CS7000™

Service Manual

Advance CS7000 Hybrid LPG, Model Number 56509000

Advance CS7000 Hybrid Diesel, Model Number 56509001

Advance CS7000 B, Model Number 56509002

Advance CS7000 Hybrid LPG EcoFlex™, Model Number 56509006

Advance CS7000 Hybrid Diesel EcoFlex™, Model Number 56509007

Advance CS7000 B EcoFlex™, Model Number 56509008

Nilfisk-Advance CS7000 Hybrid LPG EU, Model Number 56509003

Nilfisk-Advance CS7000 Hybrid Diesel EU, Model Number 56509004

Nilfisk-Advance CS7000 Battery EU, Model Number 56509005

Nilfisk Advance

English

05/11 Form No. 56043151

Contents

General Information

General Machine Description

The CS7000 machines are industrial automatic rider sweeper/scrubbers with multiple sweep/scrub single-pass coverage. Both battery (all electric) and hybrid (LPG and diesel) models are available with or without the EcoFlex™ and DustGuard™ options. The scrub system uses three disc scrub brushes with variable scrub pressure and solution flow rates. The sweep system has a center main broom and left- and right-hand side brooms.

Service Manual Purpose and Application

This Service Manual a technical resource designed to aid service personnel in maintaining and repairing the CS7000 Sweeper/Scrubber to ensure optimum performance and long service life. Please read it thoroughly before servicing your machine.

Other Reference Manuals and Information Sources

Nilfisk-Advance Publications

<table>
<tr><th>Model Name</th><th>Model Number</th><th>Instructions for Use Form Number</th><th>Parts List Form Number</th></tr>
<tr><td>Advance CS7000 Hybrid LPG</td><td>56509000</td><td rowspan="6">56041979: English, Spanish, French</td><td rowspan="6">56042540</td></tr>
<tr><td>Advance CS7000 Hybrid Diesel</td><td>56509001</td></tr>
<tr><td>Advance CS7000 B</td><td>56509002</td></tr>
<tr><td>Advance CS7000 Hybrid LPG EcoFlex™</td><td>56509006</td></tr>
<tr><td>Advance CS7000 Hybrid Diesel EcoFlex™</td><td>56509007</td></tr>
<tr><td>Advance CS7000 B EcoFlex™</td><td>56509008</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Nilfisk-Advance CS7000 Hybrid LPG EU</td><td>56509003</td><td rowspan="3">56041980: English, Turkish, Bulgarian, Romanian
56041981: Danish, Norwegian, Swedish, Finnish
56041982: German, French, Dutch, Russian
56041983: Spanish, Portuguese, Italian, Greek
56041984: Estonian, Latvian, Lithuanian, Slovenian
56041985: Slovakian, Czech, Polish, Hungarian</td><td rowspan="3">56042541</td></tr>
<tr><td>Nilfisk-Advance CS7000 Hybrid Diesel EU</td><td>56509004</td></tr>
<tr><td>Nilfisk-Advance CS7000 Battery EU</td><td>56509005</td></tr>
</table>

These manuals can be found on the following Nilfisk-Advance's electronic supported databases:

- Nilfisk-Advance Dealer Customer Zone
- Nilfisk-Advance website: www.Nilfisk-Advance-us.com
- EzParts service / parts CD-ROM

Engine Manufacturers' Technical Manuals

Engine Model	Publication Title
Diesel: D1305-E3B-KEA-1	Kubota WSM Workshop Manual, Diesel Engine, 05-E3B Series, 05-E3BG Series
LPG: WG972-GL-E3-NFK-1	Kubota WSM Workshop Manual, Gasoline, LPG Engine, WG752-G-E3, WG752-GL-E3, WG972-G-E3, WG972-GL-E3

Conventions

All references to right, left, front and rear in this manual are as seen from the Operator's seat position.

Parts and Service

Repairs should be performed by an Authorized Nilfisk-Advance Service Center that employs factory-trained service personnel and maintains an inventory of Nilfisk-Advance original replacement parts and accessories.

Call the Nilfisk-Advance Dealer named below for repair parts or service. Please specify the Model Number (same as the Part Number) and Serial Number when discussing your machine.

(Dealer, affix service sticker here.)

Nameplate

The Part (Model) Number and Serial Number of your machine are shown on the Nameplate located on the top of the machine frame, at the left rear side of the machine underneath the recovery tank. To access the Nameplate, tip the recovery tank out away from the machine.

This information is needed when ordering repair parts for the machine.

Cautions and Warning Symbols

Nilfisk-Advance uses the symbols below to signal potentially dangerous conditions. Read this information carefully and take the necessary steps to protect personnel and property.

DANGER

Danger! ***Is used to warn of immediate hazards that will cause severe personal injury or death.***

Warning! ***Is used to call attention to a situation that could cause severe personal injury.***

Caution! ***Is used to call attention to a situation that could cause minor personal injury or damage to the machine or other property.***

General Safety Instructions

Warning! ***Be sure to follow these safety precautions to avoid situations that could cause severe personal injury.***

- This machine should only be used by properly-trained and authorized persons.
- While on ramps or inclines, avoid sudden stops when loaded. Avoid abrupt sharp turns. Use low speed down hills. Clean only while ascending (driving up) the ramp.
- Keep sparks, flame and smoking materials away from batteries. Explosive gases are vented during normal operation.
- Charging the batteries produces highly-explosive hydrogen gas. Charge the batteries only in well-ventilated areas away from open flame. Do not smoke while charging the batteries.
- Remove all jewelry when working near electrical components.
- Turn the Key Switch off (O) and disconnect the batteries before servicing electrical components.
- Never work underneath a machine without safety blocks or stands to support the machine.
- Do not dispense flammable cleaning agents, operate the machine on or near these agents, or operate in areas where flammable liquids exist.
- To avoid hydraulic oil injection or injury, always wear appropriate clothing and eye protection when working with or near any hydraulic system.
- Do not operate this machine on ramps or inclines of more than a two-percent gradient.
- Only use the brushes provided with the machine or those specified in the instruction manual. The use of other brushes may impair safety.

Caution! **Do not pressure-wash the operator control panel, fuse panel, contactor panel or engine compartment area.**

Caution! ***Be sure to follow these safety precautions to avoid situations that could cause personal injury, damage to property or equipment damage.***

- This machine is not approved for use on public paths or roads.
- This machine is not suitable for picking up hazardous dust.
- Use care when using scarifier discs and grinding stones. Nilfisk-Advance will not be held responsible for any damage to floor surfaces caused by scarifiers or grinding stones.
- When operating this machine, make sure that bystanders, particularly children, are not endangered.
- Before performing any service function, carefully read all instructions pertaining to that function.
- Do not leave the machine unattended without first turning the Key Switch off (O), removing the key and securing the machine.
- Apply the parking brake before exiting the Operator's seat.
- Turn the Key Switch off (O) and remove the key before changing the brushes, and before opening any access panels.
- Take precautions to prevent hair, jewelry or loose clothing from becoming caught in moving parts.
- Use caution when moving this machine in below-freezing temperature conditions. Any water in the solution or recovery tanks, or in the hose lines could freeze, causing damage to valves and fittings. Flush with windshield washer fluid.
- The batteries must be removed from the machine before the machine is scrapped. Disposal of the batteries should be done safely and in accordance with your local environmental regulations.
- Do not use on surfaces having a gradient exceeding that marked on the machine.
- All doors and covers are to be positioned as indicated in the instruction manual before using the machine.
- Refer to the ***Electrical System*** section in this manual for additional specific battery charger warnings.

Hopper Prop Rod

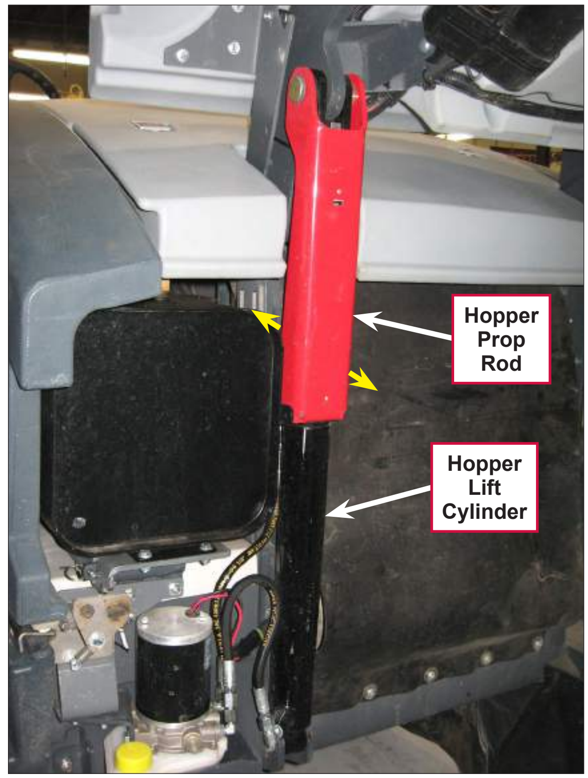
Warning! Never work underneath the raised hopper without the hopper prop rod engaged.

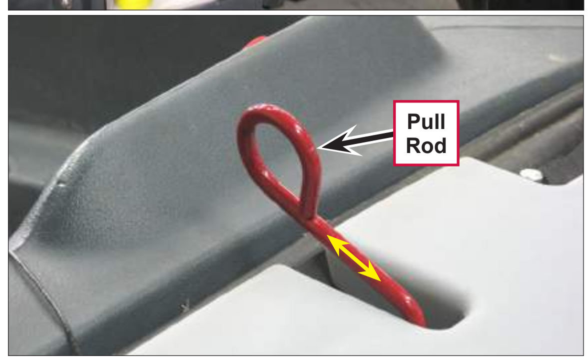
To Engage the Hopper Prop Rod

1. Press and hold the hopper raise button to raise the hopper all the way up.

2. Pull the **Pull Rod** to pivot the bottom of the **Hopper Prop Rod** toward the **Hopper Lift Cylinder** until it contacts the **Hopper Lift Cylinder**.

3. Press and hold the hopper lower button to lower the hopper until the **Hopper Prop Rod** contacts the top of the **Hopper Lift Cylinder**.





To Disengage the Hopper Prop Rod

1. Press and hold the hopper raise button to raise the hopper slightly so the **Hopper Prop Rod** lifts off of the **Hopper Lift Cylinder**.

2. Push the **Pull Rod** to pivot the bottom of the **Hopper Prop Rod** away from the **Hopper Lift Cylinder**.

3. Press and hold the hopper lower button to lower the hopper.

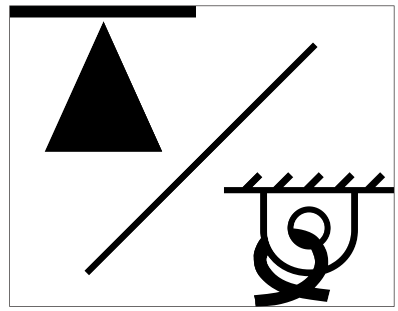
Jacking the Machine

Warning! ***Never work under a machine without safety stands or blocks to support the machine. When jacking the machine, do so at the designated Tie Down/Jacking Locations.***

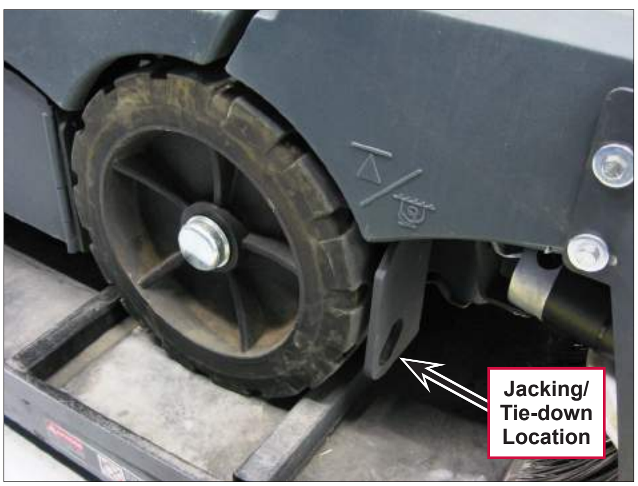
Transporting the Machine

Caution! ***Before transporting the machine on an open truck or trailer, make sure the machine is tied down securely and all access doors and covers are secured (tape and strap as needed).***

The jacking and tie-down locations are identified with a graphic molded into the exterior body panels.



The jacking and tie-down locations are in front of the front wheels, and at the rear of the machine below the solution tank.



Front Jacking/Tie-down Location


Rear Jacking/Tie-down Location

Towing the Machine

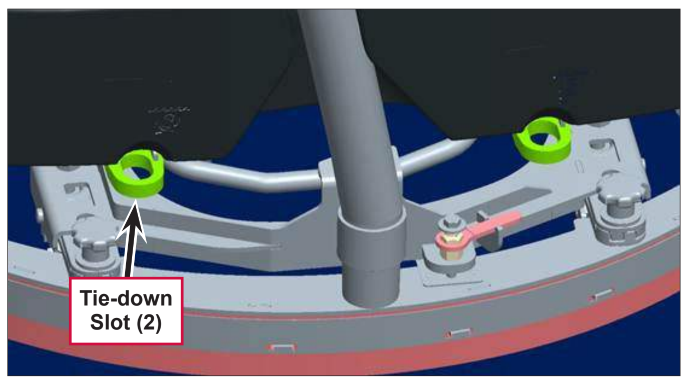
Caution! ***If the machine must be towed, move the machine for short distances only and do not move the machine faster than a normal walking pace (2-3 mph, 3-5 kph).***

Tow the machine backward from one of the rear frame tie-down locations as shown below. Do not push the machine due to the possibility of damage to the solution and recovery tanks.

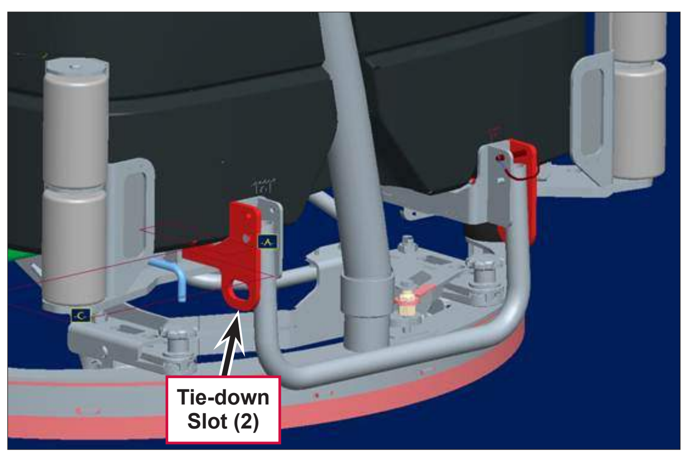
Do not tow the machine by the squeegee tool.

- To enter the "Push Mode", which allows steering while towing the machine, turn the Key Switch on while pressing and holding both the Speed Switch and the High Pressure Wand Switch.

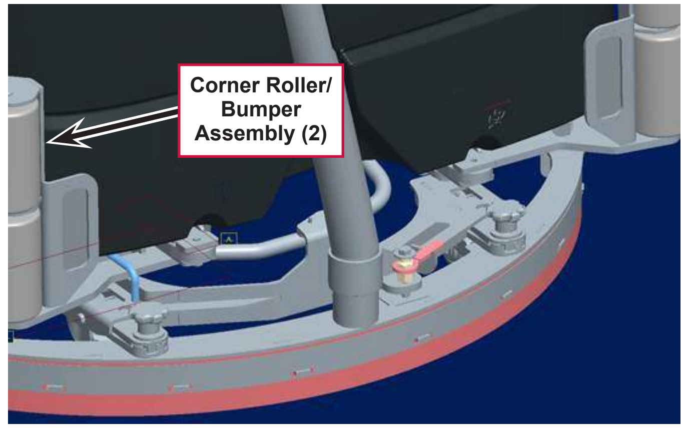
- On machines not equipped with a squeegee guard kit, tow the machine by one of the two **Tie-down Slots** on the chassis (shown in green).



- On machines equipped with a squeegee guard kit, tow the machine by the two **Tie-down Slots** on the squeegee guard (shown in red).



- On machines equipped with an "early" rear corner roller kit but no squeegee guard kit, it's recommended that you remove the left rear **Corner Roller/Bumper Assembly** in order to access a tie-down location for the tow hook. "Later" corner guard kits have been improved to allow use of the left **Tie-down Slot** for towing without removing the left corner roller/ bumper assembly.



Diagnostic and Service Tools

In addition to a full set of metric and standard tools, the following items are required in order to successfully and quickly perform troubleshooting and repair of Nilfisk-Advance Industrial floor cleaning equipment.

- Laptop computer loaded with current version of EzParts, Adobe Reader and (preferably cellular) internet access
- Digital volt ohmmeter (DVOM) with DC current clamp
- Hydrometer
- Battery load tester for checking 36V and 12V batteries.
- Automotive fuel pressure test gauge (used on diesel engines)
- Static control wrist strap
- Set of torque wrenches
- Hard (printed) copies of service manuals for regularly serviced machines (available at www.advance-us.com and other Nilfisk-Advance websites).

These tools are also available from Nilfisk-Advance, Inc.:

- Vacuum water lift gauge, p/n 56205281

Technical Specifications

General Specifications

Machine Dimensions	Length	103” [262 cm]					
	Width	With right side squeegee assembly pivoted under the machine – 48” [122 cm]					
		With squeegee – 53” [135 cm]					
	Height	Without overhead guard – 59” [150 cm]	With overhead guard (US) – 82” [208 cm]	With overhead guard (EU) – 79” [201 cm]	With debris hopper raised – 90” [229 cm]		
	Minimum Aisle Turnaround Width	Right turn – 102” [259 cm]					
		Left turn – 104” [264 cm]					
	Transport Ground Clearance	3” [7,6 cm] (side skirts on scrub deck)					
Machine Weight	Hybrid LPG	Dry Weight – 3400 lbs [1542 kg]	GVW (full solution and dust control tanks) – 4350 lbs. [1973 kg]				
	Hybrid Diesel	Dry Weight – 3313 lbs [1503 kg]	GVW (full solution and dust control tanks) – 4239 lbs. [1923 kg]				
	Battery Machine	Dry Weight – 4366 lbs [1980 kg]	GVW (full solution and dust control tanks) – 5400 lbs. [2449 kg]				
Maximum Tire Loading	Hybrid LPG (full solution and dust control tanks)	146 psi [10,26 kg/cm^2]					
	Hybrid Diesel (full solution and dust control tanks)	137 psi [9,63 kg/cm^2]					
	Battery Machine (full solution and dust control tanks)	148 psi [10,41 kg/cm^2]					
Battery Configuration	Hybrid LPG and Diesel	(3) 12-volt battery pack, (1) separate 12-volt engine starting battery					
	Battery Machine	US Battery	(1) 36-volt battery, 770 amp-hours, 6 hour rate, 5.4 hour run time				
		EU Battery	(1) 36-volt battery, 800 amp-hours, 5 hour rate, 5.4 hour run time				
Solution System	Solution Tank Capacity	75 gal. [284 L]					
	Recovery Tank Capacity	75 gal. [284 L]					
	Solution Pump	Precision-flow electric pump/solenoid valve					
	Flow Rates	One Light	Two Lights	Three Lights	Four Lights	Five Lights	
		1 gpm [3,79 L/min]	1.5 gpm [5,68 L/min]	2 gpm [7,57 L/min]	2.5 gpm [9,46 L/min]	3 gpm [11,36 L/min]	
Scrub System	Scrub Brushes	Disc (3), 17” [43 cm] dia.					
	Scrub Path	49” [124,5 cm]					
	Brush Motors	[3] 36 VDC, 1 HP, 2750 RPM, 26 Amp					
Dust Control/ DustGuard System	DustGuard Tank Capacity	29 gal. [110 L]					
	DustGuard Nozzle Flow Rate	Battery Machine	6.4 gph (size 100 nozzle)				
		LP and Diesel Machines	6.7 gph (size 100 nozzle)				
	Dust Control Motor	36 VDC, 7 Amps average, 8 Amps max.					
Sweep System	Main Broom	12.2” [31 cm] diameter x 35.4” [90 cm] long					
	Sweep Path	60.6” [154 cm]					
	Main Broom Motor	36 VDC, 1.14 HP, 3000 RPM, 20 Amps average,					
	Side Broom	15” [38,1 cm] diameter					
	Side Broom Motor	42 VDC, 2800 RPM (no load), .25 HP,					
	Hopper Weight Capacity	300 lbs [136 kg]					
	Hopper Volume Capacity	40 ft^3 [113 L]					
Vacuum System	Vacuum	Sealed	48” H_2O				
		With 1” dia. Orifice	25” to 30” H_2O				
	Vacuum Motor	42 VDC, 15 Amps average, 17 Amps max.					

Drive System	Steering	Rear wheel, "steer-by-wire" system. The steering controller receives input from the steering wheel to drive the steering actuator motor. The steering actuator motor drives a gear that meshes to a large ring gear that rotates the drive wheel assembly.	
	Brakes (service and parking)	Mechanical drum brakes, one on each front wheel, mechanically actuated	
Machine Performance	Machine Speeds	Transport speed – 5.5 mph [8.85 kph]	
		Scrubbing and sweeping speed – 3.5 mph [5.63 kph]	
	Gradeability (vehicle loaded to gross vehicle weight)	Transport – 10 degrees/17.6% slope	
		Cleaning – 10 degrees/ 17.6% slope	
	Brake Holding	18 degrees/32.5% grade	
	Tilt Stability	Empty Tanks – 24.0 degrees/44.5% grade	Full Tanks – 23.0 degrees/37.0% grade
	Approach/Trail Angles	Approach Angle – 7.5 degrees/13% grade)	Trail Angle – 20.9 degrees/38% grade)
	Maximum Machine Scrub Times	US Battery, 770 amp-hour, 6 hour rate – 5.4 hours run time	EU Battery, 800 amp-hour, 5 hour rate – 5.4 hours run time
	Fuel Consumption	Hybrid LPG – 5.5 hours	Hybrid Diesel – 15 hours (approximate)

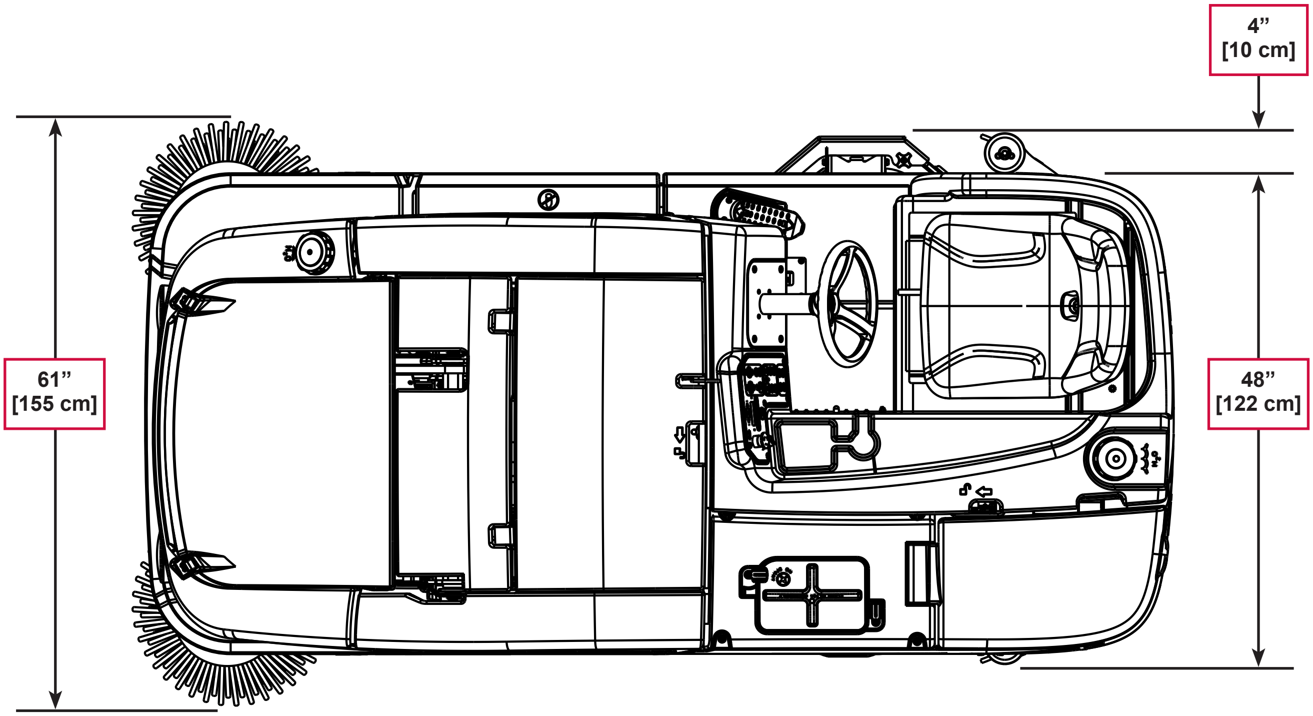
	Hybrid LPG	Hybrid Diesel	Battery Machine
Operator Sound Levels @ Operator's Ear	82 dBA	81 dBA	72 dBA
Sound Power	LwA 103	LwA 102	N/A
Hand/Arm Vibration Levels	0.33 m/s^2	0.35 m/s^2	0.36 m/s^2
Operator Seat Vibration Levels	0.03 m/s^2	0.03 m/s^2	0.02 m/s^2

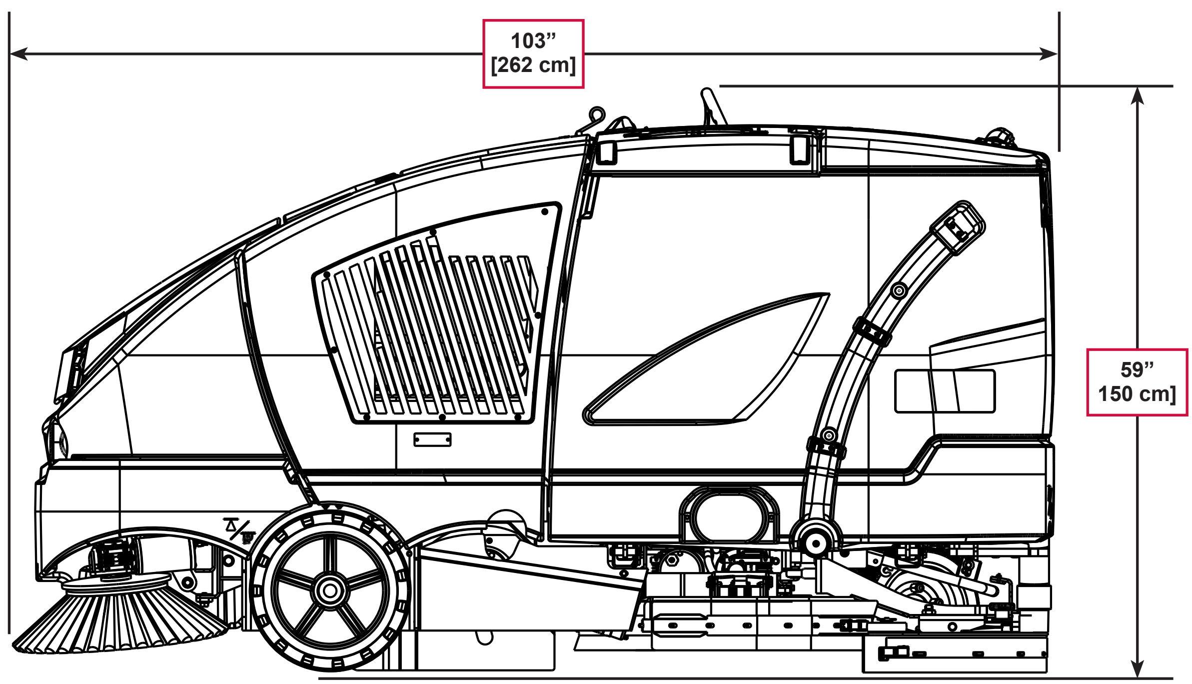
EcoFlex™ System	Refillable Cartridge Capacity	2.2 gal [8,32 L]
	Available Dilution Rates	300:1, 256:1, 200:1, 150:1, 128:1, 100:1, 64:1, 50:1, 32:1, and 26:1
	Low Detergent Warning	Standard

Fastener Torque Specifications

	Size	Plated Steel	Stainless Steel
Standard Torque Specifications (unless otherwise specified)	#10	42 in.-lb.	28 in.-lb.
	1/4"	100 in.-lb.	67 in.-lb.
	5/16"	17 ft.-lb.	11 ft.-lb.
	3/8"	31 ft.-lb.	20 ft.-lb.
	1/2"	75 ft.-lb.	50 ft.-lb.
	3/4"	270 ft.-lb.	180 ft.-lb.
	M5	61 in.-lb.	36 in.-lb.
	M6	9 ft.-lb.	62 in.-lb.
	M8	22 ft.-lb.	13 ft.-lb.
	M10	44 ft.-lb.	25 ft.-lb.
	M12	70 ft.-lb.	40 ft.-lb.

Overall Dimensions





Maintenance

Maintenance Schedule

Keep the machine in top condition by closely following the maintenance schedule. Maintenance intervals given are for average operating conditions. Machines used in severe environments may require service more often. In general:

- Keep the fuel tank filled (diesel). This helps to reduce condensation and moisture entering the fuel system.
- Be aware of the yellow Attention Indicator light, the red Warning Indicator light and the LCD Display on the Operator panel for icons and fault codes that indicate a critical or non-critical fault condition. Refer to the ***LCD Display Icons*** section for a listing and explanation of the LCD display icons and fault codes.
- Refer to the engine service manual for recommended engine service intervals and procedures.

Recommended Service Materials

- Engine Oil (refer to your engine manual)
- Manufacturer-recommended coolant (antifreeze) 50/50 mix (LPG and diesel models only)
- Lithium-base grease
- Loctite® (or equivalent) thread sealant in the appropriate grades
- Never-Seez® (or equivalent) anti-seize compound

Daily Maintenance

Caution! ***Do not pressure-wash the operator control panel, fuse panel, contactor panel or engine compartment area.***

Maintenance Item	Procedure
Perform “After Use” maintenance steps	“After use” maintenance is normally the responsibility of the machine Operator. Refer to the Instructions for Use.
Engine (LPG and diesel only)	Check the engine oil level.
	Check the engine coolant level in the reservoir.
	Check for engine and coolant leaks.
	Check the air cleaner service indicator and service the air filter when the indictor is shown red.
Recovery tank	Check that the drain hose cap is sealed.
	Drain and clean the inside of the tank; flush with clean water.
	Clean the squeegee; check the blades for damage/wear and deflection.
Scrub housing side skirts	Check for damage/wear.
Scrub brushes	Check for debris wrapped around the brushes/brooms and for damage/wear.
Main and side brooms	
Parking brake and foot pedal brake	Check for correct operation of brakes; adjust as needed.

Maintenance Every 15 to 20 Hours

Maintenance Item	Procedure
Battery/Batteries	Check the electrolyte level in the battery.
	Check the battery cables and connections.
Solution tank filter	Inspect and clean the debris filter on the solution filter system.
EcoFlex™ detergent system	Purge the detergent delivery lines.
Sweep brooms	Rotate the main broom.
	Inspect/adjust the main and side brooms.
	Inspect the side broom housing skirts.
DustGuard™	Clean the DustGuard™ system spray nozzles.
Dust hopper	Clean the hopper filter; inspect the hopper seals.

Monthly Maintenance

Maintenance Item	Procedure
Squeegee caster wheel axle and pivot	Pump a small amount of grease into each grease fitting on the machine until grease seeps out around the bearings.
Steering gears	Apply grease to lubricate.
Squeegee tool end wheels	Apply light machine oil to lubricate.
Engine/Battery compartment latch	
Recovery tank latch	
Brake Pedal (parking brake) linkage	

Maintenance Every 150 Hours

Maintenance Item	Procedure
Engine maintenance (LPG and diesel only)	Change the engine oil and oil filter. *Also review the engine manufacturer’s additional maintenance requirements.
Radiator and oil cooler (LPG and diesel only)	Inspect and clean the exterior core cooling fins.
LPG fuel system vaporizer/regulator – LPG engines only	Inspect and drain any oil buildup from the LPG fuel vaporizer/ regulator.

Maintenance Every 400 Hours

Maintenance Item	Procedure
Air intake housing and hoses (LPG and diesel only)	Inspect the complete air intake system for correct routing, kinks, restrictions, sound tight connections, holes and cracks in hoses.
Battery/Batteries	Check electrolyte level; check terminals for corrosion, loose connections.
Fuel Filter (diesel only)	Replace fuel filter cartridge (located before injector pump).

Maintenance Every 800 to 1000 Hours

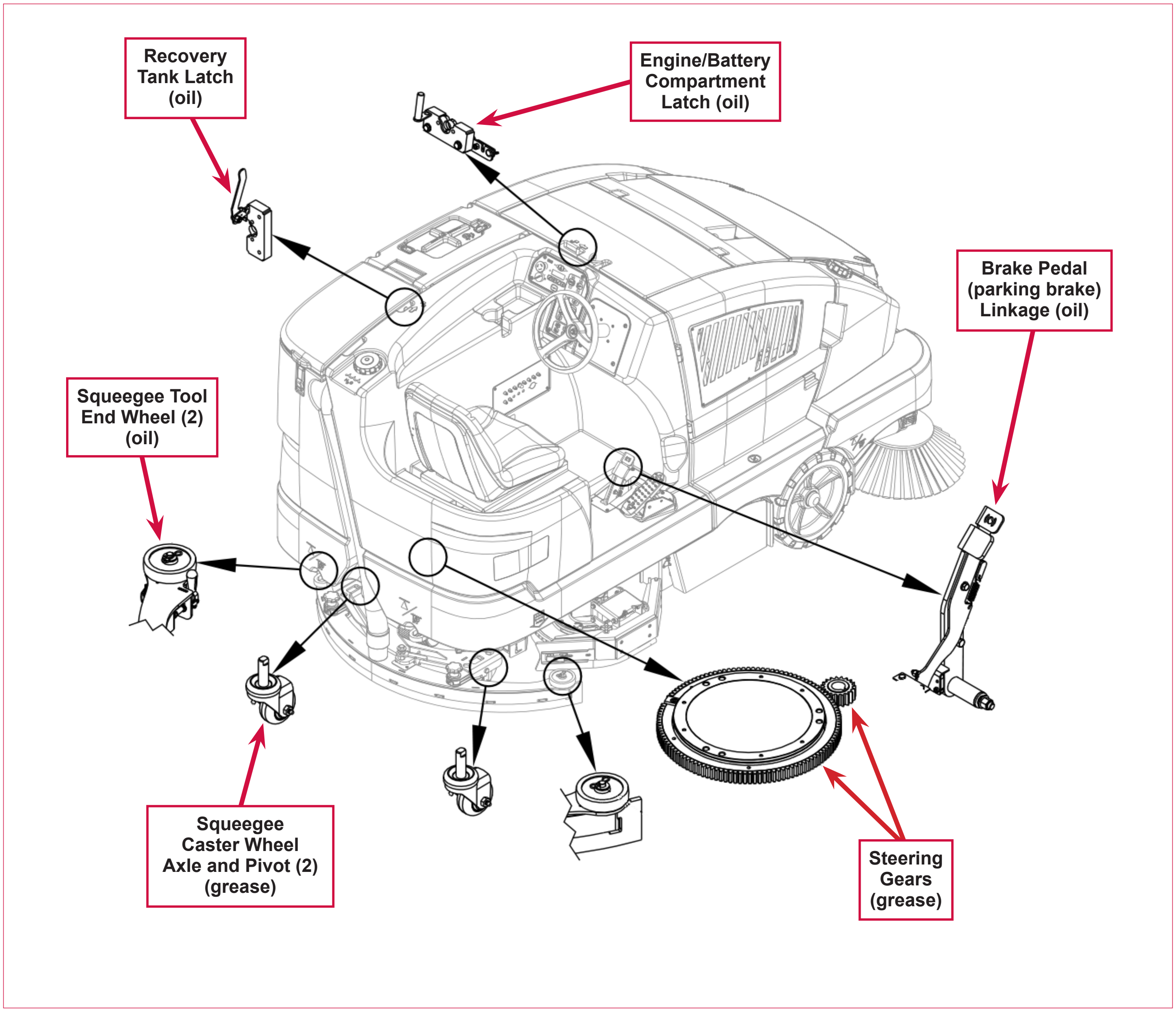
Maintenance Item	Procedure
Engine maintenance (LPG only)	Change the spark plugs.
Radiator	Flush and refill radiator with 50/50 mix of water and antifreeze.
42-volt alternator drive belt	Replace the drive belt.

Maintenance Every 2000 Hours

Maintenance Item	Procedure
Engine maintenance (LPG and diesel only)	* Review the engine manufacturer's additional maintenance requirements.

***Note:** *The engine maintenance schedule shown lists the recommended engine service intervals. Refer to the* **Other Reference Manuals and Information Sources / Engine Manufacturers' Technical Manuals** *section for list of available engine manufacturers' service manuals. Refer to these manuals for more complete maintenance and service information and instructions.*

Lubrication Points



EcoFlex System Maintenance

You will need to purge the system of the previous detergent when switching to a different detergent.

Service Note: *Move the machine over a floor drain before purging because a small amount of detergent will be dispensed in the process.*

To Purge When Changing Detergents (the scrub system must be off)

1. Disconnect and remove the detergent bottles.
2. Turn the key switch on and wait a few seconds for the start-up sequence to finish.
3. Press and hold the detergent switch for approximately two seconds.
4. Release the switch when the detergent purge icon appears on the display and the detergent indicator starts flashing.

Note: *Once activated, the purge process takes at least 10 seconds. Normally one purge cycle is adequate to purge the system.*

To Purge Weekly (the scrub system must be off)

1. Disconnect and remove the detergent bottles.
2. Install and connect bottles filled with clean hot water.
3. Turn the key switch on and wait a few seconds for the start-up sequence to finish.
4. Press and hold the detergent switch for approximately two seconds.
5. Release the switch when the detergent purge icon appears on the display and the detergent indicator starts flashing.

Note: *Once activated, the purge process takes at least 10 seconds. Normally one purge cycle is adequate to purge the system..*

To Change the Detergent Mix Ratio (the scrub system must be on)

1. Press and hold the detergent switch for two seconds.
2. Release the switch once the detergent indicator begins flashing.
3. While the light is flashing, press and release the detergent switch to select the next detergent mixture ratio. Once the desired ratio is selected, the detergent system will return to normal operation within three seconds.

Note: *The detergent mixture will be displayed for approximately 10 seconds each time the scrub mode changes, or each time the detergent switch is pressed. Once set, the detergent flow rate automatically increases and decreases with the solution flow rate, but the detergent mix ratio will remain the same. If an Operator would prefer the flexibility of setting different detergent dilution ratios for different solution flow rates, this specific programming option can be found in the* **Control System** *section.*

Note: *During scrubbing, the detergent system can be turned off at any time by pressing the detergent switch to allow scrubbing with water only. No detergent is dispensed until the scrub system is activated and the drive pedal is pushed forward.*

Service Tip: *Follow the* **To Purge Weekly** *instructions above if the machine is going to be stored for an extended period of time, or if you plan to discontinue use of the detergent system.*

Nilfisk-Advance CS7000

PM Checklist

Customer ______________________

Address ______________________

City ______________ St ______ Zip ______________

Model # ______________ Serial # ______________ Hours ______________

Defect Codes
A needs adjustment
B binding
C dirty or contaminated
D damaged, bent or torn
L leaks
M missing
W worn out

Ref	Operational Inspection Items	OK	Defect Codes (circle)	Does Not Work
1	Engine idle speed. LP - 1700 RPM; diesel - 1700 RPM		A rough	
2	Engine run speed. LP - 2500 RPM; diesel - 2200 RPM		A low power	
3	Engine maximum power speed. LP - 2700 RPM; diesel - 2400 RPM		A low power	
4	Drive pedal operation (check for forward/reverse drive and any neutral creep)		A B	
5	Drive system performance (max forward transport speed 5.5 mph)		noisy sluggish	
6	Brakes (check both service and parking)		A B W	
7	Steering		not functioning	
8	Main broom raise/lower		B D	
9	Main broom on/off		B D	
10	Side sweep brooms raise/lower		A B	
11	Side sweep brooms on/off		B L	
12	DustGuard™ (water nozzles) on/off		A C L	
13	Dust control filter		C D	
14	Scrub system (raise/lower and auto scrubbing functions)		<----->	
15	Scrub brushes on/off (will drift)		<----->	
16	Scrub brush (pressure settings 1, 2 and3)		A B	
17	Solution control (on/off and five flow settings)		C D	
18	Test and purge the EcoFlex™ detergent system (if so equipped)		C L W	
19	Squeegee system (raise/lower and auto lift in reverse)		<----->	
20	Vacuum performance - 48" of H_2O sealed; 25” to 30” of H_2O with 1” diameter orifice		C L	
21	Headlights, gauges and (optional) accessories rotating beacon, backup alarm		<----->	
22	Tilt steering mechanism and seat adjustment lever		<----->	

Ref	Visual Inspection Items	Comments	OK	Defect Codes (circle)	Does Not Work
23	Main broom bristles	min. bristle length 2” [5 cm]		A B D W	
24	Main broom motor			B D	
25	Side sweep broom bristles	min. bristle length 3” [7,63 cm]		A B D W	
26	Side broom motors			B D	
27	Scrub brush motors			B D	
28	Main scrub brushes, check for wear and rotate			D W	

Ref	Visual Inspection Items	Comments	OK	Defect Codes (circle)	Does Not Work
29	Scrub deck housing and door skirts			C D W	
30	Solution system pumps and solenoid valves	as many as six pumps		C L W	
31	Solution tank, delivery hoses and filter	clean filter screen		C L M	
32	Dust control system impeller motor			C L D	
33	Recovery tank screen and float	clean screen		B C	
34	Recovery tank debris basket	clean		C	
35	Recovery tank cover gasket			D L W	
36	Recovery tank drain hose and cap			C D L M	
37	Squeegee pick-up hose	back flush		C L	
38	Squeegee tool and blades	clean and rotate		C D W	
39	Squeegee casters, adjustment knob and linkage	grease		C W	
40	Battery/Batteries	clean and water		C	
41	Engine, oil level, hoses and belts (LP and diesel only)			C D L	
42	Engine air cleaner inner and outer elements (LP and diesel only)	check service indicator		C L	
43	Engine coolant level (LP and diesel only)	fill at reservoir		C L	
44	Radiator and oil cooler core blockage (LP and diesel only)	clean		C D L	
45	Fuel tank, filter and lines (diesel only)			C L W	
46	LP tank, hoses and fittings (LP only)			L W	
47	LP fuel filter	service life 1500 hrs.		C	
48	LP fuel regulator, lock off valve and hoses			L	
49	Diesel glow plug function light	hard starting		<----->	
50	Diesel fuel tank strainer	yearly		C	
51	Brake linkage and parking brake pedal			A B	
52	Circuit breaker panel			D M W	
53	Front tires (check lug nut torque 100 ft-lbs., 135 Nm)			A	
54	Rear drive wheel motor, steering system	grease pinion gear		D L W	
55	Front and rear tires	tread wear		C W	
56	Debris hopper	clean		C	
57	Recovery hose and pick-up screen	back flush/clean		C	
58	DustGuard™ spray nozzles and strainers	clean		C L W	

Note: *For additional service information, see the CS7000 Service Manual, form number 56043151, and the Instructions For Use for your machine model.*

Work Completed By:

Acknowledged By:

Service Technician Signature ____________ **Date** ____________

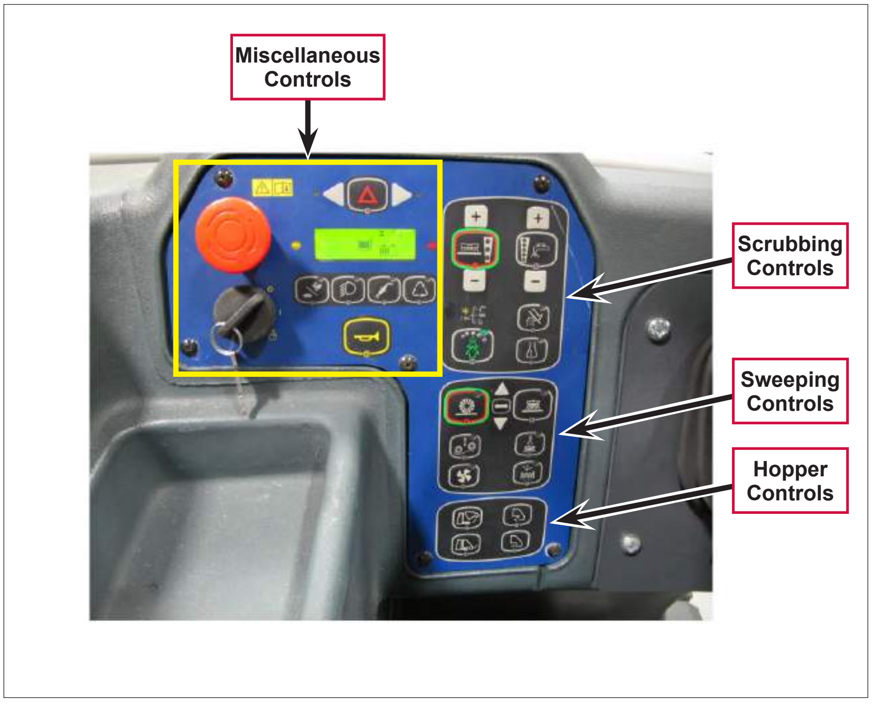
Customer Signature ____________ **Date** ____________

Machine Controls

Control Panel - General Layout

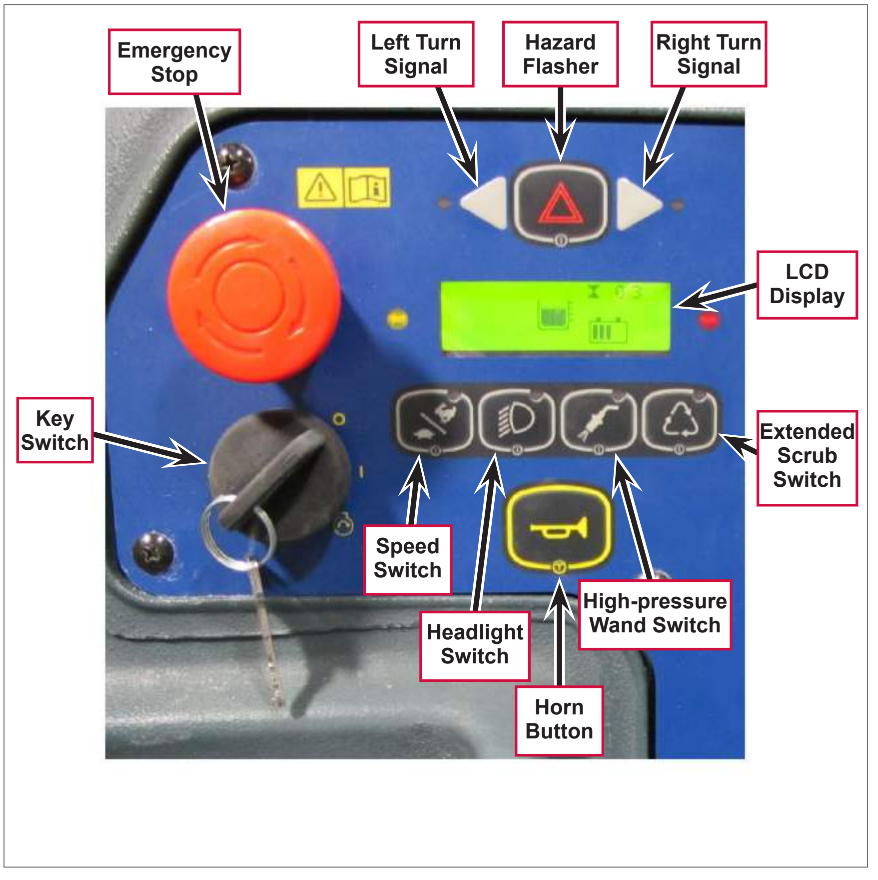
The CS7000 control panel is organized by machine function with the scrub, sweep and hopper functions conveniently grouped together. Miscellaneous controls such as the key switch, emergency-stop switch, speed control, light switch, high-pressure wand switch, extended scrub system switch and horn button are located in front of the Operator.

Note: *The switches with a "I" below them are press-and-release switches. The buttons noted with an "T" below them are momentary buttons.*



Miscellaneous Controls

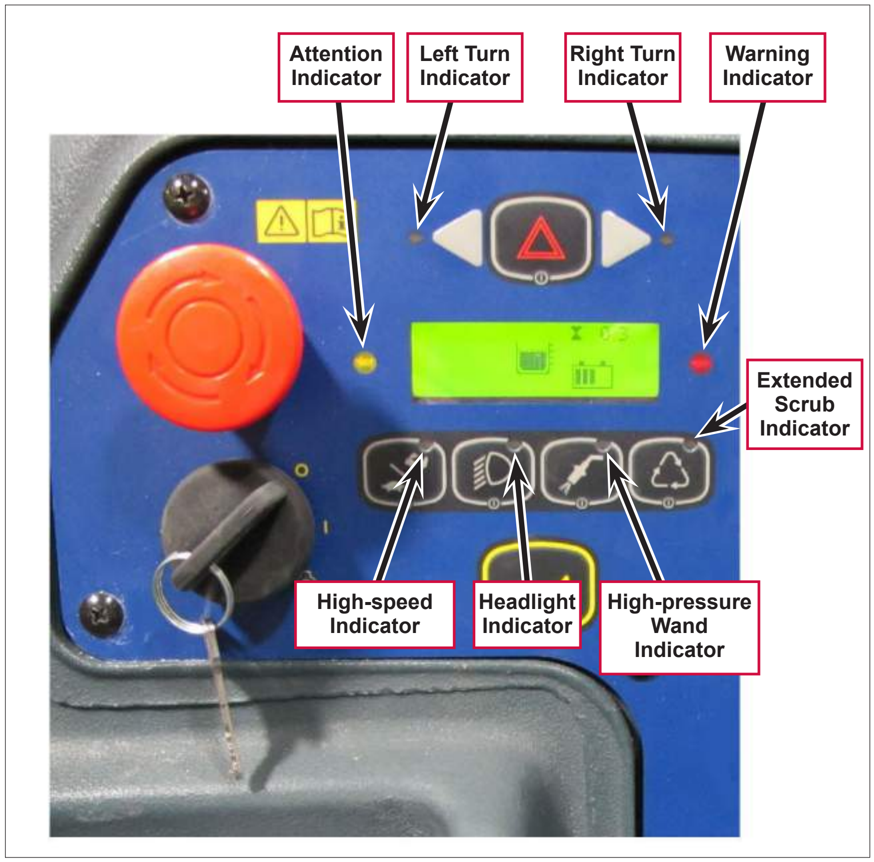
- **Emergency Stop** – maintained palm switch; removes off all power to the machine functions when pressed. To reset the **Emergency Stop** switch, rotate the red knob clockwise.
- **Left** and **Right Turn Signal** – switch on the corresponding turn signal.
- **Hazard Flasher** – (optional) switches on the four-way hazard flashers.
- **Key Switch** – main power/ ignition switch.
- **LCD Display** – displays the various machine status icons and informational displays.



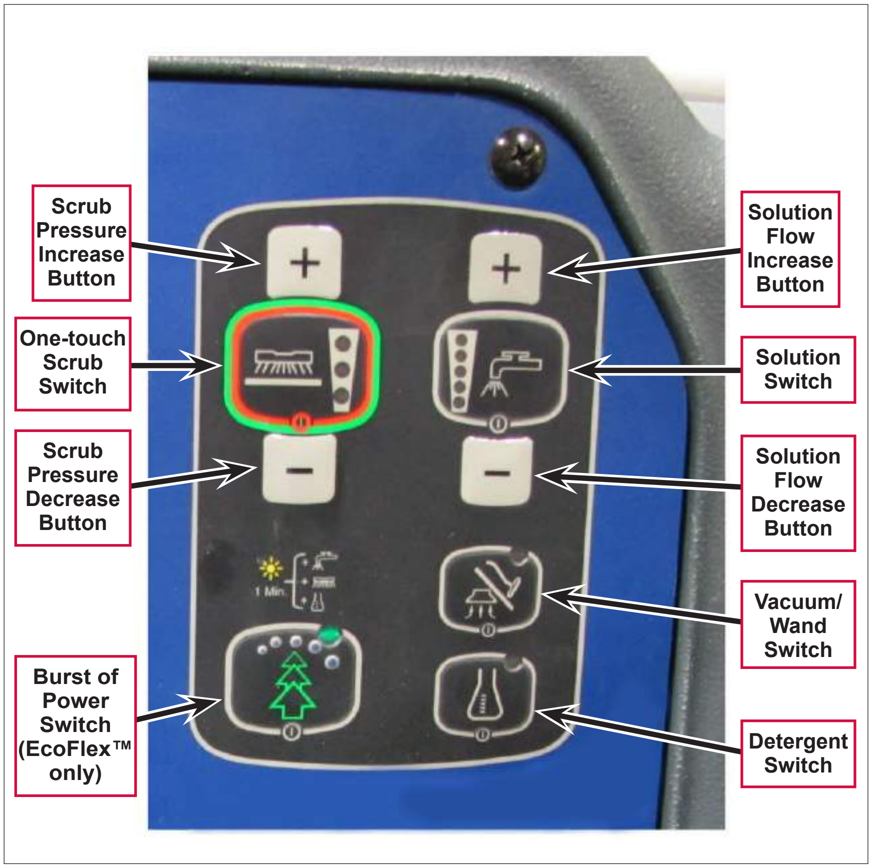
- **Speed Switch** – functions as follows:
  - LPG and diesel machines – increments the engine speed up and down through the three speed ranges. Note that the engine speed will increase automatically when certain machine functions are engaged.
  - Battery machines – increases the machine scrub speed to the full transport speed.
- **Headlight Switch** – switches on the headlights.
- **Horn Button** – sounds the horn when pressed.
- **High-pressure Wand Switch** – engages the high-pressure spray wand solution pump (LPG and diesel only).
- **Extended Scrub Switch** – enables the optional extended scrub (recycle) function.

Miscellaneous Indicators

- **Attention Indicator** – lights to alert the Operator of a machine condition requiring attention.
- **Left** and **Right Turn Indicators** – indicates that the corresponding turn signal is flashing.
- **Warning Indicator** – lights to alert the Operator of a warning or fault condition.
- **Extended Scrub Indicator** – lights to indicate that the extended scrub function is enabled.
- **High-speed Indicator** – lights to indicate that the engine is running at high speed.
- **Headlight Indicator** – lights to indicate that the headlights are on.
- **High-pressured Wand Indicator** – lights to indicate that the wand high-pressure pump is engaged.



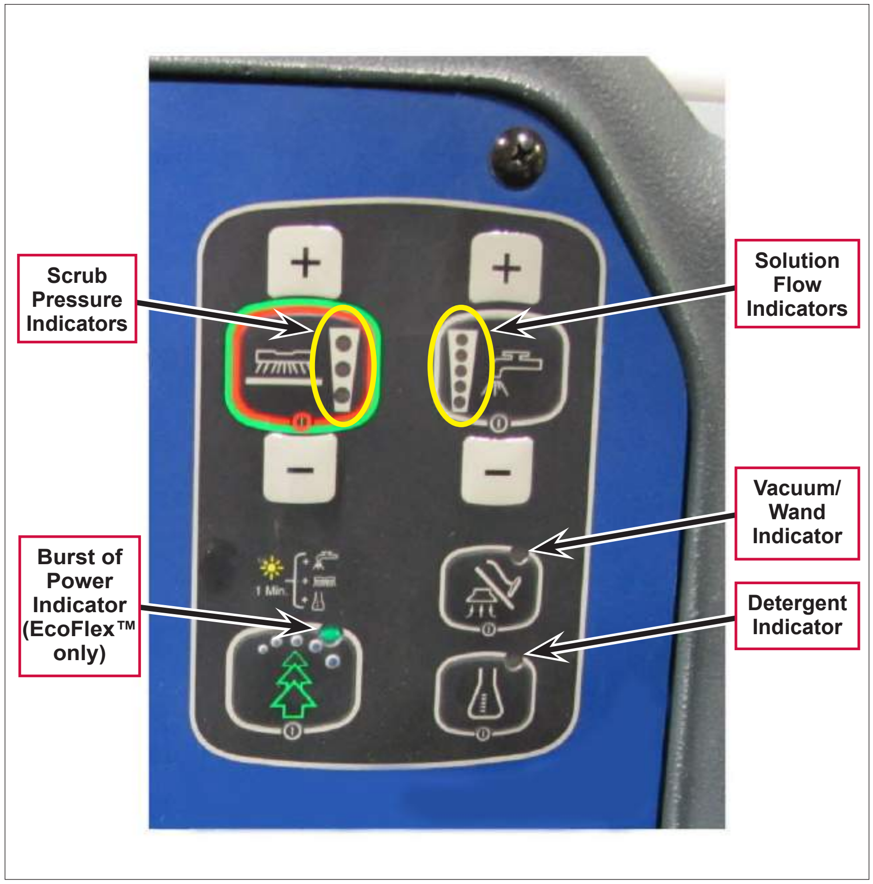
Scrub Controls



- **Scrub Pressure Increase Button** – increases the scrub pressure one level when pressed. Note that the scrub pressure LED indicators in the **One Touch Scrub Switch** will light to indicate the selected scrub pressure.
- **One Touch Scrub Switch** – enables the scrub, solution and recovery systems, and the EcoFlex™ system (if the machine is so equipped). Note that the scrub brush pressure and solution flow will be at their lowest levels. The scrub brushes will run, the solution will flow and the squeegee vacuum will turn on when the machine begins moving forward.
- **Scrub Pressure Decrease Button** – decreases the scrub pressure one level when pressed.
- **Burst Of Power Switch** – increases both the scrub brush pressure and solution flow one step higher for 60 seconds.
- **Solution Flow Increase Button** – increases the solution flow rate one level when pressed. Note that the solution flow LED indicators in the **Solution Switch** will light to indicate the selected solution flow rate.
- **Solution Switch** – enables and disables the solution system.
- **Solution Flow Decrease Button** – decreases the solution flow rate one level when pressed.
- **Vacuum/Wand Switch** – enables and disables on the vacuum system.
- **Detergent Switch** – enables and disables the detergent system (on models so equipped).

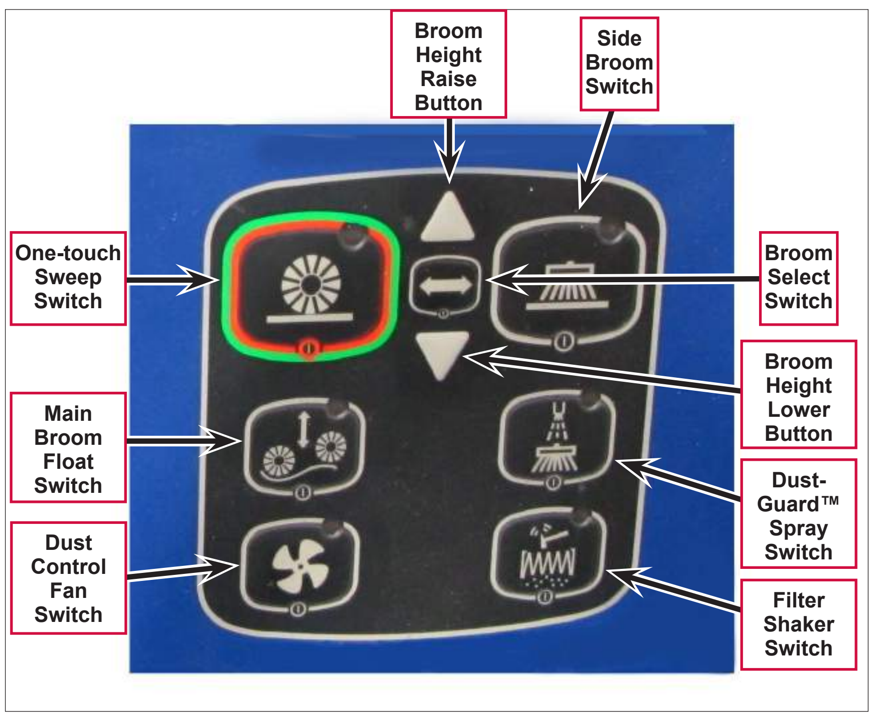
Scrub Indicators

- **Scrub Pressure Indicators** – indicate the scrub pressure setting. One LED indicates the lightest scrub pressure and three LEDs indicates the heaviest scrub pressure.
- **Burst of Power Indicator** – lights during normal operation; flashes to indicate a 60-second burst of power.
- **Solution Flow Indicators** – indicate the solution flow setting. One LED indicates the lowest solution flow and five LEDs indicate the highest solution flow.
- **Vacuum/Wand Indicator** – indicates that the vacuum system is enabled.
- **Detergent Indicator** – indicates that the detergent system is enabled.



Sweep Controls

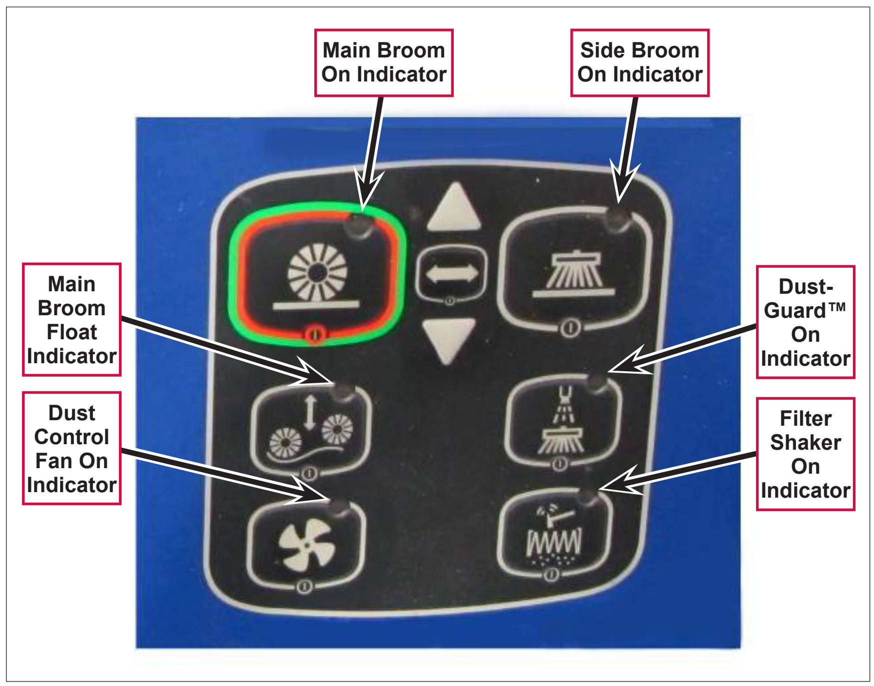
- **Broom Height Raise/Lower Buttons** – raise and lower the selected broom from its current position.
- **Side Broom Switch** – enables and disables the side brooms. Note that if you switch off the side brooms, the DustGuard™ spray nozzles will also switch off.
- **One-touch Sweep Switch** – enables the main broom, side brooms, dust control fan and DustGuard™ spray nozzles.
- **Main Broom Float Switch** – directs the main machine controller to drive the main broom actuator all the way down so the weight of the main broom is resting on the floor. The linkage is slotted to allow the broom to follow the contour of the floor.



- **Dust Control Fan Switch** – enables and disables the dust control fan.
- **Broom Select Switch** – functions as follows:
  - When the one-touch sweep is enabled, the **Broom Select Switch** selects the broom (main broom or side brooms) that will be raised or lowered when the **Broom Height Raise Button** and **Broom Height Lower Button** are pressed.
  - When the one-touch sweep is not enabled, pressing the **Broom Select Switch** once will lower the side brooms, switch on the side broom motors for a short time, then raise the side brooms. Pressing the **Broom Select Switch** twice will lower the main broom, switch on the main broom motor for a short time, then raise the main broom.
- **DustGuard™ Spray Switch** – enables and disables the DustGuard™ spray nozzles.
- **Filter Shaker Switch** – switches on the filter shaker. The shaker will cycle 16 times, then switch off.

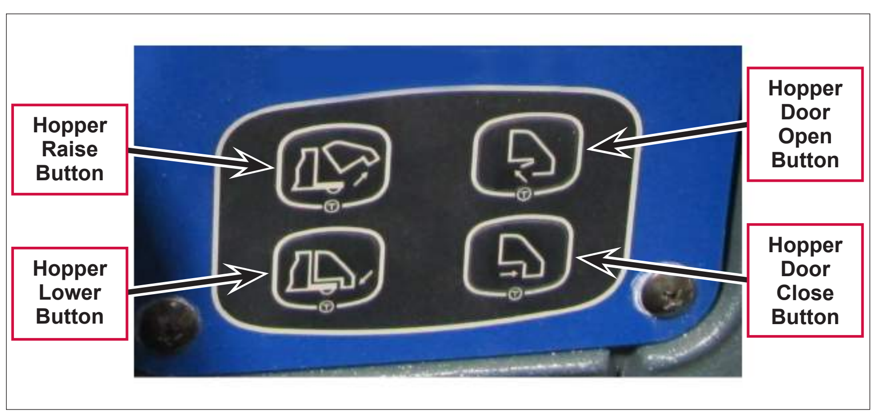
Sweep Indicators

- **Main Broom On Indicator** – indicates that the main broom is enabled.
- **Side Broom On Indicator** – indicates that the side brooms are enabled.
- **Main Broom Float Indicator** – indicates that the main broom is set to the “float” mode.
- **Dust Control Fan On Indicator** – indicates that the dust control fan is enabled.
- **DustGuard™ On Indicator** – indicates that the DustGuard™ system is enabled.
- **Filter Shaker On Indicator** – indicates that the filter shaker motor is running.



Hopper Controls

- **Hopper Raise Button** – raises the hopper.
- **Hopper Lower Button** – lowers the hopper.
- **Hopper Door Open Button** – opens the hopper door.
- **Hopper Door Close Button** – closes the hopper door.

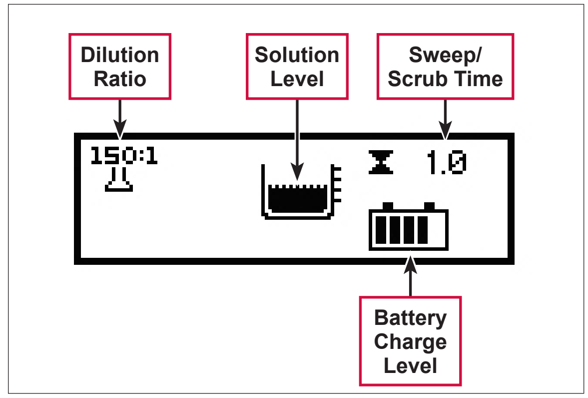


LCD Displays

General Displays

Battery Machine

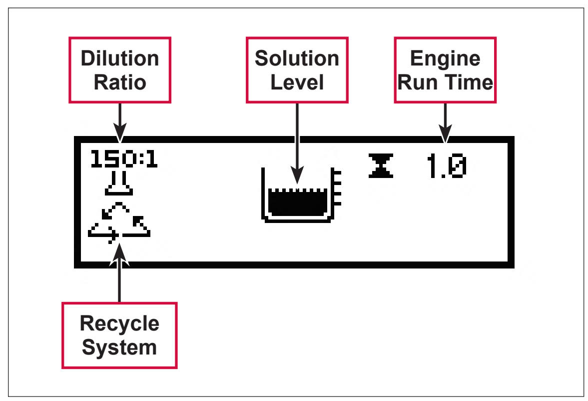
The general LCD display on the battery machine shows the solution level in the solution tank, the total sweep/scrub time on the hour meter, and the state of battery charge. If the machine is equipped with an EcoFlex™ system, the display will also show the detergent system icon and current dilution ratio.



LPG Machine

The general LCD display on the LPG machine shows the solution level in the solution tank, the total engine run time and the recycle system icon (if actuated). If the machine is equipped with an EcoFlex™ system, the display will also show the detergent system icon and current dilution ratio.

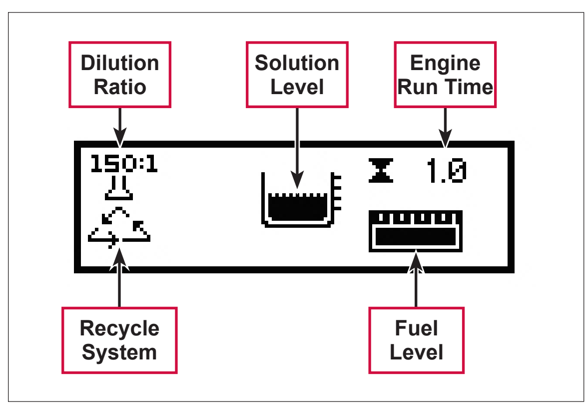
Note: No battery charge or fuel level will be displayed while the engine is running.



Diesel Machine

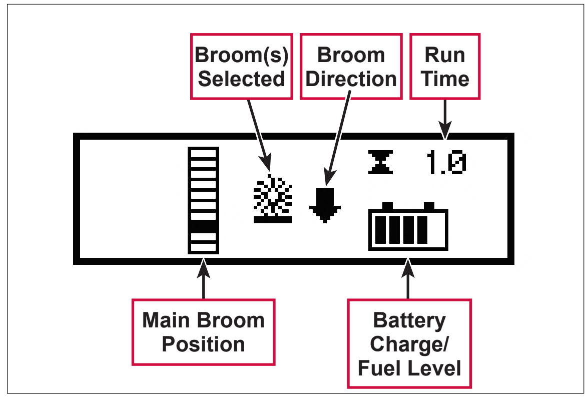
The general LCD display on the diesel machine shows the solution level in the solution tank, the total engine run time, the recycle system icon (if actuated) and the fuel tank level. If the machine is equipped with an EcoFlex™ system, the display will also show the detergent system icon and current dilution ratio.

Note: The fuel level will be displayed while the engine is running.



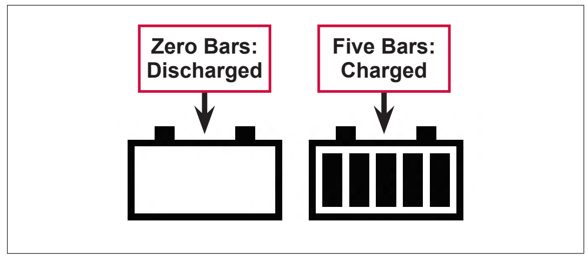
Broom Adjustment (Battery, LPG and Diesel)

The broom adjustment LCD display shows the main broom position, the broom(s) selected for adjustment, the broom movement, the total run time and the battery charge/fuel level.



Battery Charge Indicator

The battery charge indicator shows the charge state of battery and will retain the charge state when the key is turned off. Five vertical bars indicates a fully-charged battery after a complete charging cycle. No bars indicates a discharged battery. Note that no bars will be shown if the machine is in the low-voltage cutout mode.



You can choose between two different low-voltage cutout thresholds depending on whether maintenance-free or standard batteries are being used.

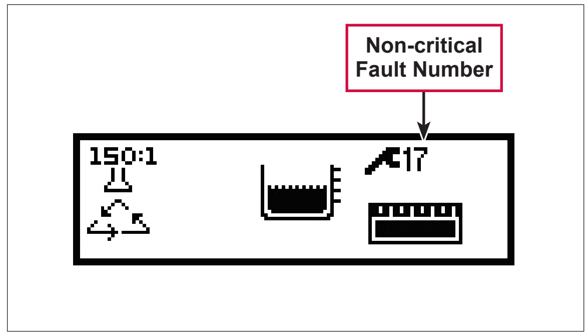
Note: *The following percentages are based on **useable** battery capacity not total battery capacity. Therefore, 100% discharge = 80% of total battery capacity for standard wet cell batteries, or 70% of total battery capacity for maintenance-free batteries.*

Battery Charge Indicator	Standard Battery	Alternate/Maintenance-free Battery
Reset to 5 bars	Low Voltage Cutout Reset	Low Voltage Cutout Reset
5 bars	Never below 35.9 V	Never below 35.9 V
4 bars	Never below 35.4 V	Never below 35.4 V
3 bars	Never below 34.4 V	Never below 34.4 V
2 bars	Never below 33.9 V	Never below 33.9 V
1 bar	Never below 32.2 V	Never below 33.3 V
0 bars	Never below 30.9 V	Never below 32.8 V
Not displayed	Low Voltage Cutout active	Low Voltage Cutout active

Fault, Caution and Warning Displays

Fault Displays

The system can detect overloads and short circuits on various hardware circuits, and detect system faults. There is no hardware detection of open circuits.

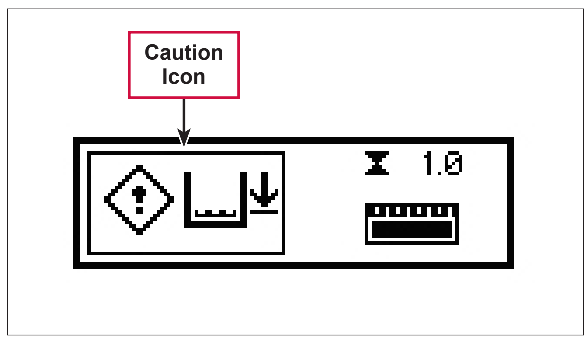


These non-critical faults detected by the main machine controller will be displayed on the display panel in the hour meter section. If more than one fault exists, the display will sequence through the fault codes at one-second intervals. Faults are display as a mechanical wrench icon followed by a two-digit code. Caution and warning displays take priority over non-critical fault displays.

Refer to the ***Electrical System*** section for a list of the non-critical fault codes.

Caution Displays

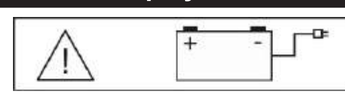
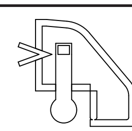
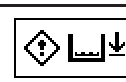
Any cautions detected by the main machine controller will be shown on the left side of the display. Only the fuel/ battery level and hour meter indicators will remain.



Cautions icons are displayed as a non-inverse graphic.

If more than one caution and/or warning exists, the display will sequence through the active warnings and cautions at one-second intervals.

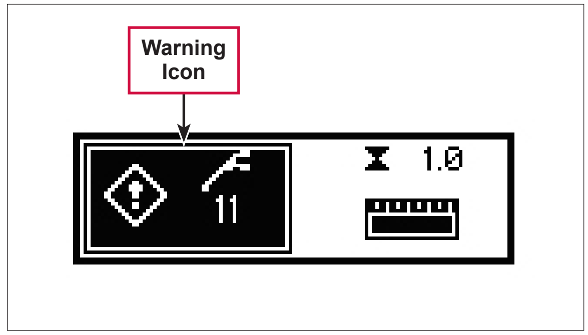
Refer to the table below for a list of the displayed cautions.

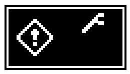
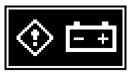
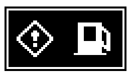
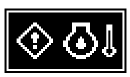
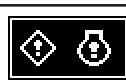
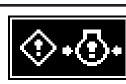
Caution	Condition	Display Icon
Low-voltage Cutout	The batteries need to be charged.	
Hopper Temperature	Hopper temperature has exceeded the operational temperature.	
Solution Level Low (Icon number 246)	Solution level has been low longer than 10 seconds	

Warning Displays

Any warnings detected by the main machine controller will be shown on the left side of the display. Only the fuel/battery level and hour meter indicators will remain. Warnings are displayed as inverse graphics. If more than one warning and/or caution exists, the display will sequence through the active warnings and cautions at one-second intervals.

Refer to the table below for a list of the displayed warnings.



Description	Display Icon
Critical fault warning	
Low battery warning	
Low fuel warning	
Parking brake warning	
Recovery tank full warning	
Engine temp hot	
Engine fault	
Engine Oil Pressure	

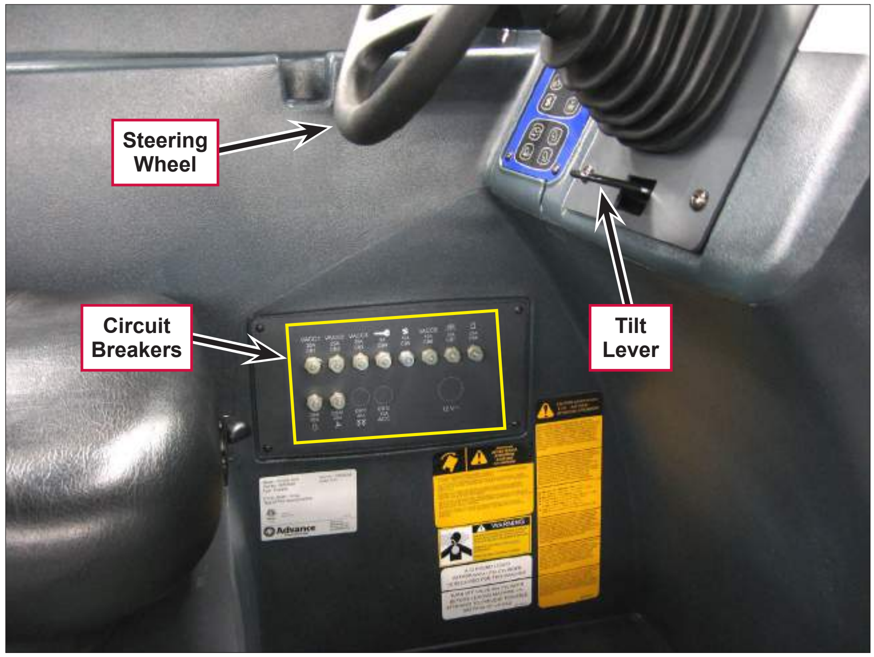
Steering Wheel

The steering system in the CS7000 is a “steer by wire” system that uses an encoder and brushless AC three-phase motor to transfer steering wheel input to the drive wheel.

Note that when the machine key switch is off, the **Steering Wheel** will “freewheel” with no turning resistance. Once the machine is powered-up, normal steering feel is restored.

The standard **Tilt Lever** allows the **Steering Wheel** to be tilted up and down to suit the Operator.

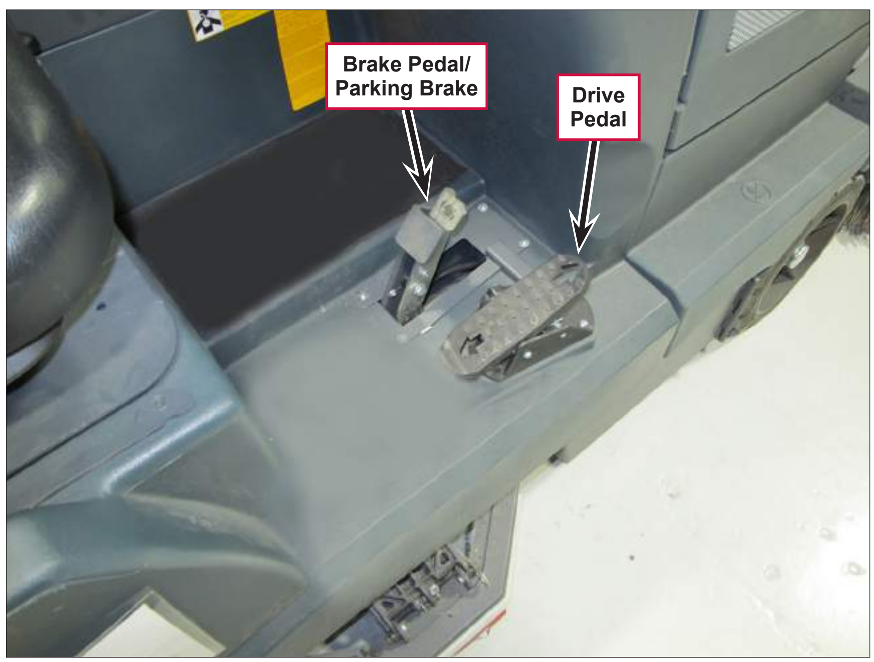
The **Circuit Breakers** are mounted on the panel adjacent to the Operator position.



Foot Pedals

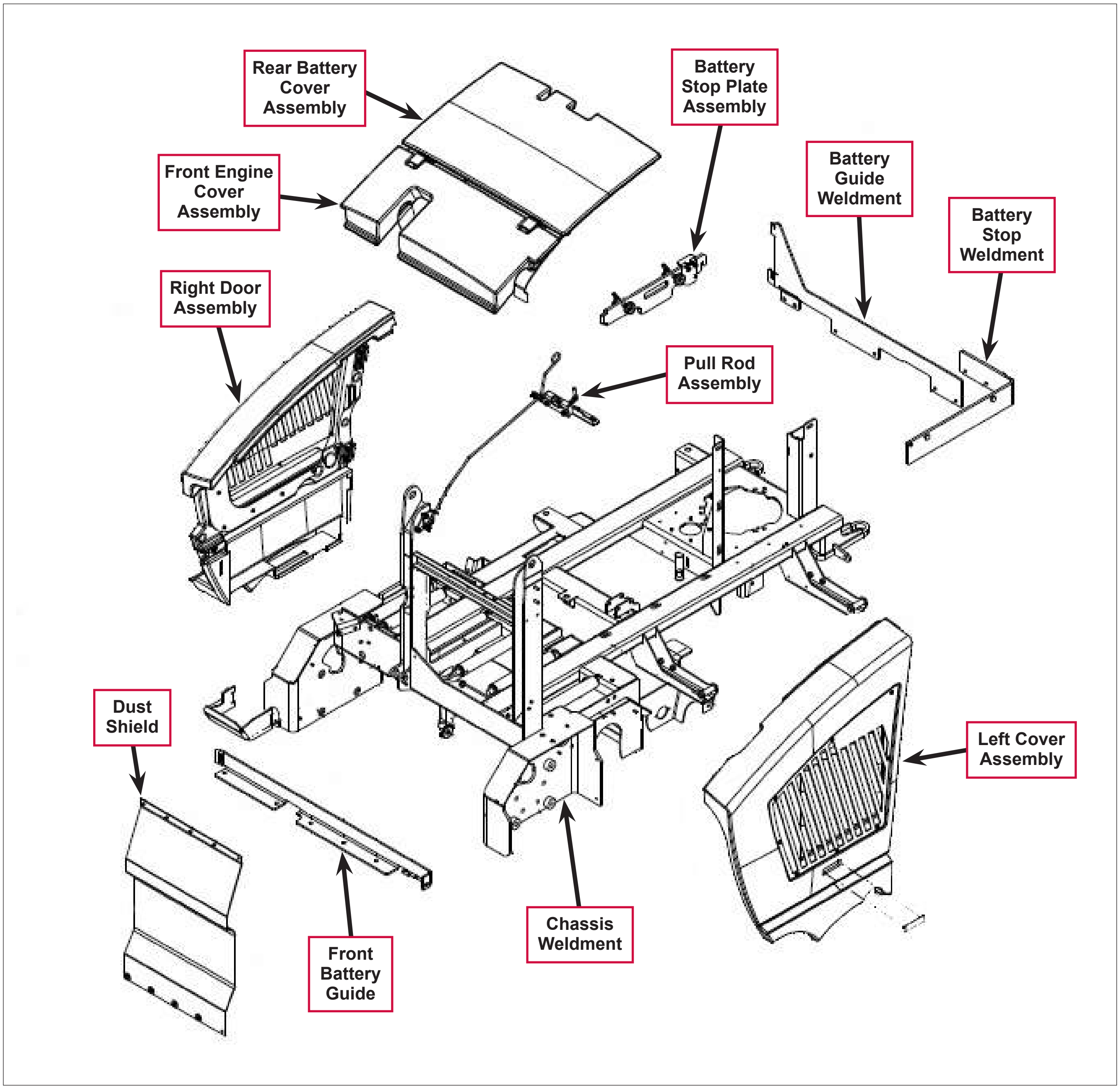
The **Brake Pedal/Parking Brake** brakes the machine, and locks in the applied position when used as a parking brake.

The **Drive Pedal** moves the machine forward and backward. Machine direction and speed are proportional to the **Drive Pedal** position.

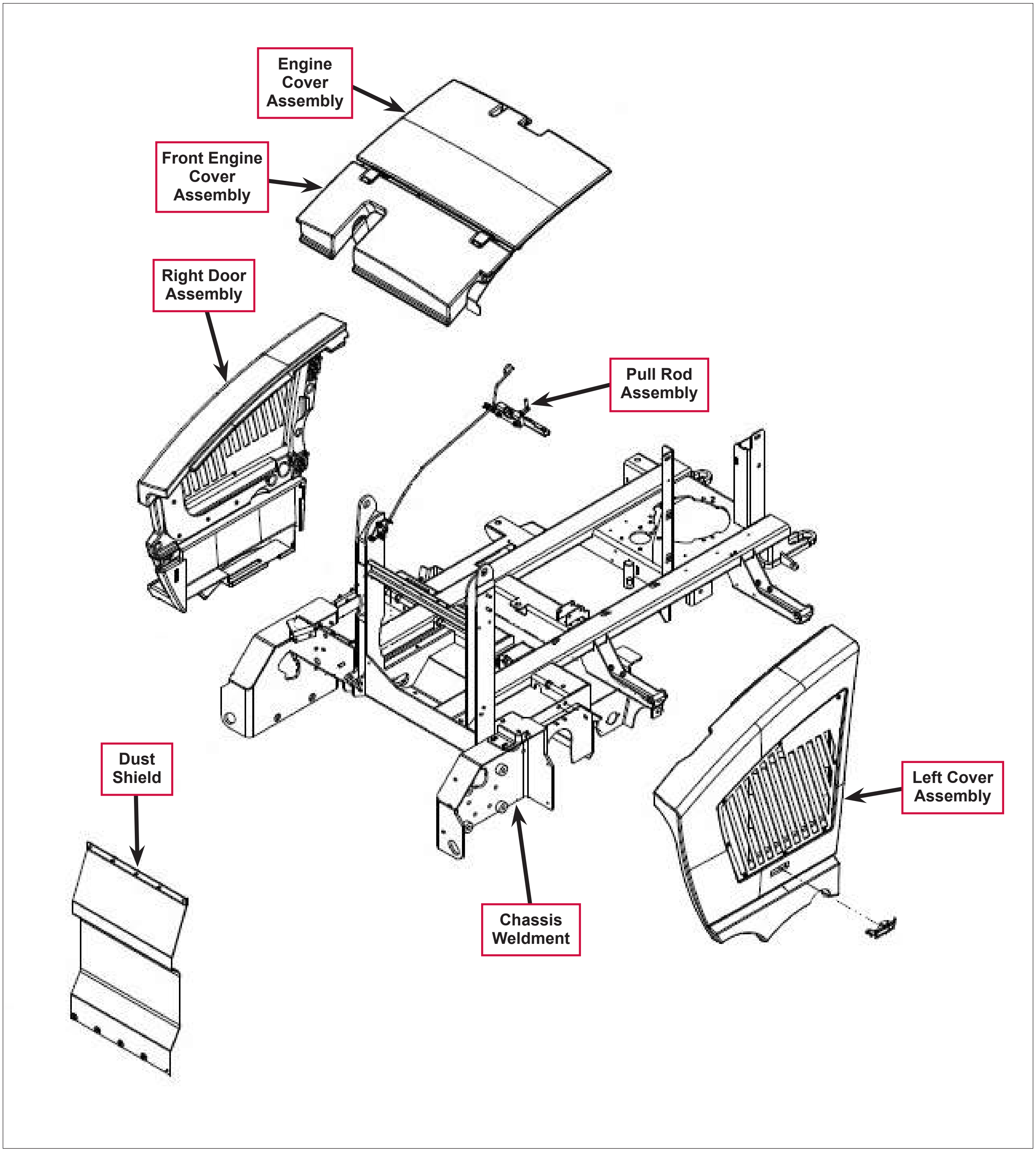


Chassis System

Component Locations - Battery Machine (major components)



Component Locations - LPG and Diesel Machine (major components)



Control System

Functional Description

The CS7000 has several “controllers” which operate various parts of the machine and which communicate with one another via a CAN bus. The CAN bus is like a “phone line” between all of the controllers that allow them to communicate with one another.

The main machine controller is responsible for operating all of the “cleaning functions” of the machine. All of the operator requests from the control panel are communicated to the main machine controller via the CAN bus. This greatly reduces the number of wires needed between the control panel and the main machine controller. The main machine controller tells the control panel what indicator lights to turn on and what to display in the LCD screen. The main machine controller monitors many circuits for overloads (shorts) and can set many diagnostic trouble codes that simplify troubleshooting.

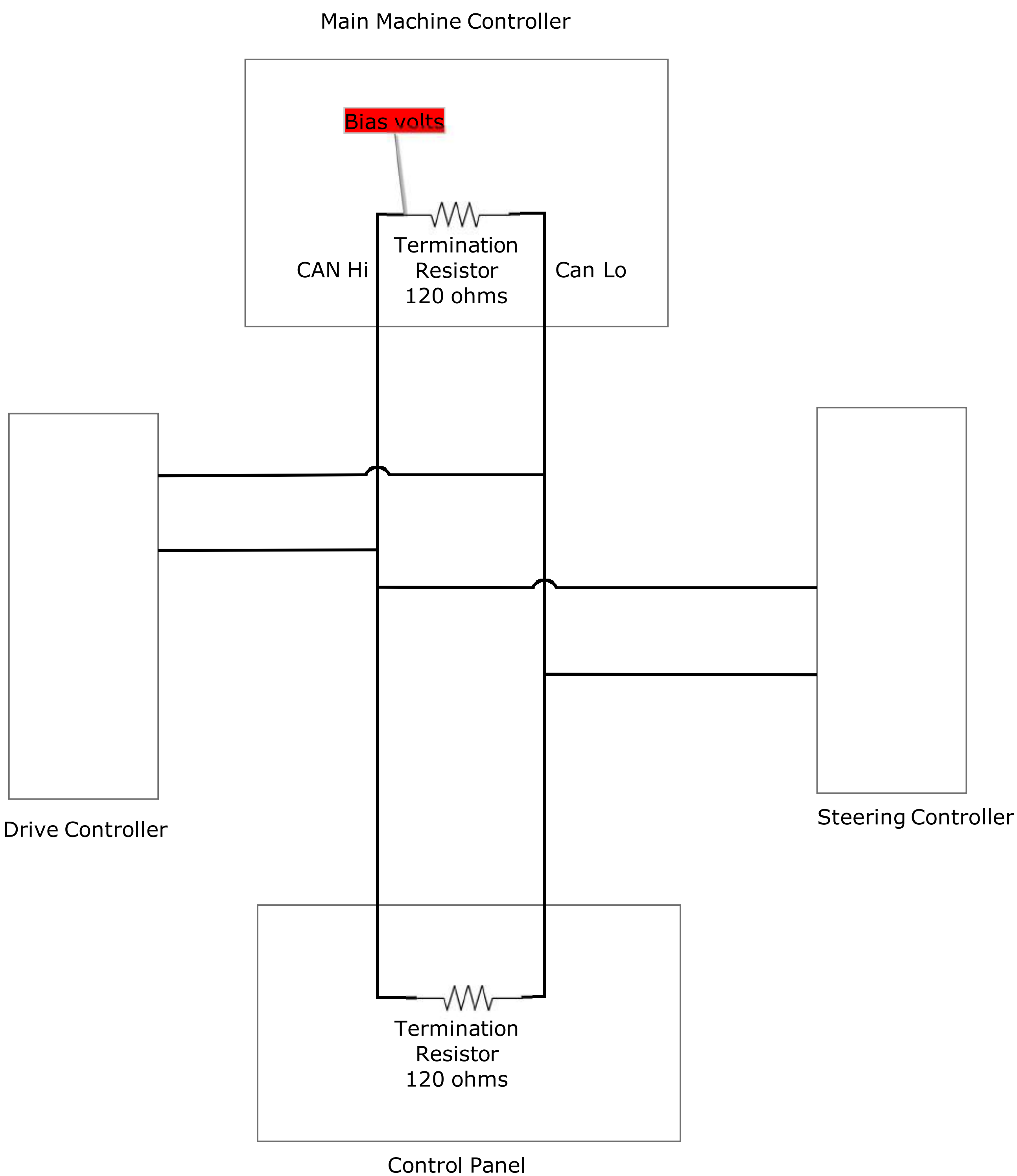
Main Machine Controller

The steering controller operates the steering system – See the ***Steering System*** chapter for more information.

The drive controller operates the wheel traction drive motor. – See the ***Wheel System, Traction*** chapter for more information.

CAN Bus Circuit

The main machine controller and the control panel are the two major players on the CAN Bus. The main machine controller provides a “bias voltage” on the CAN bus wires that the messages ride on. It also has a termination resistor inside it that connects the CAN Hi and CAN Lo circuits together. The control panel also has a termination resistor. These termination resistors are important for normal circuit operation. If one of them fails, communication will stop. The steering controller and the drive controller are both tied into the CAN Bus circuits but do not contain termination resistors.



CAN◦BUS message routing

The following outline describes what messages are communicated over the CAN Bus from one controller to another.

Control Panel

- Messages Sent
  - To Main Machine Controller
    - Operator switch inputs
  - To Drive Controller
    - None
  - To Steering Controller
    - None
- Messages Received
  - From Main Machine Controller
    - LED display instructions
    - LCD display instructions
    - Fault History for main controller, steering controller and drive controller
  - From Drive Controller
    - None
  - From Steering Controller
    - None

Main Machine Controller

- Messages Sent
  - To Control Panel
    - LED display instructions
    - LCD display instructions
    - Fault History for main controller, steering controller and drive controller
  - To Drive Controller
    - Push Mode On/Off
    - Transport Mode On/Off
    - Sweep System On/Off
    - Scrub System On/Off

    - Machine (Power Plant) Type - Battery/Engine (Hybrid)
    - Hopper Up/Down
  - To Steering Controller
    - None
- Messages Received
  - From Control Panel
    - Operator switch inputs
  - From Drive Controller
    - Drive System Fault Codes
    - Machine motion signal (Forward, Neutral, or Reverse)
  - From Steering Controller
    - Steering System Fault Codes

Drive Controller

- Messages Sent
  - To Main Machine Controller
    - Drive System Fault Codes
    - Machine motion signal (Forward, Neutral or Reverse)
    - Reverse signal
  - To Steering Controller
    - None
  - To Control Panel
    - None
- Messages Received
  - From Main Machine Controller
    - Push Mode On/Off
    - Transport Mode On/Off
    - Sweep System On/Off
    - Scrub System On/Off
    - Power Plant Type - Battery/Engine (Hybrid)
    - Hopper Up/Down
  - From Steering Controller
    - None

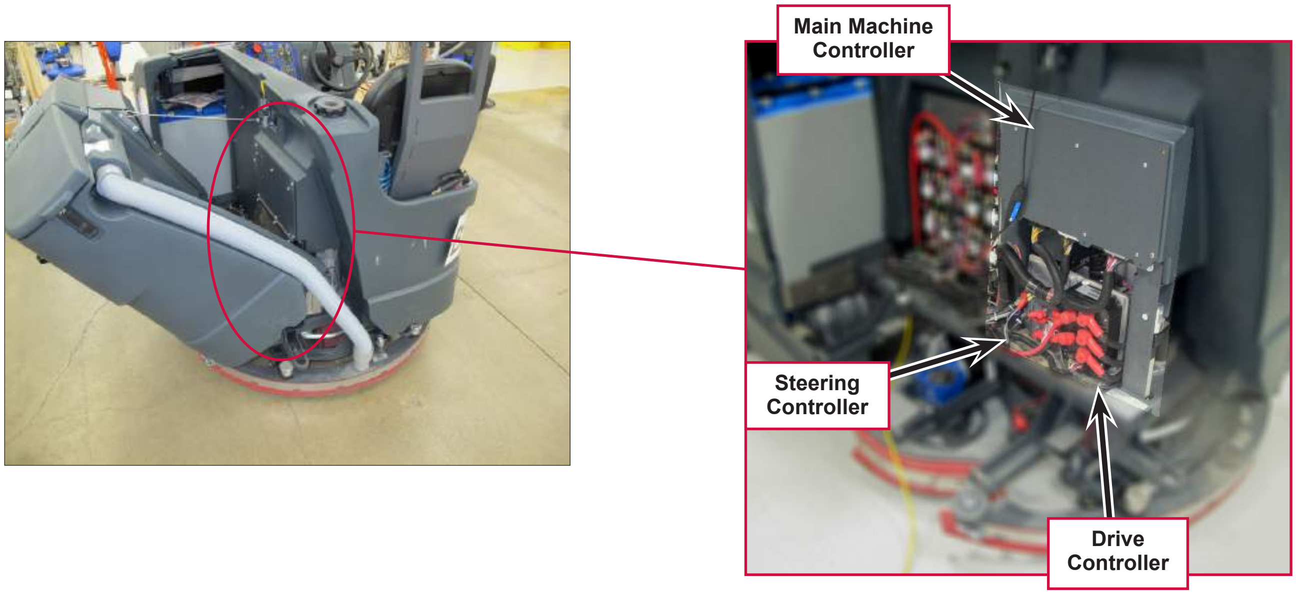
- From Control Panel
    - None

Steering Controller

- Messages Sent
    - To Main Machine Controller
        - Steering System Faults
    - To Drive Controller
        - None
    - To Control Panel
        - None
- Messages Received
    - From Main Machine Controller
        - None
    - From Drive Controller
        - None
    - From Control Panel
        - None

Component Locations

- Main Machine Controller
- Control Panel
- Drive Controller
- Steering Controller



Caution! ***Do not pressure wash the control panel, main machine controller, steering controller, drive controller or any other electrical components.***

Troubleshooting

There are two important things you need to know about electrical diagnosis on the CS7000 machine. First, it is capable of setting fault codes that can help narrow down the possible causes. Second, there is a special "Service Mode" built into the machine that will help you diagnose electrical problems quickly. See the "***Fault Codes***" and "***Service Mode***" sections below for more information.

Fault Codes

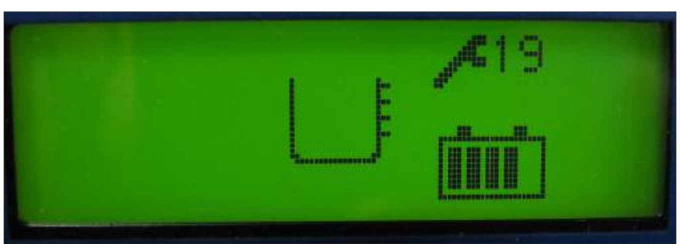
The main machine controller monitors every circuit it controls for overloads (excessive current draw). If it sees an overload it will set and display a fault code and shut the circuit down. For instance, if the side broom contactor coil becomes shorted and draws too much current, it will set and display a code 19 and shut down the side broom contactor control circuit. This means the side broom motors will not work and there will be a code 19 displayed. You should check the fault code table below to find out what "19" means. When you see that it means "Side Broom Contactor (K8) Winding Circuit Overload " that will help you narrow down the possible causes that you need to diagnose. Once the problem is corrected the fault code will no longer be displayed. However, it will remain in the fault code history.

Not all electrical problems will be accompanied by a fault code. The main machine controller does not set faults for open circuits or "not enough current draw". For instance, if the side broom motor contactor coil becomes open and draws no current, there will NOT be a code set for this condition. The side brooms will not work because of the open contactor coil but there will be no fault code. The main machine controller does not monitor every electrical circuit. For instance, it monitors the control side of the side broom contactor coil because it completes the circuit for the winding. It does not monitor the "contact" or "load" side of the contactor.

Any fault codes detected by the main machine controller will be displayed on the LCD display as they occur.

Critical faults are displayed like this code 50:

If more than one critical fault exists, the display will sequence through the active warnings and cautions at one-second intervals.



Non-critical faults are displayed like this code 19:

If more than one non-critical fault exists, the display will sequence through the fault codes and the hour meter at one-second intervals.

Fault Code Table (Main machine controller)

Fault #	Description	Setting Conditions	Consequences
00	Auxiliary Contactor (K9) Winding Circuit Overload	Short circuit or > 4 Amps	
01	12 Volt Alternator is not charging	Battery voltage is less than 10 volts with the engine running	
02	Not used		
03	Not used		
04	Excessive Engine Temperature	Engine Temperature switch closed with the engine running.	Shut down engine
05	Low Engine Oil Pressure	Loss of engine run signal (Oil pressure switch open) with the key switch still on.	Shut down engine
06	Glow Plug Relay Overload		
07	42 Volt Alternator is not charging	< 37 volts for > 30 Seconds.	
08	Throttle 1 circuit overload	Current Overload	
09	Throttle 2 circuit overload	Current Overload	
10	Start Command circuit overload	> 18 Amps	
11	Ignition On circuit overload	> 18 Amps	
12	VACC1 circuit breaker tripped	Aux Contactor energized with no voltage at J2-13 VACC1	
13	VACC2 circuit breaker tripped	Aux Contactor energized with no voltage at J3-26 VACC2	
14	VACC3 circuit breaker tripped	Aux Contactor energized with no voltage at J3-34 VACC3a and J3-35 VACC3b	
15	VACC6 circuit breaker tripped	Key on with no voltage at J2-34 VACC6a and J2-35 VACC6b	
16	Scrub Deck Actuator (M11) Overload	> 7 Amps for 4 seconds or short circuit	Disables detergent, solution and scrub motors.
17	Main Broom Actuator (M21) Overload	> 6 Amps for 4 seconds or short circuit	Disables sweep functions.
18	Side Broom Actuator (M13) Overload	> 7 Amps for 4 seconds or short circuit	Disables side brooms.
19	Side Broom Contactor (K8) Winding Circuit Overload	> 4 Amps or short circuit	Disables side brooms.
20	Dust Control Contactor (K6) Winding Circuit Overload	> 4 Amps or short circuit	Disables dust control.
21	Left Brush Contactor (K1) Winding Circuit Overload	> 4 Amps or short circuit	Disables detergent, solution and scrub motors.
22	Center Brush Contactor (K2) Winding Circuit Overload	> 4 Amps or short circuit	Disables detergent, solution and scrub motors.
23	Right Brush Contactor (K3) Winding Circuit Overload	> 4 Amps or short circuit	Disables detergent, solution and scrub motors.
24	Broom Contactor (K4) Winding Circuit Overload	> 4 Amps or short circuit	Disables sweep functions.
25	Hydraulic Pump1 Contactor (K4) Winding Circuit Overload	> 4 Amps or short circuit	

Fault #	Description	Setting Conditions	Consequences
26	Hydraulic Pump2 Contactor (K4) Winding Circuit Overload	> 4 Amps or short circuit	
27	Dust Filter Plugged	Closed switch	Warning message only
28	Dump Door Actuator (M26) Overload	> 7 Amps for 4 seconds	Disables sweep functions and hopper door.
29	Hopper Over Temperature	Closed hopper temperature switch	Turns off the Dust Control motor, the Main Broom system, the Side Broom system, and closes the hopper dump door.
30	Shaker Motor (M14) Overload	> 20 Amps or short circuit	
31	Solution Pump (M19) or Extended Scrub Pump (M25) Overload	> 24 amps or short circuit	
32	High Pressure Washer Pump Electromagnetic Clutch Overload	> 18 Amps or short circuit	
33	Low Pressure Wash Pump (M23) Overload	> 20 Amps or short circuit	
34	Dust Guard Pump (M22) Overload	> 20 Amps or short circuit	
35	Solution Solenoid Valve (L1) Winding Overload	> 4 Amps or short circuit	Disables detergent, solution and scrub motors.
36	Chemical (Detergent) pump M17 overload	> 2.5 Amps or short circuit	Disables detergent.
37	Chemical (Detergent) pump M18 overload	> 2.5 Amps or short circuit	Disables detergent.
38	Vacuum Contactor (K5) Winding Circuit Overload	> 4 Amps or short circuit	Disables detergent, solution, scrub motors and recovery.
39	Squeegee Actuator (M12) Overload	> 5 Amps for 4 seconds or short circuit	Disables detergent, solution, scrub motors and recovery.
40	Right Front Turn Signal (LT4) Overload	> 3 Amps or short circuit	
41	Left Front Turn Signal (LT7) Overload	> 3 Amps or short circuit	
42	Right Rear Stop Turn Signal (LT11) Overload	> 6 Amps or short circuit	
43	Left Rear Stop Turn Signal (LT9) Overload	> 6 Amps or short circuit	
44	Head Lamp Circuit (LT2, LT3, LT8) Overload	Short circuit	
45	Tail Lamp Circuit (LT5, LT6) Overload	> 3 Amps or short circuit	
46	Back-up Alarm (H1) Overload	> 4 Amps or short circuit	
47	Horn (H2) Overload	Short circuit	
48	Not used		

Fault #	Description	Setting Conditions	Consequences
49	Low Voltage Cutout	< 30.8 V for Wet Acid Battery < 32.5 V for Gel Battery	Warning message and disable all sweep and scrub functions except recovery system
50	A Fault Has Been Set In The Steering Controller (A5)	Steering controller has communicated an emergency error message to the main machine controller (Retrieve the specific steering system code by using the hidden menu “configuration display” fault recall.)	Disables all sweep and scrub functions
51	A Fault Has Been Set In The Drive Controller (A2)	Drive controller has communicated a fault to the main machine controller (Retrieve the specific drive system code by using the hidden menu “configuration display” fault recall.)	Disables all sweep and scrub functions
52	Vacuum Motor Circuit (M6, M7) Overload	> 40 Amps for 20 seconds or short circuit	Disables detergent, solution, scrub motors and recovery.
53	Scrub Brush Motor Circuit (M2, M3, M4) Overload	> 75 Amps for 25 seconds or short circuit	Disables detergent, solution and scrub motors.
54	Main Broom Motor (M1) Overload Note: If this code is set after installing a new broom, adjust the broom height.	> 28 Amps for 30 seconds or short circuit	Disables sweep functions.
55	Broom Motor Current Sensor fault	Main broom motor contactor has been off more than 5 seconds but the broom motor current sensor is reporting > 6 A (2.6V).(Make sure the sensor is reading the correct wire(s))	Disables sweep functions
56	Brush Motors Current Sensor fault	Brush motor contactors have been off more than 5 seconds but the brush motor current sensor is reporting > 6 A (2.6V) (Make sure the sensor is reading the correct wire(s)).	Disables scrub functions
57	Vacuum Motor Current Sensor fault	Vacuum motor contactors have been off more than 5 seconds but the brush motor current sensor is reporting > 6 A (2.6V). (Make sure the sensor is reading the correct wire(s))	Disables scrub and recovery functions

Hidden Menus

The main machine controller supports a “hidden menu” which allows you to match the controller to the machine, set some user options and perform time saving service tests. There are three main hidden menus modes; Configuration Display, Configuration Menu and User Options Menu. A unique switch sequence is used to enter each mode.

Configuration Display

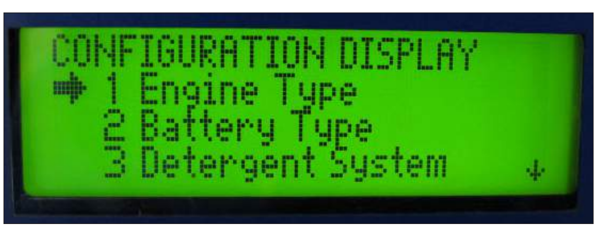
The configuration display mode is a “read only” mode that allows you to check how the main machine controller thinks the machine is equipped without running the risk of accidentally changing a value. It also allows you to check historical faults for the main machine controller, steering controller and drive controller.

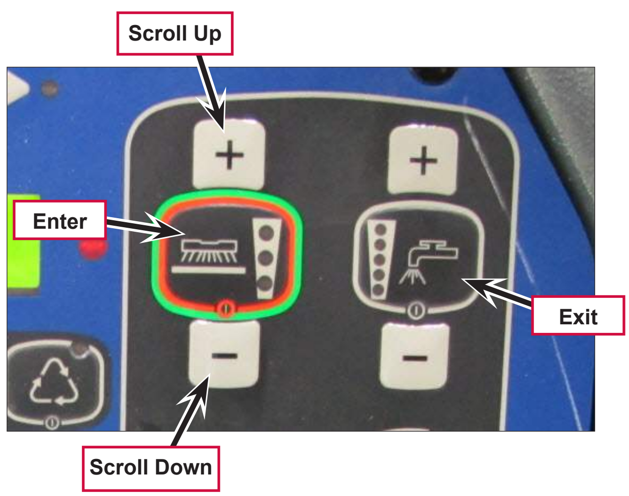
To enter the Configuration Display:

1. While Pressing and holding the hazard flasher switch, turn the key on.

2. Continue to hold the switch until the LCD reads “Configuration Display”, and then release the switch.

Once in the configuration display, you can scroll the “arrow cursor” through the menu using the scrub pressure increase and decrease buttons. To enter a menu selection, press the One-touch scrub switch. To exit and return to the configuration display mode, press the solution switch. To exit the hidden menu, turn the key switch off.





The Following is an outline of the menu:

- 1 Engine Type
- 2 Battery Type
- 3 Detergent System
- 4 EcoFlex System
- 5 Dust Guard system
- 6 Ex Scrub System
- 7 Back-Up Alarm
- 8 Signal Lights
- 9 Plugged Filter Kit
- 10 Hopper Temp Kit
- 11 Low Press Wash
- 12 High Press Wash
- 13 Scrub Motor Type
- 14 Display Screen
- 15 Fault Recall

Configuration Menu

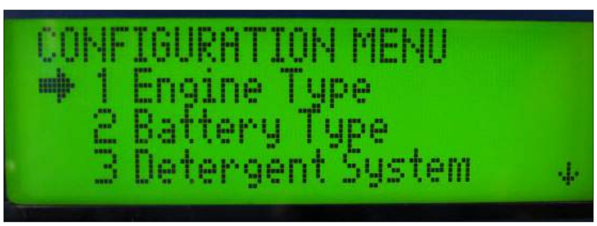
The configuration menu is a "read and write" mode that allows you to check and change the machine configuration values in order to tell the main machine controller how the machine is equipped. This "matches" the controller to the machine and must be done anytime a new main machine controller is installed.

Note The configuration menu also contains time saving service tests in the Service Menu. See the separate "Service Mode" section below for more details.

To enter the Configuration Menu:

1. While pressing and holding both of the turn signal switches, turn the key on.

2. Continue to hold the switches until the LCD reads "Configuration Menu", and then release the switches.



Once in the configuration menu, you can scroll the "arrow cursor" through the menu using the scrub pressure increase and decrease buttons. To enter a menu selection, press the One-touch scrub switch. To exit and return to the configuration menu mode, press the solution switch. To exit the hidden menu, turn the key switch off .-

The following is an outline of the menu.

- 1 Engine Type
  - 1 Undefined
  - 2 Battery
  - 3 Diesel
  - 4 Propane
- 2 Battery Type
  - 1. Undefined

  - 1 Wet (Lead Acid)
  - 2 Sealed (gel)
- 3 Detergent System
  - 1 Installed?
    - 1 Not Installed
    - 2 Installed
  - Display Format
    - 1 Ratio
    - 2 Percentage
- 4 EcoFlex System
  - 1 Not Installed
  - 2 Installed
- 5 Dust Guard system
  - 1 Not Installed
  - 2 Installed
- 6 Ex Scrub System
  - 1 Not Installed
  - 2 Installed
- 7 Back-Up Alarm
  - 1 Not Installed
  - 2 Installed
- 8 Signal Lights
  - 1 Not Installed
  - 2 Installed
- 9 Plugged Filter Kit
  - 1 Not Installed
  - 2 Installed
- 10 Hopper Temp Kit
  - 1 Not Installed
  - 2 Installed
- 11 Low Press Wash
  - 1 Not Installed
  - 2 Installed
- 12 High Press Wash
  - 1 Not Installed
  - 2 Installed
- 13 Scrub Motor Type
  - 1 Option 1
  - 2 Option 2
- 14 Display Screen
  - 1 US Display
  - 2 Global Display
- 15 Service Menu
  - 1 Service Mode
    - Example:
      - 37.1 V
      - Neutral
  - 2 Battery Level
    - E.G.
      - 2 Sealed (gel)
      - 37.710 V
      - Level 5
  - 3 Solution Reading
    - E.G.
      - Reading 0x67
      - Level 3
  - 4 Fault Detection
    - 1 Enabled
    - 2 Disabled
  - 5 About
    - Example:
      - Cougar
      - 56510353Rev_C
  - 6 Shaker Continuous
    - 1 No
    - 2 Yes

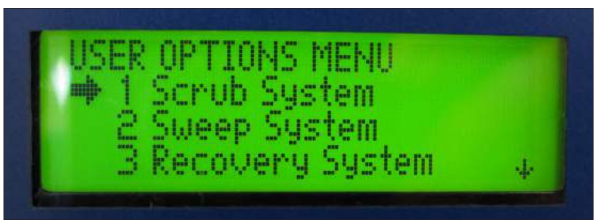
User Options Menu

The user options menu allows you to customize certain machine functions according to machine operator preferences.

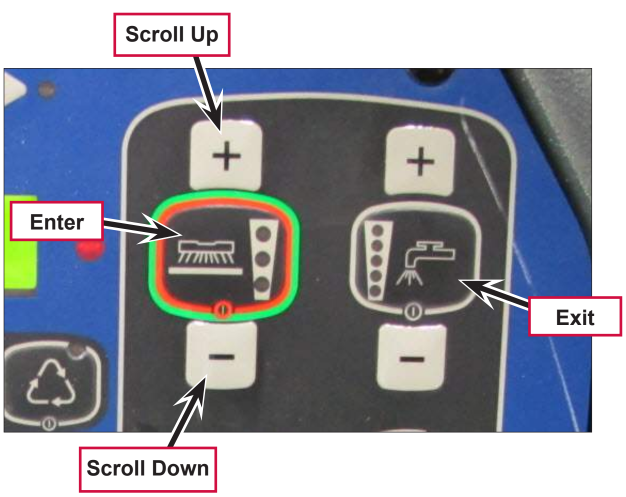
To enter the User Options Menu:

1. While pressing and holding the One-touch scrub switch AND the solution switch, turn the key on.

2. Continue to hold the switches until the LCD reads “User Options Menu”, and then release the switches.



Once in the user options menu, you can scroll through the menu using the scrub pressure increase and decrease buttons. To enter a menu selection, press the One-touch scrub switch. To exit and return to the User options menu mode, press the solution switch. To make a selection and return, press the One-touch scrub switch. To exit the hidden menu, turn the key switch off.



The following is an outline of the User Options Menu

- 1 Scrub System
  - 1 Scrub Mode 1st Use - The default scrub mode used the first time after power up. After first time, mode is last used.
    - 1 Light - The scrub mode will default to the Light setting when activated. (DEFAULT)
    - 2 Heavy - The scrub mode will default to the Heavy setting when activated.
    - 3 Extreme - The scrub mode will default to the Extreme setting when activated.
  - 2 Detergent Start Up - Determines if the detergent system will be activated when the scrub is turned on.
    - 1 Off - always disabled when the scrub system is activated.
    - 2 On - always enabled when the scrub system is activated.
    - 3 Last State - returned to state when the scrub system was last on.
  - 3 Maximum Mode - The maximum scrub mode that the operator can select.
    - 1 Light - The only available scrub mode will be the Light setting.
    - 2 Heavy - The Light and Heavy scrub mode will be available.
    - 3 Extreme - All scrub modes will be available.
  - 4 Light Scrub Mode - The light scrub pressure, solution rate and detergent rate can be programmed depending on its application where high solution rate is needed with light scrub pressure or low solution rate with heavy scrub pressure.
    - 1 Scrub Pressure -
      - RANGE: 1-MIN, 2-MED, 3-MAX
      - DEFAULT: 1-MIN
    - 2 Solution Flow
      - RANGE: Off,1 – 5
      - DEFAULT: 1
  - 5 Heavy Scrub Mode - The heavy scrub pressure, solution rate and detergent rate can be programmed depending on its application where a higher solution rate is need with heavy scrub pressure or low solution rate with heavy scrub pressure.
    - 1 Scrub Pressure
      - RANGE: 1-Min,2-Med,3-Max
      - DEFAULT: 2-Med
    - 2 Solution Flow
      - RANGE: 1 – 5
      - DEFAULT: 2
  - 6 Extreme Scrub Mode - The extreme scrub pressure, solution rate and detergent rate can be programmed depending on its application where a higher solution rate is need with extreme scrub

pressure or low solution rate with extreme scrub pressure.

        ◦ 1 Scrub Pressure

            – RANGE: 1 – 3

            – DEFAULT: 3

        ◦ 2 Solution Flow

            – RANGE: 1 – 5

            – DEFAULT: 3

    – 7 Neutral Off Delay - This determines how long before the brushes are stopped after returning to neutral

        ◦ RANGE: 0.5 – 5 seconds

        ◦ INCREMENT: 0.5 seconds

        ◦ DEFAULT: 0.5 seconds

    – 8 Scrub Down Time - When activated the scrub is lowered for a period of time before the control starts moving the deck based on the current of the brush motors.

        ◦ RANGE: 1 – 3 seconds

        ◦ INCREMENT: 0.1 seconds

        ◦ DEFAULT: 2 seconds

    – 9 Solution In Reverse - Determines whether solution will flow when the machine backs up.

        ◦ 1 Off (This is default)

        ◦ 2 On

- 2 Sweep System

    – 1 Sweep Off Timeout - This determines how long before the dust control and brooms are stopped after returning to neutral

        ◦ RANGE: 0.5 – 5 seconds

        ◦ INCREMENT: 0.5 seconds

        ◦ DEFAULT: 0.5 seconds

    – 2 Shaker Duration - Determines how long the shaker will run once it is activated.

        ◦ RANGE: 10 – 40 seconds

        ◦ INCREMENT: 1 second

        ◦ DEFAULT: 15 seconds

- 3 Recovery System -

    – 1 Sqg Down Time - Sets the time to extend the squeegee when lowering it into the active position.

        ◦ RANGE: 1 – 4 seconds

        ◦ INCREMENT: 0.25 seconds

  - DEFAULT: 4 seconds
- 2 Sqg Up Time - (Lift in Reverse) Sets the time to retract the squeegee. When backing up with the recovery system active, the control unit will automatically raise the squeegee to prevent dragging on the floor.
  - RANGE: 1 – 4 seconds
  - INCREMENT: 0.25 seconds
  - DEFAULT: 2 seconds
- 3 Vacuum Off Delay - Sets the timeout for the vacuum during the recovery power down sequence.
  - RANGE: 12 - 20 seconds
  - INCREMENT: 1 second
  - DEFAULT: 12 seconds
- 4 Recovery Mode - Sets when the recovery system begins the power down sequence (only when the Scrub System is being shut off). This is only affective when the system is operating when turned off.
  - 1 Normal - starts immediately
  - 2 Neutral - waits for the machine to return to neutral
- 5 Detect RTF (Recovery Tank Full) The machine is equipped with a feature that will automatically shut off the vacuum and scrub systems and display a recovery tank full icon on the control panel display when the recovery tank becomes full. If problems are encountered with the vacuum shutoff feature, such as the vacuum shutting off even when the recovery tank is not full, this feature can be turned off.
  - 1 No - Do not detect recovery tank full
  - 2 Yes - Detect recovery tank full (DEFAULT)

- 4 User Lockouts
  - 1 Spd Control Adjust (Battery only) - Blocks the user from increasing the speed when scrubbing or sweeping.
    - Unlocked (DEFAULT)
    - Locked
  - 2 Scrub Mode Adjust - Blocks the user from changing scrub mode settings.
    - 1 Unlocked (DEFAULT)
    - 2 Detergent - Prevents the user from changing detergent settings.
    - 3 Detergent & Sol - Prevents the user from changing detergent and solution settings.
- 5 Extended Scrub System
  - Start Up State
    - Off – always disabled when the scrub system is activated.
    - On – always enabled when the scrub system is activated.
    - Last State – returned to state when the scrub system was last on. (DEFAULT)

- 6 Low Voltage cutout - The batteries are monitored. Once the voltage drops below the cutout level, various systems are shut down to prevent depleting the batteries. The batteries must be charged above a reset level before normal operation is allowed. The LVC clearing will set the batteries to full. This setting adjusts the cutout and reset voltages. The description is on a “per cell” basis. There are 18 cells.
  – 1 1.75V, 2.15V - (DEFAULT)
  – 2 1.75V, 2.09V
  – 3 1.83V, 2.09V
- 7 Reduced Speed Mode - Cougar can be programmed to automatically limit the maximum travel speed while scrubbing only, either scrubbing or sweeping, or always.
  – When Scrub (DEFAULT) - The maximum travel speed will be reduced while scrubbing.
  – When Scrub&Sweep - The maximum travel speed will be reduced when scrubbing or sweeping.
  – Always – The maximum speed is the Scrubbing speed setting.
- 8 Engine Idle Delay - This setting adjusts how many seconds to delay before returning the engine RPM to idle after the machine stops moving.
- idle.
  – RANGE: 10 – 250 seconds
  – INCREMENT: 1 second
  – DEFAULT: 20 seconds
- 9 Back-up Alarm
  – 1 Off - never on
  – 2 Reverse Only - Only on in reverse
  – 3 Fwd & Reverse - on when in motion
  – 4 Fwd, Rev & Hopper - on when motion or the hopper is lifted
- 10 Headlights
  – 1 Normal - User controls with key switch (DEFAULT)
  – 2 Always On - On when machine is running. Key switch allow momentary off.
- 11 Broom Lift in Rev
  – 1 No
  – Yes

Service Mode

The service mode makes some diagnostic testing easier. Some outputs (like the scrub brush motors) are only turned on when other conditions are met, such as when the machine is moving. It can be difficult to check for voltage to the scrub brush motors while the machine is moving. Also, if voltage is not present, it leaves in question what other conditions may not have been met yet. The service mode solves these problems for you by allowing you to request that the controller ignore all other conditions and directly turn on the scrub brush motors (or other output loads).

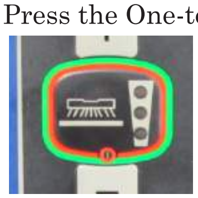
Enter the service mode through the "Configuration Menu".

1. While holding down both the left and right turn signal switches, turn the key switch on.

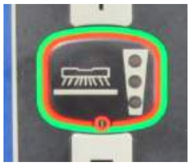
2. Continue to hold the switches down until the "Configuration Menu" is displayed, then release the switches.

3. Press and release the scrub pressure decrease button several times to scroll down the menu list until the arrow cursor is aligned with the "15 Service Menu" selection.

4. Press the One-touch scrub switch to enter the service menu.

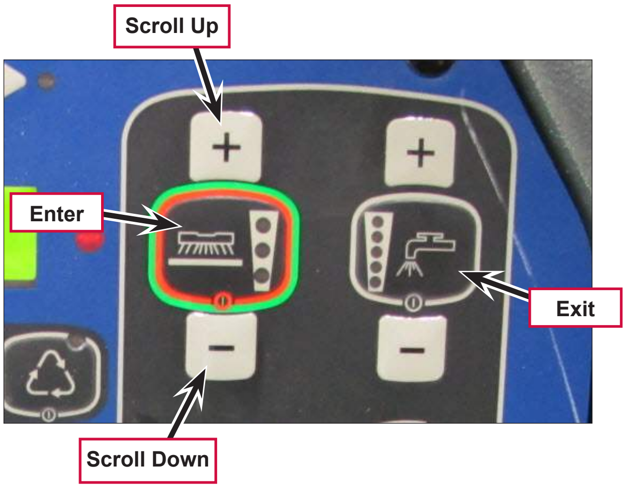


5. With the arrow cursor aligned with “Service Mode”, press the One-touch scrub switch to enter the mode.



“Service Mode” will be displayed at the top of the LCD followed by battery voltage, drive pedal position sensor voltage, drive mode (Reverse, Neutral or Forward) and any current main machine controller faults..

Once in the service mode, you will be able to turn various electrical loads on and off through the control panel buttons. Some loads are toggled on and off by a single button press, while others are only on when the button is held down. **To exit the service mode: Turn the Key Switch off.**

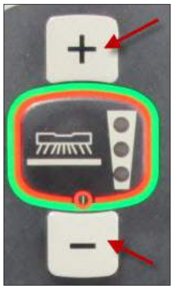


To Operate:

Scrub Motors

Pressing the One-touch scrub switch once will turn all of the brush motors on (energize all contactors) and illuminate the button LEDs. The scrub pressure indicators will be on while the brush motors are on. Pressing the switch again will turn the brush motors off (de-energize the contactors).

Scrub Deck Actuator



Pressing the scrub pressure increase button will move the deck down. Each press and release will extend the actuator motor a little. Holding the button down will run the motor in the extend direction.

Pressing the scrub pressure decrease button will move the deck up. Each press will retract the motor a little. Holding the button down will run the motor in the retract direction.

Vacuum Motor and Squeegee Actuator

Pressing the vacuum/wand switch once will move the squeegee down (extend actuator), turn on the vacuum motors (energize relay) and illuminate the vacuum/wand indicator. Pressing the button again will move the squeegee up (retract actuator) and turn the vacuum motor off (de-energize relay).

Solution Valve (and pump if equipped)

Pressing the solution switch once turns on the solution valve to allow solution to flow. At least one of the solution flow indicator lights will come on. If the model is equipped with a solution pump, the pump will run at the flow rate indicated by the solution flow indicators. While the solution system is “on” you can increase or decrease the solution flow rate by pressing the solution flow increase and decrease buttons.

Detergent Pumps

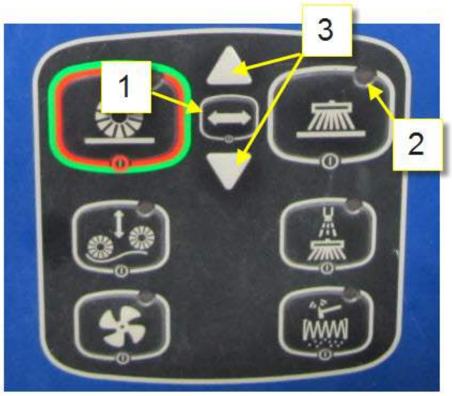
Pressing the detergent switch once will cycle the detergent pumps on and off (if equipped) and illuminate the detergent indicator. You should be able to hear and feel the pumps click. The detergent ratio will be displayed in the LCD while the pump is running. Pressing the detergent switch again will turn off the pump.

Side Broom Motors

Pressing the side broom switch once will turn on the side broom motors (energize relay). The side broom button on indicator will illuminate. Pressing the button again will turn off the side brooms (de-energize relay).

Side Broom Actuator

Press the broom select switch (1) until the side broom on indicator (2) flashes slowly. Then press and hold the down arrow (3) to move the side brooms down. Press and hold the up arrow (3) to move the side brooms up.

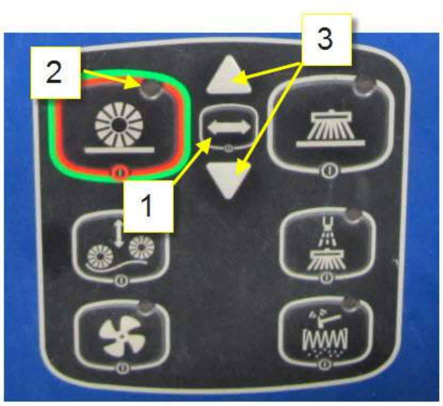


Main Broom Motors

Pressing the One-touch sweep switch once will turn on the main broom motor (energize relay). The main broom on indicator will illuminate. Pressing the button again will turn off the motor (de-energize relay).

Main Broom Actuator

Press the broom adjustment selection button (1) until the main broom button indicator (2) flashes slowly. Then press and hold the down arrow (3) to move the main broom down. Press and hold the up arrow (3)to move the main broom up.



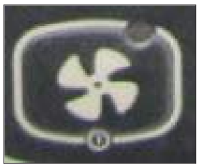
Shaker Motor

Pressing the filter shaker switch once will turn on the shaker motor and illuminate the filter shaker on indicator. Pressing the button again will turn off the motor.

Dust Guard Pump

Pressing the dust guard spray switch will turn on the dust guard pump and illuminate the dust guard on indicator. Pressing the switch again will turn off the pump.

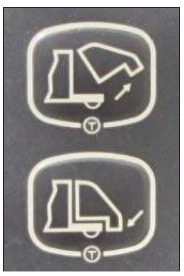
Dust Control Motor



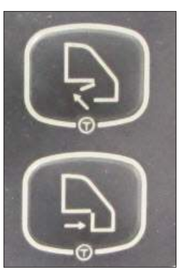
Pressing the dust control fan switch will turn on the dust control motor (energize relay) and illuminate the dust control fan on indicator. Pressing the switch again will turn off the motor (de-energize relay).

Hopper Hydraulic Pump

Pressing and holding either the hopper raise or lower buttons will energize the relays to operate the pump.

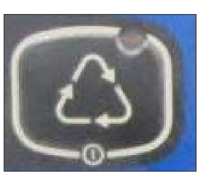


Hopper Door Motor



Pressing and holding either the hopper door open or close buttons will move the door in the appropriate direction until the limit is reached. This is different than normal operation where a single press opens or closes the door completely.

Extended Scrub Pump



Pressing the extended scrub switch will turn on the extended scrub pump (and solution pump and solution valve if equipped) and illuminate the extended scrub indicator. Pressing the switch again will turn off the pump.

High Pressure Wash Pump

Pressing the High-pressure wand switch will turn on high pressure pump electromagnetic clutch and illuminate the high pressure wand indicator. Pressing the button again will turn off the pump.

Troubleshooting

Control Panel LEDs all stay lit - CAN Bus problems

If communication on the CAN bus fails, the operator may or may not notice anything. If they notice anything it will likely be that the control panel powers up when the key is turned on but all of the LEDs remain lit and there is no response to pushing any switch on the control panel.

Control panel appearance with CAN Bus failure

If this happens, start by checking to see if either the steering controller or drive controller is causing the problem by unplugging their low current connectors one at a time. If normal operation is restored after unplugging one of the controllers, that controller is corrupting the communication on the CAN Bus and should be replaced.

Next inspect the CAN Bus wires for shorts to ground, shorts to power or short to one another.

- Turn the key off and unplug the control panel, the main machine controller, steering controller and the drive controller connectors.
- At the main machine controller connector, check for the presence of voltage on each of the CAN Bus wires. If there is voltage (example 12v or 36v), the wire is shorted to a voltage source. Find and correct the short circuit.
- Using an ohmmeter, check for continuity between each of the CAN Bus wires and battery negative. If continuity is found, there is a short to ground (battery negative). Find and correct the short circuit.
- Using an ohmmeter, check the continuity of all of the wires from the main machine controller connector to each of the other connectors. If any wire does not have continuity there is an open. Find and correct the open circuit.

If the wiring is not the problem, check to see if the main machine controller is capable of providing the "bias" voltage on the circuit.

- Make sure the key is off and then plug in only the main machine controller.
- Turn the key on and then check the voltage on each of the CAN Bus wires at the Control Panel Connector. If there is no voltage, the main machine controller is defective because it is not providing bias voltage.

If the voltage on the CAN Hi (YEL) wire is approximately 3.3v and the voltage on the CAN Low (GRN) wire is approximately 1.8v, the main machine controller is providing the bias voltage. This indicates that the control panel is the source of the problem and needs to be replaced.

Removal and Installation

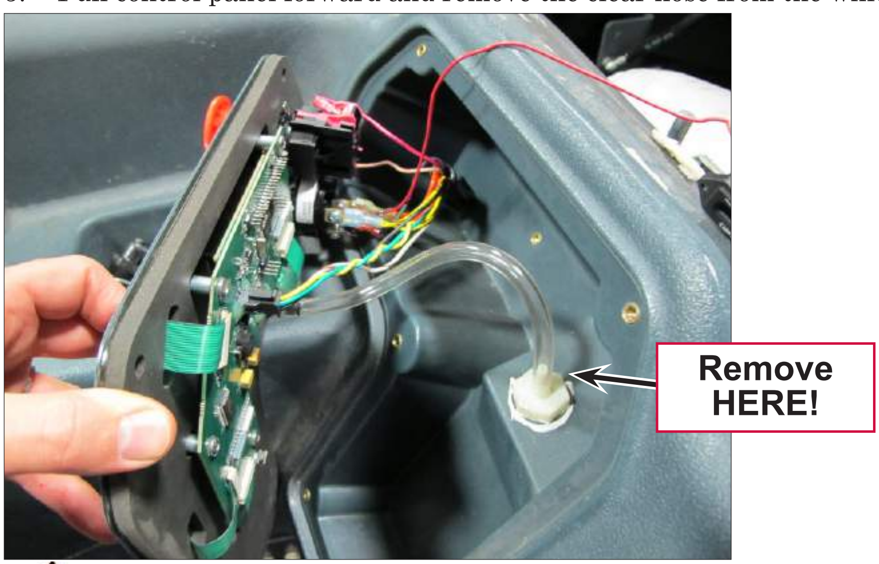
Main Machine Controller

1. Turn the key switch off and disconnect the main battery connector.
2. Remove the recovery tank.
3. Remove the control panel plate to frame fasteners
4. Lay the controller and wiring down. Disconnect the 3 electrical connectors. Note, the connectors on the harness are color coded and keyed to match the connectors on the controller.
5. Reassemble in reverse order.

Note. To avoid repeat controller failure, when replacing a controller, you should check all of the load devices it controls to make sure none of them are shorted.

Control Panel

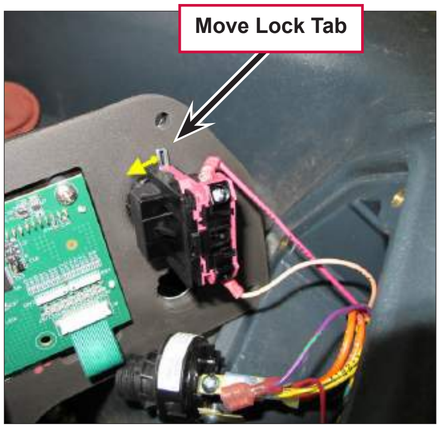
1. Empty the solution tank. (The tank must be empty upon reassembly for the solution level indicator to work properly).
2. Disconnect the main battery connector.
3. Remove key and key switch retaining nut.
4. Remove the 6 control panel mounting screws.
5. Pull control panel forward and remove the clear hose from the white fitting on the solution tank.

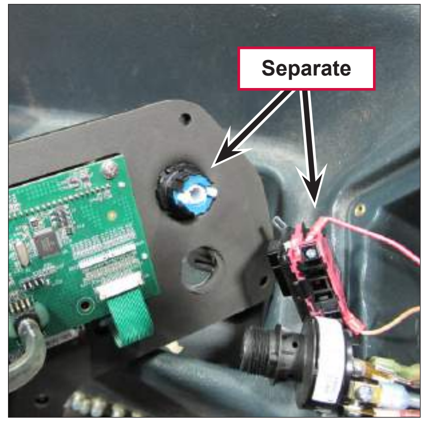


DO NOT REMOVE THE HOSE FROM THE CIRCUIT BOARD!

6. Disconnect the electrical connector.
7. Separate the key switch from the board.

8. Move the lock tab for the emergency stop switch and separate the back half of the switch from the control panel.





9. Before reassembly, make sure the solution tank is empty. The pressure sensor used to measure the tank liquid level depends on the tank being empty when the hose is reconnected.

10. Reassemble in reverse order.

Specifications

Shop Measurements – Main Machine Controller

The following tables contain some “real world” shop voltage measurements to help you recognize what “normal” looks like. All voltage values were measured with the black (Negative) voltmeter lead connected to the main battery negative unless otherwise specified.

J2 Connector (White)

J2 Pin	Wire	Circuit Description	Value/Condition
1	091 ORN/YEL	Left Front Turn Lamp	10.3v when off 0.02v when on
2	094 ORN/BLU	Left Rear Stop/Turn Lamp	11.1v when off 0.01v when on
3	098 YEL/RED	Right Front Turn Lamp	10.3v when off 0.02v when on
4	101 YEL/GRN	Right Rear Stop/Turn Lamp	11.1v when off 0.01v when on
5	107 TAN/BLK	Tail Lamps	5.1v when off 0.01v when on
6	064 BLK/YEL	Dust Control Motor Contactor Grounds to energize	0.07v when energized 37v when not energized
7	119 BRN/WHT	Detergent Pump (M17)	Pulsed voltage is too fast for useful measurement value
8	080 WHT/GRN	Squeegee Actuator Motor	37v at rest or when going down 0.04 going up
9	078 BLU/BRN	Squeegee Actuator Motor	37v at rest or when going up 0.01v going down
10	132 RED/GRN	Scrub Deck Actuator Motor	37v at rest or when going down 0.15v going up
11	135 YEL/GRA	Scrub Deck Actuator Motor	37v at rest or when going up 19v going down
12	162 BLK	Battery Negative	0.001v scrub and sweep systems running
13	057 VIO	VACC 1 Power supply from Aux Contactor	0v Key Off 37v Key On (Aux Contactor energized)
14	051 BLK/ORN	Auxiliary Contactor Grounds to energize	0.07v when energized 37v when not energized
15	163 BRN/BLK	Side Broom Motor Contactor Grounds to energize	0.08v when energized
16	063 GRN/GRA	Main Broom Motor Contactor Grounds to energize	0.08v when energized
17	045 BLU	Vacuum Motor Contactor Grounds to energize	0.08v when energized
18	150 BLK/RED	Shaker Motor PWM ground	10.6v shaker motor running

J2 Pin	Wire	Circuit Description	Value/Condition
19	116 WHT/YEL	Detergent Pump (M17)	Pulsed voltage is too fast for useful measurement value
20	157 YEL/ORN	Solution Solenoid Valve Grounds to energize	0.1v when energized
21	160 BLU/VIO	Detergent Pump (M18)	Pulsed voltage is too fast for useful measurement value
22	167 BLK/YEL	Lamps Common	12v key on
23	169 BRN	Head Lamps and Curb Lamp PWM ground to turn on lights	37v key on and lights off 33.7v key on headlights on
24	039 ORN/RED	Hydraulic Pump Motor Contactor (K12) Grounds to energize	0.08v when energized (Hopper Down)
25	047 YEL/BLU	Left Brush Motor Contactor Grounds to energize	0.08v when energized
26	015 WHT/VIO	Center Brush Motor Contactor Grounds to energize	0.08v when energized
27	061 GRA/RED	Right Brush Motor Contactor Grounds to energize	0.08v when energized
28	038 BLU/ORN	Hydraulic Pump Motor Contactor (K11) Grounds to energize	0.08v when energized (Hopper Up)
29	---		
30	---		
31	---		
32	221 GRA/BLIU	Detergent Pump (M18)	Pulsed voltage is too fast for useful measurement value
33	---		
34	054 BLK/WHT	VACC6a Power supply from Aux Relay	0v Key Off 37v Key On (Aux Relay energized)
35	053 BLK/WHT	VACC6b Power supply from Aux Relay	0v Key Off 37v Key On (Aux Relay energized)

J3 Connector (Gray)

J3 Pin	Wire	Circuit Description	Value/Condition
1	042 VIO/ORN	Extended Scrub Pump PWM ground	Not measured
2	093 RED/YEL	Solution Control Pump PWM ground	37v no flow 27v minimum flow rate 5.6v maximum flow rate
3	030 BRN/WHT	Main Broom Actuator Reversing polarity driver	37v at rest or when moving down 5.4v when moving up
4	031 RED/VIO	Main Broom Actuator Reversing polarity driver	37v at rest or when moving up 5.3v when moving down
5	106 GRA/VIO	Side Broom Actuator Reversing polarity driver	37v at rest or when moving down 0.08v when moving up

J3 Pin	Wire	Circuit Description	Value/Condition
6	111 BRN/GRN	Dump Door Actuator Reversing polarity driver	37v at rest or closing 0.07v opening
7	115 RED/GRA	Dump Door Actuator Reversing polarity driver	37v at rest or opening 0.03v closing
8	118 WHT/ORN	High Pressure Pump Clutch Coil	0.003v Off 11.9v On (Service Mode)
9	123 PINK	Ignition On Output 12v out to engine system	0v key off 12.1v key on
10	129 BLU/PINK	Start Output 12v out to starter	0v key off 10.9v cranking (12v if starter disabled)
11	131 GRA/ORN	Throttle 2 Output	0.03v or 13.8v (depending on throttle request)
12	134 GRA/BLU	Throttle 1 Output	0.03v or 13.8v (depending on throttle request)
13	137 BRN/RED	Dust Guard Control (Pump and Valve) Grounds to turn both on	0.05v when energizing valve and running pump
14	139 VIO/BRN	Horn Ground to turn on	0.24v when sounding horn
15	144 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
16	142 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
17	250 GRN/ORN	Side Broom Actuator Reversing polarity driver	37v at rest or when moving up 0.05v when moving down
18	149 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
19	154 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
20	156 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
21	159 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
22	---		
23	059 VOI/RED	12V supply Power supply from starting battery	0v key off 12.1v key on
24	171 GRN/WHT	Low Pressure Pump	37v (Not “Installed”) 0v (“Installed”)
25	---		
26	058 GRA	VACC2 Power supply from Aux Contactor	0v Key Off 37v Key On (Aux Relay energized)
27	076 GRN/BRN	Backup Alarm	Not measured
28	---		
29	166 BLK	Battery Negative	0.006v with scrub, sweep and vacuum motors free running
30	---		

J3 Pin	Wire	Circuit Description	Value/Condition
31	---		
32	049 ORN/BLK	Glow Plug Output 12v out to energize relay	11.6v when glow plug relay energized 0v key off or after time out period
33	---		
34	056 GRA/BLK	VACC3a Power supply from Aux Contactor	0v Key Off 37v Key On (Aux Relay energized)
35	055 GRA/BLK	VACC3b Power supply from Aux Contactor	0v Key Off 37v Key On (Aux Relay energized)

J7 Connector (Black)

J7 Pin	Wire	Circuit Description	Value/Condition
1	092 GRN/BLU	Interlock Switch Input	37v when all interlock switches closed 0v otherwise
2	095 GRN	CAN Bus Low	2.448v
3	099 YEL	CAN Bus High	2.52v
4	102 GRA	Run Signal Output	14v when engine running 0v key off, on or cranking (starter disabled)
5	108 GRA/YEL	Engine Coolant Temperature	4.99v normal temp
6	112 TAN/WHT	Fuel Level Sender	3.3v open circuit 1.8v float at bottom 0.37v float at top
7	117 YEL/RED	Low LP Pressure Switch	5.0v when open
8	---		
9	---		
10	130 WHT/BRN	+12v Power out to Control Panel	12.07v
11	133 BLK	B- (Ground) for Control Panel	0.002v
12	050 YEL/BRN	Suppression Diode	37v key on
13	141 ORN	Key Switch On Input	37v key on 0v key off
14	046 RED/BLK	Hopper Interlock Switch	0.0v full down position 4.8v otherwise
15	035 GRA/YEL	Extended Scrub Level Switch	4.8v (machine not equipped)
16	143 WHT/GRA	Dust Control Filter Switch	4.8v (machine not equipped)
17	145 ORN/GRA	Brake Switch	0v brake pedal at rest position 4.8v brake pedal pressed (not at rest)
18	151 YEL/VIO		
19	155 VIO/GRN	Key Switch Start Input	37v key in start 0v key off or on
20	---		
21	161 RED/ORN	Scrub Deck Retract Limit Switch	0.0v full up position 4.8v otherwise

J7 Pin	Wire	Circuit Description	Value/Condition
22	168 ORN/RED	Hopper Dump Door Extend Limit Switch	0.0v full closed position 4.8v otherwise
23	170 YEL/WHT	Hopper Dump Door Retract Limit Switch	0.0v wide open position 4.8v otherwise
24	172 BLU/YEL	+5v Power out to Current Sensors	4.97v
25	174 VIO/WHT	B- Ground for Current Sensors	0.002v
26	---		
27	178 BRN	Brush Motor Current Sense	2.49v at rest (no current) 2.86v free-running at 22 amps
28	---		
29	184 RED/WHT	Vacuum Motor Current Sense	2.49v at rest (no current) 3.01v Vac running, cover open at 28 amps
30	---		
31	215 ORN/BLU	Broom Motor Current Sense	2.49v at rest (no current) 2.71v free-running at 12 amps
32	---		
33	032 BLU/ BLK	POT High Power supply for Main Broom Actuator Position Sensor	3.304v (plugged in or unplugged)
34	033 GRA/GRN	Wiper Main Broom Actuator Position Sensor input	0.002v full up position 3.02v bottom of travel (9.93v when open)
35	034 TAN/RED	POT Low B- for Main Broom Actuator Position Sensor	0.002v

Dust Control/DustGuard™ Systems

Functional Description

Overview

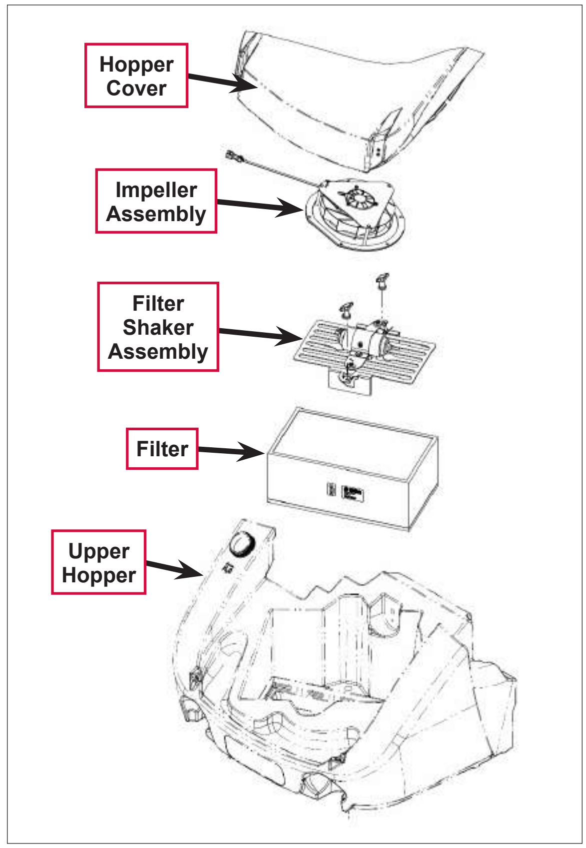
The dust control system pulls air through the hopper and through a filter to trap the dust from the hopper. The optional DustGuard™ system sprays a fine stream of water in front of each side broom to minimize the dust created by the main broom.

Dust Control System

The **Impeller Assembly**, mounted in the **Hopper Cover**, pulls air from the **Upper Hopper** through the **Filter** which traps the dust generated by the sweep system. The **Impeller Assembly** exhausts the filtered air through vents in the **Hopper Cover**.

An optional dust control filter switch will shut off the vacuum motor in the **Impeller Assembly** if the vacuum on the clean side of the filter gets too high as a result of a clogged **Filter**. When the switch is activated, the LCD will display an icon to the operator.

The removable **Filter Shaker Assembly** vibrates the **Filter** when the filter shaker switch is pressed to shake large particles from the input side of the **Filter** back into the hopper. This reduces **Filter** maintenance and helps maintain adequate airflow through the **Filter**. The **Filter Shaker Assembly** will automatically switch on when the sweep system is turned off.

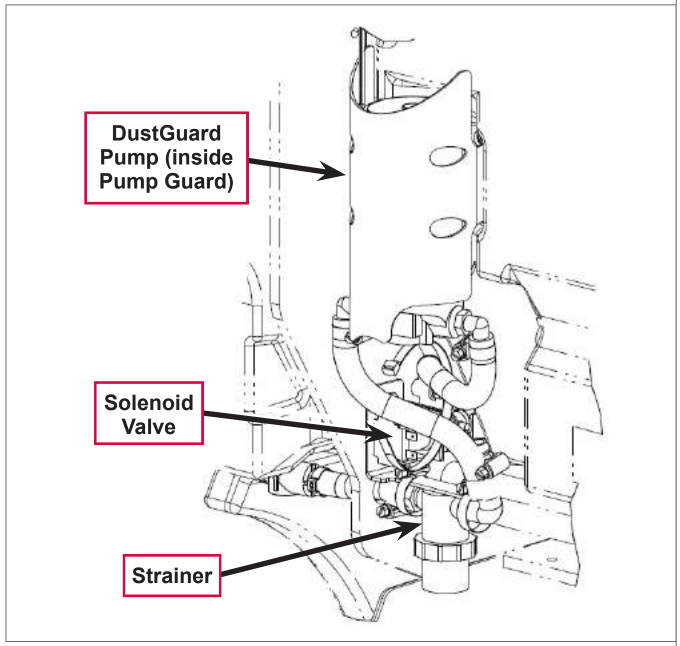


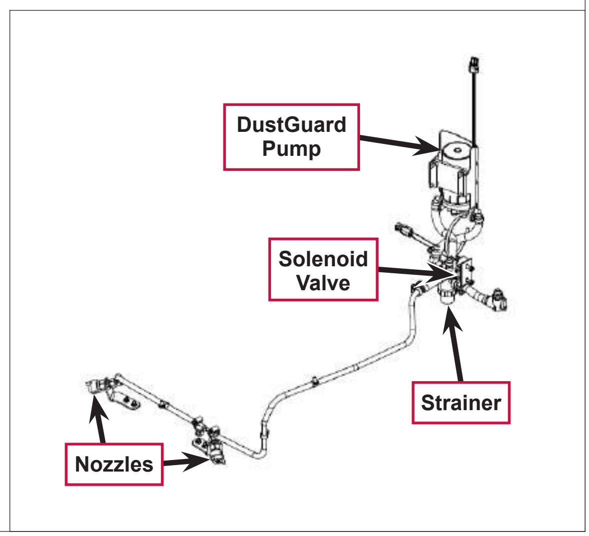
DustGuard™ Spray System (optional)

The **DustGuard Pump** pumps water from a separate reservoir in the upper hopper to **Nozzles** on the front of the machine. The **Nozzles** direct a fine stream of water onto the floor in front of the side brooms to help reduce the dust generated by the brooms.

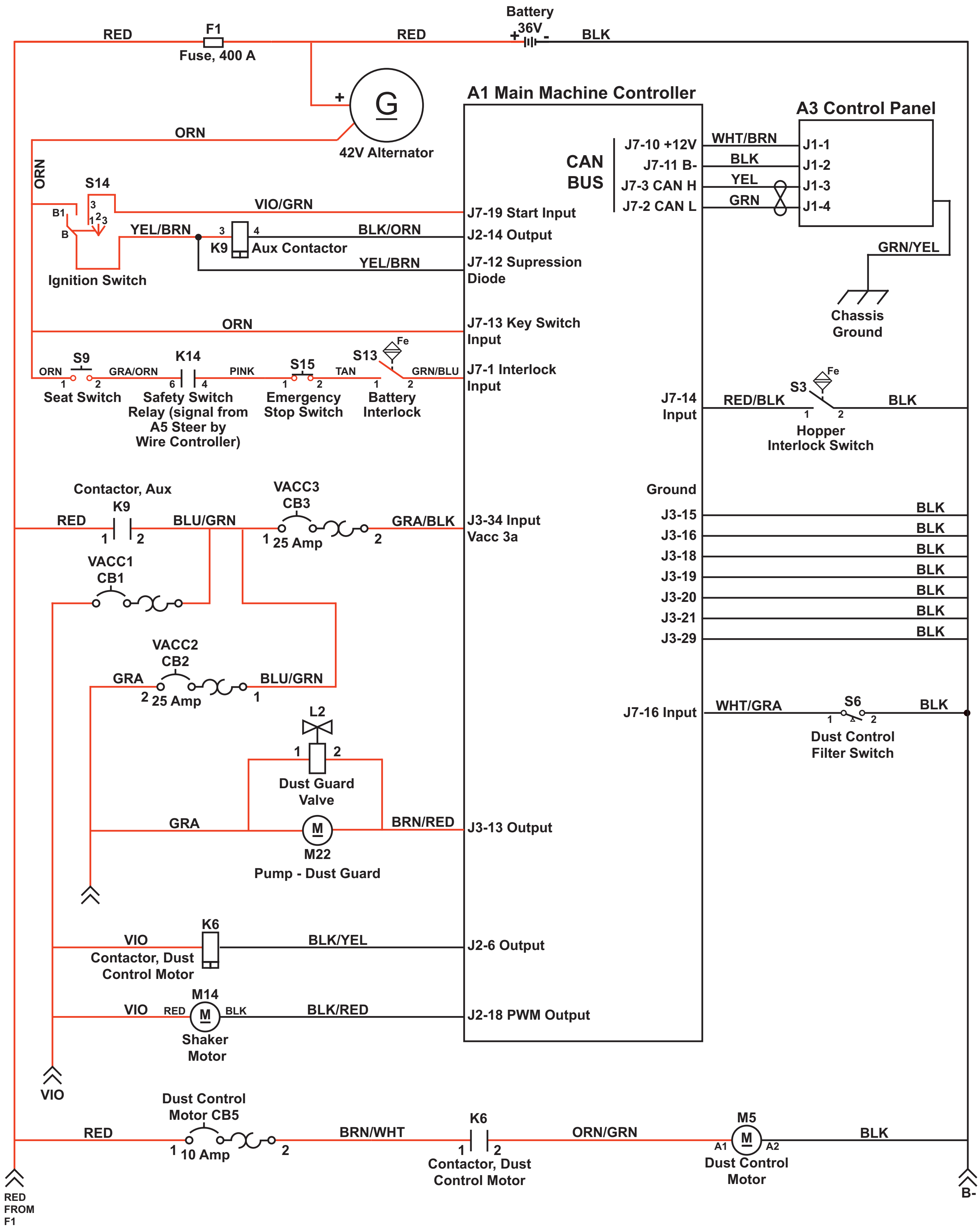
The DustGuard™ **Solenoid Valve** opens to allow water flow from the **DustGuard Pump** to the **Nozzles** when the power to the **DustGuard Pump** switches on. A removable **Strainer** is installed in the water line upstream of the **DustGuard Pump** and **Solenoid Valve**. Removable strainers are also located inside of the **Nozzle** assemblies.

When installed, the DustGuard™ spray system will turn on automatically when the main broom/ sweep system is turned on.





DustGuard™ System Wiring Diagram



Circuit Description

The following conditions must be met for the DustGuard™ system to operate:

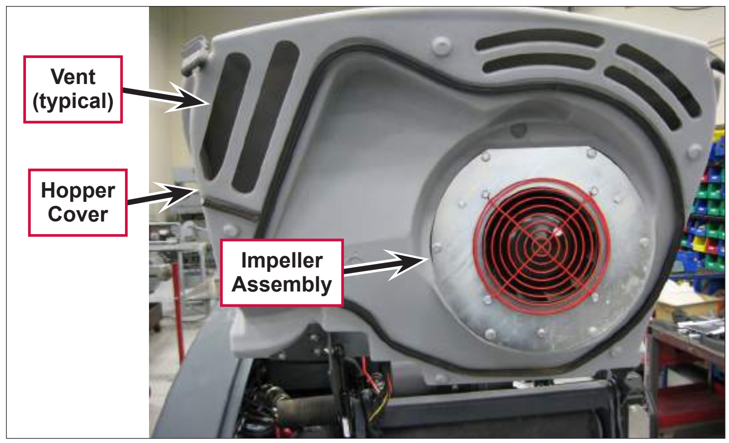
- The DustGuard™ system must be installed in the configuration menu.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed (battery machines) or jumpered (Diesel and LPG machines).
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9**, and to the 10-amp circuit breaker **CB5**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-12**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breaker **VACC2/CB2**.
- Circuit breaker **VACC1/CB1** must closed to provide positive voltage to the **Dust Control Motor Contactor K6** coil and the **Shaker Motor M14**.
- The **J2-6 Output** provides the negative ground to the **Dust Control Motor Contactor K6** coil under the following conditions:
  - If the hopper is down:
    - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the DustGuard™ spray switch (blue LED on).
    - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or backward.
  - If the hopper is up, the **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the DustGuard™ spray switch. Note that the seat switch does not have to be closed.
- Circuit breaker **CB5** must closed to provide positive voltage to the load side of **Dust Control Motor Contactor K6**.
- **Dust Control Motor Contactor K6** must be closed to provide positive voltage to the **Dust Control Motor M5**.
- **Dust Control Motor M5** must be connected to battery ground.
- Circuit breaker **VACC2/CB2** must closed to provide positive voltage to the **DustGuard Valve L2** and the **DustGuard Pump M22**.
- The **J3-13 Output** provides the negative ground to the **DustGuard Valve L2** and the **DustGuard Pump M22** under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the DustGuard™ spray switch (blue LED on).
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward.

- The **J2-18 Output** provides the negative ground to the **Shaker Motor M14** under the following conditions:
  - If the hopper is down and the DustGuard™ system is enabled, the **A1 Main Machine Controller** will switch on the **Shaker Motor M14** automatically for preset duration when the sweep system is switched off.
  - If the hopper is up, the **A1 Main Machine Controller** must receive a signal from the **A3 Operator Interface Panel** via the **CAN BUS** that the operator has pressed the filter shaker switch (blue LED on).

Component Locations

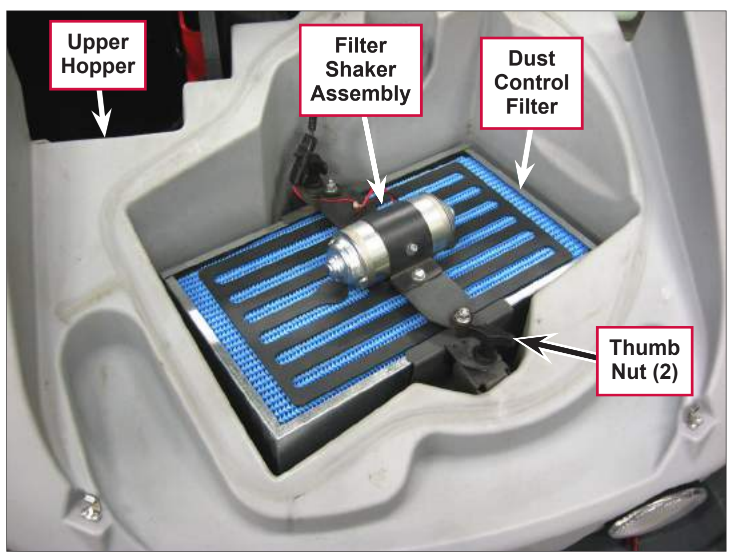
Impeller and Filter System

The **Impeller Assembly** houses the dust control vacuum motor and is mounted in the **Hopper Cover**. The **Impeller Assembly** pulls air from the hopper through the filter. The filtered air is exhausted through **Vents** in the front of the **Hopper Cover**.



The rectangular **Dust Control Filter** seals against the **Upper Hopper** and is held in place by the **Filter Shaker Assembly**.

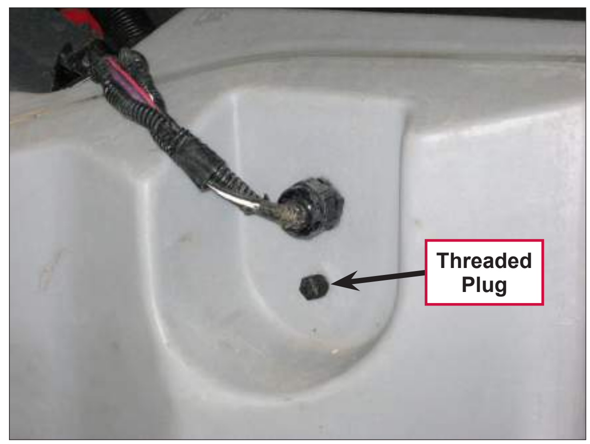
The electric motor in the **Filter Shaker Assembly** drives two eccentric weights to vibrate or "shake" the **Dust Control Filter** to dislodge dust and allow it to drop down into the hopper. Two **Thumb Nuts** secure the **Filter Shaker Assembly** and **Dust Control Filter** to the **Upper Hopper**.



Dust Control Filter Switch

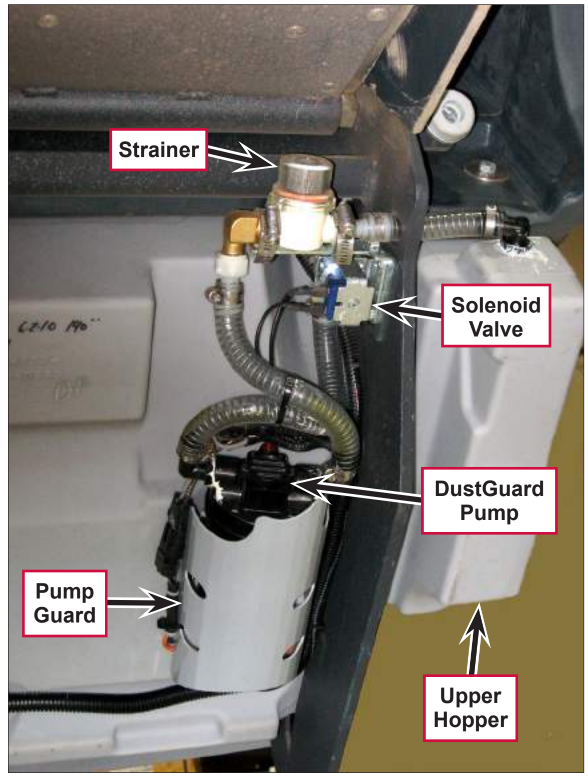
The optional **Dust Control Filter Switch** is mounted above the **Filter Shaker Assembly** on the **Upper Hopper**. The **Dust Control Filter Switch** will close and generate a warning if the hopper vacuum gets too high, indicating a plugged **Dust Control Filter**. Note that the **Dust Control Filter Switch** is factory-set to close at 2” of water, 0.147” Hg or 0.072 psi.

If the dust control filter switch is not installed in the hopper, there will be a **Threaded Plug** installed in the switch hole.



DustGuard™ Spray System

The **DustGuard Pump** is mounted on the **Upper Hopper** and is protected by the **Pump Guard**. The **Strainer** screens the incoming water upstream of the **DustGuard Pump**. The **Solenoid Valve**, downstream of the **DustGuard Pump**, opens to allow water flow to the nozzles when the power to the **DustGuard Pump** is switched on.



The **Spray Nozzles** are mounted on the front of the machine and spray an oval pattern of water mist across the width of each side broom.

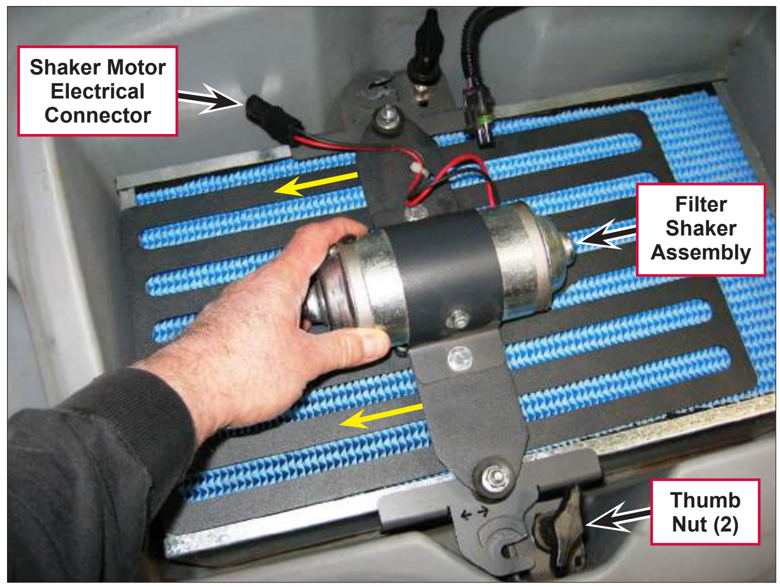
Maintenance and Adjustments

***Warning!** Before performing any machine maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.*

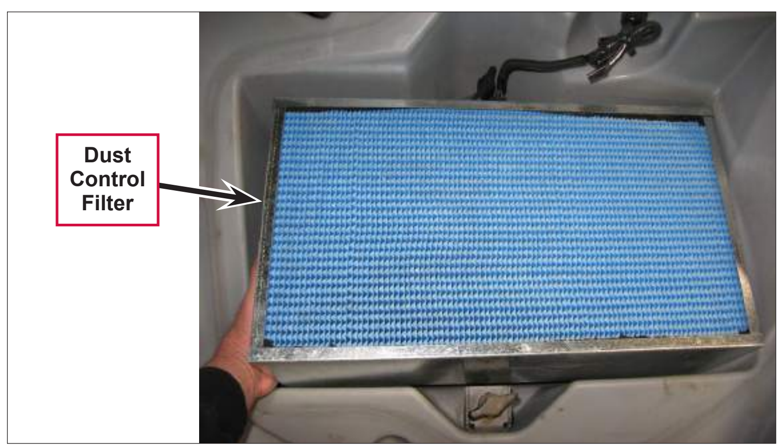
To Clean the Dust Control Filter

To Remove the Dust Control Filter

1. Lift the hopper cover.
2. Disconnect the **Shaker Motor Electrical Connector**.
3. Loosen the two **Thumb Nuts**, then slide the **Filter Shaker Assembly** toward the left and remove it from the machine.



4. Lift the **Dust Control Filter** out of the machine.
5. Inspect the top of the **Dust Control Filter** for damage. A large amount of dust on top of the **Filter** is usually caused by a hole in the **Filter** or a damaged filter gasket.



To Clean the Dust Control Filter

Caution:
- ***Wear safety glasses when cleaning the filter.***
- ***Clean the filter in a well-ventilated area.***
- ***Be careful not to puncture the filter element.***

1. Check the filter surfaces, and urethane gasket on the bottom of the filter for signs damage. If the filter surfaces or gasket are damaged, replace the filter.
2. Clean the dust control filter using either of the two methods below:

   Method 1:

   a. Vacuum any loose dust from the filter.

   b. Gently tap the filter against a flat surface (with the dirty side down) to remove loose dust and dirt.

   Method 2:

   a. Vacuum any loose dust from the filter.

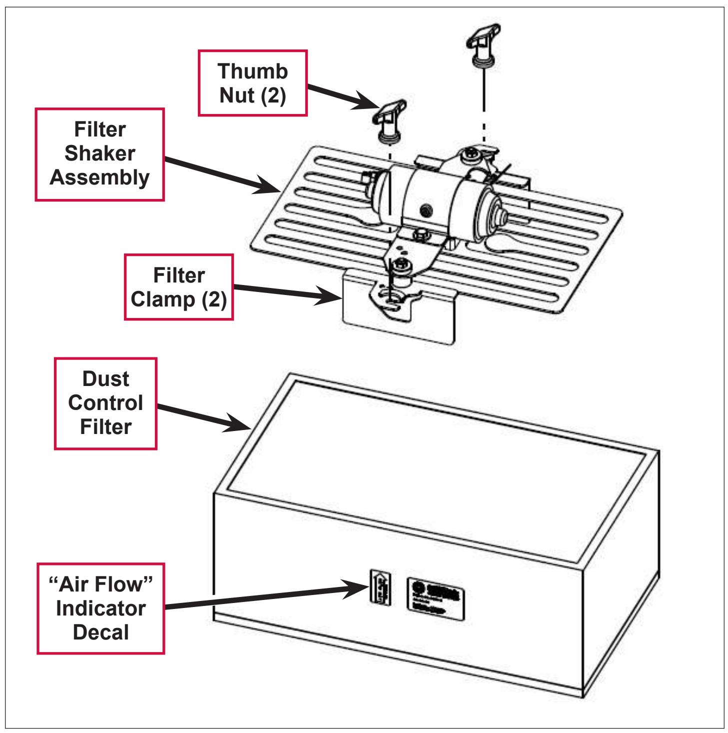
   b. Blow compressed air (maximum pressure 100 psi) into the clean side of the filter (in the opposite direction of the airflow).

To Reinstall the Dust Control Filter

1. Install the **Dust Control Filter** into the recess in the upper hopper.

Note: *Make sure the arrow on the* ***"Air Flow" Indicator Decal*** *on the side of the filter is pointing upward.*

2. Install the **Filter Shaker Assembly** onto the **Dust Control Filter**. Make sure the shaker motor electrical connector is positioned toward the rear of the machine.
3. Slide the **Filter Shaker Assembly** toward the right so the **Filter Clamps** engage the **Thumb Nut** studs on the upper hopper.
4. Tighten the two **Thumb Nuts**.
5. Reconnect the **Shaker Motor Electrical Connector**.
6. Close the hopper cover.



To Clean the DustGuard™ Strainer Screen

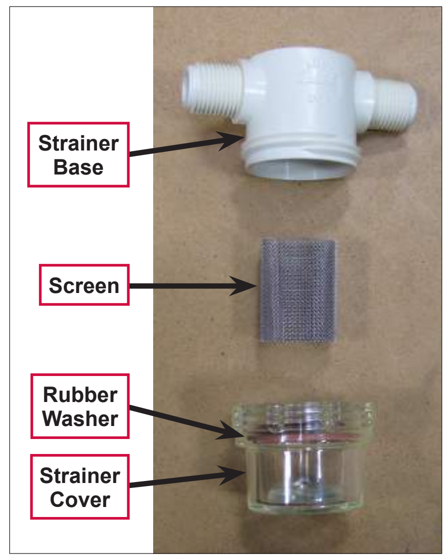
1. Drain the water from the upper hopper. Note that you can do this one of several ways. The most convenient way is to remove the **Strainer Cover** and **Screen** and drain the upper hopper through the DustGuard™ strainer.

Note: *Place a suitable container underneath the upper hopper to catch the water from the hopper reservoir.*

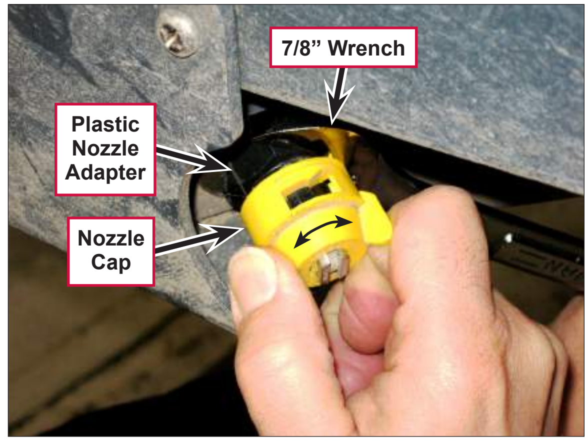
2. Raise the hopper and engage the prop rod.

Note: *Place a suitable container underneath the filter to catch any water that may leak from the hoses.*

3. Unscrew the **Strainer Cover** and remove the **Strainer Cover** and **Screen** from the **Strainer Base**.
4. Clean any accumulated dirt or debris from the **Screen**.
5. Reinstall the **Screen** into the **Strainer Base**.
6. Make sure the **Rubber Washer** is installed correctly in the **Strainer Cover**, then reinstall and hand-tighten the **Strainer Cover**.



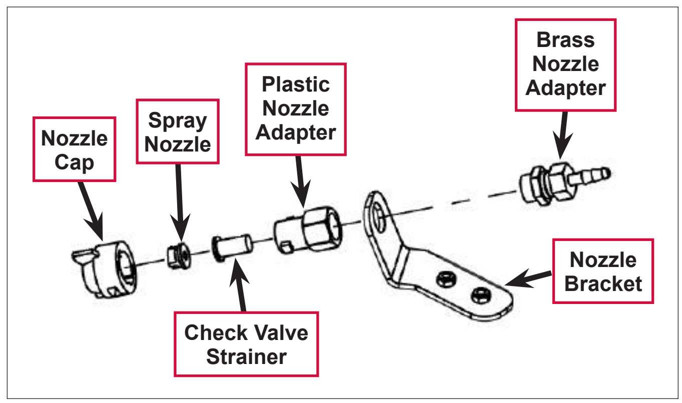
To Clean the DustGuard™ Spray Nozzles



1. Raise the hopper slightly if desired for easier access to the DustGuard™ nozzles.

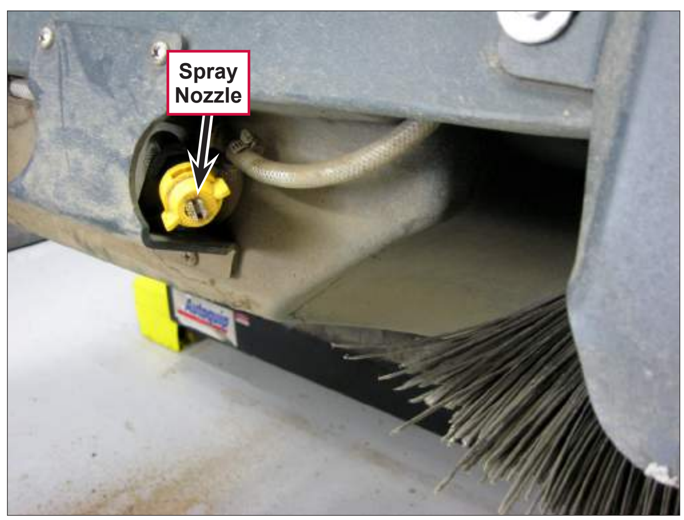
> ***Note:*** *Place a suitable container underneath the nozzles to catch any water that may leak from the hoses.*

2. Hold the **Plastic Nozzle Adapter** with a **7/8” Wrench** to keep it from rotating in the **Nozzle Bracket** when you remove the **Nozzle Cap**. This will maintain the correct spray pattern orientation of the **Spray Nozzle**.
3. Rotate the **Nozzle Cap** one-quarter turn counterclockwise (as viewed from the front of the machine) to remove the **Nozzle Cap**, **Spray Nozzle** and **Check Valve Strainer** from the **Plastic Nozzle Adapter**.
4. Rinse the **Nozzle Cap**, **Spray Nozzle** and **Check Valve Strainer** in clean water to remove any accumulated dirt or sediment. If necessary, rinse or soak the components in vinegar or other commercial cleaner to remove any mineral deposits.
5. Reassemble the DustGuard™ nozzles by following the above steps in reverse order.



To Adjust the DustGuard™ Spray Nozzles

The **Spray Nozzles** should be approximately 10 to 20 degrees from vertical as shown in order to spray the water evenly top to bottom in front of the side brooms. (Note that the hopper has been raised slightly in the adjacent photo.) The spray pattern should wet the floor across the whole width of the side broom. If the spray pattern is not correct:



1. Carefully rotate the **Plastic Nozzle Adapter** with a **7/8” Wrench** to orient the **Spray Nozzle**.
2. After you rotate the **Plastic Nozzle Adapter**, make sure the **Brass Nozzle Adapter** is holding **Plastic Nozzle Adapter** securely in the **Nozzle Bracket**. Tighten the **Brass Nozzle Adapter** to the **Plastic Nozzle Adapter** as necessary.

Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
The DustGuard™ system does not operate.	The DustGuard™ system is not installed in the configuration menu.	Make sure the DustGuard™ system is installed in the configuration menu.
Inadequate water flow to the DustGuard™ nozzles	Inadequate water level in upper hopper	Check the water level.
	The water strainer screen is plugged.	Clean the strainer screen.
	The water hoses/nozzles are plugged.	Check and clean the water hoses/nozzles as necessary.
	The water solenoid valve is plugged or not functioning correctly.	Check for voltage at the solenoid valve. • If there is voltage at the solenoid, check the solenoid coil resistance. It should measure 125 ohms ± 10%. If the coil resistance is not within spec replace the solenoid valve. • If there is no voltage at the solenoid: 1. Check the wiring and circuit breakers upstream of the solenoid. 2. Check the **J3-13** output from A1 Main Machine Controller.
	The DustGuard™ pump (**M22**) is not operating correctly.	Check for voltage at the pump. • If there is voltage at the pump, replace the pump. • If there is no voltage at the pump: 1. Check the wiring and circuit breakers upstream of the pump. 2. Check the **J3-13** output from A1 Main Machine Controller.

Problem	Cause	Correction
The dust control motor will not run.	The dust control filter switch is closed, indicating that the filter is plugged.	1. Clean the filter. 2. Check the dust control filter switch. The switch should be open with no vacuum in the hopper (dust control motor off). Replace the dust control filter switch if necessary.
	There is no voltage to the dust control motor.	1. Check the wiring and circuit breakers upstream of the dust control motor. 2. Check the coil resistance in the **K6** contactor coil. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 3. Check the continuity through contactor **K6** with the coil energized. If the contacts are open, replace the contactor. 4. Check the **J2-6** output from A1 Main Machine Controller.
	The dust control motor is not operating correctly.	If there is voltage to the dust control motor, replace the motor.
The shaker motor will not run.	There is no voltage to the shaker motor.	1. Check the wiring and circuit breakers upstream of the shaker motor. 2. Check the **J2-18** output from A1 Main Machine Controller.
	The shaker motor is not operating correctly.	If there is voltage to the shaker motor, replace the motor.

Removal and Installation

***Warning!** Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.*

To Remove and Reinstall the DustGuard™ Solenoid Valve Assembly

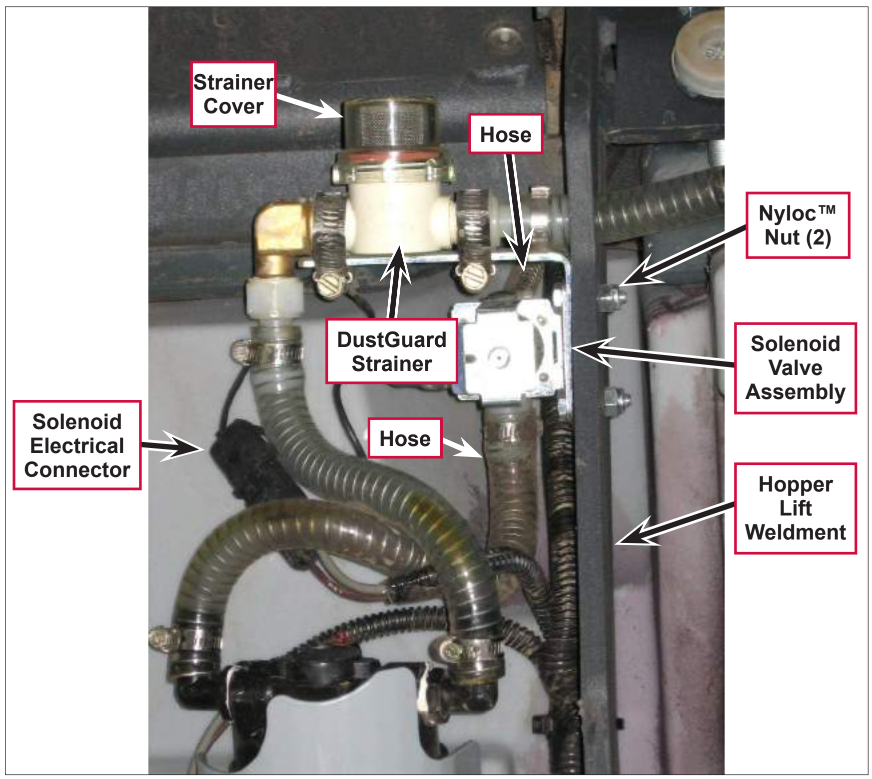
1. Drain the water from the upper hopper. Note that you can do this one of several ways. The most convenient way is to remove the **Strainer Cover** and screen and drain the upper hopper through the **DustGuard Strainer**.

***Note:** Place a suitable container underneath the upper hopper to catch the water from the hopper reservoir.*

2. Turn the key switch on, raise the hopper and engage the prop rod, then turn off the key switch.

***Note:** Place a suitable container underneath the **Solenoid Valve Assembly** to catch any water that may leak from the **Solenoid Valve Assembly** and hoses.*

3. Disconnect the **Solenoid Electrical Connector**.
4. Remove the two **Nyloc™ Nuts** holding the **Solenoid Valve Assembly** to the **Hopper Lift Weldment**.
5. Disconnect the two **Hoses** and remove the **Solenoid Valve Assembly** from the machine.
6. Reinstall the **Solenoid Valve Assembly** by following the above steps in reverse order.



To Remove and Reinstall the DustGuard™ Pump

1. Drain the water from the upper hopper. Note that you can do this one of several ways. The most convenient way is to remove the strainer cover and screen and drain the upper hopper through the DustGuard™ strainer.

Note: *Place a suitable container underneath the upper hopper to catch the water from the hopper reservoir.*

2. Turn the key switch on, raise the hopper and engage the prop rod, then turn off the key switch.

Note: *Place a suitable container underneath the* **DustGuard Pump** *to catch any water that may leak from the* **DustGuard Pump** *and hoses.*

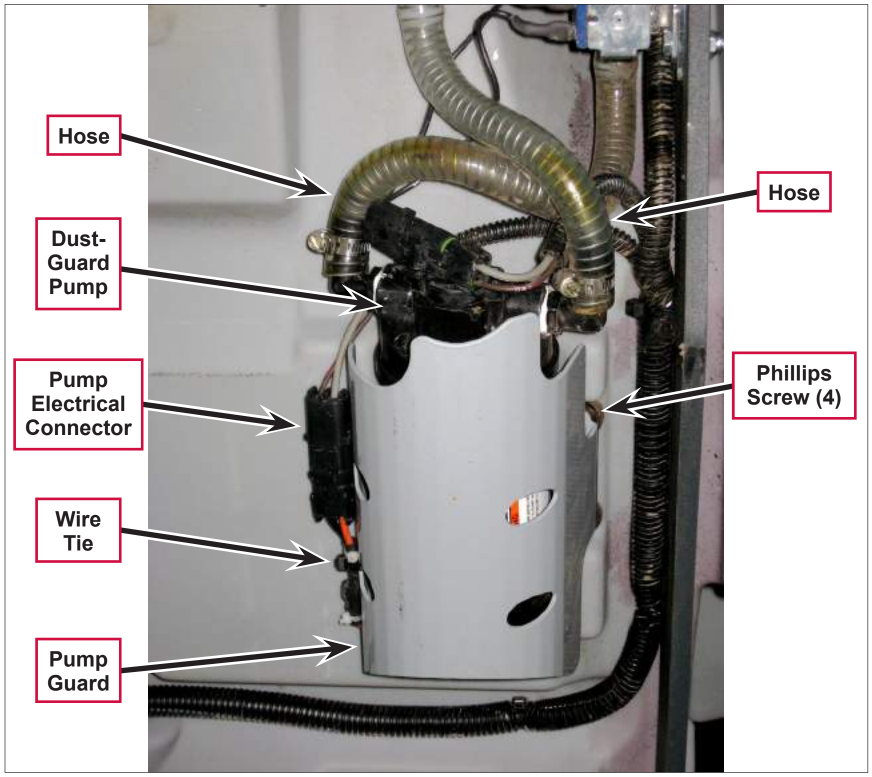
3. Disconnect the **Pump Electrical Connector**.

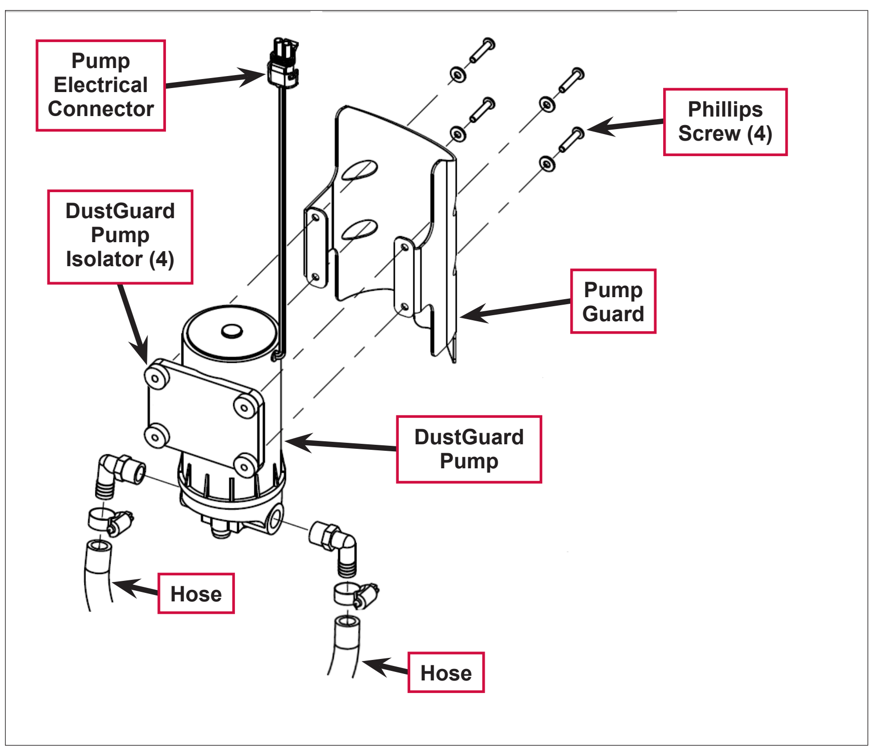
4. Disconnect the two **Hoses** from the **DustGuard Pump**.

5. Remove the four **Phillips Screws** and washers holding the **Pump Guard** and **DustGuard Pump** to the **Upper Hopper** and remove the **Pump Guard** and **DustGuard Pump** from the machine.

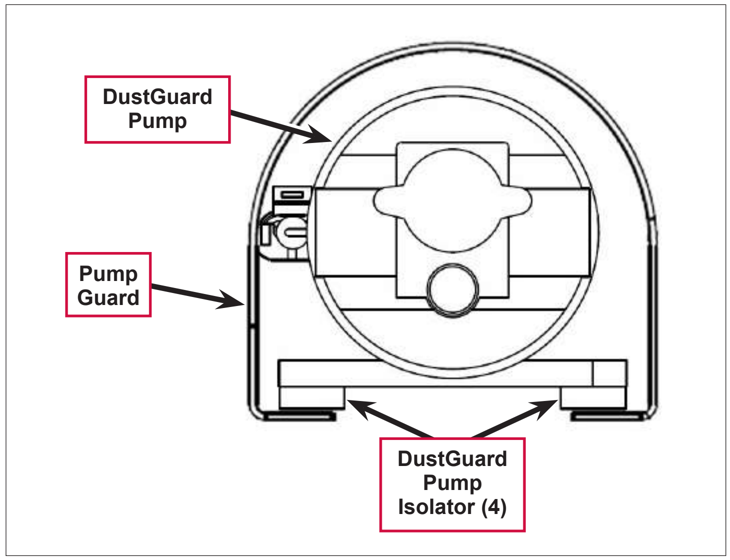
   Note that you'll need to cut the **Wire Tie** holding the **Pump Electrical Connector** wires to the **Pump Guard** in order to separate the **Pump Guard** and **DustGuard Pump**.

6. Reinstall the **DustGuard Pump** by following the above steps in reverse order.



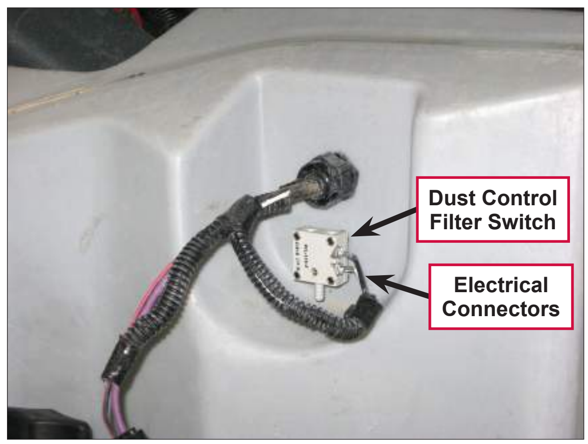


Note: *The* **Pump Guard** *base should be positioned under the four* ***DustGuard Pump Isolators***.



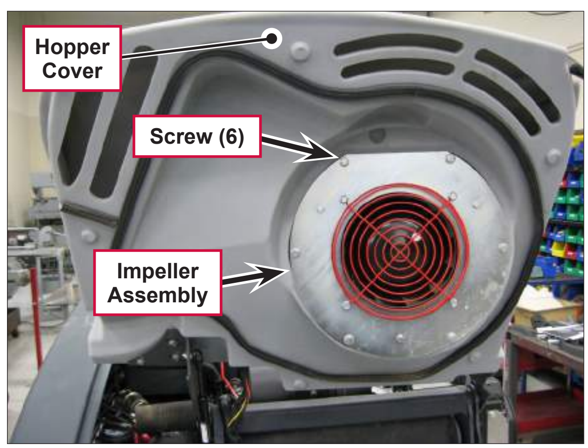
To Remove and Reinstall the Dust Control Filter Switch

1. Lift the hopper cover.
2. Disconnect the two **Electrical Connectors** from the **Dust Control Filter Switch**.
3. Unscrew the **Dust Control Filter Switch** from the upper hopper.



To Remove and Reinstall the Impeller Assembly

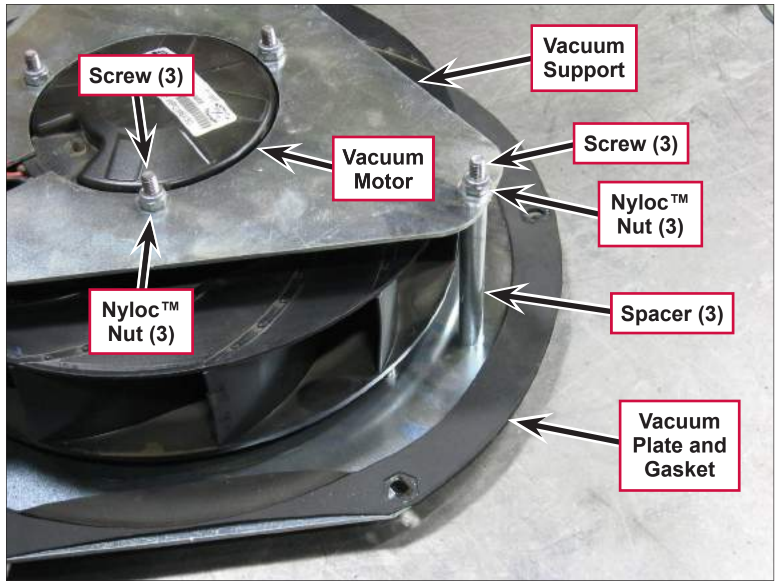
1. Lift the **Hopper Cover**.
2. Remove the six **Screws** and washers holding the **Impeller Assembly** to the **Hopper Cover**.
3. Carefully pull the **Impeller Assembly** partway off of the **Hopper Cover**.
4. Disconnect the **Vacuum Motor** electrical connector, then remove the **Impeller Assembly** from the machine.
5. Reinstall the **Impeller Assembly** by following the above steps in reverse order.

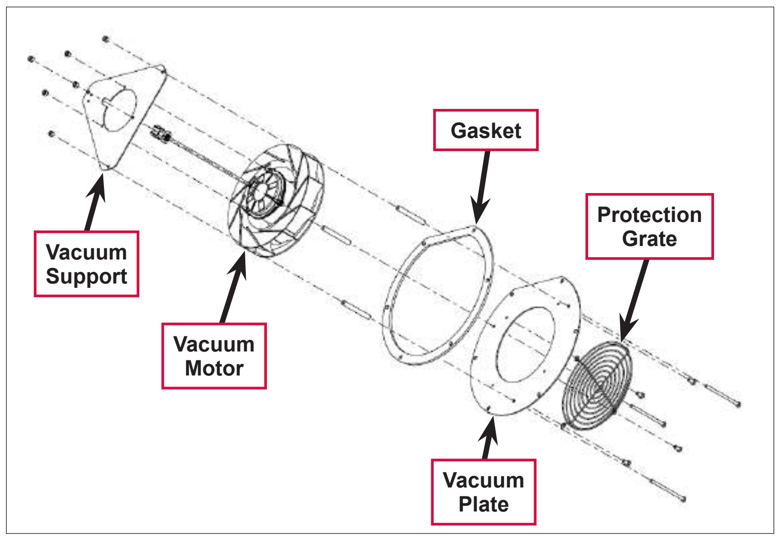


To Disassemble and Reassemble the Impeller Assembly

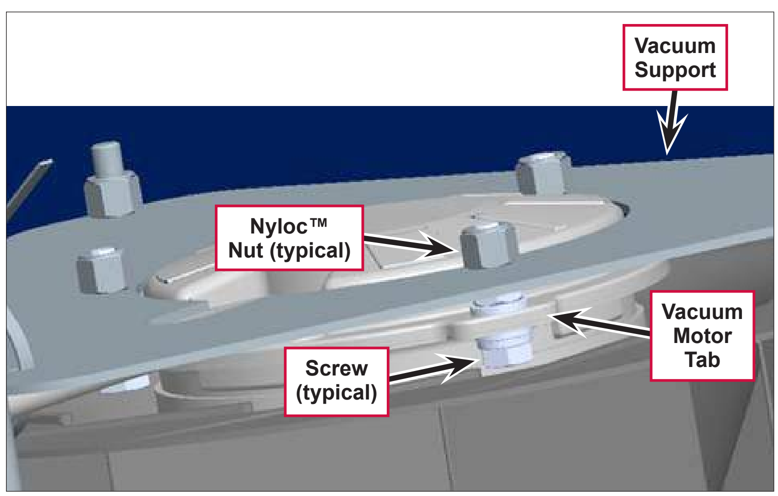
1. Remove the three **Nyloc™ Nuts**, **Screws** and **Spacers** holding the **Vacuum Plate and Gasket** to the **Vacuum Support** and attached **Vacuum Motor**.

2. Remove the three **Nyloc™ Nuts** holding the **Vacuum Motor** to the **Vacuum Support** and remove the **Vacuum Motor**.





Note: *To prevent the three **Screws** from spinning when removing the **Nyloc™ Nuts** to remove the **Vacuum Motor**, place a wrench on the **Screw** heads under the **Vacuum Motor Tabs**.*



3. Reassemble the impeller assembly following the above steps in reverse order.

Specifications

Component	Specifications
DustGuard Pump	Type - Diaphragm w/bypass
	Nominal Voltage - 36 VDC
	Flow Rate - 1.1 GPM
	Current - 1.0 Amp max.
	Pressure - 30 psi max.
DustGuard Solenoid Valve	Nominal Voltage - 36 VDC, 11 Watts
	Coil Resistance - 125 Ohms ± 10%
Dust Control Filter	Media Type - synthetic with UltraWeb (cellulose optional)
	Media Quantity - 120 ft^2 (approximate)
	Media Configuration - PowerCore
Dust Control Vacuum Motor	Current - 7 Amps average, 8 Amps max.
Dust Control Motor Contactor (K6)	118 Ohms ± 10%
Dust Control Filter Switch	Actuation setting ± 20%: factory set at 2” H_2O/ 0.147” Hg/0.072 psi
Filter Shaker Motor	Voltage - 36 VDC
	Current - 0.8 Amps average
	Power - 90 Watts
	Ingress Protection - IP44
	Insulation Class - B
	Duty - intermittent (S2 10 min.)

Electrical System

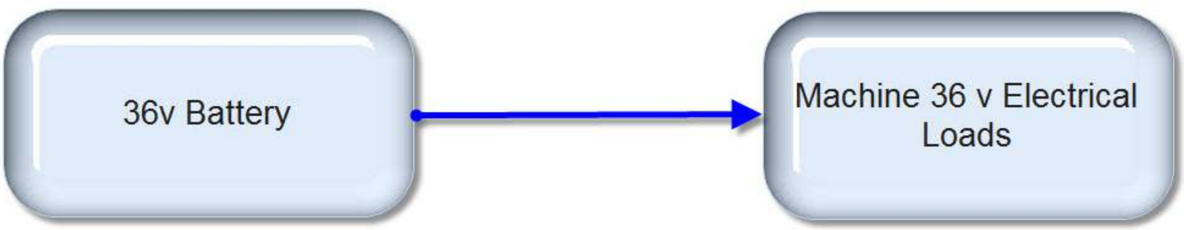
The electrical system chapter contains wiring diagrams, electrical panel information and covers other components that are not covered in other chapters. For instance, the Solution Pump is covered in the Solution System Chapter.

Functional Description

Overview

The CS7000 uses electricity to operate almost everything. The "Battery" model has a large capacity 36 volt storage battery for its only power source.

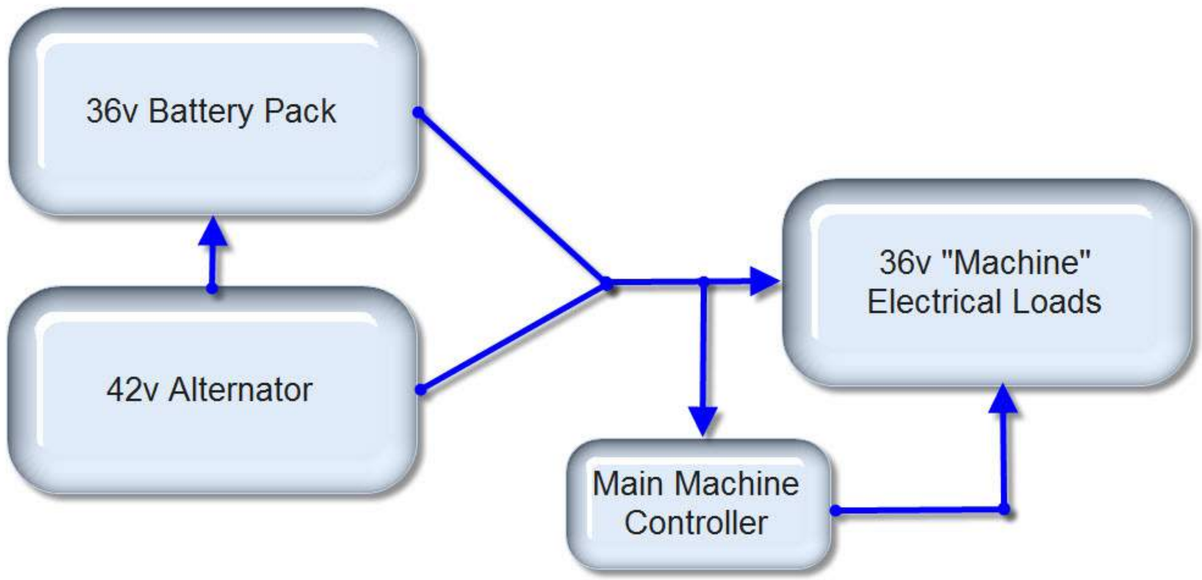
Power from the 36v battery supplies all machine electrical loads.



Battery Model Power Distribution

“Hybrid” models use a large, engine-driven 42 volt generator for their main power source with a smaller 36 volt battery pack connected in “parallel” with the generator, as a “back up”.

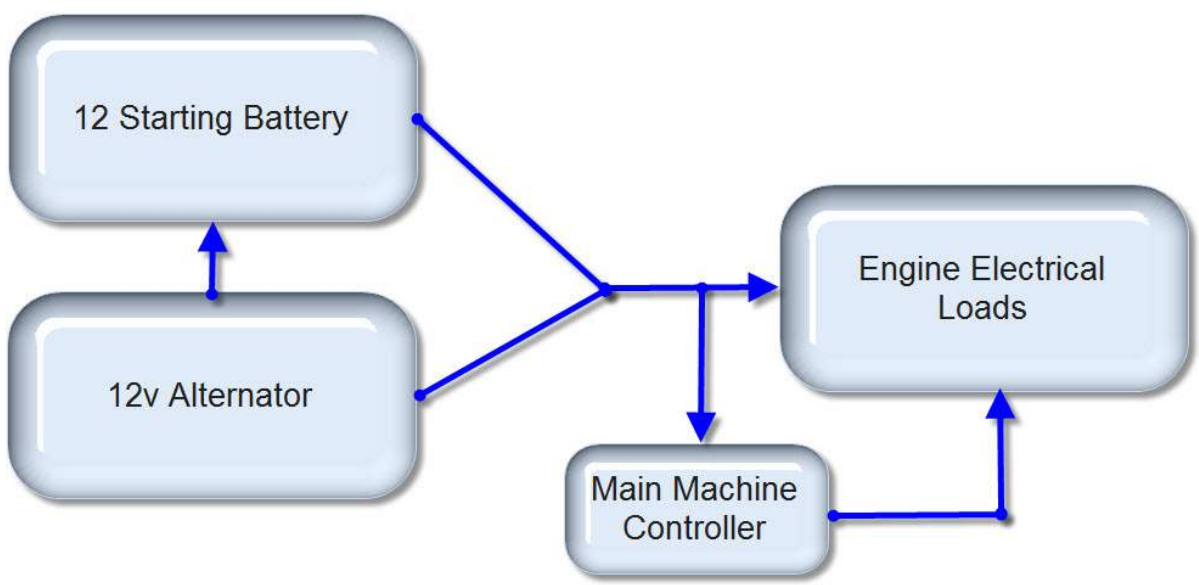
When the engine is running the 42 volt generator provides the electrical power to operate the 36v machine electrical loads as well as recharge the 36v battery pack. If the machine demands more current than the 42 volt generator can provide, the 36 volt battery pack supplies the extra boost that is needed. If the engine is not running the machine can work for a limited time on just the 36 volt battery pack The main machine uses a 36v supply to operate some 36v electrical loads.



Hybrid Power Supply

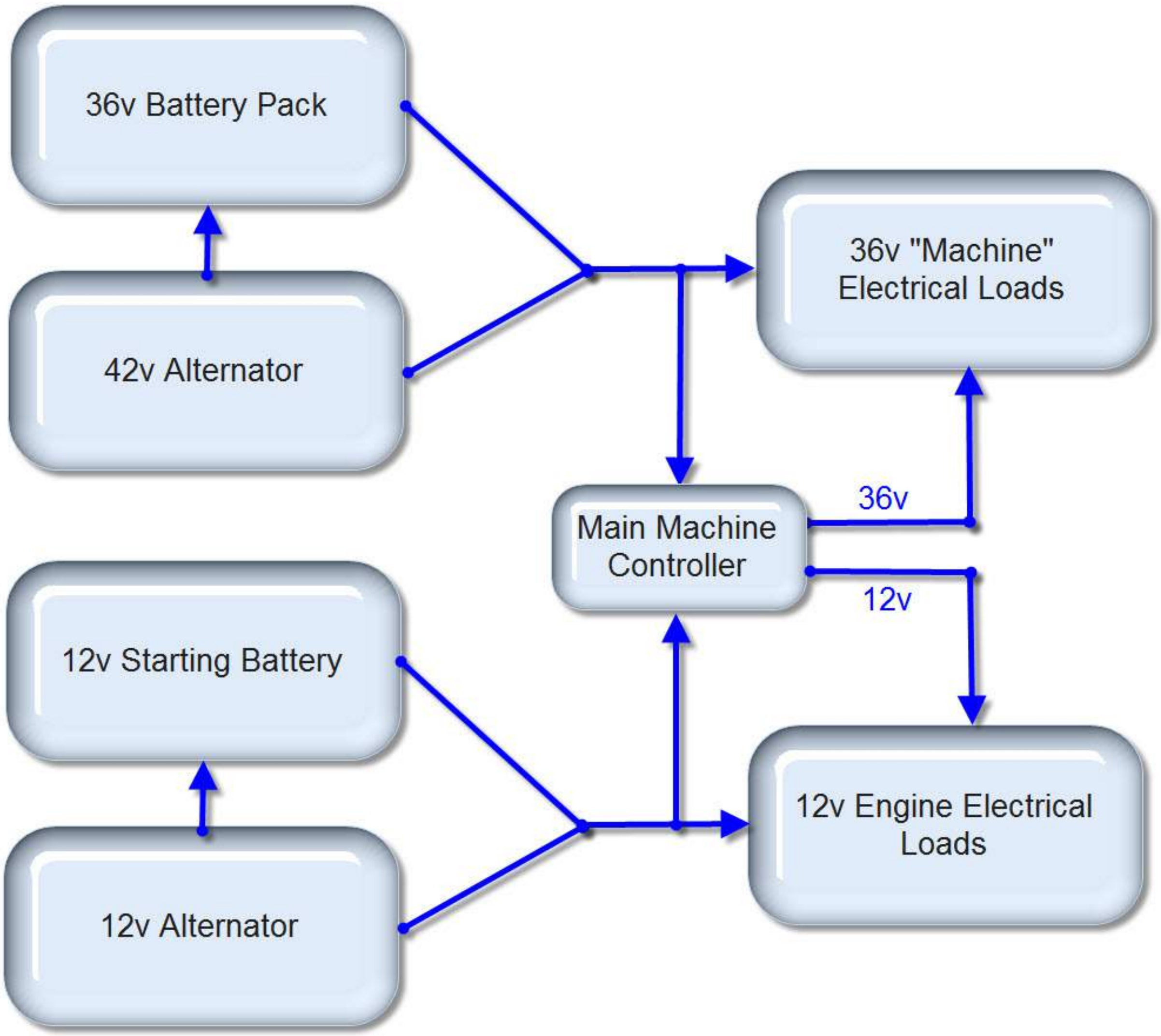
Hybrid models also have a separate 12 volt starting battery.

The main purpose of the staring battery is to start the engine. The engine drives a separate 12 volt generator (Alternator) to recharge the starting battery and supply power for 12v engine electrical loads. The main machine controller is supplied a 12v power source which it uses to control some 12v engine electrical devices.



12v Power Distribution - Engine models only

If you combine the power distribution for both the engine electrical loads and the 36v machine electrical loads it looks like this.



Combined Power Distribution - Engine Models

All models have a large connector to disconnect power from the machine. A circuit breaker panel located on the left side of the operator foot well area provides circuit protection for multiple circuits.

The electrical system makes use of hall effect current sensors to provide amp draw information to the main machine controller for some circuits.

Current Sensor

Wiring Harnesses

Wires are color coded and have connector information printed near each end of the wire. In the photo below, the left end of the wire goes to connector X274 pin A and the right side of the wire goes to connector J3 pin 9.

The main harness is the same for all models. Connectors which are not used for certain models or features have plugs covering them or may be “jumped” together as is the case for the battery interlock switch on engine models.

There are splices in the harness that are shrink wrapped. There are also two “splice saver” connectors which look like capped off connectors, but actually connect many wires together through a “comb” that is inserted into the connector.

The CAN Bus wire pairs are twisted to prevent electrical interference from corrupting the messages. If any repairs are performed on the CAN Bus wires, the wire pairs must be twisted approximately once per inch.

Circuit Protection

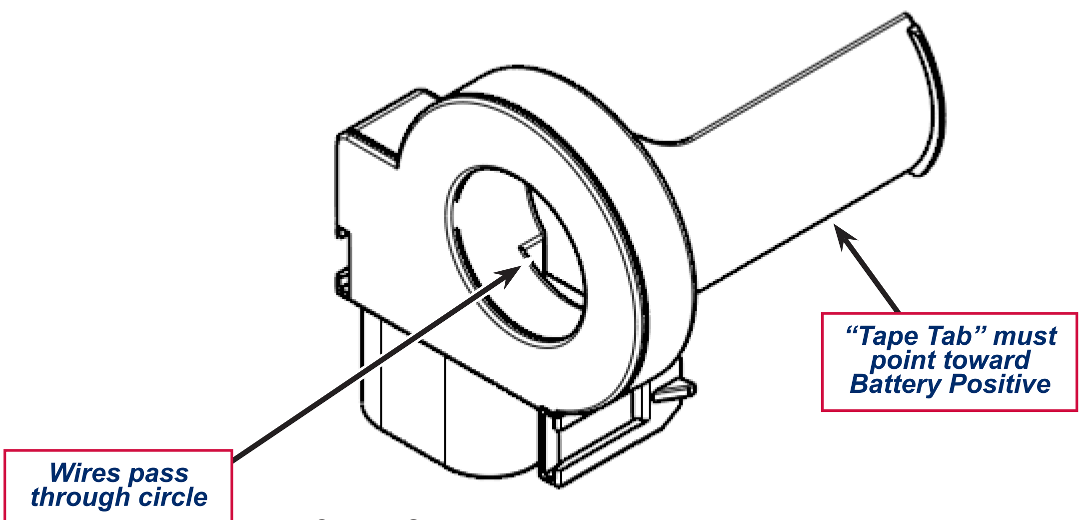
Circuit protection is accomplished with both fuses and circuit breakers. There are 2 large fuses. F1 is a 400 amp fuse that provides “complete machine” protection. F2 is a 150 amp fuse that protects the motor circuits for the main broom, scrub motors and vacuum motors.

Switched Power

A key switch (Ignition Switch) is used to provide switched power to the main machine controller but it carries only a small amount of current. The main machine controller in turn energizes an Auxiliary Contactor to provide 36 volt high current capacity supply to many circuits. The main machine controller also energizes an Auxiliary Relay which provides a 12 volt power supply to itself. The main machine controller then uses this 12 volts to switch out to various circuits like the Ignition output to the engine system.

Current Sensors

The CS7000 utilizes 3 hall effect current sensors to report amp draw information for the vacuum motors, scrub motors and main broom motor to the main machine controller. They work much like an inductive amp clamp for a digital multi-meter. The motor circuit ground wires run through the “circle loop”. The sensor “reads” the amperage and converts it to a voltage value for the main machine controller to “read”. With no current flow, the sensors report 2.5 volts. As current increases the voltage increases. (Provided the sensors are installed correctly. If they are installed “backwards” the voltage will drop with increased current).



Current Sensor

42 Volt Alternator (Generator)

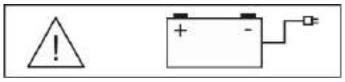
The 42 volt generator provides the electrical power needed to operate the machine and to recharge the 36 volt battery pack. It is belt driven by a pulley located at the rear of the engine (Right side of machine).

Lighting

All headlights, curb light, taillights and turn lights are controlled by the main machine controller. Head lights are standard. The curb light and turn lights are optional See the ***Options and Accessories*** chapter for more information.

Low Voltage Cutout

The scrub system and solution system are cut off by the main machine controller if the system voltage falls too low (Approx 31.5v for "wet" batteries or 32.94v for gel batteries). This is done to prevent damaging the batteries from over discharging. The operator will see the low voltage warning icon displayed when the low voltage cut out mode is active

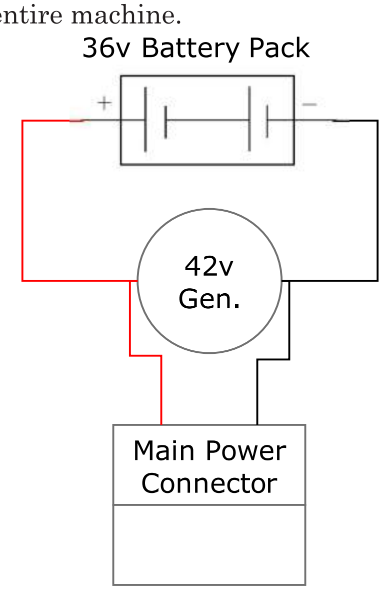


There are actually two levels of low voltage cut off. The first level disables the scrub and sweeping functions. The second level will also disable the recovery function. In either case, the hopper functions are not disabled. Once the machine has gone into the low voltage cut out mode, the batteries must be **fully** recharged before normal operation is restored (Approx 38.7v) .

Circuit Descriptions

42 Volt Generator

The 36 volt battery pack positive cable runs directly to the 42 volt generator positive terminal. The battery pack negative cable runs directly to the 42 volt generator negative terminal. The generator positive and negative terminals also have cables that go to the main power connector. When the main power connector is connected, this supplies power to the entire machine.

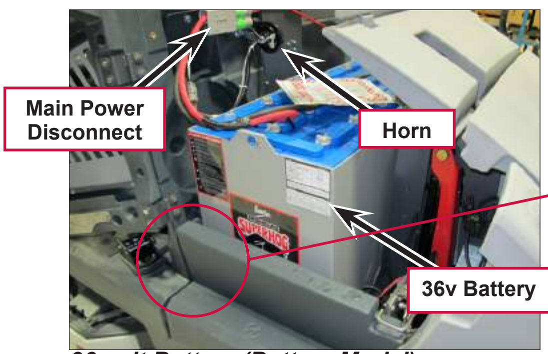


Headlights

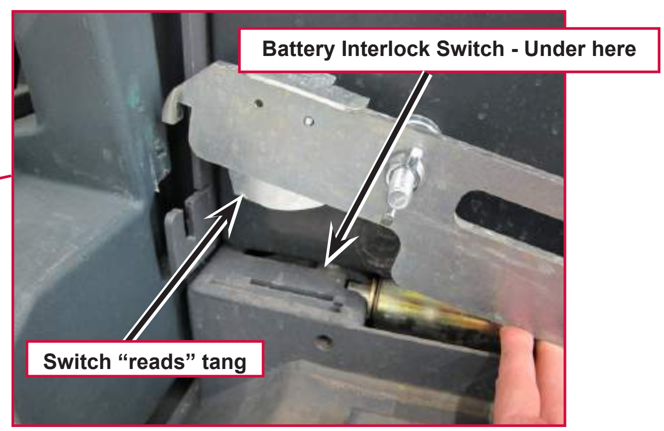
Battery positive power is supplied to the head lamps through, F1, CB6 (VACC6), and the K15a Auxiliary relay contacts. The other side of the headlights are wired in parallel to the main machine controller J2-23. To turn the headlights on, the controller switches J2-23 to ground. (It is not a complete ground. It is Pulse Width Modulated to provide approximately 3.3 volts rather than full machine system voltage.)

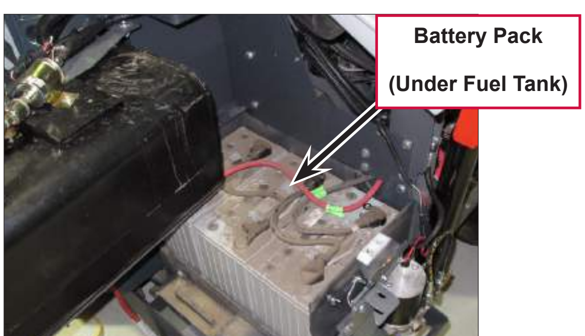
Component Locations

- 36 volt Battery (Battery Model)
- 36 volt Battery Pack (Hybrid Models) - Right of engine under fuel tank.
- 42 volt Generator - Front of engine behind rubber shield. (Raise hopper for access.)
- Circuit Breaker Panel
- Starting Battery
- Electrical Panel - Left side of solution tank under metal plate. (Remove recovery tank for access.)
- Main Fuse F1 400 Amps
- F2 150 Amp Fuse
- Auxiliary Relay - See Electrical Panel
- Auxiliary Contactor - See electrical panel
- Horn
- Battery Interlock Switch (Hybrid models use a jumper in place of this switch)
- Seat Switch



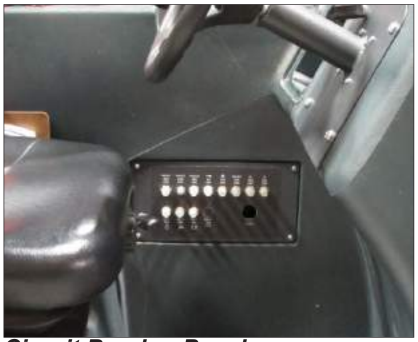
36 volt Battery (Battery Model)



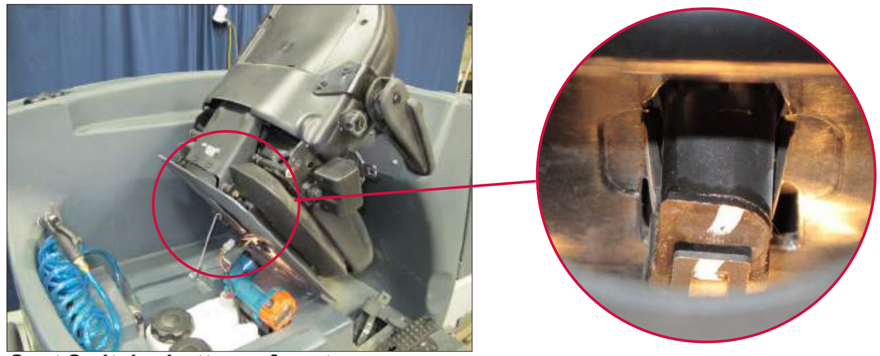


36 volt Battery Pack (Hybrid Models)

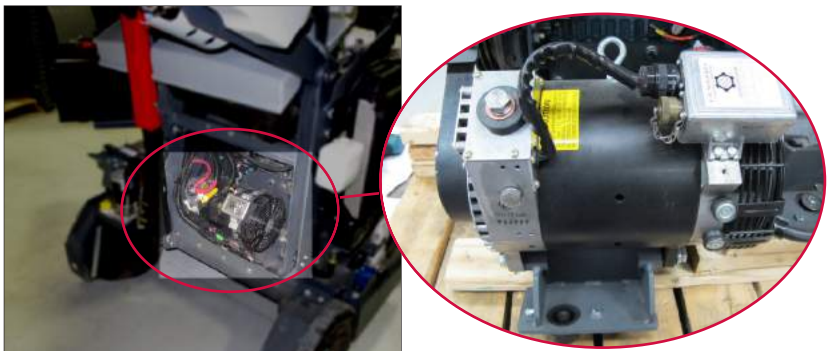

Starting Battery



Circuit Breaker Panel

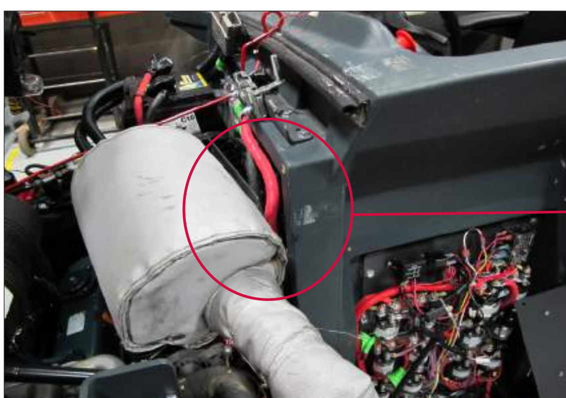


Seat Switch - bottom of seat



42 volt Generator

Electrical Panel

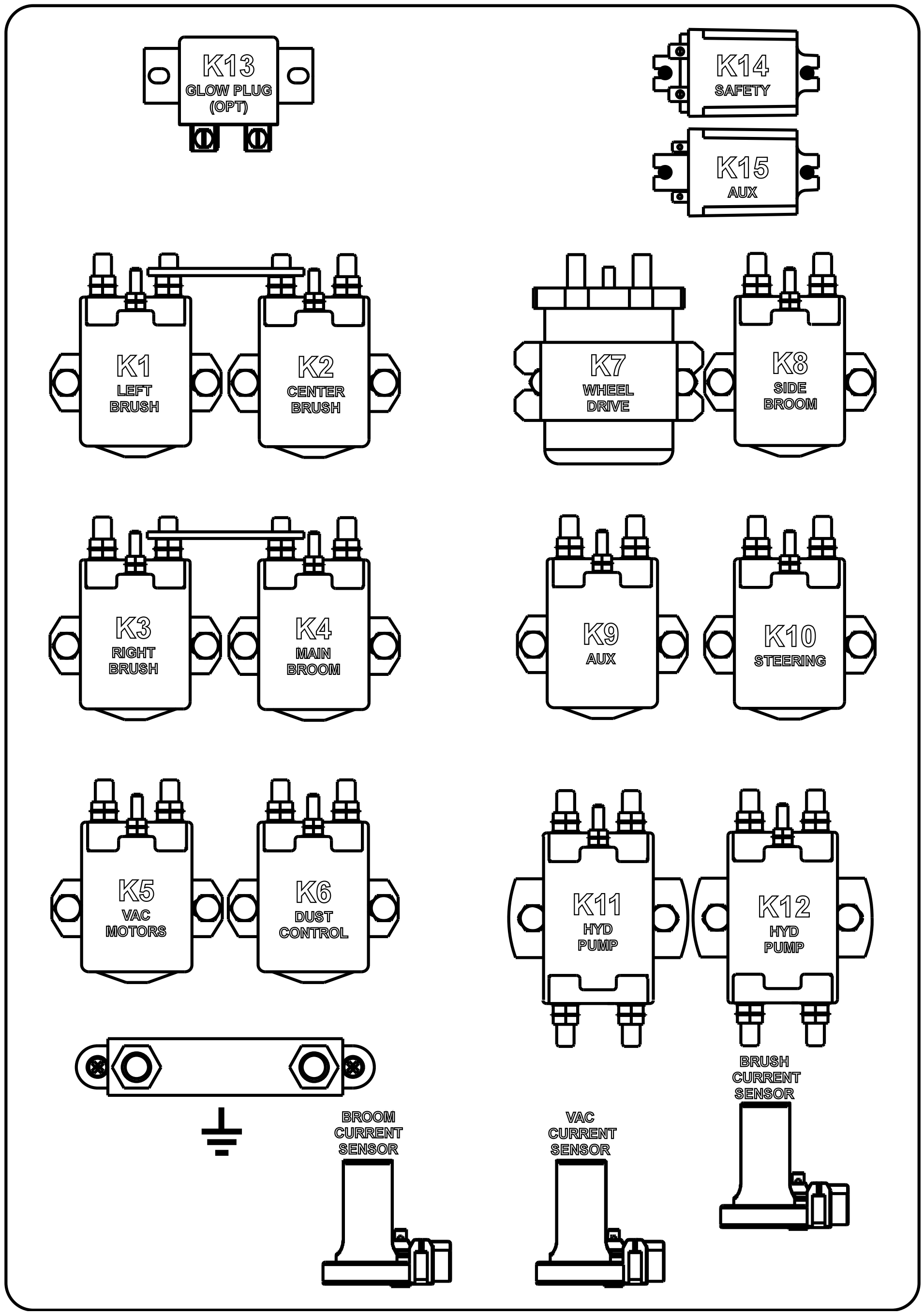


Fuse F1 400 Amps and F2 150 amps - Behind metal panel. Shown with panel pulled forward

Fuse F1 400 Amps - Side view. Shown with panel pulled forward

Electrical Panel Contactor/Relay location

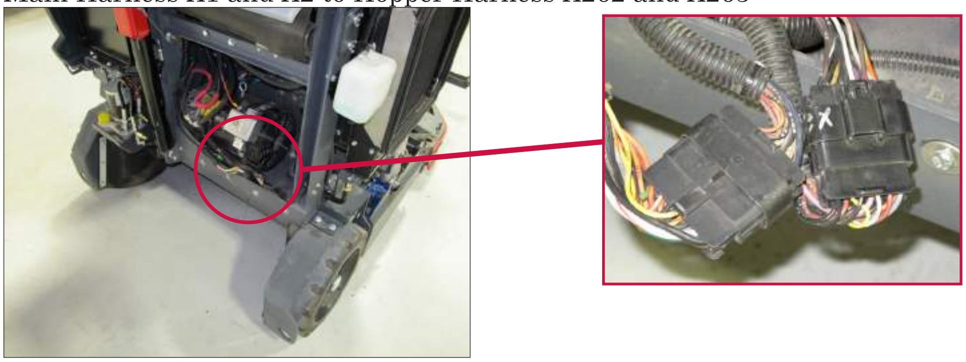
Electrical Panel



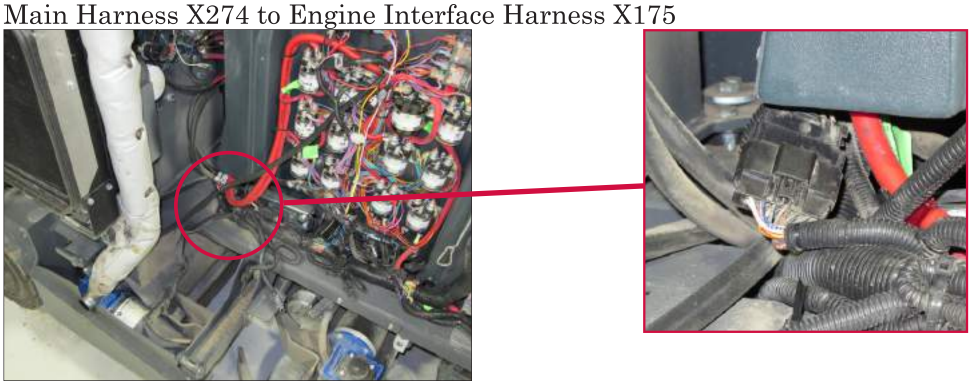
Harness to Harness Connector Locations

Most connectors are plugged into a component like the squeegee actuator; find the squeegee actuator and you can locate the squeegee actuator electrical connector. However, there are a few connectors that connect two harness. These are pictured here.

- Main Harness X1 and X2 to Hopper Harness X262 and X263

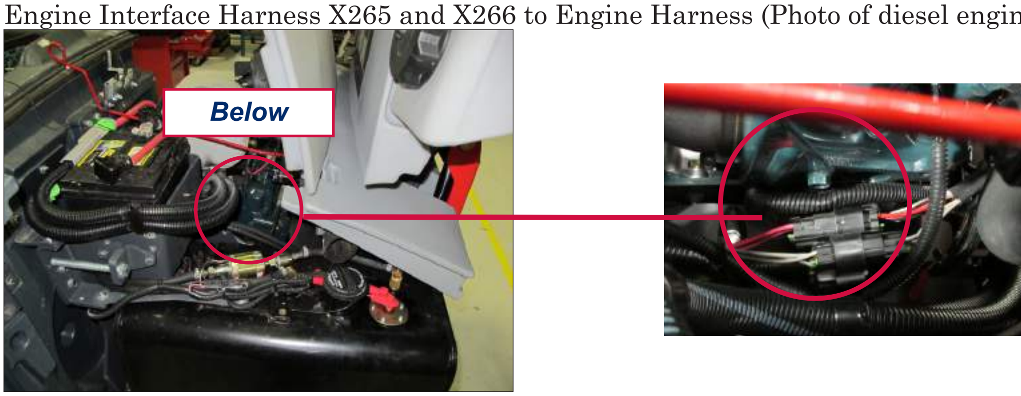


- Main Harness X274 to Engine Interface Harness X175



- Main Harness X166 to Taillight Harness X239

- Engine Interface Harness X265 and X266 to Engine Harness (Photo of diesel engine)



Connector Pin-Outs

The following pages contain details about every electrical connector that contains more than one "cavity". The connector pin-out information is organized with a table on the left which identifies the location of wires in the connector and images on the right which show what the connector looks like. The table on the left has a header that describes the connector ID, the name of the component that it plugs into and the component's ID number. (There are a few connectors that do not plug into a component but plug into another harness or are empty. These have the connector ID and the "name" of the connector only.) The images to the right of each table have a "3 dimensional" view of the connector to help you recognize it on the machine and a "2 dimensional" view of the "back side" or "wire side" of the connector. This is to help you match up the wires and pin numbers of the connector.

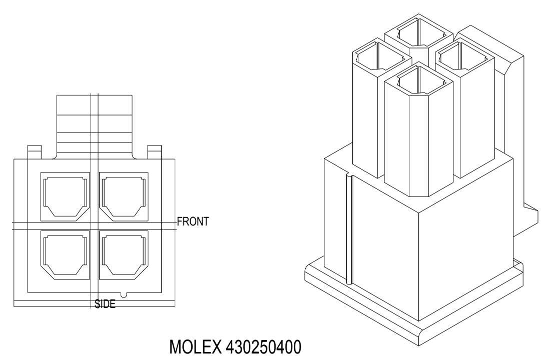
The connector pin-out information is organized by the connector ID in alphabetical order. If you are viewing this document on a computer, you can search for the component ID or component name to find the pin out chart. However, if you are viewing a paper copy, it will be easier for you to find the correct pin-out table if you know the connector ID. To learn the connector ID, find the component ID from the wiring diagram. Then use the "Component ID to Connector ID Look Up Table" below to find the connector ID.

Component ID to Connector ID Look Up Table

Component ID	Component Name	Connector ID
A1	Main Machine Controller	J2
A1	Main Machine Controller	J3
A1	Main Machine Controller	J7
A2	Drive controller	J4
A3	Control panel	J1
A5	Steering controller	J5
B1	Brush Motor Current Sensor	X183
B2	Broom Motor Current Sensor	X181
B3	Vacuum Motor Current Sensor	X182
E4	Steering wheel sensor	X98
H1	Back up alarm (Optional)	X178
J8	Can bus programmer connector	J8
J10	Drive Controller Programmer	J10
L1	Solution Solenoid Valve	X190
L2	Dust guard valve	X140
LT1	Trouble light	X258
LT2	Right headlight	X162
LT3	Left headlight	X161
LT5	Taillight, right	X154
LT6	Taillight, left	X153
LT8	Curb light (optional)	X165
LT9	Stop turn light, left	X180
LT10	Beacon (optional)	X257
LT11	Stop turn light, right	X184
M1	Main Broom motor	X25
M2	Motor, left brush	X19
M3	Motor, center brush	X18
M4	Motor, right brush	X17
M5	Dust control motor	X21
M6	Vacuum Motor	X23

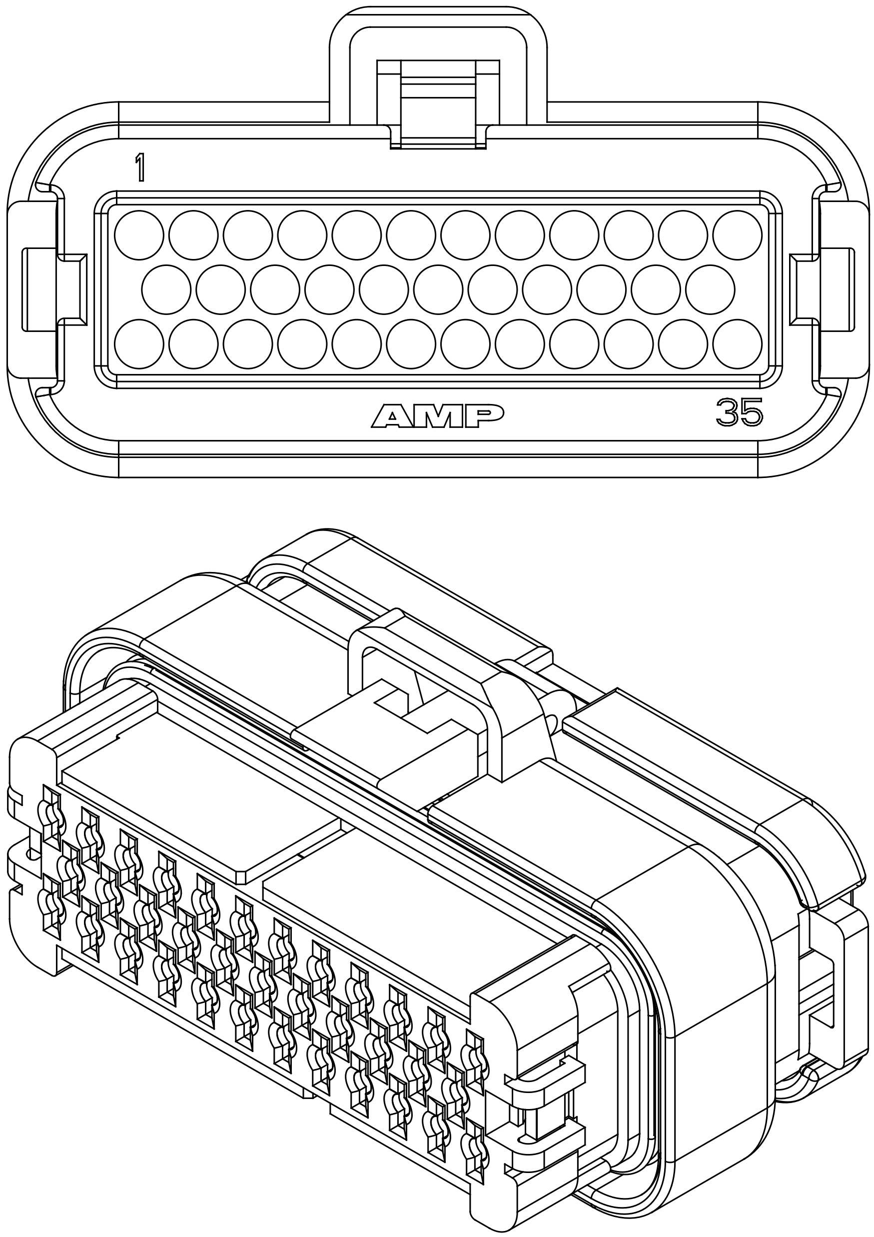
Component ID	Component Name	Connector ID
M7	Vacuum Motor	X24
M8	Right side broom motor	X28
M9	Left side broom motor	X26
M10	Hydraulic Pump, Hopper Lift	X126
M11	Scrub Deck Actuator Motor	X256
M12	Squeegee Lift actuator	X22
M13	Side broom actuator	X109
M14	Shaker motor	X20
M16	Steering Actuator	X97
M19	Pump, Solution Control (Optional)	X111
M20	Fuel pump	X275
M21	Main Broom actuator	X27
M22	Dust guard pump	X122
M23	Pump, Low Pressure (Optional)	X20
M23	Low Pressure Pump (Optional)	X120
M24	Wheel Drive Motor	X99
M24	Wheel Drive Motor	X100
M25	Pump, Extended Scrub (optional)	X118
M26	Dump door actuator motor	X124
R1	Drive Pedal Position Sensor	X145
S1	Scrub Deck Retract Limit Switch	X255
S3	Hopper Interlock Switch	X204
S4	Extended Scrub Level Switch (optional)	X268
S5	Brake switch	X202
S7	Dump door extend limit switch	X236
S8	Dump door retract limit switch	X238
S13	Battery interlock switch	X187
S16	Steering Travel Limit Switch, Right	X106
S17	Steering Travel Limit Switch, Left	X105

J1 - Control Panel (A3)	
Pin	**Wire # Color**
1	130 WHT/BRN
2	304 BLK
3	301 YEL
4	300 GRN



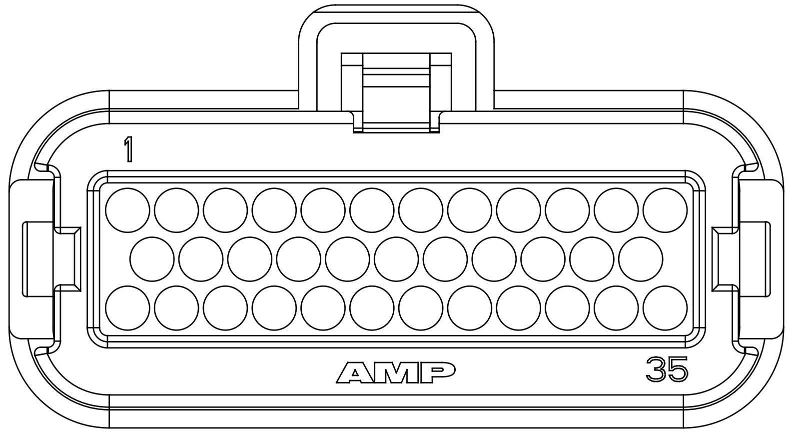
MOLEX 430250400

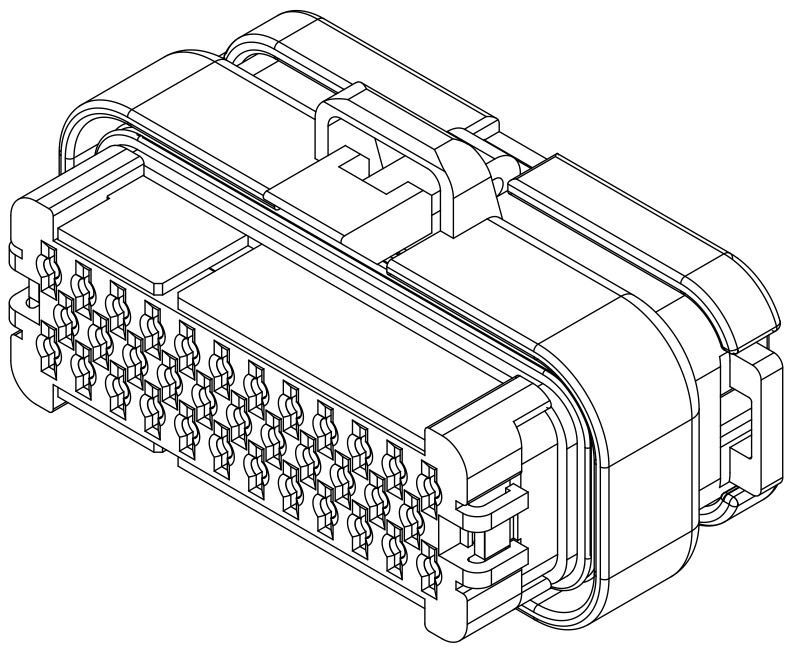
J2 - Main Machine Controller (A1)	
Pin	**Wire # Color**
1	091 ORN/YEL
2	094 ORN/BLU
3	098 YEL/RED
4	101 YEL/GRN
5	107 TAN/BLK
6	064 BLK/YEL
7	119 BRN/WHT
8	080 WHT/GRN
9	078 BLU/BRN
10	132 RED/GRN
11	135 YEL/GRA
12	162 BLK
13	057 VIO
14	051 BLK/ORN
15	163 BRN/BLK
16	063 GRN/GRA
17	045 BLU
18	150 BLK/RED
19	116 WHT/YEL
20	157 YEL/ORN
21	160 BLU/VIO
22	167 BLK/YEL
23	169 BRN
24	039 ORN/RED
25	047 YEL/BLU
26	015 WHT/VIO
27	061 GRA/RED
28	038 BLU/ORN
29	---
30	---
31	---
32	221 GRA/BLIU
33	---
34	054 BLK/WHT
35	053 BLK/WHT



J2 **AMP 776164-2**
NEUTRAL

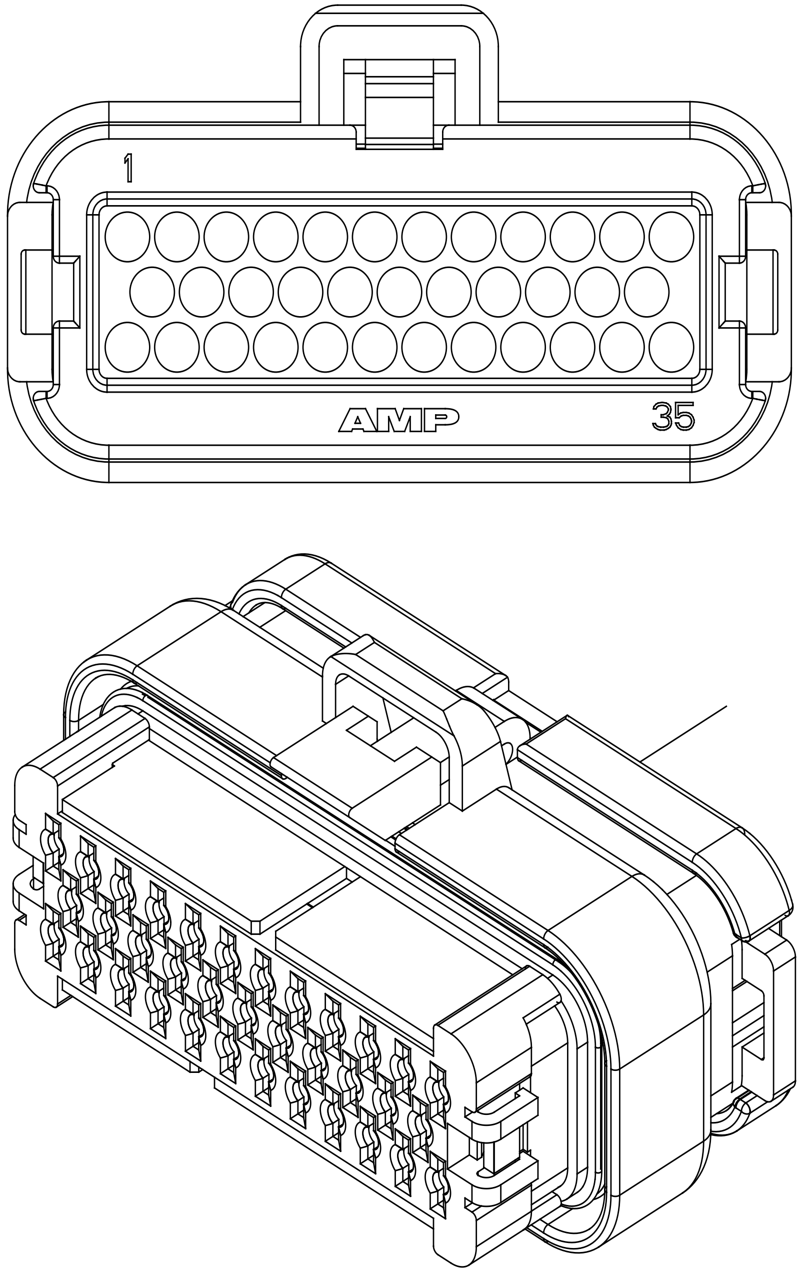
J3 - Main Machine Controller (A1)	
Pin	**Wire # Color**
1	042 VIO/ORN
2	093 RED/YEL
3	030 BRN/WHT
4	031 RED/VIO
5	106 GRA/VIO
6	111 BRN/GRN
7	115 RED/GRA
8	118 WHT/ORN
9	123 PINK
10	129 BLU/PINK
11	131 GRA/ORN
12	134 GRA/BLU
13	137 BRN/RED
14	139 VIO/BRN
15	144 BLK
16	142 BLK
17	250 GRN/ORN
18	149 BLK
19	154 BLK
20	156 BLK
21	159 BLK
22	---
23	059 VIO/RED
24	171 GRN/WHT
25	---
26	058 GRA
27	076 GRN/BRN
28	---
29	166 BLK
30	---
31	---
32	049 ORN/BLK
33	---
34	056 GRA/BLK
35	055 GRA/BLK





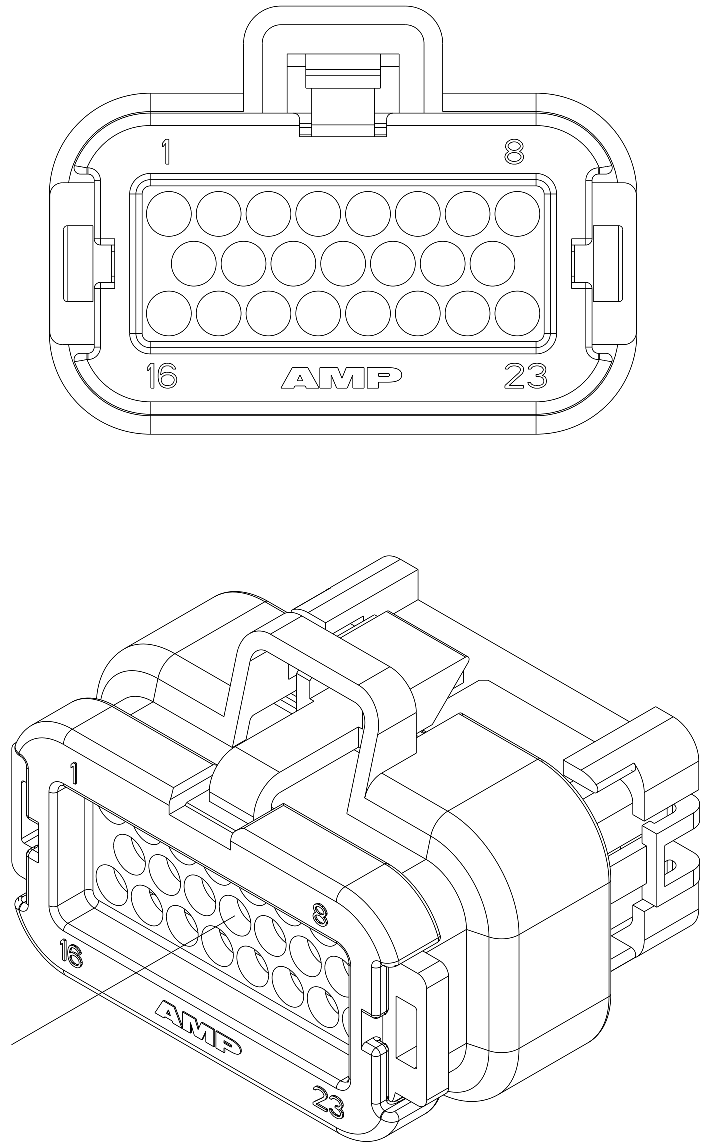
J3 **AMP 776164-4**
GRAY

J4 - Drive Controller (A2)	
Pin	**Wire # Color**
1	185 ORN
2	---
3	---
4	---
5	---
6	126 VIO/GRN
7	186 BLK/PINK
8	187 TAN/RED
9	188 GRN/BLU
10	---
11	---
12	---
13	127 TAN/ORN
14	---
15	189 WHT/BLK
16	190 BRN/RED
17	---
18	191 VIO/BLK
19	---
20	---
21	---
22	---
23	192 YEL
24	---
25	193 VIO/WHT
26	194 PINK/RED
27	---
28	195 WHT/ORN
29	196 BLU/GRN
30	---
31	197 PINK/WHT
32	198 PINK/BLU
33	---
34	---
35	342 GRN



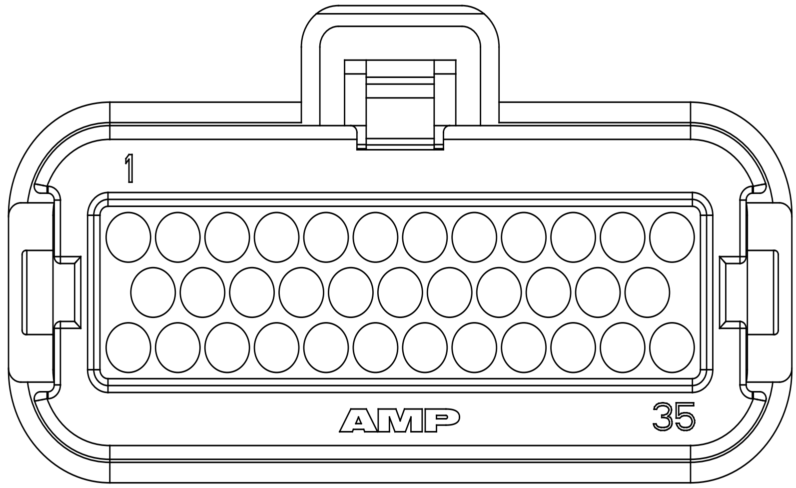
AMP 776164-1
BLACK

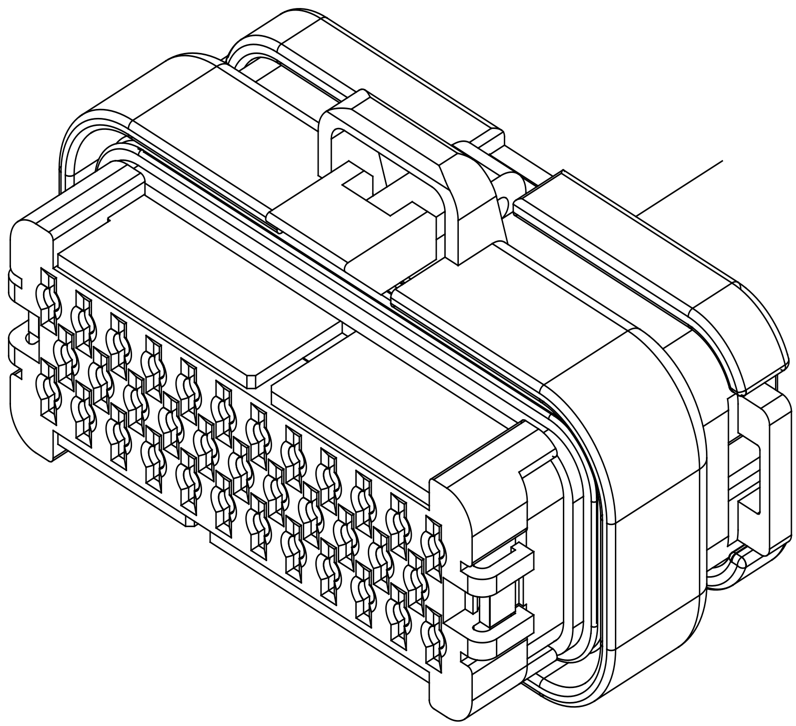
J5 - Steering Controller (A5)	
Pin	**Wire # Color**
1	083 GRA/ORN
2	199 BRN/WHT
3	200 ORN/BLK
4	201 BLK
5	202 WHT
6	203 BLU/GRA
7	---
8	204 BLK
9	---
10	308 RED/WHT
11	307 GRN/WHT
12	084 GRA/ORN
13	207 WHT/BLU
14	---
15	343 GRN
16	208 YEL/RED
17	309 BLU
18	073 VIO
19	210 ORN/RED
20	310 GRN/BLK
21	---
22	---
23	212 YEL



AMP 770680-1

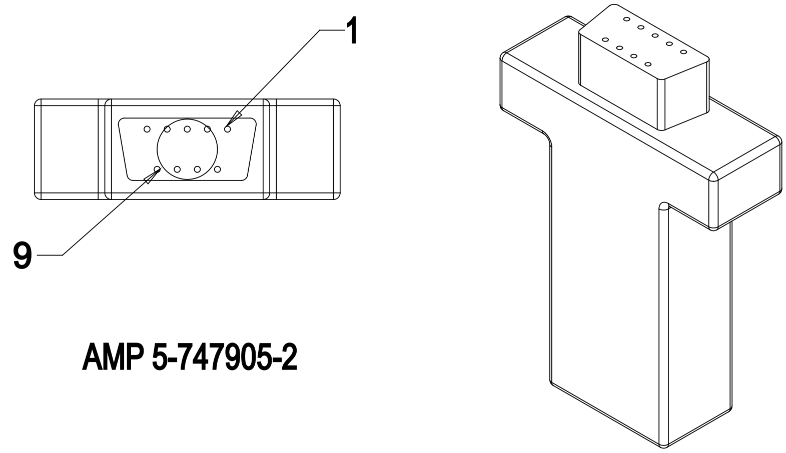
J7 - Main Machine Controller (A1)	
Pin	**Wire # Color**
1	092 GRN/BLU
2	095 GRN
3	099 YEL
4	102 GRA
5	108 GRA/YEL
6	112 TAN/WHT
7	117 YEL/RED
8	---
9	---
10	130 WHT/BRN
11	133 BLK
12	050 YEL/BRN
13	141 ORN
14	046 RED/BLK
15	035 GRA/YEL
16	143 WHT/GRA
17	145 ORN/GRA
18	151 YEL/VIO
19	155 VIO/GRN
20	---
21	161 RED/ORN
22	168 ORN/RED
23	170 YEL/WHT
24	172 BLU/YEL
25	174 VIO/WHT
26	---
27	178 BRN
28	---
29	184 RED/WHT
30	---
31	215 ORN/BLU
32	---
33	032 BLU/ BLK
34	033 GRA/GRN
35	034 TAN/RED



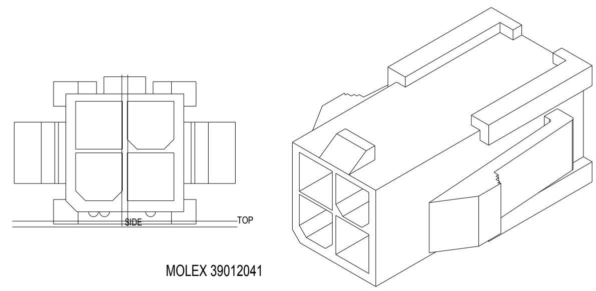


AMP 776164-1
BLACK

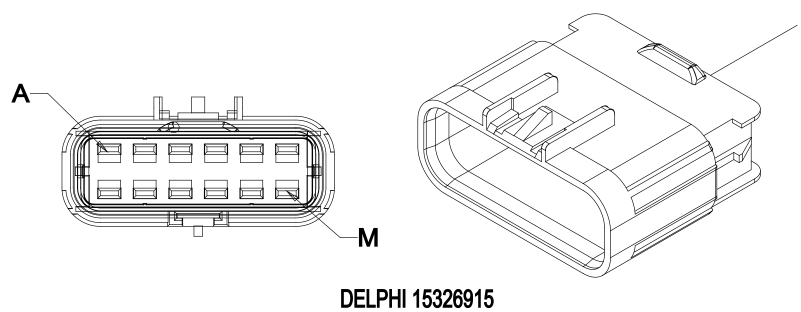
J8 - CAN Bus Connector	
Pin	**Wire # Color**
1	---
2	241 GRN
3	242 BLK
4	---
5	---
6	---
7	243 YEL
8	---
9	---



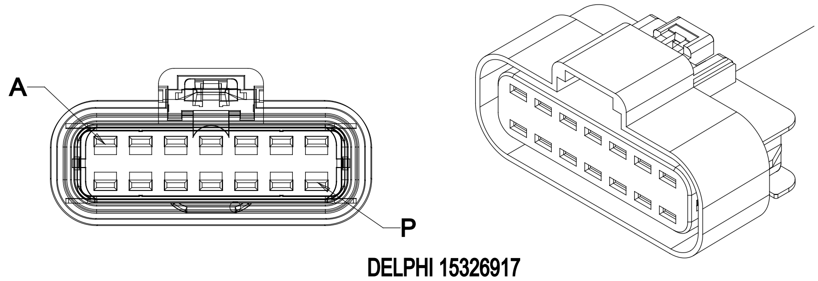
J10 - Drive Controller Programmer	
Pin	**Wire**
1	196 BLU/GRN
2	249 BLK/PINK
3	195 WHT/ORN
4	193 VIO/WHT



X1 - Hopper Harness Connector (X262)	
Pin	**Wire**
A	264 GRA
B	137 BRN/RED
C	143 WHT/GRA
D	244 BLK
E	151 YEL/VIO
F	240 BLK
G	070 ORN/GRN
H	248 BLK
J	067 VIO
K	150 BLK/RED
L	169 BRN
M	238 BLK/WHT

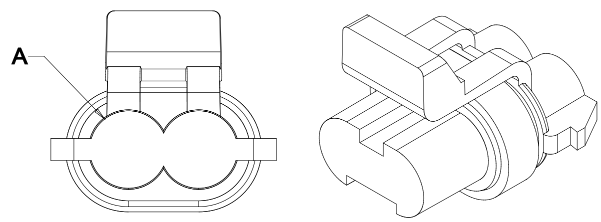


X2 - Hopper Harness Connector (X263)	
Pin	**Wire**
A	---
B	091 ORN/YEL
C	284 BLK/YEL
D	098 YEL/RED
E	106 GRA/VIO
F	250 GRN/ORN
G	111 BRN/GRN
H	115 RED/GRA
J	168 ORN/RED
K	235 BLK
L	170 YEL/WHT
M	239 BLK
N	071 WHT/RED
P	233 BLK



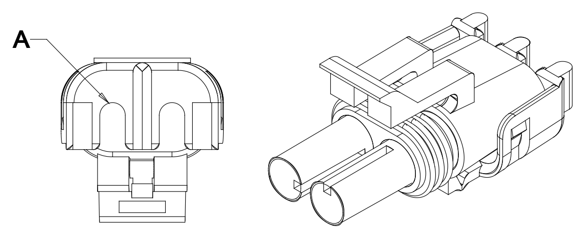
DELPHI 15326917

X17- Brush Motor, Right (M4)	
Pin	**Wire # Color**
A	251 BLK
B	152 BLU/YEL



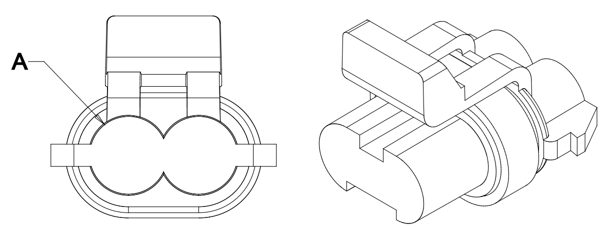
DELPHI 12052613

X18 - Brush Motor, Center (M3)	
Pin	**Wire**
A	109 GRA/BLK
B	254 BLK



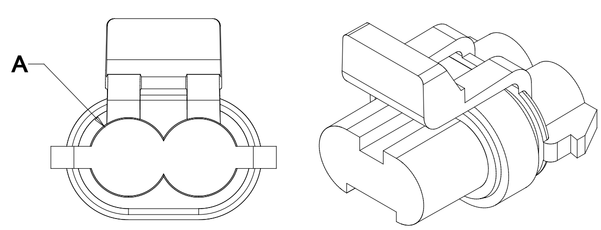
DELPHI 12015792

X19 - Brush Motor, Left (M2)	
Pin	**Wire**
A	113 WHT/ORN
B	253 BLK



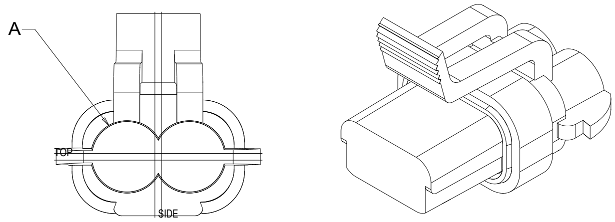
DELPHI 12052613

X20 - Shaker Motor (M14)	
Pin	**Wire**
A	267 VIO
B	268 BLK/RED



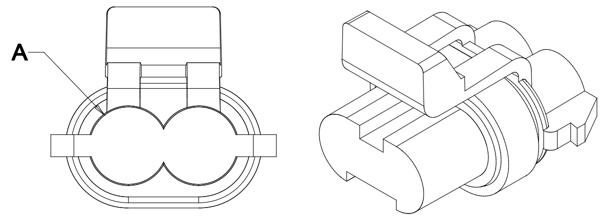
DELPHI 12052613

X21 - Dust Control Motor (M5)	
Pin	**Wire**
A	259 ORN/GRN
B	260 BLK



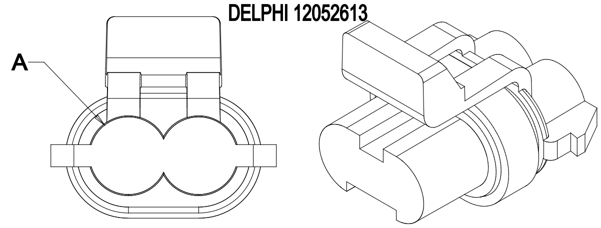
DELPHI 15300027

X22 - Squeegee Lift Actuator (M12)	
Pin	**Wire**
A	080 WHT/GRN
B	078 BLU/BRN



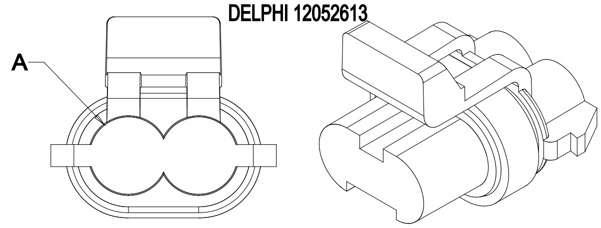
DELPHI 12052613

X23 - Vacuum Motor (M6)	
Pin	**Wire**
A	017 BLU/GRA
B	018 BLK



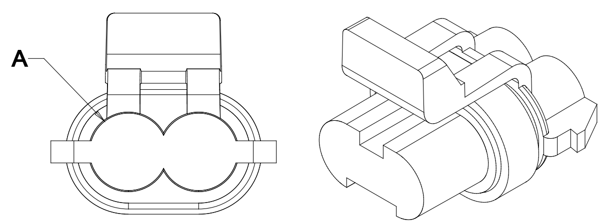
DELPHI 12052613

X24 - Vacuum Motor (M7)	
Pin	**Wire**
A	019 BLU/GRA
B	020 BLK



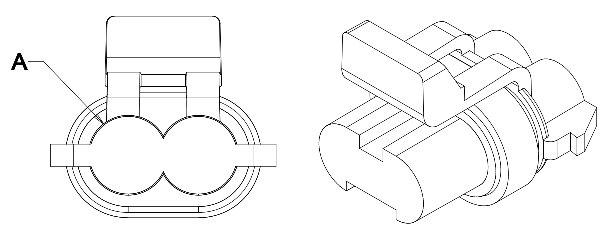
DELPHI 12052613

X25 - Main Broom Motor (M1)	
Pin	**Wire**
A	043 BRN/VIO
B	044 BLK



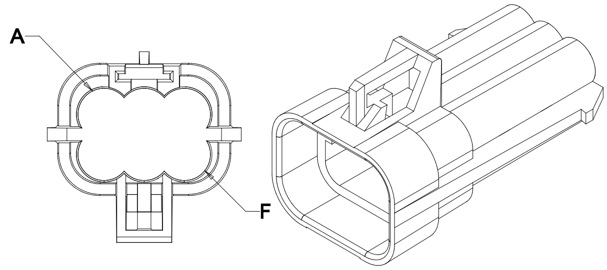
DELPHI 12052613

X26 - Left Side Broom Motor (M9)	
Pin	**Wire**
A	213 WHT/RED
B	214 BLK



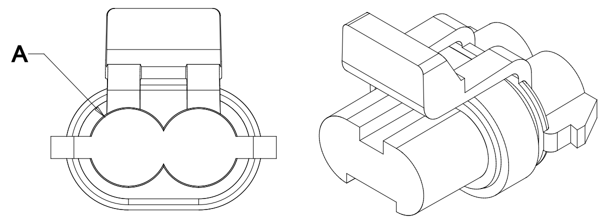
DELPHI 12052613

X27 - Main Broom Actuator (M21)	
Pin	**Wire**
A	030 BRN/WHT
B	031 RED/VIO
C	032 BLU/ BLK
D	033 GRA/GRN
E	034 TAN/RED
F	---



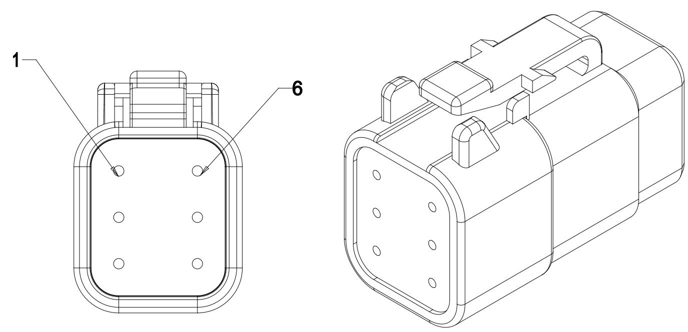
DELPHI 12124107

X28 - Right Side Broom Motor (M8)	
Pin	**Wire**
A	295 WHT/RED
B	297 BLK



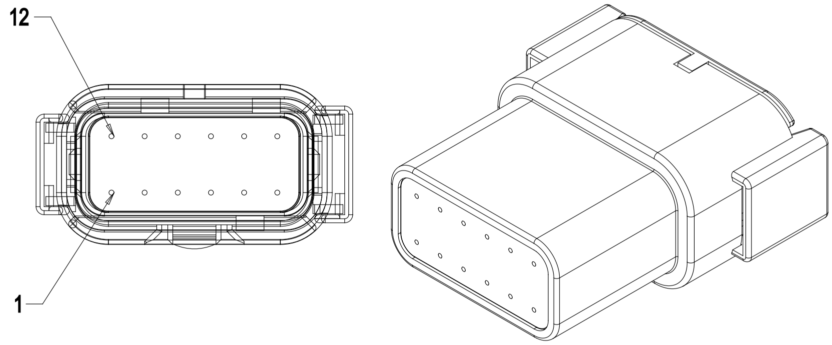
DELPHI 12052613

X97 - Steering Actuator (M16)	
Pin	**Wire**
1	299 ORN/BLK
2	202 WHT
3	203 BLU/GRA
4	208 YEL/RED
5	---
6	298 BLK



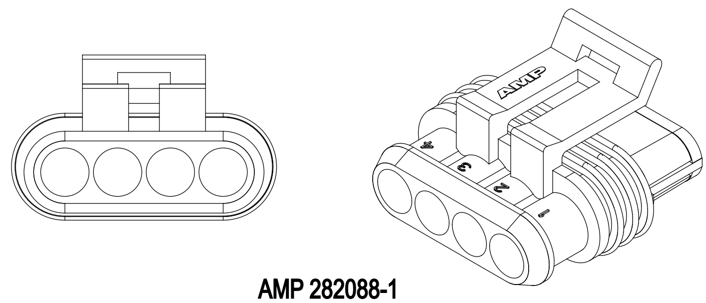
DEUTSCH DTM06-6S

X98 - Steering Wheel Sensor (E4)	
Pin	**Wire**
1	307 GRN/WHT
2	309 BLU
3	205 BLK
4	209 ORN/BLK
5	308 RED/WHT
6	310 GRN/BLK
7	206 BLK
8	211 ORN/BLK
9	199 BRN/WHT
10	329 GRA/ORN
11	---
12	---



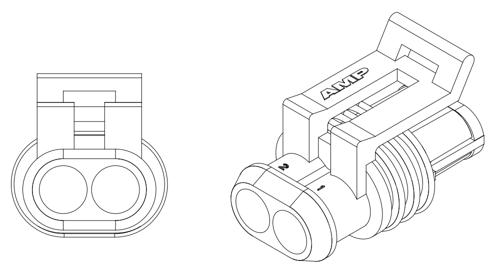
DEUTSCH DTM04-12PA

X99 - Wheel Drive Motor (M24)	
Pin	**Wire**
1	194 PINK/RED
2	198 PINK/BLU
3	197 PINK/WHT
4	288 BLK/PINK



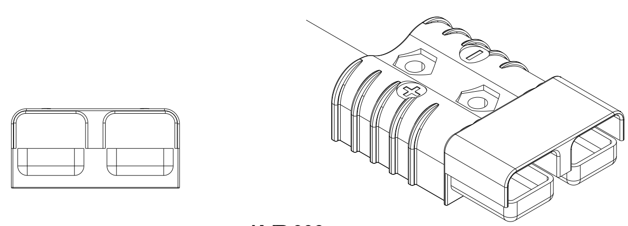
AMP 282088-1

X100 - Wheel Drive Motor (M24)	
Pin	**Wire**
1	187 TAN/RED
2	289 BLK/PINK



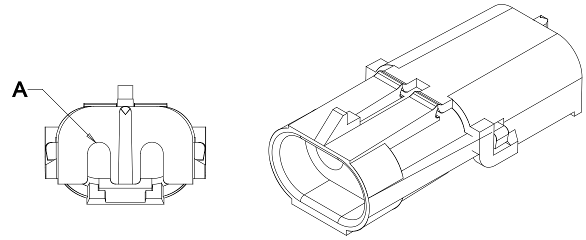
AMP 282080-1

X102 - Generator Harness Connector (X107)	
Pin	**Wire**
+	228 WELDING RED 3-0
-	235 WELDING BLK 3-0



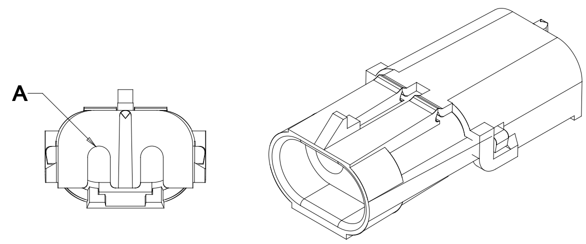
AMP 906

X105 - Steering Travel Limit Switch, Left (S17)	
Pin	**Wire**
A	210 ORN/RED
B	270 GRA/ORN



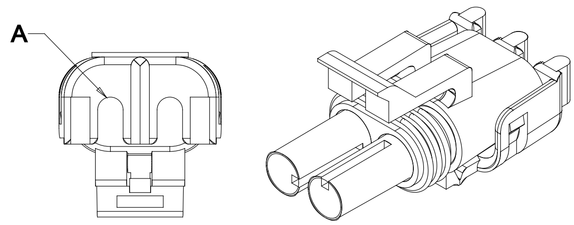
DELPHI 12010973

X106 - Steering Travel Limit Switch, Right (S16)	
Pin	**Wire**
A	207 WHT/BLU
B	277 GRA/ORN



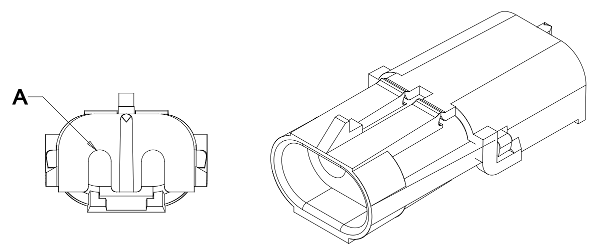
DELPHI 12010973

X109 - Side Broom Actuator (M13)	
Pin	**Wire**
A	282 GRA/VIO
B	283 GRN/ORN



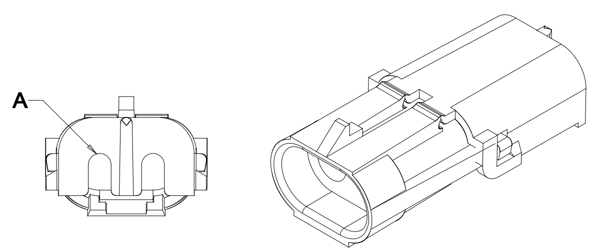
DELPHI 12015792

X111 - Pump, Solution Control (M19)	
Pin	**Wire**
A	269 GRA
B	093 RED/YEL



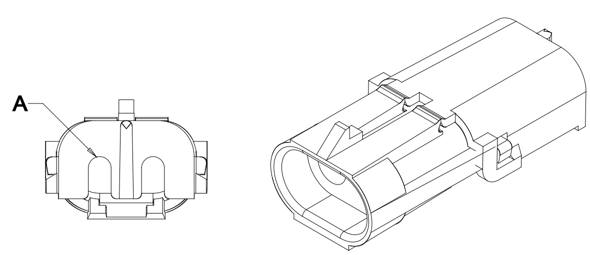
DELPHI 12010973

X118 - Pump, Extended Scrub (M25)	
Pin	**Wire**
A	041 GRA
B	042 VIO/ORN



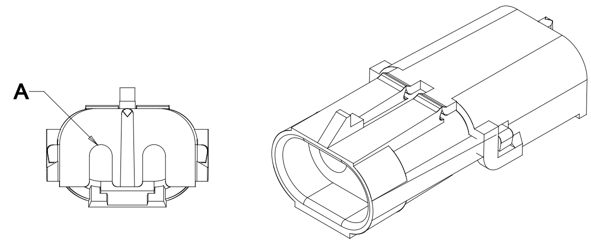
DELPHI 12010973

X120 - Low Pressure Pump (M23)	
Pin	**Wire**
A	266 GRA
B	171 GRN/WHT



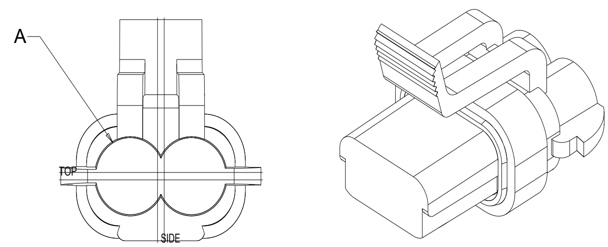
DELPHI 12010973

X122 - Dust Guard Pump (M22)	
Pin	**Wire**
A	147 GRA
B	148 BRN/RED



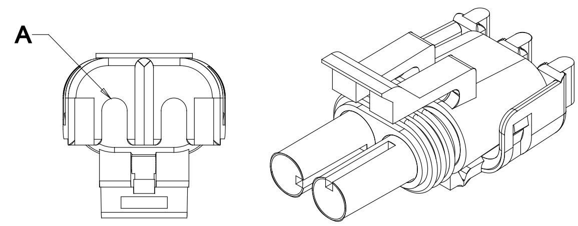
DELPHI 12010973

X124 - Dump Door Actuator Motor (M26)	
Pin	**Wire**
A	286 BRN/GRN
B	287 RED/GRA



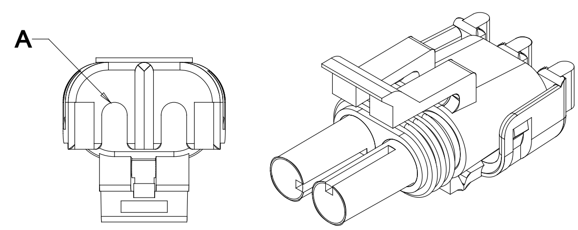
DELPHI 15300027

X126 - Hydraulic Pump, Hopper Lift (M10)	
Pin	**Wire**
A	175 BLU/YEL
B	177 RED/BRN



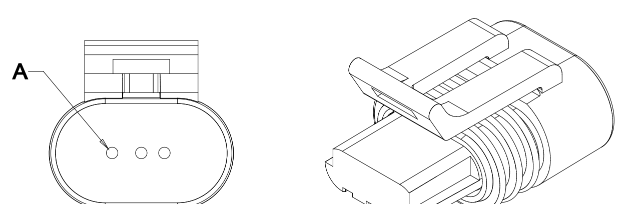
DELPHI 12015792

X140 - Dust Guard Valve (L2)	
Pin	**Wire**
A	086 GRA
B	087 BRN/RED



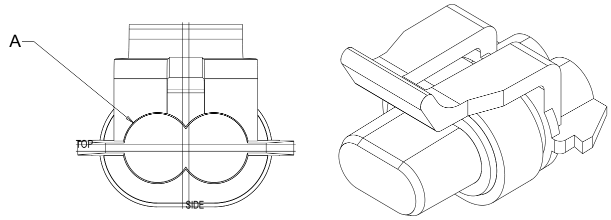
DELPHI 12015792

X145 - Drive Pedal Position Sensor (R1)	
Pin	**Wire**
A	189 WHT/BLK
B	190 BRN/RED
C	191 VIO/BLK



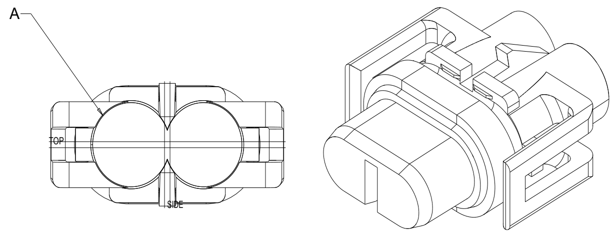
DELPHI 12162182

X153 - Tail Lamp, Left (LT9)	
Pin	**Wire**
A	010 TAN/BLK
B	011 BLK/YEL



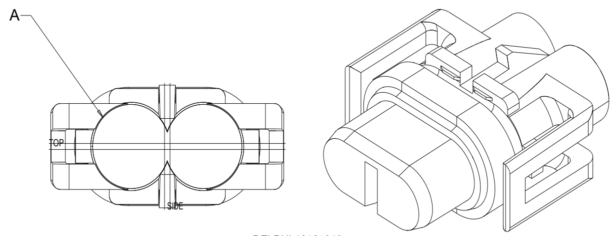
DELPHI 12052641

X154 - Tail Lamp, Right (LT5)	
Pin	**Wire**
A	012 TAN/BLK
B	025 BLK/YEL



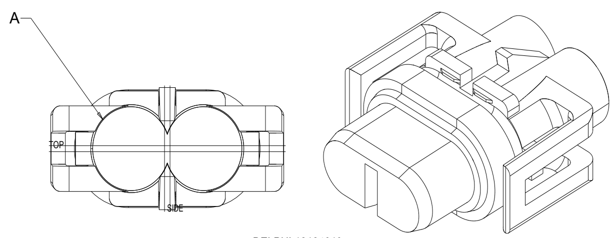
DELPHI 12124819

X161 - Left Head Lamp (LT3)	
Pin	**Wire**
A	236 BRN
B	237 BLK/WHT



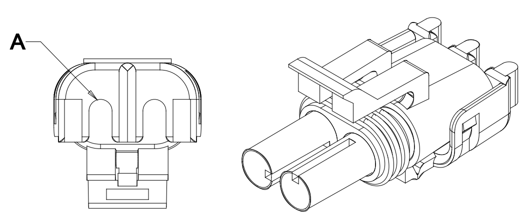
DELPHI 12124819

X162 - Right Head Lamp (LT2)	
Pin	**Wire**
A	274 BRN
B	276 BLK/WHT



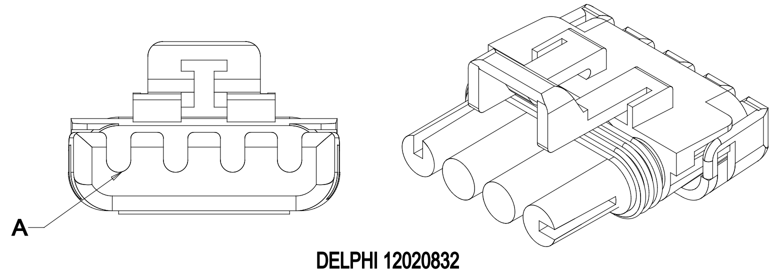
DELPHI 12124819

X165 - Curb Lamp	
Pin	**Wire**
A	273 BRN
B	275 BLK/WHT

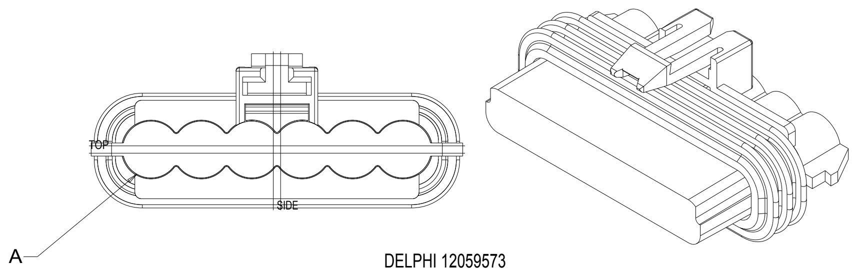


DELPHI 12015792

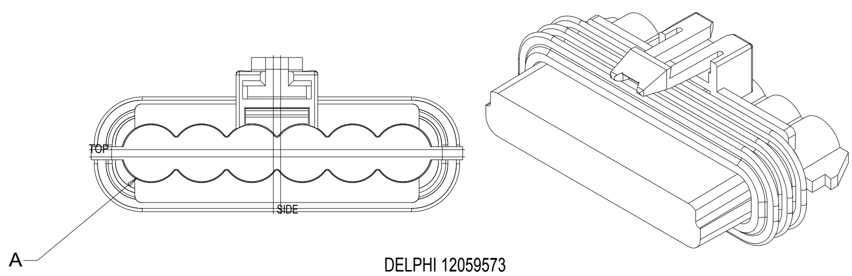
X166 - Tail Lamp Harness Connector (X239)	
Pin	**Wire**
A	094 ORN/BLU
B	107 TAN/BLK
C	285 BLK/YEL
D	101 YEL/GRN



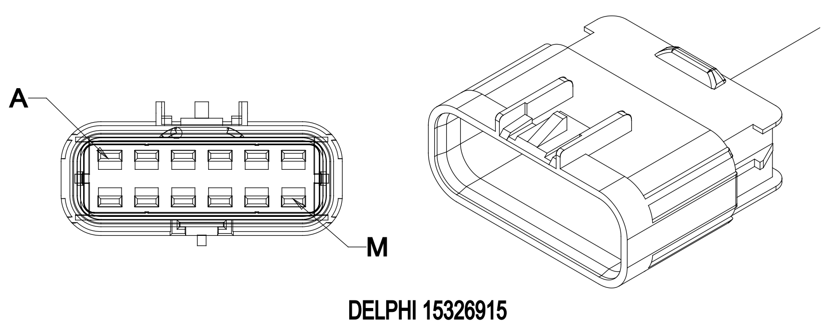
X172 - Splice Saver Connector Comb	
Pin	**Wire**
A	265 GRA
B	264 GRA
C	097 GRA
D	041 GRA
E	255 GRA
F	---



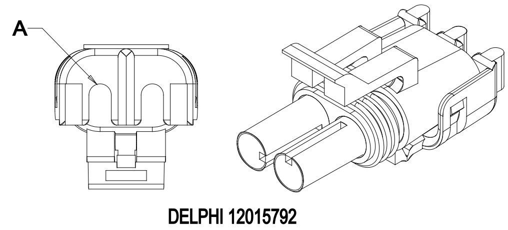
X173 - Splice Saver Connector Comb	
Pin	**Wire**
A	037 GRA
B	269 GRA
C	266 GRA
D	---
E	---
F	265 GRA



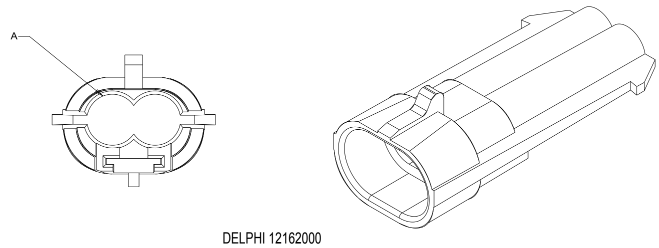
X175 - Main Harness Connector	
Pin	**Wire**
A	319 PINK
B	322 BLU/PINK
C	323 GRN/YEL
D	324 GRA
E	325 GRA/ORN
F	326 GRA/BLU
G	327 WHT/ORN
H	328 YEL/RED
J	330 TAN/WHT
K	334 BRN/ORN
L	335 ORN
M	---



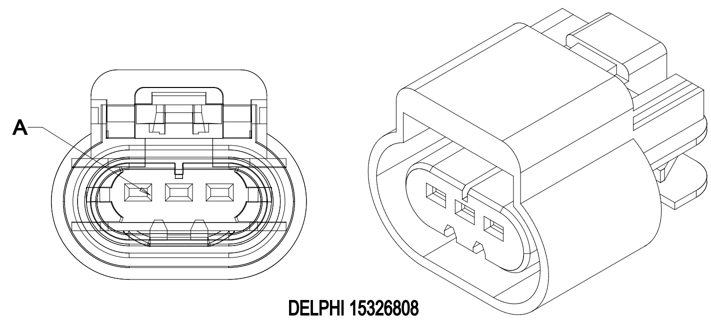
X178 - Back Up Alarm (H1)	
Pin	**Wire**
A	037 GRA
B	076 GRN/BRN



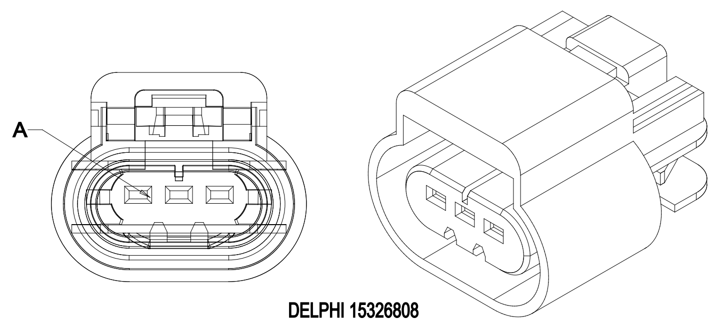
X180 - Stop/Turn Lamp, Left (LT9)	
Pin	**Wire**
A	023 ORN/BLU
B	009 BLK/YEL



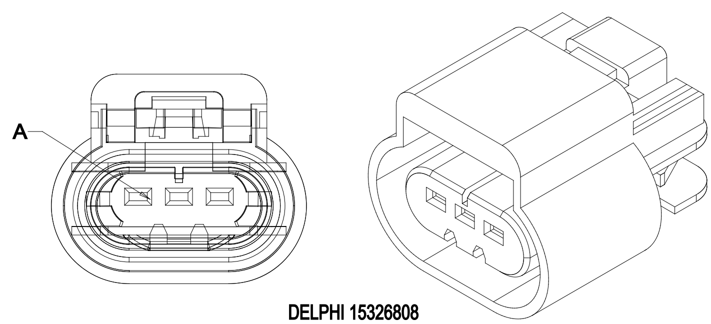
X181 - Broom Motor Current Sensor (B2)	
Pin	**Wire**
A	261 BLU/YEL
B	256 VIO/WHT
C	215 ORN/BLU



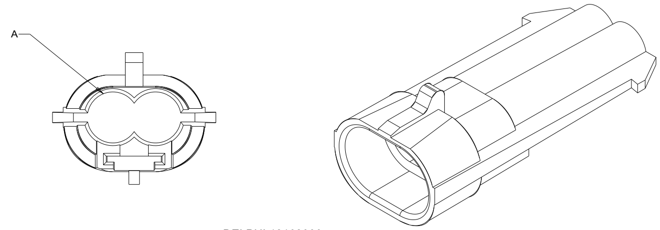
X182 - Vacuum Motor Current Sensor (B3)	
Pin	**Wire**
A	262 BLU/YEL
B	257 VIO/WHT
C	184 RED/WHT



X183 - Brush Motor Current Sensor (B1)	
Pin	**Wire**
A	263 BLU/YEL
B	258 VIO/WHT
C	178 BRN

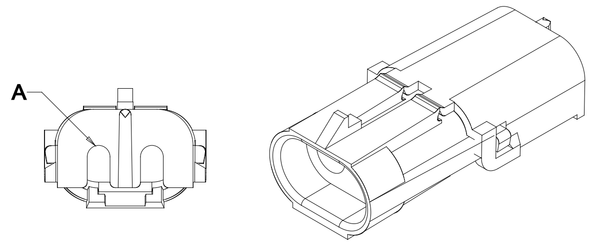


X184 - Stop/Turn Lamp, Right (LT11)	
Pin	**Wire**
A	014 YEL/GEN
B	024 BLK/YEL



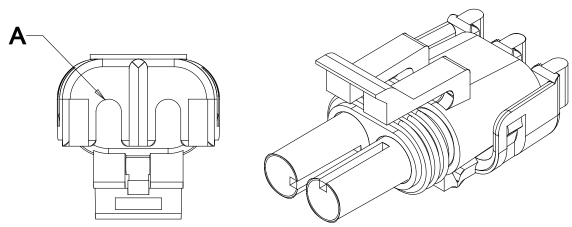
DELPHI 12162000

X187 - Battery Interlock Switch (S13)	
Pin	**Wire**
A	315 TAN
B	338 GRN/BLU



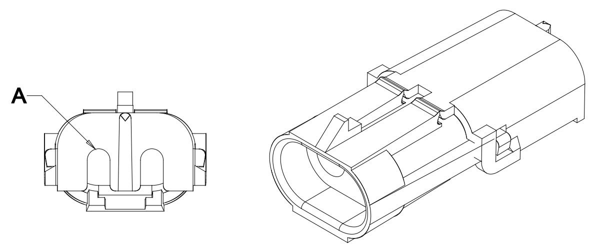
DELPHI 12010973

X190 - Solution Solenoid Valve (L1)	
Pin	**Wire**
A	157 YEL/ORN
B	089 VIO



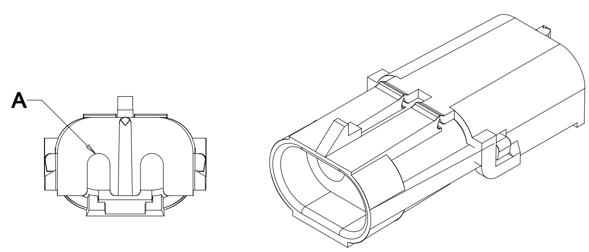
DELPHI 12015792

X202 - Brake Switch (S5)	
Pin	**Wire**
A	145 ORN/GRA
B	231 BLK



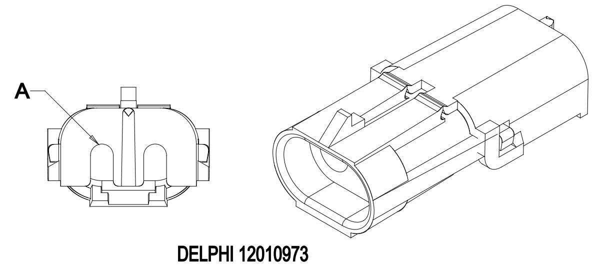
DELPHI 12010973

X204 - Hopper Interlock Switch (S3)	
Pin	**Wire**
A	046 RED/BLK
B	230 BLK

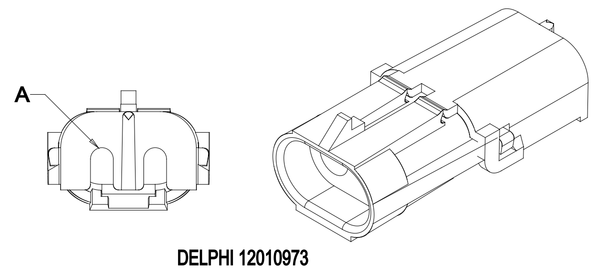


DELPHI 12010973

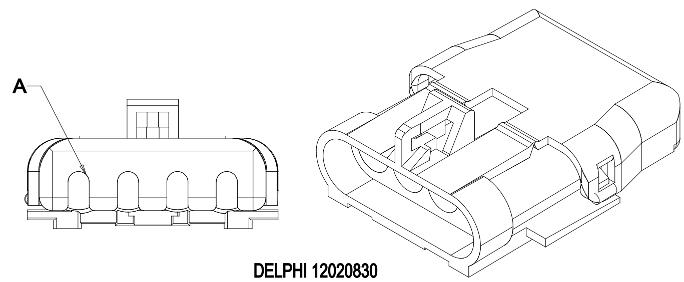
X236 - Dump Door Extend Limit Switch (S7)	
Pin	**Wire**
A	290 ORN/RED
B	291 BLK



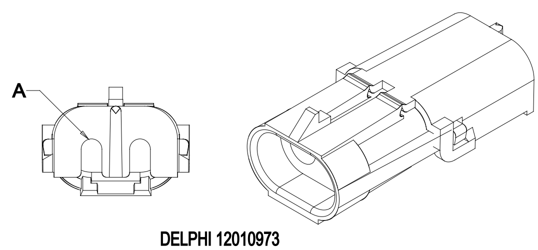
X238 - Dump Door Retract Limit Switch (S8)	
Pin	**Wire**
A	292 YEL/WHT
B	293 BLK



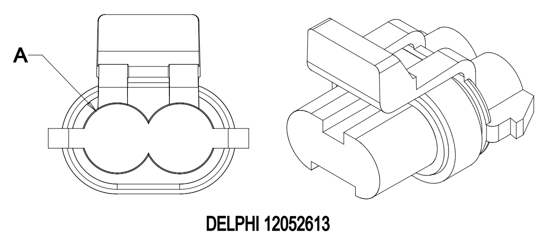
X239 - Main Harness Connector (X166)	
Pin	**Wire**
A	023 ORN/BLU
B	013 TAN/BLK
C	022 BLK/YEL
D	014 YEL/GRN



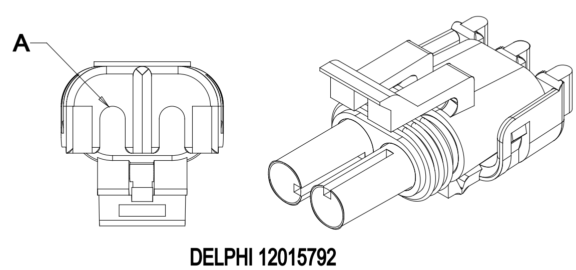
X255 - Scrub Deck Retract Limit Switch (S1)	
Pin	**Wire**
A	161 RED/ORN
B	229 BLK



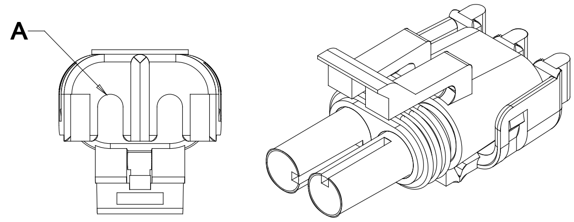
X256 - Scrub Deck Actuator Motor (M11)	
Pin	**Wire**
A	132 RED/GRN
B	135 YEL/GRA



X257 - Beacon (LT10)	
Pin	**Wire**
A	220 VIO
B	234 BLK

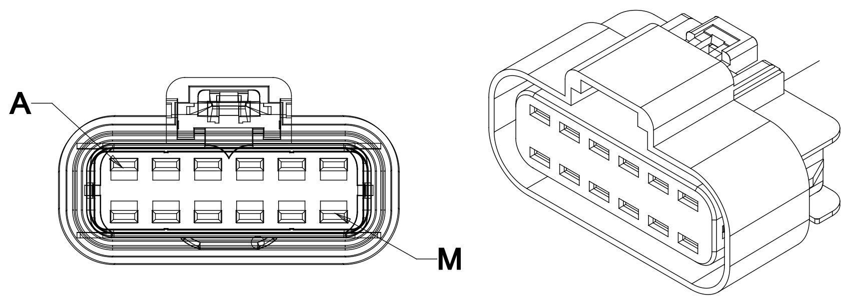


X258 - Trouble Light (LT1)	
Pin	**Wire**
A	316 YEL/BRN
B	232 BLK



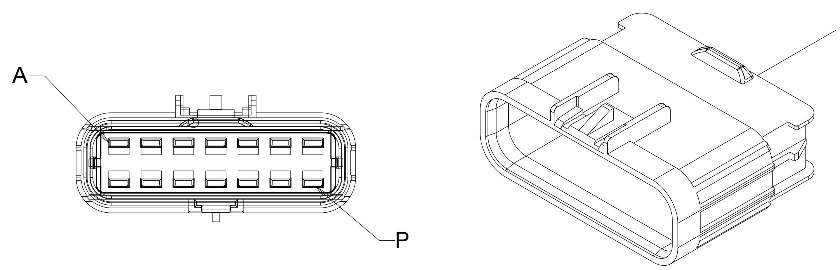
DELPHI 12015792

X262 - Main Harness Connector (X1)	
Pin	**Wire**
A	176 GRA
B	181 BRN/RED
C	223 WHT/GRA
D	224 BLK
E	225 YEL/VIO
F	226 BLK
G	259 ORN/GRN
H	260 BLK
J	267 VIO
K	268 BLK/RED
L	271 BRN
M	272 BLK/WHT



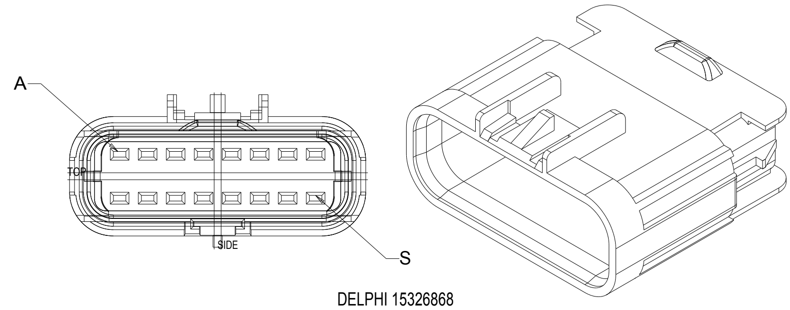
DELPHI 15326910

X263 - Main Harness Connector (X2)	
Pin	**Wire**
A	---
B	218 ORN/YEL
C	279 BLK/YEL
D	281 YEL/RED
E	282 GRA/VIO
F	283 GRN/ORN
G	286 BRN/GRN
H	287 RED/GRA
J	290 ORN/RED
K	291 BLK
L	292 YEL/WHT
M	293 BLK
N	294 WHT/RED
P	296 BLK



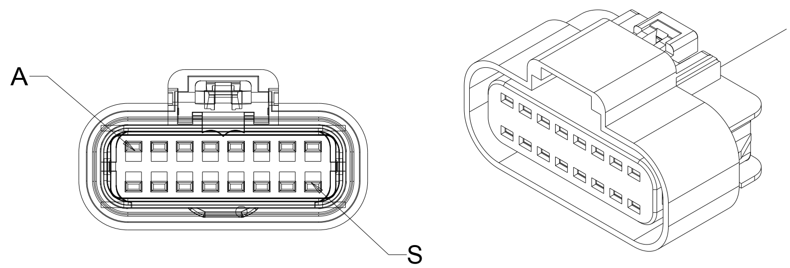
DELPHI 15326922

X265 - Engine Harness Connector	
Pin	**Wire**
A	321 PINK
B	341 PINK
C	318 BLK/RED
D	317 PINK/YEL
E	---
F	322 BLU/PINK
G	323 GRN/YEL
H	---
J	---
K	---
L	---
M	---
N	---
P	---
R	---
S	---



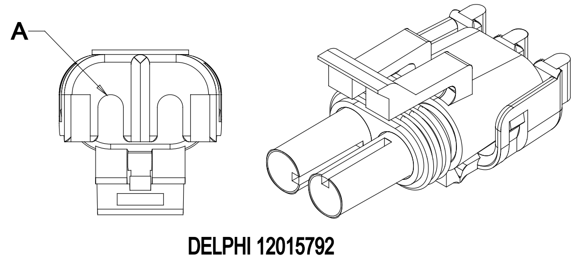
DELPHI 15326868

X266 - Engine Harness Connector	
Pin	**Wire**
A	---
B	---
C	324 GRA
D	---
E	---
F	---
G	---
H	---
J	325 GRA/ORN
K	326 GRA/BLU
L	---
M	---
N	---
P	---
R	---
S	---

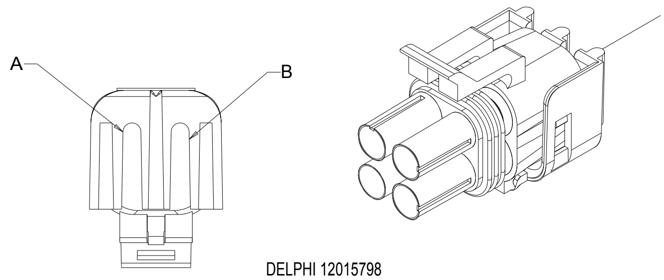


DELPHI 15326863

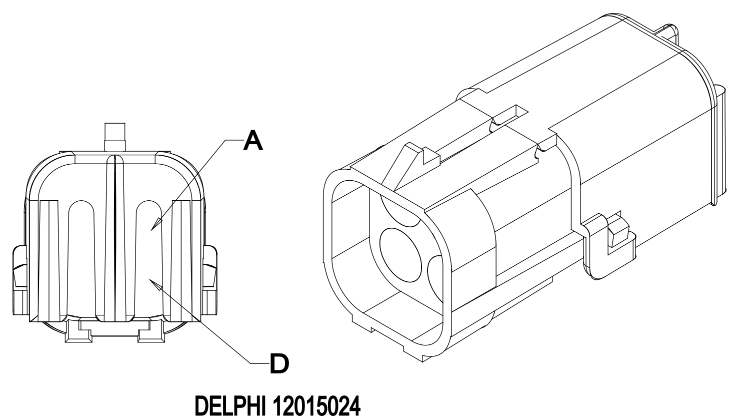
X268 - Extended Scrub Level Switch (S4)	
Pin	**Wire**
A	035 GRA/YEL
B	036 BLK



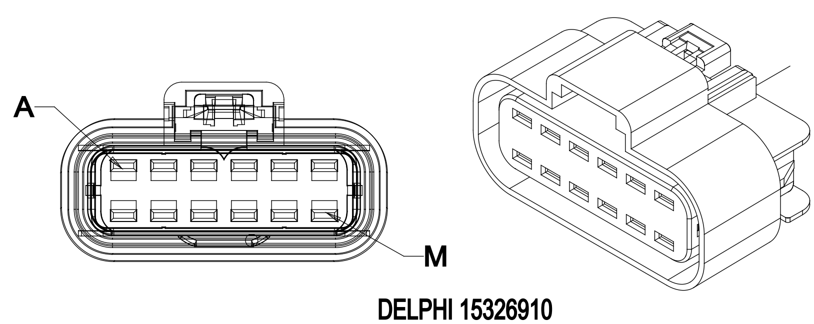
X270 - Main Harness Connector (X271)	
Pin	**Wire**
A	017 BLU/GRA
B	018 BLK
C	019 BLU/GRA
D	020 BLK



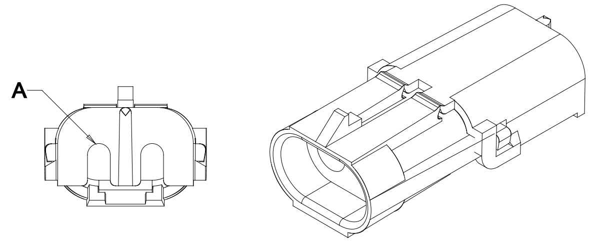
X271 - Vacuum Motor Harness (X270)	
Pin	Wire
A	026 BLU/GRA
B	027 BLK
C	028 BLU/GRA
D	029 BLK



X274 - Engine Interface Harness Connector (X175)	
Pin	**Wire**
A	123 PINK
B	129 BLU/PINK
C	108 GRA/YEL
D	102 GRA
E	131 GRA/ORN
F	134 GRA/BLU
G	118 WHT/ORN
H	117 YEL/RED
J	112 TAN/WHT
K	355 ORN
L	222 BRN/ORN
M	---



X275 - Fuel Pump (M20)	
Pin	**Wire**
A	317 PINK/YEL
B	318 BLK/RED



DELPHI 12010973

Maintenance and Adjustments

Charging the Battery (Battery Model)

See User Manual

Generator Drive Belt

The generator drive belt tension is maintained by an auto-tensioner and does not require adjustment.

Troubleshooting

42 volt generator is not charging

Potential Causes

- Broken or slipping drive belt - Check the drive belt
- No power to voltage regulator terminal - Check for battery voltage (36v) to the voltage regulator connector
- Open or corroded cable connections - visually inspect cable connections
- Generator/Regulator assembly

Insufficient machine operation time (Battery Model)

Potential Causes

- Battery is not fully charged
- Loose or corroded cable connections
- Battery

Insufficient machine operation time with engine off (Hybrid models)

Potential Causes

- Battery is not fully charged
- Loose or corroded cable connections
- Battery

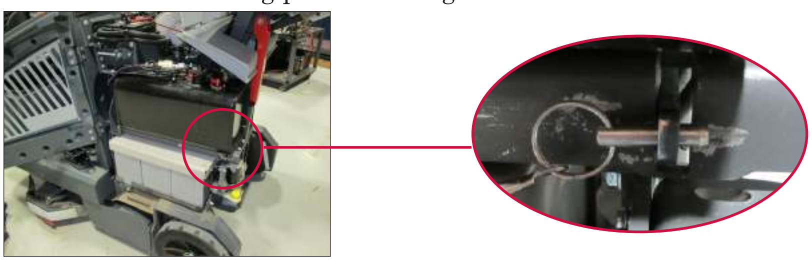
Removal and Installation

42 volt Generator Drive Belt

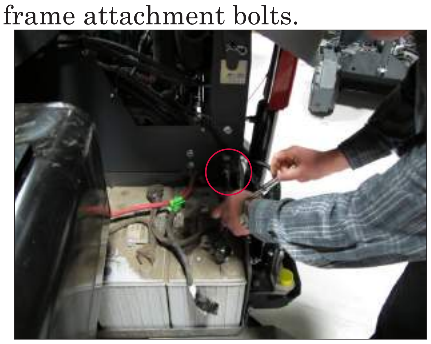
Note: Instructions are for both diesel and LPG models. Photos are of diesel.

1. Lift hopper up, engage hopper prop rod and then lower to safety lock position.
2. Open the side cover and remove the lower panel.

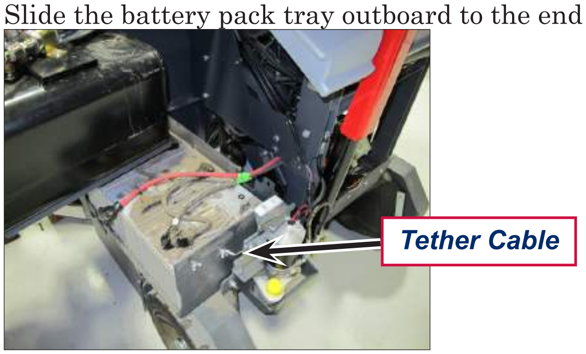
3. Remove the retaining pin and swing out the fuel tank.



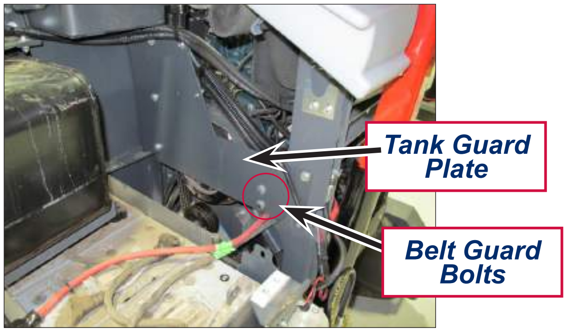
4. Remove the 36v battery pack top cover.
5. Disconnect the main battery negative and positive cables.
6. Remove the two battery pack tray to frame attachment bolts.

7. Slide the battery pack tray outboard to the end of the tether cable.



8. Remove the tank guard plate.



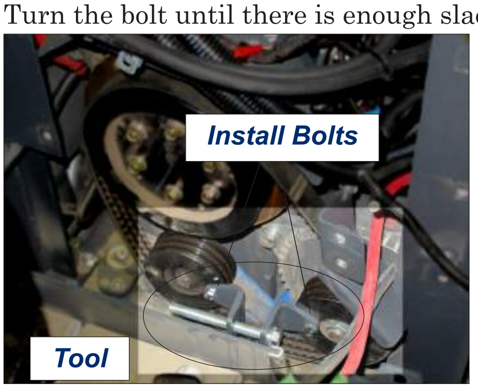
   a. Remove plate to frame bolts.

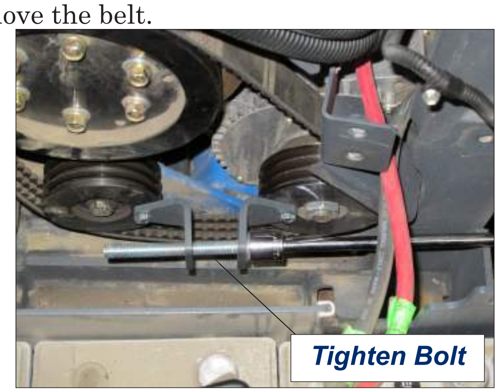
   b. Remove the plate to belt guard bolts.

   c. Remove the "P" clamp cable and fuel line fasteners.

9. Remove the belt tension release tool from the side of the starting battery.

10. Using the bolts that had attached the tool to the battery tray, bolt one end of the tool to the tensioner pulley and bolt the other end to the generator pulley. Pull the two tool halves together by "tightening" the long bolt. This will compress the auto-tensioner "spring" and release the tension on the drive belt. Turn the bolt until there is enough slack to remove the belt.



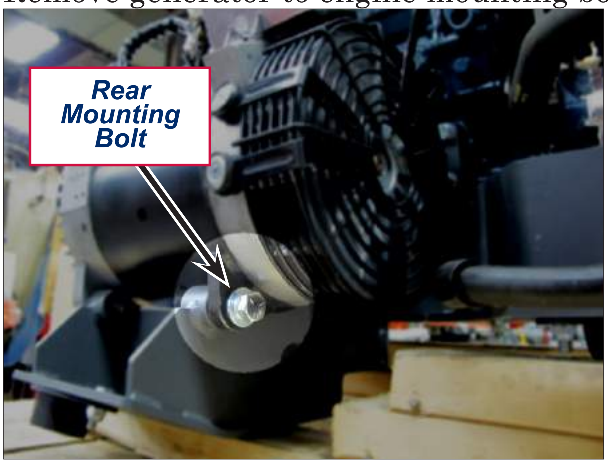


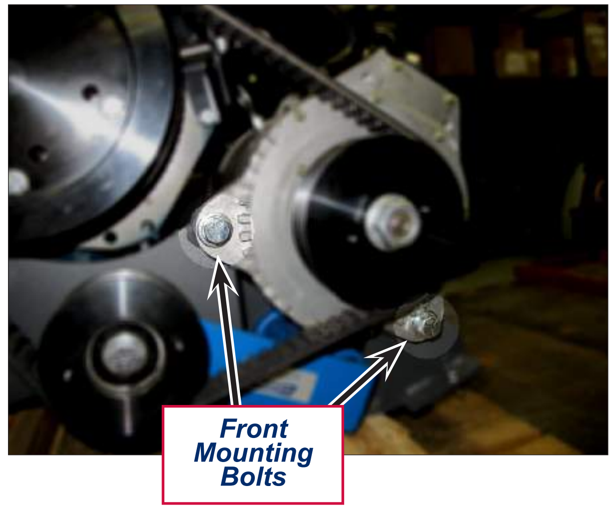
11. Remove the belt.

12. Reassemble in reverse order.

42 volt Generator

1. Remove Engine and Generator as an assembly. See relevant engine chapter.
2. Remove generator drive belt.
3. Label wiring for correct reassembly and then remove.
4. Support generator with a lift.
5. Remove generator to engine mounting bolts

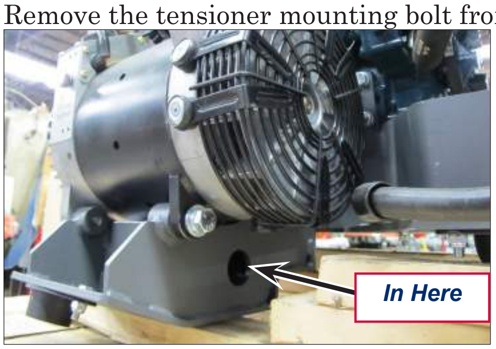




6. Remove generator.
7. Reassemble in reverse order.

Generator Drive Belt Tensioner

1. Remove Drive Belt.
2. Retract the tensioner tool bolt to relieve the spring tension.
3. Remove the tensioner tool.
4. Raise and lock hopper in place.
5. Remove lower rubber curtain fasteners to gain access to engine area and move the curtain aside.
6. Remove the tensioner mounting bolt from the back side of the generator mounting bracket. See photo.

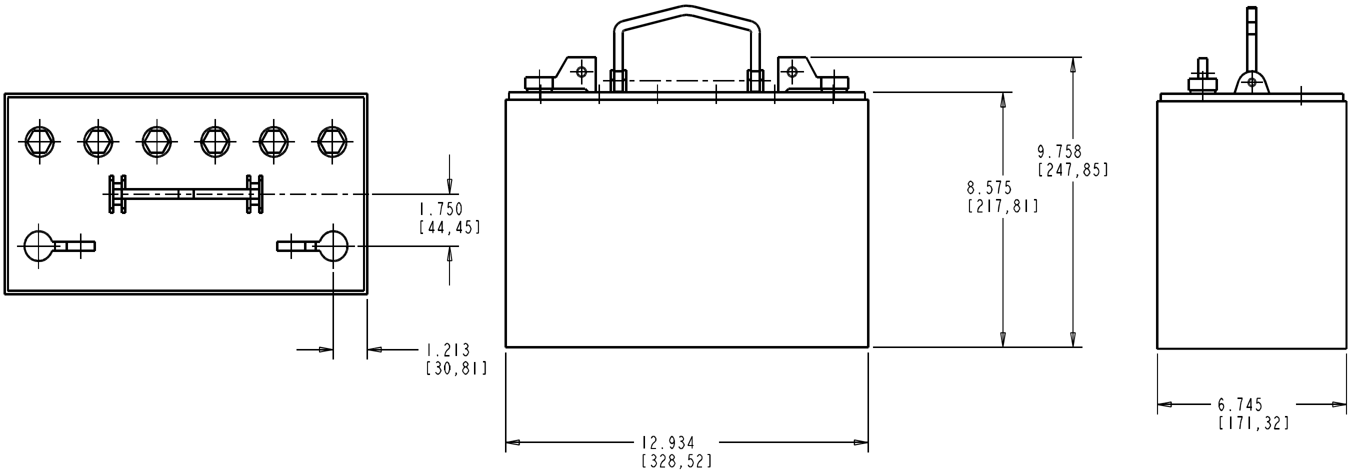


7. Reassemble in reverse order.

Specifications

Battery (Battery Model)

Capacity - 98 AH @ 20 HR



Low Voltage Cut Out

The low voltage cut out specification in use is set in the user options menu.

Menu #	Cut Out AT:	Restore Operation at:	Battery Type
1	1.75v per cell (31.5v total)	2.15v per cell (38.7v total)	Wet
2	1.83v per cell (32.9v total)	2.09v per cell (37.6v total)	Gel
3	1.75v per cell (31.5v total)	2.09v per cell (37.6v total)	(User Preference)

Battery Run Time (Battery powered machine)

Approx 5.4 hours (770 AH, 6 hr rate, and 900 AH 5 hr rate)

Auxiliary Relay

Winding Resistance: 652 Ohms

Auxiliary Contactor

Winding Resistance: 118 Ohms

Current Sensors

Amperage Measured	Voltage Output
120 A	4.5v
60 A	3.5v
45 A	3.25v
30 A	3.0v
15 A	2.75v
0 A	2.5v
-60 A	1.5v
-120 A	0.5v

Input/Output Table

Conn.	Pin	Wire	Desig.	Description	ID	Signal	Nominal Value	Black voltmeter lead on:
J2	1	091 ORN/ YEL	Output	Left Front Turn Lamp	LT7		12V OFF / 0V ON	B-(Ground)
J2	2	094 ORN/ BLU	Output	Left Rear Tail Lamp	LT9		12V OFF / 0V ON	B-(Ground)
J2	3	098 YEL/ RED	Output	Right Front Turn Lamp	LT4		12V OFF / 0V ON	B-(Ground)
J2	4	101 YEL/ GRN	Output	Right Rear Stop/Turn Lamp	LT11		12V OFF / 0V ON	B-(Ground)
J2	5	107 TAN/ BLK	Output	Tail Lamps	LT5 and LT6		12V OFF / 0V ON	B-(Ground)
J2	6	064 BLK/ YEL	Output	Dust Control Motor Contactor	K6	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	7	119 BRN/ WHT	Output	Detergent Pump	M17	PWM SIGNAL (Reversing Polarity)	0-12V	J2-19
J2	8	080 WHT/ GRN	Output	Squeegee Actuator Motor	M12	Reversing Polarity	Battery 30.5- 38V Engine ON 37-40.5V	J2-9
J2	9	078 BLU/ BRN	Output	Squeegee Actuator Motor	M12	Reversing Polarity	Battery 30.5- 38V Engine ON 37-40.5V	J2-8
J2	10	132 RED/ GRN	Output	Scrub Deck Actuator Motor	M11	Reversing Polarity	Battery 30.5- 38V Engine ON 37-40.5V	J2-11
J2	11	135 YEL/ GRA	Output	Scrub Deck Actuator Motor	M11	Reversing Polarity	Battery 30.5- 38V Engine ON 37-40.5V	J2-10
J2	12	162 BLK	Ground Supply	Battery Negative			Battery 30.5- 38V Engine ON 37-40.5V	B+
J2	13	057 VIO	Power Supply	VACC 1		Power supply from Aux Contactor	Battery 30.5- 38V Engine ON 37-40.5V	B-(Ground)
J2	14	051 BLK/ ORN	Output	Auxiliary Contactor	K9	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	15	163 BRN/ BLK	Output	Side Broom Motor Contactor	K8	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	16	063 GRN/ GRA	Output	Main Broom Motor Contactor	K4	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	17	045 BLU	Output	Vacuum Motor Contactor	K5	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	18	150 BLK/ RED	Output	Shaker Motor ground	M14	PWM SIGNAL (half second cycles)	Battery 30.5- 38V Engine ON 37-40.5V	B-(Ground)
J2	19	116 WHT/ YEL	Output	Detergent Pump	M17	PWM SIGNAL (Reversing Polarity)	0-12V	J2-7

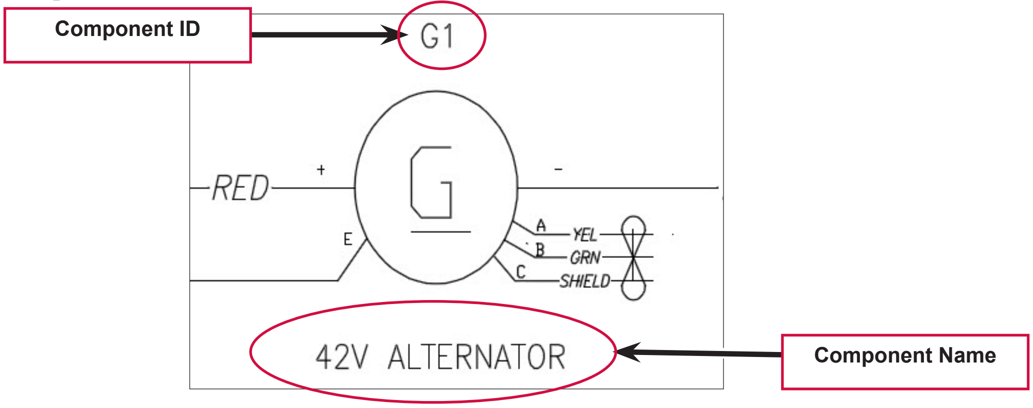
Conn.	Pin	Wire	Desig.	Description	ID	Signal	Nominal Value	Black voltmeter lead on:
J2	20	157 YEL/ ORN	Output	Solution Solenoid Valve Grounds to energize	L1	ON/OFF signal		
J2	21	160 BLU/ VIO	Output	Detergent Pump	M18	PWM SIGNAL (Reversing Polarity)	0-12V	J2-32
J2	22	167 BLK/ YEL	Output	Lamps Common		Regulated 12V supply	12	B-(Ground)
J2	23	169 BRN	Output	Head Lamps and Curb Lamp PWM ground to turn on lights	LT2, LT3, LT8	PWM ground to turn on lights	0	B-(Ground)
J2	24	039 ORN/ RED	Output	Hydraulic Pump Motor Contactor Grounds to energize	K12			
J2	25	047 YEL/ BLU	Output	Left Brush Motor Contactor	K1	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	26	015 WHT/ VIO	Output	Center Brush Motor Contactor	K2	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	27	061 GRA/ RED	Output	Right Brush Motor Contactor	K3	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	28	038 BLU/ ORN	Output	Hydraulic Pump Motor Contactor (K11) Grounds to energize	K11	Grounds to energize	36V OFF / 0V ON	B-(Ground)
J2	29	---						
J2	30	---						
J2	31	---						
J2	32	221 GRA/ BLU	Output	Detergent Pump	M18	PWM SIGNAL (Reversing Polarity)	0-12V	J2-21
J2	33	---						
J2	34	054 BLK/ WHT	Power Supply	VACC6a		Power supply from Aux Relay	36/40.5	
J2	35	053 BLK/ WHT	Power Supply	VACC6b		Power supply from Aux Relay	36/40.5	
J3	1	042 VIO/ ORN	Output	Extended Scrub Pump	M25	PWM ground	0-36V	
J3	2	093 RED/ YEL	Output	Solution Control Pump	M19	PWM ground	0-36V	
J3	3	030 BRN/ WHT	Output	Main Broom Actuator Reversing polarity driver	M21	PWM SIGNAL (Reversing Polarity)	0-36V	J3-4
J3	4	031 RED/ VIO	Output	Main Broom Actuator Reversing polarity driver	M21	PWM SIGNAL (Reversing Polarity)	0-36V	J3-3
J3	5	106 GRA/ VIO	Output	Side Broom Actuator Reversing polarity driver	M13	Reversing Polarity	Battery 30.5- 38V Engine ON 37-40.5V	J3-17
J3	6	111 BRN/ GRN	Output	Dump Door Actuator	M26	Reversing polarity driver	0-36V	J3-7
J3	7	115 RED/ GRA	Output	Dump Door Actuator Reversing polarity driver	M26	Reversing polarity driver	0-36V	J3-6
J3	8	118 WHT/ ORN	Output	High Pressure Pump Clutch Coil	Y1	High Side Driver Engine 12V	12V	B-(Ground)
J3	9	123 PINK	Output	Ignition On Output 12v out to engine system		High Side Driver Engine 12V	12V	
J3	10	129 BLU/ PINK	Output	Start Output 12v out to starter		High Side Driver Engine 12V	12V	

Conn.	Pin	Wire	Desig.	Description	ID	Signal	Nominal Value	Black voltmeter lead on:
J3	11	131 GRA/ ORN	Output	Throttle 2 Output		High Side Driver Engine 12V	0V or 12V	
J3	12	134 GRA/ BLU	Output	Throttle 1 Output		High Side Driver Engine 12V	0V or 12V	
J3	13	137 BRN/ RED	Output	Dust Guard Control (Pump and Valve)	L2, M22	Grounds to turn both on	0V	B-(Ground)
J3	14	139 VIO/ BRN	Output	Horn Ground to turn on	H2	Grounds to energize	0V	B-(Ground)
J3	15	144 BLK	Ground Supply	Battery Negative				
J3	16	142 BLK	Ground Supply	Battery Negative				
J3	17	250 GRN/ ORN	Output	Side Broom Actuator Reversing polarity driver	M13	Reversing Polarity	Battery 30.5- 38V Engine ON 37-40.5V	J3-5
J3	18	149 BLK	Ground Supply	Battery Negative				
J3	19	154 BLK	Ground Supply	Battery Negative				
J3	20	156 BLK	Ground Supply	Battery Negative				
J3	21	159 BLK	Ground Supply	Battery Negative				
J3	22	---						
J3	23	059 VIO/ RED	Power Supply	12V supply		Power supply from starting battery	12V	B-(Ground)
J3	24	171 GRN/ WHT	Output	Low Pressure Pump	M23	Grounds to energize Also requires internal pressure switch in pump	0V	B-(Ground)
J3	25	---						
J3	26	058 GRA	Power Supply	VACC2		Power supply from Aux Contactor	36V	B-(Ground)
J3	27	076 GRN/ BRN	Output	Backup Alarm	H1	Grounds to energize	0V	B-(Ground)
J3	28	---						
J3	29	166 BLK	Ground Supply	Battery Negative				
J3	30	---						
J3	31	---						
J3	32	049 ORN/ BLK	Output	Glow Plug Output		High Side Driver Engine 12V	12V	B-(Ground)
J3	33	---						
J3	34	056 GRA/ BLK	Power Supply	VACC3a		Power supply from Aux Contactor	36V	B-(Ground)
J3	35	055 GRA/ BLK	Power Supply	VACC3b		Power supply from Aux Contactor	36V	B-(Ground)
J7	1	092 GRN/ BLU	Input	Interlock Switch Input		Logic Input	36V	B-(Ground)
J7	2	095 GRN	Communi-cation	CAN Bus Low		Digital Signal	0 or 5V	B-(Ground)
J7	3	099 YEL	Communi-cation	CAN Bus High		Digital Signal	0 or 5V	B-(Ground)
J7	4	102 GRA	Output	Run Signal Input		Engine Logic Input	12 V Engine Running	B-(Ground)
J7	5	108 GRA/ YEL	Input	Engine Coolant Temperature		Logic Input	5V	
J7	6	112 TAN/ WHT	Input	Fuel Level Sender	S12	Analog Signal		
J7	7	117 YEL/ RED	Input	Low LP Pressure Switch	S11	Logic Input		
J7	8	---						

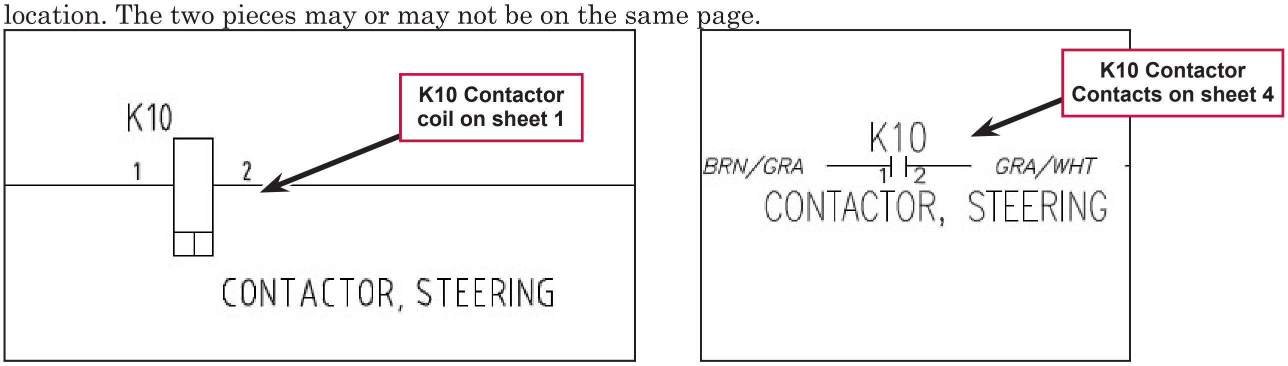
Conn.	Pin	Wire	Desig.	Description	ID	Signal	Nominal Value	Black voltmeter lead on:
J7	9	---						
J7	10	130 WHT/ BRN	Output	12v	A3	Power out to Control Panel	12V	B-(Ground)
J7	11	133 BLK	Output	B-	A3	Ground for Control Panel		
J7	12	050 YEL/ BRN	Special	Suppression Diode			36V	B-(Ground)
J7	13	141 ORN	Power Supply	Key Switch On Input	S14	Power supply	36V	B-(Ground)
J7	14	046 RED/ BLK	Input	Hopper Interlock Switch	S3	Logic Input	0 or 5V	B-(Ground)
J7	15	035 GRA/ YEL	Input	Extended Scrub Level Switch	S4	Logic Input	0 or 5V	
J7	16	143 WHT/ GRA	Input	Dust Control Filter Switch	S6	Logic Input	0 or 5V	
J7	17	145 ORN/ GRA	Input	Brake Switch	S5	Logic Input	0 or 5V	B-(Ground)
J7	18	151 YEL/ VIO	Input	Hopper Fire Switch	S10	Logic Input	0 or 5v	B-(Ground)
J7	19	155 VIO/ GRN	Input	Key Switch Start Input	S14	Logic Input	0 or 36V	B-(Ground)
J7	20	---						
J7	21	161 RED/ ORN	Input	Scrub Deck Retract Limit Switch	S1	Logic Input	0 or 5V	B-(Ground)
J7	22	168 ORN/ RED	Input	Hopper Dump Door Extend Limit Switch	S7	Logic Input	0 or 5V	B-(Ground)
J7	23	170 YEL/ WHT	Input	Hopper Dump Door Retract Limit Switch	S8	Logic Input	0 or 5V	B-(Ground)
J7	24	172 BLU/ YEL	Output	+5V		5v Power out to Current Sensors	5V	B-(Ground)
J7	25	174 VIO/ WHT	Output	B-		Ground for Current Sensors	0V	B-(Ground)
J7	26	---						
J7	27	178 BRN	Input	Brush Motor Current Sense	B1	Analog Signal	2.5 - 4.7	B-(Ground)
J7	28	---						
J7	29	184 RED/ WHT	Input	Vacuum Motor Current Sense	B3	Analog Signal	2.5 - 4.7	B-(Ground)
J7	30	---						
J7	31	215 ORN/ BLU	Input	Broom Motor Current Sense	B2	Analog Signal	2.5 - 4.7	B-(Ground)
J7	32	---						
J7	33	032 BLU/ BLK	Input	POT High	R4	Power supply for Main Broom Actuator Position Sensor	3.3V	B-(Ground)
J7	34	033 GRA/ GRN	Input	Wiper	R4	Main Broom Actuator Position Sensor input	0 to 3.3V	B-(Ground)
J7	35	034 TAN/ RED	Input	POT Low	R4	B- for Main Broom Actuator Position Sensor	0V	B-(Ground)

Wiring Diagrams

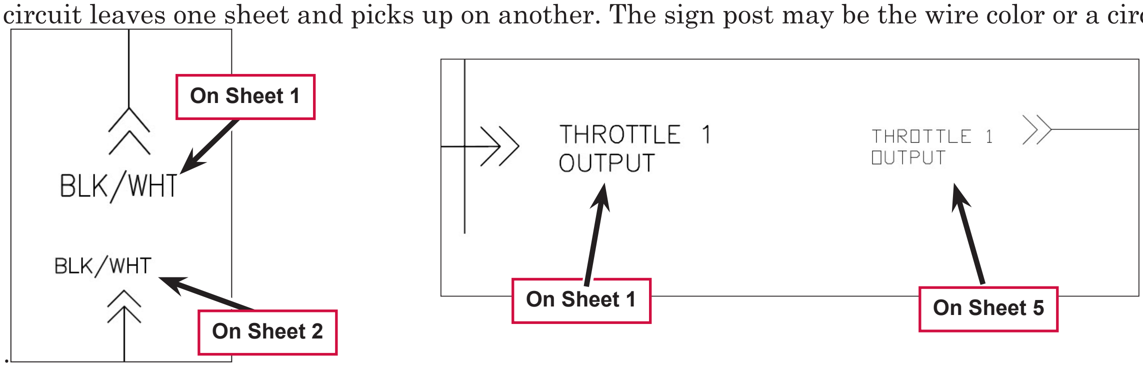
Wiring diagrams show how electrical components are connected together and to a large degree "how things work". They do not show where things are located. Here are some tips when using these diagrams. Every component has both an "ID" and a "name"



Typically relays (and contactors) are "split up" so that the relay winding is separated from the contacts. The "control" side of the relay is shown in one location and the "load" side of the relay is shown in another location. The two pieces may or may not be on the same page.

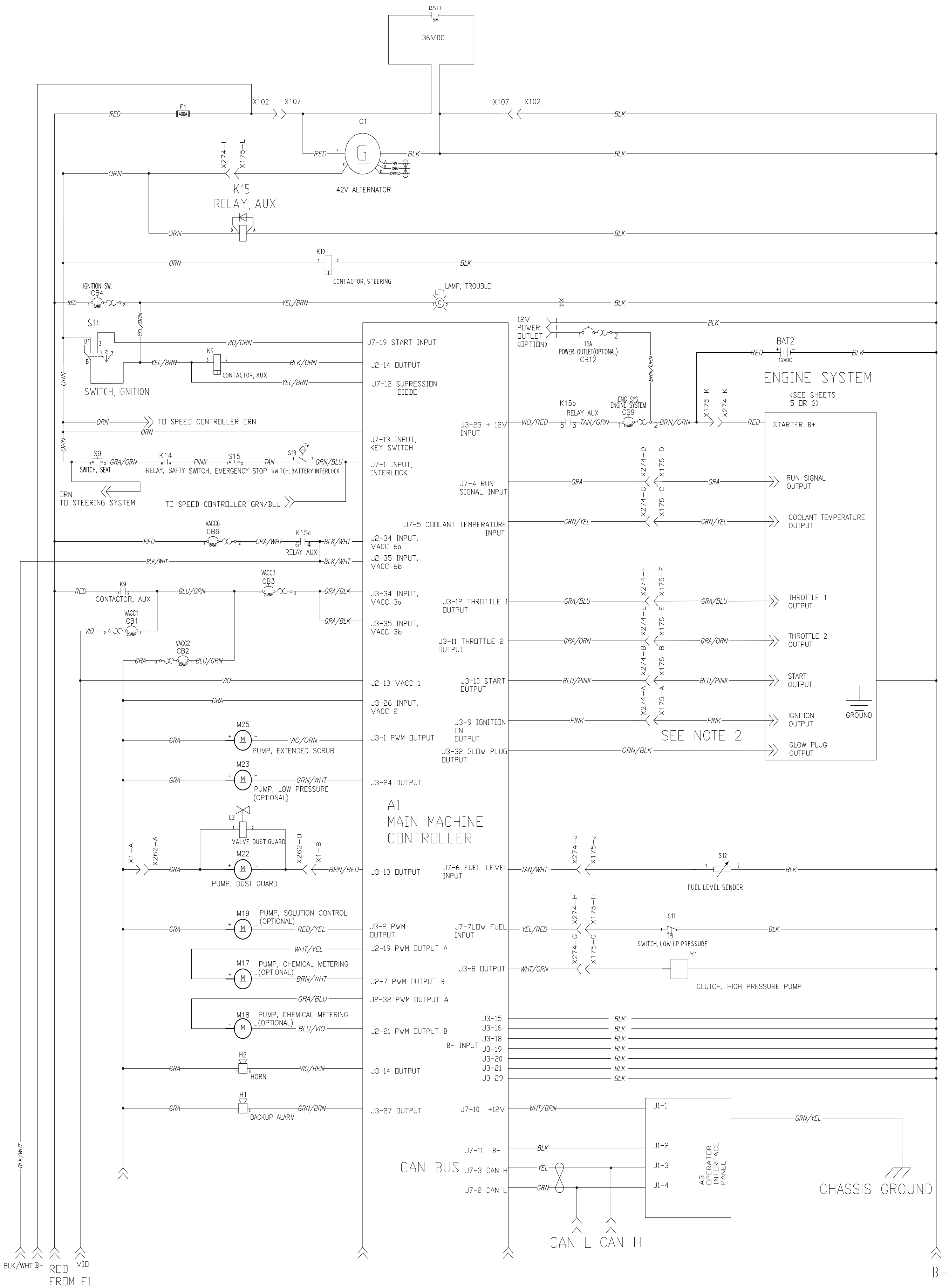


When a circuit breaks across sheets there is a "sign post" at both ends to help you quickly identify where the circuit leaves one sheet and picks up on another. The sign post may be the wire color or a circuit description.

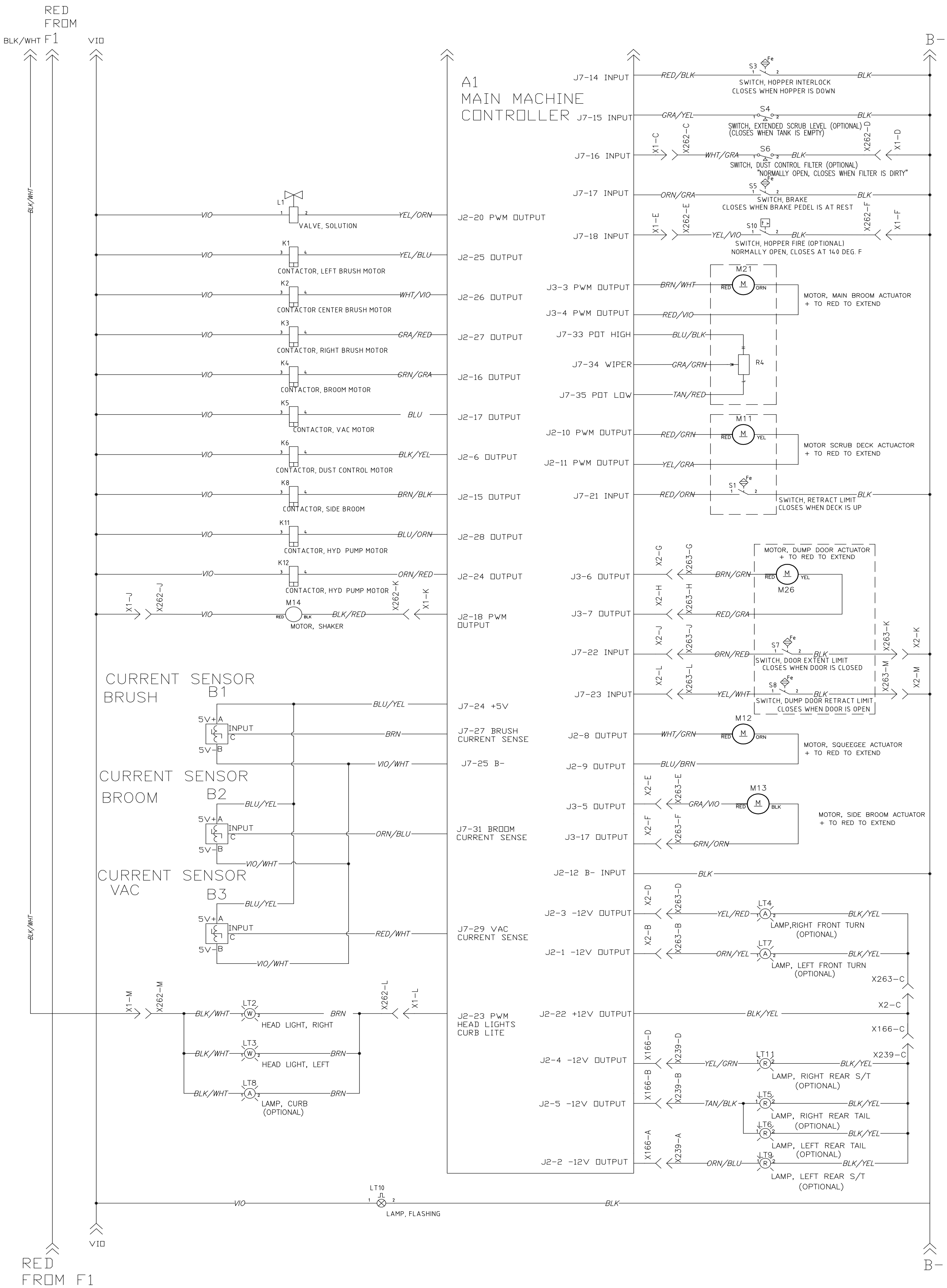


The wiring diagrams show when a circuit passes through an in-line connector and identifies the two halves of the connector. If you need to locate one of these connectors, see the ***Harness to Harness Connector Locations*** section. To find a connector that plugs into a component, see the ***Component Locations*** section to locate the component then follow the wire lead (if there is one) to the connector. If you need more detailed information about what a multi-pin connector looks like and where the wires are located in the connector, see the ***Connector Pin-Outs*** section.

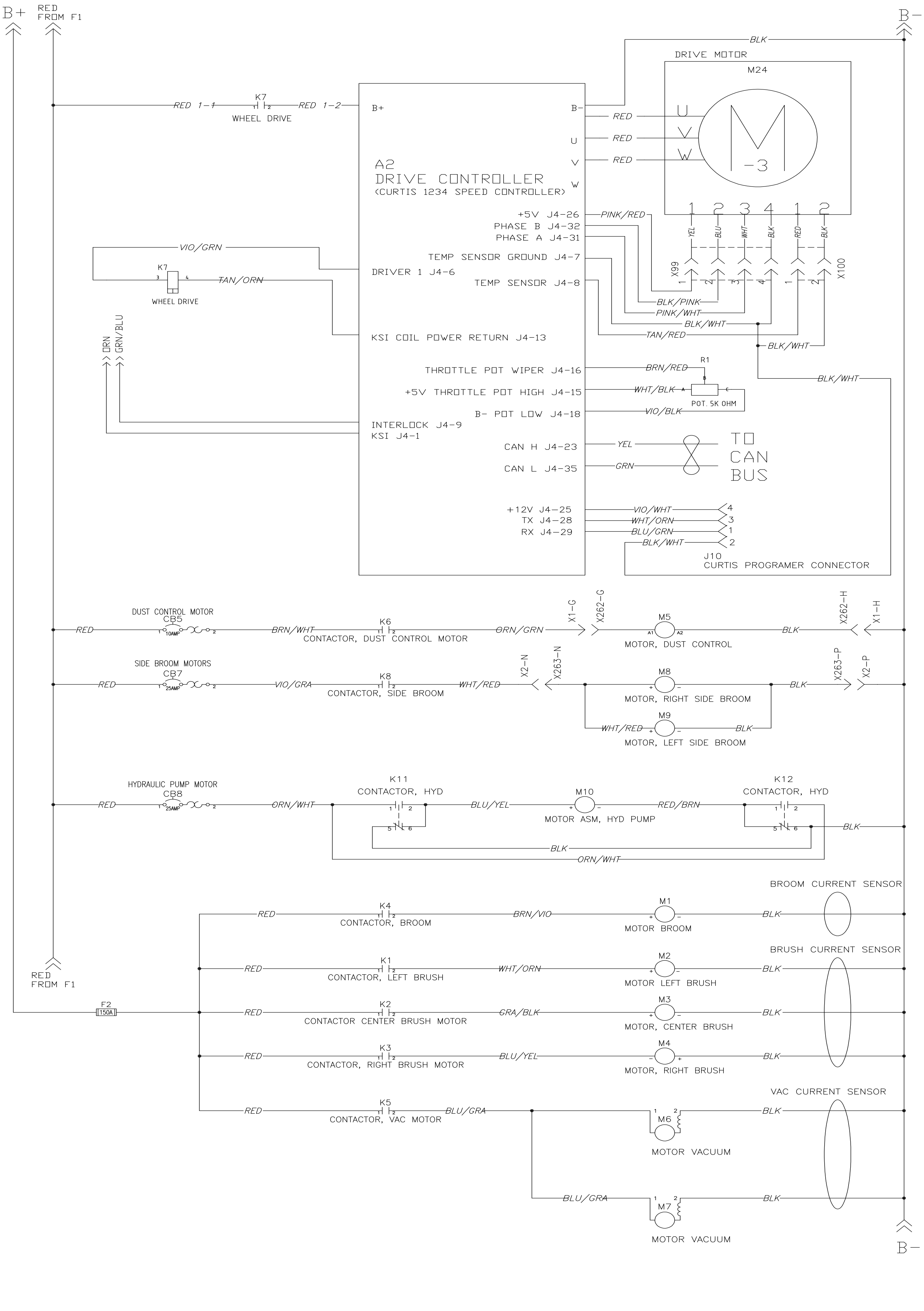
Sheet 1 of 6


36VDC
42V ALTERNATOR
K15
RELAY, AUX
CONTACTOR, STEERING
LAMP, TROUBLE
IGNITION SW.
SWITCH, IGNITION
CONTACTOR, AUX
TO SPEED CONTROLLER ORN
SWITCH, SEAT
RELAY, SAFTY SWITCH, EMERGENCY STOP
SWITCH, BATTERY INTERLOCK
ORN
TO STEERING SYSTEM
TO SPEED CONTROLLER GRN/BLU
12V POWER OUTLET (OPTION)
POWER OUTLET(OPTIONAL)
ENGINE SYSTEM
(SEE SHEETS 5 OR 6)
STARTER B+
RUN SIGNAL OUTPUT
COOLANT TEMPERATURE OUTPUT
THROTTLE 1 OUTPUT
THROTTLE 2 OUTPUT
START OUTPUT
IGNITION OUTPUT
GLOW PLUG OUTPUT
GROUND
SEE NOTE 2
PUMP, EXTENDED SCRUB
PUMP, LOW PRESSURE (OPTIONAL)
VALVE, DUST GUARD
PUMP, DUST GUARD
PUMP, SOLUTION CONTROL (OPTIONAL)
PUMP, CHEMICAL METERING (OPTIONAL)
HORN
BACKUP ALARM
A1
MAIN MACHINE
CONTROLLER
FUEL LEVEL SENDER
SWITCH, LOW LP PRESSURE
CLUTCH, HIGH PRESSURE PUMP
CAN BUS
A3 OPERATOR INTERFACE PANEL
CHASSIS GROUND
CAN L
CAN H
BLK/WHT
B+
RED
FROM F1
VIO
B-

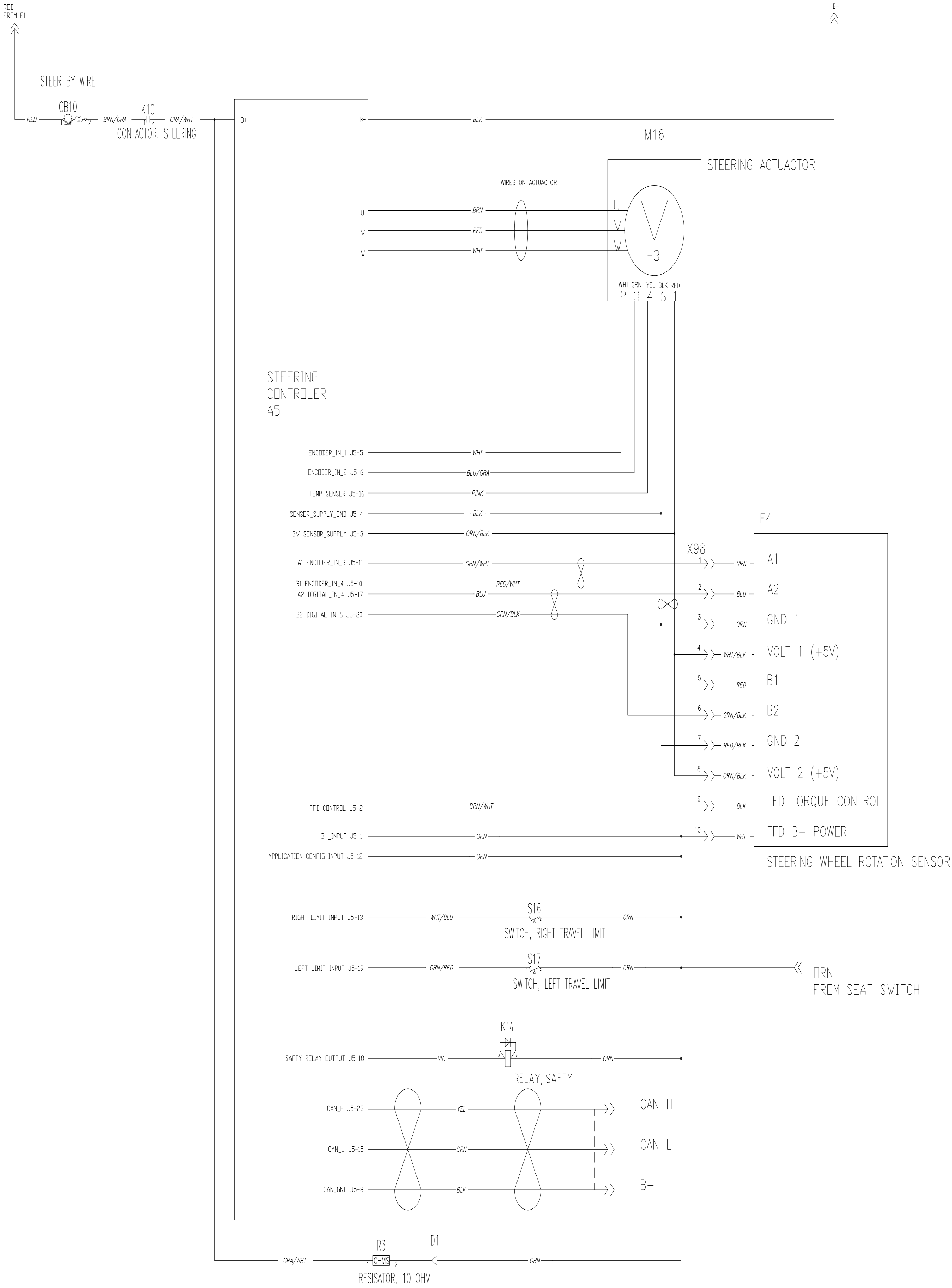
Sheet 2 of 6


RED FROM F1
BLK/WHT
VIO
B-
A1 MAIN MACHINE CONTROLLER
J7-14 INPUT
SWITCH, HOPPER INTERLOCK CLOSES WHEN HOPPER IS DOWN
J7-15 INPUT
SWITCH, EXTENDED SCRUB LEVEL (OPTIONAL) (CLOSES WHEN TANK IS EMPTY)
J7-16 INPUT
SWITCH, DUST CONTROL FILTER (OPTIONAL) "NORMALLY OPEN, CLOSES WHEN FILTER IS DIRTY"
J7-17 INPUT
SWITCH, BRAKE CLOSES WHEN BRAKE PEDEL IS AT REST
J7-18 INPUT
SWITCH, HOPPER FIRE (OPTIONAL) NORMALLY OPEN, CLOSES AT 140 DEG. F
VALVE, SOLUTION
J2-20 PWM OUTPUT
CONTACTOR, LEFT BRUSH MOTOR
J2-25 OUTPUT
CONTACTOR CENTER BRUSH MOTOR
J2-26 OUTPUT
CONTACTOR, RIGHT BRUSH MOTOR
J2-27 OUTPUT
CONTACTOR, BROOM MOTOR
J2-16 OUTPUT
CONTACTOR, VAC MOTOR
J2-17 OUTPUT
CONTACTOR, DUST CONTROL MOTOR
J2-6 OUTPUT
CONTACTOR, SIDE BROOM
J2-15 OUTPUT
CONTACTOR, HYD PUMP MOTOR
J2-28 OUTPUT
CONTACTOR, HYD PUMP MOTOR
J2-24 OUTPUT
MOTOR, SHAKER
J2-18 PWM OUTPUT
J3-3 PWM OUTPUT
J3-4 PWM OUTPUT
MOTOR, MAIN BROOM ACTUATOR + TO RED TO EXTEND
J7-33 POT HIGH
J7-34 WIPER
J7-35 POT LOW
J2-10 PWM OUTPUT
J2-11 PWM OUTPUT
MOTOR SCRUB DECK ACTUATOR + TO RED TO EXTEND
J7-21 INPUT
SWITCH, RETRACT LIMIT CLOSES WHEN DECK IS UP
J2-28 OUTPUT
MOTOR, DUMP DOOR ACTUATOR + TO RED TO EXTEND
J3-6 OUTPUT
J3-7 OUTPUT
J7-22 INPUT
SWITCH, DOOR EXTENT LIMIT CLOSES WHEN DOOR IS CLOSED
J7-23 INPUT
SWITCH, DUMP DOOR RETRACT LIMIT CLOSES WHEN DOOR IS OPEN
CURRENT SENSOR BRUSH B1
J7-24 +5V
J7-27 BRUSH CURRENT SENSE
J7-25 B-
J2-8 OUTPUT
J2-9 OUTPUT
MOTOR, SQUEEGEE ACTUATOR + TO RED TO EXTEND
CURRENT SENSOR BROOM B2
J7-31 BROOM CURRENT SENSE
J3-5 OUTPUT
J3-17 OUTPUT
MOTOR, SIDE BROOM ACTUATOR + TO RED TO EXTEND
CURRENT SENSOR VAC B3
J2-12 B- INPUT
J7-29 VAC CURRENT SENSE
J2-3 -12V OUTPUT
LAMP,RIGHT FRONT TURN (OPTIONAL)
J2-1 -12V OUTPUT
LAMP, LEFT FRONT TURN (OPTIONAL)
HEAD LIGHT, RIGHT
J2-23 PWM HEAD LIGHTS CURB LITE
J2-22 +12V OUTPUT
HEAD LIGHT, LEFT
J2-4 -12V OUTPUT
LAMP, RIGHT REAR S/T (OPTIONAL)
LAMP, CURB (OPTIONAL)
J2-5 -12V OUTPUT
LAMP, RIGHT REAR TAIL (OPTIONAL)
LAMP, LEFT REAR TAIL (OPTIONAL)
J2-2 -12V OUTPUT
LAMP, LEFT REAR S/T (OPTIONAL)
LAMP, FLASHING
VIO
RED FROM F1
B-

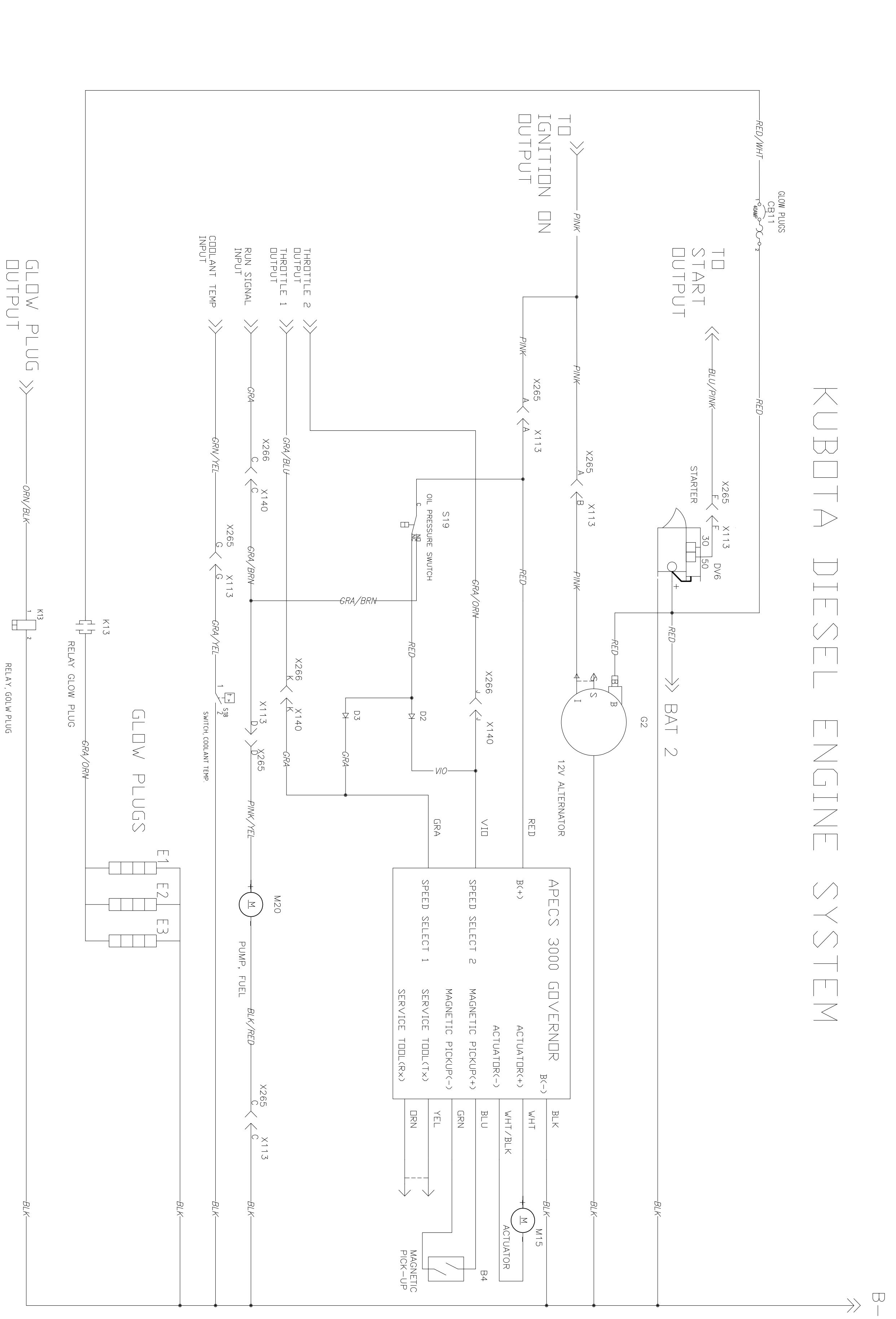
Sheet 3 of 6


B+
RED FROM F1
B-
BLK
DRIVE MOTOR
M24
K7
RED 1-1
RED 1-2
WHEEL DRIVE
B+
B-
U
V
W
RED
A2
DRIVE CONTROLLER
(CURTIS 1234 SPEED CONTROLLER)
+5V J4-26
PHASE B J4-32
PHASE A J4-31
TEMP SENSOR GROUND J4-7
DRIVER 1 J4-6
TEMP SENSOR J4-8
KSI COIL POWER RETURN J4-13
THROTTLE POT WIPER J4-16
+5V THROTTLE POT HIGH J4-15
B- POT LOW J4-18
INTERLOCK J4-9
KSI J4-1
CAN H J4-23
CAN L J4-35
+12V J4-25
TX J4-28
RX J4-29
PINK/RED
BLK/PINK
PINK/WHT
BLK/WHT
TAN/RED
X99
X100
VIO/GRN
TAN/ORN
ORN
GRN/BLU
BRN/RED
WHT/BLK
VIO/BLK
R1
POT. 5K OHM
YEL
GRN
TO CAN BUS
VIO/WHT
WHT/ORN
BLU/GRN
J10
CURTIS PROGRAMER CONNECTOR
DUST CONTROL MOTOR
CB5
10AMP
RED
BRN/WHT
K6
CONTACTOR, DUST CONTROL MOTOR
ORN/GRN
X1-G
X262-G
M5
MOTOR, DUST CONTROL
X262-H
X1-H
SIDE BROOM MOTORS
CB7
25AMP
VIO/GRA
K8
CONTACTOR, SIDE BROOM
WHT/RED
X2-N
X263-N
M8
MOTOR, RIGHT SIDE BROOM
X263-P
X2-P
M9
MOTOR, LEFT SIDE BROOM
HYDRAULIC PUMP MOTOR
CB8
25AMP
ORN/WHT
K11
CONTACTOR, HYD
BLU/YEL
M10
MOTOR ASM, HYD PUMP
RED/BRN
K12
CONTACTOR, HYD
BROOM CURRENT SENSOR
K4
CONTACTOR, BROOM
BRN/VIO
M1
MOTOR BROOM
BRUSH CURRENT SENSOR
K1
CONTACTOR, LEFT BRUSH
WHT/ORN
M2
MOTOR LEFT BRUSH
F2
150A
K2
CONTACTOR CENTER BRUSH MOTOR
GRA/BLK
M3
MOTOR, CENTER BRUSH
K3
CONTACTOR, RIGHT BRUSH MOTOR
BLU/YEL
M4
MOTOR, RIGHT BRUSH
VAC CURRENT SENSOR
K5
CONTACTOR, VAC MOTOR
BLU/GRA
M6
MOTOR VACUUM
M7
MOTOR VACUUM

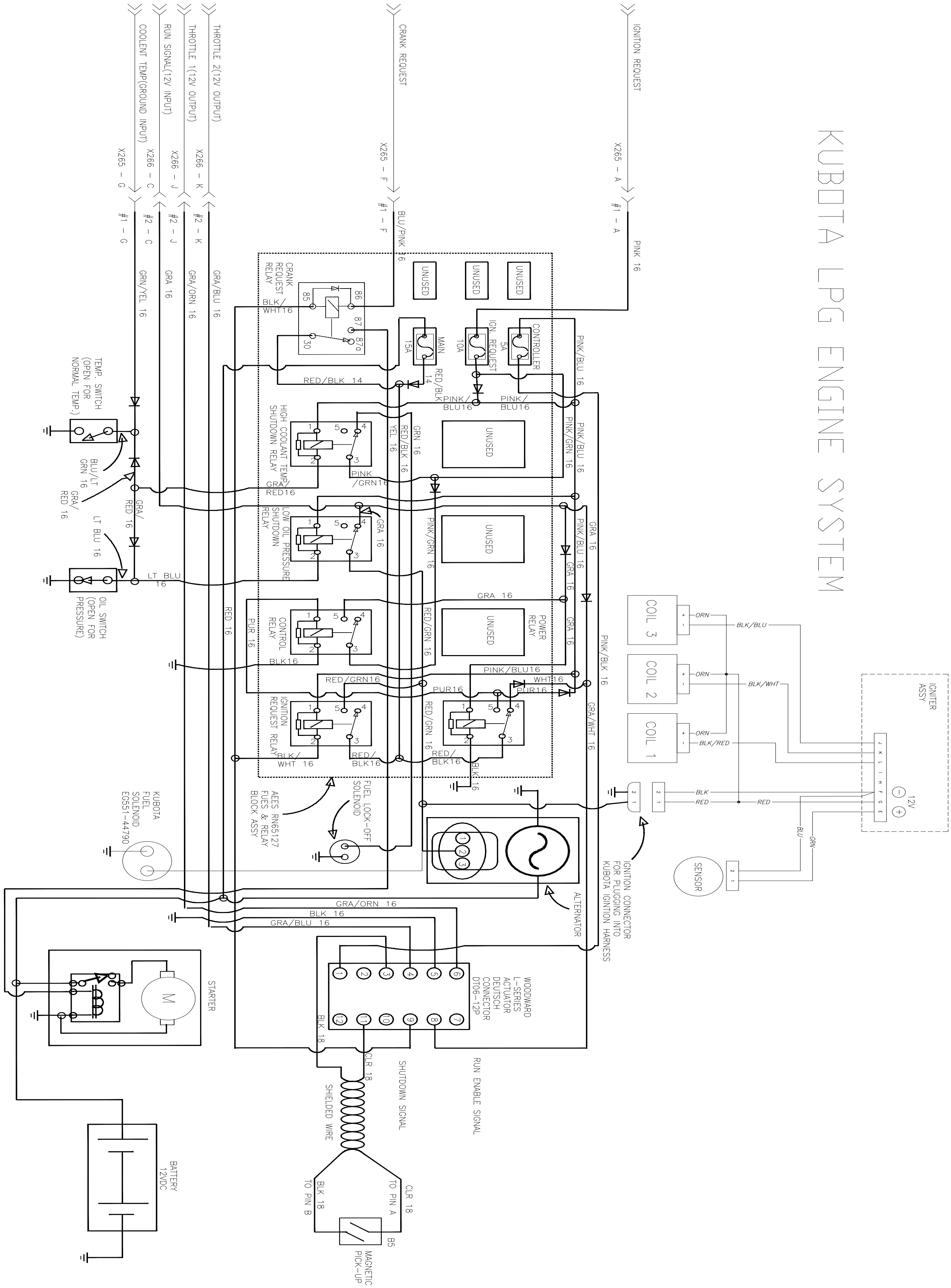
Sheet 4 of 6


RED FROM F1
B-
STEER BY WIRE
CB10
K10
CONTACTOR, STEERING
STEERING CONTROLER A5
M16
STEERING ACTUACTOR
WIRES ON ACTUACTOR
U V W
ENCODER_IN_1 J5-5
ENCODER_IN_2 J5-6
TEMP SENSOR J5-16
SENSOR_SUPPLY_GND J5-4
5V SENSOR_SUPPLY J5-3
A1 ENCODER_IN_3 J5-11
B1 ENCODER_IN_4 J5-10
A2 DIGITAL_IN_4 J5-17
B2 DIGITAL_IN_6 J5-20
X98
E4
A1
A2
GND 1
VOLT 1 (+5V)
B1
B2
GND 2
VOLT 2 (+5V)
TFD TORQUE CONTROL
TFD B+ POWER
STEERING WHEEL ROTATION SENSOR
TFD CONTROL J5-2
B+_INPUT J5-1
APPLICATION CONFIG INPUT J5-12
RIGHT LIMIT INPUT J5-13
S16
SWITCH, RIGHT TRAVEL LIMIT
LEFT LIMIT INPUT J5-19
S17
SWITCH, LEFT TRAVEL LIMIT
ORN FROM SEAT SWITCH
K14
SAFTY RELAY OUTPUT J5-18
RELAY, SAFTY
CAN_H J5-23
CAN_L J5-15
CAN_GND J5-8
CAN H
CAN L
B-
R3
OHMS
D1
RESISATOR, 10 OHM

Sheet 5 of 6


KUBOTA DIESEL ENGINE SYSTEM
TO START OUTPUT
TO IGNITION ON OUTPUT
GLOW PLUGS CB11
STARTER
DV6
BAT 2
G2
12V ALTERNATOR
S19
OIL PRESSURE SWITCH
THROTTLE 2 OUTPUT
THROTTLE 1 OUTPUT
RUN SIGNAL INPUT
COOLANT TEMP INPUT
GLOW PLUG OUTPUT
K13
RELAY GLOW PLUG
RELAY, GOLW PLUG
S18
SWITCH, COOLANT TEMP
GLOW PLUGS
E1
E2
E3
M20
PUMP, FUEL
D2
D3
APECS 3000 GOVERNOR
B(+)
B(-)
SPEED SELECT 2
SPEED SELECT 1
ACTUATOR(+)
ACTUATOR(-)
MAGNETIC PICKUP(+)
MAGNETIC PICKUP(-)
SERVICE TOOL(Tx)
SERVICE TOOL(Rx)
M15
ACTUATOR
B4
MAGNETIC PICK-UP
B-

Sheet 6 of 6


KUBOTA LPG ENGINE SYSTEM
IGNITION REQUEST
X265 – A
#1 – A
PINK 16
CRANK REQUEST
X265 – F
#1 – F
BLU/PINK 16
THROTTLE 2(12V OUTPUT)
THROTTLE 1(12V OUTPUT)
RUN SIGNAL(12V INPUT)
COOLENT TEMP(GROUND INPUT)
X266 – K
X266 – J
X266 – C
X265 – G
#2 – K
#2 – J
#2 – C
#1 – G
GRA/BLU 16
GRA/ORN 16
GRA 16
GRN/YEL 16
CRANK REQUEST RELAY
UNUSED
CONTROLLER 5A
IGN. REQUEST 10A
MAIN 15A
HIGH COOLANT TEMP SHUTDOWN RELAY
LOW OIL PRESSURE SHUTDOWN RELAY
CONTROL RELAY
POWER RELAY
IGNITION REQUEST RELAY
TEMP. SWITCH (OPEN FOR NORMAL TEMP.)
OIL SWITCH (OPEN FOR PRESSURE)
KUBOTA FUEL SOLENOID EG551-44790
FUEL LOCK-OFF SOLENOID
AEES RN65127 FUES & RELAY BLOCK ASSY
ALTERNATOR
IGNITION CONNECTOR FOR PLUGGING INTO KUBOTA IGNITION HARNESS
COIL 3
COIL 2
COIL 1
IGNITER ASSY
12V
SENSOR
STARTER
BATTERY 12VDC
WOODWARD L-SERIES ACTUATOR DEUTSCH CONNECTOR DT06-12P
RUN ENABLE SIGNAL
SHUTDOWN SIGNAL
SHIELDED WIRE
CLR 18 TO PIN A
BLK 18 TO PIN B
MAGNETIC PICK-UP
GRA/ORN 16
BLK 16
GRA/BLU 16

Engine System, Diesel

This chapter covers the fuel supply system, engine RPM governor control system and glow plug starting aid. See the Kubota D1305 Workshop Manual 9Y111-00124.pdf for information related to the mechanical engine and high pressure fuel injection system.

Functional Description

One of the engines available in the CS7000 is a Kubota Diesel (D1305-E3B-KEA-1). It is a three cylinder, liquid cooled, naturally aspirated engine. It has mechanical injector pump that is fitted with an actuator which physically moves the fuel lever inside the pump.

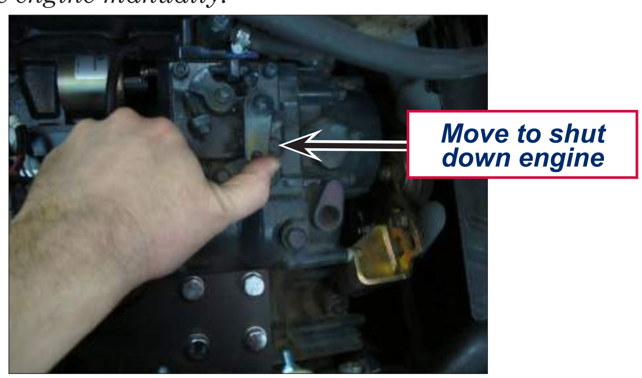
Fuel is stored in a tank on the right side of the engine compartment. The tank swings out to provide easier access to the engine compartment and contains a fuel level sending unit. An electric pump supplies low pressure fuel to the diesel injector pump. There is a replaceable fuel filter cartridge between the fuel pump and the injector pump. The injector pump has s small “return” line that runs to the closest injector. The return circuit is carried from injector to injector where it exits the rear injector and is connected to a hose which returns back to the fuel tank. .

The engine uses glow plugs to aid in starting a cold engine. The main machine controller operates a glow plug relay which supplies power to the glow plugs when needed.

The engine RPM is controlled with the Woodward APECS 3000 Electronic Engine Speed Governing System based on requests from the main machine controller. The main machine controller sends signals to the Woodward Gov. controller to request one of three engine speeds based on operator request or cleaning mode.

Note: There is a “dead man” level on the side of the injector pump that can be used to shut the injection pump fuel down to shut off the engine manually.

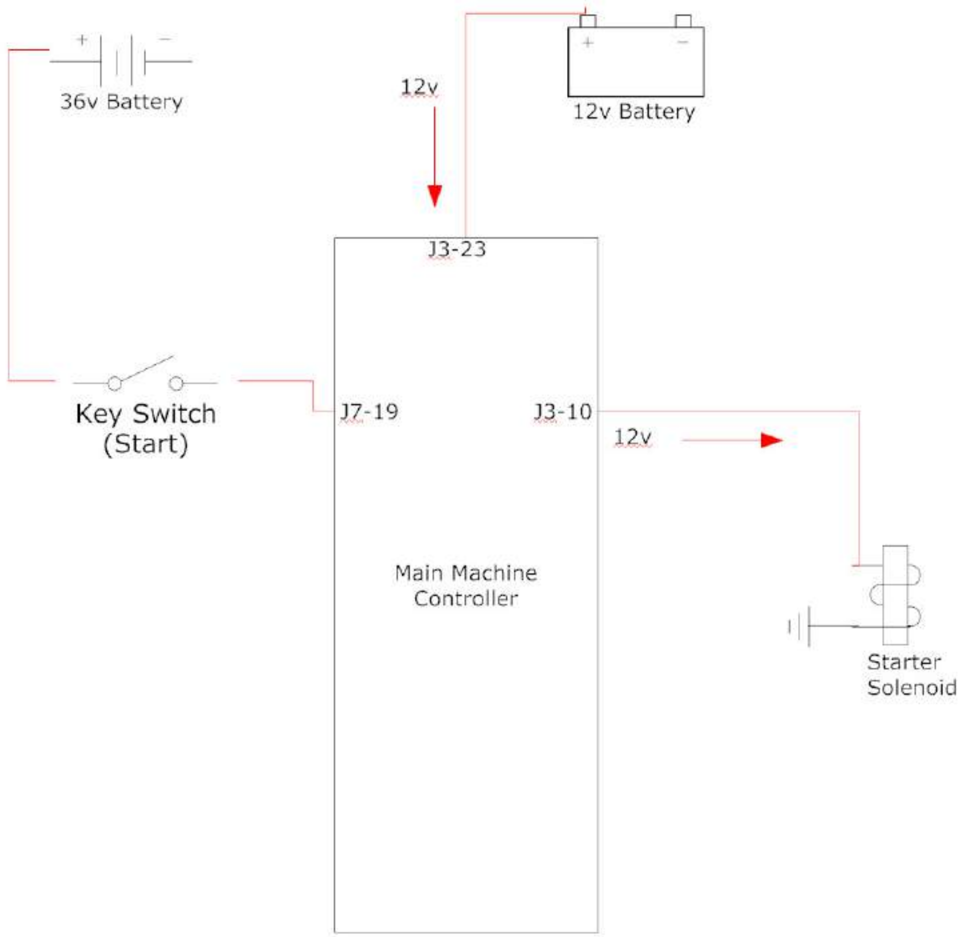
Dead man lever in normal run position



Dead man lever held in shut down position

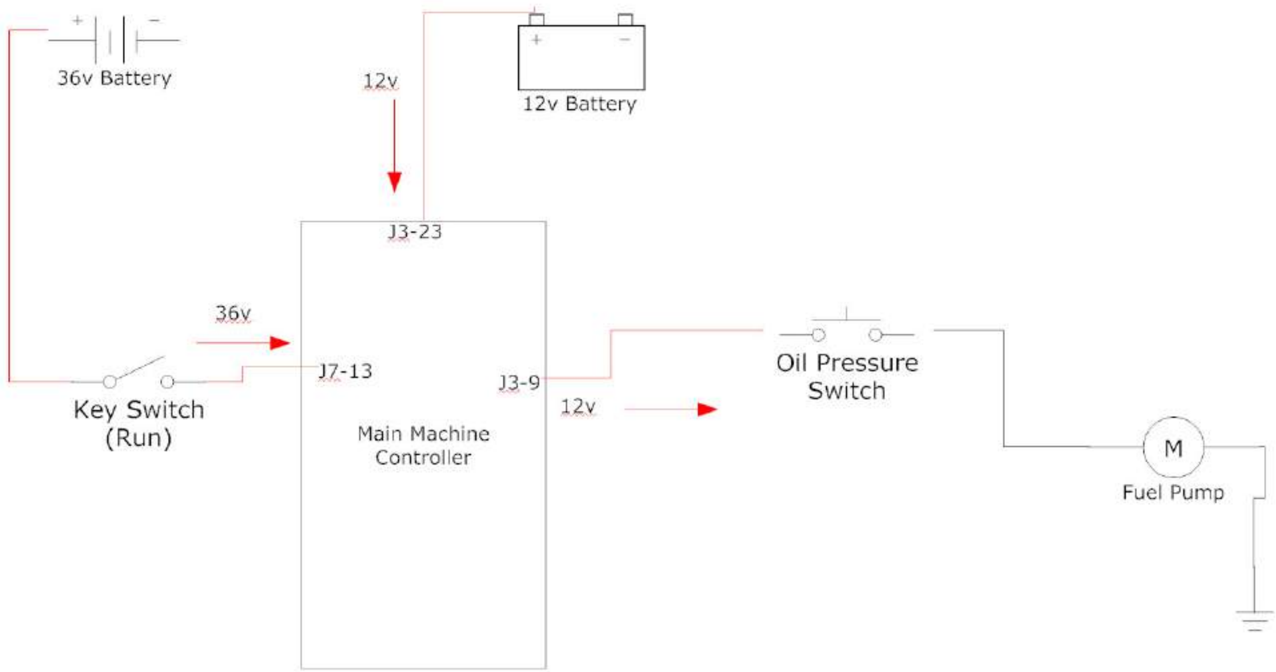
The cooling system consists of a standard radiator and belt driven fan. Note that the fan pushes air away from the engine and out through the radiator.

Engine starter control



To get the engine starter to engage, the key switch is held in the start position which supplies 36 volts to the main machine controller connector J7 pin 19. This is the start input request. The main machine controller receives a 12 V supply on connector J3 pin 23 from the engine starter battery. It uses this voltage supply to send voltage out connector J3 pin 10 to the starter solenoid.

Fuel pump control



The main machine controller uses the same 12 V battery supply from connector J3 pin number 23 to operate the fuel pump. When the key is turned on, 36 volts is supplied to the main machine controller connector J7 pin number 13. In response, the controller sends voltage out connector J3 pin number 9 to the oil pressure switch. As the engine cranks oil pressure builds up causing the oil pressure switch to close and supply voltage to the fuel pump. The other side of the fuel pump is connected to ground. If oil pressure is lost, the oil pressure switch will open removing power from the fuel pump.

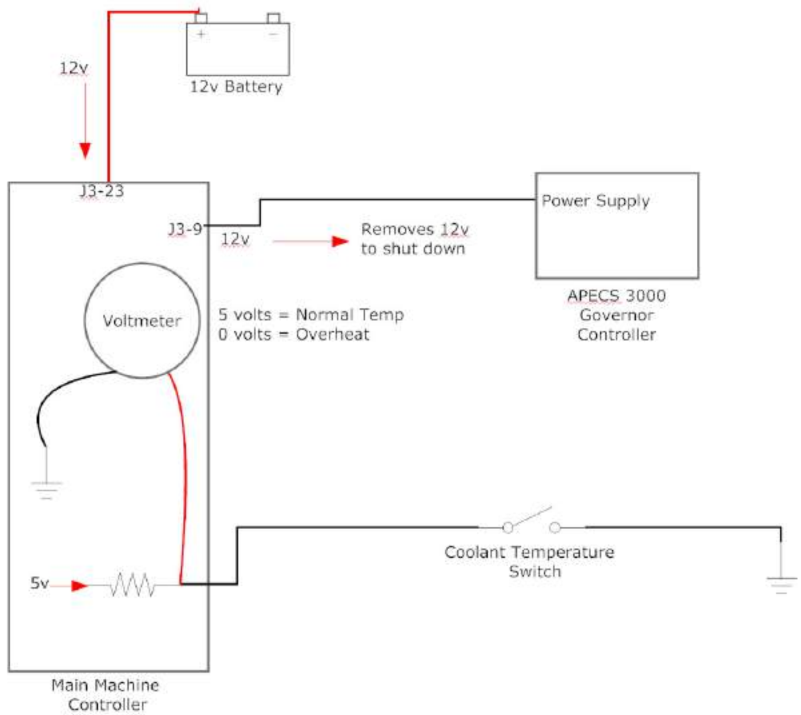
Engine Protection

The engine will be automatically shut down by the main machine controller if the engine overheats or oil pressure is lost.

When the engine is running, the main machine controller sends a 12 volt power supply out on connector J3 pin number 9 to power up the governor controller When the main machine controller wants to shut down the engine, it removes this power supply to the governor controller. When the governor loses the power supply it causes the engine to shut down.

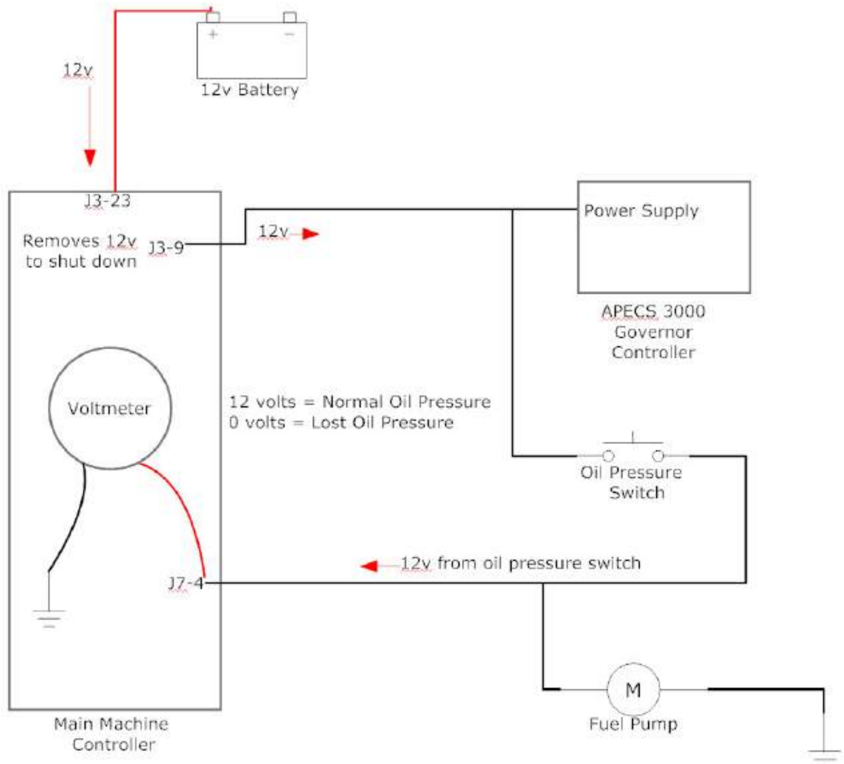
Over Temperature Shutdown

Here is how the engine over temperature shutdown works. To monitor engine temperature, the main machine controller sends a voltage through an internal resistor out connector J7 pin number 5 on the green wire with a yellow stripe to the engine coolant temperature switch. The switch is normally open. When the engine overheats the switch closes. The closing of the switch connects the voltage source to ground which drops the voltage seen by the main machine controller to nearly 0 volts. An engine temperature fault occurs when the coolant sensor switches to ground. This fault will be displayed on the Control panel. In response to the overheat condition, the main machine controller waits five seconds to give the operator time to park the machine then removes the power supply going out connector J3 pin number 9 from the APECS 3000 Governor controller, which causes the engine to shut down.



Low Oil Pressure Shutdown

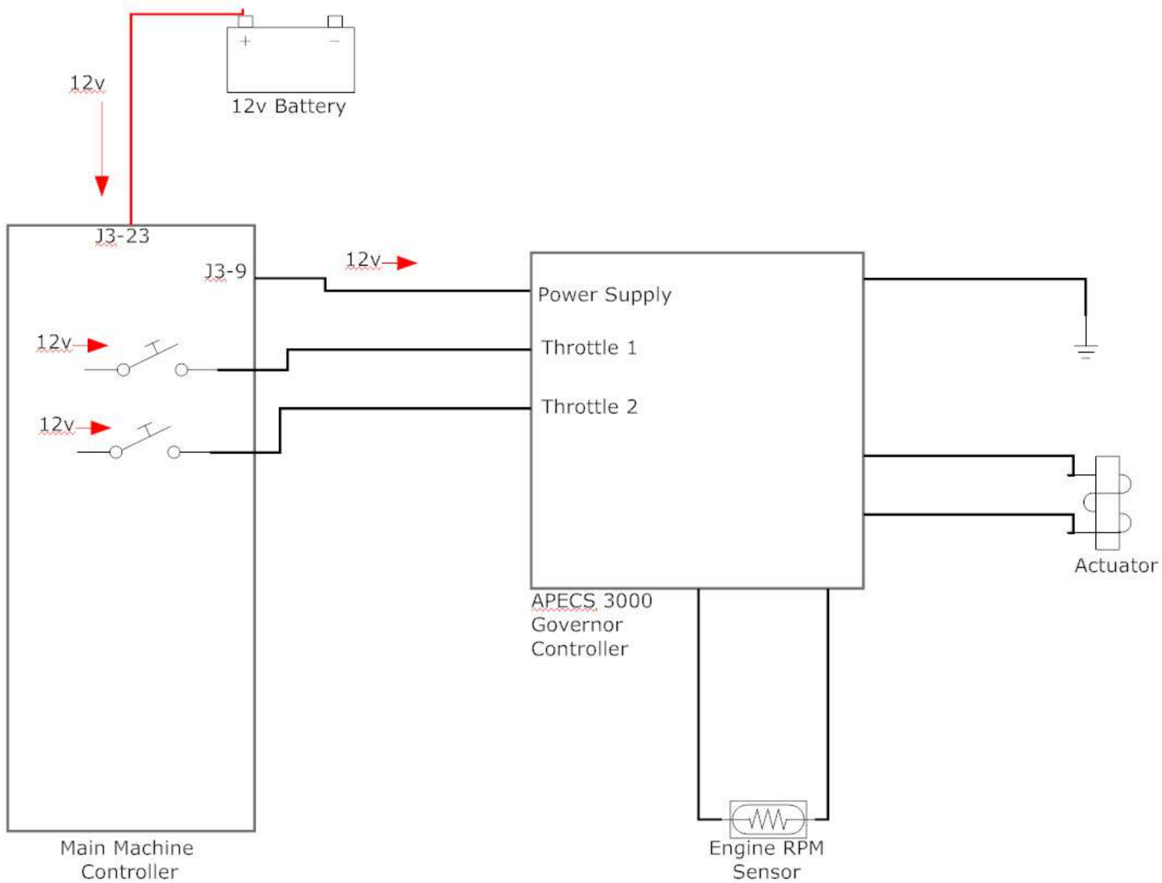
Here is how the low oil pressure shutdown works. The main machine controller sends 12 V out connector J3 pin number 9 to the APECS governor controller and the oil pressure switch. When there is oil pressure, the switch connects the voltage back as an "engine run signal" to the main machine controller connector J7 pin number 4. Once the main machine controller has seen that the engine is running, it continues to monitor that voltage. If engine oil pressure is lost, the "engine run signal" to the main machine controller will also be "lost" (voltage drops from 12v to 0v). In response, the main machine controller sets an oil pressure fault, displays it on the control panel and immediately removes the power supply going out connector J3 pin number 9 from the APECS 3000 Governor controller, which causes the engine to shut down.



Engine RPM control

The Woodward APECS (Advanced Proportional Engine Control System) controller manages the engine RPM through the use of an electronic actuator. The controller monitors the actual engine RPM via a speed sensor which reads the flywheel ring gear teeth and compares it to the desired speed setting. The controller sends out a pulse width modulated signal to an actuator, which is connected to the engine fuel control lever inside the injector pump. The actuator is “spring loaded” in the “no fuel” position. This means that by default, the actuator shuts off the fuel and prevents the engine from running when there is no electrical current available. When the governor wants to increase the engine speed, it increases the amount of current it sends through the actuator.

The main machine controller is responsible for telling the governor controller the desired RPM based on the operator’s request or machine operation mode. It communicates this with two circuits; Throttle 1 and Throttle 2. To request idle speed it does not apply voltage to either circuit. To request “Run” speed, it sends out 12 volts on throttle 2 circuit only. To request “maximum power” speed, it sends out 12 volts on throttle 1 circuit only.



Speed Mode	Engine Speed	Throttle 1	Throttle 2
Idle	1700 RPM	0	0
Run	2200 RPM	0	12v
Maximum Power	2400 RPM	12v	0

There are several conditions that will override the user's engine speed request.

- High pressure wash forces to run speed.
- If the engine is at idle speed, the engine will be forced to the run speed when sweeping only or vacuuming only. The force idle (neutral time-out) will return the engine to idle speed.
- If the engine is at idle or run speed, the engine will be forced to maximum power speed when scrubbing only or scrubbing and sweeping. The force idle (neutral time-out) will return the engine to idle speed.
- If the override is run speed, the user can change between maximum power speed and run speed.
- If the override condition goes away (e.g. sweep system turns off) and the user has not changed the engine mode, the engine is returned to the mode before the forced override.

The controller is capable of identifying some fault conditions and displaying a fault code. A flashing LED displays the fault conditions. When power is first applied to the controller, the LED will flash just once for one second to indicate that the LED is operational. If there is more than one fault, the LED will flash them all. If there are no faults the LED will flash once every reset and from then on indicate the detection of engine speed. The controller will attempt to shut the engine down for all faults and will not permit starting after reset with fault 1, 5 and 6.

Note: If any fault in the APECS governor control system causes the engine to stall, the Engine Warning message will be displayed on the control panel. This is because once the engine stalls, engine oil pressure is lost and the main machine controller responds as it always does when it sees a loss of oil pressure after the engine has been running. This means the main machine controller will display the engine warning message and remove the power supply from the APECS controller causing it to power down and turn off its status LED light.

Flash Code	Fault	Remedy
1	APECS unit not calibrated	Calibrate APECS unit
2	Engine Speed Excessive	Check parameter setting. Overspeed criteria may be too sensitive Check for electrical noise entering controller. Check wiring and connections. Check case ground. Make sure linkage moves freely, without backlash. Check tip of speed sensor.
3	Engine Speed too low	Check parameter settings. Check linkage and the actuator travel. Check load and make sure it is not greater than the capacity of the engine.

Flash Code	Fault	Remedy
4	Engine shutdown due to engine protection input	Check parameter settings. Check what may have triggered the protection input. (Loss of oil pressure, engine overheat)
5	Factory settings lost	If calibration file is available, download calibration file and cycle power again. If controller still does not work or if no calibration file is available, consult factory.
6	APECS unit failed	Electrical noise may be entering the controller. Check wiring, shielding and connections to controller. Cycle power to engine. If controller still does not work, consult factory.

Glow plug control

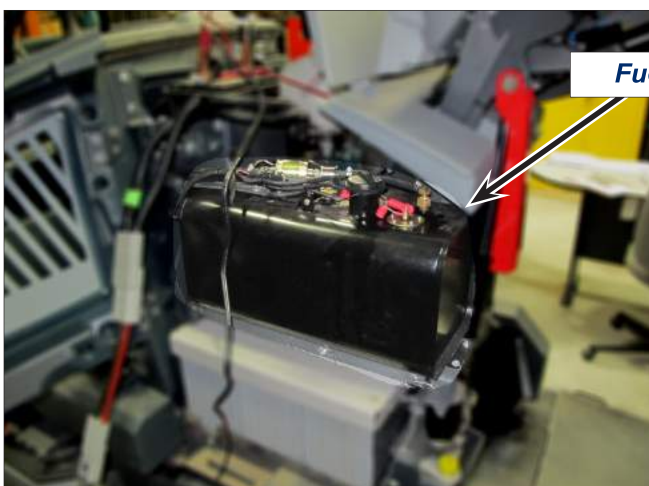
The engine is equipped with glow plugs to assist starting a cold engine. The glow plugs have an internal resistive element that increases in resistance as it heats up. This protects the glow plug from overheating by reducing the current flow as it gets hot.

Whenever the key is turned on, the main machine controller tells the control panel to display the “glow plugs on” icon and sends out 12 V from connector J3 pin number 32 to the glow plug relay winding. Since the other side of the winding is connected to ground, this energizes relay which in turn supplies power from circuit breaker 11 to the glow plugs. After approximately 10 seconds, the main machine controller de-energizes the glow plug relay by removing the 12 volts from the winding which also removes the power from the glow plugs.

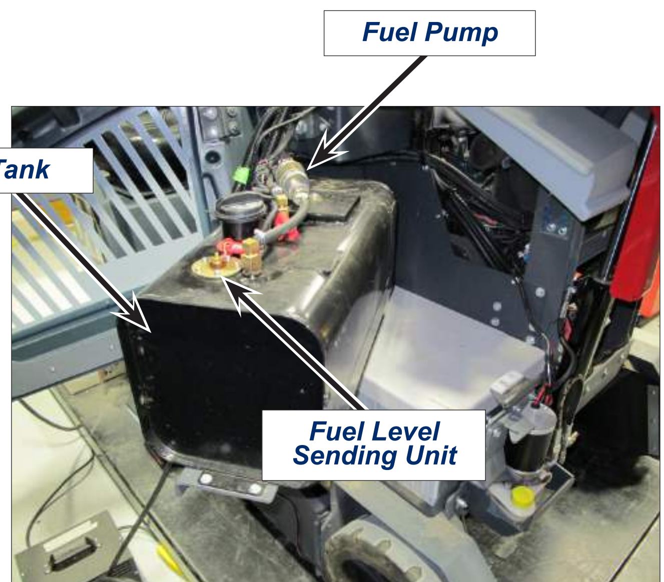
Component Locations

- Fuel tank - Right side of engine compartment
- Fuel level sending unit - Top of fuel tank
- Fuel pump - Top of fuel tank
- Fuel filter - Front left engine compartment area. Mounted on frame between engine and hopper.
- Injector pump
- APECS Governor Controller - Front engine area mounted on engine.
- Glow plugs
- Glow plug relay - Electrical panel area
- Engine starter
- Alternator (42v)
- Engine alternator (12v)
- Oil pressure switch
- Coolant temperature switch
- Actuator
- Engine RPM sensor
- Air Cleaner

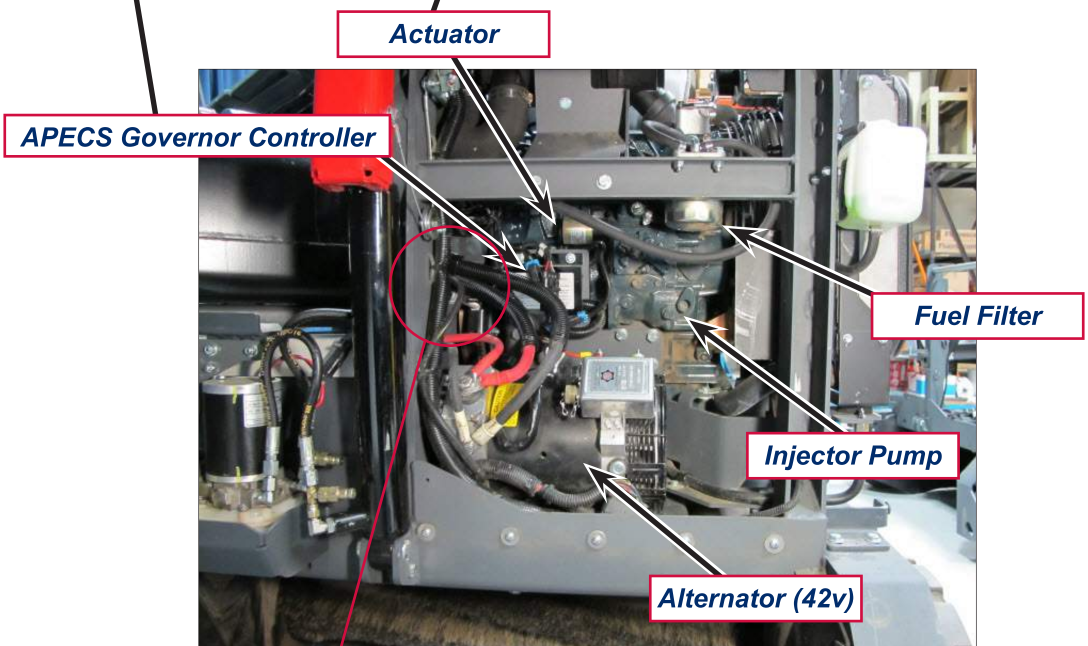
Top of engine compartment with top covers removed



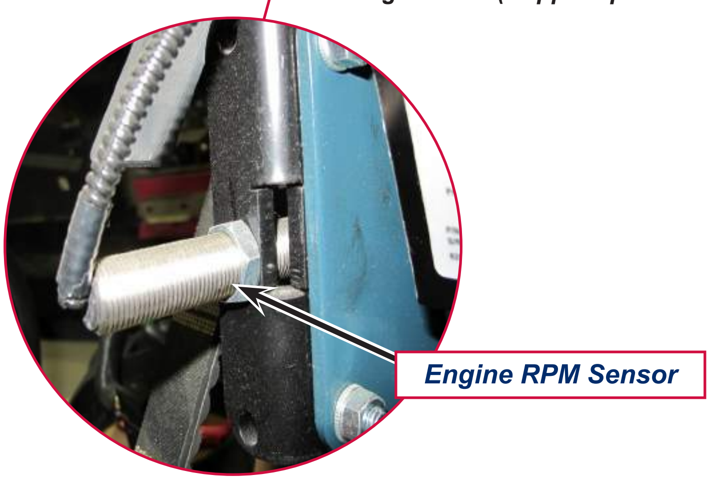
Fuel Tank (Shown with hopper up)

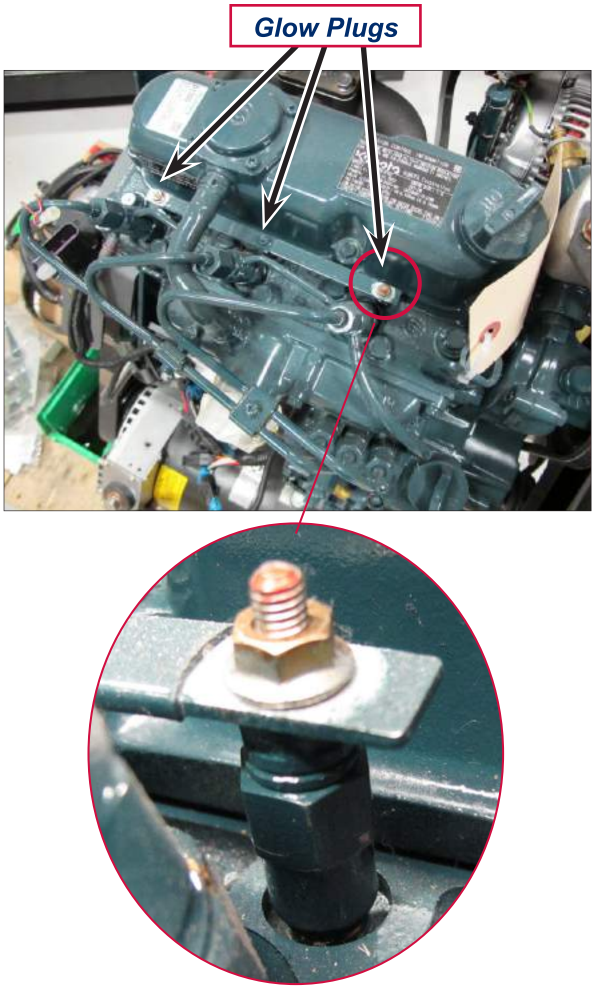


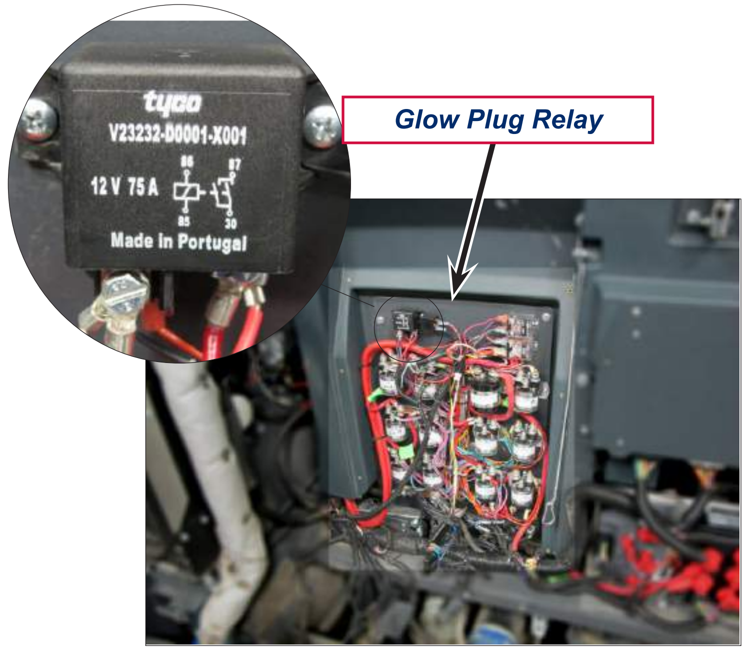
Fuel Tank (Shown swung out)



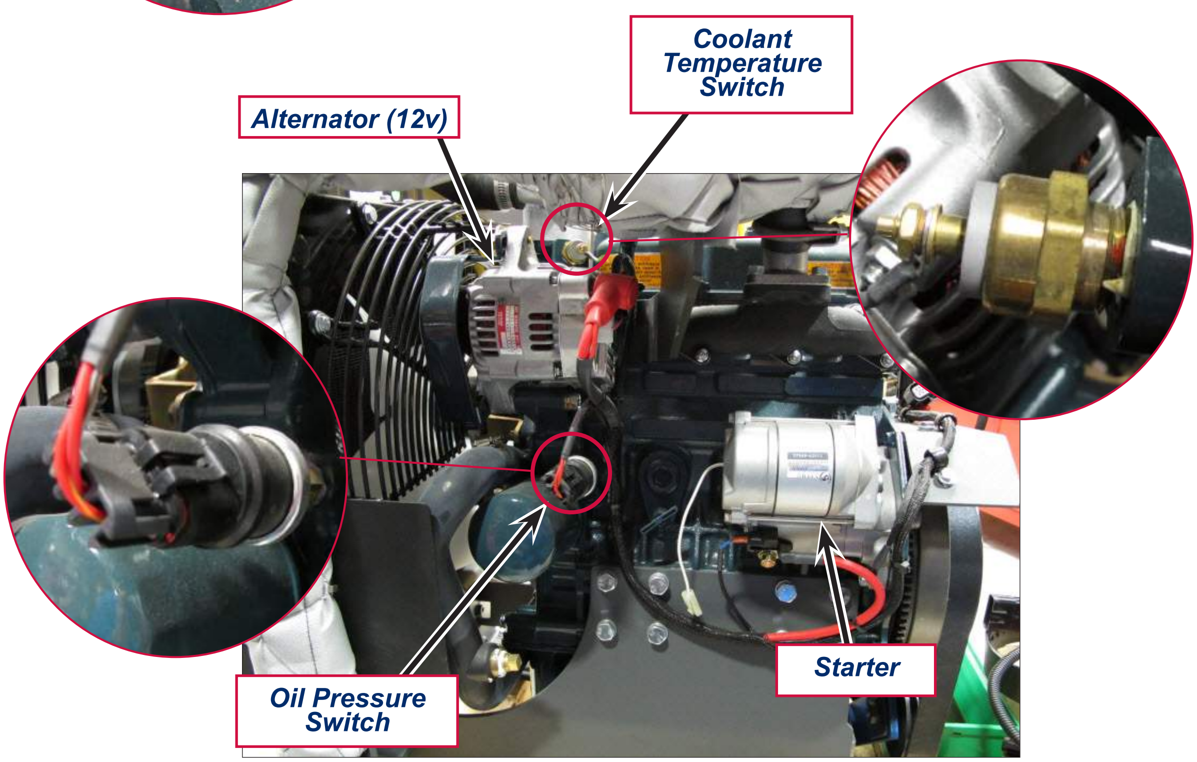
Front Engine Area (Hopper up and rubber curtain lifted)







Electrical Panel



Engine - Back Side

Maintenance and Adjustments

Diesel Engine Maintenance Schedule

First 50 hours:

- Change engine oil and filter

Every 50 hours:

- Check fuel hoses and clamps.
- Check restricted air filter indicator. Replace air filters as needed.

Every 100 hours:

- Check fan belt tension.
- Check engine starting battery

Every 200 hours:

- Change engine oil and filter
- Check radiator hoses and clamps
- Check intake air hoses

Every 400 hours:

- Replace the fuel filter

Every 500 hours:

- Flush cooling system
- Replace fan belt

Every 800 hours:

- Check valve clearance

Every 1500 hours:

- Check injection nozzle pressure

Every 3000 hours:

- Check injection pump timing

Every 2 years

- Replace radiator hoses and clamps
- Replace fuel hoses and clamps
- Replace intake air hoses
- Replace engine starting battery

Change Engine Oil and Oil Filter

1. Drain the recovery tank for later removal.
2. Shut off the engine and allow it to cool sufficiently to avoid burning yourself with hot engine oil.
3. Remove the left side engine cover.
4. Tip the recovery tank outward. Remove the squeegee vacuum hose and release the recovery tank tether cable, then lower the recovery tank to the ground for better access to the engine oil filter area.
5. Remove the oil filter with an oil filter wrench.
6. Apply a light coat of engine oil to the new filter cartridge gasket.
7. Screw the new cartridge on and tighten by hand. Over tightening may damage the gasket.
8. Remove the remote oil drain hose end from the radiator bracket.
9. Remove the plug and drain the oil into a suitable container.
10. Reinstall the plug-and reattach the drain hose to the radiator bracket.
11. Refill the engine with oil.

Change Engine Coolant

1. Allow the engine to cool sufficiently to relieve cooling system pressure and avoid burns.
2. Remove the radiator cap.
3. Remove the left side engine cover.
4. Locate the remote engine coolant drain hose, remove the plug and direct the coolant into a suitable container.
5. Reinstall the drain plug and reposition the drain hose.
6. Refill with a 50/50 mixture of engine antifreeze and water.

Replace Fuel Filter

1. Raise the hopper, engage the hopper prop rod and lower the hopper onto the safety lock.
2. Loosen the screws along the bottom edge of the rubber curtain in front of the engine compartment and move the curtain in order to gain access to the fuel filter.
3. Unscrew the filter from the filter base.
4. Apply a light coat of fuel oil on the cartridge gasket and screw it on by hand-tightening.
5. Bleed the air out of the fuel system as directed below, reinstall the rubber curtain and lower the hopper.

Bleed Fuel System

Bleeding air out of the fuel system is required if the engine ran out of fuel, the fuel filter has been replaced or the fuel lines have been opened.

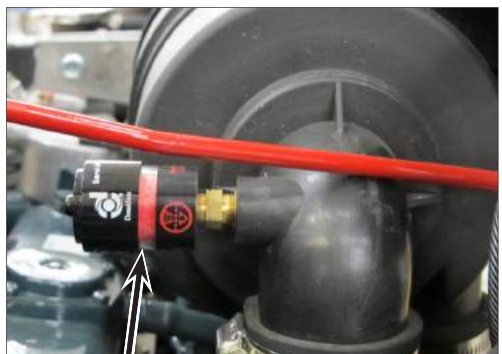
CAUTION: To avoid personal injury; Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.

1. Loosen the air vent plug at the top of the fuel filter housing.
2. Operate the fuel pump. (Cranking engine or jump with 12v power supply).
3. Tighten the air vent plug when bubbles no longer come up.

Inspect Air Filter

Check the service indicator mounted on the air cleaner elbow. If the red disc is visible in the “window”, the filters should be cleaned or replaced.

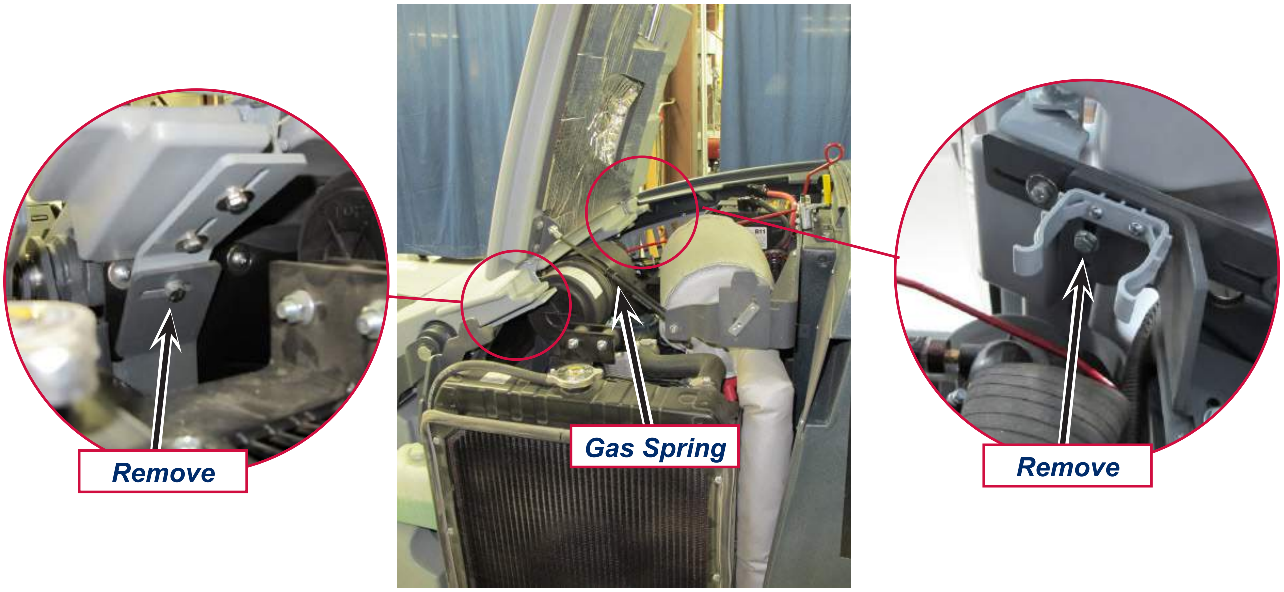
Clear Window = Okay



Red in Window = Restricted Filters

Replace Air Filters

1. Remove left side engine cover.
2. Open right side engine cover and swing out fuel tank.
3. Remove the top engine covers by:
   a. Disconnecting the gas spring from one end.
   b. Remove two bolts, one on each side, under the cover and lift the cover assembly off.



Remove Top Engine Cover Fasteners

4. Release the latches and remove the air filter housing cover.
5. Remove the outer filter element.
6. Blow out air cleaner housing with compressed air with inner filter element still in place to prevent dirt from entering the engine air intake.
7. Remove the inner filter element.
8. Clean residual dust from the inside of the air cleaner housing, taking care to prevent any dirt or debris from entering the air intake.
9. Install a new inner filter element and then the new outer filter element making sure that they seal well at their ends.
10. Install the air cleaner housing cover. “Top” is indicated on the cover.
11. Set the top engine cover in place.
12. Install the two fasteners finger tight, then close the cover and allowing it to latch properly.
13. Now, tighten the fasteners with a wrench.
14. Open the top cover, swing the fuel tank back into position and the right engine cover.
15. Install the left engine cover.

Troubleshooting

No crank – The starter does not engage

<table>
<tr><th>Possible causes</th><th>Check</th></tr>
<tr><td>36v Battery Pack drained</td><td>Battery pack voltage</td></tr>
<tr><td>Engine Battery</td><td>Load test battery</td></tr>
<tr><td>Starter</td><td>Check power to starter solenoid</td></tr>
<tr><td>Battery Cable</td><td>Check voltage drop from battery positive to starter battery terminal.</td></tr>
<tr><td>Engine Ground</td><td>Check voltage drop from starter case to battery negative.</td></tr>
<tr><td rowspan="4">No voltage to the starter solenoid
• Auxiliary Relay
• Key Switch
• Main Machine controller</td><td>Check for tripped circuit breaker #9 (CB9)</td></tr>
<tr><td>Check for power to the main machine controller from the Auxiliary Relay</td></tr>
<tr><td>Check for power to the main machine controller from Key Switch cranking circuit</td></tr>
<tr><td>Check powers, grounds, inputs and crank request output</td></tr>
</table>

Cranks but does not start

Possible causes:

- No fuel
  - Empty Tank
  - Insufficient fuel supply
    - Clogged Filter
    - Clogged line
    - Fuel pump
- Contaminated fuel
- APECS governor controller
- Engine RPM Sensor
- Actuator
- Incorrect injection timing
- Injection pump
- Mechanical engine
  - Insufficient compression
  - Fuel camshaft worn
- Plugged Intake
- Plugged Exhaust

Diagnostic steps:

1. Check governor control system.

   a. Does the APECS governor controller status light flash once immediately following “key on”?

      If not, check power and grounds for the APECS governor controller

      If so, go on to next step

   b. Does the status light come on during cranking?

      If not, check the Engine RPM sensor input. (Resistance and voltage output while cranking)

      If so, go on to next step

   c. Is there more than 4 volts available to the actuator during cranking?

      If not, the governor controller may have failed.

      If so, the governor controller appears to be working correctly. Check the fuel actuator

2. Check the fuel actuator

   a. Check the actuator resistance. It should be around 3.0 ohms.

      If it is open or shorted, replace the actuator. If it is Okay, go to the next test.

   b. Substitute the function of the actuator by removing it from the injection pump and operating the throttle control manually. (You can reach into the hole and operate it with your finger or use the dead man lever on the side of the injector pump)

3. Check fuel system

   a. Check the fuel for contamination

   b. Check the fuel pressure to the injector pump during cranking

      If the fuel supply system is Okay, check the mechanical engine.

4. Check mechanical engine

   a. Check compression

   b. Check for plugged intake or exhaust

Cannot Achieve Either Run or Maximum Engine Speed Settings (Run 2200 RPM, Maximum Power 2400 RPM).

The approach to diagnosing an engine RPM control problem is to check the inputs to the governor controller and check the output to the actuator. If the inputs are good and the output is bad, the conclusion is that the controller is the problem. If the output control is okay but the RPM doesn't change, then the actuator is the likely problem. However, don't forget that insufficient fuel supply or a restricted exhaust could appear like an RPM control problem if the engine cannot run well enough to achieve a higher RPM.

Possible Causes:

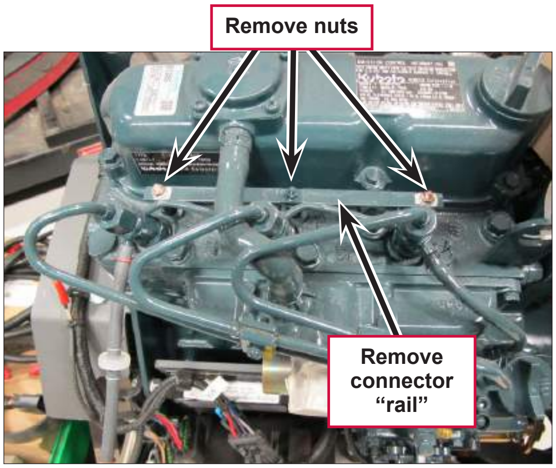
- Actuator
- APECS 3000 Governor Controller
- Wiring
- Main Machine Controller

Diagnostic steps:

1. Check the power and ground supplies to the controller.
    a. Is there sufficient power and ground?
        - If so, go on to check the speed request inputs.
        - If not, repair.
2. Check the speed request inputs
    a. With the engine running press the engine speed button and check for 12v to the throttle 1 and throttle 2 wires at the governor controller.
    b. Is 12v present on either of the throttle wires with the engine running at idle speed?
        - If so, go on to check the actuator output
        - If not, check the wiring between the main machine controller and the governor controller.
3. Check the actuator output.
    a. Does it change with the speed request?
        - If so, the actuator is the likely problem.
        - If not, the controller appears to be the problem.

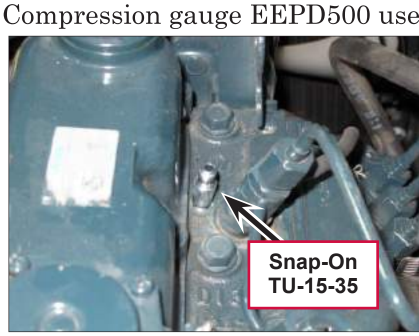
Compression Test

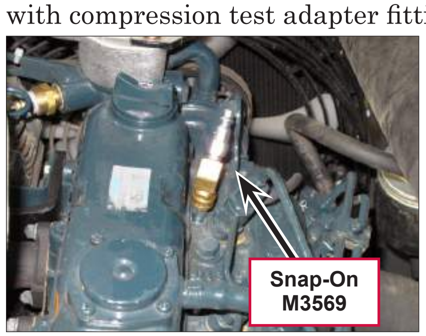
1. Begin with a fully charged battery.
2. Remove the air cleaner assembly. Cover the air inlet opening to prevent foreign objects from falling into the engine.
3. Remove the glow plug electrical connector nuts and connector “rail”.

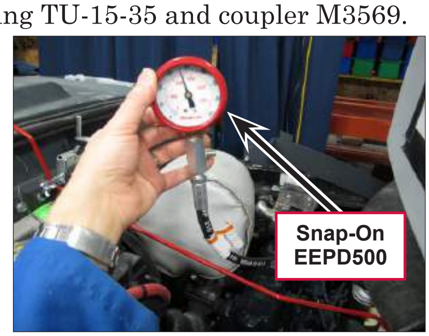


4. Insulate the electric terminal that feeds the rail to prevent it from shorting to ground.

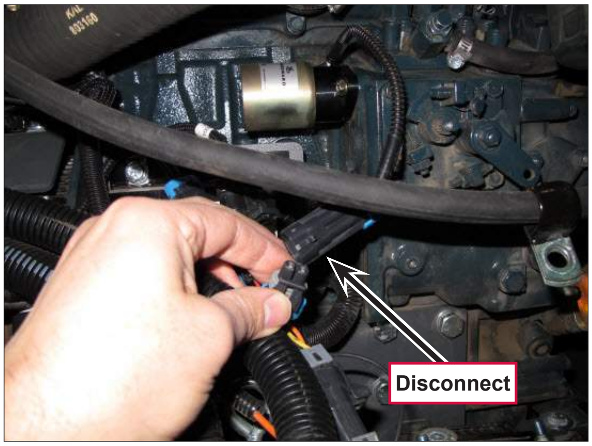
5. Clean the area around the glow plugs to prevent any debris from falling into the engine cylinders when they are removed. Remove the glow plugs.
6. To test the compression of one of the cylinders, screw in an appropriate adapter into the glow plug threads in the cylinder head and attach a suitable compression gauge. Pictured are Snap-On Diesel Compression gauge EEPD500 used with compression test adapter fitting TU-15-35 and coupler M3569.







7. Disconnect the injector pump actuator connector to prevent the engine from starting.



8. Remove any cover over the air inlet but be very careful not to allow anything to get “sucked in” during the test.

9. Crank the engine over until the compression gauge stops climbing. Record the reading.

Specification is 541 to 597 psi (3.73 to 4.11 MPa) with an allowable limit of 327 psi (2.26 MPa). Difference among Cylinders - 10% or less.

10. Repeat for the other cylinders.

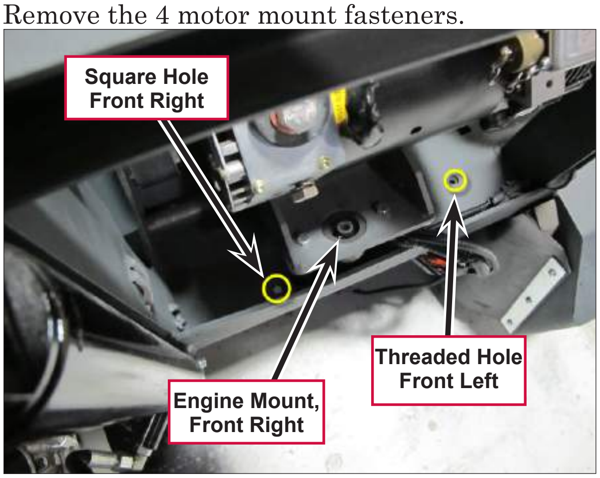
11. Reassemble in reverse order.

Removal and Installation

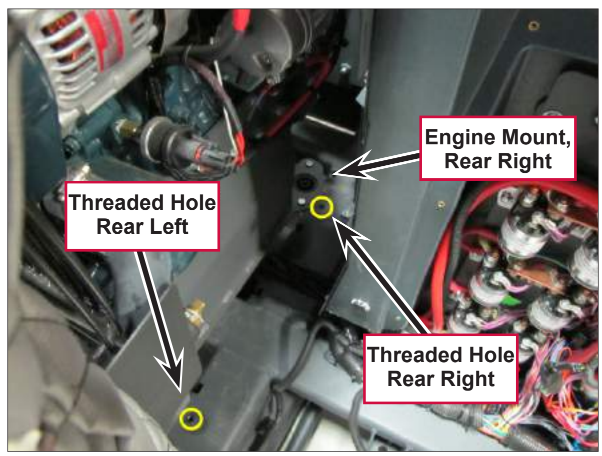
Engine Assembly

The complete engine including the exhaust, radiator and 42v alternator are removed as an assembly. There is no need to drain engine oil or coolant. The assembly is attached to the chassis at 4 rubber motor mounts. The front right mount has a square hole in the chassis for a carriage bolt. The other 3 are threaded holes in the frame.

1. Remove engine Top cover
2. Disconnect the 36v battery pack main positive and negative cables.
3. Disconnect the 12v battery negative cable.
4. Disconnect the 12v battery positive cable.
5. Disconnect fuel supply and return lines.
6. Disconnect battery positive and negative cables at the starter.
7. Disconnect the engine wiring connectors.
8. Remove the 4 motor mount fasteners.



Front engine mounting locations. Shown with hopper up and engine being installed.



Rear engine mounting locations. Shown with engine being installed.

9. Lift the assembly out of the chassis using a suitable hoist attached to the two engine lift points.
10. Reassemble in reverse order. Connect the battery negative cables last.

Specifications

Fuel Pump;

- Fuel Pressure 2.5 - 4 PSI
- Fuel Volume - 0.5 Gallons per minute

Glow Plugs

- Resistance - Approx. 0.9 ohms
- Current Draw - Approx. 12 - 13 Amps. (As the glow plugs heat up, resistance increases and current decreases)

Engine Compression

541 to 597 psi (3.73 to 4.11 MPa) with an allowable limit of 327 psi (2.26 MPa). Difference among Cylinders - 10% or less.

Engine Oil Capacity

1.5 US Gallons (5.7L)

Engine Oil Type

Refer to the following table for the suitable American Petroleum Institute (API) classification of engine oil according to the engine type (with internal EGR, external EGR or non-EGR) and the Fuel Type Used : (Low Sulfur, Ultra Low Sulfur or High Sulfur Fuels).

Fuel Type	Engine oil classification (API classification)	
	Engines with non-EGR Engines with internal EGR	Engines with external EGR
High Sulfur Fuel [0.05 % (500 ppm) ≤ Sulfur Content < 0.50 % (5000 ppm)]	CF (If the “CF-4, CG-4, CH-4, or CI-4” engine oil is used with a high-sulfur fuel, change the engine oil at shorter intervals.(approximately half))	
Low Sulfur Fuel [Sulfur Content < 0.05 % (500 ppm)] or Ultra Low Sulfur Fuel [Sulfur Content < 0.0015 % (15 ppm)]	CF, CF-4, CG-4, CH-4 or CI-4	CF or CI-4 (Class CF-4, CG-4 and CH-4 engine oils cannot be used on EGR type engines.)

- CJ-4 classification oil is intended for use in engines equipped with DPF (Diesel Particulate Filter) and is Not Recommended for use in Kubota E3 specification engines.

- Oil used in the engine should have API classification and Proper SAE Engine Oil Viscosity according to the ambient temperatures where the engine is operated.
- With strict emission control regulations now in effect, the CF-4 and CG-4 engine oils have been developed for use with low sulfur fuels, for On-Highway vehicle engines. When a Non-Road engine runs on high sulfur fuel, it is advisable to use a “CF or better” classification engine oil with a high Total Base Number (a minimum TBN of 10 is recommended).

Engine Oil Viscosity

Temperature	Viscosity
Above 25 °C (77 °F)	SAE 30 or SAE 10W-30 SAE 10W-40
0 °C to 25 °C (32 °F to 77 °F)	SAE 20 or SAE 10W-30 SAE 10W-40
Below 0 °C (32 °F)	SAE 10W or SAE 10W-30 SAE 10W-40

Cooling System

Engine Coolant

A 50/50 mix of distilled water and ethylene glycol is recommended.

Radiator Cap

13 PSI

Shop Measurements

The following information provides some “real world” shop measurements to help you recognize what “normal” looks like.

Engine RPM Sensor

Resistance: 2.2K ohms

Output while cranking (Unplugged) - 3.0 - 5.0 VAC

Output at idle (Connected) - 10.8 VAC

Actuator

Resistance: 3.0 Ohms

Engine Compression

#1 = 410 psi

#2 = 420 psi

#3 = 400

Fuel System Return Fuel Flow

4.0 oz (120 ml) with the return line removed, engine off and fuel pump running

Starter

168 Amps cranking

Glow Plug Relay

Winding 46 Ohms

Special Tools

Diesel Compression Gauge There are many brands of compression gauges available. Shown is a Snap-On EEPD500 Gauge kit	
Compression Gauge Fitting for Glow Plug threads. Shown is Snap-On TU-15-35 Threads - M8 X 1.0	
Gauge Coupler If using the Snap-On diesel compression EEPD500 Gauge kit and Snap-On TU-15-35 glow plug thread fitting, a coupler must be used to join the fitting to the gauge hose. Shown are Snap-On couplers M3569 and M3570	

Engine System - LPG

This chapter covers the things “on top” of the mechanical engine that make it run, such as the fuel system, governor control and ignition system. It also includes routine engine maintenance information and troubleshooting of engine starting or running problems. See the Kubota WG972 E3 Workshop Manual 9Y111-05710 for detailed information related to the complete mechanical engine.

Functional Description

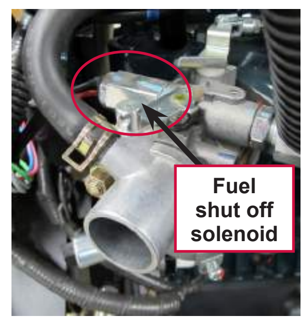
One of the engines available in the CS7000 is a LPG Kubota (WG972-GL-E3-NFK-1). It is a three cylinder, liquid cooled, naturally aspirated engine. The fuel system does not utilize a control module. It is mechanically controlled. The ignition system is “self-contained”. That is, it has no interaction with the fuel system and shares no components with it.

The fuel system begins with a 33 pound propane fuel tank which is horizontally mounted on the right side of the engine compartment. The tank swings out to provide easier access to the engine compartment. There is an in-line pressure relief valve and a pressure switch between the tank and the fuel pressure vaporizer/regulator. The fuel pressure vaporizer/regulator takes in high-pressure propane liquid, changes it to a vapor and reduces it to a constant low pressure gas for the engine to draw in and burn. The change from liquid to gas absorbs a lot of heat and acts as an air conditioner. To prevent frosting up the regulator, it is heated with engine coolant. The vaporizer/regulator supplies gaseous fuel to the carburetor through a hose. The carburetor has an additional fuel shut off solenoid that must be energized for fuel to flow through the carburetor to the engine.

Kubota LPG Engine

Propane Fuel Tank

Fuel Vaporizer/ Regulator



Carburetor

The engine RPM is controlled with a Woodward L-Series governor/speed actuator based on requests from the main machine controller. The main machine controller sends signals to the Woodward L-Series governor/speed actuator to request one of three engine speeds based on operator request or cleaning mode. The actuator has a “built in” microprocessor which receives the requests and in turn physically moves the carburetor/mixer throttle blade to achieve the requested engine speed.

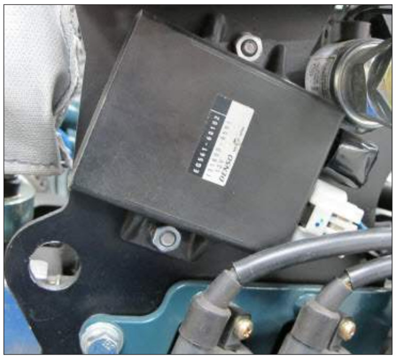
The cooling system consists of a standard radiator and belt driven fan. Note that the fan pushes air away from the engine and out through the radiator.

Woodward L Series Actuator

Circuit Descriptions

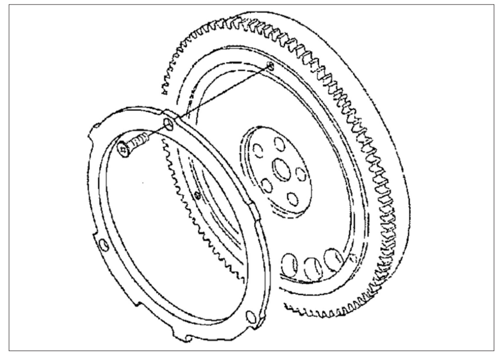
Ignition System

The ignition system consists of a spark control module (aka Ignitor), three ignition coils, and a crank position sensor. The crank position sensor reads a rotating 6 toothed ring which is mounted on the flywheel between the flywheel and the engine.

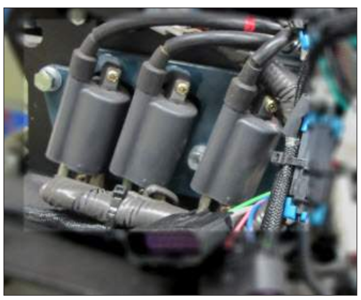


Spark Control module

Crank Position Sensor



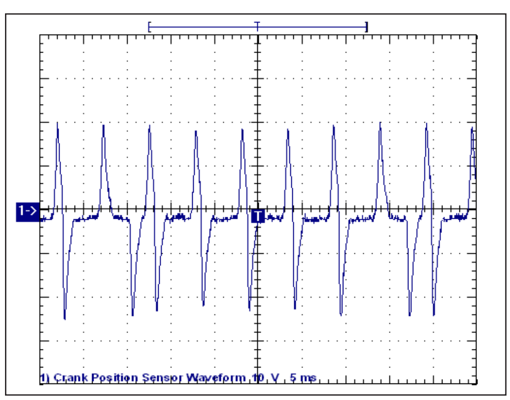
Toothed Ring and flywheel



Ignition Coils

The heart of the system is the spark control module. It controls the current flow of each ignition coil primary circuit in order to control when spark occurs based on inputs from the crank position sensor. Each coil fires twice per cylinder cycle. Once to initiate the power stroke and once in exhaust stroke (waste spark)

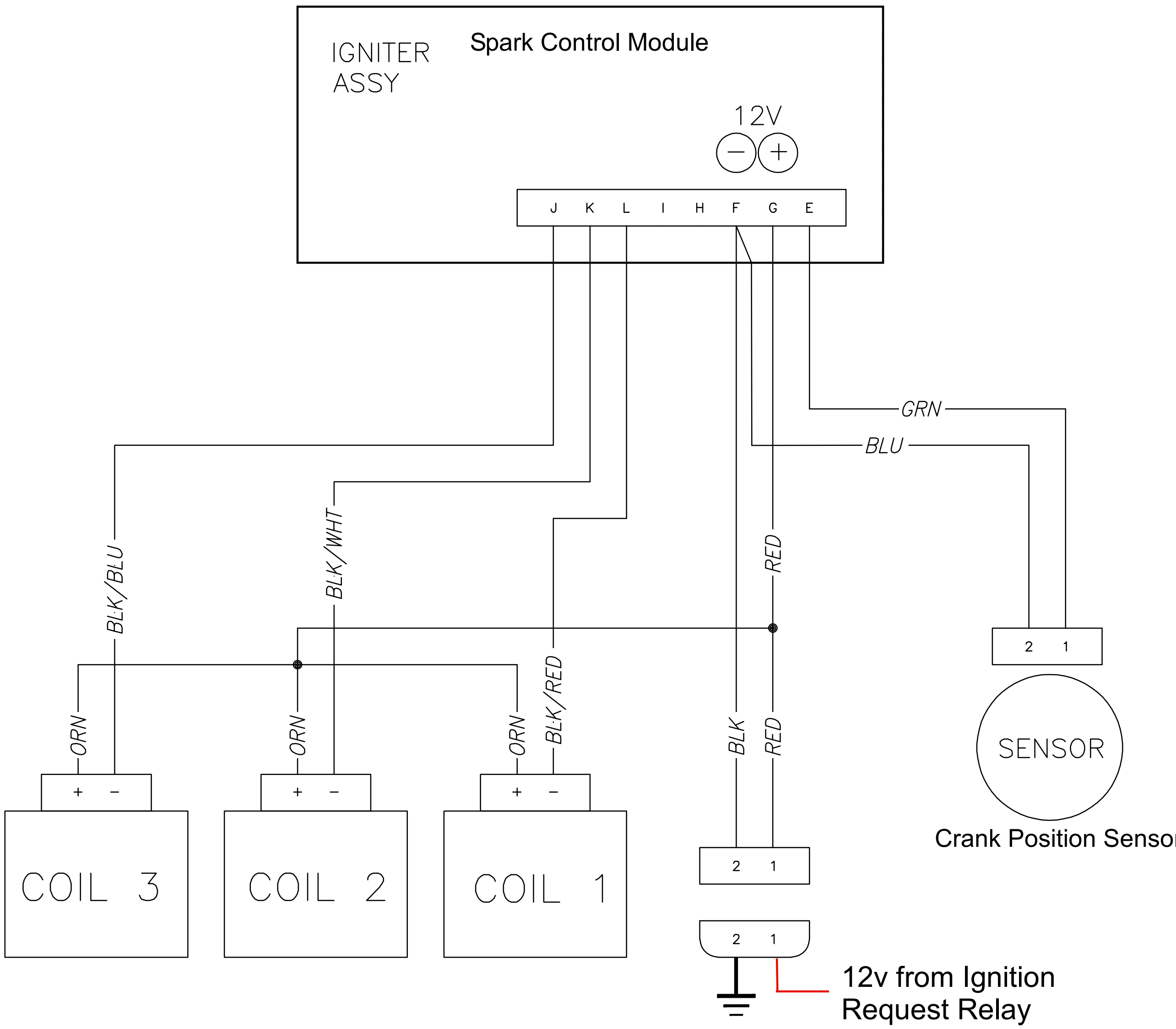
The crank sensor is a two wire “ AC pulse generator”. It has a wire coil inside of it. As the toothed ring rotates, the teeth pass in line with the end of the sensor tip. This induces a voltage spike that the spark control module can “read” as cylinder position information. The number of spikes per minute is translated as engine RPM. One tooth on the ring is wider than the other five. This creates a unique “spike” so that the spark control module can distinguish the cylinders from one another. This allows it to fire the right ignition coil at the right time. Below is what the crank sensor wave form looks like on an oscilloscope. Notice that every sixth pattern is “wide”.



The spark control module is fed power on pin G from the Ignition Request relay. Pin F is connected to ground.

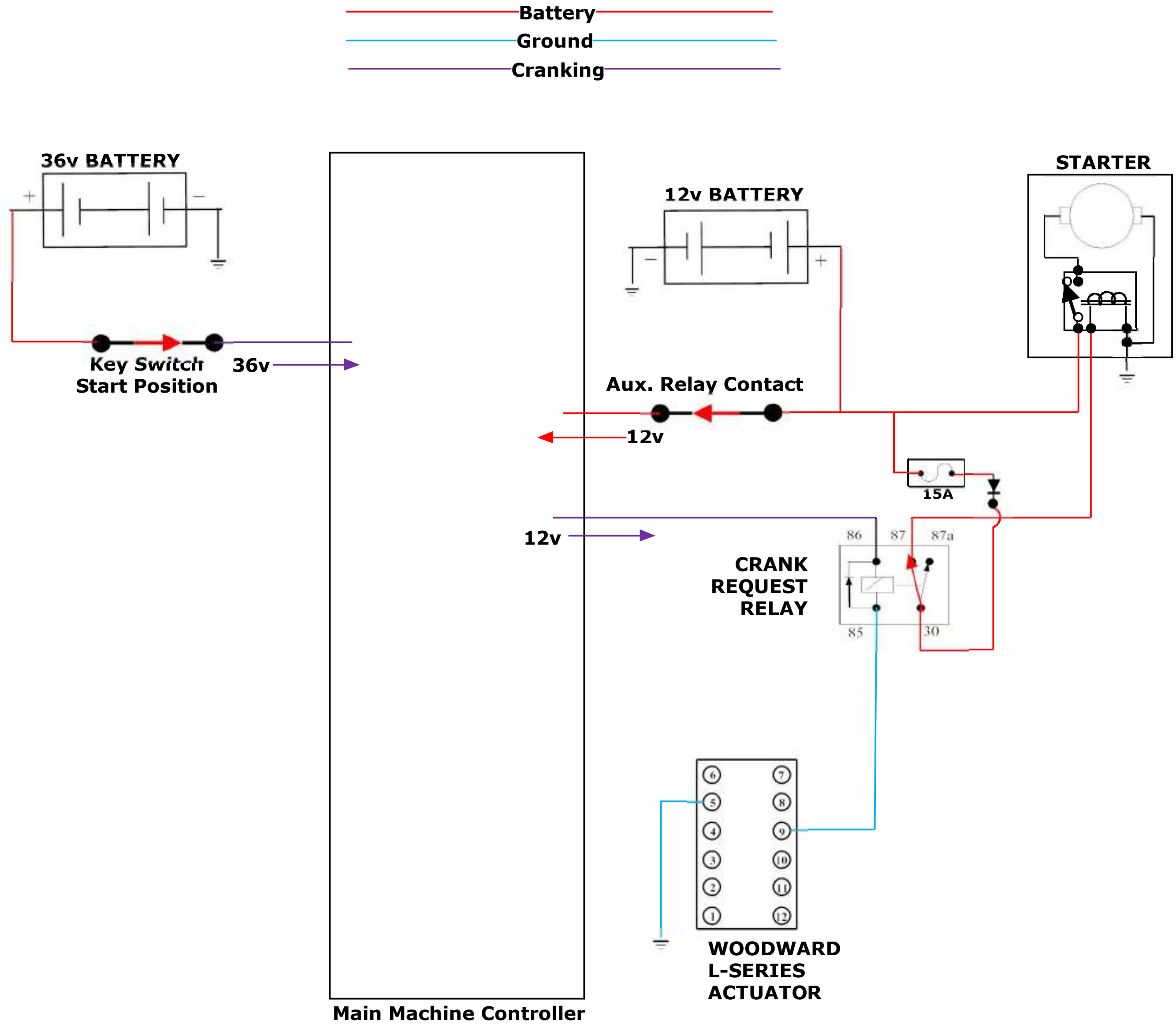
The two wires form the crank position sensor are connected to pins E and F.

All three ignition coils are fed the same power from the ignition request relay. The 12v power supply flows through each coil primary circuit to the spark control unit. The spark control unit supplies a "switched ground" for each of the ignition coil primary windings. When it supplies a ground, current flows through the coil primary winding and builds up a magnetic field around the coil. When the ground is released, the current stops flowing abruptly and the magnetic field collapses. The collapsing magnetic field induces a high voltage in the ignition coil secondary winding which produces a spark across the gap of the spark plug and ignites the air fuel mixture.



Engine Starter Control

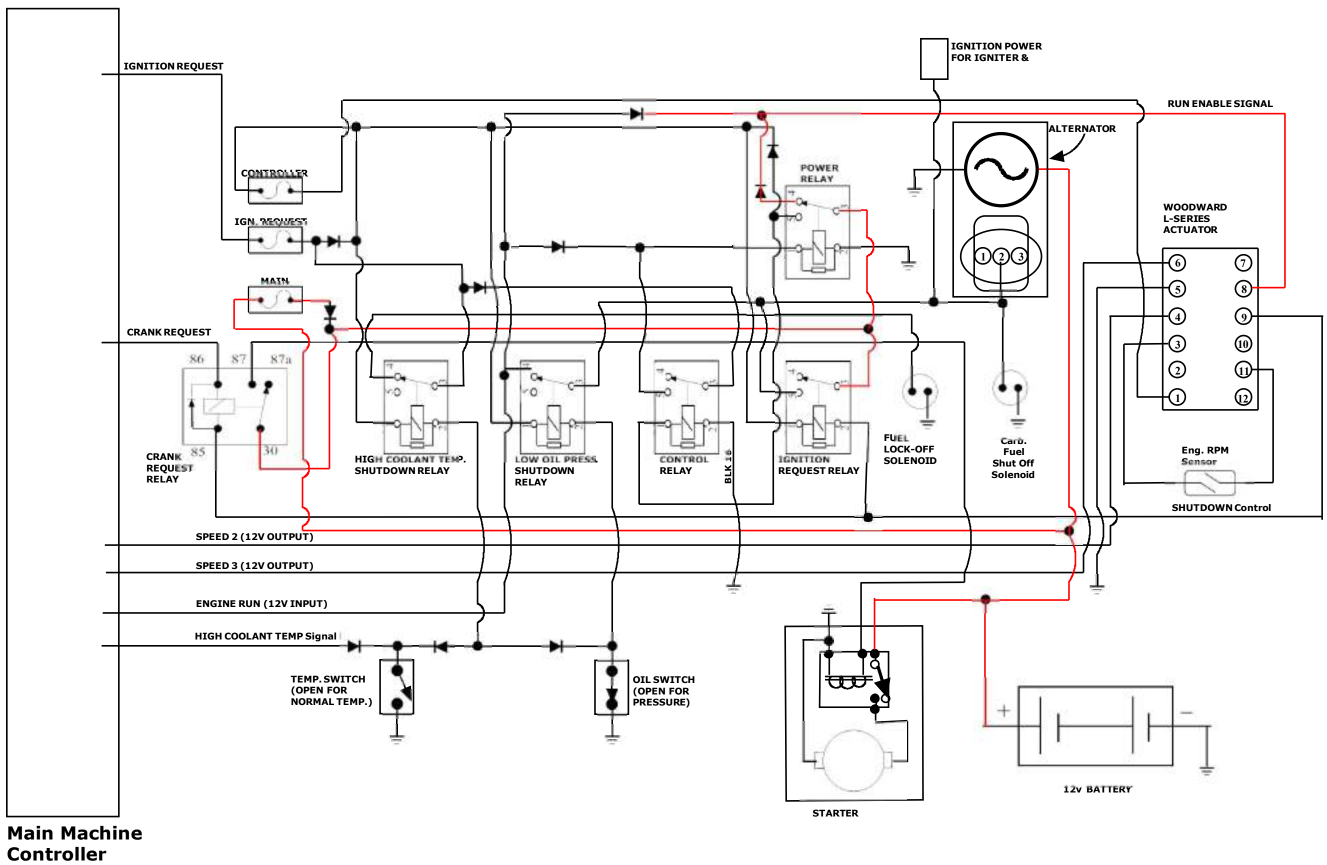
To get the engine starter to engage, the key switch is held in the start position which supplies 36 volts to the main machine controller on the violet wire with the green stripe to connector J7 pin 19. This is the start input request. The main machine controller receives a 12 V supply on connector J3 pin 23 from the engine starter battery. It uses this voltage supply to send 12 volts out of connector J3 pin 10 to the crank request relay coil. The other side of the relay coil is grounded through the Woodward L-series actuator. With power and ground across the relay winding the relay energizes and fused battery power from terminal 30 is sent to the starter solenoid.



Throttle Control Modes

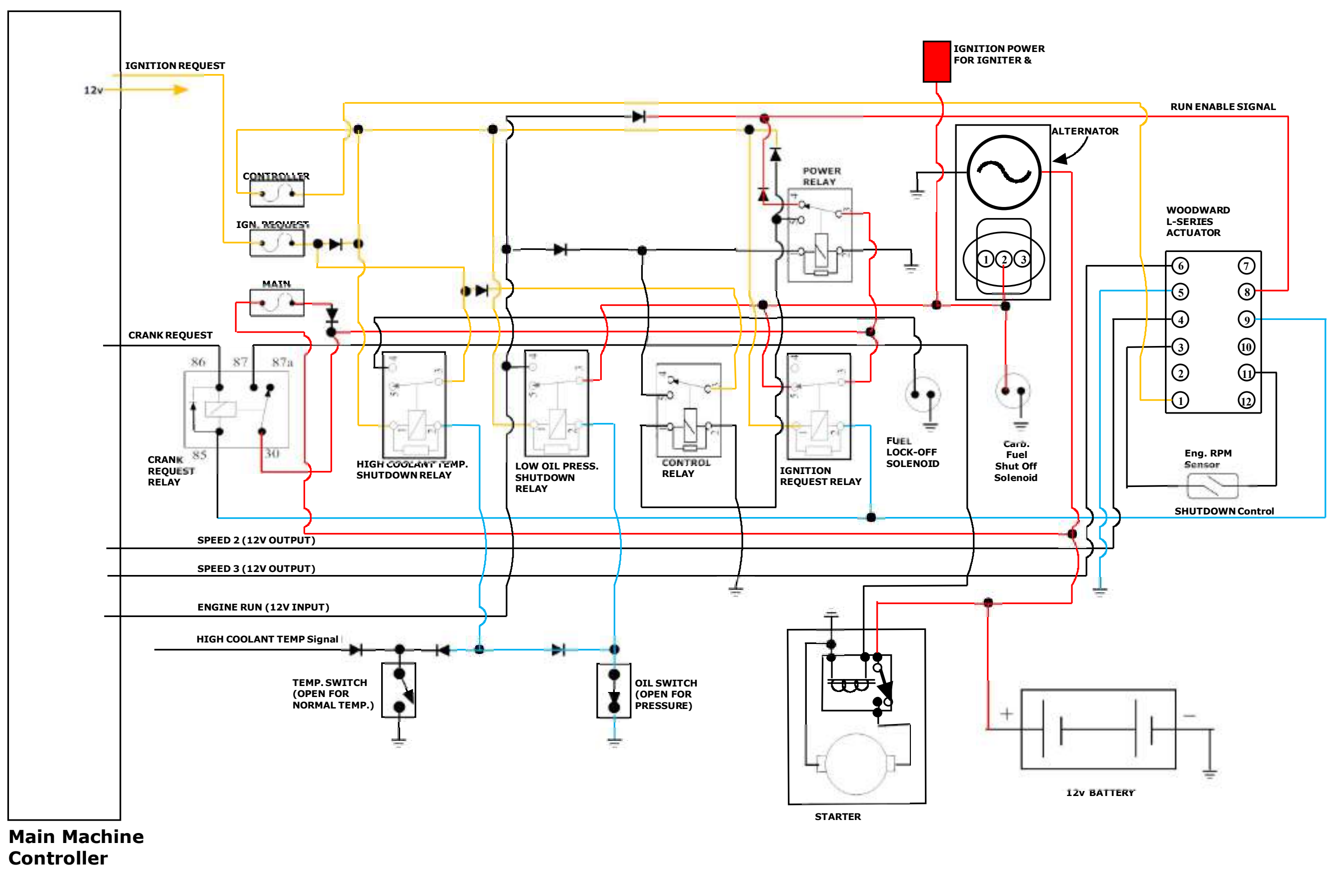
Ignition Off

- Battery power is available through the main fuse to the crank request relay common contact, the ignition request relay common contact and the power relay common contact.
- Battery power is provided to the “run enable” input of the L-Series actuator through the power relay closed at rest contacts. (If it doesn’t have this signal present on power up, it goes into an error mode.)
- There is no power to the fuel lock off solenoid.
- There is no power to the ignition system or carburetor fuel shut off solenoid.



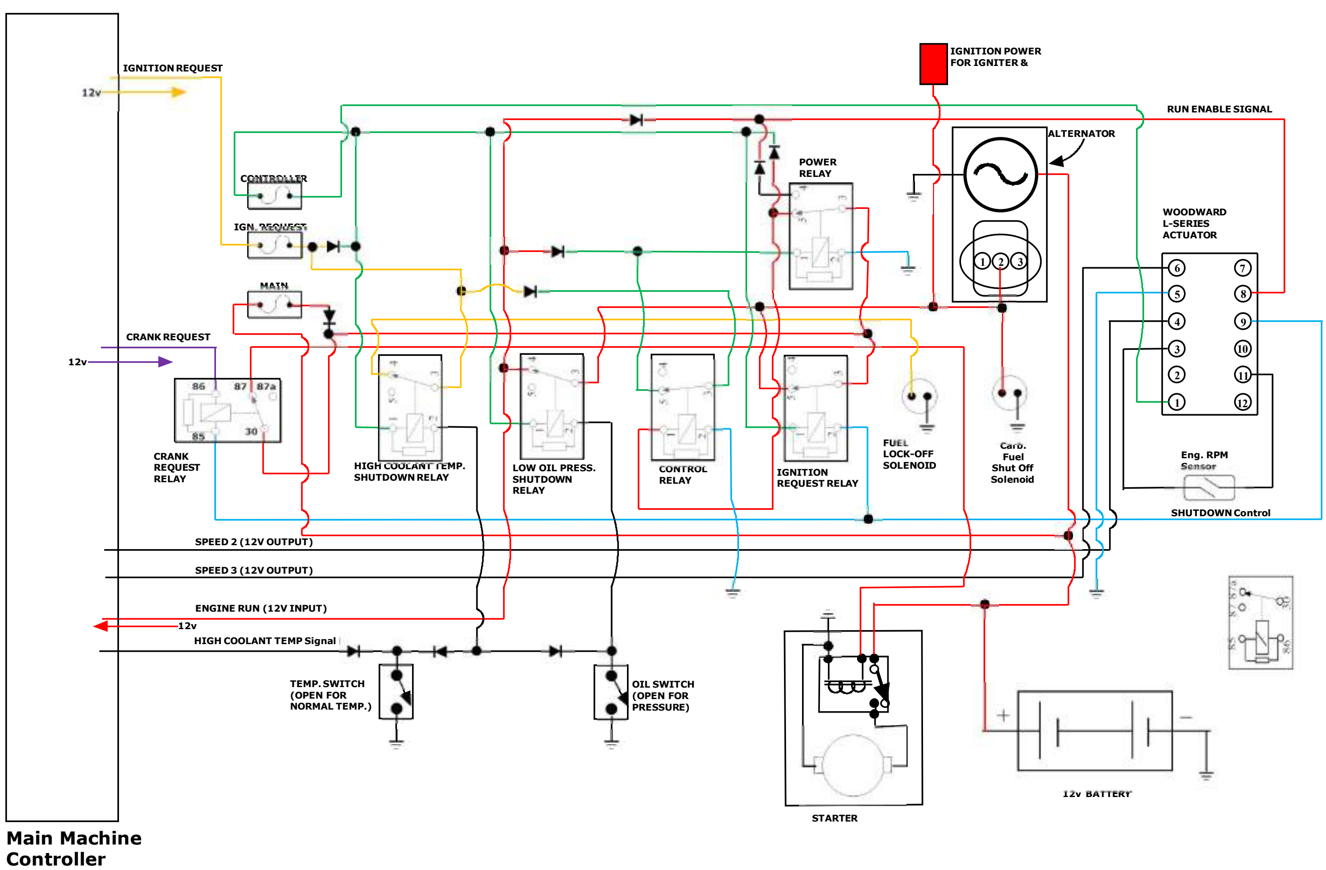
Ignition On

- When the main machine controller sees the key switch input, it sends 12v out on the Ignition Request circuit.
- When the actutor receives 12v at pin 1, it "wakes up".
- The actuator provides a ground through itself for the shut down control circuit.
  - The ignition request relay is energized (as long as there is not a shutdown condition within the L-Series actuator) passing battery power to the ignition system, carburetor fuel shut off solenoid and the low oil press. shutdown relay common contact at pin 3.
- Ignition power is provided to the common contact at pin 3 of the high coolant temp. shutdown relay and the common contact at pin 3 of the control relay.
  - Since there is no oil pressure, the oil pressure switch is closed causing the Low oil pressure shutdown relay to be energized. This prevents power from being passed to the "engine run" input into the main machine controller.
  - The high coolant temp. shutdown relay coil is also grounded through the closed oil pressure switch causing it to be energized. This prevents power from being passed to the fuel lock-off solenoid.



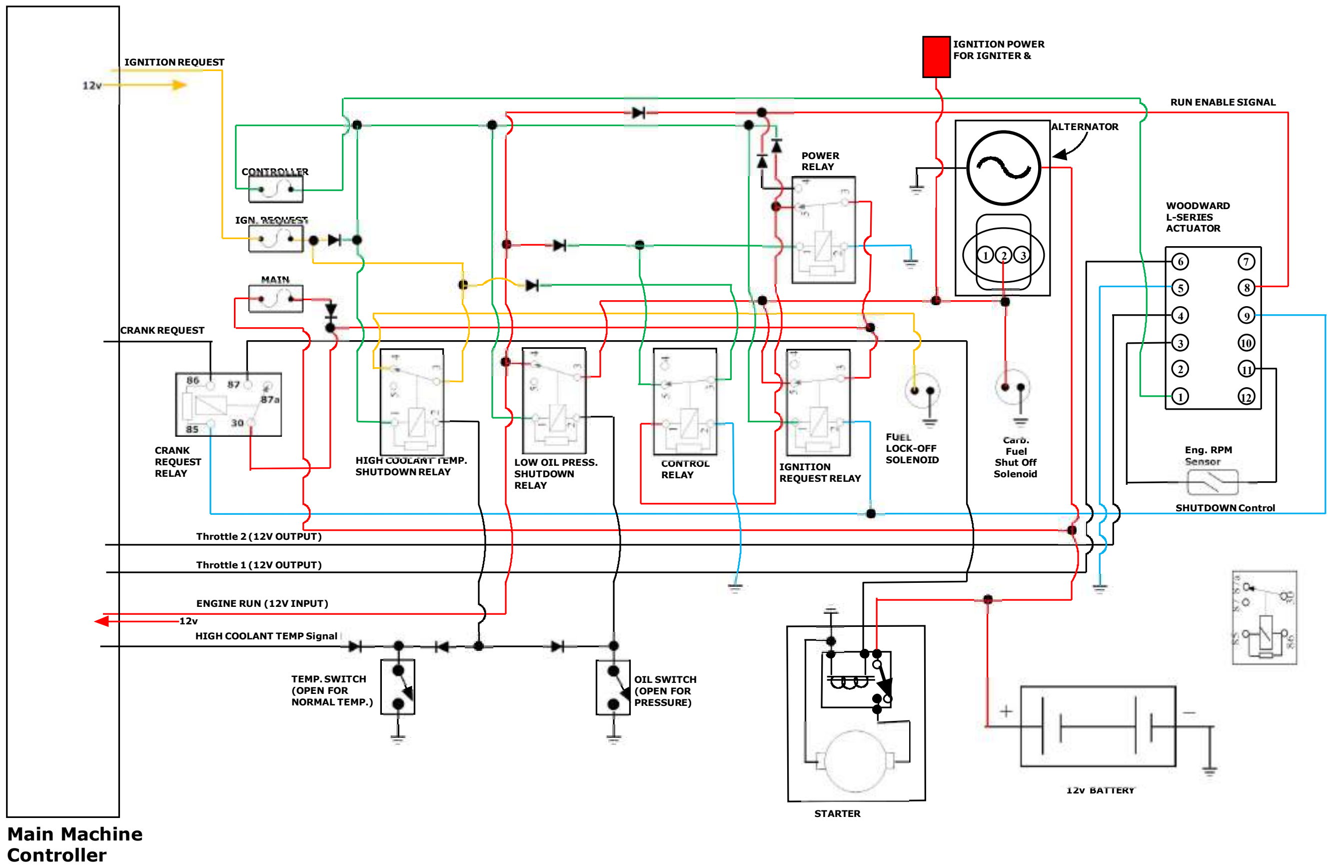
Cranking

- When the main machine controller sees the 36v cranking request from the key switch, it sends out 12v on the crank request circuit to the crank request relay winding. The other side of the winding is grounded through pin 9 of the actuator (as long as there is not a shutdown condition within the L-Series actuator). This energizes the crank request relay and battery power is passed through the contacts to the starter solenoid engaging the starter to turn the engine crankshaft. The ignition system is functional at this point, but there is not any fuel yet so the engine is not able to start.
- Once oil pressure builds up, the oil pressure switch opens.
  - The loss of ground through the oil pressure switch causes the high coolant temperature shutdown relay to de-energize. Ignition request power is then passed through the “closed at rest” contacts to the fuel lock off solenoid allowing fuel to flow and the engine to start.
  - The loss of ground through the oil pressure switch also causes the low oil pressure shutdown relay to de-energize.
    - Battery power is then passed through the “closed at rest” contacts to the main machine controller as the “engine run” signal and to the Woodward L series actuator.
      - From this point on, the “run enable” signal to the actuator is maintained by the low oil pressure shutdown relay.
    - The same power is also passed to the power relay coil energizing the relay.
      - Battery power is then passed through the “closed when energized” contacts of the power relay back into the ignition request circuit and to the control relay winding, energizing the control relay.



Normal Running

- When the key is released to the "run" position, the main machine controller turns off the voltage to the crank request circuit. This de-energizes the crank request relay and removes power from the starter solenoid.
- The rest of the circuit remains unchanged.



Engine RPM Control

The main machine controller communicates the desired engine speed mode to the actuator via the Throttle 1 and Throttle 2 wires. It either sends out 0v or 12v on each wire, depending on the desired speed mode.

Speed Mode	Engine Speed	Throttle 1	Throttle 2
Idle	1700 RPM	0	0
Run	2500 RPM	0	12v
Maximum Power	2700 RPM	12v	12v

There are several conditions that will override the user's engine speed request.

- High pressure wash forces to run speed.
- If the engine is at idle speed, the engine will be forced to the run speed when sweeping only or vacuuming only. The force idle (neutral timeout) will return the engine to idle speed.
- If the engine is at idle or run speed, the engine will be forced to maximum power speed when scrubbing

only or scrubbing and sweeping. The force idle (neutral timeout) will return the engine to idle speed.

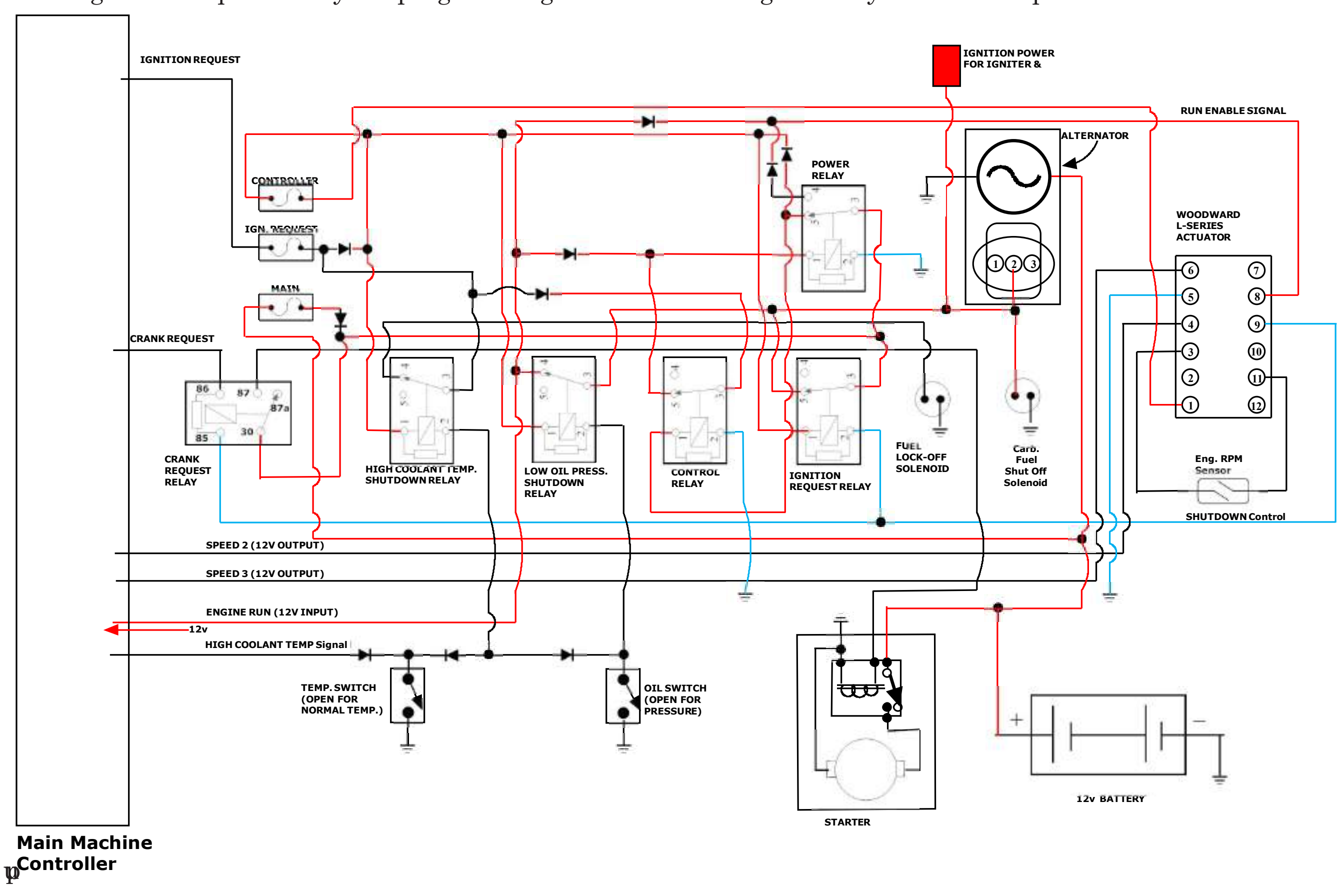
- If the override is run speed, the user can change between maximum power speed and run speed.
- If the override condition goes away (e.g. sweep system turns off) and the user has not changed the engine mode, the engine is returned to the mode before the forced override.

Normal Engine Shut Off

Step One

When the key switch is shut off, the main machine controller stops sending 12v out the ignition request circuit. This removes the power source for the fuel lock off solenoid that had been flowing through the "closed at rest" contacts of the high coolant temp shut down relay. No more fuel will flow into the vaporizer/regulator but the engine continues to run on the fuel that is "trapped" in the regulator.

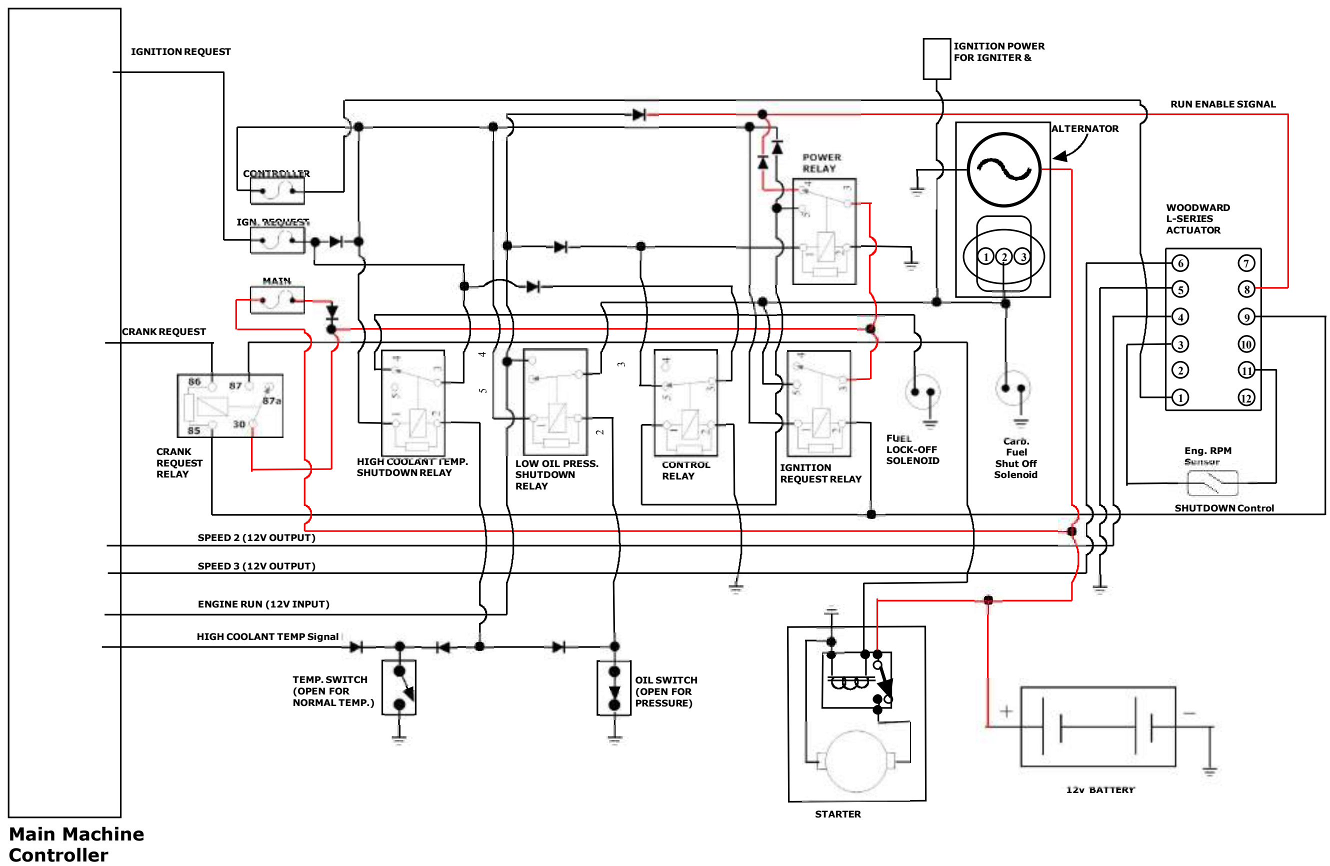
You may recall that when the key was first turned on, that the ignition request voltage energized the ignition request relay and provided power for the ignition system. If this is true, how can the engine stay running after the ignition request voltage is shut off by the main machine controller? It is able to stay running because the energized power relay is providing battery power to the ignition request relay keeping it energized so that the ignition system is still powered



Step Two

The engine continues to run until it uses up the fuel that was trapped in the vaporizer/regulator. When the engine stalls, and loses oil pressure, the oil pressure switch closes, energizing the low oil pressure shut down relay. This removes power from the power relay coil causing it to de-energize and remove power from the ignition request relay. This de-energizes the ignition request relay causing the ignition system to shut down and turns off the carburetor fuel shut off solenoid stopping the flow of any remaining fuel.

When the power relay de-energized, it also removed power from the control relay coil, low oil pressure shut down relay coil, high coolant temp shut down relay coil and pin 1 of the Woodward L series actuator. This "turns off" the actuator which, releases the switched to ground connection through pin 9 of the actuator.



Engine Protection Modes

The engine will be shut off in the event that it overheats or loses oil pressure after it has been running. The main machine controller will display a warning message to the operator for either case and will also initiate an engine shut down as a back up measure.

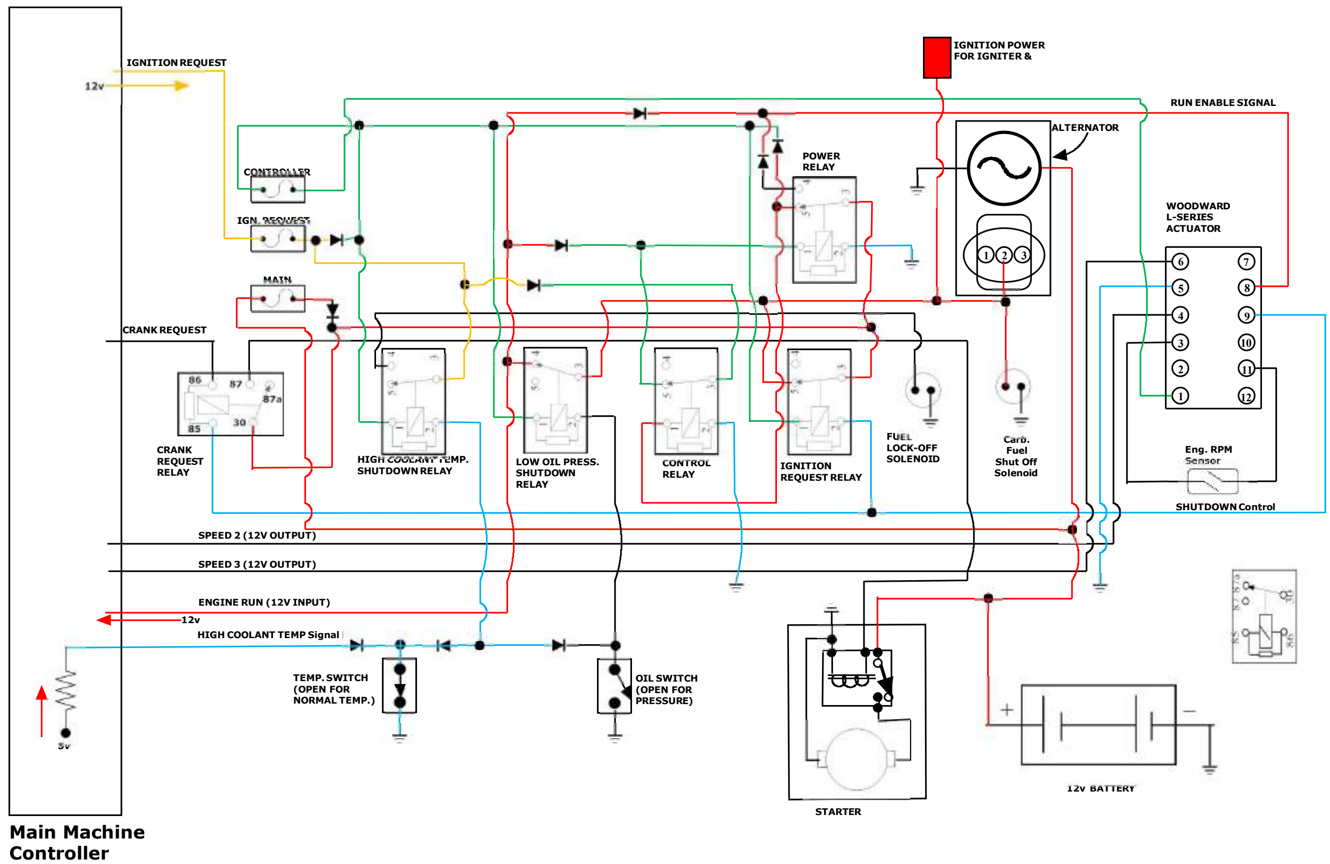
In the case of lost oil pressure, the Woodward L series actuator disables the ignition system by de-energizing the Ignition Request relay.

In the case of the engine overheating, the high coolant temperature shut down relay shuts the engine off by removing power from the fuel lock off solenoid causing the engine to run out of fuel and stall.

Engine Overheat Shutdown

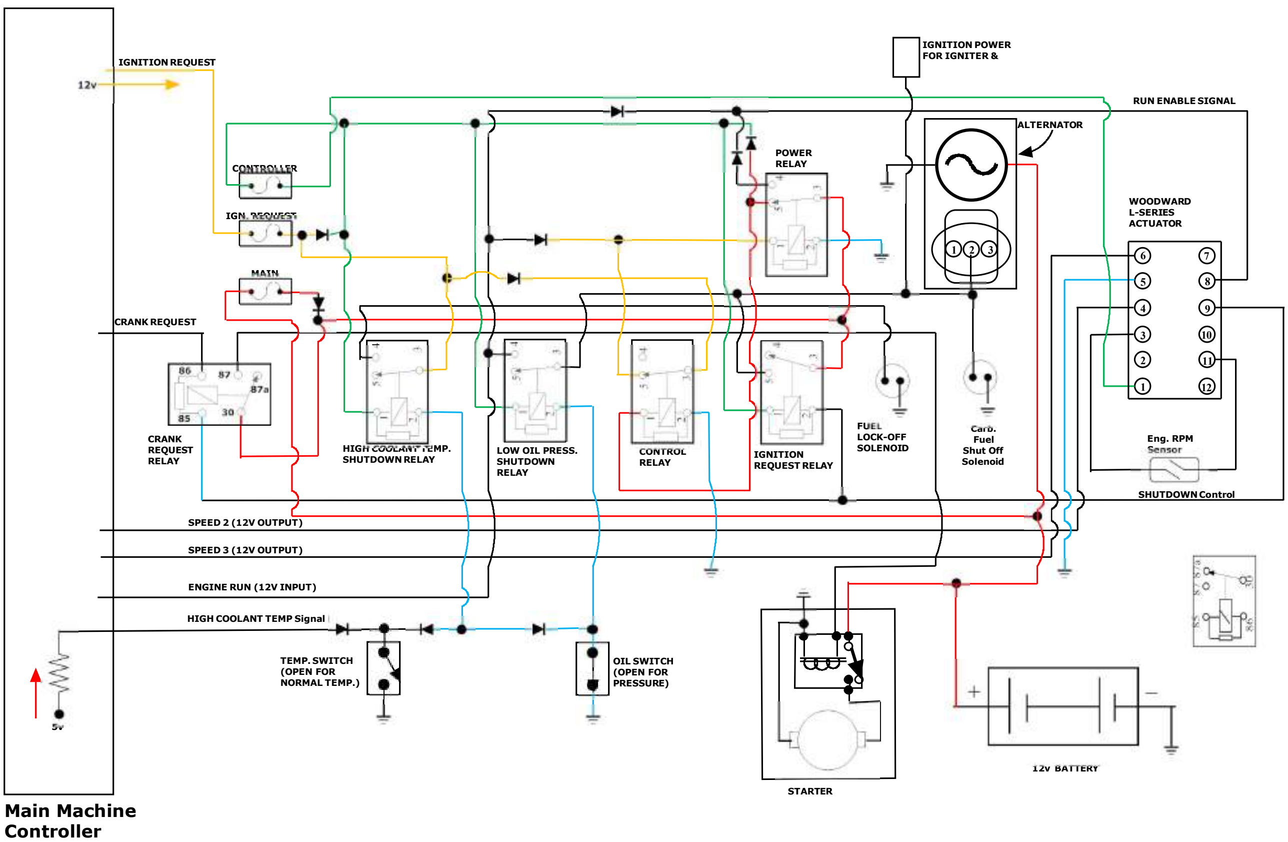
- If the engine overheats, the temperature switch closes. This completes a path to ground for the high coolant temp shut down relay and energizes the relay. This removes power from the fuel lock off solenoid. This does not shut the engine down immediately, but allows the engine to use up the fuel trapped in the regulator before stalling due to lack of fuel.

- The main machine controller monitors the engine coolant temperature by sending out a 5v feed through an internal resistor to the temperature switch. When the switch closes the voltage on the switch side drops from 5v to 0v . In response, the main machine controller sets an overheat code and alerts the operator. After a 5 second delay, it removes the 12v Ignition request signal. If the engine has not already shut down, the system will then shut down as if the operator had shut off the key (Normal engine shut off).

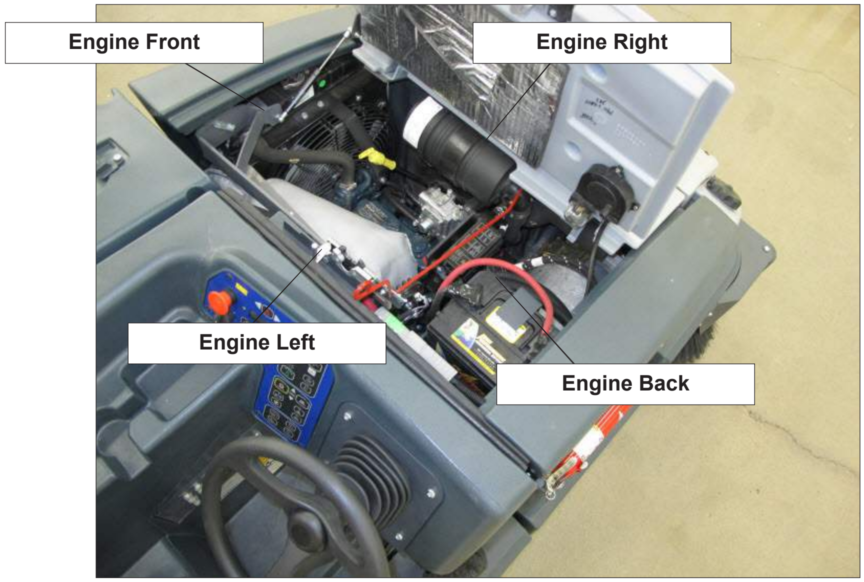


Lost Oil Pressure Shutdown

- If the engine oil pressure is lost, the oil pressure switch will close causing the low oil pressure shut down relay to energize taking power away from the “closed at rest” contact. This removes the power from the run enable signal to pin 8 of the Woodward L series actuator. The actuator immediately switches off the internal ground for the shut down control circuit at pin 9 causing the ignition request relay to de-energize. This shuts down the ignition system and the carburetor fuel shut off solenoid causing engine to stall immediately. The high coolant temp shut down relay also energizes, removing power through the closed at rest contacts to the fuel lock off solenoid.
- When the low oil pressure shut down relay energizes, power is also lost for the engine run signal to the main machine controller. The loss of the engine run signal is interpreted as “loss of oil pressure” by the main machine controller. It responds by immediately displaying an engine warning message to the operator and removing the 12v power going out to the ignition request circuit. If the engine has not already shut down, the system will then shut down as if the operator had shut off the key (Normal engine shut off).



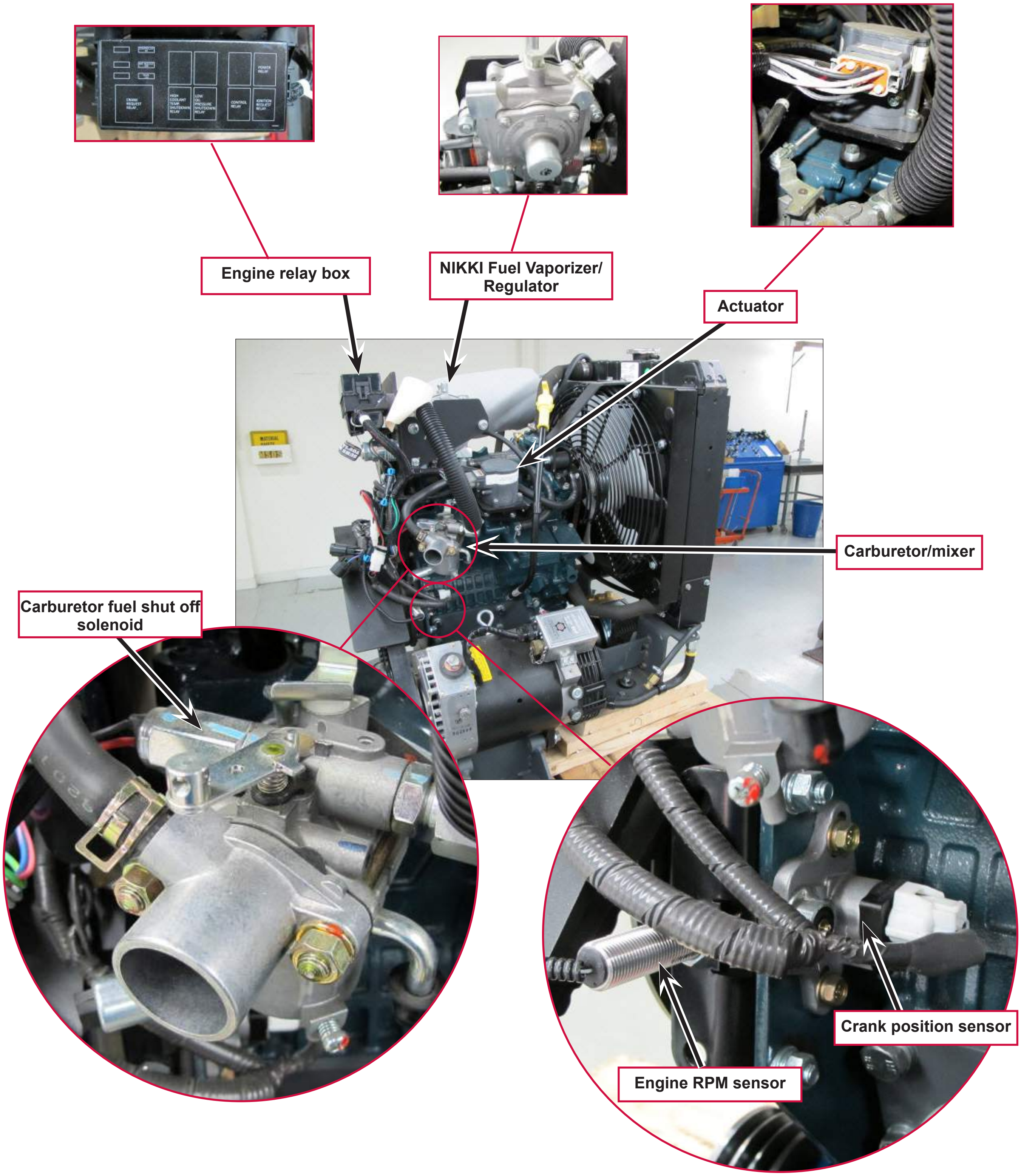
Component Locations



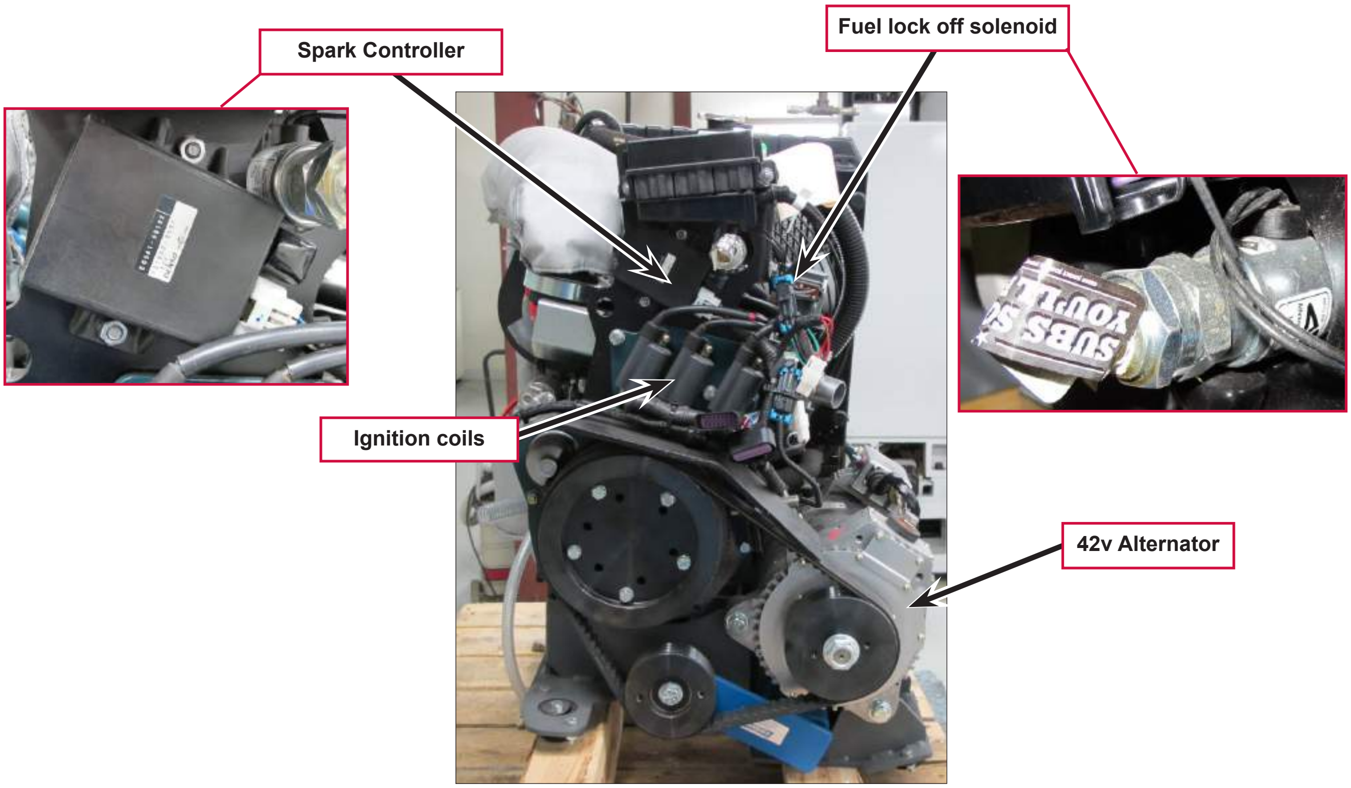
Engine components are grouped according to the area of the engine. They are photographed on an engine that is not installed in the machine for better visibility. See next pages for photos.

- **Engine Right** Side View (Toward front of machine)
  - Engine relay box
  - NIKKI Fuel Vaporizer/Regulator
  - Actuator
  - Carburetor/mixer
  - Engine RPM sensor
  - Crank position sensor
  - Carburetor fuel shut off solenoid
- **Engine Back** Side View (Toward right of machine)
  - Spark Controller
  - Fuel lock off solenoid
  - 42 V Alternator
  - Ignition coils
- **Engine Left** Side View (Toward back of machine)
  - 12 V alternator
  - Engine starter
  - Oil pressure switch
  - Coolant temperature switch
- Fuel Tank Area
  - Fuel tank
  - Pressure relief valve
  - Low LPG pressure switch

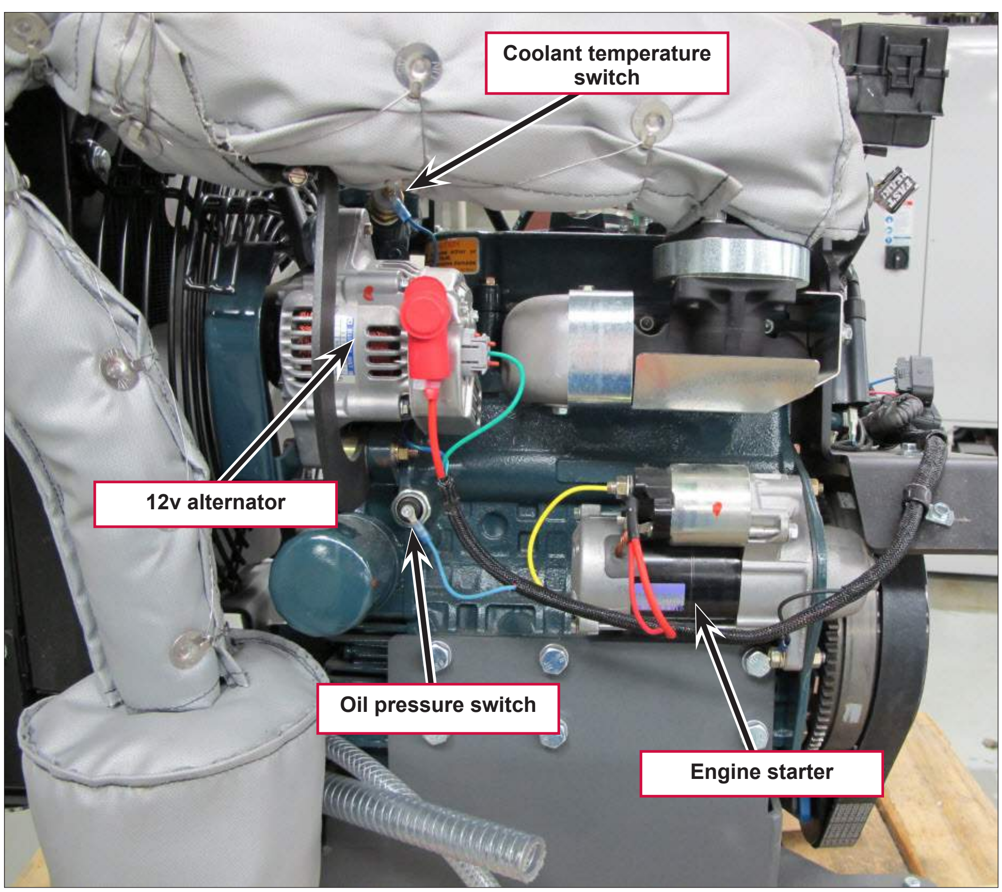
Engine Right Side View (Toward front of machine)



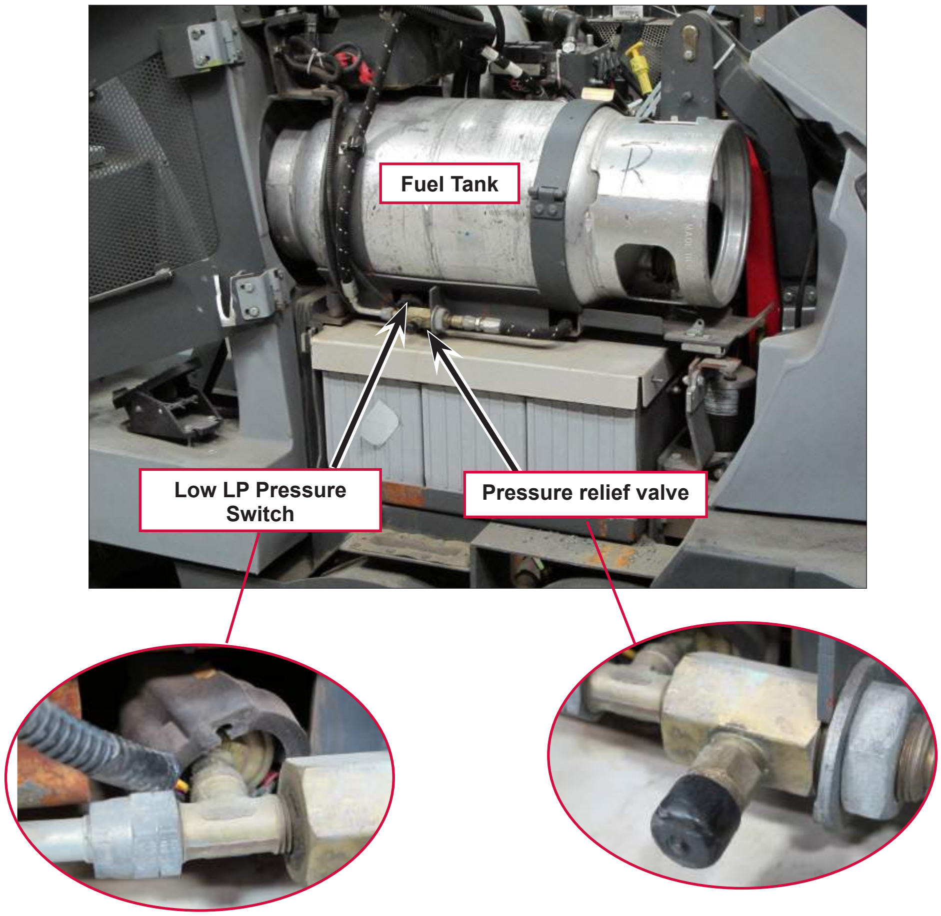
Engine Back Side View (Toward right of machine)



Engine Left Side View (Toward back of machine)



Fuel Tank Area



Maintenance and Adjustments

Maintenance Checklist

This check list is courtesy of the Kubota engine Workshop Manual. See the workshop manual for more details on performing these operations.

Daily:

- Check engine oil level
- Check and replenish coolant
- Check air cleaner element
- Check LPG tank setting condition
- Check LPG fuel connector

First 50 hours:

- Change engine oil
- Replace engine oil filter

Every 50 hours

- Clean air cleaner element
- Check LPG fuel hose and clamp bands
- LPG fuel check

Every 100 hours

- Clean spark plug
- Check fuel filter
- Check fan belt tension and damage

Every 200 hours

- Change engine oil
- Replace engine oil filter
- Check LPG tank setting condition
- Check radiator hoses and clamp bands

Every 1 year

- Replace air cleaner element
- Clean carburetor
- Clean water jacket and radiator interior

Every 1000 hours

- Replace spark plug
- Check coolant hose of LPG vaporizer
- Check vacuum lock hose of LPG vaporizer
- Drain tar
- Check valve clearance
- Clean cylinder head
- Check valve seats

Every 2 years

- Replace intake air line
- Replace LPG fuel hose and clamp bands
- Replace coolant hose of LPG vaporizer
- Replace vacuum lock hose of LPG vaporizer
- Check primary chamber
- Check air tight of secondary chamber
- Check vacuum lock system
- Replace radiator hoses and clamp bands
- Replace battery
- Change radiator coolant (L.L.C.)

Change Engine Oil and Oil Filter

1. Drain the recovery tank for later removal.
2. Shut off the engine and allow it to cool sufficiently to avoid burning yourself with hot engine oil.
3. Remove the left side engine cover.
4. Tip the recovery tank outward. Release the recovery tank tether cable and recover hose, then lower the recovery tank to the ground for better access to the engine oil filter area.
5. Remove the oil filter with an oil filter wrench.
6. Apply a light coat of engine oil to the new filter cartridge gasket.
7. Screw the new cartridge on and tighten by hand. Over tightening may damage the gasket.
8. Remove the remote oil drain hose end from the radiator bracket.
9. Remove the plug and drain the oil into a suitable container.
10. Reinstall the plug-and reattach the drain hose to the radiator bracket.
11. Refill the engine with oil.

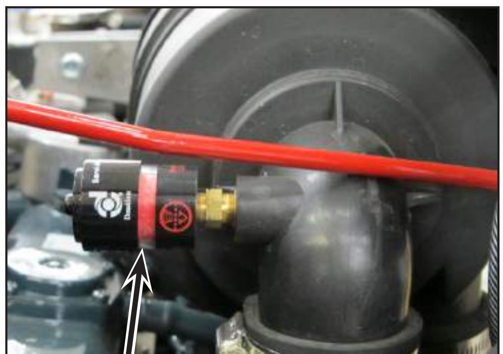
Change Engine Coolant

1. Allow the engine to cool sufficiently to relieve cooling system pressure and avoid burns.
2. Remove the left side engine cover.
3. Remove the radiator cap.
4. Locate the remote engine coolant drain hose, remove the plug and direct the coolant into a suitable container.
5. Reinstall the drain plug and reposition the drain hose.
6. Refill with a 50/50 mixture of engine antifreeze and water.

Inspect Air Filter

Check the service indicator mounted on the air cleaner elbow. If the red disc is visible in the “window”, the filters should be cleaned or replaced.

Clear Window = Okay



Red in Window = Restricted Filters

Replace Air Filters

1. Release the latches and remove the air filter housing cover.
2. Remove the outer filter element.
3. Blow out air cleaner housing with compressed air with inner filter element still in place to prevent dirt from entering the engine air intake.
4. Remove the inner filter element.
5. Clean residual dust from the inside of the air cleaner housing, taking care to prevent any dirt or debris from entering the air intake.
6. Install a new inner filter element and then the new outer filter element making sure that they seal well at their ends.
7. Install the air cleaner housing cover.

Troubleshooting

Checking Spark

1. Remove the spark plug wire from the spark plug and insert an adjustable KV tester in the end of the wire.
2. Adjust the gap to approximately 20 - 30 KV and clip the tester to a good ground on the engine.
3. Crank the engine over and check for consistent arcing across the tester gap.

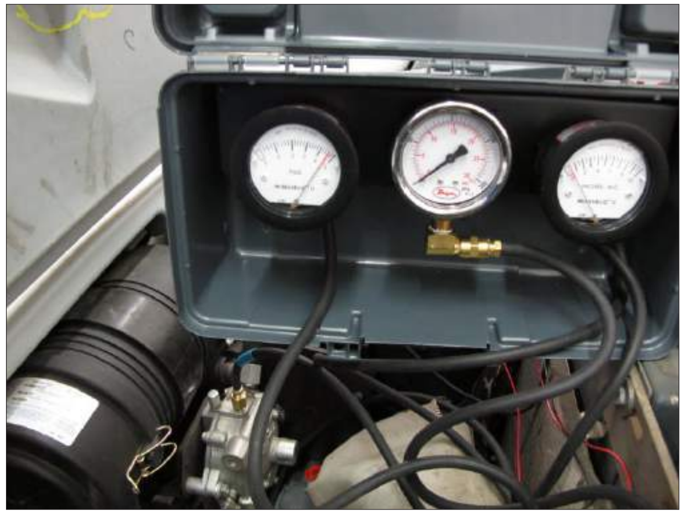
Checking LPG Primary Pressure

1. Turn off the propane tank valve with the engine running and allow the engine to run out of fuel.
2. Turn key switch off.
3. Remove the primary chamber test port plug located on top of the vaporizer regulator.

4. Install thread adapter part number 50360A into the test port.

5. Install fitting from LPG pressure test kit into the thread adapter.

6. Using the LPG test gauge kit - Part # 56504450, hook up the blue pressure gauge hose to fitting.
7. Open propane tank valve.
8. Start engine. (Specification - 4.3 PSI, 32.7kPA)
9. When finished, reinstall the test port plug using a suitable pipe thread sealant. (E.G. Loctite 30534)



No crank - The starter does not engage

Possible causes:

- 36v battery pack drained (preventing main machine controller from powering up.)
- Engine Battery
- Starter
- Battery to starter cable
- Engine Ground
- No voltage to the starter solenoid
  - Open circuit breaker CB9
  - Auxiliary Relay
    - Burned contacts or not energized
  - Key Switch
  - Main Machine Controller
  - Woodward L Series Actuator (Not supplying ground for crank request relay)
  - Crank request relay
- Wiring

Cranks but does not start – No Spark

Possible causes:

- Spark Control Module not powered up.
  - Ignition request relay
  - Woodward L Series Actuator not energizing ignition request relay
  - Spark control module ground
- Crank Position Sensor
- Spark Control Module
- Wiring
- Ignition Coils (not likely that all 3 coils would fail at once)

Cranks but does not start (has sufficient spark)

Possible causes:

- No fuel
  - Empty Tank
  - Fuel lock off solenoid stuck closed
  - Fuel lock off solenoid not energized
    - Ignition request fuse – blown
    - High coolant temp shut down relay – “Closed at rest” contacts not making connection
    - Engine oil pressure switch - not opening for pressure
    - Engine – Insufficient oil pressure to open switch
  - Pressure Regulator
- Mechanical engine
  - Insufficient compression
  - Plugged Intake
  - Plugged Exhaust
- Actuator
  - Not opening throttle

Cannot Achieve Either Run or Maximum Engine Speed Settings (Run - 2500 RPM, Maximum Power - 2700 RPM).

The approach to diagnosing an engine RPM control problem is to check the inputs to the L series actuator. If the inputs are good and the output is bad, the conclusion is that the actuator is the problem. However, don't forget that insufficient fuel supply or a restricted exhaust could appear like an RPM control problem if the engine cannot run well enough to achieve a higher RPM.

Possible Causes:

- Actuator linkage
- Actuator power supply
- Actuator
- Wiring
- Main Machine Controller

Diagnostic steps

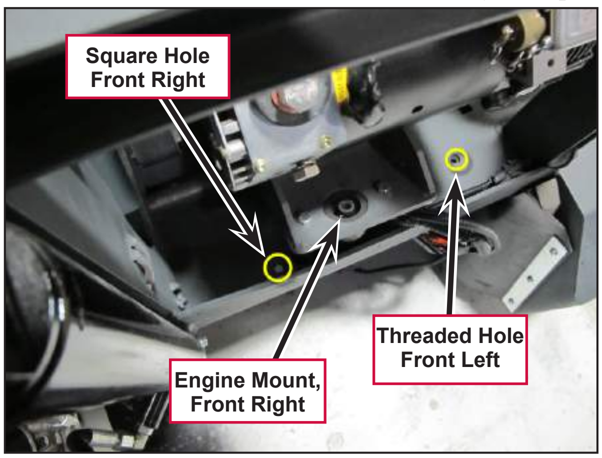
10. Visually inspect the linkage between the actuator arm and the carburetor throttle lever.
    - Is the linkage okay?
        - If not, repair
        - If so, go to next step.
11. Check the power and ground supplies to the actuator.
    - Is there sufficient power and ground?
        - If so, go on to check the speed request inputs.
        - If not, repair.
12. Check the speed request inputs - With the engine running press the engine speed button and check for 12v to the throttle 1 wire at the actuator.
    - Is 12v present on the throttle 1 wire?
        - If so, replace the actuator
        - If not, check the wiring between the main machine controller and the governor controller.
        - If the wiring is okay, check the output coming out of the main machine controller.

Removal and Installation

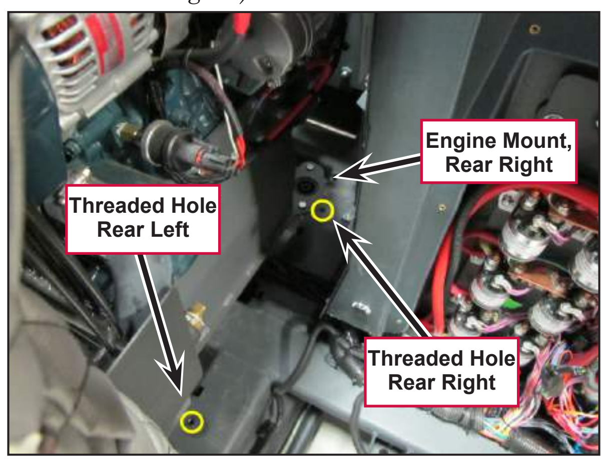
Engine Assembly

The complete engine including the exhaust, radiator and 42v alternator are removed as an assembly. There is no need to drain engine oil or coolant. The assembly is attached to the chassis at 4 rubber motor mounts. The front right mount has a square hole in the chassis for a carriage bolt. The other 3 are threaded holes in the frame.

1. Remove engine Top cover
2. Disconnect the 36v battery pack main positive and negative cables.
3. Disconnect the 12v battery negative cable.
4. Disconnect the 12v battery positive cable.
5. Disconnect fuel supply and return lines.
6. Disconnect battery positive and negative cables at the starter.
7. Disconnect the engine wiring connectors.
8. Remove the 4 motor mount fasteners. (Note: photos are of diesel engine)



Front engine mounting locations. Shown with hopper up and engine being installed.



Rear engine mounting locations. Shown with engine being installed.

9. Lift the assembly out of the chassis using a suitable hoist attached to the two engine lift points.
10. Reassemble in reverse order. Connect the battery negative cables last.

Specifications

Fuel System

Primary Chamber Pressure - 4.3 PSI (32.7 kPA)

Fuel Lock Off Solenoid Resistance - 10 ohms

Engine Oil

Engine oil capacity - 3.4 L, 0.90 U.S.gals

- IMPORTANT
  - When using an oil of different maker or viscosity from the previous one, remove all of the old oil.
  - Never mix two different types of oil.
  - Engine oil should have properties of API classification SH.
  - Use the proper SAE Engine Oil according to ambient temperature.

Above 25 °C (77 °F) - SAE30 or SAE10W-30

0 °C to 25 °C (32 °F to 77 °F) - SAE20 or SAE10W-30

Below 0 °C (32 °F) - SAE10W or SAE10W-30

Engine Coolant

Use only ethylene glycol or propylene glycol type anti-freeze for this engine. Always assure a 50% / 50% anti-freeze and water mixture regardless of temperature.

Shop Measurements

The following information provides some “real world” shop measurements to help you recognize what “normal” looks like.

Ignition System

Ignition coil primary resistance – 2.15 ohms

Ignition coil secondary resistance – 18.4 K ohms

Spark Output - 30 KV consistently (Using adjustable spark tester)

Crank position sensor resistance - 2.18 K ohms

Crank position sensor output cranking - 1.1 VAC average. 2.0 VAC RMS

Crank position sensor output running - 5.5 VAC average

Spark Controller Measurements:

Pin Letter	Wire Color on machine	Circuit	Voltage with key on unplugged
E	BLU	Crank Position Sensor	0v
F	BLK	Ground (And other leg of Crank sensor)	0.004v
G	Red	Power Supply	11.2v
H	Not used		
I	Not used		
J	BLU/BLK	Coil 3 Driver	11.2v
K	WHT/BLK	Coil 2 Driver	11.2v
L	RED/BLK	Coil 1 Driver	11.2v

Governor Control System

Woodward L Series Actuator Measurements

Pin	Wire Color	Circuit Description	Connector Unplugged Key On	Connector Plugged In Key On
1	PNK/BLK	Ignition Request	11.69v	11.4v
2	Not used			
3	BLK	Engine RPM Sensor	-	-
4	GRA/BLU	Throttle 2	7.79v	0.007v
5	BLK	Ground	0.007v	0.007v
6	GRA/ORN	Throttle 1	7.78v	0.007v
7	Not used			
8	GRA/WHT	Run Enable Signal	11.9v	11.0v
9	BLK/WHT	Shut Down Signal	11.6v	0.028v
10	Not Used			
11	CLR	Engine RPM Sensor	-	-
12	Not Used			

RPM Sensor Output (measured at the actuator Pin 3 and 11 with the connector plugged in):

- 0.68v AC when cranking
- 2.13v AC when running

Engine RPM sensor resistance - 2.07 K ohms

Fuel System

Carburetor LPG shut off solenoid resistance – 27.3 ohms

Fuel Lock Off Solenoid resistance - 10.1 ohms

Primary Pressure - 4.6 PSI

Engine

Engine Vacuum at idle - approx 14.5 - 15” HG

When returning from low RPM to idle vacuum momentarily peaks around 21” HG

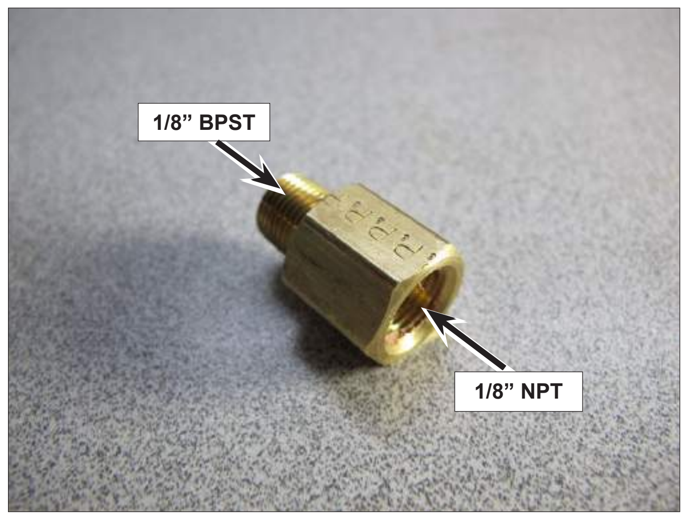
Engine Compression

- Cyl #1 - 170 PSI
- Cyl #2 - 170 PSI
- Cyl #3 - 170 PSI

Special Tools

LPG test gauge kit - Part # 56504450

LPG test port adapter. (Male 1/8” BSPT to Female 1/8” NPT) Part # 50360A



Adjustable KV Spark Tester.

Most automotive parts suppliers sell these tools. Shown is 50850 from Lisle corporation. http://www.lislecorp.com/

Hopper System

Functional Description

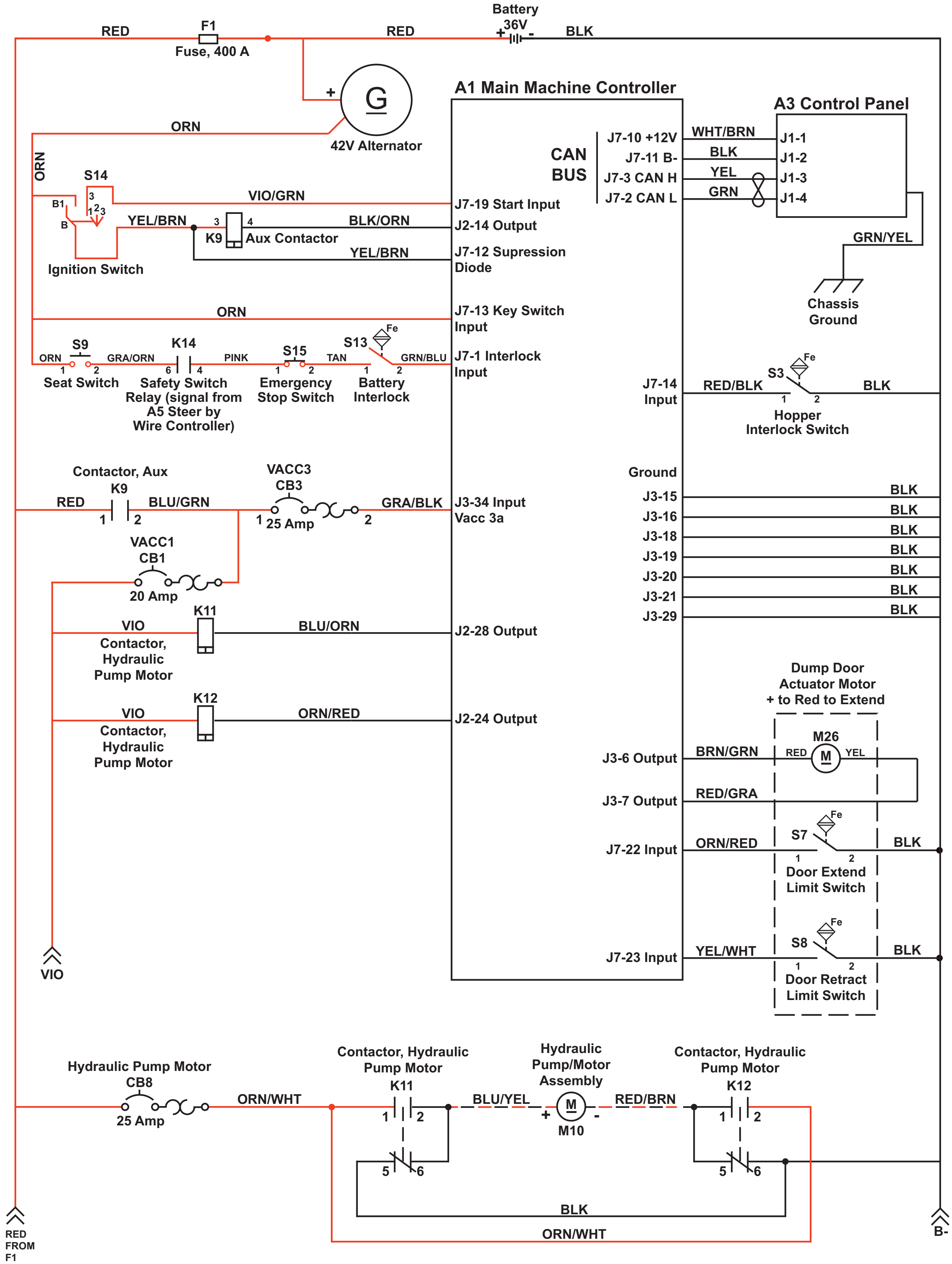
Overview

The hopper system holds the dirt, dust and debris swept up by the brooms. The hydraulic lift cylinder raises the hopper to allow the accumulated dirt and debris to be dumped into a suitable receptacle, then lowers the hopper back down into the normal operating position. The hopper lift cylinder is powered by a separate hydraulic power pack that includes an electric motor and hydraulic pump. Two double pole contactors control the lift cylinder direction by reversing the polarity to the pump motor.

The hopper dump door, driven by an electric actuator, can be opened by pressing the hopper door open button when the hopper is up to empty the hopper. Proximity sensors limit the hopper dump door actuator travel. Note that the hopper door opens automatically to receive the dirt and debris from the brooms when the hopper is in the operating position and the sweep system is enabled. Once the sweep system is switched off, the hopper door closes. An interlock prevents the hopper door from being opened manually if the hopper is down.

The hopper interlock proximity sensor signals the A1 Main Machine Controller when the hopper is closed.

Hopper System Wiring Diagram

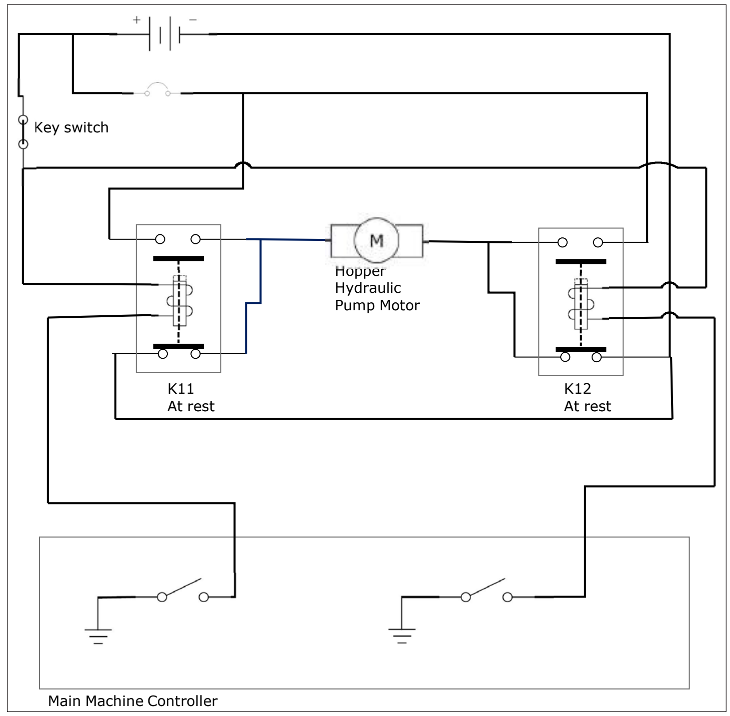


Hopper Hydraulic System Circuit Details

A hydraulic cylinder (ram), driven by a self-contained hydraulic pump and motor, raises and lowers the hopper. The pump motor power and ground polarity are reversed to make the motor run in opposite directions. Two contactors (**K11** and **K12**) are used to operate the pump. Each contactor has two sets of contacts; one that is closed when at rest (normally closed) and one that is open (normally open) when at rest.

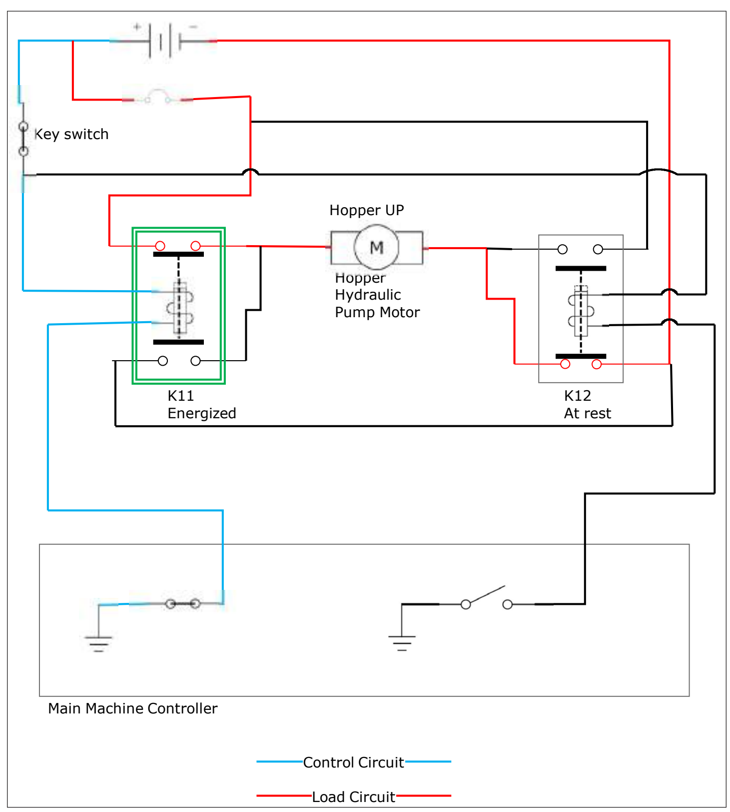
Hopper at Rest

When the hopper is "at rest", the normally-closed contacts of each contactor connect both sides of the hopper hydraulic pump motor to battery negative. Since there is no difference in electrical pressure (voltage) across the pump, no current flows and the pump remains "Off".



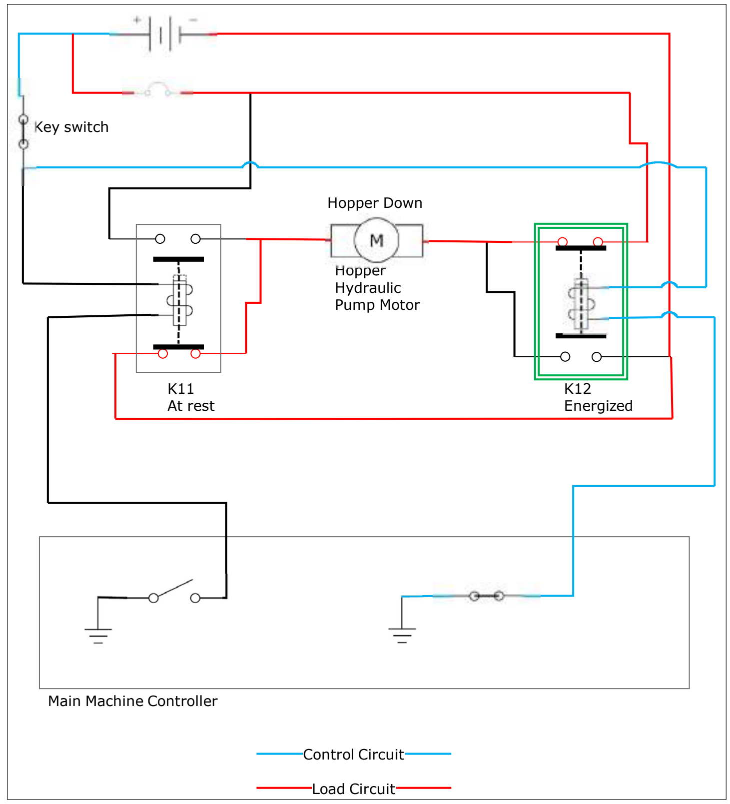
Hopper Being Raised

When the operator pushes the button to raise the hopper, the main machine controller energizes the **K11** contactor by grounding the control winding of the contactor. This causes a magnetic field to pull the normally-closed contacts open, and at the same time closes the normally-open contacts. Battery voltage is now applied through the closed set of **K11** contacts to one side of the pump. The other side of the pump is connected to battery negative through the normally-closed contacts of the **K12** contactor. This completes the circuit and causes the pump to run in the "Up" direction.



Hopper Being Lowered

When the operator pushes the button to lower the hopper, the main machine controller energizes the **K12** contactor by grounding the control winding of the contactor. This causes a magnetic field to pull the normally-closed contacts open, and at the same time closes the normally-open contacts. Battery voltage is now applied through the closed set of **K12** contacts to one side of the pump. The other side of the pump is connected to battery negative through the normally-closed contacts of the **K11** contactor. This completes the circuit and causes the pump to run in the "Down" direction.



Circuit Description

The Following Conditions Must Be Met for the Hopper to be Raised and Lowered

- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed (battery machines) or jumpered (Diesel and LPG machines).
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Hydraulic Pump Motor Contactor K12**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-12**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breaker **VACC1/CB1**.
- The **Hydraulic Pump Motor** circuit breaker **CB8** must closed to provide positive voltage to the load side of the **Hydraulic Pump Motor Contactors K11** and **K12**.
- The load side of the **Hydraulic Pump Motor Contactors K11** and **K12** must be connected to battery ground.
- The **J2-28** and **J2-24 Outputs** must provide negative ground to the **Hydraulic Pump Motor Contactor** coils **K11** and **K12** respectively when the **A1 Main Machine Controller** receives a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the hopper raise or hopper lower button.

The Following Conditions Must Be Met for the Hopper Door Open and Close

- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed (battery machines) or jumpered (Diesel and LPG machines).
- The **J3-6** and **J3-7 Outputs** must provide voltage to the **Dump Door Actuator Motor M26** when the **A1 Main Machine Controller** receives a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the hopper door open or hopper door close button.
  - For the hopper door to open, the **A1 Main Machine Controller** must not receive negative voltage at the **J7-22 Input** from the **Dump Door Extend Limit Switch S7**.
  - For the hopper door to close, the **A1 Main Machine Controller** must not receive negative voltage at the **J7-23** input from the **Dump Door Retract Limit Switch S8**.

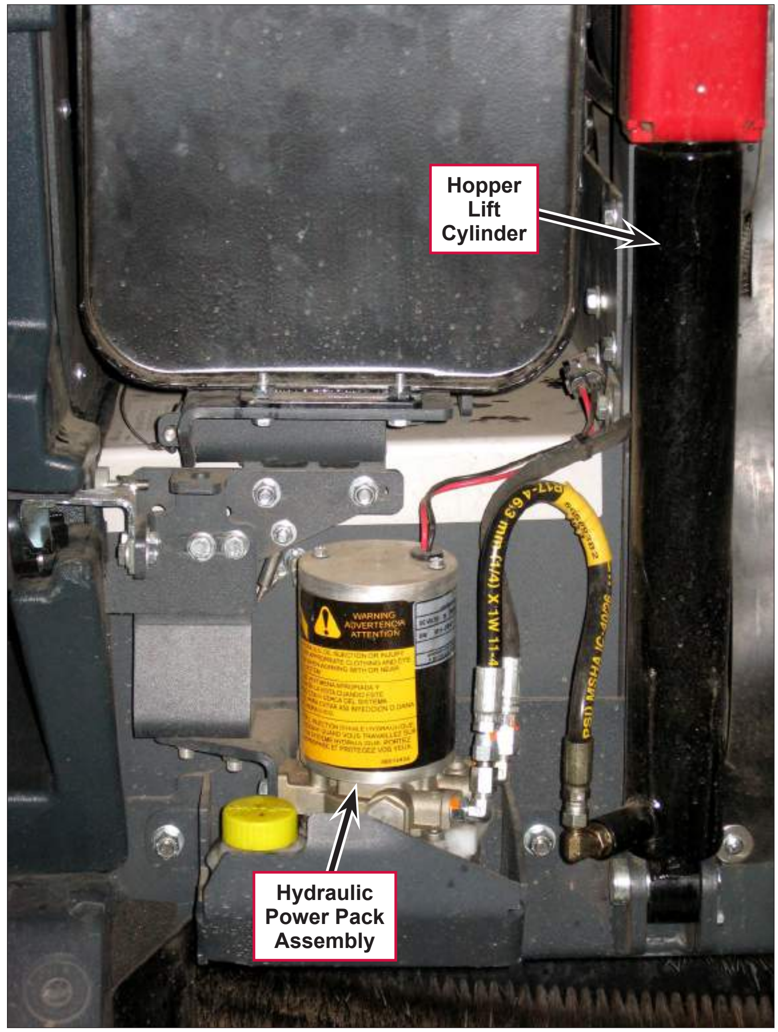
Component Locations

Upper and Lower Hopper

The **Upper Hopper** (light gray) and **Lower Hopper** (dark gray) are on the front of the machine, The **Hopper Cover** houses the dust control impeller pump, filter and filter shaker assembly. The **Upper** and **Lower Hoppers** are connected and pivot up and down as a single unit.

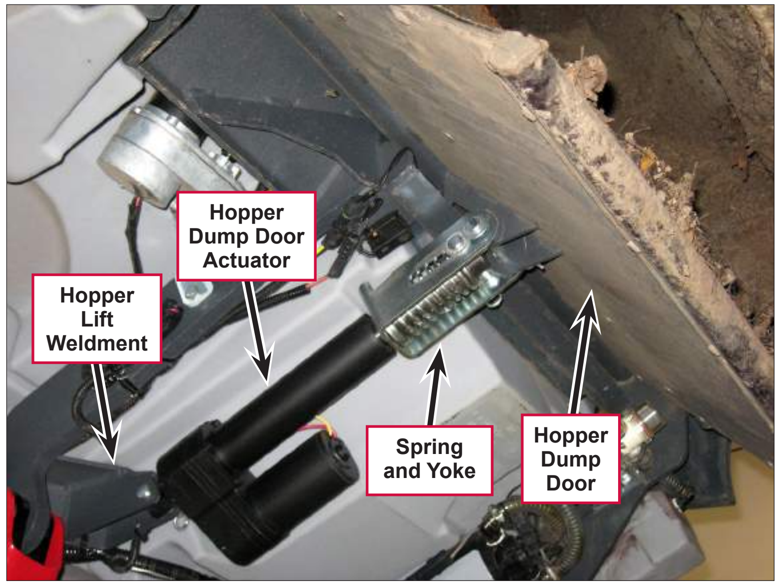
Hydraulic Power Pack Assembly

The **Hydraulic Power Pack Assembly** is mounted on the front of the machine frame and can be accessed when the hopper is up. The **Hydraulic Power Pack Assembly** extends and retracts the **Hopper Lift Cylinder** which raises and lowers the hopper.



Hopper Dump Door

The **Hopper Dump Door** on the bottom of the hopper opens to allow the hopper to be emptied.



Hopper Dump Door Actuator

The electric **Hopper Dump Door Actuator** is pinned to the **Hopper Lift Weldment** and **Hopper Dump Door** and opens and closes the **Hopper Dump Door**.

The **Spring and Yoke** on the rod end of the **Hopper Dump Door Actuator** allow the **Hopper Dump Door** to move a short distance toward the closed position when the **Hopper Dump Door** is open. This is designed to prevent machine damage if the machine is backed away from a dumpster and the **Hopper Dump Door** catches on or contacts the dumpster.

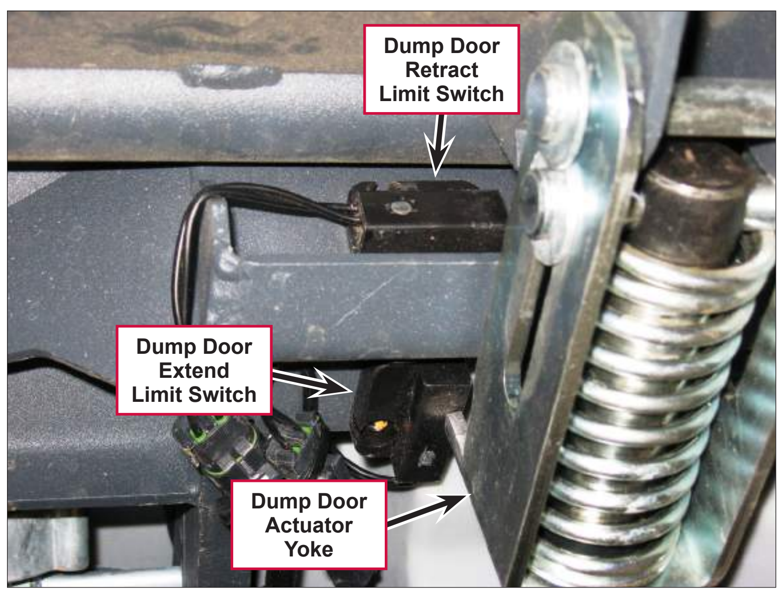
Caution: ***The Spring is pre-compressed about an inch, so use caution if you ever need to disassemble the Spring from the Yoke.***

Dump Door Extend and Retract Limit Switches

The **Dump Door Retract** and **Dump Door Extend Limit Switches** are proximity sensors that sense when the hopper dump door is open (retracted) and closed (extended).

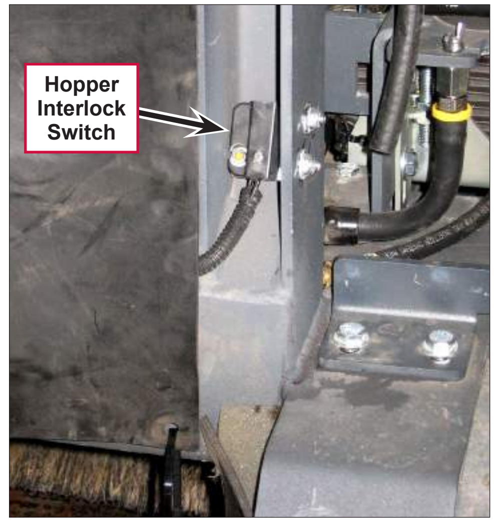
Note that:

- The **Dump Door Extend Limit Switch** senses the **Dump Door Actuator Yoke** when the dump door is closed.
- The **Dump Door Retract Limit Switch** senses the dump door itself when the door is open.



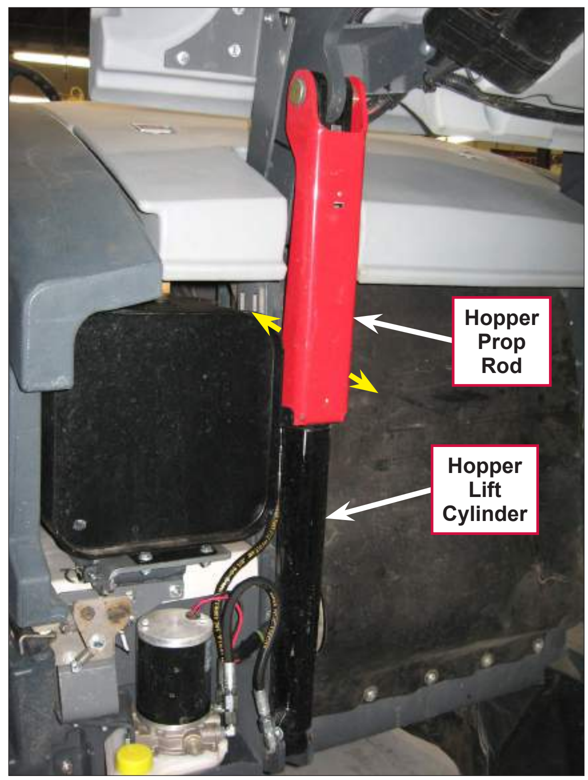
Hopper Interlock Switch

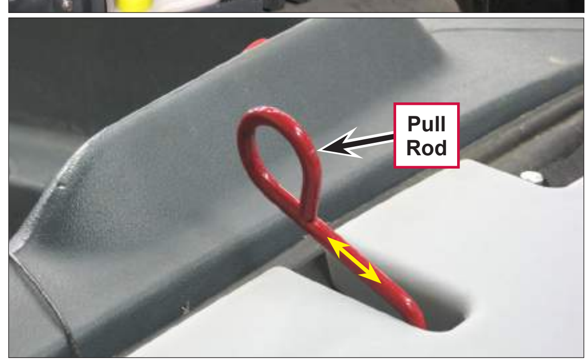
The **Hopper Interlock Switch** is a proximity sensor on the left front of the machine frame that senses when the hopper is all the way down in the normal operating position.



Hopper Prop Rod and Pull Rod

The **Hopper Prop Rod** is a safety mechanism that must be engaged when personnel are working underneath the hopper to prevent the hopper from being lowered. The **Hopper Prop Rod** pivots toward the rear of the machine to engage the top of the **Hopper Lift Cylinder** and hold the hopper in its raised position.





Warning! Before working underneath the raised hopper, engage the Hopper Prop Rod as follows:

1. Raise the hopper all the way up.
2. Pull the **Pull Rod** to pivot the bottom of the **Hopper Prop Rod** toward the **Hopper Lift Cylinder** until it contacts the **Hopper Lift Cylinder**.
3. Lower the hopper until the **Hopper Prop Rod** contacts the top of the **Hopper Lift Cylinder**.

To disengage the **Hopper Prop Rod**:

1. Raise the hopper all the way up.
2. Push the **Pull Rod** to pivot the bottom of the **Hopper Prop Rod** off of the **Hopper Lift Cylinder**.
3. Lower the hopper.

Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
The hopper will not rise or lower.	An interlock is not closed.	Before you start troubleshooting the hopper system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed (battery machines only). • The A1 Main Machine Controller is receiving the appropriate signal from the A3 Control Panel via the CAN BUS.
	There is no voltage to the **K11** and **K12** contactor coils.	Check circuit breaker **CB1 and** reset if necessary.
		The contactor **K9** is not providing positive voltage to the **K11** and **K12** contactor coils. 1. Check the **K9** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 2. Check the continuity through contactor **K9** with the coil energized. If the contacts are open, replace the contactor. 3. Check the **J2-28** and **J2-24 Outputs** from A1 Main Machine Controller.
	There is no voltage to the Hydraulic Pump/Motor Assembly **M10**.	Check circuit breaker **CB8 and** reset if necessary.
		The contactors **K11** and **K12** are not providing voltage to the Hydraulic Pump/Motor Assembly **M10**. 1. Check the coil resistance on the **K11** and **K12** contactor. If the coil resistance is not 117 ohms ± 10%, replace the contactor. 2. Check the continuity through contactors **K11** and **K12** with the coil energized. If the contacts are open, replace the contactor. 3. Check the **J2-28** and **J2-24 Outputs** from A1 Main Machine Controller.
		Check the motor wiring and connections from contactors **K11** and **K12** to the hydraulic pump motor, and the ground connections from the contactors to battery ground. Repair as necessary.

Problem	Cause	Correction
The hopper dump door will not open or close.	Something is physically lodged between the door and the lower hopper.	Check the door and hopper and clear or remove any debris or objects as necessary.
	The **Dump Door Actuator Motor M26** is not operating correctly.	1. Check the wiring and connectors from the A1 Control Board to the dump door actuator motor and repair as necessary. 2. Check the operation of the dump door actuator motor. If the motor doesn't operate with battery voltage applied to it, replace the dump door actuator. 3. Check the voltage outputs from **J3-6** and **J3-7** on the A1 Control Board.
The hopper dump door will not open.	The sensor on the Door Extend Limit Switch (**S7**) is not functioning correctly.	Check the sensor/switch function as follows: • The switch should close when it comes within approximately .250" of a ferrous material. • The switch should open when it moves approximately .313" away from the material. If the switch is not operating correctly, replace the switch.
The hopper dump door will not close.	The sensor on the Door Retract Limit Switch (**S8**) is not functioning correctly.	Check the sensor/switch function as follows: • The switch should close when it comes within approximately .250" of a ferrous material. • The switch should open when it moves approximately .313" away from the material. If the switch is not operating correctly, replace the switch.

Removal and Installation

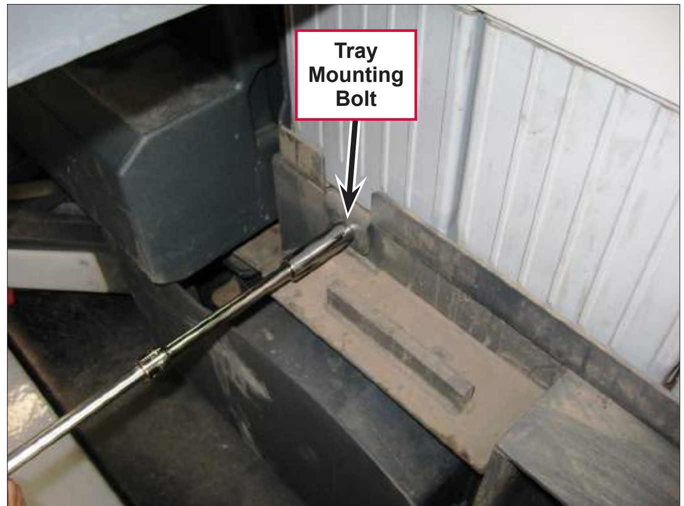
Warning! ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

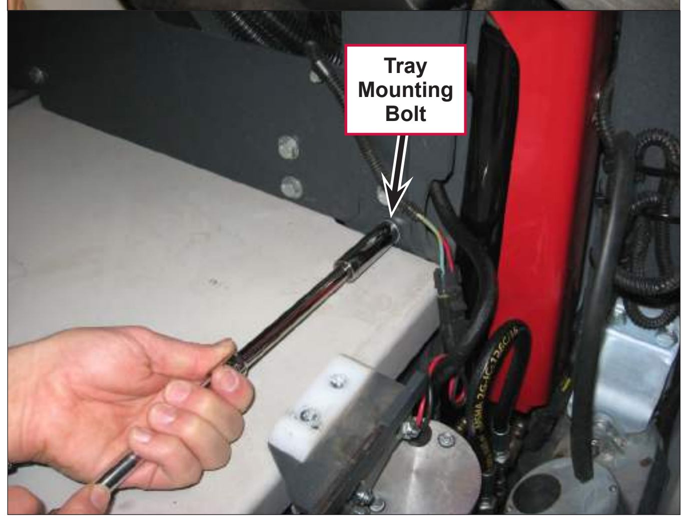
To Remove and Reinstall the Hydraulic Power Pack Assembly

LPG and Diesel Models

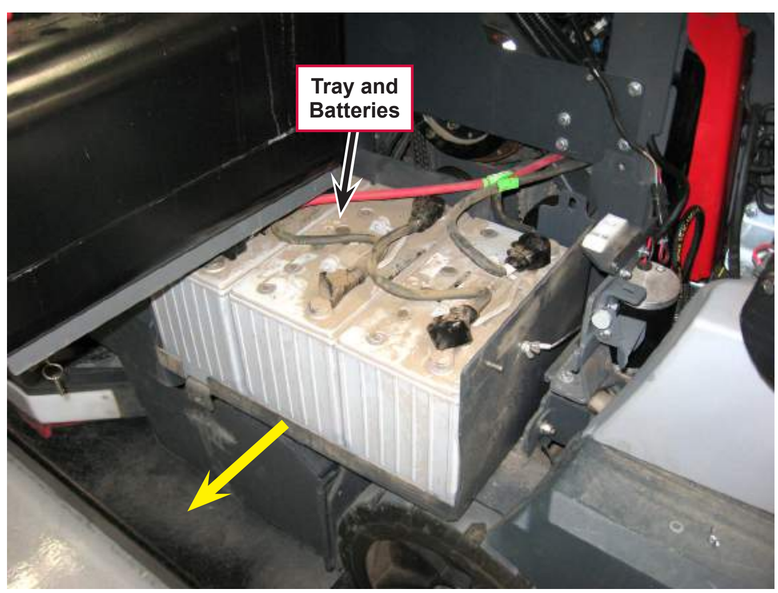
1. Disconnect the battery.
2. Open the right engine side cover and remove the right battery tray cover.
3. Swing the fuel tank out.

4. Remove the two **Tray Mounting Bolts** holding the 36-volt battery pack tray to the frame.





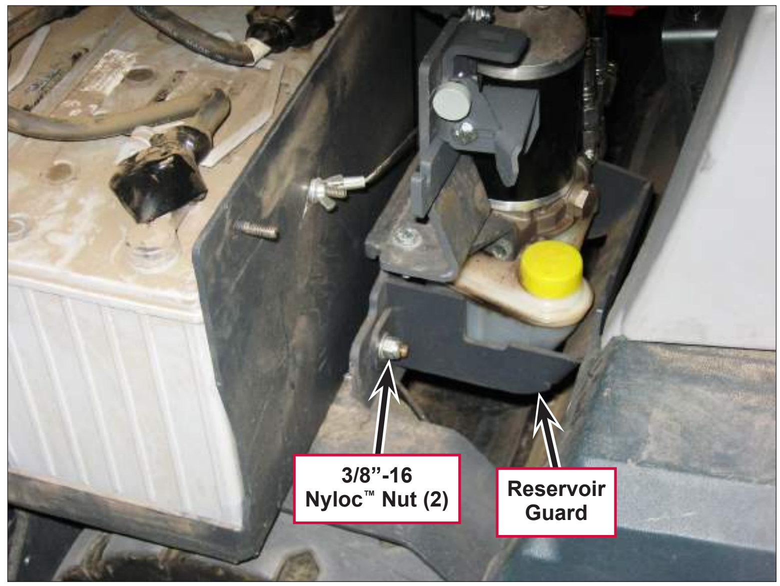
5. Slide the tray with the batteries out to the limit of the tether cable.



6. Use some large hooks to grab the bumper and raise the hopper up slightly using a hoist or other suitable method.

Warning! ***Before working underneath the raised hopper, install blocks between the hopper and chassis, or other suitable supports to prevent the hopper from accidentally lowering while you're working underneath the hopper.***

7. Remove the two **3/8"-16 Nyloc™ Nuts** and remove the **Reservoir Guard**.
8. Disconnect the pump electrical connector.
9. Disconnect the hydraulic hoses from the pump.
10. Remove the two hydraulic pump mounting bolts and remove the Hydraulic Power Pack assembly.
11. Transfer fittings to the new Hydraulic Power Pack assembly and attach the assembly to the frame but do not connect the hoses yet. The system has to be filled with oil.
12. Fill the reservoir with 10W 30 engine oil.



Note: *In the remaining steps it is important that the oil level always be maintained above the minimum mark on the reservoir.*

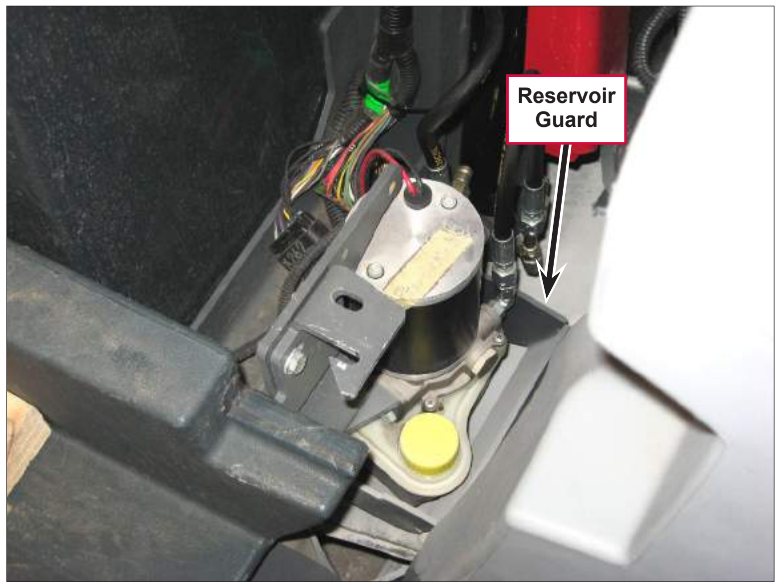
13. Plug the up port of the pump assembly.(It is labeled on the pump)
14. Momentarily run the pump to get oil out of the "down port" by pressing the hopper down switch.
15. Transfer the plug from the up port to the down port of the pump assembly
16. Momentarily run the pump to get oil out of the "up port" by pressing the hopper up switch.
17. Remove all remaining plugs from the pump and the hoses and attach the hoses to the pump assembly.
    a. Lower cylinder port hose to "up port" on pump
    b. Upper cylinder port hose to "down port" on pump
18. Run the hopper to the full up position and make sure the oil level is at the minimum mark on the reservoir.

Battery Models

1. Open the right battery side cover.
2. Use some large hooks to grab the bumper and raise the hopper up slightly using a hoist or other suitable method.

Warning! ***Before working underneath the raised hopper, install blocks between the hopper and chassis, or other suitable supports to prevent the hopper from accidentally lowering while you're working underneath the hopper.***

3. Remove the fasteners and remove the **Reservoir Guard**.
4. Disconnect the pump electrical connector.
5. Remove the hydraulic hoses from the pump.
6. Remove the two hydraulic pump mounting bolts and remove the Hydraulic Power Pack assembly.
7. Transfer fittings to the new Hydraulic Power Pack assembly and attach the assemble to the frame but do not connect the hoses yet. The system has to be filled with oil.
8. Fill the reservoir with 10W 30 engine oil.



Note: *In the remaining steps it is important that the oil level always be maintained above the minimum mark on the reservoir.*

9. Plug the up port of the pump assembly.(It is labeled on the pump)
10. Momentarily run the pump to get oil out of the "down port" by pressing the hopper down switch.
11. Transfer the plug from the up port to the down port of the pump assembly
12. Momentarily run the pump to get oil out of the "up port" by pressing the hopper up switch.
13. Remove all remaining plugs from the pump and the hoses and attach the hoses to the pump assembly.
    a. Lower cylinder hose to "up port" on pump
    b. Upper cylinder hose to "down port" on pump

14. Run the hopper to the full up position and make sure the oil level is at the minimum mark on the reservoir.

To Remove and Reinstall the Hopper Lift Cylinder

1. Raise the hopper to a convenient working height.

2. Support the hopper with a hoist to prevent it from falling once the hopper lift cylinder is disconnected.

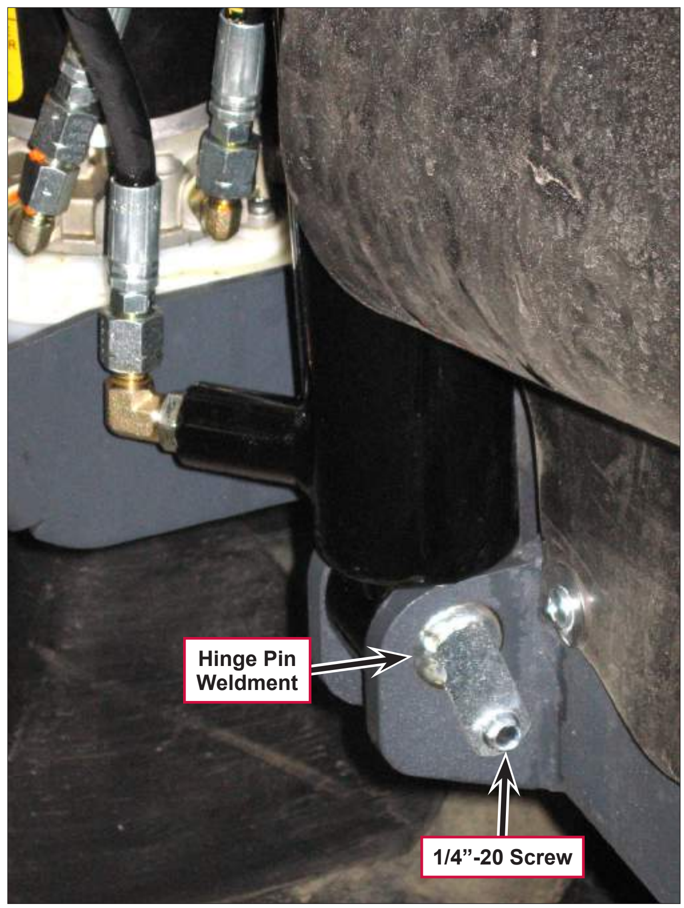
Warning! ***The hopper must be adequately supported with a hoist before the hopper lift cylinder is disconnected or removed. The hopper prop rod cannot be used to support the hopper when the hopper lift cylinder is disconnected or removed.***

3. Place a suitable container under the hopper lift cylinder to catch any hydraulic oil that may leak from the cylinder and hoses.

4. Loosen and disconnect the hoses from the cylinder. Plug the hoses to prevent dirt and air from entering the hoses.

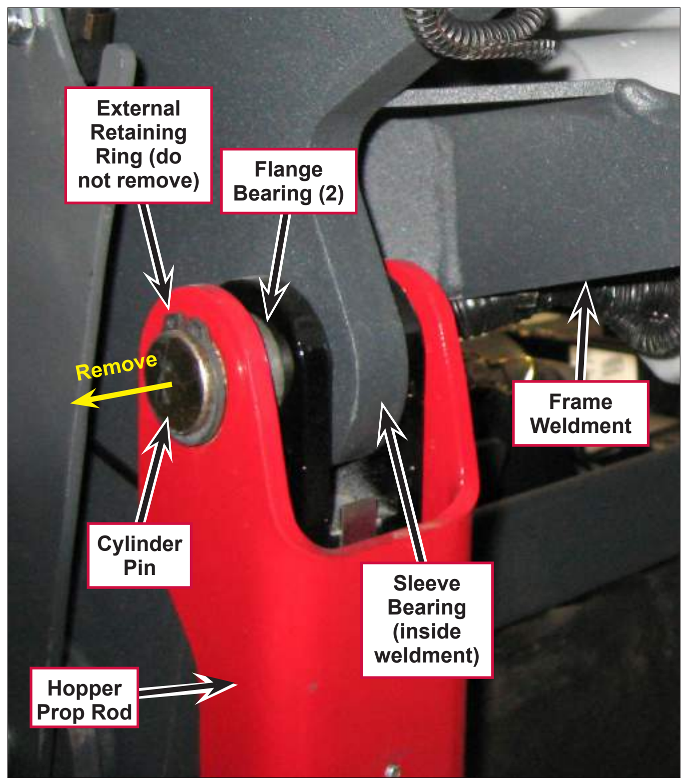
5. Plug the hopper lift cylinder ports to prevent oil from leaking out, and to prevent dirt and air from entering the cylinder.

6. Remove the **1/4”-20 Screw** holding the **Hinge Pin Weldment**, then remove the **Hinge Pin Weldment**.

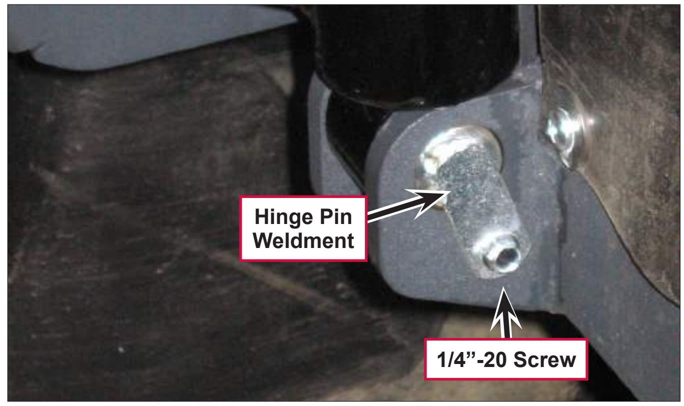


7. There are two **External Retaining Rings** holding the **Cylinder Pin** in position. To remove the **Cylinder Pin**, remove the **External Retaining Ring** next to the **Frame Weldment** as shown.

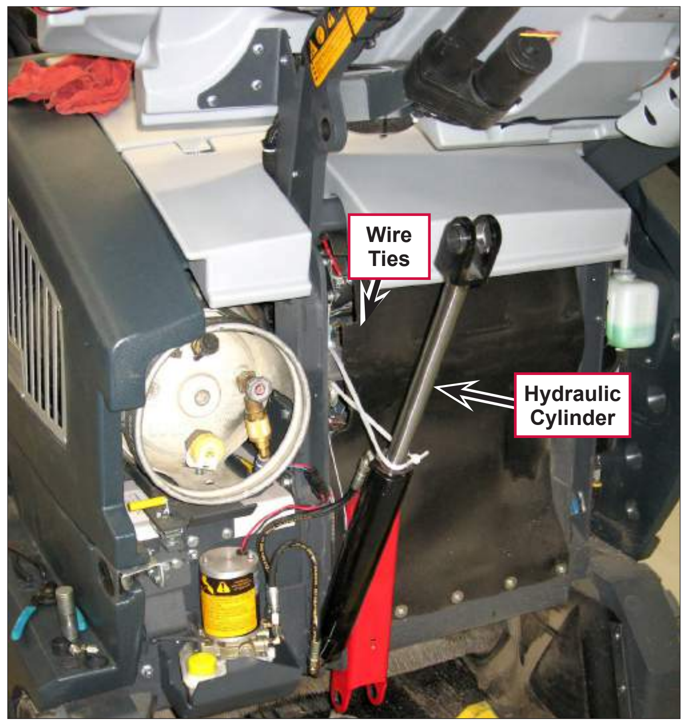
8. Support the hopper lift cylinder and hopper prop rod. Then remove the **Cylinder Pin**



9. To install the hopper lift cylinder, place it in position at the lower pivot point and reinstall the **Hinge Pin Weldment**, and the **1/4"-20 Screw.**



10. Use **Wire Ties** or other suitable strapping to support the **Hydraulic Cylinder** while you work on the system. (See adjacent photo.)



11. Reinstall elbow fittings and attach the hose from the lower cylinder port to the up port on the pump assembly.
12. Fill the reservoir with 10W 30 engine oil.

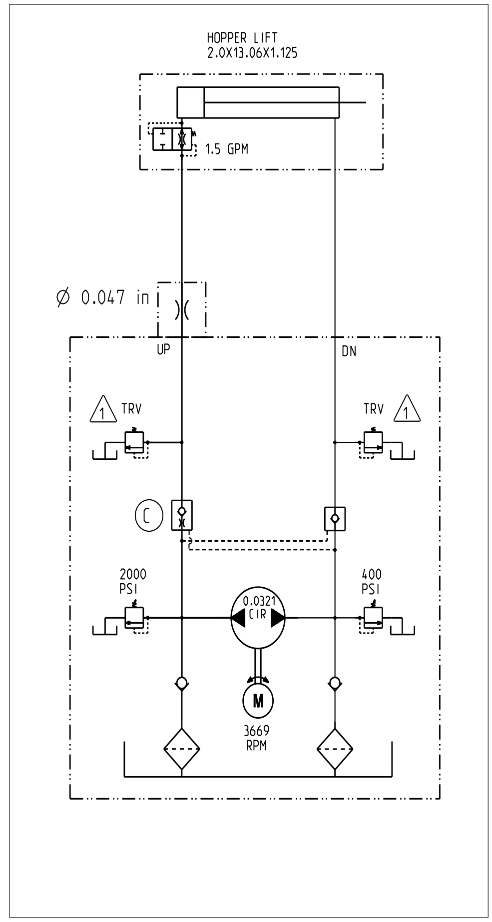
Note: *In the remaining steps it is important that the oil level always be maintained above the minimum mark on the reservoir.*

13. Operate the pump by pressing the hopper up switch on the control panel until the cylinder is fully extended.
14. Reattach the hose from the upper cylinder to the down port of the pump assembly.
15. Reattach the upper cylinder yoke along with the red safety support, flange bearing, cylinder pin and retaining ring.
16. Run the hopper down and then back to the full up position and make sure the oil level is

at the minimum mark on the reservoir.

To Replace the Oil in the Hydraulic System

Note: *Refer to the adjacent hydraulic system schematic when disassembling and reassembling the hydraulic power pack components.*

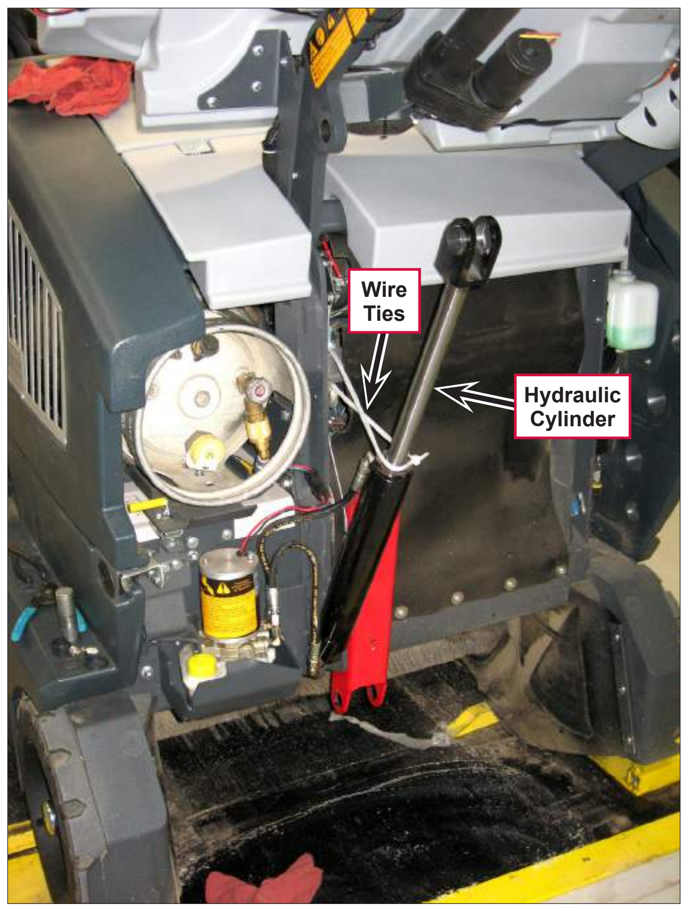


1. Raise the hopper.
2. Engage the parking brake and remove the key from the key switch.
3. Support the hopper in its raised position with an overhead hoist or other suitable support.

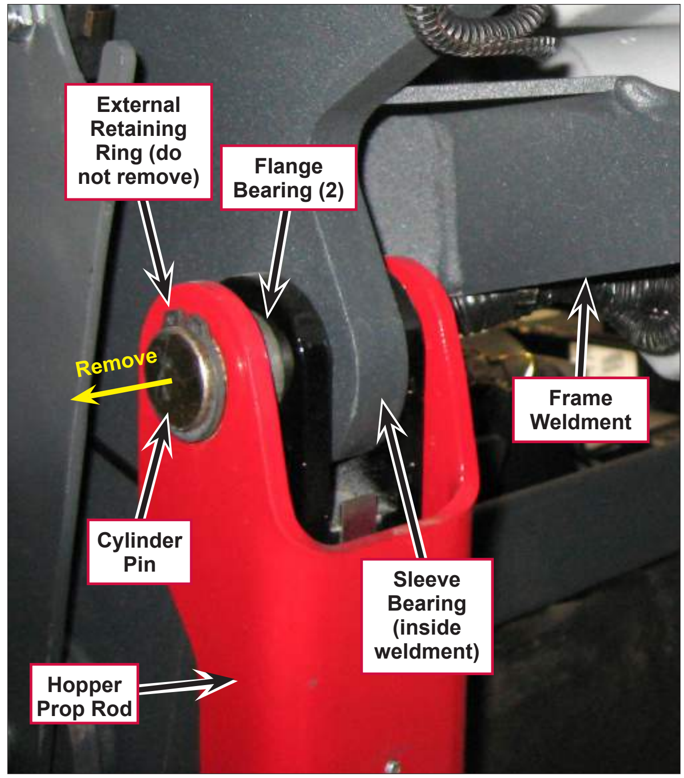
Warning!* *The hopper must be adequately and securely supported with a hoist or other suitable support before the hopper lift cylinder is disconnected. The hopper prop rod cannot be used to support the hopper when the hopper lift cylinder is disconnected or removed.

4. Remove the **External Retaining Ring** next to the **Frame Weldment** as shown.

5. Use **Wire Ties** or other suitable strapping to support the **Hydraulic Cylinder** while you work on the system.



6. Support the hopper lift cylinder and hopper prop rod. Then remove the **Cylinder Pin**



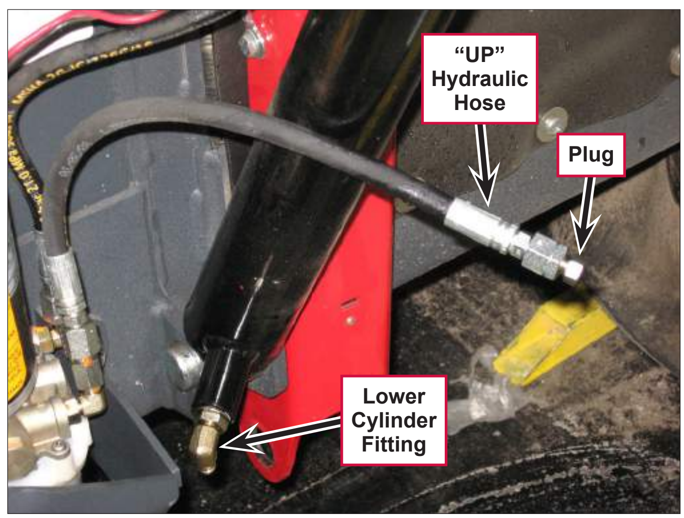
7. Place a drip pan underneath the hydraulic power pack assembly and hydraulic cylinder.

8. Disconnect the **"UP" Hydraulic Hose** from the **Lower Cylinder Fitting**.

9. Install a **Plug** into the end of the **"UP" Hydraulic Hose**. This will prevent dirt and air from being drawn into the **"UP" Hydraulic Hose** when you run the cylinder rod downward.

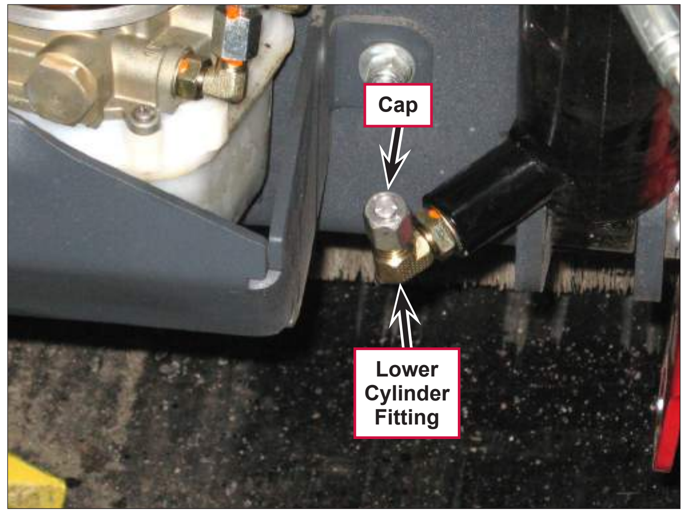
10. Rotate the **Lower Cylinder Fitting** downward to direct the oil into the drip pan.

11. Press the hopper lower button to run the pump and force the oil out of the **Lower Cylinder Fitting** until all of the oil has been drained from the bottom of the cylinder. Manually press the cylinder ram down as necessary to ensure all of the oil is out of the bottom of the cylinder.

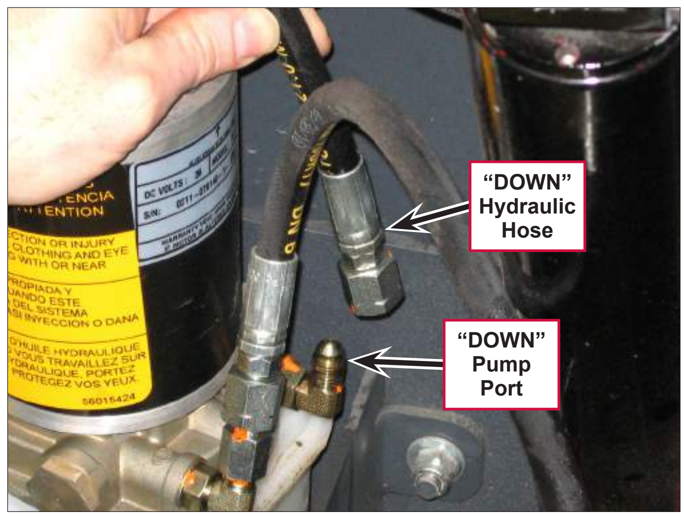


12. Rotate the **Lower Cylinder Fitting** upward back to its original upward position and make sure the **Lower Cylinder Fitting** nut is tight.

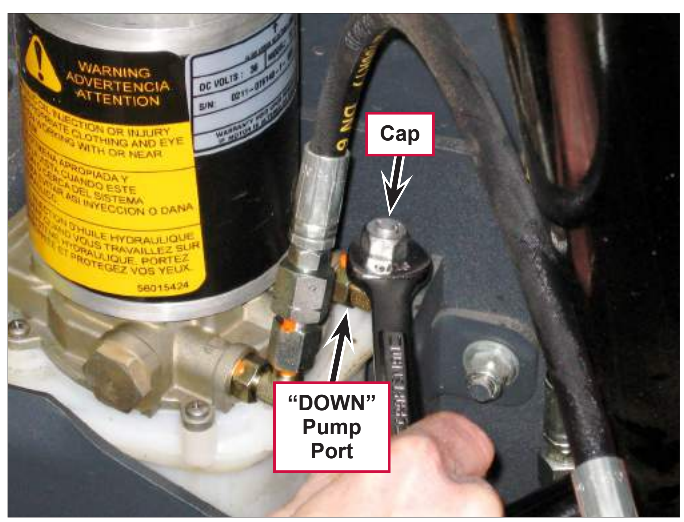
13. Install a **Cap** into the **Lower Cylinder Fitting**.



14. Disconnect the **“DOWN” Hydraulic Hose** from the **“DOWN” Pump Port**.



15. Install a **Cap** on the **“DOWN” Pump Port**.



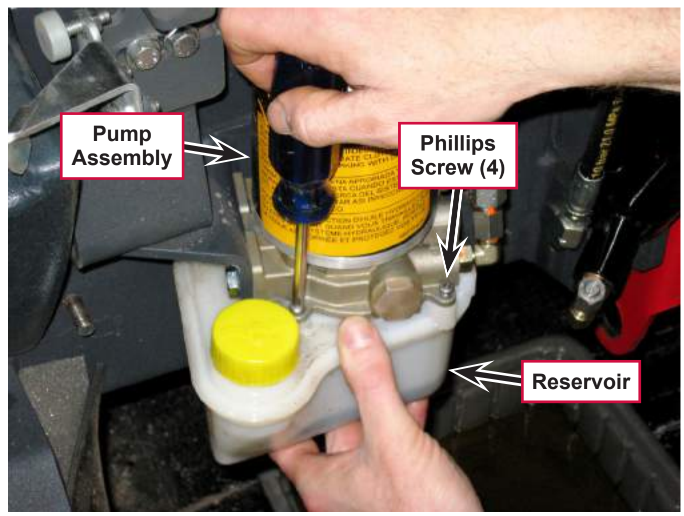
16. Remove the **Reservoir Guard**.

17. Loosen the four **Phillips Screws** holding the **Reservoir** to the **Pump Assembly** and remove the **Reservoir**.

> ***Note:*** *Leaving the* ***Phillips Screws*** *in the* ***Pump Assembly*** *will make it easier to reinstall the* ***Reservoir****.*

18. Empty the oil out of the **Reservoir**. Wipe any dirt or debris out of the **Reservoir** as necessary using a clean, lint-free rag.

19. Check the O-ring between the **Reservoir** and **Pump Assembly** to make sure it is not damaged. Replace the O-ring if necessary.



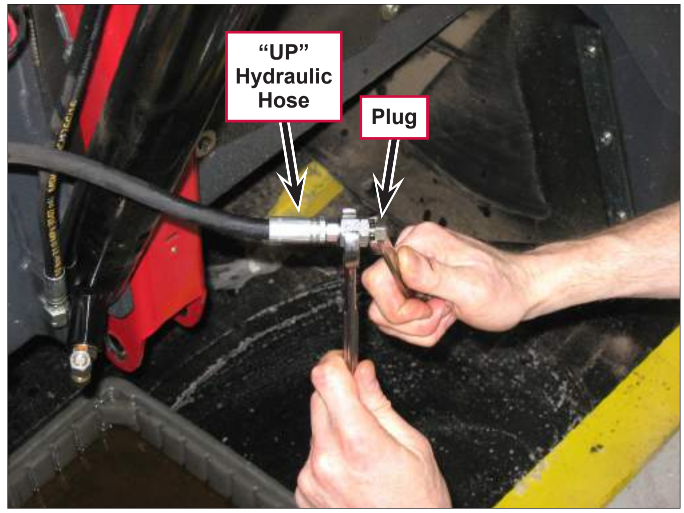
20. Make sure the O-ring between the reservoir and pump assembly is installed correctly, then reinstall the reservoir onto the pump assembly.

> ***Note:*** *The reservoir has threaded brass inserts that can be damaged if the Phillips screws are overtightened.*

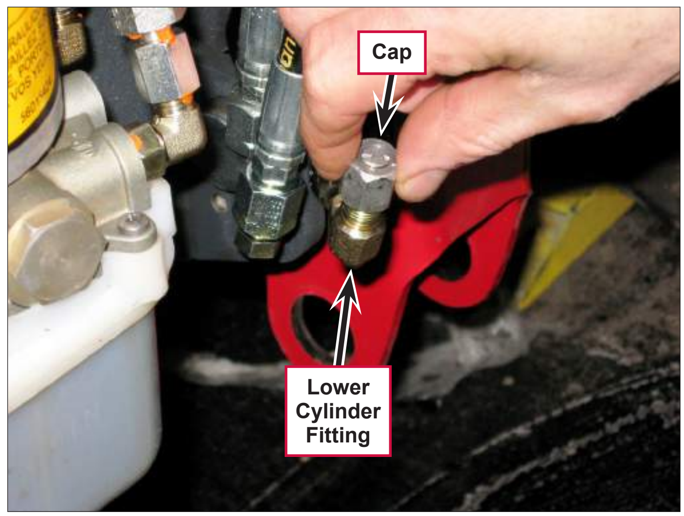
21. Carefully tighten the four Phillips screws. Do not overtighten.

22. Refill the reservoir with 10w-30 oil to the **MAX** fill line. Do not overfill.

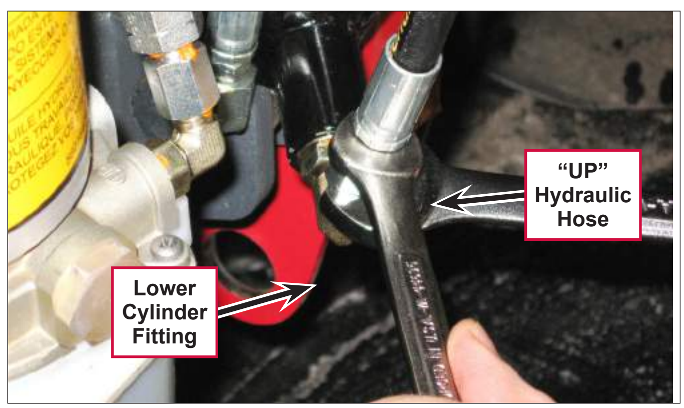
23. Loosen the **Plug** on the **"UP" Hydraulic Hose,** then position the end of the **"UP" Hydraulic Hose** over the drip pan.
24. Jog the hopper raise button to run the pump and force the oil out of the **"UP" Hydraulic Hose** until the oil runs clear with no foaming or air evident in the oil.



25. Remove the **Cap** from the **Lower Cylinder Fitting**.



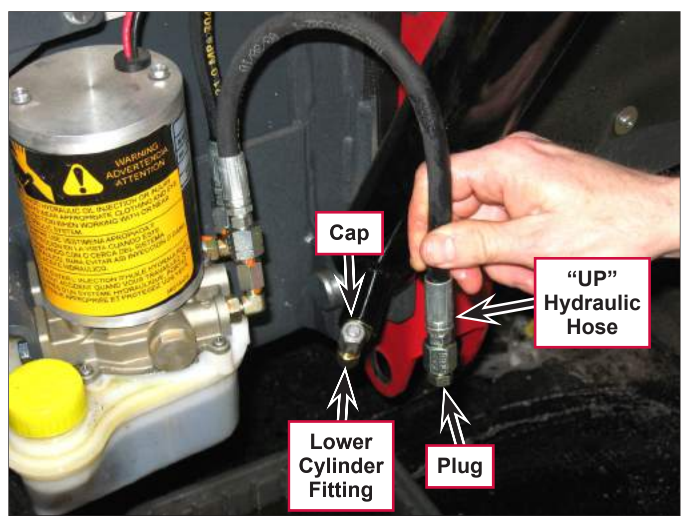
26. Remove the **Plug** from the **"UP" Hydraulic Hose** and reconnect the **"UP" Hydraulic Hose** to the **Lower Cylinder Fitting**.
27. Press the hopper raise button to raise the cylinder ram to the end of its stroke to purge the oil from the top of the hydraulic cylinder. Check the oil level in the reservoir frequently as you do this and add oil as necessary. The oil level in the reservoir should be at the **MIN** line with the cylinder ram fully-extended upward.



Note: *Be careful not to let the oil level in the reservoir fall below the* **MIN** *line to avoid introducing air into the clevis end of the cylinder. If this happens, you will have to restart the procedure from step 8.*

28. Remove the cap from the **“DOWN” Pump Port** and reconnect the **“DOWN” Hydraulic Hose** to the **“DOWN” Pump Port**.

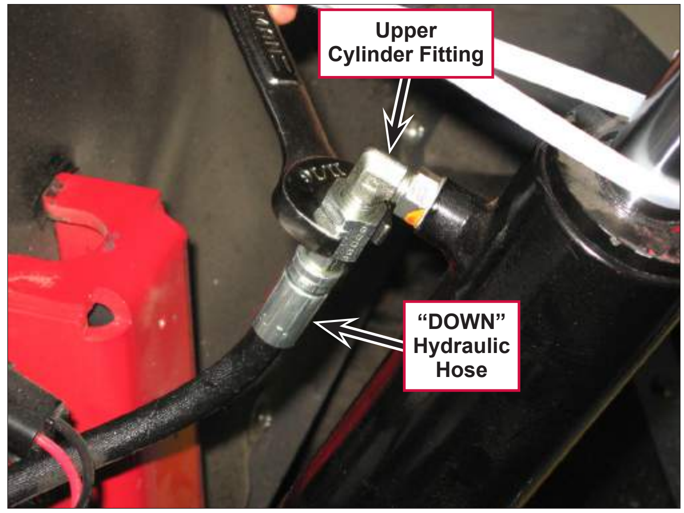
29. Disconnect the **“UP” Hydraulic Hose** from the **Lower Cylinder Fitting**.
30. Install a **Cap** onto the **Lower Cylinder Fitting**.
31. Install a **Plug** into the **“UP” Hydraulic Hose**.



32. Slightly loosen the **"DOWN" Hydraulic Hose** at the **Upper Cylinder Fitting**.

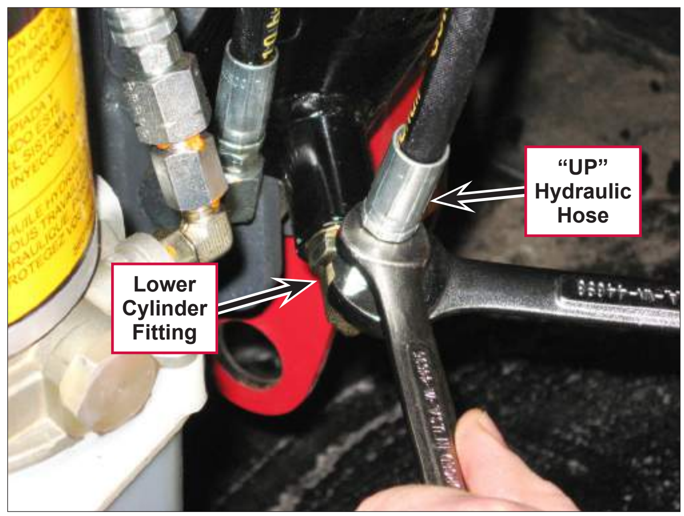
33. Jog the hopper lower button to run the pump and force the oil out of the **"DOWN" Hydraulic Hose** at the **Upper Cylinder Fitting** until the oil runs clear with no foaming or air evident in the oil.

34. Tighten the **"DOWN" Hydraulic Hose** on the **Upper Cylinder Fitting**.



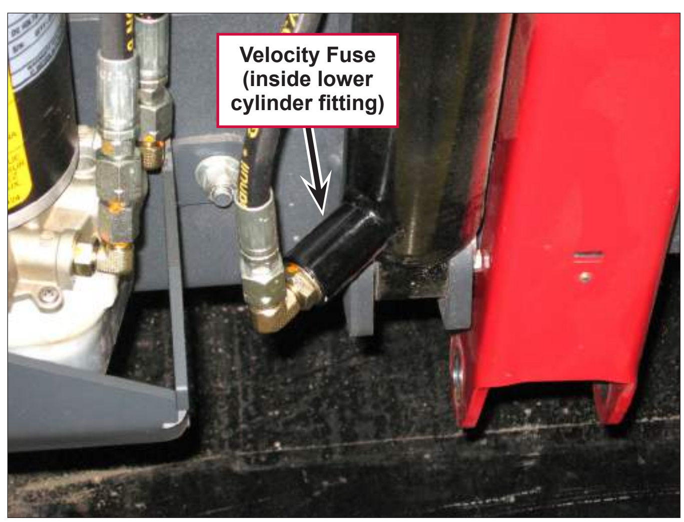
35. Remove the cap from the **Lower Cylinder Fitting**.

36. Remove the plug from the **"UP" Hydraulic Hose** and reconnect the **"UP" Hydraulic Hose** to the **Lower Cylinder Fitting**.



37. Run the hydraulic cylinder ram up and down several times using the hopper raise and hopper lower buttons to check for correct function.

Note: *There is a* **Velocity Fuse** *inside the lower (down) hydraulic cylinder port that will shut off the flow of oil through the fitting if the oil flow rate exceeds 1.5 gallons per minute. This is to prevent the hopper from dropping down if the "up" hydraulic hose or lower cylinder fitting fails. If the ram fails to retract downward, it could be due to the* **Velocity Fuse***. Let the hydraulic system sit idle for a few moments to allow the* **Velocity Fuse** *to reset, then try retracting the ram again.*

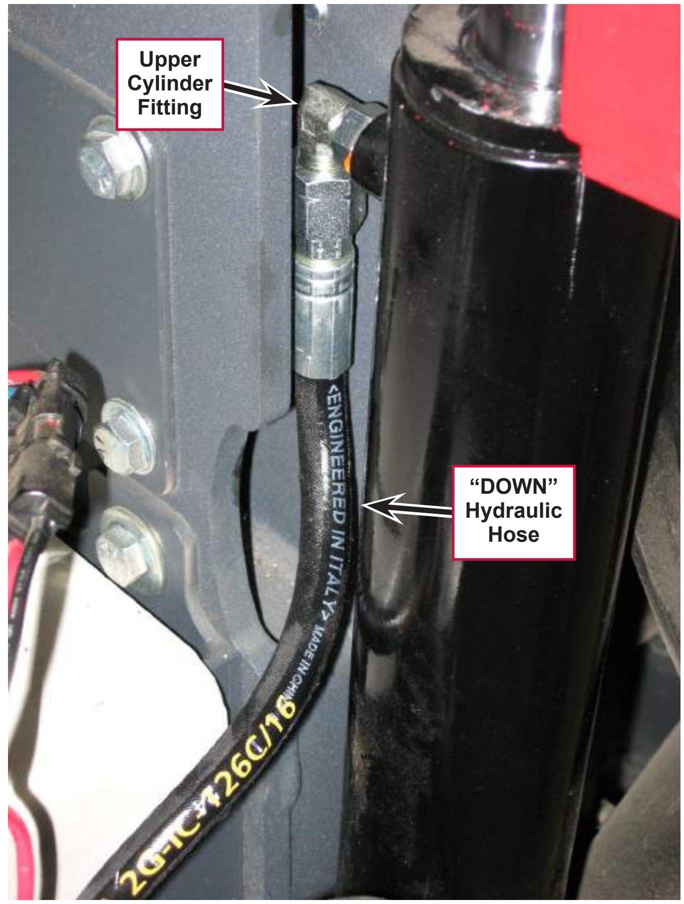


38. Remove the wire ties and reconnect the cylinder ram and prop rod to the hopper lift weldment. Make sure the sleeve bearing and the two flange bearings are not damaged and are installed correctly.

39. Raise the hopper and check the position of the **Upper Cylinder Fitting** and **"DOWN" Hydraulic Hose**.

    - The **Upper Cylinder Fitting** should be positioned vertically and with enough clearance so it doesn't contact the adjacent frame surfaces.
    - The **"DOWN" Hydraulic Hose** should be positioned so it has adequate clearance in the frame cutout.

    Loosen and reposition the **Upper Cylinder Fitting** and **"DOWN" Hydraulic Hose** as necessary to avoid any abrasion or damage.

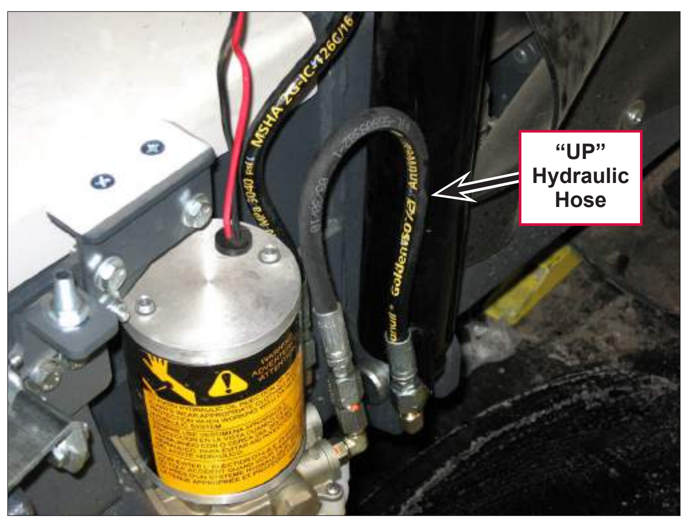


40. Raise the hopper and check the position of the **"UP" Hydraulic Hose**. The **"UP" Hydraulic Hose** should be positioned as shown so it doesn't contact the hopper when the hopper is down.

    Loosen and reposition the **"UP" Hydraulic Hose** as necessary to avoid any abrasion or damage.

41. Reinstall the reservoir guard.

42. Check the oil level in the reservoir. It should be at the **MIN** line when the cylinder is fully extended (hopper is raised).



To Remove and Reinstall the Hopper Dump Door Actuator Assembly

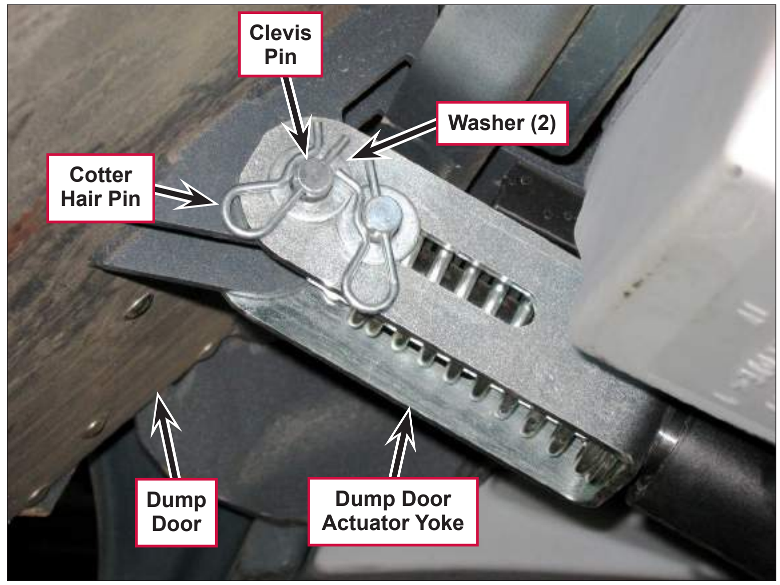
1. Open the hopper and engage the hopper prop rod.

2. Open the hopper dump door to relieve the tension on the hopper dump door actuator assembly.

3. Remove the **Cotter Hair Pin**, **Washers** and **Clevis Pin** holding the **Dump Door Actuator Yoke** to the **Dump Door**.

*Note: Lifting the **Dump Door** up slightly as you remove the **Clevis Pin** will make it easier to remove the **Clevis Pin** from the **Dump Door** and **Dump Door Actuator Yoke**.*

*Note: You don't need to remove the cotter hair pin, washers and clevis pin holding the actuator and spring in the **Dump Door Actuator Yoke**.*

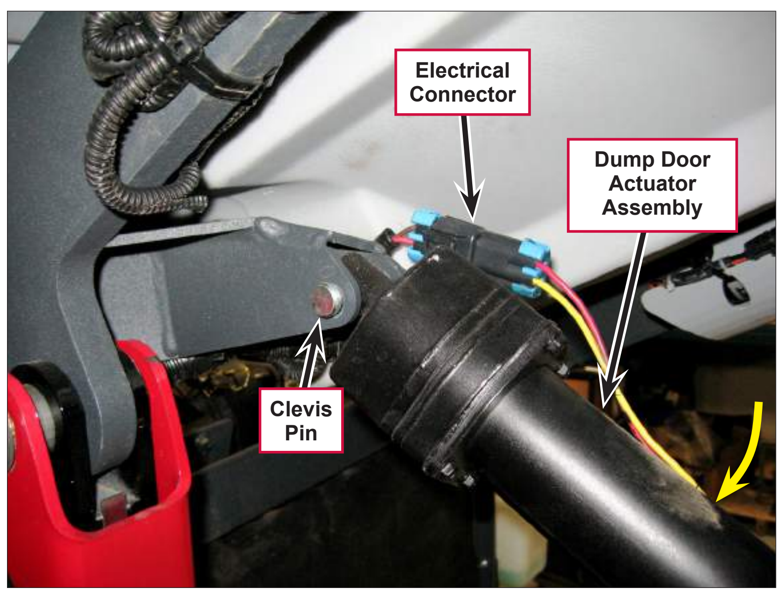


4. Carefully swing the **Door Dump Actuator Assembly** down to access the **Electrical Connector**.

5. Disconnect the **Electrical Connector**.

6. Remove the cotter hair pin, washers and **Clevis Pin** holding the **Dump Door Actuator Assembly** to the frame, then remove the **Dump Door Actuator Assembly** from the machine.

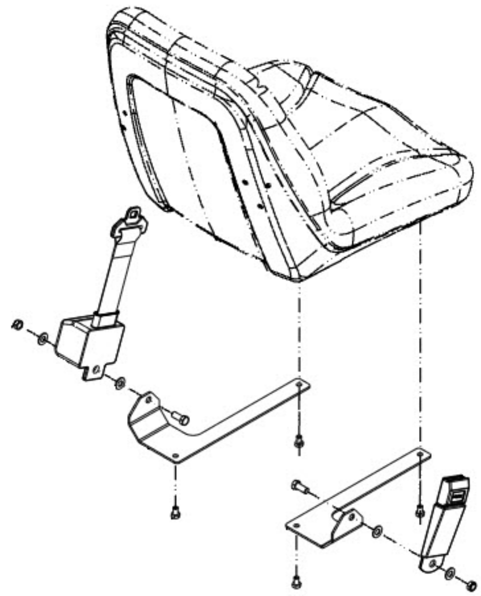
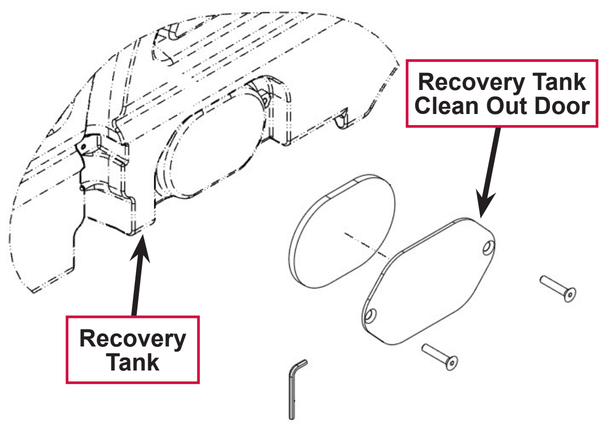
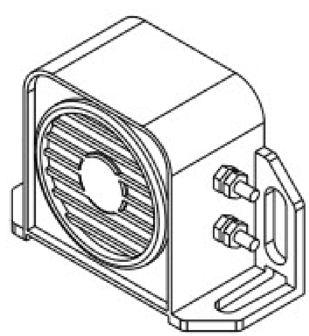
7. Reinstall the hopper dump door actuator assembly by following the above steps in reverse order.

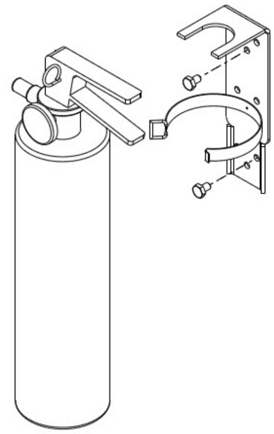


Specifications

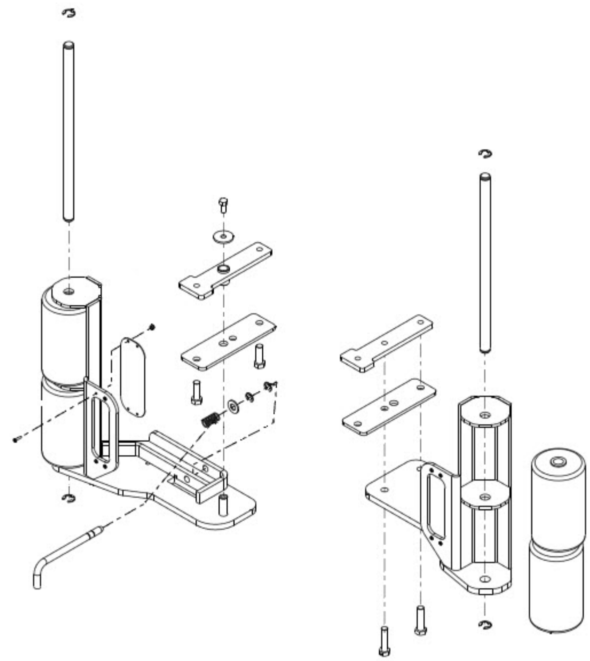
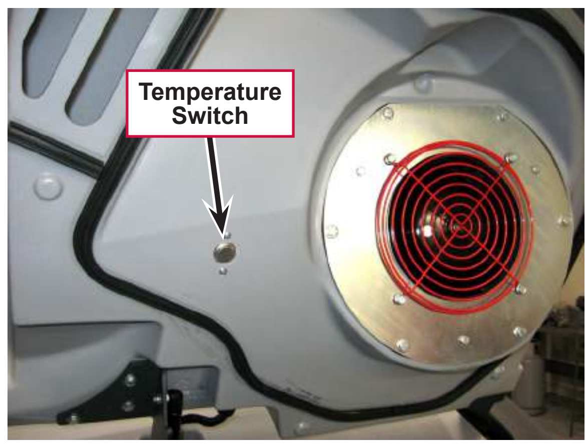
Component	Specifications	
Hydraulic Pump/Reservoir Assembly	Displacement - 0.0321 in.^{3} per revolution	
	Circuit Type - reversible, locking	
	Reservoir Capacity - 45 in.^{3} (26 in.^{3} usable)	
	Oil Type - 10W-30 automotive oil	
Hydraulic Pump Motor	Voltage - 36 VDC	
	Output Torque - 151 ft-lbs.	
	Output Speed - 3669 RPM (full load)	
	Current Draw - 15.9 Amps (full load)	
	Horsepower - 0.55 HP (full load)	
Dump Door Actuator	Voltage - 24 to 40 VDC	
	Stroke - 6 inches	
	Dynamic Load Rating - 400 lbs.	
	Static Load Rating - 1000 lbs.	
	Restraining Torque - 100 in.-lbs.	
	Clutch - ball detent, clutch setting: 600 to 900 lbs.	
	Full Load Speed - 0.55 in./sec	
	Current Rating - 9 Amps	
	Typical Current Draw - 1-3 Amps	
Proximity Sensor (Door Extend and Retract Limit Switches, Hopper Interlock Switch)	Air Gap:	Make - .250” (typical)
		Break - .313” (typical)

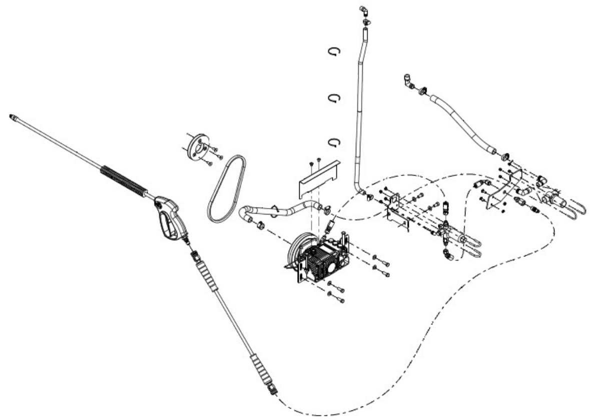
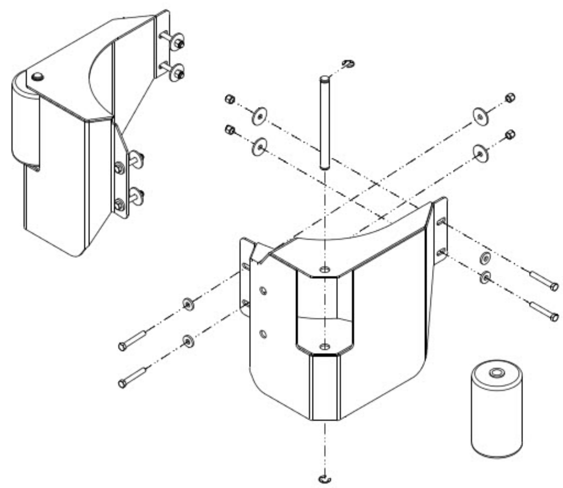
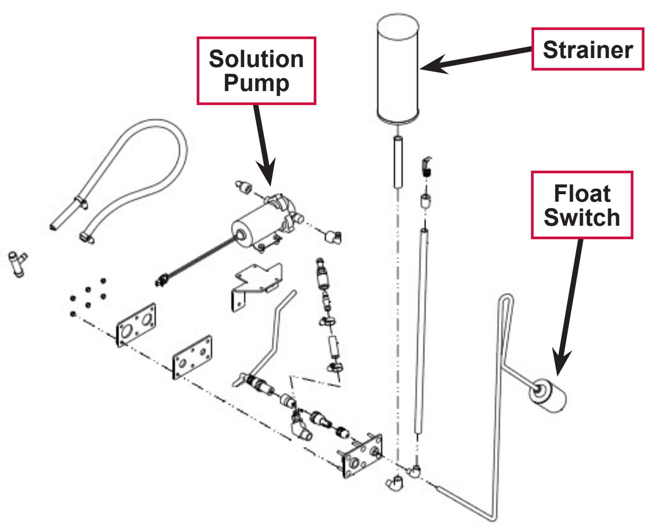
Options and Accessories

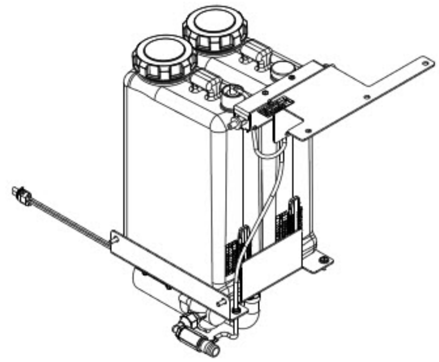
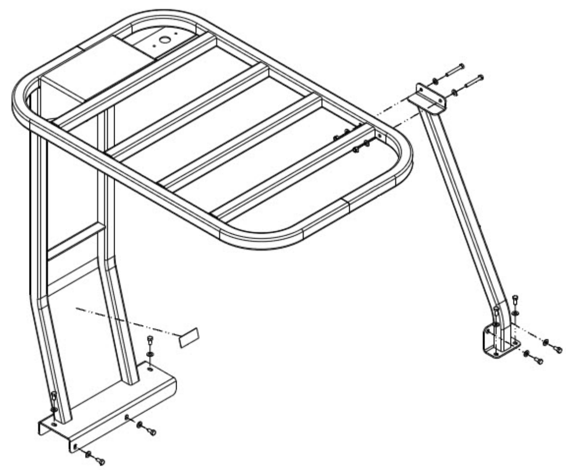
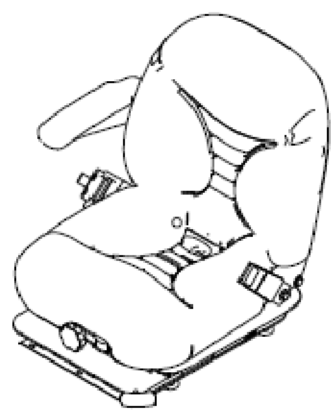
Description	Illustration
Seat Belt Kit	
Recovery Tank Clean Out Kit The Recovery Tank Clean Out Kit includes a removable **Recovery Tank Clean Out Door** to allow easier cleaning and flushing of the **Recovery Tank.**	
Back-Up Alarm Kit The Back-Up Alarm Kit includes the Back-Up Alarm, electrical connector and mounting hardware. The Back-Up Alarm connects to the existing machine wiring to sound a warning when the machine is moving in reverse.	

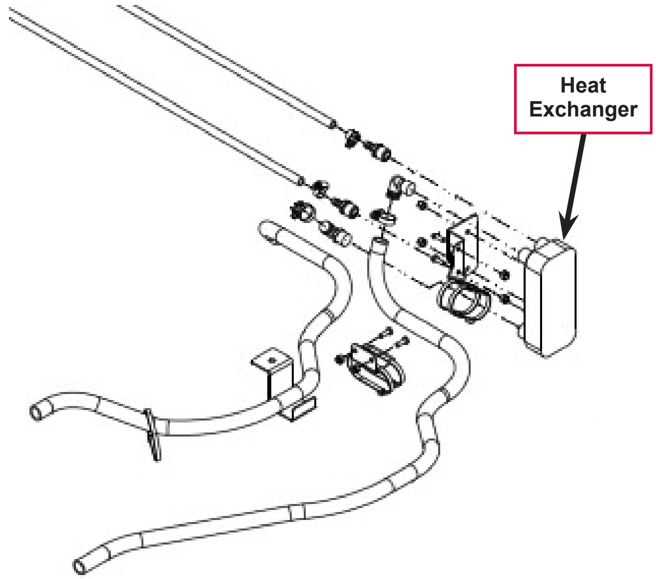
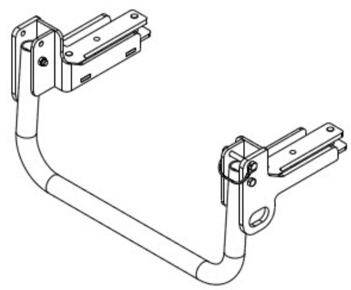
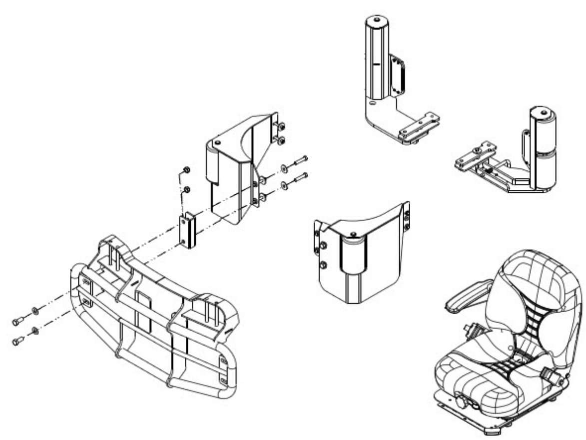
<table>
<tr><th>Description</th><th>Illustration</th></tr>
<tr><td>Fire Extinguisher Kit</td><td></td></tr>
<tr><td rowspan="2">LED Brake Light/Turn Signal Kit

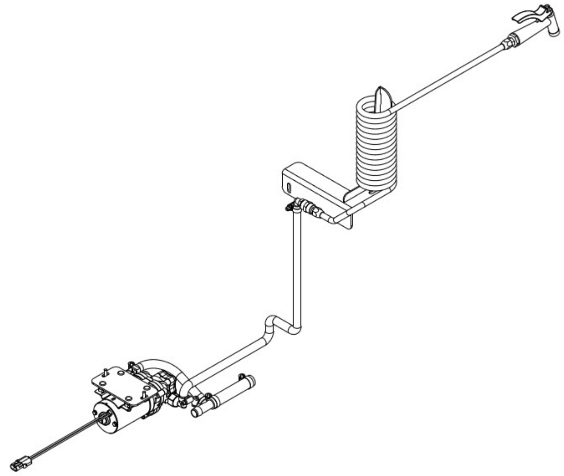
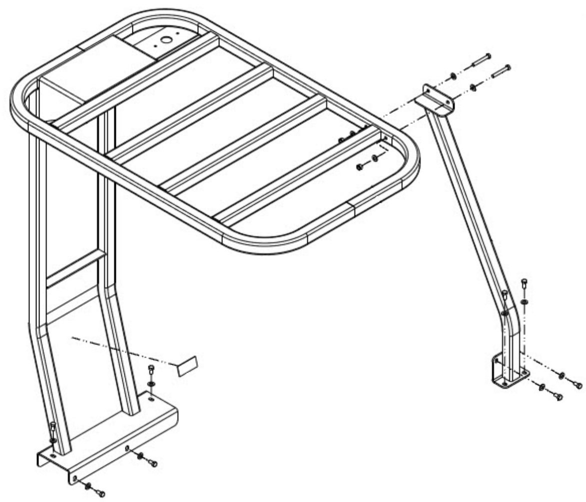
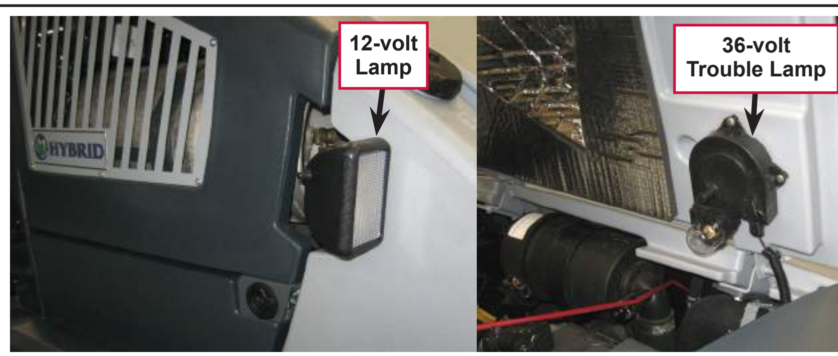
The LED Brake Light/Turn Signal Kit includes front turn signal lights, rear brake/turn signal lights, a rear corner roller kit, mounting hardware and electrical connectors. The main machine controller powers the turn signal lights and brake light. The turn signals don’t use a conventional flasher unit. The main machine controller switches the ground to the turn signals on and off.</td><td></td></tr>
<tr><td></td></tr>
</table>

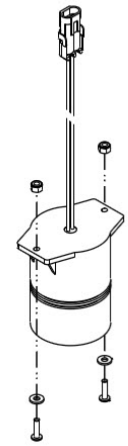
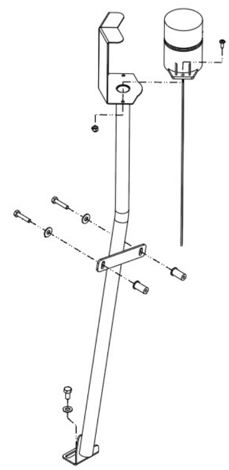
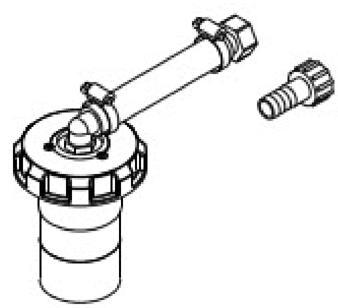
Description	Illustration
Rear Corner Roller Kit	
Hopper Temperature Sensor Kit The Hopper Temperature Sensor Kit includes a **Temperature Switch** and mounting hardware. If the temperature in the hopper rises to a certain point, the **Temperature Switch** will generate a caution and signal the main machine controller to turn off the dust control motor, main broom system and side broom system, and close the hopper dump door.	
Plugged Filter Switch Kit The Plugged Filter Switch Kit includes a **Dust Control Filter Switch** that threads into the hopper and connects to the existing wiring harness. The **Dust Control Filter Switch** will generate a warning if the hopper vacuum gets too high, indicating a plugged dust control filter.	

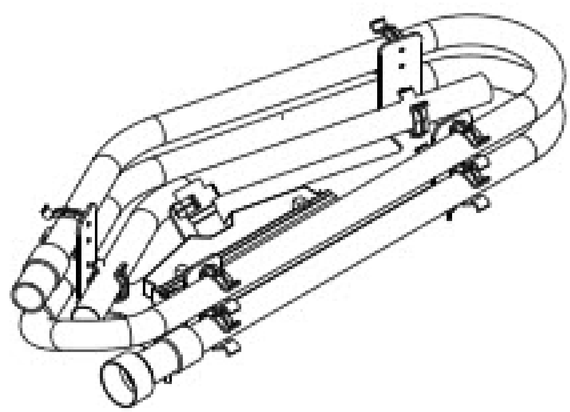
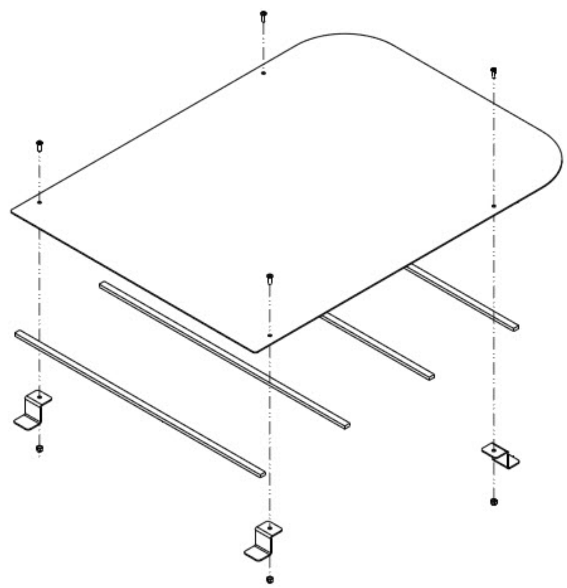
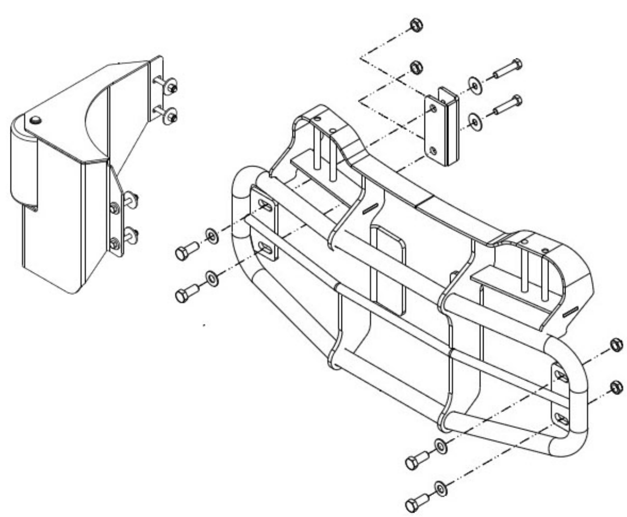
Description	Illustration
High Pressure Pump Kit - LPG and Diesel Hybrids The High Pressure Pump Kit includes a separate high-pressure solution pump, engine-driven pump clutch and drive belt, high-pressure wand assembly, and the associated valves and plumbing. The high-pressure solution pump pumps solution from the tank to the hose and wand when the clutch is engaged. Refer to the ***Solution System*** section for more information.	
Front Corner Roller Kit	
Extended Scrub Kit The Extended Scrub Kit includes an additional **Solution Pump**, a **Float Switch**, **Strainer** and associated plumbing to pump recovered water to the scrub brushes once the solution tank is empty. Refer to the ***Solution System*** section for more information.	

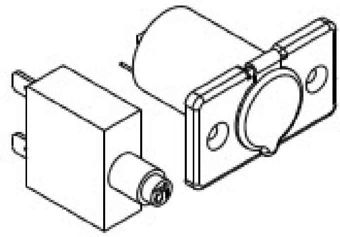
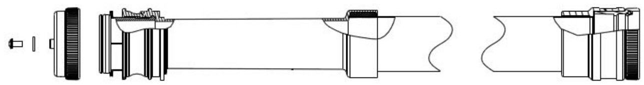
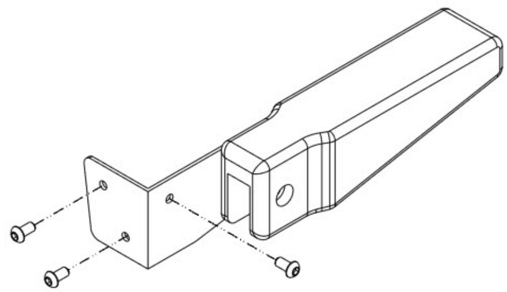
Description	Illustration
EcoFlex™ Chemical Injection Kit The EcoFlex™ Chemical Injection Kit includes the detergent pumps, detergent bottles, mounting hardware and associated plumbing to inject detergent into the solution flow to the scrub brushes. Refer to the ***Solution System*** section for more information.	
Overhead Guard Kit - 79"	
Deluxe Seat Kit	

Description	Illustration
Hot Water Scrub Kit The Hot Water Scrub Kit includes a **Heat Exchanger**, mounting hardware and associated plumbing to route the solution through the **Heat Exchanger** before it is mixed with detergent and sent to the scrub brushes. Routing through the **Heat Exchanger** will increase the solution temperature approximately 50 degrees F. The **Heat Exchanger** is plumbed to the engine cooling system and uses the hot engine coolant to heat the solution as it circulates through the **Heat Exchanger.** Refer to the ***Solution System*** section for more information.	
Squeegee Guard Kit	
Super Duty Kit The Super Duty Kit includes a front bumper kit, deluxe seat kit and a rear corner roller kit.	

Description	Illustration
Spray Wash Hose Kit The Spray Wash Hose Kit includes a separate low-pressure pump to pump solution from the solution tank to the hose and nozzle located behind the Operator seat. An automatic pressure switch will switch on the pump when the hose nozzle is opened, then shut the pump off when the nozzle is closed. Refer to the ***Solution System*** section for more information.	
Overhead Guard Kit - 82”	
Work Light Kit The Work Light Kit includes a 12-volt Lamp, 36-volt Trouble Lamp and mounting hardware. The 12-volt Lamp adds additional lighting to the operator side of the machine for visibility in low-lit areas. The pull-out 36-volt Trouble Lamp is mounted under the hood.	

Description	Illustration
Overhead Guard Beacon Kit The Overhead Guard Beacon Kit includes an LED beacon and electrical connector, and the mounting hardware to mount the beacon onto the overhead guard. The beacon will flash whenever the machine key switch is on.	
Warning Beacon Kit The Warning Beacon Kit includes an LED warning beacon and electrical connector, and the mounting hardware to mount the beacon onto the machine. The beacon will flash whenever the machine key switch is on.	
Solution Fill Shut-Off Kit The Solution Fill Shut-Off Kit allows you to connect a garden hose to the fitting and fill the solution tank without having to monitor the water level in the tank. When the solution tank is full, a float valve will automatically shut off the water flow into the tank.	

Description	Illustration
Vacuum Wand Kit	
Overhead Guard Canopy Kit	
Front Bumper Kit The Front Bumper Kit includes the front bumper weldment, a front corner roller kit and mounting hardware.	

Description	Illustration
Accessory Socket Kit The Accessory Socket Kit includes a 12-volt “automotive” type adapter to power accessories or personal electronics, and a circuit breaker.	
Drain Hose Extension	
Arm Rest Option (R/H Only)	

Recovery System

Functional Description

Overview

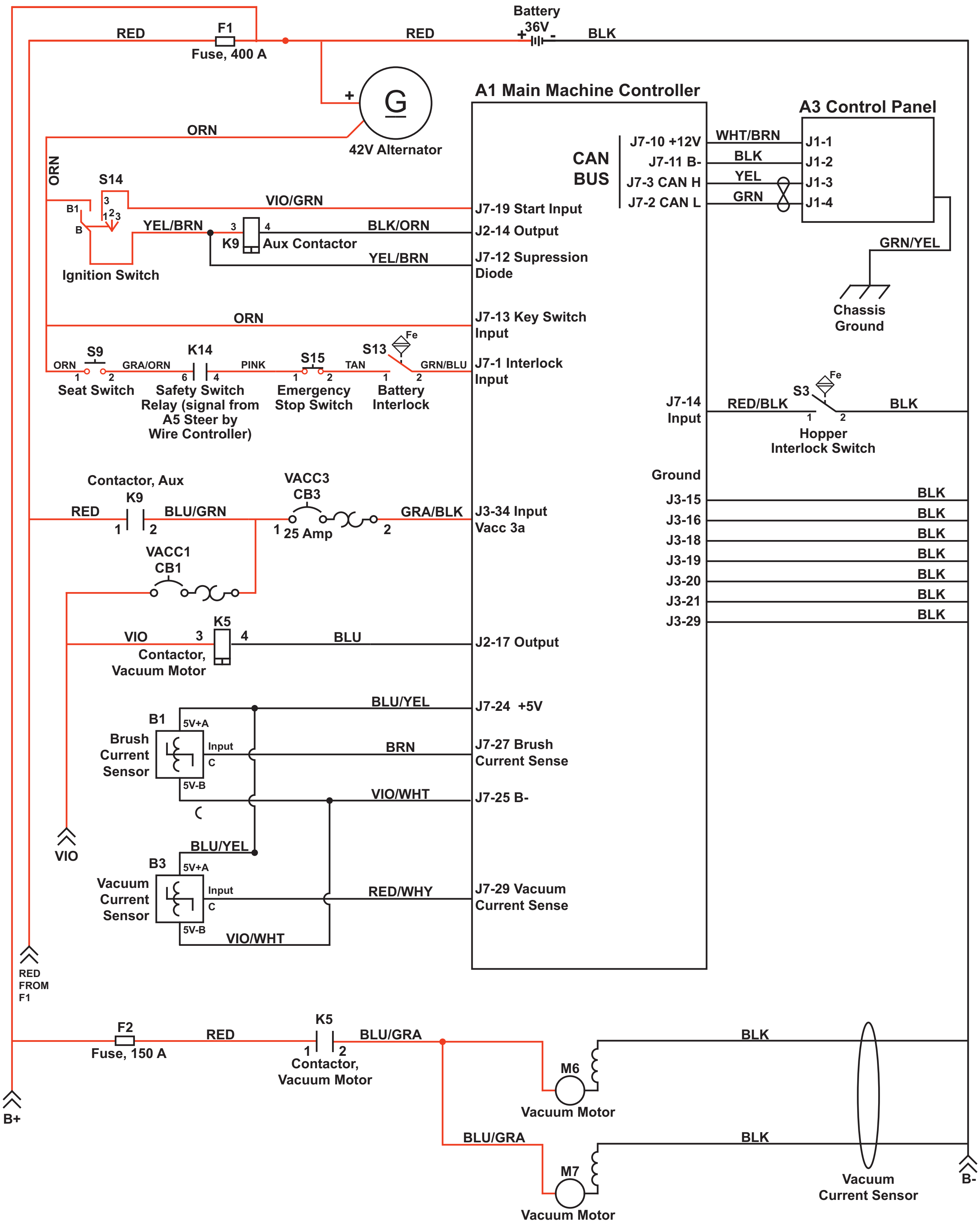
The recovery system picks up the scrubbing solution from the floor and directs it to the recovery tank. Two vacuum motors draw air from the recovery tank to create a vacuum in the tank and at the squeegee to pick up the solution. The solution travels through the squeegee hose, through a debris basket which catches any large particles, then into the recovery tank.

The vacuum motors switch on automatically when the scrub system is enabled and the machine moves forward. The motors will switch off after a predetermined time delay once machine motion stops.

The vacuum motors can also be switched on independent of the scrub system by pressing the vacuum/wand switch. This is used to pick up solution already on the floor, or when using a wand on the squeegee hose.

A current sensor monitors the combined current draw of both vacuum motors and will display a fault if the vacuum motor current draw is too high.

Recovery System Wiring Diagram



Circuit Description

The following conditions must be met for the recovery system to operate:

- The **Hopper Interlock Switch S3** must be closed.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed.
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-13**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breaker **VACC1/CB1**.
- Circuit breaker **VACC1/CB1** must be closed to provide positive voltage to the **Vacuum Motor Contactor K6**.
- The **J2-17 Output** on the **A1 Main Machine Controller** must provide a ground to the **Vacuum Motor Contactor K6** coil. **J2-17** provides ground to **K6** under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the scrub switch.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward.
  - The voltage to **J7-29 Vacuum Current Sense** on the **A1 Main Machine Controller** from the **Vacuum Current Sensor B3** must be within the acceptable range to indicate both vacuum motors are working correctly.
- The **150-amp Fuse F2** must be closed to provide positive voltage from the **Battery** to the load side of the **Vacuum Motor Contactor K6**.
- The **Vacuum Motor Contactor K6** contacts must be closed.
- The **Vacuum Motors M6** and **M7** must have connections to battery ground **B-**.

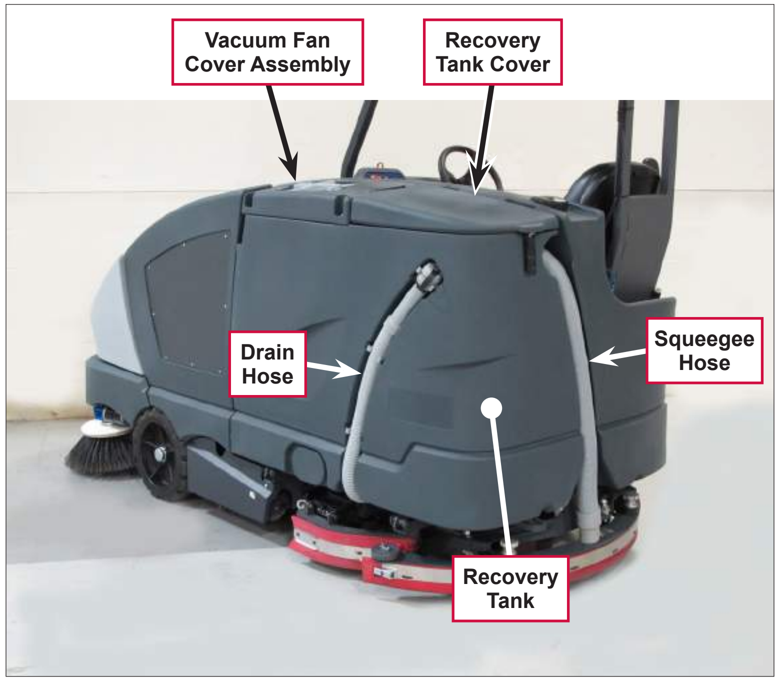
Component Locations

Recovery Tank

The **Recovery Tank** is on the left rear side of the machine. The **Squeegee Hose** carries the scrub solution from the squeegee to the **Recovery Tank**. The **Drain Hose** allows you to empty the **Recovery Tank**.

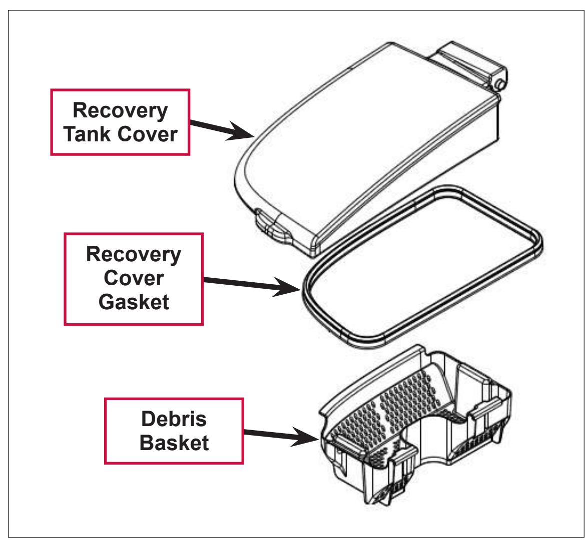
The vacuum motors are located underneath the **Vacuum Fan Cover Assembly**.

The debris basket can be accessed by opening the **Recovery Tank Cover**.



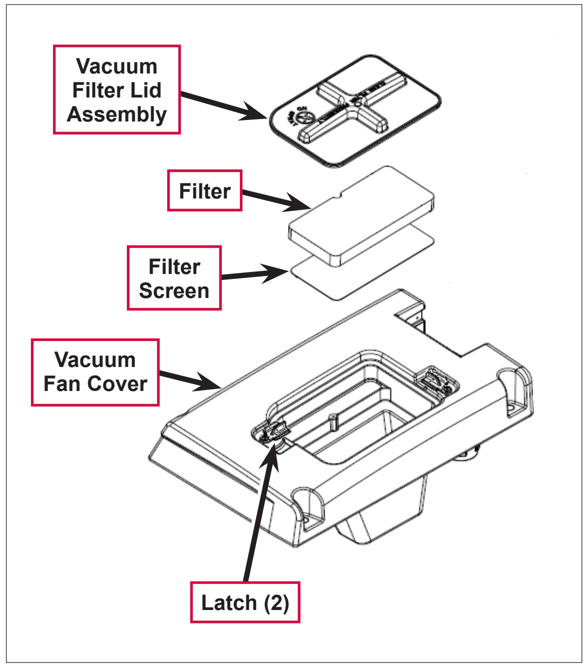
Recovery Tank Cover and Debris Basket

The **Debris Basket** is located below the **Recovery Tank Cover** and attached **Recovery Cover Gasket**. The recovered solution is directed through the **Debris Basket** before going into the recovery tank to screen out any debris or large particulates.



Vacuum Fan Cover Assembly

The **Vacuum Fan Cover Assembly** includes the **Vacuum Filter Lid Assembly**, **Filter**, **Filter Screen** and **Vacuum Fan Cover**. The **Vacuum Fan Cover Assembly** fastens to the top of the **Recovery Tank**. The two plastic **Latches** rotate to allow the **Vacuum Filter Lid Assembly** to be removed to access the **Filter** and **Filter Screen**.

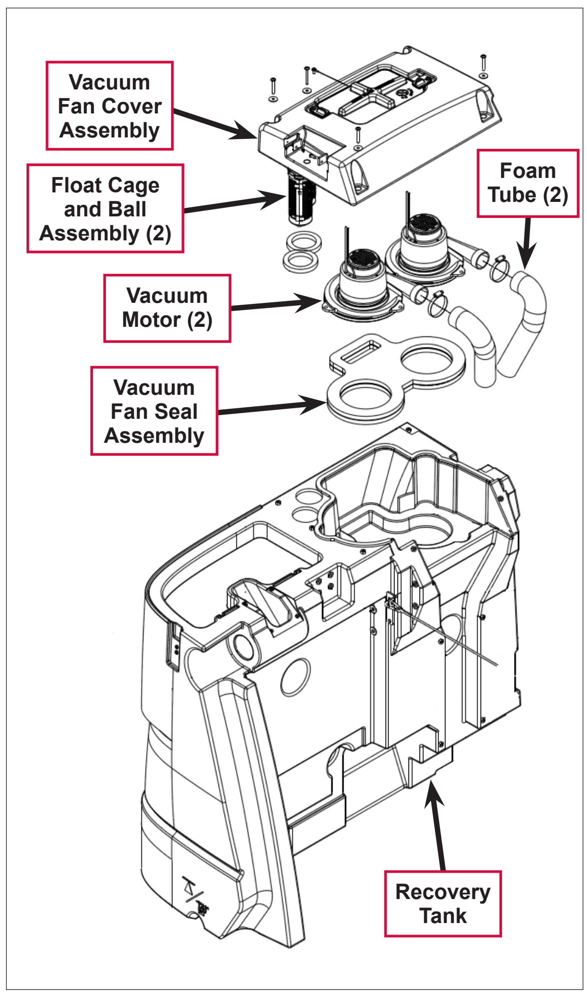


Vacuum Motors

The **Vacuum Motors** sit on the **Vacuum Fan Seal Assembly** in the **Recovery Tank** and are held in place by the **Vacuum Fan Cover Assembly**. The air from the **Vacuum Motors** is exhausted through **Foam Tubes** no minimize noise.

Float Cage and Ball Assemblies

The **Float Cage and Ball Assemblies** are attached to the **Vacuum Fan Cover Assembly** and prevent any recovered water from being drawn in through the **Vacuum Motors**.

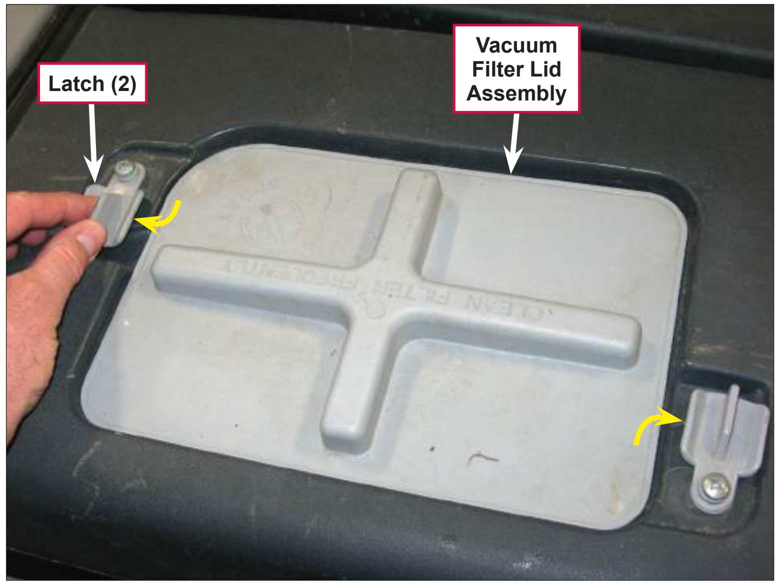


Maintenance and Adjustments

Warning! ***Before performing any machine maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Clean the Vacuum Filter and Filter Screen

1. Rotate the two **Latches** 90 degrees and remove the **Vacuum Filter Lid Assembly**.

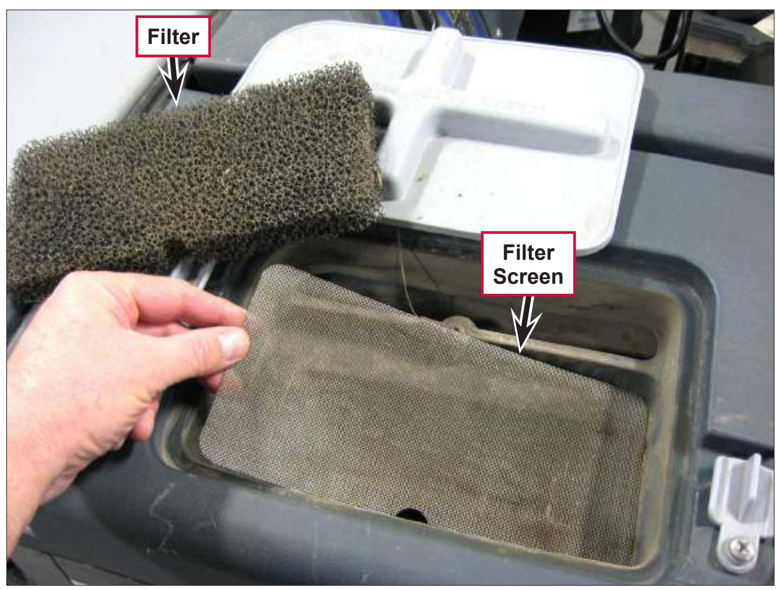


2. Remove and clean the **Filter** and **Filter Screen** with a vacuum, or by washing them in warm water.

3. When the **Filter** and **Filter Screen** are clean and dry, reinstall them into the recovery tank.

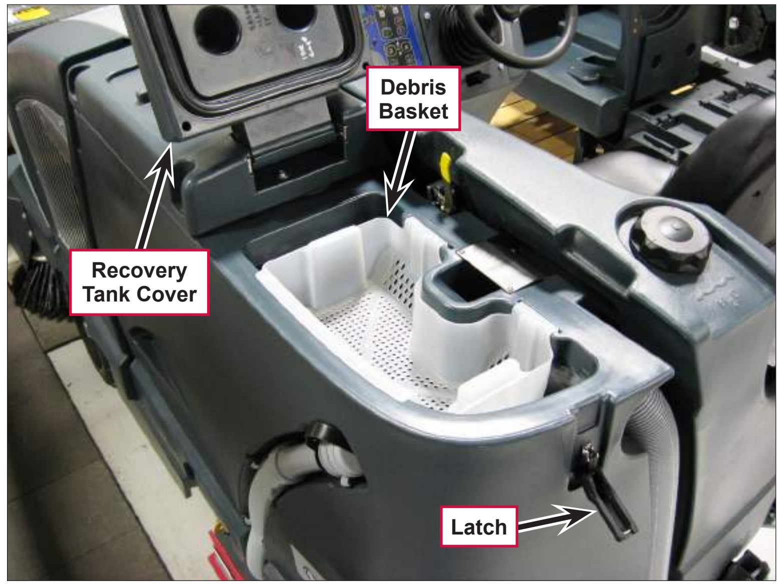
Service Note: *The* **Filter** *and* **Filter Screen** *must be completely dry before reinstalling.*

4. Rotate the two **Latches** back 90 degrees to secure the **Vacuum Filter Lid Assembly**.



To Clean the Debris Basket

1. Unhook the **Latch**, open the **Recovery Tank Cover** and lift the **Debris Basket** out of the recovery tank.
2. Rinse any accumulated material from the **Debris Basket**, then reinstall it in the recovery tank.
3. Close the **Recovery Tank Cover** and secure the **Latch**.



Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
Neither of the vacuum motors will run.	An interlock is not closed.	Before you start troubleshooting the recovery system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed. • The A1 Main Machine Controller is receiving the appropriate signal from the A3 Control Panel via the CAN BUS.
	The 150-amp Fuse (**F2**) is blown.	Check the Fuse (**F2**) and replace if necessary.
	There is no voltage to the **K5** contactor coil.	Check circuit breaker **CB1** reset if necessary.
		The contactor **K9** is not providing positive voltage to the **K5** contactor coil. 1. Check the **K9** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 2. Check the continuity through contactor **K9** with the coil energized. If the contacts are open, replace the contactor. 3. Check the **J2-14** output from A1 Main Machine Controller.
	There is no voltage to the vacuum motors.	1. Check the **K5** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 2. Check the continuity through contactor **K5** with the coil energized. If the contacts are open, replace the contactor.
	There is an open circuit in the vacuum motor wiring.	Check the vacuum motor wiring and connections from contactor **K5** to the motors, and the ground connections from the motors to battery ground. Repair as necessary.
	The vacuum current sensor (**B3**) is not operating correctly (generating a fault).	Check the wiring and connections from the A1 Main Machine Controller to the vacuum current sensor and repair as necessary.
		Check the +5V output from **J7-24** and the ground output from **J7-25** to the vacuum current sensor (**B3**) from the A1 Main Machine Controller.
		Check the input to **J7-29** on the A1 Main Machine Controller from the vacuum current sensor. If the output is not between 2.5 and 4.7 volts, replace the vacuum current sensor.

Problem	Cause	Correction
An individual vacuum motor will not run.	No voltage to the vacuum motor.	Check the wiring and connections to the vacuum motor and repair as necessary.
	The motor is not operating correctly.	If there is voltage to the vacuum motor, replace the motor.
Poor water pick-up.	There is a vacuum leak between the squeegee weldment and the recovery tank.	• Make sure the squeegee hose is installed correctly in the recovery tank and on the squeegee weldment. • Check the squeegee hose for blockage, damage or cracks and repair/replace as necessary.
	The squeegee is plugged.	• Check the squeegee and clean/repair as necessary.
	The squeegee blade(s) is/are worn out.	• Flip the squeegee blade(s) around to position a new blade surface on the floor. • Replace the squeegee blade(s).

Removal and Installation

Warning! ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Remove the Recovery Tank

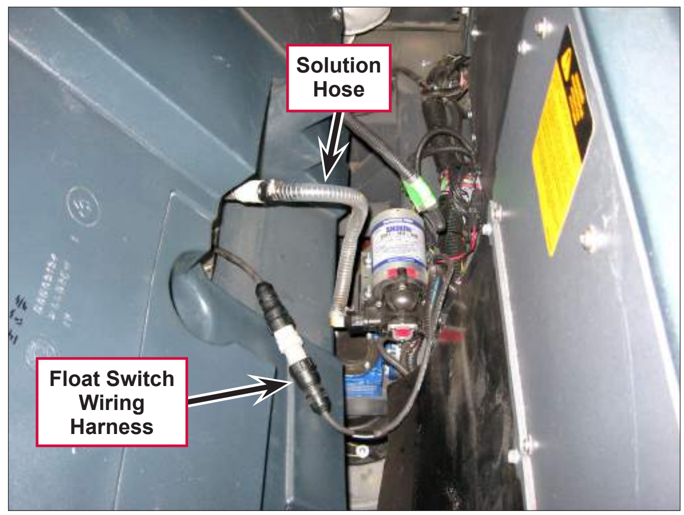
Caution: ***The recovery tank is relatively heavy. It's recommended that the recovery tank be removed by two or more persons to prevent possible personal injury or damage to the recovery tank.***

1. Drain the recovery tank.
2. Release the **Recovery Tank Latch Handle** and tip the tank away from the machine.
3. Remove the squeegee hose from the recovery tank.

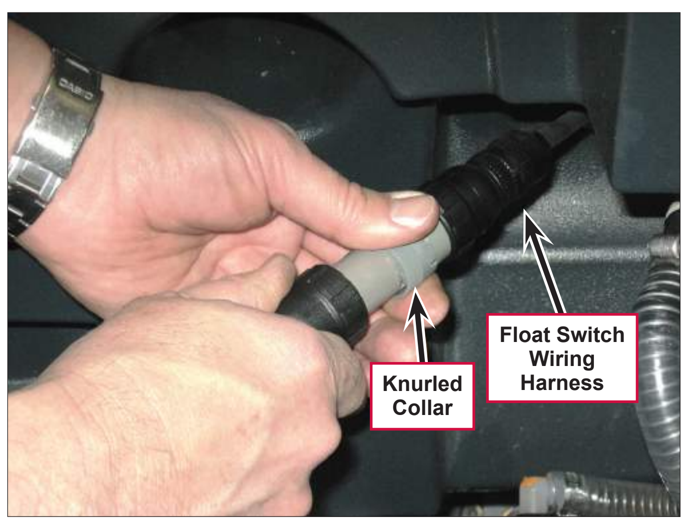
4. Disconnect the **Recovery Tank Vacuum Motor Electrical Connector**.

Note: *If your machine is equipped with an extended scrub system, you must disconnect the* ***Float Switch Wiring Harness*** *and* ***Solution Hose*** *before you can remove the recovery tank. These are described in steps 5 and 6.*

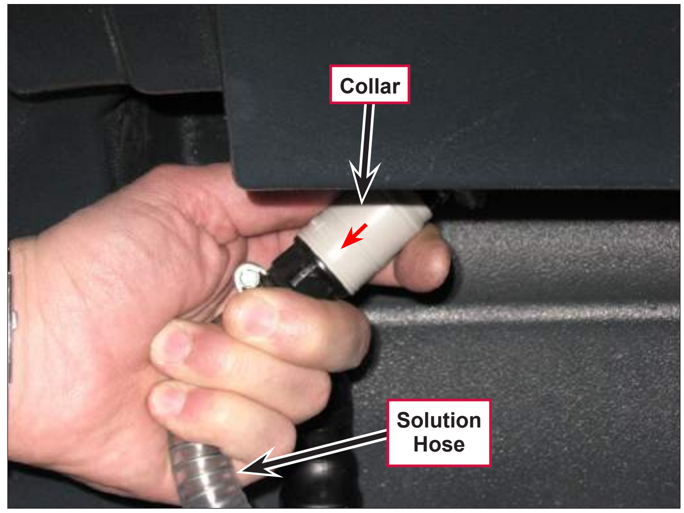
If your machine is not equipped with an extended scrub system, skip to step 7.



5. Loosen the **Knurled Collar** and disconnect the **Float Switch Wiring Harness**.

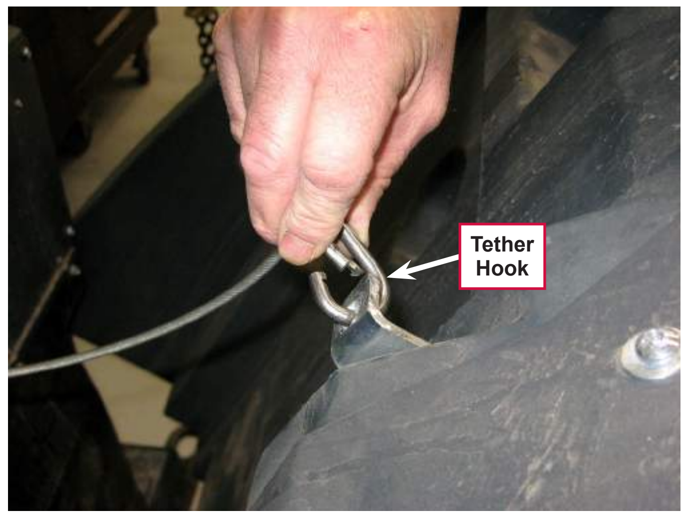


6. Pull the **Collar** on the quick-disconnect fitting and disconnect the **Solution Hose**.



7. Disconnect the **Tether Hook** and carefully tip and lift the recovery tank off of the mounting pins on the machine frame.

Service Note: *You may want to lay the recovery tank down onto a skid or other suitable platform on a pallet jack in order to more easily move the recovery tank once it's removed from the machine.*

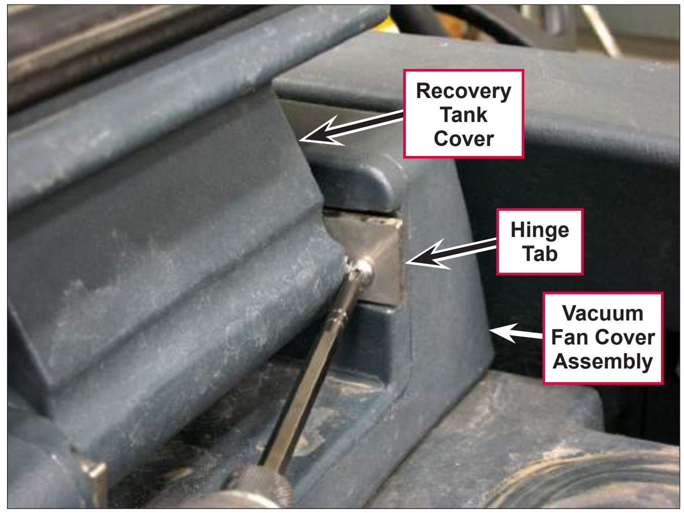


To Reinstall the Recovery Tank

1. Set the recovery tank onto the mounting pins on the machine frame.
2. Swing the recovery tank up and reattach the **Tether Hook** to the recovery tank.
3. Reconnect the recovery tank vacuum motor electrical connector.
4. Reconnect the extended scrub wiring harness and solution hose (if so equipped).
5. Reinstall the squeegee hose.
6. Swing the recovery tank up into position until the recovery tank latch handle engages.

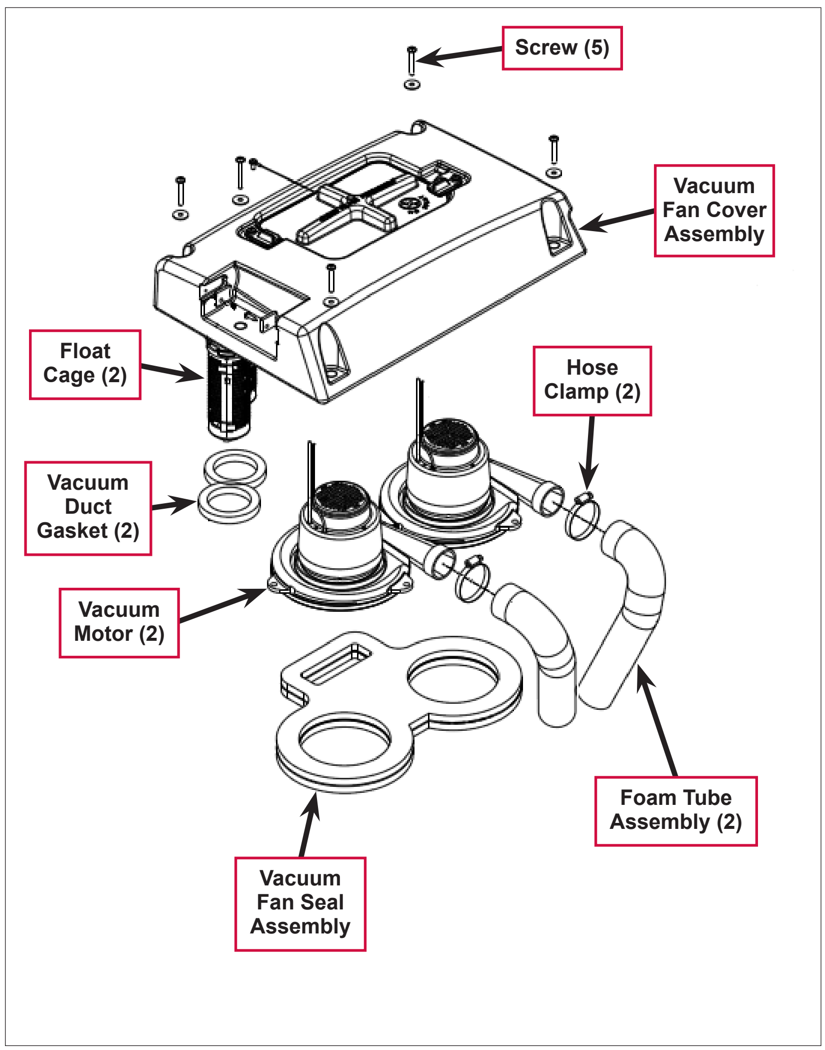
To Remove and Reinstall a Vacuum Motor

1. Lift up the **Recovery Tank Cover**.
2. Remove one of the **Hinge Tabs**, then twist and remove the **Recovery Tank Cover** from the **Vacuum Fan Cover Assembly**. This will allow access to the screw underneath the **Recovery Tank Cover** that holds the **Vacuum Fan Cover Assembly** to the recovery tank.



3. Remove the five **Screws** and washers holding the **Vacuum Fan Cover Assembly** to the recovery tank.
4. Carefully lift the **Vacuum Fan Cover Assembly** off of the recovery tank, making sure the **Float Cages** pass up through the cutouts in the tank.
5. Disconnect the **Vacuum Motor** electrical connector.
6. Loosen the **Hose Clamp** and disconnect the **Foam Tube Assembly** from the **Vacuum Motor**.
7. Carefully lift the **Vacuum Motor** out of the recovery tank.
8. Reinstall the **Vacuum Motor** by following the above steps in reverse order.

Note: *Before you reinstall a vacuum motor, check the* ***Vacuum Fan Seal Assembly*** *and the* ***Vacuum Duct Gaskets*** *for any wear or damage and replace if necessary.*



Specifications

<table>
<tr><th>Component</th><th colspan="2">Specifications</th></tr>
<tr><td rowspan="4">Vacuum Motor</td><td colspan="2">Voltage - 42 VDC</td></tr>
<tr><td colspan="2">Insulation Class - A</td></tr>
<tr><td rowspan="2">Current Draw</td><td>Average - 15 Amps</td></tr>
<tr><td>Maximum - 17 Amps</td></tr>
<tr><td rowspan="2">Vacuum System</td><td rowspan="2">Vacuum</td><td>Sealed – 48” H_2O</td></tr>
<tr><td>With 1” dia. Orifice – 25” to 30” H_2O</td></tr>
</table>

Special Tools

Vacuum water lift gauge, Nilfisk-Advance part number 56205281

Scrub System

Functional Description

Overview

The scrub system includes the scrub brushes, scrub brush motors, side squeegees, and the scrub deck actuator which lowers and raises the scrub deck.

The scrub deck actuator lowers the scrub brushes any time the scrub system is enabled. The brush motors switch on when the drive pedal is moved from the neutral position. The operator can enable the scrub system independent of the solution and recovery systems to scrub without adding or picking up solution.

Scrub Pressure Control

The electric scrub deck actuator motor (**M11**) moves the scrub deck up and down to control the scrub pressure. The retract limit switch (proximity sensor) (**S1**) stops the upward deck movement at the upper travel limit.

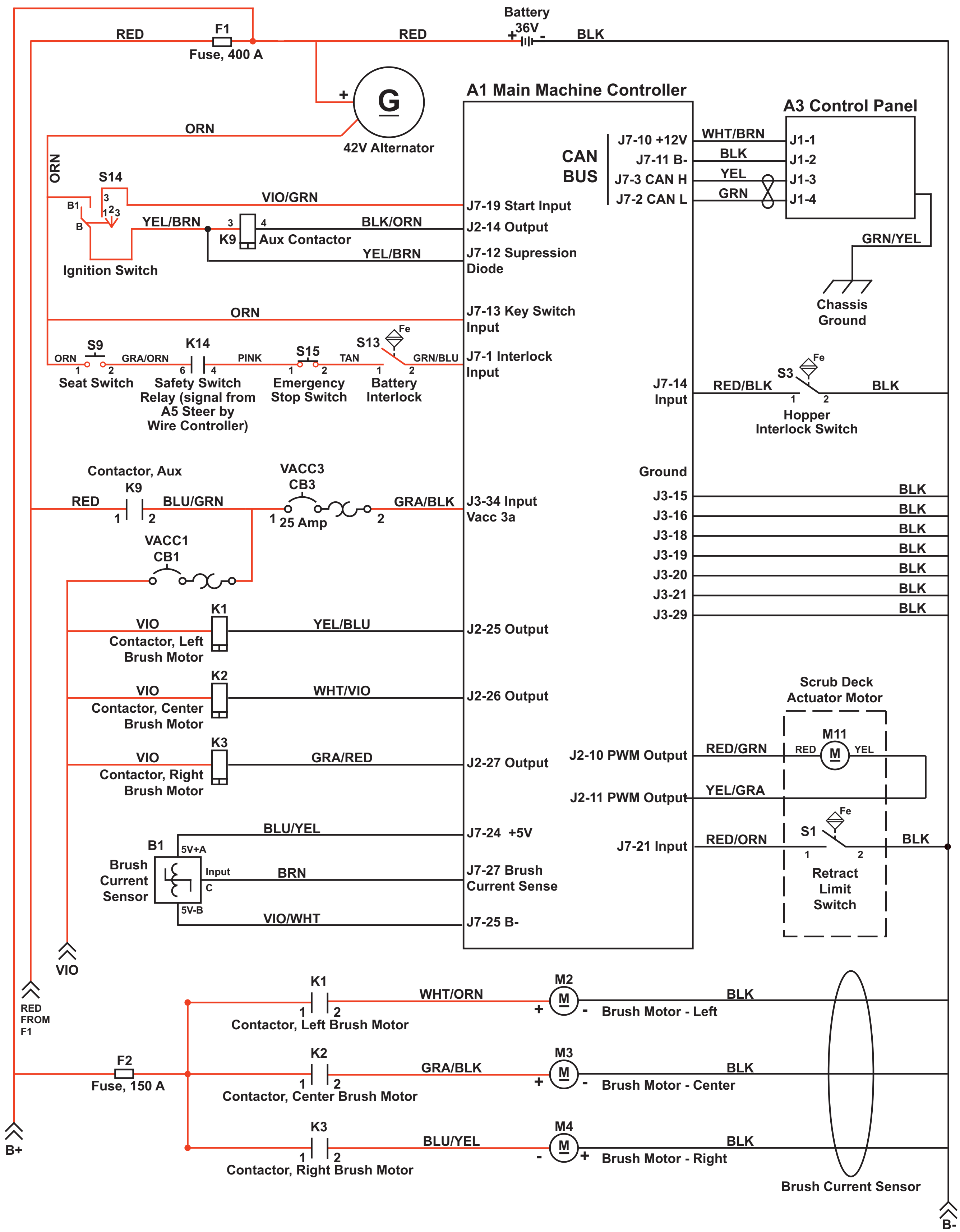
The brush current sensor (**B1**) acts like an “amp clamp” around the brush motor wires to constantly measure the total current draw of all three brush motors. This current reading is sent to the A1 Main Machine Controller on pin J7-27 Brush Current Sense. The A1 Main Machine Controller interprets this current value and raises or lowers the scrub deck as follows:

- If the brush motor current drops below the preset limits for the selected scrub pressure (1-3), the scrub deck actuator will lower the scrub deck to increase the scrub pressure and current draw until the current draw is again within the correct range.
- If the brush motor current rises above the preset limit for the selected scrub pressure, the scrub deck actuator will raise the scrub deck to decrease the scrub pressure and current draw until the current draw is again within the correct range.

The scrub brush current monitoring and scrub deck actuator allow the machine to automatically compensate for a variety of floor surfaces and scrubbing conditions while maintaining constant scrubbing pressure.

If the scrub deck actuator is unable to maintain the combined brush motor current draw below 75 amps for 25 seconds, or if there is a short circuit, the A1 Main Machine Controller will set an over-current fault code.

Scrub System Wiring Diagram



Circuit Description

The Following Conditions Must be Met for the Scrub System To Operate

- The **Hopper Interlock Switch S3** must be closed.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed.
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-13**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breakers **VACC1/CB1** and **VACC2/CB2**.
- Circuit breaker **VACC1/CB1** must be closed to provide positive voltage to **Solution Valve L1**.
- Circuit breaker **VACC2/CB2** must closed to provide positive voltage to the **Left Brush Motor Contactor K1**, the **Center Brush Motor Contactor K2** and the **Right Brush Motor Contactor K3**.
- The **J2-25**, **J2-26** and **J2-27 Outputs** on the **A1 Main Machine Controller** must provide ground to the **Left Brush Motor Contactor K1** coil, the **Center Brush Motor Contactor K2** coil and the **Right Brush Motor Contactor K3** coil respectively. The **J2-25**, **J2-26** and **J2-27 Outputs** provide a ground under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the CAN BUS that the operator has pressed the scrub switch.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or reverse.
- The **150-amp Fuse F2** must be closed to provide positive voltage from the **Battery** to the load side of **Contactors K1**, **K2** and **K3**.
- The **Brush Motors M2**, **M3** and **M4** must have connections to battery ground **B-**.

Scrub Deck Actuator Motor

- The **J2-10** and **J2-11 PWM Outputs** from the **A1 Main Machine Controller** provide voltage to the **Scrub Deck Actuator Motor M11**. The output polarity determines whether the **Scrub Deck Actuator Motor** lowers or raises the scrub deck.
- When the **Retract Limit Switch S1** closes, it connects the **J7-21 Input** to ground which signals the **A1 Main Machine Controller** that the scrub deck has reached its upper limit. The **A1 Main Machine Controller** will switch off the **J2-10** and **J2-11 PWM Outputs** to stop the upward scrub deck travel.

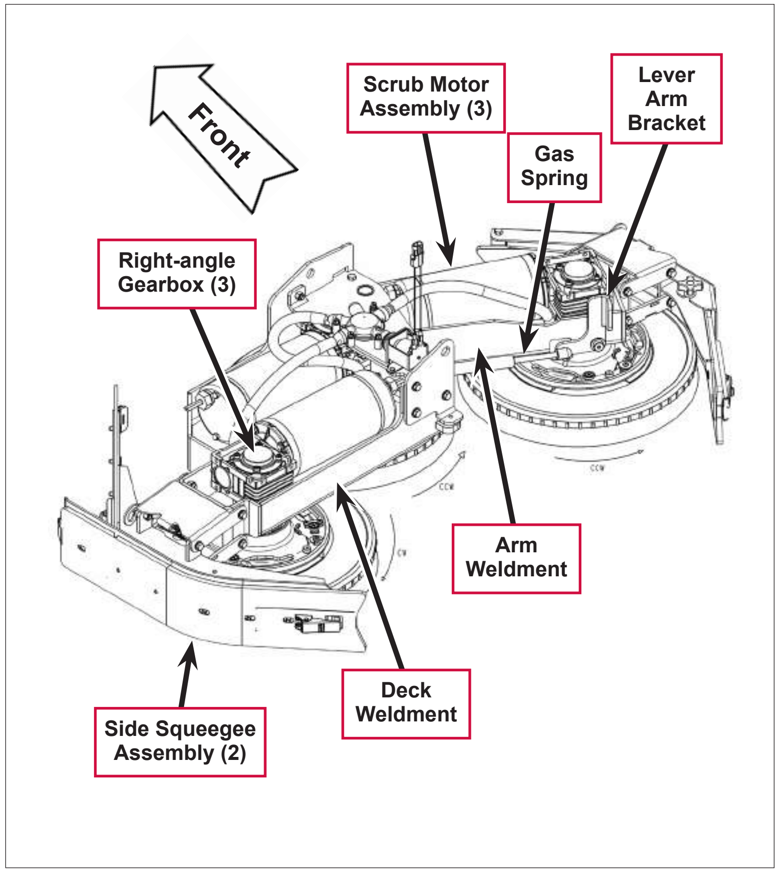
Brush Current Sensor

- **J7-24** provides +5 volts to the **Brush Current Sensor**.
- **J7-25** provides battery ground (**B-**) to the **Brush Current Sensor**.
- The Input from the **Brush Current Sensor** provides the **Brush Current Sense** signal to **J7-27** on the A1 Controller Board. The A1 Controller Board uses this current value to run the **Scrub Deck Actuator Motor M11** in the appropriate direction to either raise or lower the scrub deck to maintain the total scrub motor current draw within the prescribed range for the selected scrub pressure.

Component Locations

Scrub Motor Assemblies

The left-hand and center **Scrub Motor Assemblies** are mounted on the **Deck Weldment**. The right-hand **Scrub Motor Assembly** is mounted on the **Arm Weldment** bolted to the **Deck Weldment**. The **Right-angle Gearboxes** are mounted on spacers to position them correctly on the **Deck** and **Arm Weldments**.



Right Scrub Arm Gas Spring and Lever Arm Bracket

The **Gas Spring** keeps the right **Arm Weldment** and attached **Side Squeegee Assembly** extended outward during normal scrubbing, but will allow the **Arm Weldment** to pivot backward if the right-hand **Side Squeegee Assembly** hits an object or obstacle. This provides some compliance to prevent damage to the **Side Squeegee Assembly**.

To release the **Gas Spring** to pivot the right **Arm Weldment** backward for service or maintenance proposes, pull the top of the **Lever Arm Bracket** toward you and swing the **Arm Weldment** backward.

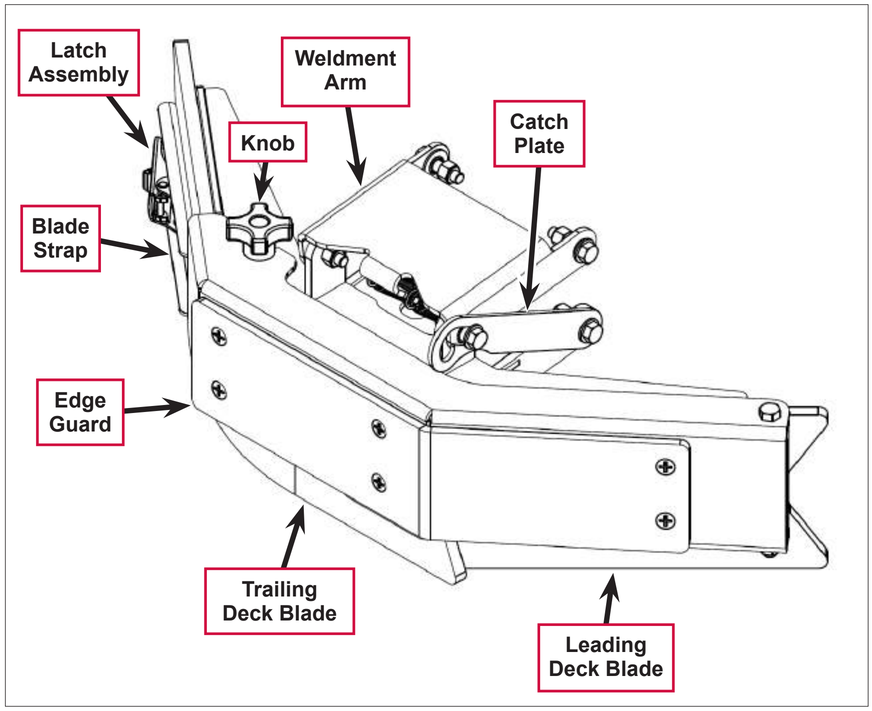
Side Squeegee Assemblies

The **Side Squeegee Assemblies** are mounted to **Weldment Arms** that are attached to the **Deck/Arm Weldments**. The **Side Squeegee Assemblies** are spring-loaded to keep them firmly on the floor. A **Catch Plate** allows you to lock the **Side Squeegee Assemblies** in the upper position for double-scrub cleaning and maintenance.

An **Edge Guard**, held in position by a **Knob**, protects the right-hand **Side Squeegee Assembly** and swings out to allow access to the **Blade Strap** and **Trailing Deck Blade**.

The **Latch Assembly** releases to allow you to remove the **Blade Strap** and **Trailing Deck Blade**.

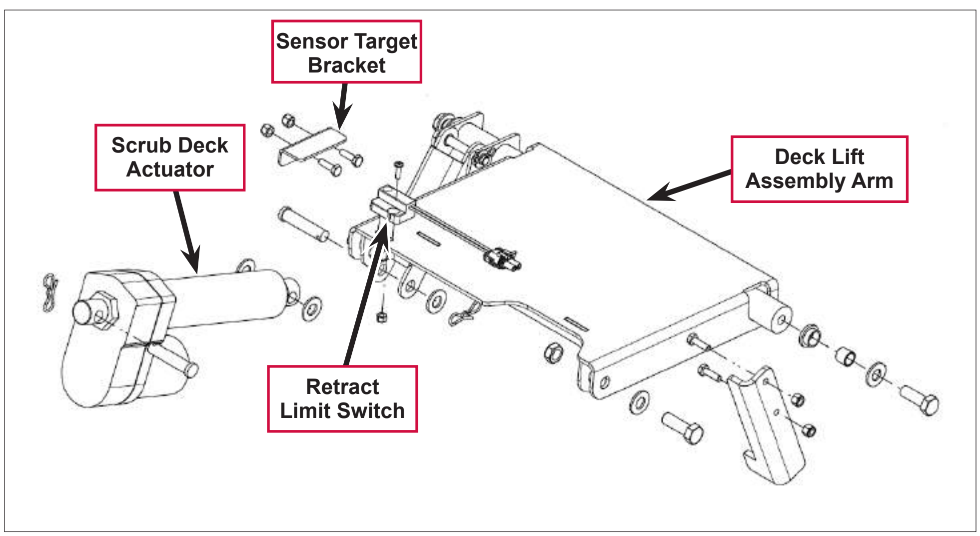
The **Leading Deck Blades** are held in place by strap weldments and wing knobs.



Scrub Deck Actuator

The **Scrub Deck Actuator** is pinned to the machine frame, and to the pivoting **Deck Lift Assembly Arm**. When the **Scrub Deck Actuator** extends or retracts, it lowers or lifts the free side of the **Deck Lift Assembly Arm**.

The **Deck Lift Assembly Arm** pivots on flange bearings and bushings in the frame to raise and lower the attached scrub deck. Note that the scrub deck is free to “float” left-to-right to conform to the floor surface.

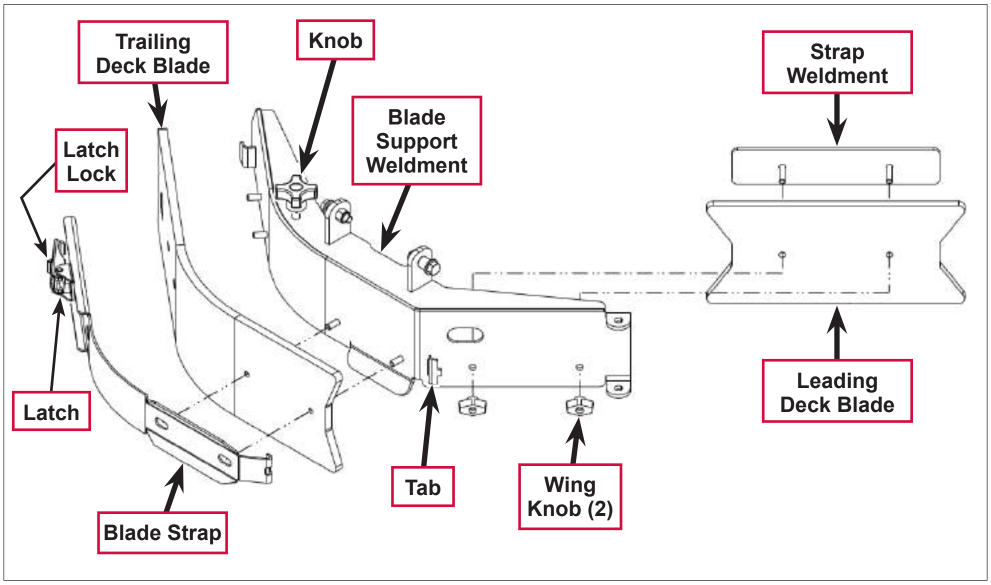


The **Retract Limit Switch S1** will detect the **Sensor Target Bracket** when the scrub deck is fully retracted upward and stop the **Scrub Deck Actuator** motor.

Maintenance and Adjustments

Warning! ***Before performing any machine maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Replace a Leading Deck Blade



1. Loosen the **Knob** and swing out the edge guard (not shown - on right-hand side squeegee assembly only).
2. Remove the two **Wing Knobs**.
3. Remove the **Strap Weldment** and **Leading Deck Blade** from inside of the **Blade Support Weldment**.
4. Reverse the existing **Trailing Deck Blade** to position a new blade surface on the floor, or install a new **Trailing Deck Blade** onto the **Strap Weldment** pins as shown.
5. Install the **Trailing Deck Blade** and **Strap Weldment** on the inside of the **Blade Support Weldment**, then reinstall and tighten the two **Wing Knobs**.
6. Swing the edge guard back into position, then tighten the **Knob** (right-hand side squeegee assembly only).

To Replace a Trailing Deck Blade

1. Loosen the **Knob** and swing out the edge guard (not shown - on right-hand side squeegee assembly only).
2. Press the **Latch Lock**, open the **Latch** and remove the **Blade Strap** and **Trailing Deck Blade** from the **Blade Support Weldment**.
3. Reverse the existing **Trailing Deck Blade** to position a new blade surface on the floor, or install a new **Trailing Deck Blade** onto the **Blade Support Weldment** pins as shown.
4. Hook the end of the **Blade Strap** into the matching **Tab** on the **Blade Support Weldment**.
5. Wrap the **Blade Strap** over the **Trailing Deck Blade** and close the **Latch**.

Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
The scrub system does not operate.	An interlock is not closed.	Before you start troubleshooting the scrub system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed. • The A1 Main Machine Controller is receiving the appropriate signal from the A3 Control Panel via the CAN BUS.
None of the scrub deck motors will run.	The 150-amp Fuse (**F2**) is blown.	Check the Fuse (**F2**) and replace if necessary.
	There is no voltage to the **K1**, **K2** and **K3** contactor coils.	Check circuit breaker **CB1** and reset if necessary.
		The contactor **K9** is not providing positive voltage to the **K1**, **K2** and **K3** contactor coils. 1. Check the **K9** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 2. Check the continuity through contactor **K9** with the coil energized. If the contacts are open, replace the contactor. 3. Check the **J2-14** output from A1 Main Machine Controller.
An individual scrub deck motor will not run.	There is no voltage to the corresponding contactor coil (**K1**/**K2**/**K3**).	1. Check the coil resistance in the **K1**/**K2**/**K3** contactor coil. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 2. Check the continuity through contactor **K1**/**K2**/**K3** with the coil energized. If the contacts are open, replace the contactor. 3. Check the **J2-25**/**J2-26**/**J2-27** output from A1 Main Machine Controller.
	There is an open circuit in the scrub motor wiring.	Check the motor wiring and connections from contactor **K1**/**K2**/**K3** to the motor, and the ground connection from the motor to battery ground. Repair as necessary.
	The motor is not operating correctly.	Replace the scrub deck motor.
The scrub deck actuator is not raising and lowering the deck.	There is an open circuit in the deck actuator motor wiring.	Check the wiring and connections from the A1 Main Machine Controller to the scrub deck actuator motor and repair as necessary.
	There is no voltage output from the A1 Main Machine Controller.	Check the output from **J2-10** and **J2-11** from the A1 Main Machine Controller.

Problem	Cause	Correction
The scrub deck actuator will not raise the deck.	The retract limit switch (**S1**) is shorted out.	Check the switch function and replace if necessary. Note that the retract limit switch is a proximity switch should be closed when close to the metal
The scrub pressure is inconsistent.	The brush current sensor (**B1**) is not operating correctly.	Check the wiring and connections from the A1 Main Machine Controller to the brush current sensor and repair as necessary.
		Check the +5V output from **J7-24** and the ground output from **J7-25** to the brush current sensor (**B1**) from the A1 Main Machine Controller.
		Check the input to **J7-27** on the A1 Main Machine Controller from the brush current sensor. If the output is not between 2.5 and 4.7 volts, replace the brush current sensor.

Removal and Installation

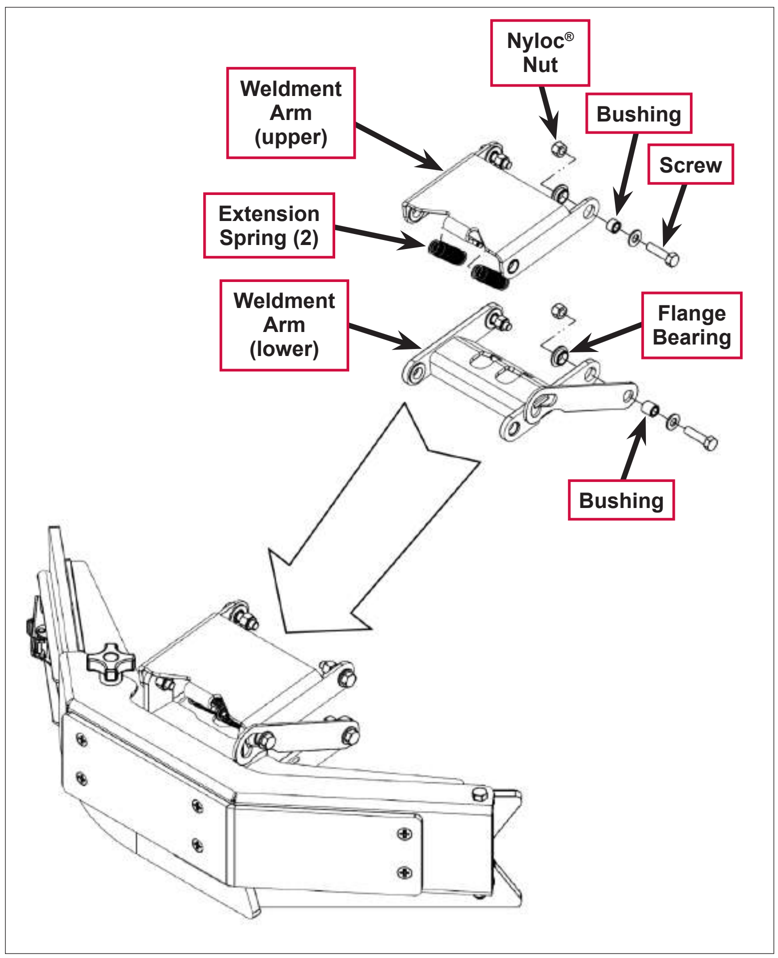
Warning! Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.

To Remove and Reinstall a Side Squeegee Assembly

1. Loosen the knob and swing out the edge guard.
2. Carefully remove the **Extension Springs** from the tabs on the upper **Weldment Arm**.
3. Remove the **Screws**, washers, **Bushings**, **Flange Bearings** and **Nyloc® Nuts** holding the side squeegee assembly to the scrub deck, then remove the side squeegee assembly from the machine.

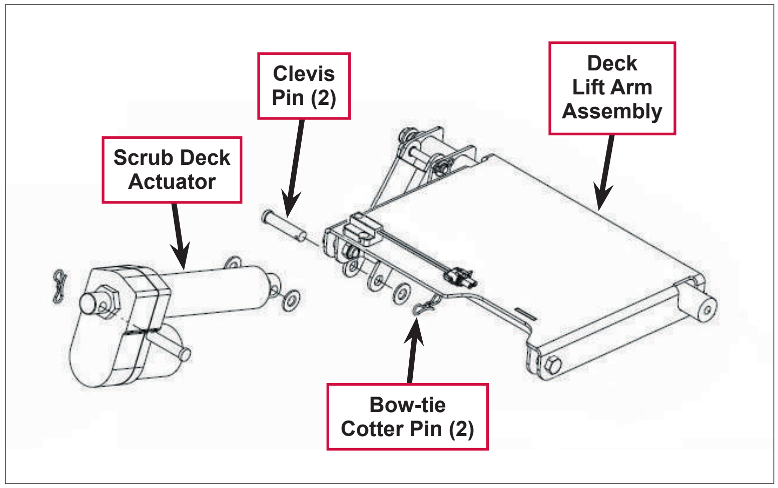
Note: The ***Bushings*** *in the upper and lower* ***Weldment Arms*** *are different. Make sure to note where the hardware items are located as you remove the squeegee assembly to ensure the mounting hardware is reinstalled correctly.*

4. Reinstall the side squeegee assembly by following the above steps in reverse order.



To Remove and Reinstall the Scrub Deck Actuator

1. Remove the recovery tank (refer to the ***Recovery System*** section).
2. Turn on the key switch and put the machine into the Service Test mode to allow you to jog the scrub deck up and down.
3. Extend the scrub deck downward in the Service Test mode to minimize the weight on the **Scrub Deck Actuator**.
4. Disconnect the **Scrub Deck Actuator** electrical connector
5. Remove the **Bow-tie Cotter Pin**, washers and **Clevis Pin** holding the **Scrub Deck Actuator** to the **Deck Lift Arm Assembly**.
6. Remove the **Bow-tie Cotter Pin** and **Clevis Pin** holding the **Scrub Deck Actuator** to the machine frame, then remove the **Scrub Deck Actuator** from the machine.



7. Reinstall the **Scrub Deck Actuator** by following the above steps in reverse order.

To Remove and Reinstall the Scrub Deck

1. Remove the recovery tank (refer to the ***Recovery System*** section).
2. Make sure the solution shutoff valve is closed, then disconnect the solution hose to the solution solenoid valve.
3. Turn on the key switch and put the machine into the Service Mode to allow you to jog the scrub deck up and down.

4. Disconnect the **Electrical Connectors** to the three **Scrub Motors**, to the **Proximity Sensor** on the **Deck Lift Arm Assembly** and to the **Solution Solenoid Valve**. Jog the **Scrub Deck** up or down as necessary to access the **Electrical Connectors**. Note that you may need to cut wire ties to access the **Electrical Connectors**.

5. Extend the scrub deck downward in the Service Test mode to minimize the weight on the **M12-1.75 x 35mm Screws** supporting the **Deck Lift Arm Assembly** and **Scrub Deck**.

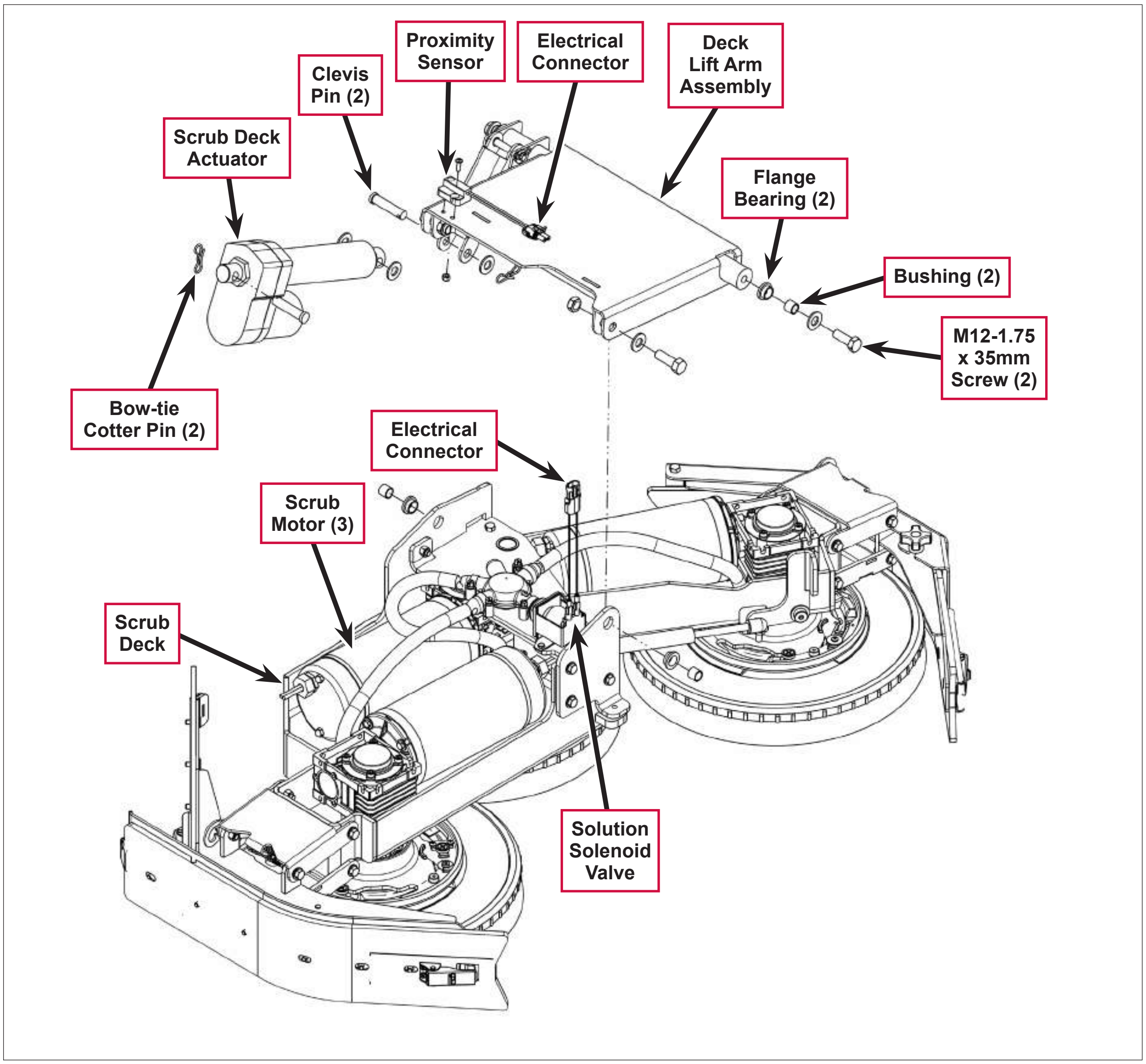
6. Remove the two **M12-1.75x 35mm Screws**, washers, **Bushings** and **Flange Bearings** holding the **Deck Lift Arm Assembly** and attached **Scrub Deck** to the machine frame.

7. Remove the **Bow-tie Cotter Pin**, washers and **Clevis Pin** holding the **Scrub Deck Actuator** to the **Deck Lift Arm Assembly**.

8. Jack the machine up as necessary to get enough clearance to remove the **Scrub Deck**, then support the machine with jack stands.

Warning! ***Never work under a machine without safety stands or blocks to support the machine. When jacking the machine, do so at the designated Tie Down/Jacking Locations.***

9. Slide the **Scrub Deck** and attached **Deck Lift Arm Assembly** out from under the machine.



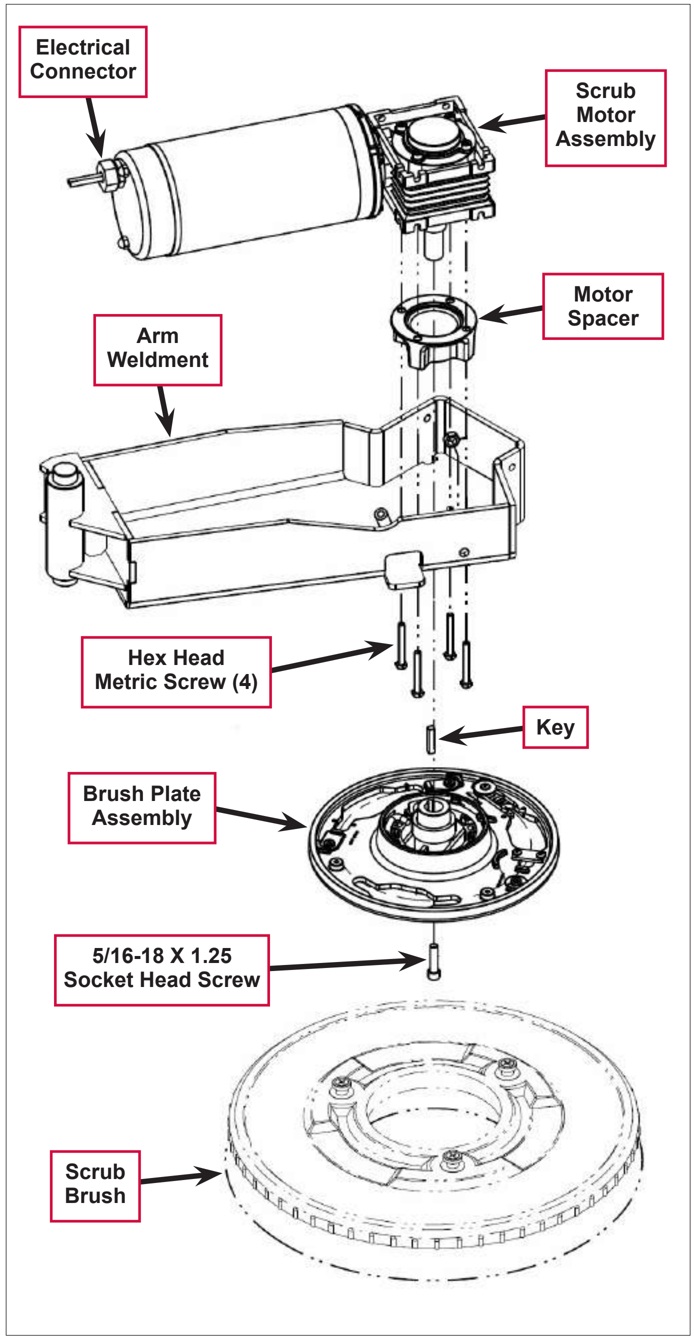
10. Reinstall the **Scrub Deck** by following the above steps in reverse order.

Service Note: *When you reinstall the* **Scrub Deck***:*

- *Make sure you reconnect the* **Scrub Motors** *to the correct* **Electrical Connectors** *in the wire harness as follows:*
  - *Left scrub motor - White/Orange wire*
  - *Center scrub motor - Gray/Black wire*
  - *Right scrub motor - Blue/Yellow wire*
- *Make sure the two* ***Flange Bearings*** *are installed in the machine frame through holes, and that the* ***Bushings*** *and washers are installed correctly before installing the two* ***M12-1.75x 35mm Screws***.
- *You may find it easier to use a tapered punch or other suitable tool to align the* ***Bushings***, ***Flange Bearings*** *and* ***Deck Lift Arm Assembly*** *with the through holes in the frame before you install the* ***M12-1.75x 35mm Screws***.

To Remove and Reinstall a Scrub Motor Assembly

1. Remove the scrub deck from the machine.
2. Disconnect the electrical connector from the **Scrub Motor Assembly**.
3. Remove the **Scrub Brush** from the **Brush Plate Assembly**.
4. Remove the **5/16-18 X 1.25 Socket Head Screw** from the gearbox shaft and carefully remove the **Brush Plate Assembly**.
5. Remove the four **Hex Head Metric Screws**, then lift the **Scrub Motor Assembly** and **Motor Spacer** off of the **Arm Weldment** (shown) or deck weldment.
6. Reassemble the **Scrub Motor Assembly** following the above steps in reverse order.

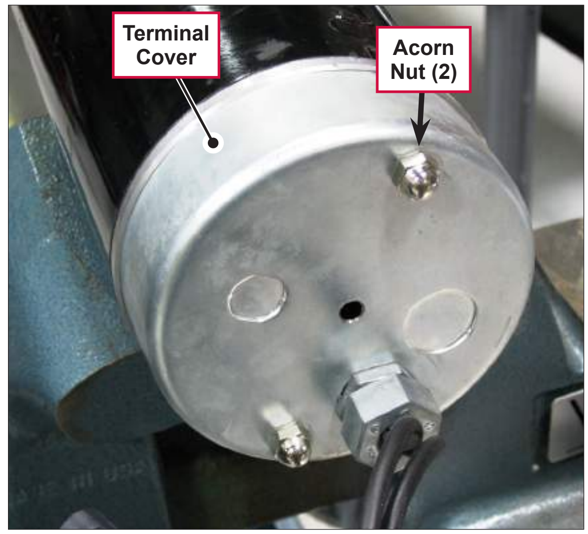


Note: *Make sure the **Key** is installed correctly before you reinstall the **Brush Plate Assembly** onto the scrub motor shaft.*

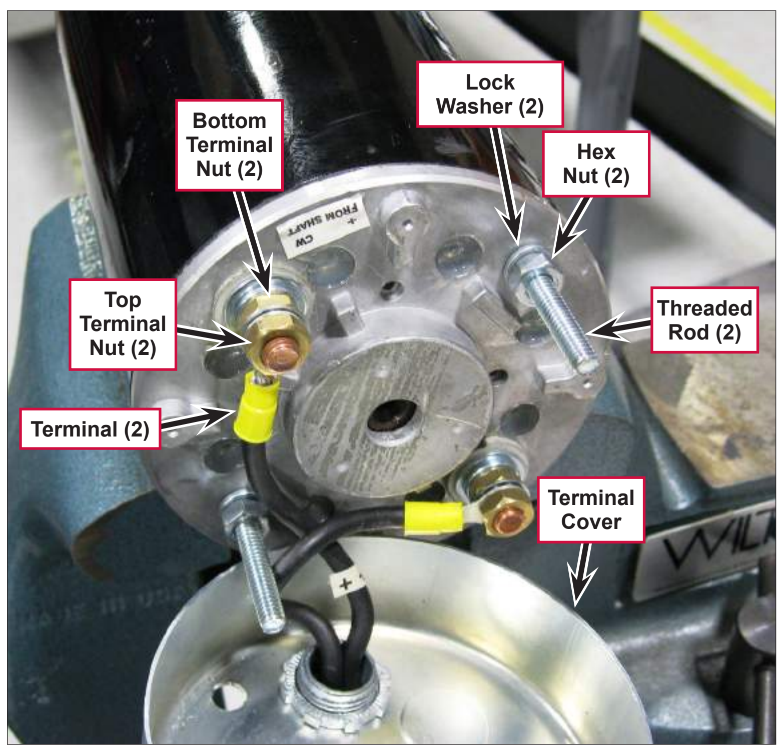
To Replace the Scrub Motor Carbon Brushes

Note: *The minimum length of the carbon brushes in the scrub motors is 0.5" [13 mm]. If the carbon brushes are less than 0.5" [13 mm] long, replace them.*

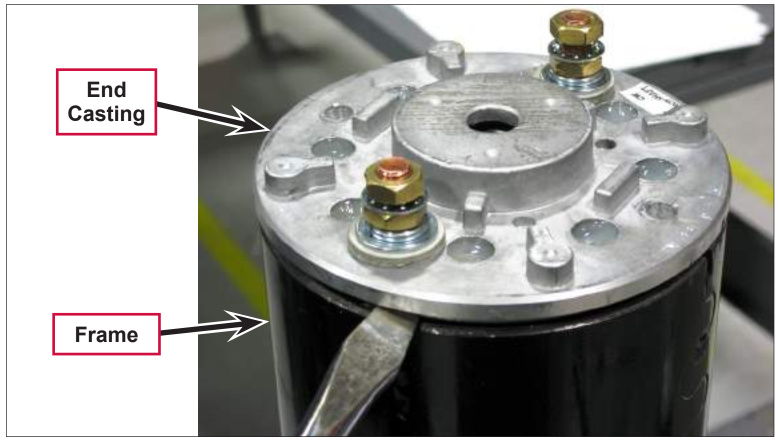
1. Remove the scrub motor assembly from the scrub deck.
2. Remove the scrub motor from the right-angle gearbox.
3. Note the position of the witness marks stamped into the frame and castings on both ends of the motor.
4. Remove the two **Acorn Nuts** and open the **Terminal Cover**.



5. Use a backup wrench to hold the **Bottom Terminal Nuts** in place, then remove the **Top Terminal Nuts** and **Terminals**. Make sure to note the wire polarity.
6. Remove the **Terminal Cover**.
7. Remove the **Hex Nuts**, **Lock Washers** and **Threaded Rods** holding the two end castings to the **Frame**.



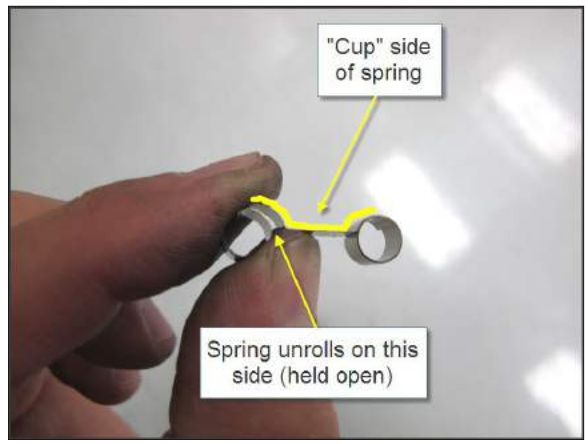
8. Carefully pry the **End Casting** from the **Frame**. Be careful not to lose the wave washer between the **End Casting** and the motor bearing.



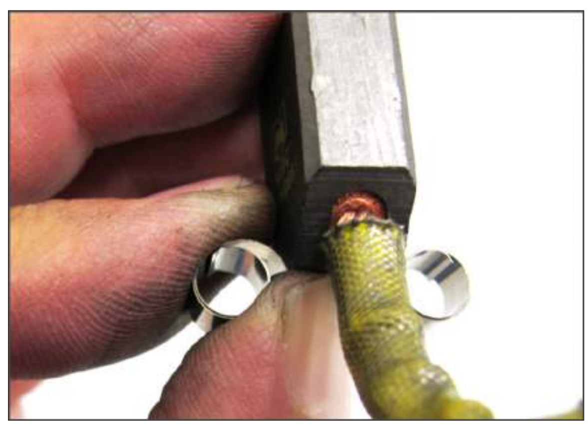
9. Replace the carbon brushes as follows:

   a. Observe how the springs roll when the brush is pushed back before taking it apart.

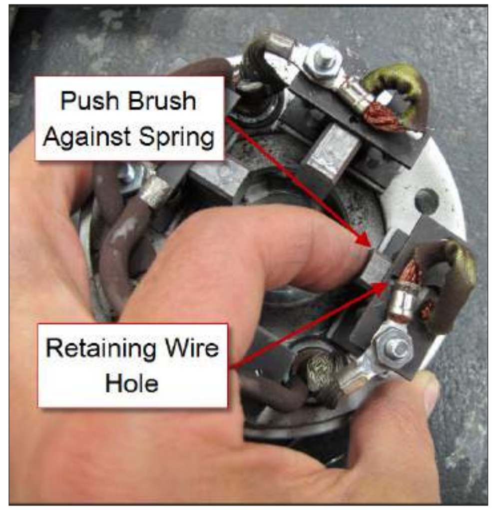
   b. Remove a brush and spring.

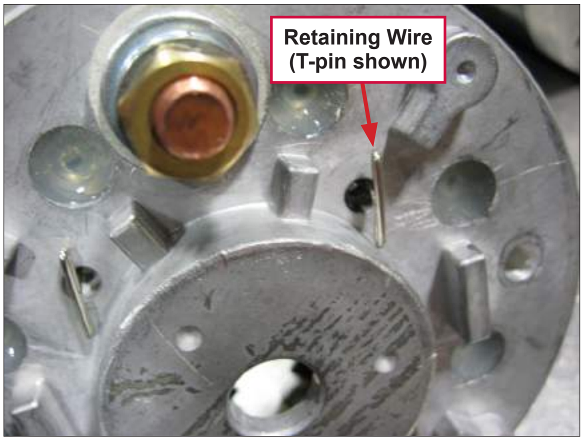


   c. Install a new brush and spring into the brush holder. Thread the brush wire lead through the brush holder. Position the back end of the brush in the “cup” of the spring so that the spring will unroll as the brush is pushed back once it is installed.

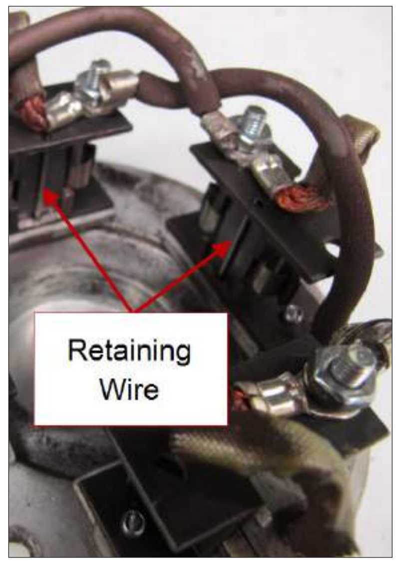


d. Push the **Brush** back against the spring and insert a stiff temporary **Retaining Wire** (paper clip or **T-pin**) through the access hole in the end cover. (Remove silicone sealer from the holes.) The wire must go through the holes in the brush holder just in front of the **Brush** to hold the **Brush** back against the spring pressure.

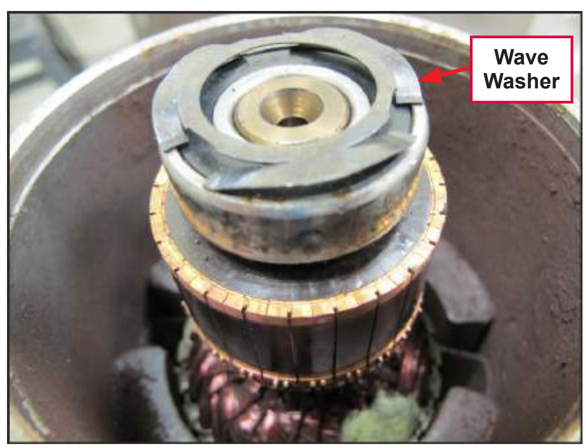




10. Install the other three **Brushes**.



11. Reinstall the **Wave Washer**. Make sure the bottom edges of the **Wave Washer** contact the outside bearing race as shown.



12. Reinstall the end casting in stages as follows.

    a. Reinstall the end casting with brushes far enough into the frame so the brushes will contact the commutator when the temporary retaining wires are removed, then remove the retaining wires.

    b. Press the end casting into the frame, leaving about a 1/8” gap between the frame and end casting. Make sure to align the witness marks on the end casting and frame as noted in step 3.

    c. Reinstall the threaded rods, lock washers and hex nuts, but don’t tighten the hex nuts yet.

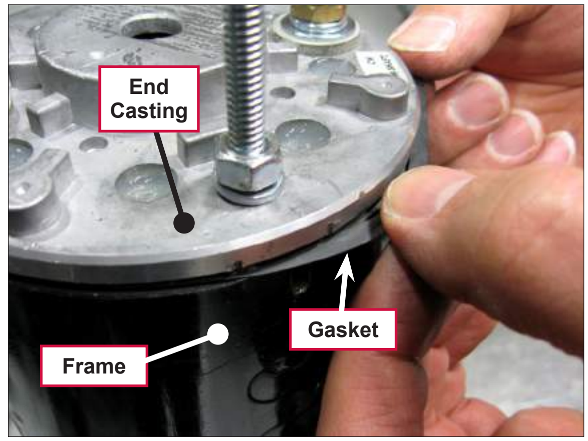
d. Carefully install a new **Gasket** between the **Frame** and the **End Casting**. Make sure the **Gasket** is seated flat on the mating surfaces.

e. Once the **Gasket** is installed, fully seat the **End Casting** onto the **Frame**.

f. Tighten the hex nuts.

13. Reinstall the terminals and top terminal nuts, then reinstall the terminal cover and acorn nuts.

14. Seal the retaining wire holes in the end cover with silicone sealant.



Specifications

Component	Specifications		
Scrub Brush Motors (all)	35 VDC, 1 HP, 2750 RPM, 26 Amp		
Scrub Brush Motor - Center	Current Draw (shop measurements)	Average - 19 Amps	Max. - 37 Amps
Scrub Brush Motor - Left	Current Draw (shop measurements)	Average - 17 Amps	Max. - 23 Amps
Scrub Brush Motor - Right	Current Draw (shop measurements)	Average - 17 Amps	Max. - 26 Amps
Deck Actuator Motor	Input Voltage - 34-40 VDC		
	Dynamic Load - 500 lbs. max.		
	Static Load - 1000 lbs. max.		
	Restraining Torque - 100 in.-lbs. min.		
	Current Draw	9 Amps max at rated dynamic load	
		2-5 Amps Typical	
	End of Stroke - Ball detent clutch with a load rating between 600 and 1000 lbs.; will ratchet at end of stroke		
	Thermal Protection - Automatic resetting thermal breaker enclosed in motor housing.		
	Wiring Polarity: • To extend actuator, connect red lead to positive and yellow lead to negative. • To retract actuator, connect yellow lead to positive and red lead to negative.		

Component	Specifications
Retract Limit Switch (Proximity Sensor)	Air Gap @ Make - .250 in. (typical)
	Air Gap @ Break - .313 in. (typical)
	Contact resistance (initial) - 150 milliohms max.

Special Tools

A spring puller is recommended to remove the Extension Springs from the Weldment Arms when removing the Side Squeegee Assemblies. There are several types of spring pullers - a typical example is shown here.	

Solution System

Functional Description

Overview

The solution system delivers water, or detergent and water, to the floor for the scrub system. The solution system includes the solution tank (main body of machine) and solution pressure (level) sensor, solution shutoff valve, solution filter, solution pump or pumps (some models), solution solenoid valve, and the associated plumbing to distribute solution to the nozzles at the three scrub brushes. A capped solution drain hose allows you to drain the solution tank.

The solution flows to the scrub brushes any time the scrub system is enabled, the scrub deck is lowered and the drive pedal is not in the neutral position. Programming options allow you to enable or disable solution flow when the machine moves in reverse. When the scrub system is disabled, no solution will flow to the brushes regardless of drive pedal or scrub deck position. The operator can enable the solution system independent of the scrub system to pre-wet the floor before enabling the scrub and/or recovery systems.

Solution Flow Control - Non-EcoFlex™ Machines

On the non-EcoFlex™ machines, an electrically-activated solenoid valve controls the solution flow. The solution is gravity-fed to the solenoid valve, and the solenoid valve output volume is controlled by the Main Controller through a PWM (pulsed width modulated) output. The A1 Main Machine Controller monitors the solution level via a solution pressure sensor. (Also refer to the ***Component Locations/Solution Tank/ Solution Pressure Sensor*** section.) As the solution level drops, the PWM output will increase to compensate for the loss of solution (head) pressure in order to maintain a consistent solution flow rate regardless of solution level in the tank. The solution solenoid's coil circuit opens and closes (pulsing on and off), pulling the valve diaphragm on and off its seat. This way the A1 Main Machine Controller can manage the three different auto flow volumes and two different override flow rates.

On non-EcoFlex™ machines, the operator must manually mix the detergent with the water in the solution tank if detergent is desired in the solution.

Solution Valve Desired Flow per Solution Setting	
Solution Flow Setting	Desired Flow (GPM)
1	1.0
2	1.5
3	2.0
4	2.5
5	3.0

Solution Flow Control - EcoFlex™ Machines

EcoFlex™ models use a solution control pump (**M19**) to supply the solution to the scrub brushes. On EcoFlex™ machines, the solution solenoid valve remains open when the solution control pump is running and the solution flow is controlled by the pump output. This allows more precise mixing of the detergent/ water mix to the brushes. The EcoFlex™ detergent delivery line is plumbed into the solution line between the solution pump and the solution solenoid valve.

EcoFlex™ Detergent System

The EcoFlex™ detergent system uses dual diaphragm pumps (**M17** and **M18**) to pump detergent into the solution flow upstream of the solution solenoid valve. Two detergent pumps are used when necessary to ensure adequate detergent supply at the higher detergent and solution flow rates. The detergent pumps receive PWM outputs from the A1 Main Machine Controller to regulate the detergent dispense rate according to the solution flow rate. The detergent supply line from the detergent bottle is split into two lines, one feeding each detergent pump. The two lines from the pumps merge into one line, which is then connected to the solution hose upstream of the solution solenoid valve.

Extended Scrub System

Machines equipped with the extended scrub system will pump the recovered water from the recovery tank to the scrub brushes when the solution tank is empty. The extended scrub system uses an additional pump (**M25**) to pump the recovered water to the scrub brushes. In order for the extended scrub system to work, the extended scrub system must be enabled, the solution tank low sensor must be actuated, and the float valve in the recovery tank must be closed to indicate adequate water level in the recovery tank. Note that when the machine is in the scrub mode:

- The solution pump will continue to run along with the extended scrub pump.
- The EcoFlex™ pumps will continue to add detergent to the recovered water.

Optional Hot Water System (LP and Diesel EcoFlex™ Machines Only)

On EcoFlex™ models equipped with the optional hot water system, the solution control pump pumps the solution to a heat exchanger. The heat exchanger is plumbed to the engine cooling system and uses the hot engine coolant to heat the solution as it circulates through the heat exchanger. The hot water system increases the solution temperature approximately 50 degrees F. The heated solution is then mixed with detergent and sent through the (open) solution solenoid valve and solution manifold to the brushes.

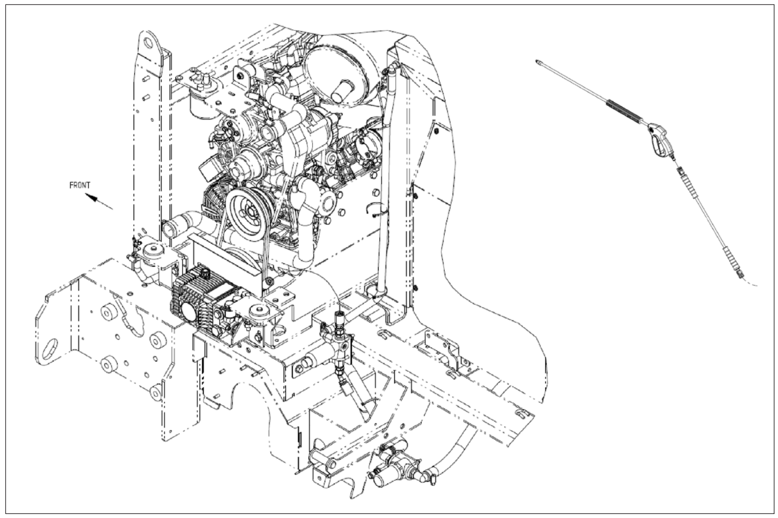
Note: *If your machine is equipped with a hot water system, do not add detergent to the solution tank as this can foul the heat exchanger.*

Optional Wash Hose Kit

The optional wash hose kit uses a separate low-pressure pump (**M23**) to pump solution from the solution tank to the hose and nozzle located behind the Operator seat. The wash hose kit operates independently and does not require the Operator to actuate the seat switch. A pressure switch on the low pressure pump will switch on the pump when the hose nozzle is opened and the solution pressure in the hose drops.

Optional High-pressure Spray System (LP and Diesel Only)

The optional high-pressure spray system uses a separate pump, driven by the engine via a clutch, to pump solution at high pressure from the tank to the hose and wand. The high-pressure spray system operates independently and has its own separate filter/strainer, and supply and return ports on the solution tank.



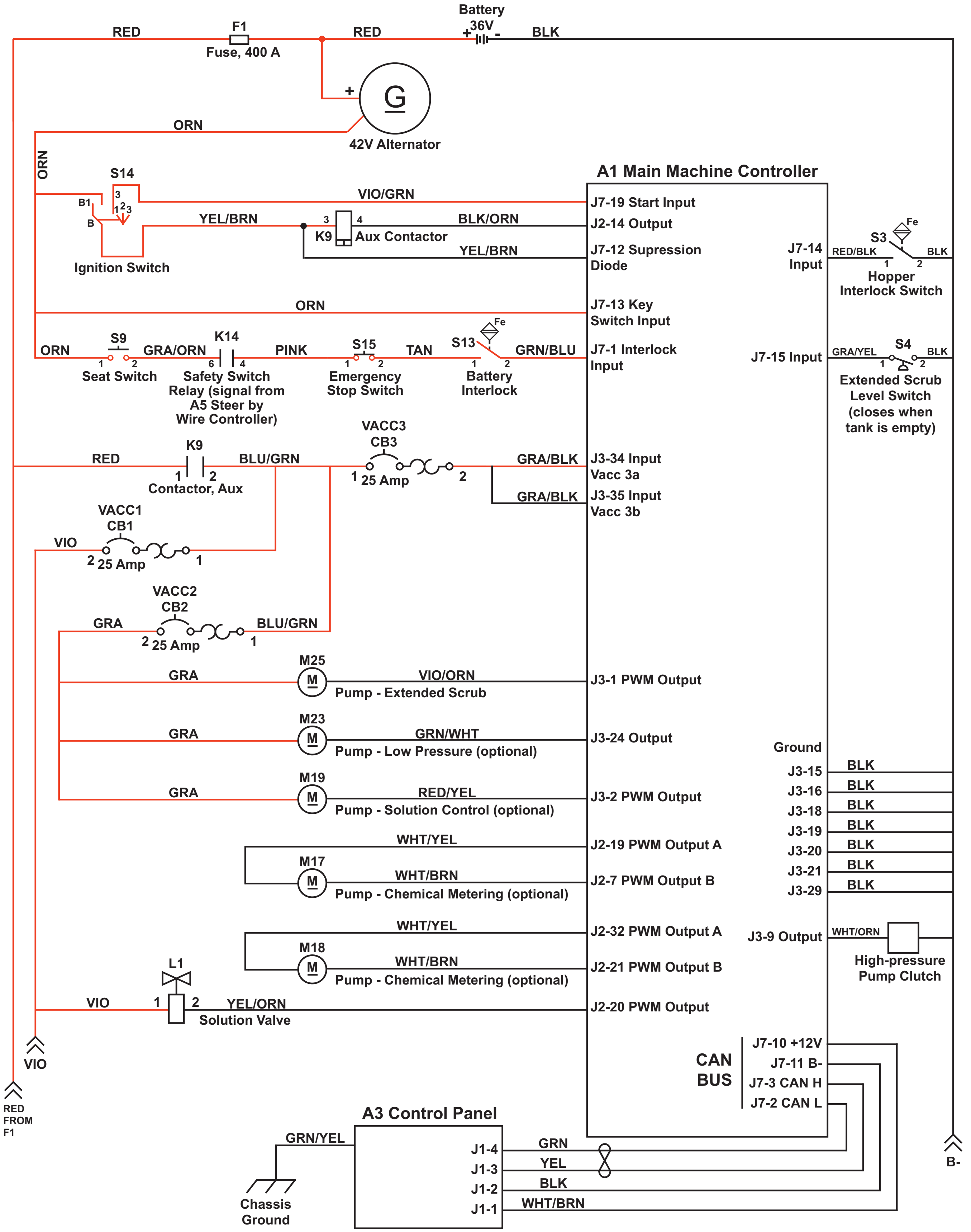
Solution Level Sensor

The solution pressure sensor sends a linear signal to the A1 Main Machine Controller to indicate the solution level in the tank. This signal is proportional to the solution level. An icon on the LCD display indicates the solution level in the tank.

If the solution level has been low longer than 10 seconds, the LCD display will show the solution level low caution icon. The conditions under which the solution level low icon is displayed depend on the state of the extended scrub system as follows:

- With the extended scrub system off:
  - If the clean solution is low, the solution level low icon will be displayed.
  - If the clean solution is not low, the solution level low icon will not be displayed.
- With the extended scrub system on:
  - If the extended scrub solution level in the recovery tank is not low, the solution level low icon will not be displayed.
  - If the extended scrub solution level is low but the clean solution level is not low, the solution level low icon will not be displayed.
  - If both the extended scrub and clean solution levels are low, the solution level low icon will be displayed.

Solution System Wiring Diagram



Circuit Description

The Following Conditions Must be Met for the Solution System to Operate

- The **Hopper Interlock Switch S3** must be closed.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed (battery machines) or jumpered (Diesel and LP machines).
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-12**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breakers **VACC1/CB1** and **VACC2/CB2**.
- Circuit breaker **VACC1/CB1** must be closed to provide positive voltage to **Solution Valve L1**.
- Circuit breaker **VACC2/CB2** must closed to provide positive voltage to the **Solution Control Pump M19** (EcoFlex™ machines only). (Note that **VACC2/CB2** must closed to provide positive voltage to the **Extended Scrub Pump M25** and **Low Pressure Pump M23** as well.)
- The **J2-20 PWM Output** provides negative ground to **Solenoid Valve L1,** and the **J3-2 PWM Output** provides negative ground to the **Solution Control Pump M19** under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the scrub switch.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or (optional) in reverse.

The Following Conditions Must be Met for the Extended Scrub System to Operate

The extended scrub system requires the same conditions to operate as does the solution system, with the following additions:

- The extended scrub function must be installed in the configuration menu.
- The **J3-1 PWM Output** provides the negative ground to the **Extended Scrub Pump M25** under the following conditions:
  - The **A1 Main Machine Controller** must receive a low-solution signal via the **CAN BUS** from the **A3 Control Panel**.
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the extended scrub switch.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or reverse.

– The **Extended Scrub Level** (float) **Switch S4** in the recovery tank must be open to prevent the **J7-15 Input** from going to battery negative. Note the switch opens when there is adequate water in the recovery tank, and closes when the recovery tank is empty.

The Following Conditions Must be Met for the Low Pressure Wash Hose to Operate

Note: *The low pressure wash hose does not require the interlocks to be closed to operate.*

- The low pressure wash function must be installed in the configuration menu.
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides voltage to the **Key Switch Input J7-13**.
- Circuit breaker **VACC2/CB2** must closed to provide positive voltage to the **Low Pressure Pump M23**.
- The **J3-24 Output** must provide negative ground to the **Low Pressure Pump M23**. This output will be active whenever the key switch is on.
- The internal pressure switch in the **Low Pressure Pump M23** must be closed for the pump to run.

Note: *The internal pressure switch in the low pressure pump is set to switch the pump on at 25 psi ± 5 psi (when the hose nozzle is opened), and shut pump off at 45 psi (when the hose nozzle is closed).*

The Following Conditions Must be Met for the EcoFlex™ System to Operate

The **J2-19**, **J2-7**, **J2-32** and **J2-21 PWM Outputs** provide power to the **Chemical Metering Pumps M17** and **M18** respectively under the following conditions:

- The detergent system and EcoFlex™ system must both be installed in the configuration menu.
- The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the scrub and EcoFlex™ switches.
- The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or reverse.

The Following Conditions Must be Met for the High-pressure Spray System to Operate

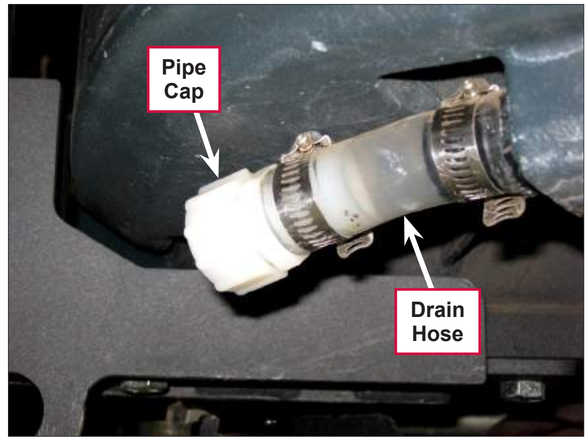
- The high pressure wash system must be installed in the configuration menu.
- The **J3-8 Output** provides positive voltage to the **High Pressure Pump Clutch** under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the scrub and detergent systems are enabled.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or reverse.
- The **High Pressure Pump Clutch** must be connected to battery negative.

Component Locations

Solution Tank

Drain Hose

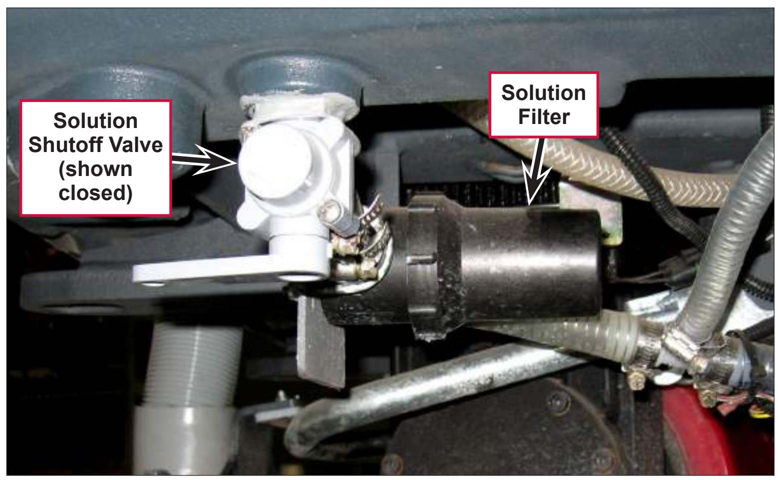
The **Drain Hose** underneath the rear right-hand side of the solution tank allows you to drain the solution tank. To drain the tank, remove the **Pipe Cap**.



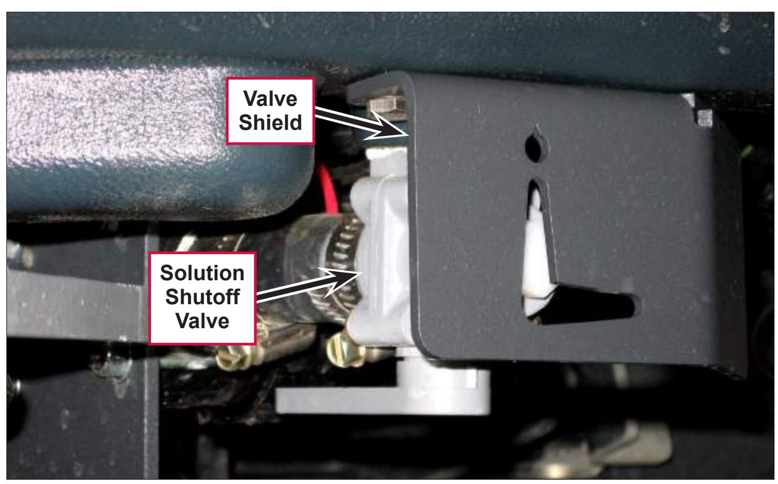
Solution Filter and Solution Shutoff Valve

The **Solution Filter** and **Solution Shutoff Valve** are mounted underneath the rear right-hand side of the solution tank.

- The **Solution Filter** prevents any dirt or particulates that may be in the solution tank from entering the solution solenoid valve and solution system.
- The **Solution Shutoff Valve** allows you shut off the solution flow to the machine for solution system maintenance.

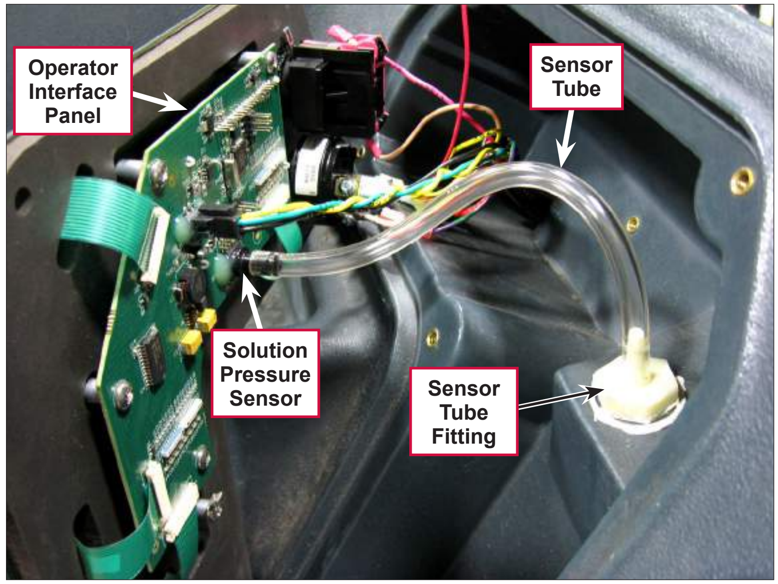


Note: *There is a* ***Valve Shield*** *mounted onto the solution tank that is not shown in the above photo. The* ***Valve Shield*** *is designed to prevent damage to the* ***Solution Shutoff Valve****.*



Solution Pressure Sensor

The **Solution Pressure Sensor** on the back of the **Operator Interface Panel** uses the air pressure in the **Sensor Tube** to determine the solution level in the tank. The **Sensor Tube** is connected via the **Sensor Tube Fitting** to a hollow vertical tube inside the solution tank. This vertical tube is open at the bottom and is filled with air. The solution in the tank will exert pressure on the air in the tube proportional to the level of solution in the tank. The **Solution Pressure Sensor** monitors the air pressure in the **Sensor Tube** and converts this pressure value to a solution level as shown on the LCD display on the **Operator Interface Panel**.

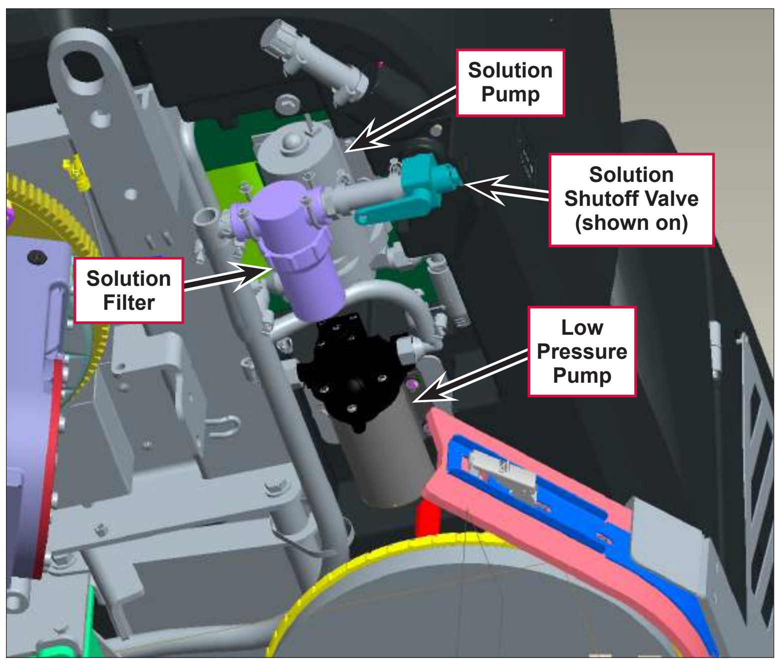


Solution Pump (EcoFlex™ Models Only)

The **Solution Pump** is mounted underneath the rear right-hand side of the solution tank and pumps the solution to the solution solenoid valve.

Low Pressure (Wash Hose) Pump

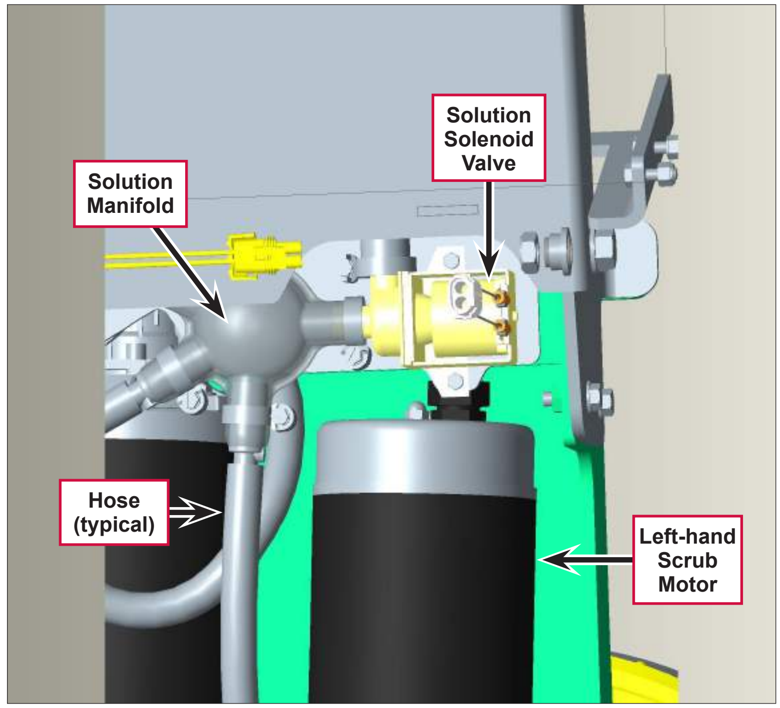
The optional **Low Pressure** (wash hose) **Pump** is mounted next to the **Solution Pump** underneath the rear right-hand side of the solution tank. The **Low Pressure Pump** pumps solution to the optional wash hose behind the Operator seat.



Solution Solenoid Valve

The **Solution Solenoid Valve** is located on the top center of the scrub deck and supplies the solution to the **Solution Manifold**. The **Solution Manifold** connects to the three **Hoses** going to the three scrub brushes. Note that the adjacent drawing is a top view looking down onto the scrub deck.

Note that the **Solution Solenoid Valve** is designed to be easy to remove and install. It is possible for dirt or debris to interfere with the **Solution Solenoid Valve** seat and prevent the seat from sealing. This can prevent the **Solution Solenoid Valve** from shutting off the solution flow completely and requires that the **Solution Solenoid Valve** be cleaned or replaced.

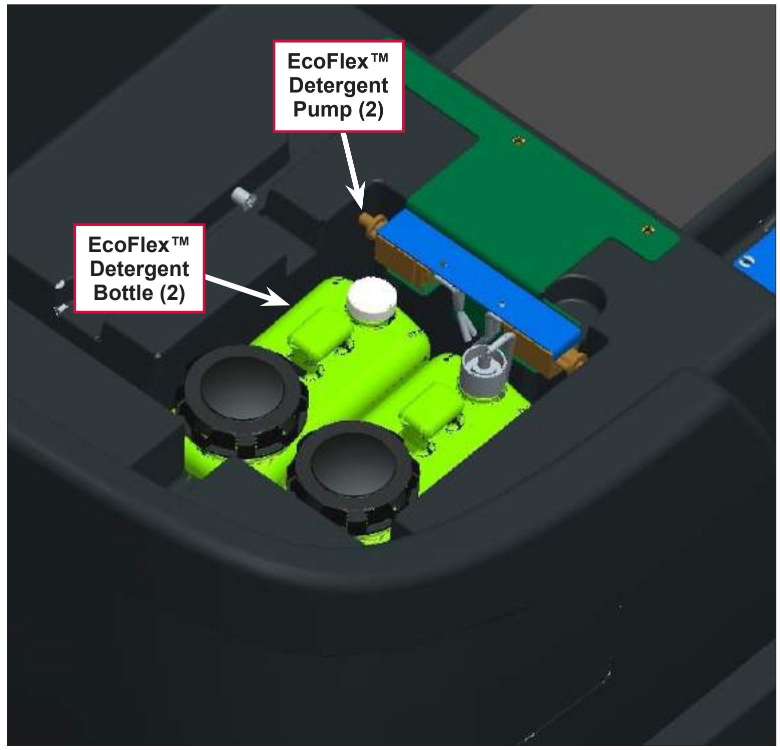


Solution Nozzles

The **Solution Nozzles** are part of the deck weldment and direct the solution onto the brushes. (The right-hand scrub motor has been loosened and moved slightly in order to show the **Solution Nozzle**.)

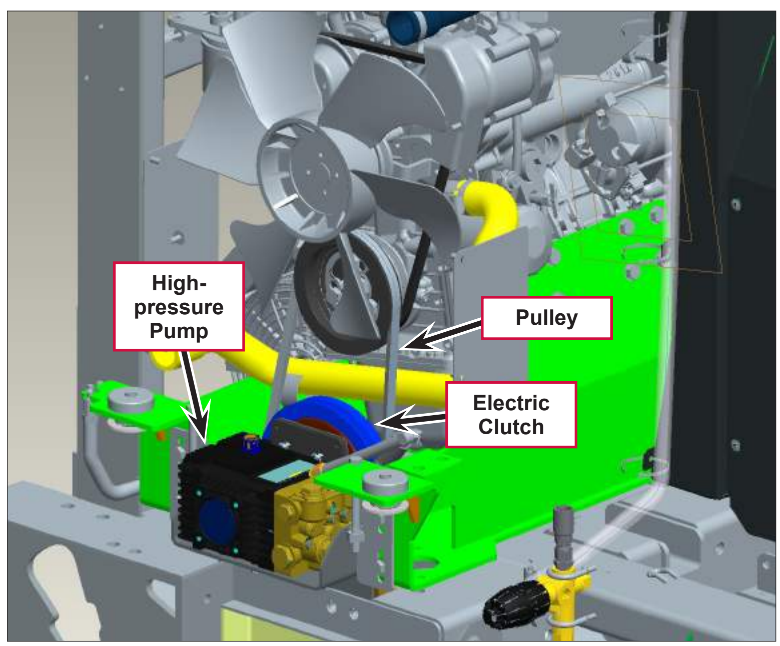
EcoFlex™ Detergent Bottles and Pumps

The **EcoFlex™ Detergent Bottles** are located underneath the Operator seat and supply detergent to the two **EcoFlex™ Detergent Pumps**. The two **EcoFlex™ Detergent Pumps** run simultaneously and pump detergent through separate lines that merge into one main detergent supply line. The detergent supply line is plumbed into the solution supply upstream of the solution solenoid valve.



High-pressure Spray System Pump

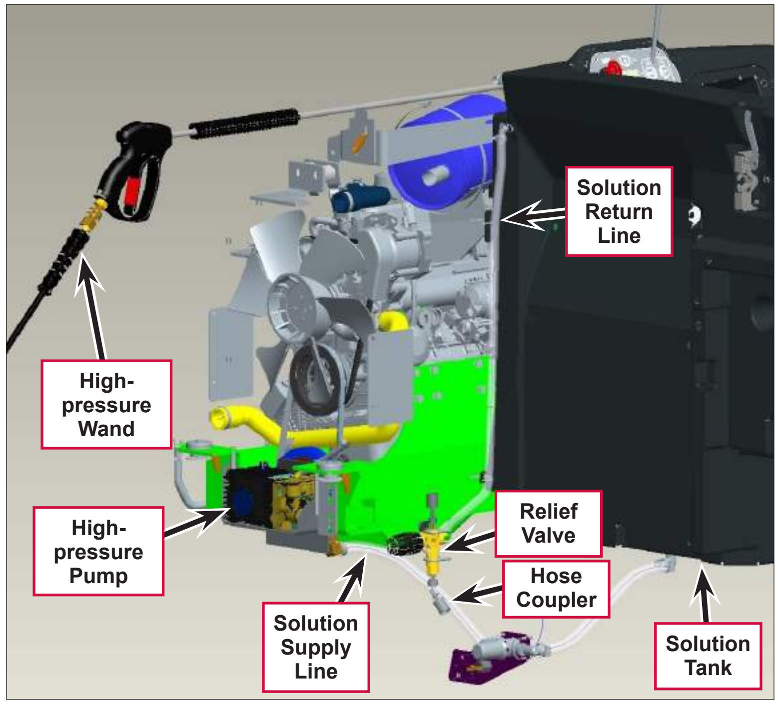
The **High-pressure Pump** is driven by an **Electric Clutch** run by a **Pulley** off of the engine. The **Electric Clutch** is engaged and drives the **High-pressure Pump** when the Operator presses the high-pressure wand switch  on the control panel.



The **Solution Supply Line** supplies solution from the **Solution Tank** to the **High-pressure Pump**. The **High-pressure Pump** pumps the solution to the **Relief Valve** which functions as follows:

- If the trigger valve on the **High-pressure Wand** is open, the solution flows through the **Hose Coupler** and to the attached **High-pressure Wand**.
- If the trigger valve on the **High-pressure Wand** is closed, the **Relief Valve** directs the solution into the **Solution Return Line** and back into the **Solution Tank**.

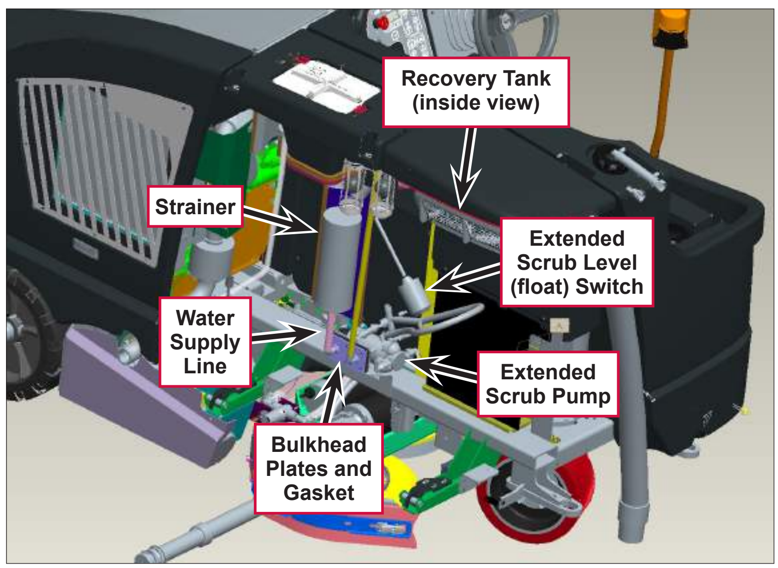
Note that the **Relief Valve** is pre-set at the factory and is not adjustable.



Extended Scrub System

When the **Extended Scrub Level** (float) **Switch** inside the **Recovery Tank** closes to indicate adequate water level, the **Extended Scrub Pump** switches on to pump water to the scrub brushes. The water passes through the **Strainer** inside the **Recovery Tank**, then through the **Water Supply Line** in the **Bulkhead Plates and Gasket** to the inlet side of the **Extended Scrub Pump**. Note that the second piece of conduit in the **Bulkhead Plates and Gasket** is for the **Extended Scrub Level Switch** wires.

The **Extended Scrub Pump** is mounted to a bracket outside of the **Recovery Tank**. The water from the **Extended Scrub Pump** is plumbed into the solution line upstream of the solution solenoid valve.



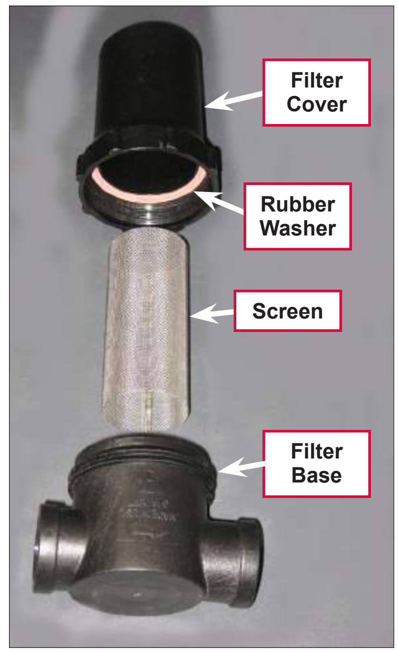
Maintenance and Adjustments

Warning! ***Before performing any machine maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Clean the Solution Filter Screen

1. Close the solution shutoff valve.

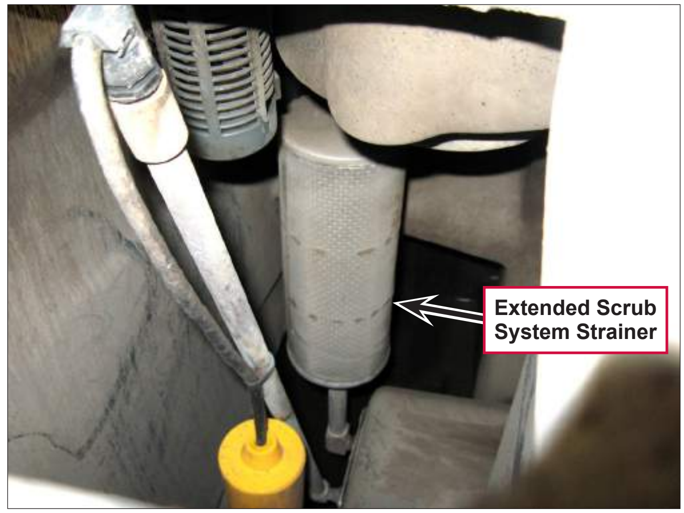
Note: *Place a suitable container underneath the filter to catch any solution that may leak from the hoses.*



2. Unscrew the **Filter Cover** and remove the **Filter Cover** and **Screen** from the **Filter Base**.
3. Clean any accumulated dirt or debris from the **Screen**.
4. Reinstall the **Screen** into the **Filter Base**.
5. Make sure the **Rubber Washer** is installed correctly in the **Filter Cover**, then reinstall and hand-tighten the **Filter Cover**.

To Clean the Extended Scrub System Strainer

1. Open the recovery tank cover and remove the debris basket.
2. Rinse any accumulated material off of the **Extended Scrub System Strainer** using normal water hose pressure.
3. Reinstall the debris basket and close the recovery tank cover.

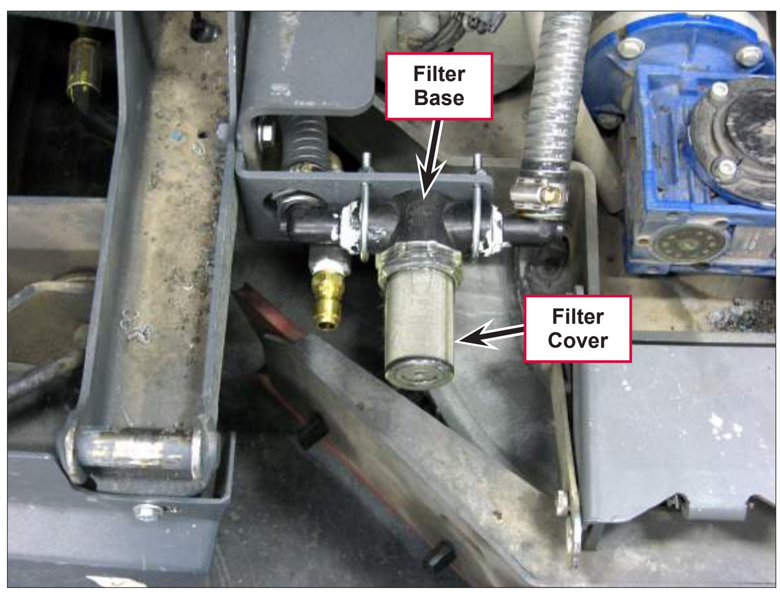


To Clean the High Pressure Solution Filter

1. Drain and remove the recovery tank.

Note: *Place a suitable container underneath the filter to catch any solution that may leak from the hoses.*

2. Unscrew the **Filter Cover** and remove the **Filter Cover** and screen from the **Filter Base**.
3. Clean any accumulated dirt or debris from the screen.
4. Reinstall the screen into the **Filter Base**.
5. Make sure the rubber washer is installed correctly in the **Filter Cover**, then reinstall and hand-tighten the **Filter Cover**.



To Adjust the Belt Tension on the High Pressure Pump

1. Drain and remove the recovery tank.

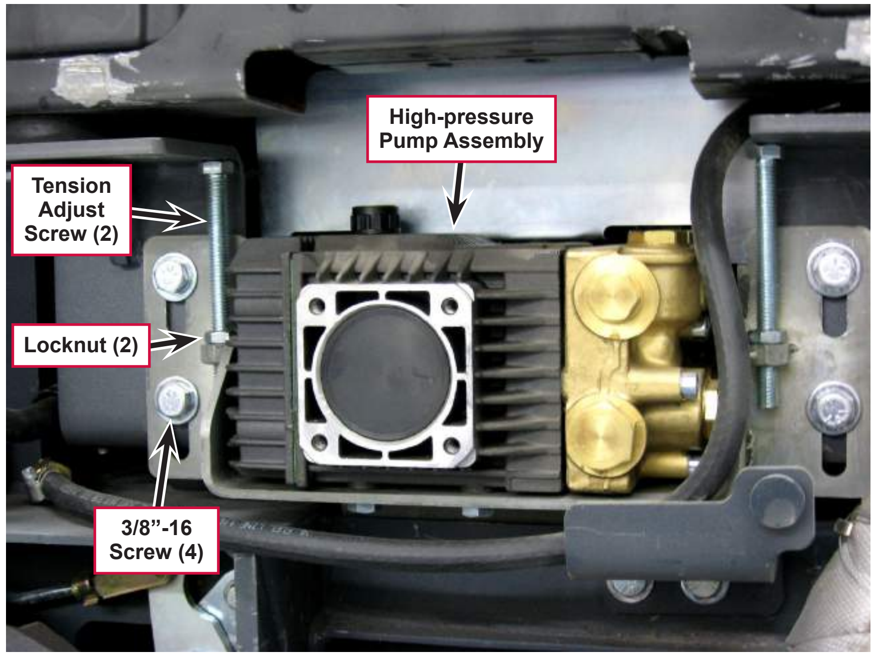
2. Loosen the four **3/8”-16 Screws** holding the **High-pressure Pump Assembly** to the machine frame.

3. Loosen the **Locknuts** on the two **Tension Adjust Screws**.

4. Adjust the **Tension Adjust Screws** to move the **High-pressure Pump Assembly** up or down as necessary to obtain the correct drive belt tension as follows:

   - **LP Machines** - the belt deflection at the center of the span should be 0.109” with an applied force between 4.9 and 7.1 lbs.

   - **Diesel Machines** - the belt deflection at the center of the span should be 0.134” with an applied force between 4.9 and 7.1 lbs.



5. When the belt tension is correct:

   a. Hold the **Tension Adjust Screws** in position to keep them from turning, then tighten the **Locknuts**.

   b. Tighten the four **3/8”-16 Screws**.

Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
The solution system does not operate.	An interlock is not closed.	Before you start troubleshooting a specific system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed. • The A1 Main Machine Controller is receiving the appropriate signal from the A3 Control Panel via the CAN BUS.
Inadequate solution flow to the brushes in the scrub mode	Inadequate solution level in tank	Check the solution level.
	The solution filter screen is plugged.	Clean the solution filter screen.
	The solution shutoff valve is plugged or inoperative.	Clean or replace the solution shutoff valve.
	The solution solenoid valve is plugged or not functioning.	Check the solution solenoid coil resistance. It should measure 72 ohms ± 10%. If the coil resistance is not within spec replace the solution solenoid valve.
	The solution manifold/solution hoses/solution nozzles are plugged.	Check and clean the manifold/hoses/solution nozzles as necessary.
	The solution control pump (**M19**) is not operating (EcoFlex™ machines only).	Check for voltage at the pump. • If there is voltage at the pump, replace the pump. • If there is no voltage at the pump: 1. Check the wiring and circuit breakers upstream of the pump. 2. Check the **J3-2** output from A1 Main Machine Controller.

Problem	Cause	Correction
Inadequate solution flow to the brushes in the extended scrub mode	The extended scrub function is not installed in the configuration menu.	Install the extended scrub function in the configuration menu.
	The stainer in the recovery tank is dirty or plugged.	Remove and clean the strainer.
	The extended scrub level (float) switch (**S4**) is not providing a ground to **J7-15 Input** on A1 Main Machine Controller.	The switch should be closed when in the lowermost position (tank empty), and open when in the uppermost position (tank full). If the continuity through the switch in its upper and lower positions is not correct: 1. Check the wiring and repair as necessary. 2. If the wiring is OK, replace the switch.
	The extended scrub pump (**M25**) is not operating correctly.	Check for voltage at the pump. • If there is voltage at the pump, replace the pump. • If there is no voltage at the pump: 1. Check the wiring and circuit breakers upstream of the pump. 2. Check the **J3-1** output from A1 Main Machine Controller.
No detergent flow to the solution system	The detergent and EcoFlex™ functions are not installed in the configuration menu.	Install both the detergent and EcoFlex™ functions in the configuration menu.
	The detergent supply lines are clogged.	Check the detergent lines and clean/replace as necessary.
	One or both of the detergent pumps are not operating correctly.	Check for voltage at the pumps. • If there is voltage at a pump, replace the pump. • If there is no voltage at a pump: 1. Check the wiring from **J2-19** and **J2-7**, and **J2-32** and **J2-21** to the pumps. 2. Check the **J2-19**, **J2-7**, **J2-32** and **J2-21** outputs from A1 Main Machine Controller.
The hot water system is not operating.	The solution is not circulating through the heat exchanger.	Check the solution hoses to and from the heat exchanger and repair/replace as necessary.

Problem	Cause	Correction
The high-pressure spray system is not operating.	The high-pressure wand switch on the control panel has not been pressed.	Press the high-pressure wand switch to engage the high-pressure solution pump.
	The high pressure wash function is not installed in the configuration menu.	Install the high pressure wash function in the configuration menu.
	The solution filter screen is plugged.	Clean the solution filter screen.
	The high-pressure pump clutch is not engaging.	Check that the belt on the engine pulley is driving the clutch pulley. Adjust the belt tension or replace the belt as necessary.
		Check the connection from the clutch to battery ground and repair as necessary.
		Check the output from **J3-9** on A1 Main Machine Controller. If there is voltage from **J3-9** to the clutch, replace the clutch.
	The relief valve is not operating.	Replace the relief valve.
The low-pressure wash hose is not operating.	The low pressure wash function is not installed in the configuration menu.	Install the low pressure wash function in the configuration menu.
	The low-pressure pump (**M23**) is not operating.	Check for voltage at the pump. • If there is voltage at the pump, replace the pump. • If there is no voltage at the pump: 1. Check the wiring and circuit breakers upstream of the pump. 2. Check the **J3-24** output from A1 Main Machine Controller.

Removal and Installation

Warning! ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

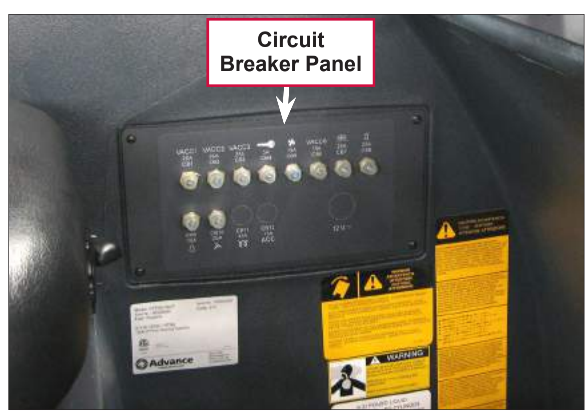
To Remove and Reinstall the Solution Tank

Caution: ***The solution tank is relatively heavy. It's recommended that the solution tank be removed by two or more persons, using the appropriate equipment, to prevent possible personal injury or damage to the solution tank.***

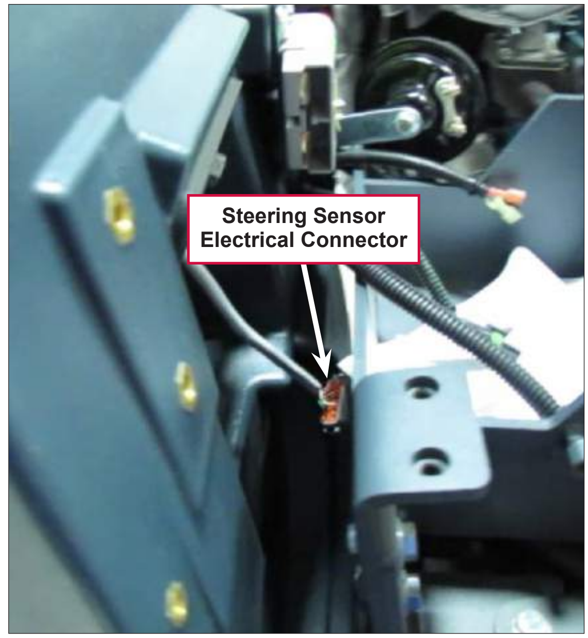
1. Disconnect the battery/batteries.
2. Drain and remove the recovery tank.
3. Drain the solution tank.
4. Disconnect the solution hoses from the solution tank.
5. Disconnect the electrical connector from the **Drive Pedal**.
6. Remove the **Brake Pedal Cover Weldment**.

7. Remove the **Circuit Breaker Panel** and disconnect the circuit breaker connectors.

Note: *Label the circuit breaker connectors as you remove them to make sure they are reconnected correctly.*

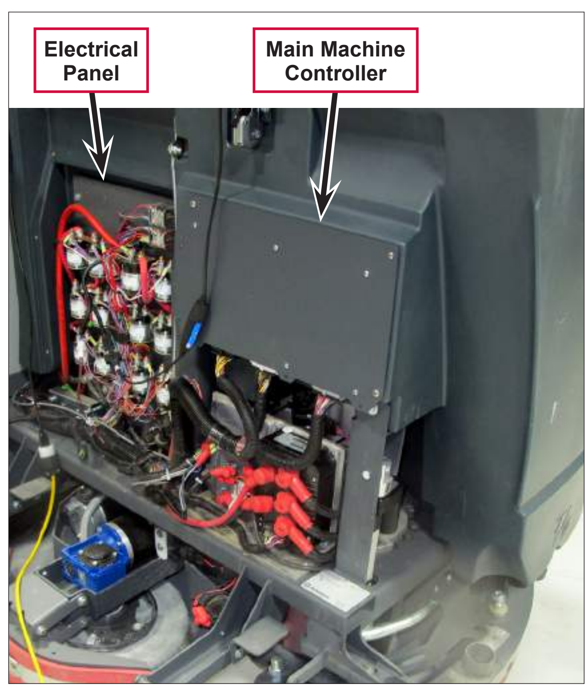


8. Disconnect the **Steering Sensor Electrical Connector**.



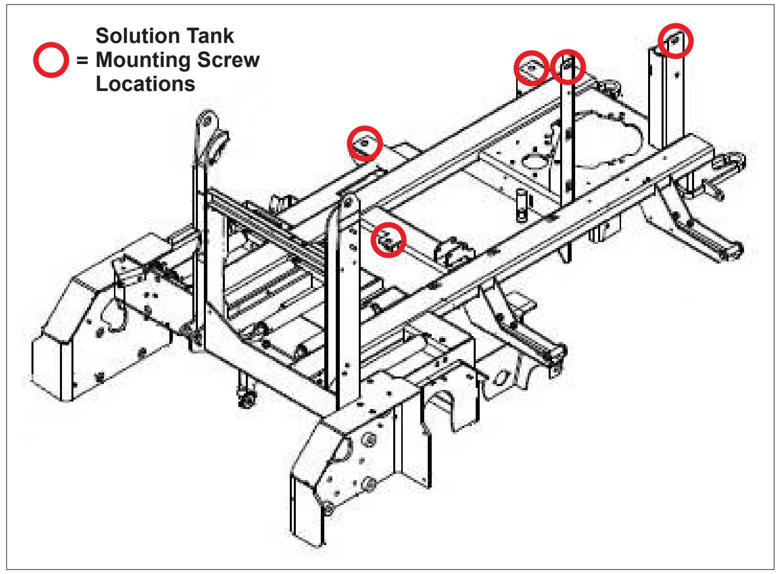
9. Disconnect the additional wiring running from the solution tank to the engine (ground, starter, engine interface, etc.).

10. Remove the **Electrical Panel**.
11. Remove the **Main Machine Controller**.
12. Disconnect any additional solution lines or electrical connectors from the solution tank that may be present if your machine is equipped with an extended scrub system, high-pressure spray system or wash hose kit.

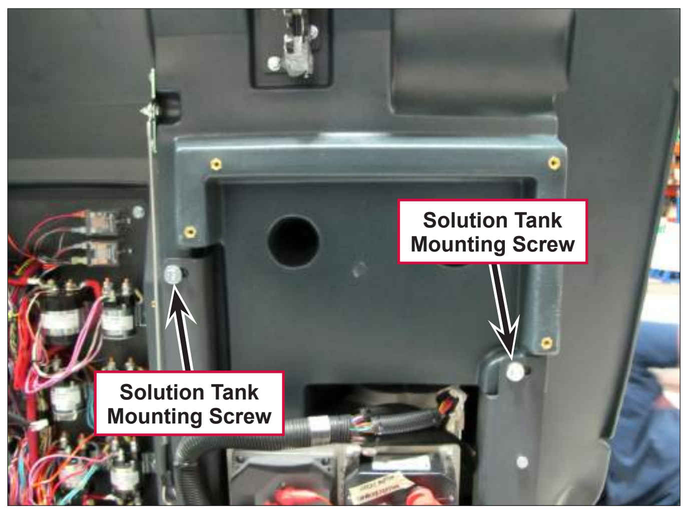


13. Remove the five mounting screws holding the solution tank to the frame. The mounting screw locations are shown below.

    The three bottom mounting screws are located underneath the machine - two on the right side and one in the center of the frame. The two top mounting screws are located on the vertical supports on the left side of the machine where the main machine controller is mounted.



    The two top **Solution Tank Mounting Screws** are located on the vertical supports on the left side of the machine.



    The bottom rear **Solution Tank Mounting Screw** is located underneath the machine on the right side by the solution shutoff valve and drain hose.

The bottom center **Solution Tank Mounting Screw** is located underneath the machine by the right-hand side squeegee assembly.

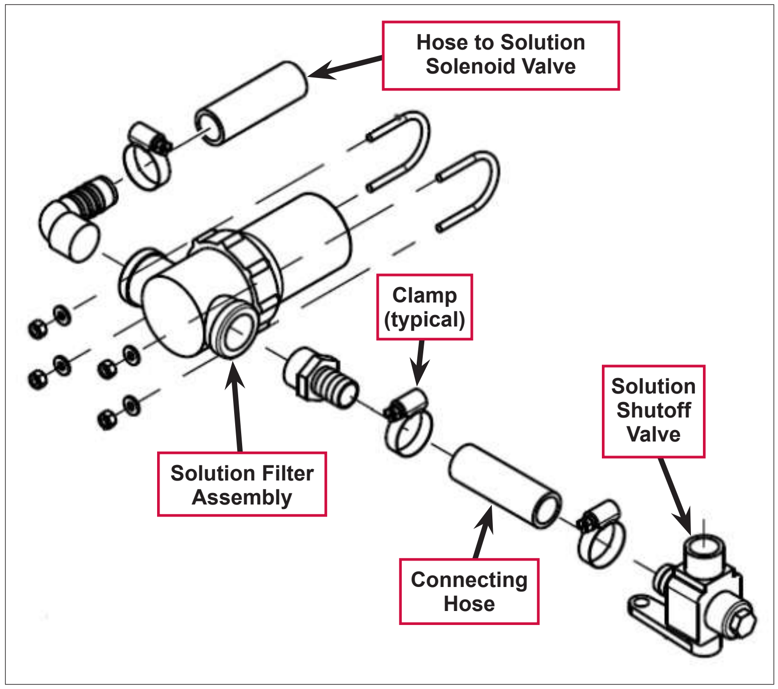
The bottom front **Solution Tank Mounting Screw** is located underneath the machine by the main broom actuator and scrub deck actuator.

14. Remove the solution tank from the machine.
15. Reinstall the solution tank by following the above steps in reverse order.

To Remove and Reinstall the Solution Shutoff Valve

1. Drain the solution tank.
2. Remove the valve shield.
3. Remove the nuts, washers and U-bolts holding the **Solution Filter Assembly** to the mounting plate.

> ***Note:*** *Place a suitable container underneath the shutoff valve to catch any solution that may leak from the hoses or filter.*



4. Loosen the clamp holding the **Connecting Hose** to the **Solution Shutoff Valve**, then disconnect the **Connecting Hose** and attached **Solution Filter Assembly** from the **Solution Shutoff Valve**.
5. Carefully unscrew the **Solution Shutoff Valve** from the solution tank.
6. Reinstall the **Solution Shutoff Valve** by following the above steps in reverse order.

> ***Service Note:*** *Apply Loctite® "No More Leaks" White Threaded Plastic Pipe Sealant to the* ***Solution Shutoff Valve*** *threads before installing it into the solution tank. Make sure the* ***Solution Shutoff Valve*** *is oriented correctly on the tank so the barbed fitting on the* ***Solution Shutoff Valve*** *aligns with* ***Connecting Hose*** *on the* ***Solution Filter Assembly****.*

To Remove and Reinstall the Solution Filter Assembly

1. Close the **Solution Shutoff Valve**.
2. Remove the nuts, washers and U-bolts holding the **Solution Filter Assembly** to the mounting plate.

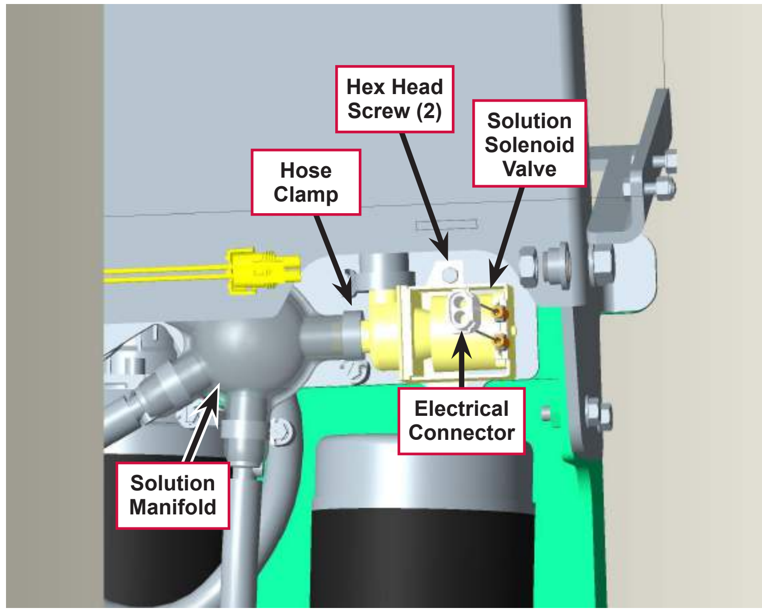
> ***Note:*** *Place a suitable container underneath the filter to catch any solution that may leak from the filter or hoses.*

3. Loosen the clamp holding the **Connecting Hose** to the **Solution Filter Assembly**, then remove the **Connecting Hose** from the **Solution Filter Assembly**.
4. Loosen the clamp on the **Hose** that runs from the **Solution Filter Assembly** to the **Solution Solenoid Valve** and remove the **Hose** from the **Solution Filter Assembly**.
5. Remove the **Solution Filter Assembly** from the machine.
6. Reinstall the **Solution Filter Assembly** by following the above steps in reverse order.

To Remove and Reinstall the Solution Solenoid Valve

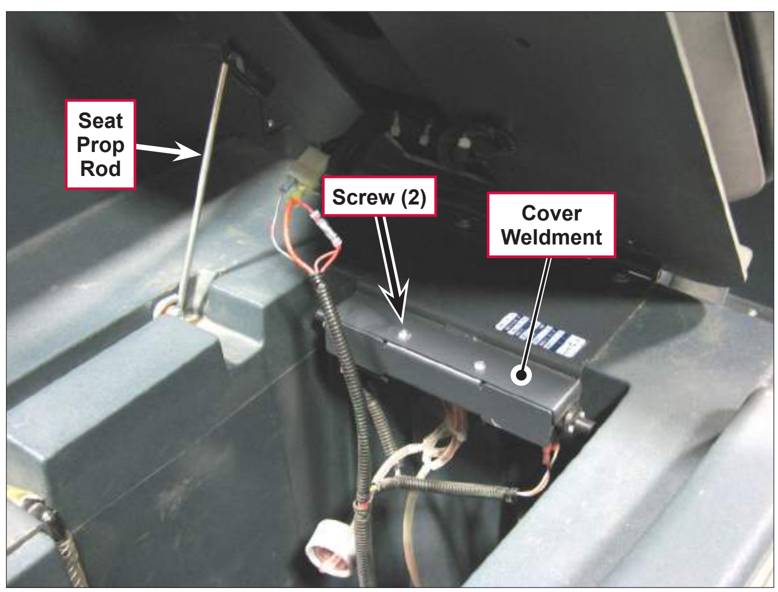
Service Note: *You can remove and the reinstall the solution solenoid valve with the scrub deck either in or out of the machine.*

1. Empty and remove the recovery tank from the machine.
2. Remove the scrub deck from the machine (if desired). (Refer to the ***Scrub System*** section.)
3. Disconnect the **Electrical Connector** on the **Solution Solenoid Valve** from the adjacent wiring harness. Note that you may need to cut the wire tie holding the **Solution Solenoid Valve** wires to the **Solution Manifold**.
4. Loosen the **Hose Clamp** holding the **Solution Solenoid Valve** to the **Solution Manifold**.
5. Remove the two **Hex Head Screws** holding the **Solution Solenoid Valve** to the deck assembly and remove the **Solution Solenoid Valve** from the machine.
6. Reinstall the **Solution Solenoid Valve** following the above steps in reverse order.



To Remove and Reinstall a Detergent Pump (EcoFlex™ Models Only)

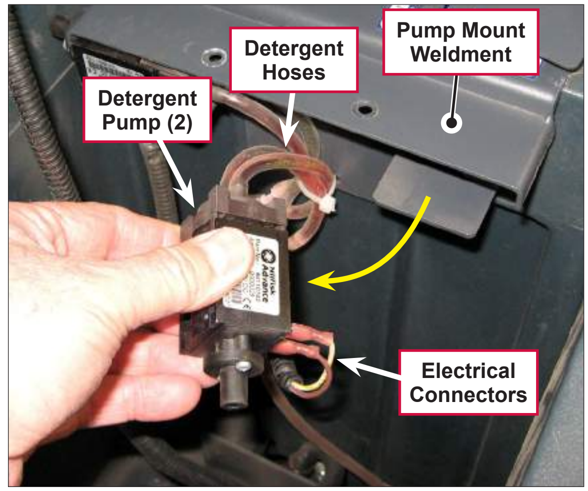
1. Lift up the Operator seat and engage the **Seat Prop Rod**.
2. Remove the detergent bottles.
3. Remove the two **Screws** holding the **Cover Weldment** and remove the **Cover Weldment**.



4. Carefully slide the **Detergent Pump** out of the **Pump Mount Weldment**.

5. Disconnect the **Detergent Hoses** and **Electrical Connectors**, then remove the **Detergent Pump** from the machine.

6. Reinstall the **Detergent Pump** by following the above steps in reverse order.



Specifications

Component	Specifications
Solution Solenoid Valve	36V, Coil Resistance - 72 ohms ± 10%
EcoFlex™ Detergent Pump	Type - diaphragm dosing pump with stroke adjustment
	Voltage - 12 VDC
	Flow Calibration - 87 ml/min ± 3 ml/min
	Water Lift - 3.5 in
Solution Control Pump (EcoFlex™ models only) Extended Scrub Pump	Type - diaphragm, self-priming, internal check valve
	Voltage - 36 VDC, permanent magnet
	Current - 3.9 Amps max.
	Flow Rate - 3.3 GPM @ 2.75 Amps with 20 psi inlet pressure

<table>
<tr><th>Component</th><th colspan="3">Specifications</th></tr>
<tr><td rowspan="11">Low-pressure (Wash Hose) Pump</td><td colspan="3">Type - diaphragm, self-priming, internal check valve</td></tr>
<tr><td colspan="3">Voltage - 36 VDC, permanent magnet</td></tr>
<tr><td colspan="3">Internal pressure switch:
• Set to switch pump on at 25 ± 5 psi
• Set to shut pump off at 45 psi</td></tr>
<tr><td colspan="3">Performance Specifications (average)</td></tr>
<tr><td>Pressure (psi)</td><td>GPM</td><td>Amps</td></tr>
<tr><td>10</td><td>3.16</td><td>2.1</td></tr>
<tr><td>20</td><td>3.00</td><td>2.6</td></tr>
<tr><td>30</td><td>2.76</td><td>2.9</td></tr>
<tr><td>40</td><td>2.62</td><td>3.2</td></tr>
<tr><td>50</td><td>2.26</td><td>3.5</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="7">High Pressure Pump</td><td colspan="3">Type - Axial piston</td></tr>
<tr><td colspan="3">Max. Pump Speed - 1750 RPM</td></tr>
<tr><td colspan="3">Max. Flow Rate - 2.11 gpm [8 l/min]</td></tr>
<tr><td colspan="3">Max Outlet Pressure - 2,200 psi [150 bar]</td></tr>
<tr><td colspan="3">Max Inlet Pressure - 116 psi [8 bar]</td></tr>
<tr><td colspan="3">Oil Type - SAE 30, 10 oz. capacity</td></tr>
<tr><td colspan="3">Shaft Rotation - counterclockwise, horizontal mounting only</td></tr>
</table>

Special Tools

Loctite® “No More Leaks” White Threaded Plastic Pipe Sealant (used on solution shutoff valve threads)	

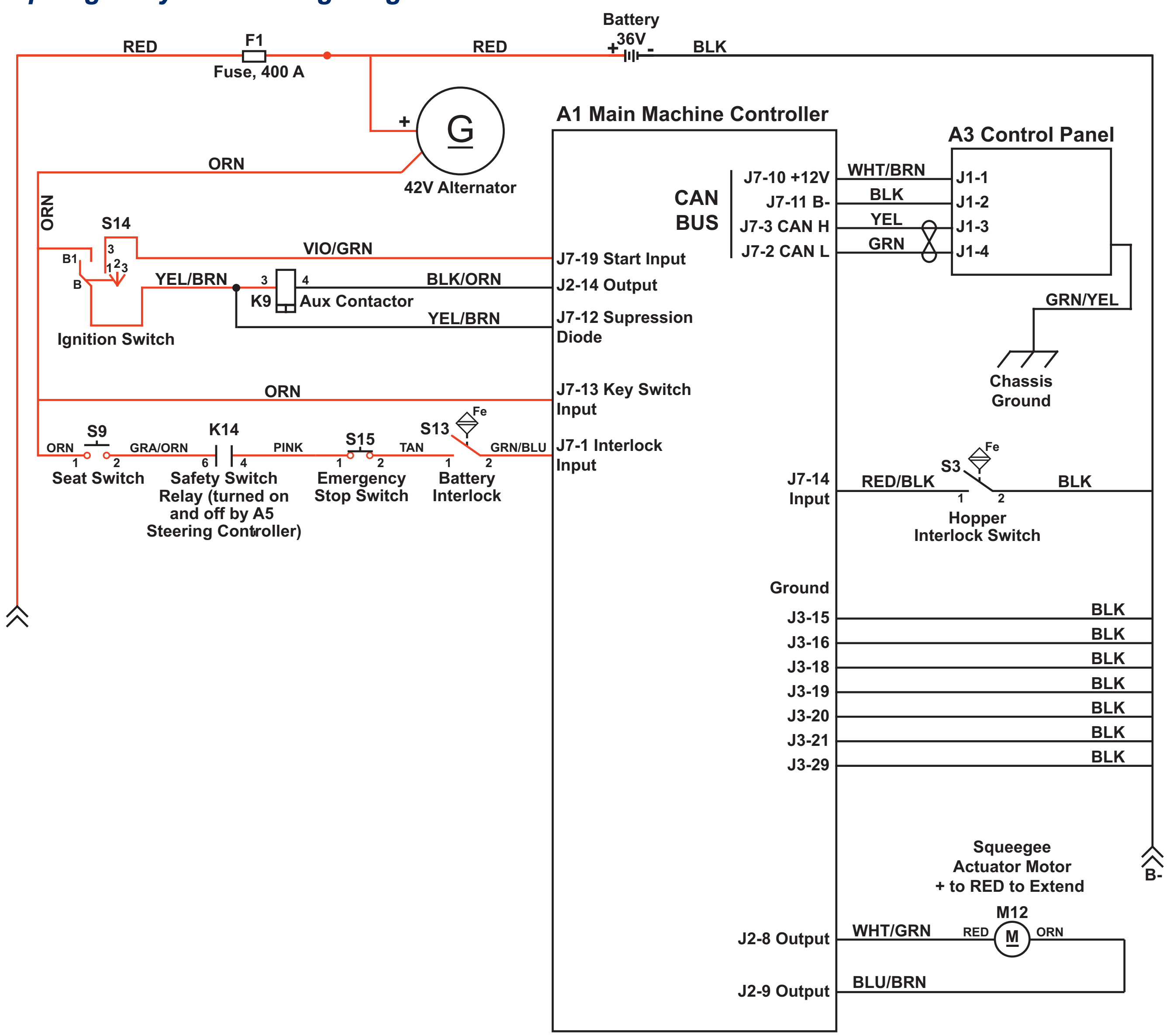
Squeegee System

Functional Description

Overview

The squeegee assembly is mounted at the bottom rear of the machine and picks up the water from the floor. Two squeegee blades (front and rear) pick up the water and direct it into the squeegee support assembly. A vacuum hose attached to the support assembly lifts the water from the squeegee and directs it to the recovery tank. The squeegee lift actuator raises and lowers the squeegee as appropriate for the operation being performed. The squeegee mounting system is designed to allow the squeegee blades enough side-to-side movement to conform to the floor surface and swing sideways when turning.

Squeegee System Wiring Diagram



Circuit Description

The following conditions must be met for the squeegee system to operate:

- The **Hopper Interlock Switch S3** must be closed.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed.
- The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the CAN BUS that the operator has pressed the scrub switch.
- The **J2-8** and **J2-9 Outputs** from the **A1 Main Machine Controller** provide voltage to the **Squeegee Actuator Motor M12**. The output polarity determines whether the **Squeegee Actuator Motor** lowers or raises the squeegee.

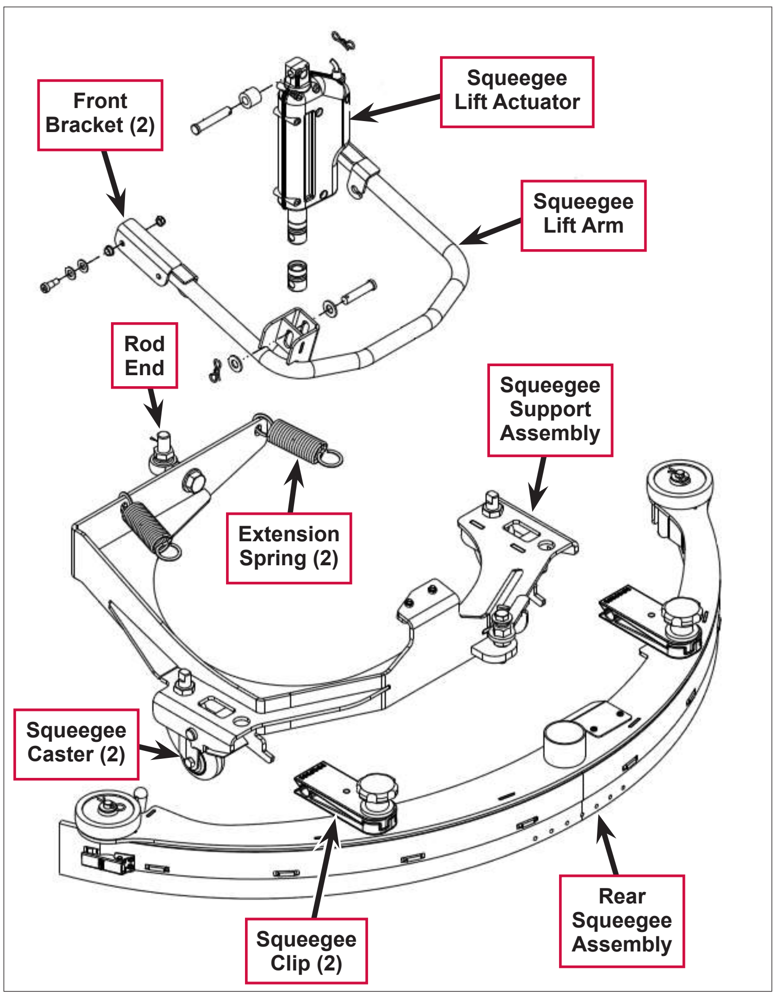
Component Locations

The **Rear Squeegee Assembly** is attached to the **Squeegee Support Assembly** with two split **Squeegee Clips** that clamp onto horizontal pins in the **Squeegee Support Assembly**.

The front of the **Squeegee Support Assembly** is attached to the machine frame by a pivoting **Rod End**. This allows the rear of the **Squeegee Support Assembly** and attached squeegee to tilt up and down, and pivot side-to-side to conform to the floor surface. The two **Squeegee Casters** support the **Squeegee Support Assembly** on the floor.

The rear of the **Squeegee Support Assembly** rests on and is supported by the **Squeegee Lift Arm**. The pivoting **Front Brackets** on the **Squeegee Lift Arm** are attached to the machine frame. The **Squeegee Lift Actuator** raises and lowers the rear of the **Squeegee Lift Arm**, which pivots up and down to raise and lower the **Squeegee Support Assembly** and the attached **Rear Squeegee Assembly**.

The **Squeegee Support Assembly** and **Rear Squeegee Assembly** swing left-to-right to allow the **Rear Squeegee Assembly** to pick up water on the inside of the corner when machine is turning. The **Extension Springs** re-center the **Squeegee Support Assembly** and **Rear Squeegee Assembly** once the machine is again moving in a straight line.

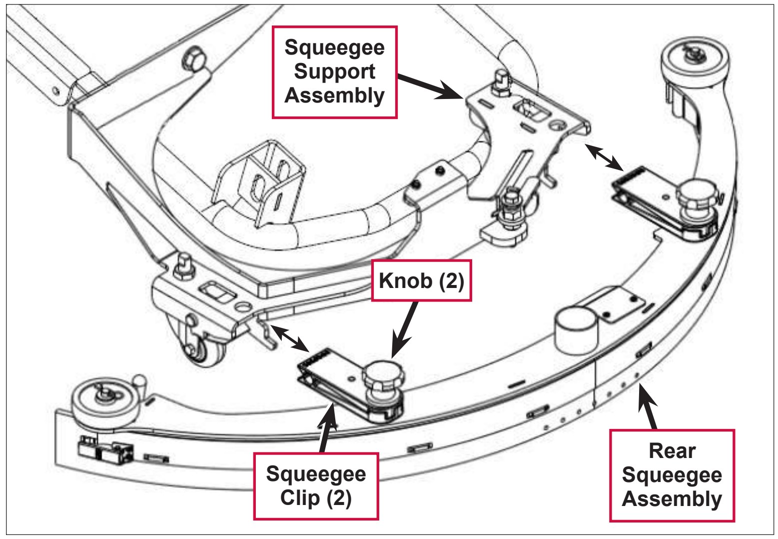


Maintenance and Adjustments

Warning!** **Before performing any squeegee maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.

To Remove and Reinstall the Squeegee Blades

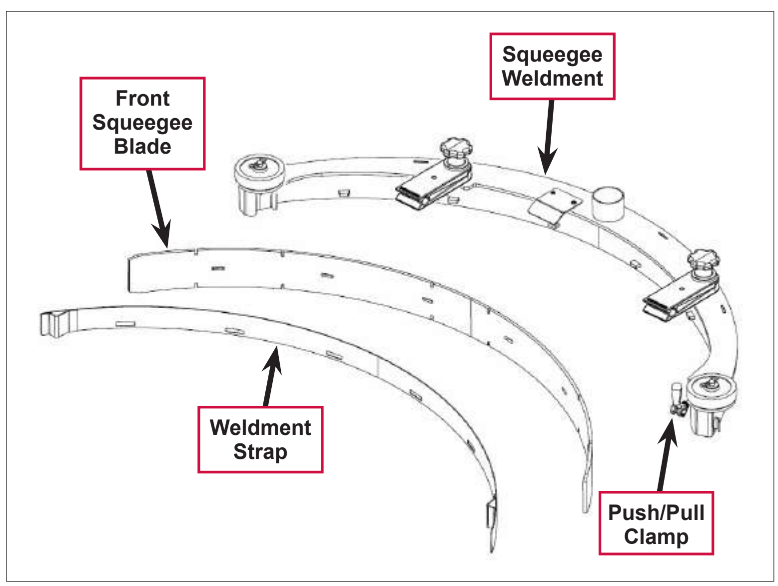
1. Raise the squeegee to its retracted position.
2. Disconnect the vacuum hose from the **Rear Squeegee Assembly**.
3. Loosen the two **Knobs** on the **Squeegee Clips** and pull the **Rear Squeegee Assembly** away from the **Squeegee Support Assembly**.



Note: *The **Squeegee Blades** have four usable edges and can be rotated end-for-end or top-to-bottom to position a new blade surface on the floor.*

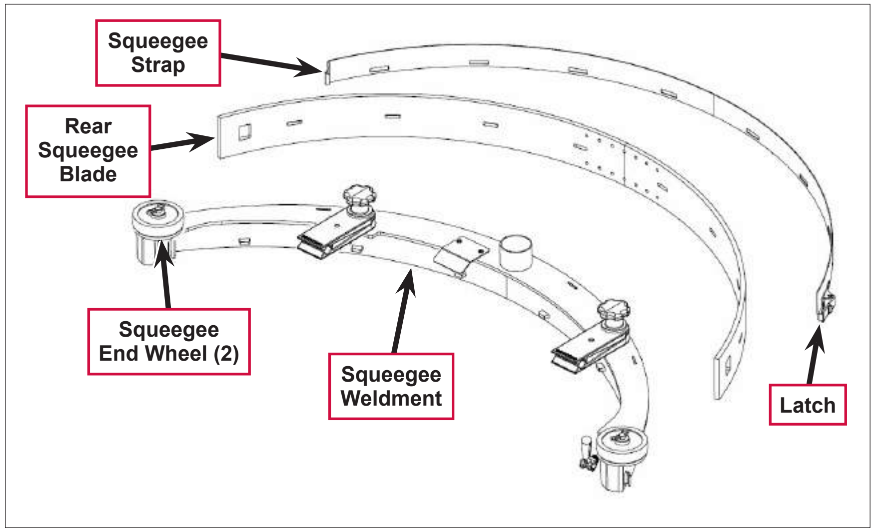
To Remove and Reinstall the Front Squeegee Blade

1. Release the **Push/Pull Clamp** and remove the **Weldment Strap**.
2. Remove the **Front Squeegee Blade** from the **Squeegee Weldment**.
3. Rotate the existing **Front Squeegee Blade** top-to-bottom or end-for-end to position a new blade surface on the floor, or install a new **Front Squeegee Blade** onto the **Squeegee Weldment** pins.
4. Reinstall the **Weldment Strap**, then secure the **Push/Pull Clamp**.



To Remove and Reinstall the Rear Squeegee Blade

1. Release the **Latch** and remove the **Squeegee Strap**.
2. Remove the **Rear Squeegee Blade** from the **Squeegee Weldment**.
3. Rotate the existing **Rear Squeegee Blade** top-to-bottom or end-for-end to position a new blade surface on the floor, or install a new **Rear Squeegee Blade** onto the **Squeegee Weldment** pins.
4. Reinstall the **Squeegee Strap**, then close the **Latch**.

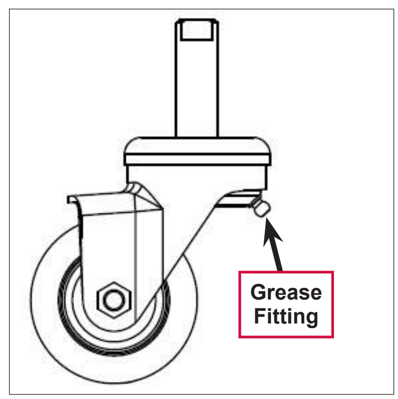


Squeegee End Wheels

Once a month apply light machine oil to the **Squeegee End Wheels**.

Squeegee Caster Wheel Bearings

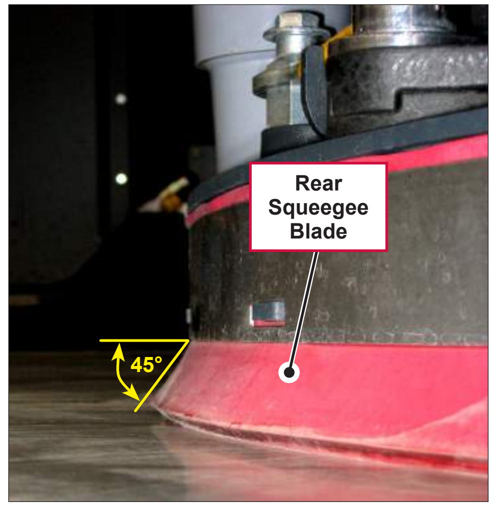
Once a month pump a small amount of grease into the **Grease Fitting** on both caster wheels on the squeegee support assembly until grease seeps out around the bearings.



To Adjust the Squeegee Tilt

1. Lower the squeegee and drive the machine forward a short distance so the squeegee assumes its normal operating angle.

2. Check the deflection angle of the **Rear Squeegee Blade**. It should be approximately 45 degrees to the floor surface as shown.

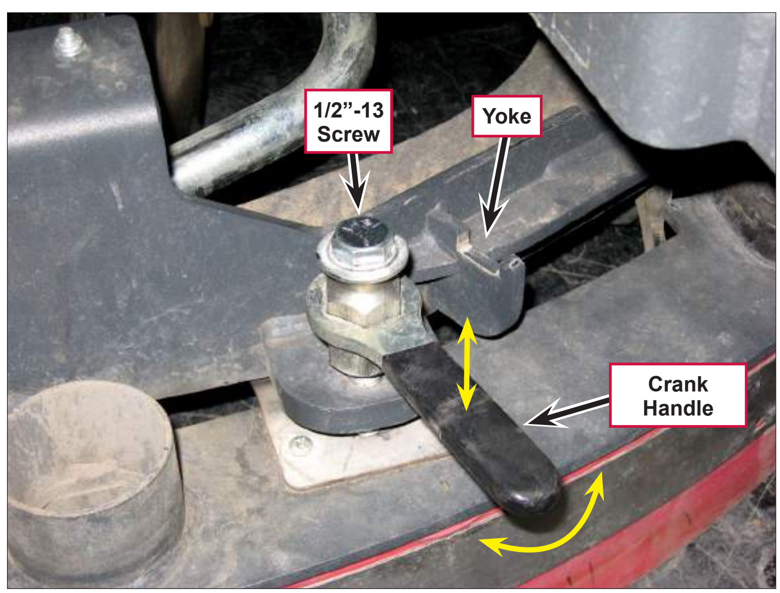


The ends of the squeegee should deflect as shown while still making full contact with the floor.

3. If the **Squeegee** tilt angle needs to be adjusted:

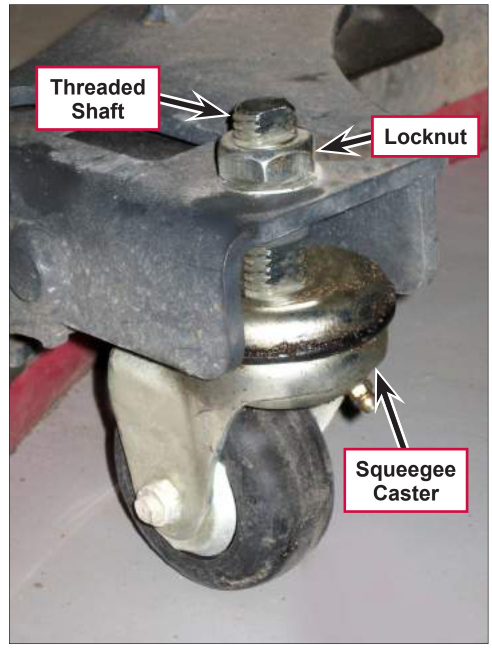
   a. Lift the **Crank Handle** out of the **Yoke**.

   b. Rotate the **Crank Handle** to raise or lower the **1/2”-13 Screw** as necessary so the squeegee blades are at the correct angle to the floor.



4. When the squeegee tilt adjustment is correct, replace the **Crank Handle** into the **Yoke**.

To Adjust the Squeegee Casters



The height of the **Squeegee Casters** may need to be adjusted to compensate for squeegee wear and to obtain the correct squeegee tilt angle. To adjust the height of a **Squeegee Caster**:

1. Loosen the **Locknut**.
2. Use a wrench on the flats of the **Threaded Shaft** to turn the **Threaded Shaft** to raise or lower the **Squeegee Caster** as necessary.
3. When the **Squeegee Caster** is at the correct height, tighten the **Locknut**.
4. Check the squeegee tilt angle and adjust as necessary. (Refer to the ***To Adjust the Squeegee Tilt*** section on the preceding page.)

Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* ***Control System/Service Mode*** *section for information on how to enter and use the Service Mode.*

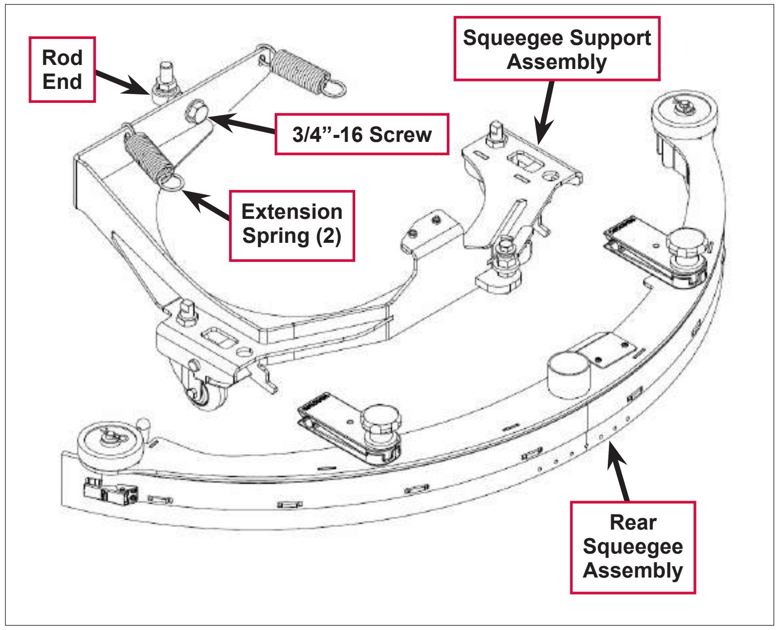
Problem	Cause	Correction
The squeegee will not rise or lower.	An interlock is not closed.	Before you start troubleshooting a specific system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed.
	The squeegee actuator motor (**M12**) is not operating.	1. Check the wiring and connectors from the A1 Main Machine Controller to the squeegee actuator motor and repair as necessary. 2. Check the operation of the squeegee actuator motor. If the motor doesn't operate correctly, replace the squeegee actuator. 3. Check the voltage outputs from **J2-8** and **J2-9** on the A1 Main Machine Controller.
The squeegee is not picking up the water effectively.	There is a vacuum leak between the squeegee weldment and the recovery tank.	• Make sure the squeegee hose is installed correctly in the recovery tank and on the squeegee weldment. • Check the squeegee hose for damage or cracks and replace if necessary.
	The squeegee blade(s) is/are worn out.	• Flip the squeegee blade(s) around to position a new blade surface on the floor. • Replace the squeegee blade(s).
	The squeegee actuator is not lowering the squeegee far enough onto the floor.	The squeegee down time is not set correctly. Refer to the ***Control System/Troubleshooting/Hidden Menus/User Options Menu*** section.
The squeegee is not picking up the water consistently along the entire length of the squeegee.	The squeegee tilt need to be adjusted.	Adjust the squeegee tilt. (Refer to the ***Maintenance and Adjustments/To Adjust the Squeegee Tilt*** section.

Removal and Installation

Warning! ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Remove and Reinstall the Squeegee Support Assembly

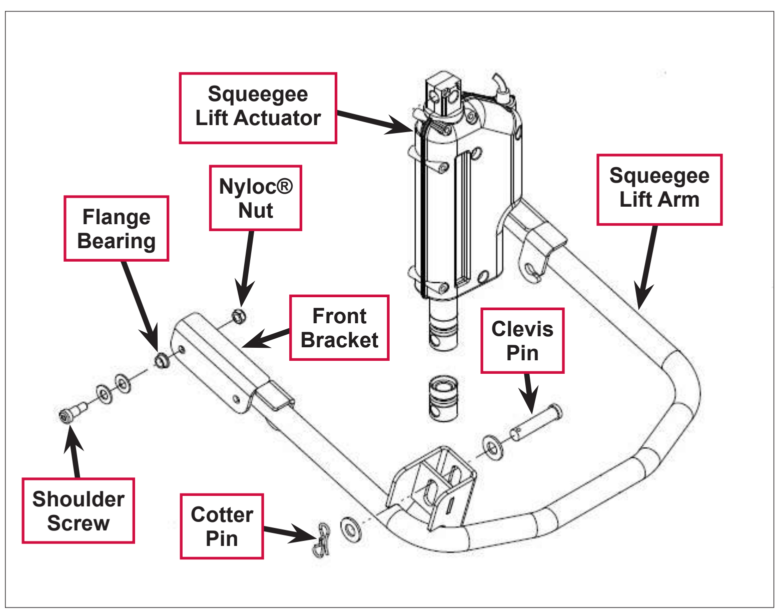
1. Remove the **Rear Squeegee Assembly**.
2. Disconnect the **Extension Springs** from the **Squeegee Support Assembly** using a spring puller. (See the ***Special Tools*** section.)
3. Remove the **3/4”-16 Screw** holding the **Squeegee Support Assembly** to the **Rod End**.
4. Carefully remove the **Squeegee Support Assembly** from the machine.
5. Reinstall the **Squeegee Support Assembly** by following the above steps in reverse order.



Note: *Use removable Loctite® thread sealer when reinstalling the* ***3/4”-16 Screw****. Tighten the* ***3/4”-16 Screw*** *to 270 ft/lbs.*

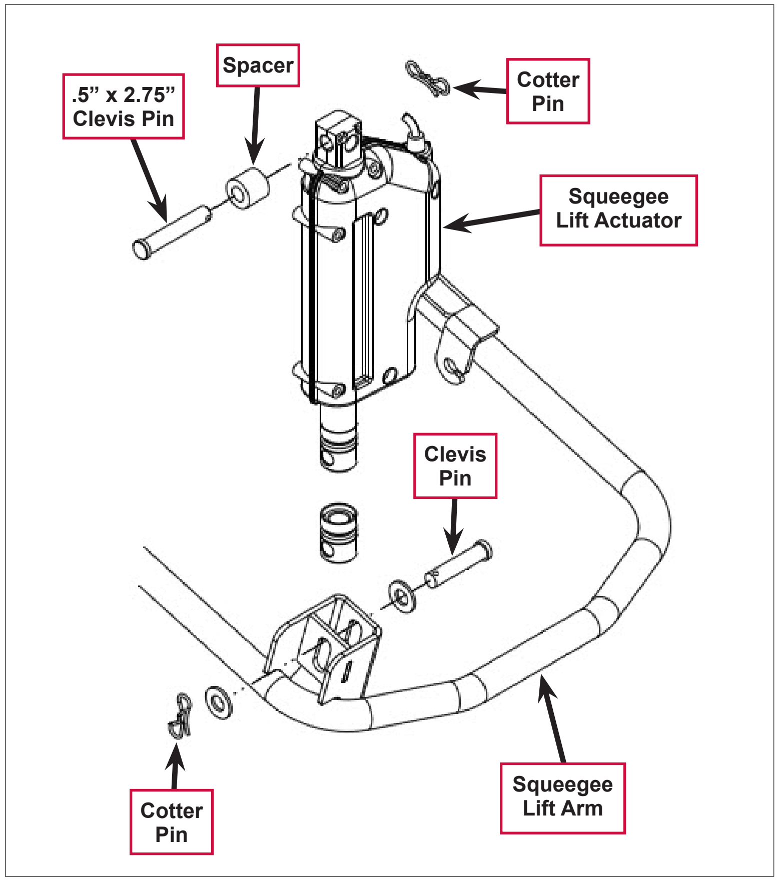
To Remove and Reinstall the Squeegee Lift Arm

1. Remove the **Rear Squeegee Assembly** and **Squeegee Support Assembly**.
2. Disconnect the **Extension Springs** from the **Squeegee Lift Arm**.
3. Remove the **Cotter Pin**, washers and **Clevis Pin** connecting the **Squeegee Lift Actuator** to the **Squeegee Lift Arm**.
4. Remove the **Shoulder Screws**, flat washers, **Flange Bearings** and **Nyloc® Nuts** connecting the **Front Brackets** to the machine frame, then remove the **Squeegee Lift Arm** from the machine.
5. Reinstall the **Squeegee Lift Arm** by following the above steps in reverse order.



To Remove and Reinstall the Squeegee Lift Actuator

1. Remove the recovery tank.
2. Remove the squeegee tool assembly. (This will reduce the weight on the **Squeegee Lift Arm**.)
3. Disconnect the lift actuator electrical connector.
4. Remove the **Cotter Pin**, washers and **Clevis Pin** connecting the **Squeegee Lift Actuator** to the **Squeegee Lift Arm**.
5. Remove the **Cotter Pin**, **.5” x 2.75” Clevis Pin** and **Spacer** connecting the **Squeegee Lift Actuator** to machine frame and remove the **Squeegee Lift Actuator** from the machine.
6. Reinstall the **Squeegee Lift Actuator** by following the above steps in reverse order.



Note: *The* ***Squeegee Lift Actuator*** *does not require adjustment after installation.*

Specifications

<table>
<tr><th>Component</th><th>Specifications</th></tr>
<tr><td>Squeegee Tool Assembly</td><td></td></tr>
<tr><td>Squeegee Blade, Front, Red Gum</td><td rowspan="2">Material - Linatex 40
Color - Red
Hardness - 40 ±5 Shore A Durometer
Tensile Strength - 3000 Psi Minimum
Elongation - 600% Minimum</td></tr>
<tr><td>Squeegee Blade, Rear, Red Gum</td></tr>
<tr><td rowspan="8">Squeegee Lift Actuator</td><td>Dynamic Load - 200 lbs. maximum</td></tr>
<tr><td>Static Load - 250 lbs. maximum</td></tr>
<tr><td>Restraining Torque - Actuator is internally restrained</td></tr>
<tr><td>Amperage - 3 Amps at rated dynamic load</td></tr>
<tr><td>End of Stroke - Actuator has internal limit switches connected to the motor to shut off power at ends of stroke</td></tr>
<tr><td>Overload Protection - Ball detent clutch with load rating between 250 and 500 lbs.</td></tr>
<tr><td>Thermal Protection - Automatic resetting thermal breaker enclosed in motor housing.</td></tr>
<tr><td>Wiring Polarity:
• To extend actuator, connect red lead to positive and orange lead to negative.
• To retract actuator, connect orange lead to positive and red lead to negative.</td></tr>
</table>

Special Tools

A spring puller is recommended to remove the Extension Springs from the Squeegee Support Assembly and Squeegee Lift Arm when removing these components. There are several types of spring pullers - a typical example is shown here.	

Steering System

Functional Description

Summary

The steering system utilizes steer by wire technology. The major electrical components are the Steering Controller, Steering Wheel Rotation Sensor, Steering Actuator and the Steering Travel Limit Switches. The Steering Controller receives input signals from the Steering Wheel Rotation sensor that tell it which direction the steering wheel is turning and how fast it is rotating. Based on these inputs the Steering Controller drives the Steering Actuator Motor with a three phase alternating current to rotate a gear. The gear is meshed to a large ring gear that rotates the drive wheel assembly either right or left. The Steering Controller also monitors two travel limit switches (proximity switches) that signal when the drive wheel has steered to is maximum desired angle in either direction.

Steering Controller

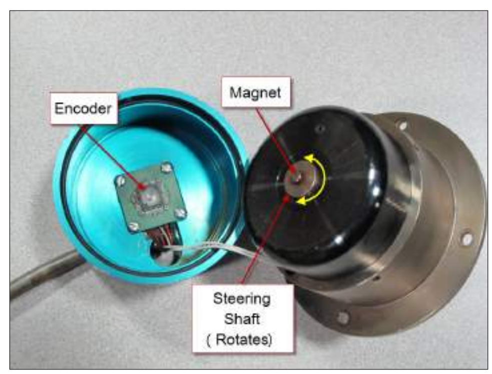
Steering Wheel Rotation Sensor

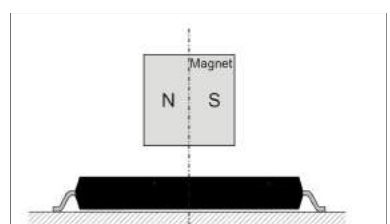
Steering Actuator

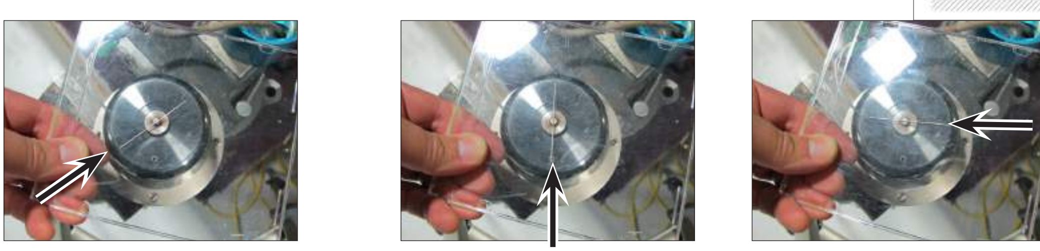
Proximity Sensor - Travel Limit Switch

Steering Wheel Rotation Sensor

The Steering Wheel Rotation Sensor has an internal “encoder” that translates steering wheel rotation information into four digital signals. The end of the steering shaft has a special “diametrically polarized” magnet on it. The line of separation between the north and south magnetic poles rotates in close proximity to the encoder. The three images below show how a wire on a clear plastic CD case rotates as the shaft rotates. The encoder “reads” the movement of the magnetic fields and creates a four 5v square wave signals. There are two pairs of signals. For each pair, when the steering wheel rotates, one of the signals switches before the other so that the controller can tell which direction the steering wheel is being turned. The second pair of signals provides “redundant” information.

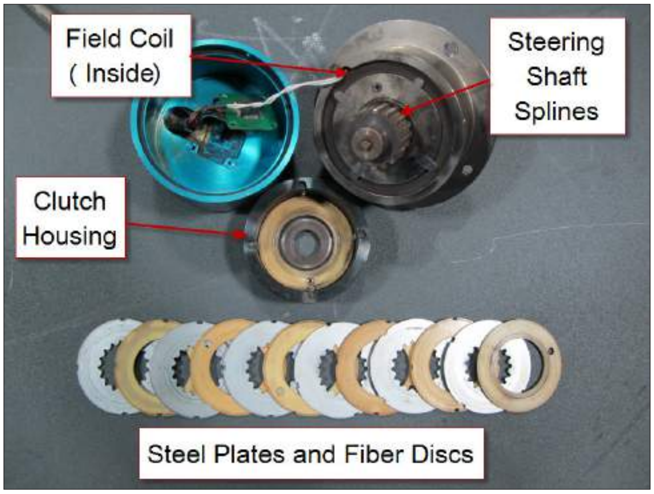


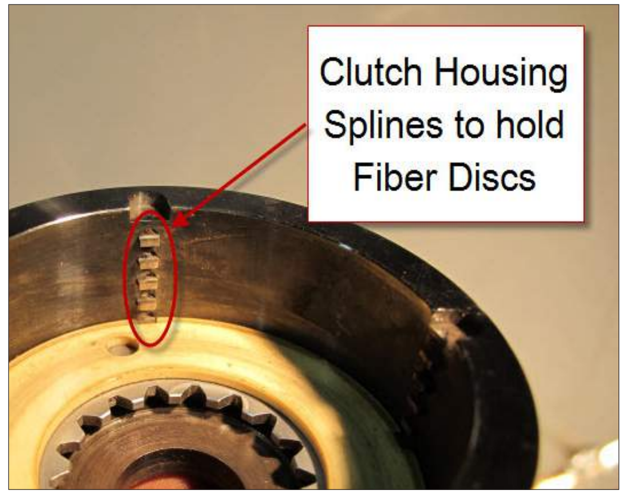




The wire rotates with the magnetic field as the steering wheel rotation sensor shaft is turned

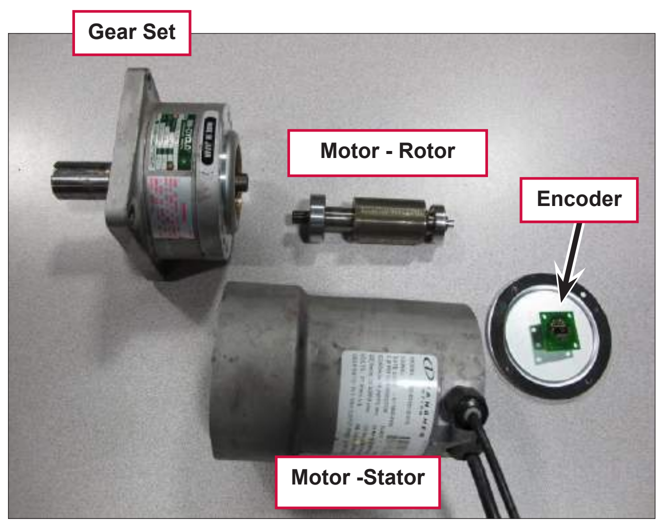
The Steering Wheel Sensor also has an electromagnetic clutch called a "Torque Feedback Device" which provides steering feel to the operator. The clutch consists of multiple fiber discs and steel plates which are alternately stacked. The steel plates are splined to the steering shaft so they always rotate with the shaft. The fiber discs are splined to the clutch housing and are held stationary. When electrical current flows through the clutch field coil winding, the magnetic field generated pulls the plates together creating friction between the plates and discs that resists steering wheel movement. The resistance is proportional to the current flow. The Steering Controller regulates the amount of current flow to provide the right steering "feel".





Steering Actuator

The Steering Actuator consists of a motor, gear set and a position sensor. The motor operates on three phase AC (Alternating Current) and is a "brushless" design. It rotates a gear set that drives the output shaft. The output shaft is keyed to a drive gear which drives a large "ring" gear to turn the rear drive wheel assembly. There is also a sensor inside the motor that reports position and rotation information to the Steering Controller. This information provides feedback to the controller so that it can verify that the motor actually moved as it was commanded to.

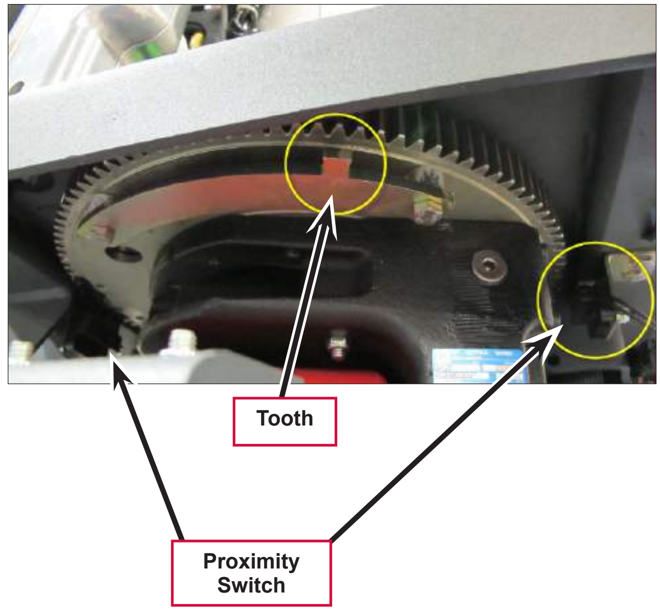


Steering Actuator

The Steering Actuator has an internal "encoder" that translates motor rotation information into digital signals. The end of the motor shaft has a special "diametrically polarized" magnet on it. The line of separation between the north and south magnetic poles rotates in close proximity to the encoder. The encoder "reads" the movement of the magnetic fields and creates a two 5v square wave signals. As the motor rotates, one of the signals switches before the other so that the controller can tell which direction the motor is rotating.

Steering Travel Limit Switches

The Steering Travel Limit Switches are magnetic “proximity” switches that are normally open. They are mounted on each side of the frame. There is a bracket mounted on the drive wheel steering ring gear with a “tooth”. As the gear rotates, the “tooth” moves with it. When the tooth lines up with one of the proximity switches, its internal switch closes to let the controller know it should stop moving in that direction.

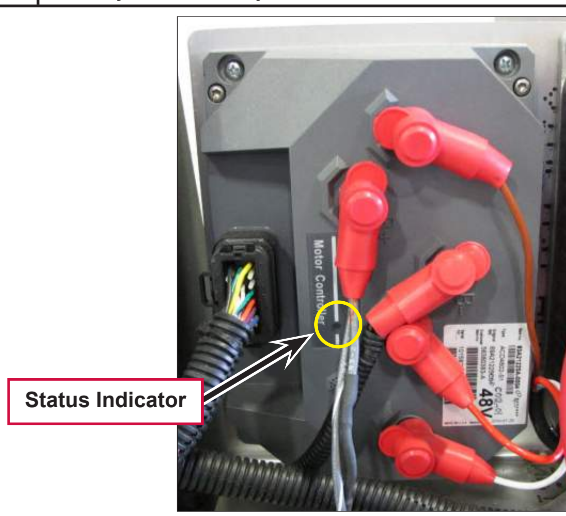


Steering Controller

The steering controller is the heart of the steer by wire system. It operates the steering actuator based on input requests from the steering wheel rotation sensor and the travel limit proximity switches. It has robust self diagnostics to protect itself and shut down the steering system if a serious error occurs. It is a sealed unit with no serviceable parts inside. It is capable of storing DTCs (Diagnostic Trouble Codes). See the ***Troubleshooting*** section for more information.

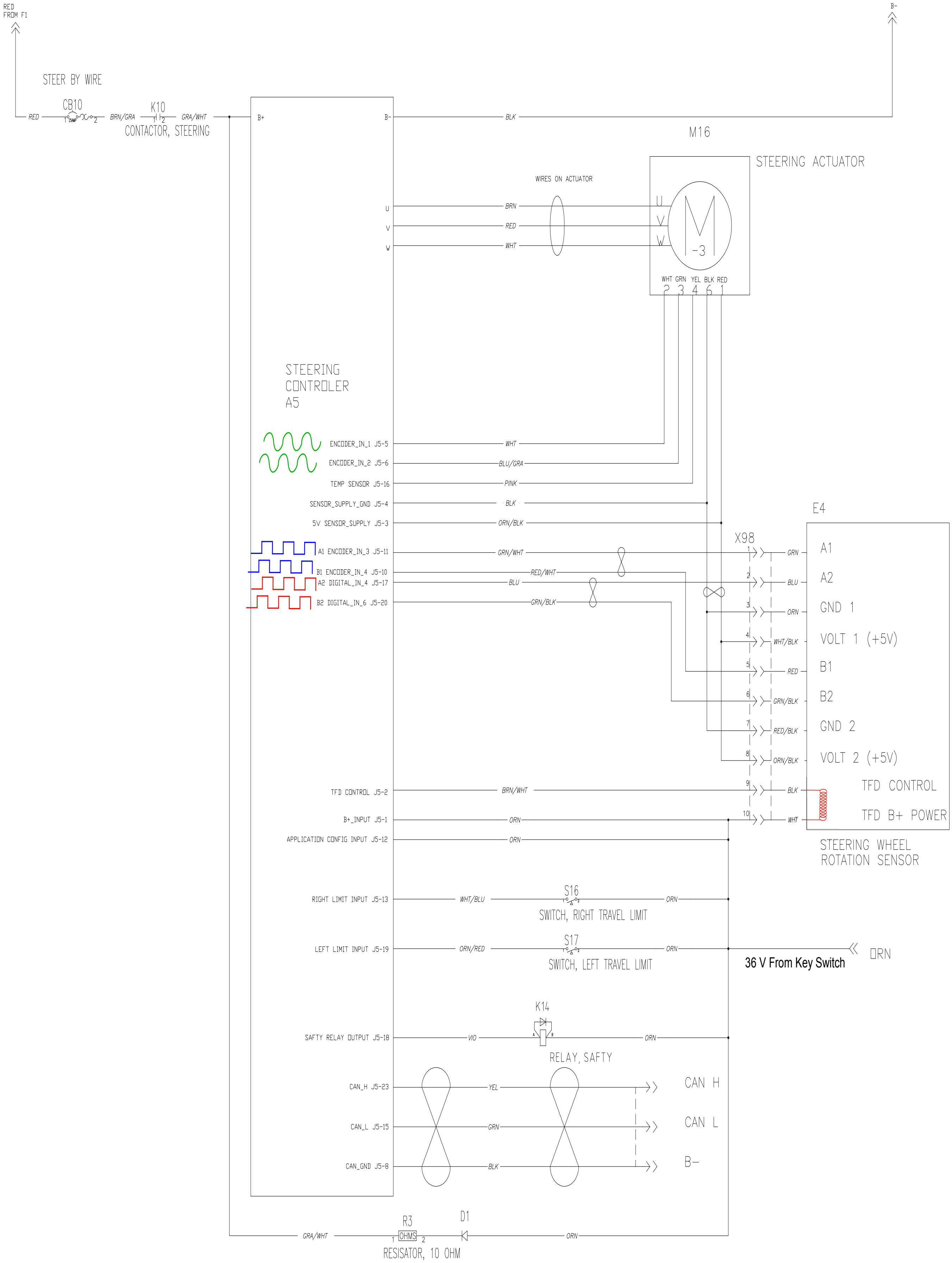
There is a green LED “Status Indicator” built into the controller that provides important information to the service technician. Note: you must be looking straight at it and not from an angle for it to be visible.

LED Indicator State	Condition
Off	The Controller is not powered up, or is powered but not functional.
Blinking slowing (1HZ)	Start-up mode.
Blinking rapidly (10HZ)	The system is disabled due to an error condition.
On steady	The system is fully functional with no error condition.



Steering Controller

Steering System Wiring Diagram

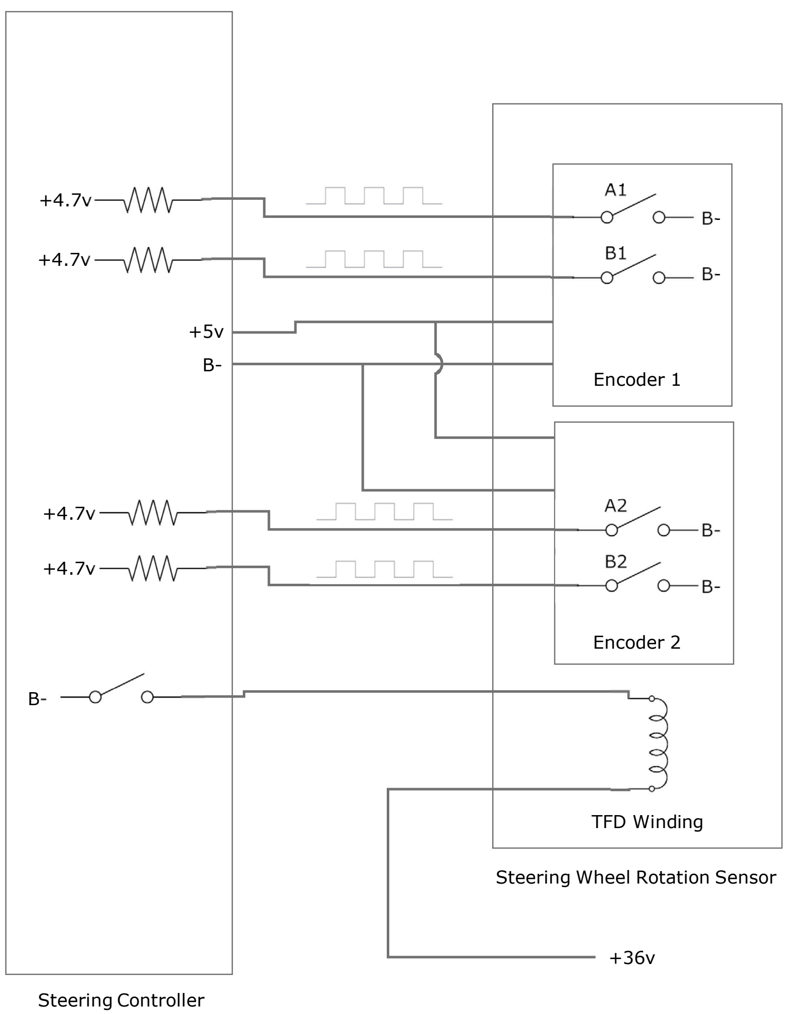


Circuit Description

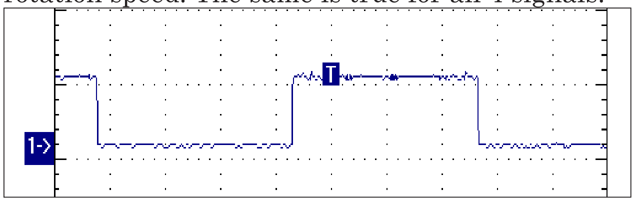
The steering controller power has more than one power supply. The main heavy current power sources are bolt on lugs that supply both battery positive and negative connections. These connection points are clearly labeled on the controller. This power is used to convert the direct current to 3 phase alternating current, which drives the actuator motor. There is also a switched power source that goes to J5-1. This power begins at the battery positive terminal goes through circuit breaker #4, through the ignition switch, through the seat switch and then to connector J5 pin 1. This is used to “wake up” the controller and supply power for lower current circuits. Power is also supplied to J5 pin 12 but this is not truly a power supply. It is used to identify what machine the controller is attached to.

The steering controller sends a 5 volt power supply out of J5-3 which provides power to the steering actuator encoder at pin 1 and the steering wheel rotation sensor encoder pins 4 and 8. The steering rotation sensor encoder has 2 grounds at pins 3 and 7. These are not connected directly to battery negative but go to steering controller J5-4. The controller provides a “clean filtered ground” for the encoder circuits. The encoder built into the steering actuator also has a ground at pin 6 which is grounded through the controller J5-4.

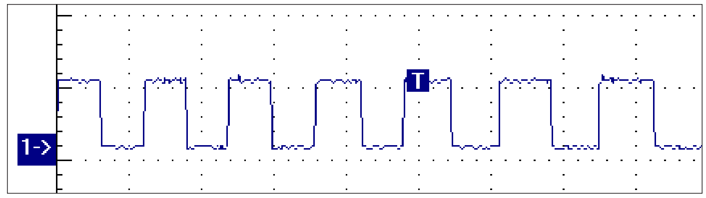
The steering wheel rotation sensor encoder has 4 “internal switches” (See image below) Each switch is fed approximately 5 volts (4.7v) from the steering controller on its own wire. As the steering wheel rotates, the switches cycle on and off to ground causing the 5v to drop to 0v and back up again. This creates four separate 5 volt square wave signals which, are “read” by the steering controller. Note that the encoder circuits use “twisted pair” wiring to eliminate electrical noise.



As the steering wheel rotates, the A1 signal switches back and forth from 0v (low) to 5v (high). When viewed on a scope (oscilloscope) it looks like a “square wave” pattern. When the steering wheel rotation is slow, the switching frequency is slow. This is seen as longer and fewer square wave patterns on the scope screen. When the steering wheel rotation is faster, the switching frequency is faster. This is seen as more but shorter patterns on the scope screen. This changing frequency is how the controller “sees” the steering wheel rotation speed. The same is true for all 4 signals.

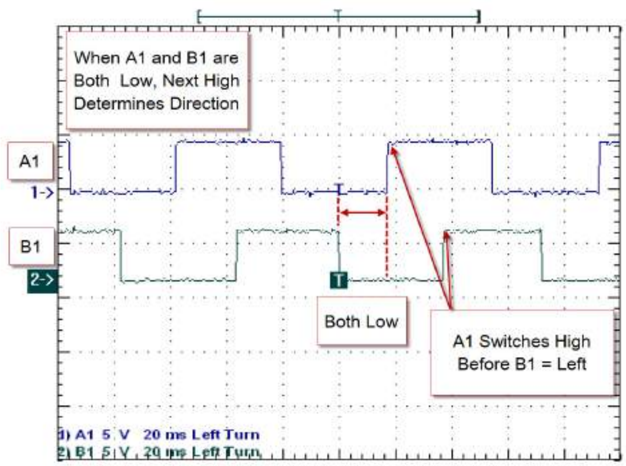


Slow Rotation

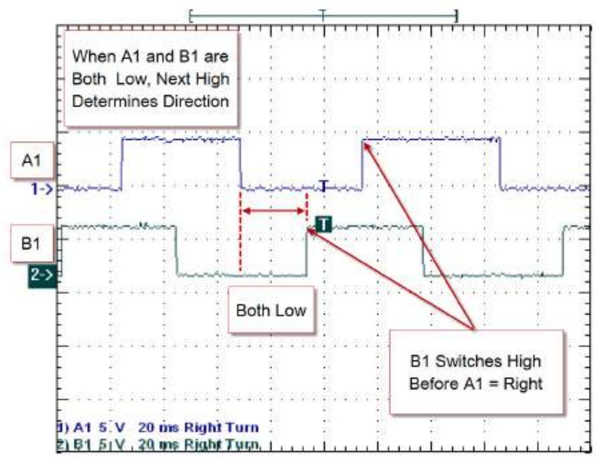


Fast Rotation

In order to determine which direction the steering wheel is rotating, the controller “looks” at two signals (A1 and B1) at a time. These signals are intentionally offset (out of phase) from one another. This is “physically” built into the way the encoder works. When A1 and B1 are both reporting “low”, the controller will be able to tell which direction the steering wheel is rotating by which of the signals goes “high” first. If A1 switches high first, then the wheel turning left. If B1 switches first, the wheel is turning right. A2 and B2 are used as an extra (redundant) pair of signals.



Left Turn

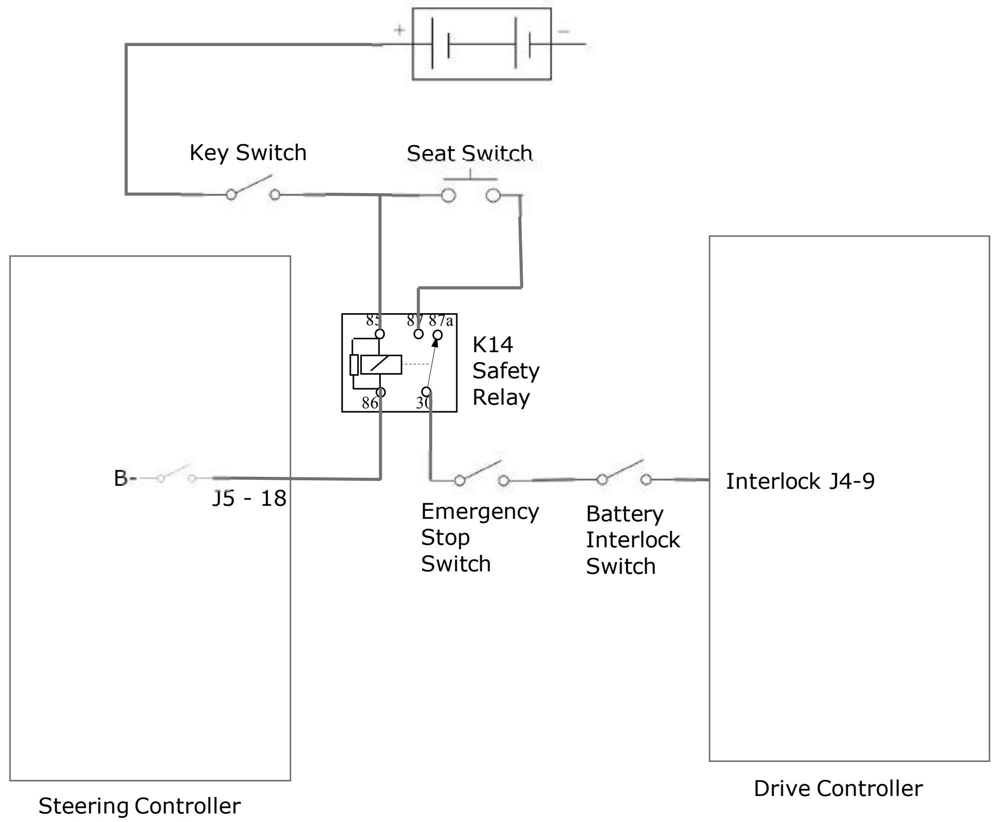


Right Turn

The steering wheel sensor also contains a TFD (Torque Feedback Device). The TFD is powered on the same circuit as the controller J5-1. Power is supplied to a coil winding inside the TFD on sensor pin 10. The power flows through the coil, out sensor pin 9 and into controller J5-2. Inside the controller, there is a “switch” that opens and closes rapidly to provide a “controlled” ground for the coil. When a ground is supplied, current flows through the winding and creates a magnetic field. As the percentage of ground time is increased, the current flow increases causing a stronger magnetic field to be created in the TFD. The magnetic field creates a “clamping” force on the TFD clutch pack, which in turn, provides “steering feel” to the operator.

There are two travel limit proximity switches. Each switch receives voltage on the same circuit as J5-1 (through the seat switch). The switches are normally open. When the cam “tooth” lines up with the switch, the switch closes sending the voltage on to the steering controller. The right travel limit switch is connected to J5-13. The left travel limit switch is connected to J5-19

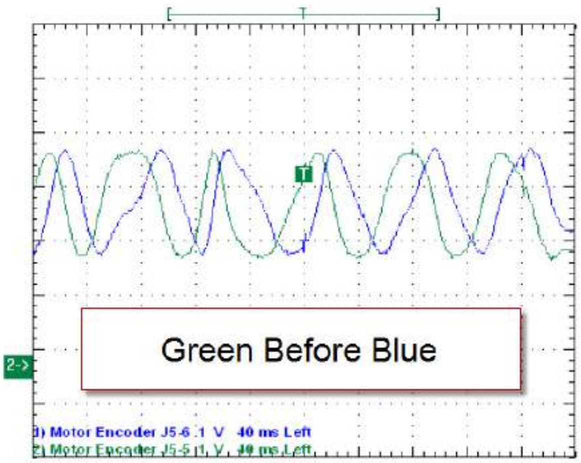
The steering controller controls a safety relay (K14) to shut down the drive wheel system in the event that there is a serious steering system error. The relay coil receives battery voltage from the key switch (The same as J5-1). The voltage flows through the relay coil and on to the controller J5-18. Inside the controller there is a “switch” that closes to battery negative to energize the relay. The relay contacts close allowing battery voltage to the drive controller interlock switch circuit J4-9. In the event of a serious steering system error, the steering controller opens its internal switch to de-energize the safety relay coil. This causes the relay contacts to open and removes the power supply from the drive motor controller. This shuts down the drive wheel system.



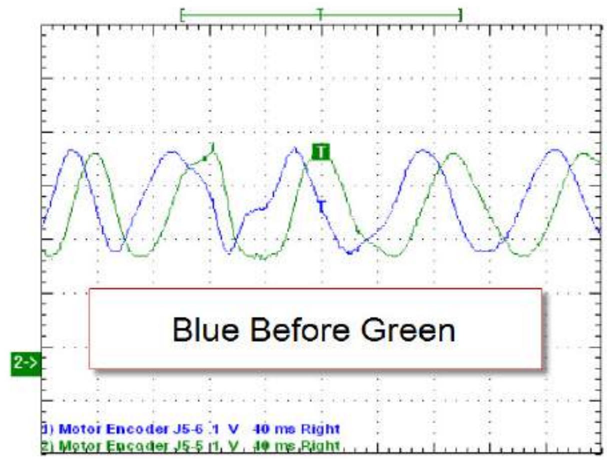
The steering controller can communicate with other devices via a “CAN bus”. The CAN bus wires are at J5-23, J5-15 and J5-8.

The steering actuator motor has 3 “stator” windings that are interconnected. These wires are the “working wires” of the motor. The controller supplies AC voltage and current to these winding to create a magnetic field that will act upon the rotor magnetic field and apply torque to spin the rotor. The controller is capable of switching the current to the windings on and off in specific order to make the motor turn either clockwise or counterclockwise and control the speed of the motor. The motor windings are wired directly to the bolt on lugs of the steering controller. They are clearly marked “U”, “V” and “W”.

The Steering Motor incorporates an encoder that reports both direction and speed information to the controller. The operation is similar to the steering wheel rotation sensor encoders however; there is only a single “pair” of signals and the pattern is not square. The frequency of the signal provides speed information. The signals are slightly offset to indicate rotation direction. The encoder receives a 5v power supply at pin 1 from the steering controller pin J5-3. The encoder is grounded on pin 6 through the steering controller J5-4. The encoder sends a wave signal out of pin 2 to controller J5-5 and out of pin 3 to controller J5-6.



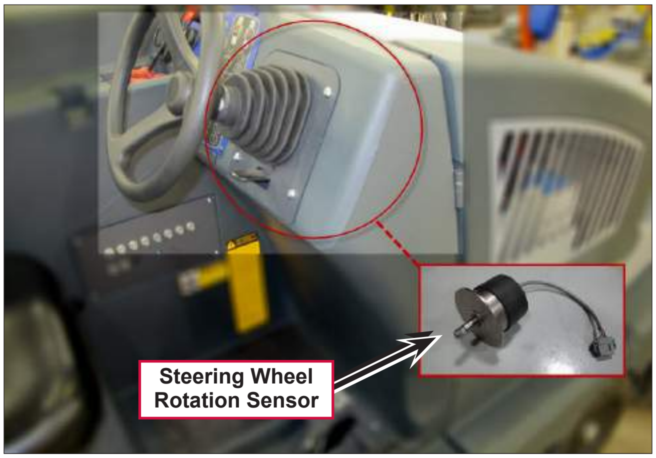
Left Turn

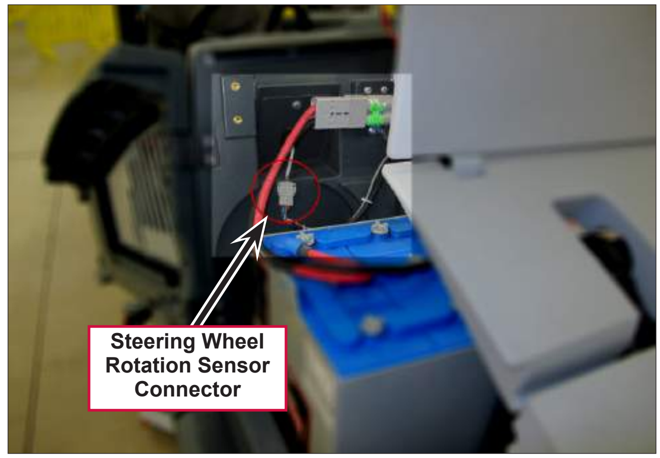


Right Turn

Component Locations

- Steering Wheel Rotation Sensor
- Steering Wheel Rotation Sensor Connector
- Steering Actuator - Rear of machine in front of drive wheel motor.
- Steering Controller - Left rear of machine





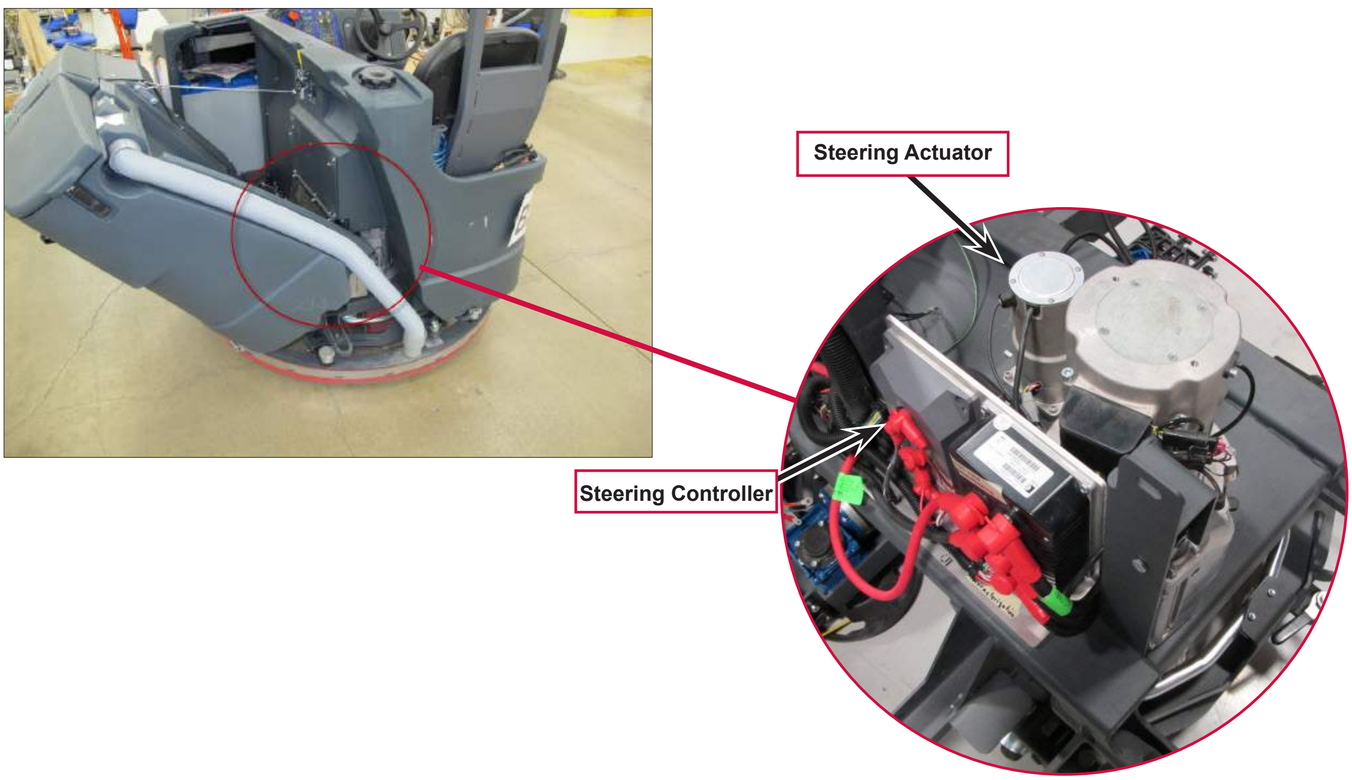


Photo taken without tanks

Maintenance and Adjustments

Check bolt torque of wiring connections at the Steering Controller every six months.

Troubleshooting

If a problem occurs with the steering system, begin by checking the Status LED condition on the steering controller and for steering system DTCs (Diagnostic Trouble Codes). If the Status LED does not light, check the power and ground supplies for the controller first. If the Status LED is flashing and there are DTCs, diagnose the cause of the DTC. If there are no codes, follow the symptom troubleshooting.

Diagnostic Trouble Codes (DTCs)

The steering controller monitors the steering system to protect itself and disable the steering system if necessary. When a serious error is detected, the controller sets a DTC (Diagnostic Trouble Code) and communicates the code to the main machine controller via the CAN bus. The main machine controller will set a "machine level" code of 50 and tell the control panel to display it to the operator. Machine code 50 means that there is a DTC set in the steering system. In order to get the specific steering system DTC, enter the "hidden menu" configuration display function.

To retrieve steering system codes from the "hidden menu":

1. Press and hold the hazard warning flasher button down while turning on the key. Wait until the "Configuration Display" screen appears, then release the button.

2. Press and release the scrub pressure decrease button several times until the cursor arrow is pointing at "15 Fault Recall, then press the scrub button to enter the fault recall menu.

3. Press the scrub pressure decrease button to scroll down to "2 Steering Faults", then press the scrub button.

4. The Steering faults menu displays all of the codes that have ever been set in the system. The codes are displayed in “reading order”, separated by commas and are sorted with the most recent at the top left. See the Diagnostic Trouble Code Table below to look up what the code means.

5. To exit, press the solution button.

Diagnostic Trouble Code Table

DTC	Error Source	Description	Check
0	AC Current – Excessive	The hardware detected excessive current flow in the steering actuator motor circuits.	Actuator - shorted/burned stator windings. Wiring (U, V & W) - Shorted to ground or one another. Steering Controller - Internal Short Note: Can also be caused by too low DC supply voltage on B+.
1	DC Power Supply - Low Voltage	The software detected that the DC power supply (B+ and B-) voltage is too low.	Battery Positive and Negative connections at source and controller Battery Positive and Negative cables
2	DC Power Supply - High Voltage	The software detected that the DC power supply (B+ and B-) voltage is too high.	Battery Positive and Negative connections at source and controller Battery Positive and Negative cables Note: If there is too much resistance between the controller and the battery during regenerative braking, the voltage can climb.
3	DC Power Supply - High Voltage	The hardware detected that the DC power supply (B+ and B-) voltage is too high.	Battery Positive and Negative connections at source and controller Battery Positive and Negative cables Note: If there is too much resistance between the controller and the battery during regenerative braking, the voltage can climb.
4	DC Power Supply Insufficient	The B+ and B- cables did not supply enough current to charge a capacitor inside the controller within 10 seconds.	Battery Positive and Negative connections at source and controller Battery Positive and Negative cables

DTC	Error Source	Description	Check
5	Motor Temperature High	The Motor Temperature is above 180 °C (356 °F)	Restrictions to steering actuator movement. Actuator - temperature sensor accuracy
6	Steering Controller Temperature High	The Steering Controller Temperature is above 125 °C (257 °F)	Restrictions to steering actuator movement. Actuator - temperature sensor accuracy
7	Steering Wheel Rotation Sensor Circuits	One or more of the four digital “encoder” signals is missing or is not occurring in the correct sequence with its paired partner.	Sensor - All 4 encoder signals for proper high voltage to low voltage switching as the steering wheel is turned slowly. Open wiring, intermittent connections. Shorted wiring - to one another or to ground. 5v power supply from steering controller to both encoder pairs B- supply for both encoders through the steering controller
8	CAN Bus communication lost	The steering controller is not receiving CAN Bus messages.	Can Bus Wiring Controller - termination resistor Note: The steering controller does not require any CAN bus messages to operate the steering system.
9	Controller Hardware Fault	The internal current sensor is out of calibration	Controller Electrical Connections Controller
10	Internal 15V supply voltage is low	The internal 15V supply voltage on the board is too low	Controller Electrical Connections Controller
11	Internal 5V supply voltage is low or high	The internal 5V supply voltage on the board is either too low or too high.	Controller Electrical Connections Controller
12	Torque Feedback Device – Excessive Current	Excessive current flow through the torque feedback device circuit.	Steering Wheel Rotation Sensor, Torque Feedback Device - Shorted winding. Short to B+ on TFD control circuit

DTC	Error Source	Description	Check
13	AC Current – Excessive	The software detected excessive current flow in the steering actuator motor circuits.	Actuator - shorted/burned stator windings. Wiring (U, V & W) - Shorted to ground or one another. Steering Controller - Internal Short Note: Can also be caused by too low DC supply voltage on B+.
14	Position calibration error	The “Center Position” has not been able to be established. (Not properly calibrated to right and left travel limit switches.) This error occurs when the steering controller calculated actuator motor position indicates the mechanism is beyond a steering travel limit switch position but the switch has not indicated that the end has been reached. (The steering controller believes that the physical position of the steered wheel is beyond the “soft limit” that should have been indicated by the steering travel limit switch closing.) This error also occurs when a steering travel limit switch closes indicating that the limit of travel has been reached but the controller calculated position indicates that the mechanism should not be near the limit of travel.	Excessive backlash in steering gears Controller Configuration Steering Limit Switches Steering Limit Switch wiring
15	Steering Actuator - Encoder Circuits	Steering Actuator encoder feedback error.	Wiring - between actuator encoder and controller Actuator - Encoder Signals
21	Current regulator supervision	Difference between set value and actual value for current regulator are above limit.	Obstructions to steering actuator gear rotation. Excessive gear backlash Loose connection in steering actuator encoder wiring. Steering Actuator
22	Position regulator supervision	Difference between set value and actual value for position regulator are above limit.	Obstructions to steering actuator gear rotation. Excessive gear backlash Loose connection in steering actuator encoder wiring. Steering Actuator

DTC	Error Source	Description	Check
23	Motor cable not connected (U,V or W wire open)	One or more of the motor cables between the steering actuator and the steering controller are not connected	Wiring - U, V and W cables and connections.
24	Position calibration error	This error occurs when the steering controller calculated actuator motor position indicates the mechanism is beyond a steering travel limit switch position but the switch has not indicated that the end has been reached. (The steering controller believes that the physical position of the steered wheel is beyond the "soft limit" that should have been indicated by the steering travel limit switch closing.) This error also occurs when a steering travel limit switch closes indicating that the limit of travel has been reached but the controller calculated position indicates that the mechanism should not be near the limit of travel. .	Excessive backlash in steering gears Controller Configuration Steering Limit Switches Steering Limit Switch wiring
25	Position sensor	This error occurs when the steering controller calculated actuator motor position indicates the mechanism is beyond a steering travel limit switch position but the switch has not indicated that the end has been reached. (The steering controller believes that the physical position of the steered wheel is beyond the "soft limit" that should have been indicated by the steering travel limit switch closing.) This error also occurs when a steering travel limit switch closes indicating that the limit of travel has been reached but the controller calculated position indicates that the mechanism should not be near the limit of travel. .	Excessive backlash in steering gears Controller Configuration Steering Limit Switches Steering Limit Switch wiring
26	Speed regulator supervision	Difference between set value and actual value for speed regulator are above limit.	Obstructions to steering actuator gear rotation. Excessive gear backlash Loose connection in steering actuator encoder wiring. Steering Actuator
27	Induction speed estimation supervision	The estimated speed is above limit	

Symptom Troubleshooting (No DTC stored)

Steering Inoperative - Steering Controller Status LED is Blinking Rapidly

Check for steering system codes.

Steering Inoperative - Steering Controller Status LED is Off

Check power and ground supplies to the steering controller.

Steering Inoperative - Steering Controller Status LED is On Steady

Check each input to make sure it is operating correctly. (Refer to the ***Specifications*** Section, ***Shop measurements*** information)

- Steering wheel rotation sensor - Each encoder signal should switch between approximately 5 volts and 0 volts as the steering wheel is turned very slowly.
- Travel limit switches - There should be approximately 0 volts at one or both inputs at the controller.

No "Steering Feel"

Possible Causes:

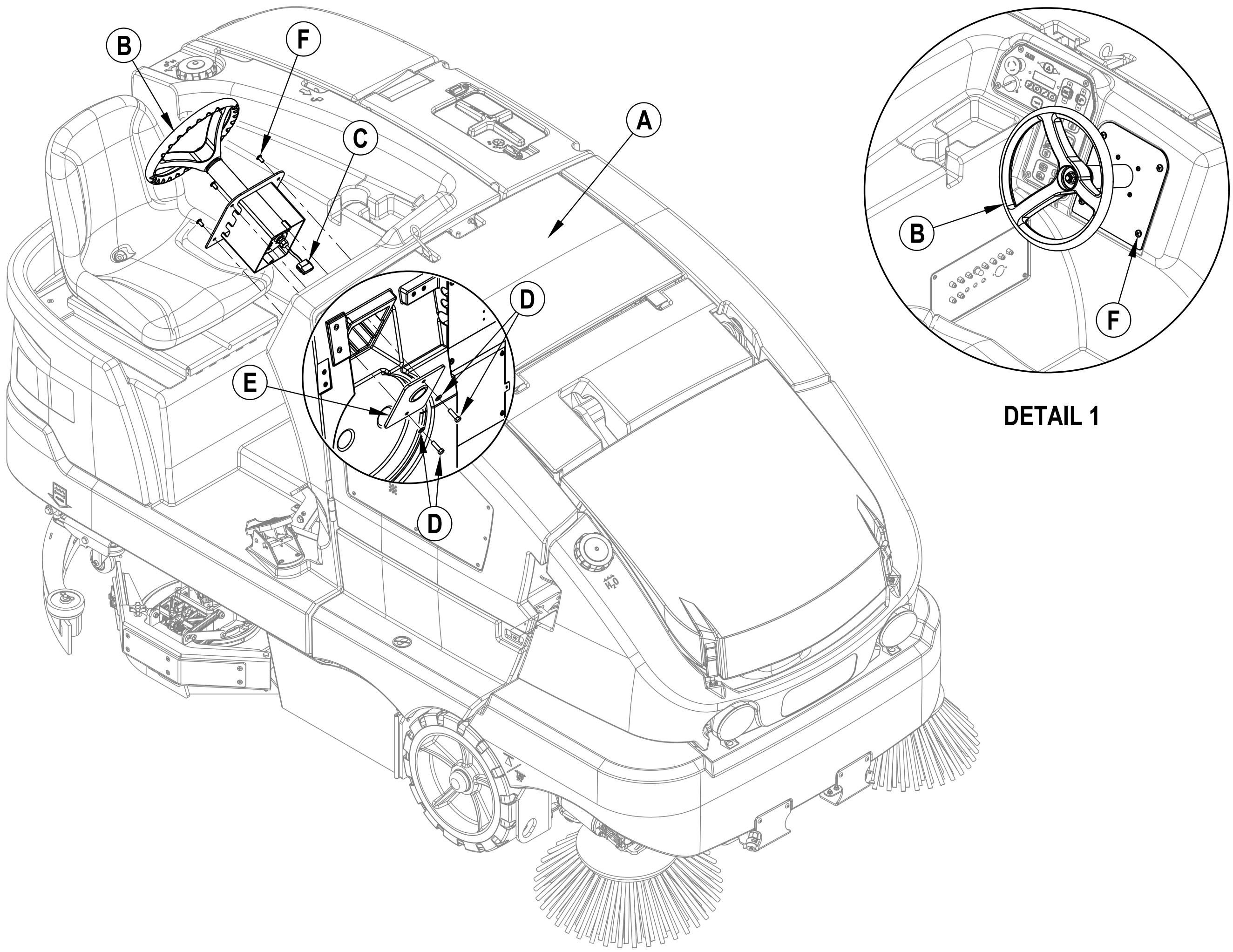
- Steering wheel rotation sensor (TFD) - Check for open circuit in the TFD coil.
- Steering Controller - Not controlling TFD
  - Check the power supply into the TFD
  - Check the ground control voltage. It should be around 24 volts.
  - Check the current draw of the TFD coil.
    - Approximately 400 mA = Regular steering feel.
    - Approximately 900 to 1000 mA = steering feel at "soft stop".
    - If the current draw is normal but the steering feel is not, replace the steering wheel rotation sensor.

Steering Wheel Is Difficult To Turn

Unplug the steering wheel rotation sensor. If the steering wheel is still difficult to turn, there is a mechanical binding in the steering wheel rotation sensor TFD.

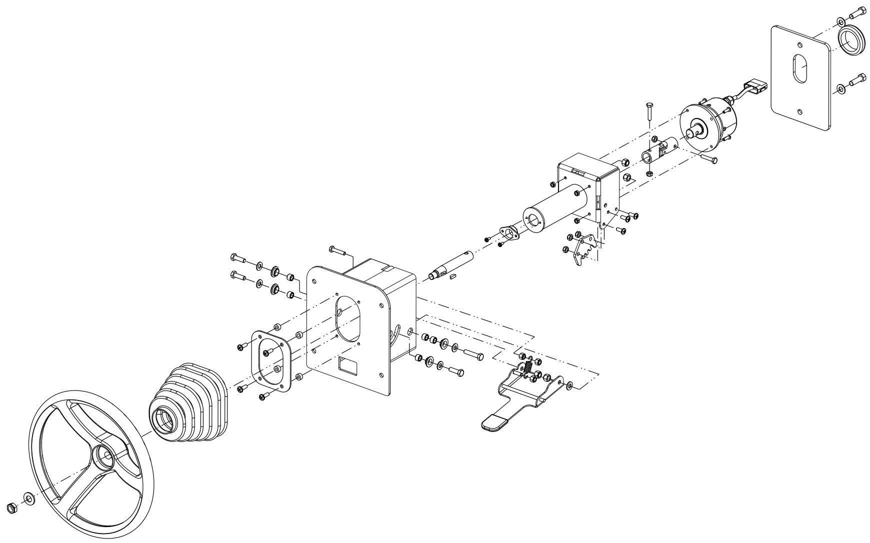
Removal and Installation

Steering Wheel Assembly



1. Turn the machine off, set the parking brake and disconnect the 36 V battery main power plug.
2. Lift the Rear Engine Cover (A) to access the Main Harness Connector and Steering Clamp Plate (E) on the Steering Assembly (B) as shown.
3. Unplug the Torque Feedback Device Connector (C) from the Main Harness.
4. Remove the hardware (D) and Steering Clamp Plate (E) from the Steering Assembly (B).
5. Remove and save the (4) Pan Screws (F) and remove the Steering Assembly (B) See Detail 1.

Steering Wheel Rotation Sensor



Caution! ***Do not hit steering wheel shaft with a hammer to remove the steering wheel. Doing so may damage the encoder inside the steering wheel sensor.***

Remove steering wheel assembly (See ***Steering Wheel Assembly*** section directly above).

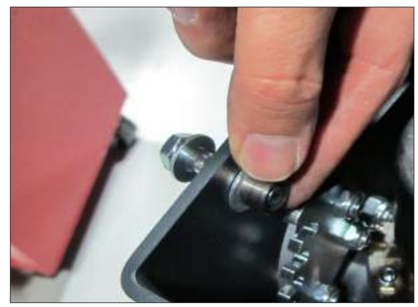
6. Remove steering wheel nut and washer.

7. Remove steering wheel using a three jaw puller. DO NOT hit the shaft with a hammer.

8. Remove retaining nut, spring and spring anchor hardware

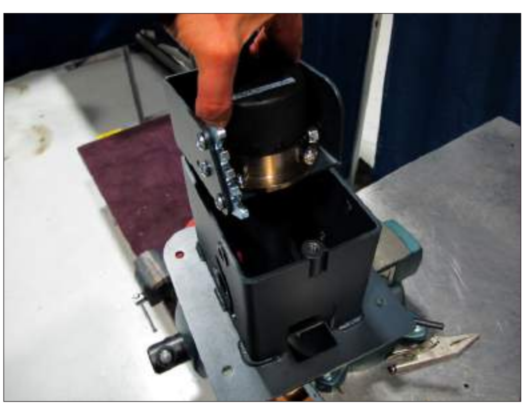
9. Remove tilt lever pivot hardware on one side.

10. Remove tilt lever pivot nut on other side. Remove tilt lever, then remove pivot hardware



11. Remove steering pivot nut and hardware on one side, then on the other.

12. Lift tilt steering “column” out of the steering mount “box”.

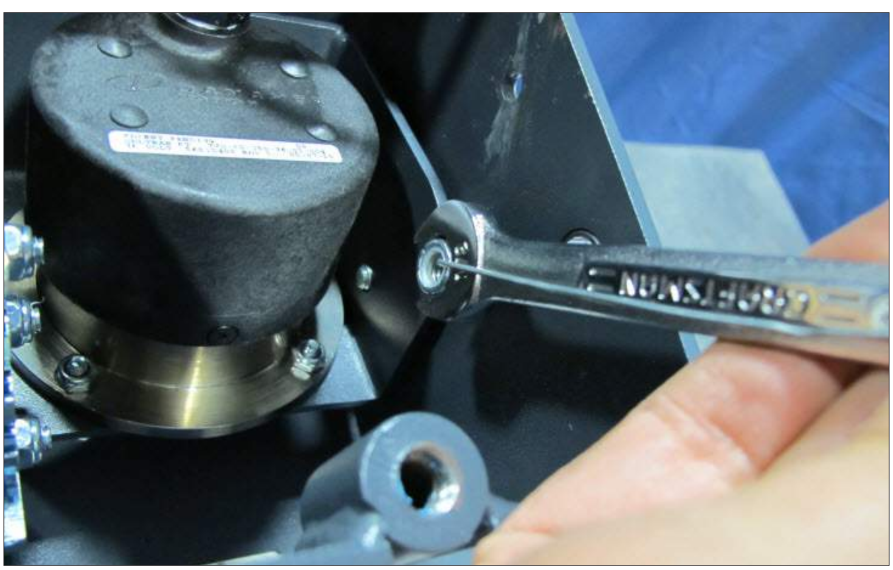


13. Remove the 4 nuts and screws securing the steering wheel rotation sensor, then remove the sensor and shaft out of the weldment.

14. Remove the nut and bolt that attaches the universal joint to the sensor shaft.

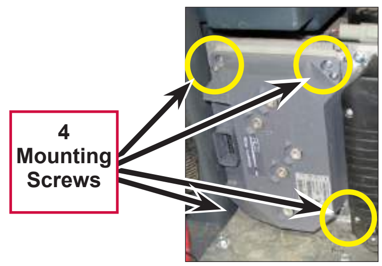
15. Reassemble in the reverse order.

    a. Reassembly tip: When installing the steering pivot hardware, use a short, bent, wire hook along with an open end wrench to position and hold the nut.



Steering Controller

1. Drain recovery tank.
2. Turn machine off, set the parking brake and disconnect the main power plug.
3. Remove recovery tank
   a. Tip tank out and let it rest on the retention cable.
   b. Disconnect the vacuum motor electrical connector. (If equipped with extended scrub, also disconnect the additional electrical connector and hose connection.)
   c. With a helper, remove the retaining cable clip, tip tank down and remove it.
4. Label controller wiring to make correct reassembly easier, then disconnect all wiring.
5. Remove 4 controller mounting screws.
6. Reassemble in reverse order.



Steering Actuator

1. Drain recovery tank.
2. Turn machine off, set the parking brake and disconnect the main power plug.
3. Remove recovery tank
   a. Tip tank out and let it rest on the retention cable.
   b. Disconnect the vacuum motor electrical connector. (If equipped with extended scrub, also disconnect the additional electrical connector and hose connection.)
   c. With a helper, remove the retaining cable clip, tip tank down and remove it.
4. Disconnect wiring to main machine controller.
5. Label the steering controller wiring and the drive controller wiring to make correct reassembly easier, then disconnect all wiring to both controllers.

6. Remove the three screws securing the controller mounting bracket to the frame, then remove the assembly.

7. Disconnect the steering actuator encoder connector.

8. Remove the four steering actuator mounting bolts.

9. Remove the steering actuator.

10. Reassemble in reverse order.

Specifications

Shop Measurements

Shop measurements are values that were measured on a real machine. While they are not "specifications", they can help you recognize normal vs. abnormal.

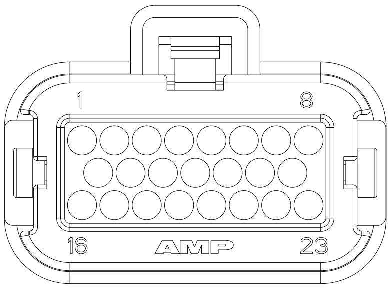
Steering Wheel Rotation Sensor Voltage Measurements

All voltages are DC unless otherwise stated and were measured with the negative (black) voltmeter lead on battery negative and the key on.

Pin #	Wire Color (harness side)	Circuit	Voltage	Condition
1	GRN/WHT	Encoder A1	4.77v 0.09v	Move steering wheel slowly. Voltage switches from low to high.
2	BLU	Encoder A2	4.77v 0.10v	Move steering wheel slowly. Voltage switches from low to high.
3	BLK	Ground	.003v	
4	ORN/BLK	5v supply	5.02v	
5	RED/WHT	Encoder B1	4.77v 0.09v	Move steering wheel slowly. Voltage switches from low to high.
6	GRN/BLK	Encoder B2	4.76v 0.10	Move steering wheel slowly. Voltage switches from low to high.
7	BLK	Ground	0.01v	
8	ORN/BLK	5v supply	5.02v	
9	BRN/WHT	TFD control	23.89v	No noticeable change at soft stop
10	GRA/ORN	TFD supply	37.76v	

Steering Controller Voltage Measurements

J5 Connector



Pin	Wire Color	Circuit	Voltage
J5-1	GRA/ORN	Key Switch Power	38.5
J5-2	BRN/WHT	TFD Control	23.9v
J5-3	ORN/BLK	5v supply - out	5.03
J5-4	BLK	Ground (Internal)	0.002v
J5-5	WHT	Motor Encoder	2.6v (motor stationary) 3.5v (motor moving)
J5-6	BLU/GRA	Motor Encoder	2.6v (motor stationary) 3.5v (motor moving)
J5-7		Not used	
J5-8	BLK	Can bus B-	0.009v
J5-9		Not used	
J5-10	RED/WHT	Steering Wheel Sensor Encoder B1	4.8v or 0.10v (switches high and low as steering wheel is moved slowly)
J5-11	GRN/WHT	Steering Wheel Sensor Encoder A1	4.8v or 0.09v (switches high and low as steering wheel is moved slowly)
J5-12	GRA/ORN	Application Config.	38.34v
J5-13	WHT/BLU	Right Travel Limit Switch	0.002v when not at limit 38.19v when at right limit
J5-14		Not used	
J5-15	GRN	Can Lo	2.45v
J5-16	PINK	Motor Temp Sensor	0.564v at “room” temperature 3.0v with sensor unplugged
J5-17	BLU	Steering Wheel Sensor Encoder A2	4.8v or 0.10v (switches high and low as steering wheel is moved slowly)
J5-18	VIO	Safety Relay Control	38.2v at initial key on 0.015v when relay is energized
J5-19	ORN/RED	Left Travel Limit Switch	0.008v when not at limit 38.2v when at left limit
J5-20	GRN/BLK	Steering Wheel Sensor Encoder B2	4.8v or 0.10v (switches high and low as steering wheel is moved slowly)
J5-21		Not used	
J5-22		Not used	
J5-23	YEL	Can Hi	2.53v

Motor U, V and W Terminal Pair Voltages

- U to V - 1.9 VAC with stationary motor. Up to 18 VAC when motor is turning quickly.
- V to W - 1.9 VAC with stationary motor. Up to 18 VAC when motor is turning quickly.
- W to U - 1.9 VAC with stationary motor. Up to 18 VAC when motor is turning quickly.

Motor U, V and W Terminal Pair Frequency

- U to V -16-20 HZ with stationary motor. Up to 250 HZ when motor is turning quickly.
- V to W - 16-20 HZ with stationary motor. Up to 250 HZ when motor is turning quickly.
- W to U - 16-20 HZ with stationary motor. Up to 250 HZ when motor is turning quickly.

System Current Draw

Measured with amp clamp around battery positive feed to steering controller.

- Approximately 4.5 amps while turning with stationary machine.

Measured at each U, V and W wire

- Approximately 4.5 amps while turning with stationary machine

Steering Contactor

Winding - 118 Ohms

Safety Relay

Winding - 813 Ohms

Special Tools

3 jaw puller for steering wheel removal.

Sweep System, Main

Functional Description

Overview

The main sweep system picks up debris from the floor and throws it into the hopper for later disposal. The main sweep system includes the main broom, broom motor, and the broom lift actuator which lowers and raises the main broom.

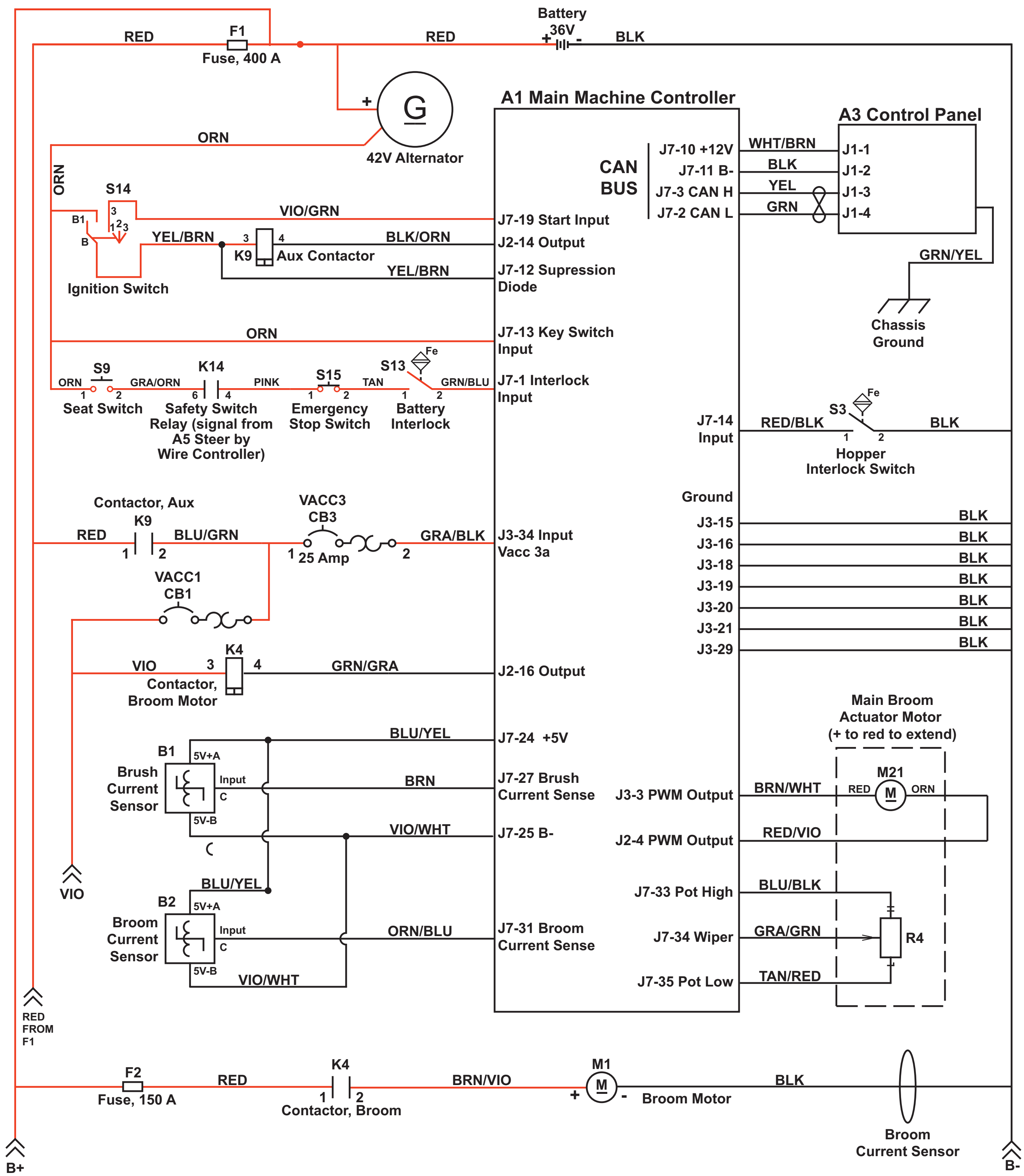
The broom lift actuator lowers the main broom any time the sweep system is enabled. The main broom motor switches on when the drive pedal is moved from the neutral position. The operator can enable the sweep system independent of the scrub system.

The hopper door opens when sweeping to allow the debris to be thrown into the hopper.

A potentiometer in the main broom actuator sends a voltage signal to the A1 Main Machine Controller that varies with the broom height. The A1 Main Machine Controller uses this signal to return the broom to the previous height setting whenever the sweep system is enabled.

The main sweep system has a “float” function in which the main machine controller drives the actuator all the way down so the weight of the main broom is resting on the floor. The linkage is slotted which allows the broom to follow the contour of the floor.

Main Sweep System Wiring Diagram



Circuit Description

The Following Conditions Must be Met for the Main Sweep System To Operate

- The **Hopper Interlock Switch S3** must be closed.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed.
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-13**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breaker **VACC1/CB1**.
- Circuit breaker **VACC1/CB1** must be closed to provide positive voltage to the **Broom Motor Contactor K4**.
- The **J2-16 Output** on the **A1 Main Machine Controller** must provide a ground to the **Broom Motor Contactor K4** coil. **J2-16** provides ground to **K4** under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the sweep switch.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or reverse.
- The **150-amp Fuse F2** must be closed to provide positive voltage from the **Battery** to the load side of the **Broom Motor Contactor K4**,
- The **Broom Motor M1** must have connections to battery ground **B-**.

Main Broom Actuator Motor

The **J3-3** and **J2-4 PWM Outputs** from the A1 Main Machine Controller provide voltage to the **Main Broom Actuator Motor M21**. The output polarity determines whether the **Main Broom Actuator Motor** lowers or raises the scrub deck.

The resistance through the main broom actuator potentiometer **R4** varies with the broom height. The **J7-33 POT HIGH** pin sends a fixed positive voltage to **R4** with **J7-35 POT LOW** as a ground. The A1 Main Machine Controller reads the voltage through **R4** from **J7-34 WIPER** to determine the broom height.

Broom Current Sensor

- **J7-24** provides +5 volts to the **Broom Current Sensor**.
- **J7-25** provides battery ground (**B-**) to the **Broom Current Sensor**.
- The Input from the **Broom Current Sensor** provides the **Broom Current Sense** signal to **J7-31** on the A1 main machine controller. The A1 main machine controller monitors the current value to set a fault code and shut down the motor if too much current is being used.

Component Locations

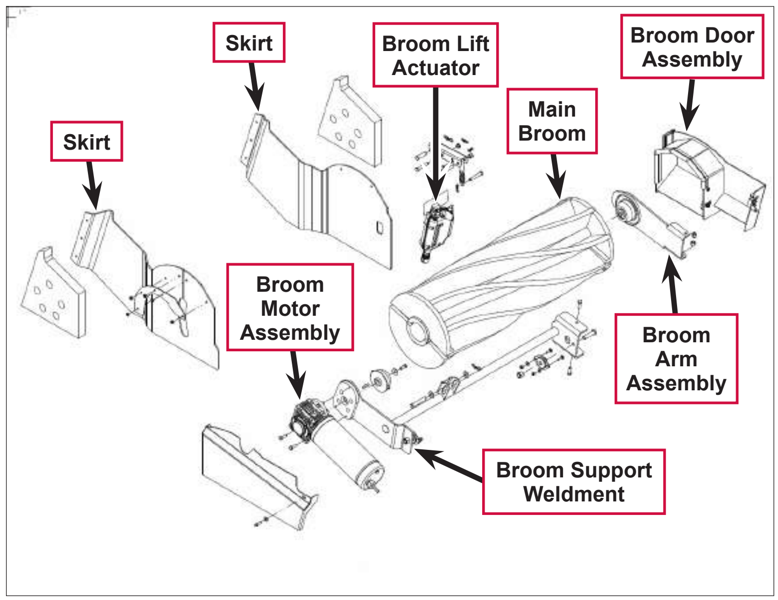
Main Broom and Drive Components

The **Main Broom** is supported by the **Broom Arm Assembly** and the **Broom Support Weldment**. The **Broom Motor Assembly** drives the **Main Broom** and is mounted to the **Broom Support Weldment**.

The **Broom Lift Actuator** raises and lowers the **Broom Support Weldment** which pivots on the machine frame to raise and lower the attached **Main Broom**.

The **Broom Door Assembly** swings out of the way to allow access to the **Broom Arm Assembly**. The **Broom Arm Assembly** is hinged to allow the **Main Broom** to be removed from the machine for maintenance or replacement.

The left and right **Skirts** direct the debris swept by the **Main Broom** into the hopper.

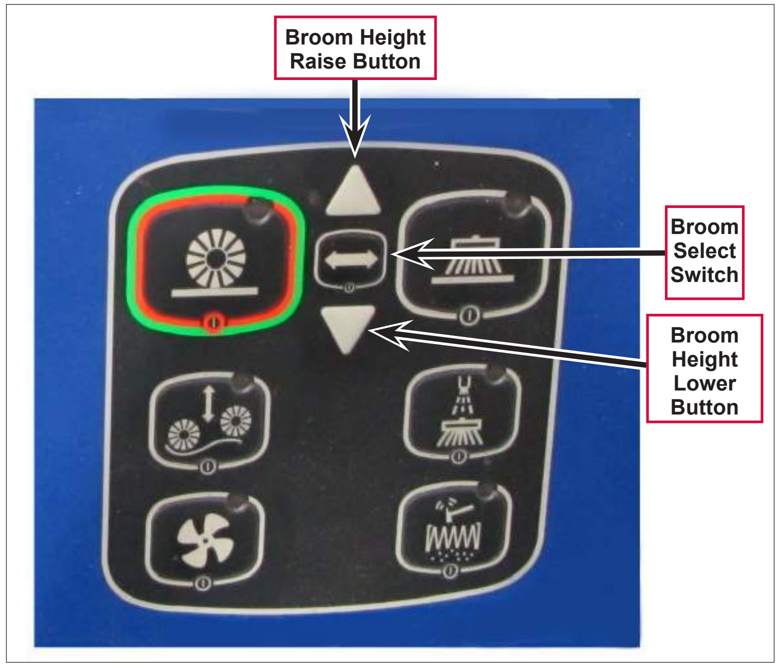


Maintenance and Adjustments

Warning! ***Before performing any maintenance or adjustments on the main sweep system, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Adjust the Main Broom Height

1. Turn the key switch on, then press the **Broom Select Switch** twice to select the main broom. The main broom motor will start and the actuator will lower the broom to its preset height. After running for a short time, the broom motor will shut off and the actuator will raise the broom to its upper position.

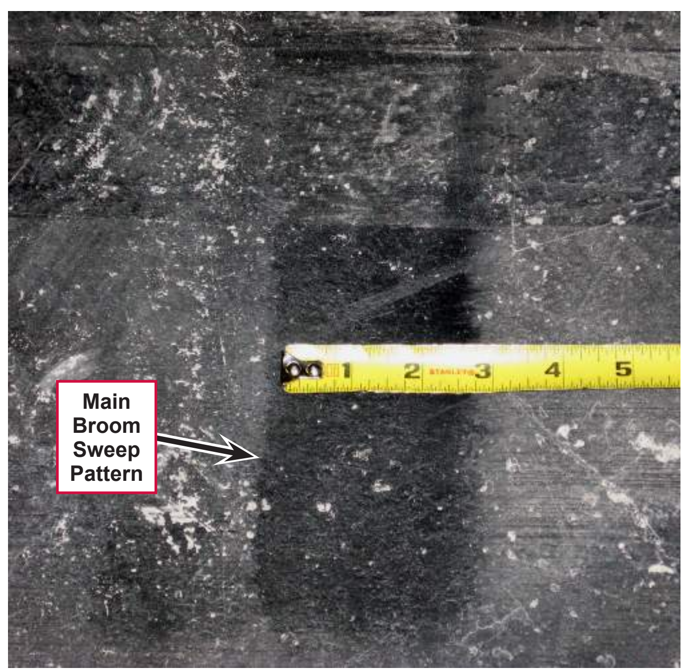


2. Check the **Main Broom Sweep Pattern** on the floor. The **Pattern** should be 2” to 3” wide, and consistent in width along the entire length of the main broom.

3. To adjust the width of the **Main Broom Sweep Pattern**, switch on and lower the main broom as described in step 1. While the main broom motor is running, press the **Broom Height Raise Button** or **Broom Height Lower Button** to adjust the broom height. Note that:

   - Raising the main broom will narrow the **Main Broom Sweep Pattern**.
   - Lowering the main broom will widen the **Main Broom Sweep Pattern**.

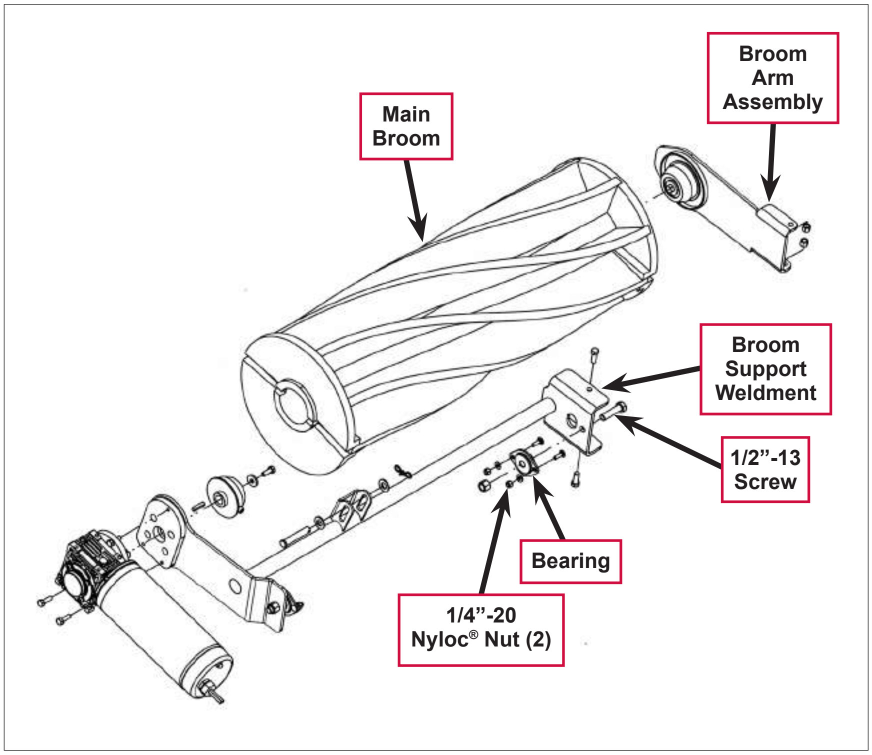
4. Allow the broom motor to stop and the broom to retract upward. The machine controller will “remember” the new main broom height and will return the broom to this position when the sweep system is enabled.



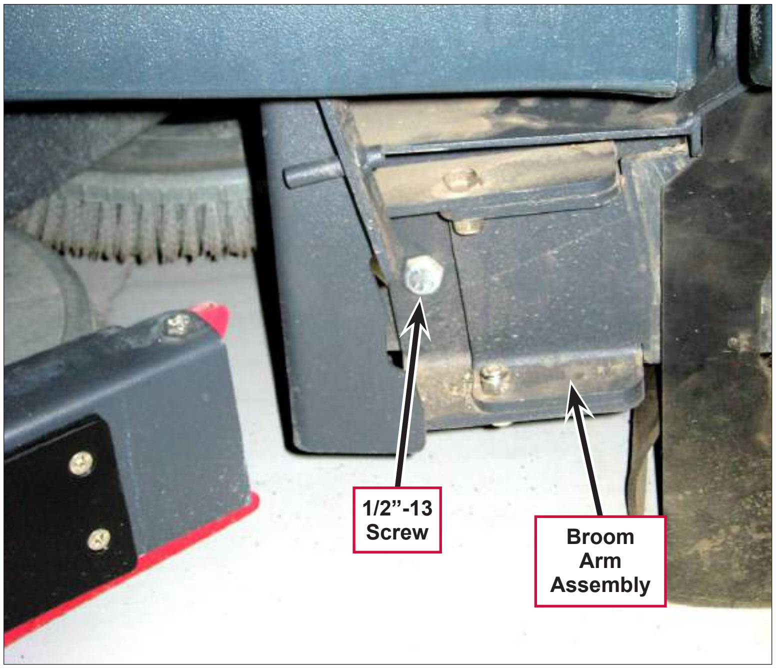
Note: *If the width of the main broom sweep pattern is not consistent along the entire length of the main broom, you may need to adjust the main broom tilt. Refer to the* **To Adjust the Main Broom Tilt** *section below.*

To Adjust the Main Broom Tilt

1. Loosen the two **1/4”-20 Nyloc® Nuts** holding the **Bearing** on which the **Broom Support Weldment** pivots on the right side. Note that the **1/4”-20 Nyloc® Nuts** and **Bearing** are accessed from the inside of the main broom compartment and are located behind the **1/2”-13 Screw** just to the rear of the **Broom Arm Assembly**. Also note that the **Bearing** and mounting screws ride in slotted holes in the supporting weldment to allow for up/down adjustment.



2. Move the **Bearing** and attached **Broom Support Weldment** up or down as necessary so the width of the main broom sweep pattern is consistent along the entire length of the main broom. Note that:
   - *Raising* the right side of the main broom will *narrow* the sweep pattern on the right side.
   - *Lowering* the right side of the main broom will *widen* the sweep pattern on the right side.



3. Tighten the two **1/4”-20 Nyloc® Nuts**.
4. Check the main broom sweep pattern.
5. Readjust the main broom tilt as necessary.

Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
The main sweep system is not operating correctly.	An interlock is not closed.	Before you start troubleshooting a specific system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed. • The A1 Main Machine Controller is receiving the appropriate signal from the A3 Control Panel via the CAN BUS.
The main broom motor will not run.	The 150-amp Fuse (**F2**) is blown.	Check the Fuse (**F2**) and replace if necessary.
	The hopper is overfilled or is “lip loaded”.	Check for a fault code 54 - Main Broom Motor Overload. If you see fault code 54, empty the hopper.
	There is no voltage to the **K4** contactor coil.	1. Check circuit breakers **CB1** and **CB3** and reset if necessary. 2. Check the **K9** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 3. Check the continuity through contactor **K9** with the coil energized. If the contacts are open, replace the contactor. 4. Check the **J2-16** output from A1 Main Machine Controller.
	There is no positive voltage to the broom motor.	1. Check the wiring and connectors from the load side of contactor **K4** to the broom motor and repair as necessary. 2. Check the **K4** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 3. Check the continuity through contactor **K4** with the coil energized. If the contacts are open, replace the contactor.
	There is no ground connection to the broom motor.	Check the wiring and connectors from the broom motor to battery ground repair as necessary.

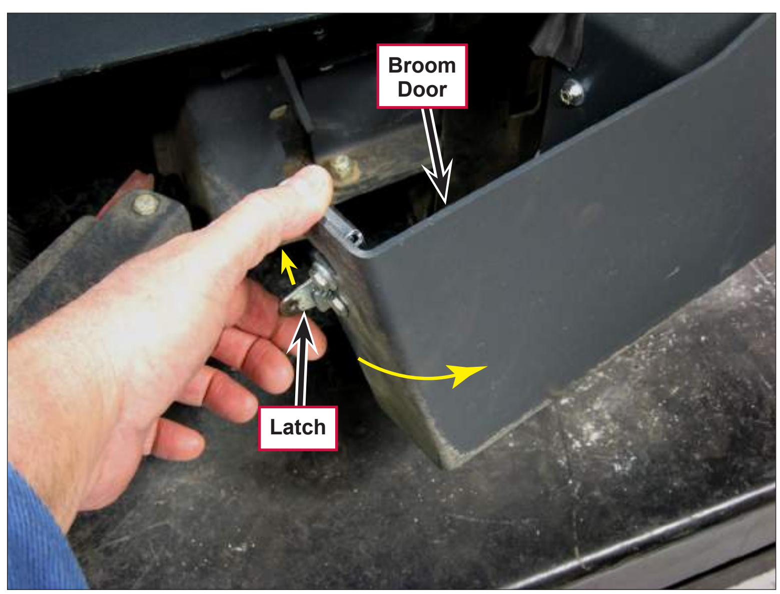
Problem	Cause	Correction
The broom lift actuator is not raising and lowering the main broom.	No voltage to the main broom actuator.	1. Check the wiring and connectors from the A1 Main Machine Controller to the main broom actuator motor and repair as necessary. 2. Check the operation of the broom lift actuator motor (**M21**). If the motor doesn't operate correctly, replace the broom lift actuator. 3. Check the voltage outputs from **J3-3** and **J2-4** on the A1 Main Machine Controller.
The main broom is not moving to the previous position when the sweep system is enabled.	The potentiometer **R4** in the broom lift actuator is not operating correctly.	1. Check the voltage output from **J7-34** to ground as the broom lift actuator raises and lowers the broom. The voltage should vary from 0 (full up position) to approximately 3.3 VDC (full down position). 2. If the voltages are not in the 0 to 3.3 volt range, replace the broom lift actuator.
	There is no voltage from the A1 Main Machine Controller to potentiometer **R4**.	Check the output from **J7-33** on the A1 Main Machine Controller.

Removal and Installation

Warning! ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

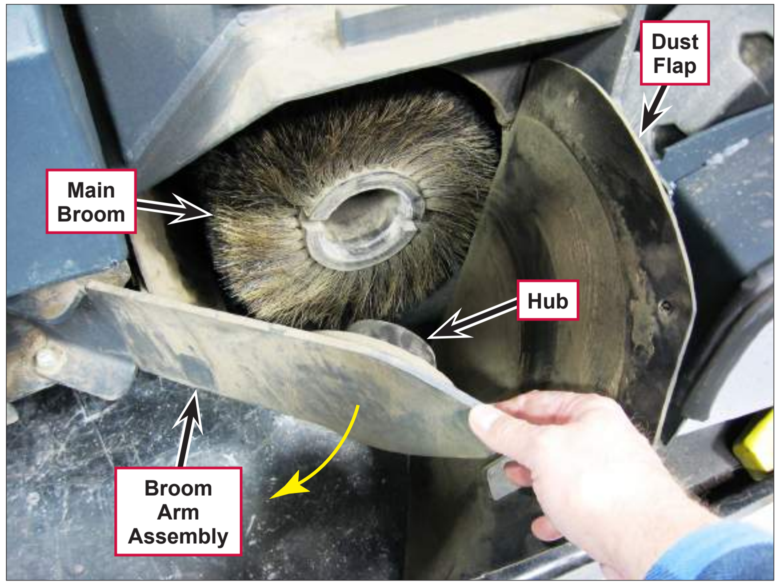
To Remove the Main Broom

1. Make sure the main broom is in the raised position.
2. Lift up the **Latch** and swing open the **Broom Door**.



3. Move the **Dust Flap** out of the way and swing open the **Broom Arm Assembly**.

4. Pull the **Main Broom** out of the machine.



To Install the Main Broom

1. Install the **Main Broom** into the machine. Rotate the **Main Broom** as necessary to make sure the broom lugs on the far side engage the drive hub on the broom motor.

2. Close the **Broom Arm Assembly**, making sure the **Main Broom** engages the **Hub** on the **Broom Arm Assembly**.

3. Move the **Dust Flap** back into position, then close and latch the **Broom Door**

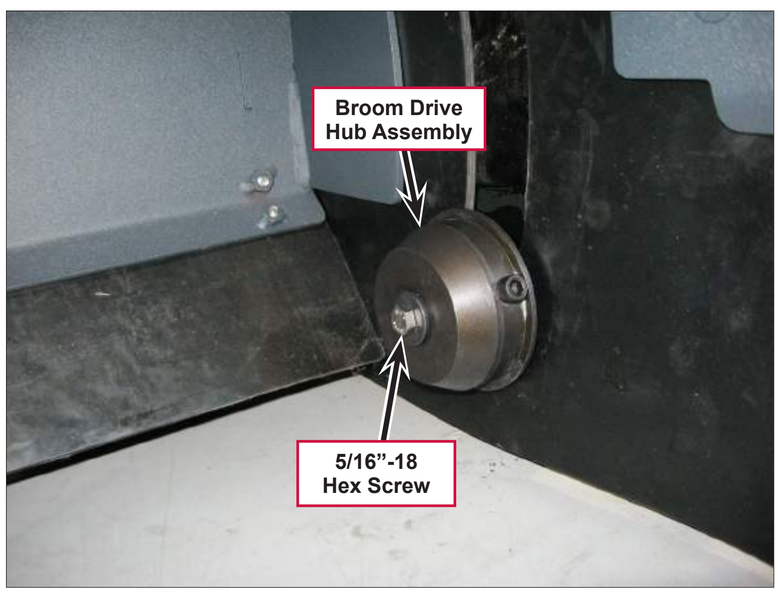
Note: *Make sure you adjust the main broom height when installing a new broom. Failure to do so will reduce the life of the broom and may lead to setting a code 54 (main broom overload) which will shut down the main broom.*

To Remove and Reinstall the Broom Motor Assembly

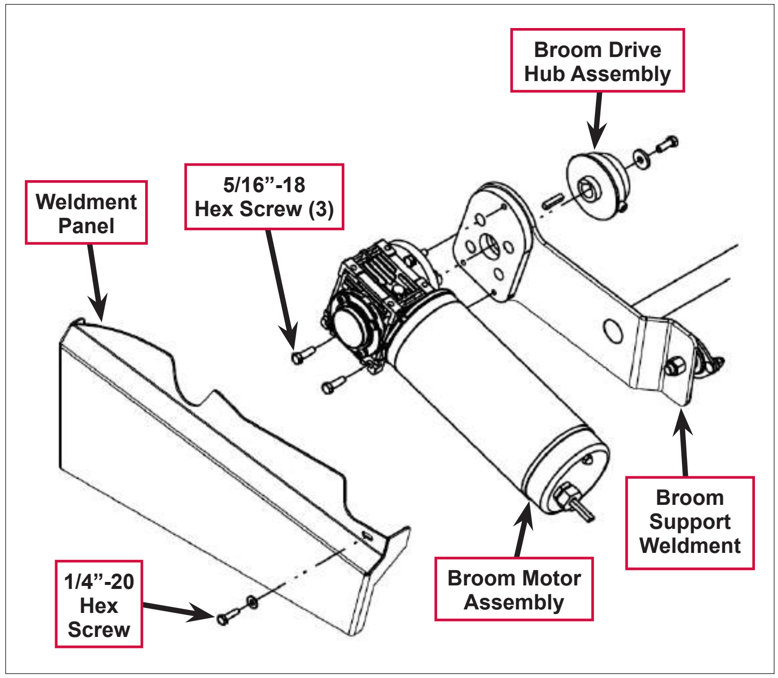
1. Remove the main broom from the machine.

2. Open the hopper and engage the prop rod.

3. Remove the **5/16”-18 Hex Screw** holding the **Broom Drive Hub Assembly** onto the gearbox shaft, then remove the **Broom Drive Hub Assembly**,washer and key.



4. Remove the **1/4"-20 Hex Screw** and washer holding the **Weldment Panel** to the machine frame. Note that the front edge of the **Weldment Panel** is pinned to the frame.
5. Disconnect the broom motor electrical connector from the wiring harness.
6. Remove the three **5/16"-18 Hex Screws** holding the **Broom Motor Assembly** to the **Broom Support Weldment** and remove the **Broom Motor Assembly** from the machine.
7. Reinstall the **Broom Motor Assembly** following the above steps in reverse order.

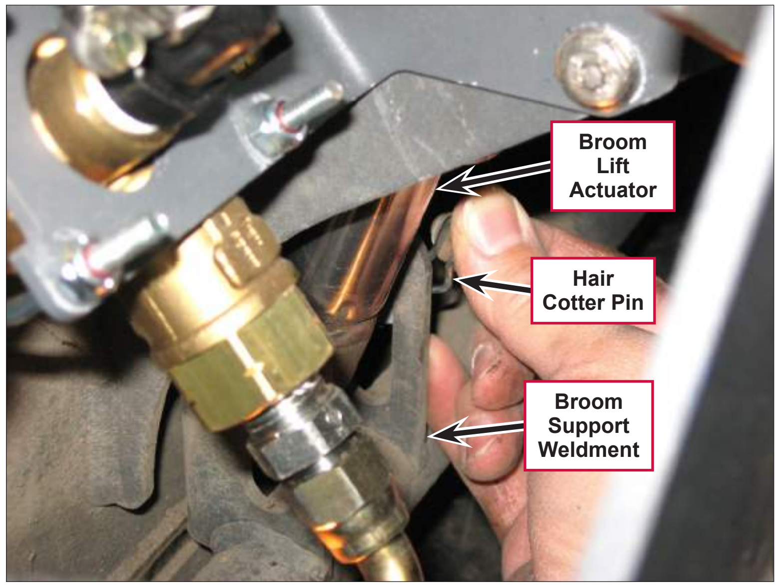


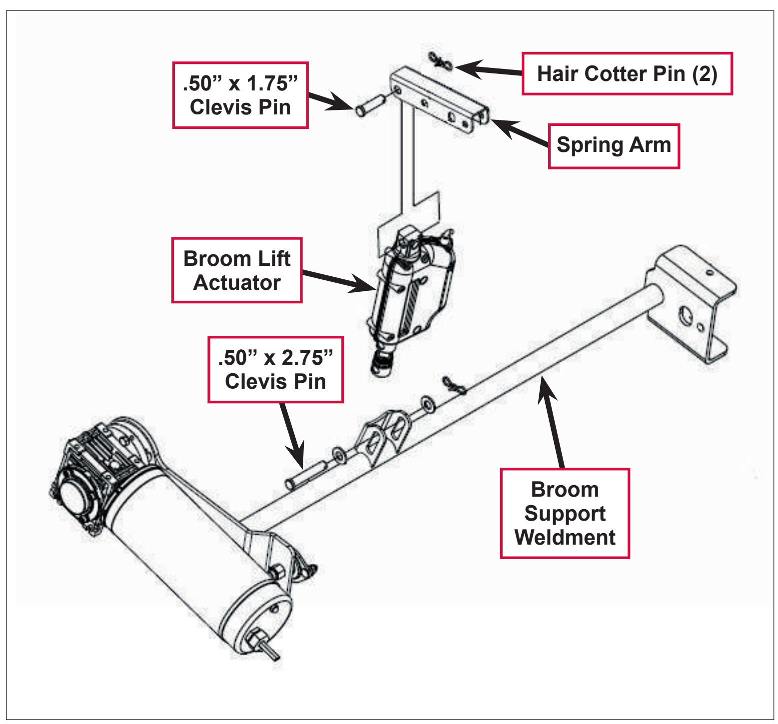
Service Note: *Apply Never-Seez® or an equivalent anti-seize compound on the gearbox shaft when you reinstall the* ***Broom Drive Hub Assembly****.*

Apply Loctite® 242 (blue) on the ***5/16"-18 Hex Screws*** *when reinstalling the* ***Broom Drive Hub Assembly*** *and* ***Broom Motor Assembly.***

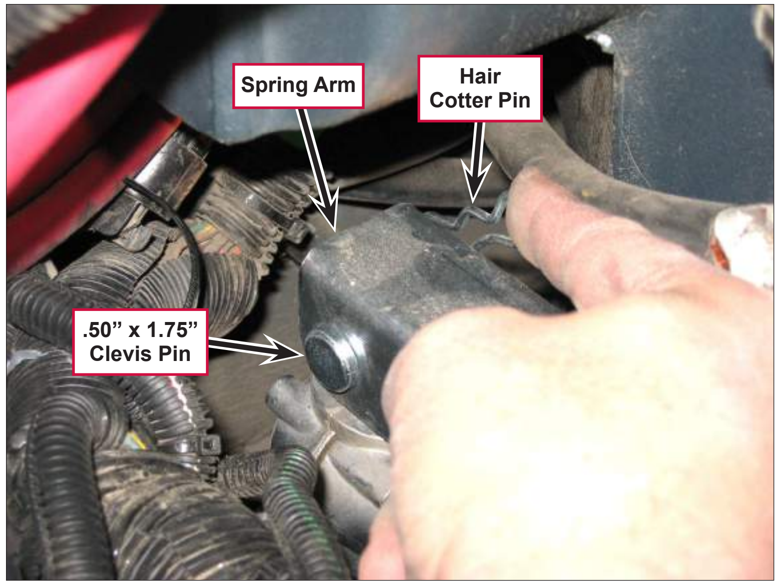
To Remove and Reinstall the Broom Lift Actuator

1. Remove the recovery tank.
2. Remove the main broom from the machine.
3. Turn the key switch on and switch the machine to the Service Mode.
4. Extend the scrub deck downward in the Service Test Mode. This will give you additional clearance for removing the hair cotter pins and clevis pins on the broom lift actuator.
5. Extend the main broom downward in the Service Test Mode so the bristles rest on the floor. This will minimize the weight on the broom lift actuator.
6. Remove the **Hair Cotter Pin**, washers and **.50" x 2.75" Clevis Pin** holding the bottom of the **Broom Lift Actuator** to the **Broom Support Weldment**.





7. Remove the **Hair Cotter Pin**, washers and **.50" x 1.75" Clevis Pin** holding the top of the **Broom Lift Actuator** to the **Spring Arm**.
8. Disconnect the **Broom Lift Actuator** electrical connector and remove the **Broom Lift Actuator** from the machine.
9. Reinstall the **Broom Lift Actuator** by following the above steps in reverse order.
10. Check the main broom height and main broom sweep pattern and adjust as necessary. (Refer to the ***To Adjust the Main Broom Height*** section.)



Specifications

Component	Specifications
Main Broom Motor	RPM - 3400
	Voltage - 36 VDC
	Amperage - 26 Amps
Main Broom Actuator	Dynamic Load - 400 lbs. maximum
	Static Load - 1000 lbs. maximum
	Restraining Torque - Actuator is internally restrained
	Input Voltage - 30 to 40 VDC
	Amperage - 4 Amps at rated dynamic load
	Overload Protection - Ball detent clutch with load rating between 450 and 700 lbs.
	Thermal Protection - Automatic resetting thermal breaker enclosed in motor housing.
	Wiring Polarity: • To extend actuator, connect red lead to positive and yellow lead to negative. • To retract actuator, connect yellow lead to positive and red lead to negative.

Sweep System, Side Broom

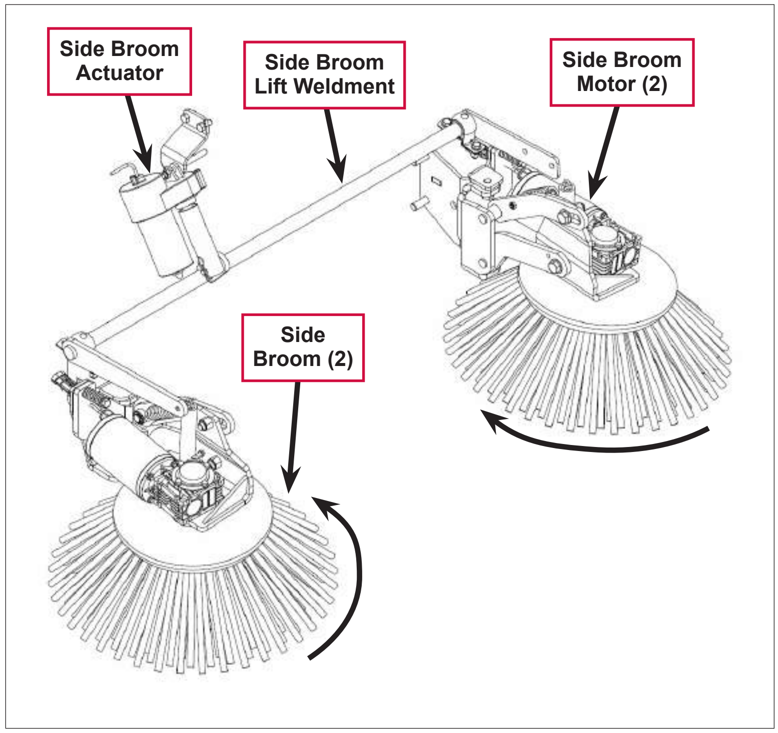
Functional Description

Overview

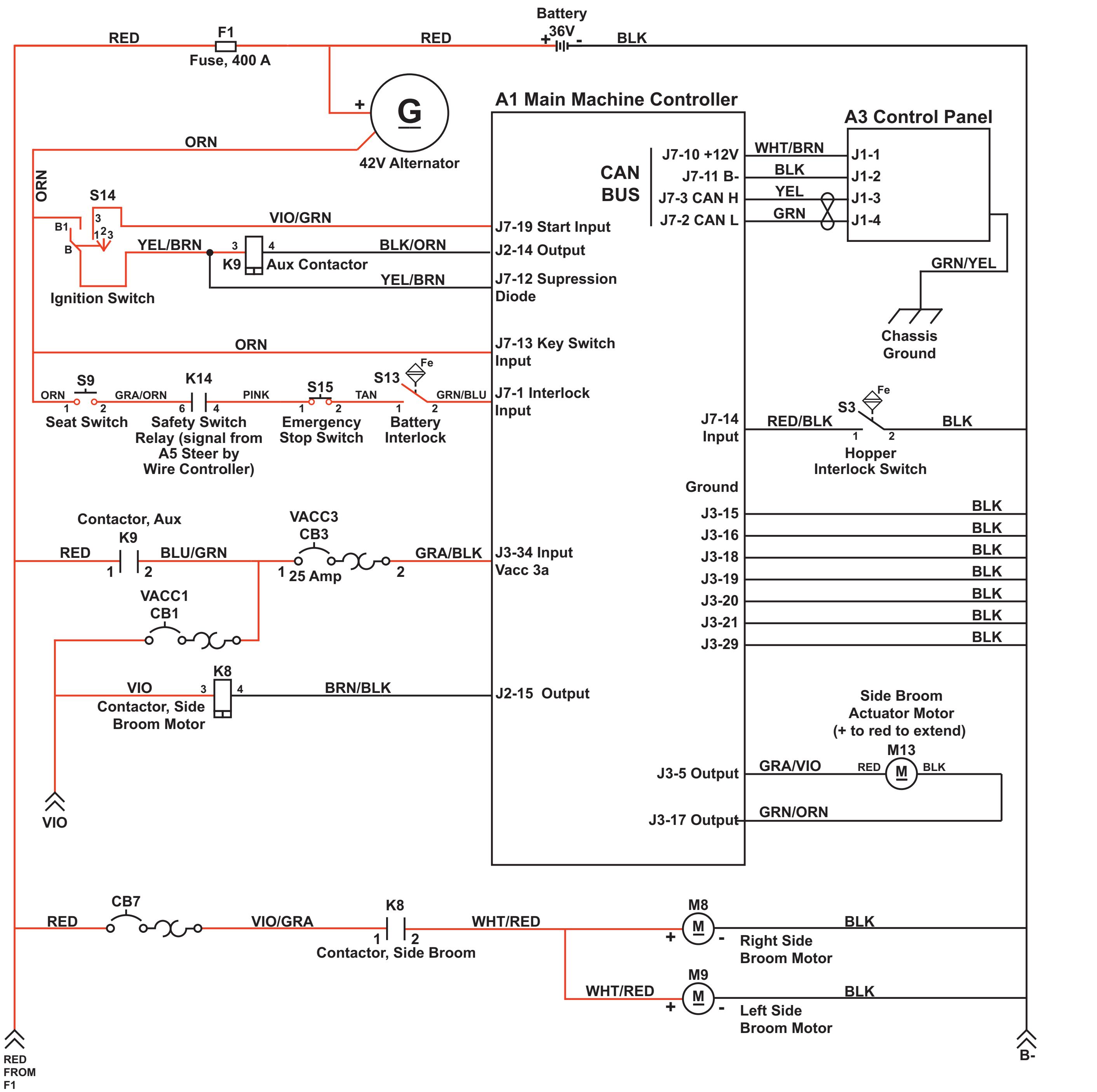
The **Side Brooms** run in opposite directions to direct debris from the sides of the machine toward the center where the main broom can direct it into the hopper.

The side broom sweep system includes the **Side Brooms**, **Side Broom Motors**, and the **Side Broom Actuator** which lowers and raises the **Side Brooms** via linkages connected to the **Side Broom LIft Weldment**.

The **Side Broom Actuator** lowers the **Side Brooms** any time the sweep system is enabled. The **Side Broom Motors** switch on when the drive pedal is moved from the neutral position. The operator can enable and disable the **Side Brooms** independent of the main sweep system.



Side Broom System Wiring Diagram



Circuit Description

The Following Conditions Must be Met for the Side Broom Sweep System To Operate

- The **Hopper Interlock Switch S3** must be closed.
- There must be positive voltage to the **J7-1 Interlock Input**. For this to happen:
  - The **Seat Switch S9** must be closed.
  - The **Safety Relay K14** on the **Steer By Wire Controller A5** must energize the coil to close the **Safety Relay K14** contactor.
  - The **Emergency Stop Switch S15** must be closed.
  - The **Battery Interlock S13** must be closed.
- The **400-amp Fuse F1** must be closed to provide positive voltage from the **Battery** to the load side of **Auxiliary Contactor K9** and circuit breaker **CB7**.
- The **Ignition Switch S14** must be closed to provide positive voltage to the **Auxiliary Contactor K9** coil. The **J2-14 Output** on the **A1 Main Machine Controller** provides ground to the **Auxiliary Contactor K9** coil when the **Ignition Switch S14** provides an input to the **Key Switch Input J7-13**.
- The **Auxiliary Contactor K9** must be closed to provide positive voltage to circuit breaker **VACC1/CB1**.
- Circuit breaker **VACC1/CB1** must be closed to provide positive voltage to the **Side Broom Motor Contactor K8** coil.
- The **J2-15 Output** on the **A1 Main Machine Controller** must provide a ground to the **Side Broom Motor Contactor K8** coil. **J2-15** provides ground to **K8** under the following conditions:
  - The **A1 Main Machine Controller** must receive a signal from the **A3 Control Panel** via the **CAN BUS** that the operator has pressed the sweep and side broom switches.
  - The **A1 Main Machine Controller** must receive a signal from the **A2 Drive Controller** via the **CAN BUS** that the machine is moving forward or reverse.
- Circuit breaker **CB7** must be closed to provide positive voltage to the load side of **Side Broom Motor Contactor K8**.
- **Side Broom Motor Contactor K8** must be closed to provide positive voltage to the **Side Broom Motors M8** and **M9**.
- The **Side Broom Motors M8** and **M9** must have connections to battery ground **B-**.

Side Broom Actuator Motor

The **J3-5** and **J3-17 Outputs** from the **A1 Main Machine Controller** provide voltage to the **Side Broom Actuator Motor M13**. The output polarity determines whether the **Side Broom Actuator Motor** lowers or raises the side brooms.

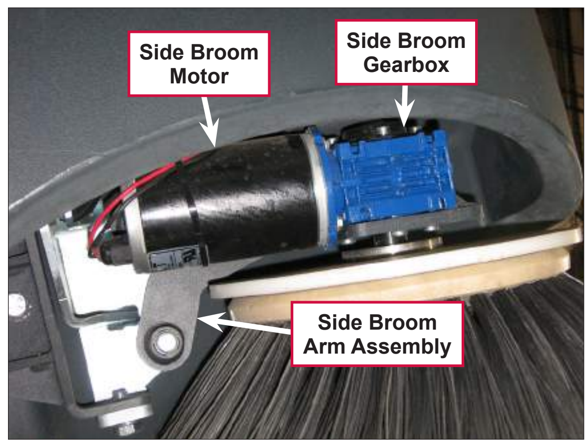
Component Locations

Side Brooms

The **Side Brooms** are mounted on the front corners of the machine, below the hopper.

Side Broom Motor Assemblies

The side broom motor assemblies consist of the **Side Broom Motors** and **Side Broom Gearbox**. The **Side Broom Motor Assemblies** are mounted on **Side Broom Arm Assemblies** connected to the side broom lift weldment.



Side Broom Actuator

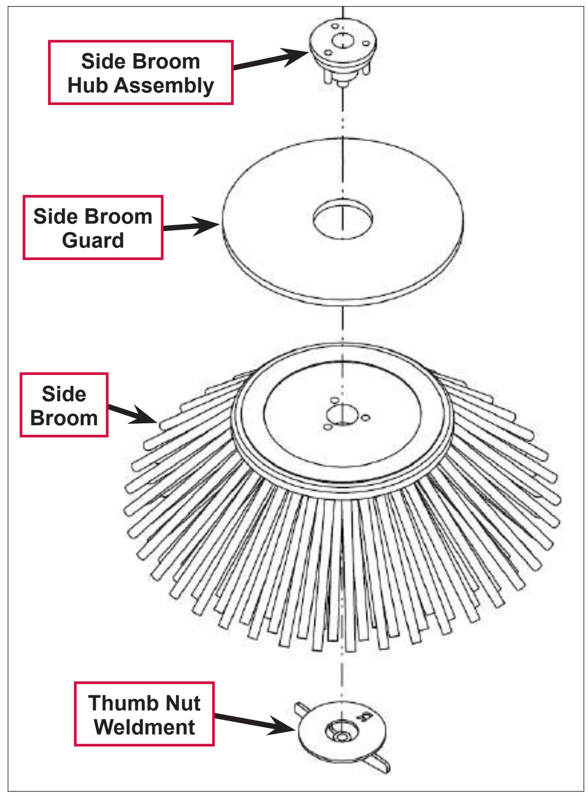
The **Side Broom Actuator** is on the upper hopper and lowers and raises the side broom lift weldment and attached side broom motor assemblies.

Maintenance and Adjustments

Warning! ***Before performing any maintenance or adjustments on the side sweep system, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Remove and Reinstall a Side Broom

1. Turn the key switch on, raise the hopper to convenient height, then turn the key switch off.
2. Remove the key from the machine.
3. Unscrew the **Thumb Nut Weldment**, then remove the **Side Broom** and **Side Broom Guard** from the **Side Broom Hub Assembly**.
4. Reinstall the **Side Broom** by following the above steps in reverse order.



Troubleshooting

Note: *You can use the Service Mode to toggle the various system components on and off to check for function. Refer to the* **Control System/Service Mode** *section for information on how to enter and use the Service Mode.*

Problem	Cause	Correction
The side sweep system is not operating correctly.	An interlock is not closed.	Before you start troubleshooting a specific system, check to make sure: • The emergency stop switch (**S15**) on the Operator control panel is disengaged (rotate clockwise). • The safety relay from the steering system (**K14**) is closed. • The seat switch (**S9**) is closed. • The battery interlock proximity sensor (**S13**) is closed. • The A1 Main Machine Controller is receiving the appropriate signal from the A3 Control Panel via the CAN BUS.
The side broom motors will not run.	The 400-amp Fuse (**F1**) is blown.	Check the Fuse (**F1**) and replace if necessary.
	Circuit breaker **CB7** is open.	Reset circuit breaker **CB7**.
	There is no voltage to the **K8** contactor coil.	1. Check circuit breakers **CB1** and **CB3** and reset if necessary. 2. Check the **K9** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 3. Check the continuity through contactor **K9** with the coil energized. If the contacts are open, replace the contactor. 4. Check the **J2-15** output from A1 Main Machine Controller.
	There is no positive voltage to the side broom motors.	1. Check the wiring and connectors from the load side of contactor **K8** to the side broom motors and repair as necessary. 2. Check the **K8** contactor coil resistance. If the coil resistance is not 118 ohms ± 10%, replace the contactor. 3. Check the continuity through contactor **K8** with the coil energized. If the contacts are open, replace the contactor.
	There is no ground connection to the side broom motors.	Check the wiring and connectors from the side broom motors to battery ground repair as necessary.

Problem	Cause	Correction
The side broom actuator is not raising and lowering the side brooms.	No voltage to the side broom actuator.	1. Check the wiring and connectors from the A1 Main Machine Controller to the side broom actuator and repair as necessary. 2. Check the voltage outputs from **J3-5** and **J3-17** on the A1 Main Machine Controller.
	The side broom actuator is not working.	Check the operation of the side lift actuator motor (**M13**). If the motor doesn't operate, replace the side broom actuator.

Removal and Installation

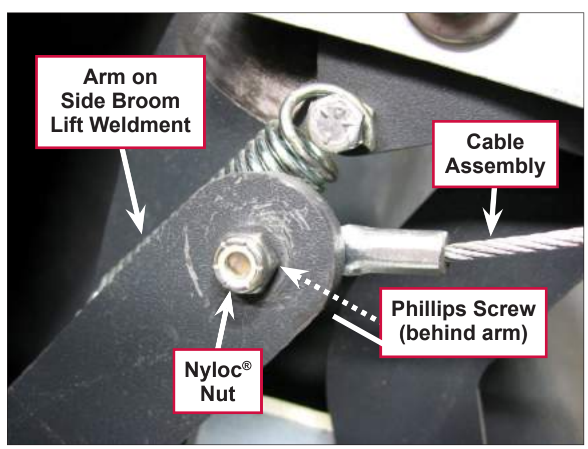
Warning! ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

To Remove and Reinstall a Side Broom Motor Assembly

1. Dump the hopper.
2. Make sure the parking brake is engaged.
3. Turn the key switch on and switch the machine to the Service Mode.
4. Raise the hopper so the side brooms are at a convenient working height, then support the hopper with jack stands or other suitable supports.

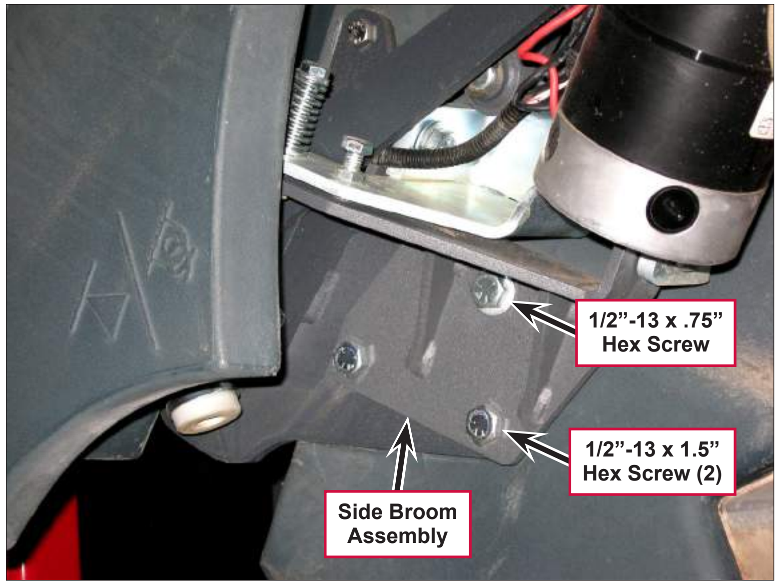
Warning! ***Always make sure the raised hopper is adequately supported before performing any work on or underneath the hopper.***

5. Extend the side brooms in the Service Mode to access the mounting hardware.
6. Open the hopper door.
7. Remove the side broom (refer to the ***To Remove and Reinstall a Side Broom*** section).
8. Disconnect the side broom motor electrical connector. Note that you may need to cut the wire tie holding the wires to the motor.
9. Remove the **Phillips Screw** and **Nyloc® Nut** holding the **Cable Assembly** to the **Arm** on the **Side Broom Lift Weldment**.



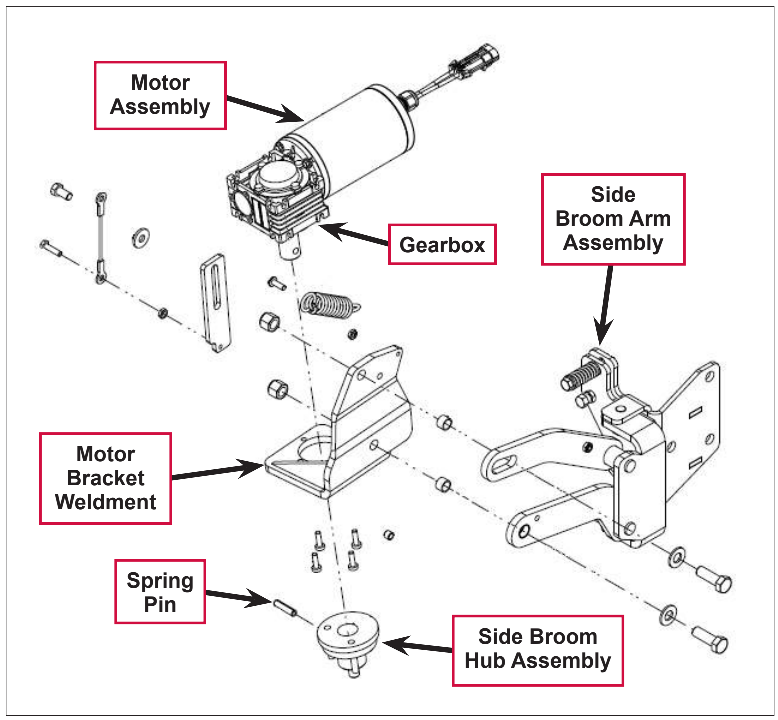
10. Slightly loosen the **1/2"-13 x .75" Hex Screw**. Note that this screw is threaded directly into the hopper lift weldment.

11. Remove the two **1/2"-13 x 1.5" Hex Screws**, washers and Nyloc® nuts. Note that the washers and Nyloc® nuts are located inside the hopper.



Note: *Removing the* ***Side Broom Assembly*** *is easier if one person holds the* ***Side Broom Assembly*** *in place while another person removes the* ***1/2"-13 x .75" Hex Screw****.*

Caution: Handle the Side Broom Assembly carefully as you remove it from the machine. The Motor Bracket Weldment and attached Motor Assembly are free to move on the Side Broom Arm Assembly and can create pinch points.

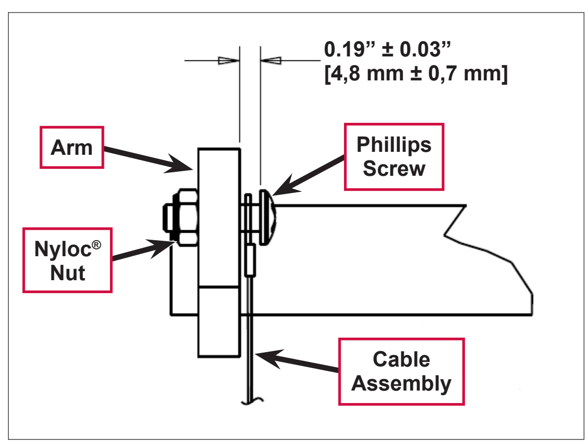


12. Remove the **1/2"-13 x .75" Hex Screw** and washer and carefully remove the **Side Broom Assembly** from the machine.

13. Reinstall the side broom motor assembly by following the above steps in reverse order.

Service Note: *Use Loctite® #242 (blue) on the* ***1/2"-13 x .75" Hex Screw*** *when you reinstall the* ***Screw****.*

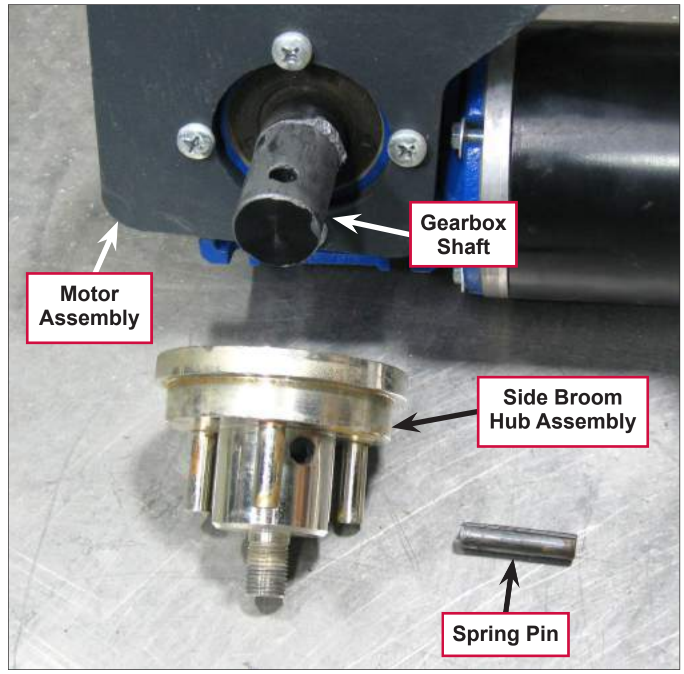
Service Note: *When you reinstall the* ***Cable Assembly*** *to the* ***Arm*** *on the side broom lift weldment, leave a 0.19" ± 0.03" [4,8 mm ± 0,7 mm] gap between the* ***Phillips Screw*** *and* ***Arm*** *to allow the* ***Cable Assembly*** *to move freely on the* ***Phillips Screw****.*



To Remove and Reinstall a Side Broom Hub Assembly

1. Remove the side broom motor assembly from the machine.
2. Make sure the **Motor Assembly** and **Side Broom Hub Assembly** are adequately supported, then carefully drive out the **Spring Pin**.
3. Remove the **Side Broom Hub Assembly** from the **Gearbox Shaft**.
4. Reinstall the **Side Broom Hub Assembly** by following the above steps in reverse order.

Service Note: *Coat the **Gearbox Shaft** with Never-Seez® or equivalent anti-seize compound before installing the **Side Broom Hub Assembly**.*



To Remove and Reinstall the Side Broom Actuator

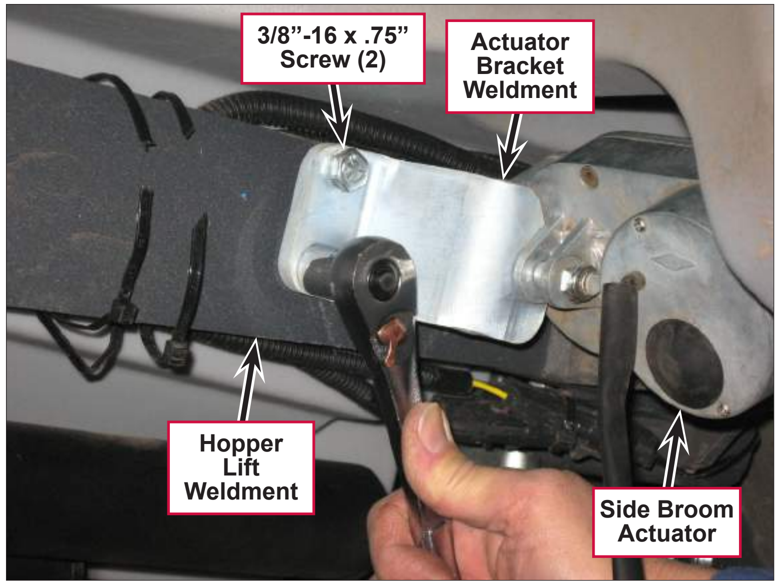
1. Dump the hopper.
2. Make sure the parking brake is engaged.
3. Turn the key switch on and switch the machine to the Service Mode.
4. Raise the hopper far enough to minimize the weight of the side brooms on the actuator, then support the hopper with jack stands or other suitable supports.

***Warning!* Always make sure the hopper is adequately supported before performing any work on or underneath the hopper.**

5. Cut the wire tie and disconnect the side broom actuator electrical connector.

6. Remove the two **3/8”-16 x .75” Screws** holding the **Actuator Bracket Weldment** to the **Hopper Lift Weldment**.

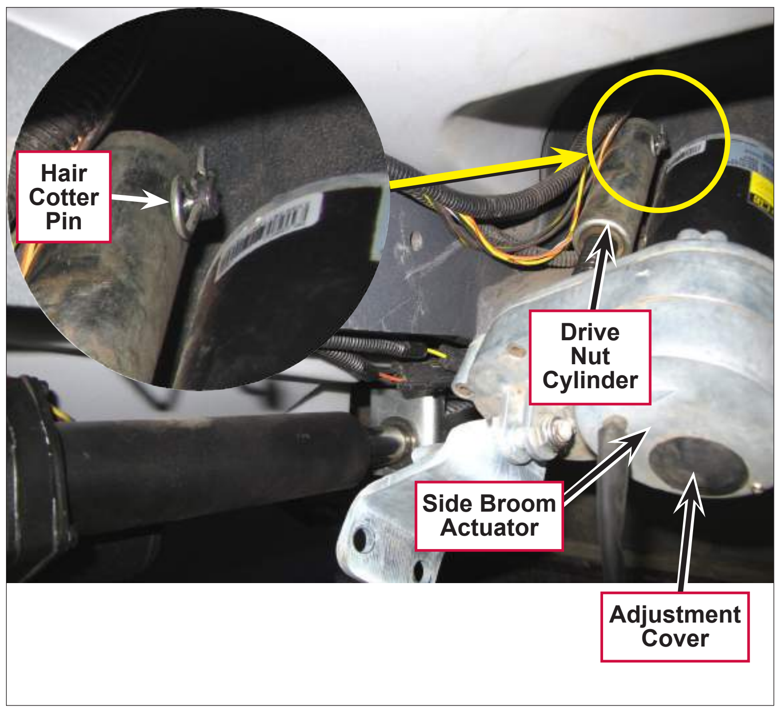
7. Extend the side brooms in the Service Mode to extend the side broom actuator. This will give you some additional clearance for better access to the hair cotter pin holding the **Side Broom Actuator** to the side broom lift weldment.



8. Use a long needle-nose pliers to remove the **Hair Cotter Pin**, then slide the **Side Broom Actuator** off of the pin on the side broom lift weldment and remove it from the machine.

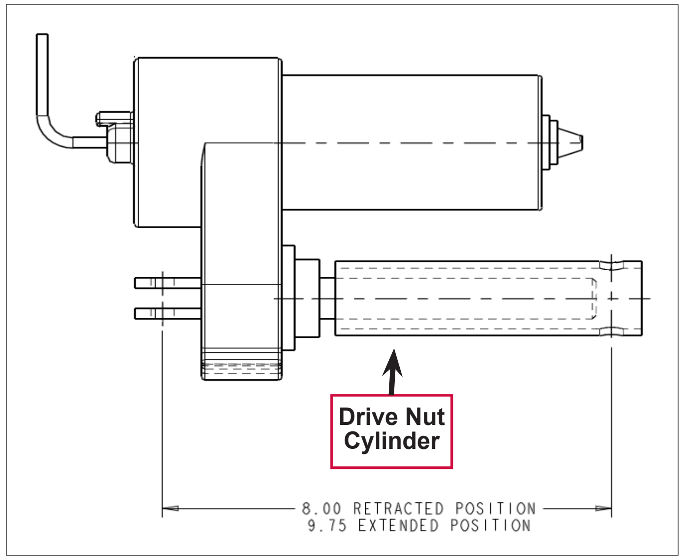
9. Reinstall the **Side Broom Actuator** by following the above steps in reverse order.

Note: *Be careful not to rotate the **Drive Nut Cylinder** on the **Side Broom Actuator** when it’s disconnected from the machine. This can change the extended and retracted positions of the **Side Broom Actuator**, and the subsequent extended and retracted positions of the side brooms.*



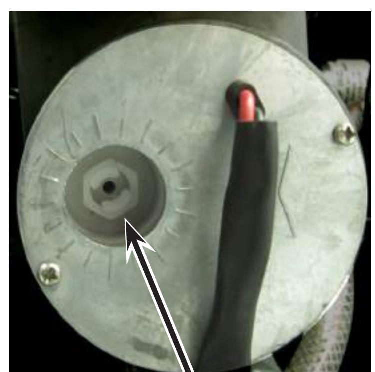
Service Note: *If you're installing a new Side Broom Actuator, or if the* **Drive Nut Cylinder** *on the existing Side Broom Actuator has been rotated on the Acme threaded shaft, check the actuator extended and retracted dimensions and set as follows:*

1. Reconnect the side broom actuator electrical connector.
2. Install the **Drive Nut Cylinder** onto the drive screw threads just a few turns.
3. Hold on to the drive nut cylinder to keep it from rotating, then retract the side broom actuator using the Service Mode until the motor stops.
4. Check the retracted position dimension as shown in the adjacent drawing.
5. Adjust the retracted position by rotating the **Drive Nut Cylinder** on the threaded shaft as necessary.
6. Hold on to the drive nut cylinder to keep it from rotating, then extend the side broom actuator using the Service Mode until the motor stops.
7. Check the extended position dimension.



8. If the distance is not correct, remove the rubber adjuster cover from the end of the motor. Then rotate the nylon nut found under the cover with a 1/2" (13 mm) SOCKET (Not a screwdriver!). Turning the nut one click will change the distance approximately on tenth of an inch (2.5 mm). After changing the adjustment, run the motor in and out and recheck the "extended" position dimension.

Remove Adjuster Cover



Rotate Nylon Nut to Adjust

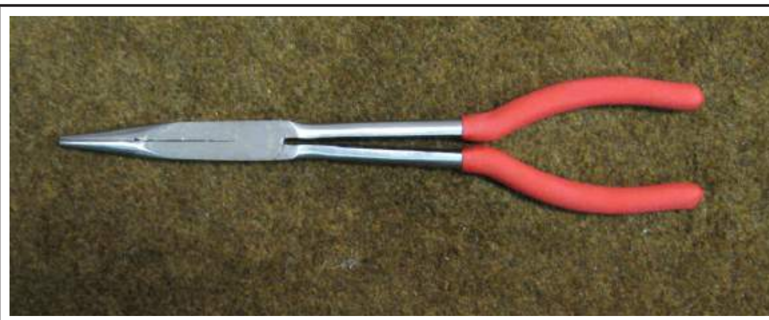
Note: Use a 1/2" (13mm) socket to turn the adjuster.

9. After each adjustment, hold the drive nut cylinder, run the actuator IN & OUT and recheck the dimensions. Reinstall the adjuster cover.

Specifications

<table>
<tr><th>Component</th><th colspan="4">Specifications</th></tr>
<tr><td rowspan="4">Side Broom Motors (all)</td><td colspan="4">No-load Speed - 2,800 RPM</td></tr>
<tr><td colspan="4">Rotation - Clockwise</td></tr>
<tr><td colspan="4">Voltage - 42 VDC</td></tr>
<tr><td colspan="4">Power - .25 HP, Continuous Duty</td></tr>
<tr><td>Side Broom Motor - Left</td><td>Current Draw (shop measurements)</td><td colspan="2">Average - 3 Amps</td><td>Max. - 4 Amps</td></tr>
<tr><td>Side Broom Motor - Right</td><td>Current Draw (shop measurements)</td><td colspan="2">Average - 3 Amps</td><td>Max. - 4 Amps</td></tr>
<tr><td rowspan="11">Side Broom Actuator</td><td colspan="4">36 VDC, 1/6 HP</td></tr>
<tr><td colspan="4">Motor-to-drive screw ratio - 21.7:1</td></tr>
<tr><td colspan="3" rowspan="2">Drive Nut Cylinder Positions</td><td>Retracted Position - 8.00”</td></tr>
<tr><td>Extended Position - 9.75”</td></tr>
<tr><td colspan="2">Current Draw (shop measurements)</td><td colspan="2">Average - 2 to 3 Amps</td></tr>
<tr><td colspan="4">Performance data for the following load conditions:</td></tr>
<tr><td>No load</td><td colspan="2">Full load</td><td>Start</td></tr>
<tr><td>Thrust - 0 lbs</td><td colspan="2">Thrust - 600 lbs</td><td>Thrust 600 - lbs</td></tr>
<tr><td>Speed - 39 in/min</td><td colspan="2">Speed - 30 in/min</td><td></td></tr>
<tr><td>Amps - 1.4 Max</td><td colspan="2">Amps - 6.7 ±1.0</td><td></td></tr>
</table>

Special Tools

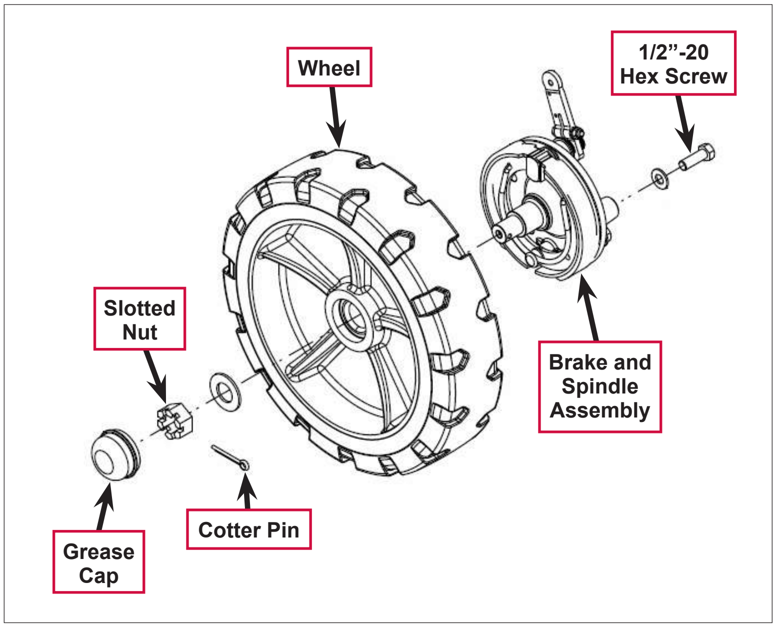
A long needle-nose pliers is recommended to remove the hair cotter pin when removing/reinstalling the side broom actuator. The photo shown here is a typical example.	

Wheel System, Non-Traction

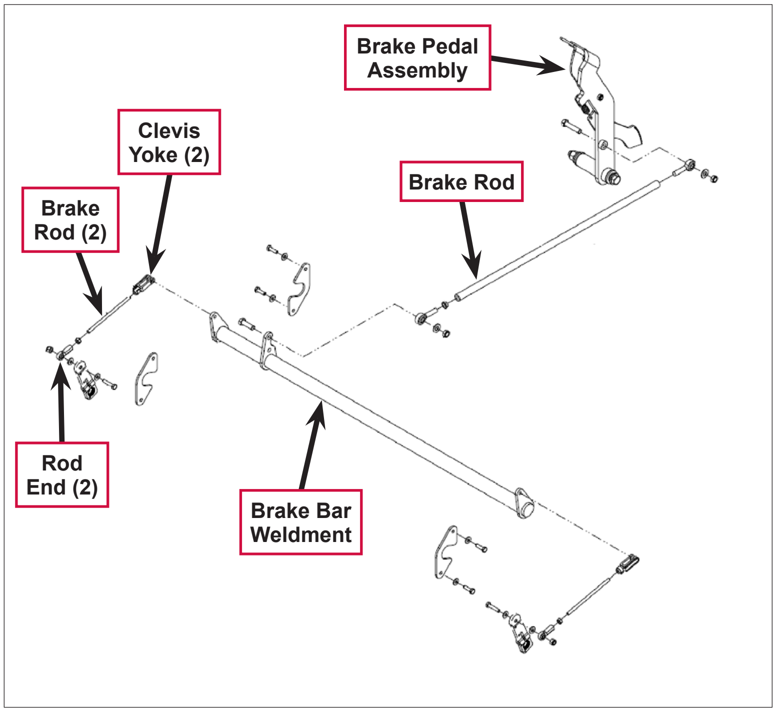
Functional Description

The non-traction wheels support the front of the machine and house the machine brakes. The wheel system includes the **Wheels**, **Brake and Spindle Assemblies** and the various mounting hardware. The wheels are mounted in the wheel wells on the front sides of the machine, between the main broom cover panels and the side brooms.

The **Wheels** are held onto the **Brake and Spindle Assemblies** with **Slotted Nuts** and **Cotter Pins**. The **Brake and Spindle Assemblies** are fastened to the machine frame with **1/2”-20 Hex Screws**.



A **Brake Rod** from the **Brake Pedal Assembly** actuates the pivoting **Brake Bar Weldment**. The **Brake Bar Weldment** actuates the two individual brake levers on the **Brake and Spindle Assemblies** via **Clevis Yokes** and attached **Brake Rods** and **Rod Ends**.

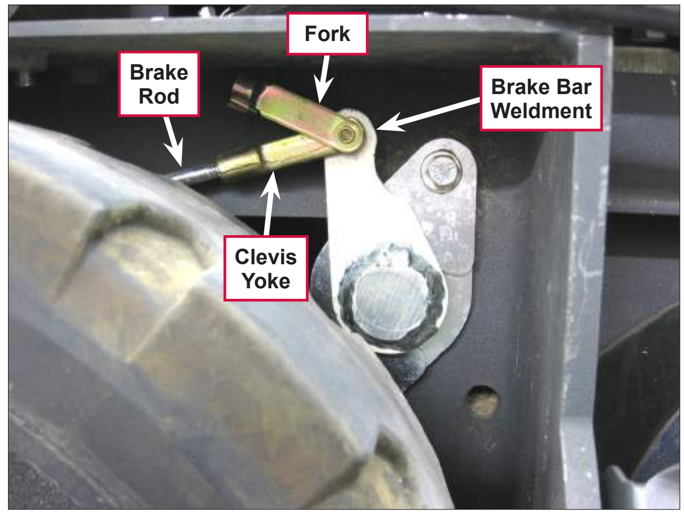


Maintenance and Adjustments

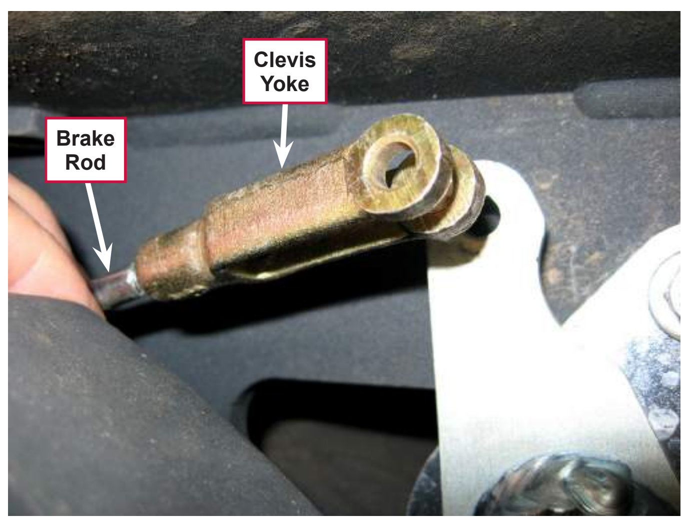
Warning! ***Before performing any maintenance or adjustments, make sure the key switch is off and the key is removed from the machine. Chock the machine wheels to prevent the machine from moving.***

To Adjust the Brakes

1. Remove the appropriate side panel to access the **Clevis Yoke**.
2. Lift the **Fork** on the **Clevis Yoke**, then pull it toward you to remove it from the **Clevis Yoke**.
3. Lift the **Clevis Yoke** out of the **Brake Bar Weldment**. This will allow the **Clevis Yoke** to rotate on the **Brake Rod**.



4. Rotate the **Clevis Yoke** on the **Brake Rod** to effectively lengthen or shorten the **Brake Rod**. Note that lengthening the **Brake Rod** will apply more pressure to the brakes with comparable brake pedal travel.
5. When the brake is adjusted correctly, reinstall the **Fork** onto the **Clevis Yoke**, then reinstall the side panel.



6. If steps 1 through 5 don't provide adequate adjustment, remove the wheel and adjust the **Rod End** as follows:

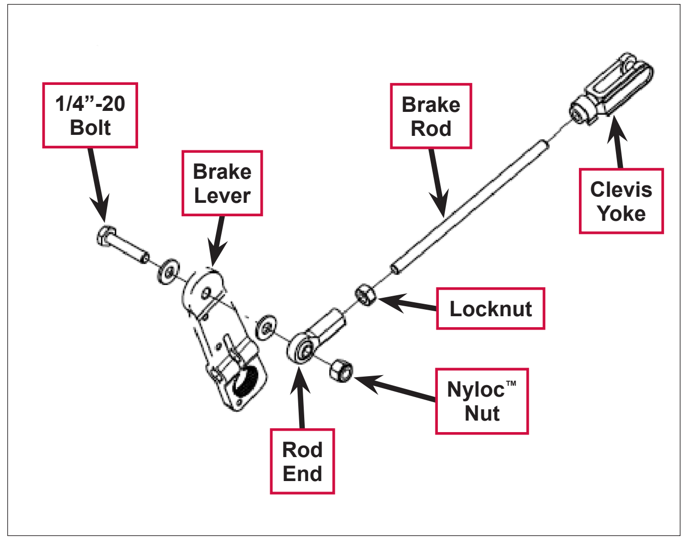
    a. Remove the **Nyloc™ Nut**, **1/4"-20 Bolt** and washers holding the **Rod End** to the **Brake Lever**.

    b. Loosen the **Locknut**.

    c. Rotate the **Rod End** on the **Brake Rod** to effectively lengthen or shorten the **Brake Rod**. Note that lengthening the **Brake Rod** will apply more pressure to the brakes with comparable brake pedal travel.

    d. When the brake is adjusted correctly, tighten the **Locknut**, then reinstall the **Rod End** onto the **Brake Lever**.

    e. Reinstall the wheel.



Troubleshooting

Problem	Cause	Correction
The wheels are making excess noise.	The wheel bearings worn.	Check the wheel, wheel bearings, and brake and spindle assembly and replace as required.
	The wheel and/or brake and spindle assembly are damaged.	
The brakes are not working correctly.	The brakes are out of adjustment	Adjust the brakes.
	The brake linings are worn out.	Replace the brake linings.

Removal and Installation

Warning! ***Before performing any maintenance or adjustments, make sure the key switch is off and the key is removed from the machine. Chock the machine wheels to prevent the machine from moving.***

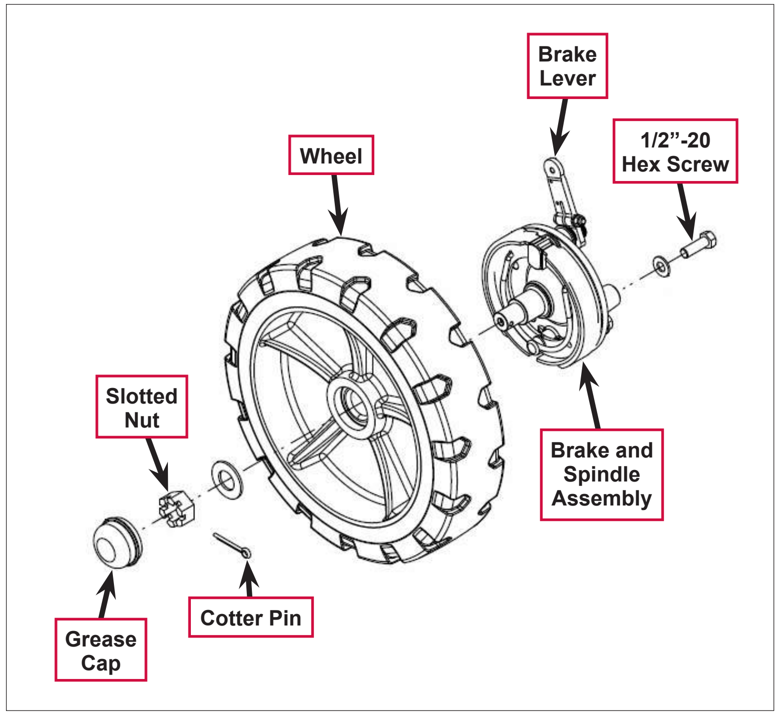
Never work under a machine without safety stands or blocks to support the machine. When jacking the machine, do so at the designated Tie Down/Jacking Locations.

To Remove and Reinstall a Wheel

1. Jack up the machine at a designated jacking point.

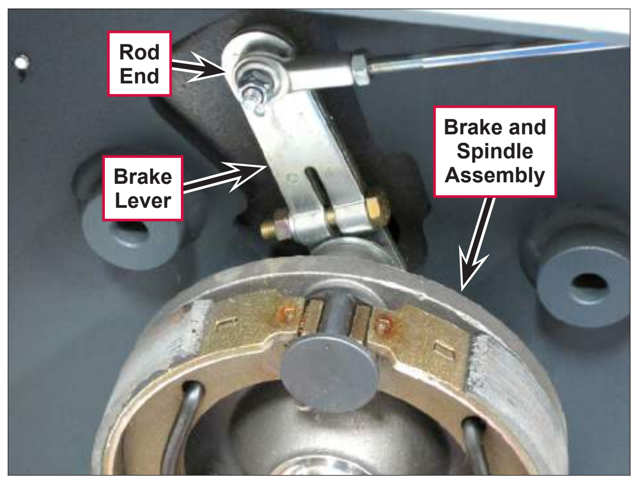
2. Install safety stands or blocks to support the machine while you work on it.

3. Remove the **Grease Cap**.
4. Remove the **Cotter Pin**, **Slotted Nut** and washer.
5. Remove the **Wheel** from the **Brake and Spindle Assembly**.
6. Reinstall the **Wheel** by following the above steps in reverse order.



To Remove and Reinstall a Brake and Spindle Assembly

1. Jack up the machine at a designated jacking point.
2. Install safety stands or blocks to support the machine while you work on it.
3. Remove the **Wheel** from the **Brake and Spindle Assembly**.
4. Remove the Nyloc nut and 1/4"-20 screw holding the **Rod End** to the **Brake Lever**.
5. Remove the two 1/2"-20 hex screws and remove the **Brake and Spindle Assembly** from the machine.
6. Reinstall the **Brake and Spindle Assembly** by following the above steps in reverse order.



Wheel System, Traction

Functional Description

A single rear wheel provides both traction drive and steering. The major components of the drive wheel system are the drive pedal, drive controller, drive wheel motor, gearbox and drive wheel. The drive wheel is mounted to a gearbox which carries the vehicle load, provides gear reduction and converts the plane of rotation from horizontal to vertical. The gearbox is driven by a brush-less three phase AC motor. A drive controller directly operates the drive motor based on input requests from a drive pedal sensor (potentiometer) which is mounted on the side of the drive pedal. If you push the pedal forward, the machine will move forward. If you push it farther forward, the machine will increase speed. If you push the pedal backward, the machine will move in reverse. The drive pedal is spring loaded in the center or "neutral" position.

Drive Pedal

Drive Controller

Drive Wheel Motor

Gearbox and Drive Wheel

Drive Pedal

The drive pedal is spring loaded in the neutral position. The drive pedal position sensor is a potentiometer mounted on the side of the pedal that tracks the pedal position. The sensor is pre-adjusted and comes with the pedal assembly.

Drive Controller

The drive controller is a self contained sealed unit. It controls when and how the current flows to the stator windings to rotate the motor based primarily on the drive pedal sensor input, but it also monitors rotational speed sensors and a temperature sensor inside the motor.

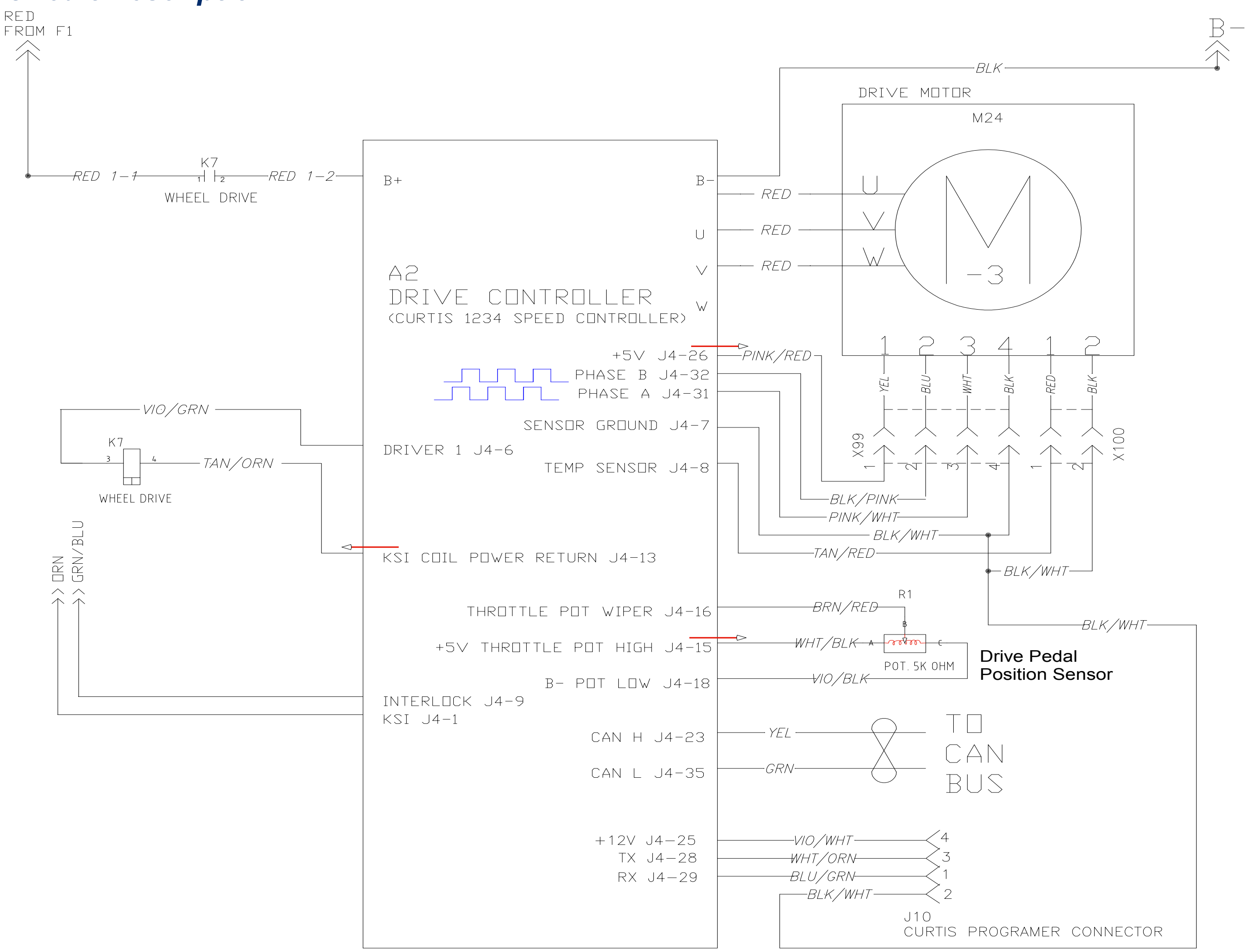
Drive Wheel Motor

The drive wheel motor is a brush-less three phase AC design. It is mounted on top of the gear box in the rear of the machine. It provides rotational power to the gear box. The wheel drive motor can change rotation direction to propel the machine both forward and backward.

Gear Box

The gear box provides gear reduction between the drive motor and the drive wheel. It converts the plane of rotation from horizontal to vertical and it supports the weight of the machine. There are no serviceable parts inside the gear box. The gear box incorporates a large turning plate bearing that allows the box to pivot in order to provide steering.

Circuit Description



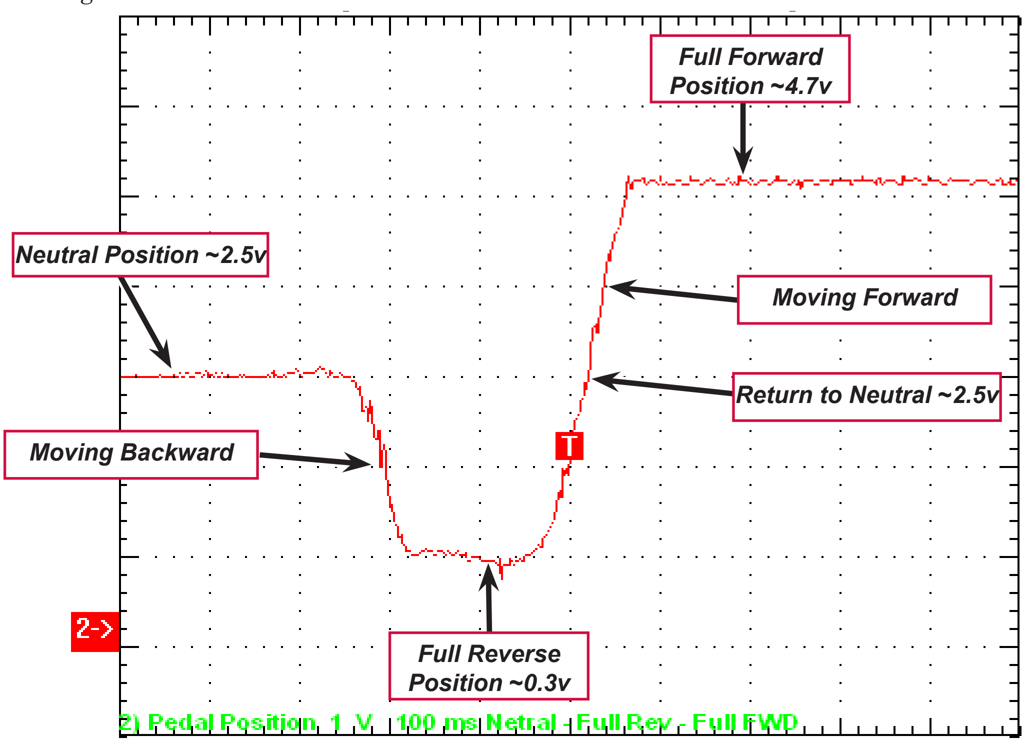
Powering up the Drive Controller

When the key switch is turned on, power is supplied on the orange wire to pin J4-1. When each interlock switch closes (seat switch, safety relay switch, emergency stop switch and battery interlock switch), power is supplied on the green/blue wire to pin J4-9. When power is available on both J4-1 and J4-9, the drive controller supplies battery voltage out of J4-13 to the K7 wheel drive contactor. The power flows through the contactor coil and back into the controller at J4-6 where it is switched to ground to energize the K7 wheel drive relay. The contacts of the energized K7 contactor supply battery power to the large B+ bolt-on terminal of the controller. Ground (Battery Negative) is supplied to the large bolt-on B- terminal of the drive controller.

Drive Pedal Sensor

The primary sensor input is the drive pedal sensor. The drive controller supplies 5 volts out of pin J4-15 on the white/black wire to the drive pedal sensor. The voltage passes through the potentiometer resistive strip and returns to the drive controller on the violet/black wire to pin J4-18 where it is grounded inside the controller. The drive pedal sensor input (wiper) goes from the sensor on the brown/red wire to pin J4-16. When the drive pedal is in the spring loaded neutral position, the wiper is exactly in the middle of the resistive strip. This provides an input equal to 1/2 of the voltage available across the resistive strip - 2.5v. When the drive pedal moves forward, the wiper moves closer to the 5v supply increasing the input voltage. When the drive pedal moves backward, the wiper moves closer to the ground supply decreasing the input voltage.

Below is an oscilloscope waveform that shows the drive pedal sensor “sweep” starting in the neutral position, moving to full reverse then to full forward.

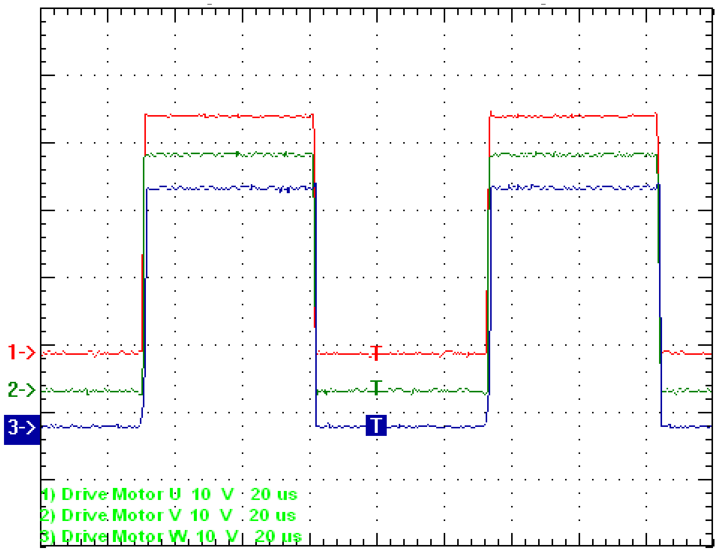


Drive Pedal Sensor Input “sweep”

Drive Motor

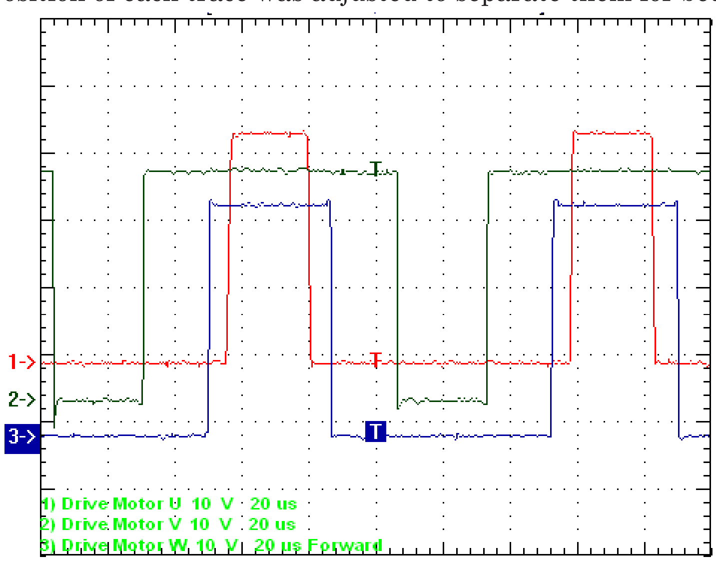
The drive controller supplies current to the drive motor stator windings on the three large U, V and W wires. When stationary, the controller pulses a current to all the motor stator windings in "unison". This holds the motor in a fixed position. To make the motor rotate, the controller shifts the timing, duration, and current of each of the windings. This continuously changes the location and strength of the magnetic field poles created by the stator windings, which causes torque to be applied to the rotor.

Below is an oscilloscope waveform that shows the 3 phases of the motor (U, V and W) when the motor is stationary. You can see how all 3 phases are being pulsed in unison. The vertical position of each trace was adjusted to separate them for better clarity. Other wise all three would blend together as a single trace.



Drive Motor U,V and W - Stationary

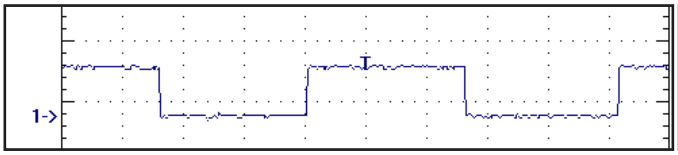
Below is an oscilloscope waveform that shows the 3 phases of the motor (U, V and W) when the motor is moving forward. You can see how each phase is now unique and no longer in unison. Again, the vertical position of each trace was adjusted to separate them for better clarity.



Drive Motor U,V and W - Moving Forward

The drive motor has an internal “encoder” that provides feedback to the drive controller regarding rotation direction and speed. The drive controller provides a 5v power supply out of pin J4-26 to the encoder connector pin 2. The drive controller provides an internal ground for the encoder at pin J4-7. The encoder has 2 “speed sensors”, Phase A and Phase B, that monitor the rotation of the motor shaft. Each sensor creates a 4v square wave pattern that increases in frequency as the motor rotation speed increases.

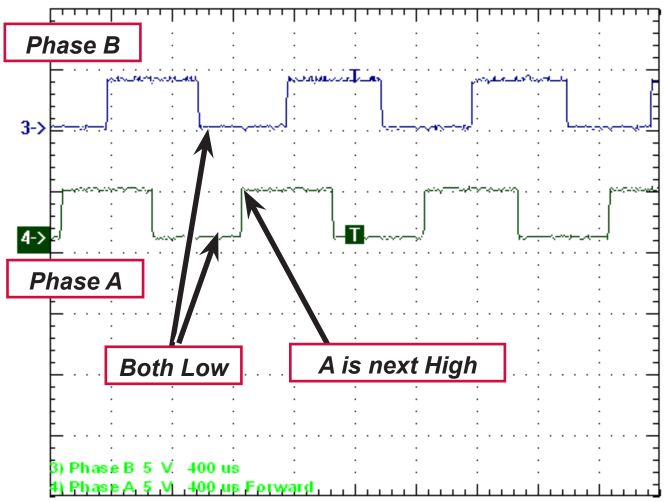
Below are oscilloscope waveforms, which show the Phase B speed sensor input when the motor is rotating slowly and when it is rotating fast.



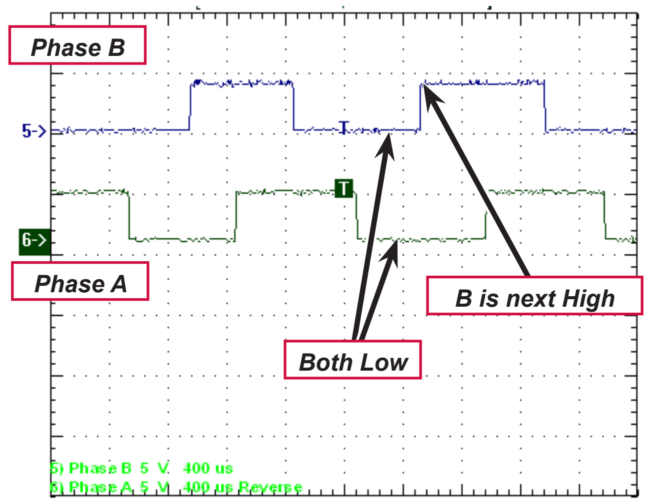
Phase B slow rotation

Phase B fast rotation

The signals that the speed sensors produce are slightly offset from one another. This allows the controller to verify the rotation direction of the motor. When both signals are low, the next signal that switches high (5v) indicates the rotation direction.



Forward Motion



Reverse Motion

The drive motor also has an internal temperature sensor that is monitored by the drive motor controller. The drive controller sends a 12v supply through an internal resistor and out pin J4-8 to the motor 2 wire connector pin 1. This is connected to the temperature sensor. The other side of the sensor is connected to the two wire connector pin 2. This is connected to the controller pin J4-7 where it is grounded inside the controller.

CAN Bus

The drive controller communicates with the main machine controller via the CAN Bus. The drive controller transmits error codes to the main machine controller. The main machine controller sends several messages to the drive controller that regulate machine speed mode.

The drive controller has three speed setting modes.

1. Transport - This is set at 100% of the total speed potential.
2. Scrubbing Speed - (Battery models only) This is set at 80% of the total speed potential. The user can override the scrubbing mode by pressing the speed switch.
3. Hopper Up - This is set at 50% of the total speed potential for safety reasons.

The following table explains what conditions dictate the speed mode which is used.

Condition	Battery Model - Speed Mode	Hybrid Models - Speed Mode
Hopper Up	Hopper Up	Hopper Up
Hopper Down, Not Scrubbing	Transport	Transport
Hopper Down, Scrubbing, No Override	Scrubbing	Transport
Hopper Down, Scrubbing, Override	Transport	Transport

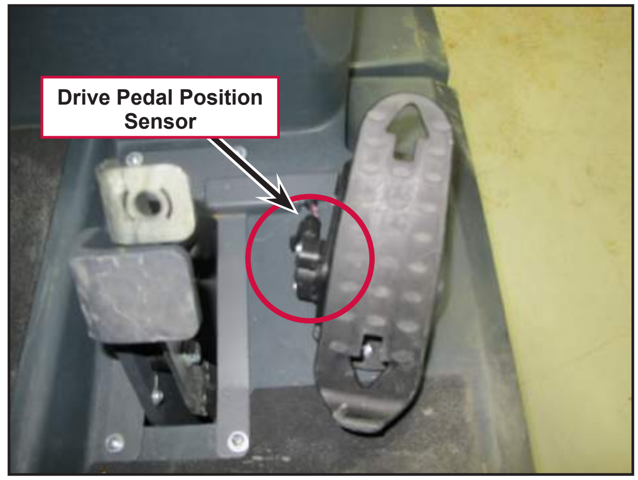
The main machine controller also communicates a special “Push Mode” request to the drive controller via the CAN Bus, when initiated by the user. Normally the drive motor “locks” the drive wheel to prevent it from rotating when in the neutral position. The push mode allows the drive wheel to turn without resistance while still allowing steering operation making it easier to tow the machine. To request the push mode, turn the key switch on while pressing and holding both the speed switch and the high pressure wand switch.

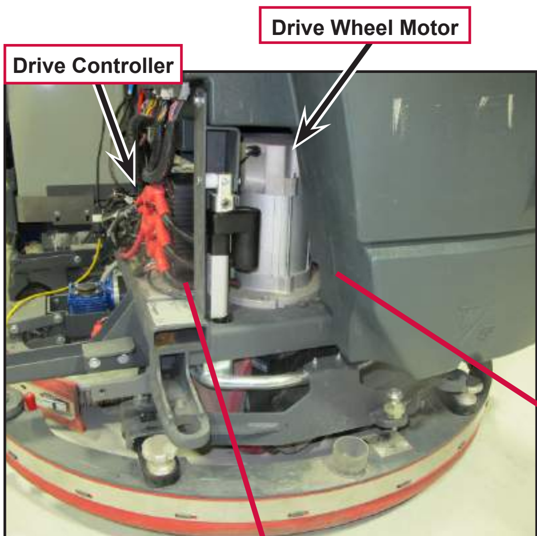
Hand Held Programmer

The drive controller can communicate with a hand held “programmer”. The controller provides power for the programmer by sending 12v out of pin J4-25 to the serial port connection pin 4. The transmit wire runs between controller pin J4-28 and serial port connection pin 3. The receive wire runs between controller pin J4-29 and serial port connection pin 1. The serial port pin 2 provides a ground for the programmer.

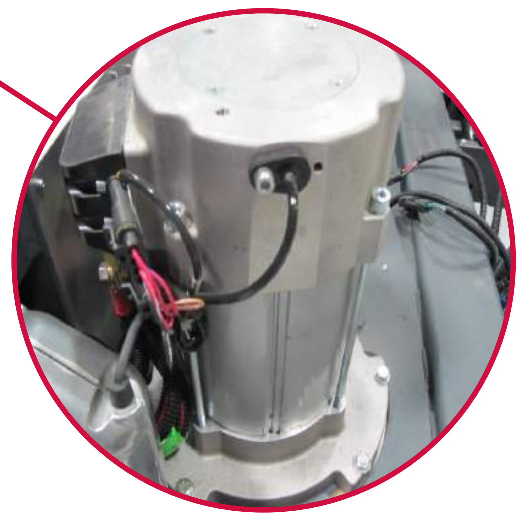
Component Locations

- Drive Pedal Position Sensor
- Drive controller
- Drive Wheel Motor





Pictured with recovery tank removed



Maintenance and Adjustments

Drive Controller

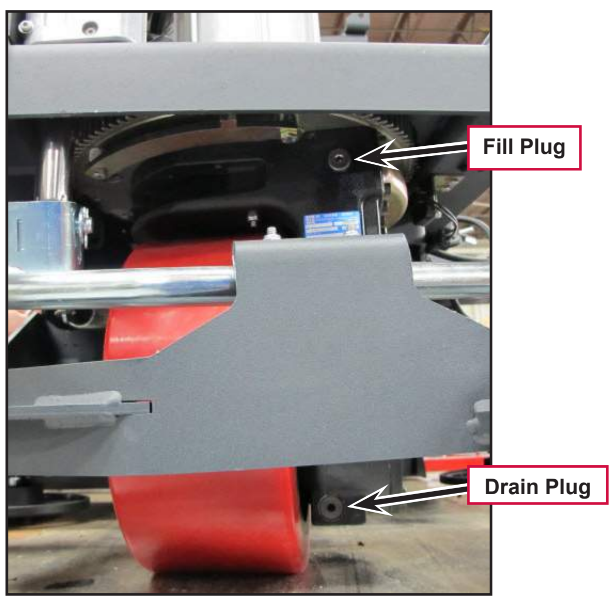
There are no user serviceable parts in Curtis 1234 controller. No attempt should be made to open, repair, or otherwise modify the controller. Doing so may damage the controller and will void the warranty. It is recommended that the controller and connections be kept clean and dry and that the controller's fault history file be checked and cleared periodically.

Drive Pedal Position Sensor

The Drive Pedal Position Sensor does not require adjustment. It comes with the pedal assembly and is pre-adjusted. If you believe it has come out of adjustment, you can adjust it using a voltmeter. With the key on and the sensor plugged in, back-probe the center "wiper" terminal with your red voltmeter lead. Connect your black voltmeter lead to battery negative. With the sensor mounting screws loose, rotate the sensor body until your voltmeter reads 2.5V then tighten the mounting screws.

Gear Box

Check the gear box oil level periodically. It should be filled to the bottom of the fill plug with 80W90 gear oil (56510411). If you want to change the oil, there is a drain plug at the bottom of the gear box.



Troubleshooting

Fault Codes

The drive controller has very robust fault code capabilities. Since most problems will result in setting a fault code, whenever there is a problem with the drive system, the first thing you should do is check for fault codes. There are three different ways to retrieve fault codes.

1. Counting the drive controller status LED flash code

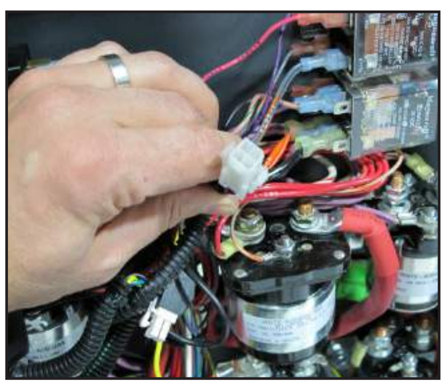
Status LEDs

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

   b. The numerical codes used by the yellow LED are listed in the troubleshooting chart, which also lists possible fault causes and describes the conditions that *set* and *clear* each fault.

2. Use the 1311 programmer.

1311 Programmer



Serial Port Connector

   a. The 1311 programmer will display all faults that are currently *set* as well as a history of the faults that have been set since the history log was last cleared. The 1311 displays the faults by name. To use the programmer, connect it to the serial port connector located on the left side of the machine by the bank of contactors.

3. Accessing the “configuration display” mode of the hidden menu

   a. Press and hold the hazard warning flasher button down while turning on the key. Wait until the “Configuration Display” screen appears, then release the button.

   b. Press and release the scrub pressure decrease button several times until the cursor arrow is pointing at “15 Fault Recall, then press the scrub button to enter the fault recall menu.

   c. Press the scrub pressure decrease button to scroll down to “3 Speed Faults”, then press the scrub button.

   d. The Speed faults menu displays all of the fault codes that have ever been set by the drive controller and communicated to the main machine controller. The codes are displayed in “reading order”, separated by commas and are sorted with the most recent at the top left. See the ***Troubleshooting Chart*** below to look up what the code means.

   e. To exit, press the solution button.

Summary of LED display formats

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

Types of LED Display	
Display	**Status**
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

Troubleshooting Chart

The troubleshooting chart, provides the following information on all the controller faults:

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

Whenever a fault is encountered and no wiring or vehicle fault can be found, shut off KSI (Key Switch) and turn it back on to see if the fault *clear*s. If it does not, shut off KSI and remove the low current 35-pin connector from the drive controller. Check the connector for corrosion or damage, clean it if necessary, and re-insert it.

Note: Some of the codes listed in the table are for circuits that are not utilized on the CS7000.

Troubleshooting Chart

Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
12	**Controller Overcurrent** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump	1. External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective.	*Set*: Phase current exceeded the current measurement limit. *Clear*: Cycle KSI.
13	**Current Sensor Fault** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 2. Controller defective.	*Set*: Controller current sensors have invalid offset reading. *Clear*: Cycle KSI.
14	**Precharge Failed** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging. 2. See Monitor menu » Battery: Capacitor Voltage.	*Set*: Precharge failed to charge the capacitor bank to the KSI voltage. *Clear*: Cycle Interlock input or use VCL function Precharge.
15	**Controller Severe Undertemp** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Temperature information is not accurate. 2. Controller is operating in an extreme environment.	*Set*: Heatsink temperature below -40°C. *Clear*: Bring heatsink temperature above -40°C, and cycle interlock or KSI.

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
16	**Controller Severe Overtemp** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Temperature information is not accurate. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle. 4. Improper mounting of controller.	*Set*: Heatsink temperature above +95°C (+203°F) *Clear*: Bring heatsink temperature below +95°C (+203°F), and cycle interlock or KSI.
17	**Severe Undervoltage** Reduced drive torque.	1. Battery Menu parameters are misadjusted. 2. Non-controller system drain on battery. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. See Monitor menu » Battery: Capacitor Voltage. 6. Blown B+ fuse or main contactor did not close.	*Set*: Capacitor bank voltage dropped below the Severe Undervoltage limit with FET bridge enabled. *Clear*: Bring capacitor voltage above Severe Undervoltage limit.
18	**Severe Overvoltage** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Battery menu parameters are misadjusted. 2. Battery resistance too high for given regen current. 3. Battery disconnected while regen braking.	*Set*: Capacitor bank voltage exceeded the Severe Overvoltage limit with FET bridge enabled. *Clear*: Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
22	**Controller Overtemp Cutback** Reduced drive and brake torque.	1. See Monitor menu » Controller: Temperature. 2. Controller is performance-limited at this temperature. 3. Controller is operating in an extreme environment. 4. Excessive load on vehicle. 5. Improper mounting of controller.	*Set*: Heatsink temperature exceeded 85°C. (+185°F) *Clear*: Bring heatsink temperature below 85°C. (+185°F)

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
23	**Undervoltage Cutback** Reduced drive torque.	1. Normal operation. Fault shows that the batteries need recharging. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Non-controller system drain on battery. 4. Battery resistance too high. 5. Battery disconnected while driving. 6. See Monitor menu » Battery: Capacitor Voltage. 7. Blown B+ fuse or main contactor did not close.	*Set*: Capacitor bank voltage dropped below the Undervoltage limit with the FET bridge enabled. *Clear*: Bring capacitor voltage above the Undervoltage limit.
24	**Overvoltage Cutback** Reduced brake torque.	1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking. 5. See Monitor menu » Battery: Capacitor Voltage.	*Set*: Capacitor bank voltage exceeded the Overvoltage limit with the FET bridge enabled. *Clear*: Bring capacitor voltage below the Overvoltage limit.
25	**+5V Supply Failure** None, unless a fault action is programmed in Vehicle Control Language.	1. External load impedance on the +5V supply (pin 26) is too low. 2. See Monitor menu » outputs: 5 Volts and Ext Supply Current.	*Set*: +5V supply (pin 26) outside the +5V±10% range. *Clear*: Bring voltage within range.
26	**Digital Out 6 Overcurrent** Digital Output 6 driver will not turn on. *Note: This circuit is not used on the CS7000*	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	*Set*: Digital Output 6 (pin 19) current exceeded 15 mA. *Clear*: Remedy the overcurrent cause and use the VCL function *Set*_DigOut() to turn the driver on again.

Troubleshooting Chart

Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
27	**Digital Out 7 Overcurrent** Digital Output 7 driver will not turn on. *Note: This circuit is not used on the CS7000*	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	*Set*: Digital Output 7 (pin 20) current exceeded 15 mA. *Clear*: Remedy the overcurrent cause and use the VCL function *Set*_DigOut() to turn the driver on again.
28	**Motor Temp Hot Cutback** Reduced drive torque.	1. Motor temperature is at or above the programmed Temperature Hot setting, and the requested current is being cut back. 2. Motor Temperature Control Menu parameters are mis-tuned. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	*Set*: Motor temperature is at or above the Temperature Hot parameter *set*ting. *Clear*: Bring the motor temperature within range.
29	**Motor Temp Sensor Fault** MaxSpeed reduced (LOS, Limited Operating Strategy), and motor temperature cutback disabled.	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2.	*Set*: Motor thermistor input (pin 8) is at the voltage rail (0 or 10V). *Clear*: Bring the motor thermistor input voltage within range.
31	**K7 Wheel Drive Contactor Coil Driver Open/Short** ShutdownDriver1.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Driver 1 (pin 6) is either open or shorted. (Pin 6 is the K7 wheel drive contactor coil driver circuit.) This fault can be set only when Main Enable = Off. *Clear*: Correct open or short, and cycle driver.

Troubleshooting Chart

Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
31	**Main Open/Short** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Main contactor driver (pin 6) is either open or shorted. (Pin 6 is the K7 wheel drive contactor coil driver circuit) This fault can be *set* only when Main Enable = On. *Clear*: Correct open or short, and cycle driver
32	**Coil2 Driver Open/Short** ShutdownDriver2. *Note: This circuit is not used on the CS7000*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Driver 2 (pin 5) is either open or shorted. This fault can be *set* only when EM Brake Type = 0. *Clear*: Correct open or short, and cycle driver.
32	**EMBrake Open/Short** ShutdownEMBrake; ShutdownThrottle; FullBrake. *Note: This circuit is not used on the CS7000*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be *set* only when EM Brake Type > 0. *Clear*: Correct open or short, and cycle driver.
33	**Coil3 Driver Open/Short** ShutdownDriver3. *Note: This circuit is not used on the CS7000*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Driver 3 (pin 4) is either open or shorted. *Clear*: Correct open or short, and cycle driver.
34	**Coil4 Driver Open/Short** ShutdownDriver4. *Note: This circuit is not used on the CS7000*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Driver 4 (pin 3) is either open or shorted. *Clear*: Correct open or short, and cycle driver.
35	**PD Open/Short** ShutdownPD. *Note: This circuit is not used on the CS7000*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set*: Proportional driver (pin 2) is either open or shorted. *Clear*: Correct open or short, and cycle driver.
36	**Encoder Fault** ShutdownEMBrake.	1. Motor encoder failure. 2. Bad crimps or faulty wiring. 3. See Monitor menu » Motor: Motor RPM.	*Set*: Motor encoder phase failure detected. *Clear*: Cycle KSI.

Troubleshooting Chart

Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
37	**Motor Open** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Motor phase is open. 2. Bad crimps or faulty wiring.	*Set*: Motor phase U, V, or W detected open. *Clear*: Cycle KSI.
38	**K7 Wheel Drive Contactor Welded** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. K7 Wheel Drive contactor tips are welded closed. 2. Motor phase U or V is disconnected or open. 3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).	*Set*: Just prior to the K7 wheel drive contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. *Clear*: Cycle KSI
39	**Main Contactor Did Not Close** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Main contactor did not close. 2. Main contactor tips are oxidized, burned, or not making good contact. 3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. 4. Blown B+ fuse.	*Set*: With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. *Clear*: Cycle KSI.
41	**Throttle Wiper High** ShutdownThrottle.	1. See Monitor menu » Inputs: 2. Throttle Pot. wiper voltage too high.	*Set*: Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_ Pot_Faults). *Clear*: Bring throttle pot wiper voltage below the fault threshold.
42	**Throttle Wiper Low** ShutdownThrottle.	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too low.	*Set*: Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function *Set*up_ Pot_Faults). *Clear*: Bring throttle pot wiper voltage above the fault threshold.

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
43	**Pot2 Wiper High** FullBrake. *Note: This circuit is not used on the CS7000*	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too high.	*Set*: Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function *Set*up_Pot_ Faults()). *Clear*: Bring Pot2 wiper voltage below the fault threshold.
44	**Pot2 Wiper Low** FullBrake. *Note: This circuit is not used on the CS7000*	1. 1. See Monitor menu » Inputs: Pot2 Raw. 2. 2. Pot2 wiper voltage too low.	*Set*: Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function *Set*up_Pot_ Faults()). *Clear*: Bring Pot2 wiper voltage above the fault threshold.
45	**Pot Low Overcurrent** ShutdownThrottle; FullBrake.	1. See Monitor menu » Outputs: Pot Low. 2. Combined pot resistance connected to pot low is too low.	*Set*: Pot low (pin 18) current exceeds 10mA. *Clear*: *Clear* pot low overcurrent condition and cycle KSI.
46	**EEPROM Failure** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump.	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL (Vehicle Control Language), by the CAN Bus, by adjusting parameters with the programmer, or by loading new software into the controller.	*Set*: Controller operating system tried to write to EEPROM memory and failed. *Clear*: Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	**HPD/Sequencing Fault** ShutdownThrottle.	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu » Inputs.	*Set*: HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. *Clear*: Reapply inputs in correct sequence.

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
47	**Emer Rev HPD** ShutdownThrottle; ShutdownEMBrake.	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	*Set*: At the conclusion of Emergency Reverse, the fault was *set* because various inputs were not returned to neutral. *Clear*: If EMR_Interlock = On, *clear* the interlock, throttle, and direction inputs. If EMR_Interlock = Off, *clear* the throttle and direction inputs.
49	**Parameter Change Fault** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	*Set*: Adjustment of a parameter setting that requires cycling of KSI. *Clear*: Cycle KSI.
51	**High Pedal Disable** ShutdownMotor;	1. There is an open in the interlock circuit J4-9 (Seat Switch, Emergency Switch, Battery Interlock, Steering Safety Relay).	*Set*: The drive pedal is outside of the neutral position when there is no voltage to the interlock circuit J4-9 *Clear*: Voltage is supplied to the interlock circuit pin J4-9 and the drive pedal is returned to neutral.
68	**VCL (Vehicle Control Language) Run Time Error** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump.	1. VCL code encountered a runtime VCL error. 2. See Monitor menu » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	*Set*: Runtime VCL code error condition. *Clear*: Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
69	**External Supply Out of Range** None, unless a fault action is programmed in VCL.	1. External load on the 5V and 12V supplies draws either too much or too little current. 2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. 3. See Monitor menu » Outputs: Ext Supply Current.	*Set*: The external supply current (combined current used by the 5V supply [pin and 12V supply [pin 25]) is either greater than the upper current threshold or than the lower current threshold. The thresholds are defined by the External Supply Max and External Supply Min parameter settings. *Clear*: Bring the external supply current within range.
71	**OS General** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump.	1. Internal controller fault.	*Set*: Internal controller fault detected. *Clear*: Cycle KSI.
72	**PDO Timeout** ShutdownInterlock; CAN NMT State *set* to Pre-operational.	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	*Set*: Time between CAN PDO messages received exceeded the PDO Timeout Period. *Clear*: Cycle KSI or receive CAN NMT message.
73	**Stall Detected** ShutdownEMBrake; Control Mode changed to LOS (Limited Operating Strategy).	1. Stalled motor. 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Problems with power supply for the motor encoder. 5. See Monitor menu » Motor: Motor RPM.	*Set*: No motor encoder movement detected. *Clear*: Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.
74	**Fault On Other Traction Controller** *Note: Not used on CS7000*	1. Dual Drive fault: see Dual Drive manual.	
75	**Dual Severe Fault** *Note: Not used on CS7000*	1. Dual Drive fault: see Dual Drive manual.	

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
87	**Motor Characterization Fault** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Motor characterization failed during characterization process. See Monitor menu » Controller: Motor Characterization Error for cause: 0=none 1=encoder signal seen, but step size not determined; *set* Encoder Step Size manually 2=motor temp sensor fault 3=motor temp hot cutback fault 4= controller overtemp cutback fault 5=controller undertemp cutback fault 6=undervoltage cutback fault 7=severe overvoltage fault 8=encoder signal not seen, or one both channels missing 9=motor parameters out of characterization range.	*Set*: Motor characterization failed during the motor characterization process. *Clear*: Correct fault; cycle KSI.
89	**Motor Type Fault** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. The Motor_Type parameter value is out of range.	*Set*: Motor_Type parameter is *set* to an illegal value. *Clear*: *Set* Motor_Type to correct value and cycle KSI.
91	**VCL/OS Mismatch** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump.	1. The VCL software in the controller does not match the OS software in the controller.	*Set*: VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. *Clear*: Download the correct VCL and OS software into the controller.
92	**EM Brake Failed to Set** ShutdownEMBrake; ShutdownThrottle.	1. Vehicle movement sensed after the EM Brake has been commanded to *set*. 2. EM Brake will not hold the motor from rotating.	*Set*: After the EM Brake was commanded to *set* and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. *Clear*: Activate the throttle.

Troubleshooting Chart			
Flash Code #	**Programmer LCD Display**/ Effect Of Fault	Possible Cause(s)	*Set*/*Clear* Conditions
93	**Encoder LOS (Limited Operating Strategy)** Enter LOS control mode.	1. Limited Operating Strategy control mode has been activated, a result of either an Encoder (Code 36) or a Stall Detect (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	*Set*: Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. *Clear*: Cycle KSI or, if LOS mode was activated by the Stall Fault, *clear* by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.
94	**Emer Rev Timeout** ShutdownEMBrake; ShutdownThrottle.	1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. 2. The emergency reverse input is stuck On.	*Set*: Emergency Reverse was activated and ran until the EMR Timeout timer expired. *Clear*: Turn the emergency reverse input Off.
98	**Illegal Model Number** ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.	1. Model_Number variable contains illegal value (not 1234, 1236, 1238, or 1298). 2. Software and hardware do not match. 3. Controller defective.	*Set*: Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_Number, and a fault is issued if one is not found. *Clear*: Download appropriate software for your controller model.
99	**Dualmotor Parameter Mismatch** *Note: Not used on CS7000*	1. Dual Drive fault: see Dual Drive manual.	

Fault History

The 1311 programmer can be used to access the controller's fault history file. The programmer will read out all the faults the controller has experienced since the last time the fault history file was cleared. Faults such as contactor faults may be the result of loose wires; contactor wiring should be carefully checked. Faults such as over temperature may be caused by operator habits or by overloading.

Removal and Installation

Drive Pedal Assembly

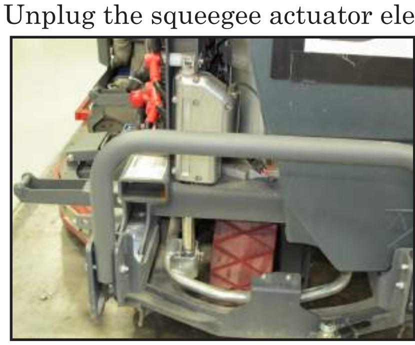
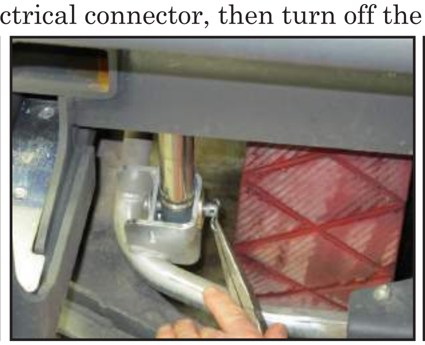
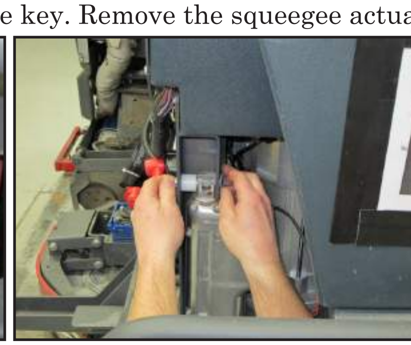
1. Disconnect drive pedal position sensor electrical connector.
2. Remove drive pedal mounting screws.
3. Remove pedal assembly.
4. Reassemble in reverse order.
5. Validate the drive pedal sensor adjustment and adjust if necessary.
   a. Use Service Mode to view the sensor voltage in the control panel LCD. See: ***Control System, Service Mode*** for instructions on how to enter the service mode.

   b. The drive pedal sensor voltage should be between 2.4v and 2.6v when in the center “neutral” position.
   c. If the voltage is not within the correct range, loosen the sensor mounting screws and rotate the sensor to achieve the correct value. Then, tighten down the mounting screws.

Drive Motor and Gearbox Assembly

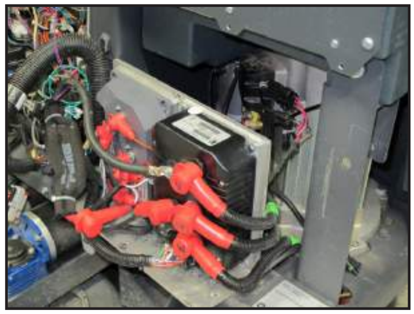
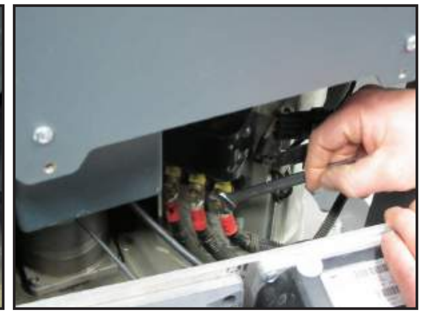
The drive motor, gearbox and drive wheel are removed as an assembly out of the bottom of the machine. Once removed, separate the motor from the gearbox.

1. Remove the squeegee tool.
2. Remove the recovery tank and hose.
3. Turn the key switch on and press the vacuum button to lower the squeegee support.
4. Unplug the squeegee actuator electrical connector, then turn off the key. Remove the squeegee actuator.

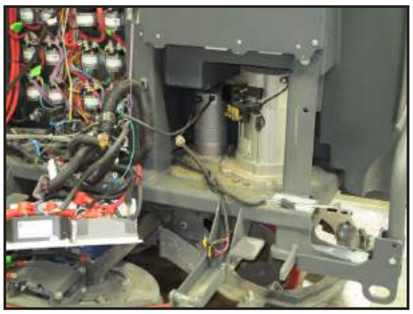




5. Disconnect the main power connector.

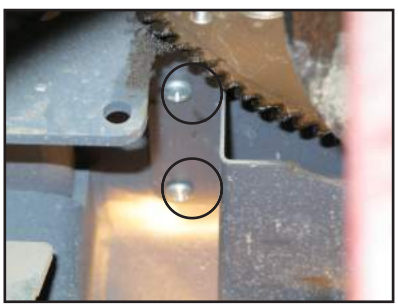
6. Disconnect all of the main machine controller connectors and pull the harness aside. Remove the controller mounting bracket fasteners and pull it away to gain access to the drive motor wiring. Label the drive motor cables for proper reassembly, then remove them from the motor.

7. Swing the controller bracket assembly out of the way (reposition the steering motor wiring as needed).



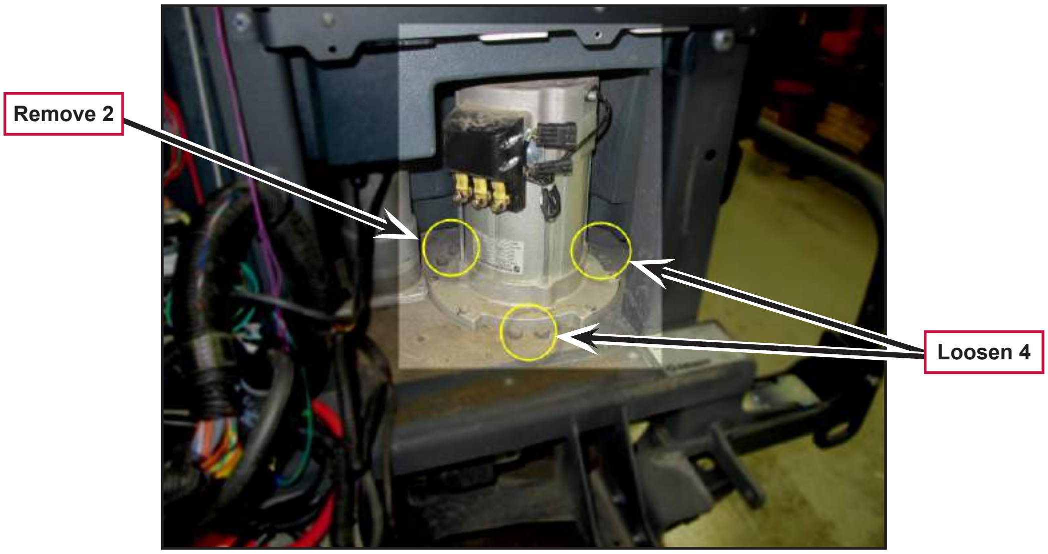
8. Working from under the machine, remove the cover plate that is under the steering drive gear. There are two screws on each side.



9. Lift the squeegee lift bar and tie it up.

10. Block drive wheel with wheel chocks on both sides so that it cannot roll.

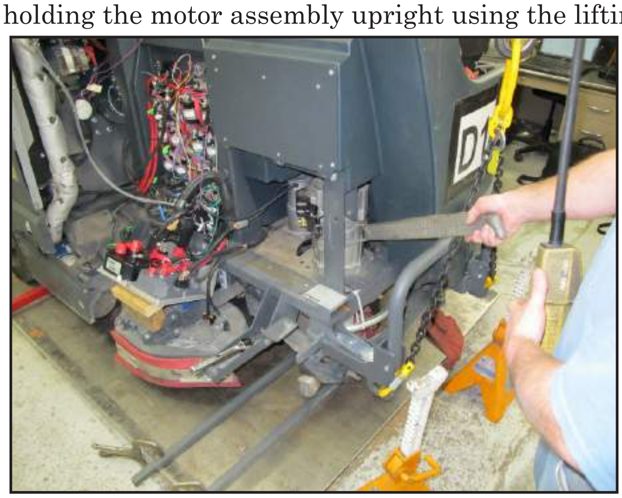
11. Remove the 2 inner gear box to frame bolts and loosen the remaining 4.

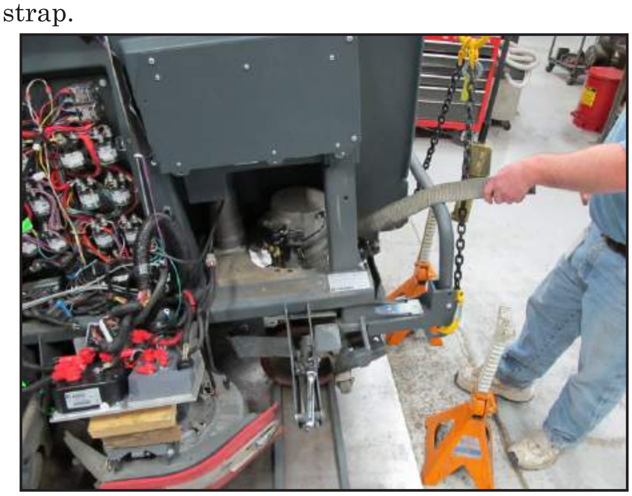


12. Lift the machine just enough to take weight off the gear box and remove the remaining 4 gear box to frame bolts.

13. Attach a lifting strap around the drive motor. You will use the strap to guide and lower the assembly.

14. Slowly lift the machine up to allow the drive motor and gear box assembly to come out the bottom while holding the motor assembly upright using the lifting strap.





15. Secure the machine safely on jack stands.

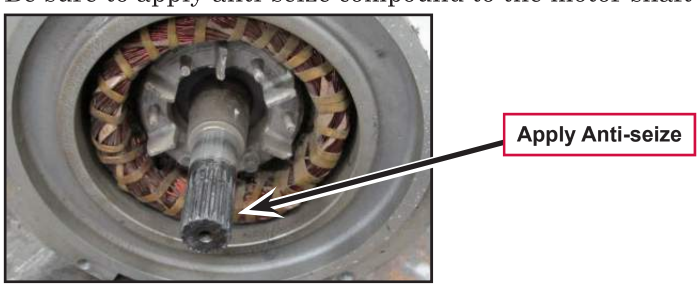
16. Hook up a hoist to the lift strap and put a slight tension on the strap. Remove the rear wheel chock and allow the assembly to roll backward and downward out of the machine controlling the movement by lowering the hoist and blocking the wheel.



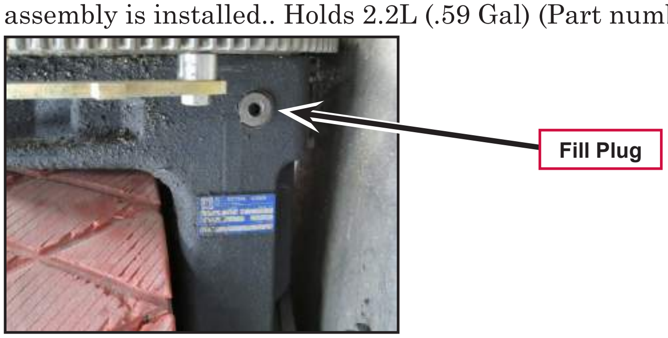
17. To separate the motor from the gear box, remove the attaching screws and pry apart.


18. Reassembly notes:

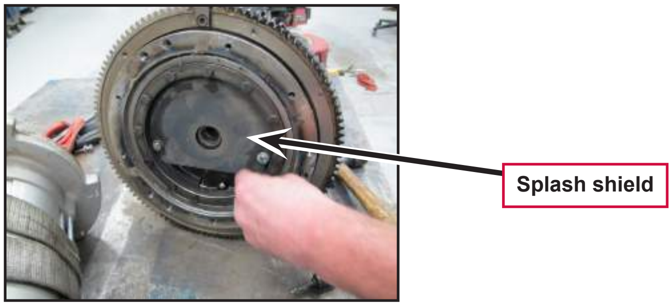
    a. Be sure to apply anti-seize compound to the motor shaft splines and gearbox splines.



    b. If installing a new gear box, be sure to fill it to the bottom of the fill plug with 80W90 oil when the assembly is installed.. Holds 2.2L (.59 Gal) (Part number 56510411).



c. If installing a new gear box, be sure to transfer the splash shield.



d. Apply 56510412 (OPEN GEAR LUBE) to front 180° of ring gear teeth and all around pinion gear teeth.

19. Reassemble in reverse order.

Drive Wheel

1. Block front wheels
2. Loosen drive wheel lug nuts.
3. Jack the rear of the machine up to get the drive wheel off the ground.
4. Remove the drive wheel lug nuts and remove the wheel.
5. Reassemble in reverse order.

Drive Controller

1. Disconnect the main power connector.
2. Remove the recovery tank.
3. Label the power and motor cables to aid in correct reassembly.
4. Remove the bolts securing the motor and power cables.
5. Disconnect the low current connector.
6. Remove controller attaching screws and remove the controller.
7. Reassemble in reverse order.

Specifications

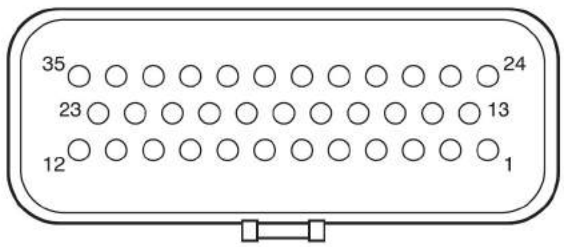
Shop Measurements

Shop measurements are values that were measured on a real machine. While they are not “specifications”, they can help you recognize normal vs abnormal.

Drive Controller Voltage Measurements

All voltages are DC unless otherwise stated and were measured with the negative (black) voltmeter lead on battery negative and the key switch on.

Low Current 35 Pin Connector (J4)



Pin	Wire Color	Circuit	Voltage
1	ORN	Key switch input. Provides logic power for the controller and power for the coil drivers.	38.12 V
2		Not Used	
3		Not Used	
4		Not Used	
5		Not Used	
6	VIO/GRN	K7 Wheel Drive Contactor Driver	Momentary 38 V at first key on. 5-6v when contactor is “on”
7	BLK/PINK	Input and output ground reference.	0.008 V
8	TAN/RED	Motor Temperature Sensor	1.22 V (Room Temp) 12 V (open circuit)
9	GRN/BLU	Interlock Switch Input	38.8 V
10		Not Used	
11		Not Used	
12		Not Used	
13	TAN/RED	K7 Wheel Drive Contactor Coil Power	38.18 V
14		Not Used	
15	WHT/BLK	Throttle POT High (5 V supply)	5.14 V
16	BRN/RED	Throttle POT wiper (Pedal Position Sensor Input)	4.79 V Full Forward 2.52 V Neutral 0.29 V Full Reverse
17		Not Used	

Pin	Wire Color	Circuit	Voltage
18	VIO/BLK	Throttle POT Low	0.21 V
19		Not Used	
20		Not Used	
21		Not Used	
22		Not Used	
23	YEL	CAN Bus High	2.53 V
24		Not Used	
25	VIO/WHT	Unregulated low power +12 V output. (Power for Serial Port Connector)	12.91 V
26	PINK/RED	Regulated low power +5v output	4.90 V
27		Not Used	
28	WHT/ORN	Serial Transmit for Serial Port Connector	0.18 V
29	BLU/GRN	Serial Receive for Serial Port Connector	0.29 V
30		Not Used	
31	PINK/WHT	Drive Motor Encoder (Speed Sensor) Signal - Phase A	4.06 V or 0.08 V stationary 2.0 V wheel spinning any speed
32	PINK/BLU	Drive Motor Encoder (Speed Sensor) Signal - Phase B	4.06 V or 0.08 V stationary 2.0 V wheel spinning any speed
33		Not Used	
34		Not Used	
35	GRN	CAN Bus Low	2.45 V

Motor U, V and W Terminal Pair Voltages

- U to V - 0.3 - 2.2 VAC with stationary motor. Up to 26 VAC with wheel off ground and full forward speed.
- V to W - 0.3 - 2.2 VAC with stationary motor. Up to 26 VAC with wheel off ground and full forward speed.
- W to U - 0.3 - 2.2 VAC with stationary motor. Up to 26 VAC with wheel off ground and full forward speed.

Motor U, V and W Terminal Pair Frequency

- U to V -21-23 KHZ with stationary motor. Up to 300 KHZ with wheel off ground and full forward speed.
- V to W -21-23 KHZ with stationary motor. Up to 300 KHZ with wheel off ground and full forward speed.
- W to U -21-23 KHZ with stationary motor. Up to 300 KHZ with wheel off ground and full forward speed.

System Current Draw - Driving only with no cleaning functions

Measured with amp clamp around battery positive feed to drive controller.

- Approximately 1-4 amps when the machine begins to move
- Average 51 amps full speed with maximum scrub pressure
- Max - 100 Amps

Wheel Drive Contactor

Winding - 194 Ohms

Special Tools

Curtis Programmer 1311 Part number 56409441