remove the cutting unit high trim height switch sensing plate from the lift arm.

CAUTION

Each lift arm weighs approximately 27 kg (60 lbs).

5. Support the lift arm and remove the lift arm pivot pin. Remove the lift arm from the machine.
6. Check the pivot pin and lift arm bushings for damage or wear and replace as necessary.
7. Continue to disassemble the lift arm as necessary.

Installing the Lift Arms

1. Tighten the bumper pad mounting screws until the screw head is flush with the surface of the pad.
2. Lightly grease and install the spherical bearing and shoulder bolt in the front lift arm hub if previously removed. Tighten the flange nut from **114 to 135 N·m (84 to 100 ft-lb)**.
3. Use an arbor press to install new flange bushings in the rear lift arm hub if necessary.
4. Lightly grease the lift arm pivot pin. Position the lift arm in the machine and install the pivot pin and pivot pin fasteners.
5. Lightly grease the lift cylinder pin. Support the lift arm and the lift cylinder and install the cylinder pin and cylinder pin fasteners.
6. When installing the right side lift arm, carefully install the cutting unit high trim height switch sensing plate to the lift arm. Check and adjust the cutting unit high trim height switch clearance; refer to Adjusting the Cutting Unit High Trim Height Switch (page 6–34).
7. Install or check and adjust the height of cut (HOC) chain U-bolts as shown in Figure 135.

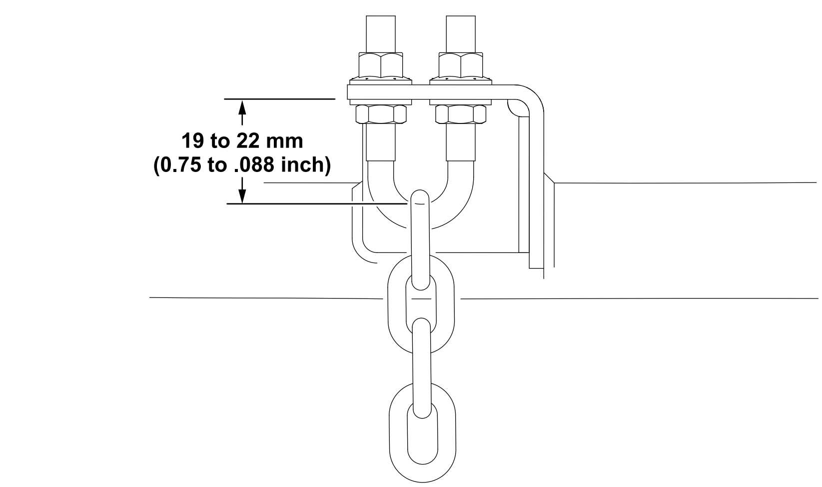

Figure 135

Installing the Lift Arms (continued)

8. Grease the lift arm and lift cylinder pivots; refer to the traction unit *Operator's Manual*.
9. Install the front wheel; refer to Removing and Installing the Wheels (page 7–5).
10. Install the cutting unit to the machine; refer to the cutting unit *Operator's Manual*.

Cutting Units

Table of Contents

General Information

Several cutting units are available for the Groundsmaster 3200, 3300, and 3310 machines. This chapter gives information about service and repair of the following units:

Model	Description
31974	Standard Series 152 cm (60 inch) Rear Discharge Rotary Mower
31975	Standard Series 183 cm (72 inch) Rear Discharge Rotary Mower
31970	Groundsmaster Series 152 cm (60 inch) Side Discharge Rotary Mower
31971	Groundsmaster Series 152 cm (60 inch) Rear Discharge Rotary Mower
31972	Groundsmaster Series 183 cm (72 inch) Side Discharge Rotary Mower
31973	Groundsmaster Series 183 cm (72 inch) Rear Discharge Rotary Mower
02835	152 cm (60 inch) F60 Flail Mower

Note: The cutting unit belt covers for Standard series and CE compliant Groundsmaster series cutting units are secured to the cutting unit with cap screws. The cutting unit belt covers for domestic (North America) Groundsmaster series cutting units do not require any tools for removal or installation. Ensure that tool-less belt covers are fully seated in the retainers before returning the machine to service.

Cutting Unit Operator's Manual

The cutting unit *Operator’s Manual* provides information regarding the specifications, operation, adjustment, general maintenance, and optional accessories for the cutting unit on your machine. Refer to the cutting unit *Operator’s Manual* for additional information when servicing the cutting unit.

Blade Stopping Time

The blades of the cutting deck must come to a complete stop in approximately five (5) seconds after the PTO switch is disengaged. To verify the blade stopping time:

1. Lower the cutting unit onto a clean section of turf or hard surface to avoid dust and debris.
2. Remove one of the rotary cutting unit belt covers, or the flail cutting unit drive belt cover.
3. Engage and then disengage the PTO switch while observing the exposed spindle or shaft pulley. Repeat this step and record the time it takes for the pulley to come to a complete stop.
4. If the stopping time is greater than seven seconds, the PTO clutch may need adjustment; refer to Adjusting the PTO Clutch (page 7–4).

Service and Repairs

WARNING

Do not start the engine and engage the PTO switch when the PTO shaft is disconnected from the cutting unit. If you start the engine and the PTO shaft is allowed to rotate, serious personal injury and machine damage could result.

If the PTO shaft is disconnected from the cutting unit, disconnect the PTO electric clutch electrical connector.

CAUTION

Do not work on the cutting unit or lift arms with the engine running.

Always shut off the engine and remove the key from the key switch before working on the cutting unit.

Rotary Cutting Units

Refer to specific cutting unit *Operator's Manual* for the cutting unit removal and installation procedures.

Tighten the cutting unit bumper pad mounting screws until the screw heads are just below the surface of the pad; refer to Figure 136).

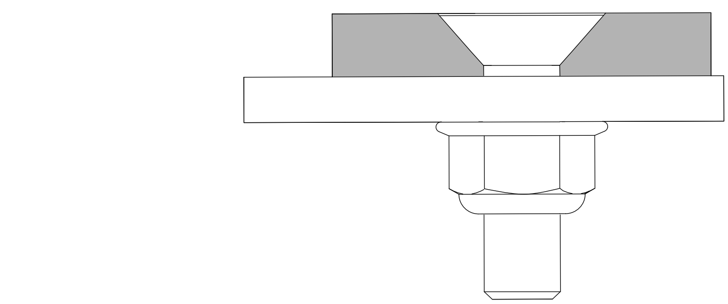

Figure 136
Cutting Unit Bumper Pad (typical)

Idler Assemblies

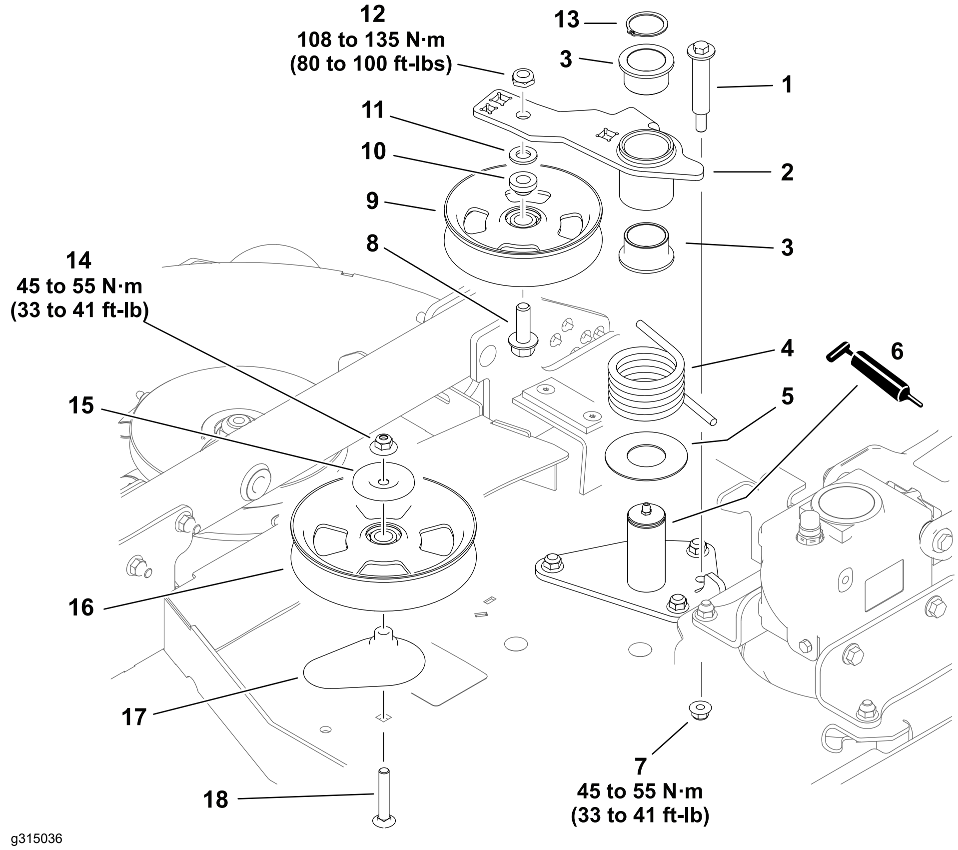

Figure 137

(side discharge cutting unit shown)

1. Shoulder bolt
2. Idler lever
3. Flange bushing (2 each)
4. Torsion spring
5. Washer
6. Idler pivot
7. Flange nut
8. Cap screw
9. Idler pulley
10. Spacer
11. Washer
12. Lock nut
13. Retaining ring
14. Flange nut
15. Dust shield
16. Idler pulley
17. Pulley spacer
18. Carriage bolt

Removing the Tensioning Idler Assembly

Refer to Figure 137 for this procedure.

1. Park the machine on a level surface, lower the cutting unit, engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the belt covers from the cutting unit.
3. Use a 3/8 inch or 1/2 inch drive ratchet or breaker bar in the idle arm to release the drive belt tension.
4. Slip the drive belt off the gearbox pulley and allow the idler to rest against the shoulder bolt.
5. Remove the fasteners securing the tensioning idler assembly to the cutting unit and remove the assembly.
6. Secure the idler assembly in a vise by clamping on the idler pivot plate.

CAUTION

The spring is under heavy load and can cause personal injury.

Be careful when removing tension from the torsion spring of the idler arm.

---

7. Use a 3/8 inch or 1/2 inch drive ratchet or breaker bar in the idle arm to move the idler arm away from the shoulder bolt.
8. Remove the shoulder bolt from the idler pivot plate then unload the idler spring tension.
9. Remove the retaining ring that retains the idler arm to the idler pivot.
10. Remove the idler components as needed.

Installing the Tensioning Idler Assembly

Refer to Figure 137 for this procedure.

1. Tighten the lock nut securing the idler pulley to the idler arm from **108 to 135 N·m (80 to 100 ft-lbs)**.
2. Lightly grease the idler pivot and assemble the tensioning idler components onto the idler pivot.
3. Secure the idler components to the idler pivot with the retaining ring.
4. Secure the idler assembly in a vise by clamping on the idler pivot plate.

CAUTION

The spring is under heavy load and can cause personal injury.

Be careful when applying tension to the torsion spring of the idler arm.

---

5. Use a 3/8 inch or 1/2 inch drive ratchet or breaker bar in the idle arm to move the idler arm (load the torsion spring) enough to install the shoulder bolt.
6. Install the shoulder bolt to the idler pivot plate. Tighten the flange nut from **45 to 55 N·m (33 to 41 ft-lb)** and release the idler arm.
7. Secure the tensioning idler assembly to the cutting unit with the previously removed fasteners.
8. Install the drive belt.
9. Grease the idler pivot and install the belt covers before returning the cutting unit to service; refer to the cutting unit *Operator's Manual*.

Removing and Installing a Stationary Idler Assembly

Refer to Figure 137 for this procedure.

1. Park the machine on a level surface, lower the cutting unit, engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the belt covers from the cutting unit.

Idler Assemblies (continued)

⚠ CAUTION ⚠

The spring is under heavy load and can cause personal injury.

Be careful when removing tension from the torsion spring of the idler arm.

---

3. Use a 3/8 inch or 1/2 inch drive ratchet or breaker bar in the idle arm to release the drive belt tension.
4. Slip the drive belt off the stationary idler pulley then unload the idler spring tension.
5. Rotate the cutting unit to the SERVICE position; refer to the traction unit *Operator's Manual*.
6. Inspect the pulley bearing and spacer shaft for damage or wear. Replace the pulley and/or the spacer if necessary.

   Note: The pulley spacer has a locating feature that must fit into the locating hole in the deck. The bottom of the pulley spacer must fit flat against the deck once installed.
7. Install the stationary idler. Tighten the lock nut from **45 to 55 N·m (33 to 41 ft-lb)**.
8. Lower the cutting unit and install the drive belt and belt covers.

Blade Spindle Assemblies

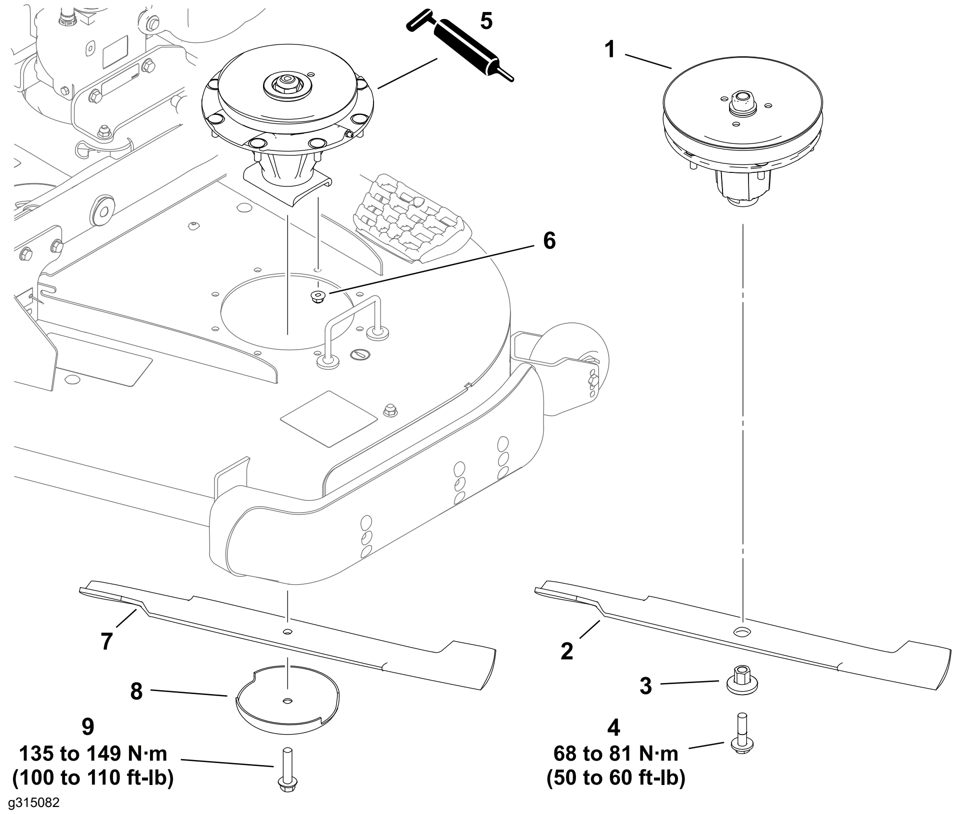

Figure 138

1. Spindle assembly – Standard
2. Blade – Standard
3. Hex bushing – Standard
4. Blade bolt – Standard
5. Spindle assembly – Groundsmaster
6. Flange nut (6 or 8 each)
7. Blade – Groundsmaster
8. Anti-scalp cup – Groundsmaster
9. Blade bolt – Groundsmaster

Removing the Blade Spindle Assemblies

Refer to Figure 138 for this procedure.

1. Park the machine on a level surface, lower the cutting unit, engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the belt covers and the drive belt from the cutting unit; refer to the cutting unit *Operator's Manual*.
3. Rotate the cutting unit to the SERVICE position; refer to the traction unit *Operator's Manual*.
4. Remove the blade bolt, hex bushing or anti-scalp cup, and blade from the spindle.
5. Remove the fasteners that secure the spindle assembly to the deck, and remove the spindle assembly from the deck.

Installing the Blade Spindle Assemblies

Refer to Figure 138 for this procedure.

1. Position the spindle assembly to the cutting unit deck.
   A. For Standard series cutting units, the spindle housing has a locating feature that must fit into the locating hole in the deck. The bottom of the spindle housing spacer must fit flat against the deck once installed.

B. For Groundsmaster series cutting units, align the spindle grease fitting with the decal on the cutting unit for each spindle.

2. Install the blade, hex bushing or anti-scalp cup, and blade bolt.

   - For standard series cutting units, tighten the blade bolt from **68 to 81 N·m (50 to 60 ft-lb)**.
   - For Groundsmaster series cutting units, tighten the blade bolt from **135 to 149 N·m (100 to 110 ft-lb)**.

3. Slowly rotate the cutting blades to check that the blades do not contact any deck component(s).

4. For Groundsmaster series cutting units, lubricate the spindle grease fittings before returning the cutting unit to service.

5. Lower the cutting unit and install the drive belt and belt covers.

Servicing the Blade Spindle (Standard Series Cutting Units)

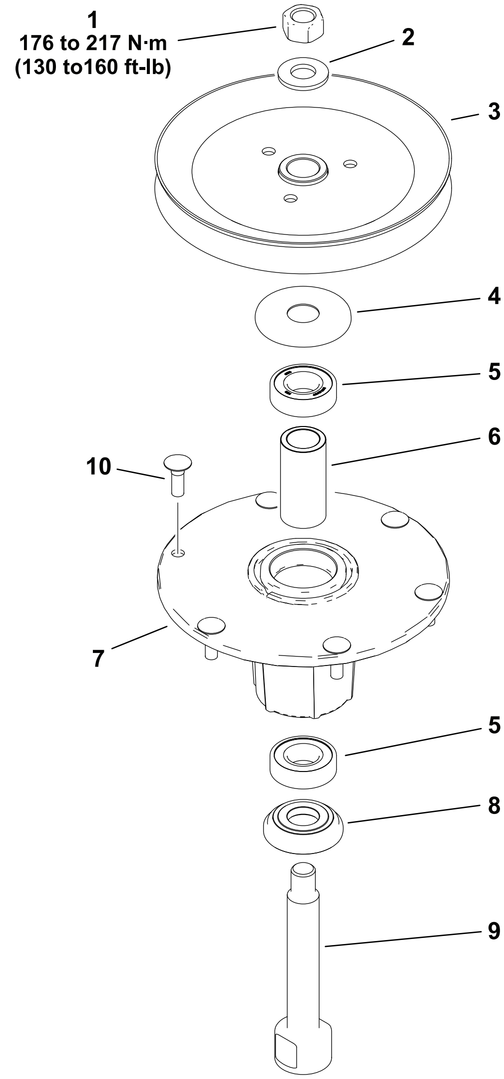

Figure 139

1. Lock nut
2. Disc spring washer
3. Pulley
4. Bearing guard
5. Ball bearing (2 each)
6. Bearing spacer
7. Spindle housing
8. Bottom guard
9. Spindle shaft
10. Drive stud (6 each)

Blade spindles for Standard series cutting units have cast aluminum spindle housings, sealed ball bearings, 25 mm (1 inch) spindle shafts, and are designed to use 5.1 mm (0.20 inch) thick blades.

Disassembling the Blade Spindle

Refer to Figure 139 for this procedure.

1. Remove the lock nut, disc spring washer, pulley, and bearing guard from the top of the spindle shaft.
2. Remove the spindle shaft and bottom guard from the spindle housing.
3. Being careful not to damage the spindle housing bore, remove the bearings and bearing spacer from the spindle housing. Discard the bearings.
4. Inspect the drive studs. Use an arbor press to replace any drive studs if necessary.

Servicing the Blade Spindle (Standard Series Cutting Units) (continued)

Assembling the Blade Spindle

Refer to Figure 139 for this procedure.

1. Install a bearing into the bottom of the spindle housing by pressing equally on the inner and outer race of the bearing. Ensure that the bearing seats against the shoulder of the bearing bore.
2. Insert the bearing spacer.

   Note: Use the spindle shaft to align the bearings and bearing spacer during assembly.
3. Support the inner and outer race of the previously installed bearing, then install a bearing into the top of the spindle housing by pressing equally on the inner and outer race of the bearing. Ensure that the bearing seats against the bearing spacer.
4. Insert the bottom guard and the spindle shaft into the spindle housing.
5. Install the bearing guard, pulley, disc spring washer, and lock nut. Tighten the lock nut from **176 to 217 N·m (130 to 160 ft-lb)**.

Servicing the Blade Spindle (Groundsmaster Series Cutting Units)

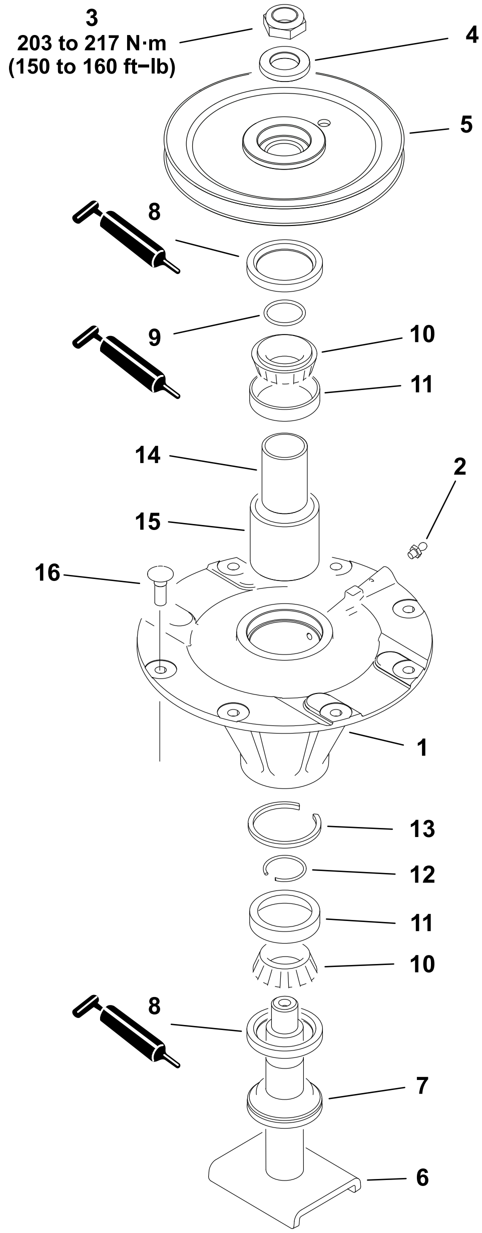

Figure 140

1.	Spindle housing	9.	O-ring
2.	Grease fitting	10.	Bearing cone (2 each)
3.	Locknut	11.	Bearing cup (2 each)
4.	Hardened washer	12.	Spacer ring
5.	Pulley	13.	Large snap ring
6.	Spindle shaft	14.	Inner bearing spacer
7.	Spindle spacer	15.	Outer bearing spacer
8.	Seal (2 each)	16.	Drive Stud (8 each)

Blade spindles for Groundsmaster series cutting units have cast iron spindle housings, greasable roller bearings, 31.7 mm (1.25 inch) spindle shafts, anti scalp cups, and are designed to use 6.3 mm (0.25 inch) thick blades.

Disassembling the Blade Spindle

Refer to Figure 140 for this procedure.

1. Remove the locknut, hardened washer, and pulley from the top of the spindle shaft.
2. Use an arbor press to remove the spindle shaft from the spindle housing.

   Note: Ensure that the spindle shaft spacer remains on the spindle shaft while removing the shaft.
3. Remove and discard the oil seals from the spindle housing.
4. Remove the bearing cones, inner bearing spacer, spacer ring and spindle shaft O− ring from the spindle housing. Discard the spindle shaft O−ring.
5. Use an arbor press to remove the bearing cups and outer bearing spacer from the housing.

   Note: The large snap ring can remain inside the spindle housing. Removing the large snap ring is very difficult.
6. Inspect the drive studs. Use an arbor press to replace any drive studs if necessary.

Assembling the Blade Spindle

IMPORTANT

Do not mix the components from one bearing set to another. Replace the bearings as a complete set only.

Do not mix the components from one spacer set to another. Replace the spacers as a complete set only.

A replacement bearing set contains 2 bearings, a spacer ring, and a large snap ring. A replacement spacer set includes the inner spacer and outer spacer.

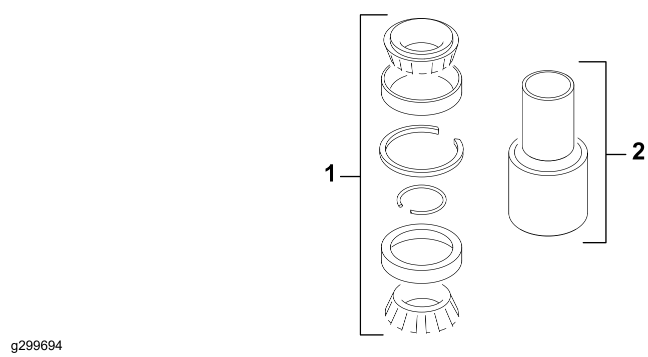

Figure 141

1. Bearing set
2. Spacer set

IMPORTANT

If new bearings are installed into a used spindle housing, it is not necessary to replace the original large snap ring. If the original snap ring is in good condition with no sign of damage (e.g., spun bearing), leave the snap ring in the housing and discard the snap ring that comes with the new bearings. If the large snap ring is damaged, replace the snap ring.

1. If previously removed, install the large snap ring into the housing groove. Ensure that the snap ring is fully seated in the housing groove.
2. Install the outer bearing spacer from the top of the spindle housing. The spacer should contact the large snap ring.
3. Use an arbor press to push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer spacer that was previously installed, and the bottom bearing cup must contact the snap ring. Ensure that the assembly is correct by supporting the first bearing cup and pressing the second bearing cup against it; refer to Figure 142.

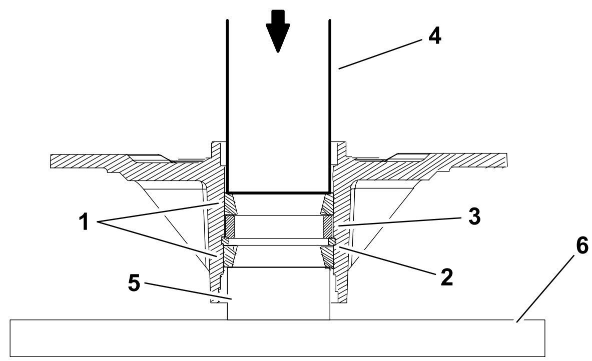

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Figure 142

1. Bearing cup	4. Arbor press
2. Large snap ring	5. Support
3. Outer spacer	6. Arbor press base

4. Pack the bearing cones with grease. Apply a film of grease on the lips of the oil seals and O-ring.

IMPORTANT

The bottom seal must have the lip facing out (down). This seal installation allows grease to purge from the spindle during the lubrication process.

5. Install the lower bearing cone and oil seal into the bottom of the spindle housing.

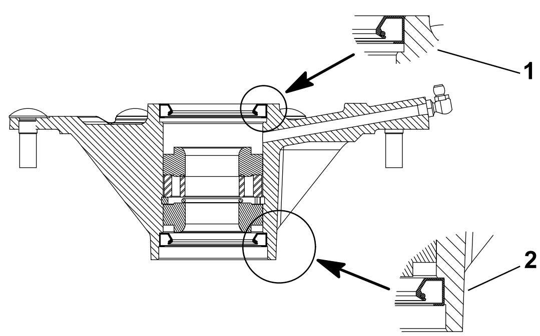

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Figure 143

1. Upper seal installation	2. Bottom seal installation

IMPORTANT

The upper seal must have the lip facing in (down). Also, install upper seal so it is flush to *1.5 mm (0.060 inch)* below the housing surface.

6. Slide the spacer ring and inner bearing spacer into the spindle housing, then install the upper bearing cone and oil seal into the top of the housing.
7. Examine the spindle shaft and shaft spacer to ensure that there are no burrs or nicks that could damage the oil seals. Install the shaft spacer onto the spindle shaft and lubricate the shaft and spacer with grease.
8. Place a thin sleeve or tape on the spindle shaft splines to prevent damage of the seal during the installation of the shaft. Carefully slide the spindle shaft with the spacer up through the spindle housing. The bottom oil seal and shaft spacer fit together when the spindle is fully inserted.
9. Install the O-ring to the top of the spindle shaft.

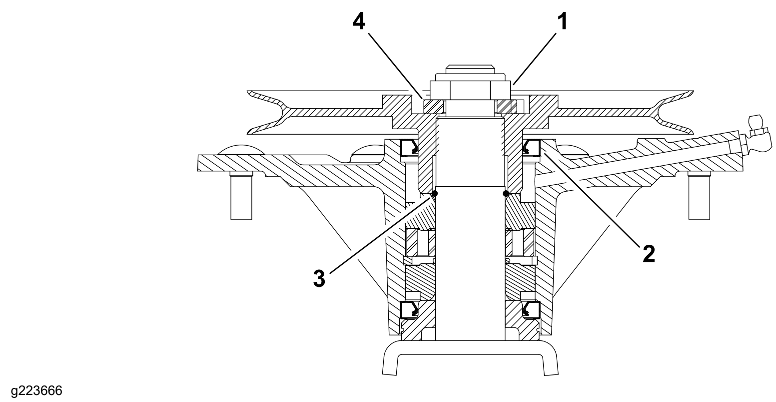


Figure 144

1. Locknut
2. Upper seal
3. O-ring
4. Hardened washer

10. Install the pulley (hub down), hardened washer, and locknut to the spindle shaft. Tighten the locknut to **203 to 217 N·m (150 to 160 ft-lb)**.

IMPORTANT

Do not use a pneumatic grease gun for greasing of the spindle housings. A pneumatic grease gun can produce high pressure inside the spindle housing that can damage the spindle seals.

11. Use a hand pump grease gun and fill the housing cavity with grease until the grease starts to come out of the lower seal.
12. Rotate the spindle shaft to ensure that it turns freely.

Rollers and Skids

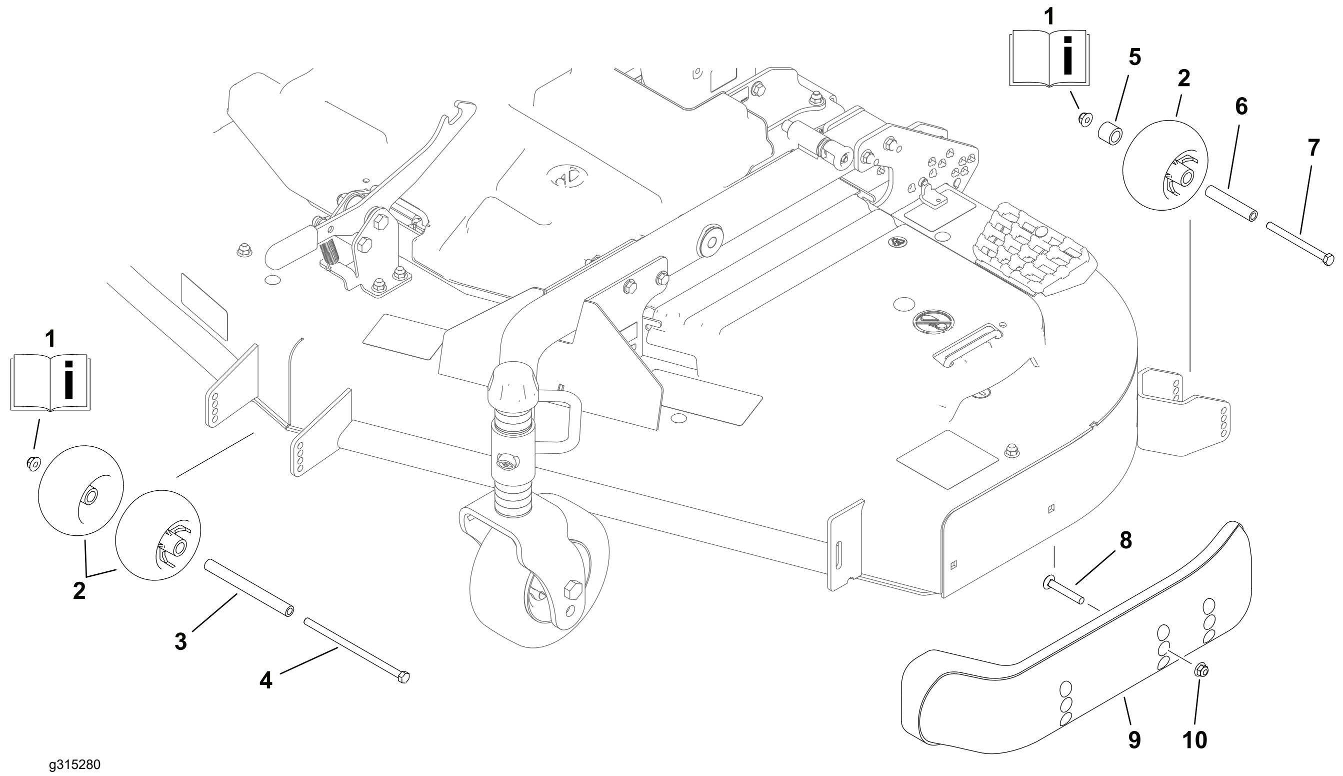


Figure 145

1. Lock nut	5. Spacer	9. Skid/bumper
2. Roller	6. Spanner	10. Flange nut (2 each)
3. Spanner	7. Cap screw	
4. Cap screw	8. Carriage screw (2 each)	

Removing and Installing the Rollers and Skids

Refer to Figure 145 for this procedure.

1. Park the machine on a level surface, lower the cutting unit, engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. To preserve the roller or skid height, record the mounting hole locations and remove the rollers or skids from the cutting unit as necessary.
3. Install the rollers or skids in the mounting holes previously recorded. Tighten the roller fasteners so the screw threads fully engage the nylon insert of the lock nut while allowing the roller to rotate freely.

Latch Assembly

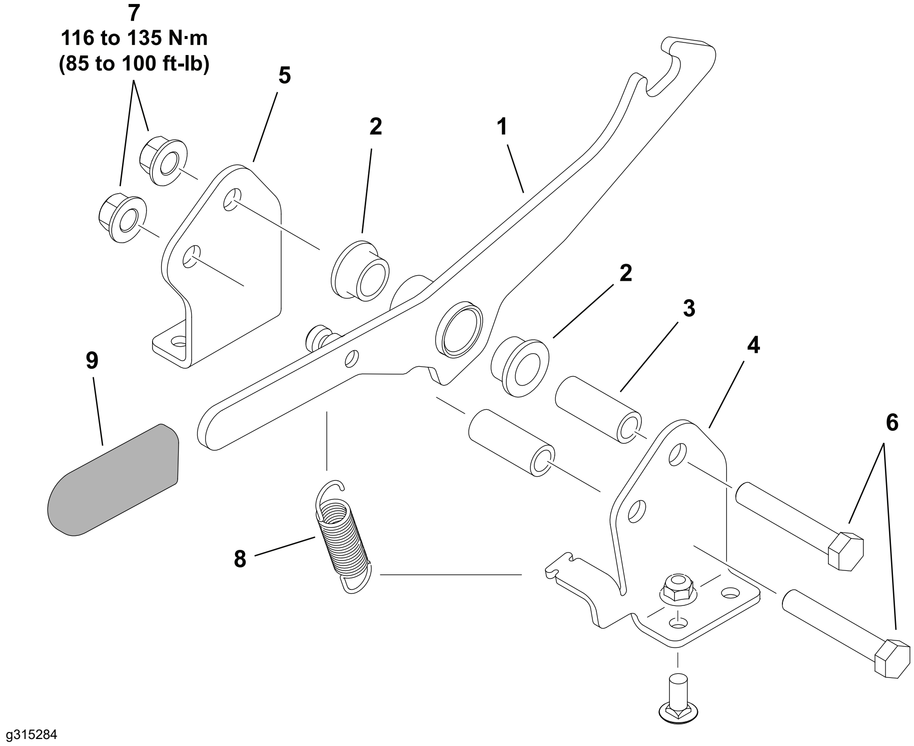


Figure 146

1. Latch arm
2. Flange bushing (2 each)
3. Spacer (2 each)
4. Latch mount – LH
5. Latch mount – RH
6. Cap screw (2 each)
7. Flange nut (2 each)
8. Extension spring
9. Handle

Servicing the Latch Assembly

Refer to Figure 146 for this procedure.

1. Park the machine on a level surface, lower the cutting unit, engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Remove the extension spring and disassemble the service latch as necessary.
3. Inspect the latch handle bushings for damage or wear and replace as necessary.
4. If the latch mounts are removed from the cutting unit, secure the mounts flat to the cutting unit before tightening the flange nuts (item 7).
5. Tighten the flange nuts (item 7) from **116 to 135 N·m (85 to 100 ft-lb)**.

Gearbox

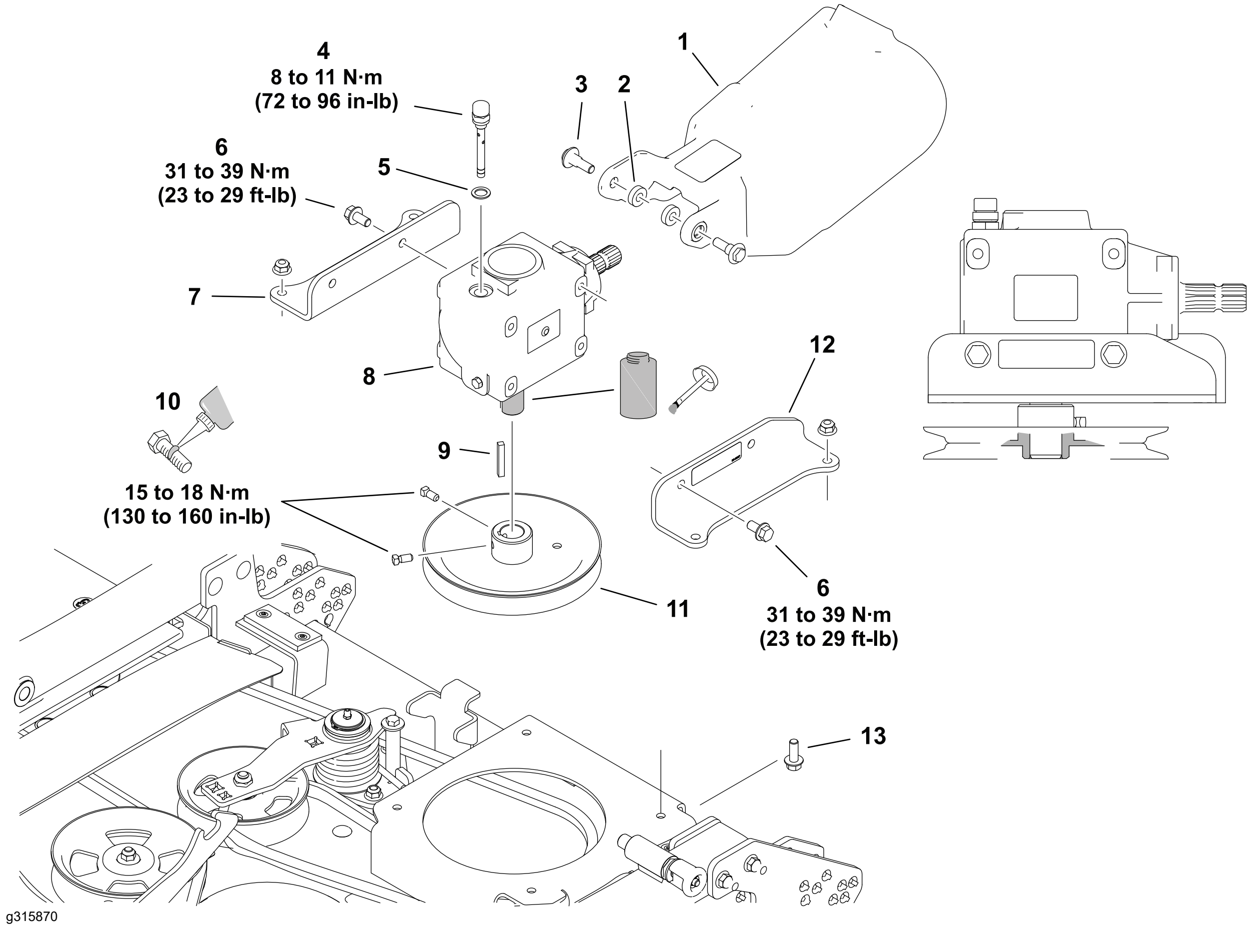


Figure 147

1. PTO guard
2. Spacer (2 each)
3. Shoulder screw (2 each)
4. Dipstick/breather
5. Copper washer
6. Cap screw (4 each)
7. Gearbox bracket – right
8. Gearbox
9. Square key
10. Set screw (2 each)
11. Pulley
12. Gearbox bracket – left
13. Cap screw (4 each)

Removing the Gearbox

WARNING

Do not start the engine and engage the PTO switch when the PTO shaft is disconnected from the cutting unit. If you start the engine and the PTO shaft is allowed to rotate, serious personal injury and machine damage could result.

If the PTO shaft is disconnected from the cutting unit, disconnect the PTO electric clutch electrical connector.

Refer to Figure 147 for this procedure.

1. Remove the cutting unit from the machine; refer to the cutting unit *Operator's Manual*.
2. Remove the belt covers from the cutting unit.

3. Use a 3/8 inch or 1/2 inch drive ratchet or breaker bar in the idle arm to release the drive belt tension.
4. Slip the drive belt off the gearbox pulley then unload the idler spring tension.
5. Remove the PTO guard from the gearbox.
6. Remove the 4 fasteners that secure the gearbox assembly to the cutting unit and remove the gearbox assembly.

Servicing the Gearbox

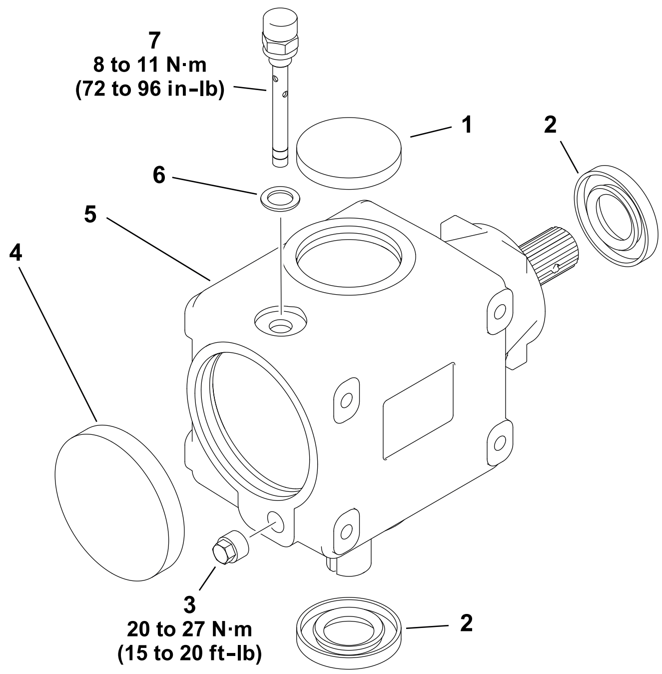


Figure 148

1. Oil cap – 2.0 inch
2. Seal (2 each)
3. Plug
4. Oil cap – 3.1 inch
5. Gearbox
6. Copper washer
7. Dipstick/breather

---

1. Dismantle the gearbox assembly as necessary.
2. If necessary, remove and replace the gearbox dipstick/breather copper washer, oil seals, and oil caps.

   Note: If internal gearbox wear or damage occurs, gearbox replacement is necessary. The internal gearbox components are not available.

Installing the Gearbox

Refer to Figure 147 for this procedure.

1. Pay attention to the left and right gearbox bracket orientation and secure the brackets to the gearbox if previously removed.
2. Tighten the gearbox bracket fasteners from **31 to 39 N·m (23 to 29 ft-lb)**.
3. Clean the gearbox output shaft, square key, and the inside of the pulley hub.
4. Apply a thin coating of anti-seize lubricant to the output shaft and install the square key.

Gearbox (continued)

5. Apply medium strength thread locking compound to the threads of the set screws and start the set screws in the pulley hub.
6. Fit the pulley to the output shaft with the set screws toward the gearbox and align the bottom of the pulley hub flush with the end of the output shaft.
7. Tighten the set screws from **15 to 18 N·m (130 to 160 in-lb)**.
8. Secure the gearbox assembly to the cutting with the previously removed fasteners and install the drive belt.
9. Tighten the drain plug from **20 to 27 N·m (15 to 20 ft-lb)**.
10. Fill the gearbox with approximately **283 ml (12 oz) petroleum or synthetic SAE 80W–90 gear lube**.
11. Install the copper washer and tighten the dipstick/breather from **8 to 11 N·m (72 to 96 in-lb)**.
12. Install the PTO guard.
13. Install the belt covers.

Castor Wheels

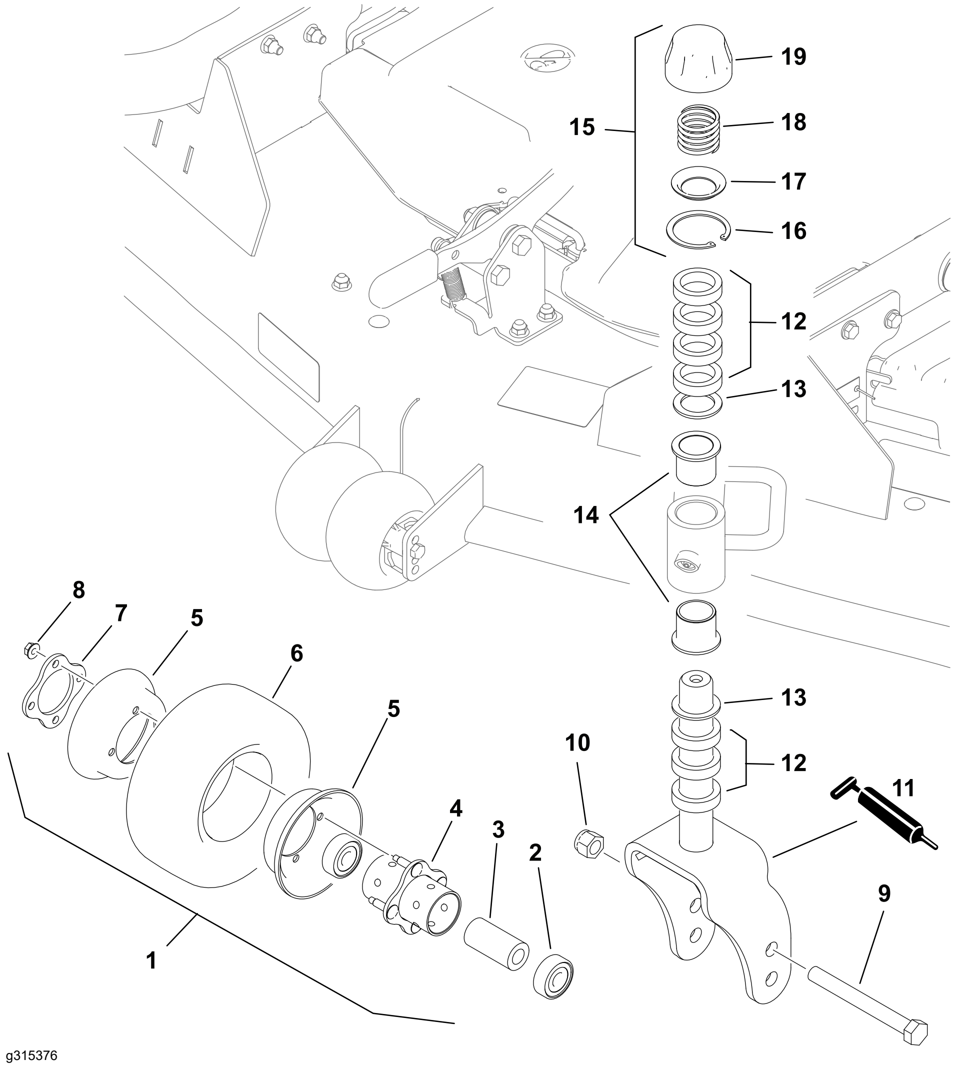


Figure 149

1. Caster wheel assembly
2. Bearing (2 each)
3. Bearing spacer
4. Wheel hub
5. Wheel rim half (2 each)
6. Tire – semi-pneumatic
7. Plate
8. Flange nut (4 each)
9. Cap screw
10. Locknut
11. Castor fork
12. Spacer (7 each)
13. Thrust washer (2 each)
14. Flange bushing (2 each)
15. Height-of Cut cap assembly
16. Retaining ring
17. Cap washer
18. Compression spring
19. Cap

Servicing the Castor Wheels

Refer to Figure 149 for this procedure.

1. Park the machine on a level surface, raise the cutting unit, engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Rotate the cutting unit to the SERVICE position; refer to the traction unit *Operator's Manual*.

Castor Wheels (continued)

3. Record the number of caster fork spacers above and below the caster arm and remove the height-of-cut cap and castor fork if necessary.

   A. Inspect the caster arm bushings for wear or damage and replace them if necessary.

   B. Inspect the height-of-cut cap for wear or damage and repair or replace it if necessary.

   C. Install the recorded number of spacers on the caster fork shaft followed by a thrust washer.

   D. Lightly grease the caster arm bushings and install the castor fork.

   E. Install a thrust washer, the remaining spacers, and the height-of-cut cap.

   Note: Ensure that the thrust washers are positioned directly above and below the castor arm bushings.

4. Record the caster wheel mounting hole and remove the castor wheel if necessary.

   A. Inspect the caster wheel bearings for wear or damage and replace them if necessary.

   B. Check that the bearing spacer fits tightly between the bearings after hub assembly.

   C. Ensure that the semi-pneumatic tires are not worn or damaged to the point they do not hold air. Replace the tire if necessary.

5. Grease the caster forks before returning the cutting unit to service; refer to the cutting unit *Operator's Manual*.

Flail Cutting Unit (Model 02835) Additional Information Pending

Refer to the flail mower *Operator's Manual* for the flail mower removal and installation procedures.

Chapter 9

Operator Cab

Table of Contents

Additional Reference Materials

Sanden SD Compressor Service Guide

General Information

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.

Electrical Components, Schematics and Wire Harness Drawings

For information regarding the operators cab electrical components (switches and relays); refer toChapter 6: Electrical System (page 6–1). The electrical schematic and wire harness drawings for the operator cab are included in Appendix A (page A–1).

Air Conditioning System

Air Conditioning Components

The air conditioning system used in the machine operator cab consists of the following components:

- A compressor mounted on the left side of the engine driven by a single V−belt.
- A condenser assembly with two (2) condenser fans located outside the rear of the cab roof assembly.
- An evaporator, a drier−receiver and an expansion valve mounted in the headliner of the cab.
- A refrigerant pressure switch
- A thermostat
- An evaporator freeze switch
- 3 relays (condenser fans, air conditioning switch signal, compressor clutch)
- The necessary hoses and tubes that connect the air conditioning system components.
- A blower fan motor that provides air movement through the evaporator and into the cab. The fan motor is a component of the mixing box located in the cab headliner. The fan motor is also used for the cab heating system.
- Operator controls to turn the air conditioning on, to adjust the fan speed and to control the cab air temperature.

Air Conditioning Performance

There are a number of factors that can affect the performance of the machine air conditioning system. To ensure that the system operates at its best, inspect the following components.

- Make sure that the heater control fully closes the heater valve in the cab headliner.
- Make sure that the condenser and evaporator fins are not obstructed and clean.
- Verify that refrigerant charge quantity and system operating pressures are correct.
- Make sure that exposed metal surfaces inside cab are insulated.
- If the ambient temperatures exceeds 43 C (110 F) apply additional window tinting to lower the solar heat load to the cab.

Cab Heater System

The cab heater system used in the machine operator cab consists of the following components:

- A heater core in the mixing box mounted in the headliner of the cab.
- Hoses to allow a circuit for engine coolant to circulate through the heater core.
- A blower fan motor that provides air movement through the heater core and into the cab. The fan motor is a component of the mixing box located in the cab headliner. The fan motor is also used for the air conditioning system.
- Operator controls to adjust the fan speed and to control the amount of coolant passing through the heater core (air temperature).

Adjustments

Adjusting the Compressor Belt Tension

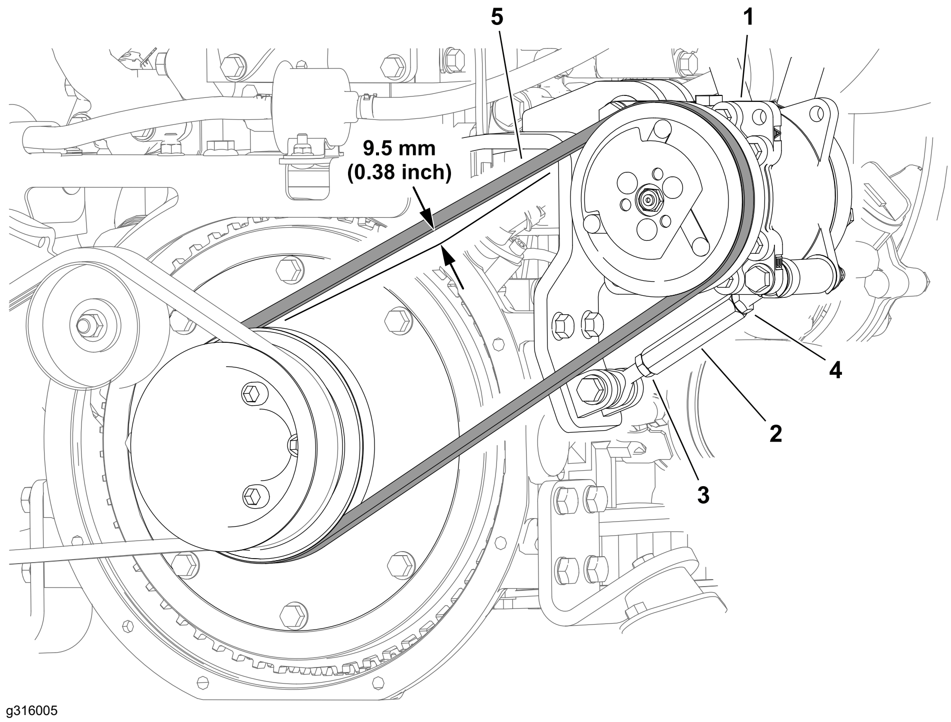


Figure 150

1. Compressor
2. Turnbuckle
3. Jam nut – left hand thread
4. Jam nut – right hand thread
5. V-belt

Compressor belt tension = **9.5 mm (0.38 inch) deflection when 4.5 kg (10 lb) is applied** to the top of the belt half way between the engine and compressor pulleys.

Note: The jam nut at the bottom of the turnbuckle has left hand threads.

1. Loosen the jam nuts at each end of the turnbuckle.
2. Rotate the turnbuckle to increase/decrease belt deflection as necessary.
3. Tighten the jam nuts and recheck the belt tension.

Adjusting the Doors

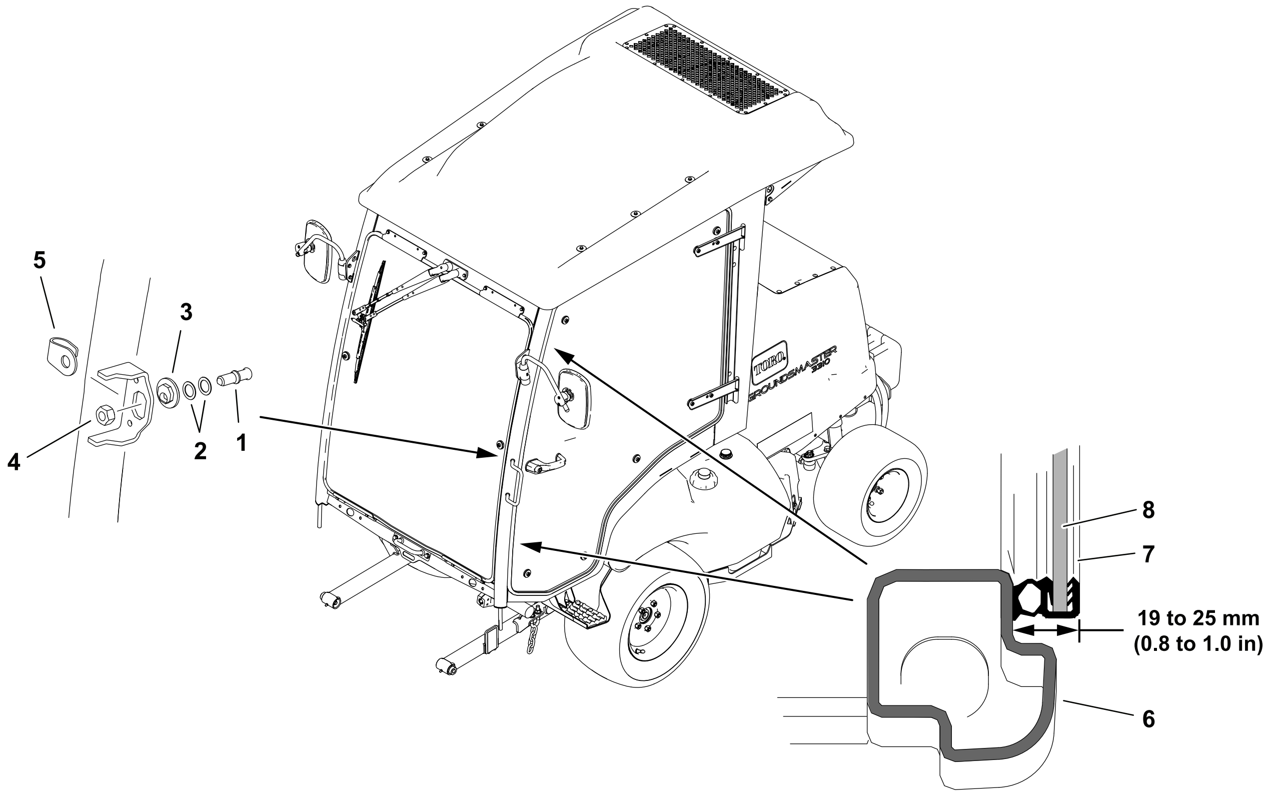


Figure 151

1. Striker stud
2. Shim (as required)
3. Adjuster
4. Lock nut
5. Striker guard
6. Frame
7. Door seal
8. Door panel

---

1. Use shims under the striker stud if necessary for proper door latch engagement.
2. Check the door adjustment to ensure that proper sealing occurs at the 2 points indicated. The distance between the sealing surface of the frame and the outer edge of the door trim when the door is fully latched should be from **19 to 25 mm (0.8 to 1.0 inch)**.
3. Loosen the striker stud lock nut to move the striker stud and adjust the door fit. Disassemble the striker stud and rotate the adjuster to increase stud movement if necessary.

Service and Repairs

General Precautions for Removing and Installing Air Conditioning System Components

WARNING

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified air conditioning service technician.

CAUTION

Always wear safety goggles or a face shield when working with air conditioning system components. Also, do not allow refrigerant contact with your skin or eyes as there would be the possibility of serious injury.

CAUTION

Never use compressed air to leak test or pressure test the air conditioning system. Under certain conditions, pressurized mixtures of refrigerant and air can be combustible.

1. Before servicing any air conditioning system components, park machine on a level surface, lower cutting decks or attachments and stop engine. Remove key from the key switch.
2. Clean machine before disconnecting, removing or disassembling any air conditioning system components. Thorough cleaning will prevent system contamination while performing service procedures.
3. Before loosening or removing any air conditioning system hose or other component, have a certified air conditioning service technician recover the system refrigerant and then evacuate the air conditioning system completely. It is illegal to vent refrigerant to the atmosphere.
4. Put caps or plugs on any air conditioning system lines, fittings or components left open or exposed to prevent moisture and contaminants from entering the system
5. Put labels on disconnected lines and hoses for proper installation after repairs are completed.
6. If compressor is removed from machine, keep compressor in the same orientation as the installed position. This will prevent compressor oil from filling the compressor cylinders.
7. Note the position of fittings (especially elbow fittings) before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hoses and tubes.
8. Always use a DOT approved tank for storing used and recycled refrigerants.

General Precautions for Removing and Installing Air Conditioning System Components (continued)

9. The air conditioning system uses R134a refrigerant. DO NOT use other refrigerants in the system. air conditioning system capacity is approximately **0.9 kg (30 oz or 1.88 lbs) of R134a refrigerant**.
10. Refrigerant containers (either full or empty) are under pressure that will increase if the containers are heated. DO NOT expose refrigerant containers to high heat sources or flame.
11. Be sure the work area is properly ventilated to prevent any accumulation of refrigerant or other fumes.
12. Make sure that caps are always placed on the pressure hose ports. These caps prevent refrigerant leakage from the system.
13. The drier−receiver component is used to collect moisture that will reduce air conditioning performance. If the air conditioning system is opened for component repair or replacement, make sure that the drier−receiver ports are plugged to prevent damage to the drier−receiver. If either the compressor or expansion valve is replaced, replacement of the drier−receiver is also recommended.
14. After installing air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system.

Air Conditioning Compressor

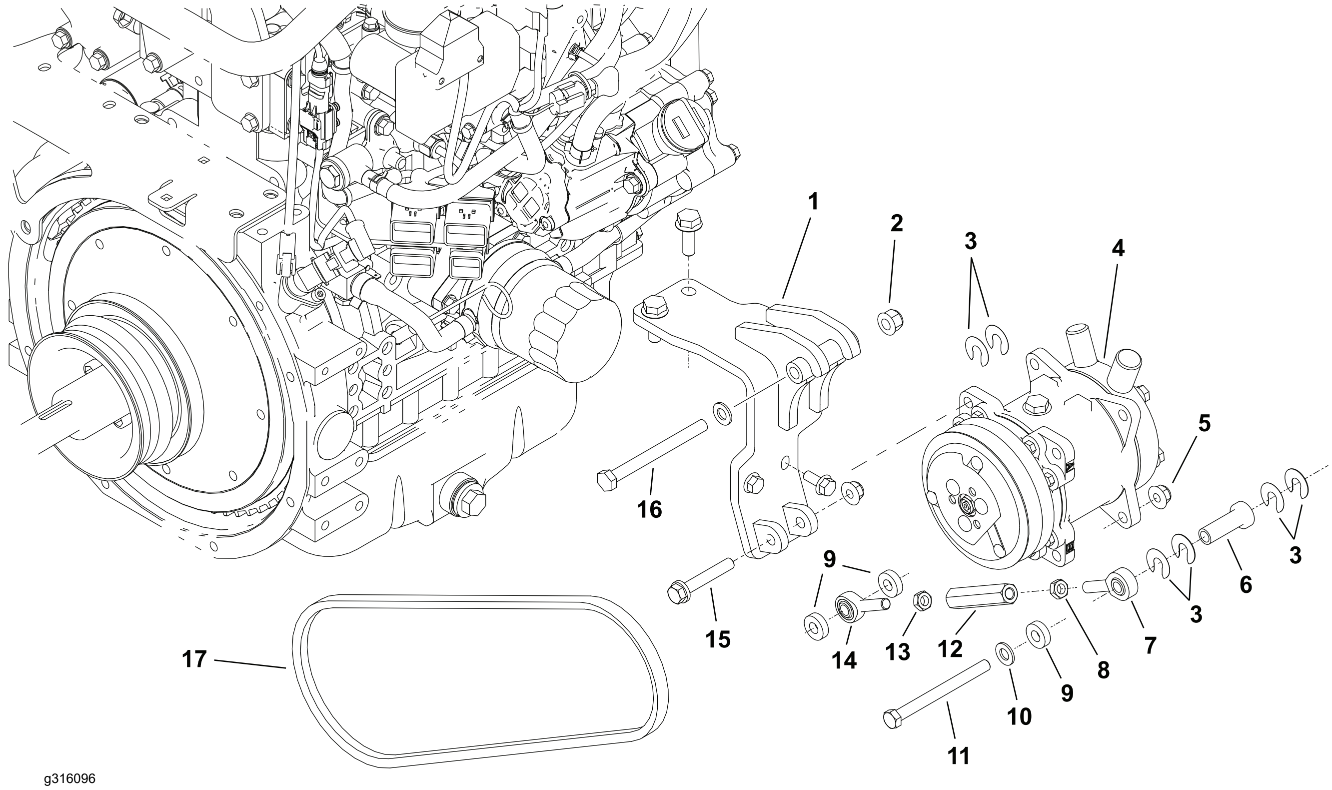


Figure 152

1. Compressor bracket
2. Flange nut (metric)
3. Shim (as required)
4. Compressor
5. Lock nut (2 each)
6. Spacer
7. Ball joint
8. Jam nut
9. Spacer (3 each)
10. Washer (2 each)
11. Cap screw
12. Turnbuckle
13. Jam nut – left hand thread
14. Ball joint – left hand thread
15. Cap screw
16. Cap screw (metric)
17. V-belt

The air conditioning compressor used on the Groundsmaster 3310 is a Sanden model SD5H09. For air conditioning compressor repair procedures; refer to the Sanden SD Compressor Service Guide.

Note: Replacement of the drier−receiver is recommended whenever the compressor is serviced or replaced.

Replacing the Compressor Drive Belt

Refer to Figure 151 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.

   Note: The jam nut at the bottom of the turnbuckle has left hand threads.
2. Loosen the turnbuckle jam nuts and rotate the turnbuckle to relieve the belt tension. Remove the V-belt from the compressor pulley.
3. Use a 1/2 inch square drive on the hydraulic pump drive belt idler arm to relieve the belt tension and remove the belt from the idler and pump pulley.
4. Disconnect the cutting unit drive shaft at the PTO clutch.
5. Remove the clutch stop strap from the PTO clutch.

Replacing the Compressor Drive Belt (continued)

6. Guide the hydraulic pump drive belt over the PTO clutch and out of the machine.
7. Guide the compressor drive belt over the PTO clutch and out of the machine.
8. To install the new drive belt, follow this procedure in reverse order.
9. Adjust the compressor belt tension; refer to Adjusting the Compressor Belt Tension (page 9–5).

Removing and Installing the Compressor

Refer to Figure 151 for this procedure.

1. Park the machine on a level surface, lower the cutting unit (or attachment), engage the parking brake, set the key switch to the OFF position and remove the key from the key switch.
2. Disconnect the compressor electrical connector from machine wire harness.

WARNING

The air conditioning system is under high pressure. Do not loosen any system fitting or component until after the system has been completely discharged by a certified air conditioning service technician.

3. Have refrigerant evacuated from air conditioning system by a certified air conditioning service technician. Disconnect the hoses at the compressor, then cap the fittings and plug the hoses to prevent contamination from entering the air conditioning system.
4. Remove the fuel tank; refer to Removing and Installing the Fuel Tank (page 4–18).
5. Loosen the turnbuckle jam nuts and rotate the turnbuckle to relieve the belt tension. Remove the V-belt from the compressor pulley and inspect for wear or damage.

IMPORTANT

To prevent compressor oil from filling the compressor cylinders, keep compressor in the same orientation as the installed position.

6. Remove the compressor from the bracket. Locate and retrieve any shims (item 2).

   Note: Use shims as needed to minimize the gap between the compressor and the bracket before tightening fasteners.
7. To install the compressor, follow this procedure in reverse order.
8. Adjust the compressor belt tension; refer to Adjusting the Compressor Belt Tension (page 9–5).
9. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant and then leak test the system. Air conditioning system capacity is 0.9 kg (30 oz or 1.88 lbs) of R134a refrigerant.

Heating and Air Conditioning Components

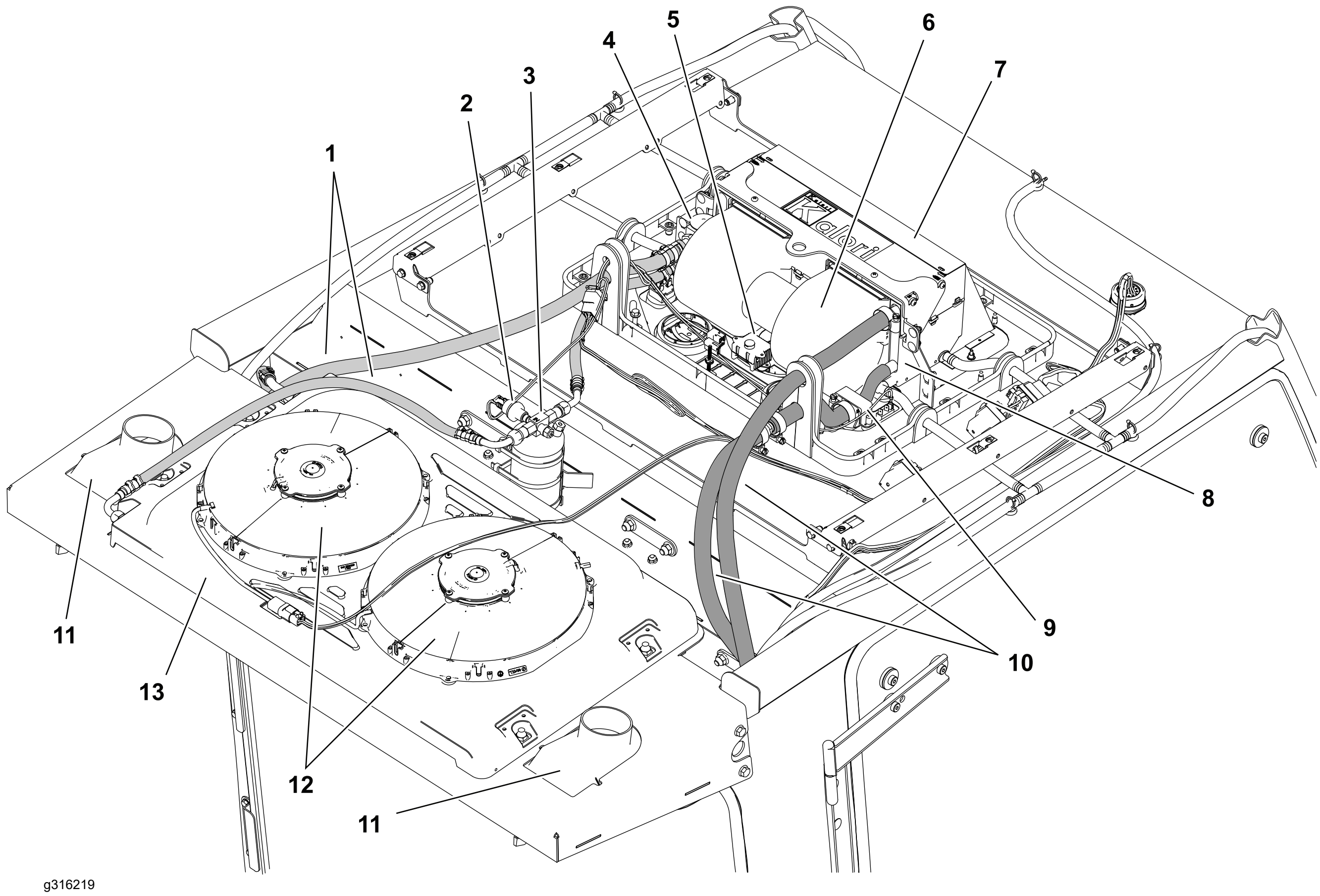


Figure 153

(shown with roof removed)

1. Refrigerant hoses
2. Pressure switch
3. Drier – receiver
4. Expansion valve
5. Thermostat – resistor
6. Blower
7. Evaporator
8. Heater core
9. Heat valve
10. Heater (engine coolant) hoses
11. Fresh air intake (2 each)
12. Condenser fans
13. Condenser

Remove the roof to access the heating and air conditioning components. Inspect and repair damaged roof seals as necessary before installing the roof.

Control Panel and Windshield Wiper Assembly

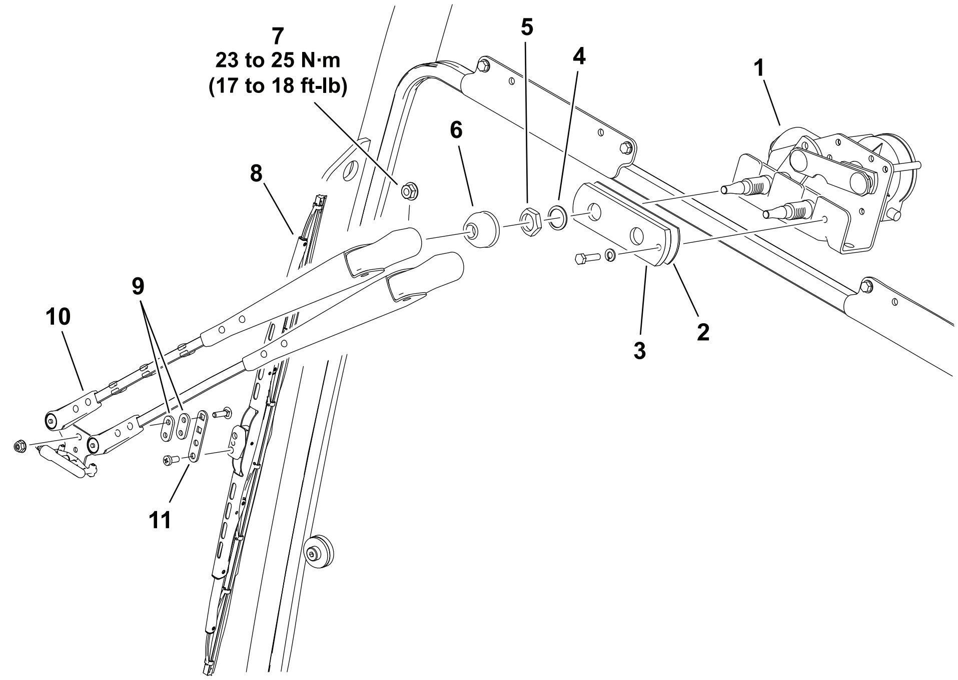


Figure 154

1. Wiper motor
2. Gasket
3. Mounting plate
4. Washer (2 each)
5. Lock nut (2 each)
6. Boot (2 each)
7. Flange nut (2 each)
8. Wiper blade
9. Spacer (2 each)
10. Wiper arm assembly
11. Bracket

Removing the Windshield Wiper Assembly

Note: If possible, operate the windshield wipers to ensure that the wiper motor shaft is in its home position prior to disassembly.

1. Disconnect the washer supply hose and remove the wiper arm assembly.
2. Remove the 4 cap screws securing the control panel cover. Disconnect the windshield wiper/washer switch from the wire harness and remove the cover assembly.
3. Remove the windshield wiper boots, lock nuts, and washers from outside the roof panel.
4. Support the wiper motor, remove the mounting plate from outside the cab, and remove the wiper motor.

Installing the Control Panel and Windshield Wiper Assembly

1. Fit the wiper motor shafts through the cab frame and install the mounting plate from outside the cab.
2. Install the washers, lock nuts, and boots.

   Note: The wiper motor must be in its home position prior to installing the wiper arm assembly. Replacement wiper motors are shipped with the motor in the home position. You may also energize and operate the wiper motor for at least one cycle to set the motor to its home position.

Installing the Control Panel and Windshield Wiper Assembly (continued)

3. With the wiper motor in it's home position, install the wiper arm assembly. The wiper blade should be approximately **7 cm (2.75 inch) from the right edge of the windshield** when in the home position. Install the flange nuts and tighten from **23 to 25 N·m (17 to 18 ft-lb)**.
4. Connect the windshield wiper switch to the wire harness and install the control panel cover.
5. Connect the washer hose.
6. Test wiper and washer operation before returning the machine to service.

Doors

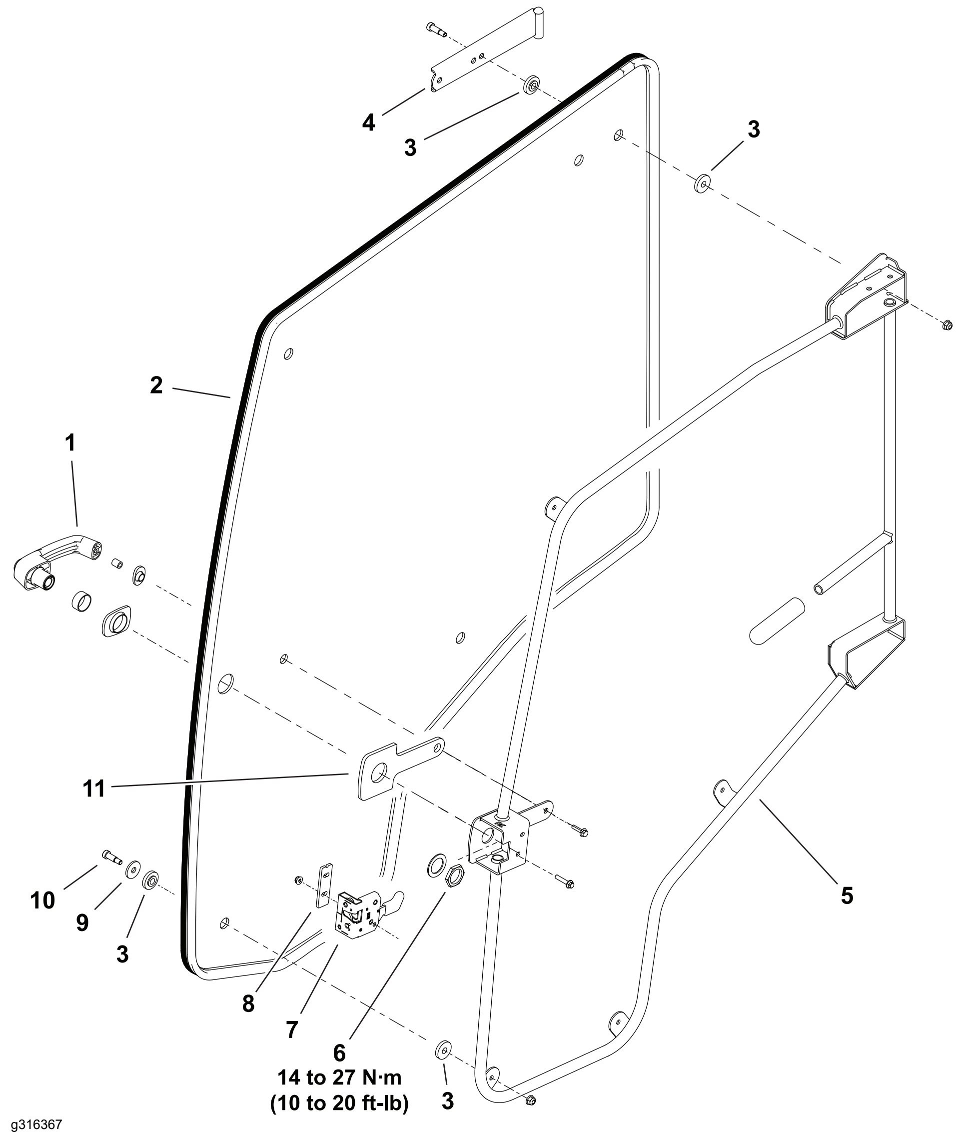


Figure 155

(right side door shown)

1. Door handle assembly
2. Door panel w/ seal
3. Neoprene flange bushing (18 each)
4. Hinge (2 each)
5. Door frame
6. Lock nut
7. Latch assembly
8. Latch support plate
9. Washer (5 each)
10. Shoulder screw (9 each)
11. Gasket

CAUTION

Each door assembly weighs approximately 424 kg (52 lbs).

Ensure the door gas strut is properly installed (rod end to cab frame, cylinder end to door frame).

Doors (continued)

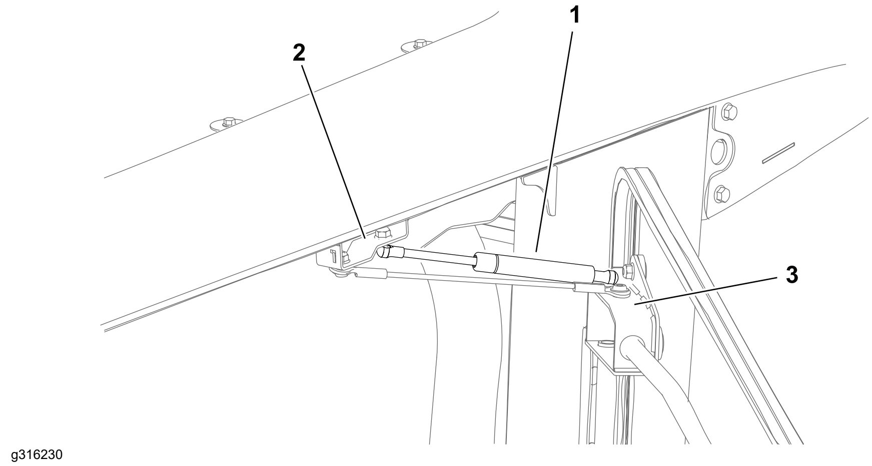


Figure 156

1. Gas strut
2. Cab frame
3. Door frame

Adjust the door fit against the frame as necessary; refer to Adjusting the Doors (page 9–6).

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

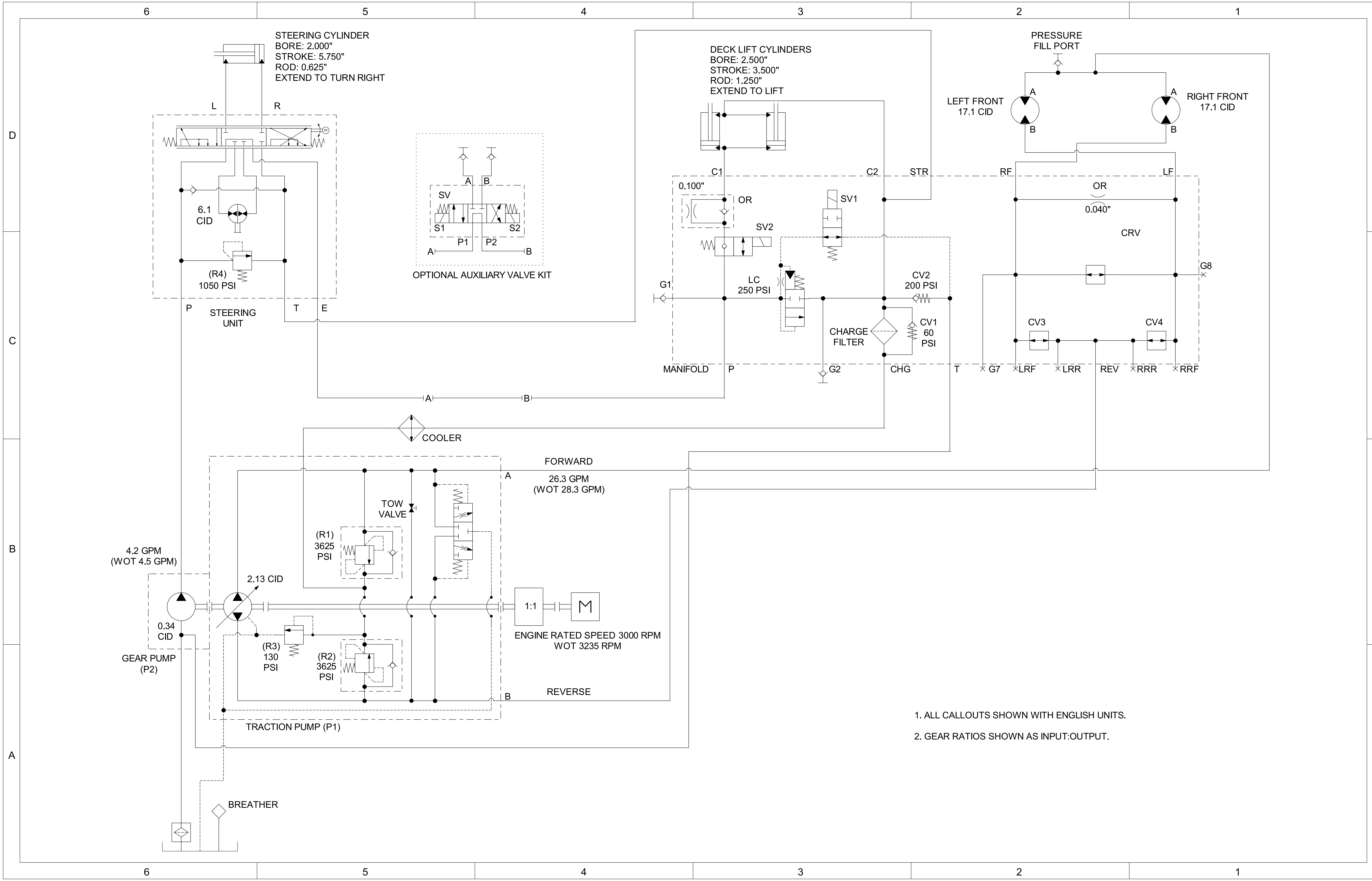
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

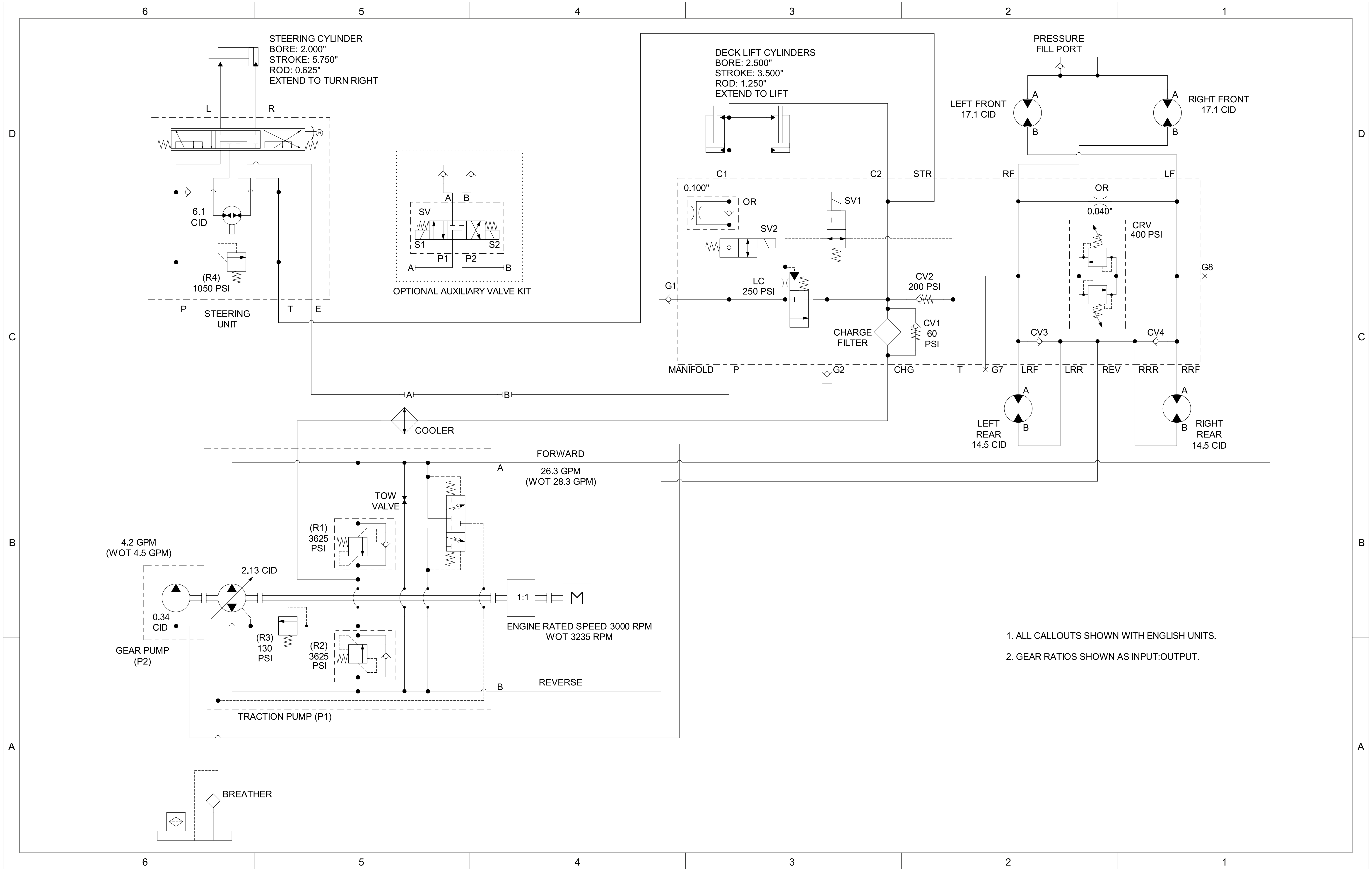
Examples:

- 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)

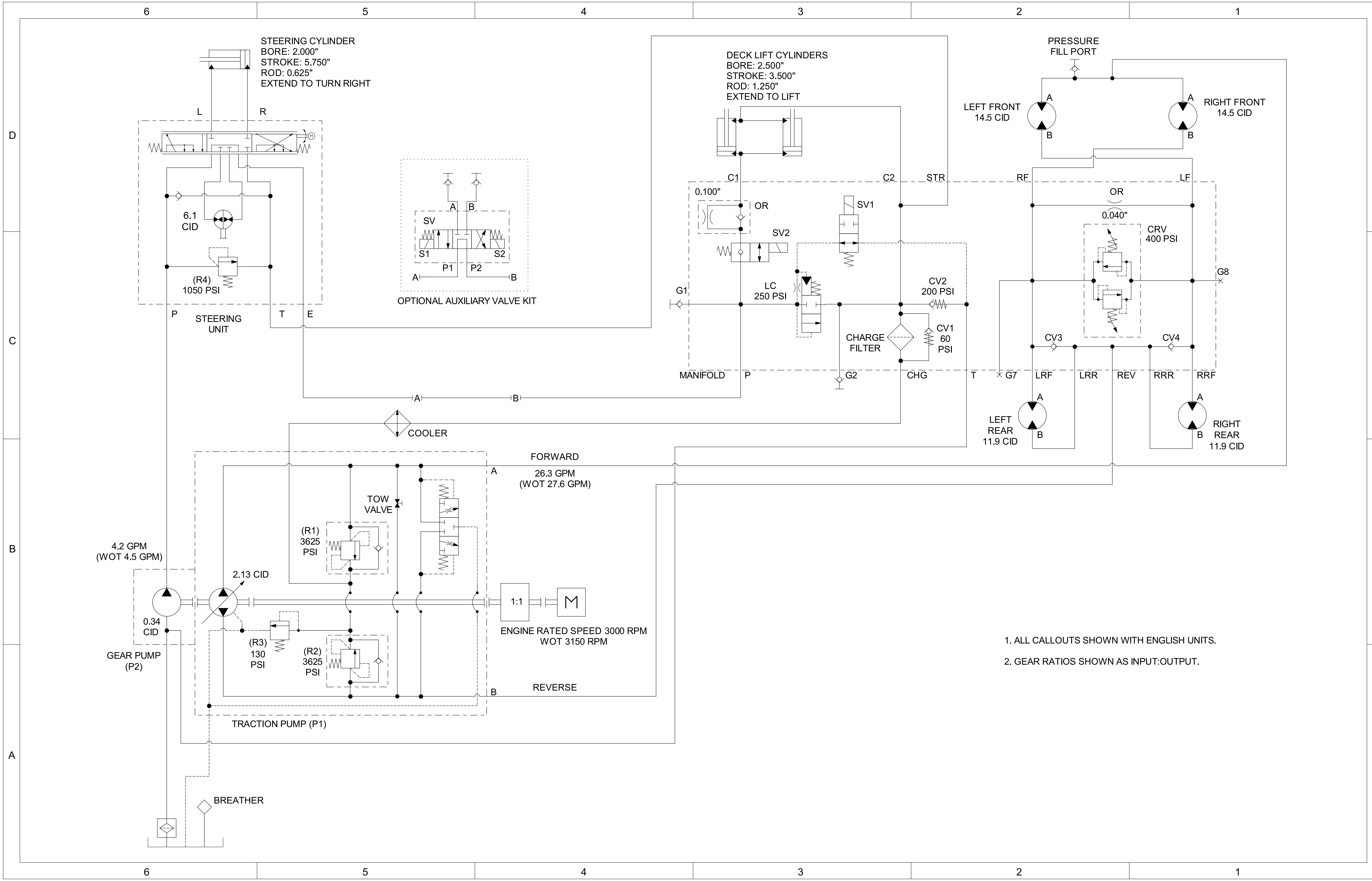
AWG Equivalents for Metric Wire		
Diagram Label	**Metric Size**	**AWG Equivalent**
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

Hydraulic Schematic – 3200 2WD

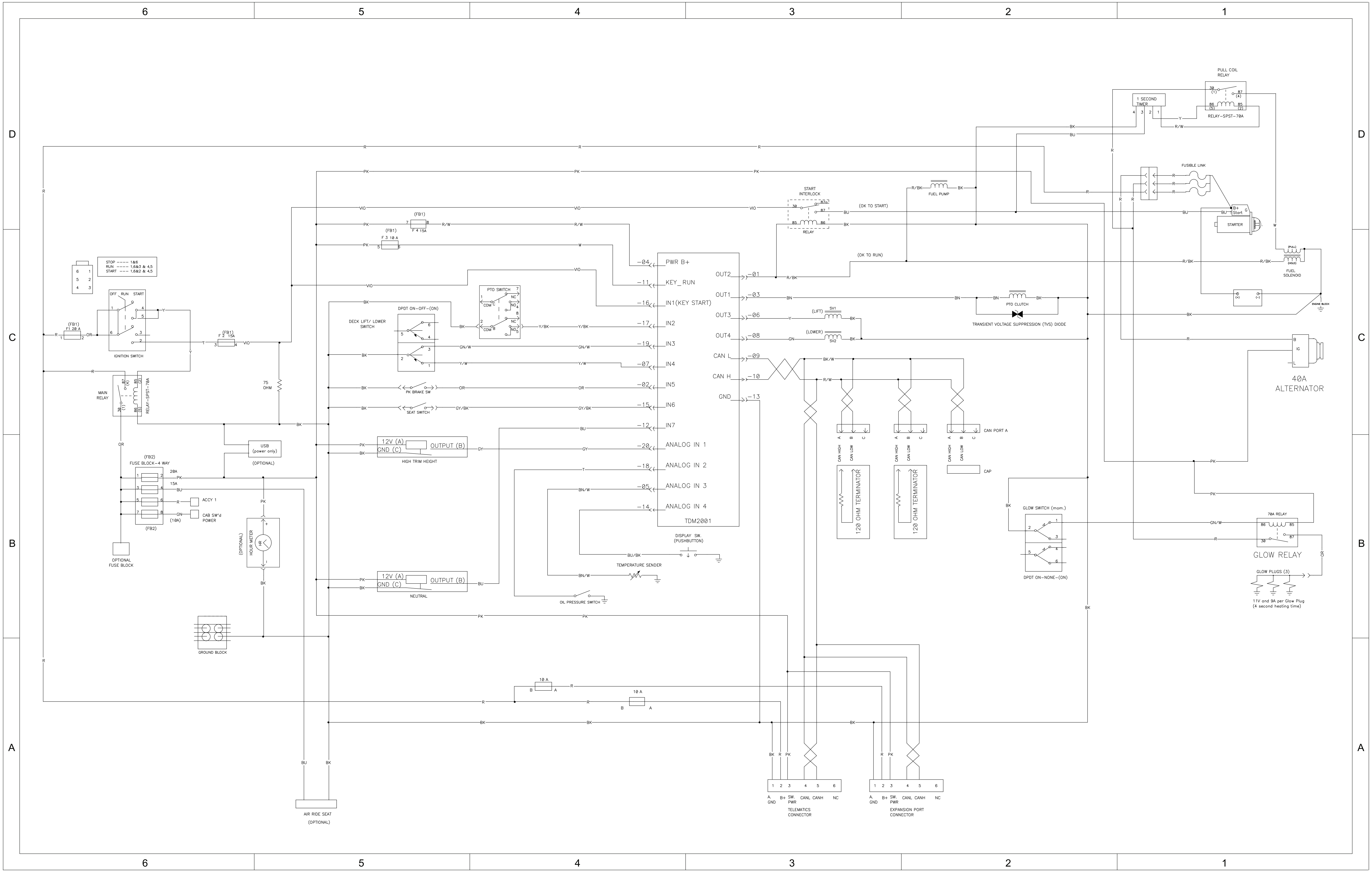



STEERING CYLINDER
BORE: 2.000"
STROKE: 5.750"
ROD: 0.625"
EXTEND TO TURN RIGHT
L
R
6.1
CID
(R4)
1050 PSI
P
STEERING
UNIT
T
E
SV
A
B
S1
S2
P1
P2
OPTIONAL AUXILIARY VALVE KIT
DECK LIFT CYLINDERS
BORE: 2.500"
STROKE: 3.500"
ROD: 1.250"
EXTEND TO LIFT
C1
C2
STR
0.100"
OR
SV1
SV2
G1
LC
250 PSI
CV2
200 PSI
CHARGE
FILTER
CV1
60
PSI
MANIFOLD
P
G2
CHG
T
PRESSURE
FILL PORT
LEFT FRONT
17.1 CID
RIGHT FRONT
17.1 CID
RF
LF
OR
0.040"
CRV
400 PSI
G8
CV3
CV4
G7
LRF
LRR
REV
RRR
RRF
LEFT
REAR
14.5 CID
RIGHT
REAR
14.5 CID
COOLER
FORWARD
26.3 GPM
(WOT 28.3 GPM)
TOW
VALVE
(R1)
3625
PSI
4.2 GPM
(WOT 4.5 GPM)
2.13 CID
0.34
CID
GEAR PUMP
(P2)
(R3)
130
PSI
(R2)
3625
PSI
1:1
ENGINE RATED SPEED 3000 RPM
WOT 3235 RPM
REVERSE
TRACTION PUMP (P1)
BREATHER
1. ALL CALLOUTS SHOWN WITH ENGLISH UNITS.
2. GEAR RATIOS SHOWN AS INPUT:OUTPUT.
g303916

Hydraulic Schematic – 3300/3310



1. ALL CALLOUTS SHOWN WITH ENGLISH UNITS.
2. GEAR RATIOS SHOWN AS INPUT:OUTPUT.



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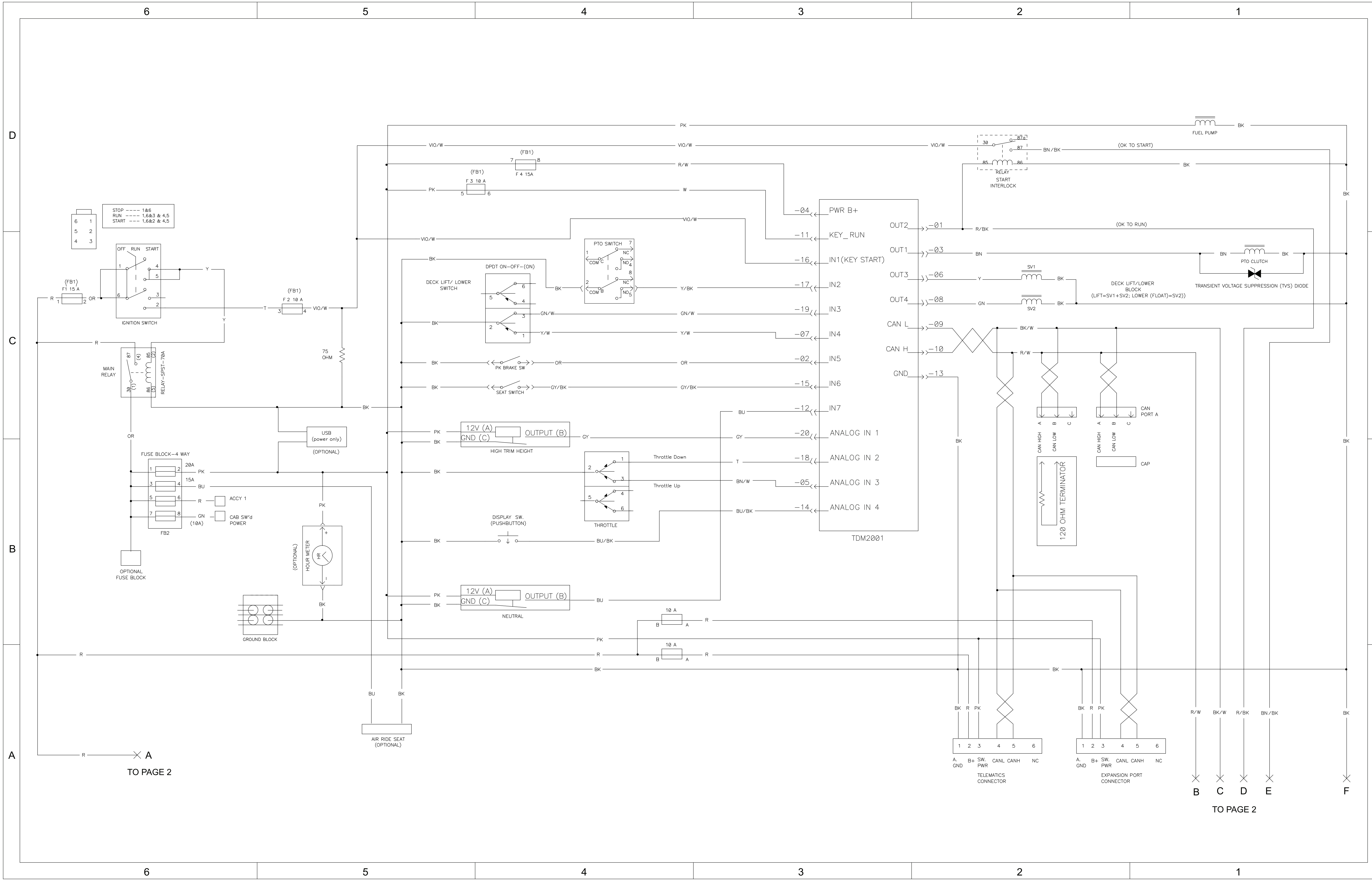
Electrical Schematic – 3300/3310



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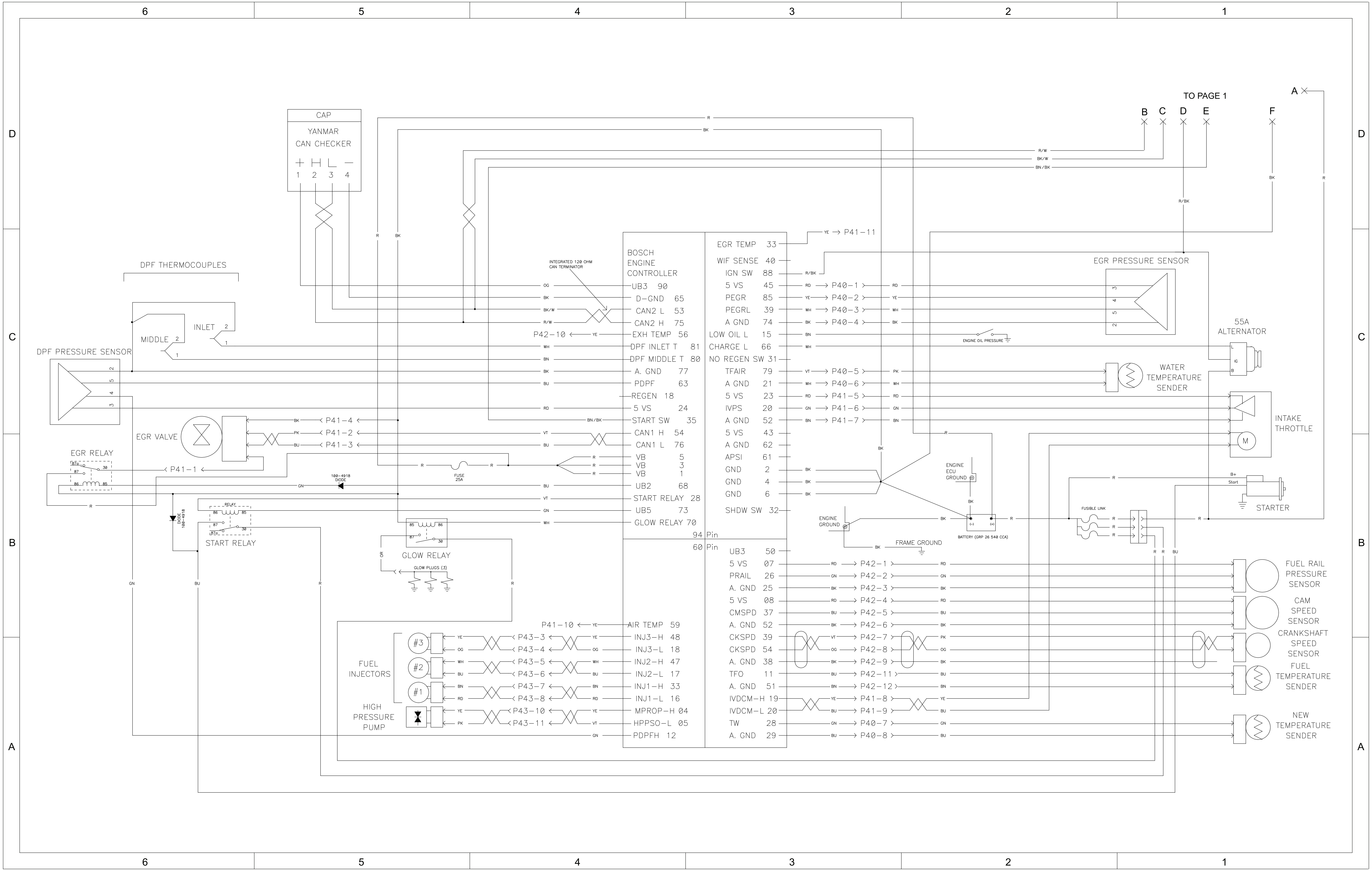
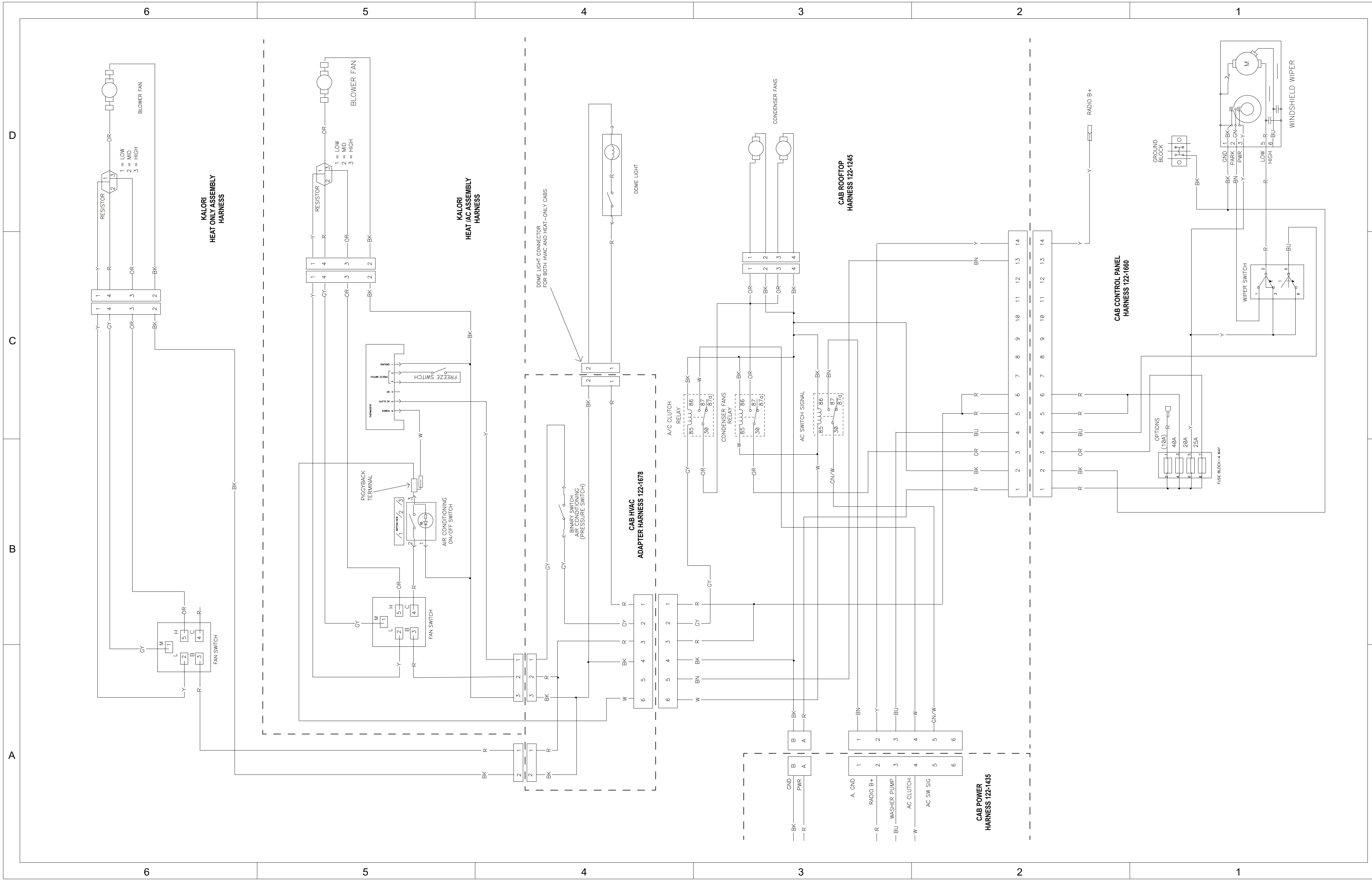

TO PAGE 1
CAP
YANMAR CAN CHECKER
DPF THERMOCOUPLES
INLET
MIDDLE
DPF PRESSURE SENSOR
EGR VALVE
EGR RELAY
START RELAY
GLOW RELAY
GLOW PLUGS (3)
BOSCH ENGINE CONTROLLER
INTEGRATED 120 OHM CAN TERMINATOR
UB3 90
D-GND 65
CAN2 L 53
CAN2 H 75
EXH TEMP 56
DPF INLET T 81
DPF MIDDLE T 80
A. GND 77
PDPF 63
REGEN 18
5 VS 24
START SW 35
CAN1 H 54
CAN1 L 76
VB 5
VB 3
VB 1
UB2 68
START RELAY 28
UB5 73
GLOW RELAY 70
94 Pin
60 Pin
EGR TEMP 33
WIF SENSE 40
IGN SW 88
5 VS 45
PEGR 85
PEGRL 39
A GND 74
LOW OIL L 15
CHARGE L 66
NO REGEN SW 31
TFAIR 79
A GND 21
5 VS 23
IVPS 20
A GND 52
5 VS 43
A GND 62
APSI 61
GND 2
GND 4
GND 6
SHDW SW 32
UB3 50
5 VS 07
PRAIL 26
A. GND 25
5 VS 08
CMSPD 37
A. GND 52
CKSPD 39
CKSPD 54
A. GND 38
TFO 11
A. GND 51
IVDCM-H 19
IVDCM-L 20
TW 28
A. GND 29
AIR TEMP 59
INJ3-H 48
INJ3-L 18
INJ2-H 47
INJ2-L 17
INJ1-H 33
INJ1-L 16
MPROP-H 04
HPPSO-L 05
PDPFH 12
FUEL INJECTORS
HIGH PRESSURE PUMP
FUSE 25A
100-4918 DIODE
EGR PRESSURE SENSOR
ENGINE OIL PRESSURE
55A ALTERNATOR
WATER TEMPERATURE SENDER
INTAKE THROTTLE
ENGINE ECU GROUND
ENGINE GROUND
FRAME GROUND
BATTERY (GRP 26 540 CCA)
FUSIBLE LINK
STARTER
FUEL RAIL PRESSURE SENSOR
CAM SPEED SENSOR
CRANKSHAFT SPEED SENSOR
FUEL TEMPERATURE SENDER
NEW TEMPERATURE SENDER
g296968

Electrical Schematic-Operator Cab



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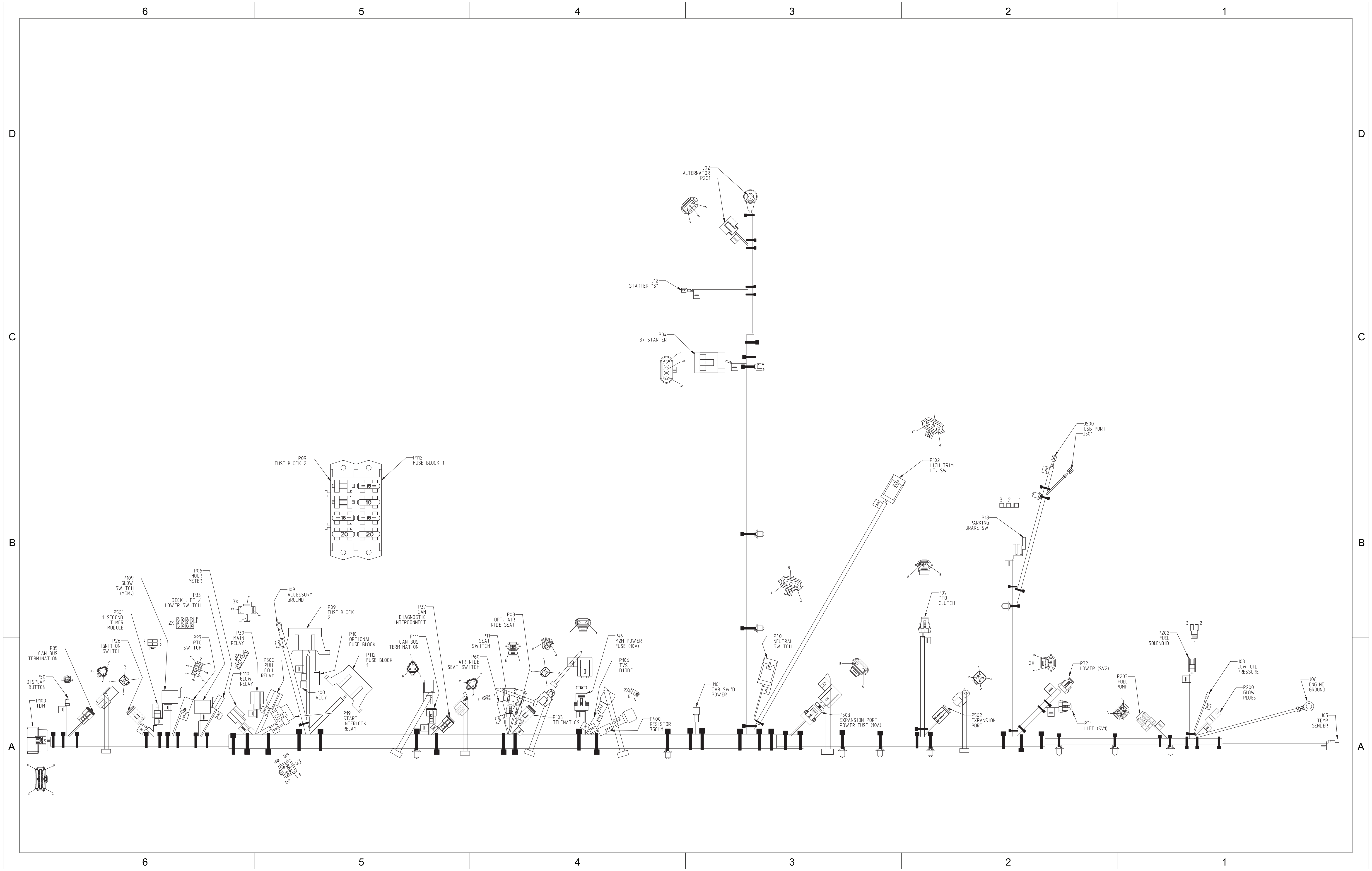
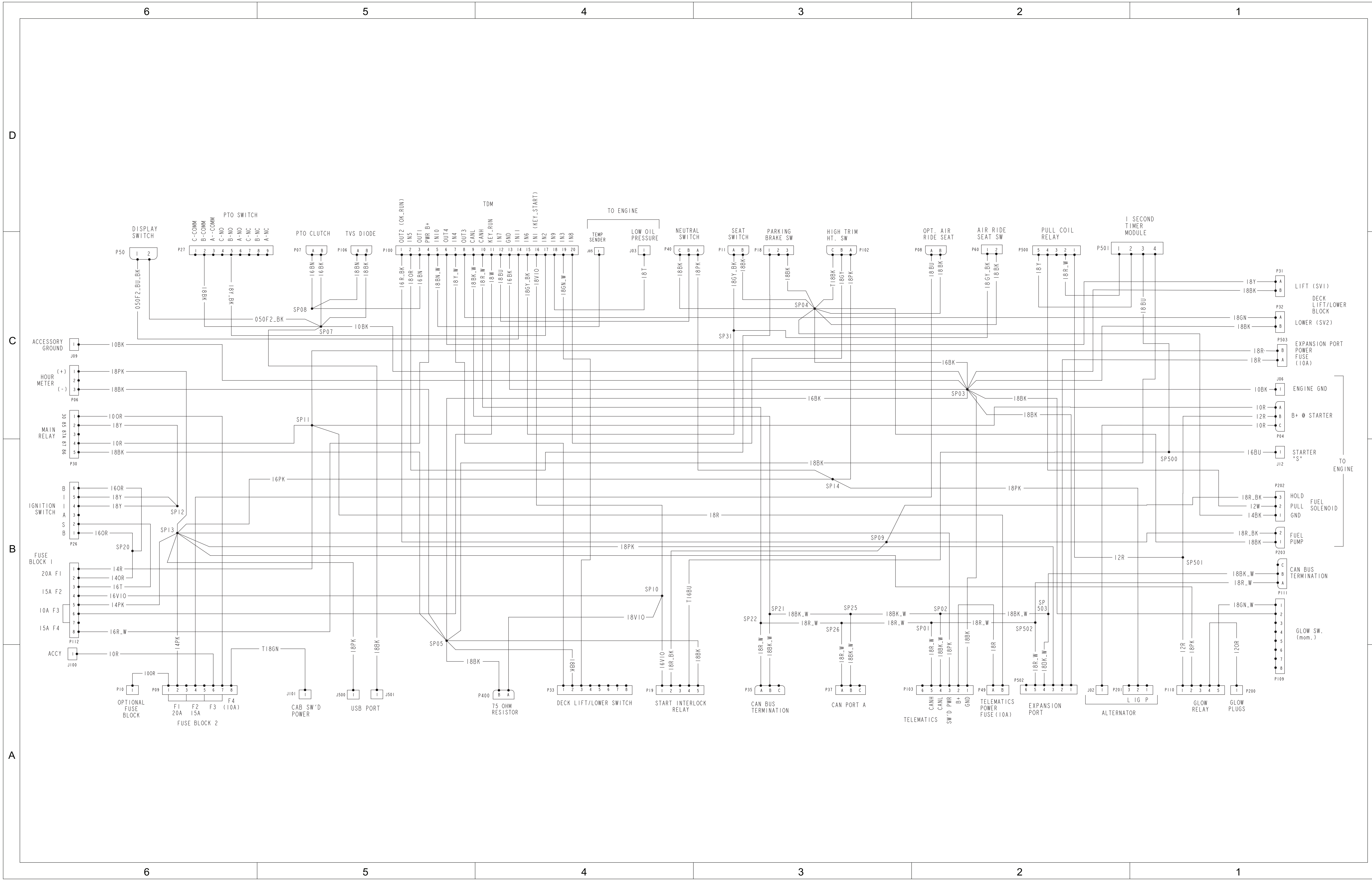
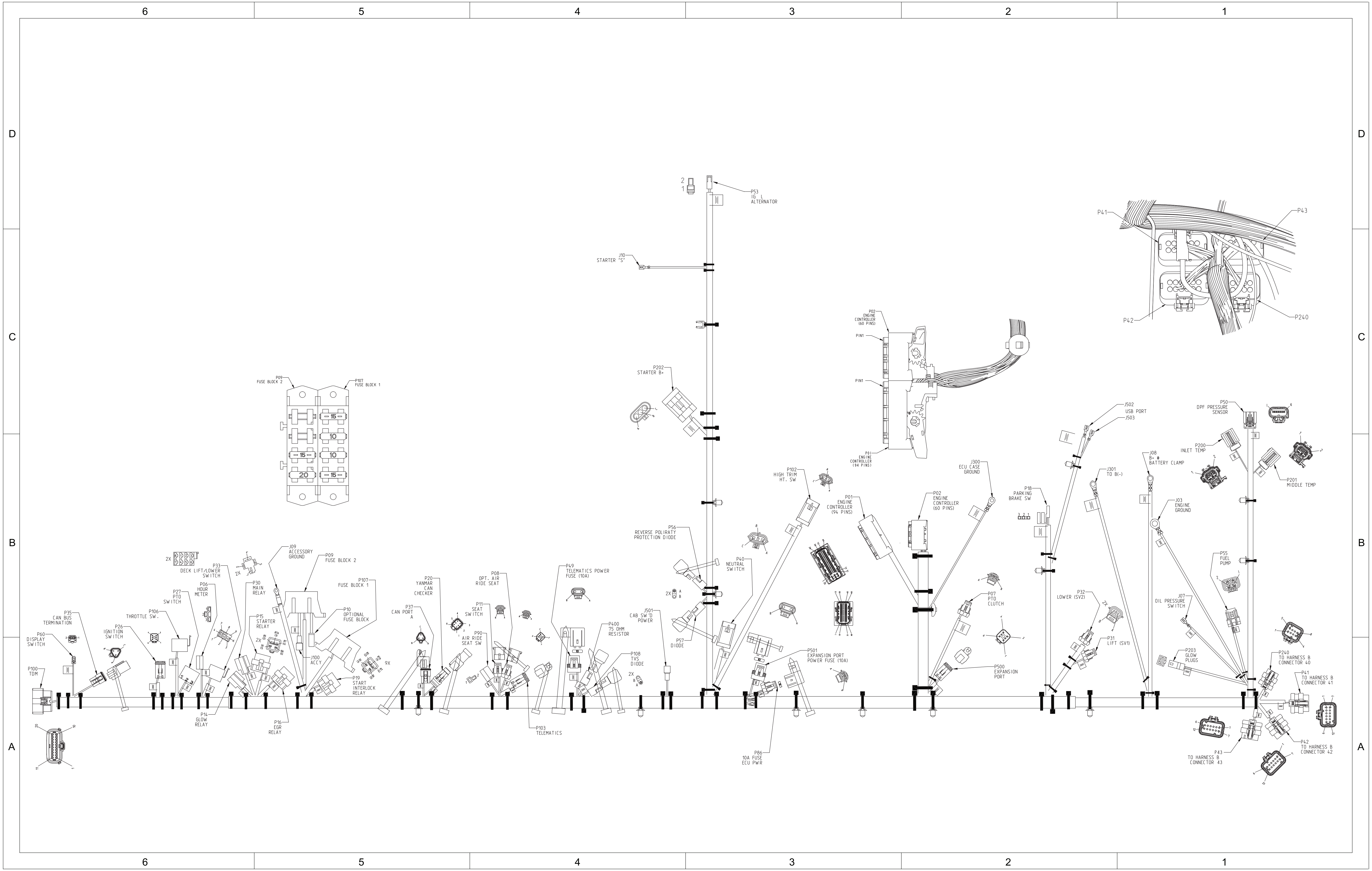


J02 ALTERNATOR
P201
J12 STARTER "S"
P04 B+ STARTER
P09 FUSE BLOCK 2
P112 FUSE BLOCK 1
J500 USB PORT
J501
P102 HIGH TRIM HT. SW
P18 PARKING BRAKE SW
P07 PTO CLUTCH
P202 FUEL SOLENOID
J03 LOW OIL PRESSURE
P200 GLOW PLUGS
J06 ENGINE GROUND
J05 TEMP SENDER
P203 FUEL PUMP
P32 LOWER (SV2)
P31 LIFT (SV1)
P502 EXPANSION PORT
P503 EXPANSION PORT POWER FUSE (10A)
P40 NEUTRAL SWITCH
J101 CAB SW'D POWER
P400 RESISTOR 750HM
P49 M2M POWER FUSE (10A)
P106 TVS DIODE
P103 TELEMATICS
P08 OPT. AIR RIDE SEAT
P11 SEAT SWITCH
P60 AIR RIDE SEAT SWITCH
P37 CAN DIAGNOSTIC INTERCONNECT
P111 CAN BUS TERMINATION
P112 FUSE BLOCK 1
P10 OPTIONAL FUSE BLOCK
P09 FUSE BLOCK 2
J09 ACCESSORY GROUND
J100 ACCY
P19 START INTERLOCK RELAY
P500 PULL COIL RELAY
P110 GLOW RELAY
P30 MAIN RELAY
P06 HOUR METER
P33 DECK LIFT / LOWER SWITCH
P27 PTO SWITCH
P109 GLOW SWITCH (M2M.)
P501 1 SECOND TIMER MODULE
P26 IGNITION SWITCH
P35 CAN BUS TERMINATION
P50 DISPLAY BUTTON
P100 TDM

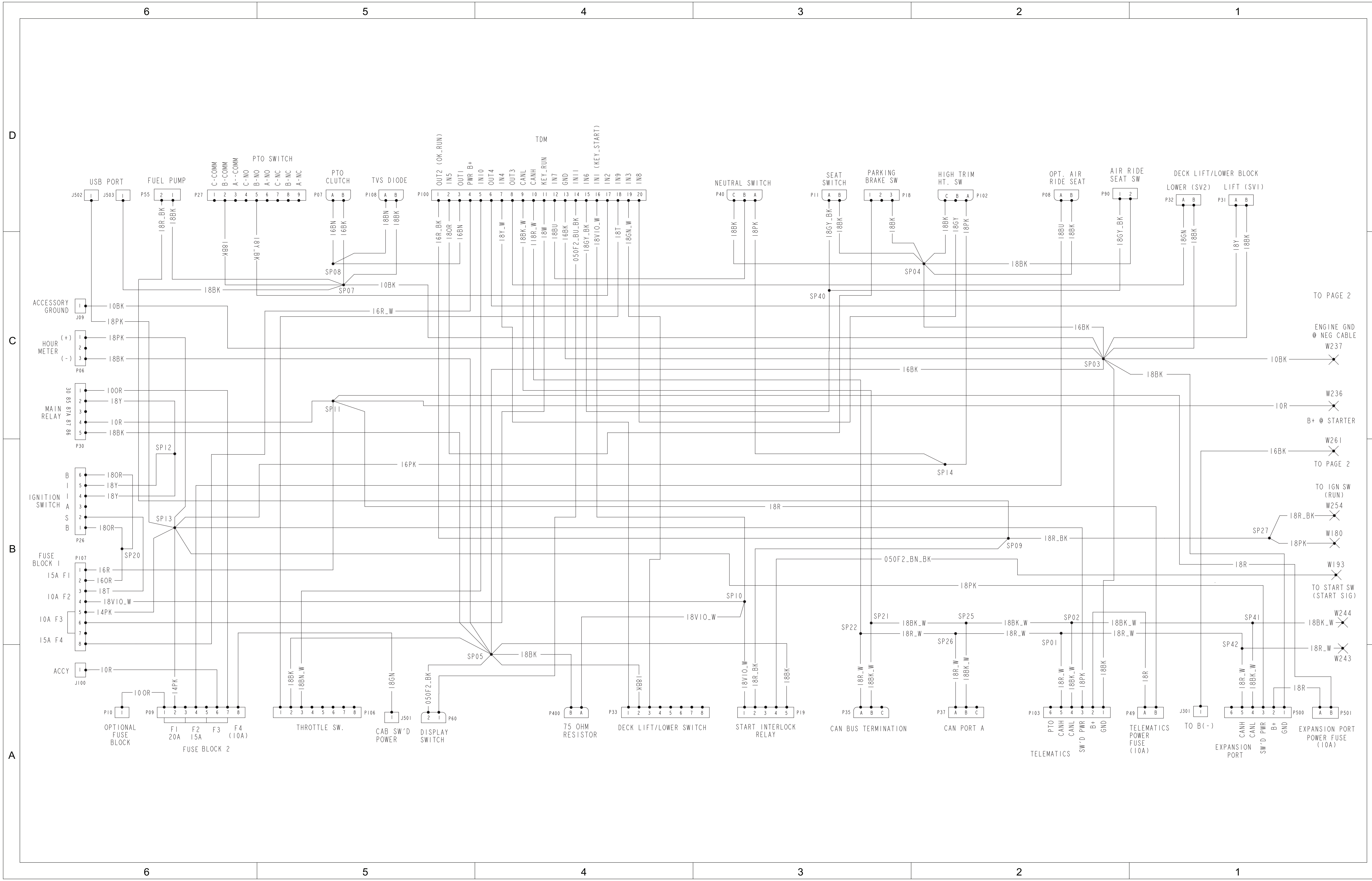
g295556


DISPLAY SWITCH
P50
PTO SWITCH
P27
C-COMM
B-COMM
A-COMM
C-NO
B-NO
A-NO
C-NC
B-NC
A-NC
PTO CLUTCH
P07
TVS DIODE
P106
TDM
P100
OUT2 (OK_RUN)
IN5
OUT1
PWR B+
IN10
OUT4
IN4
OUT3
CANL
CANH
KEY_RUN
IN7
GND
IN11
IN6
IN1 (KEY_START)
IN2
IN9
IN3
IN8
TO ENGINE
TEMP SENDER
J05
LOW OIL PRESSURE
J03
NEUTRAL SWITCH
P40
SEAT SWITCH
P11
PARKING BRAKE SW
P18
HIGH TRIM HT. SW
P102
OPT. AIR RIDE SEAT
P08
AIR RIDE SEAT SW
P60
PULL COIL RELAY
P500
1 SECOND TIMER MODULE
P501
ACCESSORY GROUND
J09
HOUR METER
P06
MAIN RELAY
P30
IGNITION SWITCH
P26
FUSE BLOCK 1
20A F1
15A F2
10A F3
15A F4
P112
ACCY
J100
LIFT (SV1)
P31
DECK LIFT/LOWER BLOCK
LOWER (SV2)
P32
EXPANSION PORT POWER FUSE (10A)
P503
ENGINE GND
J06
B+ @ STARTER
P04
STARTER "S"
J12
TO ENGINE
HOLD
PULL
GND
FUEL SOLENOID
P202
FUEL PUMP
P203
CAN BUS TERMINATION
P111
GLOW SW. (mom.)
P109
SP03
SP04
SP05
SP07
SP08
SP09
SP10
SP11
SP12
SP13
SP14
SP20
SP21
SP22
SP25
SP26
SP31
SP01
SP02
SP 503
SP502
SP500
SP501
OPTIONAL FUSE BLOCK
P10
P09
F1 20A
F2 15A
F3
F4 (10A)
FUSE BLOCK 2
CAB SW'D POWER
J101
USB PORT
J500
J501
75 OHM RESISTOR
P400
DECK LIFT/LOWER SWITCH
P33
START INTERLOCK RELAY
P19
CAN BUS TERMINATION
P35
CAN PORT A
P37
TELEMATICS
P103
CANH
CANL
SW'D PWR
B+
GND
TELEMATICS POWER FUSE (10A)
P49
EXPANSION PORT
P502
ALTERNATOR
J02
P201
L IG P
GLOW RELAY
P110
GLOW PLUGS
P200

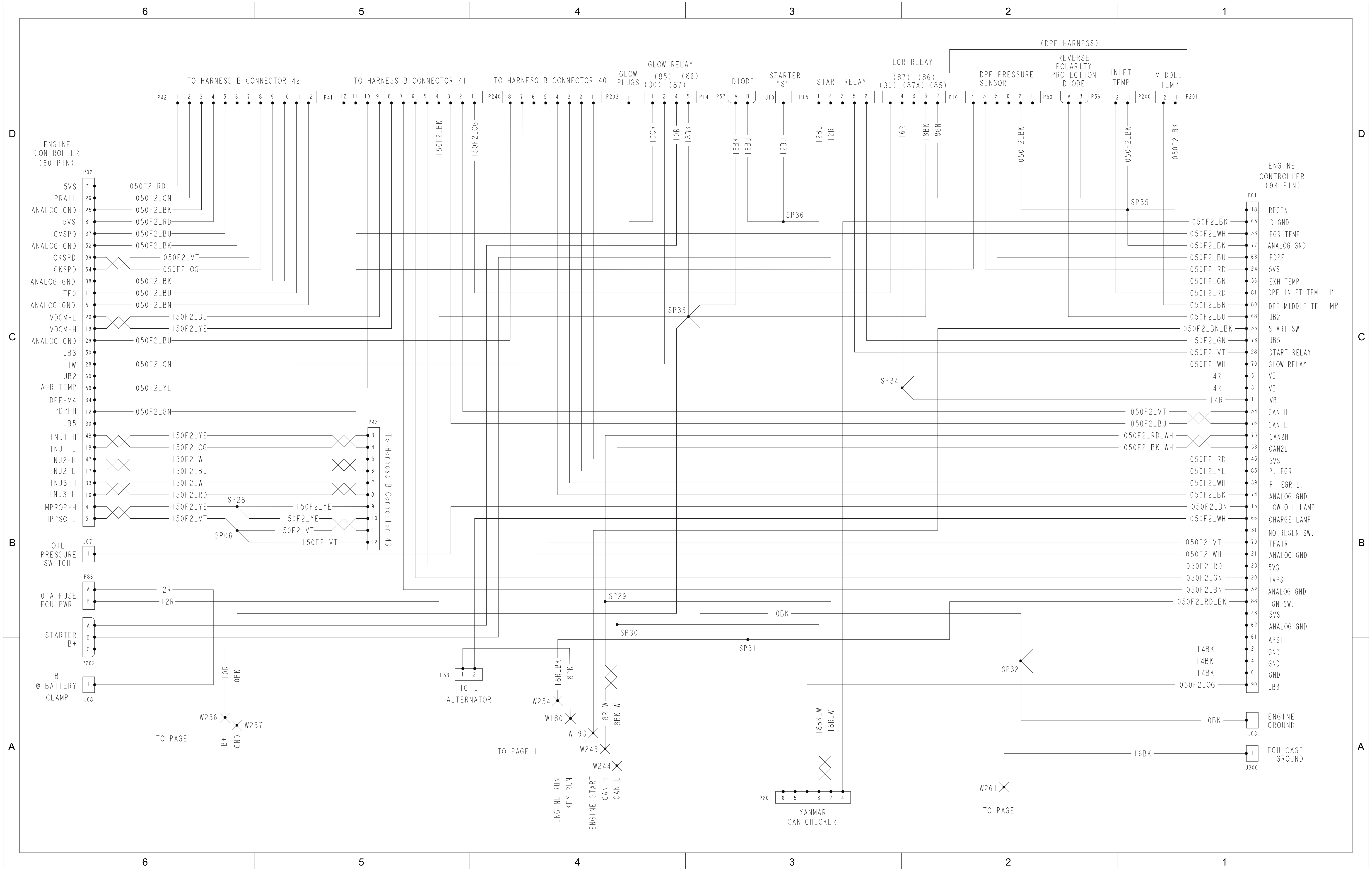
g295555


P53
IG L
ALTERNATOR
J10
STARTER "S"
P41
P43
P42
P240
P02
ENGINE CONTROLLER (60 PINS)
PIN1
P01
ENGINE CONTROLLER (94 PINS)
P202
STARTER B+
P09
FUSE BLOCK 2
P107
FUSE BLOCK 1
J502
USB PORT
J503
P50
DPF PRESSURE SENSOR
P200
INLET TEMP
P201
MIDDLE TEMP
J300
ECU CASE GROUND
J08
B+ ⊕
BATTERY CLAMP
J301
TO B(-)
P102
HIGH TRIM HT. SW
P18
PARKING BRAKE SW
J03
ENGINE GROUND
P56
REVERSE POLIRATY PROTECTION DIODE
P40
NEUTRAL SWITCH
P55
FUEL PUMP
J09
ACCESSORY GROUND
P33
DECK LIFT/LOWER SWITCH
P06
HOUR METER
P27
PTO SWITCH
P30
MAIN RELAY
P10
OPTIONAL FUSE BLOCK
P20
YANMAR CAN CHECKER
P08
OPT. AIR RIDE SEAT
P49
TELEMATICS POWER FUSE (10A)
J501
CAB SW'D POWER
P07
PTO CLUTCH
P32
LOWER (SV2)
J07
OIL PRESSURE SWITCH
P35
CAN BUS TERMINATION
P106
THROTTLE SW.
P26
IGNITION SWITCH
P60
DISPLAY SWITCH
P15
STARTER RELAY
P37
CAN PORT A
P11
SEAT SWITCH
P90
AIR RIDE SEAT SW
P400
75 OHM RESISTOR
P108
TVS DIODE
P57
DIODE
P31
LIFT (SV1)
P203
GLOW PLUGS
P240
TO HARNESS B CONNECTOR 40
P41
TO HARNESS B CONNECTOR 41
P501
EXPANSION PORT POWER FUSE (10A)
P500
EXPANSION PORT
J100
ACCY
P19
START INTERLOCK RELAY
P100
TDM
P14
GLOW RELAY
P16
EGR RELAY
P103
TELEMATICS
P86
10A FUSE
ECU PWR
P43
TO HARNESS B CONNECTOR 43
P42
TO HARNESS B CONNECTOR 42
15
10
20

g295559



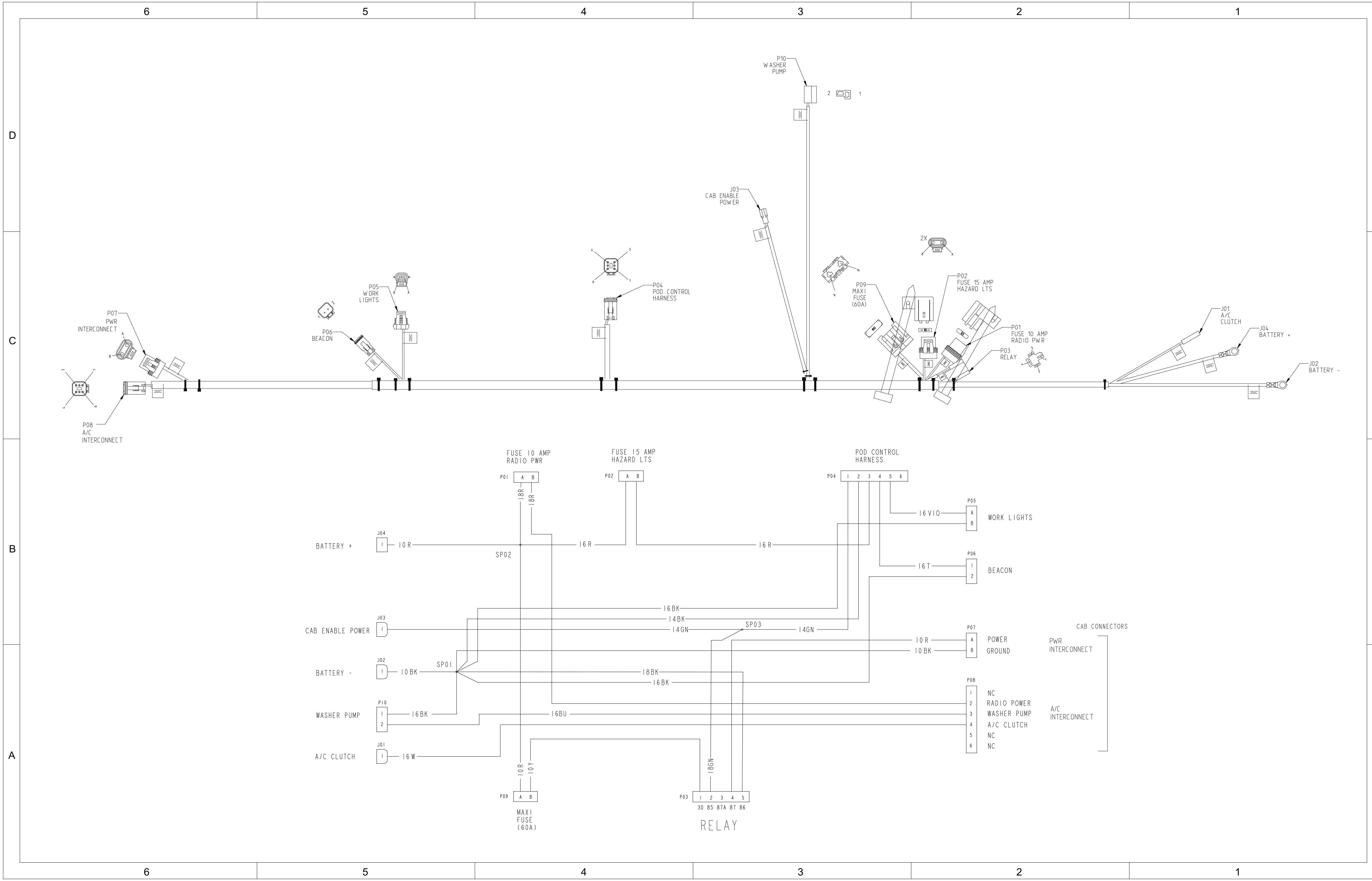
g295557



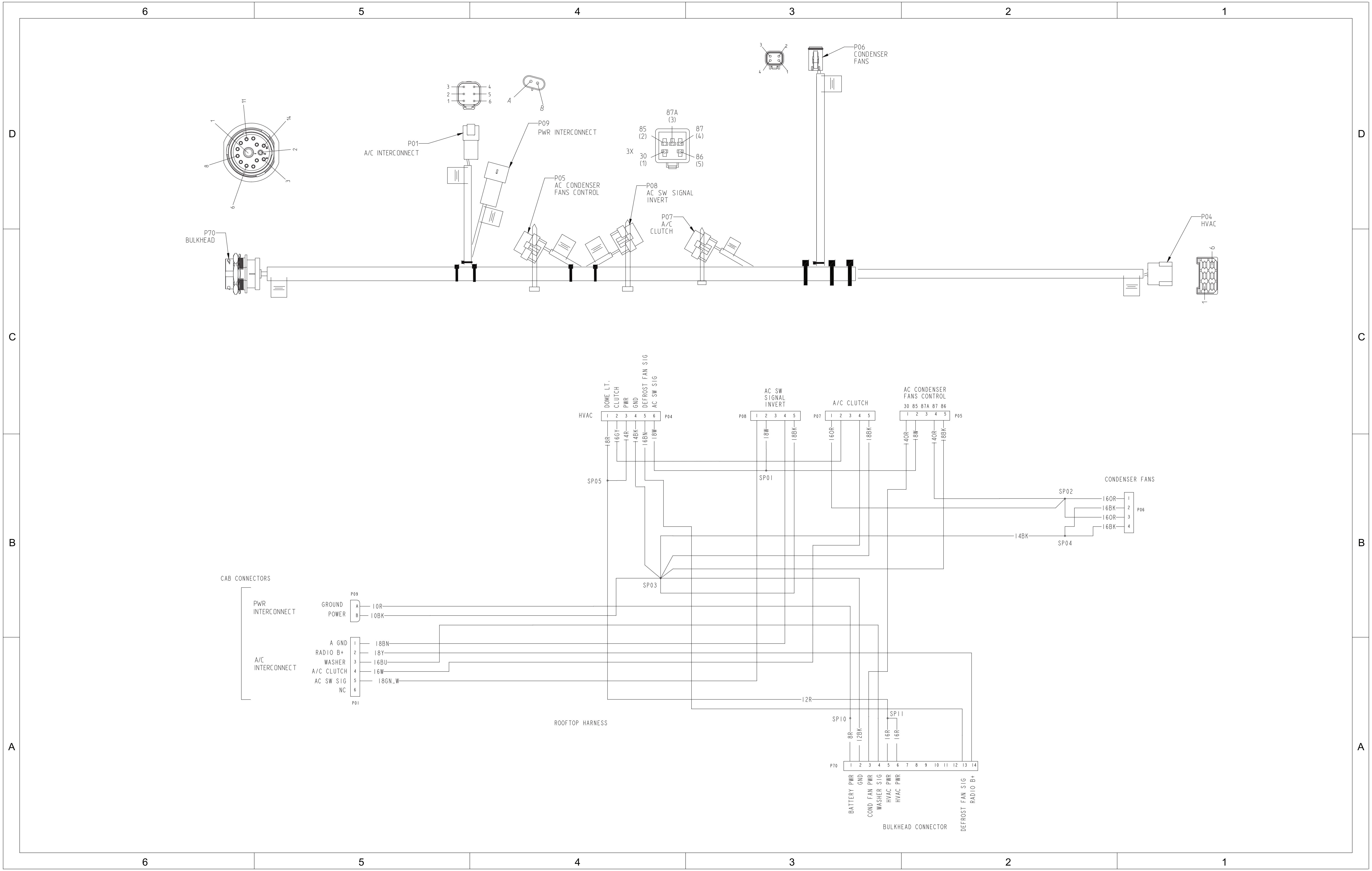
TO HARNESS B CONNECTOR 42
TO HARNESS B CONNECTOR 41
TO HARNESS B CONNECTOR 40
GLOW PLUGS
GLOW RELAY
DIODE
STARTER "S"
START RELAY
EGR RELAY
(DPF HARNESS)
DPF PRESSURE SENSOR
REVERSE POLARITY PROTECTION DIODE
INLET TEMP
MIDDLE TEMP
ENGINE CONTROLLER (60 PIN)
ENGINE CONTROLLER (94 PIN)
To Harness B Connector 43
OIL PRESSURE SWITCH
10 A FUSE ECU PWR
STARTER B+
B+ @ BATTERY CLAMP
IG L ALTERNATOR
YANMAR CAN CHECKER
ENGINE GROUND
ECU CASE GROUND
TO PAGE 1
B+
GND
ENGINE RUN
KEY RUN
ENGINE START
CAN H
CAN L

g295558

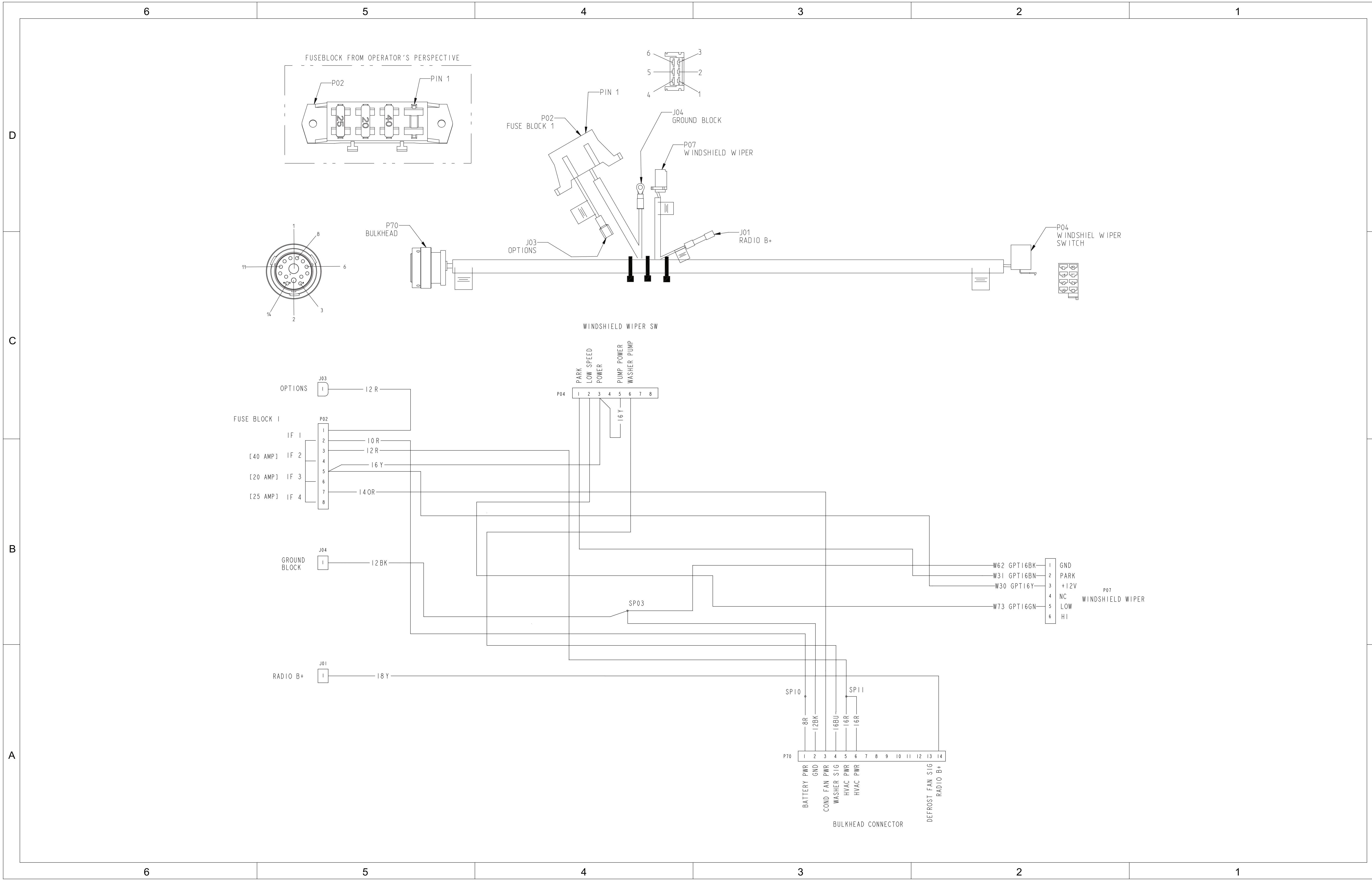
Wire Harness – Cab Power



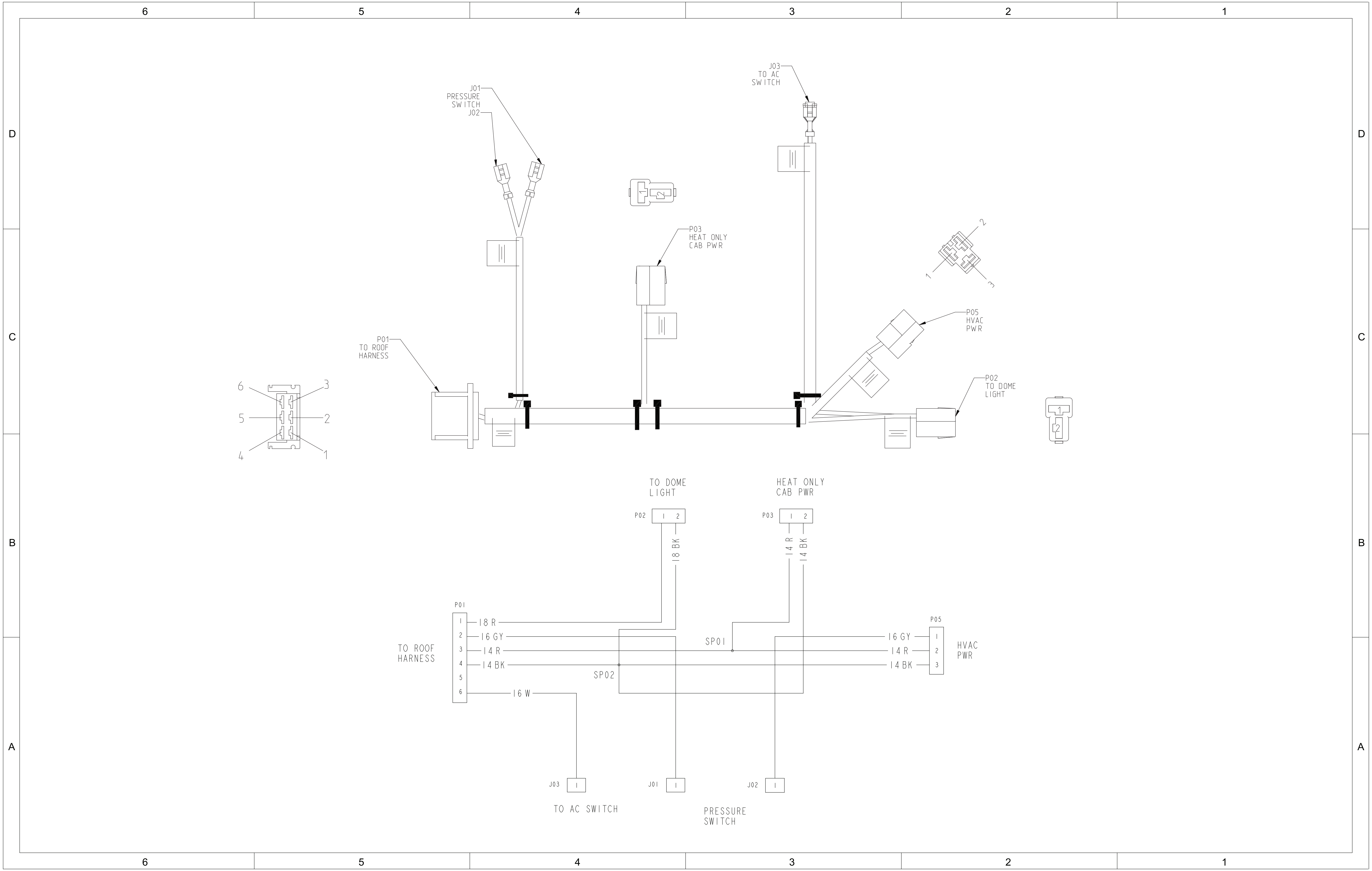
g297520


P70
BULKHEAD
P01
A/C INTERCONNECT
P09
PWR INTERCONNECT
P05
AC CONDENSER
FANS CONTROL
P08
AC SW SIGNAL
INVERT
P07
A/C
CLUTCH
P06
CONDENSER
FANS
P04
HVAC
HVAC
DOME LT.
CLUTCH
PWR
GND
DEFROST FAN SIG
AC SW SIG
AC SW
SIGNAL
INVERT
A/C CLUTCH
AC CONDENSER
FANS CONTROL
CONDENSER FANS
CAB CONNECTORS
PWR
INTERCONNECT
GROUND
POWER
A/C
INTERCONNECT
A GND
RADIO B+
WASHER
A/C CLUTCH
AC SW SIG
NC
ROOFTOP HARNESS
BATTERY PWR
GND
COND FAN PWR
WASHER SIG
HVAC PWR
HVAC PWR
DEFROST FAN SIG
RADIO B+
BULKHEAD CONNECTOR
g256477

Wire Harness – Cab Control Panel



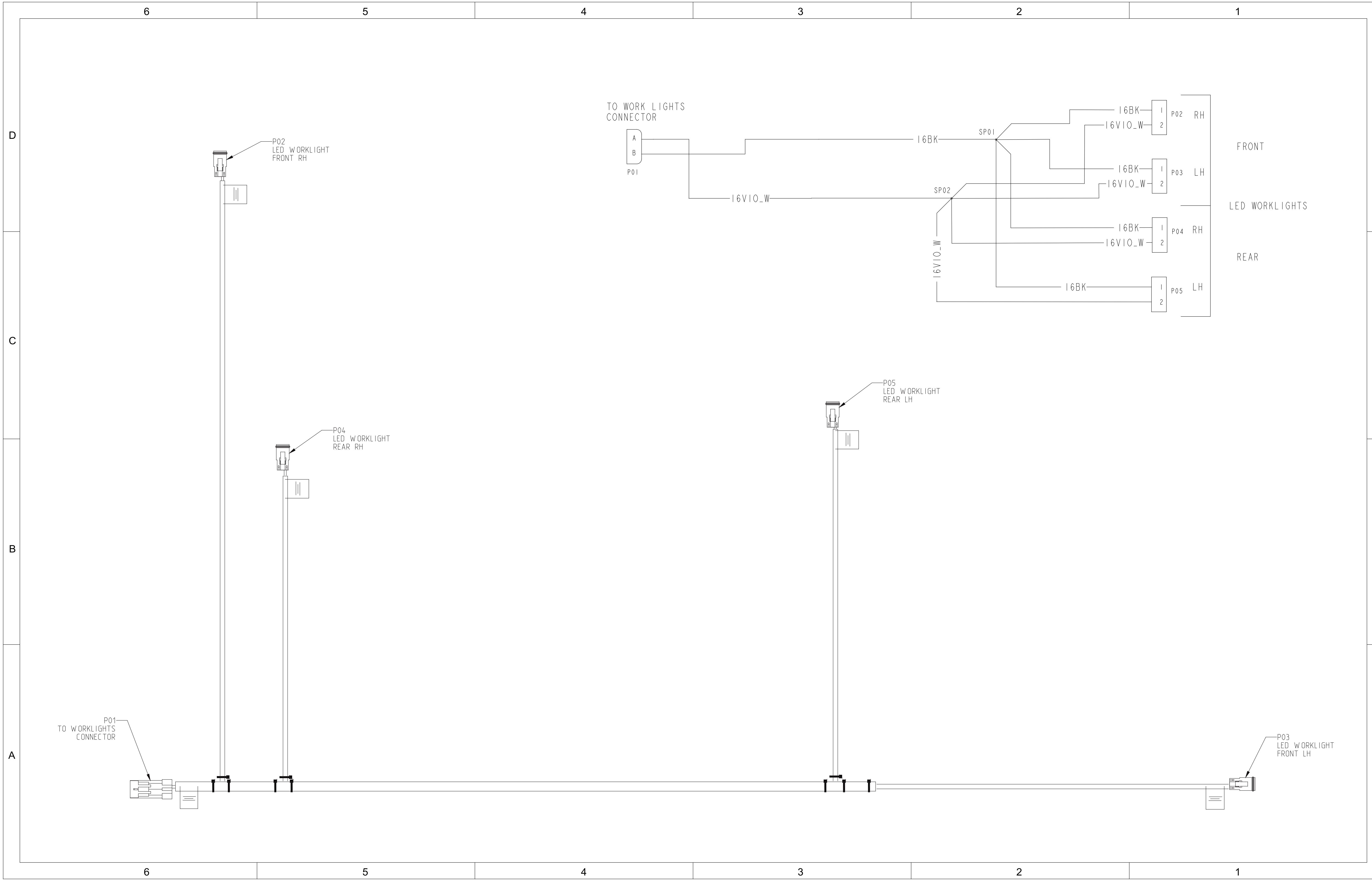
g297533

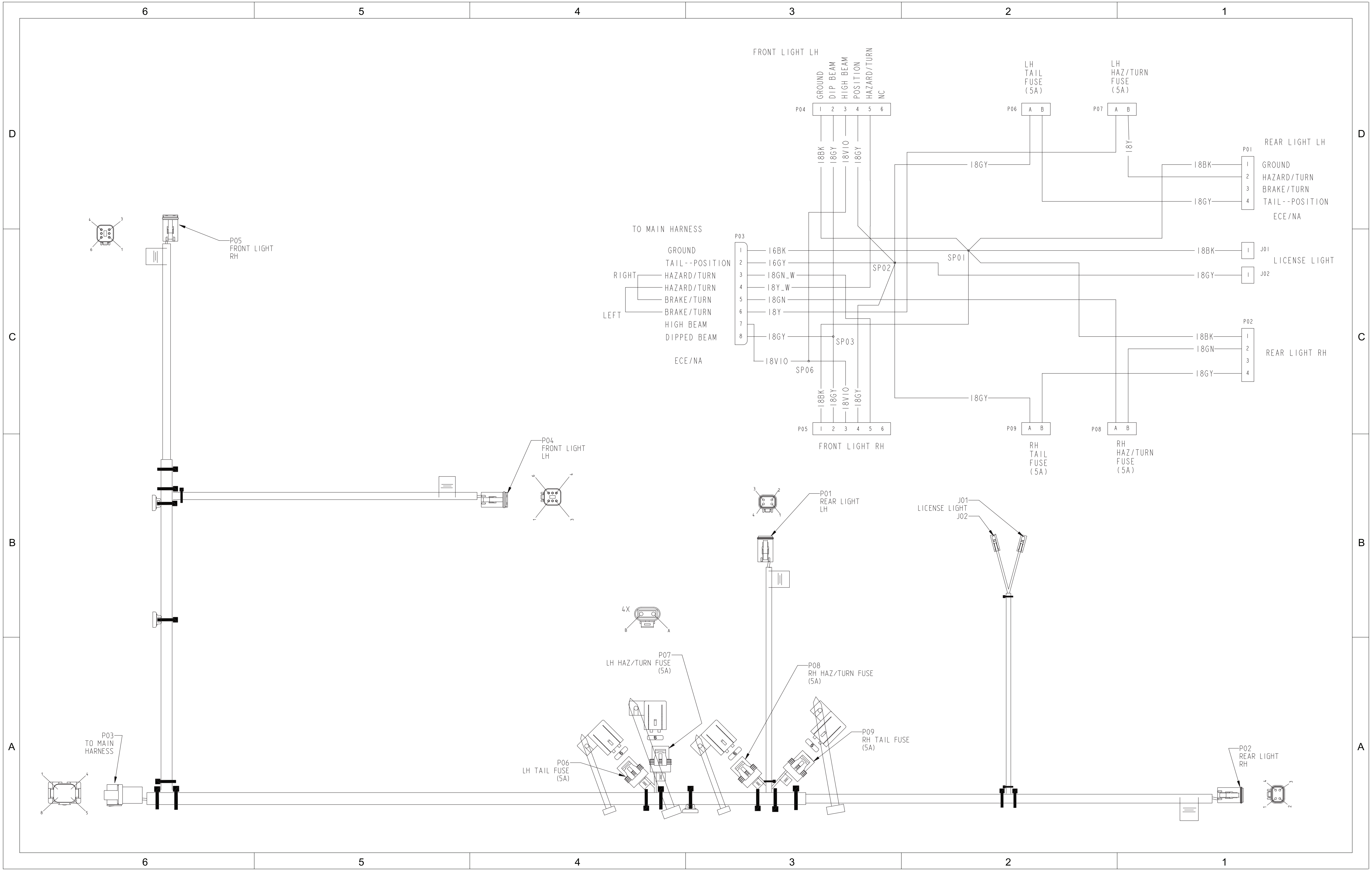


J01
PRESSURE
SWITCH
J02
J03
TO AC
SWITCH
P03
HEAT ONLY
CAB PWR
P01
TO ROOF
HARNESS
P05
HVAC
PWR
P02
TO DOME
LIGHT
TO DOME
LIGHT
HEAT ONLY
CAB PWR
P02
P03
18 BK
14 R
14 BK
P01
18 R
16 GY
14 R
14 BK
16 W
TO ROOF
HARNESS
SP01
SP02
P05
16 GY
14 R
14 BK
HVAC
PWR
J03
J01
J02
TO AC SWITCH
PRESSURE
SWITCH

g297534

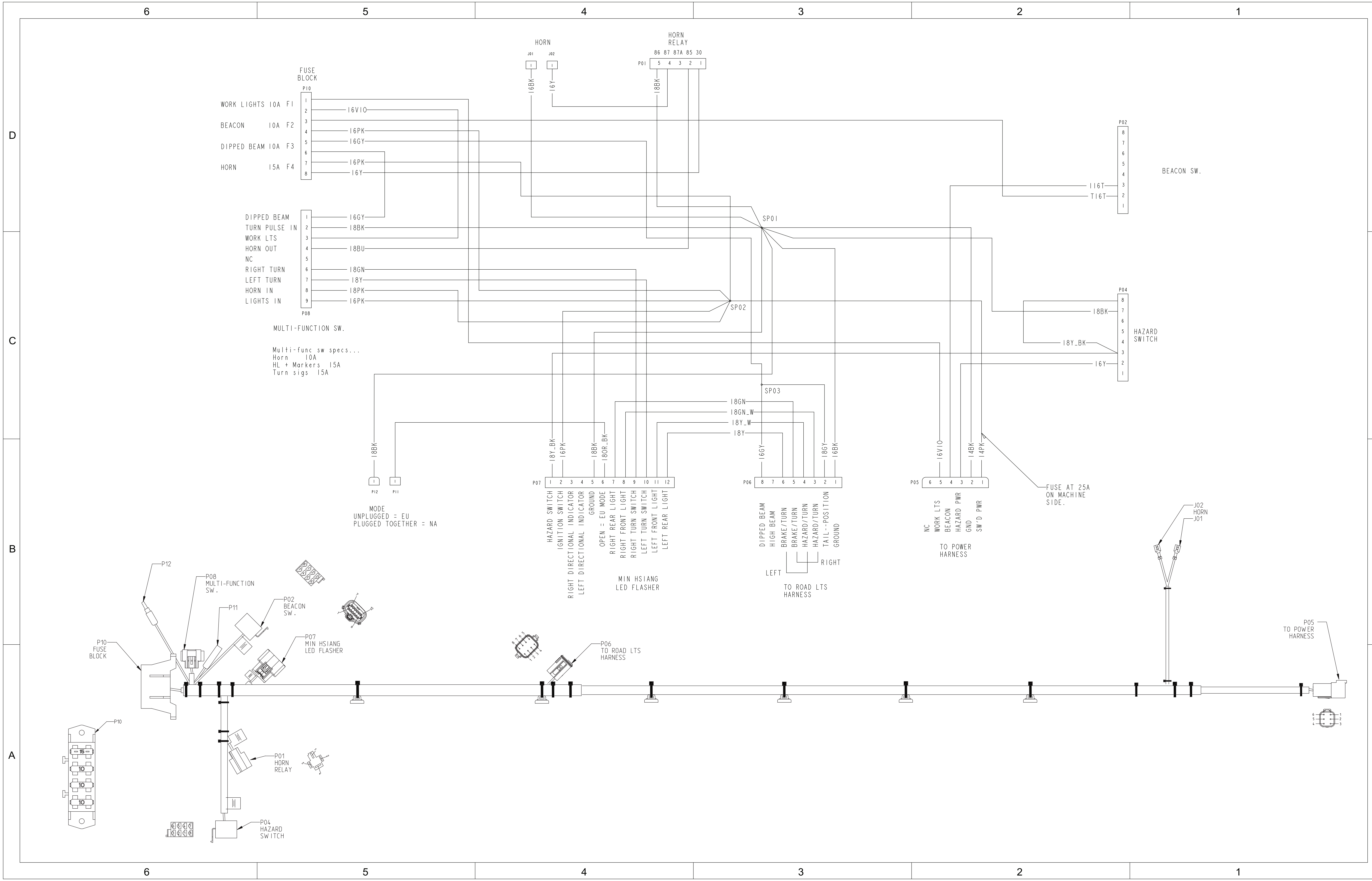
Wire Harness – Cab Work Light Kit (optional)



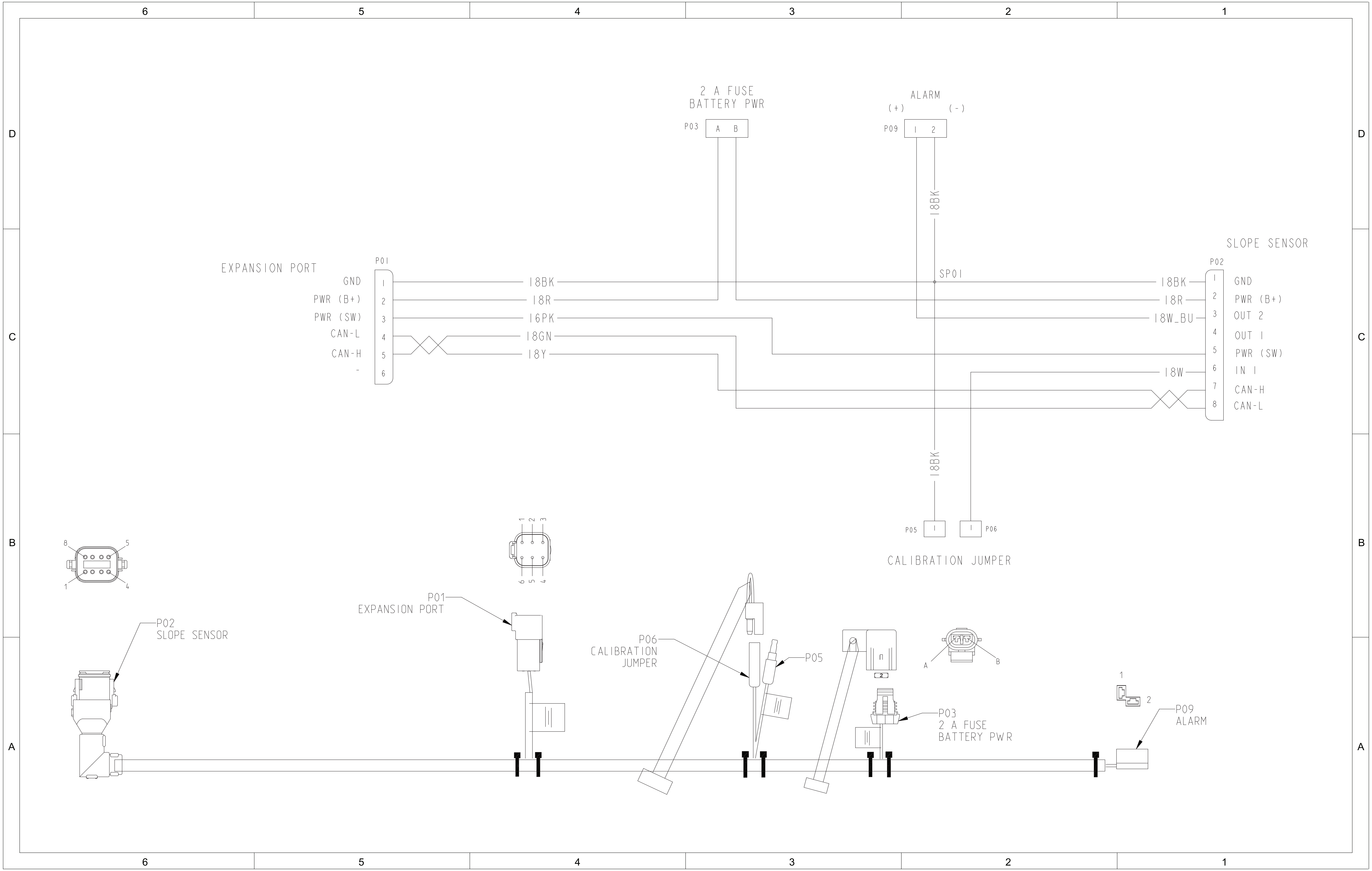

FRONT LIGHT LH
GROUND
DIP BEAM
HIGH BEAM
POSITION
HAZARD/TURN
NC
LH TAIL FUSE (5A)
LH HAZ/TURN FUSE (5A)
REAR LIGHT LH
GROUND
HAZARD/TURN
BRAKE/TURN
TAIL--POSITION
ECE/NA
TO MAIN HARNESS
GROUND
TAIL--POSITION
RIGHT
HAZARD/TURN
HAZARD/TURN
BRAKE/TURN
LEFT
BRAKE/TURN
HIGH BEAM
DIPPED BEAM
ECE/NA
LICENSE LIGHT
REAR LIGHT RH
FRONT LIGHT RH
RH TAIL FUSE (5A)
RH HAZ/TURN FUSE (5A)
P05 FRONT LIGHT RH
P04 FRONT LIGHT LH
P01 REAR LIGHT LH
J01 LICENSE LIGHT J02
4X
P07 LH HAZ/TURN FUSE (5A)
P08 RH HAZ/TURN FUSE (5A)
P09 RH TAIL FUSE (5A)
P06 LH TAIL FUSE (5A)
P03 TO MAIN HARNESS
P02 REAR LIGHT RH

g302637

Wire Harness – Road Light Kit, Controls (optional)



g306840


2 A FUSE
BATTERY PWR
P03
A B
ALARM
(+) (-)
P09
1 2
18BK
EXPANSION PORT
P01
GND
PWR (B+)
PWR (SW)
CAN-L
CAN-H
-
18BK
18R
16PK
18GN
18Y
SP01
SLOPE SENSOR
P02
18BK
18R
18W_BU
18W
GND
PWR (B+)
OUT 2
OUT 1
PWR (SW)
IN 1
CAN-H
CAN-L
18BK
P05
P06
CALIBRATION JUMPER
P01
EXPANSION PORT
P02
SLOPE SENSOR
P06
CALIBRATION
JUMPER
P05
P03
2 A FUSE
BATTERY PWR
P09
ALARM
g303863

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Count on it.