CS7010™

Service Manual

Advance Model Numbers:

56511710 (48 LPG Hybrid)
56511711 (48 LPG Hybrid EcoFlex)
56511712 (48 Diesel Hybrid)
56511713 (48 Battery)
56511810 (48 Diesel Hybrid EcoFlex)
56511811 (48 Battery EcoFlex)
56511812 (48 Fuel Cell EcoFlex)
56511813 (48 Gasoline Hybrid EcoFlex)
56511814 (48 Gasoline Hybrid)
56511819 (48 Fuel Cell)

Nilfisk
trusted since 1906

Advance

English

05/2017 Form No. 56043176

Contents

03 - General Information

General Machine Description

The CS7010 machines are industrial automatic rider sweeper/scrubbers with multiple sweep/scrub single-pass coverage. Both battery (all electric) and hybrid (engine) 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.

The fuel cell powered model is similar to the battery model in construction, except it is designed to accommodate an approved fuel cell provided by Plug Power.

Service Manual Purpose and Application

This Service Manual a technical resource designed to aid service personnel in maintaining and repairing the CS7010 Sweeper/Scrubber to ensure optimum performance and long service life. Please read it thoroughly before servicing your machine.

Revision History

Revision	Summary of Changes
5/2017	First Release

Other Reference Manuals and Information Sources

Nilfisk-Advance Publications

Model Name	Instructions for Use Form Number	Parts List
Advance CS7010	56091206: English, Spanish, French	56042665
Nilfisk CS7010		56042666

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
LPG WG972-E4 (LEV):	Kubota Workshop Manual – Gasoline, LPG, NG Engine WG972-E4 (EFI)
	Kubota Diagnostic Manual ECU System WG972-E4" Code No.9Y110-03110

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.)

Note: *On Fuel Cell models, all issues related to the fuel cell must be referred to Plug Power, not Nilfisk-Advance.*

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.

Safety

Symbols

It is important for you to read and understand this manual. The information it contains relates to protecting your safety and preventing problems. The symbols below are used to help you recognize this information.

DANGER: ***Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury.***

WARNING: ***Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.***

CAUTION: ***Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.***

Note: *Indicates an important informational message.*

General Safety Instructions

These safety instructions are included to warn you of potential bodily injury or property damage.

DANGER: ***Engine-powered machines emit exhaust gasses, including carbon monoxide, which can cause serious injury or death. Always provide adequate ventilation when using the machine.***

CAUTION: ***Read and understand all safety warnings and instructions. Failure to follow the warnings and instructions may result in electric shock, fire, and/or serious injury.***

- ***To avoid personal injury, this machine should be used only by properly trained and authorized persons. This machine is not intended for use by persons with reduced physical, sensory, or mental capabilities.***
- ***To avoid pinching or crushing hazard, stay clear of the rear drive wheel when the machine is initializing or running. When the machine is initialized, the steering system will turn the wheel to the side to identify home and limit positions of the wheel steering.***
- ***Do not operate the machine near toxic, dangerous, flammable and/or explosive materials. This machine is not suitable for collecting dangerous or hazardous materials.***
- ***In case of fire, use a powder fire extinguisher, not a water-based extinguisher.***
- ***Do not use on surfaces having a gradient exceeding that marked on the machine. While on ramps or inclines, avoid sudden stops when loaded. Avoid abrupt sharp turns.***
- ***Do not use the machine without a falling object protective structure in areas where it is likely that the operator may be struck by falling objects.***
- ***Disconnect the power source and/or batteries before servicing electrical components. Turn the key switch off before changing brushes or opening access panels.***
- ***Never work under 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.***
- ***When using floor cleaning detergents, follow all safety and handling instructions of the***

respective manufacturer.

- ***Battery charging may produce highly explosive hydrogen gas. Charge the batteries only in well-ventilated areas and away from ignition sources or open flames.***
- ***Safe operation of this machine requires the operator to ensure others within close proximity are not endangered or the machine is not left operational and unattended allowing unauthorized use.***
- ***To avoid hydraulic oil injection or injury, always wear appropriate clothing and eye protection when working with or near any hydraulic system.***
- ***Take precautions to prevent hair, jewelry, or loose clothing from becoming caught in moving parts.***

Property Damage Messages

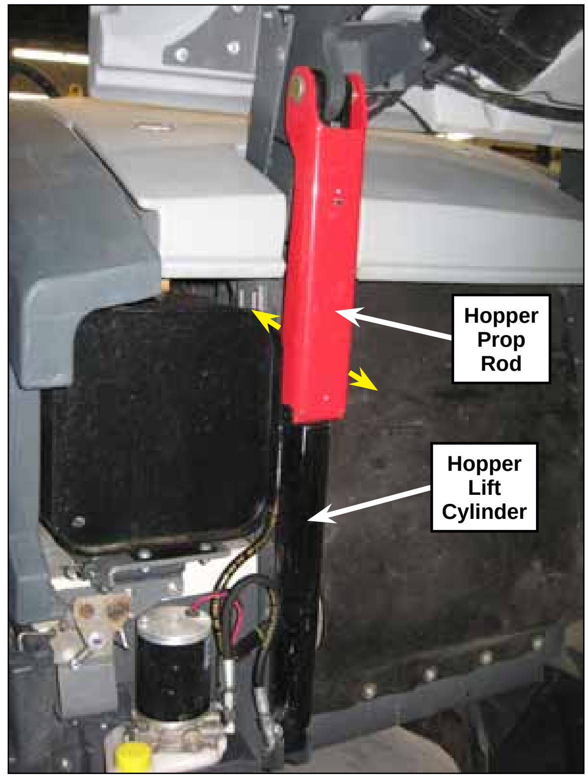
- ***Storage and operation temperature must be above 0°C and a humidity between 30% and 95%, non-condensing.***
- ***Before use, all doors and hoods should be properly latched.***
- ***This machine is not approved for use on public paths or roads.***
- ***This machine is only approved for hard surface use.***
- ***Use brushes and pads supplied with the machine or those specified in the User Manual. Using other brushes or pads could reduce safety.***
- ***Do not wash the machine with direct or pressurised water jets, or with corrosive substances.***
- ***Do not allow the brush/pad to operate while the machine is stationary to avoid damaging the floor.***
- ***The machine must be inspected by a qualified person on a regular basis, in particular to the engine and fuel systems on engine-powered machines, to ensure proper operation and compliance with local or national regulations.***
- ***If the engine misfires or runs rough, stop the engine and have the machine serviced by a qualified technician. Continued operation under this condition may result in damage to the engine, catalytic converter, or other machine components.***
- ***Use only factory authorized parts and accessories.***
- ***This machine must be properly disposed of in accordance with local laws and regulations.***

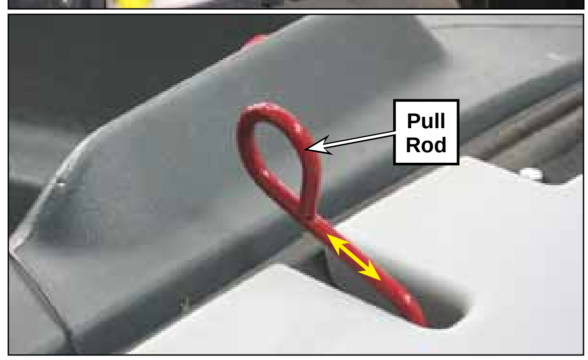
Hopper Prop Rod

CAUTION: 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.

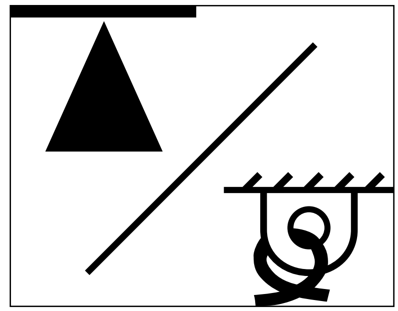
Lifting the Machine

CAUTION: Never work under a machine without safety stands or blocks to support the machine. When lifting the machine, do so at the designated Tie Down/Support Locations.

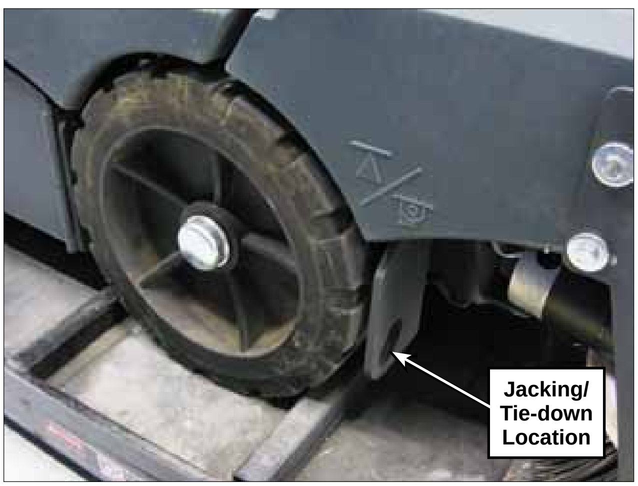
Transporting the Machine

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 lifting 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 Support/Tie-down Location

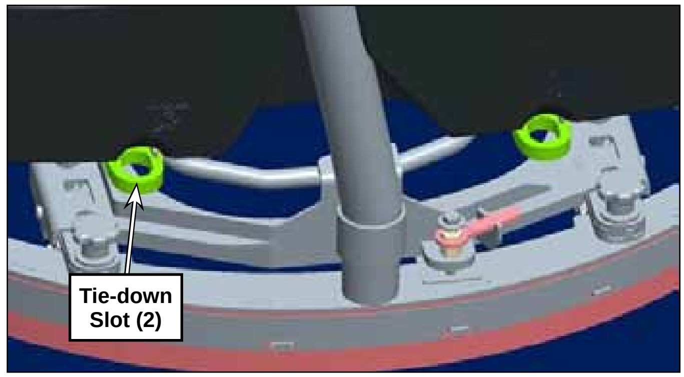
Rear Support/Tie-down Location

Towing the Machine

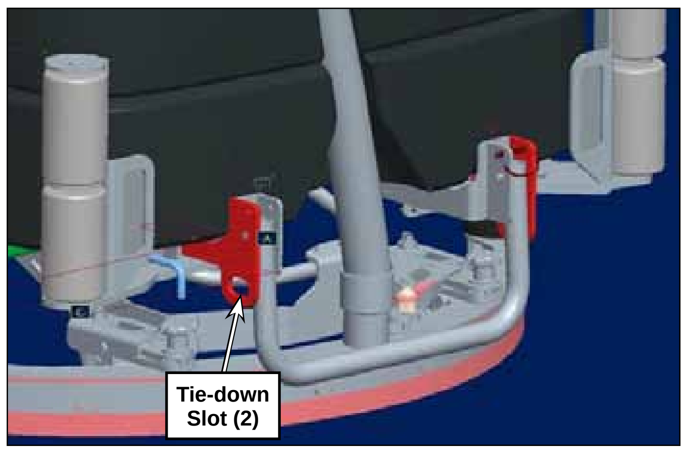
CAUTION: If the machine must be towed, move the machine for short distances only and do not move the machine faster than a normal walking pace (2-3 mph, 3-5 kph).

- ***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.***

- 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).



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 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
- 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 websites).

These tools are also available from Nilfisk, Inc.:

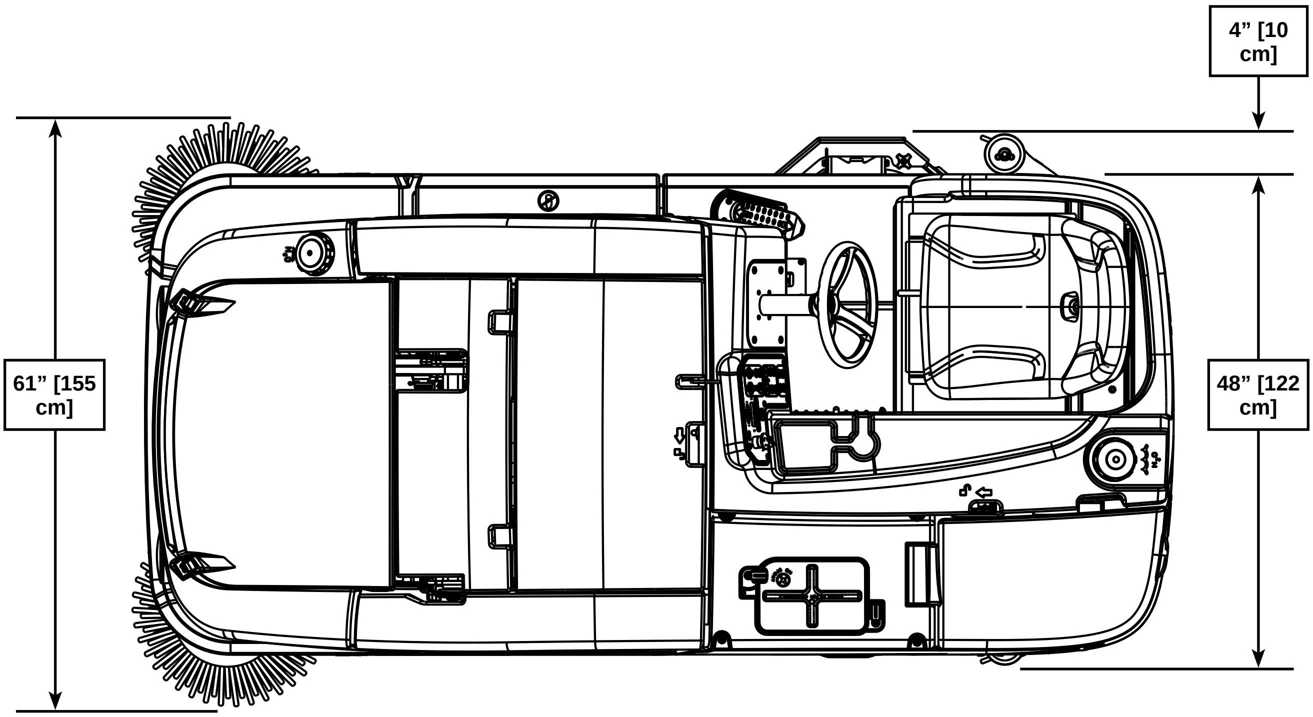
- Vacuum water lift gauge, p/n 56205281

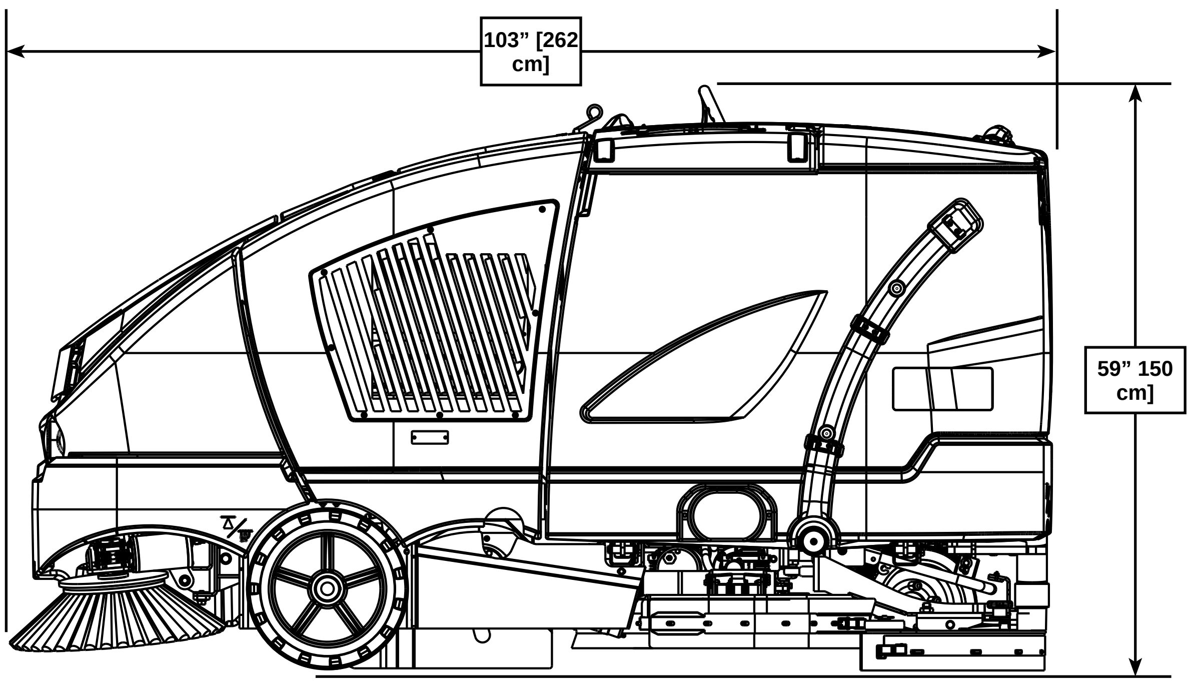
Technical Specifications

General Specifications

Model	CS7010 48G	CS7010 48LP	CS7010 48LP LEV	CS7010 48D	CS7010 48B Battery
Part Numbers	56511001	56509000 56509006	56511540 56511541	56509001 56509007	56511713 56511811
Main Battery					36V, 770 Ah, C6
Protection Grade	IPX4	IPX4	IPX4	IPX4	IPX4
Sound Pressure Level at operator ear (ISO 11201)	82dB LpA, 3dB u(LW)	82dB LpA, 3dB u(LW)	82dB LpA, 3dB u(LW)	81dB LpA, 3dB u(LW)	72dB LpA, 3dB u(LW)
Sound Power Level (ISO 3744)	103dB LWA	103dB LWA	103dB LWA	102dB LWA	
Gross Vehicle Weight	4676 lbs. (2121 kg)	4676 lbs. (2121 kg)	4676 lbs. (2121 kg)	4537 lbs. (2058 kg)	5716 lbs. (2593 kg)
Transport Weight	3636 lbs. (1649 kg)	3636 lbs (1649 kg)	3636 lbs (1649 kg)	3511 lbs (1593 kg)	4682 lbs. (2124 kg)
Vibrations at the Hand Controls (ISO 5349-1)	0.33 m/s2	0.33 m/s2	0.33 m/s2	0.35 m/s2	0.36 m/s2
Vibrations at the Hand Controls (ISO 5349-1) Uncertainty	0.03 m/s2	0.03 m/s2	0.03 m/s2	0.03 m/s2	0.04 m/s2
Vibrations at the Seat (EN 1032)	0.03 m/s2	0.03 m/s2	0.03 m/s2	0.03 m/s2	0.02 m/s2
Solution Tank Capacity	75 gal (284 L)	75 gal (284 L)	75 gal (284 L)	75 gal (284 L)	75 gal (284 L)
Recovery Tank Capacity	75 gal (284 L)	75 gal (284 L)	75 gal (284 L)	75 gal (284 L)	75 gal (284 L)
DustGuard Tank Capacity	29 gal (110 L)	29 gal (110 L)	29 gal (110 L)	29 gal (110 L)	29 gal (110 L)
Maximum Wheel Floor Loading (right front)	104.5 psi 0.720 N/mm^2	104.5 psi 0.720 N/mm^2	104.5 psi 0.720 N/mm^2	102.8 psi 0.709 N/mm^2	126.6 psi 0.873 N/mm^2
Maximum Wheel Floor Loading (left front)	104.5 psi 0.720 N/mm^2	104.5 psi 0.720 N/mm^2	104.5 psi 0.720 N/mm^2	107.9 psi 0.743 N/mm^2	125.1 psi 0.863 N/mm^2
Maximum Wheel Floor Loading (rear center)	146 psi 1.007 N/mm^2	146 psi 1.007 N/mm^2	146 psi 1.007 N/mm^2	136.5 psi 0.941 N/mm^2	147.9 psi 1.019 N/mm^2
Gradeability - Transport	21 % (12 °)	21 % (12 °)	21 % (12 °)	21 % (12 °)	21 % (12 °)
Gradeability - Cleaning	17.6 % (10 °)	17.6 % (10 °)	17.6 % (10 °)	17.6 % (10 °)	17.6 % (10 °)

Overall Dimensions





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.

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 OLED Display on the Operator panel for icons and fault codes that indicate a critical or non-critical fault condition.
- 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

Routine Maintenance

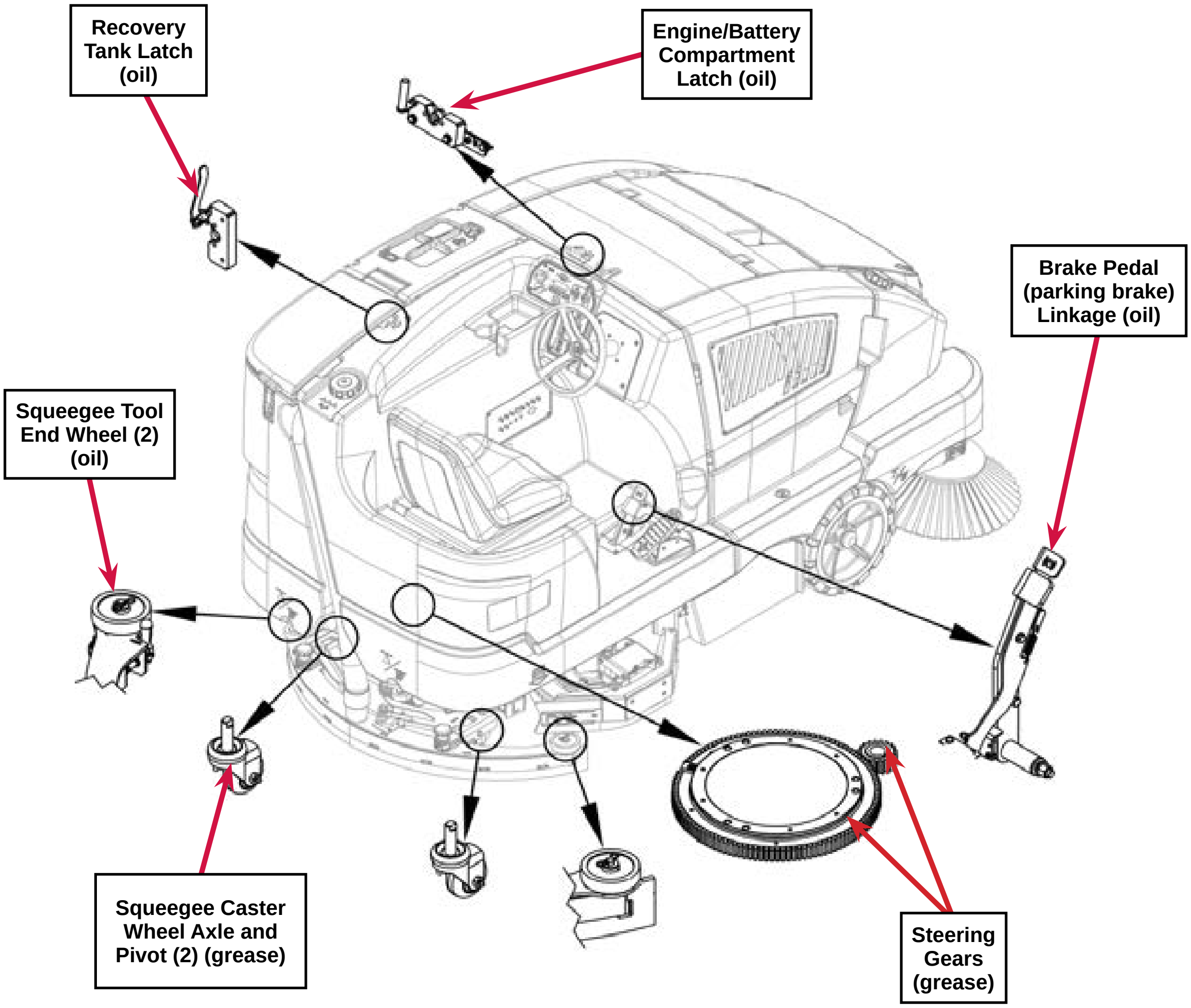
CAUTION: Do not pressure-wash the operator control panel, fuse panel, contactor panel or engine compartment area.

Maintenance Item	Interval								
	Day	Wk	Mo	15-20 Hrs	150 Hrs	400 Hrs	1000 Hrs	1500 Hrs	2000 Hrs
Charge battery (battery models)	X								
Check parking brake	X								
Check engine oil (engine models only)	X								
Check engine coolant level (engine models only)	X								
Check air filter service indicator	X								
Clean main and side brooms	X								
Check and clean the scrub brushes	X								
Drain / Check / Clean Tanks & Hoses	X								
Clean recovery tank Debris Basket (51)	X								
Check / Clean / Adjust the squeegee	X								
Clean the hopper	X								
Clean / Inspect scrub deck side skirts	X								
Check/Clean/Rinse vacuum motor foam filter and screen	X								
Check hydraulic oil level		X							

Maintenance Item	Interval								
	Day	Wk	Mo	15-20 Hrs	150 Hrs	400 Hrs	1000 Hrs	1500 Hrs	2000 Hrs
Lubricate squeegee caster wheels and pivot			X						
Lubricate steering gears			X						
Lubricate squeegee side wheels			X						
Lubricate engine/battery bay latch			X						
Lubricate recovery tank latch			X						
Lubricate brake linkage			X						
Check the electrolyte level in the battery (battery models)				X					
Check the battery cables and connections				X					
Rotate main broom				X					
Inspect and clean solution filter				X					
Rotate the scrub brushes				X					
Inspect/adjust main and side brooms				X					
Clean the DustGuard system spray nozzles				X					
Inspect broom housing skirts				X					
Check / Clean Hopper Dust Control Filter				X					
Inspect hopper seals				X					
Purge Detergent System (EcoFlex only)				X					
Clean radiator					X				
Perform general engine maintenance					X				
Change engine oil and filter					X				
Inspect and drain any oil buildup from the LP fuel EPR					X				
Inspect complete air intake system (engine models only)						X			
Check engine battery electrolyte level & terminals						X			
Replace fuel filter (engine models only)						X			
Change the spark plugs (LP and petrol only)							X		
Flush the radiator							X		
Replace Alternator Drive Belt							X		
Check vacuum motor carbon brushes (1200 hrs)							X		
Check main broom motor carbon brushes								X	
Check side broom motor carbon brushes								X	
Replace vacuum motor									X
Check scrub brush motor carbon brushes									X
Perform engine maintenance									X

Note: *Refer to the engine manual listed in the Engine Manufacturers' Technical Manuals list on page 12 for additional engine maintenance information*

Lubrication Points



EcoFlex System Maintenance

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

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.*

PM Checklist
Nilfisk-Advance CS7010

Defect Codes

A ⟶ Needs adjustment
B ⟶ Binding
C ⟶ Contaminated, dirty
D ⟶ Damaged, bent, or torn
L ⟶ Leaks
M ⟶ Missing
W ⟶ Worn out

Customer ____

Address ____

City ______________________________ **St** _____ **Zip** ________

Model # _____________ **Serial #** ________________ **Hours** _______

Ref	Operational Inspection Items	OK	Not OK	Defect Codes (circle)
1	Engine idle speed. LP - 1700 RPM; diesel - 1700 RPM			A Inconsistent
2	Engine run speed. LP - 2500 RPM; diesel - 2200 RPM			A Low power
3	Engine maximum power at run speed.			A Low power
4	Drive pedal operation (forward/reverse and any neutral creep)			A B
5	Drive system performance (max forward transport speed)			noisy slow
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 - 48” of H2O sealed; 25” to 30” of H2O with 1” orifice			C L
21	Headlights, gauges, optional beacon, backup alarm			
22	Tilt steering mechanism and seat adjustment lever			

Ref	Visual Inspection Items	OK	Not OK	Defect Codes (circle)
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

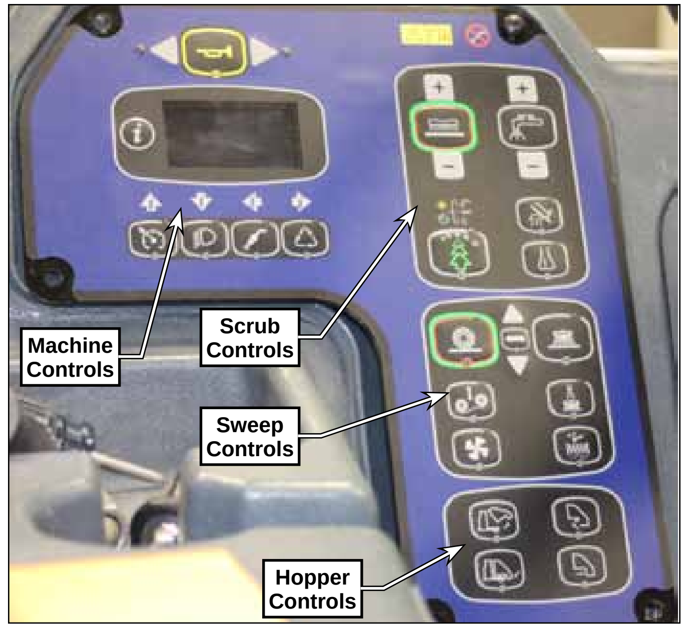
Ref	Visual Inspection Items	OK	Not OK	Defect Codes (circle)
29	Scrub deck housing and door skirts			C D W
30	Solution system pumps and solenoid valves as many as six pumps			C L W
31	Solution tank, delivery hoses and filter clean filter screen			C L M
32	Dust control system impeller motor			C L D
33	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

Comments:

Work Completed By: **Acknowledged By:**

Service Technician Signature **Date** **Customer Signature** **Date**

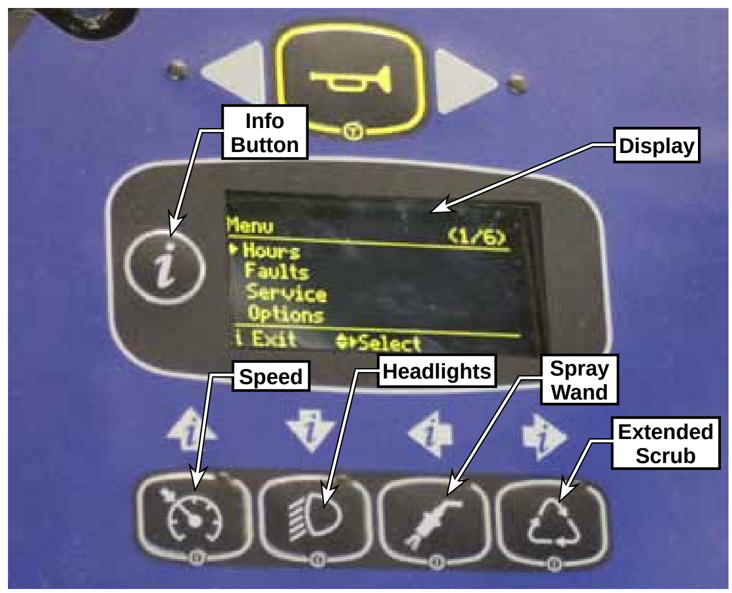
Machine Controls



Control Panel - General Layout

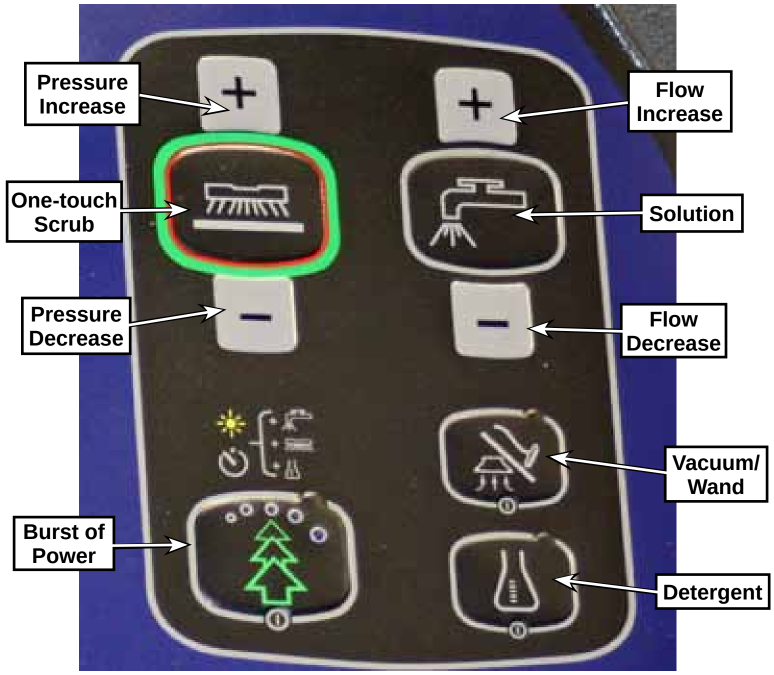
The CS7010 control panel is organized by machine function with the scrub, sweep and hopper functions conveniently grouped together. Miscellaneous controls such as the key switch, emergency-stop switch, speed control, light switch, high-pressure wand switch, extended scrub system switch and horn button are located in front of the Operator.

Miscellaneous Controls



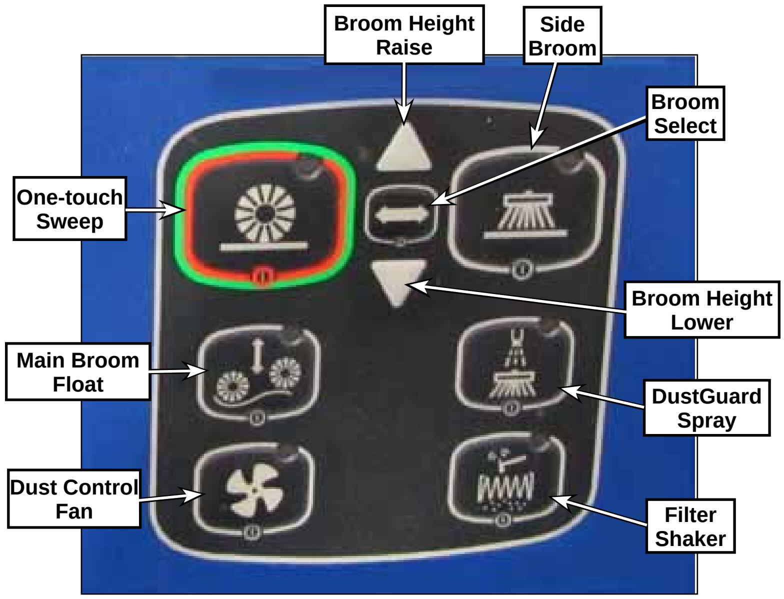
- E-Stop – maintained palm switch; removes all functions of the machine when pressed. To reset the Emergency Stop switch, rotate the red knob clockwise.
- Left and Right Turn Signal – switch on the corresponding turn signal.
- Horn Button – sounds the horn when pressed.
- Key Switch – main power/ignition switch.
- OLED Display – displays the various machine status icons and informational displays.
- Speed Switch – functions as follows:
  - Engine 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.
- High-pressure Wash Switch – engages the high-pressure spray wand solution pump (LPG and diesel only).
- Extended Scrub Switch – enables the optional extended scrub (recycle) function.

Scrub Controls



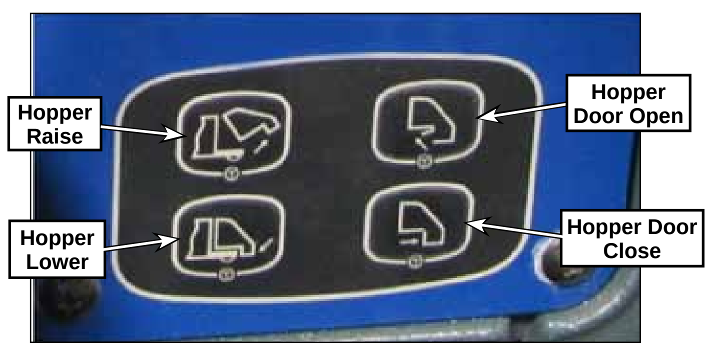
- Scrub Pressure Increase Button – increases the scrub pressure one level when pressed.
- One Touch Scrub Button – enables the scrub, solution, and recovery systems, and the EcoFlex™ system if the machine is so equipped. Note that the scrub brush pressure and solution flow will be at their lowest levels. 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 Button – increases both the scrub brush pressure and solution flow one step higher for 60 to 300 seconds.
- Solution Flow Increase Button – increases the solution flow rate one level when pressed.
- Solution Button – enables and disables the solution system.
- Solution Flow Decrease Button – decreases the solution flow rate one level when pressed.
- Vacuum/Wand Button – enables and disables on the vacuum system.
- Detergent Button – enables and disables the detergent system (on models so equipped).

Sweep Controls



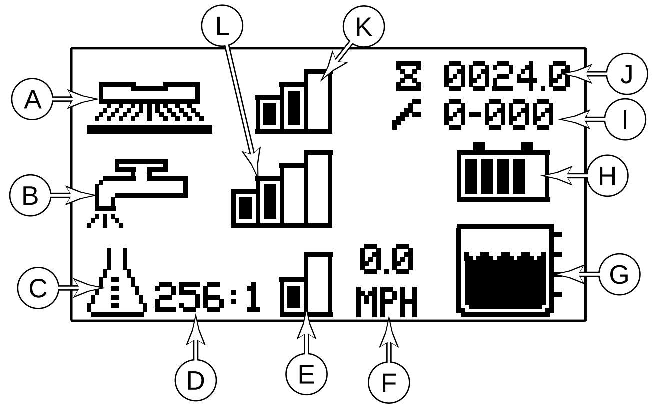
- One-touch Sweep Button – enables the main broom, side brooms, dust control fan and DustGuard™ spray nozzles.
- Broom Select Button –
  - When the one-touch sweep is enabled, the Broom Select button selects the broom (main broom or side brooms) that will be raised or lowered when the Broom Height Raise Button and Broom Height Lower Button are pressed.
  - When the one-touch sweep is not enabled, pressing the Broom Select button 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.
- Broom Height Raise & Lower Buttons – raise and lower the selected broom from its current position.
- Side Broom Button – enables and disables the side brooms. Note that if you switch off the side brooms, the DustGuard™ spray nozzles will also switch off.
- Main Broom Float Button – the main broom actuator moves 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 Button – enables and disables the dust control fan.
- DustGuard Spray Button – enables and disables the DustGuard spray nozzles.
- Filter Shaker Button – switches on the filter shaker. The shaker will cycle 16 times, then switch off.

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.

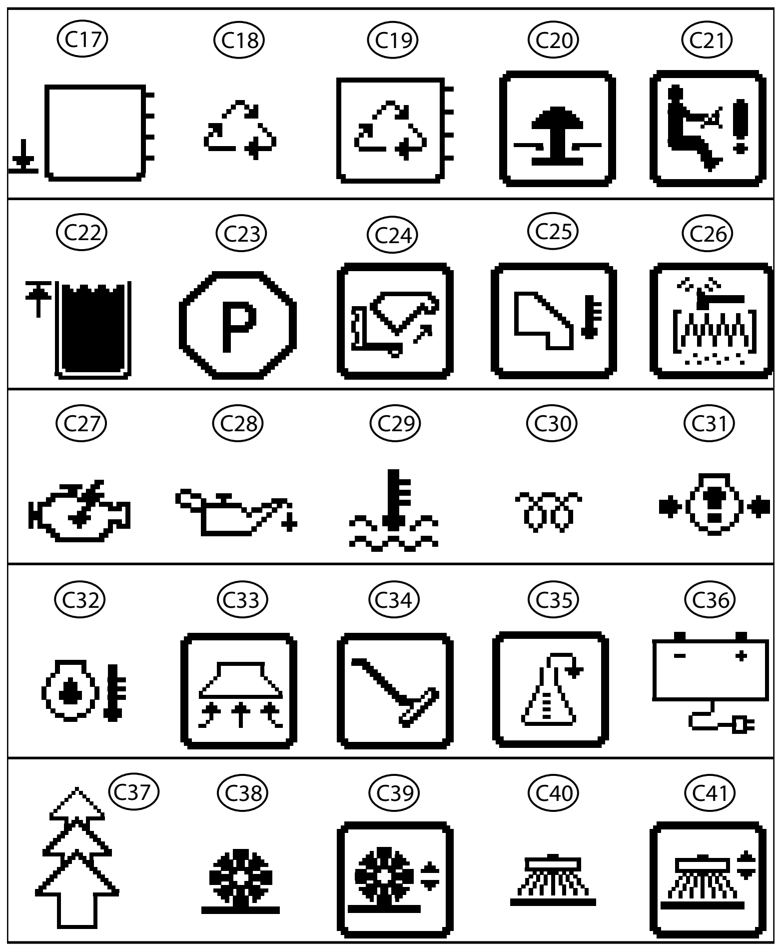
OLED Display



A. Scrub Pressure Indicator
B. Solution Flow Indicator
C. Detergent Indicator
D. Detergent Ratio Indicator
E. Detergent Indicator Bar Graph
F. Speedometer
G. Solution Tank Level Indicator
H. Battery Indicator
I. Active Fault Codes
J. Hour Meter
K. Scrub Brush Pressure Bar Graph
L. Solution Flow Rate Bar Graph

Additional Display Icons

C17 Solution Tank Empty Indicator
C18 Extended Scrub Indicator
C19 Tank with Extended Scrub
C20 Emergency Stop Activated Indicator
C21 No Operator Present Indicator
C22 Recovery Tank Full Indicator
C23 Parking Brake Indicator
C24 Hopper Raised Indicator
C25 Hopper Temperature Indicator (optional)
C26 Purge Indicator (EcoFlex models only)
C27 Check Engine Indicator
C28 Oil Pressure Indicator
C29 Engine Over-Temperature Indicator
C30 Glow Plug Caution Indicator (Diesel)
C31 Oil Pressure Indicator
C32 Engine Temperature Indicator
C33 Vacuum Mode Indicator
C34 Wand Mode Indicator
C35 Purge Indicator
C36 Battery Low Voltage Indicator
C37 Burst of Power Indicator (EcoFlex)
C38 Main Broom Indicator
C39 Main Broom Adjustment Indicator
C40 Side Broom Indicator
C41 Side Broom Adjustment Indicator

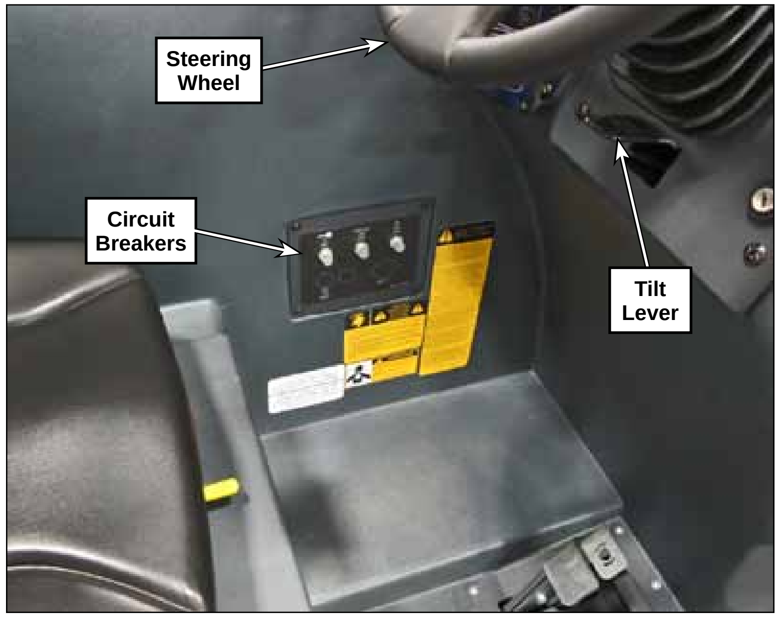


Steering Wheel

The steering system in the CS7010 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.

WARNING: When the machine is first initialized, the steering system will turn the wheel full-left and full-right rapidly to identify the home and limit positions. Keep hands, feet, and tools clear of the drive wheel when powering up the machine.



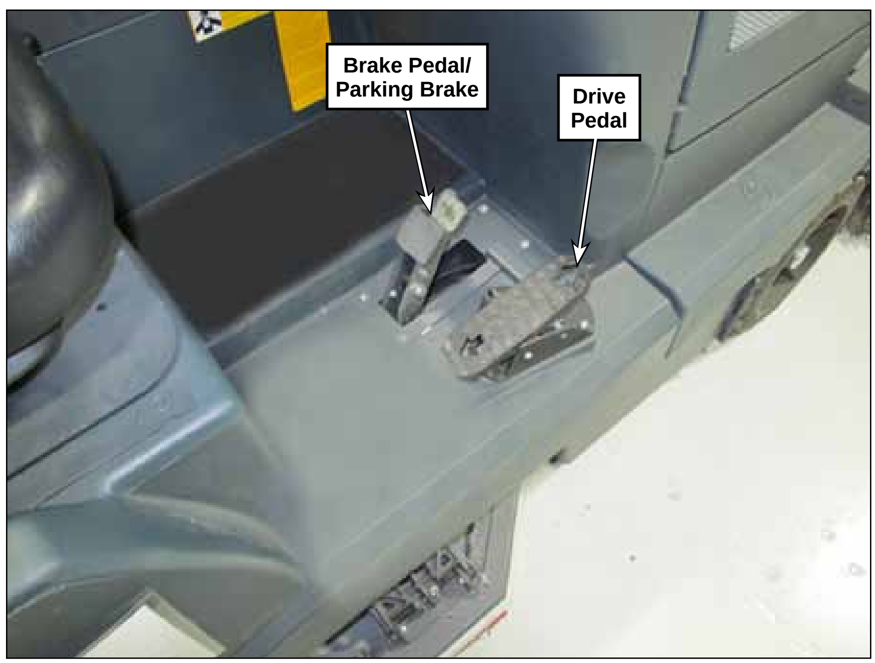
The standard tilt lever allows the steering wheel to be tilted up and down to suit the operator.

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.



04 - Control System

This control system chapter focuses primarily on the Main Machine Controller and the power modules. The machine contains several other controllers, as described below, which are discussed in their respective chapters.

Functional Description

The CS7010 is a distributed network of various controllers that interact to control all of the machine functions. The top level controller is the Main Machine Controller (MMC), which provides commands to the other controllers directing them to complete their associated tasks. (Refer to the "Functional Diagram" on page 34 .) The MMC also directly controls many of the low-power motors and devices, while also monitoring many of the system sensors.

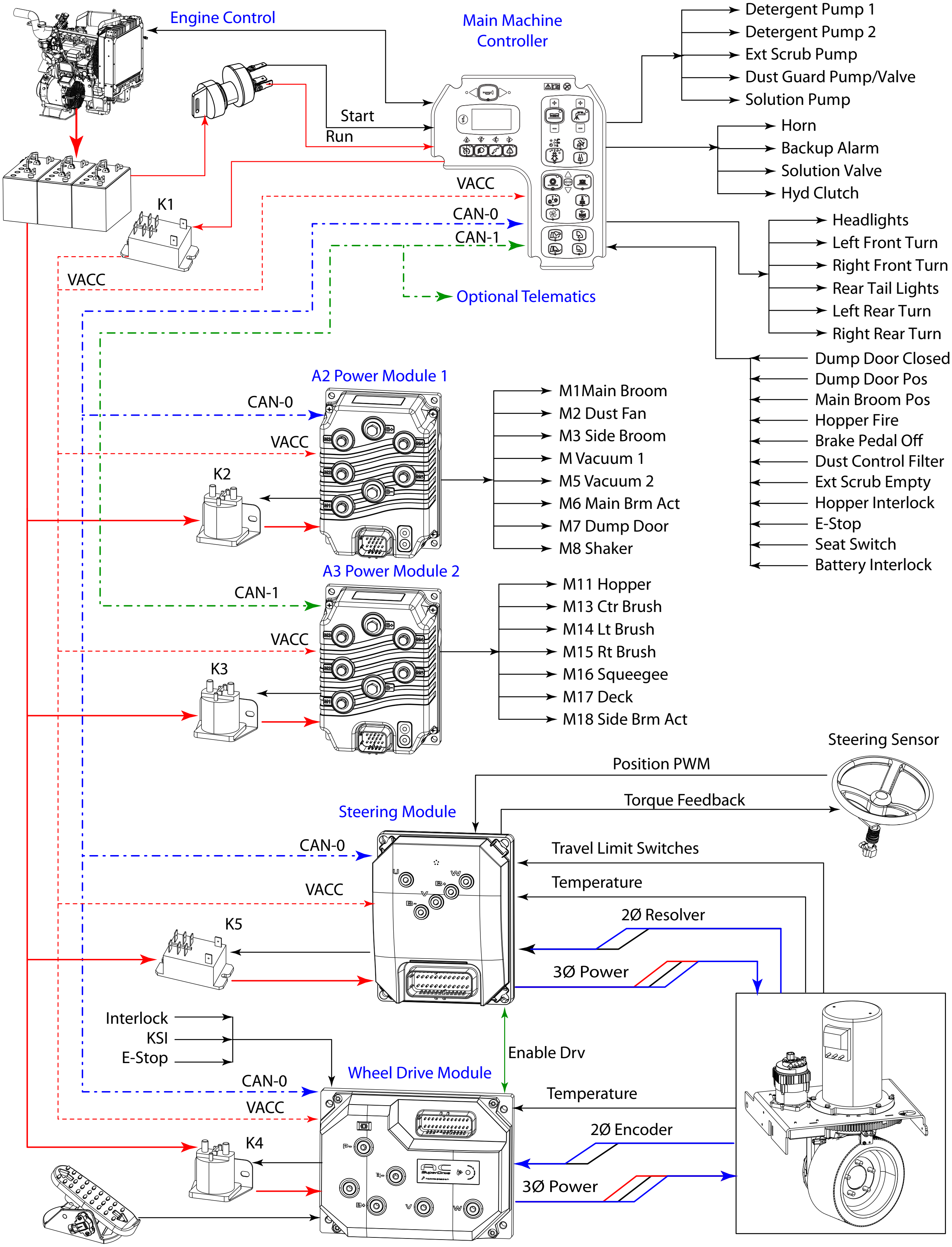
Two power modules control the high-power motors of the system, based on CANBus commands from the MMC. The power modules monitor the performance and operation of the motors, and communicates this status back to the MMC via the CANBus.

The wheel drive motor has its own dedicated controller, which drives the motor based on direct commands from the operator foot pedal, the MMC, and feedback from the motor itself. The wheel drive controller is described in more detail in the 20 - Wheel System, Traction Chapter on page 74.

The steering motor has its own dedicated controller, which drives the motor based on direct commands from the operator steering wheel (sensor) and feedback from the steering motor and steering limit switches. The steering module also has the ability to enable or disable the drive function if the steering system is not ready for machine movement. The steering module also controls the torque feedback device on the steering wheel to provide controlled resistance to rotation. The steering controller is described in greater detail in the 22 - Steering System chapter on page 84.

The engine controller is integral to the engine, and operates and monitors all engine functions semi-autonomously. The engine controller and MMC communicate for basic functions and to provide engine status to the MMC. The engine controller is described in more detail in the respective Engine chapters.

Functional Diagram

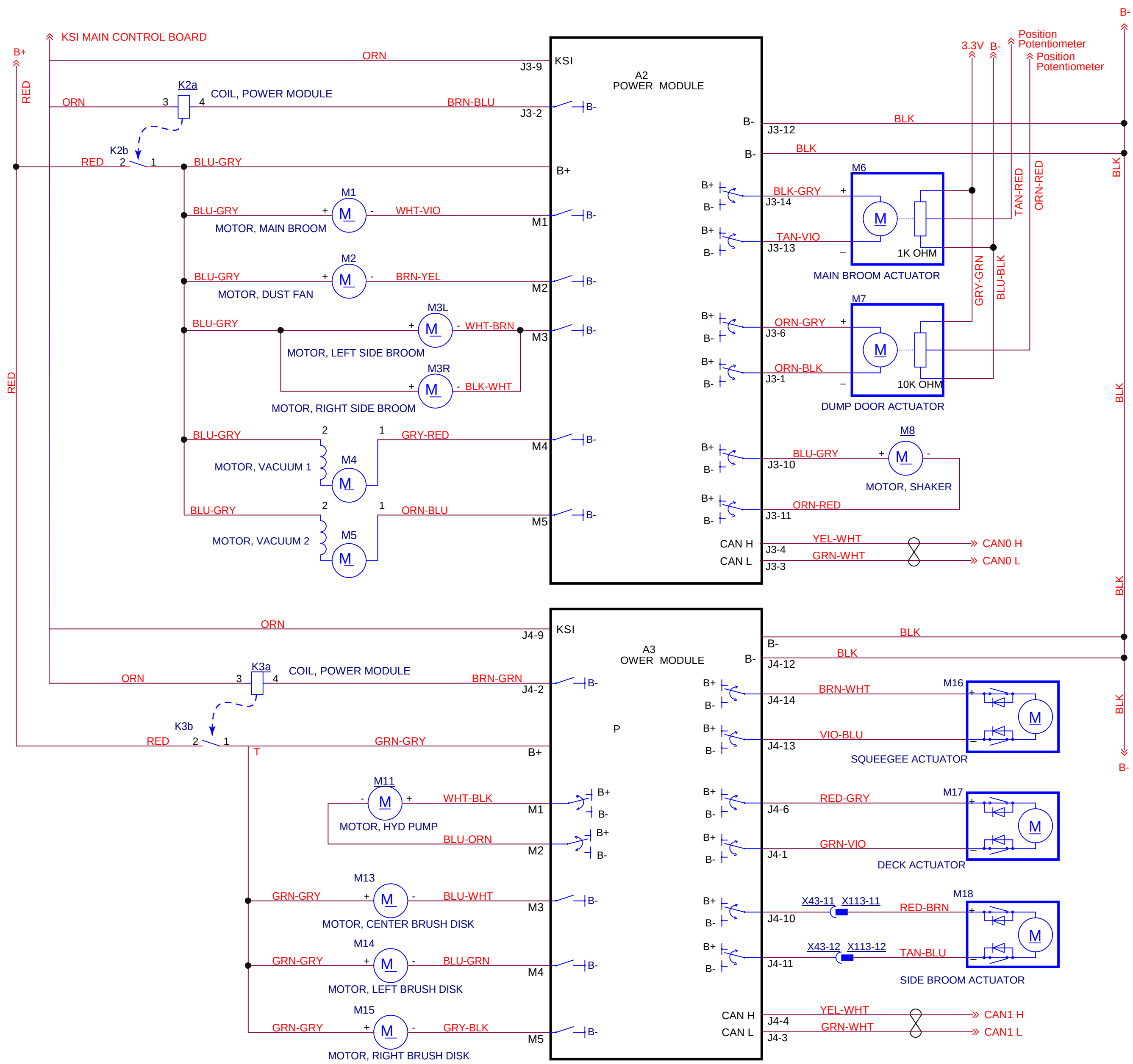


Power Modules

As the name suggests, the power modules handle the high-power output functions for the machine. They receive commands from the main machine controller via the CAN Bus network. The power modules provide basic motor control and protection, but the main machine controller controls the actual operation commands for the motors.

The power module receives its logic power from the Key Switch Input (KSI) . The power module has control of its own high-power input from the K2/K3 relays. Unlike the drive module, the power module has no direct inhibit input signals (i.e. seat switch or E-stop), except by commands on the CAN Bus.

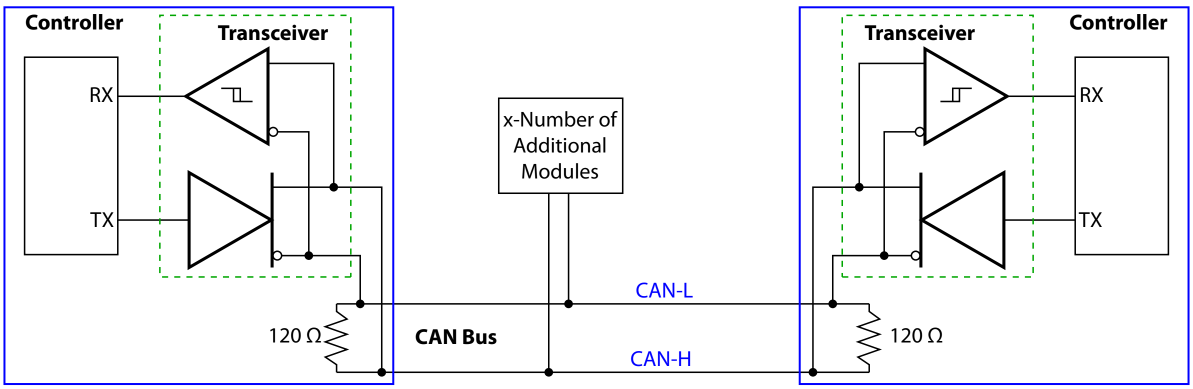
The power modules monitor the performance and health of the motors connected to them, and report this status information back to the MMC via the CAN Bus. When the MMC displays an error code for a power device, it is driven by a code from the power module on the CAN Bus.



CAN Bus Communication

CAN Bus communication was originally created for the automotive industry to allow distributed modules (Nodes) throughout the vehicle to communicate with each other over a single serial channel without any single Node being the Master of the communication channel. This means that each module broadcasts what it has to say, and all other modules on the CAN Bus see the message, but pay attention only to those messages they need to know about.

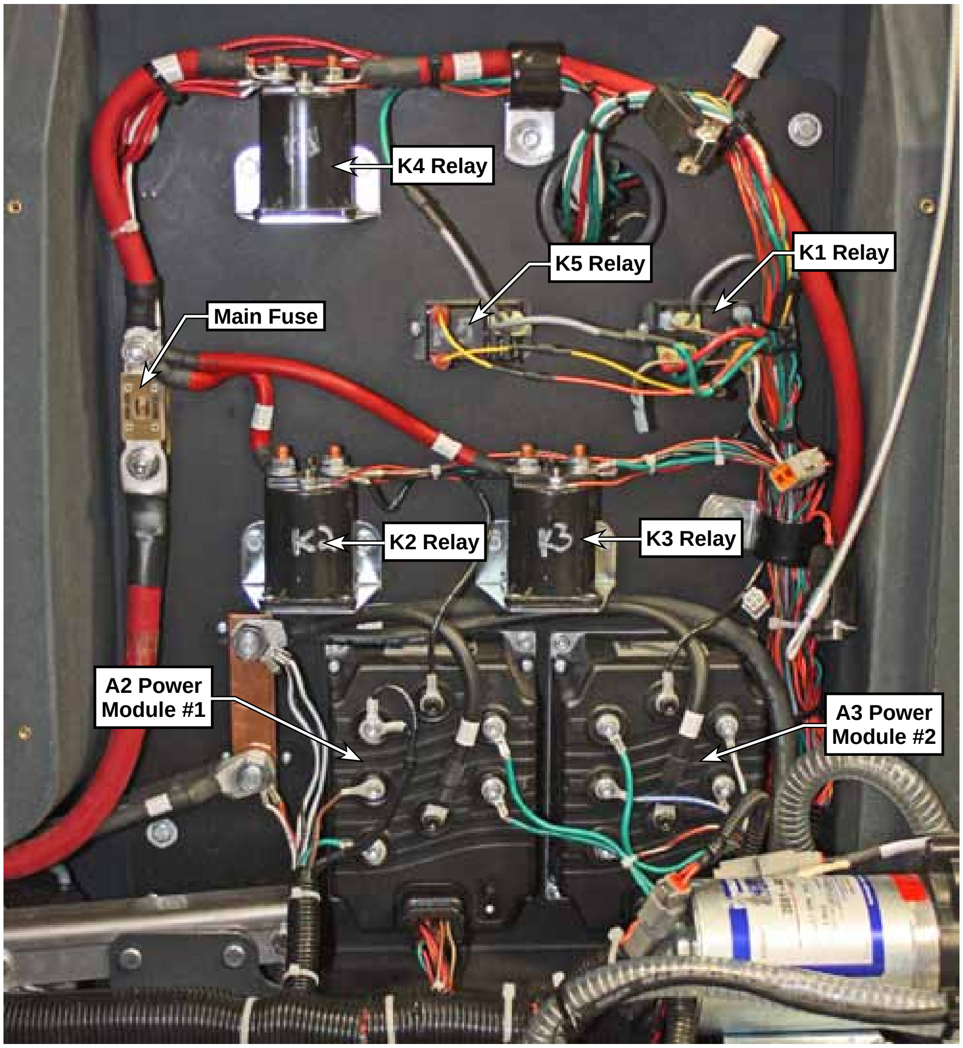
The CAN bus is a twisted-pair of wires running between all of the modules, with one wire being low and the other wire high, voltage-wise. To send a data bit, the module pulls the high and low wires apart, voltage-wise. All of the other modules monitor this to detect a communication message, which is a string of low and high binary pulses. However, the binary logic states are reverse of typical, in that a logic-1 is recessive, and the difference between CAN_H and CAN_L is low (near zero). A logic-0 is the dominant bit, and the difference between CAN_H and CAN_L is high (approximately 2.5 volts).



Because none of the modules represent the Master of the bus system, any of the modules can initiate a bus transmission any time there is not already traffic on the bus. When the module detects inactivity on the bus, it transmits a dominate bit, and begins sending the message priority level bits. But at the same time, it is also monitoring the bus itself to detect if a higher priority message was being initiated at the same time. The message with the higher priority level will have the bus high for the longest period, and therefore, that module knows that it is sending the highest priority message. The other module ceases its transmission and waits until the bus is available again.

Most CAN Bus messages originate from the Main Controller, or in response to a request from the Main Controller. However, each module can send any emergency messages at any time.

Component Locations

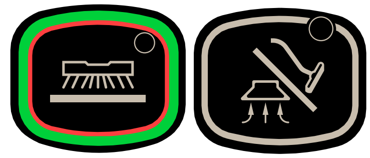


Main Machine Controller Programming

The Main Machine Controller is programmable for machine specific functions and configurations through a text menu system. Various parts of the menu system are hidden, and available only to the technician. The Technician-level (Service Mode) permits access to the whole menu system.

Service Mode Access

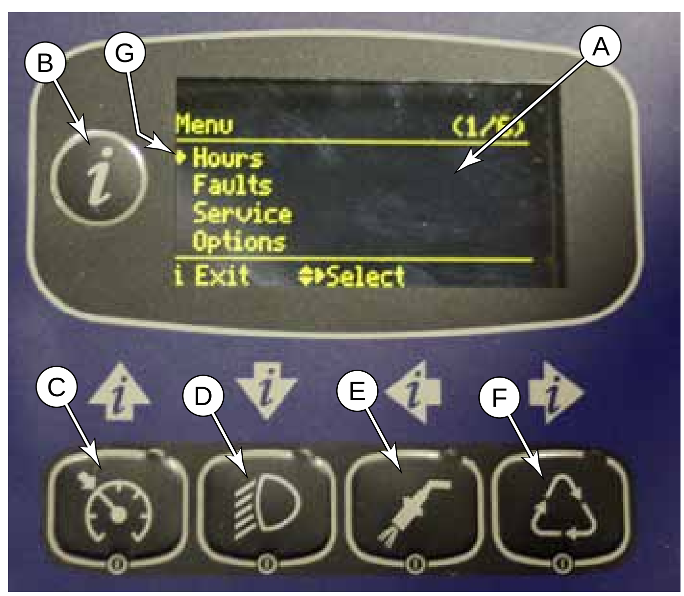
Placing the machine into Service Mode is required to gain full access to the configuration system. Start with the machine powered off. Press and hold the Scrub and Vacuum buttons then turn the key to the on position. The machine will function the same, and the display will be the same, but you will have access to the otherwise hidden menu system reserved for technicians.



Menu Navigation

The menu system is accessed by pressing the Information switch **(B)**. The LCD display will show the text-based menu system. Pressing the Information switch again, exits the menu system. Refer to “Programming Menu Outline” on page 39. The four switches below the display are used for navigating the menus. The mode of navigation is indicated by the arrows above the respective switches. Those arrows will be referenced when describing the navigation switches in this chapter.

- The Up and Down arrows **(C & D)** scroll through the menu listings. Within a configuration setting, the Up and Down arrows also scroll through the list of configuration choices.
- The Cursor arrow **(G)** signifies the current cursor position.
- The right arrow **(F)** will enter the currently identified submenu. Within a configuration setting, pressing the right arrow accepts (saves) that selection and exits back to the previous menu.
- The left arrow **(E)** backs out of any submenu to the previous menu. Within a configuration setting, pressing the left arrow cancels the selection, and exits without saving.



Programming Menu Outline

Hours
- On Time
- Drive Time
- Scrub Time
- Recovery Time
- Sweep Time
- Engine Time

Faults
- Active Faults
- Fault History
- ◆ Clear History

Service ◆
- A1 Main Controller
- A2 Power Module 1
- A3 Power Module 2
- A4 Drive Controller
- A5 Steering Contr
- Engine
- Output Test
- Panel Test

Options ◆
- Scrub Start
- Scrub Max
- BOP Time (s)
- Solution Mode
- Solution In Rev
- Shaker Time (s)
- Broom Up In Rev
- Max Speed (%)
- Lock Speed Limit
- Headlight
- Steer Home Enable
- Language

Configuration ◆
- Machine Type
- Brand
- Ecoflex
- Dust Guard
- Ext Scrub Kit
- Back-Up Alarm
- Signal Light Kit
- Plugged Filter Kit
- Hopper Temp Kit
- Hi-Press Pump Kit
- Display
- TrackClean
- Deck Down Time (s)
- Neutral Delay (s)
- Sqg Up Time (s)
- Dump Door Open V
- Vac Off Delay (s)
- Eng Idle Delay (s)
- Detect RTF

System
- Firmware
- Serial Number
- ◆ Install Firmware

A3 Power Module 2
- A3 Mod: B+, Deg C
- M11 Hopper %
  - → %Req, %Out, A
- M13 Ctr Brush %
  - → %Req, %Out, A
- M14 Lt Brush %
  - → %Req, %Out, A
- M15 Rt Brush %
  - → %Req, %Out, A
- M16 Squeegee %
  - → %Req, %Out, A
- M17 Deck %
  - → %Req, %Out, A
- M18 Side Brm Act %
  - → %Req, %Out, A

A2 Power Module 1
- A2 Mod: B+, Deg C
- M1 Main Broom
  - → %Req, %Out, A
- M2 Dust Fan
  - → %Req, %Out, A
- M3 Side Broom
  - → %Req, %Out, A
- M4 Vacuum 1
  - → %Req, %Out, A
- M5 Vacuum 2
  - → %Req, %Out, A
- M6 Main Brm Act
  - → %Req, %Out, A
- M7 Dump Door
  - → %Req, %Out, A
- M8 Shaker
  - → %Req, %Out, A

A1 Main Controller
- J1-1 Throttle 1
- J1-2 Throttle 2
- J1-3 Hi Press Pump
- J1-4 Glowplug
- J1-5 Headlights
- J1-7 Ignition
- J1-8 Solution Valve
- J1-9 Engine Start
- J1-10 E-Stop
- J1-11 Interlock
- J1-12 Seat Switch
- J1-13 12V
- M19/20 Det Pumps
- J1-18 Backup Alarm
- J1-20 Rt Turn
- J1-21 Key Start
- J1-22 Eng Run V
- J1-23 KSI
- J1-24 Tailights
- J1-25 Lt Turn
- J1-26 Dust Guard
- J1-28 Solution Pump
- J1-30 VACC 2
- J1-31 Lt Stop
- J1-32 Rt Stop
- J1-33 Ext Scrub Pump
- J1-35 Horn
- J2-8 Filter Plugged
- J2-9 Brake Switch
- J2-10 Ext Scrub Sw
- J2-13 Hopper Down
- J2-14 Hopper Temp
- J2-15 Eng Temp
- J2-16 Oil Pressure
- J2-17 Dump Door V
- J2-18 Dump Door Close
- J2-20 Eng MIL
- J2-22 Main Broom V
- J2-23 Fuel Level V
- Sol Level V

A4 Drive Controller
- Speed (mph/kph)
- Max RPM
- R4 Throttle %
- R4 Throttle V
- M9 Encoder RPM
- M9 Motor RPM
- M9 Motor RMS Amps
- M9 Motor DC Amps
- M9 Motor degC
- A4 degC
- B+ V
- J5-4 K4 Enable
- J5-28 E-Stop
- J5-12 Seat Switch
- J5-19 Drive Enable

Output Test
- H1 Backup Alarm
- H2 Horn
- L2 Sol Valve
- LT2-4 Headlights
- LT5 LF Turn
- LT6 RF Turn
- LT7,8 Taillights
- LT9 LR Turn
- LT10 RR Turn
- M19,20 Det Pump
- M21 Ext Scrub
- M22,L1 Dust Grd
- M23 Sol Pump
- Y1 Hi Press Pump
- M1 Main Broom %
- M2 Dust Fan %
- M3 Side Brooms %
- M4 Vacuum 1 %
- M5 Vacuum 2 %
- M6 MB Act %
- M7 Dump Door %
- M8 Shaker %
- M11 Hopper %
- M13 Ctr Brush %
- M14 Rt Brush %
- M15 Lt Brush %
- M16 Squeegee %
- M17 Deck %
- M18 SB Act %
- Eng Speed

Engine
- Type
- J1-1 Throttle 1
- J1-2 Throttle 2
- J1-4 Glow Plug
- J1-7 Ingnition
- J1-9 Eng Start
- J1-13 12V
- J1-21 Key Start
- J1-22 Engine Run V
- J2-15 Eng Temp
- J2-16 Oil Pressure
- J2-20 Eng MIL
- J2-23 Fuel Level V
- Total Amps

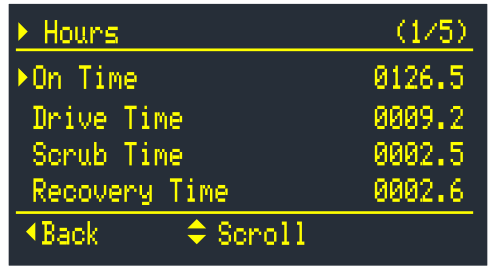
A5 Steering Controller
- Steer Angle
- E1 TFD Angle
- E1 TFD RPM
- J6-27 L Limit Sw
- J6-15 R Limit Sw
- M10 Encoder Angle
- M10 Encoder RPM
- M10 Motor RPM
- M10 Motor RMS Amps
- M10 Motor DC Amps
- M10 Motor DegC
- A5 Ctrl degC
- B+ V
- J6-13 K5 Enable
- J6-4 Drive Enable
- J6-24 TFD Enable

◆ = Service-Only Access

Some Abbreviations Spelled Out
Some Entries Grouped for Brevity

Hours Menu

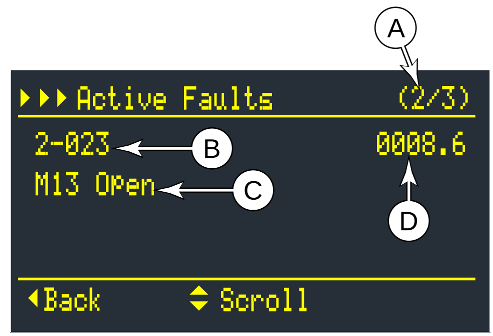
The hours menu displays the amount of time the machine has been active in each of the listed categories. The On Time represents the total time that the machine has been powered up, regardless whether it was active or sitting neutral. The remaining times indicate how long the machine was active and performing the specific functions. This information can be helpful when determining which preventive maintenance tasks are due to be performed.



Faults Menu

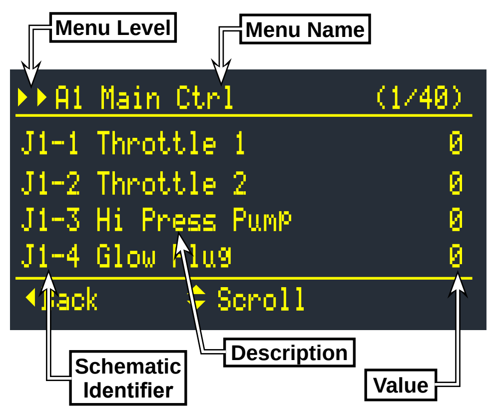
The faults menu lists the active or past machine faults. This can be helpful for troubleshooting, or for predicting a pending component failure. For example, if a motor has a history of increasingly frequent over-current errors, it may be a sign of a pending motor failure.

The information displayed in each fault entry is: **(A)** Fault occurrence number, **(B)** Error Code, **(D)** Drive-Time Hour Meter when the fault occurred, and **(C)** Error Description.



Service Menu

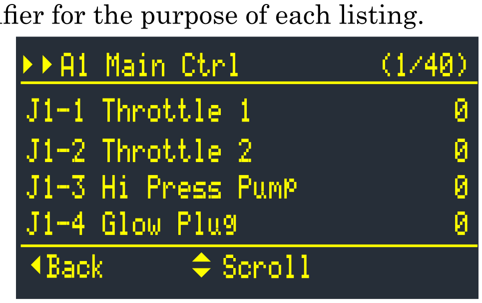
The Service menu provides access to diagnostic tools for troubleshooting the machine. Except for the Panel Test, each of these entries brings up a submenu for the applicable system module or function.



A1 Main Controller

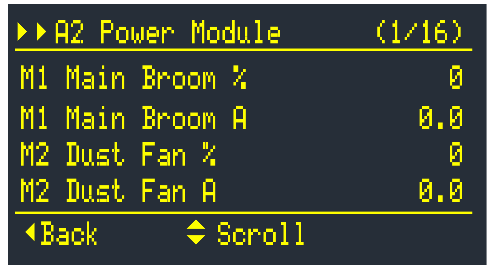
In addition to communicating with the other machine controllers, the main controller includes some direct input and output functions for sensors and low-power devices. This menu displays the status of the various input and output signals.

This menu is effective for troubleshooting by verifying whether the controller's inputs and outputs are active/inactive as expected to be. Refer to the schematic and schematic identifier for the purpose of each listing.



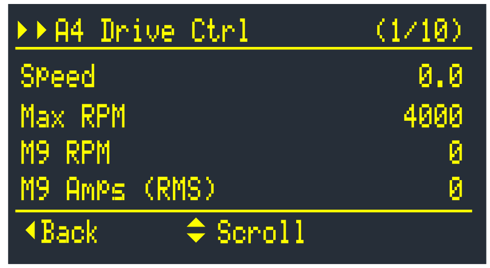
A2 and A3 Power Modules

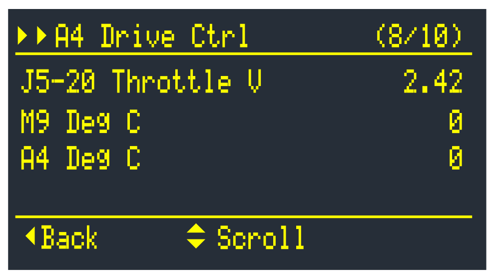
The two Power Module menus provide information regarding all of the motors which are driven by the power modules. It lists the PWM % commanded to the motor as well as the amperage drawn by the motor.



A4 Drive Controller

The Drive Controller menu provides status information about the drive motor and the drive controller itself. A brief summary of each listing is described below.





Speed (mph/kph): This displays the actual speed of the machine.

Max RPM: This is the maximum permissible motor RPM.

M9 RPM: This displays the output rpm of the wheel motor.

M9 Amps: This displays the net amperage to the drive motor in either AC RMS or DC amps.

Encoder RPM: This displays the effective rpm of the A and B phase encoders within the wheel motor. It represent the frequency of the PWM signal.

Throttle %: This displays the throttle command resulting from the throttle position.

Throttle Voltage: This displays the wiper voltage from the throttle potentiometer.

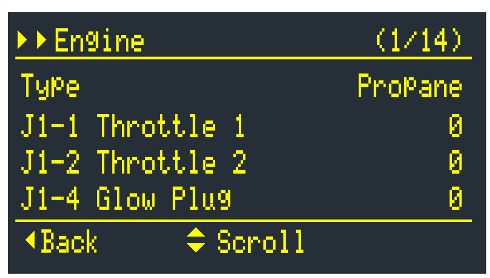
M9 Deg C: This represents the internal temperature (˚C) of the wheel motor. The motor has an internal temperature sensor and reports this value to the Drive Controller.

A4 Deg C: This represents the internal temperature (˚C) of the drive controller itself.

E4 Temp Cutback %: This represents the percentage of power available to the motor when reduced due to an over-temperature condition within the Drive Controller, to protect the controller.

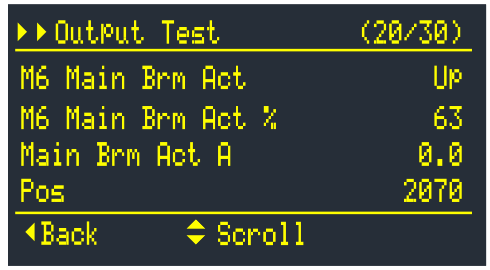
Engine Menu

The engine menu provides status for the inputs/outputs between the main controller and the engine module. The same listing is shown under the main controller menu, but broken out separately here for convenience.



Output Test

The Output Test menu provides manual control of various system functions for troubleshooting purposes. This permits devices to be operated even when prerequisite conditions are not met, such as permitting the scrub brushes to turn on with the hopper up and the machine stationary. In addition to output control, each selection also provides status information for the particular device.



The output options will vary for each listing, and may include On/Off, Forward/Reverse/Off, Up/Down, etc.

For outputs under PWM control, the commanded PWM% and the actual load amperage is shown.

For actuators with position feedback, the position information is also shown.

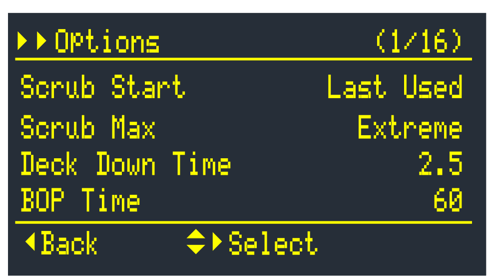
Panel Test

The Panel Test screen provides a means to verify the functionality of all of the control panel switches, LEDs, and display pixels.

- Pressing the Up navigation switch will turn all screen pixels on, to reveal if any pixels are not working.
- Pressing the Down navigation switch will illuminate all LED indicators.
- Pressing any non-navigation switch will display that switches number on the display. The actual switch number isn't critical for troubleshooting because the membrane switches are not an electrical array (like a computer keyboard), but instead are direct individual inputs into the main controller circuit board.
- Note, the navigation switches are not included in the panel test, because they still function as navigation switches, and are known to work by their actions.

Options Menu

The Options Menu provides for making machine settings specific for the uses and needs of the operator.



Scrub Start: This sets the scrub mode default at startup. The choices are Light, Heavy, Extreme, and Last Used. (Last means that whichever mode was selected during the previous session will remain for the next session.)

Scrub Max: This sets the maximum permitted scrub level that the operator can select, and locks out that level and those above it. The choices are Light, Heavy, and Extreme.

Deck Down Time: This sets how long the actuator is run in the downward direction when the scrub deck is moved down. The deck stops when the timer ends.

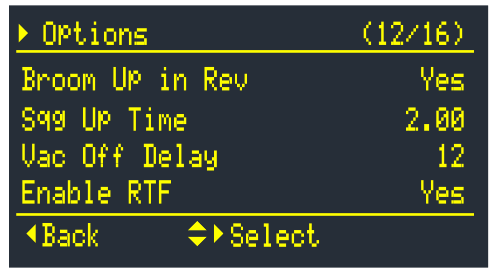
BOP Time: This sets the length of time (in seconds) Burst of Power remains active after pressing the BoP switch. The minimum is 60 seconds, the maximum is 300 seconds (5 minutes), and the increment is every 60 seconds (1 minute).

Neutral Delay (s): This sets how long the brushes remain active (in seconds) when the machine is stationary. The minimum is 1/2 second, the maximum is 5 seconds, and the increment is every 1/2 second.

Solution: This sets the mode for solution rate. The choices are Proportional (based on travel speed) and Fixed (constant rate).

Solution In Rev: This sets whether solution will flow when the machine is in reverse.

Shaker Time: This sets the length of time the shaker operates when activated.

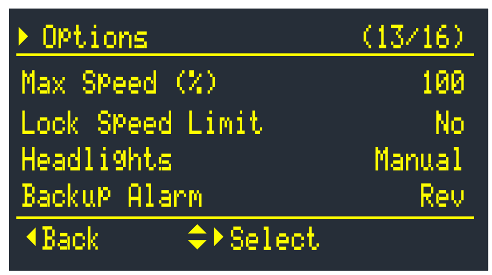


Broom Up in Rev: This sets whether the main broom is raised when the machine moves in reverse.

Squeegee Up Time: This sets the amount of time that the main controller activates the actuator motor in the upward direction after it sees a “reverse movement” signal.

Vac Off Delay (s): This sets the length of time (in seconds) that the vacuum motor will continue to run after the squeegee is lifted (to clear the hose of remaining water). The minimum is 10 seconds, the maximum is 20 seconds, and the increment is every 1 second.

Enable RTF (Recovery Tank Full): This enables detection of a full recovery tank by monitoring a sudden drop of the vacuum motor amperage.



Max Speed (%): This sets the maximum speed (percent of maximum) the operator can propel the machine forward. The minimum is 50%, the maximum is 100%, and the increment is every 10%.

Lock Speed Limit: This sets whether the operator can use the “set max speed” feature.

Headlights: This sets whether the optional headlights are automatically turned on at startup.

Steering Home Enable: This enables the steering home routine at machine initialization. When active, the drive wheel will turn full-left and then to center to establish home and limit positions.

Backup Alarm: This sets when the backup alarm is active. The choices are Off, Reverse, Reverse/Forward, Reverse/Forward/Hopper Up.

Configuration Menu

The configuration menu provides access to configure the machine based on which options are installed. If you install an option to a customer's machine, you will need to configure the controller to specify that the option is installed, or the option may not function. Additional information is contained in the instruction sheets that accompany the option kits.

Machine Type: This sets the type of power plant the machine uses. The choices are: Propane, Battery, Diesel, and Gas.

Battery: This sets the battery type for the purpose of battery voltage monitoring. The choices are Wet, Bench, and Sealed. The battery types will have slightly different voltage levels during their discharge cycles.

Brand: This sets the branding of the machine (Nilfisk or Advance). This should never be changed unless you are replacing the main controller.

Detergent: This sets whether the detergent system is installed.

Ecoflex: This sets whether the EcoFlex detergent pump system is installed.

Dust Guard: This sets whether the dust guard water spray is installed.

Extended Scrub: This sets whether the extended scrub option is installed.

Backup Alarm: This sets whether the backup alarm is installed.

Signal Lights: This sets whether the optional signal lights are installed.

Plugged Filter: This sets whether the plugged filter sensor is installed.

Hopper Temp: This sets whether the hopper temperature sensor is installed.

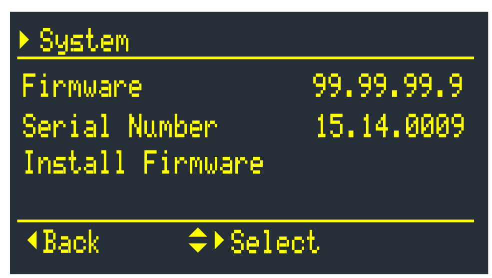
Pressure Wash: This sets whether the optional pressure wash pump and wand are installed.

Display: This sets the units of the display between US imperial and Metric.

TrackClean: This sets whether the TrackClean module is installed.

System Menu

The system menu displays the firmware revision number and the serial number of the control board. It also provides access for updating the firmware.



Troubleshooting

When troubleshooting the machine, the CS7010 main controller should be one of the first steps for most troubleshooting scenarios. All of the distributed controllers throughout the system report their status back to the main controller, including error codes. So when any of the controllers, including the MMC itself, experience any sort of fault, the operator's interface will display that/those fault(s).The tables in the next section below describe each of these error codes, along with possible causes and remedies.

Many error codes will disable the applicable function to protect components, and may require the machine to be reset in order to clear the condition prior to testing.

Another troubleshooting tool is the Output Test function in the service menu, and described on page 42. Use the output test to manually activate devices to be able to make sound, heat, vibration observations, as well as electrical measurements.

Fault Codes

All error codes are presented as 4-digit numbers (x-yyy), where the first digit represents which controller is reporting the error, and the remaining digits identify the actual error code.

- 1- indicates the A1 Main Controller , below
- 2- indicates the “A2 Power Module #1” on page 48
- 3- indicates the “A3 Power Module #2” on page 51
- 4- indicates the “A4 Drive Controller” on page 54
- 5- indicates the “A5 Steering Controller” on page 55

A1 Main Controller			
Fault Code	Description	Level	Condition
1-001	K1 Coil Open	Critical	The controller commanded the K1 relay to close, but no input voltage was detected at VACC2. • The K1 relay uses redundant contacts, so the likely cause is relay coil failure or an open circuit in the wires.
1-002	K1 Coil Short	Non-Critical	The controller has detected high current (more than 5 amps) to the K1 relay coil. Check the coil. Check the wires for shorts.
1-003	K1 Contact Weld	Non-Critical	The controller is detecting voltage present at the VACC2 input, but the K1 relay is not commanded to close • Disconnect the relay output wires. If the condition persists, then it is known to be a short to Bat+ in the wires. • If the condition clears after disconnecting the output wires, then it is known that the contacts have fused and the relay must be replaced.
1-010	CAN Bus 0	Critical	CAN bus 0 is in bus-off state. The controller has seen no response from other controllers on the bus.
1-011	CAN Bus 1	Critical	CAN bus 1 is in bus-off state. The controller has seen no response from other controllers on the bus.

A1 Main Controller			
Fault Code	**Description**	**Level**	**Condition**
1-101	L2 Sol Valve Short	Non-Critical	The controller has detected more than 5 amps at the Solution Solenoid. • The most likely cause is a damaged solenoid with an internal short. • Check the coil resistance of the solenoid. If it is significantly below the normal coil resistance of 108 Ω, then replace the solenoid.
1-102	M22,L1 Dust Grd Short	Non-Critical	The controller has detected more than 10 amps at the optional Dust Guard shared output for either the pump or solenoid. • Isolate which device is the cause by disconnecting each of them. • If the condition persists when both are disconnected, the cause is a short in the wiring or a control board failure.
1-103	H1 Backup Alarm Short	Non-Critical	The controller has detected more than 5 amps at the optional backup alarm. • The most likely cause is a damaged coil with an internal short. • Check the coil resistance of the alarm. If it is significantly below the normal coil resistance of 5.8 Ω, then replace the horn.
1-104	LT2-4 Headlights Short	Non-Critical	The controller has detected more than 5 amps at the optional headlights (LT2,3,or 4). • The most likely cause is a short in the wires leading to the headlight due to chaffing or melting. • Disconnect all headlights. If the condition clears, at least one of the headlights is faulty.
1-105	H2 Horn Short	Non-Critical	The controller has detected more than 5 amps at the horn. • The most likely cause is a damaged coil with an internal short. • Check the coil resistance of the horn. If it is significantly below the normal coil resistance of 5.8 Ω, then replace the horn.

<table>
<tr><th colspan="4">A1 Main Controller</th></tr>
<tr><th>Fault Code</th><th>Description</th><th>Level</th><th>Condition</th></tr>
<tr><td>1-106</td><td>M19 Det Pump 1 Short</td><td>Non-Critical</td><td rowspan="2">The controller has detected more than 2 amps at one of the optional detergent pumps under the operator’s seat.
• The most likely cause is a loose wire at the pump touching the other terminal.
• Swap the pump wires (pump 1 for 2) according to the color codes below.
– If the controller thinks the same pump is faulty, then you know the short is in the wires.
– If the controller thinks the other pump is faulty, then you know that one of them is faulty. (disconnect each one to find out which one is faulty).
<table><tr><th></th><th>Positive</th><th>Negative</th></tr><tr><td>Pump 1</td><td>White/Yellow</td><td>Blue/Yellow</td></tr><tr><td>Pump 2</td><td>White/Red</td><td>Blue/Red</td></tr></table></td></tr>
<tr><td>1-107</td><td>M20 Det Pump 2 Short</td><td>Non-Critical</td></tr>
<tr><td>1-108</td><td>Y1 HP Pump Short</td><td>Non-Critical</td><td>The controller has detected more than 10 amps in the high pressure pump clutch that engages the pump.</td></tr>
<tr><td>1-109</td><td>M23 Sol Pump Short</td><td>Non-Critical</td><td rowspan="7">The controller has detected excessive amperage in the associated component. (Sol Pump = 18A, Scrub pump = 10A, all others = 5A)
• Inspect the wires leading to the device for chafing or damage.
• Inspect the device for damage..</td></tr>
<tr><td>1-110</td><td>M21 Ext Scrub Pump Short</td><td>Non-Critical</td></tr>
<tr><td>1-111</td><td>LT7,8 Taillights Short</td><td>Non-Critical</td></tr>
<tr><td>1-112</td><td>LT6 RF Turn Short</td><td>Non-Critical</td></tr>
<tr><td>1-113</td><td>LT5 LF Turn Short</td><td>Non-Critical</td></tr>
<tr><td>1-114</td><td>LT10 RR Turn Short</td><td>Non-Critical</td></tr>
<tr><td>1-115</td><td>LT9 LR Turn Short</td><td>Non-Critical</td></tr>
<tr><td>1-201</td><td>U13 Sol Level Sensor</td><td>Non-Critical</td><td>The on-board solution level pressure sensor has invalid value. Check the sensor tubing for leaks or blockages.
• To test the function of the on-board sensor, pinch the tubing fully closed several inches away from the Main Controller, and then compress or pinch more areas between the first pinch and the controller, and watch for pressure changes on the display.
• Drain the solution tank, and then open the joint in the tubing behind the main controller. Close the joint, then refill the tank, and check the results again.</td></tr>
<tr><td>1-300</td><td>Check Engine</td><td>Non-Critical</td><td>The engine Malfuntion Indicator Light (MIL) signal was active (propane machines only)</td></tr>
<tr><td>1-301</td><td>Engine Overtemp</td><td>Non-Critical</td><td>The engine temperature fault input was active. Either the coolant is low, ot the input is shorted to ground.</td></tr>
<tr><td>1-302</td><td>Oil Pressure</td><td>Non-Critical</td><td>The engine oil pressure fault input was active.</td></tr>
<tr><td>1-303</td><td>Eng No Run Signal</td><td>Non-Critical</td><td>The engine run signal from the engine to the MMC was lost after the engine had been running for at least 3 seconds.</td></tr>
<tr><td>1-320</td><td>Eng Ignition Short</td><td>Non-Critical</td><td rowspan="2">The output current is above 18 amps.</td></tr>
<tr><td>1-321</td><td>Eng Start Short</td><td>Non-Critical</td></tr>
</table>

A1 Main Controller			
Fault Code	**Description**	**Level**	**Condition**
1-322	Eng Throttle 1 Short	Non-Critical	The output current is above 5 amps.
1-323	Eng Throttle 2 Short	Non-Critical	
1-324	Eng Glow Plug Short	Non-Critical	Output current is above 5 amps (diesel machines only)
1-350	Alternator 12V	Non-Critical	Engine 12V alternator fault - voltage was below 10V for more than 10sec when engine is running
1-351	Alternator 42V	Non-Critical	Engine 42V alternator fault - voltage was below 37V for more than 30sec
1-352	R1 Fuel Level Sensor	Non-Critical	Fuel level sensor has invalid value
1-560	EEPROM Configuration	Warning	Error reading intial configuration eeprom values - using default values
1-561	EEPROM Options	Warning	Error reading intial user options eeprom values - using default values
1-562	EEPROM System Values	Warning	Error reading intial system eeprom values - using default values
1-563	EEPROM Fault Log	Warning	Error reading intial fault log eeprom values - fault history cleared
1-564	EEPROM Usage Log	Warning	Error reading intial usage log eeprom values - all machine hours reset to 0

System indicator 2, Power Module #1 Error Codes

A2 Power Module #1			
Fault Code	**Description**	**Level**	**Condition**
2-001	A2 PM 1 Timeout	Critical	The main controller is not receiving power module heartbeat messages
2-011	Precharge Fail	Critical	The precharge failed to charge the internal capacitor bank to the KSI voltage. Check wires for loose connection.
2-012	K2 Overload	Critical	Main contactor coil current is higher than setting current
2-013	K2 Contact Weld	Critical	The power module is detecting power on the main incoming battery line, but the module is not commanding the relay to close.
2-014	K2 Contact Open	Critical	The power module commanded the K2 relay to close, but is not detecting power on the main incoming battery line.
2-017	OverVolt Cutoff	Critical	The DC capacitor bank voltage exceeded over-voltage cutoff limit. If the condition persists after a full system reset, the power module is likely at fault.
2-018	UnderVolt Cutoff	Critical	The DC capacitor bank voltage dropped below under-voltage cutoff limit. Check for low battery or loose power terminal connections.

A2 Power Module #1			
Fault Code	Description	Level	Condition
2-021	M1 Main Broom Open	Non-Critical	The power module has detected an open circuit (amperage below 0.5A) to the respective motor. This could be the result of a disconnected wire at the motor or module, or it could be that the motor's brushes have worn beyond service.
2-022	M2 Dust Fan Open	Non-Critical	
2-023	M3 Side Brooms Open	Non-Critical	
2-024	M4 Vac 1 Open	Non-Critical	
2-025	M5 Vac 2 Open	Non-Critical	
2-026	M6 MB Act Open	Non-Critical	
2-027	M7 Dump Door Open	Non-Critical	
2-028	M8 Shaker Open	Non-Critical	
2-031	M1 Main Broom Overload	Non-Critical	The power module has detected the motor is operating above its established parameters (amperage above 70 amps). The most common cause for such an error is when the motor is experiencing an obstruction, binding, or under excessive load.
2-032	M2 Dust Fan Overload	Non-Critical	
2-033	M3 Side Brooms Overload	Non-Critical	
2-034	M4 Vac 1 Overload	Non-Critical	
2-035	M5 Vac 2 Overload	Non-Critical	
2-036	M6 MB Act Overload	Non-Critical	
2-037	M7 Dump Door Overload	Non-Critical	
2-038	M8 Shaker Overload	Non-Critical	
2-041	M1 Main Broom Overcurrent	Critical	The power module has detected that the amperage to the associated motor is beyond the limits of the power module (amperage above 160 amps). Possible causes for this could be short circuit or locked motor rotor.
2-042	M2 Dust Fan Overcurrent	Critical	
2-043	M3 Side Brooms Overcurrent	Critical	
2-044	M4 Vac 1 Overcurrent	Critical	
2-045	M5 Vac 2 Overcurrent	Critical	
2-046	M6 MB Act Overcurrent	Critical	The power module has detected that the amperage to the associated motor is beyond the limits of the power module (amperage above 25 amps). Possible causes for this could be short circuit or locked motor rotor.
2-047	M7 Dump Door Overcurrent	Critical	
2-048	M8 Shaker Overcurrent	Critical	

A2 Power Module #1			
Fault Code	**Description**	**Level**	**Condition**
2-051	M1 Main Broom Mosfet Short	Critical	The power module has detected that the output switching transistor for the respective motor is not switching off when expected. If the condition persists, the likely cause is that the power module has failed and needs replacement. • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
2-052	M2 Dust Fan Mosfet Short	Critical	
2-053	M3 Side Brooms Mosfet Short	Critical	
2-054	M4 Vac 1 Mosfet Short	Critical	
2-055	M5 Vac 2 Mosfet Short	Critical	
2-056	M6 MB Act Mosfet Short	Critical	
2-057	M7 Dump Door Mosfet Short	Critical	
2-058	M8 Shaker Mosfet Short	Critical	
2-061	M1 Main Broom Current Sensor	Non-Critical	The power module has detected unexpected results for the applicable output current sensor. If the motor appears to be operating correctly, the power module may be damaged. • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
2-062	M2 Dust Fan Current Sensor	Non-Critical	
2-063	M3 Side Brooms Current Sensor	Non-Critical	
2-064	M4 Vac 1 Current Sensor	Non-Critical	
2-065	M5 Vac 2 Current Sensor	Non-Critical	
2-066	OverTemp Cutoff	Critical	The power module internal temperature exceeded cutoff temperature
2-067	UnderTemp Cutoff	Critical	The power module internal temperature is below -40C
2-071	M1 Main Broom Overload Trip	Non-Critical	An existing overload condition (greater than 70 amps) has continued for a preset time period and the power module has shut down the load.
2-072	M2 Dust Fan Overload Trip	Non-Critical	
2-073	M3 Side Brooms Overload Trip	Non-Critical	
2-074	M4 Vac 1 Overload Trip	Non-Critical	
2-075	M5 Vac 2 Overload Trip	Non-Critical	
2-076	M6 MB Act Stall	Non-Critical	The motor current has exceeded the stall value (10 amps). The motor will not be operated in the stalled direction until it is first operated in the opposite direction.
2-077	M7 Dump Door Stall	Non-Critical	
2-078	M8 Shaker Stall	Non-Critical	
2-081	EEPROM Fault	Critical	EEPROM checksum error
2-082	PDO Timeout	Critical	Did not receive PDO message from the main controller in the timeout period
2-083	CAN Bus	Critical	Internal CAN Bus counter exceeded 128
2-084	Actuator Timeout	Critical	Internal master did not receive slave controller message in timeout period
2-086	OverTemp Cutback	Non-Critical	Internal temperature exceeded cutback temperature - output current will be reduced

A2 Power Module #1			
Fault Code	**Description**	**Level**	**Condition**
2-087	UnderTemp Cutback	Non-Critical	Internal temperature is below -25C - output current will be reduced
2-088	K2 Coil Open	Critical	The module has detected an open circuit at the K2 relay coil.
2-091	M1 Main Broom HW Fault	Critical	The power module's output is not working properly and all outputs are disabled and the K2 relay is opened. • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
2-092	M2 Dust Fan HW Fault	Critical	
2-093	M3 Side Brooms HW Fault	Critical	
2-094	M4 Vac 1 HW Fault	Critical	
2-095	M5 Vac 2 HW Fault	Critical	
2-096	Parameter Change	Critical	The module's output mode was improperly changed. Reset the machine.
2-097	M6 MB Act Current Sensor	Non-Critical	Current sensor has invalid value • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
2-098	M7 Dump Door Current Sensor	Non-Critical	
2-101	M8 Shaker Current Sensor	Non-Critical	
2-102	Thermal Sensor	Critical	Thermal sensor has invalid value • Cycle the machine power. If the condition persists, replace the power module.
2-103	K2 Coil Short	Critical	Main contactor coil or lead wire is shorted

System indicator 3, Power Module #2 Error Codes

A3 Power Module #2			
Fault Code	**Description**	**Level**	**Condition**
3-001	A3 PM 2 Timeout	Critical	The main controller is not receiving power module heartbeat messages
3-011	Precharge Fail	Critical	The precharge failed to charge the internal capacitor bank to the KSI voltage
3-012	K3 Overload	Critical	Main contactor coil current is higher than setting current (2 amps)
3-013	K3 Contact Weld	Critical	The power module is detecting power on the main incoming battery line, but the module is not commanding the relay to close.
3-014	K3 Contact Open	Critical	The power module commanded the K3 relay to close, but is not detecting power on the main incoming battery line.
3-017	OverVolt Cutoff	Critical	The DC capacitor bank voltage exceeded over-voltage cutoff limit. If the condition persists after a full system reset, the power module is likely at fault.

A3 Power Module #2			
Fault Code	**Description**	**Level**	**Condition**
3-018	UnderVolt Cutoff	Critical	The DC capacitor bank voltage dropped below under-voltage cutoff limit. Check for low battery or loose power terminal connections.
3-021	M11 Hopper Open	Non-Critical	The power module has detected an open circuit (amperage below 0.5A) to the respective motor. This could be the result of a disconnected wire at the motor or module, or it could be that the motor's brushes have worn beyond service.
3-022	M11 Hopper Open	Non-Critical	
3-023	M13 Ctr Brush Open	Non-Critical	
3-024	M14 Lt Brush Open	Non-Critical	
3-025	M15 Rt Brush Open	Non-Critical	
3-026	M16 Squeegee Open	Non-Critical	
3-027	M17 Deck Open	Non-Critical	
3-028	M18 SB Act Open	Non-Critical	
3-031	M11 Hopper Overload	Non-Critical	The power module has detected the motor is operating above its established parameters (above 70 amps). The most common cause for such an error is when the motor is experiencing an obstruction, binding, or under excessive load.
3-032	M11 Hopper Overload	Non-Critical	
3-033	M13 Ctr Brush Overload	Non-Critical	
3-034	M14 Lt Brush Overload	Non-Critical	
3-035	M15 Rt Brush Overload	Non-Critical	
3-036	M16 Squeegee Overload	Non-Critical	
3-037	M17 Deck Overload	Non-Critical	
3-038	M18 SB Act Overload	Non-Critical	
3-041	M11 Hopper Overcurrent	Critical	The power module has detected that the amperage to the associated motor is beyond the limits of the power module (160 amps). Possible causes for this could be short circuit or locked motor rotor.
3-042	M11 Hopper Overcurrent	Critical	
3-043	M13 Ctr Brush Overcurrent	Critical	
3-044	M14 Lt Brush Overcurrent	Critical	
3-045	M15 Rt Brush Overcurrent	Critical	
3-046	M16 Squeegee Overcurrent	Critical	The power module has detected that the amperage to the associated motor is beyond the limits of the power module (25 amps). Possible causes for this could be short circuit or locked motor rotor.
3-047	M17 Deck Overcurrent	Critical	
3-048	M18 SB Act Overcurrent	Critical	

A3 Power Module #2			
Fault Code	**Description**	**Level**	**Condition**
3-051	M11 Hopper Mosfet Short	Critical	The power module has detected that the output switching transistor for the respective motor is not switching off when expected. If the condition persists, the likely cause is that the power module has failed and needs replacement. • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
3-052	M11 Hopper Mosfet Short	Critical	
3-053	M13 Ctr Brush Mosfet Short	Critical	
3-054	M14 Lt Brush Mosfet Short	Critical	
3-055	M15 Rt Brush Mosfet Short	Critical	
3-056	M16 Squeegee Mosfet Short	Critical	
3-057	M17 Deck Mosfet Short	Critical	
3-058	M18 SB Act Mosfet Short	Critical	
3-061	M11 Hopper Current Sensor	Non-Critical	The power module has detected unexpected results for the applicable output current sensor. If the motor appears to be operating correctly, the power module may be damaged. • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
3-062	M11 Hopper Current Sensor	Non-Critical	
3-063	M13 Ctr Brush Current Sensor	Non-Critical	
3-064	M14 Lt Brush Current Sensor	Non-Critical	
3-065	M15 Rt Brush Current Sensor	Non-Critical	
3-066	OverTemp Cutoff	Critical	The power module internal temperature exceeded cutoff temperature
3-067	UnderTemp Cutoff	Critical	The power module internal temperature is below -40C
3-071	M11 Hopper Overload Trip	Non-Critical	An existing overload condition (above 70 amps) has continued for a preset time period and the power module has shut down the load.
3-072	M11 Hopper Overload Trip	Non-Critical	
3-073	M13 Ctr Brush Overload Trip	Non-Critical	
3-074	M14 Lt Brush Overload Trip	Non-Critical	
3-075	M15 Rt Brush Overload Trip	Non-Critical	
3-076	M16 Squeegee Stall	Non-Critical	The motor current has exceeded the stall value (10 amps). The motor will not be operated in the stalled direction until it is first operated in the opposite direction.
3-077	M17 Deck Stall	Non-Critical	
3-078	M18 SB Act Stall	Non-Critical	
3-081	EEPROM Fault	Critical	EEPROM checksum error
3-082	PDO Timeout	Critical	Did not receive PDO message from the main controller in the timeout period

A3 Power Module #2			
Fault Code	**Description**	**Level**	**Condition**
3-083	CAN Bus	Critical	Internal CAN Bus counter exceeded 128
3-084	Actuator Timeout	Critical	Internal master did not receive slave controller message in timeout period
3-086	OverTemp Cutback	Non-Critical	Internal temperature exceeded cutback temperature - output current will be reduced
3-087	UnderTemp Cutback	Non-Critical	Internal temperature is below -25C - output current will be reduced
3-088	K3 Coil Open	Critical	The module has detected an open circuit at the K3 relay coil.
3-091	M11 Hopper HW Fault	Critical	The power module's output is not working properly and all outputs are disabled and the K3 relay is opened. • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
3-092	M11 Hopper HW Fault	Critical	
3-093	M13 Ctr Brush HW Fault	Critical	
3-094	M14 Lt Brush HW Fault	Critical	
3-095	M15 Rt Brush HW Fault	Critical	
3-096	Parameter Change	Critical	The module's output mode was improperly changed.
3-097	M16 Squeegee Current Sensor	Non-Critical	Current sensor has invalid value • Disconnect the associated output and then cycle the machine power. If the condition persists, replace the power module.
3-098	M17 Deck Current Sensor	Non-Critical	
3-101	M18 SB Act Current Sensor	Non-Critical	
3-102	Thermal Sensor	Critical	Thermal sensor has invalid value
3-103	K3 Coil Short	Critical	Main contactor coil is shorted

System Indicator 4, Drive Controller Error Codes

A4 Drive Controller			
Fault Code	**Description**	**Level**	**Condition**
4-001	A4 Drive Ctrl Timeout	Critical	Main controller is not receiving drive controller heartbeat messages
4-100	Motor Short	Critical	The controller has detected a persistent short circuit in the power stage, and the motor output is disabled. This could be a motor phase-to-phase short or a phase-to-battery.
4-101	DC Bus Low	Critical	DC bus voltage is below predefined level. Check battery voltage and loose connections at battery.
4-102	DC Bus High	Critical	DC bus voltage is above predefined level. Possibly from high braking torque.
4-103	HW Overvolt	Critical	DC bus voltage is above level defined by hardware design. Possibly from high braking torque.
4-104	Precharge Fail	Critical	Capacitor bank charging error - DC bus voltage is below predefined level for predefined time
4-105	Motor OverTemp	Critical	Motor temperature is above 180 °C

A4 Drive Controller			
Fault Code	**Description**	**Level**	**Condition**
4-106	Ctrl OverTemp	Critical	Controller power stage temperature is above 110 °C
4-108	CAN Fault	Critical	CAN bus communication error, typically a timeout
4-109	Current Sensor	Critical	Current sensor offset is too high
4-111	High-Side Fault	Critical	High-side output short-circuit or over-current
4-112	K4 Contactor	Critical	K4 contactor coil output short-circuit or over-current
4-113	Motor OverCurrent	Critical	Motor rms current is too high
4-114	Sensor Supply Current	Critical	12V sensor supply current is too high or too low
4-115	Encoder Fault	Critical	Commutator encoder sensor speed is invalid
4-116	Encoder Open	Critical	Encoder feedback sensor chA or chB is open
4-117	Internal Supply	Critical	One of the internal supply values is invalid
4-118	Pwr Stg Watchdog	Critical	Power stage watchdog timeout
4-119	K4 Contact Weld	Critical	Main contactor weld fault - unexpected voltage at B+ input
4-121	Throttle Not Zero	Critical	Throttle position held outside of neutral at startup for longer than 5sec
4-122	Motor Speed High	Critical	Motor speed is too high
4-125	Motor Slip Speed	Critical	Motor slip-speed is invalid
4-126	Motor AC Current	Critical	Motor AC current is invalid
4-127	Motor Frequency	Critical	Motor frequency is above 599Hz
4-128	CPU Fault	Critical	Internal cpu fault or startup test failed
4-129	CPU EEPROM	Non-Critical	EEPROM checksum error
4-130	Ctrl Temp Sensor	Non-Critical	Controller power stage temperature sensor is open or short-circuited
4-131	Motor Temp Sensor	Non-Critical	Motor temperature sensor is open or short-circuited
4-214	K4 Contact Open	Critical	Main contactor output is open
4-224	Throttle Signal	Critical	Throttle pot value is out-of-range
4-227	Drive Enable Open	Critical	Drive enable signal from steering controller is open

System Indicator 5, Steering Controller Error Codes

A5 Steering Controller			
Fault Code	**Description**	**Level**	**Condition**
5-001	A5 Steer Ctrl Timeout	Critical	Main controller is not receiving steering controller pdo messages
5-100	Motor Short	Critical	Motor phase wiring short circuit
5-101	DC Bus Low	Non-Critical	DC bus voltage is below predefined level
5-102	DC Bus High	Non-Critical	DC bus voltage is above predefined level
5-103	HW Overvolt	Critical	DC bus voltage is above level defined by hardware design
5-104	Precharge Fail	Critical	Capacitor bank charging error - DC bus voltage is below predefined level for predefined time

A5 Steering Controller			
Fault Code	**Description**	**Level**	**Condition**
5-105	Motor OverTemp	Critical	Motor temperature is above 180degC
5-106	Ctrl OverTemp	Critical	Controller power stage temperature is above 110degC
5-107	TFD Fault	Critical	TFD sensor wires are open or there is an invalid value
5-108	CAN Fault	Critical	CAN bus communication error, typically a timeout
5-109	Current Sensor	Critical	Current sensor offset is too high
5-110	Application Fault	Critical	Internal test failed - possible proximity limit switch fault
5-111	High-Side Fault	Critical	High-side output short-circuit or over-current
5-112	K5 Contactor	Critical	Main contactor output short-circuit or over-current
5-113	Motor OverCurrent	Critical	Motor rms current is too high
5-114	Sensor Supply Current	Critical	12V sensor supply current is too high or too low
5-115	Encoder Fault	Critical	Encoder feedback sensor speed is invalid
5-117	Internal Supply	Critical	One of the internal supply values is invalid
5-118	Enable Drive Output	Critical	Enable drive output is open, short-circuited or has over-current
5-119	K5 Contact Weld	Critical	Main contactor weld fault - unexpected voltage at B+ input
5-120	Locked Rotor	Critical	Locked rotor test failed - motor speed is too low while motor rms current is too high
5-121	Power Stage Off	Critical	Controller power stage was unexpectedly turned off
5-123	Dynamic Ref Ratio	Non-Critical	Dynamic reference ratio value is invalid
5-124	Control Fault	Critical	Motor speed control has detected an error - speed or position control is faulty
5-125	Speed Cross Fault	Critical	Speed cross error - difference in main/supervisor speeds is invalid
5-126	Motor Limits	Critical	Motor speed/current/frequency is too high or invalid
5-127	Internal Comm	Critical	Internal communication error
5-128	CPU Fault	Critical	Internal cpu fault or startup test failed
5-129	CPU EEPROM	Non-Critical	EEPROM checksum error
5-130	Ctrl Temp Sensor	Non-Critical	Controller power stage temperature sensor is open or short-circuited
5-131	Motor Temp Sensor	Non-Critical	Motor temperature sensor is open or short-circuited

Device Output Dependencies

When troubleshooting machine devices, it is helpful to know under what conditions that device is normally permitted to operate. The table below lists these dependencies for each device in the machine.

Output Dependencies		
Output	**Dependencies**	**Comments**
Power Module Contactor K2	• Key Switch Input (KSI) is high • Communicating with Main Machine Controller	(Certain faults can turn this output off)
Power Module Contactor K3	• Key Switch Input (KSI) is high • Communicating with Main Machine Controller	(Certain faults can turn this output off)
Main Relay K1	• Key Switch Input (KSI) is high • No main relay fault.	
Dust Guard Pump and Solenoid Valve	• Dustguard enabled in Configuration Menu • Sweep system active • Positive throttle % value from Wheel Drive Controller • No main broom, side broom or DustGuard system faults • Hopper interlock switch closed • Not turned off by operator	This basically tracks the sweep system. Anything that inhibits sweep will inhibit dust guard.
Dust Fan Motor M2	• Hopper down • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • Hopper temp switch open (If installed and configured) • Positive throttle % value from Wheel Drive Controller • No main broom system faults • Not in Low Voltage Cut-out • Not shut off by operator pressing side broom button	Turns on automatically when sweep is started. If in neutral, the dust fan turns on automatically when the hopper is raised
Throttle 1	• No throttle output fault	
Throttle 2	• No throttle output fault	
Start Output	• No start output fault	
Ignition Output	• No ignition output fault	
Glow Plug Output	• No glow plug output fault	
Hydraulic Pump Motor (up)	• Not in Panel Test • Not in Output Test • No hopper output fault • Dump Door switch SW13 closed	If the dump door is open, it will be closed first, unless the hopper is already partially up.
Hydraulic Pump Motor (down)	• Not in Panel Test • Not in Output Test • No hopper output fault • Hopper Interlock Switch open	
Clutch High Pressure Pump	• "Menu" not active • No high pressure pump fault	

Output Dependencies		
Output	**Dependencies**	**Comments**
Horn H2	• Not in Panel Test • Not in Output Test • No horn output fault	
Backup Alarm H1	• Enabled in options menu • Opt: Applicable throttle % from Drive Controller • Opt: Hopper interlock switch SW6 open • No backup alarm output fault • Not in output test	The dependencies will vary based on which option is set for forward/reverse/hopper alarms.
Solution Valve L2	• Hopper down • Positive throttle % from Drive Controller • Opt: Negative throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No scrub, recovery or solution system faults • Recovery tank not full • Not in Low Voltage Cut-out	May be configured for solution on in reverse
Headlights	• No headlight fault • Not in output test menu	
Left Front Turn Lamp	• Enabled in Configuration menu • No Left Front turn lamp fault • Not in output test menu	
Right Front Turn Lamp	• Enabled in Configuration menu • No Right Front turn lamp fault • Not in output test menu	
Tail Lamps	• Enabled in Configuration menu • No tail light fault • Not in output test menu	
Left Rear Stop Lamp	• Enabled in Configuration menu • No stop lamp fault • Not in output test menu	
Right Rear Stop Lamp	• Enabled in Configuration menu • No stop lamp fault • Not in output test menu	
Vacuum Motor 1 or 2 - Recovery Mode	• Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	

Output Dependencies		
Output	**Dependencies**	**Comments**
Vacuum Motor 1 or 2 - Wand Mode	• Hopper down • E-Stop closed • Battery Interlock closed • No critical faults • No recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	
Center Brush Motor Left Brush Motor Right Brush Motor	• Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No scrub system or recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	
Deck Actuator - Up	• E-Stop switch closed • No Deck Actuator Fault	
Deck Actuator - Down	• Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No scrub system or recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	
Detergent Pump M19 Detergent Pump M20	• Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No scrub, solution, detergent or recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	
Extended Scrub Pump	• Extended Scrub enabled button pressed • Option "installed" • Extended Scrub level switch SW7 open (Tank not empty) • Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No scrub, solution, or recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	

Output Dependencies		
Output	**Dependencies**	**Comments**
Solution Pump	• Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No scrub, recovery or solution system faults • Recovery tank not full • Not in Low Voltage Cut-out	If solution in reverse is configured, any non-neutral throttle input will set.
Squeegee Actuator - Up	• E-Stop switch closed • No Squeegee Actuator Fault	
Squeegee Actuator - Down (Recovery Mode)	• Hopper down • Positive throttle % from Drive Controller • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • No recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	
Squeegee Actuator - Down (Wand Mode)	• Hopper down • E-Stop closed • Battery Interlock closed • No critical faults • No recovery system faults • Recovery tank not full • Not in Low Voltage Cut-out	
Steering Contactor K5	• Key Switch Power input • No fault that would cause it to intentionally turn off	
Steering Motor	• No steering fault condition	
TFD Output	• No steering fault condition	
Enable Drive J6-4	• Steering system checks ok including finding home position	
Main Broom Motor M1	• Hopper down • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • Hopper temp switch open (If installed and configured) • Positive throttle % from Drive Controller • No main broom system faults • Not in Low Voltage Cut-out	

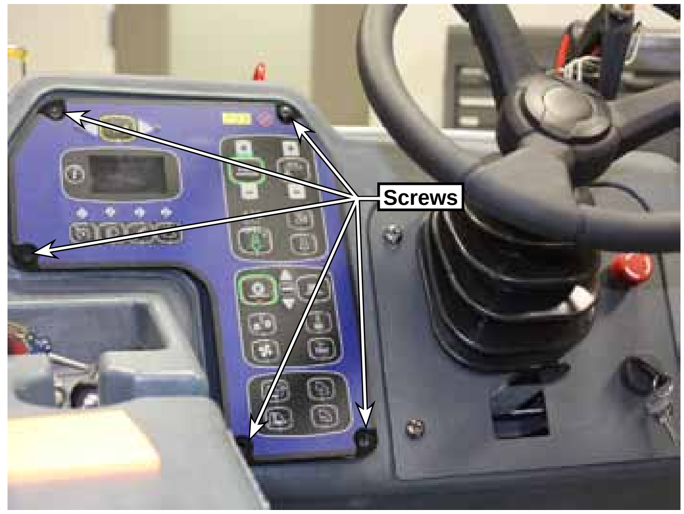
Output Dependencies		
Output	**Dependencies**	**Comments**
Side Broom Motors	• Hopper down • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • Hopper temp switch open (If configured) • Positive throttle % from Drive Controller • No main broom or side broom system faults • Not in Low Voltage Cut-out • Not turned off by operator	
Main Broom Actuator - Down	• Hopper down • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • Hopper temp switch open (If configured) • No main broom system faults • Not in Low Voltage Cut-out	Adjustment set point properly set to lower broom to floor
Main Broom Actuator - Up	• E-Stop closed • No actuator fault	
Dump Door Actuator - Open (Manual Operation)	• Hopper interlock switch open • Dump door position voltage above Dump Door Open V in Configuration menu • No dump door actuator fault	
Dump Door Actuator - Open (Automatic Operation)	• Dump door position voltage above Dump Door Open V in Configuration menu • No dump door actuator fault • Sweep system active (for manual operation)	Open the door until the pot voltage is below a "set point" (Dump Door Open V in Configuration menu)
Dump Door Actuator - Close (Manual Operation)	• Dump Door close switch SW13 is open • Hopper interlock switch is open	
Dump Door Actuator - Close (Automatic Operation)	• Dump Door close switch SW13 is open • No dump door actuator fault	
Shaker Motor (Manual Operation)	• Hopper interlock switch closed • Not in output test • Not in panel test • No shaker motor fault	
Shaker Motor (Automatic Operation)	• Had to have been sweeping • Hopper interlock switch closed • No shaker motor fault	The shaker should start automatically whenever you stop sweeping and run for a time. The operator can manually override and turn it off.
Side Broom Actuator - Up	• E-Stop closed • No side broom actuator fault	

Output Dependencies		
Output	**Dependencies**	**Comments**
Side Broom Actuator - Down	• Hopper down • Seat switch closed • E-Stop closed • Battery Interlock closed • No critical faults • Hopper temp switch open (If configured) • No main broom or side broom system faults • Not in Low Voltage Cut-out	Adjustment set point properly set to lower broom to floor
Wheel Drive Contactor K4	• Drive Controller active	
Wheel Drive Motor	• Enable Drive input from the steering controller • No fault condition that would shut it down • Drive Pedal Position Sensor input outside of neutral dead band range • E-stop, battery interlock, and seat switch closed.	

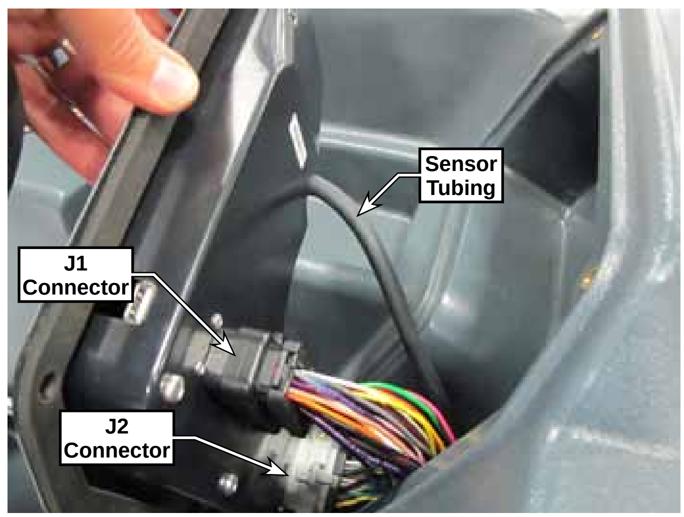
Removal and Installation

Main Machine Controller

1. Disconnect the main battery connector.
2. Begin draining the solution tank. The tank must be empty when reconnecting the pressure sensor tubing during reassembly. You can continue disassembly while the tanks drains.
3. Remove the 5 control panel mounting screws.



4. Pull control panel forward and disconnect the 2 electrical connectors.
5. Carefully remove the sensor tubing from the back of the control board Take care to not damage the integrated circuit chip on the circuit board.
6. Before reconnecting the sensor tubing, make sure the solution tank is empty. If the tubing is connected when the tank is full, the pressure reported to the sensor will be too low.



Specifications—Shop Measurements

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. These measurements were taken from a single machine, and may vary from machine to machine.

Main Machine Controller

J1 Connector

J1 Pin	Wire	Circuit Description	Value/Condition	Comments
1	GRY-BLU	Throttle 1	Idle - 0 V Low - 12.2 V High - 12.2 V	Throttle 1 and Throttle 2 function similar to a 2-bit binary number to give 3 states from 2 wires.
2	GRY-ORN	Throttle 2	Idle - 0 V Low - 0 V High - 12.2 V	
3	WHT-ORN	Hyd. Clutch	11.6 V on	
4	ORN-BLK	Glow Plug output	Estimate +12V	Not available on test machine
5	BRN	Headlights	36.7 V off 0.87 V on	
6	YEL-BRN	VACC1	38.1 V key off or on	Battery voltage. Always present.
7	PNK	Ignition output	12.1 V Key on	Engine Run signal
8	YEL-ORN	L2 Solution Valve	37.8 V off 0.87 V on	
9	BLU-PNK	Start output	11.7 V Cranking	
10	GRY-ORN	E-Stop input	37.9 V Closed 0 V Open	
11	BRN-BLU	Battery Interlock input	37.8 V Closed 0 V Open	
12	PNK	Seat Switch input	37.8 V Closed 0 V Open	
13	VIO-RED	12V Input	12.1 V	Engine Battery
14	WHT-YEL	M23 Detergent pump	12.4 V off Pulse On	The detergent pumps operate on a pulse-DC which alternates positive to negative with each stroke of the solenoid. The two pumps operate out of phase, where one is positive when the other is negative.
15	BLU-YEL	M23 Detergent pump		
16	WHT-RED	M24 Detergent pump		
17	BLU-RED	M24 Detergent pump		
18	GRN-BRN	H1 Backup Alarm	36.22 V off 0.57 V on	
19	BLK-ORN	K1 Main Relay Control	38.1 V off 0.6 V on	
20	YEL-RED	LT6 Right Front Turn	Estimated 12V off 0V on	Not available on test machine
21	VIO-GRN	Start Input	37.9 Key in start position	

J1 Pin	Wire	Circuit Description	Value/Condition	Comments
22	GRY	Run Signal input	4.5 V Key on 0.018 Engine Running	Signal from engine controller. The run signal is active low for the LEV engine but all the other engines the run signal is high (+12V).
23	ORN	KSI (Key Switch Input)	37.9 V Key on	
24	TAN-RED	Tail lamp control	Estimated 12V off 0V on	Not available on test machine
25	ORN-YEL	LT5 Left Front Turn	Estimated 12V off 0V on	Not available on test machine
26	BRN-RED	M1 and L1 Dust Guard	37.8 V off 0.11 V on	
27	BLK	Battery Negative Power	0.001 V	
28	RED-YEL	M22 Solution Pump	37.8 V off 0.12 V on	
29	VIO	VACC2	37.9 V Key on	Positive battery power through the K1 relay
30	GRY-ORN	VACC2	37.9 V Key on	
31	ORN-BLU	LT9 Left Rear Turn/ Stop Lamp control	Estimated 12V off 0V on	Not available on test machine
32	YEL-GRN	LT10 Right Rear Turn/ Stop Lamp control	Estimated 12V off 0V on	Not available on test machine
33	VIO-ORN	M19 Extended Scrub Pump	27.8 V off 0.06 V on	
34	BLK	Battery Negative Power	0.001 V	
35	VIO-BRN	H2 Horn	37.8 V off 0.12 V on	

J2 Connector

J2 Pin	Wire	Circuit Description	Value/Condition	Comments
1	YEL-BRN	CAN 0 High	2.79 V	
2	GRN	CAN 0 Low	2.30 V	
3	BLK	Battery Negative Power	0.001 V	
4	BLU-BLK	Sensor Ground	0.001 V	
5				
6	BLK	Battery Negative Power	0.001 V	
7	GRY-GRN	3.3V sensor supply	2.89 V	
8	WHT-GRN	Dust Control Filter	4.7 V open 0.001 V closed	(Closes when filter is dirty)
9	ORN-GRY	Brake Switch input	5.7 V open 0.001 V closed	(Closes when pedal is at rest)
10	GRY-YEL	Extended Scrub Level	5.1 V open 0.001 V closed	(Closes When tank is empty)
11	GRN-WHT	CAN 1 Low	2.53 V	
12	YEL/WHT	CAN 1 High	2.61 V	
13	GRY-VIO	Hopper Interlock	5.7 V open 0.001 V closed	(Closes when hopper is down)
14	YEL-VIO	Hopper Fire Switch	4.9 V open	(Closes at 140 degrees F.)
15	GRN-YEL	Coolant Temp input	4.7 V	ECU output 3. The input is active-low, and will be pulled to ground for an over-temp condition
16	YEL-RED	Oil Pressure input	5.2 V Engine off or running	ECU output 2 (LEV engine only). Active-low input which will be pulled to ground if the oil pressure is low while the engine is running.
17	ORN-RED	Dump Door Position	0.91 V door closed 0.19 V door open	Analog input from actuator
18	GRN-ORN	Dump Door Closed	4.9 V open 0.001 V closed	(Closes when door is closed)
20	TAN-RED	MIL input	12.2 V no MIL 0.03 V MIL	Malfunction Indicator Lamp, a.k.a. Check engine light
21	BLK-YEL	12V output for exterior lamps	12.01 V	
22	TAN-RED	Main Broom Position Sensor	2.50 V up 1.23 V down	Analog input from actuator
23	TAN-WHT	Fuel Level input	3.28 V	LPG with pressure

Power Modules

A2 Power Module 1

For clarity, some outputs listed in the table are out of sequence so that related functions can be grouped together for those motors using 2-pin outputs.

Pin	Wire	Circuit Description	Value/Condition	Comments
J3- 1	ORN-BLK	M7 Dump Door Actuator	Close - 3.4 V Rest - 1.1 V Open - 35.1	Motor function controlled by voltage difference between J3-1 and J3-6. Close: P1 to P6 = B+ Open: P1 to P6 = B- Rest: P1 to P6 = same (0V)
J3- 6	ORN-GRY	M7 Dump Door Actuator	Close - 38 V Rest - 1.1 V Open - 0.05 V	
J3- 2	BRN-BLU	K2 Coil	0.84 V on	
J3- 3	GRN-WHT	CAN 0 Low	2.3 V	
J3- 4	YEL-WHT	CAN 0 High	2.79 V	
J3- 5	ORN-YEL	Curtis Programmer	15.7 V	
J3- 7	ORN-VIO	Curtis Programmer	0.001 V	
J3- 8	ORN-WHT	Curtis Programmer	0.04 V	
J3- 9	ORN	KSI	38.14 V	(Key Switch Input)
J3- 10	BLU-GRY	M8 Shaker Motor	35+ volts	Pulses positive voltage on and off
J3- 11	ORN-RED	M8 Shaker Motor	0.01	Negative side is constant
J3- 12	BLK	Battery Negative (Low Power)	0.003 V	One vacuum motor running
J3- 13	TAN-VIO	M6 Main Broom Actuator	Up - 15.5 V Rest - 1.1 V Down -22.4 V	Motor function controlled by voltage difference between J3-13 and J3-14. Up: P13 to P14 = B- (PWM) Down: P13 to P14 = B+ (PWM) Rest: P13 to P14 = same (0V)
J3- 14	BLK-GRY	M6 Main Broom Actuator	Up - 0.01 V Rest - 1.1 V Down - 38.1 V	
Lug- B-	BLK	Battery Negative (High Power)	0.006 V	One vacuum motor running
Lug- B+	BLU-GRY	Battery Positive (High Power)	38.26 V	
Lug- M1	WHT-VIO	M1 Main Broom Motor	38.2 V off 5.9 V on	PWM to Ground
Lug- M2	BRN-YEL	M2 Dust Fan Motor	38.0 V off 0.03 V on	
Lug- M3	WHT-BRN	M3 L &R Side Broom Motors control	38.1 V off 5.9 V on	PWM to Ground
Lug- M4	GRY-RED	M4 Vacuum Motor 1 control	38.1 V off 5.9 V on	PWM to Ground
Lug- M5	ORN-BLU	M5 Vacuum Motor 2 control	38.1 V off 5.9 V on	PWM to Ground

A3 Power Module 2

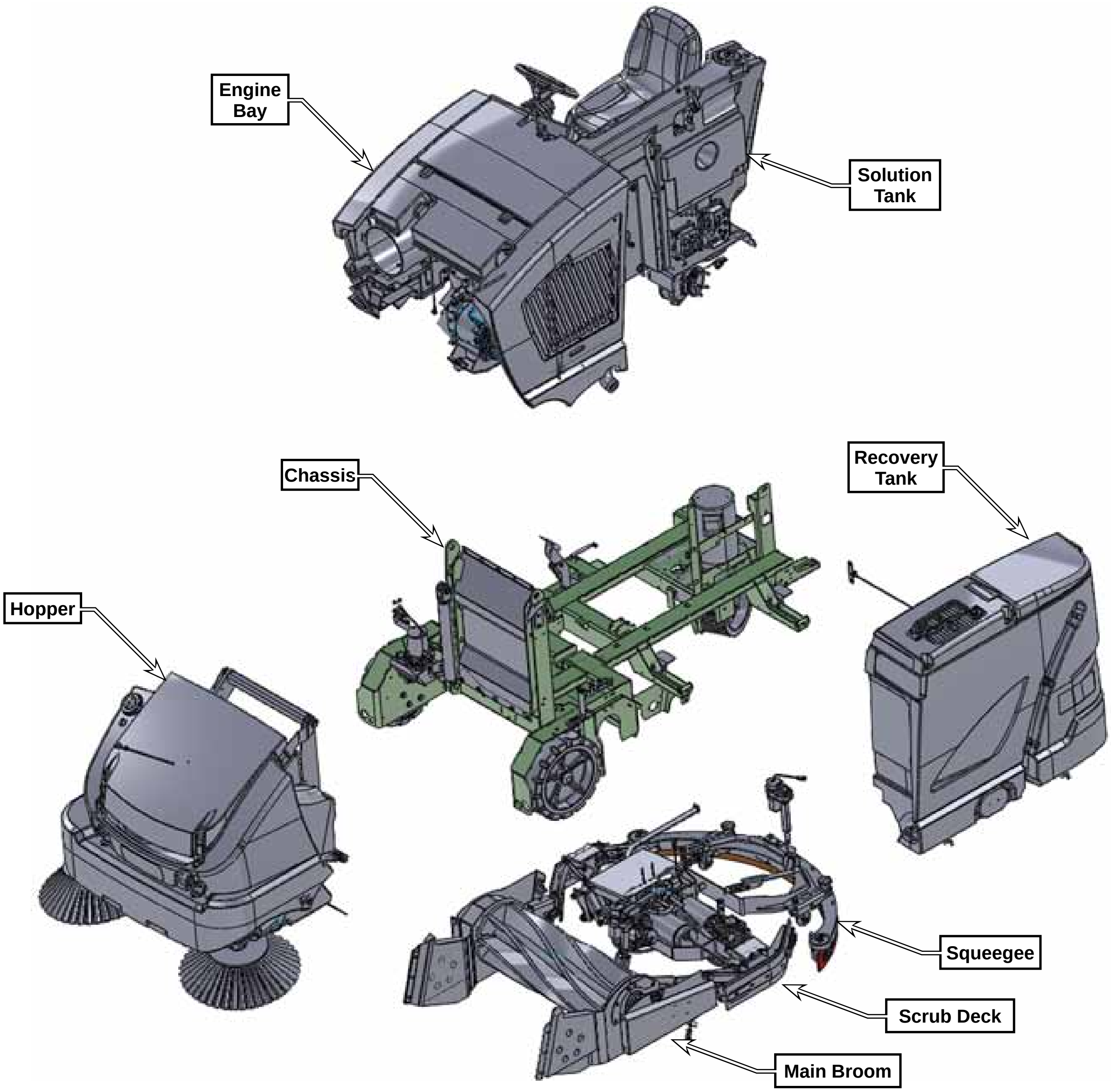
For clarity, some outputs listed in the table are out of sequence so that related functions can be grouped together for those motors using 2-pin outputs.

Pin	Wire	Circuit Description	Value/Condition	Comments
J4- 1	GRN-VIO	M17 Deck Actuator Motor	“Up - 22.5 V Rest - 1.1 V Down - 15.6 V”	Motor function controlled by voltage difference between J4-1 and J4-6. Up: P1 to P6 = B+ (PWM) Down: P1 to P6 = B- (PWM) Rest: P1 to P6 = same (0V)
J4- 6	RED-GRY	M17 Deck Actuator Motor	“Up - 37.0 V Rest - 1.0 V Down - 0.02 V”	
J4- 2	BRN-GRN	K3Coill	11.6 V on	
J4- 3	GRN-WHT	CAN 1 Low	2.53 V	
J4- 4	YEL-WHT	CAN 1 High	2.60 V	
J4- 5	PNK-YEL	Curtis Programmer	15.8 V	
J4- 7	PNK-VIO	Curtis Programmer	0.001 V	
J4- 8	PNK-WHT	Curtis Programmer	0.042 V	
J4- 9	ORN	KSI	37.9 V	(Key Switch Input)
J4- 10	RED-BRN	M18 Side Broom Actuator	“Up - 20.5 V Rest - 1.1 V Down - 15.5 V”	
J4- 11	TAN-BLU	M18 Side Broom Actuator	“Up - 37.1 V Rest - 1.0 V Down - 0.01 V”	
J4- 12	BLK	Battery Negative (Low Power)	0.004 V	With hopper moving up
J4- 13	VIO-BLU	M16 Squeegee Actuator	“Up - 5.7 V Rest - 1.4 V Down - 32.3 V”	Motor function controlled by voltage difference between J4-13 and J4-14. Up: P13 to P14 = B- (PWM) Down: P13 to P14 = B+ (PWM) Rest: P13 to P14 = same (0V)
J4- 14	BRN-WHT	M16 Squeegee Actuator	“Up - 37.9 V Rest - 1.0 V Down - 0.03 V”	
Lug B-	BLK	Battery Negative	0.01 V	With hopper moving up
Lug B+	GRN-GRY	Battery Positive	38.43 V	
Lug M1	WHT-BLK	M11 Hydraulic Pump	“Up - 37.7 V Rest - 37.8 V Down - 0.02 V”	Motor function controlled by voltage difference between Lug M1 and Lug M2. Up: M1 to M2 = B- Down: M1 to M2 = B+ Rest: M1 to M2 = same (0V)
Lug M2	BLU-ORN	M11 Hydraulic Pump	“Up - 0.06 V Rest - 37.7 V Down - 37.9 V”	
Lug M3	BLU-WHT	M13 Center Brush Disc	“Off - 38.14 V On 87% - 5.9 V On 100% - 0.04 V”	
Lug M4	BLU-GRN	M14 Left Brush Disc	“Off - 38.1 V On 87% - 6.3 V On 100% - 0.04 V”	
Lug M5	GRY-BLK	M15 Right Brush Disc Motor control	“Off - 38.1 V On 87% - 6.3 V On 100% - 0.04 V”	

10 - Chassis System

Functional Description

The chassis is the primary backbone of the machine that all other systems attach.

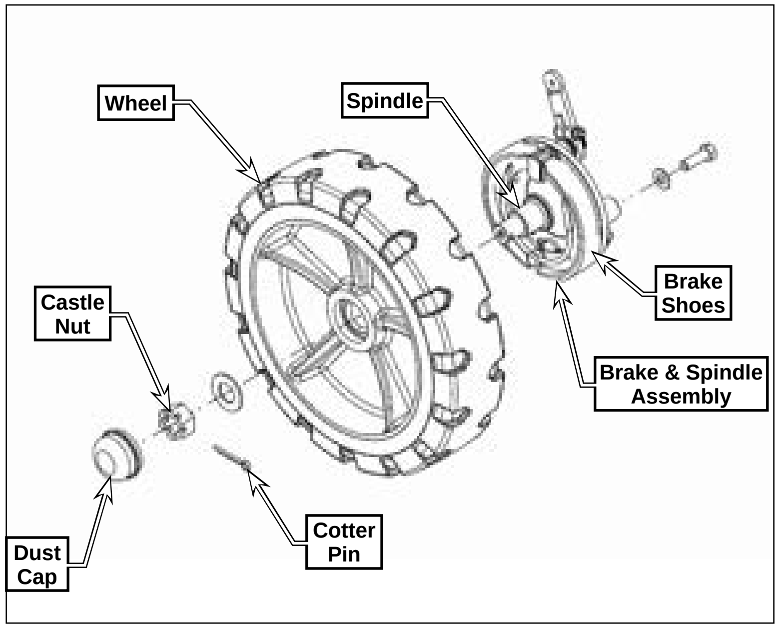


14 - Wheel System, Non-Traction

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.

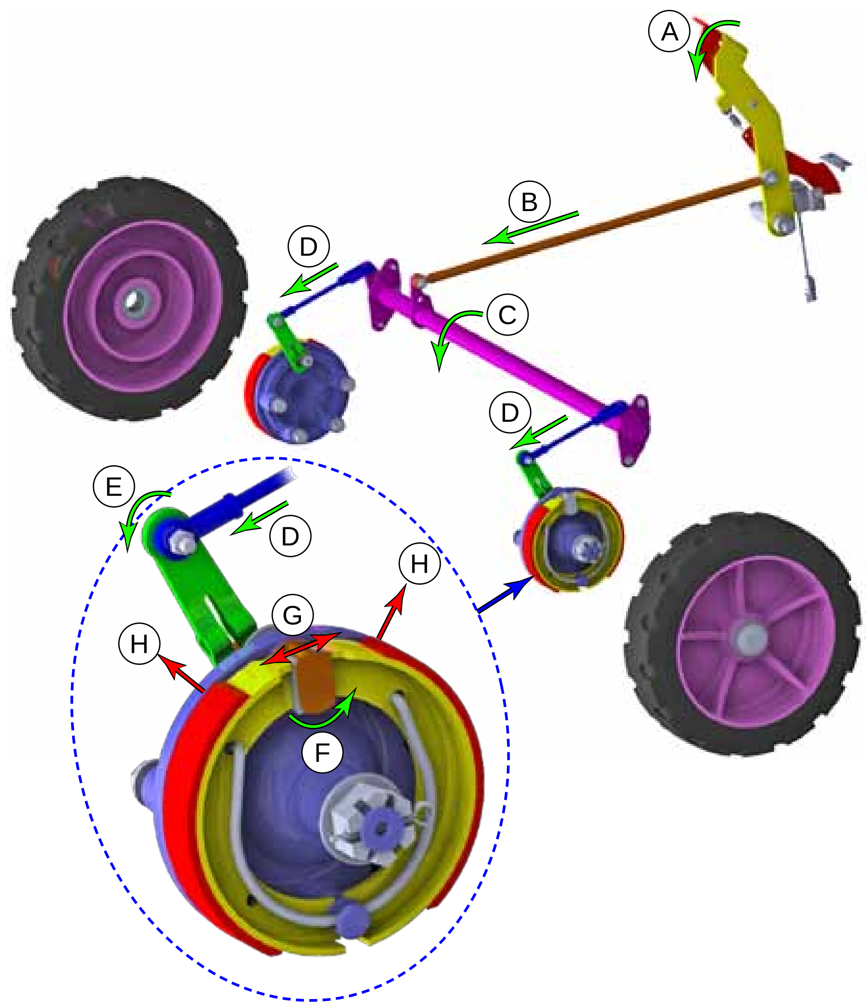
The wheels are held onto the spindles with castle nuts and cotter pins. The brake and spindle assemblies are fastened to the machine frame with 1/2”-20 hex screws.



The braking system is a latching drum brake, which serves as both the primary brake, as well as the parking brake, when latched. The brakes are actuated with a mechanical link from the operator’s foot pedal back to the brake shoes.

When the brake pedal is depressed **(A)**, the brake rod is moved forward **(B)**, which causes the brake bar to rotate **(C)** about its axis. This in turn causes the actuator lever **(D)** to rotate the brake cam **(F)**.

It is the brake cam that pushes outward **(G)** against the brake shoes, which presses against **(H)** the inside of the drum of the wheel.



Maintenance and Adjustments

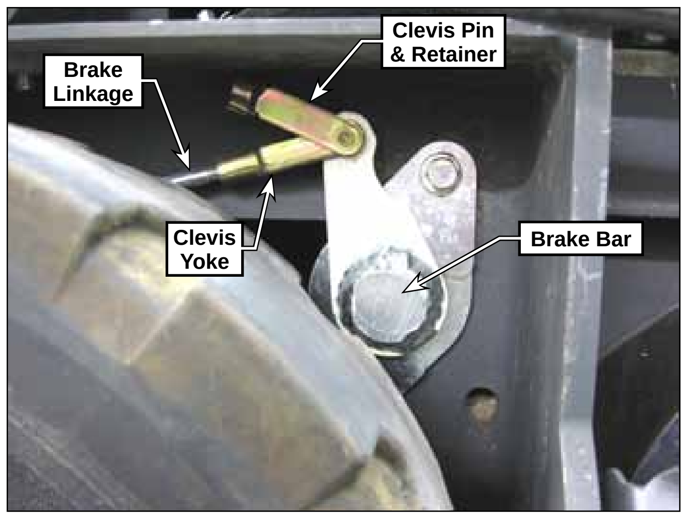
Adjust the Brakes

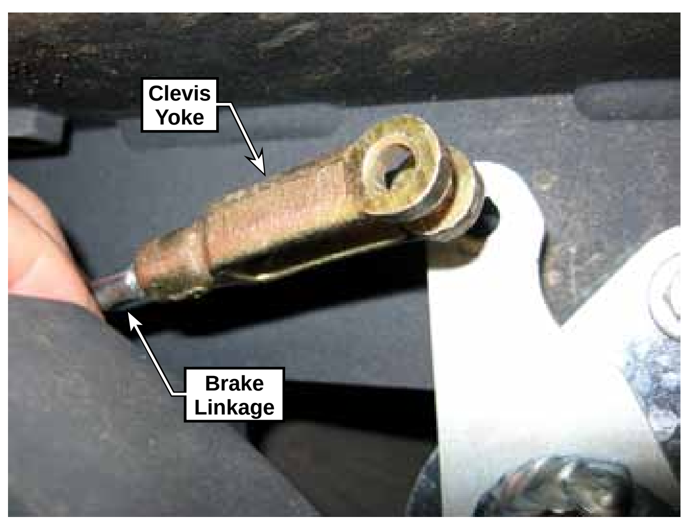
As the brake shoe lining wears, it requires greater travel from the shoes to press firmly against the drums in the wheels. When properly adjusted, the brakes should be fully released when the brake pedal is in the relaxed position, and the brakes should be firmly engaged before the brake pedal reaches the bottom of its travel limit.

1. Raise the front of the machine just enough to lift the wheels clear of the ground, and support it with appropriate jack stands.
2. Remove the two engine side panels to expose the brake linkage and yokes.
3. Gradually depress the parking brake pedal (latch) until slight resistance is observed on one of the wheels. This should represent when the brake shoes are just beginning to contact the drum.
4. Compare the brake resistance for both right and left wheels to turn, and adjust the brake linkage as necessary (described below) so they feel equal. This will become your starting point to ensure both left and right brakes are acting equally.
5. Fully depress the brake pedal to check for sufficient movement, and that the brake pedal stops before reaching its bottom limit. The amount of pedal travel is subjective, but if the brakes are fully engaged when the pedal is about halfway is typical.

Adjustment

6. Rotate the clevis pin retainer off the yoke, and remove the clevis pin.
7. While counting the number of turns, tighten or loosen the yoke on the brake linkage rod.
   - Unscrew the yoke to increase braking force.
   - Tighten the yoke to decrease braking force.
8. Adjust the other brake yoke by the same number of turns to keep both right and left brakes operating equally.





Troubleshooting

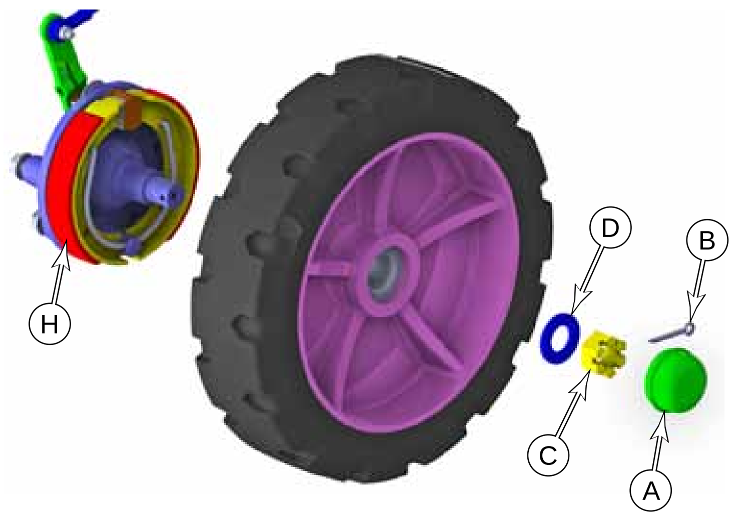
Problem	Cause	Correction
The wheels are making excess noise.	The wheel bearings worn.	Check the wheel, wheel bearings, and brake and spindle assembly and replace as required.
	The wheel and/or brake and spindle assembly are damaged.	
The brakes are not working correctly.	The brakes are out of adjustment	Adjust the brakes.
	The brake linings are worn out.	Replace the brake linings.

Removal and Installation

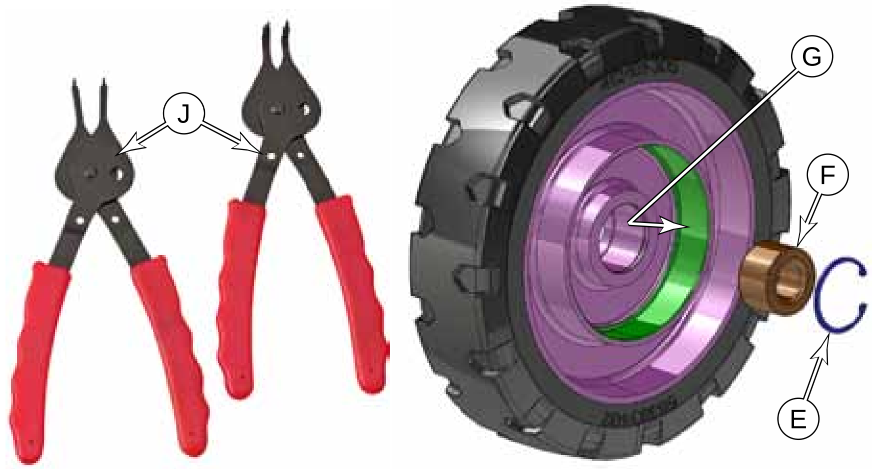
Wheel
Wheel Bearing

Regardless whether the procedure is being completed to replace a wheel versus a bearing, both right and left sides should be completed together. Replacing only 1 wheel can result in adverse brake wear if the brake drums are not equal.

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.



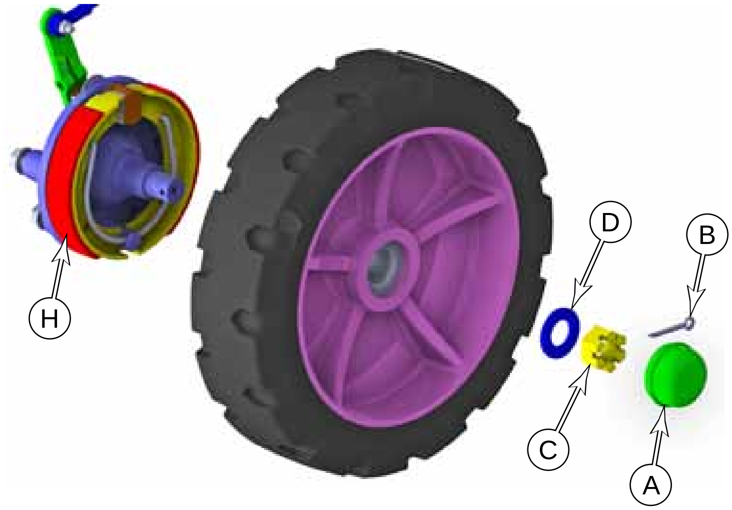
1. Jack the front of the machine enough to raise the front wheels slightly off the ground, and place jack stands under the machine for safety.
2. Using a sharp-edged tool, carefully work the dust cap **(A)** loose from the wheel. Take care not to damage or deform the cap.
3. Remove the cotter pin **(B)** from the castle nut **(C)**, and remove the nut, washer **(D)**, and wheel from the axle spindle.
4. Using a retaining ring pliers **(J)**, remove the retaining ring **(E)** from the wheel hub, and remove the bearing **(F)**.
5. Before replacing the wheel, inspect the brake linings **(H)** and the drum surface **(G)** for excessive wear.
6. During replacement, tighten the castle nut **(C)** enough to be slightly snug, and then continue turning enough to insert the cotter pin **(B)** through the shaft.
7. If the wheels have been replaced, inspect the Brake adjustment described on page 71



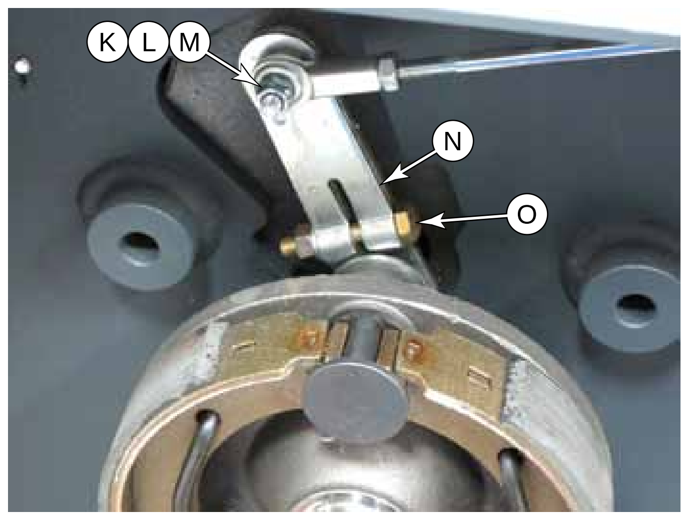
Brake and Spindle Assembly

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.

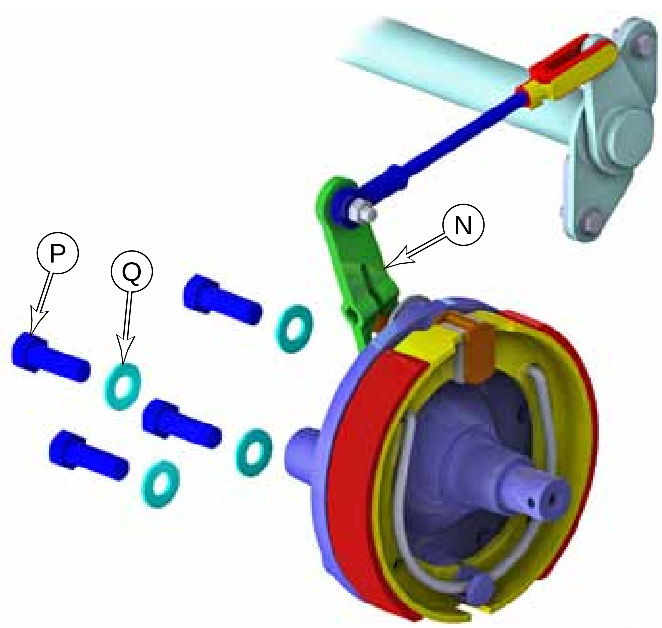
1. Jack the front of the machine enough to raise the front wheels slightly off the ground, and place jack stands under the machine for safety.
2. Using a sharp-edged tool, carefully work the dust cap **(A)** loose from the wheel. Take care not to damage or deform the cap.
3. Remove the cotter pin **(B)** from the castle nut **(C)**, and remove the nut, washer **(D)**, and wheel from the axle spindle **(K)**.



4. Remove the nut **(K)**, 2 washers **(L)**, and bolt **(M)** that secure the brake linkage to the brake actuator arm **(N)**, and remove the linkage.
5. Remove the four bolts **(P)** and washers **(Q)** that secure the brake assembly to the machine frame, and remove the assembly.



6. Compare the old and new brake assembly to ensure that the brake actuator lever **(N)** is in the same position. If not, loosen the clamping screw **(O)**, remove the lever from the splined shaft, and reinstall it in the correct angular position.
7. Install the new spindle assembly.
8. Before reinstalling the wheel, inspect the drum surface for wear, and the wheel bearing for proper movement.
9. After replacing both brake assemblies, Adjust the Brakes described on page 71.



20 - 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, remotely commutated 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

InMotion Drive Controller

Drive Wheel Motor

Gearbox and Drive Wheel

Drive Motor

The drive motor is a 3-phase, remotely commutated, AC induction motor; which is commonly referred to as a brushless DC motor. Even though it is an AC motor, it is powered from a controlled DC power source that simulates AC power. Each of the 3 motor windings is sequentially energized with either zero-volts, positive battery voltage, or inverted battery voltage. This creates a rotating magnetic field in the windings just like a normal 3-phase AC motor.

Unlike a normal AC motor that just receives blind AC power at a given frequency, the drive motor functions as a servo-motor, in that the motor provides positional feedback back to the motor driver for the actual rotor position. This is referred to as remotely commutated. Two encoders inside the motor report the actual rotational position of the rotor back to the controller. This permits the driver to know which of the 3 windings needs to be energized to rotate the motor in the desired direction, and even position. This type of motor can literally be rotated a fraction of a turn and stopped, if desired.

The motor also reports its operational temperature back to the motor driver. This is a protection feature to prevent motor damage due to excessive heat. The drive controller can either reduce power to the motor, or if severe enough, shut down the motor.

Drive Pedal Potentiometer

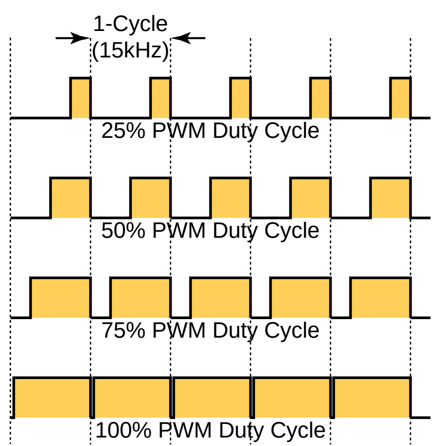
The drive pedal potentiometer is a variable resistor connected to the Pin J5--20 input of the drive controller, with pins J5--31 and J5--32 as reference voltages. As the resistance changes, the drive controller increases or decreases drive motor speed.

The drive pedal is set up in what's called a wig-wag configuration, where drive direction is controlled by a single potentiometer. When the throttle potentiometer is in the center position, the wiper voltage is approximately 2.8 volts. The speed controller interprets any voltage between 2.3V and 3.3V as neutral and the output to the motor will be zero. Forward or Reverse movement of the drive pedal rotates the potentiometer shaft and the wiper voltage is increased for forward travel, or decreased for reverse travel. The magnitude of the voltage difference away from the neutral point also determines the speed that the motor will be driven.

To allow for minor variation in the pedal returning to the neutral position, the drive controller establishes a deadband around the 2.8-volt center. This results in a plus/minus range of voltages where the controller assumes the pedal is still in the neutral position. The deadband for this drive controller (2.3 to 3.3 V) is set in the machine's firmware, and is not adjustable.

Drive Controller

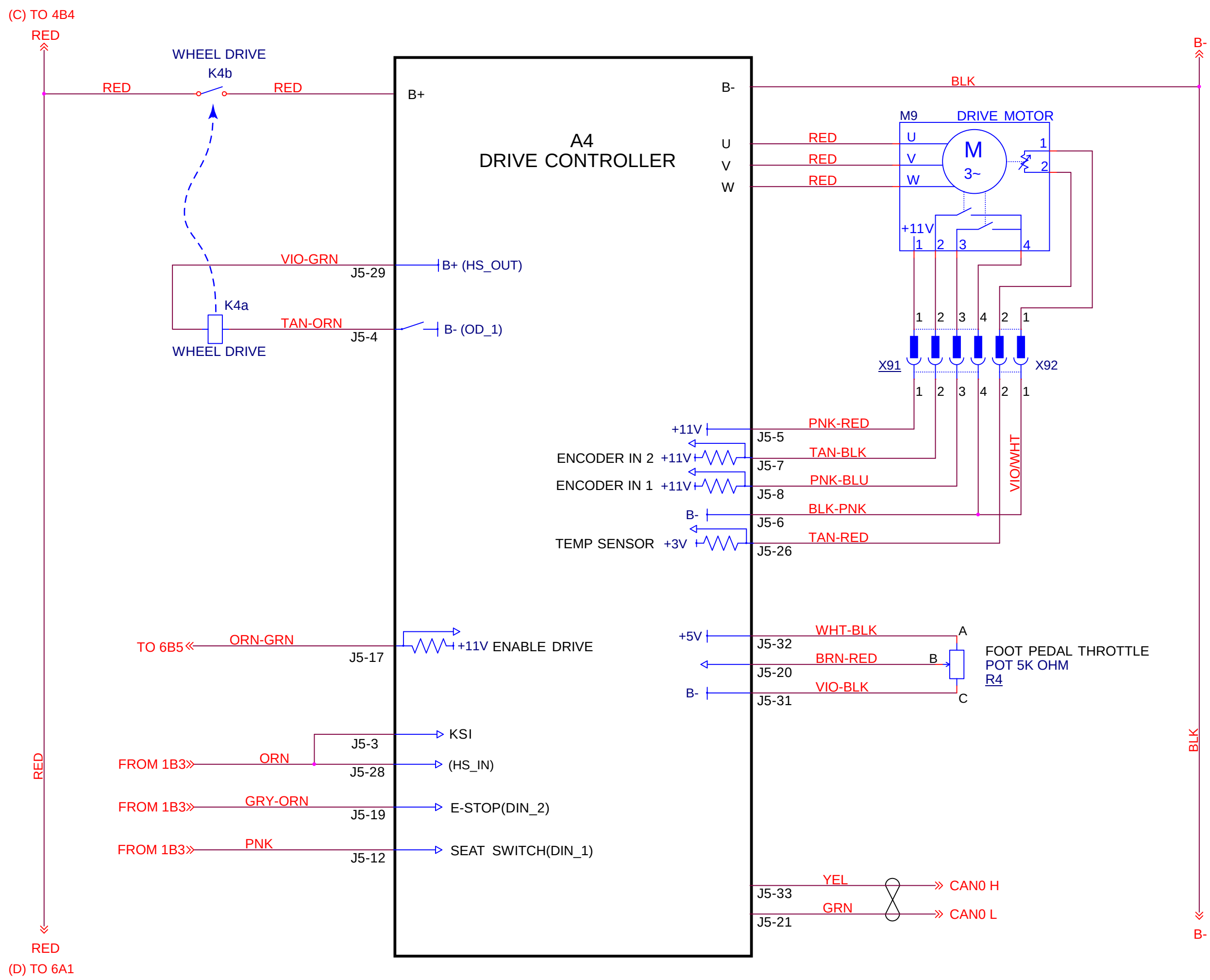
The drive motor is controlled from an InMotion AC Superdrive controller, which is an AC induction motor controller for battery operated equipment. The controller generates a square wave, 3-phase, pulse-width-modulated output to the motor. The speed controller is designed specifically for DC motors with remote commutation. Pulse-width-modulation (PWM) is a form of motor speed control that alters the power to a motor by rapidly turning the power on and off. The ratio (also called "duty cycle") between the On and Off states determines how much power the motor receives. The shorter the "off-time" the closer to full power the motor will receive. This switching occurs so fast (between 4 and 16kHz for this controller) that the motor simply sees it as a reduction in power (voltage) instead of the rapid on/off. PWM is a standard motor control technique because it is easier to turn power all the way on and all the way off, than it is to vary the magnitude of the power. Varying the magnitude would create a lot of heat that would need to be dissipated.



Another unique aspect of the drive controller compared to other PWM motor controllers in the system, is that the wheel drive motor requires remote commutation. Mechanical commutation happens with motor brushes in other motors. For remote commutation, the controller needs to know what the actual internal rotational position of the rotor is inside the motor.

The drive motor contains a pair of encoders that tell the drive controller what the rotational position is of the rotor. The drive controller uses this information to determine which phase outputs should be energized.

Circuit Description



Powering up the Drive Controller

The KSI input is the primary control power for the drive controller. This originates from the keyswitch input when the vehicle key is in the on position. The drive controller is also enabled/disabled by the interlock and seat switch inputs. If either of these inputs is open-circuit, the drive controller is disabled. When closed, they provide positive battery signals to the controller.

When the drive controller is active, it energizes the coil of the K4 relay, which in turn provides high-current power to the controller for motor output.

CAN Bus

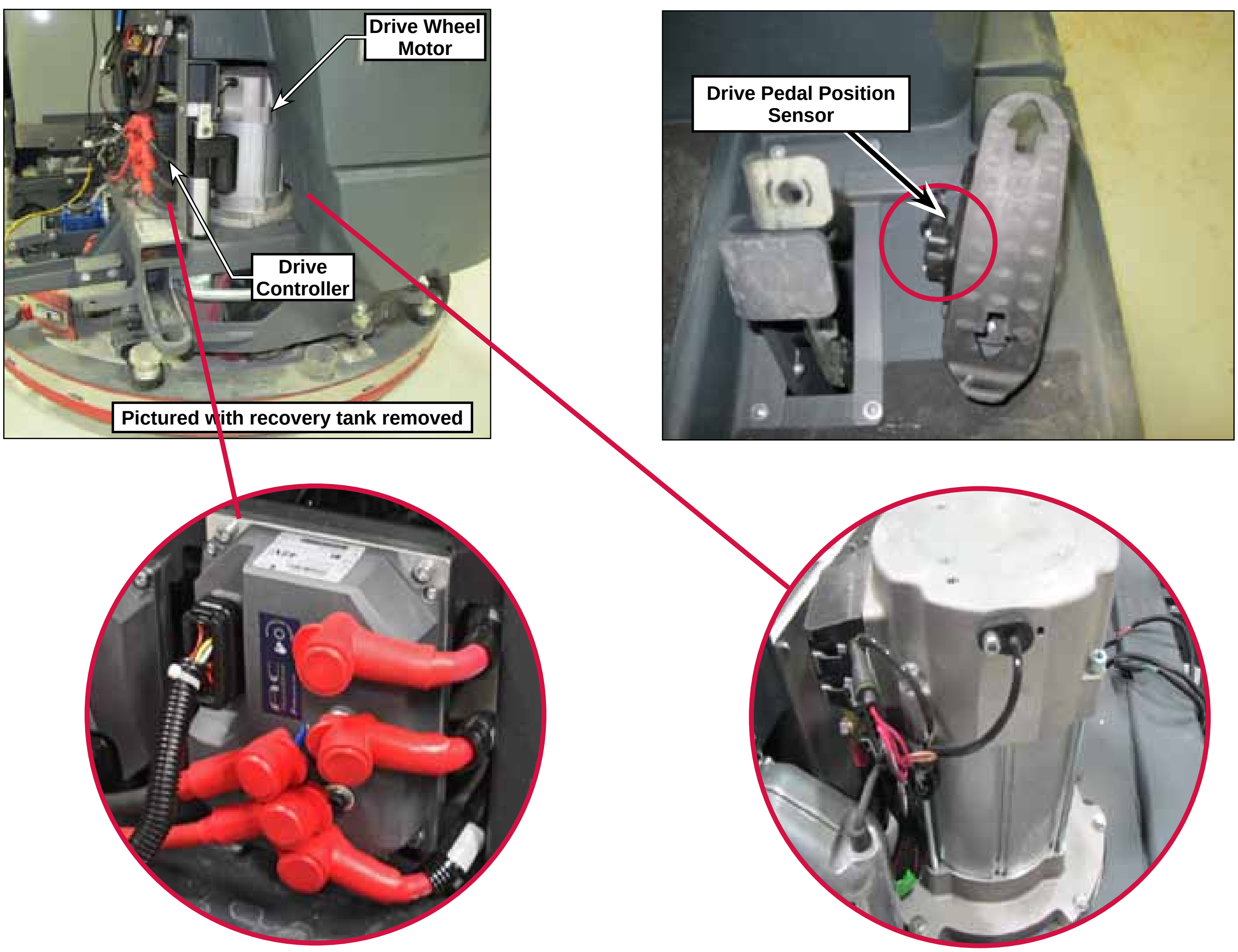
The drive controller communicates with the main machine controller via the CAN Bus. The drive controller transmits error codes to the main machine controller. The main machine controller sends several messages to the drive controller that regulate machine speed mode. The drive controller has three speed 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

Component Locations

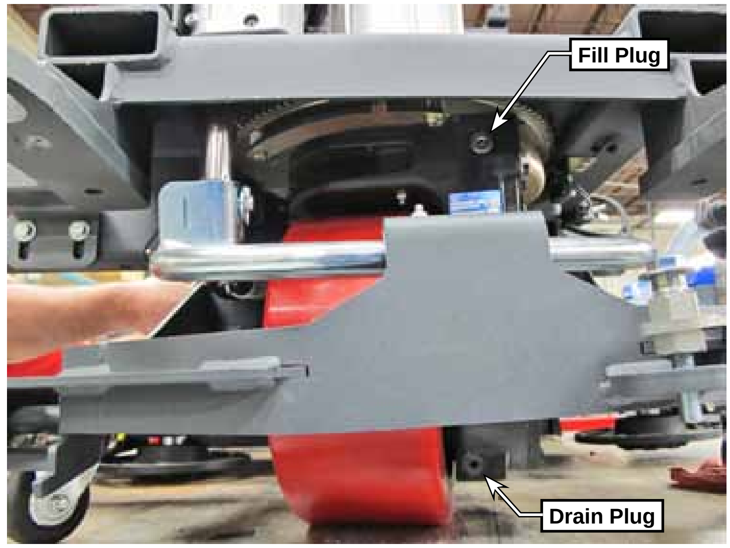


Maintenance and Adjustments

Gear Box Oil

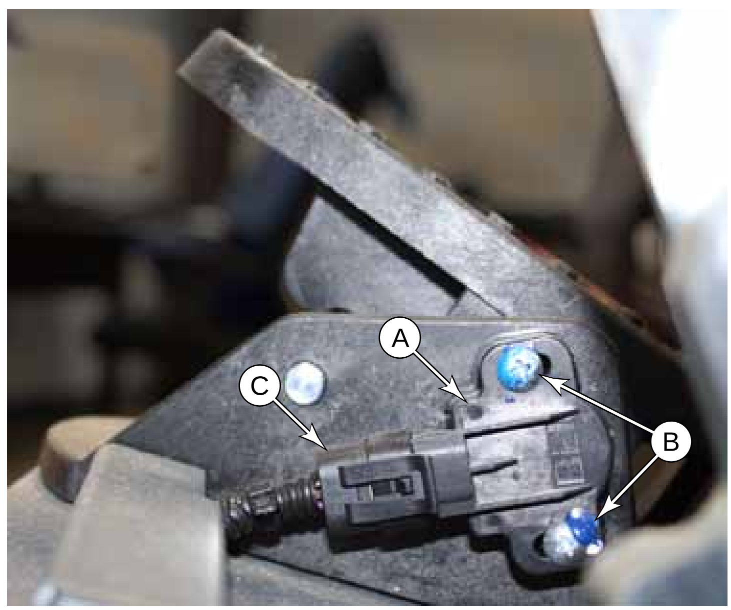
CAUTION: Disconnect the main battery connector before servicing the drive system. If the machine is unexpectedly powered on, the steering initialization routine can cause serious injury.

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.



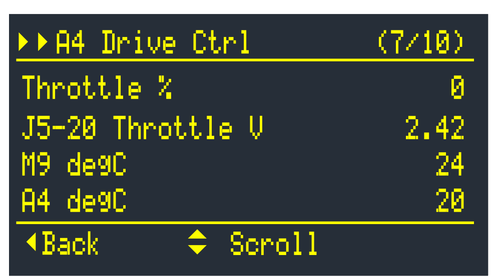
Drive Pedal Neutral Position

The drive pedal neutral position should not normally need to be adjusted, but use this procedure if the drive controller is issuing an error that the drive pedal is not at neutral when starting up. The rotational position of the potentiometer on the side of the drive pedal is adjustable to ensure that the potentiometer (returned voltage) is at the approximate midpoint of the bias voltage of 0 to 5 volts.



1. On the display, press the "i" button to enter the menu system, scroll down to enter the "Service" menu, and then scroll down until Throttle % and Voltage are displayed on the screen.

- As long as the you're not in the operator's seat, the machine shouldn't move. However, if the machine does begin to move during this procedure, be ready to press the E-Stop button.



2. Loosen the two mounting screws **(B)** that secure the potentiometer **(A)** to the drive pedal.

3. Slowly rotate the potentiometer until the wiper voltage (J5-20) is close to 2.5 volts.

4. Retighten the mounting screws, and verify the adjustment result.

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.

All fault codes for all system modules are displayed by the Main Machine Controller. Because multiple related fault codes may span different machine modules, all fault codes are presented in the Controller chapter of this manual. The A4 Drive Controller fault codes are listed on page 54.

Removal and Installation

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.

2. Remove the recovery tank and hose.

CAUTION: Before turning the key on below, make sure all personnel and equipment are clear of the drive and steering system. The steering system will initialize.

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.

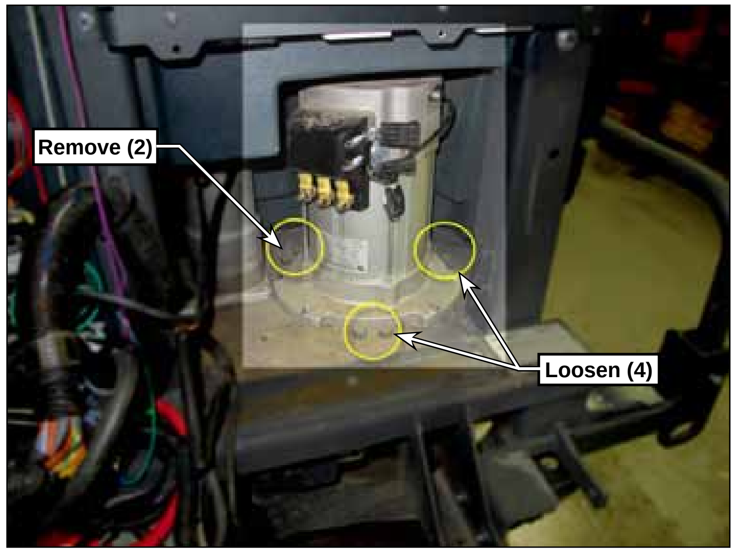
6. Remove the Drive Controller described on page 82.

7. Remove the Steering Controller described on page 93.

8. Label the drive motor and steering motor cables for proper reassembly, then remove them from the motors.

9. Working from under the machine, remove the cover plate that is under the steering drive gear. There are two screws on each side.

10. Lift the squeegee lift bar and tie it up.
11. Block the drive wheel with wheel chocks on both sides so that it cannot roll.
12. Remove the 2 inner gear box to frame bolts and loosen the remaining 4.
13. Lift the machine just enough to take weight off the gear box and remove the remaining 4 gear box to frame bolts.



14. Attach a strap around the drive motor. You will use the strap to guide and lower the assembly.
15. 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.

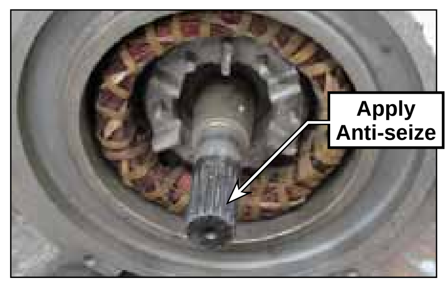
16. Secure the machine safely on jack stands.

17. 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.

18. To separate the motor from the gear box, remove the attaching screws and pry apart.

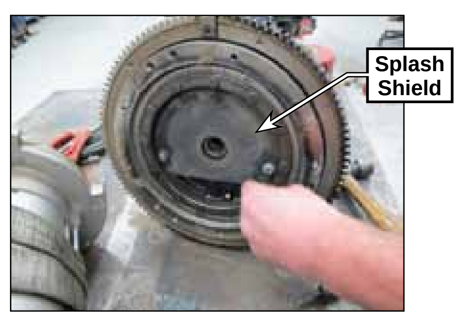
Reassembly Notes:

- Be sure to apply anti-seize compound to the motor shaft splines and gearbox splines.



- 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).

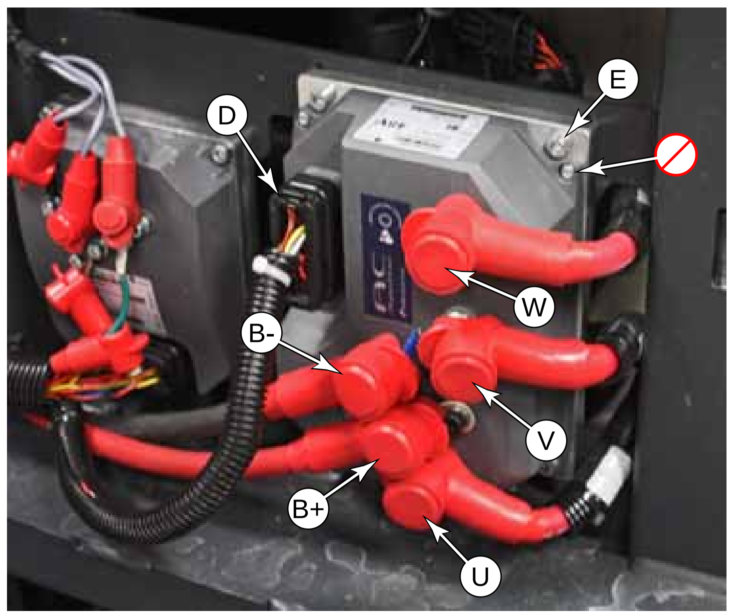
- If installing a new gear box, be sure to transfer the splash shield.
- Apply 56510412 (OPEN GEAR LUBE) to front 180° of ring gear teeth and all around pinion gear teeth.
- Reassemble in reverse order.



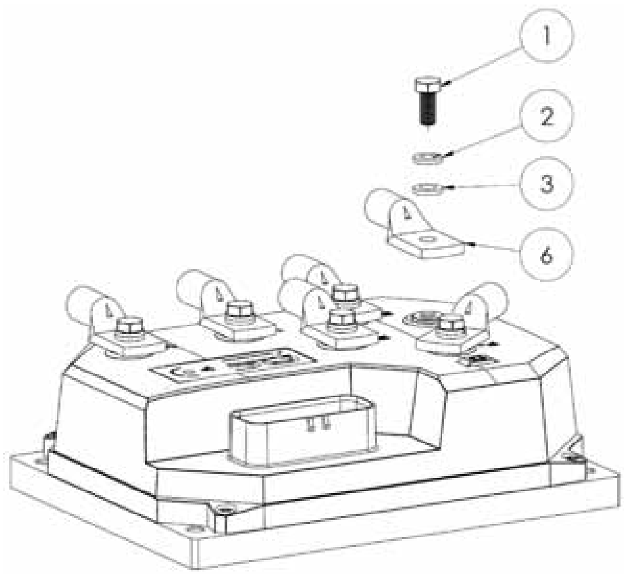
Drive Wheel

1. Chock front wheels and disconnect the main battery connector.
2. While the weight of the machine is still on the drive wheel, slightly loosen the 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 battery connector.
2. Open the recovery tank.
3. Disconnect the low current connector **(D)**.
4. Label the power and motor cables to aid in correct reassembly. **(B+,B-,U,V,W)**
5. Remove the screw, spring washer, and flat washer that secures each cable lug, and remove the cable.
6. Remove the four controller mounting screws **(E)** and remove the controller. (Do not remove the controller from its baseplate.)
7. Reassemble in reverse order. When attaching cables use the correct hardware in the correct order to avoid damage caused from a loose connection. Torque to 90 In-Lbs (10.17 Nm).
   - Screw **(1)**, Lock Washer **(2)**, Flat Washer **(3)**, Cable Lug **(6)**.



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. All voltages are DC unless otherwise stated and were measured with the negative (black) voltmeter lead on battery negative and the key switch on.

Wheel Drive K4 Contactor

Winding - 194 Ohms

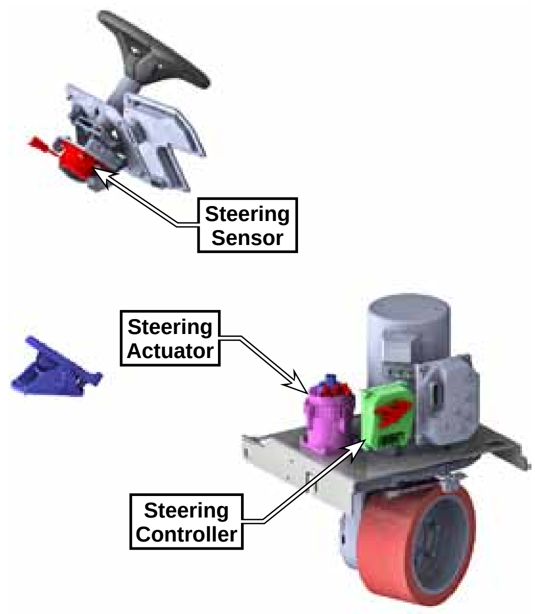
Drive Controller

Pin	Wire Color	Measured Voltage	Comments
J5-3	ORN	38.29 V	KSI (Control Power) Input
J5-4	TAN-ORN	5.07 V	K4 Coil Control: PWM Bat-
J5-5	PNK-RED	10.8 V	11V out commutator
J5-6	BLK-PNK	0.003 V	Sensor ground out
J5-7	TAN-BLK	0.12 V or 10.67 V stationary 5.4 V pulsed (average) in motion	Commutator 1 input
J5-8	PNK-BLU		Commutator 2 input
J5-12	PNK	38.29 V	Seat Switch input
J5-17	ORN-GRN	10 V Disabled 0 V Enabled	Enable Drive (Steering Ready) Drive provides 10 V bias. Steering controller grounds circuit to enable drive.
J5-19	GRY-ORN	38.27 V	E-Stop Switch input
J5-20	BRN-RED	4.8 V full forward 2.5 V center (neutral) 0.08 V full reverse	R4 Foot Pedal Throttle input
J5-21	GRN	2.30 V	CAN 0 Low
J5-26	TAN-RED	0.46 V at 69 Deg. F. 2.99 V with sensor unplugged	Drive Motor Temperature Sensor input
J5-28	ORN	38.29 V	KSI Input (same as J5-3)
J5-29	VIO-GRN	38.4 V	Unswitched Bat+ to K4 coil
J5-31	VIO-BLK	0.003 V	Bat- to throttle pot
J5-32	WHT-BLK	5.02 V	5V to throttle pot
J5-33	YEL	2.78 V	CAN 0 High
Lug B-	BLK	0.001 V	Battery Negative Power Supply
Lug B+	RED	38.08 V	Battery Positive Power Supply
Lug U	RED	26.2 VAC full speed forward .053 VAC stationary	Measured U to V. PWM output.
Lug V	RED		
Lug W	RED		Not measured

22 - Steering System

Functional Description

The steering system utilizes steer-by-wire technology, which means there is no mechanical connection between the operator's steering wheel and the drive wheel steering mechanism. The steering mechanism at the drive wheel uses a large ring gear to rotate the entire drive wheel and motor assembly. A smaller spur gear is attached to the steering motor, to provide a significant gear reduction and control of the larger ring gear of the drive assembly.



The steering motor is controlled by a dedicated steering controller, which monitors the performance and position of the steering motor, as well as receiving steering position commands from the operator's steering wheel.

The operator's steering wheel is connected to a rotary position sensor with integral TFD (Tactile Feedback Device a.k.a. Torque Feedback Device). ("Tactile" is the more correct term, but "Torque" is more intuitive to the function.). The TFD provides resistance to turning the wheel (i.e. it opposes torque) to give the operator the feel of a mechanical steering wheel control.

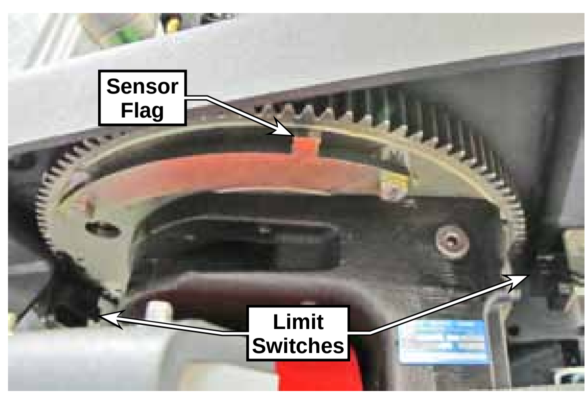
Steering Limit Switches

To ensure the steering controller doesn't command the drive wheel to turn past its design limits, proximity sensors are mounted below the ring gear to notify the controller that it has reached its intended steering limits. As a redundant measure, there is also a mechanical stop beyond the positions of the proximity sensors that the wheel cannot rotate past.

The limit switches are ferrous metal sensing reed switches, that contain a small but strong rare earth magnet that deflects the reed contact inside the switch in the presence of iron-based metals.

Function

When the steering controller is first energized, it doesn't know the locations of the limit switches until it senses them. When the steering controller is commanded to turn the wheel far enough to reach a limit switch, the switch closes when the sensor flag passes in front of the sensor. The steering controller then backs off on the steering angle so the flag clears the sensor position. As a result, the sensors close only momentarily when they are activated, because the wheel immediately moves back away.



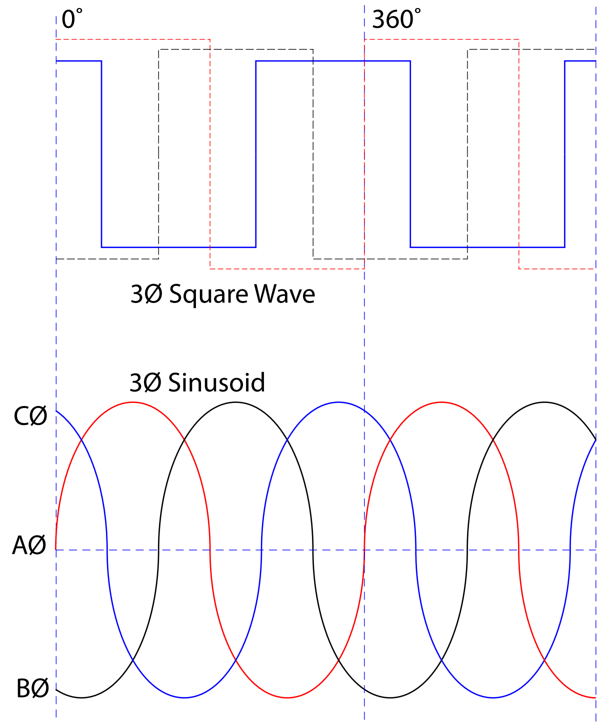
Steering Motor

The steering motor is a 3-phase AC, permanent magnet, remotely commutated motor with internal resolver commutation feedback. The first part of this description is fairly common, and is electrically the same as brushless DC motors used elsewhere. The difference with this motor is that it is intended to operate from a simulated 3-phase sinusoidal input.

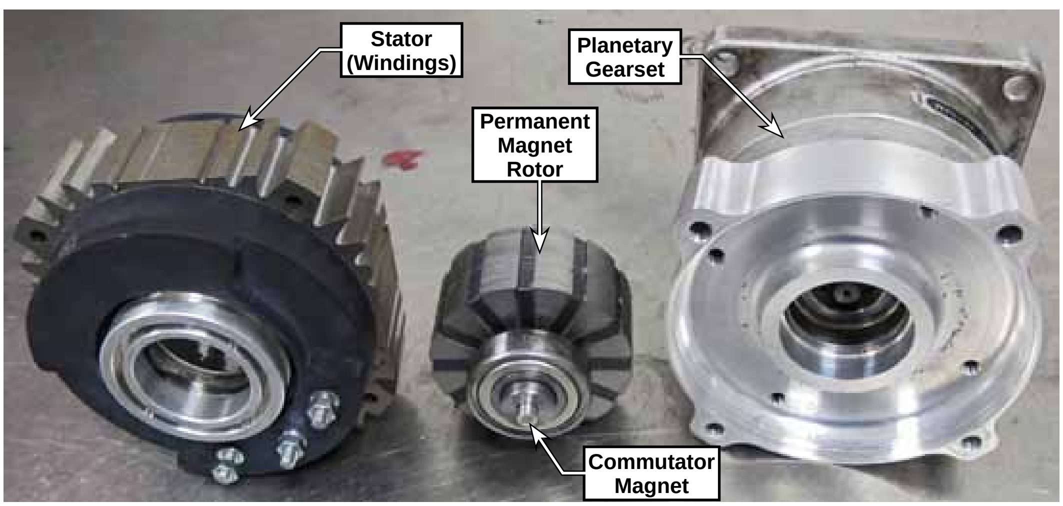
The motor itself could be driven by either square wave DC, or sinusoidal AC, but the sinusoidal waveform permits higher torque and holding power than the square wave.

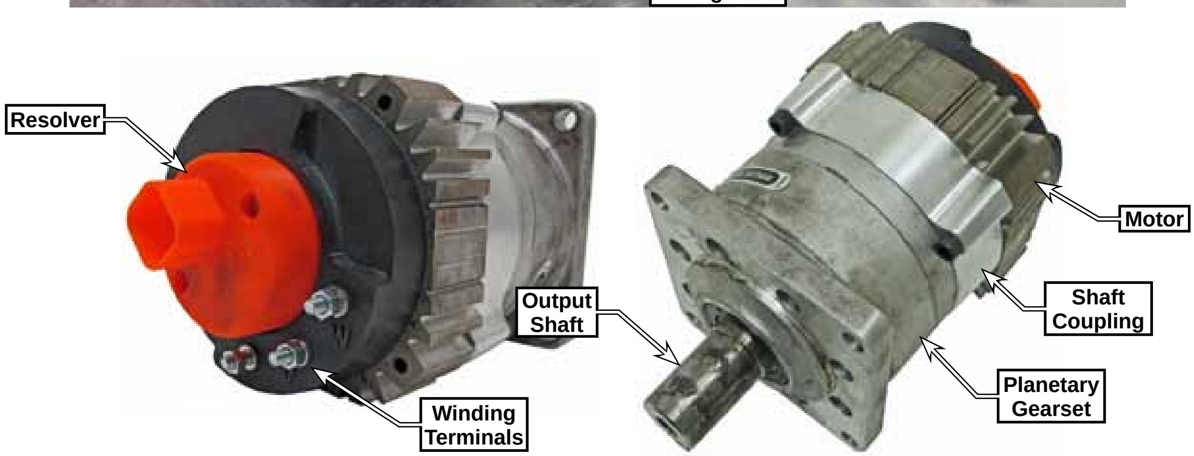
With a square wave input, the magnetic field in the motor winding is at full magnitude both before and after the optimal timing for maximum torque. An analogy is the pedals of a bicycle, and this would represent pushing down on a pedal before the pedal has reached the top of its stroke. You waste some power opposing the desired rotation.

With a sinusoidal waveform, the peak magnetic field coincides with the optimal torque timing. This results in a higher torque for the same amount of power.

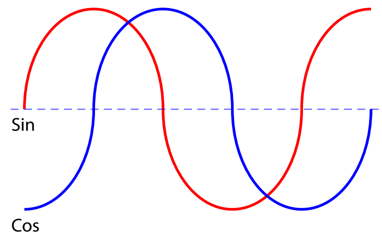


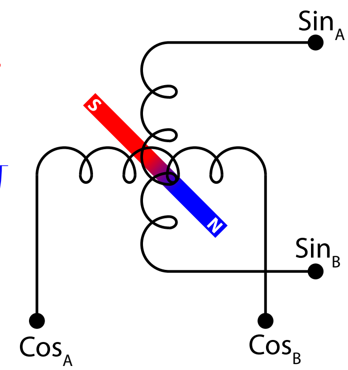
The drawback to the sinusoidal input is that it requires more complexity to control in order to achieve the correct timing. The motor provides this greater detail in position feedback by using a “Resolver” instead of an “encoder”. A resolver is the analog version of an encoder, which is digital.





Commutator Resolver





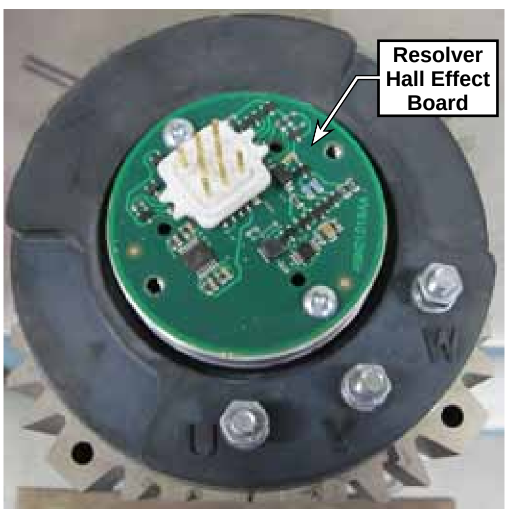
Commutation is the process of switching power in the motor windings to coincide with the position of the magnetic field of the rotor. A brushed motor achieves this with mechanical commutation (the brushes). Remote commutation means that the motor needs to tell the controller when it should switch power to the windings, based on the physical rotational position of the rotor.

Most brushless DC motors accomplish this information using digital encoders. This results in the square wave power input. Sinusoidal AC motors/controllers need more precise positional information to achieve optimal timing. They need analog data. This is provided by a resolver instead of an encoder.

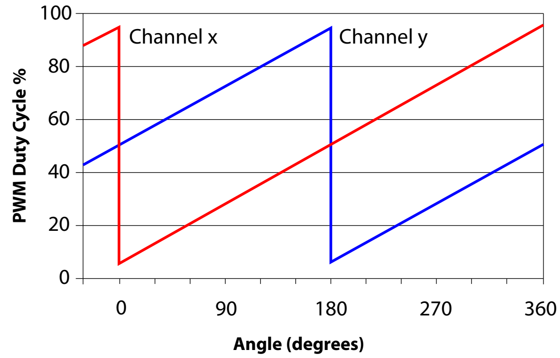
Some resolvers are literally miniature AC generators, while others, including the steering motor, are based on rotary hall effect sensors, but the effect is the same. The hall effect sensors, or generator coils, are placed 90-electrical-degrees apart above a rotating magnet on the rotor (shown above-right). The resulting output is a 2-phase sinusoidal signal (shown above-left).

The drive controller mathematically interprets this 2-phase signal to create the commutation points for each of the three output phases to the motor.

Some resolvers are 3-phase generators, and these do not need mathematical interpretation to create the commutation points. They are directly matched to the positions of the rotor. The coils are 120-electrical degrees apart instead of the 90 degrees.

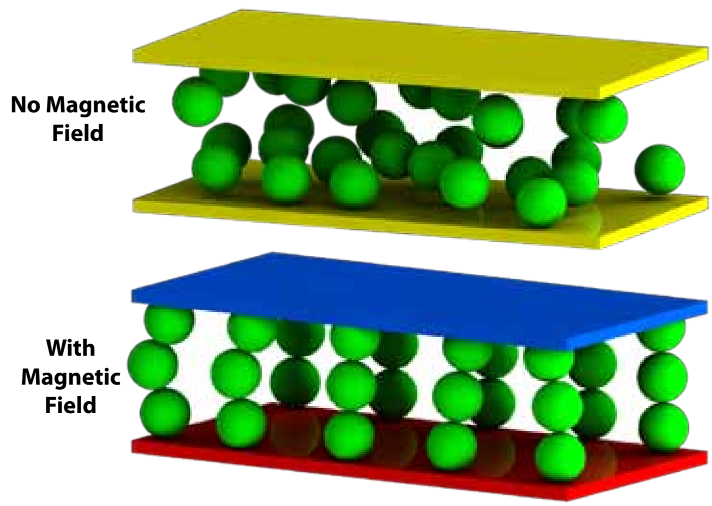


Steering Position Sensor & TFD



The operator's steering wheel is connected to a rotary position sensor with an integral Torque Feedback Device (TFD). Even though this is a single device, the two functions are distinct and semi-unrelated. The position sensor is based on rotary hall effect sensors internally, but the output to the steering controller is a 2-channel PWM signal representation of absolute position.

As the steering wheel is rotated, the two PWM channels ramp their voltages up or down, and the two channels are 180 degrees apart. The steering controller uses this information, in conjunction with the right and left limit switches to synchronize steering wheel and drive wheel position.



The Torque Feedback Device (TFD) provides a mechanical feel to the steering wheel movement by resisting rotation. But the TFD isn't just passive friction. It is an active device which uses a MagnetoRheological Fluid (MR Fluid) that is electrically controlled. MR Fluid is a suspension of small particles that align in the presence of a magnetic field. This alignment alters the fluid's effective viscosity to the point that becomes semi-rigid with an elastic-like sheer strength.

When the MR Fluid is placed between two moving surfaces, it resists movement between those surfaces, depending on the strength of the magnetic field.

The steering controller sends a PWM signal to the TFD to control the amount of resistive torque the TFD exhibits. Normally this remains a constant resistance, however, when the steering controller detects that the drive has reached either the right or left limit switches, it increases the PWM rate, increasing the magnetic field, to give the steering wheel the feel of a limit stop.

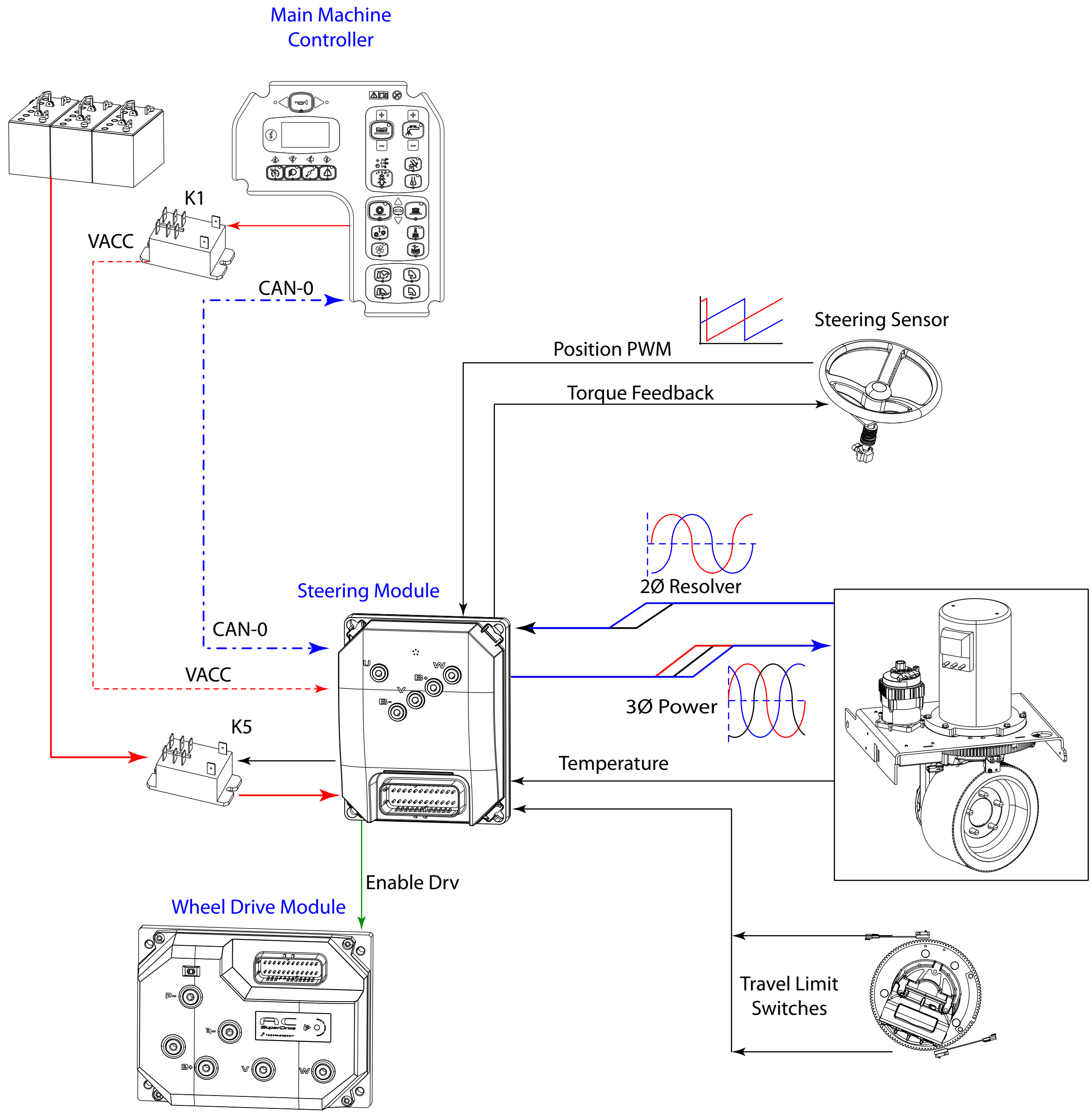
Steering Controller

The steering controller is semi-autonomous, although it does still communicate with the Main Machine Controller (via the CAN Bus), and also notifies the drive controller that the steering system is ready for travel. The steering controller receives input commands from the operator's steering wheel, and outputs motor control to the steering actuator motor. The steering controller also monitors the steering limit switches to prevent the steering assembly from turning too far left or right.

As with the other controllers in the system, the steering controller receives its logic power from the keyswitch (KSI) to activate the controller. The controller then activates its own primary power by energizing the K5 relay coil by switching J6-13 to Bat-. This relay provides the main high-power energy to the controller.

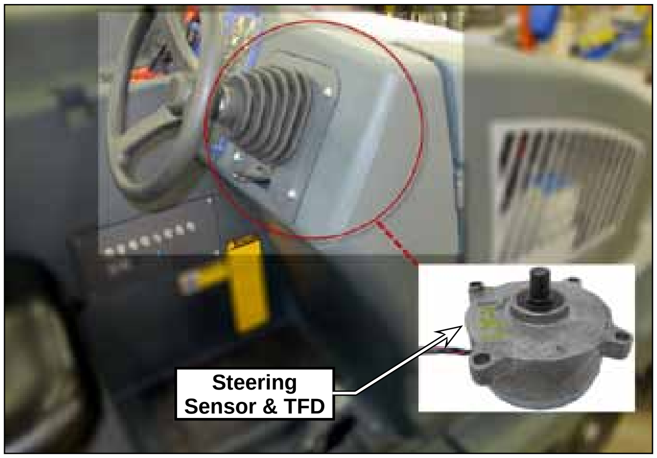
The steering controller is different from most other motor controllers in the system, in that it produces an electronically generated AC sinewave output, compared to the more common DC squarewave of other drives. This output is still PWM modulated to control the amount of power, however.

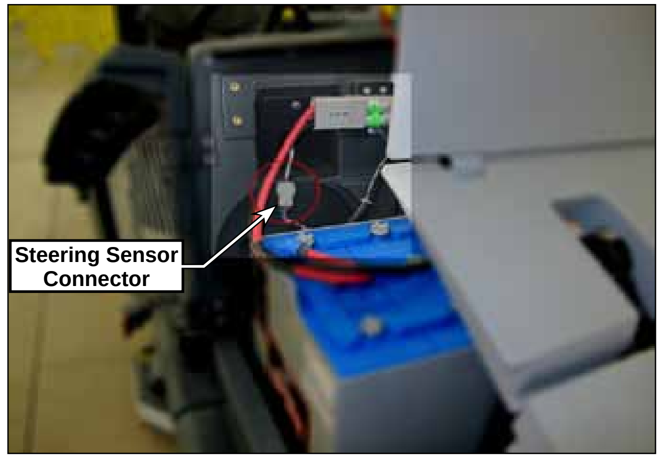
Functional Diagram



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





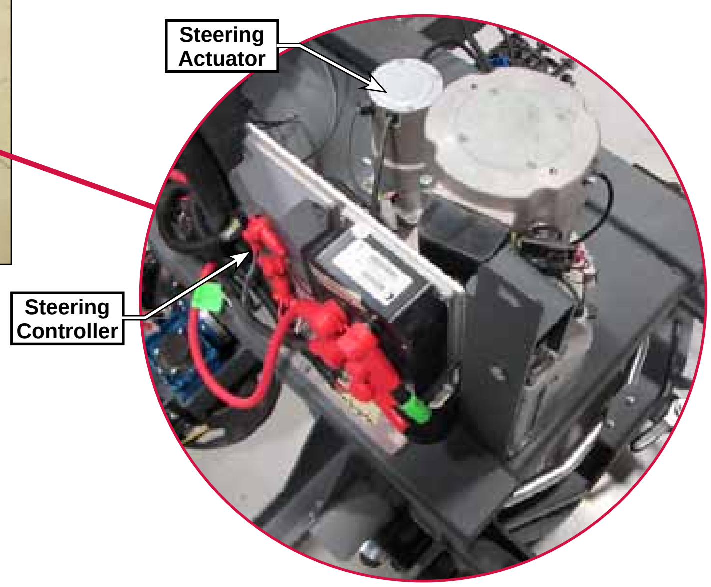


Photo taken without tanks

Troubleshooting

Fault Codes

The steering controller has very robust fault code capabilities. Since most problems will result in setting a fault code, whenever there is a problem with the steering system, the first thing you should do is check for fault codes.

All fault codes for all system modules are displayed by the Main Machine Controller. Because multiple related fault codes may span different machine modules, all fault codes are presented in the Controller chapter of this manual. The A5 Steering Controller fault codes are listed on page 55.

Symptom Troubleshooting

Very few steering system failure scenarios exist that won't originate with an error code. Virtually all faults between the steering controller and steering actuator are monitored by the controller, including signal loss, miswiring, and short circuits. The TFD and steering limit switches are the primary components that can have a failure mode that is not automatically detected. These failure modes are also partially interrelated, as one failure may impact the other.

Loss of Steering Resistance

The primary cause would be a signal loss between the steering controller and the TFD. Troubleshoot for broken or disconnected wires by checking voltage between them to be non-zero volts. Check the TFD coil for resistance of around 5 ohms.

Excessive Steering Resistance and/or Drive Wheel Position Errors

The outward symptom would be excessive voltage at the TFD coil, however, this is most likely caused by the steering controller detecting one or both steering limit switches being closed when they shouldn't be.

- A short to ground on the J6-26 wire from the controller would cause the TFD coil to be at maximum torque all the times. Aside from difficulty turning the steering wheel, all other steering functions would respond normally.
- If one or both of the limit switches have failed in the on (closed) condition, the steering controller will show the following error codes: 4-227 Drive Enable Open, 5-110 Application Fault.
- If one sensor is closed, the steering wheel will not turn in that direction, but will turn in the opposite direction. However, the drive wheel will only move slightly, and further steering commands are ignored.
- Similarly, if both sensors are closed, the steering wheel won't turn in either direction and the wheel won't move.
- Also note that if a limit switch was tripped at an incorrect location (such as a stray piece of metal near the sensor, or your own troubleshooting steps), but then later returned to normal operation, the steering controller will remember this position as though it was a valid limit even though the sensor no longer trips at that position. This would be a false limit position, and the controller needs to be reset (machine power cycle) in order to ”forget” this false position.

Limit Switch Testing

Because the limit switches are mechanical switch contacts, they can be tested as a conventional switch using an ohm meter. When a non-magnetic steel object is positioned near the face of the sensor, the reed switch should close. However, note that using a magnetized object may result in unexpected results if the magnet polarity opposes the North/South polarity of the switch's internal magnet.

Removal and Installation

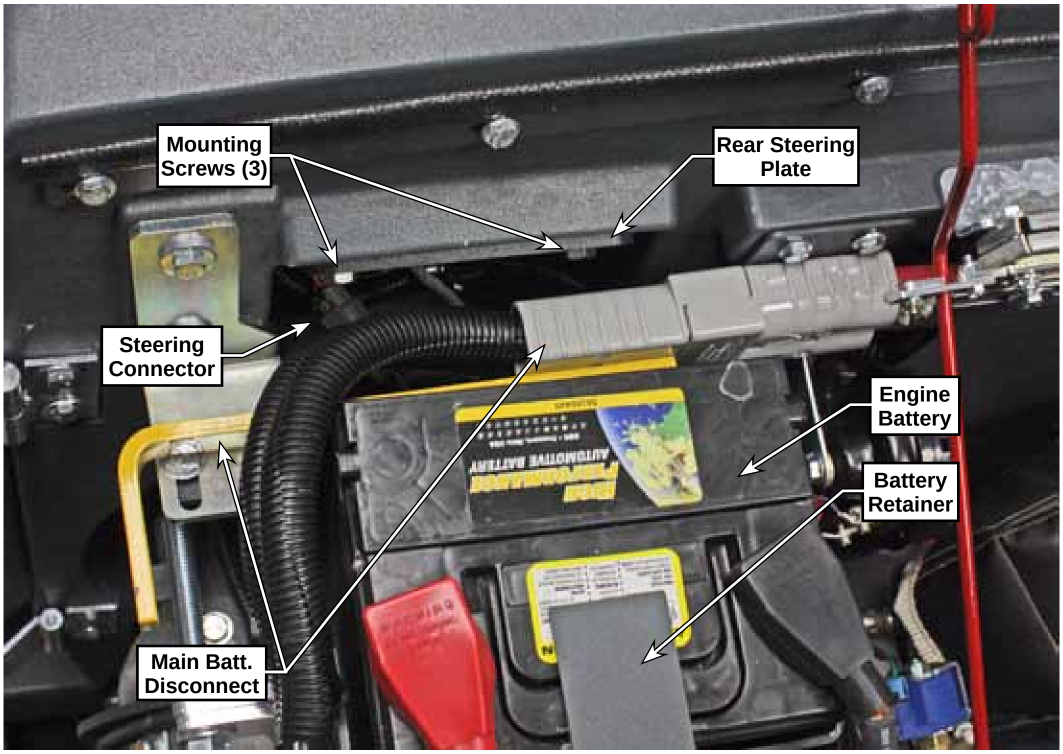
Steering Wheel Sensor and TFD

This procedure requires removal of the steering wheel and also the steering assembly from the machine in order to properly access the sensor/TFD. Even though it would appear that some of these steps could be skipped during disassembly, the reassembly process would be very difficult.

1. Open the hood for the engine area and disconnect the main battery connector, and also disconnect the engine battery terminals.

2. Loosen the nut securing the battery retaining bracket, slide the bracket away, and remove the engine battery.

3. Disconnect the steering harness connector.



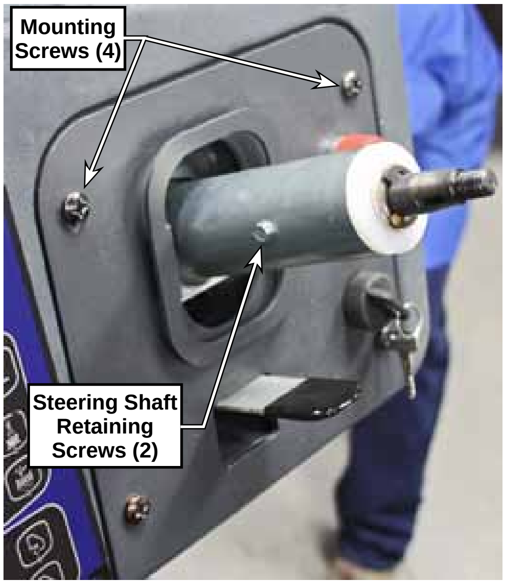
CAUTION: Do not hammer on the steering wheel shaft to loosen the taper, as doing so may damage the encoder inside the steering wheel sensor. Use a wheel puller.

4. Pry off the center cap from the steering wheel to expose the retaining nut.

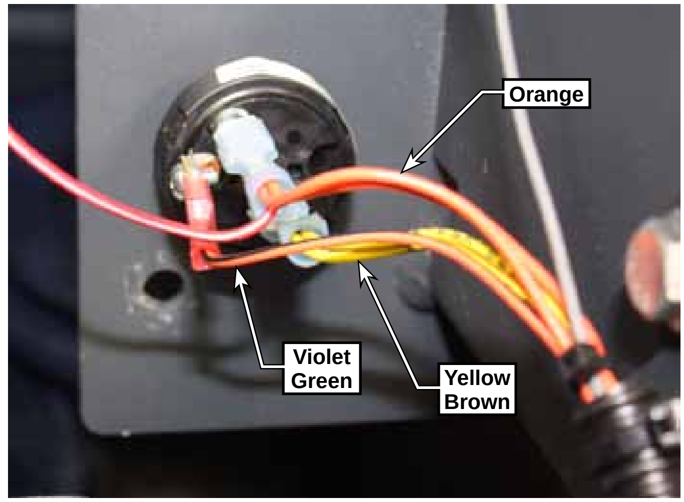
5. Remove the steering wheel retaining nut and washer, and use a wheel puller to lift the wheel off the tapered shaft. The tapered shaft has a woodruff key. Take care not to lose it.

6. Remove the 3 screws securing the rear steering plate (above), and remove the plate.

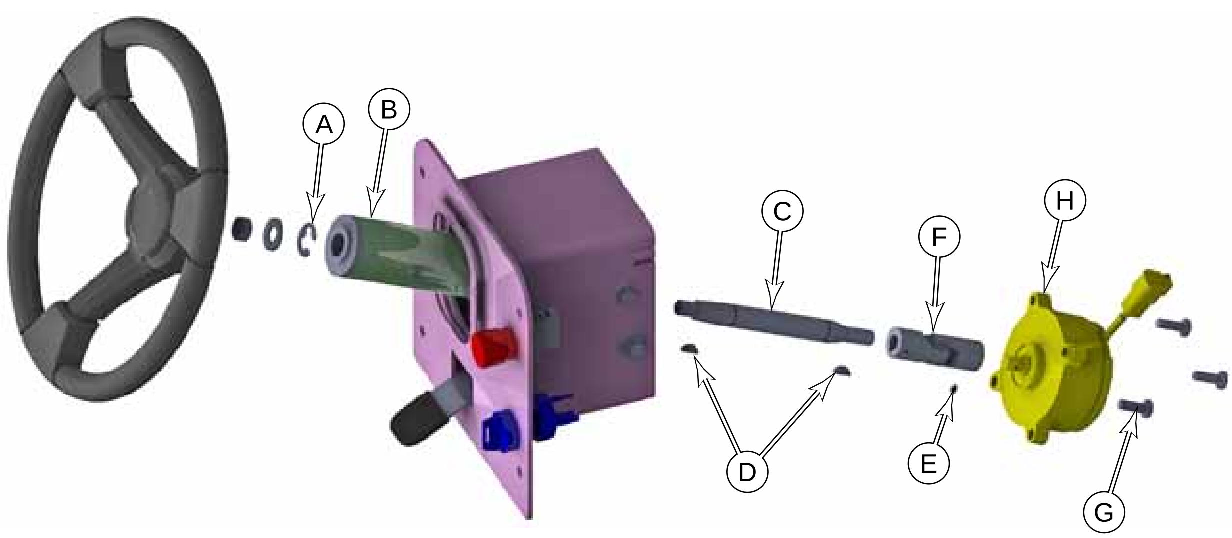
7. Remove the 4 screws that secure the front of the steering assembly (right), and lift the assembly out the front enough to access the E-stop and ignition wires.



8. Disconnect the 2 wires from the E-stop switch.
9. Disconnect the 3 wires from the ignition switch. Make note of the wire positions for later replacement.
10. Finish removing the steering assembly from the machine.



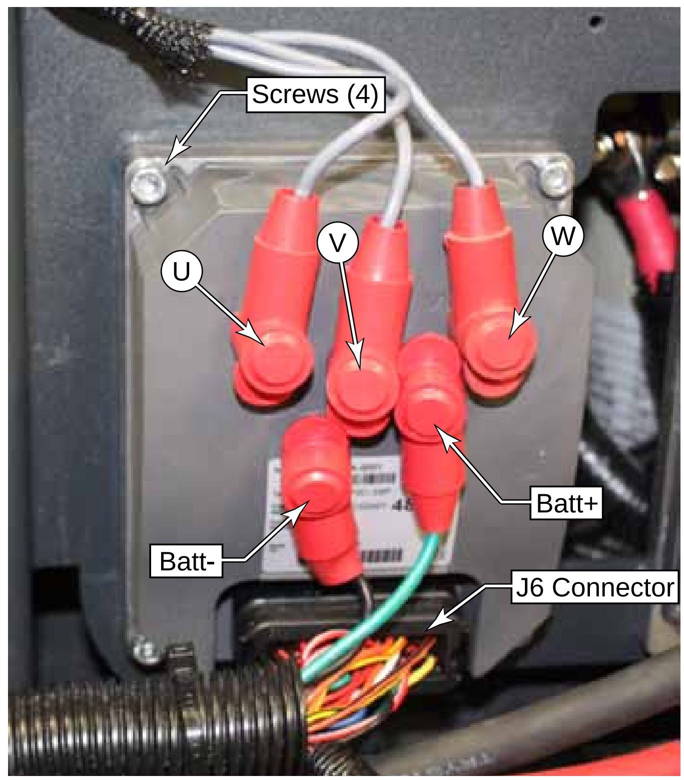
11. Remove the E-clip **(A)** from the top of the steering shaft **(C)**.
12. Remove the 3 screws **(G)** that secure the encoder **(H)** to the steering assembly.
13. Push the steering shaft **(C)** into the steering column **(B)**, and remove the shaft, U-joint **(F)** and encoder **(H)**. Note that the connection between the U-joint and steering shaft is just a slip fit. Pushing the shaft out instead of pulling the encoder, makes it easier to keep the parts together and not lose the woodruff key **(D)**.
14. Loosen the setscrew **(E)** on the U-joint, and remove the encoder from the U-joint.



15. During reassembly, pre-assemble the steering shaft, woodruff key, U-joint, and encoder before inserting the steering shaft into the steering column. Make sure the woodruff key hasn't fallen out during this step.

Steering Controller

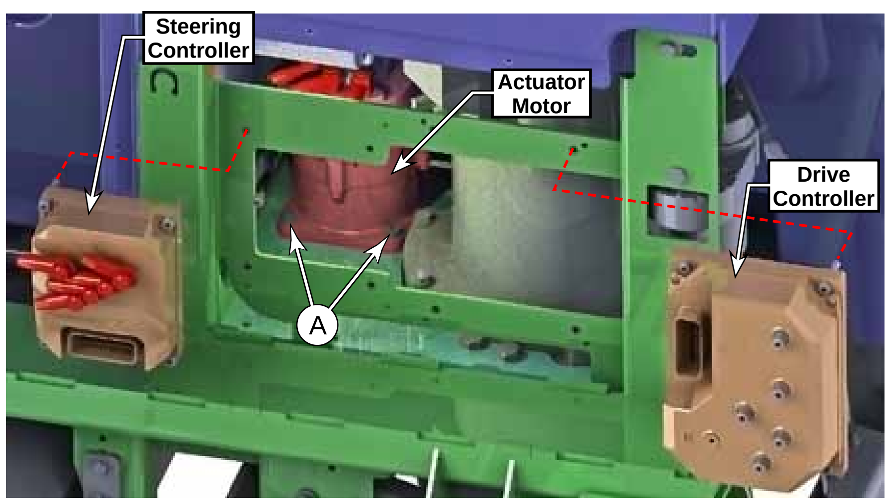
1. Drain recovery tank.
2. Turn machine off, set the parking brake and disconnect the main power plug.
3. Tip the recovery tank out and let it rest on the support cable.
4. Disconnect any electrical or vacuum connections to the recovery tank so that it can be lowered horizontal.
5. With a helper, remove the support cable clip, and tip tank down onto an elevated support. Remove the tank if desired.



6. Label the steering controller wiring to make correct reassembly easier, then disconnect all wiring.
7. Remove 4 controller mounting screws, and remove the controller.

Steering Actuator Motor

1. Perform all of the steps listed above to remove the steering controller.
2. For additional room to work, you may choose to also remove the Drive Controller described on page 82. Access to the actuator motor is through the frame where the two controllers are mounted.
3. Disconnect the data connector from the actuator motor.
4. Remove the four steering actuator mounting screws **(A)**.
5. Tilt the actuator sideways to remove it through the opening in the frame. It is a tight fit and may require skewing the motor back and forth to get through the opening.



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. All voltages are DC unless otherwise stated and were measured with the negative (black) voltmeter lead on battery negative and the key on.

Steering Controller Measurements

Pin #	Wire Color	Circuit	Voltage	Comments
J6-1	VIO-WHT	TFD coil (positive)	37.9 V	Unswitched side
J6-3	ORN-GRN	KSI (Key Switch Input)	38.2 V	
J6-4	ORN-GRN	Enable Drive output	0.001 V	Active low when steering ready
J6-5	RED-BLU	12V power to resolver	10.94 V	
J6-6	BLK	Internal sensor ground	0.002 V	
J6-7	VIO-GRY	Encoder 1A input	1.2 - 3.7 V, variable	Analog resolver signal for motor rotor position
J6-8	WHT-GRY	Encoder 1B input		
J6-10	BLK	Batt- Control Power	0.001 V	
J6-11	BLK	Batt- to steering wheel sensor	0.002 V	
J6-13	YEL-BLK	K5 Relay Coil	7.85 V	PWM to Batt-
J6-15	ORN-RED	SW12 Right Travel limit switch	38.2 V blocked	Sensor will only be blocked momentarily in normal operation
J6-16	GRN-WHT	TFD encoder 1	0.40 - 4.59 V	Analog voltage from sensor that ramps up/down with position
J6-17	GRN-BLK	TFD encoder 2		
J6-18	VIO-PNK	Encoder 3A input	1.2-3.7 V variable	Analog resolver signal for motor rotor position
J6-19	WHT-PNK	Encoder 3B input		
J6-21	GRN	CAN 0 Low	2.3 V	
J6-23	RED-GRN	5V power for TFD encoders	4.97 V	
J6-24	BRN-GRN	TFD coil (negative)	"34.7 V "normal feel" 28.2 V at limit stop	PWM to ground
J6-26	PINK	Steering Actuator temperature	1.11 V at 22 Deg. C.	
J6-27	ORN-BLU	SW11 Left Travel limit switch	38.5 V momentary	
J6-29	YEL-BLU	K5 relay coil	38.6 V	Unswitched Batt+
J6-30	GRN-WHT	TFD encoder 1	0.40 - 4.59 V	Analog voltage from sensor that ramps up/down with position
J6-31	GRN-BLK	TFD encoder 2		
J6-33	YEL	CAN 0 High	2.78 V	
Lug B-	BLK	Battery Negative	0.001 V	Main power
Lug B+	GRY-WHT	Battery Postive	38.49 V	Main power
Lug U	BRN	M26 Steering Actuator Motor phase output		PWM vector sinusoidal simulation
Lug V	RED			
Lug W	WHT			

24 - 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 CS7010 is an electrically driven system, but with various prime-power configurations. All configurations utilize a 36-volt battery system, but the hybrid models incorporate engine-alternator power generation to constantly charge the batteries.

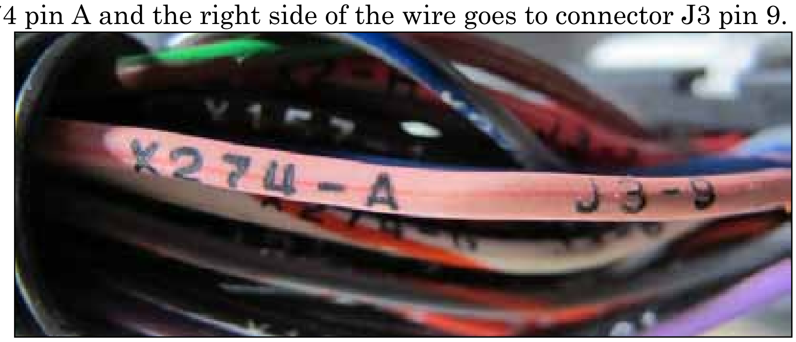
When the engine is running the alternator provides the electrical power to operate the machine electrical loads as well as recharge the battery pack. If the machine's instantaneous power demand is higher than the alternator can provide, the battery pack supplies the extra boost that is needed. If the engine is not running the machine can work for a limited time on just the battery pack

Another unique aspect of the Hybrid models is that they also have a separate 12 volt battery, which is primarily for starting the machine, but also powers engine related functions. The engine contains a separate alternator for charging this system.

All models have a large connector to disconnect battery power from the machine, however, note that this does not disconnect the batteries from the engine generator. A circuit breaker panel located on the left side of the operator foot well area provides circuit protection for multiple circuits.

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.

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

There are several layers of circuit protection. The top level protection is the 400-amp fuse from the main battery pack. The second level protection is the circuit breakers in the operator's platform. This includes the 5-amp circuit breaker to the main controller, the 25-amp breaker to loads on the main controller, and a 25-amp breaker to the steering system. Each of the secondary controllers and power modules contain their own internal overload protection for their respective loads.

Un-Switched Power

Some devices receive power even when the machine is not in operation. The only way to disable power to these devices and circuits is to disconnect the main battery connector. The main control board always receives logic power, because it needs to detect the ignition key sequence to start the engine and also initiate power to other subsystems. Even though the main power relays are not active until their respective controllers are active, the relays are always receiving unswitched power to their contacts.

Switched Power

The ignition switch doesn't really carry any machine power function, but it notifies the main controller that the key has been operated and the machine should begin operation. The main controller then activates the K1 relay, which provides operational power to the rest of the system. Each of the secondary controllers and power modules receive their main logic power through the K1 relay.

Prime Power Alternator (Generator)

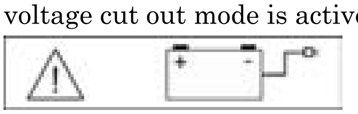
The 42 volt generator provides the electrical power needed to operate the machine and to recharge the 36 volt battery pack. It is belt driven by a pulley located at the rear of the engine (Right side of machine). The alternator contains an external voltage regulator to provide sufficient voltage to the main battery pack to charge the batteries.

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 on curb lights and turn lights.

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

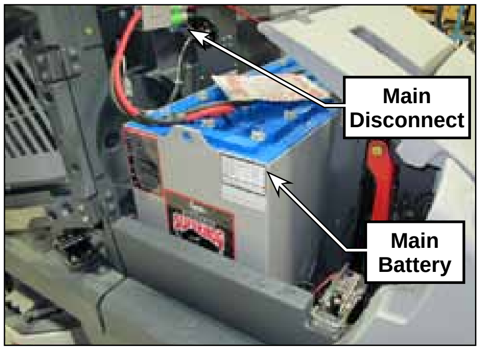


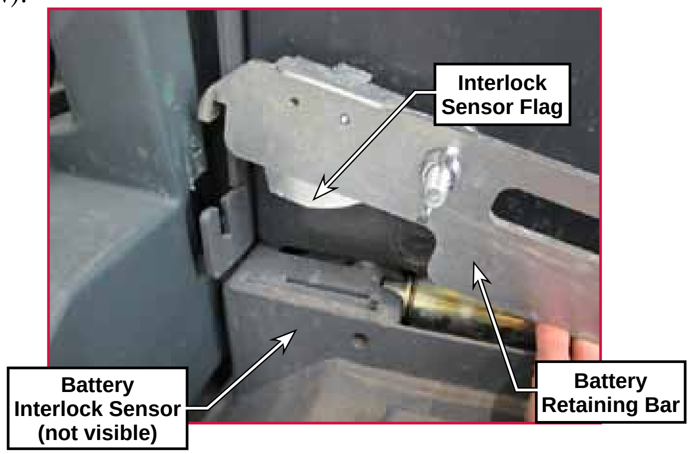
There are actually two levels of low voltage cut off. The first level disables the scrub and sweeping functions. The second level will also disable the recovery function. In either case, the hopper functions are not disabled. Once the machine has gone into the low voltage cut out mode, the batteries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

Component Locations

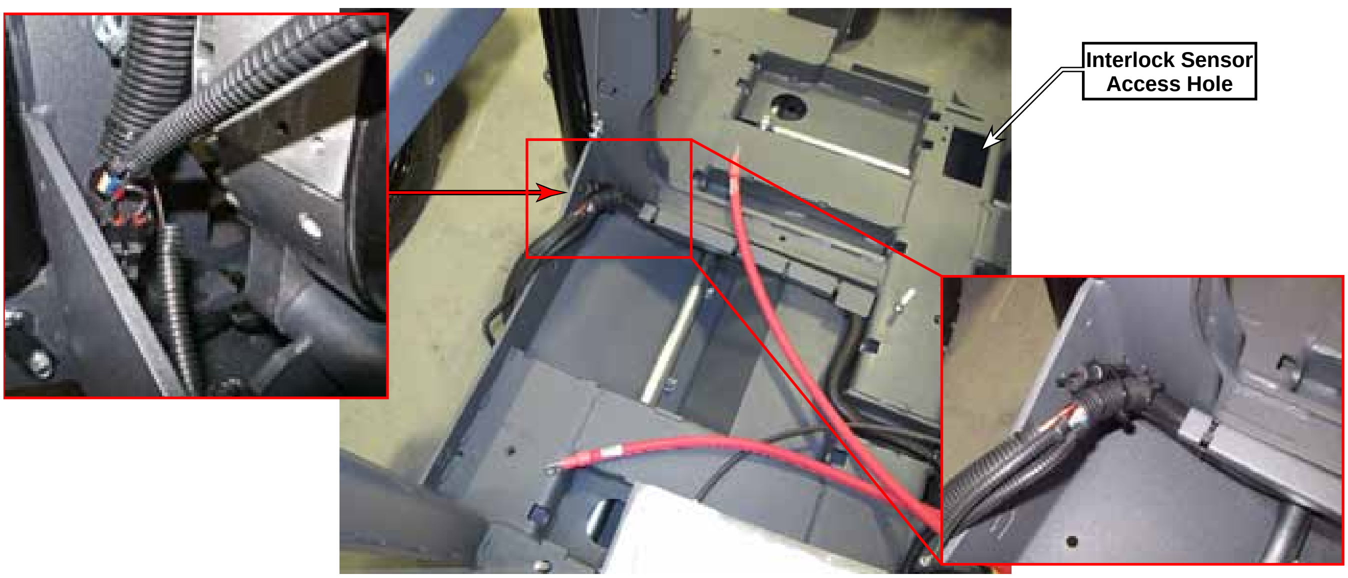
Battery Interlock or Interlock Jumper

Battery powered machines have an interlock switch (proximity sensor), to detect if the battery retaining bar is not lowered into position. If the sensor is open, machine function is disabled to prevent the batteries from shifting in the machine during travel. The proximity sensor is inside the main chassis frame, but there is an access hole behind the sensor (see middle image below).

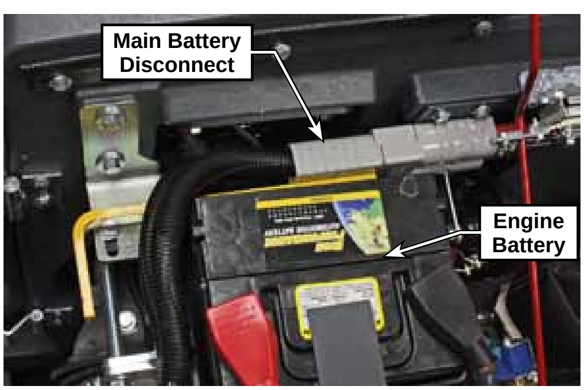


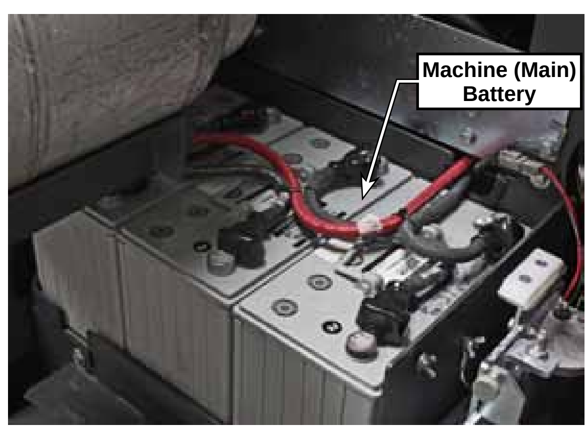


For non-battery powered machines, this interlock sensor is bypassed with a jumper. This jumper is located in the front corner near the generator. If this jumper is disconnected, the machine will not function.



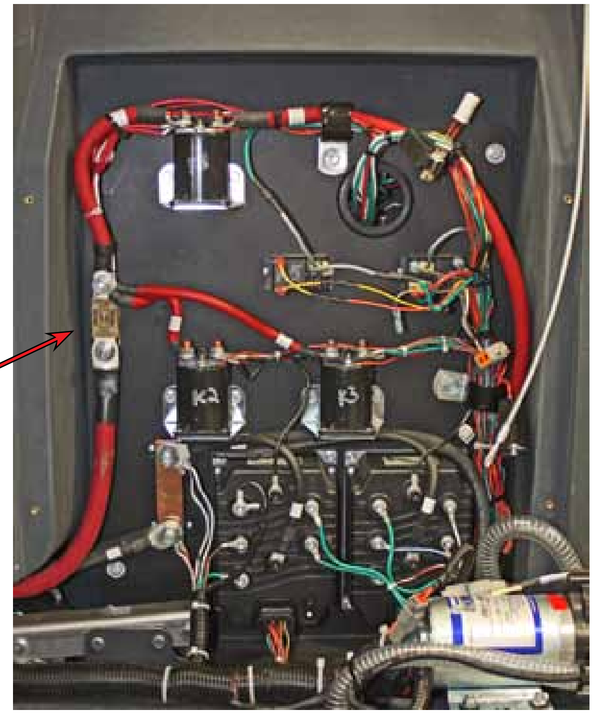
Hybrid Machine Batteries





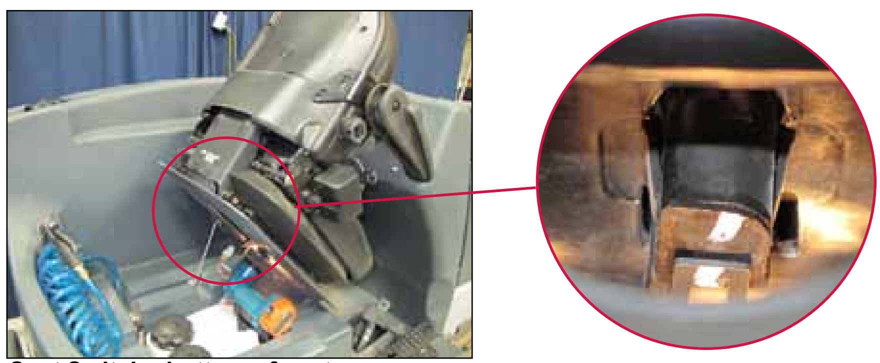
Circuit Protection and Control

Circuit Breaker Panel

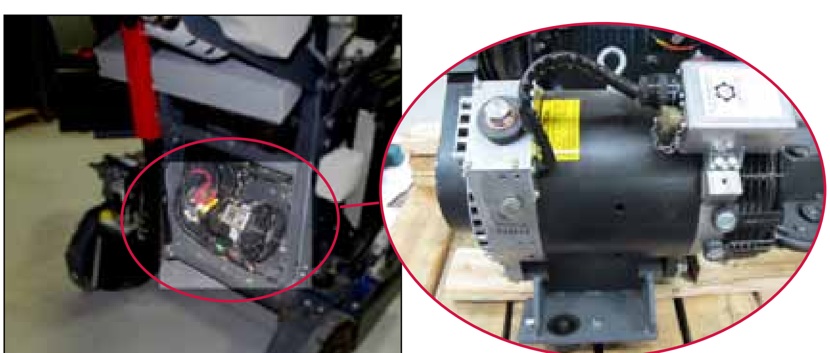


Electrical Panel

400 Amp Fuse

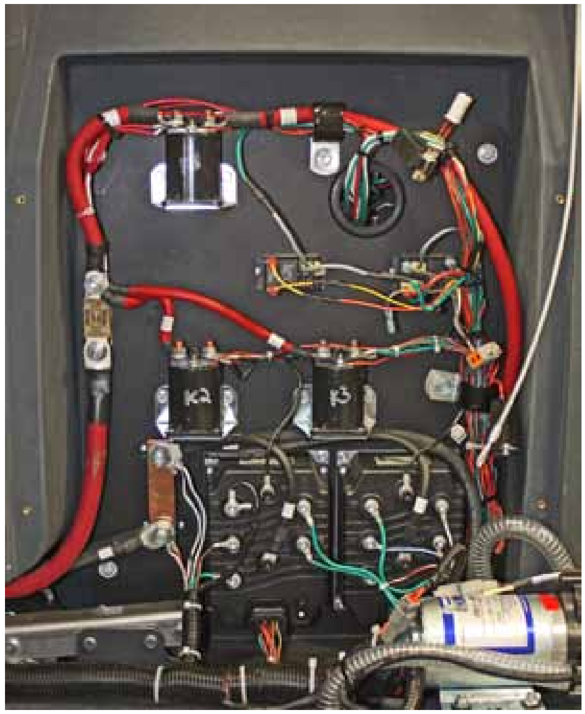


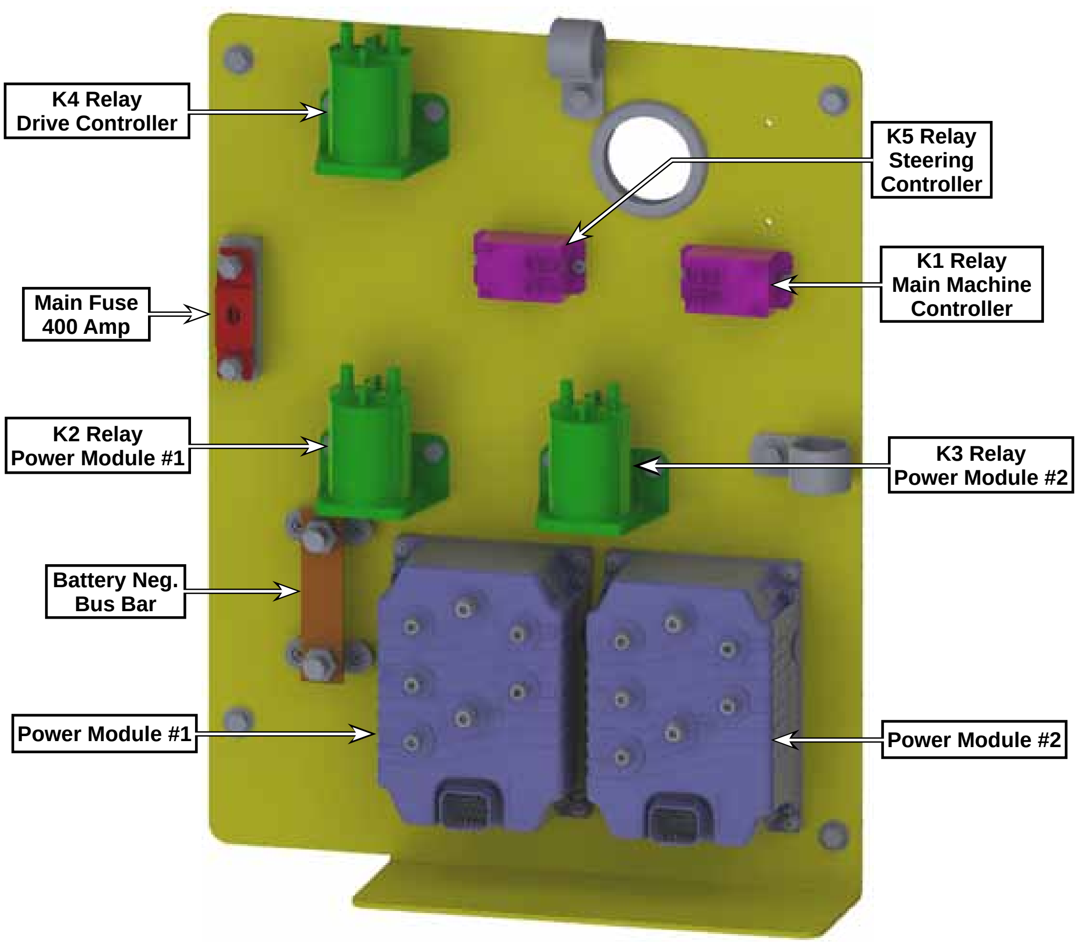
Seat Switch - bottom of seat



Alternator Generator

Electrical Panel Layout



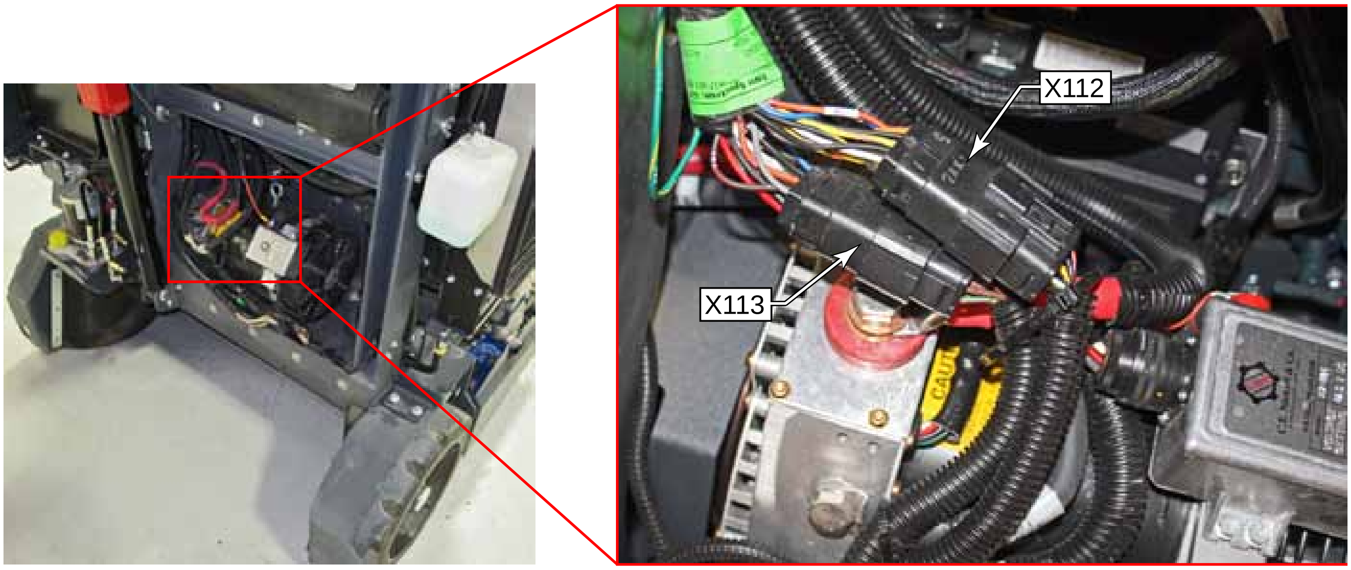


Harness to Harness Connector Locations

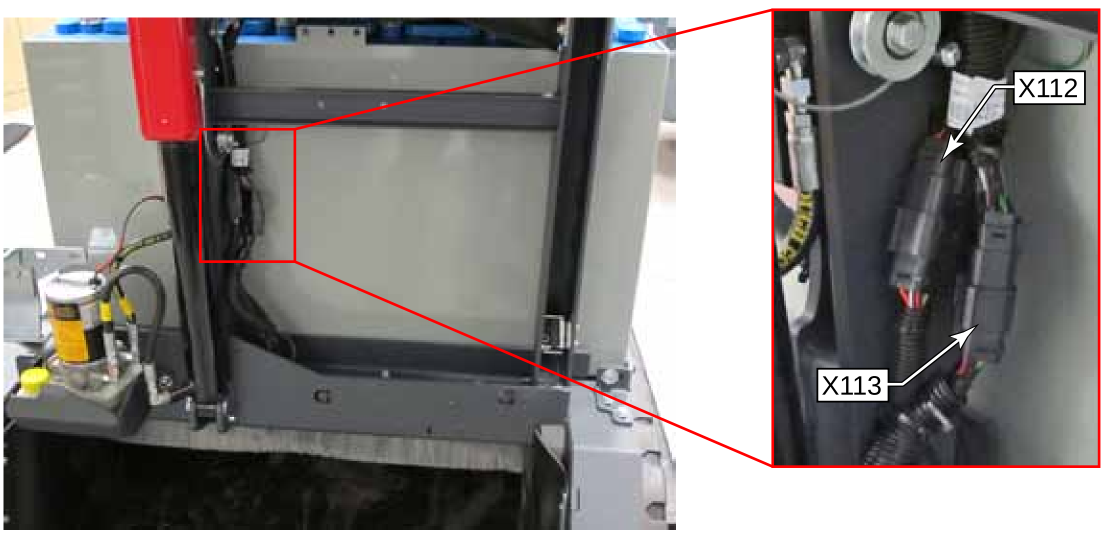
Most connectors are plugged into a component like the squeegee actuator; find the squeegee actuator and you can locate the squeegee actuator electrical connector. However, there are a few connectors that connect two harness. These are pictured here.

Main Harness X42 and X43 to Hopper Harness X112 and X113

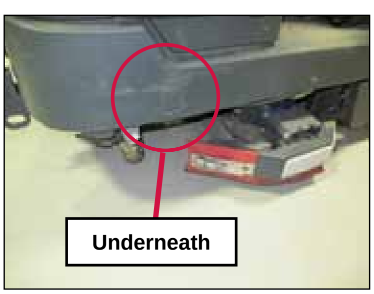
Engine Models

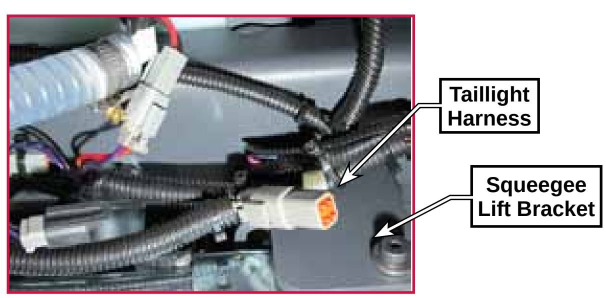


Battery Model

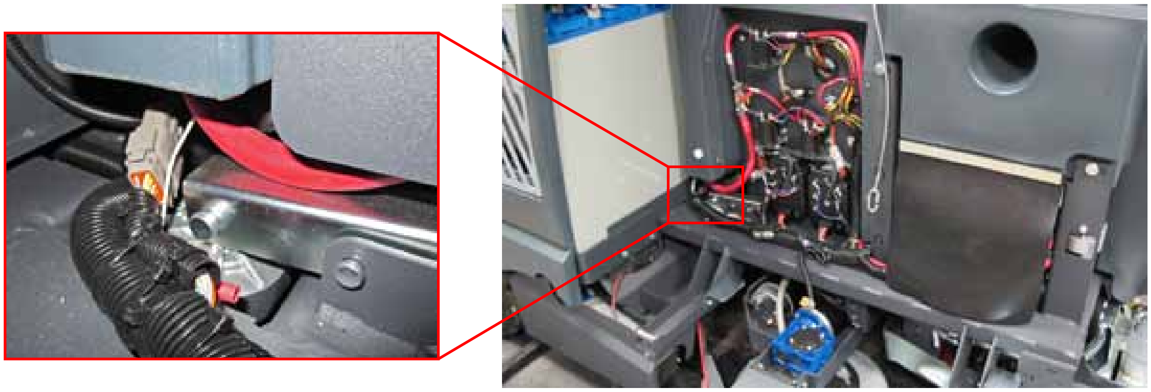


Main Harness X99 to Taillight Harness X152

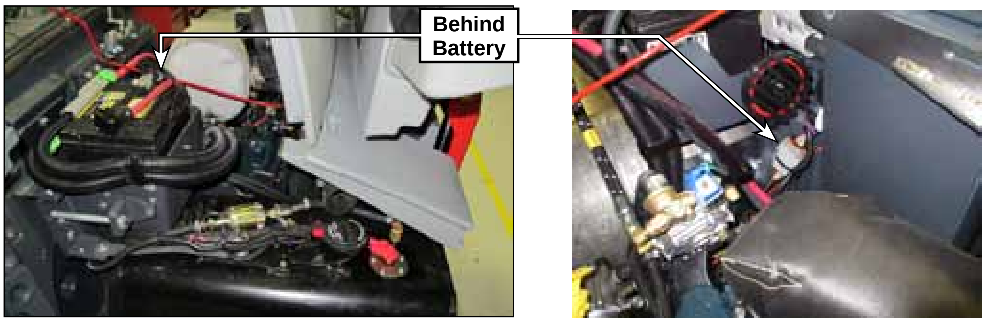




Main Harness X45 to Engine Interface Harness X137

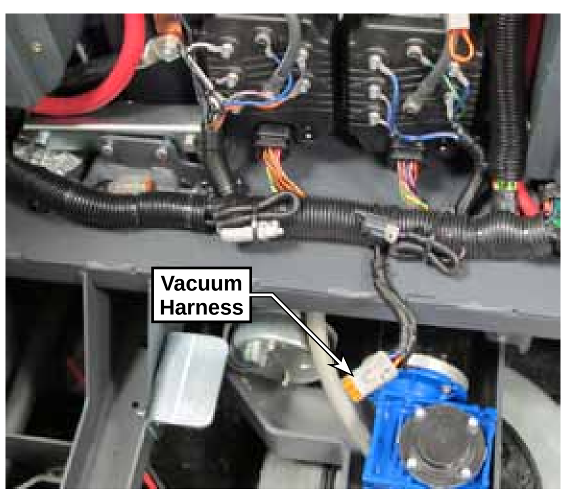


Engine Interface Harness X137 to Engine Harness (Photo of diesel engine)



Telematics Jumper

Vacuum Motor Harness

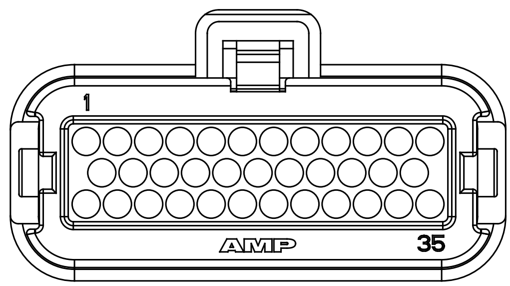


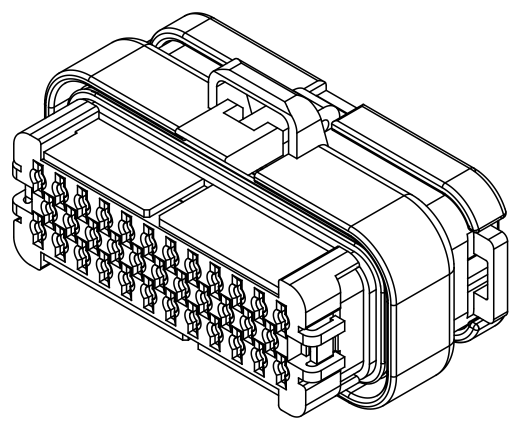
Connector Pin-Outs

The following pages contain details about every electrical connector that contains more than one “cavity”. This is to help you match up the wires and pin numbers of the connector.

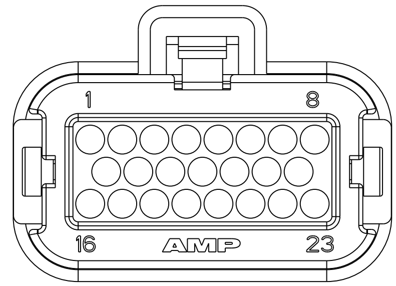
J1 Main Machine Controller

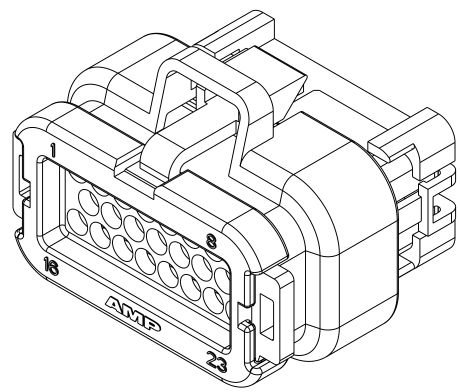
Pin	Color	Name
1	GRY-BLU	Throttle 1
2	GRY-ORN	Throttle 2
3	WHT-ORN	Hyd. Clutch
4		
5	BRN	Headlights
6	YEL-BRN	VACC1
7	PNK	Ignition output
8	YEL-ORN	L2 Solution Valve
9	BLU-PNK	Start output
10	GRY-ORN	E-Stop input
11	GRN-BLU	Battery Interlock input
12	PNK	Seat Switch input
13	VIO-RED	12V Input
14	WHT-YEL	M23 Detergent pump
15	BLU-YEL	M23 Detergent pump
16	WHT-RED	M24 Detergent pump
17	BLU-RED	M24 Detergent pump
18	GRN-BRN	H1 Backup Alarm
19	BLK-ORN	K1 Main Relay Control
20	YEL-RED	LT6 Right Front Turn
21	VIO-GRN	Start Input
22	GRY	Run Signal input
23	ORN	KSI (Key Switch Input)
24	TAN-RED	Tail lamp control
25	ORN-YEL	LT5 Left Front Turn
26	BRN-RED	M1 and L1 Dust Guard
27	BLK	Battery Negative Power
28	RED-YEL	M22 Solution Pump
29	VIO	VACC2
30	VIO	VACC2
31	ORN-BLU	LT9 Left Rear Turn/Stop
32	YEL-GRN	LT10 Right Rear Turn/Stop
33	VIO-ORN	M19 Extended Scrub Pump
34	BLK	Battery Negative Power
35	VIO-BRN	H2 Horn



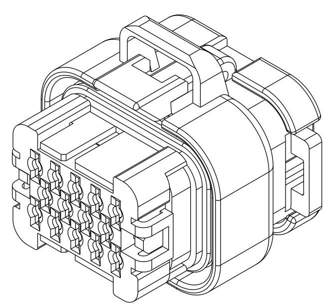


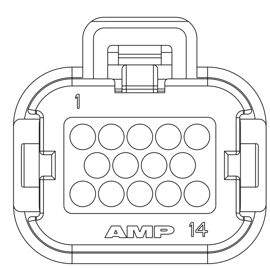
J2 Main Machine Controller			
Pin	**Color**	**Name**	
1	YEL-BRN	Throttle 1	
2	GRN	Throttle 2	
3	BLK	Hyd. Clutch	
4	BLU-BLK		
5		Headlights	
6	BLK	VACC1	
7	GRY-GRN	Ignition output	
8	WHT-GRN	L2 Solution Valve	
9	ORN-GRY	Start output	
10	GRY-YEL	E-Stop input	
11	GRN-WHT	Battery Interlock input	
12	YEL/WHT	Seat Switch input	
13	GRY-VIO	12V Input	
14	YEL-VIO	M23 Detergent pump	
15	GRN-YEL	M23 Detergent pump	
16	YEL-RED	M24 Detergent pump	
17	ORN-RED	M24 Detergent pump	
18	GRN-ORN	H1 Backup Alarm	
19	TAN-RED	K1 Main Relay Control	
20	BLK-YEL	LT6 Right Front Turn	
21	TAN-RED	Start Input	
22	TAN-WHT	Run Signal input	

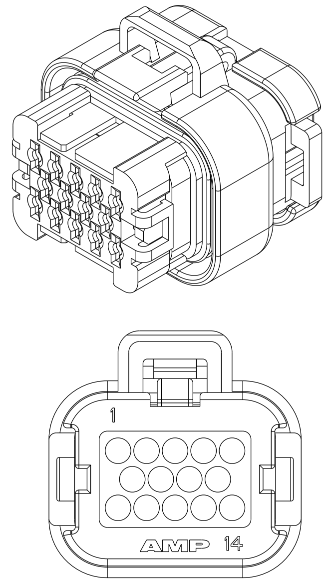




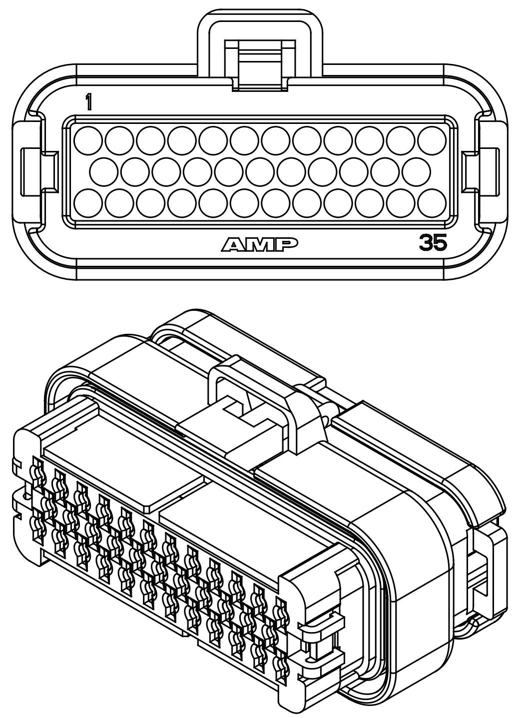
J3 Power Module #1			
Pin	**Color**	**Name**	
1	ORN-BLK	M7 Dump Door Actuator	
2	BRN-BLU	K2 Coil	
3	GRN-WHT	CAN 0 Low	
4	YEL-WHT	CAN 0 High	
5	ORN-YEL	Curtis Programmer	
6	ORN-GRY	M7 Dump Door Actuator	
7	ORN-VIO	Curtis Programmer	
8	ORN-WHT	Curtis Programmer	
9	ORN	KSI	
10	WHT-BLK	M8 Shaker Motor	
11	BLU-ORN	M8 Shaker Motor	
12	BLK	Battery Negative	
13	TAN-VIO	M6 Main Broom Actuator	
14	BLK-GRY	M6 Main Broom Actuator	



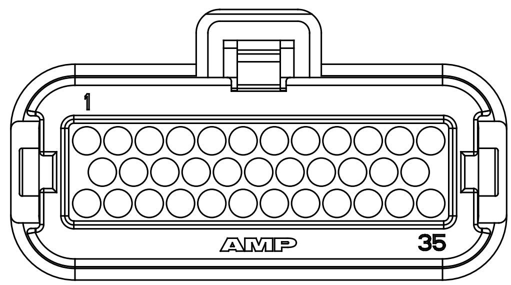


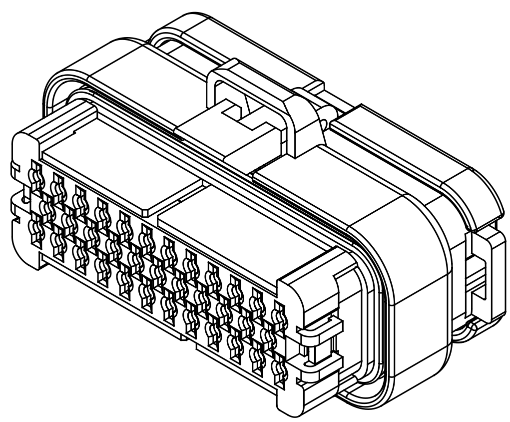
J4 Power Module #2			
Pin	**Color**	**Name**	
1	GRN-VIO	M17 Deck Actuator Motor	
2	BRN-GRN	K3Coill	
3	GRN-WHT	CAN 1 Low	
4	YEL-WHT	CAN 1 High	
5	PNK-YEL	Curtis Programmer	
6	RED-GRY	M17 Deck Actuator Motor	
7	PNK-VIO	Curtis Programmer	
8	PNK-WHT	Curtis Programmer	
9	ORN	KSI	
10	RED-BRN	M18 Side Broom Actuator	
11	TAN-BLU	M18 Side Broom Actuator	
12	BLK	Battery Negative	
13	VIO-BLU	M16 Squeegee Actuator	
14	BRN-WHT	M16 Squeegee Actuator	

J5 Drive Controller		
Pin	**Color**	**Name**
1		
2		
3	ORN	KSI (Control Power) Input
4	TAN-ORN	K4 Coil Control: PWM Bat-
5	PNK-RED	11V out commutator
6	BLK-PNK	Sensor ground out
7	TAN-BLK	Commutator 1 input
8	PNK-BLU	Commutator 2 input
9		
10		
11		
12	PNK	Seat Switch input
13		
14		
15		
16		
17	ORN-GRN	Steering Ready
18		
19	GRY-ORN	E-Stop Switch input
20	BRN-RED	R4 Foot Pedal Throttle
21	GRN	CAN 0 Low
22		
23		
24		
25	TAN-RED	Motor Temperature
26		
27		
28	ORN	KSI Input
29	VIO-GRN	Unswitched Bat+ to K4 coil
30		
31	VIO-BLK	Bat- to throttle pot
32	WHT-BLK	5V to throttle pot
33	YEL	CAN 0 High
34		
35		

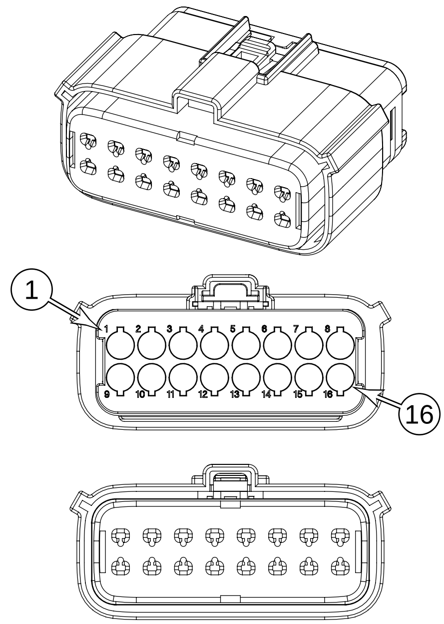


J6 Steering Controller			
Pin	**Color**	**Name**	
1	VIO-WHT	TFD coil (positive)	
2			
3	ORN-GRN	KSI (Key Switch Input)	
4	ORN-GRN	Enable Drive output	
5	RED-BLU	12V power to resolver	
6	BLK	Internal sensor ground	
7	VIO-GRY	Encoder 1A input	
8	WHT-GRY	Encoder 1B input	
9			
10	BLK	Batt- Control Power	
11	BLK	Batt- to steering wheel sensor	
12			
13	YEL-BLK	K5 Relay Coil	
14			
15	ORN-RED	SW12 Right Travel limit switch	
16	GRN-WHT	TFD encoder 1	
17	GRN-BLK	TFD encoder 2	
18	VIO-PNK	Encoder 3A input	
19	WHT-PNK	Encoder 3B input	
20			
21	GRN	CAN 0 Low	
22			
23	RED-GRN	5V power for TFD encoders	
24	BRN-GRN	TFD coil (negative)	
25			
26	PINK	Steering Actuator temperature	
27	ORN-BLU	SW11 Left Travel limit switch	
28			
29	YEL-BLU	K5 relay coil	
30	GRN-WHT	TFD encoder 1	
31	GRN-BLK	TFD encoder 2	
32			
33	YEL	CAN 0 High	
34			
35			

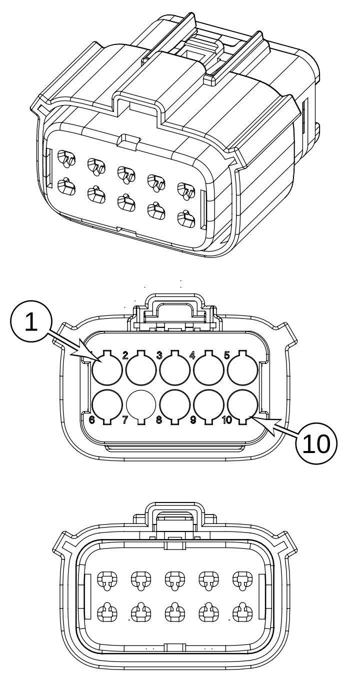




X113 Hopper Harness 2			
Pin	Color	Name	
1	VIO-WHT	TFD coil (positive)	
2			
3	ORN-GRN	KSI (Key Switch Input)	
4	ORN-GRN	Enable Drive output	
5	RED-BLU	12V power to resolver	
6	BLK	Internal sensor ground	
7	VIO-GRY	Encoder 1A input	
8	WHT-GRY	Encoder 1B input	
9			
10	BLK	Batt- Control Power	
11	BLK	Batt- to steering wheel sensor	
12			
13	YEL-BLK	K5 Relay Coil	
14			
15	ORN-RED	SW12 Right Travel limit switch	
16	GRN-WHT	TFD encoder 1	

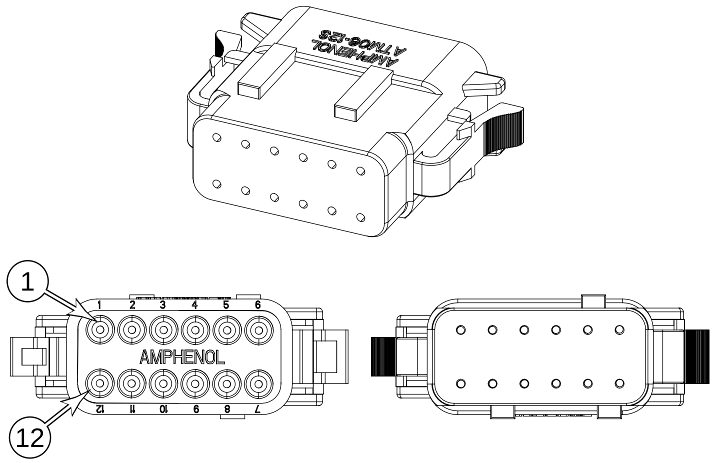


X112 Hopper Harness 1			
Pin	Color	Name	
1	VIO-WHT	TFD coil (positive)	
2			
3	ORN-GRN	KSI (Key Switch Input)	
4	ORN-GRN	Enable Drive output	
5	RED-BLU	12V power to resolver	
6	BLK	Internal sensor ground	
7	VIO-GRY	Encoder 1A input	
8	WHT-GRY	Encoder 1B input	
9			
10	BLK	Batt- Control Power	
11	BLK	Batt- to steering wheel sensor	
12			
13	YEL-BLK	K5 Relay Coil	
14			
15	ORN-RED	SW12 Right Travel limit switch	
16	GRN-WHT	TFD encoder 1	



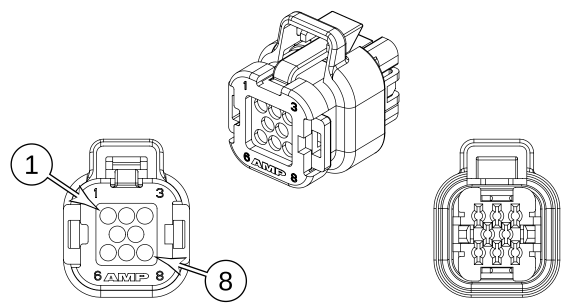
X45 Engine Interface

Pin	Color	Name
1	PINK	Ignition
2	BLU-PNK	Start
3	GRN-YEL	Coolant temp
4	GRY	Run signal
5	GRY-ORN	Throttle 2
6	GRY-BLU	Throttle 1
7	WHT-ORG	Hydraulic clutch
8	YEL-RED	Oil Pressure
9	TAN-WHT	Fuel level
10		
11	ORN	KSI
12	TAN-RED	Check Engine



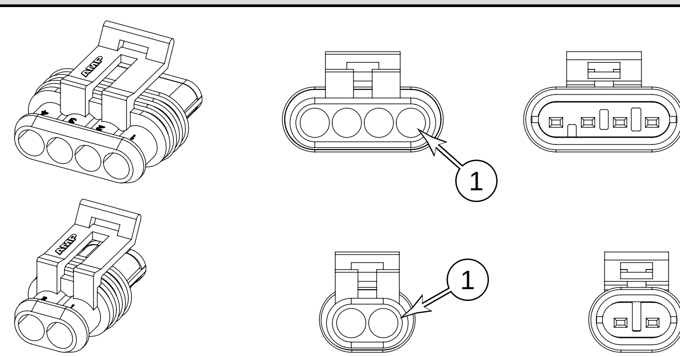
X98 Steering Motor

Pin	Color	Name
1	VIO-PNK	Encoder 3B
2	WHT-PNK	Encoder 3A
3	BLK	B-
4	BLK	B-
5	YEL-RED	Temperature
6	VIO-GRY	Encoder 1A
7	WHT-GRY	Encoder 1B
8	RED-BLU	+12V

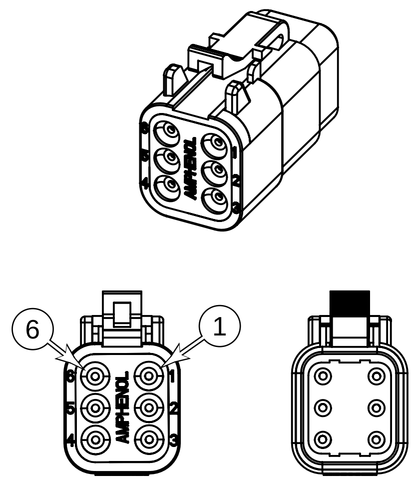


X91/92 Wheel Drive Motor

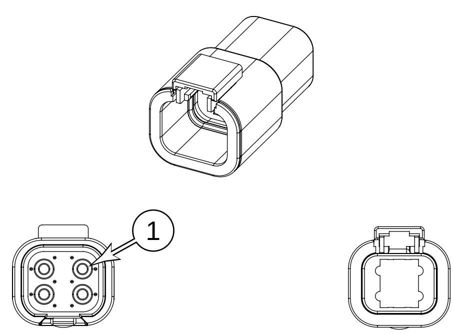
Pin	Color	Name
1	PNK-RED	+11 V
2	PNK-BLU	Encoder 2
3	TAN-BLK	Encoder 1
4	PNK-BLK	B-
1	TAN-RED	Temp Sensor
2	PNK-BLK	B-



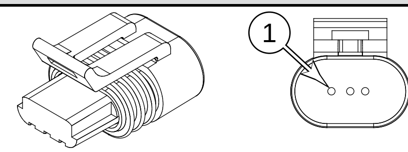
Common 6-Pole Connectors		
X56 Steering Wheel Position Sensor		
Pin	**Color**	**Name**
1	RED-GRN	+5
2	BLK	Gnd
3	GRN-GRY	Encoder 1
4	GRN-BLK	Encoder 2
5	VIO-WHT	Batt+
6	BRN-GRN	TFD control
X82 Main Broom Actuator		
Pin	**Color**	**Name**
1	BLK-GRY	PWM A
2		
3	TAN-VIO	PWM B
4	GRY-GRN	Pot+
5	TAN-RED	Wiper
6	BLU-BLK	Pot-
X130 Dump Door Actuator		
Pin	**Color**	**Name**
1	ORN-GRY	PWM A
2		
3	ORN-BLK	PWM B
4	BLU-BLK	Pot+
5	ORN-RED	Wiper
6	BLU-BLK	Pot-



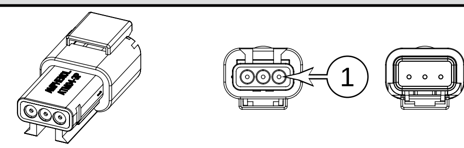
Common 4-Pole Connectors		
X85 Vacuum Motor Harness		
Pin	**Color**	**Name**
1	GRY-RED	Vac 1 Control
2	BLU-GRY	B+
3	ORN-BLU	Vac 2 Control
4	BLU-GRY	B+
X99 Tail Light Harness		
Pin	**Color**	**Name**
1	ORN-BLU	Right Turn
2	TAN-RED	Tail Lights
3	BLK-YEL	B-
4	YEL-GRN	Left Turn



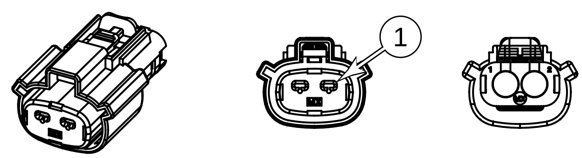
X47 Foot Pedal			
Pin	**Color**	**Name**	
1	WHT-BLK	+5	
2	BRN-RED	Wiper	
3	VIO-BLK	Gnd	



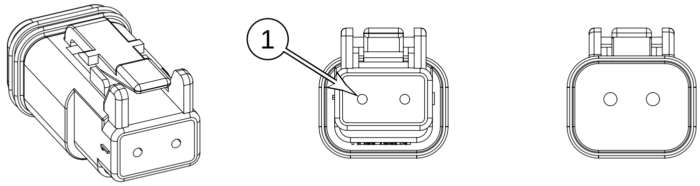
X124 Shaker Motor			
Pin	**Color**	**Name**	
1	BLU-GRY	Control A	
2	ORN-RED	Control B	
3	GRN-YEL	Chassis Ground	



2-Pole High Power Connectors		
X107 Main Broom		
Pin	**Color**	**Name**
1	BLU-GRY	B+
2	WHT-VIO	Ctrl
X104 Right Brush		
Pin	**Color**	**Name**
1	GRY-BLK	Ctrl
2	GRN-GRY	B+
X106 Center Brush		
Pin	**Color**	**Name**
1	BLU-WHT	Ctrl
2	GRN-GRY	B+
X105 Left Brush		
Pin	**Color**	**Name**
1	GRN-GRY	B+
2	BLU-GRN	Ctrl



Common 2-Pole Connectors



X48 Foot Brake		
Pin	**Color**	**Name**
1	ORN-GRY	Signal
2	BLK	Gnd

X100 Deck Actuator		
Pin	**Color**	**Name**
1	RED-GRY	Control A
2	GRN-VIO	Control B

X57 Beacon		
Pin	**Color**	**Name**
1	VIO	B+
2	BLK	Gnd

X101 Extended Scrub Pump		
Pin	**Color**	**Name**
1	VIO-ORN	Control
2	VIO	KSI

X84 Extended Scrub Level		
Pin	**Color**	**Name**
1	GRY-YEL	Signal
2	BLK	GND

X102 Soultion Control Pump		
Pin	**Color**	**Name**
1	RED-YEL	Control
2	VIO	KSI

X86 Backup Alarm		
Pin	**Color**	**Name**
1	VIO	B+
2	GRN-BRN	Control

X103 Low Pressure Pump		
Pin	**Color**	**Name**
1	VIO	KSI
2	BLK	B-

X87 Squeegee Actuator		
Pin	**Color**	**Name**
1	BRN-WHT	Control A
2	VIO-BLU	Control B

X114 Dust Guard Valve		
Pin	**Color**	**Name**
1	VIO	KSI
2	BRN-RED	Control

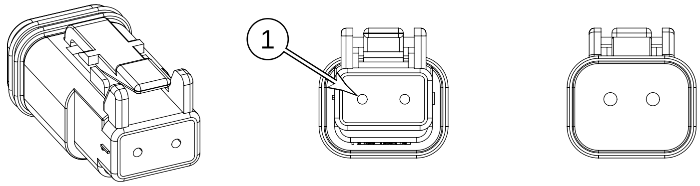
X93 Left Limit Switch		
Pin	**Color**	**Name**
1	ORN	KSI
2	ORN-RED	Signal

X115 Dust Guard Pump		
Pin	**Color**	**Name**
1	VIO	KSI
2	BRN-RED	Control

X94 Right Limit Switch		
Pin	**Color**	**Name**
1	ORN	KSI
2	WHT-BLU	Signal

X123 Dust Fan		
Pin	**Color**	**Name**
1	BLU-GRY	K2 B+
2	BRN-YEL	Control

Common 2-Pole Connectors (continued)



X125 Left Side Broom		
Pin	Color	Name
1	GRN-GRY	K2 B+
2	WHT-BRN	Control

X133 Right Side Broom		
Pin	Color	Name
1	GRN-GRY	K B+
2	BLK-WHT	Control

X127 Left Headlight		
Pin	Color	Name
1	BLK-WHT	KSI
2	BRN	Control

X135 Dump Door Closed Switch		
Pin	Color	Name
1	GRN-ORG	Signal
2	BLU-BLK	B-

X132 Side Broom Actuator		
Pin	Color	Name
1	RED-BRN	Control A
2	TAN-BLU	Control B

X136 Right Headlight		
Pin	Color	Name
1	BLK-WHT	KSI
2	BRN	Control

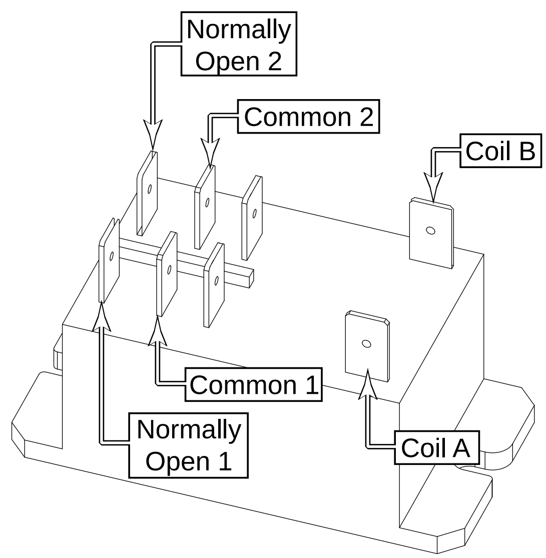
K1 and K5 Relays

The K1 and K5 relays are Single-Pole, Double-Throw (SPDT) box relays. They have two sets of contacts (1 & 2) that close when the coil is energized. When the coil is energized, common 1 connects to Normally Open 1; and Common 2 connects to Normally Open 2.

Both sets of contacts are the same and can be interchanged. Just note that set 1 is isolated from set 2, so they operate as 2 independent switches.

The coil operates at 36 volts, and does not have polarity. So the wires on A and B can be reversed.

The two unlabeled/unused terminals are Normally Closed contacts that open when the relay is energized.



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

Alternator-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)

Note: *Hybrid machines are not normally intended to be operated without the engine running.*

Potential Causes

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

Removal and Installation

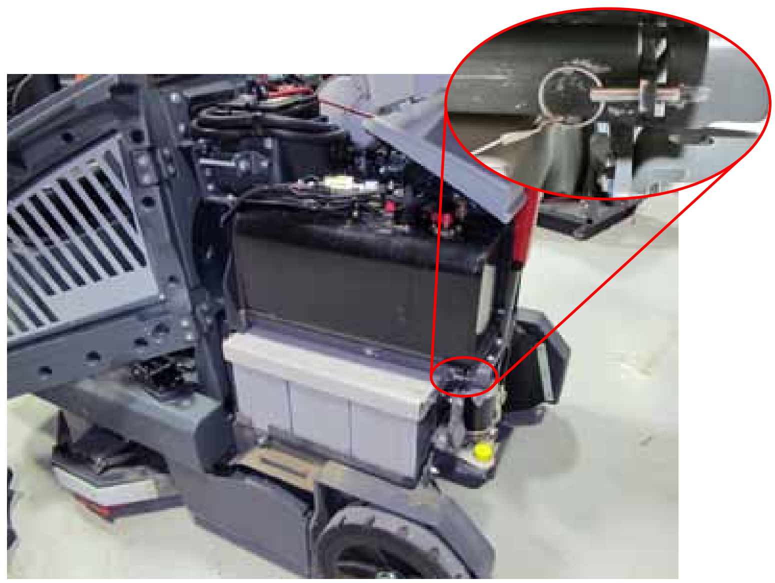
Alternator-Generator Drive Belt

WARNING: Severe arc-flash hazard. Use caution when working with the main battery terminals to avoid shorting across the battery.

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.

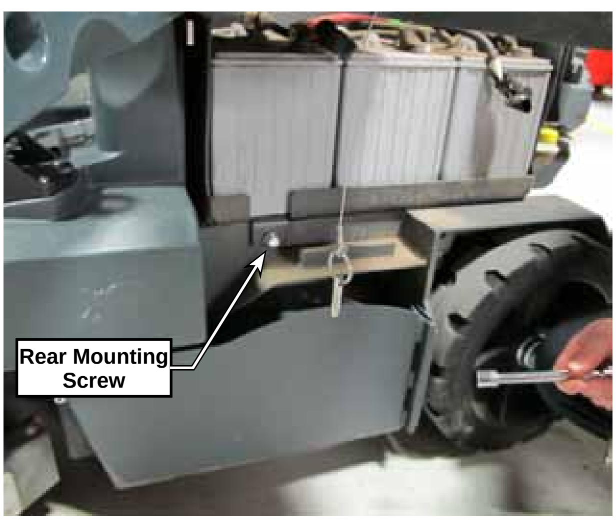


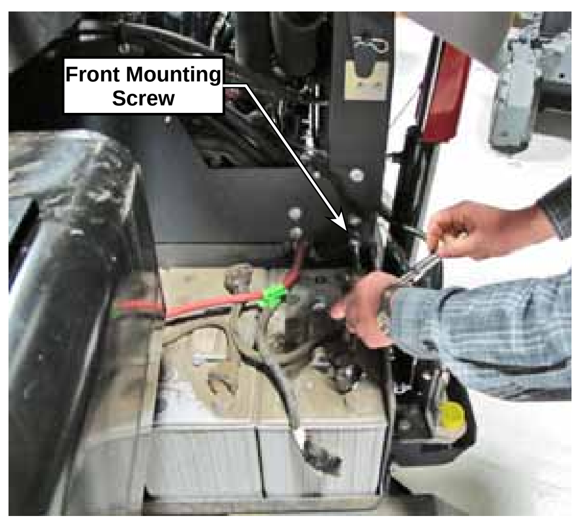
3. Remove the retaining pin and swing out the fuel tank.

4. Remove the 36v battery pack top cover.

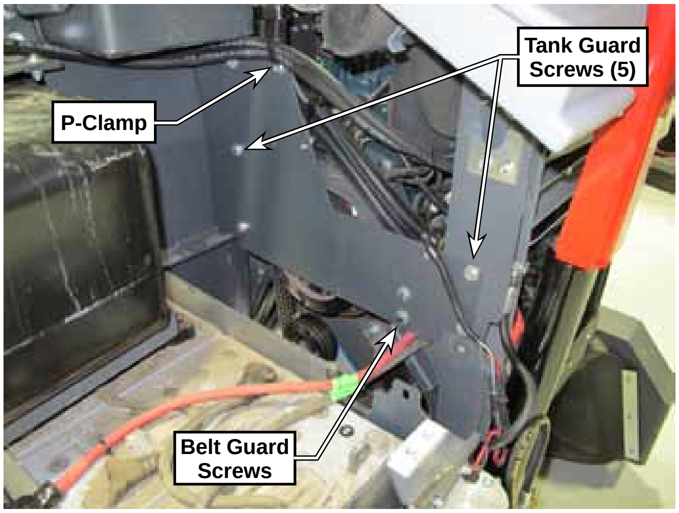
5. Disconnect the main battery negative and positive cables from the battery terminals.

6. Remove the front and rear mounting screws that secure the battery pack tray to frame.

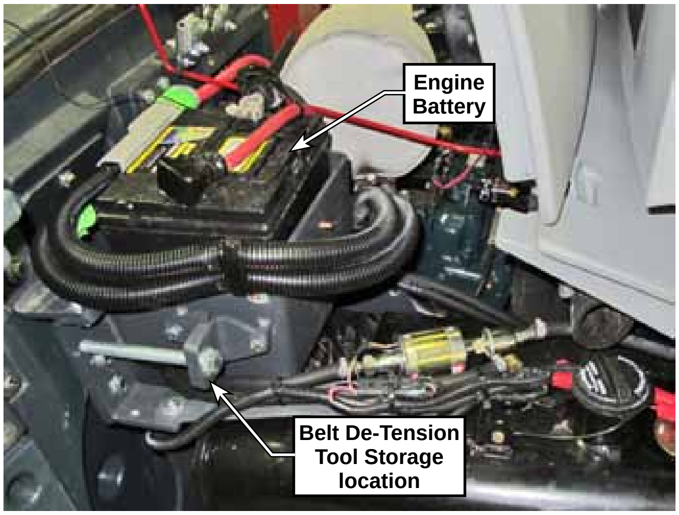




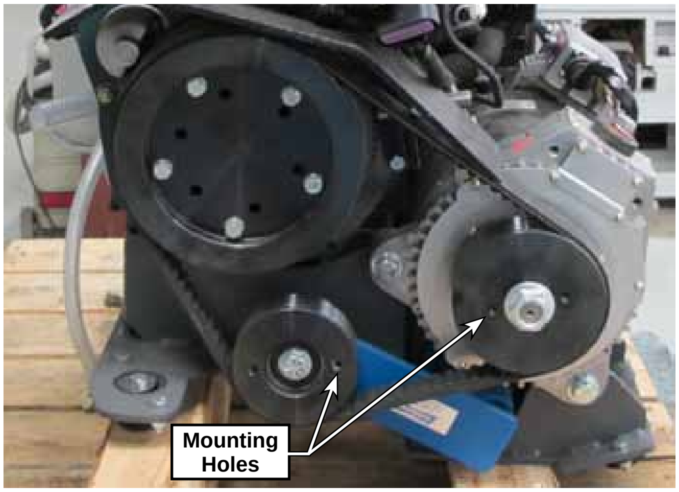
7. Slide the battery tray out until it reaches the end of the tether cable.
8. Remove the two screws that secure the belt guard to the back of the tank guard plate.
9. Remove the P-Clamp, cable, and fuel lines from the top of the tank guard plate.
10. Remove the 5 screws that secure the tank guard plate to the frame, and remove the plate.

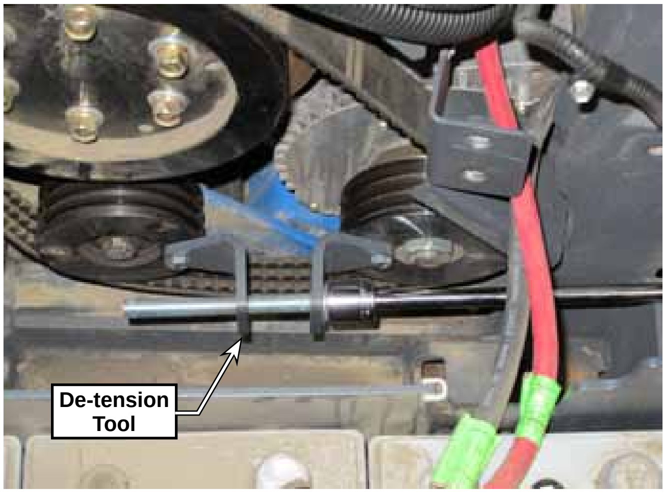


11. A belt de-tensioning tool is stored on the side of the engine battery box. Remove the two screws securing it to the box and remove the tool from storage.
12. Unscrew the adjustment screw on the tension tool until the two halves are far enough apart to reach the mounting holes in the generator pulley and idler pulley.
13. Using the screws that previously attached the tool to the battery box, bolt the de-tensioning tool across the two pulleys.
14. Begin tightening the adjustment screw to draw the idler pulley toward the generator pulley until enough tension has been removed from the belt to remove it.



15. Replace the belt and reassemble the machine. Make sure to replace the de-tension tool in its storage location.

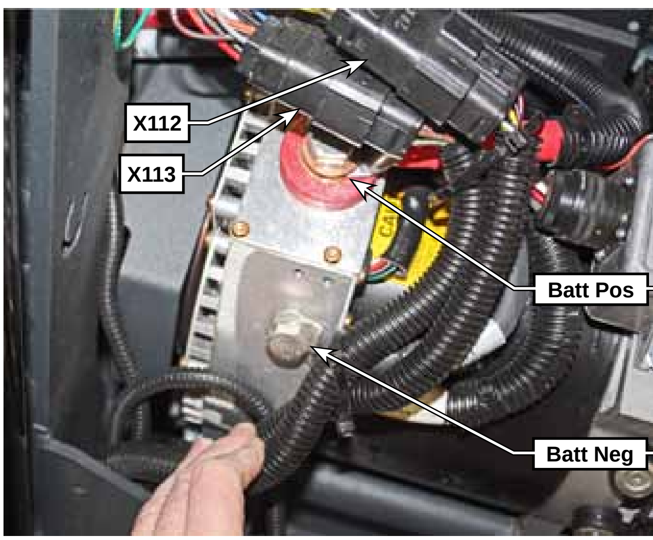


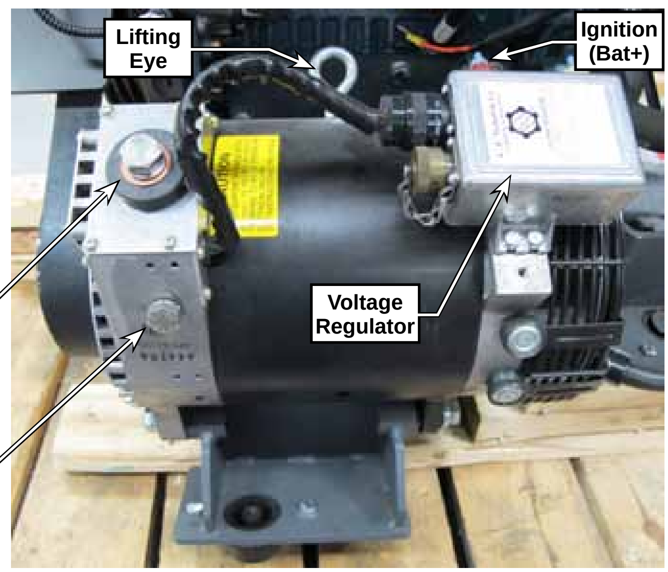


Alternator-Generator

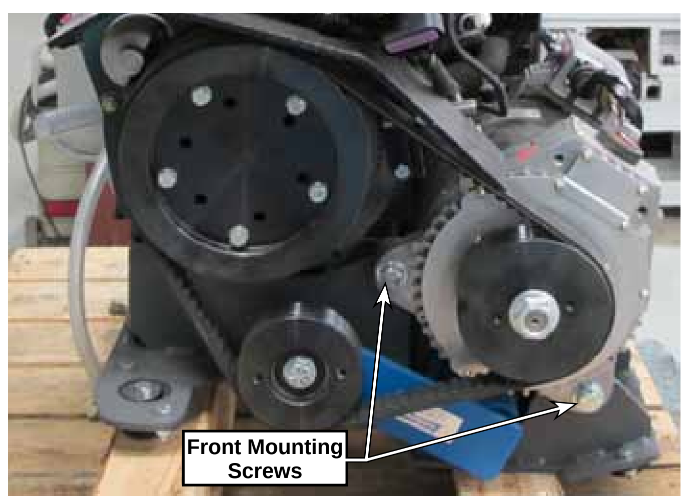
WARNING: Severe arc-flash hazard. Use caution when working with the main battery terminals to avoid shorting across the battery.

1. Remove the Alternator-Generator Drive Belt described on page 114. In conjunction with that procedure, also remove the belt guard when removing the tank guard.
   - Verify that the main battery cables are still disconnected from the drive belt procedure.
2. Unbolt the dust curtain to expose the front of the engine area.
3. Disconnect the X112 and X113 hopper harness connectors, and free up all of the nearby wiring away from the generator.
4. Remove the two main battery positive cables from the generator. Make note of washer and cable sequence for later reassembly.
5. Remove the two main battery negative cables from the generator. Make note of washer and cable sequence for later reassembly.
6. Remove the orange ignition wire from the voltage regulator.
7. Check to make sure no additional wires, cables, or other components can get snagged on the generator during removal.





8. Remove the two front and one rear mounting screws that secure the generator to the engine frame.
9. Using necessary slings and/or the lifting eye, lift the generator out of the machine.



Wiring Diagrams

Working with Schematics and Diagrams

Wiring diagrams show how electrical components are connected together and to a large degree “how things work”. However, they do not specifically show where things are located on the machine. The most common diagram is the schematic. The schematic represents the connections and interactions between components, using abstract symbols to generically represent the components. There are different forms of schematics, which vary depending on their purpose and even type of system. Schematics can be used to represent electrical systems, hydraulic systems, pneumatic systems, or countless other interconnected systems.

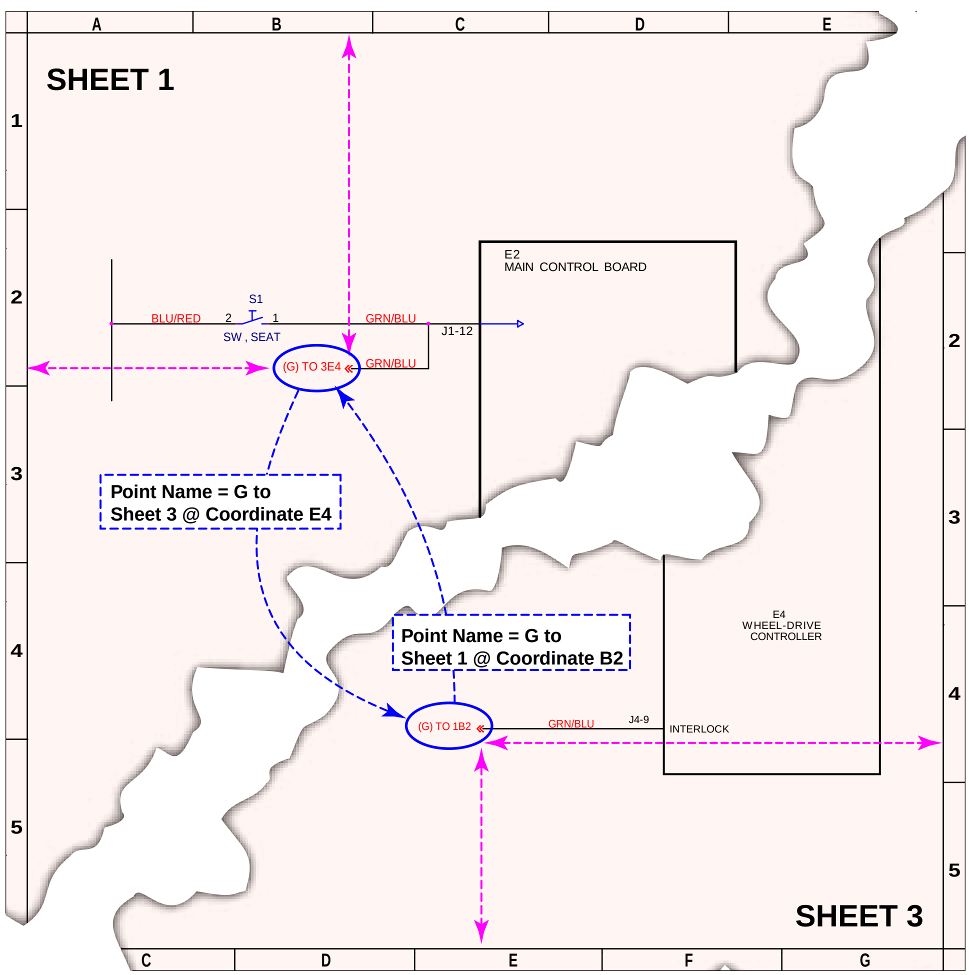
Navigation

In some cases it is necessary to have references across different areas of a drawing. These references can point across the drawing sheet, or to different sheets in a multi-sheet schematic. The references are commonly referred to as “Tags”. At a minimum, tags typically have a name or designation, but they may also contain coordinate pointers to their counterpart.

In the sample diagram below, the output from the seat switch needs to connect to the main controller on sheet #1 and also to the drive controller on sheet #3. The identifying name could be an actual name, such as (Seat Switch), or in this case, just a letter designator (G). Both ends of a tag will have the same identifier.

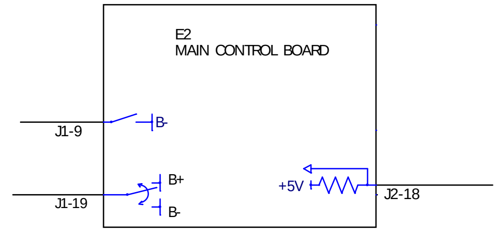
In addition to the identifier, the tag also contains coordinate information to help you locate the mating tag faster. So the first tag contains the coordinates of the second tag, and the second tag contains the coordinates of the first tag. The format of these coordinates are Sheet, Column, and Row.

These coordinates are part of the default title blocks on engineering drawings, and run around the perimeter of the drawing sheet. The columns are represented by the letters across the top/bottom of the drawing, and the rows are represented by the numbers down the sides of the drawing.



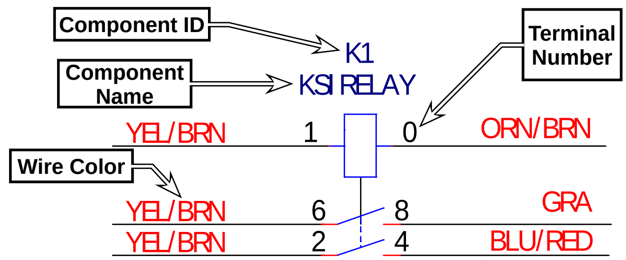
Common Schematic Symbols

Control Board Inputs and Outputs: Not all control board inputs or outputs are given special symbolic meaning, but to the left are a couple of commons symbols. The right-hand side shows an input with a pull-up resistor. The significance of this input is that when the input is an open circuit, the pull-up resistor forces the input positive. This type of input is active when the external device pulls the signal to ground.

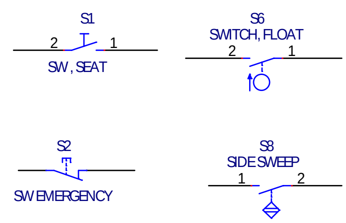


The two outputs on the left signify a PWM controlled output, with the upper symbol signifying a positive PWM, and the lower symbol signifying a reversing positive/negative PWM control.

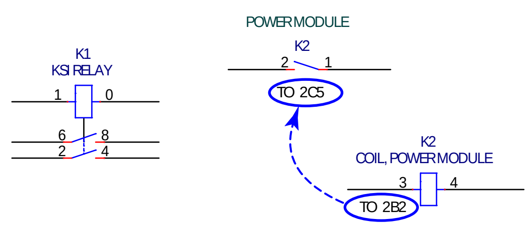
Identification: Each component on the schematic contains a variety of identifying information that is useful for troubleshooting and tracing circuits. The component ID is used throughout the system to identify the device, including in the controller menu display. The component name helps identify the device as it relates to the machine itself. The wire color identifiers help for tracing wire connections to the device, and when applicable, the terminal numbers identify where those wires connect to the device.



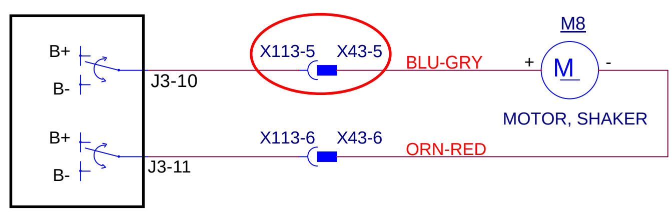
Switches: Switches come in several types, but the most significant aspect about a switch is whether its contacts are normally-open or normally-closed. Schematically, normally-open switches are drawn with the switch blade above the contact position, and normally-closed switches are drawn with the switch blade below the contact. Some switches are shown with additional pictographic elements to signify the type of action used to control the switch. For example, a float switch uses a symbol resembling a float ball.



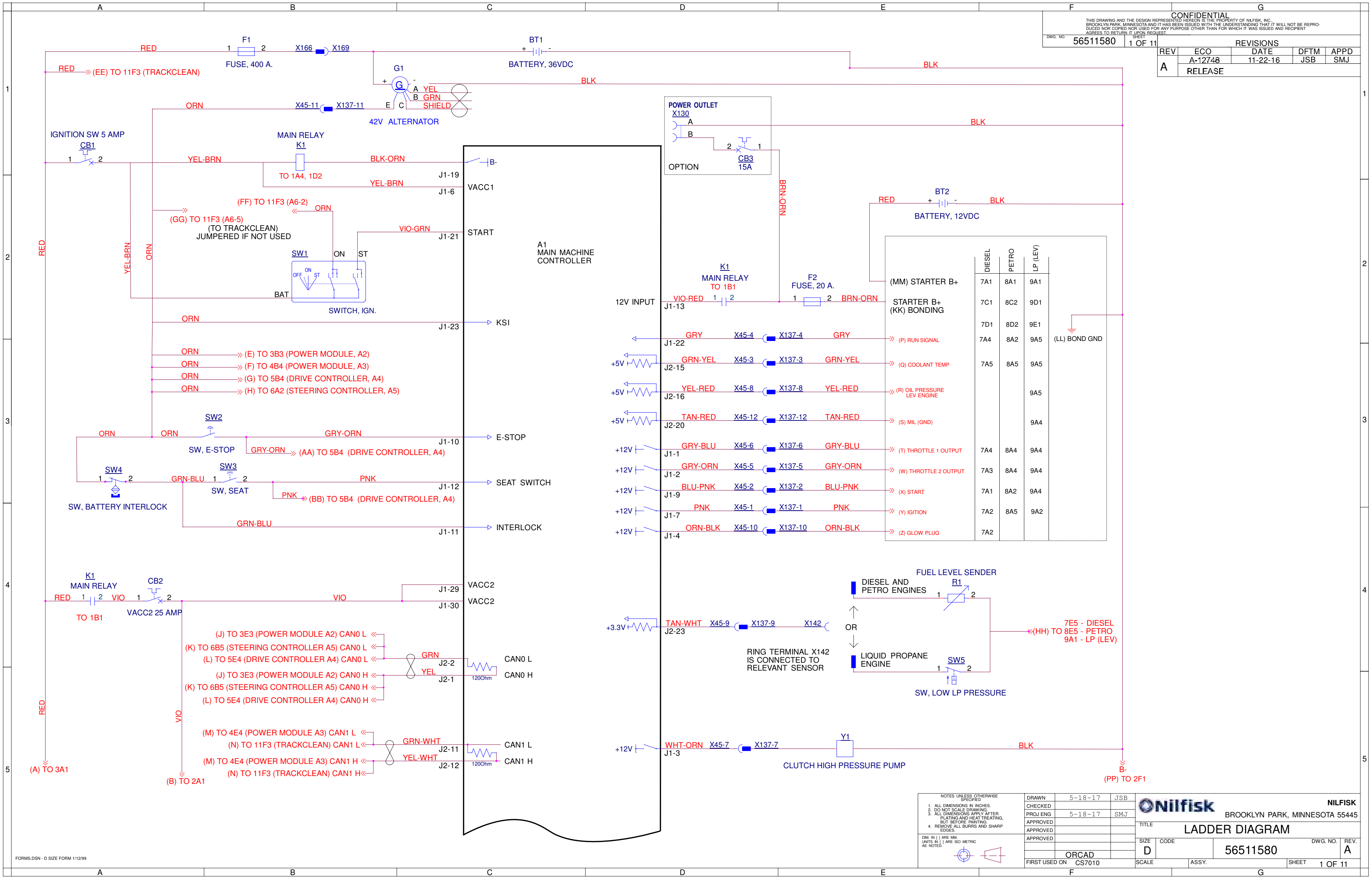
Relays: Relays are solenoid-controlled switches. Whenever possible, they are drawn with the relay coil and switch(s) stacked vertically, with a dotted line between them to signify the control. When the coil and contacts can't be kept together, they use reference tags as shown to the right .



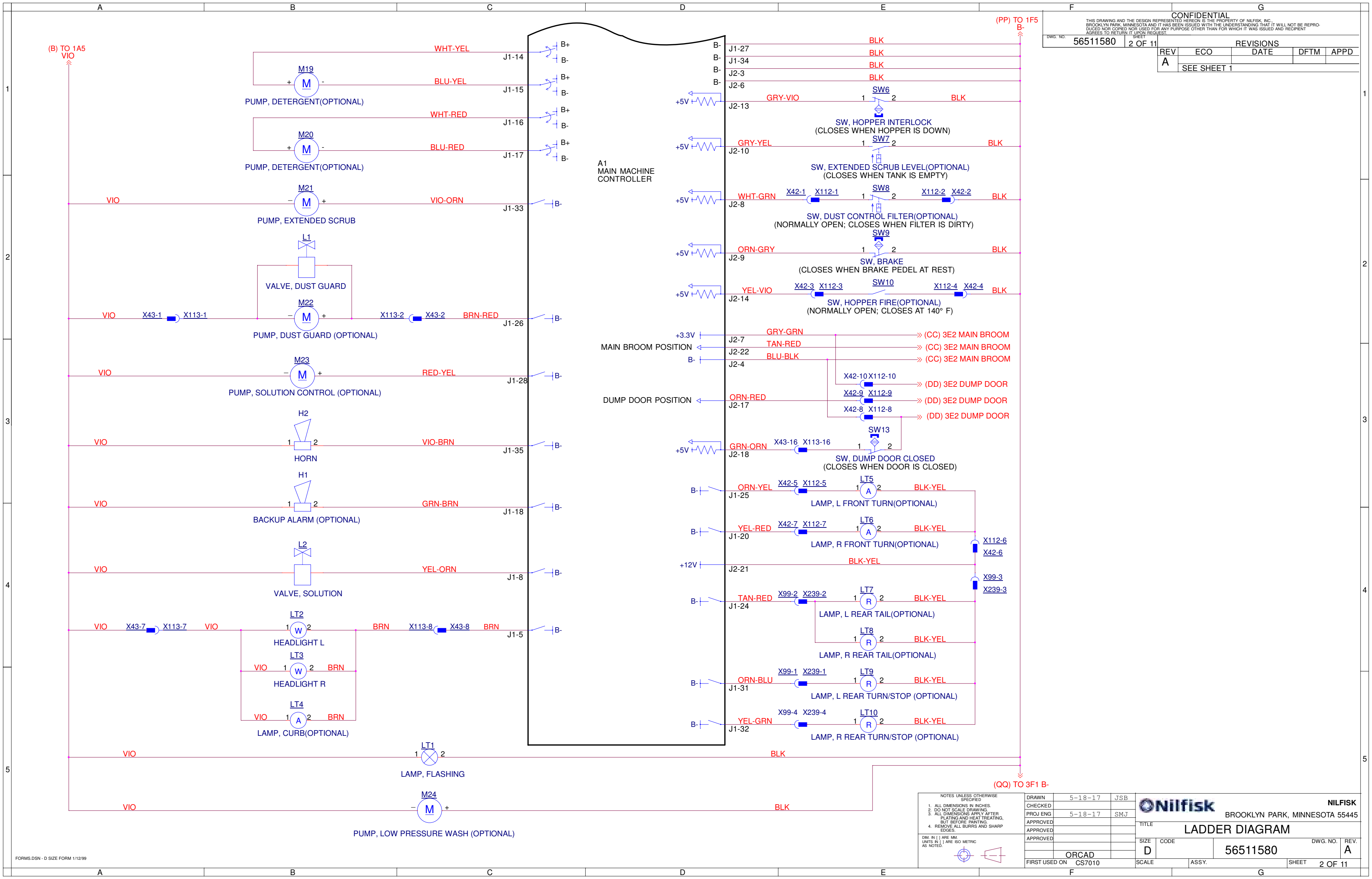
The wiring diagrams show when a circuit passes through an in-line connector. The connector symbol identifies the male and female connector numbers, and also the pin number of the particular wire. The "Connector Pin-Outs" on page 102 contains tables of all connectors and their pin assignments, which correlate to the designations in the schematic.



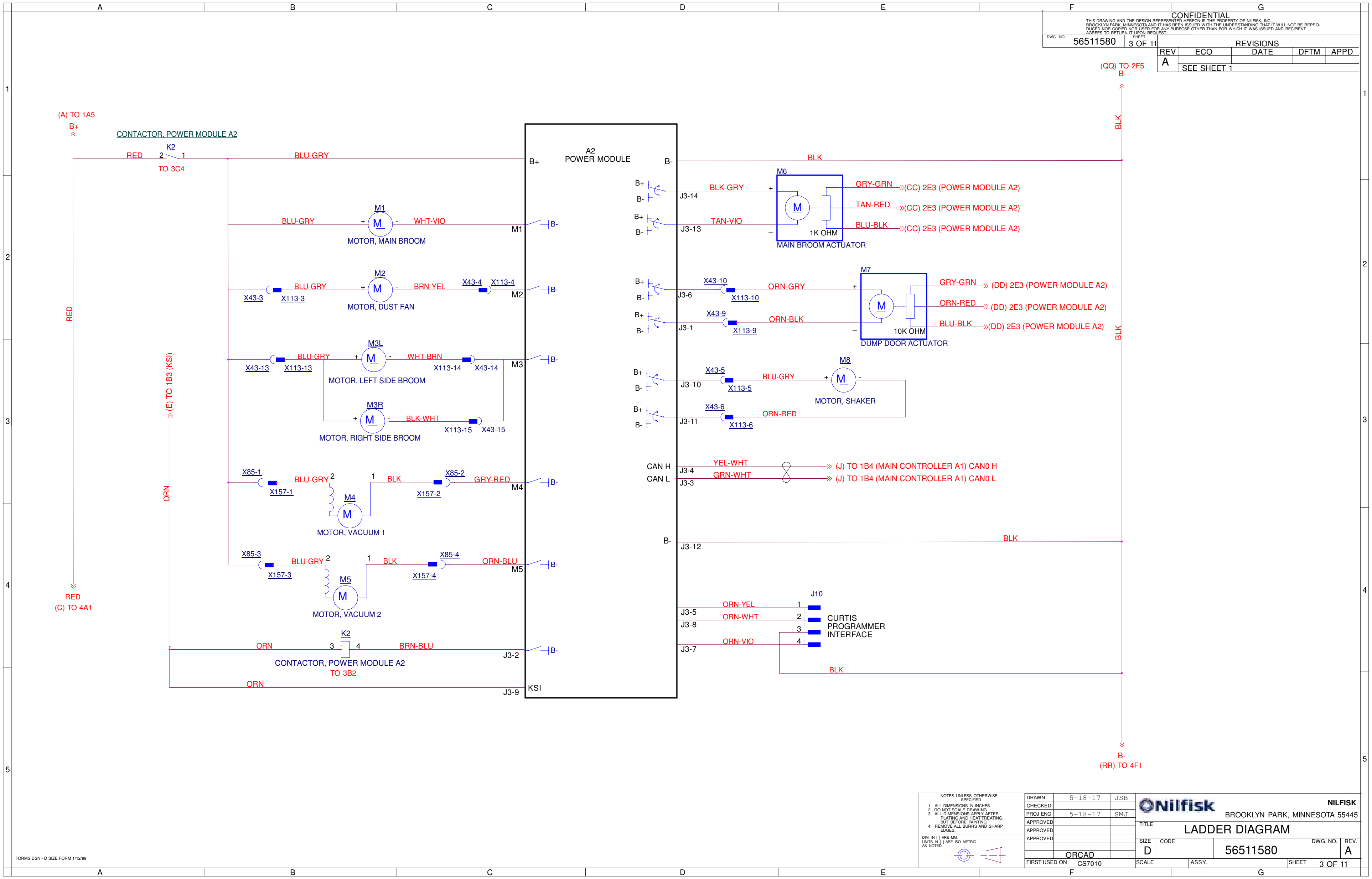
Main Schematic (Ladder Diagram)
56511580, Rev A, 11/22/2016
Sheet 1, Main Controller Part 1



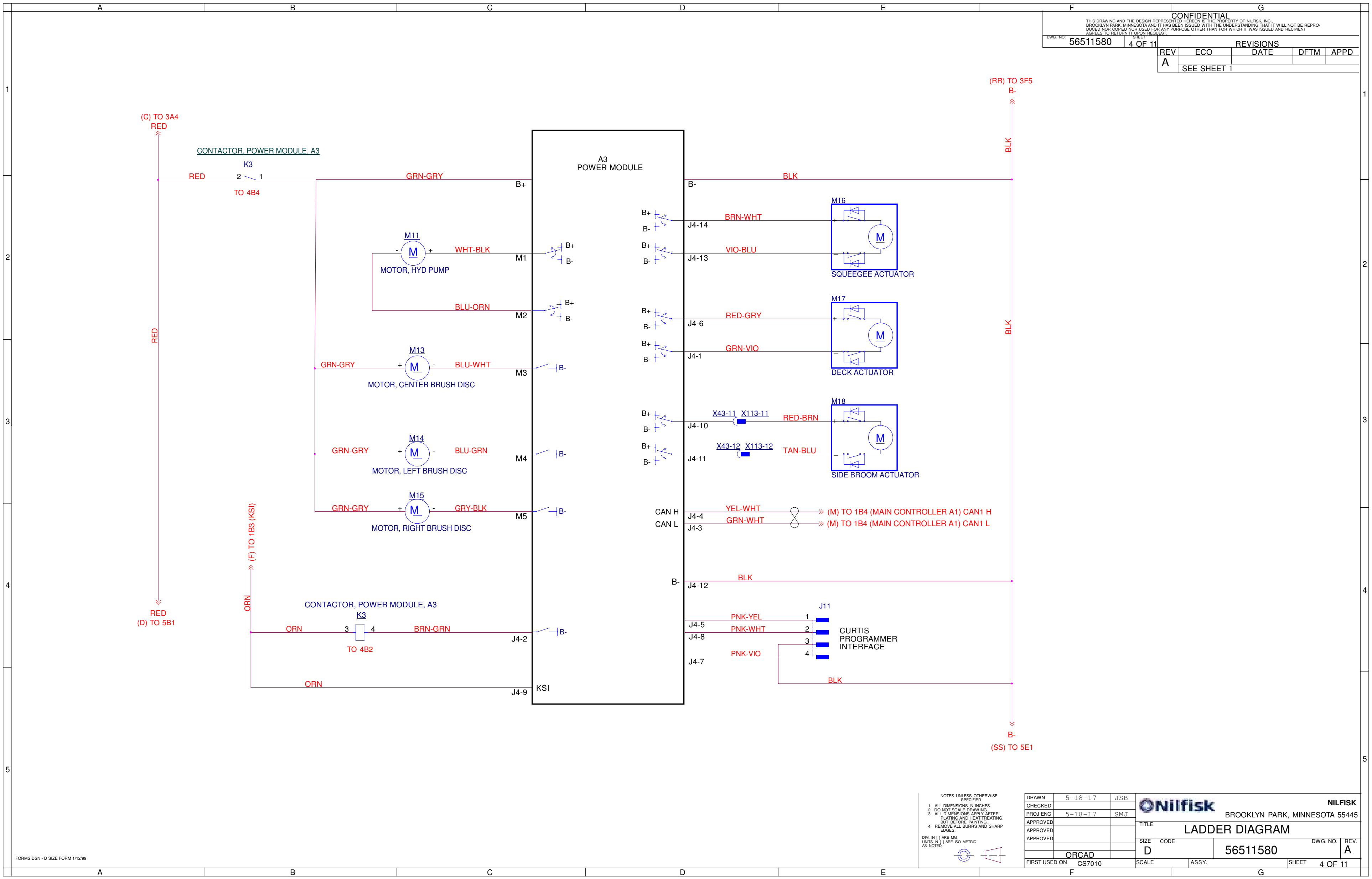
Sheet 2, Main Controller Part 2



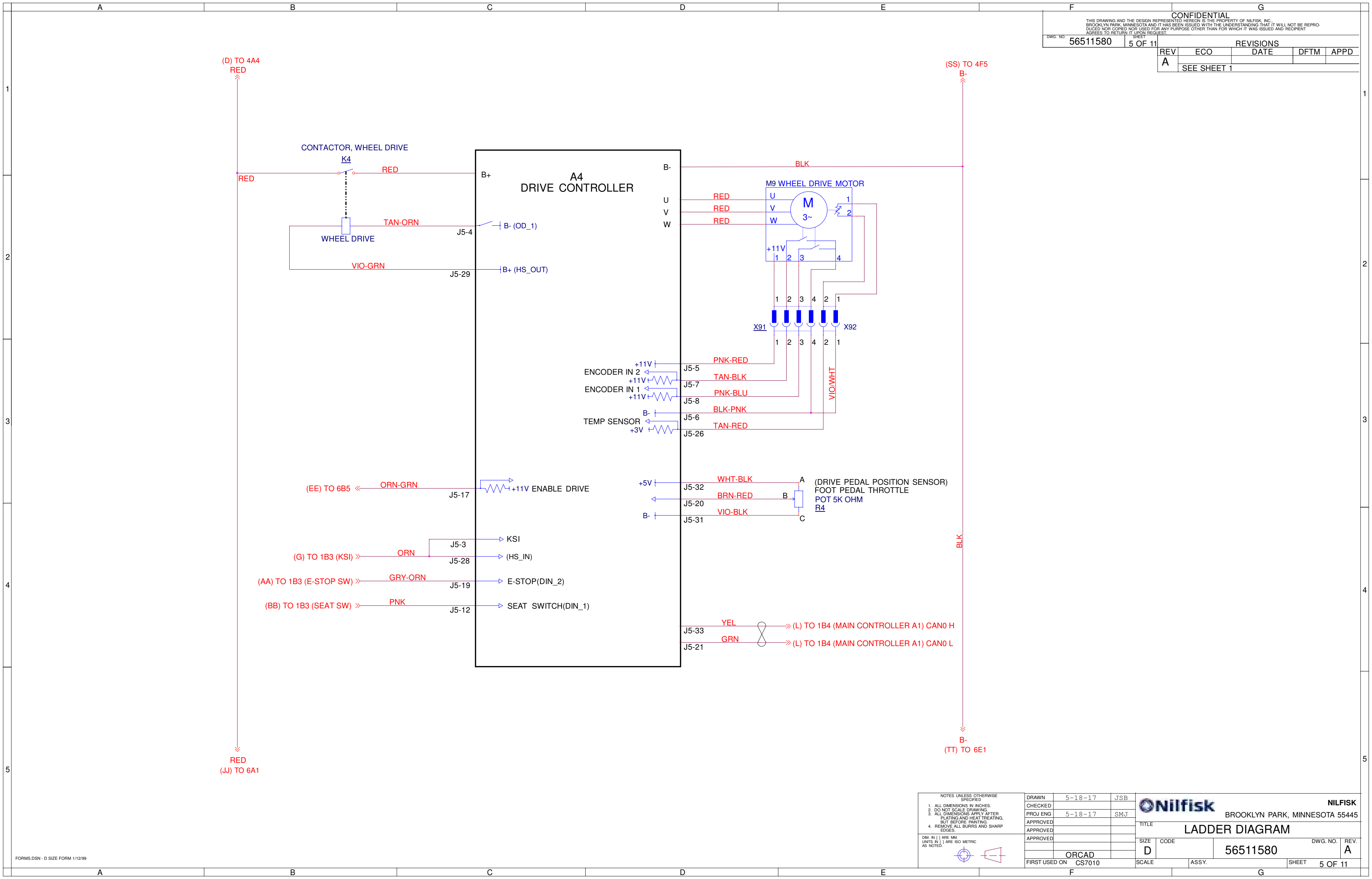
Sheet 3, A2 Power Module #1



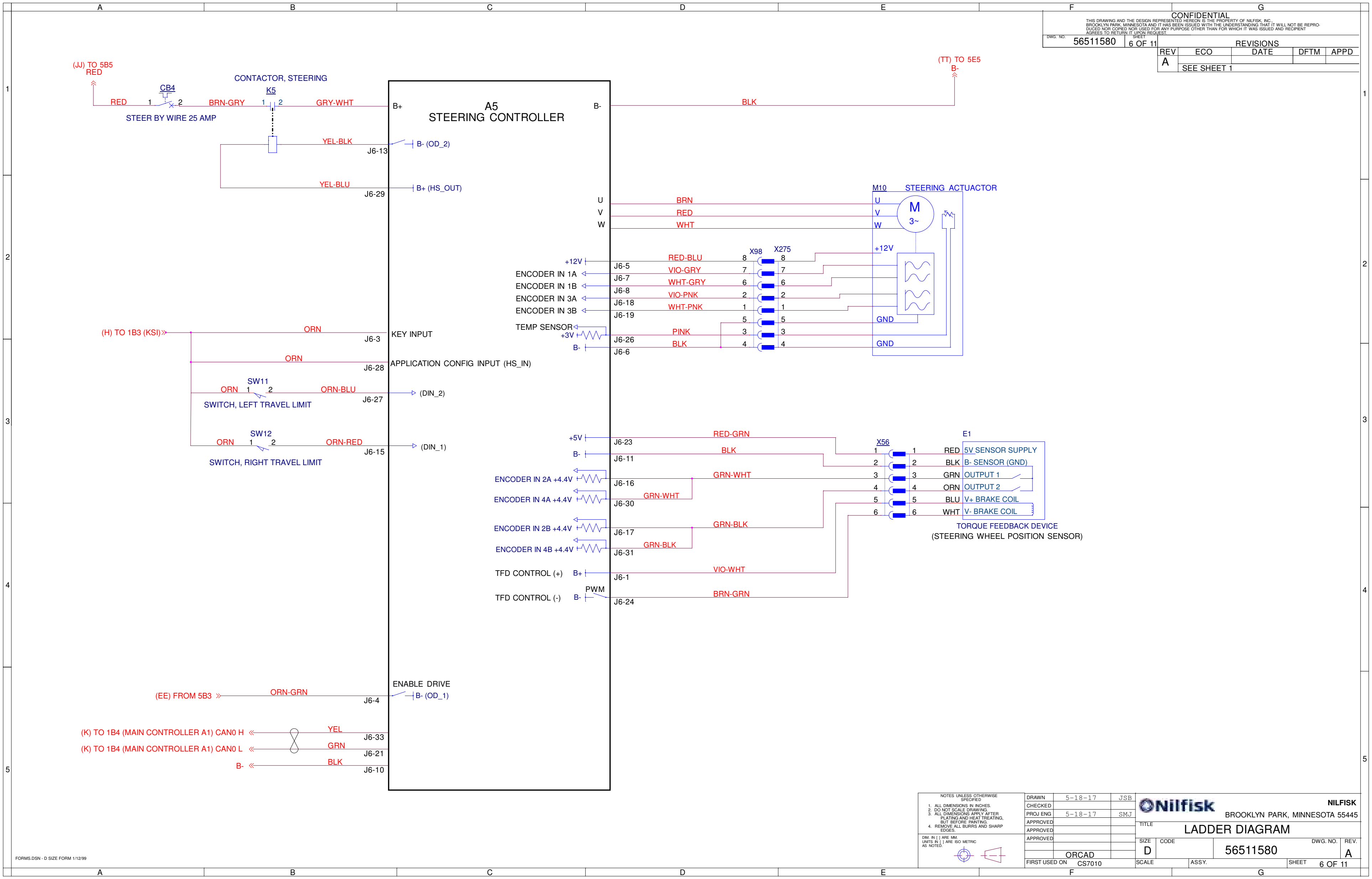
Sheet 4, A3 Power Module #2



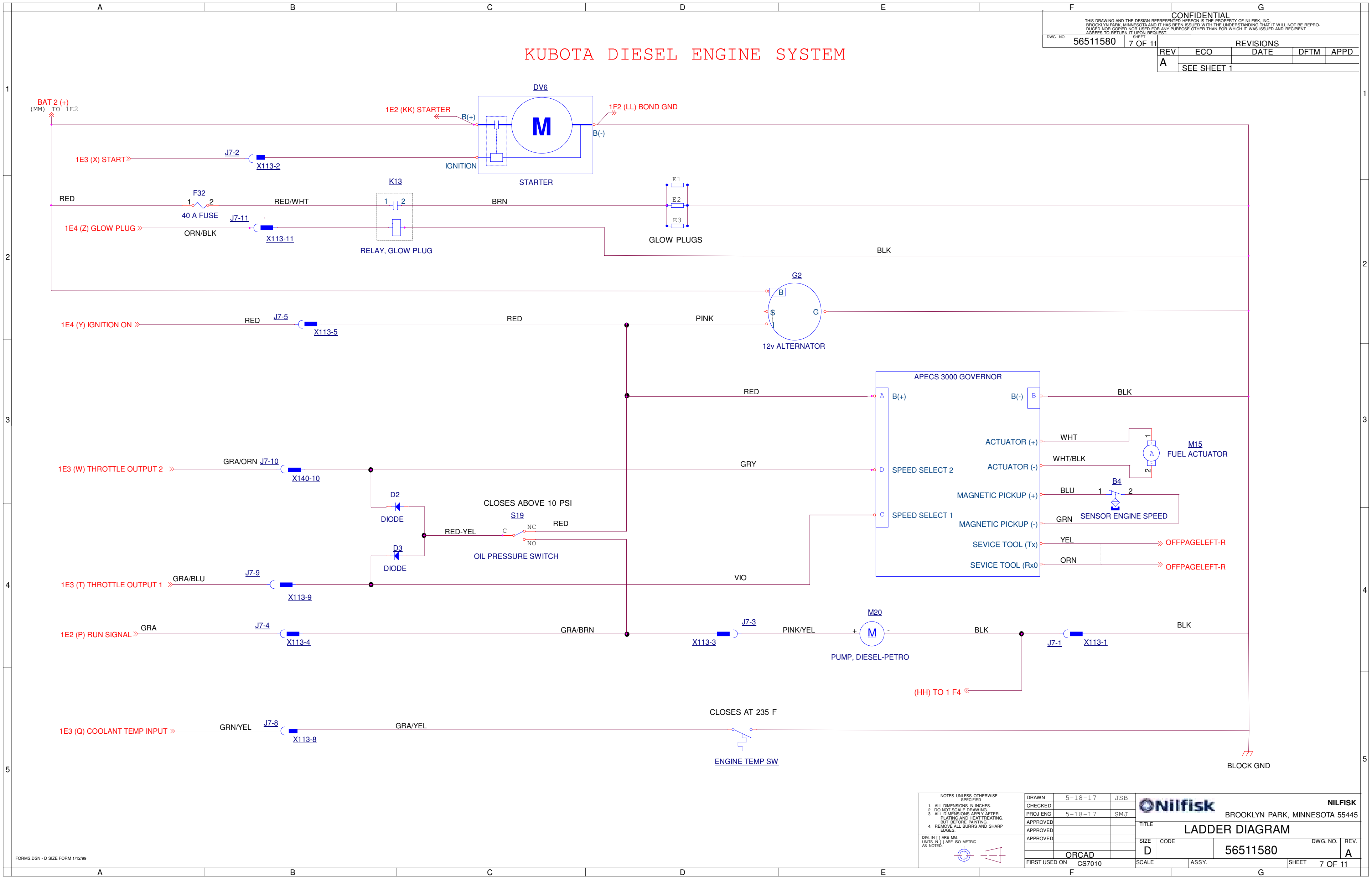
Sheet 5, A4 Drive Controller



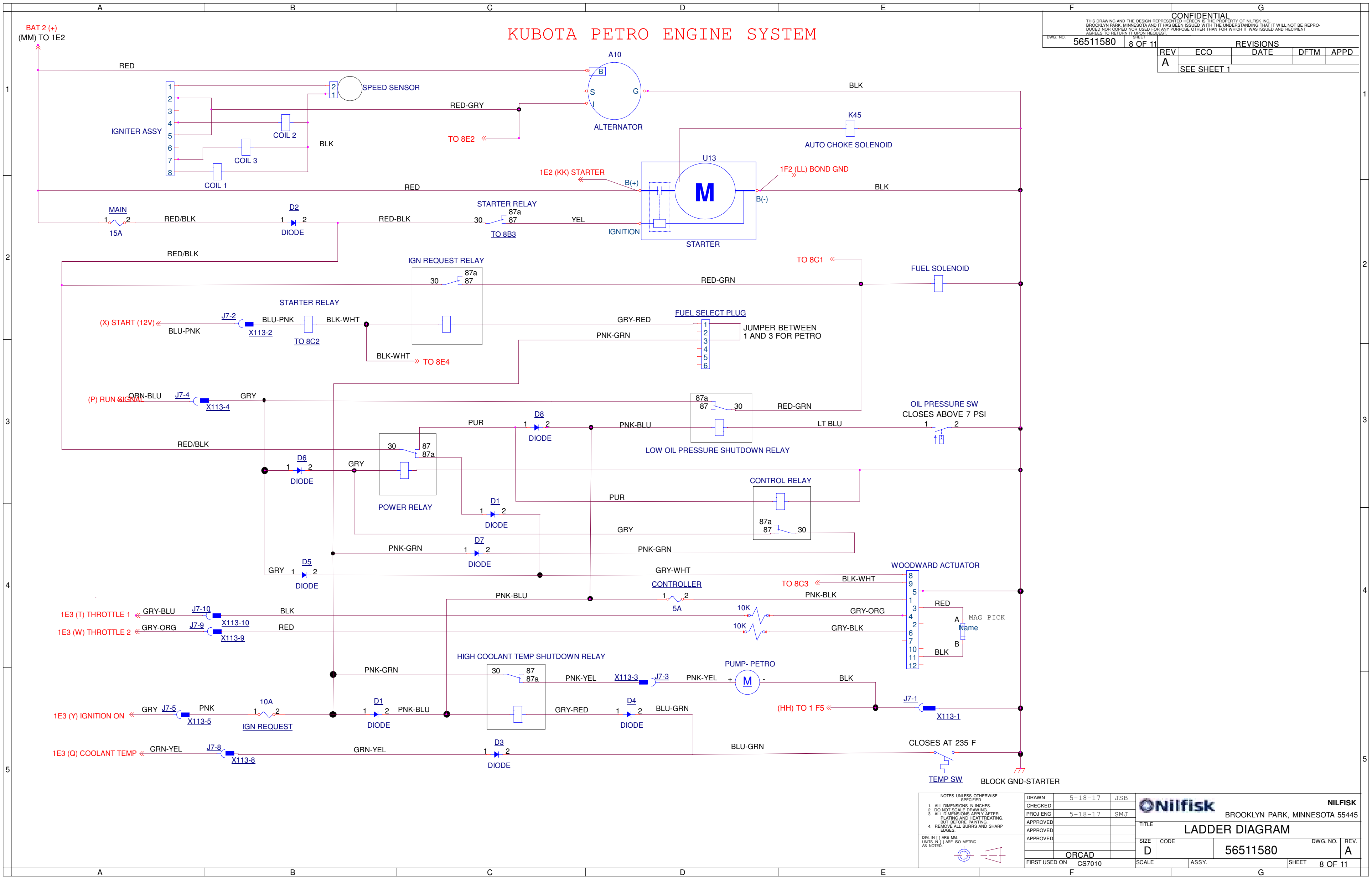
Sheet 6, A5 Steering Controller



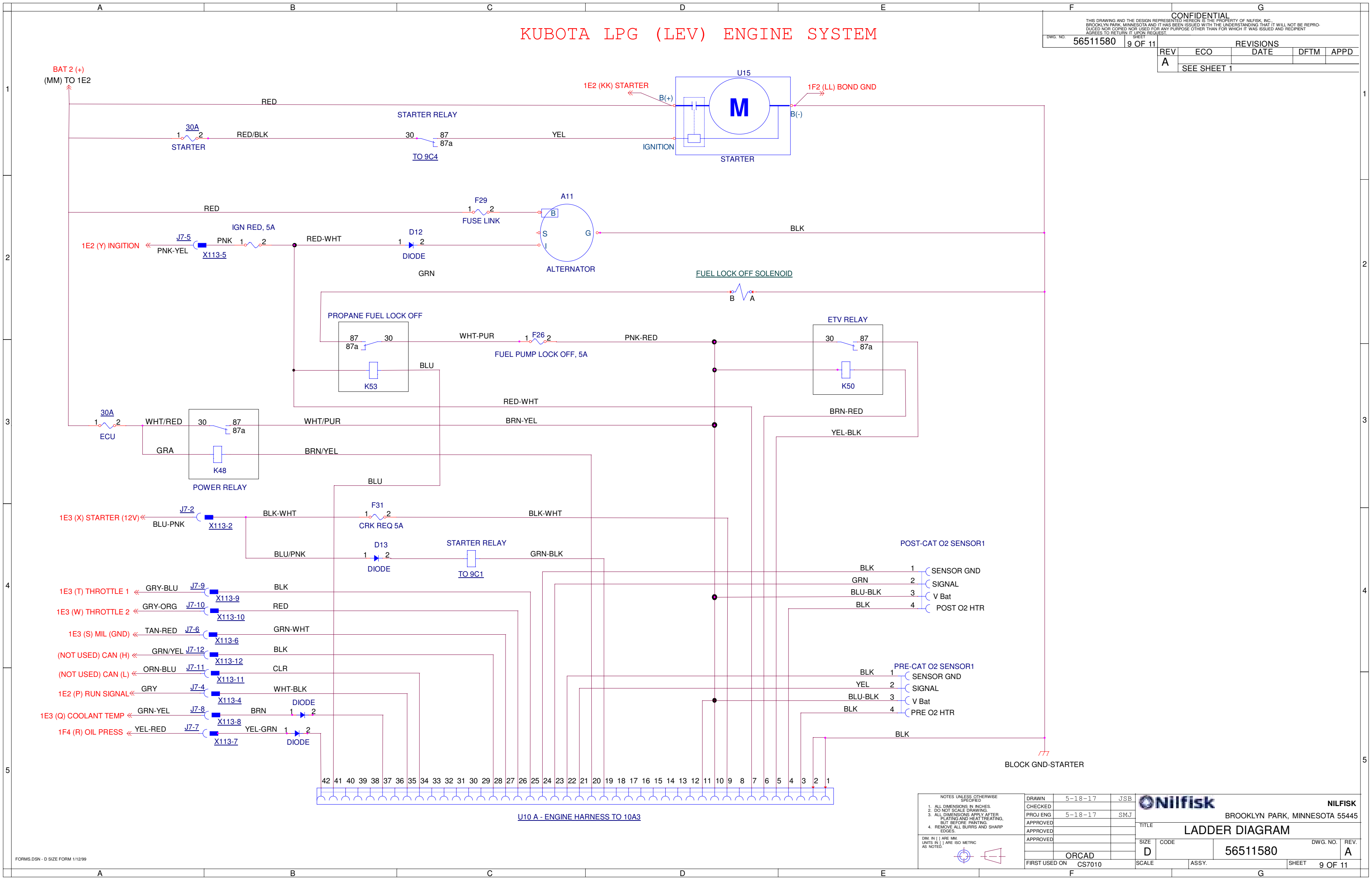
Sheet 7, Kubota Diesel Engine System



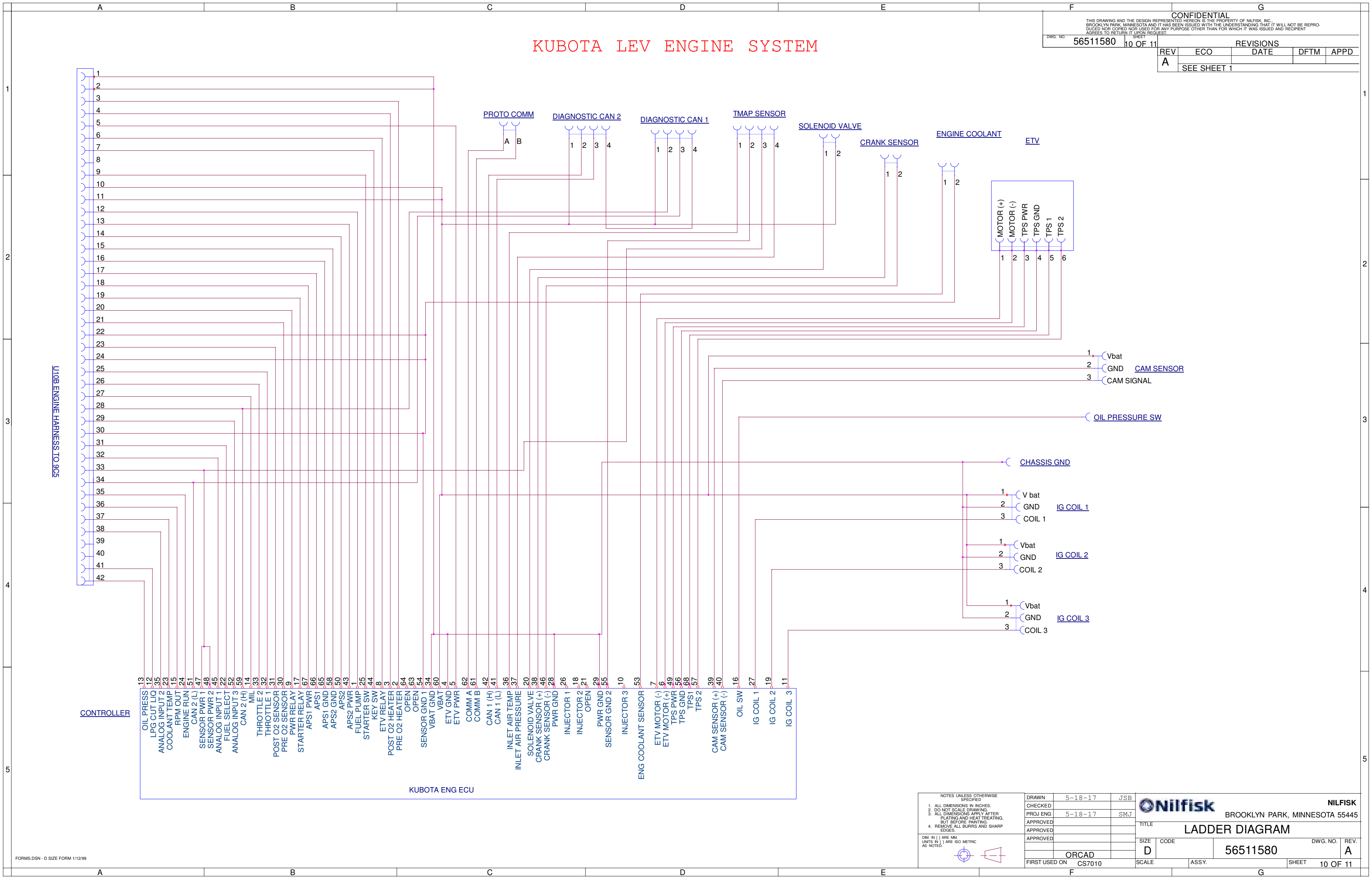
Sheet 8, Kubota Gasoline Engine System



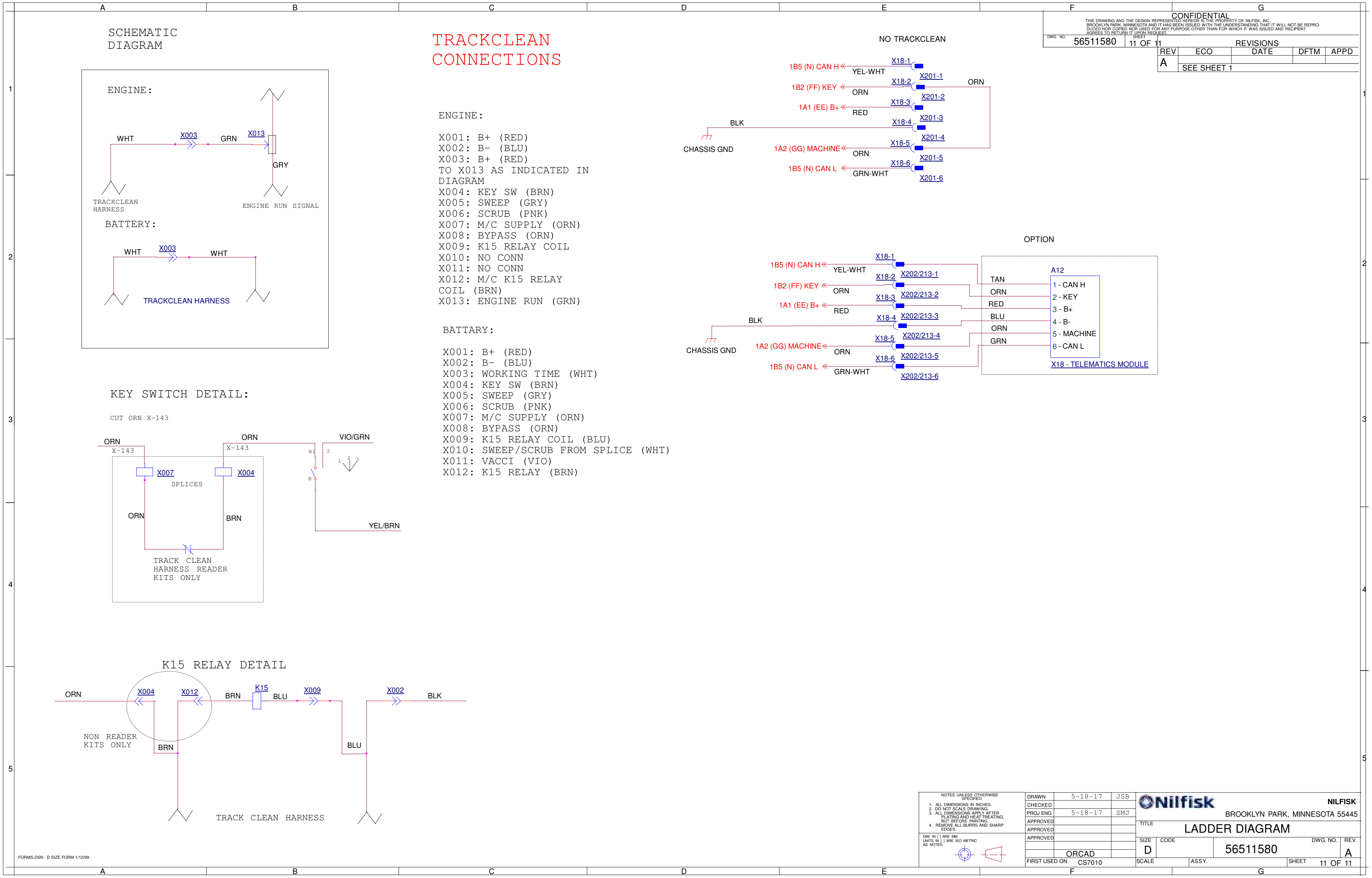
Sheet 9, Kubota LEV Engine System Part 1



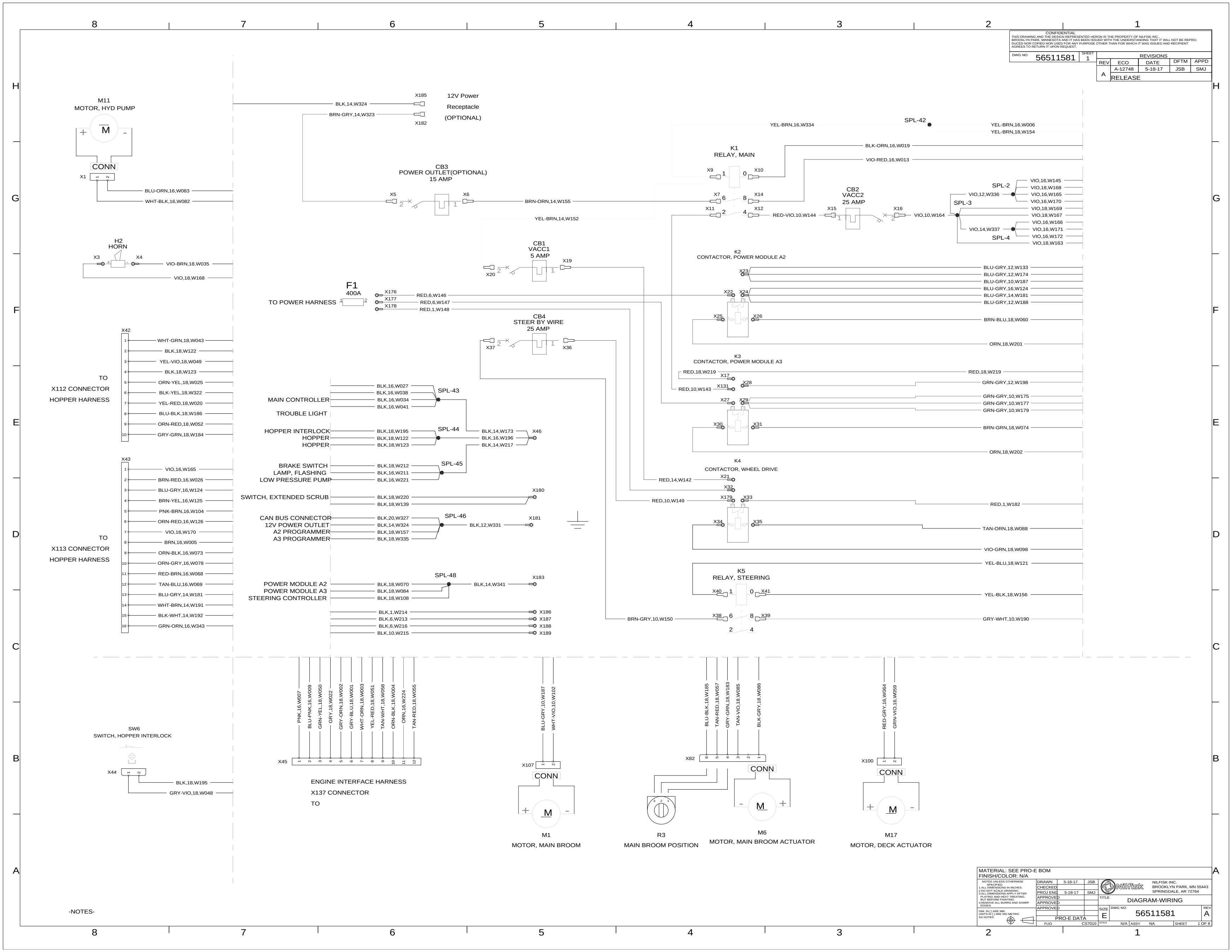
Sheet 10, Kubota LEV Engine System Part 2



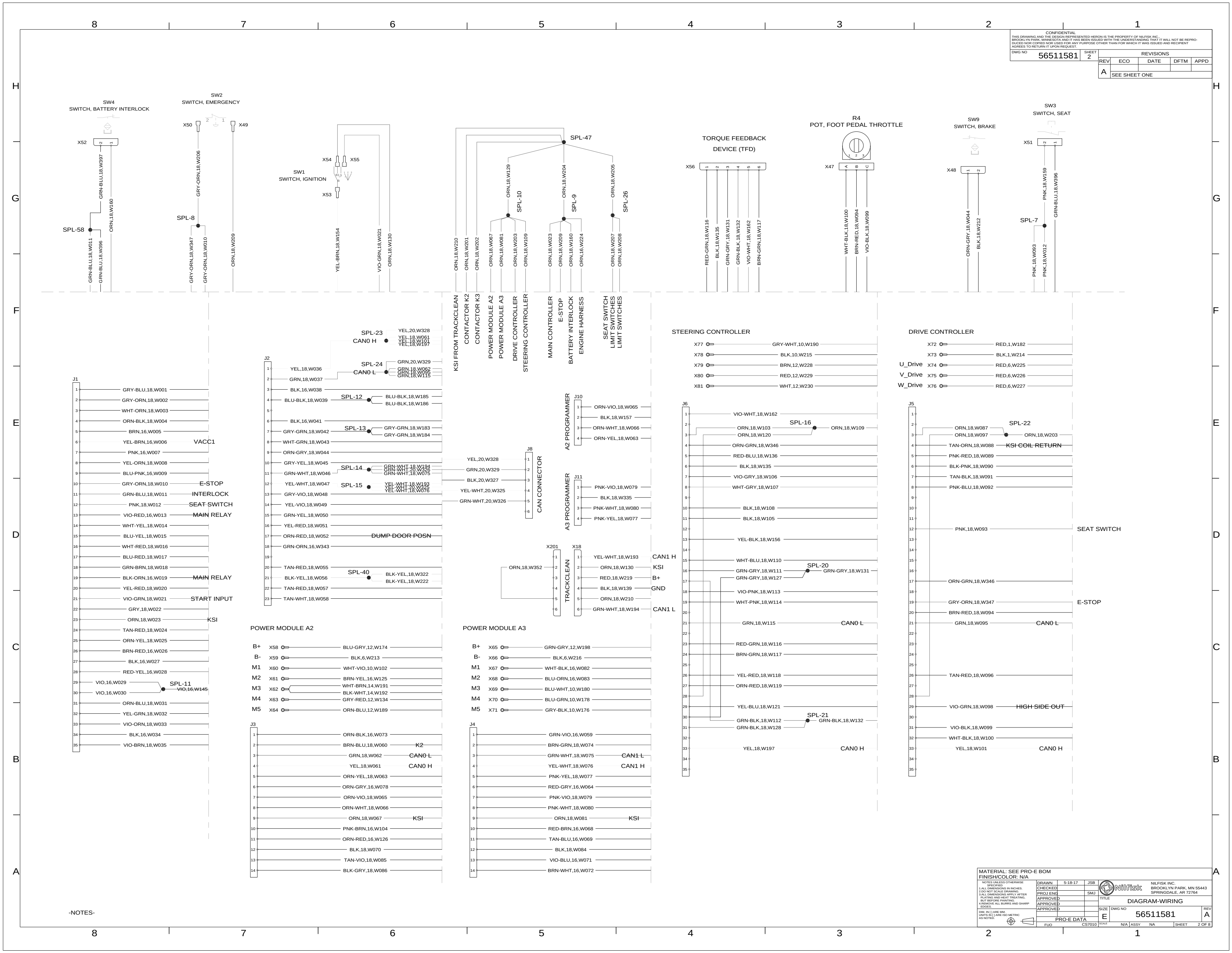
Sheet 11, Trackclean Connections



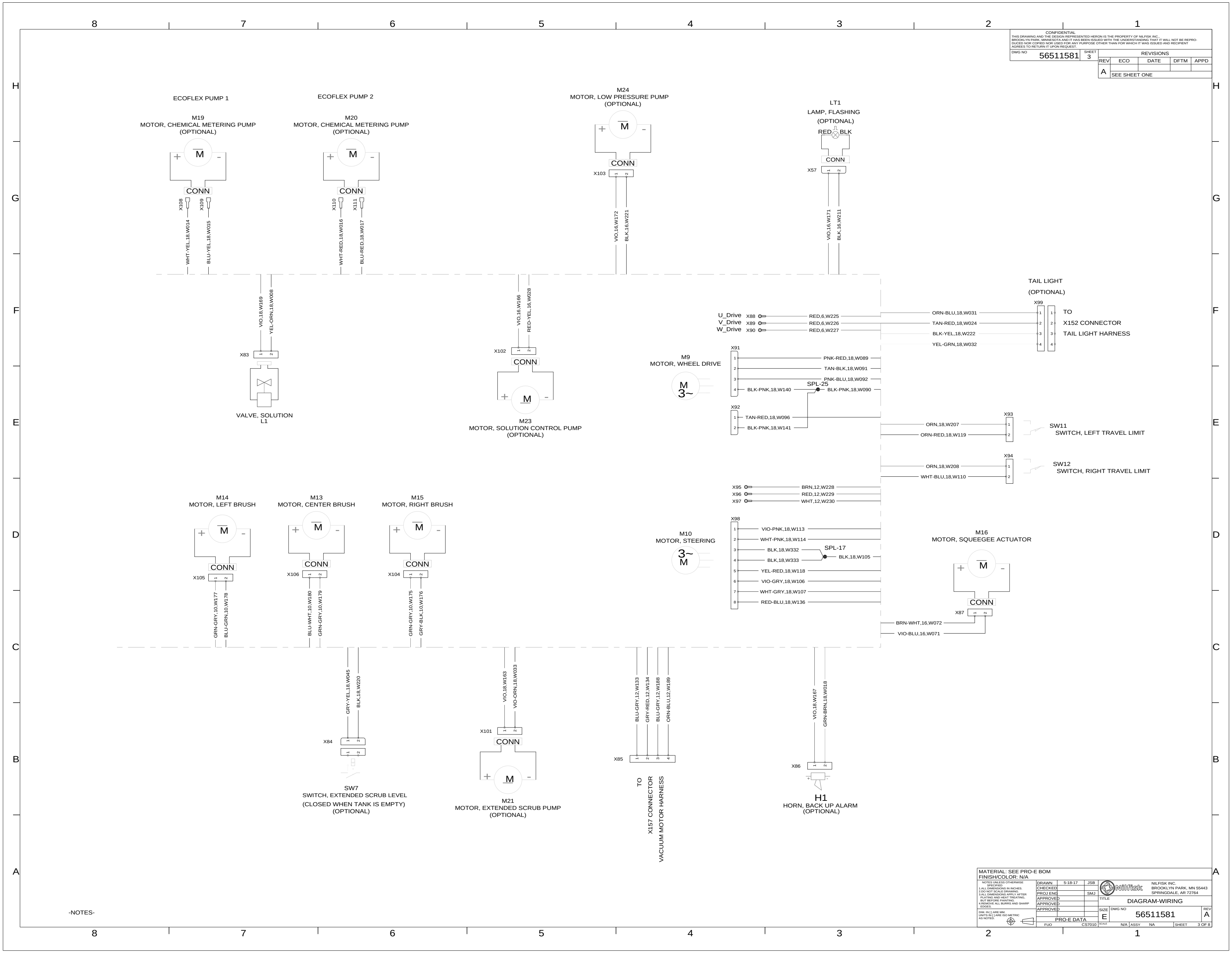
Wiring Harness Diagram
56511581, Rev A, 9-01-2017
Sheet 1: Main Harness 1



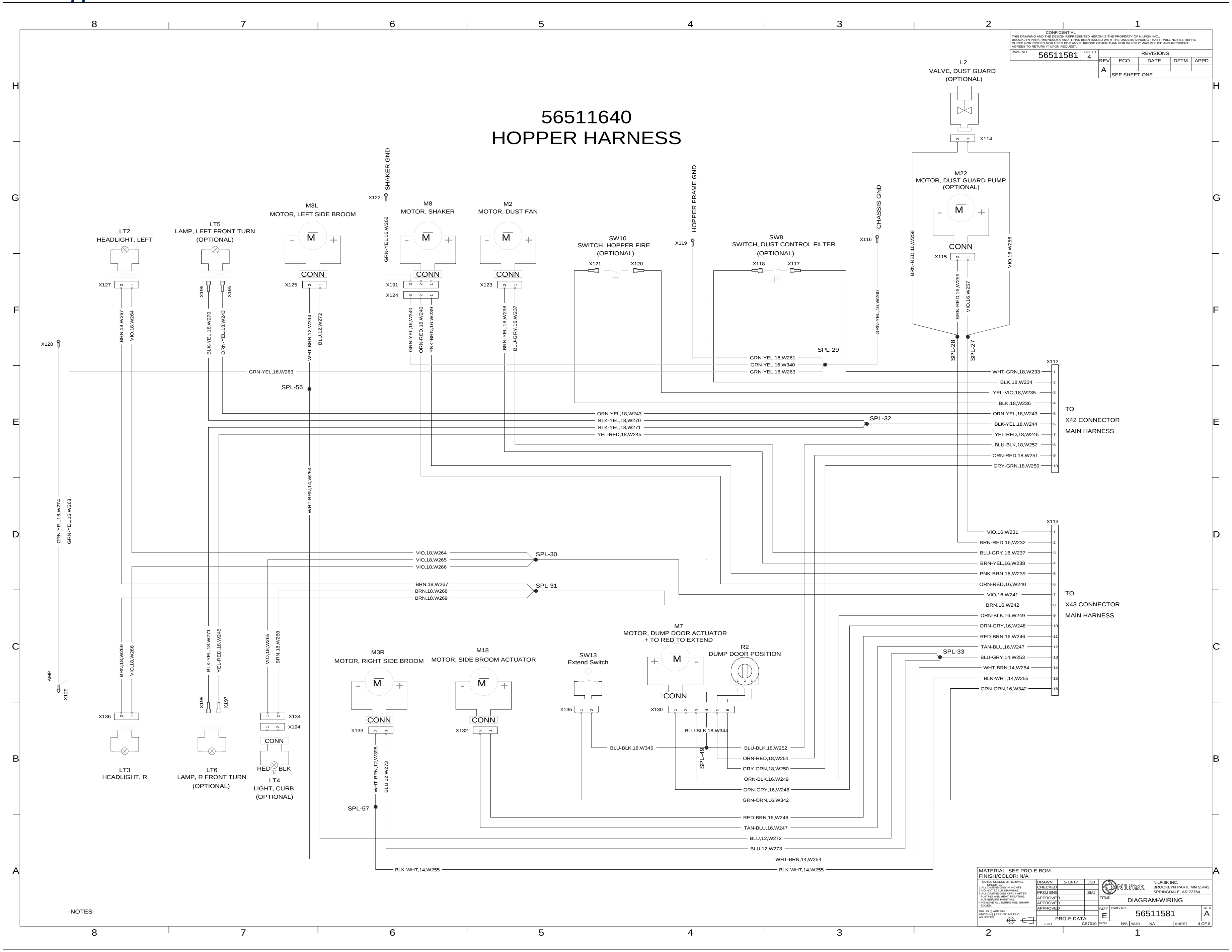
Sheet 2: Main Harness 2



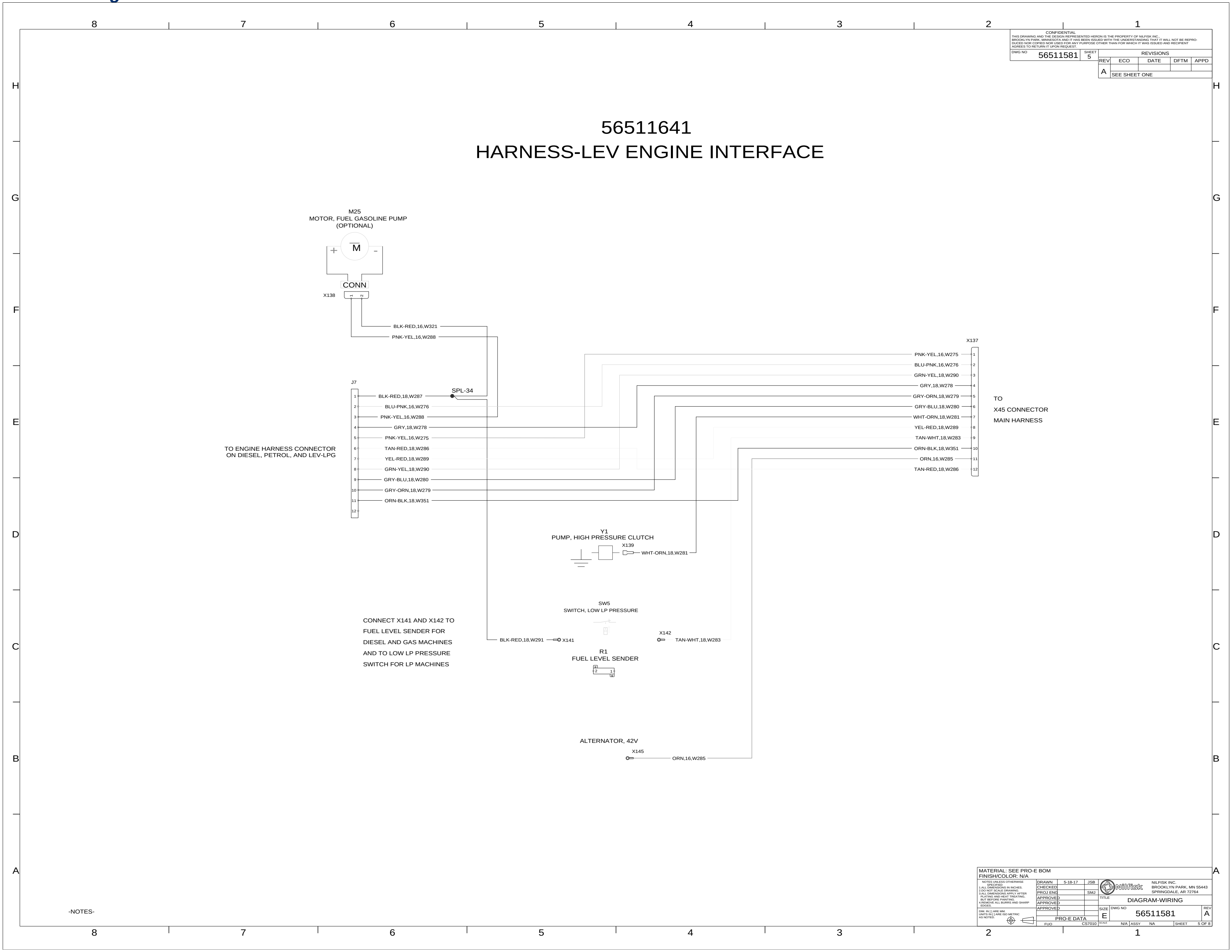
Sheet 3: Main Harness 3



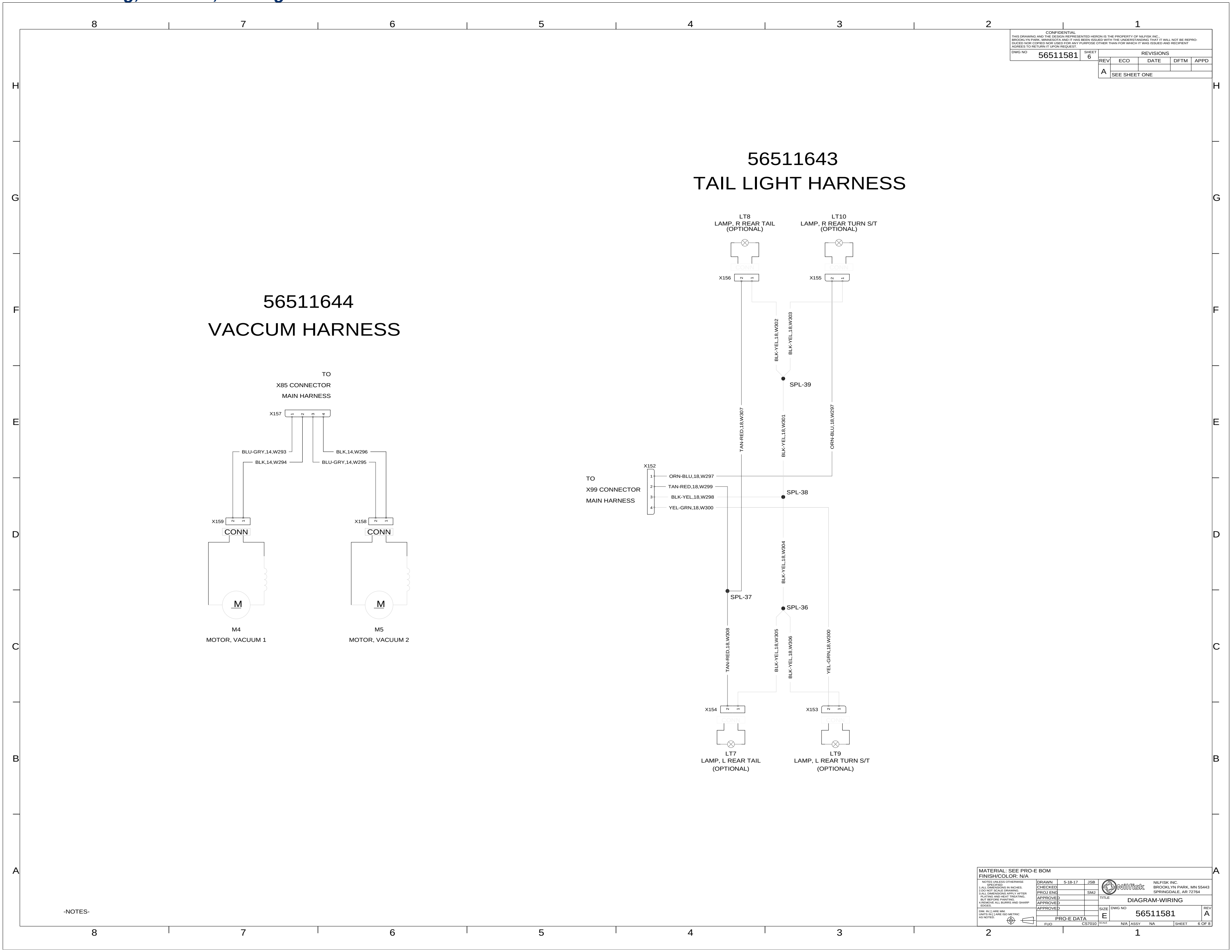
Sheet 4: Hopper Harness



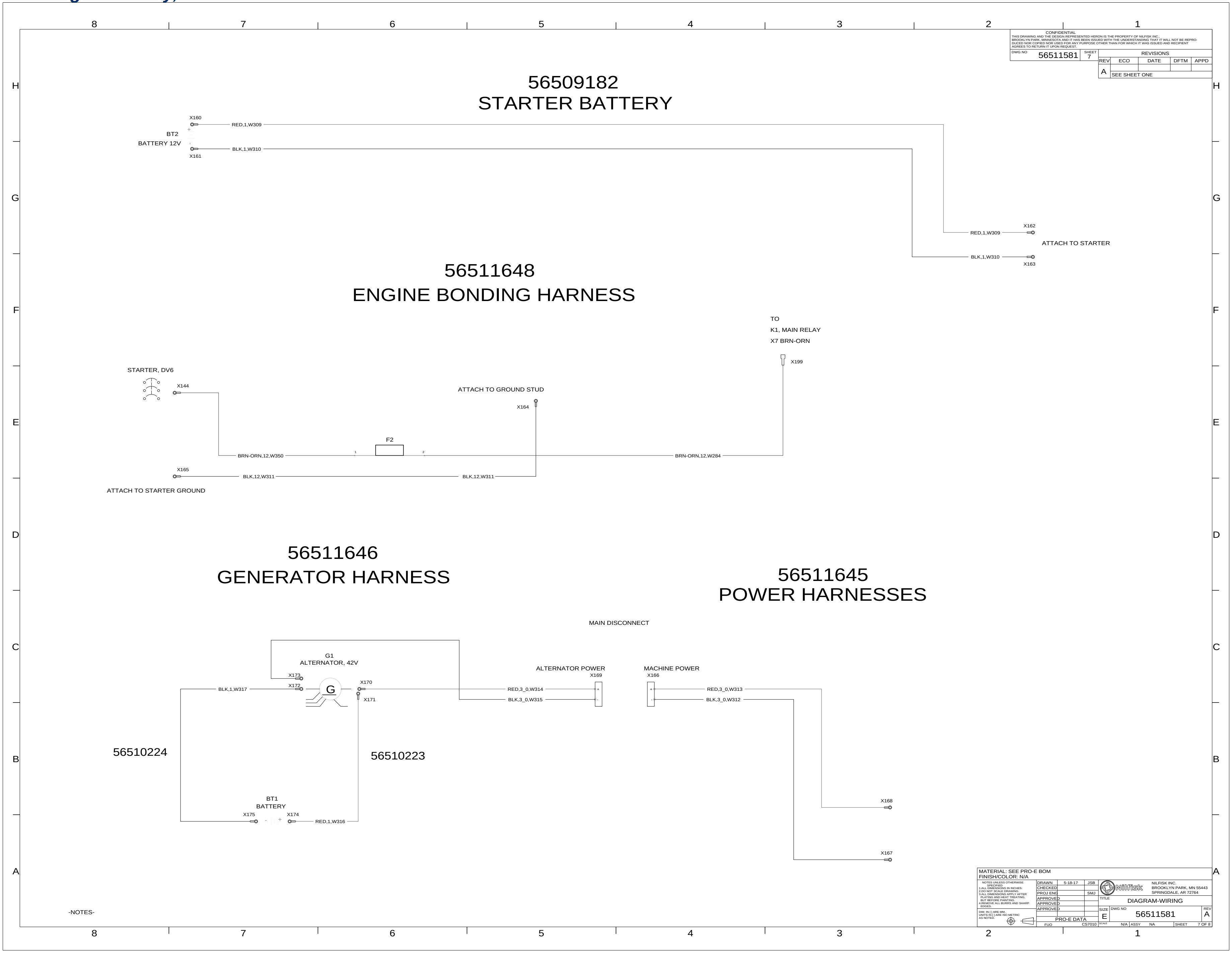
Sheet 5: LEV Engine Interface



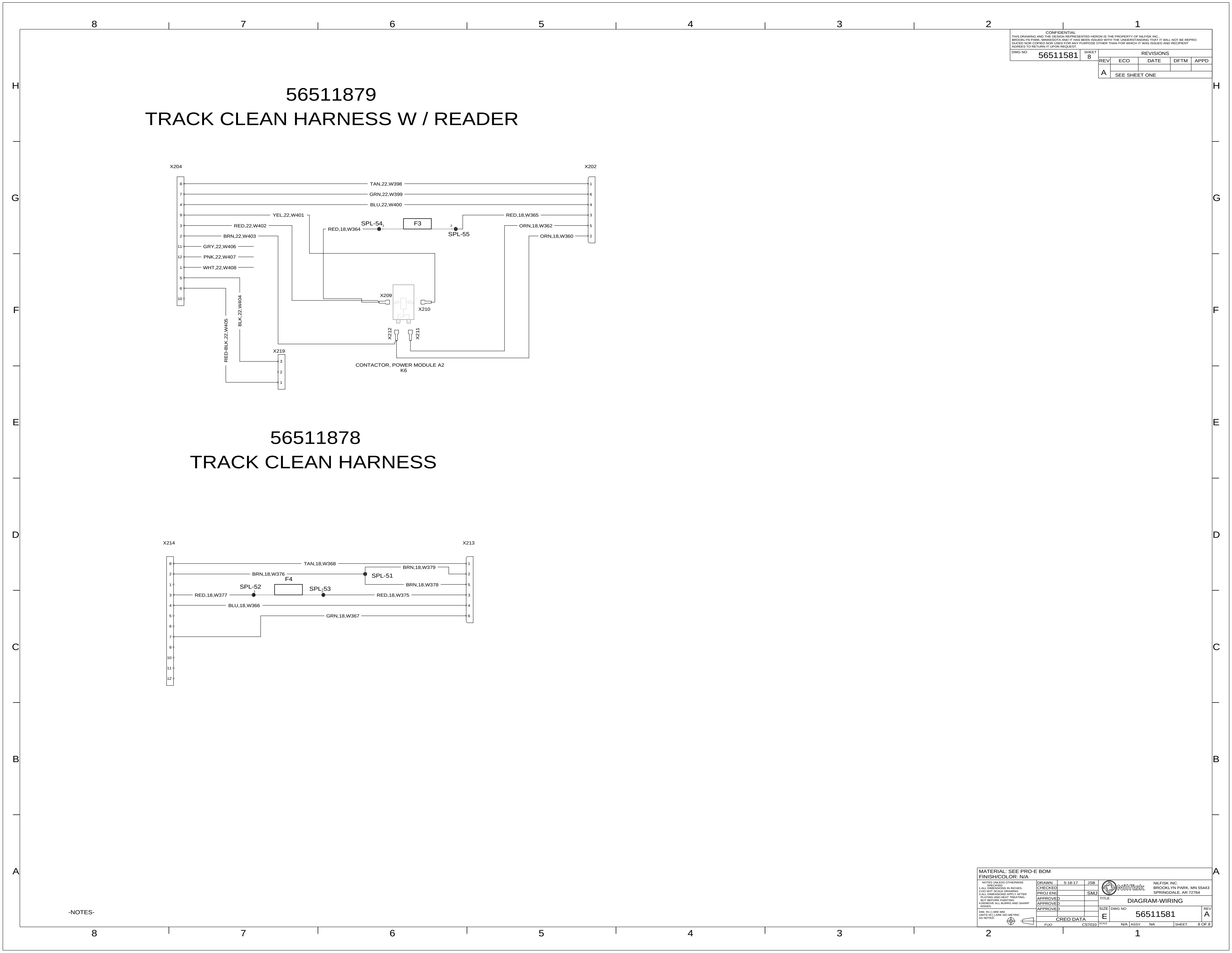
Sheet 6: Glow Plug, Vacuum, Tail Light



Sheet 7: Engine Battery, Generator Harness



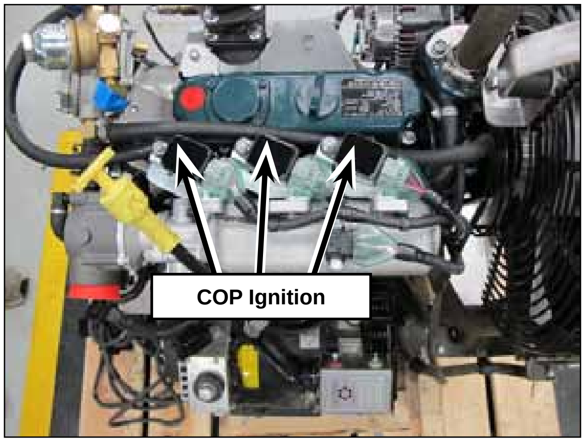
Sheet 8: Trackclean Harness



28 - Engine System - LPG LEV

This chapter provides a brief summary of the Kubota propane “LEV” (Low Emission Vehicle) engine which was introduced around September 2015. Kubota refers to the engine model as WG972-E4. “E4” designates EPA Tier 3 / CARB Tier 4 models, depending on engine displacement and output classification. “E4” engines are identified with “EF” at the end of the Model designation, on the US EPA label.

Since more than one WG972 propane engine is available, the easiest way to visually identify the “E4” model is that it has COP (Coil On Plug) ignition.



See the Kubota “Workshop Manual – Gasoline, LPG, NG Engine WG972-E4 (EFI)” Code No.9Y111-11080 for detailed information related to the complete mechanical engine. See the Kubota “Diagnostic Manual ECU System WG972-E4” Code No.9Y110-03110 for detailed information on the engine management system.

Functional Description

The WG972-E4 engine is a three cylinder, liquid cooled, naturally aspirated engine. An Engine Control Unit (ECU) is mounted to the side of the engine block. The ECU manages the engine speed, the ignition system and the fuel system. The ECU and main machine controller convey several pieces of information through dedicated wires such as requested engine speed and whether to display the MIL icon.

The fuel system begins with a 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.

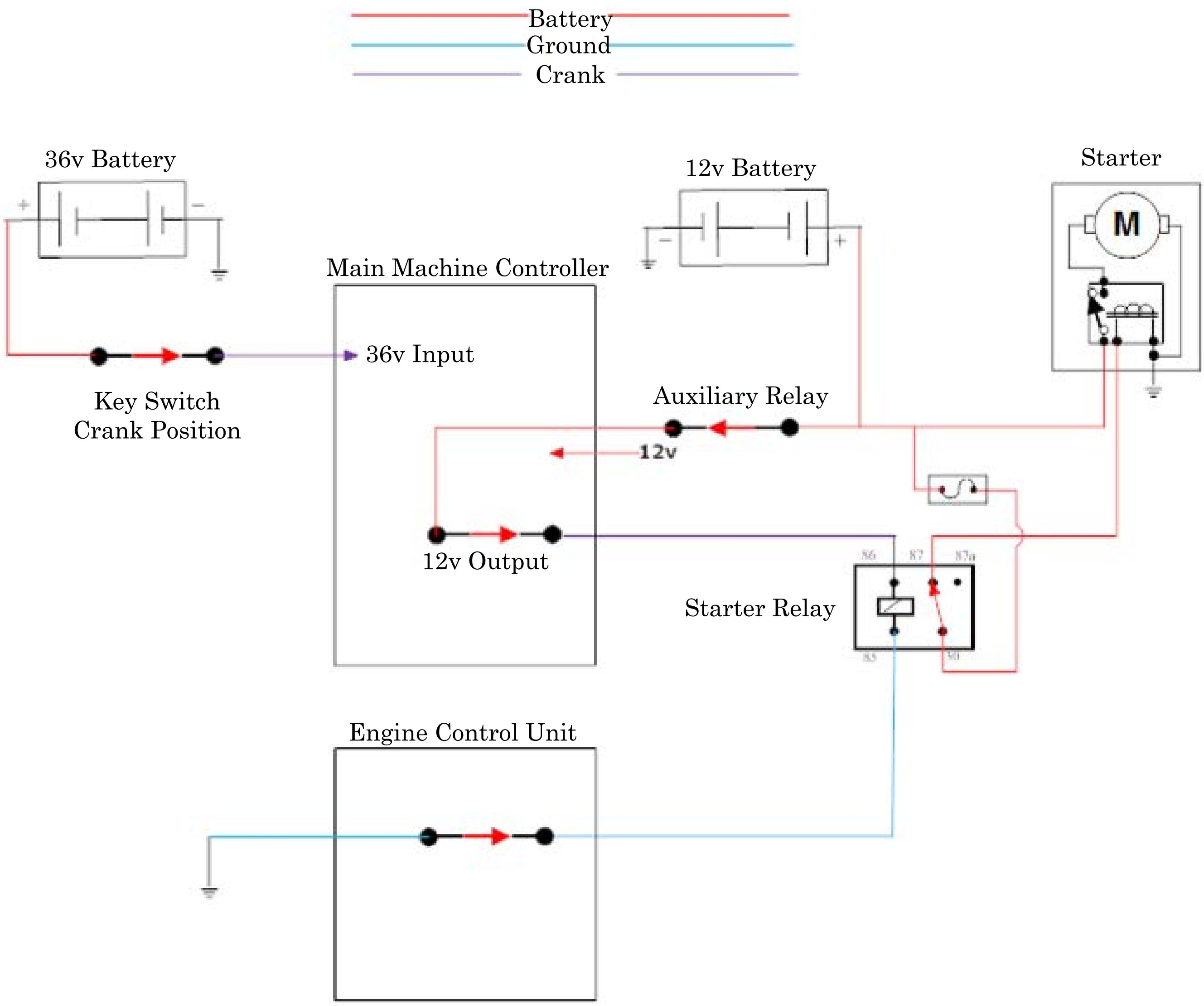
The engine RPM is controlled by the ECU through a motorized throttle according to input requests from the main machine controller.

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.

Circuit Descriptions

Engine Starter Control

Holding the key switch in the start position supplies a 36 volt “input request” to the main machine controller to engage the engine starter. In turn the main machine controller sends a 12 volt output to the starter relay winding. The other side of the winding connects to the ECU. The ECU must connect the circuit to battery negative to energize the starter relay. If the engine is already running, the ECU will prevent the starter relay from operating.



Engine RPM Control

The ECU directly monitors the engine speed and adjusts the throttle angle to maintain the current target engine speed.

The main machine controller communicates the desired engine speed mode to the ECU 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 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 machine is in transport mode at idle (1700 rpm) and the controller detects an amperage draw greater than 60 amps, the engine will increase to run mode (2500 rpm). Speed will be returned to idle when the amperage drops below 40 amps.
- If the machine is in transport, sweep, or recovery at run speed and the controller detects an amperage draw greater than 90 amps, the engine will increase to maximum power (2700 rpm). Speed will be returned to run mode when the amperage drops below 80 amps.
- 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

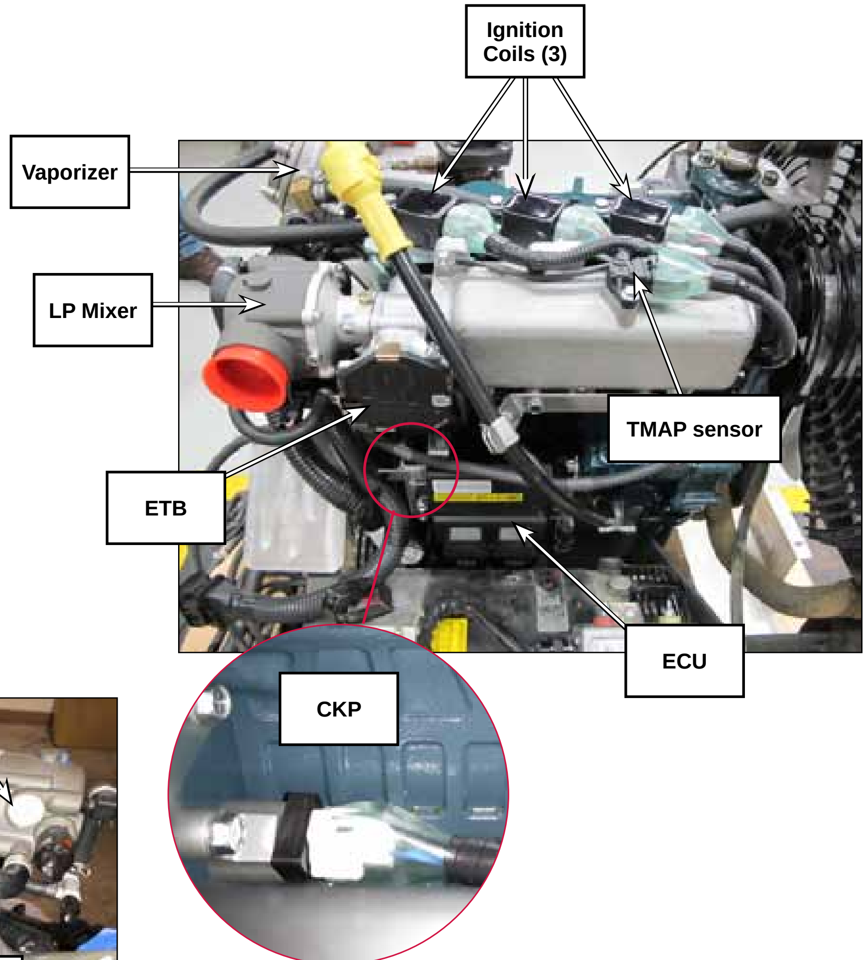
Shutting off the key switch removes the 36v "key switch input" from the main machine controller. The main controller then removes the 12v "ignition on" output from the ECU. The ECU shuts off the engine.

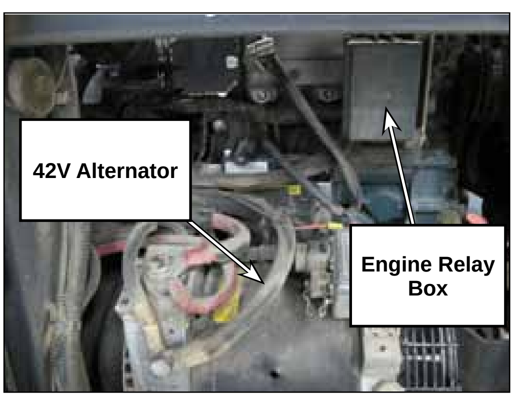
Engine Protection Modes

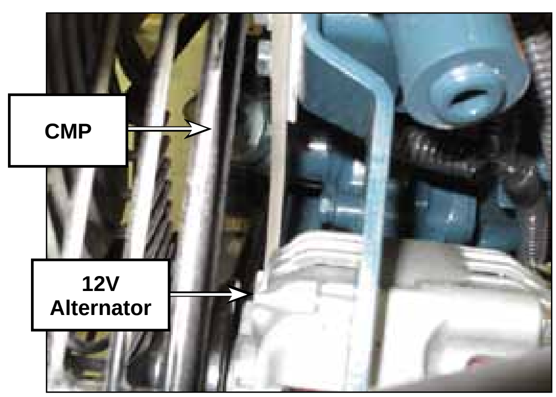
The ECU will shut off the engine if it overheats or loses oil pressure. If this occurs, the ECU informs the main controller the engine has been intentionally shut down in order to protect it from damage. The main controller responds by displaying both the low oil pressure warning and the high engine temperature warning icons to the operator (Both icons are displayed since the main machine controller only knows that the ECU shut down the engine and does not know if it was due to loss of oil pressure or to over temperature).

Component Locations

- Ignition Coils (3)
- Temperature Manifold Absolute Pressure (TMAP) sensor
- Electronic Throttle Body (ETB)
- Vaporizer
- Engine Control Unit (ECU)
- Crankshaft Position Sensor (CKP)
- Engine Coolant Temperature (ECT)
- Camshaft Position Sensor (CMP)
- Engine relay box

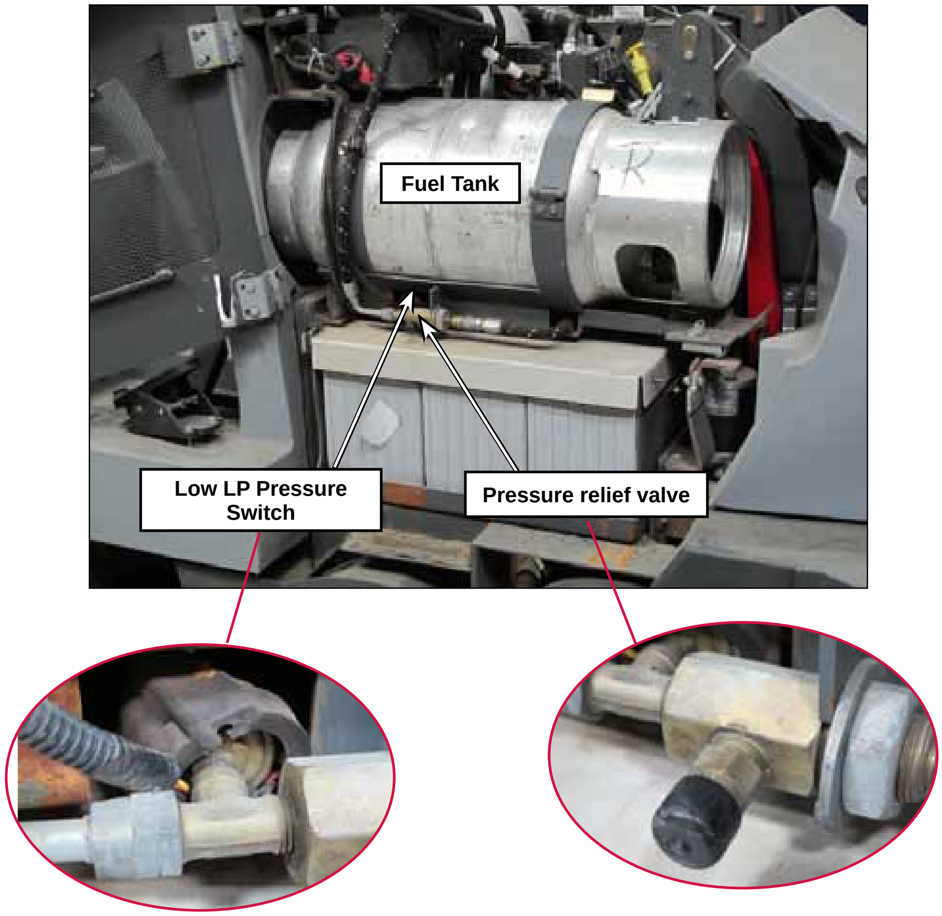






- Fuel Tank Area
  - Fuel tank
  - Pressure relief valve
  - Low LPG pressure switch

Fuel Tank Area



Maintenance and Adjustments

Maintenance Checklist

Refer to the Kubota “Workshop Manual – Gasoline, LPG, NG Engine WG972-E4 (EFI)” Code No.9Y111-11080

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

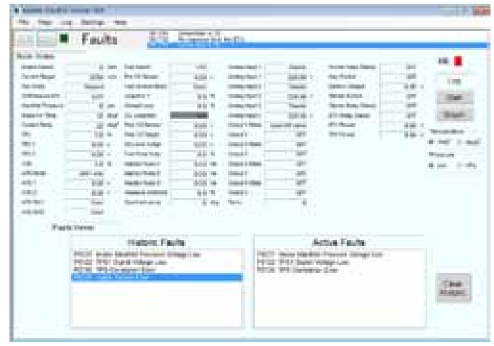
Red in Window = Restricted Filters

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

Engine Management System



Kubota provides software that enables you to use a laptop to interface with the engine controller like an “automotive scan tool”. It is called the Kubota Gasoline Service Tool (KGST). Although it mentions “gasoline” (petrol) in the name, it is also for use with the propane fueled engine. The KGST is essential for troubleshooting engine management system issues.

The KGST software and Kubota KGST User Guide are available through EZparts.

You will need:

- Laptop with USB port
- KGST Software (Found in EZParts)
- ECOM Cable for connecting the laptop to the machine. (See Special Tools section.)
  - ECOM Cable driver (Found in EZParts)
- ECOM Cable adapter to go between the ECOM cable in the machine diagnostic connector. (See Special Tools section.)

See the Kubota KGST User Guide for further instructions. The software requires the use of a password for the WGG972GL-E4 (LEV) engine. The password is:

- LayVijZuWSOp

Checking Spark

1. Remove ignition coil from the spark plug and insert an adjustable KV tester in the end of the coil boot in place of a spark plug.
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. Swing out the propane tank.
4. Remove the steel plate.

5. Remove the primary chamber test port plug located on top of the vaporizer regulator and install the test fitting.

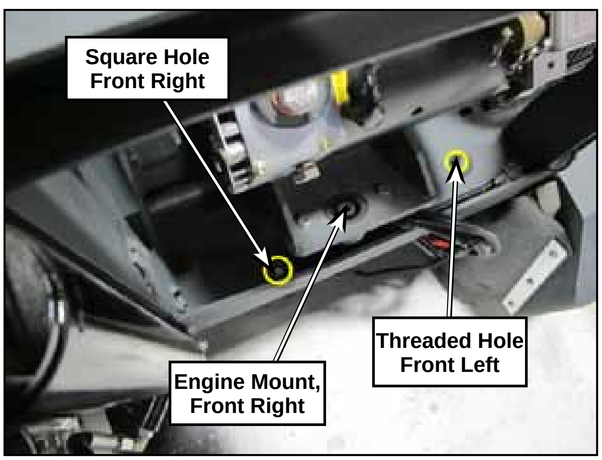
6. Install fitting from LPG pressure test kit into the thread adapter.
7. Using the LPG test gauge kit - Part # 56504450, hook up the blue pressure gauge hose to the fitting.
8. Open propane tank valve.
9. Start engine. (Specification - 4.3 PSI, 32.7kPA)
10. When finished, reinstall the test port plug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

Removal and Installation

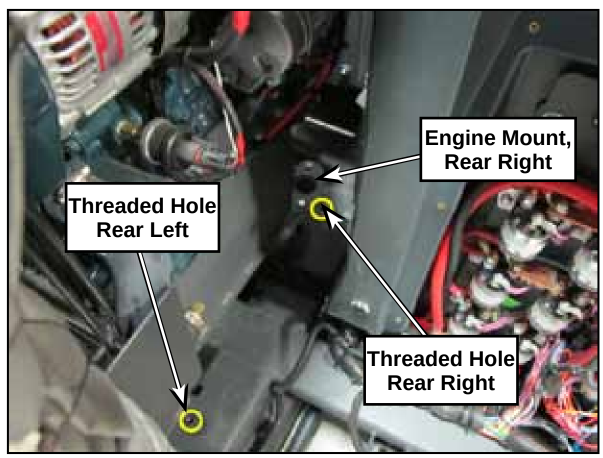
Engine Assembly

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)
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.



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



Rear engine mounting locations. Shown with engine being installed.

Specifications

Fuel System

Fuel Lock Off Solenoid Resistance - 12.65 Ω @ 20° C (60° F)

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 or better.
  - 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. Keep in mind they are done on only one machine with non-calibrated gauges.

Ignition System

Used Fluke 16 Multimeter

- Spark Output - 30 KV consistently (Using adjustable spark tester)
- Crank position sensor resistance - 2.1 K ohms
- Crank position sensor output cranking - 4.0 VAC average

Fuel System

- Fuel Lock Off Solenoid resistance - 13 ohms
- Primary Pressure - 3.4 PSI
- Engine coolant temperature sensor - 0.875v at 142 Deg. F.

Engine

Engine Vacuum at idle (1700 RPM) - approx 16.5 - 17” HG

When returning from Run (2500 RPM) to idle (1700 RPM) vacuum momentarily peaks around 22” HG

Engine Compression

- Cyl #1 - 190 PSI
- Cyl #2 - 185 PSI
- Cyl #3 - 175 PSI

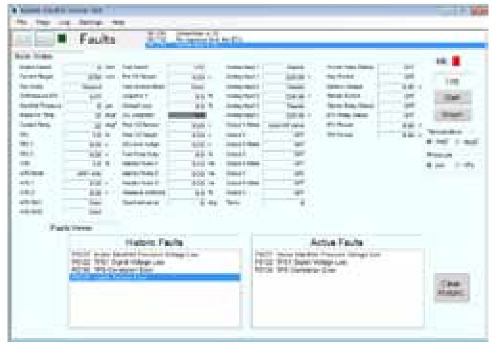
Special Tools

KGST Software.

Download from EZparts

Password for use with the WGG972GL-E4 (LEV) engine: YyiVhVpVjPvV

> ***Note:*** *Kubota renews the password annually. Contact Technical Support if the password is no longer valid.*



Diagnostic Cable Adapter Part# 56511575

Used to connect ECOM cable to Kubota LEV diagnostic connector

ECOM Cable - Diagnostic Communication Cable and software, p/n 56305647

> ***Note:*** *The "Ecom" cable is used but the software on the CD is for the GM engines.*

LPG test gauge kit - Part # 56504450

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

28 - 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

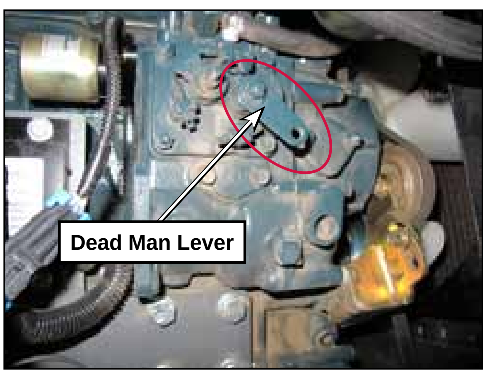
One of the engines available in the CS7010 is a Kubota Diesel (D1305-E3B-KEA-1). It is a three cylinder, liquid cooled, naturally aspirated engine. It has mechanical injector pump that is fitted with an actuator which physically moves the fuel lever inside the pump.

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. .

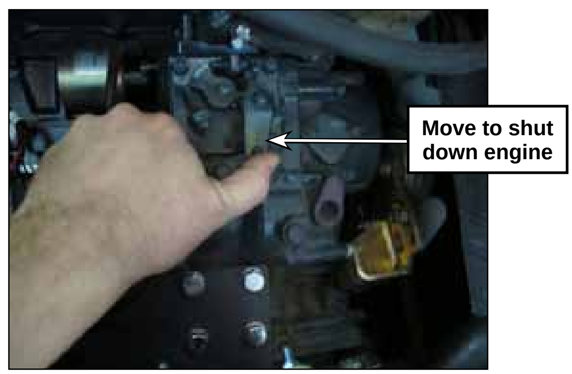
The engine uses glow plugs to aid in starting a cold engine. The main machine controller operates a glow plug relay which supplies power to the glow plugs when needed.

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” lever 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

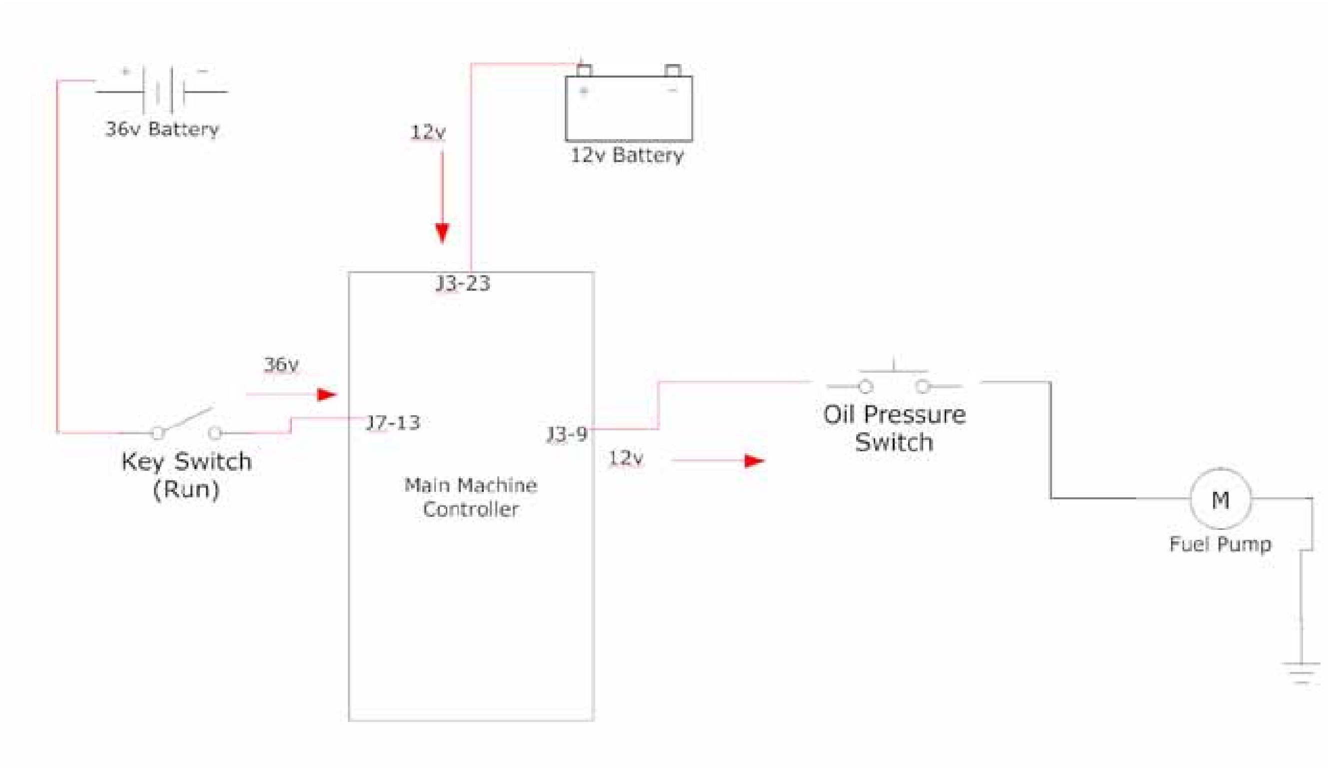
The cooling system consists of a standard radiator and belt driven fan. Note that the fan pushes air away from the engine and out through the radiator.

Engine starter control

The Main Machine Controller controls the starter solenoid on the engine, based on the input from the keys witch.

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 J1 pin 21. This is the start input request. The main machine controller receives a 12 V supply on connector J1 pin 13 from the engine starter battery. It uses this voltage supply to send voltage out connector J1 pin 9 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.

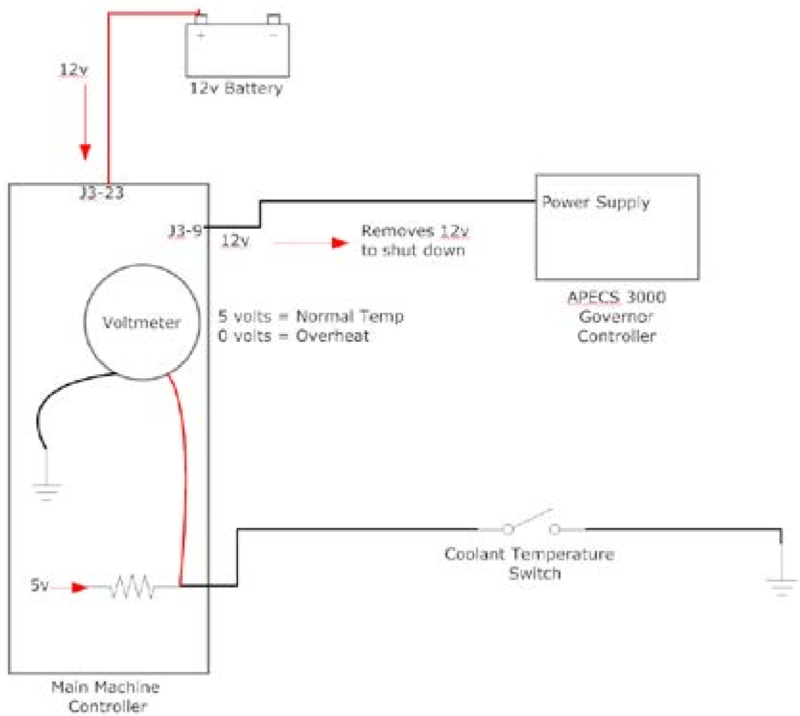
Engine Protection

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.

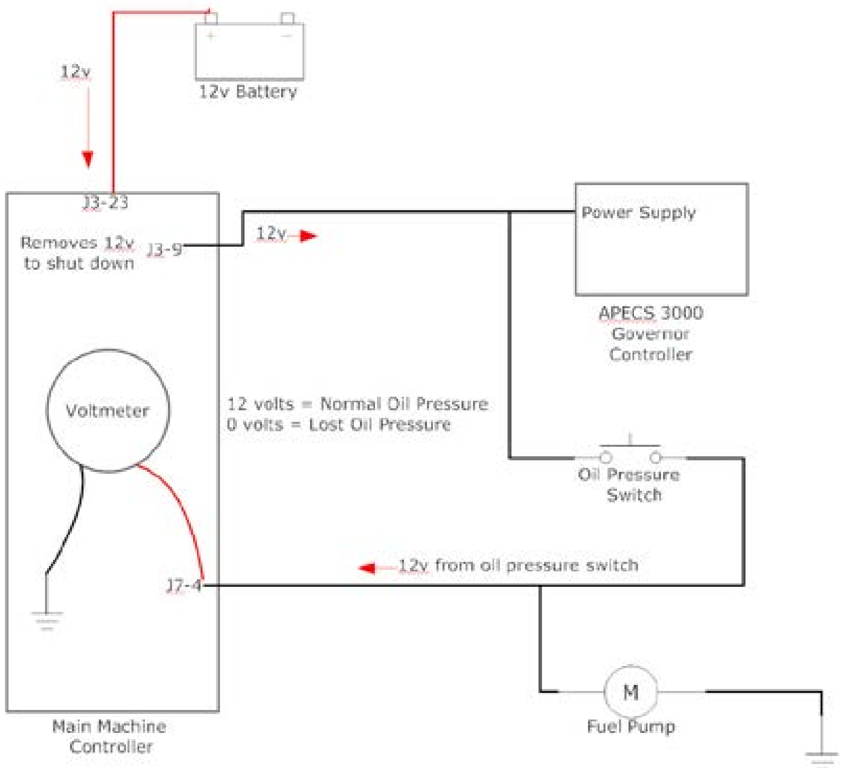
Over Temperature Shutdown

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

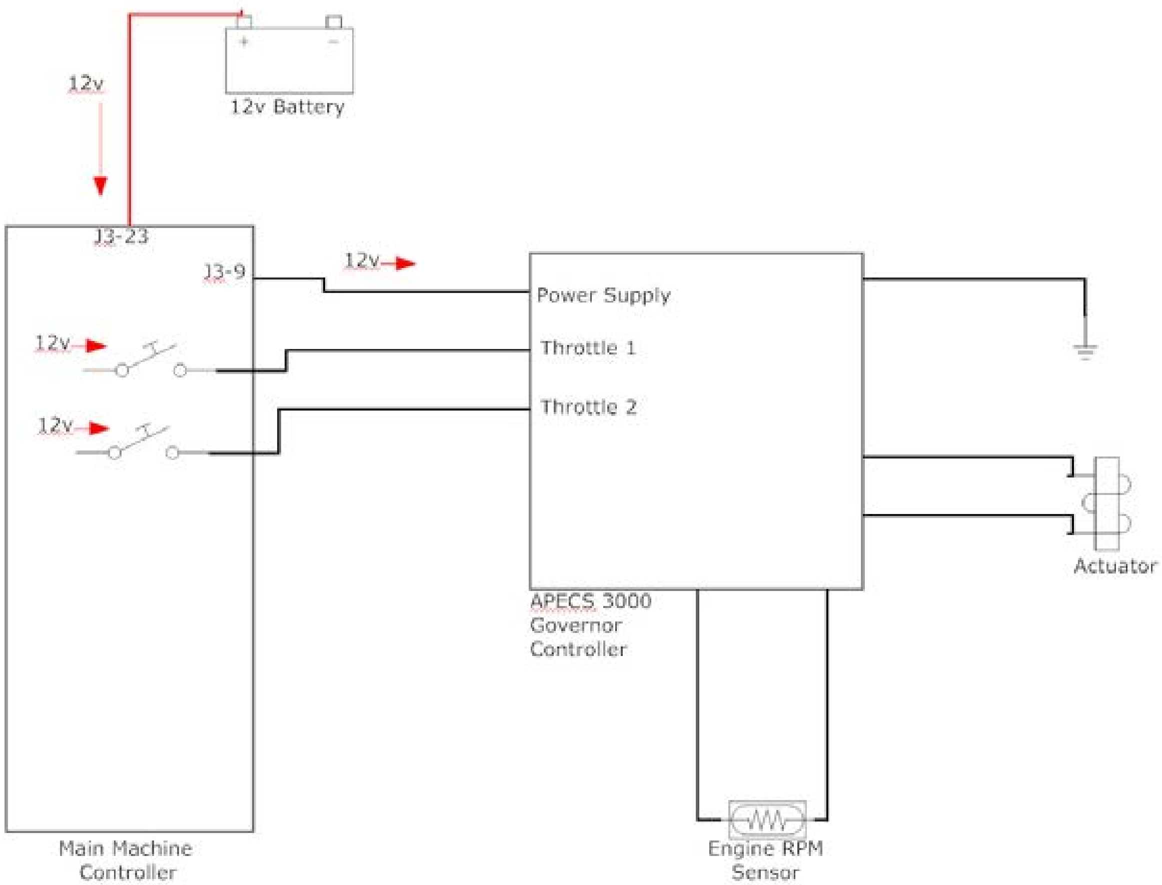
Here is how the low oil pressure shutdown works. The main machine controller sends 12 V out connector J3 pin number 9 to the APECS governor controller and the oil pressure switch. When there is oil pressure, the switch connects the voltage back as an “engine run signal” to the main machine controller 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.
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.

Flash Code	Fault	Remedy
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.

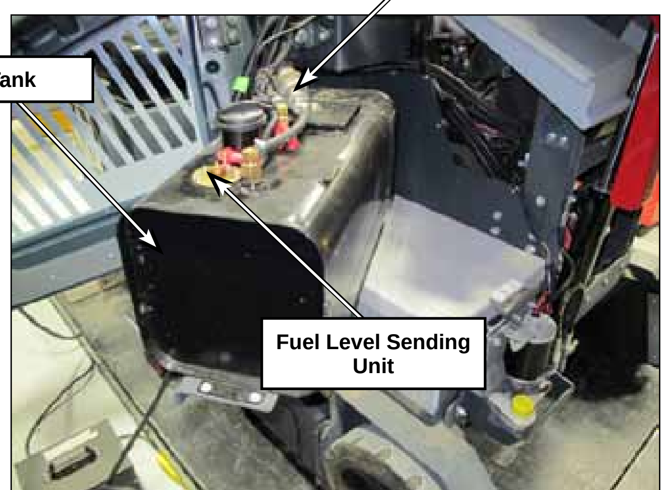
Whenever the key is turned on, the main machine controller tells the control panel to display the “glow plugs on” icon and sends out 12 V from connector J3 pin number 32 to the glow plug relay winding. Since the other side of the winding is connected to ground, this energizes relay which in turn supplies 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

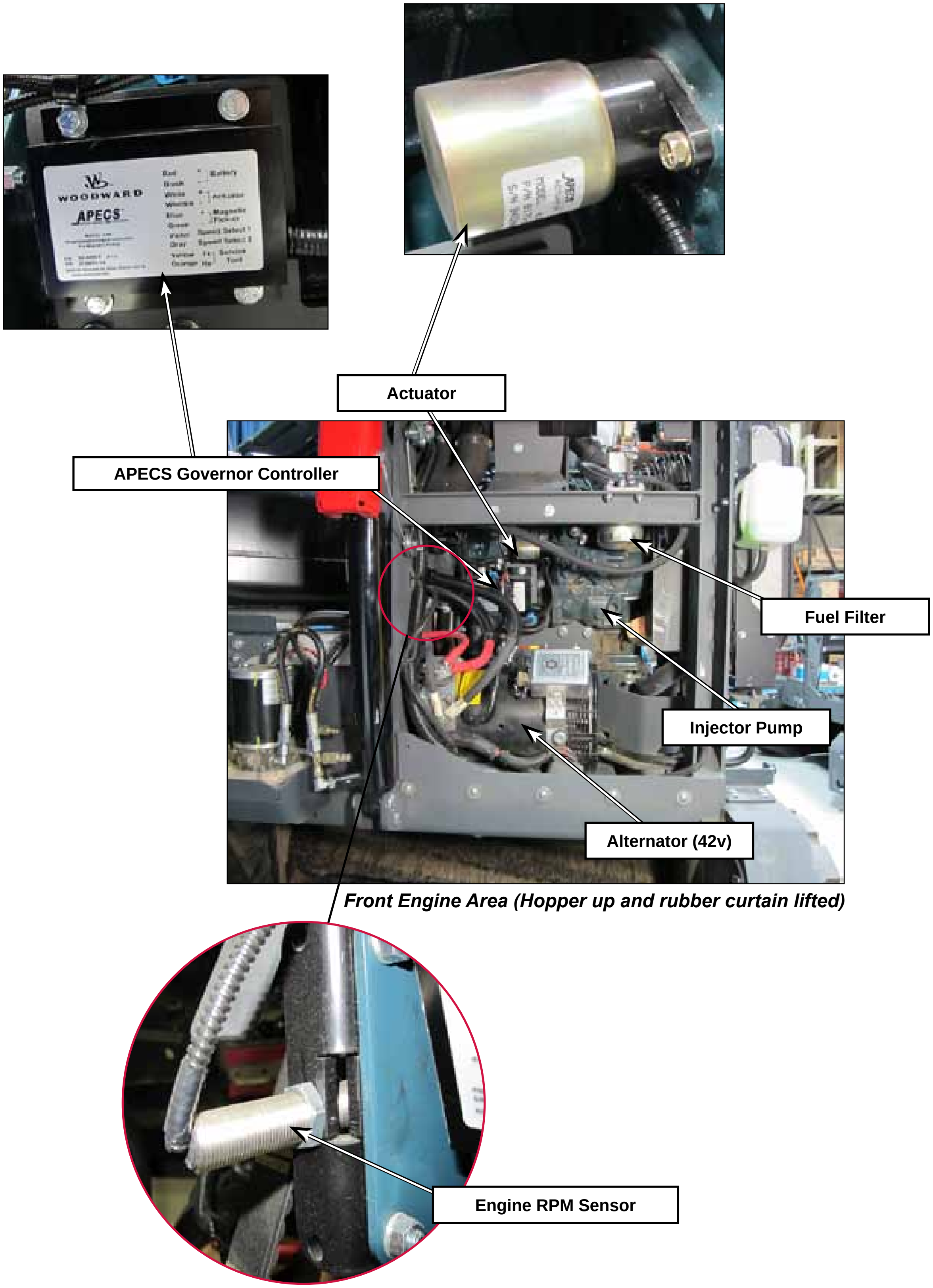
- Fuel tank - Right side of engine compartment
- Fuel level sending unit - Top of fuel tank
- Fuel pump - Top of fuel tank
- Fuel filter - Front left engine compartment area. Mounted on frame between engine and hopper.
- Injector pump
- APECS Governor Controller - Front engine area mounted on engine.
- 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

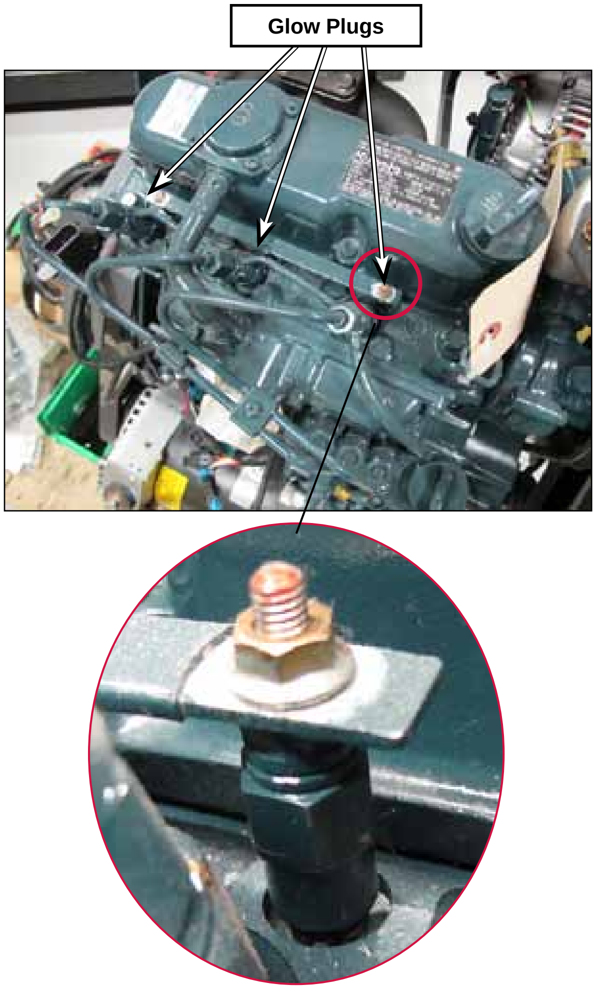
Fuel Tank (Shown with hopper up)

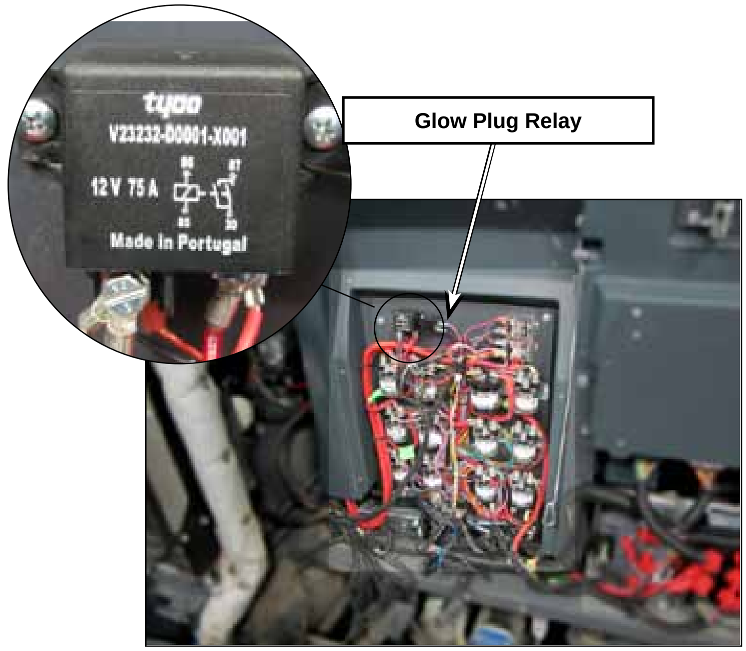


Fuel Tank (Shown swung out)

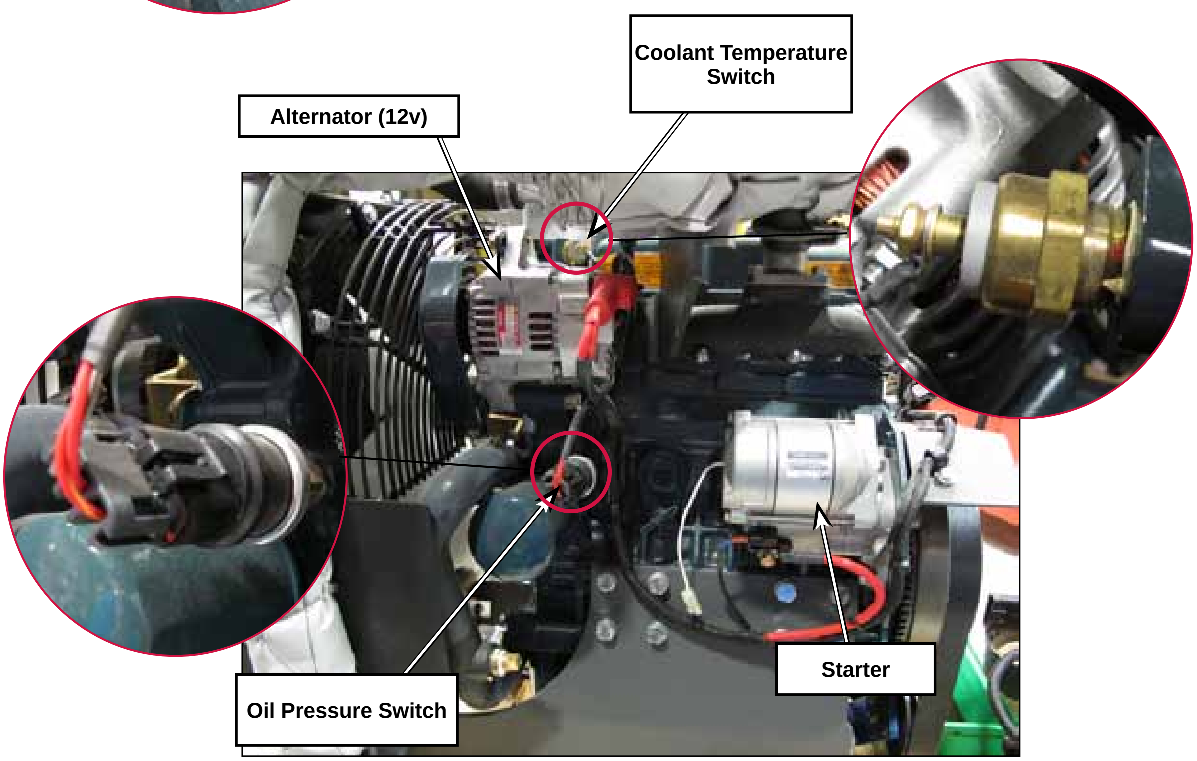


Front Engine Area (Hopper up and rubber curtain lifted)





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

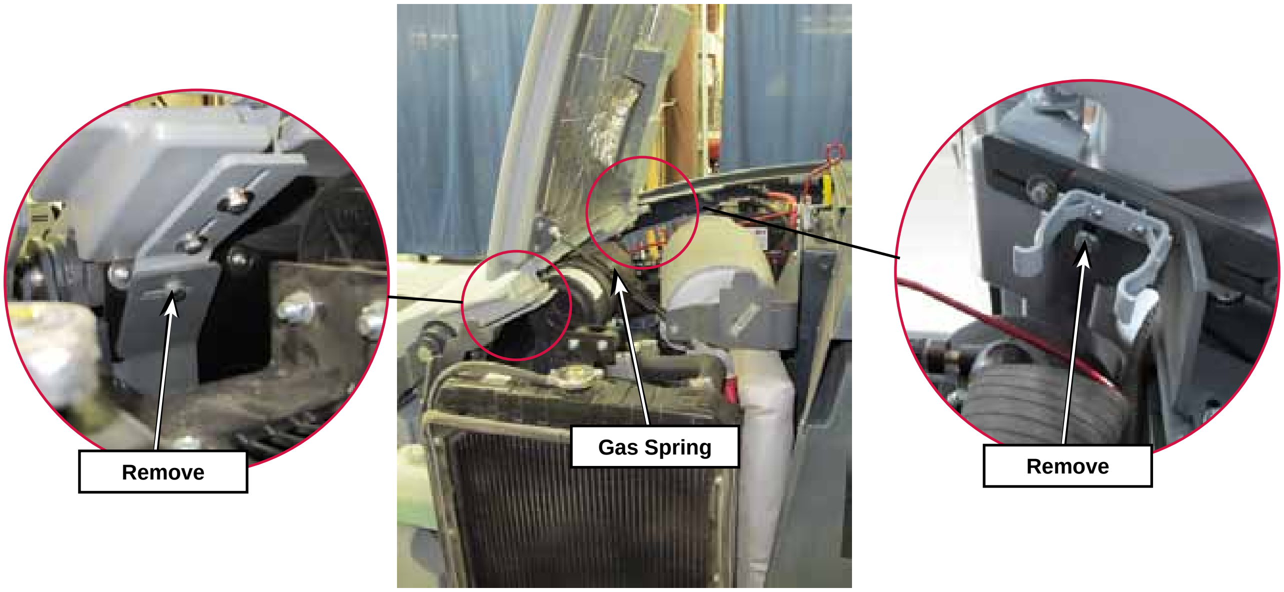
Check the service indicator mounted on the air cleaner elbow. If the red disc is visible in the “window”, the filters should be cleaned or replaced.

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

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:

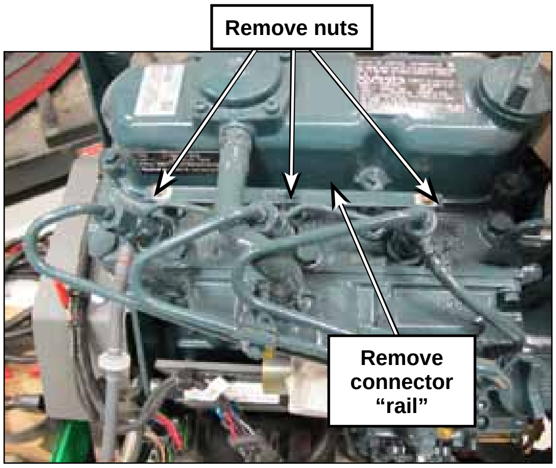
- Actuator
- APECS 3000 Governor Controller
- Wiring
- Main Machine Controller

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.

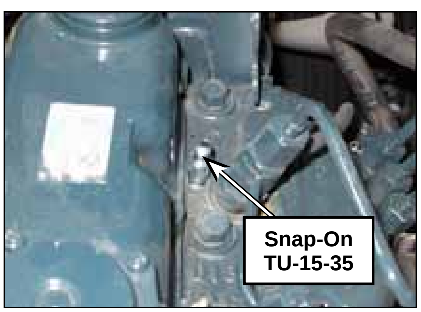
Compression Test

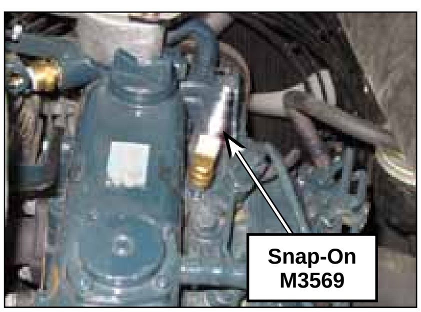
1. Begin with a fully charged battery.
2. Remove the air cleaner assembly. Cover the air inlet opening to prevent foreign objects from falling into the engine.
3. Remove the glow plug electrical connector nuts and connector “rail”.



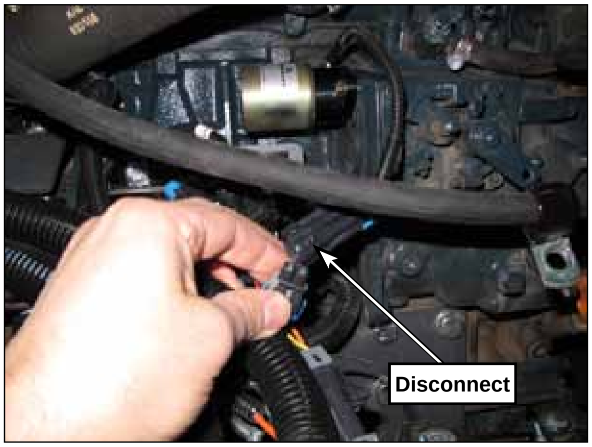
4. Insulate the electric terminal that feeds the rail to prevent it from shorting to ground.

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

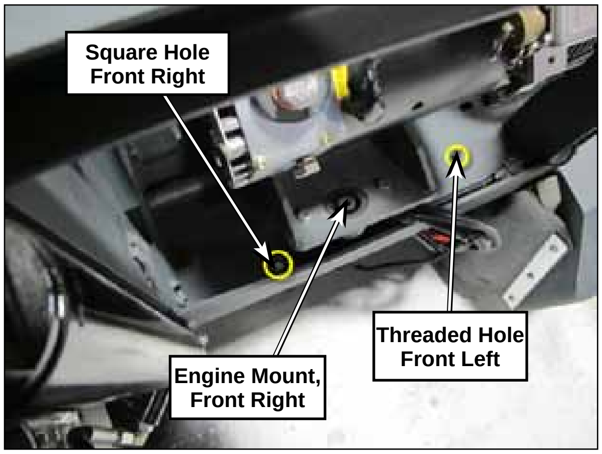
Engine RPM Sensor Installation

1. Screw in the sensor until the end of the sensor contacts the engine starter ring gear.
2. Back out the sensor 1/2 turn to establish an air gap between the sensor and the ring gear
3. Tighten the jamb nut.
4. Connect the electrical connector

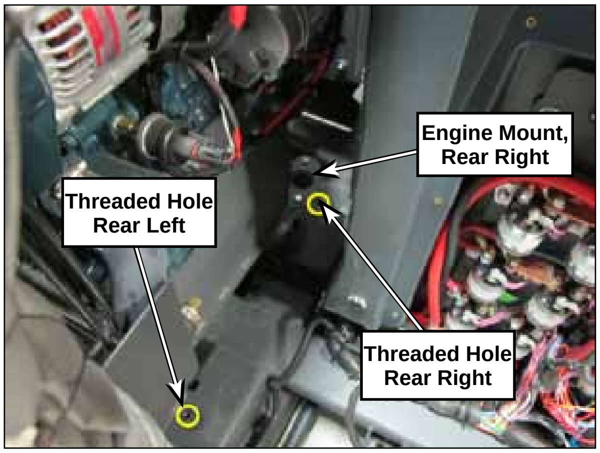
Engine Assembly

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	

28 - Engine System - Petrol (Gasoline)

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

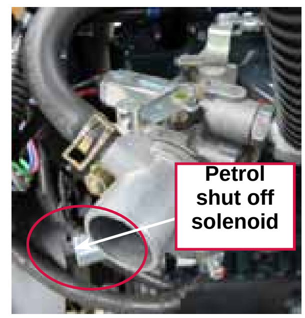
Kubota WG972-GL-E3-NFK-1 Petrol (Gasoline)

The Kubota WG972 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 petrol (gasoline) 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. An electric fuel pump is mounted to the top of the tank. The tank contains a fuel level sending unit. The carburetor has an additional fuel shut off solenoid that must be energized for petrol to flow through the carburetor to the engine.

Kubota Engine

Gasoline (Petrol) Fuel Tank



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

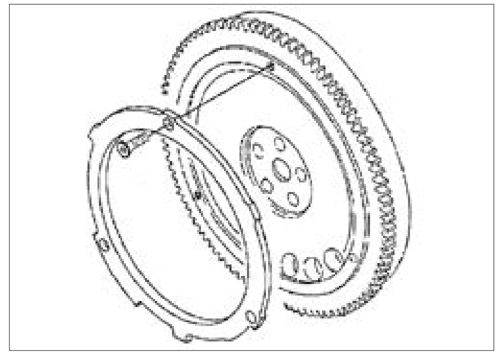
Circuit Descriptions

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

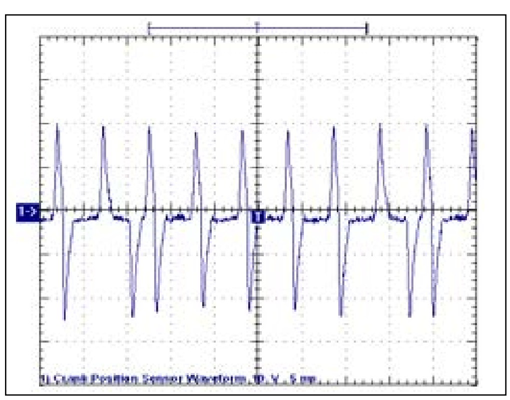


Toothed Ring and flywheel

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)

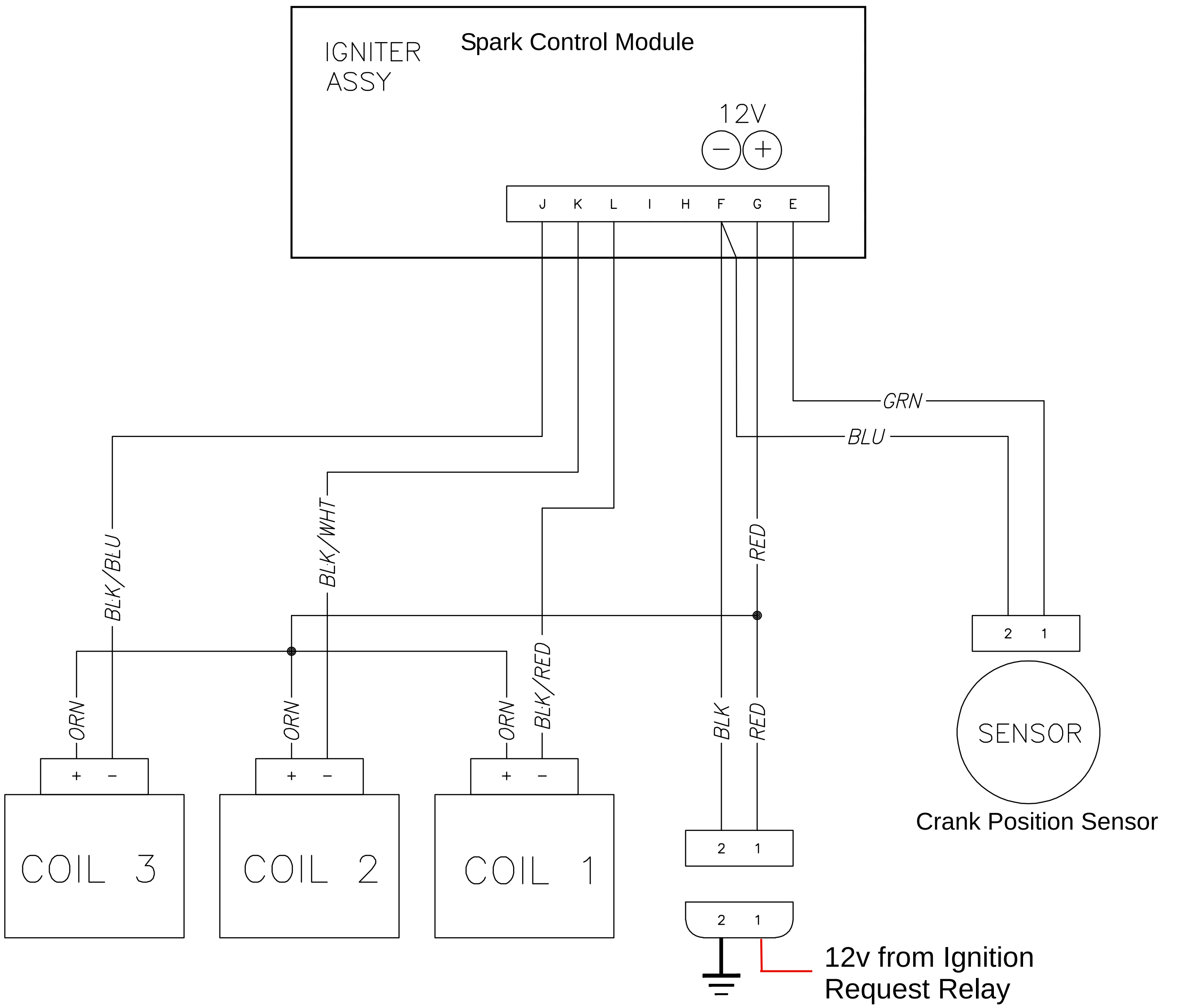
The crank sensor is a two wire “ AC pulse generator”. It has a wire coil inside of it. As the toothed ring rotates, the teeth pass in line with the end of the sensor tip. This induces a voltage spike that the spark control module can “read” as cylinder position information. The number of spikes per minute 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.

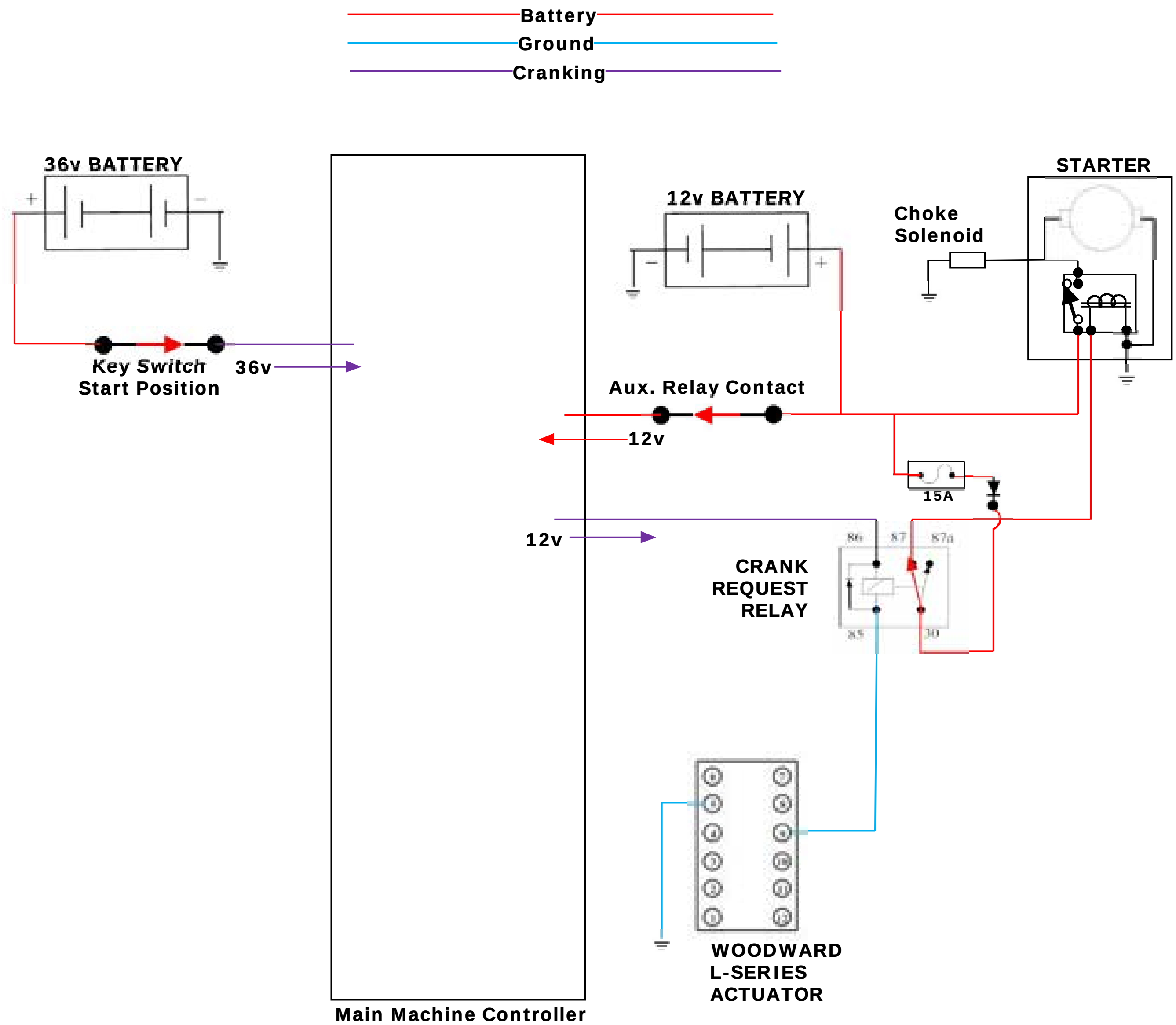
The two wires form the crank position sensor are connected to pins E and F.

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 and Carburetor Choke Control

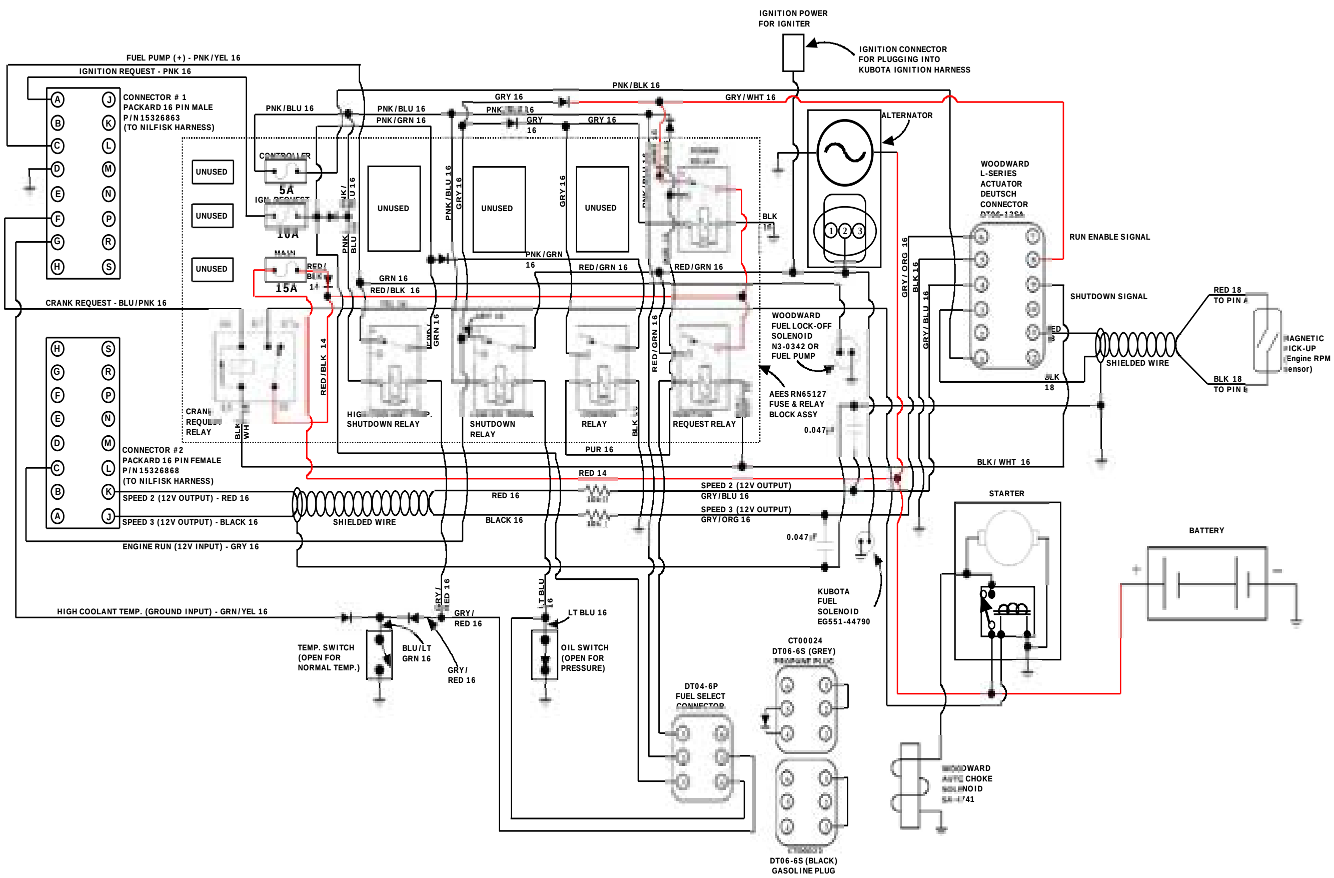
To get the engine starter to engage, the key switch is held in the start position which supplies 36 volts to the main machine controller on the violet wire with the green stripe to connector J7 pin 19. This is the start input request. The main machine controller receives a 12 V supply on connector J3 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. An electrically operated solenoid pulls the carburetor choke closed when the starter is engaged.



Throttle Control Modes

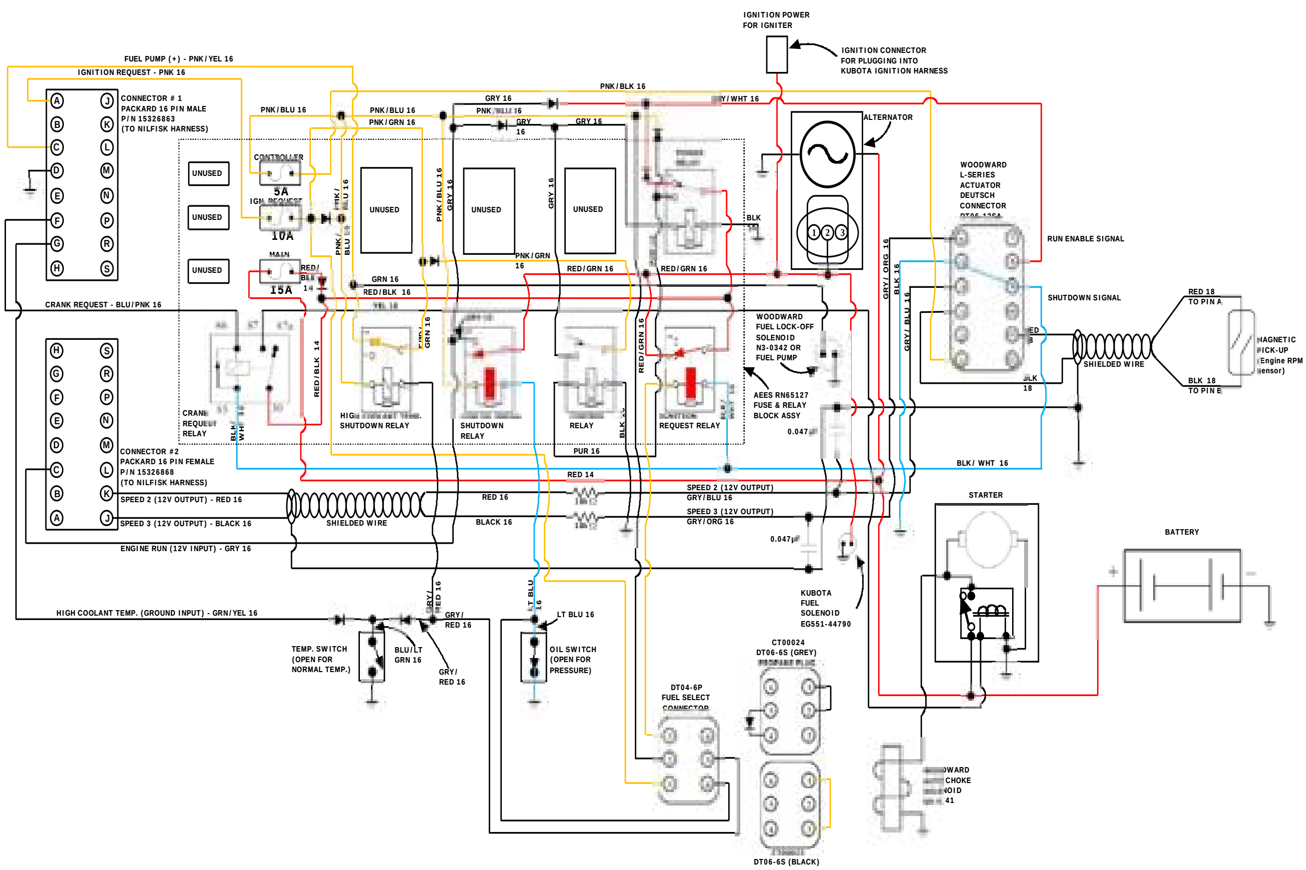
Ignition Off

- 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 ignition system or carburetor fuel shut off solenoid.



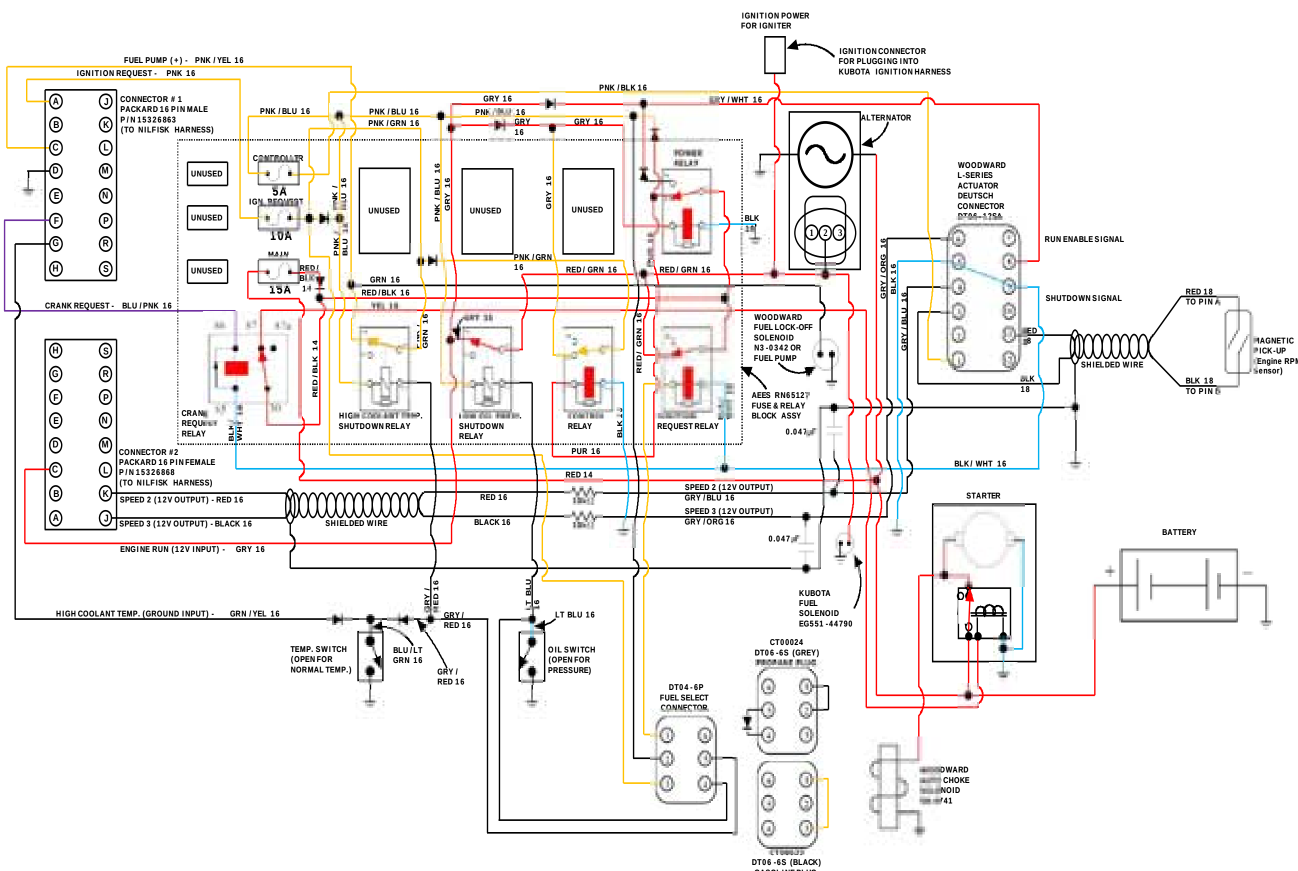
Ignition On

- When the main machine controller sees the key switch input, it sends 12v out on the Ignition Request circuit.
- 12v is provided to the common contact at pin 3 of the high coolant temp. shutdown relay and on through the normally closed contacts to the fuel pump.
- Ignition power is fed to the low oil pressure shut down relay energizing the relay
  – Since there is no oil pressure, the oil pressure switch is closed causing the relay to be energized. This prevents power from being passed to the “engine run” input into the main machine controller.
- 12v passes through the fuel select connector from pin 3 to 1 via the gasoline plug connector to the ignition request relay coil.
- 12v is provided to the actuator pin 1, which wakes it up.
  – The actuator provides a switched path from pin 9 to 5. This provides a ground for the ignition request relay turning it on.
  – The ignition request relay passes battery power to the ignition system, carburetor fuel shut off solenoid and the low oil pressure shutdown relay common contact at pin 3.
  – Solenoid.



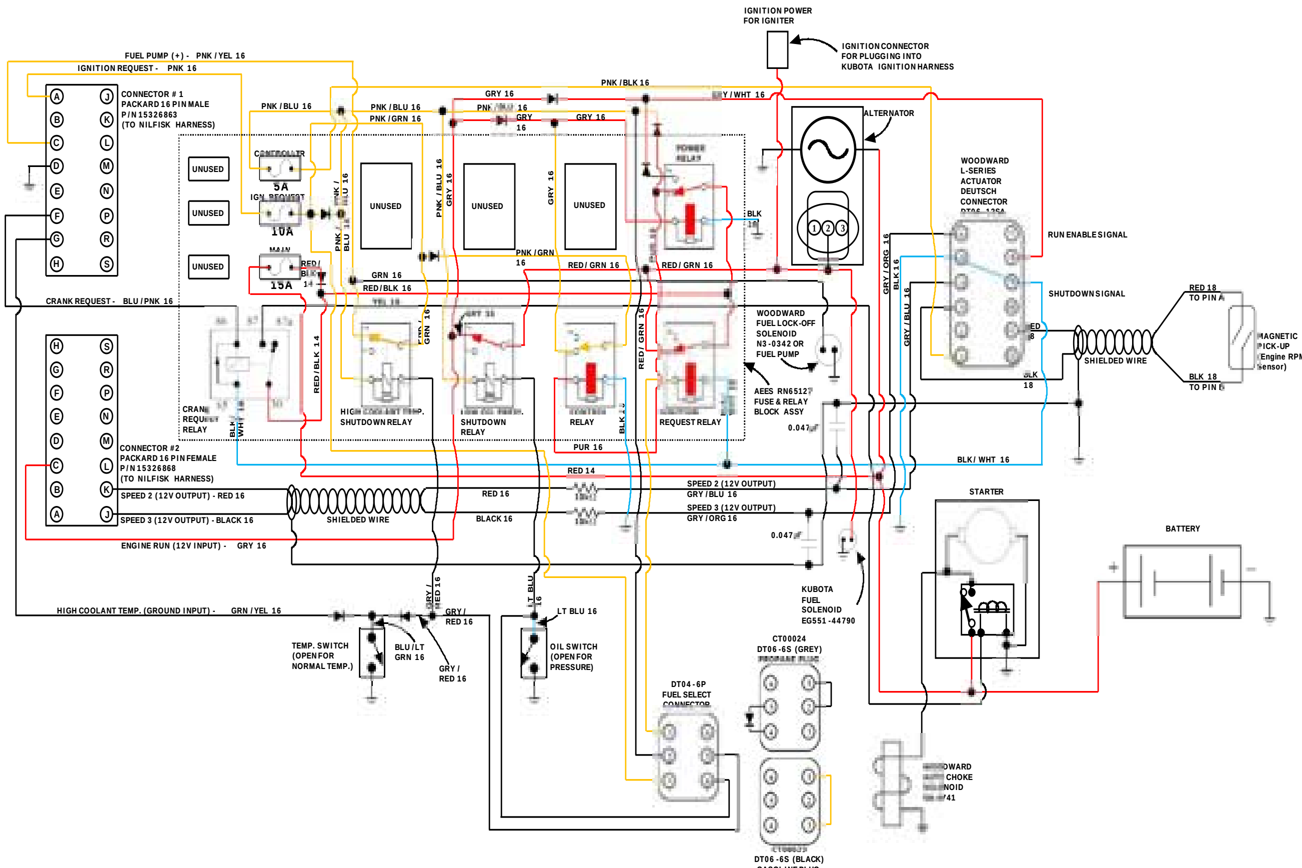
Cranking

- 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 starter motor power is also fed to the choke solenoid which pulls the carburetor choke closed.
- Once oil pressure builds up, the oil pressure switch opens.
  - The loss of ground through the oil pressure switch 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 pin 8. 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 Woodward L-series actuator directly monitors the engine speed sensor input and adjusts the throttle linkage to maintain the current target engine speed. If it is unable to maintain the speed within the desired "window", it will shut the engine down by removing the path to battery negative for the ignition request relay through the actuator. Note that if the actuator loses the RPM signal while the engine is running, it will shut the engine down. If the actuator never sees an RPM signal, it does not know that the engine is running and has not tried but failed to control the RPM. Therefore it remains in a "cranking mode" and does not shut the engine down.

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

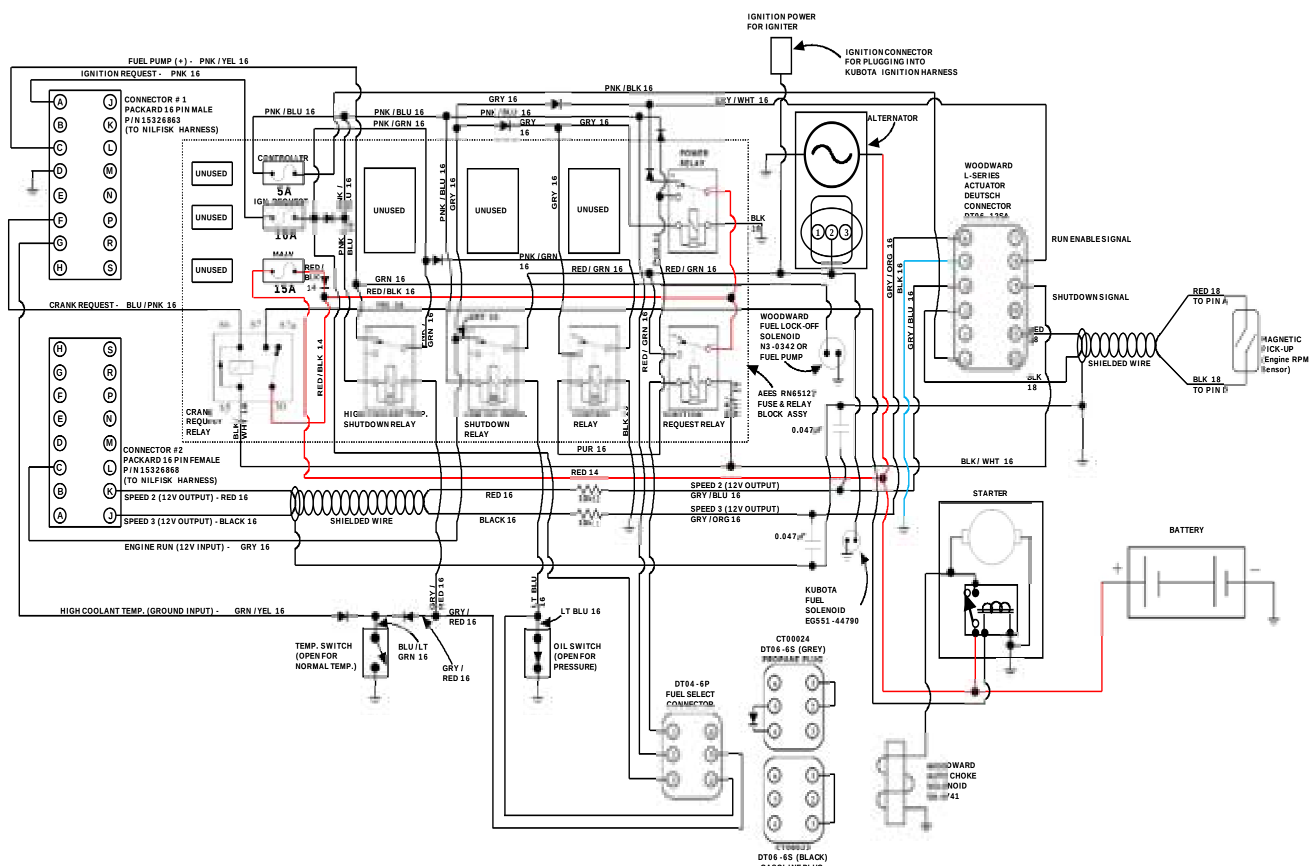
There are several conditions that will override the user's engine speed request.

- 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 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.

Normal Engine Shut Off

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 pump that had been flowing through the "closed at rest" contacts of the high coolant temp shut down relay and from the ignition request relay, which turns it off. Turning off the ignition request relay causes ignition to be immediately lost and the engine to shut off. It also turns off the gasoline shut off solenoid on the carburetor

Several other events also take place. The ignition request power is lost from pin 1 of the Woodward actuator. When this happens, it switches off the path to ground from pin 9 to 5. De-energizing the ignition request relay also results in the loss of the engine run signal through the low oil pressure shut down relay closed at rest contacts, turning off the power relay and control relay.



Engine Protection Modes

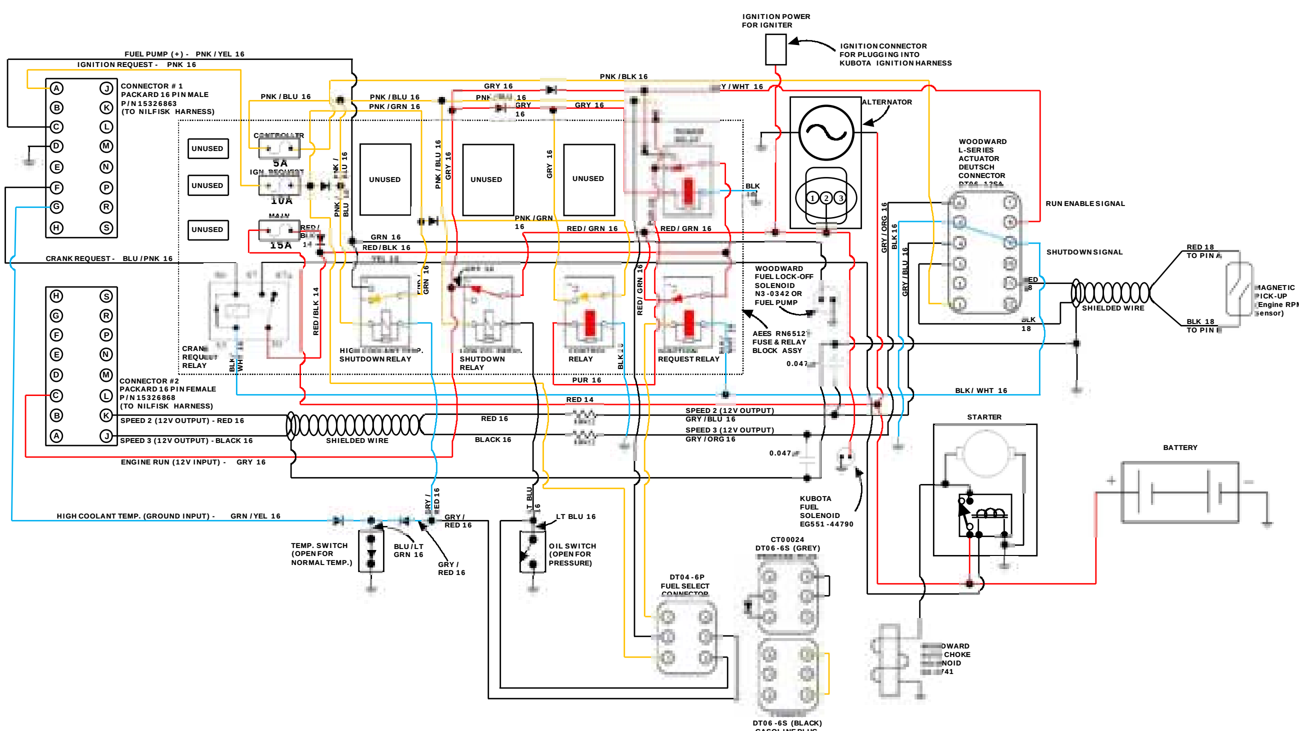
The engine will be shut off in the event that it overheats or loses oil pressure after it has been running. The main machine controller will display a warning message to the operator for either case and will also initiate an engine shut down as a back up measure.

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 pump causing the engine to run out of fuel and stall.

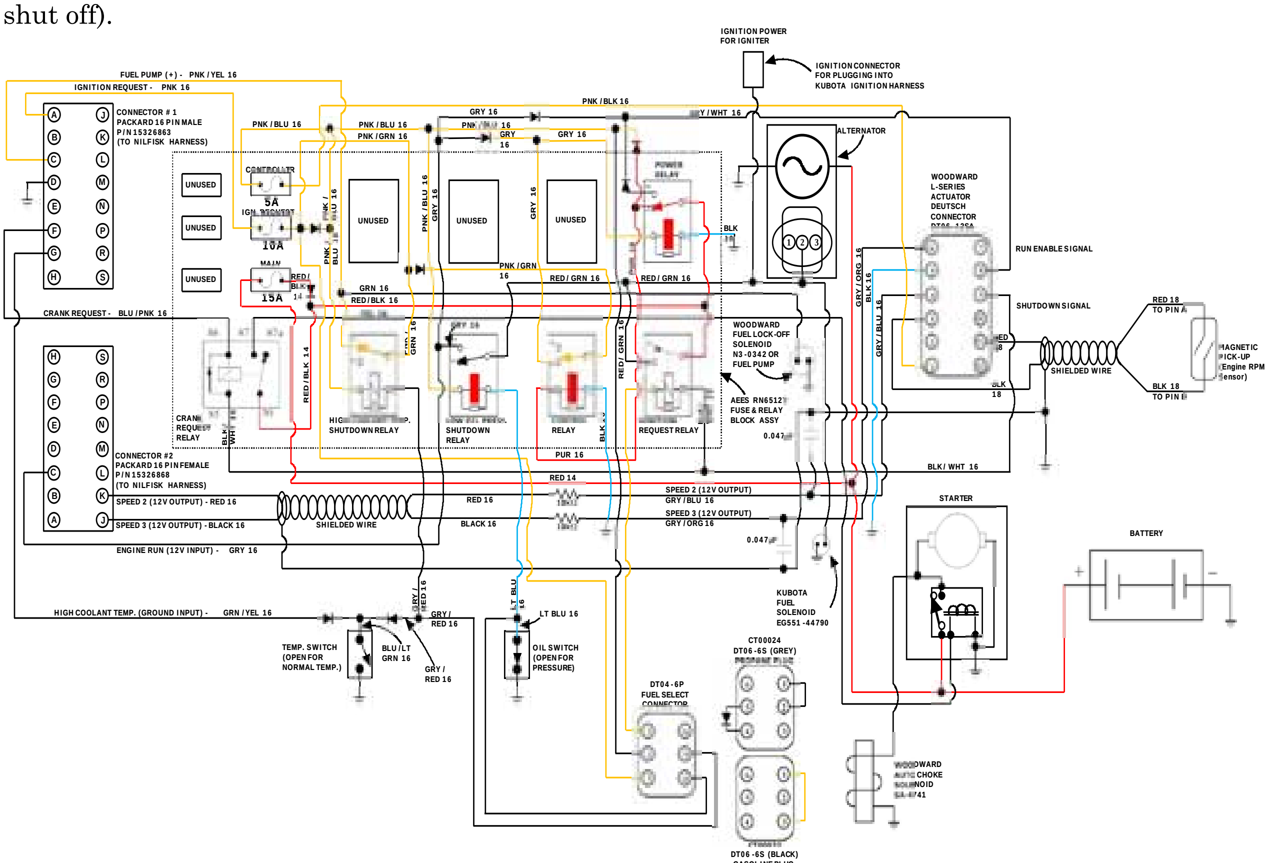
Engine Overheat Shutdown

- 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 pump. This does not shut the engine down immediately, but allows the engine to use up the fuel in the carburetor float bowl 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

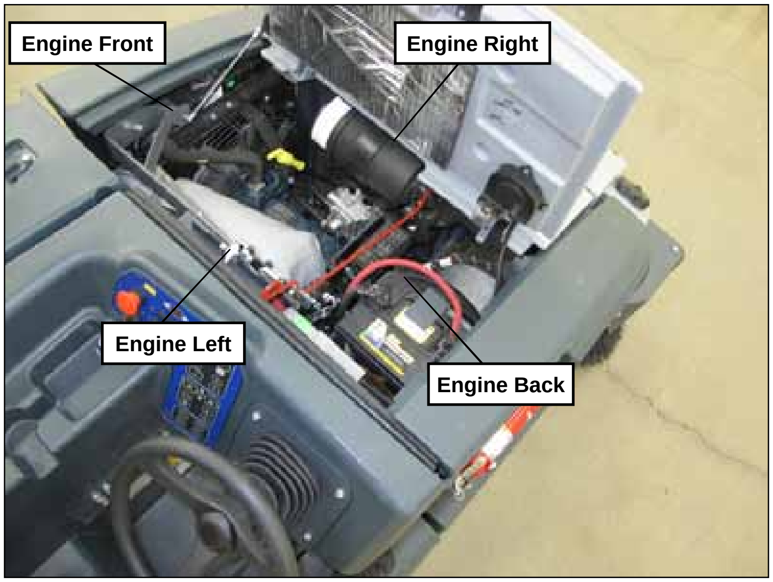
- If the engine oil pressure is lost, the oil pressure switch will close causing the low oil pressure shut down relay to energize taking power away from the “closed at rest” contact. This removes the power from the run enable signal to pin 8 of the Woodward L series actuator. The actuator immediately 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 the engine to stall immediately. Note that the power relay remains “latched-on” due to ignition voltage supplied by the control relay.
- 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).



Note: If the engine stalls due to loss of fuel or ignition, oil pressure will eventually be lost. When this happens the main machine controller will treat it as a lost oil pressure condition, display a warning message to the machine operator and initiate the lost oil pressure shut down sequence.

Component Locations

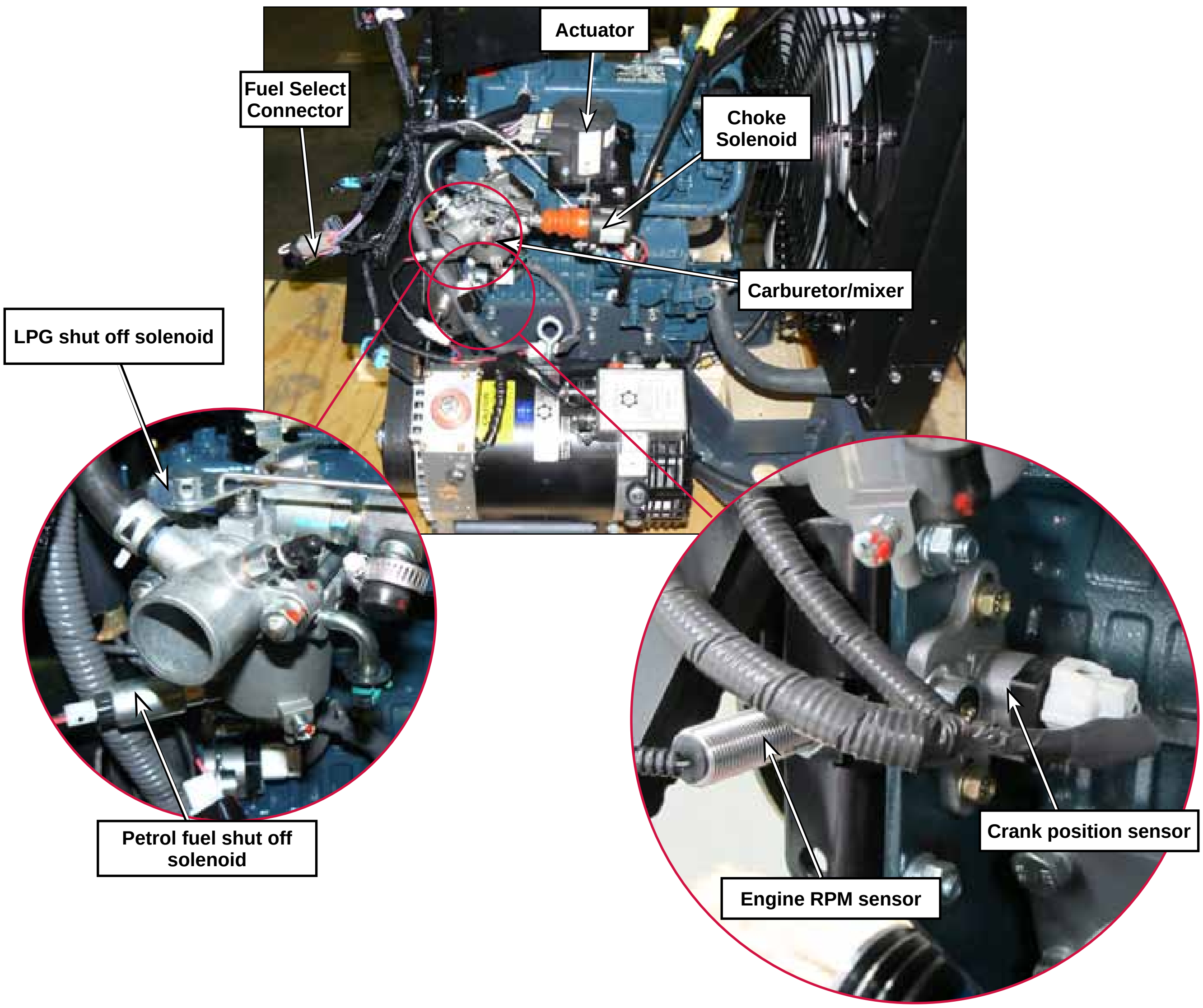
Engine components are grouped according to the area of the engine. They are photographed on an engine that is not installed in the machine for better visibility.



LPG Engine Pictured

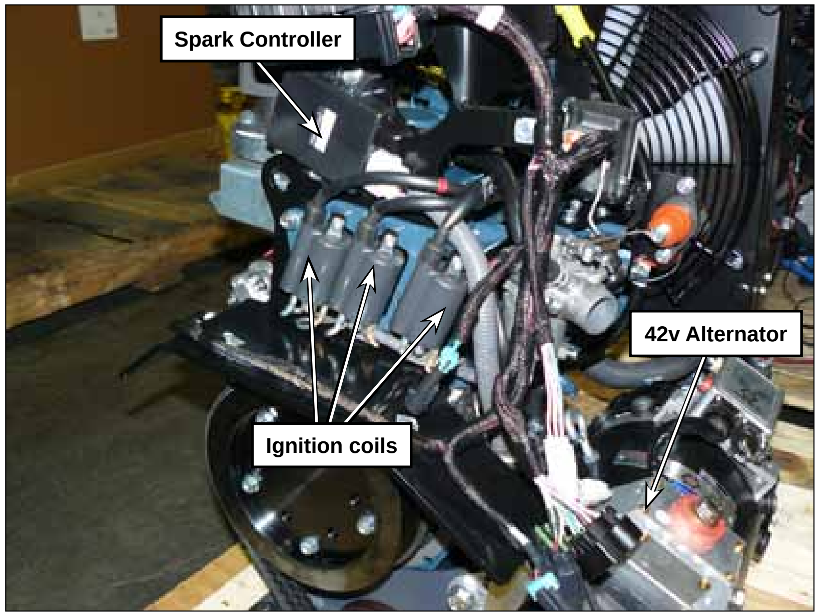
Engine Right Side View (Toward front of machine)

- Actuator
- Choke Solenoid
- Carburetor/mixer
- Engine RPM sensor
- Crank position sensor
- Petrol fuel shut off solenoid
- Fuel Select Connector



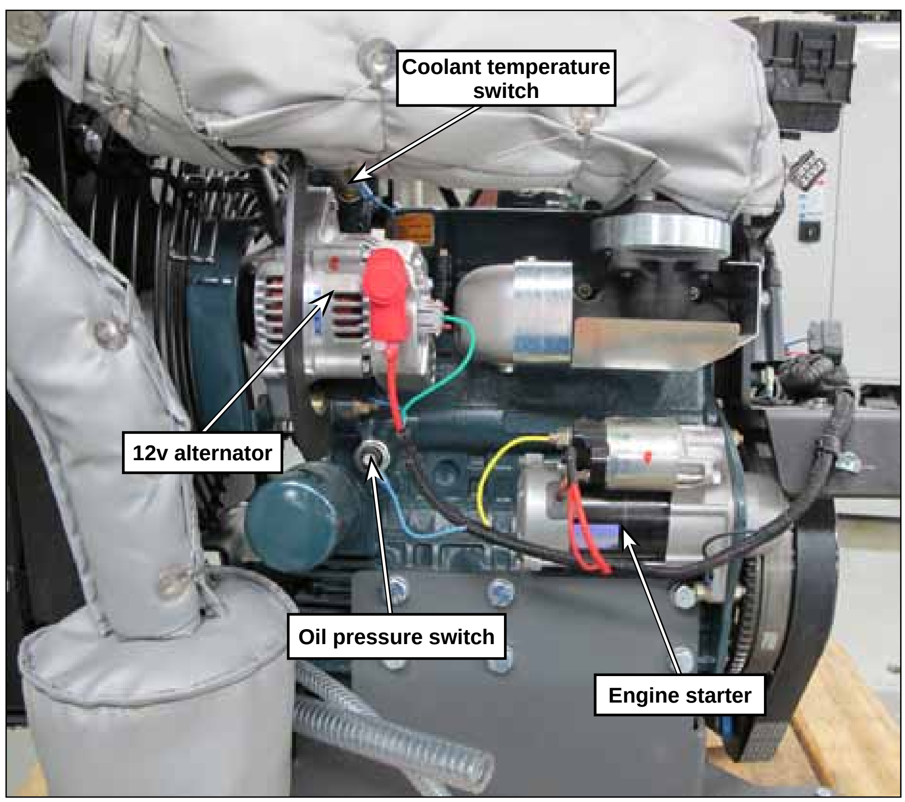
Engine Back Side View (Toward right of machine)

- Spark Controller
- 42 V Alternator
- Ignition coils



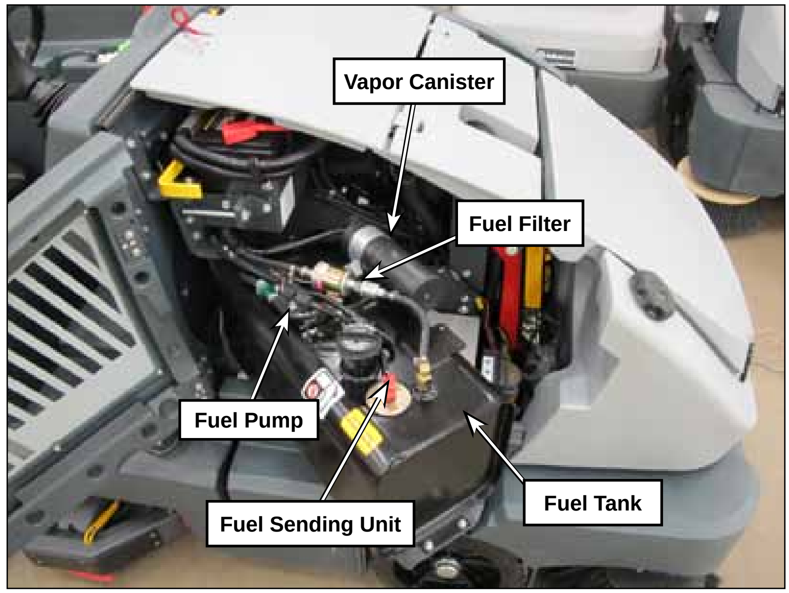
Engine Left *Side View (Toward back of machine)*

- 12 V alternator
- Engine starter
- Oil pressure switch
- Coolant temperature switch



Fuel Tank Area

- Fuel tank
- Fuel Pump
- Fuel Filter
- Fuel Sending Unit
- Vapor Canister



Maintenance and Adjustments

Maintenance Checklist

This check list is courtesy of the Kubota Gasoline, LPG, 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

First 50 hours:

- Change engine oil
- Replace engine oil filter

Every 50 hours

- Clean air cleaner element
- Check fuel hoses and clamps

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 radiator hoses and clamp bands

Every 1 year

- Replace air cleaner element
- Replace gasoline fuel hose, clamp bands and fuel filter
- Clean fuel tank inside
- Clean water jacket and radiator interior

Every 1000 hours

- Replace spark plug
- Check valve clearance
- Clean combustion chamber if necessary

Every 2 years

- Replace intake air line
- Replace breather hose
- Replace radiator hoses and clamp bands
- Replace battery
- Replacing ignition wires
- 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.

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 pump inoperative
  - No electrical power to fuel pump
    - Ignition request fuse – blown
    - High coolant temp shut down relay – “Closed at rest” contacts not making connection
    - Open wire on positive or negative side of fuel pump
  - No power to carburetor petrol fuel shut off solenoid
- Mechanical engine
  - Insufficient compression
  - Plugged Intake
  - Plugged Exhaust
- Actuator
  - Not opening throttle

Achieves one but not ALL RPM modes.

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:

- Failed Engine Speed Sensor
- Actuator linkage
- Actuator power supply
- Actuator
- Wiring
- Main Machine Controller

Diagnostic steps

1. 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.
2. Check the power and ground supplies to the actuator.
   - Is there sufficient power and ground?
     - If so, go on to check the Engine RPM Sensor input.
     - If not, repair.
3. Check the Engine RPM Sensor input. (Check the AC voltage while the engine is running or check resistance of sensor through wiring harness from the actuator connector.)
   - Is the Engine RPM sensor input okay?
     - If so, go on to check the speed request inputs.
     - If not, repair.
4. 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

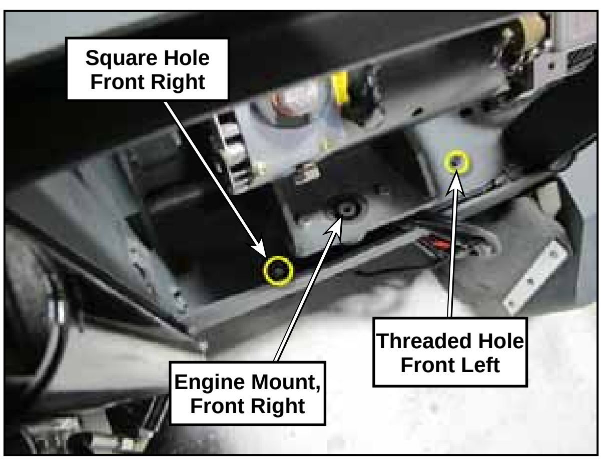
Engine RPM Sensor Installation

1. Screw in the sensor until the end of the sensor contacts the engine starter ring gear.
2. Back out the sensor 1/2 turn to establish an air gap between the sensor and the ring gear
3. Tighten the jamb nut.
4. Connect the electrical connector

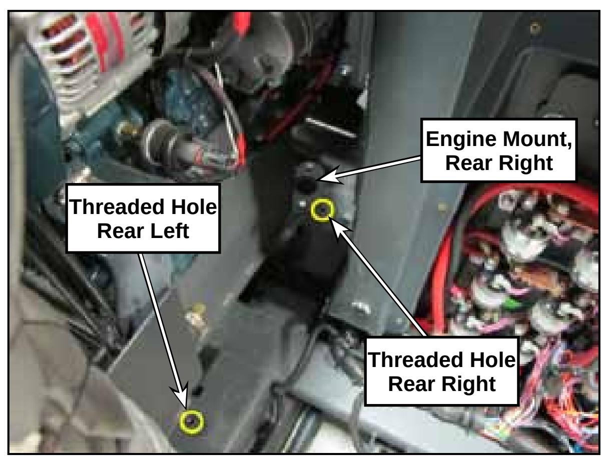
Engine Assembly

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

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 or better.
  - 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 1	7.79v	0.007v
5	BLK	Ground	0.007v	0.007v
6	GRA/ORN	Throttle 2	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

Fuel Pressure - 3.5-4.0 PSI (24-27 Kpa)

Fuel volume - 0.5L in 15 seconds

Carburetor Fuel Shut-off Solenoid resistance - 38 ohms

Electric Choke Solenoid resistance - 2.5 ohms

Engine

Engine Vacuum at idle - approx 17.5 inches HG (59 Kpa)

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

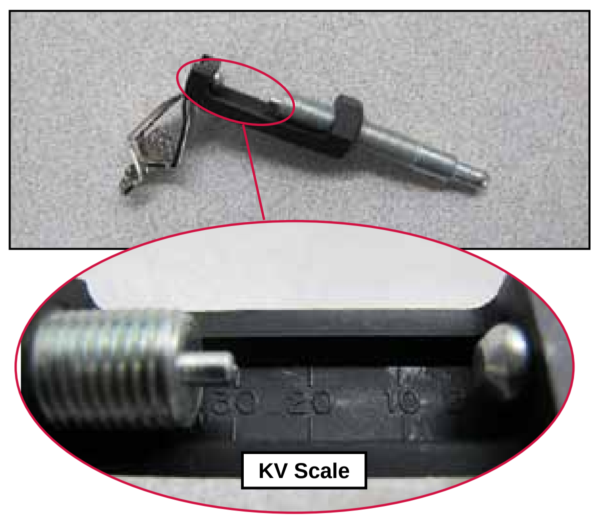
Engine Compression

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

Special Tools

Adjustable KV Spark Tester.

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



30 - 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 level (pressure) 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 Main Machine Controller monitors the solution level via a solution pressure sensor. 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 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 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 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 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.

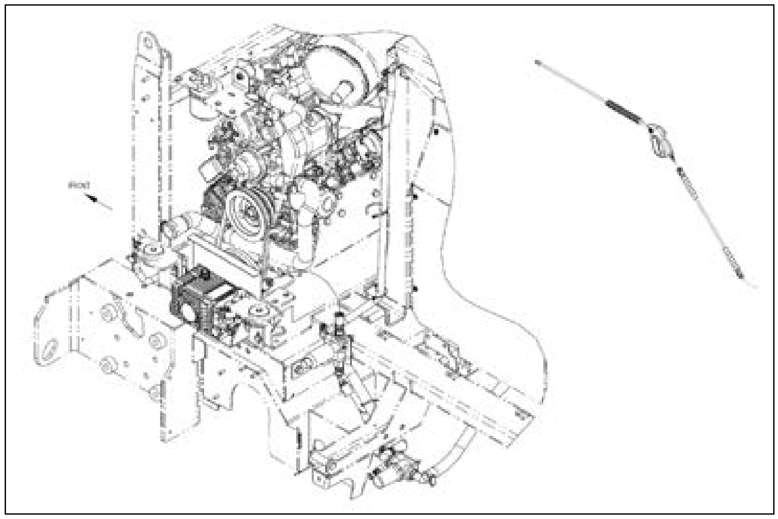
Note: *If your machine is equipped with a hot water system, do not add detergent to the solution tank as this can foul the heat exchanger.*

Optional Wash Hose Kit

The optional wash hose kit uses a separate low-pressure pump 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.



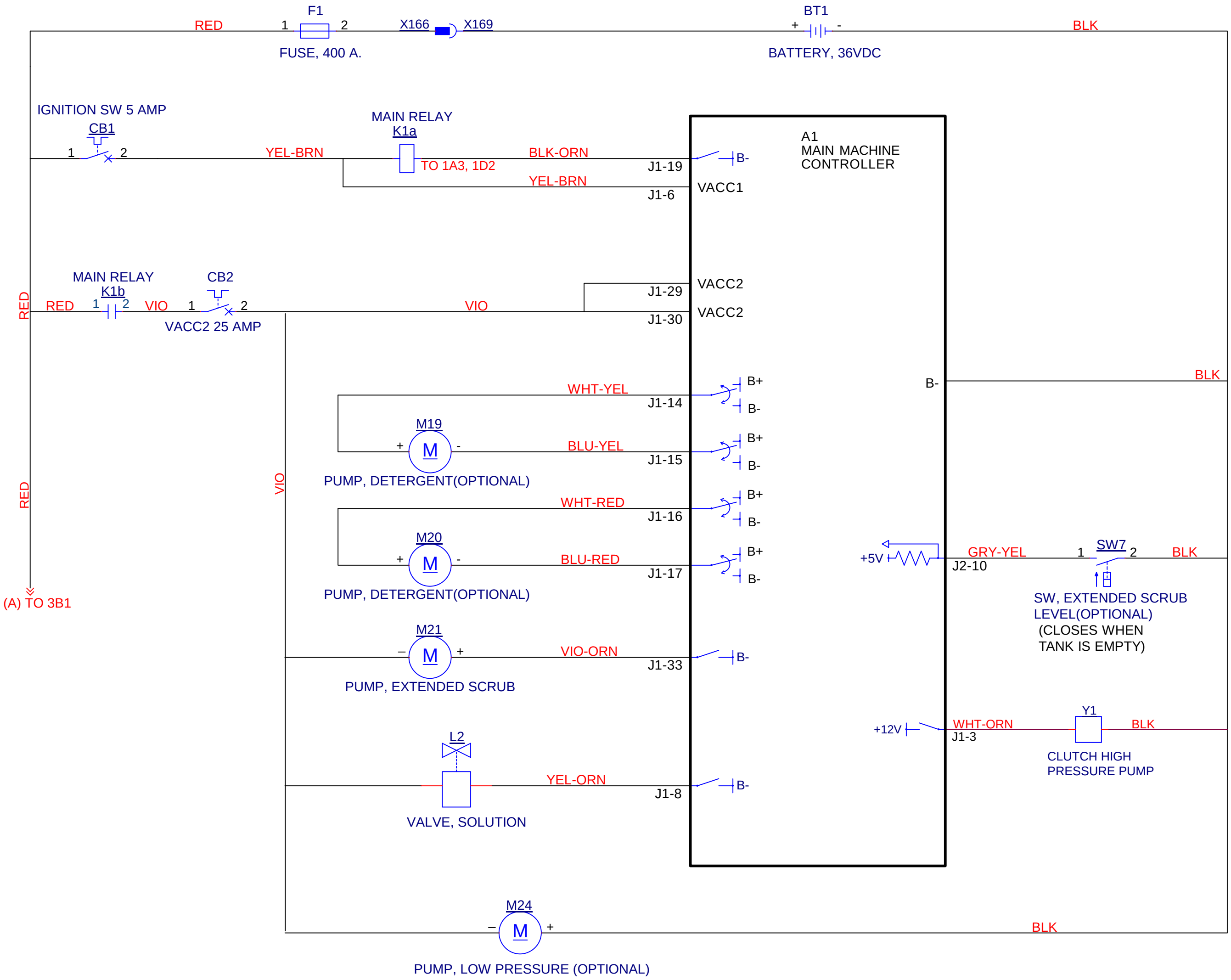
Solution Level Sensor

The solution level sensor is a pressure sensor contained directly on the Main Machine controller circuit board. A flexible tube transmits the pressure of the water in the solution tank (called the head pressure) to the sensor on the control board.

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 K1 relay provides positive power to the solution solenoid, low pressure pump, and extended scrub pump. Because the output of the K1 relay also goes to the main controller, the main controller knows whether the K1 relay is open or closed, and will issue a fault code if there are any failures upstream from this point.

The extended scrub pump and solution solenoid valve are activated when the main controller provides a PWM path to ground. The low pressure pump is always active, but operates by on-demand when a drop in output pressure is detected.

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 high pressure pump is mechanically driven off the engine, but contains an electric clutch to engage power when needed. The main controller provides positive battery power to the clutch.

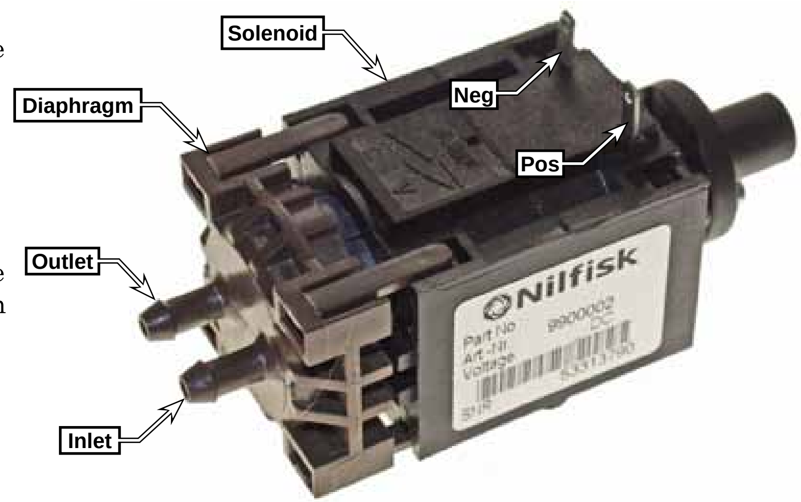
Extended Scrub System

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 Main Machine Controller must detect a low-solution condition from the on-board pressure sensor.
- The extended scrub level sensor (float switch) must be open to indicate that the recovery tank is not empty.

EcoFlex Option

Machines that have the EcoFlex option have on-board detergent mixing using a pump-driven detergent injection system. The detergent is stored in the removable detergent tank below the operator's seat, which has a suction hose from the detergent pumps. The detergent pumps draw the liquid from the detergent tank and inject it into the solution line before the solution solenoid. The flow rate of the detergent is controlled by the Main Machine Controller using PWM.



There are two detergent pumps that operate in parallel to deliver detergent to the scrub deck. Each pump uses a solenoid-driven diaphragm with one-way check valves. As the solenoid oscillates in and out, it drives a flexible diaphragm that draws fluid in during the retraction stroke, and drives fluid out during the compression stroke. The check valves allow fluid to enter only though the inlet port, and exit only through the outlet port.

Unlike an AC solenoid that moves its plunger the same direction regardless of the electrical polarity, a DC solenoid changes its direction of travel depending on the electrical polarity of the coil. Even though the EcoFlex pumps use DC solenoids, they still contain a mechanical return spring to return the plunger to its relaxed state when no power is present.

In many other machines, the solenoid is actively driven in only one direction (usually intake), but passively returned via the return spring (usually exhaust). For higher flow rates, the CS7010 machine uses AC-Driven, Active-Return solenoid pumps. So even though the return spring already wants to "Passively" drive the plunger outward, the Main Machine Controller "Actively" pushes the plunger back out. So in effect, the pumps are DC solenoids driven by an AC square-wave signal.

In the forward-bias direction, with positive-to-positive and negative-to-negative, as shown above; the solenoid plunger retracts away from the diaphragm. This results in a suction at the inlet port, and fluid is drawn into the cavity caused by the diaphragm.

If voltage is simply removed at this point, the return spring will passively push the plunger forward, and the spring pressure will push the fluid out of the outlet port. However, if the solenoid is reverse-biased with positive-to-negative and negative-to-positive, the plunger is actively pushed forward with a greater force than what the spring alone can impart.

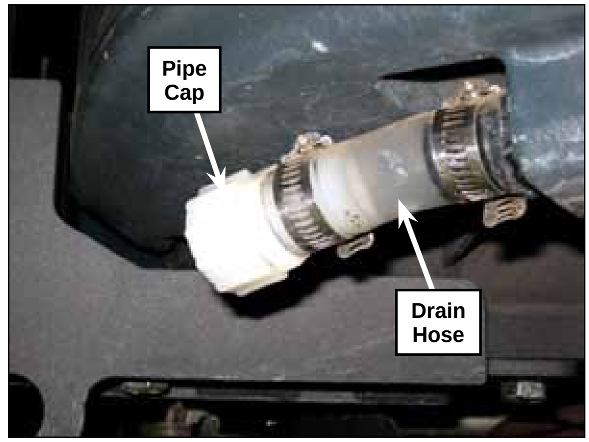
One thing to note about troubleshooting any solenoid driven pump, is that if the solenoid is already in its relaxed (compression) stroke, energizing the coil in the reverse-bias direction will not give any outward appearance that the solenoid was activated, because it is already driven in that same direction. So if manually powering the coil, make sure to check both polarities before concluding whether the solenoid has failed or not.

Component Locations

Solution Tank

Drain Hose

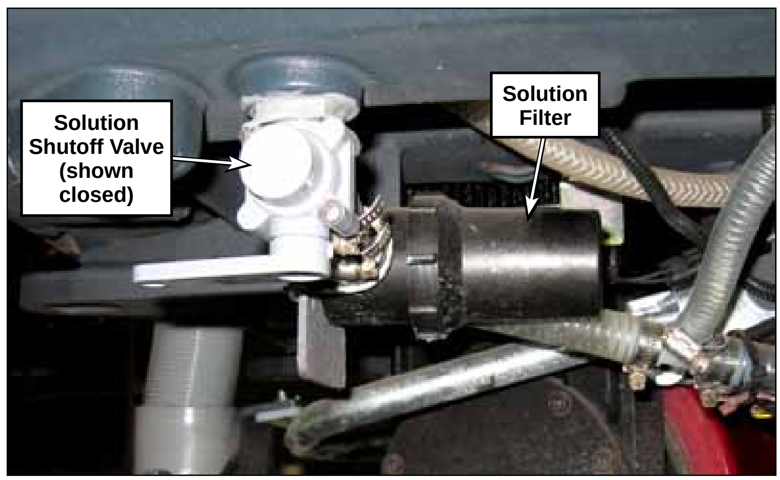
The Drain Hose underneath the rear right-hand side of the solution tank allows you to drain the solution tank. To drain the tank, remove the Pipe Cap.



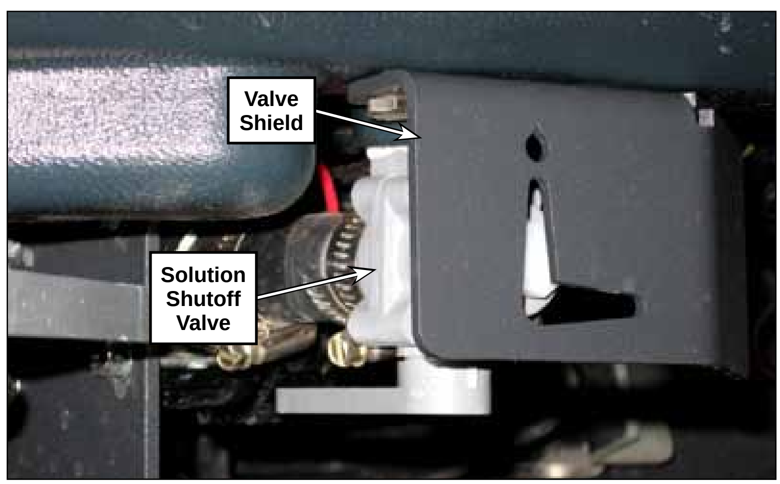
Solution Filter and Solution Shutoff Valve

The Solution Filter and Solution Shutoff Valve are mounted underneath the rear right-hand side of the solution tank.

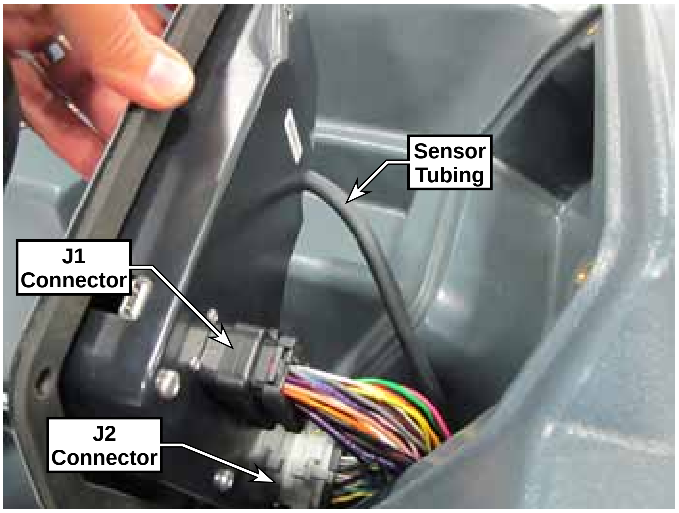
- The Solution Filter prevents any dirt or particulates that may be in the solution tank from entering the solution solenoid valve and solution system.
- The Solution Shutoff Valve allows you shut off the solution flow to the machine for solution system maintenance.



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



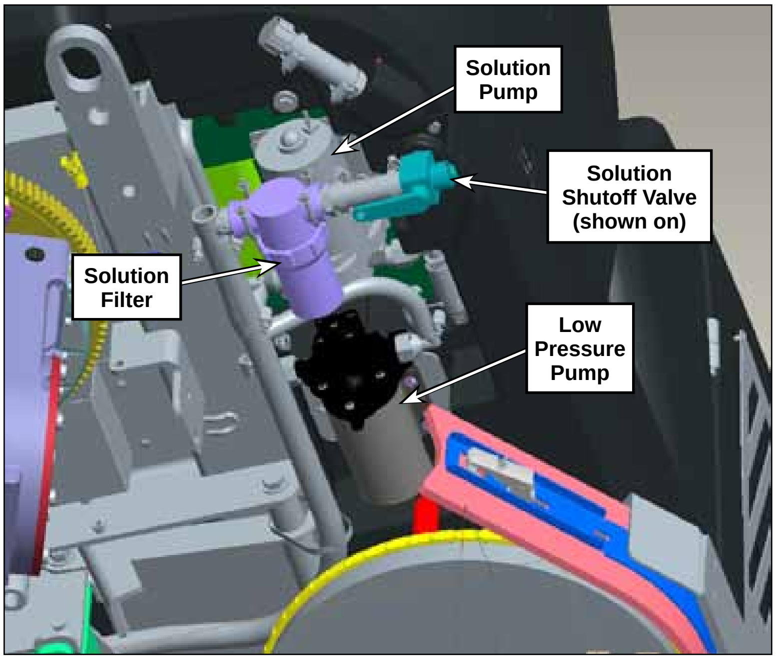
The level in the solution tank is detected with a remote-read pressure transducer located on the Main Machine Control board. The weight of the water column in the solution tank produces a pressure greater than the local atmospheric pressure. The sensor detects this difference in pressure and mathematically converts it into a water depth reading.

Because the control board and sensor are located above the bottom of the solution tank, a sensor tube serves to convey this pressure up to the control board. The weight of the water in the tank compresses the air that is in the sensor tube, and this air pressure is what pushes against the sensor. This is why it is important that the sensor tube be filled with air before it is connected to the solution tank. If it were filled with water, the weight of that column of water would cancel out some of the weight of the water column in the solution tank. Because air is compressible and water is not, it should be noted that some water will enter the sensor tube when the solution tank is full. This is what creates the pressure in the tube.

For example, if you were to open the tubing joint, shown above, while the solution tank was full, the water column in the tubing would equalize to the height of the water level in the tank, but no pressure would be inside the tubing. If you then sealed this tubing by reconnecting the joint, that would establish a new zero-pressure height. If you then drained the solution tank, the sensor would then begin seeing negative pressures in the tubing.

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.



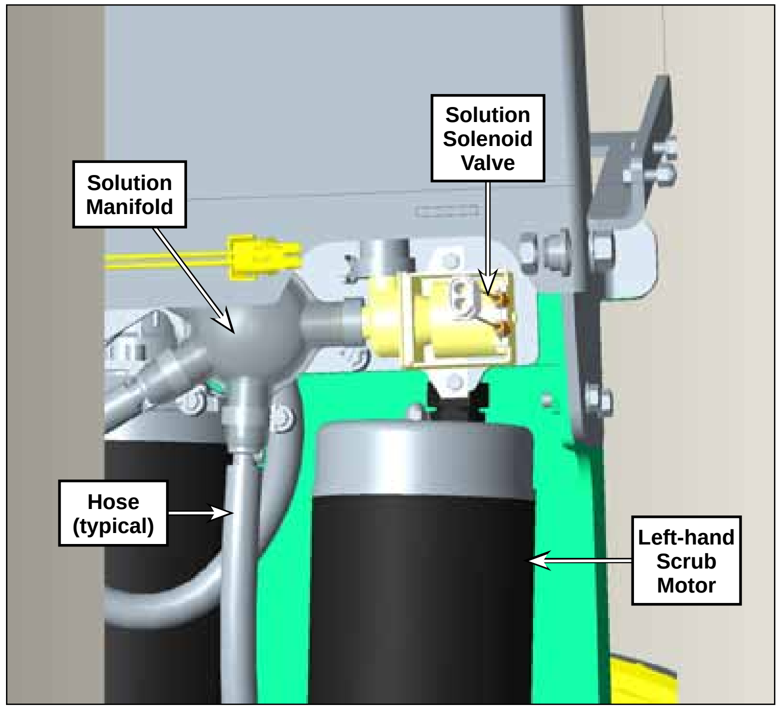
Low Pressure (Wash Hose) Pump

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.

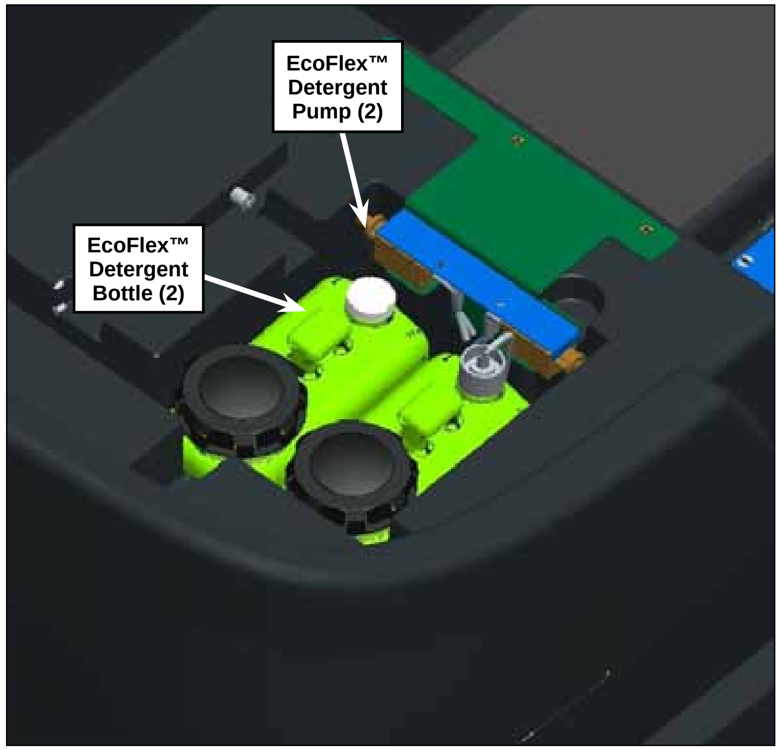


Solution Nozzles

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.)

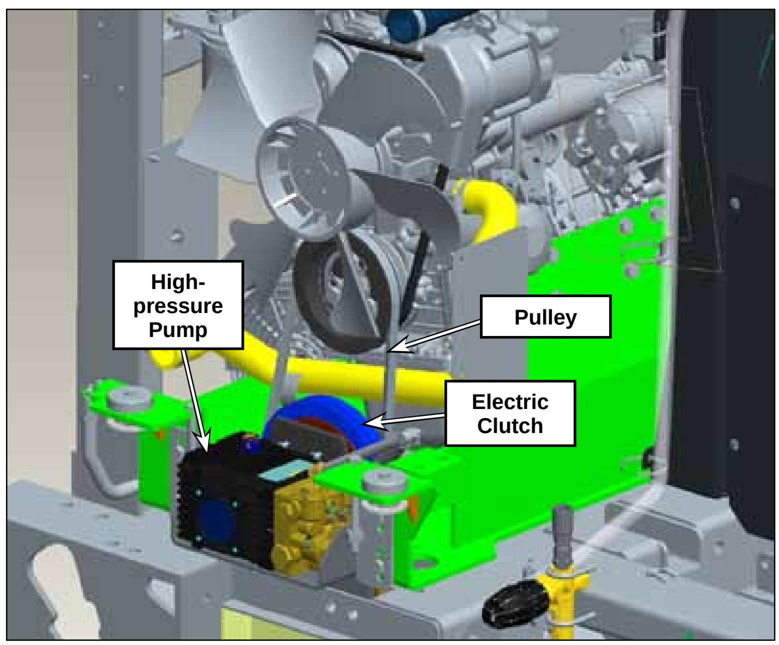
EcoFlex™ Detergent Bottles and Pumps

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

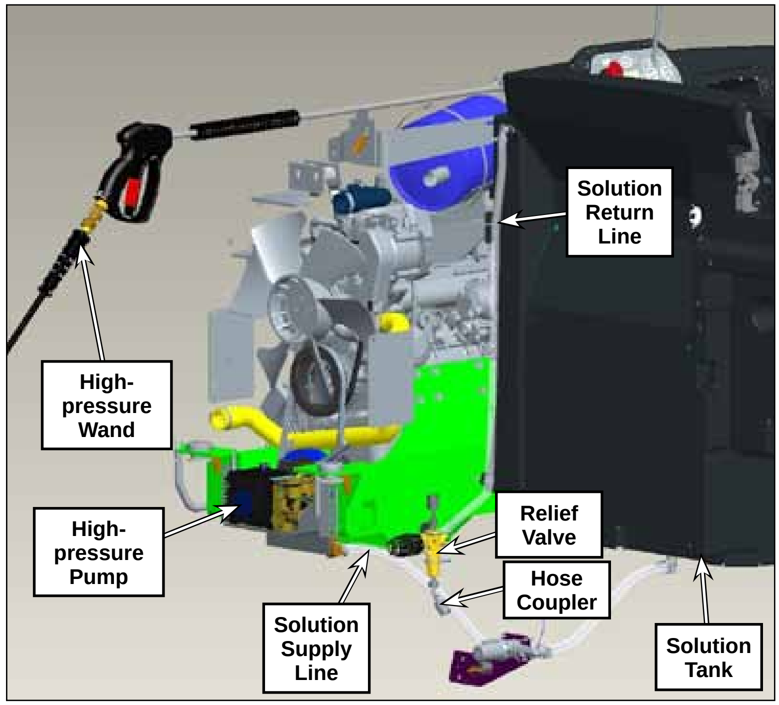
The High-pressure Pump is driven by an Electric Clutch run by a Pulley off of the engine. The Electric Clutch is engaged and drives the High-pressure Pump when the Operator presses the high-pressure wand switch on the control panel.



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.

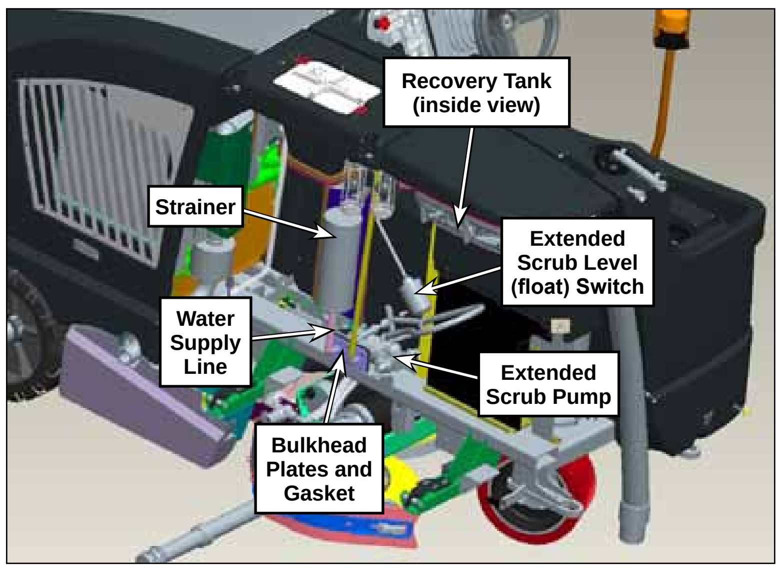
Note that the relief valve is pre-set at the factory and is not adjustable.



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

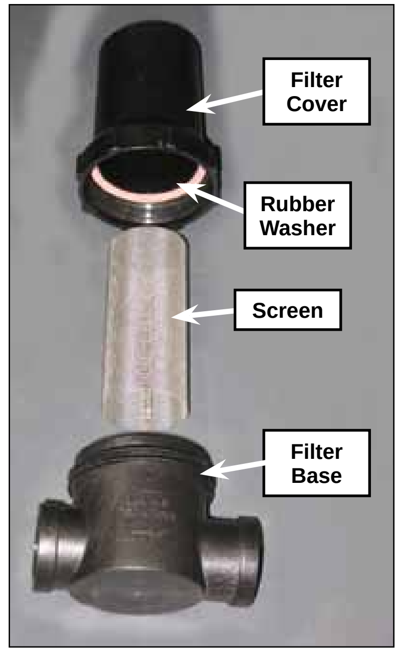
CAUTION: Before performing any machine maintenance or adjustments, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.

To Clean the Solution Filter Screen

1. Close the solution shutoff valve.

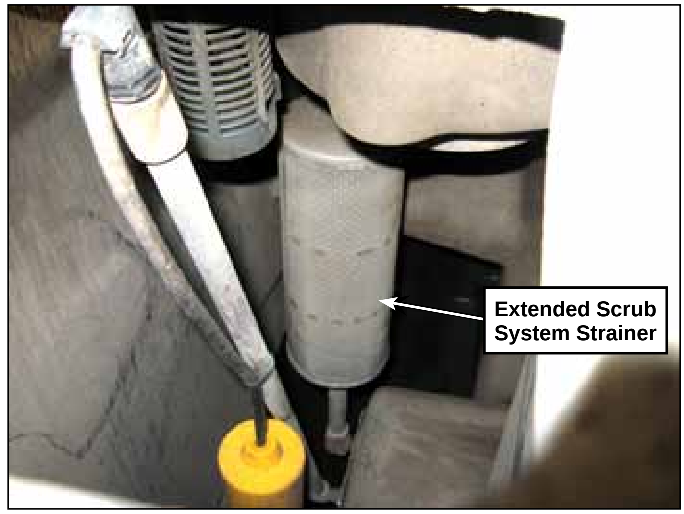
Note: *Place a suitable container underneath the filter to catch any solution that may leak from the hoses.*

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.

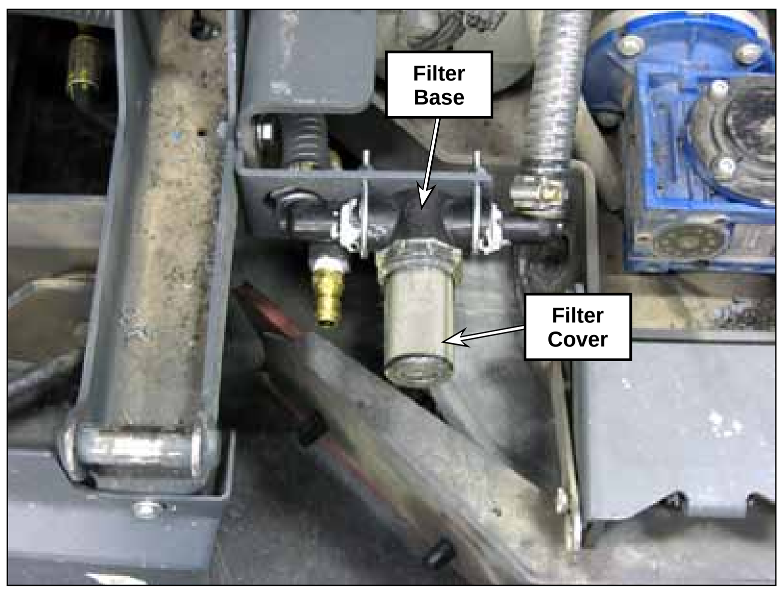


To Clean the High Pressure Solution Filter

1. Drain and remove the recovery tank.

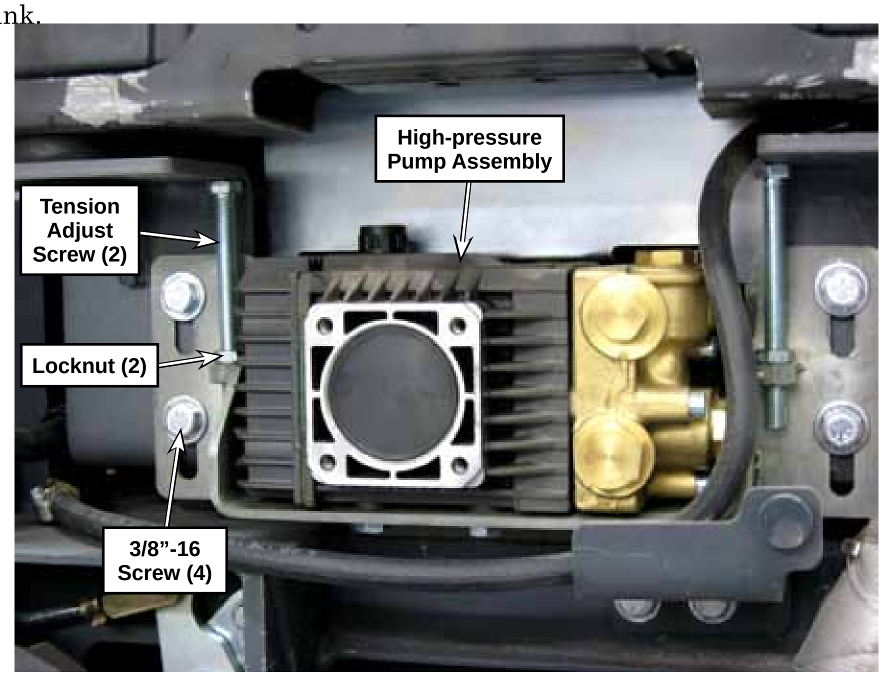
Note: *Place a suitable container underneath the filter to catch any solution that may leak from the hoses.*

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:



   - **LPG Machines** - For a new belt, a deflection of 0.12” when a force of 2.6 to 2.8 lbs is applied and for a used belt a deflection of 0.12” when a force of 2.2 to 2.4 lbs is applied..
   - **Diesel Machines** - For a new belt, a deflection of 0.13” when a force of 2.4 to 2.5 lbs is applied and for a used belt a deflection of 0.13” when a force of 2.1 to 2.2 lbs is applied.

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
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.
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.

Problem	Cause	Correction
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.
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.

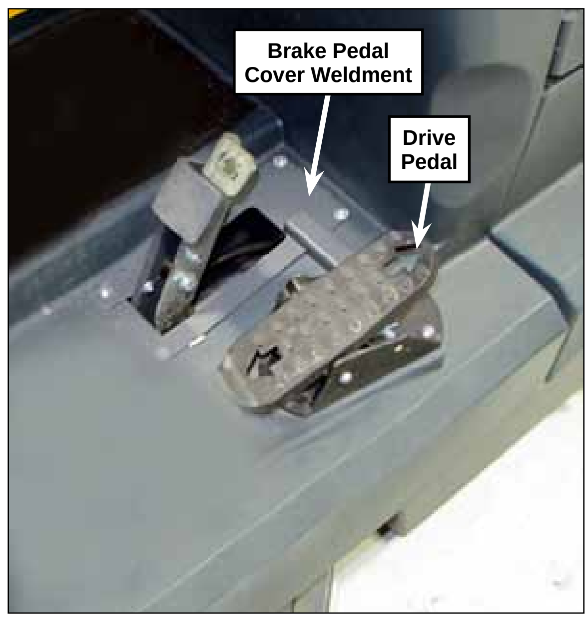
Removal and Installation

***CAUTION:** 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.*

Solution Tank

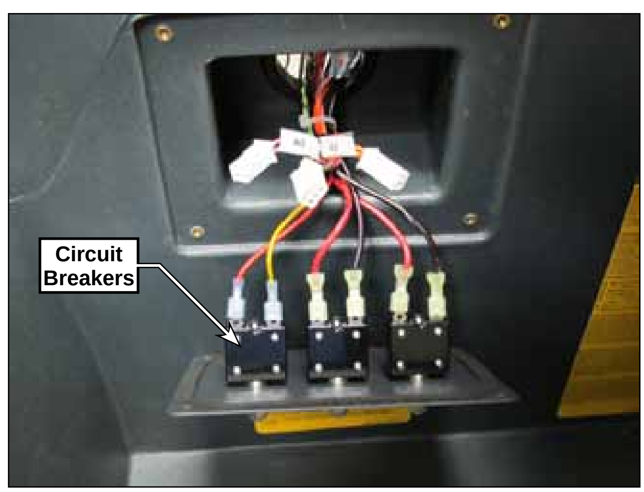
***CAUTION:** The solution tank is relatively heavy. It's recommended that the solution tank be removed by two or more persons, using the appropriate equipment, to prevent possible personal injury or damage to the solution tank.*

1. Disconnect the main battery.
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.

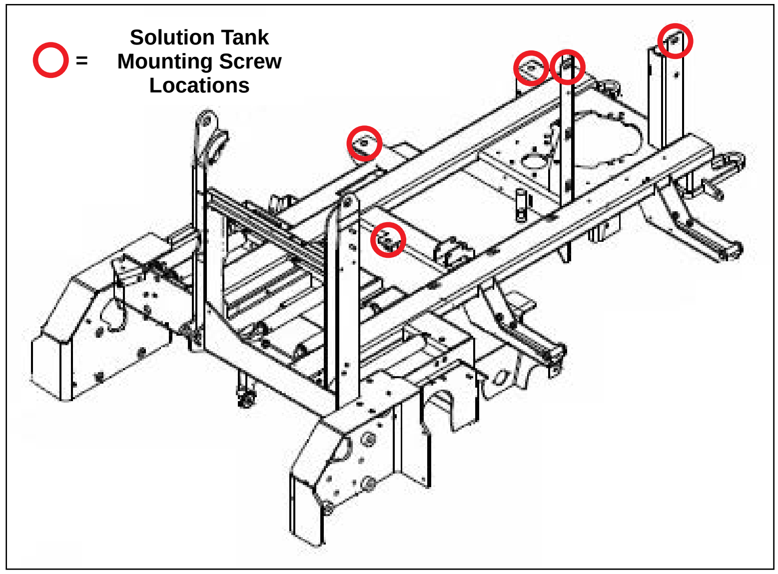
9. Disconnect the additional wiring running from the solution tank to the engine (ground, starter, engine interface, etc.).

10. Remove the Electrical Panel.

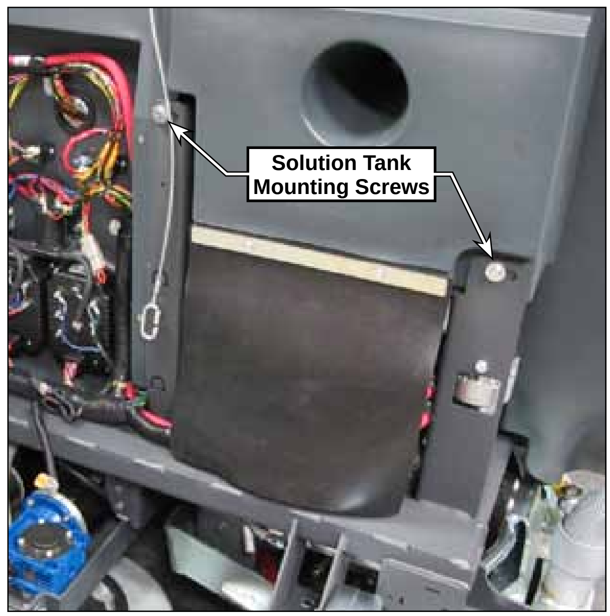
11. Disconnect any additional solution lines or electrical connectors from the solution tank that may be present if your machine is equipped with an extended scrub system, high-pressure spray system or wash hose kit.

12. 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 drive 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.

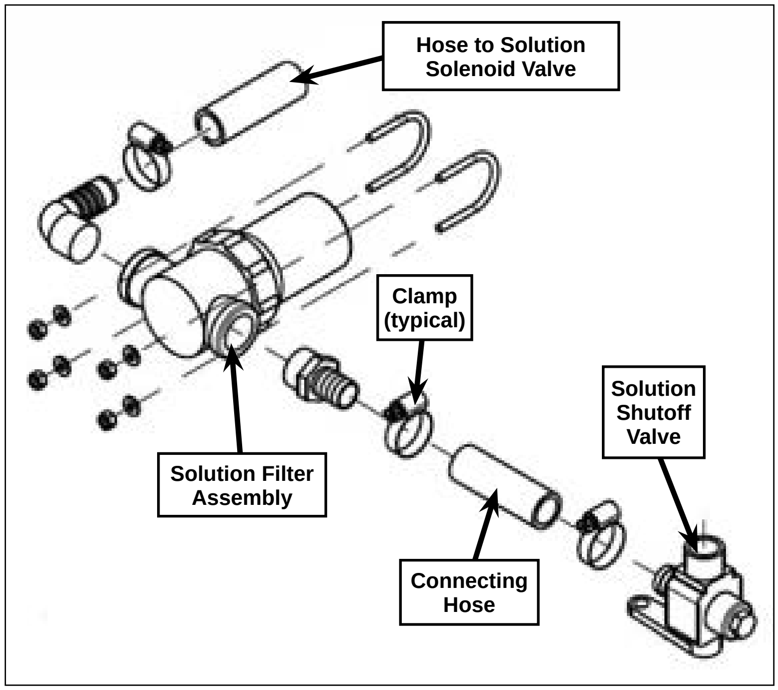
13. Remove the solution tank from the machine.
14. Reinstall the solution tank by following the above steps in reverse order.

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.



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.*

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.

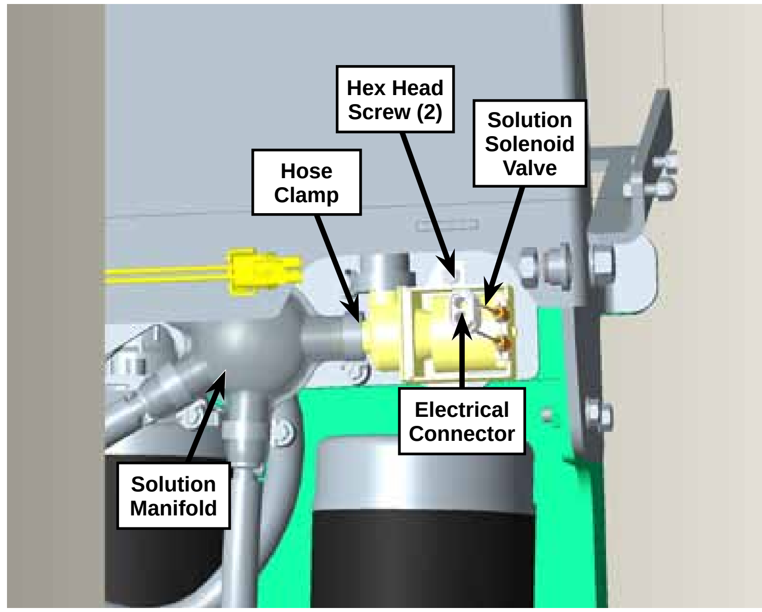
Note: *Place a suitable container underneath the filter to catch any solution that may leak from the filter or hoses.*

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.

Solution Solenoid Valve

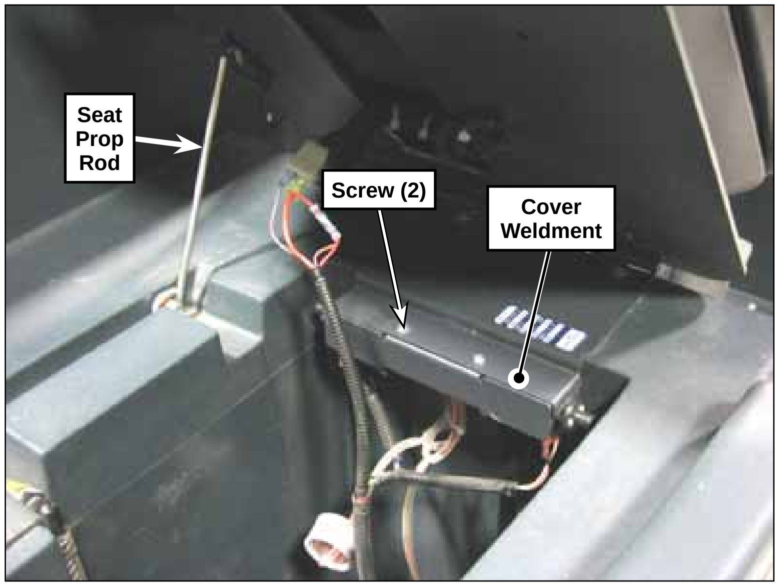
Note: *You can remove and the reinstall the solution solenoid valve with the scrub deck either in or out of the machine.*

1. Empty and remove the recovery tank from the machine.
2. 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.
3. Loosen the Hose Clamp holding the Solution Solenoid Valve to the Solution Manifold.
4. Remove the two Hex Head Screws holding the Solution Solenoid Valve to the deck assembly and remove the Solution Solenoid Valve from the machine.
5. Reinstall the Solution Solenoid Valve following the above steps in reverse order.



Detergent Pump (EcoFlex™ Models Only)

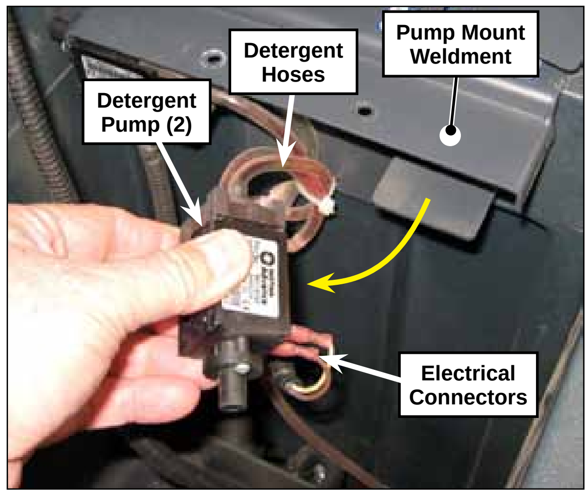
1. Lift up the Operator seat and engage the Seat Prop Rod.
2. Remove the detergent bottles.
3. Remove the two screws holding the cover weldment and remove the cover weldment.



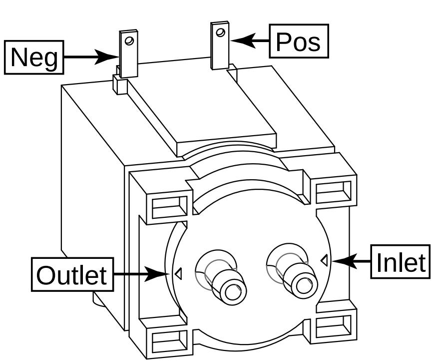
4. Carefully slide the detergent pump out of the pump mount weldment.
5. Disconnect the wires to the affected pump. Make note which wire was connected to which terminal for replacement. If you are unsure during replacement, use the color codes and polarity identification shown below:

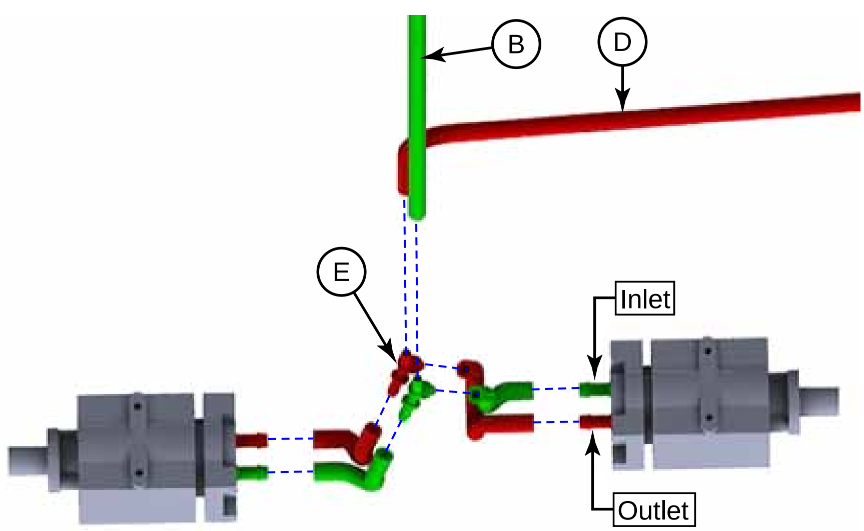
	Positive	Negative
Pump 1	WHT-YEL	BLU-YEL
Pump 2	WHT-RED	BLU-RED

6. Unplug the plastic tubes, and remove the pump.



During replacement, note the electrical and fluid polarity as shown below to the left, and the tube crossover, as shown to the right.



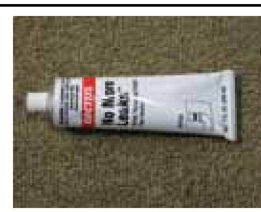


Specifications

<table>
<tr><th>Component</th><th colspan="3">Specifications</th></tr>
<tr><td>Solution Solenoid Valve</td><td colspan="3">36V, Coil Resistance - 72 ohms ± 10%</td></tr>
<tr><td rowspan="4">EcoFlex™ Detergent Pump</td><td colspan="3">Type - diaphragm dosing pump with stroke adjustment</td></tr>
<tr><td colspan="3">Voltage - 12 VDC</td></tr>
<tr><td colspan="3">Flow Calibration - 87 ml/min ± 3 ml/min</td></tr>
<tr><td colspan="3">Water Lift - 3.5 in</td></tr>
<tr><td rowspan="4">Solution Control Pump
(EcoFlex™ models only)

Extended Scrub 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">Current - 3.9 Amps max.</td></tr>
<tr><td colspan="3">Flow Rate - 3.3 GPM @ 2.75 Amps with 20 psi inlet pressure</td></tr>
<tr><td rowspan="10">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 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)	

34 - Scrub System

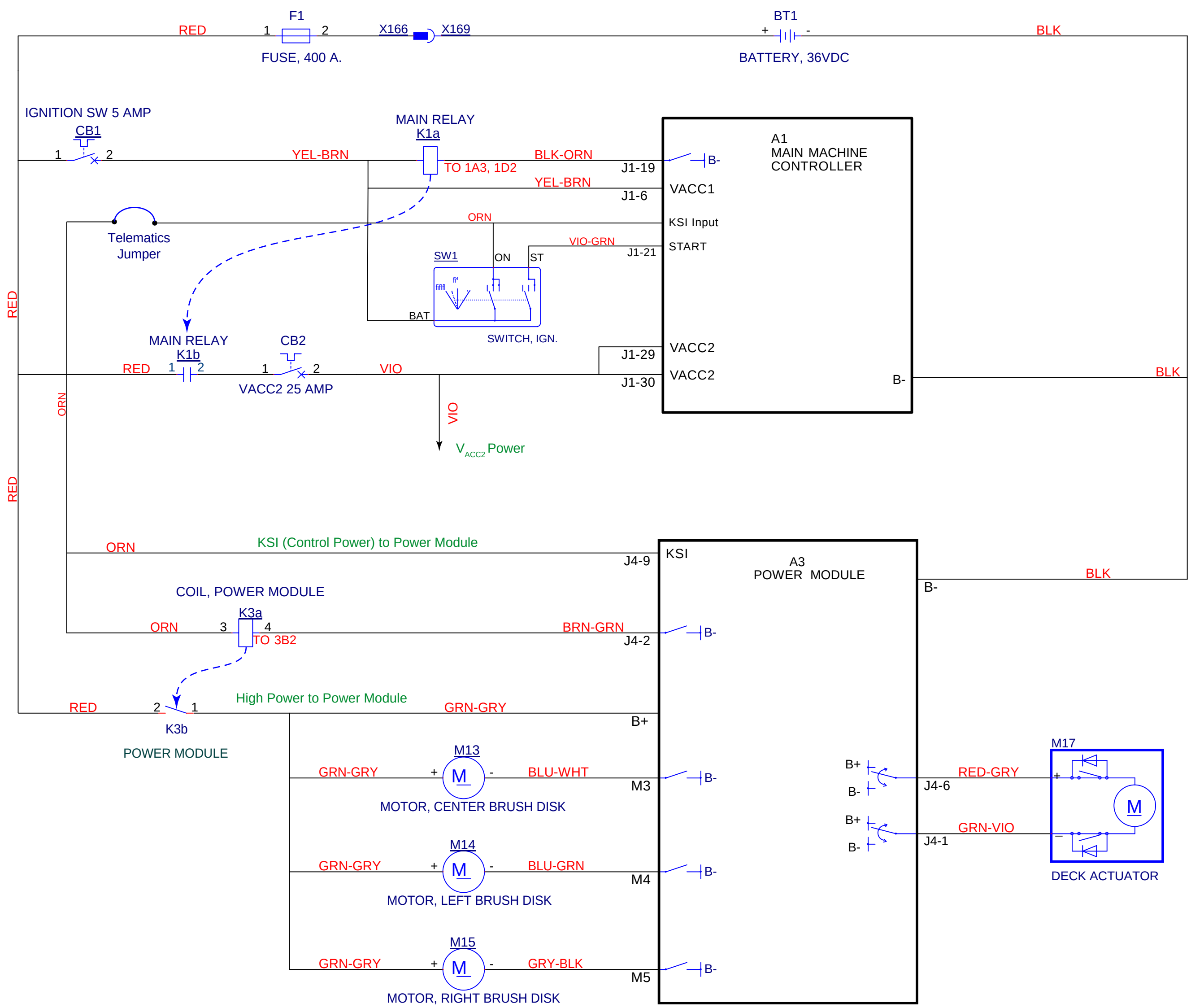
Functional Description

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 System Wiring Diagram



Circuit Description

Scrub functions are driven by the Main Machine Controller via Power Module #2 using CAN Bus commands. The Power Module receives its control power (turn-on power) via the KSI (Keyswitch) input. The power module controls its own main power by energizing the K3 relay. This provides both internal positive high-power, as well as external positive power to the brush motors.

The power module controls the brush motors by switching the output to ground. The amperage through the motor is monitored by the power module. The deck lift actuator is controlled by a reversible PWM output. The actuator contains internal limit switches to control travel, and will be described in more detail below.

Scrub Deck Actuator Motor

The PWM Outputs from Power Module #2 provide voltage to the Scrub Deck Actuator Motor. The output polarity determines whether the Scrub Deck Actuator lowers or raises the scrub deck.

The top of the actuator gearbox contains a pair of limit switches that are activated by cams driven from the motor. These limit switches have diodes in parallel, which effectively turns the switch into a polarized switch. Each switch functions only when the input polarity opposes the direction of the respective diode. The significance of this is that the retraction limit switch, for example, will open the circuit when the motor reaches the upper retracted limit, but will still keep the circuit closed if the polarity is reversed to extend the actuator.

The power module monitors the brush motor amperage and reports this back to the Main Controller. The Main Controller uses this information to increase or decrease scrub deck pressure by raising or lowering the actuator to achieve the target amperage.

Component Locations

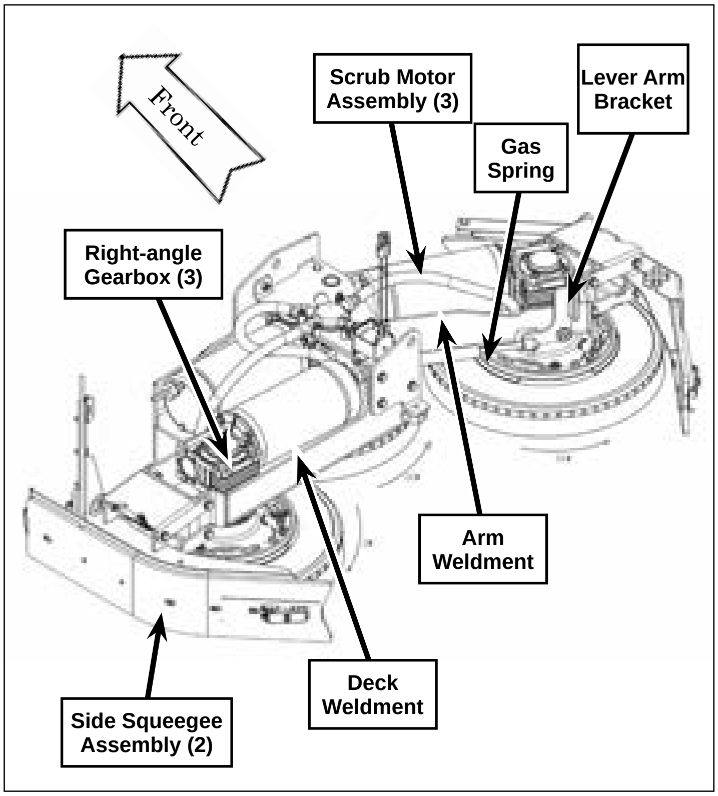
Scrub Motor Assemblies

The left-hand and center scrub motor assemblies are mounted on the main deck platform. The right-hand scrub motor is mounted on a swingarm platform. The right-angle gearboxes are mounted on spacers to position them correctly on the deck and swingarm platforms.

Right Swingarm

A gas spring keeps the right swingarm and attached side squeegee assembly extended outward during normal scrubbing, but will allow the swingarm to pivot backward if the right-hand side squeegee 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 swingarm backward for service or maintenance proposes, pull the top of the lever arm toward you and swing the swingarm backward.



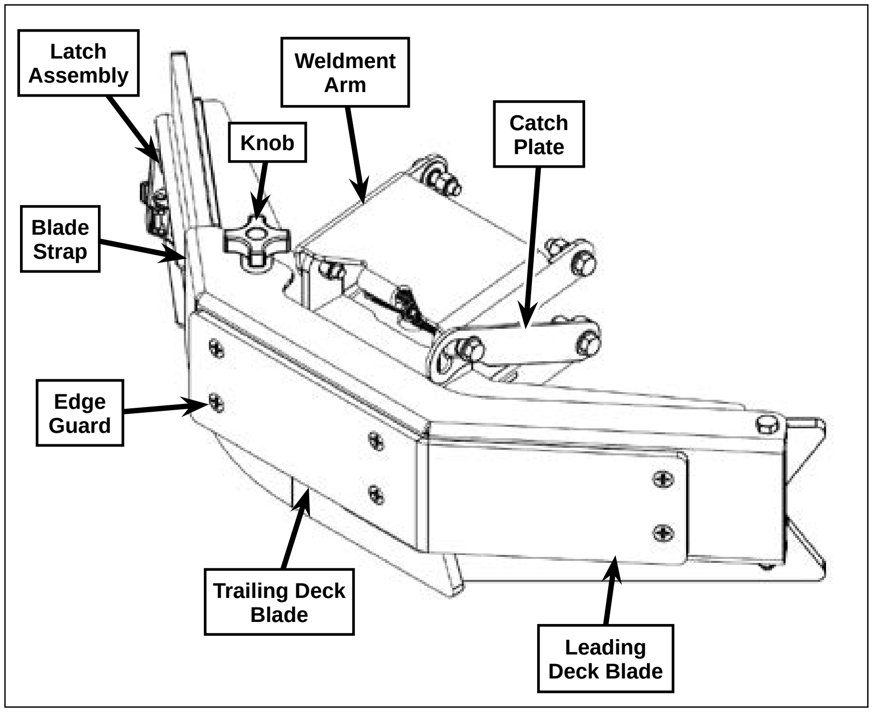
Side Squeegee Assemblies

The side squeegee assemblies are mounted to arms that are attached to the main deck and swingarm. The side squeegee assemblies are spring-loaded to keep them firmly on the floor. A catch plate allows you to lock the side squeegee 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 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.

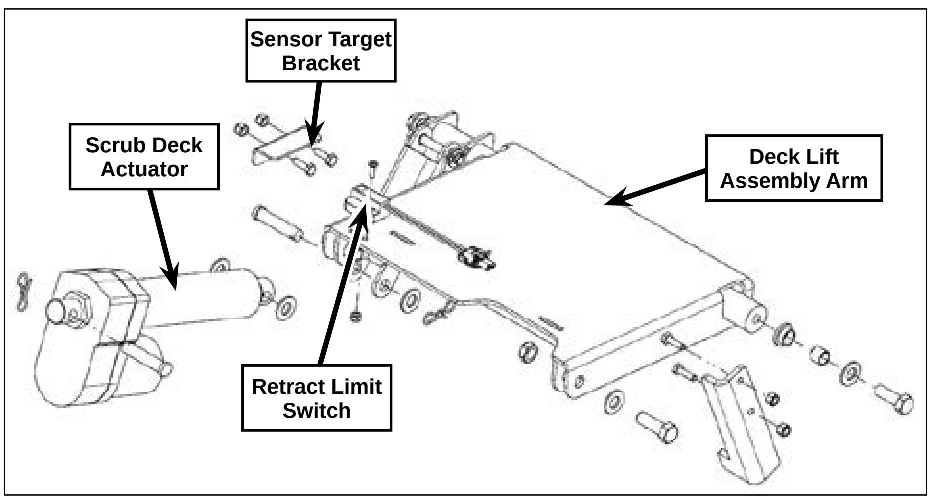
The leading deck blades are held in place by strap weldments and wing knobs.



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.

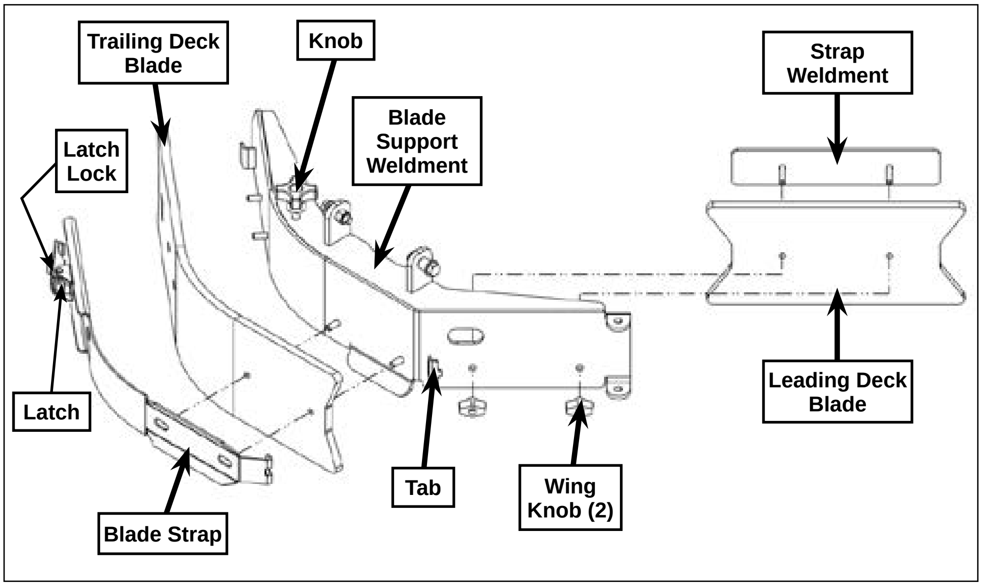
The deck lift assembly arm pivots on flange bearings and bushings in the frame to raise and lower the attached scrub deck. Note that the scrub deck is free to “float” left-to-right to conform to the floor surface.



Maintenance and Adjustments

CAUTION: Before working near the scrub deck, disconnect the main battery connector to prevent the deck from moving unexpectedly if the machine were to initialize.

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).

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.

Removal and Installation

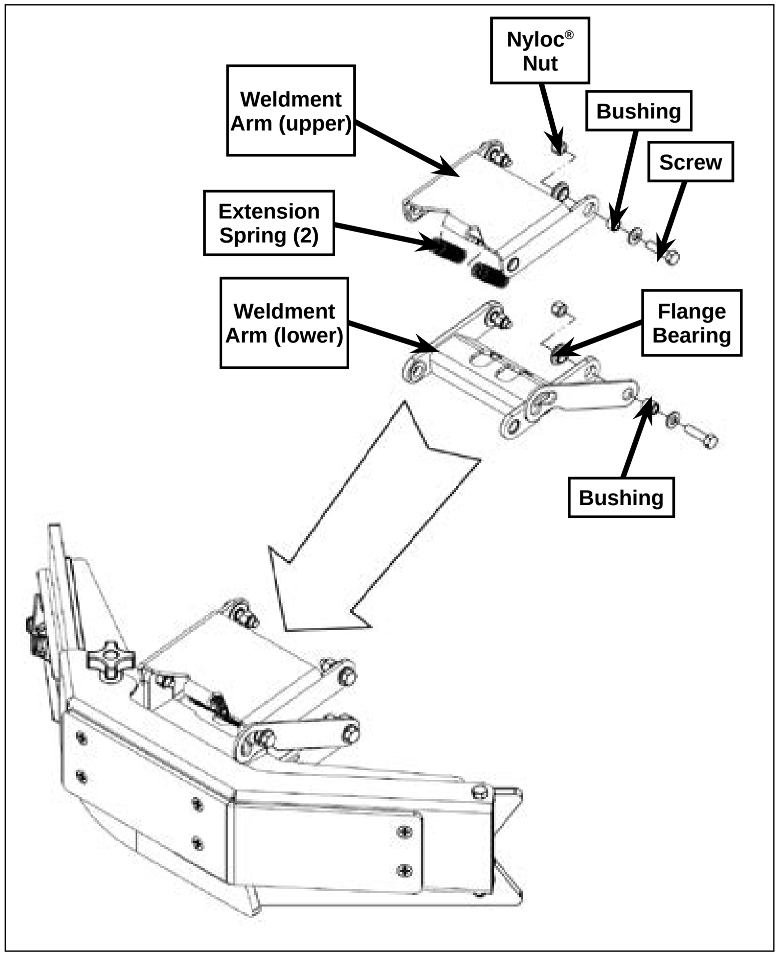
CAUTION: Before working near the scrub deck, disconnect the main battery connector to prevent the deck from moving unexpectedly if the machine were to initialize.

Side Squeegee Assembly

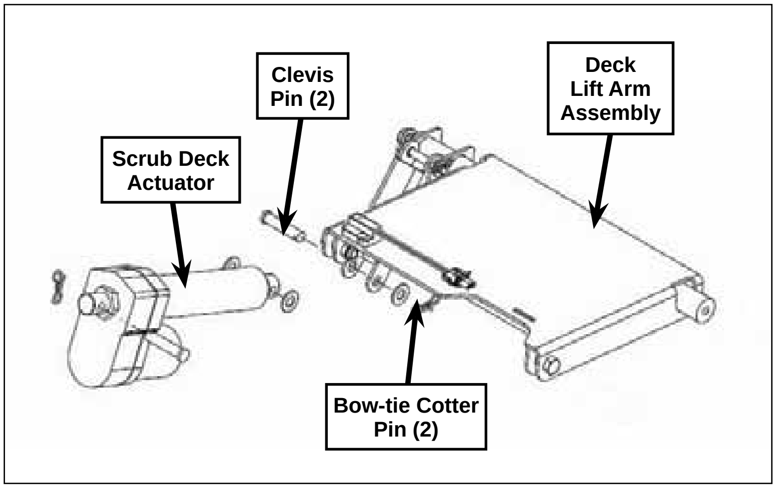
1. Loosen the knob and swing out the edge guard.
2. Carefully remove the Extension Springs from the tabs on the upper Weldment Arm.
3. Remove the Screws, washers, Bushings, Flange Bearings and Nyloc® Nuts holding the side squeegee assembly to the scrub deck, then remove the side squeegee assembly from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



Scrub Deck Actuator



1. Remove the Recovery Tank described on page 252.

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.

CAUTION: Disconnect the main battery connector before reaching between the scrub deck and the machine frame. The scrub deck could cause serious injury if it raises unexpectedly.

4. Disconnect the Scrub Deck Actuator electrical connector

Note: *If this procedure is being completed for any reason other than to replace the actuator, take care to not rotate the output shaft of the actuator, as this will require readjustment during assembly.*

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.

Actuator Adjustment

If the actuator is new or otherwise not properly adjusted, it is necessary to set the mechanical retracted position. This is controlled by a limit switch inside the actuator.

1. Plug the actuator back into the machine electrical connector.

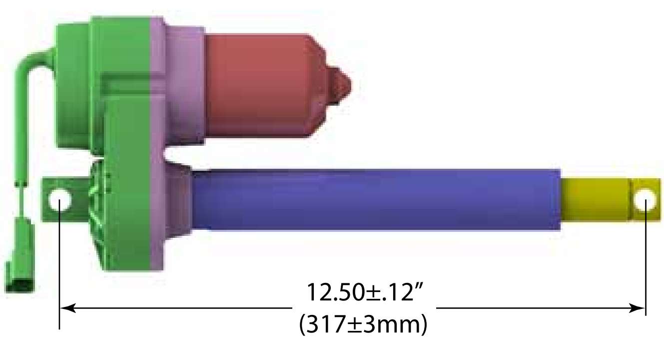
2. Power up the machine, enter Service Test mode, and retract the actuator by raising the scrub deck.

   - It is not necessary to hold the output shaft from turning. You may choose to do so if the actuator is fully extended, but let go before the actuator fully retracts.

3. After the actuator has stopped, rotate the end shaft in or out until the distance between the two mounting holes equals 12.50±.12” (317±3mm), and the holes are aligned as shown..

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

5. When complete, cycle the scrub deck up and down to check the positions. If necessary, adjust the Deck Down Time in the Configuration menu.

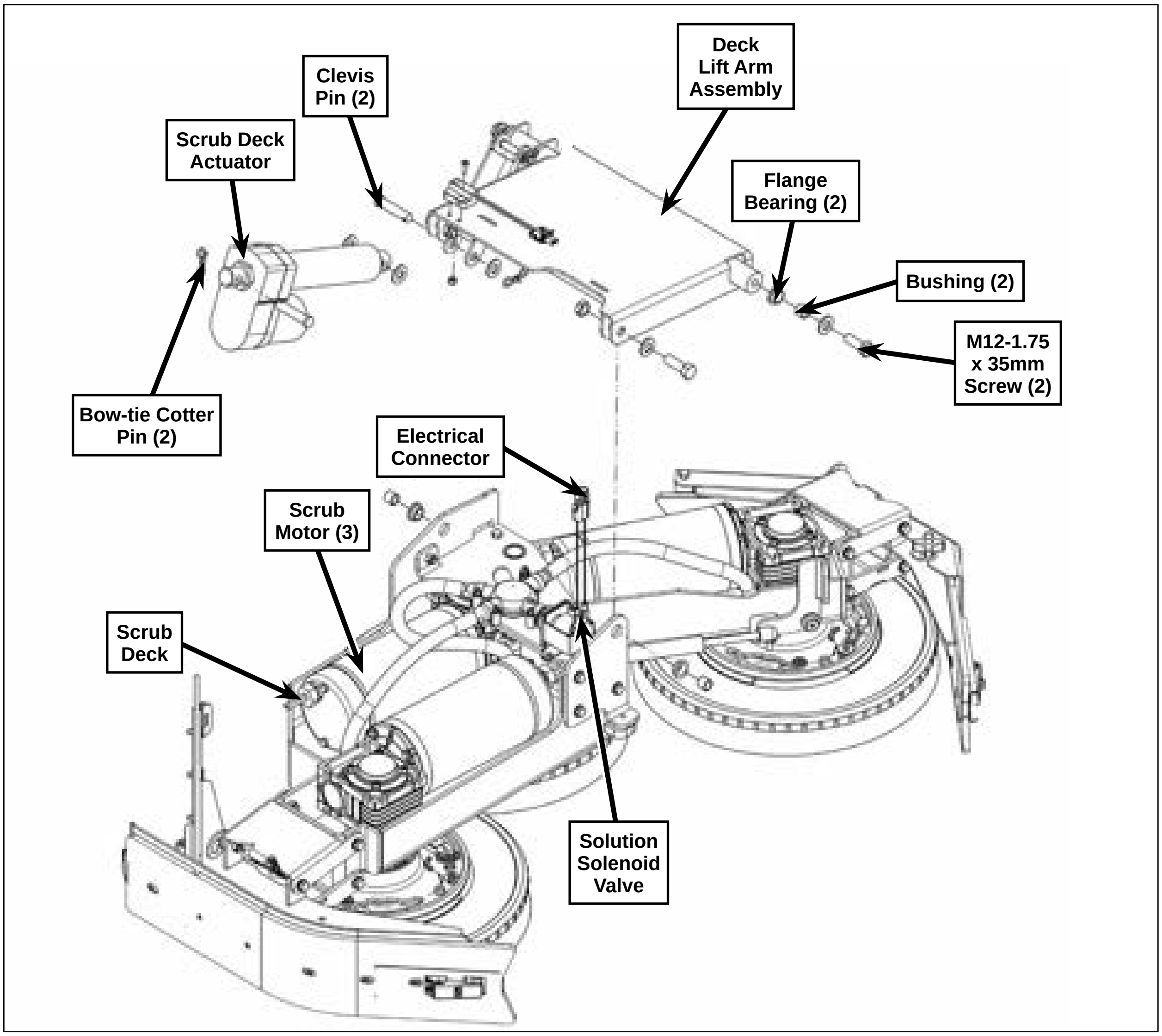


Scrub Deck

1. Remove the Recovery Tank described on page 252.
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.

CAUTION: Disconnect the main battery connector before reaching between the scrub deck and the machine frame. The scrub deck could cause serious injury if it raises unexpectedly.

4. Disconnect the Electrical Connectors:
   - To the three Scrub Motors. Make note of which connector connects to each motor for later replacement.
   - To the Solution Solenoid Valve.
   - *It may be necessary to j*og the scrub deck up or down 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 screws



supporting the deck lift arm assembly and scrub deck, and remove the two screws, washers, bushings, and flange bearings holding the deck lift arm assembly and attached scrub deck to the machine frame.

6. Remove the bow-tie cotter pin, washers and clevis pin holding the scrub deck actuator to the deck lift arm assembly.

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

CAUTION: 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.

8. Slide the scrub deck and attached deck lift arm assembly out from under the machine.

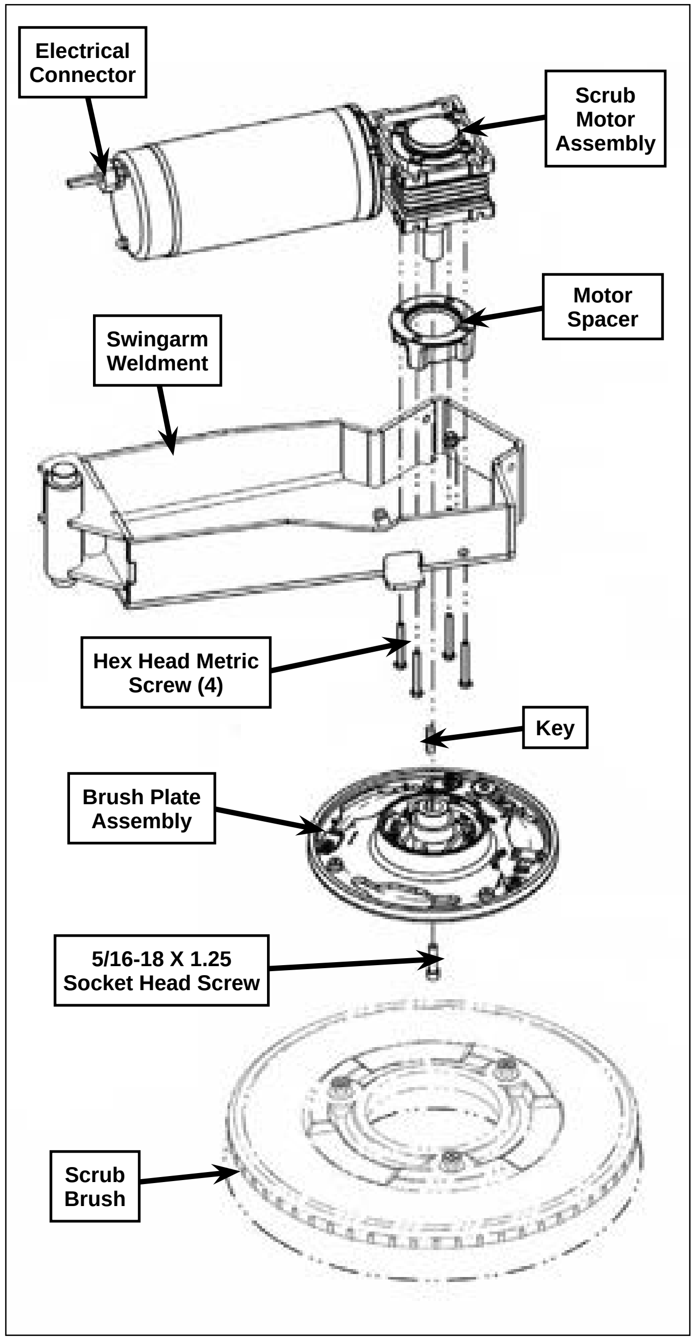
9. Reinstall the Scrub Deck by following the above steps in reverse order and the following notes:

   - Make sure you reconnect the Scrub Motors to the correct Electrical Connectors in the wire harness
   - 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 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 screws.

Scrub Motor

1. Remove the Scrub Deck described on page 230.
2. Disconnect the electrical connector from the Scrub Motor Assembly.
3. Remove the Scrub Brush from the Brush Plate Assembly.
4. Remove the 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.

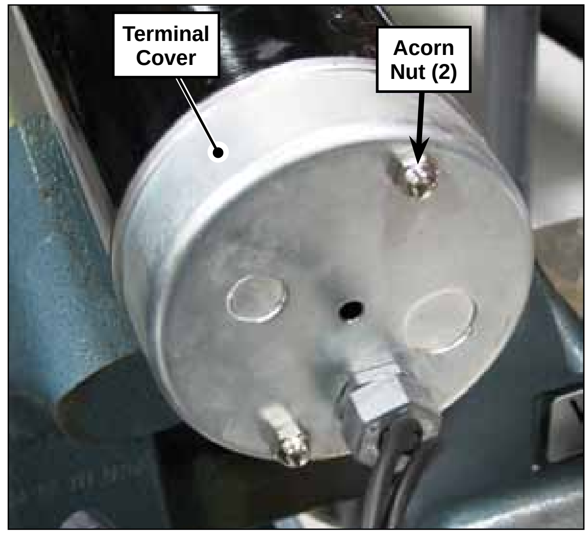
Note: *Make sure the Key is installed correctly before you reinstall the Brush Plate Assembly onto the scrub motor shaft.*



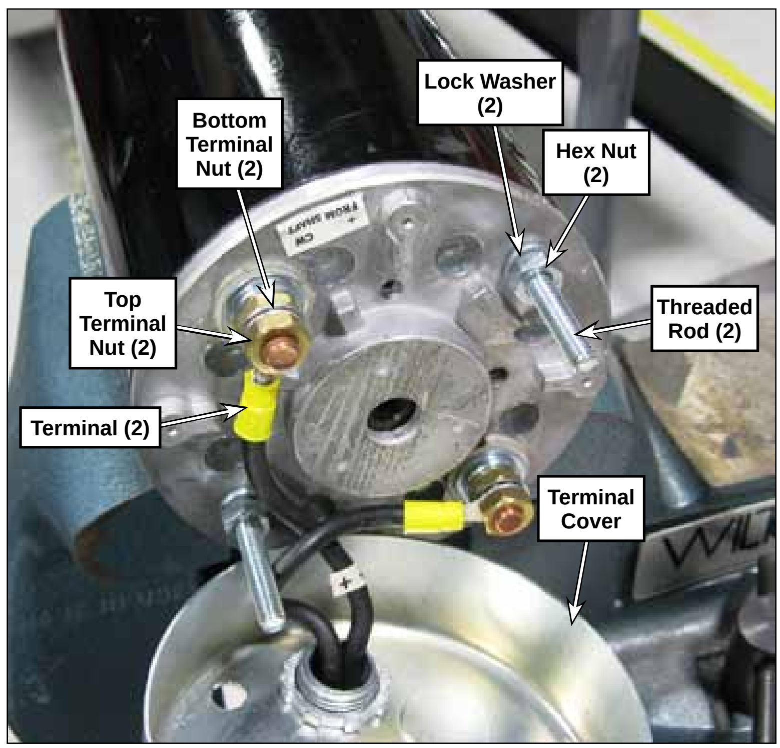
Scrub Motor Carbon Brushes

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.*

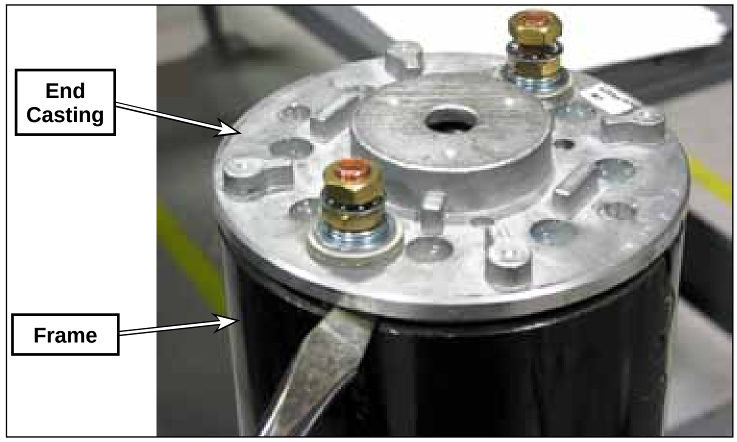
1. Remove the Scrub Motor described on page 232.
2. Remove the scrub motor from the right-angle gearbox.
3. Note the position of the witness marks stamped into the frame and castings on both ends of the motor.
4. Remove the two acorn nuts and open the terminal cover.



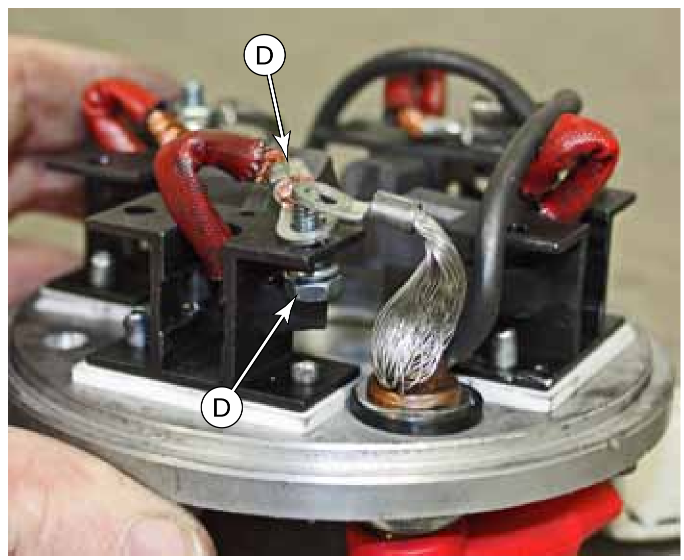
5. Use a backup wrench to hold the bottom terminal nuts in place, then remove the top terminal nuts and terminals. Make sure to note the wire polarity.
6. Remove the terminal cover.
7. Remove the hex nuts, lock washers and threaded rods holding the two end castings to the frame.



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. Note the following:
    - The rotor's bearing is a light press into the top cap. It will come free fairly easily, but care must be taken to not skew the cap in the process.
    - A very light tap on the side of the cap with a plastic deadblow hammer should be enough to loosen the cap enough to begin prying with a small screw driver.
    - Taking care not to damage the aluminum cap, work the small screw driver around the cap enough to be able to get two medium sized screw drivers in 180° apart, and then pry up on both sides evenly.



9. Slowly and gently, lift the top cap up until the 4 brushes clear the commutator and rotor bearing.
10. Remove the nut from the terminal screw **(D)**, and lift the brush wire off the screw.
11. Slide the brush toward the center to remove the brush and coil spring.



Note: *When placing the coil spring and brush back into position, note the direction the coil spring faces so that it uncoils properly.*

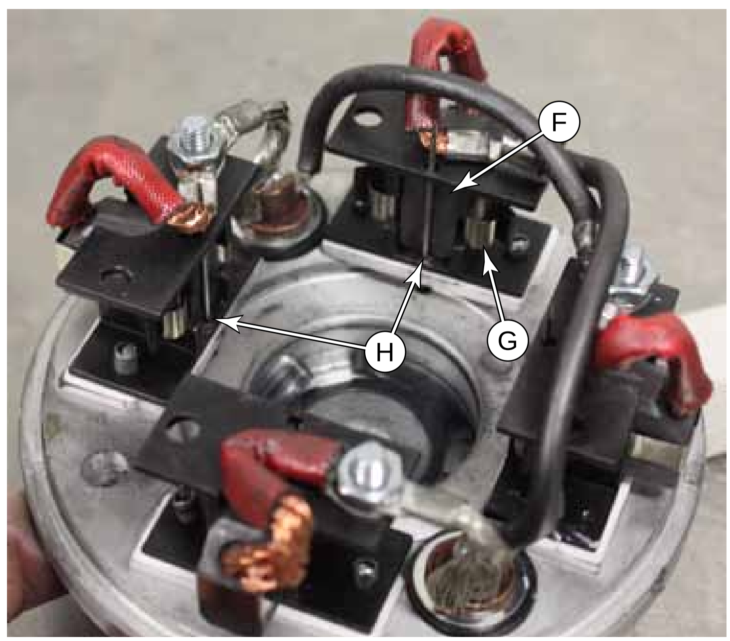
Note: *You will need 4 temporary retaining pins, such as straightened out paperclips. Have them ready before completing the next steps.*

12. While holding the brush **(F)** and coil spring **(G)** together, feed the brush wire through the brush holder.

13. Insert the brush and coil spring into the brush holder. The brush wire should be toward the top, away from the brush cap.

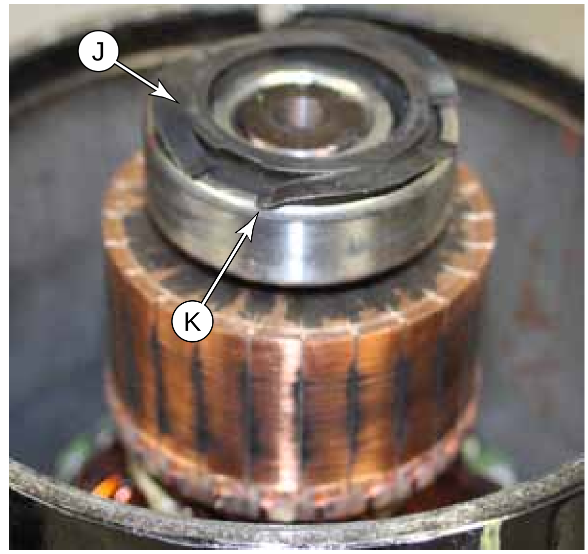
14. Compress the brush all the way in to the brush holder, and insert the temporary retaining pin.

    - Insert the pin from the opposite side of the end cap, through the bottom of the brush holder, in front of the brush, and up through the top of the brush holder.
    - Make sure the pin is inserted in such a way that it can be removed after the motor is completely reassembled.
    - The purpose of the pin is to hold the brush retracted while you install the end cap back onto the motor.

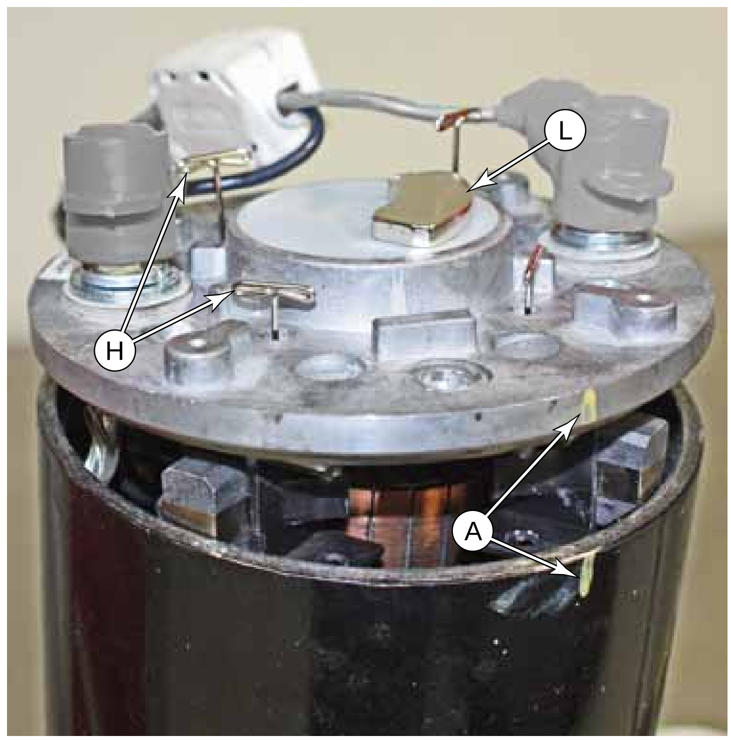


Note: *The wave washer **(J)** fits between the rotor bearing and the end cap. When placing it in the end cap before assembly, note that the fingers **(K)** face toward the bearing.*

The picture to the right is only for reference. It is easier to place the washer in the end cap than it is to leave it on the bearing.



15. Place the wave washer **(J)** in the bearing pocket of the end cap with the fingers **(K)** facing toward the bearing. Use a Rare Earth magnet **(L)** on the opposite side of the cap to hold the washer in place. (A less powerful magnet can be used, but a Rare Earth magnet is powerful enough to hold itself in place.)
16. Place the end cap over the top of the motor, and lower it until the coil springs prevent you from lowering it any farther.
    - Make sure to realign the marks **(A)** that you made on the motor before disassembly.
    - When the brushes are compressed in this manner, they are too wide to fit the cap all the way into the motor. The coil springs will catch on the edge of the motor housing.



17. With the end cap on the motor as far as it will go, begin removing the pins **(H)** to allow the brushes to move toward the commutator.
18. Press the end cap down on to the bearing.
19. Install the two long screws **(B)** that secure the top cap to the bottom cap.
20. Remove the permanent magnet.

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.		
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.	

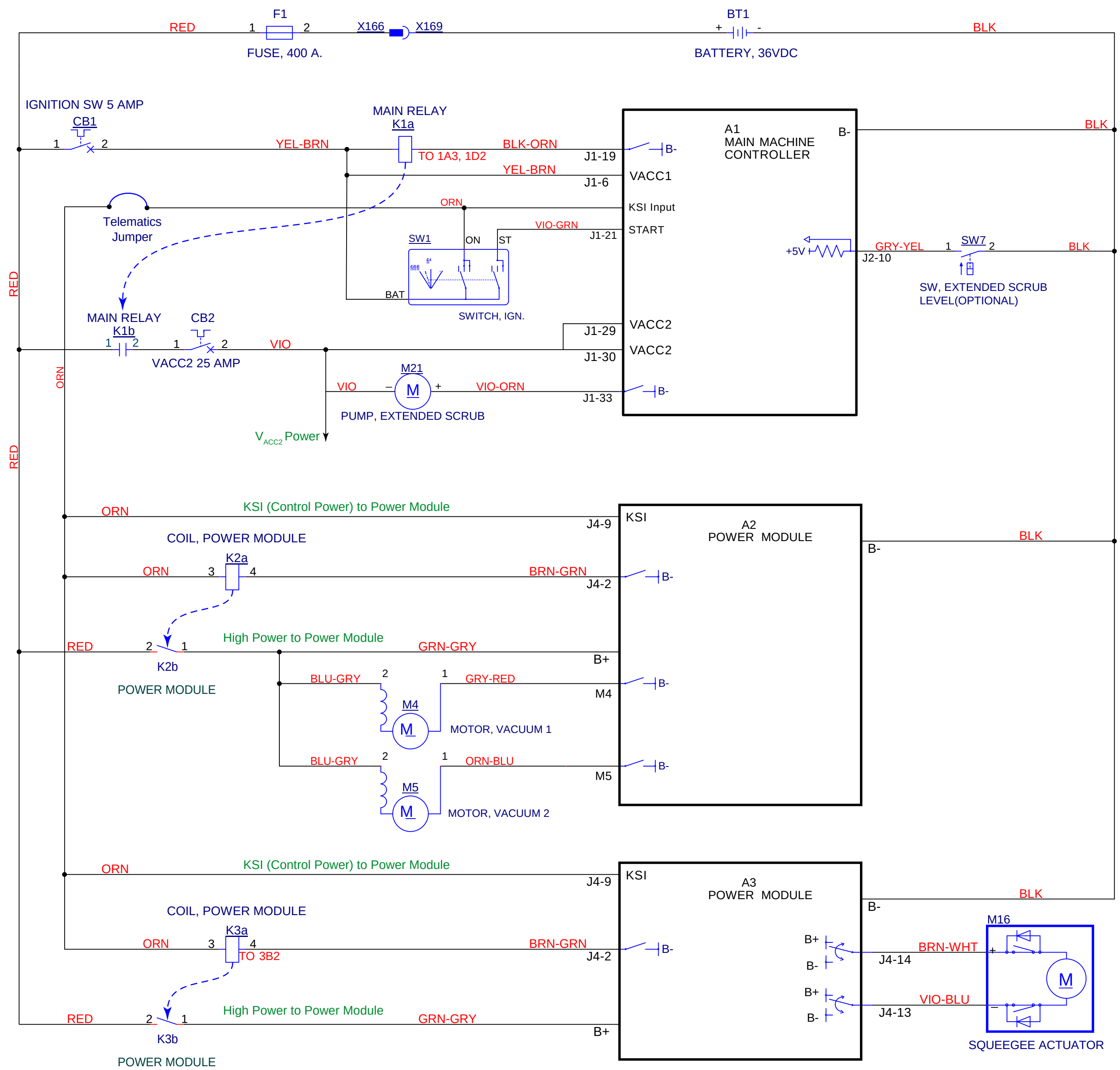
38 - Squeegee System

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 actuator is driven by the power module #2 via commands from the Main Controller. 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 and Recovery Wiring Diagram



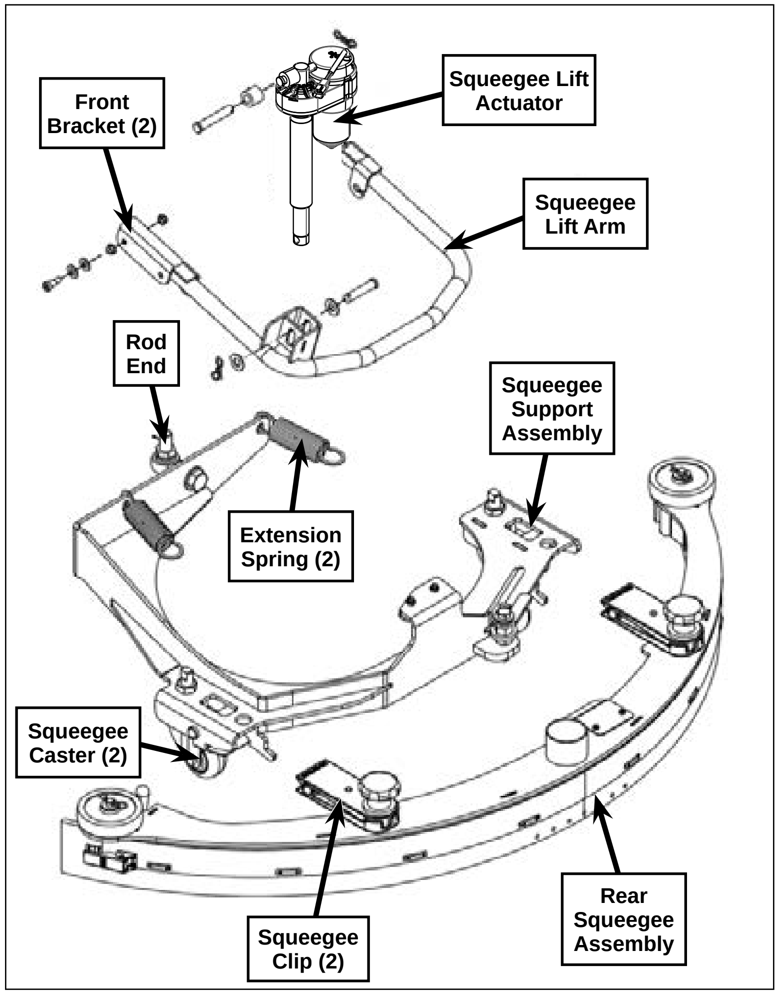
Component Locations

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.

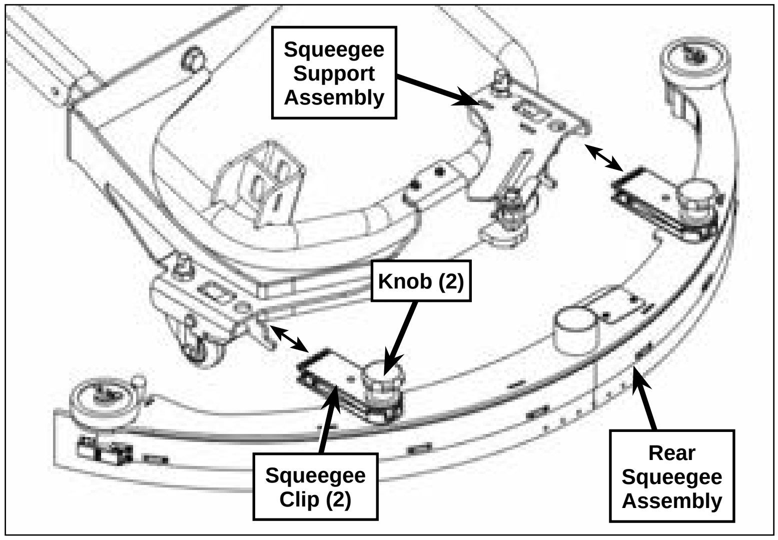


Maintenance and Adjustments

CAUTION: Disconnect the main battery connector before working near the drive wheel. If the machine is unexpectedly powered on, the steering initialization routine can cause serious injury.

Changing Squeegee Blades

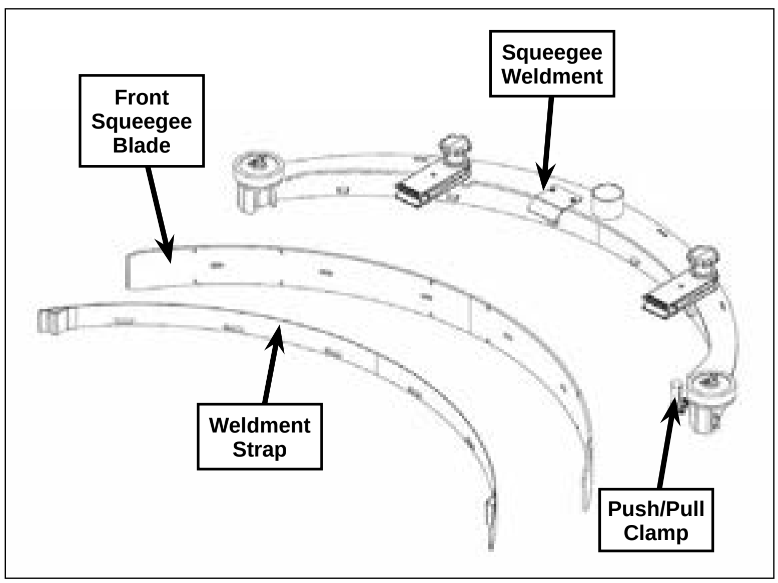
1. Raise the squeegee to its retracted position.
2. Disconnect the vacuum hose from the rear squeegee assembly.
3. Loosen the two knobs on the squeegee clips and pull the rear squeegee assembly away from the squeegee support assembly.



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.*

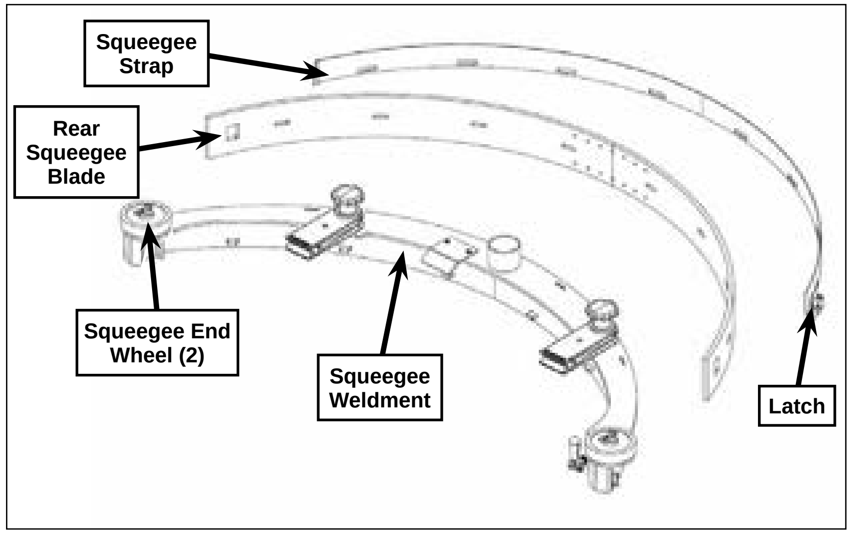
Front Squeegee Blade

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.



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.

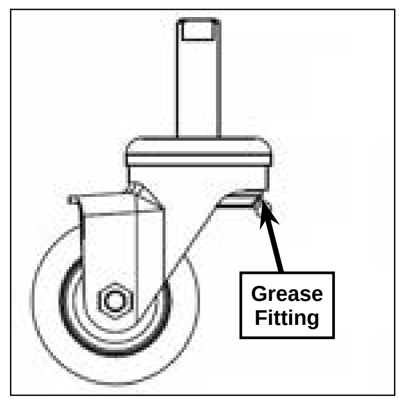


Squeegee End Wheels

Once a month apply light machine oil to the squeegee end wheels.

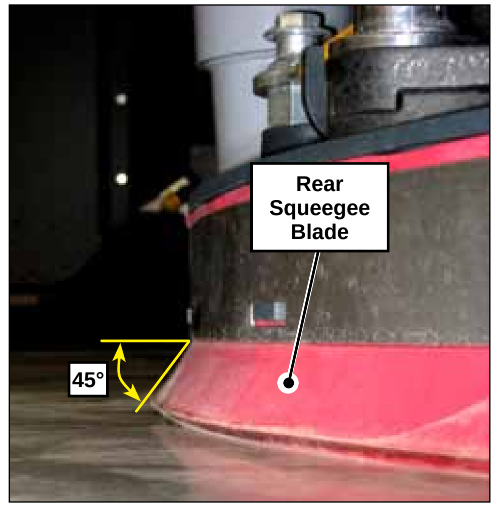
Squeegee Caster Wheel Bearings

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.



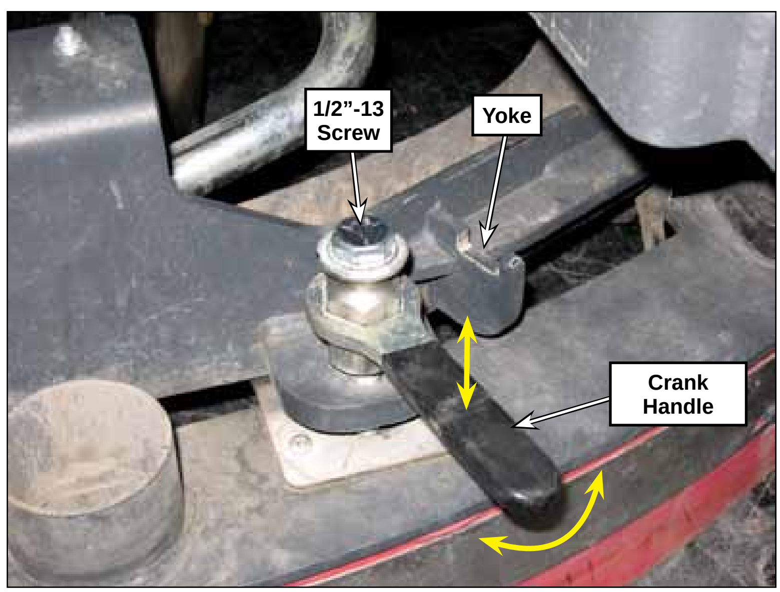
Squeegee Tilt Adjustment

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.

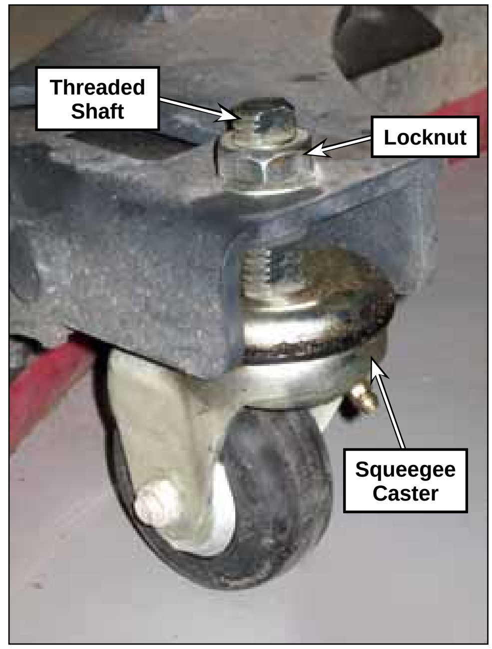
3. If the squeegee tilt angle needs to be adjusted:
4. Lift the crank handle out of the yoke
5. Rotate the crank handle to raise or lower the 1/2”-13 screw as necessary so the squeegee blades are at the correct angle to the floor.
6. When the squeegee tilt adjustment is correct, replace the crank handle into the yoke.



Squeegee Casters Adjustment

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.)



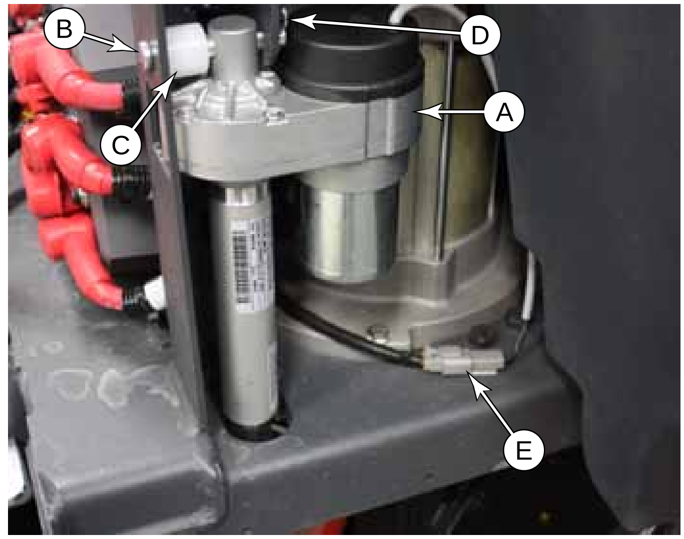
Troubleshooting

Problem	Cause	Correction
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

CAUTION: 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.

Squeegee Lift Actuator

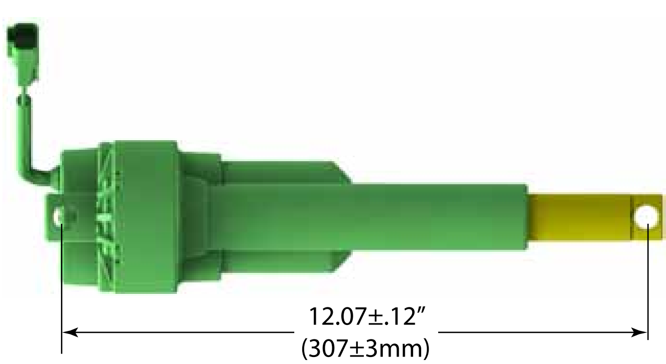


1. Tilt the recovery tank down.
2. Remove the squeegee to reduce the weight on the squeegee lift arm.
3. Disconnect the lift actuator electrical connector **(E)**.
4. Remove the cotter pin, spacer**,** and clevis pin connecting the squeegee lift actuator to the squeegee lift arm.
5. Remove the cotter pin **(D)**, spacer **(C),** and clevis pin **(B)** connecting the squeegee lift actuator to the machine chassis, and remove the actuator.

Actuator Adjustment

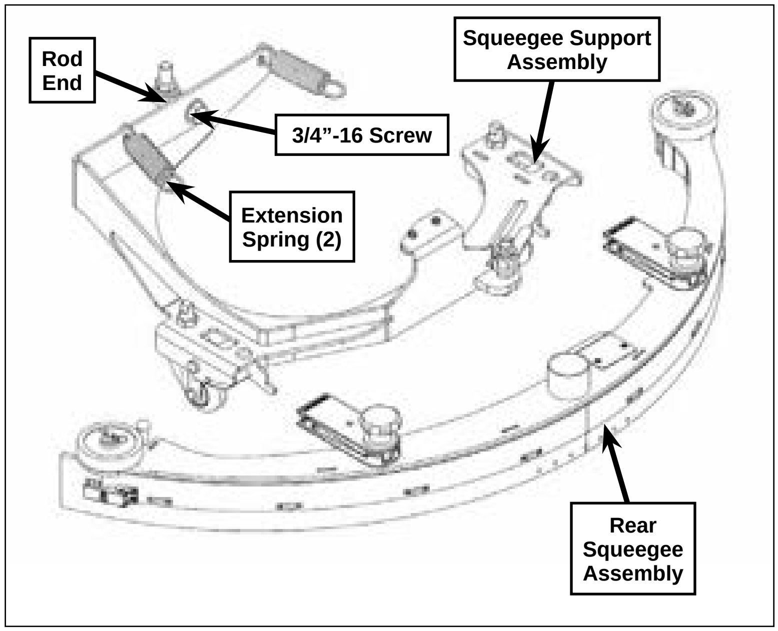
If the actuator is new or otherwise not properly adjusted, it is necessary to set the mechanical retracted position. This is controlled by a limit switch inside the actuator.

1. Plug the actuator back into the machine electrical connector.
2. Power up the machine, enter Service Test mode, and retract the actuator by raising the squeegee.
   - It is not necessary to hold the output shaft from turning. You may choose to do so if the actuator is fully extended, but let go before the actuator fully retracts.
3. After the actuator has stopped, rotate the end shaft in or out until the distance between the two mounting holes equals 12.07±.12” (307±3mm), and the holes are aligned as shown..
4. Reinstall the actuator by following the above steps in reverse order.
5. When complete, cycle the squeegee up and down to check the positions. If necessary, adjust the Squeegee Down Time in the Configuration menu.



Squeegee Support Assembly

CAUTION: ***Disconnect the main battery connector before working near the drive wheel. If the machine is unexpectedly powered on, the steering initialization routine can cause serious injury.***

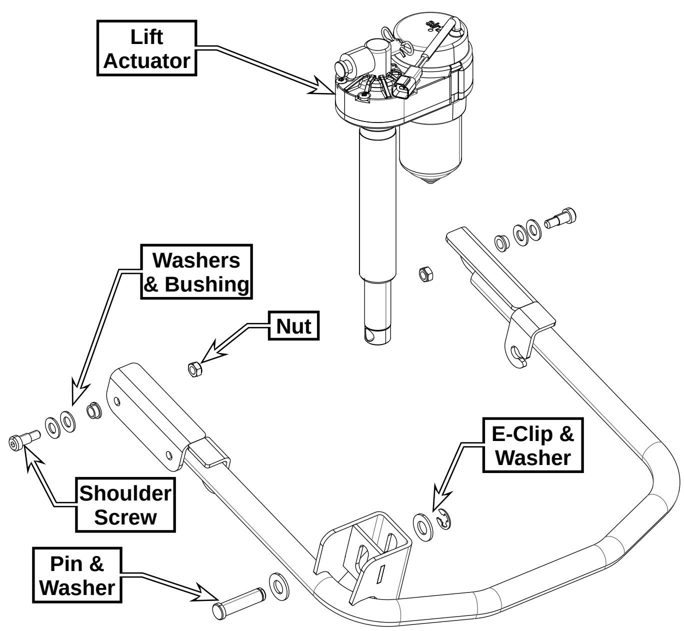


1. Remove the Rear Squeegee Assembly.
2. Disconnect the Extension Springs from the Squeegee Support Assembly using a spring puller. (See the Special Tools section.)
3. Remove the 3/4”-16 Screw holding the Squeegee Support Assembly to the Rod End.
4. Carefully remove the Squeegee Support Assembly from the machine.
5. Reinstall the Squeegee Support Assembly by following the above steps in reverse order.

Note: *Use removable thread sealer when reinstalling the 3/4”-16 Screw. Tighten the 3/4”-16 Screw to 270 ft/lbs.*

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 pin, washers and E-clip connecting the squeegee lift actuator to the squeegee lift arm.
4. Remove the shoulder screws, flat washers, bushing 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.



Specifications

Component	Specifications
Squeegee Tool Assembly	
Squeegee Blade, Front, Red Gum	Material - Linatex 40 Color - Red Hardness - 40 ±5 Shore A Durometer Tensile Strength - 3000 Psi Minimum Elongation - 600% Minimum
Squeegee Blade, Rear, Red Gum	
Squeegee Lift Actuator	Dynamic Load - 200 lbs. maximum
	Static Load - 250 lbs. maximum
	Restraining Torque - Actuator is internally restrained
	Amperage - 3 Amps at rated dynamic load
	End of Stroke - Actuator has internal limit switches connected to the motor to shut off power at ends of stroke
	Overload Protection - Ball detent clutch with load rating between 250 and 500 lbs.
	Thermal Protection - Automatic resetting thermal breaker enclosed in motor housing.
	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.

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.	

40 - Recovery System

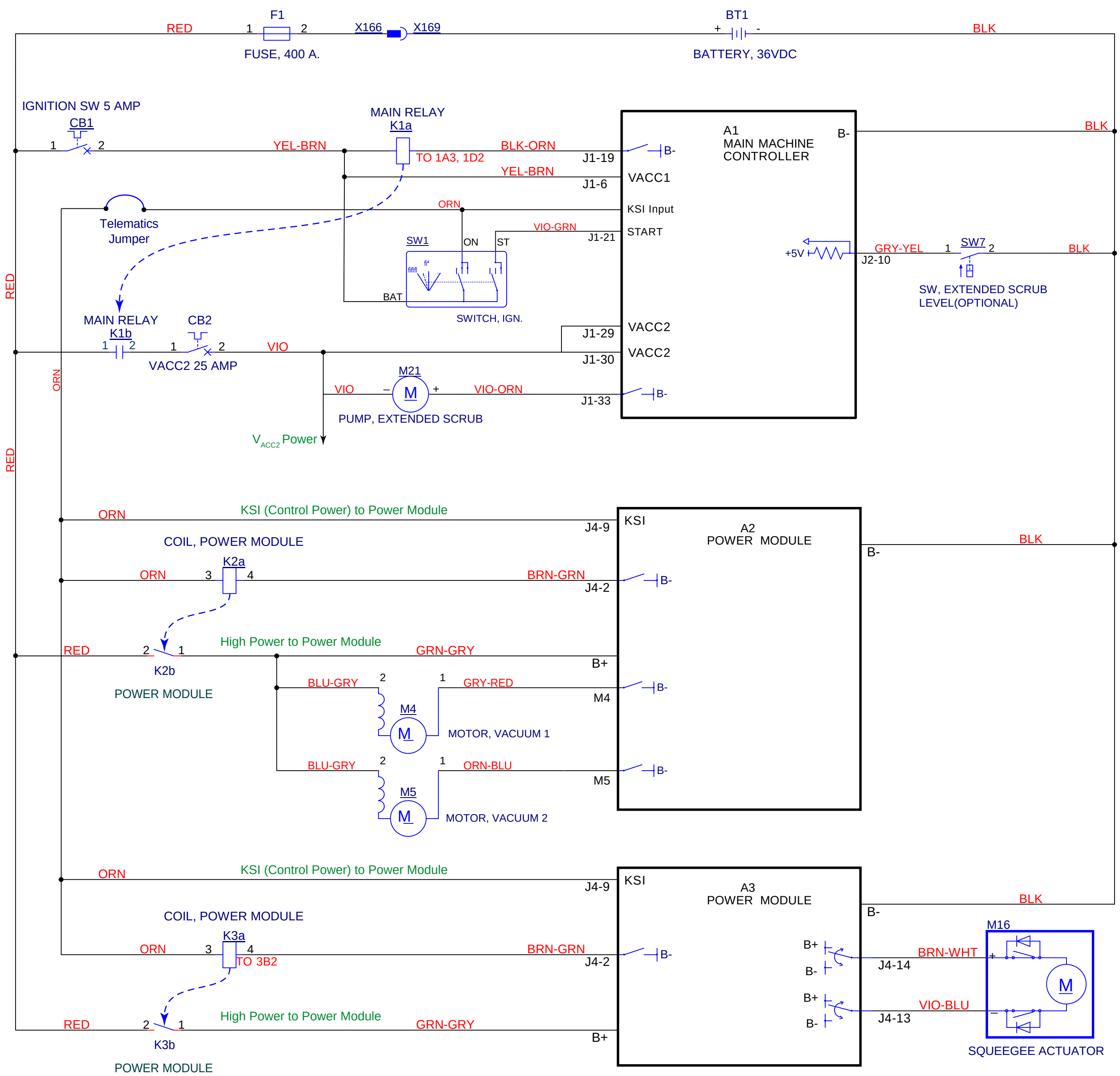
Functional Description

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.

Recovery and Squeegee Wiring Diagram



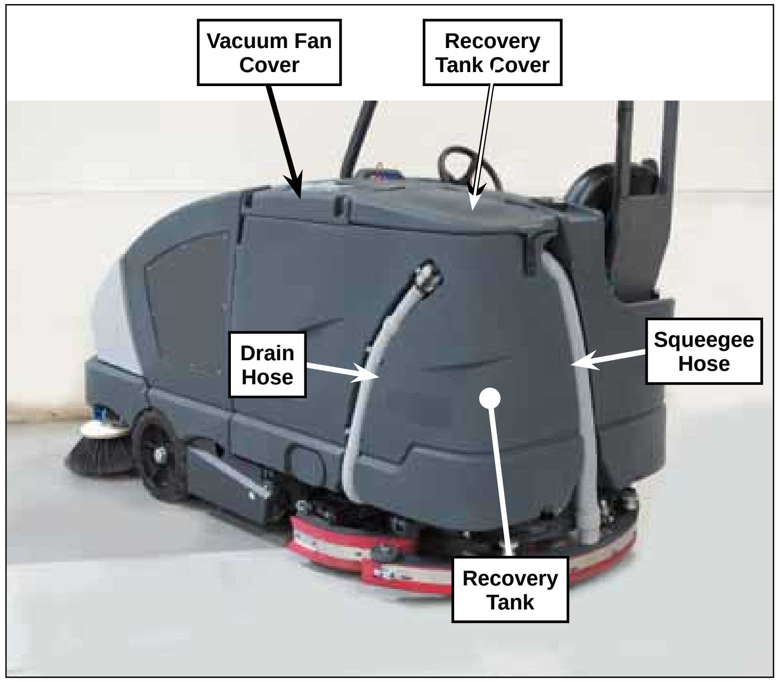
Component Locations

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.

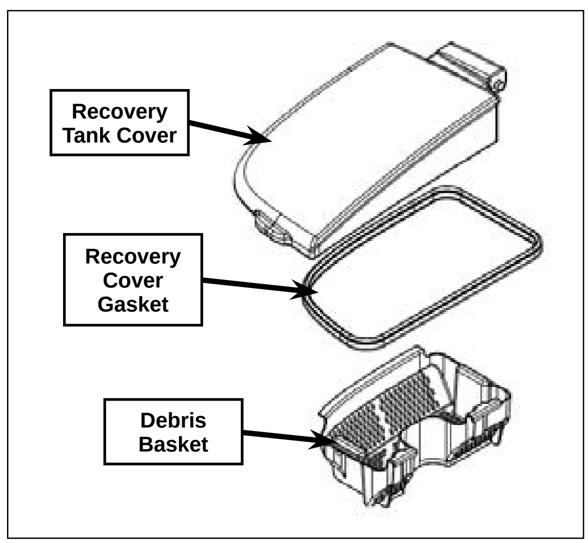
The vacuum motors are located underneath the vacuum fan cover assembly.

The debris basket can be accessed by opening the recovery tank cover.



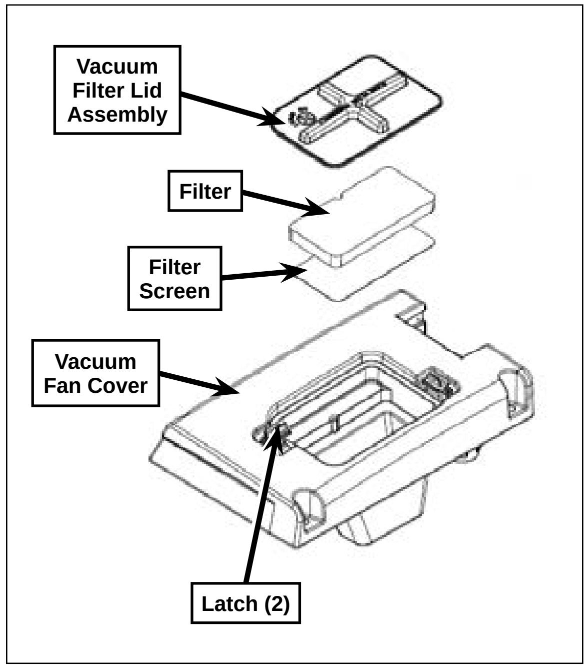
Recovery Tank Cover and Debris Basket

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.

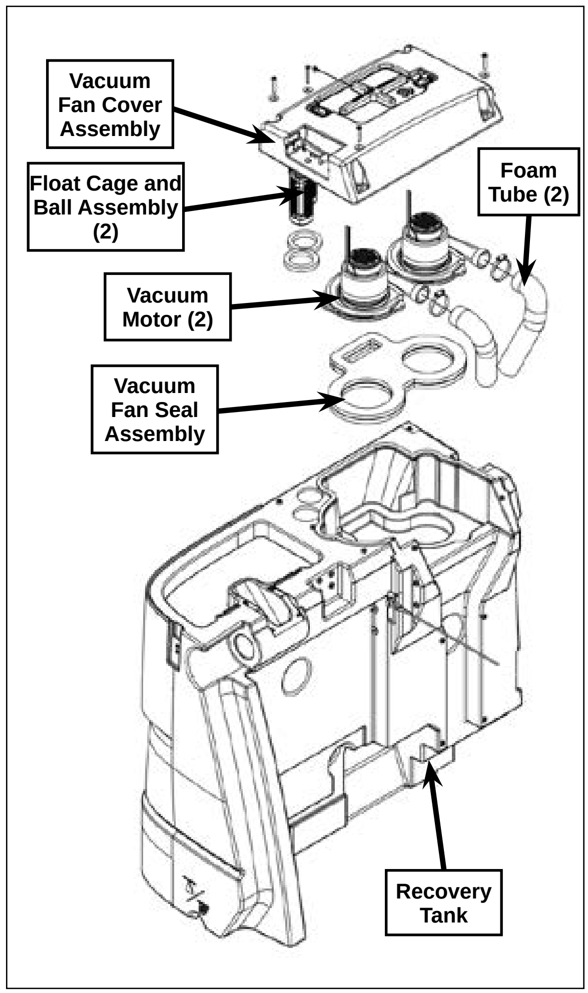


Vacuum Motors

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.

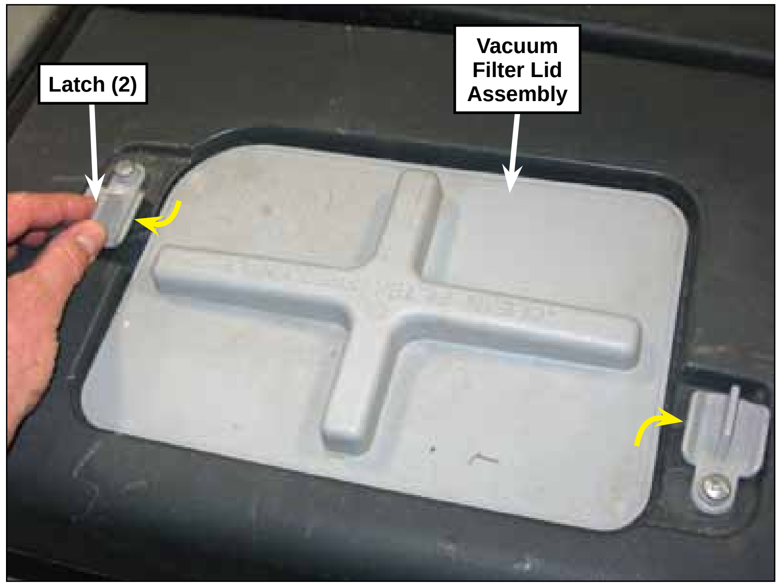


Maintenance and Adjustments

CAUTION: 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.

Clean the Vacuum Filter and Filter Screen

1. Rotate the two latches 90 degrees and remove the vacuum filter lid assembly.



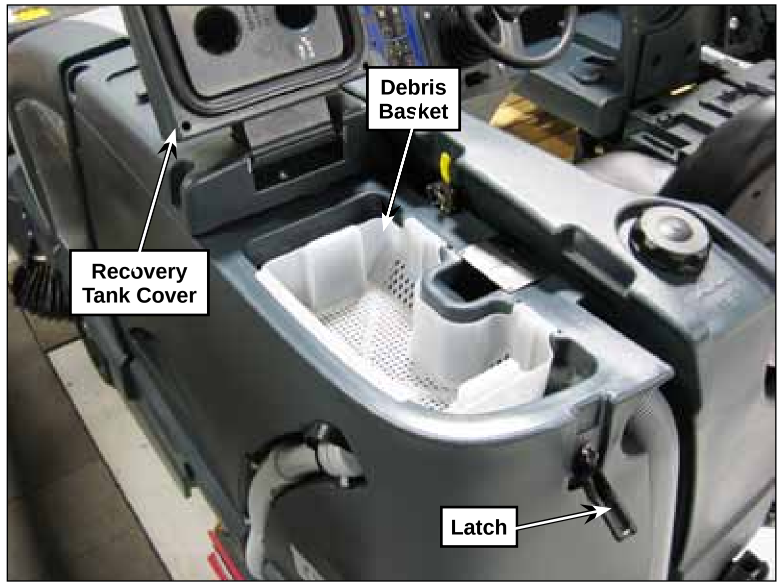
2. Remove and clean the filter and filter screen with a vacuum, or by washing them in warm water.
3. When the filter and filter screen are clean and dry, reinstall them into the recovery tank.

*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.

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

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

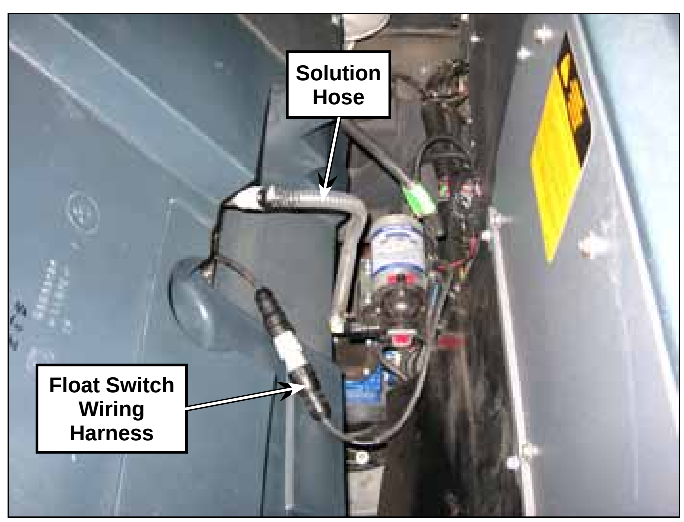
Recovery Tank

***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.*

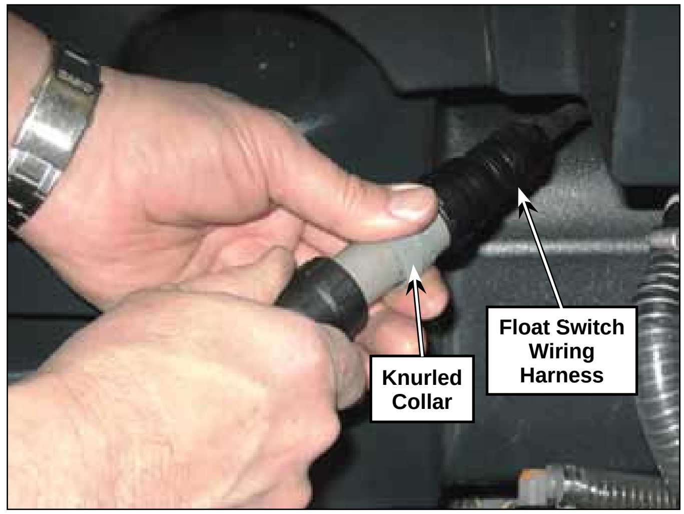
1. Drain the recovery tank.
2. Release the recovery tank latch handle and tip the tank away from the machine.
3. Remove the squeegee hose from the recovery tank.

4. Disconnect the recovery tank vacuum motor electrical connector.

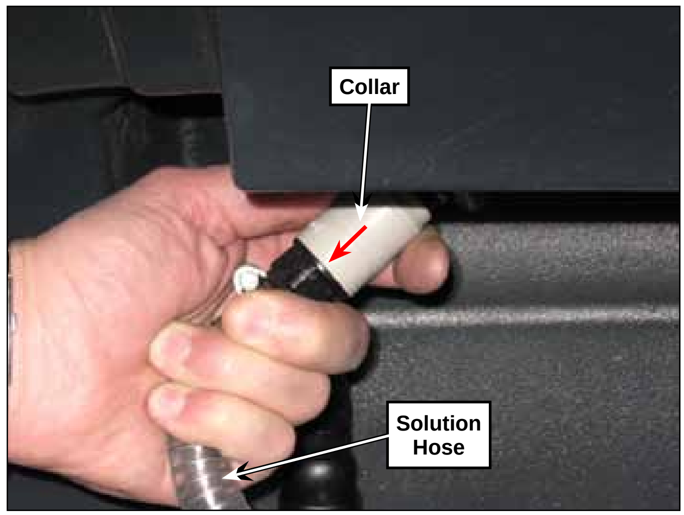
***Note:** If your machine is equipped with an extended scrub system, you must disconnect the float switch wiring harness and solution hose before you can remove the recovery tank. These are described in steps 5 and 6. If your machine is not equipped with an extended scrub system, skip to step 7.*



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.

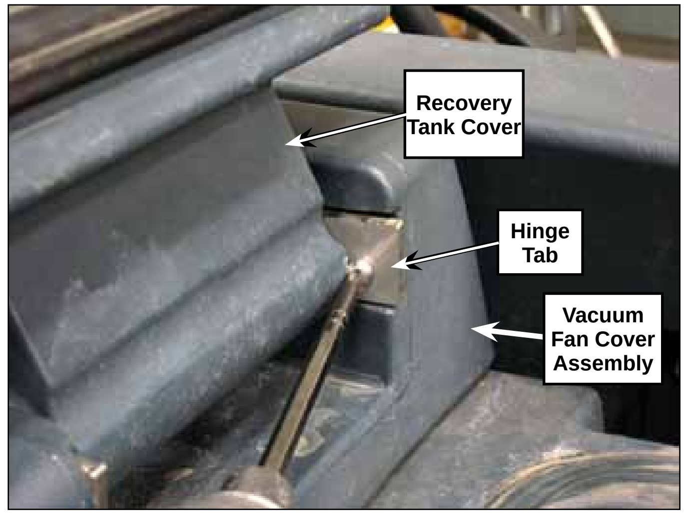


7. Disconnect the Tether Hook and carefully tip and lift the recovery tank off of the mounting pins on the machine frame.

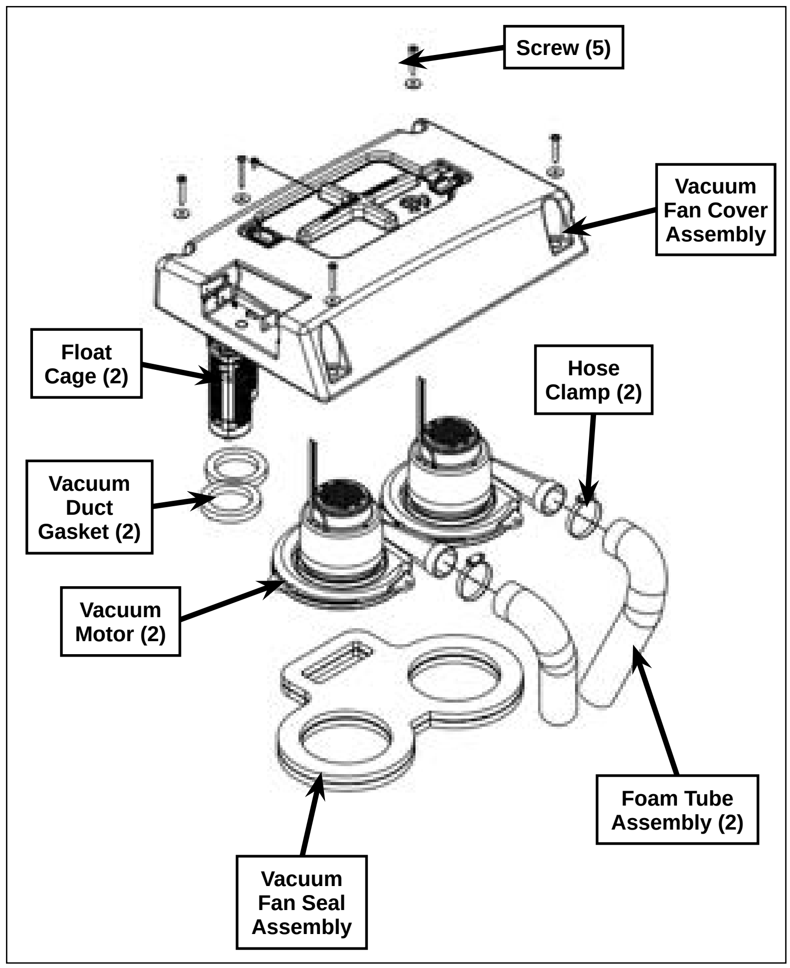
Note: *You may want to lay the recovery tank down onto a skid or other suitable platform on a pallet jack in order to more easily move the recovery tank once it's removed from the machine.*

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

Component	Specifications	
Vacuum Motor	Voltage - 42 VDC	
	Insulation Class - A	
	Current Draw	Average - 15 Amps
		Maximum - 17 Amps
Vacuum System	Vacuum	Sealed – 48” H_2O
		With 1” dia. Orifice – 25” to 30” H_2O

Special Tools

Vacuum water lift gauge, Nilfisk-Advance part number 56205281

42 - 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.

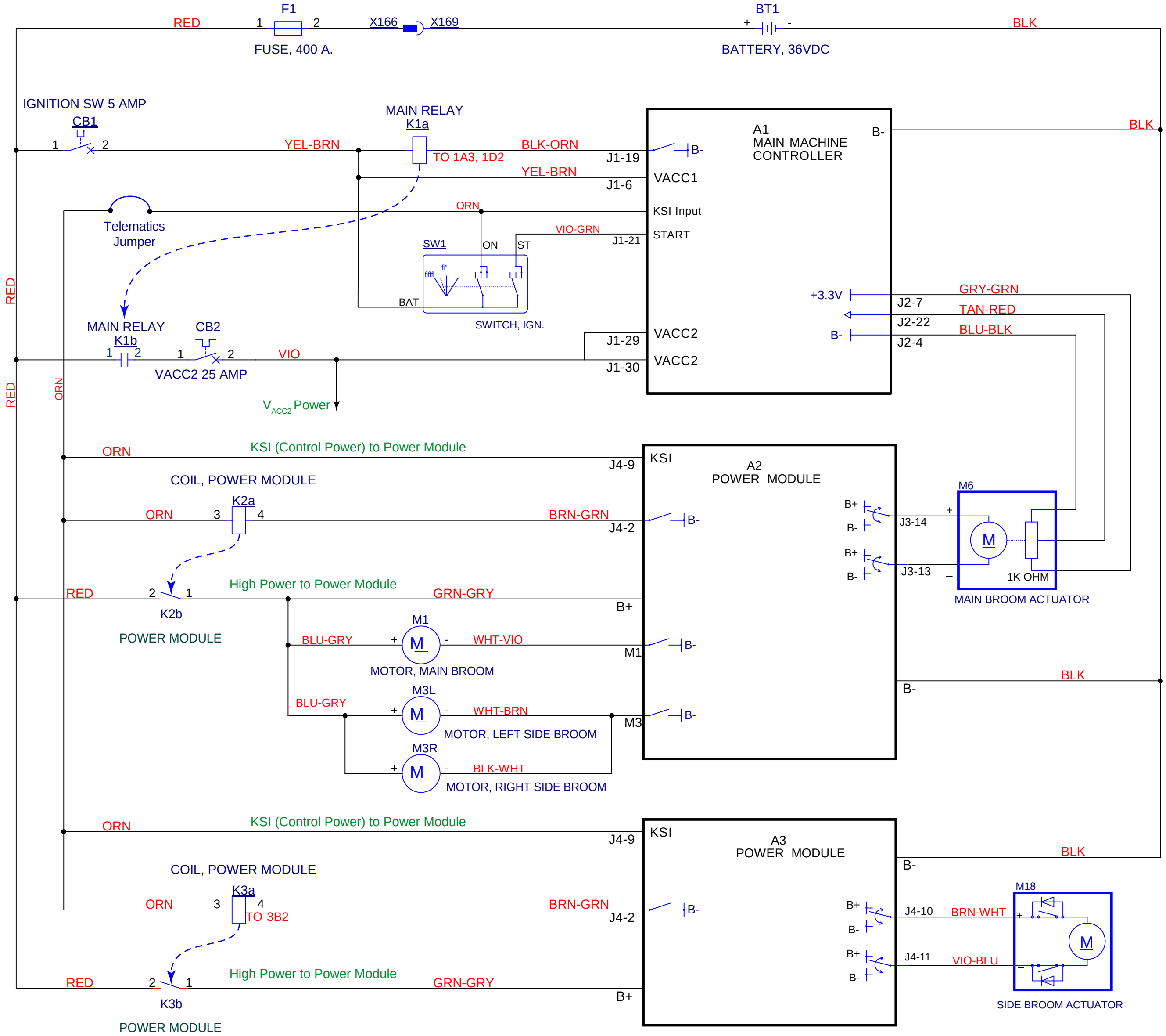
The hopper door opens when sweeping to allow the debris to be thrown into the hopper.

A potentiometer in the main broom actuator sends a voltage signal to the Main Machine Controller that varies with the broom height. The 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.

Sweep System Wiring Diagram

The diagram below contains both main broom and side broom circuitry.



Circuit Description

Main Broom Actuator

The main broom actuator raises and lowers the main broom. Instead of the typical end limit switches, this actuator provides analog position feedback to the Main Machine Controller. A potentiometer in the head of the actuator returns a variable voltage between 0 and 3.3 volts back to the main controller. The main controller interprets this voltage to determine the main broom position. The main controller commands movement of the actuator via CAN Bus messages to Power Module #1 (A2).

Main Broom Motor

The main broom motor is driven by Power Module #1 by CAN Bus commands from the main controller. The motor is active when the sweep system is active (broom lowered) and the drive pedal is out of the neutral position.

Component Locations

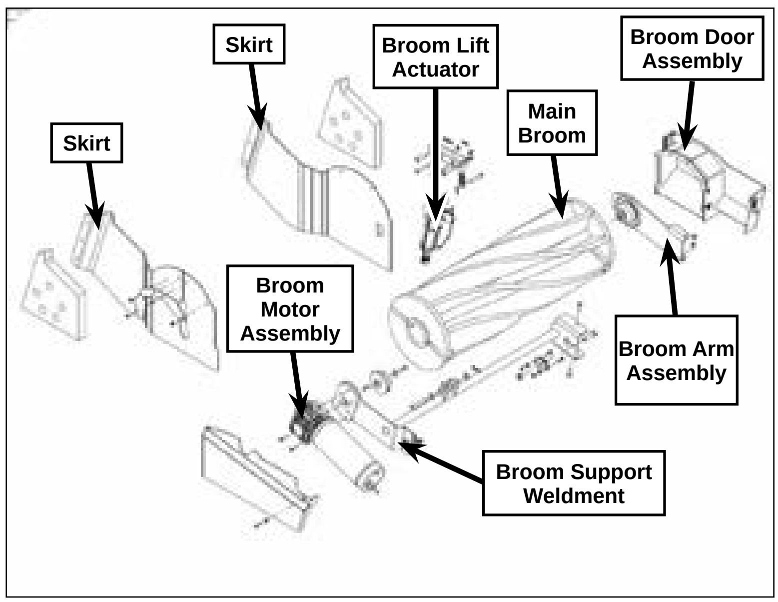
Main Broom and Drive Components

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.

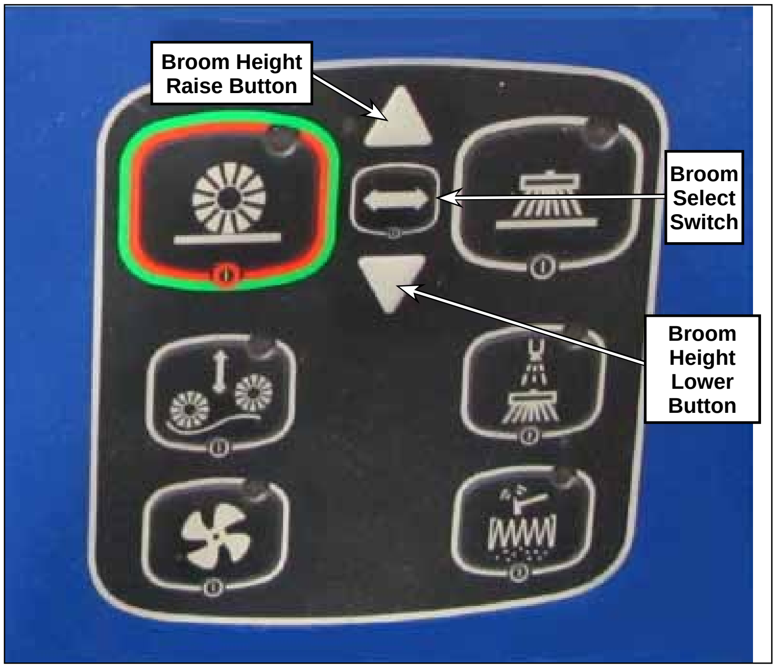


Maintenance and Adjustments

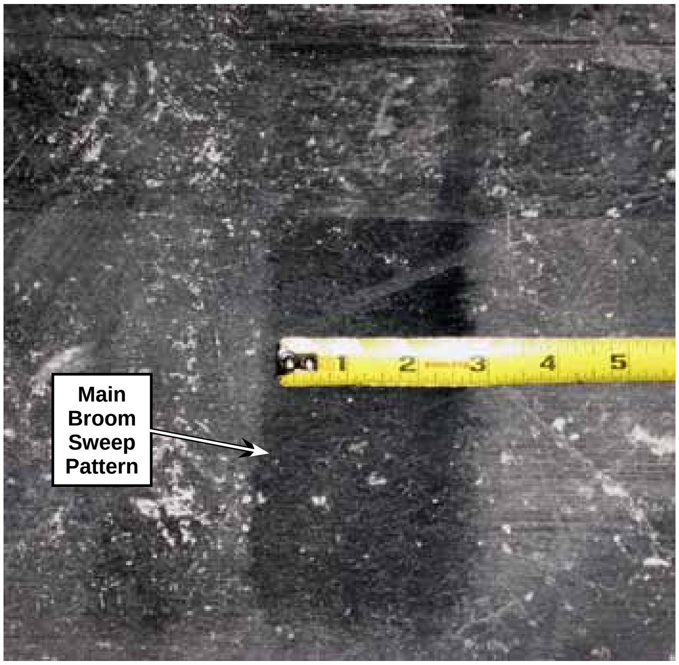
CAUTION: ***Before performing any maintenance or adjustments on the main sweep system, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

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” (50-75 mm) 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 Adjust the Main Broom Tilt section below.*

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:

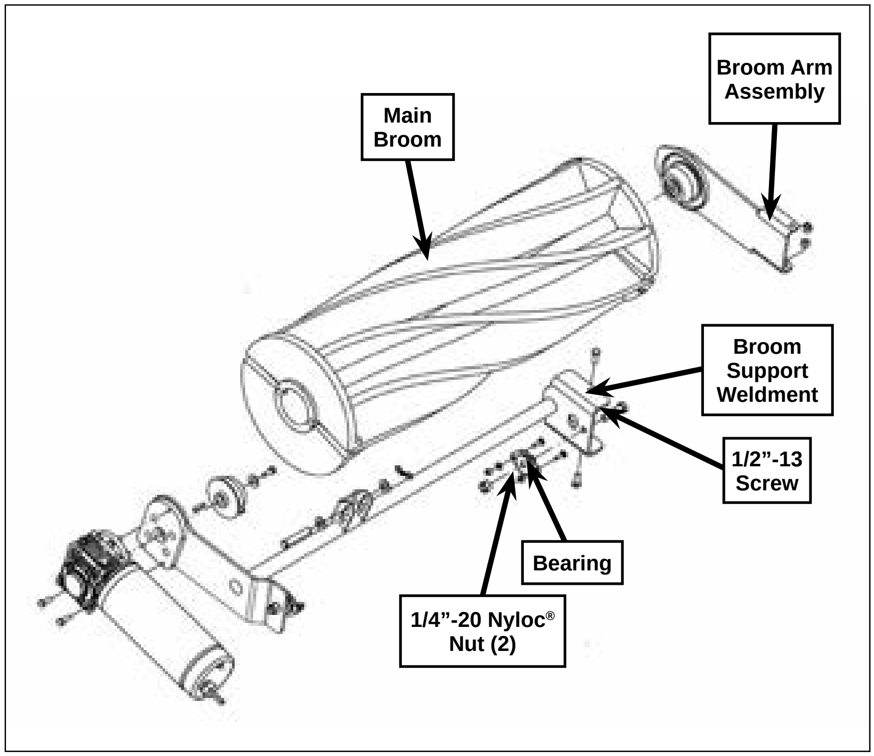
   Raising the right side of the main broom will narrow the sweep pattern on the right side.

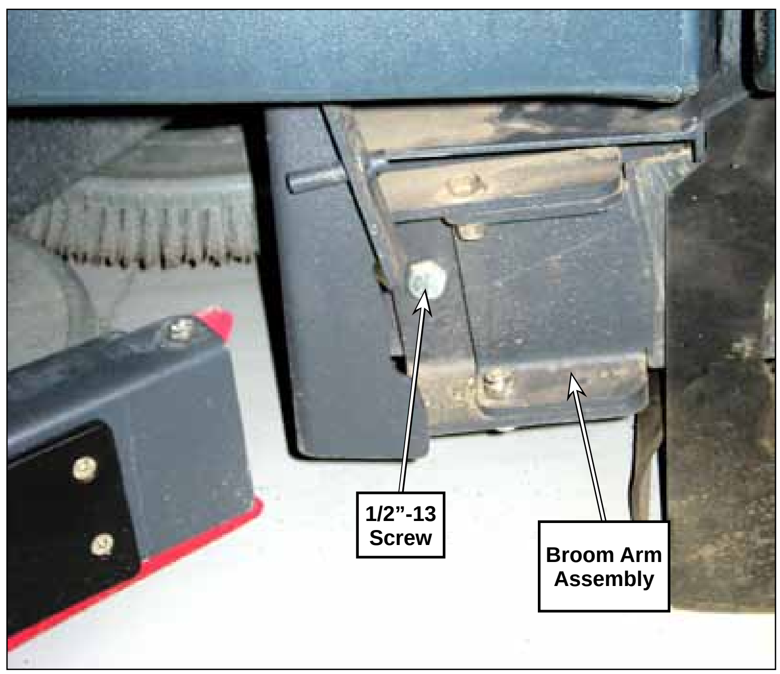
   Lowering the right side of the main broom will widen the sweep pattern on the right side.

3. Tighten the two 1/4”-20 nyloc® nuts.

4. Check the main broom sweep pattern.

5. Readjust the main broom tilt as necessary.



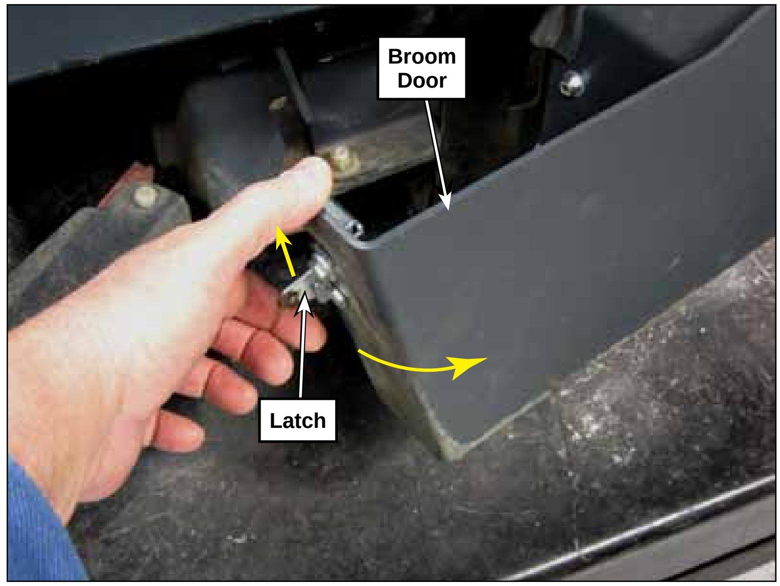


Removal and Installation

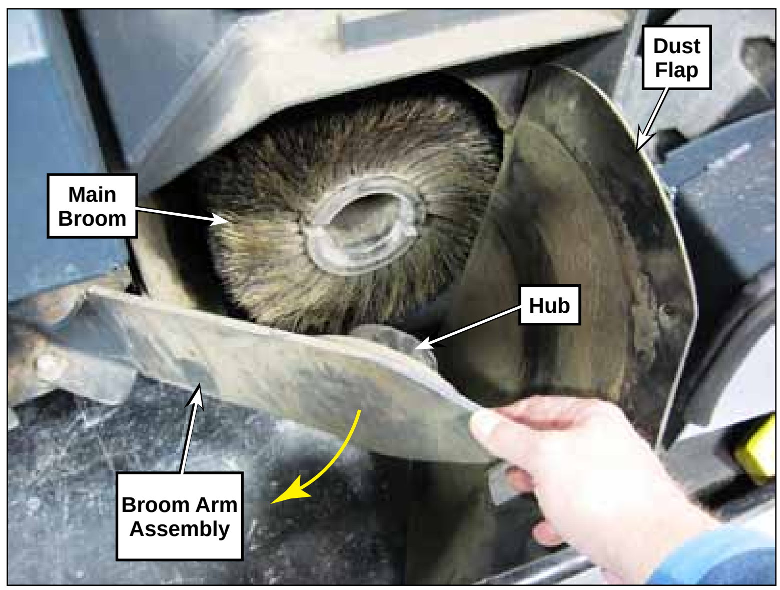
CAUTION: ***Before removing or reinstalling any machine components, make sure the key switch is off, the key is removed from the machine and the parking brake is engaged.***

Main Broom

1. Make sure the main broom is in the raised position.
2. Lift up the Latch and swing open the Broom Door.



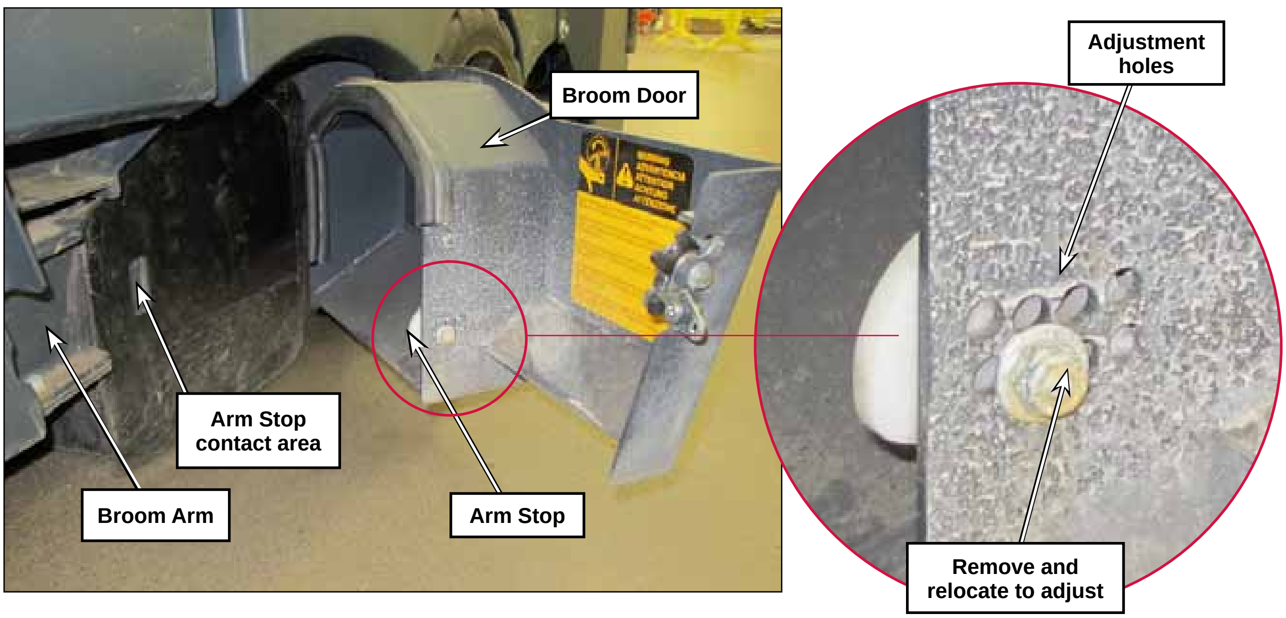
3. Move the Dust Flap out of the way and swing open the Broom Arm Assembly.
4. Pull the Main Broom out of the machine.



Replacement

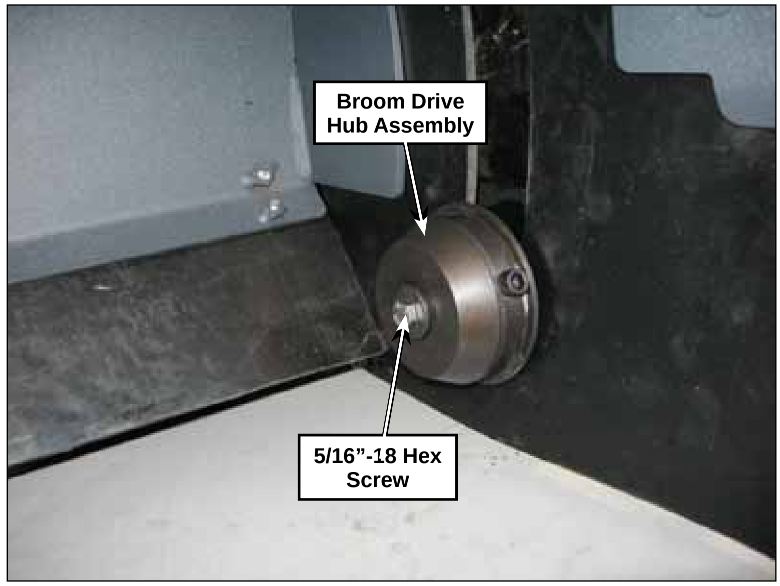
1. Install the Main Broom into the machine. Rotate the Main Broom as necessary to make sure the broom lugs on the far side engage the drive hub on the broom motor.
2. Close the Broom Arm Assembly, making sure the Main Broom engages the Hub on the Broom Arm Assembly.
3. Move the Dust Flap back into position, then close and latch the Broom Door
4. Check and adjust the broom Arm Stop on the Broom Door as necessary. The Arm Stop should be adjusted to prevent the Broom Arm from moving outward while still allowing the door to latch easily.

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 main broom overload error code which will shut down the main broom.*

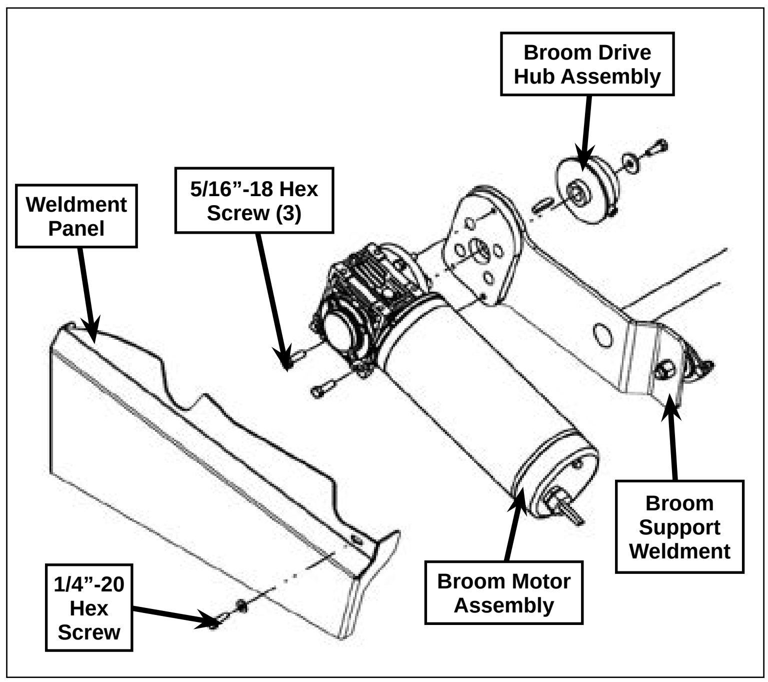


Broom Motor

1. Remove the Main Broom described on page 261.
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.

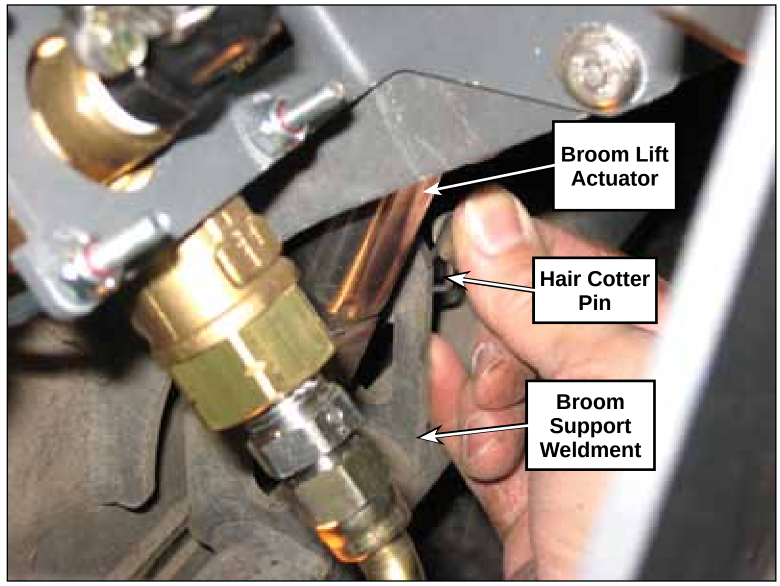


4. Remove the 1/4”-20 hex screw and washer holding the weldment panel to the machine frame. Note that the front edge of the weldment panel is pinned to the frame.
5. Disconnect the broom motor electrical connector from the wiring harness.
6. Remove the three 5/16”-18 hex screws holding the broom motor 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.

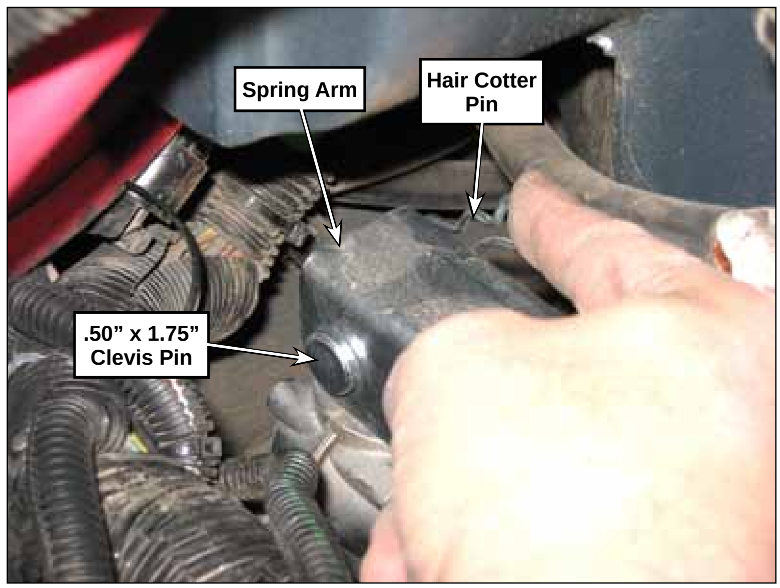


Note: *Apply Never-Seez® or an equivalent anti-seize compound on the gearbox shaft when you reinstall the Broom Drive Hub Assembly. Apply Loctite® 242 (blue) on the 5/16”-18 Hex Screws when reinstalling the Broom Drive Hub Assembly and Broom Motor Assembly.*

Broom Lift Actuator



1. Remove the Recovery Tank described on page 252.
2. Remove the Main Broom described on page 261.
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. The broom lift actuator itself doesn’t need to be adjusted, but the main broom height and main broom sweep pattern described in the “Adjust the Main Broom Height” on page 259 should be checked and adjusted as necessary

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.

48 - Sweep System, Side Broom

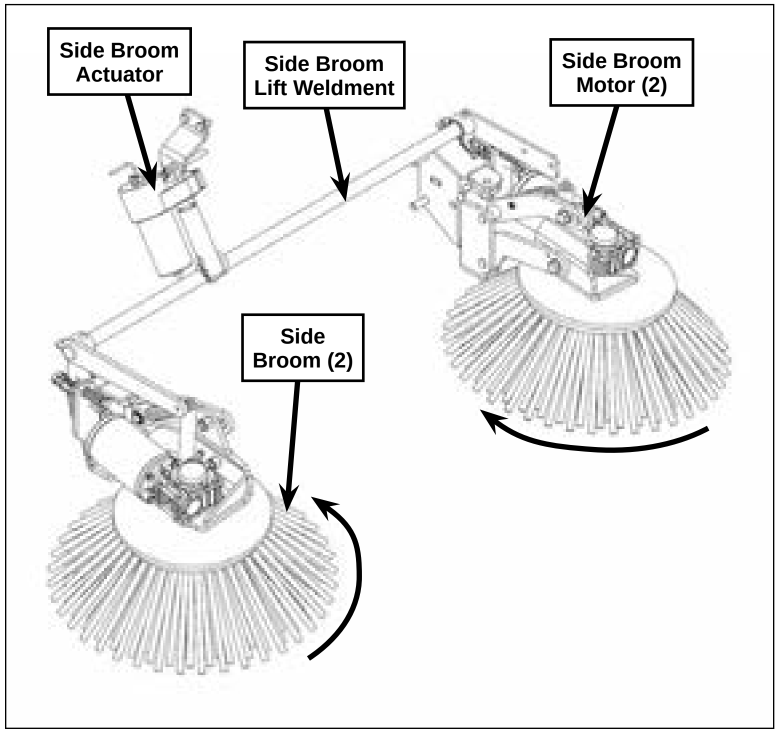
Functional Description

Overview

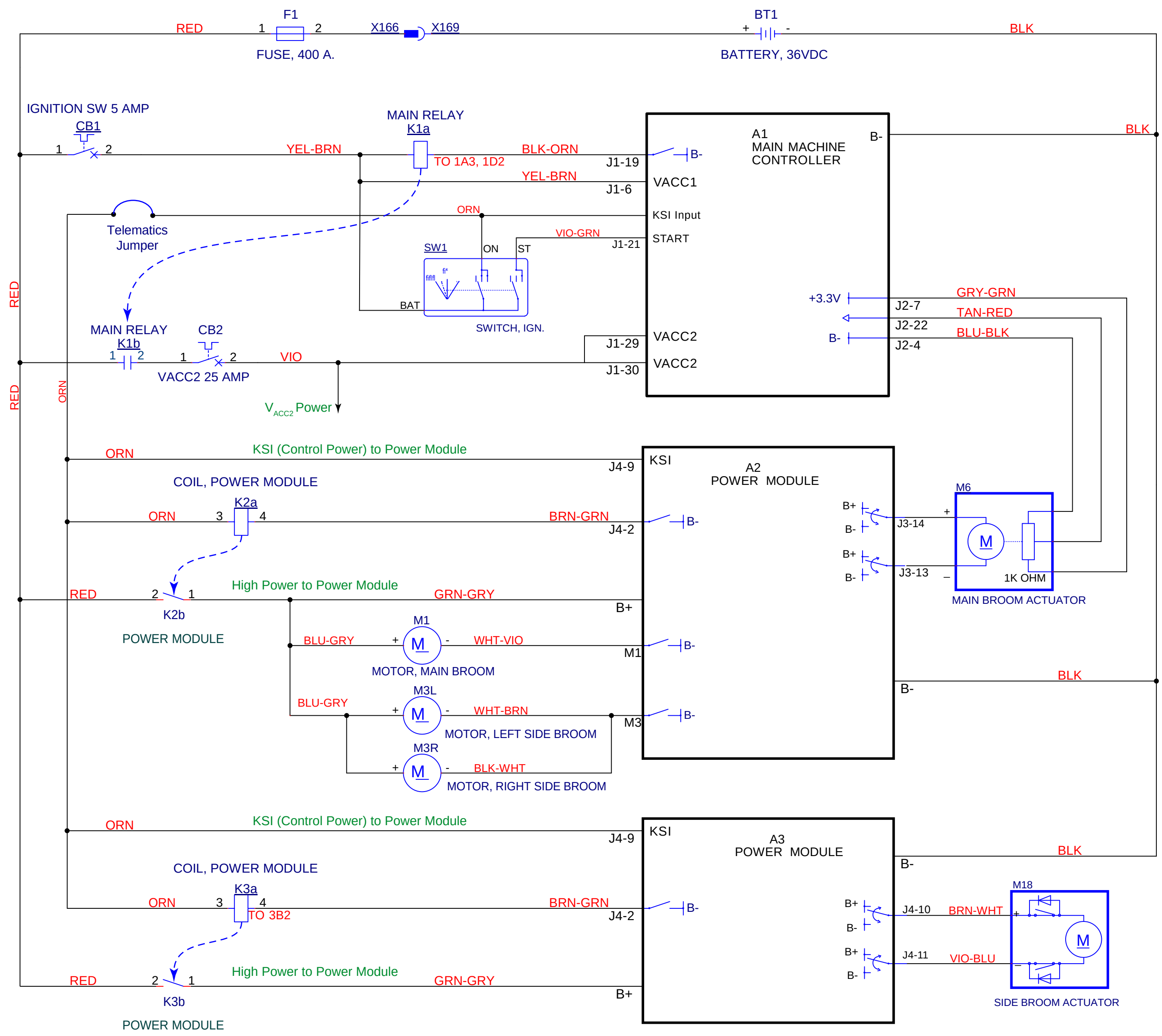
The Side Brooms run in opposite directions to direct debris from the sides of the machine toward the center where the main broom can direct it into the hopper.

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. When setting the down position of the side brooms, the controller counts the run-time of the actuator motor. 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.



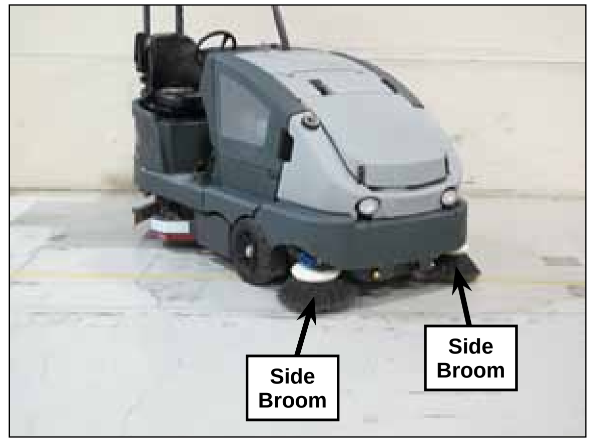
Side Broom and Main Broom Wiring Diagram



Component Locations

Side Brooms

The Side Brooms are mounted on the front corners of the machine, below the hopper.



Side Broom Motors

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

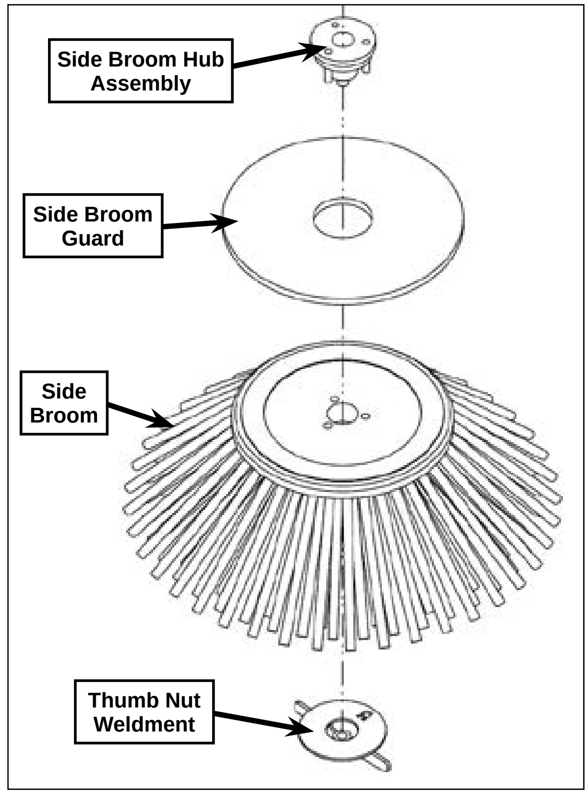
The Side Broom Actuator is on the upper hopper and lowers and raises the side broom lift weldment and attached side broom motor assemblies.

Maintenance and Adjustments

CAUTION: 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.

Replacing 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.

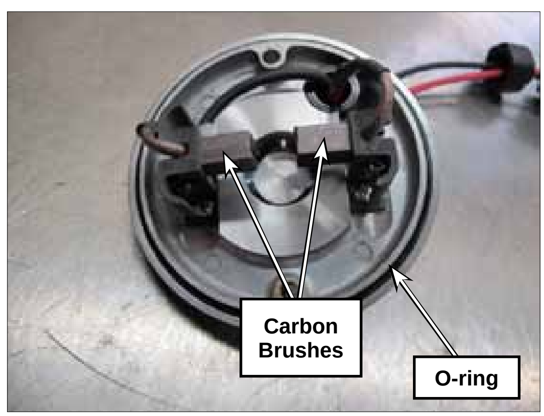


Side Broom Motor Carbon Brushes

1. Remove the Side Broom Motor described on page 272.
2. Create witness marks on the gearbox, motor end bells (covers) and the motor casing for reassembly.

3. Loosen the wire retaining nut and remove the two through bolts. Do not lose or damage the rubber washers.

4. Remove the end cover. Do not lose or damage the O-ring seal.



5. Inspect the carbon brushes and replace as necessary. New brush length is approximately 13/16” (20 mm)

6. Reinstall the cover with O-ring in place.
7. Gently pry the carbon brushes back against their springs just far enough to slip them over the commutator.
8. Gently slide the cover into place and align the witness marks made earlier.
9. Reinstall the through bolts and tighten the wire retaining nut.

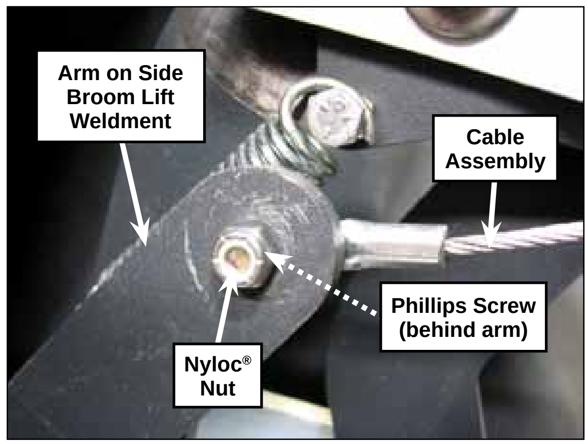
Removal and Installation

CAUTION: 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.

Side Broom Motor

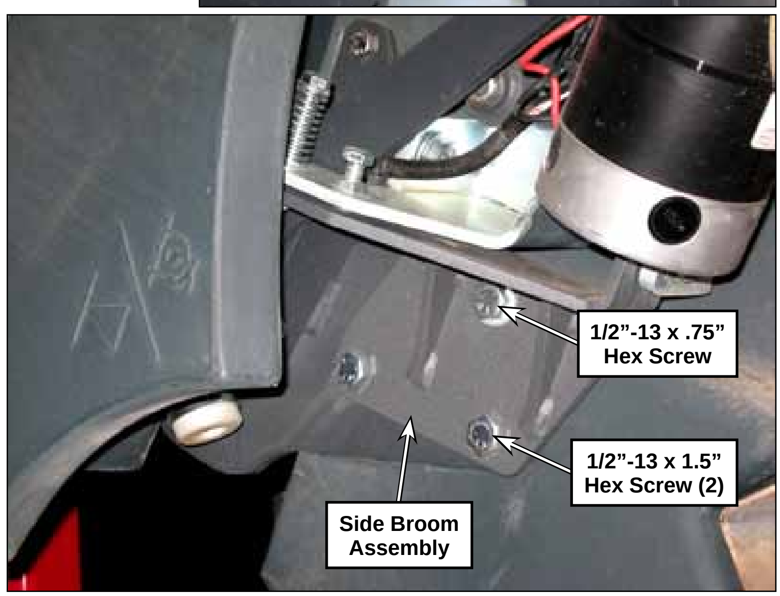
1. Empty the hopper.
2. Make sure the parking brake is engaged.
3. Turn the key switch on and switch the machine to the Service Mode.
4. Raise the hopper so the side brooms are at a convenient working height, then support the hopper with jack stands or other suitable supports.

CAUTION: 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.
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.

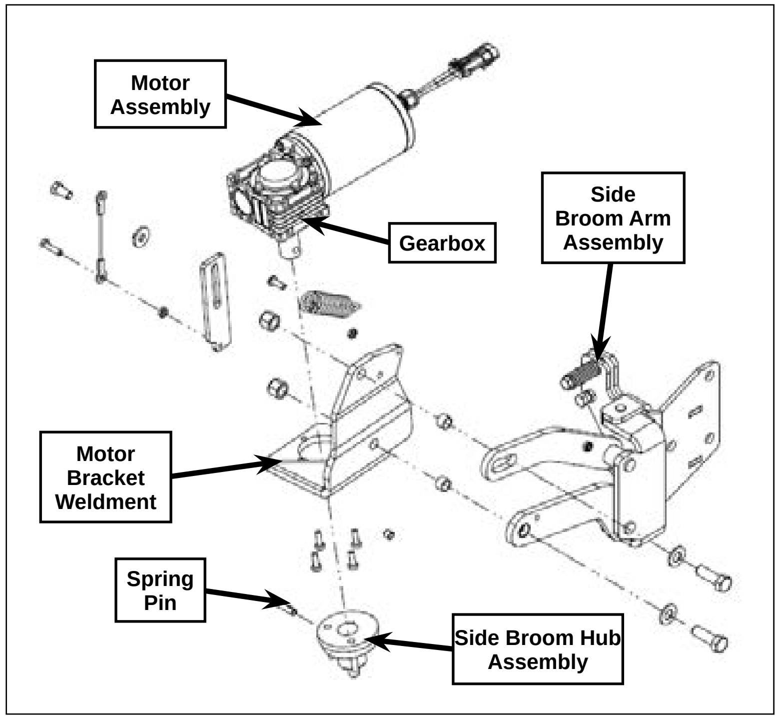
Note: *Removing the side broom assembly is easier if one person holds the side broom assembly in place while another person removes the 1/2”-13 x .75” Hex screw.*



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.

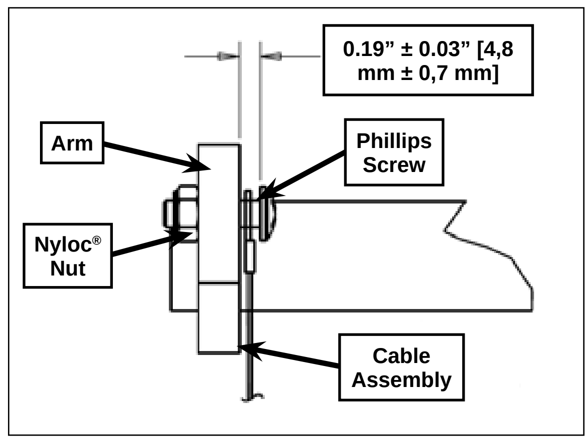
12. Remove the 1/2”-13 x .75” Hex Screw and washer and carefully remove the Side Broom Assembly from the machine.

13. Reinstall the side broom motor assembly by following the above steps in reverse order.



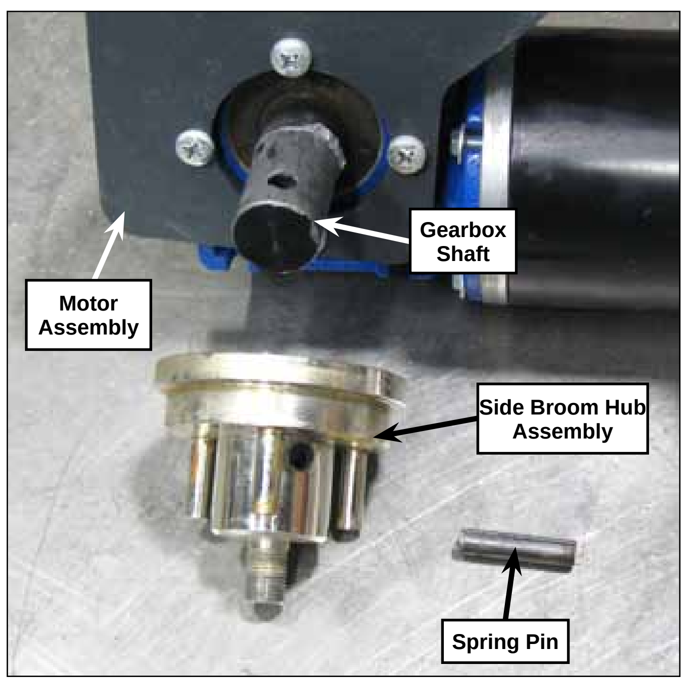
Note: *Use Loctite® #242 (blue) on the 1/2”-13 x .75” Hex Screw when you reinstall the Screw.*

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.*



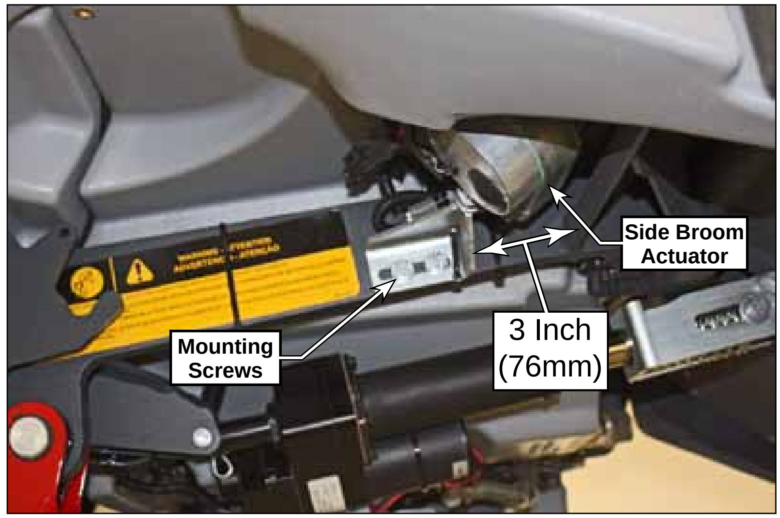
Side Broom Hub

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.
5. Coat the Gearbox Shaft with Never-Seez® or equivalent anti-seize compound before installing the Side Broom Hub Assembly.



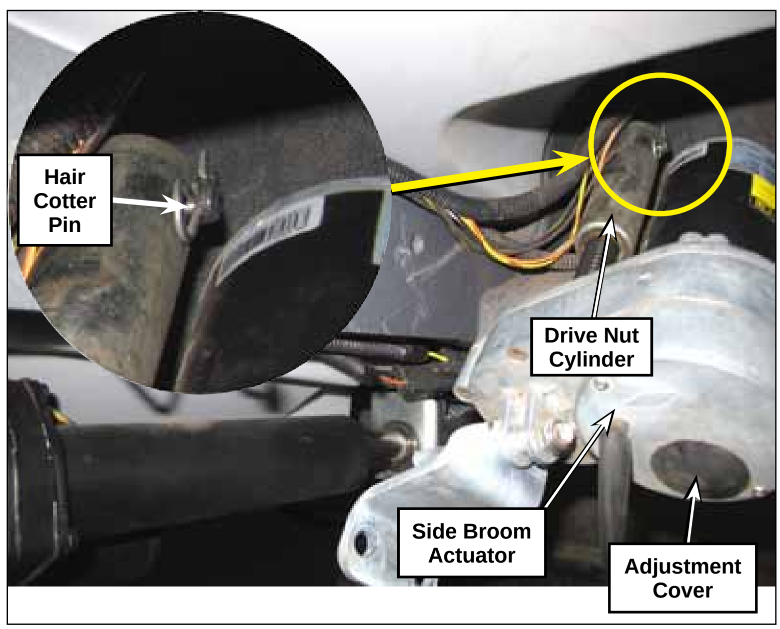
Side Broom Actuator

1. Empty the hopper and make sure the parking brake is engaged.
2. Turn the key switch on and switch the machine to the Service Mode.
3. 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.



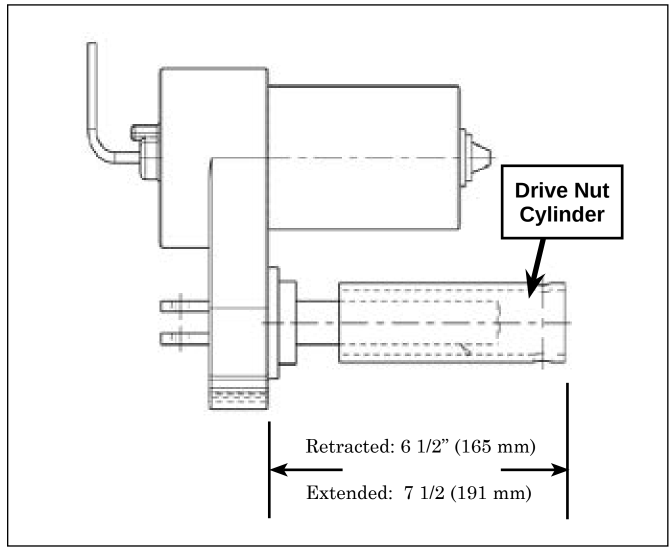
CAUTION: Always make sure the hopper is adequately supported before performing any work on or underneath the hopper.

4. Cut the wire tie and disconnect the side broom actuator electrical connector.
5. Remove the two 3/8”-16 x .75” Screws holding the actuator bracket to the hopper lift frame.
   - Note the position of the bracket for later replacement. The bracket should be 3 inches away from the frame, as shown above.
6. 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.
7. 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.
8. Reinstall the Side Broom Actuator by following the above steps in reverse order.

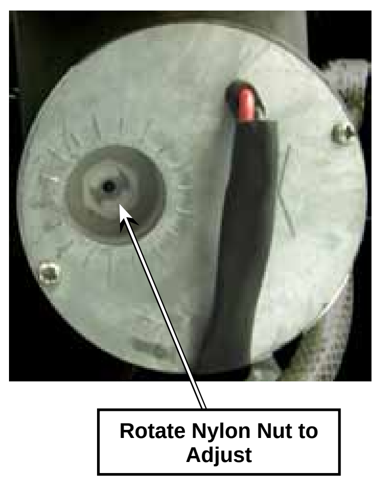


Note: *Be careful not to rotate the drive nut cylinder on the side broom actuator when it’s disconnected from the machine. This can change the extended and retracted positions of the side broom actuator, and the subsequent extended and retracted positions of the side brooms.*

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.



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="6">Specifications</th></tr>
<tr><td rowspan="4">Side Broom Motors (all)</td><td colspan="6">No-load Speed - 2,800 RPM</td></tr>
<tr><td colspan="6">Rotation - Clockwise</td></tr>
<tr><td colspan="6">Voltage - 42 VDC</td></tr>
<tr><td colspan="6">Power - .25 HP, Continuous Duty</td></tr>
<tr><td>Side Broom Motor - Left</td><td colspan="2">Current Draw (shop measurements)</td><td colspan="2">Average - 3 Amps</td><td colspan="2">Max. - 4 Amps</td></tr>
<tr><td>Side Broom Motor - Right</td><td colspan="2">Current Draw (shop measurements)</td><td colspan="2">Average - 3 Amps</td><td colspan="2">Max. - 4 Amps</td></tr>
<tr><td rowspan="10">Side Broom Actuator</td><td colspan="6">36 VDC, 1/6 HP</td></tr>
<tr><td colspan="6">Motor-to-drive screw ratio - 21.7:1</td></tr>
<tr><td colspan="4" rowspan="2">Drive Nut Cylinder Positions</td><td colspan="2">Retracted Position - 8.00”</td></tr>
<tr><td colspan="2">Extended Position - 9.75”</td></tr>
<tr><td colspan="3">Current Draw (shop measurements)</td><td colspan="3">Average - 2 to 3 Amps</td></tr>
<tr><td colspan="6">Performance data for the following load conditions:</td></tr>
<tr><td colspan="2">No load</td><td colspan="2">Full load</td><td colspan="2">Start</td></tr>
<tr><td colspan="2">Thrust - 0 lbs</td><td colspan="2">Thrust - 600 lbs</td><td colspan="2">Thrust 600 - lbs</td></tr>
<tr><td colspan="2">Speed - 39 in/min</td><td colspan="2">Speed - 30 in/min</td><td colspan="2"></td></tr>
<tr><td colspan="2">Amps - 1.4 Max</td><td colspan="2">Amps - 6.7 ±1.0</td><td colspan="2"></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.	

50 - Dust Control/DustGuard™ Systems

Functional Description

Overview

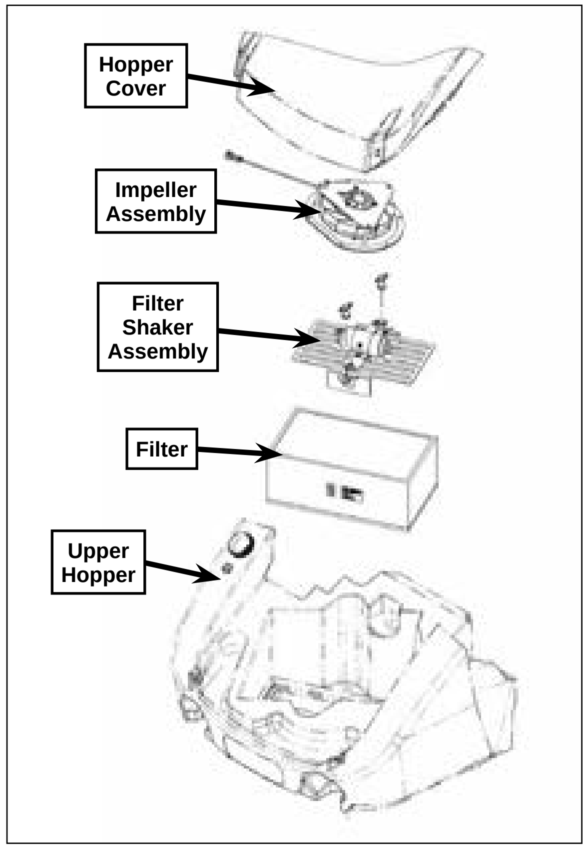
The dust control system pulls air through the hopper and through a filter to trap the dust from the hopper. The optional DustGuard system sprays a fine stream of water in front of each side broom to minimize the dust created by the main broom.

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.

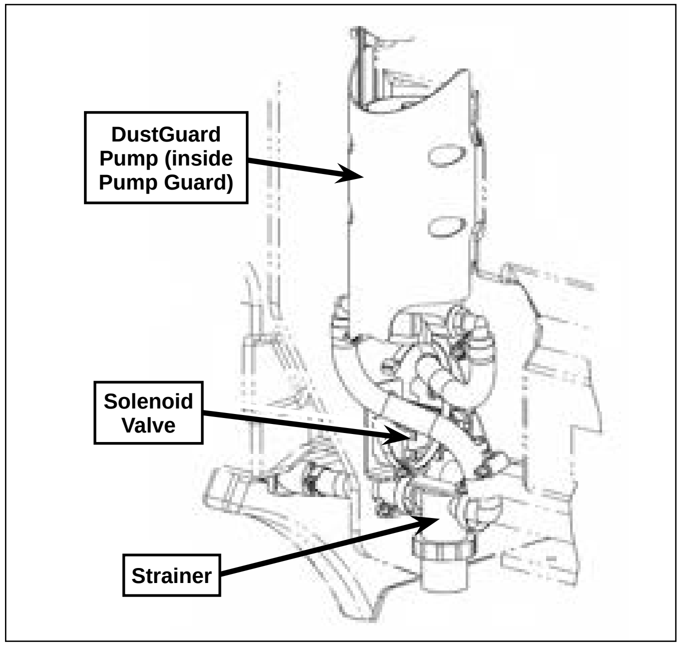


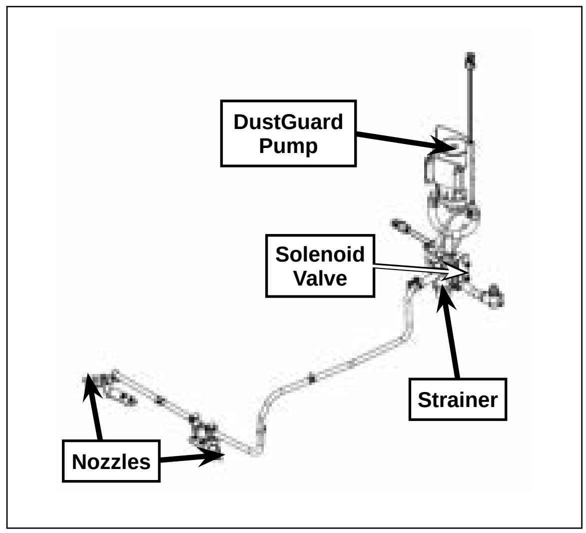
DustGuard Spray System (optional)

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.

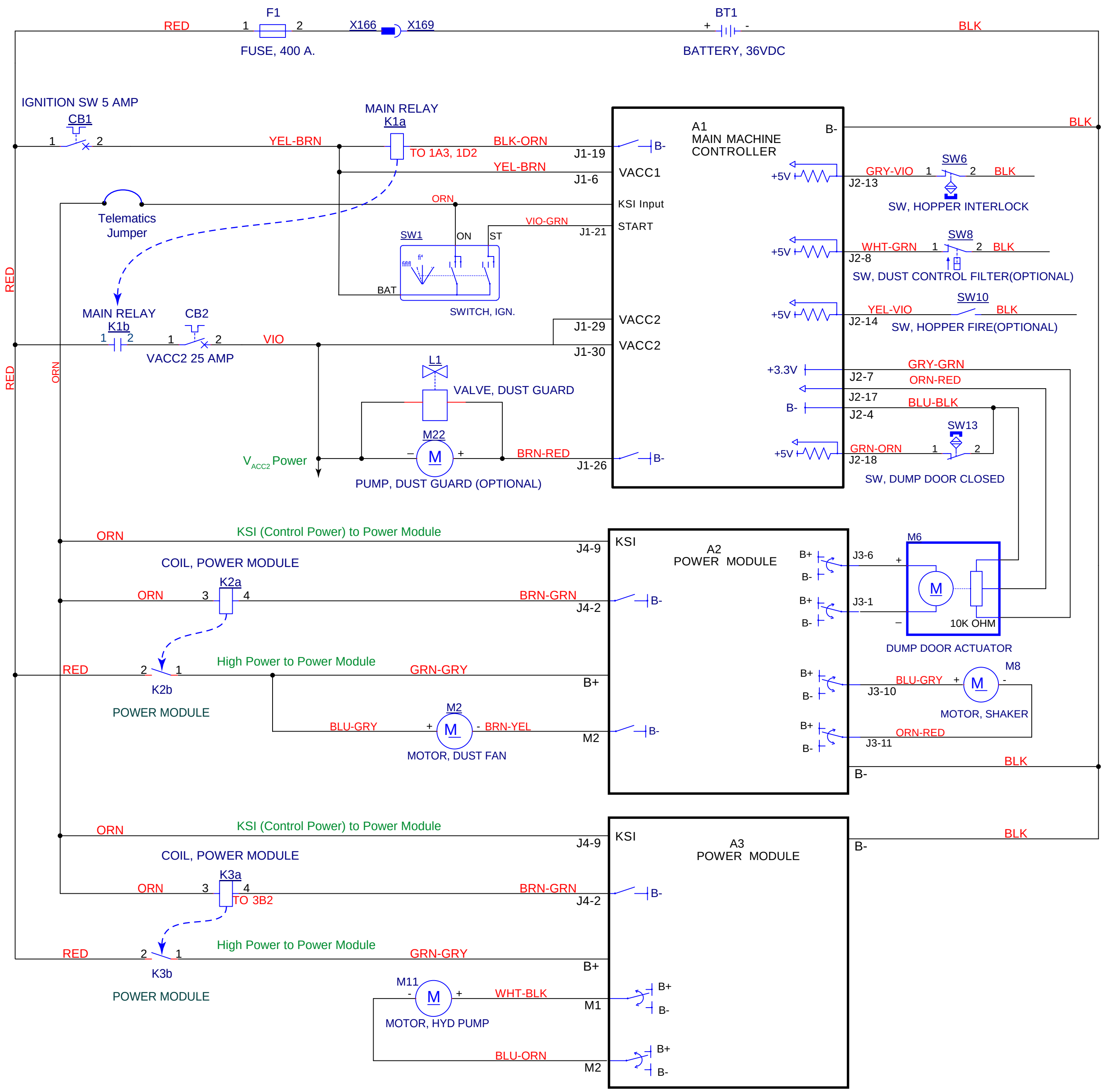
The DustGuard Solenoid Valve opens to allow water flow from the DustGuard Pump to the Nozzles when the power to the DustGuard Pump switches on. A removable Strainer is installed in the water line upstream of the DustGuard Pump and Solenoid Valve. Removable strainers are also located inside of the Nozzle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

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





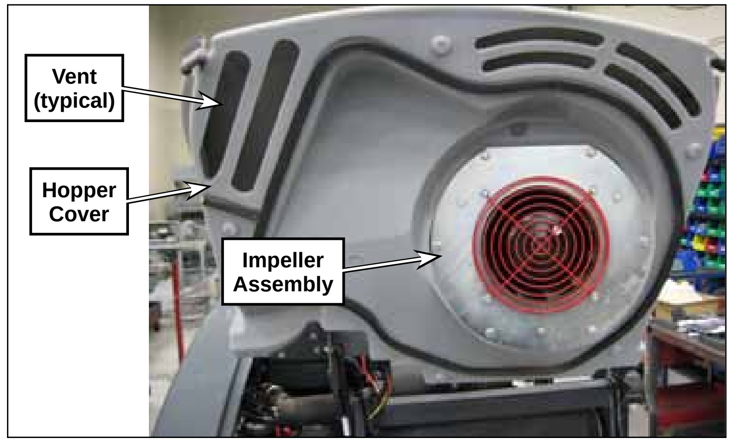
Dust Control and Hopper Wiring Diagram



Component Locations

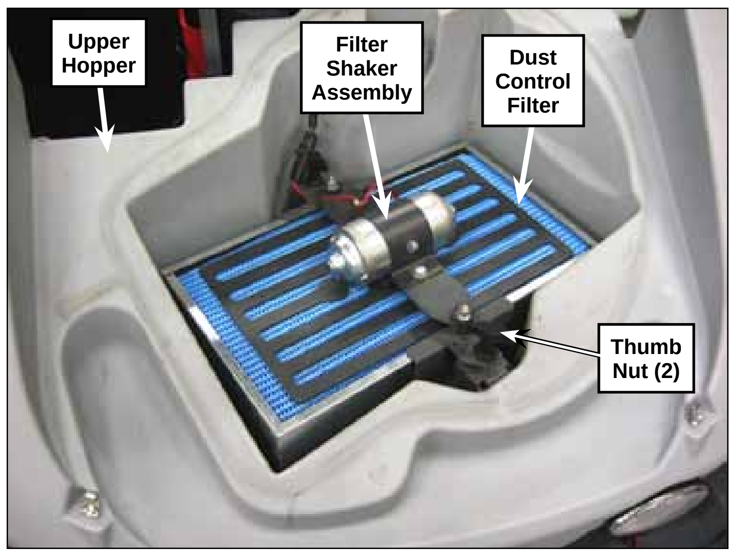
Impeller and Filter System

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.

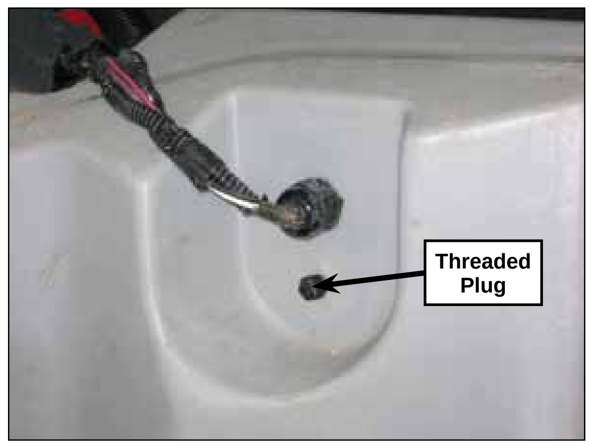
The electric motor in the Filter Shaker Assembly drives two eccentric weights to vibrate or “shake” the Dust Control Filter to dislodge dust and allow it to drop down into the hopper. Two Thumb Nuts secure the Filter Shaker Assembly and Dust Control Filter to the Upper Hopper.



Dust Control Filter Switch

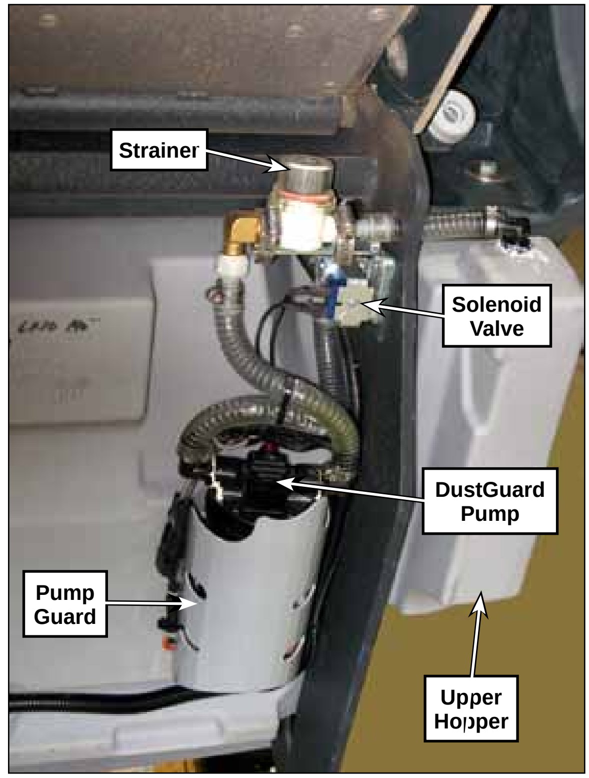
The optional Dust Control Filter Switch is mounted above the Filter Shaker Assembly on the Upper Hopper. The Dust Control Filter Switch will close and generate a warning if the hopper vacuum gets too high, indicating a plugged Dust Control Filter. Note that the Dust Control Filter Switch is factory-set 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.

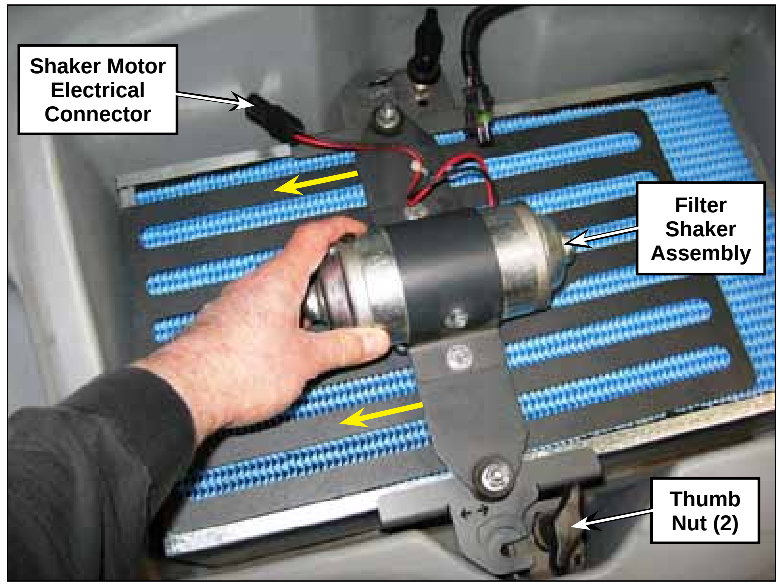


The Spray Nozzles are mounted on the front of the machine and spray an oval pattern of water mist across the width of each side broom.

Maintenance and Adjustments

CAUTION: 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.

Clean the Dust Control Filter



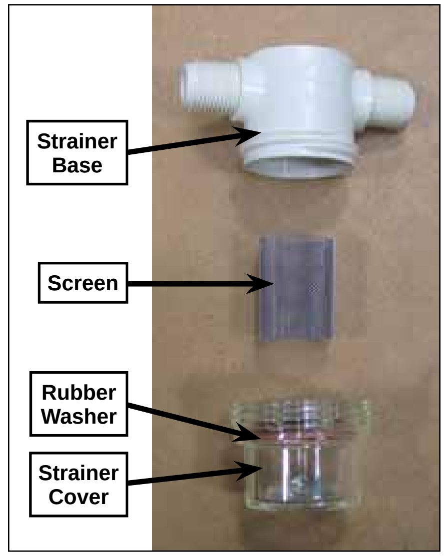
1. Lift the hopper cover.
2. Disconnect the Shaker Motor Electrical Connector.
3. Loosen the two Thumb Nuts, then slide the Filter Shaker Assembly toward the left and remove it from the machine.
4. Lift the Filter out of the machine.

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

5. Inspect the filter and urethane gasket for damage.
   - A large amount of dust on top of the Filter may be a sign of a punctured filter or damaged seal.
   - If the filter surfaces or gasket are damaged, replace the filter.
6. Clean the filter:
   a. Tap the filter on a hard surface to knock off heavy debris.
   b. Vacuum the surface to remove remaining debris.
   c. Blow compressed air (maximum pressure 100 psi) into the clean side of the filter to remove fine dust.
7. During replacement, make sure the arrow on the side of the filter is pointing upward.

Clean the DustGuard Strainer Screen

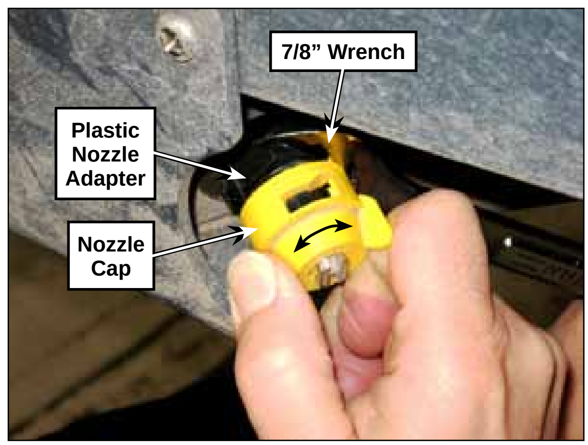
1. Drain the water from the upper hopper. Note that you can do this one of several ways. The most convenient way is to remove the Strainer Cover and Screen and drain the upper hopper through the DustGuard strainer.



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.
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.

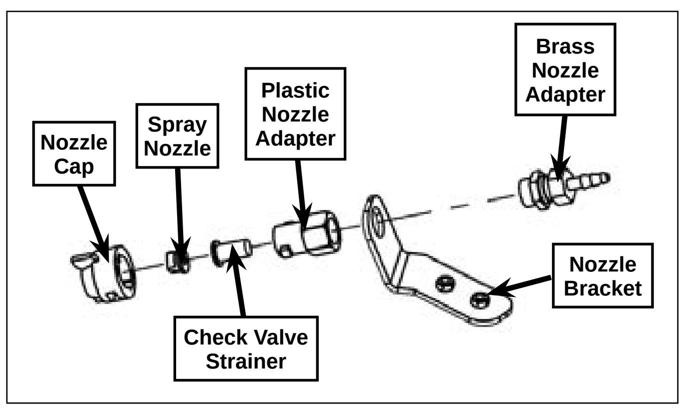
Clean the DustGuard Spray Nozzles



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.

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

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 replace the solenoid valve. • If there is no voltage at the solenoid, check the wiring and circuit breakers upstream of the solenoid.
	The DustGuard pump 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, check the wiring and circuit breakers upstream of the pump.
The dust control motor will not run.	Clogged Filter switch	1. Clean the filter. 2. Check the filter switch. The switch should be open with no vacuum in the hopper Replace the dust control filter switch if necessary.
	Failed motor.	Use service test mode to test the motor.
The shaker motor will not run.	Failed motor.	Use service test mode to test the motor.

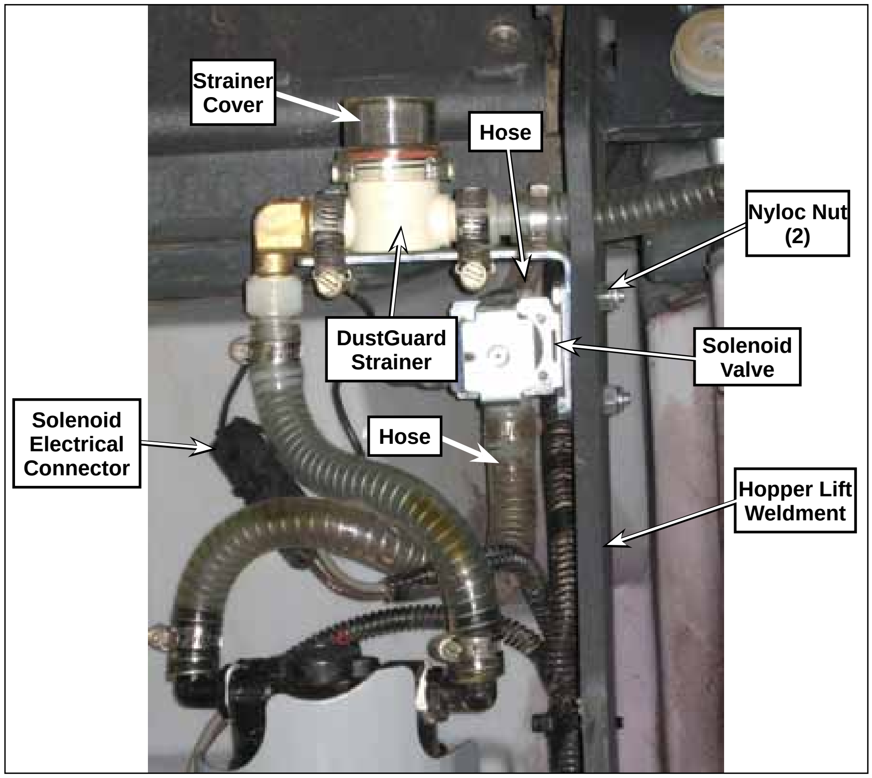
Removal and Installation

CAUTION: 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.

DustGuard Solenoid Valve

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.

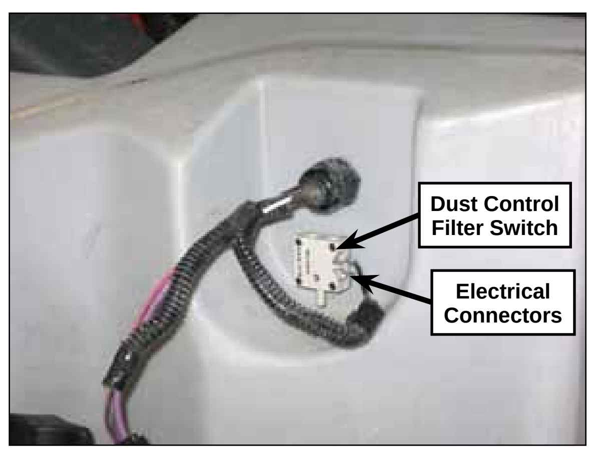
Note: *Place a suitable container underneath the upper hopper to catch the water from the hopper reservoir.*



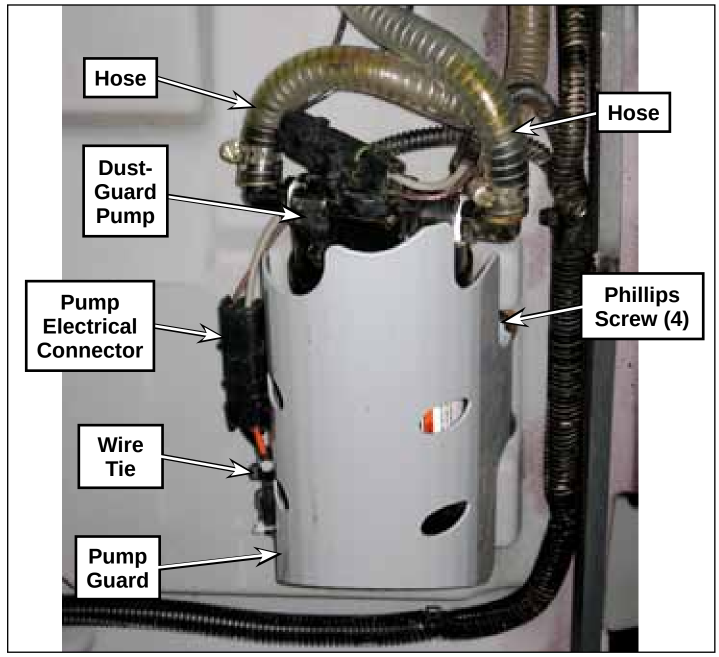
2. Turn the key switch on, raise the hopper and engage the prop rod, then turn off the key switch.
3. Disconnect the Solenoid Electrical Connector.
4. Remove the two Nyloc Nuts holding the Solenoid Valve Assembly to the Hopper Lift Weldment.
5. Disconnect the two Hoses and remove the Solenoid Valve Assembly from the machine.
6. Reinstall the Solenoid Valve Assembly by following the above steps in reverse order.

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.



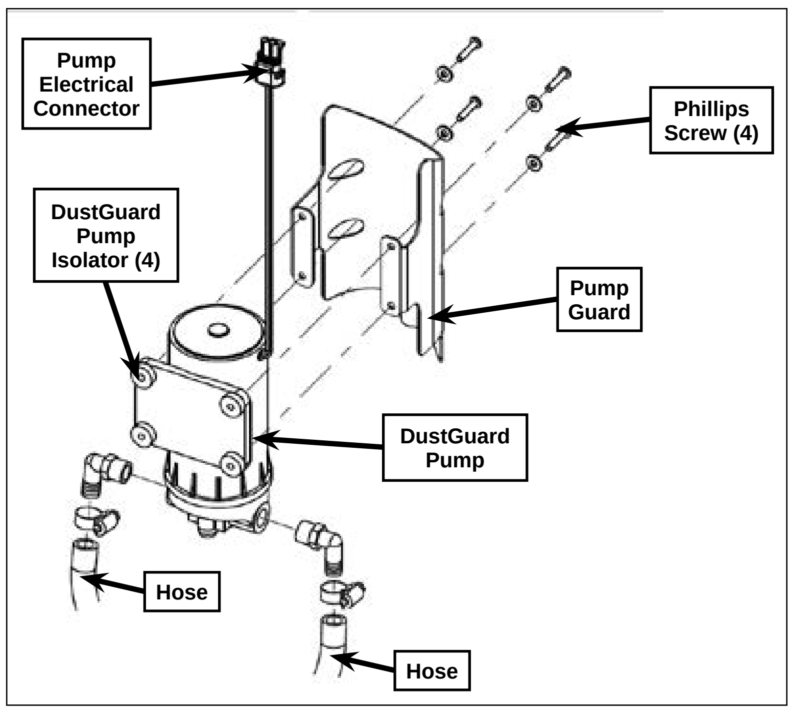
DustGuard Pump



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.*

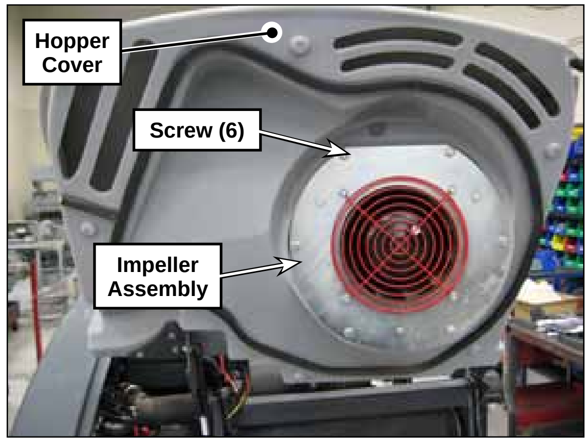
2. Turn the key switch on, raise the hopper and engage the prop rod, then turn off the key switch.
3. Disconnect the Pump Electrical Connector.
4. Disconnect the two Hoses from the DustGuard Pump.



5. Remove the four phillips screws and washers holding the pump guard and pump to the upper hopper and remove the guard and pump.
   - Note that the pump guard is positioned below the 4 isolation pads.
6. Reinstall the DustGuard Pump by following the above steps in reverse order.

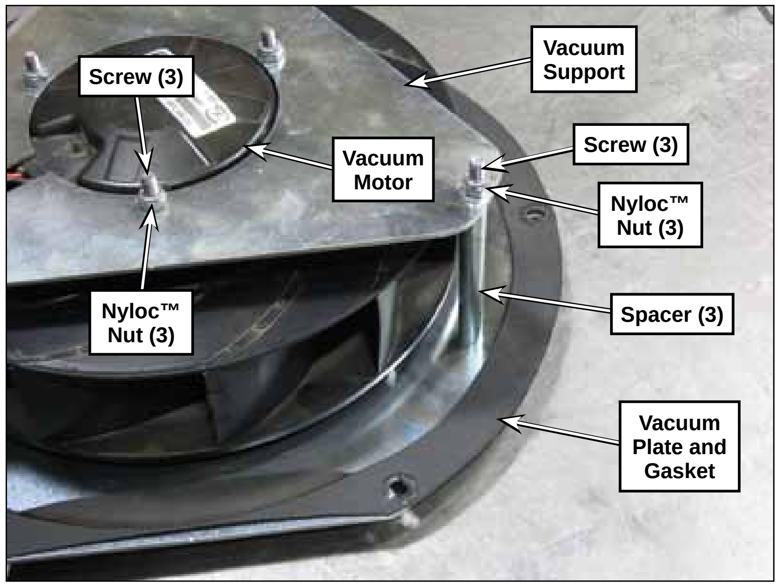
Impeller Assembly

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.

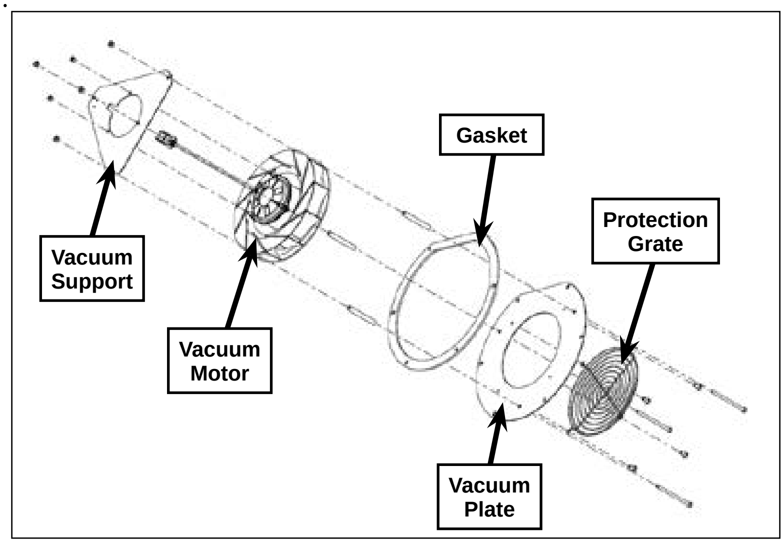


5. Remove the three nyloc nuts, screws and spacers holding the vacuum plate and gasket to the vacuum support and attached vacuum motor.
6. Remove the three nyloc nuts holding the vacuum motor to the vacuum support and remove the vacuum motor.

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.*



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



Specifications

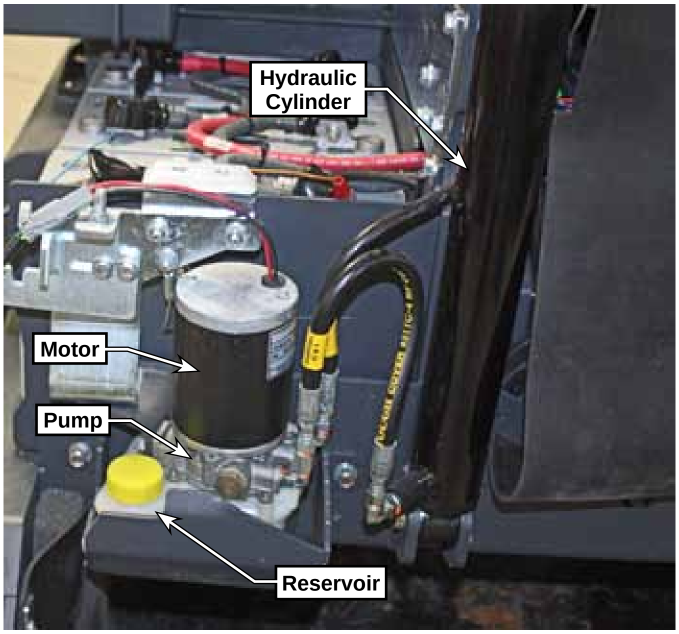
Component	Specifications
DustGuard Pump	Type - Diaphragm w/bypass
	Nominal Voltage - 36 VDC
	Flow Rate - 1.1 GPM
	Current - 1.0 Amp max.
	Pressure - 30 psi max.
DustGuard Solenoid Valve	Nominal Voltage - 36 VDC, 11 Watts
	Coil Resistance - 125 Ohms ± 10%
Dust Control Filter	Media Type - synthetic with 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.)

52 - Hopper System

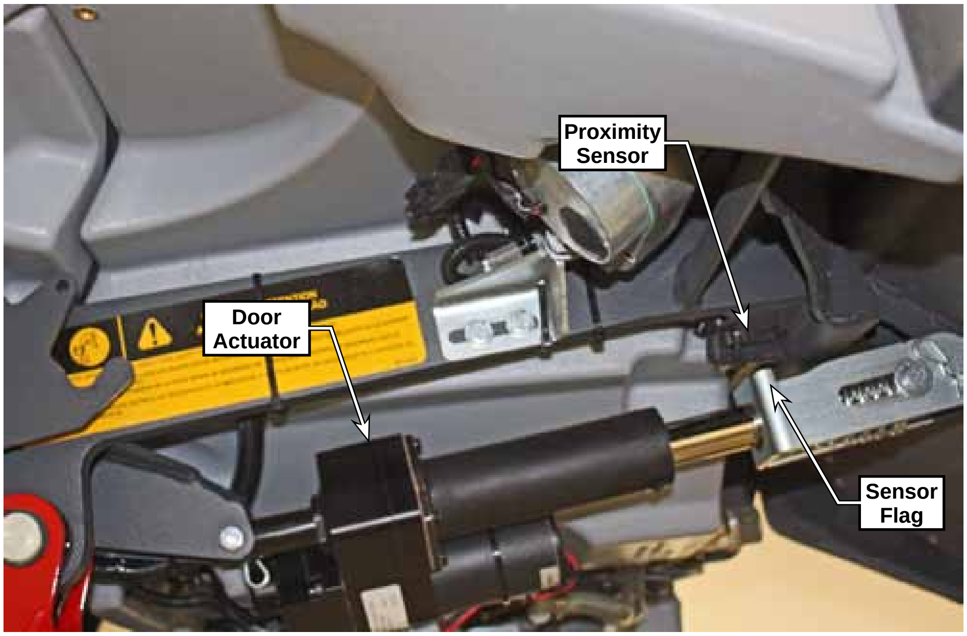
Functional Description

Overview

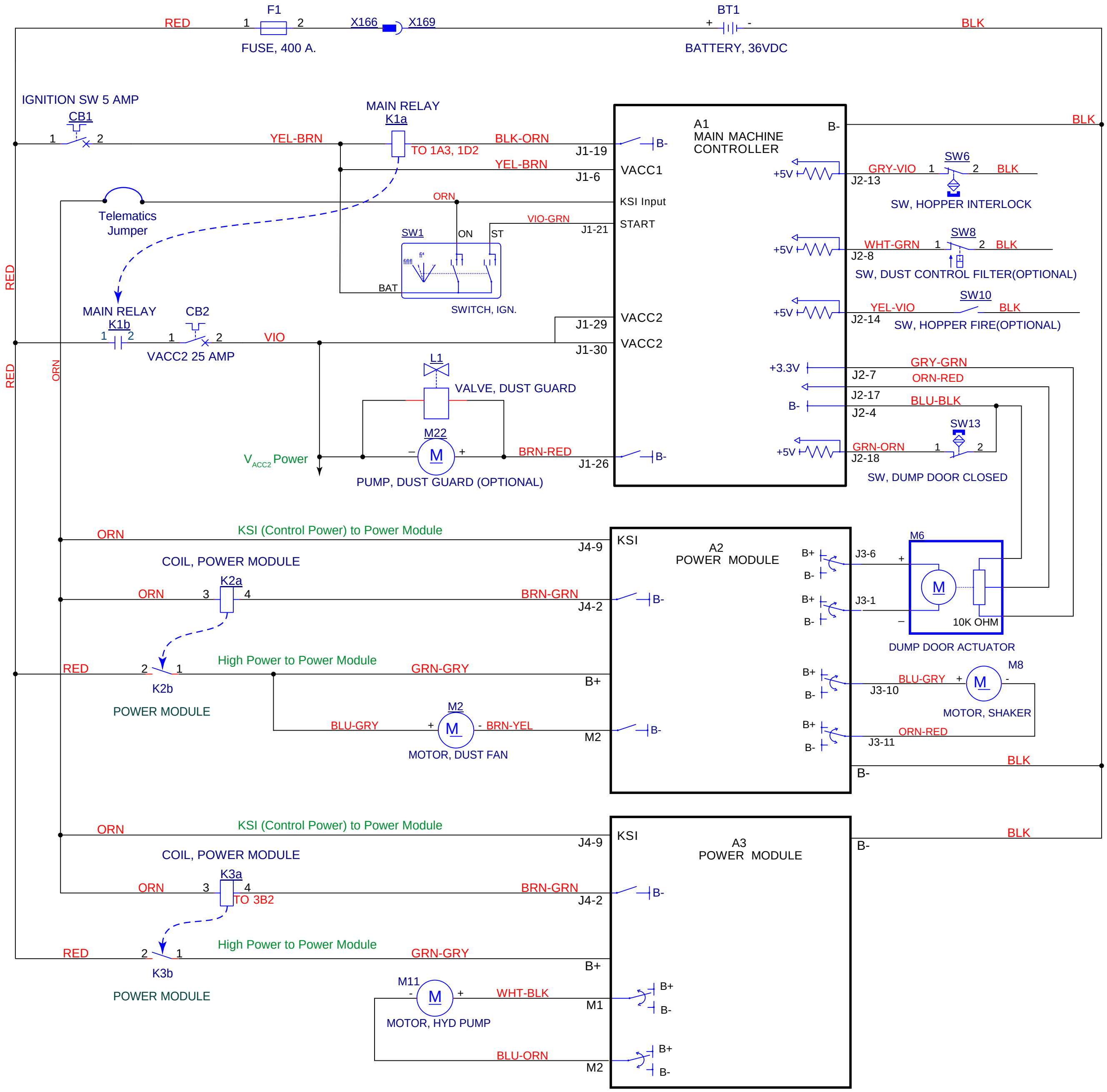
The hopper system holds the dirt, dust and debris swept up by the brooms. The hydraulic lift cylinder raises the hopper to allow the accumulated dirt and debris to be dumped into a suitable receptacle, then lowers the hopper back down into the normal operating position. The hopper lift cylinder is powered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



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. A proximity sensor detects when the hopper dump door is closed. The actuator contains a position potentiometer to let the Main Controller know the distance the actuator has traveled for the door open position. The controller then turns off the actuator motor. 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. The controller will not permit the dump door to be manually opened when the hopper is in the down position.



Hopper and Dust Control Wiring Diagram



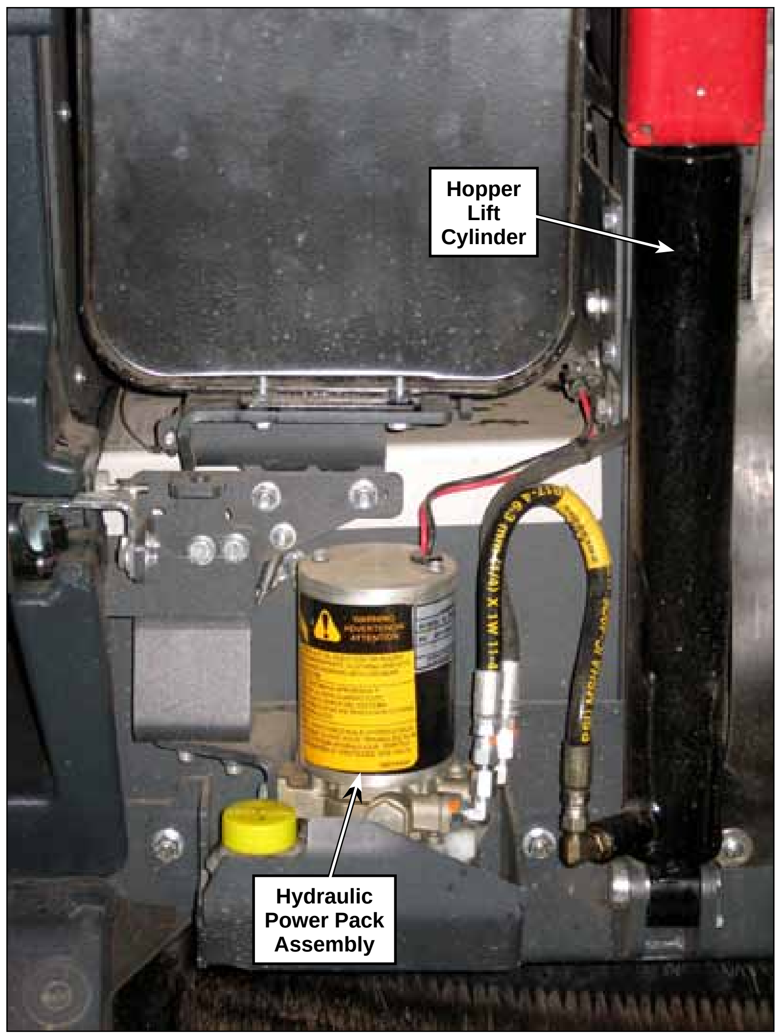
Component Locations

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.

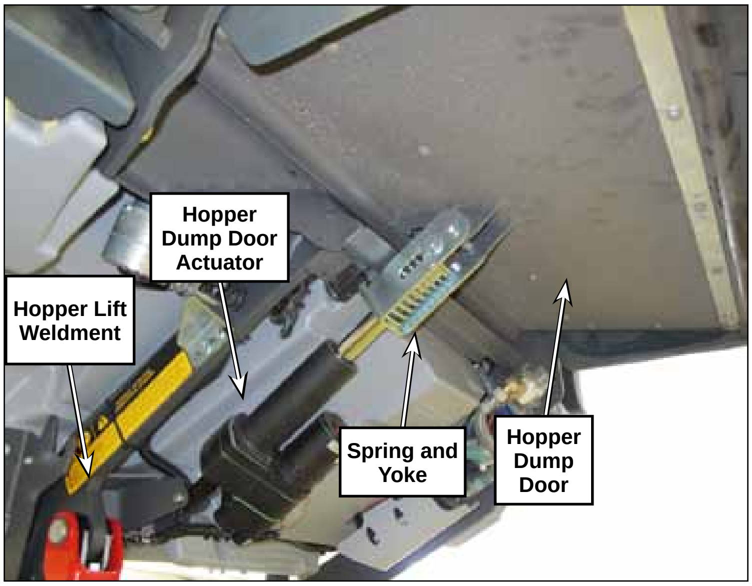
Hydraulic Power Pack Assembly

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

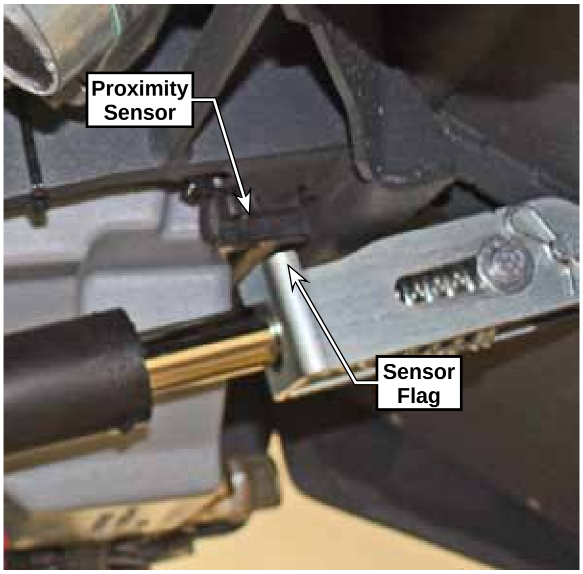
The electric Hopper Dump Door Actuator is pinned to the Hopper Lift Weldment and Hopper Dump Door and opens and closes the Hopper Dump Door.

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 Limit Switch

The Dump Door Limit Switch is a proximity sensor that sense when the hopper dump door is closed. As the dump door closes, the bracket between the actuator and the door moves closer to the sensor to trigger the sensor. To increase the sensitivity of this position, the bracket is notched so that only the flag portion of the bracket gets close enough to trigger the sensor.



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.

CAUTION:* *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.

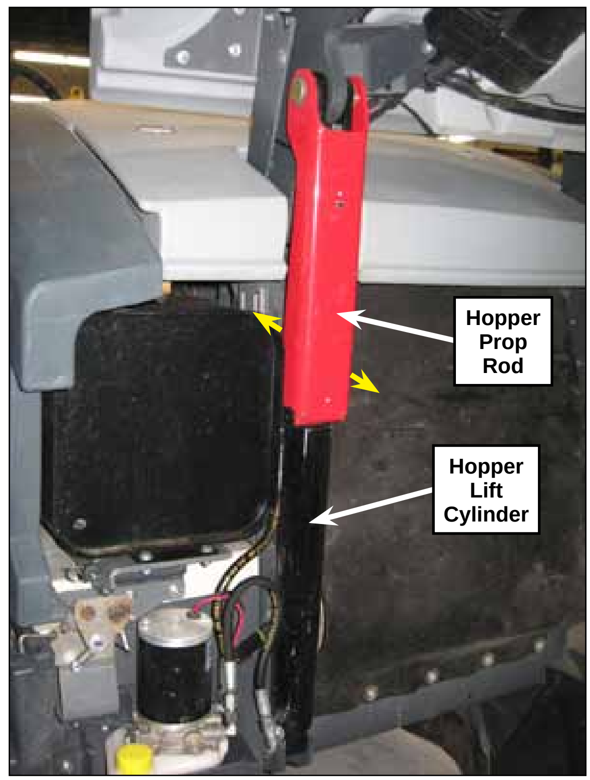
3. Lower the hopper until the Hopper Prop Rod contacts the top of the Hopper Lift Cylinder.

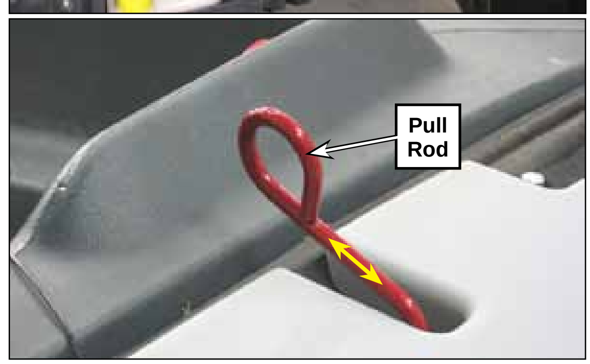
To disengage the Hopper Prop Rod:

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.





Maintenance and Adjustment

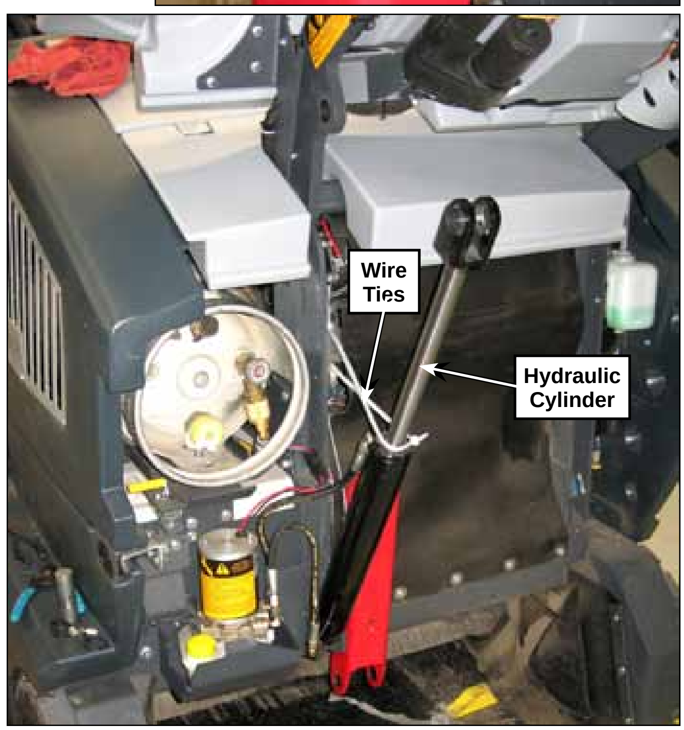
Hydraulic Oil Change/Flush

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.

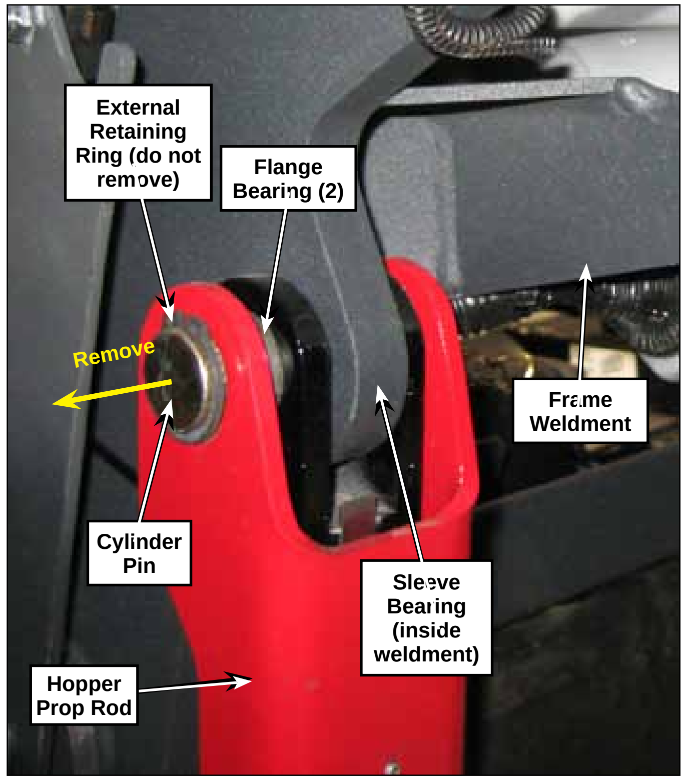
CAUTION: The hopper must be adequately and securely supported with a hoist or other suitable support before the hopper lift cylinder is disconnected. The hopper prop rod cannot be used to support the hopper when the hopper lift cylinder is disconnected or removed.

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

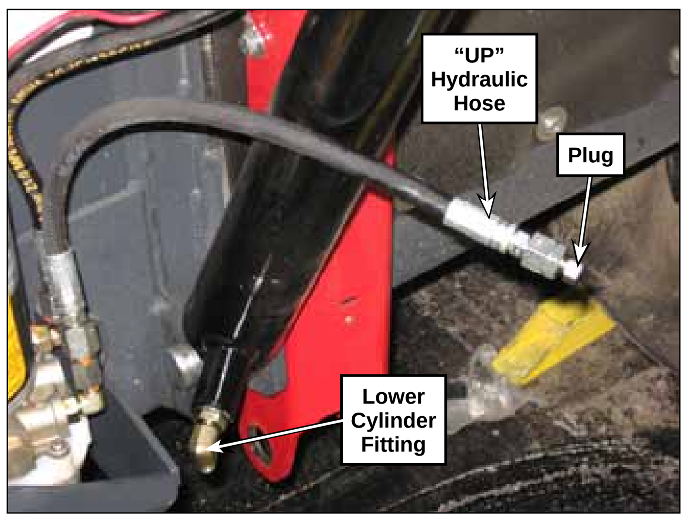
2. Use Wire Ties or other suitable strapping to support the Hydraulic Cylinder while you work on the system.



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

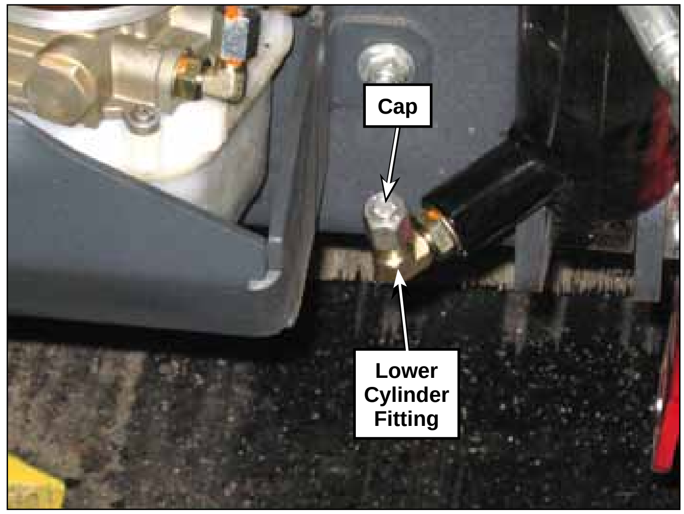


1. Place a drip pan underneath the hydraulic power pack assembly and hydraulic cylinder.
2. Disconnect the “UP” Hydraulic Hose from the Lower Cylinder Fitting.
3. Install a Plug into the end of the “UP” Hydraulic Hose. This will prevent dirt and air from being drawn into the “UP” Hydraulic Hose when you run the cylinder rod downward.
4. Rotate the Lower Cylinder Fitting downward to direct the oil into the drip pan.
5. 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.

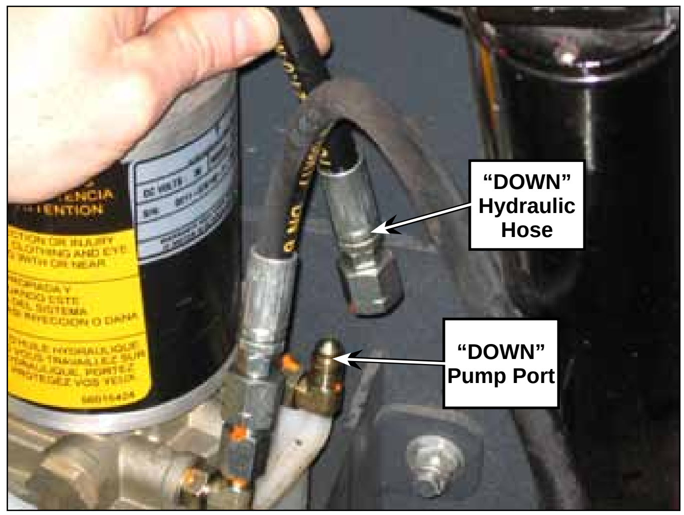


6. Rotate the Lower Cylinder Fitting upward back to its original upward position and make sure the Lower Cylinder Fitting nut is tight.

7. Install a Cap into the Lower Cylinder Fitting.



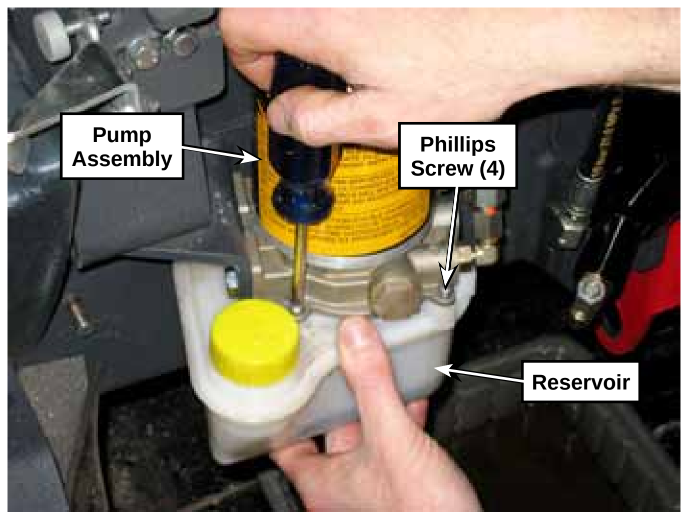
8. Disconnect the “DOWN” Hydraulic Hose from the “DOWN” Pump Port.



9. Install a Cap on the “DOWN” Pump Port.

10. Remove the Reservoir Guard.

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



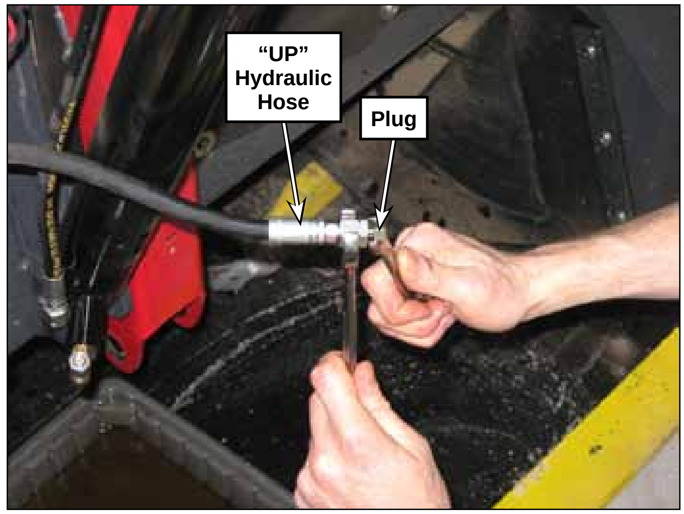
Note: *Leaving the Phillips Screws in the Pump Assembly will make it easier to reinstall the Reservoir.*

12. Empty the oil out of the Reservoir. Wipe any dirt or debris out of the Reservoir as necessary using a clean, lint-free rag.
13. Check the O-ring between the Reservoir and Pump Assembly to make sure it is not damaged. Replace the O-ring if necessary.
14. Make sure the O-ring between the reservoir and pump assembly is installed correctly, then reinstall the reservoir onto the pump assembly.

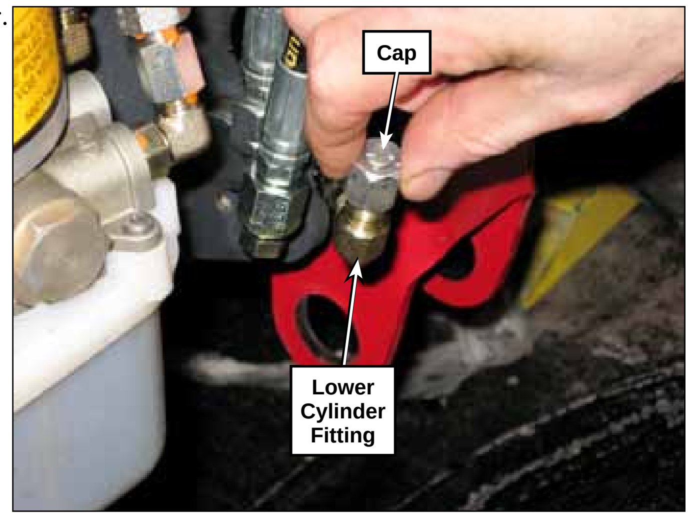
Note: *The reservoir has threaded brass inserts that can be damaged if the Phillips screws are overtightened.*

15. Carefully tighten the four Phillips screws. Do not overtighten.
16. Refill the reservoir with 10w-30 oil to the MAX fill line. Do not overfill.

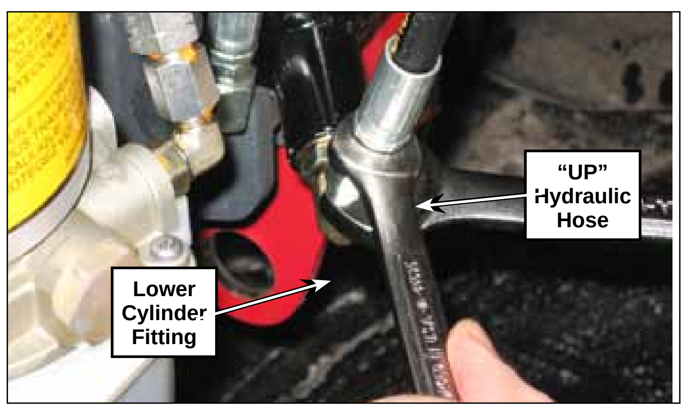
17. Loosen the Plug on the "UP" Hydraulic Hose, then position the end of the "UP" Hydraulic Hose over the drip pan.
18. Jog the hopper raise button to run the pump and force the oil out of the "UP" Hydraulic Hose until the oil runs clear with no foaming or air evident in the oil.



19. Remove the Cap from the Lower Cylinder Fitting.



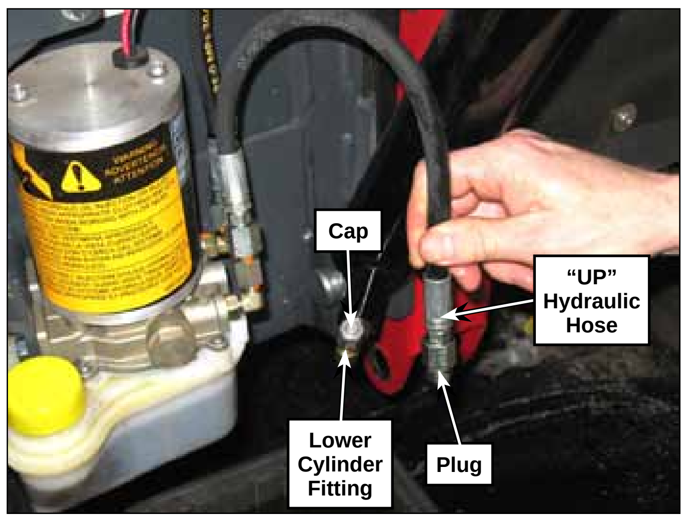
20. Remove the Plug from the "UP" Hydraulic Hose and reconnect the "UP" Hydraulic Hose to the Lower Cylinder Fitting.
21. Press the hopper raise button to raise the cylinder ram to the end of its stroke to purge the oil from the top of the hydraulic cylinder. Check the oil level in the reservoir frequently 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.



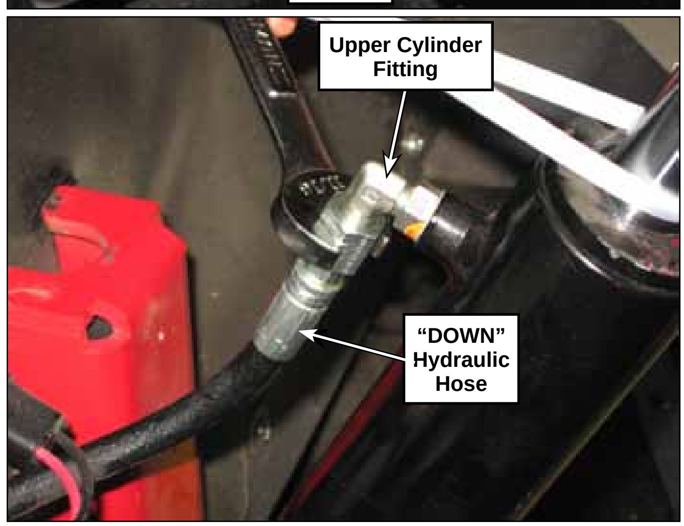
Note: *Be careful not to let the oil level in the reservoir fall below the MIN line to avoid introducing air into the clevis end of the cylinder. If this happens, you will have to restart the procedure from step 8.*

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

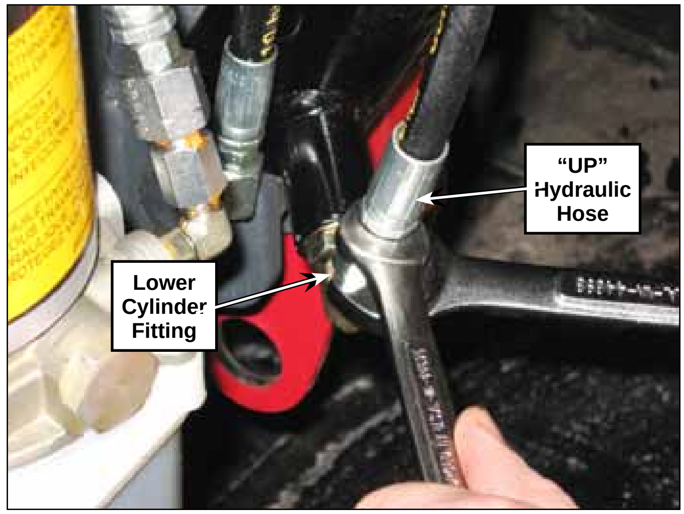
23. Disconnect the “UP” Hydraulic Hose from the Lower Cylinder Fitting.
24. Install a Cap onto the Lower Cylinder Fitting.
25. Install a Plug into the “UP” Hydraulic Hose.



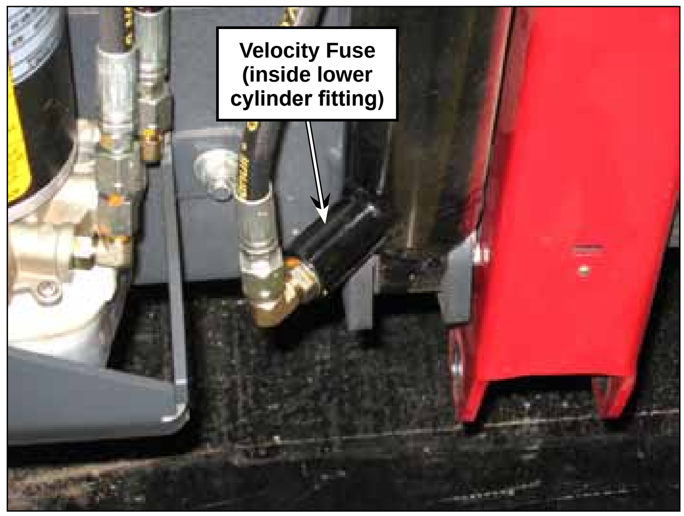
26. Slightly loosen the “DOWN” Hydraulic Hose at the Upper Cylinder Fitting.
27. Jog the hopper lower button to run the pump and force the oil out of the “DOWN” Hydraulic Hose at the Upper Cylinder Fitting until the oil runs clear with no foaming or air evident in the oil.
28. Tighten the “DOWN” Hydraulic Hose on the Upper Cylinder Fitting.



29. Remove the cap from the Lower Cylinder Fitting.
30. Remove the plug from the "UP" Hydraulic Hose and reconnect the "UP" Hydraulic Hose to the Lower Cylinder Fitting.



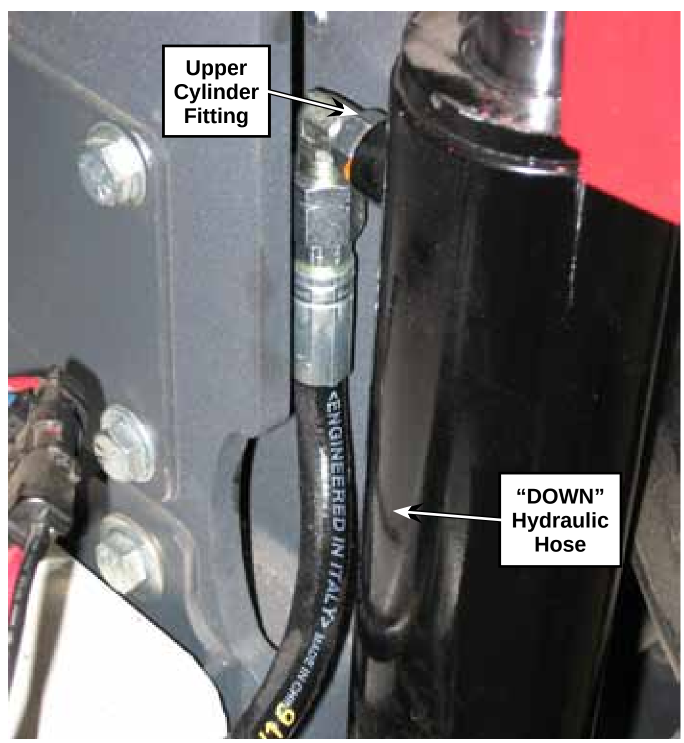
31. Run the hydraulic cylinder ram up and down several times using the hopper raise and hopper lower buttons to check for correct function.



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.*

32. 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.
33. 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.

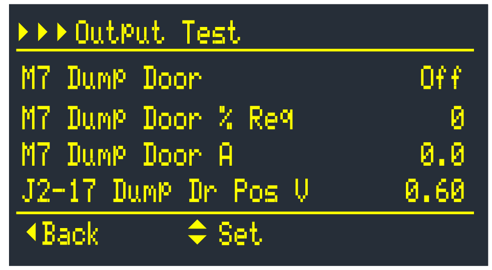


34. Raise the hopper and check the position of the “UP” Hydraulic Hose. The “UP” Hydraulic Hose should be positioned as shown so it doesn’t contact the hopper when the hopper is down.
35. Loosen and reposition the “UP” Hydraulic Hose as necessary to avoid any abrasion or damage.
36. Reinstall the reservoir guard.
37. Check the oil level in the reservoir. It should be at the MIN line when the cylinder is fully extended (hopper is raised).

Dump Door Actuator Adjustment

There are two stages for adjusting the dump door actuator. The first is to ensure that the internal potentiometer is synchronized to the actuator lead screw. The second is to adjust door open position.

Synchronize the Potentiometer



1. Raise the hopper and engage the prop rod for safety.
2. Enter Service Test Mode on the machine, and navigate to the Output Test menu, followed by the M7 Dump Door test menu (as shown to the right).
3. Using the Up/Down navigation buttons, open the dump door.
   - The Up button retracts the actuator (open door), and continues for only as long as you hold the button.
4. Continue holding the Up button until one of the following conditions takes place (whichever comes first):
   - Either the actuator reaches its full retracted position, and the internal clutch on the actuator begins to “ratchet”. (The actuator will make a distinctive ratcheting sound.)
   - Or the J2-17 potentiometer voltage shown on the display approaches 0.60 volts. Note that the actuator may coast slightly when you release the button. So it may overshoot the value unless you release the button before it reaches 0.60 volts.

The goal of the procedure is to have the actuator fully retracted (mechanical limit) while the potentiometer voltage reads between 0.45 to 0.75 volts (0.60 volts is the target). If this is correct, then stage 1 is complete and you can jump to the door open adjustment. If not, then you will have to disconnect the actuator from the door and make adjustments.

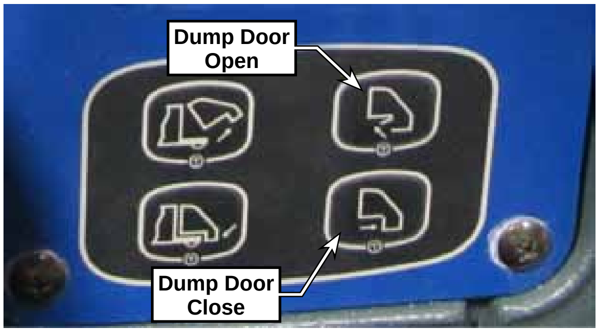
5. Disconnect the yoke from the dump door by removing the clevis pin.

> ***Note:*** *In the following steps, if you are not able to rotate the yoke because the spring is compressed and tight, it may be necessary to first extend the actuator, make the adjustment, and then retract the actuator to check the result.*

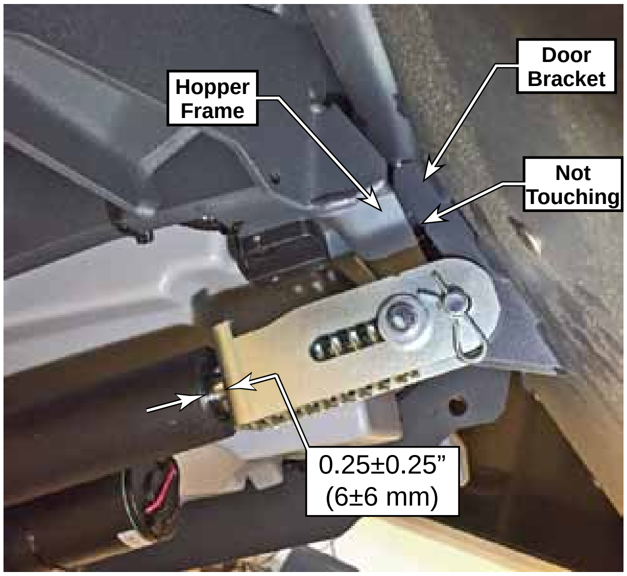
6. If the potentiometer voltage is at the correct range but the actuator is not bottomed out, then manually rotate the yoke in full-turn increments until it bottoms out.
   - Make sure the sensor flag is facing toward the sensor.
7. If the actuator is bottomed out but the potentiometer voltage is too high, then unscrew the actuator/yoke to achieve 0.60 volts. Each full turn of the yoke should result in approximately 0.10 volts on the potentiometer.
8. Reconnect the yoke to the dump door, and verify the adjustment by retracting the actuator in the Output Test menu, as done previously.
9. Continue on to the Open Door Position adjustment described below.

Dump Door Open Position

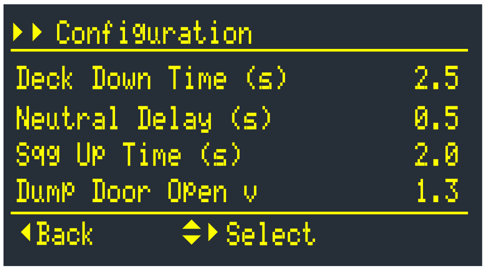
1. If the hopper is not still raised from the first part of this procedure, raise it and engage the prop rod.
2. To ensure the dump door is first closed, press the dump door close button on the control panel.
3. Open the dump door by pressing the Dump Door Open button on the control panel.



4. Examine the position of the actuator and yoke. The end of the yoke should be 0.25±0.25 inch (6 ± 6 mm) away from the actuator body, and the dump door bracket is not touching the hopper frame.



5. To make adjustments, go to the configuration menu and select Dump Door Open voltage.
   - If the yoke distance is too large, increase the voltage.
   - If the yoke distance is too small, decrease the voltage.



Note:

– *The default voltage setting in the configuration is 1.3 volts*

– *When the door is opened, the actuator will "coast" a little after it is turned off. So the final voltage shown in the Output menu when the door stops will be slightly less than the programmed voltage in the Configuration menu. This is normal.*

– *Each revolution of the lead screw is approximately 0.1 volts on the potentiometer.*

6. Cycle the door using the open and close buttons described above to verify the changes.

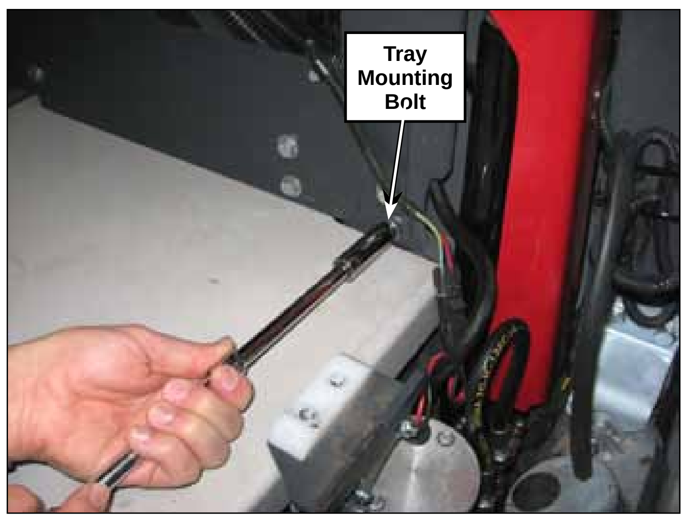
Removal and Installation

CAUTION: 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.

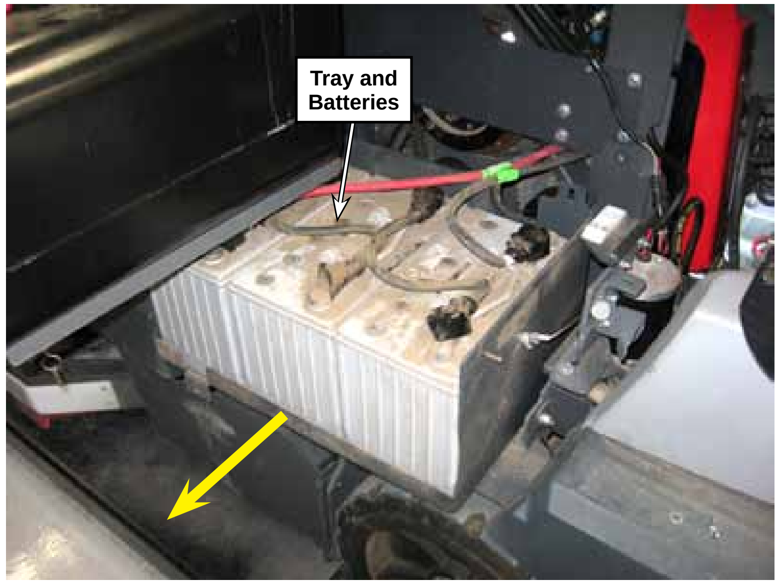
Hydraulic Power Pack Assembly

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.

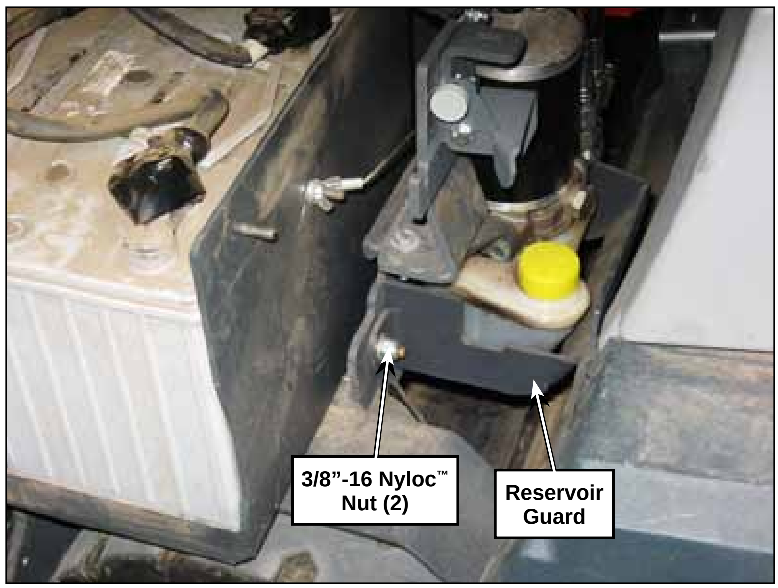


5. Slide the tray with the batteries out to the limit of the tether cable.



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

CAUTION:* *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.

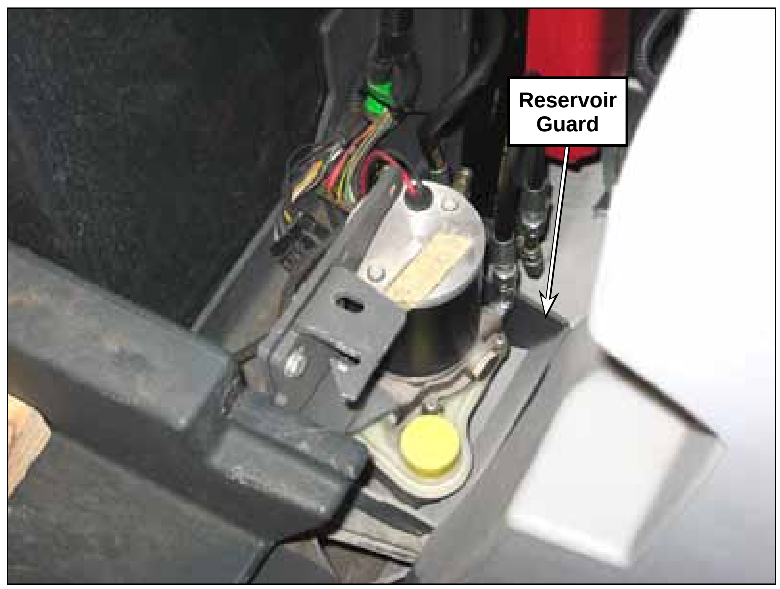
17. Remove all remaining plugs from the pump and the hoses and attach the hoses to the pump assembly.

18. Lower cylinder port hose to “up port” on pump

19. Upper cylinder port hose to “down port” on pump

20. 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.

CAUTION: 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.

14. Lower cylinder hose to "up port" on pump

15. Upper cylinder hose to "down port" on pump

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

Hopper Lift Cylinder

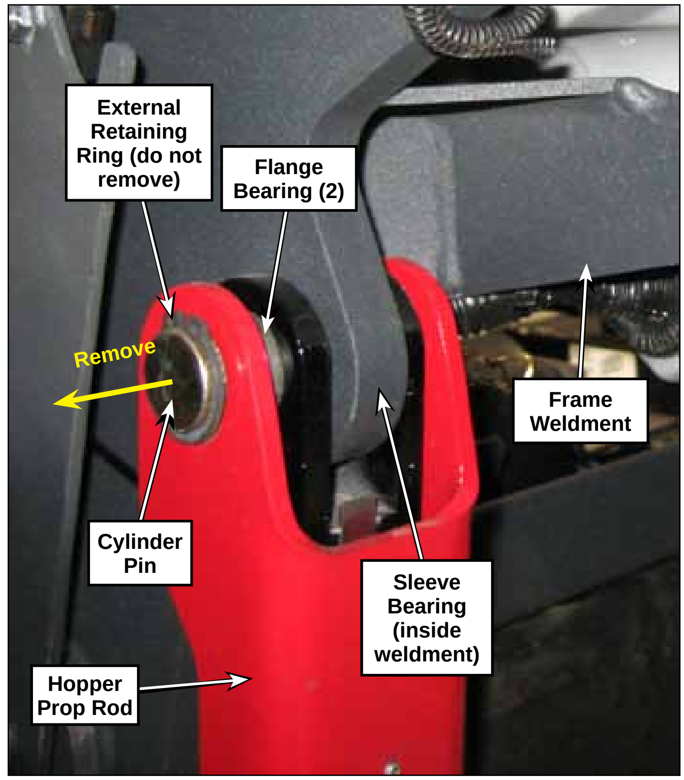
1. Raise the hopper to a convenient working height.
2. Support the hopper with a hoist to prevent it from falling once the hopper lift cylinder is disconnected.

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.

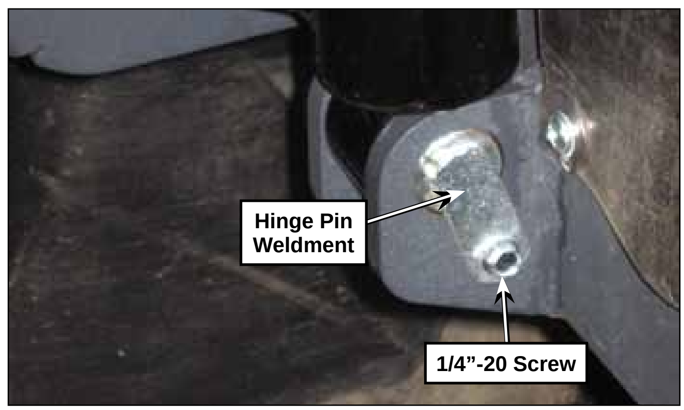
3. Place a suitable container under the hopper lift cylinder to catch any hydraulic oil that may leak from the cylinder and hoses.
4. Loosen and disconnect the hoses from the cylinder. Plug the hoses to prevent dirt and air from entering the hoses.
5. Plug the hopper lift cylinder ports to prevent oil 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.

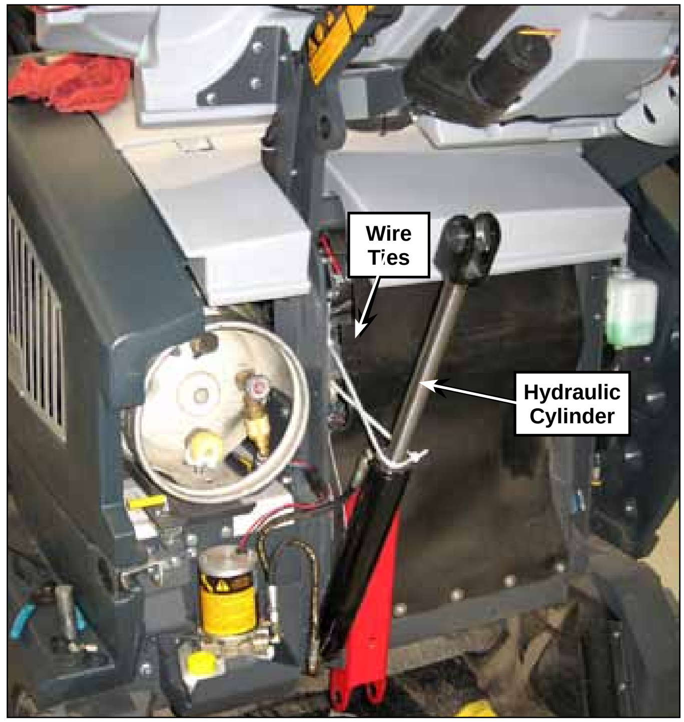
8. Support the hopper lift cylinder and hopper prop rod. Then remove the Cylinder Pin



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.

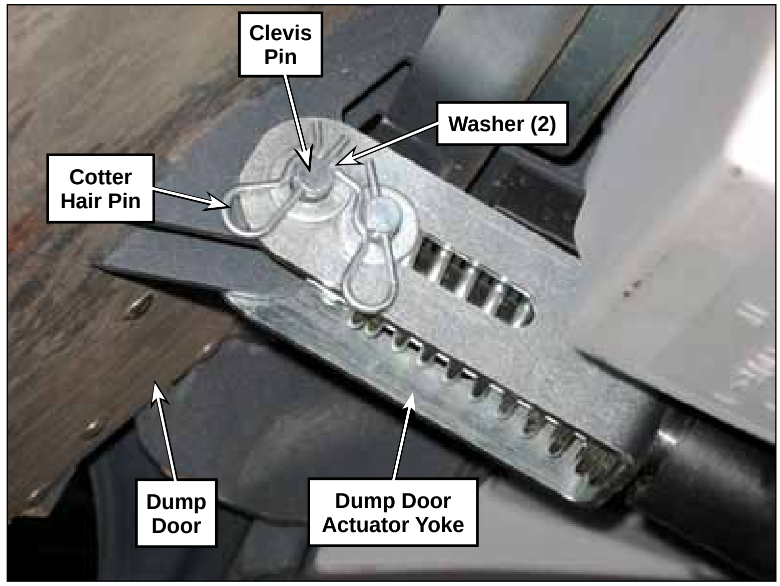
Hopper Interlock Switch

The hopper interlock switch detects when the hopper frame is in the fully down position. Symptoms of failure or misadjustment are that certain machine functions will be disabled as though the hopper was raised. For example, the scrub system is disabled and machine travel speed is reduced.

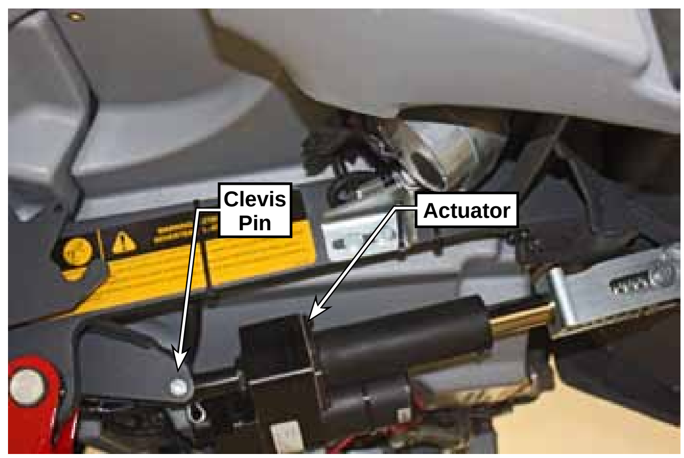
CAUTION: To avoid the risk of crushing injury, never work under an elevated hopper without the prop rod engaged.

1. Raise the hopper and engage the prop rod.
2. Turn off the machine and remove the key.
3. Disconnect the switch’s electrical connector.
4. Remove the two nuts, washers, and carriage bolts that secure the mounting bracket to the machine’s main chassis.
5. Remove the socket head cap screw and nut that secure the sensor to the bracket, and remove the sensor.
6. Replace the new sensor onto the bracket, and make sure the wires are passing through the cutout in the bracket.
    - Take care to not overtighten the screw, as the sensor tab could fracture.
7. Reinstall the sensor and bracket onto the machine chassis.
    - Pull the sensor bracket all the way forward in the slotted mounting holes.
    - Snug the nuts just enough that the bracket stays in place, but not so tight that the bracket won’t slide when the hopper is closed in the step below.
8. Reconnect the electrical connector.
9. Turn the machine on and lower the hopper to the closed position, and then raise it again enough that you can access the two mounting nuts.
10. Taking care to not move the bracket, tighten the two mounting nuts for the bracket.

Hopper Dump Door Actuator



1. Open the hopper and engage the hopper prop rod.
2. If possible, open the hopper dump door to relieve the tension on the hopper dump door actuator.
3. Remove the cotter pin, washers and clevis pin holding the dump door actuator yoke to the dump door.
   - 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.
   - You don't need to remove the second clevis pin that holds the actuator to the actuator yoke.

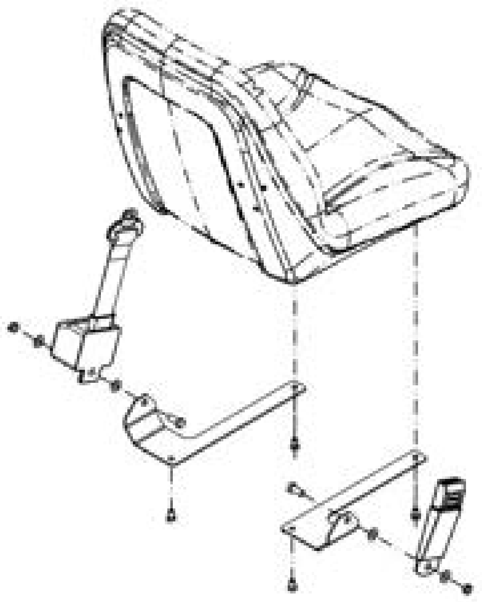
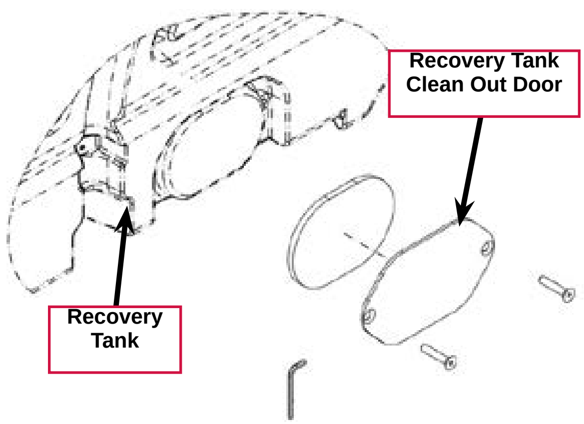
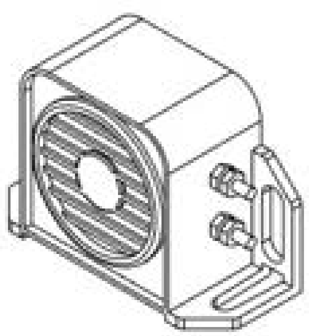


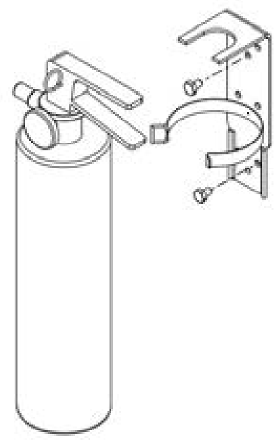
4. Disconnect the actuator electrical connector.
5. Remove the cotter pin, washers and clevis pin holding the dump door actuator to the machine frame, and remove the actuator from the machine.
6. Perform the Dump Door Actuator Adjustment described on page 303.

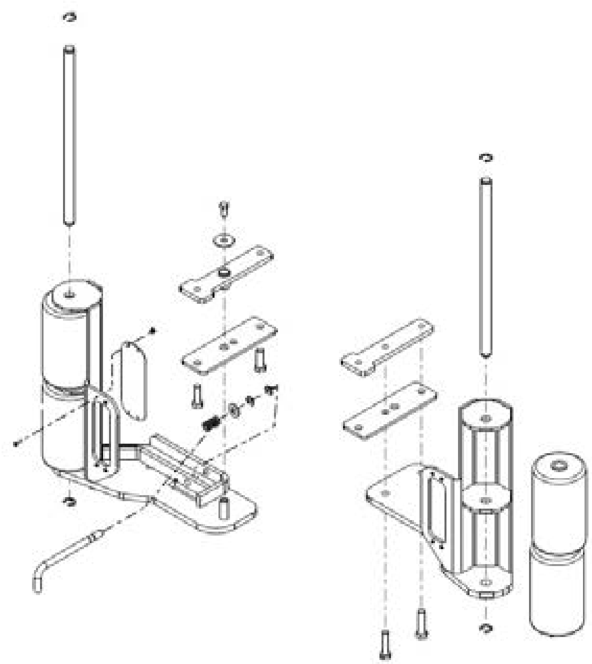
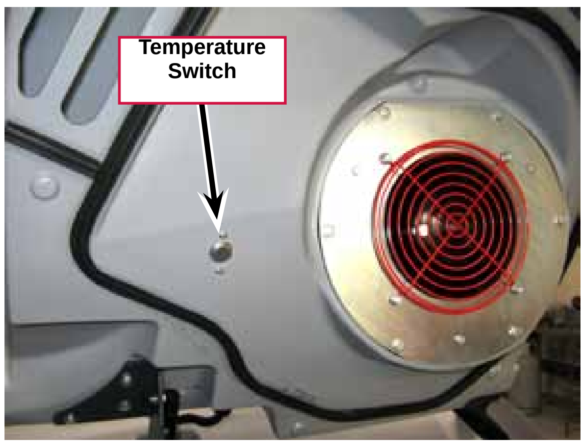
Specifications

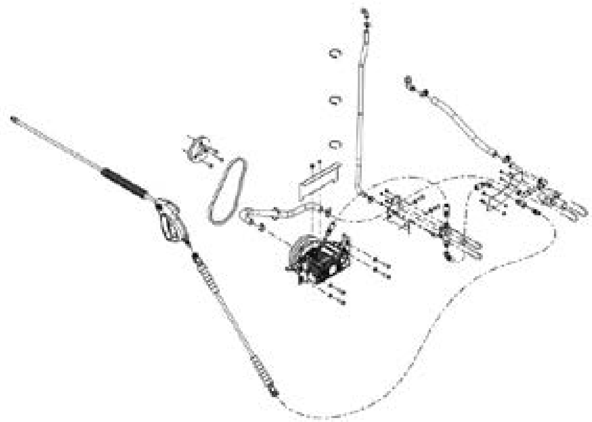
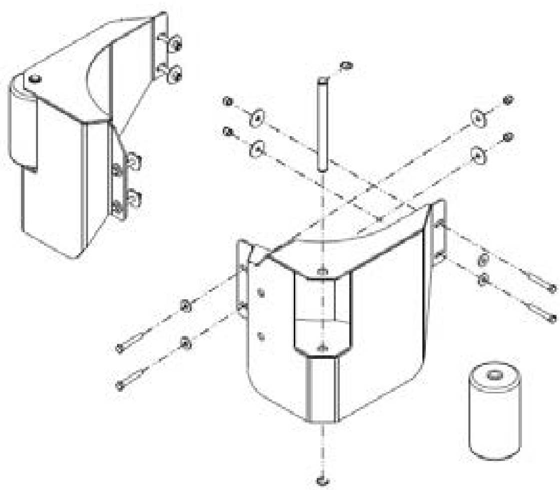
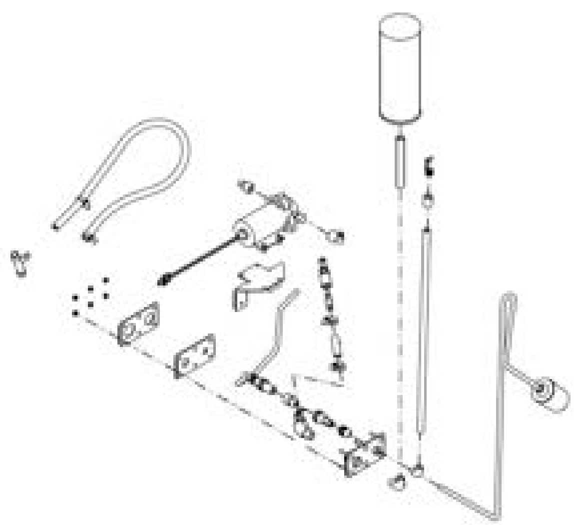
Component	Specifications	
Hydraulic Pump/Reservoir Assembly	Displacement - 0.0321 in.^{3} per revolution	
	Circuit Type - reversible, locking	
	Reservoir Capacity - 45 in.^{3} (26 in.^{3} usable)	
	Oil Type - 10W-30 automotive oil	
Hydraulic Pump Motor	Voltage - 36 VDC	
	Output Torque - 151 ft-lbs.	
	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)

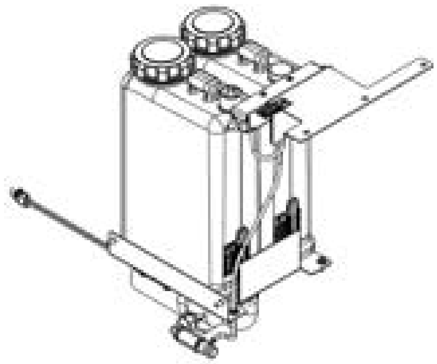
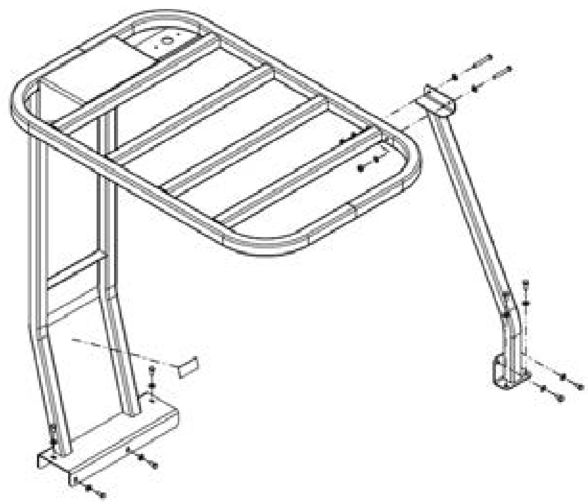
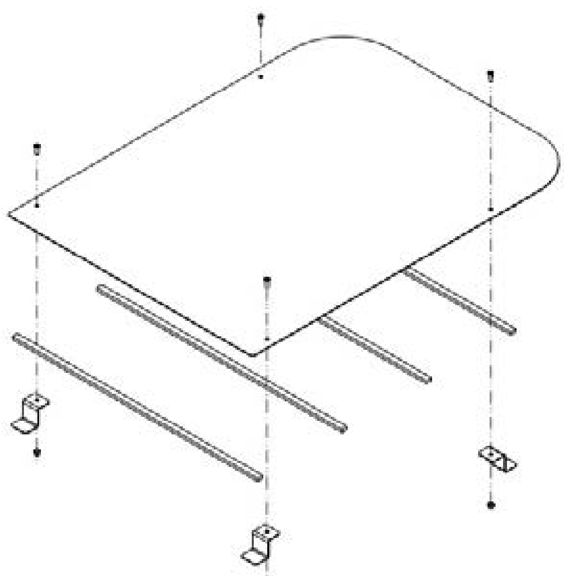
90 - Options and Accessories

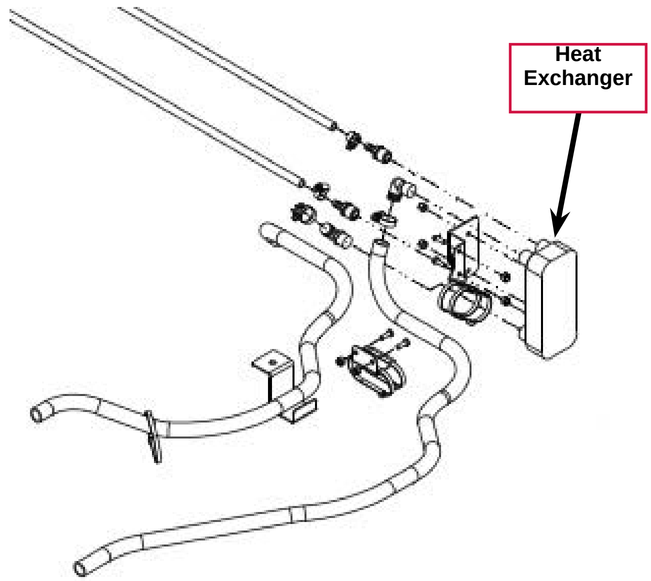
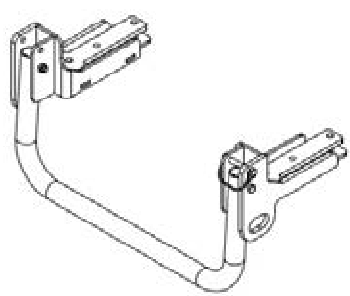
Description	Illustration
Seat Belt Kit	
Recovery Tank Clean Out Kit The Recovery Tank Clean Out Kit includes a removable Recovery Tank Clean Out Door to allow easier cleaning and flushing of the Recovery Tank.	
Back-Up Alarm Kit The Back-Up Alarm Kit includes the Back-Up Alarm, electrical connector and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

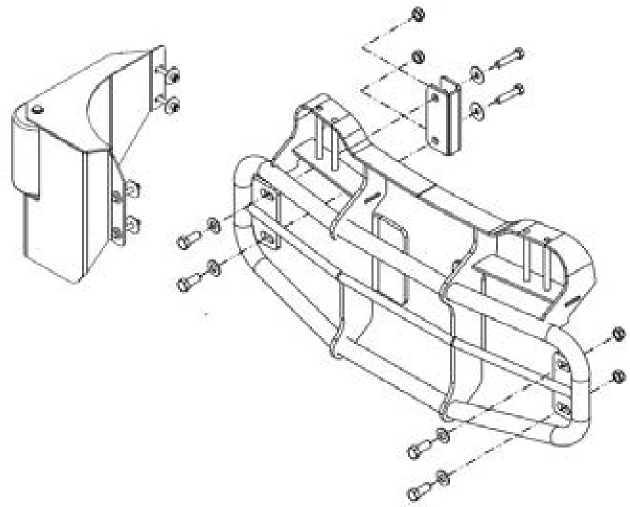
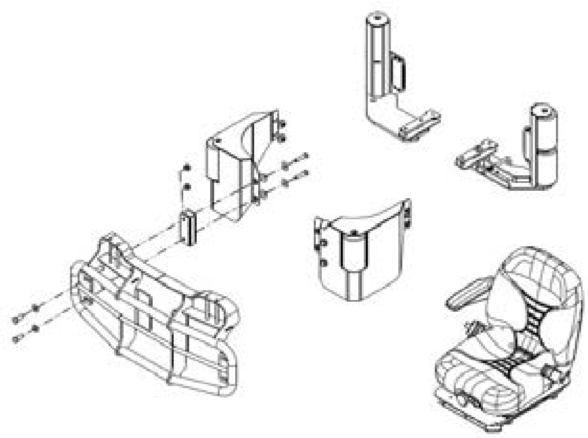
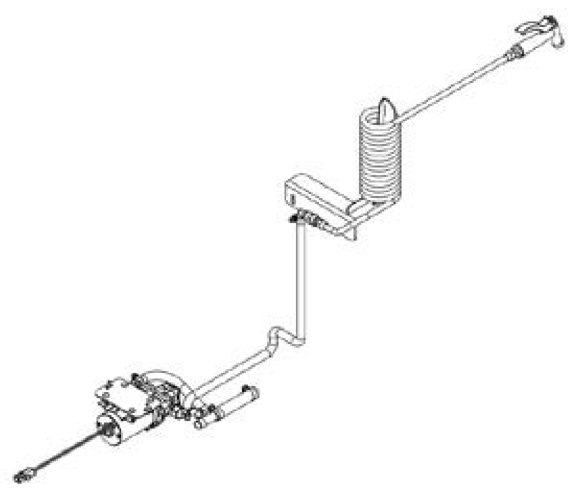
Description	Illustration
Fire Extinguisher Kit	
LED Brake Light/Turn Signal Kit The LED Brake Light/Turn Signal Kit includes front turn signal lights, rear brake/turn signal lights, a rear corner roller kit, mounting hardware and electrical connectors. The main machine controller powers the turn signal 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.	 

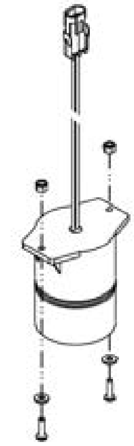
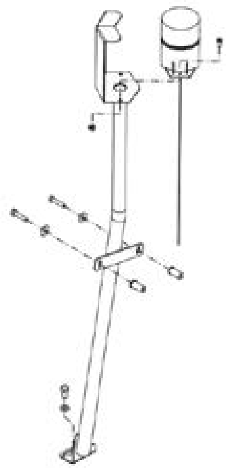
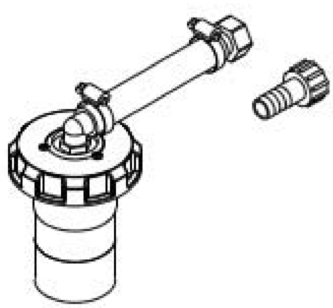
Description	Illustration
Rear Corner Roller Kit	
Hopper Temperature Sensor Kit The Hopper Temperature Sensor Kit includes a Temperature Switch and mounting hardware. If the temperature in the hopper rises to a certain point, the Temperature Switch will generate a caution and signal the main machine controller 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.	

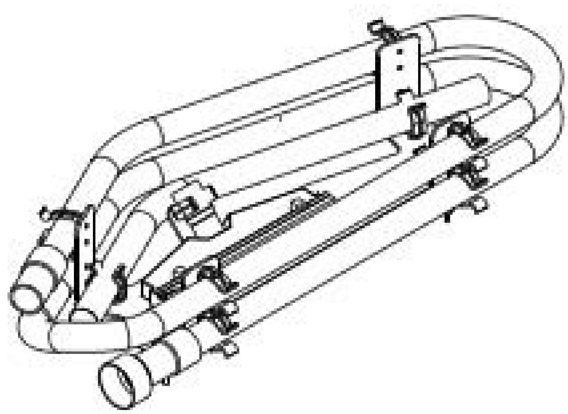
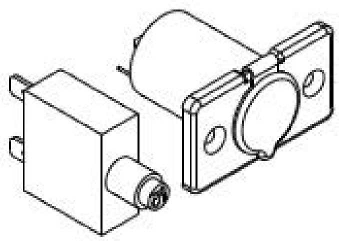
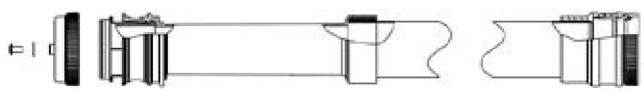
Description	Illustration
High Pressure Pump Kit - Engine Powered Hybrids The High Pressure Pump Kit includes a separate high-pressure solution pump, engine-driven pump clutch and drive belt, high-pressure wand assembly, and the associated valves and plumbing. The high-pressure solution pump pumps solution 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 - 82" Standard Clearance **Overhead Guard Kit - 79" Low Clearance**	
Overhead Guard Canopy Kit	

Description	Illustration
Deluxe Seat Kit **with seat belt and arm rest**	
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	

Description	Illustration
Front Bumper Kit The Front Bumper Kit includes the front bumper weldment, a front corner roller kit and mounting hardware.	
Super Duty Kit The Super Duty Kit includes a front bumper kit, deluxe seat kit and a rear corner roller kit.	
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.	

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	
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 **(Standard Seat, R/H Only)**