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TORO®

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Service Manual

Groundsmaster 5900 Traction Unit

(Models 31598 and 31599)

8111 Lyndale Avenue South
Bloomington, MN 55420

Revision History

Revision	Date	Description
–	2009	Initial issue.
A	2016	Updated Hydraulic and Electrical chapters.
B	03/2018	Added revision history.
C	05/2018	Added VA02 series planetary information.

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

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Notes:

Preface

The purpose of this publication is to provide the service technician with the information for troubleshooting, testing, and repair of the major systems and components of the Groundsmaster 5900 and 5910 machines (Models 31598 and 31599).

Refer to the traction unit *Operator's Manuals* for operating, maintenance, and adjustment instructions. Keep a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine with this *Service Manual* for reference. Additional copies of the *Operator's Manuals* and *Parts Catalogs* are available at www.toro.com.

DANGER

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

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.

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Figure 1

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 Torque Specifications (page 2–4).

Fluid Specifications

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

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

Table of Contents

Additional Reference Materials

DANFOSS D SERIES GEAR PUMP SEAL KIT SERVICE INSTRUCTION BULLETIN

REXROTH VARIABLE PUMP A10VG REPAIR INSTRUCTIONS

REXROTH VARIABLE PUMP A10VG REPAIR MANUAL

DANFOSS H1 CLOSED CIRCUIT AXIAL PISTON PUMPS SERVICE MANUAL

DANFOSS H1 CLOSED CIRCUIT AXIAL PISTON PUMPS REPAIR INSTRUCTIONS

EATON REPAIR INFORMATION: MODEL 74318 and 74348 PISTON MOTORS

PARKER TORQMOTORTM SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)

EATON PARTS AND REPAIR INFORMATION: 5 SERIES STEERING CONTROL UNITS

ICE COMPRESSOR SERVICE MANUAL

Safety

Table of Contents

Safety Instructions

The Groundsmaster 5900 and 5910 machines are tested and certified by Toro for compliance with the existing safety standards and specifications. Although the hazard control and accident prevention do not fully depend on the design and configuration of the machine, these factors are also dependent on the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. The 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 following safety instructions.

Before Operating the Machine

- Review and understand the contents of the *Operator's Manual* and *Operator's DVD* before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Additional copies of the *Operator's Manual* are available at www.toro.com.
- Keep all the shields, safety devices, and decals in place. If a shield, safety device, or decal is illegible or damaged, repair or replace it before operating the machine. Also, tighten any loose nuts, bolts, or screws to ensure that the machine is in safe operating condition.
- Ensure that the interlock switches are adjusted correctly so that the engine does not start unless the traction pedal is in the NEUTRAL position and PTO switch is off (disengaged).
- Diesel fuel is flammable; handle it carefully.
  - Use an approved fuel container.
  - Do not remove the fuel tank cap while the engine is hot or running.
  - Do not smoke while handling the fuel.
  - Fill the fuel tank outdoors and only to a level within an inch of the top of the tank, not the filler neck. Do not overfill the fuel tank.
  - Wipe up any spilled fuel.

While Operating the Machine

- Sit on the seat when starting and operating the machine.
- Before you start the engine, do the following steps:
  1. Set the parking brake.
  2. Ensure that the traction pedal is in the NEUTRAL position and the PTO switch is off (disengaged).
  3. After you start the engine, release the parking brake and keep foot off the traction pedal. Ensure that the machine does not move.

     Note: If the machine movement is evident, the traction pedal is adjusted incorrectly; therefore, shut off the engine and adjust the traction system until the machine does not move when you release the traction pedal.

While Operating the Machine (continued)

DANGER

The exhaust fumes are hazardous and have the potential of injury or death.

Do not run the engine in a confined area without adequate ventilation.

CAUTION

Running the engine causes the engine, radiator, and exhaust system to become hot. Touching a hot engine, radiator, or exhaust system can burn you.

Do not touch the engine, radiator, or exhaust system while the engine is running or soon after you stop it.

- Before getting off the seat, do the following steps:

1. Ensure that the traction pedal is in the NEUTRAL position.
2. Set the parking brake.
3. Lower the cutting decks fully to the ground.

IMPORTANT

When you lower the cutting decks fully to the ground, the pressure from the lift circuit releases and prevents the cutting decks from accidentally lowering to the ground.

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4. Disengage the cutting decks and wait for the cutting blades to stop fully.
5. Operate the engine at low-idle speed for at least 5 minutes after the full load operation to allow the turbocharger to cool.
6. Shut off the engine and remove the key from the key switch. Wait for all moving parts to stop.

- If you park the machine on a slope, block or chock the wheels.

Maintenance and Service

- Before servicing or making any adjustments to the machine, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
- Ensure that the machine is in safe operating condition by keeping all the nuts, bolts, and screws tight.
- Shut off the engine before checking or adding the oil to the engine crankcase.
- To reduce potential fire hazards, keep the engine area free of excessive grease, grass, leaves, and dirt. Clean the protective screen on the machine frequently.
- Do not store the machine or a fuel container inside where there is an open flame, such as near a water heater or furnace.

- Do not overspeed the engine by changing the governor setting. To ensure safety and accuracy, check the maximum engine speed.
- Disconnect the batteries before servicing the machine. Disconnect the negative battery cable and then the positive cables. If the battery voltage is necessary for troubleshooting or test procedures, temporarily connect the batteries. Connect the positive battery cables and then the negative cable.
- Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes, and clothing. Protect your face, eyes, and clothing when working with a battery.
- Battery gases can explode. Keep the cigarettes, sparks, and flames away from the battery.
- When changing the attachments, tires, or performing other services, use correct blocks, hoists, and jacks to raise and support the machine. Ensure that the machine is parked on a solid level surface, such as a concrete floor. Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine. Always block the wheels with chocks. Use appropriate jack stands to support the raised machine. Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury; refer to Jacking Instructions (page 1–5).
- Ensure that all of the hydraulic line connectors are tight and that all the hydraulic hoses and lines are in good condition before applying pressure to the system.
- Keep your body and hands away from pin-hole leaks in the hydraulic lines that eject hydraulic fluid under high pressure. Use cardboard or paper to find hydraulic leaks. The hydraulic fluid escaping under pressure can penetrate the skin and cause injury. If hydraulic fluid is accidentally injected into the skin, you must have it surgically removed within a few hours by a doctor familiar with this type of injury. Otherwise, gangrene may result.
- Before disconnecting or performing any work on the hydraulic system, release all the pressure in system by shutting off the engine and lowering the cutting decks to the ground.
- Ensure that all of the engine fuel system connectors and components are correctly installed and that all the fuel hoses are in good condition before starting the engine.
- Keep your body and hands away from leaks in the fuel-injection lines. Use cardboard or paper to find high-pressure fuel leaks. Leaking fuel under pressure can penetrate the skin and cause injury.
- If you must run the engine to perform maintenance or an adjustment, keep your hands, feet, clothing, and other parts of the body away from the cutting decks and other moving parts. Keep the bystanders away.
- At the time of manufacture, the machine conformed to the safety standards for riding mowers. To ensure the optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. The replacement parts and accessories of other manufacturers can result in non-conformance with the safety standards and can void the warranty.
- When welding on the machine, disconnect all the battery cables to prevent damage to the machine electronic equipment. Disconnect the negative battery cable and then the positive cable. Disconnect and remove the engine electronic control module (ECM) from the engine before welding on the machine. Also, attach the welder ground cable not more than 610 mm (2 ft) from the welding location.
- If major repairs are necessary, contact an Authorized Toro Distributor.

Jacking Instructions

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to raise and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

Raising the Front of the Machine

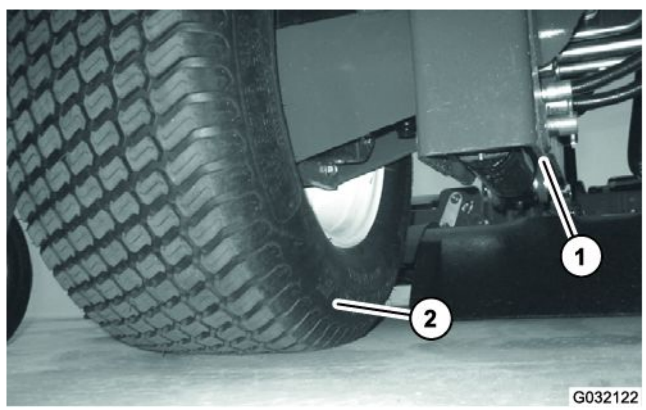

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Figure 2

1. Frame jacking point
2. Front tire

1. Block the 2 rear tires with chocks to prevent the machine from moving.
2. Position the jack correctly under the frame, just to the inside of the front tire.

   Note: Ensure that the jack does not contact the hydraulic lift cylinder.
3. Position the appropriate jack stands under the frame as close to the front wheel as possible to support the machine.

Raising the Rear of the Machine

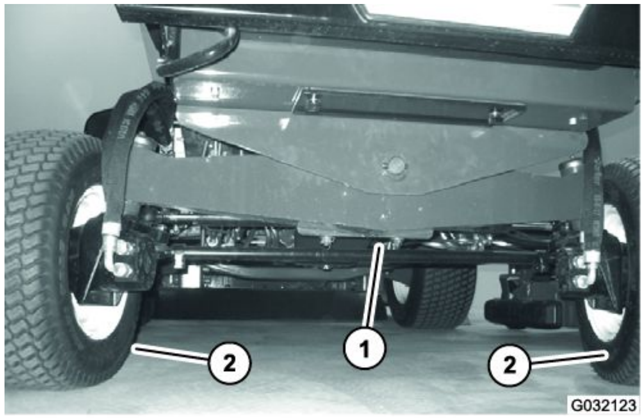

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Figure 3

1. Rear axle jacking point
2. Rear tire

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1. Set the parking brake and block the 2 front tires with chocks to prevent the machine from moving.
2. Position the jack correctly under the center of the rear axle. Lift the rear of the machine off the ground.
3. Use appropriate jack stands under the rear axle to support the machine.

Safety and Instructional Decals

The numerous safety and instruction decals are affixed to your machine. If any decal becomes illegible or damaged, install a new decal. The decal part numbers are listed in the *Parts Catalog*.

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Chapter 2

Specifications and Maintenance

Table of Contents

Specifications

Insert a copy of the *Operator's Manuals* and *Parts Catalogs* for your machine at the end of this chapter. Additionally, if any optional equipment or accessories are installed to your machine, insert the *Installation Instructions*, *Operator's Manuals*, and *Parts Catalogs* for those options at the end of this chapter.

The maintenance procedures and recommended service intervals for your machine are covered in the *Operator's Manual*. Refer to this publication when performing the regular equipment maintenance.

Decimal and Millimeter Equivalents

Fractions			Decimals	mm	Fractions			Decimals	mm
		1/64	0.015625	0.397			33/64	0.515625	13.097
	1/32		0.03125	0.794		17/32		0.53125	13.494
		3/64	0.046875	1.191			35/64	0.546875	13.891
1/16			0.0625	1.588	9/16			0.5625	14.288
		5/64	0.078125	1.984			37/64	0.578125	14.684
	3/32		0.09375	2.381		19/32		0.59375	15.081
		7/64	0.109275	2.778			39/64	0.609375	15.478
1/8			0.1250	3.175	5/8			0.6250	15.875
		9/64	0.140625	3.572			41/64	0.640625	16.272
	5/32		0.15625	3.969		21/32		0.65625	16.669
		11/64	0.171875	4.366			43/64	0.671875	17.066
3/16			0.1875	4.762	11/16			0.6875	17.462
		13/64	0.203125	5.159			45/64	0.703125	17.859
	7/32		0.21875	5.556		23/32		0.71875	18.256
		15/64	0.234375	5.953			47/64	0.734375	18.653
1/4			0.2500	6.350	3/4			0.7500	19.050
		17/64	0.265625	6.747			49/64	0.765625	19.447
	9/32		0.28125	7.144		25/32		0.78125	19.844
		19/64	0.296875	7.541			51/64	0.796875	20.241
5/16			0.3125	7.938	13/16			0.8125	20.638
		21/64	0.328125	8.334			53/64	0.828125	21.034
	11/32		0.34375	8.731		27/32		0.84375	21.431
		23/64	0.359375	9.128			55/64	0.859375	21.828
3/8			0.3750	9.525	7/8			0.8750	22.225
		25/64	0.390625	9.922			57/64	0.890625	22.622
	13/32		0.40625	10.319		29/32		0.90625	23.019
		27/64	0.421875	10.716			59/64	0.921875	23.416
7/16			0.4375	11.112	15/16			0.9375	23.812
		29/64	0.453125	11.509			61/64	0.953125	24.209
	15/32		0.46875	11.906		31/32		0.96875	24.606
		31/64	0.484375	12.303			63/64	0.984375	25.003
1/2			0.5000	12.700	1			1.000	25.400
1 mm = 0.03937 inch					**0.001 inch = 0.0254 mm**				

U.S. to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.914
	Feet	Meters	0.305
	Feet	Centimeters	30.48
	Inches	Meters	0.025
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.093
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.405
Volume	Cubic Yards	Cubic Meters	0.765
	Cubic Feet	Cubic Meters	0.028
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.908
	Pounds	Kilograms	0.454
	Ounces (Avdp.)	Grams	28.349
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.138
	Inch-pounds	Kilogram-Centimeters	1.152
Liquid Volume	Quarts	Liters	0.946
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subtract 32° 2. Multiply by 5/9

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 the lubricated fasteners 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 must 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.

Identifying the Fastener

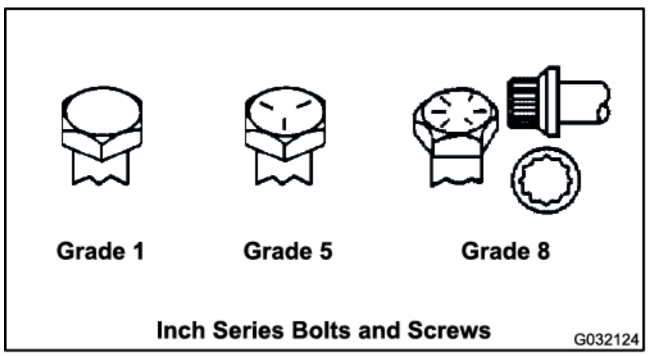

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Figure 4

Identifying the Fastener (continued)

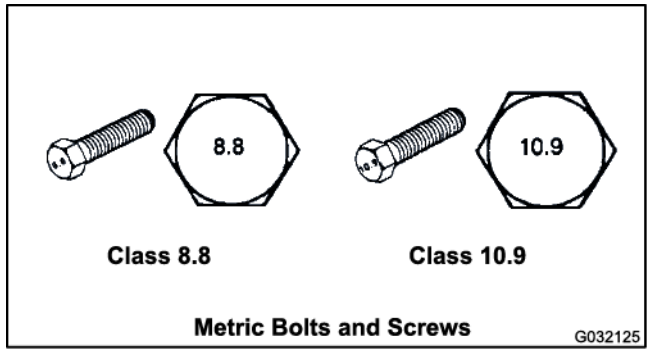

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Figure 5

Calculating the Torque Values When Using a Drive-Adapter Wrench

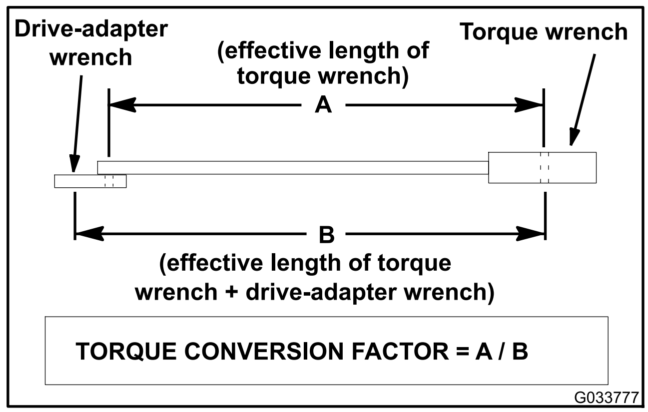

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Figure 6

Using a drive-adapter wrench (e.g., crowfoot wrench) in any position other than 90º and 270º 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 6) 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)**.

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

Thread Size	Grade 1, 5 and 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs and Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)	
	in-lb	in-lb	N·cm	in-lb	N·cm	in-lb	N·cm
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	328 ± 34	41± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1146 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft-lb	ft-lb	N·m	ft-lb	N·m	ft-lb	N·m
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

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

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

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	57 ± 6 in-lb	644 ± 68 N·cm	78 ± 8 in-lb	881 ± 90 N·cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N·cm	133 ± 14 in-lb	1503 ± 158 N·cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N·m	28 ± 3 ft-lb	38 ± 4 N·m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N·m	54 ± 6 ft-lb	73 ± 8 N·m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N·m	93 ± 10 ft-lb	126 ± 14 N·m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N·m	229 ± 23 ft-lb	310 ± 31 N·m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N·m	450 ± 46 ft-lb	610 ± 62 N·m

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

Note: The torque values must be reduced when installing the fasteners into the threaded aluminum or brass. The specified torque value should be determined based on the fastener size, the aluminum or base material strength, 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	140 ± 20 in-lb	73 ± 12 in-lb
5/16 - 18 UNC	215 ± 35 in-lb	145 ± 20 in-lb
3/8 - 16 UNC	35 ± 10 ft-lb	18 ± 3 ft-lb
1/2 - 13 UNC	75 ± 15 ft-lb	50 ± 10 ft-lb

Thread Cutting Screws
(Zinc Plated Steel)

Type 1, Type 23 or Type F	
Thread Size	**Baseline Torque****
No. 6 - 32 UNC	20 ± 5 in-lb
No. 8 - 32 UNC	30 ± 5 in-lb
No. 10 - 24 UNC	38 ± 7 in-lb
1/4 - 20 UNC	85 ± 15 in-lb
5/16 - 18 UNC	110 ± 20 in-lb
3/8 - 16 UNC	200 ± 100 in-lb

Other Torque Specifications (continued)

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque*	
7/16 - 20 UNF Grade 5	65 ± 10 ft-lb	88 ± 14 N·m
1/2 - 20 UNF Grade 5	80 ± 10 ft-lb	108 ± 14 N·m
M12 X 1.25 Class 8.8	80 ± 10 ft-lb	108 ± 14 N·m
M12 X 1.5 Class 8.8	80 ± 10 ft-lb	108 ± 14 N·m

*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	20 ± 5 in-lb
No. 8	15	18	30 ± 5 in-lb
No. 10	12	16	38 ± 7 in-lb
No. 12	11	14	85 ± 15 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

N·cm X 0.08851 = in-lb

ft-lb X 1.3558 = N·m

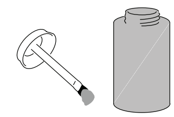
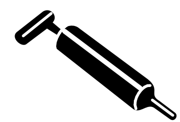
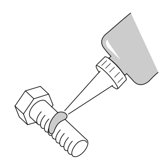
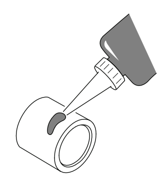
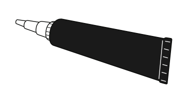
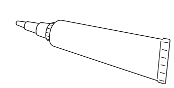
N·m X 0.7376 = ft-lb

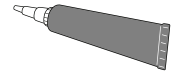
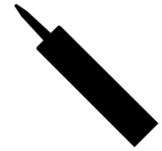
Shop Supplies

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.

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 prior to 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 -51F to 232C (-60F to 400F), while high temperature variants can preform in temperatures up to 343C (650F)	

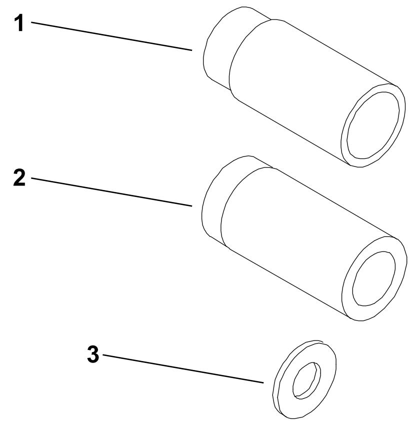
Special Tools

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

Toro 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.



57 LPM (15 GPM) Hydraulic Tester Kit

Toro Part 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.

150 LPM (40 GPM) Hydraulic Tester

Toro 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

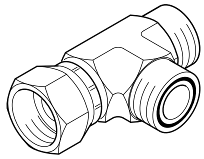
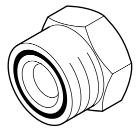
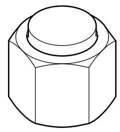
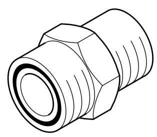
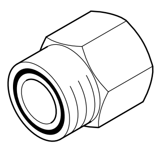
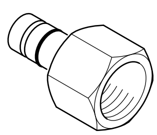
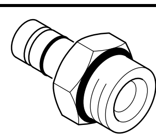
Toro Part No. TOR6007

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

Toro 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

Toro 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 2–13).

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

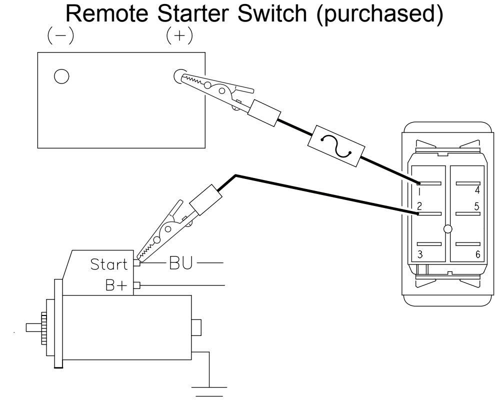
Remote Starter Switch

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)

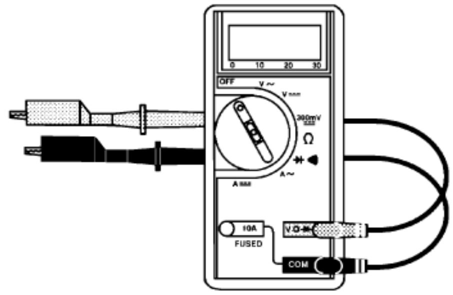
Note: For information on using the remote starter switch to prime the hydraulic pumps.

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.

Diesel Engine

Table of Contents

Specifications

Diesel Engine

Item	Description
Make/Designation	Cummins, 4-cycle, 4-cylinder, liquid cooled, turbocharged, diesel engine
Bore	95 mm (3.74 inches)
Stroke	115 mm (4.53 inches)
Total displacement	3300 cm^3 (201 in^3)
Firing order	1 (closest to the engine pulley) - 2 - 4 - 3
Direction of rotation	Clockwise (viewed from the engine pulley)
Compression ratio	17:1
Intake valve clearance Exhaust valve clearance	0.35 mm (0.014 inch) 0.50 mm (0.020 inch)
Fuel	Diesel or Biodiesel (up to B20) with low/ultra-low sulfur content
Fuel tank capacity	132 L (35 US gallons)
Fuel injection pump	Zexel rotary type VE pump
Injection nozzle	Closed nozzle, hole type
Governor	Electronic
Low idle (no load)	1350 rpm
High idle (no load)	2750 rpm
Oil pump	Geroter type
Engine oil	API CH-4 or CI-4 (refer to the *Operator's Manual* for viscosity)
Crankcase-oil capacity	8.0 L (8.5 qt) with filter
Starter	12 VDC, 2.2 kW
Alternator/Regulator	12 VDC, 120 A
Coolant capacity Machine without cab Machine with cab	 12.8 L (13.5 qt) 17 L (18 qt)
Engine dry weight	275 kg (606 lb)

Diesel Engine (continued)

Engine Fastener Torque Specifications

Item	Description
Alternator adjusting bolt	31 N·m (23 ft-lb)
Alternator mounting bracket bolt (2 each)	31 N·m (23 ft-lb)
Alternator mounting bolt	66 N·m (49 ft-lb)
Crankshaft pulley bolt	372 N·m (274 ft-lb)
Exhaust manifold flange-head screw (8 each)	45 N·m (33 ft-lb)
Front cover flange-head screw (16 each)	19 N·m (14 ft-lb)
Oil drain plug	51 N·m (38 ft-lb)
Oil pan flange-head screw (24 each)	32 to 51 N·m (24 to 38 ft-lb)
Oil suction tube flange-head screw (2 each)	19 N·m (14 ft-lb)
Starter mounting flange-head screw (2 each)	43 N·m (32 ft-lb)
Thermostat housing flange-head screw (2 each)	19 N·m (14 ft-lb)
Turbocharger mounting nut (4 each)	30 N·m (22 ft-lb)
Turbocharger oil drain line bolt (2 each)	24 N·m (18 ft-lb)
Turbocharger oil supply line banjo bolt	24 N·m (18 ft-lb)
Valve adjustment nut (rocker arm)	39 to 49 N·m (29 to 36 ft-lb)
Valve cover nut (3 each)	9 N·m (80 in-lb)
Water pump pulley flange-head screw (4 each)	31 N·m (23 ft-lb)

General Information

This chapter gives information about specifications of the Cummins B3.3 diesel engine used in the Groundsmaster 5900 and 5910 machines. 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.

Some service and repair parts for the engine in your Groundsmaster are supplied through your Authorized Toro Distributor. Be prepared to provide your distributor with the Toro model and serial number of your machine to obtain the parts.

The detailed information on the engine troubleshooting, testing, disassembly, and assembly is identified in the Cummins Service Manual, which explains the use of some specialized tools and test equipment. However, the specialized nature of some engine repairs may dictate that the work be done at an engine repair facility.

Operator's Manual

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

Engine Identification

The engine data plate, located near the starter motor, includes the engine serial number and control parts list number. The fuel injection data plate is located on the fuel injection pump. The ECM data plate is on the electronic control module attached to the flywheel end of the engine. These engine identification tags will assist in identifying the correct parts and service information for the Cummins engine in your machine.

Engine Electronic Control Module (ECM)

The Cummins engine that is used in the Groundsmaster 5900 and 5910 machines use an electronic control module (ECM) for engine management and to communicate with the TEC controllers and operator InfoCenter on the machine. Plug the engine ECM electrical connectors into the controller before you move the machine key switch from the OFF position to either the ON or START position. If the engine ECM is to be disconnected for any reason, ensure that the key switch is in the OFF position with the key removed before disconnecting the ECM. Also, to prevent damaging the module when welding on the machine, disconnect and remove the engine ECM from the engine before welding.

Shutting Off the Engine

IMPORTANT

Before shutting off the engine after mowing or full-load operation, allow the engine to run at low-idle speed for 5 minutes. This allows the turbocharger and internal engine components to adequately cool-down. Failure to allow this cool-down period may lead to premature turbocharger and engine failure.

Fuel-Injection System

The engine fuel-injection system operates at high pressures while the engine is running. Do not loosen any fuel system components, fittings, or hoses while the engine is running.

Keep your body and hands away from leaks in fuel-injection lines. Use cardboard or paper to find high pressure fuel leaks if they may exist. Leaking fuel under pressure can penetrate skin and cause injury.

Adjustments

Adjusting the Valve Clearance

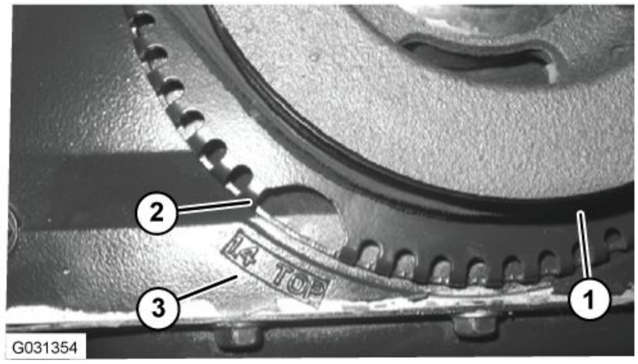


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Figure 7

1. Crankshaft pulley
2. Tone wheel cutout
3. TDC indicator

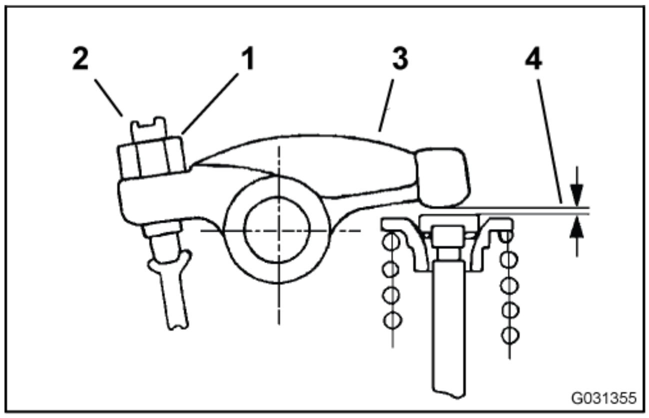

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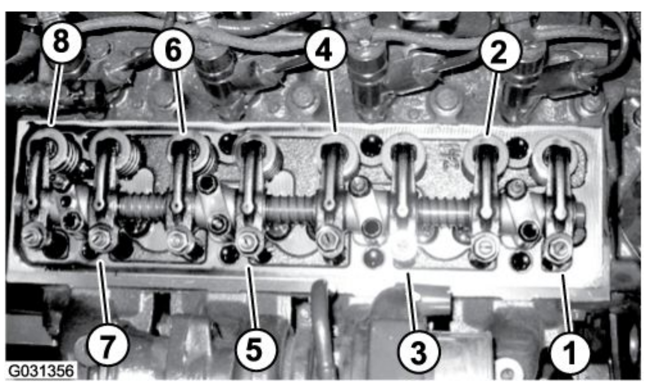
Figure 8

1. Locknut
2. Adjustment screw
3. Rocker arm
4. Valve clearance



g031356

Figure 9

1. #1 intake
2. #1 exhaust
3. #2 intake
4. #2 exhaust
5. #3 intake
6. #3 exhaust
7. #4 intake
8. #4 exhaust

Adjusting the Valve Clearance (continued)

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood.
3. Remove the valve cover from the engine; refer to Removing the Valve Cover (page 3–28).
4. Position the engine crankshaft so that the cylinder #1 is at the top dead center (TDC) at the end of the compression stroke.
   A. While watching the movement of the cylinder #4 intake valve, turn the engine crankshaft clockwise.

      Note: When the cylinder #4 intake valve starts to open, cylinder #1 is near TDC at the end of the compression stroke.

   B. Continue turning the crankshaft clockwise until the cutout in the tone wheel (attached to the back of the crankshaft pulley) aligns with “1.4 TOP” cast in the engine front cover; refer to Figure 7.
5. In this crankshaft position, adjust the valve clearance for intake valves for the cylinders #1 and #3, and exhaust valves for the cylinders #1 and #2; refer to Figure 8 and Figure 9.
   A. Loosen the locknut on the rocker arm adjustment screw.
   B. Insert the correct feeler gauge between the valve stem and the rocker arm.
      - The intake valve clearance specification is 0.35 mm (0.014 inch).
      - The exhaust valve clearance specification is 0.50 mm (0.020 inch)

   C. Adjust the screw until you feel a small drag on the feeler gauge.
   D. Hold the adjustment screw in position and tighten the locknut to secure the valve clearance adjustment; torque the locknut to **39 to 49 N·m (29 to 36 ft-lb)**.
   E. After you tighten the locknut, check the valve clearance again.
6. Turn the crankshaft clockwise for 1 complete revolution.

   Note: The tone wheel cutout should again be aligned with “1.4 TOP.”
7. In this crankshaft position, adjust the valve clearance for intake valves for the cylinders #2 and #4, and exhaust valves for the cylinders #3 and #4. Follow the procedure under step 5.
8. Install the valve cover to the engine; refer to Installing the Valve Cover (page 3–28).
9. Lower the hood and secure it.

Service and Repairs

Air Filter System

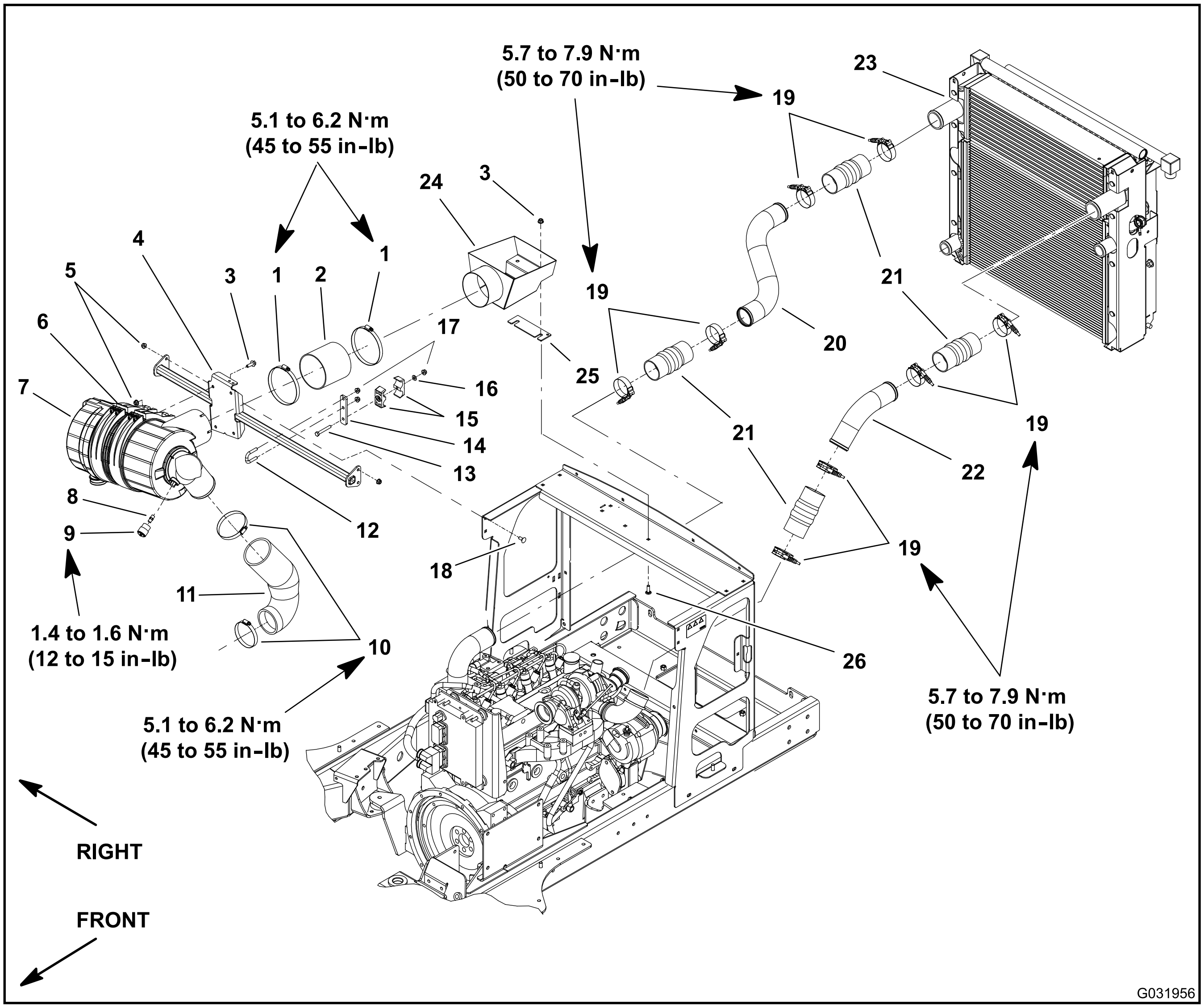


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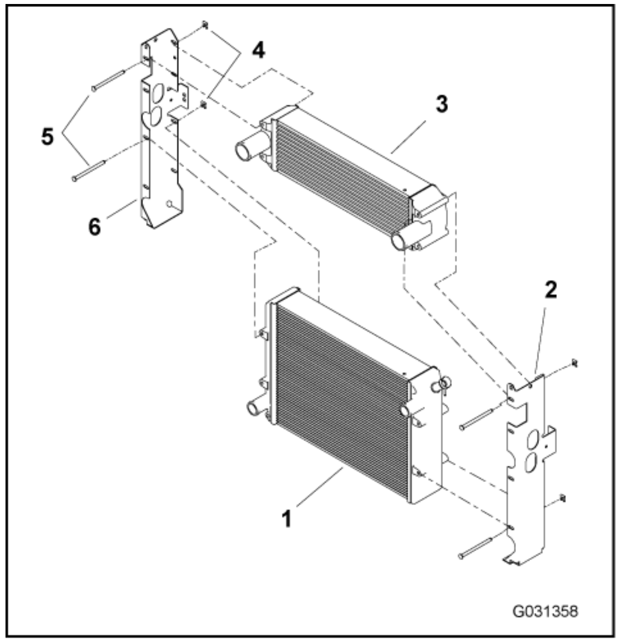
Figure 10

1. Clamp
2. Air hose
3. Flange-head screw (6 each)
4. Air cleaner mount
5. Flange nut (8 each)
6. Air cleaner mounting band (2 each)
7. Air cleaner assembly
8. Adapter
9. Service indicator
10. Worm clamp
11. Intake tube
12. U-bolt
13. Bolt
14. Mount plate
15. Tube clamp
16. Flat washer
17. Flange nut (3 each)
18. Carriage screw (4 each)
19. Hose clamp (8 each)
20. Tube
21. Air intake tube (4 each)
22. Tube
23. Radiator assembly
24. Airbox
25. Shim (as needed)
26. Carriage screw (2 each)

Note: Machines with serial number above 313000300 use an air filter sensor rather than the service indicator (item 9 in Figure 10); refer to Air Filter Sensor (Machines with Serial Number Above 313000300) (page 5–95) for additional information regarding the air filter sensor.

Removing the Air Filter System



g031358

Figure 11

1. Radiator
2. Left cooler bracket
3. Charge air cooler
4. Pin clip (8 each)
5. Pin (8 each)
6. Right cooler bracket

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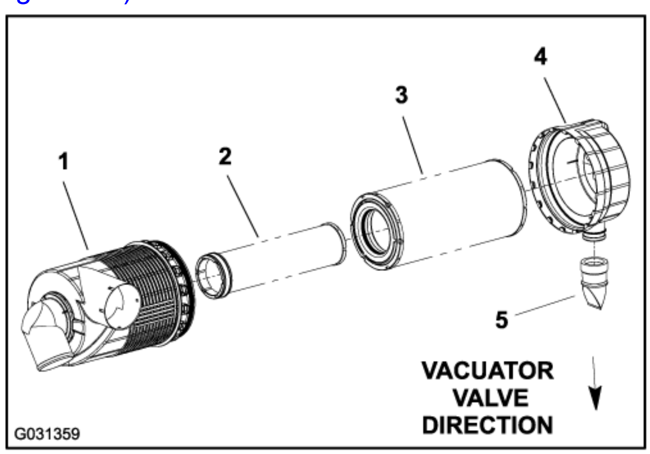
1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Remove the air cleaner components as shown in Figure 10.
4. Examine all the tubes and clamps for wear or damage. Replace the components as necessary.

   Note: If the charge air cooler in the radiator assembly requires service (Figure 11); refer to Removing the Radiator (page 3–20) and Installing the Radiator (page 3–22).



g031359

Figure 12

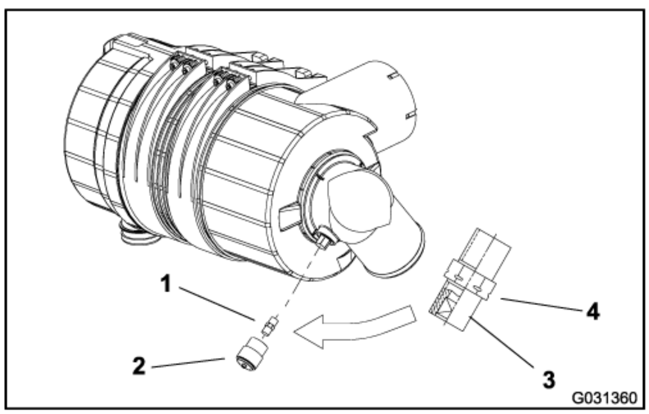
1. Air cleaner housing
2. Safety filter
3. Filter element
4. Cover
5. Vacuator valve

Installing the Air Filter System

IMPORTANT

Leaks in the air filter system will cause serious engine damage. Ensure that all the air cleaner components are in good condition and are properly secured during installation.

1. Assemble the air cleaner system; refer to Figure 10.
   A. Ensure that the tabs in the air cleaner mounting bands align fully with the slots in the air cleaner body.
   B. Align the clamps (item 1) so that there is no interference with hood foam when you close the hood.
   C. Torque the clamps (items 1 and 10) to **5.1 to 6.2 N·m (45 to 55 in-lb)**.
   D. Torque the hose clamps (item 19) to **5.7 to 7.9 N·m (50 to 70 in-lb)**.
   E. Ensure that the air cleaner vacuator valve points down after assembly (Figure 12).
   F. If the service indicator (item 9) and adapter (item 8) were removed from the air cleaner housing, apply thread sealant to the adapter threads before installing the adapter and indicator to the housing.



g031360

Figure 13

1. Adapter
2. Service indicator
3. Adapter filter element
4. Adapter grooves

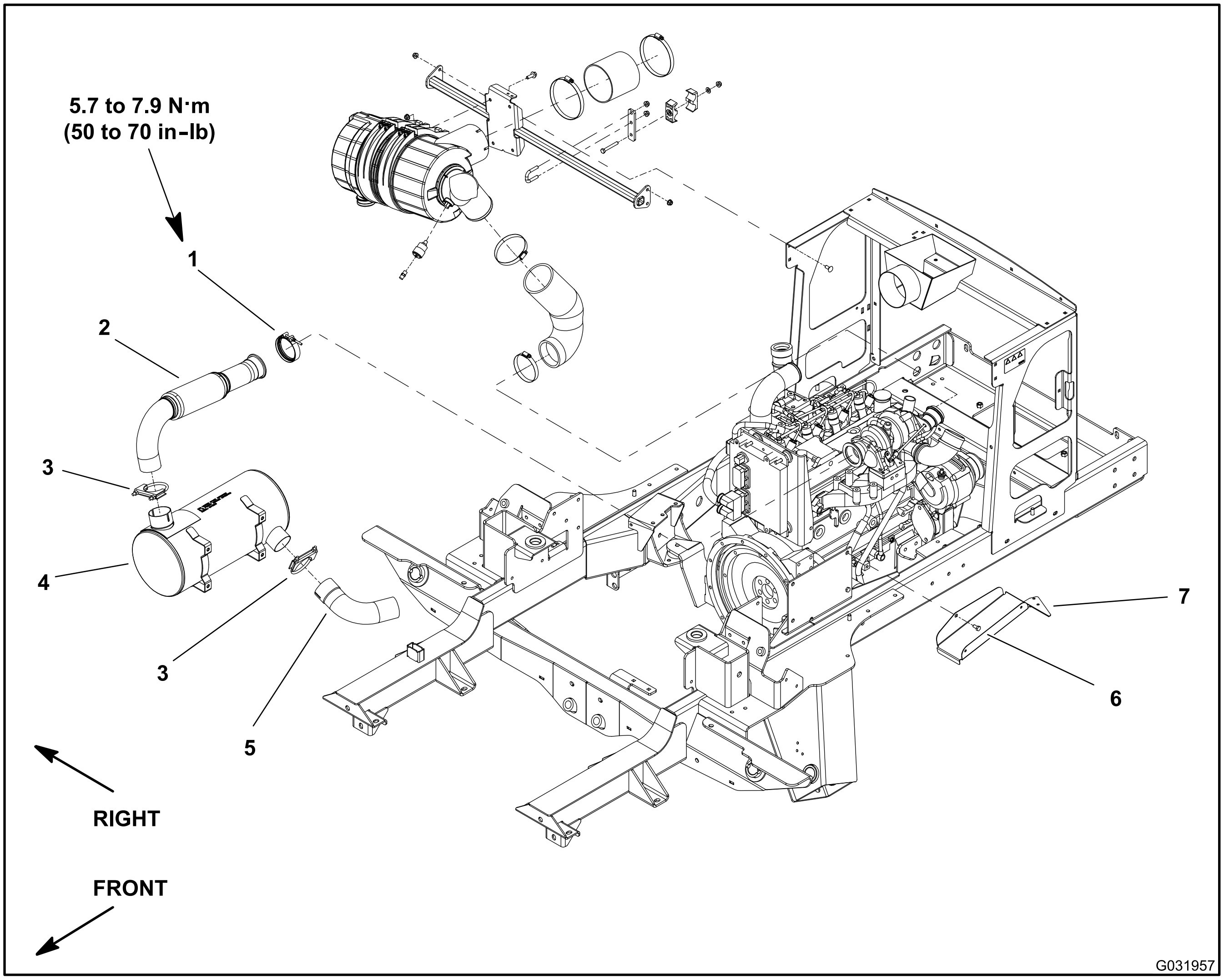
   G. Install the adapter so that the grooves in the adapter hex and adapter filter element are installed toward the service indicator (Figure 13); torque the indicator to **1.4 to 1.6 N·m (12 to 15 in-lb)**.

2. Apply chalk on the airbox lip, lower the hood, and check that the hood makes a continuous seal around the airbox (item 24 in Figure 10).

   Note: If necessary, use shim(s) to adjust the location of the airbox for the correct sealing with the hood.

3. Lower the hood and secure it.

Exhaust System



g031957

Figure 14

1. Exhaust clamp
2. Exhaust tube
3. Muffler clamp (2 each)
4. Muffler
5. Tailpipe
6. Flange-head screw (4 each)
7. Heat shield

Removing the Exhaust System

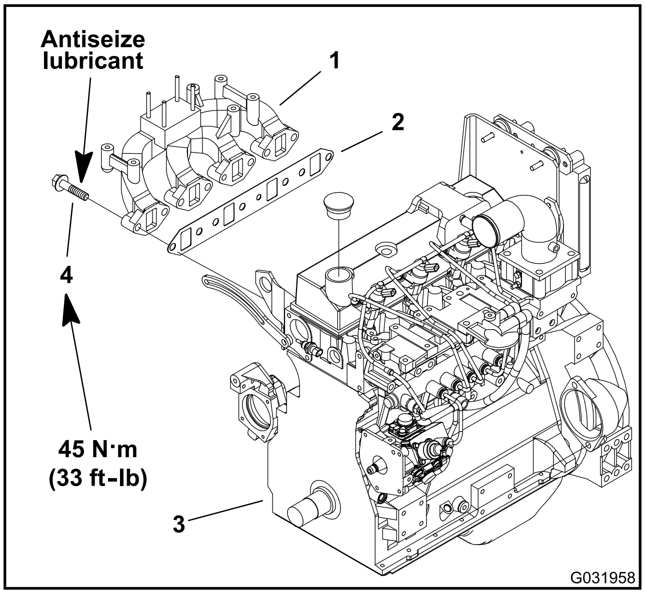
CAUTION

A hot engine and exhaust system can cause burns.

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

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the exhaust system.
3. Remove the side panel from the right side of the frame to get easier access to the exhaust system components.

Removing the Exhaust System (continued)



g031958

Figure 15

1. Exhaust manifold
2. Manifold gasket
3. Engine
4. Flange-head screw (8 each)

4. Remove the muffler and/or exhaust tube from the engine as shown in Figure 14.
5. If necessary, remove the exhaust manifold from the engine; refer to Figure 15.
   A. Remove the turbocharger from the exhaust manifold; refer to Removing the Turbocharger (page 3–14).
   B. Support the exhaust manifold to prevent it from falling.
   C. Remove the 8 flange-head screws that attach the exhaust manifold to the cylinder head, and remove the manifold from the engine.
   D. Remove and discard the manifold gasket. Clean the mating surfaces of the cylinder head and manifold.
6. If you are leaving the opening of exhaust system components exposed for a length of time, cover the openings to prevent contaminants from entering into the components.

Installing the Exhaust System

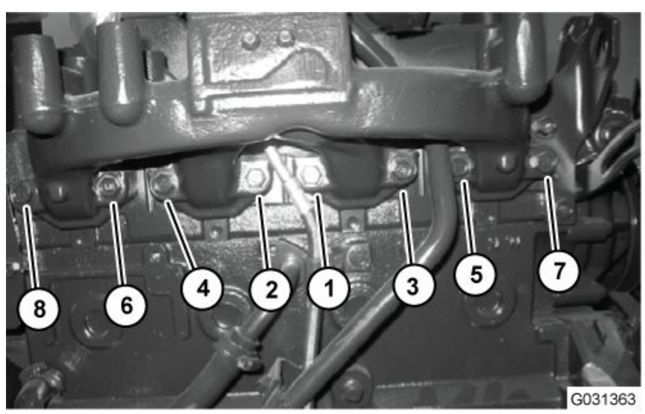


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Figure 16

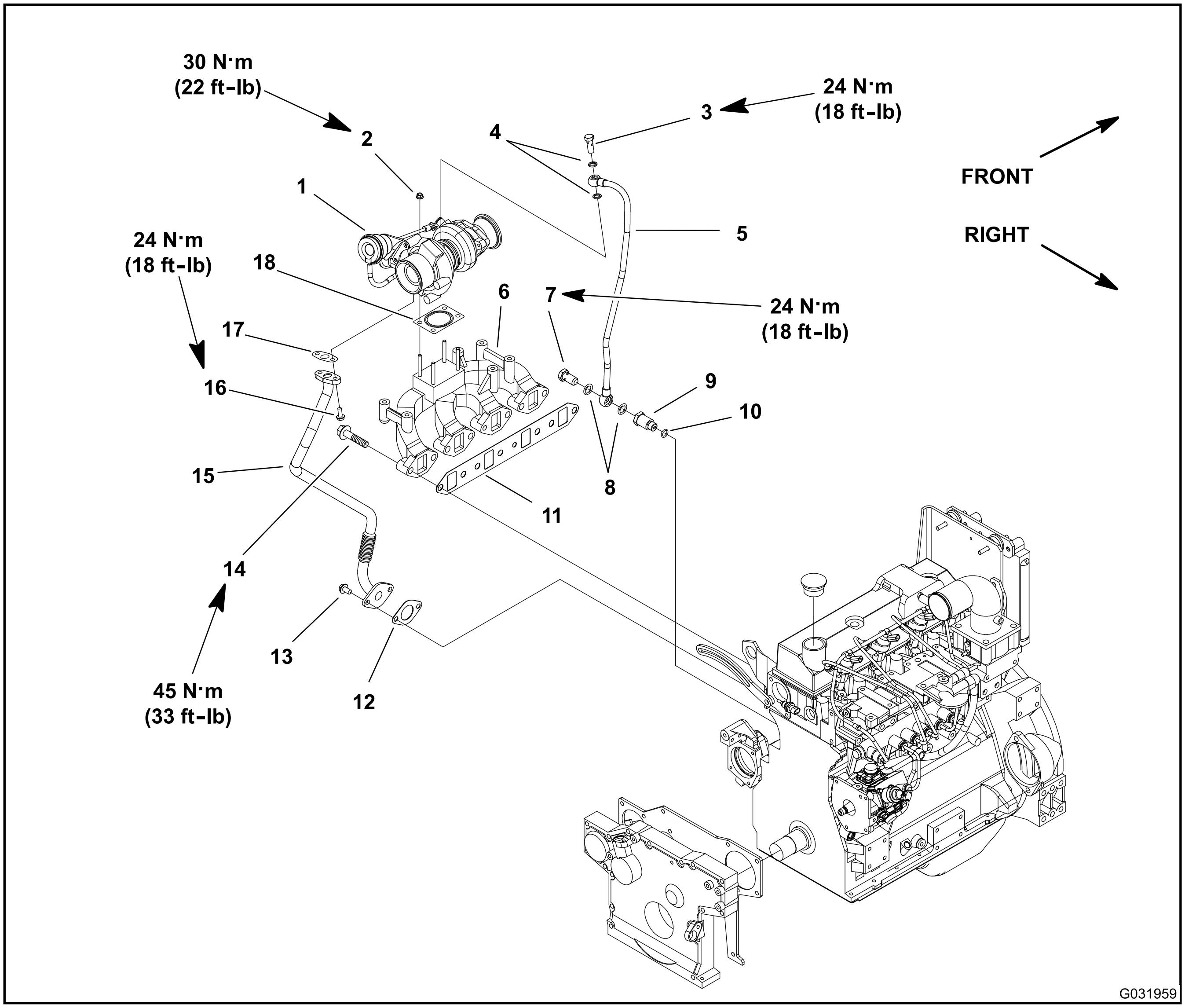
Installing the Exhaust System (continued)

Note: Ensure that all of the sealing surfaces of the exhaust system are free of unwanted material or damage that can prevent a tight seal.

1. Remove all of the covers and plugs that you placed while removing the exhaust system.
2. If the exhaust manifold was removed, install it onto the engine (Figure 15):
   A. Apply anti-seize lubricant to the threads of the 8 flange-head screws that are attached to the exhaust manifold.
   B. Align the new manifold gasket and exhaust manifold to the cylinder head and assemble the gasket and manifold to the head with the 8 flange-head screws.
   C. Tighten the flange-head screws in the sequence as shown in Figure 16; torque the flange-head screws to **45 N·m (33 ft-lb)**.
   D. Install the turbocharger to the exhaust manifold; refer to Installing the Turbocharger (page 3–15).
3. Install the muffler and/or exhaust tube to the engine; torque the exhaust clamp (item 1 in Figure 14) to **5.7 to 7.9 N·m (50 to 70 in-lb)**.
4. After you complete the exhaust system assembly, check that the tailpipe is aligned approximately parallel to the ground.

   Note: If necessary, loosen the clamp and adjust the tailpipe.
5. Install and attach the side panel to the right side of the frame.
6. Lower the hood and secure it.

Turbocharger



g031959

Figure 17

1. Turbocharger assembly
2. Flange nut (4 each)
3. Banjo bolt
4. Sealing washer
5. Oil supply tube
6. Exhaust manifold
7. Banjo bolt
8. Sealing washer
9. Coupling
10. O-ring
11. Exhaust manifold gasket
12. Gasket
13. Flange-head screw (2 each)
14. Flange-head screw (8 each)
15. Oil drain tube
16. Flange-head screw (2 each)
17. Gasket
18. Turbocharger gasket

Removing the Turbocharger

CAUTION

A hot engine and exhaust system can cause burns.

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

Removing the Turbocharger (continued)

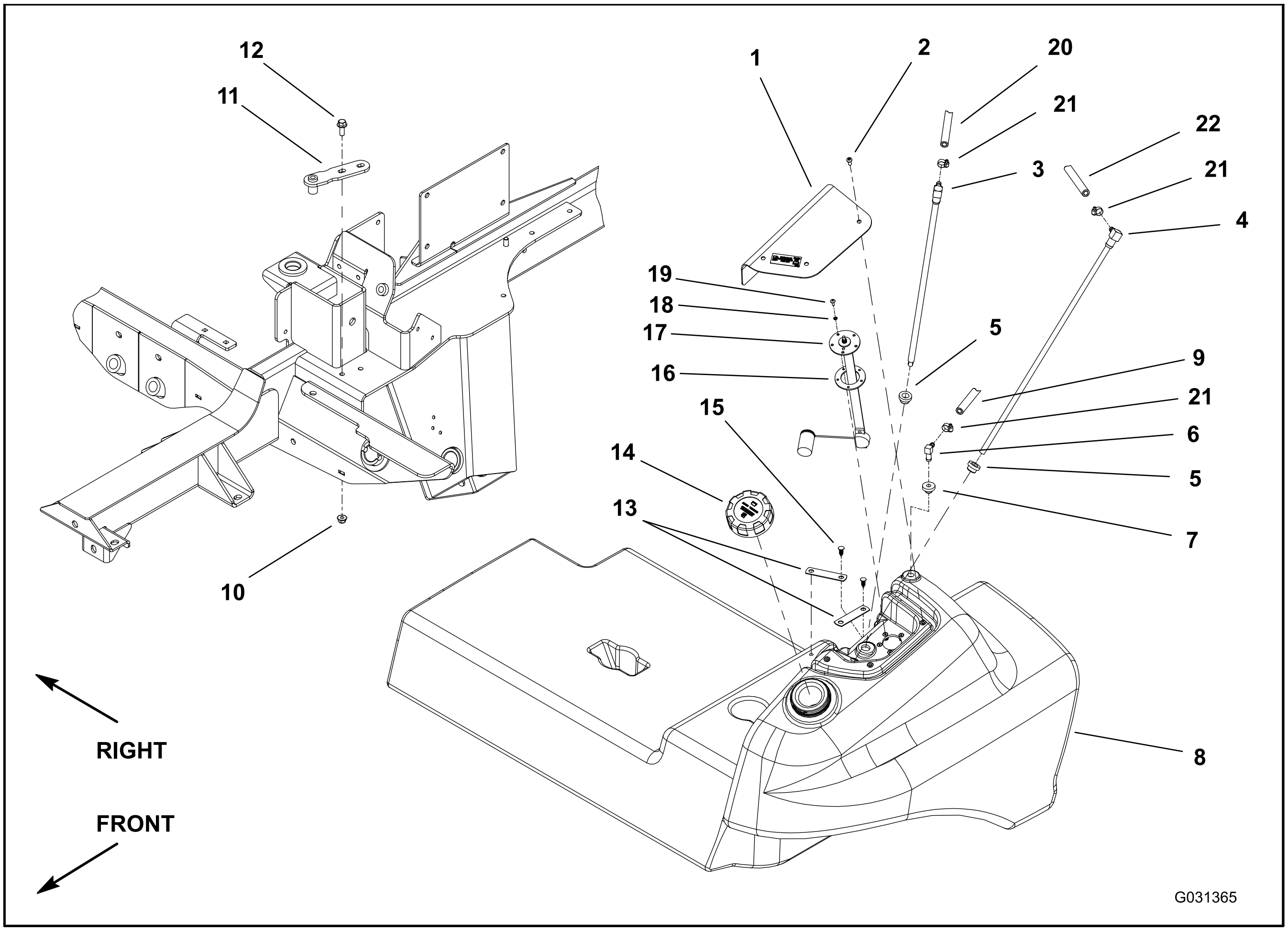
1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Clean the turbocharger area to prevent contaminants from entering into the engine.
4. Loosen the clamps that attach the exhaust tube to the turbocharger outlet and muffler inlet, and remove the exhaust tube.
5. Loosen the clamps that attach the air intake tube to the turbocharger inlet and air cleaner outlet, and remove the air intake tube.
6. Remove the 2 flange-head screws that attach the oil drain line to the turbocharger. Disconnect the oil drain line from the turbocharger.
7. Remove the banjo bolt that secures the oil supply line to the turbocharger. Disconnect the oil supply from the turbocharger.
8. Remove the 4 flange nuts that attach the turbocharger to the exhaust manifold.
9. Carefully lift the turbocharger from the exhaust manifold.
10. Put suitable covers on the engine, air cleaner, and turbocharger openings to prevent contaminants from entering into the openings. Also, insert plugs into the openings of the oil supply lines and drain lines.

Installing the Turbocharger

Note: Ensure that the sealing surfaces of the muffler flange and exhaust manifold are free of unwanted material or damage that can prevent a tight seal.

1. Install new gaskets if the old gaskets are damaged.
2. Remove all of the covers and plugs that you placed during the removal process.
3. Align the turbocharger with the exhaust manifold and attach it with the 4 flange nuts; torque the flange nuts to **30 N·m (22 ft-lb)**.
4. Align the oil drain line with the turbocharger and assemble the line to the turbocharger with the 2 flange-head screws; torque the flange-head screws to **24 N·m (18 ft-lb)**.
5. Fill the oil supply line port with clean engine oil to ensure that the turbocharger is lubricated on start-up.
6. Align the oil supply line with the turbocharger and attach it with the banjo bolt; torque the banjo bolt to **24 N·m (18 ft-lb)**.
7. Install the air intake tube to the turbocharger inlet and air cleaner outlet. Secure the intake tube with the clamps.
8. Install the exhaust tube to the turbocharger outlet and muffler inlet. Secure the exhaust tube with the clamps.
9. Lower the hood and secure it.

Fuel Tank



g031365

Figure 18

1. Fitting cover
2. Socket-head screw (3 each)
3. Fuel supply standpipe
4. Fuel return standpipe
5. Bushing (2 each)
6. Vent elbow fitting
7. Bushing
8. Fuel tank
9. Fuel hose (2 each)
10. Flange nut (2 each)
11. Tank hold-down
12. Flange-head screw (2 each)
13. Clamp (2 each)
14. Cap
15. Plug (4 each)
16. Gasket
17. Fuel sender
18. Lock washer (5 each)
19. Screw (5 each)
20. Fuel hose
21. Worm clamp (3 each)
22. Fuel hose

DANGER

Diesel fuel is highly flammable and explosive. A fire or explosion from fuel can burn you and others and can damage property.

- **Use caution whenever you store or handle diesel fuel.**
- **Do not smoke while filling the fuel tank.**
- **Do not fill the fuel tank while the engine is running, hot, or when the machine is in an enclosed area.**
- **Always fill the fuel tank outside 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 maintenance intervals recommended in the *Operator's Manual*. Check the lines for deterioration, damage, leaks, or loose connections. Replace the hoses, clamps, and connections as necessary.

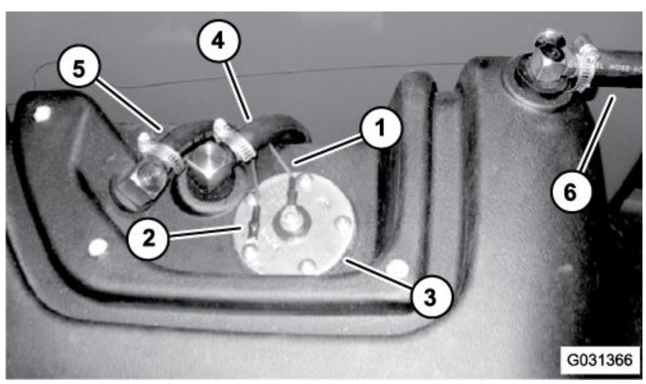
Draining and Cleaning the Fuel Tank

Drain and clean the fuel tank at the maintenance intervals recommended in the *Operator's Manual*. If the fuel system becomes dirty or if the machine is stored for an extended period, drain and clean the fuel tank.

To clean the fuel tank, flush the tank out with clean diesel fuel. Ensure that the fuel tank is free of contamination and unwanted material.

Removing the Fuel Tank

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the rear wheels with chocks and lift the front of the machine with a jack. Support the machine with jack stands.
3. Remove the front left wheel in order to remove the fuel tank.
4. Transfer the fuel from the fuel tank with a fuel transfer pump into a suitable container.



g031366

Figure 19

1. Sender power wire
2. Sender ground wire
3. Fuel sender
4. Fuel supply hose
5. Return fuel hose
6. Vent hose

Removing the Fuel Tank (continued)

5. Remove the 3 socket-head screws that attach the fitting cover (item 1 in Figure 18) to the fuel tank, and remove the fitting cover (item 1 in Figure 18) from the fuel tank.
6. Disconnect the sender power wire (blue/red) and sender ground wire (black) from the fuel sender in the fuel tank (items 1 and 2 in Figure 19).
7. Label the fuel hoses to ensure that the hoses are correctly assembled.
8. Disconnect the fuel hoses from the fuel-supply standpipe (item 3 in Figure 18), return standpipe (item 4 in Figure 18), and vent-elbow fitting (item 6 in Figure 18) at the top of the fuel tank (Figure 19).
9. Remove the fuel lines from under the clamps (item 13 in Figure 18) that support the fuel lines adjacent to the standpipes.

   Note: If necessary, remove the plugs and clamps from the top of the tank.
10. Remove the 2 flange-head screws and 2 flange nuts that attach the tank hold-down (item 11 in Figure 18) to the frame, and remove the tank hold-down.
11. Slide the fuel tank out from the left side of the machine and remove the tank.

   Note: If necessary, remove the standpipes, elbow bushings, and fuel sender from the tank.

Installing the Fuel Tank

1. If the standpipes, elbow bushings, and fuel sender were removed from the fuel tank, install the standpipes, bushings, and sender into the tank.
2. Slide the fuel tank inward from the left side of the machine (Figure 18).
3. Align the tank hold-down (item 11 in Figure 18) to the fuel tank and frame of the machine.
4. Assemble the tank hold-down to the fuel tank and machine frame with the 2 flange-head screws and 2 flange nuts.
5. Route the fuel-supply and fuel-return hoses under the clamps at the top of the tank.
6. Assemble the fuel-supply hoses onto the fuel-supply standpipe, fuel-return hoses onto the return standpipe, and vent hose onto the vent-elbow fitting that you marked.
7. Install the hose clamps onto the hoses and tighten the clamps by hand.
8. Connect the electrical wiring to the fuel sender as follows:

   A. Connect the blue/red wire to the center terminal of the fuel sender (Figure 18).

   B. Connect the black wire to any screw that secures the fuel sender to the fuel tank

   C. Apply battery terminal protector (Toro Part No. 107-0392) to the wire terminal connections for corrosion protection.
9. Align the fitting cover to the fuel tank and attach the cover to the tank with the 3 socket-head screws (Figure 18).

Installing the Fuel Tank (continued)

WARNING

Failure to maintain proper torque could result in failure or loss of the wheel and may result in personal injury.

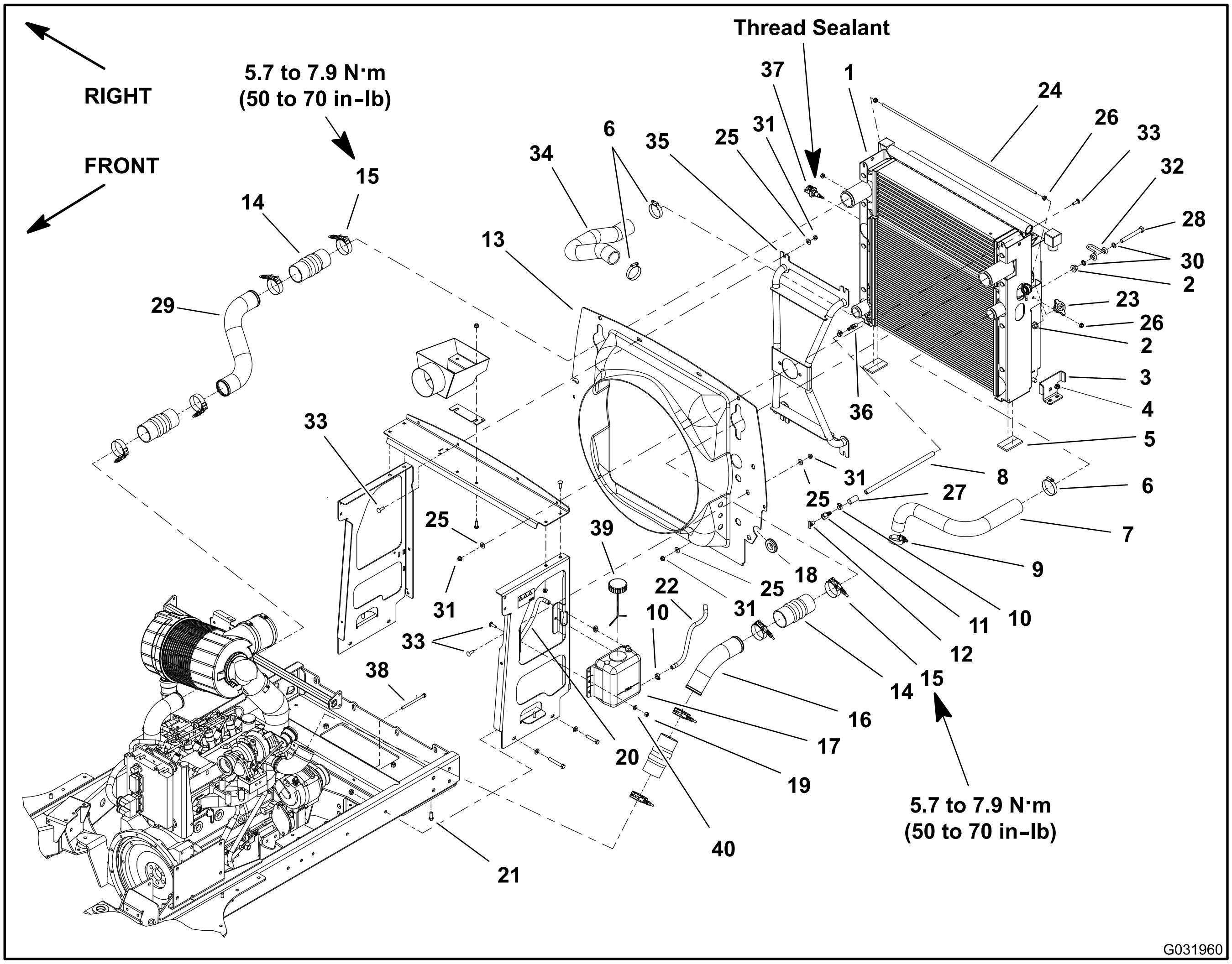
Maintain the proper torque of the wheel lug nuts.

10. Install the front left wheel assembly onto the machine, and tighten the wheel lug nuts by hand.

11. Remove the jack stands and lower the machine to the ground. Torque the wheel lug nuts to **95 to 122 N·m (70 to 90 ft-lb)** in a crossing pattern.

12. Fill the tank with fuel.

Radiator



g031960

Figure 20

1. Radiator assembly	11. Barb fitting	21. Bolt (4 each)	31. Flange nut (14 each)
2. Flange nut (4 each)	12. Drain cock fitting	22. Reservoir hose	32. Clamp (2 each)
3. Support plate (2 each)	13. Fan shroud	23. Radiator cap	33. Carriage screw (14 each)
4. Flange nut (4 each)	14. Air intake tube (4 each)	24. Support rod	34. Lower radiator hose
5. Rubber pad (4 each)	15. Hose clamp (8 each)	25. Flat washer (10 each)	35. Fan motor bracket
6. Hose clamp (3 each)	16. Tube	26. Flange nut (4 each)	36. Fitting
7. Upper radiator hose	17. Coolant reservoir	27. Hose sleeve	37. Coolant level sensor
8. Overflow hose	18. Grommet (2 each)	28. Bolt (2 each)	38. Bolt (2 each)
9. Hose clamp	19. Locknut (2 each)	29. Tube	39. Reservoir cap
10. Worm clamp (5 each)	20. Hose	30. Washer (4 each)	40. Flat washer (2 each)

Removing the Radiator

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the radiator.
3. Rotate the clamps that attach the oil cooler to the radiator frame. Tilt the oil cooler to the rear of the machine.

Removing the Radiator (continued)

4. Loosen the hose clamps and disconnect the air intake tubes (item 14 in Figure 20) from the charge air cooler.
5. Disconnect the wire harness connector from the coolant level sensor at the right side of the radiator.

WARNING

Ethylene-glycol antifreeze is poisonous.

Discard the coolant correctly.

Keep the coolant in a correctly labeled container.

Keep coolant away from children and pets.

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 radiator when the coolant is hot.

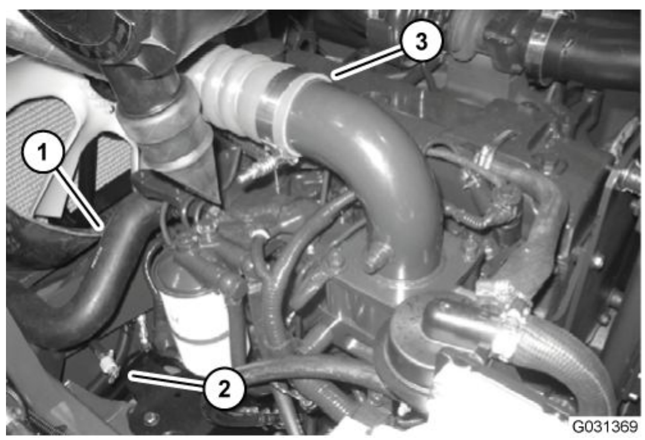


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Figure 21

1. Radiator hose
2. Radiator drain
3. Air intake tube

Removing the Radiator (continued)

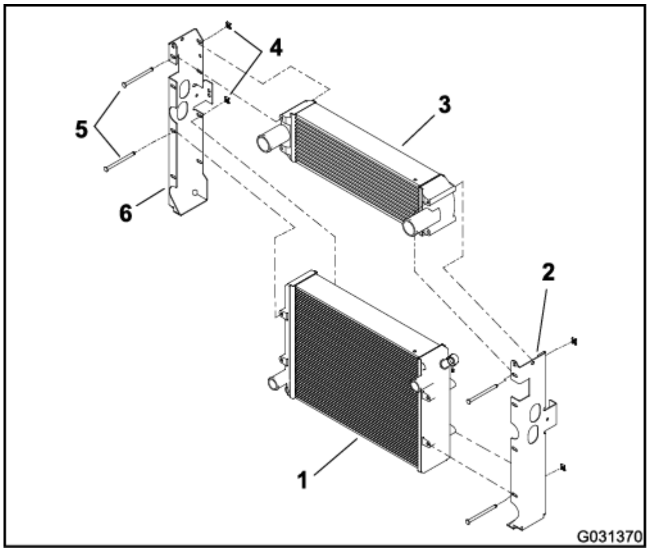

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Figure 22

1. Radiator
2. Left cooler bracket
3. Charge air cooler
4. Pin clip (8 each)
5. Pin (8 each)
6. Right cooler bracket

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6. Open the drain cock fitting and drain the radiator into a suitable container. The drain cock fitting is located near the hydraulic 4-wheel drive manifold (Figure 21).
7. Loosen the hose clamps and disconnect the upper and lower coolant hoses (item 6 in Figure 20) from the radiator.
8. Loosen the hose clamp that secures the coolant drain hose to the fitting (item 36 in Figure 20) at the bottom of the radiator, and remove the coolant drain hose assembly from the radiator.
9. Disconnect the reservoir hose (item 22 in Figure 20) from the radiator vent tube.
10. Remove the 2 carriage screws (item 33 in Figure 20), 2 flat washers, and 2 flange nuts that secure the radiator to the fan shroud and support.
11. Tilt the radiator and charge air cooler assembly to the rear of the machine and carefully lift the radiator and cooler assembly from the machine.
12. Cover or plug the radiator and hose openings to prevent contamination.
13. Examine the rubber pads (item 5 in Figure 20) at the bottom of the radiator.

    Note: Replace the pads if they are worn or damaged.
14. Disassemble the radiator and charge air cooler assembly as shown in Figure 22.

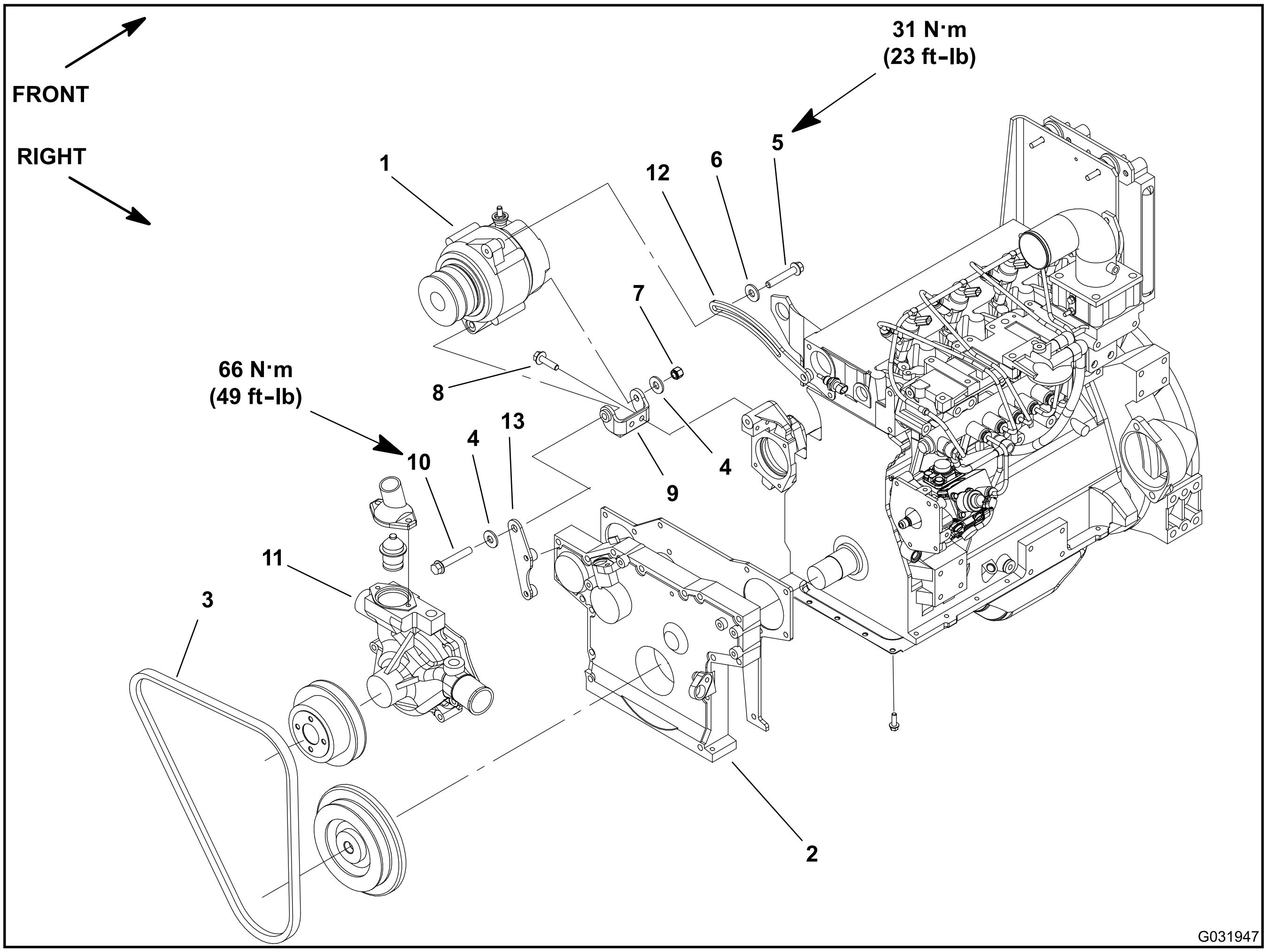
Installing the Radiator

1. Assemble the radiator and charge air cooler assembly as shown in Figure 22.

    Note: Apply thread sealant to the coolant level sensor if the coolant level sensor is removed.
2. Remove the covers and plugs from the radiator and hoses that you placed while removing the radiator.
3. Carefully lower the radiator and charge air cooler assembly into the machine.

4. Assemble the radiator to the fan shroud and support with the 2 carriage screws, 2 flat washers, and 2 flange nuts.
5. Connect the upper and lower radiator hoses to the radiator; attach the hoses with hose clamps (item 6 in Figure 20).
6. Connect the air intake tubes (item 14 in Figure 20) to the charge air cooler, and attach them with the hose clamps.
7. Connect the wire harness connector to the coolant level sensor at the right side of the radiator.
8. Install the coolant drain hose assembly to the radiator fitting and secure the drain hose with a hose clamp.
9. Connect the reservoir hose (item 22 in Figure 20) to the radiator vent tube and secure the hose with a hose clamp.
10. Close the drain cock fitting. Fill the radiator with coolant.
11. Assemble the oil cooler to the radiator frame.
12. Operate the engine and check for coolant leaks.
13. Lower the hood and secure it.

Alternator



g031947

Figure 23

1. Alternator
2. Front cover
3. Belt
4. Bevel washer (2 each)
5. Flange-head screw
6. Flat washer
7. Hex nut
8. Flange-head screw (2 each)
9. Alternator bracket
10. Bolt
11. Water pump
12. Adjusting bracket
13. Alternator bracket

Removing the Alternator

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Remove the battery access panel; refer to Removing and Installing the Battery (page 5–103).
4. Disconnect the negative battery cable.
5. Disconnect the positive battery cable.
6. Loosen the flange-head screw (items 5 in Figure 23) that secures the alternator to the adjusting bracket.
7. Rotate the alternator toward the engine to loosen the drive belt, and remove the belt from the alternator pulley.
8. Examine the drive belt for glazing or damage.

Removing the Alternator (continued)

Note: Replace the belt, if necessary.

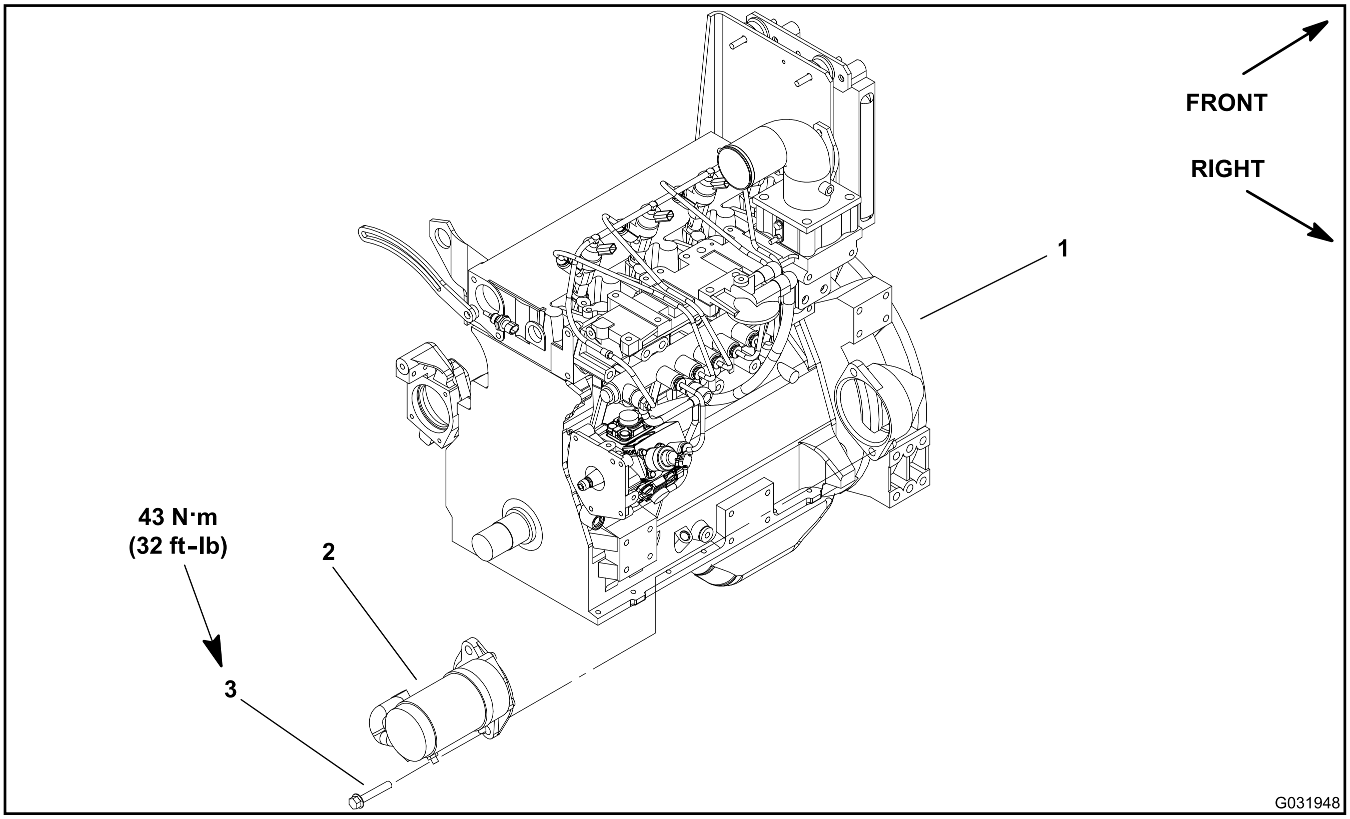
9. For assembly purposes, label all the wires that connect to the alternator. Disconnect the wires from the alternator terminals and keep the wires away from the alternator.
10. Support the alternator to prevent the alternator from shifting or falling.
11. Remove the flange-head screw and flat washer that attach the alternator to the adjusting bracket (item 12 in Figure 23).
12. Remove the bolt, 2 bevel washers, and hex nut that attach the alternator to the alternator brackets (items 9 and 13 in Figure 23).
13. Carefully remove the alternator from the engine and machine.

Installing the Alternator

1. Align the alternator with the engine brackets.
2. Attach the alternator to the alternator brackets and adjusting bracket with the screw, bolt, nut, and washers.

   Note: Do not fully tighten the fasteners.
3. Align the drive belt onto the alternator pulley. Rotate the alternator away from the engine to properly tension the drive belt.
4. Tighten the bolt, nut, and flange-head screw to secure the alternator. Torque the bolt at the mounting bracket (item 10 in Figure 23) to **66 N·m (49 ft-lb)**. Torque the flange-head screw at the adjusting bracket (item 5 in Figure 23) to **31 N·m (23 ft-lb)**.
5. Use the labels that you attached while removing the alternator to correctly connect the wires to the starter terminals.
6. Install the battery access panel; refer to Removing and Installing the Battery (page 5–103).
7. Connect the positive battery cable to the positive battery terminal.
8. Connect the negative battery cable to the negative battery terminal.
9. Lower the hood and secure it.

Starter Motor

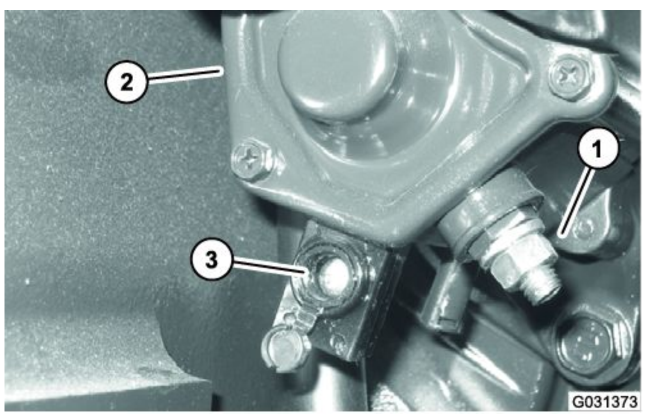


g031948

Figure 24

1. Engine
2. Starter motor
3. Flange-head screw (2 each)

Removing the Starter Motor



g031373

Figure 25

1. Starter stud
2. Starter solenoid
3. Screw

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Remove the battery access panel; refer to Removing and Installing the Battery (page 5–103).
4. Disconnect the negative battery cable.

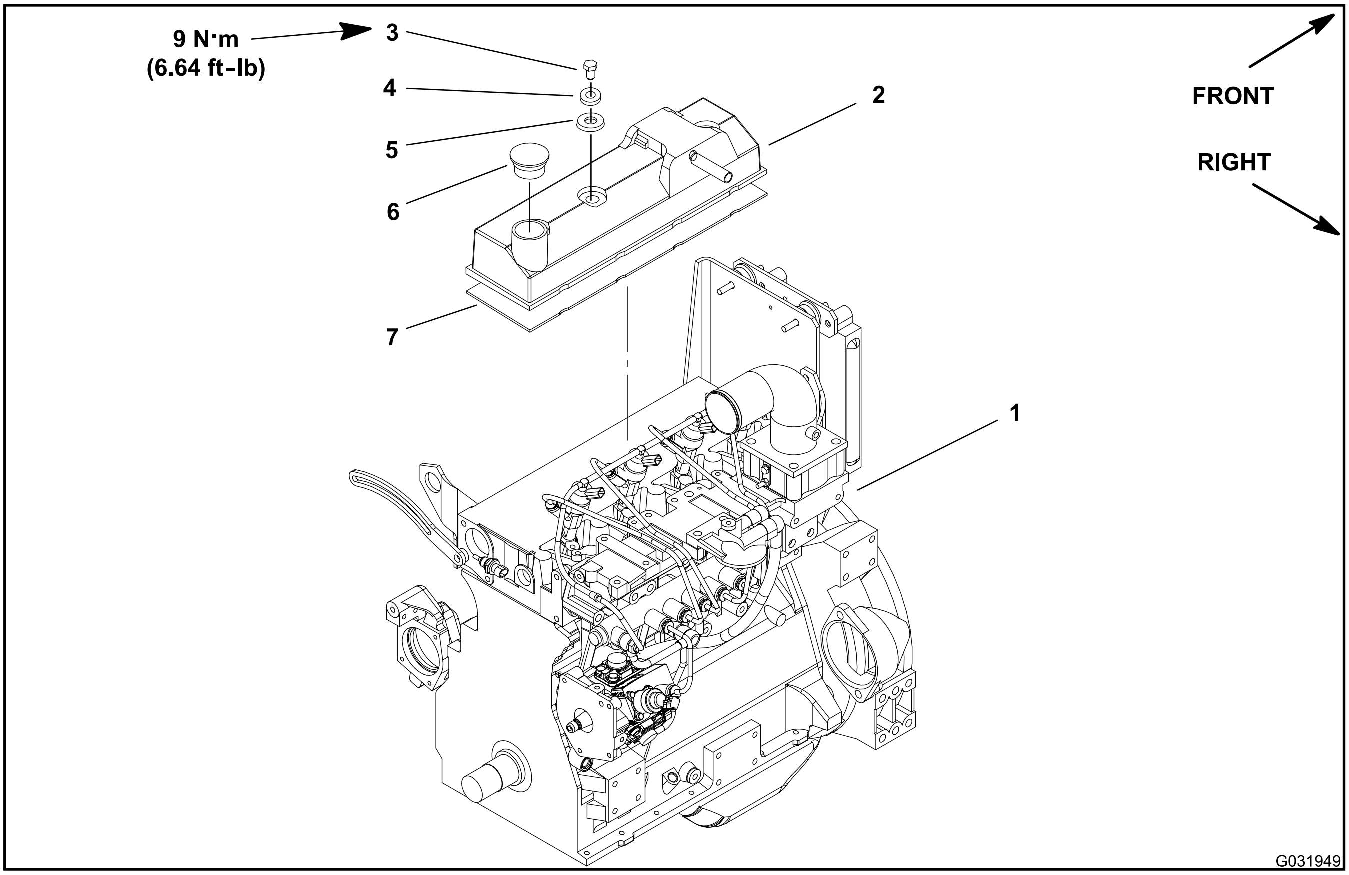
Removing the Starter Motor (continued)

5. Disconnect the positive battery cable.
6. Label all the wires that connect to the starter. Disconnect the wires from the starter terminals and position them away from starter; refer to Figure 25.
   A. Remove the nut and lock washer that attach the cable to the starter stud, and remove the cable from the starter stud.
   B. Loosen the screw used to attach the blue wire of the harness to the starter solenoid, and disconnect the wire from the starter.
7. Support the starter to prevent the starter from shifting or falling.
8. Remove the 2 flange-head screws that attach the starter to the engine.
9. Carefully remove the starter from the engine and machine.

Installing the Starter Motor

1. Align the starter with the engine housing.
2. Assemble the starter to the engine with the 2 flange-head screws; torque the screws to **43 N·m (32 ft-lb)**.
3. Use the labels that you attached while removing the starter motor to correctly connect the wires to the starter terminals.
4. Install the battery access panel; refer to Removing and Installing the Battery (page 5–103).
5. Connect the positive battery cable to the positive battery terminal.
6. Connect the negative battery cable to the negative battery terminal.
7. Lower the hood and secure it.

Valve Cover



g031949

Figure 26

1. Engine
2. Valve cover
3. Locknut (3 each)
4. Flat washer (3 each)
5. Isolation washer (3 each)
6. Oil fill cap
7. Valve cover gasket

Removing the Valve Cover

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Clean the valve cover and cylinder head to prevent contaminants from entering into the engine.
4. Remove the crankcase breather tube from the valve cover; refer to Removing the Engine Breather System (page 3–30).
5. Remove the 3 locknuts, 3 flat washers, and 3 isolator washers that secure the valve cover to the cylinder head.
6. Remove the valve cover from the cylinder head.
7. Remove and discard the valve cover gasket.

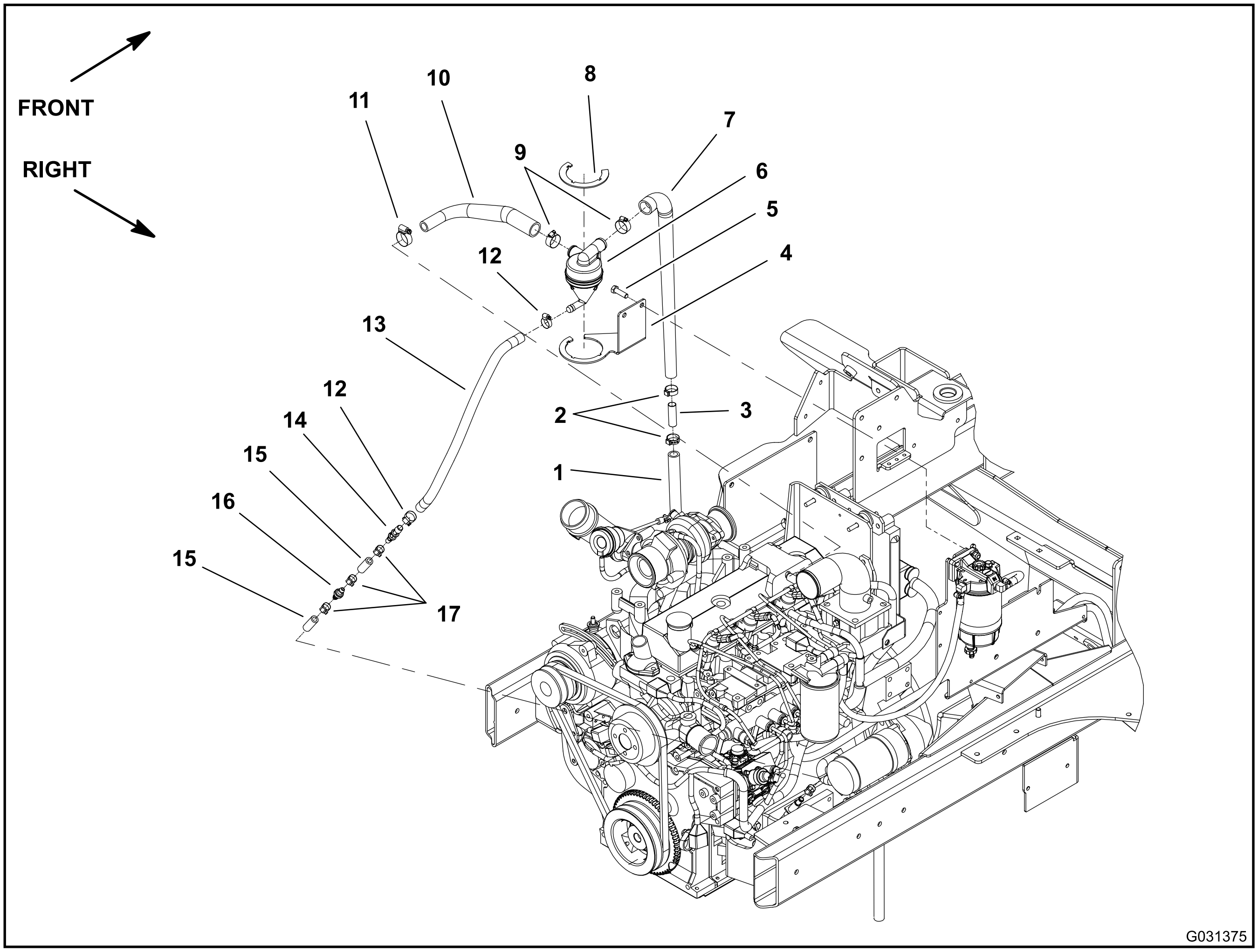
Installing the Valve Cover

1. Align new gasket and valve cover to the cylinder head.
2. Attach the valve cover to the cylinder head with the 3 isolator washers, 3 flat washers, and 3 locknuts; torque the locknuts to **9 N·m (80 in-lb)**.

Installing the Valve Cover (continued)

3. Connect the crankcase breather tube to the valve cover and secure the hose with a hose clamp; refer to Installing the Engine Breather System (page 3–31).
4. Add the specified oil into the crankcase of the engine until the oil level is correct.
5. Lower the hood and secure it.

Engine Breather System



g031375

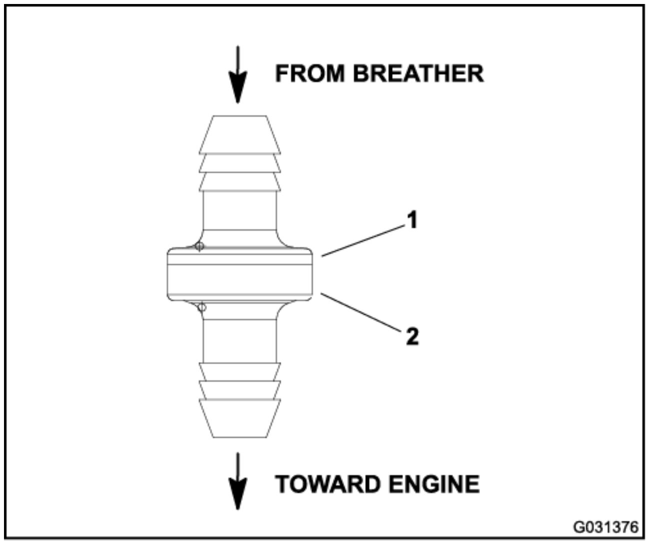
Figure 27

1. Hose
2. Hose clamp
3. Spacer
4. Breather mount plate
5. Bolt (2 each)
6. Breather
7. Breather outlet hose
8. Latch plate
9. Hose clamp
10. Breather inlet hose
11. Hose clamp
12. Hose clamp
13. Breather hose
14. Hose barb
15. Hose
16. Check valve
17. Worm clamp

Removing the Engine Breather System

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Clean the breather components before removing the parts to prevent contaminants from entering into the breather system.
4. Remove the breather components as shown in Figure 27.

Installing the Engine Breather System



g031376

Figure 28

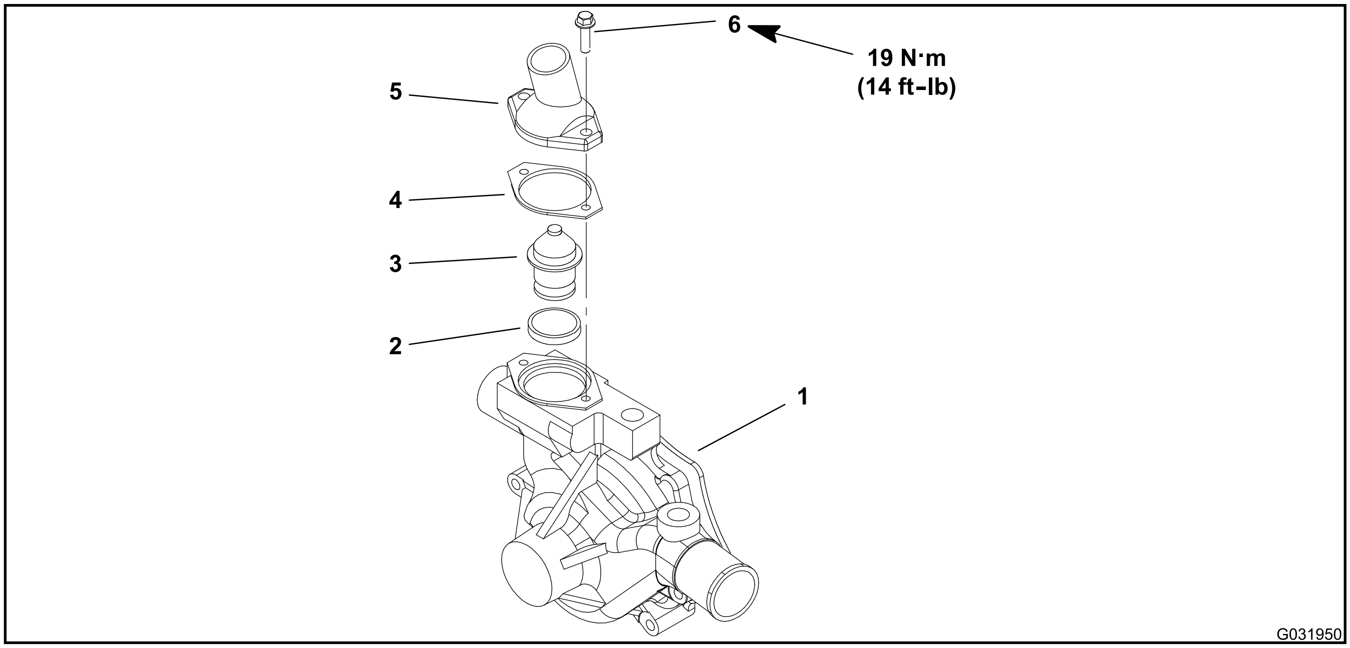
1. Base (gray)
2. Cover (black)

1. Install the breather components, refer to Figure 27.

   Note: If the check valve (item 16 in Figure 27) is removed, ensure that it is installed with the black side toward the engine oil pan; refer to Figure 28.

2. Lower the hood and secure it.

Thermostat



g031950

Figure 29

1. Water pump
2. Seal
3. Thermostat
4. Gasket
5. Thermostat housing
6. Flange-head screw (2 each)

Removing the Thermostat

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.

WARNING

Ethylene-glycol antifreeze is poisonous.

Discard the coolant correctly.

Keep the coolant in a correctly labeled container.

Keep coolant away from children and pets.

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 radiator when the coolant is hot.

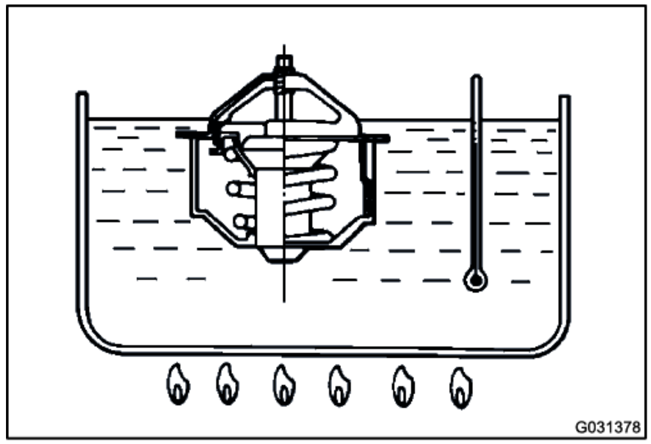
3. Drain the coolant from the radiator and engine; refer to Removing the Radiator (page 3–20).
4. Remove the upper coolant hose from the thermostat housing.

Removing the Thermostat (continued)

5. Remove the 2 flange-head screws that attach the thermostat housing to the water pump, and remove the thermostat housing.
6. Remove the thermostat and seal from the water pump housing.
7. Clean the gasket surfaces of the pump and thermostat housing.
8. Inspect the thermostat sealing areas in the pump housing. Clean the sealing surfaces if there is corrosion or contamination.

Testing the Thermostat

1. Remove the thermostat; refer to Water Pump (page 3–34) and Thermostat (page 3–32).



g031378

Figure 30

2. Hang the thermostat and a thermometer in a container of water; refer to Figure 30.

   Note: For accurate test results, do not allow the thermostat or thermometer to touch the container.

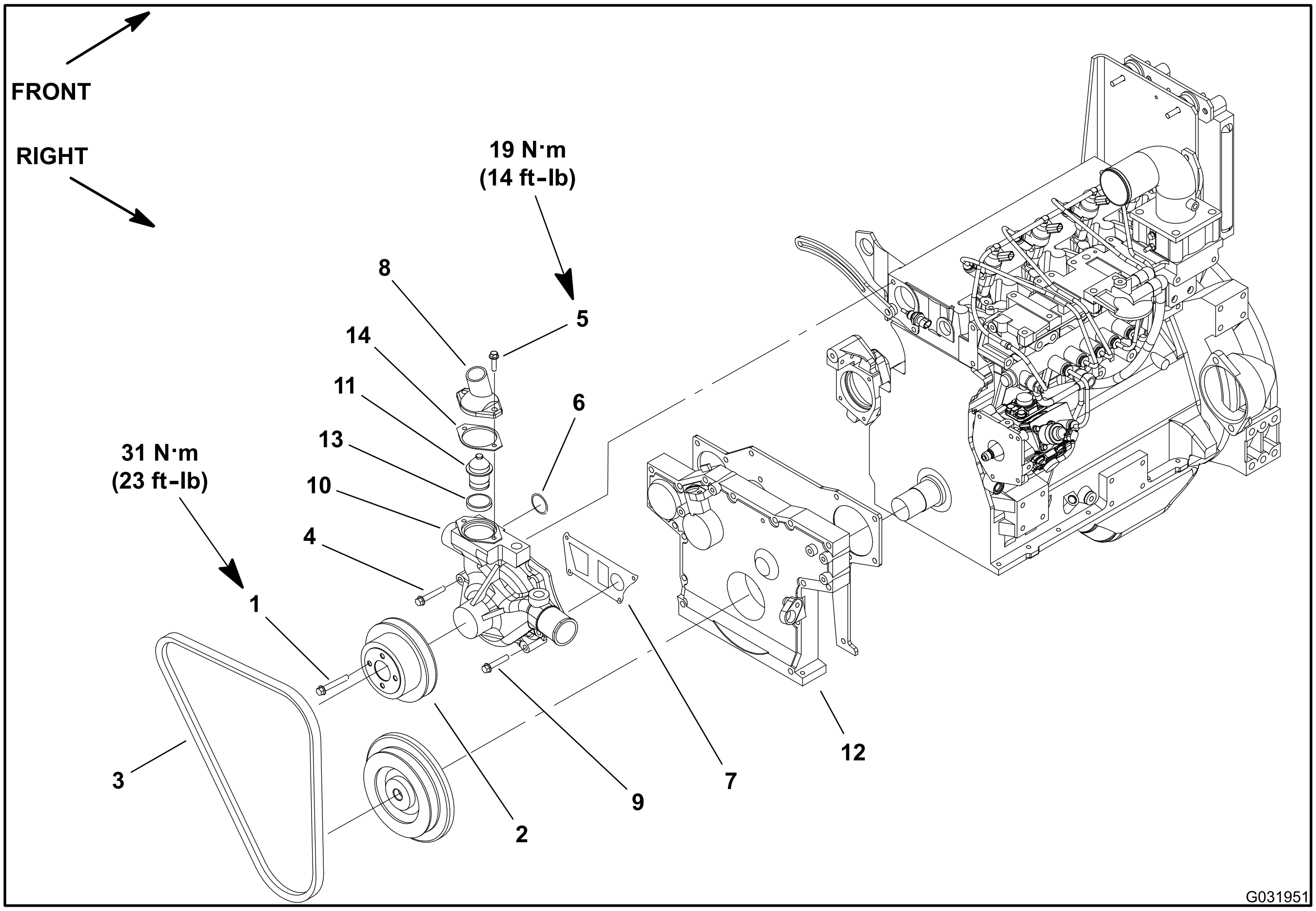
3. Slowly heat the water and stir the water to maintain the uniform water temperature. Note and record the temperature for the following:
   - The thermostat should start to open at 82°C (180°F).
   - The thermostat should fully open to 8 mm (0.315 inch) lift at 95°C (203°F).

   Note: Replace the thermostat, when it is not opening fully, partially, or freely.

Installing the Thermostat

1. Install the seal and thermostat into the water pump housing.
2. Align the thermostat gasket and housing to the water pump housing. Assemble the thermostat housing to the water pump with the 2 flange-head screws; torque the screws to **19 N·m (14 ft-lb)**.
3. Install the upper coolant hose to the thermostat housing and secure the hose with a hose clamp.
4. Fill the cooling system with coolant.
5. Run the engine and check for any coolant leaks.
6. Lower the hood and secure it.

Water Pump



g031951

Figure 31

1.	Flange-head screw (4 each)	6.	O-ring	11.	Thermostat
2.	Water pump pulley	7.	Gasket	12.	Front cover
3.	Belt	8.	Thermostat housing	13.	Seal
4.	Flange-head screw	9.	Flange-head screw (3 each)	14.	Gasket
5.	Flange-head screw (2 each)	10.	Water pump		

Removing the Water Pump

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.

WARNING

Ethylene-glycol antifreeze is poisonous.

Discard the coolant correctly.

Keep the coolant in a correctly labeled container.

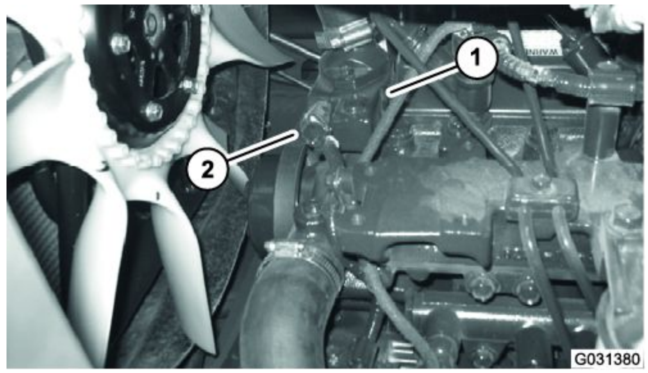
Keep coolant away from children and pets.

Removing the Water Pump (continued)

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 radiator when the coolant is hot.



g031380

Figure 32

1. Water pump
2. Temperature sensor

3. Drain the coolant from the radiator and engine; refer to Removing the Radiator (page 3–20).
4. Disconnect the wire harness connector from the temperature sensor at the water pump housing; refer to Figure 32.
5. Remove the upper and lower radiator hoses from the water pump.
6. On the Groundsmaster 5910 machine:
   A. Remove the cab heater hoses from the water pump.
   B. Remove the air conditioning compressor drive belt.
7. Remove the alternator and drive belt from the engine; refer to Removing the Alternator (page 3–24).
8. Remove the flange-head screws that attach the water pump to the engine.
9. Carefully remove the water pump from the engine.
10. Remove and discard the O-ring and gasket that are installed between the water pump and the engine.
11. If necessary, remove the thermostat from the water pump; refer to Removing the Thermostat (page 3–32).
12. If necessary, remove the pulley from the water pump as follows:
    A. Remove the 4 flange-head screws that attach the pulley to the pump shaft.
    B. Separate the pulley from the pump shaft.

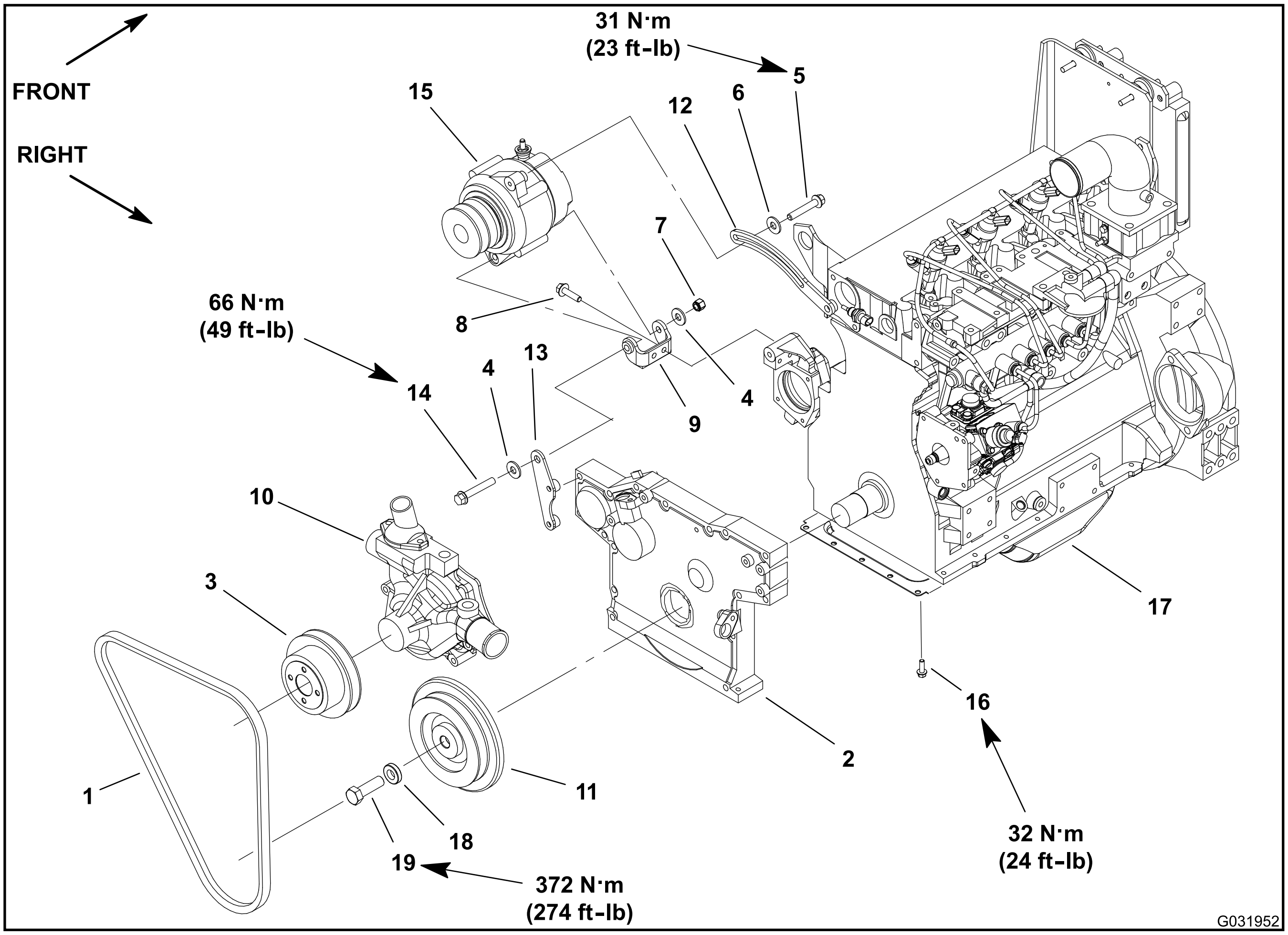
Installing the Water Pump

1. Clean the gasket surfaces on the engine, water pump, and thermostat housing.
2. Insert new O-ring and gasket into the water pump housing.

Installing the Water Pump (continued)

3. Align the water pump to the engine and secure the pump to the engine with the flange-head screws.
4. If the pulley was removed, assemble the pulley to the water pump shaft with the 4 flange-head screws. Torque the flange-head screws to **31 N·m (23 ft-lb)**.
5. If the thermostat was removed, install the thermostat to the water pump; refer to Installing the Thermostat (page 3–33).
6. Install the upper and lower radiator hoses to the water pump, and secure the hoses with hose clamps.
7. On the Groundsmaster 5910 machine:
   A. Install the cab heater hoses to the water pump.
   B. Install and adjust the air conditioning compressor drive belt.
8. Connect the wire harness connector to the temperature sensor at the water pump; refer to Figure 32.
9. Install the alternator and drive belt to the engine; refer to Installing the Alternator (page 3–25).
10. Adjust the drive belt alignment and tension.
11. Fill the cooling system with coolant.
12. Run the engine and check for any coolant leaks.
13. Lower the hood and secure it.

Front Cover



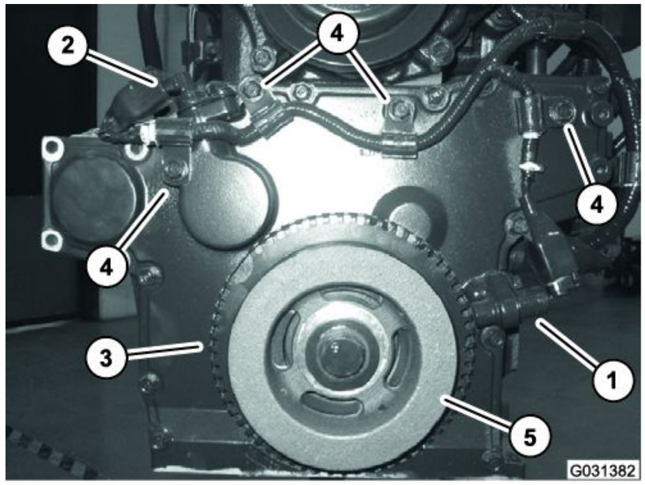
g031952

Figure 33

1. Belt
2. Front cover
3. Water pump pulley
4. Bevel washer (2 each)
5. Flange-head screw
6. Flat washer
7. Hex nut
8. Flange-head screw (2 each)
9. Alternator bracket
10. Water pump assembly
11. Crankshaft pulley with tone wheel
12. Adjusting bracket
13. Alternator bracket
14. Bolt
15. Alternator
16. Flange-head screw
17. Oil pan
18. Mounting plate
19. Bolt

Removing the Front Cover

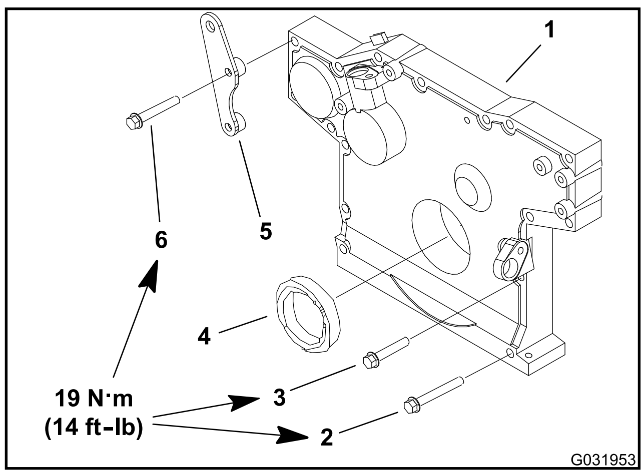
1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Loosen the bolt that attach the alternator to the alternator brackets.
4. Rotate the alternator toward the engine to loosen the drive belt, and remove the belt from the machine.
5. On the Groundsmaster 5910 machine, remove the air conditioning compressor drive belt.



g031382

Figure 34

1. Crankshaft-position sensor
2. Camshaft-position sensor
3. Tone wheel
4. Harness clamp
5. Crankshaft pulley



g031953

Figure 35

1. Front cover
2. Flange-head screw
3. Flange-head screw
4. Oil seal
5. Alternator bracket
6. Flange-head screw

6. Remove the electrical components from the front cover (Figure 34) as follows:
   A. Remove the screws that attach the electrical harness clamps to the front cover.
   B. Remove the screws that attach the crankshaft-position sensor and camshaft-position sensor to the front cover.
   C. Carefully remove the 2 sensors from the front cover.

      Note: Inspect the O-rings on the sensors and replace them if necessary.

   D. Position the wire harness and sensors away from the front cover.
7. Remove the 5 flange-head screws that attach the oil pan to the front cover; refer to Removing the Oil Pan (page 3–41).

Removing the Front Cover (continued)

8. Remove the locknut and thrust washer that attach the rear axle pivot shaft to the frame.
9. Slide the pivot shaft toward the rear of the machine to give the clearance to remove the engine pulley bolt; refer to Removing the Rear Axle (page 6–27).
10. Remove the crankshaft pulley (Figure 34).

IMPORTANT

When removing the crankshaft pulley, ensure that you do not damage the tone wheel that is attached to the rear side of the pulley.

Note: Use an appropriate holding tool to prevent the pulley and crankshaft from turning.

A. Separate and remove the bolt and mounting plate that attach the pulley to the crankshaft.

B. Separate the pulley from the crankshaft.

C. Locate and retrieve the woodruff key from the crankshaft.

11. Remove the 16 flange-head screws that attach the front cover to the engine; refer to Figure 35.

    Note: The 3 different lengths of the flange-head screws are used to attach the front cover. To assist with assembly, note the location of the screws while removing them.

12. Rotate the alternator bracket away from the front cover.
13. Carefully remove the front cover from the engine.
14. Remove the seal from the front cover.

    Note: Ensure that you do not damage the seal bore in the cover.

15. Clean all of the components after removing them, and remove all the sealants from the front cover sealing surfaces.
16. Inspect the crankshaft surface in the oil seal area for wear or damage. Repair or replace the crankshaft if necessary.

Installing the Front Cover

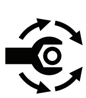
1. Ensure that the mounting surfaces on the engine, front cover, and oil pan are fully cleaned.
2. Fill 50% of the seal lip space with grease. Using the Cummins seal installer tool #3164900 (or equivalent) to install new oil seal into the front cover.
3. Apply the Cummins sealant #3164067 (or equivalent) to the front cover mounting surfaces.

   Note: Ensure that you apply sealant to all of the engine and oil pan mating surfaces.

4. Carefully install the front cover to the engine.

   Note: Ensure that you do not damage the oil seal during assembly.

5. Rotate the alternator bracket to the front cover.



6. Use the notes that you recorded during front cover removal to identify the correct location of the 3 lengths of flange-head screws. Assemble the front cover to the engine with the 16 flange-head screws; torque the screws to **19 N·m (14 ft-lb)**.

Installing the Front Cover (continued)

7. Attach the oil pan to the front cover with the 5 flange-head screws. Torque the screws to **19 N·m (14 ft-lb)**.
8. Install the crankshaft pulley:

IMPORTANT

When installing the crankshaft pulley, ensure that you do not damage the tone wheel that is attached to the rear side of the pulley.

   A. Insert the woodruff key into the crankshaft slot.

   B. Carefully slide the pulley onto the crankshaft.

   Note: Ensure that you do not damage the oil seal in the front cover. Ensure that the keyslot in the pulley is aligned with the woodruff key in the crankshaft.

   C. Install the mounting plate (item 18 in Figure 33) and bolt (item 19 in Figure 33) to the pulley and crankshaft; torque the bolt to **372 N·m (274 ft-lb)**.

   Note: Use an appropriate holding tool to prevent the pulley and crankshaft from turning.

9. Attach the electrical components to the front cover (Figure 34) as follows:

   A. Position the wire harness and sensors to the front cover.

   B. Apply a light film of clean oil to the O-rings of the crankshaft position sensor and camshaft position sensor. Carefully install the sensors into the front cover with the screws.

   C. Attach the electrical harness clamps to the front cover.

10. Attach the rear axle pivot shaft to the frame; refer to Removing the Rear Axle (page 6–27).

    A. Slide the axle pivot shaft toward the front of the machine.

    Note: Ensure that the roll pin on the pivot shaft is positioned in the frame reliefs.

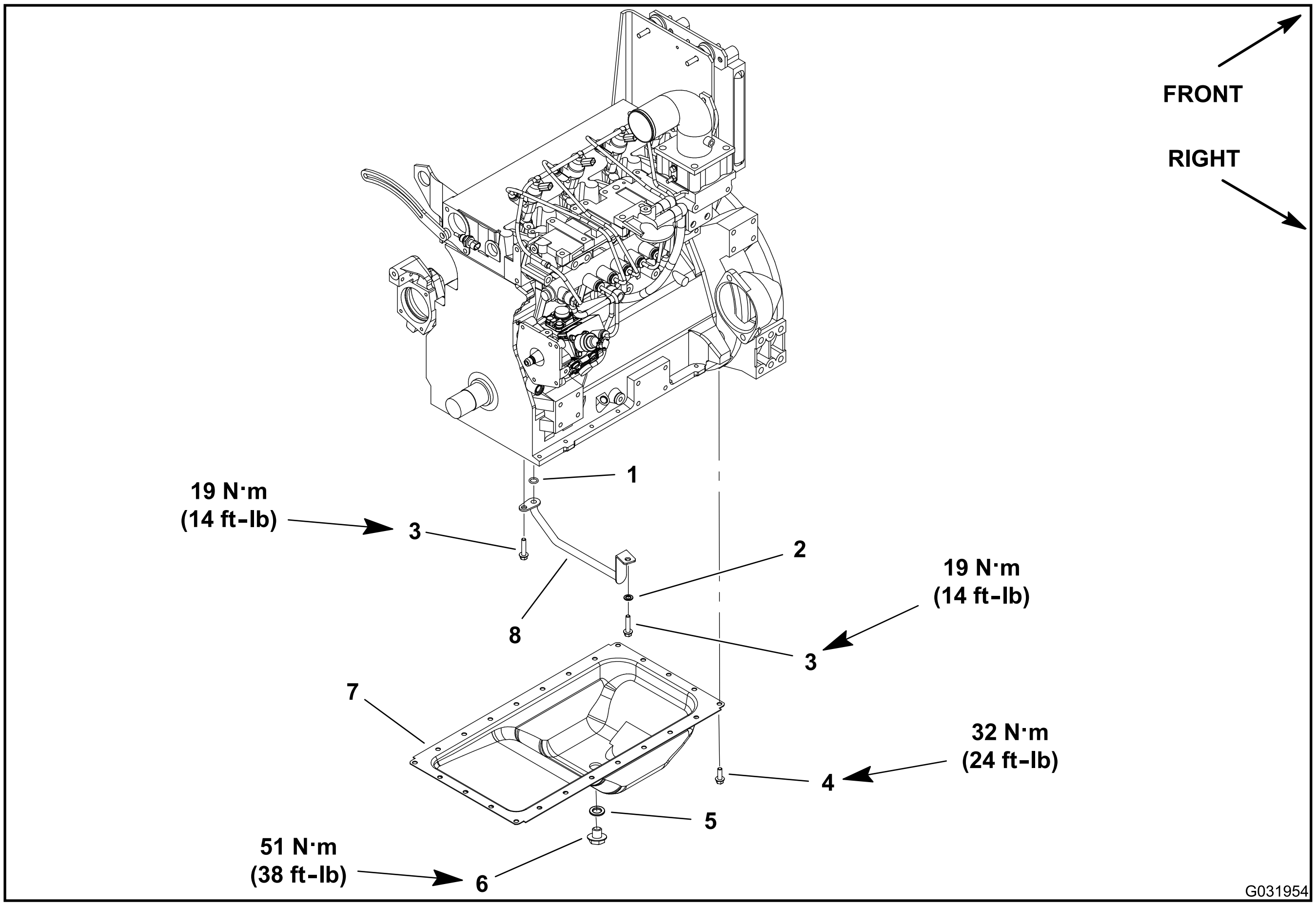
    B. Install the thrust washer and locknut onto the pivot shaft.

    C. Tighten the locknut to prevent any axial movement of the rear axle.

    Note: Ensure that the axle pivots freely after you tighten the locknut.

11. Position the drive belt to the crankshaft, water pump, and alternator pulleys.
12. Tension the belt and tighten the alternator mounting screws; refer to Installing the Alternator (page 3–25).
13. On the Groundsmaster 5910 machine, install and adjust the air conditioning compressor drive belt.
14. Check the engine oil level and adjust if necessary.
15. Start the engine and check for any oil leakage.
16. Lower the hood and secure it.

Oil Pan



g031954

Figure 36

1. O-ring
2. Flat washer
3. Flange-head screw (2 each)
4. Flange-head screw (24 each)
5. Sealing washer
6. Drain plug
7. Oil pan
8. Oil suction tube

Removing the Oil Pan

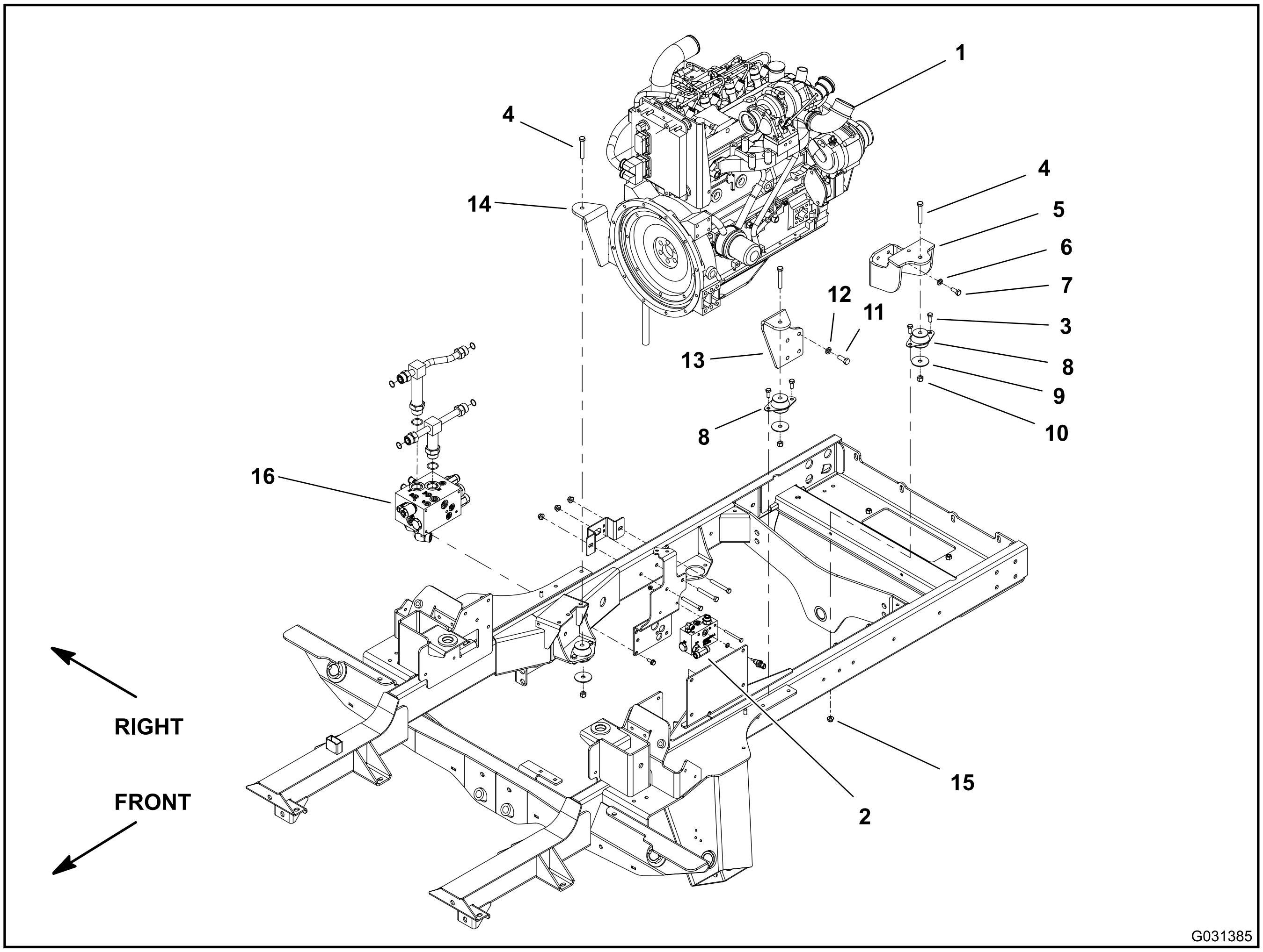
1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to get access to the engine.
3. Drain the oil from the engine.
4. Remove the 24 flange-head screws that attach the oil pan to the engine.
5. Carefully remove the oil pan from the engine.

   Note: Do not damage the oil pan or the sealing surface.
6. If necessary, remove the 2 flange-head screws that attach the oil suction tube to the engine, and remove the oil suction tube.
7. Clean the sealing surfaces of the removed components. Examine the parts for any cracks or other damages.

Installing the Oil Pan

1. If the oil suction tube was removed, install the O-ring on the tube and align the tube with the engine.
2. Use the 2 flange-head screws to secure the oil suction tube to the engine; torque the screws to **19 N·m (14 ft-lb)**.
3. Using the Cummins sealant #3164067 (or equivalent), apply a 1 mm (0.039 inch) sealant bead around all the oil pan mounting screw holes.
4. Apply a 3 mm (0.118 inch) sealant bead to the oil pan mounting surface.
5. Carefully lift and align the oil pan with the cleaned engine mounting surface and assemble the oil pan to the engine with the 24 flange-head screws. Torque the screws to **32 N·m (24 ft-lb)**.
6. Install the drain plug (item 6 in Figure 36) into the oil pan; torque the drain plug to **51 N·m (38 ft-lb)**.
7. Add the specified oil into the crankcase of the engine until the oil level is correct.
8. Start the engine and check for any oil leakage.
9. Lower the hood and secure it.

Engine



g031385

Figure 37

1. Engine assembly
2. Traction flush manifold
3. Bolt (8 each)
4. Bolt (4 each)
5. Rear engine mount (2 each)
6. Lock washer (4 each)
7. Bolt (4 each)
8. Engine isolator mount (4 each)
9. Snubbing washer (4 each)
10. Locknut (4 each)
11. Bolt (4 each)
12. Lock washer (4 each)
13. Front left engine mount
14. Front right engine mount
15. Flange nut (8 each)
16. 4-wheel drive control manifold

Removing the Engine

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Drain the oil from the engine.
3. Remove the hood; refer to Removing the Hood (page 7–37).
4. Remove the battery access panel; refer to Removing and Installing the Battery (page 5–103).
5. Disconnect the negative battery cable.
6. Disconnect the positive battery cable.

WARNING

Ethylene-glycol antifreeze is poisonous.

Discard the coolant correctly.

Keep the coolant in a correctly labeled container.

Keep coolant away from children and pets.

DANGER

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

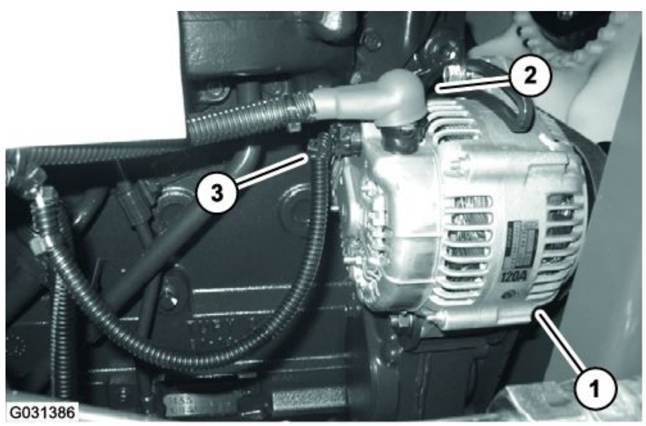
Do not open the radiator cap or drain the radiator when the coolant is hot.

7. Drain the coolant from the radiator into a suitable container; refer to Removing the Radiator (page 3–20).

CAUTION

After operating the engine, muffler, and exhaust pipe are hot and can burn you and others.

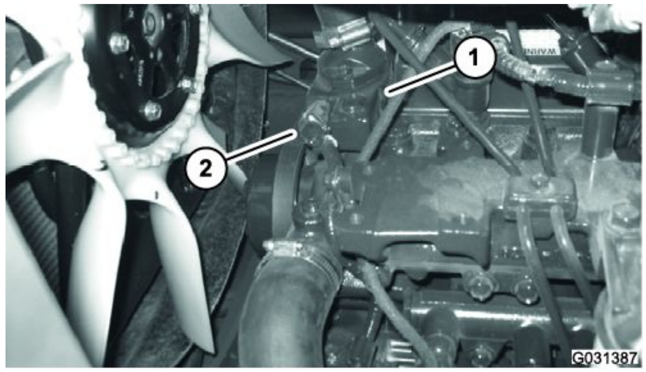
Allow the muffler and exhaust pipe to cool before working on or near them.



g031386

Figure 38

1. Alternator
2. Cable
3. Harness connector



g031387

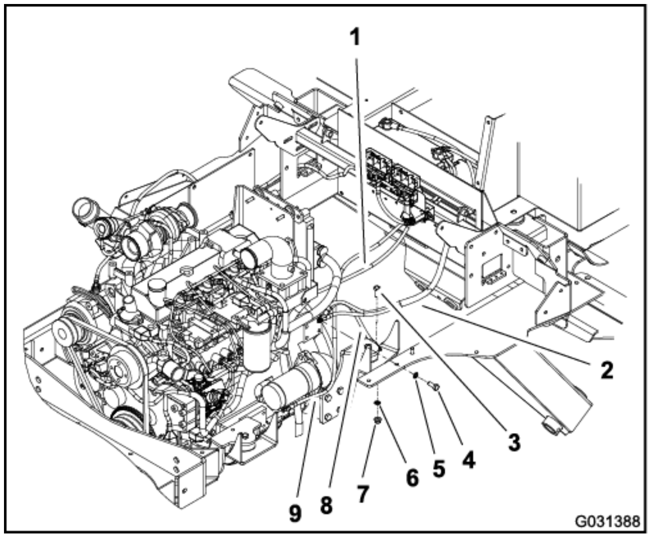
Figure 39

1. Water pump
2. Temperature sensor

8. Disconnect the coolant hoses from the radiator.
9. Remove the exhaust system from the engine; refer to Removing the Exhaust System (page 3–11).
10. Remove the air cleaner system from the engine; refer to Removing the Air Filter System (page 3–9).
11. Remove the intake hoses from the charge air cooler.
12. Note the location of the cable ties used to attach the electrical wires. Disconnect the wires and/or electrical connections from the following electrical components:
    A. The alternator; refer to Figure 38.
    B. The temperature sensor at the water pump housing; refer to Figure 39.
    C. The battery, frame, and wire harness ground at the engine block; refer to Figure 40.
    D. The engine electronic control module
    E. The electric starter motor
    F. The air intake heater
    G. The air conditioning compressor (Groundsmaster 5910 machine only); refer to Figure 41.
13. Disconnect the fuel hose from the water separator outlet; refer to Figure 42.
14. Put the caps on the fuel hose and water separator outlet to prevent contamination.

IMPORTANT

Support the hydraulic pump assembly to prevent the pump from falling.



g031388

Figure 40

1. Positive battery cable
2. Negative battery cable
3. Bolt
4. Bolt
5. Internal lock washer
6. Internal lock washer
7. Flange nut
8. Negative battery cable
9. Positive battery cable

15. Remove the hydraulic pump assembly from the engine; refer to Gear Pump (page 4–108) and Piston (Traction) Pump (page 4–112).
16. On the Groundsmaster 5910 machine, remove the air conditioning compressor from the brackets; refer to Air Conditioning Compressor (page 9–6).

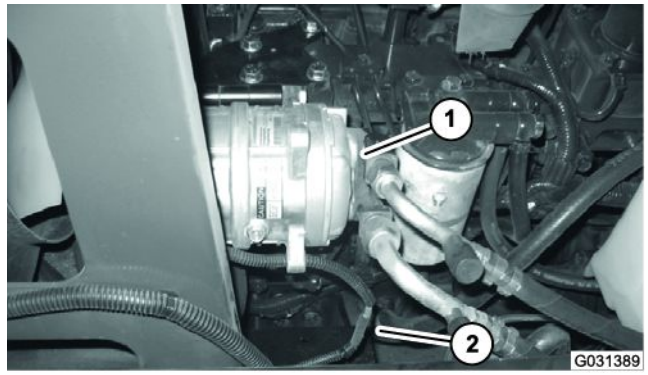
    Note: Position the compressor away from the engine. Ensure that you do not damage the compressor or the compressor hoses. Support the compressor to ensure that the compressor does not fall while you are removing the engine.
17. Remove the cable ties that attach the wiring harness, fuel lines, and hydraulic hoses to the engine.

CAUTION

The engine is very heavy, and a hoist not rated for the weight of the engine may fail, causing possible injury and damage to the engine.

Use hoist equipment rated to lift the engine, which is approximately 275 kg (606 lb).

Removing the Engine (continued)



g031389

Figure 41

1. Air conditioning compressor
2. Connector

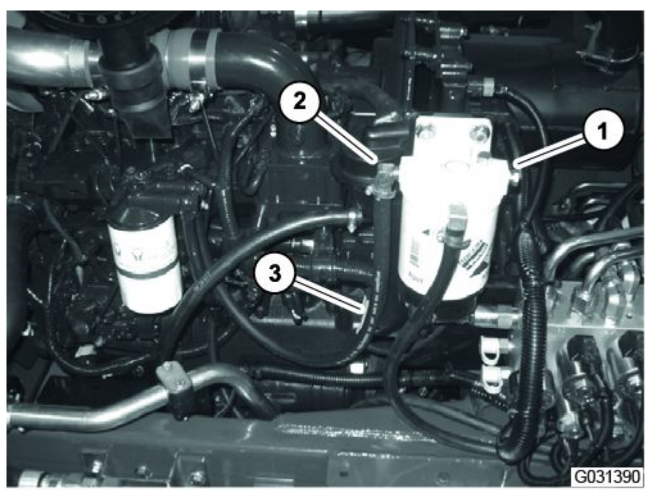
18. Connect the hoist to the front and rear lift tabs on the engine.
19. Remove the locknuts, snubbing washers, and bolts that attach the engine brackets to the engine isolator mounts.

IMPORTANT

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

IMPORTANT

Do not damage the engine, fuel lines, hydraulic lines, electrical harness, or any other parts while removing the engine.



g031390

Figure 42

1. Water separator
2. Outlet
3. Fuel hose

20. Carefully lift the engine from the machine.
21. If necessary, remove the engine mount brackets from the engine.

Removing the Engine (continued)

22. If necessary, remove the engine isolator mounts (item 8 in Figure 37) from the engine.

    Note: There is a fastener at the right, front motor mount that is attached to the frame ground cable.

23. Install suitable covers and plugs on all of the engine openings to prevent contamination.

Installing the Engine

IMPORTANT

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

1. If removed, install the engine mount brackets to the engine and isolator mounts to the frame.
2. Remove all of the covers and plugs from the engine openings that you placed while removing the engine.

CAUTION

The engine is very heavy, and a hoist not rated for the weight of the engine may fail, causing possible injury and damage to the engine.

Use hoist equipment rated to lift the engine, which is approximately 275 kg (606 lb).

3. Connect the hoist to the front and rear lift tabs on the engine.

IMPORTANT

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

IMPORTANT

Do not damage the engine, fuel lines, hydraulic lines, electrical harness, or any other parts while installing the engine.

4. Slowly lower the engine into the machine.
5. Align the engine mount brackets with the engine isolator mounts and assemble the brackets to the mounts with the bolts, snubbing washers, and locknuts.
6. Connect the fuel hose to the water separator outlet; refer to Figure 42.
7. Install the hydraulic pump assembly to the engine; refer to Gear Pump (page 4–108) and Piston (Traction) Pump (page 4–112).
8. On the Groundsmaster 5910 machine, install the air conditioning compressor to the brackets; refer to Installing the Air Conditioning Compressor (page 9–8).

Note: Ensure that the drive belt is correctly tensioned.

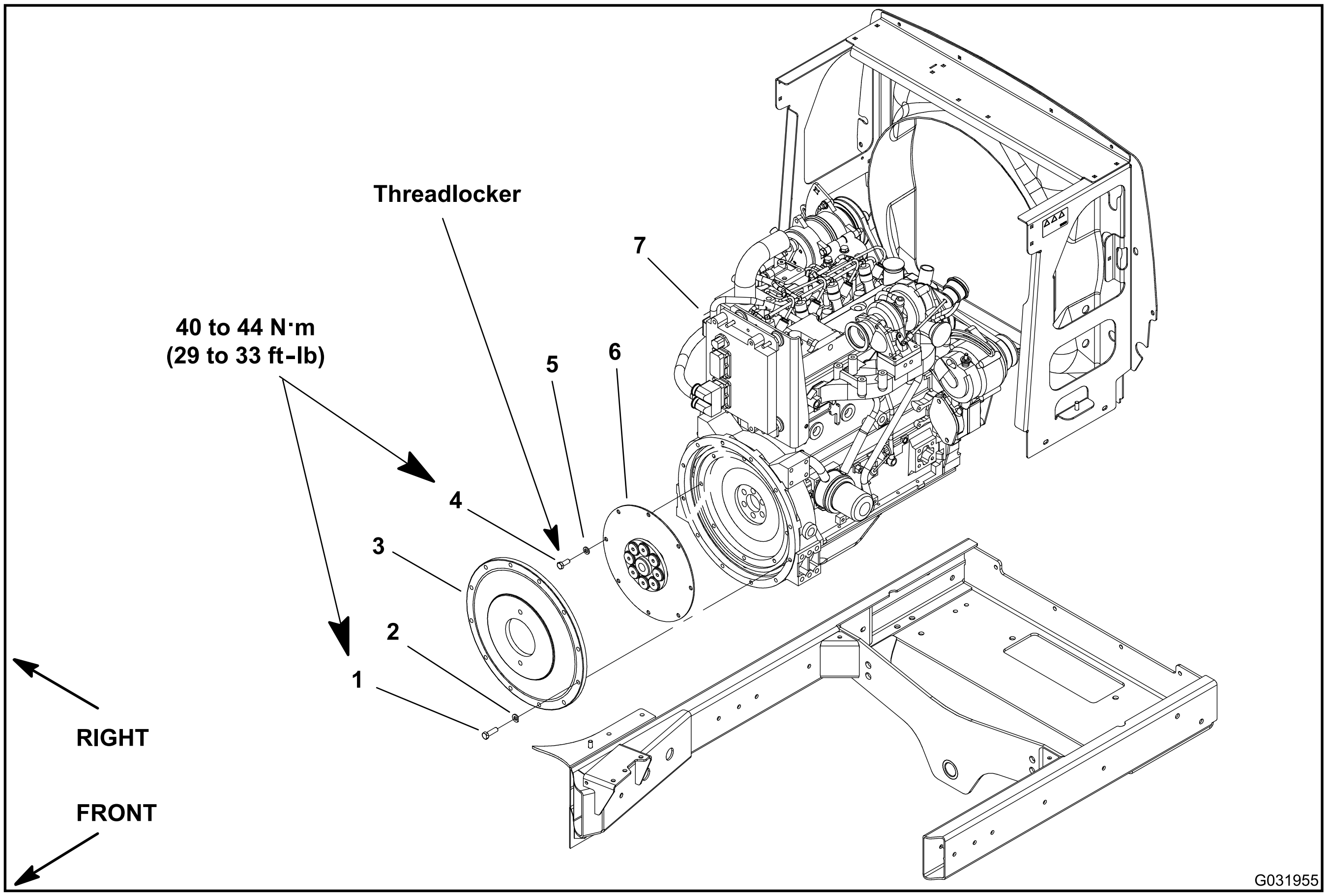
9. Use the notes that you recorded while removing the engine to connect the wires and/or electrical connections to the following electrical components:
   A. The alternator; refer to Figure 38.
   B. The temperature sensor at the water pump housing; refer to Figure 39.
   C. The battery, frame, and wire harness ground at the engine block; refer to Figure 40.
   D. The engine electronic control module

IMPORTANT

When connecting the wire harness to the engine electronic control module, ensure that the harness connector tab is aligned with the corresponding slot in the control module.

   E. The electric starter motor
   F. The air intake heater
   G. The air conditioning compressor (Groundsmaster 5910 machine only); refer to Figure 41.
10. Install the air cleaner assembly to the engine and intake hoses to the charge air cooler; refer to Installing the Air Filter System (page 3–10).
11. Attach the intake system hoses with a hose clamp; torque the hose clamp to **5.1 N·m to 6.2 N·m (45 to 55 in-lb)**.
12. Install the exhaust system to the machine; refer to Installing the Exhaust System (page 3–12).
13. Connect the coolant hoses to the radiator. Ensure that the drain cock fitting is closed. Fill the radiator and reservoir with coolant.
14. Check that the electrical harness, fuel lines, and hydraulic hoses are positioned away from rotating, high-temperature, and moving components.
15. Install the battery access panel; refer to Removing and Installing the Battery (page 5–103).
16. Attach the batteries to the machine with the straps.
17. Connect the positive battery cable.
18. Connect the negative battery cable.
19. Check and adjust the engine oil as necessary.
20. Check and adjust hydraulic fluid as necessary.
21. Bleed the fuel system.
22. Run the engine and check for leaks.
23. Operate the hydraulic controls to correctly fill the hydraulic system; refer to Charging the Hydraulic System (page 4–99).
24. Install the hood to the machine; refer to Installing the Hood (page 7–38).

Flywheel Coupling Assembly



g031955

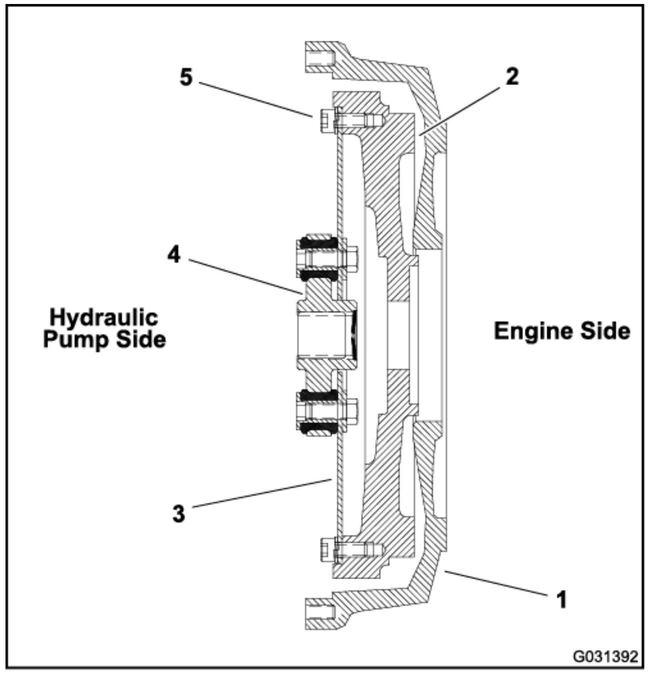
Figure 43

1. Bolt (12 each)
2. Washer (12 each)
3. Coupling housing
4. Bolt (8 each)
5. Washer (8 each)
6. Flywheel coupling
7. Engine assembly

Disassembling the Flywheel Coupling

1. If the engine is in the machine, remove the hydraulic pump assembly from the engine to service the coupling; refer to Gear Pump (page 4–108) and Piston (Traction) Pump (page 4–112).
2. Remove the coupling housing and flywheel coupling from the engine; refer to Figure 43.

Assembling the Flywheel Coupling



g031392

Figure 44

1. Flywheel housing
2. Engine flywheel
3. Flywheel coupling
4. Coupling hub
5. Bolt (8 each)

---

1. Align the flywheel coupling with the engine flywheel; refer to Figure 44.

   Note: Ensure that the coupling hub is aligned away from the flywheel.

2. Apply the Permatex™ Blue Gel medium-strength thread-locking compound (or equivalent) to the threads of the 20 bolts (item 4 in Figure 43).

3. Assemble the coupling to the engine flywheel with the 8 bolts and 8 washers, and torque the bolts to **40 to 44 N·m (29 to 33 ft-lb)**.

4. Align the coupling housing with the engine.

5. Assemble the coupling housing with the 12 bolts and 12 washers, with a crossing pattern tightening procedure, and torque the bolts to **40 to 44 N·m (29 to 33 ft-lb)**.

6. If the engine is in the machine, install the hydraulic pump assembly to the engine; refer to Gear Pump (page 4–108) and Piston (Traction) Pump (page 4–112).

Chapter 4

Hydraulic System

Table of Contents

Additional Reference Materials

DANFOSS D SERIES GEAR PUMP SEAL KIT SERVICE INSTRUCTION BULLETIN
REXROTH VARIABLE PUMP A10VG REPAIR INSTRUCTIONS
REXROTH VARIABLE PUMP A10VG REPAIR MANUAL
DANFOSS H1 CLOSED CIRCUIT AXIAL PISTON PUMPS SERVICE MANUAL
DANFOSS H1 CLOSED CIRCUIT AXIAL PISTON PUMPS REPAIR INSTRUCTIONS
EATON REPAIR INFORMATION: MODEL 74318 and 74348 PISTON MOTORS
PARKER TORQMOTORTM SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)
EATON PARTS AND REPAIR INFORMATION: 5 SERIES STEERING CONTROL UNITS

Specifications

Hydraulic System

Item	Description
Piston (traction) pump (before serial number 313000300) Maximum pump displacement (per revolution)	Rexroth Bosch, variable displacement piston pump 63 cm³ (3.84 in³)
Piston (traction) pump (after serial number 313000300) Maximum pump displacement (per revolution)	Sauer-Danfoss, variable displacement piston pump 68 cm³ (4.15 in³)
Traction relief pressure Forward (before serial number 313000300) Forward (after serial number 313000300) Reverse (before serial number 313000300) Reverse (after serial number 313000300)	 29,900 kPa (4,330 psi) 35,000 kPa (5,080 psi) 36,800 kPa (5,330 psi) 28,000 kPa (4,060 psi)
Charge circuit relief pressure Before serial number 313000300 After serial number 313000300	 2,280 kPa (330 psi) 2,000 kPa (290 psi)
Front wheel motors Displacement (per revolution)	Eaton fixed displacement piston motor 29.5 cm³ (1.8 in³)
Rear wheel motors Displacement (per revolution)	Parker orbital rotor motor, TG series 238 cm³ (14.5 in³)
Gear pump Section P1 displacement (per revolution) Section P2 displacement (per revolution) Section P3 displacement (per revolution)	Sauer-Danfoss 3-section gear pump, D series 31.8 cm³ (1.94 in³) 31.8 cm³ (1.94 in³) 20.5 cm³ (1.25 in³)
Cutting deck motors Displacement (per revolution) Relief pressure (front and left decks) Relief pressure (right deck)	Casappa gear motor 26.4 cm³ (1.61 in³) 20,700 kPa (3,000 psi) 13,800 kPa (2,000 psi)
Steering control unit	Eaton steering unit, series 5
Steering circuit relief pressure	14,500 kPa (2,100 psi)
Lift/lower circuit relief pressure	9,300 kPa (1,350 psi)
Engine cooling fan motor Displacement (per revolution)	Casappa gear motor 16.9 cm³ (1.03 in³)
Hydraulic filters (2 each)	Spin-on cartridge type 280 kPa (40 psi) bypass in filter manifold (filter manifold includes filter restriction indicator)
Hydraulic reservoir capacity	71.9 L (19 US gallons)

Hydraulic System (continued)

Hydraulic reservoir capacity	100 Mesh (in reservoir)
Hydraulic fluid	Refer to the *Operator's Manual*

General Information

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

Checking the Hydraulic Fluid

g031393

Figure 45

1. Hydraulic-fluid cap
2. Tank cover

The hydraulic system on your machine is designed to operate on anti-wear hydraulic fluid. The reservoir holds approximately 71.9 L (19 US gallons) of hydraulic fluid (Figure 45). Refer to the *Operator's Manual* for the procedure on checking the hydraulic-fluid level and hydraulic fluid recommendations.

IMPORTANT

Check the hydraulic-fluid level daily.

Releasing Pressure from the Hydraulic System

Release all the pressure in the hydraulic system before you work on the hydraulic system or disconnect hydraulic components by performing the following:

1. Move the machine to a level surface.
2. Shut off the PTO.
3. Shut off the engine.
4. Set the parking brake.
5. While sitting in the operator's seat, rotate the key switch to the RUN position.
6. Press the deck-lift switches to the LOWER position, and then release the switches.
7. Rotate the key switch to the OFF position and remove the key from the key switch.

Towing the Traction Unit

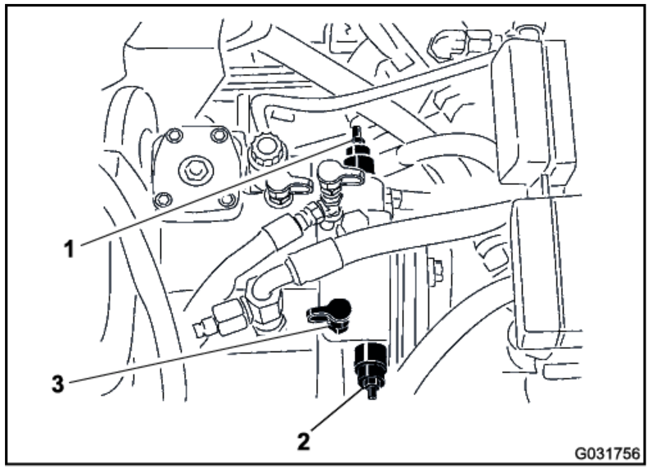


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Figure 46

1. Forward bypass valve
2. Reverse bypass valve
3. Reverse test port (MA)

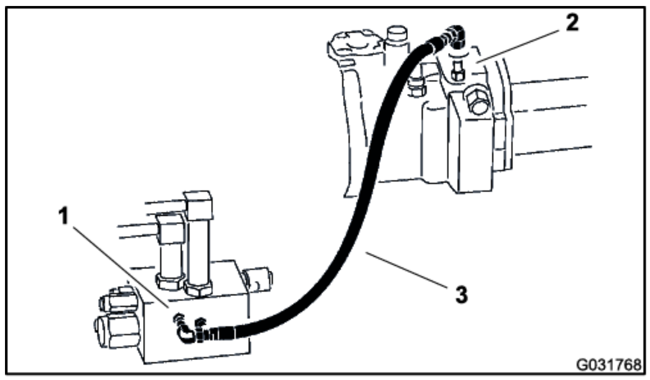

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Figure 47

1. 4-wheel drive control manifold reverse test port (G2)
2. Traction pump reverse-pressure test port (MA)
3. Hydraulic hose

IMPORTANT

If you exceed the towing-speed limit, you can severely damage the piston pump.

If you must tow or push the machine, move the machine forward at a speed below 3.2 km/h (2 mph) for a distance of 0.4 km (1/4 mile) or less. If you need to move the machine more than 0.4 km (1/4 mile), transport the machine on a trailer. The piston (traction) pump is equipped with 2 bypass valves that you must open for towing or pushing; refer to Figure 46.

Towing the Traction Unit (continued)

IMPORTANT

If you must push or tow the machine in the reverse direction, hydraulically bypass the check valve in the 4-wheel drive manifold by performing the following.

Parts needed for this procedure: Hydraulic hose (Part No. 95-8843)—1 each, coupler fitting (Part No. 95-0985)—2 each, and hydraulic fitting (Part No. 340-77)—2 each.

1. Connect the hydraulic hose to the reverse pressure-test port (MA) of the traction pump with 1 hydraulic coupler and 1 hydraulic fitting.
2. Connect the other end of the hydraulic hose to the manifold-test port (G2) (Figure 47) of the traction pump with 1 hydraulic coupler and 1 hydraulic fitting.

If you must tow the machine, do the following procedure:

1. Find the bypass valves on the traction pump; refer to Figure 46.
2. Open both bypass valves on the traction pump by doing the following:
   A. Loosen the jam nuts at the stem of the each bypass valve.
   B. Rotate the stems of the bypass valves 6 full turns.
   C. Tighten the jam nuts.
3. Tow or push the machine forward as necessary. Ensure that you do not exceed the speed limit or distance limit; refer to Towing the Traction Unit (page 4–7).

IMPORTANT

Use the tow option to bypass the high-pressure relief valves. If the hydraulic traction circuit loses hydraulic fluid or becomes too hot, catastrophic component damage can occur.

4. After you move the machine, close both valves as follows:
   A. Loosen the jam nuts at the stem of each bypass valve.
   B. Fully tighten the stems of the bypass valves.

      Note: Do not use more than **11 N·m (8 ft-lb)** of torque to close the bypass valves.

   C. Tighten the jam nuts.

   Note: Refer to the *Operator's Manual* for additional information regarding towing your machine.

Traction Circuit Component Failure

The traction circuit of the Groundsmaster 5900 and 5910 machines is a closed loop system that includes the piston (traction) pump and 4-wheel motors. If a component failure occurs in the traction circuit, contamination from the damaged component will circulate throughout the traction circuit. This contamination can damage other components in the circuit, so remove the contamination to prevent additional component failure.

Traction Circuit Component Failure (continued)

The recommended procedure to remove contamination from the traction circuit is to temporarily install the Toro high-flow hydraulic-fluid filter into the traction circuit; refer to Special Tools (page 4–42). Use a hydraulic-fluid filter when you connect the hydraulic test gauges in order to test the traction circuit components or after you replace a damaged traction circuit component (e.g., traction (piston) pump or wheel motor). Using a filter will remove contaminates from the hydraulic fluid in the traction circuit, thereby preventing additional component damage.

IMPORTANT

Keep the engine speed below 2,200 rpm to prevent damage to the high flow hydraulic filter during the use on a Groundsmaster 5900 or 5910 machine. Higher engine speeds may allow excessive hydraulic flow to the filter.

After you have installed the Toro high flow hydraulic filter kit in the traction circuit, raise and support the machine with all the wheels off the ground. Then, operate the traction circuit to allow the hydraulic fluid flow throughout the circuit. The filter removes contaminants from the traction circuit during the circuit operation. Because the Toro high flow filter is bi-directional, the traction circuit can be operated in both the forward and reverse direction. When you are certain that the filter has removed the contaminates from the hydraulic fluid of the traction circuit, remove the filter. Refer to Filtering the Closed-Loop Traction Circuit (page 4–102) for additional information on using the Toro high flow hydraulic filter.

The alternative to using the Toro high flow hydraulic filter kit after a traction circuit component failure is to disassemble the entire traction circuit, drain the hydraulic fluid and clean all the components, hydraulic tubes, and hydraulic hoses in the traction circuit. Operating the machine with contaminants in the traction circuit could cause additional damage to components of the traction circuit.

Hydraulic Hoses

The hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to the 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 for the following signs of deterioration or damage:

- A hose that is hard, cracked, cut, abraded, charred, leaking, or otherwise damaged.
- A hose that is kinked, crushed, flattened, or twisted.
- A hose cover that is blistered, soft, degraded, or loose.
- Hose fittings that are cracked, damaged, or badly corroded.

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 2 wrenches, hold the hose straight with 1 wrench and tighten the hose swivel nut onto the fitting with the other wrench; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).

Note: If the hose has an elbow at 1 end, tighten the swivel nut on the elbow end before you tighten the nut on the straight end of the hose.

Hydraulic Hoses (continued)

For more hydraulic hose information; refer to the Hydraulic Hose Servicing (Part No. 94813SL) in the *Toro Service Training Book*.

WARNING

Relieve all pressure in the hydraulic system before performing any work on the system; refer to Releasing Pressure from the Hydraulic System (page 4–6).

- **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.**

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting)

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.

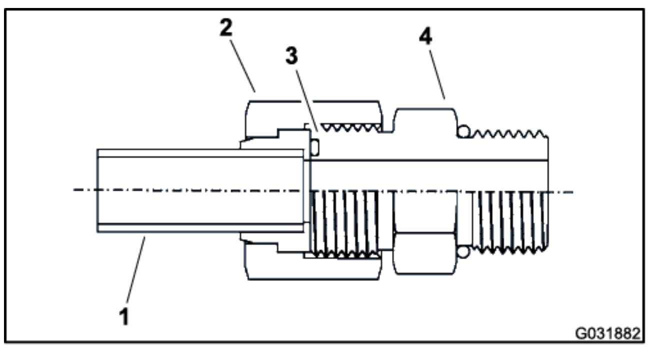

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Figure 48

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

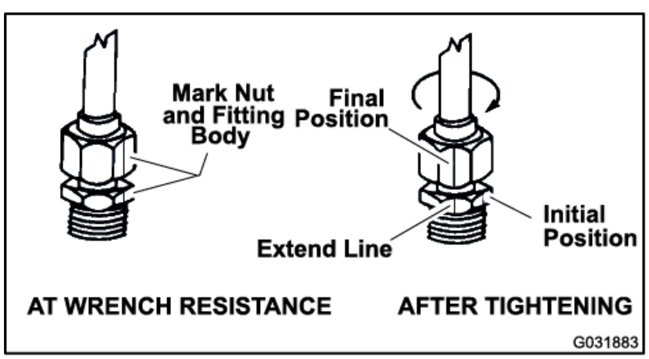

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Figure 49

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (continued)

2. To help prevent a hydraulic leak, replace the face seal O-ring when you open the connection.

   Note: Ensure that the O-ring is installed and correctly seated in the groove of the fitting. Lightly lubricate the O-ring with only 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; refer to Figure 48.

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 Hose/Tube Installation Torque Table (page 4–11).

   Note: This procedure to tighten the swivel nut requires a drive-adapter wrench (e.g., crowfoot wrench).

   Note: Using a drive-adapter wrench in any position other than 90º and 270º 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. Using a torque wrench with a drive-adapter wrench lowers the torque value than that of the installation torque listed in the table. Calculate the compensated torque value using the formulas described in Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–5). Also refer to the Hose/Tube Installation Torque Table (page 4–11) that follows.

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; refer to Figure 49.

   A. Use a wrench to tighten the swivel nut onto the fitting until you feel light resistance with the wrench—approximately **3.39 N·m (30 in-lb)**.

   B. Put a mark on the swivel nut and body of the fitting. Hold the hose/tube with a wrench to prevent the hose/tube from turning.

   C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (FFWR); refer to Flats From Wrench Resistance Table (page 4–12).

      Note: The markings on the nut and body of the fitting show that the connection is correctly tightened.

Hose/Tube Installation Torque Table

Fitting Dash Size	Hose/Tube Side Thread Size (inch(es)—threads per inch)	Installation Torque
4	9/16—18	25 to 29 N·m (18 to 22 ft-lb)
6	11/16—16	37 to 44 N·m (27 to 33 ft-lb)
8	13/16—16	51 to 63 N·m (37 to 47 ft-lb)
10	1—14	82 to 100 N·m (60 to 74 ft-lb)
12	1–3/16—12	116 to 142 N·m (85 to 105 ft-lb)
16	1–7/16—12	150 to 184 N·m (110 to 136 ft-lb)
20	1–11/16—12	190 to 233 N·m (140 to 172 ft-lb)

Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (continued)

Flats From Wrench Resistance Table

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

Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port)

Installing the Non-Adjustable Fittings

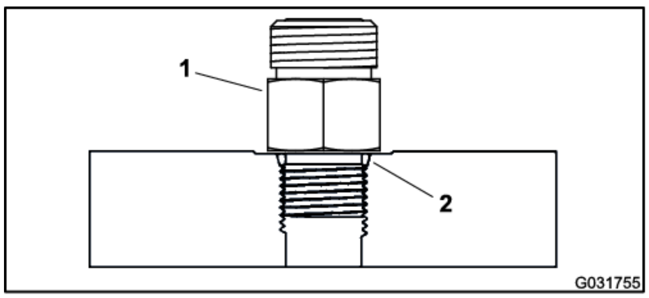

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Figure 50

1. Fitting
2. O-ring

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 only clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.

IMPORTANT

Before installing the fitting into the port, determine the material of which the port is made. Installing a fitting into an aluminum port requires a reduced 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 Fitting Installation Torque Table (page 4–13).

Installing the Non-Adjustable Fittings (continued)

Note: Using a drive-adapter wrench in any position other than 90º and 270º 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. Using a torque wrench with a drive-adapter wrench lowers the torque value than that of the installation torque listed in the table. Calculate the compensated torque value using the formulas described in Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–5). Also refer to the Fitting Installation Torque Table (page 4–13) that follows.

5. If a torque wrench is not available or if the space at the port prevents the use of a torque wrench, use the alternative procedure Flat From Finger Tight Table (page 4–13) 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 FFFT. If the port material is aluminum, tighten the fitting to 60% of the listed FFFT.

Flat From Finger Tight Table

Size	FFFT
4 (1/4 inch nominal hose or tubing)	1.00 ± 0.25
6 (3/8 inch)	1.50 ± 0.25
8 (1/2 inch)	1.50 ± 0.25
10 (5/8 inch)	1.50 ± 0.25
12 (3/4 inch)	1.50 ± 0.25
16 (1 inch)	1.50 ± 0.25

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

Installing an Adjustable Fitting

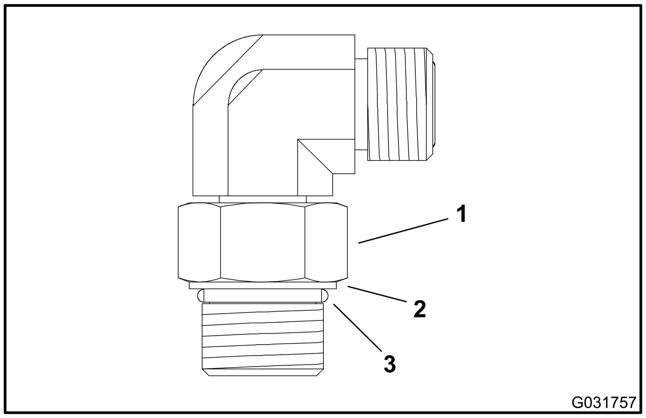

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Figure 51

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

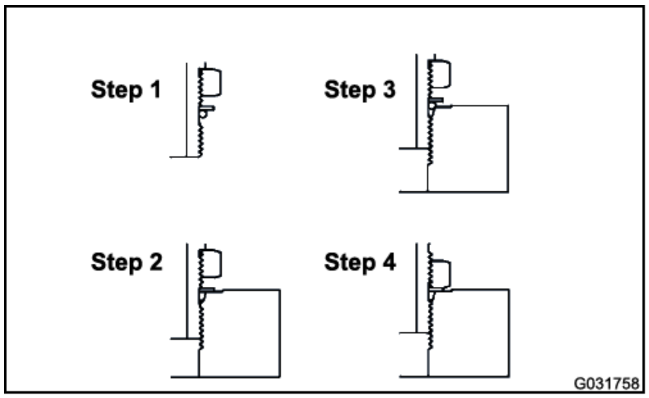

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Figure 52

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 only clean hydraulic fluid. Ensure that the threads of the fitting are clean with no lubricant applied.
4. Turn back the locknut 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 52).

IMPORTANT

Before installing the fitting into the port, determine the material of which the port is made. Installing a fitting into an aluminum port requires a reduced installation torque.

5. Install the adjustable fitting into the port by hand until the washer contacts the face of the port (Step 2 in Figure 52).
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 52).

Installing an Adjustable Fitting (continued)

Note: Do not rotate the adjustable fitting more than 1 turn counterclockwise.

7. Hold the fitting in the correct alignment with a wrench and use a torque wrench to tighten the fitting to the recommended torque value within the specified range of torque values; refer to Fitting Installation Torque Table (page 4–13).

   Note: This tightening procedure requires a drive-adapter wrench (e.g., crowfoot wrench).

   Note: Using a drive-adapter wrench in any position other than 90º and 270º 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. Using a torque wrench with a drive-adapter wrench lowers the torque value than that of the installation torque listed in the table. Calculate the compensated torque value using the formulas described in Calculating the Torque Values When Using a Drive-Adapter Wrench (page 2–5). Also refer to the Fitting Installation Torque Table (page 4–13).

8. If a torque wrench is not available or if space at the port prevents the use of a torque wrench, use the alternative procedure Flat From Finger Tight Table (page 4–15) given below;

   A. Hold the fitting in the correct alignment with a wrench and, if the port material is steel, tighten the locknut with a second wrench to the listed FFFT (Step 4 in Figure 52).

   B. If port material is aluminum, tighten the fitting to 60% of the listed FFFT; refer to Flat From Finger Tight Table (page 4–15).

Flat From Finger Tight Table

Size	FFFT
4 (1/4 inch nominal hose or tubing)	1.00 ± 0.25
6 (3/8 inch)	1.50 ± 0.25
8 (1/2 inch)	1.50 ± 0.25
10 (5/8 inch)	1.50 ± 0.25
12 (3/4 inch)	1.50 ± 0.25
16 (1 inch)	1.50 ± 0.25

Hydraulic Schematic

Note: Download a free copy of the *Hydraulic Schematic* for your Groundsmaster 5900 or 5910 machine by visiting www.Toro.com and searching for your machine from the Manuals link on the home page.

Hydraulic Flow Diagrams

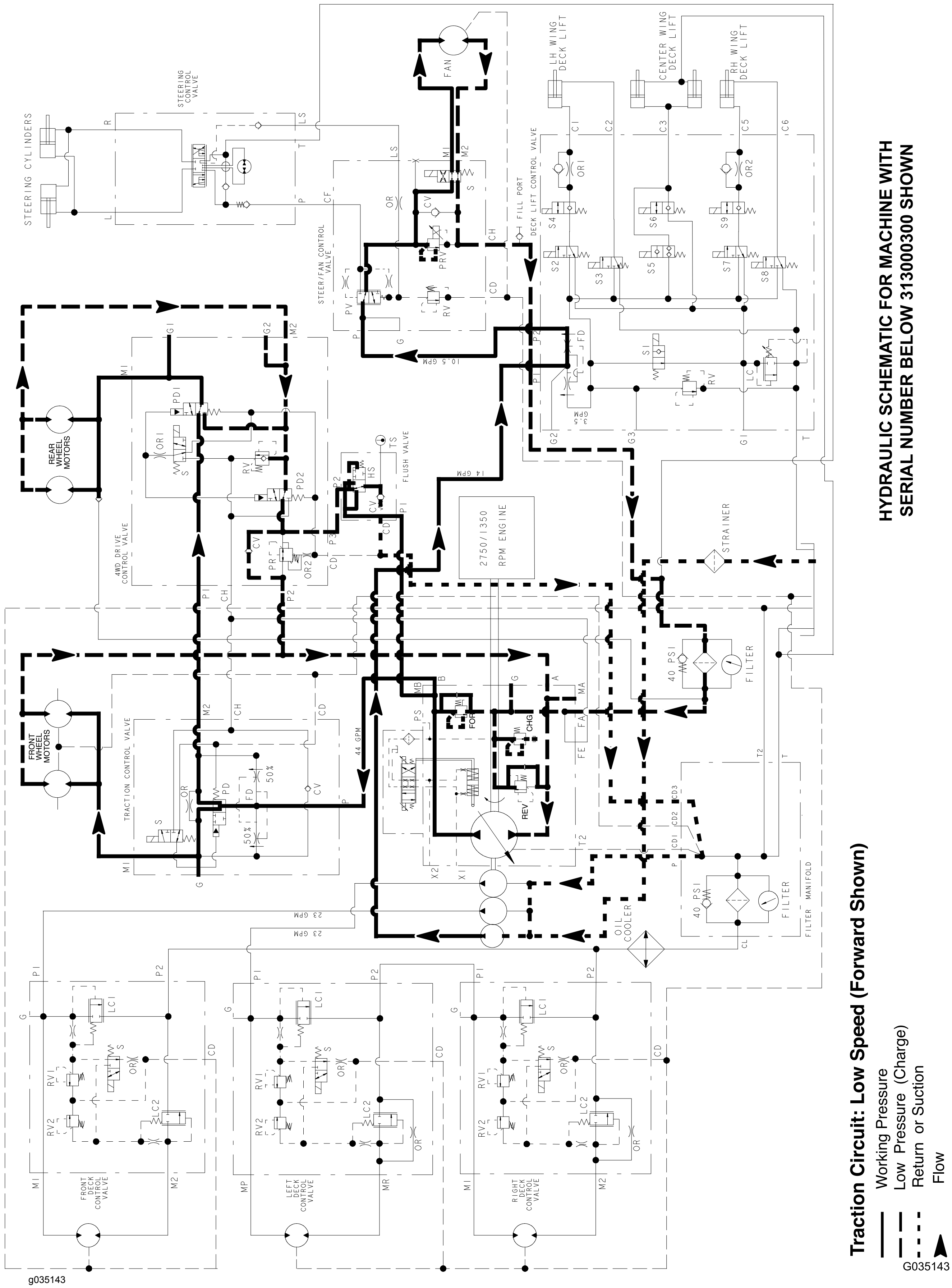

Figure 53

Traction Circuit: Low Speed

A variable displacement, bi-directional piston pump is directly connected to the engine flywheel, the piston pump supplies hydraulic flow to the traction circuit. An electronic proportional-servo assembly controls the movement of the swash plate of the piston pump. Pressing the traction pedal rotates a potentiometer that sends a signal to the machine TEC-5002 controller. The controller in turn sends a related PWM (pulse width modulation) output signal to the hydrostat-electronic control to turn the pump-swash plate accordingly to control the output of the pump. The hydraulic fluid from the hydrostat is directed to the front- and rear-wheel motors through the traction-control valve, 4-wheel drive control valve, and traction flush control manifolds.

The operating pressure on the high-pressure side of the closed loop traction circuit is determined by the amount of load developed at the fixed displacement wheel motors. As the load increases, the circuit pressure can increase to the relief-valve settings; refer to Specifications (page 4–4) for the traction circuit relief valve pressures.

If the circuit pressure is more than the relief-valve setting, fluid flows through the relief valve to the low-pressure side of the closed loop traction circuit.

You can measure the traction circuit pressure (forward and reverse) at the test ports on the hydrostat.

The traction circuit enables operation in either low speed (4-wheel assist) or high speed (2-wheel drive).

The traction pump and wheel motors use a small amount of hydraulic fluid for internal lubrication. The fluid is designed to leak across the pump and motor parts and into the component case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage.

The gear pump section (P3) that supplies fluid to the steering, lift, and cooling fan circuits, also supplies the charge fluid for the traction circuit. The gear pump is driven directly off the traction pump. It supplies charge fluid constantly to the traction circuit to make up for fluid that is lost to the internal leakage in the traction pump and wheel motors. The charge-pump flow is directed through the charge-oil filter before the pump flow enters the hydrostat. This filter has a bypass valve that permits the charge-fluid flow to the closed traction loop if the filter is plugged.

A relief valve in the hydrostat limits the traction charge pressure; refer to Specifications (page 4–4) for the charge pressure setting. You can measure the charge pressure at the charge-pressure test port (G) on the hydrostat.

Forward Direction

With the low-speed range selected and the traction pedal pushed in the forward direction, fluid from the hydrostat port MB passes through the traction control valve; refer to the Traction Circuit: Traction Control (page 4–24). The fluid flow from the traction-control valve port M1 drives the front-wheel motors in the forward direction and then returns to the hydrostat. The fluid flow from the traction control valve port M2 is routed to the P1 port of the 4-wheel drive control valve where it is directed to the PD1 cartridge and out of the manifold to drive the rear-wheel motors in the forward direction. The fluid returning from the rear motors again enters the 4-wheel drive control valve at the M2 port. Flow passes through the PD2 cartridge, CV check valve, out valve port P2, and back to the hydrostat.

To keep the traction-circuit fluid properly cooled, a flush valve is incorporated into the traction circuit. When in the forward direction, forward pressure shifts the

Forward Direction (continued)

flush valve spools, allowing a small amount of hydraulic fluid to bleed off to cool the closed loop traction circuit. The charge system replenishes the fluid that is bled from the traction circuit because of the flush valve operation.

When you go down a hill, the tractor becomes an over-running load that drives the wheel motors. In this condition, the rear wheel motors can lock up as the fluid is pumped from the motors, increasing the pressure as it returns to the hydrostat. To prevent the wheel from locking up, an adjustable relief valve (RV) in the 4-wheel drive control valve reduces the rear motor pressure created in downhill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in the reverse low speed as it does in the forward direction. However, the flow through the circuit is reversed. The fluid flow from the hydrostat port MA is directed to the front-wheel motors and to 4-wheel drive control valve port P2. Fluid to the front-wheel motors moves them in the reverse direction and then returns to the hydrostat through the traction-control valve. The fluid flow to the 4-wheel drive control valve flows through the PR pressure reducing valve that limits the downstream pressure to the rear-wheel motors to 4,500 kPa (650 psi) so that the rear wheels do not scuff the turf. This reduced-pressure flow passes through the PD2 cartridge and out port M2 to the rear-wheel motors. Return fluid from the rear motors again enters the 4-wheel drive control valve at port M1, flows through the PD1 cartridge, exits the manifold at port P1, and returns to the hydrostat through the traction control manifold.

When in the reverse direction, the flush-valve spool stays in the unshifted position to prevent any loss of traction circuit fluid.

Reverse Direction (continued)

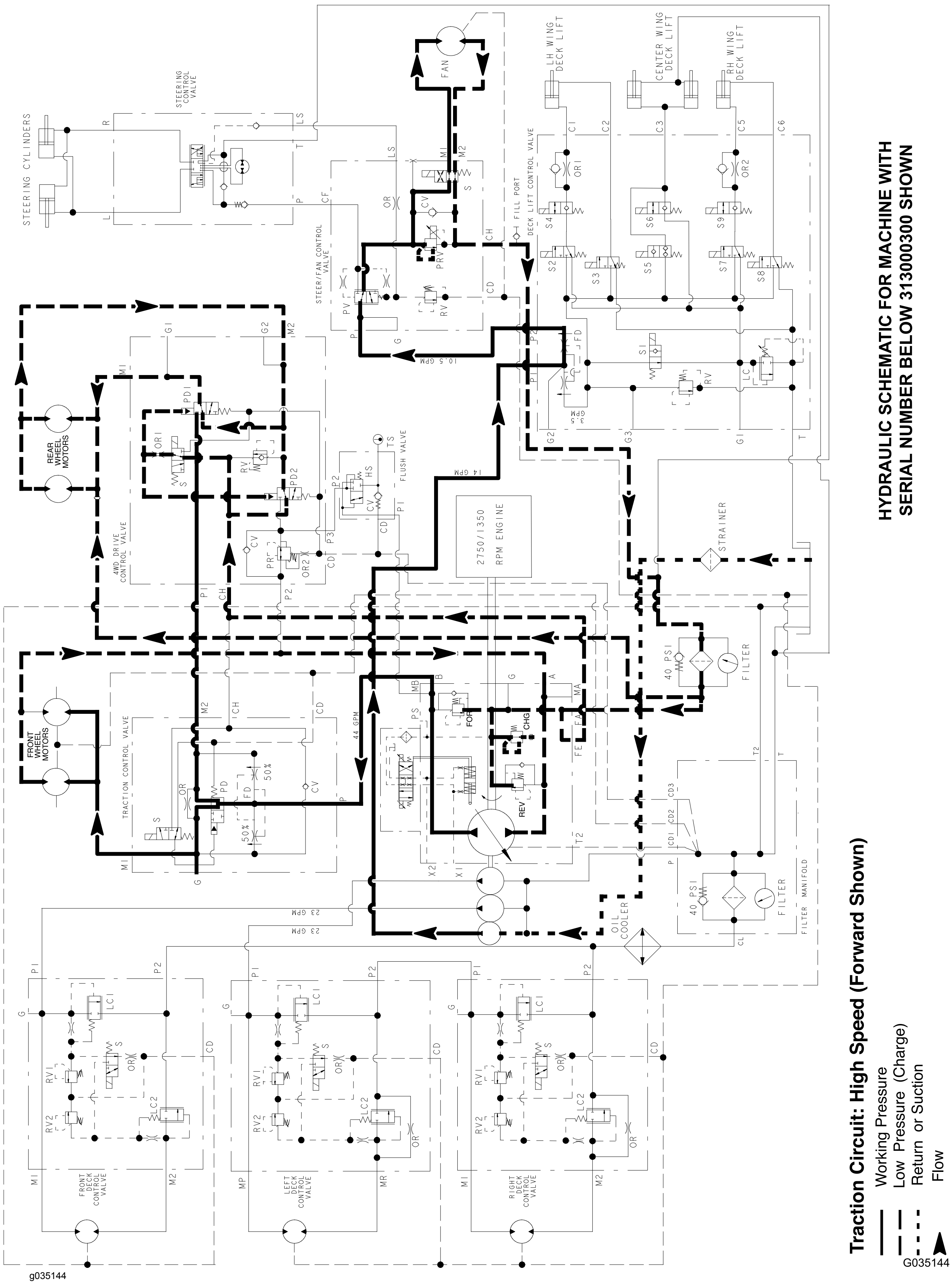

Figure 54

Traction Circuit: High Speed

A variable displacement, bi-directional piston pump is directly connected, the piston pump supplies the hydraulic flow to the traction circuit. The movement of the swash plate of the piston pump is controlled by an electronic proportional-servo assembly. Pressing the traction pedal rotates a potentiometer that sends a signal to the machine TEC-5002 controller. The controller in turn sends a related PWM (pulse width modulation) output signal to the hydrostat-electronic control to turn the pump swash plate accordingly to control the output of the pump. The hydraulic fluid from the hydrostat is directed to the front and rear wheel motors through the traction-control valve, 4-wheel drive control valve, and traction flush control manifolds.

The operating pressure on the high-pressure side of the closed loop traction circuit is determined by the amount of load developed at the fixed-displacement wheel motors. As the load increases, the circuit pressure can increase to the relief-valve settings; refer to Specifications (page 4–4) for the traction circuit relief valve pressures.

If the circuit pressure is more than the relief valve setting, fluid flows through the relief valve to the low-pressure side of the closed loop traction circuit.

You can measure the circuit pressure (forward and reverse) at the test ports on the hydrostat.

The traction circuit provides the operation in either low speed (4-wheel assist) or high speed (2-wheel drive).

The traction pump and wheel motors use a small amount of hydraulic fluid for internal lubrication. The fluid is designed to leak across the pump and motor parts and into the component case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage.

The gear pump section (P3) that supplies fluid to the steering, lift, and cooling fan circuits also supplies the charge fluid for the traction circuit. The gear pump is driven directly off the traction pump. It supplies charge fluid constantly to the traction circuit to make up for fluid that is lost in the internal leakage in the traction pump and wheel motors. The Charge-pump flow is directed through the charge-fluid filter before pump flow enters to the hydrostat. This filter has a bypass valve that permits the charge-fluid flow to the closed traction loop if the filter is plugged.

A relief valve in the hydrostat limits the traction charge pressure; refer to Specifications (page 4–4) for the charge pressure setting. You can measure the charge pressure at the charge-pressure test port (G) on the hydrostat.

Forward Direction

With the Hi-Lo speed switch in the high-range position, the solenoid valve (S) in the 4-wheel drive control manifold is energized. The solenoid valve spool moves to direct the charge pressure that moves the PD1 and PD2 control valve spools. The shifted PD1 valve prevents the hydraulic flow from the hydrostat to the rear-wheel motors, all the hydrostat flow is directed to the front-wheel motors with the flow blocked to the rear-wheel motors that allow a higher transport speed in the forward direction.

Without flow to the rear-wheel motors, the rotating rear-wheels drive the rear-wheel motors so that they act like a pump. Inlet fluid to the rear-wheel motors is supplied by a check valve that allows the charge fluid into the rear-wheel motor circuit. Fluid leaving the rear-wheel motors enters the 4-wheel drive at port M2 and is directed back to the rear-wheel motors through the PD1 cartridge and manifold port M1. To allow for rear-wheel loop cooling when in the

Forward Direction (continued)

forward transport operation, a small amount of fluid exits through the shifted PD2 cartridge and returns to the charge circuit.

Reverse Direction

With the Hi-Lo speed switch in the high-range position, the solenoid valve (S) in the 4-wheel drive control manifold is energized. The solenoid valve spool moves to direct the charge pressure that shifts the PD1 and PD2 control valve spools. The fluid flow from the hydrostat port MA enters the 4-wheel drive control manifold at port P2, flows through the PR pressure reducing valve, and is stopped at the shifted PD2 valve. With the flow blocked to the rear wheel motors, all hydrostat flow is directed to the front-wheel motors to allow a higher transport speed in the reverse direction.

Without flow to the rear-wheel motors, the rotating rear wheels drive the rear-wheel motors so that they act like a pump. Inlet fluid to the rear-wheel motors is supplied by a check valve at the 4-wheel drive control manifold CH port that allows the charge fluid into the rear-wheel motor circuit. This charge fluid is routed through the shifted PD2 cartridge and out the manifold port M2 to the rear-wheel motors. Return flow from the rear-wheel motors enters the 4-wheel drive control manifold at port M1 through the shifted PD1 cartridge and is then directed back to the rear-wheel motors as they turn in the reverse direction.

Reverse Direction (continued)

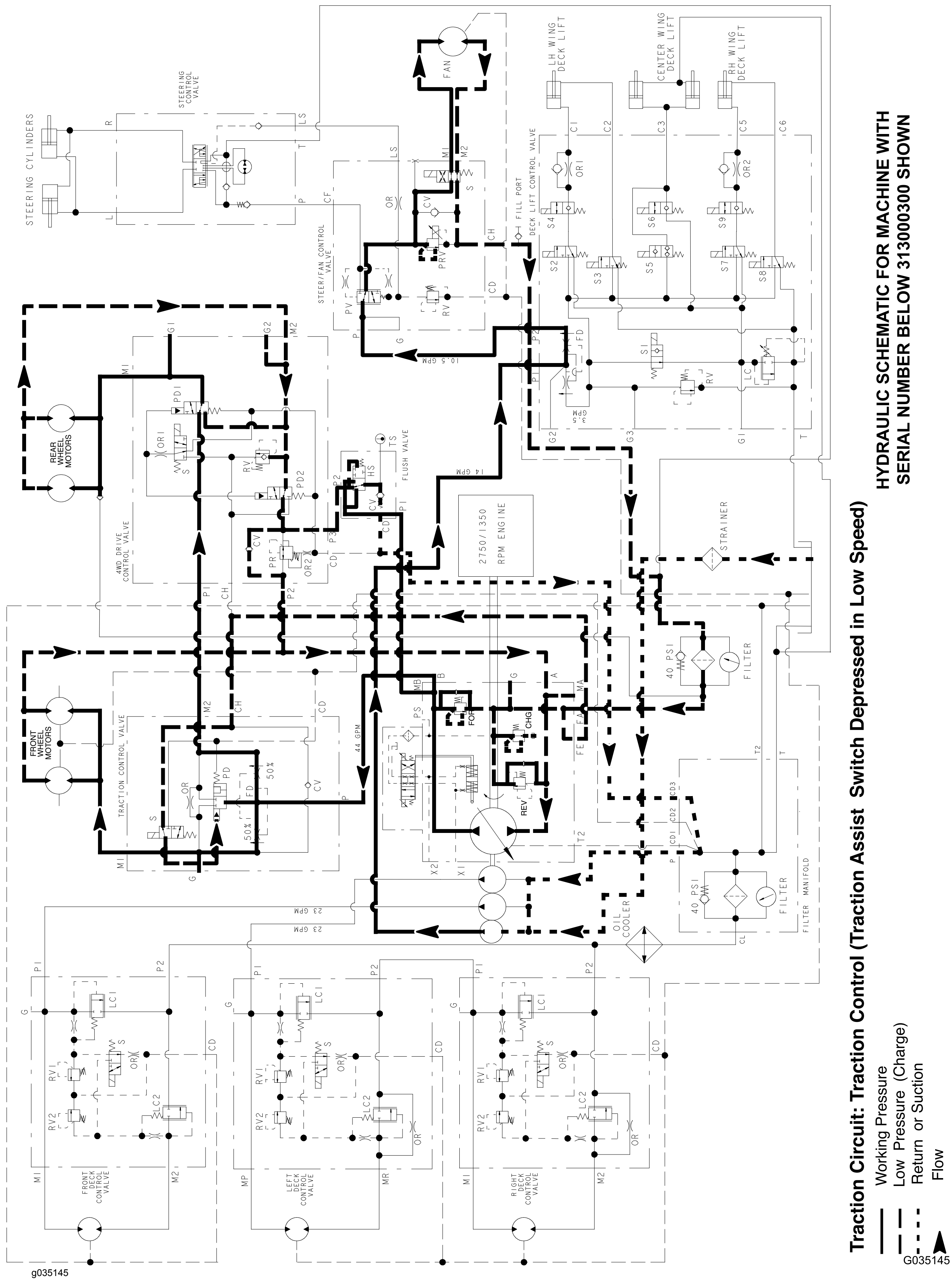

Figure 55

Traction Circuit: Traction Control

A flow divider is incorporated into the traction circuit to supply a proportioned flow to the front- and rear-wheel motors for a true 4-wheel drive system. When the Hi-Lo speed switch is in the LOW position and you press the traction pedal in the forward direction, the operator can engage the traction flow divider when low-traction situations could lead to wheel spin. The engaged flow divider divides the traction pump flow equally between the front- and rear-wheel motors to reduce the chance of excessive flow going to a spinning wheel.

The TEC-5001 controller does not allow the traction assist to operate while the tractor is in the high-speed range in either the forward or reverse direction. The controller also prevents the traction assist operation in the reverse direction while the machine is in the low-speed range.

The lift/lower circuit has a counterbalance system to enhance the traction control more. Applying a constant pressure to the base end of the lift cylinders enables you to get the counterbalance to lift the cutting decks a small distance. This action causes some of the cutting deck weight to be transferred to the traction unit to improve traction. An adjustable counterbalance valve (LC) in the deck-lift control manifold controls the amount of counterbalance pressure in the lift circuit.

Traction Assist Switch in the OFF Position

In the low-speed range with the traction assist switch in the OFF position, the solenoid valve (S) in the traction control manifold is de-energized to allow the PD cartridge spool in the NEUTRAL position. With the traction pedal in the forward direction, the hydraulic fluid from the hydrostat port MB enters the traction control manifold at port P, flows through the FD cartridge, and enters the PD cartridge. Flow at the PD cartridge divides into 2 circuits if the downstream pressure changes. The flow from the PD cartridge splits between the M1 manifold port for the front-wheel motors and the M2 manifold port for the rear-wheel motors.

Traction Assist Switch in the ON Position

In the low-speed range with the traction pedal in the forward direction and the momentary traction assist switch pressed and held in the ON position, the solenoid valve (S) in the traction control manifold is energized to allow the charge pressure to shift to the PD cartridge spool. The shifted PD cartridge blocks the fluid flow from the hydrostat, thereby pushing the hydrostat fluid flow through the FD proportional flow control valve. The flow from the hydrostat is divided approximately equally between the front- and rear-wheel motors while you press in the traction assist switch.

Traction Assist Switch in the On Position (continued)

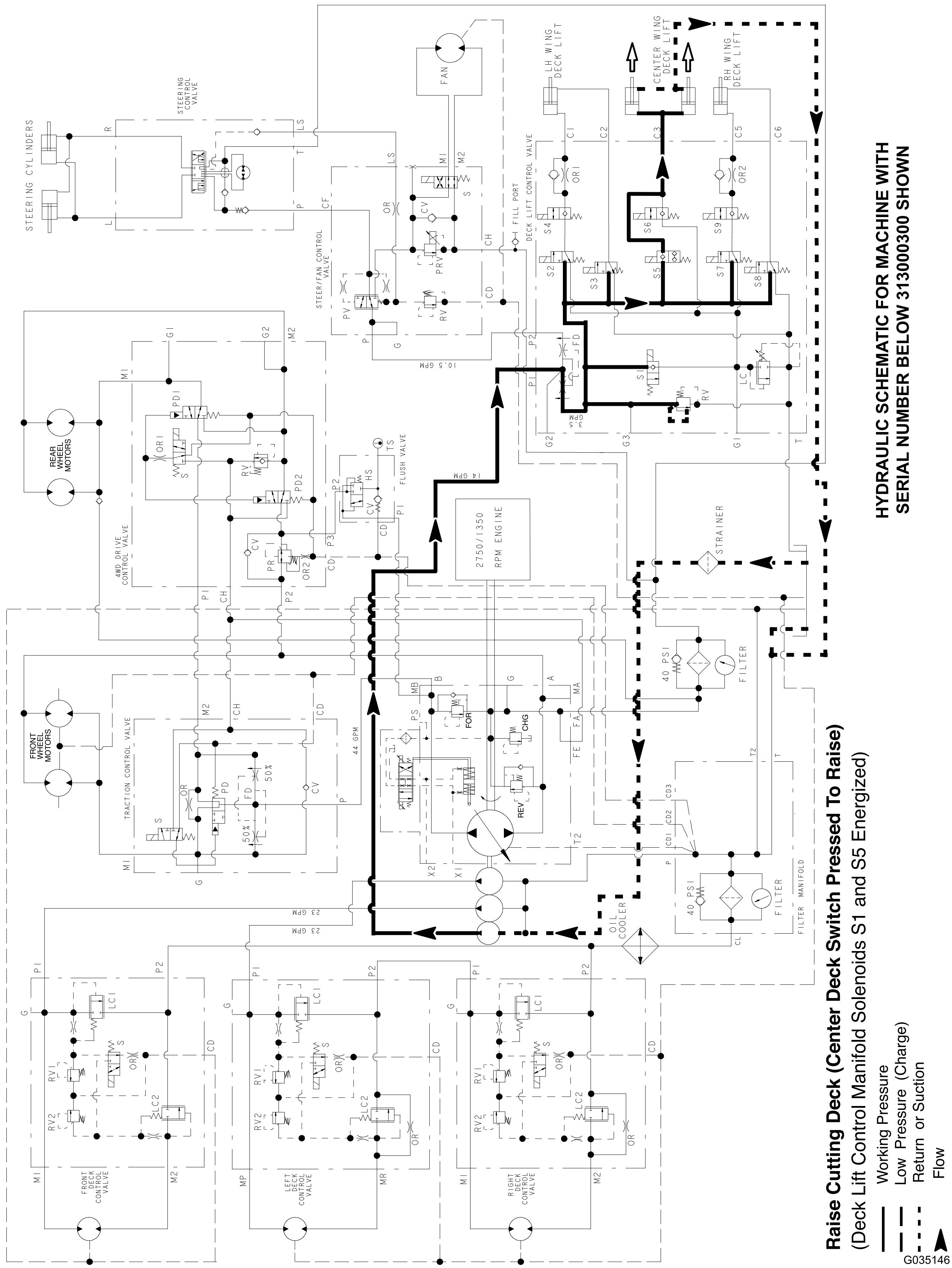

Figure 56

Raising the Cutting Deck

A 3-section gear pump is connected to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the lift-control manifold, steering/cooling fan control manifold, and traction charge circuit. The hydraulic flow from the pump section (P3) is divided between the lift/lower circuit and the steering/cooling fan/charge circuit by a proportional flow divider located in the lift-control manifold. This flow divider splits the pump flow approximately 25% for the lift/lower circuit (15.1 L/minute or 4 gallons/minute) and 75% for the steering/cooling fan/charge circuit (37.9 L/minute or 10 gallons/minute).

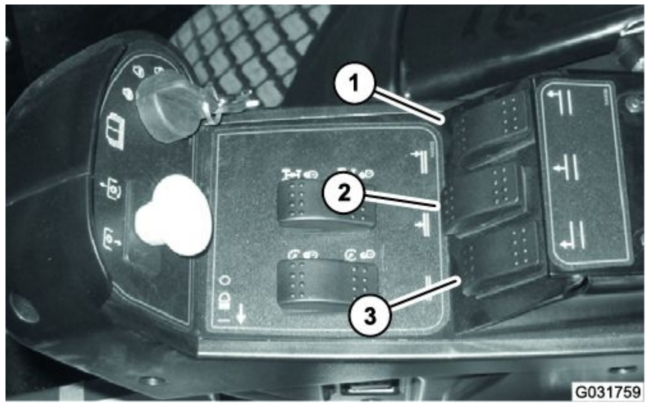

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Figure 57

1. Right deck switch
2. Center deck switch
3. Left deck switch

An adjustable counterbalance valve (LC) in the lift-control manifold keeps the back pressure on the deck-lift cylinders to transfer some of the cutting deck weight to the traction unit to improve the traction. A relief valve (RV) in the lift control manifold limits the lift/lower circuit pressure to 9,300 kPa (1,350 psi).

You can raise each of the cutting decks (center, right, and left) independently using 3 switches on the armrest console (Figure 57). Pressing the rear of a switch provides an input for the TEC-5001 controller to raise a cutting deck. The controller provides the electrical outputs to the solenoids in the lift-control manifold, allowing the appropriate valve shift to raise a deck.

When the cutting decks are stationary, all the solenoids in the lift-control manifold are de-energized. In this position, the flow from the gear pump that is proportioned for the lift/lower circuit is bypassed through the solenoid valve S1, counterbalance logic cartridge LC, and returns to the hydraulic-fluid reservoir.

Note: Ensure that the operator is in the operator's seat to raise a cutting deck.

Raising the Center Cutting Deck

To raise the center cutting deck, press the rear of the center console switch. The switch signal is an input to the TEC-5001 controller that gives an electrical output to the solenoid valves S1 and S5 in the lift-control manifold. The energized solenoid valves shift to allow a passage for circuit fluid flow to the head side of the center deck lift cylinder. The shifted S1 prevents the fluid flow from returning directly to the reservoir. The shifted S5 allows the fluid path to the head side of the lift cylinder to extend the lift cylinder and lift the center cutting deck. The fluid from the extending cylinder returns to the hydraulic reservoir.

When you release the deck switch, the lift/lower control solenoids are de-energized and the center deck lift cylinders and center cutting deck are held in position.

Raising the Right Cutting Deck

Press the rear of the right console switch to send an input to the TEC-5001 controller to raise the right cutting deck. The controller gives an electrical output to the solenoid valves S1 and S7 in the lift-control manifold. The energized solenoid valves shift to allow a passage for circuit fluid flow to the rod end of the right deck lift cylinder. The shifted S1 prevents the fluid flow from returning directly to the reservoir. The shifted S7 allows the fluid path through the check valve at S9 (de-energized), check valve at OR2, and to the head side of the lift cylinder to extend the lift cylinder and raise the right cutting deck. The fluid from the extending cylinder is directed through the S9 (de-energized) and returns to the hydraulic reservoir.

When you release the deck switch, the lift/lower control solenoids are de-energized and the lift cylinder and right cutting deck are held in position.

Raising the Left Cutting Deck

Press the rear of the left console switch to send an input to the TEC-5001 controller to raise the left cutting deck. The controller gives an electrical output to the solenoid valves S1 and S2 in the lift-control manifold. The energized solenoid valves move to allow a passage for circuit fluid flow to the head side of the left deck lift cylinder. The shifted S1 prevents fluid flow from returning directly to the reservoir. The shifted S2 allows the fluid path through the check valve at S4 (de-energized), check valve at OR1, and to the head side of the lift cylinder to extend the lift cylinder and raise the left cutting deck. The fluid from the extending cylinder is directed through S3 (de-energized) and returns to the hydraulic reservoir.

When you release the deck switch, the lift/lower control solenoids are de-energized and the lift cylinder and left cutting deck are held in position.

Raising the Left Cutting Deck (continued)

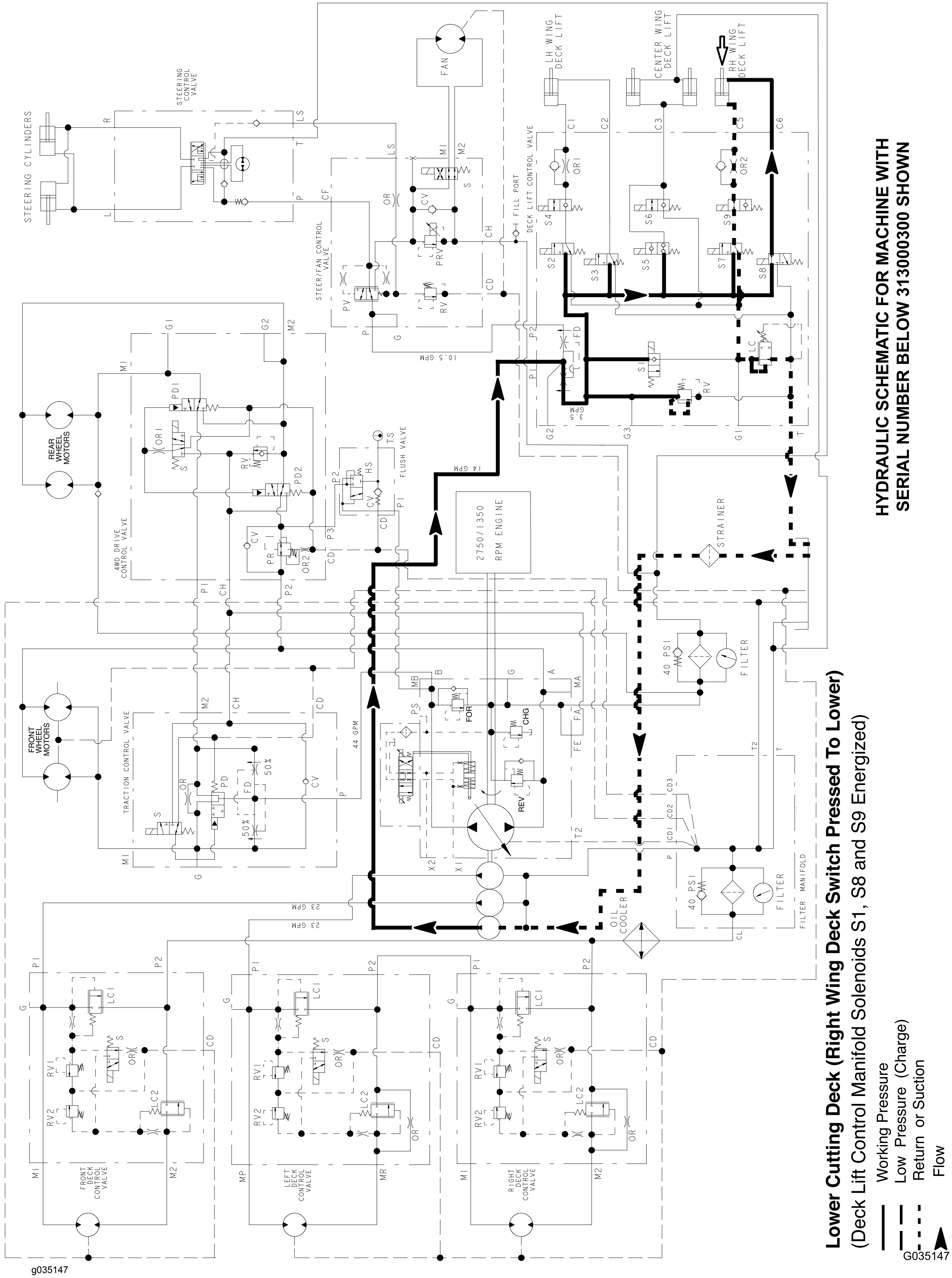

Figure 58

Lowering the Cutting Deck

A 3-section gear pump is connected to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the lift-control manifold, steering/cooling fan control manifold, and traction charge circuit. The hydraulic flow from the pump section (P3) is divided between the lift/lower circuit and the steering/cooling fan/charge circuit by a proportional flow divider in the lift-control manifold. This flow divider divides the pump flow approximately 25% for the lift/lower circuit and 75% for the steering/cooling fan/charge circuit.

An adjustable counterbalance valve (LC) in the lift-control manifold keeps the back pressure on the deck lift cylinders to transfer some of the cutting deck weight to the traction unit to improve traction. A relief valve (RV) in the lift-control manifold limits the lift/lower circuit pressure to 9,300 kPa (1,350 psi).

You can lower each of the cutting decks (center, right, and left) independently with the use of 3 switches on the armrest console (Figure 57). Pressing the front of a switch gives an input for the TEC-5001 controller to lower a cutting deck. The controller provides the electrical outputs to the solenoids in the lift-control manifold, allowing the applicable valve shift to lower the deck.

When the cutting decks are stationary, all the solenoids in the lift-control manifold are de-energized. In this position, the flow from the gear pump that is proportioned for the lift/lower circuit is bypassed through the solenoid valve S1, counterbalance logic cartridge LC, and returns to the hydraulic fluid reservoir.

Note: Ensure that the operator is in the operator’s seat to raise a cutting deck.

Lowering the Center Cutting Deck

Press the front of the center console switch to lower the center cutting deck. The switch signal is an input to the TEC-5001 controller, which gives an electrical output to the solenoid valve S6 in the lift-control manifold. The energized solenoid valve S6 moves to allow a passage for the fluid flow from the rod end of the center deck lift cylinders. The weight of the cutting deck causes the center deck lift cylinders to retract and lower the center cutting deck.

When you release the deck switch, the lift/lower control solenoid is de-energized and the lift cylinders and center cutting deck are held in position.

Lowering the Right Cutting Deck

Press the front of the right console switch to send an input to the TEC-5001 controller to lower the right wing deck. The controller gives an electrical output to the solenoid valves S1, S8, and S9 in the lift-control manifold. The energized solenoid valves shift to allow a passage for circuit fluid flow to the rod end of the right deck lift cylinder. The shifted S1 prevents the fluid flow from returning directly to the reservoir. The shifted S8 allows a fluid path to the shaft end of the lift cylinder to retract the lift cylinder and lower the right cutting deck. The fluid from the retracting cylinder flows through orifice OR2 to control the drop speed of the cutting deck. Flow is then directed through the moved S9, counterbalance valve (LC), and returns to the hydraulic reservoir.

When you release the deck switch, the lift/lower control solenoids de-energize and the lift cylinder and right cutting deck are held in position.

Lowering the Left Cutting Deck

Press the front of the left console switch to send an input to the TEC-5001 controller to lower the left wing deck. The controller gives an electrical output to the solenoid valves S1, S3, and S4 in the lift-control manifold. The energized solenoid valves shift to allow a passage for circuit fluid flow to the rod end of

Lowering the Left Cutting Deck (continued)

the left deck lift cylinder. The shifted S1 prevents fluid flow that returns directly to the reservoir. The shifted S3 allows a fluid path to the shaft end of the lift cylinder to retract the lift cylinder and lower the left cutting deck. The fluid from the retracting cylinder flows through orifice OR1 to control the drop speed of the cutting deck. Flow is then directed through the shifted S3, counterbalance valve (LC), and returns to the hydraulic reservoir.

When you release the deck switch, the lift/lower control solenoids de-energize and the lift cylinder and left cutting deck are held in position.

Cutting Deck Float

The cutting deck float allows the fully lowered cutting decks to follow the ground surface contours. The lift-control manifold solenoid valves S4 (left deck), S6 (center deck), and S9 (right deck) are energized when you fully lower the decks. These energized solenoids provide a fluid passage to and from the lift cylinders to allow the cylinder and cutting deck movement while it moves. Counterbalance pressure affects the operation of the deck float.

Note: If you fully lower a deck and move the key switch from the OFF position to the RUN position, the deck is not in float until you momentarily press the deck lift/lower switch to lower.

Cutting Deck Float (continued)

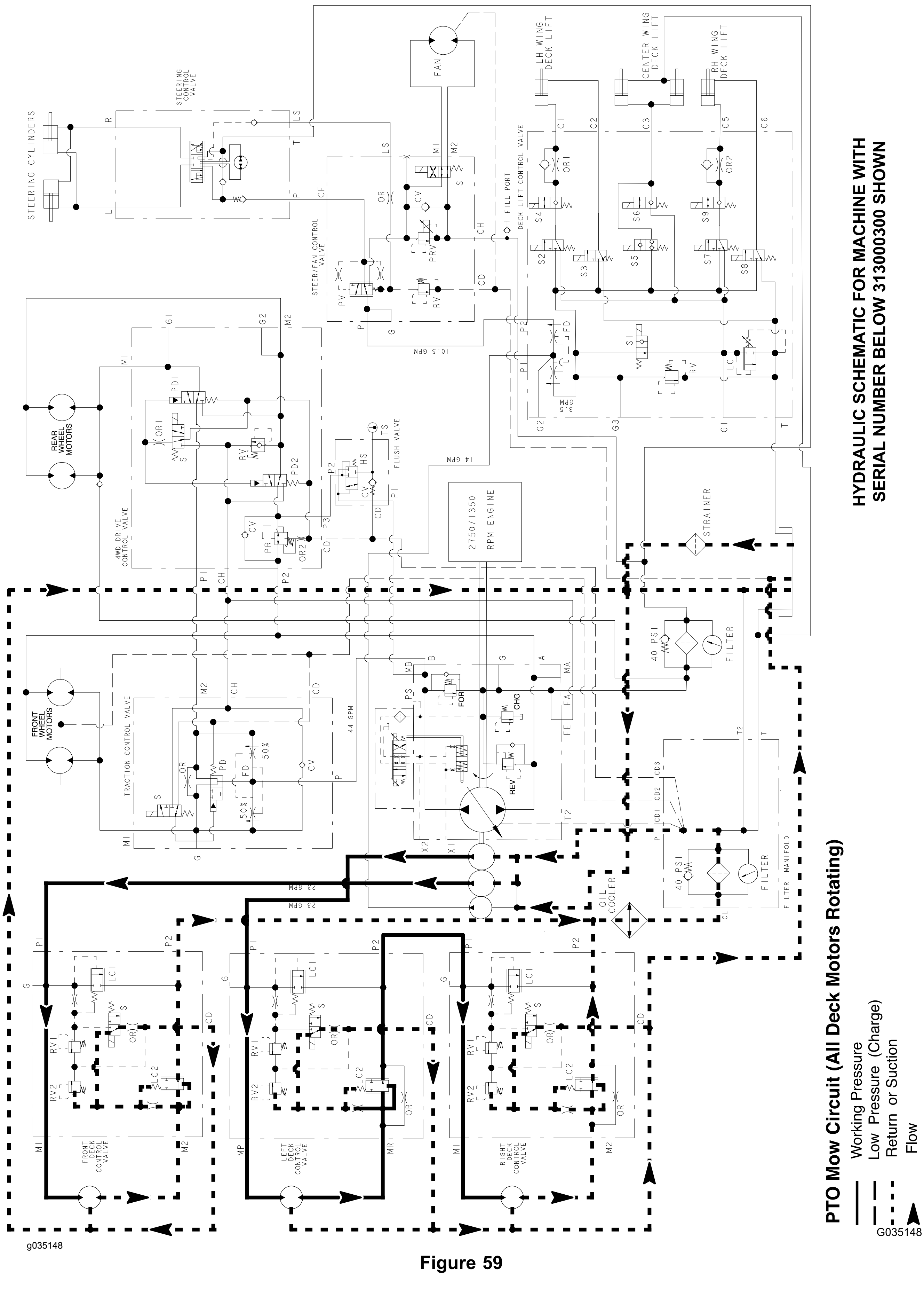

Figure 59

PTO Mow Circuit

A 3-section gear pump is connected to the piston (traction) pump. The hydraulic flow for the PTO mow circuit is supplied by 2 sections of the gear pump. The gear pump section (P1) nearest to the piston pump supplies hydraulic flow in series to the right and left decks, while the next gear pump section (P2) supplies the center deck. Each of the 3 cutting decks is controlled by a hydraulic control manifold equipped with a solenoid control valve (S); logic cartridges (LC1) and (LC2); a brake-relief cartridge (RV2); and a circuit-relief cartridge (RV1).

PTO Disengaged

When you turn off the PTO switch or if you raise the deck with the PTO switch on, the PTO manifold solenoid valve (S) is not energized and the solenoid spool is in the NEUTRAL position. The solenoid valve spool in neutral allows a small amount of hydraulic flow to return to the tank through a manifold sensing line that causes a pressure increase, shifting the logic cartridge LC1. The pump flow is routed through the shifted LC1 and out manifold port P2. The logic cartridge LC2 stays in the unshifted position to prevent the return flow from the deck motor to keep the motor from rotating.

Return flow from the front and right deck control manifolds is routed through the oil cooler, oil filter, and then to the gear-pump input. Return flow from the left deck control manifold supplies the right deck.

PTO Engaged

When you turn on the PTO switch and lower the decks, the TEC-5002 controller does not energize the PTO control-manifold solenoid valve (S). The shifted solenoid valve spool prevents the sense line flow through the spool, which causes the logic cartridge LC1 to be in its NEUTRAL position. The gear pump flow entering the manifold is routed out to the manifold port M1 and then to the cutting deck motor. The return flow from the deck motor again enters the manifold port M2. The shifted solenoid valve spool allows a small amount of hydraulic flow to return to the tank through a manifold sensing line, which causes a pressure increase that shifts the logic cartridge LC2. The hydraulic flow is routed through the shifted LC2, out manifold port P2, through the oil cooler and filter and then is routed to the gear pump input. The deck motor continues to rotate as long as solenoid valve (S) is energized.

The deck motor case drain leakage returns directly to the hydraulic reservoir.

PTO Circuit Relief

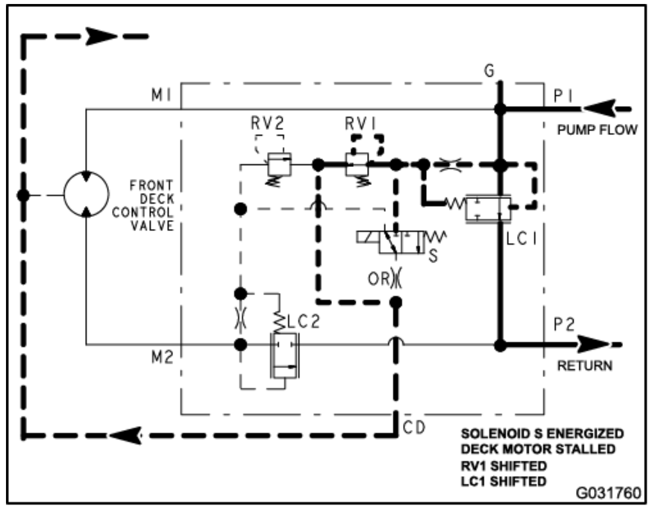

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Figure 60

A relief valve (RV1) in the hydraulic control manifold limits the maximum mow circuit pressure for each deck. The center and left deck relief valves are set at 20,700 kPa (3,000 psi) and the right deck relief valve is set at 13,800 kPa (2,000 psi).

The relief valve (RV1) and logic cartridge (LC1) work together as a 2-stage relief. When there is increased circuit resistance or if a cutting blade hits an object, the relief valve feels the increased pressure. If the circuit pressure is more than the relief valve setting, the relief valve opens and allows a small amount of hydraulic flow to return to the tank through a manifold sensing line. This flow causes a pressure increase that shifts the logic cartridge LC1 and diverts the circuit flow away from the deck motor to manifold port P2 (Figure 60). When the circuit pressure lowers, the relief valve (RV1) closes, returning the logic cartridge LC1 to its NEUTRAL position and allowing the flow to return to the deck motor.

PTO Mow Circuit Cutting Deck Blade Braking

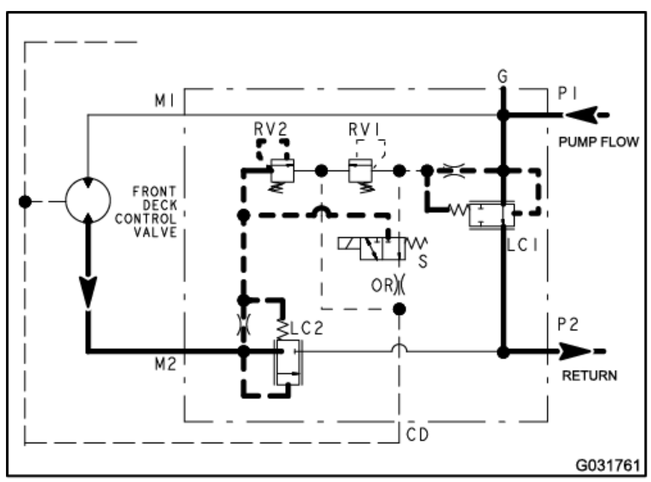

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Figure 61

PTO Mow Circuit Cutting Deck Blade Braking (continued)

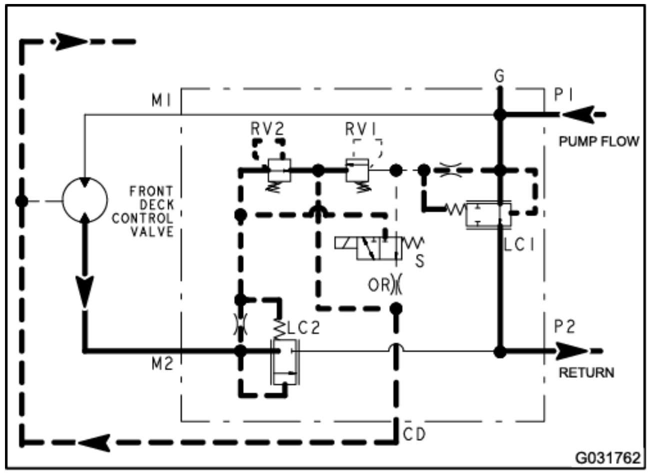

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Figure 62

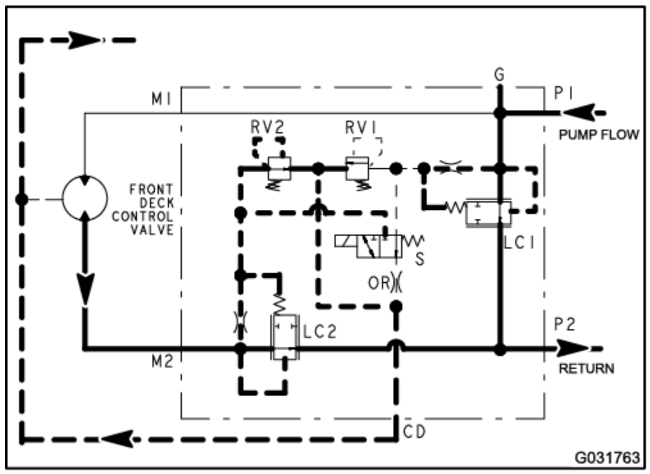

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Figure 63

When the operator turns the PTO switch to the OFF position or if the deck is in the raised position with the PTO switch on, the PTO control manifold solenoid valve (S) gets de-energized causing logic cartridge (LC1) to shift; refer to PTO Mow Circuit (page 4–32). This shifted cartridge allows the fluid to return to manifold port P2. At the same time, the solenoid valve (S) in the NEUTRAL position prevents any sense line from flowing through the spool, which causes the logic cartridge LC2 to shift to the NEUTRAL position, blocking the return flow from the deck motor and slowing down the cutting blades (Figure 61).

The inertia of the rotating cutting blades effectively turns the deck motor into a pump, causing an increase in the pressure, as the flow from the motor comes up in contact with the closed logic cartridge (LC2). When this pressure builds to approximately 4,100 kPa (600 psi), the relief valve (RV2) opens and allows a small amount of hydraulic flow to return to the tank through a manifold sensing line (Figure 62). This flow causes a pressure increase that shifts the logic cartridge LC2 and once again allows the fluid flow from the motor (Figure 63). When return pressure drops below 4,100 kPa (600 psi), the relief valve (RV2) reseats and cause LC2 to close and again block the return flow from the deck motor to slow down the cutting blades more. The brake relief valve opening and the logic cartridge shifting occurs several times in a very short time as the blades come to a stop. Once the blades stop, the logic cartridge LC2 remains in the NEUTRAL position to keep the deck motor from rotating.

PTO Mow Circuit Cutting Deck Blade Braking (continued)

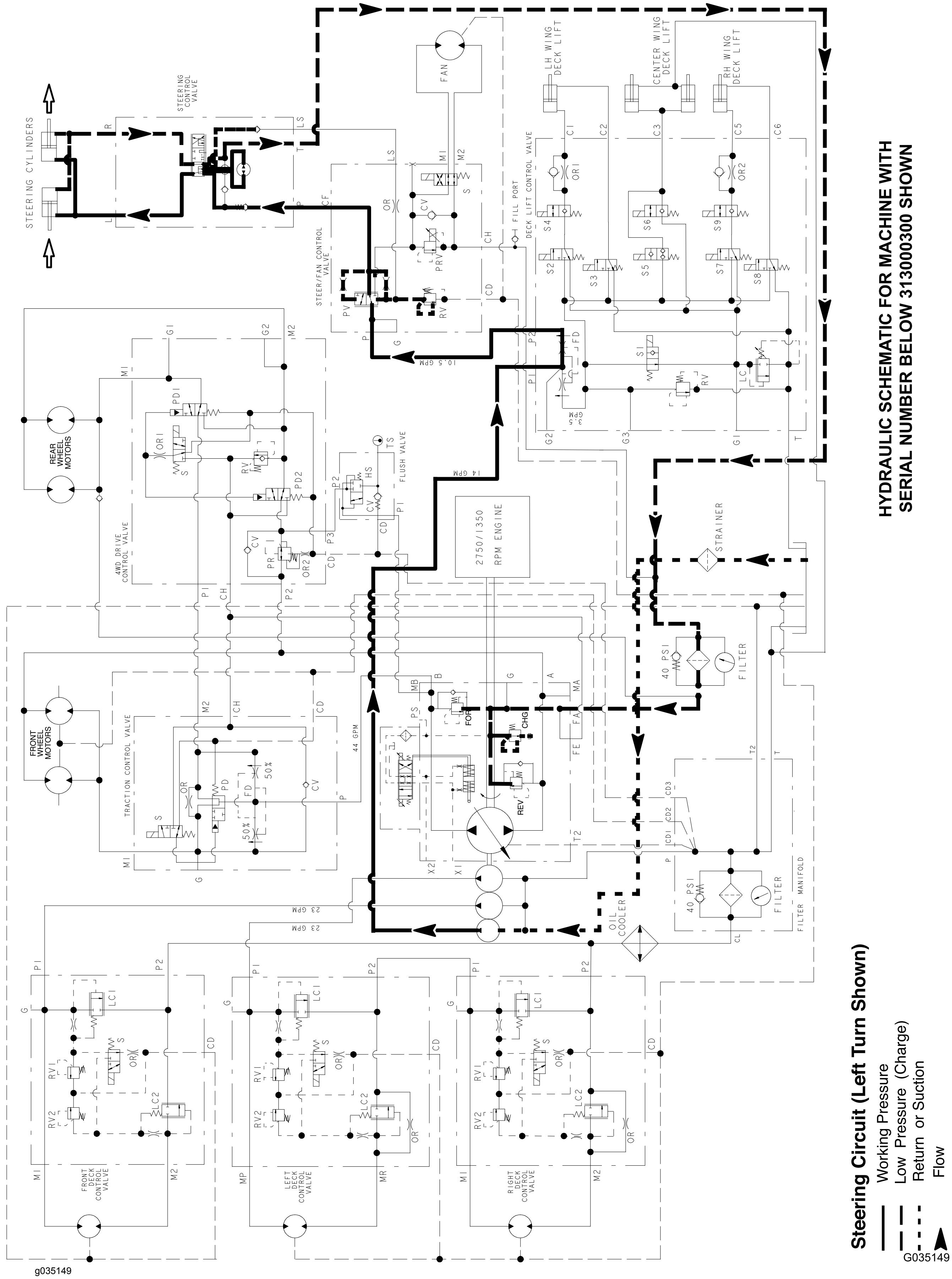


Figure 64

Steering Circuit

A 3-section gear pump is connected to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the steering/cooling fan control manifold, lift control manifold, and traction charge circuit. The hydraulic flow from pump section (P3) is divided between the steering/cooling fan/charge circuit and the lift/lower circuit by a proportional flow divider located in the lift-control manifold. This flow divider divides the pump flow approximately 75% for the steering/cooling fan/charge circuit (39.7 L/minute or 10.5 gallons/minute) and 25% for the lift/lower circuit (13.2 L/minute or 3.5 gallons/minute).

The steering/cooling fan control manifold controls the operation of the steering control valve and the gear motor drives the engine cooling fan. The priority valve (PV) in the manifold controls the fluid flow to the steering control valve that is a closed center, load sensing valve. The steering control valve senses the fluid flow necessary to steer and the priority valve (PV) supplies the correct amount of fluid. The fluid not used by steering is provided to the cooling fan motor.

When the steering wheel is in the NEUTRAL, at-rest position and engine is running, the hydraulic fluid from the lift-control manifold flow divider enters the steering/cooling fan control manifold port P, flows through the priority valve (PV), and through the steering control valve, where it stops at the spool. The fluid is also sent to both ends of the (PV) spool. At 1 end of the spool, fluid is directed to the steering-relief valve (RV) and is directed through the OR orifice and out to the LS manifold port to the steering-control valve. This flow provides steering-load sense pressure and is directed through a small passage in the steering-control valve spool and sleeve before returning to the charge circuit. While this load sense pressure returns to the charge circuit, the priority valve (PV) spool shifts to direct the pump flow to the engine fan motor circuit. The fluid does not flow through the steering-control valve without the steering input.

Turning Left

When turning the machine left with the engine running, the turning of the steering wheel positions the spool valve so that the load sense flow is blocked off. Without load-sense flow, the pressure on the ends of the manifold priority valve (PV) starts to equalize, causing the priority valve to move to its NEUTRAL position, which allows the required fluid to flow to the steering control valve. The fluid is routed out from manifold port CF into the steering valve port P, and through the steering control spool is pulled through the rotary meter section and out of the L port to the steering cylinders. The rotary meter ensures that the fluid flow to the cylinders is proportional to the amount of turn on the steering wheel. The fluid that leaves the cylinders flows back through the steering valve R port, spool valve, out the T port, and then used for traction circuit charge fluid.

The steering wheel and steering control valve return to the NEUTRAL position when the turn is complete.

Turning Right

When turning the machine right with the engine in operation, the turning of the steering wheel positions the spool valve so that the load sense flow is blocked off. Without load-sense flow, the pressure on the ends of the manifold priority valve (PV) starts to equalize, causing (PV) to move to its NEUTRAL position, which allows the required fluid to flow to the steering control valve. The fluid is routed out from manifold port CF into the steering valve port P, through the steering control spool is drawn through the rotary meter section and out of the R port to the steering cylinders. The rotary meter ensures that the fluid flow to the cylinders is proportional to the amount of turn on the steering wheel. The

Turning Right (continued)

fluid that leaves the cylinders flows back through the steering valve L port, spool valve, out of the T port and then used for traction circuit charge fluid.

The steering wheel and steering control valve return to the NEUTRAL position when the turn is complete.

Steering Relief Operation

While steering, when the steering cylinders are at the end of their stroke or if there is a obstruction in a rear wheel (e.g., a curb), the pressure in the steering circuit increases. The relief valve (RV) in the steering/cooling fan control manifold senses this pressure increase. When this pressure builds to approximately 14,500 kPa (2,100 psi), the relief valve (RV) opens, allowing the hydraulic flow to return to the tank. This causes flow across the relief valve side orifice of priority valve (PV), which shifts the spool in (PV) to send fluid away from the steering circuit to the fan motor circuit. The relief valve (RV) controls the action of priority valve (PV) and allows the priority valve to divert only the sufficient fluid flow to the steering circuit to keep the relief pressure.

Steering Relief Operation (continued)

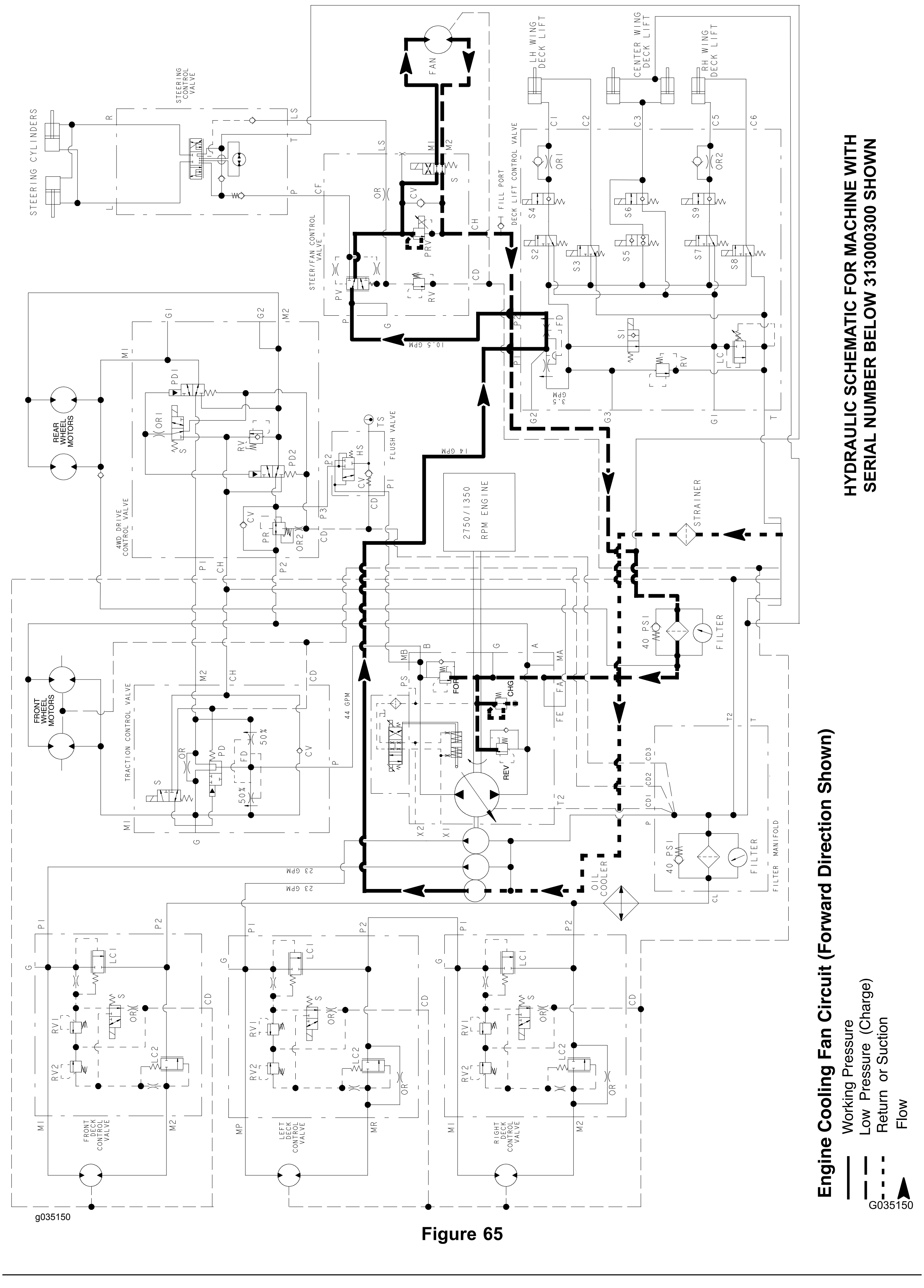


Figure 65

Engine Cooling Fan Circuit

A 3-section gear pump is connected to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the steering/cooling fan control manifold, the lift-control manifold and the traction charge circuit. The hydraulic flow from pump section (P3) is divided between the steering/cooling fan/charge circuit and the lift/lower circuit by a proportional flow divider located in the lift control manifold. This flow divider splits pump flow approximately 75% for the steering/cooling fan/charge circuit (39.7 L/minute or 10.5 gallons/minute) and 25% for the lift/lower circuit (13.2 L/minute or 3.5 gallons/minute).

The steering/cooling fan control manifold controls the operation of the steering control valve and the gear motor that drives the engine cooling fan. The priority valve (PV) in the manifold controls the fluid flow to the steering control valve that is a closed center, load-sensing valve. The steering-control valve senses the fluid flow that requires steering and the priority valve (PV) supplies the correct amount of fluid. The fluid not used by steering is provided to the fan motor. The steering/cooling fan-control manifold controls the speed and direction of the fan motor based on the electrical output from the TEC-5002 controller.

When the steering wheel is in the NEUTRAL, at-rest position, and the engine is running, the hydraulic fluid from the lift control manifold flow divider enters the steering/cooling fan control manifold port P, flows through the priority valve (PV), and to the steering control valve, where it stops at the spool. The fluid is sent to the both ends of the (PV) spool. On 1 end of the spool, fluid is directed to the steering relief valve (RV) and is directed through the OR orifice and out LS manifold port to the steering-control valve. This flow provides steering load sense pressure and is directed through a small passage in the steering control valve spool and sleeve before returns to the charge circuit. While this load sense pressure that goes back to the charge circuit, the priority valve (PV) spool moves to the direct pump flow to the cooling fan motor circuit. The fluid does not flow through the steering control valve without steering input, so all the circuit fluid is available for the cooling fan motor.

The proportional relief valve (PRV) controls the fluid flow from the priority valve (PV) to the cooling fan. The PRV adjusts the fan circuit pressure and flow based on a PWM (pulse width modulation) signal from the TEC-5002 controller. The controller uses engine coolant and hydraulic-fluid temperature to give the proper PWM signal for the PRV. The fan circuit flow selects the speed of the cooling fan.

If the fan motor stalls for some reason, the priority valve (PRV) has a secondary function as a circuit relief to limit the fan motor pressure to 22,800 kPa (3,300 psi).

When the engine is turned off, the over-running inertia load of the fan blades drives the fan motor and turns the fan motor into a pump. The check valve (CV) in the steering/cooling fan control manifold opens to keep the motor circuit full of fluid so that the fan motor does not cavitate.

Forward Direction Fan Operation

The fluid flow from the priority valve (PV) is sent through the de-energized solenoid valve (S), out manifold port M1, and then to turn the cooling fan motor. Return flow from the motor enters the manifold at port M2, through the de-energized solenoid valve (S), out the manifold port CH and then used for traction circuit charge fluid.

Reverse Direction Fan Operation

The TEC-5002 controller can move the cooling fan in reverse direction to clean the unwanted material from the radiator, oil cooler, and rear intake screen. If the hydraulic fluid and/or engine coolant temperature increase to a level that is too high, the PWM signal to the PRV valve is sent to slow down the cooling fan. The controller then energizes the solenoid valve (S) in the steering/cooling fan control manifold to move the cooling fan motor fluid flow in the reverse direction so that the controller runs in reverse. The controller selects the amount of time that the fan should run in reverse before the fan runs in the forward direction.

Special Tools

You can order these special tools from your Toro Distributor.

Hydraulic Pressure Testing Kit

g031764

Figure 66

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: 7,000 kPa (1,000 psi), 35,000 kPa (5,000 psi), and 70,000 kPa (10,000 psi) gauges; refer to Testing the Hydraulic System (page 4–52).

Toro Part No. TOR47009

15 GPM Hydraulic Tester (Pressure and Flow)

g031765

Figure 67

Use this tester to test the hydraulic circuits and components for flow and pressure capacities as recommended in Testing the Hydraulic System (page 4–52). This tester includes the following:

1. Inlet Hose: This hose connects the system circuit to the inlet side of the hydraulic tester.
2. Load Valve: Turn the valve to restrict the flow to create a simulated working load in the circuit.
3. Pressure Gauge: A glycerine filled pressure gauge 0 to 35,000 kPa (0 to 5,000 psi) to provide operating circuit pressure.

15 GPM Hydraulic Tester (Pressure and Flow) (continued)

4. Flow Meter: This meter measures the actual fluid flow in the operating circuit with a gauge rated at 5 to 55 L/minute (1 to 15 gallons/minute).
5. Outlet Hose: A hose from the outlet side of the hydraulic tester that connects to the hydraulic system circuit.
6. Fittings: An assortment of hydraulic fittings are included with this kit.

Toro Part No. TOR214678

40 GPM Hydraulic Tester (Pressure and Flow)

g035151

Figure 68

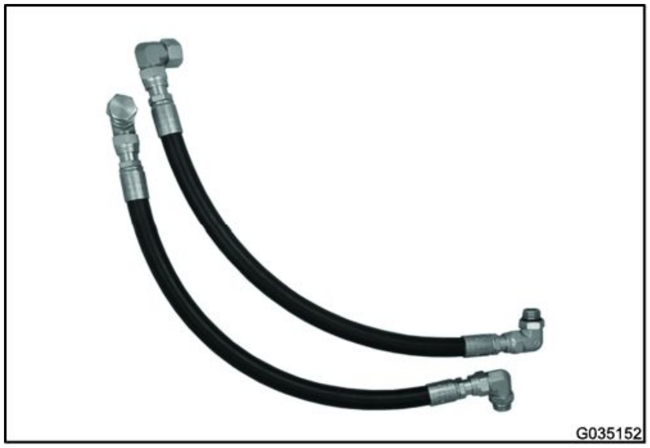
Use this tester to test the hydraulic circuits and components for flow and pressure capacities as recommended in Testing the Hydraulic System (page 4–52). This tester includes the following:

1. Load Valve: Turn the valve to restrict the flow to create a simulated working load in the circuit.
2. Pressure Gauge: A glycerine filled pressure gauge 0 to 35,000 kPa (0 to 5,000 psi) to provide operating circuit pressure.
3. Flow Meter: This meter measures the actual fluid flow in the operating circuit with a gauge rated at 20 to 150 L/minute (4 to 40 gallons/minute).

Toro Part No. AT40002

Note: This tester does not include the hoses; refer to Hydraulic Hose Kit (page 4–44).

Hydraulic Hose Kit



g035152

Figure 69

This kit includes the fittings and hoses that are used to connect the 40 GPM hydraulic tester (AT40002) or high flow hydraulic filter kit (TOR6011) to the machine hydraulic traction system components.

Toro Part No. TOR6007

High Flow Hydraulic Filter Kit

g035050

Figure 70

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 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.

Toro Part No. TOR6011

High Flow Hydraulic Filter Kit (continued)

Note: This kit does not include the hoses; refer to Hydraulic Hose Kit (page 4–44).

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

O-Ring Kit

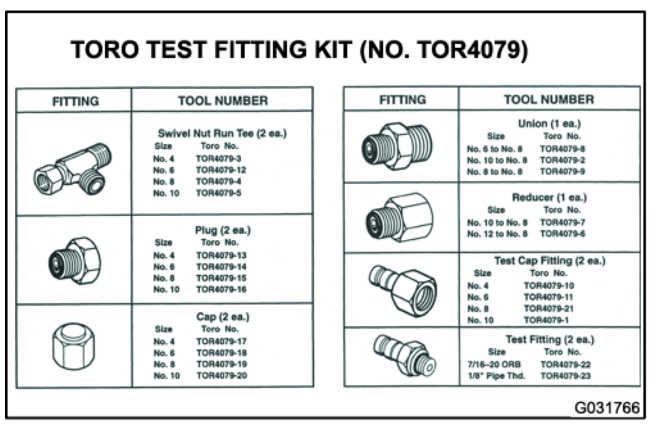
g033395

Figure 71

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

Toro Part No. 117-2727

Hydraulic Test Fitting Kit



g031766

Figure 72

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

The kit includes: tees, unions, reducers, plugs, caps, and male test fittings.

Toro Part No. TOR4079

Measuring Container

g031767

Figure 73

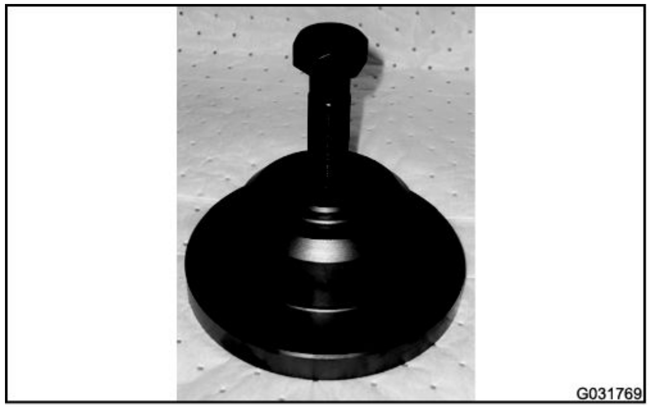
Use this container to test hydraulic motor efficiency (motors with case drain lines only). Limit the outlet flow from the motor and measure the leakage from the case drain line to measure the efficiency of a hydraulic motor while the hydraulic system pressurizes the motor.

The table gives the gallons per minute (gpm) conversion for the measured milliliter or ounce motor case drain leakage.

Toro Part No. TOR4077

GPM	mL/15 seconds	oz/15 seconds
0.1	95	3.2
0.2	189	6.4
0.3	284	9.6
0.4	378	12.8
0.5	473	16.0
0.6	568	19.2
0.7	662	22.4
0.8	756	25.6
0.9	852	28.8
1.0	946	32.0

Rear Wheel Hub Puller



g031769

Figure 74

The rear wheel hub puller allows you to safely remove the wheel hub from the rear wheel motor shaft.

Toro Part No. TOR6100

Troubleshooting

The following charts contains information to troubleshoot hydraulic circuit problems. There can be more than 1 cause for a machine malfunction.

Refer to Testing the Hydraulic System (page 4–52) for precautions and specific hydraulic test procedures.

General Hydraulic System Problems

Problem	Possible Causes
The hydraulic system operates hot.	• The engine speed is too low. • The hydraulic-fluid level in the reservoir is low. • The hydraulic fluid is contaminated or is the wrong type. • The brakes are applied or they do not move freely. • The piston pump by-pass valve is open or damaged. • The cooling system does not operate correctly. • The charge pressure is low. • The traction circuit pressure is incorrect. • The pump(s) or motor(s) are damaged.
The hydraulic fluid in the reservoir foams.	• The hydraulic reservoir fluid level is low. • The wrong type of fluid is in the hydraulic system. • There are air leaks in the suction line.
The hydraulic fluid is leaking.	• The fitting(s), hose, or tube is loose or damaged. • An O-ring is missing or damaged.

Traction Problems

Problem	Possible Causes
The machine operates in 1 direction only.	• The system charge check valve and/or the system relief valve is not functioning. • The orifice or screen in the piston (traction) pump control assembly is blocked or damaged. • The pilot direction valve in 4-wheel drive control manifold is damaged or does not move freely. • The traction-control potentiometer is not functioning.
The traction pedal is sluggish.	• The traction control pedal is stuck or does not move freely. • The charge pressure is low. • The piston pump servo control valve is damaged.
The machine travels too far before it stops when you release the traction pedal.	• Traction control pedal assembly does not move freely or is out of adjustment. • The piston pump servo control valve is damaged. • The traction pedal does not return to the NEUTRAL position.
The traction power is lost or the machine does not operate in either direction.	• The hydraulic-fluid level in the reservoir is low. • The brakes are applied or they do not move freely. • The charge pressure is low. • The piston pump bypass valve is open or damaged. • The orifice or screen in the piston (traction) pump control assembly is blocked or damaged. • The traction-control potentiometer is damaged or disconnected.
The 4-wheel drive does not engage.	• An electrical problem exists; refer to the Chapter 5: Electrical System (page 5–1). • The solenoid valve on the 4-wheel drive control manifold is not functioning. • Cartridge valve in 4-wheel drive control manifold is damaged or does not move freely.
The 4-wheel drive does not disengage.	• An electrical problem exists; refer to the Chapter 5: Electrical System (page 5–1). • The solenoid valve on the 4-wheel drive control manifold is not functioning. • Cartridge valve in 4-wheel drive control manifold is damaged or does not move freely.

PTO Problems

Problem	Possible Causes
The cutting decks do not operate. **Note:** The decks must be fully lowered and the traction speed in the MOW position for the decks to operate.	• An electrical problem exists; refer to the Chapter 5: Electrical System (page 5–1). • The gear pump is worn or damaged.
A cutting deck motor does not operate.	• An electrical problem exists; refer to the Chapter 5: Electrical System (page 5–1). • There is a problem with the cutting deck; refer to Chapter 8: Cutting Decks (page 8–1). • The system pressure to the affected deck motor is low. • The Woodruff key on the affected deck motor is damaged (the motor rotates but the deck belt and blades do not rotate). • The solenoid valve in the deck PTO control manifold is not functioning. • The cartridge valve in the deck PTO control manifold is damaged or does not move freely. • The deck motor or gear pump section is damaged.
All the cutting deck motors operate slowly.	• The engine speed is too low. • There is a problem with the cutting deck; refer to Chapter 8: Cutting Decks (page 8–1). • The deck motor or gear pump section is damaged.
The cutting deck stops under a load.	• The relief valve in the deck PTO control manifold is bypassed. • There is a problem with the cutting deck; refer to Chapter 8: Cutting Decks (page 8–1). • The deck motor has internal leakage (bypassed fluid). • The cutting deck gear pump section is inefficient.

Steering Circuit Problems

Problem	Possible Causes
Steering is off or slow.	• The steering components (e.g., tie rods, steering cylinder ends) are worn or do not move freely. • The steering cylinder does not move freely. • The hydraulic-fluid level in the reservoir is low (other hydraulic systems affected as well). • The steering-relief valve (RV) in the steering/cooling fan control valve does not move freely or is damaged. • The flow divider (FD) in the deck-lift control valve is not functioning. • The proportional valve (PV) in the steering/cooling fan control valve is not functioning. • The steering cylinder leaks internally. • The steering control valve is worn or damaged. • The gear pump section (P3) is worn or damaged. **Note:** A worn or damaged gear pump section (P3) affects the traction (charge) and lift circuits.

Lift/Lower Problem

Problem	Possible Causes
The cutting deck does not raise.	• The engine speed is too low. • The hydraulic-fluid level in the reservoir is low. • The lift-arm pivots do not move freely. • A lift cylinder is damaged. • The relief valve in the lift-control manifold does not move freely. • The pilot valve in the lift-control manifold is damaged or does not move freely. • The proportional flow divider in the lift-control manifold is not functioning. • The gear pump section for the lift-control manifold is worn or damaged.
The cutting deck raises, but does not stay up. **Note:** The lift cylinders cannot give a fully perfect seal. The lift arms lower after some time if they are left in the raised position during storage.	• The lift-circuit lines or fittings are leaking. • A lift cylinder is damaged.
The side cutting deck lowers too quickly.	• The orifice in the lift-control valve is missing or damaged. • The check valve in the lift-control valve is not functioning.
The side cutting deck lowers too slowly.	• The orifice in the lift-control valve is connected or not functioning. • The lift-arm pivots do not move freely. • A lift cylinder is damaged.
The cutting deck does not lower.	• The lift-arm pivots do not move freely. • A lift cylinder is damaged. • The counterbalance pressure is too much. • The lift-control valve is worn or damaged. • The pilot valve in the lift-control manifold is damaged or does not move freely.

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 4–42).

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

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

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.

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.**

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 Releasing Pressure from the Hydraulic System (page 4–6).

1. 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 too much wear on hydraulic components.
2. Install metal caps or plugs on the hydraulic lines that are left open or exposed during the testing or removal of the components.
3. Ensure that the engine is in good operating condition.

   Note: Use a phototac when you perform a hydraulic test. The engine speed can affect the accuracy of the tester readings.
4. Ensure that the inlet and the outlet hoses for a tester with pressure and flow capabilities are properly connected and not reversed to prevent damaging the hydraulic tester or components.
5. When you use a hydraulic tester with pressure and flow capabilities, open the tester load valve fully before you start the engine to reduce the possibility of damaging the components.
6. Install the fittings by hand and ensure that they are not cross-threaded before you tighten them with a wrench.
7. Position the tester hoses to prevent the rotating machine parts from damaging the hoses or tester.
8. Check the hydraulic-fluid level in the hydraulic reservoir. Ensure that the tank is full after you connect the test equipment.
9. Check the control linkages for incorrect adjustment, free movement, or broken parts.
10. Install the test gauges, operate the engine at low speed, and check for hydraulic-fluid leaks.
11. Perform all the hydraulic tests with hydraulic fluid at normal operating temperature.
12. Before using the machine, ensure that the hydraulic reservoir has the correct fluid level. Remove the test equipment and check for hydraulic-fluid leaks.

Determining which Hydraulic Tests to Perform

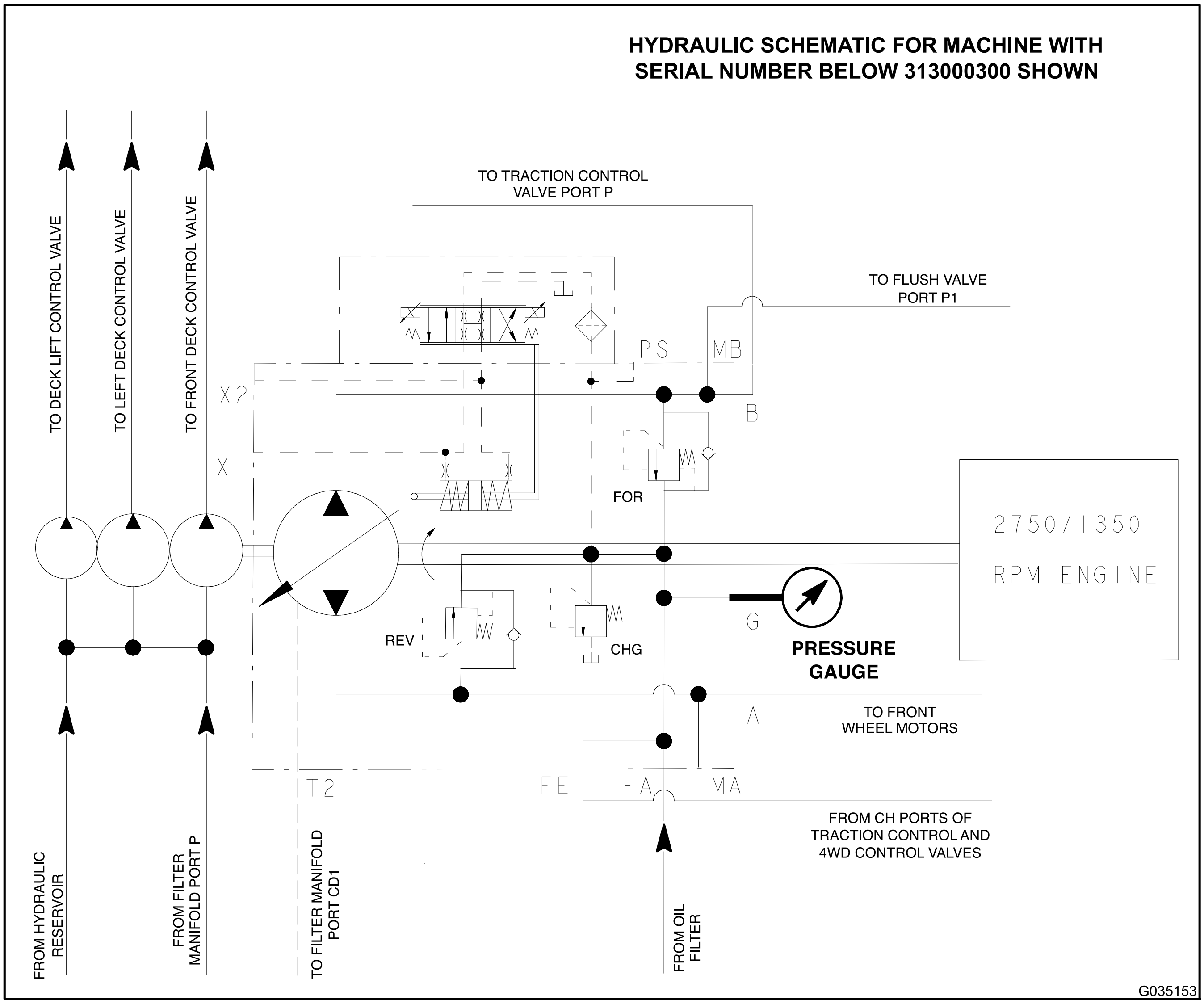
Before beginning any hydraulic test, identify if the problem is related to the traction circuit, the PTO (mow) circuit, the lift circuit, or the steering/engine-cooling-fan circuit. Once you identify the damaged system, perform tests on that circuit.

1. If there is a traction circuit problem, perform 1 or more of the following tests: traction circuit charge pressure, traction circuit relief pressure, rear traction circuit (RV) relief pressure, traction circuit reducing valve (PR) pressure, counterbalance pressure tests, and/or piston (traction) pump flow tests.
2. If there is a PTO (mow) circuit problem, perform 1 or more of the following tests: cutting deck circuit pressure, cutting deck circuit relief pressure, cutting deck motor case drain leakage, and/or gear pump (P3) flow tests.

Determining which Hydraulic Tests to Perform (continued)

3. If there is a lift circuit problem, perform 1 or more of the following tests: lift/lower circuit relief pressure, counterbalance pressure, and/or gear pump (P3) flow tests.
4. If there is a steering/engine cooling fan circuit problem, perform 1 or more of the following tests: steering circuit relief pressure, steering cylinder internal leakage, and/or gear pump (P3) flow tests.

Testing the Traction Circuit Charge Pressure (Using Pressure Gauge)



g035153

Figure 75

Perform the traction circuit charge-pressure test to ensure that the traction charge circuit is operating correctly.

Testing the Traction Circuit Charge Pressure

Note: Machines with serial number below 313000300 have a Rexroth piston (traction) pump. Machines with serial number above 313000300 have a Sauer-Danfoss piston pump. The traction circuit charge pressure testing is similar regardless of the pump brand. Testing differences for both pump brands are included in the following procedure.

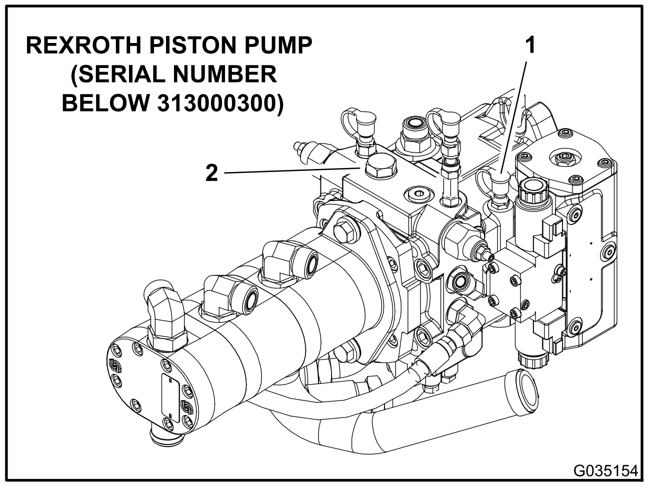
1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

   Note: Ensure that the hydraulic tank is full.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

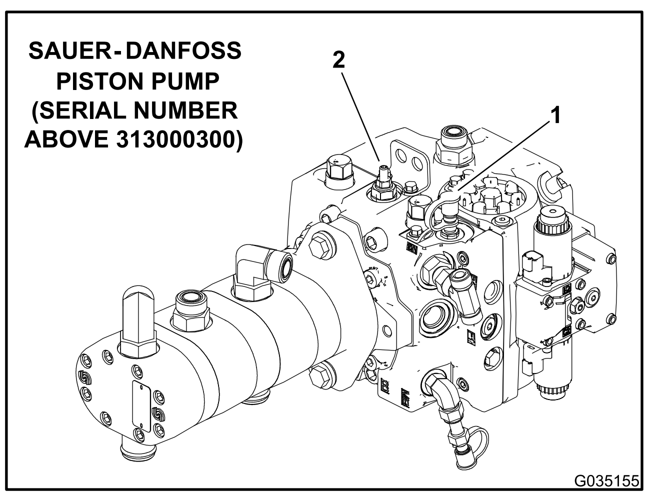
Read all Warning, Cautions, and precautions at the beginning of this section.



g035154

Figure 76

1. Charge-pressure test port
2. Charge-relief valve



g035155

Figure 77

1. Charge-pressure test port
2. Charge-relief valve

Testing the Traction Circuit Charge Pressure (continued)

2. Connect a 7,000 kPa (1,000 psi) pressure gauge to the charge-pressure test port fitting on the piston pump (Figure 76 or Figure 77).
3. After you install the pressure gauge, start and operate the engine at idle speed. Check for the hydraulic-fluid leaks at the tester connections and correct before continuing the test.
4. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.
5. Operate the engine at full engine speed (2,750 rpm) with no load on the hydraulic system. The gauge reading should be:
   - 2,180 to 2,370 kPa (315 to 345 psi) for Rexroth pump
   - 1,900 to 2,240 kPa (275 to 325 psi) for Sauer pump
6. Shut off the engine and record the test results.
7. If there is no pressure, or pressure is low, do the following:

   A. Check for a restriction in the gear pump intake line or reservoir strainer.

   B. Check the charge-pressure relief valve located in the piston pump (Figure 76 or Figure 77). Adjust if necessary; refer to Servicing the Piston (Traction) Pump (Rexroth) (page 4–117) or Servicing the Piston (Traction) Pump (Sauer-Danfoss) (page 4–119).

   C. Consider that a forward or reverse relief valve in the piston pump is leaking or damaged.

   D. Check for leaks in the traction-control manifold, the mow/transport manifold and/or the steering/cooling fan manifold.

   Note: The damaged cartridge seals in these manifolds causes low charge circuit pressure.

   E. If necessary, check for internal damage or worn parts in the gear pump (P3) which supplies hydraulic fluid to the charge circuit.

   Note: A worn or damaged gear pump (P3) also affects the operation of the deck lift/lower, steering, and engine-cooling-fan systems.

8. With the pressure gauge connected to the charge-pressure test port, take the gauge reading while operating the machine in forward and reverse directions. Start the engine, release the parking brake, and put the throttle at full engine speed (2,750 rpm). Apply the brakes and push the traction pedal forward while monitoring the pressure gauge. Repeat this for reverse direction. Shut off the engine and record the test results.

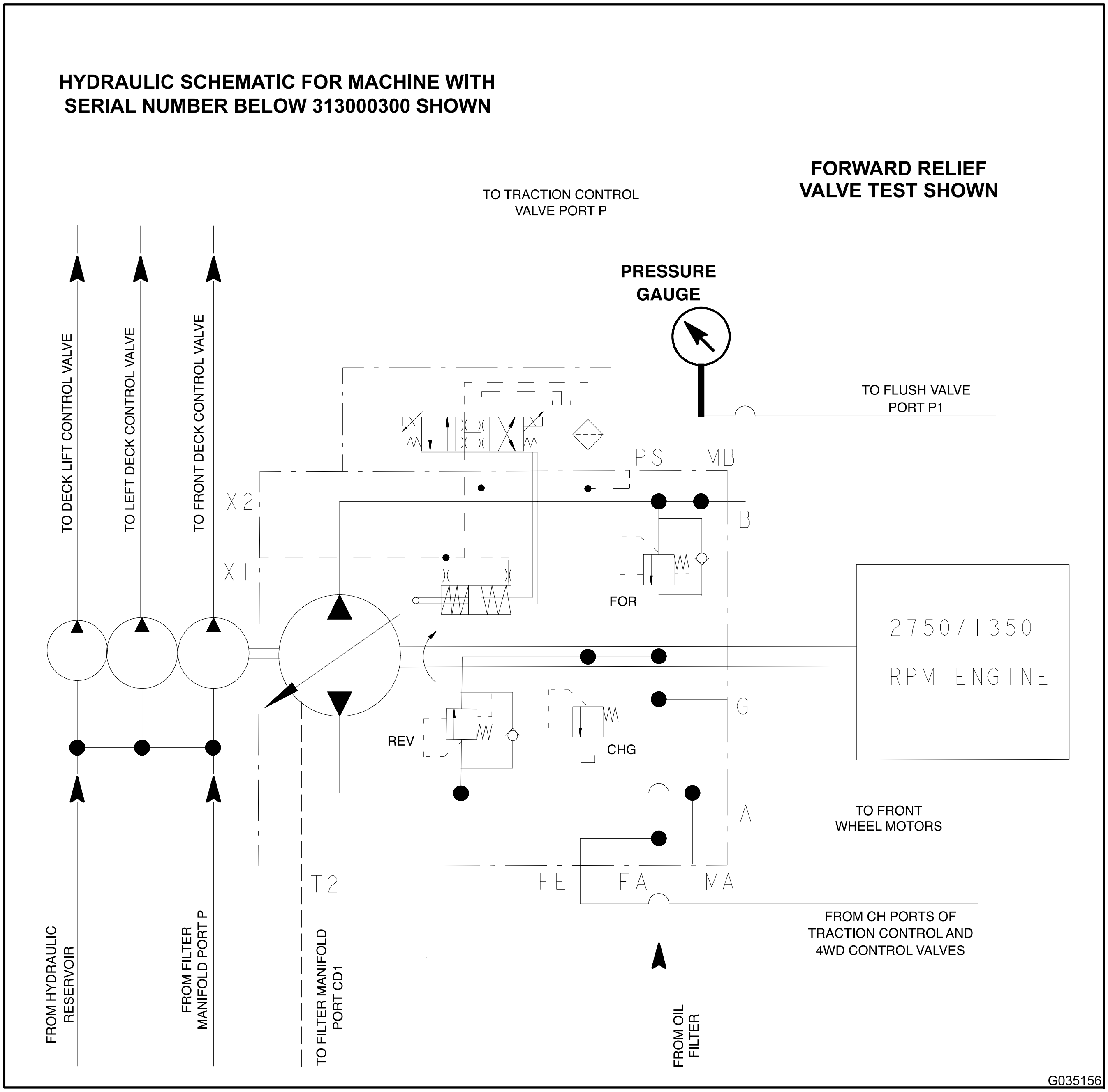
   Note: Ensure that the pressure gauge reading is 2,180 to 2,370 kPa (315 to 345 psi) for the Rexroth pump and 1,900 to 2,240 kPa (275 to 325 psi) for the Sauer pump.

9. If the charge pressure meets specifications under no load (step 5), but consistently drops more than 15% when under a traction load (step 8), the piston (traction) pump and/or traction wheel motor(s) are probably worn and inefficient.

   Note: When the pump and/or traction motor(s) are worn or damaged, the charge pump cannot keep up with internal leakage in the traction circuit components.

10. After you complete the charge pressure testing, disconnect the pressure gauge from the test port.

Testing the Traction Circuit Relief Pressure (Using Pressure Gauge)



g035156

Figure 78

Perform the traction circuit relief pressure test to ensure that the forward and reverse traction circuit relief pressures are correct.

Testing the Traction Circuit Relief Pressure

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

   Note: Ensure that the hydraulic tank is full.

Testing the Traction Circuit Relief Pressure (continued)

CAUTION

Performing the traction circuit relief pressure test on the hydraulic system can cause personal injury and property damage.

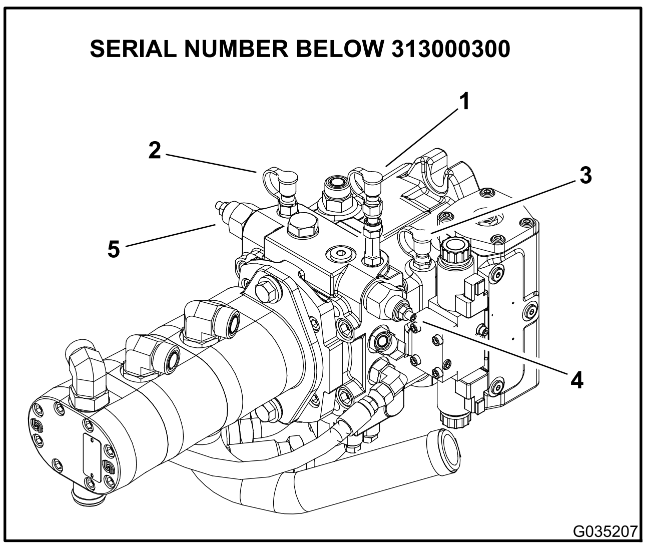
Perform this test in an open area that is away from people and obstructions.

2. Move the machine to an open area, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.

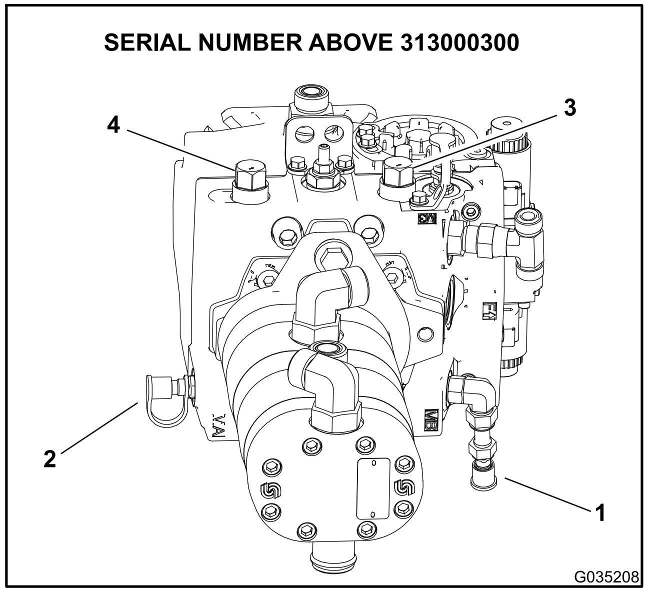


g035207

Figure 79

1. Forward test port
2. Reverse test port
3. Charge-pressure test port
4. Forward relief valve
5. Reverse relief valve

Testing the Traction Circuit Relief Pressure (continued)



g035208

Figure 80

1. Forward test port
2. Reverse test port
3. Forward relief valve
4. Reverse relief valve

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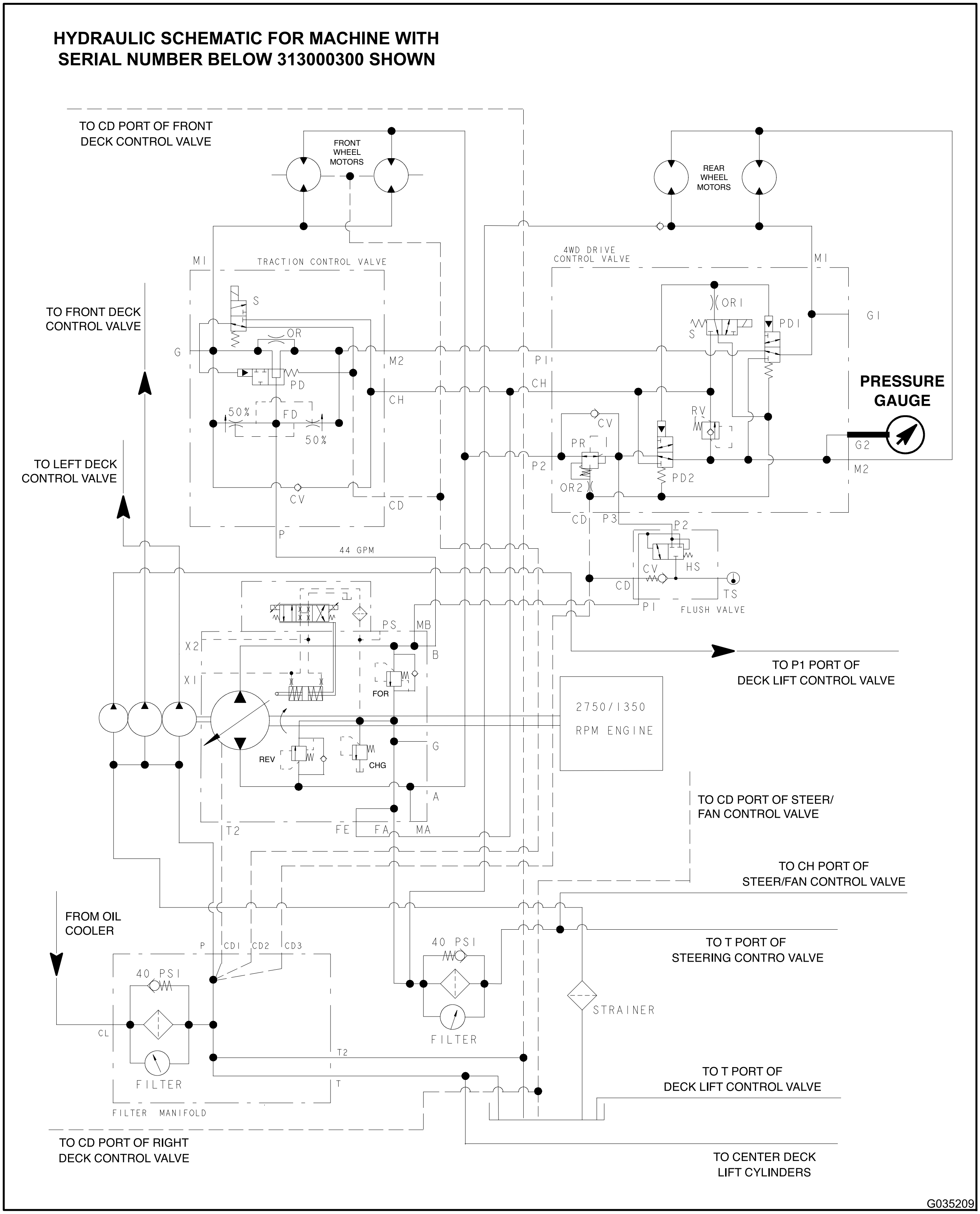
3. Connect a 70,000 kPa (10,000 psi) pressure gauge to the traction circuit test port to check the function (Figure 79 or Figure 80).
4. Start the engine and operate it at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
5. Sit on the seat and operate the engine at full speed (2,750 rpm), and release the parking brake.
6. Apply the service brakes fully, and slowly press the traction pedal in the appropriate direction (forward or reverse). While pressing the traction pedal, look at the pressure reading on the gauge. As the traction relief valve lifts, the gauge needle will stop momentarily.
   - For the machine with serial number below 313000300, the gauge reading should be:
     - 29,200 to 30,500 kPa (4,230 to 4,430 psi) in forward
     - 36,100 to 37,400 kPa (5,230 to 5,430 psi) in reverse
   - For the machine with serial number above 313000300, the gauge reading should be:
     - 27,400 to 28,700 kPa (3,960 to 4,160 psi) in forward
     - 34,400 to 35,700 kPa (4,980 to 5,180 psi) in reverse
7. Release the traction pedal, shut off the engine, and record the test results.
8. If traction pressure is low, examine the traction pump relief valves (Figure 79 or Figure 80). Clean or replace the valves as required. If the relief valves are in good condition, the traction pump or wheel motors may be worn and inefficient.

   Note: These cartridge type valves are factory set and are not adjustable.
9. After you complete the relief pressure testing, disconnect the pressure gauge from the test port.

Testing the Rear Traction Circuit (RV) Relief Pressure (Using Pressure Gauge)



g035209

Figure 81

Testing the Rear Traction Circuit (RV) Relief Pressure

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

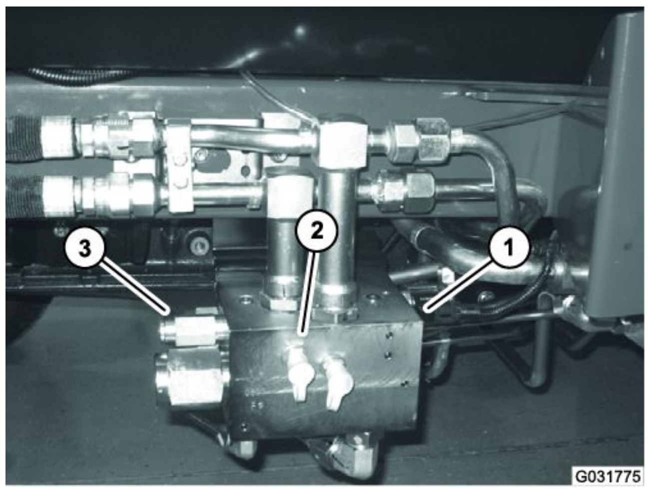
   Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g031775

Figure 82

1. 4-wheel drive control manifold
2. Test port G2
3. Relief valve RV

3. Connect a 35,000 kPa (5,000 psi) gauge to the test port G2 on the 4-wheel drive control manifold on the right side of the machine (Figure 82).
4. After you install the pressure gauge, start the engine and operate it at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
5. Operate the engine at full speed (2,750 rpm).
6. Operate the machine in 4-wheel drive with the cutting decks lowered.
7. Drive the machine forward down a slope, decrease the pressure on the traction pedal, and monitor the pressure gauge.
8. Increase the pressure until the relief valve (RV) lifts. Record the test results.

IMPORTANT

Ensure that the gauge reading is approximately 8,300 kPa (1,200 psi).

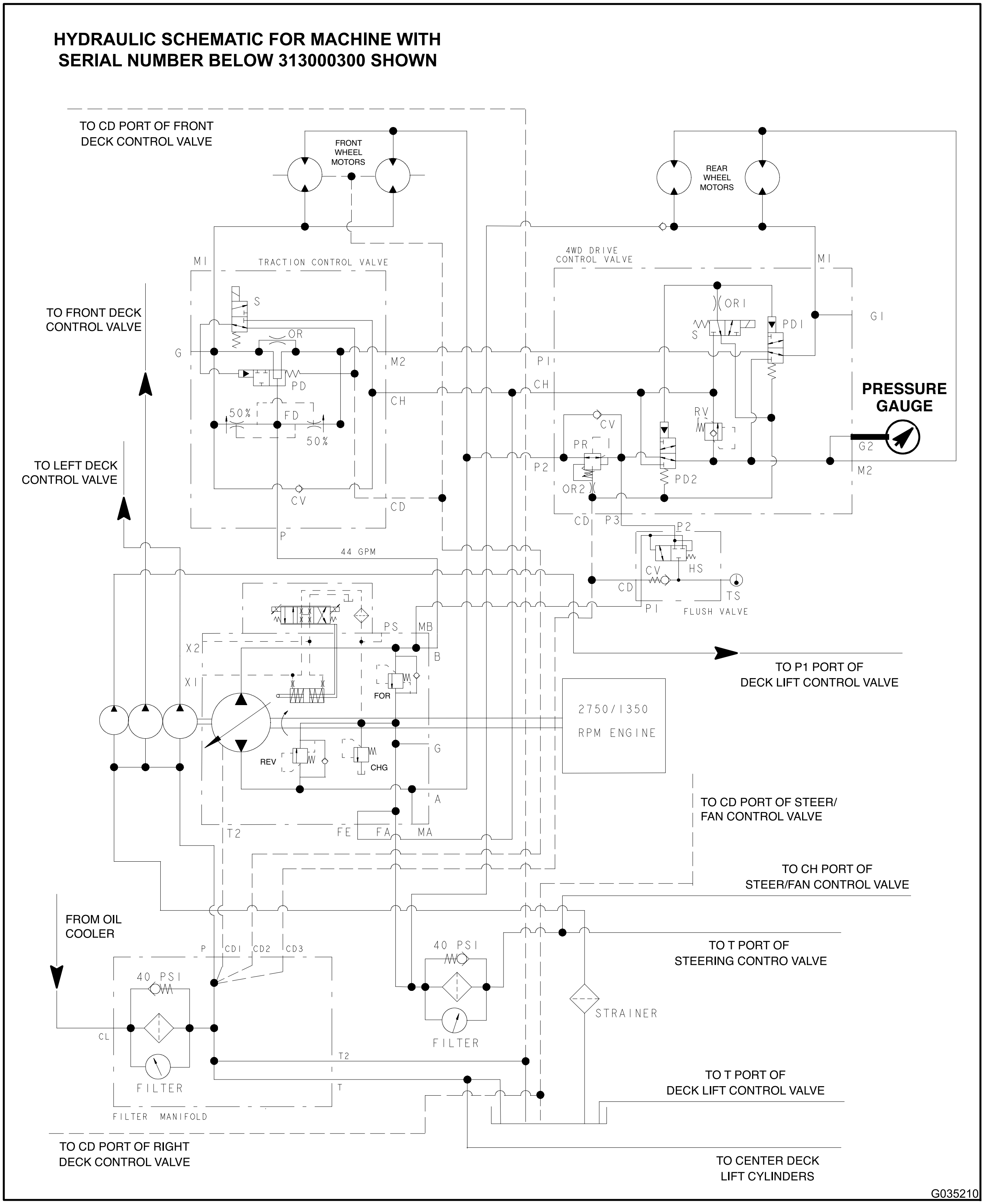
9. If necessary, adjust the relief valve (RV) so that the pressure is correct; refer to Adjusting the Pressure Valve (page 4–94).

Testing the Rear Traction Circuit (RV) Relief Pressure (continued)

Note: Relief valve (RV) is located on the rear side of the 4-wheel drive control manifold (Figure 82).

10. Disconnect the pressure gauge from the manifold-test port.

Testing the Traction Circuit Reducing Valve (PR) Pressure (Using Pressure Gauge)



g035210

Figure 83

Testing the Traction Circuit Reducing Valve (PR) Pressure

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

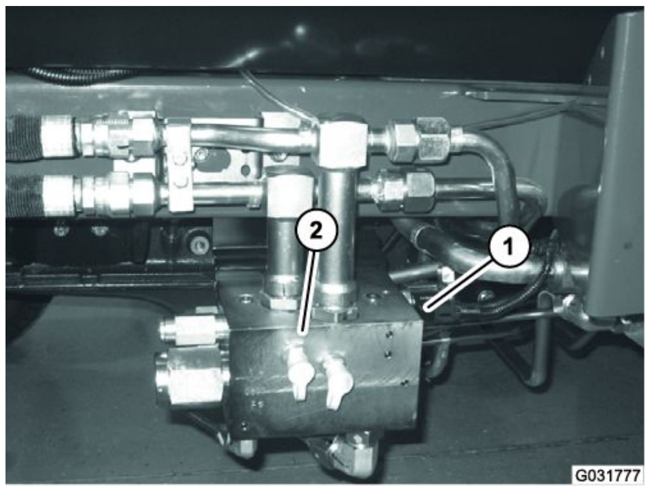
   Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g031777

Figure 84

1. 4-wheel drive control manifold
2. Test port G2

3. Connect a 7,000 kPa (1,000 psi) pressure gauge to the test port G2 on the 4-wheel drive control manifold on the right side of the machine (Figure 84).
4. After you install the pressure gauge, start the engine and operate it at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
5. Operate the engine at full speed (2,750 rpm).
6. Sit on the seat and release the parking brake. Apply the service brakes fully and slowly press the traction pedal in reverse. While pressing the traction pedal, look at the pressure reading on the gauge.

IMPORTANT

Ensure that the gauge reading is approximately 4,500 kPa (650 psi).

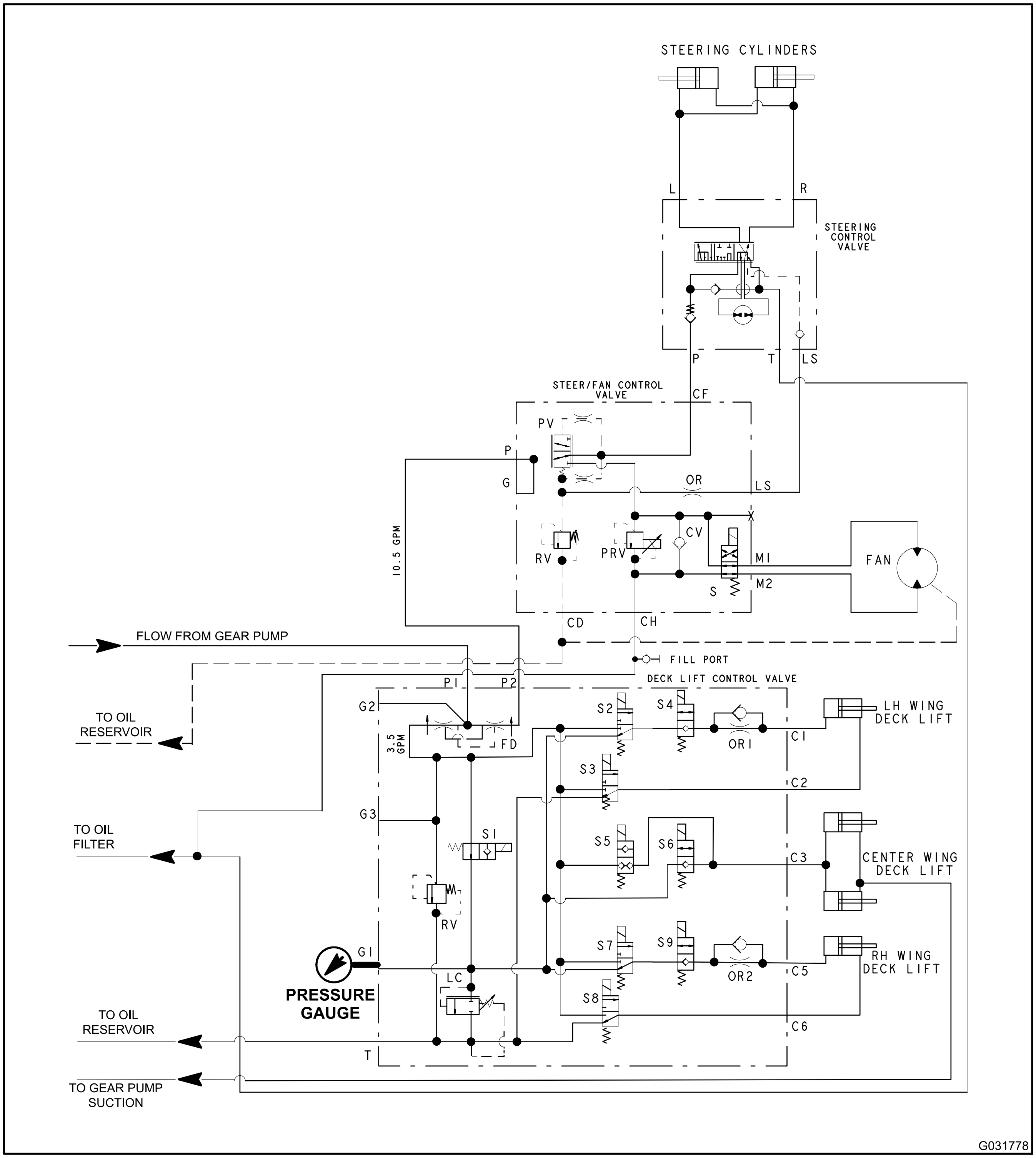
7. Shut off the engine and record the test results.
8. If necessary, adjust the pressure reducing valve (PR) so that the pressure is correct; refer to Adjusting the Pressure Valve (page 4–94).

   Note: The pressure reducing valve (PR) is located at the lower, rear side of the 4-wheel drive control manifold (Figure 84).

Note: Do not remove the reducing valve from the hydraulic manifold for adjustment.

9. Disconnect the pressure gauge from the test port.

Testing the Counterbalance Pressure (Using Pressure Gauge)



g031778

Figure 85

Testing the Counterbalance Pressure

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

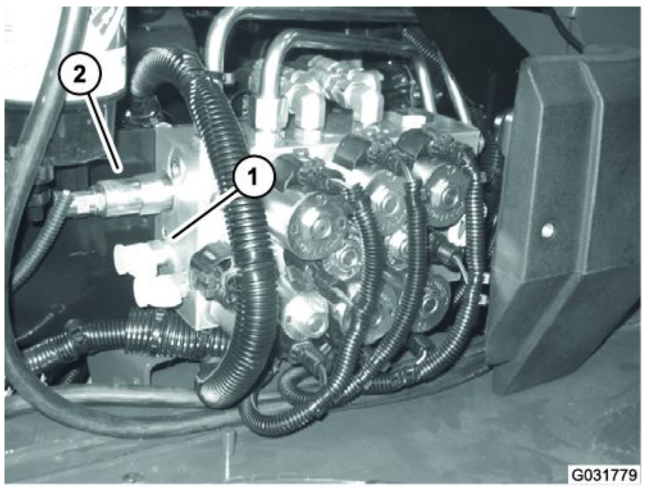
   Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g031779

Figure 86

1. Counterbalance test port
2. Counterbalance valve

3. Connect a 7,000 kPa (1,000 psi) pressure gauge to the test port G1 on the lift control manifold (Figure 86).
4. After you install the pressure gauge, start the engine and operate at idle speed. Check for the hydraulic-fluid leaks and correct before continuing the test.
5. Operate the engine at full engine speed (2,750 rpm) with no load on the system.

   Note: Do not engage the cutting decks.

IMPORTANT

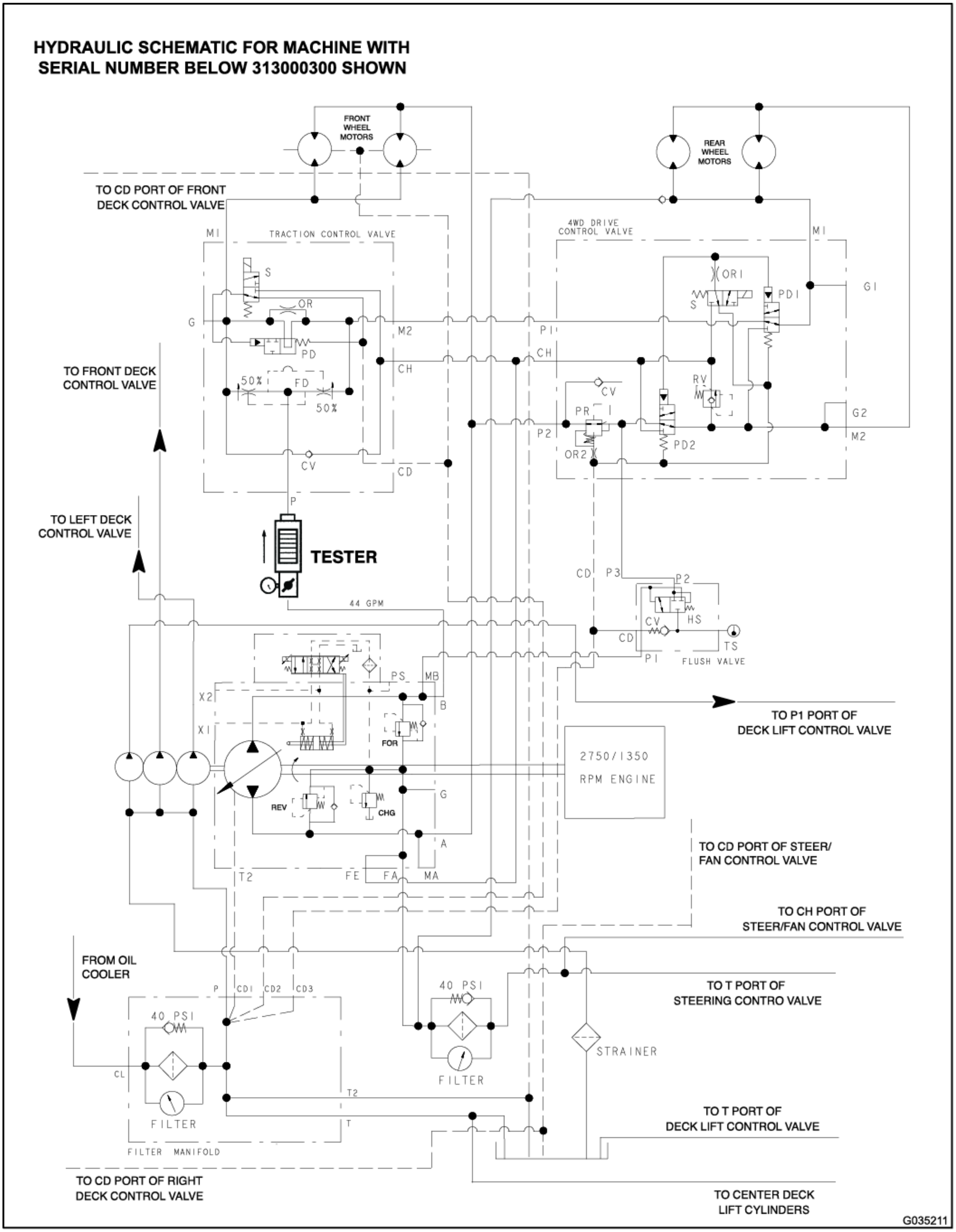
Ensure that gauge reading is 2,490 to 2,620 kPa (360 to 380 psi).

6. Shut off the engine and record the test results.
7. If necessary, adjust the counterbalance valve so that the pressure is correct; refer to Adjusting the Pressure Valve (page 4–94).

   Note: The counterbalance valve is located on the rear side of the lift control manifold; refer to Figure 86.

8. Disconnect the pressure gauge from the test port.

Testing the Piston (Traction) Pump Flow (Using Tester with Pressure Gauge and 40 GPM Flow Meter)



g035211

Figure 87

Testing the Piston (Traction) Pump Flow

This test measures the piston (traction) pump output (flow). During this test, the pump load is created at the flow meter using the adjustable load valve on the tester.

Note: Before performing the piston pump flow test, ensure that the traction speed is set to 100% using the InfoCenter settings menu.

IMPORTANT

At normal engine high-idle speed, the traction circuit flow for the Groundsmaster 5900 or 5910 machines exceeds 150 L/minute (40 gallons/minute). For this test, use a 40 GPM Hydraulic Tester #AT40002 (pressure and flow) and Hydraulic Hose Kit; refer to Special Tools (page 4–42). Ensure that the engine speed is adjusted as described in the following test procedure. If the engine runs at normal high-idle speed while testing, the hydraulic tester may get damage.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.

Note: Two people are required to complete the following test procedure.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and ensure that the hydraulic fluid is at normal operating temperature.

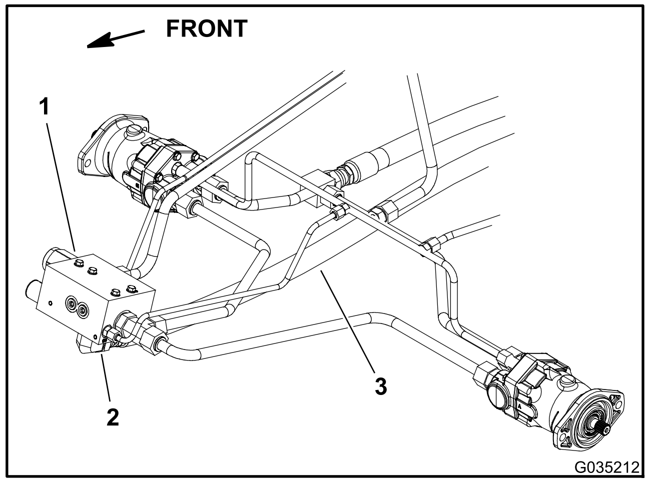
CAUTION

During this test all the wheels will be off the ground and rotating.

Ensure that the machine is supported so that it will not move and accidentally fall to prevent injuring anyone near the machine.

2. Lift and support the machine so that all the wheels are off the ground; refer to Jacking Instructions (page 1–5).

Testing the Piston (Traction) Pump Flow (continued)



g035212

Figure 88

1. Traction control manifold
2. Fitting in the P port
3. Hose from the piston pump

3. Clean the junction of the hydraulic hose from the piston pump and 90° fitting in the P port (item 2 in Figure 88) at the bottom of the traction control manifold which is attached to the bottom of the front axle frame. Disconnect the hose from the 90° fitting.

IMPORTANT

When you install the tester, ensure that the oil flow indicator arrow on the flow gauge is showing that the fluid will flow from the disconnected hydraulic hose, through the tester, and into the traction control manifold fitting.

4. Install a 40 GPM tester (flow and pressure) in series between the manifold fitting and the disconnected hose to allow flow from the traction pump to the tester. Use a hydraulic hose kit to connect the tester to the machine; refer to Special Tools (page 4–42).

   Note: Ensure that the fitting and hose connections are properly tightened.

IMPORTANT

After installing the 40 GPM tester (flow and pressure), ensure that the flow-control valve on the tester is fully open.

5. After you install the tester, start the engine and run it at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
6. Increase the engine speed while using the InfoCenter display to obtain the proper engine speed as follows:
   - For the machine with serial number below 313000300, the engine speed should be 2,400 rpm for flow testing.
   - For the machine with serial number above 313000300, the engine speed should be 2,200 rpm for flow testing.

Testing the Piston (Traction) Pump Flow (continued)

7. Slowly push the traction pedal in fully forward position. Keep the pedal fully pressed in the forward position.
8. Have a second person monitor the pressure gauge on the tester carefully and slowly close the flow control valve until you get 6,900 kPa (1,000 psi) on the gauge. Verify with the InfoCenter display that the engine speed is still at the correct speed as listed above.

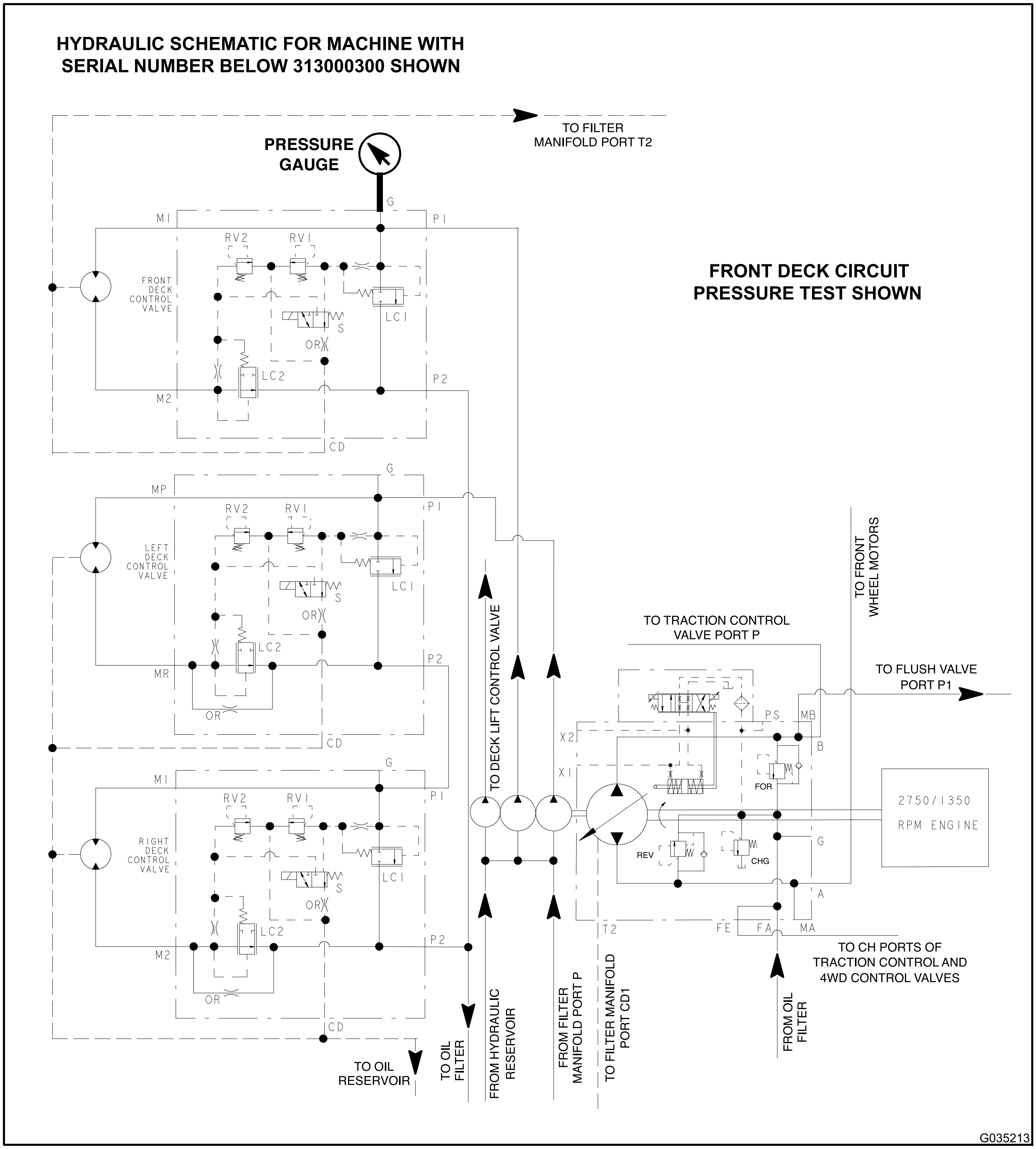
   Note: If the engine speed drops during testing, the pump flow will decrease and flow test results will be inaccurate.
9. Observe the flow gauge. The flow indication should be approximately 141.9 L/minute (37.5 gallons/minute).
10. Release the traction pedal to the NEUTRAL position, open the flow control valve on the tester, shut off the engine, and record the test results.
11. If the flow is less than 125 L/minute (33 gallons/minute), consider the following:
    A. The piston pump swash plate is not being rotated fully (e.g., the traction speed is not set to 100%).

    B. The traction pedal is not calibrated correctly; refer to Calibrating the Traction Pedal (page 5–98).

    C. The forward traction relief valve is leaking or damaged.

    D. The piston pump needs to be repaired or replaced as necessary.
12. Make necessary repairs before you perform any additional traction circuit tests.
13. After you complete the testing, disconnect the tester from the manifold fitting and the machine hydraulic hose. Connect the hose to the manifold fitting again and lower the machine to the ground.

Testing the Cutting Deck Circuit Pressure (Using Pressure Gauge)

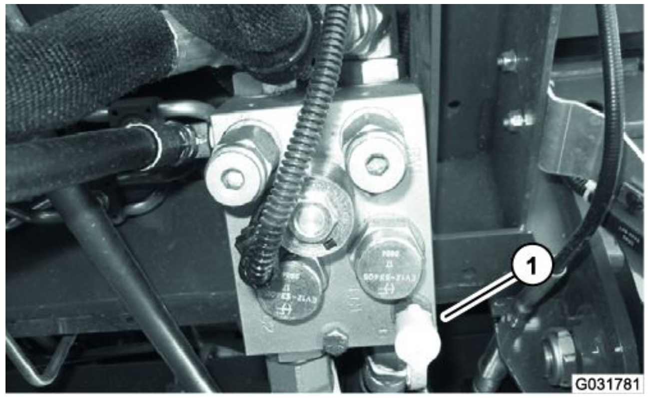


g035213

Figure 89

Perform the cutting deck circuit pressure test to ensure that the cutting deck circuit pressures are correct.

Testing the Cutting Deck Circuit Pressure



g031781

Figure 90

1. Center deck circuit-pressure test port G

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

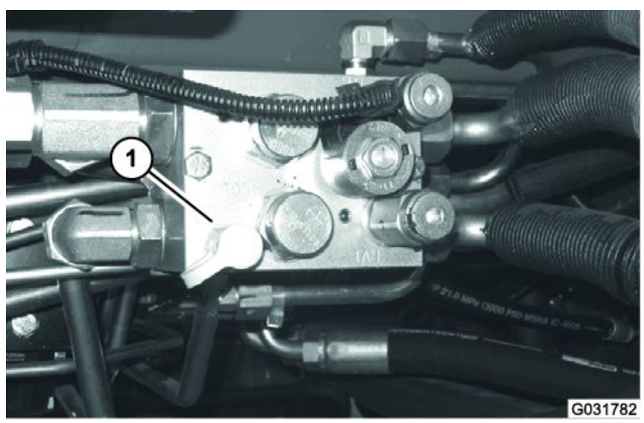
   Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g031782

Figure 91

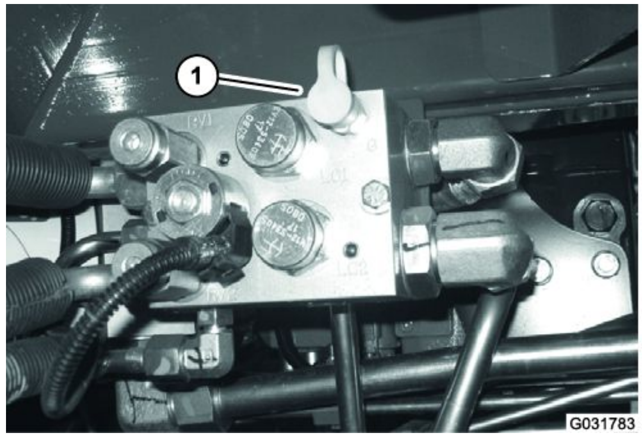
1. Right wing deck circuit-pressure test port G

3. Install the 35,000 kPa (5,000 psi) pressure gauge with the hydraulic hose that is attached to the deck manifold-test port G to test the deck (Figure 90, Figure 91, and Figure 92).
4. After you install the pressure gauge, start the engine and operate it at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.

CAUTION

Cutting blades are sharp and may cause personal injury.

Stay away from the cutting decks while you perform the test.



g031783

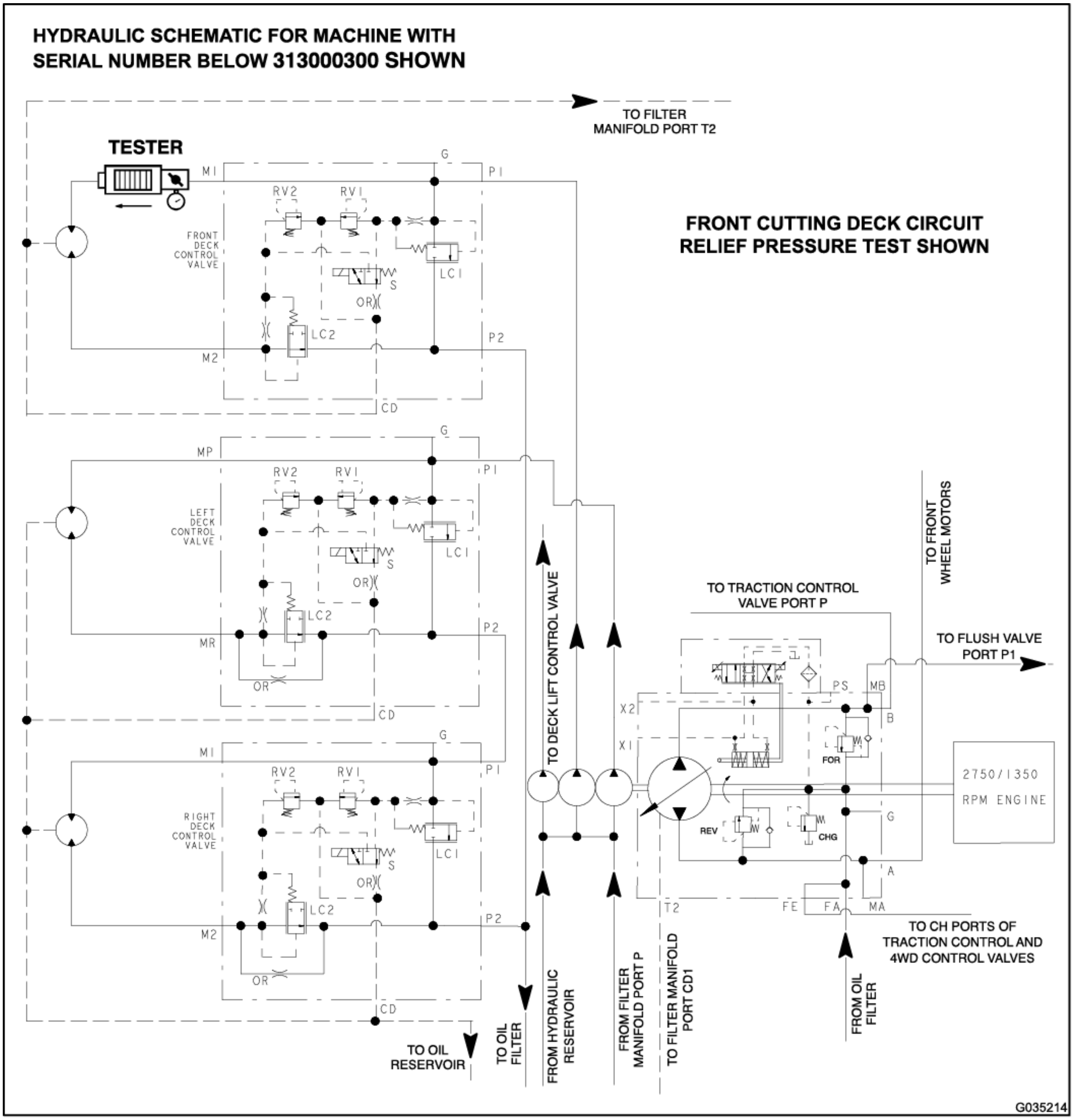
Figure 92

1. Left wing deck circuit-pressure test port G

5. Sit on the seat and operate the engine at full speed (2,750 rpm). Release the parking brake and engage the cutting decks.
6. Monitor the pressure gauge carefully while you are mowing with the machine.

   Note: The cutting deck circuit pressure should be 6,900 to 22,000 kPa (1,000 to 3,200 psi); for the right wing deck, the pressure should be 14,440 kPa (1,000 to 2,100 psi). The pressure will change if the mowing conditions change.
7. Disengage the cutting decks and shut off the engine.
8. Record the test results.
9. Disconnect the pressure gauge with the hose from the manifold test port.

Testing the Cutting Deck Circuit Relief Pressure (Using Tester with Pressure Gauge and 40 GPM Flow Meter)



g035214

Figure 93

Perform the cutting deck circuit relief pressure test to ensure that the deck circuit relief pressures are correct.

Testing the Cutting Deck Circuit Relief Pressure

1. Ensure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

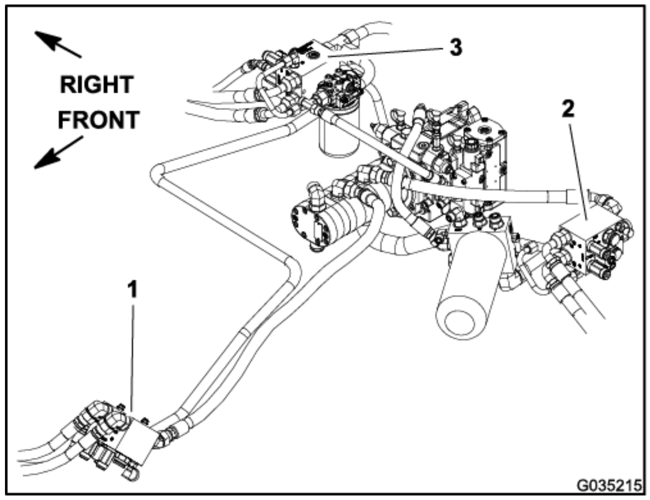
   Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g035215

Figure 94

1. Front deck manifold
2. Left deck manifold
3. Right deck manifold

IMPORTANT

To prevent hydraulic tester damage, use a 40 GPM Hydraulic Tester #AT40002 (pressure and flow) and Hose Kit for this test; refer to Special Tools (page 4–42).

3. Locate the PTO (deck) control manifold for the cutting deck that you are testing (Figure 94). Disconnect the hydraulic hose from the fitting in the PTO manifold port M1 (front or right deck) or port MP (left deck).

IMPORTANT

Ensure that the oil flow indicator arrow on the flow gauge is showing that the fulid will flow from the manifold, through the tester, and into the disconnected hydraulic hose.

4. Install a 40 GPM tester (flow and pressure) in series between the PTO manifold port (M1 or MP) and the disconnected hose.

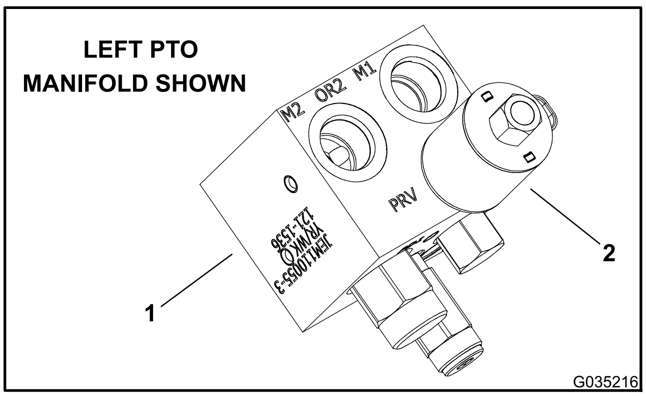
   Note: Ensure that the flow control valve on the tester is fully open.

CAUTION

The cutting deck blades will rotate when you lower the cutting decks with the PTO switch in the ON position.

Keep away from the cutting decks during the test to prevent personal injury from the rotating blades. Do not stand in front of the machine.

5. After you install the hydraulic tester, start the engine and run it at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
6. Increase the engine speed to high-idle speed (2,750 rpm). Release the parking brake and engage the cutting decks.
7. While monitoring the tester pressure gauge carefully, slowly close the tester flow control valve to fully closed.
8. As the cutting deck circuit relief valve lifts, the system pressure should be approximately:
   - 20,000 to 21,300 kPa (2,900 to 3,100 psi) for the center and left decks
   - 13,100 to 14,400 kPa (1,900 to 2,100 psi) for the right deck
9. After you identify the relief valve pressure, fully open the tester flow control valve, disengage the cutting decks, and decrease the engine speed to low idle. Shut off the engine and record the test results.



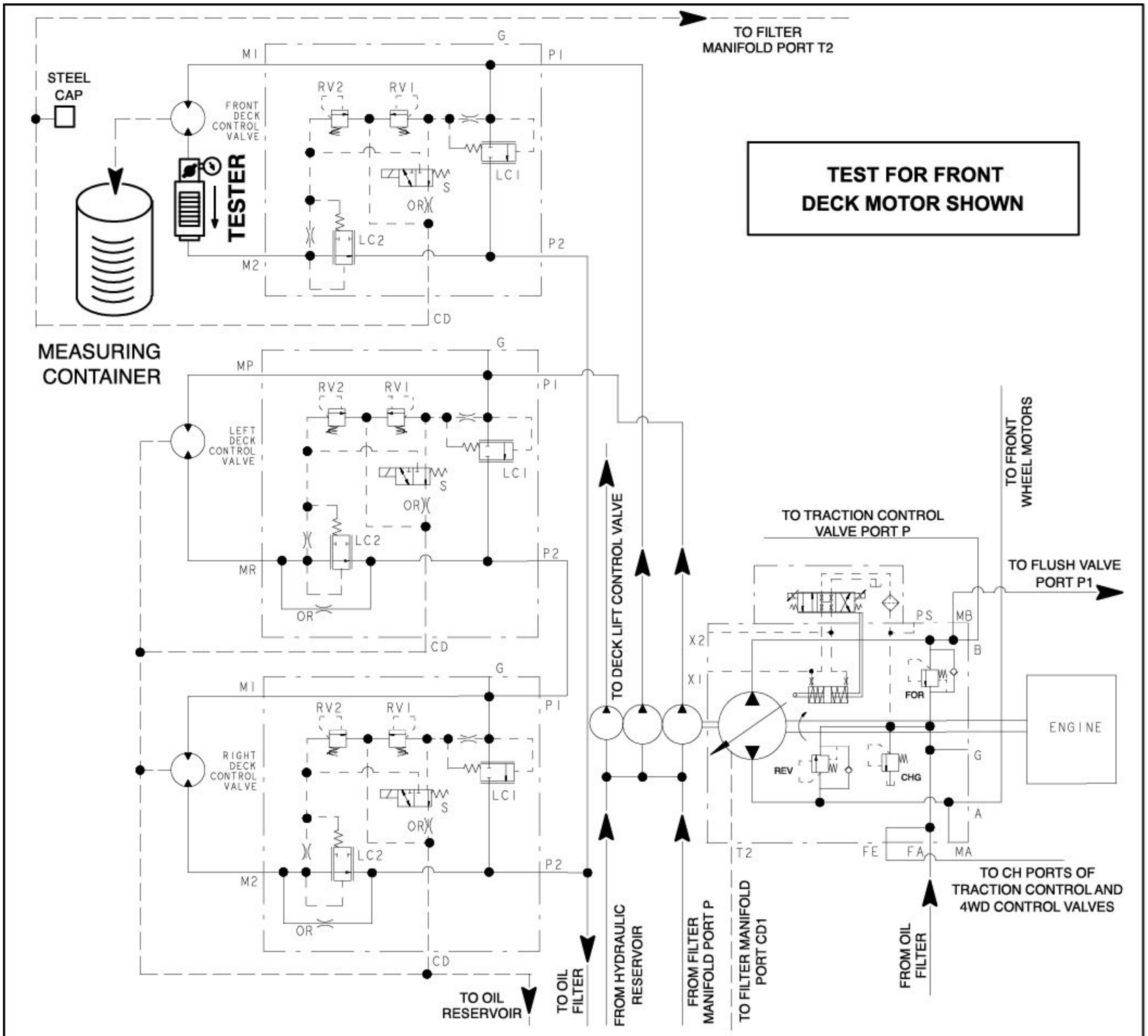
g035216

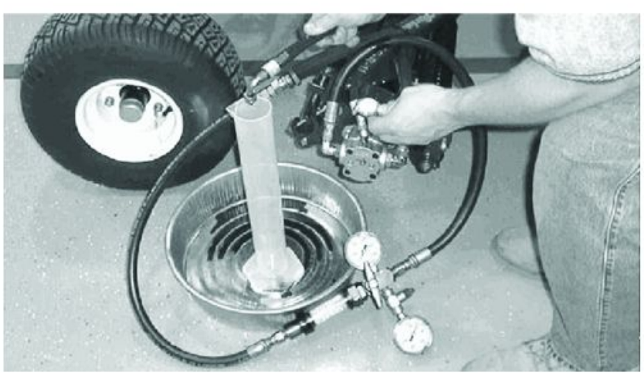
Figure 95

1. PTO manifold
2. PRV valve

10. If the relief pressure is incorrect, remove the PRV valve on the deck manifold and clean or replace the valve; refer to Servicing the PTO Control Manifold (page 4–158). Also, if the pressure is still low after the PRV valve service, check for restriction in the gear pump intake line. Inspect the first gear pump section (for the center cutting deck circuit) and/or the second gear pump section (for the side cutting deck circuits) for wear, damage, or inefficiency; refer to Testing the Gear Pump (P3) (PTO, Steering, Cooling Fan, Lift/Lower, and Traction Charge Circuits) Flow (Using Tester with Pressure Gauges and Flow Meter) (page 4–89).
11. After you complete the relief pressure testing, disconnect the tester from the PTO manifold fitting and hydraulic hose. Connect the hydraulic hose that was disconnected for test procedure.
12. Repeat the test for the other cutting deck circuits if necessary.

Testing the Cutting Deck Motor for Case Drain Leakage (Using Tester with Pressure Gauge and 40 GPM Flow Meter)





GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

G035217

g035217

Figure 96

Testing the Cutting Deck Motor for Case Drain Leakage

Note: Over a period of time, a deck motor can wear internally. A worn motor may bypass the hydraulic fluid to its case drain that reduces the motor efficiency. After sometime, sufficient fluid loss causes the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system and affect quality of cut.

Note: One method to find a failing or malfunctioning deck motor is to have another person observe the machine while mowing in dense turf. A bad motor will run slower, produce fewer clippings, and may cause a different appearance on the turf.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.

IMPORTANT

To prevent hydraulic tester damage, use a 40 GPM Hydraulic Tester #AT40002 (pressure and flow) and Hose Kit for this test; refer to Special Tools (page 4–42).

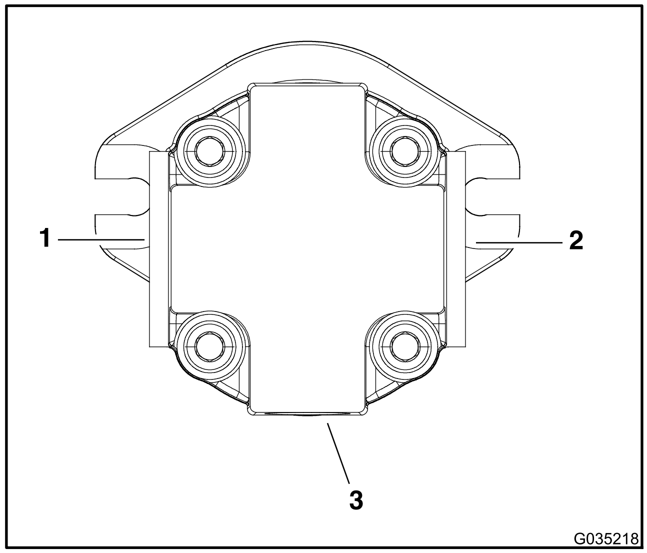
Note: Two people are required to complete the following test procedure.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

   Note: Ensure that the hydraulic reservoir is full.

   Note: The side deck motors are connected in series. To isolate a damaged side deck motor, both motors in the circuit may have to be tested by starting with the left deck motor; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings.

Testing the Cutting Deck Motor for Case Drain Leakage (continued)



g035218

Figure 97

1. Flow (in)
2. Flow return (out)
3. Case drain

2. Disconnect the hydraulic return hose from the deck motor that you are testing (Figure 97).

IMPORTANT

Ensure that the oil flow indicator arrow on the flow gauge is showing that the fluid will flow from the motor, through the tester, and into the disconnected hydraulic hose.

3. Install a 40 GPM tester (flow and pressure) in series with the deck motor and the disconnected return hose.

IMPORTANT

After installing a 40 GPM tester (flow and pressure), Ensure that the flow control valve on the tester is fully open.

4. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
5. Increase the engine speed and ensure that the hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Shut off the engine and remove the key from the key switch.
6. For the deck motor to be tested, disconnect the motor case drain hose (small diameter hose) where it connects to the front PTO manifold tee fitting or hydraulic tube at the side PTO manifold (not at the motor). Put a steel cap on the open tee fitting or tube connection, leave the case drain hose open.

Testing the Cutting Deck Motor for Case Drain Leakage (continued)

⚠ CAUTION ⚠

The cutting deck blades will rotate when you lower the cutting decks with the PTO switch in the ON position.

Keep away from the cutting decks during the test to prevent personal injury from the rotating blades. Do not stand in front of the machine.

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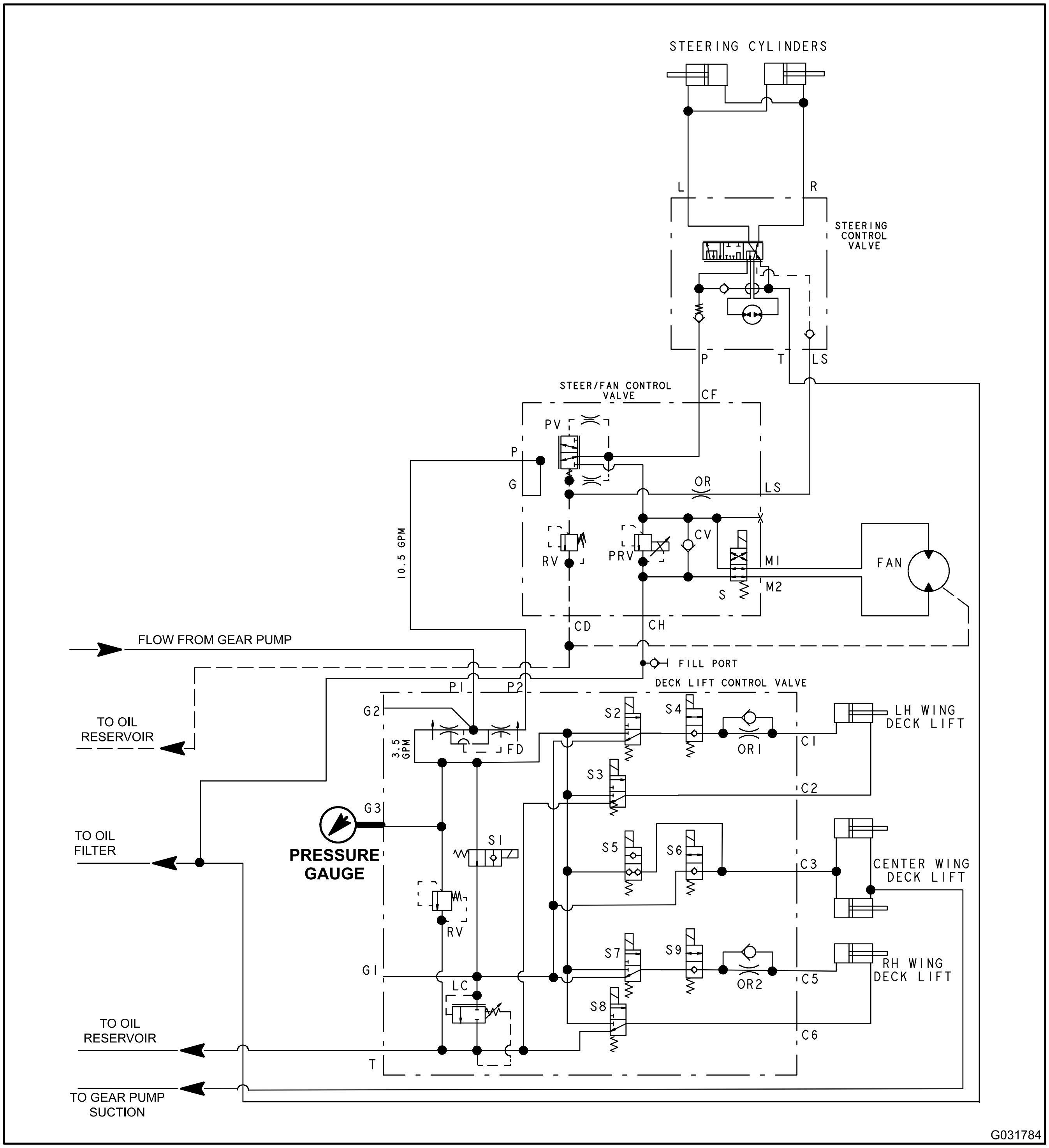
7. Sit on the seat, start the engine, and increase the engine speed to full speed (2,750 rpm). Engage the cutting decks.
8. While monitoring the tester pressure gauge, have a second person slowly close the flow control valve on the tester until you get a pressure of 8,300 kPa(1,200 psi).

   Note: Use a graduated container, special tool TOR4077 to measure the case drain leakage.
9. Have the second person measure the flow from the open case drain hose for 15 seconds, then disengage the cutting decks, open the flow control valve on the tester, and shut off the engine. Record the test results.

   Test results: The case drain leakage should be less than 672 ml (23 oz) of hydraulic fluid in 15 seconds.
10. If the case drain flow is more than 672 ml (23 oz), the deck motor is worn or damaged and should be repaired or replaced.
11. After you complete the testing, disconnect the tester from the motor and hydraulic hose. Connect the return hose to the deck motor again. Remove the cap from the PTO manifold tee fitting or hydraulic tube and connect the case drain hose again.
12. Repeat the test for the additional deck motors if necessary.

Testing the Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)



g031784

Figure 98

Perform the lift/lower circuit relief valve pressure test to ensure that the lift circuit relief pressure is correct.

Testing the Lift/Lower Circuit Relief Pressure

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

Testing the Lift/Lower Circuit Relief Pressure (continued)

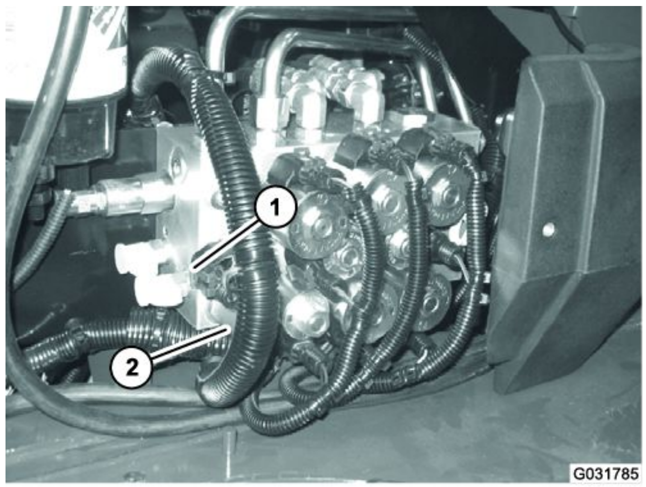
Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g031785

Figure 99

1. Lift circuit test port G3
2. Relief valve RV

3. Connect a 35,000 kPa (5,000 psi) pressure gauge to the lift circuit test port G3 on the lift control manifold (Figure 99).

   Note: Route the gauge hose to allow the operator to view the gauge.

4. After you install the pressure gauge, start the engine at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
5. Sit on the seat and operate the engine at full speed (2,750 rpm).
6. While sitting on the seat, press and hold 1 of the deck lift switches to fully raise a cutting deck. Momentarily hold the switch with the deck fully raised while looking at the gauge.

   Note: Ensure that the gauge reading is approximately 9,300 kPa (1,350 psi).

7. Shut off the engine and record the test results.

   Note: Do not remove the relief valve from the hydraulic manifold for adjustment.

8. If the relief pressure is too high, do the following steps:
   A. Remove the cap on the relief valve (RV) in the lift-control manifold (Figure 99). Turn the adjustment socket counterclockwise to decrease the relief pressure; refer to Adjusting the Pressure Valve (page 4–94).

      Note: Turning the socket 1/8 turn makes a measurable change in the relief pressure.

Testing the Lift/Lower Circuit Relief Pressure (continued)

B. Check the relief pressure and adjust it again as necessary.

C. Install and tighten the cap on the relief valve after adjustment.

9. If the relief pressure is too low, do the following steps:

   A. Check for a restriction in the gear pump intake line or reservoir strainer.

   B. Check the lift cylinder for internal leakage. If the cylinder is not leaking, remove the cap on the relief valve (RV) in the lift-control manifold (Figure 99) and turn the adjustment socket clockwise to adjust the valve to increase the relief pressure; refer to Adjusting the Pressure Valve (page 4–94).

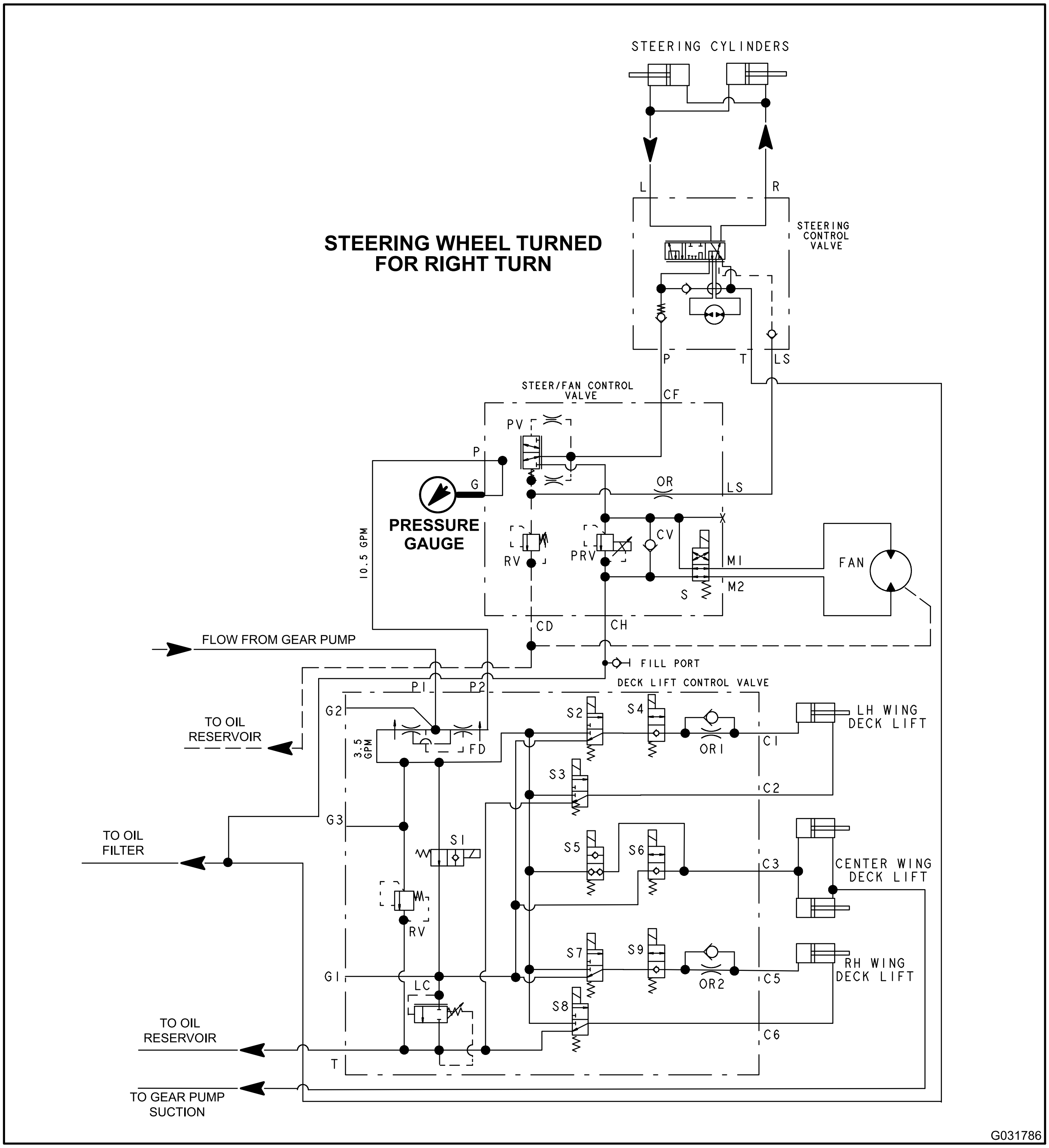
      Note: Turning the socket 1/8 turn makes a measurable change in the relief pressure.

   C. Check the relief pressure and adjust it again as required. If pressure is still too low, check the gear pump (P3) or lift cylinder(s) for wear, damage, or inefficiency.

   D. Install and tighten the cap on the relief valve after adjustment.

10. Disconnect the pressure gauge from the test port.

Testing the Steering Circuit Relief Pressure (Using Pressure Gauge)



g031786

Figure 100

Perform the steering circuit relief valve pressure test to ensure that the steering circuit relief pressure is correct.

Testing the Steering Circuit Relief Pressure

1. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

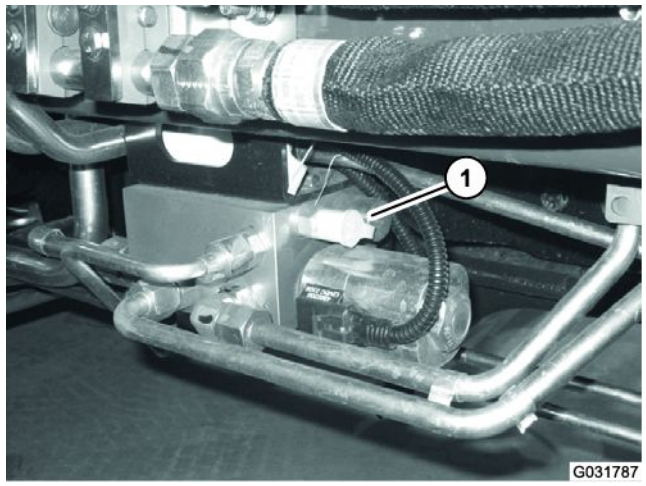
Note: Ensure that the hydraulic tank is full.

2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.



g031787

Figure 101

1. Steering circuit-pressure test port G

3. Connect a 35,000 kPa (5,000 psi) pressure gauge onto the steering circuit pressure-test port G on the steering/cooling fan control manifold (Figure 101).
4. Start the engine and operate the engine at idle speed. Check for hydraulic-fluid leaks at the tester connections and correct before continuing the test.
5. Operate the engine at full speed (2,750 rpm).

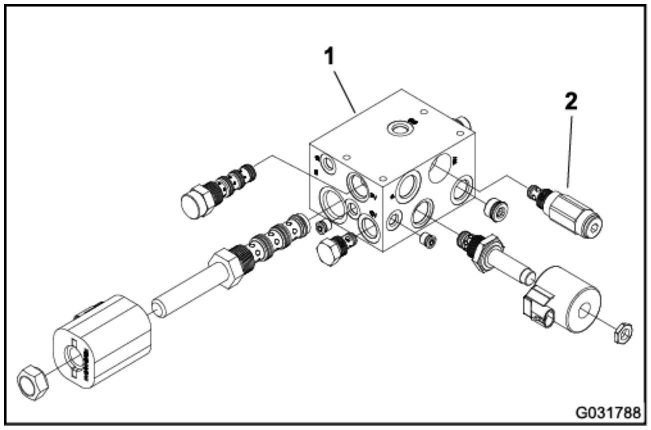
IMPORTANT

Hold the steering wheel at full lock long enough to get a system-pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering components.

6. Turn the steering all the way in 1 direction and momentarily hold the steering wheel against the resistance.

   Note: Ensure that the gauge reading is 13,800 to 15,100 kPa (2,000 to 2,200 psi).

Testing the Steering Circuit Relief Pressure (continued)



g031788

Figure 102

1. Steering/fan manifold
2. Steering relief valve

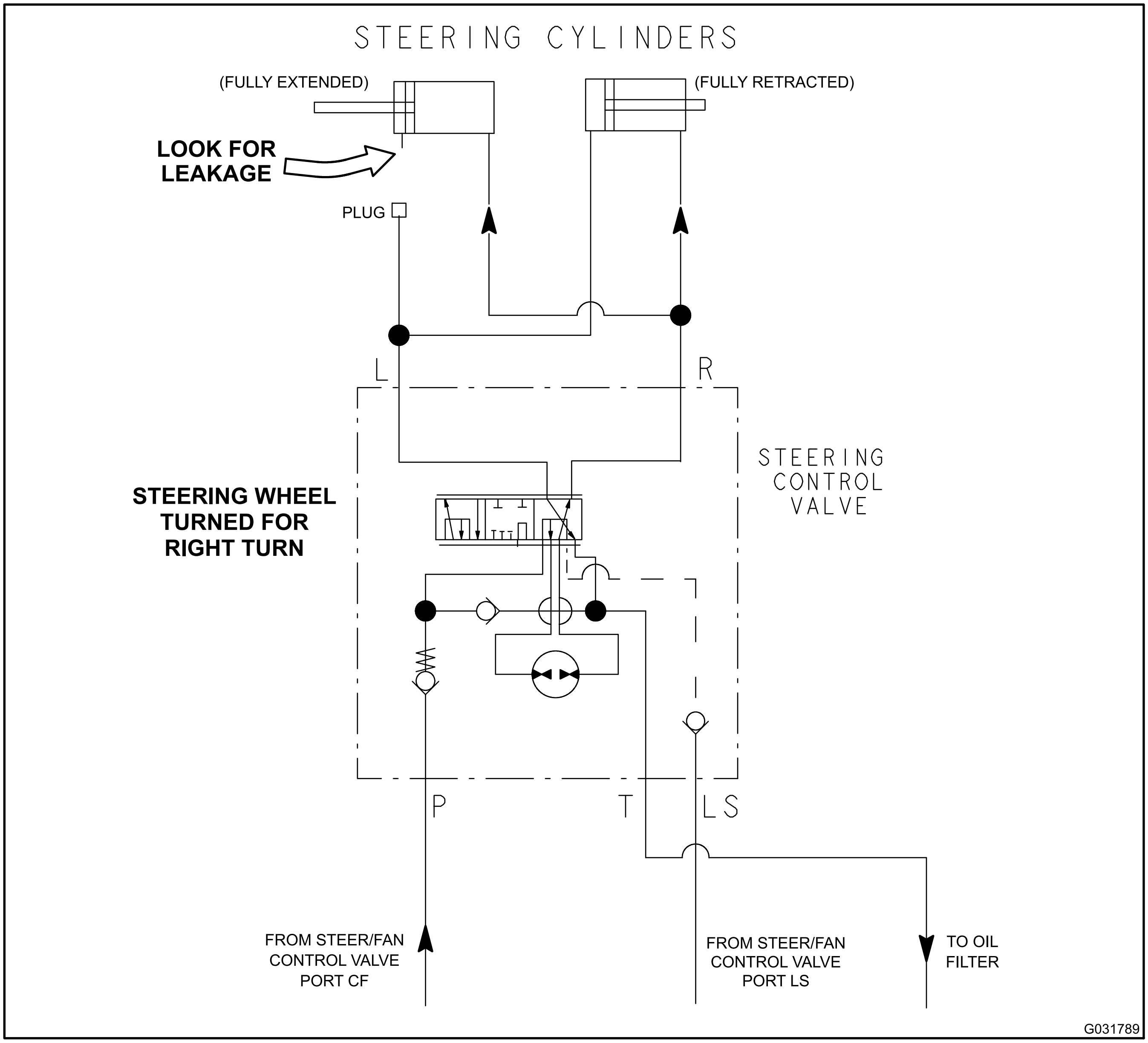
7. Shut off the engine and record the test results.

   Note: If steering relief pressure is incorrect and there are a lift/lower problems, check the gear pump (P3) for wear and inefficiency. If the steering wheel continues to turn at the end of the cylinder travel (with less than the normal effort), check the steering cylinder and steering control valve for wear or damage.

8. If you do not meet the relief pressure specification, adjust the relief valve (RV) in the steering/cooling fan control manifold (Figure 102) so that the pressure is correct; refer to Adjusting the Pressure Valve (page 4–94).

9. Disconnect the pressure gauge from the manifold-test port.

Testing the Steering Cylinder for Internal Leakage



g031789

Figure 103

Perform the steering cylinder internal leakage test if you identify a steering problem. This test determines if a steering cylinder is not functioning.

Note: The operation of the steering circuit is affected by the rear tire pressure, binding of steering cylinders, extra weight on the vehicle, and/or binding of the rear axle steering components. Check these items before proceeding with the steering cylinder internal leakage test.

Testing the Steering Cylinder for Internal Leakage

1. Ensure that the hydraulic fluid is at the normal operating temperature.
2. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.

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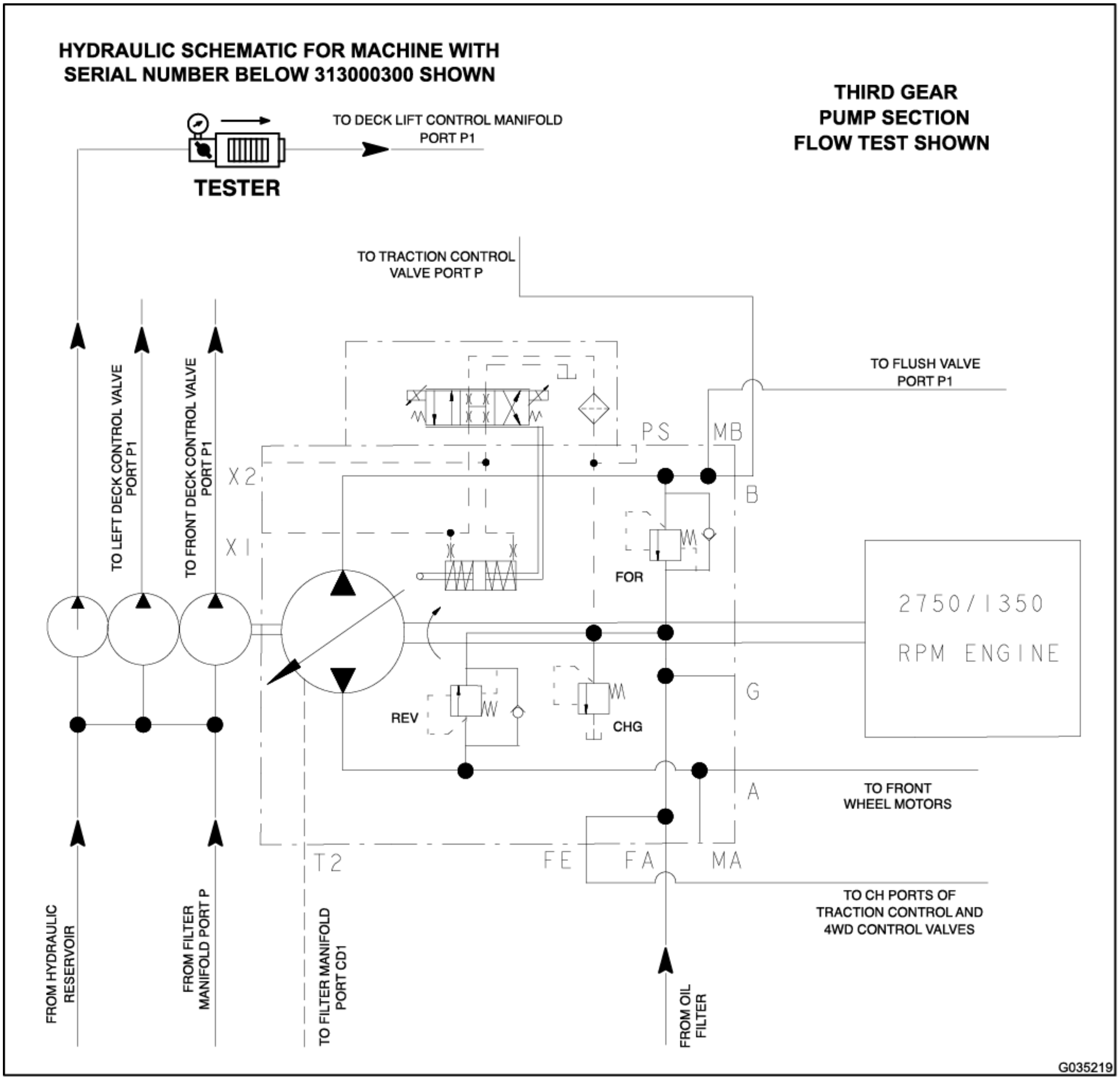
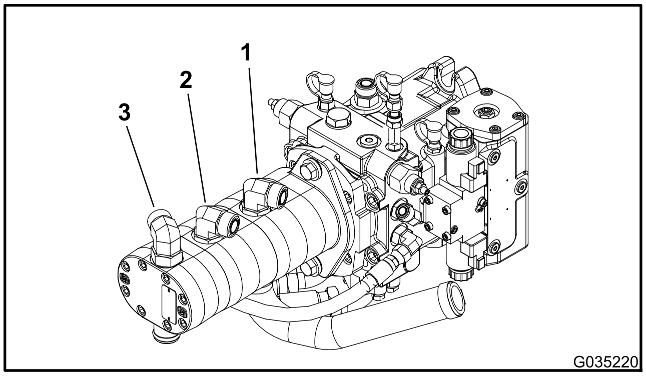
3. Turn the steering wheel and fully extend the steering cylinder rod to test the cylinder.
4. Clean the area around the hydraulic hose to test at the rod end of the steering cylinder.
5. Put a drain pan under the steering cylinder, and remove the hydraulic hose from the fitting at the rod end of the steering cylinder to test the steering cylinder.
6. Install a steel plug into the disconnected hose.
7. Remove all the hydraulic fluid from the drain pan. Ensure that the empty drain pan stays under the open fitting of the steering cylinder.
8. Turn the steering wheel in the same direction to extend the cylinder. Monitor the open fitting on the extended steering cylinder as you turn the steering wheel. If fluid comes out the fitting while you are turning the steering wheel, repair or replace the steering cylinder that has internal leakage; refer to Steering Cylinders (page 4–186) and Servicing the Steering Cylinder (page 4–188). Check the drain pan for any sign of fluid indicating cylinder leakage.
9. After testing, remove the plug from the hydraulic hose. Connect the hose to the steering cylinder fitting.
10. If there is a steering problem and the steering cylinder tested satisfactorily, service the steering control valve; refer to Steering Control Valve (page 4–182) and Servicing the Steering Control Valve (page 4–185).
11. Check the hydraulic-fluid level in the hydraulic reservoir and adjust it if necessary.

Testing the Gear Pump (P3) (PTO, Steering, Cooling Fan, Lift/Lower, and Traction Charge Circuits) Flow (Using Tester with Pressure Gauges and Flow Meter)



g035219

Figure 104



g035220

Figure 105

1. First gear pump section (wing decks)
2. Second gear pump section (center deck)
3. Third gear pump section (steering, lift/lower, fan, and charge)

Perform the gear pump flow test to ensure that the mow, steering, cutting deck lift/lower, engine cooling fan, and traction charge circuits have sufficient hydraulic-fluid flow. The gear pump sections are shown in Figure 105. The first gear pump section provides hydraulic flow for both the wing cutting decks. The second gear pump section provides hydraulic flow for the front cutting deck. The third gear pump section provides hydraulic flow for the steering, deck lift/lower, engine cooling fan, and traction charge circuits.

Note: Over a period of time, the gears and wear plates in the gear pump can wear. A worn pump may bypass the hydraulic fluid and make the pump less efficient. After sometime, sufficient fluid loss will occur and cause circuit problems (e.g., the cutting deck motors stalling under heavy cutting conditions, lift or steering problems). Continued operation with a worn, inefficient gear pump can generate excessive heat, cause damage to the seals and other components in the hydraulic system.

Testing the Gear Pump (P3) Flow

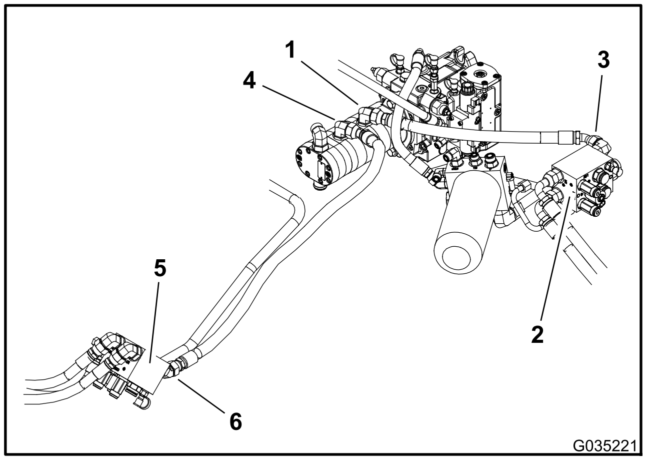
CAUTION

Performing testing on the hydraulic system can cause personal injury and damage to the equipment.

Read all Warning, Cautions, and precautions at the beginning of this section.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.

Testing the Gear Pump (P3) Flow (continued)



g035221

Figure 106

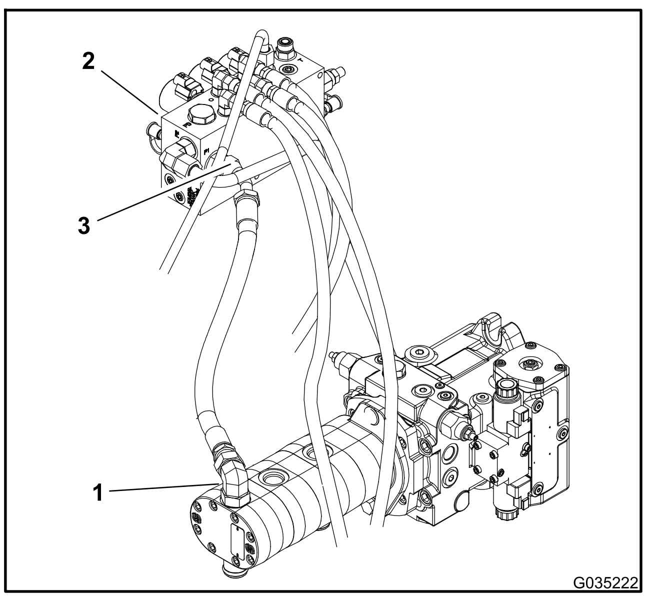
1. First pump section outlet
2. Left deck manifold
3. Manifold P1 port
4. Second pump section outlet
5. Front deck manifold
6. Manifold P1 port

2. Determine the gear pump section that you are testing. Disconnect the hydraulic hose from appropriate manifold fitting for the gear pump section that you are testing:

   A. For the 1st gear pump section (wing deck flow), disconnect the hydraulic hose from the fitting in the left deck manifold port P1 (Figure 106).

   B. For the 2nd gear pump section (front deck flow), disconnect the hydraulic hose from the fitting in the front deck manifold port P1 (Figure 106).

   C. For the 3rd gear pump section (steering, lift/lower, fan, and traction charge circuits), raise the hood and disconnect the hydraulic hose from the fitting in the lift manifold port P1 (Figure 107).



g035222

Figure 107

1. Third pump section outlet
2. Lift manifold
3. Manifold P1 port

IMPORTANT

To prevent hydraulic tester damage, use a 40 GPM Hydraulic Tester #AT40002 (pressure and flow) and Hose Kit for this test; refer to Special Tools (page 4–42).

IMPORTANT

Ensure that the oil flow indicator arrow on the flow gauge is showing that the fluid flows from the pump, through the tester, and into the hydraulic hose.

3. Install a 40 GPM tester (flow and pressure) in series with the disconnected hose and hydraulic fitting in the manifold.

IMPORTANT

After installing the 40 GPM tester (flow and pressure), ensure that the flow control valve on the tester is fully open.

4. Start the engine and increase the engine speed to high-idle speed. Check for hydraulic-fluid leaks and correct before continuing the test.

   Note: Do not engage the cutting decks.

5. Ensure that the hydraulic fluid is at the normal operating temperature by operating the machine for approximately 10 minutes.

   Note: Ensure that the hydraulic reservoir is full.

IMPORTANT

Do not fully restrict the fluid flow through the tester. In this test, the flow tester is positioned before the circuit relief valve. The pump damage can occur if the fluid flow is fully restricted.

6. While monitoring the pressure gauge, slowly close the flow control valve on the tester until you get 6,900 kPa (1,000 psi) on the gauge. Verify with the InfoCenter display that the engine is still running at the correct high-idle speed (2,750 rpm).

   Note: If the engine speed drops during testing, the pump flow will decrease and flow test results will be inaccurate.

7. The normal flow indication for the 3 gear pump sections is listed in the Gear Pump Flow Table (page 4–93).
8. Once the gear pump section flow is determined, open the tester flow control valve and shut off the engine. Record the test results.
9. If a pressure of 6,900 kPa (1,000 psi) cannot be obtained or flow is less than the minimum flow listed in the Gear Pump Flow Table (page 4–93), check for restriction in the pump intake line. If the intake line is not restricted, consider that the tested gear pump section is worn or damaged.
10. After you complete the testing, disconnect the tester from the hydraulic hose and fitting in the manifold. Connect the hose to the manifold fitting again;

refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).

11. If the hood was opened, lower and secure the hood.

    Note: Ensure that the hydraulic reservoir is full.

Gear Pump Flow Table

Pump section	Normal flow	Minimum flow
First section	83 L/minute (22 gallons/minute)	74 L/minute (19.6 gallons/minute)
Second section	83 L/minute (22 gallons/minute)	74 L/minute (19.6 gallons/minute)
Third section	53 L/minute (14.1 gallons/minute)	48 L/minute (12.6 gallons/minute)

Adjustments

Adjusting the Pressure Valve

The mow/transport and lift control manifolds include the adjustable pressure valves. If testing indicates that the circuit pressure setting is incorrect, adjust these valves; refer to Testing the Hydraulic System (page 4–52).

Note: Do not remove the valve from the hydraulic manifold to adjust the valve.

IMPORTANT

Do not remove the cap from the valve or make the valve adjustment while engine is running; this can cause the hydraulic fluid to eject under pressure from the valve without the cap in place.

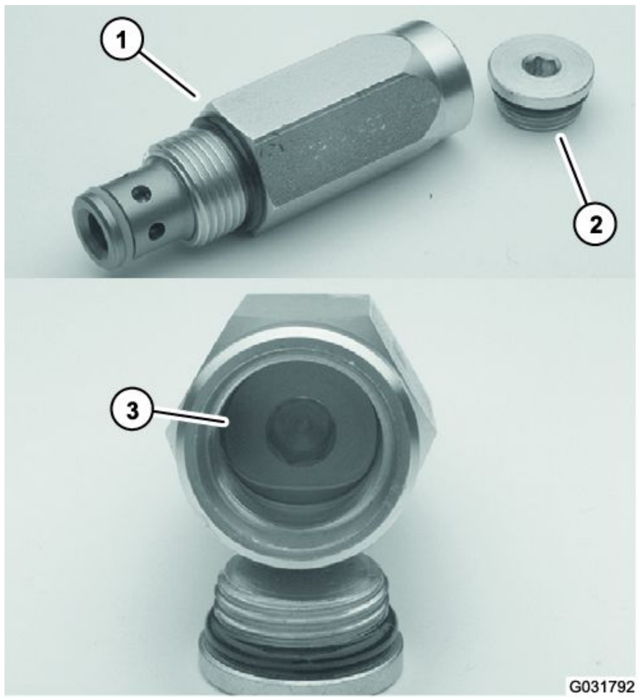


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Figure 108

1. Hydraulic valve
2. Valve cap
3. Adjustment socket

1. Shut off the engine and wait for all moving parts to stop.
2. Use an allen wrench to remove the cap from the hydraulic valve.
3. Increase the pressure setting by turning the adjustment socket on the valve clockwise.

   Note: Turn the socket 1/8 turn to make a measurable change in the pressure.
4. Decrease the pressure setting by turning the adjustment socket on the valve counterclockwise.

   Note: Turn the socket 1/8 turn to make a measurable change in the pressure.
5. Install the cap on the valve.
6. Check the valve pressure again using the correct test procedure and adjust again if necessary.

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 decks, shut off the engine, set the parking brake, 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.

CAUTION

Pressurized hydraulic fluid can cause injury. Operate all the hydraulic controls to release the system pressure.

- **Operate the controls with the key switch in the RUN position and the engine shut off.**
- **Actuate all the electrically operated control valves.**
- **Turn the key switch to the OFF position after releasing the pressure.**
- **Remove the key from the key switch.**

3. Install caps or plugs on the hydraulic lines, hydraulic fittings or components that are left open or exposed to prevent hydraulic system contamination.
4. Label all the disconnected hydraulic lines and hoses for proper installation after repairs are completed.
5. Note the position of the hydraulic fittings (especially elbow fittings) on the hydraulic components before removal.

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

After Repairing or Replacing the Components

1. Check the hydraulic-fluid level in the hydraulic reservoir and add the correct quantity of fluid if necessary.

IMPORTANT

Drain and fill the hydraulic-system reservoir and change the oil filter if the component failure is severe or the system is contaminated; refer to Flushing the Hydraulic System (page 4–96).

2. Lubricate the O-rings and seals with clean hydraulic fluid before installing the hydraulic components.
3. Remove all of the caps or plugs from the hydraulic tubes, hydraulic fittings, and components before connecting them again.

After Repairing or Replacing the Components (continued)

4. Use proper tightening procedures when installing the hydraulic hoses and fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10) and Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
5. After you complete the repairs, check the control linkages or cables for proper adjustment, binding, or broken parts.
6. 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 4–99).
7. Check for hydraulic-fluid leaks. Shut off the engine and repair leaks if necessary.
8. Check the hydraulic-fluid level in the hydraulic reservoir and add the correct quantity of fluid 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 pinhole leaks or nozzles that eject high-pressure hydraulic fluid.**
- **Use a piece of cardboard or paper to find hydraulic leaks.**
- **Relieve 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, or deterioration. Repair the damaged hydraulic lines and hoses before operating the machine.

Flushing the Hydraulic System

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 decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Flushing the Hydraulic System (continued)

CAUTION

Pressurized hydraulic fluid can cause injury. Operate all the hydraulic controls to release the system pressure.

- **Operate the controls with the key switch in the RUN position and the engine shut off.**
- **Actuate all the electrically operated control valves.**
- **Turn the key switch to the OFF position after releasing the pressure.**
- **Remove the key from the key switch.**

2. Drain the hydraulic reservoir.
3. Drain the complete hydraulic system. Drain all the hoses, tubes, and components while the system is warm.
4. Remove and replace the 2 hydraulic-fluid filters.
5. Inspect and clean the hydraulic reservoir; refer to Inspecting the Hydraulic Reservoir (page 4–106).
6. Connect all the hydraulic hoses, tubes, and components that are disconnected while draining the system.

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

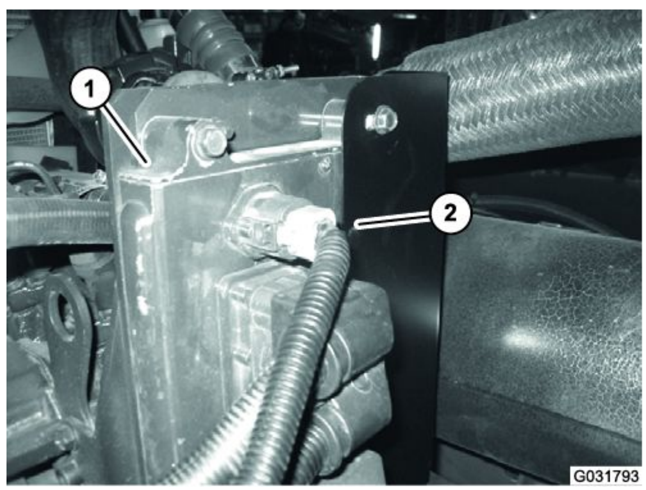

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Figure 109

1. Engine ECM
2. Power connector

Flushing the Hydraulic System (continued)

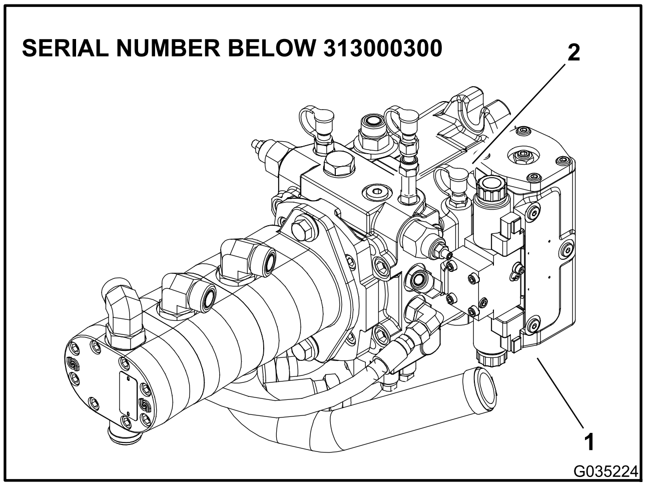

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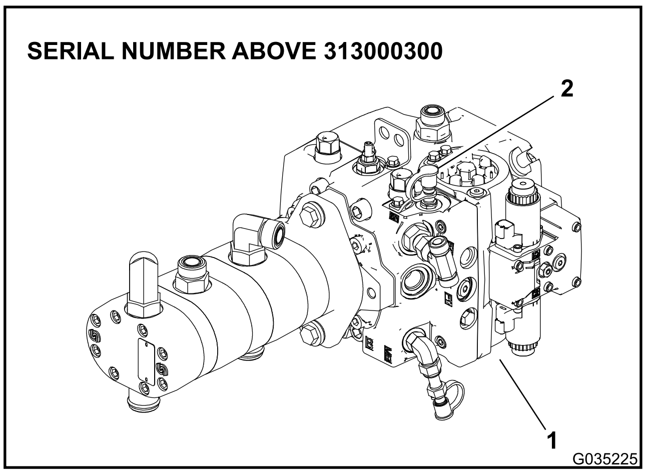
Figure 110

1. Piston pump
2. Charge-pressure test port



g035225

Figure 111

1. Piston pump
2. Charge-pressure test port

7. Fill the hydraulic reservoir with the correct quantity of new hydraulic fluid.

IMPORTANT

Before unplugging the wire harness power connector from the engine ECM, ensure that the key switch is in the OFF position and the key is removed from the switch. Removing the power connector from the engine ECM while the electrical power is on can damage the ECM.

8. Ensure that the key switch is in the OFF position and the key is removed from the switch.
9. Disconnect the wire harness power connector from the engine ECM to prevent the engine-fuel solenoid from energizing (Figure 109).

   Note: This prevents the engine from starting while you crank the engine.

Flushing the Hydraulic System (continued)

10. Connect a 7,000 kPa (1,000 psi) pressure gauge onto the charge-pressure test port fitting on the piston (traction) pump; refer to Figure 110 or Figure 111.
11. Turn the key switch to the START position and engage the starter for 30 seconds to prime the traction and gear pumps. Wait for 2 minutes to allow the starter to cool and then repeat this step.
12. Do the step 11 again until the pressure gauge attached to the charge-pressure test port indicates that the pressure in the charge circuit is increasing.
13. Ensure that the key switch is in the OFF position and the key is removed from the switch.

IMPORTANT

Before plugging the wire harness power connector to the engine ECM, ensure that the key switch is in the OFF position and the key is removed from the switch. Connecting the power connector from the engine ECM while the electrical power is on can damage the ECM.

14. Connect the wire harness power connector to the engine ECM; refer to Figure 109.
15. Disconnect the pressure gauge from the charge-pressure test port; refer to Figure 110 or Figure 111.
16. Start the engine and operate it at low idle (1,350 rpm) for a minimum of 2 minutes. Increase the engine speed to high idle (2,750 rpm) for a minimum of 1 minute under no load.
17. Raise and lower the cutting decks several times. Turn the steering wheel fully left and right several times.
18. Shut off the engine and check the entire machine for hydraulic-fluid leaks.

    Note: Check the hydraulic-fluid level in the hydraulic reservoir and add the correct quantity of fluid if necessary.
19. Operate the machine for 2 hours under normal operating conditions.
20. Check the condition of the hydraulic fluid. If the new fluid shows any signs of contamination, do steps 1 through 15 again until the fluid is clean.
21. Assume the normal operation and follow the recommended maintenance intervals.

Charging the Hydraulic System

Note: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps, or lift cylinders, it is important that the hydraulic system is charged properly. Remove the air from the system and its components to reduce the chance of damage.

Charging the Hydraulic System (continued)

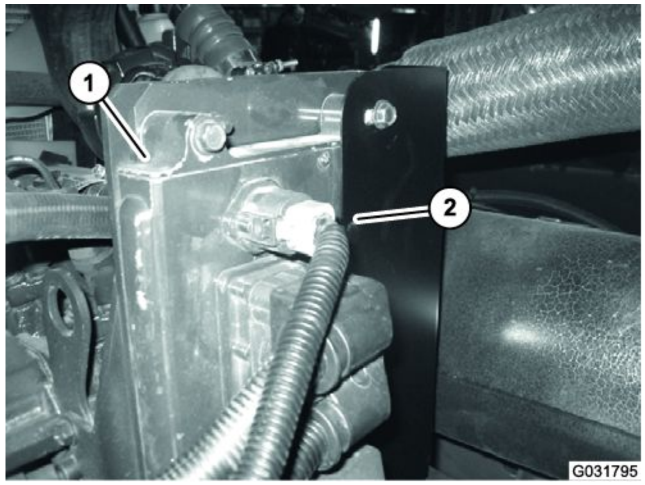


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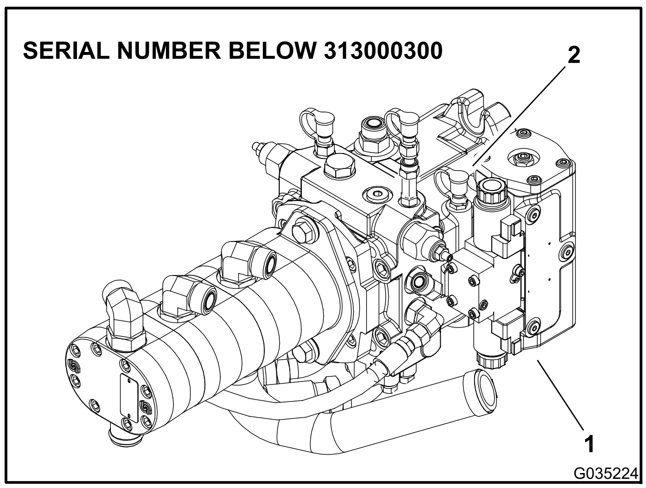
Figure 112

1. Engine ECM
2. Power connector



g035224

Figure 113

1. Piston pump
2. Charge-pressure test port

IMPORTANT

Change the hydraulic-fluid filter when you repair or replace the hydraulic components.

1. Position the machine on a level surface, and remove the key from the key switch.
2. Ensure that all of the hydraulic connections, lines, and components are tight.

   Note: Flush and fill the hydraulic system and reservoir whenever there is a severe component failure or the system is contaminated; refer to Flushing the Hydraulic System (page 4–96).
3. Ensure that the hydraulic reservoir is full. Add the correct quantity of hydraulic fluid if necessary.

Charging the Hydraulic System (continued)

IMPORTANT

Before unplugging the wire harness power connector from the engine ECM, ensure that the key switch is in the OFF position and the key is removed from the switch. Removing the power connector from the engine ECM while the electrical power is on can damage the ECM.

4. Ensure that the key switch is in the OFF position and the key is removed from the switch.
5. Disconnect the wire harness power connector from the engine ECM to prevent the engine-fuel solenoid from energizing (Figure 112).

   Note: This prevents the engine from starting while you crank the engine.
6. Connect a 7,000 kPa (1,000 psi) pressure gauge onto the charge-pressure test port fitting on the piston (traction) pump; refer to Figure 113 or Figure 114.

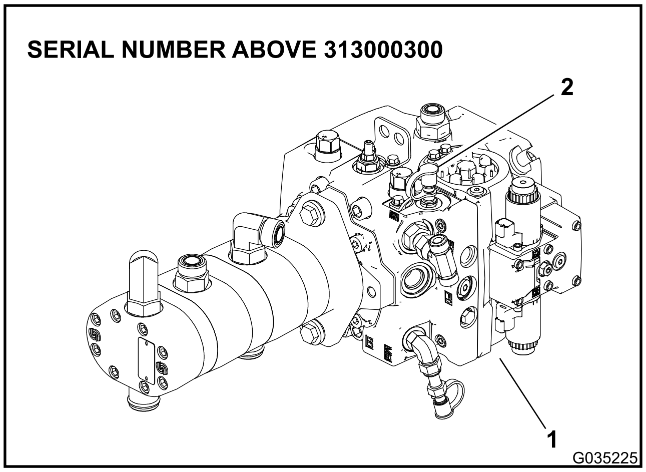


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Figure 114

1. Piston pump
2. Charge-pressure test port

7. Ensure that the traction pedal is in the NEUTRAL position. Turn the key switch to the START position and engage the starter for 30 seconds to prime the traction and gear pumps. Wait for 2 minutes to allow the starter to cool and do this step again.
8. Do the step 7 again until the pressure gauge attached to the charge-pressure test port indicates that the pressure in the charge circuit is increasing.
9. Ensure that the key switch is in the OFF position and the key is removed from the switch.

IMPORTANT

Before plugging the wire harness power connector to the engine ECM, ensure that the key switch is in the OFF position and the key is removed from the switch. Connecting the power connector from the engine ECM while the electrical power is on can damage the ECM.

10. Connect the wire harness power connector to the engine ECM; refer to Figure 112.

Charging the Hydraulic System (continued)

11. Disconnect the pressure gauge from the charge-pressure test port; refer to Figure 114.

WARNING

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–5).

---

12. Lift 1 front and 1 rear wheel off the ground and place the appropriate jack stands under the frame to support the machine. Block the remaining wheels with chocks to prevent the movement of the machine.
13. Ensure that the traction pedal is in the NEUTRAL position. Start the engine and operate it at low-idle speed (1,350 rpm).

    Note: The charge pump should pick up the fluid and fill the hydraulic system. If there is no indication of fill in 30 seconds, shut off the engine and find the cause.
14. After the hydraulic system starts to show the signs of fill, operate the lift control switches until the lift cylinders extend and retract several times.

    Note: If the cylinders do not move after 15 seconds or the gear pump sounds abnormal, shut off the engine immediately and find the cause or problem. Inspect for loose filter or suction lines, blocked suction line, damaged charge relief valve, or damaged gear pump.
15. If the lift cylinders move in 15 seconds, continue to step 16.
16. Operate the traction pedal in the forward and reverse directions. The wheels off the ground should rotate in the proper direction.
    A. If the wheels rotate in a wrong direction, shut off the engine and inspect the hydraulic line placement at the piston (traction) pump and wheel motors. Correct the hydraulic line installation before you proceed.
    B. If the wheels rotate in the proper direction, shut off the engine.
17. Use the InfoCenter for checking the traction NEUTRAL position and interlock switch operation.
18. Remove the jack stands from the frame and lower the machine to the ground, and remove the chocks from the remaining wheels.
19. If you replace or rebuilt the piston (traction) pump or a wheel motor, operate the machine so that all the wheels rotate slowly for 10 minutes.
20. Operate the machine by gradually increasing its work load to full over a 10 minute period.
21. Stop the machine. Check the hydraulic-fluid level in the hydraulic reservoir and add correct quantity of fluid if necessary. Check the hydraulic components for leaks and tighten any loose connections.

Filtering the Closed-Loop Traction Circuit

Filtering a closed-loop hydraulic system after a major component failure (e.g., traction (piston) pump or wheel motor) is necessary to prevent unwanted material from transmitting throughout the system. If a closed-loop hydraulic system filtering tool is not used to ensure the system cleanliness, repeat failures, as well as subsequent damage to other hydraulic components in the affected system, will occur. To effectively remove the contamination from the closed-loop traction circuit, use the Toro high flow hydraulic filter and hydraulic hose kits (Special Tools (page 4–42)).

1. Park the machine on a level surface, shut of the engine, and remove the key from the key switch.
2. Lift and support the machine so that all the wheels are off the ground; refer to Jacking Instructions (page 1–5).

   Note: If the wheel motor was replaced, install a high-flow filter to the inlet of the new motor instead of to the piston pump hose. This will prevent system contamination from entering and damaging the new wheel motor.

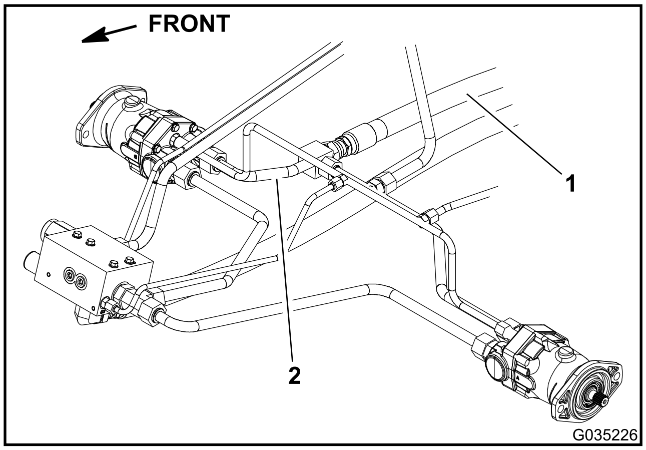

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Figure 115

1. Hose from the piston pump
2. Hydraulic tube

3. Clean the junction of the hydraulic hose from the piston pump and hydraulic tube which is connected to the right front wheel motor (Figure 115). Disconnect the hose from the tube.
4. Connect the Toro high flow hydraulic filter in series between the hydraulic tube and disconnected hose. Use the hydraulic hose kit (Special Tools (page 4–42)) to connect the filter to the machine.

   Note: Ensure that the hose connections are properly tightened.

IMPORTANT

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

5. After you install the high-flow filter to the machine, check and fill the reservoir with the correct quantity of new hydraulic fluid.
6. Start the engine and run it at low-idle speed. Check for hydraulic-fluid leaks at the filter and hose connections. Correct any leaks before you proceed.

Filtering the Closed-Loop Traction Circuit (continued)

⚠ CAUTION ⚠

During this procedure, all the wheels will be off the ground and rotating.

Ensure that the machine is well supported so it will not move and accidentally fall to prevent injuring anyone around the machine.

IMPORTANT

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

7. With the engine running at low-idle speed, slowly move the traction pedal to the forward direction to allow flow through the traction circuit and high-flow filter. Keep the traction circuit engaged in forward for 5 minutes while gradually increasing both forward pressure on the traction pedal and engine speed until engine is running at 2,000 rpm. Monitor the filter indicator to ensure that the green color is showing during operation.
8. With the engine running at 2,000 rpm and traction pedal moved to the forward direction, periodically apply brakes to increase pressure in the traction circuit. While monitoring the filter indicator, continue this process for 5 more minutes.

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 reverse 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. With the engine running at 2,000 rpm, alternately move the traction pedal from forward to reverse. 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. Connect the hydraulic hose to the hydraulic tube; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).

    Note: Ensure that you properly tighten the hose.
12. Lower the machine to the ground.
13. Check the hydraulic-fluid level in the hydraulic reservoir and add the correct quantity of fluid if necessary.

Hydraulic Reservoir

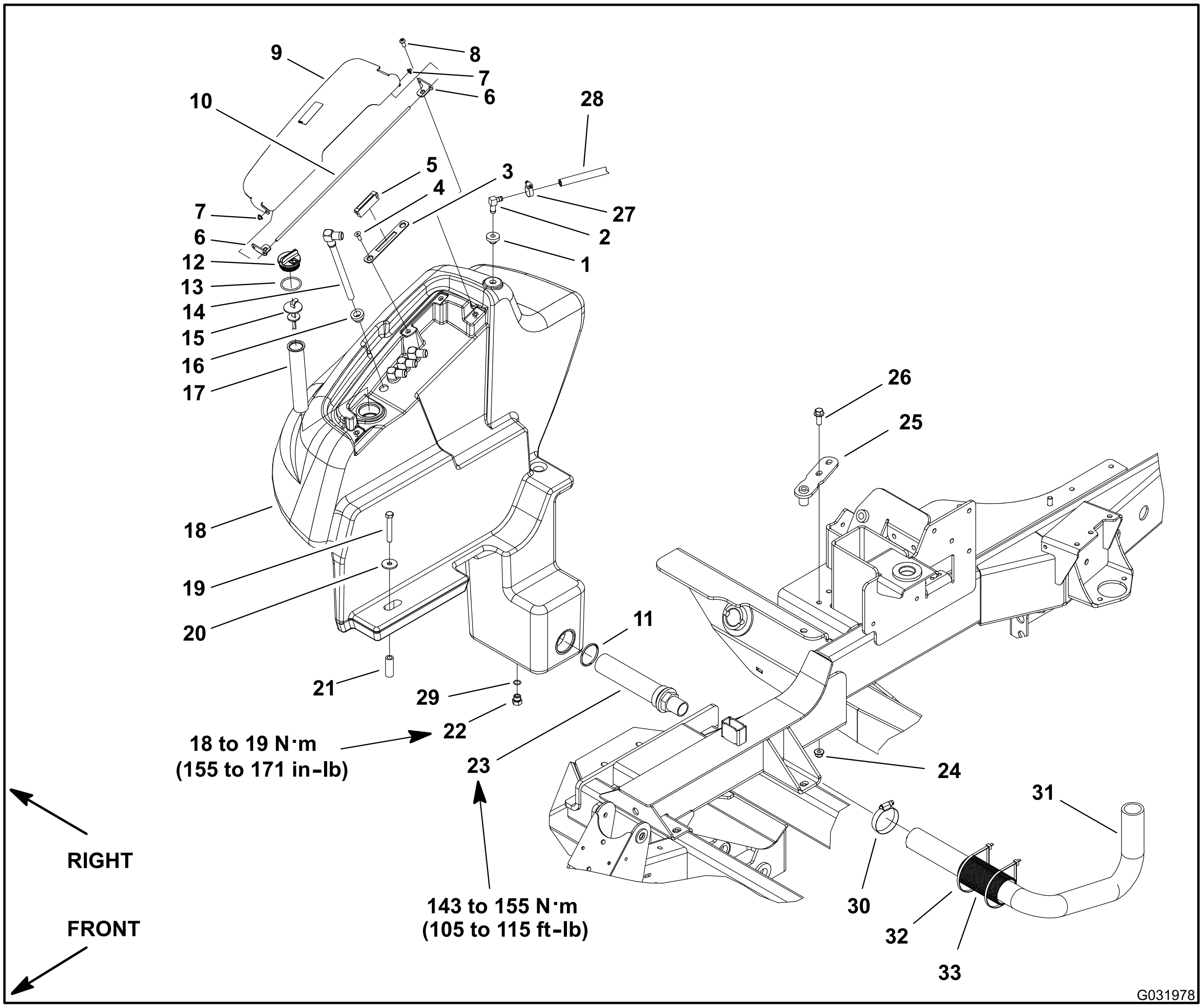

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Figure 116

1. Bushing
2. Elbow fitting
3. Latch plate
4. Socket-head screw (2 each)
5. Magnetic catch
6. Hinge bracket (2 each)
7. Push nut (2 each)
8. Socket-head screw (2 each)
9. Tank cover
10. Rod
11. O-ring
12. Reservoir cap
13. O-ring
14. Stand pipe
15. Dipstick
16. Bushing (4 each)
17. Screen filter
18. Hydraulic reservoir
19. Bolt
20. Washer
21. Spacer
22. Drain plug
23. Tank strainer
24. Flange nut (2 each)
25. Tank hold-down
26. Flange-head screw
27. Hose clamp
28. Hose
29. O-ring
30. Hose clamp
31. Suction hose
32. Cable tie (2 each)
33. Hose guard

Removing the Hydraulic Reservoir

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Removing the Hydraulic Reservoir (continued)

2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
3. Clean the exterior of the reservoir, fittings, and hoses before removing the hydraulic reservoir to prevent contaminants from entering into the hydraulic system.

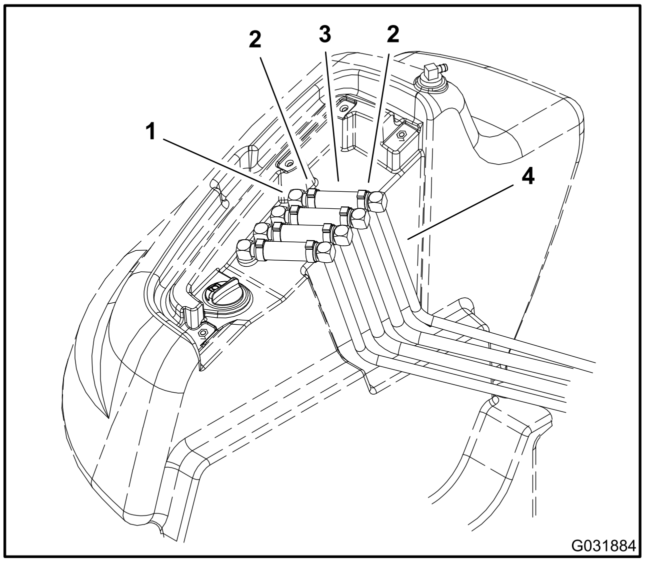

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Figure 117

1.	Stand pipe	3.	Hydraulic hose
2.	Hose clamp	4.	Hydraulic tube

4. Remove the drain plug and drain the reservoir into a suitable container.
5. To get access to the reservoir fasteners, loosen the fuel tank and slide it toward the left side of the machine; refer to Removing the Fuel Tank (page 3–17).
6. For assembly purposes, label all the hydraulic hoses to identify their correct position on the reservoir.

   Note: The original production clamps, used to attach the hoses to the stand pipes and hydraulic tubes, are crimped; you must cut them in order to remove the hoses (Figure 117). The replacement clamps are traditional worm clamps.
7. Disconnect the hydraulic hoses from the reservoir fittings. Install caps or plugs on the fittings and hoses to prevent contamination.
8. Remove the hydraulic reservoir; refer to Figure 116.

Inspecting the Hydraulic Reservoir

1. Clean the hydraulic reservoir and tank strainer with solvent.
2. Inspect the reservoir for leaks, cracks, or other damage.

Installing the Hydraulic Reservoir

1. Install the reservoir; refer to Figure 116.

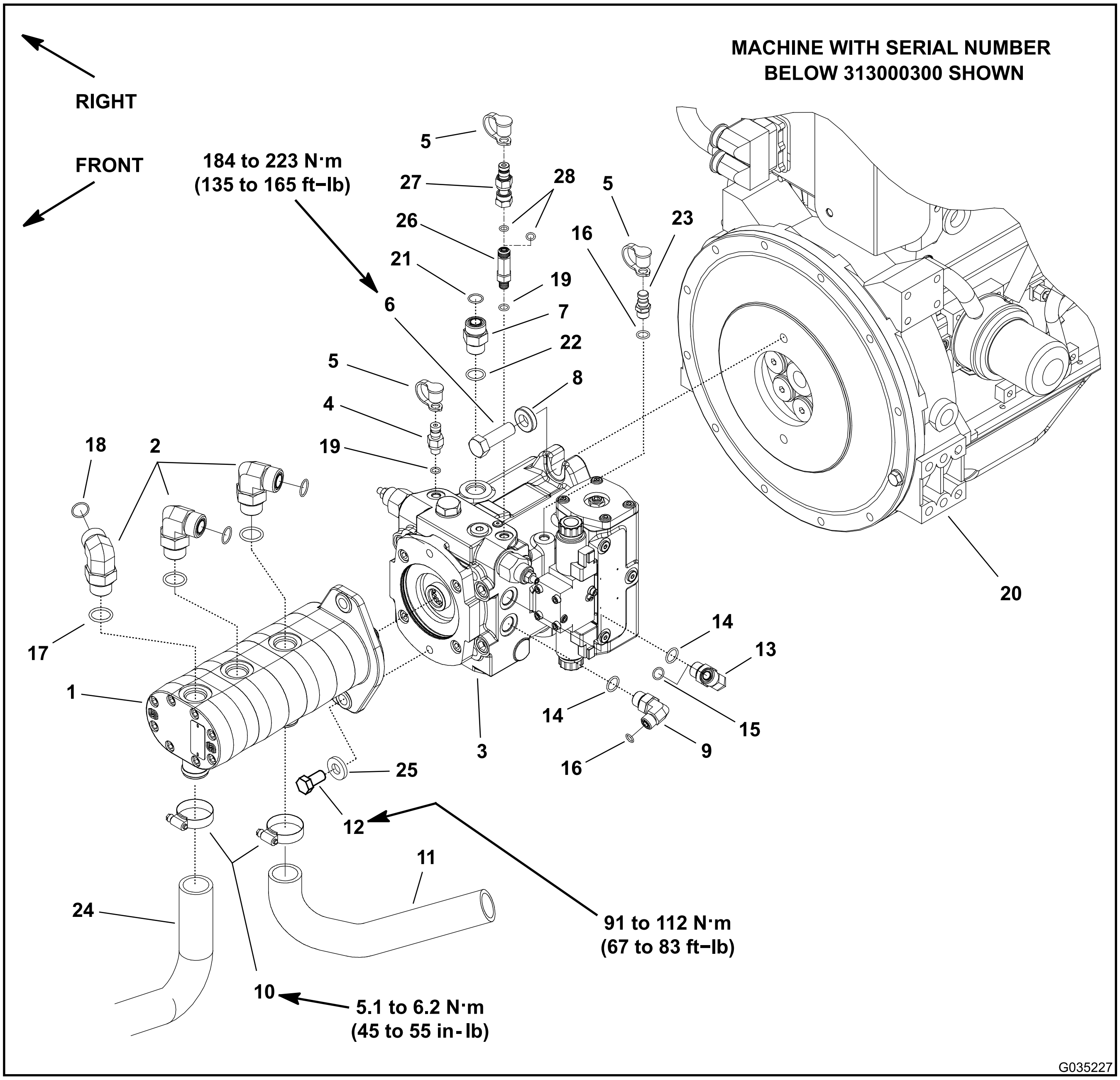
   A. Torque the drain plug (item 22 in Figure 116) to **18 to 19 N·m (155 to 171 in-lb)**.

   B. Torque the tank strainer (item 23 in Figure 116) to **143 to 155 N·m (105 to 115 ft-lb)**.

Installing the Hydraulic Reservoir (continued)

2. Remove the caps or plugs that were installed during the removal process.
3. Use the tags that you placed during reservoir removal to connect the hydraulic hoses to the reservoir fittings and secure the hoses with the hose clamps.
4. If the hose guard (item 33 in Figure 116) was removed, install the guard with the split oriented up and attach it with 2 cable ties.
5. Slide the fuel tank to the correct location on the machine and attach in place; refer to Installing the Fuel Tank (page 3–18).
6. Fill the reservoir with the correct quantity of new hydraulic fluid.

Gear Pump



g035227

Figure 118

1. Gear pump
2. 90° hydraulic fitting
3. Piston pump
4. Quick fitting
5. Dust cap
6. Bolt (2 each)
7. Hydraulic adapter
8. Flat washer (2 each)
9. 90° hydraulic fitting
10. Clamp
11. Hose (from filter)
12. Bolt (2 each)
13. 90° hydraulic fitting
14. O-ring
15. O-ring
16. O-ring
17. O-ring
18. O-ring
19. O-ring
20. Engine
21. O-ring
22. O-ring
23. Diagnostic fitting
24. Hose (from hydraulic tank)
25. Washer (2 each)
26. Tee fitting
27. Test fitting
28. O-ring

Removing the Gear Pump

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the hood to get access to the gear pump; refer to Removing the Hood (page 7–37).
3. Drain the hydraulic reservoir.
4. Clean the exterior of the pump and fittings before removing the pump to prevent contaminants from entering into the hydraulic system.
5. Label all the hydraulic hose connections for assembly purposes.
6. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
7. Disconnect all the hydraulic lines from the gear pump and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for correct assembly.

⚠ CAUTION ⚠

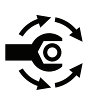
The weight of the gear pump assembly is approximately 19 kg (42 lb).

Ensure that you support the gear pump correctly before removing the pump mounting screws.

8. Support the gear pump assembly to prevent it from falling.
9. Remove the 2 bolts and 2 washers that attach the gear pump to the piston pump, and remove the gear pump from the machine.
10. If you remove the hydraulic fittings from the gear pump, put a mark on the fitting orientation for correct assembly.
11. Remove the fittings from the pump and discard the O-rings.

Installing the Gear Pump

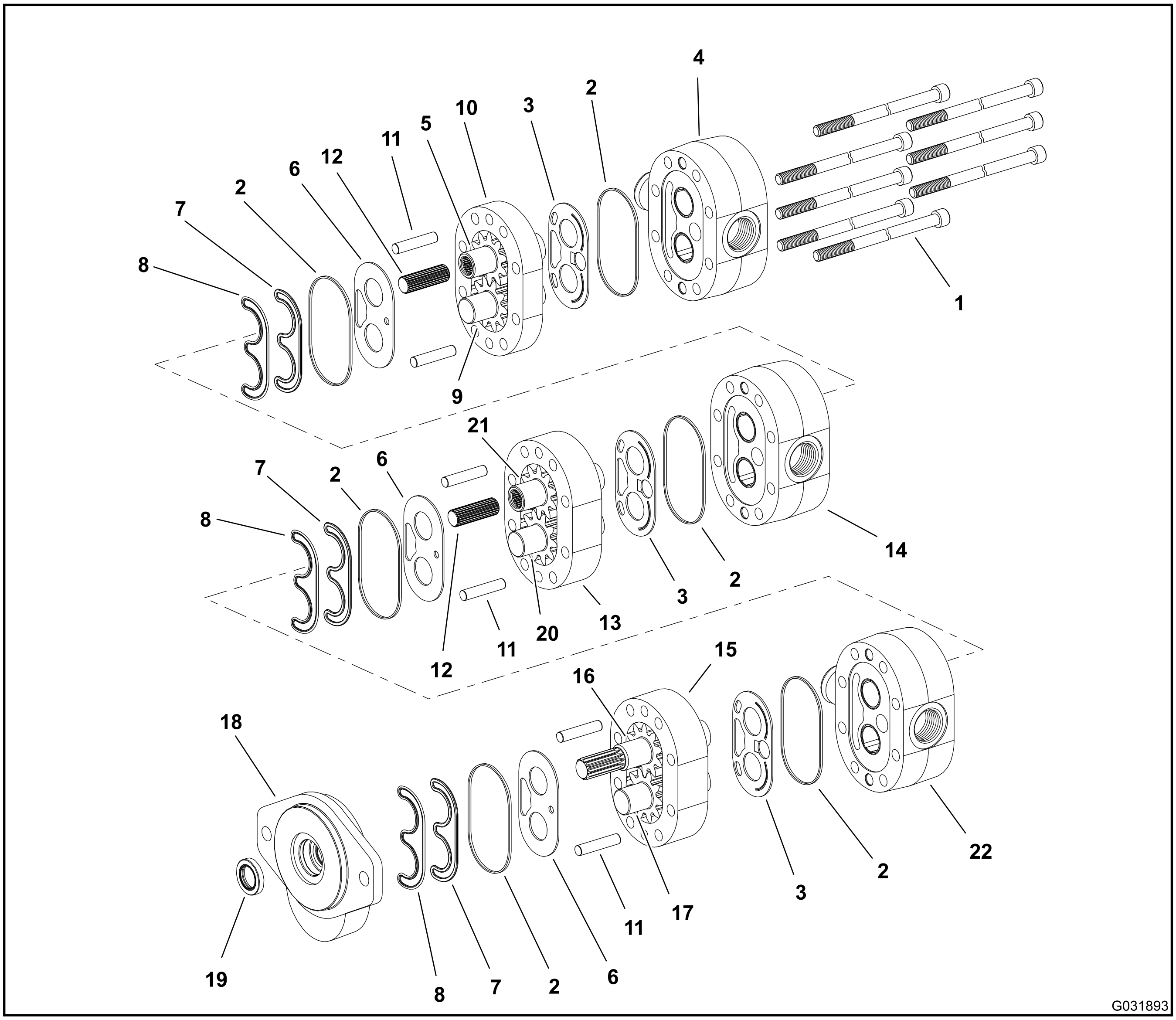
1. If the fittings were removed from the gear pump, lubricate and install new O-rings onto the fittings. To properly align and install the fittings into the pump openings, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).



2. Position the gear pump to the piston pump. Align the gear-pump input shaft splines with the piston-pump coupler and slide the gear-pump input shaft into the piston-pump coupler. Attach the gear pump to the piston pump with 2 bolts and 2 washers. Torque the bolts to **91 to 112 N·m (67 to 83 ft-lb)**.
3. Remove the caps or plugs from the hydraulic lines and fittings. Install the hydraulic lines to the gear pump; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
4. Remove and replace the hydraulic filters.
5. Fill the hydraulic reservoir with the correct quantity of new hydraulic fluid.

   Note: Correctly fill the hydraulic system; refer to Charging the Hydraulic System (page 4–99).
6. Shut off the engine and check for hydraulic-fluid leaks. Check the hydraulic-fluid level in the hydraulic reservoir.
7. Install the hood; refer to Installing the Hood (page 7–38).

Servicing the Gear Pump



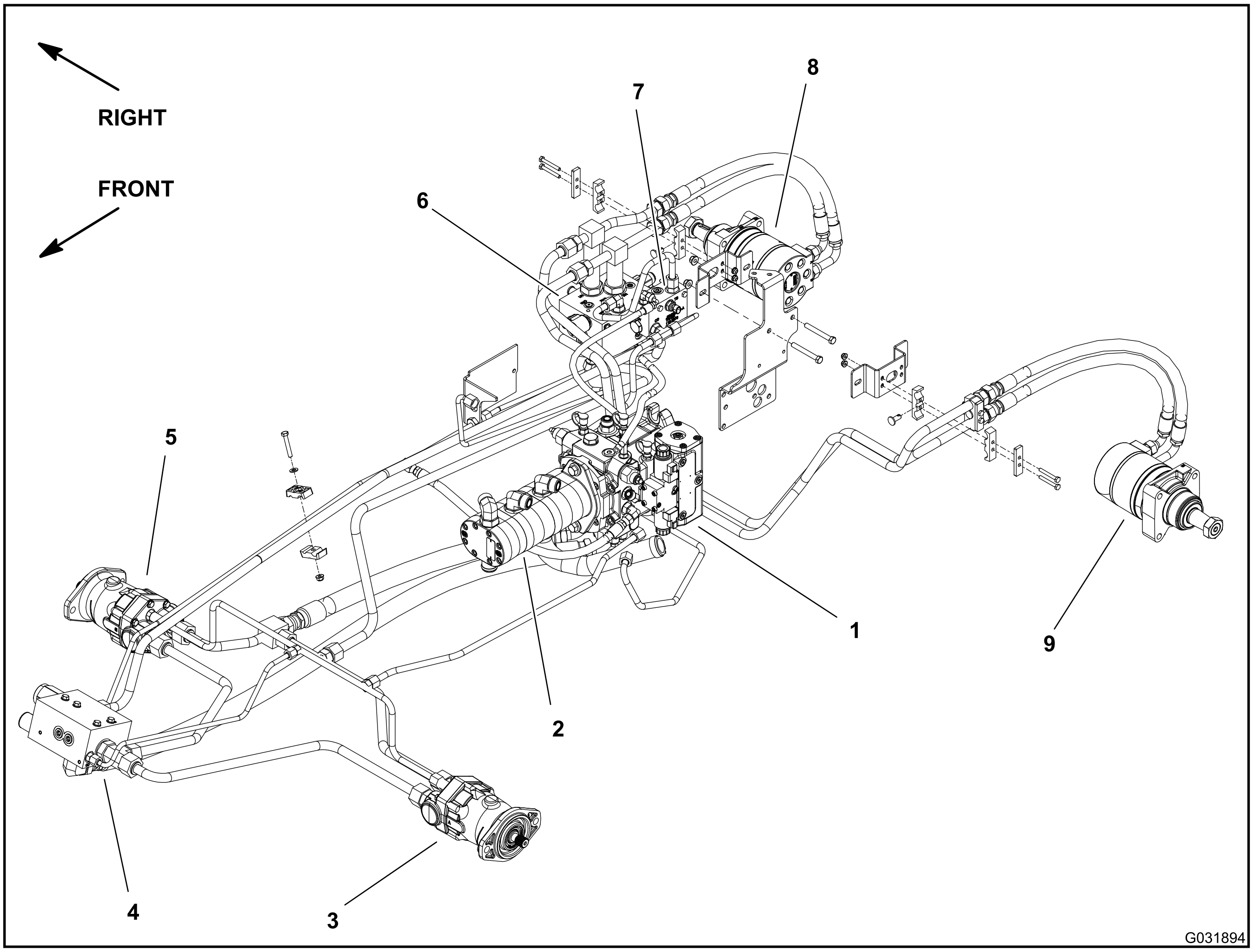
g031893

Figure 119

1. Socket-head screw (8 each)
2. Seal ring
3. Deflecting plate
4. Rear cover
5. Drive gear
6. Deflecting plate
7. Load seal
8. Pre-load seal
9. Idler gear
10. Gear housing
11. Dowel pin (6 each)
12. Drive coupler
13. Gear housing
14. Bearing plate
15. Gear housing
16. Drive gear
17. Idler gear
18. Mounting flange
19. Seal
20. Idler gear
21. Drive gear
22. Bearing plate

Note: For the gear pump repair procedures; refer to the Sauer Danfoss D Series Gear Pump Seal Kit Service Instruction Bulletin at the end of this chapter.

Traction Circuit



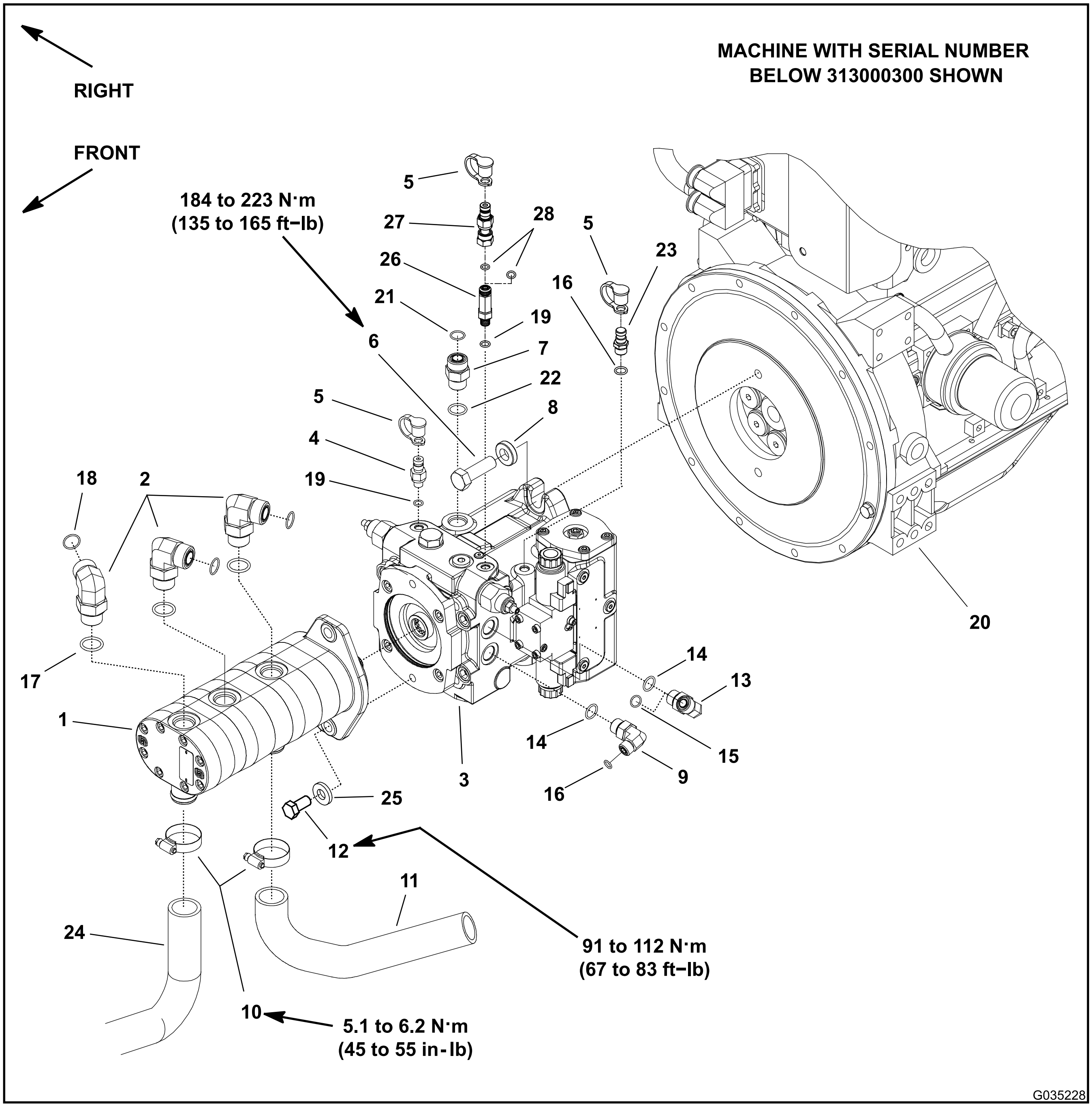
g031894

Figure 120

1. Piston (traction) pump
2. Gear pump
3. Left front wheel motor
4. Traction control manifold
5. Right front wheel motor
6. 4-wheel drive control manifold
7. Traction flush manifold
8. Right rear wheel motor
9. Left rear wheel motor

Refer to Figure 120 for the components that are used in the traction circuit of the machine. Procedures for removal, installation, and disassembly/assembly of these components are provided on the following pages of this section.

Piston (Traction) Pump

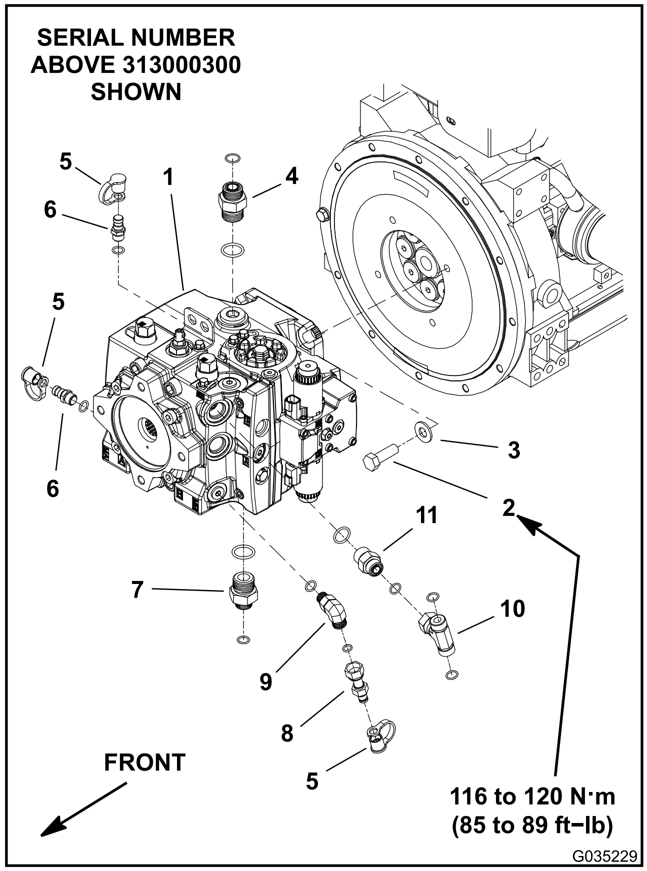


g035228

Figure 121

1. Gear pump
2. 90° hydraulic fitting
3. Piston pump
4. Quick fitting
5. Dust cap
6. Bolt (2 each)
7. Hydraulic adapter
8. Flat washer (2 each)
9. 90° hydraulic fitting
10. Clamp
11. Hose (from filter)
12. Bolt (2 each)
13. 90° hydraulic fitting
14. O-ring
15. O-ring
16. O-ring
17. O-ring
18. O-ring
19. O-ring
20. Engine
21. O-ring
22. O-ring
23. Diagnostic fitting
24. Hose (from hydraulic tank)
25. Washer (2 each)
26. Tee fitting
27. Test fitting
28. O-ring

Removing the Piston (Traction) Pump

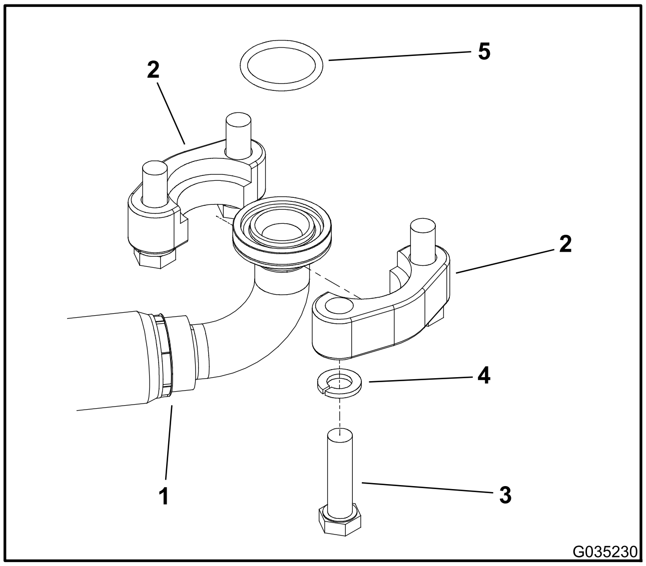


g035229

Figure 122

1. Piston pump
2. Bolt (4 each)
3. Washer (4 each)
4. Straight fitting
5. Dust cap
6. Diagnostic fitting
7. Adapter fitting
8. Test nipple
9. 90° fitting
10. Tee fitting
11. Straight fitting

Removing the Piston (Traction) Pump (continued)



g035230

Figure 123

1. Hydraulic hose
2. Flange
3. Bolt (4 each)
4. Lock washer (4 each)
5. O-ring

Note: Machines with serial number below 313000300 have a Rexroth piston (traction) pump (Figure 121). Machines with serial number above 313000300 have a Sauer-Danfoss piston pump (Figure 122). Removal and installation of the piston pump is very similar regardless of the pump brand.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the hood to get access to the hydraulic pumps; refer to Removing the Hood (page 7–37).
3. Drain the hydraulic reservoir.
4. Clean the exterior of the pump assembly including the hydraulic hoses before removing the pump to prevent contaminants from entering into the hydraulic system.
5. For assembly purposes, label the wire harness leads of traction pump solenoids. Disconnect the wire harness connectors from the 2 solenoids on the pump.
6. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
7. Label all the hydraulic hose connections for assembly purposes.
8. Put a drain pan below the pump assembly, and remove all of the hydraulic hoses connected to the piston and gear pumps. The traction circuit supply hose flanges are shown in Figure 123.
9. Install plugs or caps on the disconnected hydraulic hoses and fittings to prevent contaminants from entering into the system.
10. Remove the gear pump from the machine; refer to Removing the Gear Pump (page 4–109).

Removing the Piston (Traction) Pump (continued)

CAUTION

The weight of the Rexroth piston pump assembly is approximately 39 kg (86 lb). The weight of the Sauer-Danfoss piston pump assembly is approximately 50 kg (110 lb).

Ensure that you support the piston pump correctly before removing the pump mounting screws.

11. Attach a hoist to the piston pump to support the pump and safely remove the pump from the machine.
12. Remove the 2 bolts and 2 flat washers that retain the pump assembly to the flywheel coupling housing on the engine.
13. Carefully slide the pump assembly from the housing on the engine and lift the pump out of the machine.
14. If you remove the hydraulic fittings from the piston pump, put a mark on the fitting orientation for correct assembly.
15. If necessary, remove the fittings from the pump and discard the O-rings.

Installing the Piston (Traction) Pump

1. If the fittings were removed from the piston pump, lubricate and install new O-rings onto the fittings. To properly align and install the fittings into the pump openings, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Attach a hoist to the piston pump to support the pump and safely install the pump into the machine.
3. Carefully lower the piston pump into the machine and position it to the flywheel coupling housing on the engine.

   Note: Support the pump to ensure that you do not apply side loads to the flywheel coupling and that the pump pilot is aligned with the coupling housing on the engine.

IMPORTANT

Support the pump to prevent it from moving or falling while you install the 2 bolts and 2 flat washers securing the piston pump to the engine housing.

4. Install the 2 bolts and 2 flat washers and attach the piston pump to the housing; Refer to Figure 121 (Rexroth pump) or Figure 122 (Sauer-Danfoss pump) for bolt torque specifications.
5. Install the gear pump to the piston pump; refer to Installing the Gear Pump (page 4–109).
6. Use the labels that you attached during removal to correctly connect the 2 wire harness connectors to the solenoids on the traction pump.
7. Remove the plugs or caps from the disconnected hydraulic hoses. Install the hoses to the correct location on the gear and piston pumps; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
8. Remove and replace the hydraulic filters.

Installing the Piston (Traction) Pump (continued)

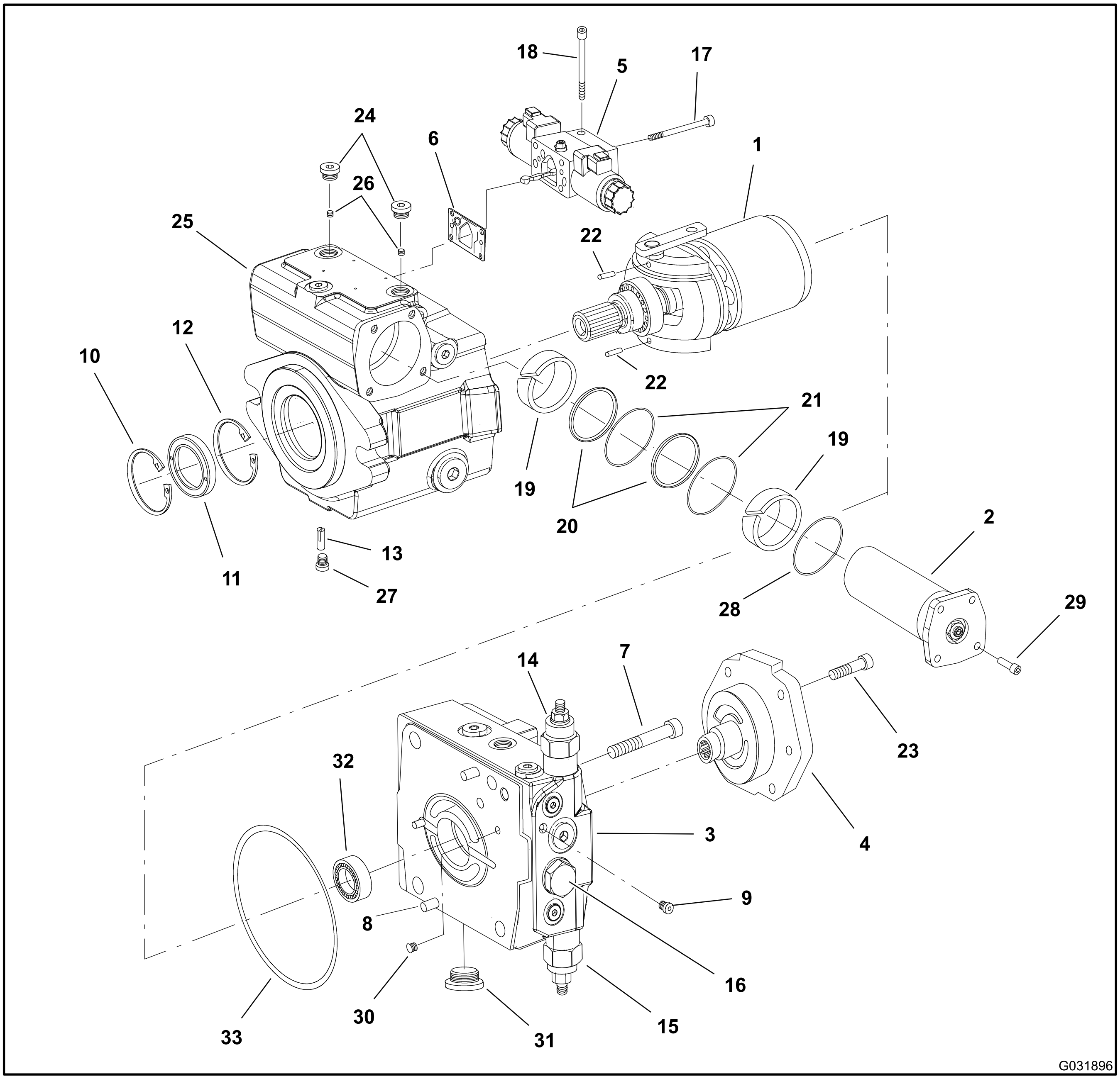
9. Fill the hydraulic reservoir with the correct quantity of fluid.

   Note: Correctly fill the hydraulic system; refer to Charging the Hydraulic System (page 4–99).

10. Shut off the engine and check for hydraulic-fluid leaks. Check the hydraulic-fluid level in the hydraulic reservoir.

11. Install the hood; refer to Installing the Hood (page 7–38).

Servicing the Piston (Traction) Pump (Rexroth)



g031896

Figure 124

1. Rotary group
2. Stroking piston assembly
3. Port plate assembly
4. Pump support plate assembly
5. EP control assembly
6. Gasket
7. Socket-head screw (4 each)
8. Dowel pin (2 each)
9. Plug
10. Retaining ring
11. Shaft seal
12. Retaining ring
13. Joint pin
14. Forward traction relief valve
15. Reverse traction relief valve
16. Charge relief valve
17. Socket-head screw (4 each)
18. Socket-head screw
19. Guide ring
20. Rod seal
21. O-ring
22. Dowel pin (2 each)
23. Socket-head screw (4 each)
24. Plug
25. Pump housing
26. Orifice
27. Plug
28. O-ring
29. Socket-head screw (4 each)
30. Clamping pin
31. Plug
32. Bearing
33. O-ring

Servicing the Piston (Traction) Pump

The Rexroth piston pump is used on the Groundsmaster machines with serial number below 313000300. For the piston (traction) pump repair procedures on these machines; refer to the Rexroth Variable Pump A10VG Repair Instructions and Repair Manual at the end of this chapter.

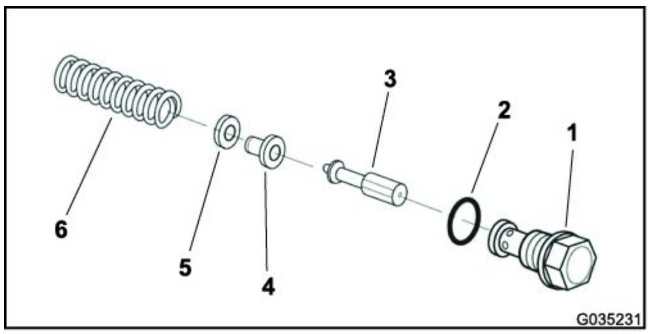
IMPORTANT

If a piston (traction) pump fails; refer to the Traction Circuit Component Failure (page 4–8) for information regarding the importance of removing contamination from the traction circuit.

Adjusting the Piston Pump Charge Relief Valve

If the testing determines that the traction circuit charge pressure is incorrect; refer to Testing the Traction Circuit Charge Pressure (Using Pressure Gauge) (page 4–54), it might be necessary to adjust the piston pump charge relief valve (item 16 in Figure 124). Adjust the charge relief valve as follows:

1. Remove the charge relief valve from the piston pump.



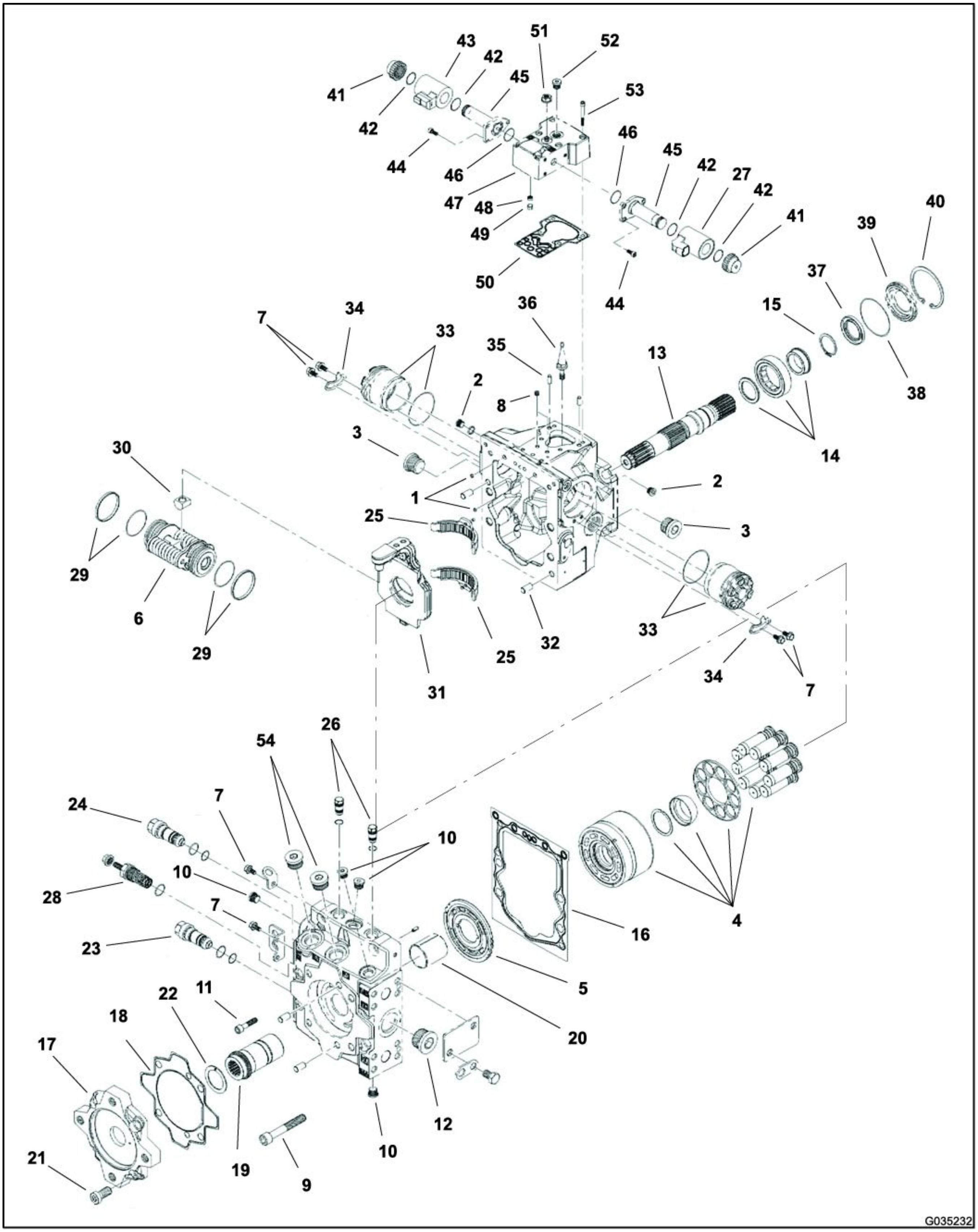
g035231

Figure 125

1. Relief valve cap
2. O-ring
3. Poppet valve
4. Cap
5. Shim(s)
6. Spring

2. Use shims to adjust the charge pressure relief valve (Figure 125). If measured charge pressure is low, add the shim(s) between the relief valve cap and spring. If the charge pressure is high, remove the shim(s) from the relief valve cap and spring.
3. Install the relief valve components back into the piston pump port.
4. Check the charge pressure using correct test procedure and adjust the charge relief valve again if necessary.

Servicing the Piston (Traction) Pump (Sauer-Danfoss)



g035232

Figure 126

Figure 126 (continued)

1. Screen (2 each)
2. Plug with O-ring (2 each)
3. Plug with O-ring (2 each)
4. Cylinder block assembly
5. Valve plate
6. Servo piston
7. Screw (6 each)
8. Orifice (2 each)
9. Screw (4 each)
10. Plug with O-ring (4 each)
11. Screw (2 each)
12. Plug
13. Shaft
14. Bearing assembly
15. Retaining ring
16. Gasket
17. Adapter
18. Adapter seal
19. Coupling
20. Bearing
21. Screw (4 each)
22. Thrust plate
23. Reverse relief valve assembly
24. Forward relief valve assembly
25. Swash plate bearing assembly
26. Pressure limiter plug (2 each)
27. Forward solenoid coil
28. Charge relief valve assembly
29. Servo piston seal assembly
30. Piston follower
31. Swash plate
32. Dowel pin (2 each)
33. Servo cylinder assembly (2 each)
34. Locking plate (2 each)
35. Dowel pin (2 each)
36. Feedback pin
37. Seal
38. O-ring
39. Seal carrier
40. Retaining ring
41. Coil nut (2 each)
42. O-ring
43. Reverse solenoid coil
44. Screw (3 each solenoid)
45. Solenoid (2 each)
46. O-ring
47. Control housing
48. Screen (2 each)
49. Retaining ring (2 each)
50. Gasket
51. Locknut
52. Plug
53. Screw (6 each)
54. Plug (2 each)

Servicing the Piston (Traction) Pump

The Sauer-Danfoss piston pump is used on the Groundsmaster machines with serial number above 313000300. For the piston (traction) pump repair procedures on these machines; refer to the Sauer-Danfoss H1 Closed Circuit Axial Piston Pumps Service Manual and Repair Instructions at the end of this chapter.

Note: The forward (item 27 in Figure 126) and reverse (item 43 in Figure 126) solenoid coils are identical.

IMPORTANT

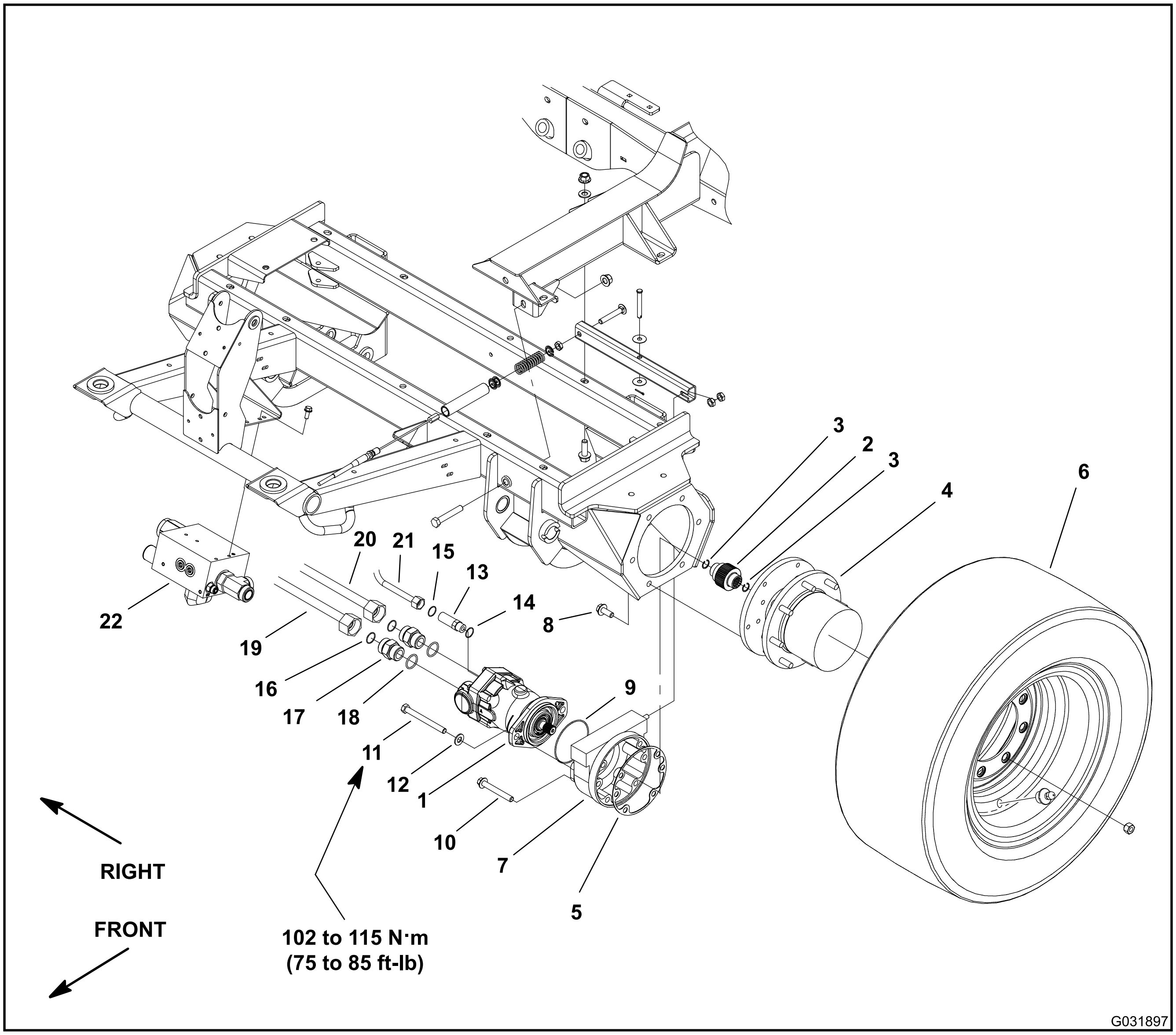
If a piston (traction) pump fails; refer to the Traction Circuit Component Failure (page 4–8) for information regarding the importance of removing contamination from the traction circuit.

Adjusting the Piston Pump Charge Relief Valve

If the testing determines that the traction circuit charge pressure is incorrect; refer to Testing the Traction Circuit Charge Pressure (Using Pressure Gauge) (page 4–54), it might be necessary to adjust the piston pump charge relief valve (item 28 in Figure 126). Adjust the charge relief valve as follows:

1. Loosen the locknut on the relief valve assembly.
2. Rotate the adjusting screw clockwise to increase the setting and counterclockwise to decrease the setting.
3. Hold the adjusting screw and torque the locknut to **12 N·m (9 ft-lb)** to secure the adjustment.
4. Check the charge pressure using correct test procedure and adjust the charge relief valve again if necessary.

Front Wheel Motors



g031897

Figure 127

1. Front wheel motor
2. Splined brake shaft
3. Internal retaining ring
4. Planetary assembly
5. Gasket
6. Front wheel assembly
7. Brake assembly (left)
8. Flange-head screw (6 each planetary)
9. O-ring
10. Flange-head screw (4 each brake)
11. Bolt (2 each motor)
12. Flat washer (2 each motor)
13. Hydraulic fitting
14. O-ring
15. O-ring
16. O-ring
17. Hydraulic fitting (2 each motor)
18. O-ring
19. Hydraulic tube
20. Hydraulic tube
21. Hydraulic tube
22. Traction control manifold

Removing the Front Wheel Motors

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).

Removing the Front Wheel Motors (continued)

3. Clean the exterior of the motor, hydraulic tubes, and fittings before removing the motor to prevent contaminants from entering into the hydraulic system.
4. To easily access the hydraulic tube fittings at the wheel motor, remove the pin that secures the lift cylinder to the front deck lift arm and lower the front of the lift cylinder; refer to Removing the Front Deck Lift Cylinder (page 4–166).
5. Disconnect the hydraulic tubes from the wheel motor. Also, loosen the fittings that are at other end of the tubes, to shift the tubes while removing the wheel motor.
6. Install plugs or caps on the disconnected hydraulic lines and fittings to prevent contamination.

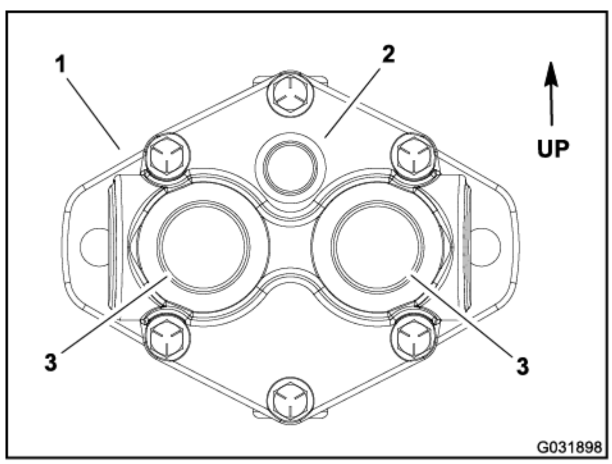
IMPORTANT

Before loosening the fasteners, support the wheel motor to prevent the motor from falling during removal.

7. Remove the 2 bolts and 2 flat washers that attach the front wheel motor to the brake and planetary assemblies.
8. Slide the front wheel motor from the brake assembly and remove it from the machine.
9. Remove and discard the O-ring that is installed between the wheel motor and the brake assembly.
10. If necessary, remove the fittings from the wheel motor and discard the O-rings from the fittings.

Installing the Front Wheel Motors

1. If the fittings were removed from the wheel motor, lubricate and install new O-rings onto the fittings. Install the fittings into the motor ports and tighten them; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Lightly lubricate the new O-ring (item 9 in Figure 127) with oil and install it on the wheel motor flange.



g031898

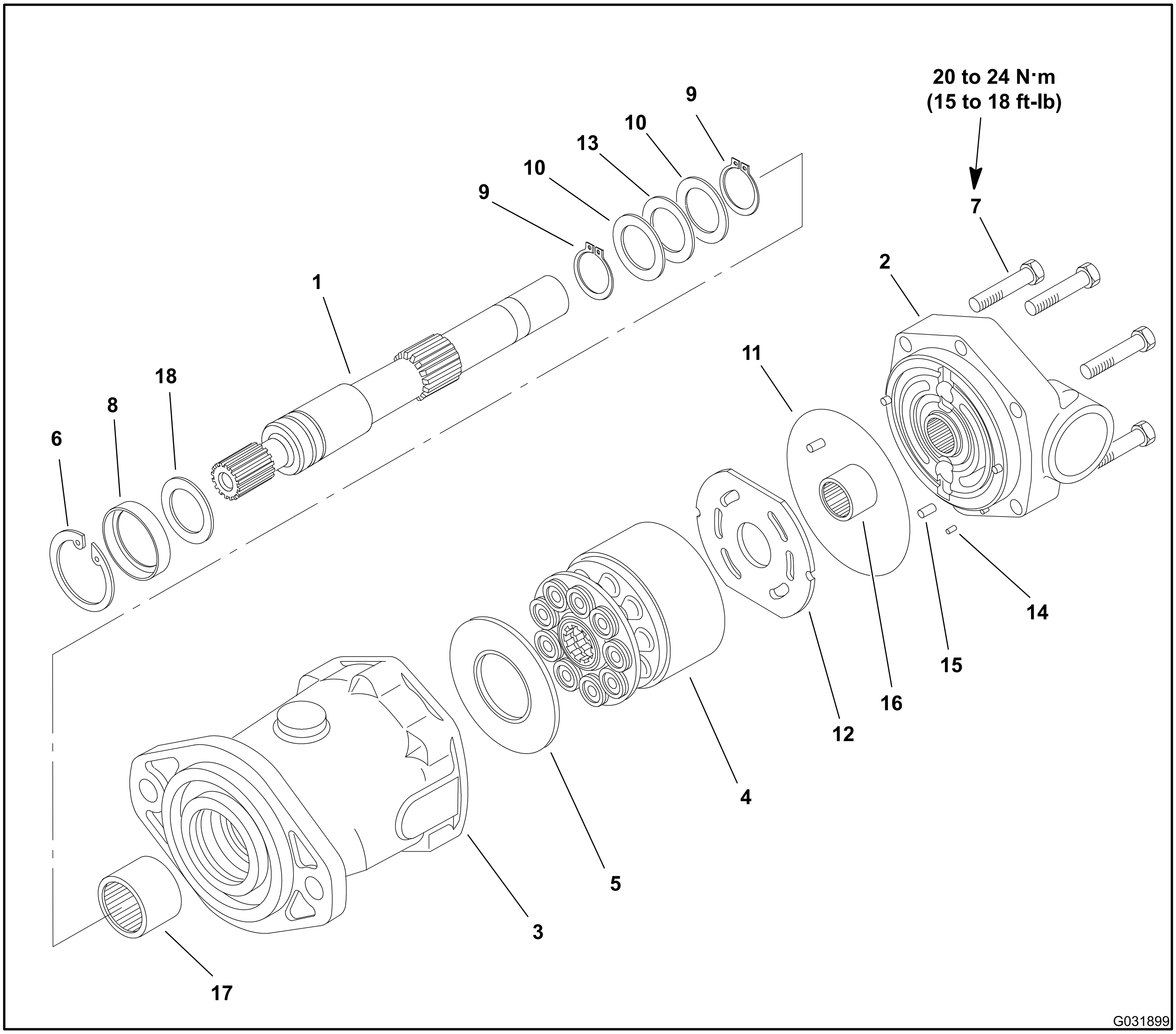
Figure 128

1. Wheel motor backplate
2. Case drain port
3. Supply line port

Installing the Front Wheel Motors (continued)

3. Position the wheel motor to the brake assembly and ensure that the case drain port is above the supply line ports; refer to Figure 128.
4. Align the splines on the motor shaft and splined brake shaft in the brake assembly. Slide the motor into the brake assembly.
5. Attach the motor to the brake and planetary assemblies with the 2 bolts and 2 flat washers; torque the bolts to **102 to 115 N·m (75 to 85 ft-lb)**.
6. Remove the plugs or caps from the hydraulic lines and fittings. Attach the hydraulic tubes to the wheel motor and tighten all the tube fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
7. Fill the reservoir with the correct quantity of new hydraulic fluid.

Servicing the Front Wheel Motor



g031899

Figure 129

1. Driveshaft
2. Backplate
3. Housing assembly
4. Rotating assembly
5. Cam plate insert
6. Retaining ring
7. Bolt (6 each)
8. Shaft seal
9. Retaining ring
10. Thrust race
11. O-ring
12. Valve plate
13. Thrust bearing
14. Roll pin
15. Roll pin
16. Bearing
17. Bearing
18. Washer

Note: The front wheel motors on the 5900 and 5910 machines are the Eaton Model 74348 motors. The front wheel motors are identical. For the wheel motor repair procedures; refer to the Eaton Repair Information: Model 74318 and 74348 Piston Motors at the end of this chapter.

IMPORTANT

If a wheel motor fails; refer to the Traction Circuit Component Failure (page 4–8) for information regarding the importance of removing contamination from the traction circuit.

Rear Wheel Motors

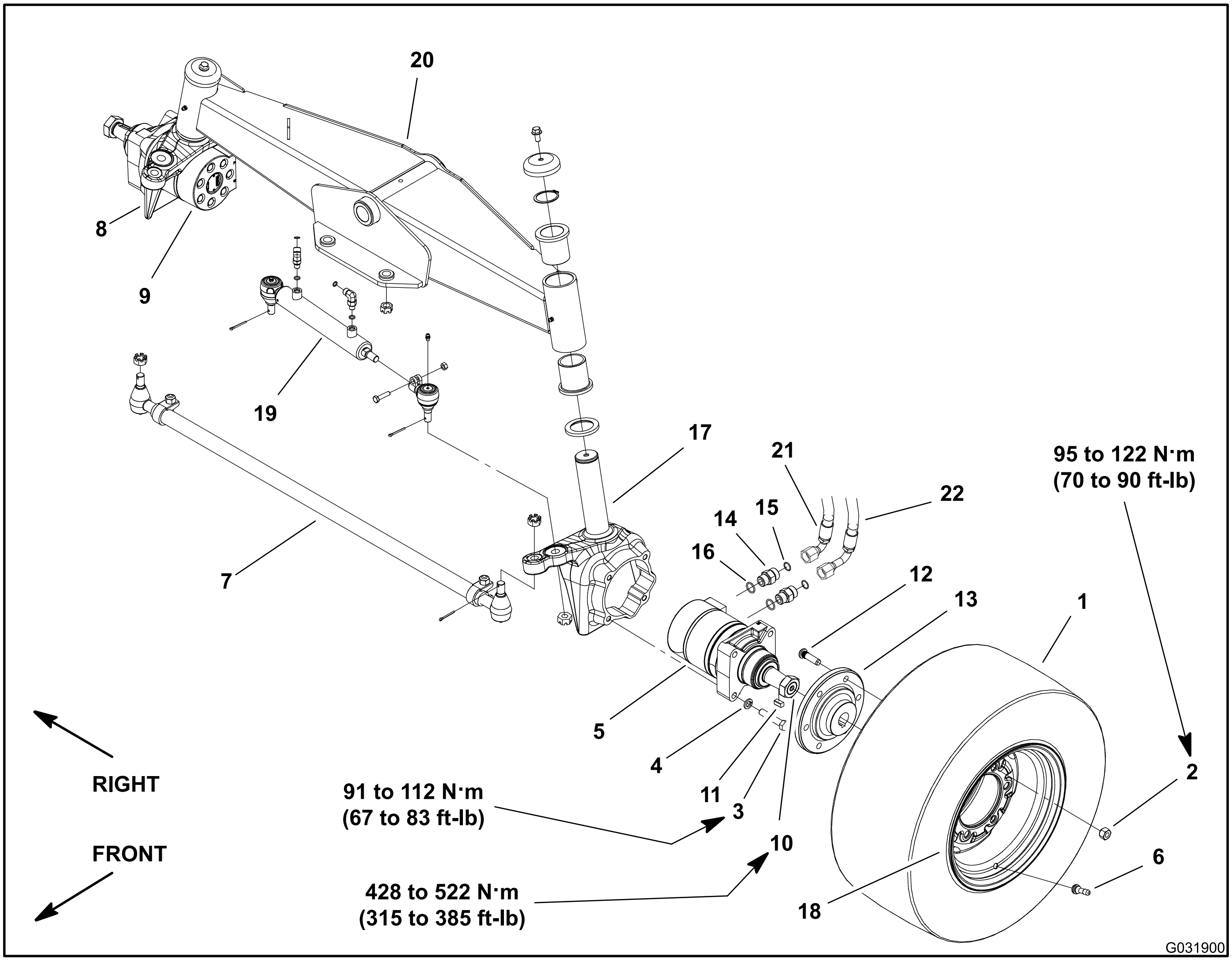


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Figure 130

1. Rear tire
2. Wheel lug nut (6 each wheel)
3. Bolt (4 each motor)
4. Lock washer (4 each motor)
5. Left wheel motor
6. Valve stem
7. Tie rod assembly
8. Right steering spindle
9. Right wheel motor
10. Hex nut
11. Square key
12. Wheel stud (6 each wheel)
13. Wheel hub
14. Hydraulic fitting
15. O-ring
16. O-ring
17. Left steering spindle
18. Wheel rim
19. Steering cylinder (2 each)
20. Rear axle
21. Hydraulic hose
22. Hydraulic hose

Removing the Rear Wheel Motors

WARNING

Before disconnecting or doing any work on the hydraulic system, release all the pressure in the system; refer to Releasing Pressure from the Hydraulic System (page 4–6).

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Removing the Rear Wheel Motors (continued)

2. Block the front wheels with chocks to prevent the machine from moving.
3. Loosen, but do not remove the 6 wheel-lug nuts and hex nut (item 10 in Figure 130) that secures the wheel hub to the wheel motor.

WARNING

Before lifting the machine with a jack, review and follow Jacking Instructions (page 1–5).

4. Lift the machine with a jack and remove the rear wheel. Support the machine with jack stands.
5. Remove the rear wheel assembly from the machine; refer to Removing the Wheel (page 6–5).

IMPORTANT

Do not hit the wheel hub, wheel-hub puller, or wheel motor with a hammer while removing or installing. Hammering can damage the wheel motor.

6. Loosen the hex nut (item 10 in Figure 130) 2 turns and then use a hub puller to remove the wheel hub; refer to Special Tools (page 4–42).
7. Remove the loosened hex nut and wheel hub from the motor shaft.
8. Locate and retrieve the square key from the wheel motor shaft.
9. Clean the hydraulic hose ends and fittings on the rear wheel motor to prevent contaminants from entering into the hydraulic system.
10. Label all the hydraulic hoses for assembly purposes, and remove the hydraulic hoses from the fittings on the wheel motor. Allow the hoses to drain into a suitable container.
11. Remove the hydraulic fittings from the wheel motor.
12. Remove and discard the O-rings from the fittings.
13. Install clean plugs into the disconnected hydraulic hoses and wheel motor ports to prevent system contamination.
14. Support the wheel motor to prevent it from falling during removal.
15. Remove the 4 bolts and 4 lock washers that attach the wheel motor to the steering spindle.
16. Remove the wheel motor from the frame.

Installing the Rear Wheel Motors

IMPORTANT

Because of the internal differences in the rear wheel motors, do not interchange the rear wheel motors on the machine (e.g., do not put the right side motor on the left side of the machine). The left side wheel motor has a yellow identification mark on the motor housing. If necessary, use the *Parts Catalog* and Part Number on the wheel motor to identify the right and left motors.

Installing the Rear Wheel Motors (continued)

1. Position the rear wheel motor to the steering spindle.

   Note: Ensure that the ports in the wheel motor are facing toward the rear of the machine.

2. Attach the wheel motor to the spindle with the 4 bolts and 4 lock washers; torque the bolts to **91 to 112 N·m (67 to 83 ft-lb)**.

3. Remove the plugs from the disconnected hydraulic hoses and wheel motor ports.

4. Lubricate and install new O-rings to the hydraulic fittings. Install the fittings into the wheel motor ports; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

5. Remove the caps or plugs that were installed during the removal process.

6. Use the labels that you attached during removal to correctly connect the hydraulic hoses to the wheel motor fittings; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).

7. Ensure that the tapers of the wheel motor shaft and wheel hub are clean.

8. Position the square key to the key slot in the wheel motor shaft.

IMPORTANT

After removing the hex nut that secures the wheel hub to the wheel motor, do not use it again.

9. Place the wheel hub on the motor shaft and attach it with new hex nut (item 10 in Figure 130).

10. Install the wheel assembly to the machine and attach it with 6 wheel-lug nuts.

11. Lower the machine to the ground.

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 lug nuts.

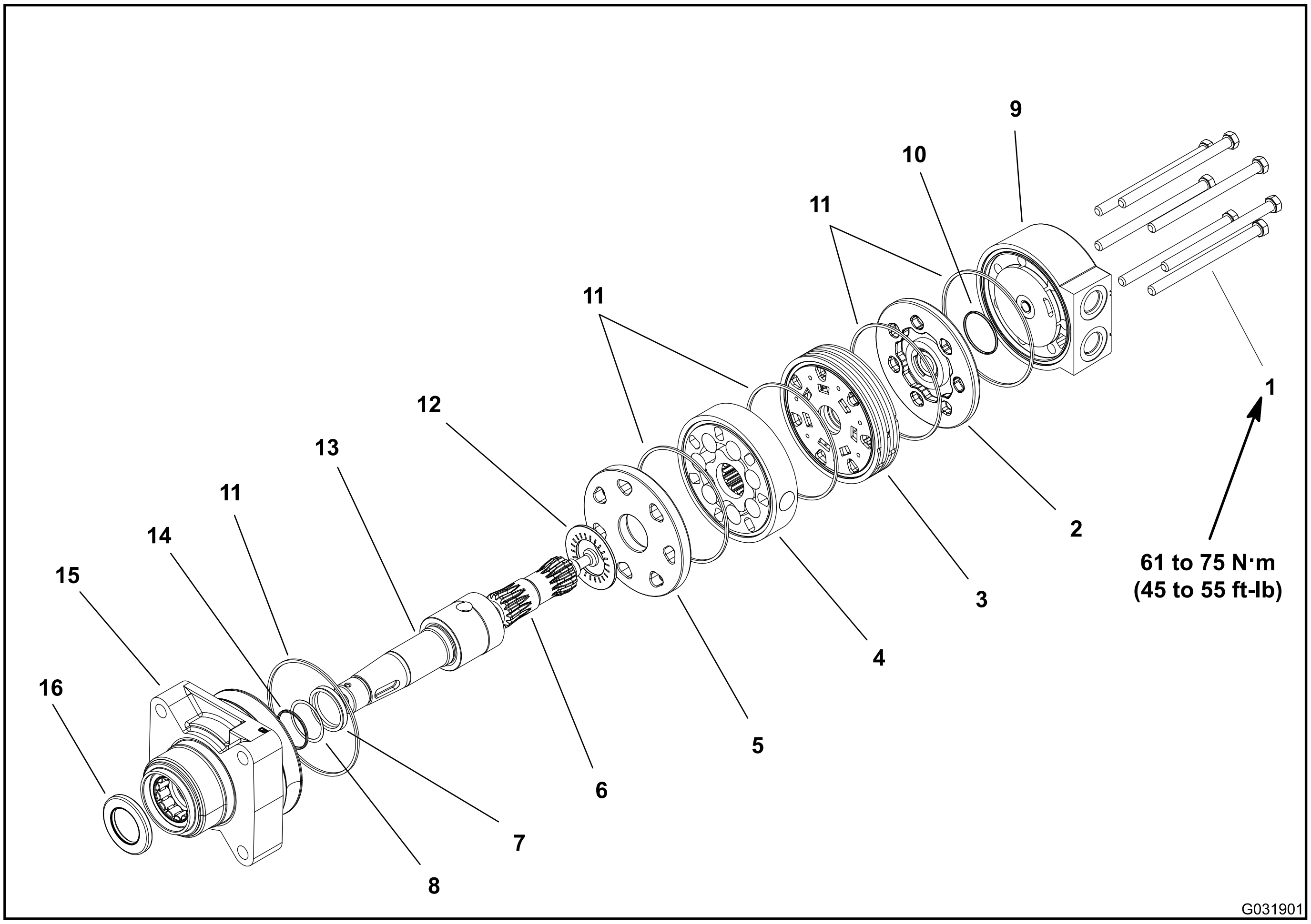
12. Torque the hex nut (item 10 in Figure 130) to **428 to 522 N·m (315 to 385 ft-lb)**.

13. Torque the wheel-lug nuts to **95 to 122 N·m (70 to 90 ft-lb)**.

14. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.

15. After you complete the assembly, ensure that the hydraulic hoses and fittings do not contact anything through the full range of axle motion. Also, check for hydraulic-fluid leaks.

Servicing the Rear Wheel Motor



g031901

Figure 131

1. Bolt (7 each)
2. Commutator assembly
3. Manifold
4. Stator assembly
5. Wear plate
6. Drive link
7. Shaft seal
8. Back-up washer
9. End cover
10. Commutator ring
11. Body seal (5 each)
12. Thrust bearing
13. Coupling shaft
14. Back-up ring
15. Housing
16. Dirt and water seal

Note: The rear wheel motors of the Groundsmaster 5900 and 5910 machines are the Parker Torqmotor™ TG Series. The right and left motors are of same basic design but the right side motor has a reverse timed manifold to allow the correct rotation in forward and reverse direction. The left side wheel motor has a yellow identification mark on the motor housing.

Note: For the rear wheel motor repair procedures; refer to the Parker Torqmotor™ Service Procedure (TC, TB, TE, TJ, TF, TG, TH, and TL Series) at the end of this chapter.

IMPORTANT

If a wheel motor fails; refer to the Traction Circuit Component Failure (page 4–8) for information regarding the importance of removing contamination from the traction circuit.

Traction Control Manifold

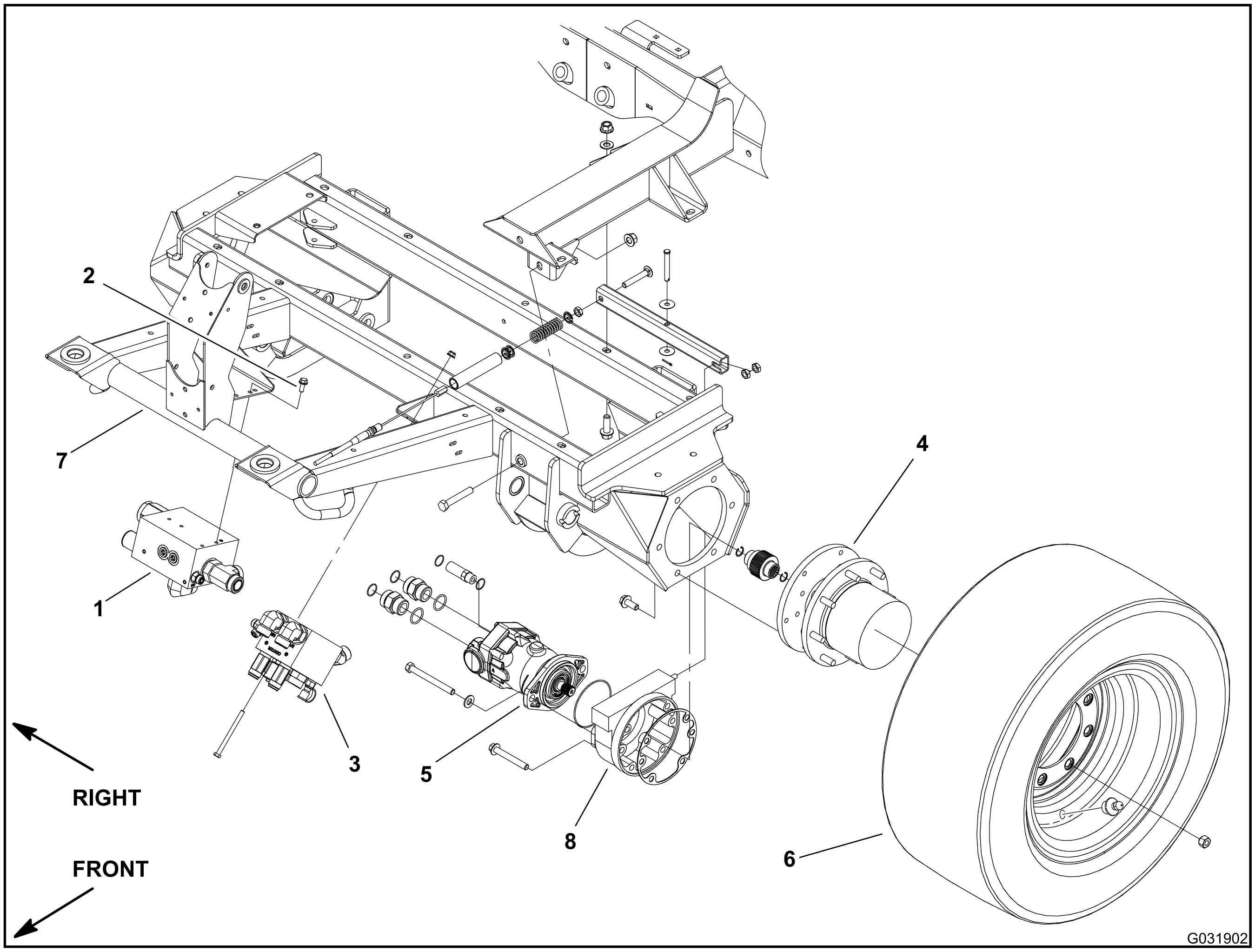


Figure 132

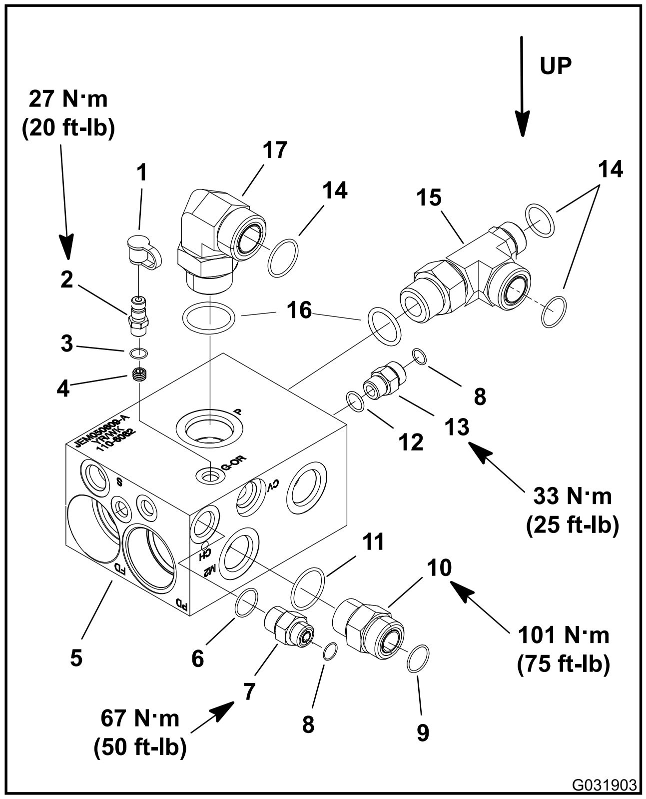
1. Traction control manifold
2. Flange-head screw (4 each)
3. Front PTO control manifold
4. Planetary assembly
5. Left front wheel motor
6. Front wheel assembly
7. Frame assembly
8. Brake assembly

Note: The ports on the traction control manifold are marked for easy identification of the components. Example: P is the piston pump connection port and S is the location for the solenoid valve; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Removing the Traction Control Manifold

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
2. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
3. Disconnect the wire harness connector from the solenoid valve.
4. Disconnect all the hydraulic lines from the manifold and install caps or plugs on the open hydraulic lines and fittings to prevent system contamination. Label the disconnected hydraulic lines for proper assembly.

Removing the Traction Control Manifold (continued)



g031903

Figure 133

1. Dust cap
2. Quick fitting (G-OR)
3. O-ring
4. Orifice (G-OR)
5. Manifold
6. O-ring
7. Straight fitting (CH)
8. O-ring
9. O-ring
10. Straight fitting (M2)
11. O-ring
12. O-ring
13. Straight fitting (CD)
14. O-ring
15. Tee fitting (M1)
16. O-ring
17. 90° fitting (P)

5. Remove the hydraulic manifold from the frame; refer to Figure 132.
6. If you remove the hydraulic fittings from the manifold, put a mark on the fitting orientation for correct assembly.
7. Remove the fittings from the manifold and discard the O-rings.

Installing the Traction Control Manifold

1. If the fittings were removed from the manifold, lubricate and install new O-rings onto the fittings. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 133 for the straight fitting installation torque.

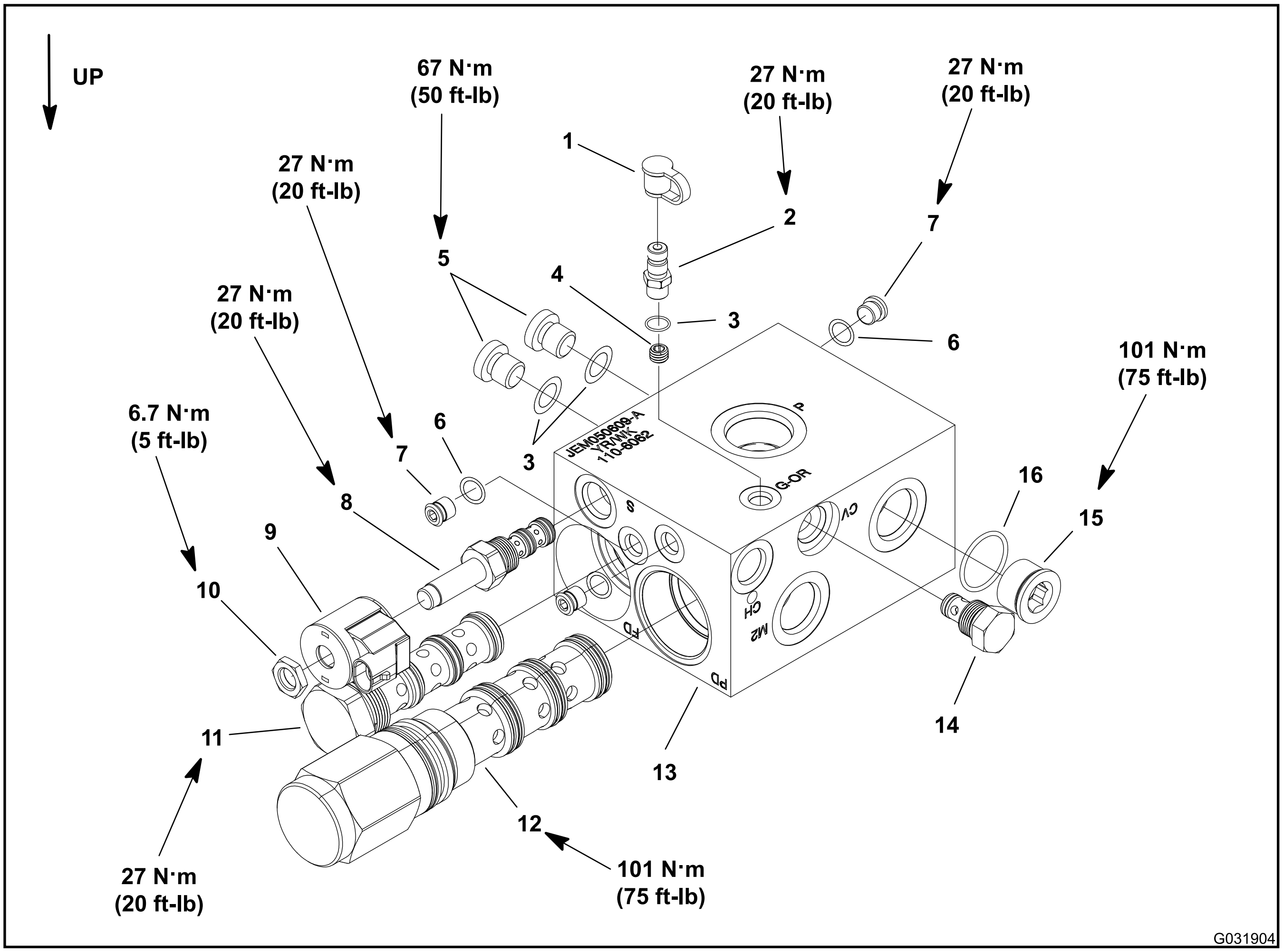
   Note: For information on tightening procedures for other manifold fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

2. Install the traction control manifold to the frame; refer to Figure 132.
3. Remove the caps and plugs from the fittings and hoses.

Installing the Traction Control Manifold (continued)

4. Use the labels that you attached during removal to correctly connect the hydraulic lines to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
5. Connect the wire harness connector to the solenoid valve.
6. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.

Servicing the Traction Control Manifold



g031904

Figure 134

1. Dust cap
2. Quick fitting (G-OR)
3. O-ring
4. Orifice (G-OR)
5. #8 NWD plug
6. O-ring
7. #4 NWD plug (3 each)
8. Solenoid valve (S)
9. Solenoid coil
10. Nut
11. Flow divider (FD)
12. Pilot directional valve (PD)
13. Manifold body
14. Check valve (CV)
15. #12 NWD plug
16. O-ring

Note: The ports on the traction control manifold are marked for easy identification of the components. Example: P is the piston pump connection port and S is the location for the solenoid valve; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Note: The traction control manifold includes several zero-leak NWD 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 zero-leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing the plugs; refer to Figure 134 for the plug installation torque.

Servicing the Valve Cartridge

1. Ensure that the entire outer surface of the manifold is clean before you remove the valve.
2. If the cartridge is solenoid-operated, remove the nut securing the solenoid coil to the cartridge valve. Carefully slide the solenoid coil off the valve.

IMPORTANT

Slight bending or distortion of the stem tube can cause binding and malfunction. Carefully handle the valve cartridge.

3. Remove the cartridge valve with a deep socket wrench. Note the correct location of the O-rings, sealing rings, and back-up rings.
4. Remove and discard the seal kit.
5. Visually examine the port in the manifold for damaged sealing surfaces, damaged threads, and contamination. Also, inspect the cartridge valve for damaged sealing surfaces and contamination.
   A. Contamination can cause the valves to stick or hang up. Contamination can accumulate in small valve orifices or seal areas and cause malfunction.
   B. If the sealing surfaces of the valve are pitted or damaged, the hydraulic system can be too hot or there can be water in the system.

CAUTION

Use the eye protection such as goggles when using the compressed air.

6. Use clean-mineral spirits and clean the cartridge valve. Put the valve in the clean-mineral spirits to flush out contamination.

IMPORTANT

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

If the cartridge design allows, use a wood or plastic probe to press the internal spool in and out for 20 to 30 times to flush out contamination.

Ensure that you do not damage the cartridge. Use the compressed air for cleaning.

7. Install the cartridge valve as follows:
   A. Lubricate the new seal kit components with clean hydraulic fluid and install them onto the valve.
   B. Install the O-rings, sealing rings, and back-up rings correctly on the cartridge valve for proper operation and sealing.

Servicing the Valve Cartridge (continued)

IMPORTANT

Slight bending or distortion of the stem tube can cause binding and malfunction. Carefully handle the valve cartridge.

C. Turn the cartridge valve carefully into the manifold port. The valve should go in easily without binding.

D. Use a deep socket and torque the cartridge valve; refer to Figure 134 for the torque value.

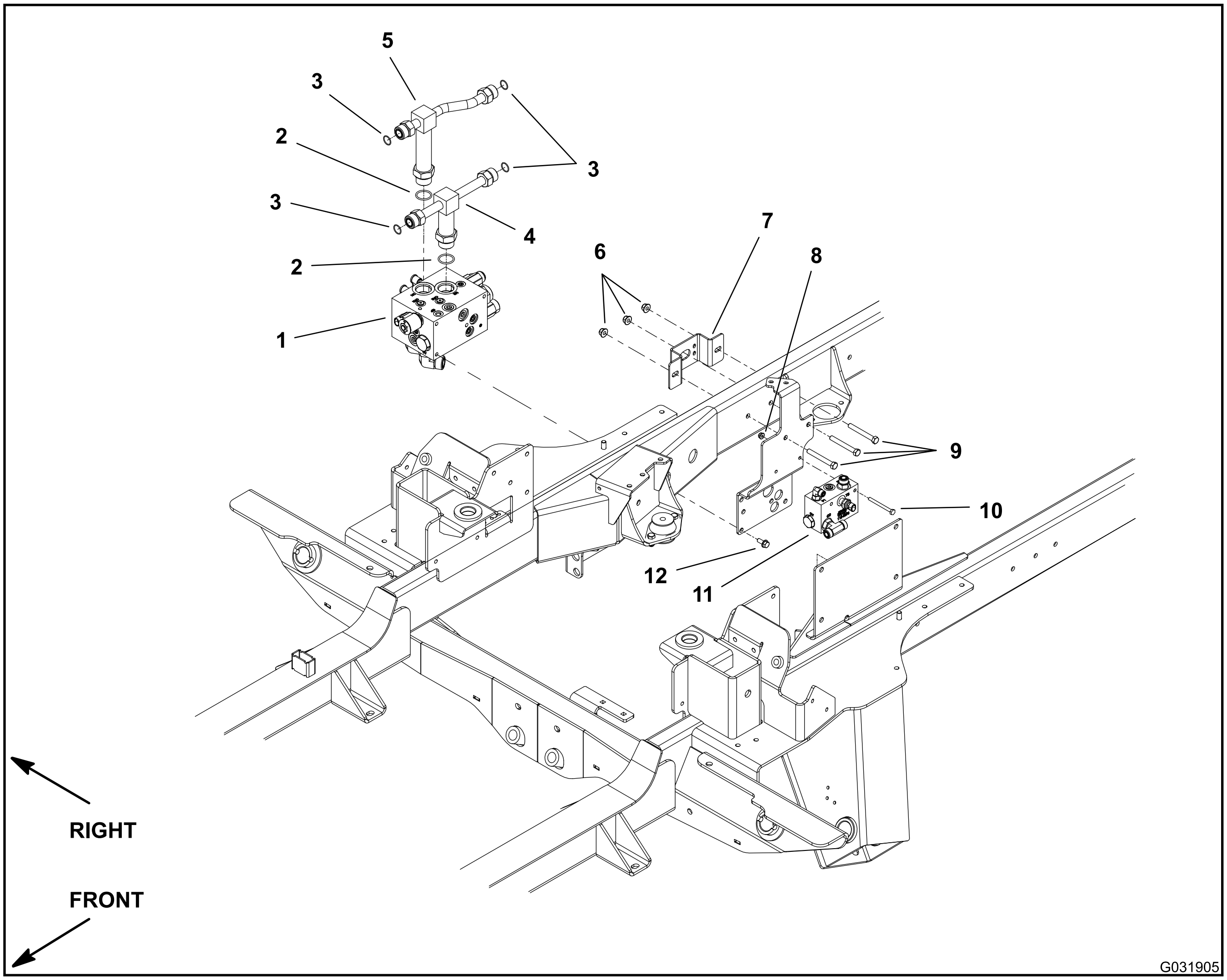
E. If the cartridge is solenoid-operated, carefully install the solenoid coil to the cartridge valve. Torque the nut; refer to Figure 134 for the torque value.

IMPORTANT

Overtightening the nut can damage the solenoid or cause valve malfunction. Do not overtighten the nut.

8. If the problems still exist, remove the valve and clean it again or replace the valve.

4-Wheel Drive Control Manifold



g031905

Figure 135

1.	4-wheel drive control manifold	5.	Hydraulic tee fitting	9.	Bolt
2.	O-ring	6.	Flange nut	10.	Bolt (2 each)
3.	O-ring	7.	Bulkhead mount plate	11.	Flush manifold
4.	Hydraulic tee fitting	8.	Flange nut (2 each)	12.	Flange screw (4 each)

Note: The ports on the 4-wheel drive control manifold are marked for easy identification of the components. Example: P1 is the pump supply port for the forward direction and S is the location for the solenoid valve; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

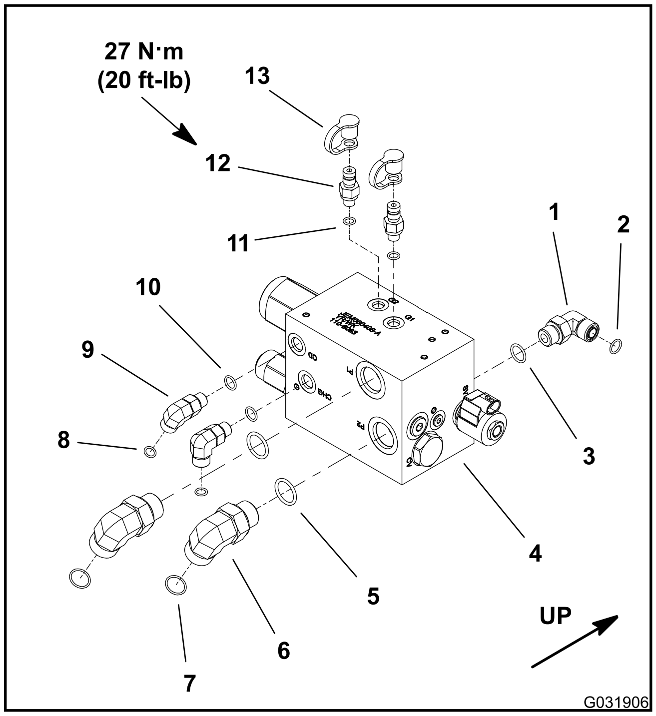
Removing the 4-Wheel Drive Control Manifold

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
2. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
3. Disconnect the wire harness connector from the solenoid valve.

Removing the 4-Wheel Drive Control Manifold (continued)

4. Disconnect all the hydraulic lines from the manifold and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for proper assembly.
5. Support the manifold to prevent it from falling.
6. Remove the 4 flange screws that attach the 4-wheel drive control manifold to the frame, and remove the manifold from the frame.
7. If you remove the hydraulic fittings from the manifold, put a mark on the fitting orientation for correct assembly.
8. Remove the fittings from the manifold and discard the O-rings.

Installing the 4-Wheel Drive Control Manifold



g031906

Figure 136

1. 90° fitting (P3)
2. O-ring
3. O-ring
4. 4-wheel drive manifold
5. O-ring
6. 90° fitting (P1 and P2)
7. O-ring
8. O-ring
9. 90° (CHG and CD)
10. O-ring
11. O-ring
12. Quick fitting (G1 and G2)
13. Dust cap

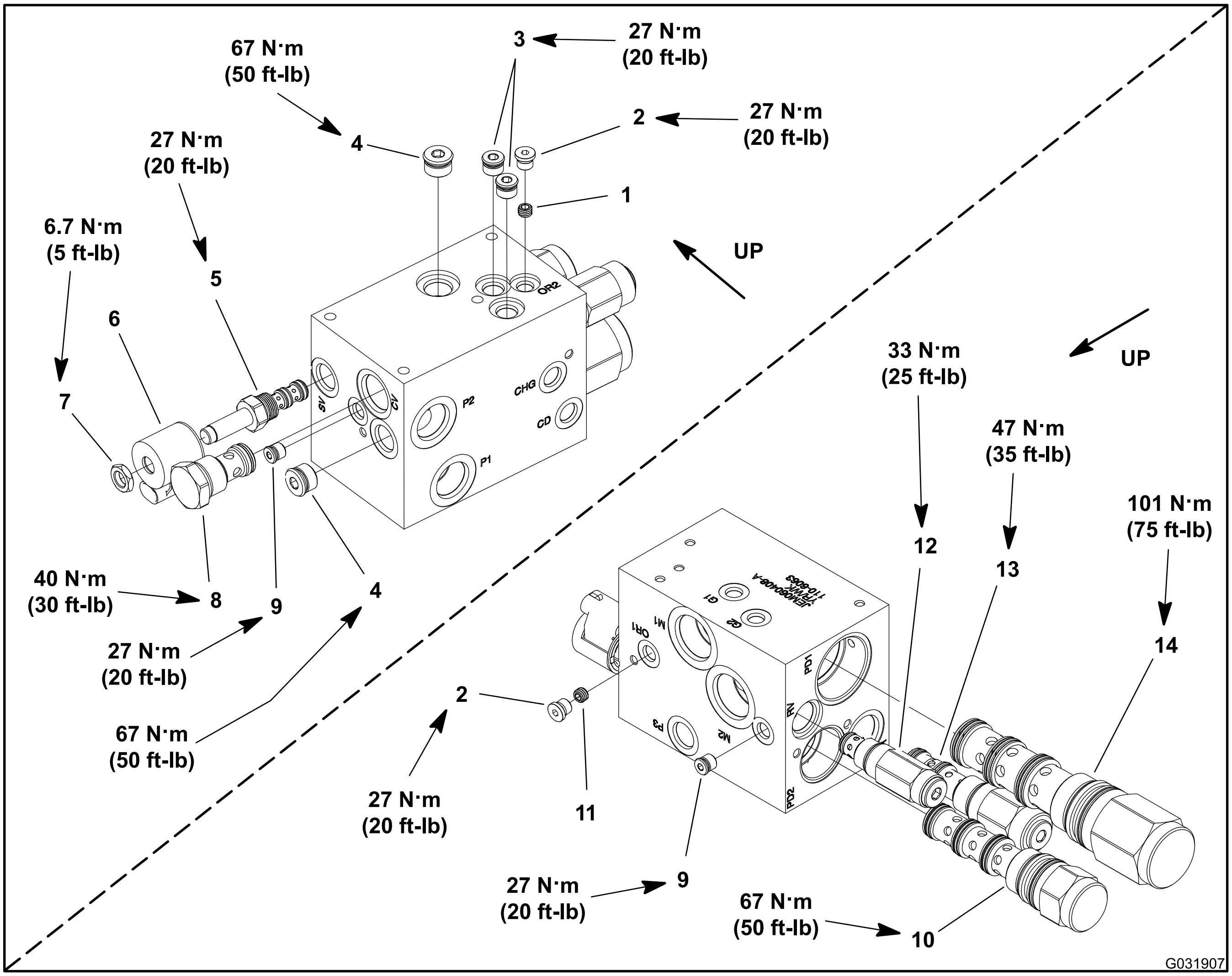
---

1. If the fittings were removed from the manifold, do the following steps:
   A. Lubricate and install new O-rings with clean hydraulic fluid onto the fittings.
   B. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 136 for straight fitting installation torque. For more information on tightening procedures for adjustable fitting; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

Installing the 4-Wheel Drive Control Manifold (continued)

2. Position the 4-wheel drive control manifold to the frame and attach it with 4 flange screws.
3. Remove the caps and plugs from the fittings and hoses.
4. Correctly connect the hydraulic lines to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
5. Connect the wire harness connector to the solenoid valve.
6. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.

Servicing the 4-Wheel Drive Control Manifold



g031907

Figure 137

1. Orifice (0.040) (OR2)
2. Plug with O-ring
3. NWD #6 plug with O-ring
4. NWD #8 plug with O-ring
5. Solenoid valve (SV)
6. Solenoid coil
7. Nut
8. Check valve (CV)
9. NWD #4 plug with O-ring
10. Directional pilot valve (PD2)
11. Orifice (0.030) (OR1)
12. Relief valve (RV)
13. Pressure valve (PR)
14. Directional pilot valve (PD1)

Note: The ports on the 4-wheel drive control manifold are marked for easy identification of the components. Example: P1 is the pump supply port for the forward direction and RV is the location for the relief valve; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Servicing the Valve Cartridge

For the solenoid and control valve service procedures; refer to Servicing the Traction Control Manifold (page 4–133). Refer to Figure 137 for the 4-wheel drive control manifold cartridge valve and plug installation torque.

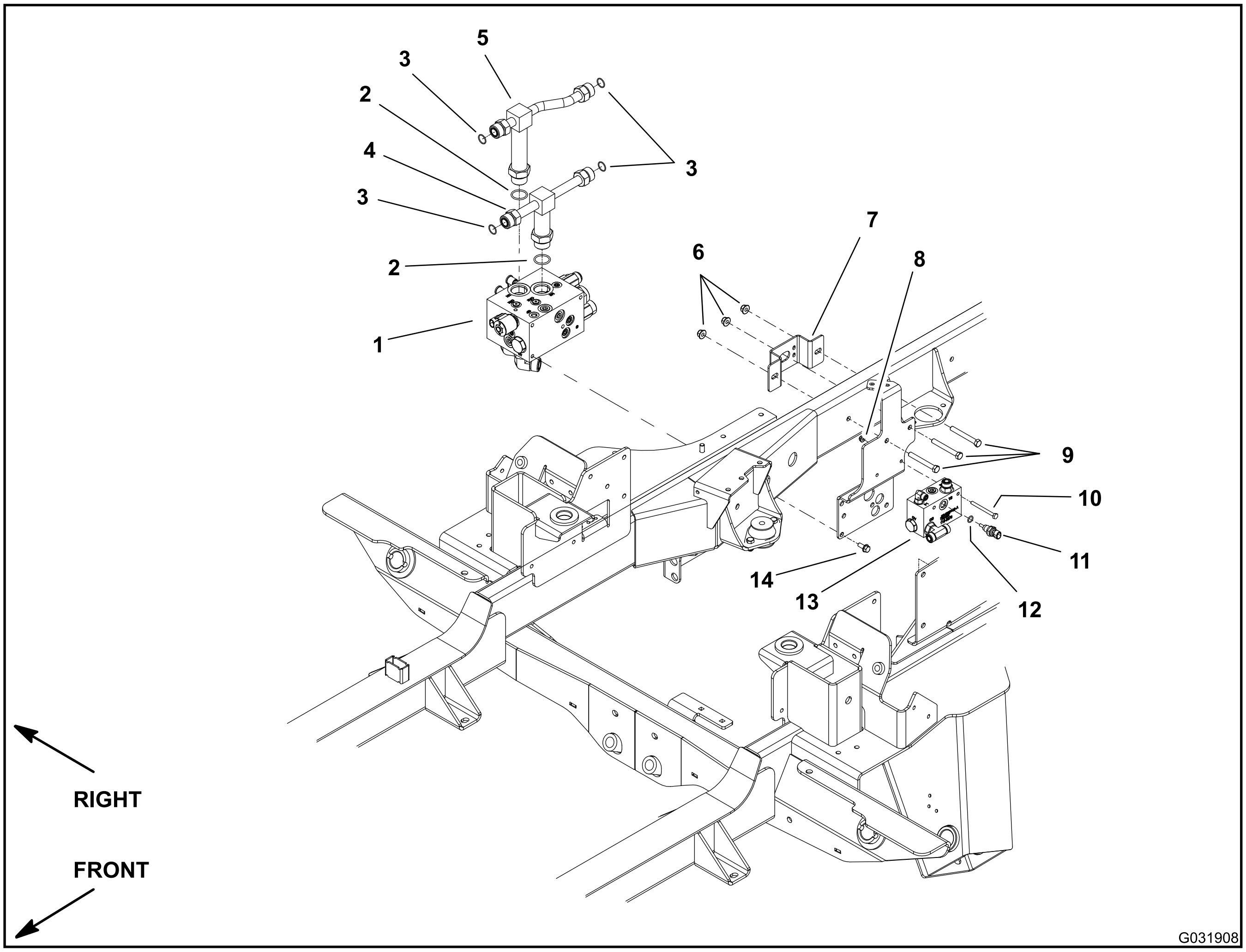
Servicing the Valve Cartridge (continued)

Note: The 4-wheel drive control manifold includes several zero-leak NWD 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 have an O-ring as a secondary seal. If zero-leak plug removal is necessary, lightly rap the plug head by using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing the plugs; refer to Figure 137 for the plug installation torque.

IMPORTANT

An orifice is placed below the plugs in the control manifold OR1 and OR2 ports. If you remove 1 of these plugs, ensure that you remove the orifice and label the orifice position for assembly purposes.

Traction Flush Manifold



g031908

Figure 138

1. 4-wheel drive control manifold
2. O-ring
3. O-ring
4. Hydraulic tee fitting
5. Hydraulic tee fitting
6. Flange nut
7. Bulkhead mount plate
8. Flange nut (2 each)
9. Bolt
10. Bolt (2 each)
11. Hydraulic-fluid temperature sender
12. O-ring
13. Flush manifold assembly
14. Flange screw (4 each)

Note: The ports on the traction flush manifold are marked for easy identification of the components. Example: CV is the check valve port and TS is the temperature sender port; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Note: The traction flush manifold includes a zero-leak NWD plug. This plug has a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero-leak plug also has an O-ring as a secondary seal. If zero-leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug; the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing the plug; refer to Figure 139 for the plug installation torque.

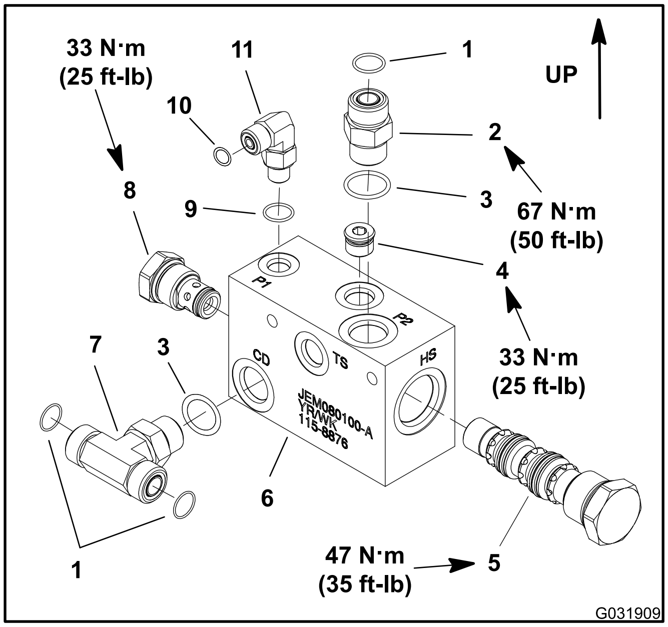
Removing the Traction Flush Manifold

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).

Removing the Traction Flush Manifold (continued)

2. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
3. Disconnect the hydraulic lines from the flush manifold and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for proper assembly.
4. Support the flush manifold to prevent it from falling.
5. Remove the 2 bolts and 2 flange nuts that attach the manifold to the frame (Figure 138), and remove the flush manifold from the machine.
6. If you remove the hydraulic fittings from the flush manifold, put a mark on the fitting orientation for correct assembly.
7. Remove the fittings from the manifold and discard the O-rings.

Installing the Traction Flush Manifold



g031909

Figure 139

1. O-ring
2. Straight fitting (P2)
3. O-ring
4. #6 NWD plug/O-ring
5. Shuttle valve (HS)
6. Flush manifold
7. Tee fitting (CD)
8. Check valve (CV)
9. O-ring
10. O-ring
11. 90° fitting (P1)

---

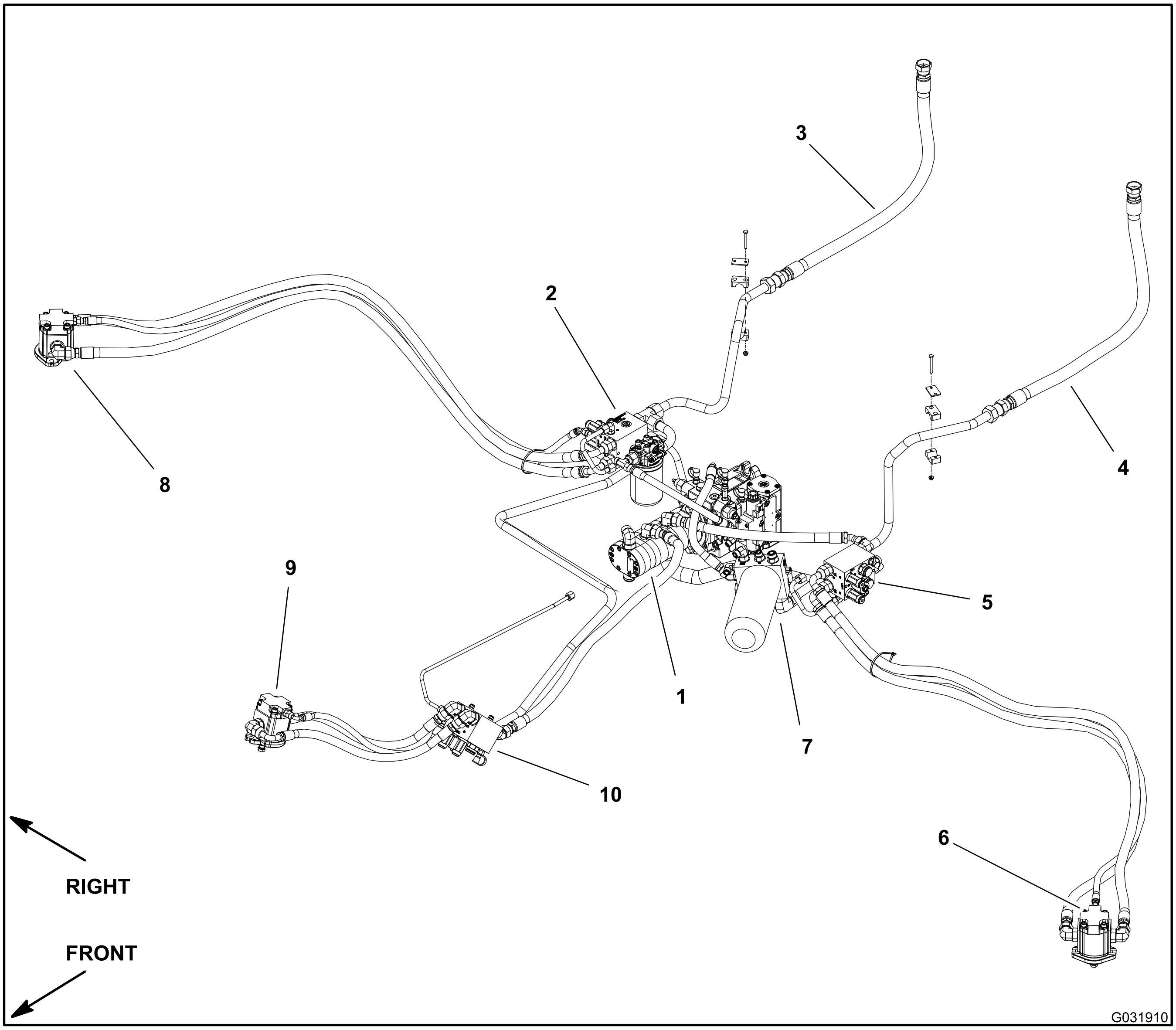
1. If the fittings were removed from the manifold, do the following steps:
   A. Lubricate and install new O-rings with clean hydraulic fluid onto the fittings.
   B. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 139 for the straight fitting installation torque.

      Note: For information on tightening procedures for adjustable fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Refer to Figure 139 for the check valve, shuttle valve, and plug installation torque.

Installing the Traction Flush Manifold (continued)

3. Position the flush manifold to the frame, and attach it with 2 bolts and 2 flange nuts.
4. Remove the caps and plugs from the fittings and hoses. Correctly connect the hydraulic lines to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
5. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.

PTO Circuit



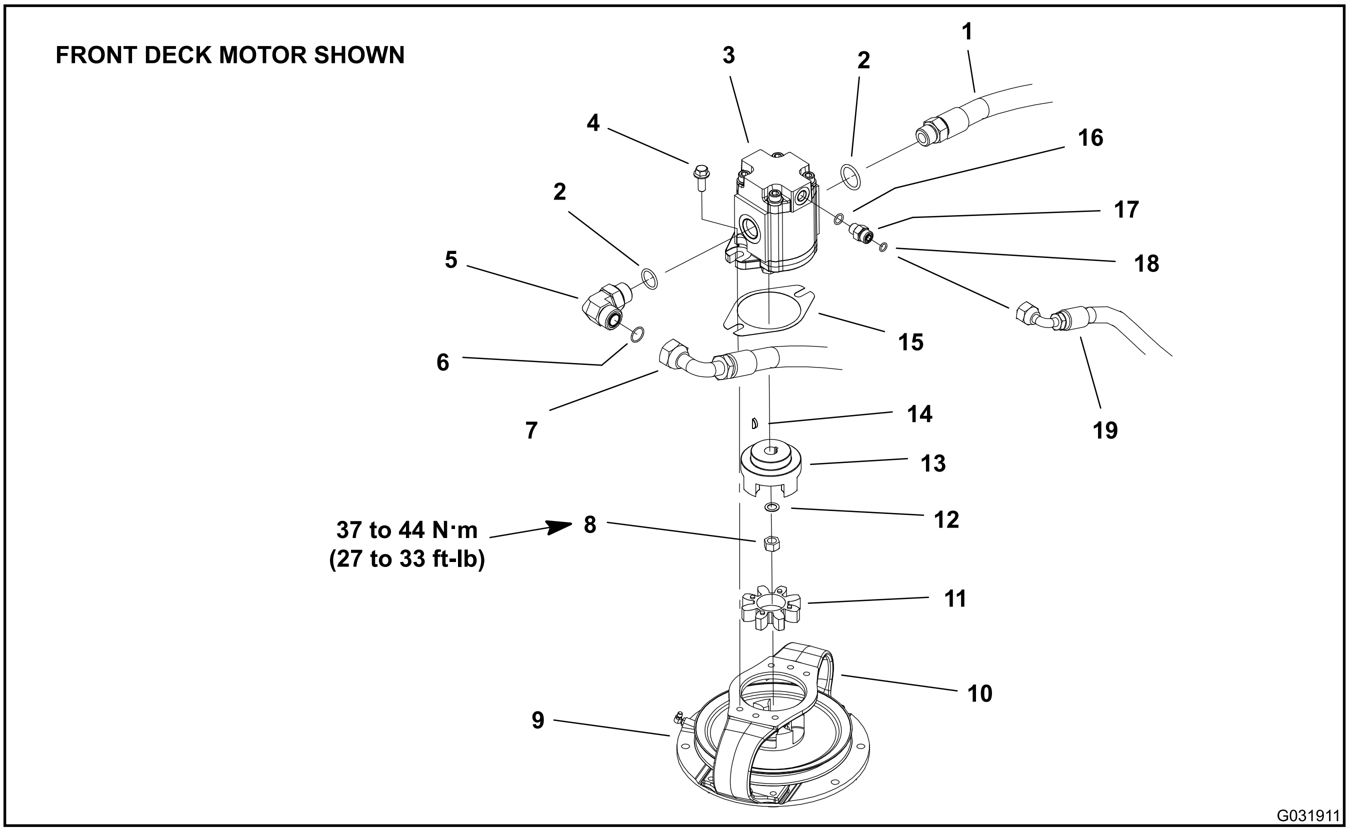
g031910

Figure 140

1. Gear pump
2. Right PTO control manifold
3. Hydraulic hose to oil cooler
4. Hydraulic hose from oil cooler
5. Left PTO control manifold
6. Left cutting deck motor
7. Filter manifold
8. Right cutting deck motor
9. Front cutting deck motor
10. Front PTO control manifold

Refer to Figure 140 for the components that are used in the PTO circuit of the machine. Procedures for removal, installation, and disassembly/assembly of these components are provided on the following pages of this section.

Cutting Deck Motor



g031911

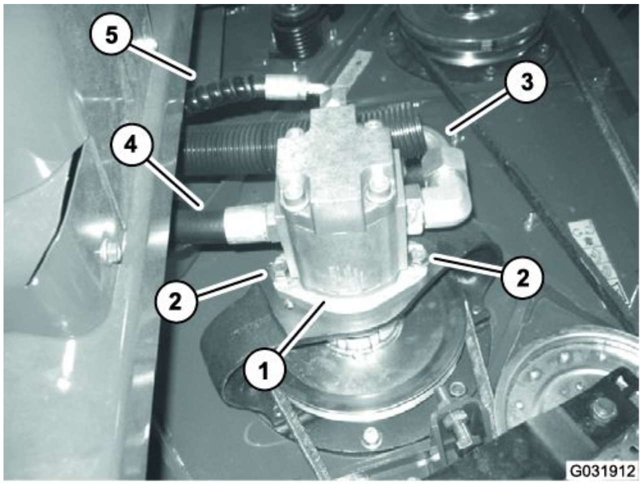
Figure 141

1. Hydraulic hose
2. O-ring
3. Cutting deck motor
4. Flange-head screw (2 each)
5. 90° hydraulic fitting
6. O-ring
7. Hydraulic hose
8. Hex nut
9. Spindle assembly
10. Motor mount
11. Spider
12. Washer
13. Spider hub
14. Woodruff key
15. Mounting shim (if equipped)
16. O-ring
17. Hydraulic fitting
18. O-ring
19. Hydraulic hose

Removing the Cutting Deck Motor

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting deck cover to get access to the cutting deck motor.
3. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
4. Label the hydraulic lines for proper assembly.
5. Disconnect the hydraulic hoses from the deck motor, and install caps or plugs on the fittings and hoses to prevent contamination; refer to Figure 141.

Removing the Cutting Deck Motor (continued)



g031912

Figure 142

1. Deck motor (front)
2. Flange-head screw
3. Inlet hose
4. Return hose
5. Case drain hose

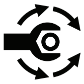
6. Remove the 2 flange-head screws that attach the hydraulic motor to the motor mount; refer to Figure 141.
7. Carefully remove the hydraulic motor from the cutting deck.

   Note: Do not damage the spider hub that is attached to the motor.

8. Locate and remove the spider and mounting shim(s) (if present) from the deck.
9. If you remove the hydraulic fittings from the deck motor, put a mark on the fitting orientation for correct assembly.
10. Remove the fittings from the motor and discard the O-rings.
11. If necessary, remove the hex nut and washer that attach the spider to the motor shaft. Use a suitable puller to remove the hub from the shaft, and remove the woodruff key.

Installing the Cutting Deck Motor

1. If the fittings were removed from the deck motor, lubricate and install new O-rings onto the fittings. To properly align and install the fittings into the motor ports, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).



2. If the woodruff key and spider hub were removed, install them to the motor shaft and secure them with the hex nut and washer. Torque the nut to **37 to 44 N·m (27 to 33 ft-lb)**.
3. Check for proper clearance between the spider hub and the spindle pulley. Install the motor to the cutting deck without placing the spider in the spindle pulley.

   Note: Ensure that the clearance between the hub and the pulley valleys is 21.1 to 23.6 mm (0.830 to 0.930 inch). If necessary, use mounting shim(s) between the motor and the motor mount to adjust clearance.

Installing the Cutting Deck Motor (continued)

4. Position the spider into the spindle pulley. If necessary, place the mounting shim(s) on the deck and carefully install the hydraulic motor to the cutting deck.

   Note: Ensure that you do not damage the spider hub that is attached to the motor.

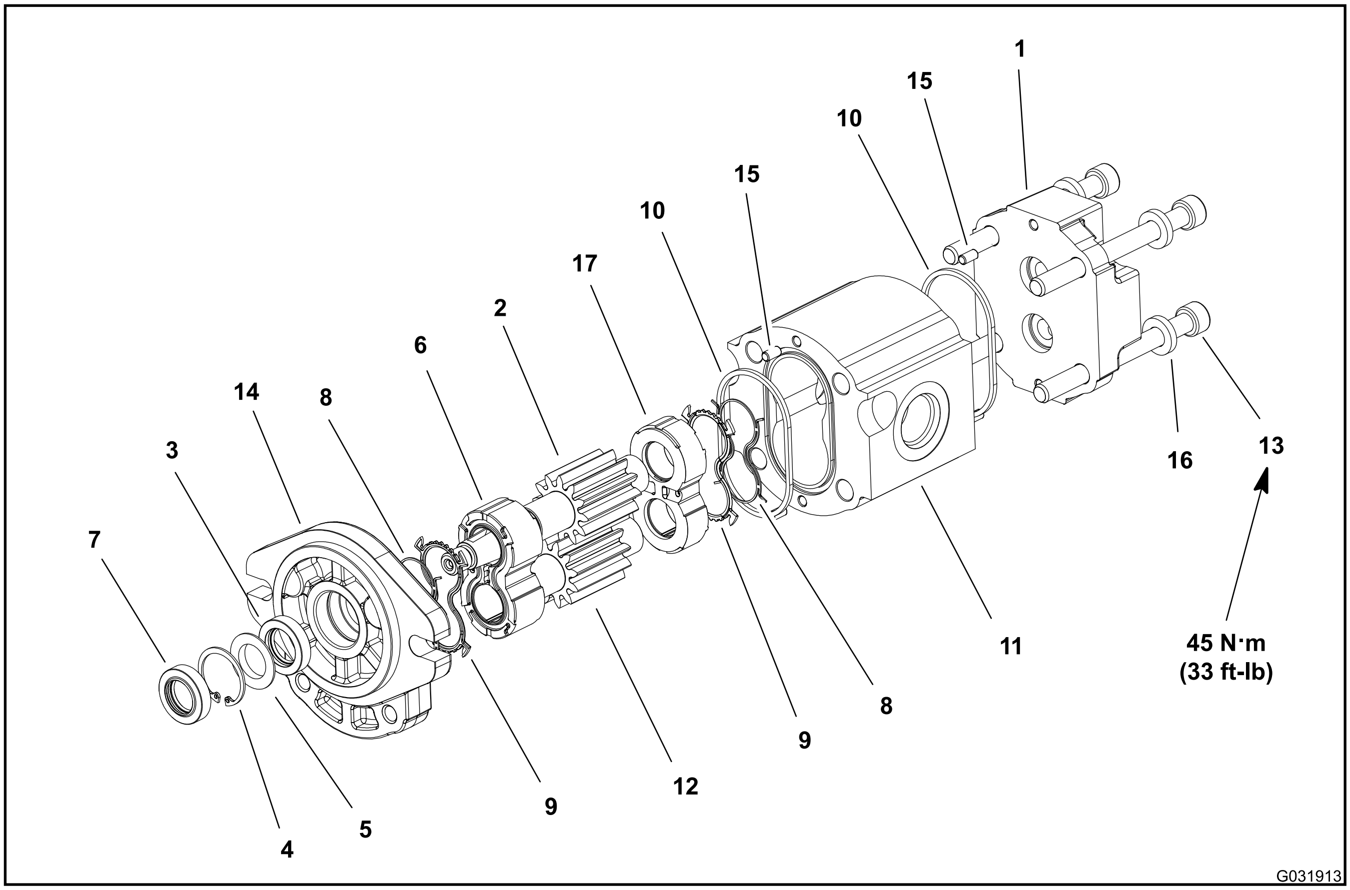
5. Attach the motor to the cutting deck with the 2 flange-head screws.

IMPORTANT

For proper hydraulic hose routing, ensure that the cutting decks are fully lowered before installing the hoses to the deck motor.

6. Remove the caps or plugs from the fittings and hoses. Correctly connect the hydraulic hoses to the deck motor; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
7. After you complete the assembly, check that the hydraulic hoses and fittings do not contact the moving components through the full range of deck movement.
8. Install the cutting deck cover.
9. Fill the reservoir with the correct quantity of new hydraulic fluid.

Servicing the Cutting Deck Motor



g031913

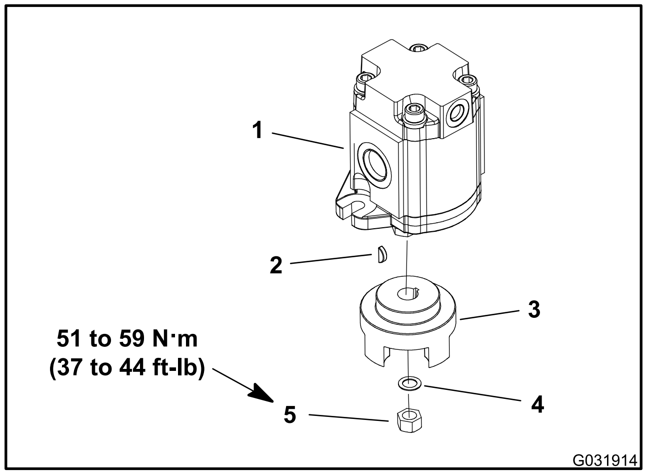
Figure 143

1. Rear cover
2. Drive gear
3. Shaft seal
4. Retaining ring
5. Flange washer
6. Front wear plate
7. Dust seal
8. Pressure seal
9. Back-up gasket
10. O-ring
11. Body
12. Idler gear
13. Bolt (4 each)
14. Front flange
15. Dowel pin (4 each)
16. Washer (4 each)
17. Rear wear plate

Disassembling the Cutting Deck Motor

1. Plug the motor ports and clean the exterior of the motor. After cleaning, remove the plugs and drain the fluid out of the motor.

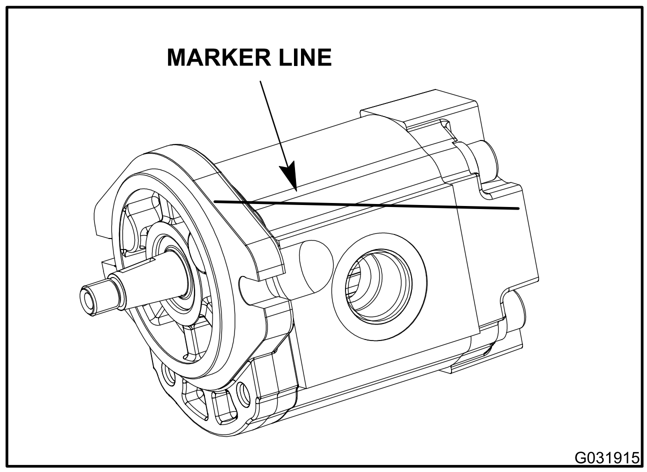
Disassembling the Cutting Deck Motor (continued)



g031914

Figure 144

1. Deck motor
2. Woodruff key
3. Spider hub
4. Washer
5. Nut



g031915

Figure 145

2. Remove the nut and washer that attach the spider hub to the motor shaft (Figure 144). Use a suitable puller to remove the hub from the shaft, and remove the woodruff key.
3. Use a marker and make a diagonal line across the front flange, body, and rear cover for assembly purposes; refer to Figure 145.

IMPORTANT

To prevent distorting the motor housing during assembly, do not clamp the housing in a vise.

4. Clamp the front flange of the motor in a vise equipped with soft jaws, with the shaft end down.
5. Loosen the bolts from the rear cover.
6. Remove the motor from the vise and then remove the bolts.

Disassembling the Cutting Deck Motor (continued)

7. Remove the rear cover from the body.
8. Lift the body straight up and carefully remove it.

   Note: Ensure that the rear wear plate remains on the drive and idler gear shafts.
9. Remove and discard the O-rings from the body.
10. Locate and retrieve the dowel pins.

IMPORTANT

Before removing the wear plates, note the position of the open and closed side of the wear plates. Also identify the wear plates (front and rear) with a marker for proper assembly.

11. Carefully remove the rear wear plate, idler gear, drive gear, and front wear plate from the front flange.
12. Remove and discard the back-up gaskets and pressure seals from the wear plates.
13. Turn the front flange over, with the seal side up.

IMPORTANT

Ensure that you do not damage the front flange counter bore when removing the seals from the front flange.

14. Carefully remove the dust seal, retaining ring, flange washer, and shaft seal from the front flange (Figure 147) and discard the seals.

Inspecting the Cutting Deck Motor

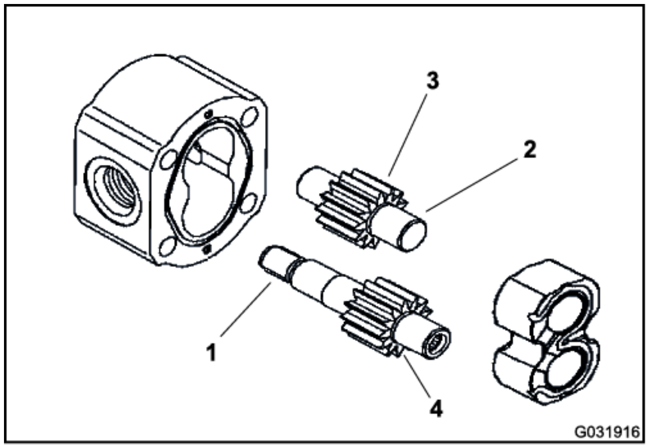
1. Remove any nicks and burrs from all the parts with emery cloth.

⚠ CAUTION ⚠

Use the eye protection such as goggles when using the compressed air.

2. Clean all the parts with solvent and dry them with compressed air.

Inspecting the Cutting Deck Motor (continued)



g031916

Figure 146

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

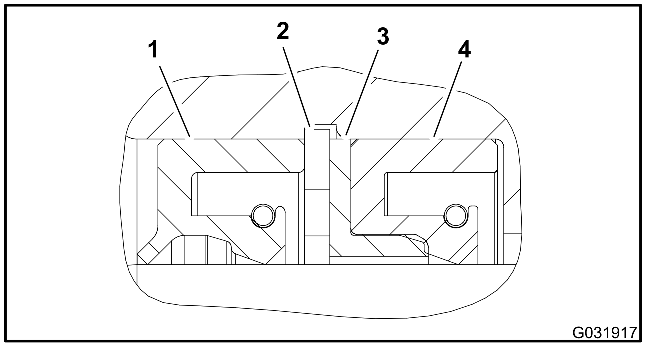
3. Inspect the drive gears and idler gears for the following; refer to Figure 146.
   A. Gear shafts must be free from rough surfaces and excessive wear at the bushing points and sealing areas. Replace the gears if you find any scoring, rough surfaces, or wear on the gear shafts.
   B. Gear teeth must be free from excessive scoring and wear. Replace the gears if you find any broken or nicked gear teeth.
   C. Gear face edge must be free from sharpness. The sharp gear edges will mill into the wear plates. Replace the gears if you find any sharp gear face edge.
4. Inspect the wear plates for the following:
   A. Bearing areas must not have excessive wear or scoring.
   B. Face of the wear plates that are in contact with the gears must be free from wear, roughness, or scoring.
   C. Thickness of the wear plates must be equal.
5. Inspect the front flange and rear cover for damage or wear.

Assembling the Cutting Deck Motor

Note: When assembling the motor, check the marker line on each part to ensure that the parts are properly aligned.

1. Lubricate the O-rings, pressure seals, back-up gaskets, and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic fluid.

Assembling the Cutting Deck Motor (continued)



g031917

Figure 147

1. Dust seal
2. Retaining ring
3. Flange washer
4. Shaft seal

2. Install new seals into the front flange (Figure 147) as follows:
   A. Press the shaft seal into the front flange until it reaches the bottom of the bore.
   B. Install the flange washer into the front flange and then install the retaining ring into the groove of the front flange.
   C. Install a new dust seal into the front flange.
3. Place the front flange, seal side down, on a flat surface.
4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the back-up gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.
5. Apply a light coating of petroleum jelly to the exposed side of the front flange.
6. Lubricate the drive gear shaft with clean hydraulic fluid.
7. Insert the drive end of the driveshaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor.
8. Carefully install the shaft into the front flange.
9. Lubricate the idler gear shaft with clean hydraulic fluid. Install the idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic fluid to the gear faces.
10. Install the rear wear plate with a pressure seal side up and the open side of pressure seal pointing to the inlet side of the motor.
11. Apply a light coating of petroleum jelly to new O-rings and O-ring grooves in the body. Install new O-rings to the body.
12. Install the locating dowels in the body. Align the marker line on the body and front flange.

IMPORTANT

Do not dislodge the seals during installation.

13. Gently slide the body onto the assembly and align the dowels with firm hand pressure.
14. Check that the surface of the rear wear plate is slightly below the face of the body.

Assembling the Cutting Deck Motor (continued)

Note: If the wear plate is not below the body, check the assembly for a shifted pressure seal, back-up gasket, or O-ring. Correct the shifting before you proceed.

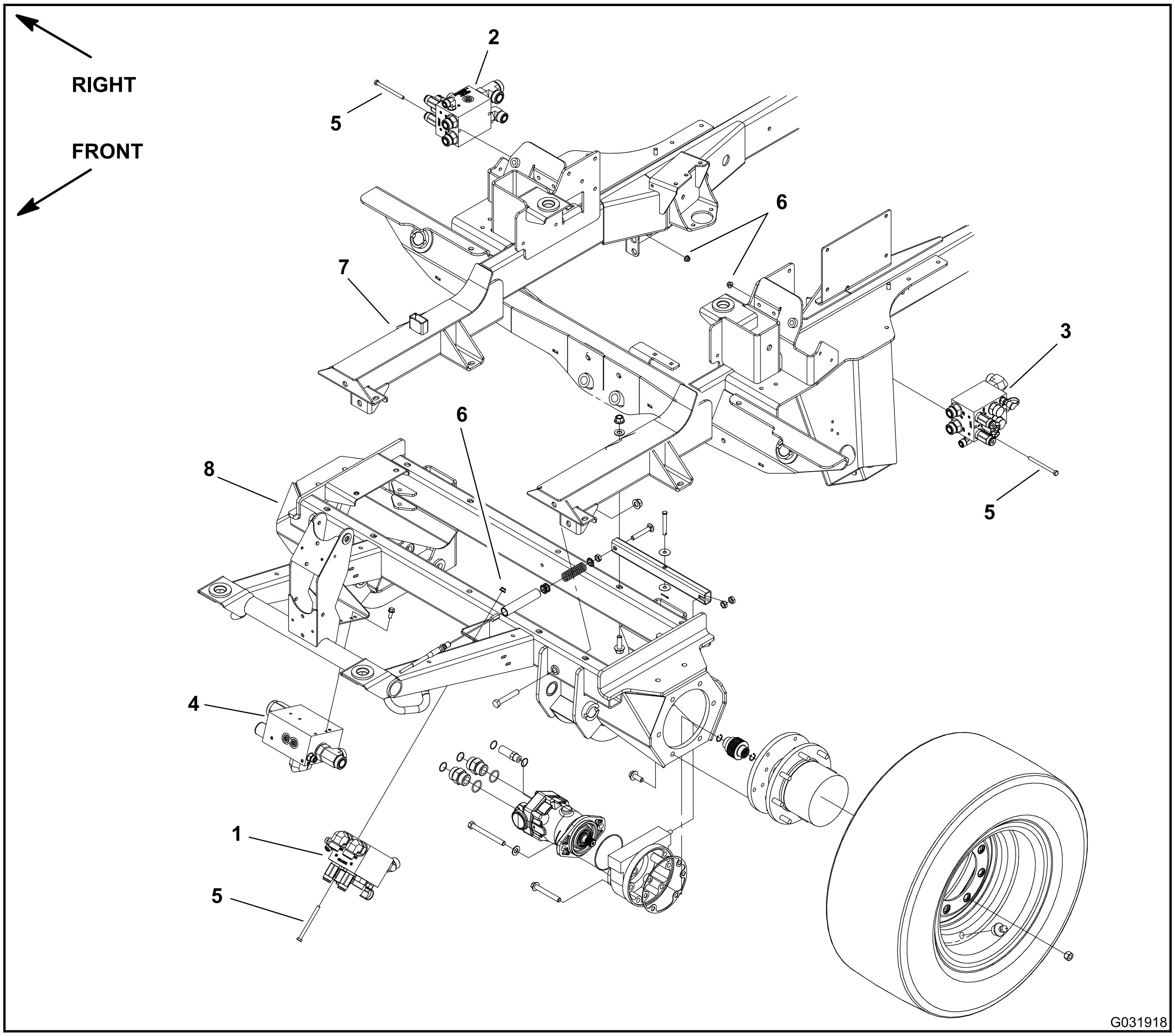
15. Apply a light coating of petroleum jelly to the exposed side of the rear cover.
16. Use the marker line for proper location and place the rear cover on the assembly, and align the dowels with firm hand pressure.
17. Install the 4 bolts with 4 washers and tighten them by hand.

IMPORTANT

To prevent distorting the motor housing during assembly, do not clamp the housing in a vise.

18. Place the front flange of the motor in a vise equipped with soft jaws.
19. Alternately torque the bolts to **45 N·m (33 ft-lb)**.
20. Remove the motor from the vise.
21. Place a small quantity of clean hydraulic fluid in the inlet of the motor and rotate the driveshaft away from the inlet for 1 revolution. If you see any binding, disassemble the motor and check for assembly problems.

PTO Control Manifolds



g031918

Figure 148

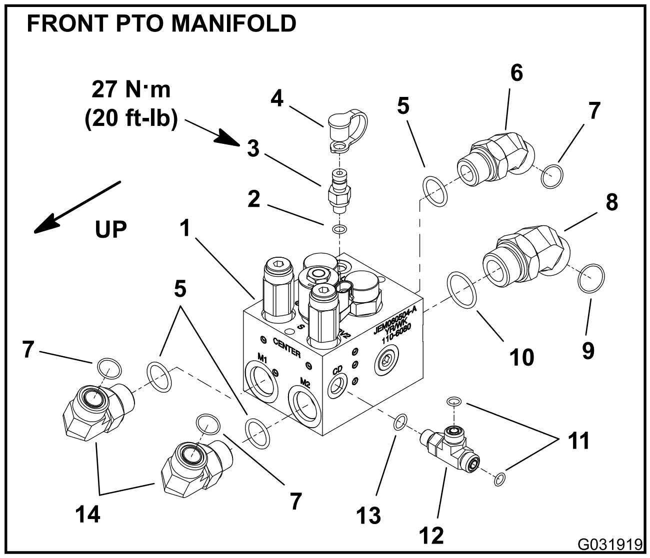
1. Front PTO control manifold
2. Right PTO control manifold
3. Left PTO control manifold
4. Traction control manifold
5. Bolt (2 each manifold)
6. Flange nut (2 each manifold)
7. Main frame
8. Front axle frame

The control manifolds for the 3 cutting deck sections are very similar.

Note: When servicing the PTO control manifolds, do not interchange the parts from 1 control manifold to another.

Note: The ports on the PTO control manifolds are marked for easy identification of the components. Example: S is the solenoid valve and M2 is the return from the deck motor; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Removing the PTO Control Manifolds



g031919

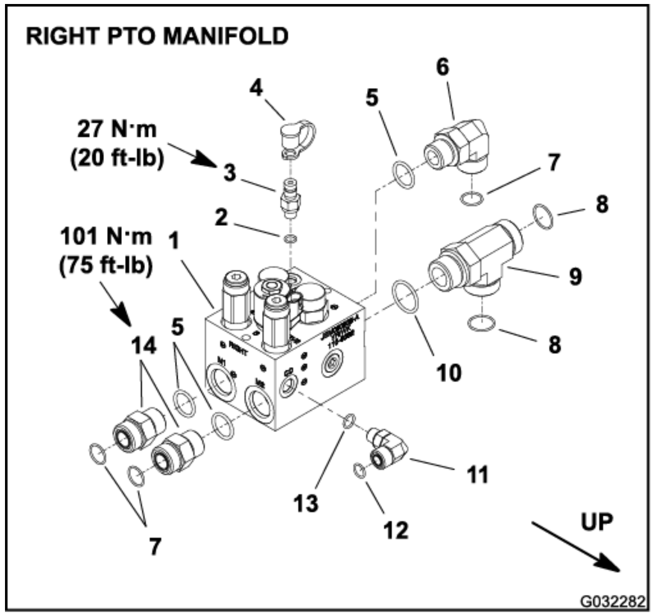
Figure 149

1. Front PTO manifold
2. O-ring
3. Quick fitting
4. Dust cap
5. O-ring
6. Hydraulic 45° fitting
7. O-ring
8. Hydraulic 45° fitting
9. O-ring
10. O-ring
11. O-ring
12. Hydraulic tee fitting
13. O-ring
14. Hydraulic 90° fitting

---

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
2. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
3. Disconnect the wire harness connector from the manifold solenoid valve.
4. Disconnect the hydraulic lines from the manifold and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for proper assembly.
5. Support the PTO control manifold to prevent it from falling.
6. Remove the 2 bolts and 2 flange nuts that attach the manifold to the frame, and remove the PTO control manifold from the frame.
7. If you remove the hydraulic fittings from the manifold, put a mark on the fitting orientation for correct assembly.
8. Remove the fittings from the manifold and discard the O-rings.

Installing the PTO Control Manifolds

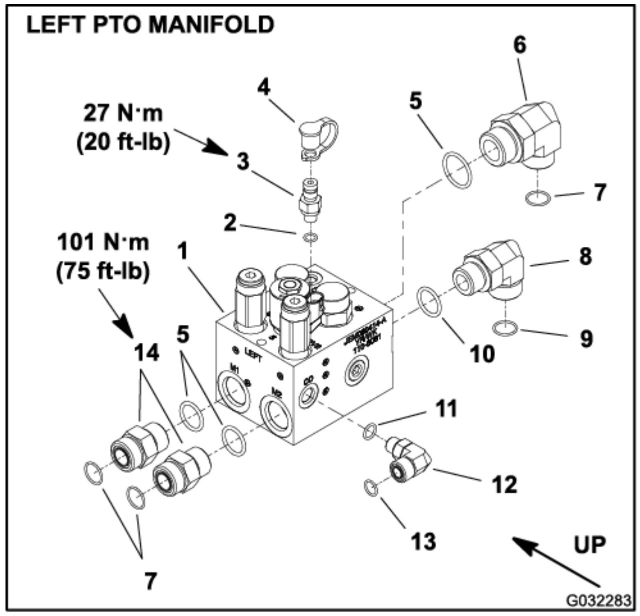


g032282

Figure 150

1. Right PTO manifold
2. O-ring
3. Quick fitting
4. Dust cap
5. O-ring
6. Hydraulic 90° fitting
7. O-ring
8. O-ring
9. Hydraulic tee fitting
10. O-ring
11. Hydraulic 90° fitting
12. O-ring
13. O-ring
14. Straight fitting

Installing the PTO Control Manifolds (continued)



g032283

Figure 151

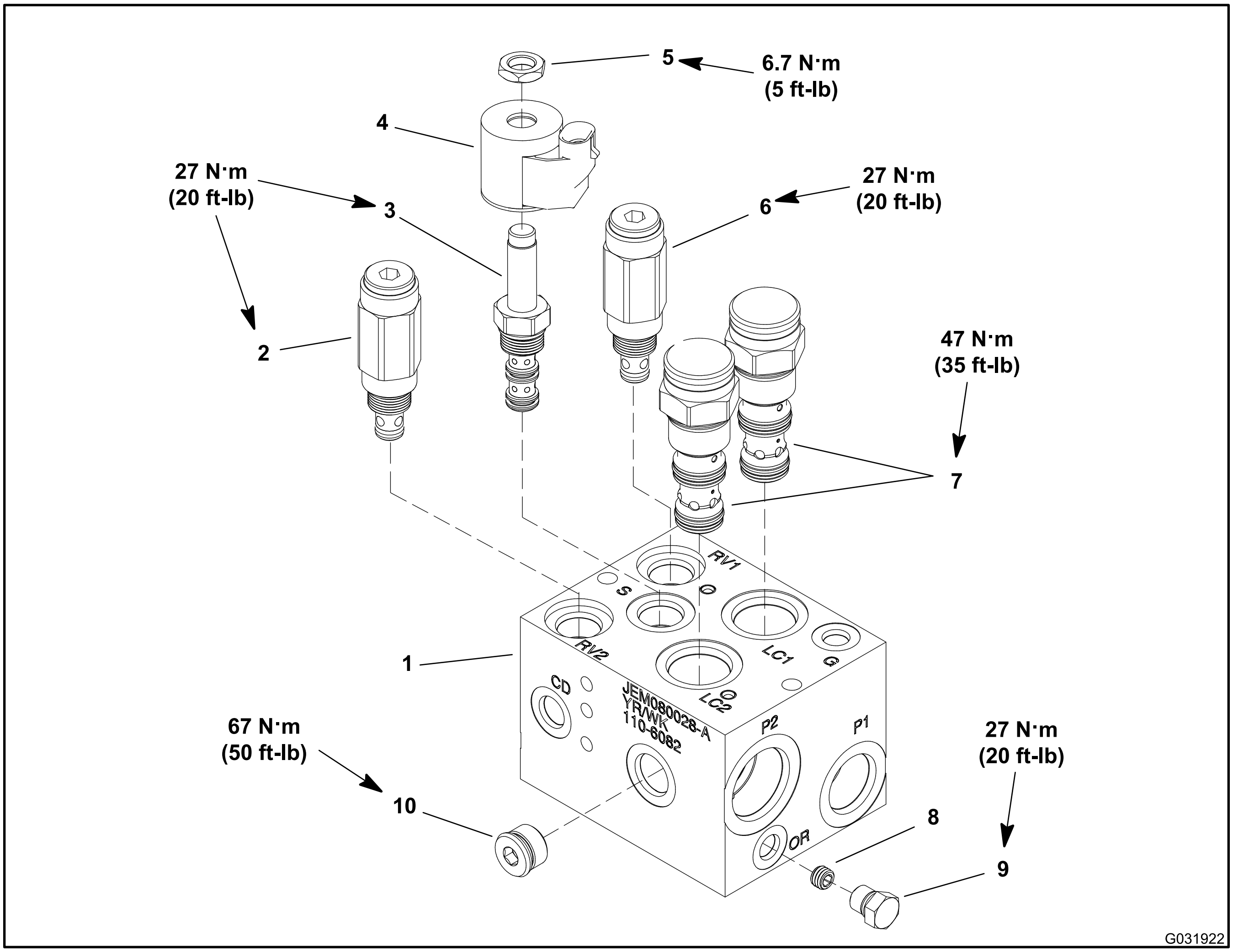
1. Left PTO manifold
2. O-ring
3. Quick fitting
4. Dust cap
5. O-ring
6. Hydraulic 90° fitting
7. O-ring
8. Hydraulic 90° fitting
9. O-ring
10. O-ring
11. O-ring
12. Hydraulic 90° fitting
13. O-ring
14. Straight fitting

---

1. If the fittings were removed from the manifold, do the following steps:
   A. Lubricate and install new O-rings with clean hydraulic fluid onto the fittings.
   B. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 149, Figure 150, and Figure 151 for the straight fitting installation torque.

      Note: For information on tightening procedures for adjustable fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Position the PTO control manifold to the frame and attach it with 2 bolts and 2 flange nuts.
3. Remove the caps and plugs from the fittings and hoses.
4. Connect the hydraulic lines correctly to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
5. Connect the wire harness connector to the solenoid valve.
6. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.

Servicing the PTO Control Manifold



g031922

Figure 152

1. Manifold body
2. Relief valve (RV2)
3. Solenoid valve (S)
4. Solenoid coil
5. Nut
6. Relief valve (RV1)
7. Spool logic element (LC1 and LC2)
8. Orifice (OR) (right and left only)
9. NWD #4 plug with O-ring
10. NWD #8 plug with O-ring

Note: The ports on the PTO control manifolds are marked for easy identification of the components. Example: S is the solenoid valve and M2 is the return from the deck motor; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port location.

Note: The PTO control manifolds have several zero-leak NWD plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist the vibration induced plug loosening. The zero-leak plugs also have an O-ring as a secondary seal. If zero-leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using a wrench to remove the plug: the impact allows plug removal with less chance of damage to the head of the plug. When installing the plugs; refer to Figure 152 for the plug installation torque.

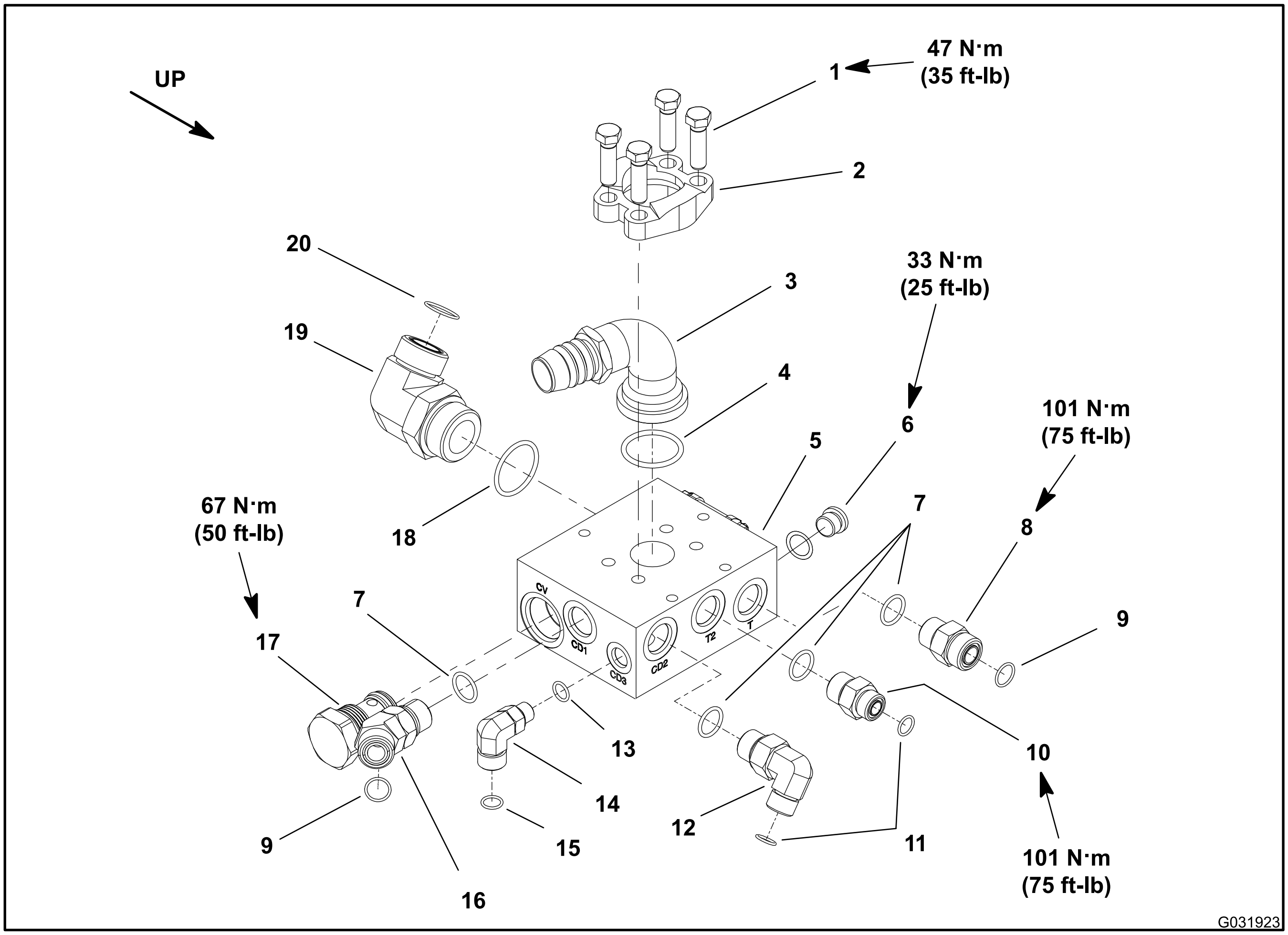
Servicing the Valve Cartridge

The control manifolds for the 3 cutting deck sections are very similar. The manifold for the right and left side decks include an orifice (item 8 in Figure 152) that is not used on the front deck manifold. Also, the relief valve (RV1) on the right side manifold is set to a lower pressure 13,800 kPa (2,000 psi) than the relief valve (RV1) pressure on the front and left side manifold 20,700 kPa (3,000 psi).

Note: When servicing the deck control manifolds, do not interchange the parts from 1 control manifold to another.

For the solenoid and control valve service procedures; refer to Servicing the Traction Control Manifold (page 4–133). Refer to Figure 152 for the PTO control manifold cartridge valve and plug installation torque.

Filter Manifold



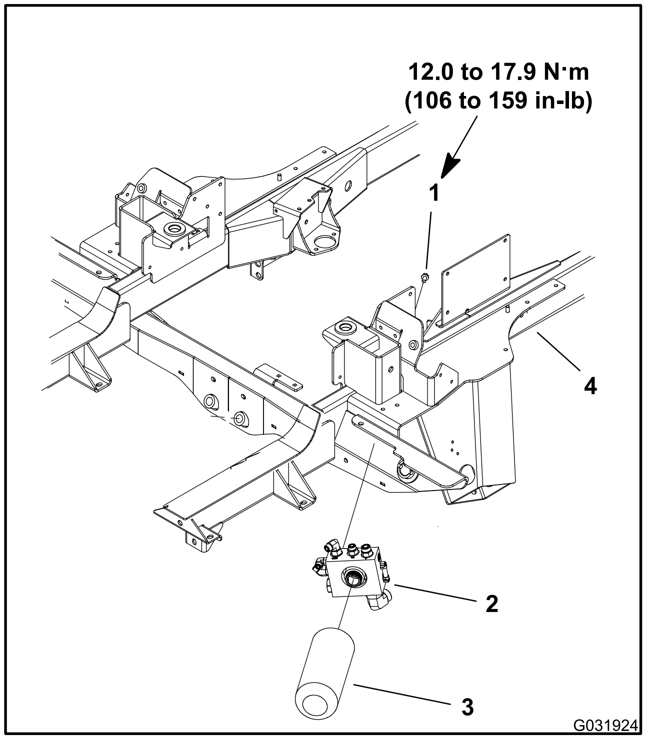
g031923

Figure 153

1. Bolt and lock washer (4 each)
2. Split flange
3. Fitting
4. O-ring
5. Filter manifold
6. NWD #6 plug with O-ring
7. O-ring
8. Straight fitting (T)
9. O-ring
10. Straight fitting (T2)
11. O-ring
12. 90° hydraulic fitting (CD2)
13. O-ring
14. 90° hydraulic fitting (CD3)
15. O-ring
16. 45° hydraulic fitting (CD1)
17. Check valve (CV)
18. O-ring
19. 90° hydraulic fitting (CL)
20. O-ring

Note: The ports on the filter manifold are marked for easy identification of the components. Example: CL is the connection port for the return from the oil cooler and CV is the check valve port; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Removing the Filter Manifold



g031924

Figure 154

1. Flange-head screw (4 each)
2. Filter manifold
3. Oil filter
4. Main frame

---

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
2. Raise the hood to get access to the filter manifold.
3. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
4. Disconnect the hydraulic lines from the filter manifold and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for proper assembly.
5. Support the filter manifold to prevent it from falling.
6. Remove the 4 flange-head screws that attach the manifold to the frame (Figure 154), and remove the filter manifold from the machine.
7. If you remove the hydraulic fittings from the filter manifold, put a mark on the fitting orientation for correct assembly.
8. Remove the fittings from the manifold and discard the O-rings.

Installing the Filter Manifold

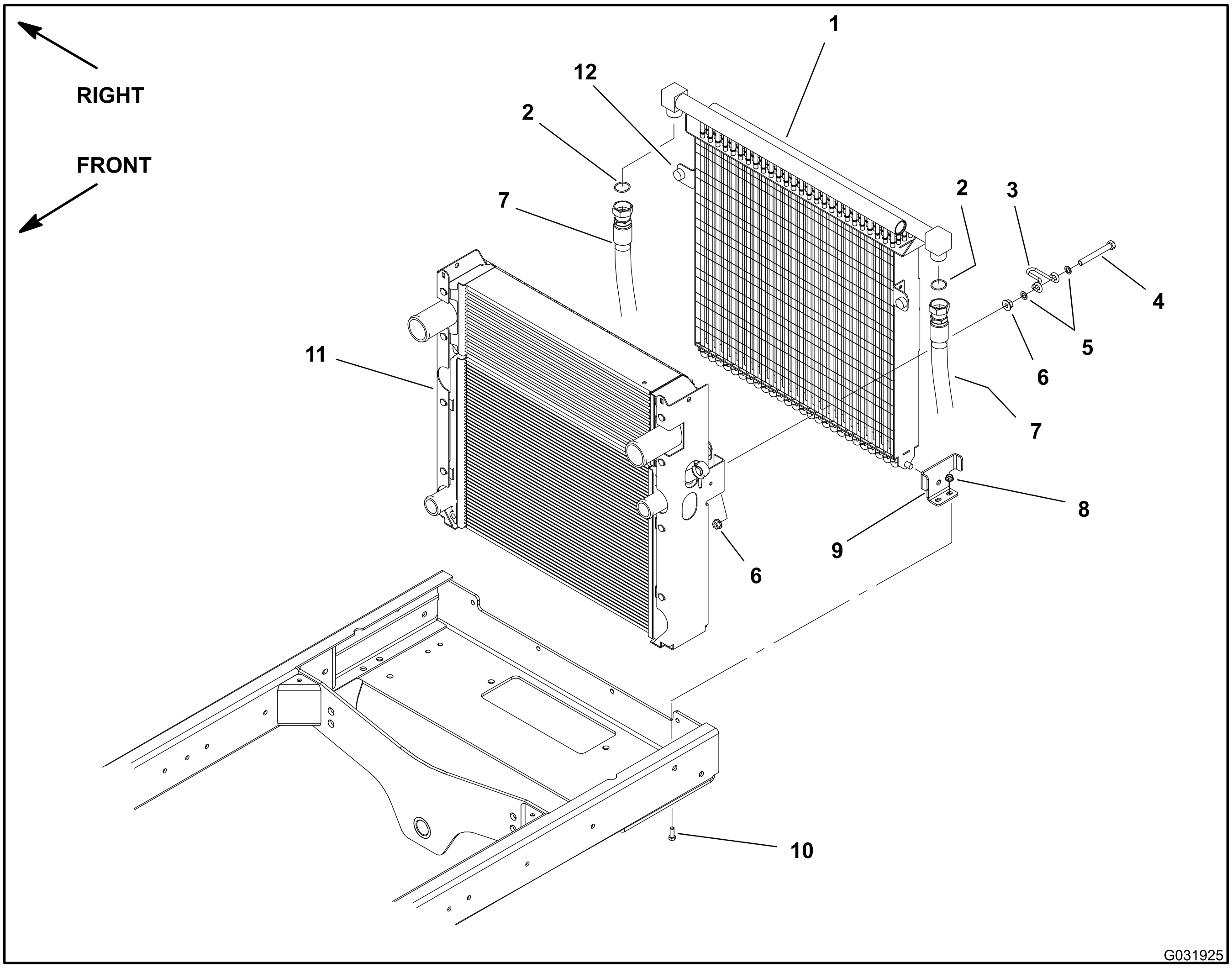
1. If the fittings were removed from the manifold, do the following steps:
   A. Lubricate and install new O-rings with clean hydraulic fluid onto the fittings.
   B. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 153 for the straight fitting installation torque.

   Note: For information on tightening procedures for adjustable fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

Installing the Filter Manifold (continued)

2. Refer to Figure 153 for the check valve and plug installation torque.
3. Position the filter manifold to the frame and attach it with 4 flange-head screws. Torque the screws to **12.0 to 17.9 N·m (106 to 159 in-lb)**; refer to Figure 154.
4. Remove the caps and plugs from the fittings and hoses. Correctly connect the hydraulic lines to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
5. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.
6. Lower the hood and secure it.

Hydraulic Oil Cooler



g031925

Figure 155

1. Oil cooler
2. O-ring
3. Clamp (2 each)
4. Bolt (2 each)
5. Washer (4 each)
6. Flange nut (4 each)
7. Hydraulic hose (2 each)
8. Flange nut (4 each)
9. Support plate (2 each)
10. Bolt (4 each)
11. Radiator assembly
12. Bumper (2 each)

Removing the Hydraulic Oil Cooler

CAUTION

A hot radiator and oil cooler can cause burns.

Allow the engine and cooling systems to cool before working on or near them.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Raise the hood to get access to the oil cooler.
3. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).

Removing the Hydraulic Oil Cooler (continued)

4. Clean the exterior of the oil cooler and hydraulic hoses before removing the oil cooler to prevent contaminants from entering into the hydraulic system.
5. Remove the oil cooler; refer to Figure 155.
6. Use a back-up wrench on the oil cooler fittings to remove the hydraulic hoses from the fittings. Install caps or plugs on the oil cooler and hydraulic hose openings to prevent contamination.

Inspecting the Hydraulic Oil Cooler

1. Back flush the oil cooler with cleaning solvent. After cleaning the cooler, ensure that all the solvent is drained from the cooler.

CAUTION

Use the eye protection such as goggles when using the compressed air.

2. Use the compressed air in the opposite direction of the fluid flow to dry the interiors of the oil cooler.
3. Install plugs on both ends of the oil cooler. Clean the exterior of the oil cooler and ensure that all the fins are clear of dirt and unwanted material.

   Note: Ensure that the oil cooler is free from corrosion, cracked tubes, and excessive pitting of tubes.

Installing the Hydraulic Oil Cooler

1. Remove the caps or plugs that were installed during the removal process.
2. Install the oil cooler; refer to Figure 155.
3. Use a back-up wrench on the oil cooler fittings to install the hydraulic hoses to the fittings.
4. Fill the reservoir with the correct quantity of new hydraulic fluid.
5. Lower the hood and secure it.

Cutting Deck Raise/Lower Circuit

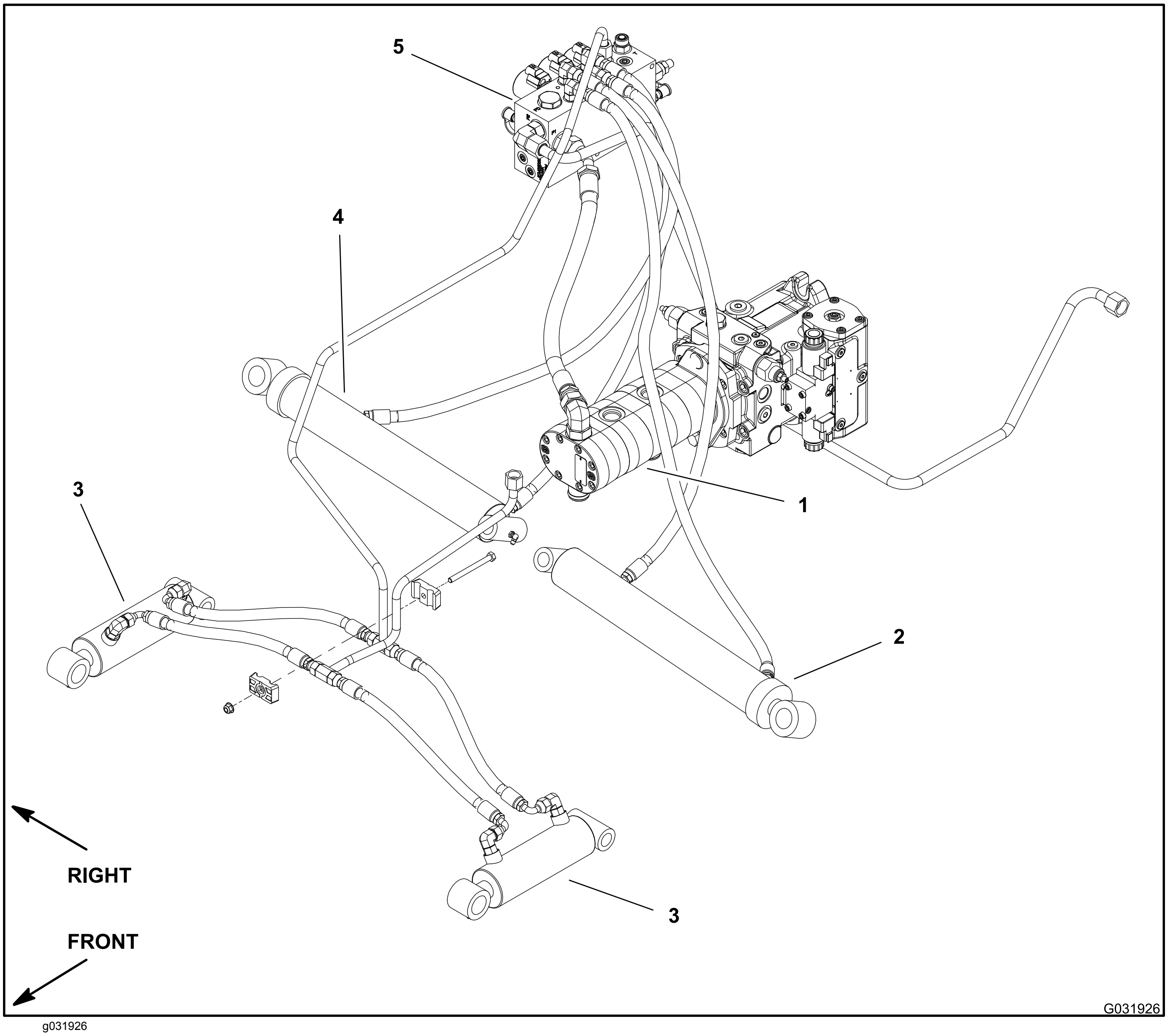
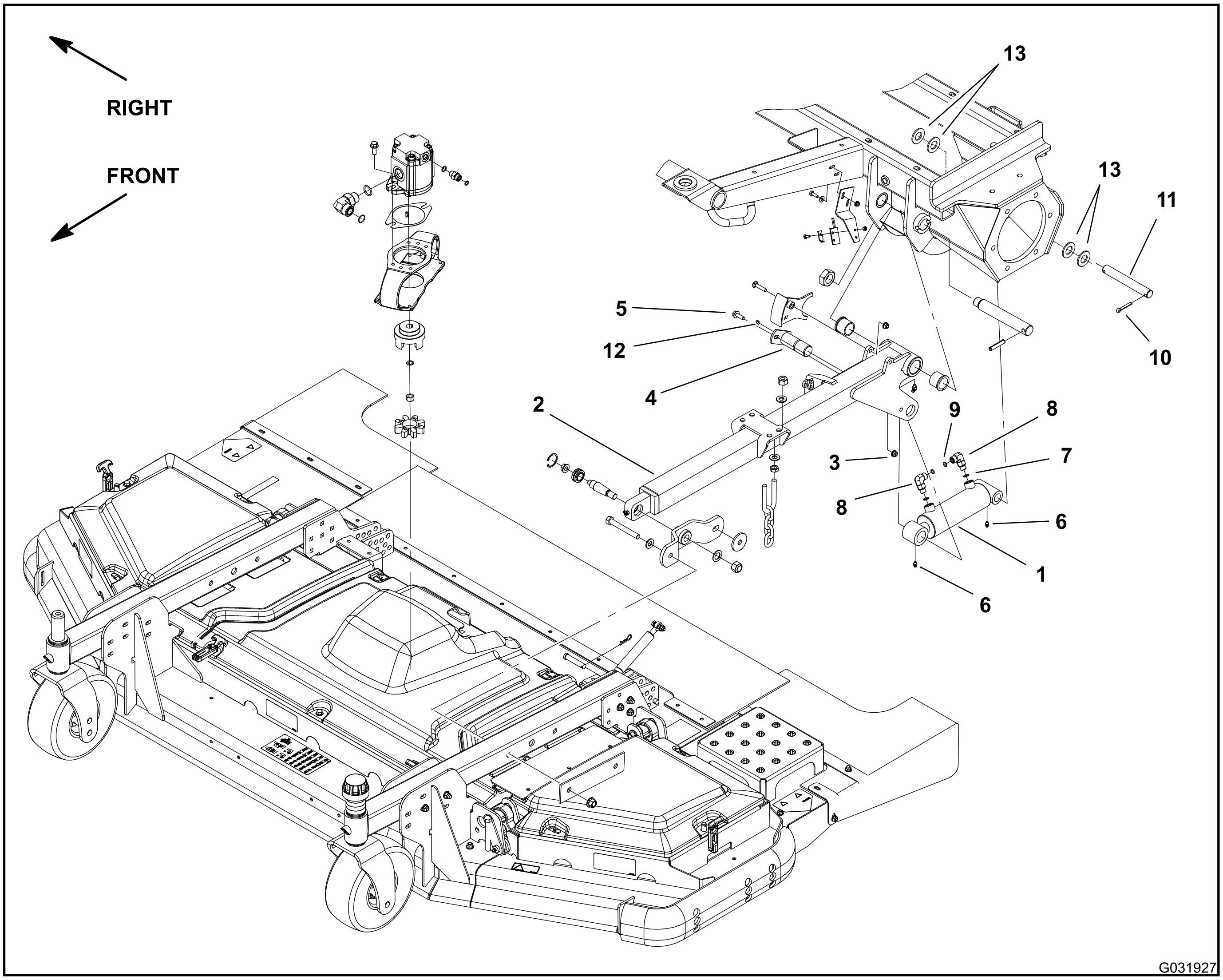


Figure 156

1. Gear pump
2. Left cutting deck lift cylinder
3. Front cutting deck lift cylinder
4. Right cutting deck lift cylinder
5. Lift control manifold

Note: Refer to Figure 156 for the components that are used in the cutting deck raise/lower circuits of the machine. Procedures for removal, installation, and disassembly/assembly of these components are provided in the following pages of this section.

Front Deck Lift Cylinder



g031927

Figure 157

1. Lift cylinder
2. Lift arm (left)
3. Flange nut
4. Pin
5. Flange-head screw
6. Grease fitting
7. O-ring
8. 90° hydraulic fitting
9. O-ring
10. Cotter pin (2 each pin)
11. Clevis pin
12. Plug
13. Flat washer (4 each pin)

Removing the Front Deck Lift Cylinder

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
3. Clean the exterior of the lift cylinder and fittings before removing the lift cylinder to prevent contaminants from entering into the hydraulic system.

IMPORTANT

Ensure that you release the lift system pressure before removing the lift cylinder; refer to Releasing Pressure from the Hydraulic System (page 4–6).

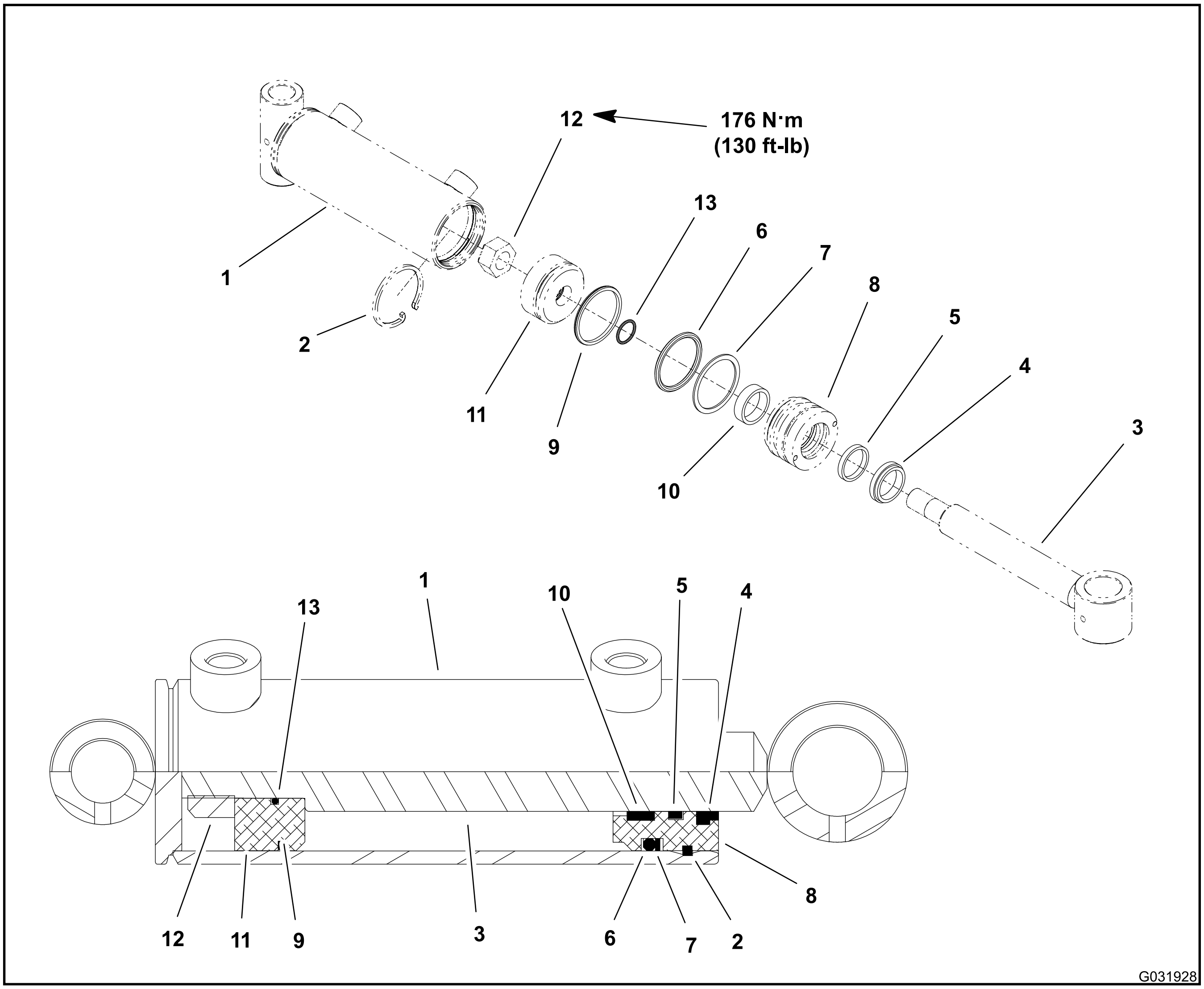
Note: For easy assembly, label all the hydraulic hoses to identify their correct position on the lift cylinder.

4. Disconnect the hydraulic hoses from the lift cylinder fittings. Install caps or plugs on the fittings and hoses to prevent contamination. Label the hydraulic lines for proper assembly.
5. Remove the flange-head screw (item 5 in Figure 157) and flange nut (item 3 in Figure 157) that attach the pin (item 4 in Figure 157) to the lift arm. Remove the pin from the lift arm and cylinder shaft clevis that releases the lift cylinder from the lift arm.
6. Remove the cotter pin (item 10 in Figure 157) and 2 flat washers (item 13 in Figure 157) from 1 end of the clevis pin (item 11 in Figure 157). Pull the clevis pin from the frame and cylinder barrel clevis.
7. Remove the lift cylinder from the machine.
8. If you remove the hydraulic fittings from the lift cylinder, put a mark on the fitting orientation for correct assembly.
9. Remove the fittings from the cylinder and discard the O-rings.

Installing the Front Deck Lift Cylinder

1. If the fittings were removed from the lift cylinder, lubricate and install new O-rings with clean hydraulic fluid onto the fittings. To properly align and install the fittings into the cylinder ports, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Ensure that the cotter pin (item 10 in Figure 157) and 2 flat washers (item 13 in Figure 157) are installed on 1 end of the clevis pin (item 11 in Figure 157).
3. Align the cylinder barrel clevis with the frame and insert the clevis pin (item 11 in Figure 157) into the frame and cylinder clevis. Attach the lift pin with the 2 flat washers (item 13 in Figure 157) and cotter pin (item 10 in Figure 157).
4. Insert the pin (item 4 in Figure 157) through the lift arm and cylinder shaft clevis. Attach the pin to the lift arm with the flange-head screw (item 5 in Figure 157) and flange nut (item 3 in Figure 157).
5. Remove the caps or plugs that were installed during the removal process.
6. Use the tags that you placed during cylinder removal and correctly connect the hydraulic hoses to the lift cylinder; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
7. Fill the reservoir with the correct quantity of new hydraulic fluid.
8. Lubricate the lift cylinder grease fittings.
9. After you complete the assembly, operate the lift cylinder to check that the hydraulic hoses and fittings do not contact any machine components.

Servicing the Front Deck Lift Cylinder



g031928

Figure 158

1. Barrel with clevis
2. Retaining ring
3. Shaft with clevis
4. Dust seal
5. Shaft seal
6. O-ring
7. Back-up ring
8. Head
9. Piston seal
10. Wear ring
11. Piston
12. Locknut
13. O-ring

Disassembling the Front Deck Lift Cylinder

1. Slowly pump the cylinder shaft to remove the hydraulic fluid from the lift cylinder into a drain pan.
2. Plug both the ports and clean the outer surface of the cylinder.

IMPORTANT

When you clamp the barrel of the cylinder in a vise, clamp the barrel clevis only to prevent damage. Do not close the vise on the barrel.

Disassembling the Front Deck Lift Cylinder (continued)

3. Mount the lift cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.
4. Remove the retaining ring that secures the head in the barrel as follows:
   A. Use a spanner wrench to rotate the head clockwise, until the edge of the retaining ring appears in the barrel opening.
   B. Put a screw driver under the beveled edge of the retaining ring to start moving the retaining ring through the opening.
   C. Rotate the head counterclockwise to remove the retaining ring from the barrel and head.
5. Carefully twist and pull the shaft and remove the shaft with head and piston.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

6. Mount the shaft correctly in a vise equipped with soft jaws by clamping on the shaft clevis, and remove the locknut and piston from the shaft. Slide the head from the shaft.
7. Remove the piston seal and O-ring from the piston, and remove the O-ring, back-up ring, wear ring, dust seal, and shaft seal from the head.
8. Wash the parts in clean solvent and dry them with compressed air.

IMPORTANT

Do not wipe the parts dry with paper towels or a cloth. They let lint accumulate in the hydraulic system, which will damage it.

9. Carefully inspect the internal surface of the barrel for damage (deep scratches, out-of-round, etc.).
   A. Replace the entire cylinder if the barrel is damaged.
   B. Inspect the shaft and piston for excessive scoring, pitting, or wear.
   C. Replace any damaged parts.

Assembling the Front Deck Lift Cylinder

1. Clean all the parts before assembling.
2. Put a coating of clean hydraulic fluid on the new O-rings, piston seal, wear ring, shaft seal, back-up ring, and dust seal.
   A. Install the piston seal and O-ring to the piston.
   B. Install the back-up ring, O-ring, wear ring, shaft seal, and dust seal to the head.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

Assembling the Front Deck Lift Cylinder (continued)

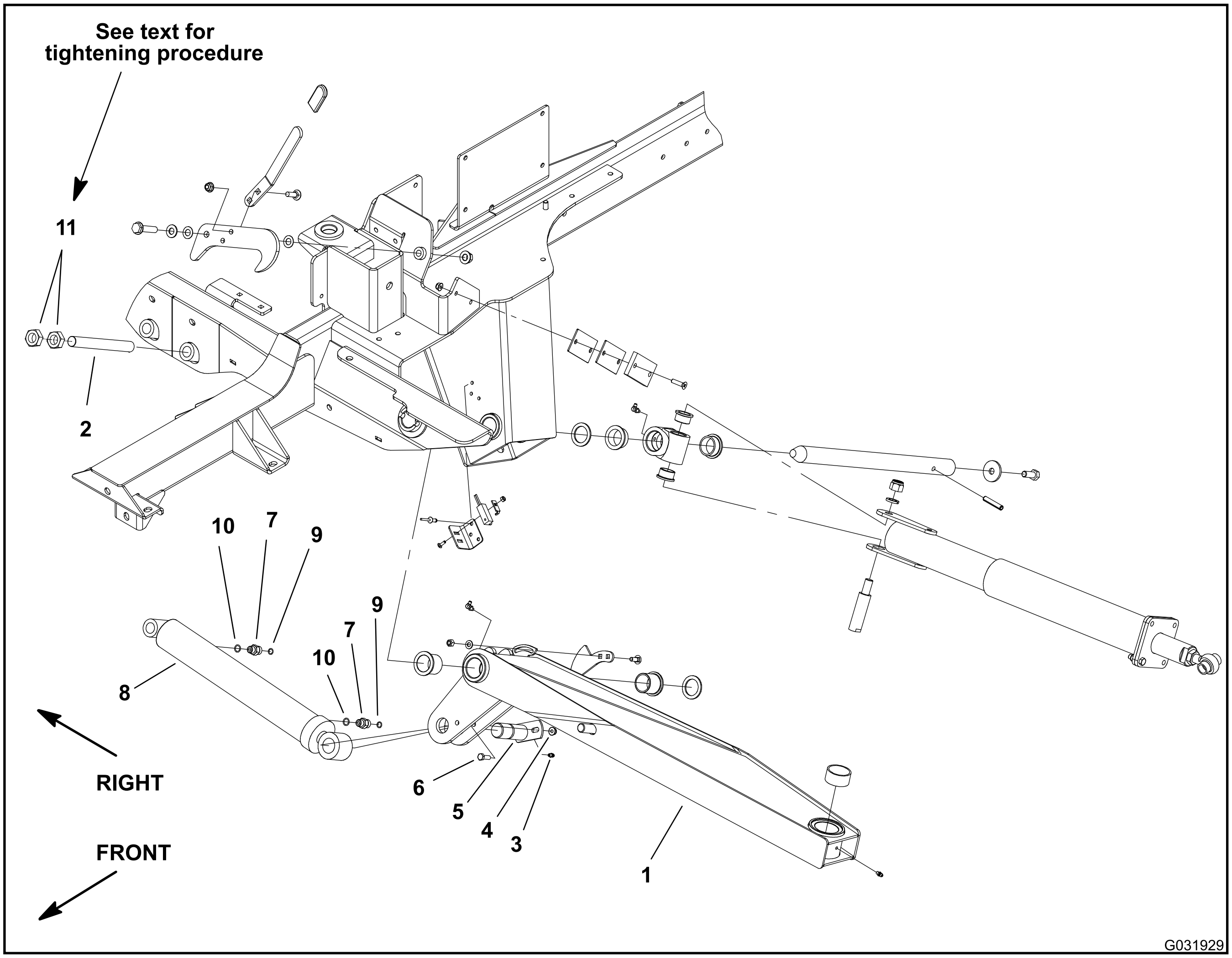
3. Mount the shaft correctly in a vise equipped with soft jaws by clamping on the shaft clevis.
   A. Put a coating of clean hydraulic fluid on the shaft.
   B. Slide the head and piston onto the shaft.
   C. Attach the piston to the shaft with the locknut; torque the locknut to **176 N·m (130 ft-lb)**.
4. Lubricate the head and piston with clean hydraulic fluid. Slide the shaft assembly carefully into the cylinder barrel.

IMPORTANT

When you clamp the barrel of the cylinder in a vise, clamp the barrel clevis only to prevent damage. Do not close the vise on the barrel.

5. Mount the lift cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.
6. Secure the head in the barrel with the retaining ring.
   A. Align the retaining ring hole in the head with the access slot in the barrel.
   B. Insert the retaining ring hook into the hole and rotate the head clockwise until the retaining ring completely sits into the barrel and covers the ring ends.

Wing Deck Lift Cylinder



g031929

Figure 159

1. Wing deck lift arm (left)
2. Pin
3. Grease fitting
4. Flange nut
5. Pin
6. Bolt
7. Hydraulic fitting (2 each cylinder)
8. Wing deck lift cylinder (left)
9. O-ring
10. O-ring
11. Jam nut (4 each pin)

Removing the Wing Deck Lift Cylinder

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
3. Clean the exterior of the lift cylinder and fittings before removing the lift cylinder to prevent contaminants from entering into the hydraulic system.

IMPORTANT

Ensure that you release the lift system pressure before removing the lift cylinder; refer to Releasing Pressure from the Hydraulic System (page 4–6).

Removing the Wing Deck Lift Cylinder (continued)

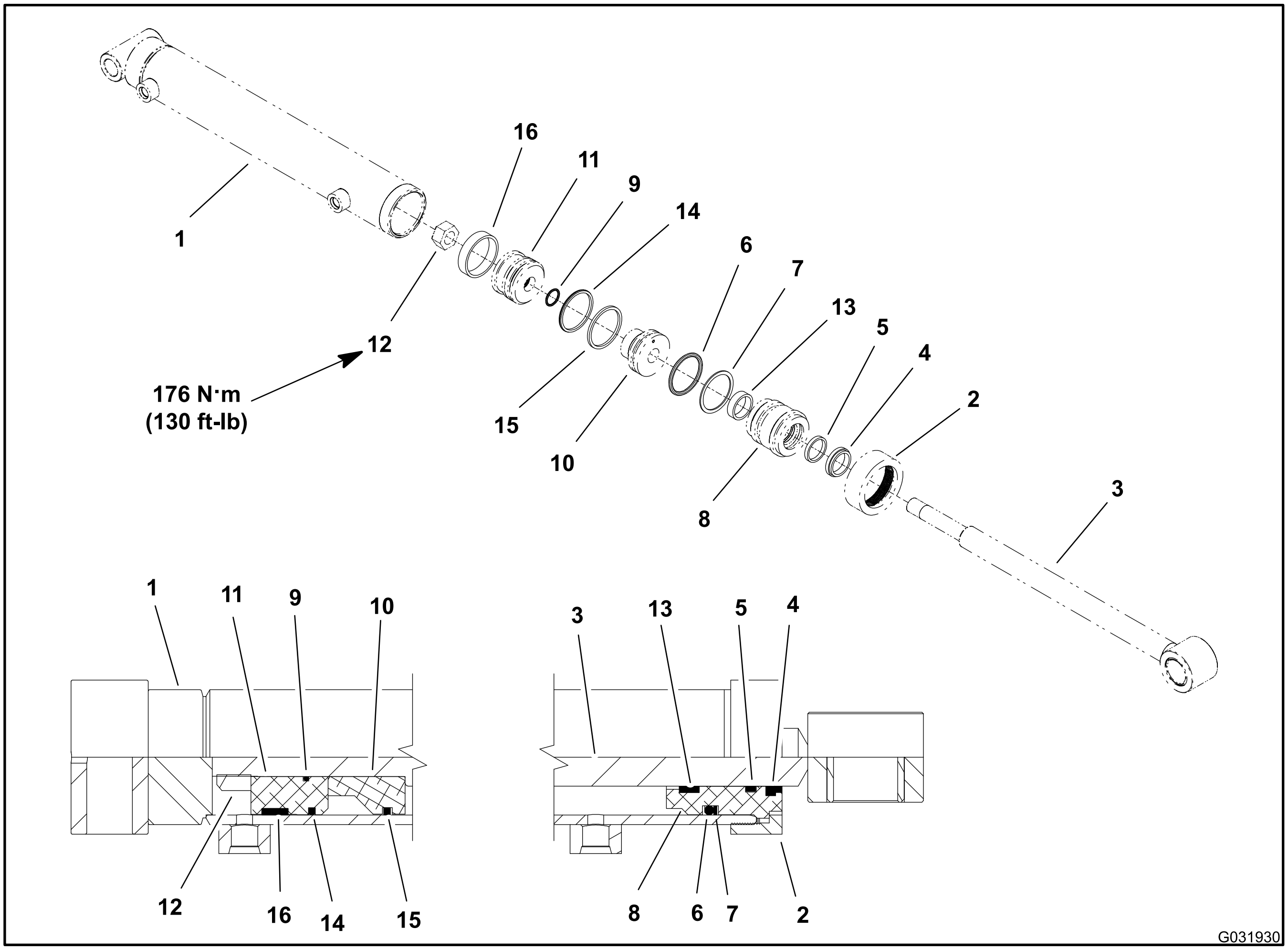
Note: For easy assembly, label all the hydraulic hoses to identify their correct position on the lift cylinder.

4. Disconnect the hydraulic hoses from the lift cylinder fittings. Install caps or plugs on the fittings and hoses to prevent contamination. Label the hydraulic lines for proper assembly.
5. Remove the bolt (item 6 in Figure 159) and flange nut (item 4 in Figure 159) that attach the pin (item 5 in Figure 159) to the lift arm. Remove the pin from the lift arm and cylinder shaft clevis that releases the lift cylinder from the lift arm.
6. Remove the 2 jam nuts (item 11 in Figure 159) from 1 end of the pin (item 2 in Figure 159). Pull the pin from the frame and cylinder barrel clevis.
7. Remove the lift cylinder from the machine.
8. If you remove the hydraulic fittings from the lift cylinder, put a mark on the fitting orientation for correct assembly.
9. Remove the fittings from the cylinder and discard the O-rings.

Installing the Wing Deck Lift Cylinder

1. If the fittings were removed from the lift cylinder, lubricate and install new O-rings with clean hydraulic fluid onto the fittings. To properly align and install the fittings into the cylinder ports, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Ensure that the 2 jam nuts (item 11 in Figure 159) are installed on 1 end of the pin (item 2 in Figure 159).
3. Hold the inner jam nut in alignment with a wrench and torque the outer jam nut to **82 to 94 N·m (60 to 70 ft-lb)**.
4. Position the cylinder barrel clevis to the frame.
5. Insert the pin (item 2 in Figure 159) through the frame and cylinder clevis. Attach the lift pin with the 2 jam nuts (item 11 in Figure 159). Tighten the first jam nut by hand to take up as much free play as possible.
6. Hold the first jam nut in alignment with a wrench and torque the second jam nut to **82 to 94 N·m (60 to 70 ft-lb)**.
7. Insert the pin (item 5 in Figure 159) through the lift arm and cylinder shaft clevis. Attach the pin to the lift arm with a bolt (item 6 in Figure 159) and flange nut (item 4 in Figure 159).
8. Remove the caps or plugs that were installed during the removal process.
9. Use the tags that you placed during cylinder removal to correctly connect the hydraulic hoses to the lift cylinder; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
10. Fill the reservoir with the correct quantity of new hydraulic fluid.
11. Lubricate the lift cylinder grease fittings.
12. After you complete the assembly, operate the lift cylinder to check that the hydraulic hoses and fittings do not contact anything.

Servicing the Wing Deck Lift Cylinder



g031930

Figure 160

1. Barrel with clevis
2. External collar
3. Shaft with clevis
4. Dust seal
5. Shaft seal
6. O-ring
7. Back-up ring
8. Head
9. O-ring
10. Cushion
11. Piston
12. Locknut
13. Wear ring
14. Piston seal
15. Steel ring
16. Wear ring

Disassembling the Wing Deck Lift Cylinder

1. Slowly pump the cylinder shaft to remove the hydraulic fluid from the lift cylinder.
2. After you remove the fluid from the cylinder, connect the 2 ports and clean the outer surface of the cylinder.

IMPORTANT

When you clamp the barrel of the cylinder in a vise, clamp the barrel clevis only to prevent damage. Do not close the vise on the barrel.

3. Mount the lift cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.

Disassembling the Wing Deck Lift Cylinder (continued)

4. Use a spanner wrench to loosen and remove the collar from the barrel.
5. Carefully twist and pull the shaft and remove it with head, cushion, and piston.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

6. Mount the shaft correctly in a vise equipped with soft jaws by clamping on the shaft clevis.
7. Remove the locknut from the shaft. Slide the shaft, cushion, and head off the shaft.
8. Remove the piston seal, wear ring, and O-ring from the piston.
9. Remove the O-ring, back-up ring, dust seal, wear ring, and shaft seal from the head.
10. Wash the parts in clean solvent and dry them with compressed air.

IMPORTANT

Do not wipe the parts dry with paper towels or a cloth. They let lint accumulate in hydraulic system, which will damage it.

11. Carefully inspect the internal surface of the barrel for damage (deep scratches, out-of-round, etc.).
    A. Replace the entire cylinder if the barrel is damaged.
    B. Inspect the shaft and piston for excessive scoring, pitting, or wear.
    C. Replace any damaged parts.

Assembling the Wing Deck Lift Cylinder

1. Clean all the parts before you start assembling.
2. Put a coating of clean hydraulic fluid on the new O-rings, piston seal, rod seal, back-up ring, wear rings, and dust seal.
    A. Install the piston seal, wear ring, and O-ring to the piston.
    B. Install the back-up ring, O-ring, shaft seal, wear ring, and dust seal to the head.

IMPORTANT

Clamping the vise jaws against the shaft surface could damage the shaft. When securing the shaft in a vise, clamp the shaft clevis only.

3. Mount the shaft correctly in a vise equipped with soft jaws by clamping on the shaft clevis.
    A. Put a coating of clean hydraulic fluid on the shaft.
    B. Slide the external collar, head, cushion, and piston onto the shaft.
    C. Attach the piston to the shaft with the locknut; torque the locknut to **176 N·m (130 ft-lb)**.

Assembling the Wing Deck Lift Cylinder (continued)

4. Lubricate the head, cushion, and piston with clean hydraulic fluid. Slide the shaft assembly carefully into the cylinder barrel.

IMPORTANT

When you clamp the barrel of the cylinder in a vise, clamp the barrel clevis only to prevent damage. Do not close the vise on the barrel.

5. Mount the lift cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.
6. Use a spanner wrench and tighten the collar onto the barrel.

Lift Control Manifold

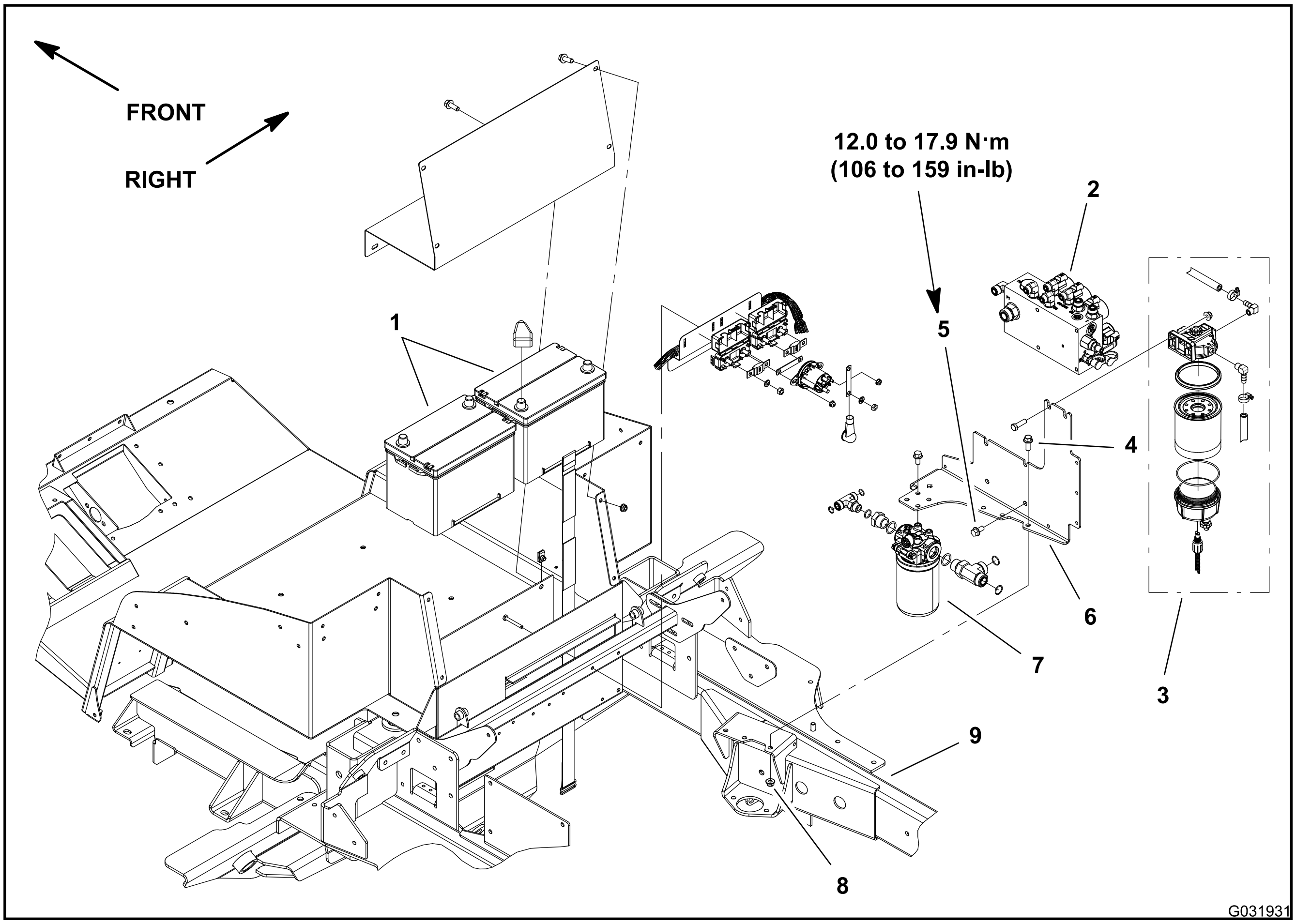


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Figure 161

1. Battery
2. Lift control manifold
3. Water separator assembly
4. Flange-head screw (3 each)
5. Flange-head screw (4 each)
6. Mounting plate
7. Hydraulic filter
8. Flange nut (3 each)
9. Frame

Note: The ports on the lift control manifold are marked for easy identification of the components. Example: P1 is the supply port from the gear pump and FD is the flow divider cartridge location; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Removing the Lift Control Manifold

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
2. Raise the hood and remove the right side panel to get access to the lift control manifold.
3. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
4. For assembly purposes, label the wire harness leads of manifold solenoids. Disconnect the wire harness connectors from the solenoids on the manifold.
5. Disconnect all the hydraulic lines from the manifold and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for correct assembly.

Removing the Lift Control Manifold (continued)

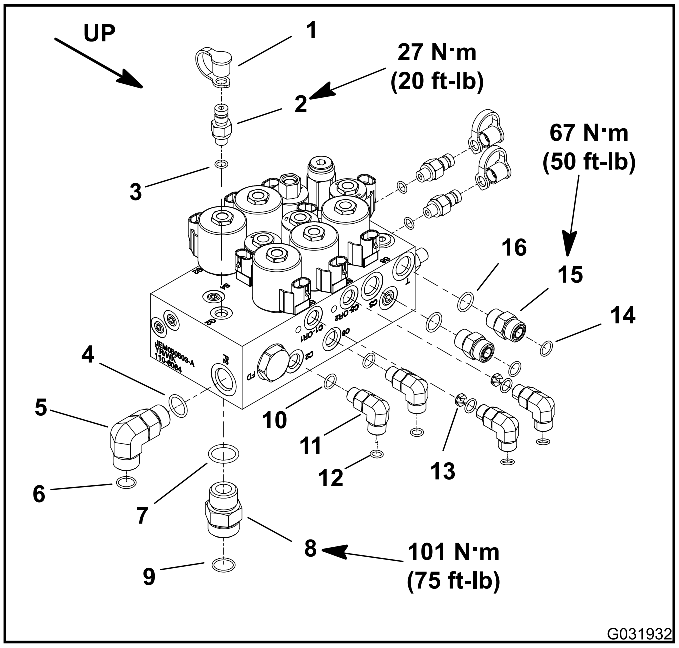
6. Remove the hydraulic manifold from the frame; refer to Figure 161.

IMPORTANT

An orifice is placed below the 90° hydraulic fittings in the control manifold C1-OR1 and C5-OR2 ports. If 1 of these fittings is removed from the manifold, ensure that you remove the orifice and label the orifice position for assembly purposes.

7. If you remove the hydraulic fittings from the manifold, put a mark on the fitting orientation for correct assembly.
8. Remove the fittings from the manifold and discard the O-rings.

Installing the Lift Control Manifold



g031932

Figure 162

1. Dust cap
2. Quick fitting (3 each)
3. O-ring
4. O-ring
5. 90° fitting
6. O-ring
7. O-ring
8. Straight fitting
9. O-ring
10. O-ring
11. 90° fitting (4 each)
12. O-ring
13. Orifice disc (2 each)
14. O-ring
15. Straight fitting (2 each)
16. O-ring

1. If the fittings were removed from the manifold, do the following steps:
   A. Lubricate and install new O-rings with clean hydraulic fluid onto the fittings.

Installing the Lift Control Manifold (continued)

IMPORTANT

When installing the orifice in manifold port C1-OR1 or C5-OR2, ensure that the orifice is flat in the base of the port cavity. Letting the orifice stay cocked in the cavity can damage the manifold.

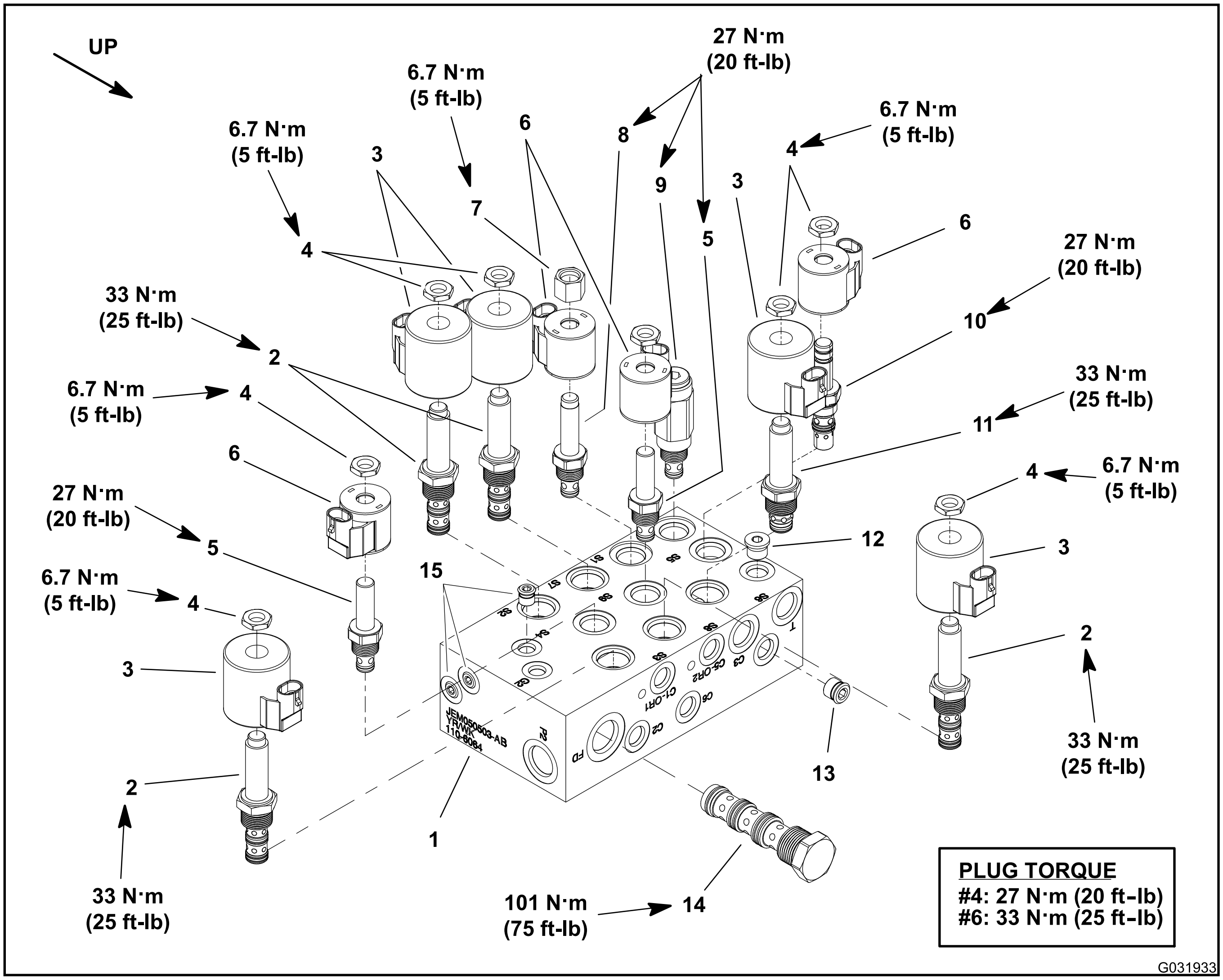
B. If the fitting was removed from the manifold port C1-OR1 or C5-OR2, place the orifice in the port before you install the fitting.

C. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 162 for the straight fitting installation torque.

Note: For information on tightening procedures for adjustable fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

2. Install the lift control manifold to the frame with the 4 flange-head screws; torque the flange-head screws to **12.0 to 17.9 N·m (106 to 159 in-lb)**; refer to Figure 161.
3. Remove the caps and plugs from the fittings and hoses. Correctly connect the hydraulic lines to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
4. Use the labels that you attached during removal to correctly connect the wire harness connectors to the solenoids on the lift control manifold.
5. Ensure that the hydraulic tank is full. Add the correct quantity of fluid if necessary.
6. Attach the right side panel to the machine.
7. Lower the hood and secure it.

Servicing the Lift Control Manifold



g031933

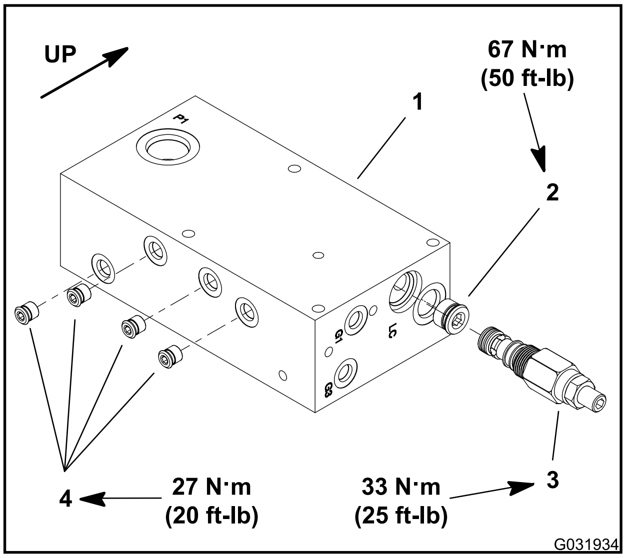
Figure 163

1. Lift manifold
2. Solenoid valve (S2, S3, S7 and S8)
3. Solenoid coil (5 each)
4. Solenoid nut
5. Solenoid valve (S4 and S9)
6. Solenoid coil (4 each)
7. Solenoid nut
8. Solenoid valve (S1)
9. Relief valve (RV)
10. Solenoid valve (S5)
11. Solenoid valve (S6)
12. SAE #6 plug with O-ring
13. NWD #6 plug with O-ring
14. Flow divider (FD)
15. SAE #4 plug with O-ring (7 each)

Note: The ports on the lift control manifold are marked for easy identification and assembly of the components. Example: P1 is the supply port from the gear pump and FD is the flow divider cartridge location; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Note: The lift control manifold includes several zero-leak NWD 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 zero-leak plug removal is necessary, use a punch and hammer to lightly rap the plug head before using an allen wrench to remove the plug: the impact will allow the plug removal with less chance of damage to the socket head of the plug. When installing the plugs; refer to Figure 163 for the plug installation torque.

Servicing the Valve Cartridge



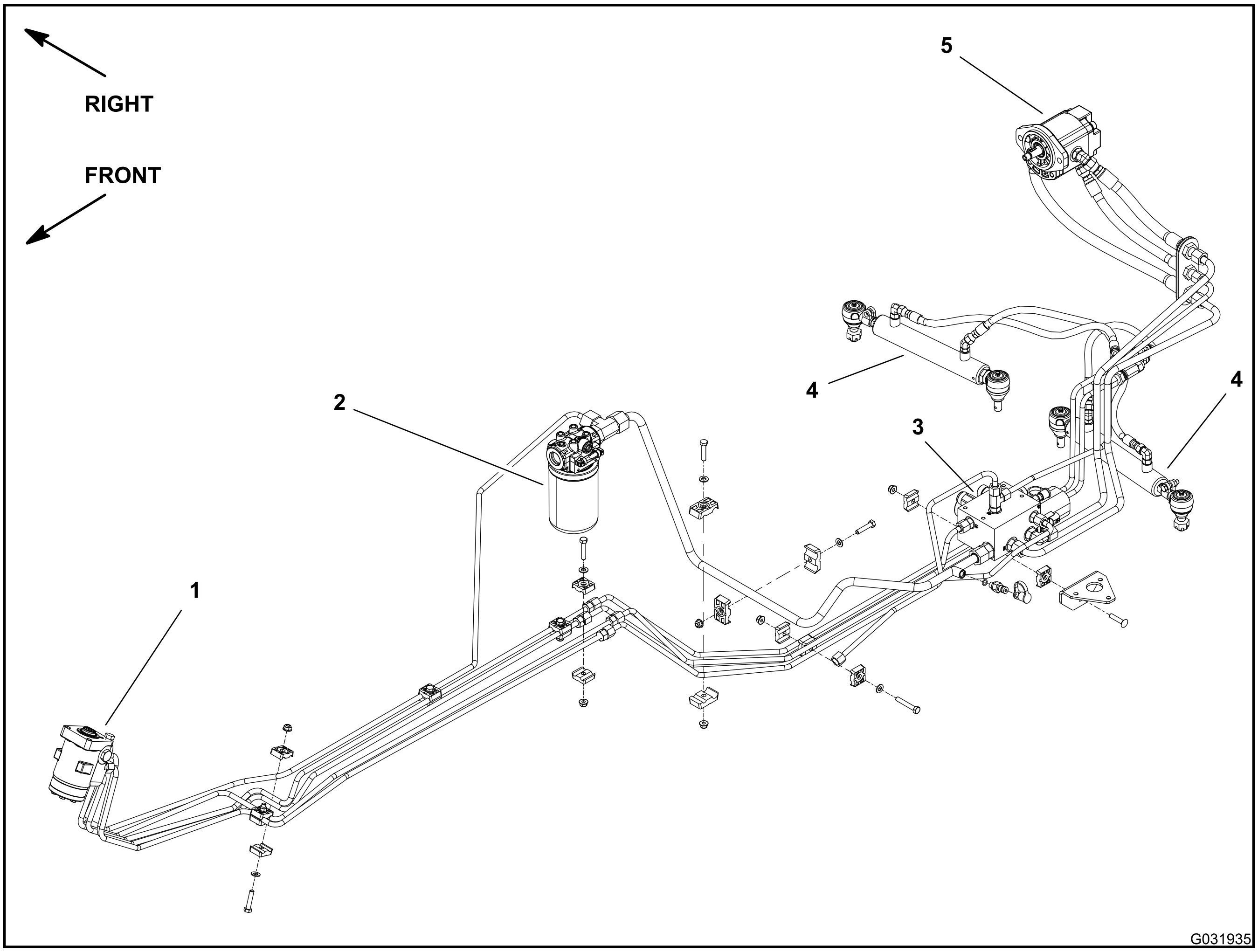
g031934

Figure 164

1. Lift manifold
2. NWD #8 plug/O-ring
3. Logic valve (LC)
4. SAE #4 plug/O-ring

For the cartridge valve service procedures; refer to Servicing the Traction Control Manifold (page 4–133). Refer to Figure 163 and Figure 164 for the lift control manifold cartridge valve and plug installation torque.

Steering and Engine Cooling Fan Circuit



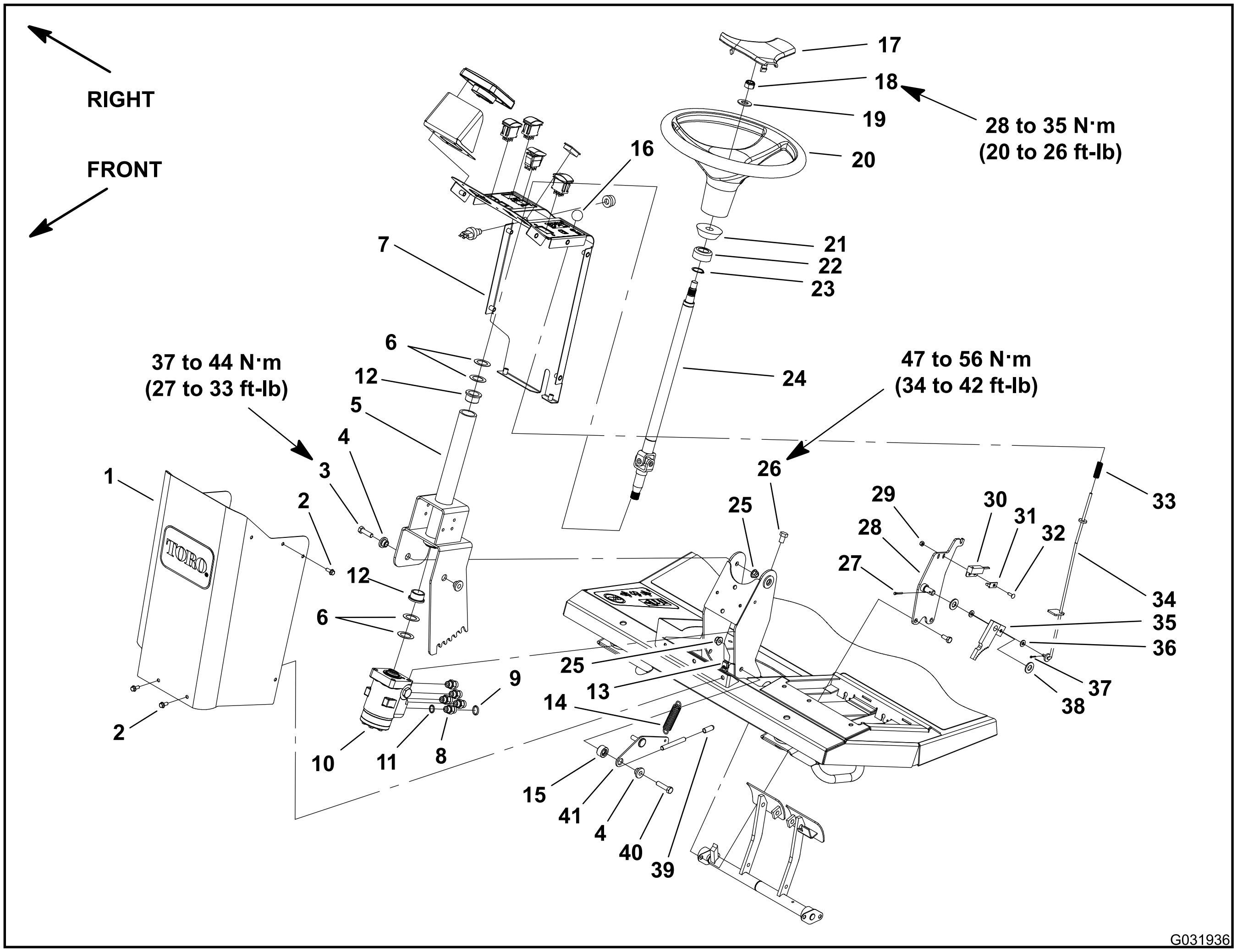
g031935

Figure 165

1. Steering control valve
2. Oil filter
3. Steering/cooling fan control manifold
4. Steering cylinder (2 each)
5. Engine cooling fan motor

Refer to Figure 165 for the components that are used in the steering and engine cooling fan circuit of the machine. Procedures for removal, installation, and disassembly/assembly of these components are provided in the following pages of this section.

Steering Control Valve



g031936

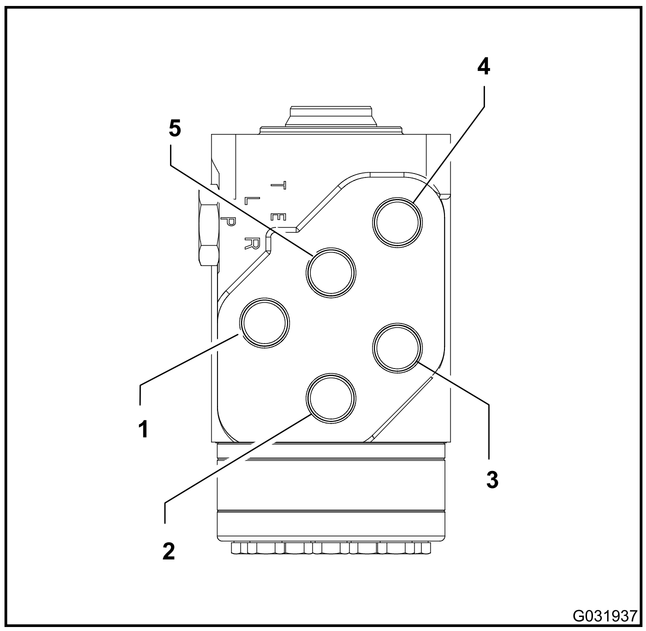
Figure 166

1. Steering tower cover
2. Flange-head screw
3. Bolt (2 each)
4. Pivot hub (3 each)
5. Steering column assembly
6. Thrust washer (4 each)
7. Steering tower
8. Hydraulic fitting (5 each)
9. O-ring
10. Steering control valve
11. O-ring
12. Flange bushing (2 each)
13. Clip (2 each)
14. Spring
15. Spacer
16. Knob
17. Steering wheel cover
18. Hex nut
19. Flat washer
20. Steering wheel
21. Foam collar
22. Steering seal
23. External snap ring (2 each)
24. Steering shaft assembly
25. Flange nut (3 each)
26. Bolt (4 each)
27. Cotter pin
28. Parking brake pivot
29. Locknut
30. Proximity switch
31. Switch plate
32. Carriage bolt
33. Compression spring
34. Parking brake rod
35. Parking brake rack
36. Flat washer (2 each)
37. Cotter pin
38. Flat washer (2 each)
39. Cap
40. Bolt
41. Tilt lever

Removing the Steering Control Valve

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
3. Remove the steering tower cover (item 1 in Figure 166).
4. Clean the exterior of the steering valve, hydraulic tubes, and fittings before removing the steering valve to prevent contaminants from entering into the hydraulic system.
5. Disconnect the hydraulic tubes from the steering control valve. Install caps or plugs on the fittings and tubes to prevent contamination. Label the hydraulic lines for proper assembly.
6. Support the steering control valve to prevent it from falling.
7. Remove the 4 bolts that attach the steering control valve to the machine. Slide the steering control valve from the lower end of the steering shaft and remove it from the machine.
8. If necessary, remove the fittings from the control valve and discard the O-rings from the fittings.

Installing the Steering Control Valve



g031937

Figure 167

1. In port (P)
2. Right turn port (R)
3. Load sensing port (LS)
4. Out port (T)
5. Left turn port (L)

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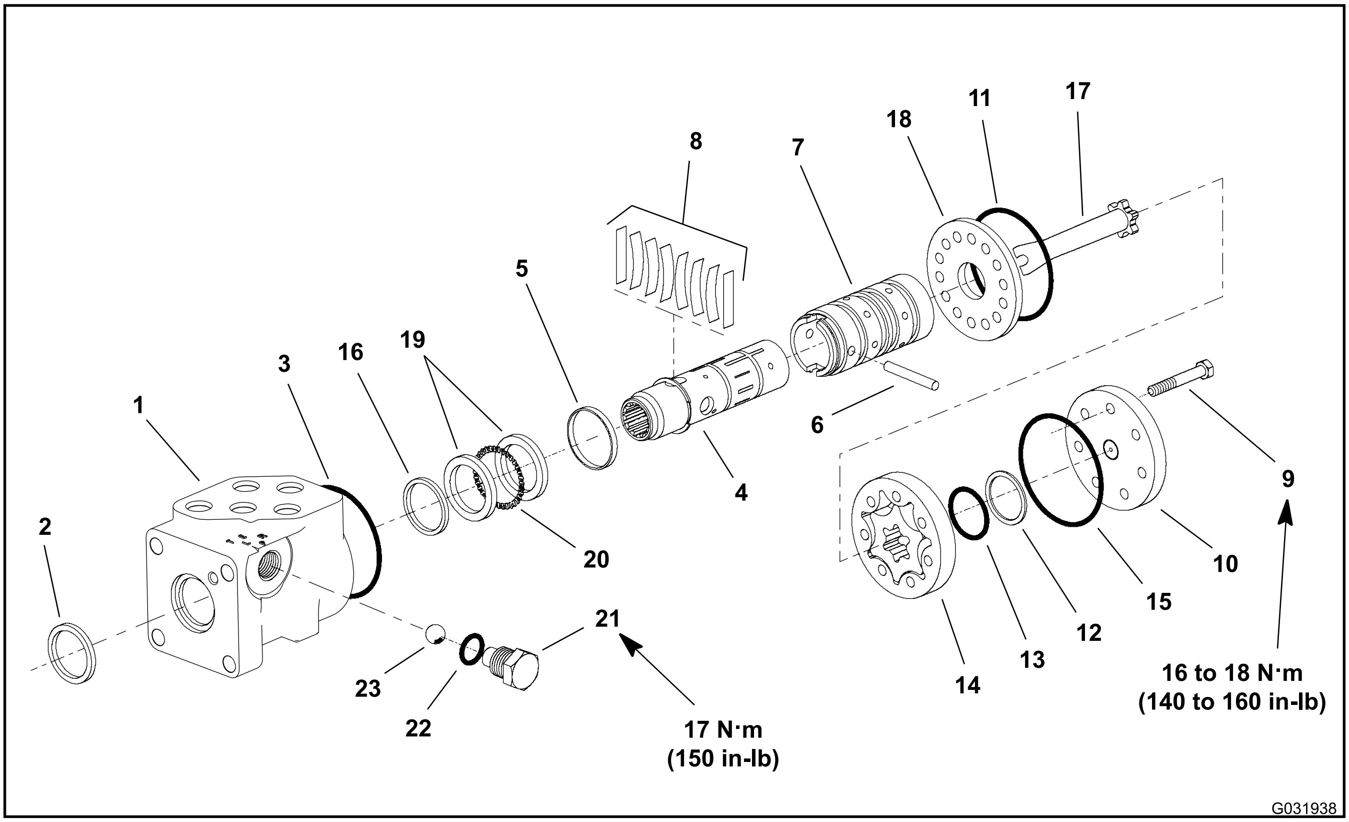
1. If the fittings were removed from the steering control valve, lubricate and install new O-rings onto the fittings.
2. Install the fittings into the control valve and tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
3. Slide the steering control valve onto the lower end of the steering shaft. Attach the control valve to the machine with the 4 bolts; torque the bolts to **47 to 56 N·m (34 to 42 ft-lb)**.

Installing the Steering Control Valve (continued)

4. Remove the caps or plugs that were installed during the removal process.
5. Use the tags that you placed during control valve removal to identify the correct tube placement and correctly connect the hydraulic tubes to the fittings on the steering valve; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
6. Install the steering tower cover (item 1 in Figure 166).
7. Fill the reservoir with the correct quantity of new hydraulic fluid.

Servicing the Steering Control Valve



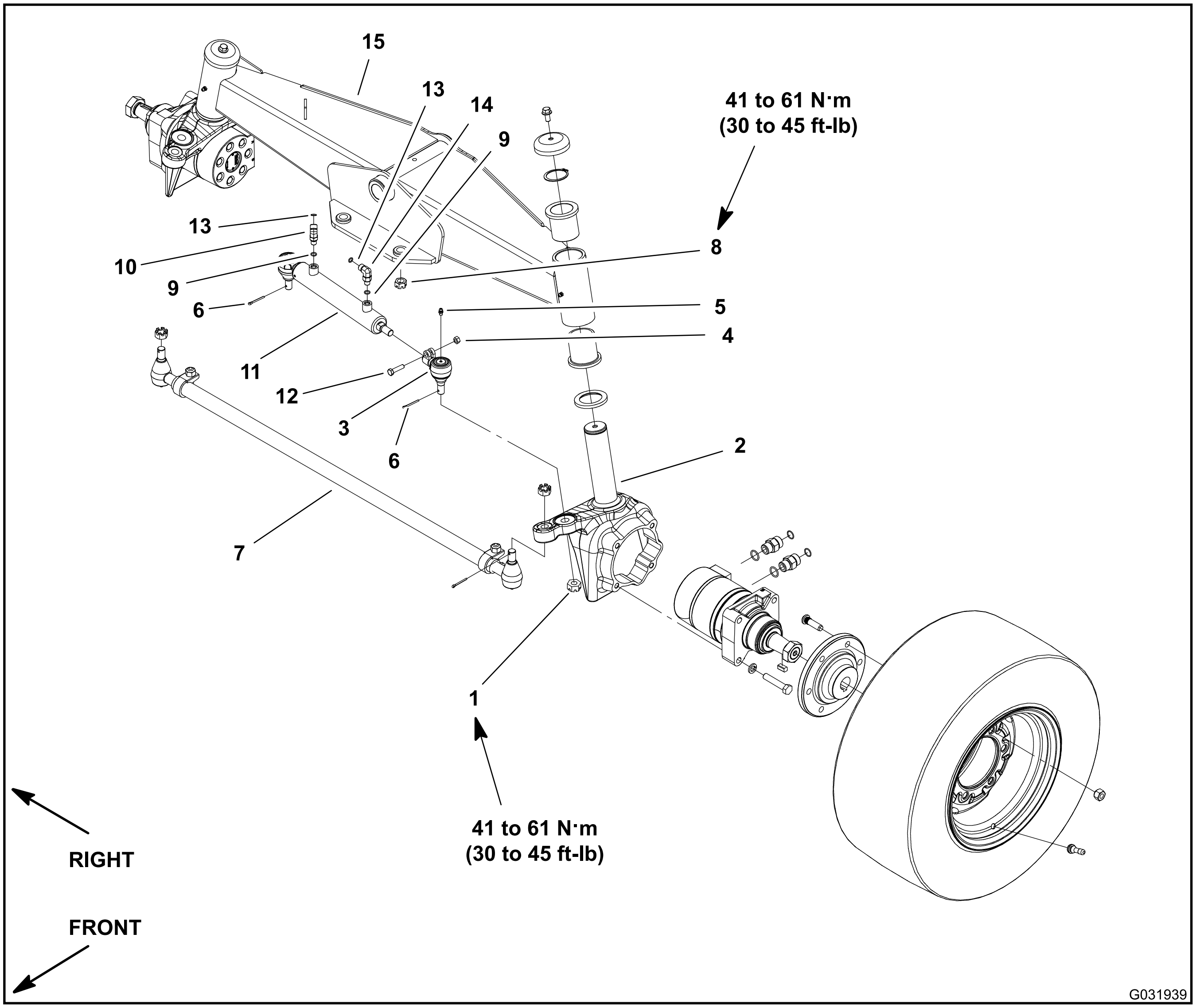
g031938

Figure 168

1. Steering valve housing
2. Dust seal
3. O-ring
4. Spool
5. Spring retaining ring
6. Pin
7. Sleeve
8. Centering springs/spacers
9. Bolt (7 each)
10. End cap
11. O-ring
12. Seal ring
13. O-ring
14. Geroter
15. O-ring
16. Quad seal
17. Geroter drive
18. Wear plate
19. Bearing race
20. Thrust bearing
21. Plug
22. O-ring
23. Check ball

Note: For the steering control valve repair procedures; refer to the Eaton Parts and Repair Information: 5-Series Steering Control Units at the end of this chapter.

Steering Cylinders



g031939

Figure 169

1. Slotted hex nut
2. Left steering spindle
3. Cylinder Ball joint
4. Hex nut
5. Grease fitting
6. Cotter pin
7. Tie rod assembly
8. Slotted hex nut
9. O-ring
10. 45° hydraulic fitting
11. Steering cylinder
12. Bolt
13. O-ring
14. 90° hydraulic fitting
15. Rear axle

Removing the Steering Cylinders

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
3. Clean the exterior of the cylinder, fittings, and hoses before removing the steering cylinder to prevent contaminants from entering into the hydraulic system.

   Note: For easy assembly, label all the hydraulic hoses to identify their correct position on the steering cylinder.

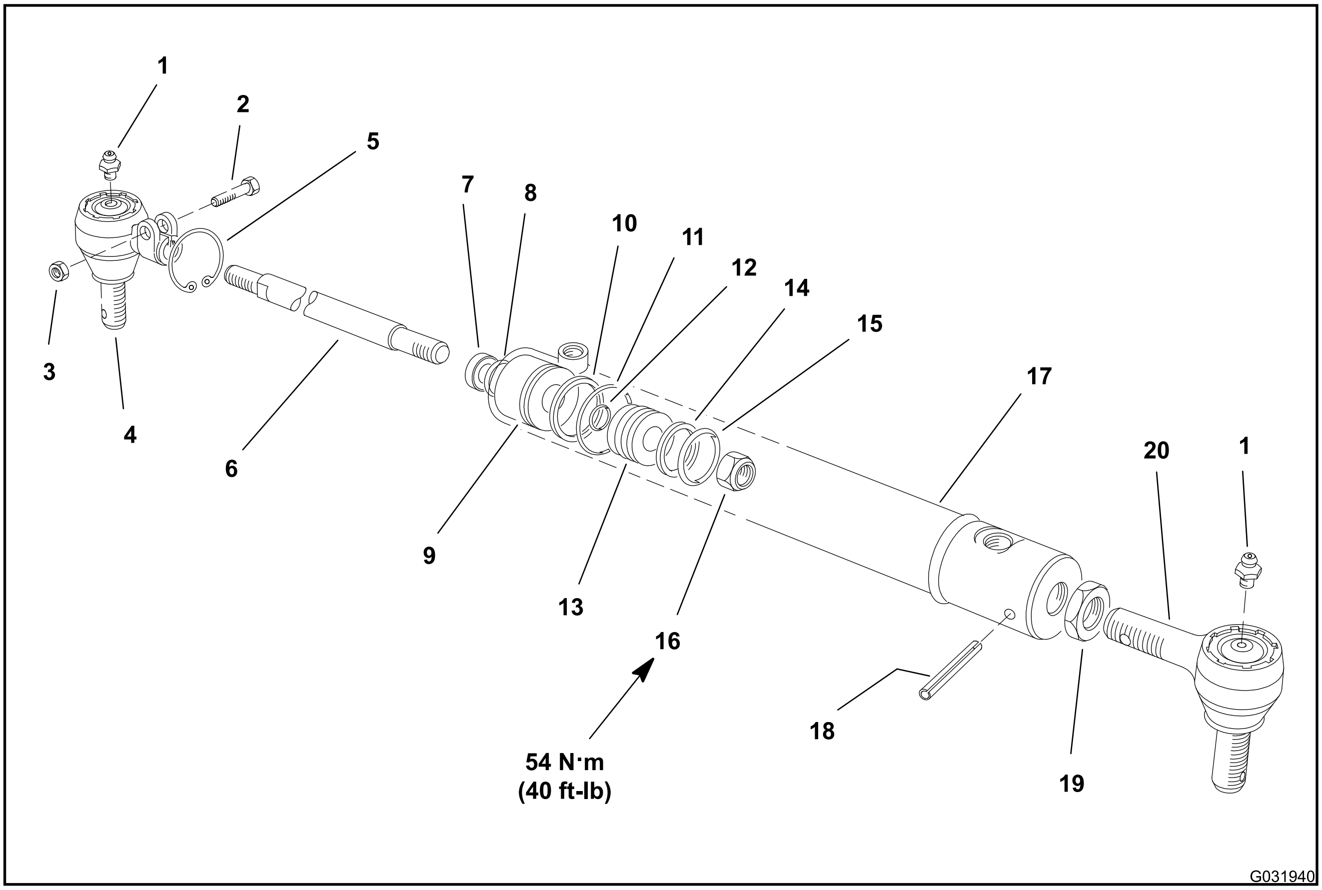
Removing the Steering Cylinders (continued)

4. Disconnect the hydraulic hoses from the steering cylinder fittings. Install caps or plugs on the fittings and hoses to prevent contamination. Label the hydraulic lines for proper assembly.
5. Remove the cotter pins and slotted hex nuts (items 1 and 8 in Figure 169) that attach the cylinder ball joints to the rear axle and steering spindle.
6. Disconnect the ball joints from the rear axle and steering spindle, and remove the steering cylinder from the machine.
7. If you remove the hydraulic fittings from the steering cylinder, put a mark on the fitting orientation for correct assembly.
8. Remove the fittings from the steering cylinder and discard the O-rings from the fittings.

Installing the Steering Cylinders

1. If the fittings were removed from the steering cylinder, lubricate and install new O-rings onto the fittings. To properly align and install the fittings into the cylinder ports, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).
2. Clean the tapers on the steering-cylinder ball joints. Also, clean the ball joint bores of the rear axle assembly and steering spindle.
3. Position the steering cylinder to the machine.
4. Attach the steering cylinder to the rear axle and steering spindle with the slotted hex nuts (items 1 and 8 in Figure 169). Torque the slotted hex nuts to **41 to 61 N·m (30 to 45 ft-lb)** while you align the ball joint hole with the slot in the nut. Insert the cotter pins.
5. Remove the caps or plugs that were installed during the removal process.
6. Use the tags that you placed during cylinder removal to correctly connect the hydraulic hoses to the steering cylinder; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
7. Fill the reservoir with the correct quantity of new hydraulic fluid.
8. Lubricate the cylinder ball joint grease fittings.
9. After you complete the assembly, operate the steering cylinder to check that the hydraulic hoses and fittings do not contact any machine components.

Servicing the Steering Cylinder



g031940

Figure 170

1. Grease fitting
2. Bolt
3. Locknut
4. Piston rod ball joint
5. Snap ring
6. Piston rod
7. Rod wiper
8. Rod seal
9. Head
10. Back-up ring
11. O-ring
12. O-ring
13. Piston
14. Slipper seal
15. O-ring
16. Locknut
17. Barrel
18. Roll pin
19. Jam nut
20. Barrel end ball joint

Disassembling the Steering Cylinder

1. Slowly pump the piston rod to remove the fluid from the steering cylinder.
2. After you remove the fluid from the cylinder, connect the 2 ports and clean the outer surface of the cylinder.
3. Remove the snap ring (item 5 in Figure 170) that secures the head in the barrel.
4. Hold the end of the piston rod and use a twist and pull motion to carefully remove the piston, piston rod, and head from the cylinder barrel.
5. Use a wrench on the piston rod flats to prevent the rod from turning, remove the locknut (item 16 in Figure 170) from the rod, and remove the piston and head from the rod.
6. Remove all the seals and O-rings from the head and piston.
7. Wash the parts in clean solvent and dry them with compressed air.

IMPORTANT

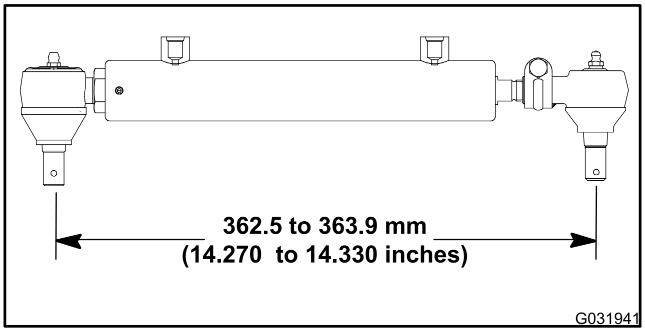
Do not wipe the parts dry with paper towels or a cloth. They let lint accumulate in the hydraulic system, which will damage it.

8. Carefully inspect the internal surface of the barrel for damage (deep scratches, out-of-round, etc.).
   A. Replace the entire cylinder if the barrel is damaged.
   B. Inspect the shaft and piston for excessive scoring, pitting, or wear.
   C. Replace any damaged parts.
9. If you must remove the piston rod ball joint (item 4 in Figure 170), loosen the bolt (item 2 in Figure 170) and locknut (item 3 in Figure 170) and then unscrew the ball joint from the piston rod.
10. If necessary, remove the barrel end ball joint (item 20 in Figure 170) from the barrel as follows:
    A. Loosen the jam nut (item 19 in Figure 170).
    B. Remove the roll pin (item 18 in Figure 170) from the barrel.
    C. Unscrew the ball joint from the barrel.

Assembling the Steering Cylinder

1. Use a complete repair kit when you assemble the cylinder. Put a coating of clean hydraulic fluid on all new seals and O-rings.
2. Install new O-rings and slipper seal to the piston and a new O-ring, back-up ring, rod seal, and rod wiper to the head.
3. Lubricate the shaft with clean hydraulic fluid. Slide the head and piston onto the piston rod.
4. Use a wrench on the piston rod flats to prevent the rod from turning, install and tighten the locknut (item 16 in Figure 170). Torque the locknut to **54 N·m (40 ft-lb)**.
5. Put a coating of clean hydraulic fluid on all the cylinder parts for easy assembly.
6. Carefully slide the piston rod assembly into the cylinder barrel and ensure that you do not damage the seals or O-rings.
7. Attach the head in the barrel with the snap ring. Ensure that the snap ring is fully seated in the groove of the barrel.
8. If the barrel end ball joint (item 20 in Figure 170) was removed, install the ball joint to the barrel as follows:
   A. Turn the ball joint into the barrel so that the roll pinhole in the joint aligns with the hole in the barrel.
   B. Move the roll pin into the aligned holes in the barrel and ball joint.
   C. Tighten the jam nut.

Assembling the Steering Cylinder (continued)

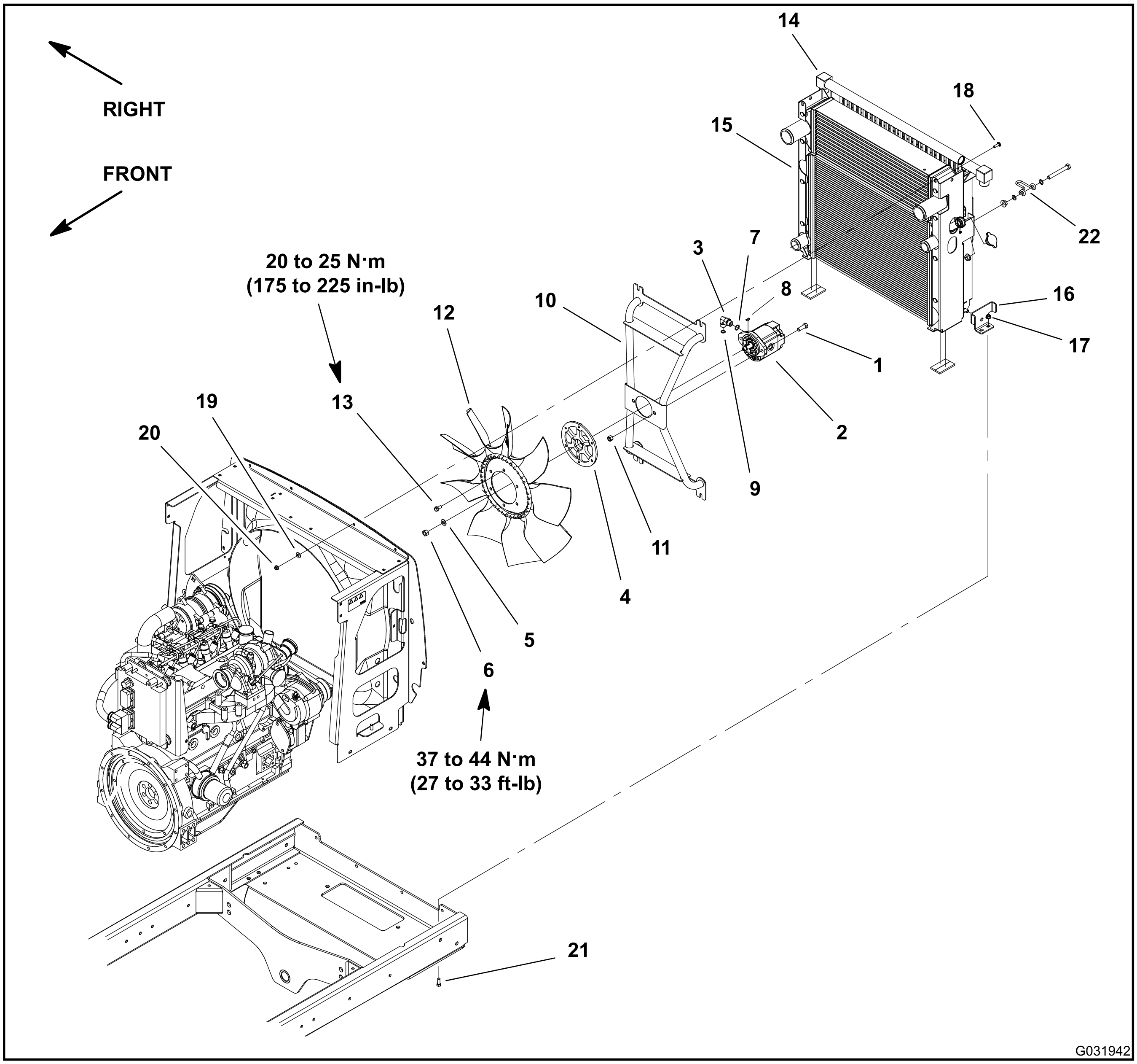


g031941

Figure 171

9. If the piston rod end ball joint (item 4 in Figure 170) was removed, fully retract the piston rod and thread the ball joint onto the rod so that the center-to-center length is 362.5 to 363.9 mm (14.270 to 14.330 inches); refer to Figure 171.
10. Tighten the bolt (item 2 in Figure 170) and locknut (item 3 in Figure 170).

Engine Cooling Fan Motor



g031942

Figure 172

1. Socket-head screw (2 each)
2. Cooling fan motor
3. 90° hydraulic fitting
4. Fan hub
5. Flat washer
6. Hex nut
7. O-ring
8. Woodruff key
9. O-ring
10. Fan motor bracket
11. Locknut (2 each)
12. Cooling fan
13. Flange-head screw (6 each)
14. Oil cooler
15. Radiator assembly
16. Oil cooler support plate (2 each)
17. Flange nut (4 each)
18. Carriage screw (2 each)
19. Flat washer (2 each)
20. Flange nut (2 each)
21. Bolt (4 each)
22. Clamp (2 each)

Removing the Engine Cooling Fan Motor

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Removing the Engine Cooling Fan Motor (continued)

2. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
3. Unlatch the hood and raise it.

CAUTION

A hot radiator and oil cooler can cause burns.

Allow the engine and cooling systems to cool before working on or near them.

IMPORTANT

Ensure that you do not damage the radiator, oil cooler, or other machine components while loosening and removing the fan motor.

4. Remove the air intake box from the top of the radiator assembly; refer to Removing the Air Filter System (page 3–9).
5. Remove the hex nut (item 6 in Figure 172) and flat washer (item 5 in Figure 172) that attach the fan hub and fan assembly to the fan motor.
6. Use a suitable puller and remove the fan hub (with fan attached) from the fan motor shaft.

   Note: Ensure that you do not damage the fan. Position the fan assembly away from the fan motor.
7. Disconnect the hydraulic hoses from the cooling fan motor. Install caps or plugs on the fittings and hoses to prevent contamination. Label the hydraulic lines for proper assembly.
8. Support the fan motor to prevent it from falling, and remove the 2 socket-head screws (item 1 in Figure 172) and locknuts (item 11 in Figure 172) that attach the fan motor to the fan motor bracket.
9. Carefully lower the fan motor and remove it from the machine.
10. If you remove the hydraulic fittings from the fan motor, put a mark on the fitting orientation for correct assembly.
11. Remove the fittings from the motor and discard the O-rings.

Installing the Engine Cooling Fan Motor

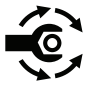
1. If the fittings were removed from the fan motor, lubricate and install new O-rings onto the fittings. To properly align and install the fittings into the motor ports, use the marks that you made when they were removed. Tighten the fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

IMPORTANT

Ensure that you do not damage the radiator, oil cooler, or other machine components while installing the fan motor.

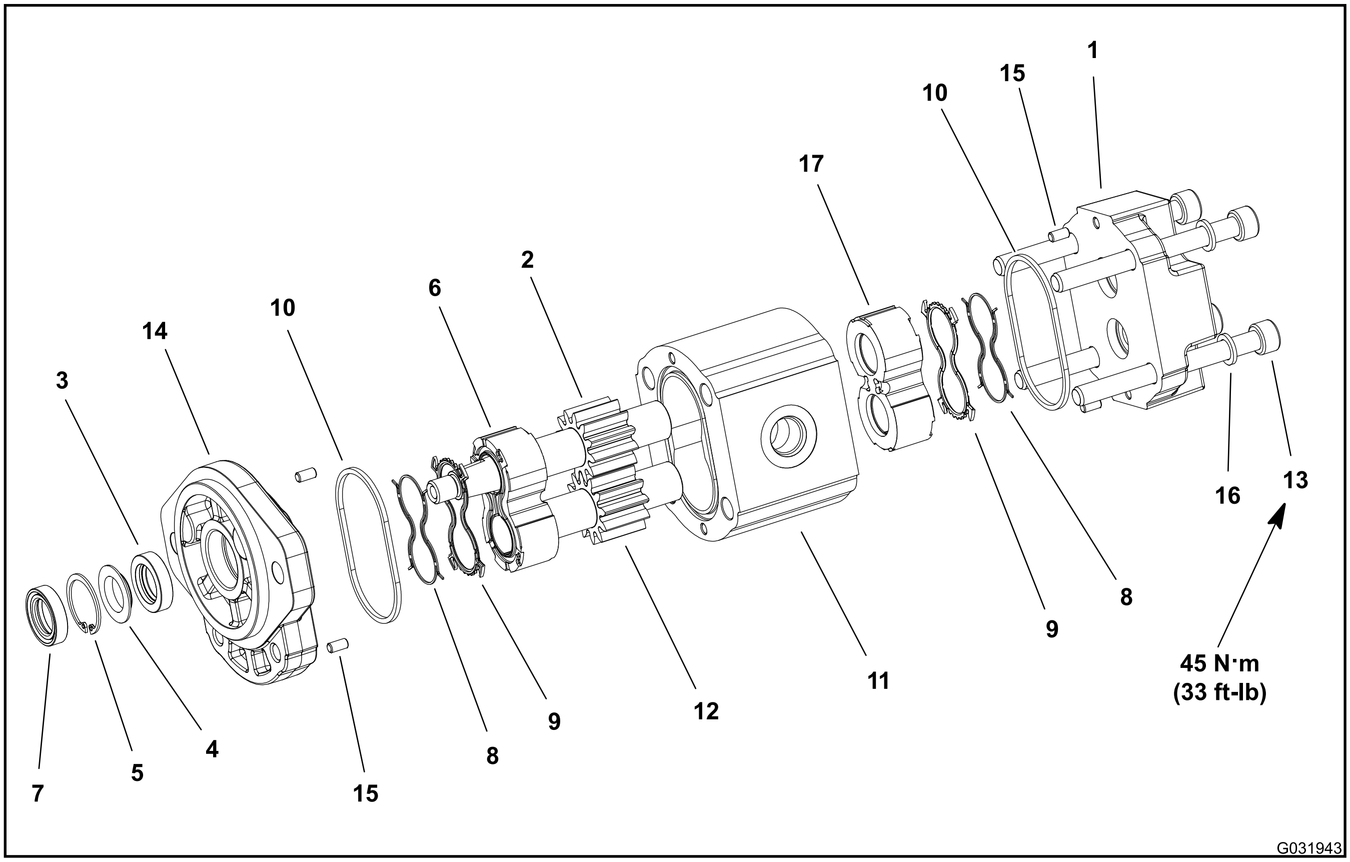
Installing the Engine Cooling Fan Motor (continued)

2. Carefully position the fan motor to the fan motor bracket. Loosely attach the motor to the bracket with the socket-head screws (item 1 in Figure 172) and locknuts (item 11 in Figure 172).
3. Remove the caps or plugs that were installed during the removal process. Connect the hydraulic hoses to the cooling fan motor; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).
4. Tighten the 2 socket-head screws (item 1 in Figure 172) and locknuts (item 11 in Figure 172) to attach the fan motor to the bracket.



5. Clean the tapered surfaces of the fan motor shaft and fan hub. Position the fan hub (with fan attached) onto the motor shaft and attach it with flat washer (item 5 in Figure 172) and hex nut (item 6 in Figure 172). Torque the nut to **37 to 44 N·m (27 to 33 ft-lb)**.
6. Install the air intake box to the top of the radiator assembly; refer to Installing the Air Filter System (page 3–10).
7. Lower the hood and secure it with the latches.
8. Fill the reservoir with the correct quantity of new hydraulic fluid.

Servicing the Engine Cooling Fan Motor



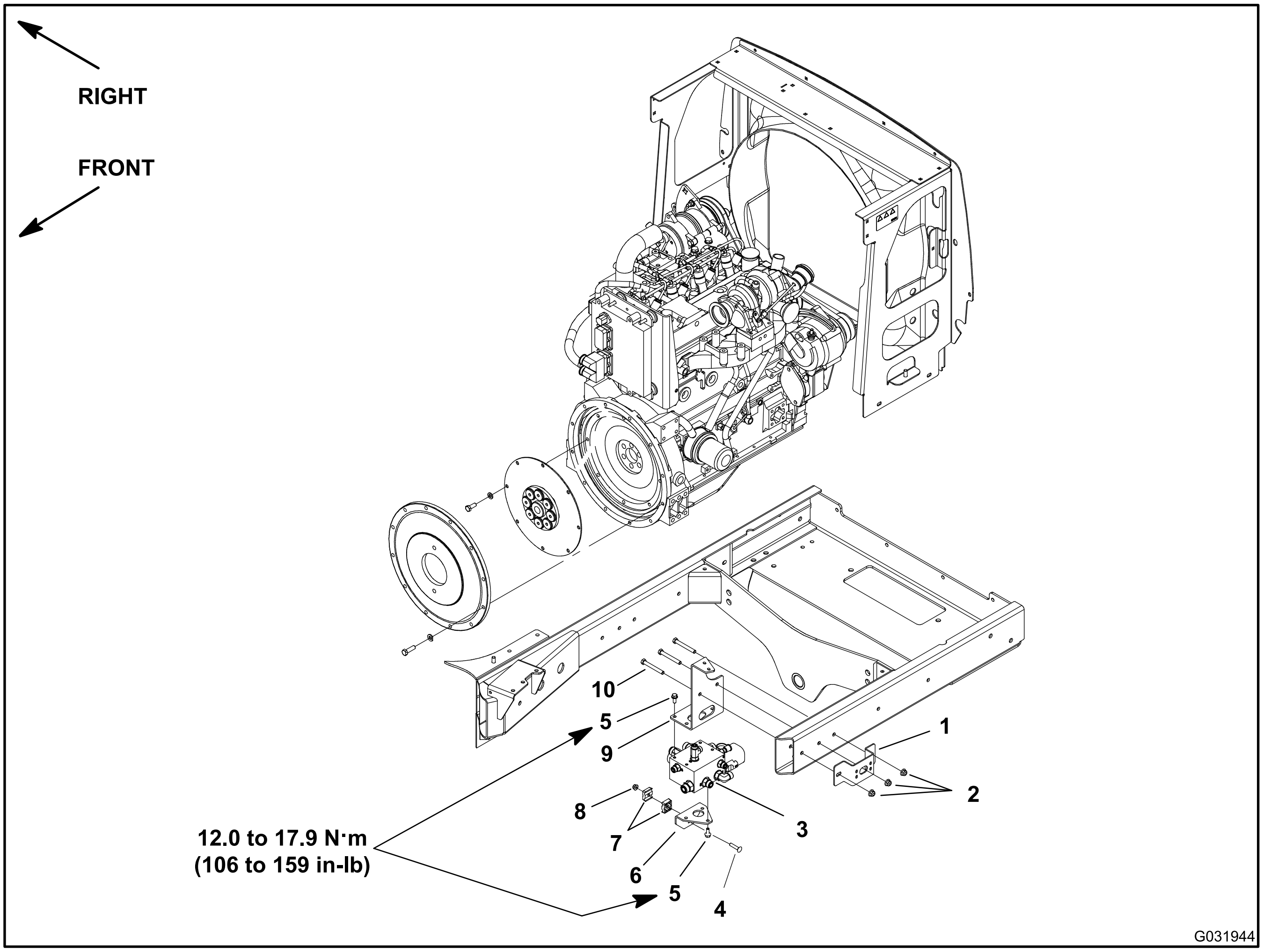
g031943

Figure 173

1. Rear cover
2. Drive gear
3. Shaft seal
4. Flange washer
5. Retaining ring
6. Front wear plate
7. Dust seal
8. Pressure seal
9. Back-up gasket
10. O-ring
11. Body
12. Idler gear
13. Bolt (4 each)
14. Front flange
15. Dowel pin (4 each)
16. Washer (4 each)
17. Rear wear plate

For the disassembly, inspection, and assembly procedures of the cooling fan motor; refer to Servicing the Cutting Deck Motor (page 4–148).

Steering/Engine Cooling Fan Control Manifold



g031944

Figure 174

1. Bulkhead mount plate
2. Flange nut (3 each)
3. Steering/cooling fan manifold
4. Carriage bolt
5. Flange-head screw (7 each)
6. Tube mount plate
7. Tube clamp
8. Flange nut
9. Manifold mount plate
10. Bolt (3 each)

Note: The ports on the steering/cooling fan manifold are marked for easy identification of the components. Example: P is the connection port for the supply from the lift control valve and RV is the relief cartridge valve port; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Removing the Steering/Engine Cooling Fan Control Manifold

1. Read the General Precautions for Removing and Installing the Hydraulic System Components (page 4–95).
2. Raise the hood to get access to the steering/cooling fan control manifold.
3. Clean the exterior of the manifold and fittings before removing the manifold to prevent contaminants from entering into the hydraulic system.
4. For assembly purposes, label the wire harness leads of the manifold solenoids. Disconnect the wire harness connectors from the solenoids on the manifold.

Removing the Steering/Engine Cooling Fan Control Manifold (continued)

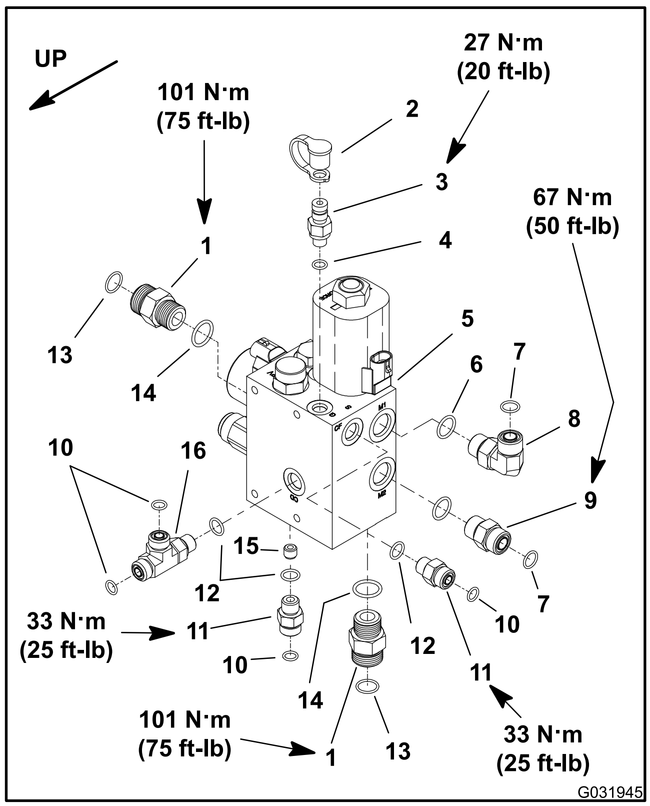
5. Disconnect all the hydraulic lines from the manifold and install caps or plugs on the open hydraulic lines and fittings. Label the disconnected hydraulic lines for proper assembly.
6. Remove the steering/cooling fan manifold from the frame; refer to Figure 174.

IMPORTANT

An orifice is placed below the hydraulic fitting in the control manifold LS port. When removing this fitting from the manifold, ensure that you remove the orifice and label the orifice position for assembly purposes.

7. If you remove the hydraulic fittings from the manifold, put a mark on the fitting orientation for correct assembly.
8. Remove the fittings from the manifold and discard the O-rings.

Installing the Steering/Engine Cooling Fan Control Manifold



g031945

Figure 175

1. Straight fitting (P and CH)
2. Dust cap
3. Quick fitting (G)
4. O-ring
5. Manifold assembly
6. O-ring
7. O-ring
8. 90° fitting (M1)
9. Straight fitting (M2)
10. O-ring
11. Straight fitting (CF and LS)
12. O-ring
13. O-ring
14. O-ring
15. Orifice (LS)
16. Tee fitting (CD)

Installing the Steering/Engine Cooling Fan Control Manifold (continued)

1. If the fittings were removed from the manifold, do the following steps:

   A. Lubricate and install new O-rings with clean hydraulic fluid onto the fittings.

   IMPORTANT

   When installing the orifice in manifold port LS, ensure that the orifice is flat in the base of the port cavity. Letting the orifice stay cocked in the cavity can damage the manifold.

   B. If the fitting was removed from the manifold port LS, install the orifice in the port.

   C. To properly align and install the fittings into the manifold openings, use the marks that you made when they were removed; refer to Figure 175 for the straight fitting installation torque.

   Note: For information on tightening procedures for adjustable fittings; refer to Installing the Hydraulic Fittings (SAE Straight Thread O-Ring Fitting into the Component Port) (page 4–12).

2. Install the steering/cooling fan manifold to the frame; refer to Figure 174. Attach the manifold to the mount plates with the flange-head screws; torque the flange-head screws to **12.0 to 17.9 N·m (106 to 159 in-lb)**.

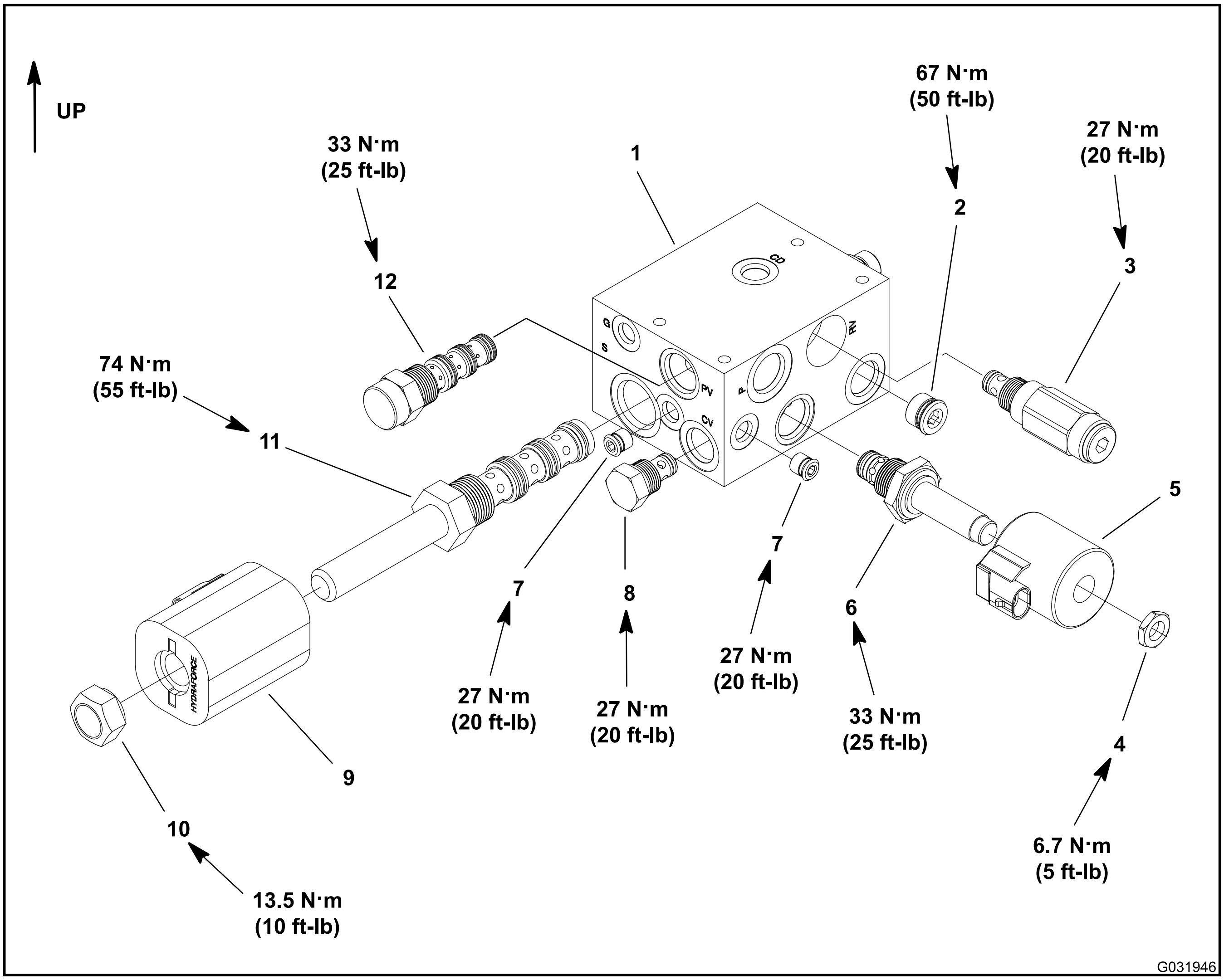
3. Remove the caps and plugs from the fittings and hoses. Correctly connect the hydraulic lines to the manifold; refer to Installing the Hydraulic Hose and Tube (O-Ring Face Seal Fitting) (page 4–10).

4. Use the labels that you attached during removal to correctly connect the wire harness connectors to the solenoids on the manifold.

5. Ensure that the hydraulic tank is full. Add the correct quantity of fluid.

6. Lower the hood and secure it.

Servicing the Steering/Engine Cooling Fan Control Manifold



g031946

Figure 176

1. Steering/cooling fan manifold
2. NWD #8 plug with O-ring
3. Relief valve (RV)
4. Solenoid nut
5. Solenoid coil
6. Proportional relief valve (PRV)
7. NWD #4 plug with O-ring (2 each)
8. Check valve (CV)
9. Solenoid coil
10. Solenoid nut
11. Solenoid valve (S)
12. Compensator valve (PV)

Note: The ports on the steering/cooling fan manifold are marked for easy identification and assembly of the components. Example: P is the connection port for the supply from the lift control valve and RV is the relief cartridge valve port; refer to the Hydraulic Schematic in Chapter 10—Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port.

Servicing the Valve Cartridge

For the cartridge valve service procedures; refer to Servicing the Traction Control Manifold (page 4–133). Refer to Figure 176 for the steering/cooling fan manifold cartridge valve and plug installation torque.

Servicing the Valve Cartridge (continued)

Note: The steering/cooling fan control manifold includes several zero-leak NWD 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 zero-leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow the plug removal with less chance of damage to the socket head of the plug. When installing the plugs; refer to Figure 176 for the plug installation torque.

Chapter 5

Electrical System

Table of Contents

General Information

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

Toro Electronic Controllers (TEC)

The Groundsmaster 5900 and 5910 machines use 2 Toro Electronic Controllers (TEC) to manage the machine electrical functions. The controllers are microprocessor controlled that sense the condition of various switches (inputs) and direct electrical power to control the appropriate machine functions (outputs) based on the inputs. The CAN bus system provides the communication between the 2 Toro controllers, the Cummins engine controller, and the InfoCenter display. The status of inputs to the controllers as well as outputs from the controllers can be monitored with the InfoCenter display.

The controllers appear identical but they are different in terms of the connectors and internal hardware. They are arranged in master/slave configuration and thus you cannot interchange. The TEC-5002 master controller is responsible for powering up both the TEC-5001 slave controller and the Cummins engine controller. The TEC-5002 also controls the engine start circuit.

IMPORTANT

Before performing any welding on the machine, do the following to prevent damaging the electrical system of the machine:

- Disconnect the battery cables from the batteries.
- Disconnect the wire harness connectors from the 2 Toro Electronic Controllers.
- Disconnect the wire harness connectors from the engine controller.
- Disconnect the terminal connector from the alternator.

Cummins Engine Electronic Control Module (ECM)

The Cummins engine that is used in the Groundsmaster 5900 and 5910 uses an electronic control module (ECM) for engine management, that communicates with the TEC controllers and InfoCenter display on the machine. Plug all the engine ECM electrical connectors into the controller before you move the machine key switch from the OFF position to either the RUN or START position. If the engine ECM is to be disconnected for any reason, ensure that the key switch is in the OFF position with the key removed before disconnecting the engine ECM.

CAN-Bus Communications

The 2 TEC controllers (TEC-5001 and TEC-5002), the Cummins engine controller and InfoCenter display used on the Groundsmaster 5900 and 5910 machines communicate with each other on a CAN bus system. This system allows the traction unit to fully integrate all the different electrical components of the tractor and bring them together as one. The CAN bus system reduces the number of electrical components and connections that are used on the machine and allows the number of wires in the wire harness to be significantly reduced. The integration of the electrical functions also allows the InfoCenter display to assist with the electrical system diagnostics.

The CAN identifies the controller area network that is used between the controllers on the machine. The 2 specially designed, twisted cables form the

CAN-Bus Communications (continued)

bus. These wires provide the data pathways between the controllers (TEC-5001, TEC-5002 and the Cummins controller) and InfoCenter display used on the machine. The engineering term for these cables are the CAN High and CAN Low. At the ends of the twisted pair of bus cables are the 120-ohm termination resistors.

The CAN bus link controls each of the components that requires only 4 wires to operate and communicate to the system: CAN High, CAN Low, B+ (power) and ground.

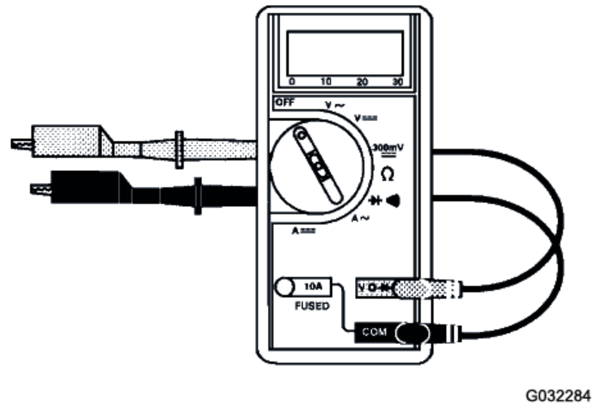
Electrical Drawings

The electrical schematic and wire harness drawings for the Groundsmaster 5900 and 5910 are located in Chapter 10—Foldout Drawings.

Special Tools

You can order these special tools from your Authorized Toro Distributor. Some tools are also available from a local supplier.

Multimeter



g032284

Figure 177

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.

Dielectric Gel

g032129

Figure 178

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

Toro Part No. 107-0342

Battery Terminal Protector

g032130

Figure 179

Use this aerosol spray on the battery 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.

Toro Part No. 107-0392

Battery Hydrometer

g032131

Figure 180

Use the battery hydrometer when measuring the specific gravity of the battery electrolyte. Get this tool locally.

Troubleshooting

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.

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 Chapter 10—Foldout Drawings.

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

Note: Use the InfoCenter display when troubleshooting a Groundsmaster 5900 or 5910 electrical problem.

Starting Problems

Problem	Possible Causes
All the electrical power is dead, including the InfoCenter display.	• The batteries are discharged. • The battery cables are loose or corroded. • The fuse 1F1 (5 A) to the key switch is damaged. • The key switch or circuit wiring is damaged.
The starter solenoid clicks, but the starter does not crank. **Note:** If the starter solenoid clicks, the problem is not in the interlock circuit.	• The batteries are discharged. • The battery cables are loose or corroded. • The ground cable is loose or corroded. • The wiring at the starter motor is damaged. • The starter solenoid or starter motor is damaged.
The engine starts, but stops when the key switch is released from the START position.	• The engine or fuel system is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1).
The engine cranks, but does not start.	• The engine and/or fuel can be too cold. • The fuel tank is empty. • The engine or fuel system is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1). • The hydraulic load is slowing the engine cranking speed.
The engine cranks, but should not, when you press the traction pedal.	• The traction pedal potentiometer is out of adjustment. • The traction pedal potentiometer or circuit wiring is damaged.
Nothing happens when you attempt to start the engine. The InfoCenter display operates with the key switch in the RUN position. **Note:** Use the InfoCenter display to assist with identifying the problem.	• The traction pedal is not in the NEUTRAL position. • The operator seat is unoccupied or the parking brake is not applied. • The PTO switch is engaged. • The traction pedal potentiometer is out of adjustment. • The traction pedal potentiometer or circuit wiring is damaged. • The seat switch or circuit wiring is damaged. • The parking brake switch or circuit wiring is damaged. • The key switch or circuit wiring is damaged. • The start relay or circuit wiring is damaged. • The TEC-5002 fuses (3F1, 3F2, 3F3, 3F4) are damaged. • The maxi fuse #1 is damaged • The controller power relay is damaged. • The wiring to start circuit components is loose, corroded or damaged; refer to Electrical Schematics and Wire Harness Drawings in Chapter 10—Electrical Drawings. • The engine coolant sensor or circuit wiring is damaged. • The hydraulic temperature sender or circuit wiring is damaged. • The starter solenoid or starter motor is damaged. • The engine or fuel system is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1). • The TEC-5002 controller is damaged.

General Run and Transport Problems

Problem	Possible Causes
The engine continues to run, but should not, when the key switch is turned to the OFF position.	• The key switch or circuit wiring is damaged. • The engine or engine controller is malfunctioning; refer to Chapter 3: Diesel Engine (page 3–1). • The TEC-5002 controller is damaged.
The engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	• The seat switch or circuit wiring is damaged. • The traction pedal potentiometer is out of adjustment. • The traction pedal potentiometer or circuit wiring is damaged. • The TEC-5002 controller is damaged.
The engine shuts off during the operation, but it is able to start again. **Note:** If the excessive coolant temperature causes the engine to shutdown, the operator can start the engine by moving the machine to a short distance. After starting the engine in this condition, the engine runs for approximately 10 seconds before it shuts off again.	• The parking brake is engaged. • The operator is raising from the seat (the seat switch not fully pressed). • The seat switch or circuit wiring is damaged. • The key switch or circuit wiring is damaged. • The machine is being operated on a slope with a low fuel level. • The parking brake switch or circuit wiring is damaged.
The engine shuts down when you press the traction pedal.	• The parking brake is set. • The operator is not fully pressing the seat switch. • The seat switch or circuit wiring is damaged. • The parking brake switch or circuit wiring is damaged. • The TEC–5002 controller is damaged.
The batteries do not charge.	• The wiring to the charging circuit components is loose, corroded, or damaged; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings. • The alternator belt is loose or damaged. • The battery cables are loose or corroded. • The 125 A mega fuse is damaged. • The alternator is damaged. • The battery is damaged.

Cutting Deck (PTO) Operating Problems

Problem	Possible Causes
The PTO remains engaged, but should not, with no operator in the seat.	• The seat switch or circuit wiring is damaged. • The TEC–5002 controller is damaged.
The cutting decks run, but should not, when raised. The cutting decks shut off with PTO switch.	• The up limit switch or circuit wiring is damaged. • The TEC–5002 controller is damaged.
The cutting decks run, but should not, when raised. The cutting decks do not shut off with PTO switch.	• Both the up limit switch (or circuit wiring) and PTO switch (or circuit wiring) are damaged. • A hydraulic problem in the PTO circuit exists; refer to the Troubleshooting (page 4–48).
A cutting deck does not operate when lowered with the PTO engaged.	• The up limit switch for affected deck is out of adjustment. • The up limit switch or circuit wiring for affected deck is damaged. • The control manifold solenoid coil S or circuit wiring for affected deck is damaged. • A hydraulic problem in the PTO circuit exists; refer to the Troubleshooting (page 4–48).
None of the cutting decks operate. Cutting decks are able to raise and lower.	• The PTO switch is in the OFF position. • The high temperature of engine coolant or hydraulic fluid has disabled the cutting decks. • The seat switch or circuit wiring is damaged. • The PTO switch or circuit wiring is damaged. • The cutting deck up limit switch or circuit wiring is damaged. • The mow/transport switch or circuit wiring is damaged. • The hydraulic temperature sender or circuit wiring is damaged. • The coolant temperature sender or circuit wiring is damaged. • A hydraulic problem in the PTO circuit exists; refer to the Troubleshooting (page 4–48). • The TEC–5002 controller is damaged.
The cutting decks run, but should not, when lowered with PTO switch in the OFF (disengaged) position.	• The PTO switch or circuit wiring is damaged. • The TEC–5002 controller is damaged.

Cutting Deck Lift/Lower Problems

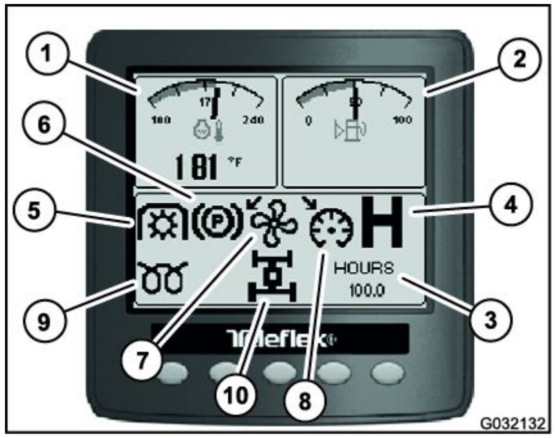
Problem	Possible Causes
None of the cutting decks lowers.	• The mow/transport switch is in the TRANSPORT position. • The operator is not fully pressing the seat switch. • The TEC–5001 fuses (4F1, 4F2, 4F3, 4F4) are damaged. • The seat switch or circuit wiring is damaged. • The mow/transport switch or circuit wiring is damaged. • The lift control manifold solenoid coil S1 or circuit wiring is damaged. • A hydraulic problem in the lift/lower circuit exists; refer to the Troubleshooting (page 4–48). • The TEC–5001 controller is damaged.
None of the cutting units raises.	• The lift control manifold solenoid coil S1 or circuit wiring is damaged. • A hydraulic problem in the lift/lower circuit exists; refer to the Troubleshooting (page 4–48). • The TEC–5001 controller is damaged.
The front cutting deck does not raise or lower, but both the wing cutting decks raise and lower.	• The front deck lift switch or circuit wiring is damaged. • The lift control manifold solenoid coils S5 or S6 or circuit wiring is damaged. A hydraulic problem exists; refer to the Troubleshooting (page 4–48). • The TEC–5001 controller is damaged.
The right wing cutting deck does not raise or lower, but the front and left wing cutting decks raise and lower.	• The right deck lift switch or circuit wiring is damaged. • The lift control manifold solenoid coils S7, S8, or S9 or circuit wiring is damaged. • A hydraulic problem exists; refer to the Troubleshooting (page 4–48). • The TEC–5001 controller is damaged.
The left wing cutting deck does not raise or lower, but the front and right wing cutting decks raise and lower.	• The left deck lift switch or circuit wiring is damaged. • The lift control manifold solenoid coils S2, S3, or S4 or circuit wiring is damaged. • A hydraulic problem exists; refer to the Troubleshooting (page 4–48). • The TEC–5001 controller is damaged.

InfoCenter Display

The machine InfoCenter display is a LCD device that is located on the steering tower. The InfoCenter provides information to the operator during the operation of the machine, provides the electrical system diagnostic assistance for the technicians, and allows inputs for the adjustable machine settings.

The power for the InfoCenter is available when the main power relay is energized (key switch is in the START or RUN position). The fuse 1F3 protects the InfoCenter power circuit. A CAN bus system involving the TEC-5001 controller, TEC-5002 controller, Cummins ECM, and the InfoCenter provides necessary machine communication to the InfoCenter.

Note: The TEC controllers and the InfoCenter display used on the Groundsmaster 5900 and 5910 machines are matched for the correct operation of the machine. If any of these components are replaced for any reason, then system software must be programmed by your Authorized Toro Distributor.



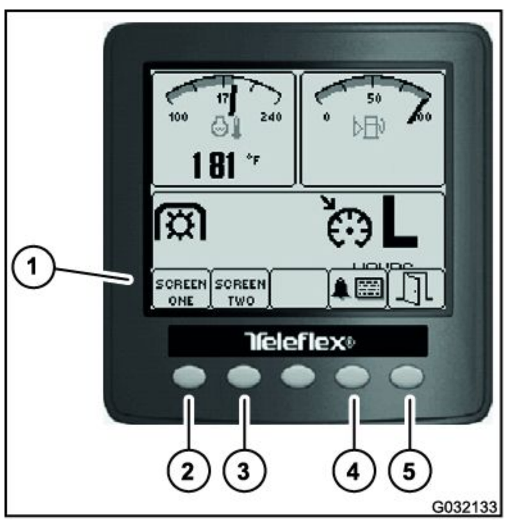
g032132

Figure 181

1. Coolant temperature
2. Fuel level
3. Machine hours
4. Traction speed
5. PTO icon
6. Parking brake icon
7. Cooling fan icon
8. Cruise icon
9. Intake heater icon
10. Traction assist icon

The InfoCenter replaces the traditional gauges by displaying the engine and machine status. This information is displayed on the 2 screens and the operator can select this information.

InfoCenter Screen 1 (Figure 181) is the default screen that is displayed when the key switch is in either the RUN or START position. Screen 1 displays the engine coolant temperature, fuel level, machine hours, and whether the traction speed is in Low or High speed range. The Indicator icons also appear on this screen when the PTO is engaged, when the parking brake is set, when the engine cooling fan rotates in reverse, when the cruise control is engaged, when the air intake heater is energized, and when the traction assist is engaged.



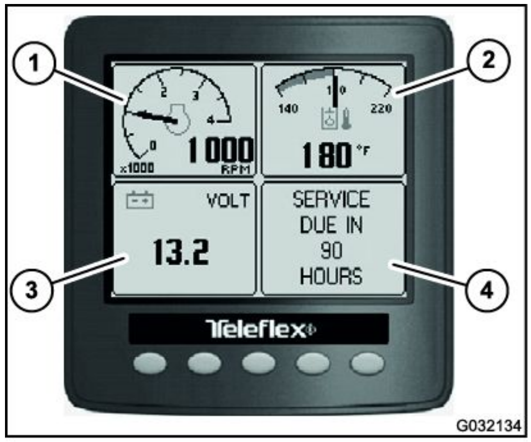
g032133

Figure 182

1. Navigation menu
2. Screen 1 access button
3. Screen 2 access button
4. Fault access button
5. Exit menu button

Operator Information (continued)

You can access the InfoCenter navigation menu (Figure 182) by pressing and releasing any of the left 4 buttons on the display. The navigation menu automatically closes after a short display time or press the button under the opened door to close it.

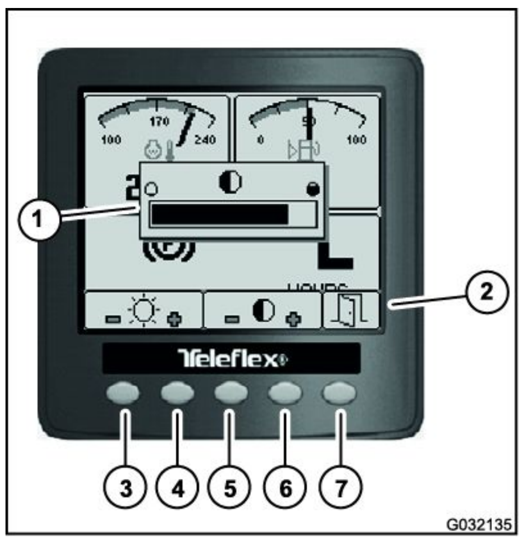


g032134

Figure 183

1. Engine rpm
2. Hydraulic fluid temperature
3. Battery voltage
4. Time until next service

You can view the InfoCenter Screen 2 (Figure 183) by accessing the InfoCenter navigation menu and by pressing the button under the screen 2. The screen 2 displays the engine rpm, hydraulic-fluid temperature, battery voltage, and operating time until the next service.



g032135

Figure 184

1. Indicator bar
2. Menu
3. Brightness - button
4. Brightness + button
5. Contrast - button
6. Contrast + button
7. Exit button

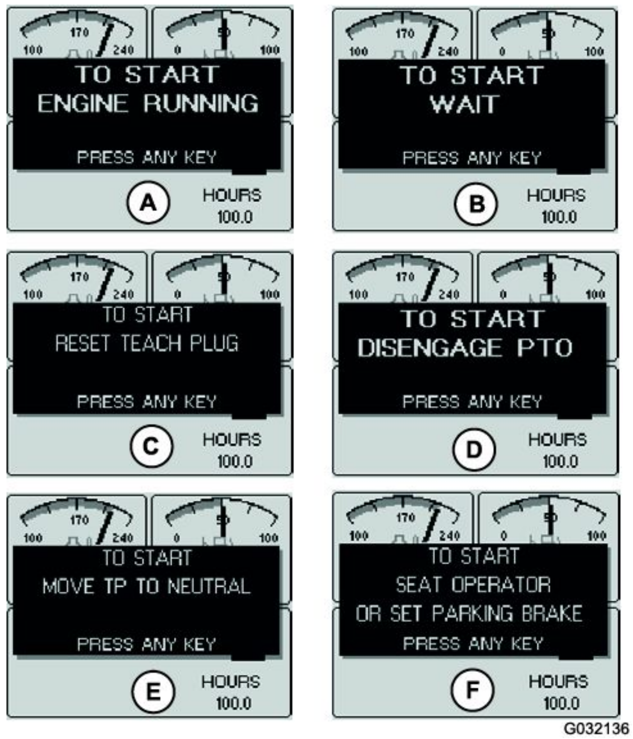
You can access the InfoCenter controls for the brightness and contrast by pressing and releasing the right button on the InfoCenter (Figure 184). Use the display buttons to change the screen image and to exit the control screen.

Operator Advisories

The operator advisories are automatically displayed by the InfoCenter when a machine function requires additional action. For example, if the operator attempts to start the engine when the traction pedal is pressed, an advisory is identified on the InfoCenter display that the traction pedal must be in the NEUTRAL position. An advisory does not log into any fault log.

You can clear the displayed advisories from the display by pressing any of the InfoCenter buttons.

The advisories are available for the following functions:

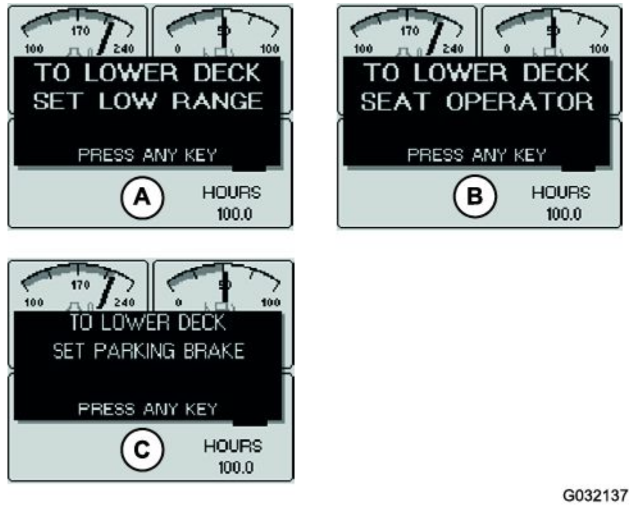


g032136

Figure 185

1. The TO START advisory identifies that the engine starter does not engage after you turn the key switch to the START position; refer to Figure 185.
   A. ENGINE RUNNING: The engine is already running.
   B. WAIT: The engine is signalling wait due to air intake heater is energized.
   C. RESET TEACH PLUG: The traction pedal teach wires are connected.
   D. DISENGAGE PTO: The PTO switch is pulled out (engaged) and you must disengage it before the starter operates.
   E. MOVE TP TO NEUTRAL: The traction pedal is not in the NEUTRAL position.
   F. SEAT OPERATOR OR SET PARKING BRAKE: Ensure that the operator is in the seat or that the parking brake is set to engage the starter.

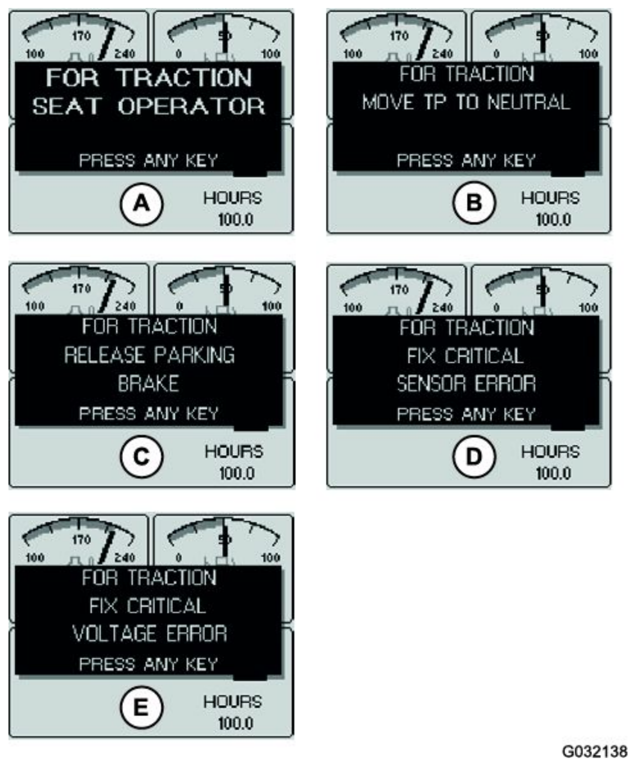
Operator Advisories (continued)



g032137

Figure 186

2. The TO LOWER DECK advisory identifies that the cutting deck does not lower when you press the lower deck switch; refer to Figure 186.
   A. SET LOW RANGE: The machine is set to a high speed range and must be in low speed before the decks lower.
   B. SEAT OPERATOR: The operator must be in the seat to lower the cutting decks.
   C. SET PARKING BRAKE: Set the parking brake to lower the cutting deck.



g032138

Figure 187

3. The FOR TRACTION advisory identifies that the traction drive does not engage when you press the traction pedal; refer to Figure 187.

Operator Advisories (continued)

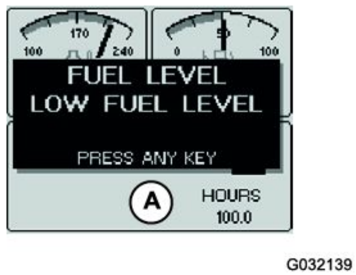
A. SEAT OPERATOR: The operator must be in the seat to press the traction pedal.

B. MOVE TP TO NEUTRAL: The traction pedal is not in the NEUTRAL position.

C. RELEASE PARKING BRAKE: The parking brake is set and you must release the brake before the traction drive engages.

D. FIX CRITICAL SENSOR ERROR: The critical traction pedal sensor error exists.

E. FIX CRITICAL VOLTAGE ERROR: The critical traction pedal voltage error exists.

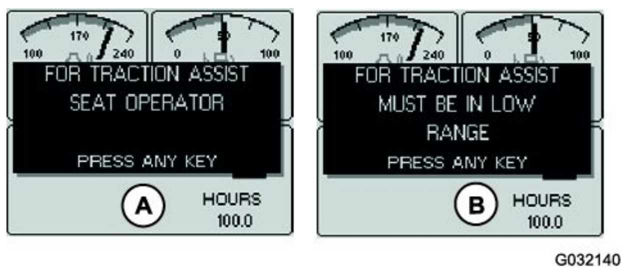


g032139

Figure 188

4. The FUEL LEVEL advisory identifies that the fuel remaining in the tank is low; refer to Figure 188.

   LOW FUEL LEVEL: The fuel left in the fuel tank is less than 5 US gallons.



g032140

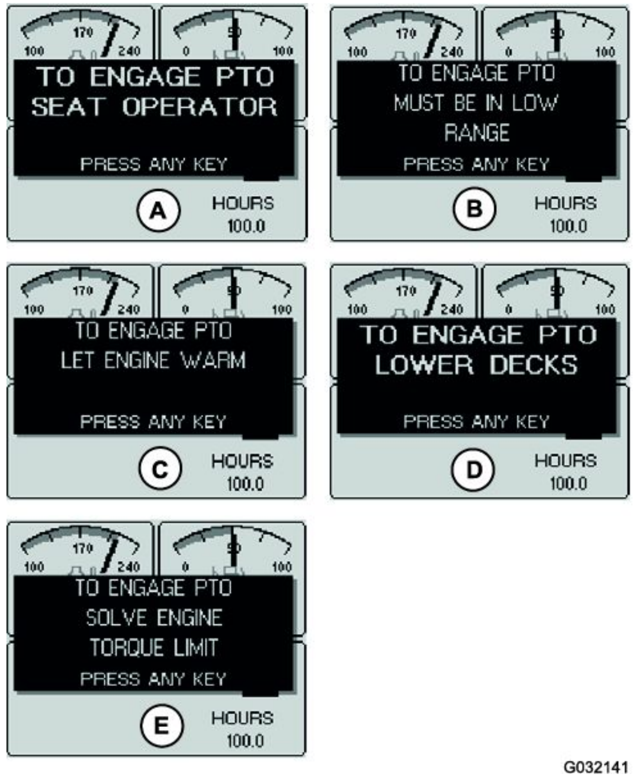
Figure 189

5. The FOR TRACTION ASSIST advisory identifies that the traction assist system does not engage when you press the traction assist switch; refer to Figure 189.

   A. SEAT OPERATOR: The operator must be in the seat to engage the traction assist.

   B. MUST BE IN LOW RANGE: The machine is set to high speed range and must be in low speed to engage the traction assist.

Operator Advisories (continued)



g032141

Figure 190

6. The TO ENGAGE PTO advisory identifies that the PTO does not engage when you pull out the PTO switch; refer to Figure 190.

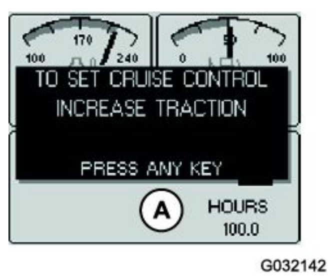
   A. SEAT OPERATOR: The operator must be in the seat to engage the PTO.

   B. MUST BE IN LOW RANGE: The machine is set to high speed range and must be in low speed before the PTO engages.

   C. LET ENGINE WARM: The engine must reach the operating temperature before the PTO engages.

   D. LOWER DECKS: No cutting decks are lowered. You must fully lower at least 1 deck before the PTO engages.

   E. SOLVE ENGINE TORQUE LIMIT: The engine torque is limited.

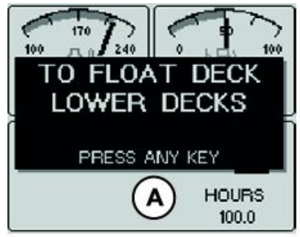


g032142

Figure 191

7. The TO SET CRUISE CONTROL advisory identifies that the cruise control does not engage when you press the cruise control switch; refer to Figure 191.

   INCREASE TRACTION: The forward ground speed is too low to engage the cruise control.



g032143

Figure 192

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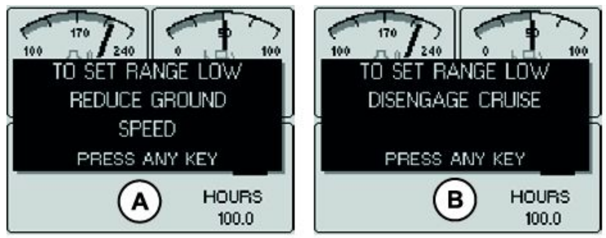
8. The TO FLOAT DECK advisory identifies that the cutting decks are not in the floating mode; refer to Figure 192.

   LOWER DECKS: Press the deck lower switch(es) to fully lower the decks and engage the float position.



g032144

Figure 193

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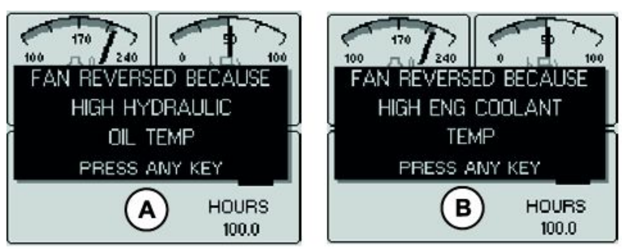
9. The TO SET RANGE LOW advisory identifies that the low speed range does not engage when the high-low speed switch is pressed; refer to Figure 193.

   A. REDUCE GROUND SPEED: The ground speed must be less than 2 mph in order to engage the low speed range.

   B. DISENGAGE CRUISE: The cruise control is engaged and you must disengage in order to engage the low speed range.



g032145

Figure 194

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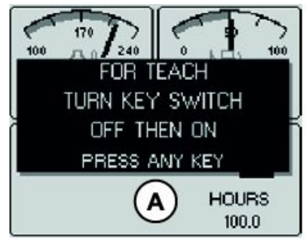
10. The FAN REVERSED BECAUSE advisory identifies that the engine cooling fan rotates in reverse; refer to Figure 194.

    A. HIGH HYDRAULIC FLUID TEMP: The hydraulic fluid temperature above 95°C (203°F) is causing the cooling fan motor to rotate in reverse.

    B. HIGH ENGINE COOLANT TEMP: The engine coolant temperature above 93°C (199°F) is causing the cooling fan motor to rotate in reverse.

Operator Advisories (continued)



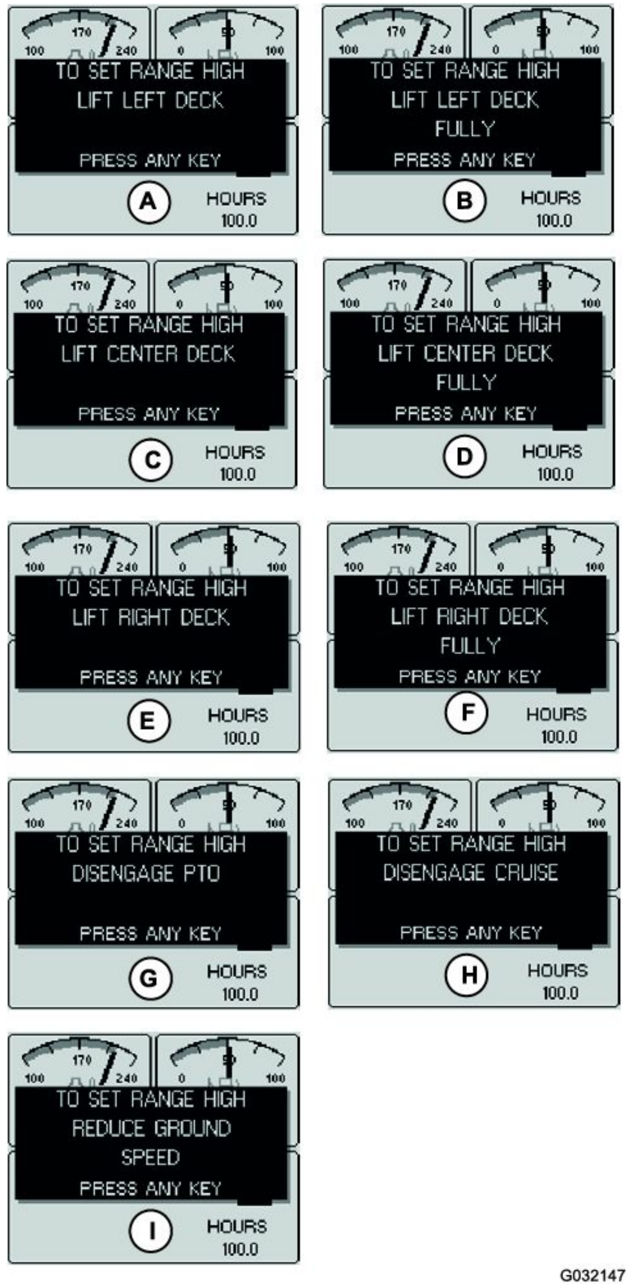
g032146

Figure 195

11. The FOR TEACH advisory identifies that the traction pedal teach function is not accessible; refer to Figure 195.

    TURN KEY SWITCH OFF THEN ON: To access the traction pedal teach function, turn the key switch to the OFF position and then to RUN position.

Operator Advisories (continued)



g032147

Figure 196

12. The TO SET RANGE HIGH advisory identifies that the high speed range does not engage when the high-low speed switch is pressed; refer to Figure 196.
    A. LIFT LEFT DECK: The left cutting deck is lowered and must be raised before the high speed range can be engaged.
    B. LIFT LEFT DECK FULLY: The left cutting deck is lowered below the up limit switch and must be raised before the high speed range can be engaged.
    C. LIFT CENTER DECK: The center (front) cutting deck is lowered and must be raised before the high speed range can be engaged.
    D. LIFT CENTER DECK FULLY: The center (front) cutting deck is lowered below the up limit switch and must be raised before the high speed range can be engaged.

Operator Advisories (continued)

E. LIFT RIGHT DECK: The right cutting deck is lowered and must be raised before the high speed range can be engaged.

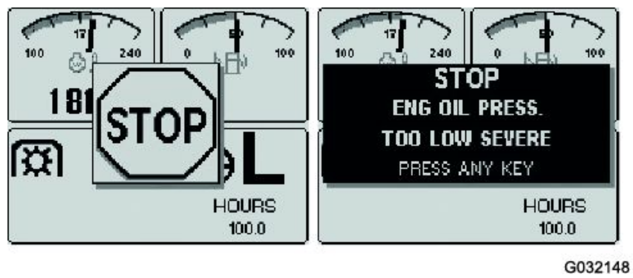
F. LIFT RIGHT DECK FULLY: The right cutting deck is lowered below the up limit switch and must be raised before the high speed range can be engaged.

G. DISENGAGE PTO: The PTO is engaged and must be shut off before the high speed range can be engaged.

H. DISENGAGE CRUISE: The cruise control is engaged and must be shut off before the high speed range can be engaged.

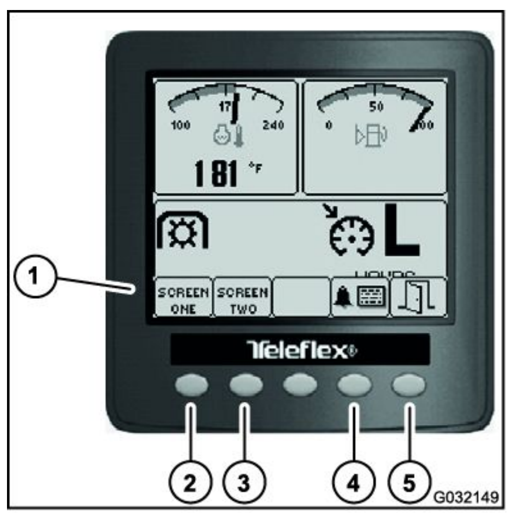
I. REDUCE GROUND SPEED: The ground speed must be less then 2 mph in order to engage the high speed range.

Engine Faults



g032148

Figure 197

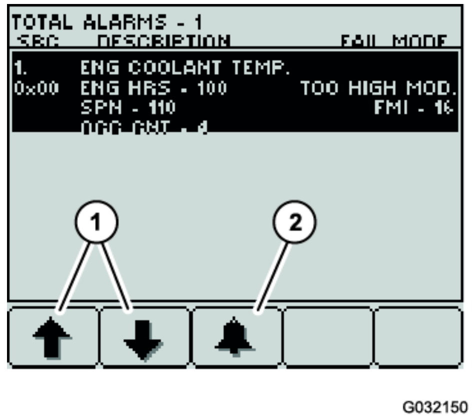


g032149

Figure 198

1. Navigation menu
2. Screen 1 access button
3. Screen 2 access button
4. Fault access button
5. Exit menu button

Engine Faults (continued)



g032150

Figure 199

1. Navigation arrows
2. Alarm icon

The InfoCenter monitors the critical engine electrical functions (e.g., engine oil pressure, engine operating temperature) and alerts the operator if any potential issues occurs. If the Cummins controller identifies an engine electrical fault, the InfoCenter alternately displays a warning icon and provides information about the fault; refer to Figure 197.

If the STOP fault is displayed on the InfoCenter, the operator must stop the machine operation and engine as quickly and as safely as possible to reduce damage to the engine.

If the CHECK ENGINE fault is displayed on the InfoCenter, the operator must take the machine to a service center as early as possible.

In order to clear the displayed fault, the engine problem must be resolved.

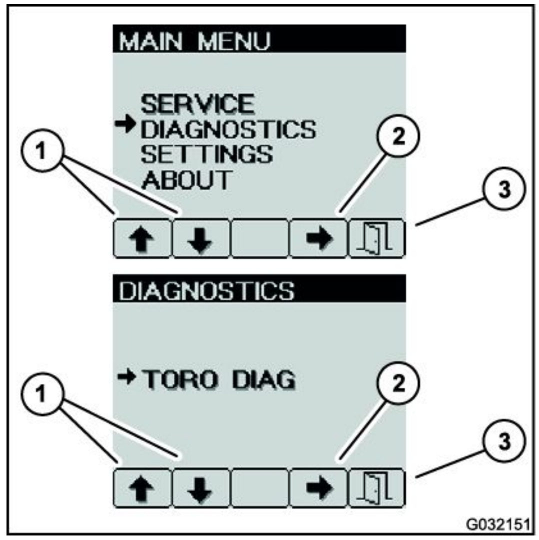
Note: All the engine electrical faults are stored in the Cummins controller and you can use the Cummins diagnostic software to access them.

To access the additional information regarding the displayed fault:

1. Press and hold any of the buttons on the display to access the InfoCenter navigation menu; refer to Figure 198.
2. Press the button under the fault access icon.
3. The fault description is displayed on the InfoCenter; refer to Figure 199. If there are multiple faults, you can use the navigation arrows to view them.
4. Press the button under the alarm icon to exit the fault description screen.

Diagnostics

The InfoCenter DIAGNOSTICS screens you allow to test the TEC controller electrical inputs and outputs. The separate code reader or computer is not necessary to access the information. Use the DIAGNOSTICS screens to identify and troubleshoot the machine electrical functions.



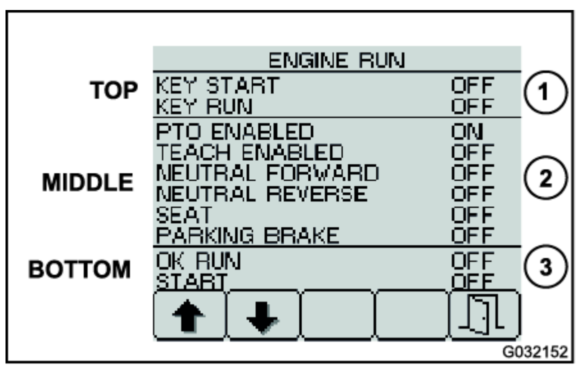
g032151

Figure 200

1. Navigation arrows
2. Enter (accept)
3. Exit from menu

To access the DIAGNOSTICS screen; refer to Figure 200:

- Go to the MAIN MENU screen by pressing and holding the right button on the InfoCenter.
- Use the navigation arrows to choose the DIAGNOSTICS.
- Use the navigation arrows to choose the TORO DIAG.
- Use the navigation arrows to choose the machine function that must be evaluated.



g032152

Figure 201

1. Function inputs
2. Additional inputs
3. Outputs

Each DIAGNOSTICS screen is separated into the 3 areas of information (Figure 201). The top section identifies the controller inputs that are necessary for the function that is being evaluated. The middle section identifies the additional inputs that are involved with the chosen function. The bottom section identifies the TEC outputs.

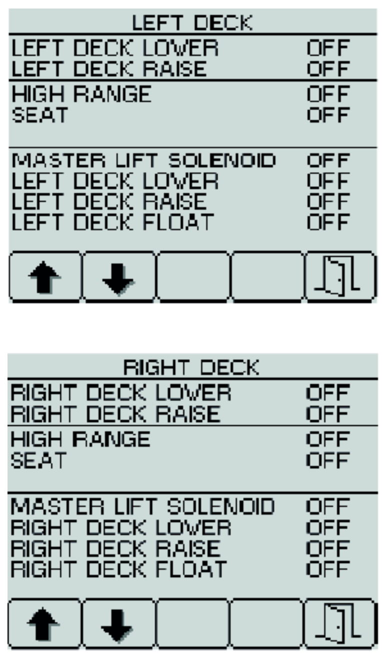
Diagnostics (continued)

For the troubleshooting purposes, use the DIAGNOSTICS screens to identify if a switch and its circuit wiring are functioning correctly. For example, if the ENGINE RUN diagnostic screen is displayed and the key switch is in the RUN position (ON), the PTO switch can be engaged and disengaged while viewing the screen. The PTO ENABLED item must indicate the change in the status of the PTO switch. If there is no change on the screen when the switch changes its state, investigate for a switch or circuit wiring problem.

When the TEC controllers receives the correct inputs, the outputs identified on the DIAGNOSTICS screen must show as ON. If the inputs are correctly positioned and the output remains OFF, a problem with the TEC controller power (circuit wiring or fuse) or controller itself must be suspected.

Note that the DIAGNOSTICS screen can not identify the damaged output component. For example, if the starter solenoid is damaged, the ENGINE RUN screen could show that all the inputs and outputs are correct for the function selected. The controller output occurs but the damaged solenoid prevents the engine from starting.

The DIAGNOSTICS screens are available for the functions listed on the following pages:



G032191

g032191

Figure 202

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1. LEFT DECK and RIGHT DECK controls (Figure 202)

   Note: The cutting decks does not lower when the high speed range is selected. Also, the decks does not raise or lower if the operator is not in the seat while the engine is running.

   To lower the left or right cutting deck, the following inputs must be initiated:

   - The left or right lift/lower switch is pressed to lower (DECK LOWER ON).
   - The high-low speed switch must be in Low (HIGH RANGE OFF).
   - The seat must be occupied (SEAT ON).

   If the proper inputs exist, the following outputs must occur:

Diagnostics (continued)

The left or right deck lower (MASTER LIFT SOLENOID O and DECK LOWER ON).

Once the deck is fully lowered, the following outputs must occur:

The left or right deck in the float mode (DECK FLOAT ON).

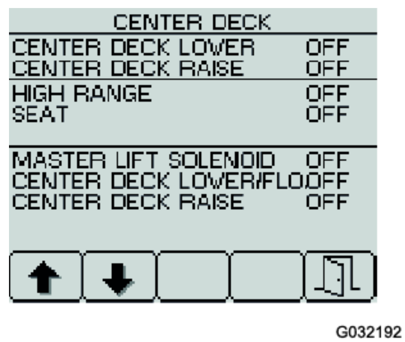
Note: If the deck is already fully lowered when the key switch is moved from the OFF position to RUN position, the deck will not be in float until the deck lift/lower switch is momentarily pressed to lower.

To raise a left or right cutting deck, the following inputs must be initiated:

- The left or right deck lift/lower switch is pressed to raise (DECK RAISE ON).
- The high-low speed switch must be in Low (HIGH RANGE OFF).
- The seat must be occupied (SEAT ON).

If the proper inputs exist, the following outputs must occur:

The left or right deck raise (MASTER LIFT SOLENOID ON and DECK RAISE ON)



g032192

Figure 203

2. CENTER DECK controls (Figure 203)

Note: The cutting decks does not lower when you select the high speed range. Also, the decks do not raise or lower if the operator is not in the seat while the engine is running.

To lower the center (front) cutting deck, the following inputs must be initiated:

- The center deck lift/lower switch is pressed to lower (CENTER DECK LOWER ON).
- The high-low speed switch must be in Low (HIGH RANGE OFF).
- The seat must be occupied (SEAT ON).

If the proper inputs exist, the following outputs must occur:

The center deck lower (CENTER DECK LOWER/FLO ON).

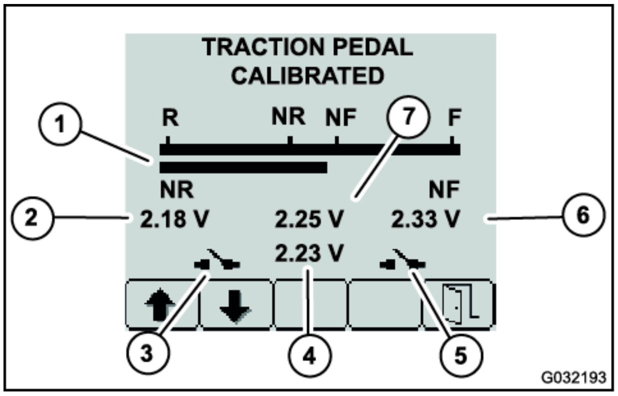
To raise the center (front) cutting deck, the following inputs must be initiated:

- The center deck lift/lower switch is pressed to raise (CENTER DECK RAISE ON).
- The high-low speed switch must be in Low (HIGH RANGE OFF).

If the proper inputs exist, the following outputs must occur:

The center deck raise (MASTER LIFT SOLENOID ON and CENTER DECK RAISE ON).

Diagnostics (continued)



g032193

Figure 204

1. Indicator bar
2. Neutral close/open voltage (reverse)
3. Neutral switch state change voltage (reverse)
4. Voltage for pedal in present position
5. Neutral switch state change voltage (forward)
6. Neutral close/open voltage (forward)
7. Neutral center target voltage

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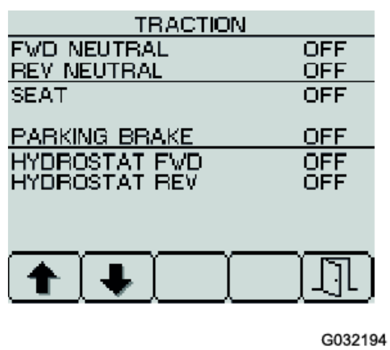
3. TRACTION PEDAL sensor function (Figure 204)

   The traction pedal DIAGNOSTIC screen identifies the state of the traction pedal potentiometer.

   - An indicator bar shows the relative location of the traction pedal range.
   - The voltages for the NEUTRAL position state change.
   - The present state of the forward and reverse neutral switches.



g032194

Figure 205

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4. TRACTION (Figure 205)

   To engage the forward traction, the following inputs must be initiated:

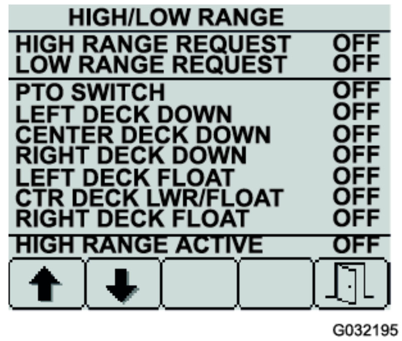
   - The traction pedal is pressed to the forward (FWD NEUTRAL ON and REV NEUTRAL OFF).
   - The seat must be occupied (SEAT ON).
   - Parking brake not set (PARKING BRAKE OFF).

   If the listed inputs exist, the following outputs must occur:

   The forward traction is engaged (HYDROSTAT FORWARD ON).

Diagnostics (continued)

The reverse traction diagnostic inputs and outputs are similar to the forward direction.



g032195

Figure 206

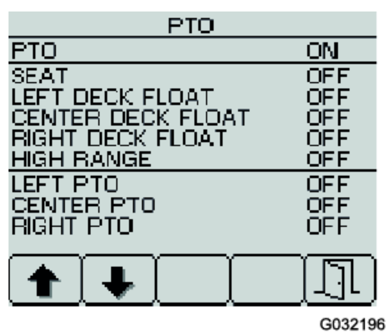
5. HIGH/LOW RANGE (Figure 206)

   To engage the traction high range speed, the following inputs must be initiated:

   - The PTO must be off (PTO SWITCH OFF).
   - All the cutting decks must be raised (All DECK DOWN OFF and all DECK FLOAT OFF).
   - The high-low speed switch is pressed to HI (HIGH RANGE REQUEST ON).

   If the listed inputs exist, the following outputs must occur:

   The high range speed is engaged (HIGH RANGE ACTIVE ON).



g032196

Figure 207

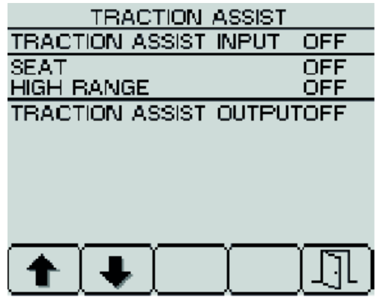
6. PTO (Figure 207)

   To engage the PTO, the following inputs must be initiated:

   - The PTO switch is pulled out (PTO ON).
   - The seat must be occupied (SEAT ON).
   - The cutting deck(s) must be fully lowered into the float position (LEFT, CENTER and/or RIGHT DECK FLOAT ON).
   - The high-low speed switch must be in Low (HIGH RANGE OFF).

   If the proper inputs exist, ensure that the following outputs must occur:

   - The left deck is engaged (LEFT PTO ON).
   - The center deck is engaged (CENTER PTO ON).
   - The right deck is engaged (RIGHT PTO ON).



G032197

g032197

Figure 208

7. TRACTION ASSIST (Figure 208)

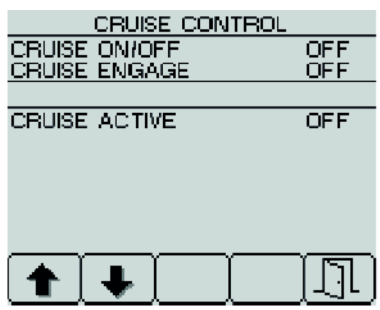
   Note: The traction assist engages when the low speed range is selected and the traction pedal is pressed in the forward direction.

   To engage the forward traction assist, the following inputs must be initiated:

   - The traction assist switch is pressed to engage the traction assist (TRACTION ASSIST INPUT ON).
   - The seat must be occupied (SEAT ON).
   - Ensure that the high-low speed switch must be in Low (HIGH RANGE OFF).

   If the listed inputs exist, the following outputs must occur:

   The traction assist is engaged (TRACTION ASSIST OUTPUT ON).



G032198

g032198

Figure 209

8. CRUISE CONTROL (Figure 209)

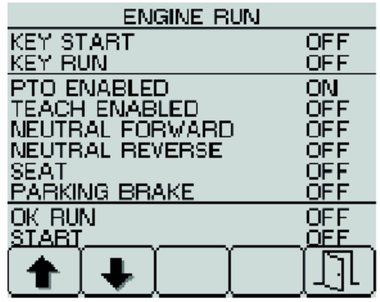
   To engage the cruise control, the following inputs must be initiated:

   - The cruise control switch is in the ON position (CRUISE ON/OFF ON).
   - The cruise control switch is pressed to engage the cruise control (CRUISE ENGAGE ON).

   If the listed inputs exist, the following outputs must occur:

   The cruise control is engaged (CRUISE ACTIVE ON).

Diagnostics (continued)



G032199

g032199

Figure 210

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9. ENGINE RUN (Figure 210)

   When the key switch is in the ON position, the ENGINE RUN diagnostic screen must show:

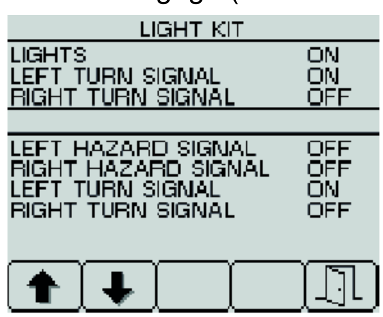
   - KEY RUN input ON
   - OK RUN output ON

   To allow the engine to start, the following inputs must be initiated:

   - The key switch must be turned to START (KEY START and KEY RUN both ON)
   - The PTO is disengaged (PTO ENABLED OFF)
   - The traction pedal is not in TEACH mode (TEACH ENABLED OFF)
   - The traction pedal is in NEUTRAL (NEUTRAL FORWARD and NEUTRAL REVERSE both OFF)
   - The seat is occupied or the parking brake is set (either SEAT ON or PARKING BRAKE ON)

   If the listed inputs exist, the following outputs must occur:

   The engine starter motor must engage (OK RUN and START both ON)



G032200

g032200

Figure 211

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10. LIGHT KIT operation (Figure 211)

    To operate the left hazard light and left turning signals, the following inputs must be initiated:

    - The headlight switch is pressed to turn the lights ON (LIGHTS ON).
    - The left turning signal switch is pressed (LEFT TURN SIGNAL ON).

    If the listed inputs exist, the following outputs must occur:

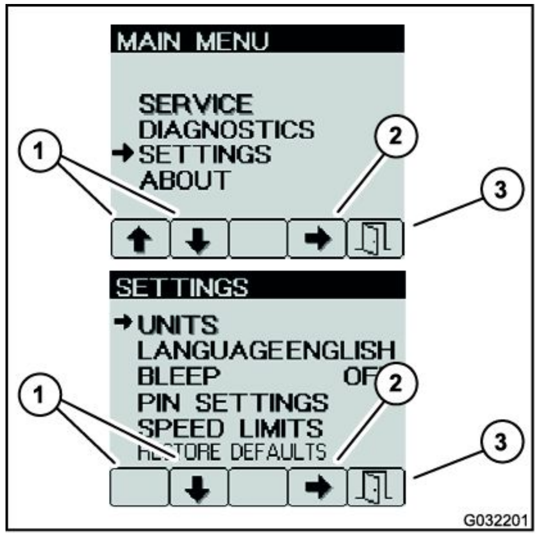
    The left turning signal and hazard lights is ON (LEFT HAZARD SIGNAL and LEFT TURN SIGNAL ON).

Diagnostics (continued)

The right hazard and right turn signal diagnostic inputs and outputs are similar to the left direction.

Administration Settings

The administration SETTINGS screens provide display choices for the InfoCenter display.



g032201

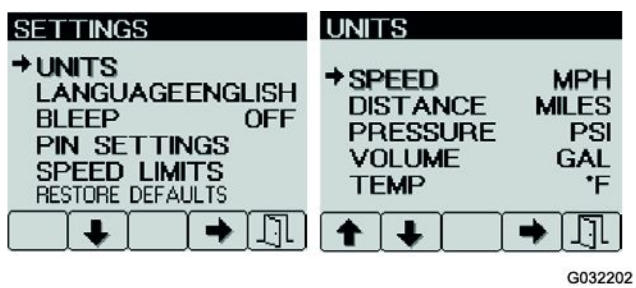
Figure 212

1. Navigation arrows
2. Enter (accept)
3. Exit from menu

To access the administration SETTINGS screen; refer to Figure 212 and do the following:

- Go to the MAIN MENU screen by pressing and holding the right button on the InfoCenter.
- Use the navigation arrows to choose SETTINGS.
- Use the navigation arrows to choose the SETTINGS menu items to view or change.

Choices in SETTINGS are available for the following items:



g032202

Figure 213

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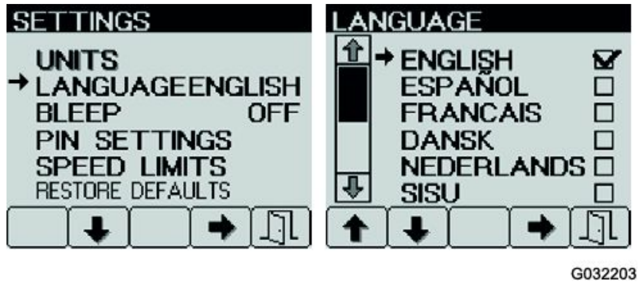
1. UNITS (Figure 213)

   The UNITS settings allow the InfoCenter display to show the speed, distance, pressure, volume, and temperature in U.S. or metric units.

Administration Settings (continued)



g032203

Figure 214

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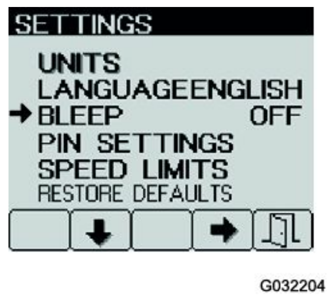
2. LANGUAGE options (Figure 214)

   The LANGUAGE settings allow the InfoCenter display to choose the language. Use the navigation arrows to choose a language and use the enter arrow to accept the chosen language.



g032204

Figure 215

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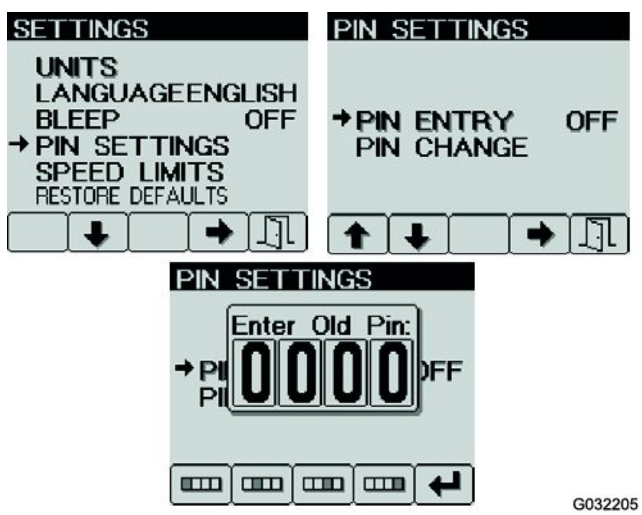
3. BLEEP (Figure 215)

   When the BLEEP is ON, a tone from the InfoCenter sounds whenever a button is pressed on the InfoCenter. When the BLEEP is OFF, the tone does not sound.



g032205

Figure 216

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4. PIN SETTINGS (Figure 216)

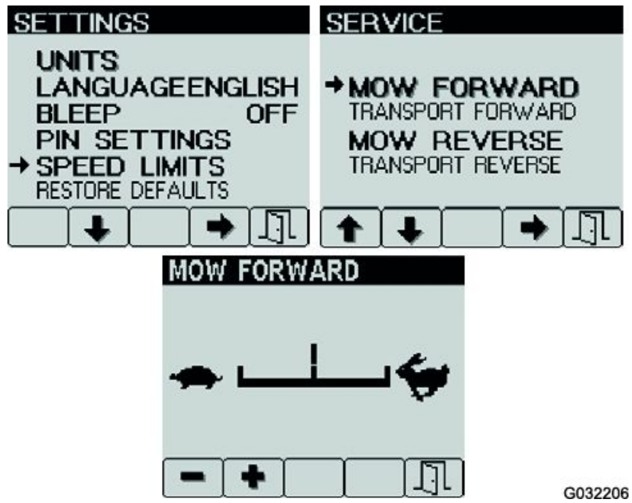
   Using a PIN allows the ability to set a password and protect access to the InfoCenter SETTINGS screens.

Administration Settings (continued)

If a PIN is desired for the InfoCenter access, use the navigation buttons to change the PIN ENTRY to ON.

To enter the PIN, use the navigation buttons to accept the PIN CHANGE. Use the InfoCenter display buttons to enter the desired 4 digit PIN and accept the PIN.

Note: If you choose the PIN (PIN ENTRY ON), ensure that you record the PIN for future use, to access the InfoCenter display. If the PIN reset is necessary (e.g., the If you forgot the PIN), then contact your Authorized Toro Distributor.



g032206

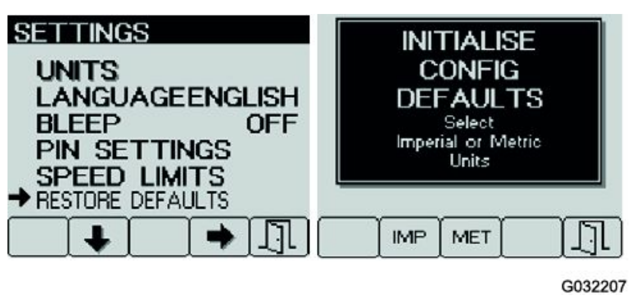
Figure 217

5. SPEED LIMITS (Figure 217)

   Use the SPEED LIMITS settings to adjust the maximum ground speed for the machine and also, speed adjustments are available for the forward and reverse in both the high and low speed range settings.

   Use the navigation button to choose the speed that must be adjusted, an indicator identifies the current speed limit. To change the speed limits press the + or – button under the InfoCenter. After the speed adjustment is done exit the screen.

   Exit the screen after ground speed adjustments are complete.



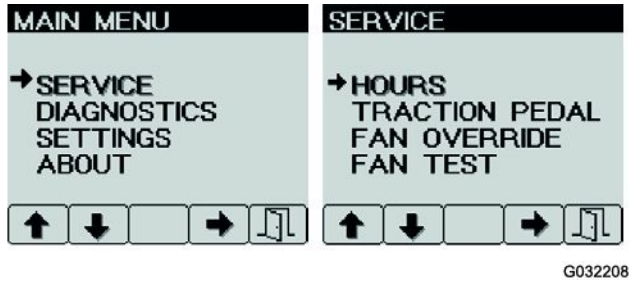
g032207

Figure 218

6. RESTORE DEFAULTS (Figure 218)

   Use the RESTORE DEFAULTS settings to accept the InfoCenter defaults settings.

Administration Service



g032208

Figure 219

To access the administration SERVICE screens; refer to Figure 219.

To access the MAIN MENU screen, press and hold the right button on the InfoCenter.

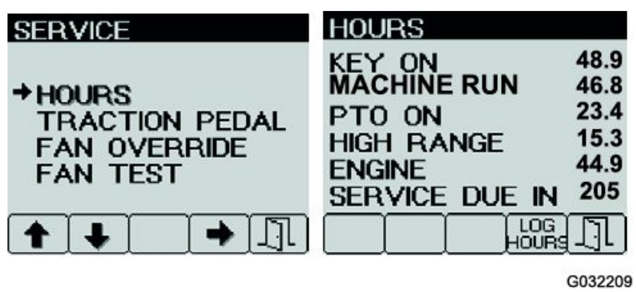
To choose SERVICE, use the buttons under the navigation arrows.

To select the SERVICE, press the button under the enter (right arrow).

To access the administration SERVICE screen; refer to Figure 219 and do the following.

- Go to the MAIN MENU screen by pressing and holding the right button on the InfoCenter.
- Use the navigation arrows to choose SERVICE.
- Use navigation arrows to choose which of the SERVICE items is to view or change.

The SERVICE choices are available for the following items:



g032209

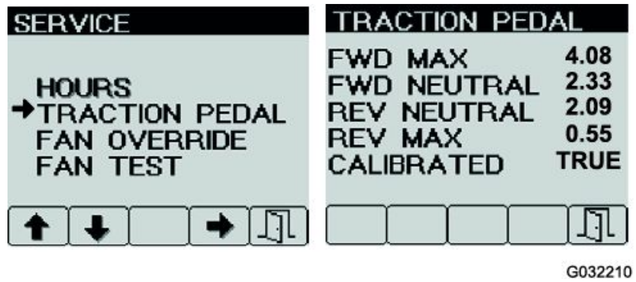
Figure 220

1. HOURS (Figure 220)

   The hours screen identifies the time that the machine is operated in different functions.

   In the HOURS screen, the SERVICE DUE IN function identifies the running time before the next service is necessary and can be reset by pressing the button under RESET HOURS. The interval time can be chosen for the next service and either accepted or cancelled.

Administration Service (continued)

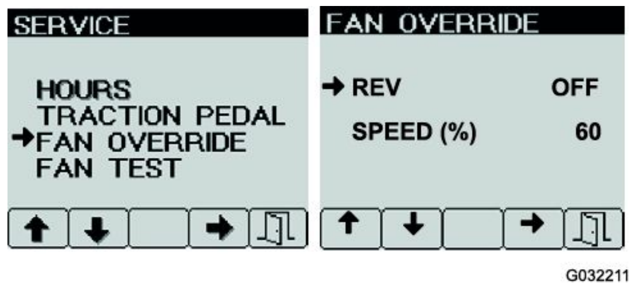


g032210

Figure 221

2. TRACTION PEDAL (Figure 221)

   The traction pedal screen lists the calibration values stored in the TEC-5002 controller for the different pedal positions. This screen also identifies that the traction pedal calibration is completed.



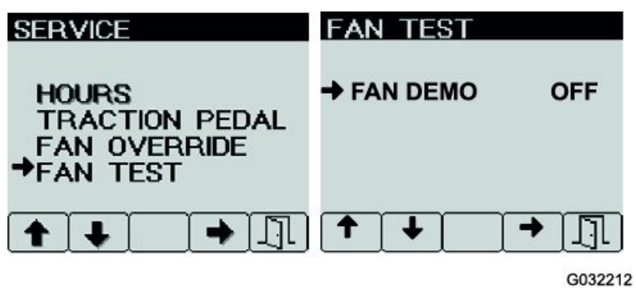
g032211

Figure 222

3. FAN OVERRIDE (Figure 222)

   The fan override screen allows to test the direction and speed of the cooling fan motor if necessary. The engine must run to allow the fan override option to be available.

   Note: Set the parking brake for the fan override to be operational.



g032212

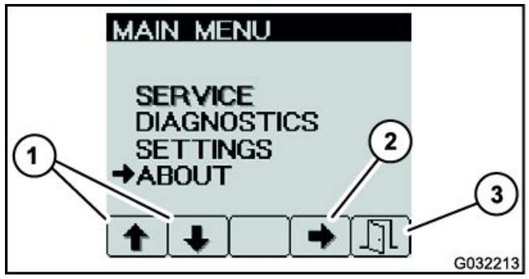
Figure 223

4. FAN TEST (Figure 223)

   The fan test screen gives the opportunity to put the cooling fan motor through a demonstration mode. The fan motor changes the speed and direction when the FAN DEMO is ON. The engine must run for the fan test option to be available.

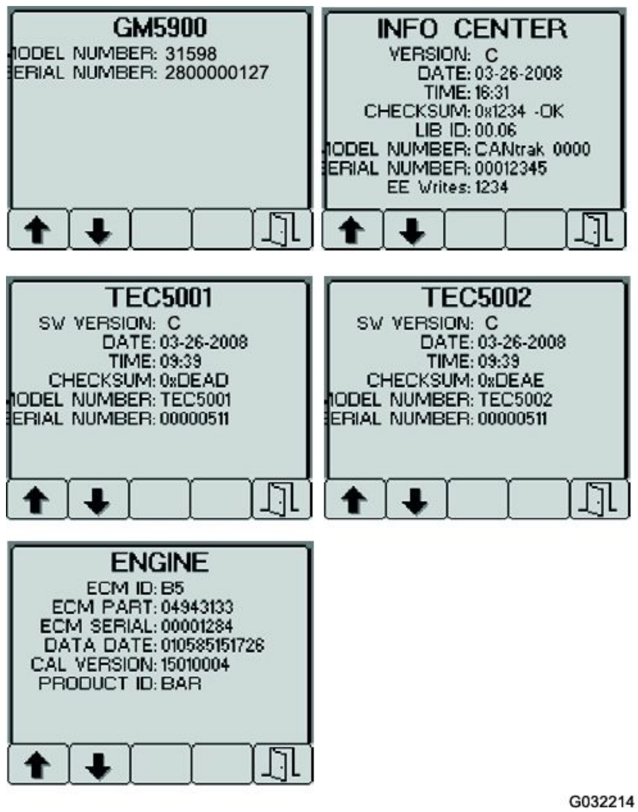
   Note: Set the parking brake for the fan test to be operational.

Administration About



g032213

Figure 224



g032214

Figure 225

The Administration ABOUT screens provide information about the machine, InfoCenter display, 2 Toro controllers, and Cummins engine controller.

To access the administration ABOUT screen; refer to Figure 224.

- Go to the MAIN MENU screen by pressing and holding the right button on the InfoCenter.
- Use the navigation arrows to choose ABOUT.
- Choose and view the Information about the Machine (model and serial number), InfoCenter, TEC-5001, TEC-5002, and Cummins engine controller on the different ABOUT screens (Figure 225). Use the navigation arrows to move between the screens.

Note: The TEC controllers and the InfoCenter display are matched for the correct operation of the machine. If any of these components are replaced for any reason, then system software must be programmed by your Authorized Toro Distributor.

Electrical System Quick Checks

Testing the Battery (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals; refer to Battery Test Table (page 5–39).

Set the multimeter to the DC volts settings. The battery must be at a temperature of 16°C to 38°C (60°F to 100°F). Ensure that the key is in the OFF position and all the accessories are turned off.

Connect the positive (+) meter lead to the positive battery post and negative (-) meter lead to the negative battery post.

Note: This test provides a relative condition of the battery. The load testing of the battery provides additional and more accurate information; refer to Servicing the Battery (page 5–102).

Battery Test Table

Voltage Measured	Battery Charge Level
12.68 V (or higher)	Fully charged (100%)
12.45 V	75% charged
12.24 V	50% charged
12.06 V	25% charged
11.89 V	0% charged

Testing the Charging System

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

Use a digital multimeter to set the DC volts. Connect the positive (+) multimeter lead to the positive battery post and negative (-) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

Note: When starting the engine, the battery voltage drops and then must increase once the engine is running.

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

Start the engine and run it at high-idle speed (3,450 rpm). Allow the battery to charge for a minimum time of 3 minutes. Record the battery voltage.

Note: After running the engine for a minimum time of 3 minutes, the battery voltage must be minimum 0.50 V higher than that of the initial battery voltage.

Refer to Battery Voltage Table (page 5–40) for an example of a charging system that is functioning.

Testing the Charging System (continued)

Battery Voltage Table

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

Checking the Operation of the Interlock Switches

CAUTION

Operating the machine with disconnected safety switches could result in injury to the operator or others and damage to property.

Do not disconnect the 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 interlock switch operation is described in the *Operator's Manual*. Your machine is equipped with 2 Toro Electronic Controllers (TEC) that monitor the interlock switch operation. Information on the TEC is described in the *Operator's Manual* and in .

The interlock system used on your machine includes the seat switch, traction pedal potentiometer, parking brake switch, the cutting deck position switches, mow/transport switch, and PTO switch. Testing of the individual interlock switches is included in .

Note: Use the InfoCenter display to test the Toro Electronic Controller inputs and outputs before further troubleshooting of an electrical problem on your machine.

Testing the Component

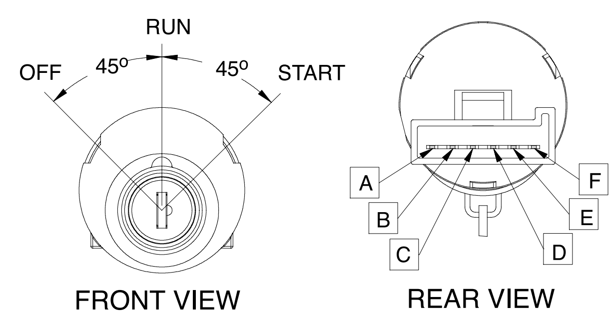
For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g., unplug the wire harness connector from the key switch before doing a continuity check of the switch).

IMPORTANT

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

Key Switch

SERIAL NUMBER BELOW 313000300



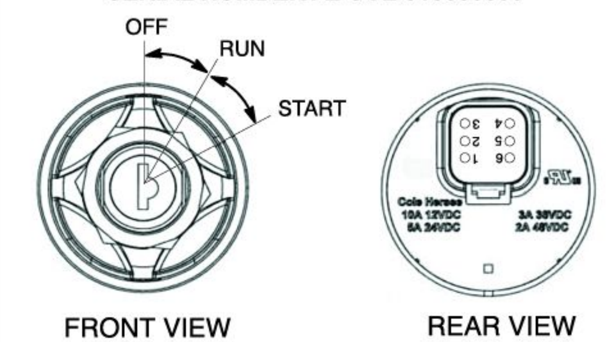
POSITION	CIRCUITS
OFF	NONE
RUN	B + C + F, D + E
START	A + B + C

G035233

g035233

Figure 226

SERIAL NUMBER ABOVE 313000300



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

G035234

g035234

Figure 227

The key switch has 3 positions (OFF, RUN, and START). The key switch is located on the console arm; refer to Figure 226.

Testing the Key Switch

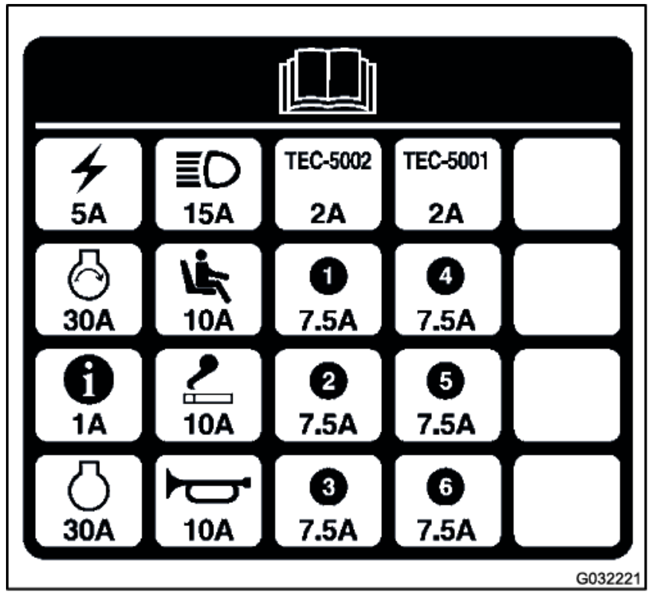
1. Before you disconnect the key switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the key switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the key switch and circuit wiring are not functioning correctly, then test the key switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Disassemble the console arm to get access to the key switch; refer to Disassembling the Console Arm (page 7–20).
6. The key switch terminals and circuit logic are shown in Figure 226 and Figure 227. With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the key switch if the testing identifies a damaged switch.
7. Connect the wire harness connector to the switch after testing.
8. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
9. Assemble the console arm cover; refer to Assembling the Console Arm (page 7–21).

   Note: On the machines with serial number above 313000300 (Figure 227), the key switch terminals 1 and 6 are connected internally. The terminals 4 and 5 are also connected internally. These terminals should have continuity regardless of switch position.

Fuses

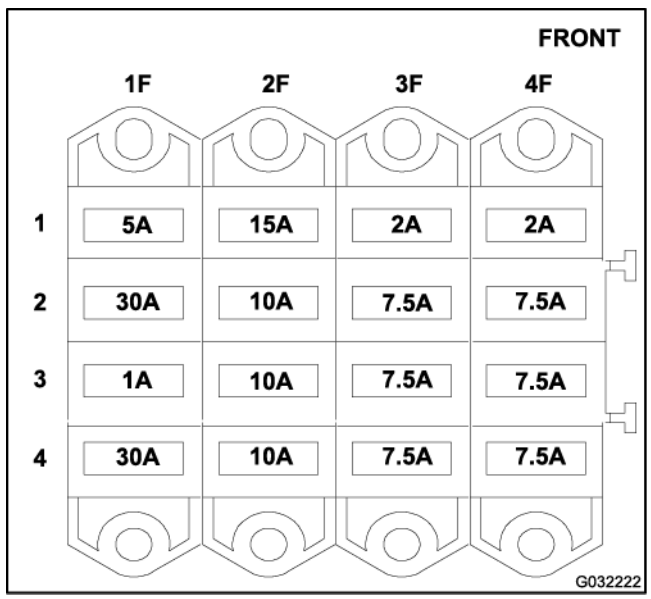
The fuse blocks are located to the right of the operator seat under the power center console.

Identification and Function



g032221

Figure 228



g032222

Figure 229

The fuse 1F1 (5 A) supplies power to the key switch terminal B.

The fuse 1F2 (30 A) supplies power to the starter solenoid circuit.

The fuse 1F3 (1 A) supplies power to the InfoCenter display.

The fuse 1F4 (30 A) supplies power to the Cummins engine controller.

The fuse 2F1 (15 A) supplies power to the road and brake light circuits.

Identification and Function (continued)

The fuse 2F2 (10 A) supplies power to the air ride seat suspension seat compressor.

The fuse 2F3 (10 A) supplies power to the power point.

The fuse 2F4 (10 A) supplies power to the horn circuit.

The fuse 3F1 (2 A) supplies logic power for the TEC-5002 master controller.

The fuse 3F2 (7.5 A) supplies power to the TEC-5002 master controller.

The fuse 3F3 (7.5 A) supplies power to the TEC-5002 master controller.

The fuse 3F4 (7.5 A) supplies power to the TEC-5002 master controller.

The fuse 4F1 (2 A) supplies logic power for the TEC-5001 slave controller.

The fuse 4F2 (7.5 A) supplies power to the TEC-5001 slave controller.

The fuse 4F3 (7.5 A) supplies power to the TEC-5001 slave controller.

The fuse 4F4 (7.5 A) supplies power to the TEC-5001 slave controller.

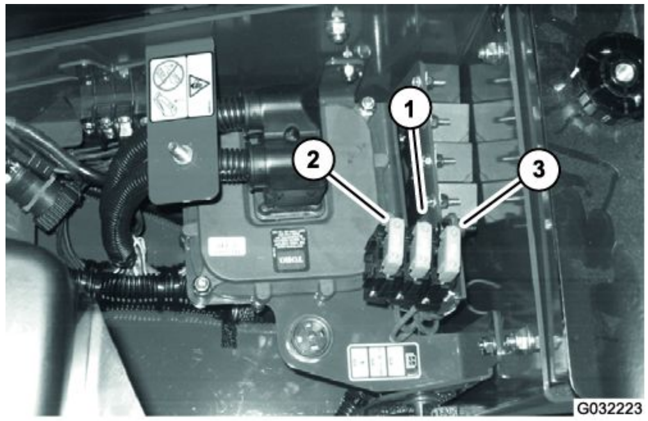
Testing the Fuse

Note: Ensure that the key switch is in the OFF position and the key is removed from the key switch.

1. Remove the power center cover from the operator platform to access the fuses.
2. Remove the fuse from the fuse block for testing.

   Note: Ensure that the fuse is having continuity across the terminals.
3. After you complete the fuse test, install and attach the power center cover.

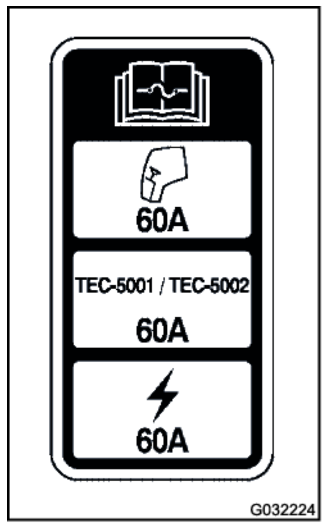
Maxi Fuses



g032223

Figure 230

1. Maxi fuse #1
2. Maxi fuse #2
3. Maxi fuse #3



g032224

Figure 231

Three 60 A maxi fuses are used on the machine for protection of the main electrical circuits. The maxi fuse block is located to the right of the operator seat under the power center console; refer to Figure 230.

Identification and Function

The maxi fuse #1 protects the controller power circuit.

The maxi fuse #2 protects the main power circuit.

The maxi fuse #3 protects the cab power circuit.

Testing the Maxi Fuses

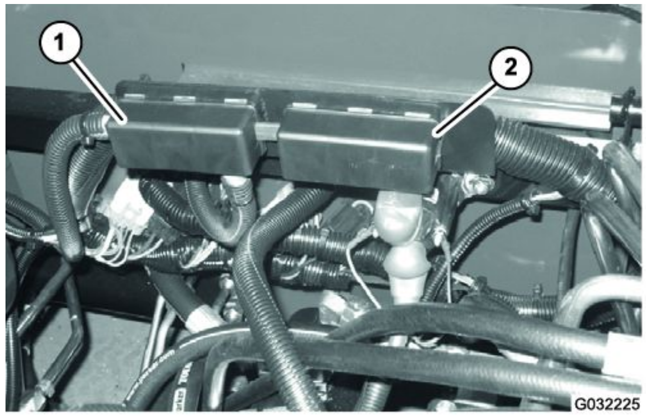
1. Ensure that the key switch is in the OFF position and the key is removed from the switch.
2. Remove the power center cover from the operator platform to access the maxi fuses.
3. Remove the fuse from the fuse block for testing.

   Note: Ensure that the fuses are having continuity across the terminals.

Testing the Maxi Fuses (continued)

4. After you complete the fuse test, install and attach the power center cover.

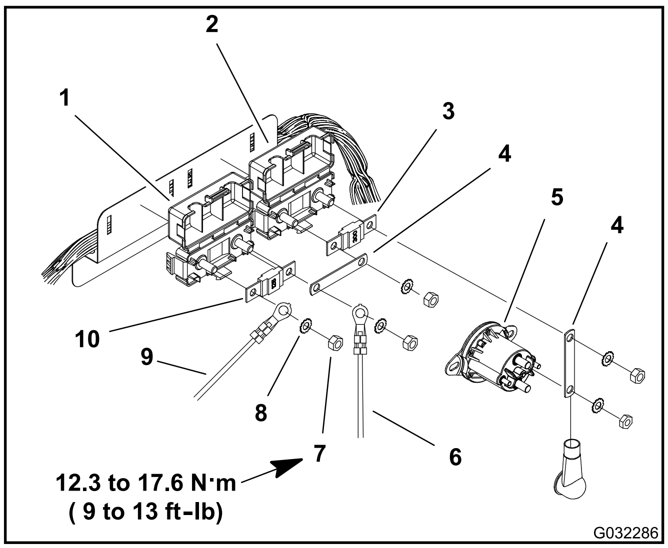
Mega Fuses



g032225

Figure 232

1. Alternator mega fuse
2. Intake heater mega fuse



g032286

Figure 233

1. Alternator fuse holder
2. Heater fuse holder
3. 300 A mega fuse
4. Jumper strap
5. Contactor
6. Battery cable
7. Flange nut
8. Lock washer
9. Alternator cable
10. 125 A mega fuse

Two mega fuses are used on the machine for protection of the high-amperage circuits. One of the mega fuses is a 125 A fuse and protects the alternator circuit. The other mega fuse is a 300 A fuse that is a component in the intake air heater circuit. The mega fuse blocks are attached to a hood support frame behind the batteries; refer to Figure 232.

Testing the Mega Fuses

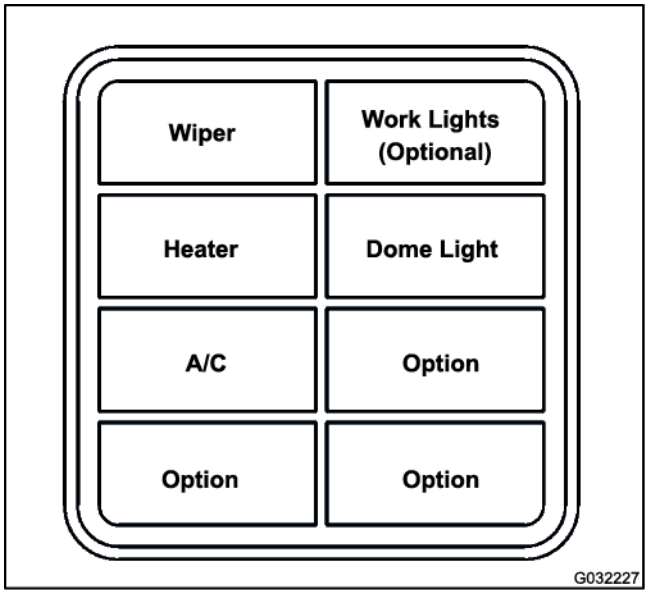
1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.

Testing the Mega Fuses (continued)

2. Disconnect the battery cables from the battery terminals; refer to Servicing the Battery (page 5–102).
3. Lift the hood to get access to the fuse holders.
4. Press the latch that keeps the fuse holder cover and lift the cover.
5. Remove the flange nuts and lock washers that attach the fuse to the holder; refer to Figure 233.
6. Remove the fuse for testing.

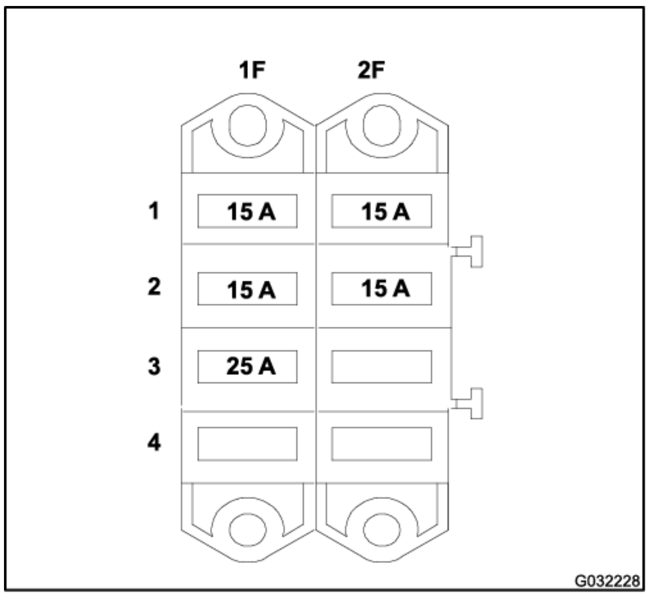
   Note: Ensure that the fuse is having continuity across the terminals.
7. After you complete the test, slide the fuse onto the fuse holder studs. Place the cables and jumper straps that were removed onto the studs.
8. Attach the fuse and conductors with the lock washers and flange nuts; torque the nuts to **12.3 to 17.6 N·m (9 to 13 ft-lb)**.
9. Close and attach the fuse holder cover.
10. Lower the hood and secure it.
11. Connect the battery cables to the battery terminals; refer to Servicing the Battery (page 5–102).

Cab Fuses (Groundsmaster 5910 Machine Only)



g032227

Figure 234



g032228

Figure 235

The cab fuse blocks are located in the cab headliner.

Identification and Function

The fuse 1F1 (15 A) supplies power to the windshield wiper.

The fuse 1F2 (15 A) supplies power to the heater circuit.

The fuse 1F3 (25 A) supplies power to the air conditioner circuit.

The fuse 2F1 (15 A) supplies power to the optional cab work lights.

The fuse 2F2 (15 A) supplies power to the cab dome light.

The fuses 1F4, 2F3, and 2F4 are available for optional equipment.

Testing the Cab Fuses

Ensure that the key switch is in the OFF position and the key is removed from the key switch, and remove the fuse from the fuse block for testing.

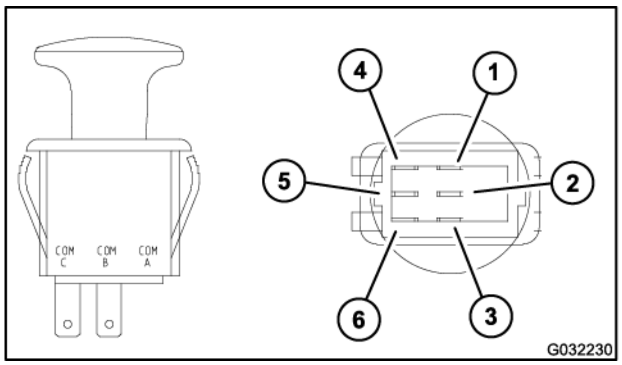
Note: Ensure that the fuse is having continuity across the fuse terminals.

PTO Switch

g032229

Figure 236

1. Console arm
2. PTO switch



g032230

Figure 237

The PTO switch is located on the console arm; refer to Figure 236. Pull up the PTO switch to engage the PTO (cutting decks or implement).

The TEC-5002 controller monitors the position of the PTO switch (up or down). Using the inputs from the PTO switch and other switches in the interlock system, the TEC controller controls the energizing of the hydraulic solenoid valves to drive the cutting deck motors.

IMPORTANT

During the operation of the machine, if the PTO shuts down and the InfoCenter indicates the excessive engine coolant temperature, avoid shutting off the engine. Under this condition, disengage the PTO, slowly drive to a safe flat area, lower the engine speed to the SLOW position, and set the parking brake. Allow the engine to be idle for several minutes while it cools to a safe level, and check the cooling system before returning the machine to service.

Testing the PTO Switch

1. Before you disconnect the PTO switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).

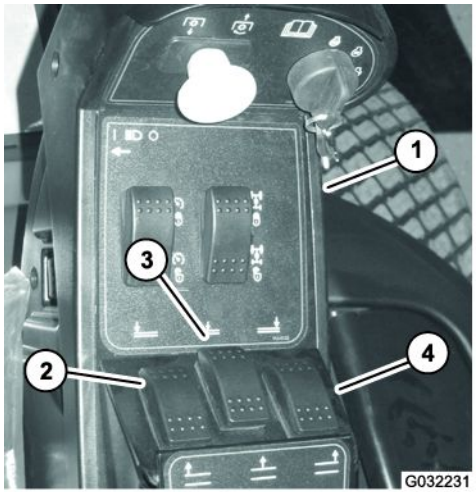
Testing the PTO Switch (continued)

2. If the diagnostic display verifies that the PTO switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the PTO switch and circuit wiring are not functioning correctly, then test the PTO switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Disassemble the console arm to get access to the PTO switch; refer to Disassembling the Console Arm (page 7–20).
6. The switch terminals are marked as in Figure 237. The circuit logic of the PTO switch is in the Circuit Logic Table (page 5–51). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.
7. Connect the wire harness connector to the switch after testing.
8. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Wiring Schematic and Circuit Drawings in Chapter 10—Foldout Drawings.
9. Assemble the console arm cover; refer to Assembling the Console Arm (page 7–21).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
OFF (DOWN)	COM B + NC B COM C + NC C	COM B + NO B COM C + NO C
ON (UP)	COM B + NO B COM C + NO C	COM B + NC B COM C + NC C

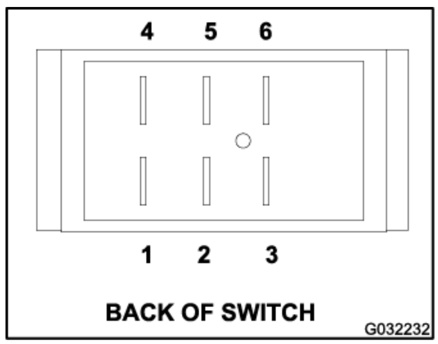
Cutting Deck Lift Switches



g032231

Figure 238

1. Console arm
2. Left lift switch
3. Front lift switch
4. Right lift switch



g032232

Figure 239

The cutting deck lift switches are used as inputs for the TEC-5001 controller to raise or lower the cutting decks. When you press and hold the front of a lift switch, the controlled deck (left, front, or right) lowers. When you press and hold the rear of a lift switch, the controlled deck raises. The deck stays in the position when you release the switch. The lift switches are located on the console arm; refer to Figure 238.

Testing the Cutting Deck Lift Switches

1. Before you disconnect the cutting deck lift switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the lift switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the lift switch and circuit wiring are not functioning correctly, then test the lift switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Disassemble the console arm to get access to the cutting deck lift switches; refer to Disassembling the Console Arm (page 7–20).

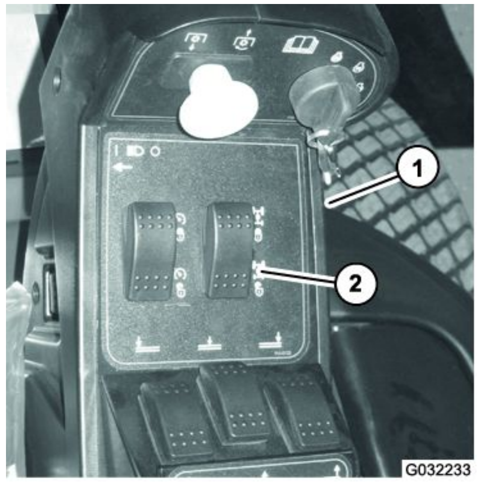
Testing the Cutting Deck Lift Switches (continued)

6. The switch terminals are marked as in Figure 239. The circuit logic of the lift switches is in the Circuit Logic Table (page 5–53). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.
7. Connect the wire harness connector to the switch after testing.
8. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
9. Assemble the console arm cover; refer to Assembling the Console Arm (page 7–21).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
DECK RAISE	2+3 5+6	2+1 5+4
NEUTRAL	None	All
DECK LOWER	2+1 5+4	2+3 5+6

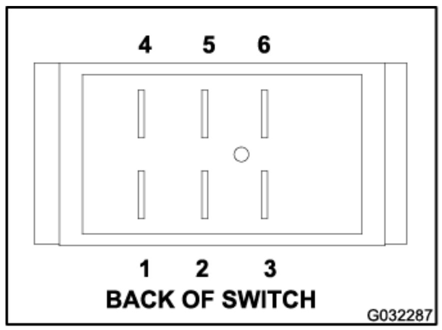
Traction Assist Switch



g032233

Figure 240

1. Console arm
2. Traction assist switch



g032287

Figure 241

The traction-assist switch is used as an input for the TEC-5001 controller to energize the solenoid valve in the traction-control manifold. When you press the traction-assist switch, the hydraulic flow splits equally between the front and rear wheels to enhance the traction. The traction-assist switch functions only when the machine is in the low-speed range and in the forward direction. The traction-assist switch is located on the console arm; refer to Figure 240.

Testing the Traction Assist Switch

1. Before you disconnect the traction assist switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the traction-assist switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the traction-assist switch and circuit wiring are not functioning correctly, then test the traction-assist switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Disassemble the console arm to get access to the traction-assist switch; refer to Disassembling the Console Arm (page 7–20).
6. The switch terminals are marked as in Figure 241. The circuit logic of the traction-assist switch is in the Circuit Logic Table (page 5–55). With the use of a multimeter (ohms setting), test the switch functions to determine if the

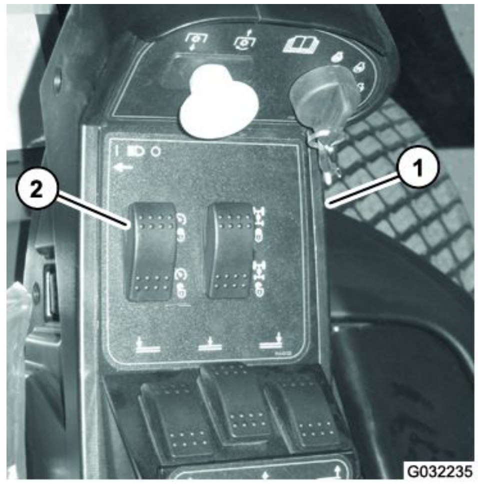
continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.

7. Connect the wire harness connector to the switch after testing.
8. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
9. Assemble the console arm cover; refer to Assembling the Console Arm (page 7–21).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
NORMAL	2+3 5+6	2+1 5+4
TRACTION ASSIST	2+1 5+4	2+3 5+6

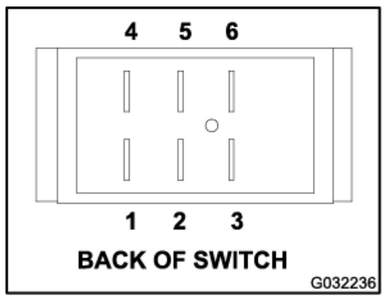
Cruise Control Switch



g032235

Figure 242

1. Console arm
2. Cruise control switch



g032236

Figure 243

The cruise control switch is used as an input for the TEC-5002 controller to maintain the ground speed. The cruise control function engages (set) when you press the front of the cruise control switch. The cruise control function disengages when you press the rear of the cruise control switch. The cruise control switch is located on the console arm; refer to Figure 242.

Note: The cruise function also disengages when you press the brake pedal or when you press the traction pedal to the reverse direction.

Testing the Cruise Control Switch

1. Before you disconnect the cruise control switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the cruise control switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the cruise control switch and circuit wiring are not functioning correctly, then test the cruise control switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Disassemble the console arm to get access to the cruise control switch; refer to Disassembling the Console Arm (page 7–20).
6. The switch terminals are marked as in Figure 243. The circuit logic of the cruise control switch is in the Circuit Logic Table (page 5–57). With the use of a multimeter (ohms setting), test the switch functions to determine if the

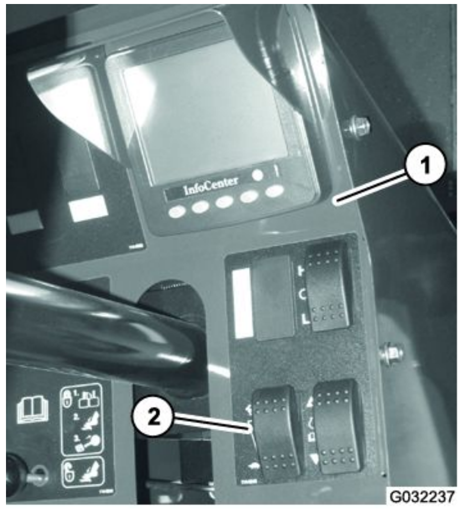
continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.

7. Connect the wire harness connector to the switch after testing.
8. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
9. Assemble the console arm cover; refer to Assembling the Console Arm (page 7–21).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
NORMAL	2+3	5+6
CRUISE ENGAGE	2+3 5+6	None
CRUISE DISENGAGE	None	All

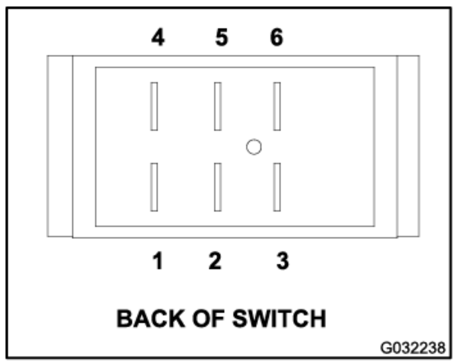
Throttle Control Switch



g032237

Figure 244

1. Steering tower
2. Throttle control switch



g032238

Figure 245

The throttle control switch is used as an input for the engine control module to adjust the engine speed to 1 of 3 rpm settings: low idle (1,350 rpm), mid idle (2,400 rpm), or high idle (2,750 rpm). The throttle control switch is located on the steering tower; refer to Figure 244.

Testing the Throttle Control Switch

1. Before you disconnect the throttle control switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the throttle control switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the throttle control switch and circuit wiring are not functioning correctly, then test the throttle control switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Remove the front steering tower cover; refer to Disassembling the Steering Tower (page 7–4).
6. Locate the throttle control switch and disconnect the wire harness connector from the switch.

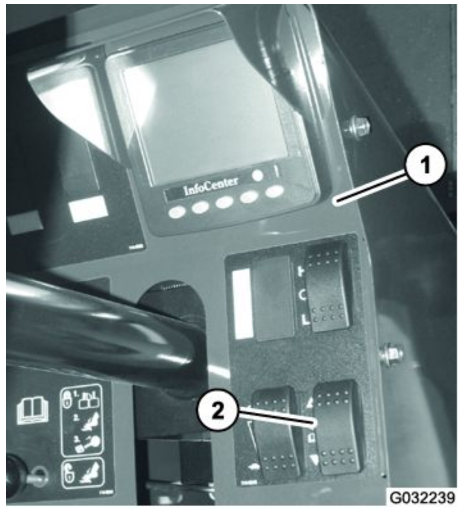
Testing the Throttle Control Switch (continued)

7. The switch terminals are marked as in Figure 245. The circuit logic of the throttle control switch is in the Circuit Logic Table (page 5–59). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.
8. Connect the wire harness connector to the switch after testing.
9. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
10. Install the front steering tower cover; refer to Assembling the Steering Tower (page 7–4).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
Low idle	2+1 5+4	2+3 5+6
Mid idle	2+3 5+4	2+1 5+6
High idle	2+3 5+6	2+1 5+4

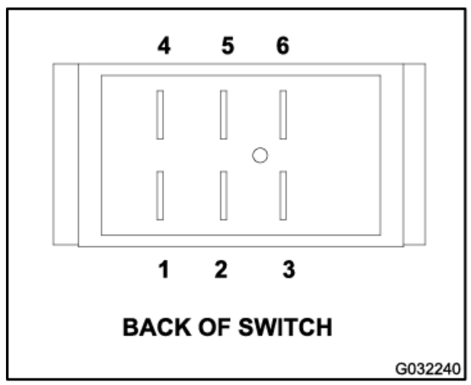
Increment/Decrement Switch



g032239

Figure 246

1. Steering tower
2. Increment/decrement switch



g032240

Figure 247

The increment/decrement switch is used as an input for the engine control module to raise or lower the engine speed in small amounts. When you press and hold the switch in the forward position, the engine speed increases. Conversely, when you press the rear of the switch, the engine speed decreases. The increment/decrement switch is located on the steering tower; refer to Figure 246.

Testing the Increment/Decrement Switch

1. Before you disconnect the increment/decrement switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the increment/decrement switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the increment/decrement switch and circuit wiring are not functioning correctly, then test the increment/decrement switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.

Testing the Increment/Decrement Switch (continued)

5. Remove the front steering tower cover; refer to Disassembling the Steering Tower (page 7–4).

6. Locate the increment/decrement switch and disconnect the wire harness connector from the switch.

7. The switch terminals are marked as in Figure 247. The circuit logic of the increment/decrement switch is in the Circuit Logic Table (page 5–61). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.

8. Connect the wire harness connector to the switch after testing.

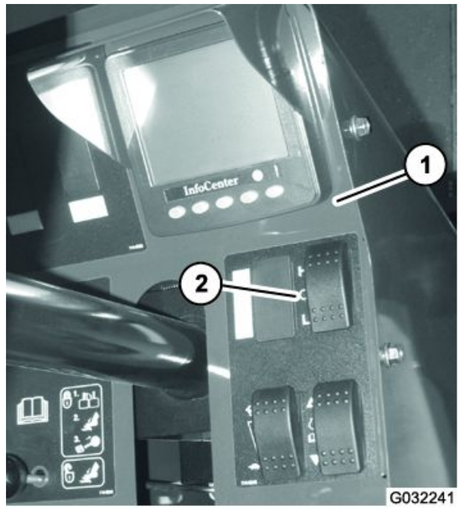
9. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.

10. Install the front steering tower cover; refer to Assembling the Steering Tower (page 7–4).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
SPEED INCREASE	2+3 5+6	2+1 5+4
NEUTRAL	None	All
SPEED DECREASE	2+1 5+4	2+3 5+6

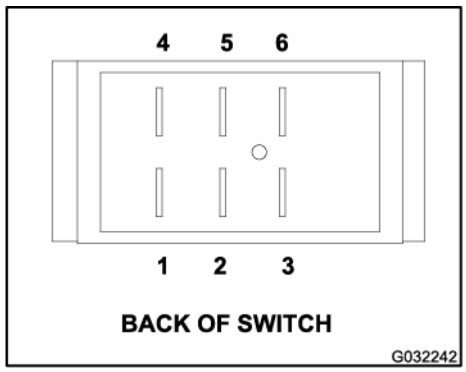
High-Low Speed Switch



g032241

Figure 248

1. Steering tower
2. High-Low speed switch



g032242

Figure 249

The high-low speed switch is used as an input for the TEC-5001 controller to set the machine traction speed for high-speed range (transport) or low-speed range (mow). To change the speed range settings with the speed switch, stop the machine or move it very slowly. The high-low speed switch is located on the steering tower; refer to Figure 248.

Testing the High-Low Speed Switch

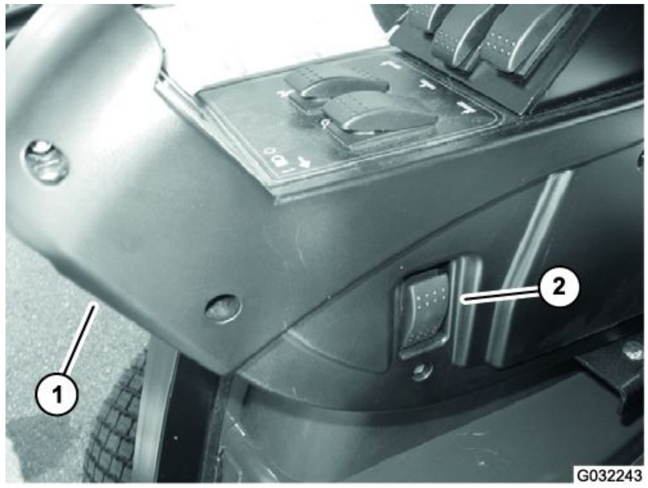
1. Before you disconnect the mow/transport switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the mow/transport switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the mow/transport switch and circuit wiring are not functioning correctly, then test the mow/transport switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch
5. Remove the front steering tower cover; refer to Disassembling the Steering Tower (page 7–4).

6. Locate the mow/transport switch and disconnect the wire harness connector from the switch.
7. The switch terminals are marked as in Figure 249. The circuit logic of the mow/transport switch is in the Circuit Logic Table (page 5–63). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.
8. Connect the wire harness connector to the switch after testing.
9. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
10. Install the front steering tower cover; refer to Assembling the Steering Tower (page 7–4).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
Mow speed	2+3 5+6	2+1 5+4
Neutral	None	All
Transport speed	2+1 5+4	2+3 5+6

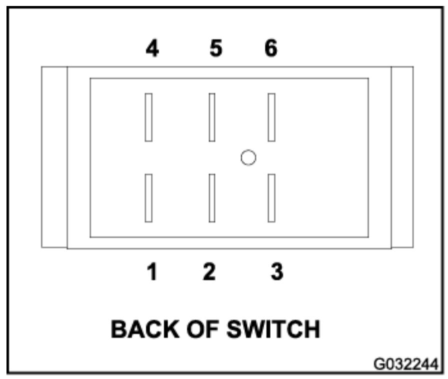
Headlight Switch



g032243

Figure 250

1. Console arm
2. Headlight switch



g032244

Figure 251

The headlight switch is used as an input for the TEC-5002 controller to provide power for the headlights and taillights. The headlight switch is located on the operator side of the control console; refer to Figure 250.

Testing the Headlight Switch

1. Before you disconnect the headlight switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the headlight switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the headlight switch and circuit wiring are not functioning correctly, then test the headlight switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Remove the inside control arm cover to get access to the headlight switch; refer to Disassembling the Console Arm (page 7–20).
6. Locate the headlight switch and disconnect the wire harness connector from the switch.
7. The switch terminals are marked as in Figure 251. The circuit logic of the headlight switch is in the Circuit Logic Table (page 5–65). With the use of

Testing the Headlight Switch (continued)

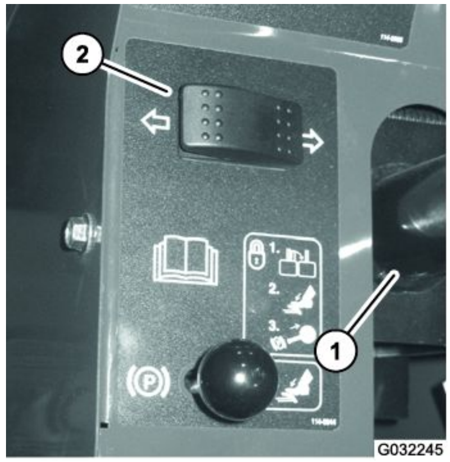
a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.

8. Connect the wire harness connector to the switch after testing.
9. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
10. Install the inside control arm cover; refer to Assembling the Console Arm (page 7–21).

Circuit Logic Table

Switch Position	Normal Circuits	Other Circuits
OFF	2+3	5+6
ON	2+1	5+4

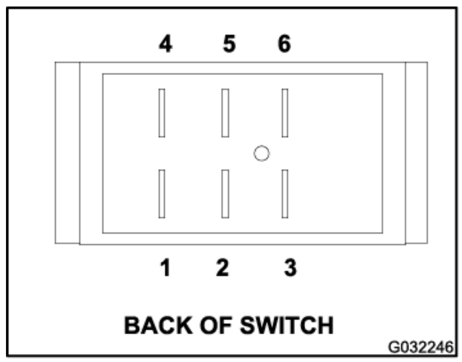
Turn Signal Switch



g032245

Figure 252

1. Steering column
2. Turn signal switch



g032246

Figure 253

The turn signal switch is used as an input for the TEC-5002 controller to provide power for the turn signals. The switch is located on the steering tower; refer to Figure 252.

Testing the Turn Signal Switch

1. Before you disconnect the turn signal switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the turn signal switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the turn signal switch and circuit wiring are not functioning correctly, then test the turn signal switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Remove the front steering tower cover; refer to Disassembling the Steering Tower (page 7–4).
6. Locate the turn signal switch and disconnect the wire harness connector from the switch.
7. The switch terminals are marked as in Figure 253. The circuit logic of the turn signal switch is in the Circuit Logic Table (page 5–67). With the use of a multimeter (ohms setting), test the switch functions to determine if the

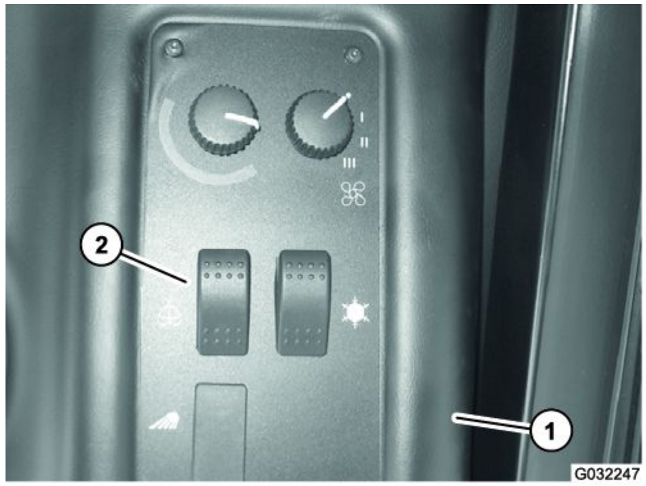
continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.

8. Connect the wire harness connector to the switch after testing.
9. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
10. Install the front steering tower cover; refer to Assembling the Steering Tower (page 7–4).

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
Right Turn	2+3 5+6	2+1 5+4
Neutral	None	All
Left Turn	2+1 5+4	2+3 5+6

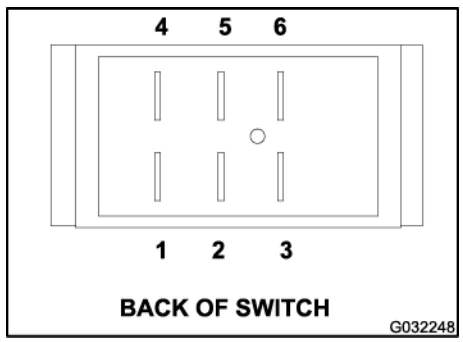
Windshield Wiper/Washer Switch (Groundsmaster 5910 Machine Only)



g032247

Figure 254

1. Cab headliner
2. Wiper/washer switch



g032248

Figure 255

The windshield wiper/washer switch controls the operation of the windshield wiper and washer pump. The windshield wiper/washer switch is located in the cab headliner; refer to Figure 254.

Testing the Windshield Wiper/Washer Switch (Groundsmaster 5910 Machine Only)

1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Remove the switch plate from the cab headliner.
3. Locate the windshield wiper/washer switch and unplug the wire harness connector from the switch.
4. The switch terminals are marked as in Figure 255. The circuit logic of the wiper/washer switch is in the Circuit Logic Table (page 5–69). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.
5. Connect the wire harness connector to the switch after testing.
6. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.

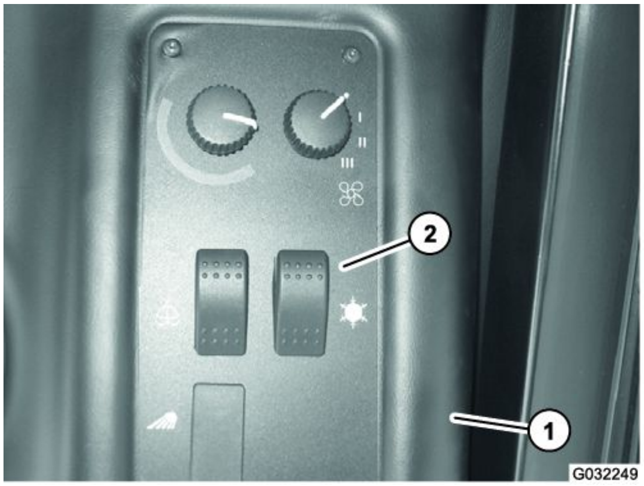
Testing the Windshield Wiper/Washer Switch (Groundsmaster 5910 Machine Only) (continued)

7. Install the switch plate to the cab headliner.

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
OFF	None	All
WIPER ON	2+3	5+6
WASHER ON	2+3 5+6	None

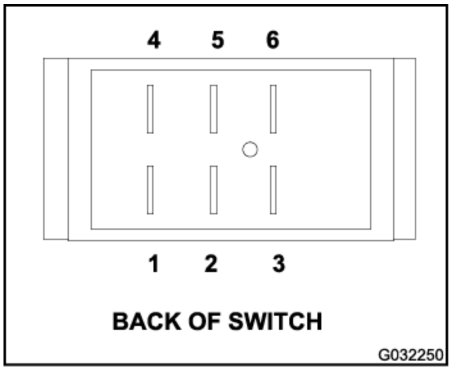
Air Conditioning Switch (Groundsmaster 5910 Machine Only)



g032249

Figure 256

1. Cab headliner
2. Air conditioning switch



g032250

Figure 257

The air conditioning switch controls the operation of the air conditioning system. The switch is located in the cab headliner; refer to Figure 256.

Testing the Air Conditioning Switch (Groundsmaster 5910 Machine Only)

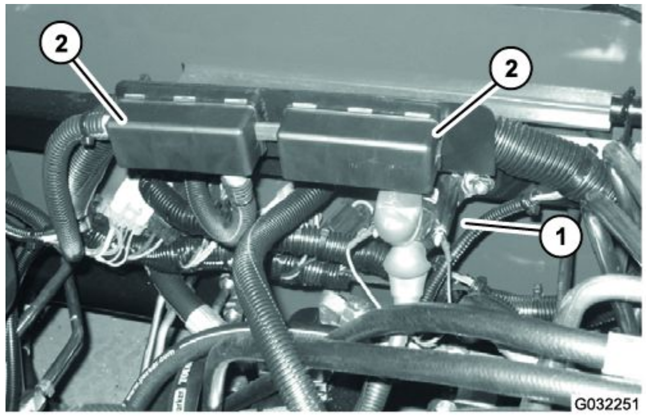
1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Remove the switch plate from the cab headliner.
3. Locate the air conditioning switch and disconnect the wire harness connector from the switch.
4. The switch terminals are marked as in Figure 257. The circuit logic of the air conditioning switch is in the Circuit Logic Table (page 5–71). With the use of a multimeter (ohms setting), test the switch functions to determine if the continuity exists between the various terminals for each position. Check the continuity between the switch terminals. Replace the switch if the testing identifies a damaged switch.
5. Connect the wire harness connector to the switch after testing.
6. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
7. Install the switch plate to the cab headliner.

Testing the Air Conditioning Switch (Groundsmaster 5910 Machine Only) (continued)

Circuit Logic Table

Switch Position	Closed Circuits	Open Circuits
Air conditioning Off	2+3 5+6	2+1 5+4
Air conditioning On	2+1 5+4	2+3 5+6

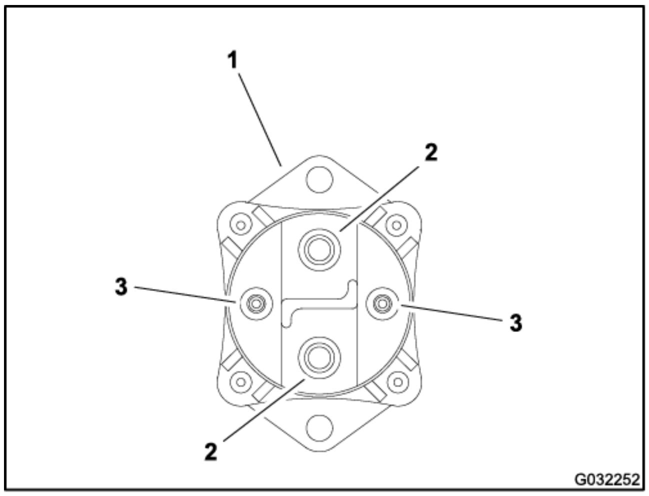
Intake Air Heater Contactor



g032251

Figure 258

1. Air heater contactor
2. Mega fuse holder



g032252

Figure 259

1. Contactor
2. Main post
3. Coil posts

The intake air heater contactor of the Groundsmaster 5900 and 5910 provides current for the engine intake air heater. The contactor is attached to a frame bracket behind the batteries; refer to Figure 258. The engine ECM energizes the contactor when the low temperatures are detected before starting the engine.

Testing the Intake Air Heater Contactor

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Lift and support the hood to access the intake-air heater solenoid.
3. Disconnect the battery cables from the battery terminals; refer to Servicing the Battery (page 5–102).
4. Locate the contactor. Note the wire connector locations on the contactor for assembly purposes. Disconnect all the harness electrical connectors from the contactor.
5. Use the jumper wires, apply 12 VDC directly across the contactor coil posts; refer to Figure 259.

Testing the Intake Air Heater Contactor (continued)

Note: The contactor must click. With the contactor coil energized, the resistance across the contactor main posts must be less than 1 ohm.

6. Remove the voltage from the contactor coil posts.

   Note: The contactor must click. With the contactor coil not energized, the resistance across the contactor main posts must be infinite ohms.

7. With the voltage removed from all the contactor posts, measure the resistance across the contactor coil posts. The resistance of the coil must be approximately 13.5 ohms; refer to Figure 259.

8. With the voltage removed from all the contactor posts, measure the resistance across the contactor main posts. The resistance must be infinite ohms; refer to Figure 259.

9. If the testing determines that the contactor is damaged, replace the contactor.

10. After you complete the test, connect the harness connectors to the contactor.

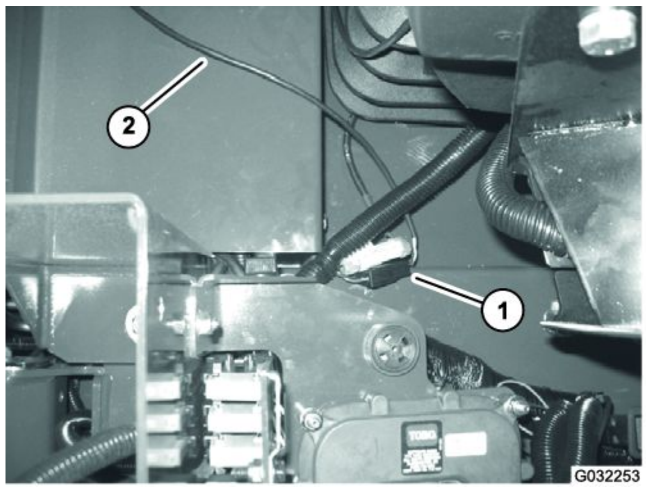
11. Connect the battery cables to the battery terminals; refer to Servicing the Battery (page 5–102).

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. The seat switch is an input for the TEC-5002 controller. If the traction system or PTO switch is engaged when the operator raise out of the seat, the traction system or PTO operation stops. The seat switch and its electrical connector are located in the seat assembly.

Testing the Seat Switch

1. Before you disconnect the seat switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the seat switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the seat switch and circuit wiring are not functioning correctly, then test the seat switch.



g032253

Figure 260

1. Electrical connector
2. Seat switch wire

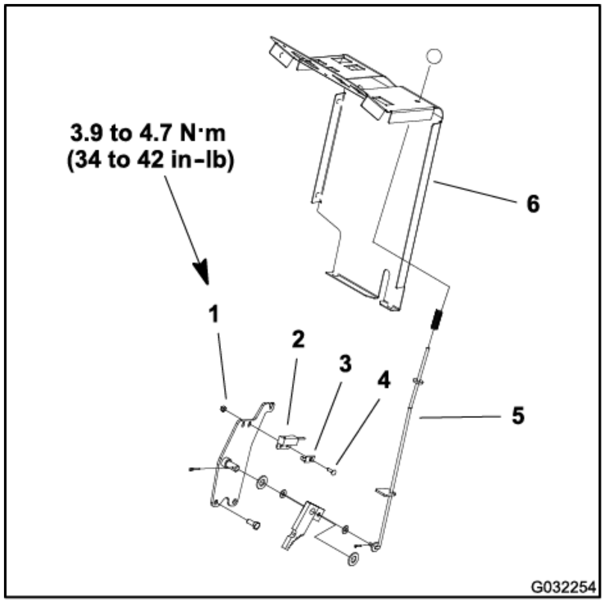
Note: Testing of the seat switch can be done without seat removal by disconnecting the seat wire from the machine wire harness; refer to Figure 260.

4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Disconnect the seat switch electrical connector from the machine wire harness.
6. Connect a multimeter (ohms setting) across the connector terminals to check the continuity of the switch.
7. With no pressure on the seat, ensure that there is no continuity (infinite resistance) between the seat switch terminals.
8. Press directly onto the seat switch through the seat cushion. Ensure that there is continuity (zero resistance) as the seat cushion approaches near the bottom of its travel.
9. If the testing determines that the seat switch is damaged, replace the seat switch; refer to Servicing the Operator Seat (page 7–28).
10. Connect the switch connector to the machine wire harness.

Testing the Seat Switch (continued)

11. If the switch testing is correct and the circuit problem still exists, check the wire harness; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.

Parking Brake Switch



g032254

Figure 261

1. Locknut
2. Parking brake switch
3. Switch plate
4. Carriage bolt
5. Parking brake rod
6. Steering tower cover

The switch used for the parking brake is normally the open proximity switch that is located under the steering tower cover (Figure 261). The parking brake switch is an input for the TEC-5002 controller. When you do not set the parking brake, a tab on the brake rod is positioned near the switch sense zone that causes the switch to close. When you set the parking brake, the brake rod tab is positioned away from the switch allowing the switch to be in NORMAL, OPEN position (no continuity).

Testing the Parking Brake Switch

1. Before you disconnect the parking brake switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the parking brake switch and circuit wiring are functioning correctly, then no more switch testing is necessary
3. If the diagnostic display determines that the parking brake switch and circuit wiring are not functioning correctly, then test the parking brake switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Remove the front steering tower cover; refer to Disassembling the Steering Tower (page 7–4).
6. Locate the parking brake switch and disconnect the wire harness connector from the switch.
7. Disconnect the switch electrical connector from the machine wire harness.
8. Connect a multimeter (ohms setting) across the connector terminals to check the continuity of the switch.
9. With the parking brake released (the brake rod tab away from the brake switch), ensure that there is no continuity (infinite resistance) between the switch terminals.

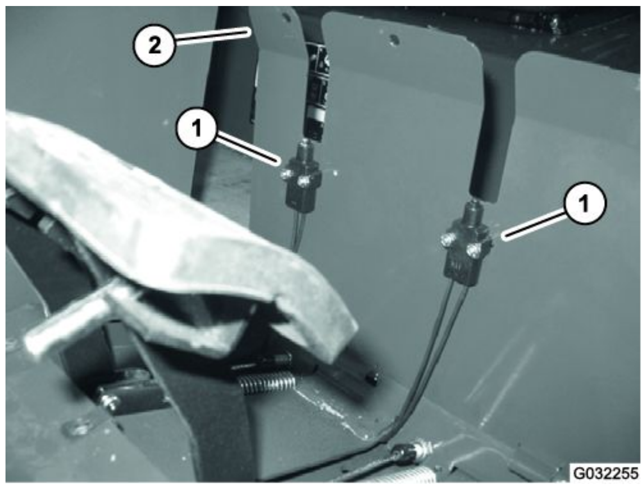
Testing the Parking Brake Switch (continued)

10. With the parking brake set (the brake rod tab close to the brake switch), ensure that there is a continuity (zero resistance) between the switch terminals.
11. Replace the switch if necessary.
12. After you complete the test, correctly connect the wire harness connector to the parking brake switch.
13. Install the front steering tower cover; refer to Assembling the Steering Tower (page 7–4).

Adjusting the Parking Brake Switches

When the parking brake is not set (the brake rod tab near the switch), there must be a gap of 1.6 mm (0.062 inch) between the switch and the brake rod tab.

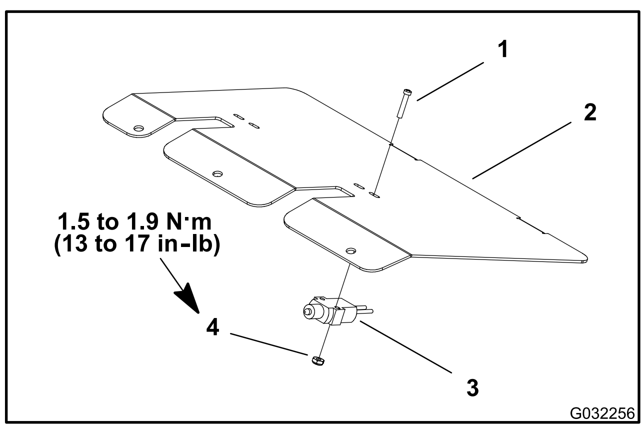
Service Brake Switches



g032255

Figure 262

1. Service brake switch
2. Footrest panel



g032256

Figure 263

1. Screw (2 each switch)
2. Footrest panel
3. Switch (2 each)
4. Locknut (2 each switch)

The 2 switches used for the service brakes are normally open switches that are located under the footrest panel; refer to Figure 262. The service brake switches provide inputs for the TEC-5002 controller. When you do not press a brake pedal, the brake pedal assembly contacts the switch plunger to close the switch. When you apply a brake, the brake pedal assembly moves away from the switch plunger, allowing the switch plunger to extend and the switch to open.

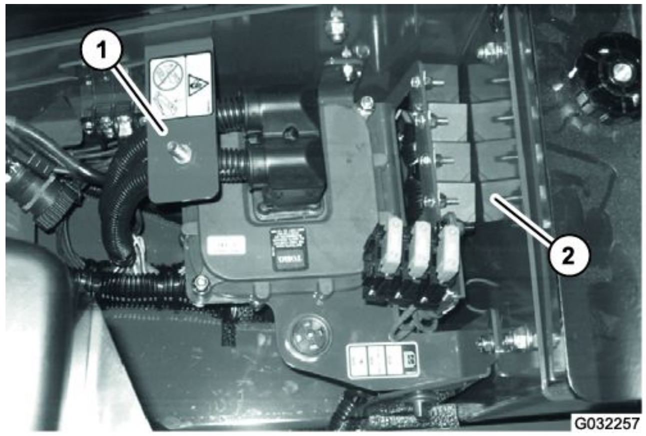
Testing the Service Brake Switches

1. Before you disconnect the service brake switch for testing, ensure that you test the switch and its circuit wiring as a TEC controller input with the InfoCenter diagnostic display; refer to the InfoCenter Display (page 5–13).
2. If the diagnostic display verifies that the service brake switch and circuit wiring are functioning correctly, then no more switch testing is necessary.
3. If the diagnostic display determines that the service brake switch and circuit wiring are not functioning correctly, then test the seat switch.
4. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
5. Locate the service brake switch for testing.
6. Disconnect the switch electrical connector from the machine wire harness.
7. Connect a multimeter (ohms setting) across the connector terminals to check the continuity of the switch.
8. With the service brake released (service brake switch plunger pressed), ensure that there is a continuity (zero resistance) between the switch terminals.
9. With the service brake set (service brake switch plunger extended), ensure that there is no continuity (infinite resistance) between the switch terminals.
10. Replace the switch if necessary.
11. After you complete the test, connect the switch electrical connector again to the machine wire harness.

Adjusting the Service Brake Switches

Adjust the service brake switch so that the switch plunger always makes full contact with the brake pedal; tighten the fasteners to **1.5 to 1.9 N·m (13 to 17 in-lb)**.

Main Power, Controller, Start, and Cab (Groundsmaster 5910 Machine Only) Relays



g032257

Figure 264

1. Cover attachment screw
2. Relay location

The Groundsmaster 5900 and 5910 machines use 3 identical relays to control the electrical power circuits. The Groundsmaster 5910 machine uses an additional relay for the cab electrical components. The relays are attached to the operator platform under the power center cover; refer to Figure 264.

The main power relay supplies electrical power to the InfoCenter display, operator seat, power point receptacle, horn, road lights, brake lights, and optional electrical equipment. The main power relay is energized when the key switch is in the START or RUN position.

The controller relay supplies electrical input power to the 2 electrical controllers (TEC-5001 and TEC-5002). The controller relay is energized when the key switch is in the START or RUN position.

The start relay supplies electrical power to the engine starter solenoid. TEC-5002 controller energizes the start relay when the correct start functions are initiated (key switch to RUN, traction pedal in NEUTRAL, PTO switch OFF).

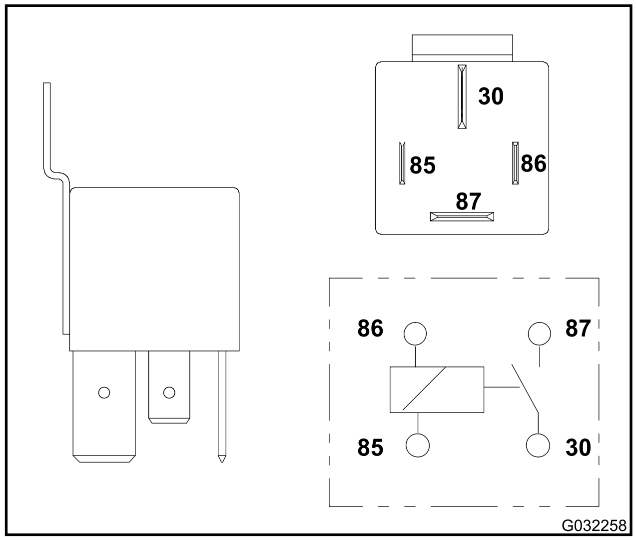
The cab relay used on the Groundsmaster 5910 machine supplies power to the cab electrical functions (air conditioning, fan, windshield washer/wiper, and cab work lights). This relay energizes when the key switch is in the START or RUN position.

Testing the Main Power, Controller, Start, and Cab (Groundsmaster 5910 Machine Only) Relays

1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Remove the power center cover from the operator platform to access the relays.
3. Disconnect the machine wire harness connector from the relay for testing.

   Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The multimeter displays a small resistance value (usually 0.5 ohms or less) that is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component you are testing.

Testing the Main Power, Controller, Start, and Cab (Groundsmaster 5910 Machine Only) Relays (continued)



g032258

Figure 265

4. Use a multimeter (ohms setting), measure the coil resistance between the terminals 85 and 86; refer to Figure 265.

   Note: The resistance must be between 70 and 100 ohms.

5. Check that there is an infinite resistance (no continuity) between the terminals 30 and 87.
6. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87. Ground the terminal 86 and apply +12 VDC to the terminal 85. The relay must break continuity between the terminals 30 and 87 as +12 VDC is set and removed from the terminal 85.
7. Disconnect the meter leads and jumper wires from the relay terminals. Connect the machine wire harness connector to the relay.
8. Install and attach the power center cover.

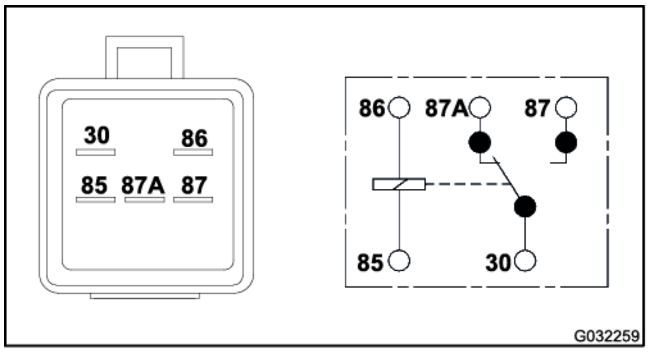
Air Conditioning Relay (Groundsmaster 5910 Machine Only)

A relay is used to control the air conditioning electrical power circuit of the Groundsmaster 5910 machine. When the air conditioning switch energizes, the relay provides current for the air conditioning components. The relay is attached to the cab headliner above the switch panel.

Testing the Air Conditioning Relay (Groundsmaster 5910 Machine Only)

1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Remove the screws that secures the switch panel to the headliner in the cab. Locate the relay and disconnect the machine wire harness connector from the relay, and remove the relay for easier testing.

   Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The multimeter displays a small resistance value (usually 0.5 ohms or less) that is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component you are testing.



g032259

Figure 266

3. Use a multimeter (ohms setting), measure the coil resistance between the terminals 85 and 86 (Figure 266).

   Note: Ensure that the resistance is in between 70 and 90 ohms.
4. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87. Ground the terminal 86 and set +12 VDC to the terminal 85. The relay must break continuity between the terminals 30 and 87 as +12 VDC is set and removed from the terminal 85.
5. Disconnect the voltage and multimeter leads from the relay terminals.
6. Connect the multimeter (ohms setting) leads to the relay terminals 30 and 87A. Ground the terminal 86 and set +12 VDC to the terminal 85. The relay must break continuity between the terminals 30 and 87A as +12 VDC is set and removed from the terminal 85.
7. Disconnect the voltage and multimeter leads from the relay terminals.
8. Attach the relay to the machine and connect the machine wire harness connector to the relay.

Toro Electronic Controller (TEC)

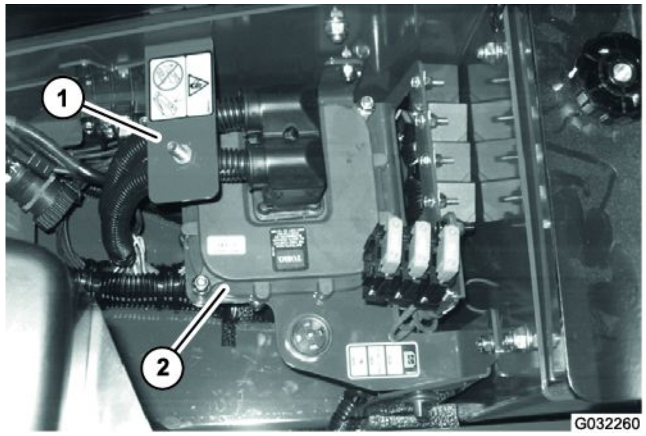


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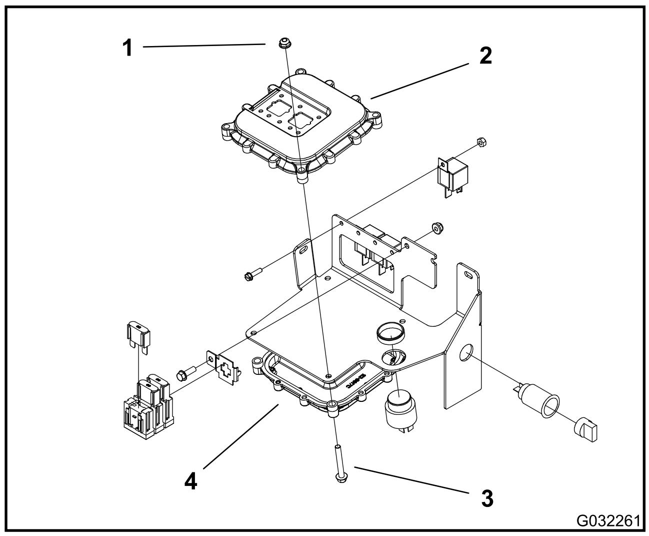
Figure 267

1. Cover attachment point
2. Controller location



g032261

Figure 268

1. Flange nut (4 each)
2. TEC-5001
3. Flange screw
4. TEC-5002

Groundsmaster 5900 and 5910 machines use 2 Toro Electronic Controllers (TEC). The controllers are attached to the operator platform under the power center cover; refer to Figure 267. Use the InfoCenter display when checking the inputs and outputs of the TEC used on your machine; refer to the Troubleshooting (page 4–48).

The logic power is provided to both the controllers as long as the battery cables are connected to the batteries. A 2 A fuse provides circuit protection for this logic power to each of the controllers.

The TEC-5002 master controller (lower) monitors the states of the following components as inputs: key switch, seat switch, parking brake switch, service brake switches, traction pedal potentiometer, hydraulic temperature sender, fuel-level sender, PTO switch, and cruise control switch.

The TEC-5002 controller controls the electrical output to the following components: TEC-5001, traction pump solenoid coils, engine cooling-fan hydraulic-valve solenoid coils, PTO circuit hydraulic-valve solenoid coils, start relay, and turn signals. The Fuses 3F2, 3F3, and 3F4 provides the circuit protection for TEC-5002 outputs.

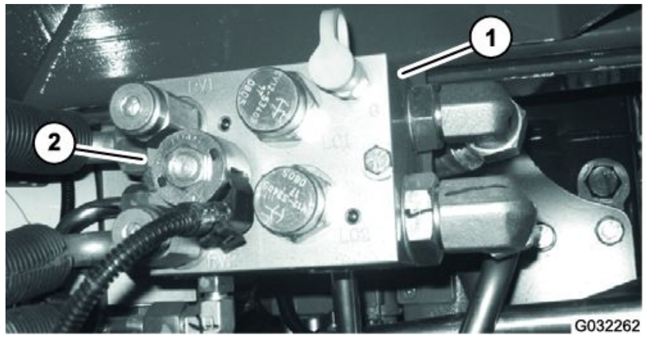
The TEC-5001 slave controller (upper) monitors the states of the following components as inputs: key switch, cutting deck lift switches, traction assist switch, mow/transport switch, and cutting deck position sensors.

The TEC-5001 controller controls the electrical output to the following components: lift circuit hydraulic-valve solenoid coils, traction-assist hydraulic-valve solenoid coil, mow/transport hydraulic-valve solenoid coil, and audio alarm. The fuses 4F2, 4F3, and 4F4 provides the circuit protection for TEC-5001 outputs.

Because of the solid state circuitry built into the TEC, there is no procedure to test the controllers directly. The controllers may get damaged if an attempt is made to test them with an electrical test device (e.g., digital multimeter).

Note: The TEC controllers and the InfoCenter display used on the Groundsmaster 5900 and 5910 are matched for the correct operation of the machine. If any of these components are replaced, then the system software must be programmed by your Authorized Toro Distributor.

Hydraulic Valve Solenoid Coils



g032262

Figure 269

1. Left PTO manifold
2. Solenoid coil (port S)

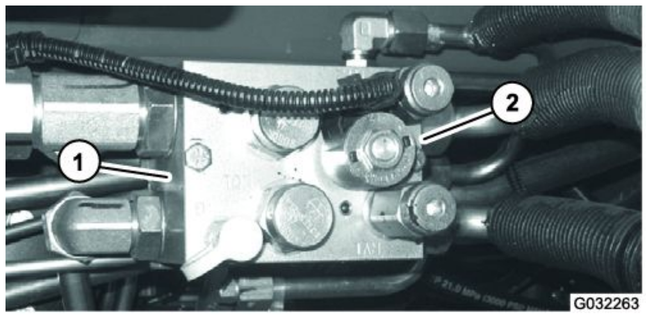


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Figure 270

1. Right PTO manifold
2. Solenoid coil (port S)

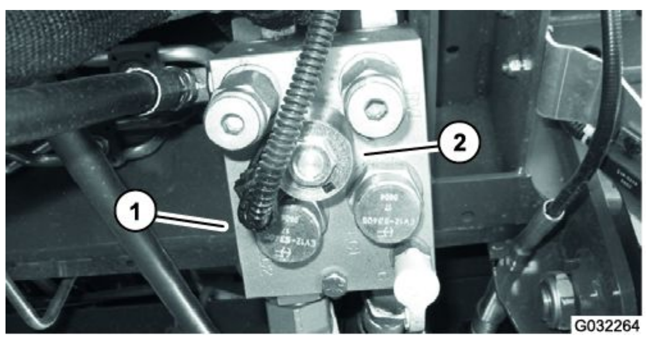

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Figure 271

1. Center PTO manifold
2. Solenoid coil (port S)

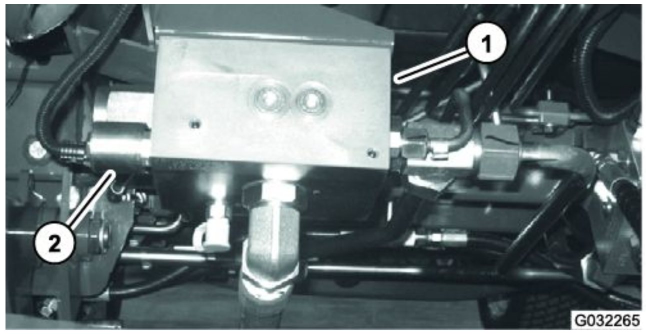

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Figure 272

1. Traction control manifold
2. Solenoid coil (port S)

There are numerous hydraulic valve solenoid coils on the hydraulic manifolds of the machine. When the solenoid coils are energized, the hydraulic-valve shift occurs to control the hydraulic flow. Testing of these solenoid coils can be done with the solenoid coil on the hydraulic valve.

Testing the Hydraulic Valve Solenoid Coils

Note: The InfoCenter display does not identify a damaged solenoid coil or solenoid circuit wiring problem. The InfoCenter display verifies that the output current from the TEC is available for the solenoid coil but the display does not verify that the solenoid coil and circuit wiring is functioning correctly.

1. Identify the solenoid coil that must be tested.
2. Disconnect the wire harness electrical connector from the hydraulic solenoid valve coil that must be tested.

   Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The multimeter displays a small resistance value (usually 0.5 ohms or less) that is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component that you are testing.

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

   A. The solenoid coils at the following control manifold ports are the same:

      - PTO manifold port S (Figure 269, Figure 270, and Figure 271)
      - Traction manifold port S (Figure 272)
      - 4-wheel drive manifold port SV (Figure 273)
      - Lift manifold ports S1, S4, S5, and S9 (Figure 274)

      Note: The resistance of these coils must be approximately 8.8 ohms.

Testing the Hydraulic Valve Solenoid Coils (continued)

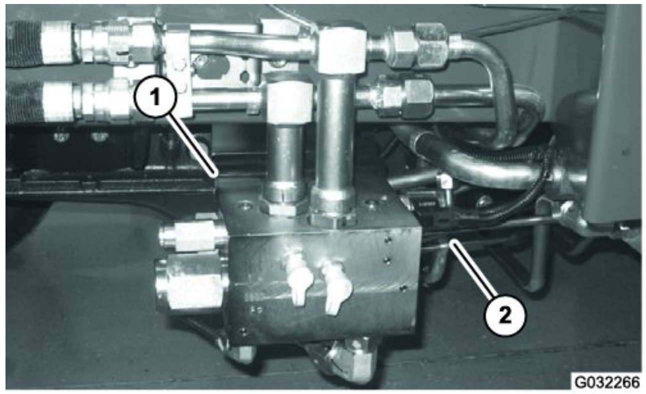

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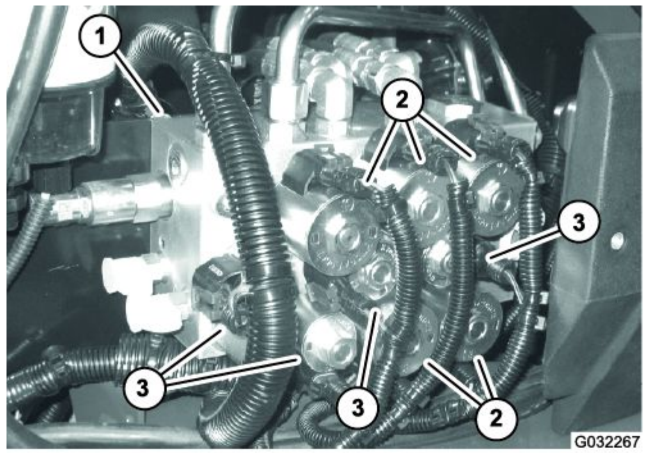
Figure 273

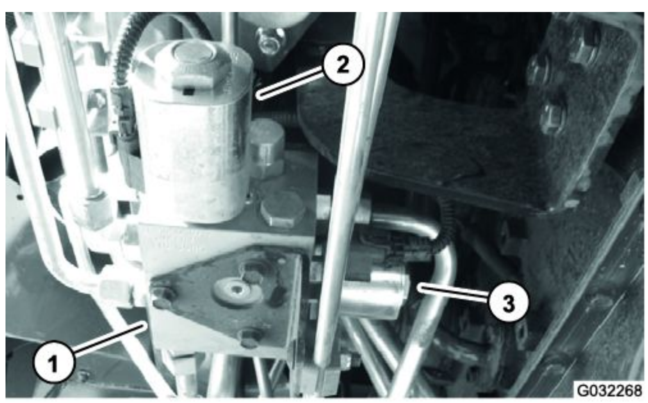
1. 4-wheel drive control manifold
2. Solenoid coil (port SV)



g032267

Figure 274

1. Lift control manifold
2. Solenoid coil (ports S2, S3, S6, S7, and S8)
3. Solenoid coil (ports S1, S4, S5, and S9)



g032268

Figure 275

1. Steering/fan manifold
2. Solenoid coil (port S)
3. Solenoid coil (port PRV)

B. The solenoid coils at the following control manifold ports are the same:

Testing the Hydraulic Valve Solenoid Coils (continued)

- Lift manifold ports S2, S3, S6, S7, and S8 (Figure 274)
- Steering/cooling fan manifold port PRV (Figure 275)

Note: The resistance of these coils must be approximately 7.1 ohms.

C. Ensure that the resistance of the solenoid coil at steering/cooling fan manifold port S is approximately 4.6 ohms; refer to Figure 275.

4. If the solenoid coil resistance is incorrect, replace the coil; refer to Hydraulic Valve Solenoid Coils (page 5–84).

   Note: To help in troubleshooting, you can exchange the identical solenoid coils. If the machine problem follows the exchanged coil, an electrical problem likely exists. If the problem remains unchanged, something other than the solenoid coil is the likely problem source (e.g., switch, circuit wiring, hydraulic problem).

5. After you complete the testing, connect the wire harness electrical connector to the solenoid coil.

Fuel Sender

The fuel sender is located on the top of the fuel tank. The resistance of the fuel sender increases as the fuel level in the fuel tank decreases. The TEC controller uses the fuel sender as an input to generate an output for the InfoCenter fuel gauge.

Two styles of fuel senders are used on the Groundsmaster 5900 and 5910 machines. Early production machines were equipped with a pivoting float design that has 2 wire harness terminals. Later machines have a sliding float design and a single wire harness connector. The pivoting float design may have been replaced with the sliding float design.

Testing the Fuel Sender

1. Ensure that the key switch is in the OFF position and the key is removed from the key switch.
2. Disconnect the wire harness connector(s) at the fuel sender.

CAUTION

Turning the key switch to the RUN position when the circuit wiring is not connected could lead to sparking, resulting in fire or an explosion.

When testing the circuit wiring and fuel gauge, ensure that the wire connections are attached before turning the key switch to the RUN position.

3. To test the circuit wiring and InfoCenter display fuel gauge, use a jumper wire to connect the 2 harness wires leading to the fuel sender and turn the key switch to the RUN position.

   Note: The InfoCenter fuel gauge should indicate a full fuel tank.
4. Turn the key switch to the OFF position and continue testing the fuel sender if the circuit wiring and gauge are acceptable.
5. Remove the screws and lock washers that attach the fuel sender to the fuel tank.
6. Carefully remove the fuel sender and gasket from the fuel tank. Clean all the fuel from the sender.

   Note: Before taking small resistance readings with a digital multimeter, short the meter test leads together. The meter displays a small resistance value. Subtract this internal resistance of the meter and test leads from the measured value of the component.

CAUTION

Testing the fuel sender could create sparking, and when testing with fuel in the sender or near the fuel tank could result in a fire or an explosion.

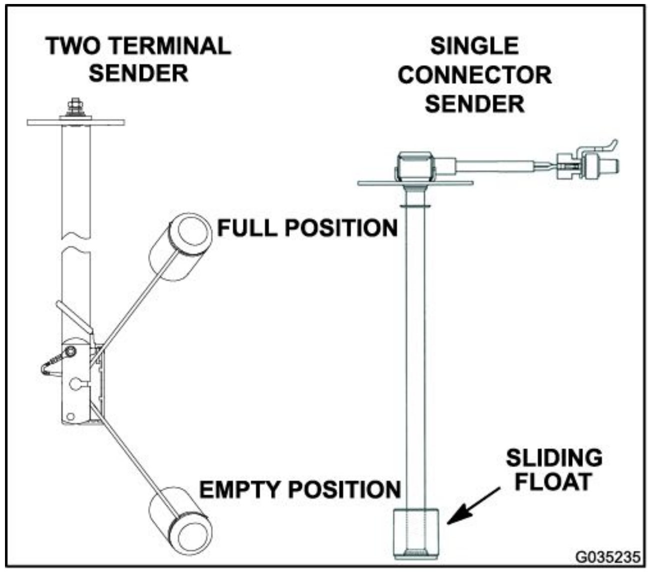
Ensure that the fuel sender is completely dry (no fuel on it) before the testing. Perform the test away from the tank.

Testing the Fuel Sender (continued)

7. Use a multimeter to check the resistance of the sender with the float in the full and empty positions. The expected resistance values are shown in the Fuel Sender Resistance Table (page 5–89).

Fuel Sender Resistance Table

Connector style	Resistance (full)	Resistance (empty)
Two Terminals	27.5 to 39.5 ohms	240 to 260 ohms
Single Connector	28 to 33 ohms	240 to 250 ohms



g035235

Figure 276

8. Replace the sender if the testing determines that the sender is damaged. Carefully install the sender into the fuel tank and secure the sender with the fasteners that were removed.
9. Secure the wire harness connector(s) to the fuel sender. On the two terminal senders, apply battery terminal protector (Special Tools (page 5–6)) to the sender terminals for corrosion protection.

Hydraulic Fluid Temperature Sender

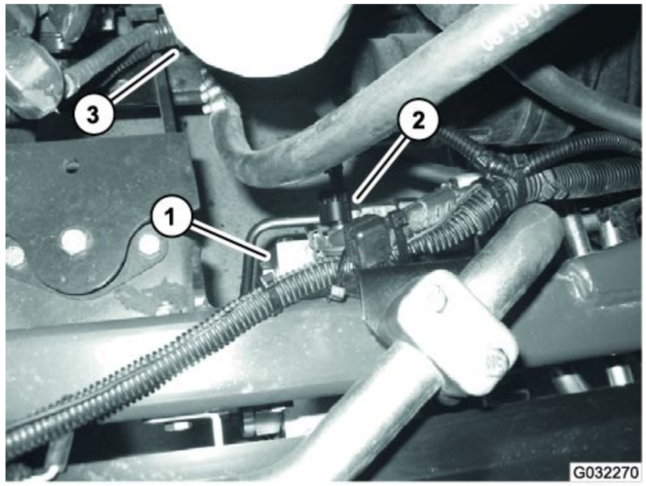


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Figure 277

1. Hydraulic flush manifold
2. Oil temperature sender
3. Fuel water separator

The hydraulic-fluid temperature sender is attached to the hydraulic-flush manifold in the port TS; refer to Figure 277.

Testing the Hydraulic Fluid Temperature Sender

1. Locate the fluid temperature sender on the hydraulic flush manifold. Disconnect the wire harness connector from the temperature sender.
2. Clean the hydraulic-flush manifold around the temperature sender, and remove the sender from the manifold.
3. Put the sensing end of the sender in a container of fluid with a thermometer and slowly heat the fluid; refer to Figure 278.

CAUTION

The hydraulic fluid is hot and could cause personal injury or fire.

Handle the hot fluid with extreme care.

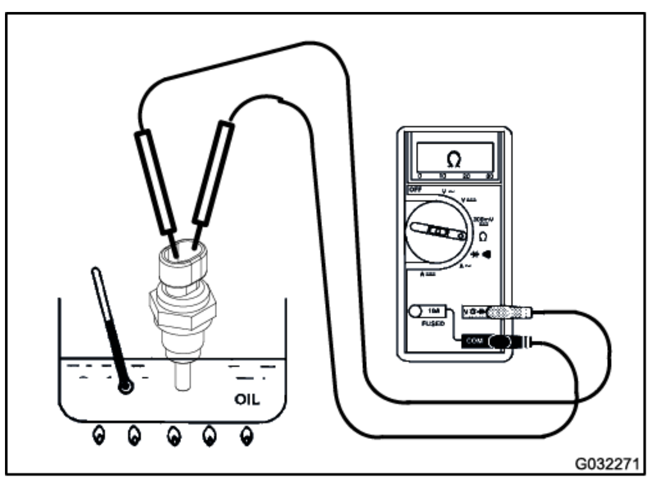

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Figure 278

Note: Before taking the small resistance readings with a digital multimeter, short the multimeter test leads together. The multimeter displays a small resistance value (usually 0.5 ohms or less) that is because of the internal resistance of the multimeter and test leads. Subtract this value from the measured value of the component you are testing.

4. Check the resistance of the sender with a multimeter (ohms setting) as the fluid temperature increases.

   A. The meter must indicate to 11,600 to 13,500 ohms at 20°C (68°F).

   B. The meter must indicate to 2,300 to 2,500 ohms at 60°C (140°F).

   C. The meter must indicate to 605 to 669 ohms at 100°C (212°F).

   D. If the sender does not meet the specifications, replace it.

5. After allowing the sender to cool, install the sender to the flush control manifold as follows:

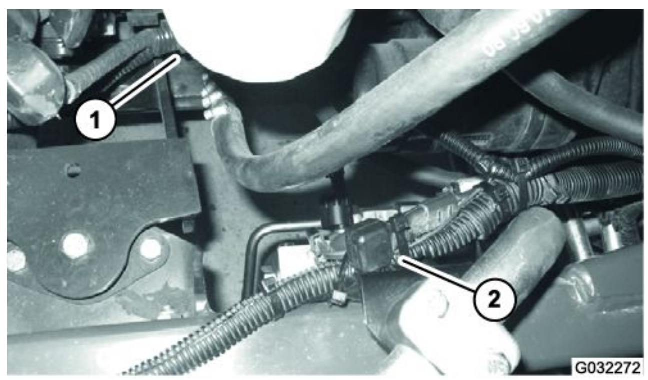
   A. Install the new O-ring on the sender.

   B. Install the sender into the hydraulic flush manifold; torque the sender to **16.3 N·m (12 ft-lb)**.

   C. Connect the wire harness to the sender.

6. Check and fill the hydraulic system to the correct level.

Diode Assembly

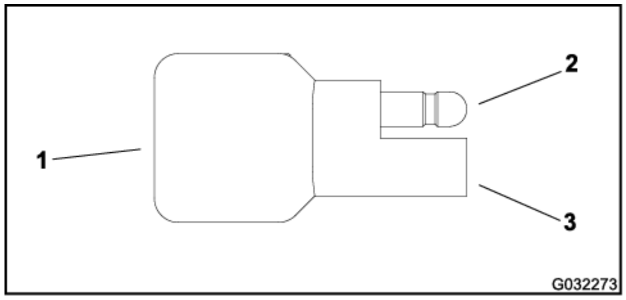


g032272

Figure 279

1. Fuel water separator
2. Diode

A diode assembly is used in the Groundsmaster 5900 wire harness (Figure 279). The diode is used for the circuit protection from the voltage spikes that occur when the starter solenoid is de-energized. The diode plugs into the wire harness near the fuel water separator.



g032273

Figure 280

1. Diode
2. Male terminal
3. Female terminal

Testing the Diode Assembly

The diode can be tested by using a digital multimeter (diode test or ohms setting); refer to Diode Test Table (page 5–92).

Diode Test Table

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	Yes
Male	Female	No

Audible Alarm

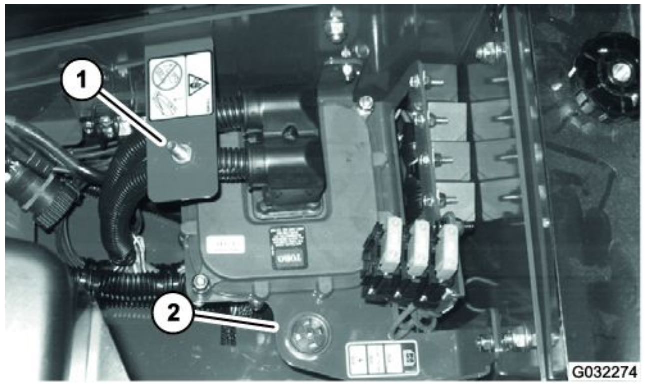


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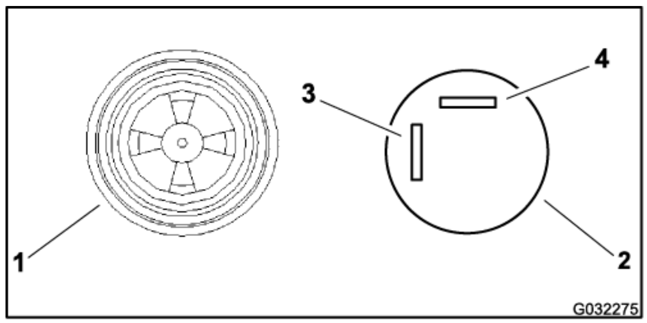
Figure 281

1. Cover attachment screw
2. Audible alarm



g032275

Figure 282

1. Top view
2. Bottom view
3. Positive (+) terminal
4. Negative (-) terminal

The audible alarm operates to tell the operator when there is a problem in the machine. The electrical current for the alarm is provided as an output from the slave Toro Electronic Controller. The audible alarm is located to the right of the operator's seat under the power center console; refer to Figure 281.

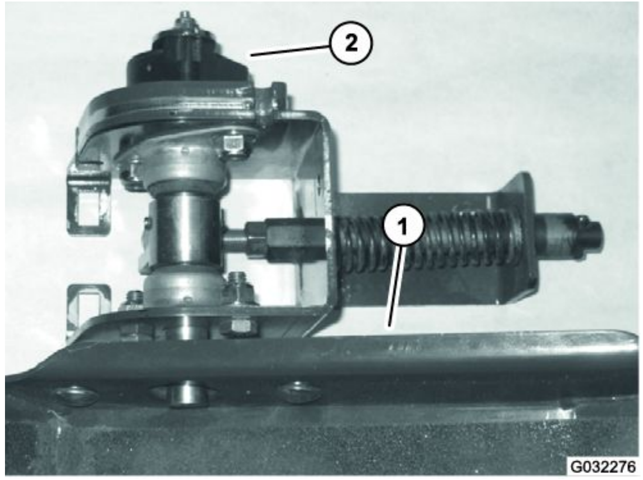
Testing the Audible Alarm

IMPORTANT

An improper connection can damage the alarm. Monitor the polarity on the alarm terminals while testing.

1. Ensure that the key switch is in the OFF position, and remove the key from the key switch.
2. Remove the power center cover from the operator platform to access the audible alarm.
3. Isolate the alarm from the circuit. Correctly connect the 12 VDC source to the terminals; refer to Figure 282.
4. The alarm must operate, and remove the voltage source from the alarm. Connect the alarm to the circuit.
5. Install and attach the power center cover.

Traction Pedal Potentiometer



g032276

Figure 283

1. Traction pedal
2. Traction potentiometer

The traction pedal potentiometer is connected to the traction pedal assembly (Figure 283). This potentiometer determines the neutral band for the traction pedal, direction of travel desired by the operator, and traction speed. The potentiometer is a single analog, dual-digital signal electronic device. The potentiometer portion is a variable resistor that provides an analog signal to the TEC-5002 controller to determine the desired ground speed based on how far the traction pedal is moved. The traction pedal potentiometer also contains 2 switches that are used to determine the neutral position (deadband) and indicate the direction of travel (forward or reverse). As you press the traction pedal, the internal wiper of the potentiometer moves and sends the analog signal to the TEC-5002 controller to determine the direction and speed of the machine.

The traction pedal potentiometer must be calibrated with the TEC-5002 controller to determine the neutral and full speed set points for both the forward and reverse directions.

A correctly installed and calibrated traction pedal potentiometer is critical to accurate traction response and potentiometer life. Use care when installing and calibrating the potentiometer.

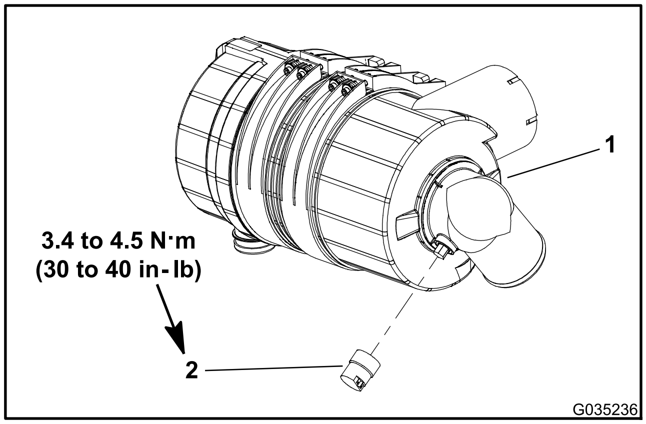
Before suspecting a damaged potentiometer, follow Calibrating the Traction Pedal (page 5–98). If the potentiometer replacement is necessary; refer to Traction Pedal (page 7–22).

Air Filter Sensor (Machines with Serial Number Above 313000300)

The machines with serial number above 313000300 use an air filter sensor to monitor the condition of the air filter. The sensor is normally open and closes when the air filter is restricted.

Note: Service the engine air filter only when CHECK AIR FILTER is displayed on the InfoCenter. Changing the air filter before it is necessary only increases the chance of dirt entering into the engine when you remove the air filter.

Testing the Air Filter Sensor



g035236

Figure 284

1. Air cleaner assembly
2. Air filter sensor

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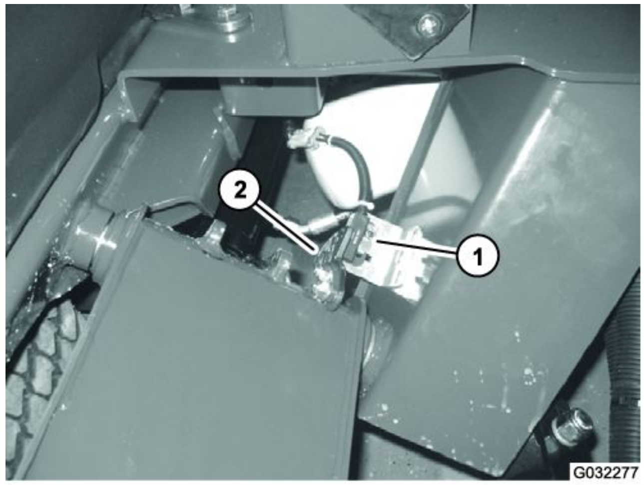
1. If CHECK AIR FILTER is displayed on the InfoCenter, check the air filter and replace or service the filter as necessary.
2. If CHECK AIR FILTER continues to be displayed on the InfoCenter after air filter service, disconnect the wire harness connectors from the sensor.
   A. If CHECK AIR FILTER is no longer displayed on the InfoCenter, replace the air filter sensor.
   B. If CHECK AIR FILTER continues to be displayed on the InfoCenter, check the sensor circuit wiring; refer to the Electrical Schematics and Wire Harness Drawings in Chapter 10—Foldout Drawings.
3. After you complete the testing, ensure that the wire harness connectors are attached to the air filter sensor.

Up Limit Switches



g032277

Figure 285

1. Up limit switch (left)
2. Sensing plate

The cutting deck up limit switches are normally open proximity switches that are attached to the brackets located on the traction unit frame (Figure 285). The sensing plates used for the switches are located on the cutting deck lift arms.

When a cutting deck is in the lowered position, the sensing plate is near the up limit switch and the switch is closed. This closed switch is used as an input for the controller to provide current flow to the cutting deck hydraulic-solenoid valve when PTO is engaged, allowing the cutting deck to operate.

When a cutting deck is raised, the sensing plate is moved away from the up limit switch and the switch opens. This open switch is used as an input for the controller to prevent the current flow to the cutting deck hydraulic-solenoid valve, preventing the cutting deck from operating.

Testing the Up Limit Switch

Note: Monitor the operation of a up limit switch and its circuit wiring with the InfoCenter before disconnecting the switch for testing; refer to InfoCenter Display (page 5–13). If the InfoCenter display verifies that the up limit switch and circuit wiring are functioning correctly, testing of the switch is not necessary.

1. Verify with the InfoCenter display that the deck position switch and circuit wiring are not functioning correctly.
2. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
3. Disconnect the up limit switch that requires testing from the machine wire harness.
4. Connect a multimeter (ohms setting) across the switch connector terminals to check the continuity of the switch.
5. With the cutting unit in the lowered position, ensure that there is a continuity (zero resistance) across the switch terminals.
6. Raise the cutting unit. Ensure that there is no continuity (infinite resistance) across the switch terminals.
7. Replace the switch as required. Connect the switch to the machine wire harness.

Adjusting the Up Limit Switch

Adjust the up limit switch to 1.8 to 3.3 mm (0.070 to 0.130 inch) to have the clearance between the switch and sensing plate on the lift arm.

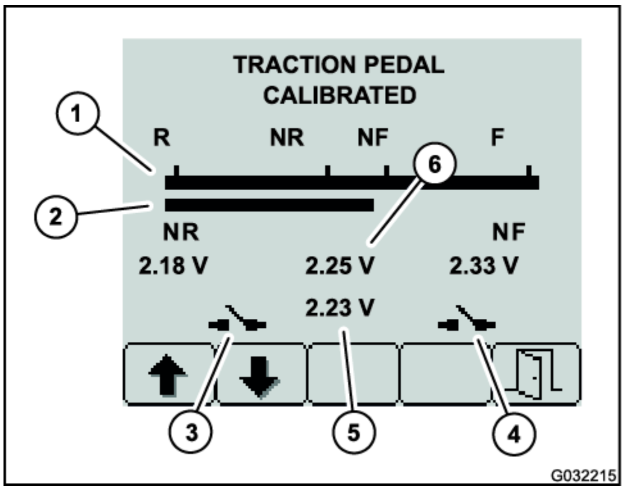
Adjustments

Calibrating the Traction Pedal

IMPORTANT

A properly installed and calibrated traction pedal potentiometer is critical to accurate traction system response and for reliable sensor life. Use care when removing, installing, and calibrating the traction pedal potentiometer.

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and set the parking brake.
2. Ensure that you plug the wire harness connector into the traction pedal potentiometer.



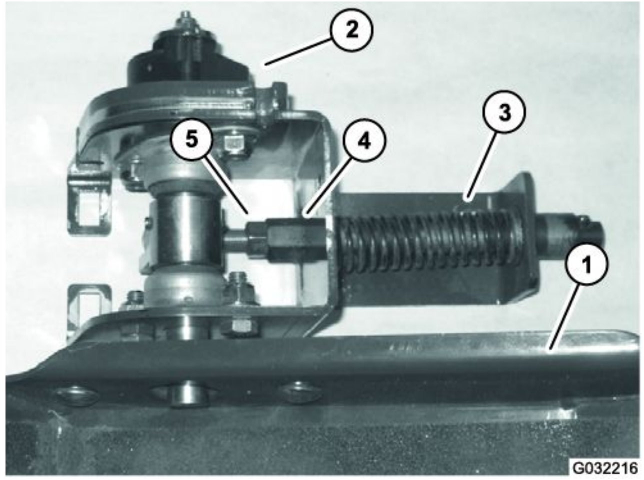
g032215

Figure 286

1. Bar graph
2. Indicator bar
3. Reverse switch icon
4. Forward switch icon
5. Neutral voltage
6. Midpoint voltage

3. Turn the key switch to the ON position but do not start the engine.
4. Use the InfoCenter display diagnostic menu; refer to the InfoCenter Display (page 5–13) to get the TRACTION PEDAL CALIBRATED screen on the display; refer to Figure 286.
5. On the bar graph in the screen, the indicator bar must be between the NR and NF. Also, the 2 switch icons on the screen must be open. To change the indicator bar location do as follows:
   A. Remove the traction pedal cover and spring cover from the front platform; refer to Disassembling the Traction Pedal (page 7–23).
   B. Loosen the hex nut that secures the neutral spring adjustment; refer to Figure 287.

Calibrating the Traction Pedal (continued)



g032216

Figure 287

1. Traction pedal
2. Pedal potentiometer
3. Compression spring
4. Spring shaft
5. Hex nut

C. Slowly rotate the spring shaft while watching the switch icons (Figure 287). When 1 of the switch icons closes, stop rotating the shaft and mark the shaft position.

D. Slowly rotate the shaft in the opposite direction until the second switch icon closes and mark the shaft position.

E. Rotate the spring shaft to the mid-point of the 2 shaft positions. Tighten the hex nut to attach the adjustment.

Note: At this setting, the indicator bar must be in between the NR and NF. Also, the neutral voltage value must be within 0.02 V of the midpoint voltage.

Note: When adjusting the traction pedal, the voltage values must be similar to the values in Figure 286. If you rotate the spring shaft too quickly during the adjustment, the voltage values can be considerably different than the values in the table.

6. Test the traction system operation.
7. Install the traction pedal cover and spring cover to the front platform; refer to Assembling the Traction Pedal (page 7–23).

Traction Pedal Teach

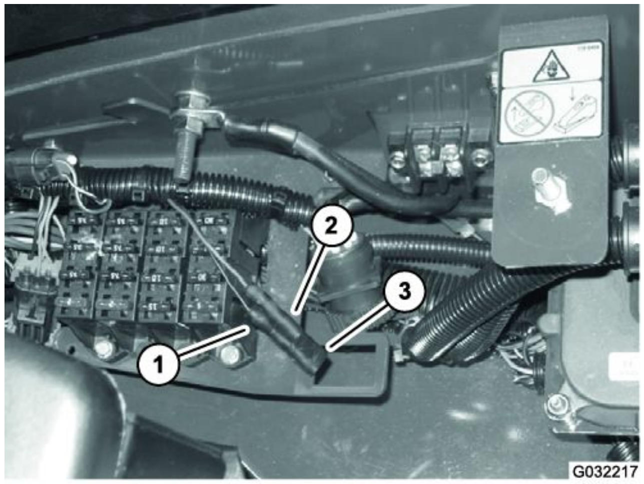


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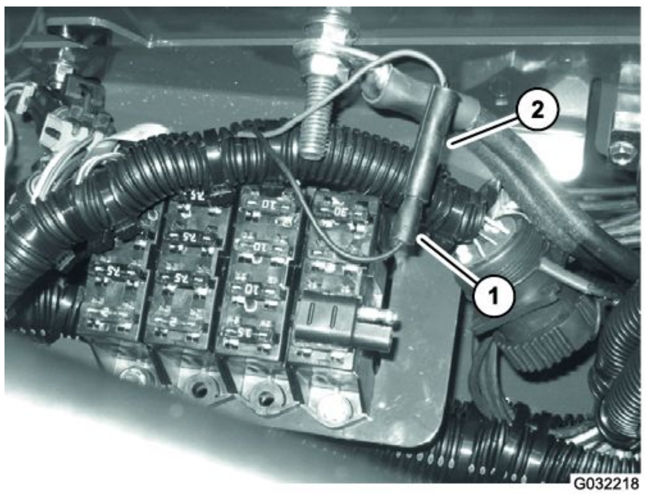
Figure 288

1. Male teach wire
2. Female teach wire
3. Termination cap



g032218

Figure 289

1. Remove the power center console located to the right of the operator seat.
2. Locate the wire harness termination cap that connects the 2 traction pedal teach wires; refer to Figure 288.
3. Remove the termination cap and connect the 2 teach wires together; refer to Figure 289.
4. Turn the key switch to the ON position but do not start the engine. The InfoCenter display will be in the TEACH mode. Follow the screen prompts and calibrate the traction potentiometer valves to the TEC-5002 controller.
5. After you complete the calibration, turn the key switch to the OFF position. Separate the 2 teach wires and connect the wire harness termination cap to the wires.
6. Install and attach the power center console.

Service and Repairs

Battery Storage

If you keep the machine for more than 30 days:

1. Remove the batteries and charge them fully; refer to Servicing the Battery (page 5–102).
2. Either keep the batteries on a shelf or on the machine.
3. Disconnect the cables if the batteries are kept on the machine.
4. Store the batteries in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To prevent the batteries from freezing, ensure that you charge them fully; refer to Servicing the Battery (page 5–102).

Battery Care

1. The battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where the temperatures are extremely high, the battery will discharge more rapidly than that of the machine is stored in a location where the temperatures are cool.

WARNING

The gases are explosive; also, they can cause nausea.

- **Wear safety goggles and rubber gloves when working with electrolyte. Charge the battery in a well ventilated place so that the gasses produced while charging can dissipate.**
- **Keep open flames and electrical sparks away from the battery; do not smoke.**
- **Disconnect the charger from the electrical outlet before connecting or disconnecting charger leads to or from the battery posts.**

IMPORTANT

Do not remove fill caps while cleaning.

2. Check the battery condition weekly or after every 50 hours of operation. Keep the terminals and full battery case clean because a dirty battery discharges slowly.
   A. Clean the battery by washing entire case with a solution of baking soda and water to clean the battery. Rinse with a clear water.
   B. Apply a layer of battery terminal protector (Toro Part No. 107-0392) or petroleum jelly to the battery posts and cable connectors to prevent corrosion.
3. Tighten the battery cables on the terminals to provide a good electrical contact.

Battery Care (continued)

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.

4. If corrosion occurs at the battery terminals, disconnect the cables. Always disconnect the negative (-) cables first. Clean the clamps and terminals separately. Connect the cables again with the positive (+) cables first. Apply a layer of battery terminal protector (Toro Part No. 107-0392) or petroleum jelly to the battery posts and cable connectors to prevent corrosion.
5. Check the electrolyte level every 25 operating hours, and every 30 days if the machine is in storage.
6. Maintain the cell level with the distilled or demineralized water.

   Note: Do not fill the cells above the fill line.

Servicing the Battery

The batteries are 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.

Specifications

Battery specifications	BCI Group Size 34 690 CCA at -17.8°C (0°F) Reserve Capacity of 110 minutes at 26.7°C (80°F)
Battery dimensions (including terminal posts)	Length 259 mm (10.2 inches) Width 168 mm (6.6 inches) Height 203 mm (8.0 inches)
Battery electrolyte specific gravity	Fully Charged: 1.265 corrected to 80°F (26.7°C) Discharged: less than 1.240

Removing and Installing the Battery

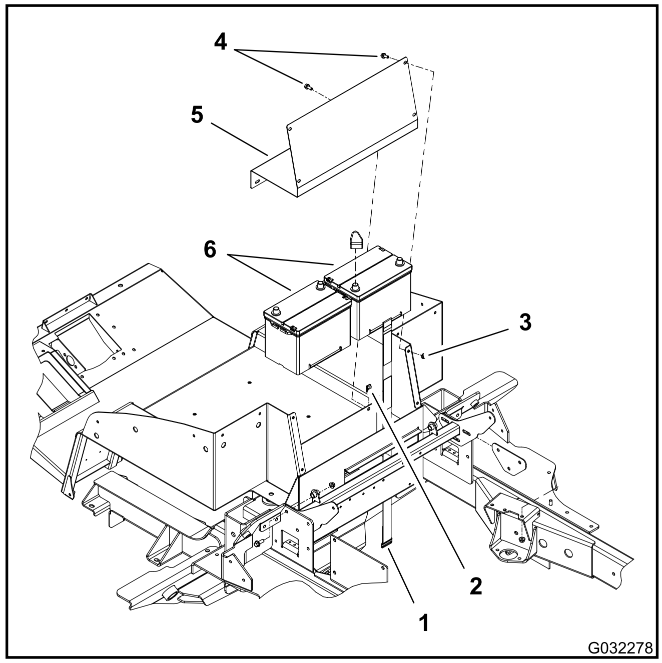


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Figure 290

1. Battery strap (2 each)
2. U-nut (2 each)
3. Flange nut (4 each)
4. Flange screw (6 each)
5. Battery panel
6. Battery (2 each)

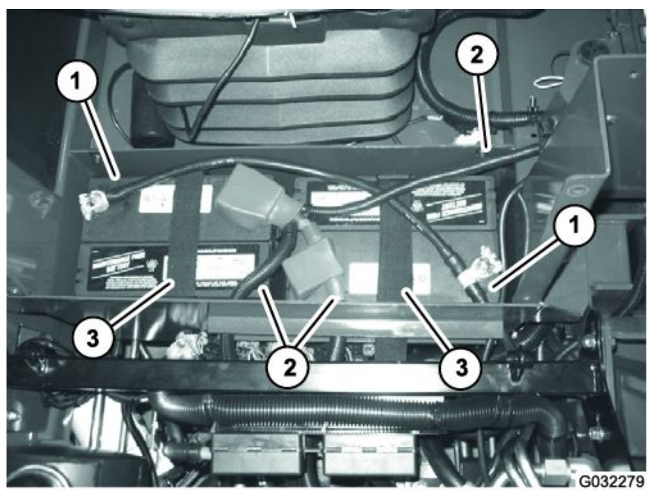

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Figure 291

1. Negative (-) cable
2. Positive (+) cable
3. Battery strap

1. Remove the fasteners that attach the battery panel to the machine.
2. Remove the panel to access the batteries.
3. Loosen and remove the negative cables from the batteries. After you remove the 2 negative cables, loosen and remove the positive cables.
4. Loosen the battery straps that attach the batteries to the machine.
5. Carefully remove the batteries from the machine.
6. Install the batteries in the reverse order.

Note: Ensure that you connect and tighten the 2 positive cables to the batteries before connecting the negative cables.

Note: Before connecting the negative (ground) cables to the battery, connect a digital multimeter (set to DC A) between the negative battery post and the negative (ground) cable connector. Ensure that the reading is less than 0.1 A. If the reading is 0.1 A or more, test and repair the electrical system of the machine for the short circuits or damaged components.

7. Attach the batteries with the battery straps.
8. Position the battery panel in place and attach it with the removed fasteners that were removed.

Inspecting, Maintaining, and Testing the Battery

1. Do the following inspections and maintenance:
   A. Check the battery case for cracks. Replace the battery if cracked or leaking.
   B. Check the battery terminal posts 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 tight.

   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 a baking soda and water, and then flush it with clean water.
   D. Check that the cover seal is not broken. Replace the battery if the seal is broken or leaking.
   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

Ensure that the area around the cells is clean before opening the battery 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 5.5°C (10°F) above 26.7°C (80°F) add 0.004 to the specific gravity reading. For each 5.5°C (10°F) below 26.7°C (80°F) subtract 0.004 from the specific gravity reading; refer to the Cell Specific Gravity Example (page 5–105).

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.

D. Charge at the rate and time given in Charging the Battery (page 5–106) or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell is less than 0.050. If you can not meet these charging conditions, replace the battery.

Cell Specific Gravity Example

Cell Temperature	100°F
Cell Specific Gravity	1.245
37.7°C minus 26.7°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 26.7°C (80°F)	1.253

3. Do a high-discharge test with an adjustable load tester. This is 1 of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is required to do this test.

CAUTION

Follow the load tester manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals before load testing the battery. If the voltage is less than 12.4 VDC, charge the battery.

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 battery cell.

E. Connect a battery load tester to the battery terminals following the load tester manufacturer's instructions. Connect a digital multimeter to the battery terminals.

F. Apply a test load of 345 A (1–1/2 the cranking performance rating of the battery) for 15 seconds.

G. Take a battery voltage reading at 15 seconds, then remove the test load. This reading is the test voltage.

H. Use the Minimum Voltage Table (page 5–106), determine the minimum voltage for the electrolyte temperature of the center battery cell.

Inspecting, Maintaining, and Testing the Battery (continued)

I. If the test voltage is below the minimum voltage in the Minimum Voltage Table (page 5–106), replace the battery. If the test voltage is at or above the minimum, return the battery to the service.

Minimum Voltage Table

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	–1.1°C
8.9	20°F	-6.7°C
8.7	10°F	-12.2°C
8.5	0°F	-17.8°C

Charging the Battery

To minimize damage to the battery and to allow the battery to charge fully, do the following slow charging procedure. You can do this charging procedure with a constant current battery charger that is readily available.

IMPORTANT

Follow the battery charger manufacturer's instructions when using a battery charger.

Note: Using specific gravity of the battery cells is the most accurate procedure of determining the battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.
2. Determine the charging time and rate using the battery charger manufacturer's instructions or the following Battery Charge Level Table (page 5–107).

⚠ CAUTION ⚠

Charging a frozen battery can cause explosion and can cause personal injury. Let the battery warm to 16°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 explosive gases can cause nausea.**
- **Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.**

Charging the Battery (continued)

3. Follow the battery charger manufacturer's instructions, connect the charger cables to the battery. Ensure that you make a good connection.
4. Charge the battery following the battery charger 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 and temporarily stop the charging rate.
6. Three hours before the end of the charging, 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 readings, 1 after the other.

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 Level Table

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	11.3hrs @ 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

Hydraulic Valve Solenoid Coil

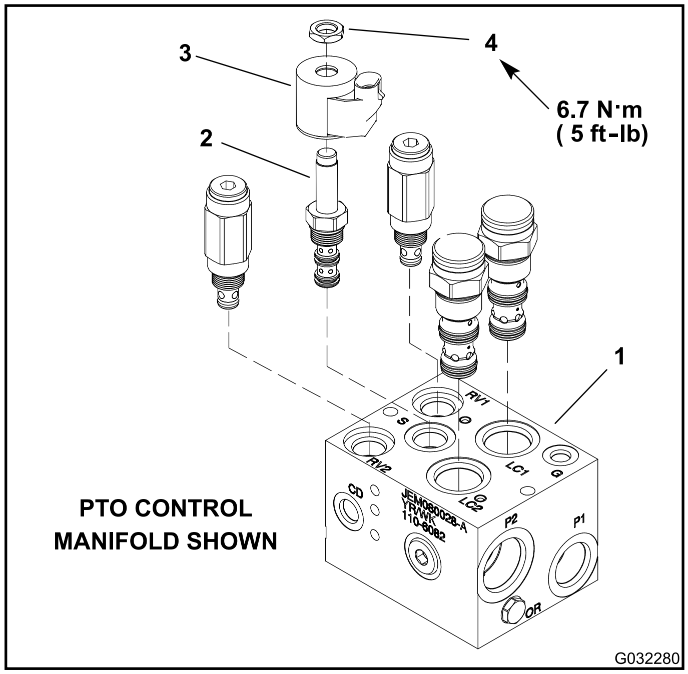

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Figure 292

1. Hydraulic manifold
2. Solenoid valve
3. Solenoid valve cell
4. Nut

You can replace a hydraulic valve solenoid coil on a hydraulic control manifold without opening the hydraulic system.

Removing the Hydraulic Valve Solenoid Coil

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Locate the solenoid valve coil that you replace.
3. Disconnect the wire harness electrical connector from the solenoid valve coil that you replace.
4. Remove the nut from the hydraulic valve.
5. Slide the solenoid coil from the valve.
6. Clean any corrosion or dirt from the valve stem.

Installing the Hydraulic Valve Solenoid Coil

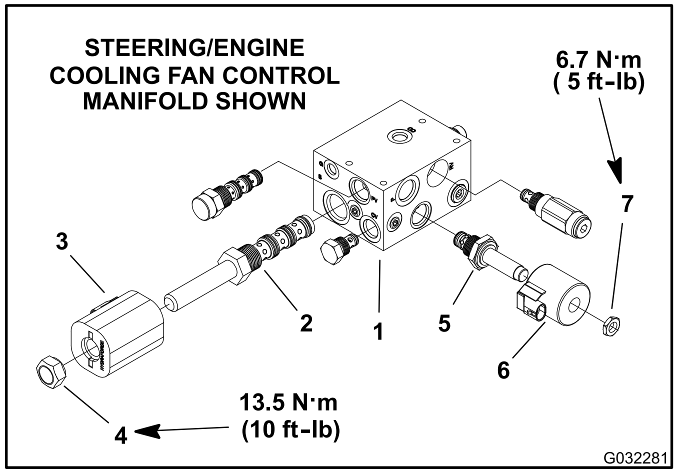

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Figure 293

1. Steering/fan manifold
2. Solenoid valve S
3. Solenoid valve coil
4. Nut
5. Solenoid valve PRV
6. Solenoid valve coil
7. Nut

1. Slide the new coil assembly onto the hydraulic valve.
2. Install the nut onto the valve and torque the nut as follows:

   A. For the solenoid valve S on the steering/engine cooling fan control manifold, torque the coil retaining nut to **13.5 N·m (10 ft-lb)**.

   B. For all other solenoid valves on the machine, torque the coil retaining nut to **6.7 N·m (5 ft-lb)**.

   Note: Do not overtighten the nut.
3. Connect the machine wire harness connector to the solenoid coil.

Chapter 6

Axles, Planetaries, and Brakes

Table of Contents

Specifications

Axles, Planetaries, and Brakes

Item	Specification
Tire pressure Front tire Rear tire	 345 kPa (50 psi) 207 kPa (30 psi)
Rear wheel toe-in	0 to 3.05 mm (0 to 0.120 inch)
Planetary gear drive oil Capacity (each planetary)	SAE 85W-140 weight gear lube 0.47 to .59 L (16 to 20 fl oz)
Wheel lug nut torque (front and rear)	115 to 135 N·m (85 to 100 ft-lb)
Steering cylinder slotted hex nut torque	41 to 61 N·m (30 to 45 ft-lb)
Steering tie rod slotted hex nut torque	48 to 67 N·m (35 to 50 ft-lb)
Planetary, Brake and Wheel Motor mounting screw torque: OPH-2 series planetary VA02 series planetary	 81 N·m (60 ft-lb) 101 to 115 N·m (75 to 85 ft-lb)
Front wheel motor mounting screw torque	102 to 115 N·m (75 to 85 ft-lb)
Rear wheel hub nut torque	428 to 522 N·m (315 to 385 ft-lb)

General Information

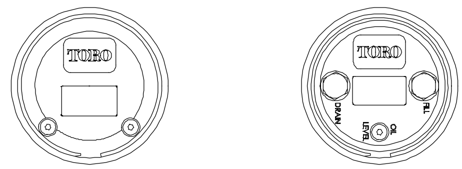
The *Operator's Manual* provides information regarding the operation, general maintenance, and maintenance intervals for your machine. Refer to the *Operator's Manual* for additional information when servicing the machine.

Adjustments

Planetary Drive Assembly Endplay (OPH-2 series planetary drives)

A front planetary drive assembly that is properly operating should have no endplay. Any endplay in a planetary assembly indicates that there are potential problems with the planetary. Check the planetary endplay at the maintenance intervals specified in the *Operator's Manual*.

Checking the Planetary Drive Assembly Endplay (OPH-2 series planetary drives)



OPH-2 series planetary   VA02 series planetary

g253951

Figure 294

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1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and remove the key from the key switch.

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to raise and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

---

2. Block the rear wheels with chocks and lift the front of the machine with a jack. Support the machine with jack stands; refer to the Jacking Instructions (page 1–5).
3. Hold the front wheel and check for endplay in the planetary assembly as indicated by the axial wheel movement. Ensure that there is no endplay in the assembly.
4. If any endplay is detected, disassemble, inspect, and service the planetary; refer to Servicing the OPH-2 Series Planetary Drive (page 6–17).
5. After you complete the planetary endplay check, lower the machine to the ground.

Service and Repairs

Wheels

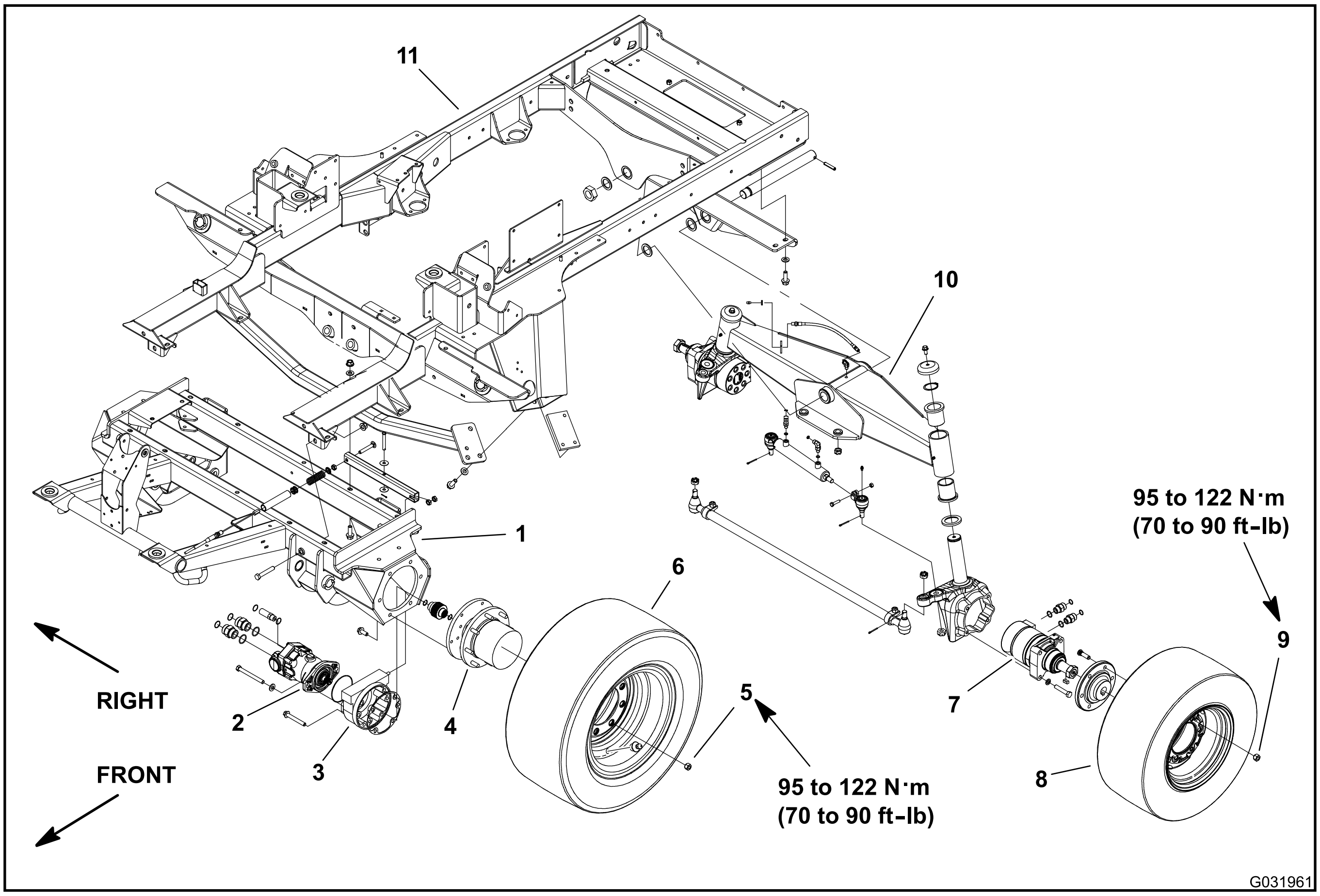

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Figure 295

1. Front axle frame
2. Front wheel motor
3. Brake assembly
4. Planetary assembly
5. Wheel lug nut (8 each front wheel)
6. Front wheel assembly
7. Rear wheel motor
8. Rear wheel assembly
9. Wheel lug nut (6 each rear wheel)
10. Rear axle
11. Main frame

Removing the Wheel

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the rear wheels with chocks to prevent the machine from moving.
3. Loosen, but do not remove the wheel-lug nuts that attach the wheel to the machine.

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

Properly support the machine with jack stands.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to lift and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

---

4. Lift the machine with a jack until the wheel to be removed is off the ground; refer to Jacking Instructions (page 1–5). Support the machine with appropriate jack stands.
5. Remove the wheel lug nuts and then remove the wheel from the machine.

Installing the Wheel

Note: The front wheel uses 8 wheel-lug nuts. The rear wheel uses 6 wheel-lug nuts.

1. Install the wheel and attach it with wheel-lug nuts.
2. Lower the machine to the ground.

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 lug nuts.

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3. Torque the wheel-lug nuts to **95 to 122 N·m (70 to 90 ft-lb)** in a crossing pattern.

Brake Assembly

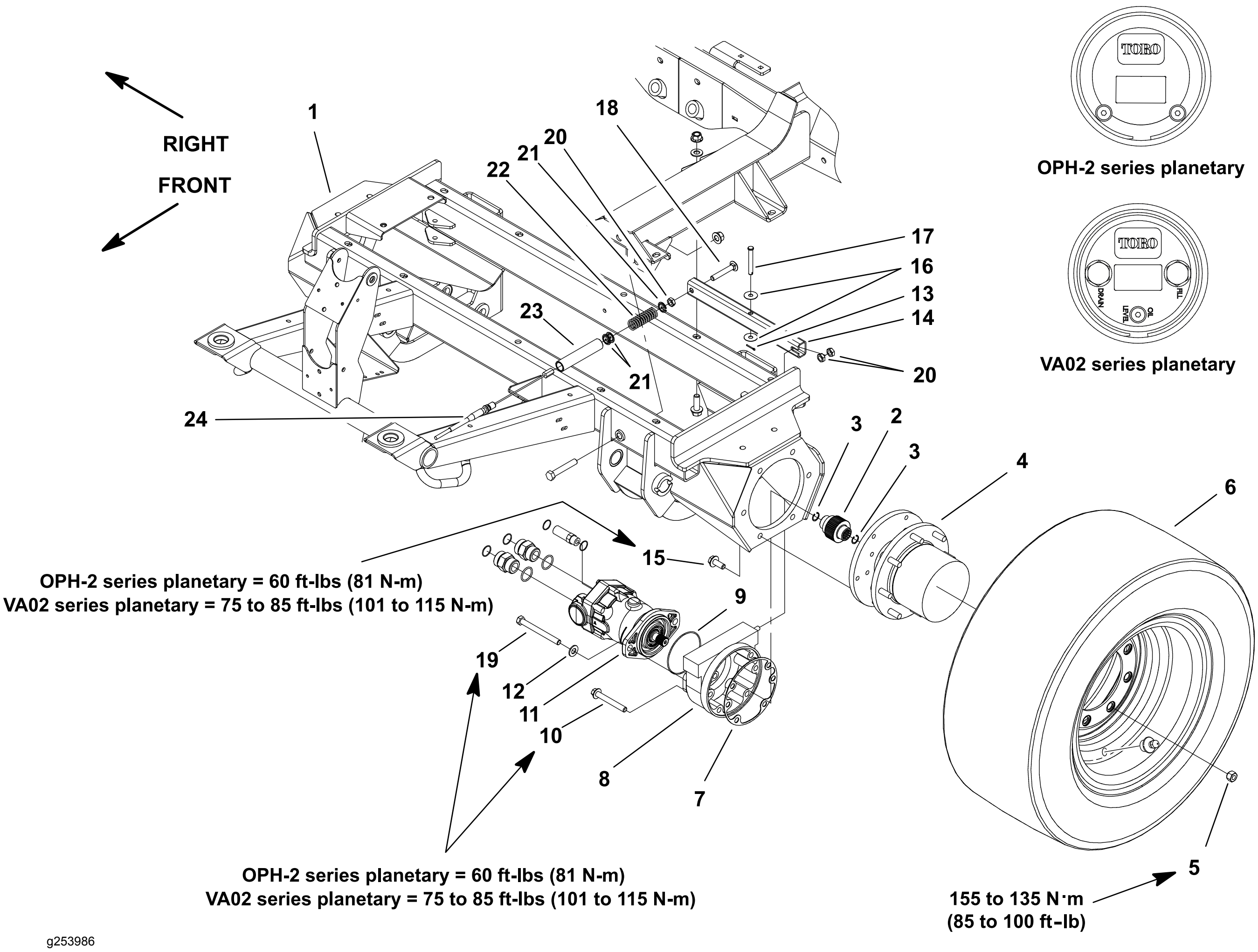

Figure 296

1. Front axle frame	9. O-ring	17. Clevis pin
2. Splined brake coupler	10. Flange-head screw (4 each side) OPH-2 planetary = 90 mm lg. VA02 planetary = 80 mm lg	18. Carriage screw
3. Retaining ring	11. Front wheel motor (2 each)	19. Bolt (2 each motor) OPH-2 planetary = 120 mm lg VA02 planetary = 110 mm lg
4. Planetary assembly (2 each)	12. Flat washer (2 each motor)	20. Jam nut
5. Wheel lug nut (8 each wheel)	13. Cotter pin	21. Spring plate
6. Front wheel assembly	14. Brake lever (2 each)	22. Compression spring
7. Gasket	15. Flange-head screw (6 each side)	23. Spacer
8. Brake assembly (left)	16. Washer	24. Brake cable (left)

Removing the Brake Assembly

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and remove the key from the key switch.

   Note: Do not set the parking brake.

2. Drain the oil from the planetary/brake assembly.
3. Block the rear wheels with chocks to prevent the machine from moving.

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

Properly support the machine with jack stands.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to lift and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

4. Lift the front of the machine with a jack until the wheel to be removed is off the ground. Support the machine with appropriate jack stands; refer to Jacking Instructions (page 1–5).
5. Remove the front wheel assembly.
6. Remove the hydraulic wheel motor; refer to Removing the Front Wheel Motors (page 4–121).
7. Remove the brake lever (item 14 in Figure 296) from the brake assembly pull rod as follows:
   A. Remove tension on the brake cable.
   B. Remove the cotter pin (item 13 in Figure 296) that secures the brake lever to the front axle frame.
   C. Slide the clevis pin (item 17 in Figure 296) outward from the axle frame bracket and brake lever.

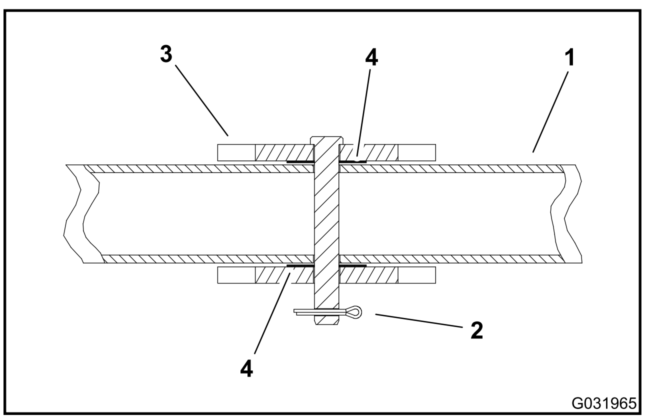

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Figure 297

1. Brake lever
2. Cotter pin
3. Frame bracket
4. Washer

   D. Remove the 2 washers (item 16 in Figure 296) that are installed between the brake lever and the frame bracket; refer to Figure 297.

Removing the Brake Assembly (continued)

E. Move the brake lever to the center of the machine to disengage the lever slot from the pull rod on the brake assembly.

F. Remove the 4 flange-head screws (item 10 in Figure 296) that attach the brake assembly to the machine, and remove the brake assembly from the machine.

Note: Do not drop the splined brake coupler (item 2 in Figure 296) while removing the brake assembly.

8. Remove and discard the gasket (item 7 in Figure 296).

Note: Ensure that you remove all the gasket material from the brake and planetary assemblies.

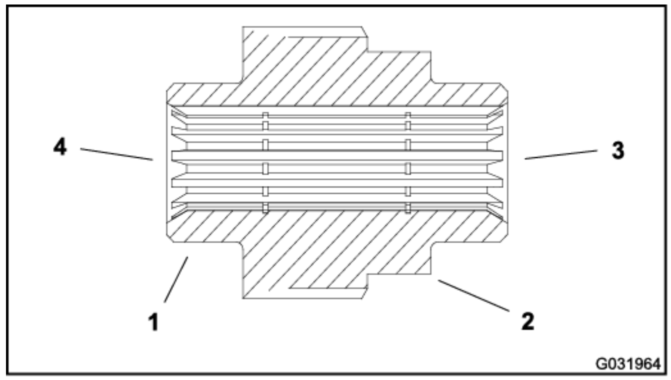

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Figure 298

1. Splined brake coupler
2. Brake coupler step
3. Hydraulic motor end
4. Planetary assembly end

9. Remove the splined brake coupler (item 2 in Figure 296).

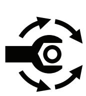
10. Remove and discard the gasket (item 7 in Figure 296). Make sure that all gasket material and sealant is removed from both the brake and the planetary assembly.

11. Complete the brake inspection and repair; refer to Servicing the Brake (page 6–12).

Installing the Brake Assembly

1. Ensure that the internal retaining rings are fully seated in the grooves of the splined brake coupler (item 2 in Figure 296). Slide the splined brake coupler into the brake assembly.

Note: You must install the stepped end of the coupler toward the hydraulic wheel motor; refer to Figure 298.



2. Apply the Loctite gasket sealant #2 (or equivalent) to the sealing surfaces of new gasket (item 7 in Figure 296). Align gasket and secure brake assembly to planetary.

- For OPH-2 series planetary drives: tighten screws to **81 N·m (60 ft-lb)**.
- For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft-lb)**.

Installing the Brake Assembly (continued)

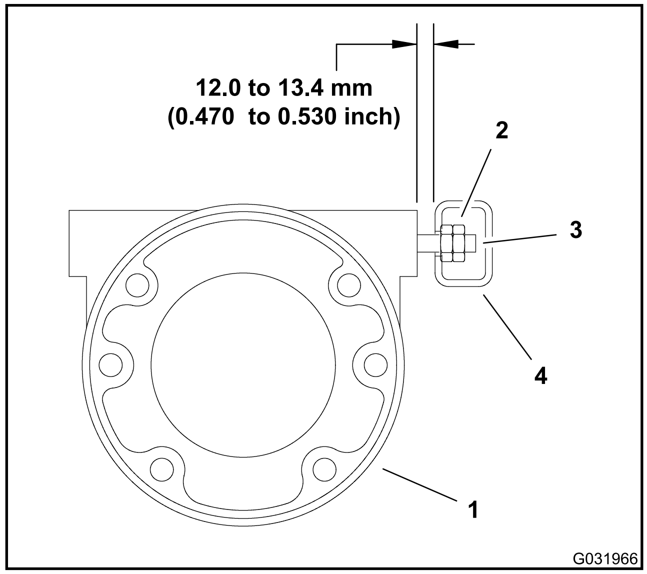


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Figure 299

1. Brake assembly
2. Jam nut (2 each)
3. Brake pull rod
4. Brake lever

3. Attach the brake lever (item 14 in Figure 296) to the brake pull rod as follows:
   A. Position the brake lever so that the brake lever slot fits around the pull rod on the brake assembly; refer to Figure 299.
   B. Place the 2 washers (item 16 in Figure 296) between the brake lever and the frame bracket; refer to Figure 297.
   C. Slide the clevis pin (item 17 in Figure 296) through the frame bracket, washers, and brake lever.
   D. Attach the brake lever to the front axle frame with the cotter pin (item 13 in Figure 296).
   E. After you complete the assembly, ensure that the brake lever rotates freely.

4. Make sure the wheel motor O-ring (item 9 in Figure 296) is in position and secure the wheel motor to the planetary with two (2) cap screws and flat washers.
   - For OPH-2 series planetary drives: tighten screws from **81 N·m (60 ft-lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft-lb)**.
5. Install the front wheel assembly.
6. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
7. Check and adjust brake cables for proper brake operation (see machine *Operator's Manual*).

Installing the Brake Assembly (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 lug nuts.

8. Lower machine to ground. Torque wheel lug nuts from **116 to 135 N·m (85 to 100 ft-lb)**.

Servicing the Brake

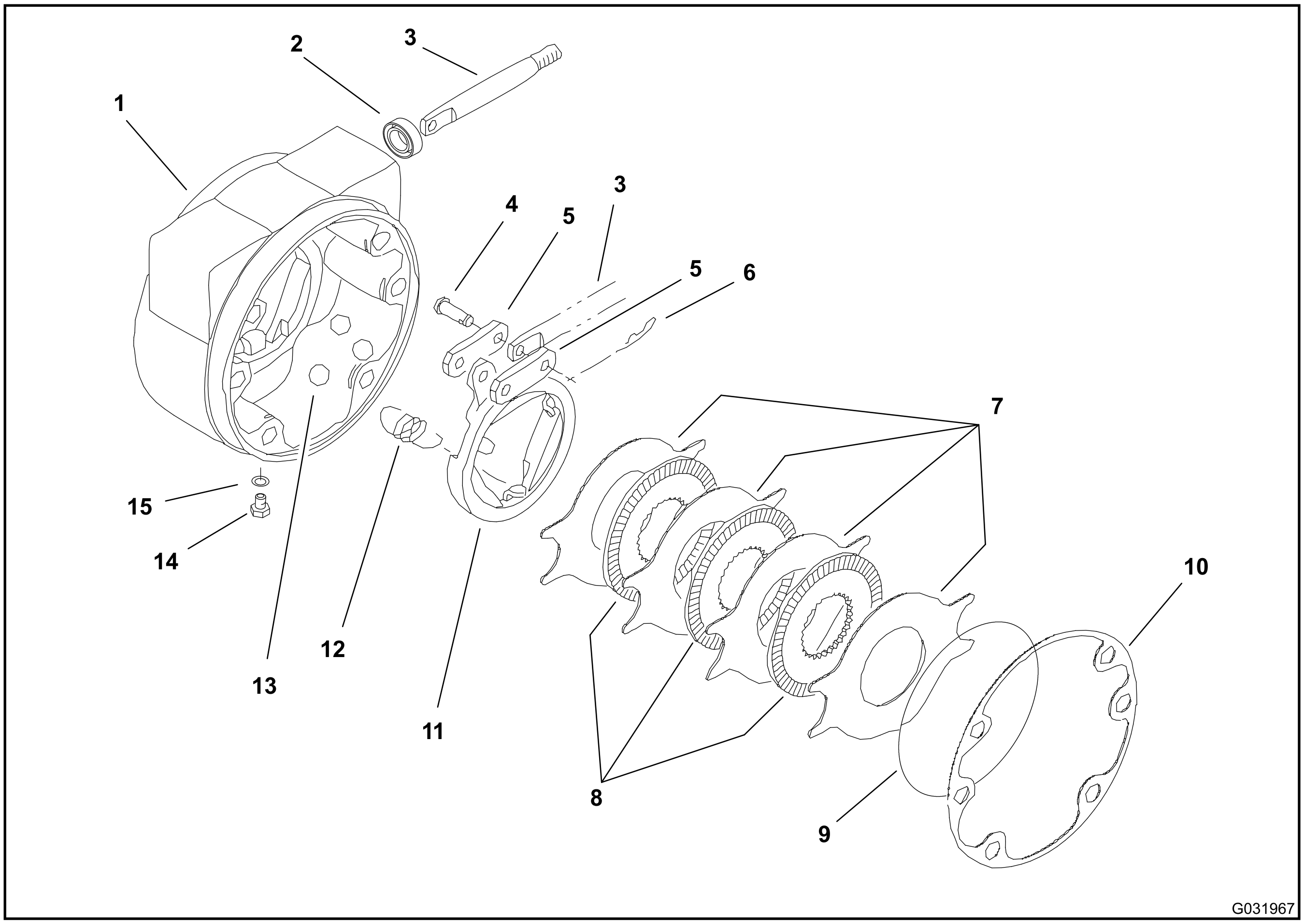

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Figure 300

1.	Brake housing (left)	6.	Hitch pin (2 each)	11.	Rotating actuator
2.	Seal	7.	Stationary disc (4 each)	12.	Extension spring (3 each)
3.	Pull rod	8.	Rotating disc (3 each)	13.	Ball (3 each)
4.	Clevis pin (2 each)	9.	Retaining ring	14.	Plug
5.	Link (2 each)	10.	Gasket	15.	O-ring

Disassembling the Brake

1. Discard the gasket material (item 10 in Figure 300) from the brake housing and planetary drive mounting surfaces.
2. Remove the retaining ring (item 9 in Figure 300) from the brake housing.
3. Remove the 4 stationary discs (item 7 in Figure 300) and 3 rotating discs (item 8 in Figure 300).
4. Remove the 3 extension springs (item 12 in Figure 300).
5. Remove the actuator assembly (items 11, 6, 5, 4, and 3 in Figure 300) and balls (item 13 in Figure 300).
6. Remove the seal (item 2 in Figure 300) from the brake housing. Discard the seal.

Inspecting the Brake

1. Wash the parts in cleaning solvent. Inspect the components for wear or damage.

Inspecting the Brake (continued)

2. Check that the stack of 4 stationary and 3 rotating discs have a minimum thickness of 11.2 mm (0.440 inch).

Assembling the Brake

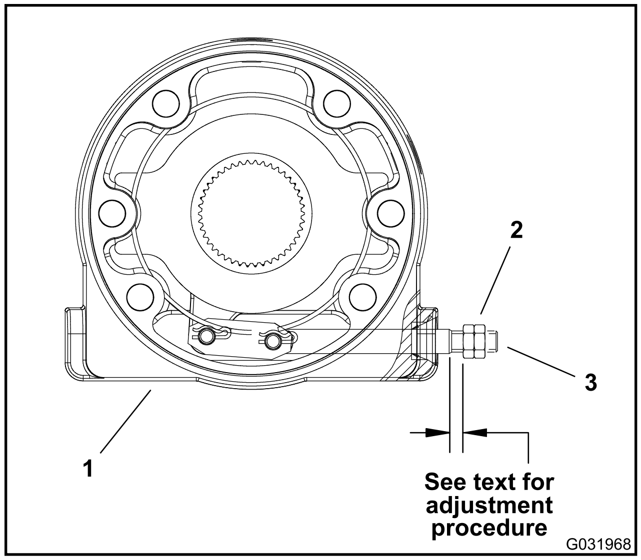

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Figure 301

1. Brake assembly
2. Jam nut (2 each)
3. Brake pull rod

---

1. Reverse the 2 through 6 to assemble the brakes, install new parts as necessary. Ensure that you install a new seal (item 2 in Figure 300).
2. When you install the jam nuts onto the brake pull rod, position the inner jam nut so that it is 3.0 mm (0.120 inch) from the step in the brake pull rod. From that point, loosen the inner jam nut 3 flats. While holding the inner jam nut in alignment with a wrench, install and tighten the outer jam nut; refer to Figure 301.

Planetary Drive Assembly

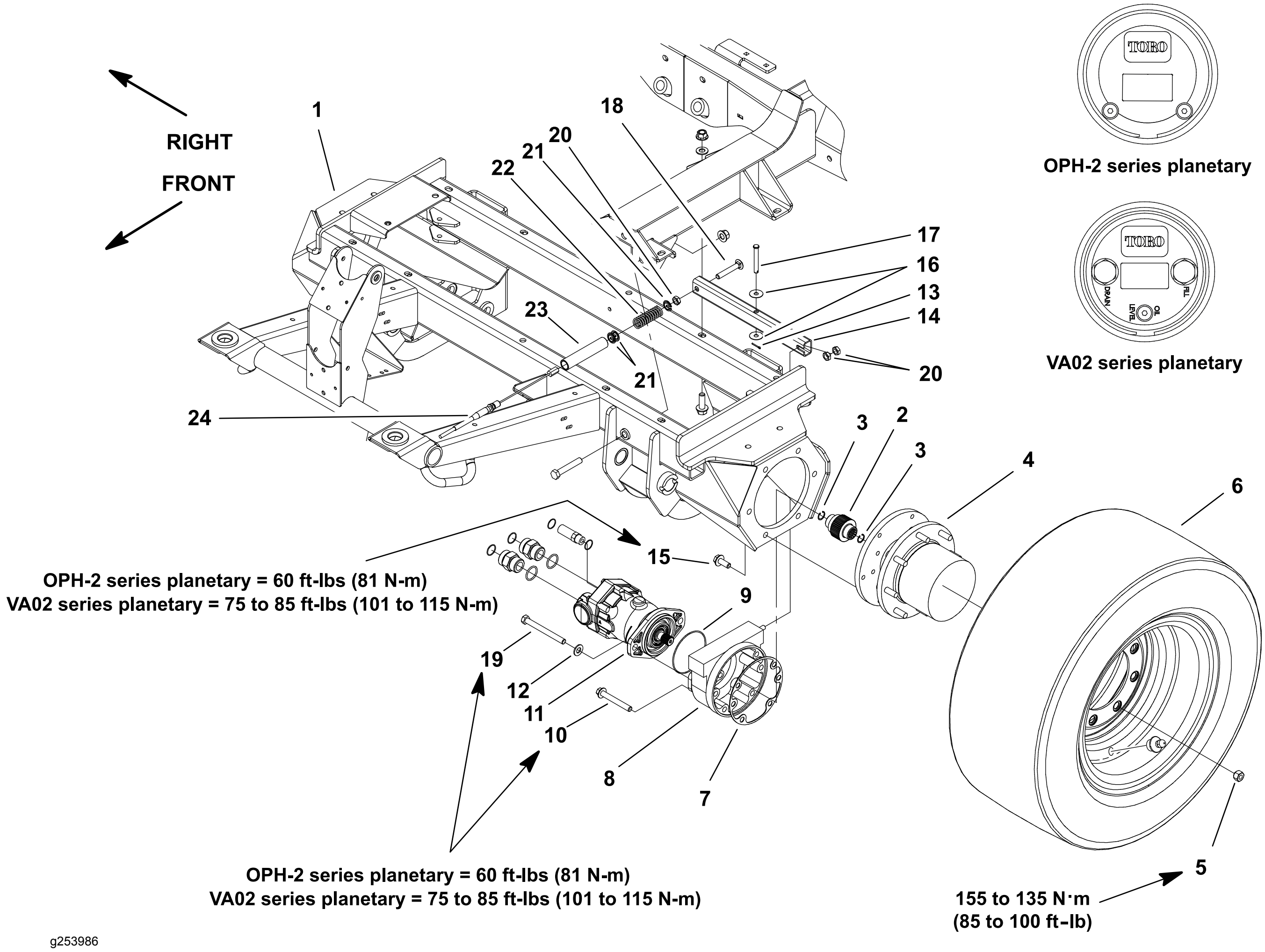

Figure 302

1.	Front axle frame	9.	O-ring	17.	Clevis pin
2.	Splined brake shaft	10.	Flange-head screw (4 each side) OPH-2 planetary = 90 mm lg. VA02 planetary = 80 mm lg	18.	Carriage screw
3.	Retaining ring	11.	Front wheel motor (2 each)	19.	Bolt (2 each motor) OPH-2 planetary = 120 mm lg VA02 planetary = 110 mm lg
4.	Planetary assembly (2 each)	12.	Flat washer (2 each motor)	20.	Jam nut
5.	Wheel lug nut (8 each wheel)	13.	Cotter pin	21.	Spring plate
6.	Front wheel assembly	14.	Brake lever (2 each)	22.	Compression spring
7.	Gasket	15.	Flange-head screw (6 each side)	23.	Spacer
8.	Brake assembly (left)	16.	Washer	24.	Brake cable (left)

Note: The planetary drive assembly can be serviced with the planetary installed to machine (see Planetary Drive Service in this section). Use the following procedure to remove and install the planetary drive assembly from machine.

Removing the Planetary Drive Assembly

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, and remove the key from the key switch.

   Note: Do not set the parking brake.

Removing the Planetary Drive Assembly (continued)

2. Drain oil from the planetary drive/brake assembly.
3. Block the rear wheels with chocks to prevent the machine from moving.

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

Properly support the machine with jack stands.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to lift and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

---

4. Lift the front of the machine with a jack. Support the machine with appropriate jack stands; refer to Jacking Instructions (page 1–5).
5. Remove the front wheel assembly.
6. Remove the hydraulic wheel motor; refer to Removing the Front Wheel Motors (page 4–121).
7. Remove the brake assembly; refer to Removing the Brake Assembly (page 6–7).
8. Support the planetary assembly to prevent the assembly from falling. Loosen and remove the 6 flange-head screws that attach the planetary assembly to the frame. Remove the planetary assembly from the machine.
9. Remove and discard the gasket (item 7 in Figure 302).

   Note: Ensure that all the gasket material and sealant is removed from the brake and planetary assemblies.

Installing the Planetary Wheel Drive Assembly

1. Position the planetary assembly to the machine frame. Install the 6 flange-head screws that attach the planetary assembly to the frame.
   - For OPH-2 series planetary drives: tighten screws to **81 N·m (60 ft-lb)**.
   - For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft-lb)**.
2. Apply the Loctite gasket sealant #2 (or equivalent) to the sealing surfaces of a new gasket (item 7 in Figure 302). Install the new gasket to the brake assembly.
3. Install the brake assembly; refer to Installing the Brake Assembly (page 6–9).
4. Make sure wheel motor O-ring (item 9 in Figure 302) is in position and secure wheel motor to planetary with two (2) cap screws and flat washers.

Installing the Planetary Wheel Drive Assembly (continued)

- For OPH-2 series planetary drives: tighten screws to **81 N·m (60 ft-lb)**.
- For VA02 series planetary drives: tighten screws from **101 to 115 N·m (75 to 85 ft-lb)**.

5. Install the front wheel assembly.
6. Fill planetary drive with gear lube; refer to traction unit Operator's Manual. A portion of the gear lube will pass into the brake assembly automatically.
7. Check for proper brake operation and adjust brake cables if necessary.

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 lug nuts.

8. Lower machine to ground. Torque wheel lug nuts from 85 to 100 ft-lb (116 to 135 N-m).

Servicing the OPH-2 Series Planetary Drive

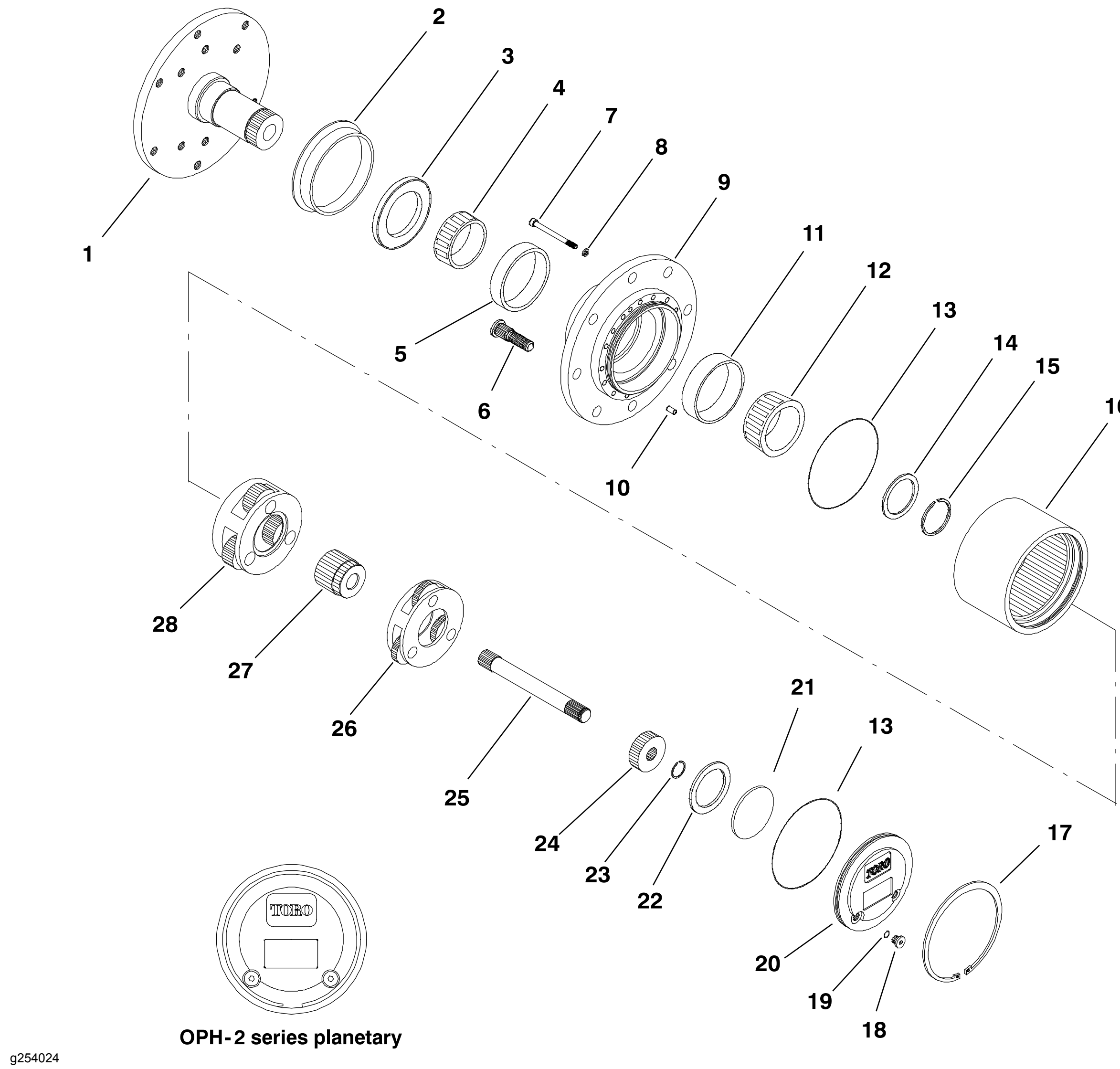

Figure 303

1. Spindle	11. Outer bearing cup	21. Thrust plug
2. Boot seal	12. Outer bearing cone	22. Thrust washer
3. Oil seal	13. O-ring	23. Retaining ring
4. Inner bearing cone	14. Thrust washer	24. Primary gear
5. Inner bearing cup	15. Retaining ring (external)	25. Driveshaft
6. Wheel stud (8 each)	16. Ring gear	26. Primary carrier assembly
7. Socket-head screw (16 each)	17. Retaining ring (internal)	27. Secondary gear
8. Lock washer (16 each)	18. Plug (2 each)	28. Secondary carrier assembly
9. Housing	19. O-ring (2 each)	
10. Dowel pin (2 each)	20. End cap	

Note: The planetary drive assembly can be serviced with the planetary installed to machine. If the spindle (item 1 in Figure 303) needs to be removed; refer to Planetary Drive Assembly (page 6–14).

Disassembling the OPH-2 Series Planetary Drive

1. Park machine on a level surface, stop engine and remove key from the ignition switch.

Disassembling the OPH-2 Series Planetary Drive (continued)

2. Drain oil from planetary drive/brake assembly; refer to traction unit Operator's Manual.
3. Chock rear wheels and jack up front of machine; refer to Jacking Instructions (page 1–5). Support machine with jack stands and remove the front wheel assembly.

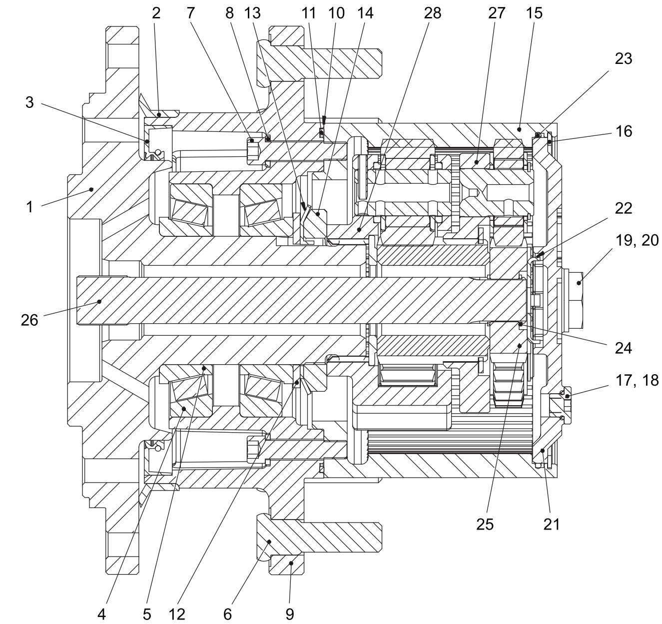

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Figure 304

1. Spindle
2. Boot seal
3. Oil seal
4. Inner bearing cone
5. Inner bearing cup
6. Wheel stud (8)
7. Socket head screw (16)
8. Lock washer (16)
9. Housing
10. Dowel pin (2)
11. Outer bearing cup
12. Outer bearing cone
13. O-ring
14. Thrust washer
15. Retaining ring (external)
16. Ring gear
17. Retaining ring (internal)
18. Plug (2)
19. O-ring (2)
20. End cap
21. Thrust plug
22. Thrust washer
23. Retaining ring
24. Primary gear
25. Drive shaft
26. Primary carrier assy.
27. Secondary gear
28. Secondary carrier assy

4. Remove the retaining ring (item 17).
5. Remove the end cap (item 20).
6. Remove the thrust plug (item 21) and thrust washer (item 22) that remain in the end cap bore for cleaning and inspection.
7. Remove the driveshaft assembly (items 23, 24, and 25). If necessary, remove the retaining ring and primary gear from the shaft.
8. Remove the primary carrier (item 26), secondary gear (item 27), and secondary carrier (item 28).

   Note: Steps 9 through 13 are necessary only when you do the inspection or replace the bearings and/or seals.

Disassembling the OPH-2 Series Planetary Drive (continued)

IMPORTANT

Do not use the retaining ring (item 15) again after removal.

9. Remove the retaining ring (item 15) and thrust washer (item 14). Discard the retaining ring.
10. Carefully remove the housing (item 9) from the spindle (item 1). Remove the outer bearing cone (item 12).
11. Remove and discard the seals (items 2 and 3) and O-rings (item 13) from the housing.
12. Remove the inner bearing cone (item 4) from the housing. If necessary, remove the bearing cups (items 5 and 11) from the housing.
13. If you must remove the wheel stud (item 6), use a press to remove the stud(s) from the housing.
14. If necessary, remove the socket-head screws (item 7) with lock washers (item 8) that attach the ring gear (item 16) to the housing. Remove the ring gear and 2 dowel pins (item 10) from the housing.

Assembling the OPH-2 Series Planetary Drive

1. Clean the parts in solvent and dry the parts after cleaning. Inspect the parts for damage or excessive wear and replace as necessary.
2. If any wheel studs were removed, use a press to install new studs into the housing.

   Note: Ensure that you press the stud shoulder fully against the housing surface.

   Note: Use new seal and shim kits when assembling the planetary drive.
3. If the spindle and housing were separated, do the following steps:

   A. Press the bearing cups (items 5 and 11) into the housing (item 9).

      Note: Ensure that you fully press the cups to the shoulder of the housing bore.

   B. Set the inner bearing cone (item 4) into the inner bearing cup.

   C. Clean the seal bore in the housing.

   D. If the OD (outer diameter) of the oil seal (item 3) is not rubber or does not have a sealant coat, apply a light coat of silicone sealant to the seal bore in the housing. Install the seal into the housing so that it is flush with the housing face. Lightly grease the seal lips.

   E. Pack the boot seal (item 2) with grease and install it on the housing.

   F. If the ring gear was removed from the housing, place the dowel pins (item 10) in the housing. Attach the ring gear to the housing with lock washers (item 8) and socket-head screws (item 7); torque the socket-head screws to **13.3 to 16.3 N·m (118 to 144 in-lb)**.

   G. Lightly oil the bearing journals on the spindle shaft. Slide the housing assembly onto the spindle (item 1) and ensure that you do not damage the seal or spindle.

      Note: Ensure that the inner bearing in the housing fully seats against the spindle shaft shoulder.

   H. Install the outer bearing cone (item 12) onto the spindle.

Note: The planetary shim kit includes the retaining ring and several thrust washers with the thickness in incremental steps of 0.10 mm (0.004 inch).

I. Measure the thickness of the thrust washer (item 14) that was removed during disassembly. Choose a new thrust washer of equal thickness or the next available thickness from the thrust washers in the shim kit.

J. Apply a light coat of oil to the spindle shaft, thrust washer (item 14), and new retaining ring (item 15). Install the thrust washer onto the spindle shaft.

WARNING

Failing to fully install the retaining ring (item 15) in the spindle groove could result in loss of wheel and personal injury.

K. Carefully install the new retaining ring (item 15) into the spindle shaft groove and ensure not to distort the ring.

Note: If a correct thrust washer is installed, the retaining ring fits tightly between the thrust washer and the spindle groove. Tap the OD (outer diameter) of the retaining ring that start in the center and working out toward each end to ensure that the retaining ring is correctly seated into the spindle groove. Ensure that the retaining ring ID (inner diameter) is fully seated to the spindle shaft groove.

L. After the retaining ring is installed, ensure that there is no endplay in the assembly. If necessary, remove the retaining ring and install a thrust washer of different thickness to adjust endplay.

M. Install a new O-ring (item 13) into the groove in the housing.

4. Install the secondary carrier (item 28), secondary gear (item 27), and primary carrier (item 26) ensuring that the carrier gear teeth align with the ring gear and spline on the spindle shaft.
5. If the primary gear (item 24) is removed from the driveshaft, slide the gear onto the shaft and attach it with the retaining ring (item 23).
6. Install the driveshaft assembly (items 25, 24 and 23). Ensure that the driveshaft spline aligns with the carrier gears.
7. Install the thrust plug (item 21) and thrust washer (item 22) into the end cap (item 20). Ensure that the thrust plug and thrust washer are captive on inside of the end cap (item 20).
8. Install a new O-ring (item 13) and then install the end cap. Attach the cap with the retaining ring (item 17).
9. Check the operation of the planetary drive. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, the gears are not rolling freely, then examine the planetary for incorrect assembly or damaged components.
10. Install the wheel assembly.
11. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
12. Test planetary drive operation.

Assembling the OPH-2 Series Planetary Drive (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 lug nuts.

13. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **116 to 135 N·m (85 to 100 ft-lb)**.

Servicing the VA02 Series Planetary Drive

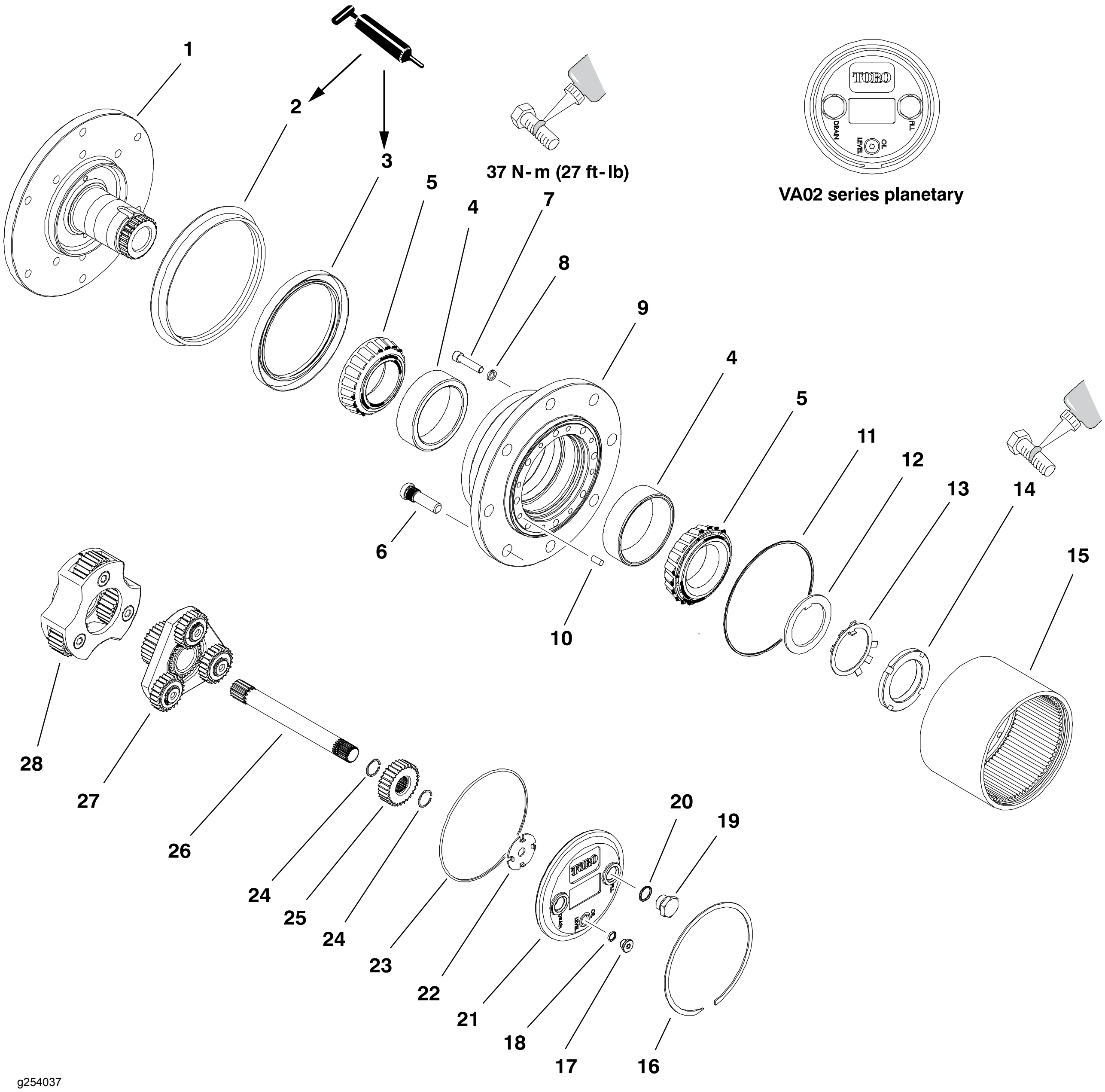

Figure 305

1. Spindle
2. Boot seal
3. Lip seal
4. Inner bearing cup (2 each)
5. Inner bearing cone (2 each)
6. Wheel stud (8 each)
7. Socket-head screw (16 each)
8. Lock washer (16 each)
9. Housing
10. Dowel pin (4 each)
11. O-ring
12. Spacer
13. Locking washer
14. Lock nut
15. Ring gear
16. Retaining ring (internal)
17. Plug
18. O-ring
19. Plug (2 each)
20. O-ring (2 each)
21. End cap
22. Thrust plate
23. O-ring
24. Retaining ring (2 each)
25. Primary gear
26. Drive shaft
27. Primary carrier assembly
28. Secondary carrier assembly

Note: The planetary drive assembly can be serviced with the planetary installed to machine. If the spindle (item 1 inFigure 305) needs to be removed; refer to Planetary Drive Assembly (page 6–14).

Disassembling the VA02 Series Planetary Drive

1. Park machine on a level surface, stop engine and remove key from the ignition switch.
2. Drain oil from planetary drive and brake assembly; refer to traction unit *Operator's Manual*.
3. Chock the rear wheels and jack up the front of the machine; refer to Jacking Instructions (page 1–5). Support machine with jack stands and remove rear wheel assembly.

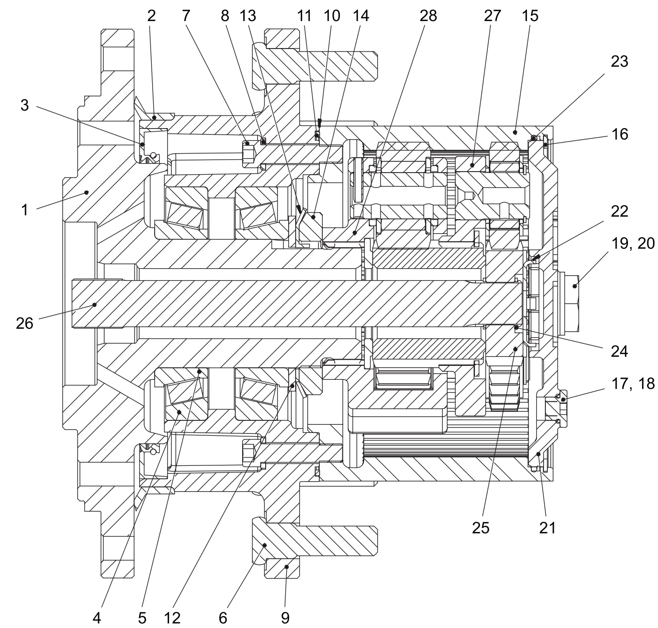

Figure 306

1. Spindle
2. Boot seal
3. Lip seal
4. Inner bearing cup (2 each)
5. Inner bearing cone (2 each)
6. Wheel stud (8 each)
7. Socket-head screw (16 each)
8. Lock washer (16 each)
9. Housing
10. Dowel pin (4 each)
11. O-ring
12. Spacer
13. Locking washer
14. Lock nut
15. Ring gear
16. Retaining ring (internal)
17. Plug
18. O-ring
19. Plug (2 each)
20. O-ring (2 each)
21. End cap
22. Thrust plate
23. O-ring
24. Retaining ring (2 each)
25. Primary gear
26. Drive shaft
27. Primary carrier assembly
28. Secondary carrier assembly

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4. Remove retaining ring (item 16).
5. Remove end cap and thrust plate. Retrieve and discard O-ring from ring gear bore.
6. Remove primary gear and drive shaft assembly (items 24-26).
7. Remove primary carrier and secondary carrier from ring gear.
8. Bend the locking washer tab away from the lock nut. Use a TMFS12 spanner socket to remove the 55 x 1.5 mm lock nut. Remove the locking washer and spacer. Discard the locking washer.
9. Carefully remove housing and bearing cones from spindle.

Disassembling the VA02 Series Planetary Drive (continued)

10. Remove and discard seals from housing.
11. If necessary, remove bearing cups from housing.
12. If wheel stud removal is necessary, use a press to remove the stud(s) from the housing.
13. If necessary, remove the ring gear from the housing:

    Note: High strength thread locking compound was used during assembly. It may be necessary to heat the ring gear near the mounting screws to release the screws.

    A. Remove socket head screws (item 7) and lock washers that secure the ring gear to the housing.

    B. Remove the ring gear and retrieve the four (4) dowel pins (item 10) from housing.

    C. Remove the O-ring from the housing bore and discard.

Assembling the VA02 Series Planetary Drive

Note: Use new seals, O-rings and locking washer when assembling the planetary drive.

1. Thoroughly clean parts in solvent and dry completely after cleaning. Inspect parts for damage or excessive wear and replace as necessary.
2. If any wheel studs were removed, use a press to install new studs into housing. Make sure that stud shoulder is fully pressed against housing surface.
3. If ring gear was removed from housing:

    A. Fit four (4) dowel pins in housing.

    B. Apply a light coat of grease to a new O-ring and install it in the housing bore.

    C. Apply high strength thread locking compound and secure ring gear to housing with lock washers and socket head screws. Tighten screws to **37 N·m (27 ft-lb)**.

4. If previously removed, press bearing cups into housing. Cups should be pressed fully to shoulder of the housing bore.
5. Fit inner bearing cone onto spindle. Make sure inner bearing cone seats fully against spindle shoulder. If inner bearing is not seated fully, lightly tap bearing cone on inner hub until it seats properly.
6. Make sure that seal bore in housing is thoroughly cleaned. If OD of seal is not rubber or does not have a sealant coating, apply a light coating of silicone sealant to seal bore in housing. Install seal into housing so it is flush with housing face.
7. Install boot seal. Cover surface of lip seal and boot seal with grease.
8. Lightly oil bearing cups then place housing assembly over spindle and inner bearing cone. Take care to not damage seals or spindle during installation.
9. Fit outer bearing cone onto spindle.
10. Align key on spacer and install spacer onto spindle shaft.
11. Align key on locking washer and install locking washer onto spindle shaft.

IMPORTANT

Perform the following steps without interruption. Once the thread locking compound is applied, you have only a few minutes before the curing process will influence the bearing lock nut torque.

12. Install the bearing lock nut:
    A. Apply high strength thread locking compound (Loctite 263 or equivalent) and install the lock nut.
    B. Tighten the lock nut to **150 N·m (110 ft-lb)**.
    C. Rotate the housing on the spindle a few revolutions to align the bearings.
    D. Tighten the lock nut to **200 N·m (150 ft-lb)**.
    E. Rotate the housing on the spindle a few revolutions to seat the bearings.

IMPORTANT

If installing the bearing nut with the spindle installed on machine, have an assistant hold the housing firmly in position during the following step.

    F. Loosen the lock nut completely, then tighten to **122 N·m (90 ft-lb)**.

IMPORTANT

Continue to tighten the lock nut until it aligns with one of the locking washer tabs. Do Not loosen the lock nut to align it with the locking washer tabs.

    G. Secure the lock nut by bending one of the locking washer tabs into a slot in the lock nut.
13. Install secondary carrier and primary carrier making sure that carrier gear teeth align with ring gear and spline on spindle shaft.
14. If primary gear (item 25) was removed from drive shaft, slide gear onto shaft and secure with retaining rings.
15. Install drive shaft assembly (items 24-26) making sure that drive shaft spline aligns with carrier gears.
16. Cover the outer face of the thrust plate with grease and fit thrust plate onto end cap. Make sure that thrust plate tabs are captive in end cap.
17. Apply a light coat of grease to a new O-ring and install it in the ring gear bore. Avoid pinching or cutting the O-ring and install the end cap. Use a soft mallet to fully seat the end cap.
18. Secure the end cap with the retaining ring. Make sure the retaining ring is fully seated in the ring groove.
19. Check operation of planetary drive by hand. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

Assembling the VA02 Series Planetary Drive (continued)

20. Install the front wheel assembly.
21. Fill planetary drive with gear lube; refer to traction unit *Operator's Manual*. A portion of the gear lube will pass into the brake assembly automatically.
22. Test planetary drive operation.

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.

23. Remove jack stands and lower machine to ground. Tighten wheel lug nuts in a crossing pattern from **116 to 135 N·m (85 to 100 ft-lb)**.

Rear Axle

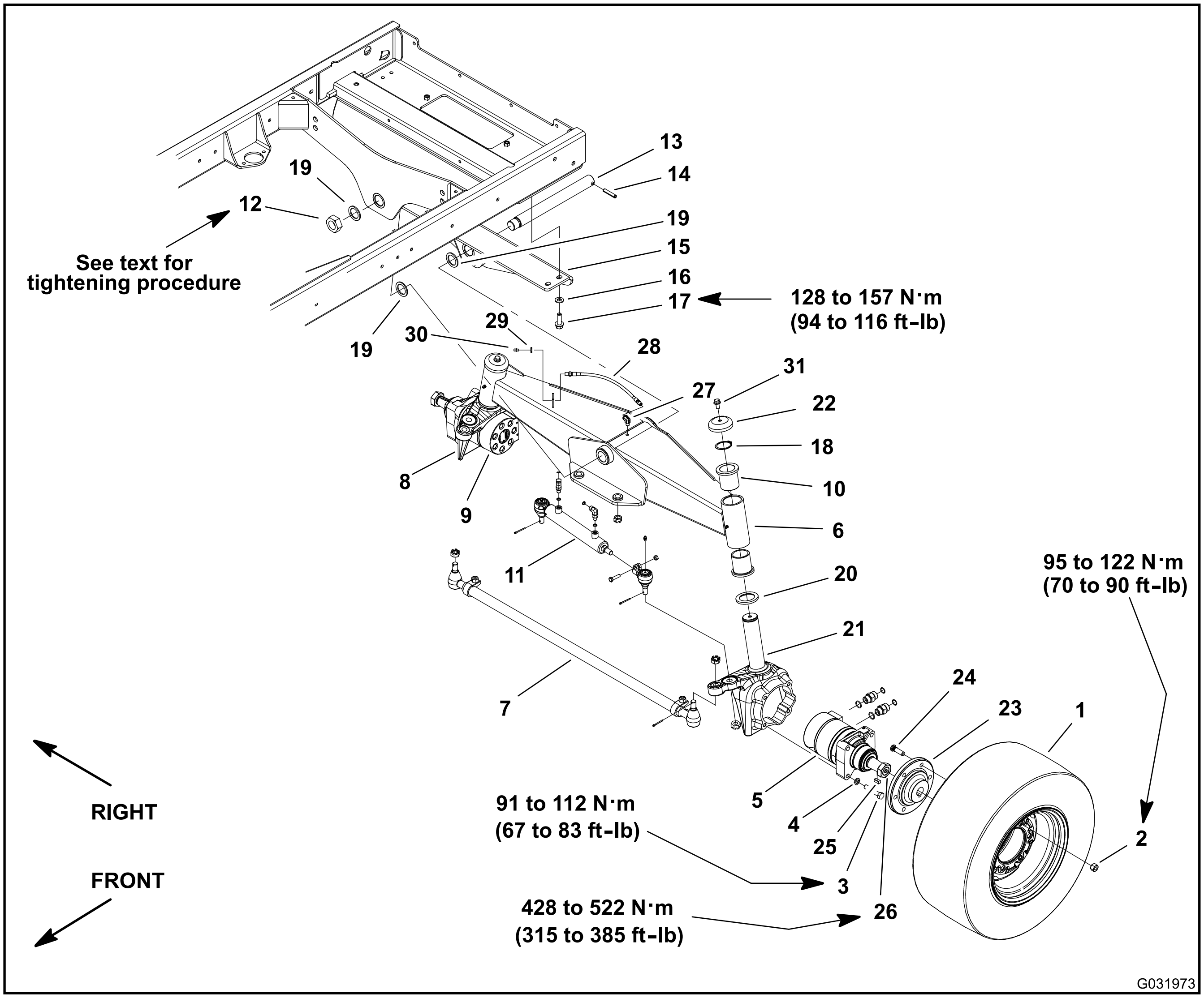

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Figure 307

1. Rear wheel assembly
2. Wheel lug nut (6 each wheel)
3. Bolt (4 each motor)
4. Lock washer (4 each motor)
5. Left wheel motor
6. Rear axle
7. Tie rod
8. Right spindle
9. Right wheel motor
10. Flange bushing (4 each)
11. Steering cylinder (2 each)
12. Locknut
13. Axle pivot shaft
14. Roll pin
15. Axle support
16. Flat washer (4 each)
17. Flange-head screw (4 each)
18. Retaining ring
19. Thrust washer (3 each)
20. Thrust washer
21. Left spindle
22. Spindle cap
23. Wheel hub
24. Wheel stud (6 each hub)
25. Square key
26. Hex nut
27. Elbow
28. Hose
29. Nut
30. Grease fitting
31. Flange-head screw

Removing the Rear Axle

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Block the front wheels with chocks to prevent the machine from moving.

Removing the Rear Axle (continued)

3. Clean the hydraulic hose ends and fittings on the steering cylinders and rear wheel motors to prevent hydraulic system contamination.

   Note: For easy assembly, label the hydraulic hoses to locate their correct position on the steering cylinders and rear wheel motors.

4. Disconnect the hydraulic hoses from the steering cylinders and rear wheel motors. Install caps or plugs on all the fittings and hoses to prevent contamination.

5. Remove the locknut (item 12 in Figure 307) and thrust washer (item 19 in Figure 307) that secures the axle pivot shaft (item 13 in Figure 307) to the frame.

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

Properly support the machine with jack stands.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to lift and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

6. Lift the machine with a jack (just ahead of the rear wheels) until the clearance exists to allow rear axle removal. Support the machine with appropriate jack stands to prevent it from falling.

7. Support the rear axle to prevent it from falling.

8. Pull the axle pivot shaft from the frame and rear axle. This releases the rear axle and 2 thrust washers (item 19 in Figure 307) from the frame. Carefully lower the entire axle assembly and remove it from under the machine.

   Note: If necessary, service the rear wheel motors or steering cylinders; refer to the Service and Repairs (page 4–95).

Installing the Rear axle

1. Clean the rear axle pivot shaft. Inspect the shaft for wear or damage and replace it if necessary.

2. Position the rear axle assembly to the frame. Install the thrust washer (item 19 in Figure 307) between each side of the axle and frame. Lift the axle assembly to the frame and slide the pivot shaft through the frame, thrust washers, and axle. Ensure that the roll pin on the pivot shaft is positioned in frame reliefs.

3. Install a thrust washer (item 19 in Figure 307) and locknut (item 12 in Figure 307) onto the pivot shaft. Tighten the locknut to eliminate any axial

movement of the rear axle. Ensure that the axle can still pivot freely after you tighten the locknut.

4. Lower the machine to the ground.
5. Correctly install the hydraulic hoses to the steering cylinders and rear wheel motors.

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 lug nuts.

6. Torque the wheel-lug nuts to **95 to 122 N·m (70 to 90 ft-lb)**.
7. Check the hydraulic-fluid level in the hydraulic reservoir.
8. Lubricate the rear axle pivot bushings through the grease fitting on the rear axle.
9. Operate the machine and check the hydraulic connections at the steering cylinders and wheel motors for leaks.
10. After you complete the assembly and adjustments, ensure that there is no contact between the machine components while the rear wheels move from steering lock to lock. Adjust if necessary.

Servicing the Rear Axle

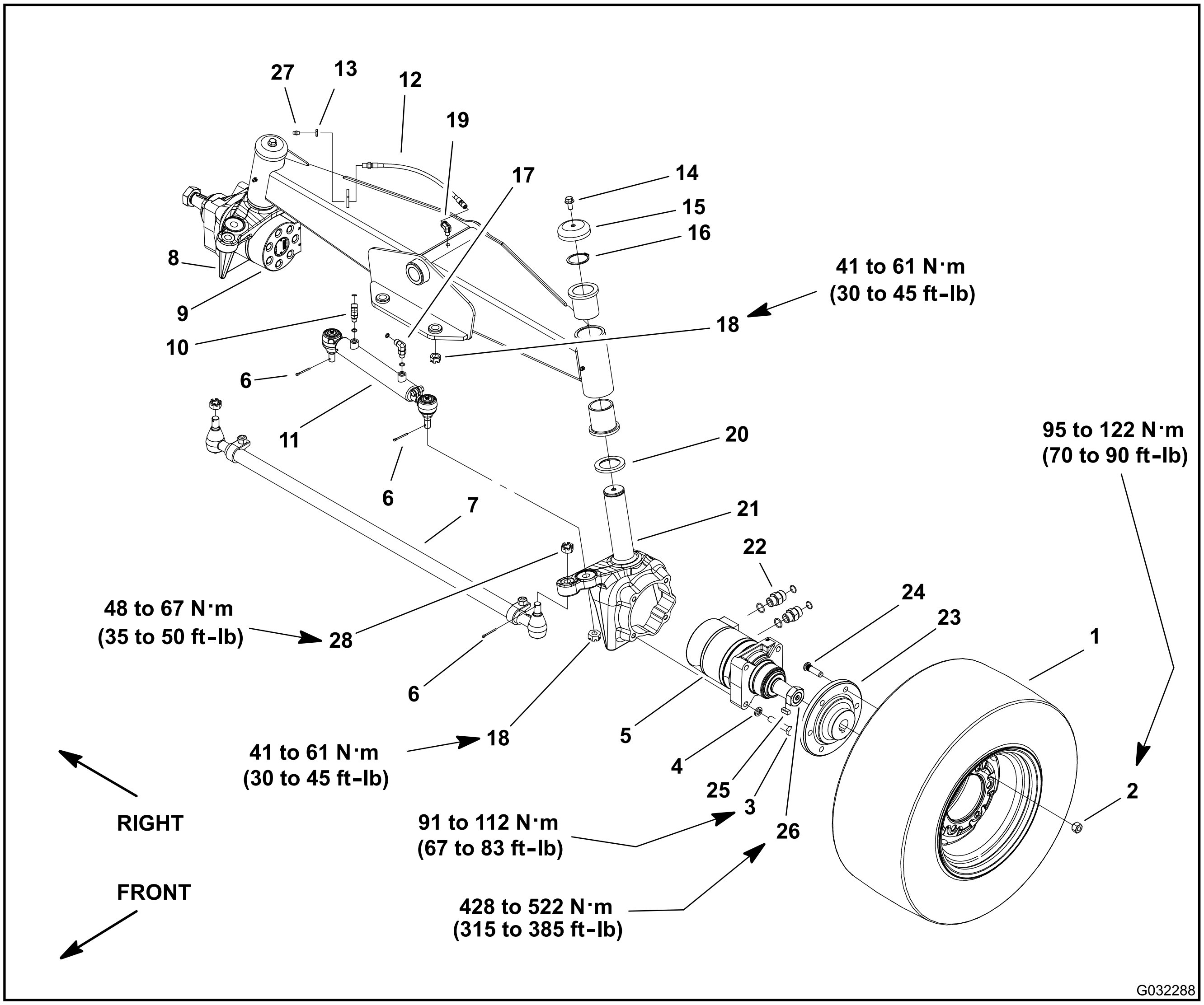

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Figure 308

1. Rear wheel assembly
2. Wheel lug nut (6 each wheel)
3. Bolt (4 each motor)
4. Lock washer (4 each motor)
5. Left wheel motor
6. Cotter pin
7. Tie rod assembly
8. Right spindle
9. Right wheel motor
10. 45° hydraulic fitting
11. Steering cylinder (2 each)
12. Hose
13. Nut
14. Flange-head screw
15. Spindle cap
16. Retaining ring
17. 90° hydraulic fitting
18. Slotted hex nut
19. Elbow
20. Thrust washer
21. Left spindle
22. Hydraulic fitting (2 each motor)
23. Wheel hub (2 each)
24. Wheel stud (6 each wheel)
25. Square key
26. Hex nut
27. Grease fitting
28. Slotted hex nut

Note: If necessary, service the rear wheel motors or steering cylinders; refer to the Service and Repairs (page 4–95).

Tie Rod Assembly

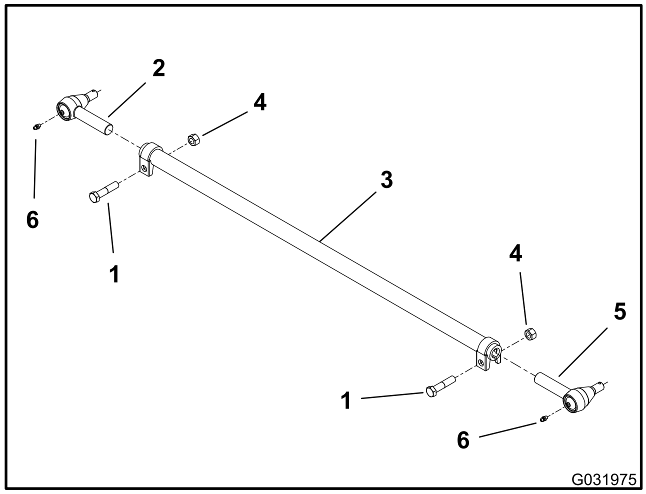

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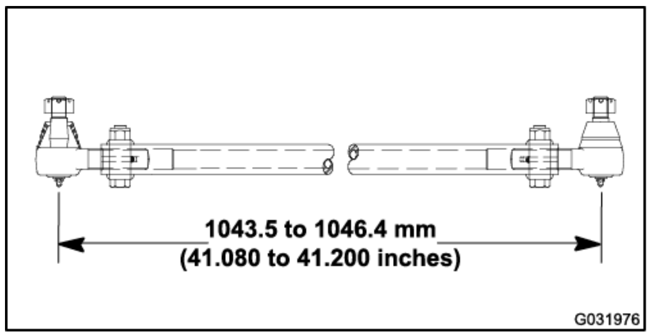
Figure 309

1. Bolt
2. Tie rod end
3. Tie rod tube
4. Locknut
5. Tie rod end
6. Grease fitting



g031976

Figure 310

1. Remove the cotter pin and slotted hex nut that attach the tie rod ends to the steering spindles. Separate the tie rod ends from the spindle and remove the tie rod from the machine.

   Note: 1 of the tie rod ball joints has left-hand threads.

2. Loosen the bolt and locknut and then unscrew the ball joint from the tie rod.
3. Turn the ball joints equally into the tie rod so that the center to center length is 1043.5 to 1046.4 mm (41.080 to 41.200 inches); refer to Figure 310.
4. Clean the tapered surfaces of the tie rod ball joints and steering spindles.
5. Connect the tie rod ends to the steering spindles with the slotted hex nuts; torque the nuts to **48 to 67 N·m (35 to 50 ft-lb)**.
6. Install the cotter pin.
7. Check and adjust the rear wheel toe-in. After toe-in is correct, tighten the bolt and locknut.

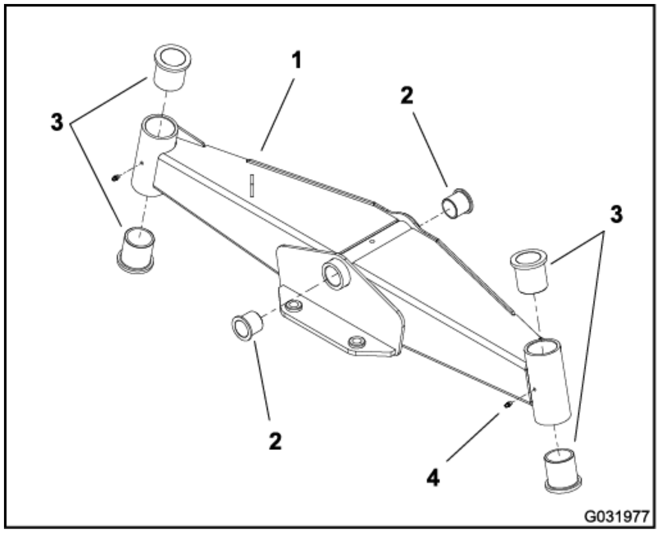
   Note: The correct rear wheel toe-in specification is 0 to 3.05 mm (0 to 0.120 inch).

8. Lubricate the tie rod ball joints.

Tie Rod Assembly (continued)

9. After you complete the assembly and adjustments, ensure that there is no contact between the machine components while the rear wheels move from steering lock to lock. Adjust if necessary.

Rear Axle Spindle Bushings



g031977

Figure 311

1. Rear axle
2. Pivot bushing
3. Spindle bushing
4. Grease fitting

The rear wheel spindles must fit snugly to the rear axle. Excessive movement of the spindle in the axle might indicate that the rear axle spindle bushings (Figure 311) are worn and must be replaced.

1. Loosen, but do not remove the wheel-lug nuts that attach the rear wheels to the axle.
2. Remove the rear axle from the machine; refer to Removing the Rear Axle (page 6–27).
3. Remove the rear wheels from the axle.
4. Remove the cotter pin and slotted hex nut that attach the tie rod end to the steering spindle. Separate the tie rod end from the spindle.
5. Remove the cotter pin and slotted hex nut that attach the steering cylinder ball joint to the steering spindle. Separate the steering cylinder from the spindle.
6. If necessary, remove the wheel motor from the steering spindle; refer to Removing the Rear Wheel Motors (page 4–126).
7. Remove the flange-head screw, spindle cap, and retaining ring that attach the steering spindle into the axle tube. Slide the spindle out of the axle tube to get access to the spindle bushings.
8. Locate and retrieve the thrust washer (item 20 in Figure 308) from the steering spindle shaft.
9. Use a bushing removal tool to remove the 2 spindle bushings from the axle tube.

   Note: Ensure that you do not damage the box of the axle tube.
10. Clean the inner surface of the axle tube to remove any dirt or unwanted materials.

Rear Axle Spindle Bushings (continued)

11. Apply grease to the inner and outer surfaces of new bushings. Use a press to install the bushings into the top and bottom of the axle tube. Press the bushings into the tube until the bushing flange shoulder contacts the tube.
12. Clean the steering spindle shaft. Inspect the spindle for wear and replace it if worn or damaged.
13. Install the thrust washer (item 20 in Figure 310) onto the spindle shaft and slide the shaft up through the axle tube. Hold the spindle shaft assembly in position and install the retaining ring (item 16 in Figure 310) into the groove in the spindle shaft.
14. Install the spindle cap and flange-head screw.
15. Clean the tapered surfaces of the tie rod ends, steering cylinder ball joints, and steering spindle.
16. Connect the tie rod end to the steering spindle with the slotted hex nut and cotter pin; torque the nut to **48 to 67 N·m (35 to 50 ft-lb)**.
17. Attach the steering cylinder ball joint to the steering spindle with the slotted hex nut and cotter pin; torque the nut to **41 to 61 N·m (30 to 45 ft-lb)**.
18. If removed, install the rear wheel motor; refer to Installing the Rear Wheel Motors (page 4–127).
19. Attach the rear wheels to the axle with the wheel-lug nuts; refer to Installing the Wheel (page 6–6).

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 lug nuts.

20. Install the rear axle to the machine; refer to Installing the Rear axle (page 6–28).
21. After you lower the machine to the ground, torque the wheel-lug nuts to **95 to 122 N·m (70 to 90 ft-lb)**.
22. Lubricate the steering spindles through the grease fittings on the rear axle.
23. Check the rear wheel toe-in and adjust it if necessary.

    Note: The correct rear wheel toe-in specification is 0 to 3.05 mm (0 to 0.120 inch).
24. Operate the machine and check the hydraulic connections at the steering cylinders and wheel motors for leaks.
25. After you complete the assembly and adjustments, ensure that there is no contact between the machine components while the rear wheels move from steering lock to lock. Adjust if necessary.

Axle Pivot Bushings

The rear axle must be held in place snugly by the axle pivot shaft. Excessive movement of the axle, that is often characterized by erratic steering, might indicate the worn axle pivot bushings. To correct the problem, replace the rear axle pivot bushings (Figure 311).

Axle Pivot Bushings (continued)

1. Loosen, but do not remove the wheel-lug nuts that attach the rear wheels to the axle.
2. Remove the rear axle from the machine; refer to Removing the Rear Axle (page 6–27).
3. Remove the rear wheels from the axle; refer to Removing the Wheel (page 6–5).
4. Use a bushing removal tool to remove the 2 axle pivot bushings from the axle pivot tube.

   Note: Ensure that you do not damage the bore of the pivot tube during the bushing removal.
5. Clean the inner surface of the tube to remove all dirt and unwanted material.
6. Apply grease to the inner and outer surfaces of new bushings. Use a press to install the bushings into the top and bottom of the axle tube. Press the bushings into the tube until the bushing flange shoulder contacts the tube.
7. Attach the rear wheels to the axle with the wheel-lug nuts; refer to Installing the Wheel (page 6–6).

⚠ 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 lug nuts.

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8. Install the rear axle to the machine; refer to Installing the Rear axle (page 6–28).
9. After you lower the machine to the ground, torque the wheel-lug nuts to **95 to 122 N·m (70 to 90 ft-lb)**.

Chapter 7

Chassis

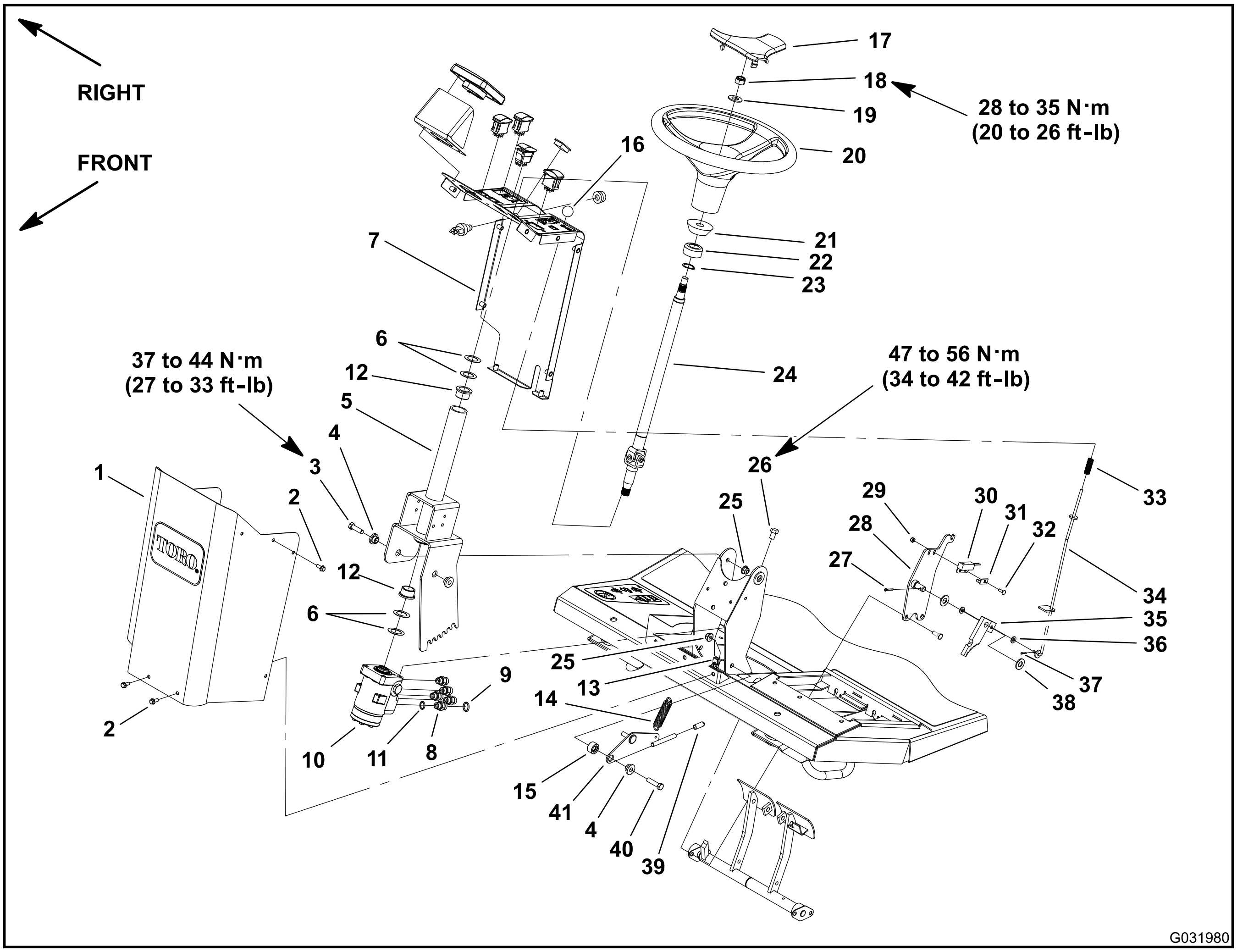
Table of Contents

General Information

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

Service and Repairs

Steering Tower



g031980

Figure 312

1. Steering tower cover
2. Flange-head screw
3. Bolt (2 each)
4. Pivot hub (3 each)
5. Steering column assembly
6. Thrust washer (4 each)
7. Steering tower
8. Hydraulic fitting (5 each)
9. O-ring
10. Steering control valve
11. O-ring
12. Flange bushing (2 each)
13. Clip (2 each)
14. Spring
15. Spacer
16. Knob
17. Steering wheel cover
18. Hex nut
19. Flat washer
20. Steering wheel
21. Foam collar
22. Steering seal
23. External snap ring (2 each)
24. Steering shaft assembly
25. Flange nut (3 each)
26. Bolt (4 each)
27. Cotter pin
28. Parking brake pivot
29. Locknut
30. Proximity switch
31. Switch plate
32. Carriage bolt
33. Compression spring
34. Parking brake rod
35. Parking brake rack
36. Flat washer (2 each)
37. Cotter pin
38. Flat washer (2 each)
39. Cap
40. Bolt
41. Tilt lever

Note: If the steering control valve (item 10 in Figure 312) requires removal; refer to the Steering Control Valve (page 4–182).

Disassembling the Steering Tower

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Disassemble the steering tower; refer to Figure 312.

Assembling the Steering Tower

Assemble the steering tower; refer to Figure 312.

1. If the steering wheel was removed, torque the hex nut (item 18 in Figure 312) to **28 to 35 N·m (20 to 26 ft-lb)**.
2. If the steering column (item 5 in Figure 312) was removed, torque the bolt (item 3 in Figure 312) to **37 to 44 N·m (27 to 33 ft-lb)**.
3. Use the thrust washers (item 6 in Figure 312) on the steering column as necessary and remove the endplay of the steering shaft.

Wing Deck Rear Impact Arm Assembly

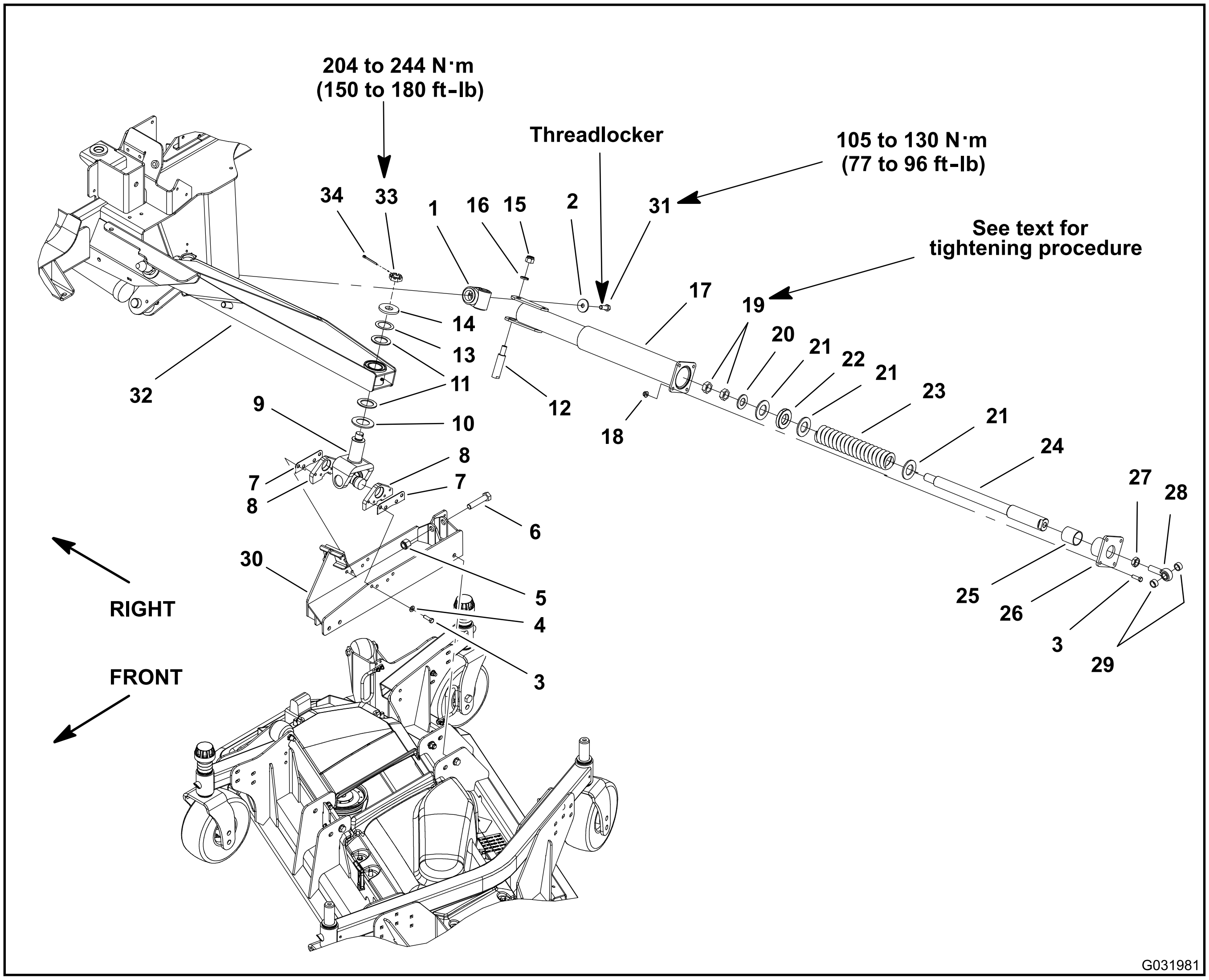


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Figure 313

1. Pivot hub
2. Thrust washer
3. Bolt
4. Flat washer
5. Locknut
6. Bolt
7. Shim
8. Base mount
9. Joint yoke
10. Spacer
11. Thrust washer
12. Pivot shaft
13. Thrust washer (as required)
14. Hardened washer
15. Locknut
16. Lock washer
17. Rear impact arm housing
18. Flange nut (4 each impact arm)
19. Jam nut
20. Flat washer
21. Plain washer
22. Plastic bearing
23. Compression spring
24. Spring shaft
25. Plain bushing
26. Housing
27. Jam nut
28. Rod end
29. Spacer
30. Deck connection
31. Bolt
32. Lift arm (left)
33. Slotted hex nut
34. Cotter pin

Removing the Wing Deck Rear Impact Arm Assembly

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.

Removing the Wing Deck Rear Impact Arm Assembly (continued)

2. Remove the bolt (item 6 in Figure 313) and locknut (item 5 in Figure 313) that secures the rod end of the rear impact arm to the cutting deck connection.
3. Locate and remove the spacer (item 29 in Figure 313) from each side of the rod end.
4. Remove the locknut (item 15 in Figure 313) and lock washer (item 16 in Figure 313) that secures the rear impact arm pivot shaft (item 12 in Figure 313).
5. Slide the pivot shaft from the pivot hub and impact arm clevis. Remove the rear impact arm assembly from the machine.

Disassembling the Wing Deck Rear Impact Arm Assembly

1. Disassemble the wing deck rear impact arm assembly; refer to Figure 313.
2. Clean the rear impact arm components and inspect for worn parts. Replace the components as required.

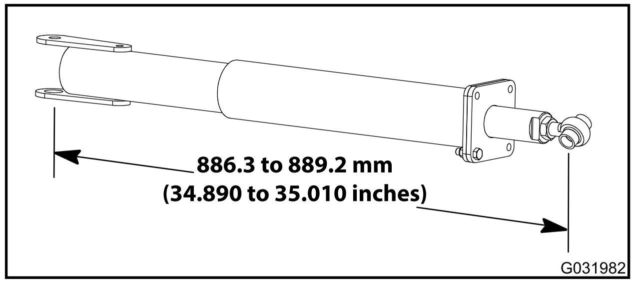
Assembling the Wing Deck Rear Impact Arm Assembly

1. Slide the plain washer (item 21 in Figure 313), compression spring (item 23 in Figure 313), second plain washer (item 21 in Figure 313), plastic bearing (item 22 in Figure 313), third plain washer (item 21 in Figure 313), and then the flat washer (item 20 in Figure 313) onto the spring shaft.
2. Thread 1 jam nut (item 19 in Figure 313) onto the shaft and tighten it so that the spring length is 304.8 mm (12 inches).
3. Slide the housing (item 26 in Figure 313) onto the rod end of the assembled spring shaft.
4. Insert the assembly into the rear impact arm housing (item 17 in Figure 313).
5. Temporarily attach the housing (item 26 in Figure 313) to the rear impact arm housing with the 2 bolts (item 3 in Figure 313) and 2 flange nuts (item 18 in Figure 313).

IMPORTANT

Remove all the endplay from the spring shaft assembly for correct operation and to ensure its long life.

6. Hold the end of the spring shaft. Push in and pull out the shaft to determine if any endplay exists in the spring shaft assembly.
7. If endplay in the spring shaft assembly exists, access the jam nut through the open end of the rear impact arm housing and insert a 3/4 inch socket onto the jam nut (item 19 in Figure 313) on the spring shaft. Loosen the jam nut until you remove all the endplay in the shaft.
8. When there is no endplay in the spring shaft assembly, remove the 2 bolts and 2 flange nuts that attach the housing (item 26 in Figure 313) to the rear impact arm housing. Remove the spring shaft assembly from the housing.
9. Thread the second jam nut (item 19 in Figure 313) onto the end of the spring shaft.



g031982

Figure 314

10. Hold the first jam nut with a wrench to prevent it from turning, torque the second jam nut to **184 to 223 N·m (135 to 165 ft-lb)** to attach the spring adjustment.
11. Fully fill the spring with grease. Apply approximately 1.1 kg (40 oz) of grease to a clean spring.
12. Install the spring shaft assembly into the rear impact arm housing and attach the housing (item 26 in Figure 313) with the 4 bolts (item 3 in Figure 313) and 4 flange nuts (item 18 in Figure 313).
13. Thread the rod end (item 28 in Figure 313) with jam nut (item 27 in Figure 313) into the end of the spring shaft so that the distance from the center of the rod end to the center of the pivot shaft mounting hole is 886.3 to 889.2 mm (34.890 to 35.010 inches); refer to Figure 314.

    Note: Do not tighten the jam nut until you check the alignment of the cutting deck to the traction unit; refer to Figure 314.

Installing the Wing Deck Rear Impact Arm Assembly

1. Position the rear impact arm assembly to the cutting deck connection and frame.
2. Slide the pivot shaft (item 12 in Figure 313) through the rear impact arm clevis and hub. Attach the pivot shaft with the lock washer and locknut.
3. Position the spacers on both sides of the rod end of the rear impact arm assembly. Attach the rod end of the rear impact arm to the deck connection with the bolt (item 6 in Figure 313) and locknut (item 5 in Figure 313).
4. Lubricate the rear impact arm grease fittings.
5. After you complete the installation, raise and lower the cutting deck to check that the hydraulic hoses and fittings do not contact anything.

Note: Because of the differences in the grass conditions and counterbalance setting of the traction unit, cut the grass and check the appearance before you start the formal cutting. Refer to the *Operator's Manual* for correcting the cutting deck mismatch procedures.

Lift Arm Joint Yoke

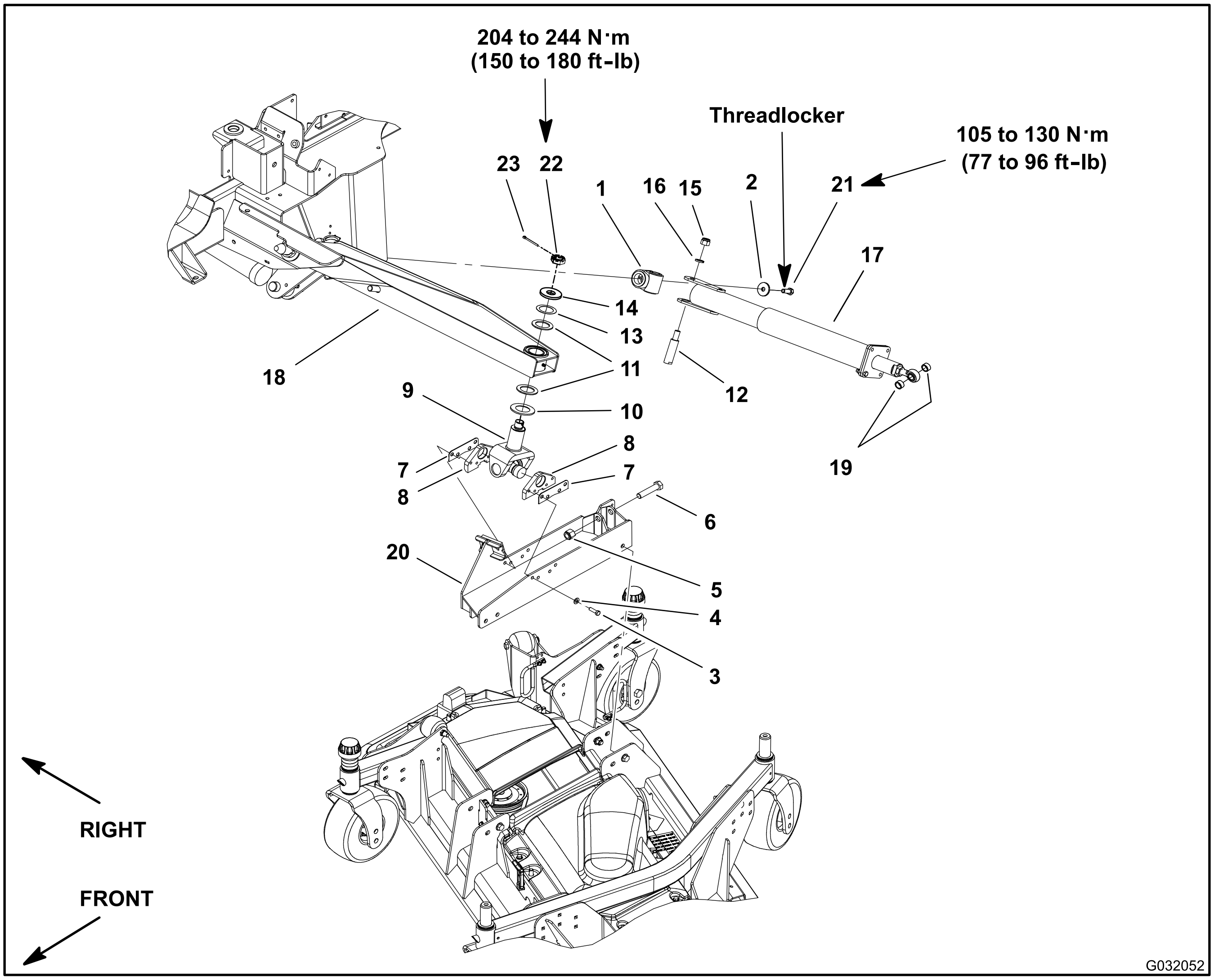


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Figure 315

1.	Pivot hub	9.	Joint yoke	17.	Rear impact arm assembly
2.	Thrust washer	10.	Spacer	18.	Lift arm (left)
3.	Bolt (8 each yoke)	11.	Thrust washer	19.	Spacer
4.	Flat washer (8 each yoke)	12.	Pivot shaft	20.	Deck connection
5.	Locknut	13.	Thrust washer (as required)	21.	Bolt
6.	Bolt	14.	Hardened washer	22.	Slotted hex nut
7.	Shim	15.	Locknut	23.	Cotter pin
8.	Base mount	16.	Lock washer		

Removing the Joint Yoke

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cotter pin (item 23 in Figure 315) and then the slotted hex nut (item 22 in Figure 315) from the joint yoke shaft. Remove the hardened washer (item 14 in Figure 315) and thrust washers (items 11 and 13 in Figure 315, if equipped) from the joint yoke shaft.

Removing the Joint Yoke (continued)

3. Remove the 8 bolts (item 3 in Figure 315) and 8 flat washers (item 4 in Figure 315) that attach the base mounts (item 8 in Figure 315) to the cutting deck connection.
4. Raise the lift arm enough to free the joint yoke from the lift arm. Remove the thrust washer (item 11 in Figure 315) and spacer (item 10 in Figure 315) from the yoke shaft.
5. Lift the joint yoke and base mounts from the deck mount.
6. Locate and retrieve the shim (item 7 in Figure 315) installed between each base mount and deck mount.

Disassembling the Joint Yoke

1. Remove the snap rings from the yoke.

IMPORTANT

Support the yoke when removing the cross and bearings to prevent the yoke damage.

2. Press the base mounts from the joint yoke. Slide the bearings from the joint yoke.
3. Use a press to remove the cross and remaining bearings from the yoke as follows:
   A. Place a small socket against 1 bearing and a large socket against the yoke on the opposite side.
   B. While you support the large socket, apply pressure on the small socket to partially push the opposite bearing into the large socket.
   C. Remove the yoke from the press, hold the partially removed bearing and tap on the yoke to completely remove the bearing.
   D. Repeat the process for the remaining bearing.
   E. Clean and inspect all the components.

Assembling the Joint Yoke

1. Apply a coat of grease to the bearing bores of the yoke. Also, apply grease to the bearings and seal of the bearing assembly.
2. Press 1 bearing partially into the yoke.

IMPORTANT

When installing the cross into the bearing, ensure that you do not damage the bearing seal.

3. Carefully insert the cross into the bearing and yoke.

Assembling the Joint Yoke (continued)

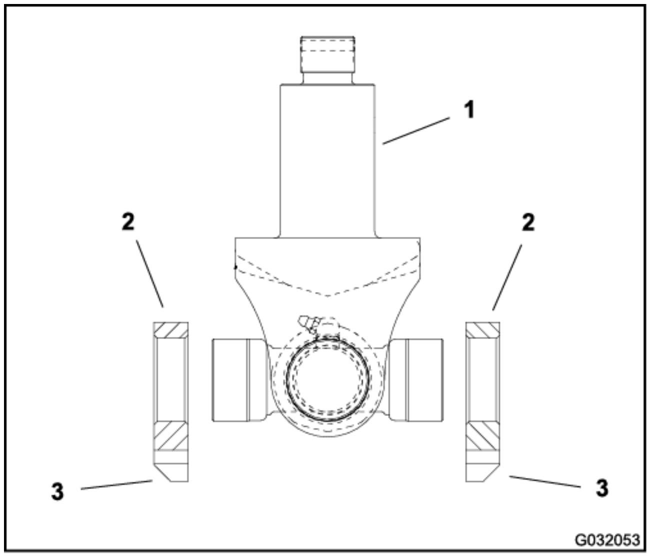

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Figure 316

1. Joint yoke
2. Base mount
3. Angled edge

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4. Hold the cross to align and press the bearing in until it hits the yoke.
5. Carefully position the second bearing into the yoke bore and onto the cross shaft. Press the bearing into the yoke.
6. Install the snap rings to the bearings to attach the bearings in place.
7. Press the base mounts to the joint yoke with the angled edge of the mounts assembled away from the joint (Figure 316). Flush the outer side of the yoke bearing cups with the base mount surfaces.
8. Ensure that the assembled joint yoke moves without any binding. Lightly rap the yoke lugs with a soft-faced hammer to remove slight binding. If the binding continues, disassemble the joint yoke to identify and remove the source of binding.

Installing the Joint Yoke

1. Install the joint yoke to the lift arm as follows:
   A. Position the spacer (item 10 in Figure 315) and then the thrust washer (item 11 in Figure 315) onto the joint yoke shaft.
   B. Insert the yoke shaft up through the lift arm bushings.
   C. Position the second thrust washer (item 11 in Figure 315) onto the joint yoke shaft and then place the thrust washers (item 13 in Figure 315) as necessary to remove as much clearance as possible between the second thrust washer and the hardened washer (item 14 in Figure 315) location.
   D. Install the slotted hex nut to attach the joint yoke to the lift arm; torque the nut to **204 to 244 N·m (150 to 180 ft-lb)**.

   Note: Ensure that the joint yoke rotates in the lift arm without any binding and that the excessive clearance does not exist in the yoke assembly.
2. Carefully lower the lift arm to position the base mounts to the deck connection.
3. Install the shims between the deck connection and the base mounts. Attach the base mounts with the 8 bolts and 8 flat washers.

4. Apply grease to the joint yoke and lift arm bushing after you install it on the machine.
5. After you complete the assembly, raise and lower the cutting deck to ensure that the hydraulic hoses and fittings do not contact anything.

Front Deck Lift Arms

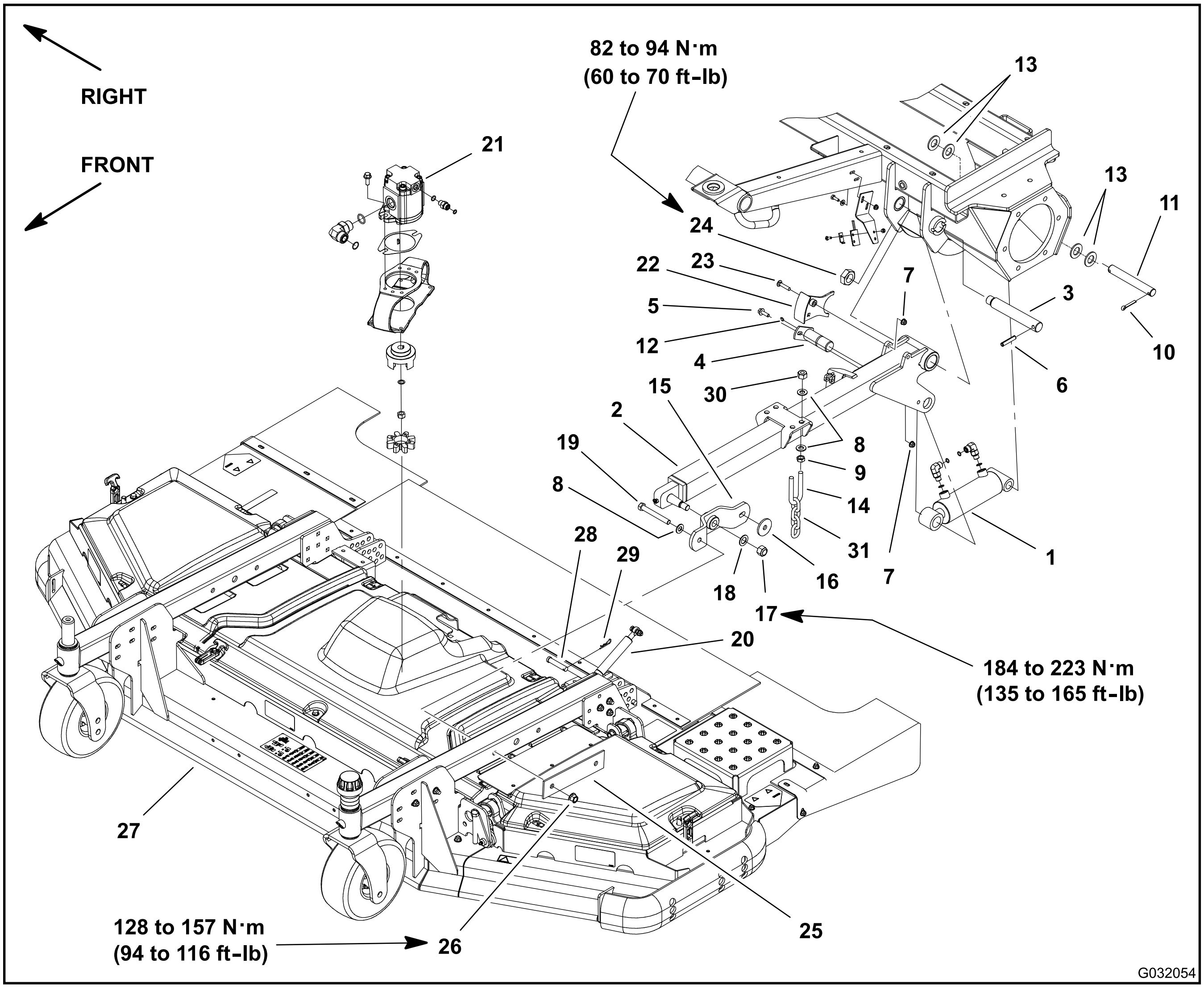

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Figure 317

1. Lift cylinder (left)
2. Lift arm (2 each)
3. Lift arm pin
4. Lift cylinder pin
5. Flange-head screw
6. Roll pin
7. Flange nut
8. Flat washer
9. Jam nut (2 each U-bolt)
10. Cotter pin (2 each clevis pin)
11. Clevis pin
12. Plug
13. Flat washer (4 each pin)
14. U-bolt (2 each)
15. Support hub (2 each)
16. Thrust washer
17. Locknut
18. Flat washer
19. Bolt (2 each hub)
20. Damper assembly
21. Front deck motor
22. Trigger sensor
23. Carriage screw
24. Locknut
25. Plate
26. Locknut
27. Front deck assembly
28. HOC clevis pin (2 each)
29. Hair pin (2 each)
30. Locknut (2 each U-bolt)
31. HOC chain

Note: If the lift cylinder (item 1 in Figure 317) requires removal; refer to the Front Deck Lift Cylinder (page 4–166).

Removing the Front Deck Lift Arms

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the front cutting deck; refer to Removing the Front Cutting Deck (page 8–7).

CAUTION

Failing to properly support the machine with jack stands can cause the machine to move or fall and can result in personal injury.

Properly support the machine with jack stands.

When changing the attachments, tires, or performing other services, do the following steps:

- **Use correct blocks, hoists, and jacks to lift and support the machine.**
- **Park the machine on a solid level surface, such as a concrete floor.**
- **Before you lift the machine, remove all the attachments that may interfere with the safe and correct lift of the machine.**
- **Always block the wheels with chocks.**
- **Use appropriate jack stands to support the raised machine.**

---

3. Block the rear wheels with chocks and lift the front of the machine with a jack. Support the machine on the jack stands. Remove the front wheel that is next to the lift arm; refer to Removing the Wheel (page 6–5).
4. Remove the flange-head screw and flange nut that attach the lift cylinder pin (item 4 in Figure 317) to the lift arm. Remove the pin and separate the lift cylinder from the lift arm.
5. Remove the locknut (item 24 in Figure 317) that secures the lift arm pin (item 3 in Figure 317).
6. Support the lift arm and slide the pin from the frame and lift arm, and remove the lift arm from the frame.
7. As required, disassemble the lift arm (Figure 317).

   A. Remove the height-of-cut chain.

   B. Remove the locknut, flat washer, and support hub from the tapered stud in the lift arm.

   C. Remove the retaining ring that secures the spherical bearing in the lift arm. Remove the tapered stud with the spherical bearing from the lift arm. Separate the flange nut and spherical bearing from the stud.

   D. Press the flange bushings from the lift arm. Clean the lift arm bore.

Installing the Front Deck Lift Arms

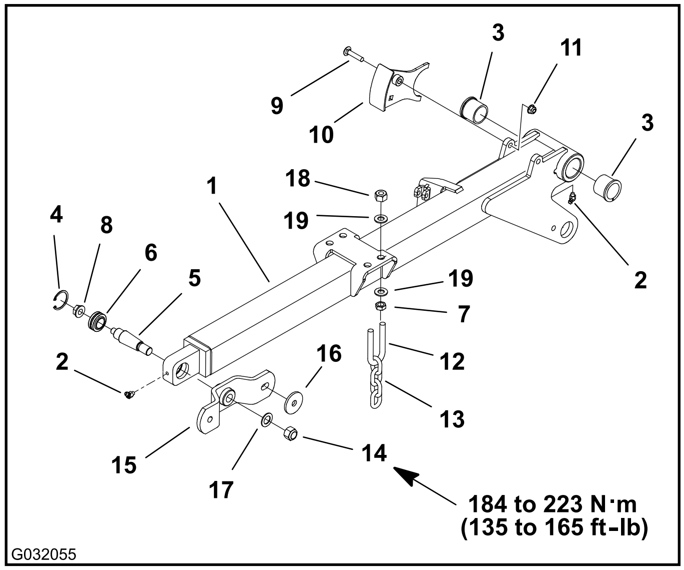

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Figure 318

1. Lift arm (left)
2. Grease fitting
3. Flange bushing
4. Retaining ring
5. Tapered stud
6. Spherical bearing
7. Jam nut (2 each)
8. Flange nut
9. Carriage screw
10. Trigger sensor
11. Flange nut
12. U-bolt
13. HOC chain
14. Locknut
15. Support hub
16. Thrust washer
17. Flat washer
18. Locknut (2 each)
19. Flat washer (4 each)

---

1. If removed, install the components to the lift arm (Figure 318).
   A. Assemble the height-of-cut chain U-bolt so that the thread portion of the U-bolt extends 30.5 mm (1.2 inches) above the mounting plate on the lift arm.
   B. Lightly lubricate the new flange bushings and press the bushings into the lift arm.

      Note: Ensure that the bushing flange is pressed fully to the lift arm surface.
   C. Install the spherical bearing on the tapered stud and attach it with the flange nut. Install the stud with the spherical bearing into the lift arm and attach it with the retaining ring.
   D. Clean the tapered surfaces of the stud and the mounting boss of the support hub. Attach the support hub (position the slotted hole in the hub toward the rear of the deck) to the tapered stud with the flat washer and locknut; tighten the locknut to **184 to 223 N·m (135 to 165 ft-lb)**.
2. Position the lift arm to the frame and insert the lift arm pin. Align the roll pin into the frame slots and install the locknut on the pin; torque the locknut to **82 to 94 N·m (60 to 70 ft-lb)**.
3. Align the lift cylinder with the lift arm. Slide the lift cylinder pin through the lift arm and cylinder end. Attach the pin with the flange-head screw and flange nut.

Installing the Front Deck Lift Arms (continued)

4. Install the front wheel assembly; refer to Installing the Wheel (page 6–6).
5. Lower the machine to the ground.

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 lug nuts.

6. Torque the wheel-lug nuts equally to **95 to 122 N·m (70 to 90 ft-lb)** in a crossing pattern.
7. Install the cutting deck; refer to Installing the Front Cutting Deck (page 8–9).
8. Lubricate the lift arm grease fittings.
9. After you complete the assembly, raise and lower the cutting deck to check that the hydraulic hoses and fittings do not contact anything.

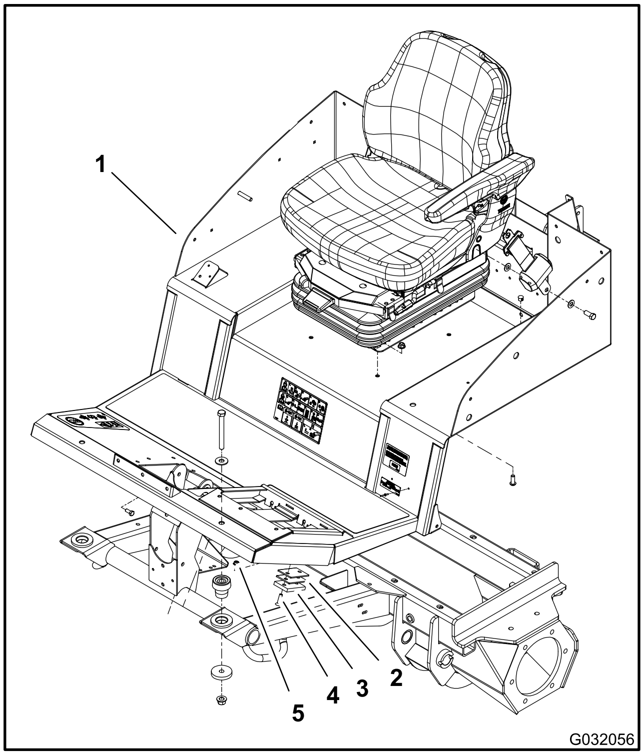

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Figure 319

1. Operator platform
2. Shim pad
3. Bumper pad
4. Flange-head screw
5. Flange nut

10. When the lift arms are fully raised, check that the gap between the lift arms and the bumper pads at the bottom of the operator platform is approximately 2.5 mm (0.1 inch); refer to Figure 319.

    Note: If necessary, add or remove the shim pads so that the gap is correct.
11. Check for the correct operation of the front deck proximity switch.
12. Check the height-of-cut and deck pitch adjustment. Adjust if necessary.

Wing Deck Lift Arms

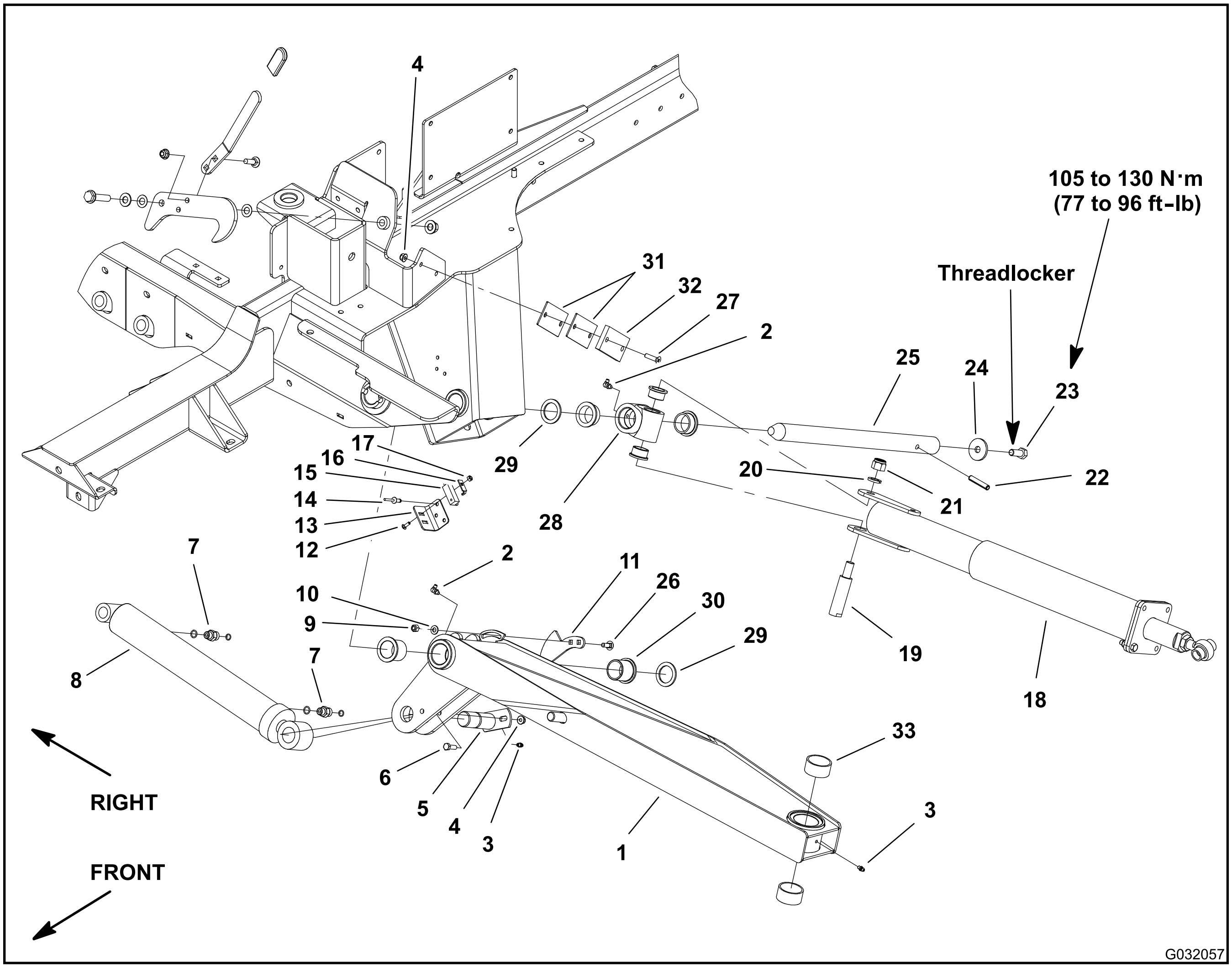

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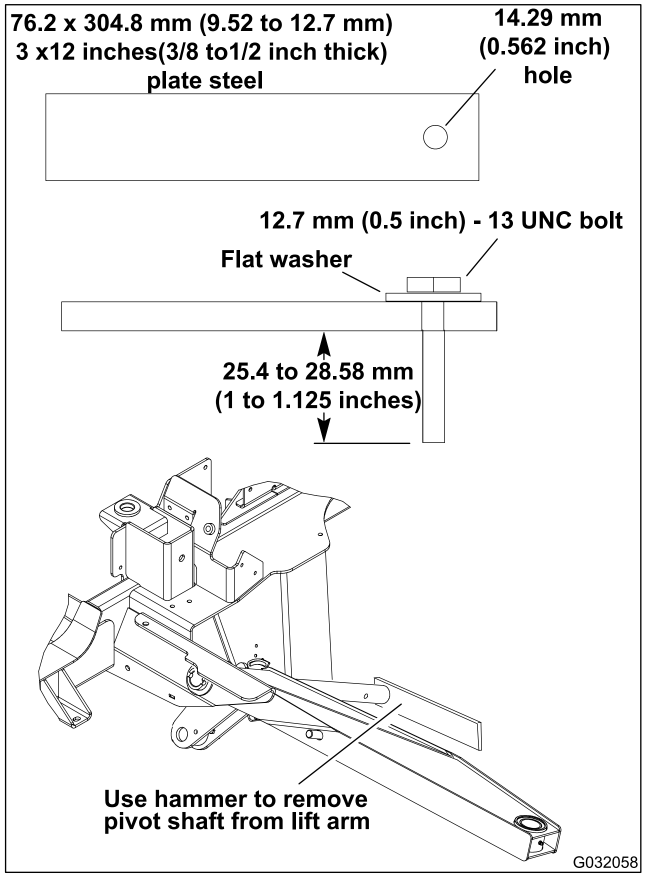
Figure 320

1. Lift arm (left)
2. Grease fitting
3. Grease fitting
4. Flange nut
5. Lift cylinder pin
6. Bolt
7. Hydraulic fitting
8. Lift cylinder
9. Locknut (2 each plate)
10. Flat washer (2 each plate)
11. Sensing plate
12. Carriage bolt
13. Aluminum plate
14. Rivet (3 each plate)
15. Proximity sensor
16. Switch plate
17. Locknut
18. Impact arm assembly
19. Pivot shaft
20. Lock washer
21. Locknut
22. Roll pin
23. Bolt
24. Thrust washer
25. Lift arm pivot shaft
26. Carriage screw (2 each plate)
27. Screw (2 each pad)
28. Pivot hub assembly
29. Thrust washer
30. Flange bushing (2 each arm)
31. Shim pad
32. Bumper pad
33. Straight bushing (2 each arm)

Note: If the wing deck lift cylinder (item 8 in Figure 320) requires removal; refer to the Wing Deck Lift Cylinder (page 4–171).

Removing the Wing Deck Lift Arms

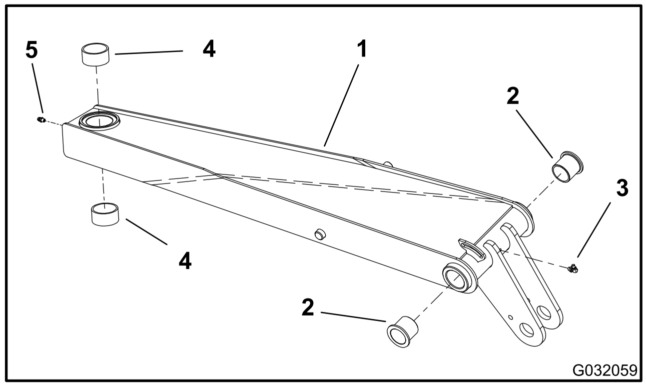


g032058

Figure 321

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the wing deck from the lift arm; refer to the Wing Cutting Deck (page 8–10).
3. Remove the wing deck impact arm assembly from the pivot hub; refer to the Wing Deck Rear Impact Arm Assembly (page 7–5).
4. Remove the joint yoke and cutting deck connection from the lift arm (Figure 323) as follows:
   A. Support the cutting deck connection to prevent it from falling.
   B. Remove the cotter pin, slotted hex nut, hardened washer, and thrust washers from the joint yoke shaft.
   C. Lower the joint yoke, cutting deck connection, and wing deck impact arm assembly from the lift arm.
5. Remove the bolt and flange nut that attach the lift cylinder pin (item 5 in Figure 320) to the lift arm. Slide the cylinder pin from the lift cylinder and lift arm. Separate the lift cylinder from the lift arm.

Removing the Wing Deck Lift Arms (continued)



g032059

Figure 322

1. Lift arm (left)
2. Flange bushing
3. Grease fitting
4. Straight bushing
5. Grease fitting

6. Remove the bolt (item 23 in Figure 320) and thrust washer (item 24 in Figure 320) from the lift arm pivot shaft.
7. Slide the wing deck impact arm pivot hub and thrust washer (item 29 in Figure 320) from the lift arm pivot shaft.
8. Remove the roll pin (item 22 in Figure 320) that retains the lift arm pivot shaft to the frame. Discard the roll pin.
9. Support the lift arm to prevent it from shifting or falling. Pull the lift arm pivot shaft from the lift arm and frame. Locate and remove the thrust washer (item 29 in Figure 320) while removing the pivot shaft.

   Note: If the pivot shaft is difficult to remove, fabricate a puller as shown in Figure 321. Attach the puller to the end of pivot shaft with the pictured bolt and a flat washer. Remove the pivot shaft from the lift arm and frame with a hammer.
10. Remove the lift arm from the machine.
11. If necessary, press the bushings from the lift arm (Figure 322). Clean the lift arm bores.

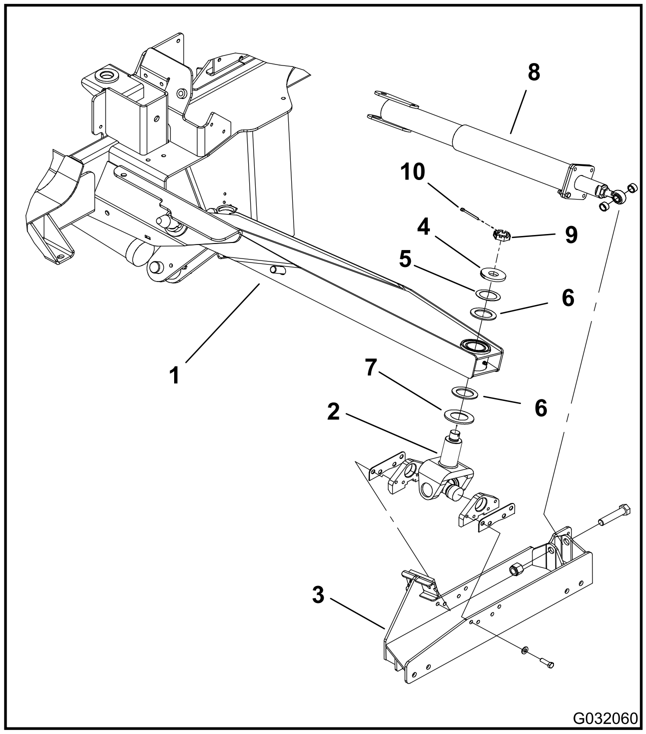
Installing the Wing Deck Lift Arms

1. If the bushings were removed from the lift arm, press new bushings into the lift arm bores.

   Note: Ensure that the bushings are pressed fully to the lift arm surface.
2. Apply anti-seize lubricant to the lift arm pivot shaft.
3. Position the lift arm to the frame with the thrust washer (item 29 in Figure 320) correctly placed between the rear of the lift arm pivot hub and the frame. Slide the pivot shaft into the frame, thrust washer, and lift arm until the roll pin holes in the pivot shaft align with the frame.
4. Install a new roll pin (item 22 in Figure 320) to attach the lift arm pivot shaft to the frame.
5. Slide the thrust washer (item 29 in Figure 320) and then the wing deck impact arm pivot hub onto the pivot shaft.

   Note: Ensure that the thrust washer is between the frame and the pivot hub.

Installing the Wing Deck Lift Arms (continued)



g032060

Figure 323

1. Lift arm (left)
2. Joint yoke
3. Deck connection
4. Hardened washer
5. Thrust washer
6. Thrust washer
7. Spacer
8. Rear impact arm
9. Slotted hex nut
10. Cotter pin

---

6. Apply the Permatex™ Blue Gel medium-strength thread-locking compound (or equivalent) to the threads of the bolt (item 23 in Figure 320). Attach the pivot hub to the pivot shaft with the thrust washer (item 24 in Figure 320) and bolt; torque the bolt to **105 to 130 N·m (77 to 96 ft-lb)**.

7. Install the joint yoke and cutting deck connection to the lift arm (Figure 323) as follows:

   A. Ensure that the spacer and thrust washer are installed on the joint yoke.

   B. Lift the joint yoke, cutting deck connection, and wing deck impact arm assembly to the lift arm. Slide the joint yoke into the lift arm bore.

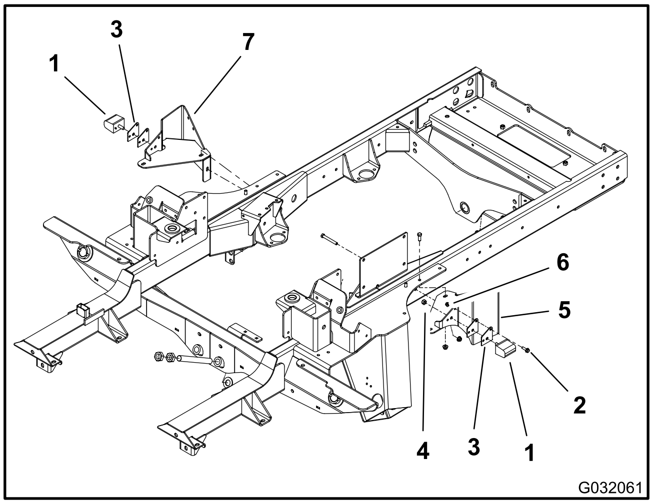
   C. Place the second thrust washer onto the joint yoke shaft and then place the thrust washers (item 5 in Figure 323) as necessary to remove as much clearance as possible between the second thrust washer and hardened washer (item 4 in Figure 323) location.

   D. Install the slotted hex nut to attach the joint yoke to the lift arm; torque the hex nut to **204 to 244 N·m (150 to 180 ft-lb)**.

   Note: Ensure that the joint yoke rotates in the lift arm without any binding and excessive clearance does not exist in the yoke assembly.

8. Attach the wing deck rear impact arm assembly to the pivot hub; refer to the Wing Deck Rear Impact Arm Assembly (page 7–5).

9. Position and install the wing cutting deck to the machine; refer to the Wing Cutting Deck (page 8–10).
10. After you complete the assembly, lubricate the lift arm grease fittings.
11. After you complete the assembly, raise and lower the cutting deck to check that the hydraulic hoses and fittings do not contact anything.
12. When you raise the lift arm fully, check that the gap between the lift arm and the bumper pad (item 32 in Figure 320) is approximately 2.5 mm (0.1 inch). If necessary, add or remove the shim pads (item 31 in Figure 320) so that the gap is correct.



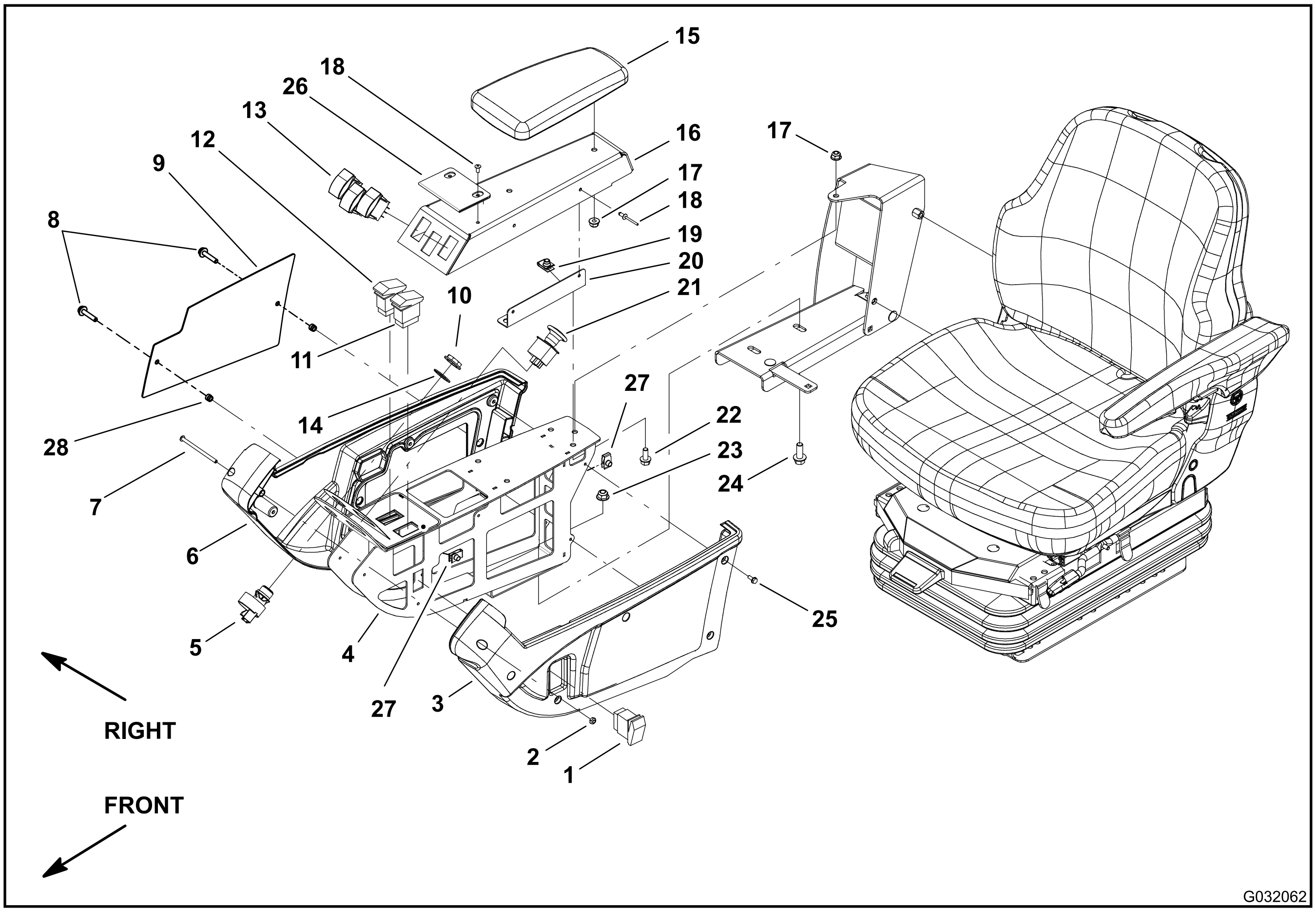
g032061

Figure 324

1. Bumper
2. Flange-head screw
3. Bumper shim
4. Locknut
5. Left stop bracket
6. Flange nut
7. Right stop bracket

13. When you raise the lift arm fully, the lift arm should slightly contact the bumper at the stop bracket (Figure 324). There should be less than 1 bumper shim of interference. If necessary, add or remove the bumper shims so that there is slight contact.
14. Check for the correct operation of the wing deck proximity switch.

Console Arm



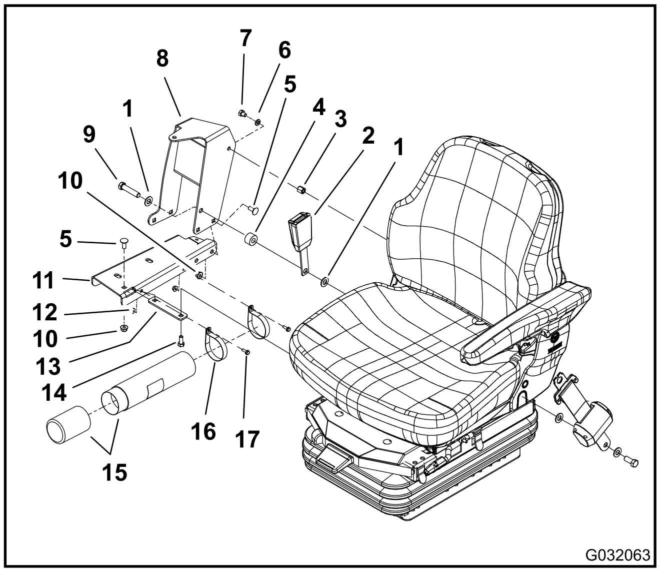
g032062

Figure 325

1. Headlight switch
2. Locknut
3. Left cover
4. Console arm panel
5. Key switch
6. Right cover
7. Screw
8. Bolt (2 each)
9. Cover plate
10. Nut
11. Cruise switch
12. 4-wheel drive traction assist switch
13. Lift/lower switch (3 each)
14. Lock washer
15. Arm rest
16. Arm panel
17. Flange nut (3 each)
18. Rivet (4 each)
19. U-nut (4 each)
20. Mounting angle
21. PTO switch
22. Flange-head screw (5 each)
23. Flange nut (2 each)
24. Flange-head screw (2 each)
25. Washer-head screw (10 each)
26. Switch guard
27. Clip (2 each)
28. Flange spacer (2 each)

Disassembling the Console Arm

1. Park the machine on a level surface, lower the cutting units, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the 2 bolts (item 8 in Figure 325) and then the cover plate (item 9 in Figure 325) from outside of the console arm.
3. Locate and retrieve the 2 flange spacers (item 28 in Figure 325).



g032063

Figure 326

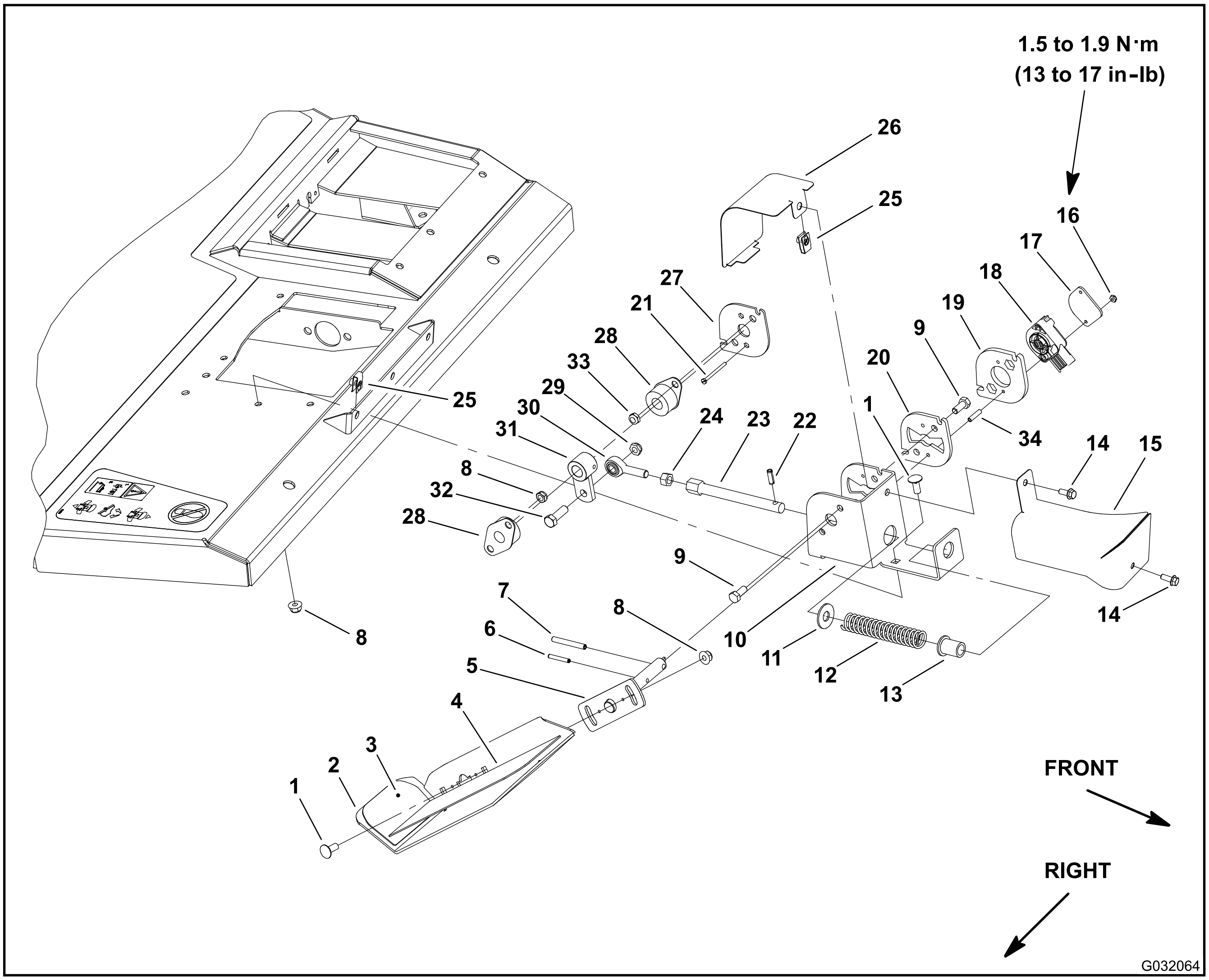
1. Flat washer
2. Seat belt buckle
3. Coupling nut
4. Spacer
5. Carriage screw (5 each)
6. Lock washer
7. Bolt
8. Arm support
9. Bolt
10. Flange nut
11. Support channel
12. Flange nut (2 each)
13. Support bracket
14. Bolt
15. Manual tube
16. R-clamp (2 each)
17. Screw (2 each)

4. At the front of the console arm, remove the screw (item 7 in Figure 325) and locknut (item 2 in Figure 325) that attach the console arm covers to each other.
5. Remove the 5 washer-head screws (item 25 in Figure 325) that attach each cover to the console arm panel.
6. Remove the console arm covers from the machine. As the left cover (item 3 in Figure 325) is removed from the console arm, disconnect the wire harness connector from the headlight switch.
7. Remove the electrical components from the console arm as shown in Figure 325.
8. If necessary, remove the console panel and supports from the machine; refer to Figure 325 and Figure 326.

Assembling the Console Arm

1. Install all the removed electrical and console arm components; refer to Figure 325 and Figure 326.
2. Position the covers to the console arm. As the left cover (item 3 in Figure 325) is placed, connect the wire harness connector to the headlight switch.
3. Attach each cover to the console arm with the 5 washer-head screws (item 25 in Figure 325). Install the screw (item 7 in Figure 325) and locknut (item 2 in Figure 325) to attach the covers at the front of the console arm.
4. Position the cover plate and flange spacers to outside of the console arm and attach it with 2 bolts.

Traction Pedal



g032064

Figure 327

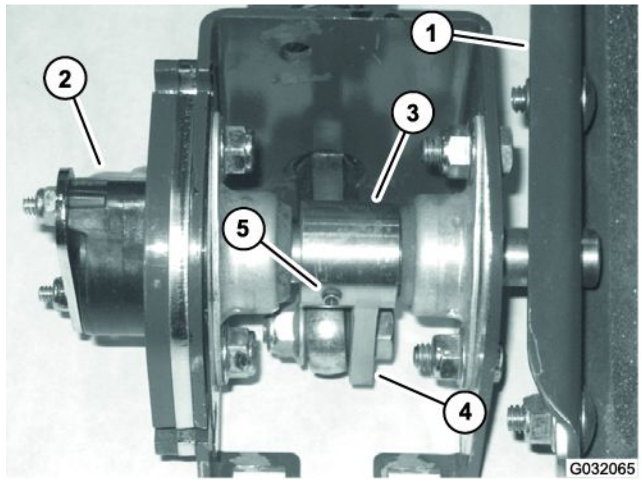
1. Carriage screw (6 each)
2. Traction pedal
3. Pedal abrasive
4. Pedal abrasive
5. Traction pedal shaft
6. Slotted roll pin
7. Roll pin
8. Flange nut (6 each)
9. Bolt (4 each)
10. Mounting bracket
11. Flat washer
12. Compression spring
13. Spring retainer
14. Flange-head screw (2 each)
15. Spring cover
16. Locknut (2 each)
17. Capture plate
18. Traction pedal potentiometer
19. Mounting plate
20. Shim plate
21. Screw (2 each)
22. Roll pin
23. Spring shaft
24. Hex nut
25. Clip (2 each)
26. Traction pedal cover
27. Cover plate
28. Flange mount bearing (2 each)
29. Locknut
30. Rod end bearing
31. Traction pedal hub
32. Bolt
33. Locknut (4 each)
34. Standoff spacer (2 each)

IMPORTANT

A correctly installed and calibrated traction pedal potentiometer is critical to accurate traction system response and for reliable potentiometer life. Use care when removing, installing, and calibrating the traction pedal potentiometer.

Disassembling the Traction Pedal

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.



g032065

Figure 328

1. Traction pedal
2. Pedal potentiometer
3. Traction pedal hub
4. Pedal hub bracket
5. Slotted roll pin

2. Disconnect the machine wire harness connector from the potentiometer (item 18 in Figure 327) on the traction pedal.
3. If you remove the traction pedal from the traction pedal shaft, use a marker or paint pen on the pedal and shaft to identify the location of the pedal for assembly purposes.
4. Disassemble the traction pedal as shown in Figure 327 and Figure 328. When you remove the roll pins (items 6, 7, and 22 in Figure 327), ensure that you support the shaft to prevent component damage.

Assembling the Traction Pedal

1. Assemble the traction pedal; refer to Figure 327 and Figure 328.
   A. Apply anti-seize lubricant to the spring shaft (item 23 in Figure 327) that is installed between the hex head and the roll pin hole.

   Note: The bracket of the traction pedal hub (item 31 in Figure 327) is near to the traction pedal than the slotted roll pin (Figure 328).

   B. Use a press to install the slotted roll pin (item 6 in Figure 327) and roll pin (item 7 in Figure 327).

   Note: Do not distort the roll pins during assembly.

   C. Ensure that the roll pin (item 7 in Figure 327) is fully inside the groove of the shim plate (item 20 in Figure 327). The roll pin should not contact the shim plate throughout the operating range.

Assembling the Traction Pedal (continued)

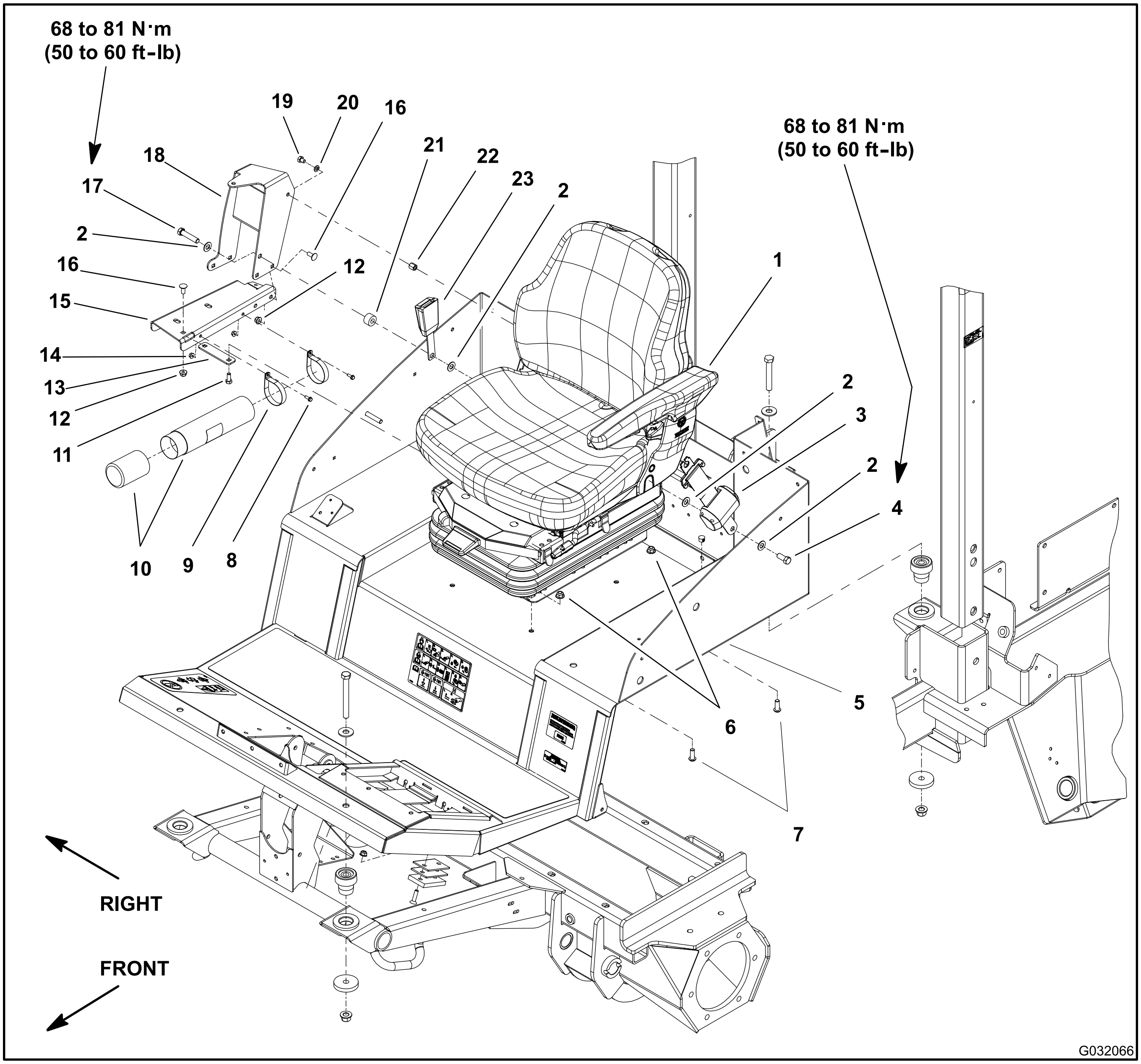
D. To install the traction pedal potentiometer (item 18 in Figure 327), slightly press and hold the traction pedal in reverse. Align the slot at the end of the pedal shaft with the slot in the potentiometer. Slide the potentiometer onto the screws and release the pedal. Hold the potentiometer in position while you install the capture plate (item 17 in Figure 327) and locknuts (item 16 in Figure 327).

E. Torque the locknuts (item 16 in Figure 327) to **1.5 to 1.9 N·m (13 to 17 in-lb)**.

F. Loosen the hex nut (item 24 in Figure 327) to calibrate the potentiometer. Also, do not install the spring cover (item 15 in Figure 327) and traction pedal cover (item 26 in Figure 327) until you complete the calibration of the potentiometer.

2. Connect the machine wire harness connector into the traction pedal potentiometer (item 18 in Figure 328).
3. After you complete the assembly of the traction pedal, calibrate the traction pedal potentiometer using the InfoCenter display; refer to Calibrating the Traction Pedal (page 5–98).
4. Ensure that you tighten the hex nut (item 24 in Figure 327) after the potentiometer adjustment.
5. Install the spring cover (item 15 in Figure 327) and traction pedal cover (item 26 in Figure 327).

Operator Seat



g032066

Figure 329

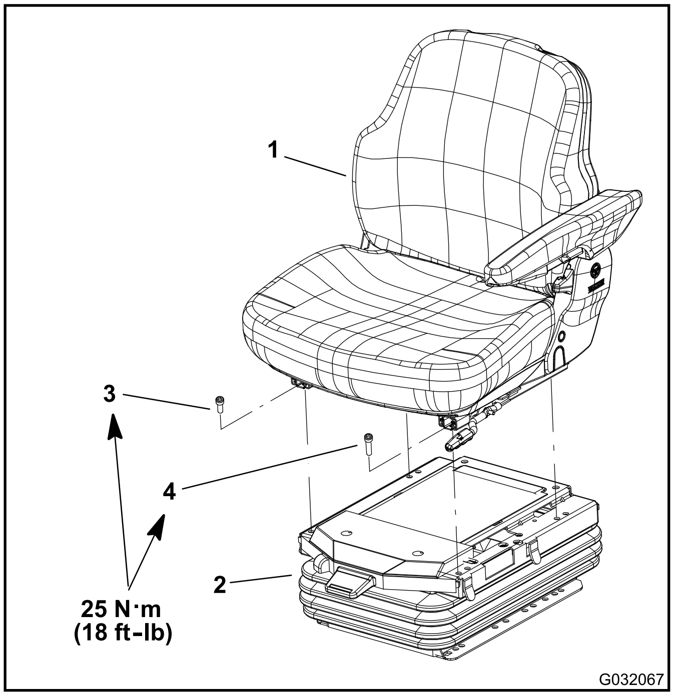
1. Seat assembly
2. Flat washer (4 each)
3. Seat belt
4. Bolt
5. Seat platform
6. Flange nut (4 each)
7. Carriage screw (4 each)
8. Screw (2 each)
9. R-clamp (2 each)
10. Manual tube
11. Bolt
12. Flange nut
13. Support bracket
14. Flange nut (2 each)
15. Support channel
16. Carriage screw (5 each)
17. Bolt
18. Console arm support
19. Bolt
20. Lock washer
21. Spacer
22. Coupling nut
23. Seat belt buckle

Removing the Operator Seat

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Disconnect the seat electrical connector from the machine wire harness.

Removing the Operator Seat (continued)

3. Support the control arm assembly to prevent it from shifting.



g032067

Figure 330

1. Seat
2. Suspension assembly
3. Torx-head screw (M8x12) (3 each)
4. Torx-head screw (M8x16)

4. Remove the flange nut (item 12 in Figure 329) and carriage screw (item 16 in Figure 329) that attach the support bracket (item 13 in Figure 329) to the support channel (item 15 in Figure 329).
5. Remove the bolt (item 19 in Figure 329) and lock washer (item 20 in Figure 329) that attach the console arm support (item 18 in Figure 329) to the coupling nut (item 22 in Figure 329).
6. Remove the bolt (item 17 in Figure 329), 2 flat washers (item 2 in Figure 329), spacer (item 21 in Figure 329), and seat belt buckle (item 23 in Figure 329) from the seat and console arm support (item 18 in Figure 329).
7. Carefully move the console arm assembly away from the seat.
8. Remove the 4 torx-head screws (items 3 and 4 in Figure 330) that attach the seat to the seat suspension.

   Note: The screw near the seat adjustment handle is longer than the other 3 screws.
9. Lift the seat from the seat suspension and remove it from the machine.

Installing the Operator Seat

1. Carefully position the seat to the seat suspension.
2. Attach the seat to the seat suspension with the 4 torx-head screws (Figure 330). Ensure that the longer screw is positioned near the seat adjustment handle; torque the screws to **25 N·m (18 ft-lb)**.
3. Position and attach the console arm assembly to the seat. Install all the fasteners before you fully tighten them.

Installing the Operator Seat (continued)

A. Attach the support bracket (item 13 in Figure 329) and support channel (item 15 in Figure 329) with flange nut (item 12 in Figure 329) and carriage screw (item 16 in Figure 329).

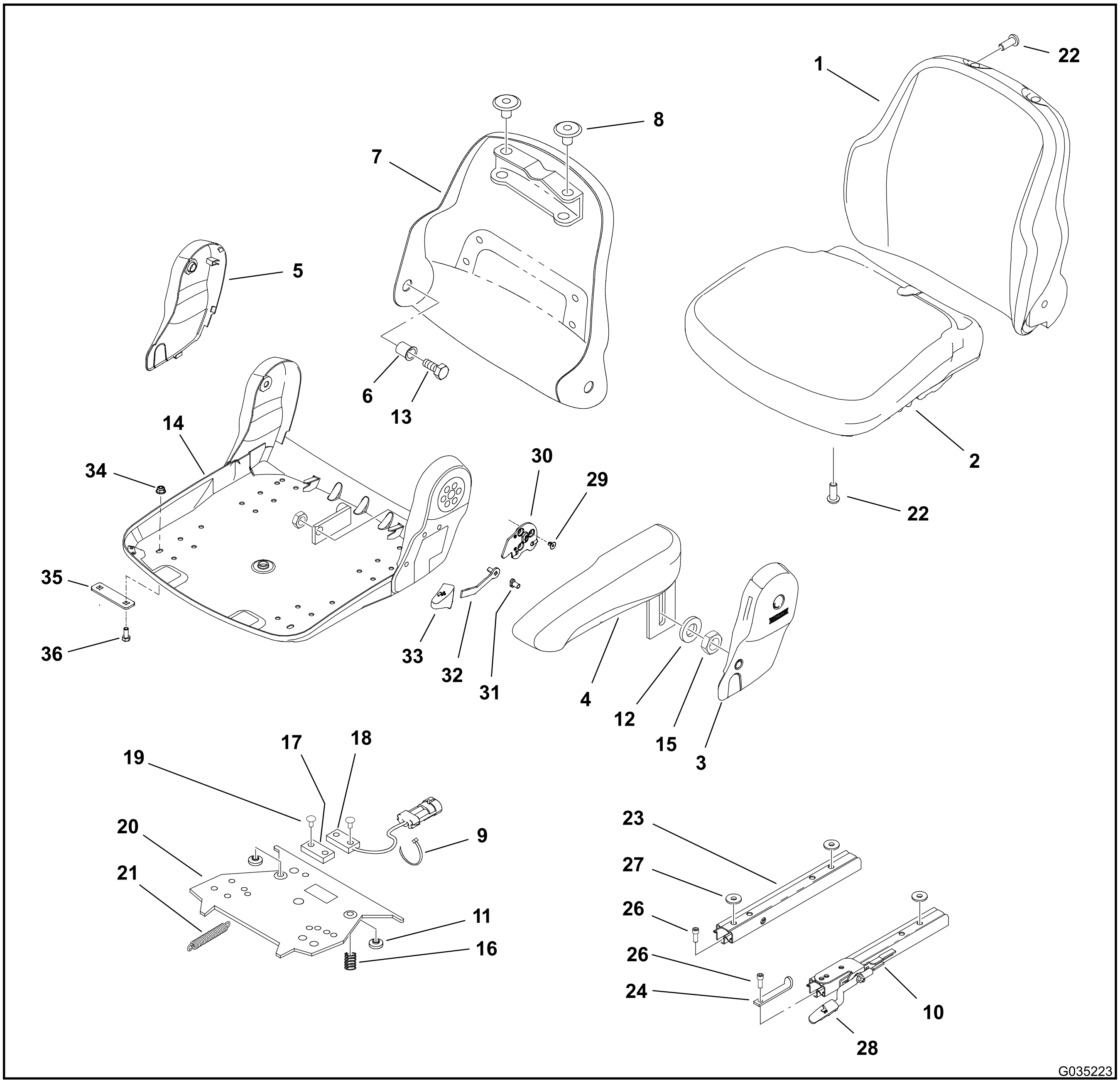
B. Attach the console arm support (item 18 in Figure 329) to the coupling nut with the bolt (item 19 in Figure 329) and lock washer (item 20 in Figure 329).

C. Place the flat washer (item 2 in Figure 329), seat belt buckle (item 23 in Figure 329), and spacer (item 21 in Figure 329) between the seat and the console arm support (item 18 in Figure 329) and attach them with flat washer (item 2 in Figure 329) and bolt (item 17 in Figure 329); torque the bolt to **68 to 81 N·m (50 to 60 ft-lb)**.

D. Fully tighten all the fasteners to attach the console arm assembly to the seat.

4. Connect the seat electrical connector to the machine wire harness.

Servicing the Operator Seat



g035223

Figure 331

1. Backrest cushion
2. Seat cushion
3. Left support cover
4. Left armrest
5. Right support cover
6. Bushing (2 each)
7. Backrest
8. Plug (2 each)
9. Cable tie (3 each)
10. Left adjustment rail
11. Bumper (2 each)
12. Washer
13. Bolt (2 each)
14. Seat
15. Nut
16. Spring (2 each)
17. Magnet
18. Seat switch
19. Rivet (4 each)
20. Mounting plate
21. Return spring
22. Torx-head screw (5 each)
23. Right adjustment rail
24. Rail stop
25. Torx-head screw
26. Torx-head screw (3 each)
27. Washer (3 each)
28. Handle
29. Flat-head screw (3 each)
30. Adaptor plate
31. Headscrew
32. Lever
33. Handle
34. Nut
35. Support bracket
36. Bolt

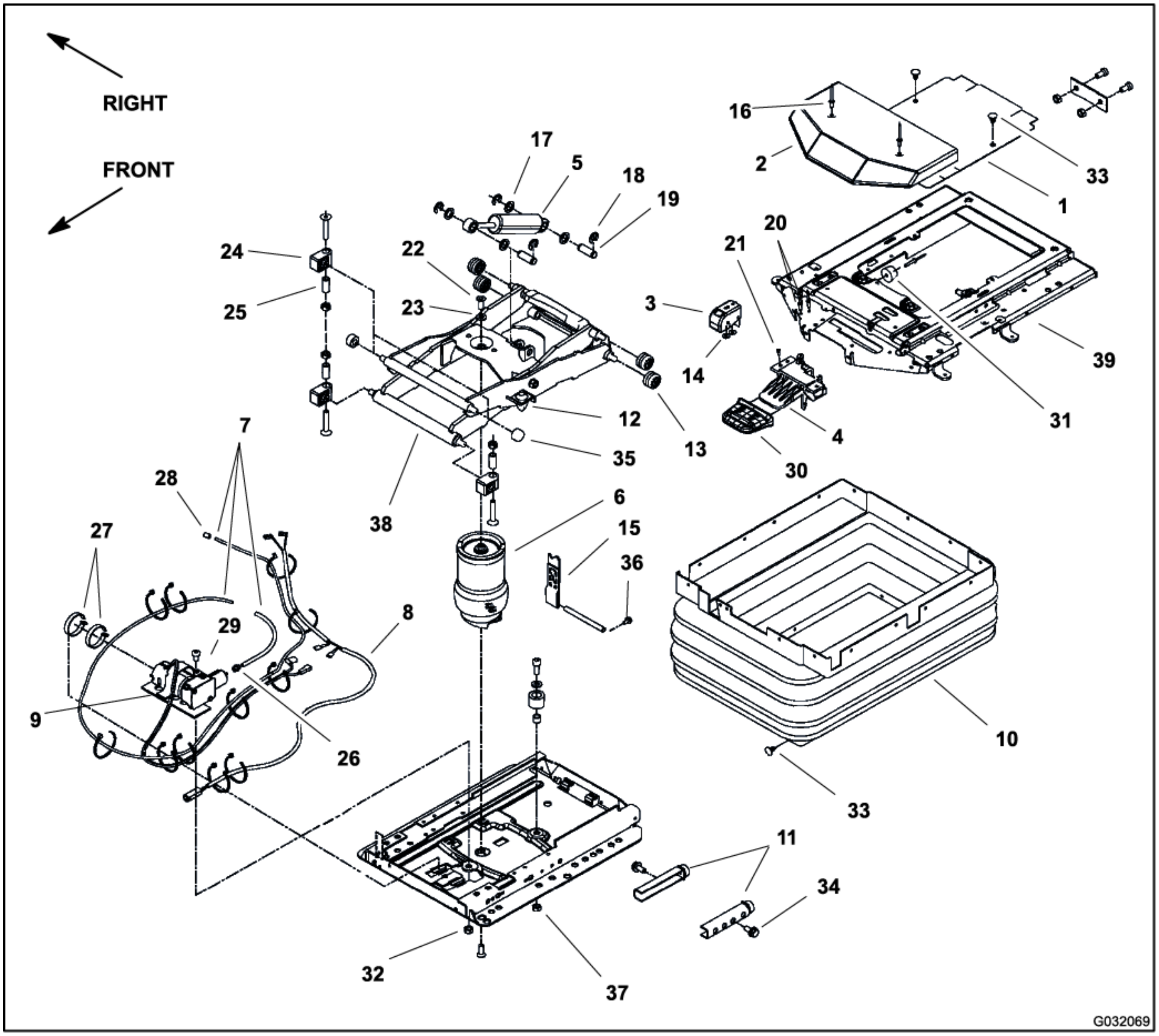
Disassembling the Operator Seat

1. Remove the seat from the machine for service; refer to Removing the Operator Seat (page 7–25).
2. Disassemble the operator seat as shown in Figure 331.

Assembling the Operator Seat

1. Assemble the operator seat; refer to Figure 331.
2. Install the seat to the machine; refer to Installing the Operator Seat (page 7–26).

Operator Seat Suspension (Machine with Serial Number Below 315000200)



g032069

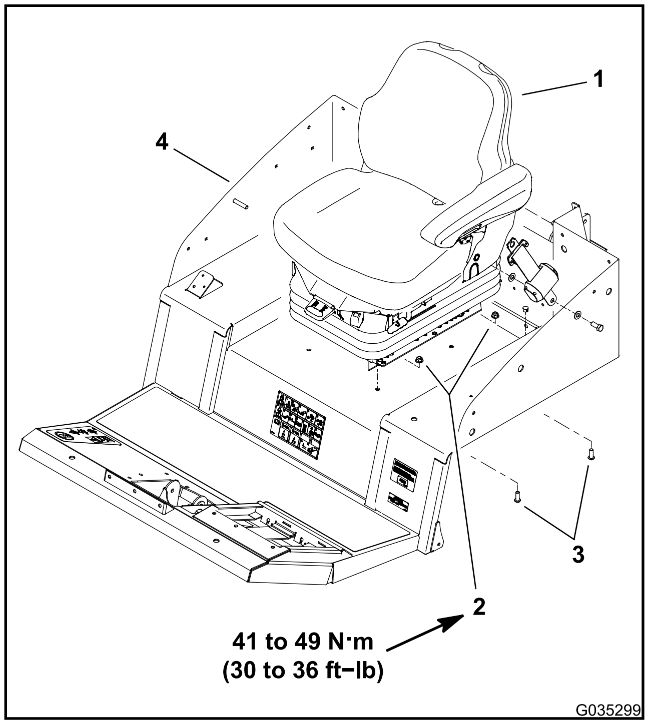
Figure 332

1.	Cover	14.	Washer (2 each)	27.	Clamp (2 each)
2.	Cover	15.	Tether	28.	Hose nipple
3.	Level control	16.	Rivet (2 each)	29.	Screw
4.	Air control valve	17.	Washer (4 each)	30.	Handle
5.	Shock absorber	18.	C-clip (4 each)	31.	Bumper
6.	Air spring assembly	19.	Pin (2 each)	32.	Nut
7.	Air tube assembly	20.	Rivet (2 each)	33.	Plastic plug (23 each)
8.	Wire harness	21.	Washer (3 each)	34.	Screw (2 each)
9.	Compressor	22.	Screw (2 each)	35.	Roller (2 each)
10.	Bellows	23.	Washer	36.	Screw (4 each)
11.	Stop	24.	Housing support (4 each)	37.	Base plate
12.	Bumper seat (2 each)	25.	Spacer (4 each)	38.	Suspension frame
13.	Roller (4 each)	26.	Hose nipple	39.	Upper plate

Note: You can service most of the seat suspension components with the seat suspension base mounted to the frame platform. If the air spring assembly (item 6 in Figure 332) requires removal, remove the seat suspension base from the seat platform.

Disassembling the Operator Seat Suspension

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.



g035299

Figure 333

1. Operator seat assembly
2. Flange nut (4 each)
3. Screw (4 each)
4. Seat platform

---

2. Remove the operator seat from the seat suspension; refer to Removing the Operator Seat (page 7–25).
3. Disconnect the seat suspension electrical connector from the machine wire harness.
4. If the air spring assembly (item 6 in Figure 332) or base plate (item 37 in Figure 332) requires removal, remove the seat suspension from the seat platform (Figure 333).
   A. To get access to the seat suspension mounting screws, slide the fuel tank toward the left side of the machine. Support the tank to prevent it from shifting; refer to Removing the Fuel Tank (page 3–17).
   B. Remove the 4 screws and 4 flange nuts that attach the seat suspension to the seat platform.
   C. Lift the seat suspension from the machine.
5. Remove the seat suspension components as shown in Figure 332.

Assembling the Operator Seat Suspension

1. Install all the seat suspension components that were removed; refer to Figure 332.

Assembling the Operator Seat Suspension (continued)

2. If the seat suspension is removed from the seat platform (Figure 333), do the following:

   A. Position the seat suspension onto the seat platform.

   B. Attach the seat suspension to the seat platform with the 4 screws and 4 flange nuts.

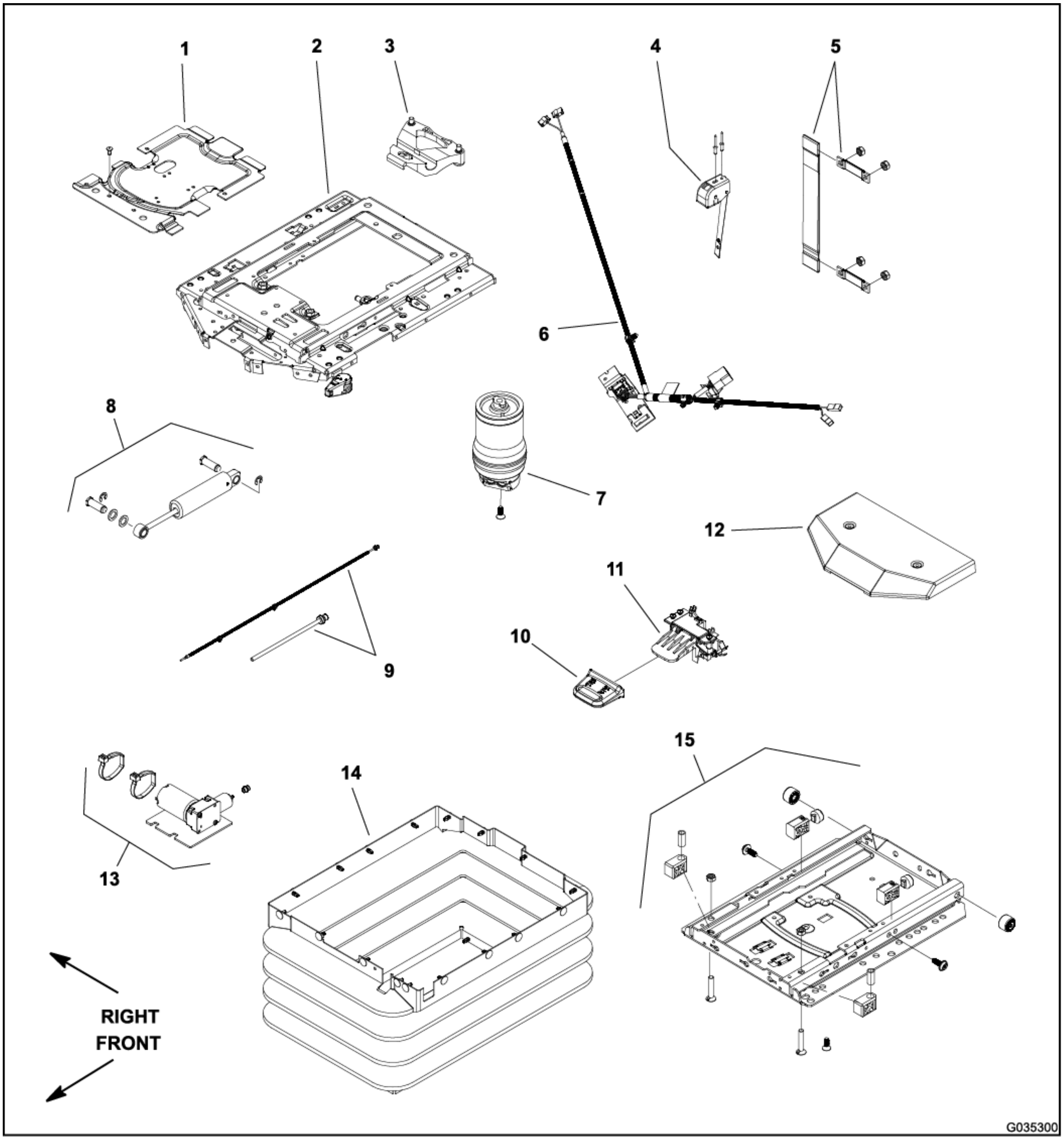
   C. Slide the fuel tank toward the right side of the machine; refer to Installing the Fuel Tank (page 3–18).

   Note: Ensure that the fuel tank and front wheel are attached correctly.

3. Install the operator seat to the seat suspension; refer to Installing the Operator Seat (page 7–26).

4. Connect the seat electrical connectors to the machine wire harness.

Operator Seat Suspension (Machine with Serial Number Above 315000200)



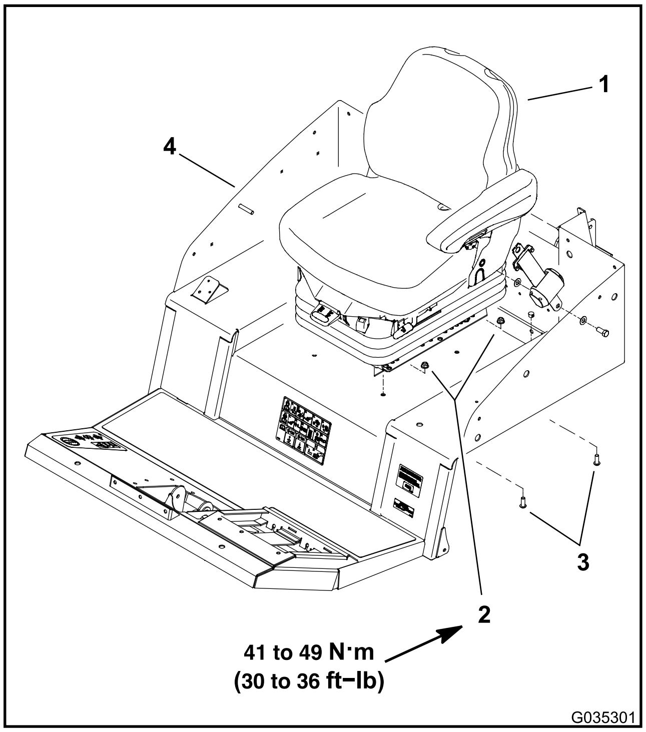
g035300

Figure 334

1. Cover assembly
2. Upper suspension
3. Thrust limiter
4. Control lever
5. Tether
6. Wire harness
7. Air spring assembly
8. Shock absorber
9. Air tube assembly
10. Handle
11. Air control valve
12. Cover
13. Compressor
14. Bellows
15. Lower seat suspension

Note: You can service most of the seat suspension components with the lower seat suspension (item 15 in Figure 334) mounted to the frame platform. If the air spring assembly (item 7 in Figure 334) requires removal, remove the lower seat suspension from the seat platform.

Disassembling the Operator Seat Suspension



g035301

Figure 335

1. Operator seat assembly
2. Flange nut (4 each)
3. Screw (4 each)
4. Seat platform

---

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the operator seat from the seat suspension; refer to Removing the Operator Seat (page 7–25).
3. Disconnect the seat suspension electrical connector from the machine wire harness.
4. Remove the seat suspension components as shown in Figure 334.
5. Remove the lower seat suspension from the seat platform (Figure 335) as follows:
   A. To get access to the lower seat suspension mounting screws, slide the fuel tank toward the left side of the machine. Support the tank to prevent it from shifting; refer to Removing the Fuel Tank (page 3–17).
   B. Remove the 4 screws and 4 flange nuts that attach the lower seat suspension to the seat platform.
   C. Lift the seat suspension from the machine.

Assembling the Operator Seat Suspension

1. If removed, install the lower seat suspension to the seat platform (Figure 335) as follows:
   A. Position the seat suspension onto the seat platform.

Assembling the Operator Seat Suspension (continued)

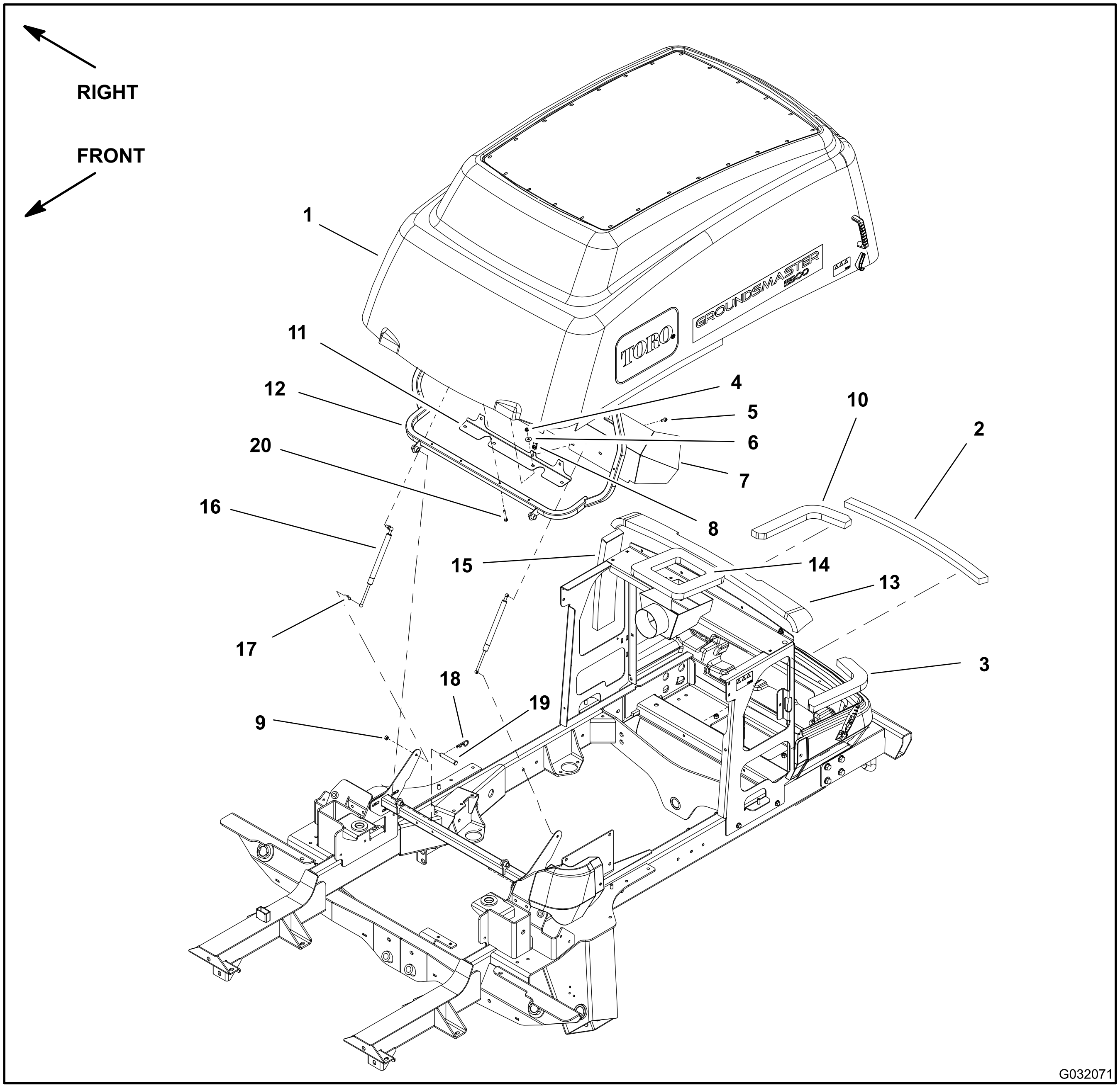
B. Attach the seat suspension to the seat platform with the 4 screws and 4 flange nuts. Tighten the 4 flange nuts to **41 to 49 N·m (30 to 36 ft-lb)**.

C. Slide the fuel tank back into its position and install the fuel tank; refer to Installing the Fuel Tank (page 3–18).

Note: Ensure that the fuel tank and front wheel are attached correctly.

2. Install all the seat suspension components that were removed; refer to Figure 334.
3. Install the operator seat to the seat suspension; refer to Installing the Operator Seat (page 7–26).
4. Connect the seat electrical connectors to the machine wire harness.

Hood



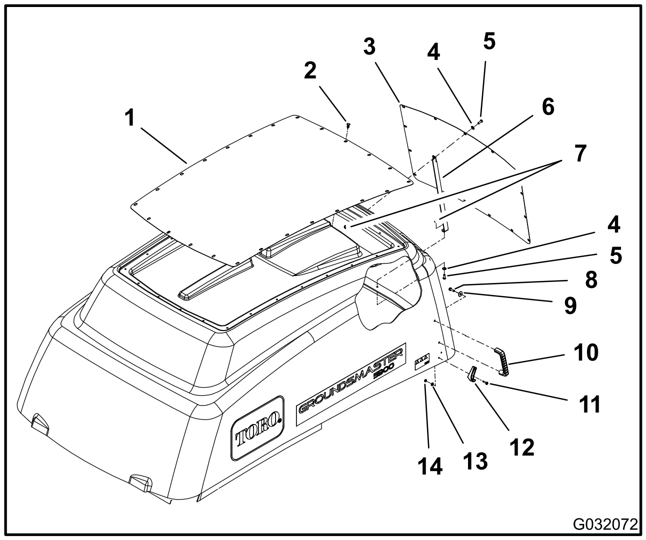
g032071

Figure 336

1. Hood
2. Rear hood foam seal
3. Left rear foam seal
4. Flange nut (8 each)
5. Flange-head screw (3 each)
6. Washer (8 each)
7. Heat shield
8. Clip (3 each)
9. Hex nut (2 each cylinder)
10. Right rear foam seal
11. Support plate
12. Hood frame
13. Top foam seal
14. Air box foam seal
15. Side foam seal (2 each)
16. Gas spring (2 each)
17. Ball stud (2 each cylinder)
18. Hair pin (2 each)
19. Clevis pin (2 each)
20. Bolt (8 each)

Note: The removal and installation of the hood requires 2 people.

Removing the Hood



g032072

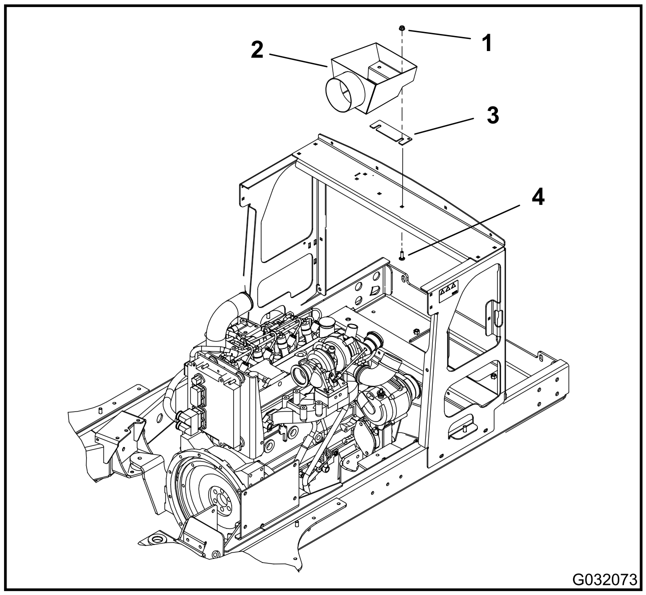
Figure 337

1. Top screen
2. Plug
3. Rear screen
4. Flat washer (2 each)
5. Screw (2 each)
6. Hood strap
7. Flange nut (2 each)
8. Screw (4 each)
9. Washer (4 each)
10. Handle (2 each)
11. Screw (4 each)
12. Latch (2 each)
13. Flat washer (4 each)
14. Locknut (2 each)

---

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Unlatch the hood and raise it.
3. Have a person support the rear of the raised hood.
4. Have a second person to disengage the gas springs from the front ball. Lift the flat clip until the ball is released from the spring socket.
5. Remove the 2 hair pins (item 18 in Figure 336) that attach the clevis pins to the frame.
6. While supporting the hood on both sides, remove the 2 clevis pins (item 19 in Figure 336) that attach the hood to the machine. Raise the hood and remove it from the rear of the machine.
7. Inspect all the foam seals for damage. Also, ensure that the foam seals show an indication of effective sealing with the hood. Remove and replace the foam seals if necessary.
8. If necessary, remove the hood components; refer to Figure 336 and Figure 337.

Installing the Hood



g032073

Figure 338

1. Flange nut (2 each)
2. Air box
3. Shim (as needed)
4. Carriage screw (2 each)

---

1. Replace all the hood components that were removed; refer to Figure 336 and Figure 337.
2. While supporting the hood on both sides, position the hood to align the clevis pin holes in the hood and machine frames. Install the 2 clevis pins to attach the hood to the machine.
3. Have a person support the rear of the raised hood.
4. Have a second person attach the gas springs to the machine frame. Align the ball and socket, and press them together to engage.
5. Lower the hood and check that the hood makes a continuous seal around the air cleaner system airbox.

   Note: If necessary, use shim(s) to adjust the location of the airbox for the correct sealing with the hood; refer to Figure 338.
6. Lower the hood and secure it with the latches.

Chapter 8

Cutting Decks

Table of Contents

Specifications

Cutting Decks

g032074

Figure 339

Mounting: The cutting decks are supported by the lift arms controlled with the hydraulic-lift cylinders.

Construction: The deck chambers are welded steel construction reinforced with the channels and plates.

Height-of-cut range: 25.4 to 152 mm (1 to 6 inches) adjustable in 12.7 mm (1/2 inch) increments. The center deck height-of-cut adjustment is achieved by changing spacers on the castor wheels, positioning the castor arms again in the deck brackets, positioning the castor wheel axles again in the castor forks, and adjusting the length of the deck support chains. The wing deck adjustment is achieved by changing spacers on the castor wheels, positioning the castor arms again in the deck brackets, and positioning the castor wheel axles again in the castor forks.

Deck drive: The closed loop hydraulic system operates the hydraulic motor on each cutting deck. The motor drives 1 spindle directly with the remaining deck section spindle(s) driven by the B-section kevlar v-belt(s). The blade spindles are 31.7 mm (1-1/4 inch) shafts supported by the greaseable, tapered roller bearings.

Cutting blade: The cutting blade dimensions are 508 mm (20 inches) long, 64 mm (2.5 inches) wide, and 6.4 mm (0.25 inch) thick. The anti-scalp cup is installed on each cutting blade. The center deck includes 5 blades and each wing deck includes 3 blades.

Width of cut: The front deck provides 2337 mm (92 inches) width of cut. Each wing deck has 1448 mm (57 inches) width of cut. The total width of cut is 4877 mm (192 inches).

Cutting Decks (continued)

Discharge: The clippings are discharged from the rear of the cutting deck.

Suspension system: A fully floating suspension with the hydraulic counterbalance. The front deck is suspended from the lift arms and has 2 castor wheels, 2 adjustable skids, and 3 anti-scalp rollers. The wing decks are suspended from the lift arms and have 4 castor wheels, 2 adjustable skids, and 2 anti-scalp rollers.

General Information

CAUTION

Do not install or work on the cutting deck or lift arms with the engine running. Always shut off the engine and remove the key from the key switch.

Operator's Manual

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

Castor Wheel Tire Pressure

The castor tires on the cutting deck should be inflated to 345 kPa (50 psi).

Blade Stopping Time

The blades of the cutting deck should come to a complete stop in approximately 5 seconds after the PTO switch is shut off.

Note: Ensure that the decks are lowered onto a clean section of turf or hard surface to prevent dust and unwanted material.

To check the blade stopping time, have a second person stay away from the deck minimum at 6100 mm (20 ft) and monitor 1 of the cutting deck blades. Have the operator shut off the cutting deck and record the time it takes for the blades to come to a complete stop. If this stopping time is more than 7 seconds, the braking valve (RV2) on the deck drive hydraulic control manifold may need adjustment.

Troubleshooting

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, uneven ground conditions, sponginess or attempting to cut off the excessive grass height may not always be overcome by adjusting the machine.

Remember that the effective or actual height-of-cut depends on the cutting unit weight, tire pressures, hydraulic counterbalance settings, and turf conditions. The effective height-of-cut will be different than the bench set height-of-cut.

Factors that can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Maximum governed engine speed.	Ensure that the throttle control is placed in the FAST position when mowing. Check the maximum governed engine speed; refer to Chapter 3: Diesel Engine (page 3–1).
2. Blade speed.	All the deck blades should rotate at the same speed. Refer to the items in the Troubleshooting (page 4–48).
3. Tire pressure.	Check the air pressure of all the machine tires including the cutting deck castor tires. Adjust to the pressures specified in the *Operator's Manual*.
4. 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.
5. Mower housing condition.	Ensure that the cutting chambers are in good condition. Keep the underside of the deck clean. The unwanted material buildup can reduce the cutting performance.
6. Height-of-cut.	Ensure that all the deck height-of-cut adjustments are the same. Adjust the deck as specified in the *Operator's Manual*.
7. Cutting deck alignment and ground following.	Check the lift arms and cutting deck pivot pins for wear, damage, or binding.
8. Roller and castor wheel condition.	All the rollers and caster wheels should rotate freely. Replace the bearings if worn or damaged.
9. Grass conditions.	Mow when the grass is dry for best cutting results. Also, remove only 25.4 mm (1 inch) or 1/3 of the grass blade when cutting.

Service and Repairs

CAUTION

Do not install or work on a cutting deck or lift arm with the engine running. Always shut off the engine and remove the key from the key switch.

Front Cutting Deck

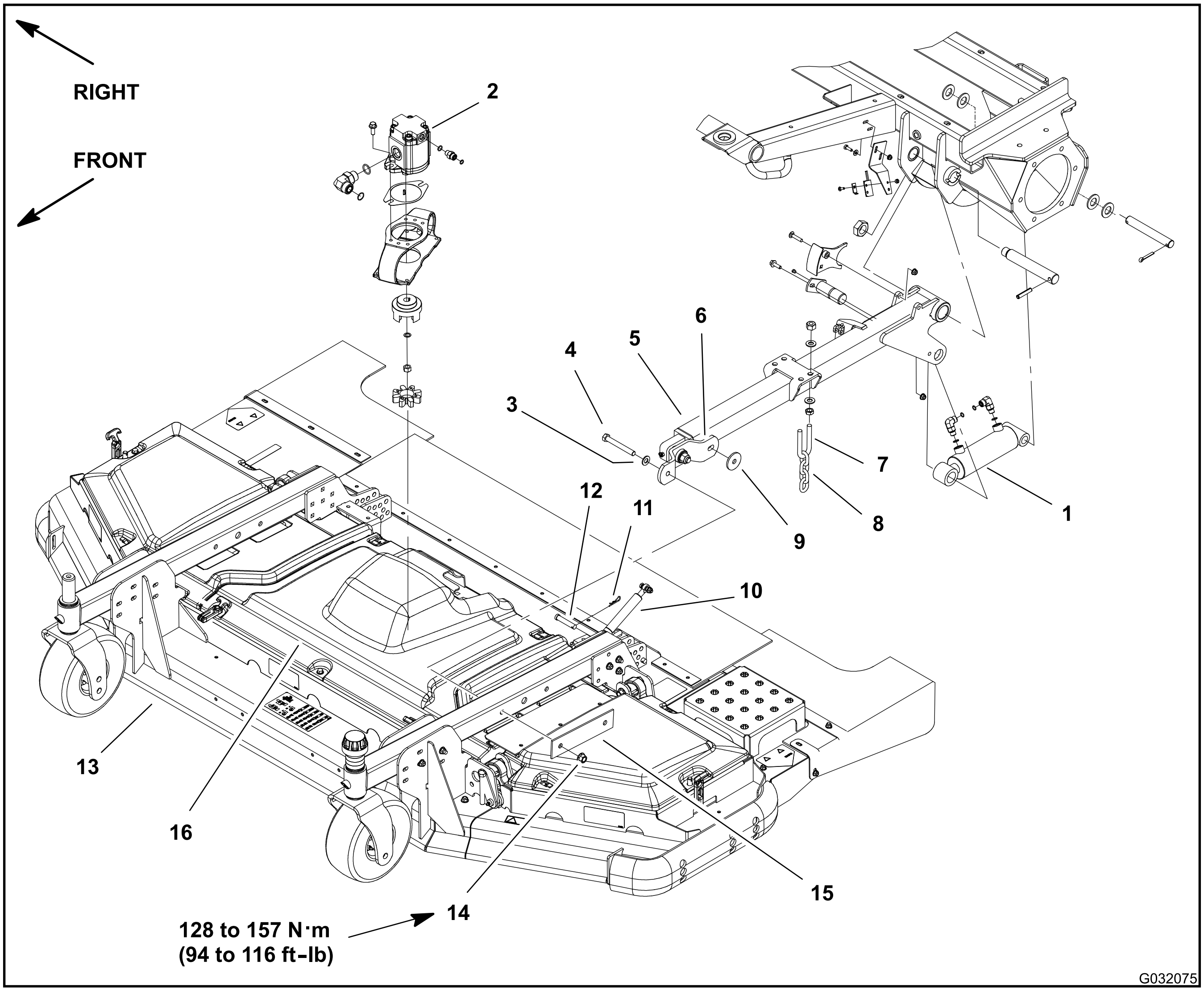


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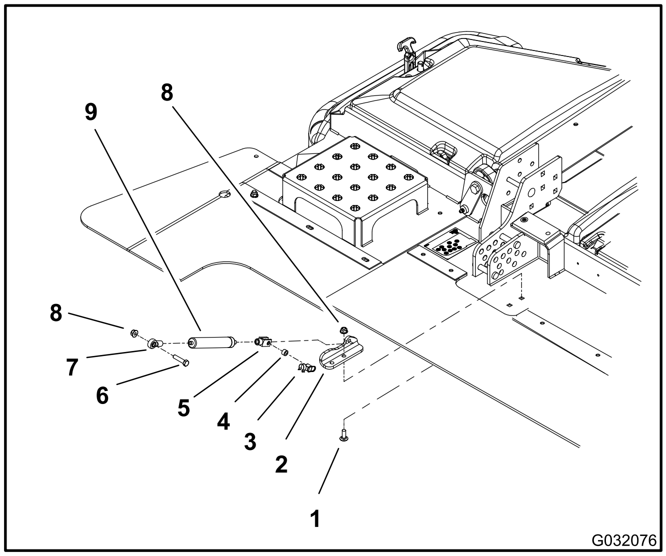
Figure 340

1. Lift cylinder (left)
2. Hydraulic deck motor
3. Flat washer (2 each lift arm)
4. Bolt (2 each lift arm)
5. Lift arm assembly (left)
6. Support hub (1 each lift arm)
7. U-bolt (1 each lift arm)
8. HOC chain (1 each lift arm)
9. Thrust washer (1 each lift arm)
10. Damper assembly
11. Hairpin (1 each lift arm)
12. Clevis pin (1 each lift arm)
13. Front cutting deck
14. Locknut (2 each lift arm)
15. Plate (1 each lift arm)
16. Center deck cover

Removing the Front Cutting Deck

1. Position the machine on a clean, level surface. Lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the center deck cover to access the hydraulic deck motor.
3. Remove the hydraulic motor from the cutting deck; refer to Removing the Cutting Deck Motor (page 4–145).
4. Position and support the motor away from the cutting deck.
5. Start the engine and raise the deck slightly. Shut off the engine and remove the key from the key switch.



g032076

Figure 341

1. Carriage screw (2 each)
2. Damper mount
3. Spring pin
4. Spacer
5. Clevis rod end
6. Bolt
7. Bearing rod end
8. Flange nut (3 each)
9. Damper

6. Remove the hairpins (item 11 in Figure 340) and clevis pins (item 12 in Figure 340) that attach the height-of-cut chains to the rear of the cutting deck.
7. Remove the spring pin and spacer that attach the damper to the damper mount on the deck (Figure 341 and Figure 342). Position the damper away from the cutting deck.
8. Start the engine and lower the deck to the ground. Shut off the engine and remove the key from the key switch.
9. Remove the bolts (item 4 in Figure 340), flat washers (item 3 in Figure 340), plate (item 15 in Figure 340), and locknuts (item 14 in Figure 340) that attach the lift arm support hubs to the cutting deck.
10. Remove the thrust washer (item 9 in Figure 340) that is installed between the lift arm and the rear slotted hole in the support hub.
11. Slide the cutting deck away from the traction unit.

Installing the Front Cutting Deck

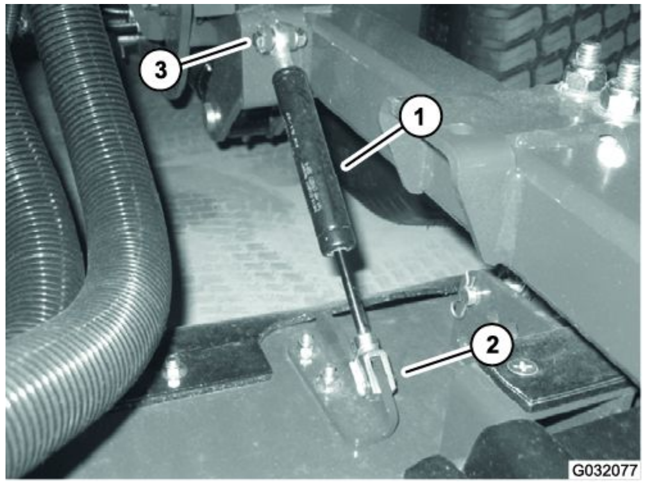


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Figure 342

1. Damper
2. Clevis rod end
3. Bearing rod end

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1. Position the machine on a clean, level surface. Lower the front lift arms, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Position the cutting deck to the lift arms.
3. Align the lift arm support hub to the cutting deck.

   Note: Ensure that the slotted hole in the support hub is toward the rear of the deck.
4. Place the thrust washer (item 9 in Figure 340) between the lift arm and the rear, slotted hole in the support hub.
5. Attach the lift arm support hub to the deck with the bolts (item 4 in Figure 340), flat washers (item 3 in Figure 340), plate (item 15 in Figure 340), and locknuts (item 14 in Figure 340); torque the fasteners to **128 to 157 N·m (94 to 116 ft-b)**.
6. Start the engine and raise the deck slightly. Shut off the engine and remove the key from the key switch.
7. Install the clevis pins and hairpins that attach the height-of-cut chains to the rear of the cutting deck.
8. Position the damper to the mount on the cutting deck. Install the spacer and spring pin to attach the damper to the deck; refer to Figure 341 and Figure 342.
9. Start the engine and lower the deck to the ground. Shut off the engine and remove the key from the key switch.
10. Install the hydraulic motor to the cutting deck; refer to Installing the Cutting Deck Motor (page 4–146).
11. Install all the cutting deck covers that were removed.
12. Lubricate the grease fittings on the cutting deck and lift arm assemblies; refer to the *Operator's Manual*.

Wing Cutting Deck

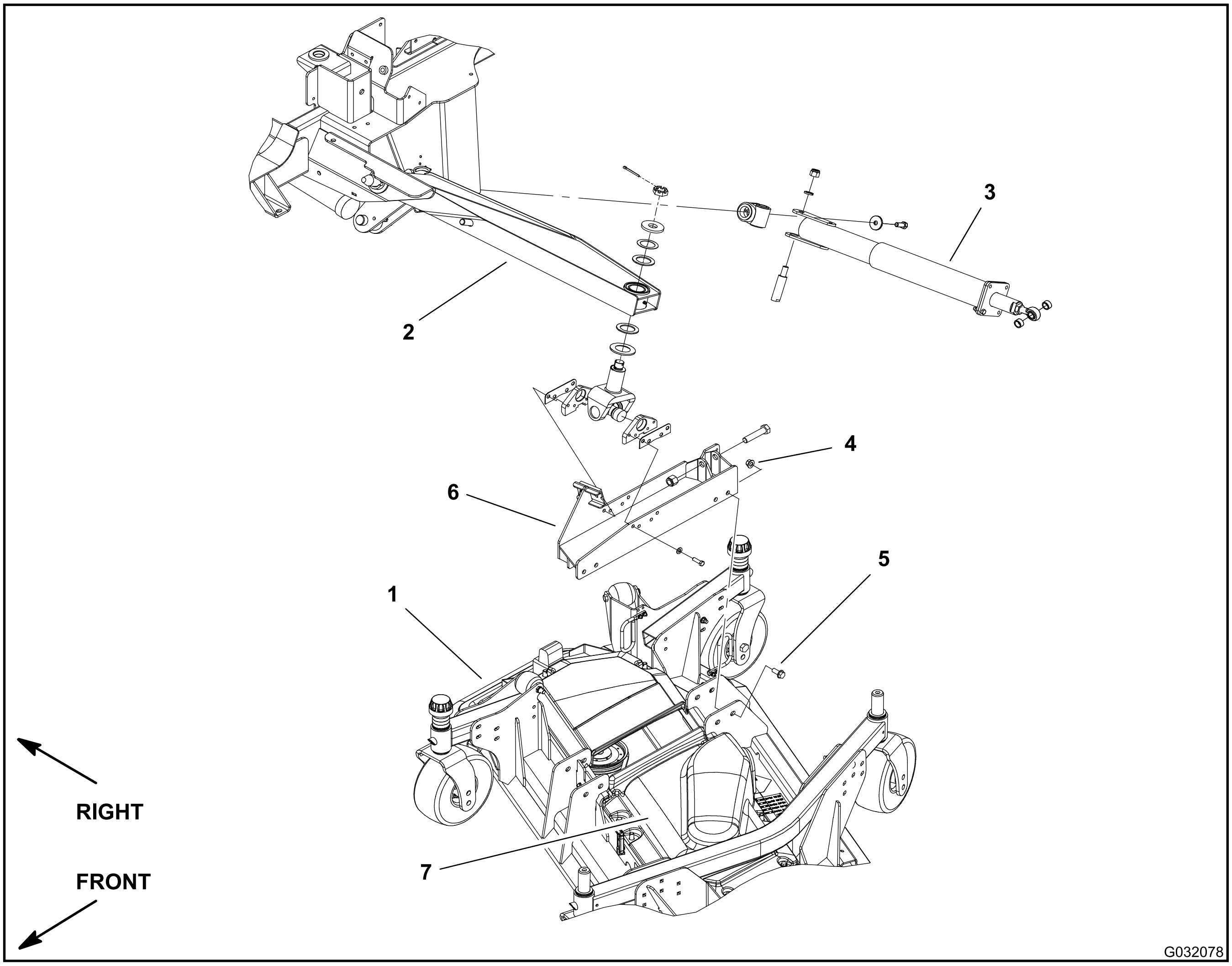

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Figure 343

1. Wing cutting deck (left)
2. Lift arm (left)
3. Rear impact arm assembly
4. Locknut (8 each)
5. Flange-head screw (8 each)
6. Deck connection (left)
7. Deck outer cover

Removing the Wing Cutting Deck

1. Position the machine on a clean, level surface. Lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the cutting deck outer cover to access the hydraulic deck motor.

Removing the Wing Cutting Deck (continued)

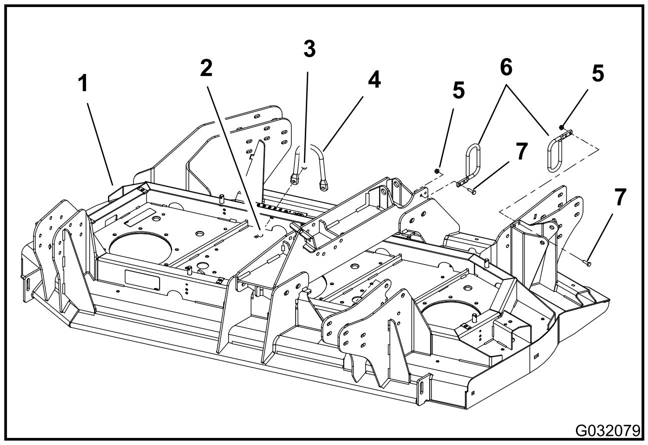

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Figure 344

1. Wing deck (right)
2. Carriage screw (2 each)
3. Flange nut (2 each)
4. Hose guide
5. Flange nut (4 each)
6. Loop guide
7. Bolt (4 each)

---

3. Remove the 3 hose guides from the cutting deck (Figure 344). Keep the 2 loop guides (item 6 in Figure 344) on the hydraulic hoses.
4. Remove the hydraulic motor from the cutting deck; refer to Removing the Cutting Deck Motor (page 4–145).
5. Position and support the motor away from the cutting deck.
6. Remove the 8 flange-head screws (item 5 in Figure 343) and 8 locknuts (item 4 in Figure 343) that attach the deck connection (item 6 in Figure 343) to the cutting deck.
7. Raise the lift arm enough to separate the deck connection from the cutting deck.
8. Slide the cutting deck away from the traction unit.

Installing the Wing Cutting Deck

1. Position the machine on a clean, level surface. Lower the wing deck lift arm, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Position the wing cutting deck to the raised lift arm.
3. Lower the lift arm while you align the deck connection to the cutting deck.
4. Install the deck connection to the cutting deck with the 8 flange-head screws (item 5 in Figure 343) and 8 locknuts (item 4 in Figure 343); tighten the fasteners.
5. Install the hydraulic motor to the cutting deck; refer to Installing the Cutting Deck Motor (page 4–146).
6. Position and attach the 3 hose guides to the cutting deck; refer to Figure 344.
7. Install all the cutting deck covers that were removed.
8. Lubricate the grease fittings on the cutting deck and lift arm assemblies; refer to the *Operator’s Manual*.

Idler Assembly

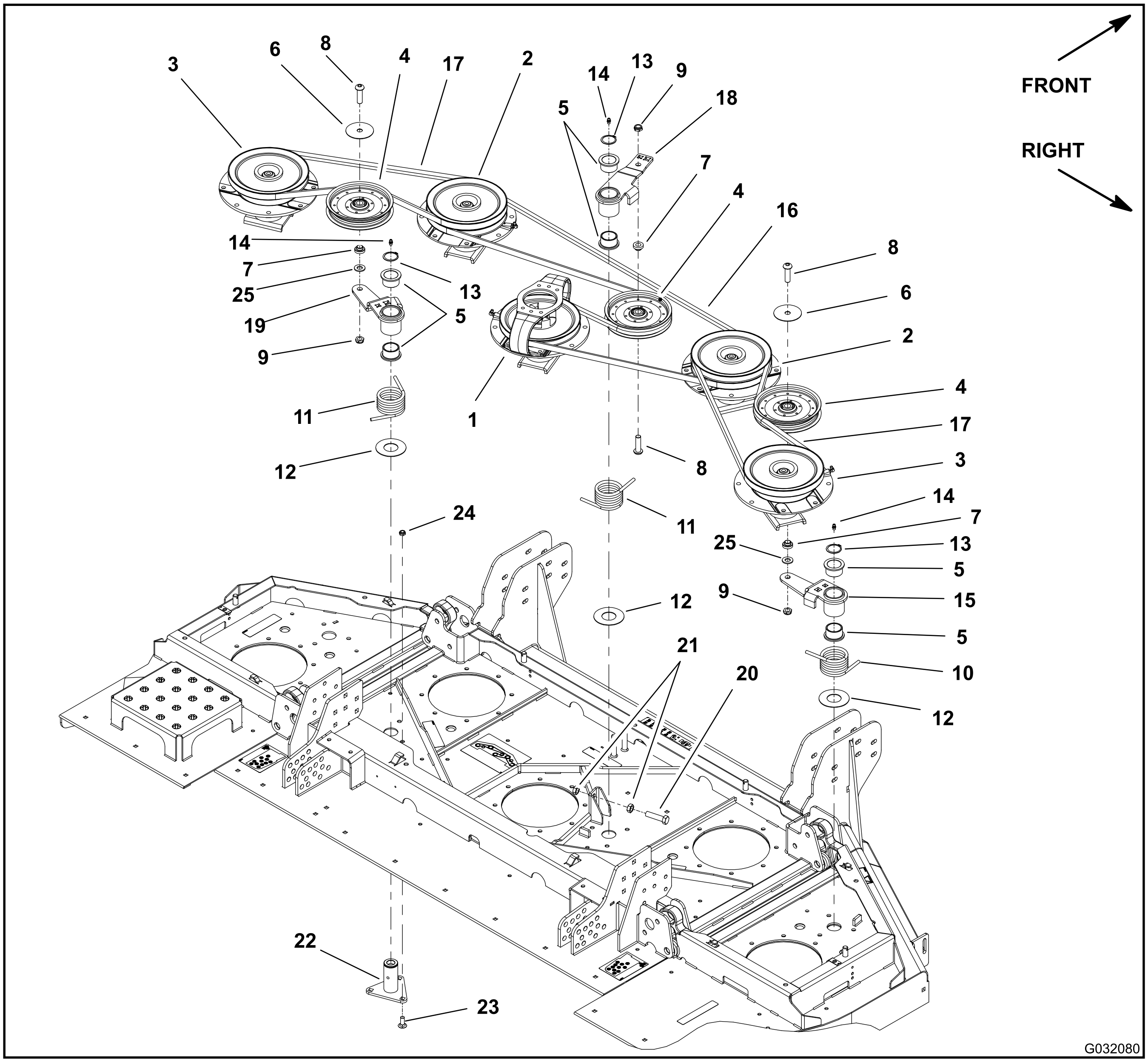

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Figure 345

1. Drive spindle assembly
2. Driven spindle assembly (double)
3. Driven spindle assembly (single)
4. Idler pulley
5. Flange bushing
6. Flat washer
7. Idler spacer
8. Screw
9. Locknut
10. Torsion spring
11. Torsion spring
12. Washer
13. Snap ring
14. Grease fitting
15. Low idler arm
16. V-belt
17. V-belt
18. High idler arm
19. Low idler arm
20. Stop bolt
21. Jam nut
22. Idler pivot post
23. Carriage screw (3 each post)
24. Locknut (3 each post)
25. Flat washer

Note: The front deck is shown in Figure 345. The idler assemblies used on the wing decks are very similar.

Removing the Idler Assembly

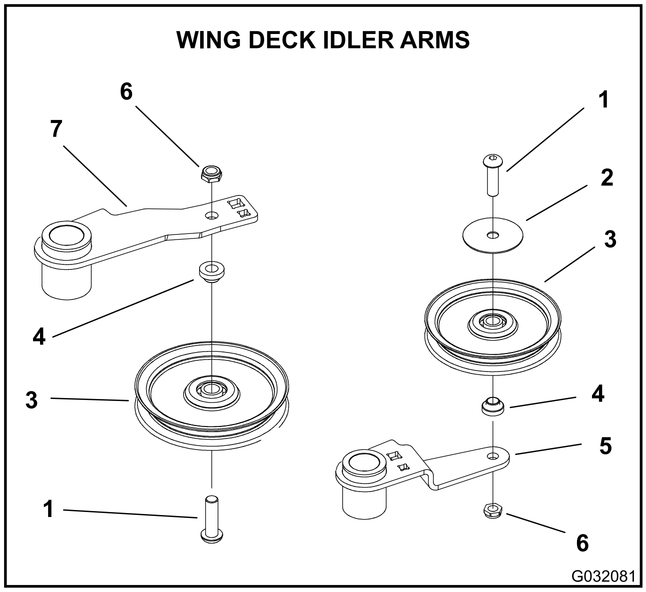

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Figure 346

1. Screw
2. Flat washer
3. Idler pulley
4. Idler spacer
5. Low idler arm
6. Locknut
7. High idler arm

---

1. Park the machine on a level surface, lower the cutting deck. Shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the deck covers from the top of the cutting deck.
3. If you remove the high idler assembly on the front deck, loosen the jam nuts (item 21 in Figure 345) that attach the idler stop bolt (item 20 in Figure 345) to the cutting deck to allow clearance between the high idler arm and the stop bolt.
4. Use an appropriate socket wrench to rotate the idler arm away from the drive belt to release the tension of the belt. Remove the drive belt(s) from the deck pulleys.
5. Insert a nut driver or small piece of pipe onto the end of the torsion spring for the idler arm.

CAUTION

Be careful when removing the tension from the idler arm torsion spring. The spring is under heavy load and can cause personal injury.

---

6. Carefully push the torsion spring end down and away from the idler arm to unhook the spring from the arm.
7. Remove the snap ring that retains the idler arm assembly to the cutting deck.
8. Remove the idler components as shown in Figure 345. Note the location of the flat washer(s), idler spacer, locknut, and screw when you remove the idler assemblies; refer to Figure 345 and Figure 346.

Installing the Idler Assembly

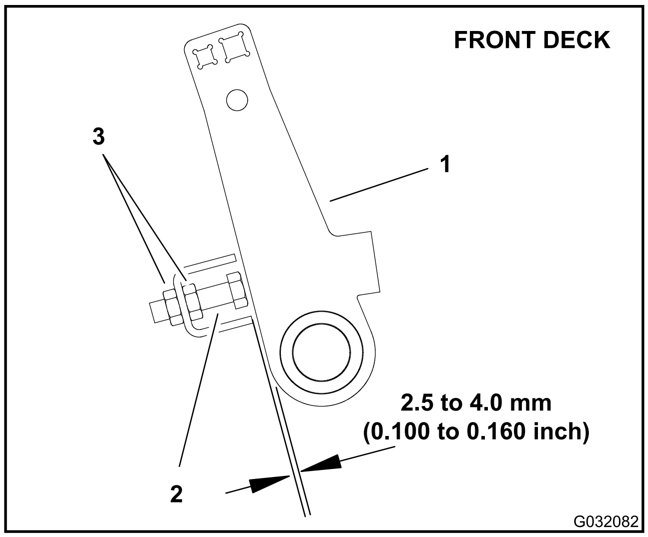
1. Install the idler components that were removed; refer to Figure 345. Attach the idler arm assembly to the cutting deck with the snap ring.
2. Insert a nut driver or small piece of pipe onto the end of the torsion spring for the idler arm.

CAUTION

Be careful when applying the tension to the idler arm torsion spring. The spring is under heavy load and can cause personal injury.

3. Carefully push down on the torsion spring end to get the spring under the idler arm mounting plate. Then release the spring slowly to lock it into the place.
4. Use an appropriate socket wrench on the idler arm to release the tension of the drive belt, position the drive belt(s) to the deck pulleys.

   Note: Ensure that the idler pulley tensions the rear side of the belt.



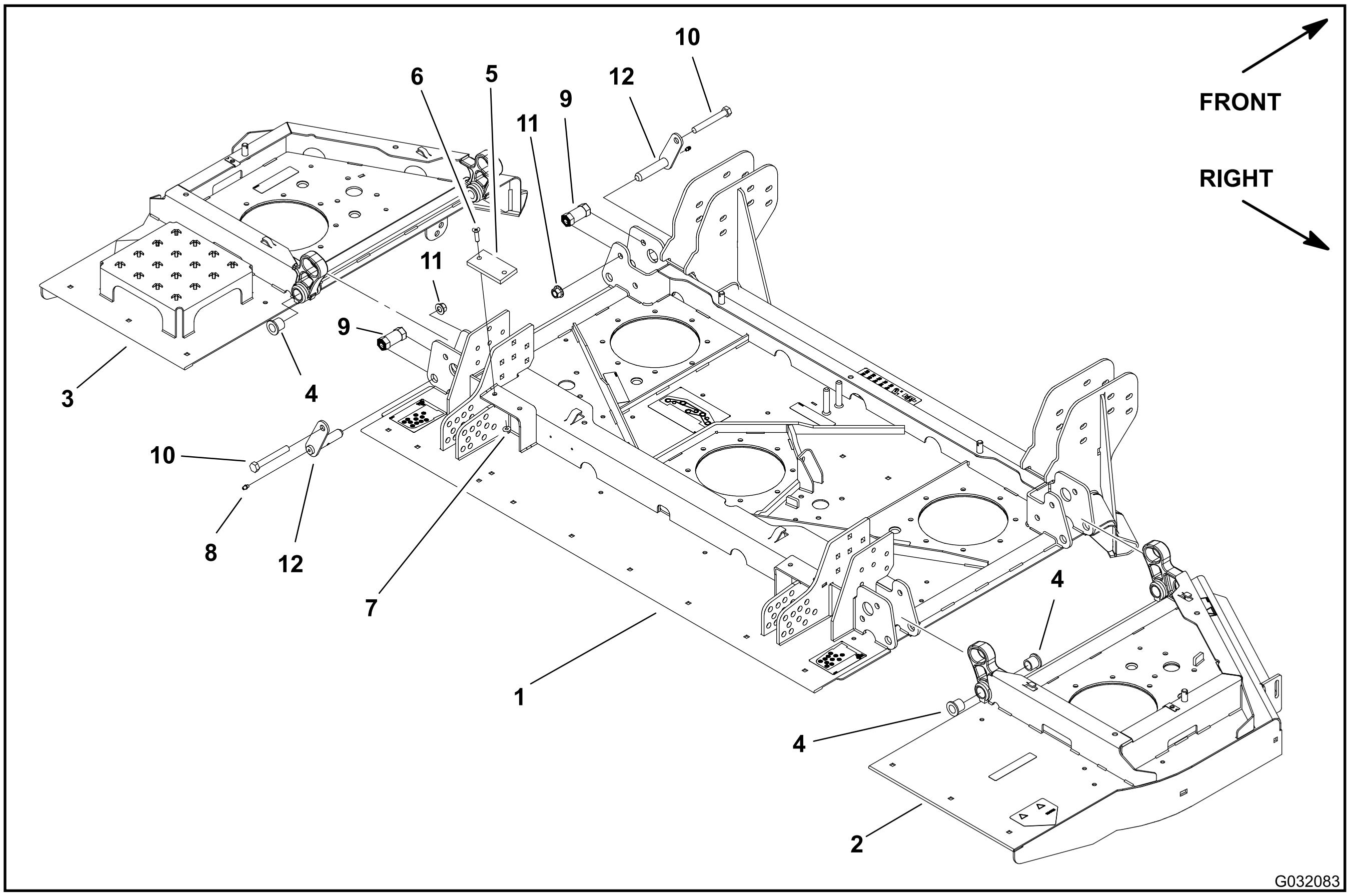
g032082

Figure 347

1. High idler arm
2. Stop bolt
3. Jam nut

5. On the front deck, ensure that the clearance between the high idler arm and the stop bolt is from 2.5 to 4 mm (0.1 to 0.16 inch). If necessary, adjust the location of the jam nut on the stop bolt for proper clearance; refer to Figure 347.
6. Install the deck covers to the cutting deck.

Front Deck Winglets



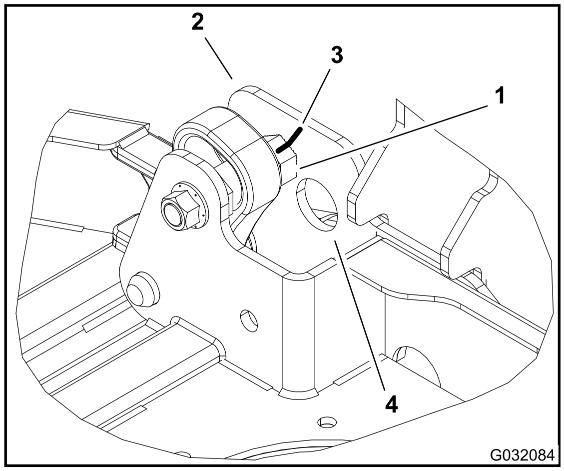
g032083

Figure 348

1. Center deck
2. Right deck winglet
3. Left deck winglet
4. Flange bushing (4 each winglet)
5. Bumper pad (2 each)
6. Screw (4 each)
7. Flange nut (4 each)
8. Grease fitting
9. Eccentric (2 each winglet)
10. Bolt (2 each winglet)
11. Locknut (2 each winglet)
12. Hinge pin (2 each winglet)

Disassembling the Front Deck Winglets

1. Park the machine on a level surface, lower the front cutting deck, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the covers from the front cutting deck.
3. Use an appropriate socket wrench to rotate the idler arm away from the drive belt to release the tension of the belt. Remove the drive belt from the deck winglet spindle.



g032084

Figure 349

1. Eccentric
2. Deck bracket
3. Marker/paint line
4. Eccentric removal hole

4. For assembly alignment purposes, use a marker or paint pen on the eccentric and deck brackets to identify the location of the eccentric; refer to Figure 349.
5. Remove the locknut, bolt, eccentric, and hinge pin from the front and rear winglet hinges. Use the hole in the deck bracket to remove the eccentric from the deck. Slide the winglet away from the front deck.
6. Inspect the hinge pin, eccentric, and flange bushings in the deck winglet. Replace the worn or damaged components.

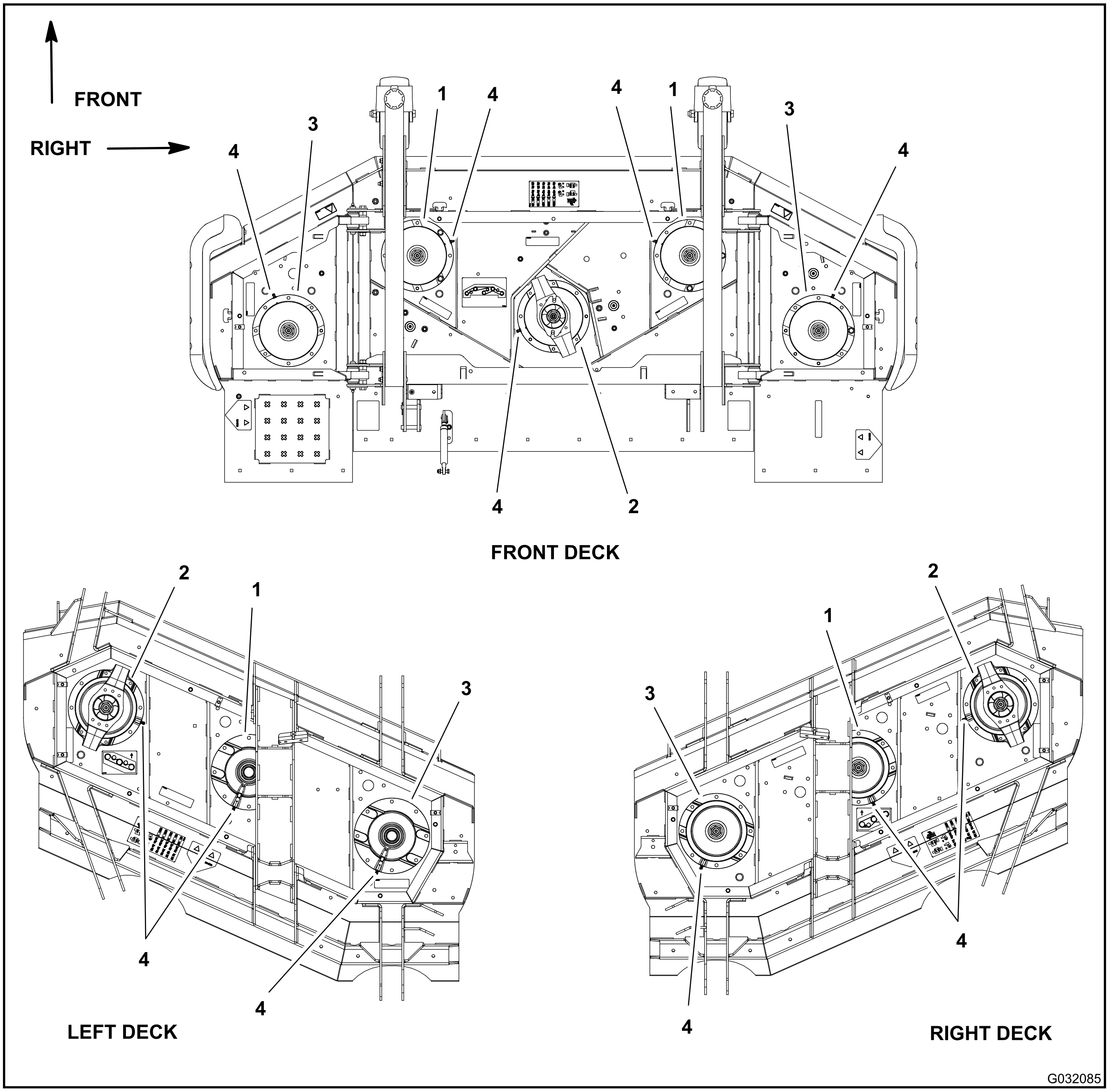
Assembling the Front Deck Winglets

1. Position the winglet to the front deck.
2. Attach the deck winglet to the center deck with the hinge pin.
3. Position the eccentrics in the center frame brackets and install the bolt and locknut.

   Note: Do not fully tighten the fasteners.
4. Use an appropriate socket wrench on the idler arm to release the tension of the drive belt, position the drive belt to the deck winglet spindle.

   Note: Ensure that the idler pulley tensions the rear side of the belt.
5. Use the marker or paint pen line that you made during disassembly to position the eccentric (Figure 349). Check the front deck blade plane and adjust as necessary; refer to the *Operator's Manual* for additional adjustment information.
6. After you adjust the blade plane correctly, tighten the locknut to attach the eccentric in position.
7. Lubricate the hinge pin grease fittings.
8. Install and attach all the covers that were removed to the front cutting deck.

Blade Spindle



g032085

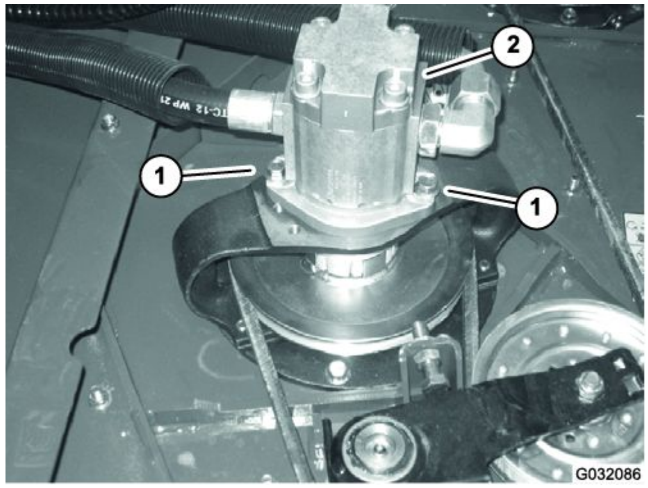
Figure 350

1. Driven spindle (double pulley)
2. Drive spindle
3. Driven spindle (high pulley)
4. Grease fitting

Removing the Blade Spindle

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the covers from the cutting deck to get access to the blade spindle.
3. If the drive spindle requires service, remove the hydraulic motor from the cutting deck; refer to Removing the Cutting Deck Motor (page 4–145).

Removing the Blade Spindle (continued)



g032086

Figure 351

1. Flange-head screw
2. Hydraulic motor

4. Position the motor away from the spindle.
5. Use an appropriate socket wrench to loosen the idler pulley to release the tension of the belt. Remove the drive belt from the spindle for servicing.
6. Start the engine and raise the cutting deck. Shut off the engine and remove the key from the key switch. Latch or block up the cutting deck so that it cannot fall accidentally.

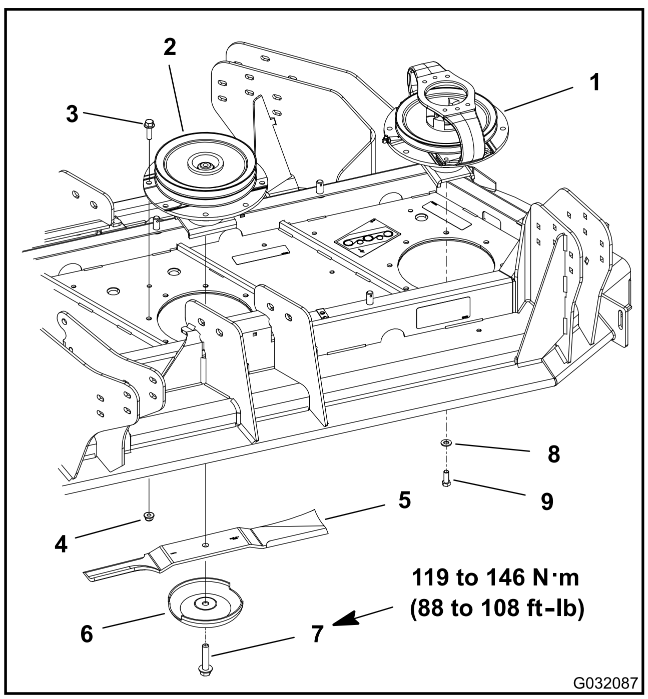


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Figure 352

1. Drive spindle
2. Driven spindle
3. Flange-head screw
4. Flange nut
5. Cutting blade
6. Anti-scalp cup
7. Blade bolt
8. Flat washer
9. Bolt

Removing the Blade Spindle (continued)

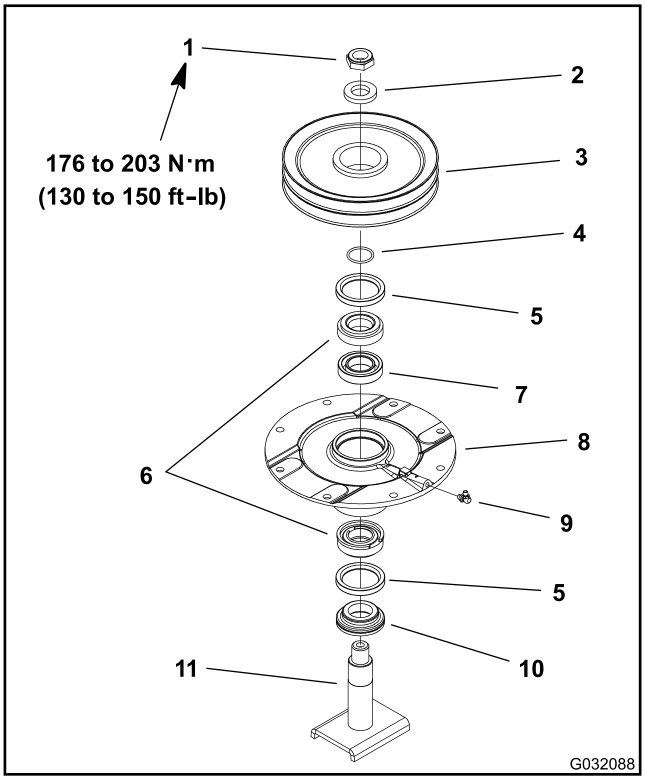
7. Remove the cutting blade, anti-scalp cup, and blade bolt from the spindle for servicing.
8. Remove the spindle housing assembly from the deck as follows:
   A. For the driven spindle assemblies, remove the 8 flange-head screws with the flange nuts that attach the spindle to the deck.
   B. For the drive spindle assemblies, loosen and remove the 4 flange-head screws with the flange nuts that attach the spindle to the deck and then remove the 4 bolts with the flat washers that attach the spindle and hydraulic motor mount to the deck.
   C. Lift the spindle assembly from the deck.

Installing the Blade Spindle

1. Position the spindle on the cutting deck and note the orientation of the grease fitting (Figure 350). Attach the spindle assembly to the deck with the correct fasteners.
2. Install the cutting blade, anti-scalp cup, and blade bolt to the spindle; tighten the blade bolt to **119 to 146 N·m (88 to 108 ft-lb)**.
3. Slowly rotate the cutting blades to check that the blades do not contact any deck components.
4. Install the drive belt to the spindle pulleys and idler pulley(s).
5. If the drive spindle was removed, install the hydraulic motor to the cutting deck; refer to Installing the Cutting Deck Motor (page 4–146).
6. Install the covers to the cutting deck.

Servicing the Blade Spindle

Disassembling the Blade Spindle



g032088

Figure 353

1. Locknut
2. Hardened washer
3. Pulley
4. O-ring
5. Oil seal
6. Bearing set
7. Spacer set
8. Spindle housing
9. Grease fitting
10. Shaft spacer
11. Spindle shaft

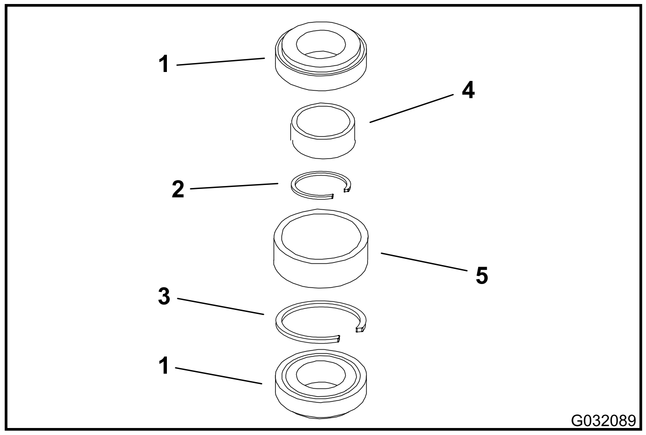
---

1. Loosen and remove the locknut from the top of the spindle shaft. Remove the hardened washer and pulley from the spindle. For drive spindle, remove the hydraulic motor mount.
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. Carefully remove the oil seals from the spindle housing.
4. Allow the bearing cones, inner bearing spacer, and spacer ring to drop out of the spindle housing.
5. Use an arbor press to remove the 2 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.

Disassembling the Blade Spindle (continued)



g032089

Figure 354

1. Bearing
2. Spacer ring
3. Large snap ring
4. Inner bearing spacer
5. Outer bearing spacer

Assembling the Blade Spindle

Note: A replacement spindle bearing set contains 2 bearings, a spacer ring, and a large snap ring (items 1, 2, and 3 in Figure 354). You cannot purchase these parts separately. Also, do not mix the bearing set components from 1 deck spindle to the another.

Note: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Figure 354). Do not mix the bearing spacers from 1 deck spindle to the another.

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), keep 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.

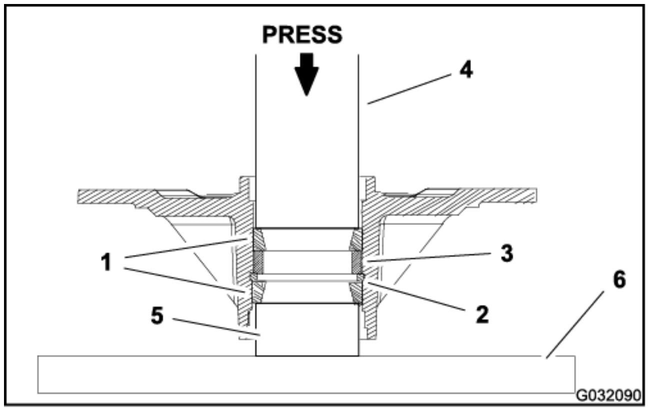
1. If the large snap ring was removed from the spindle housing, install the snap ring into the housing groove.

   Note: Ensure that the snap ring is fully seated in the housing groove.

2. Install the outer bearing spacer into the top of the spindle housing.

   Note: Ensure that the spacer fits against the snap ring.

Assembling the Blade Spindle (continued)



g032090

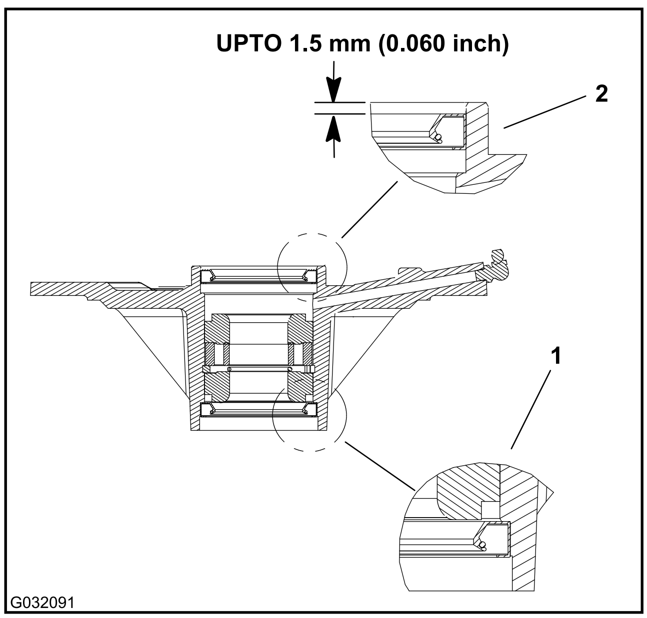
Figure 355

1. Bearing cups
2. Large snap ring
3. Large outer spacer
4. Arbor press
5. Support
6. Arbor press base

3. Use an arbor press and push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer bearing spacer that is previously installed, and the bottom bearing cup must contact the snap ring.

   Note: Ensure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it; refer to Figure 355.

4. Fill the bearing cones with grease. Apply a film of grease on the lips of the oil seals and O-ring.



g032091

Figure 356

1. Bottom seal installation
2. Upper seal installation

5. Install the lower bearing cone and greased oil seal into the bottom of the spindle housing.

Note: Ensure that the bottom seal must have the lip facing out (down). This seal installation allows grease to purge from the spindle during the lubrication process; refer to Figure 356.

IMPORTANT

If you are replacing the bearings, ensure that you use the spacer ring that is included with a new bearing set; refer to Figure 354.

6. Slide the spacer ring and inner bearing spacer into the spindle housing, then install the upper bearing cone and greased oil seal into the top of the housing.

   Note: Ensure that the upper seal has the lip facing in (down) and upper seal is flush to 1.5 mm (0.06 inch) recessed to the housing surface; refer to Figure 356.

7. Inspect the spindle shaft and shaft spacer to ensure that there are no burrs or nicks that could damage the oil seals. Lubricate the shaft and spacer with grease.
8. Install the spindle shaft spacer onto the shaft. Place a thin sleeve or tape on the spindle shaft splines to prevent damage of the seal during the installation of the shaft.
9. Carefully slide the spindle shaft with the spacer up through the spindle housing.

   Note: When you fully install the spindle, the bottom oil seal and spindle spacer fit together.

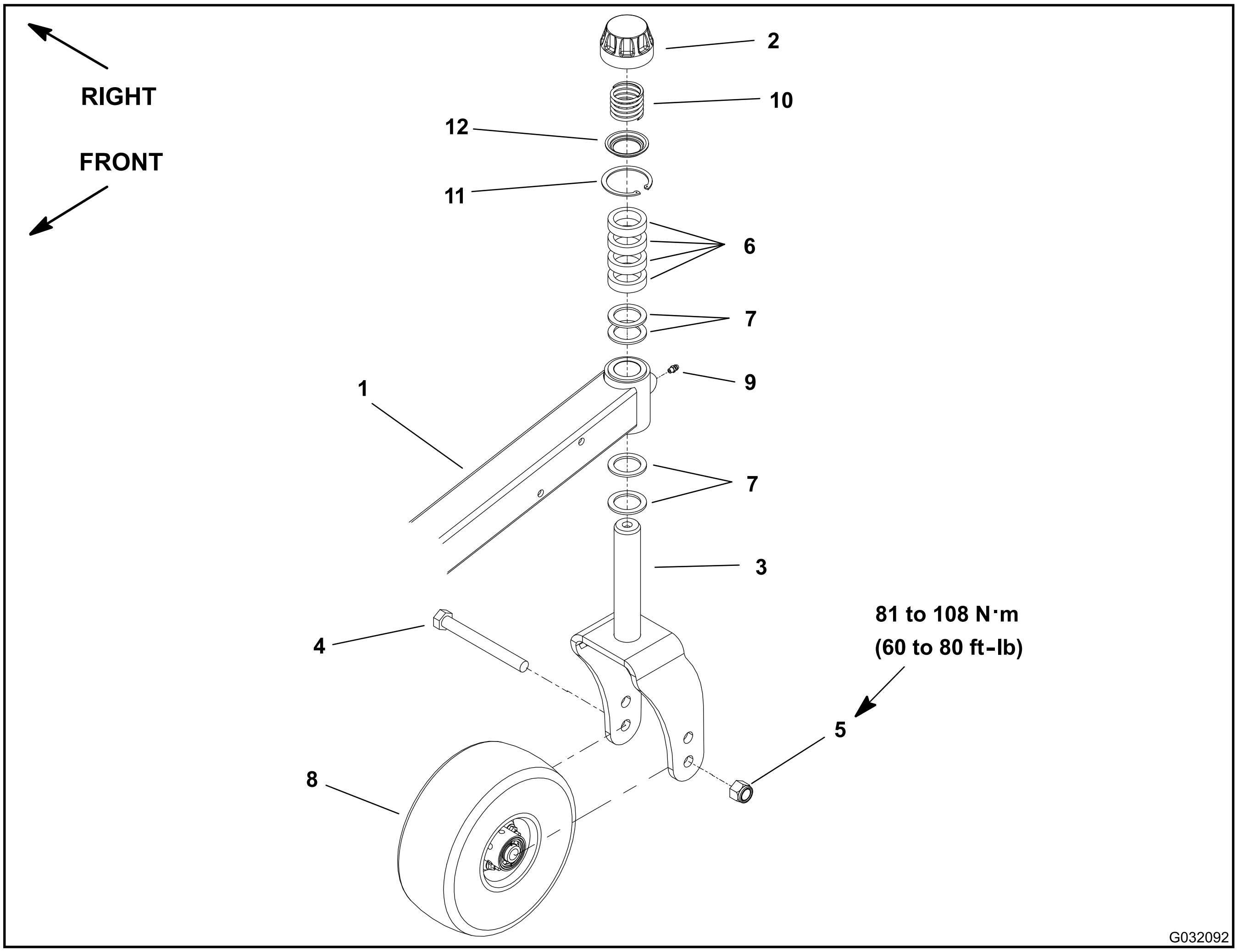
10. Install the greased O-ring to the top of the spindle shaft.
11. Install the pulley (hub down), hardened washer, and locknut to the spindle shaft; tighten the locknut to **176 to 203 N·m (130 to 150 ft-lb)**.

IMPORTANT

The pneumatic grease guns can produce high pressure inside the spindle housing that can damage the spindle seals. Therefore, do not use the pneumatic grease guns for greasing of the spindle housing.

12. Attach a hand pump grease gun to the grease fitting on the housing and fill the housing cavity with grease until the grease starts to come out of the lower seal.
13. Rotate the spindle shaft to ensure that it turns freely.

Castor Forks and Wheels

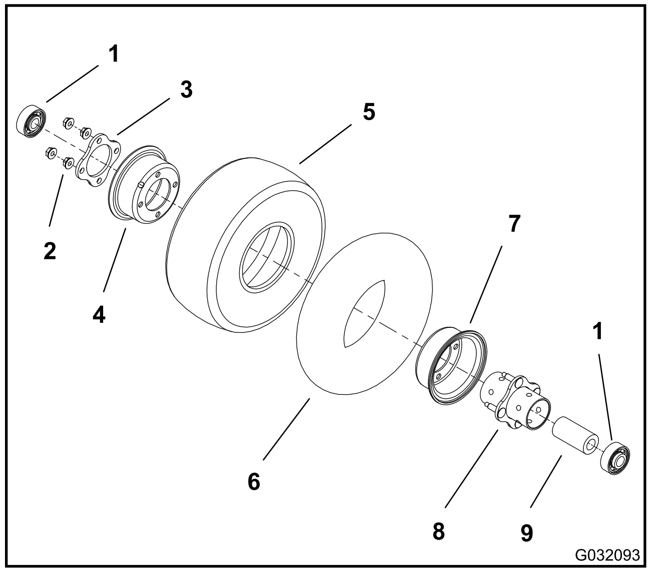


g032092

Figure 357

1. Castor arm (wing deck)
2. Cap
3. Castor fork
4. Castor wheel bolt
5. Locknut
6. Castor spacer
7. Thrust washer
8. Castor wheel
9. Grease fitting
10. Compression spring
11. Retaining ring
12. Bolt

Disassembling the Castor Forks and Wheels



g032093

Figure 358

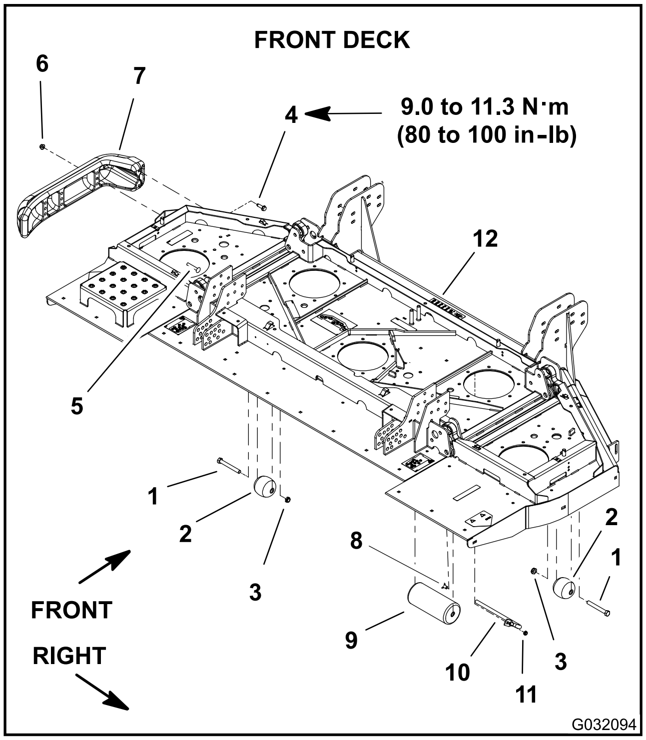
1. Bearing
2. Flange nut (4 each)
3. Plate
4. Rim half
5. Tire
6. Inner tube
7. Rim half
8. Hub
9. Bearing spacer

Disassemble the castor forks and wheels; refer to Figure 357 and Figure 358.

Assembling the Castor Forks and Wheels

1. Assemble the castor forks and wheels; refer to Figure 357 and Figure 358.
   A. Install the castor wheels so that the valve stem extends toward the left side of the machine.
   B. Insert the castor wheel bolt (item 4 in Figure 357) from the right side of the machine.
   C. Torque the castor wheel locknut to **81 to 108 N·m (60 to 80 ft-lb)**.
2. Lubricate the castor fork grease fitting.
3. Check the height-of-cut setting and adjust if necessary.

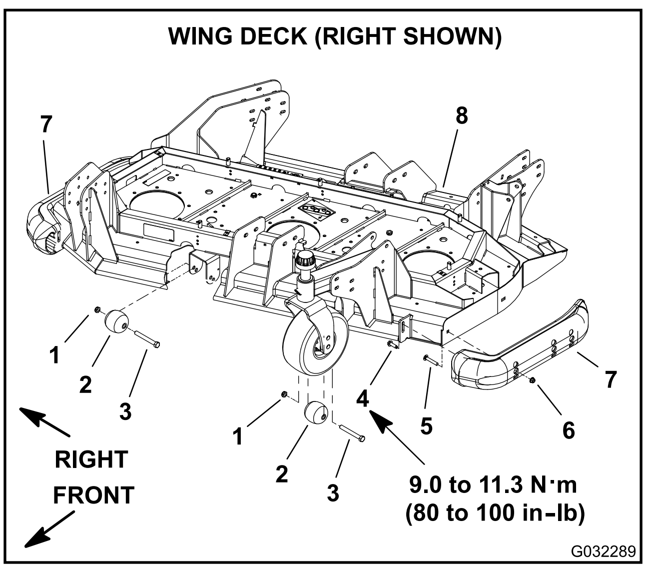
Deck Skids and Rollers



g032094

Figure 359

1. Bolt
2. Roller
3. Locknut
4. Washer-head screw
5. Carriage screw
6. Flange nut
7. Bumper skid (2 each)
8. Carriage screw
9. Roller
10. Roller shaft
11. Flange nut



g032289

Figure 360

1. Locknut
2. Roller
3. Bolt
4. Washer-head screw
5. Carriage screw
6. Flange nut
7. Bumper skid

Removing the Deck Skids and Rollers

Remove the skids and rollers from the deck; refer to Figure 359 and Figure 360.

Installing the Deck Skids and Rollers

Install the skids and rollers to the deck; refer to Figure 359 and Figure 360.

1. Ensure that you install the skids (item 7 in Figure 359) in the same mounting hole height position (lower, middle, or upper).
2. Ensure that you install all the deck rollers (items 2 and 9 in Figure 359) in the same mounting hole height position (lower or upper).
3. When you install the roller (item 2 in Figure 359) on the front deck winglets (Figure 359), install the bolt with the threads orientated toward the centerline of the deck. Install and tighten the locknut so that the nylon locking insert in the nut is fully engaged by the bolt threads and the roller rotates freely.
4. When you install the roller (item 2 in Figure 360) on a wing deck (Figure 360), install the bolt with the threads orientated away from the centerline of the machine. Install and tighten the locknut so that the nylon locking insert in the nut is fully engaged by the bolt threads and the roller rotates freely.

Chapter 9

Operator Cab

Table of Contents

Additional Reference Materials

ICE COMPRESSOR SERVICE MANUAL

General Information

The information in this chapter pertains to the operator cab of the Groundsmaster 5910 machine.

Operator’s Manual

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

Electrical Components and Schematic

Information regarding the Groundsmaster 5910 electrical cab components (switches and relay) is included in Chapter 5: Electrical System (page 5–1). The electrical schematic and harness drawings for the operator cab are included in Chapter 10—Foldout Drawings.

Air Conditioning System

The air conditioning system used on the Groundsmaster 5910 machine consists of the following components:

1. A compressor mounted on the engine and driven by a V-belt.
2. A condenser and condenser fan located on the top of the cab.
3. A drier-receiver, an expansion valve and an evaporator (combined with the heater core) mounted in the headliner of the cab.
4. The necessary hoses and tubes that connect the system components.
5. A fan motor that provides air movement through the evaporator and into the cab. The fan motor is located in the cab headliner and is also used for the cab heating system.
6. The operator controls to turn the air conditioning ON, to adjust the fan speed, and to control the cab air temperature.

Cab Heater System

The cab heater system used on the Groundsmaster 5910 machine consists of the following components:

1. A heater core located in the cab headliner.
2. The hoses to allow a circuit for engine coolant to circulate through the heater core. The heater core (combined with the air conditioning evaporator) is located in the headliner of the cab.
3. A fan motor that provides air movement through the heater core and into the cab. The fan motor is located in the cab headliner and is also used for the air conditioning system.
4. The operator controls to adjust the fan speed and to control the cab air temperature.

Air Conditioning System Performance

There are a number of factors that can affect the performance of the air conditioning system of your Groundsmaster 5910 machine.

To ensure the best system operation, inspect the following components:

1. Ensure that the heater control fully closes the heater valve in the cab headliner.
2. Ensure that the evaporator fins are clean.
3. Check that the refrigerant charge quantity and system operating pressures are correct.
4. Ensure that the exposed metal surfaces inside the cab are insulated.
5. If the ambient temperatures exceeds 43°C (110°F), apply additional window tinting to lower solar heat load to the cab.
6. Install the ball valve at the water pump outlet to positively shut off the engine coolant to the cab components. You can use Toro Part No. #117-3291 for this purpose.

Service and Repairs

General Precautions for Removing and Installing the Air Conditioning System Components

CAUTION

Loosening any system fitting or component allows the pressurized air to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

WARNING

Do not let the refrigerant contact your skin or eyes as there is a possibility of serious injury.

Always wear safety goggles or a face shield when you work with the air conditioning system components.

CAUTION

In some conditions, the pressurized mixtures of the refrigerant and air are combustible.

Do not use the compressed air for leak test or pressure test of the air conditioning system.

1. Before you service any air conditioning system components, park the machine on a level surface, set the parking brake, lower the cutting decks or attachments, and shut off the engine. Remove the key from the key switch.
2. Clean the machine before you disconnect, remove, or disassemble any air conditioning system components. Clean the system to prevent the system contamination while you perform the service procedures.
3. Install caps or plugs on any lines, fittings, or components that are left open or exposed to prevent system contamination.
4. Before you loosen or remove any air conditioning system hoses or other components, have a certified air conditioning service technician collect the system refrigerant and then evacuate the air conditioning system completely. It is illegal to open the refrigerant to the atmosphere.
5. Label all the disconnected hydraulic lines and hoses for proper installation after repairs are completed.
6. If you remove the compressor from the machine, keep the compressor in the same orientation as it was in the installed position. This prevents the compressor oil from filling the compressor cylinders.
7. Note the position of the fittings (especially elbow fittings) before removal.

   Note: Mark the parts, if necessary, and ensure that they are aligned correctly when installing the hoses and tubes.

General Precautions for Removing and Installing the Air Conditioning System Components (continued)

8. Always use a DOT approved tank to store the used and recycled refrigerants.
9. The Groundsmaster 5910 air conditioning system uses R134a refrigerant. Do not use other refrigerants in the system.

   Note: The capacity of the air conditioning system is 0.57 kg (1.25 lb) of R134a refrigerant.
10. The refrigerant containers (either full or empty) are under pressure and the pressure increases if you heat them. Do not expose the refrigerant containers to high-heat sources or flame.
11. Ensure that the work area is properly ventilated to prevent any accumulation of the refrigerant or other fumes.
12. Ensure that the 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 reduces the air conditioning performance. If the air conditioning system is opened for the component repair or replacement, replace the drier-receiver.
14. After you install the air conditioning components, have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

Air Conditioning Compressor

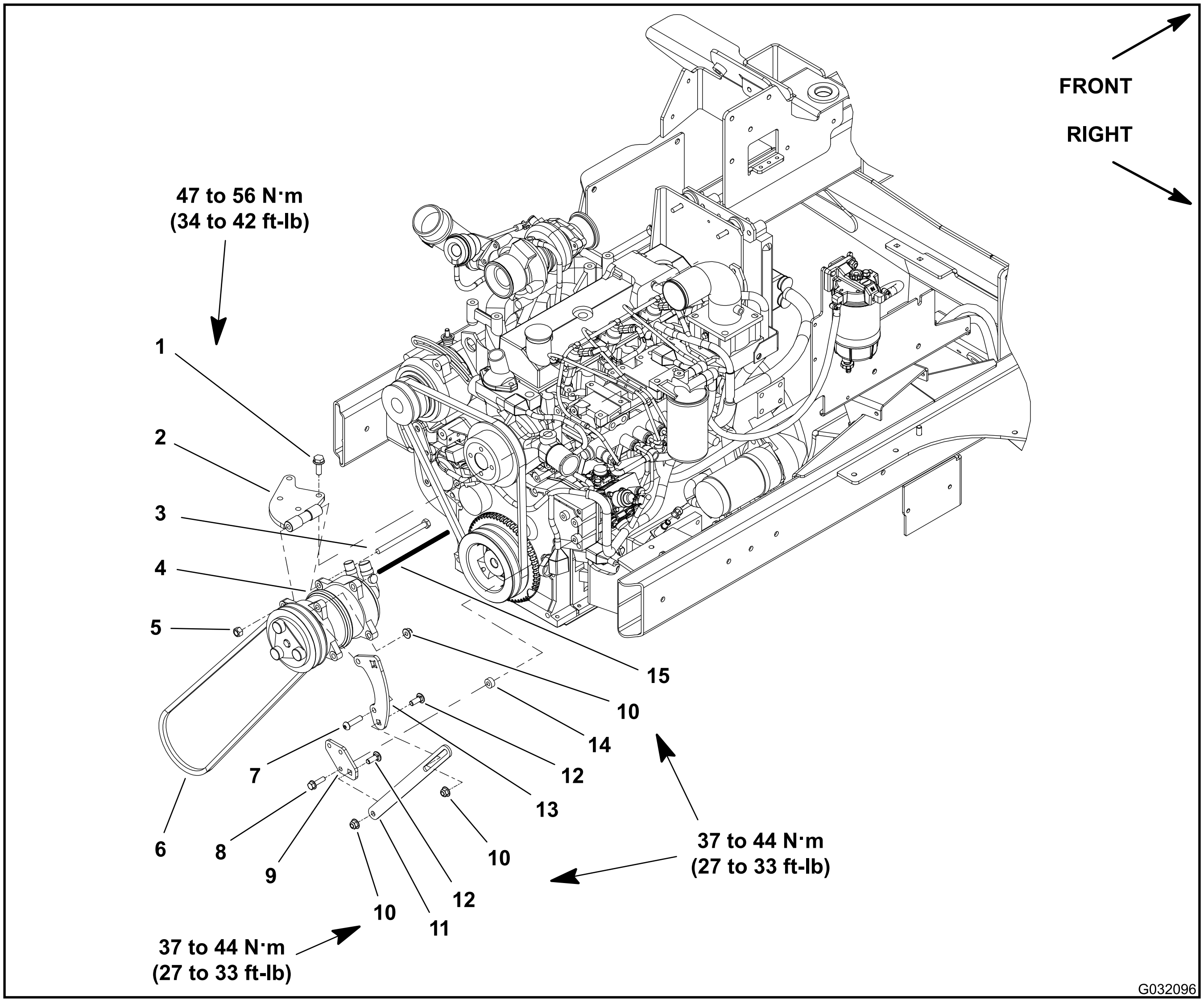


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Figure 361

1. Flange-head screw (4 each)
2. Pivot plate
3. Bolt
4. Air conditioning compressor
5. Locknut
6. Belt
7. Button-head screw (2 each)
8. Flange-head screw (3 each)
9. Mount plate
10. Flange nut (4 each)
11. Tensioner arm
12. Carriage screw (2 each)
13. Mount plate
14. Spacer (3 each)
15. Conduit

Removing the Air Conditioning Compressor

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Raise the hood to get access to the engine.

Removing the Air Conditioning Compressor (continued)

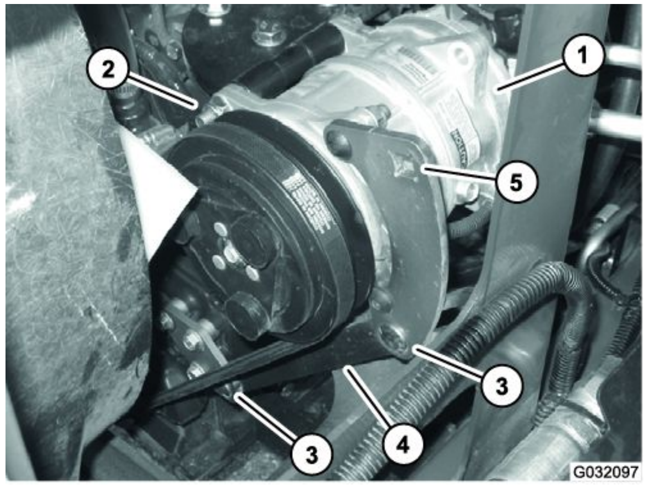

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Figure 362

3. Loosen the carriage screws and flange nuts that attach the air conditioning compressor and tensioner arm (Figure 362). Rotate the compressor to loosen the drive belt. Remove the belt from the air conditioning compressor pulley.
4. Inspect the compressor drive belt for glazing or damage. Replace the belt if necessary.
5. Disconnect the compressor electrical connector from the machine wire harness.
6. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 9–4).

CAUTION

Loosening any system fitting or component allows the pressurized air to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

7. Have a certified air-conditioning service technician evacuate the refrigerant from the air conditioning system.
8. Label and remove the hoses from the compressor. Immediately install the caps on the hoses and fittings to prevent moisture and contaminants from entering into the system.
9. Support the compressor to prevent it from shifting or falling.

   Note: There may be shims mounted between the compressor and the pivot plate. When you remove the compressor, note the location and quantity of the shim for assembly purposes.
10. Remove the carriage screw and flange nut that attach the compressor to the tensioner arm. Remove the bolt and locknut that attach the compressor to the pivot plate.

Removing the Air Conditioning Compressor (continued)

IMPORTANT

To prevent the compressor oil from filling the compressor cylinders, keep the compressor in the same orientation as it was in the installed position.

11. Carefully remove the compressor from the engine and machine.
12. If necessary, remove the compressor mounting brackets from the engine.

    Note: Replace the drier-receiver whenever you remove the air conditioning compressor from the system; refer to Heater and Evaporator Assembly (page 9–16).

Installing the Air Conditioning Compressor

1. If the compressor mounting brackets were removed, attach them to the engine.
2. Position the compressor to the pivot plate and tensioner arm on the engine.

   Note: Ensure that the clearance between the compressor mounting flanges and pivot plate is less than 0.10 mm (0.004 inch). If necessary, install the shims between the compressor flanges and pivot plate to adjust clearance. Refer to the *Parts Catalog* for shim kit.
3. Attach the compressor to the pivot plate and tensioner arm with the fasteners and nuts that were removed.

   Note: Do not fully tighten the fasteners.

IMPORTANT

After the compressor is installed, ensure that you rotate the compressor driveshaft several times to correctly distribute the oil in the compressor. Perform this procedure to prevent damage of the compressor because of the oil slugging.

4. Manually rotate the compressor driveshaft at least 10 revolutions to ensure that there is no compressor oil in the compressor cylinders.
5. Place the drive belt onto the compressor pulley.
6. Tension the compressor drive belt.

   A. Insert a torque wrench in the square hole on the compressor mount plate; refer to Figure 362.

   B. Rotate the compressor with the torque wrench to **37 to 44 N·m (27 to 33 ft-lb)**.

   C. Hold the compressor in position and tighten the fasteners to attach the compressor in place; torque the flange nuts that attach the tensioner arm to **37 to 44 N·m (27 to 33 ft-lb)**.
7. Remove the caps that you placed on the hoses and fittings during the removal process. Use the labels that you attached during removal to correctly attach the hoses to the compressor.
8. Connect the compressor electrical connector to the machine wire harness.

Installing the Air Conditioning Compressor (continued)

9. Have a certified air conditioning service technician evacuate the air conditioning system completely, correctly recharge the system with R134a refrigerant, and perform the leak test on the system.

   Note: The capacity of the air conditioning system is 0.57 kg (1.25 lb) of R134a refrigerant.

10. Lower the hood and secure it.

Servicing the Air Conditioning Compressor

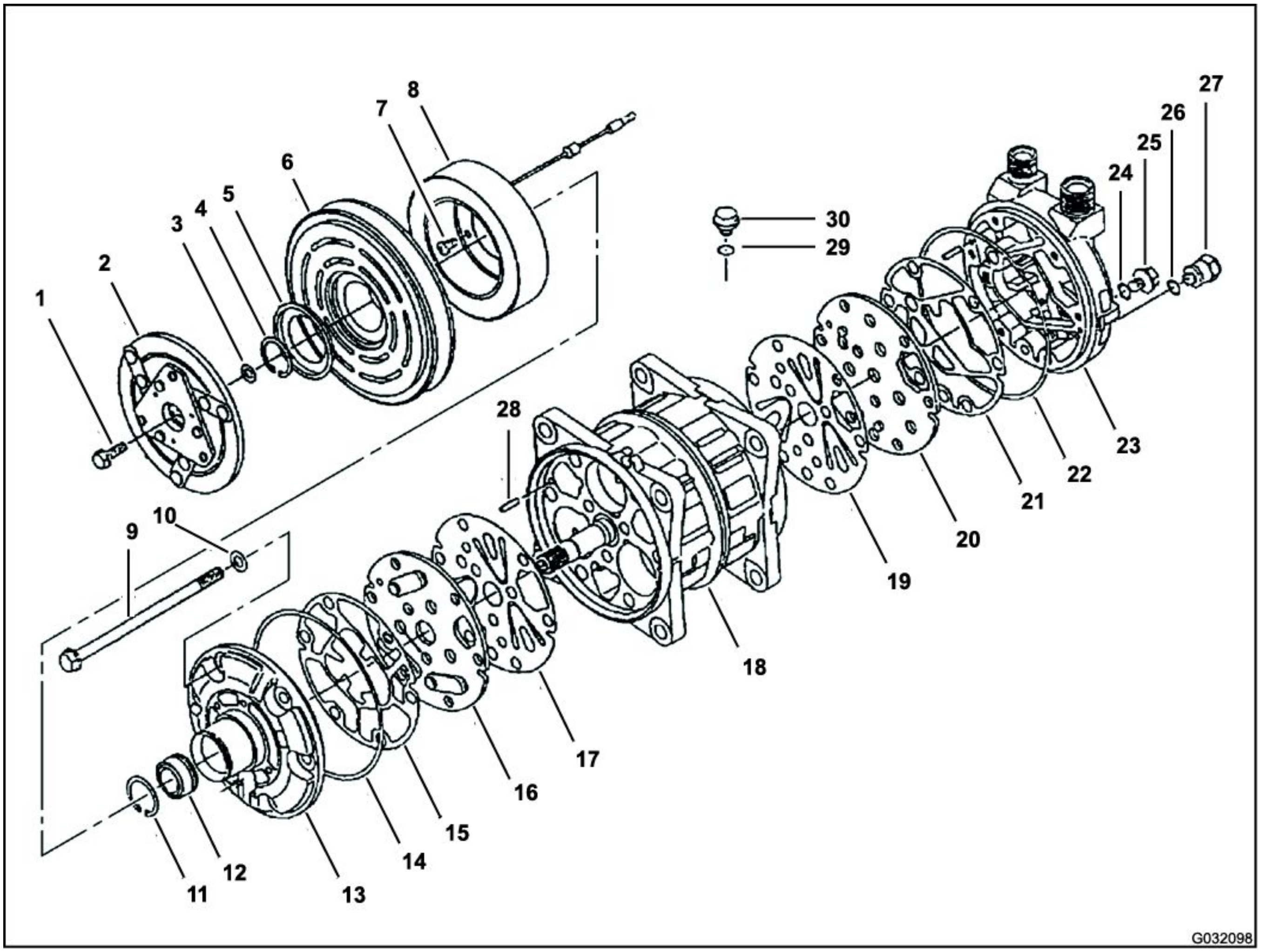

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Figure 363

1.	Armature bolt	11.	Snap ring	21.	Rear gasket
2.	Armature plate	12.	Shaft seal	22.	Body O-ring
3.	Shim	13.	Front cylinder head	23.	Rear cylinder head
4.	Snap ring	14.	Body O-ring	24.	O-ring
5.	Cover	15.	Front gasket	25.	Drain plug
6.	Pulley assembly	16.	Front valve plates	26.	O-ring
7.	Coil screw (3 each)	17.	Front suction valve	27.	Pressure relief valve
8.	Coil	18.	Cylinder shaft assembly	28.	Alignment pin
9.	Body bolt (6 each)	19.	Rear suction valve	29.	O-ring
10.	Washer (6 each)	20.	Rear valve plate	30.	Oil fill plug

Servicing the Air Conditioning Compressor (continued)

Note: The air conditioning compressor used on the Groundsmaster 5910 machine is an International Components Engineering (ICE) model TM—16. For the air conditioning compressor repair procedures; refer to the ICE Compressor Service Manual at the end of this chapter.

Roof Assembly

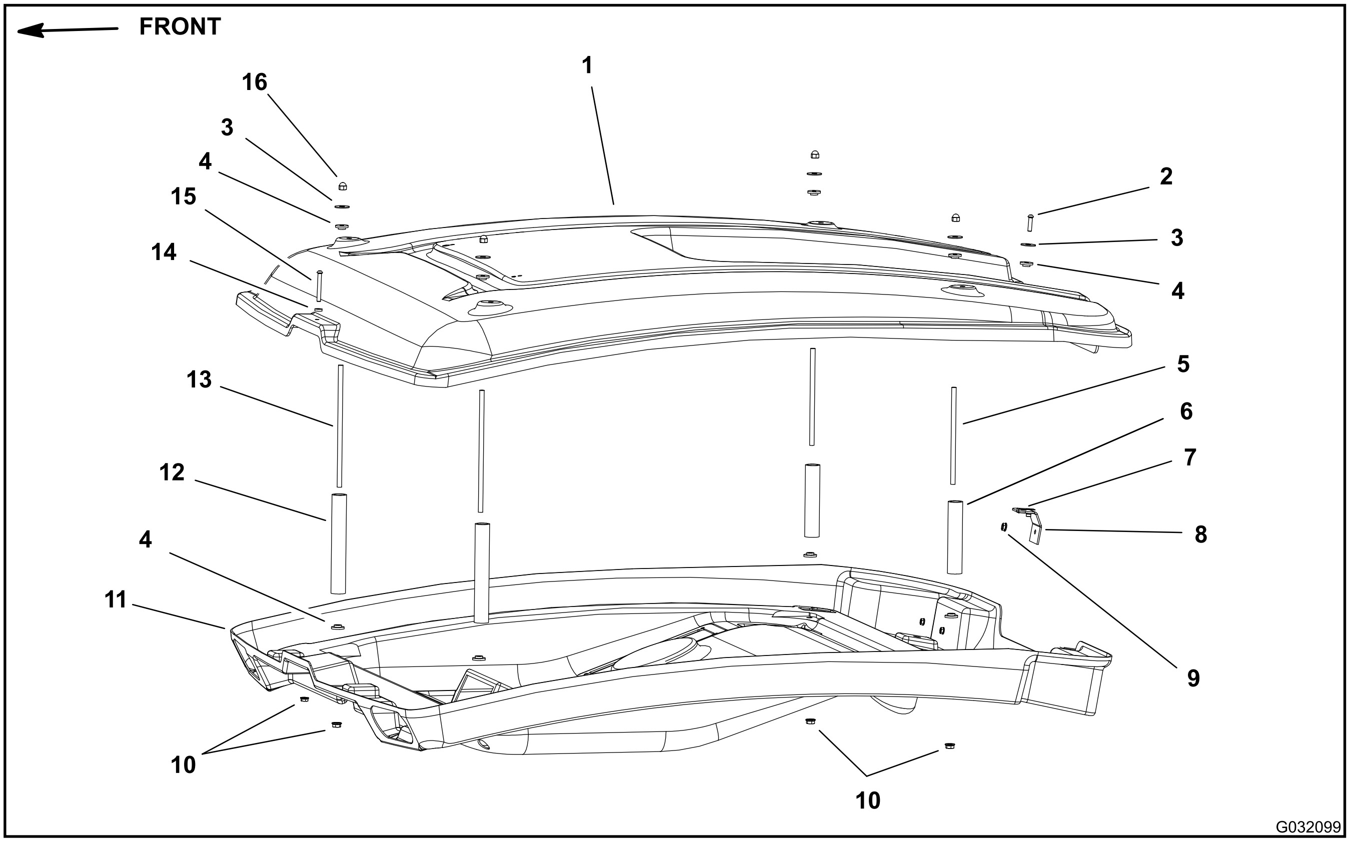

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Figure 364

1. Roof
2. Screw (2 each)
3. Flat washer (6 each)
4. Bushing
5. Rear fastener (2 each)
6. Rear spacer (2 each)
7. Panel nut
8. Roof mount
9. Flange nut
10. Flange nut (4 each)
11. Headliner
12. Front spacer (2 each)
13. Front fastener (2 each)
14. Rubber washer
15. Bolt
16. Hex nut (4 each)

Get access to the heater core and air conditioning components that are located under the cab roof by loosening, raising, and supporting the roof panel.

Removing the Roof Assembly

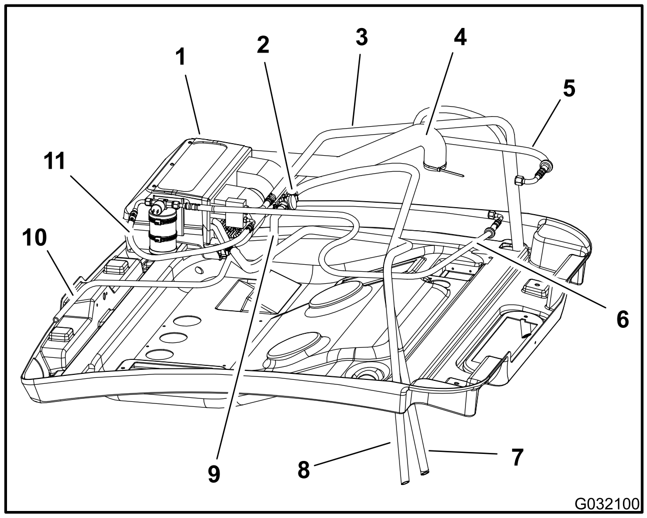

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Figure 365

1. Heater evaporator assembly
2. Heater valve
3. Air conditioning hose: evaporator to compressor
4. Air duct hose
5. Air conditioning hose: compressor to condenser
6. Air conditioning hose: condenser to drier
7. Heater hose: thermostat to heater valve
8. Heater hose: heater core to water pump
9. Heater hose: heater valve to heater core
10. Condensation drain hose (2 each)
11. Air conditioning hose: drier to evaporator

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1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the 2 screws (item 2 in Figure 364), flat washers (item 3 in Figure 364), and bushings (item 4 in Figure 364) that attach the rear of the roof to the roof mount.
3. Remove the bolt (item 15 in Figure 364) and rubber washer (item 14 in Figure 364) that attach the front of the roof.
4. Remove the 4 hex nuts (item 16 in Figure 364), 4 flat washers (item 3 in Figure 364), and 4 bushings (item 4 in Figure 364) that attach the roof to the front and rear fasteners.
5. Carefully lift the front of the roof while leaving the rear of the roof against the headliner. Support the front of the roof in the raised position to get access to the heater and air conditioning components.

Removing the Roof Assembly (continued)

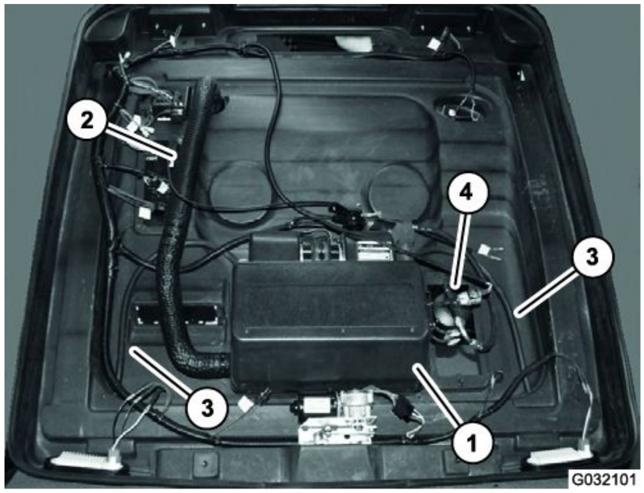

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Figure 366

1. Heater evaporator
2. Air duct hose
3. Drain hose
4. Drier-receiver

Installing the Roof Assembly

1. Ensure that all the components in the headliner and roof are installed and attached.
2. Remove the support and carefully tilt the roof into its position.
3. Attach the roof to the headliner with all the fasteners that were removed.

Air Conditioning Condenser Assembly

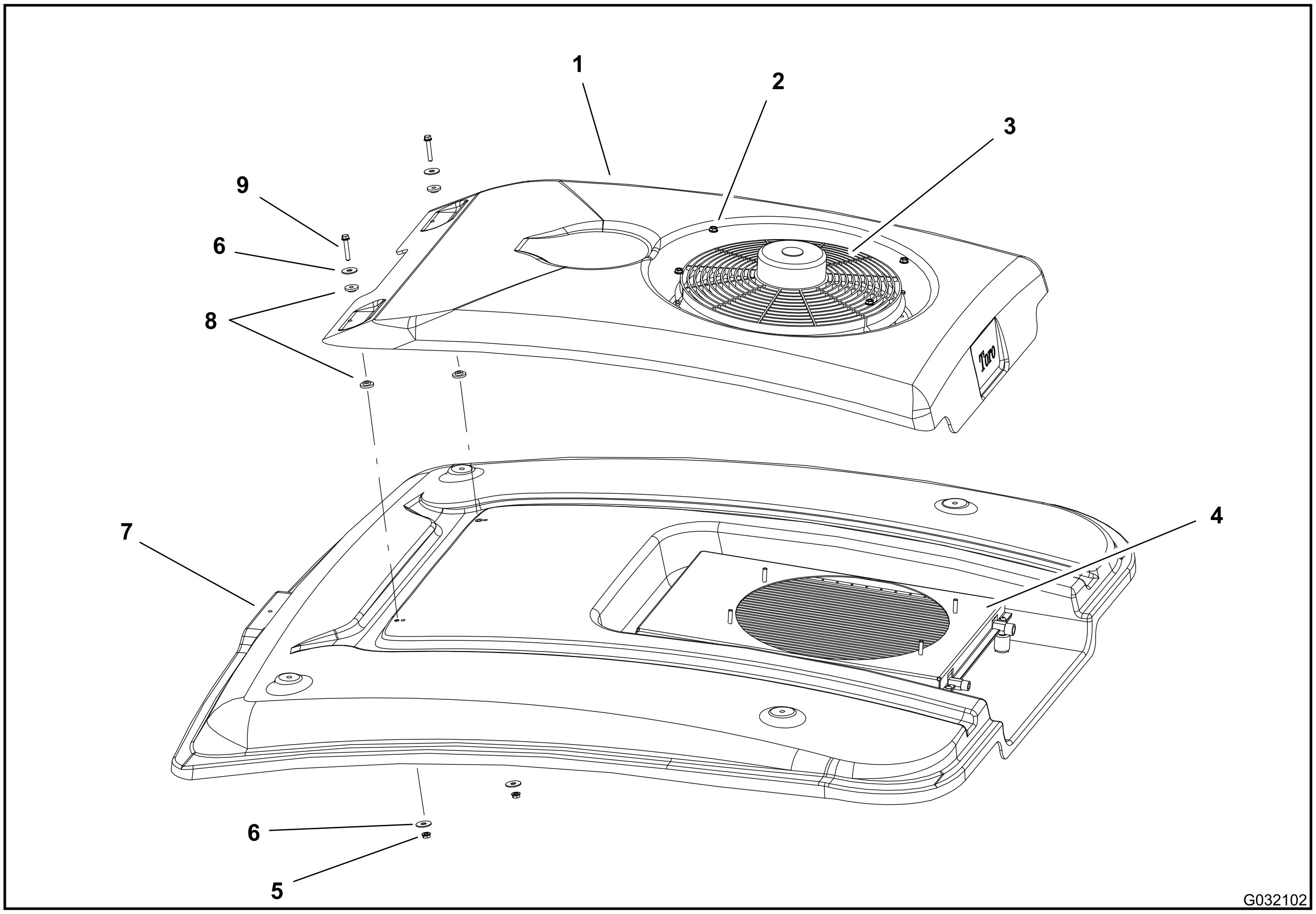

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Figure 367

1. Condenser cover
2. Flange nut (4 each)
3. Condenser fan
4. Condenser coil assembly
5. Flange nut (2 each)
6. Flat washer (4 each)
7. Roof
8. Bushing (4 each)
9. Flange-head screw (2 each)

Removing the Air Conditioning Condenser Assembly

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the fasteners that attach the roof in place. Lift and support the roof to get access to the condenser assembly; refer to Removing the Roof Assembly (page 9–11).
3. Disconnect the wire harness connector from the condenser fan motor.
4. Remove the flange nuts (item 2 in Figure 367) that attach the condenser fan and cover to the condenser coil.
5. Remove the fasteners (items 5, 6, 8, and 9 in Figure 367) that attach the condenser cover to the roof. Lift the cover and condenser fan from the roof.
6. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 9–4).

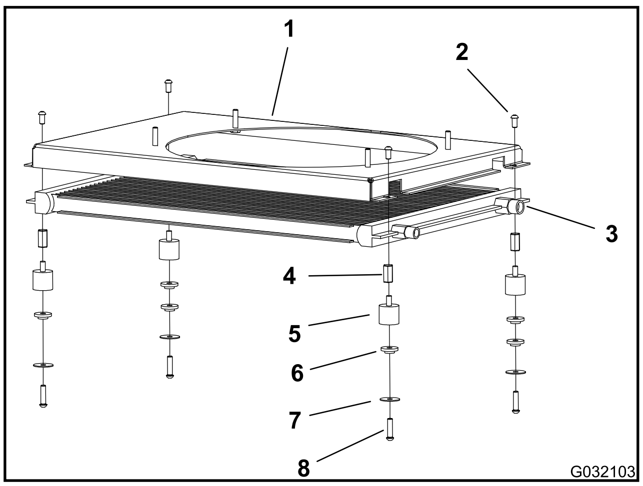
Removing the Air Conditioning Condenser Assembly (continued)

CAUTION

Loosening any system fitting or component allows the pressurized air to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

7. Have a certified air conditioning service technician evacuate the refrigerant from the air conditioning system.
8. Label and remove the hoses from the condenser coil. Immediately install the caps on the hoses and fittings to prevent moisture and contaminants from entering into the system.



g032103

Figure 368

1. Condenser fan mount
2. Screw (4 each)
3. Condenser coil
4. Coupler nut (4 each)
5. Isolator mount (4 each)
6. Bushing (6 each)
7. Flat washer (4 each)
8. Screw (4 each)

9. Remove the condenser coil from the roof; refer to Figure 368.

   Note: Replace the drier-receiver whenever you open the air conditioning system; refer to the Heater and Evaporator Assembly (page 9–16).

Installing the Air Conditioning Condenser Assembly

1. Install the condenser coil to the roof; refer to Figure 368.
2. Remove the caps that you placed on the hoses and fittings during the removal process. Use the labels that you attached during removal to correctly attach the hoses to the condenser coil.
3. Position the condenser cover and condenser fan to the roof. Attach the cover and fan with the fasteners (items 5, 6, 8, and 9 in Figure 367) that were removed.
4. Attach the condenser fan to the condenser coil with the flange nuts (item 2 in Figure 367).
5. Connect the wire harness connector to the condenser fan motor.

Installing the Air Conditioning Condenser Assembly (continued)

6. Ensure that all the machine air conditioning components are installed and attached.
7. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

   Note: The capacity of the air conditioning system is 0.57 kg (1.25 lb) of R134a refrigerant.
8. Lower and install the roof assembly; refer to Installing the Roof Assembly (page 9–12).

Heater and Evaporator Assembly

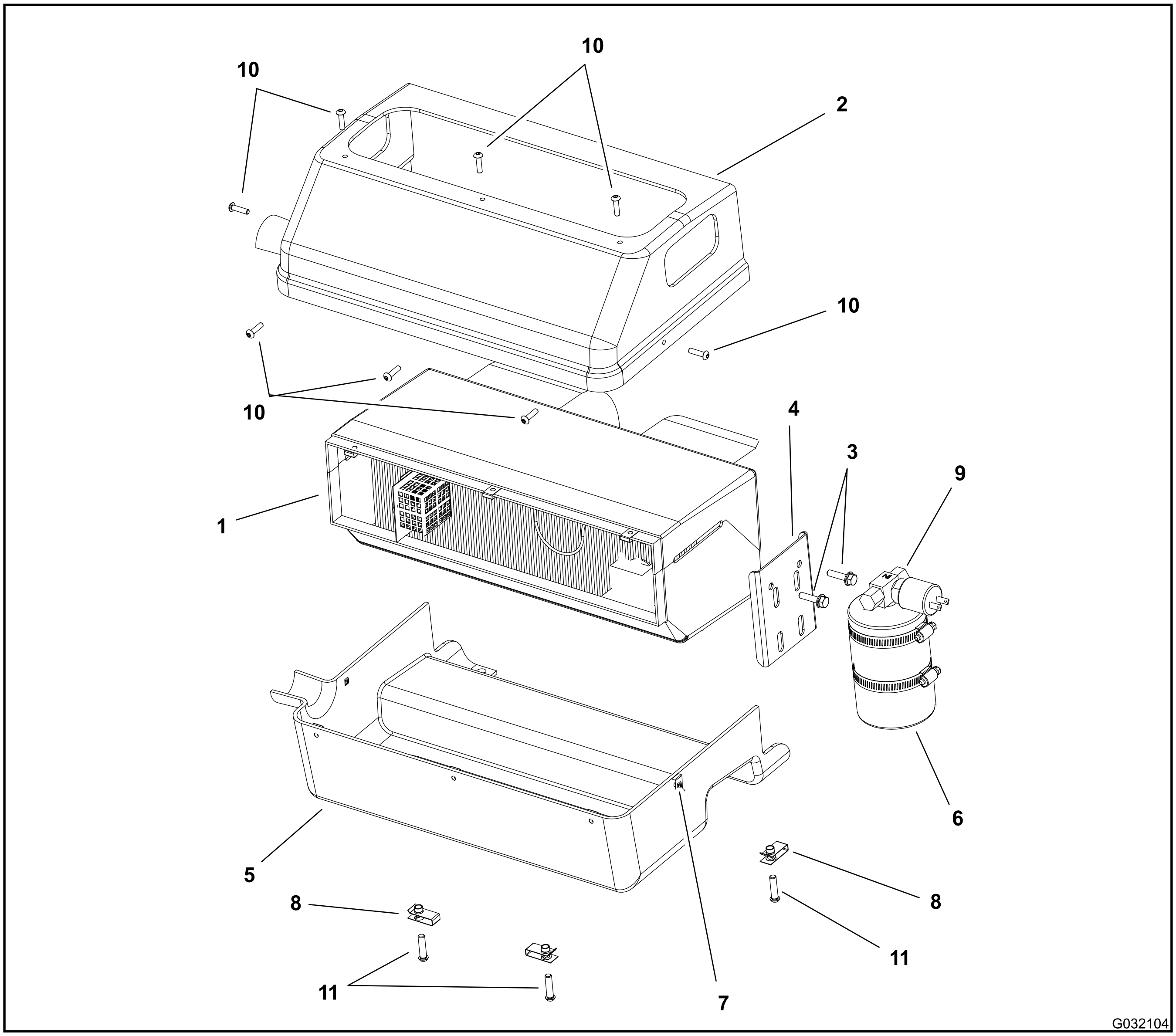


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Figure 369

1. Heater and evaporator assembly
2. Top cover
3. Flange-head screw (2 each)
4. Drier-receiver mount
5. Bottom cover
6. Hose clamp (2 each)
7. Speed nut (8 each)
8. Panel nut (4 each)
9. Drier-receiver
10. Screw (8 each)
11. Screw (5 each)

Removing the Heater and Evaporator Assembly

1. Park the machine on a level surface, lower the cutting decks, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the fasteners that attach the roof in place. Lift and support the roof to get access to the condenser assembly; refer to Removing the Roof Assembly (page 9–11).
3. Disconnect the wire harness connectors from the fan motor and binary switch on the drier-receiver.
4. Read the General Precautions for Removing and Installing the Air Conditioning System Components (page 9–4).

CAUTION

Loosening any system fitting or component allows the pressurized air to escape, causing possible injury.

Do not loosen any system fitting or component until a certified air conditioning service technician discharges the system completely.

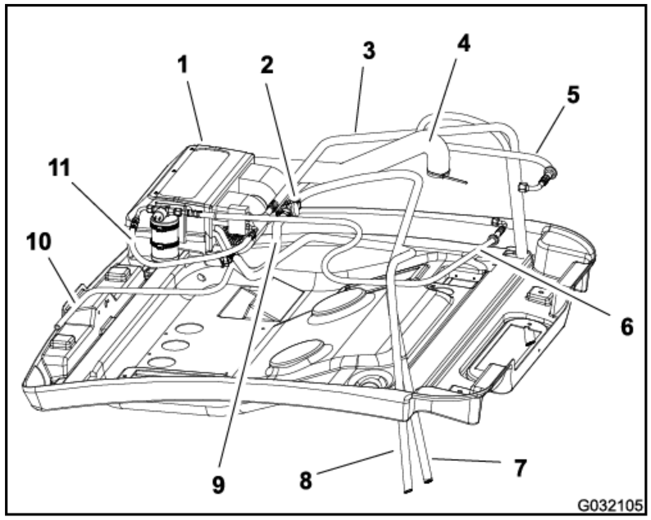

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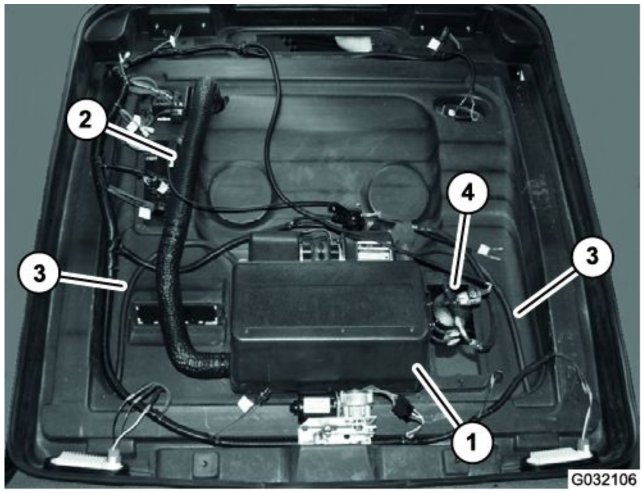
Figure 370

1. Heater evaporator assembly
2. Heater valve
3. Air conditioning hose: evaporator to compressor
4. Air duct hose
5. Air conditioning hose: compressor to condenser
6. Air conditioning hose: condenser to drier
7. Heater hose: thermostat to heater valve
8. Heater hose: heater core to water pump
9. Heater hose: heater valve to heater core
10. Condensation drain hose (2 each)
11. Air conditioning hose: drier to evaporator

5. Have a certified air conditioning service technician evacuate the refrigerant from the air conditioning system.
6. Label and remove the hoses from the heater core, evaporator, and drier-receiver. Immediately install the caps on the hoses and fittings to prevent moisture and contaminants from entering into the system.

Removing the Heater and Evaporator Assembly (continued)

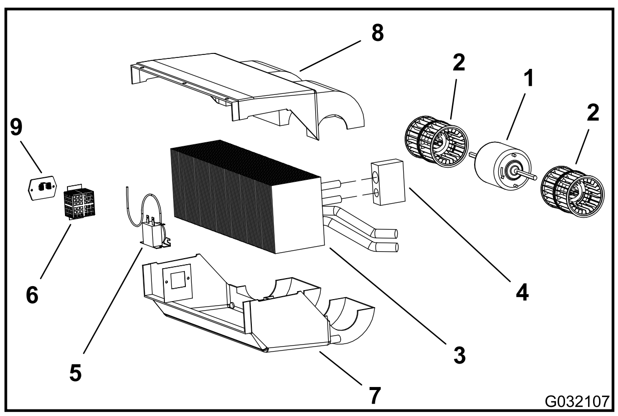


g032106

Figure 371

1.	Heater evaporator	3.	Drain hose
2.	Air duct hose	4.	Drier-receiver

7. Loosen the hose clamp that secures the air duct hose to the heater and evaporator assembly covers. Slide the hose from the covers.
8. Remove the screws that attach the top cover to the bottom cover. Remove the top cover to access the heater and evaporator assembly.



g032107

Figure 372

1.	Fan motor	6.	Resistor guard
2.	Blower wheel	7.	Bottom housing
3.	Evaporator/heater core	8.	Top housing
4.	Expansion valve	9.	Resistor
5.	Freeze switch		

9. Disassemble the heater and evaporator assembly; refer to Figure 372.

   Note: Replace the drier-receiver whenever you open the air conditioning system.

Installing the Heater and Evaporator Assembly

1. Assemble the heater and evaporator assembly; refer to Figure 372.

   Note: Ensure that the expansion valve is covered with insulating tape to prevent condensation issues.

Installing the Heater and Evaporator Assembly (continued)

2. Position the heater and evaporator assembly into the bottom cover in the headliner. Attach the top cover to the bottom cover with the screws that were removed.
3. Slide the air duct hose onto the heater and evaporator assembly covers and secure the air duct hose with a hose clamp.
4. Remove the caps that you placed on the hoses and fittings during the removal process. Use the labels that you attached during removal to correctly attach the hoses to the heater core, evaporator, and drier-receiver.
5. Ensure that the condensation hoses are secured to the bottom housing of the heater and evaporator assembly and are routed to the cab frame for correct draining of the condensate.
6. Connect the wire harness connectors to the fan motor and binary switch on the drier-receiver.
7. Ensure that all the machine air conditioning components are installed and attached.
8. Have a certified air conditioning service technician evacuate the air conditioning system completely, properly recharge the system with R134a refrigerant, and perform the leak test on the system.

   Note: The capacity of the air conditioning system is 0.57 kg (1.25 lb) of R134a refrigerant.
9. Operate the heater system to ensure that there is no leakage of coolant.
10. Lower and install the roof assembly; refer to Installing the Roof Assembly (page 9–12).

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

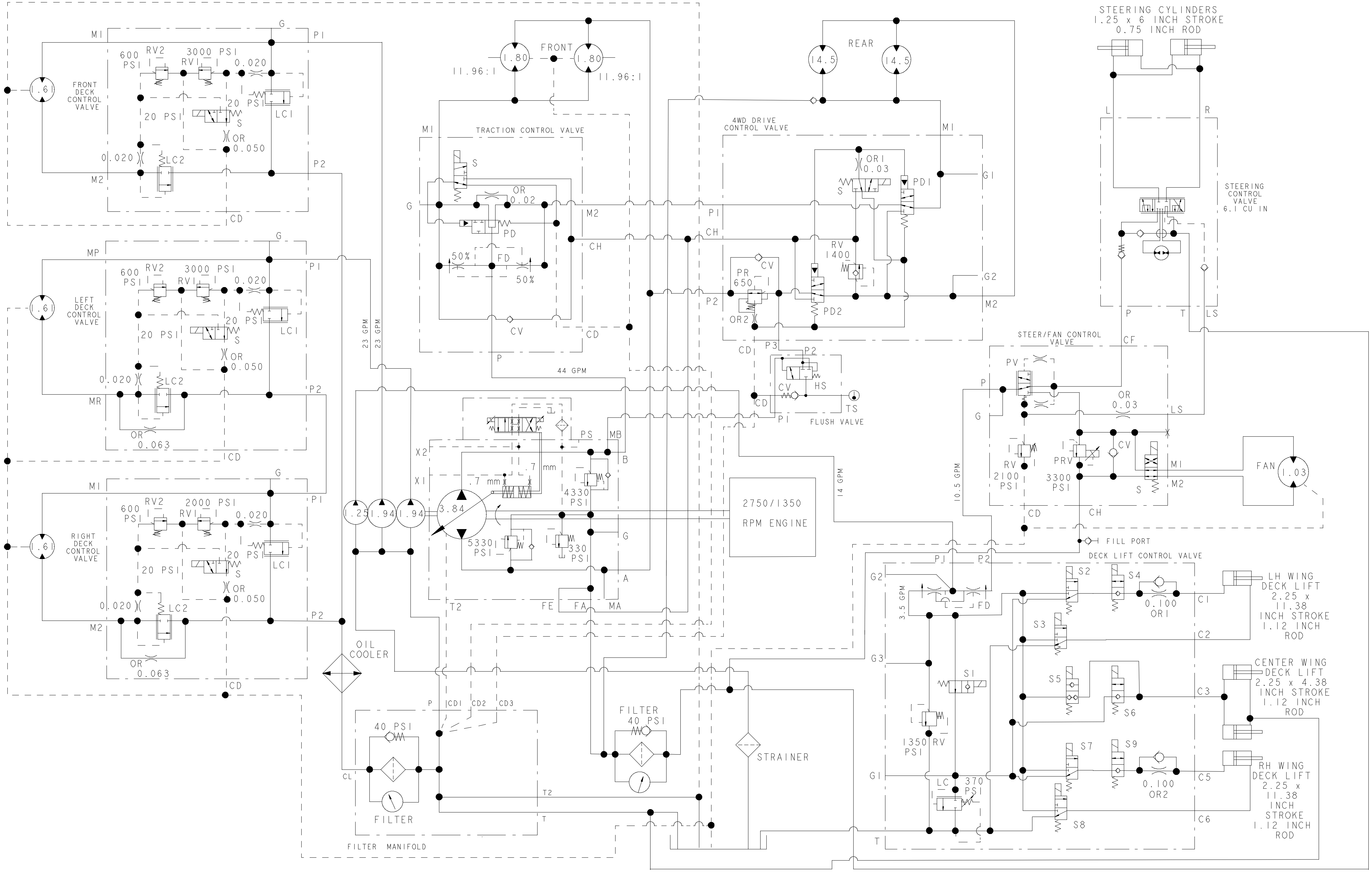
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

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)

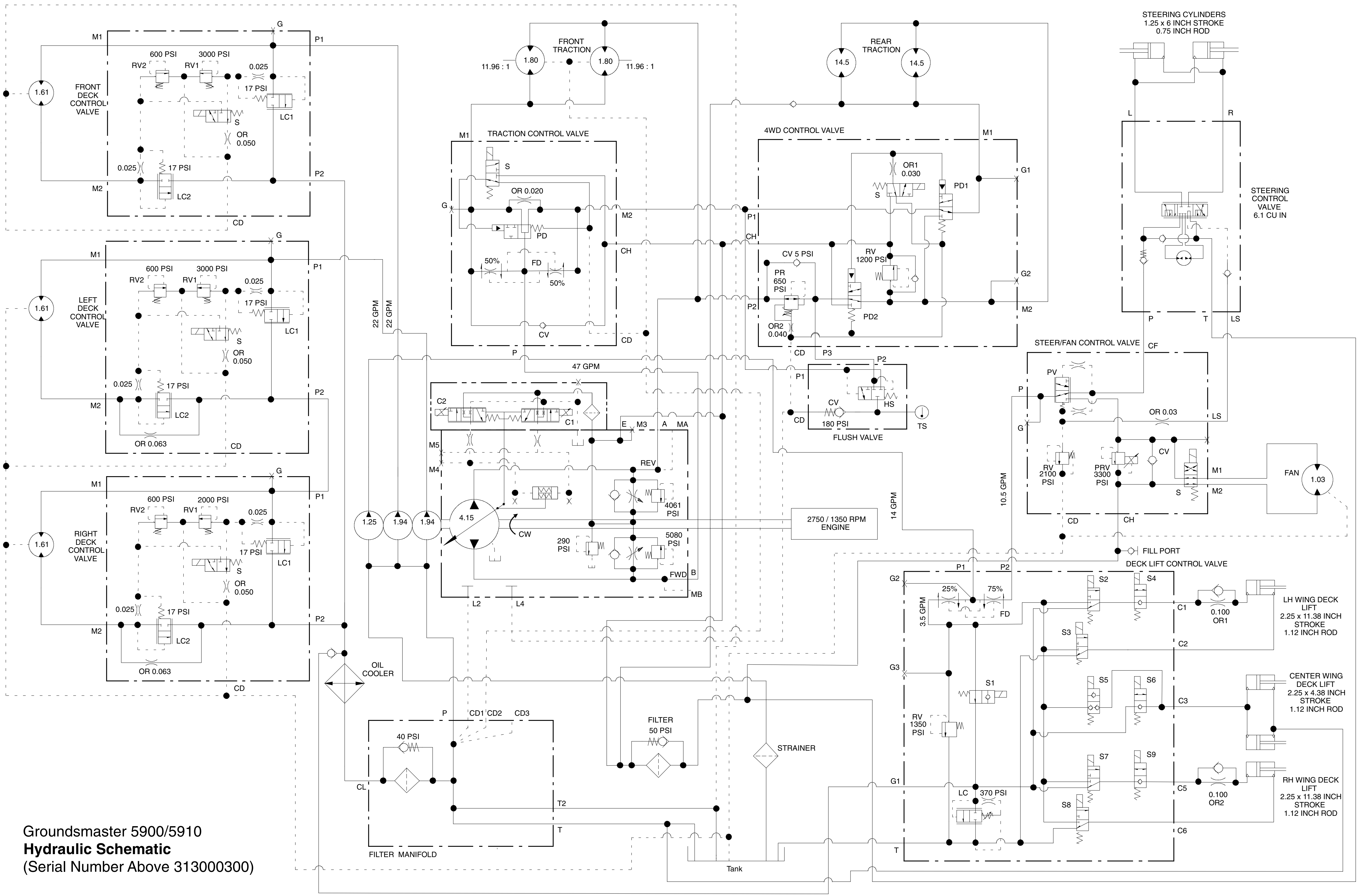
AWG Equivalents for Metric Wire		
Diagram Label	Metric Size	AWG Equivalent
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA

Hydraulic Schematic (Serial Number Below 313000300)



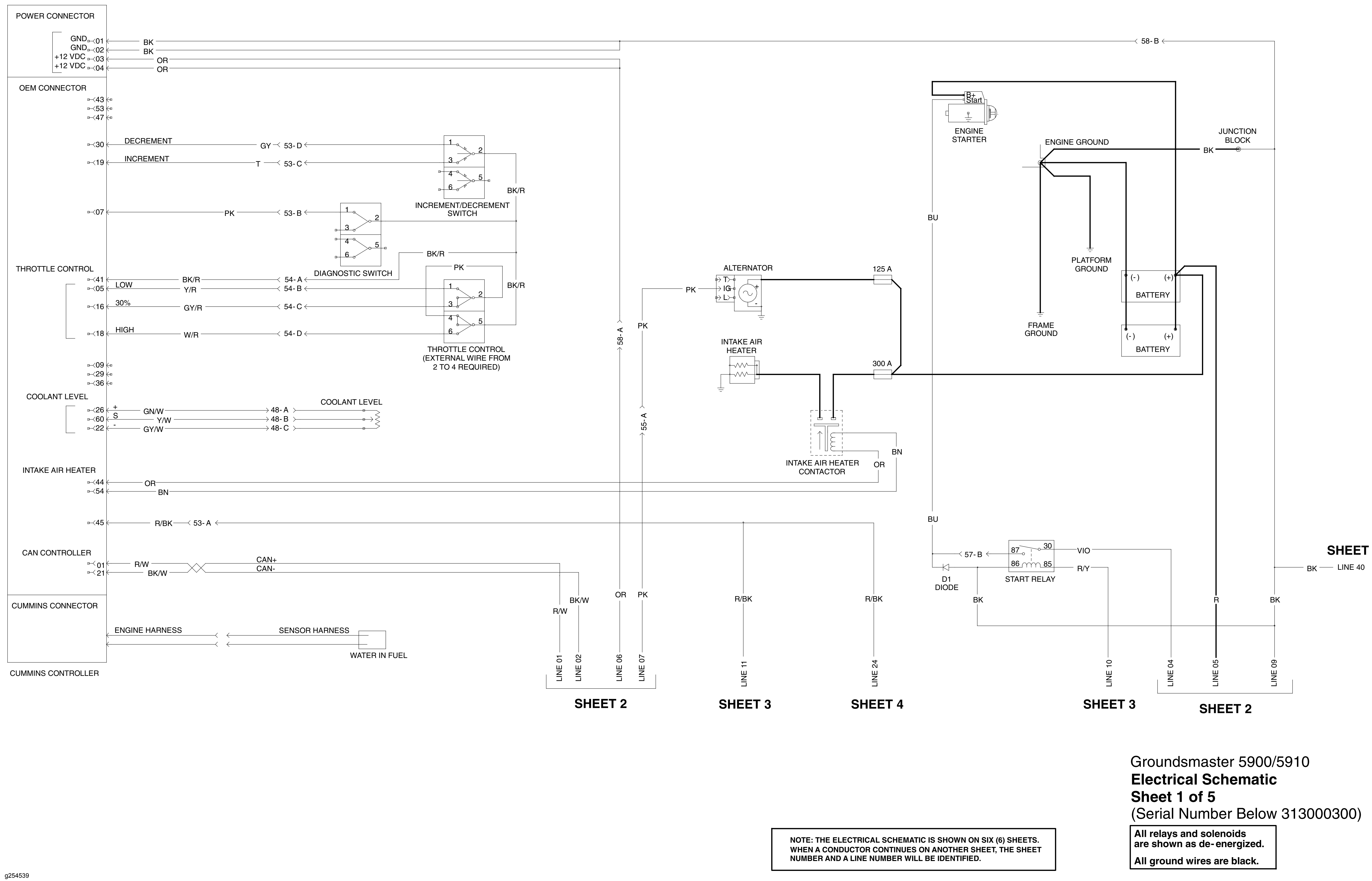
Groundsmaster 5900/5910
Hydraulic Schematic
(Serial Number Below 313000300)

g254537



Groundsmaster 5900/5910
Hydraulic Schematic
(Serial Number Above 313000300)

g254538

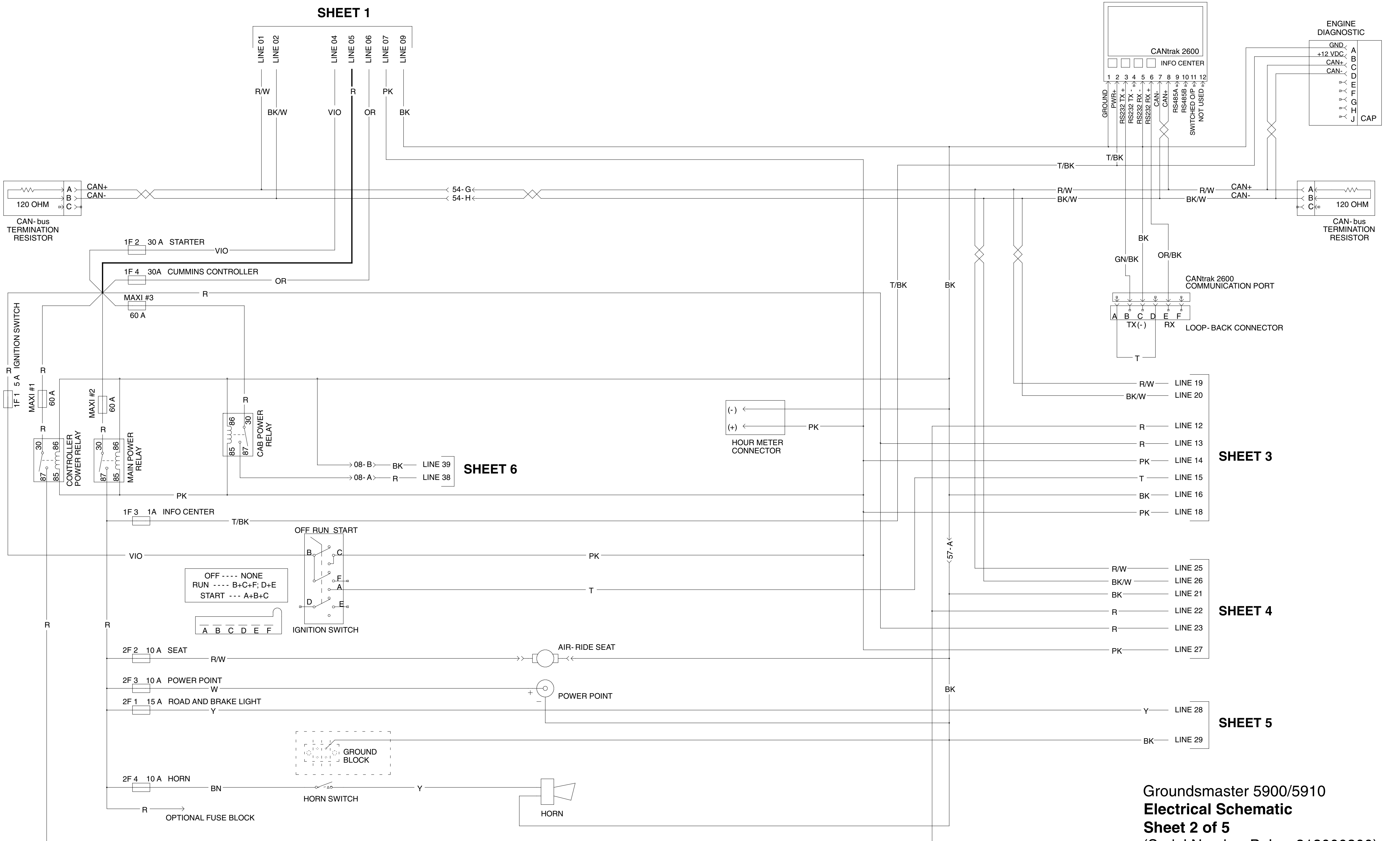


Groundsmaster 5900/5910
Electrical Schematic
Sheet 1 of 5
(Serial Number Below 313000300)

All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.



Groundsmaster 5900/5910
Electrical Schematic
Sheet 2 of 5
(Serial Number Below 313000300)

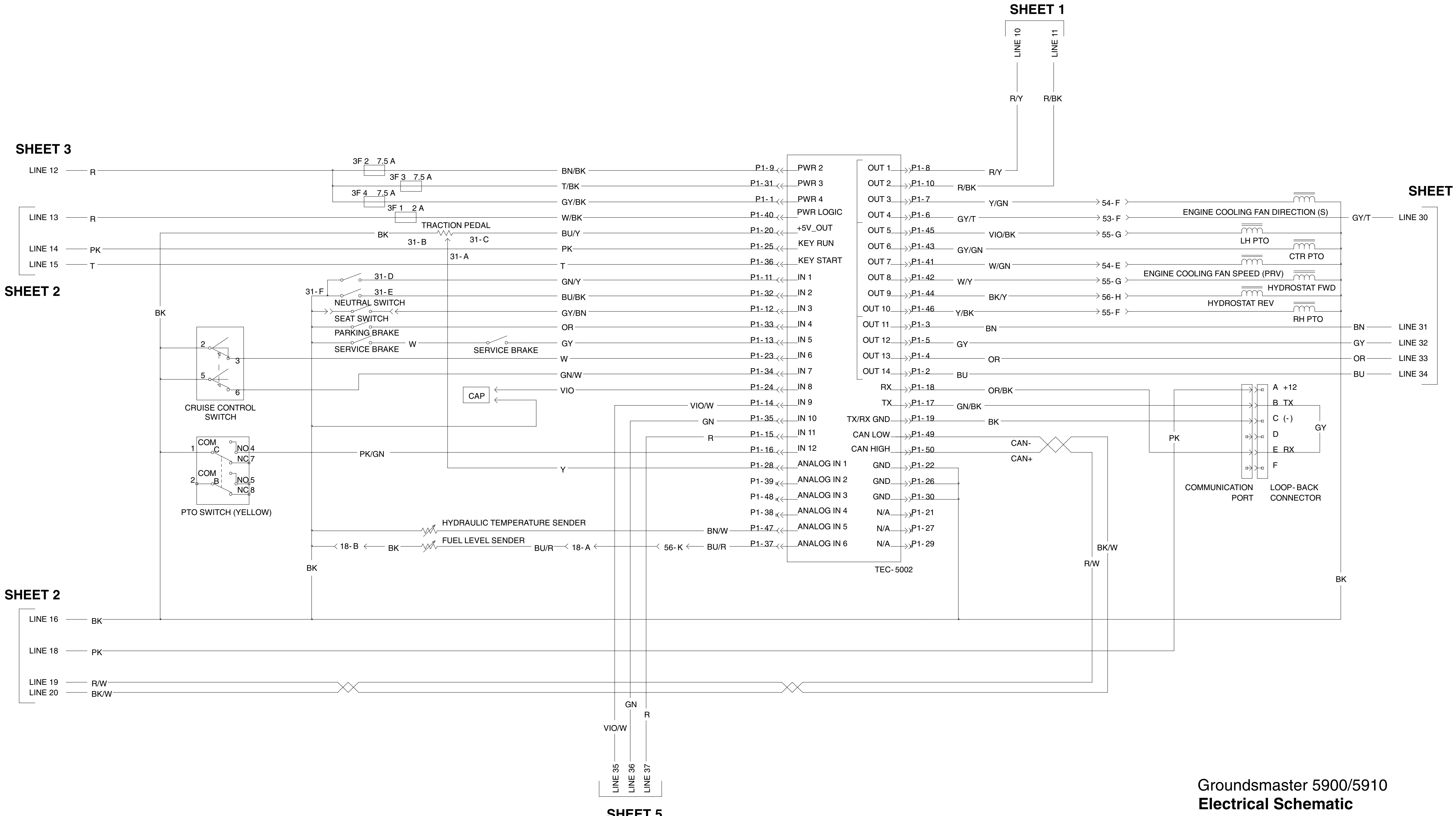
All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

g254540

Electrical Schematic Sheet 3 of 5 (Serial Number Below 313000300)



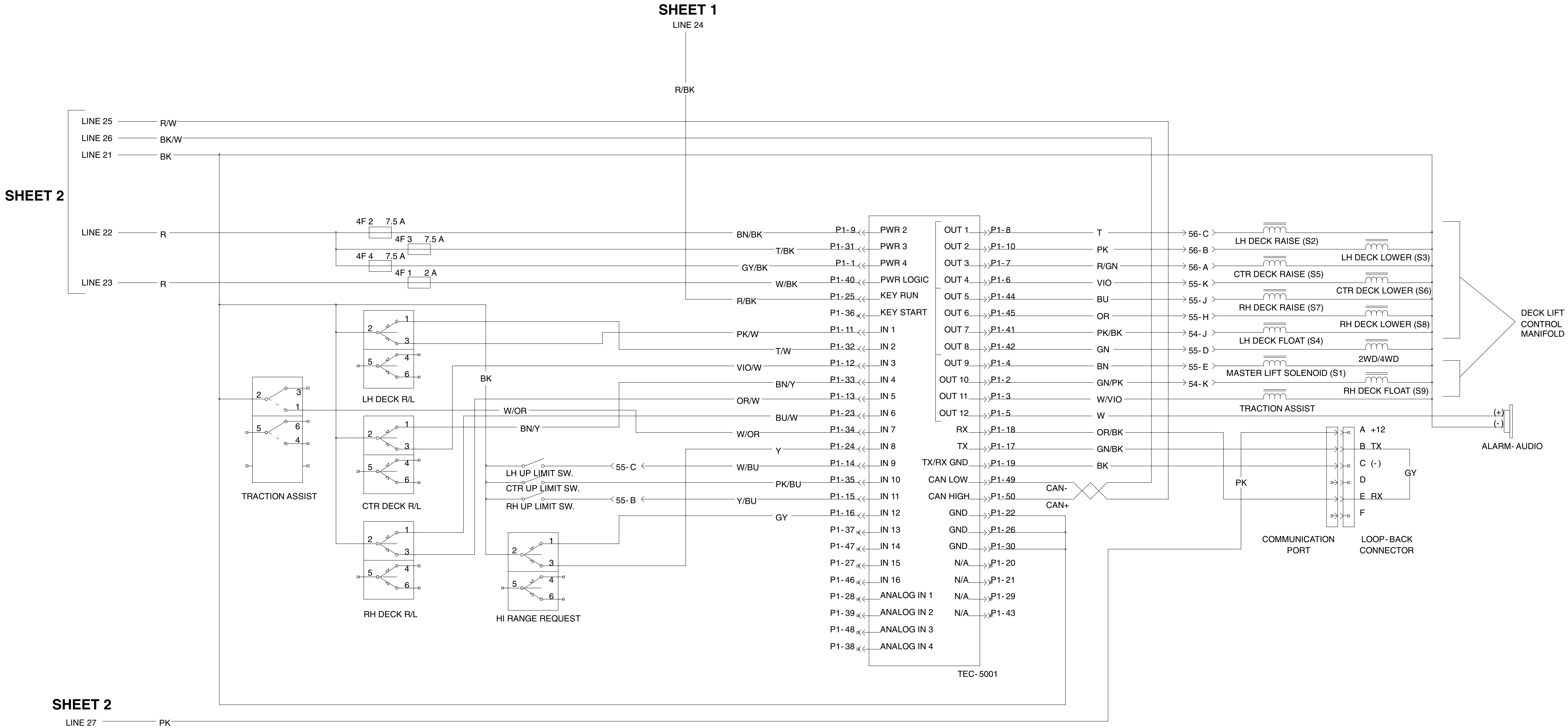
Groundsmaster 5900/5910
Electrical Schematic
Sheet 3 of 5
(Serial Number Below 313000300)

All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

g254541



Groundsmaster 5900/5910
Electrical Schematic
Sheet 4 of 5
(Serial Number Below 313000300)

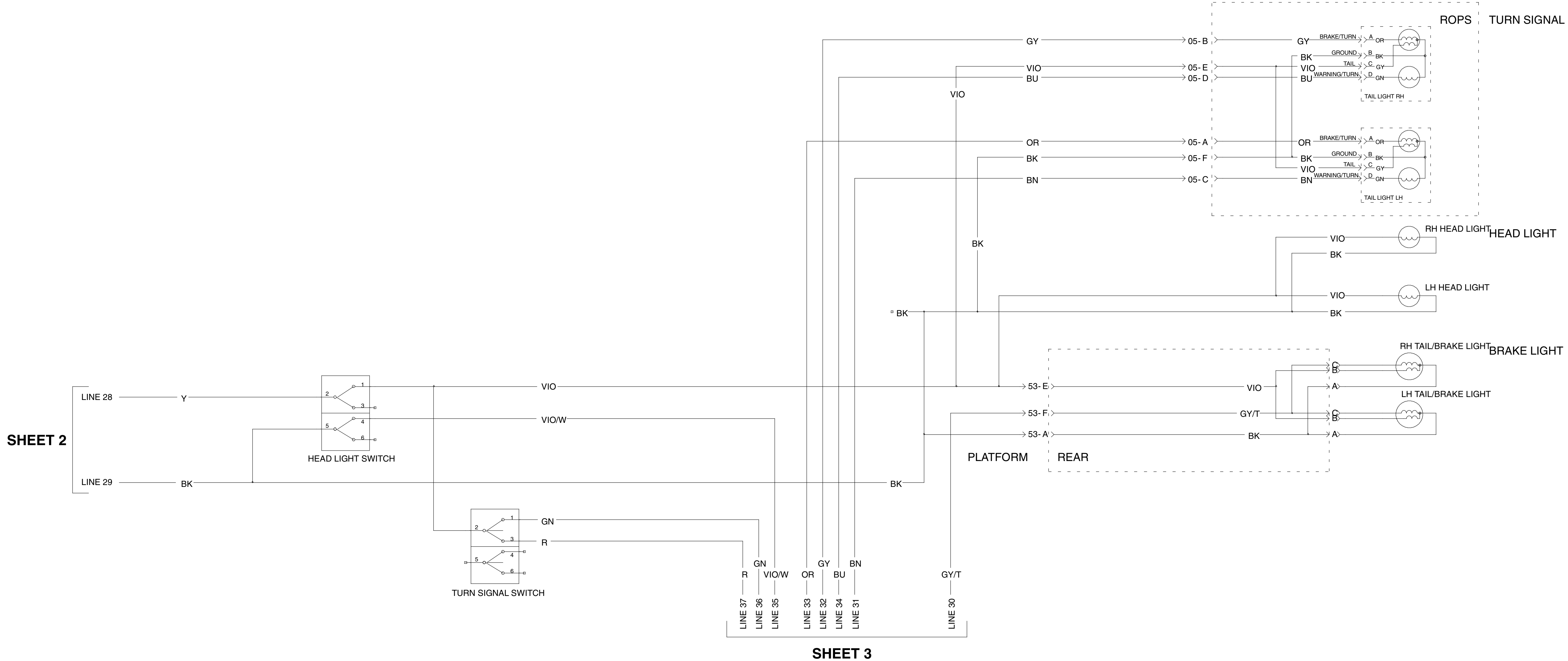
NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de- energized.

All ground wires are black.

g254542

Electrical Schematic Sheet 5 of 5 (Serial Number Below 313000300)



Groundsmaster 5900/5910
Electrical Schematic
Sheet 5 of 5
(Serial Number Below 313000300)

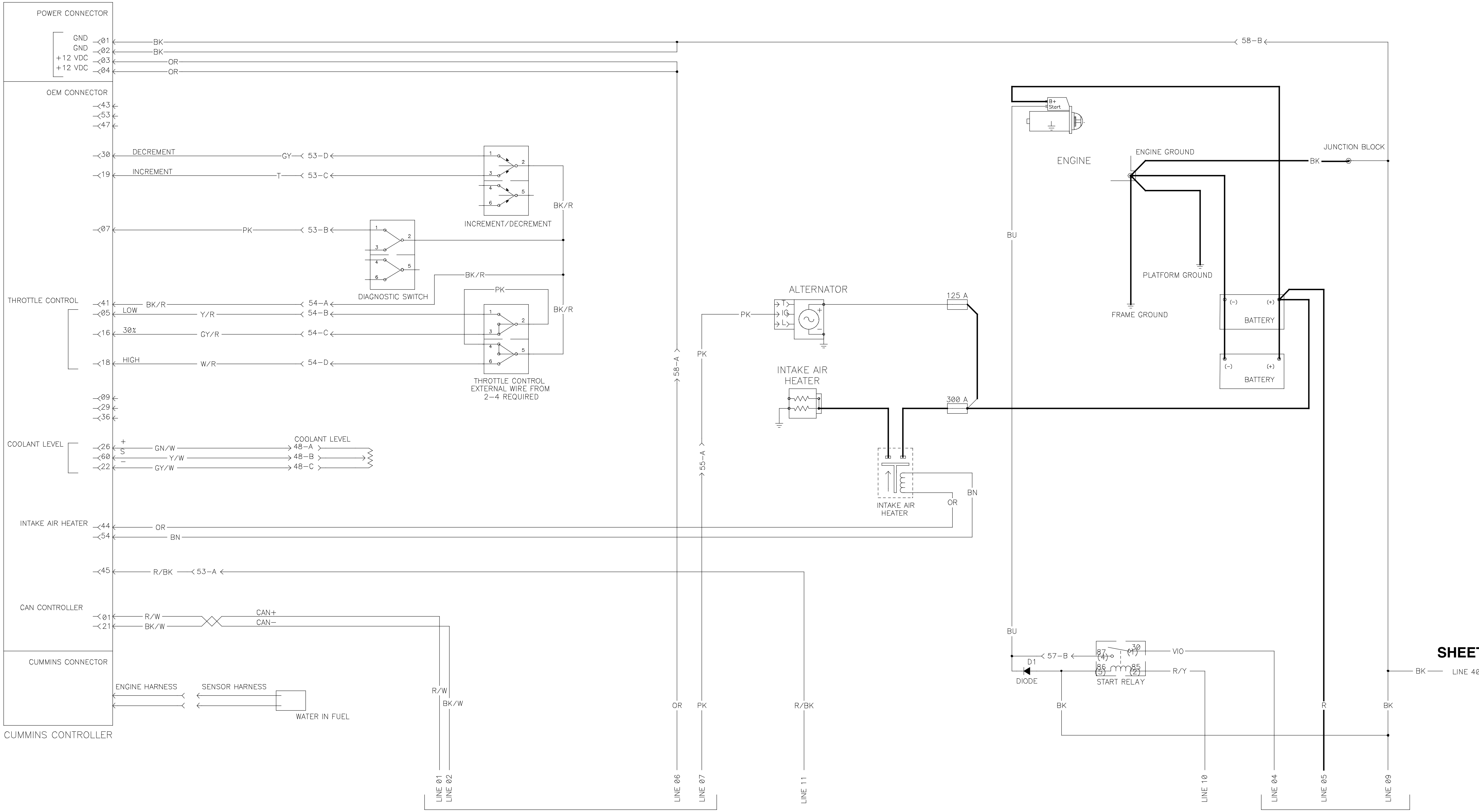
NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254543

Electrical Schematic Sheet 1 of 5 Serial Number From 313000301 to 313999999)



Groundsmaster 5900/5910
Electrical Schematic
Sheet 1 of 5
(Serial Number From 313000301 to 313999999)

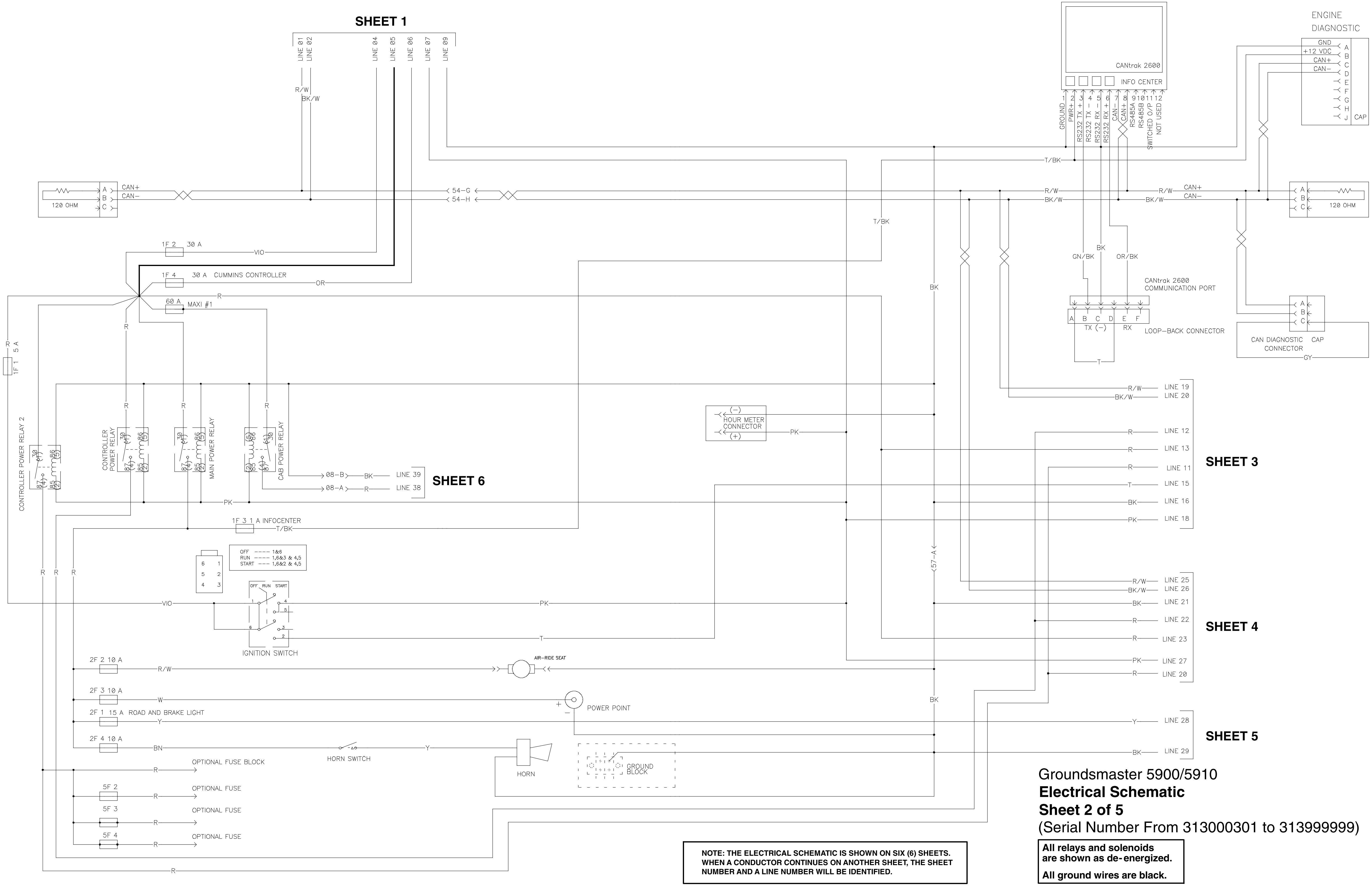
All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

g254544

Electrical Schematic Sheet 2 of 5 (Serial Number From 313000301 to 313999999)



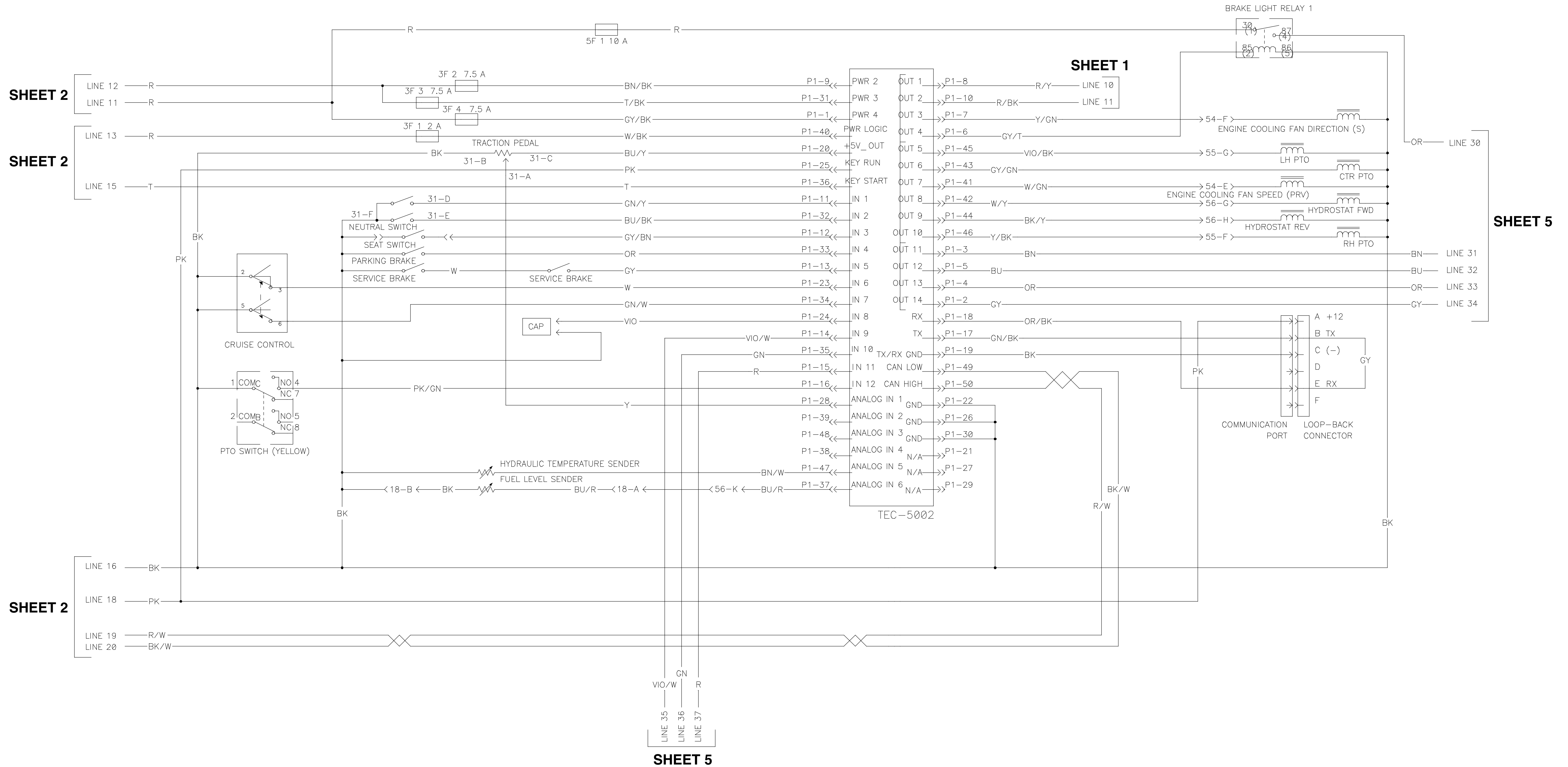
Groundsmaster 5900/5910
Electrical Schematic
Sheet 2 of 5
(Serial Number From 313000301 to 313999999)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

Electrical Schematic Sheet 3 of 5 (Serial Number From 313000301 to 313999999)



Groundsmaster 5900/5910

Electrical Schematic

Sheet 3 of 5

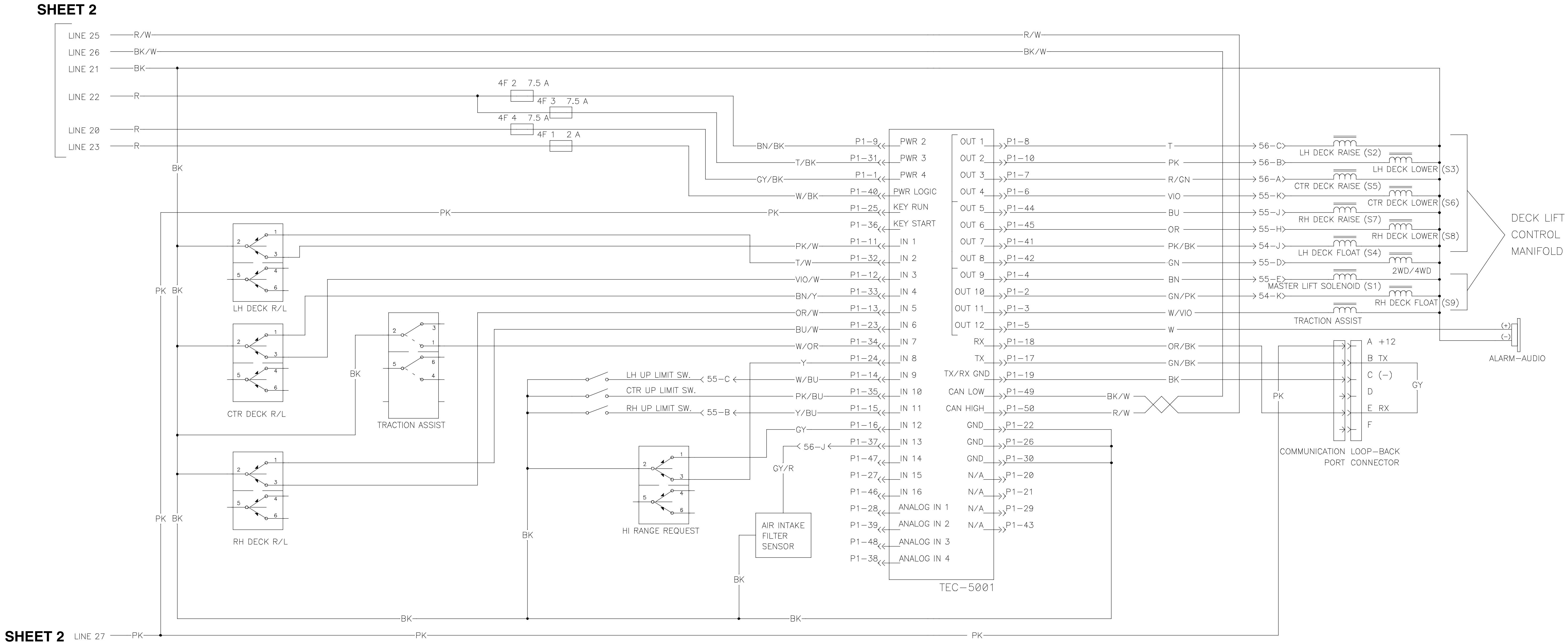
(Serial Number From 313000301 to 313999999)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.
All ground wires are black.

g254546

Electrical Schematic Sheet 4 of 5 (Serial Number From 313000301 to 313999999)



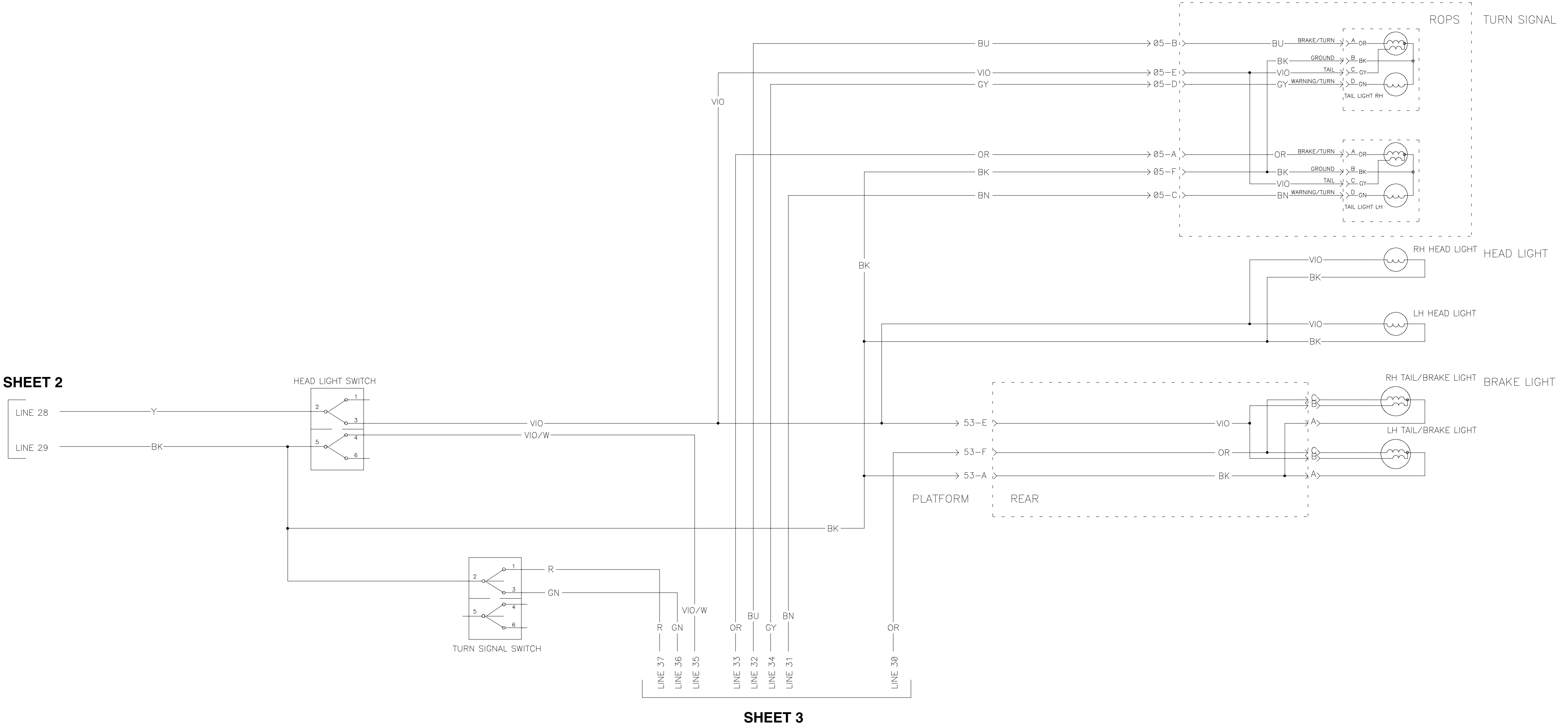
Groundsmaster 5900/5910
Electrical Schematic
Sheet 4 of 5
(Serial Number From 313000301 to 313999999)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254547



Groundsmaster 5900/5910
Electrical Schematic
Sheet 5 of 5
(Serial Number From 313000301 to 313999999)

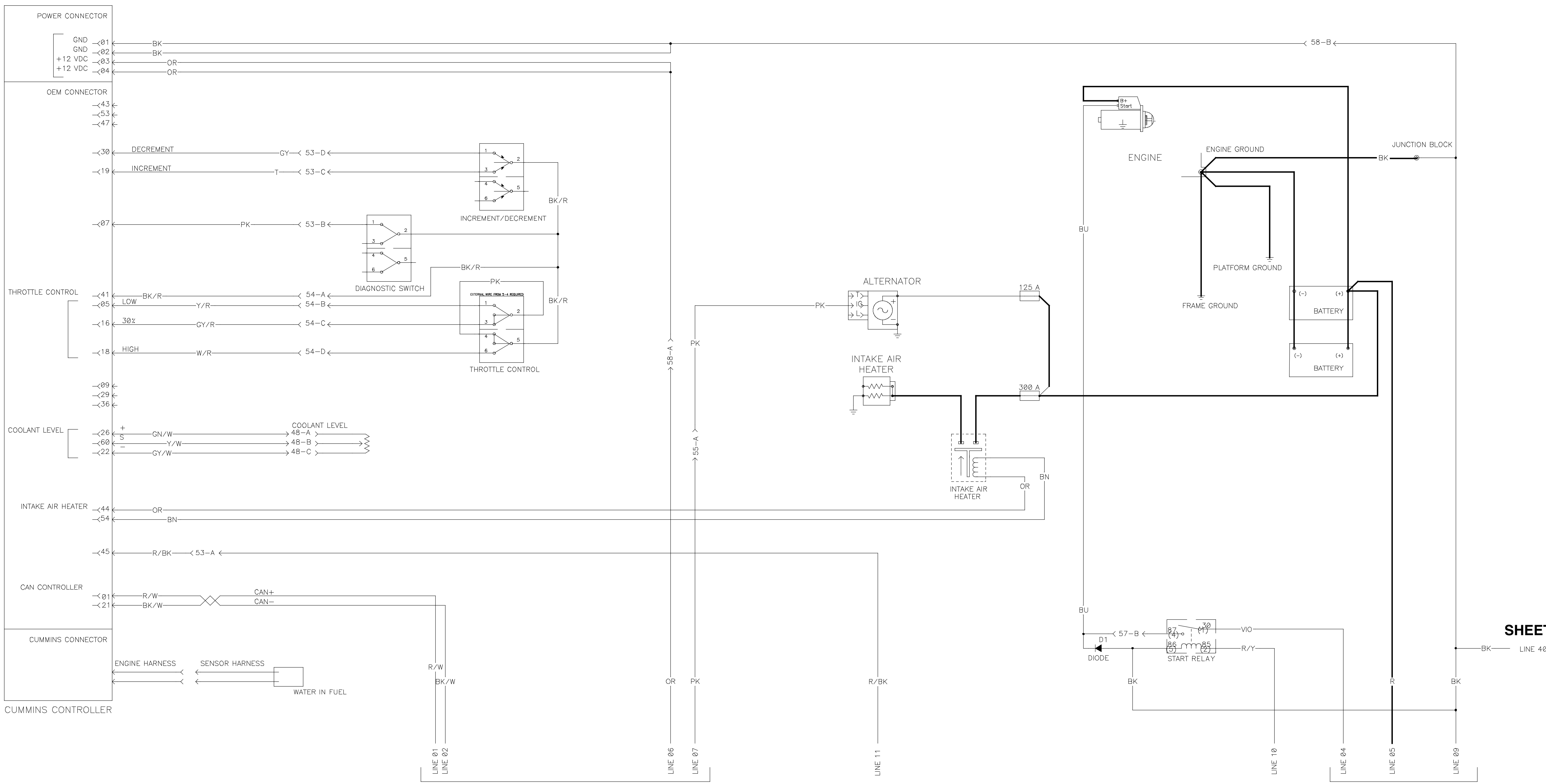
NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254548

Electrical Schematic Sheet 1 of 5 (Serial Number Above 314000000)



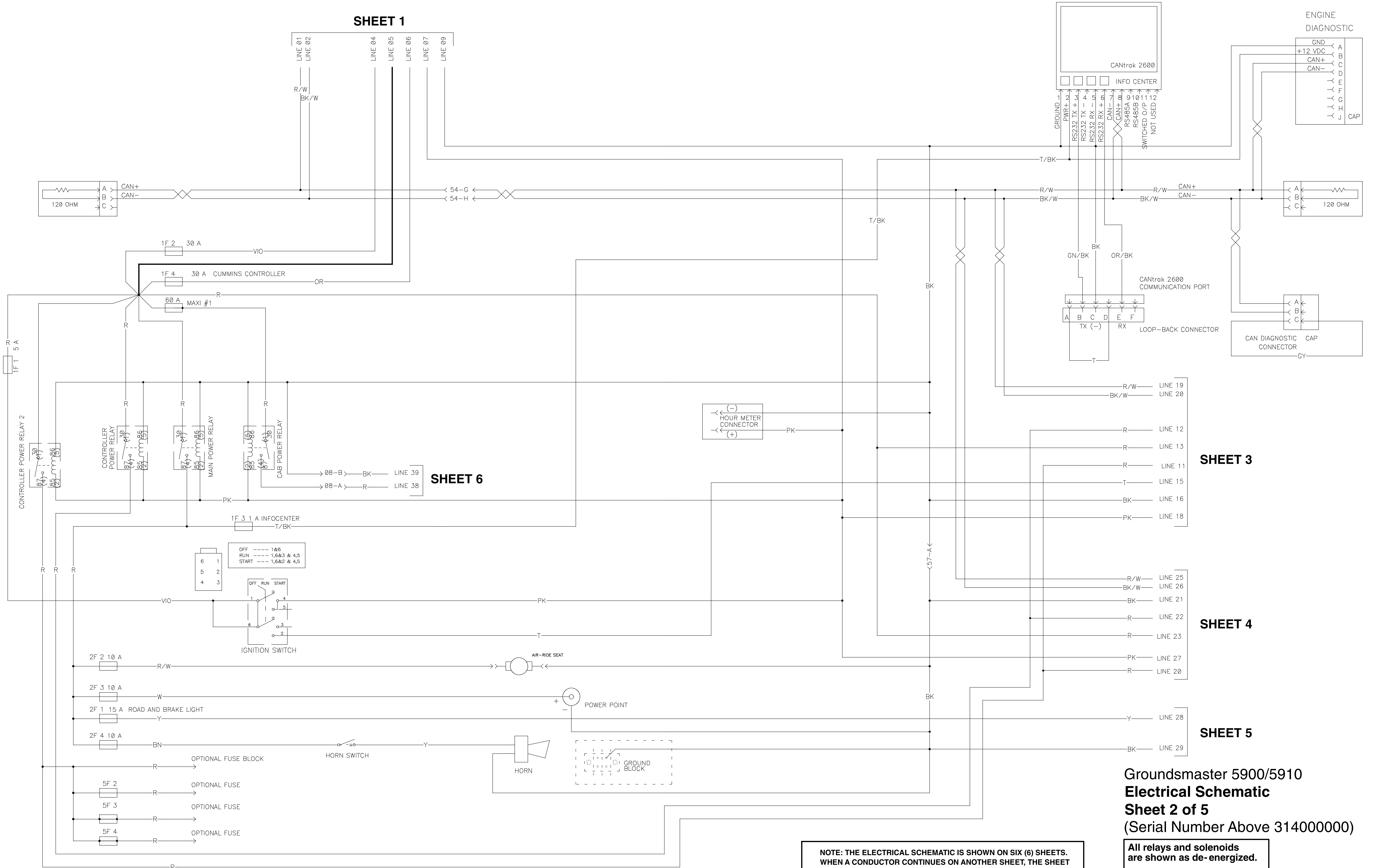
Groundsmaster 5900/5910
Electrical Schematic
Sheet 1 of 5
(Serial Number Above 314000000)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254549



Groundsmaster 5900/5910
Electrical Schematic
Sheet 2 of 5
(Serial Number Above 314000000)

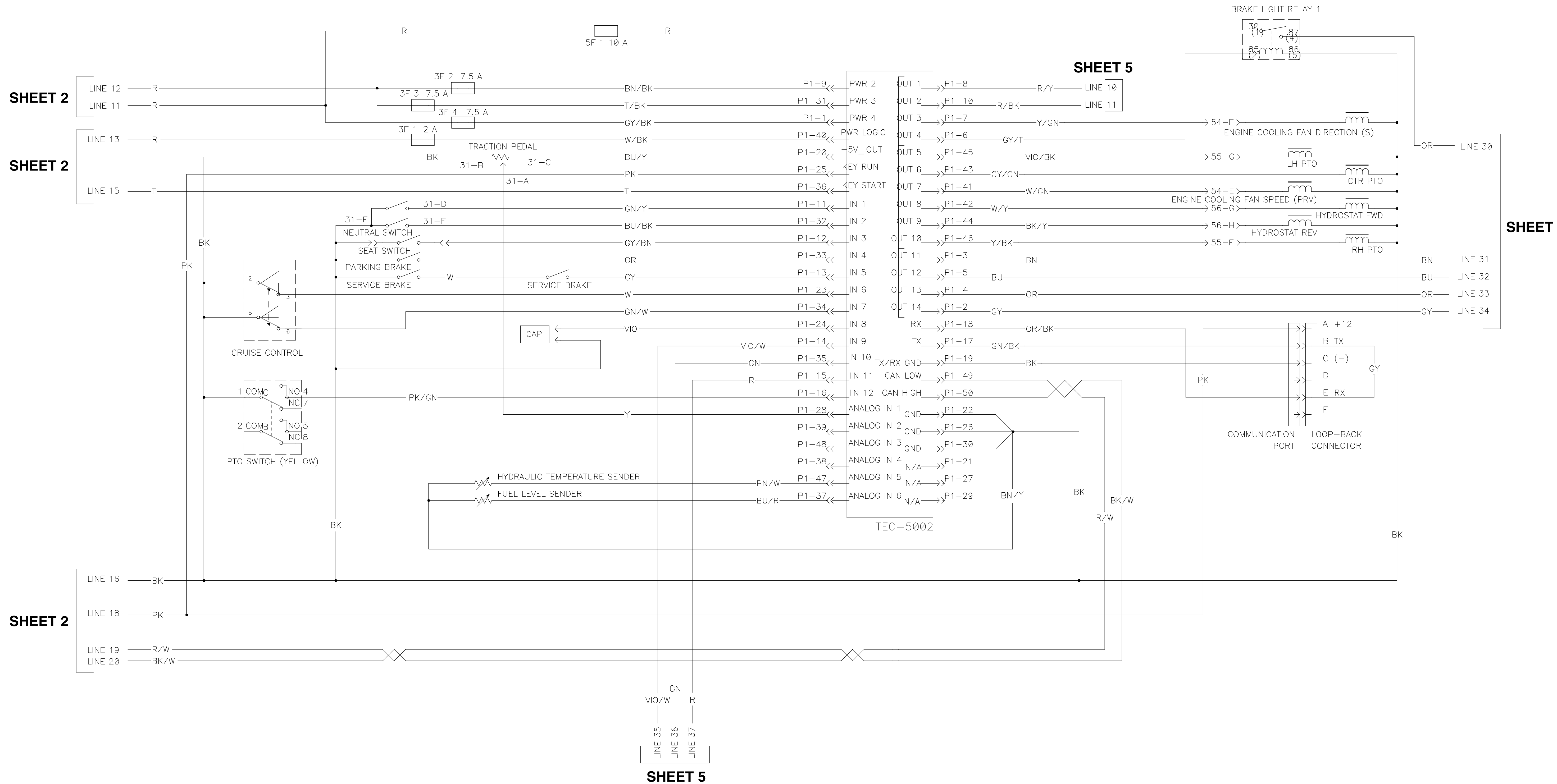
All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

g254550

Electrical Schematic Sheet 3 of 5 (Serial Number Above 314000000)



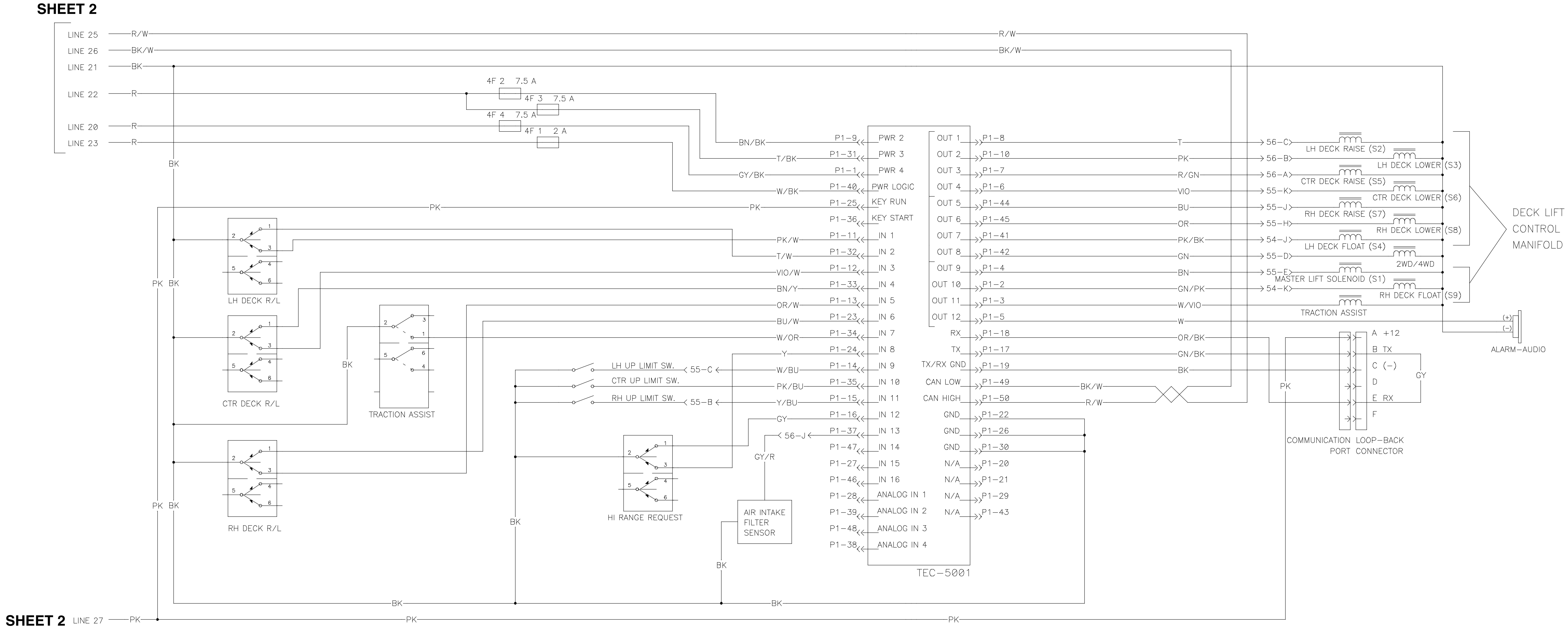
Groundsmaster 5900/5910
Electrical Schematic
Sheet 3 of 5
(Serial Number Above 314000000)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254551



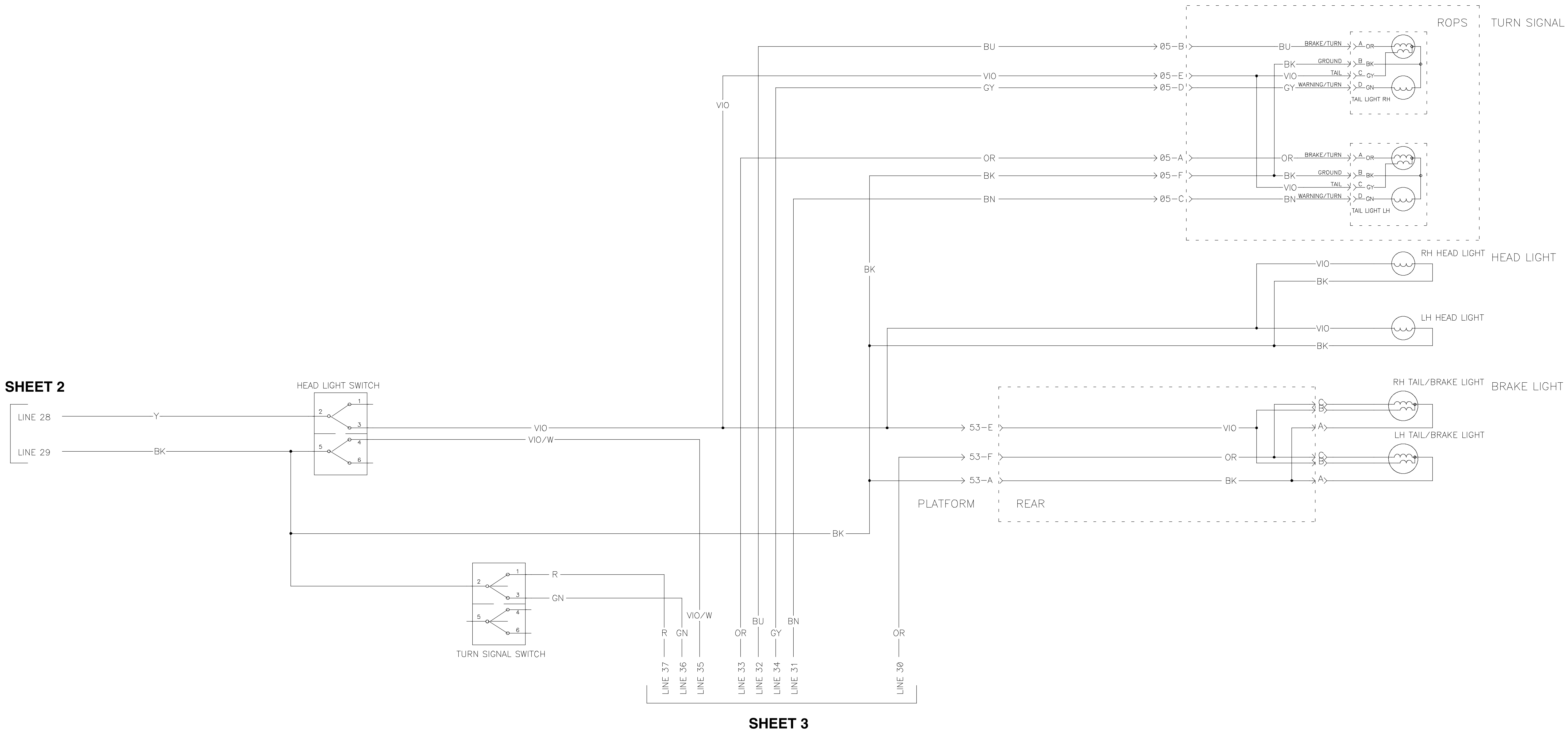
Groundsmaster 5900/5910
Electrical Schematic
Sheet 4 of 5
(Serial Number Above 314000000)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254552



Groundsmaster 5900/5910
Electrical Schematic
Sheet 5 of 5
(Serial Number Above 314000000)

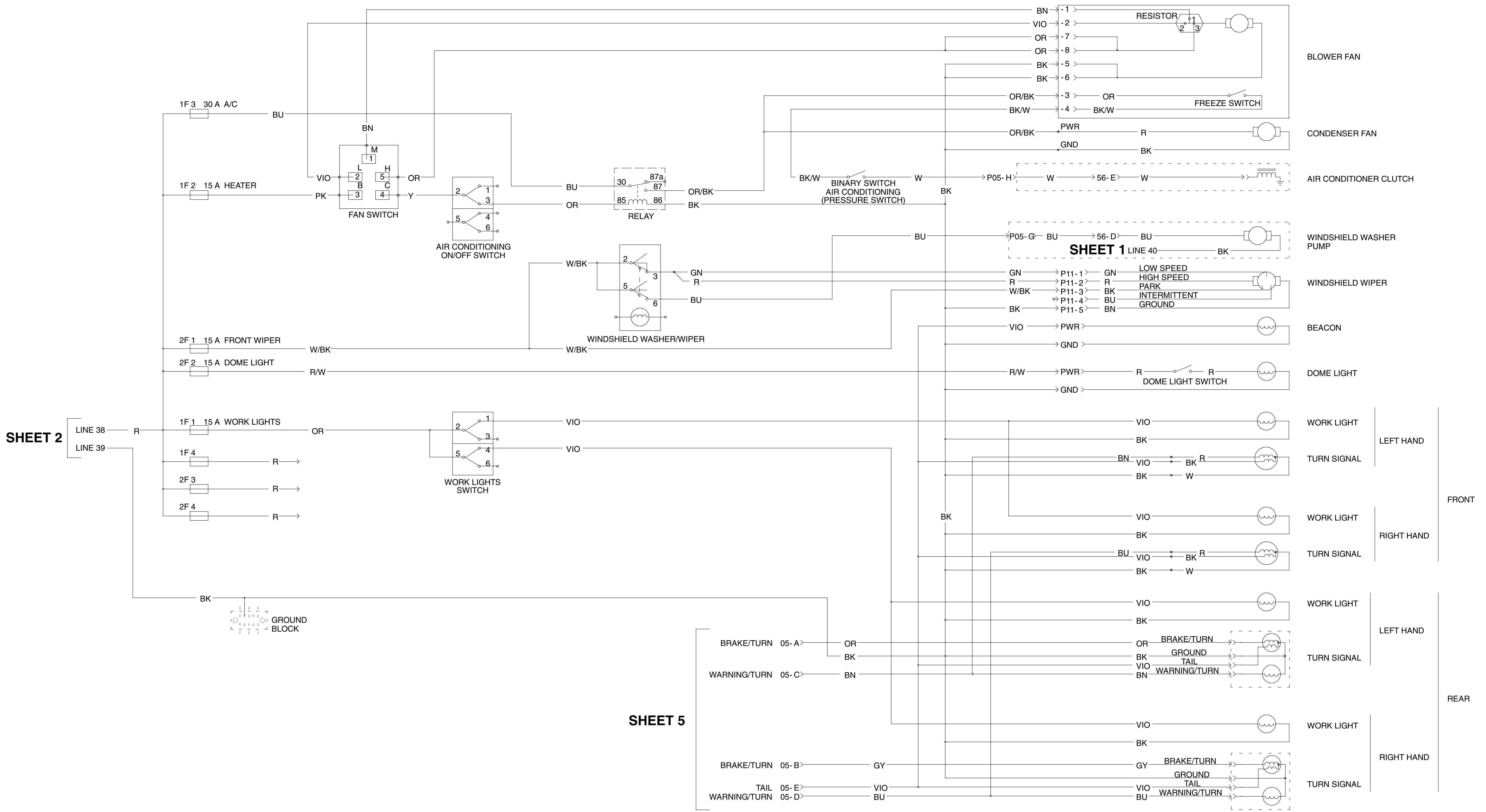
All relays and solenoids are shown as de-energized.

All ground wires are black.

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

g254553

Electrical Schematic Operator Cab (Serial Number Below 313000300)



Groundsmaster 5900/5910
Electrical Schematic
Operator Cab
(Serial Number Below 313000300)

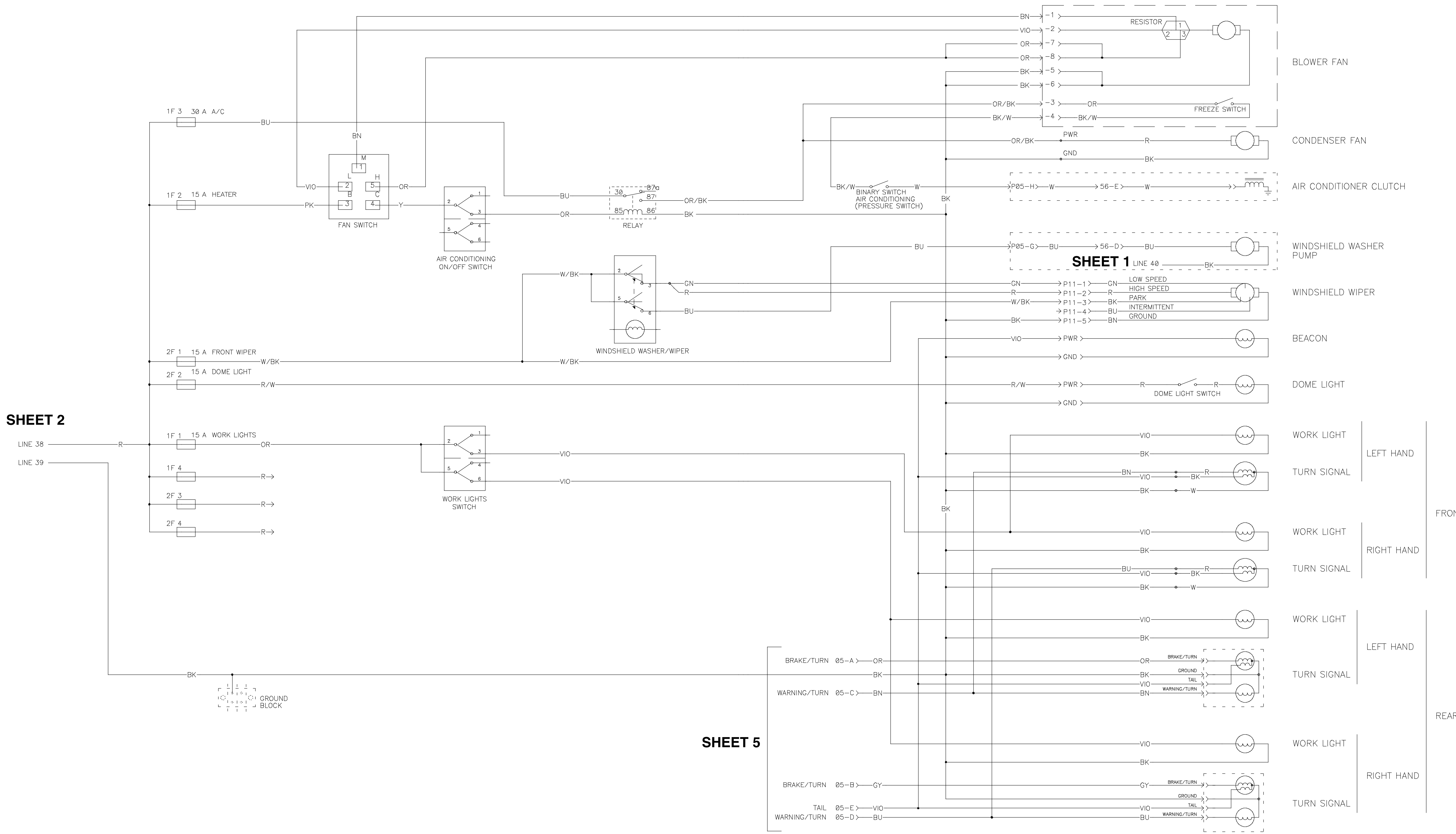
NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254554

Electrical Schematic Operator Cab (Serial Number From 313000301 to 313999999)



Groundsmaster 5900/5910

Electrical Schematic

Operator Cab

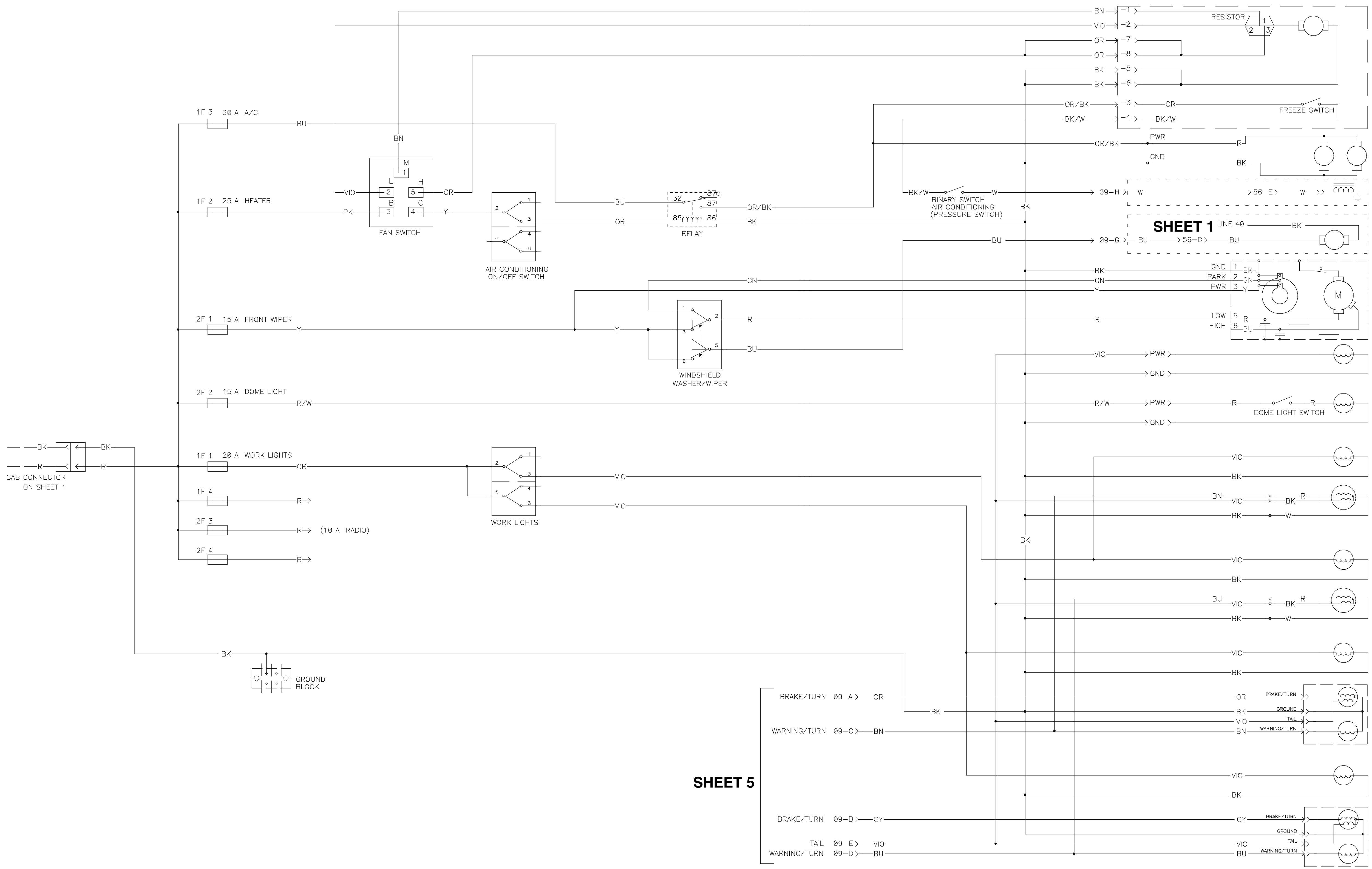
(Serial Number From 313000301 to 313999999)

NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254555



Groundsmaster 5900/5910
Electrical Schematic
Operator Cab
(Serial Number Above 314000000)

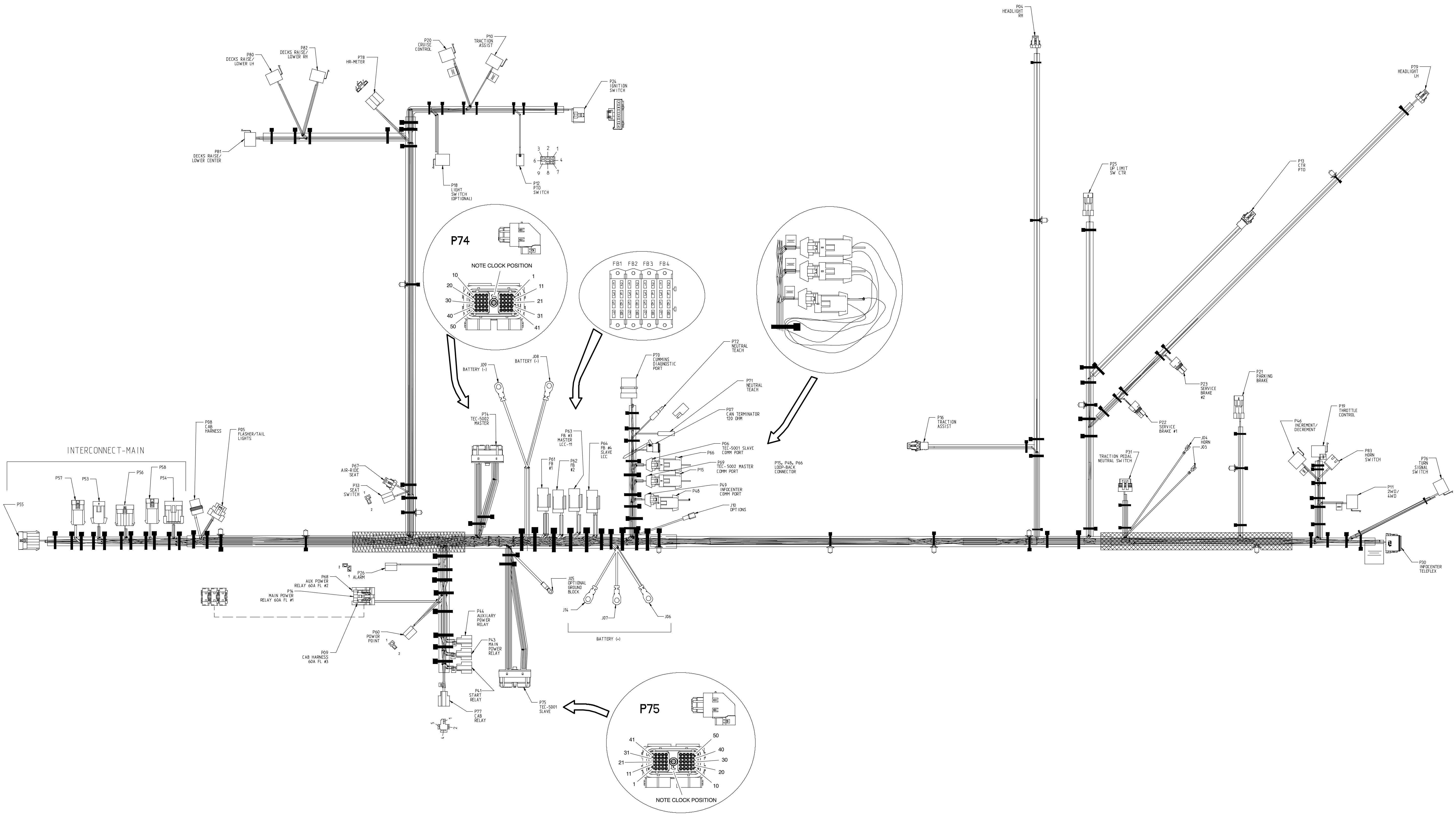
NOTE: THE ELECTRICAL SCHEMATIC IS SHOWN ON SIX (6) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, THE SHEET NUMBER AND A LINE NUMBER WILL BE IDENTIFIED.

All relays and solenoids are shown as de-energized.

All ground wires are black.

g254556

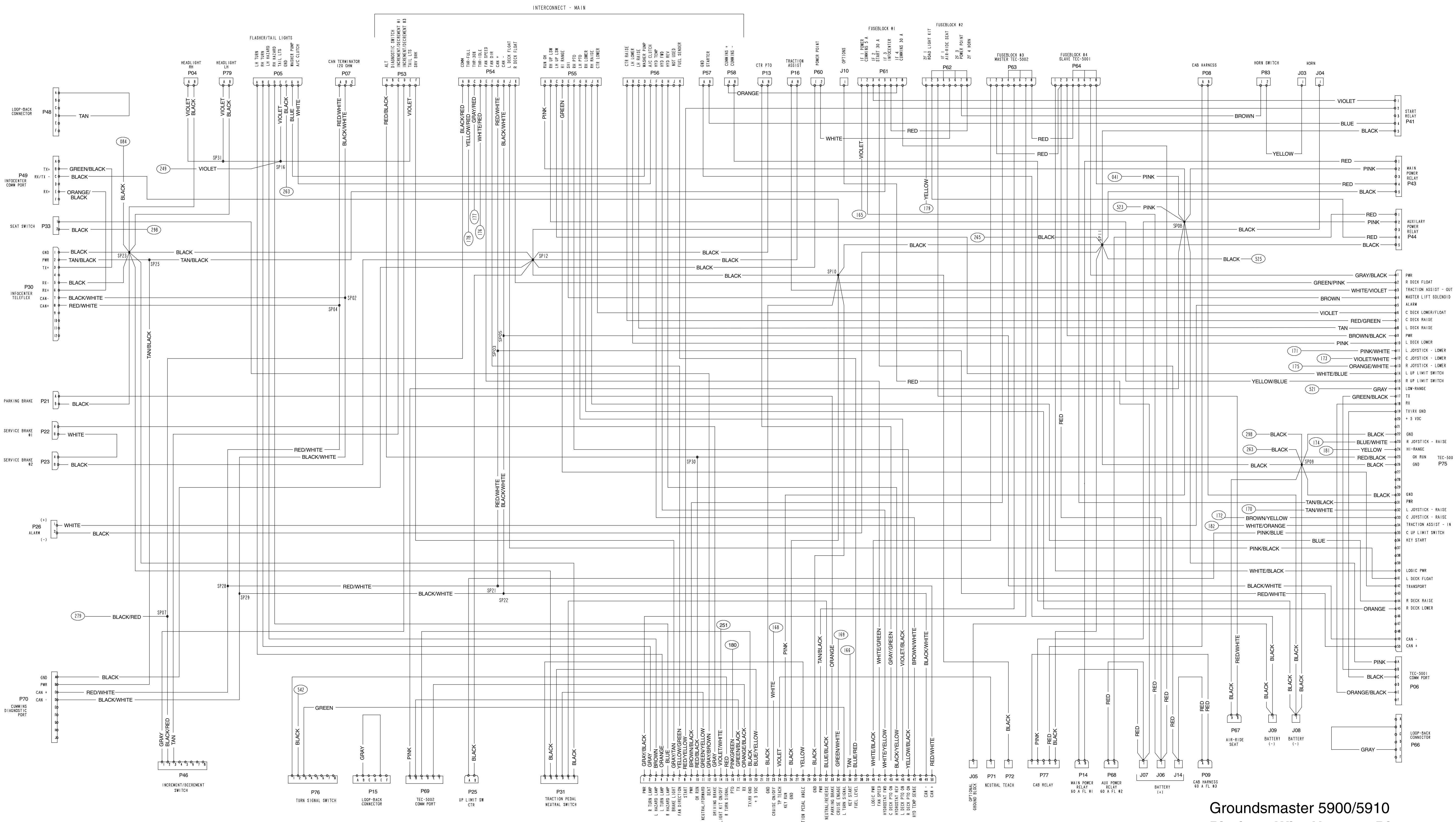
Platform Wire Harness Drawing (Serial Number Below 310000000)



g254557

Groundsmaster 5900/5910
Platform Wire Harness Drawing
(Serial Number Below 310000000)

Platform Wire Harness Diagram Sheet 1 of 2 (Serial Number Below 310000000)



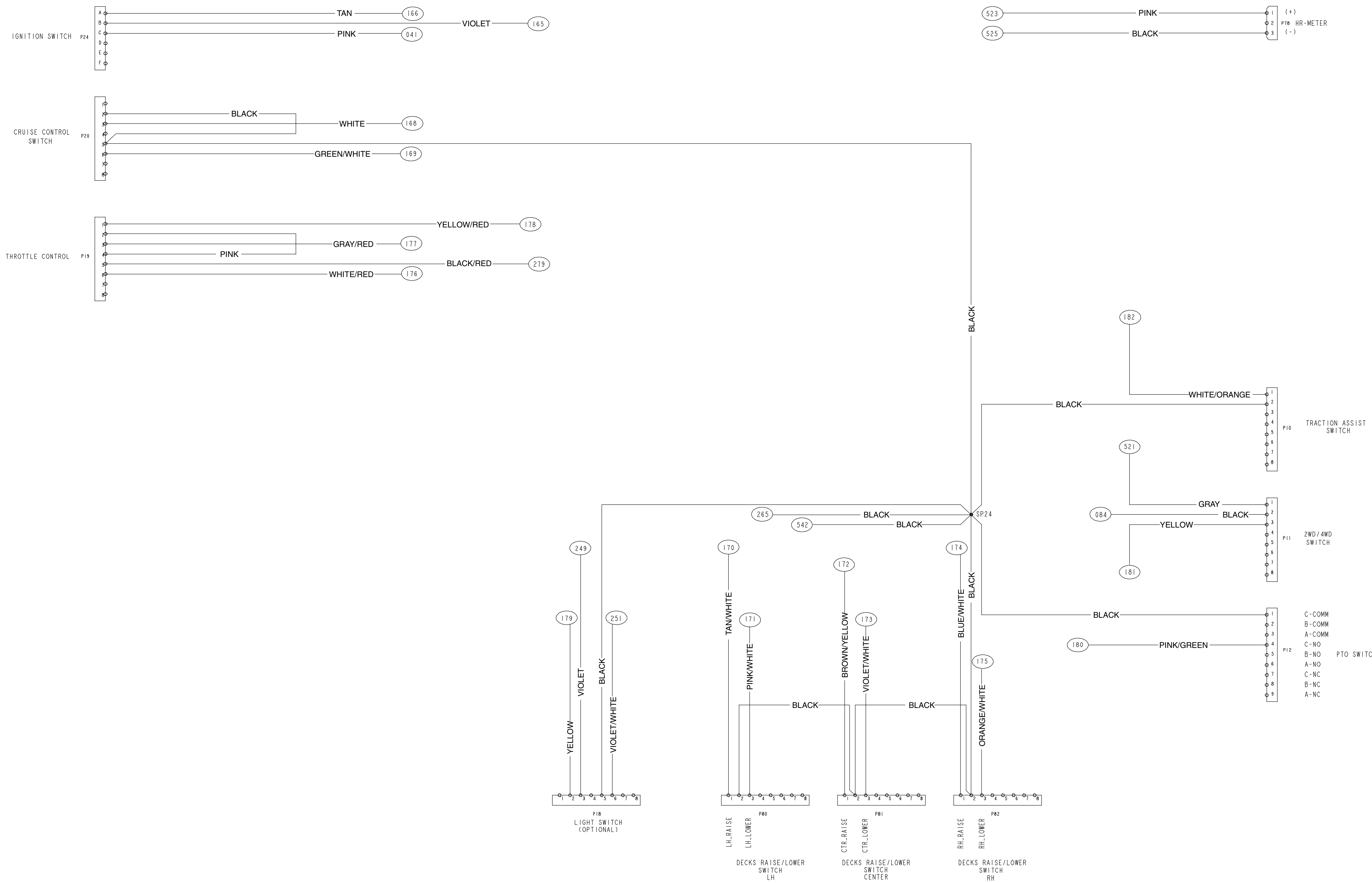
Groundsmaster 5900/5910

Platform Wire Harness Diagram
Sheet 1 of 2
(Serial Number Below 310000000)

NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

g254558

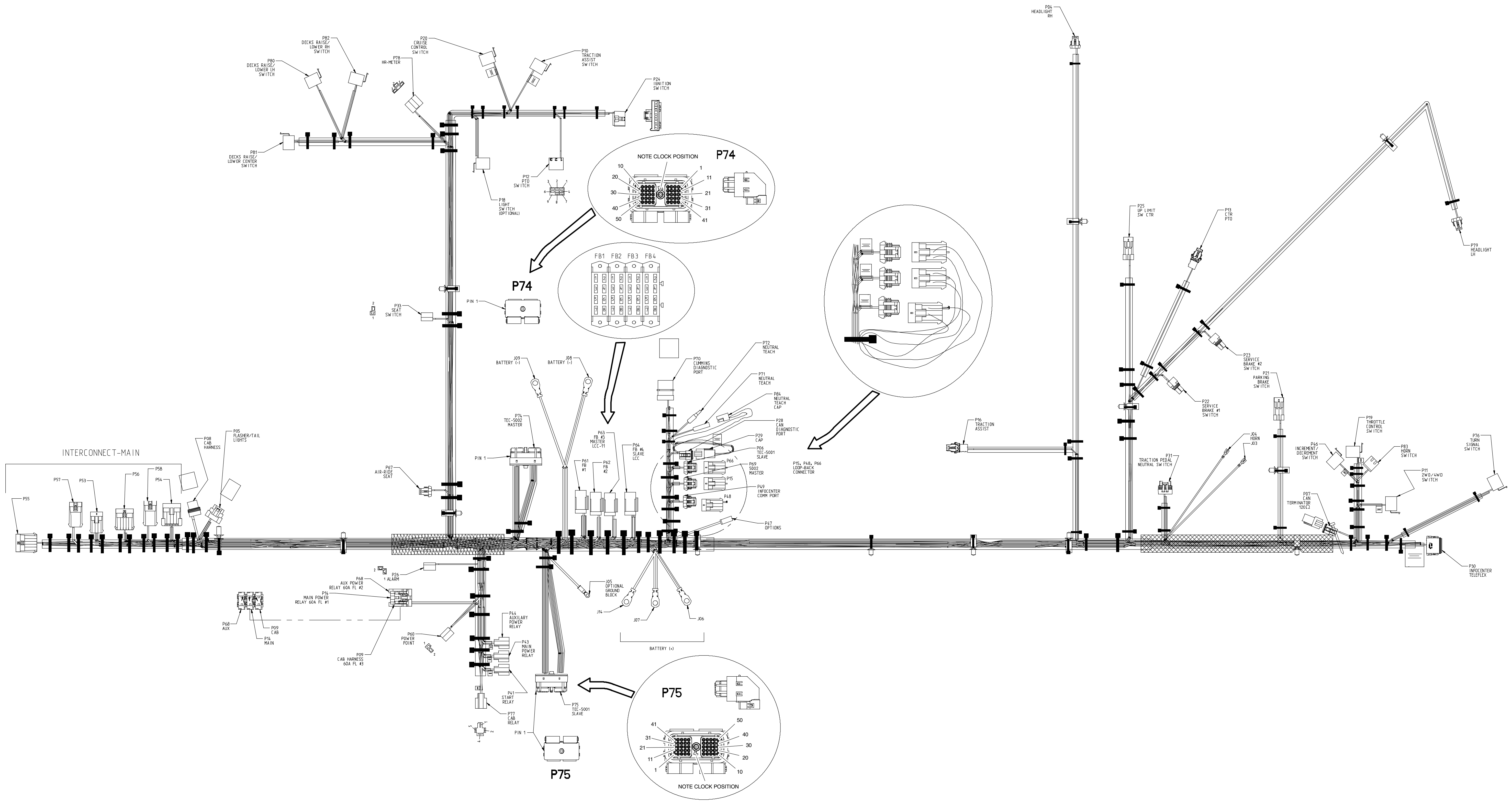
Platform Wire Harness Diagram Sheet 2 of 2 (Serial Number Below 310000000)



g254559

NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

Groundsmaster 5900/5910
Platform Wire Harness Diagram
Sheet 2 of 2
(Serial Number Below 310000000)



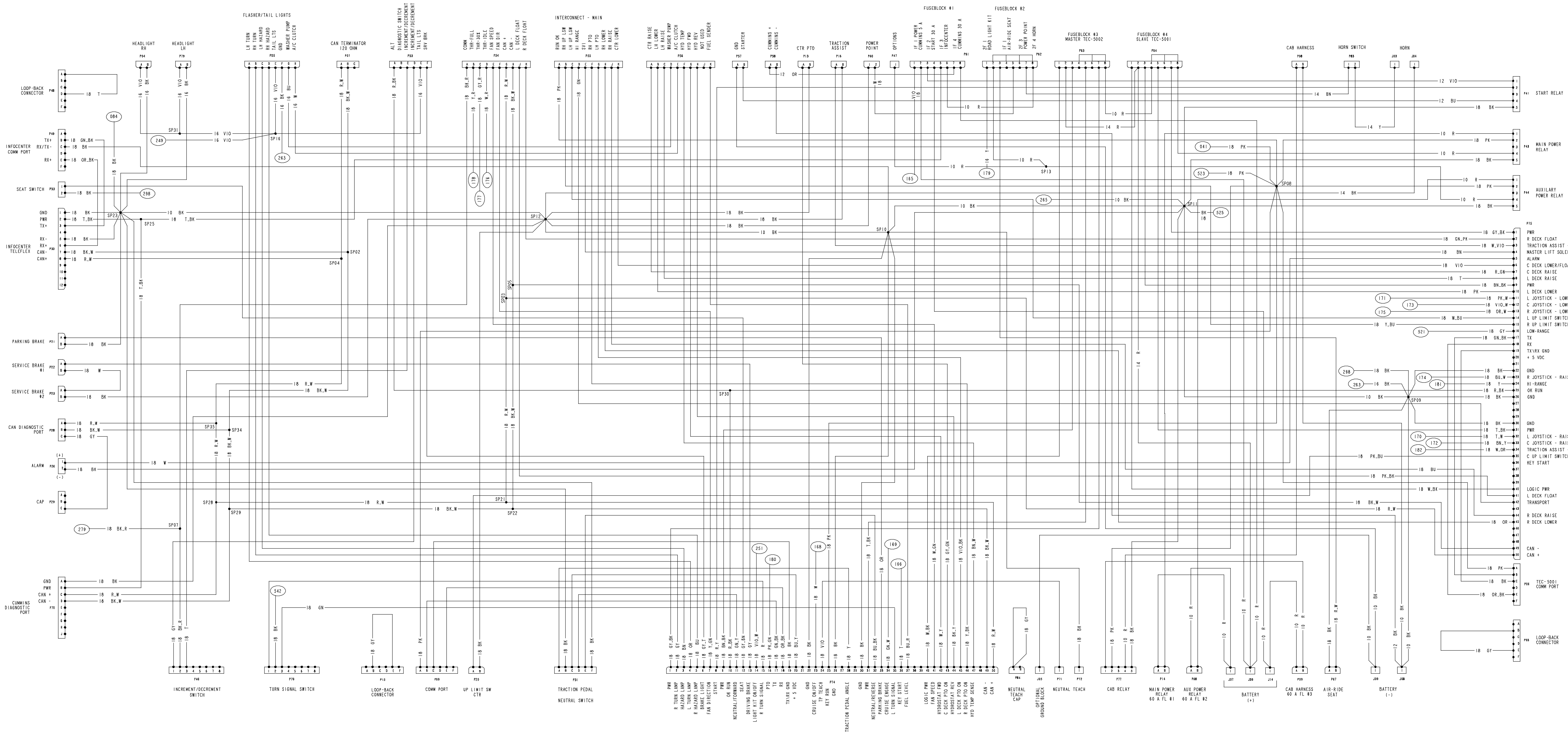
Groundsmaster 5900/5910

Platform Wire Harness Drawing

(Serial Number From 310000001 to 313000300)

g254560

Platform Wire Harness Diagram Sheet 1 of 2 (Serial Number From 310000001 to 313000300)



NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

g254561

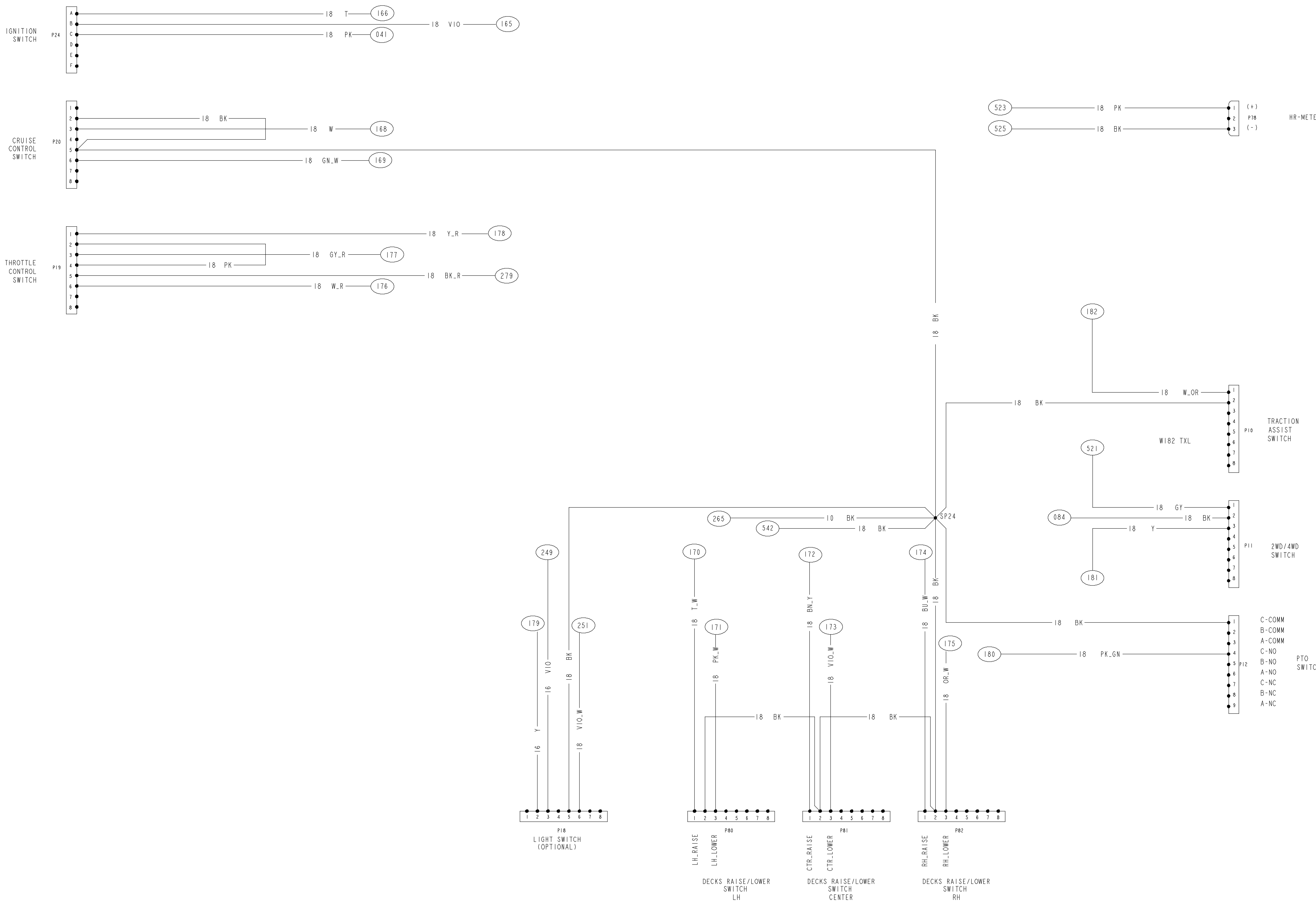
Groundsmaster 5900/5910

Platform Wire Harness Diagram

Sheet 1 of 2

(Serial Number From 310000001 to 313000300)

Platform Wire Harness Diagram Sheet 2 of 2 (Serial Number From 310000001 to 313000300)



NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

Groundsmaster 5900/5910

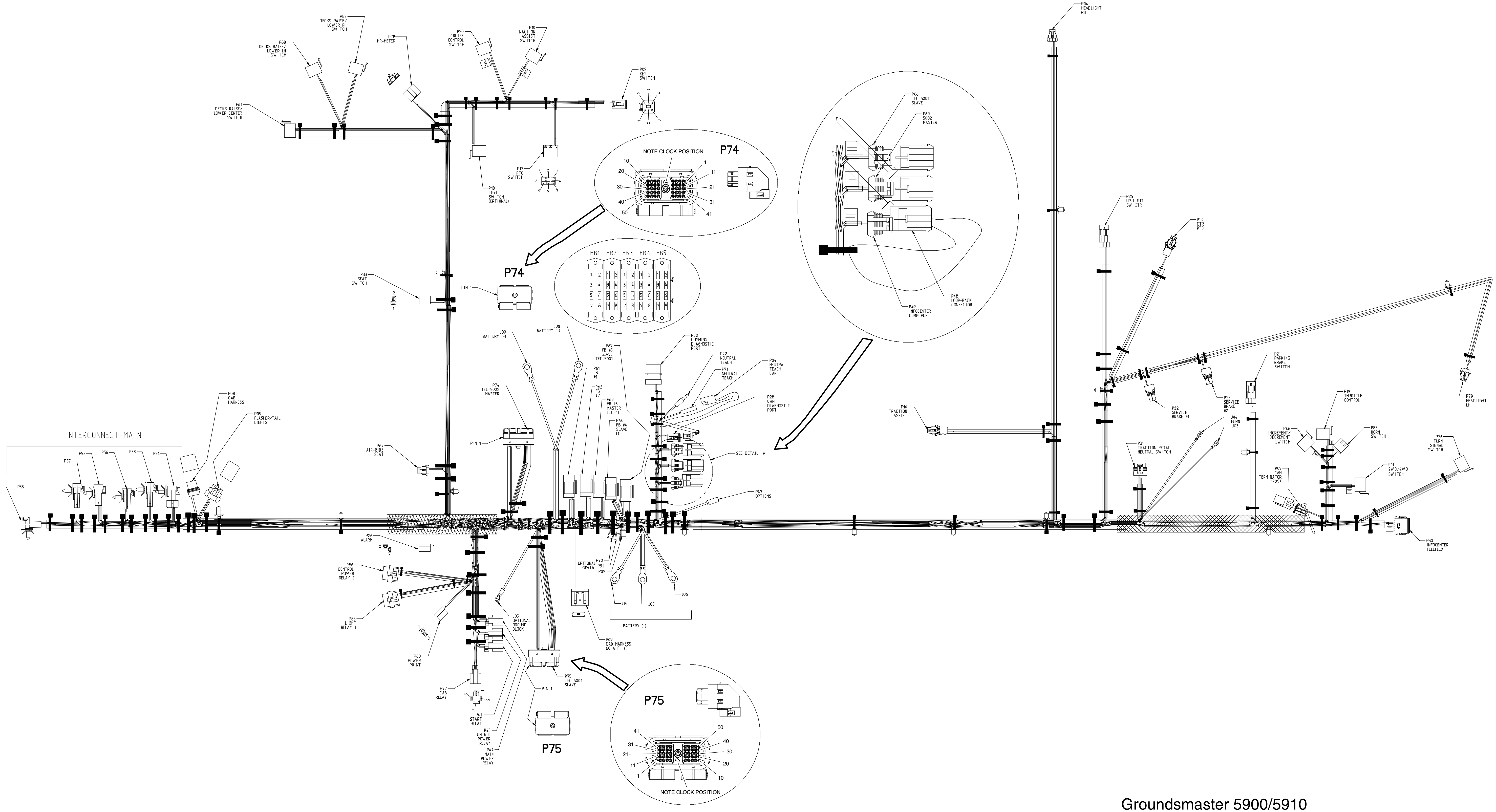
Platform Wire Harness Diagram

Sheet 2 of 2

(Serial Number From 310000001 to 313000300)

g254562

Platform Wire Harness Drawing (Serial Number From 313000301 to 313999999)



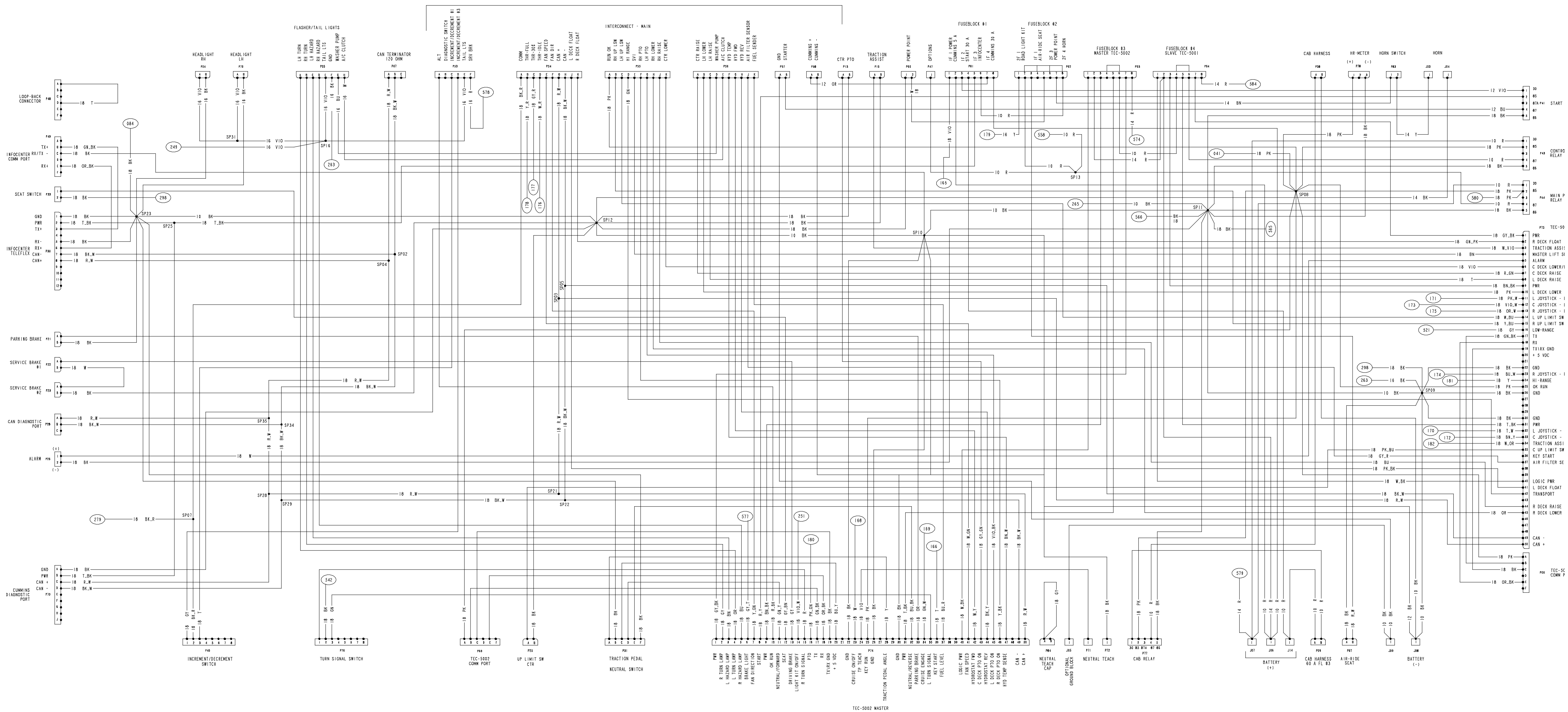
Groundsmaster 5900/5910

Platform Wire Harness Drawing

(Serial Number From 313000301 to 313999999)

g254563

Platform Wire Harness Diagram Sheet 1 of 2 (Serial Number From 313000301 to 313999999)

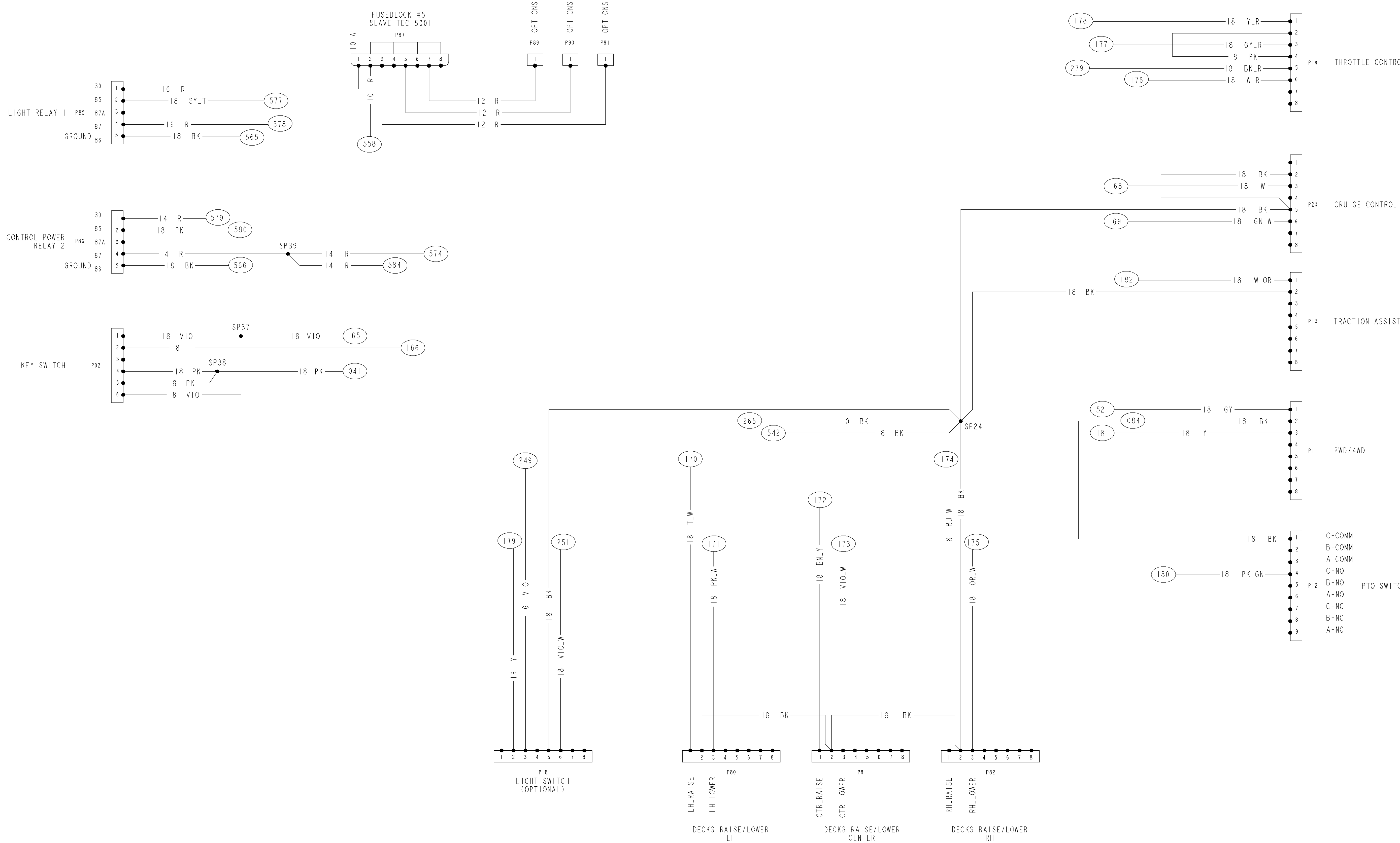


NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

Groundsmaster 5900/5910
Platform Wire Harness Diagram
Sheet 1 of 2
(Serial Number From 313000301 to 313999999)

g254564

Platform Wire Harness Diagram Sheet 2 of 2 (Serial Number From 313000301 to 313999999)



Groundsmaster 5900/5910

Platform Wire Harness Diagram

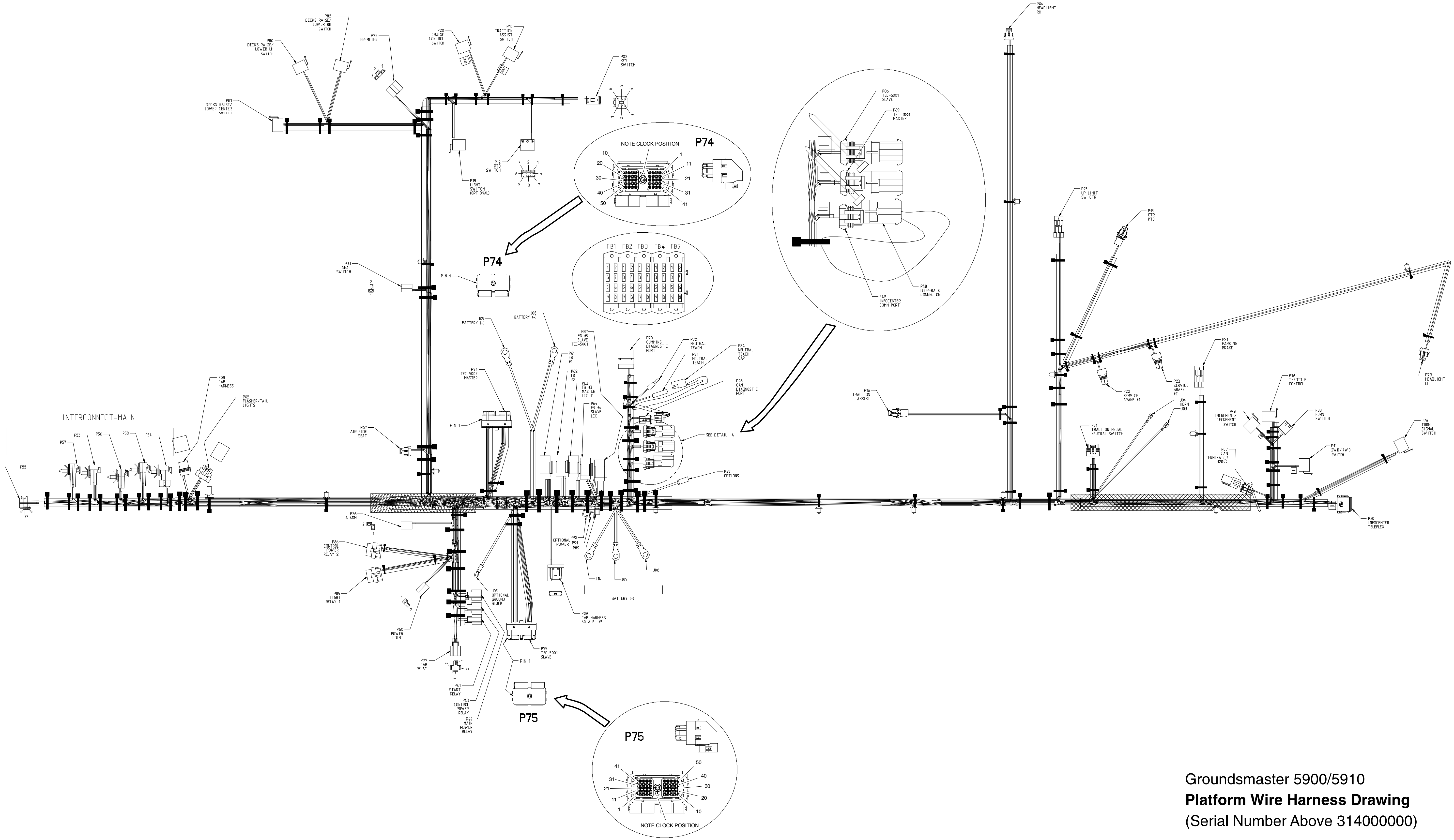
Sheet 2 of 2

(Serial Number From 313000301 to 313999999)

NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

g254565

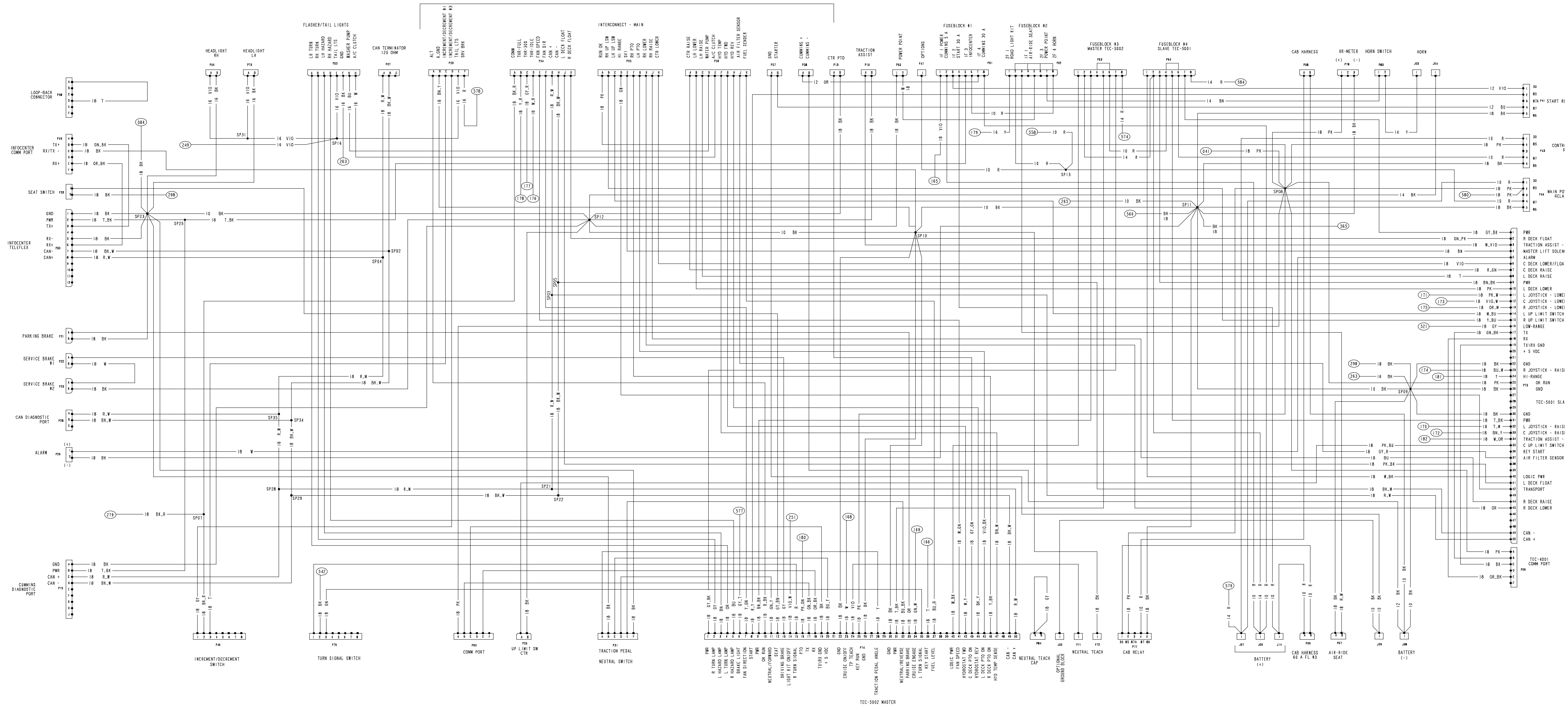
Platform Wire Harness Drawing (Serial Number Above 314000000)



Groundsmaster 5900/5910
Platform Wire Harness Drawing
(Serial Number Above 314000000)

g254566

Platform Wire Harness Diagram Sheet 1 of 2 (Serial Number Above 314000000)



g254567

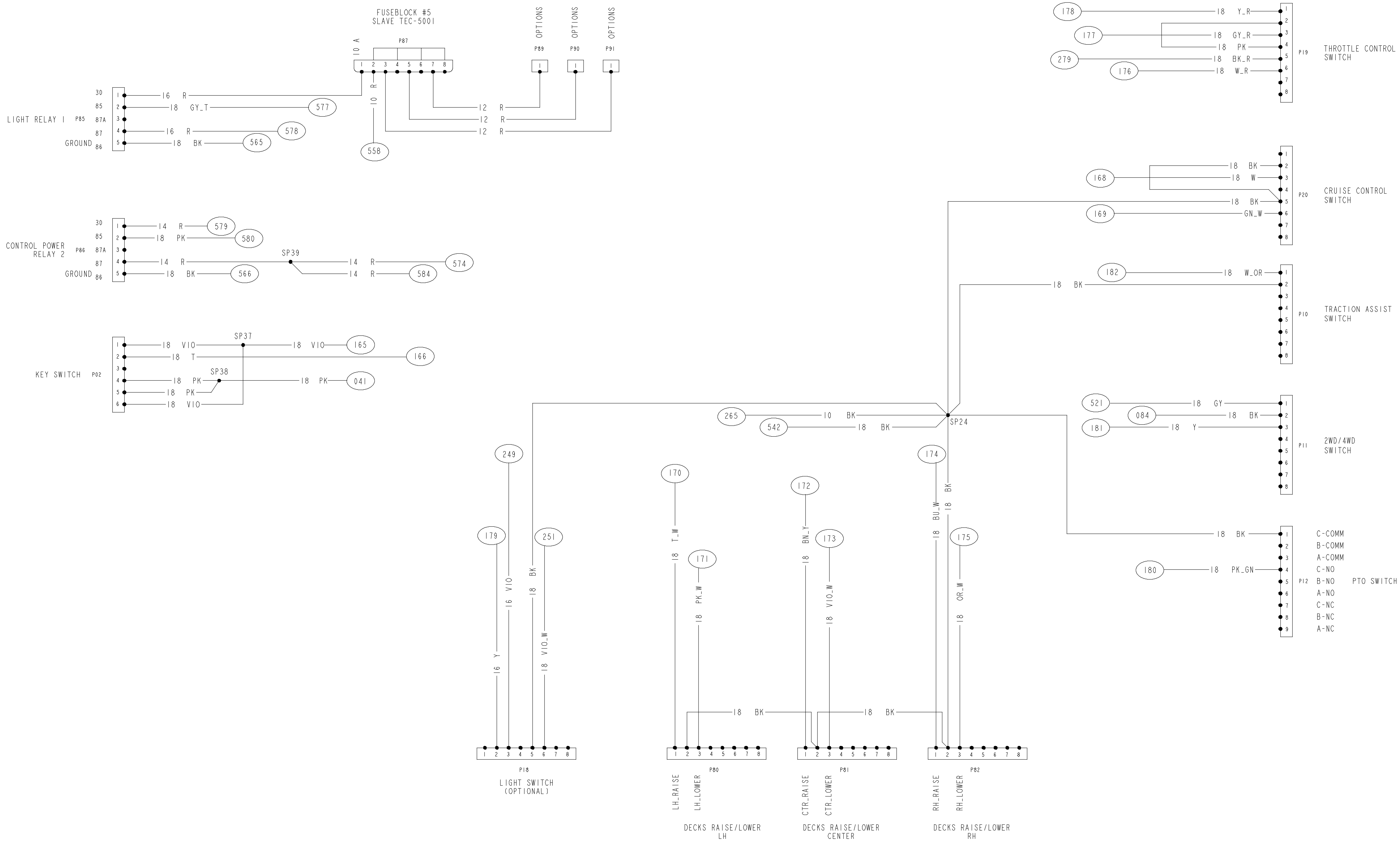
NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

Groundsmaster 5900/5910

Platform Wire Harness Diagram

Sheet 1 of 2

(Serial Number Above 314000000)



NOTE: THE PLATFORM WIRE HARNESS DIAGRAM IS SHOWN ON TWO (2) SHEETS. WHEN A CONDUCTOR CONTINUES ON ANOTHER SHEET, A REFERENCE NUMBER WILL BE IDENTIFIED.

Groundsmaster 5900/5910

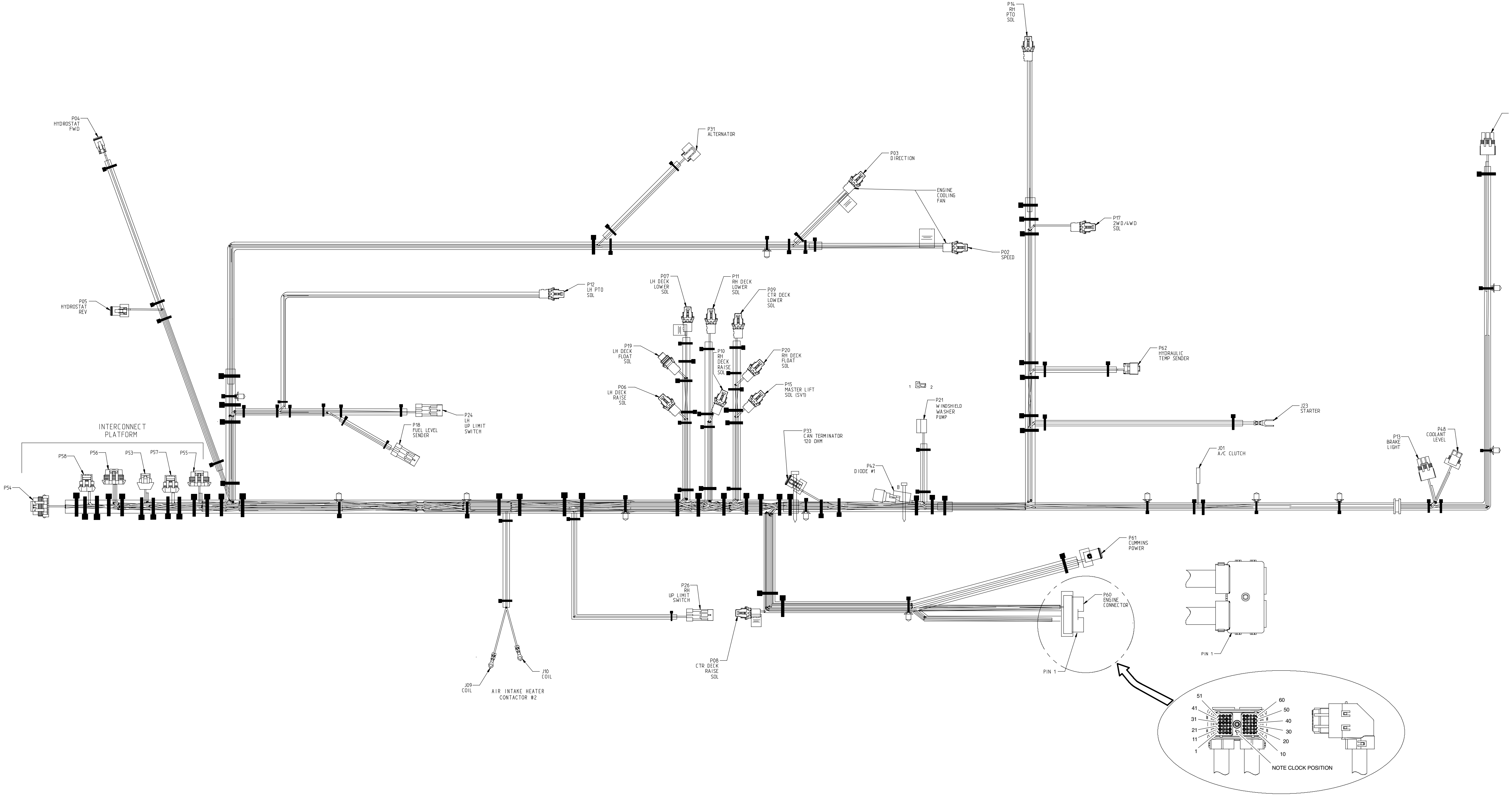
Platform Wire Harness Diagram

Sheet 2 of 2

(Serial Number Above 314000000)

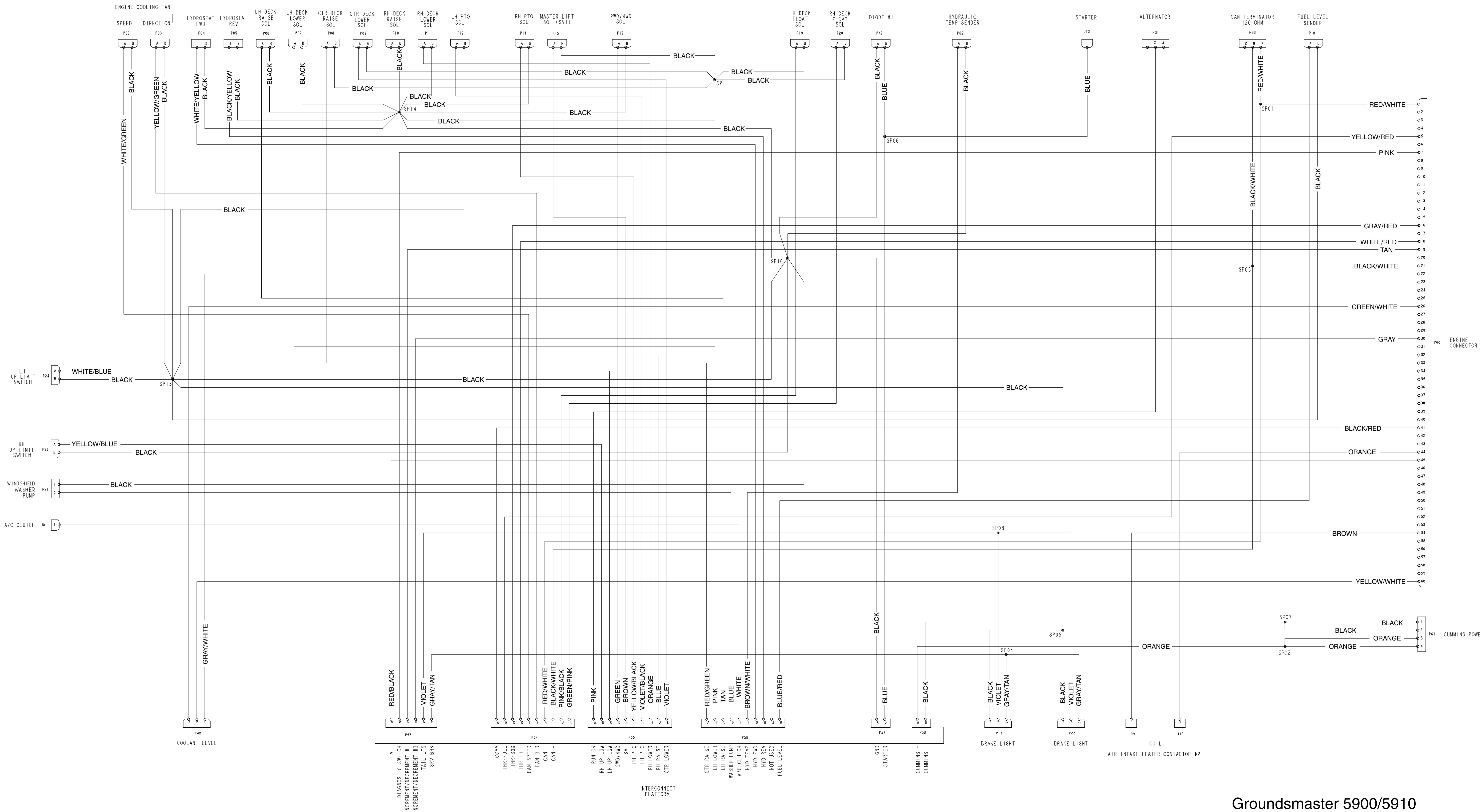
g254568

Rear Wire Harness Drawing (Serial Number Below 313000300)



Groundsmaster 5900/5910
Rear Wire Harness Drawing
(Serial Number Below 313000300)

g254569



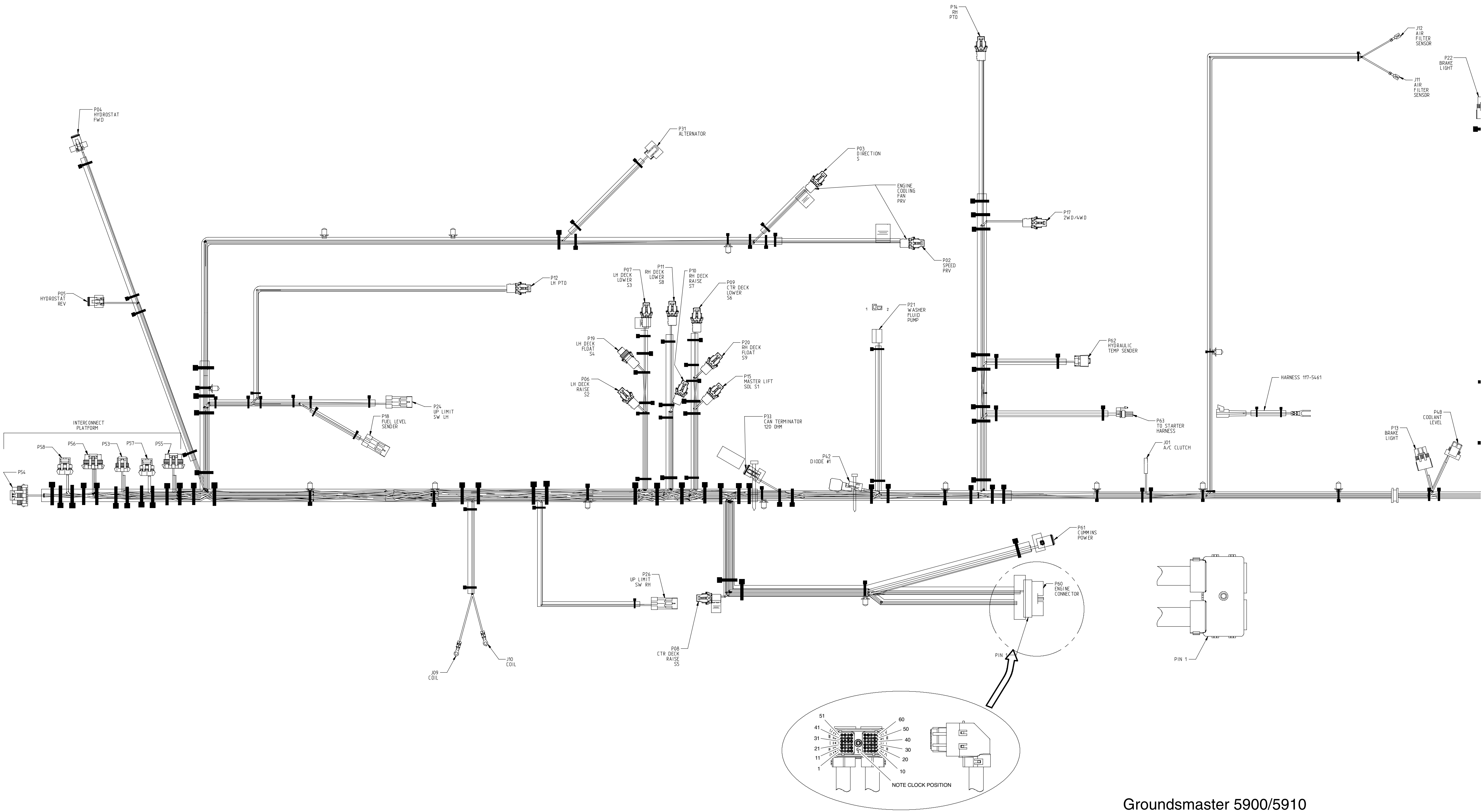
Groundsmaster 5900/5910

Rear Wire Harness Diagram

(Serial Number Below 313000300)

g254570

Rear Wire Harness Drawing (Serial Number From 313000301 to 313999999)



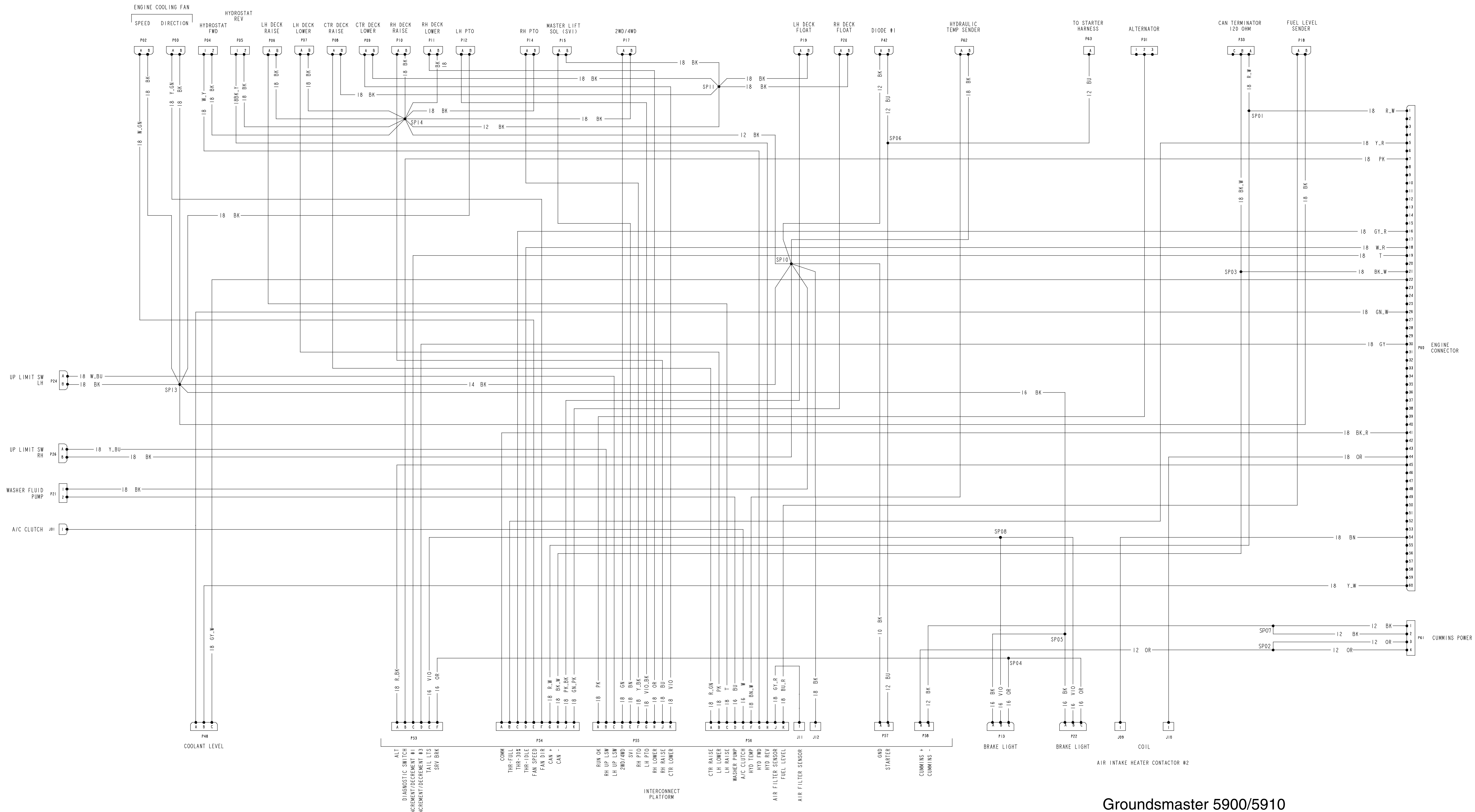
Groundsmaster 5900/5910

Rear Wire Harness Drawing

(Serial Number From 313000301 to 313999999)

g254571

Rear Wire Harness Diagram (Serial Number From 313000301 to 313999999)



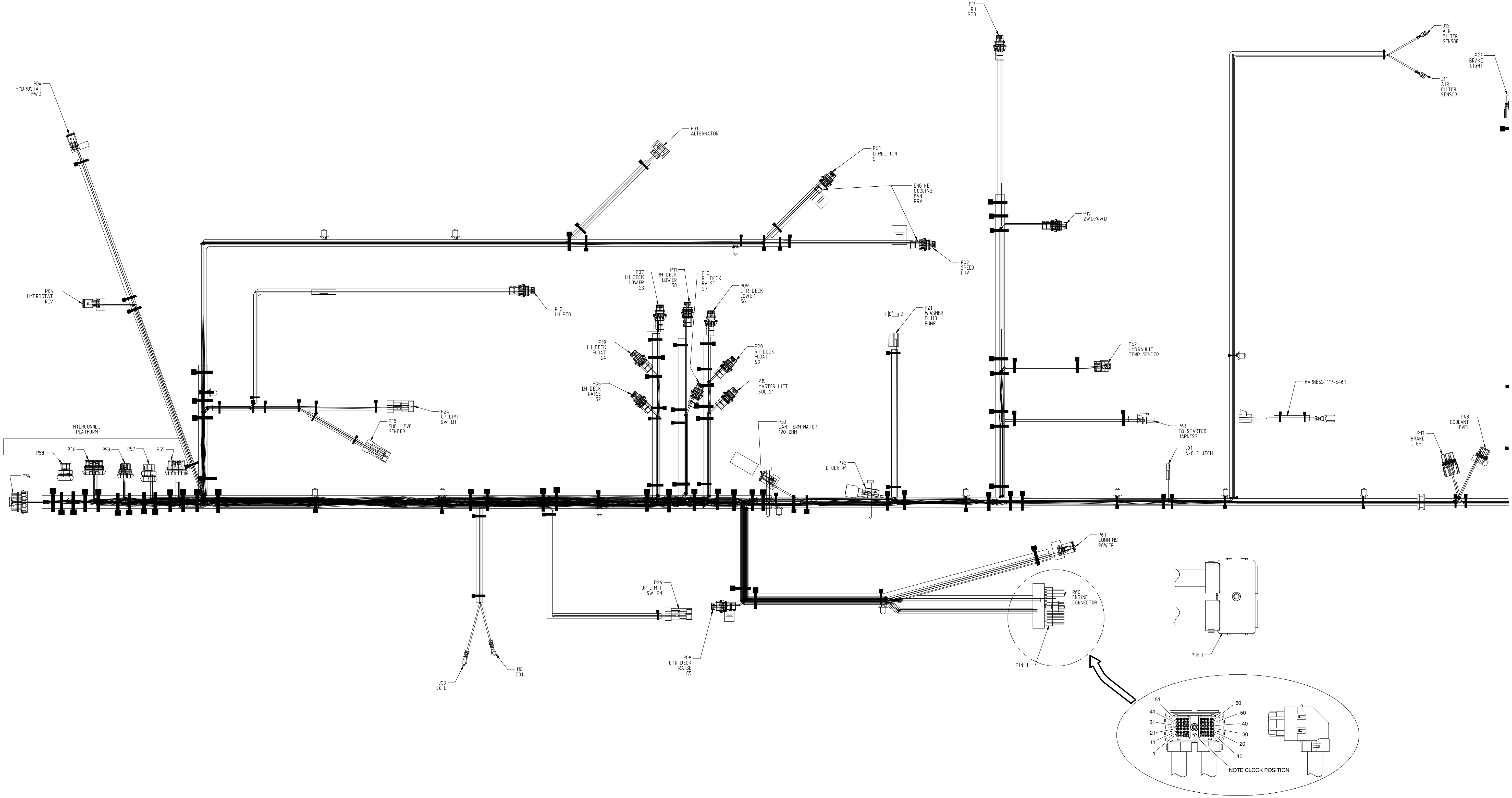
Groundsmaster 5900/5910

Rear Wire Harness Diagram

(Serial Number From 313000301 to 313999999)

g254572

Rear Wire Harness Drawing (Serial Number Above 314000000)

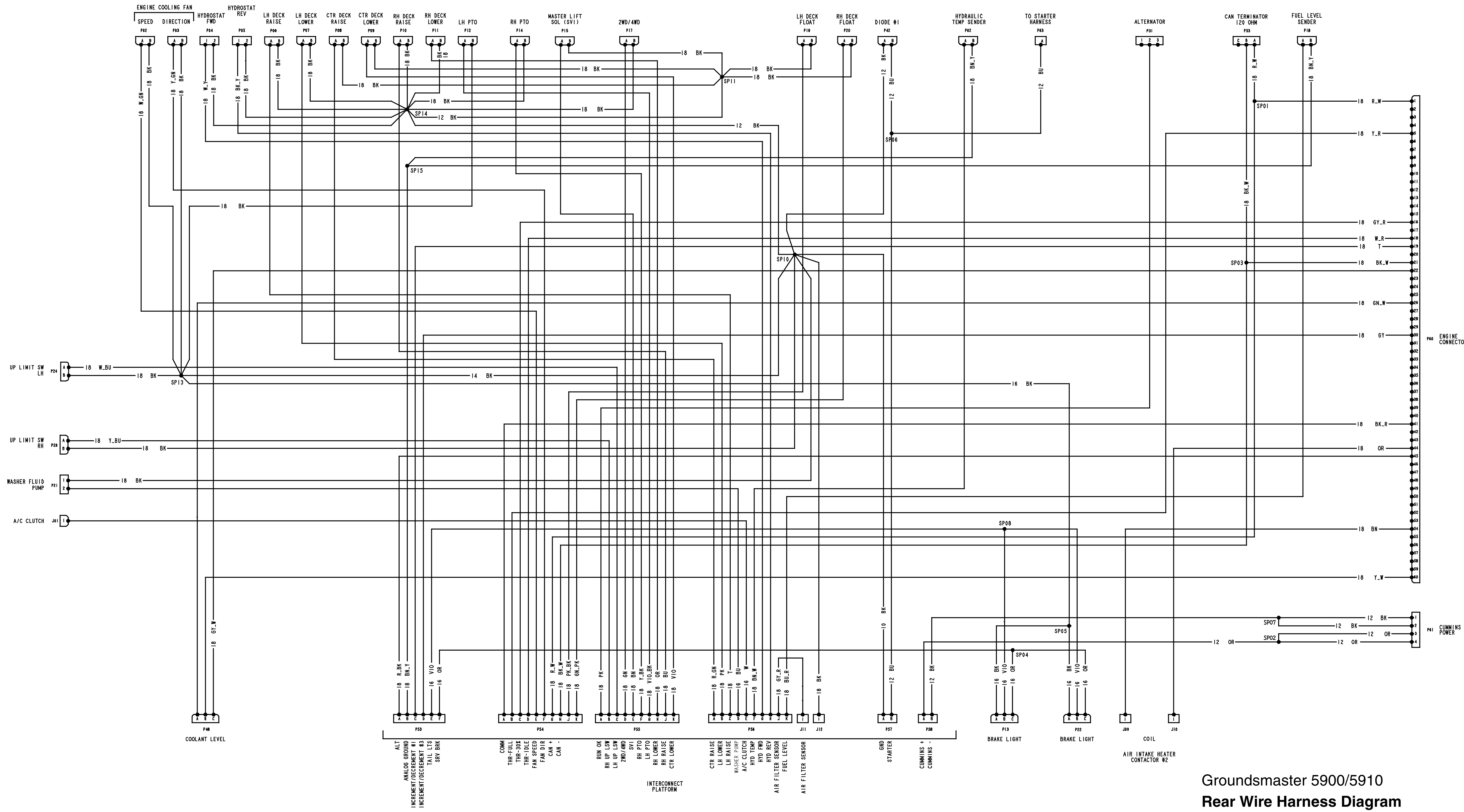


g254573

Groundsmaster 5900/5910

Rear Wire Harness Drawing

(Serial Number Above 314000000)



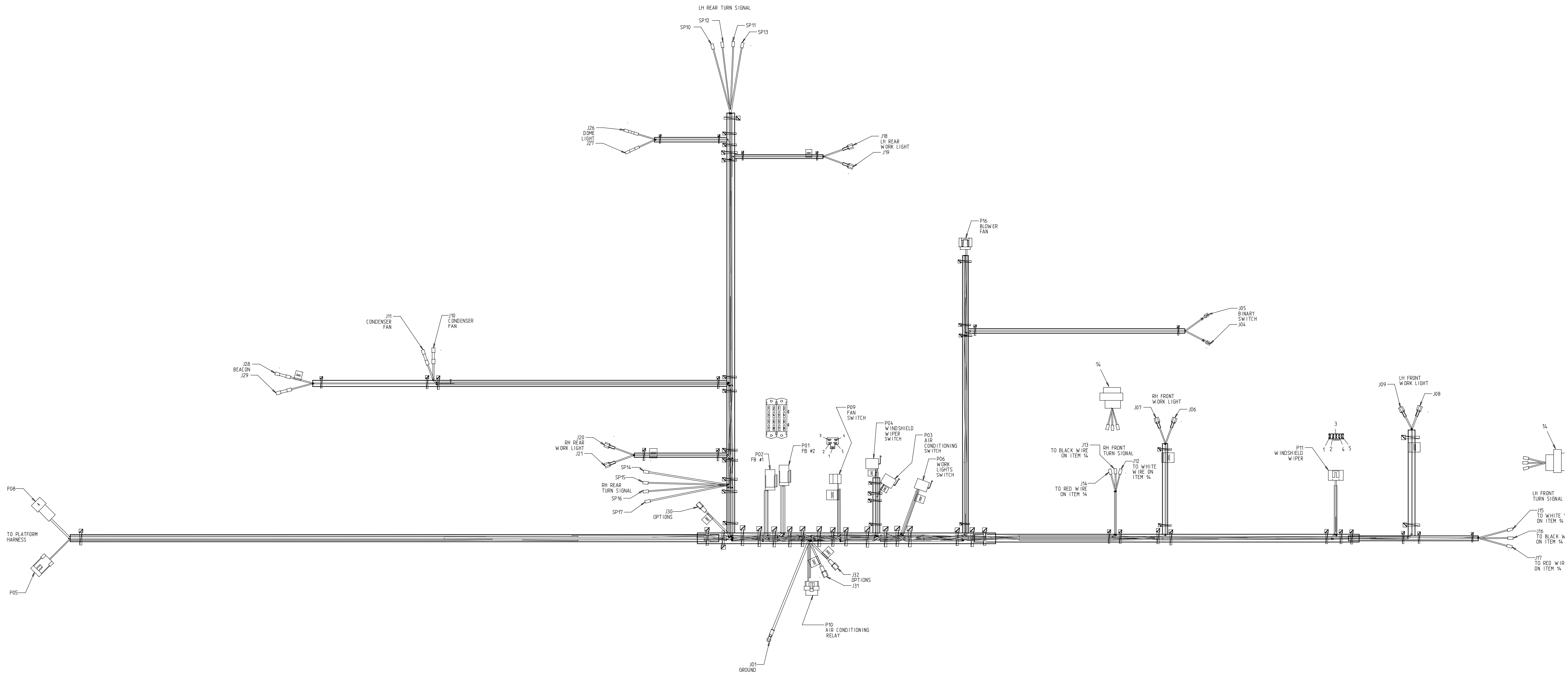
Groundsmaster 5900/5910

Rear Wire Harness Diagram

(Serial Number Above 314000000)

g254574

Cab Wire Harness Drawing (Serial Number Below 314999999)



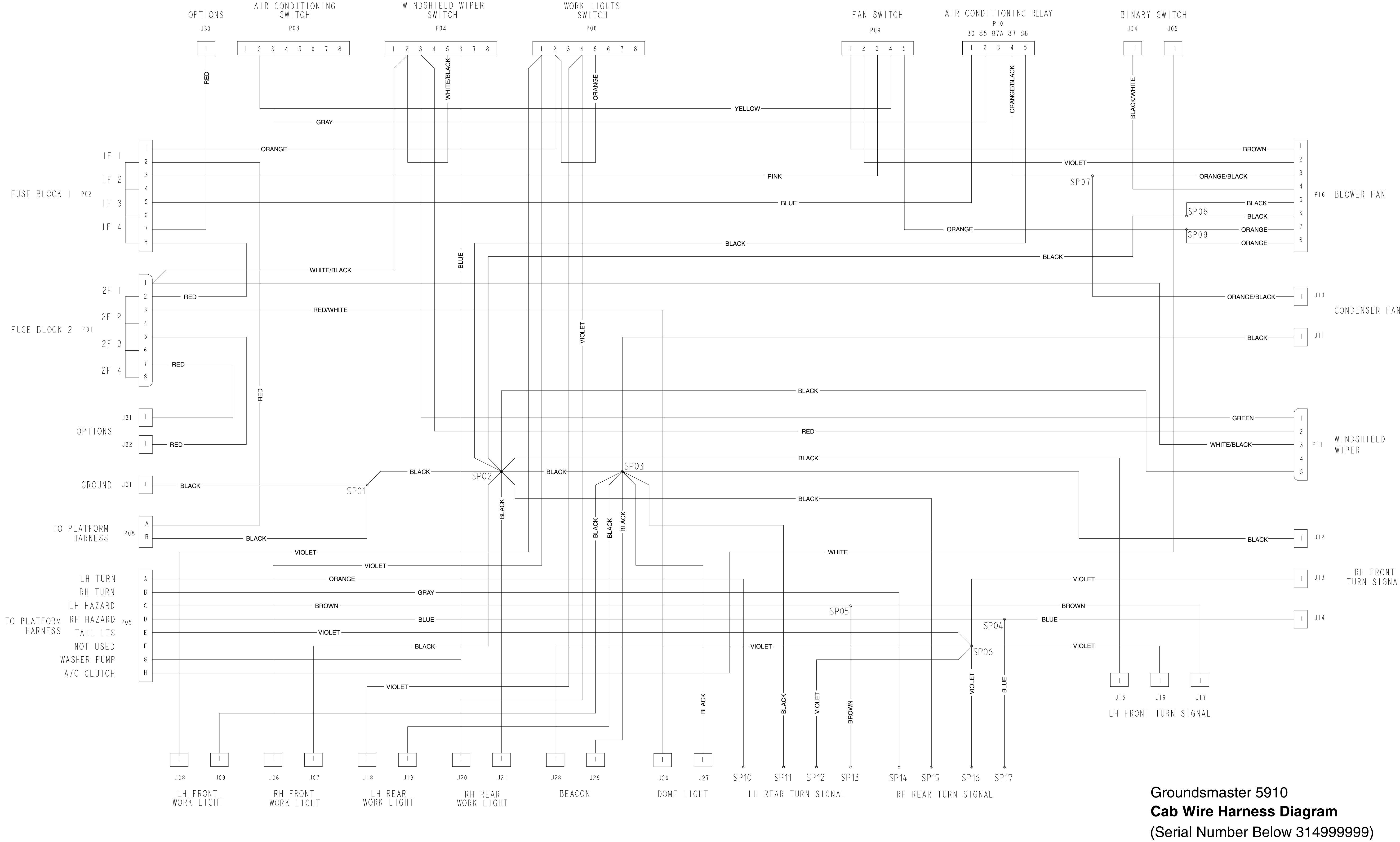
g254575

Groundsmaster 5910

Cab Wire Harness Drawing

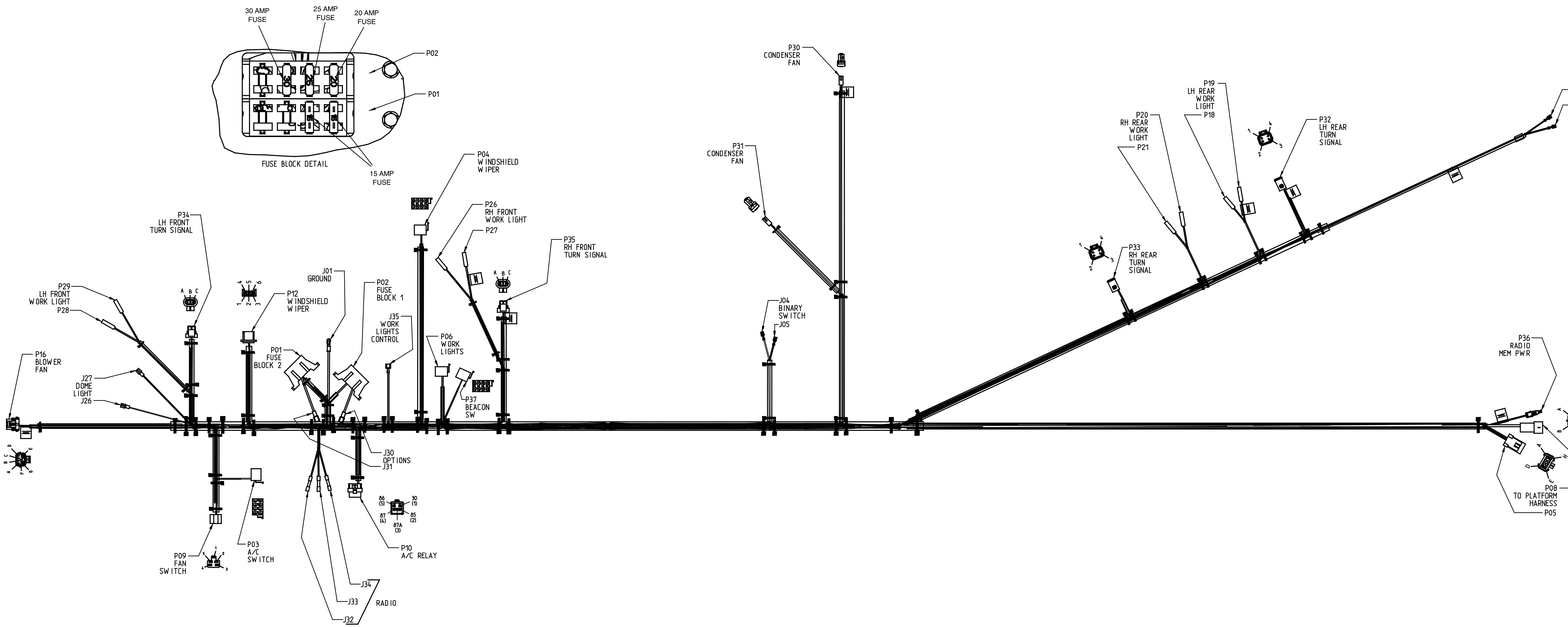
(Serial Number Below 314999999)

Cab Wire Harness Diagram (Serial Number Below 314999999)



Groundsmaster 5910
Cab Wire Harness Diagram
(Serial Number Below 314999999)

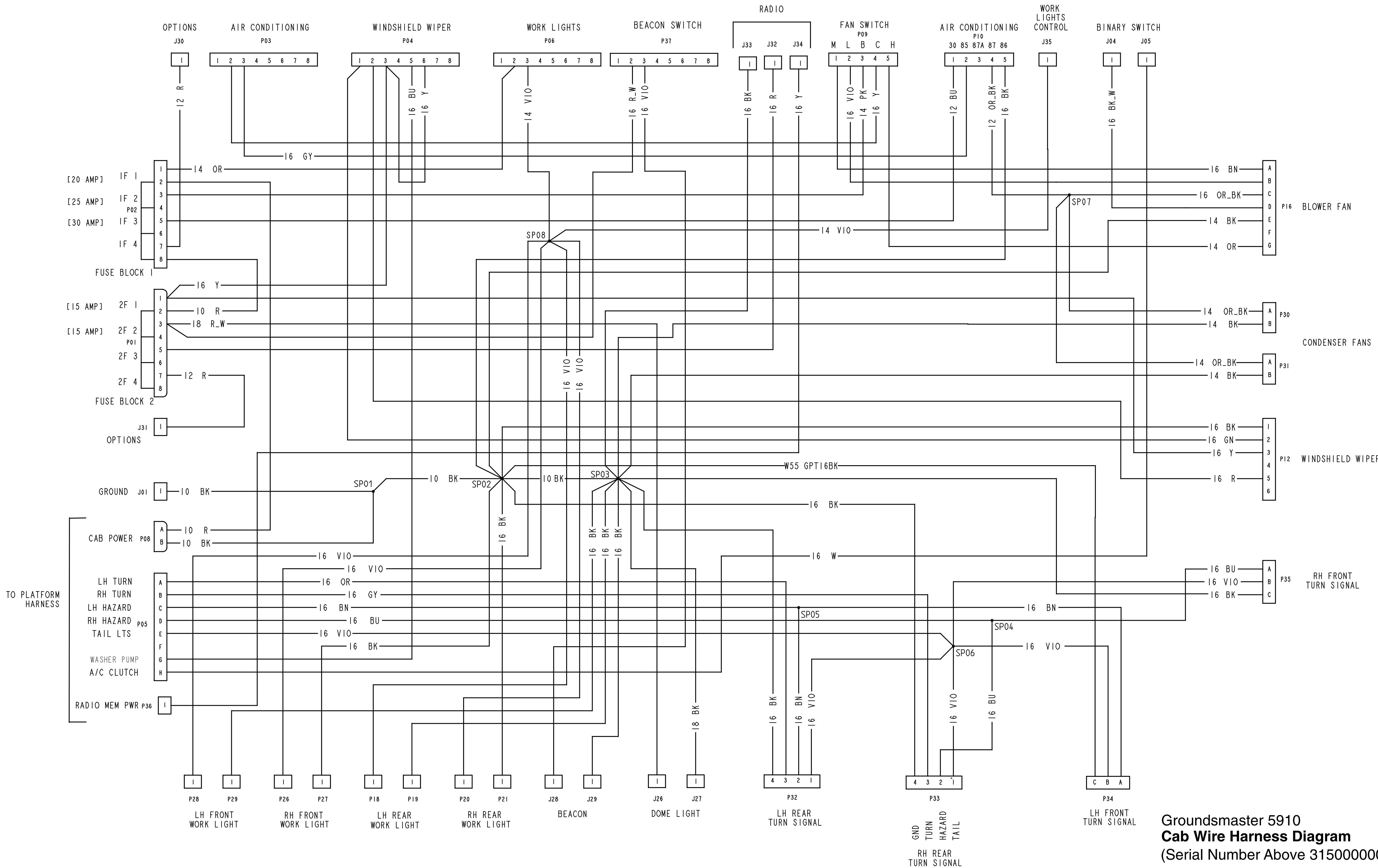
Cab Wire Harness Drawing (Serial Number Above 315000000)



Groundsmaster 5910
Cab Wire Harness Drawing
(Serial Number Above 315000000)

g254577

Cab Wire Harness Diagram (Serial Number Above 315000000)



Groundsmaster 5910
Cab Wire Harness Diagram
(Serial Number Above 315000000)

g254578

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Count on it.