SC5000

Service Manual

Advance Models:

56117001	34D
56117003	32C
56117004	36C

Nilfisk Models:

566117805	860D
56117807	810C
56117808	910C

Nilfisk trusted since 1906

Advance

Language

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Contents

03 - General Information 7
General Machine Description 7
Service Manual Purpose and Application 7
Other Reference Manuals and Information Sources 7
Revision Table 7
Parts And Service 8
Diagnostic and Service Tools 8
Conventions 8
Modifications 8
Nameplate 8
Safety 9
Symbols 9
General Safety Instructions 9
Transporting the Machine 11
Moving a Disabled Machine 11
Lifting the Machine 12
Technical Specifications 13
Fastener Torque Specifications 14
Maintenance Schedule 14
Maintenance Procedure References 15
Lubricate the Machine 15
Know Your Machine 16
Main Assemblies 16
Machine Components 17
Front RH View 17
Rear LH View 18
04 - Control System 19
Functional Description 19
Functional Diagram 20
Drive Controller 21
Power Module 22
Main Machine Controller 23
Main Controller Operational Modes 24
Operational Mode Prerequisites 24
Control Panel 26
CAN Bus Communication 27
Component Locations 28
Main Machine Controller Programming 29
Service Mode Access 29
Menu Navigation 29
Programming Menu Outline 30
Hours Menu 31
Faults Menu 31
Keys Menu 31
Authorizing User Keys 31
Deauthorizing User Keys 31

Service Menu 32
A1 Main Controller *32*
A3 Power Module *33*
A4 Drive Controller *34*
Output Test *35*
Deck Lift *35*
Panel Test *36*
Options Menu 36
Configuration Menu 37
System Menu 38
Impact Log *38*
Troubleshooting 39
Main Controller (A1) Error Codes *41*
Power Module (A2) Error Codes *49*
User Interface (A9) Error Codes *68*
Specifications 70
Sample Shop Voltage Measurements *70*
Maintenance 74
Firmware Update *74*
Removal and Installation 75
Main Machine Controller *75*
14 - Wheel System, Non-Traction 77
Functional Description 77
Removal and Installation 78
Rear Wheel Bearings and Seal *78*
Rear Brake Calipers *80*
20 - Drive System 83
Functional Description 83
Drive Motor *83*
Drive Pedal Potentiometer *83*
Drive Controller *84*
Operational Mode Prerequisites *85*
Troubleshooting 85
Drive Controller (A4) Error Codes *85*
Removal and Installation 92
Drive Controller *92*
Drive Wheel Assembly *93*
Electromechanical Brake *96*
Drive Tire *97*
Specifications 100
Sample Shop Voltage Measurements *100*
22 - Steering System 101
Functional Description 101
Maintenance and Adjustment 102
Steering Chain Tension *102*
Removal and Installation 103
Steering Column Covers *103*
Steering Offset Box *104*

24 - Electrical System 106
Functional Description 106
Low Voltage Cutout 107
Onboard Battery Charger 107
Component Locations 108
Troubleshooting 109
Battery Testing 109
Battery Charger Error Codes 110
Maintenance and Adjustment 120
Battery Settings 120
Onboard Battery Charger 120
Removal and Installation 121
Batteries 121
Wiring Diagrams 122
Understanding the Features of the Electrical Circuit Diagram 122
Device Labeling 123
Navigation 123
Electrical Circuit Diagram 124
Sheet 1, Contents 124
Sheet 2: Power/Charger/Main Controller Power 125
Sheet 3: Controller Power 126
Sheet 4: Main Controller Functions 127
Sheet 5: Power Module 128
Sheet 6: Drive Module 129
Sheet 7: Vehicle Circuits 130
Sheet 8: CAN Bus 131
Condensed Electrical Circuit Diagram 132
Sheet 1: Main Machine Controller 132
Sheet 2: Power Module 133
Sheet 3: Drive Controller 134
Using the Wiring Diagram 135
Wire Numbers 135
Splice Points 135
Connector Numbers 135
Wiring Diagram 136
Sheet 1 136
Sheet 2 137
Appendix A: CAN Wiring 138
Appendix B: KSI Wiring 139
Harness Diagram 140
Sheet 1: Navigation 140
Sheet 2: Lower Elec. Bay, Front Chassis 141
Sheet 3: Drive Controller, Traction Harness 142
Sheet 4: Main Controller, KSI Relay Areas 143
Sheet 5: Power Module, Machine Power 144
Sheet 6: Lower Chassis and Scrub Deck Areas 145
Sheet 7: Rear Chassis, Recovery, OBC, Column Harness 146
3D Harness Connector Diagrams 147
All Harnesses 147
Power Distribution 148
Main Harness, Electrical Bay 149

Column Harness and Main Harness-Front *150*
Traction Harness *151*
Main Harness, Rear *152*
Electrical Connector Pin-Out Assignments 153
30 - Solution System 167
Functional Description 167
Shutoff Valve *167*
Solution Solenoid *167*
Solution Level Sensor *167*
External Wash Options *168*
EcoFlex Option *169*
Plumbing Diagram *170*
Operational Mode Prerequisites *170*
Troubleshooting 171
Detergent Not Flowing *171*
Solution Level Indication is not Correct *172*
Testing individual sensor bodies *172*
Removal and Installation 174
Solution Solenoid *174*
Detergent Pump *175*
Wash Hose Pump (Option) *176*
Specifications 177
34 - Scrub System, Disc 178
Functional Description 178
Deck Lift Actuator *178*
Scrub Control *179*
Operational Mode Prerequisites *179*
Circuit Overview *180*
Maintenance and Adjustment 181
Lift Actuator Limit Adjustment *181*
Removal and Installation 183
Scrub Deck *183*
Deck Lift Actuator *184*
Brush Motor *184*
Brush Motor Brushes *185*
Specifications 187
Special Tools 187
Actuator Test Kit *187*
34 - Scrub System, Cylindrical 188
Functional Description 188
Deck Lift Actuator *188*
Scrub Control *189*
Operational Mode Prerequisites *190*
Circuit Overview *190*
Maintenance and Adjustment 191
Lift Actuator Limit Adjustment *191*
Removal and Installation 193
Scrub Deck *193*
Deck Lift Actuator *195*
Brush Drive Belt *196*

Brush Motor 196
Brush Motor Brushes 198
Specifications 200
Special Tools 200
Actuator Test Kit 200
38 - Squeegee System 201
Functional Description 201
Squeegee Lift Actuator 201
Squeegee 202
Maintenance and Adjustment 202
Squeegee Blade Cleaning and Inspection 202
Squeegee Height and Tilt Adjustment 203
Squeegee Actuator Limit Adjustment 204
Removal and Installation 206
Squeegee Lift Actuator 206
Specifications 207
Special Tools 207
Actuator Test Kit 207
40 - Recovery System 208
Functional Description 208
Vacuum Motor and Recovery Tank 208
Operational Mode Prerequisites 208
Vacuum Motor Control Circuit Overview 209
Troubleshooting 210
Vacuum Suction Test 211
Removal and Installation 212
Recovery Tank 212
Vacuum Motor 212
Vacuum Motor Brushes 214
Specifications 215
Special Tools 215
90 - Options and Accessories 216
Beacon 216
Headlights 216
Blue Light 216
On Board Charger (OBC) 216
EcoFlex 216
Scrub-N-Vac 217
Wash Hose 217
TrackClean 217
Dual Vacuum 217
Side Sweep 217
Various Mechanical Kits 218

03 - General Information

General Machine Description

The SC5000 machine is a battery-powered, ride-on, self-propelled commercial floor scrubbing machine with either a disc or cylindrical scrub system, and suitable for use in commercial applications. The machine is available with one of three deck types. The 34D/860D has a 34" (860mm) dual disc brush deck. The 32C//810C has a 32" (810mm) dual cylindrical brush deck. The 36C/910C has a 36" (910mm) dual cylindrical brush deck.

The machine is powered by six, 6-volt batteries connected in series, to provide 36 VDC to the motors and controls.

Service Manual Purpose and Application

This Service Manual is a resource for professional service technicians. It provides information for understanding how the machine operates, where components are located, basic troubleshooting, maintenance and mechanical service operations.

The cover page of this manual lists each machine part number that the manual applies to. Compare the part number of the machine you are working on to the model numbers listed on the cover page to be sure you are using the correct manual.

Other Reference Manuals and Information Sources

Nilfisk Documents	
Document Name	**Document Number**
Parts List	56042680
Instructions For Use (US,TR)	56091220
Instructions For Use (DA,NO,SV,FI)	56091221
Instructions For Use (DE,FR,NL,RU)	56091222
Instructions For Use (ES,PT,IT,GR)	56091223
Instructions For Use (ET,LV,LT,SL)	56091224
Instructions For Use (SK,CS,PL,HU)	56091225
Instructions For Use (CR,BG,RO)	56091226
Advance Documents	
Document Name	**Document Number**
Parts List	56042679
Instructions For Use (US,ES,FR)	56091219

Revision Table

Revision	Comments
06/2021	Initial Release
03/2022	Add brakes as standard equipment
Rev C, 2023	Lost Comms Diagnostics, Electrical Diagram Improvements

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.

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 Advance commercial floor cleaning equipment.

- Digital voltmeter (DVM) with DC current clamp
- Hydrometer
- Battery load tester for checking batteries
- Set of torque wrenches

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

- Vacuum water lift gauge, p/n 56205281.

Conventions

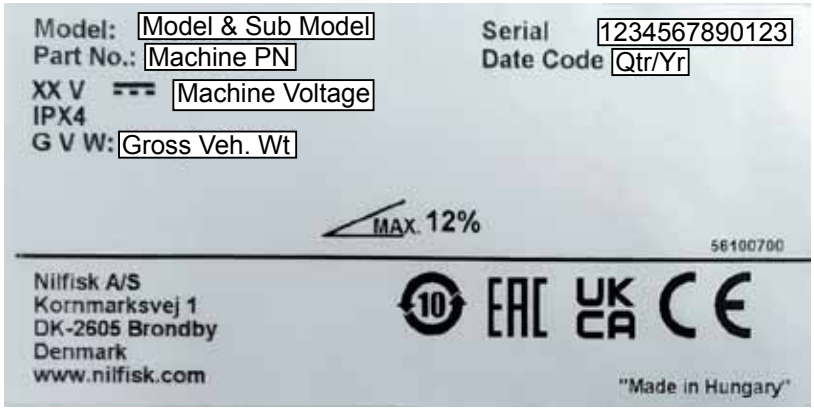
All references to right, left, front and rear in this manual are as seen from the Operator's position.

Modifications

Modifications and additions to the cleaning machine which affect capacity and safe operation shall not be performed by the owner or user without prior written approval from Nilfisk Inc. Unapproved modifications will void the machine warranty and make the owner/user liable for any consequential damages.

Nameplate

The machine nameplate is located on the rear of the steering column. The nameplate contains important identification information which is needed when ordering parts, such as the machine Model Number (Part No.) and Serial Number.



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.

***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.*
- *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.*
- *Disconnect the power source and/or batteries before servicing electrical components*
- *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.*
- *Take precautions to prevent hair, jewelry, or loose clothing from becoming caught in moving parts.*

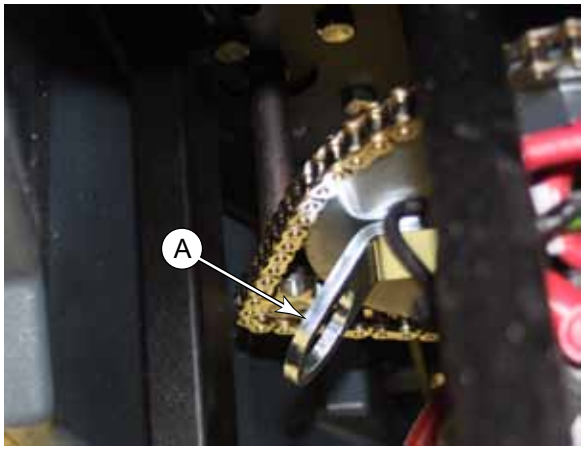
Property Damage Messages

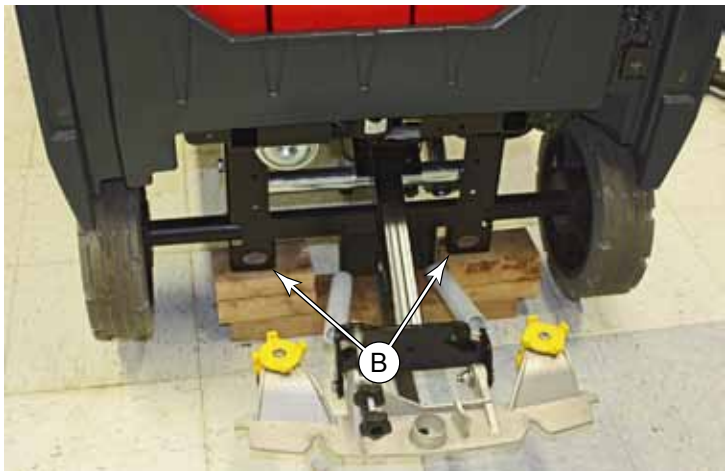
- ***Storage and operation temperature must be above 0°C and a humidity between 30% and 95%, non-condensing.***
- ***Before use, all doors and hoods should be properly latched.***
- ***This machine is not approved for use on public paths or roads.***
- ***This machine is only approved for hard surface 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.***
- ***Use only factory authorized parts and accessories.***
- ***This machine must be properly disposed of in accordance with local laws and regulations.***

Transporting the Machine

Observe the following guidelines when preparing the machine for shipping:

- Drain both the recovery and solution tanks. If the tanks are left full or partially full, the sloshing solution may make the load unstable.
- If transport will occur below freezing temperatures, place a small amount of non-toxic antifreeze in the recovery tank, solution tank, and solution lines. After transport, make sure to dispose of the used antifreeze in an environmentally friendly manner according to local regulations.
- Close and secure all covers, panels, and doors.
- Disconnect the main battery connector.
- If the loading, unloading, or transport operations may damage the squeegee or the scrub deck, remove them before moving the machine.
- Secure the machine to the transport vehicle using the three tie-down locations shown below (1-front **(A)** and 2-rear **(B)**).

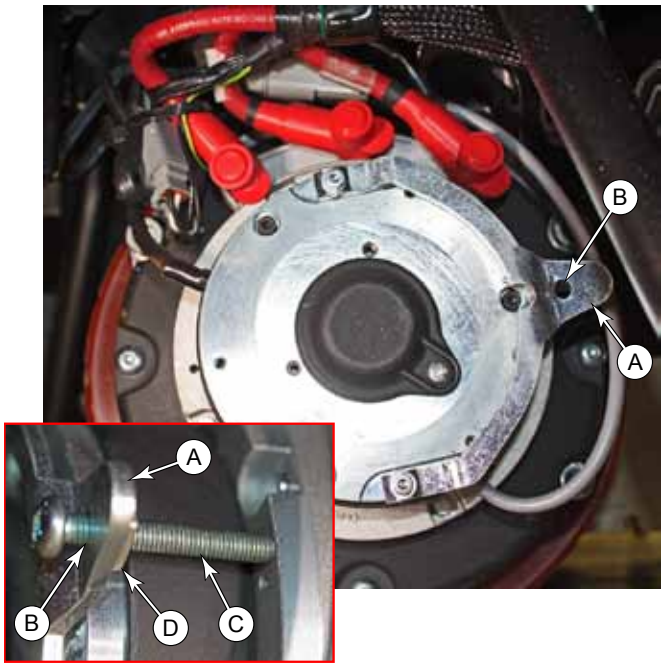




Moving a Disabled Machine

Moving a disabled machine requires manually deactivating the traction motor EM brake. To disable the brake, lift the release lever **(A)** away from the wheel.

To hold the lever in the disengaged position while moving the machine, you may place an object or tool between the release lever and the motor housing. For longer travel, or if transporting across a bumpy surface, you may want to place an M6 or 1/4-20 screw **(C)** through the hole in the lever **(B)**, with a tensioning nut **(D)** on the back of the lever, and the screw lightly pressing on the motor housing.



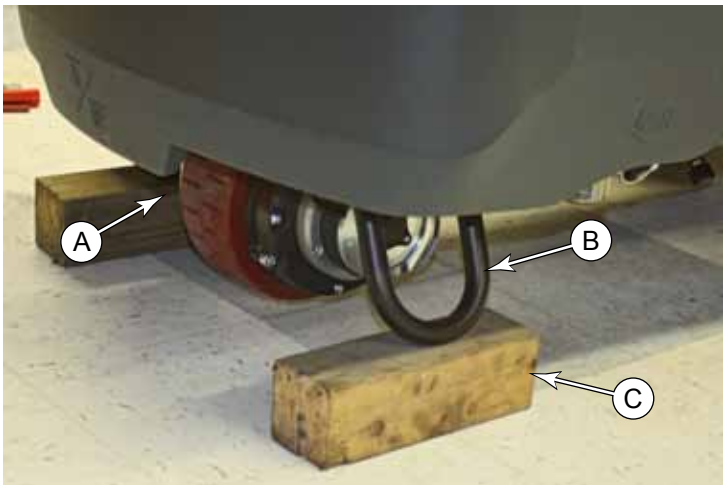
Lifting the Machine

CAUTION: Never work under a machine without safety stands or blocks to support the machine.

- ***Drain the recovery and solution tanks to prevent sloshing water from unbalancing the machine.***
- ***Lift only from the subframe of the machine, as shown below.***
- ***Never lift the rear of the machine without first stabilizing the front.***

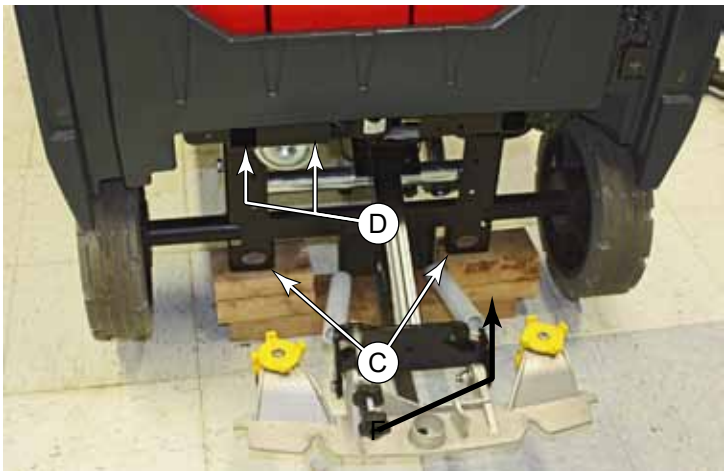
Lift or Stabilize the Front of the Machine

1. Drain both the recovery and solution tanks to reduce the weight of the machine.
2. Using the lifting point **(A)** located on the right anti-tip hoop, raise the front of the machine, and place support blocks **(C)** under both anti-tip hoops **(B)**.
   - Minimum support blocks of 1-inch (25mm) thick may be used for stabilizing the front if the purpose is to raise the rear.
   - If taller support blocks are used, make sure they are wide enough to be stable, and will not tip over if the machine is bumped.



Lift the Rear of the Machine

3. Make sure the front of the machine has been stabilized (above) before lifting the rear of the machine.
4. Remove the squeegee assembly for easier access to the rear lifting points.
5. Depending on the type of jack available, use a low-profile floor jack to lift from the hold-down brackets **(C)**, or use a bottle-jack to lift from the underside of the main chassis platform **(D)**.
6. When the machine is raised, place support blocks below the hold down brackets **(C)**.



Note: *The machine is shown with the recovery tank removed for clarity. It is not necessary to remove it for this procedure.*

Technical Specifications

Advance Model **Nilfisk Model**		**SC5000 32C** **SC5000 810C**	**SC5000 36C** **SC5000 910C**	**SC5000 34D** **SC5000 860D**
Advance Part Number **Nilfisk Part Number**	**Units**	**56117001** **56117807**	**56117003** **56117808**	**56117004** **56117805**
Voltage, Batteries	V	36		
Battery Capacity (max)	Ah C20	420		
Protection Grade, Operating		Class 3		
Protection Grade, Charging		Class 1		
Sound Pressure Level IEC 60335-2-72: 2002 Amend. 1:2005,ISO 11203, ISO 3744	dB(A)/ 20µPa	63		
Sound Pressure level KpA, (IEC 60335-2-72, ISO 11203) Uncertainty	dB(A)	3.0		
Gross Vehicle Weight*	lbs / kg	1876 / 850	1886 / 855	1870 / 848
Transportation Weight**	lbs / kg	1416 / 642	1426 / 646	1410 / 640
Maximum Wheel Floor Loading (center front)	psi / kg/cm²	177.7 / 12.5	184.1 / 12.9	182.1 / 12.8
Maximum Wheel Floor Loading (right rear)	psi / kg/cm²	169.8 / 11.9	167.5 / 11.8	161.3 / 11.3
Maximum Wheel Floor Loading (left rear)	psi / kg/cm²	187.4 / 13.2	183.6 / 12.9	173.5 / 12.2
Vibrations at the Hand Controls (ISO 5349-1)	m/s²	1.14		
Vibrations at the Seat (EN 1032)	m/s²	0.19		
Gradeability Transport*	% (°)	20 / 11		
Gradeability Cleaning*	% (°)	12 / 6.8		
Machine Length	inch / cm	62.6 / 159		
Machine Height	inch / cm	57.7 / 146		
Machine Height (w/ overhead guard)	inch / cm	79 / 200		
Machine Width	inch / cm	37.5 / 95	41.3 / 105	37.5 / 95
Machine Width with J-model Squeegee	inch / cm	43 / 109		
Minimum Aisle Turn Width	inch / cm	**66 / 168**		
Solution Tank Capacity	Gallon / L	37 / 140		
Recovery Tank Capacity	Gallon / L	38.8 / 147		
Transport Speed (Fwd. Maximum)	mph / kph	5 / 8		
Transport Speed (Rev. Maximum)	mph / kph	3 / 4.8		
Battery Compartment Size	inch / cm	H: 17.1 / 43.5, W: 21.8 / 55.5, L: 24.8 / 62.9		
Scrub Brush Size	inch / cm	**O.D.:** 5.75 / 14.6 **I.D.:** 1.75 / 4.5 **L:** 31.1 / 78.9	**O.D.:** 5.75 / 14.6 **I.D.:** 1.75 / 4.5 **L:** 35.1 / 89.1	**O.D.:** 17. 0 / 43.2 (2 discs)
Scrub Brush Speed	rpm	776.5	776.5	250
Hopper Capacity - Cylindrical	in³ / L	575 / 9.4	652 / 10.7	—
Cleaning Path Width (scrubbing path)	inch / cm	31.6 / 80.3	35.6 / 90.5	33.2 / 84.3
Sweeping Path with optional side broom	inch / cm	37.4 / 95.0	37.4 / 95.0	—

*Gross Vehicle Weight: Standard machine without options, full solution tank and empty recovery tank, with removable scrub brushes, batteries installed and 165 lb / 75 kg operator.

**Transportation Weight: Standard machine without options, empty solution and recovery tanks, with batteries installed and no operator.

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 Schedule

Maintenance intervals given are for average operating conditions. Machines used in severe operational environments may require service more often.

Maintenance Item	Interval			
	Daily	Weekly	Monthly	Yearly
Charge Batteries	•			
Check/Clean Tanks & Hoses	•			
Check/Clean/Rotate the Brushes/Pads	•			
Check/Clean the Squeegee	•			
Empty/Clean Debris Catch Tray in Recovery Tank	•			
Check/Clean the vacuum motor foam filter	•			
Clean Hopper on Cylindrical System	•			
Clean the surface of the magnetic smartkey reader	•			
Check Battery Cell Water Level (does not apply to gel cell batteries)		•		
Inspect Scrub Housing Skirts		•		
Inspect and clean Solution Filter		•		
Clean Solution Trough on Cylindrical System		•		
Purge Detergent System (if present)		•		
* Clean the solution tank		•		
Lubricate the Machine			•	
Check Vacuum Motor Carbon Brushes (replace motor at 2000 hrs)				1200 Hrs
Check Brush Motor Carbon Brushes				1200 Hrs

* Cleaning the solution tank is only needed if you use a mixture of water and detergent within the tank.

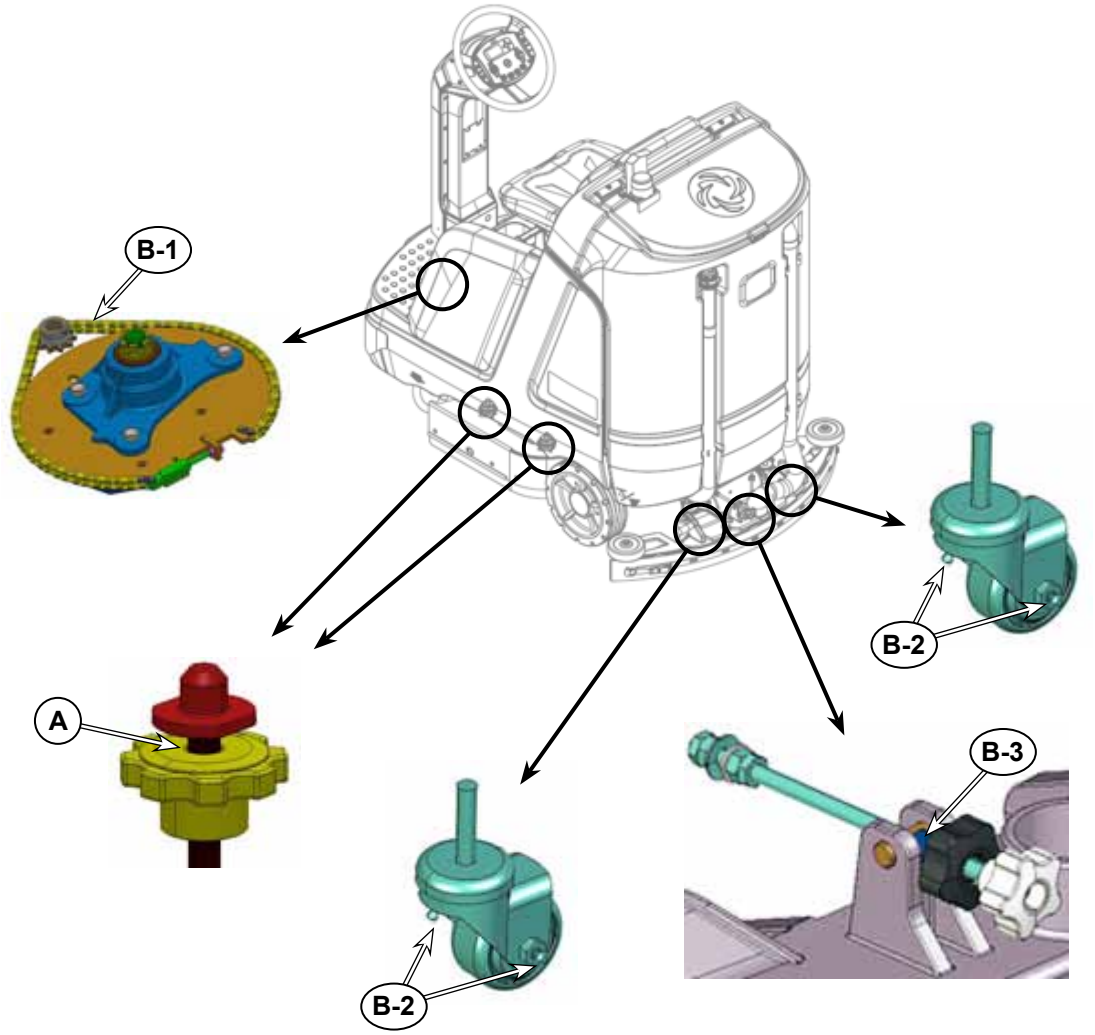
Note: *See the individual machine system sections for maintenance information.*

Maintenance Procedure References

- Vacuum Motor Brushes described on page 214
- Disc Brush Motor Brushes described on page 185
- Cylindrical Brush Motor Brushes described on page 198

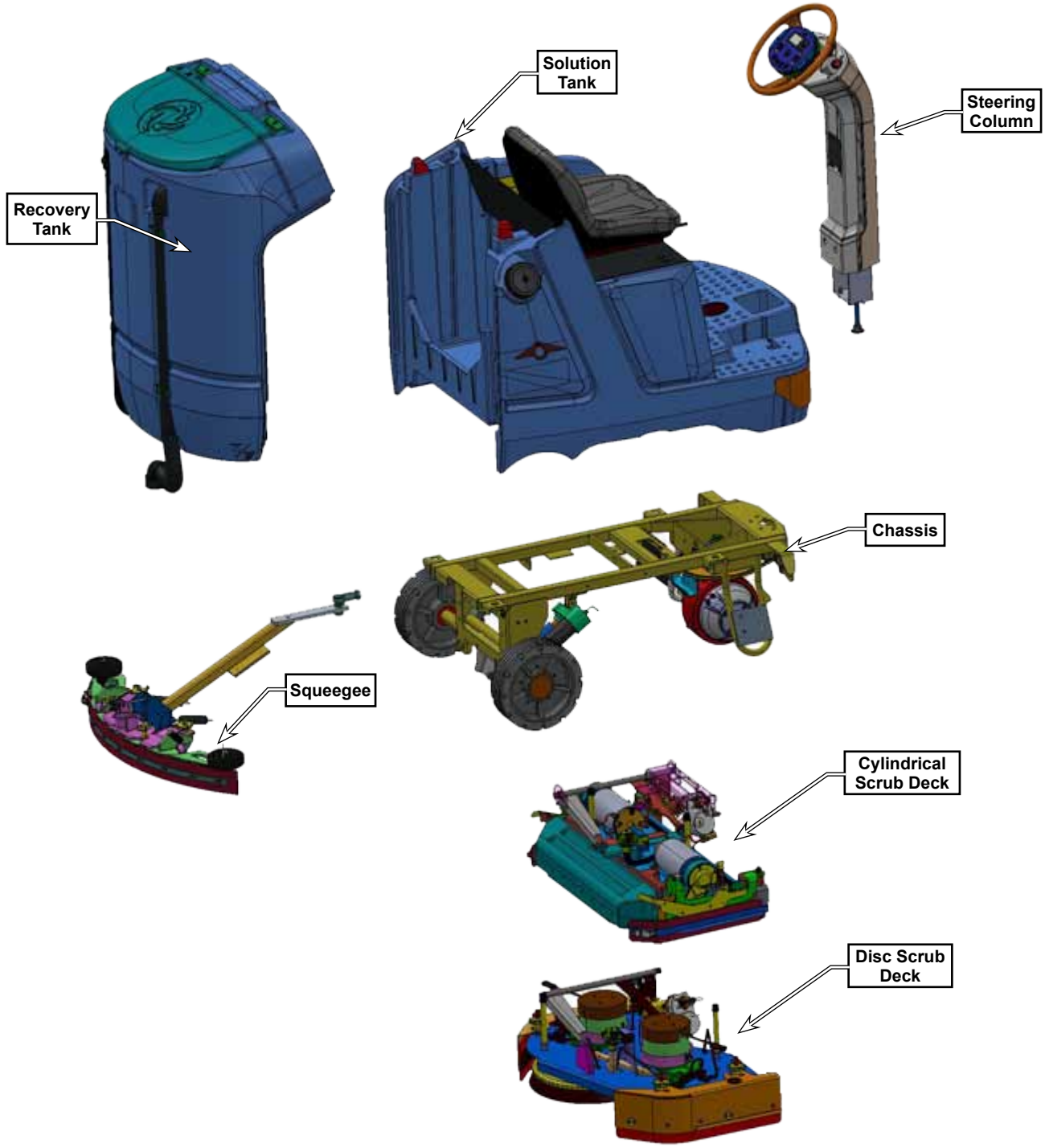
Lubricate the Machine

- Once per month, apply light machine oil to the threads of the side blade down adjustment knob **(A)**.
- Once per quarter grease these components:
  - the steering chain **(B-1)**
  - the squeegee wheel axles and pivots (two zerks) **(B-2)**
  - the threads of the squeegee mount angle adjustment knob **(B-3)**



Know Your Machine

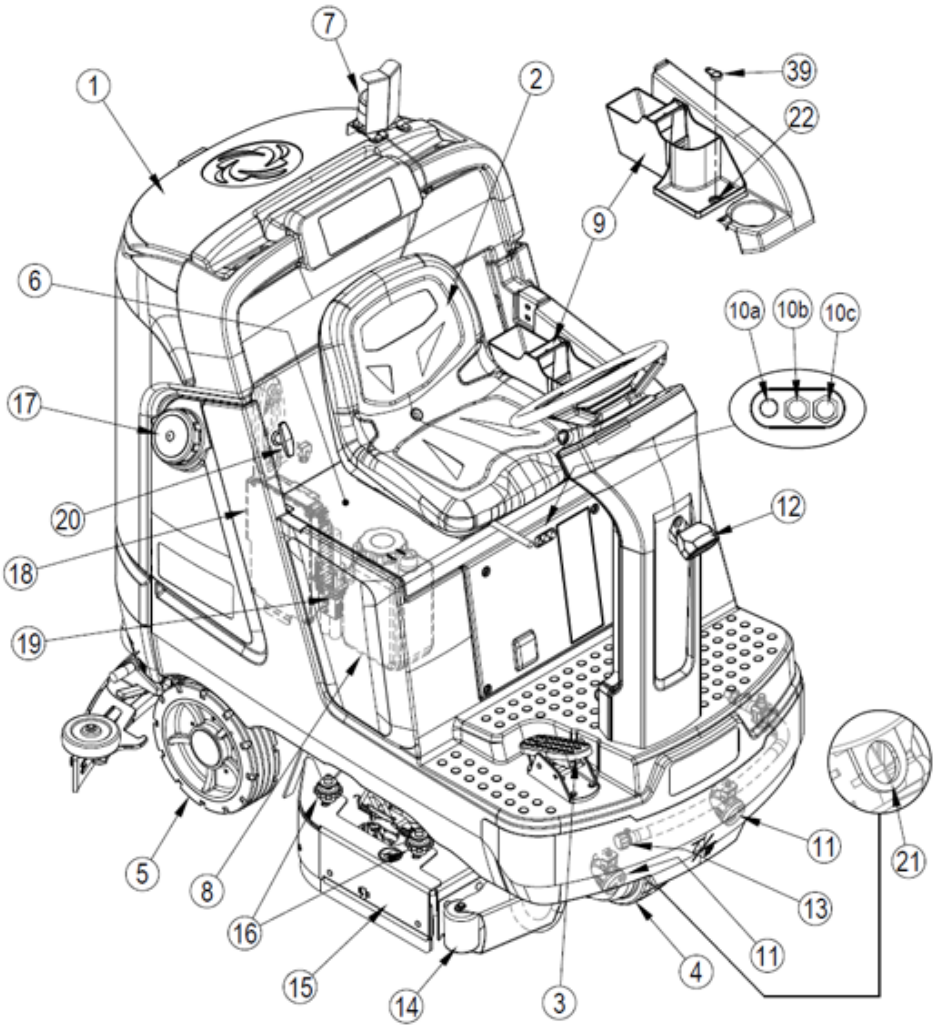
Main Assemblies



Machine Components

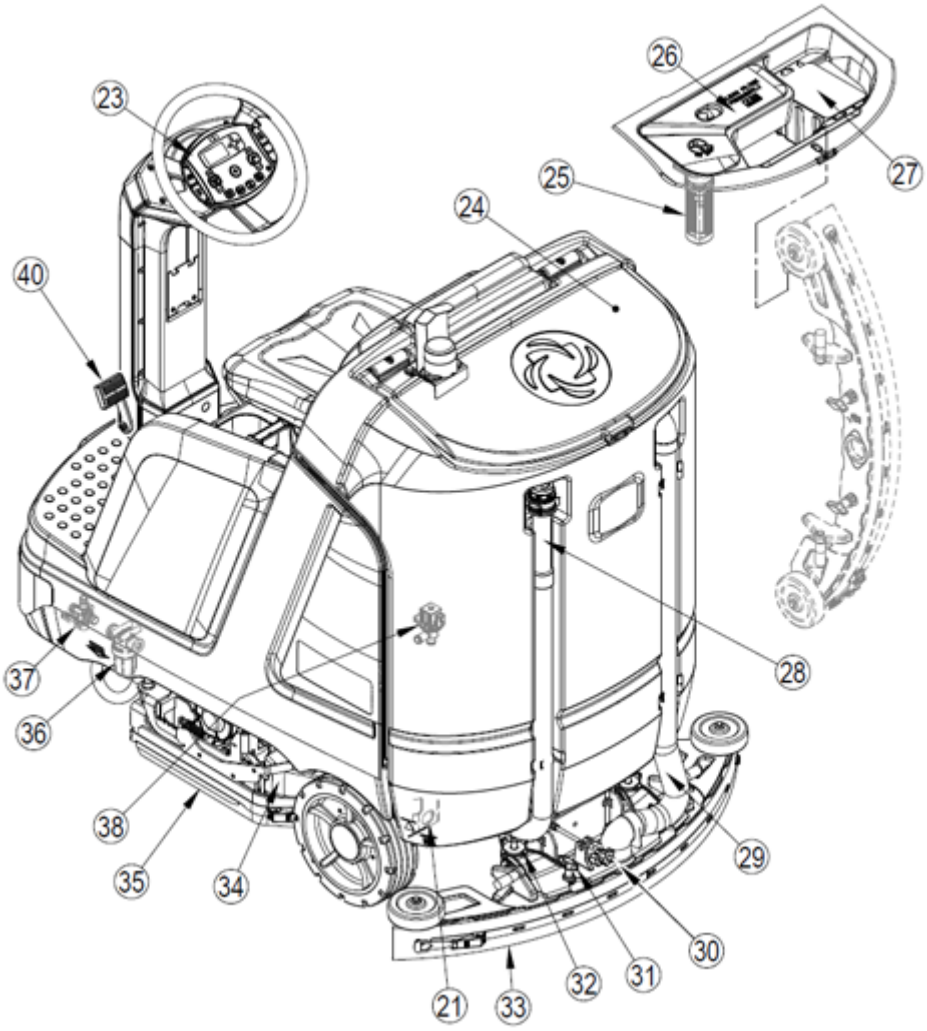
Front RH View

1	Recovery Tank Cover	11	Headlights (optional)
2	Operator's Seat	12	Blue Light (optional)
3	Drive Pedal	13	Solution Tank Drain Hose
4	Drive Wheel	14	Front Roller Bumper
5	Rear Wheel	15	Scrub Deck
6	Battery Compartment (under seat)	16	Side Blade Assembly Removal Knobs
7	Warning Beacon	17	Solution Tank Fill
8	Detergent Cartridge (EcoFlex models only)	18	Onboard Battery Charger (optional)
9	Storage Box	19	Machine Battery Connector
10	Circuit Breakers	20	Battery Compartment Latch
10a	Drive Controller 70 Amp (CB2)	21	Tie-Down Location (1 front)
10b	Control Board 5 Amp (CB1)	22	SmartKey™ Reader
10c	Control Board 5 Amp (CB3)	39	Magnetic SmartKey™



Rear LH View

21	Tie Down Location (2 rear)	31	Squeegee Mount Thumb Nuts
23	Control Panel	32	Squeegee Caster Lock Knob
24	Recovery Tank Cover	33	Squeegee Assembly
25	Recovery Tank Shutoff Float	34	Hopper (Cylindrical only)
26	Vacuum Motor Filter Housing	35	Scrub Deck
27	Debris Catch Tray	36	Solution Filter
28	Recovery Tank Drain Hose	37	Solution Shutoff Valve
29	Recovery Hose	38	Solution Solenoid Valve (on scrub deck)
30	Squeegee Tilt Adjust Knob	40	Brake Pedal



04 - Control System

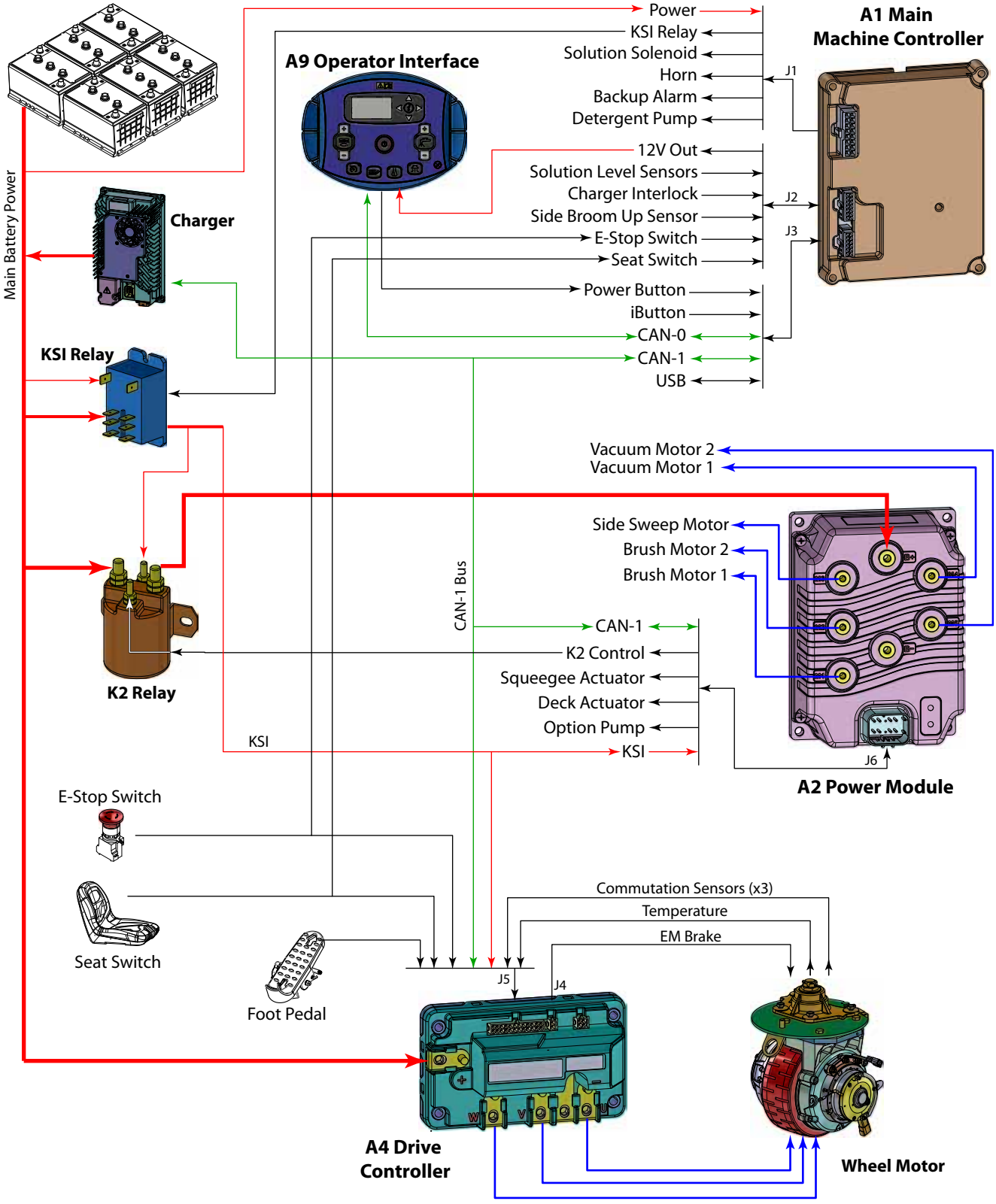
Functional Description

The division of the SC5000 System by logic function starts with the Main Machine Controller (MMC or Main Controller). As the name implies, this acts as the central controller that ties all of the other modules together. These functions are summarized below, and explained in greater detail in subsequent sections.

Module	Communication	Function
Main Controller	CANBus-0 CANBus-1	• CANBus-0 is the communication channel between the MMC and the User Interface. All other devices utilize CANBus-1. • Commands the Power Module when and how to operate all of the machine motors. • Notifies the Drive Controller the direction of the wheel motor. • Communicates with the onboard battery charger
User Interface Module	CANBus-0	• Communicates operator command inputs with the MMC. • Displays machine status information received from the MMC.
Onboard Charger	CANBus-1 Interlock	• Monitors and charges the batteries when connected to facility power (AC Mains Power) • Opens the interlock circuit to the MMC when the charger is connected to mains power. • Communicates with the Main Controller regarding battery status and charging parameters.
Power Module	CANBus-1	• Receives commands from the main controller regarding motor operation. • Controls and monitors the brush motors, vacuum motor(s), deck lift actuator, squeegee actuator, option pump, and side sweep motor. • Provides status to the Main Controller regarding motor operation.
Drive Controller	CANBus-1	• Controls and monitors the wheel motor. • Receives speed information directly from the operator controls. Receives direction control from Main Controller.
TrackClean-1 (Optional)	CANBus-1	• Receives status and data from the Main Controller for remote data logging and remote communications..

Functional Diagram

The Functional Block Diagram represents a high-level overview of the system interactions and communications. It is not intended to show every component or connection. For a more detailed examination of system interconnections, refer to the "Wiring Diagrams" on page 122 of the Electrical Chapter.



Drive Controller

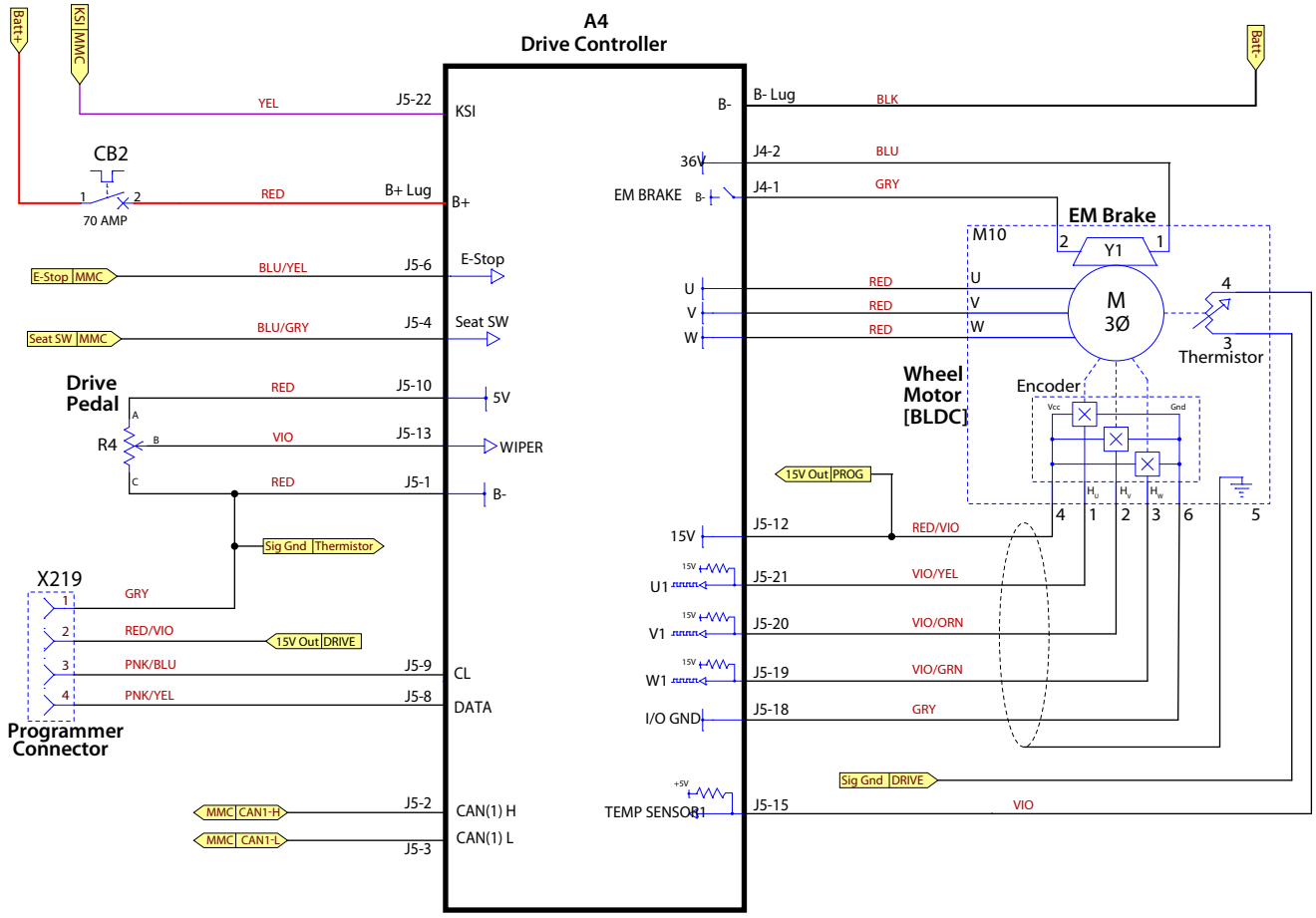
The drive controller operates and monitors the wheel motor. It generates a 3-phase Pulse Width Modulated (PWM) power control to the wheel motor. Even though it is actually DC power, it resembles a 3-phase system because the polarity reversals and zero-crossings resemble a 3-phase AC system. This pseudo 3-phase power permits the wheel motor to achieve full torque at near zero rpm, and very precise position control.

In order to generate this pseudo 3-phase signal, the drive controller needs to know the exact rotational position of the rotor inside the wheel motor. This is referred to as Remotely Commutated (i.e. brushless motor). The motor tells the controller what its rotational position is, and which of its 3 primary windings should be energized in order to rotate in the desired direction. This is accomplished with a set of 3 hall effect encoders inside the motor that send pulsed timing signals back to the controller to identify its exact position.

The controller also monitors the internal temperature of the motor to protect it from damage due to overheating.

The drive controller receives its logic power from the KSI relay, but it also has its own high-power input through the 70 amp circuit breaker, CB2. When the main machine controller has not energized the KSI relay, the drive controller is off. The drive controller also has 2 enabling inputs directly from the operator's seat switch, and the E-stop button. If either one of these switches is open, the drive is disabled, but has power.

The drive controller receives forward and reverse direction commands from the Main Machine Controller via the CANBus, and receives its speed control directly from the operator's foot pedal. The drive pedal sensor is a hall effect rotary position sensor with a PWM output that simulates the voltage output from a variable resistor. The drive controller receives the varying voltage input from 1 to 4 volts. The low voltage 1 is considered neutral, and as the voltage increases, so does the speed commanded by the operator.

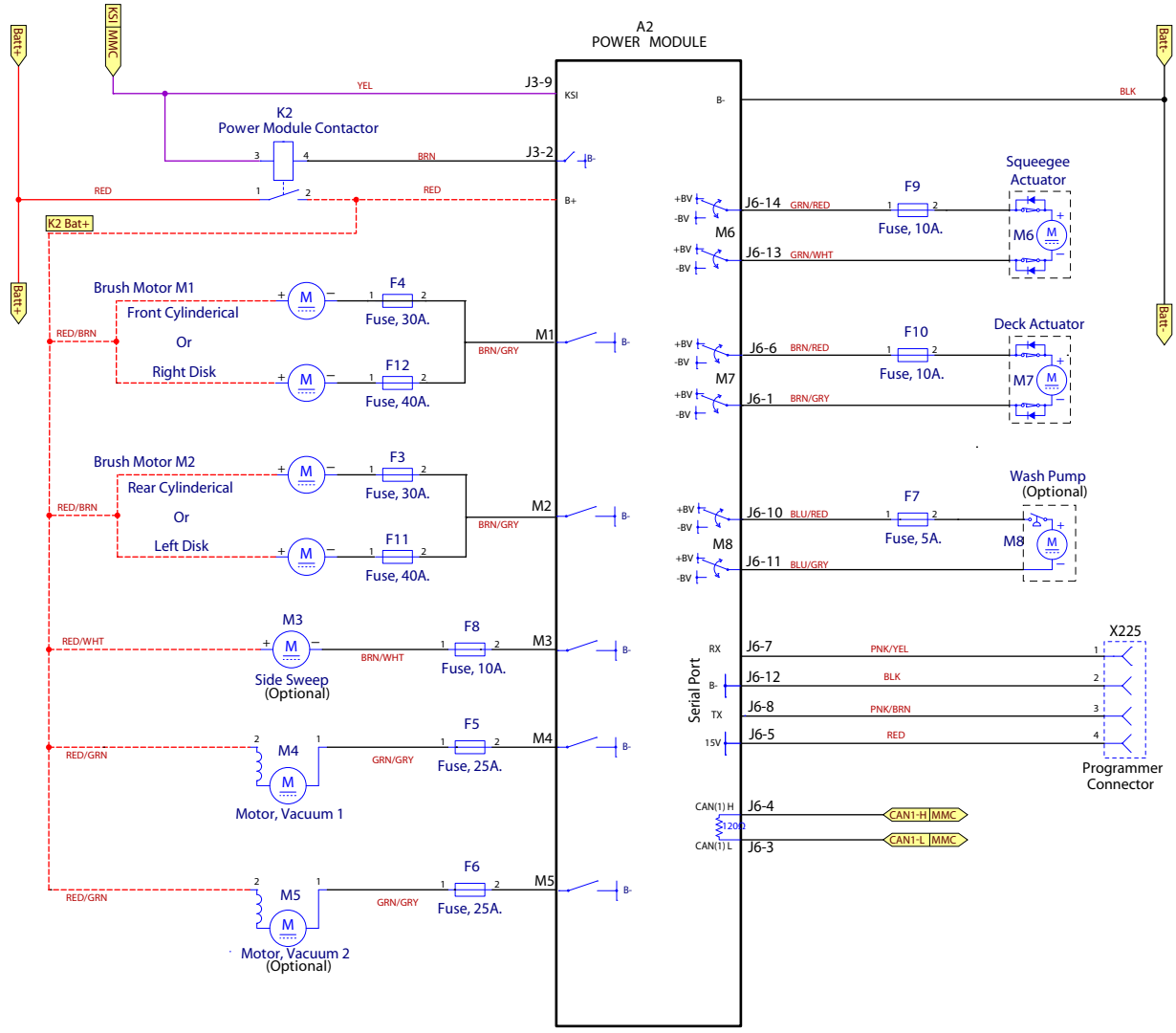


Power Module

As the name suggests, the power module handles the high-power output functions for the machine. It receives its commands from the main machine controller via the CAN Bus network. The power module provides 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 KSI relay, which is controlled by the main machine controller. The power module has control of its own high-power input from the K2 relay. 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.

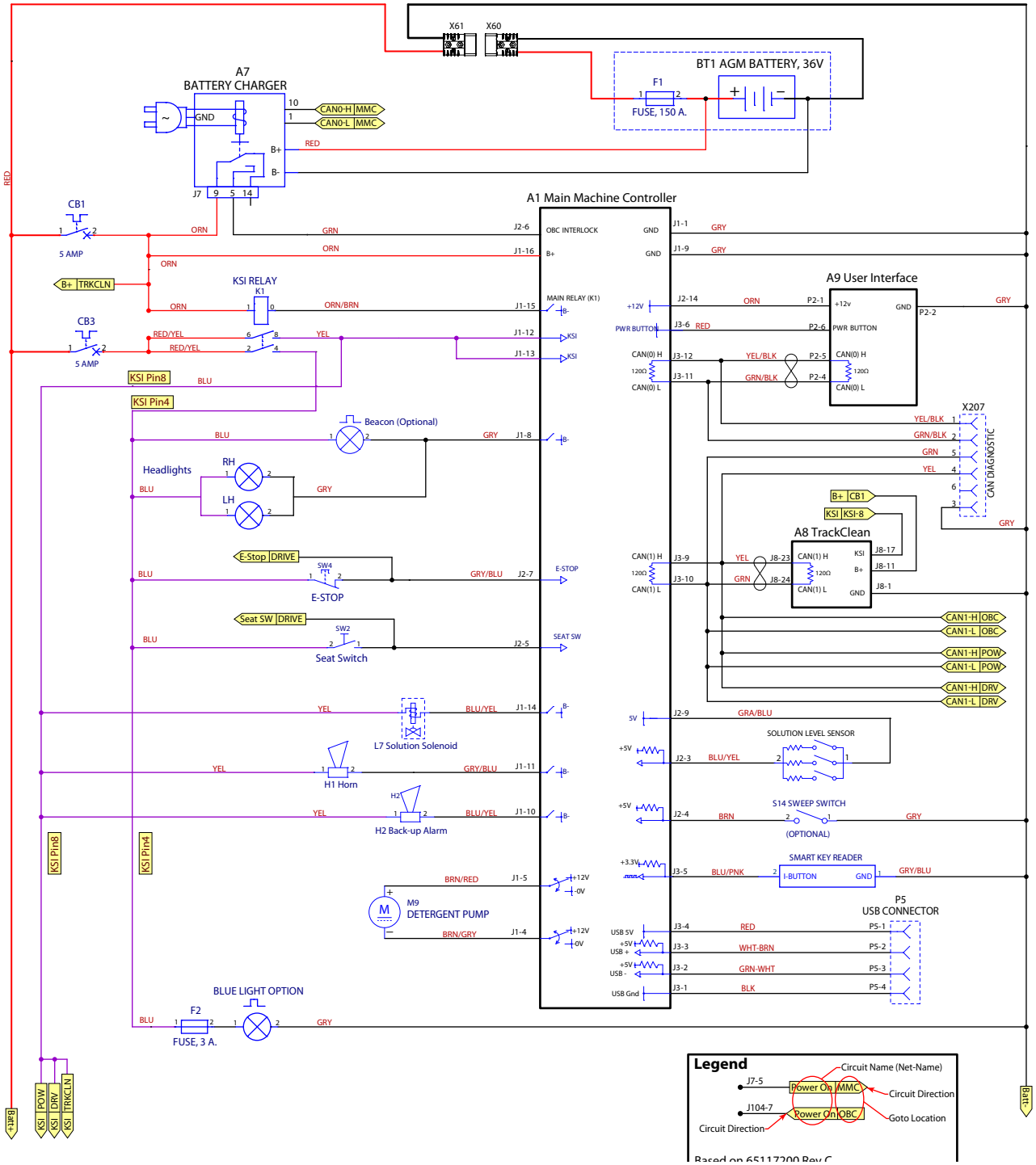
The power module has 2 types of outputs. The higher power outputs are non-reversing PWM control. The lower power outputs are reversing PWM control. The power module is capable of monitoring the output amperage from each of the outputs, and reporting this information to the main machine controller via the CAN Bus.



Main Machine Controller

As the name implies, the Main Machine Controller (MMC) is the primary controller for the system. The MMC directly or indirectly controls the functions of the machine. Because the MMC controls the on/off function of the whole machine, it is always receiving logic power through the 5 amp circuit breaker, but controls the status of the KSI relay to itself and the other controllers.

The MMC communicates with the Power and Drive controllers and the optional TrackClean-1 module through the CAN Bus. It also uses a second CAN Bus to communicate with the operator interface module.



Main Controller Operational Modes

The main controller is firmware driven using a micro controller to set operational modes based on machine input and function. These modes of operation are described below.

- Normal Modes
  - Active Scrub
  - Recovery only (Wand or regular recovery)
  - Disc brush install
  - Detergent purge
- Inhibit modes
  - Estop – shuts down all systems including drive. Reset with Estop switch. Has icon displayed.
  - Impact lock-out – shuts down scrub, solution and recovery system. Has padlock icon displayed. Reset by power on with supervisor key.
  - Low voltage cut-out – has icon displayed
    - First stage – shuts off scrub
    - Second stage – shuts off recovery too
  - Recovery Tank Full (RTF) – Shuts off scrub solution and vacuum. Has icon displayed.
  - Critical Fault – shuts down scrub solution and recovery. Has exclamation triangle icon displayed

Operational Mode Prerequisites

Before the main controller can activate any of the operational modes, it must first check that the appropriate prerequisites are met.

- **Scrub System Outputs**
  - Brush Motors M1 and M2 or Deck Actuator M7 (seat switch must be closed to enter scrub mode)
    - No scrub system fault (brush motors and actuator motor)
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero
    - No E-stop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (first or second stage)
    - No RTF inhibit
- **Recovery System Outputs**
  - Vac motors M4 and M5 – Recovery mode (Seat switch closed upon entry) or Squeegee Actuator M6
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero (and not timed out)
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (second stage)
    - No RTF inhibit
    - Note M5 also requires Vacuum option set to dual in configuration menu

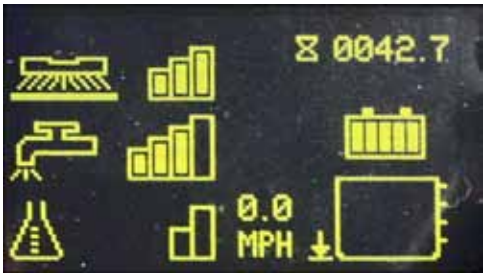
  - Vac motors M4 and M5 – Wand mode (seat switch open upon entry) or Squeegee Actuator M6
    - No recovery system fault (vac motors and squeegee)
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (second stage)
    - No RTF inhibit
    - Note M5 also requires Vacuum option set to dual in the configuration menu
- **Solution System Outputs**
  - Solution Solenoid L1 –
    - Scrub system active
    - No solution solenoid fault
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (first or second stage)
    - No RTF inhibit
    - Not turned off with the membrane switch
    - Not momentarily turned off by the solution timed off paddle switch input
  - Spray wash pump M8
    - No spray wash pump M8 fault
    - Solution tank is not empty
    - Option (Opt) pump in configuration menu set to “Spray Wash”
- **Detergent System outputs**
  - Detergent Pump M8
    - Solution system is active
    - EcoFlex is enabled in the configuration menu
    - Not turned off with the control panel detergent switch
- **Side Sweep System Outputs**
  - Side Sweep Motor M3
    - No sweep motor M3 fault
    - Scrub brushes active
    - Side Sweep set to “yes” in the configuration menu
    - Side Sweep switch open
- **Other Main Controller outputs**
  - Horn H1
    - Always active. Follows S3 horn switch input.
- **Drive Controller outputs**
  - Wheel motor
    - No “interlock” message from the main controller on the CAN bus

Control Panel

The control panel (display) is a standalone controller for receiving user input and displaying machine status to the operator. The display communicates this information with the Main Machine Controller via the CAN(0) bus.

Power Button (A): The signal for the On/Off power button passes directly to the Main Machine Controller, even though it is integrated into the control panel. The power button is a simple switch that connects the P2-6 output to ground. The Main Machine Controller sees this ground signal as a power button press, and either powers on or off the machine

The remainder of the display module is not active until the MMC provides it with 12-volt power.



Display (B): The LCD display provides feedback to the operator with various text messages and graphic icons. The main screen shows scrub pressure, solution flow, detergent flow, speed, machine hours, battery charge level, solution tank level, and any fault codes. The display will change as necessary to convey the appropriate information.

Information (C) and Menu Navigation (D): Pressing the information button enters or exits the system menus. The navigation buttons provide navigation and entry for the menus, and will be discussed in greater detail in "Programming Menu Outline" on page 30.

One-Touch Scrub (E): When the One-Touch Scrub is selected, the brushes and squeegee are lowered to the floor, and the solution solenoid is briefly activated to pre-wet the brushes. The scrub, solution, vacuum and detergent (EcoFlex models) systems are all enabled and will start when the Drive Pedal is activated.

Solution Button (F): The solution button enables or disables the solution solenoid. However, the solution solenoid isn't energized unless the scrub system is engaged and the machine is in motion.

Speed Limit Button (G): The speed limit button sets the maximum speed of the machine to whatever the current speed is in scrub mode to reduce driver fatigue. Allows full pedal deflection at the set speed.

Brush Install Button (H): The brush install button lowers the deck and spins the brush motors briefly to aid in the installation of the brushes. (Disc deck only).

Vacuum Button (K): The vacuum button turns the vacuum on and off, and automatically lowers or raises the squeegee. Because a hand operated vacuum wand is available as an option, the vacuum will operate even when the operator is not in the seat and the seat switch is closed.

Detergent Button (J): The detergent button enables or disables the optional detergent pump. However, the detergent pump isn't energized unless the solution system is also active, and the machine is in motion.

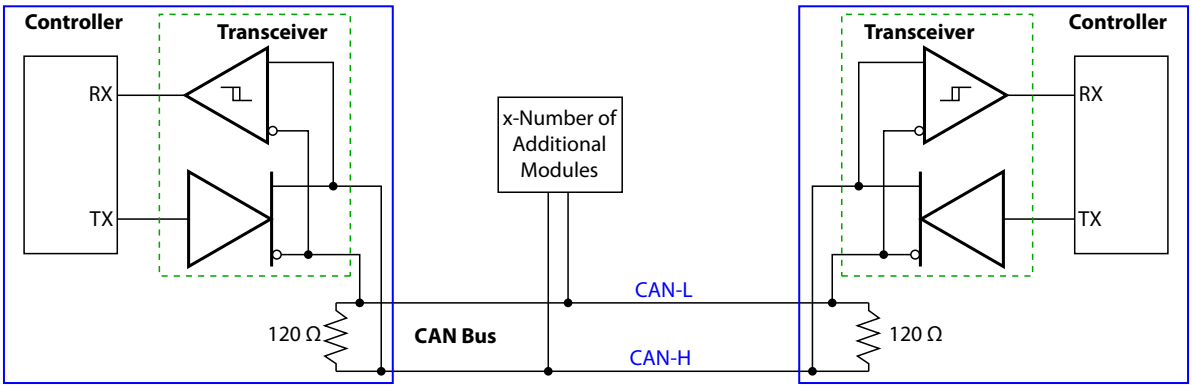
SmartKey Reader (Located near the seat): The key reader provides a serial connection between the SmartKey and the main machine controller. The controller checks the serial number of the key to determine if it is authorized to enable the machine's operation.

Different keys (operator-blue versus supervisor-yellow) have different levels of access to the control system. Operator keys can be authorized/de-authorized for the machine, so that each operator may have his or her own uniquely identified key.

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).

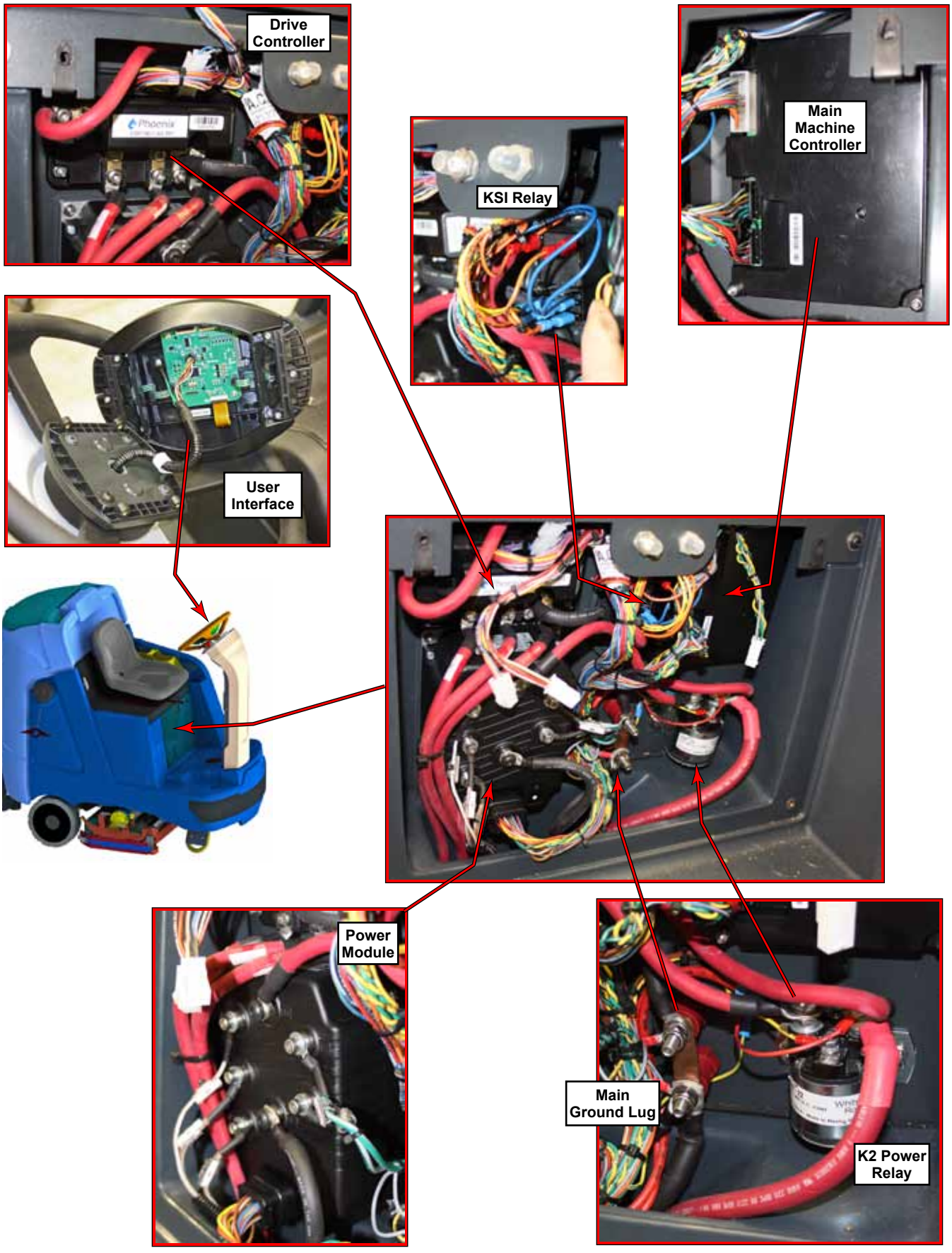


Because none of the modules represent the Master of the bus system, any of the modules can initiate a bus transmission any time there is not already traffic on the bus. When the module detects inactivity on the bus, it transmits a dominate bit, and begins sending the message priority level bits. But 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. Below are typical message sequences for the SC5000 machine.

- Every 100ms, the Main Controller broadcasts the PWM Requested values for the Right Brush, Squeegee Actuator, Deck Actuator, and Option Pump.
  - In response, the Power Module broadcasts the actual current flow for each of the above motors.
- Every 100ms, the Main Controller broadcasts the PWM Requested values for the Left Brush, Side Sweep, Vacuum 1, and Vacuum 2.
  - In response, the Power Module broadcasts the actual current flow for each of the above motors.
- Every 500ms, the Main Controller requests the actual (output) PWM for each of the motors listed above.
  - In response, the Power Module broadcasts the actual PWM for each of the above motors.
- Every 100ms, the Main Controller broadcasts drive enable, direction, and speed limit messages.
  - In response, the Drive Module broadcasts the vehicle speed, motor temperature, motor RPM, throttle command, throttle pot voltage, and motor current.
- Every 200ms, the Main Controller requests various Drive Controller parameters.
  - In response, the Drive Module broadcasts interlock, E-stop, phase A and B encoder position, drive controller temperature, and temperature cutback %.

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, depending on the user level access: User, Supervisor, Technician. The User-level access is limited to just reading operational parameters. The Supervisor-level access is permitted to program keys and access the Options menus. 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. Depending on the machine type, there are a couple of variations for access. Start with the machine powered off.

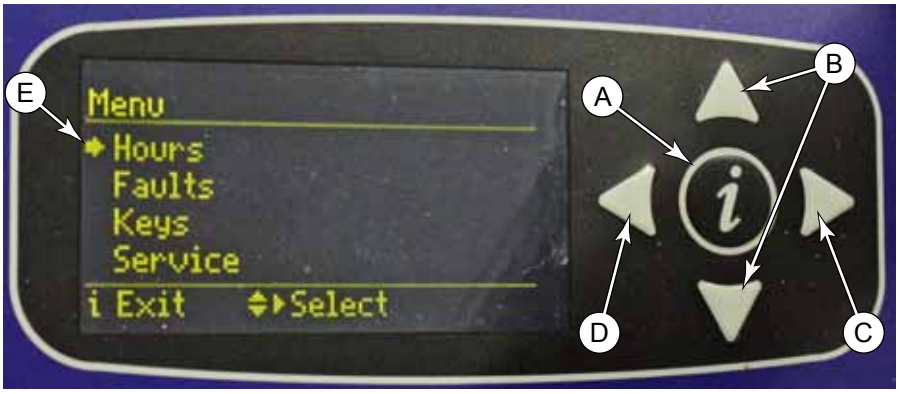
For a Nilfisk branded machine, place a user or supervisor SmartKey in the key reader, and then simultaneously press the Scrub, Vacuum, and Power switches to turn the machine on in service mode.

- For an Advance branded machine, a SmartKey is not required. Simultaneously press the Scrub, Vacuum, and Power switches to turn the machine on in service mode.

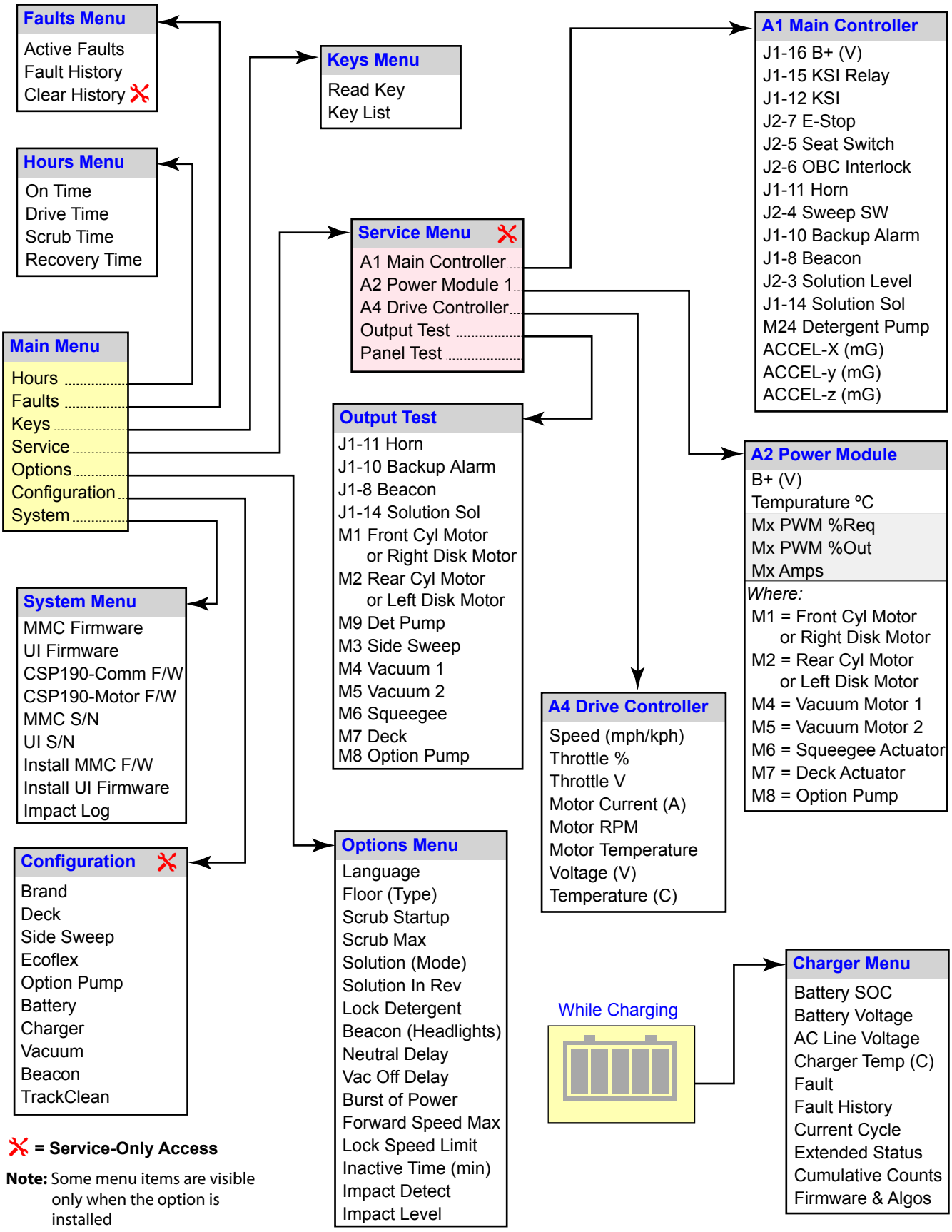
Menu Navigation

The menu system is accessed by pressing the Information switch **(A)**. 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 30.

- The Up and Down arrows **(B)** 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 **(E)** signifies the current cursor position.
- The right arrow **(C)** will enter the currently identified submenu. Within a configuration setting, pressing the right arrow accepts that selection and exits back to the previous menu.
- The left arrow **(D)** 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

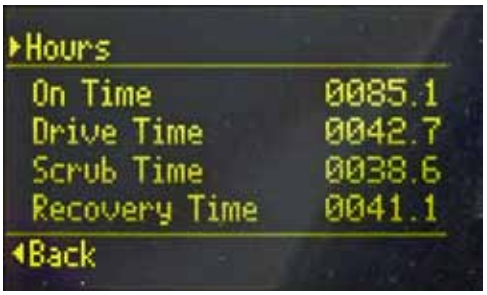


= **Service-Only Access**

Note: Some menu items are visible only when the option is installed

Hours Menu

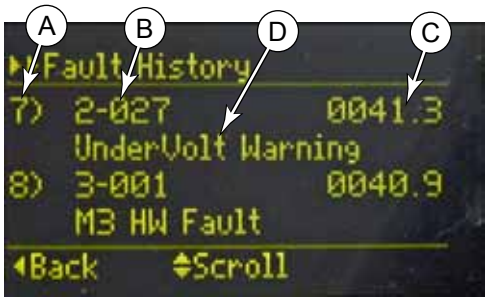
The hours menu displays the amount of time the machine has been active in each of the listed categories. The On Time represents the total time that the machine has been powered up, regardless whether it was active or sitting neutral. The remaining times indicate how long the machine was active and performing 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 is: **(A)** Fault occurrence number, **(B)** Error Code, **(C)** Drive-Time Hour Meter when the fault occurred, and **(D)** Error Description.



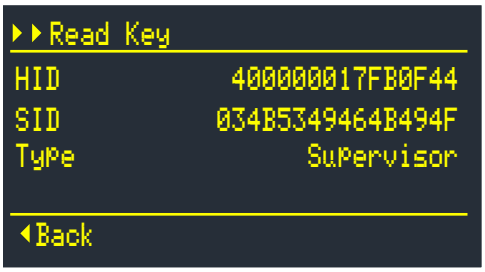
The fault history can also be cleared (available only to the technician in Service Mode). This should be done only if all past faults are accounted for or diagnosed.

Keys Menu

The Keys menu displays information about the current key, and also permits the addition or deletion of authorized user keys. User level keys (blue keys) can be authorized or de-authorized to operate the machine. However, if no keys have been authorized, then all user keys will be accepted.

Every key has a Hard-coded ID number (HID). This is the serial number for the key, and is also imprinted on the back of the key. Supervisor level keys also contain a Soft-coded ID number (SID), which determines the key type.

Authorizing User Keys



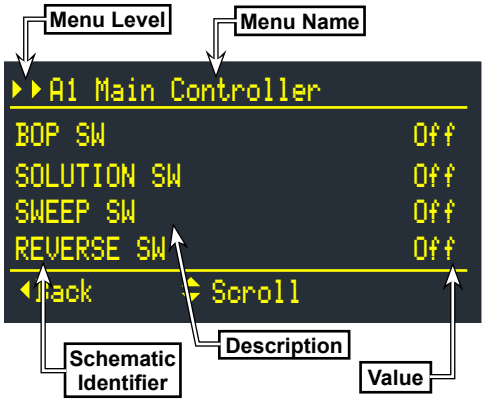
1. Start the machine with a supervisor key or in service mode.
2. Go to the Keys/Read Key menu function.
3. Replace the key with a user-level key to be programmed.
4. Press the Up arrow switch to add the key, and then the Right arrow switch to save.

Deauthorizing User Keys

1. Start the machine with a supervisor key or in service mode.
2. Go to the Keys/List Keys menu function.
3. Scroll to the key to be deleted in the list, and press the Right arrow switch to select it.
4. Press the Up arrow switch to delete the key, and then the Right arrow switch to save.
   - If all user keys are removed from the list, then any user key will be authorized to start the machine.

Service Menu

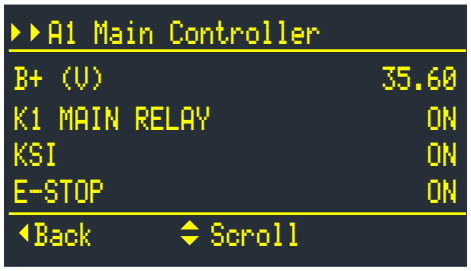
The Service menu provides access to diagnostic tools for troubleshooting the machine. Except for the Panel Test, each of these entries brings up a submenu for the applicable system module or function. To aid in navigating this information, these submenus are hyperlinked below:



- "A1 Main Controller" on page 32
- "A3 Power Module" on page 33
- "A4 Drive Controller" on page 34
- "Output Test" on page 35
- "Panel Test" on page 36

A1 Main Controller

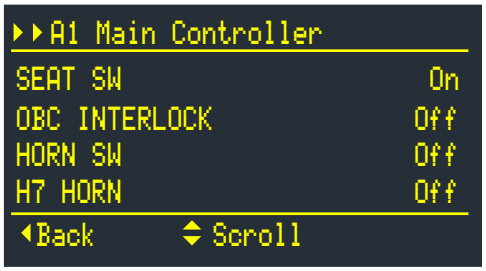
In addition to communicating with the other machine controllers, the main controller includes some direct input and output functions for sensors and low-power devices. This menu displays the status of the various input and output signals.



Battery Voltage: This shows the actual battery voltage as seen by the Main Controller. This voltage should be slightly less than the actual battery voltage as measured at the batteries due to minor voltage drop in the wiring to the control panel.

K1 Main Relay (KSI Out): This is an output indicator for the KSI relay, which is controlled by the Main Controller. This signifies that the controller is commanding the KSI relay to close.

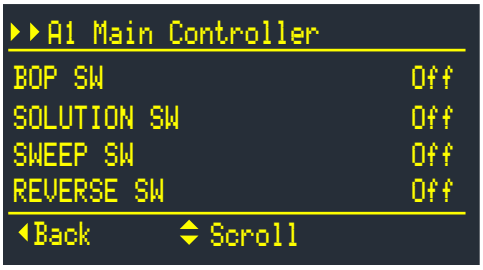
KSI (KSI In): This is a confirmation input from the KSI relay, so that the controller knows that the relay is active when commanded. This input also provides additional battery power for the higher power outputs from the controller.



E-Stop: This is the input signal from the E-stop switch. The E-stop switch is active-open (i.e. normally closed), so this input should normally be a "On" unless the E-stop button is depressed.

Seat Switch: This is the input from the operator's seat switch to verify the operator is in position to operate the machine. The switch is closed when the operator is seated.

OBC Interlock (Charger): This is the input from the Onboard charger, if present. When the charger is not installed, this input is always zero, and ignored by the controller. However, when the charger is installed, a zero indicates the charger is plugged in, and the system should be disabled.



Horn Switch (In): This is the input from the horn switch on the operator's steering column.

Horn (Out): This is the output to the horn.

BOP Switch: This is the input from the Burst of Power switch on the operator's steering column.

Solution Switch: This is the input from the solution switch on the operator's steering column.

Sweep Switch (Sensor): Sensor input to detect when the side sweep motor is in the stowed position.

Reverse Switch: This input toggles the direction of travel from forward to reverse.

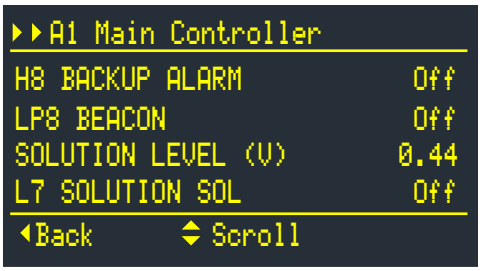
Backup Alarm: This is the output to the optional backup alarm.

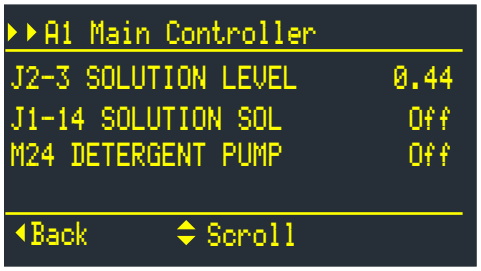
Beacon: This is an output indicator to signify when the beacon output is active.

Solution Level Sensor: This is an input from the solution level sensors, which is displayed as a voltage drop, but is measuring the current through the sensor circuit.

Solution Solenoid: This is the output indicator for the solution solenoid. It signifies that the controller is commanding the solenoid to be active.

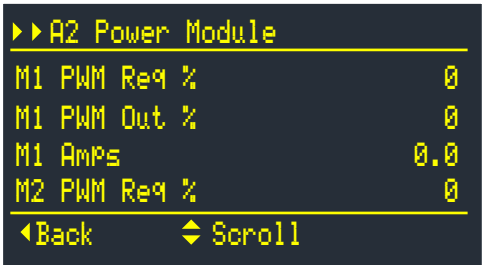
Detergent Pump: This entry is the output to the optional detergent pump.





A3 Power Module

The Power Module menu provides information regarding all of the motors which are driven by the power module. The list of information for each motor is as follows:



- **Requested PWM %:** This is the value (by percent) that the power module has been instructed to apply to the particular motor.
- **Output PWM %:** This is the actual output PWM value (in percent) that the power module is sending to the motor. When a motor is first started, its PWM out will be less than the requested PWM, as the motor speed is gradually increased.
- **Output Amps:** This is the actual amperage the power module is recording for the particular motor.

The motors are referenced by number. The actual motors are listed below:

M1 = Right Disk or Front Cyl.

M2 = Left Disk or Rear Cyl.

M3 = Side Sweep

M4 = Vacuum 1

M5 = Vacuum 2

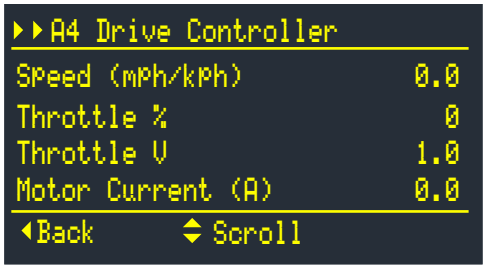
M6 = Squeegee Lift Actuator

M7 = Deck Lift Actuator

M8 = Option Pump

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.

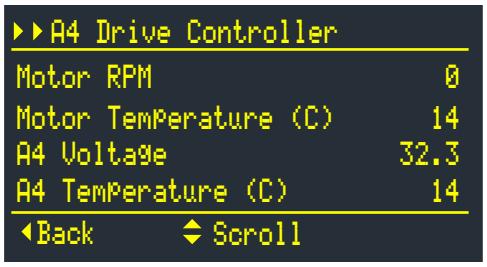


Speed (mph/kph): This displays the actual speed of the machine.

Throttle %: This displays the throttle position as percent of maximum position.

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

Motor Current: This displays the net amperage to the drive motor.



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

Motor Temperature: 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 Voltage: This represents the battery voltage present at the drive controller.

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

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 solution solenoid to be active without the scrub system active.

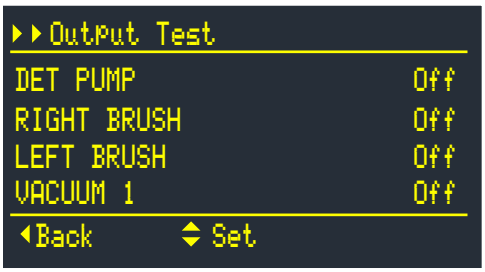
Horn: The horn is always connected to Bat+, and the Main Controller switches the Bat- connection to activate the horn.

Backup Alarm: The backup alarm is always connected to Bat+, and the Main Controller switches the Bat- connection to activate the alarm.

Beacon: The beacon is always connected to Bat+, and the Main Controller switches the Bat- connection to activate the lamp.

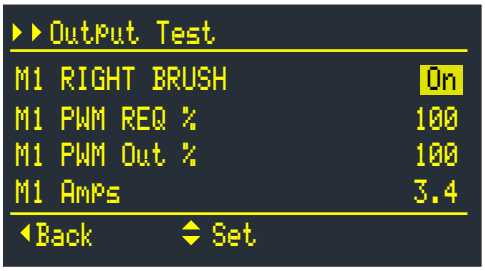
Solution Solenoid: The solution solenoid is always connected to Bat+, and the Main Controller switches the Bat- connection to activate the solenoid.

Detergent Pump: The detergent pump is actually a spring-loaded solenoid that is energized and de-energized by the controller. When energized, one output will be 12V and the other output will be 0V.

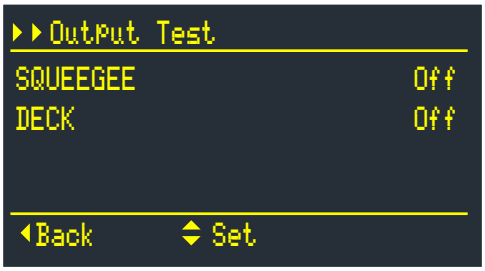


Right and Left Brush: These two screens allow On/Off control of the brush motors. The additional 3 lines provide status on the motor.

Vacuum 1 and 2: These two screens provide Off/On power control to the main vacuum and optional second vacuum motors. Pressing the Up/Down arrow buttons cycle through the power options.

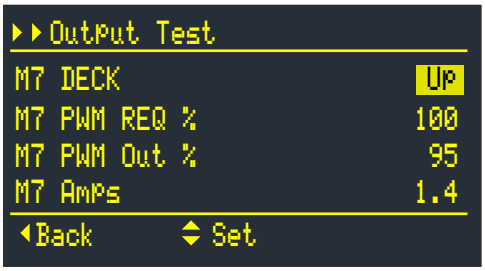


Squeegee Lift: The Squeegee Lift screen provides Up/Down/Off control for the squeegee lift actuator. However, the actuator still controls the upper and lower position limits mechanically, inside the actuator body. Therefore, if the squeegee is already raised and you issue the UP command, the actuator still will not move, because the mechanical limit is already reached. Another effect that you may notice is that the Output PWM will remain at 100%, but when the lift reaches its limit, the current drops to zero.



Deck Lift

The Deck Lift screen provides Up/Down/Off control for the deck lift actuator. However, the actuator still controls the upper and lower position limits mechanically, inside the actuator body. Therefore, if the deck is already raised and you issue the UP command, the actuator still will not move, because the mechanical limit is already reached. Another effect that you may notice is that the Output PWM will remain at 100%, but when the lift reaches its limit, the current drops to zero.



Panel Test

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

The display shows a graphical representation of all of the control panel switches. When you depress a switch **(A)**, its representation on the screen highlights **(B)** to show the press was detected.

Pressing the Down Arrow **(C)** turns on all of the panel LEDs to verify that they are functional.

Pressing the Up Arrow **(D)** will turn on (scroll) through all pixels on the display screen to detect if any pixels are dropping out.

The Left Arrow **(E)** returns to the previous menu, and the Information button **(F)** exits the menu system.

Options Menu

The Options Menu provides for making machine settings specific for the uses and needs of the operator. This menu is also available to the Supervisor, but not to the operator.

Language: This sets the interface language For the machine. The available languages are: Español, Français, Deutsch, English, Italiano, and Português

Floor: This sets the floor type for either standard or smooth.

Scrub Startup: This sets the scrub mode default at startup. The choices are Light, Heavy, Extreme, and Last Used.

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

Solution: This sets the mode for solution rate. The choices are Proportional, Fixed, and UK.

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

Lock Detergent: This sets whether the operator can adjust the detergent ratio.

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.

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.

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

Fwd Speed Max (%): 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.

Inactivity Time (min): This sets the length of time (in minutes) before the machine powers down after inactivity. The minimum is 1 minute, the maximum is 30 minutes, and the increment is every minute.

Impact Detect: This sets how the machine handles impact detection. The choices are Off, record to log, and lockout the machine.

Impact Level: This sets the threshold for impact detection. The choices are high and low.

Configuration Menu

The configuration menu provides technician-only 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.

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

Deck: This sets the deck type installed on the machine. The options are (Advance/Nilfisk) 34D/860D, 32C/810C, and 36C/910C.

Side Sweep: This sets whether the optional side broom is installed. This option is available only for 36C/910C machines. If the side broom kit also includes Dust Guard, you will also need to set the option pump type too.

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

Opt Pump: This sets whether the spray wash option pump is installed.

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

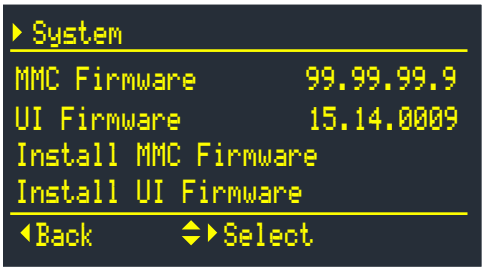
Charger: This sets whether the onboard battery charger is installed.

Vacuum: This sets whether there is 1 vacuum motor or 2 vacuum motors.

Beacon: This sets whether the beacon is installed.

TrackClean-1: This sets whether the TrackClean-1 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, and checking the impact log.

Impact Log

If an impact event occurs and the machine has been set up for the “lock out” option, a pad lock symbol is shown to the operator and scrubbing functions are inhibited. The machine can still be driven., but the machine must be powered on using a supervisor key to “reset” the lock out and restore scrubbing functions.

The impact log will display a list of impact events with an impact value of acceleration in 1/1000 G’s (Gravity). If an individual impact event is viewed, all three axis of acceleration are displayed.

Troubleshooting

Any error codes initiated by any module will be sent to the main controller via the CAN Bus, and shown on the display and recorded to the log. Each of these codes for the main controller and power module are listed in the tables below, along with some basic troubleshooting steps to help isolate the cause. The Drive Controller (A4) Error Codes are listed in the Drive System chapter on page 85.

Error Code Index

1-001 K1 KSI Relay Coil Open 41
1-002 K1 KSI Rly Coil Short 42
1-003 K1 KSI Contact Weld 43
1-010 CAN Bus 0 44
1-011 CAN Bus 1 44
1-101 Solution Solenoid Short 45
1-102 Beacon Short 45
1-103 Backup Alarm Short 45
1-105 H1 Horn Short 46
1-106 M8 Det Pump Short 46
1-201 Level Sensor 47
1-560 EEPROM Config Fault 47
1-561 EEPROM Options 47
1-562 EEPROM Sys Values 47
1-563 EEPROM Fault Log 47
1-564 EEPROM User Key List 47
1-565 EEPROM Impact Log 47
1-566 EEPROM Statistics 47
1-701 No Comm: A2 Power Mod 48
1-705 No Comm: A9 Interface Mod 48
1-710 No Comm: A3 Drive Mod 48
2-011 Precharge Fail 49
2-012 K2 Overload 50
2-013 K2 Contact Weld 50
2-014 K2 Contact Open 51
2-017 Overvoltage Cutoff 51
2-018 Undervoltage Cutoff 52
2-021 M1 Scrub Motor Open 52
2-022 M2 Scrub Motor Open 52
2-023 M3 Sweep Motor Open 53
2-024 M4 Vacuum Motor 1 Open 53
2-025 M5 Vacuum Motor 2 Open 53
2-027 M7 Actuator Motor Open 54
2-028 M8 Option Pump Motor Open 54
2-031 M1 Scrub Motor Overload 55
2-032 M2 Scrub Motor Overload 55
2-033 M3 Sweep Motor Overload 55
2-034 M4 Vacuum Motor 1 Overload 55
2-035 M5 Vacuum Motor 2 Overload 55
2-036 M6 Squeegee Act Mtr Overload 56
2-037 M7 Deck Act Mtr Overload 56
2-038 M8 Option Pump Motor Overload 56
2-041 M1 Scrub Motor Overcurrent 57
2-042 M2 Scrub Motor Overcurrent 57
2-043 M3 Sweep Motor Overcurrent 57
2-044 M4 Vacuum Motor 1 Overcurrent 58
2-045 M5 Vacuum Motor 2 Overcurrent 58
2-046 M6 Squeegee Act Mtr Overcurrent 59

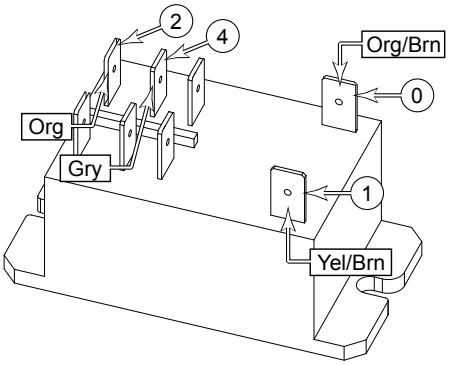
2-047 M7 Deck Act Mtr Overcurrent 60
2-048 M8 Option Pump Motor Overcurrent 60
2-051 M1 Mosfet Short. 61
2-052 M2 Mosfet Short. 61
2-053 M3 Mosfet Short. 61
2-054 M4 Mosfet Short. 61
2-055 M5 Mosfet Short. 61
2-056 M6 Mosfet Short. 61
2-057 M7 Mosfet Short. 61
2-058 M10 Mosfet Short 61
2-061 M1 Current Sensor Fault 61
2-062 M2 Current Sensor Fault 61
2-063 M3 Current Sensor Fault 61
2-064 M4 Current Sensor Fault 61
2-065 M5 Current Sensor Fault 61
2-066 OverTemp Cutoff 61
2-067 UnderTemp Cutoff 62
2-071 M1 Scrub Motor Overload Trip 62
2-072 M2 Scrub Motor Overload Trip 62
2-073 M3 Sweep Motor Overload Trip 62
2-074 M4 Vacuum Motor Overload Trip 63
2-075 M5 Vacuum Motor Overload Trip 63
2-076 M6 Squeegee Act Mtr Stall 63
2-077 M7 Deck Act Mtr Stall 63
2-078 M8 Option Pump Motor Stall 64
2-081 EEPROM Fault 64
2-082 PDO Timeout Fault 64
2-083 CAN Bus Fault 65
2-084 Internal Comm Timeout 65
2-086 Over Temp Cutback 65
2-087 Under Temp Cutback 66
2-088 K2 Coil Open 66
2-091 M1 Hardware Fault 67
2-092 M2 Hardware Fault 67
2-093 M3 Hardware Fault 67
2-094 M4 Hardware Fault 67
2-095 M5 Hardware Fault 67
2-096 Parameter Change 67
2-097 M6 Act Out Current Sensor. 67
2-098 M7 Act Out Current Sensor. 67
2-101 M10 Option Pump Current Sensor 67
2-102 Temperature Sensor Fault 68
2-103 K2 Coil Short 68
4-705 Display Lost Comms 68

Main Controller (A1) Error Codes

1-001 K1 KSI Relay Coil Open

Description	(K1 KSI Relay Open) The controller has detected that the KSI relay is not responding to a closure command.	
Setting Conditions	The controller has commanded the KSI relay to close, but 36 volts is not detected at the output contacts. (Note, because KSI is not active, this may result in multiple modules to fail to boot, causing unrelated errors to appear.)	**When Monitored** Always
Possible Causes	• Circuit breaker CB1 is open. • Loose wire at the KSI relay • Faulty relay	
Initial Action	Press the CB1 circuit breaker reset button.	

Troubleshooting Steps



1. Remove the control board from its mounting, but leave all connections intact.
2. Check the voltage between KSI contact 2 and the main ground lug in the electrical bay.
   – If 36 volts is not present, trace the fault back through CB1 and back to the main battery.
   – If 36 volts is present, continue.
3. Power the machine, and as necessary, use the service menu to ensure the KSI relay is commanded to be energized.
4. Check the voltage between KSI contact 4 and the main ground lug.
   – If 36 volts is present, repair the gray wire between the KSI relay and the main controller.
   – If 36 volts is not present, continue.
5. Check the voltage between contact 0 and contact 1 of the KSI relay coil.
   – If the voltage is at or near 36 volts, replace the KSI relay.
   – If the voltage is not near 36 volts, continue.
6. Check the voltage between contact 1 (yellow/brown wire) and the battery ground lug in the electrical bay.
   – If the voltage is not near 36 volts, repair or replace the harness between the relay and the 5-amp circuit breaker CB1.
7. Check the voltage between contact J1-3 and J1-2 at the main control board connector.
   – If the voltage is not near 36 volts, replace the main control board.
   – If the voltage is at or near 36 volts, repair or replace the wiring harness between the control board and the KSI relay.

1-002 K1 KSI Rly Coil Short

Description	The controller has detected a short circuit to the KSI relay coil.	
Setting Conditions	The amp draw exceeds 5 amps	**When Monitored** Always
Possible Causes	Short in the relay coil. Short to battery in the control line.	
Initial Action	None	

Troubleshooting Steps

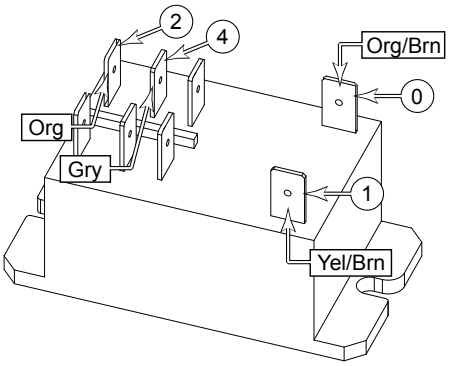
1. Disconnect the spade lugs from the relay terminals, and check if the error persists.
   - If the error clears, replace the relay.
   - If the error persists, repair or replace the wiring between the controller and the relay.

1-003 K1 KSI Contact Weld

Description	The controller has detected that the KSI relay output power is active after the controller has de-energized the relay coil.	
Setting Conditions	Power is detected at contacts J1-12 and J1-13 when the KSI relay is not commanded to be energized.	**When Monitored** Always
Possible Causes	• Fused relay contacts. • Short to B+ in relay output • Short to B- in relay coil control.	
Initial Action	None	

Troubleshooting Steps

1. Disconnect the spade lugs from the relay coil, and check if the error persists.
   – If the error clears, the relay is functioning correctly. Proceed to step 2 to isolate the cause as either a short or control board failure.
   – If the error persists, proceed to step 3 to isolate the cause as either a short or relay contact weld.



2. Isolate the cause between control wire short to ground, or main control board.
   a. Shut down the machine, and disconnect the main battery disconnect.
   b. Disconnect the J1 connector from the main control board.
   c. Disconnect the spade lugs from the KSI relay coil.
   d. Check for continuity between J1-15 (or Org/Brn at the relay) and the main grounding terminal in the electrical bay.
      – If the resistance is at or near zero ohms (continuity), repair or replace the Org/Brn wire between the relay and the main controller.
      – If the resistance is not near zero (no continuity), make one more confirmation check of the controller. Continue to next step.
   e. Leave the KSI realy coil terminals disconnected, but reconnect the J1 connector to the main control board, and re-connect the battery disconnect.
   f. Re-power the machine, verify that the KSI relay is NOT commanded to be on, and verify that the error persists.
   g. Check the voltage between J1-16 and J1-15 at the main control board.
      – If the voltage is at or near 36 volts, replace the main control board.
3. Isolate the cause between a short to power or the relay contacts welded.
   a. With the error still being reported, disconnect the output terminal from contact 4 of the KSI relay.
      – If the error clears, replace the KSI relay.
      – If the error persists, trace the gray wire emanating from the KSI relay, to repair a short to battery positive.

1-010 CAN Bus 0

Description	CAN bus 0 is in bus-off state	
Setting Conditions	Main controller has no response from any other controller on CAN0 Bus	**When Monitored** Always
Possible Causes	CAN0 wires open or shorted	
Initial Action	Reboot the machine	

Troubleshooting Steps

1. Power down the machine, and unplug the main battery disconnect.
2. Disconnect the J3 connector from the main control board.
3. Check the resistance between contacts J3-11 and J3-12 of the controller harness connector.
   - If the resistance is showing open-circuit, repair or replace the twisted pair wiring between the main controller and the user interface panel.
   - If the resistance is showing short circuit, proceed to step 4 to isolate the harness from the modules.
4. Disconnect the user interface connector, and recheck the resistance between J2-1 and J2-2.
   - If the resistance is no longer showing short circuit, replace the battery charger.
5. Disconnect the autonomy module, and recheck the resistance between J3-11 and J3-12.
   - If the resistance is no longer showing short circuit, replace the user interface panel.
   - If the resistance is still showing short circuit, repair or replace the twisted pair wiring between the main controller and the interface panel.

1-011 CAN Bus 1

Description	CAN bus 1 is in bus-off state	
Setting Conditions	Main controller has no response from any other controller on CAN1 Bus	**When Monitored** Always
Possible Causes	CAN1 wires open or shorted	
Initial Action	Reboot the machine	

Troubleshooting Steps

1. Power down the machine, and unplug the main battery disconnect.
2. Disconnect the J3 connector from the main control board.
3. Check the resistance between contacts J3-9 and J3-10 of the controller harness connector.
   - If the resistance is showing open-circuit, repair or replace the twisted pair wiring between the main controller and the drive module.
   - If the resistance is showing short circuit, proceed to step 4 to isolate the harness from the modules.
4. One module at a time, disconnect the TrackClean-1, Power module, and Drive module; and recheck the resistance between J3-9 and J3-10.
   - If the resistance is no longer showing short circuit, replace the specific module.
   - If the resistance is still showing short circuit, repair or replace the main harness.

1-101 Solution Solenoid Short

Description	Solution solenoid - too much current	
Setting Conditions	Amp Draw is higher than 5 Amps	**When Monitored** Always
Possible Causes	• Shorted Solution Solenoid • Control wire shorted to power	
Initial Action	None	

Troubleshooting Steps

Disconnect the solution solenoid and check if the error persists.

- If the error persists, the control wire is shorted to battery positive power. Repair or replace the harness.
- If the error clears, replace the solenoid.

1-102 Beacon Short

Description	Beacon - too much current	
Setting Conditions	Amp Draw is higher than 5 Amps	**When Monitored** Always
Possible Causes	• Shorted beacon • Control wire shorted to power	
Initial Action	None	

Troubleshooting Steps

Disconnect the beacon and check if the error persists.

- If the error persists, the control wire is shorted to battery positive power. Repair or replace the harness.
- If the error clears, replace the beacon.

1-103 Backup Alarm Short

Description	Backup Alarm - too much current	
Setting Conditions	Amp Draw is higher than 5 Amps	**When Monitored** Always
Possible Causes	• Shorted backup alarm • Control wire shorted to power	
Initial Action	None	

Troubleshooting Steps

Disconnect the backup alarm and check if the error persists.

- If the error persists, the control wire is shorted to battery positive power. Repair or replace the harness.
- If the error clears, replace the alarm.

1-105 H1 Horn Short

Description	Horn - too much current	
Setting Conditions	Amp Draw is higher than 5 Amps	**When Monitored** Always
Possible Causes	• Shorted horn • Control wire shorted to power	
Initial Action	None	

Troubleshooting Steps

Disconnect the horn and check if the error persists.

- If the error persists, the control wire is shorted to battery positive power. Repair or replace the harness.
- If the error clears, replace the horn.

1-106 M8 Det Pump Short

Description	Detergent pump 1 - too much current	
Setting Conditions	Amp Draw is higher than 2 Amps	**When Monitored** Always
Possible Causes	• Shorted Pump (solenoid) Winding M8 • Either control wire shorted to power or ground	
Initial Action	None	

Troubleshooting Steps

1. Disconnect both wires from the detergent pump.
2. Measure the resistance of the solenoid coil.
   - If the resistance is less than 8 ohms, replace the solenoid.
   - Otherwise, continue.
3. With the machine powered, but not scrubbing, check the voltage from each wire of the solenoid and the main ground lug.
   - If either measurement is significantly different from 12 volts (near 0 volts or near 36 volts), that wire is shorted to an alternate power source.
   - If both voltages are near 12 volts, and the error persists while the solenoid is disconnected, replace the main controller.

1-201 Level Sensor

Description	Solution tank level sensor voltage is out of range.
Setting Conditions	**When Monitored**: Always
Possible Causes	• Broken sensor • Control wire shorted to power
Initial Action	None

Troubleshooting Steps

Disconnect the solution sensor and check if the error persists.

- If the error persists, the control wire is shorted to battery positive power. Repair or replace the harness.
- If the error clears, replace the sensor.

1-560 EEPROM Config Fault
1-561 EEPROM Options
1-562 EEPROM Sys Values
1-563 EEPROM Fault Log
1-564 EEPROM User Key List
1-565 EEPROM Impact Log
1-566 EEPROM Statistics

Description	Unable to read EEPROM values - using default values
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Hard power cycle the machine by disconnecting the main bat. If the error persists, replace the main controller.

Troubleshooting Steps

1-701 No Comm: A2 Power Mod
1-705 No Comm: A9 Interface Mod
1-710 No Comm: A3 Drive Mod

Description	Do not see heartbeat messages from respective module.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	Internal software issue	
Initial Action	See below	

Troubleshooting Steps

1. Hard power-cycle the machine by disconnecting and reconnecting the battery, before powering the machine back on.
   - If the fault clears, place the machine back into service.
   - If the fault persists, continue.
2. Power down the machine.
3. Disconnect the applicable controller based on the specific error code:
4. Re-power the machine.
   - If the fault remains, replace the main controller.
   - If the fault clears, continue to step 5 to confirm the applicable module is faulty.
5. Reconnect the applicable controller, and re-power the machine.
   - If the fault remains clear, place the machine back into service.
   - If the fault returns, replace the previously disconnected module.

Power Module (A2) Error Codes

Power module error codes will be displayed on the main display. However, the error number is also flashed on the two-color status LED on the module itself. The status LED has 2 colors; red and yellow. The red LED will flash out which digit of the code is coming next, and the yellow LED will flash out the value of that digit.

For example, to flash out an M4 Overload error with a code of 034, the red LED will flash once, followed by the yellow LED flashing 3 times. Then the red LED will flash twice, followed by the yellow LED flashing 4 times.

2-011 Precharge Fail

Description	The capacitor bank failed to charge to the KSI voltage. The K2 relay will not be allowed to close.	
Setting Conditions	The DC bus did not charge to within 5 volts of the KSI voltage within 1.5 seconds.	**When Monitored** Bootup
Possible Causes	To reduce the amount of arcing inside the K2 relay when it closes, the power module pre-charges the DC bus capacitors using KSI power through a current limiting resistor. If the voltage across this resistor remains more than 5 volts, the power module knows that the DC bus is not charging properly, and something is bleeding power out of the DC bus. This may be caused by: • A device connected to the DC bus has a low to medium resistance path to ground. • Failed power module mosfets	
Initial Action	Reboot the machine to confirm the error is repeatable.	

Troubleshooting Steps

1. Power down the machine, and disconnect the main battery connector in the electrical bay.
2. Isolate the B+ circuit.
   a. Wait a few moments for the DC bus to self-discharge, and then confirm full-discharge by carefully shorting the B+ and B- lugs on the power module. (There may be a brief spark.)
   b. Disconnect the large red wire from the B+ lug on the power module.
   c. Restart the machine.(Ignore the resulting K2 Contact Open error, 2-014)
      – If the error persists, replace the power module.
      – If the error clears, go to step 3 to isolate the load versus MOSFET failure.
3. Isolate the motor circuits.
   a. Power down the machine, and disconnect the main battery connector in the electrical bay.
   b. Reconnect the main power cable to the B+ lug on the power module.
   c. Confirm full-discharge of the DC bus by carefully shorting the B+ and B- lugs on the power module.
   d. One at a time, disconnect each motor output on the power module.
   e. Restart the machine.
      – If the error clears, the motor circuit has a low to medium resistance path to ground. Diagnose and repair the circuit.
      – If the error persists and all motors have been disconnected, replace the power module.

2-012 K2 Overload

Description	Excessive current to the K2 relay coil.	
Setting Conditions	Relay coil current exceeded 2 amps.	**When Monitored** Always
Possible Causes	Degraded relay coil. Complete failure likely.	
Initial Action	Replace the K2 relay	

Troubleshooting Steps

2-013 K2 Contact Weld

Description	K2 contacts welded closed.	
Setting Conditions	The power module has detected power on the B+ input lug when the K2 relay was not commanded to be closed.	**When Monitored** Always
Possible Causes	• Relay failure. • Short to ground at the relay coil control wire.	
Initial Action	None	

Troubleshooting Steps

1. Confirm that the error is still active. If the error is active, the Power module will not be commanding the K2 relay to close. (This is necessary for troubleshooting.)
   - If the error has cleared, you will not be able to diagnose the problem. However, repetitive reoccurrence of the error may be indicative of pitting of the relay contacts, and the relay should be replaced.
   - If the error is still active, continue to step 2.
2. Check the voltage across the relay coil.
   - If the voltage is 36 volts, inspect the brown wire between the relay and power module for a short to ground.
   - If the voltage is at or near zero volts, the coil is not energized, continue.
3. Disconnect the Blue/Gray output wire from the K2 relay.
4. Check the voltage between the relay post and the battery ground post in the electrical bay.
   - If the voltage remains 36 volts, the relay contacts are welded. Replace the relay.
   - If the voltage is not 36 volts, continue.
5. Check the voltage between the disconnected Blue/Gray wire and the battery ground post.
   - If the voltage is 36 volts, the wire Is shorted to battery positive. Repair the wire.
   - If the voltage is not 36 volts, and the error persists, replace the power module.

2-014 K2 Contact Open

Description	K2 Power Module contactor did not close	
Setting Conditions	The power module did not detect power at the B+ lug when the K2 relay was commanded to close.	**When Monitored** Always
Possible Causes	• Open circuit in the relay coil • Faulty relay	
Initial Action	None	

Troubleshooting Steps

1. Check the voltage between the two coil terminals of the K2 relay.
   – If the voltage is at or near zero volts, continue to step 2
   – If the voltage is at 36 volts, proceed to step 3.
2. Check the voltage between contacts J3-2 and J3-9 at the power module.
   – If the voltage is 36 volts, repair or replace the Brown wire between J3-2 and the relay.
   – If the voltage is not 36 volts, replace the power module.
3. Check the voltage between the output contact of the K2 relay and the main ground lug in the electrical bay.
   – If the voltage is zero volts, replace the K2 relay.
   – If the voltage is 36 volts, continue to step 4.
4. Check the voltage between B+ and B- lugs of the power module.
   – If the voltage is at or near 0 volts, repair or replace the main wire between the K2 relay and the B+ lug.
   – If the voltage is 36 volts, replace the power module.

2-017 Overvoltage Cutoff

Description	Excessive voltage present at Power Module power supply	
Setting Conditions		**When Monitored** Always
Possible Causes	Faulty power module.	
Initial Action		

Troubleshooting Steps

The machine is battery-powered. There is no common failure that can cause the batteries to achieve a voltage high enough to trigger this error.

2-018 Undervoltage Cutoff

Description	Insufficient voltage present at Power Module power supply	
Setting Conditions	Voltage below 18 volts.	**When Monitored** Always
Possible Causes	Loose or corroded connection	
Initial Action	None	

Troubleshooting Steps

Isolate the cause by systematically checking voltages back to the battery. (Each test below assumes the previous tests indicated an undervoltage condition, and that the current location is the first position where full voltage was detected.)

- If multiple modules are reporting similar errors, the fault lies at or near the main battery terminals, the main ground lug, or the input lug at the K2 relay.

1. Check the voltage between the B+ and B- lugs of the power module.
   – If the voltage is at or near 36 volts, replace the power module.
2. Check the voltage between the B+ lug at the power module and the main ground lug in the electrical bay.
   – If the voltage is at or near 36 volts, repair or replace the ground wire leading to the power module.
3. Check the voltage at the output lug of the K2 relay and the main ground lug.
   – If the voltage is at or near 36 volts, replace the positive wire between the K2 relay and the power module.
   – If the voltage is below 36 volts, replace the K2 relay.

2-021 M1 Scrub Motor Open
2-022 M2 Scrub Motor Open

Description	Scrub motor is open circuit.	
Setting Conditions	The power module has detected no current on the M1 or M2 output lugs. The scrub motor uses both lugs. So these errors should be reported together.	**When Monitored** Always
Possible Causes	• If only one of these errors is reported, there is either a misplaced wire, or a short to battery power (and a short circuit error should also be reported.). • Disconnected motor. • Worn carbon brushes	
Initial Action	Check Fuse F4.	

Troubleshooting Steps

1. Unplug the brush motor connector.
2. Check the resistance between contacts 1 and 2 of the brush motor. (The static resistance should be very low.)
   – If the resistance is high (open circuit), inspect the Brush Motor Brushes described on page 185 or Brush Motor Brushes described on page 198.
   – If the resistance is low (0.5 to 1.0 ohms), repair or replace the wiring harness between the motor and the power module.

2-023 M3 Sweep Motor Open

Description	Sweep motor is open circuit.	
Setting Conditions	The power module has detected no current on the M3 output lug. .	**When Monitored** Always
Possible Causes	• Disconnected motor. • Worn carbon brushes	
Initial Action	Check Fuse F6	

Troubleshooting Steps

1. Unplug the sweep motor connector.
2. Check the resistance between contacts 1 and 2 of the sweep motor. (The static resistance should be very low.)
   – If the resistance is high (open circuit), replace the motor brushes
   – If the resistance is low (0.5 to 1.0 ohms), repair or replace the wiring harness between the motor and the power module.

2-024 M4 Vacuum Motor 1 Open
2-025 M5 Vacuum Motor 2 Open

Description	The vacuum motor is open circuit.	
Setting Conditions	The power module has detected no current on the M4 or M5 output lug.	**When Monitored** Always
Possible Causes	• Faulty wiring • Worn carbon brushes	
Initial Action	Check Fuse F7 (Vac1) or Fuse F8 (Vac 2)	

Troubleshooting Steps

1. Disconnect the vacuum motor connector in the battery bay.
2. Power up the machine and command the vacuum motor to run.
3. Check the voltage at the harness connector.
   – If the voltage is at or near 36 volts (any voltage not near 0 volts), Inspect or replace the Vacuum Motor Brushes described on page 214.
   – If the voltage is at or near zero, repair the main harness.

2-027 M7 Actuator Motor Open

Description	The power module has detected an open circuit in the deck actuator circuit.	
Setting Conditions	The power module examines the circuit for voltage drop, which should be near 0 volts when the motor is not commanded to operate.	**When Monitored** Bootup
Possible Causes	• Loose connection • Failed limit switch diode (internal fault)	
Initial Action	Check Fuse F10	

Troubleshooting Steps

1. Use the Service menu, Output test to confirm that the actuator is non-functional in either direction.
   – If the actuator is functional, and the error is still reported, replace the power module.
2. Disconnect the J6 connector from the power module.
3. Disconnect the deck actuator from the main harness. (X83, 2-pin connector).
4. Check the harness for open circuit.
   a. Check the resistance between J6-6 at the power module to contact 1 at the actuator connector.
   b. Check the resistance between J6-1 at the power module to contact 2 at the actuator connector.
      – If either reading is open-circuit, repair or replace the harness.
      – If both readings are at or near 0 ohms, replace the deck actuator.

2-028 M8 Option Pump Motor Open

Description	Wash pump motor is open circuit.	
Setting Conditions	The power module has detected no current on the M8 output.	**When Monitored** Always
Possible Causes	• Disconnected motor. • Worn carbon brushes	
Initial Action	Check Fuse F7	

Troubleshooting Steps

1. Disconnect the J6 connector from the power module.
2. Disconnect the option pump from the main harness.
3. Check the harness for open circuit.
   a. Check the resistance between J6-10 at the power module to contact 1 at the pump connector.
   b. Check the resistance between J6-11 at the power module to contact 2 at the pump connector.
      – If either reading is open-circuit, repair or replace the harness.
      – If both readings are at or near 0 ohms, replace the pump motor.

2-031 M1 Scrub Motor Overload
2-032 M2 Scrub Motor Overload

Description	M1 or M2 Scrub Motor Overload	
Setting Conditions	The brush motor uses M1 or M2 outputs. The power module detected current above 70 amps to the brush motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, but not short-circuit level, it is likely that the motor is in a locked-rotor condition.	
Initial Action	None	

Troubleshooting Steps
Inspect the scrub deck for causes of locked rotor, such as debris wrapped around the shaft or failed output bearings. If the output is not locked, replace the brush motor.

2-033 M3 Sweep Motor Overload

Description	M3 Side Sweep Motor Overload	
Setting Conditions	The side sweep motor uses the M3 output. The power module detected current above 70 amps to the side sweep motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, but not short-circuit level, it is likely that the motor is in a locked-rotor condition.	
Initial Action	None	

Troubleshooting Steps
Inspect the side sweep for causes of locked rotor, such as debris wrapped around the shaft or failed output bearings. If the output is not locked, replace the motor.

2-034 M4 Vacuum Motor 1 Overload
2-035 M5 Vacuum Motor 2 Overload

Description	M4 or M5 Vacuum Motor Overload	
Setting Conditions	The power module has detected current above 70 amps in the vacuum motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, but not short-circuit level, it is likely that the motor is in a locked-rotor condition.	
Initial Action	Replace the vacuum motor	

Troubleshooting Steps
Note that an obstruction in the suction hose will actually reduce the motor amperage, not increase it. So that is not a likely cause.

2-036 M6 Squeegee Act Mtr Overload

Description	M6 Squeegee actuator motor overload.	
Setting Conditions	The power module has detected excessive current in the squeegee lift actuator, but less than short circuit amperage.	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, it is likely that the motor is in a locked-rotor condition, such as the leadscrew nut being driven into the gear housing.	
Initial Action	Check the Squeegee Actuator Limit Adjustment described on page 204	

Troubleshooting Steps
If the actuator is properly adjusted and no signs of binding are observed, replace the actuator.

2-037 M7 Deck Act Mtr Overload

Description	M7 deck lift actuator motor overload.	
Setting Conditions	The power module has detected excessive current in the deck lift actuator, but less than short circuit amperage.	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, it is likely that the motor is in a locked-rotor condition, such as the leadscrew nut being driven into the gear housing.	
Initial Action	Check the Lift Actuator Limit Adjustment described on page 181	

Troubleshooting Steps
If the actuator is properly adjusted and no signs of binding are observed, replace the actuator.

2-038 M8 Option Pump Motor Overload

Description	M8 Wash Pump Motor Overload	
Setting Conditions	The power module detected excessive current to the pump motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, but not short-circuit level, it is likely that the motor is in a locked-rotor condition.	
Initial Action	None	

Troubleshooting Steps
Inspect the pump motor for causes of locked rotor. If the output is not locked, replace the motor.

2-041 M1 Scrub Motor Overcurrent
2-042 M2 Scrub Motor Overcurrent

Description	The power module has detected scrub motor current has exceeded the limitations of the power module.	
Setting Conditions	The power module detected current above 160 amps to the brush motor. This is a short circuit condition.	**When Monitored** Always
Possible Causes	• Motor short • Wiring short	
Initial Action	None	

Troubleshooting Steps

1. Disconnect the scrub motor, and check the resistance of the harness contacts leading back toward the power module.
   – If the resistance is at or near 0 ohms, the M1 and M2 wires are shorted to each other. Repair or replace the harness.
   – If the resistance is not near 0 ohms, then the motor is at fault. Replace the scrub motor.
   Note that the scrub motor resistance is normally very low (less than 1/2 ohm), so that is not typically used as a conclusive diagnostic test.

2-043 M3 Sweep Motor Overcurrent

Description	The power module has detected sweep motor current above 160 amps, which exceeds the limitations of the power module.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, it is likely that the motor or control wiring is shorted.	
Initial Action	None	

Troubleshooting Steps

1. Disconnect the motor connector.
2. Check the resistance between the contacts on the harness leading back toward the power module.
   – If the resistance is at or near 0 ohms, repair or replace the harness.
   – If the resistance is not near 0 ohms, replace the sweep motor.

2-044 M4 Vacuum Motor 1 Overcurrent
2-045 M5 Vacuum Motor 2 Overcurrent

Description	The power module has detected vacuum motor current above 160 amps, which exceeds the limitations of the power module.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, it is likely that the motor or control wiring is shorted.	
Initial Action	None	

Troubleshooting Steps

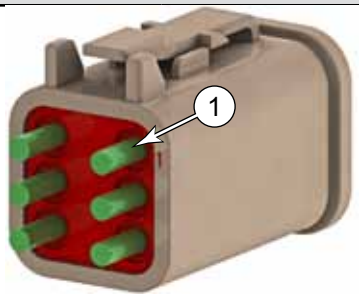
1. Disconnect the vacuum motor connector located in the battery bay.
2. Check the resistance between the contacts on the harness leading back toward the power module.
   - If the resistance is at or near 0 ohms, repair or replace the harness.
   - If the resistance is not near 0 ohms, continue.
3. Partially remove the vacuum motor to gain access to the electrical connector adjacent to the motor.
4. Check the resistance between the contacts on the harness leading back toward the power module.
   - If the resistance is at or near 0 ohms, repair or replace the sub-harness between the vacuum motor and the previous connector.
   - If the resistance is not near 0 ohms, replace the vacuum motor.

2-046 M6 Squeegee Act Mtr Overcurrent

Description	The power module has detected squeegee actuator motor current above 25 amps, which exceeds the limitations of the power module.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	• Failed actuator motor • Short between the motor windings.	
Initial Action	None	

Troubleshooting Steps

1. Measure the actuator motor resistance.
   a. Disconnect the actuator connector.
   b. Measure the resistance between contacts 1 and 2 of the actuator connector.
      • Make sure to check resistance in both forward and reverse polarity, in case the actuator is stopped at a limit switch.
      – If the resistance is less than 250 ohms, replace the actuator.
      – If the resistance is greater than 250 ohms, continue.



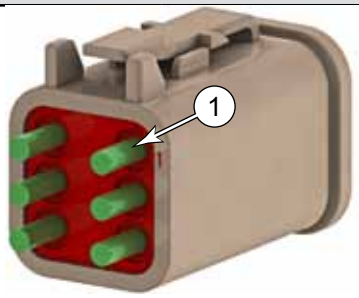
2. Test the harness.
   a. With the actuator still disconnected, power up the machine with Service mode access.
   b. Navigate to the Output Test menu and command the M6 Squeegee Actuator to operate in one direction, and then the other. Clear any errors as necessary to continue.
      – If the motor overcurrent error occurs in both directions of travel, the motor wires (BLU/GRY & ORN/GRY) are shorted to one another.
      – If the error occurs in the UP direction but not the DN direction, either BLU/GRY shorted to B-negative, or ORN/GRY shorted to B-positive.
      – If the error occurs in the DN direction but not the UP direction, either BLU/GRY shorted to B-positive, or ORN/GRY shorted to B-negative.
      • Repair or replace the harness as appropriate.

2-047 M7 Deck Act Mtr Overcurrent

Description	The power module has detected deck actuator motor current above 25 amps, which exceeds the limitations of the power module.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	• Failed actuator motor • Short between the motor windings.	
Initial Action	None	

Troubleshooting Steps

1. Measure the actuator motor resistance.
   a. Disconnect the deck actuator connector.
   b. Measure the resistance between contacts 1 and 2 of the actuator connector.
      • Make sure to check resistance in both forward and reverse polarity, in case the actuator is stopped at a limit switch.
      – If the resistance is less than 250 ohms, replace the actuator.
      – If the resistance is greater than 250 ohms, continue.



2. Test the harness.
   a. With the actuator still disconnected, power up the machine with Service mode access.
   b. Navigate to the Output Test menu and command the M7 Deck Actuator to operate in one direction, and then the other. Clear any errors as necessary to continue.
      – If the motor overcurrent error occurs in both directions of travel, the motor wires (BLU/GRY & ORN/GRY) are shorted to one another.
      – If the error occurs in the UP direction but not the DN direction, either BLU/GRY shorted to B-negative, or ORN/GRY shorted to B-positive.
      – If the error occurs in the DN direction but not the UP direction, either BLU/GRY shorted to B-positive, or ORN/GRY shorted to B-negative.
      • Repair or replace the harness as appropriate.

2-048 M8 Option Pump Motor Overcurrent

Description	The power module has detected wash pump motor current above 25 amps, which exceeds the limitations of the power module.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	Because the overcurrent condition has reached the maximum permissible amperage of the power module, it is likely that the motor or control wiring is shorted.	
Initial Action	None	

Troubleshooting Steps

1. Disconnect the motor connector.
2. Check the resistance between the contacts on the harness leading back toward the power module.
   – If the resistance is at or near 0 ohms, repair or replace the harness.
   – If the resistance is not near 0 ohms, replace the motor.

2-051 M1 Mosfet Short
2-052 M2 Mosfet Short
2-053 M3 Mosfet Short
2-054 M4 Mosfet Short
2-055 M5 Mosfet Short
2-056 M6 Mosfet Short
2-057 M7 Mosfet Short
2-058 M10 Mosfet Short

Description	The power module has detected a short circuit in the output mosfet.	
Setting Conditions	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.	**When Monitored** Always
Possible Causes	Failed power module	
Initial Action	Replace the power module	

Troubleshooting Steps

2-061 M1 Current Sensor Fault
2-062 M2 Current Sensor Fault
2-063 M3 Current Sensor Fault
2-064 M4 Current Sensor Fault
2-065 M5 Current Sensor Fault

Description	Power module current sensor fault.	
Setting Conditions	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.	**When Monitored** Always
Possible Causes	Same	
Initial Action	Replace the power module	

Troubleshooting Steps

2-066 OverTemp Cutoff

Description	The temperature of the power module has exceeded the permissible operating temperature.	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	• Ambient air temperature too warm. • Excessive motor loading for prolonged periods.	
Initial Action	Power down machine, open hood, and let cool.	

Troubleshooting Steps

2-067 UnderTemp Cutoff

Description	Internal temperature is below -40C	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	Power module failure	
Initial Action	If the error doesn't clear, replace the power module	

Troubleshooting Steps

2-071 M1 Scrub Motor Overload Trip
2-072 M2 Scrub Motor Overload Trip

Description	Scrub Motor Overload Trip	
Setting Conditions	The power module detected current above 70 amps for more than 5 seconds to the brush motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	• Failing brush motor • Obstruction to rotation, such as failed bearings or material wrapped around the motor shaft	
Initial Action	None	

Troubleshooting Steps
Inspect the scrub deck output bearings. If the bearings are not faulty, replace the brush motor.

2-073 M3 Sweep Motor Overload Trip

Description	M3 Sweep Motor Overload	
Setting Conditions	The power module has detected current above 70 amps for more than 5 seconds in the vacuum motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	Failing side sweep motor	
Initial Action		

Troubleshooting Steps
Inspect the sweep motor for obstructions. If the motor is unobstructed, replace the motor.

2-074 M4 Vacuum Motor Overload Trip
2-075 M5 Vacuum Motor Overload Trip

Description	M5 Vacuum Motor Overload	
Setting Conditions	The power module has detected current above 70 amps for more than 5 seconds in the vacuum motor, but less than a short circuit amperage.	**When Monitored** Always
Possible Causes	Failing vacuum motor	
Initial Action	Replace the vacuum motor	

Troubleshooting Steps
Note that an obstruction in the suction hose will actually reduce the motor amperage, not increase it. So that is not a likely cause.

2-076 M6 Squeegee Act Mtr Stall

Description	M6 squeegee lift actuator motor overload.	
Setting Conditions	The power module has detected excessive current in the squeegee lift actuator, but less than short circuit amperage.	**When Monitored** Always
Possible Causes	• Improper actuator adjustment • Failing actuator	
Initial Action	Check the Squeegee Actuator Limit Adjustment described on page 204	

Troubleshooting Steps
If the actuator is properly adjusted and no signs of binding are observed, replace the actuator.

2-077 M7 Deck Act Mtr Stall

Description	M7 deck lift actuator motor overload.	
Setting Conditions	The power module has detected excessive current in the deck lift actuator, but less than short circuit amperage.	**When Monitored** Always
Possible Causes	• Improper deck actuator adjustment • Failing actuator	
Initial Action	Check the Lift Actuator Limit Adjustment described on page 181	

Troubleshooting Steps
If the actuator is properly adjusted and no signs of binding are observed, replace the actuator.

2-078 M8 Option Pump Motor Stall

Description	M8 wash pump motor overload.	
Setting Conditions	The power module has detected excessive current in the wash pump, but less than short circuit amperage.	**When Monitored** Always
Possible Causes	• Failing motor	
Initial Action		

Troubleshooting Steps
Replace the pump motor

2-081 EEPROM Fault

Description	EEPROM checksum error	
Setting Conditions		**When Monitored** Always
Possible Causes		
Initial Action	Reboot the machine. If the error doesn't clear, replace the power module.	

Troubleshooting Steps

2-082 PDO Timeout Fault

Description	Did not receive PDO message from the main controller in the timeout period	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	This error likely won't be reported by the Main Machine Controller, as it would indicate a communication failure.	
Initial Action		

Troubleshooting Steps

2-083 CAN Bus Fault

Description	Internal CAN bus error
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error doesn't clear, replace the power module.

Troubleshooting Steps

2-084 Internal Comm Timeout

Description	Internal master did not receive slave controller message in timeout period
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error doesn't clear, replace the power module.

Troubleshooting Steps

2-086 Over Temp Cutback

Description	Internal temperature exceeded cutback temperature - output current will be reduced
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Shut down the machine and let it cool. If the error persists, replace the power module.

Troubleshooting Steps

2-087 Under Temp Cutback

Description	Internal temperature is below -25C - output current will be reduced	
Setting Conditions		**When Monitored** Always
Possible Causes		
Initial Action	If the error persists after the machine has warmed, replace the power module.	

Troubleshooting Steps

2-088 K2 Coil Open

Description	Main contactor coil not detected	
Setting Conditions	Same	**When Monitored** Always
Possible Causes	• Disconnected K2 relay coil • Faulty relay	
Initial Action	None	

Troubleshooting Steps

1. Leave the machine powered.
2. Check the voltage between the Gray wire at the K2 relay coil and the main ground lug in the electrical bay.
   – If the voltage is not at or near battery voltage, repair or replace the gray wire.
3. Check the voltage between the brown wire at the K2 relay coil and the main ground lug in the electrical bay.
   – If the voltage is at or near 0 volts, and the K2 relay is not active, replace the K2 relay.
   – If the K2 relay is active, and the error is still being reported, replace the power module.
   – If the voltage is at or near battery voltage, continue.
4. Check the voltage between contact J3-2 and the main ground lug in the electrical bay.
   – If the voltage is at or near 0 volts, repair or replace the brown wire.
   – If the voltage is at or near 36 volts, and the error is still being reported, replace the power module.

2-091 M1 Hardware Fault
2-092 M2 Hardware Fault
2-093 M3 Hardware Fault
2-094 M4 Hardware Fault
2-095 M5 Hardware Fault

Description	Output hardware is defective	
Setting Conditions	Internal hardware fault	**When Monitored** Always
Possible Causes		
Initial Action	Disconnect the respective motor and reboot the machine. if the error persists, replace the power module.	

Troubleshooting Steps

2-096 Parameter Change

Description	Invalid parameter change	
Setting Conditions		**When Monitored** Always
Possible Causes		
Initial Action	Reboot the machine	

Troubleshooting Steps

2-097 M6 Act Out Current Sensor
2-098 M7 Act Out Current Sensor
2-101 M10 Option Pump Current Sensor

Description	Current sensor has invalid value	
Setting Conditions	Internal error	**When Monitored** Always
Possible Causes		
Initial Action	Reboot the machine. If the error persists, replace the power module	

Troubleshooting Steps

2-102 Temperature Sensor Fault

Description	Internal temperature sensor has invalid value	
Setting Conditions	Same	**When Monitored** Always
Possible Causes		
Initial Action	Reboot the machine. If the error persists, replace the power module	

Troubleshooting Steps

2-103 K2 Coil Short

Description	K2 Power Module contactor coil is shorted	
Setting Conditions		**When Monitored** Always
Possible Causes		
Initial Action		

Troubleshooting Steps

1. Disconnect the Brown wire from the K2 relay coil.
2. Check the resistance across the relay coil terminals.
   – If the resistance is at or near 0 ohms, replace the relay.
3. Check the resistance between the loose brown wire and the Gray wire on the relay coil.
   – If the resistance is at or near 0 ohms, repair or replace the wiring between the relay and power module.

User Interface (A9) Error Codes

4-705 Display Lost Comms

Description	The user interface display has lost communication with the Main Machine Controller	
Setting Conditions	This error code is set by the display itself, and represents a loss of CAN bus communication to the MMC.	**When Monitored** Always
Possible Causes	• The MMC is known to be powered, because it is supplying the 12V needed for the display to show this error. • Failure of all or part of the CAN0 network. • MMC is at fault.	
Initial Action	Reboot the machine and see if the error persists.	

Troubleshooting Steps continued on next page

Troubleshooting Steps (4-705 Display Lost Comms)

Refer to the Wiring Diagram "Appendix A: CAN Wiring" on page 138 for wire tracing information.

1. Measure the resistance between pins 1 and 2 of the X207 CAN diagnostic port located near the MMC.
   - If the value is near 60Ω, then it can be concluded that the display is connected, the MMC is connected, and there are no short circuits between CAN-H and CAN-L. Proceed to Step 2 to check for shorts to ground.
   - If the value is near 120Ω, then is can be concluded that either the display or the MMC are disconnected (open circuit) from the CAN0 network. Proceed to Step 3.
   - If the value is near zero or significantly below 60Ω, it is likely there is a short between CAN-H and CAN-L somewhere in the network. Proceed to Step 4.
2. Check for continuity between CAN(0)-H and the main ground lug, and also between CAN(0)-L and the main ground lug.
   - If either value is at or near zero, that circuit is shorted to ground. Proceed to Step 4 to help isolate the location for repair.
   - If both values are not near zero, then testing is inconclusive and either the MMC or display is at fault, and additional testing will be required (such as polling a connected TrackClean module or using an oscilloscope) to determine which component is at fault.
3. Open Circuit Tracing:
   a. Disconnect J104 from the MMC and recheck the resistance between pins 1 and 2 of X207.
      – If the value remains near 120Ω, the open circuit is known to exist at J104 or W136/W135, near the MMC connector.
      – If the value changes to open-circuit, then the open circuit is located toward the user interface. Continue to next step.
   b. Reconnect J104 and disconnect the J10/P1 harness connector located inside the base of the steering column. (Continue).
   c. Check the resistance between pins 11 and 12 of the J10 (machine side) connector.
      – If the value is open, repair or replace the harness between J10 and J104.
   d. Check the resistance between pins 11 and 12 of the P1 (steering column side) connector.
      – If the value is open, repair or replace the steering column harness.
4. Short Circuit Tracing:
   a. One at a time, disconnect J102 (if present), J109, and finally J104 from the MMC, and recheck pins 1 and 2 of X207 for a short circuit.
      – If the short circuit cleared when you disconnected J102, repair or replace the harness leading to the Li-Ion battery.
      – If the short circuit cleared when you disconnected J109, repair or replace the harness(s) between J109 and the TrackClean module.
      – If the short circuit cleared ONLY when all 3 connectors were disconnected, then there is an internal fault in the MMC. Replace the MMC.
      – If the short circuit remains, continue to the next step.
   b. One at a time, disconnect J7 at the battery charger, and J10 to the column harness, and recheck pins 1 and 2 of X207 for a short circuit.
      – If the short circuit clears when J7 is disconnected, replace the battery charger.
      – If the short circuit clears when J10 is disconnected, repair or replace the column harness or replace the display.
      – If the short circuit persists, repair or replace the main harness.

Specifications

Sample Shop Voltage 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. Most outputs were turned on using the Service/Output test function. Machine battery voltage at time of testing was 37.25V.

J1 Main Machine Controller				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1	W102	GRY	Ground	
2				
3				
4	W152	BRN-GRY	Detergent Pump	Repeating pulse train Off/Pos//Neg/Off. Pulses too short for accurate voltage measurement.
5	W151	BRN-RED	Detergent Pump	
6				
7				
8	W074	GRY-BLU	Beacon	Not Available
9	W102	GRY	Ground	Reference
10	W078	GRY-BLU	Backup Alarm	B+ = off, 0.01 = on
11	W082	GRY-BLU	Horn	B+ = off, 0.1 = on
12	W109	YEL	KSI In	B+
13	W109	YEL	KSI In	B+
14	W145	BLU-YEL	Solution Solenoid	B+ = off, 0.1 = on
15	W106	ORN-BRN	KSI Coil Out	0.62 = on
16	W100	ORG	Bat+	B+

J2 Main Machine Controller				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1				
2				
3	W115	BLU-YEL	Solution Level +5V	5.0
4	W125	BRN	Sweep Switch	Not Available
5	W108	BLU-WHT	Seat Switch	Open = 0.2, Seated = B+
6	W030	GRN	OBC Interlock	Not Available
7	W107	GRY-BLU	E-STOP	Open = B+, Closed = 0.02
8				

J2 Main Machine Controller				
Pin#	**Wire**	**Color**	**Function**	**Observations**
9	W120	GRY-BLU	Solution Level Return	(Empty, 1 sensor, 2 sensors, 3 sensors) Actual: 0.03, 2.39, 4.51, 6.44 mA MMC Display: 0.00, 0.24, 0.44, 0.64 (The display numbers are presumed voltage across a 100 ohm internal resistor.)
10				
11				
12				
13				
14	W	ORG	+12V Out	11.69 V

J3 Main Machine Controller				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1	W133	BLK	USB Ground	0V
2	W132	GRN-WHT	USB+	3.0V
3	W131	WHT-BRN	USB-	0.7V
4	W130	RED	USB +5V	4.98V
5	W104	BLU-PNK	Smart Key In	3.33V
6	W248	RED	Power Button In	0.0V
7				
8				
9	W138	YEL	CAN-1 H	2.63V
10	W139	GRN	CAN-1 L	2.48V
11	W136	GRN-BLK	CAN-0 L	2.49V
12	W135	YEL-BLK	CAN-0 H	2.43V

J4 Drive Controller Brake				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1	W176	GRY	Brake Ground	**Parked = 33.56V, Drive = 0.15V**
2	W175	BLU	Brake +36V	**B+**

J5 Drive Controller				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1	W165	GRY	Potentiometer Gnd	0V
2	W195	YEL	CAN-1 H	2.6V
3	W196	GRN	CAN-1 L	2.5V
4	W163	BLU-GRY	Seat Switch In	Open = 0.02V, Seated = B+
6	W164	BLU-YEL	E-Stop In	Closed = B+, Open/Active = 0.02V
8	W193	PNK-YEL	Programmer Data	N/A
9	W194	PNK-BLU	Programmer Clock	N/A
10	W166	RED	Potentiometer +5V	N/A
12	W198	RED-ORG	+15V Out	13.3V
13	W168	VIO	Throttle In (Pot Wiper)	1.0 to 4.0V through full range movement
15	W173	VIO	Motor Temperature In	1.18V = -114°C (faulty thermocouple)
18	W189	GRY	I/O Ground	0V
19	W188	VIO-GRN	Encoder A	AC V = 2.78 at full speed 0 V at park
20	W187	VIO-ORN	Encoder B	
21	W186	VIO-YEL	Encoder C	
22	W162	YEL	KSI In	B+
23				
24				
Motor Lugs				
U				0 to 12.7 V AC, from parked to full speed Machine raised off the ground
V				
W				

J6 Power Module				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1	W232	BRN-GRY	Deck Actuator -	Down = 3.8 V, Up = 34.2 V, Stationary = 3.8 V
2	W019	BRN	K2 Coil Out	
3	W245	GRN	CAN-1 L	
4	W244	YRL	CAN-1 H	
5	W240	RED	Curtis Prog +15V	
6	W231F	BRN-RED	Deck Actuator +	Down = 37 V, Up = 0.1 V, Stationary = 0 V
7	W242	PNK-YEL	Curtis Prog RX	
8	W243	PNK-BRN	Curtis Prog TX	
9	W202	YEL	KSI In	B+
10	W233F	BLU-RED	Opt. Pump +	
11	W234	BLU-GRY	Opt. Pump -	
12	W241	BLK	Curtis Prog Gnd	
13	W230	BRN-WHT	Squeegee Act. +	Down = 3.7 V, Up = 37 V, Stationary = 3.7 V
14	W229F	GRN-RED	Squeegee Act. -	Down = 37 V, Up = 0 V, Stationary = 0 V

Maintenance

Firmware Update

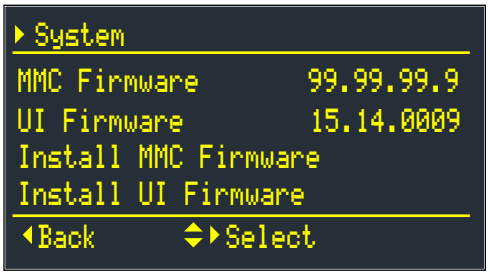
Both the Main Controller (MMC) and User Interface (UI) firmwares can be updated using the built-in USB access port below the steering wheel.

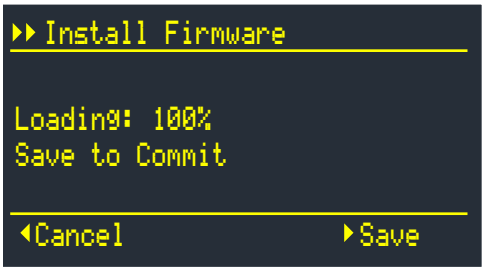
Note: *It is essential that the major release revision of the MMC and the UI are compatible. Having incompatible MMC and UI revisions could result in an inoperable machine. The best way to ensure compatibility, is to obtain the latest revision file of each one and update them both.*

Requirements:

- MMC Filename = 56117207.nff
- UI Filename = 56117212.nff
- USB flash drive formatted for FAT/FAT32 with the files located in the root directory.

1. Copy the firmware file to the root directory of a USB flash drive. The file needs to be located in the root directory or the Controller won't know where to find it.
2. If the file names include revision identifiers or other variations from the required names, rename the files to the names listed above.
3. Start the machine with Service Mode Access:
   - While holding the Scrub and Vacuum buttons, press and release the power button, and then release all buttons.
4. Insert your USB flash drive into the USB port.
5. Press the Information button to enter the machine menu, and scroll down to the System menu, and then select "Install Firmware".
6. The display will show the revision level of the new firmware. Press the Up navigation arrow to install the firmware.
7. The display will show the progress, and when complete, will display "Save to Commit".
8. Press the Right navigation arrow to save the file, which will be installed when the machine is restarted. To cancel the installation, press the Left navigation arrow.
9. If necessary, repeat the last steps to load the second firmware file.
10. Power down the machine and wait at least 15 seconds before restarting the machine.





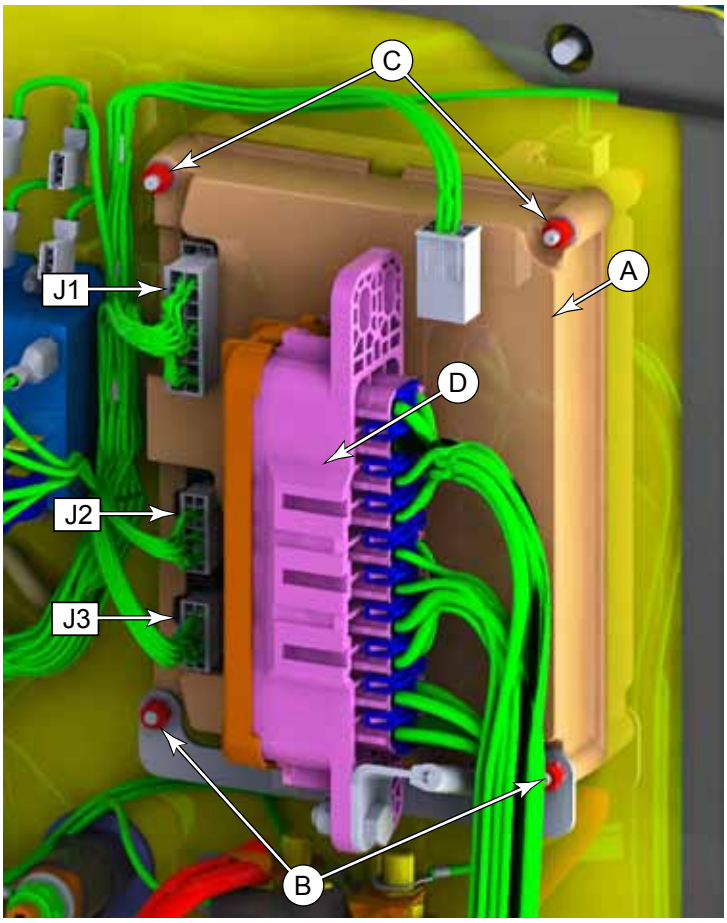
11. Navigate back to the system menu to confirm the appropriate firmware revision is installed.

Removal and Installation

Main Machine Controller

CAUTION: The main controller is always receiving power, even when the machine is off. Make sure to disconnect the main battery connector before working on the control board.

1. Iff the machine is functional enough to access the service menu, enter the Configuration and Options menus and record the existing values.
   - While holding the Scrub and Vacuum buttons, press and release the power button to start the machine with service-mode access.
   - Record the existing values in the tables provide on page 2 of this procedure.
2. Turn the machine off and disconnect the main battery connector in the battery bay.
3. Disconnect the J1, J2, and J3 connectors from the controller.
4. Remove the two lower nuts **(B)** that secure the fuse block **(D)** and controller **(A)** to the electrical bay. Move the fuse block to the side.
5. Remove the upper two nuts **(C)** that secure the controller, and remove the controller.
6. Install the new controller following the reverse of the steps.



Configure the Controller

7. While holding the Scrub and Vacuum buttons, press and release the power button to start the machine with service-mode access.

8. Press the Information button to enter the menu system, and navigate to the Configuration menu.
   - Prior to replacement, and if possible, enter any existing configuration information into the table below to transfer the settings to the new controller.
   - After replacement, transfer these settings into the new controller.

Configuration		
Parameter	**Range**	**Value**
Brand	Advance/Nilfisk	
Deck	32C/36C/34D	
Side Sweep	Yes/No	
Ecoflex	Yes/No	
Opt Pump	Spray Wash/None	
Battery	Type, MFG, Model	
Charger	Yes/No	
Vacuum	Single/Dual	
Beacon	Yes/No	
TrackClean-1	Yes/No	

9. Navigate to the Options menu.
   - Prior to replacement, and if possible, enter any existing configuration information into the table below to transfer the settings to the new controller.
   - After replacement, transfer these settings into the new controller.

Options		
Parameter	**Range**	**Value**
Language	List	
Floor	Standard, Smooth, Polisher	
Scrub Startup	Last, Light, Heavy, Extreme	
Scrub Max	Light, Heavy, Extreme	
Solution (Mode)	Prop, UK, Fixed	
Solution In Rev	Yes/No	
Lock Detergent	Yes/No	
Beacon	On/Off	
Neutral Delay (s)	0.5-5.0	
Vac Off Delay (s)	10-20	
Burst of Power (s)	60-300	
Fwd Speed Max (%)	50-100	
Lock Speed Limit	Yes/No	
Inactive Time (min)	1 to 30	
Impact Detect	Off/Lockout/Log	
Impact Level	Low/High	

14 - Wheel System, Non-Traction

Functional Description

The non-traction wheels are intended to carry the majority of the machine's weight. The wheels are strategically located below the battery compartment and between the recovery and solution tanks. The non-traction wheels are mounted directly to the machine's subframe.

Removal and Installation

Rear Wheel Bearings and Seal

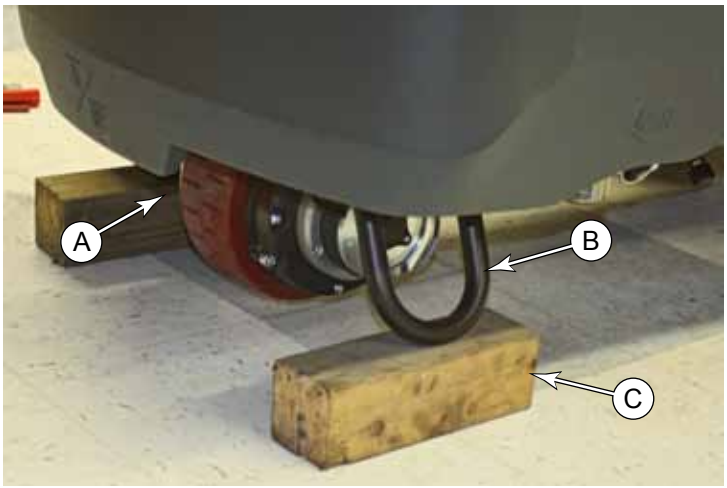
The rear wheel bearings are sealed and do not require lubrication. Severely worn bearings may be detected by wheel wobble or grinding sounds. A less obvious symptom of bearing failure is when the wheel easily freewheels when spun by hand with the machine elevated off the ground. A good sealed bearing should have a slight but smooth resistance to freewheel.

The wheel bearings are pressed into the wheel hub. To complete this procedure, you will need a bearing puller and a press. There are many different types of bearing pullers that will operate on the internal bore of a bearing (35mm in this case). As one example, a pilot bearing puller is shown to the right.

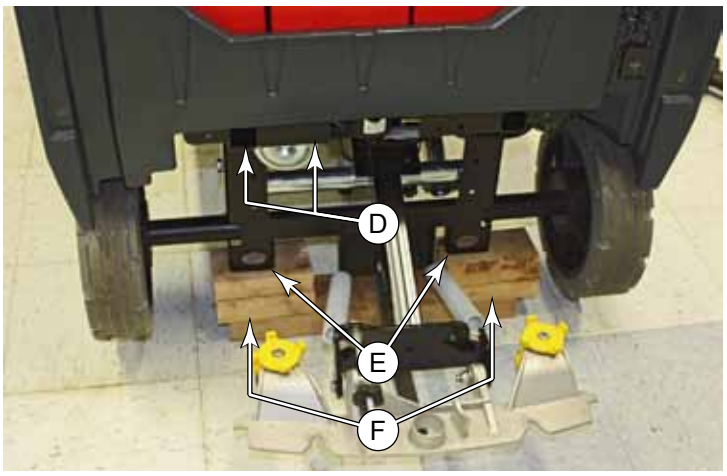
WARNING: Never work under a machine without safety stands or blocking to support the machine.

– ***Never jack the rear of the machine without first stabilizing the front of the machine.***

1. To reduce the weight of the machine, drain both the recovery and solution tanks.
2. Using the lifting point **(A)** located on the right anti-tip hoop, raise the front of the machine, and place support blocks **(C)** under both anti-tip hoops **(B)**.
   - Failure to stabilize the front of the machine can result in the machine being unstable when the rear end is lifted.

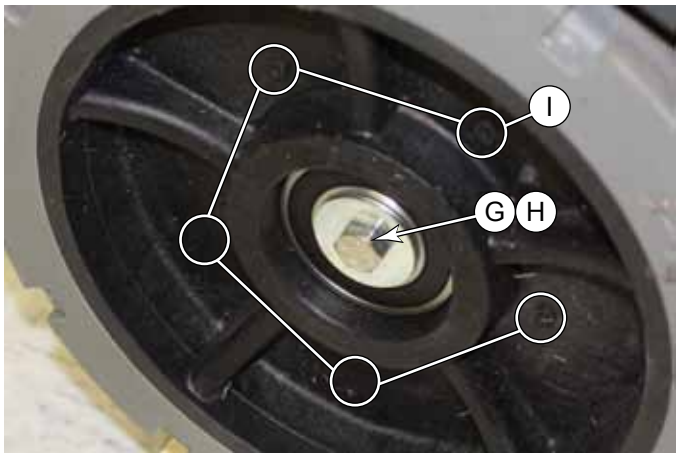


Note: *The machine is shown with the recovery tank and squeegee removed for clarity. It is not necessary to remove them for this procedure.*

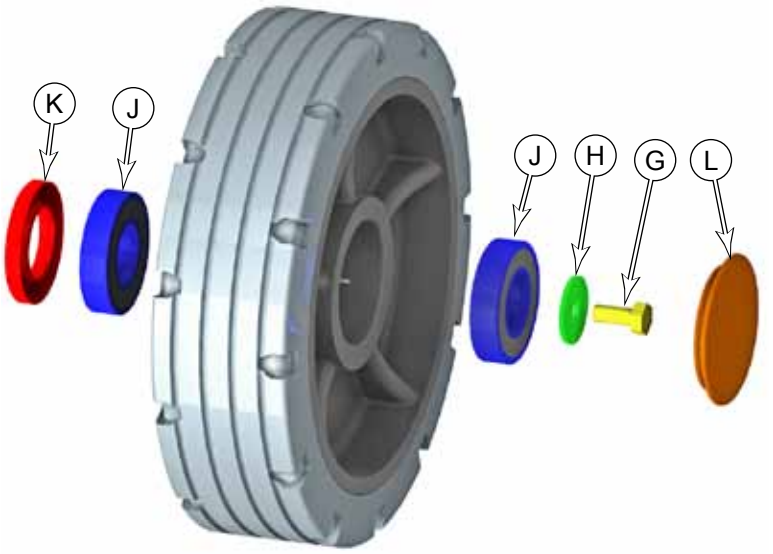


3. Using the left side of the chassis, as close to the center as possible **(D)**, raise the rear of the machine, and place blocks **(F)** under the tie-down eyelets **(E)**.

4. Remove the 5 screws **(I)** that secure the brake rotor to the wheel, and rest the rotor on the axle.
5. Using a sharp tool, such as a knife or chisel, pry the dust cap **(L)** off the wheel hub.
6. Using a 17mm socket, remove the screw **(G)** and washer **(H)** that secures the wheel to the axle, and remove the wheel.

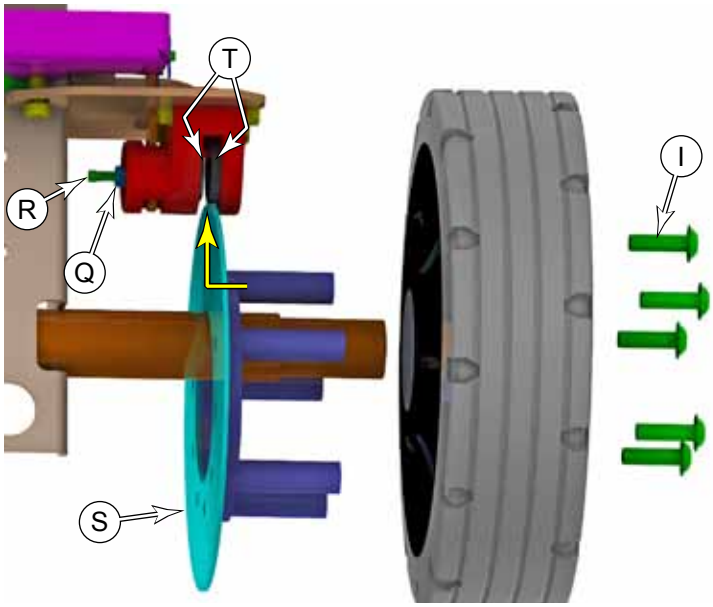


7. Using a seal puller or similar means, pull the inboard seal **(K)** from the wheel hub.
   - The act of removing the seal will destroy the seal. You must replace the seal with a new one.
8. Using a suitable bearing puller, remove both the inboard and outboard bearings **(J)**.



Replacement

9. Press new bearings into the hub. Make sure to press along the outer race (72mm Ø) to avoid damaging the bearing.
10. Press a new inboard seal into the hub, and apply a light film of general purpose lithium grease to the seal lip.
11. Apply a thin film of anti-seize (loctite LB 8150, LB 8009, or equal) to the axles before installing the wheels.
12. Slide the rotor disk **(S)** in between the inboard and outboard brake pads **(T)**.
13. Slide the wheel on to the axle, and reinstall the 5 screws **(I)** holding the rotor to the wheel.
14. Reinstall the wheel.



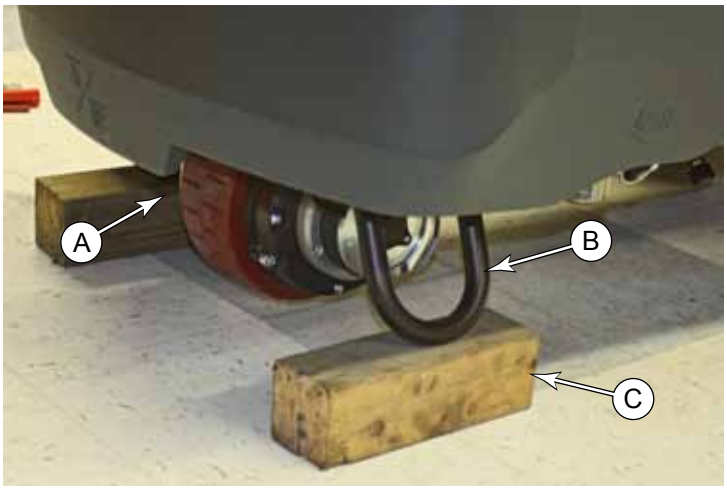
Rear Brake Calipers

Calipers should be replaced in pairs. The calipers are right- and left-handed. The difference between the two is the arrow direction stamped on to the actuator bar, which must point toward the rear of the machine.

WARNING: Never work under a machine without safety stands or blocking to support the machine.

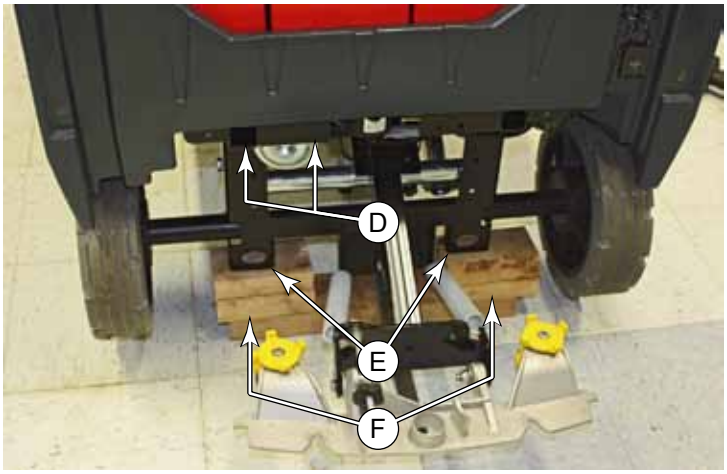
– ***Never jack the rear of the machine without first stabilizing the front of the machine.***

1. To reduce the weight of the machine, drain both the recovery and solution tanks.
2. Using the lifting point **(A)** located on the right anti-tip hoop, raise the front of the machine, and place support blocks **(C)** under both anti-tip hoops **(B)**.
   - Failure to stabilize the front of the machine can result in the machine being unstable when the rear end is lifted.



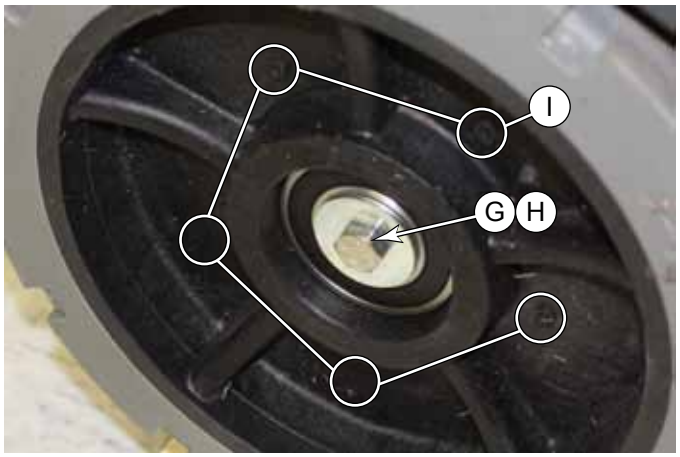
Note: *The machine is shown with the recovery tank and squeegee removed for clarity. It is not necessary to remove them for this procedure.*

3. Using the left side of the chassis, as close to the center as possible **(D)**, raise the rear of the machine, and place blocks **(F)** under the tie-down eyelets **(E)**.

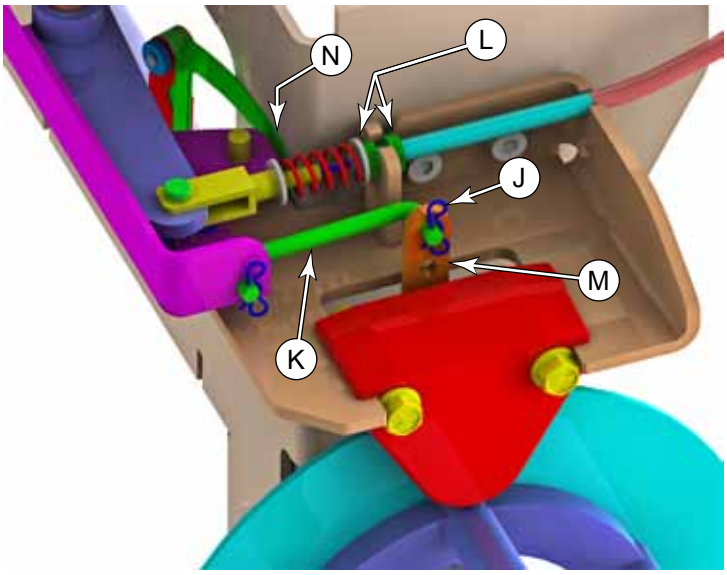


Remove Both Right and Left Wheels

4. Remove the 5 screws (I) that secure the brake rotor to the wheel, and rest the rotor on the axle.
5. Using a sharp tool, such as a knife or chisel, pry the dust cap **(L)** off the wheel hub.
6. Using a 17mm socket, remove the screw **(G)** and washer **(H)** that secures the wheel to the axle, and remove the wheel.
7. Repeat for the second wheel.



Remove Both Calipers



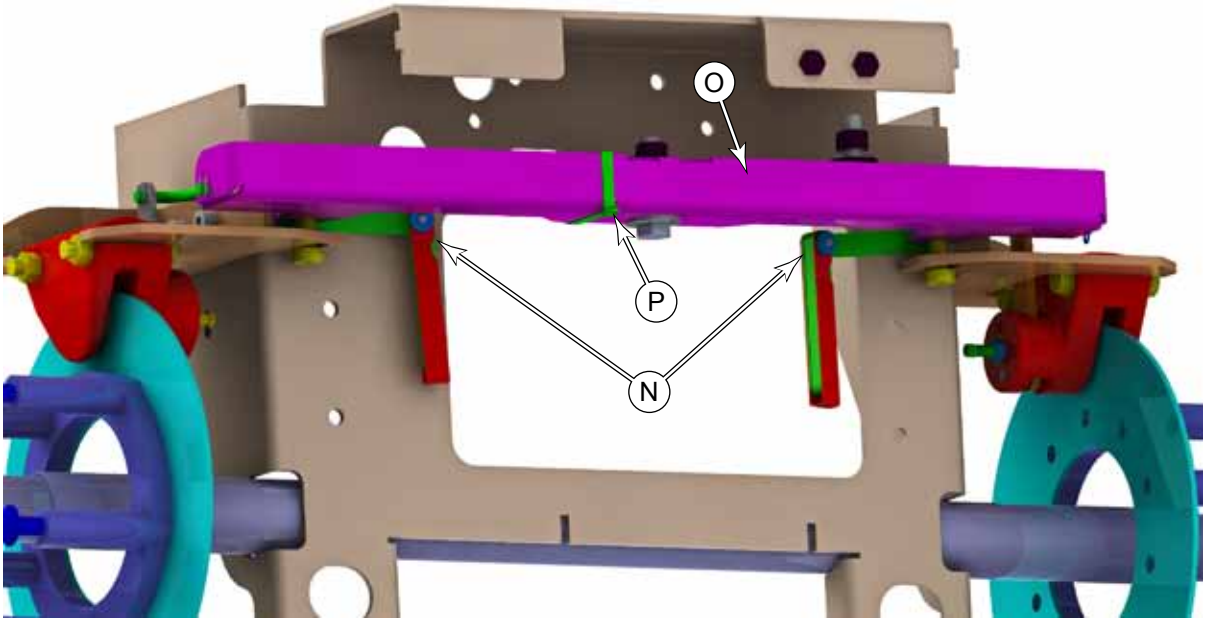
8. Remove the cotter Pin **(J)** and disconnect the link arm **(K)**.
9. Slide the caliper off the mounting bracket.
10. Repeat for the second caliper.

Check/Adjust the Cable Length

Before the calipers can be adjusted, the balance bar **(O)** must be parallel to the frame and at a known distance. This part of the procedure is best completed before the new calipers are installed.

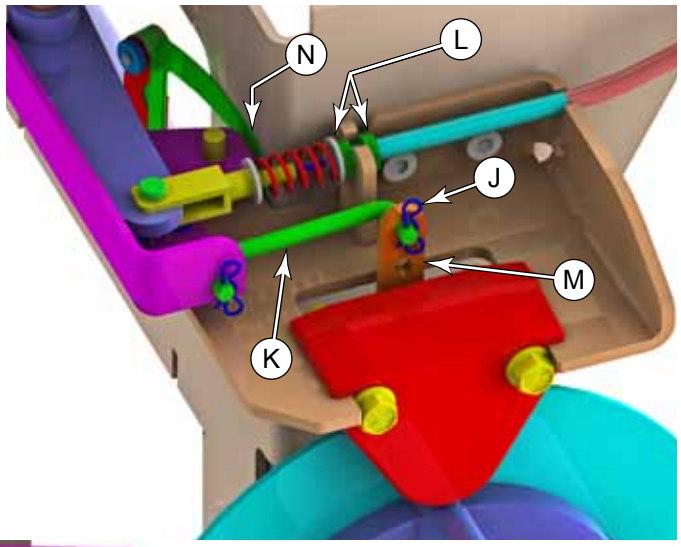
You will need a pair of 3 to 4 mm shims and a long cable tie, string, or tape. This setup should remain in place for the remainder of the procedure.

11. Make sure the brake pedal is released and in its relaxed, upright position.
12. Place a pair of 3 to 4 mm shims (or feeler gauges) **(N)** between the balance bar **(O)** and the main chassis, as shown. If necessary, tape the shims down so they remain in place.
13. As necessary, adjust the two cable adjustment nuts **(L)** so the balance bar just touches both shims evenly. Retighten the nuts.
14. To keep the balance bar in this position for the remainder of the procedure, temporarily secure it against the shims/frame with a cable tie **(P)**.



Install the Calipers

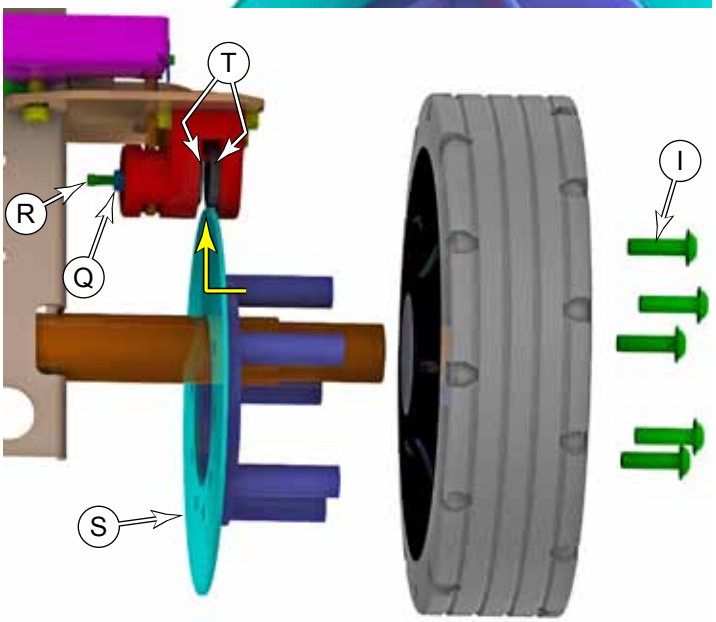
The calipers are right- and left-handed. There is an arrow stamped into the actuator bar **(M)**. Make sure the arrow is pointing toward the rear of the machine when the caliper is mounted.



15. Apply some general purpose grease to the slide area of the caliper mounting bracket.
16. Slide the caliper onto the mounting bracket.
17. Connect the link arm **(K)** to the upper hole in the actuator bar **(M)**, and install the cotter pin.

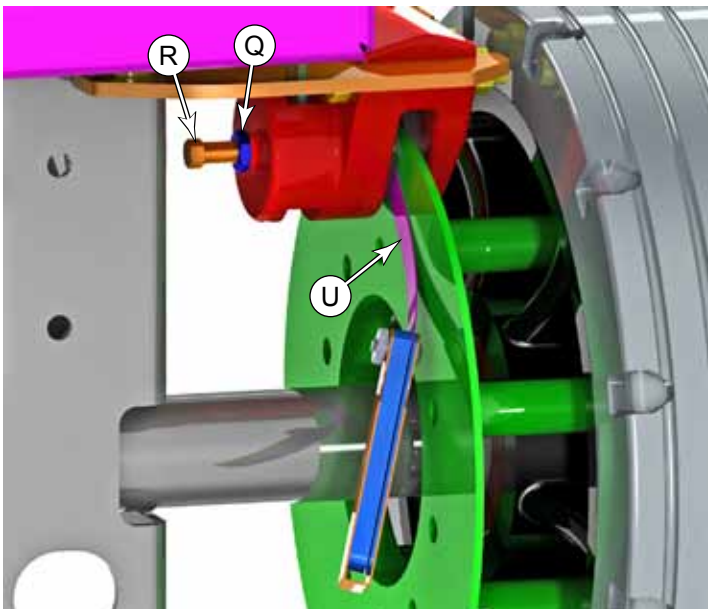
Reinstall the Wheels

18. Apply a thin film of anti-seize (loctite LB 8150, LB 8009, or equal) to the axles before installing the wheels.
19. Apply a film of general purpose lithium grease to the seal on the inside of the wheel hub.
20. Loosen the jam nut **(Q)** on the back of the caliper.
21. As necessary, unscrew the caliper adjustment screw **(R)** until the rotor **(S)** can fit between the brake pads **(T)**.
22. Raise the rotor in between the brake pads, slide the wheel onto the axle, and install the 5 mounting screws **(I)** that secure the rotor to the wheel.
    - Torque the screws to 15 lb•ft (20 N•m)
23. Secure the wheel to the axle using the screw **(G)** and washer **(H)**.



Adjust the Caliper Actuator

24. Make sure the balance bar is still held 3 to 4 mm away from the chassis.
25. Place a 0.020” (0.5 mm) feeler gauge **(U)** between the rotor and the brake pad.
26. Tighten the adjustment screw **(R)** until the brake pad lightly presses against the feeler gauge.
27. Tighten the jam nut **(Q)**.
28. Repeat for the second caliper.
29. Remove the shims **(N)** and cable tie **(P)** from the balance bar, and test the brakes before releasing the machine.



20 - Drive System

Functional Description

The drive system of the SC5000 machine consists of a single drive wheel with an integral motor. The drive wheel connects to the subframe with a rotational bearing and flange to provide steering rotation.

Steering control is made through the steering column that passes through a universal joint to translate the rotation from the angled steering wheel to the vertical shaft and pinion sprocket. The pinion sprocket drives a chain that wraps around the steering sprocket. The steering sprocket has no chain teeth, but the chain is fixed to the sprocket at the ends of the chain using standard master links.

Drive Motor

The drive motor is a 3-phase, remotely commutated, permanent magnet AC 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. Three 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

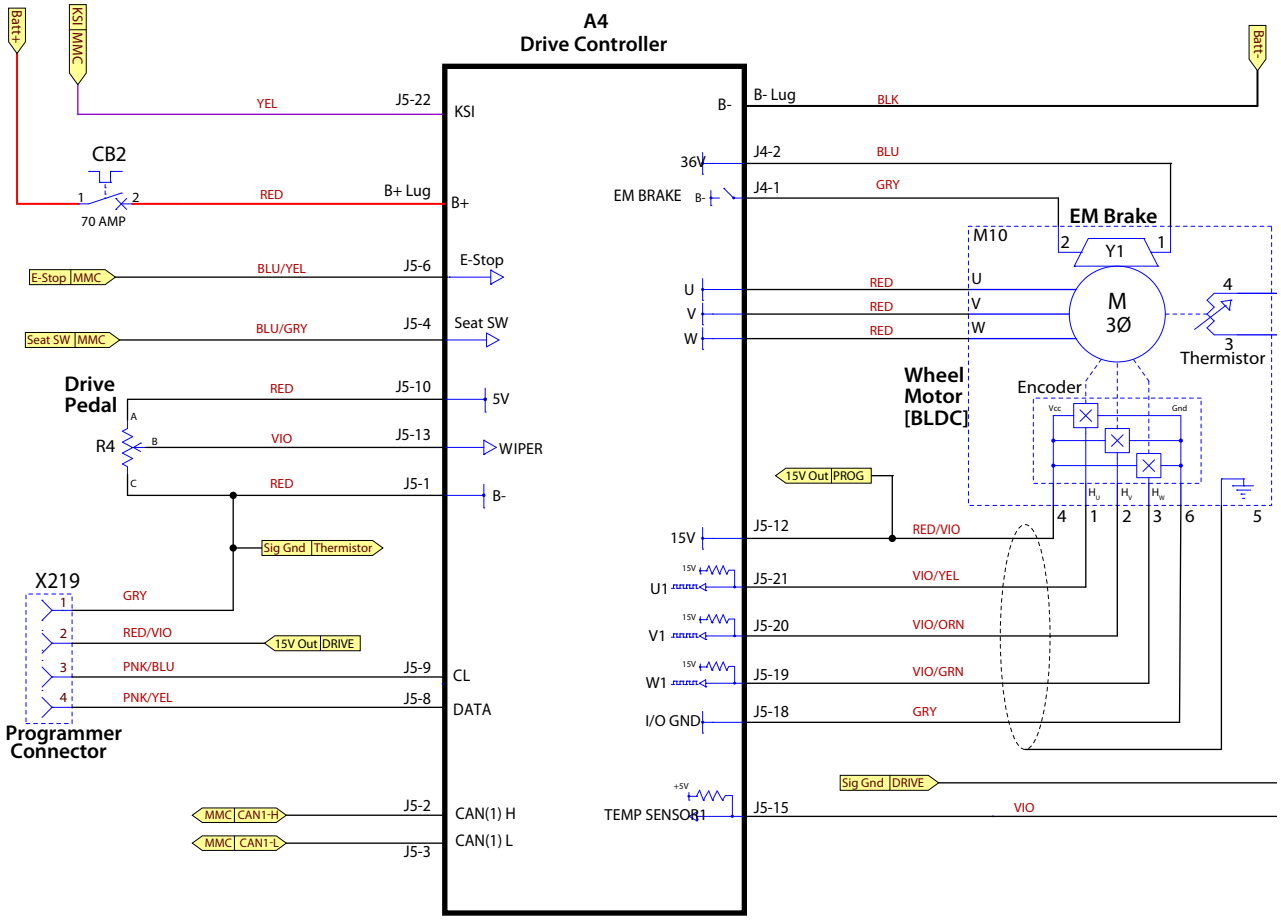
The drive pedal potentiometer (R3 pot) is a variable resistor connected to the Pin J5-13 input of the drive controller, with pins J5-1 and J5-110 as reference voltages. As the resistance changes, the drive controller increases or decreases drive motor speed.

The drive pedal is set up in a linear configuration, where drive speed is controlled by the drive pedal, and the drive direction is commanded from the Main Machine Controller via the CANBus. The speed controller interprets any voltage between 1.0V and 4.0V as a valid speed command, and any voltage outside of that range as deadband.

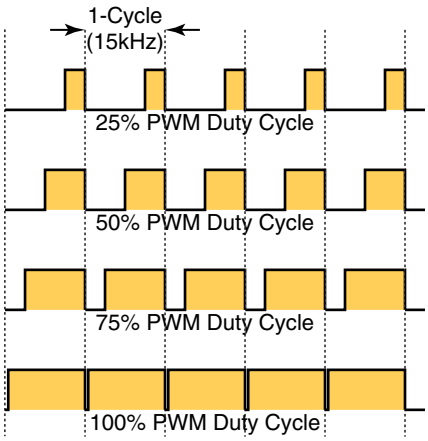
Drive Controller

The KSI relay provides logic power to the drive controller. When the main machine controller is not energizing the KSI relay, the drive controller has no logic power. However, the drive controller has unswitched power through the CB2 circuit breaker, which provides separate high-current power output for the motor control. The drive controller also monitors the E-stop switch and seat switch, so that either one can disable the drive output. Output is disabled if either the seat switch or E-stop is open. The drive controller also receives many of its operating parameters from the main machine controller.

The motor contains an electromechanical brake, that releases only when power is present. The drive controller releases the brake when the wheel motor is commanded to turn.



The drive motor is controlled from a Phoenix drive controller, which is a 3-phase 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 (15kHz 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.



Operational Mode Prerequisites

Before the main controller can activate any of the operational modes, it must first check that the appropriate prerequisites are met.

- **Drive Controller outputs**
  - Drive wheel motor
    - No “interlock” message from the main controller on the CAN bus (only active during auto disc brush install mode)

Troubleshooting

Drive Controller (A4) Error Codes

The drive controller error codes will be displayed on the main display. However, the error number is also flashed on the two-color status LED on the module itself. The status LED has 2 colors; red and yellow. The red LED will flash out which digit of the code is coming next, and the yellow LED will flash out the value of that digit.

For example, to flash out an M4 Overload error with a code of 034, the red LED will flash once, followed by the yellow LED flashing 3 times. Then the red LED will flash twice, followed by the yellow LED flashing 4 times.

3-008 Battery Voltage

Description	The battery voltage is too high or too low.	
Setting Conditions		**When Monitored**
		Always
Possible Causes		
Initial Action	Reboot the machine. .	

Troubleshooting Steps

3-017 Brake Short
3-018 Brake Open

Description	The drive controller has detected an open or short circuit on the brake solenoid.	
Setting Conditions		**When Monitored**
		Always
Possible Causes		
Initial Action		

Troubleshooting Steps

3-019 Quickstop Active

Description	A drive inhibit signal was activated while the machine was in motion.

Setting Conditions	**When Monitored**
	Always

Possible Causes

Initial Action

Troubleshooting Steps

3-020 Throttle not in Neutral

Description	The throttle potentiometer was not within the neutral deadband during initialization

Setting Conditions	**When Monitored**
	Always

Possible Causes

Initial Action Reboot the machine.

Troubleshooting Steps

3-033 Motor Short

Description	A short circuit was detected at the output to the wheel motor.

Setting Conditions	**When Monitored**
	Always

Possible Causes

Initial Action

Troubleshooting Steps

3-034 Motor Open

Description	An open circuit was detected at the output to the wheel motor.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	

Troubleshooting Steps

3-035 Power Relay Short

Description	False Error. This machine does not use a K3 relay.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-036 PSL Moto Short

Description	False Error. This machine does not use a Power Seat Lifter Motor.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-040 Motor Sensor Error

Description	Unexpected signals from the 3 commutator sensors.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-041 Temp Sensor Fault

Description	The temperature sensor input is out of range.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-042 Hi-V Protect Error

Description	An overvoltage condition was detected on the output to the motor.
Setting Conditions	**When Monitored**: Always
Possible Causes	Intermittent open circuit or arcing
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-049 FET Over-Temp

Description	The temperature of output power transistors is too high. The machine will be operating in thermal cutback.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	

Troubleshooting Steps

3-050 Motor Over-Temp

Description	The wheel motor's internal sensor is reporting a high temperature.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-065 Charger V Too High
3-066 Charger Cycle Timeout
3-067 Charger Over-Temp

Description	False error. The charger is not controlled by the drive controller on this machine.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-081 Low FET Error
3-082 High FET Error

Description	Precharge error with the internal DC Bus during initialization.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Disconnect the battery for 1 minute, and reboot the machine.

Troubleshooting Steps

3-083 Throttle Failband
3-084 Throttle Failband 2

Description	The throttle input is outside of the permitted range.
Setting Conditions	**When Monitored**: Always
Possible Causes	Direct short in the throttle signal, or a short to a power source.
Initial Action	

Troubleshooting Steps

3-113 Controller Over-Temp

Description	The internal drive controller sensor is reporting a temperature above operating limits. The drive controller will be disabled.
Setting Conditions	**When Monitored**: Always
Possible Causes	
Initial Action	Reboot the machine. If the error persists, replace the drive controller.

Troubleshooting Steps

3-255 Internal Failure

Description	The drive controller is detecting an internal error.

Setting Conditions	**When Monitored**
	Always

Possible Causes

Initial Action Reboot the machine. If the error persists, replace the drive controller.

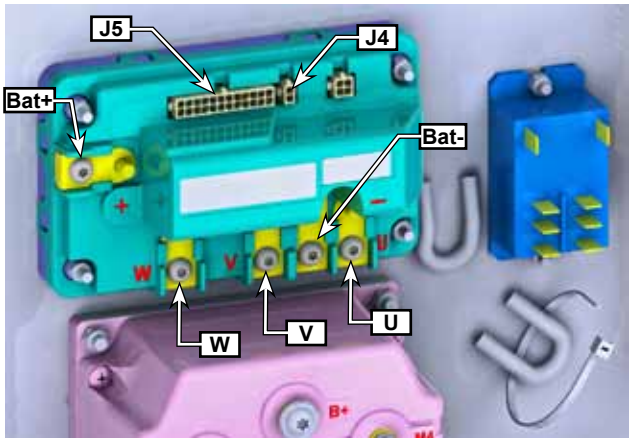
Troubleshooting Steps

Removal and Installation

Drive Controller

WARNING: Disconnect the main battery connector before servicing the drive controller. The drive controller has high-amperage, unswitched battery power at its terminals.

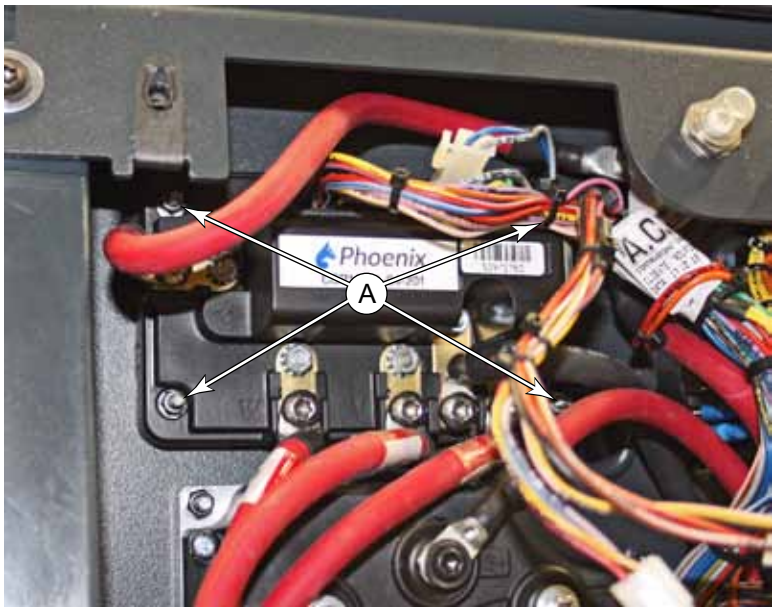
1. Turn off the machine and disconnect the main battery connector.
2. Remove the 4 screws that secure the electrical bay cover, and remove the cover.
3. Disconnect the EM brake connector **(J4)** from the drive controller.
4. Disconnect the logic cable connector **(J5)** from the drive controller.
5. Disconnect the battery positive and negative connections **(Bat+, Bat-)** from the drive controller.



6. Make sure the motor leads are labeled for reassembly, and then disconnect the three motor leads **(U, V, W)**.

Note: *If any of the wires are reversed during replacement, the drive motor will rotate backward and operate loudly as the motor windings conflict with one another. The drive controller will also likely issue an encoder fault because the encoder will provide unexpected results.*

7. Remove the 4 nuts **(A)** from the outer corners of the module that secure the module to the machine frame, and remove the module.



Replacement Notes

- When replacing the controller, torque the nuts to 18 to 19 lb•in (2.1 to 2.2 N•m).
- When replacing the wire lugs, torque the screws to 28 to 33 lb•in (3.2 to 3.8 N•m).
- After replacement, test the machine drive functions in an open area to ensure proper operation.

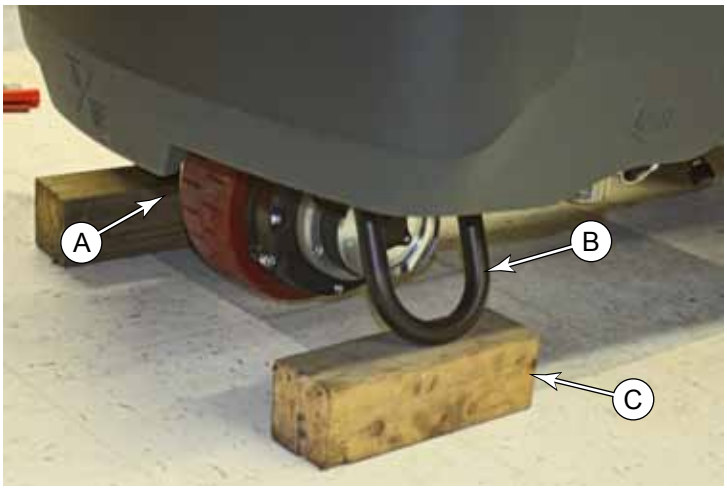
Drive Wheel Assembly

WARNING: Never work under machine without safety stands or blocking to support the machine. Disconnect the battery connector before servicing machine.

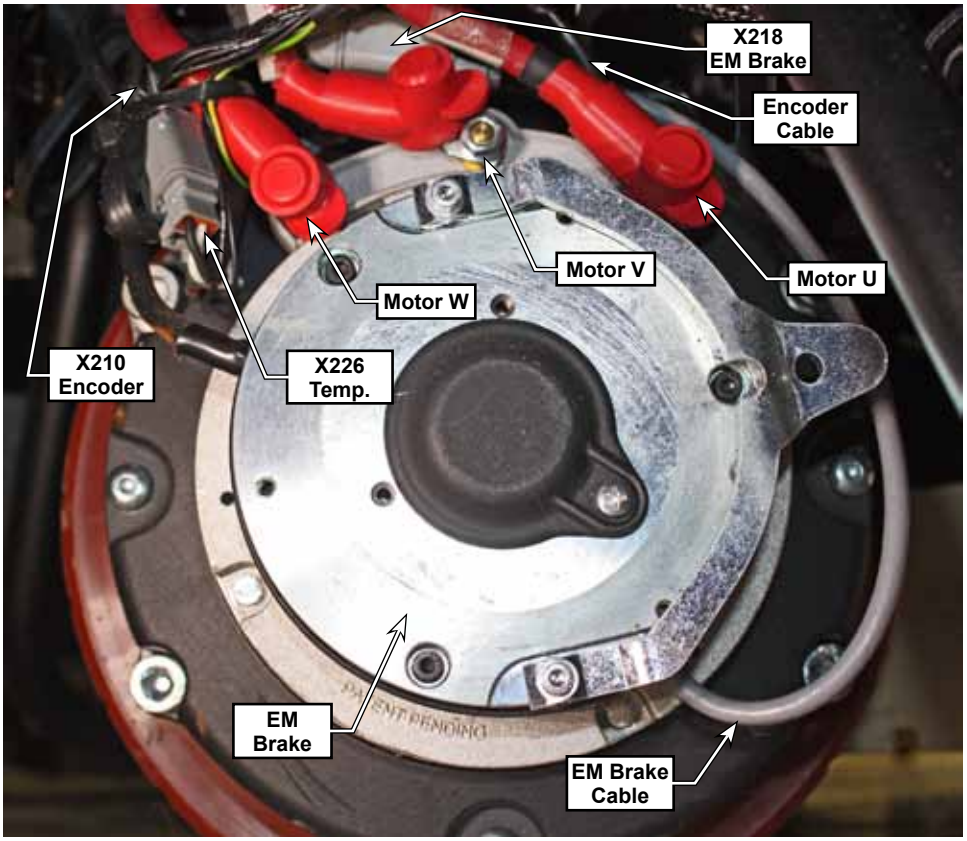
1. Turn off the machine and disconnect the batteries.
2. To reduce the weight of the machine, drain both the recovery and solution tanks.

Note: *Raising the machine at this point in the procedure is optional, and may assist you in disconnecting the steering chain. However, you will have to lower the machine while the spindle nut is being removed later in the procedure.*

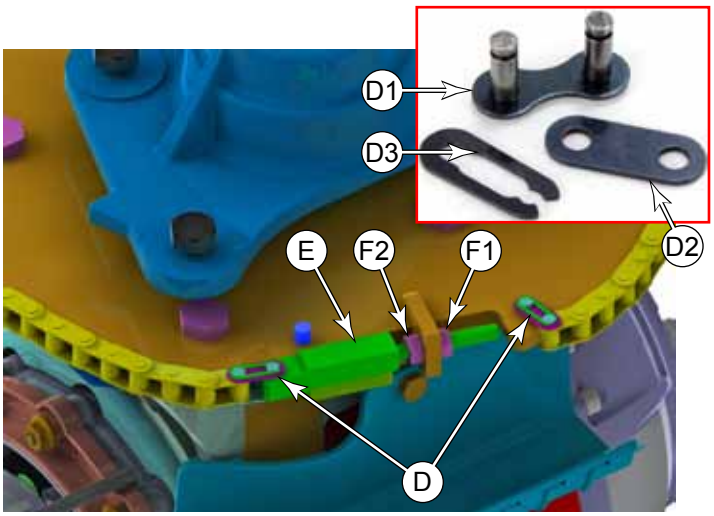
3. (Optional) Using the lifting point **(A)** located on the right anti-tip hoop, raise the front of the machine, and place support blocks **(C)** under both anti-tip hoops **(B)**.



4. Turn the steering wheel to the right to make the motor wiring connections more accessible.
5. Cut any cable ties as necessary.
   - Make sure to replace the cable ties during reassembly.
6. Disconnect the following connections to the wheel motor:
   - X218, EM Brake connector
   - X226, Temperature connector
   - X210, Encoder connector
   - U, V, W, Motor power lugs



7. Turn the steering wheel all the way to the right to make the steering chain connections easier to access.



Note: *There are two options for disconnecting the steering chain from the chain disk.* ***Method 1*** *is to remove the master link that holds the chain to the tension block, and* ***Method 2*** *removes the tension block from the chain disk.*

Method 1: Master Link

Unless the steering chain has been previously removed, the master link retainer is likely on the top side of the chain.

8. Slide the retainer **(D3)** off the master link, link **(D1)**, and remove the plate **(D2)** and link **(D1)**.

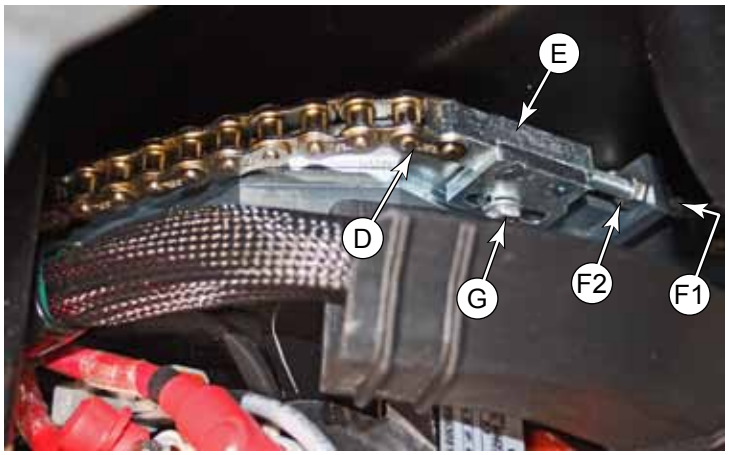
9. Free the steering chain from the steering column sprocket, and then temporarily tie the loose end of the chain back to the tension adjuster to protect the chain for the remainder of the procedure.

Method 2: Tension Block

10. Remove the outer adjustment nut **(F1)** from the tension block's threaded rod.

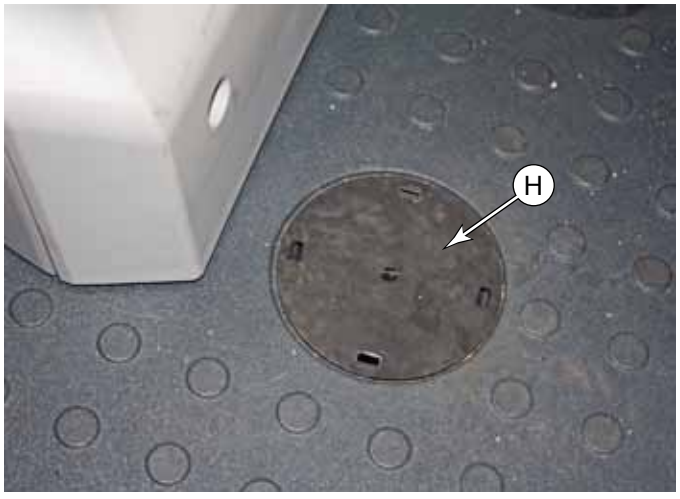
11. Remove the clamping screw **(G)** that secures the tension block to the chain disk.

12. Slide the tension block out far enough to remove the chain from the steering column sprocket and then temporarily replace the tension block onto the chain disk to protect the chain for the remainder of the procedure.

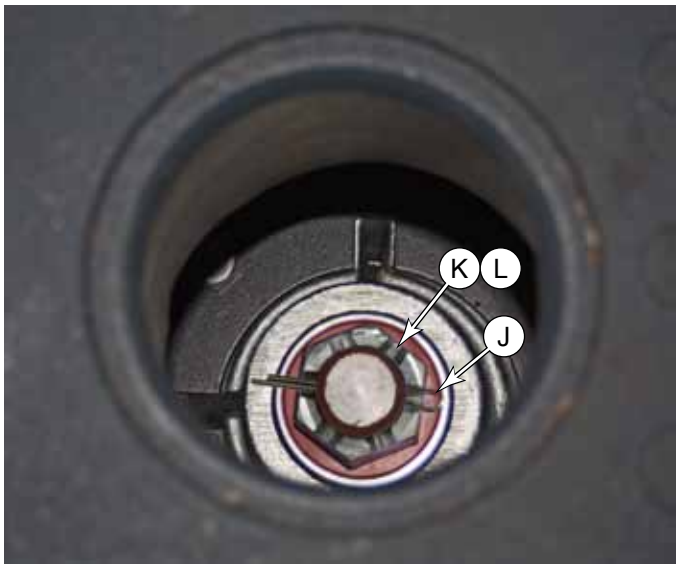


13. If the machine was previously raised, lower it back to the ground at this time.

14. Carefully pry the spindle cover **(H)** out of the floor of the solution tank in front of the steering column. Take care to not break the retaining tabs of the cover.



15. Remove the cotter pin **(J)** from the castle nut **(K)**.
16. Using a 36 mm socket, remove the castle nut **(K)** and washer **(L)**.
17. Slowly begin to raise the machine away from the drive wheel.
    - As the machine is being raised, confirm that there are no obstructions or wires hung up on the motor assembly.
    - As necessary, support the wheel assembly with chocks to prevent it from tipping while you finish raising the machine.



Castle Nut Torque

During reassembly, torque the cast nut according to the following steps.

18. Torque the castle nut to 40 ± 4 lb•ft (54 ± 5.5 N•m)
19. Unscrew the castle nut 20 degrees.
20. Continue to unscrew the nut until the cotter pin hole aligns with the nearest castle nut slot. Do not exceed a total of 80 degrees of rotation from the torqued position, to achieve this alignment.
21. Install the cotter pin.

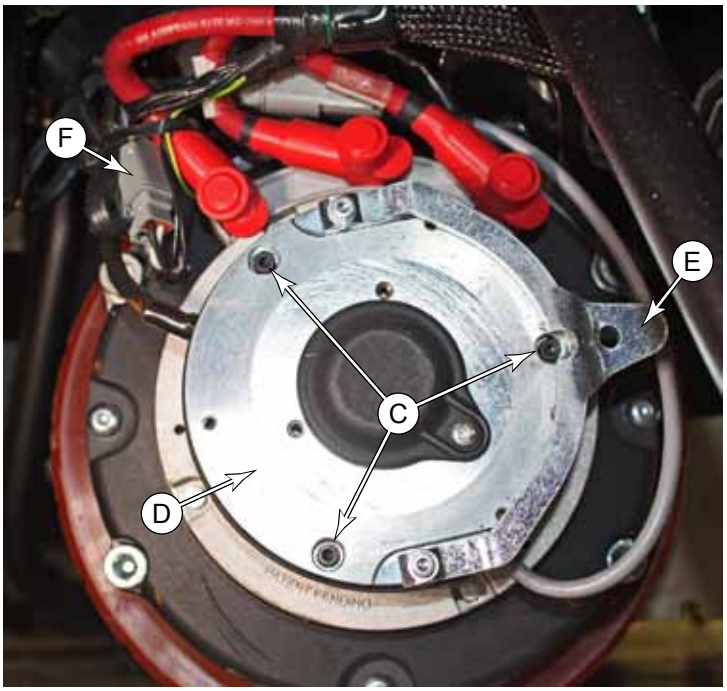
Steering Chain Tension

Note: *During reattachment of the steering chain, when the drive wheel is pointing straight forward, one of the spokes of the steering wheel should be pointing straight down.*

22. As necessary, turn the inner adjustment nut **(F2)** clockwise to move it away from the tension block.
23. Tighten the outer adjustment nut **(F1)** against the tension block to increase the chain tension, until there is about 1/4 inch (6 mm) deflection in the chain at the midpoint between the chain disk and the steering column sprocket.
24. Tighten the inner adjustment nut **(F2)** against the tension block by turning it counterclockwise.

Electromechanical Brake

1. Disconnect the EM Brake electrical connector **(F)**.
2. Remove the three screws **(C)** that secure the brake module **(D)** to the motor.
3. Free up the brake wire from the motor housing, and remove the brake.
4. During replacement, use a screw driver to hold the brake release lever **(E)** raised. This will allow the spline gear to float while you realign the mounting screws.
5. Tighten the 3 mounting screws to 3 Nm.

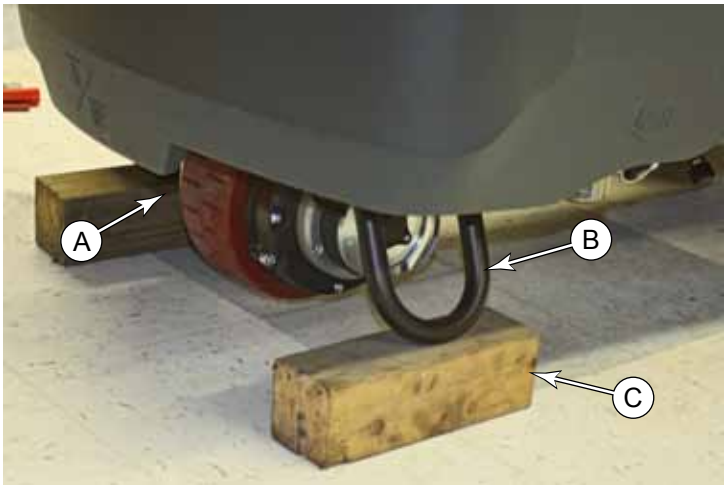


Drive Tire

The drive tire consists of the urethane tire and the metal rim that it is attached to. The drive tire may be replaced without removing the wheel motor assembly from the machine. Pressing the rim off the wheel motor requires the tire pulling kit (56422174).

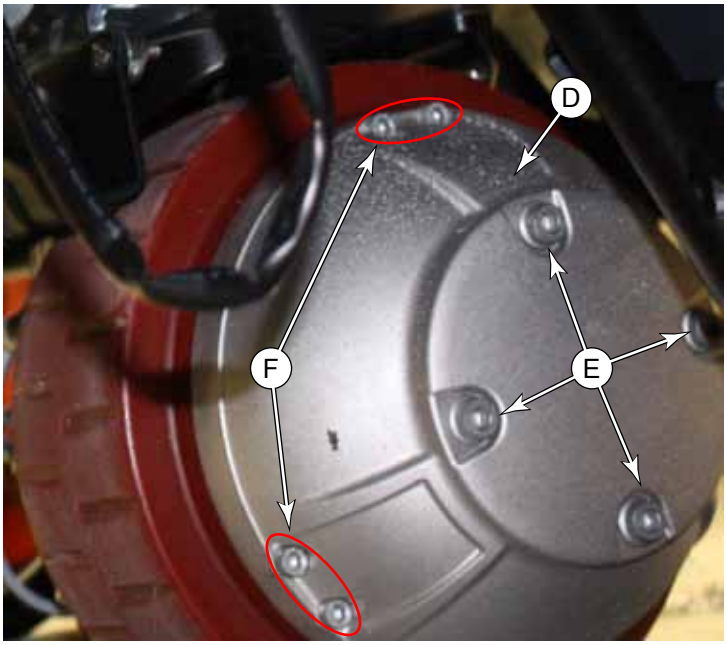
WARNING: This procedure requires working on an elevated machine. Make sure all safety precautions are in place before beginning this procedure. Use appropriate lifting points, jack stands, and wheel chocks. Make sure to disconnect the main battery connector under the operator's seat.

1. To reduce the weight of the machine, drain both the recovery and solution tanks.
2. Chock both rear wheels to prevent the machine from moving. Once the front wheel is off the ground, there will be no machine brake.
3. Disconnect the main battery connector under the operator's seat.
4. Lift the machine at the lifting point **(A)** until the drive wheel is slightly off the ground, and then place blocks **(C)** under the anti-tip hoops **(B)**.



Note: *The drive hub screws may contain thread locking compound. The best method for releasing locking compound is to apply mild heat to the screws. The compound begins to loosen up at just over 150°F (65°C). If you need to apply heat, make sure to remove the plastic cover.*

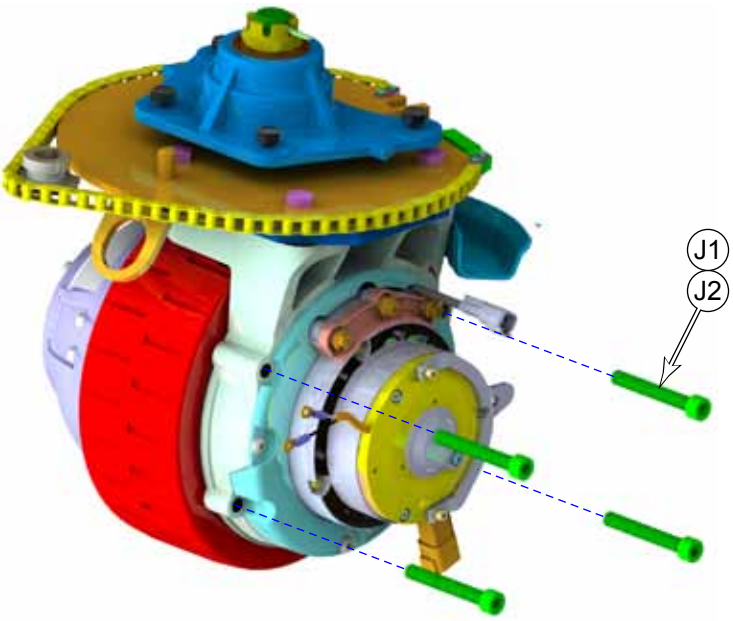
5. As necessary, apply a mild heat to the 4 screws **(E)** that secure the hub **(D)** to the drive disk **(G, shown later)**. It doesn't take a lot of heat nor high temperature. The goal is just to warm the threads to around 150°F (65°C) to soften the thread locking compound.
7. While each screw is still warm from heating, use a 6mm hex key to loosen the 4 screws **(E)**. A low-power impact driver may be helpful, but use caution to not sheer the screws or cam out the heads.
8. Using a 5mm hex key, remove the six screws **(F)** that secure the drive hub to the wheel rim. (The hub is lightly pressed to the drive disk **(G)**, and will come loose later.)



9. Turn the steering wheel so the other side of the motor is facing outward.

10. Remove the housing screws **(J1)** from the drive wheel, and replace them with the longer screws from the wheel puller kit.

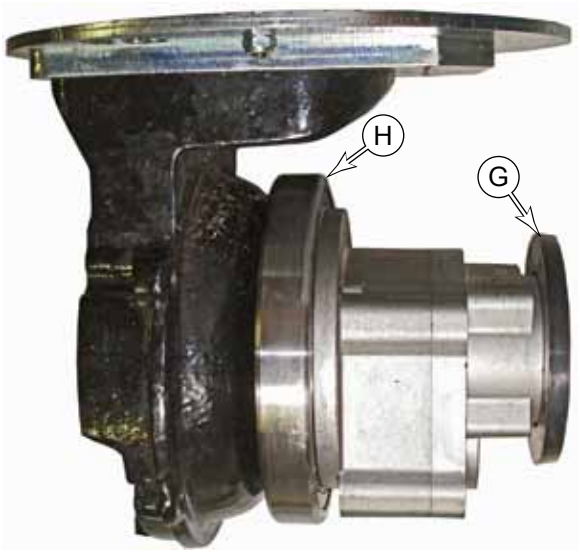
    - Insert the four wheel puller screws **(J2)** into the threaded holes of the drive housing, and hand tighten them until they equally touch the metal rim of the tire.



Note: *Even though the screws are referred to as "Wheel Puller Screws", they actually "Push" the wheel off the bearing.*

11. Gradually tighten each screw at about 1/2 to 1 turn at a time. Work in a crisscross pattern so each screw pushes the wheel off the main bearing **(H)** equally. (The wheel hub **(D)** will come free from the drive disk **(G)** after just a few turns.)

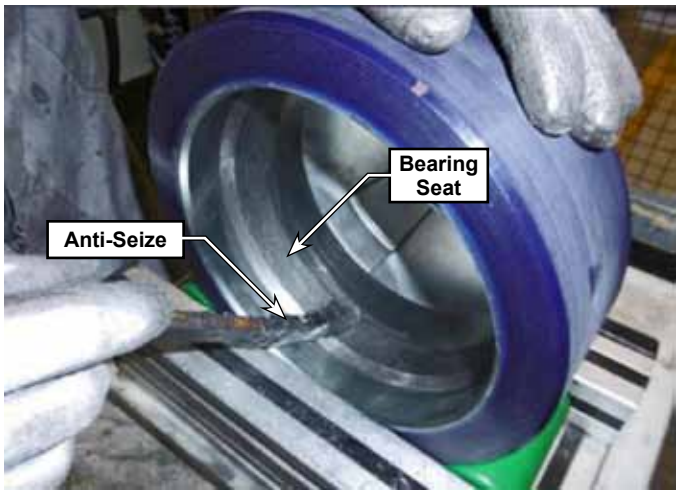
For reference, the wheel/tire presses over the main bearing **(H)**. The drive hub is lightly pressed onto the tapered drive disk **(G)** of the gearbox.



Replacement Procedure

12. Apply anti-seize, such as Loctite 8150, to the bearing seat of the replacement wheel.

13. Remove the wheel pulling screws **(J2)** from the drive housing.



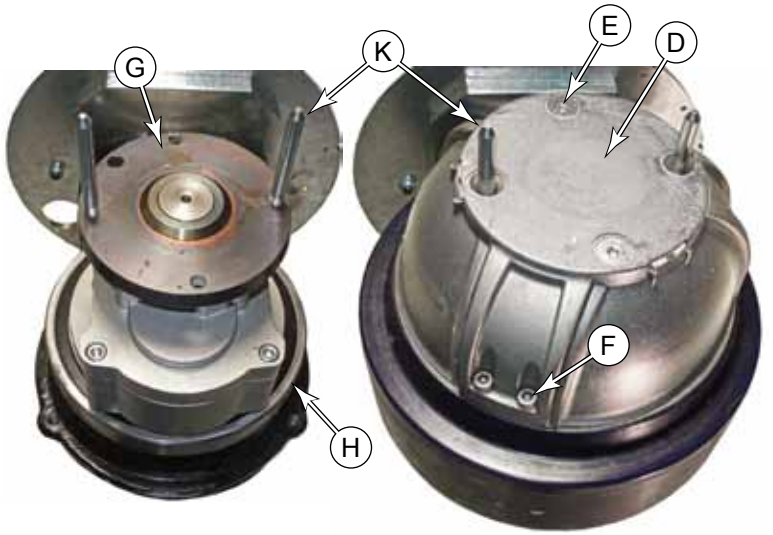
14. Attach the original drive hub **(D)** to the new wheel using 6 new screws **(F)**. Torque to 39 Nm (29 lb•ft).

15. Loosely install the two alignment pins **(K)** into two of the threaded holes of the drive disk **(G)**.

16. Slide the drive hub (with the new wheel/ tire) over the alignment pins.

17. Gently tap on the upper portion of the drive hub **(D)** to get the wheel started over the main bearing **(H)** until the mounting screws **(E)** can be started in their threads.

18. Remove the alignment pins **(G)**, and replace them with the two remaining mounting screws **(E)**.



19. In small increments, simultaneously tighten all four mounting screws to pull the drive hub tight to the drive disk **(G)**.

20. Finish reassembling the machine by reversing the disassembly steps.

Specifications

Parameter	Range
Brake Coil Resistance	• 54 Ω

Sample Shop Voltage Measurements

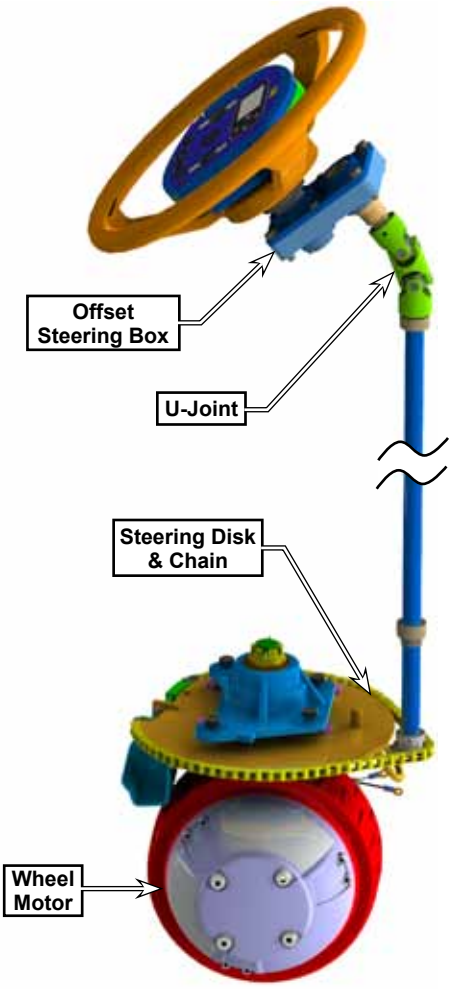
The following table contains some “real world” shop voltage measurements to help you recognize what “normal” looks like. All voltage values were measured with the black (Negative) voltmeter lead connected to the main battery negative unless otherwise specified. Most outputs were turned on using the Service/Output test function.

J5 Drive Controller				
Pin#	**Wire**	**Color**	**Function**	**Observations**
1	W165	GRY	Potentiometer Gnd	0V
2	W195	YEL	CAN-1 H	2.6V
3	W196	GRN	CAN-1 L	2.5V
4	W163	BLU-GRY	Seat Switch In	Open = 0.02V, Seated = B+
6	W164	BLU-YEL	E-Stop In	Closed = B+, Open/Active = 0.02V
8	W193	PNK-YEL	Programmer Data	N/A
9	W194	PNK-BLU	Programmer Clock	N/A
10	W166	RED	Potentiometer +5V	N/A
12	W198	RED-ORG	+15V Out	13.3V
13	W168	VIO	Throttle In (Pot Wiper)	1.0 to 4.0V through full range movement
15	W173	VIO	Motor Temperature In	1.18V = -114°C (faulty thermocouple)
18	W189	GRY	I/O Ground	0V
19	W188	VIO-GRN	Encoder A	AC V = 2.78 at full speed 0 V at park
20	W187	VIO-ORN	Encoder B	
21	W186	VIO-YEL	Encoder C	
22	W162	YEL	KSI In	B+
Motor Lugs				
U				0 to 12.7 V AC, from parked to full speed Machine raised off the ground
V				
W				

22 - Steering System

Functional Description

The drive system on the SC5000 machine consists of a single, steerable drive wheel at the front of the machine. Steering control is made through the steering column that passes through an offset box and a universal joint to translate the rotation from the angled steering wheel to the vertical shaft and pinion sprocket. The pinion sprocket drives a chain that wraps around the steering disk. The steering disk has no chain teeth, but the chain is fixed to the sprocket at the ends of the chain using standard master links.



U-Joint

The steering U-joint permits the steering wheel to operate on the steering shaft from an off-axis direction. The U-joint is a 2-segment type, which allows for a greater axis angle without binding in the rotation.

Offset Steering Box

The purpose of the offset steering box is to permit electrical wiring to pass through the center of steering wheel and shaft for the operator controls mounted in front of the steering wheel. The input shaft is hollow for this purpose.

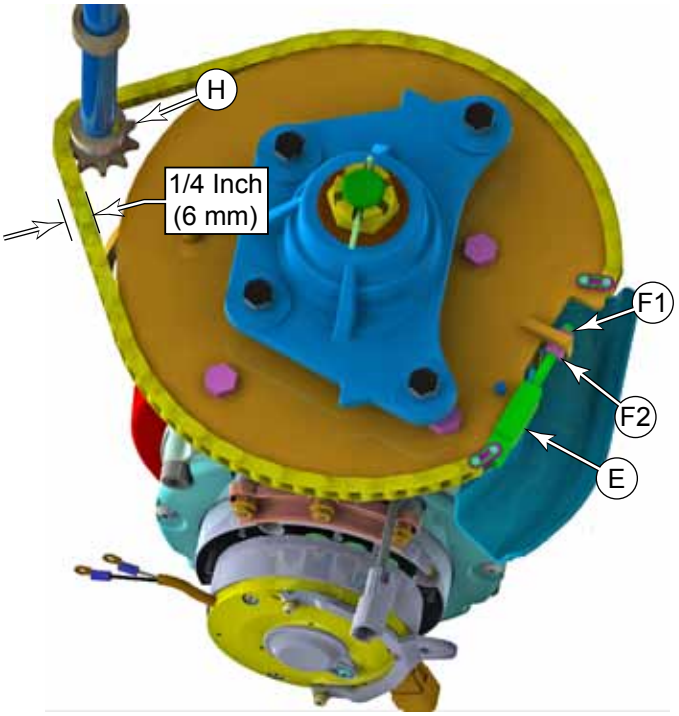
The input and output shafts are connected by a toothed belt that couples the rotation of one shaft to the other shaft.

Maintenance and Adjustment

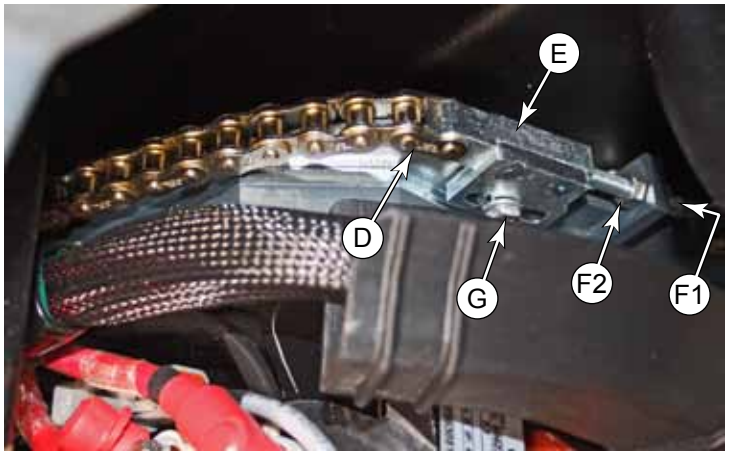
Steering Chain Tension

Note: *If this procedure is being completed because the steering chain was disconnected or serviced, it is best to confirm that the steering wheel is oriented correctly before the chain is tensioned.*

- *When the drive wheel is pointing forward, one of the steering wheel spokes should be pointing downward.*
- *If necessary, skip the chain to a different tooth on the steering sprocket **(H)**.*



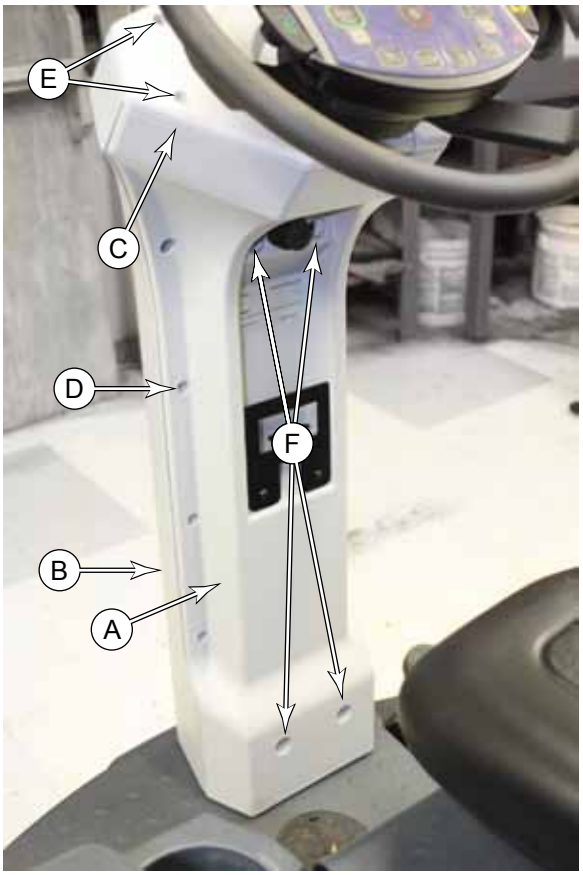
1. Loosen the inner adjustment nut **(F2)** from the tension block's threaded rod.
2. Loosen the clamping screw **(G)** that secures the tension block **(E)** to the chain disk.
3. Tighten the outer adjustment nut **(F1)** against the tension block to increase the chain tension, until there is about 1/4 inch (6 mm) deflection in the chain at the midpoint between the chain disk and the steering column sprocket.
4. Tighten the inner adjustment nut **(F2)** against the tension block by turning it counterclockwise.



Removal and Installation

Steering Column Covers

1. Remove the 8 self-tapping screws **(D)** that secure the rear column cover **(A)** to the front column cover **(B)**.
2. Remove the 4 self-tapping screws **(E)** that secure the top column cover **(C)** to the front and rear covers.
3. Remove the 4 machine screws **(F)** that secure the rear column cover to the steering column chassis.
4. Starting at the bottom, pull the rear column cover away from the steering column, and remove the cover.

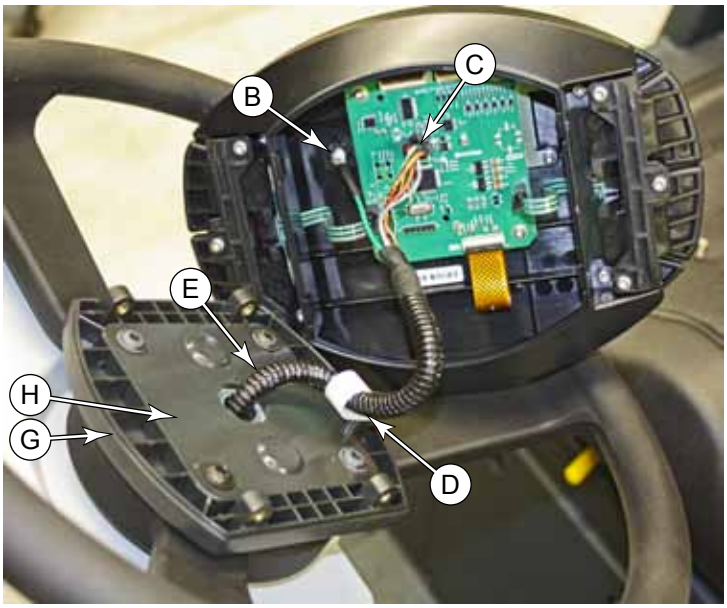


5. Remove the 4 self-tapping screws **(G)** that secure the front column cover **(B)** to the steering column chassis, and remove the front cover.
6. Remove the top column cover **(C)** by sliding it forward, away from the steering shaft.

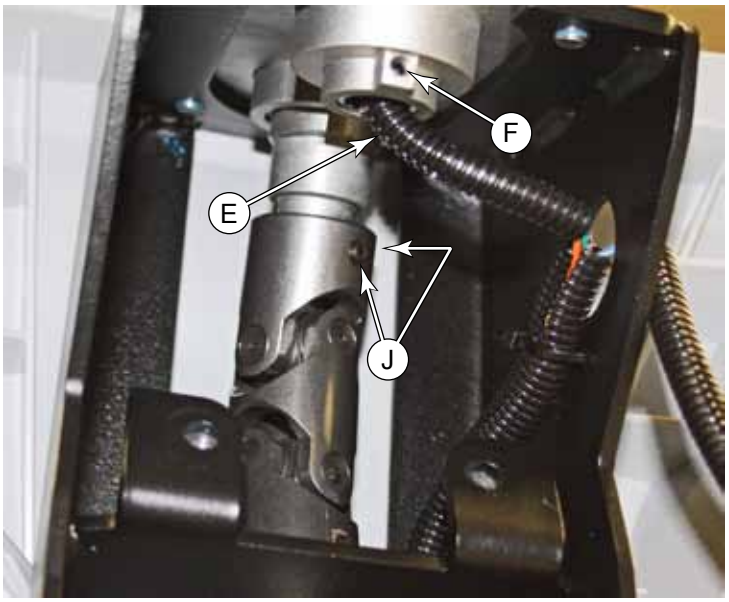
Steering Offset Box

1. Shut down the machine.
2. Remove the rear and top steering column covers, as described in the "Steering Column Covers" on page 103. (It's not necessary to remove the front cover.)
3. Remove the four screws **(A)** that secure the display assembly to the top of the steering column.

4. Disconnect the grounding wire by removing the screw **(B)**.
5. Disconnect the display connector **(C)**.
6. Remove or loosen the P-clamp **(D)** as necessary, and retract the harness **(E)** through the center shaft of the steering box.

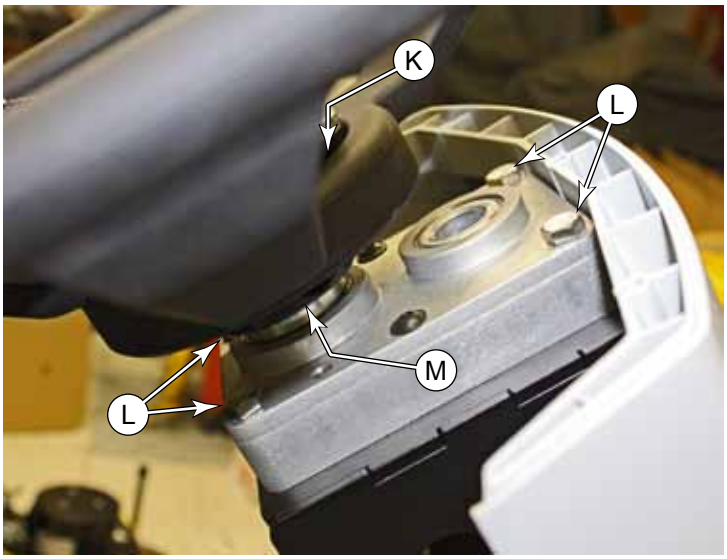


7. Loosen the setscrew **(F)** that secures the stationary shaft, and slide the operator display mounting assembly **(G** and **H)** out of the steering box.
8. Before the steering wheel is removed, turn the steering wheel as necessary to access the two setscrews **(J)** that secure the U-joint to the steering box shaft. Loosen the setscrews.



9. Remove the two screws **(K**, not visible**)** that secure the steering wheel to the clamping collar **(M)** of the steering box, and remove the wheel.

10. Remove the four screws **(L)** that secure the steering box to the steering column frame, and slide the box out of the U-joint to remove it.

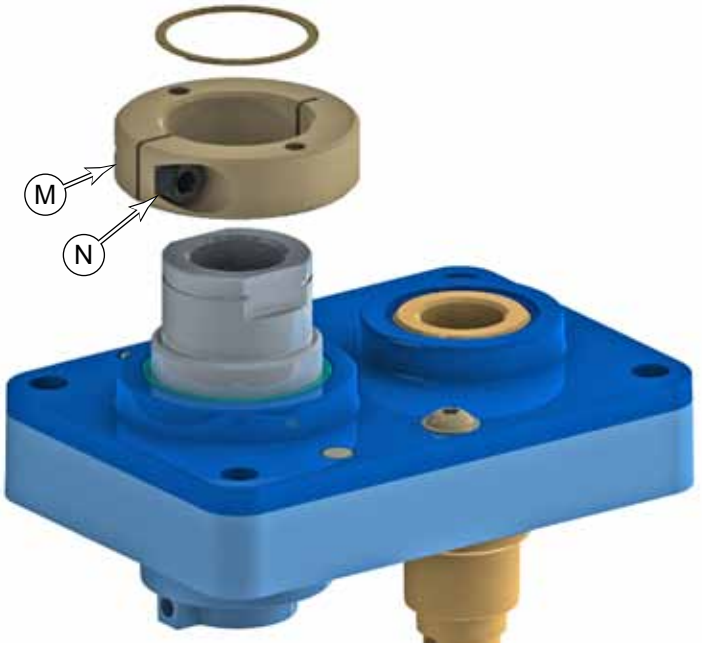


11. Reassemble the machine incorporating the procedures listed below.

Steering Wheel Alignment

The steering wheel bolts onto a clamping collar of the steering offset box (see step 9 above). This clamping collar is retained by a retaining ring, but also clamps down on the steering shaft to prevent rotation. If the clamping screw **(N)** is loosened, the collar can be rotated, but not removed.

With the drive wheel pointing forward, one of the spokes of the steering wheel should be pointing straight downward. If the steering wheel is not properly lined up, loosen the clamping screw **(N)**, rotate the steering wheel, and then retighten the clamping screw.

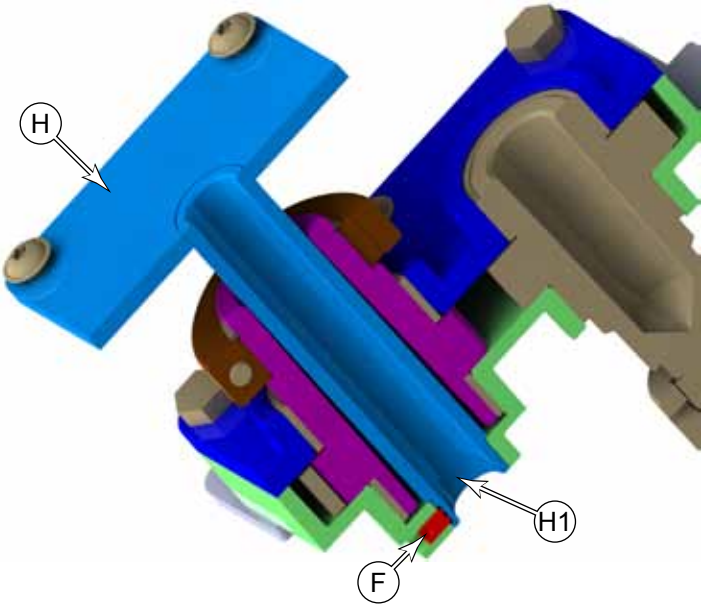


Securing the User Interface Mount

12. Insert the user interface mount assembly **(G** and **H)** into the gearbox until the shaft **(H1)** bottoms out in the gear box.

13. If the setscrew **(F)** does not have a thread lock patch, apply Loctite 242 or 243 to the setscrew.

14. Gradually tighten the setscrew while rotating the mount **(H)** to feel for the center of the shaft-flat. Once the shaft-flat center is found (the mounting plate is aligned horizontally), tighten the setscrew to 53±5 in-lbs (6±0.6 Nm).

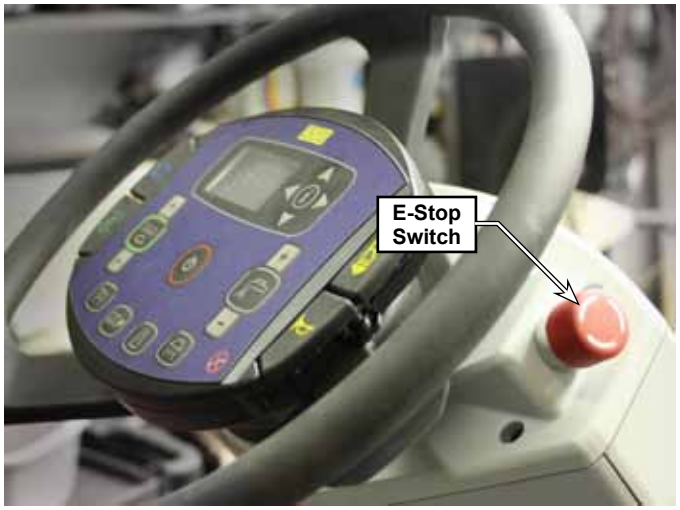


24 - Electrical System

Functional Description

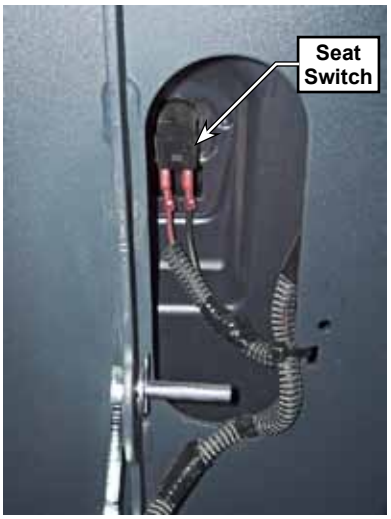
The SC5000 machine is powered using six, 6-volt batteries connected in series, for a total system nominal voltage of 36 volts. To protect the batteries from over discharge, the system is protected with a 150 amp fuse **(F1)** located on the battery positive main terminal. All connections are downstream from this main fuse (except for the optional battery charger).

Adjacent to the steering wheel is an Emergency Stop (E-Stop) switch. This is a normally closed switch that opens when active (button depressed). The E-stop switch is connected to both the main control board and the drive controller. The switch doesn't directly lock out any electrical circuit, but indicates to the particular module that all applicable functions should be inhibited.



When the E-stop is activated, the machine ceases all output functions without reset. For example, the vacuum motor and brush motors will immediately be stopped, but the squeegee and deck lift actuators will remain in the down position. However, if the machine is turned off in this E-stop condition, the squeegee and deck will first be raised before the machine fully powers down.

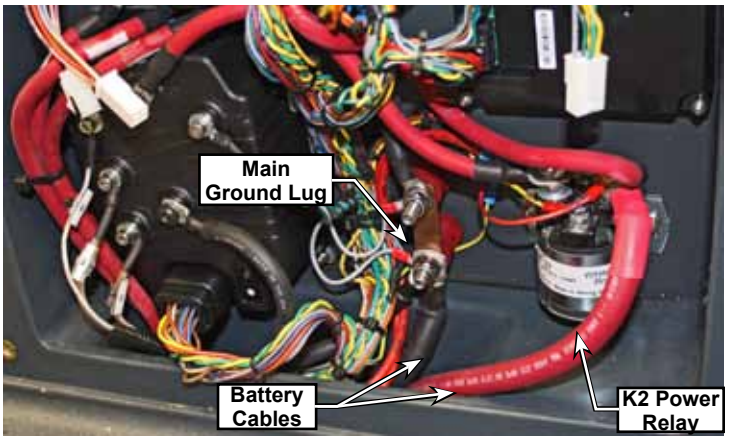
Another protective device is the operator's seat switch. This is a normally open switch that detects the operator's weight in the seat and closes. The output of the seat switch is connected to both the main controller and the drive controller. When the switch is open, all drive functions are disabled. Unlike the E-stop switch, though, the seat switch does not disable most other machine functions. For example, the optional vac wand and wash hose features are intended to be operated when the operator is not seated.



The machine may be equipped with an optional onboard charger for charging the batteries. The charger is generally autonomous and is connected directly to the batteries. However, it also contains an interlock feature to notify the Main Machine Controller that the charger is plugged in to facility power. When the charger is active, the Main Machine Controller disables all functions of the machine to prevent damage to either the machine or the charger.

The main electrical bay is located below the operator's seat, behind a removable panel. This contains the Main Machine Controller, the Drive Controller, and the Power Module. The K2 Relay provides high-energy power to the power module, and is controlled by the power module itself.

One side of the K2 power relay coil is connected to battery power, and the Power Module activates the relay by pulling the other connection to ground.



Low Voltage Cutout

The main machine controller is equipped with a low-voltage cutout feature to prevent over-discharging of the batteries. When the battery voltage falls below a defined threshold, some machine functions are disabled. These threshold values are dependant on the type of battery specified in the main controller. In the first stage of cutout, the scrub system is disabled, but the recovery system will remain active. At the second stage, even the recovery system will be disabled, but the drive system remains active.

The drive controller has its own cutback feature, separate from the main controller. When the drive controller senses battery voltage too low, it will reduce power output to the drive motor to protect the battery.

Cutout Level	Threshold-Wet	Threshold-AGM	Affected Systems
Stage 1	30.8	32.6	All scrub functions disabled
Stage 2	30.6	32.4	Both scrub and recovery disabled

Onboard Battery Charger

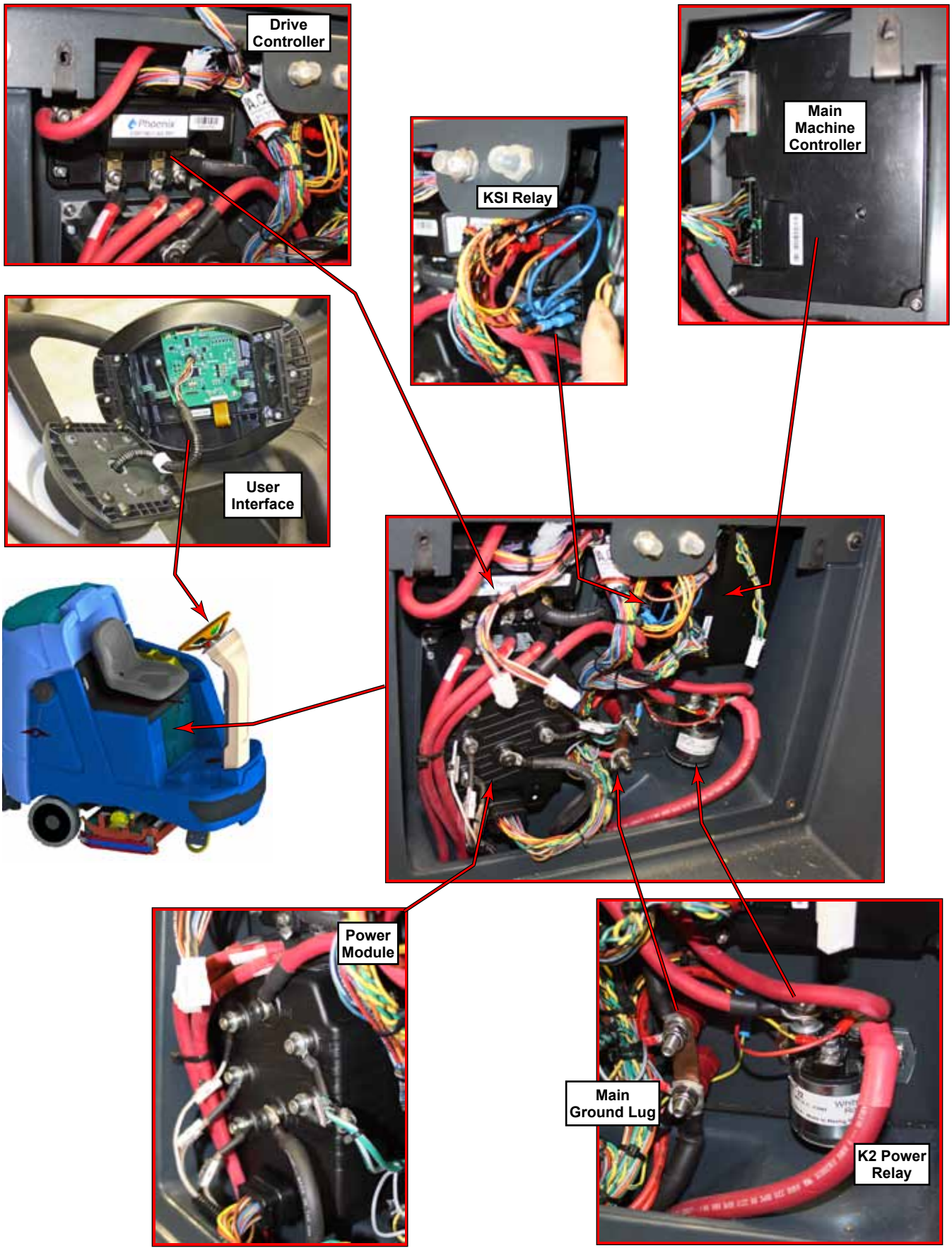
An optional on-board battery charger is mounted below the operator's seat on the right side of the batteries. The charger should be a Delta-Q model RC1200. The charger is intelligent and semi-autonomous and charges the batteries when the machine is plugged in to facility power.

The charger communicates with the Main Machine Controller (MMC) via the CAN-0 bus. The MMC tells the charger which charging profile it should be using based on the type of battery installed in the machine. The charger can also communicate battery and charger status back to the MMC.

To prevent any machine operation while the charger is plugged in, the charger contains an interlock relay which closes a circuit back to the MMC when ever the charger is plugged in. During normal operation, the Interlock Return signal is open-circuited, which the MMC detects as a low-voltage. When the charger is plugged in, the Interlock Return is connected to battery+ by the relay, and the MMC detects this as a high-voltage.

Note: *If the battery charger is disconnected from the batteries, when it gets re-connected, it will not have CANBus communication enabled. This will result in a controller error code of 1-058 for loss of communication. To reset communication, plug the charger into facility power (as though charging the batteries) for 30 seconds.*

Component Locations



Troubleshooting

Battery Testing

A battery problem is usually recognized by the machine operator as a decrease in the machine's running time. This condition is usually caused by one or more "dead cells" in the battery system. There are 2 ways to find a dead cell:

- Use a hydrometer to check the specific gravity (or "state of charge") of the fluid in each cell. A dead cell is one that reads 50 points (or more) lower than the other cells.
- Use a volt meter to check the voltage of each battery. Look for a battery with a voltage that is 1 or 2 volts less than the other batteries. Check under the following conditions:
  - With the batteries fully charged,
  - With the scrub and drive motors running,
  - With the batteries discharged, but still above the voltage cutoff threshold.

If the batteries in the machine are more than 1 year old, it's usually best to replace the whole set, rather than replacing one or two batteries. Mixing old and new batteries can result in over-charging problems.

The Main Machine Controller also monitors the battery voltage, and progressively disables functionality when the batteries are reaching a full depleted voltage. These voltage thresholds will vary depending on the type of battery installed (configured in the controller). For example, wet batteries are permitted to drain to a lower voltage than AGM batteries.

Battery Charger Error Codes

8-E001 High battery voltage

Description	Battery voltage too high.	
Setting Conditions	The battery voltage is higher than the software setting.	**When Monitored** Charging
Possible Causes		

Initial Action

Troubleshooting Steps
• Check the battery voltage and cable connections. • Check battery size and condition. • This error will automatically clear once the condition has been corrected.

8-E002 Low battery voltage

Description	Battery voltage too low to start a charge cycle.	
Setting Conditions	Algorithm dependent – typically 0.1V/cell.	**When Monitored** Charging
Possible Causes		

Initial Action

Troubleshooting Steps
• Check the battery voltage and cable connections. • Check battery size and condition. Batteries may be overdischarged. • Use another charger to bring the batteries above the minimum voltage. • This error will automatically clear once the condition has been corrected.

8-E003 Charge timed out

Description

Setting Conditions	When Monitored
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Charger output reduced due to high temperatures. Operate at lower ambient temperature. • Charger output reduced due to low AC voltages. Check AC voltage. • Check for shorted or damaged cells. • Poor battery health. Replace battery. • Very deeply discharged battery. Retry charge. • Poorly connected battery. Check connections. • This error will automatically clear once the charger is reset by cycling DC or by loss of AC for over 10 minutes.

8-E004 Battery below min volt

Description	Battery could not be trickle charged up to the minimum voltage. May also be used for other battery-related errors depending on the algorithm.

Setting Conditions	When Monitored
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Check for shorted or damaged cells. • Poor battery health. Replace battery. • Check DC connections. • This error will automatically clear once the charger is reset by cycling DC or by loss of AC for over 10 minutes.

8-E007 Bat. Ah limit reached

Description	Charge amp-hour Limit reached. Algorithm dependent.

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Charger output reduced due to high temperatures. Operate at lower ambient temperature
• Charger output reduced due to low AC voltages. Check AC voltage.
• Check for shorted or damaged cells.
• Poor battery health. Replace battery.
• Very deeply discharged battery. Retry charge.
• Poorly connected battery. Check connections.
• This error will automatically clear once the charger is reset by cycling DC or by loss of AC for over 10 minutes.

8-E008 Batt Temp Out of Range

Description	Battery temperature out of range. Algorithm dependent.

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Cool or warm batteries as needed.
• Check temperature sensor and connections.
• This error will automatically clear once the condition has been corrected.

8-E012 Reverse polarity

Description Battery connected with reverse polarity.

Setting Conditions	When Monitored
	Always

Possible Causes

Initial Action

Troubleshooting Steps
• Reverse the charger connections to the battery.

8-E013 Bat. not taking current

Description The battery is not taking a charge.

Setting Conditions	When Monitored
	Charging

Possible Causes High resistance connection

Initial Action

Troubleshooting Steps
• This error will automatically clear once the charger is reset by cycling DC or AC.

8-016 Software upgrade fail
8-018 Software upgrade fail

Description

Setting Conditions	When Monitored
	Updating

Possible Causes

Initial Action

Troubleshooting Steps
• Ensure the USB flash drive is properly formatted and is not corrupted. • Ensure the USB flash drive does not draw excessive current. • Copy the install files to the USB flash drive again. • Retry the update by reinserting the USB Flash Drive into the charger. • If software updates continue to fail, replace the charger

8-017 USB error

Description	USB mount/unmount error

Setting Conditions	**When Monitored**
	Updating

Possible Causes

Initial Action

Troubleshooting Steps
• Remove and re-insert the USB Drive. • Ensure the USB flash drive is properly formatted and is not corrupted. • Ensure the USB flash drive does not draw excessive current. • If the condition persists then remove AC and battery for minimum 30 seconds and retry charger.

8-019 Software Rev Incorrect

Description	Hardware build does not support software version

Setting Conditions	**When Monitored**
	Updating

Possible Causes	The charger hardware does not support the new software version trying to be programmed. Existing SW is left running.

Initial Action

Troubleshooting Steps

8-E020 Active algo not set

Description	No active algorithm selected

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Reboot the machine, and plug the charger into facility power for 30 seconds. If the error persists, replace the charger.

8-E021 Active algo not set

Description	High battery voltage while charging. Algorithm dependent – typically 2.8V/cell

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• When already full, some new batteries may exhibit this error. Cycle the batteries and see if it reoccurs. • Check battery size and condition. Resistive batteries in poor condition may cause this. Some new batteries if charged when already full will also cause this. Cycle the batteries a few times. • Check the battery voltage and cable connections. • This error will automatically clear once the condition has been corrected.

8-E022 Low battery voltage

Description	Low battery voltage while charging. Algorithm dependent – typically 0.1V/cell

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Another device may be drawing current from the battery. • Check the battery voltage and cable connections. • Check battery size and condition. Batteries may be over-discharged. Use another charger to bring the batteries above the minimum voltage. • This error will automatically clear once the condition has been corrected.

8-E023 AC voltage high

Description	High AC voltage error (>270VAC)	
Setting Conditions		**When Monitored** Charging
Possible Causes	AC voltage is too high. Connect charger to an AC source that provides stable AC between 85 - 270 VAC / 45-65 Hz. This error will automatically clear once the condition has been corrected.	

Initial Action

Troubleshooting Steps

8-E024 Failed to initialize

Description	Charger failed to turn on properly	
Setting Conditions		**When Monitored** Charging
Possible Causes		

Initial Action

Troubleshooting Steps
1. Disconnect AC input and battery for 30 seconds. 2. Reconnect the battery first, and then plug the charger into facility power for 30 seconds. 3. Unplug the charger and reboot the scrubber. 4. If error persists, replace the charger

8-E025 AC voltage dipped

Description	The AC voltage is too low.	
Setting Conditions	AC voltage has dipped below 80 VAC 3 times in 30 seconds	**When Monitored** Charging
Possible Causes		

Initial Action

Troubleshooting Steps

8-026 USB Script Failed

Description One or more USB script commands failed

Setting Conditions	When Monitored
	Updating

Possible Causes

Initial Action

Troubleshooting Steps
• Ensure the USB flash drive is properly formatted. • Ensure the right update package is being used. • Copy the install files to the USB flash drive again. • Retry the update by reinserting the USB Flash Drive into the charger.

8-027 USB overcurrent fault

Description USB overcurrent fault

Setting Conditions	When Monitored
	Updating

Possible Causes

Initial Action

Troubleshooting Steps
• USB hardware overcurrent protection has been tripped. Remove and reinsert USB flash drive. If condition persists, try using a different USB flash drive.

8-E028 Incompatible algo

Description Algorithm error

Setting Conditions	When Monitored
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
• Update charger software, continue to use existing algorithm or select a different charging algorithm that is compatible.

8-E029 CAN bus error

Description	Cannot transmit on CAN bus	
Setting Conditions		**When Monitored**
		Charging
Possible Causes	The CANBus has to be functional for this error to be reported to the Main Machine Controller.	

Initial Action

Troubleshooting Steps
1. Disconnect AC input and battery for 30 seconds.
2. Reconnect the battery first, and then plug the charger into facility power for 30 seconds.
3. If error persists, replace the charger

8-E030 CAN HeartBeat-1 timeout

Description	CAN heartbeat timeout from Main Machine Controller	
Setting Conditions		**When Monitored**
		Charging
Possible Causes	The CANBus has to be functional for this error to be reported to the Main Machine Controller.	

Initial Action

Troubleshooting Steps
1. Disconnect AC input and battery for 30 seconds.
2. Reconnect the battery first, and then plug the charger into facility power for 30 seconds.
3. If error persists, replace the charger

8-E031 ADC Vref out of range

Description	The Vref for the ADC measurements has triggered an alarm	
Setting Conditions		**When Monitored**
		Charging
Possible Causes		

Initial Action

Troubleshooting Steps
1. Disconnect AC input and battery for 30 seconds.
2. Reconnect the battery first, and then plug the charger into facility power for 30 seconds.
3. If error persists, replace the charger

8-E037 CANdownload failure

Description	CAN Open reprogramming failed

Setting Conditions	**When Monitored**
	Bootup

Possible Causes

Initial Action Reboot the machine.

Troubleshooting Steps

8-E038 Fan failure
8-E040 Fan voltage low

Description	The cooling fan on the side of the charger is not working properly.

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps

8-F001 LLC excessive leakage
8-F002 PFC excessive leakage
8-F003 PFC long boost time
8-F004 Calibration failed
8-F005 Excess relay volt drop

Description	Internal charger fault

Setting Conditions	**When Monitored**
	Charging

Possible Causes

Initial Action

Troubleshooting Steps
1. Disconnect AC input and battery for 30 seconds. 2. Reconnect the battery first, and then plug the charger into facility power for 30 seconds. 3. If error persists, replace the charger

Maintenance and Adjustment

Battery Settings

Onboard Battery Charger

The Main Machine Controller uses the battery information to determine the appropriate low-voltage-cutout values for each specific battery type. It also communicates with the optional on-board battery charger to set the appropriate charging algorithm for the specific battery type.

When the batteries are changed, the battery type should be set in the configuration menu. If the machine is upgraded to include the optional battery charger, the battery settings should already be present, but it is good practice to confirm the settings.

Battery Charger Algorithm

Batteries operate on chemical reactions that produce an electrical charge. Charging a battery reverses these chemical reactions so they can produce power again. Because these chemical reactions are complex, their reversal is also complex, at least from the standpoint of maintaining good health of the battery. This process is referred to as a charging algorithm. During the charging algorithm, various stages of the charging process are handled differently, depending on the chemical makeup of the battery.

Battery charging occurs in various phases, such as an initial charge, to a bulk charge, to an equalization or gassing phase. During each of these phases, the method and rate of charge is varied to optimize the reverse chemical reaction. Some may be constant-current, some constant-voltage, and some may be other methods. The Delta-Q charger is an intelligent charger that incorporates these various charging algorithms for multiple battery types.

Set or Confirm the Battery Setting

The battery parameters, including charging algorithm, are stored in the MMC in a lookup table based on manufacturer, model, and size information. After you select the manufacturer's name, the available battery models for that manufacturer will be available to select, followed by the charger algorithm used. This information is summarized in the table to the right.

1. Start the machine with Service Mode access.
2. Navigate to the Configuration menu and select "Battery".
3. Select the Manufacturer name and press the right arrow to save.
4. Select the Model (size) of the battery and press the right arrow to save.
5. The charge algorithm will be automatically set. However if necessary, a charge algorithm not shown in the table may also be entered manually.
6. Restart the machine

Manufacturer	Model	Charger Algorithm
US Battery	Wet 6x-420 Ah	173
	Wet 6x-310 Ah	72
	AGM 6x-312 Ah	43
Trojan	Wet 6x-420 Ah	None
	Wet 6x-310 Ah	7
Full River	AGM 6x-312 Ah	43
Discover	AGM 6x-312 Ah	141
Exide	Gel 1x-280 Ah	51
	Gel 1x-320 Ah	12
	Wet 1x-320 Ah	21
	Wet 1x-255 Ah	21
Generic	Wet 1x-200-250 Ah	11
	Gel 1x-200-300 Ah	12
	AGM 1x-200-400 Ah	43
	Wet 1x-33-400 Ah	73
	Wet 1x-250-320 Ah	72

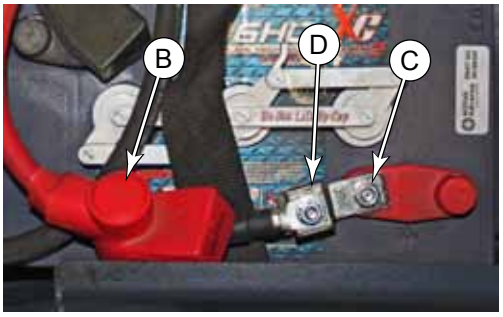
Removal and Installation

Batteries

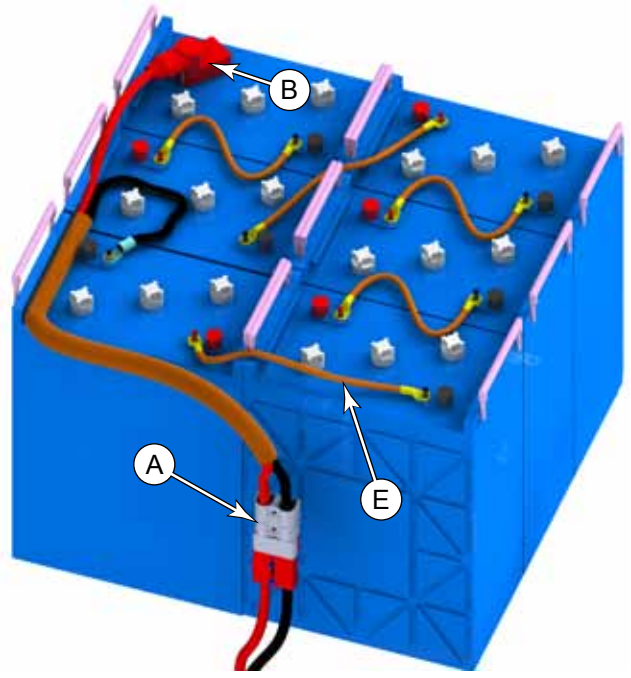
CAUTION: *Use extreme caution when working with batteries. Sulfuric acid in batteries can cause severe injury if allowed to contact the skin or eyes.*

- *Explosive hydrogen gas is vented from the batteries through openings in the battery caps. Do not smoke while servicing the batteries.*
- *Remove all jewelry. Wear safety glasses, rubber gloves and a rubber apron*
- *Do not allow tools to touch more than one battery terminal at a time*
- *Electrical components in this machine can be severely damaged if the batteries are not installed and connected properly.*
- *The batteries are extremely heavy and may require a lifting device or assistance to remove and replace into the machine.*

Note: *If replacing a monoblock battery, the procedure is generally the same, except you must remove the recovery tank so that you can lift the battery pack out with a hoist.*



1. Turn the off the machine and disconnect the main battery connector **(A)**.
2. Pull back the insulating boot **(B)** and disconnect the main battery connector's positive terminal at **(C)**. Do not disconnect at lug **(D)** because that secures the 150 amp fuse.
3. In a similar manner, remove the main battery connector's negative terminal. However, there is no fuse at the negative terminal.
4. Taking care to not short across the battery terminals, remove each of the interconnecting cables **(E)** from the batteries.
5. Make sure the battery straps are not damaged or cut, and then lift out each of the batteries from the battery bay.
6. Install the new batteries into the compartment. Note the orientation of the batteries shown to the right.

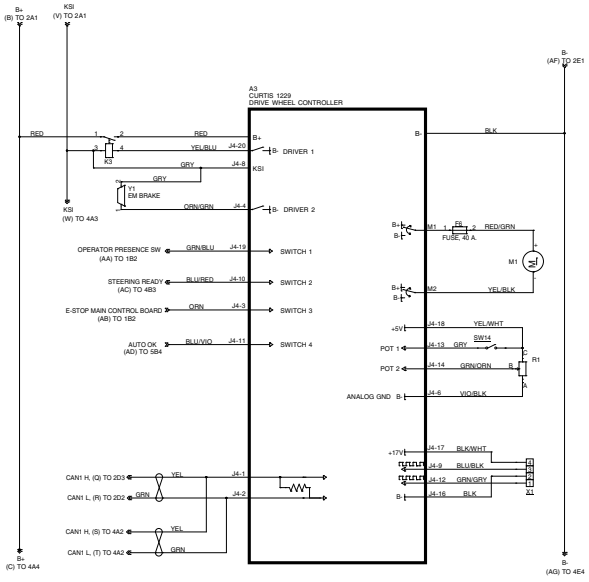


7. Reconnect the battery cables.
   - All cables are connected positive-to-negative for a series connection between all 6 batteries.
   - Position the cables so the battery caps can be easily removed for battery service.
   - Take care to not over torque the cable connector, as this may damage the battery post.
8. Coat the terminals with spray-on battery terminal coating (available at most auto parts stores).
9. Configure the Battery Settings described on page 120

Wiring Diagrams

Understanding the Features of the Electrical Circuit Diagram

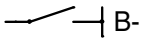
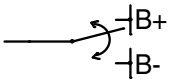
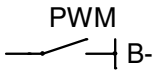
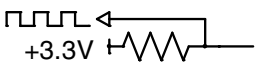
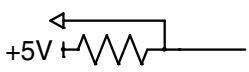
The electrical circuit diagram is sometimes referred to as a ladder diagram because it is historically rooted in a type of schematic that resembled the rungs of a ladder. Over time it has evolved into a hybrid ladder diagram, specifically to accommodate the presence of intelligent control modules that drive the system components. (Such as the main controller and power module, for example.) Even as a hybrid diagram, it still maintains some of the features of a true ladder diagram.



Positive voltage source(s) are represented by vertical "Rails" on the left side of the diagram, and the negative voltages source (typically only 1, being battery negative) is represented by a vertical Rail on the right side of the diagram. Devices are drawn between the two rails, and current flows from the positive rail, through the load, and to the negative rail.

Unique to the hybrid ladder diagram are the intelligent controllers that control if and when devices are connected to either positive or negative power. Even though not technically accurate, circuit symbols have been drawn inside the controller outlines to represent the electrical function that takes place inside. These represent the function, but not an actual device. For example, even though a symbol may look like a switch, it cannot be tested as though it was a real switch.

Some of the common controller internal symbols are described below:

	**Output, Switch to positive or negative power.** The controller serves to complete the circuit to the respective power source, most commonly battery negative.
	**Output, Bi-directional switch to power** These outputs are always in pairs, and are for reversible loads. • For forward direction, one output is positive and the other is negative. • For reverse direction, one output is negative and the other is positive. • For no movement, both outputs are the same, which may be positive, negative, or zero, depending on the controller.
	**Pulse Width Modulation (PWM) Switch** This is an electronic (transistor) switch that completes the circuit to either battery positive or battery negative power. The duty cycle between on and off states determines how much power the load receives.
	**Digital Data Out** This symbol indicates that the output is a digital stream of data pulses.
	**Digital Data In, with Pullup** This symbol represents a digital data stream input signal that is active-low, and the pullup resistor represents the open-circuit (inactive) signal voltage.
	**Discrete Input with Pullup** This symbol represents a binary (On/Off) input with a 5-volt pullup resistor. When the switch or sensor is off (open circuit) the pullup resistor makes the input equal 5 volts. When the switch or sensor is closed, the input typically goes to 0 volts.

Device Labeling

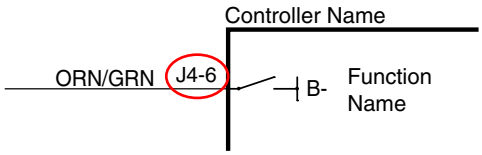
Device Numbers (Names):

Each device is given its own unique identifier. The letter prefix identifies the type of device, such as “K” for a relay, “L” for a solenoid, “M” for motor, and “A” for a control module; just to name a few. Then each device within that class is given a unique number. For example, “K1” is the main KSI relay. However, because this particular relay serves a common function, it is also identified by a simple name too: “KSI” (Legacy for Key Switch Input).

Device numbers and device names (when they exist) are synonymous, but device names are preferred because they are easier to remember, so long as they are unique and descriptive. Device numbers are frequently used for the machine’s display, where character count is important.

Connector Contact Numbers:

All of the circuit lines going to any of the control modules will have indicators for their wire color and the connector pin-out location. When 2 colors are listed for a wire color, the first color is the main color and the second color is the color of a stripe on the wire.



For the connector identifier example shown (J4-6), the first part “J4” represents the connector number, and the last part “6” represents the pin number within that connector. This information, along with the “Electrical Connector Pin-Out Assignments” on page 153 is used locate the physical wires on the machine.

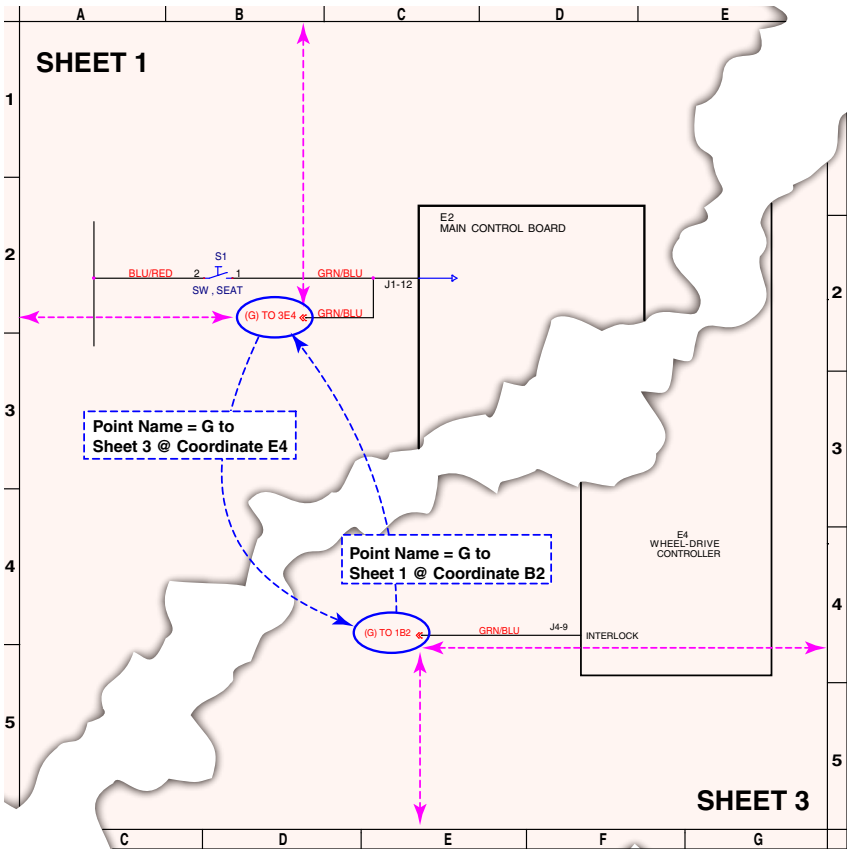
Navigation

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 to the right, 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.

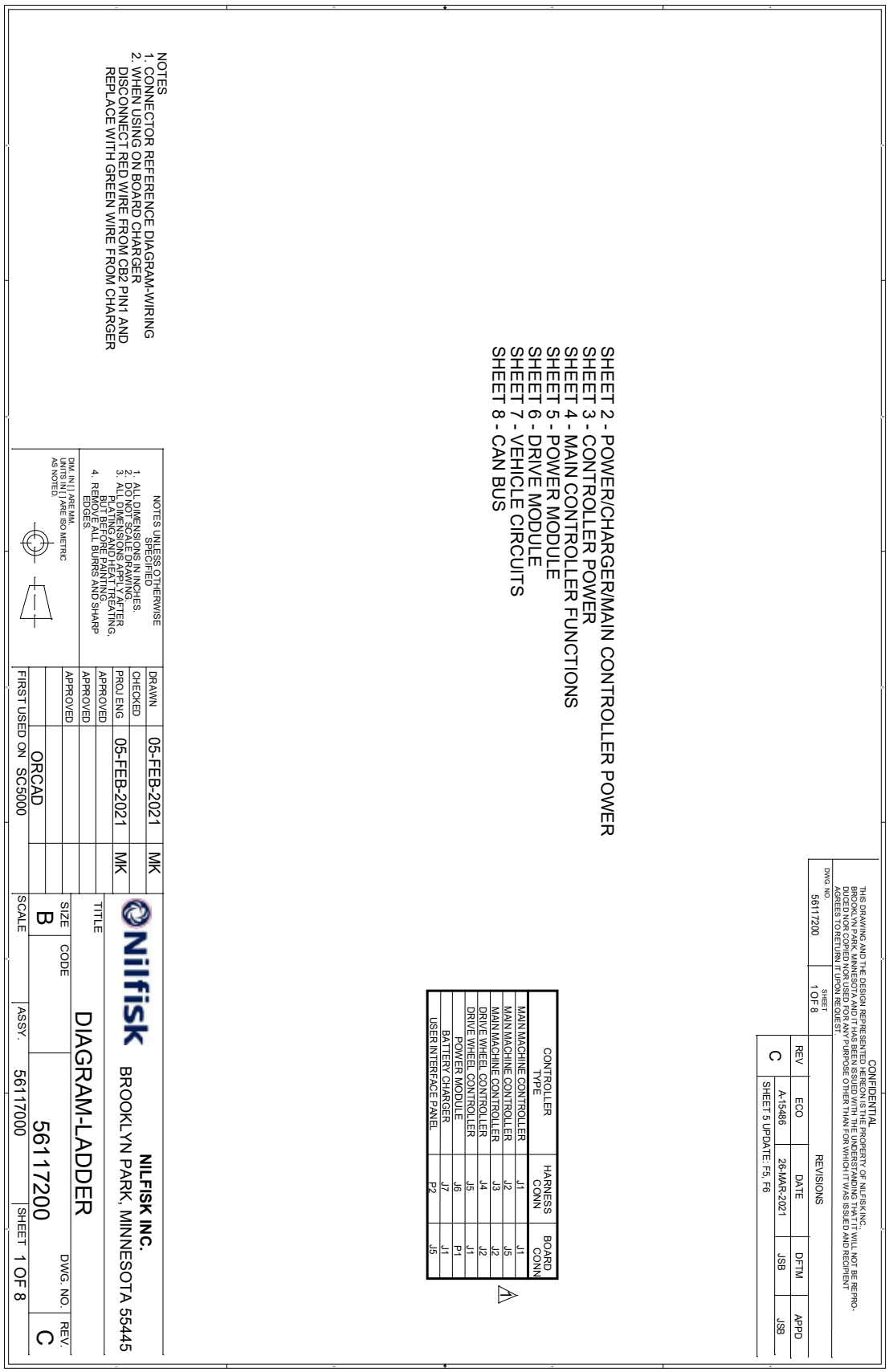
These coordinates are part of the default title blocks on engineering drawings, and run around the perimeter of the drawing sheet. The columns are represented by the letters across the top/bottom of the drawing, and the rows are represented by the numbers down the sides of the drawing.



Electrical Circuit Diagram

Drawing 56117200, Rev. C

Sheet 1, Contents



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DWG NO. 56117200 | SHEET 1 OF 8

REVISIONS

REV	ECO	DATE	DFTM	APPD
C	A-15486	26-MAR-2021	JSB	JSB
	SHEET 5 UPDATE: F5, F6			

SHEET 2 - POWER/CHARGER/MAIN CONTROLLER POWER
SHEET 3 - CONTROLLER POWER
SHEET 4 - MAIN CONTROLLER FUNCTIONS
SHEET 5 - POWER MODULE
SHEET 6 - DRIVE MODULE
SHEET 7 - VEHICLE CIRCUITS
SHEET 8 - CAN BUS

CONTROLLER TYPE	HARNESS CONN	BOARD CONN
MAIN MACHINE CONTROLLER	J1	J1
MAIN MACHINE CONTROLLER	J2	J5
MAIN MACHINE CONTROLLER	J3	J2
DRIVE WHEEL CONTROLLER	J4	J2
DRIVE WHEEL CONTROLLER	J5	J1
POWER MODULE	J6	P1
BATTERY CHARGER	J7	J1
USER INTERFACE PANEL	P2	J5

NOTES
1. CONNECTOR REFERENCE DIAGRAM-WIRING
2. WHEN USING ON BOARD CHARGER DISCONNECT RED WIRE FROM CB2 PIN1 AND REPLACE WITH GREEN WIRE FROM CHARGER

NOTES UNLESS OTHERWISE SPECIFIED
1. ALL DIMENSIONS IN MILLIMETERS.
2. DO NOT SCALE DRAWING.
3. ALL DIMENSIONS APPLY AFTER PLATING AND HEAT TREATING.
4. REMOVE ALL BURRS AND SHARP EDGES.

DIM. IN [ ] ARE MM
UNITS IN [ ] ARE ISO METRIC
AS NOTED

	DRAWN	05-FEB-2021	MK
	CHECKED		
	PROJ ENG	05-FEB-2021	MK
	APPROVED		
	APPROVED		

FIRST USED ON SC5000 | ORCAD

Nilfisk

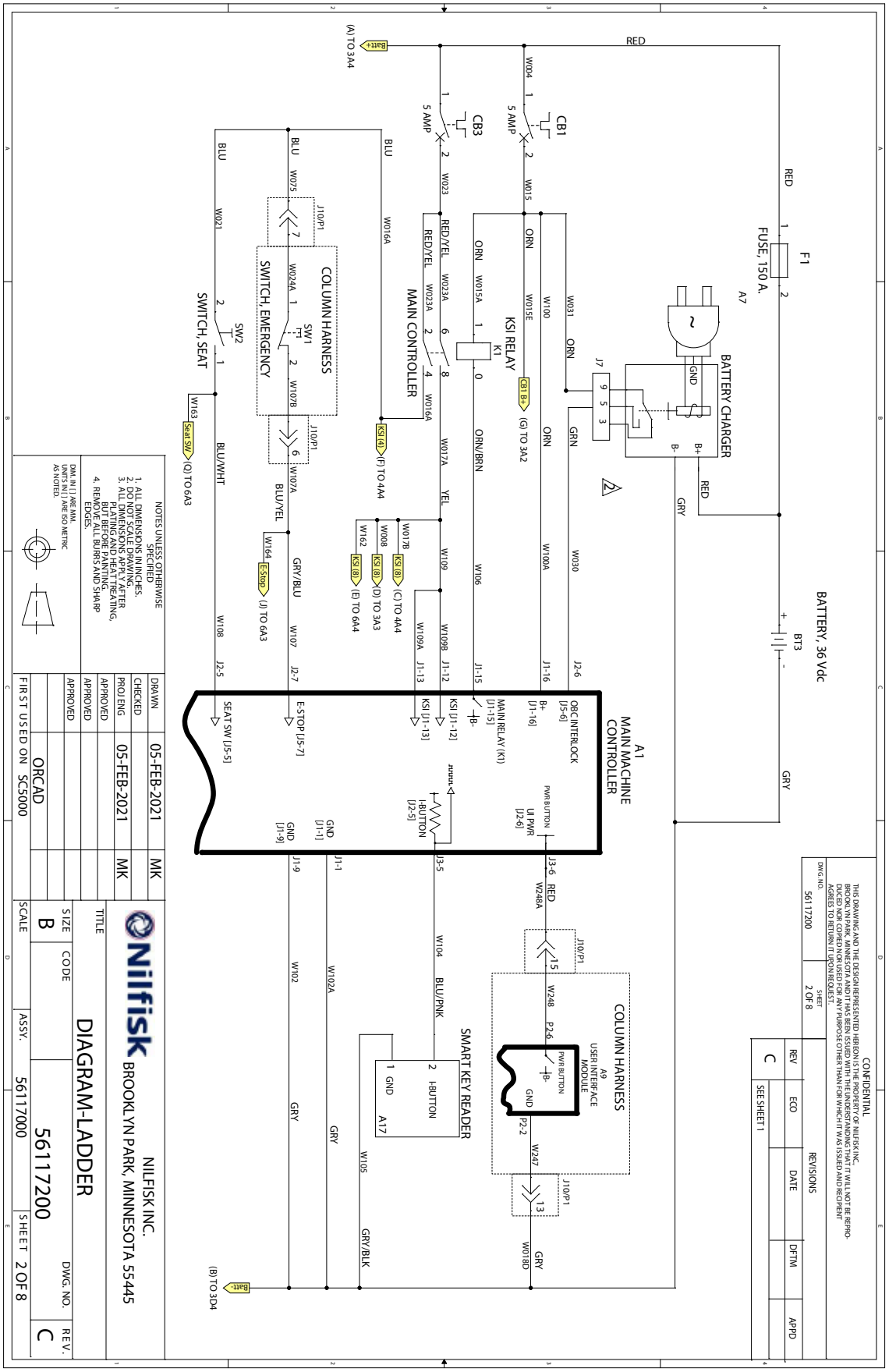
NILFISK INC.
BROOKLYN PARK, MINNESOTA 55445

TITLE
DIAGRAM-LADDER

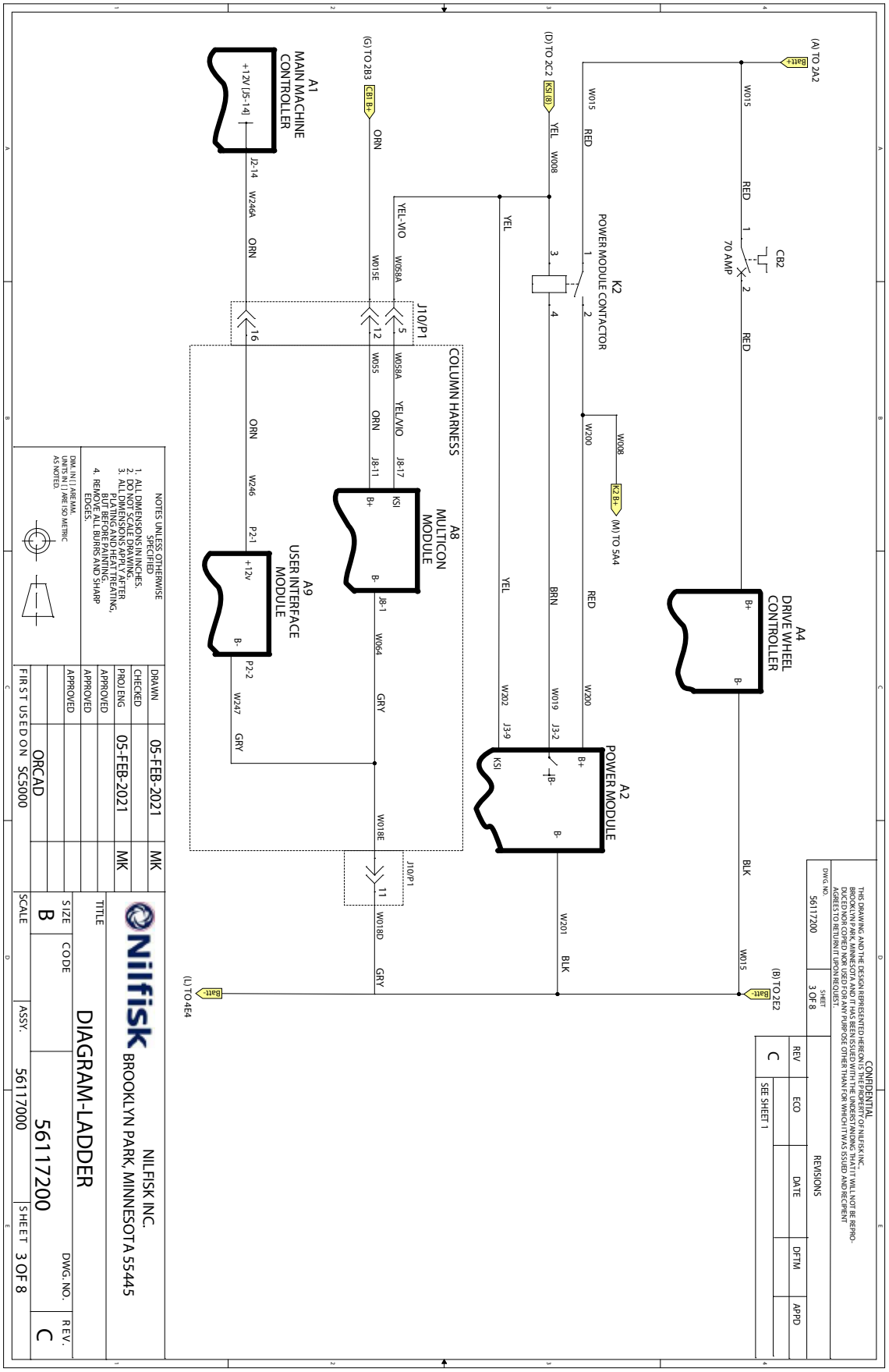
SIZE	CODE	DWG. NO.	REV.
B		56117200	C

SCALE | ASSY. 56117000 | SHEET 1 OF 8

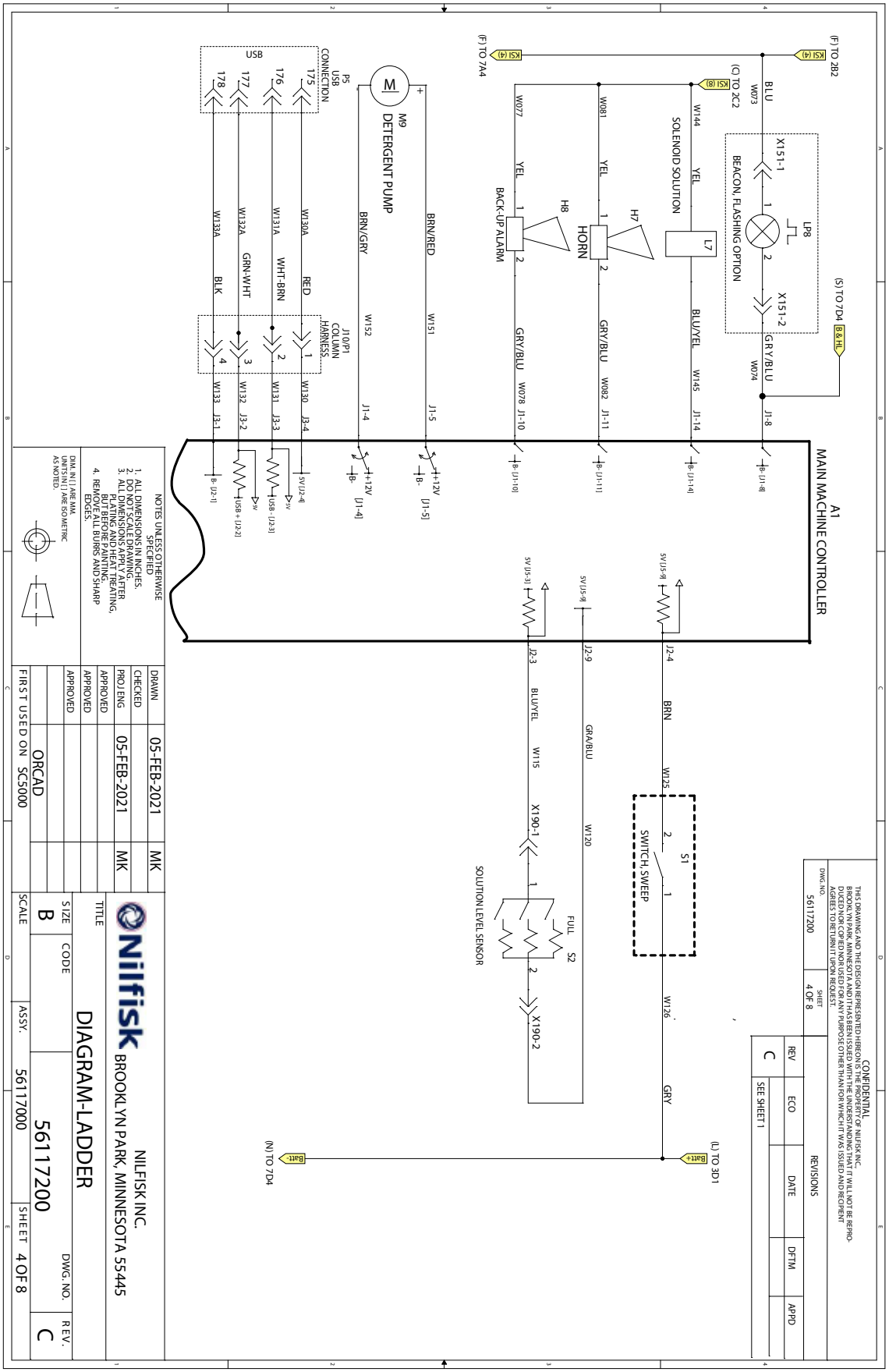
Sheet 2: Power/Charger/Main Controller Power



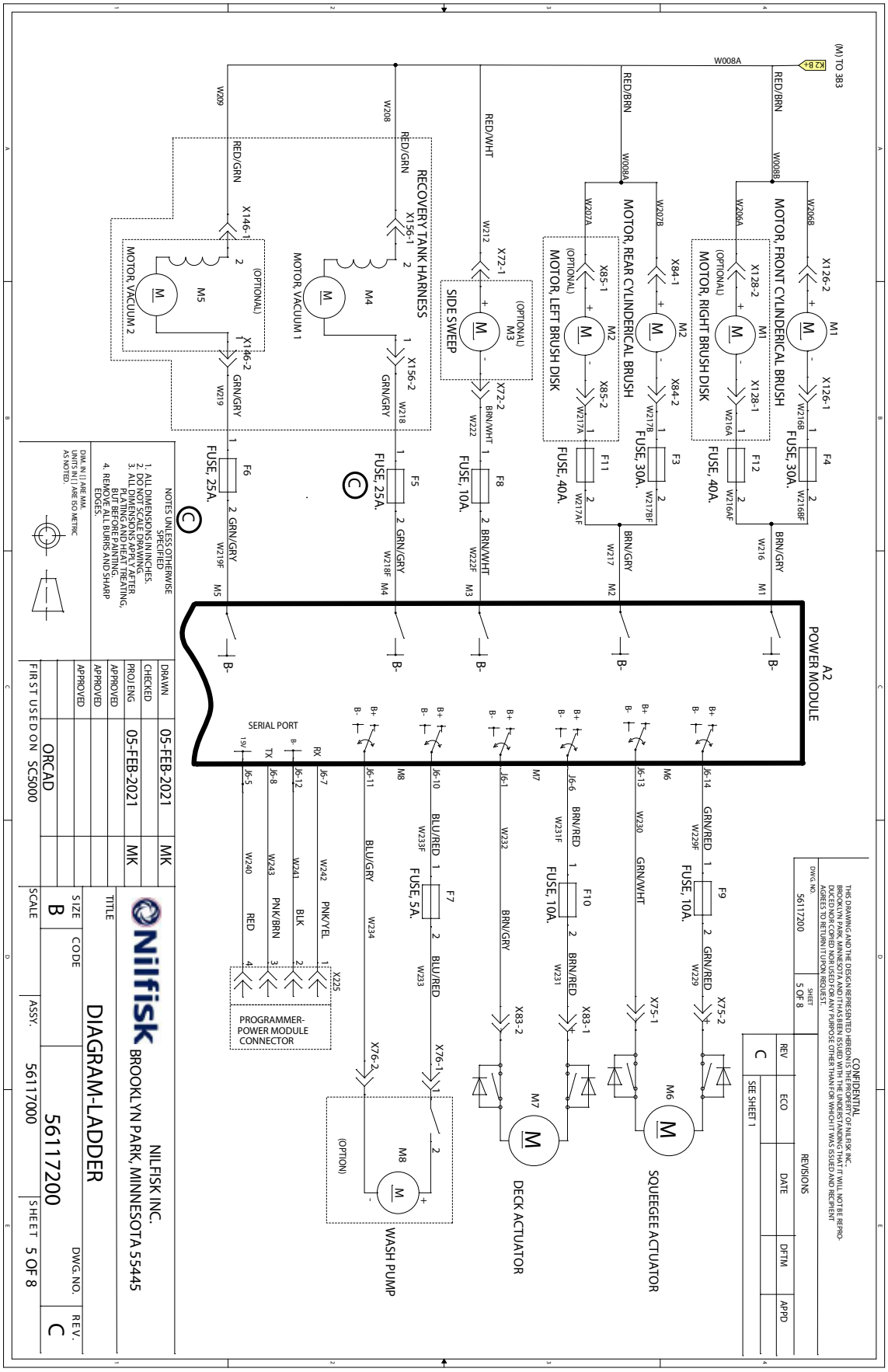
Sheet 3: Controller Power



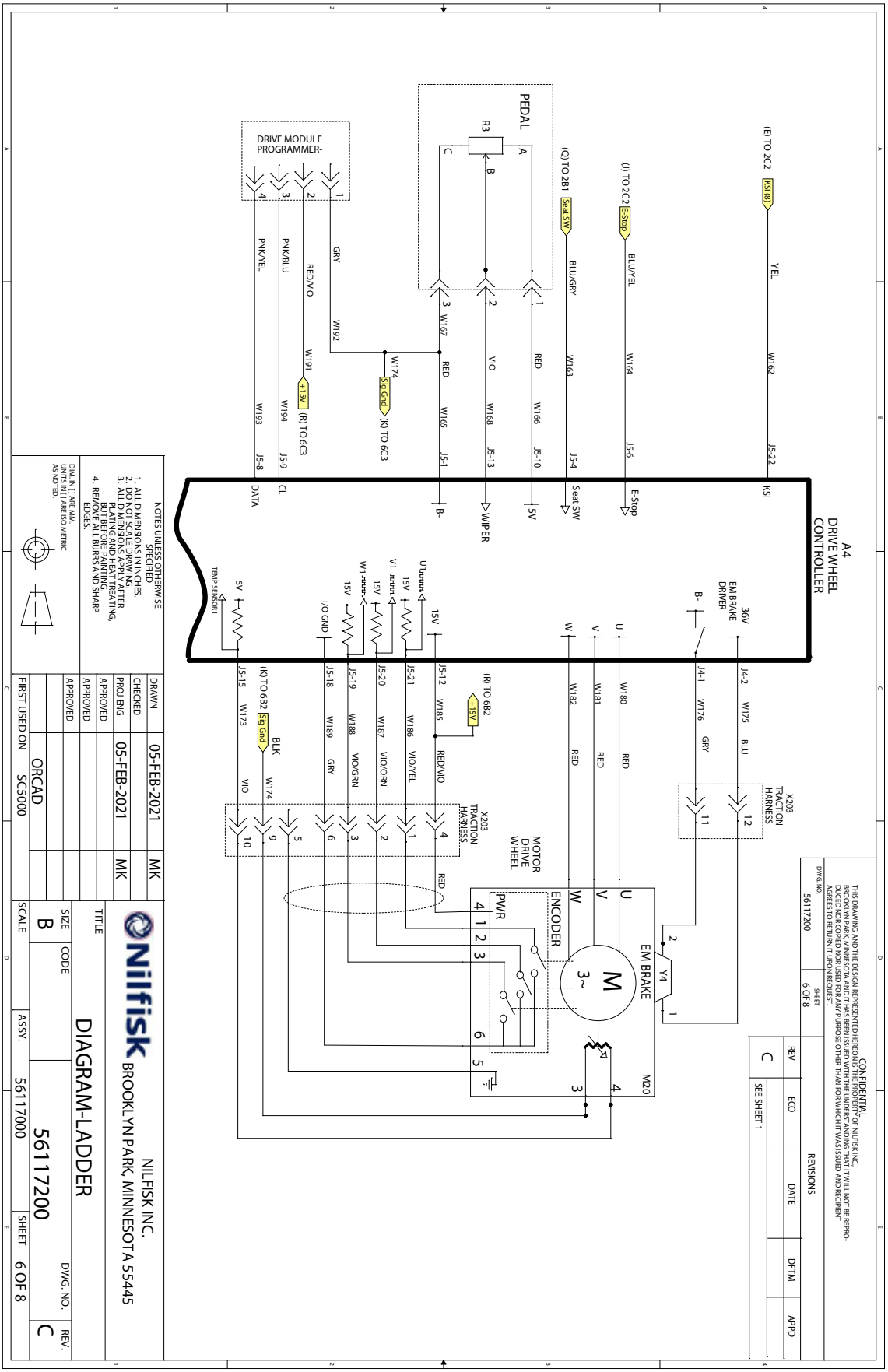
Sheet 4: Main Controller Functions



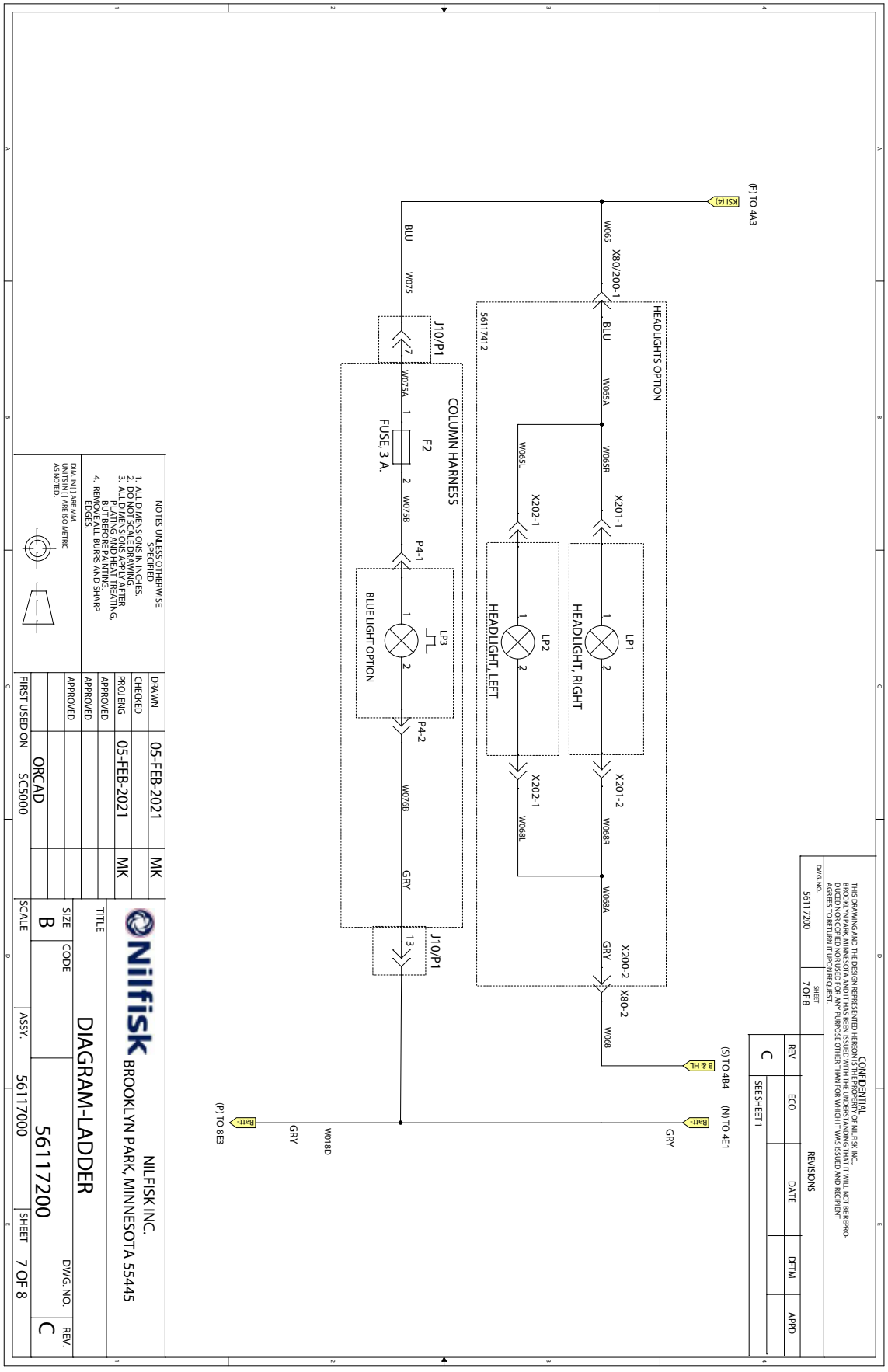
Sheet 5: Power Module



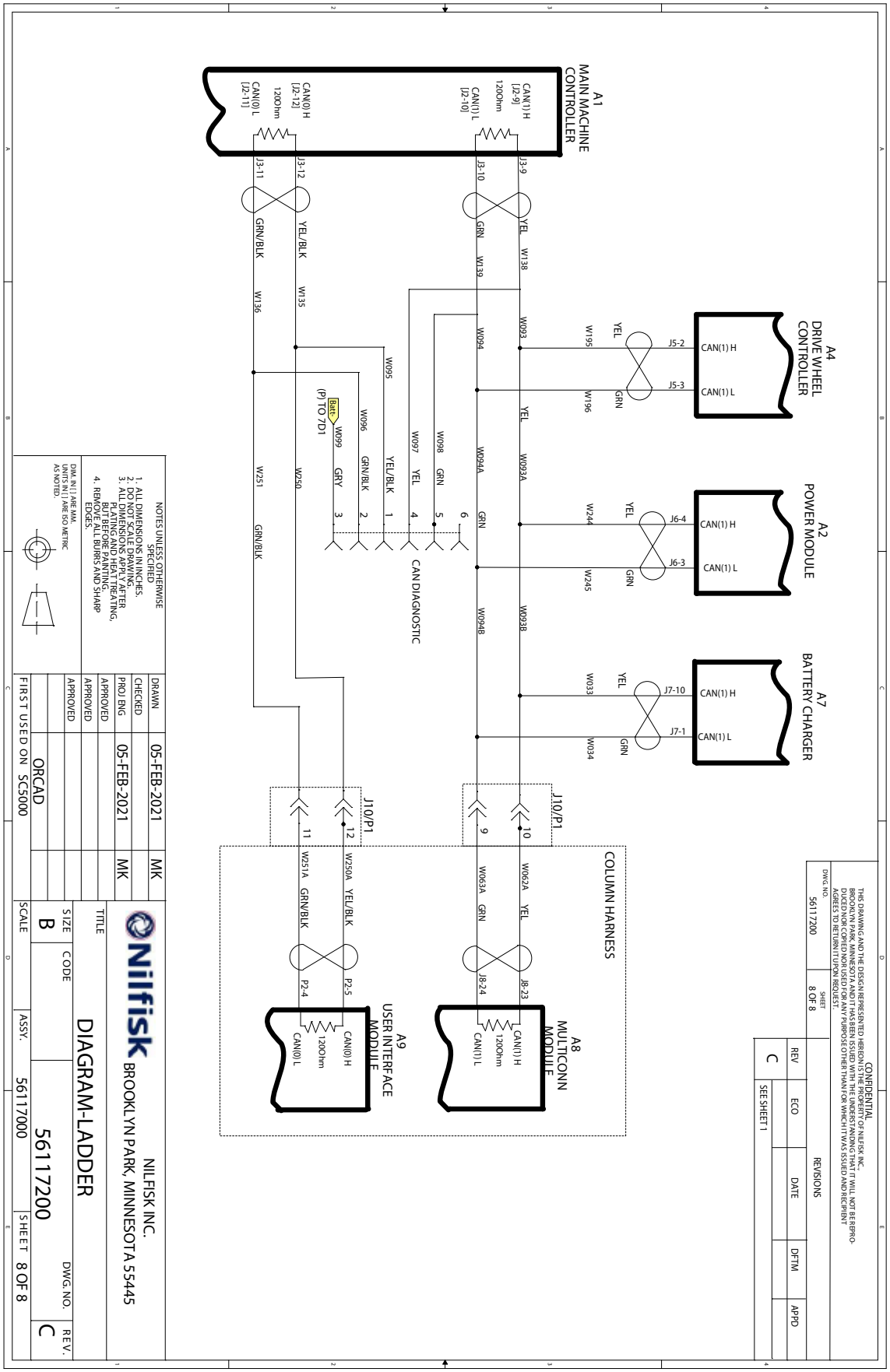
Sheet 6: Drive Module



Sheet 7: Vehicle Circuits



Sheet 8: CAN Bus



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DWG NO.	SHEET
56117200	8 OF 8

REVISIONS				
REV	ECO	DATE	DFTM	APPD
C	SEE SHEET 1			

NOTES UNLESS OTHERWISE SPECIFIED
1. ALL DIMENSIONS IN INCHES.
2. DO NOT SCALE DRAWING.
3. ALL DIMENSIONS APPLY AFTER PLATING AND PAINTING.
4. REMOVE ALL BURRS AND SHARP EDGES.

DIM. IN [ ] ARE MM.
UNITS IN [ ] ARE ISO METRIC AS NOTED.

DRAWN	05-FEB-2021	MK
CHECKED		
PROJ ENG	05-FEB-2021	MK
APPROVED		
APPROVED		
APPROVED		

FIRST USED ON SC5000 | ORCAD

Nilfisk BROOKLYN PARK, MINNESOTA 55445 NILFISK INC.

TITLE: DIAGRAM-LADDER

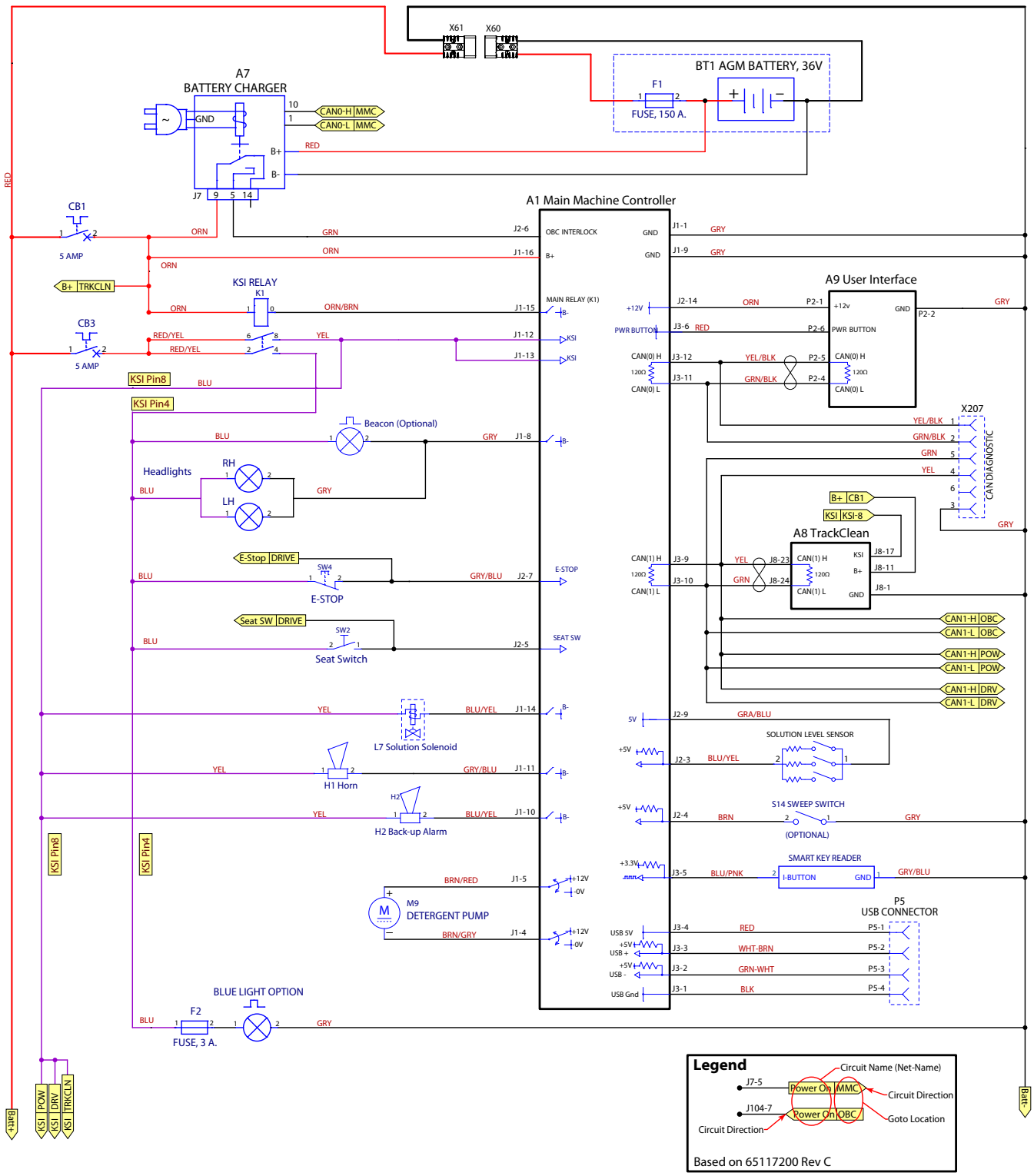
SIZE	CODE	DWG. NO.	REV.
B	56117200		C

SCALE	ASSY.	SHEET
	56117000	8 OF 8

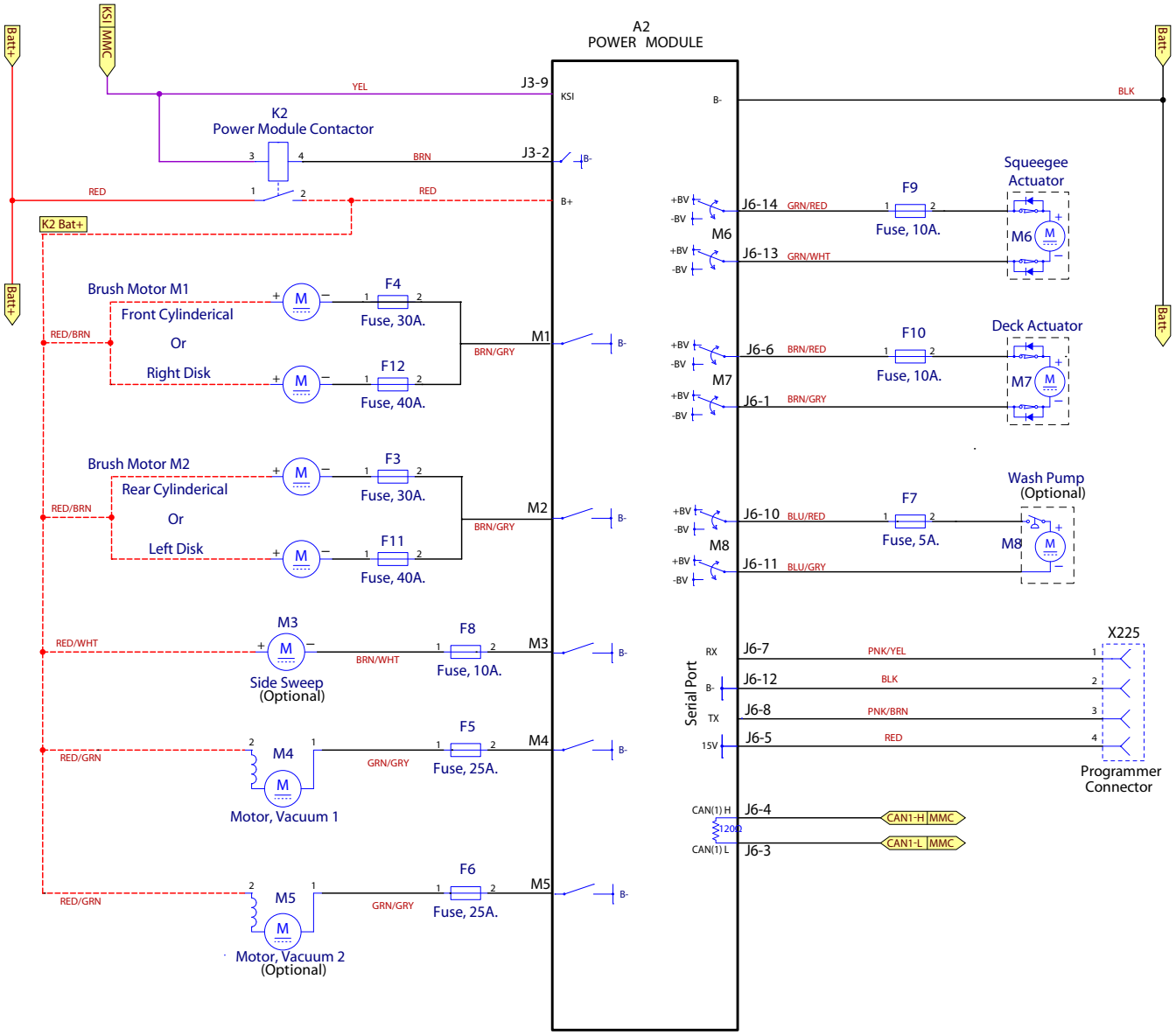
Condensed Electrical Circuit Diagram

The Condensed Electrical Circuit Diagram is electrically the same as the engineering "Electrical Circuit Diagram" on page 124, but is condensed down into the more classical functional areas. Each of the functional area sheets were created as standalone diagrams, and therefore, circuit interconnects (Goto Jumps) are reference by a net-name (network name) instead of sheet coordinates (see the Legend for reference.)

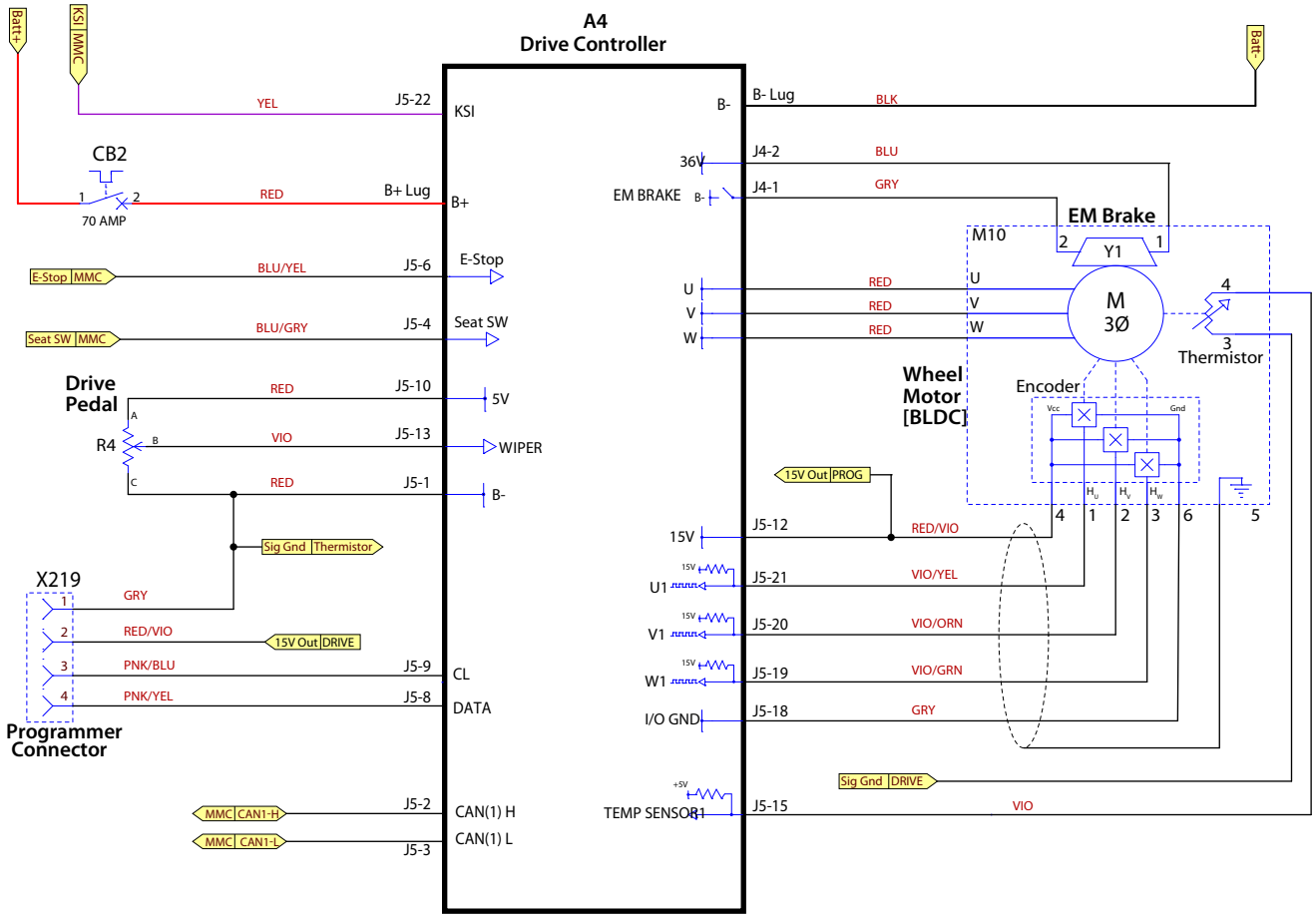
Sheet 1: Main Machine Controller



Sheet 2: Power Module



Sheet 3: Drive Controller



Using the Wiring Diagram

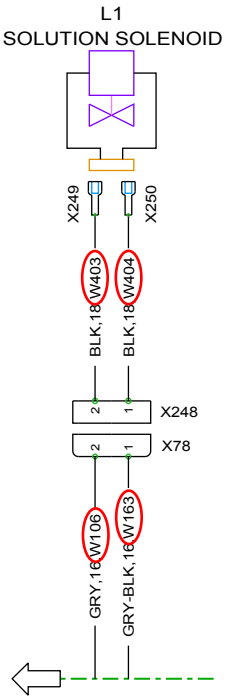
The wiring diagram contains detailed information about the physical wiring within the machine. Every wire segment is listed. Every connector is listed. Even the hidden splice points between wires are listed. This information is useful for tracing a specific circuit as it passes through the machine.

Wire Numbers

Every wire is labeled with 3 items: Wire color, Wire Gauge, and Wire Number. The wire number in the diagram is also printed on the actual wire used in the machine itself. The wire number can be used to locate both ends of any wire segment in the machine.

Even though an individual electrical circuit may pass from one electrical connector to another connector, that circuit may be made up from multiple wire segments. Each of those segments is identified in this diagram. The circuit may pass through a splice point or an intermediate connector (such as shown to the right), but each wire has only 2 connection points.

To trace a complete circuit, you would need to search for both ends of any wire number, and see where they connect to the next wire segment. And then repeat this for each wire segment in the circuit.



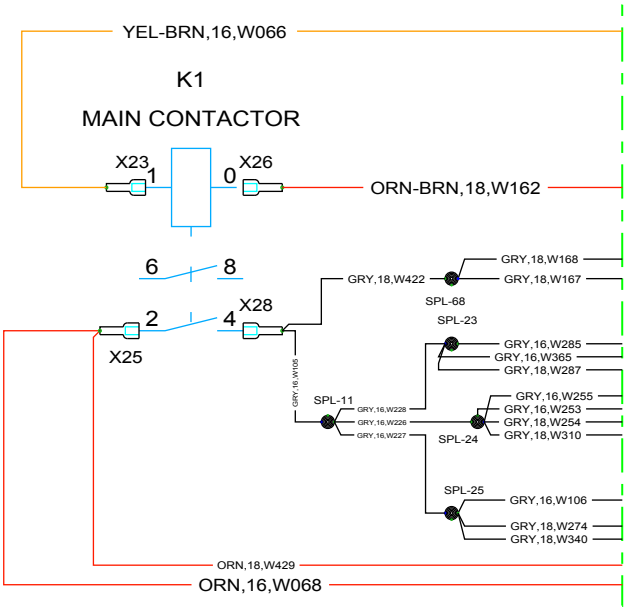
Service Tip: **We use the Ladder Diagram to trace a circuit, but use the harness diagram to trace the wires that make up that circuit.**

Splice Points

Another valuable piece of information in the harness diagram is whether splice points exist in a circuit. Splice points are used when a circuit needs to divide and travel on to multiple destinations. Each splice point also has its own unique identifier (SPL) number. Power distribution leaving the K1 (KSI) contactor is prime example of using multiple splice points to distribute this common circuit to multiple locations.

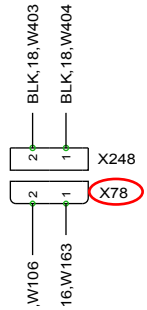
This knowledge can be helpful in troubleshooting. If multiple components fail, and it is discovered that they all share a common splice point, it can be concluded that a wire failure occurred at or upstream from that splice point.

Conversely, if only one component has failed, then it can be concluded that a wire failure has not occurred in an upstream wire segment.



Connector Numbers

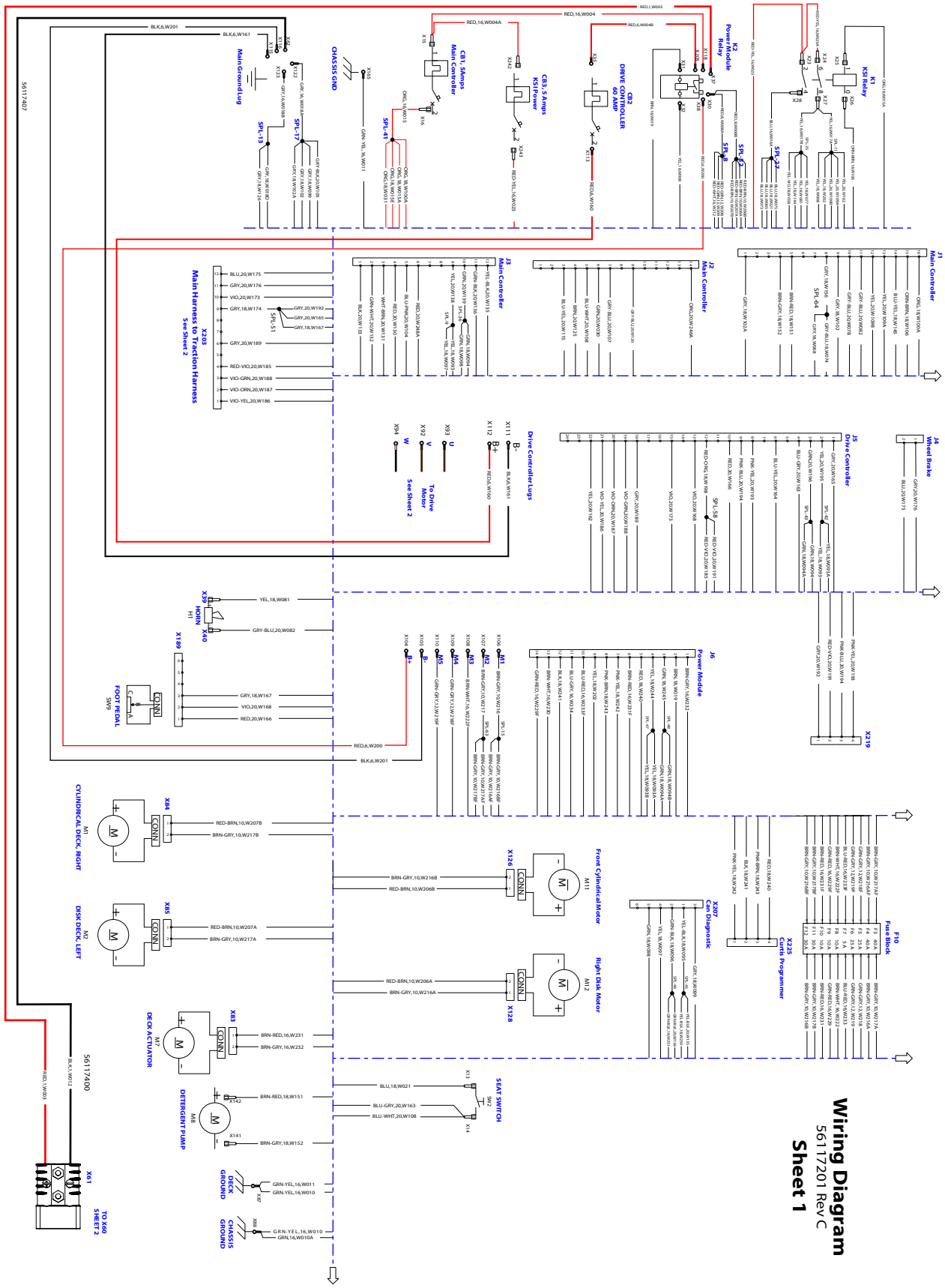
Every harness connector throughout the system is given a unique connector ID number. The ID numbers can be used to locate the connector in the machine and to look up pin assignments in the "Electrical Connector Pin-Out Assignments" on page 153. This information is used for tracing circuits and electrical signals throughout the machine. When there are mating connectors to a device, the harness-side connector is shown for pin-out assignment.



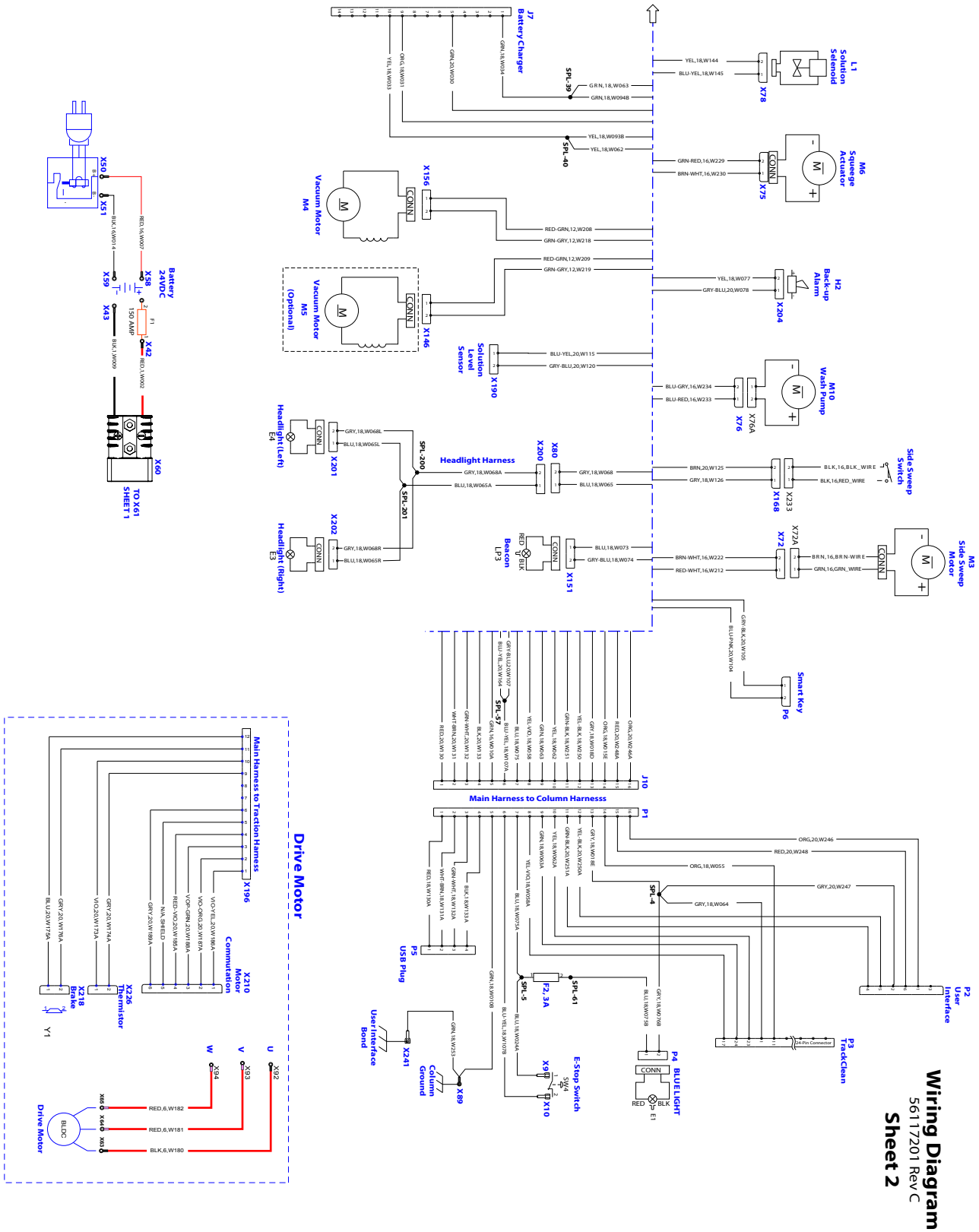
Wiring Diagram

Modified Drawing 56117201, Rev. C

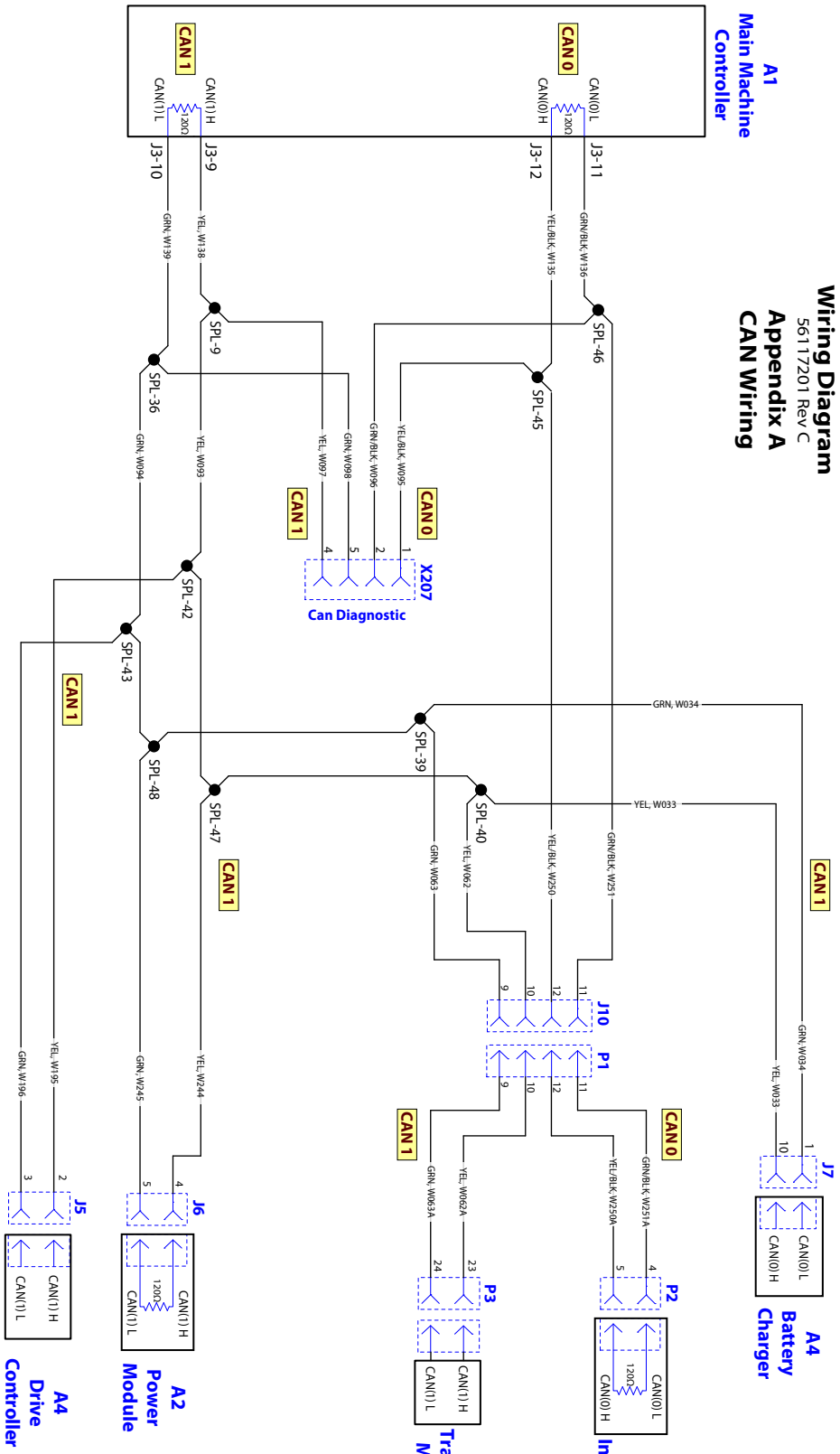
Sheet 1



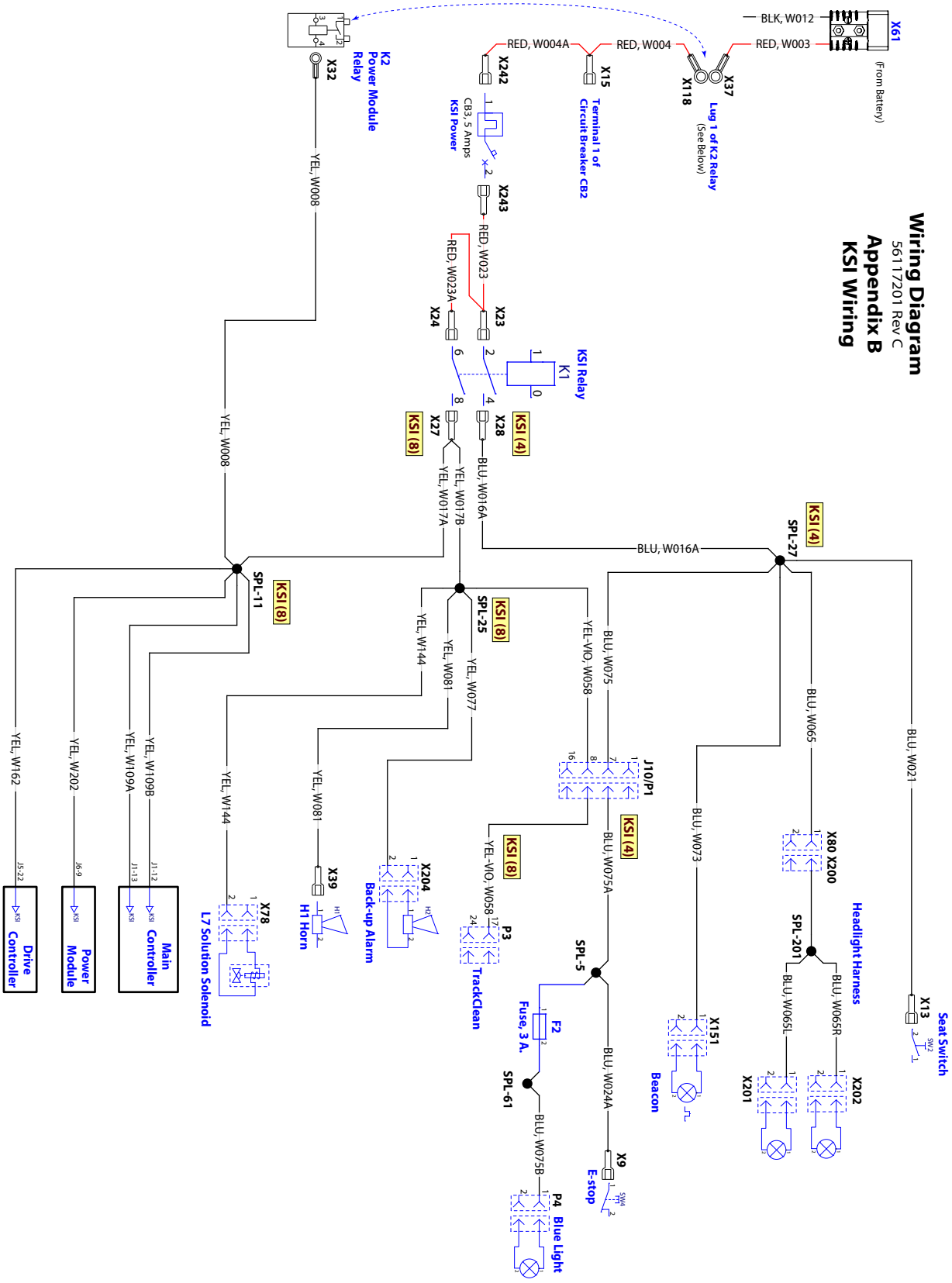
Sheet 2


Wiring Diagram
56117201 Rev C
Sheet 2
Drive Motor
Main Harness to Traction Harness
Main Harness to Column Harnesss
Headlight Harness
Battery 24VDC
TO X61 SHEET 1
Smart Key
Side Sweep Switch
E-Stop Switch
BLUE LIGHT
Back-up Alarm
Wash Pump
Side Sweep Motor
Squeege Actuator
Vacuum Motor M4
Vacuum Motor M5 (Optional)
Solution Level Sensor
Solution Solenoid
Battery Charger
Headlight (Left) E4
Headlight (Right) E3
Beacon LP3
Brake
Thermistor
Commutation Motor
USB Plug
User Interface Bond
Column Ground
TrackClean
User Interface
BLDC
F2.3A
150 AMP

Appendix A: CAN Wiring



Appendix B: KSI Wiring



Harness Diagram

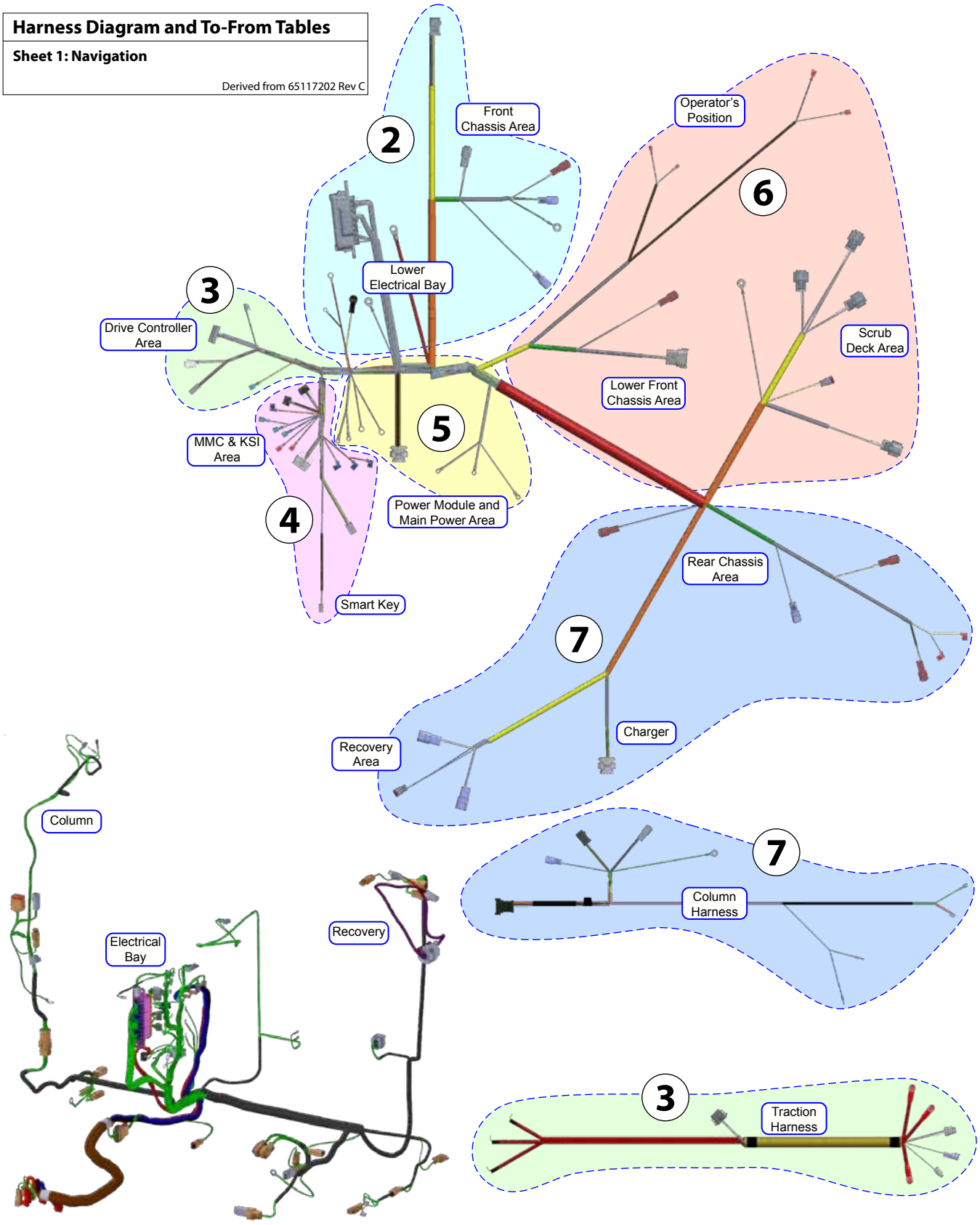
Derived from Drawing 56117202, Rev. C

Sheet 1: Navigation

Harness Diagram and To-From Tables

Sheet 1: Navigation

Derived from 65117202 Rev C



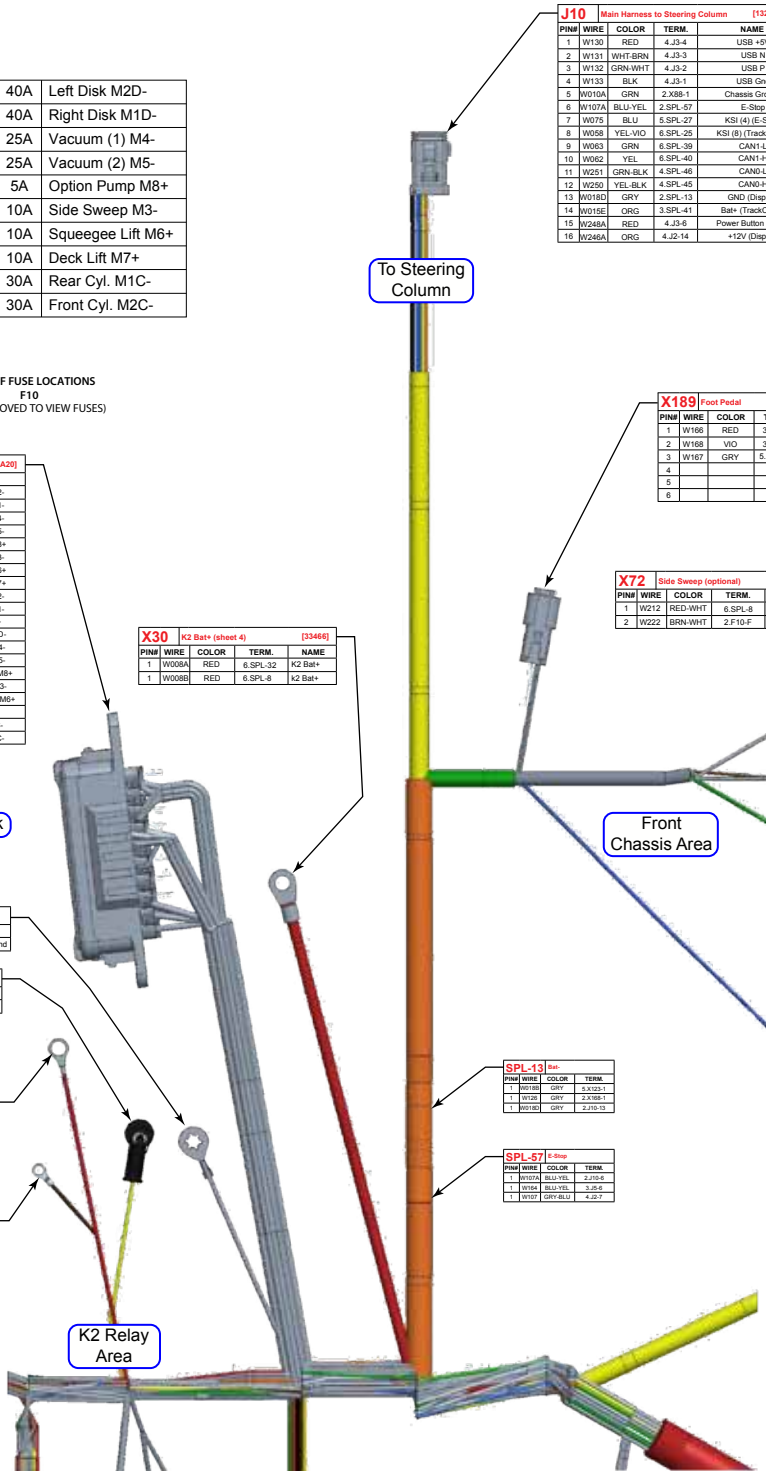
Sheet 2: Lower Elec. Bay, Front Chassis

Harness Diagram and To-From Tables

Sheet 2: Lower Electrical Bay
Front Chassis Area

F3	40A	Left Disk M2D-
F4	40A	Right Disk M1D-
F5	25A	Vacuum (1) M4-
F6	25A	Vacuum (2) M5-
F7	5A	Option Pump M8+
F8	10A	Side Sweep M3-
F9	10A	Squeegee Lift M6+
F10	10A	Deck Lift M7+
F11	30A	Rear Cyl. M1C-
F12	30A	Front Cyl. M2C-

VIEW OF FUSE LOCATIONS
F10
(CAP REMOVED TO VIEW FUSES)



J10 Main Harness to Steering Column [132015-0116]

PIN#	WIRE	COLOR	TERM.	NAME
1	W130	RED	4.J3-4	USB +5V
2	W131	WHT-BRN	4.J3-3	USB N
3	W132	GRN-WHT	4.J3-2	USB P
4	W133	BLK	4.J3-1	USB Gnd
5	W010A	GRN	2.X88-1	Chassis Ground
6	W107A	BLU-YEL	2.SPL-57	E-Stop
7	W075	BLU	5.SPL-27	KSI (4) (E-Stop)
8	W058	YEL-VIO	6.SPL-25	KSI (8) (TrackClean)
9	W063	GRN	6.SPL-39	CAN1-L
10	W062	YEL	6.SPL-40	CAN1-H
11	W251	GRN-BLK	4.SPL-46	CAN0-L
12	W250	YEL-BLK	4.SPL-45	CAN0-H
13	W018D	GRY	2.SPL-13	GND (Display)
14	W015E	ORG	3.SPL-41	Bat+ (TrackClean)
15	W248A	RED	4.J3-6	Power Button Return
16	W246A	ORG	4.J2-14	+12V (Display)

X189 Foot Pedal [ATM04-6P]

PIN#	WIRE	COLOR	TERM.	NAME
1	W166	RED	3.J5-10	Potentiometer +5V
2	W168	VIO	3.J5-13	Throttle (Pot Wiper)
3	W167	GRY	5.SPL-51	Bat-
4				
5				
6				

X72 Side Sweep (optional) [AT04-2P]

PIN#	WIRE	COLOR	TERM.	NAME
1	W212	RED-WHT	6.SPL-8	K2 Bat+
2	W222	BRN-WHT	2.F10-F	Side Sweep M29-

X168 Side Sweep Switch (optional) [ATM04-2P]

PIN#	WIRE	COLOR	TERM.	NAME
1	W126	GRY	2.SPL-13	Bat-
2	W125	BRN	4.J2-4	Side Sweep Switch

F10 Fuse Block [HWA20]

PIN#	WIRE	COLOR	TERM.	NAME
1	W217AF	BRN-GRY	5.SPL-63	Power Mod M2-
2	W216AF	BRN-GRY	5.SPL-15	Power Mod M1-
3	W218F	GRN-GRY	5.X109-1	Power Mod M4-
4	W219F	GRN-GRY	5.X110-1	Power Mod M5-
5	W233F	BLU-RED	5.J6-10	Power Mod M8+
6	W222F	BRN-WHT	5.X108-1	Power Mod M3-
7	W229F	GRN-RED	5.J6-14	Power Mod M6+
8	W231F	BRN-RED	5.J6-6	Power Mod M7+
9	W217BF	BRN-GRY	5.SPL-63	Power Mod M2-
10	W216BF	BRN-GRY	5.SPL-15	Power Mod M1-
A	W217A	BRN-GRY	6.X85-2	Left Disk M2D-
B	W216A	BRN-GRY	6.X128-1	Right Disk M1D-
C	W218	GRN-GRY	7.X156-2	Vacuum (1) M4-
D	W219	GRN-GRY	7.X146-2	Vacuum (2) M5-
E	W233	BLU-RED	7.X76-1	Option Pump M8+
F	W222	BRN-WHT	2.X72-2	Side Sweep M3-
G	W229	GRN-RED	7.X75-2	Squeegee Lift M6+
H	W231	BRN-RED	6.X83-1	Deck Lift M7+
I	W217B	BRN-GRY	6.X84-2	Rear Cyl. M1C-
J	W216B	BRN-GRY	6.X126-2	Front Cyl. M2C-

X30 K2 Bat+ (sheet 4) [33466]

PIN#	WIRE	COLOR	TERM.	NAME
1	W008A	RED	6.SPL-32	K2 Bat+
1	W008B	RED	6.SPL-8	k2 Bat+

X88 Chassis Ground [62787-1]

PIN#	WIRE	COLOR	TERM.	NAME
1	W010	GRN-YEL	6.X87-1	Chassis Ground
2	W010A	GRN	2.J10-5	Chassis Ground

X165 Machine Ground [63602-1]

PIN#	WIRE	COLOR	TERM.	NAME
1	W011	GRN-YEL	6.X87-1	Chassis Ground

X32 K2-4 Coil+ [2-34112-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W008	YEL	3.SPL-11	KSI

SPL-13 Bat-

PIN#	WIRE	COLOR	TERM.
1	W018B	GRY	5.X123-1
1	W126	GRY	2.X168-1
1	W018D	GRY	2.J10-13

X118 K2-1 Common [34114]

PIN#	WIRE	COLOR	TERM.	NAME
1	W004	RED	4.X15-1	F1 Bat+

SPL-57 E-Stop

PIN#	WIRE	COLOR	TERM.
1	W107A	BLU-YEL	2.J10-6
1	W164	BLU-YEL	3.J5-6
1	W107	GRY-BLU	4.J2-7

X80 Headlight Option [ATM04-2P]

PIN#	WIRE	COLOR	TERM.	NAME
1	W065	BLU	5.SPL-27	KSI
2	W068	GRY	5.SPL-64	Headlight/Beacon-

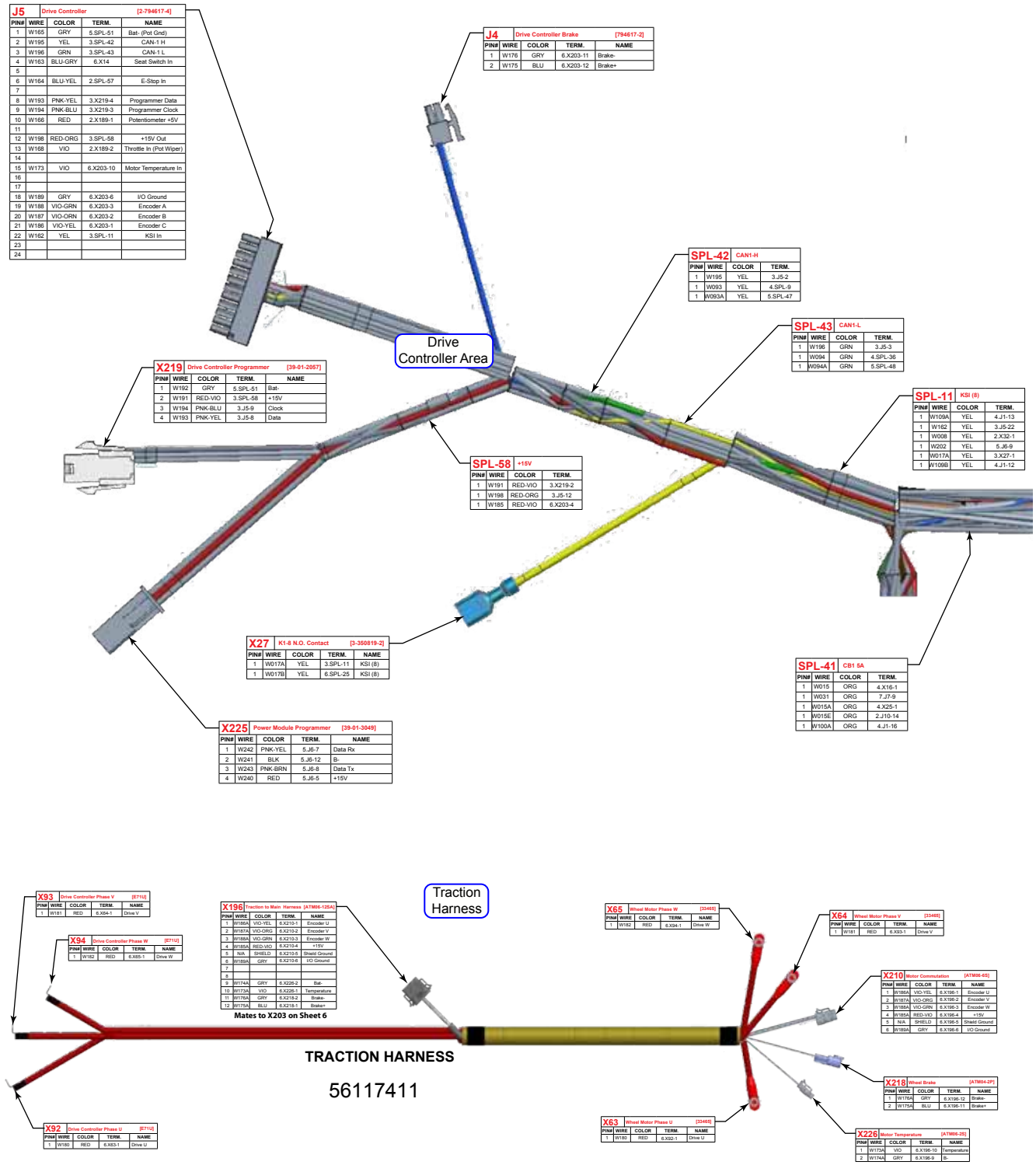
X31 K2-3 Coil- [2-34112-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W019	BRN	5.J6-2	K2 Coil Out

Sheet 3: Drive Controller, Traction Harness

Harness Diagram and To-From Tables

Sheet 3: Drive Controller Area
Traction Harness



J5 Drive Controller [2-794617-4]

PIN#	WIRE	COLOR	TERM.	NAME
1	W165	GRY	5.SPL-51	Bat- (Pot Gnd)
2	W195	YEL	3.SPL-42	CAN-1 H
3	W196	GRN	3.SPL-43	CAN-1 L
4	W163	BLU-GRY	6.X14	Seat Switch In
5				
6	W164	BLU-YEL	2.SPL-57	E-Stop In
7				
8	W193	PNK-YEL	3.X219-4	Programmer Data
9	W194	PNK-BLU	3.X219-3	Programmer Clock
10	W166	RED	2.X189-1	Potentiometer +5V
11				
12	W198	RED-ORG	3.SPL-58	+15V Out
13	W168	VIO	2.X189-2	Throttle In (Pot Wiper)
14				
15	W173	VIO	6.X203-10	Motor Temperature In
16				
17				
18	W189	GRY	6.X203-6	I/O Ground
19	W188	VIO-GRN	6.X203-3	Encoder A
20	W187	VIO-ORN	6.X203-2	Encoder B
21	W186	VIO-YEL	6.X203-1	Encoder C
22	W162	YEL	3.SPL-11	KSI In
23				
24				

J4 Drive Controller Brake [794617-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W176	GRY	6.X203-11	Brake-
2	W175	BLU	6.X203-12	Brake+

SPL-42 CAN1-H

PIN#	WIRE	COLOR	TERM.
1	W195	YEL	3.J5-2
1	W093	YEL	4.SPL-9
1	W093A	YEL	5.SPL-47

SPL-43 CAN1-L

PIN#	WIRE	COLOR	TERM.
1	W196	GRN	3.J5-3
1	W094	GRN	4.SPL-36
1	W094A	GRN	5.SPL-48

X219 Drive Controller Programmer [39-01-2057]

PIN#	WIRE	COLOR	TERM.	NAME
1	W192	GRY	5.SPL-51	Bat-
2	W191	RED-VIO	3.SPL-58	+15V
3	W194	PNK-BLU	3.J5-9	Clock
4	W193	PNK-YEL	3.J5-8	Data

SPL-11 KSI (8)

PIN#	WIRE	COLOR	TERM.
1	W109A	YEL	4.J1-13
1	W162	YEL	3.J5-22
1	W008	YEL	2.X32-1
1	W202	YEL	5.J6-9
1	W017A	YEL	3.X27-1
1	W109B	YEL	4.J1-12

SPL-58 +15V

PIN#	WIRE	COLOR	TERM.
1	W191	RED-VIO	3.X219-2
1	W198	RED-ORG	3.J5-12
1	W185	RED-VIO	6.X203-4

X27 K1-8 N.O. Contact [3-350819-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W017A	YEL	3.SPL-11	KSI (8)
1	W017B	YEL	6.SPL-25	KSI (8)

SPL-41 CB1 5A

PIN#	WIRE	COLOR	TERM.
1	W015	ORG	4.X16-1
1	W031	ORG	7.J7-9
1	W015A	ORG	4.X25-1
1	W015E	ORG	2.J10-14
1	W100A	ORG	4.J1-16

X225 Power Module Programmer [39-01-3049]

PIN#	WIRE	COLOR	TERM.	NAME
1	W242	PNK-YEL	5.J6-7	Data Rx
2	W241	BLK	5.J6-12	B-
3	W243	PNK-BRN	5.J6-8	Data Tx
4	W240	RED	5.J6-5	+15V

X93 Drive Controller Phase V [E71U]

PIN#	WIRE	COLOR	TERM.	NAME
1	W181	RED	6.X64-1	Drive V

X94 Drive Controller Phase W [E71U]

PIN#	WIRE	COLOR	TERM.	NAME
1	W182	RED	6.X65-1	Drive W

X92 Drive Controller Phase U [E71U]

PIN#	WIRE	COLOR	TERM.	NAME
1	W180	RED	6.X63-1	Drive U

X196 Traction to Main Harness [ATM06-12SA]

PIN#	WIRE	COLOR	TERM.	NAME
1	W186A	VIO-YEL	6.X210-1	Encoder U
2	W187A	VIO-ORG	6.X210-2	Encoder V
3	W188A	VIO-GRN	6.X210-3	Encoder W
4	W185A	RED-VIO	6.X210-4	+15V
5	N/A	SHIELD	6.X210-5	Shield Ground
6	W189A	GRY	6.X210-6	I/O Ground
7				
8				
9	W174A	GRY	6.X226-2	Bat-
10	W173A	VIO	6.X226-1	Temperature
11	W176A	GRY	6.X218-2	Brake-
12	W175A	BLU	6.X218-1	Brake+

X65 Wheel Motor Phase W [33465]

PIN#	WIRE	COLOR	TERM.	NAME
1	W182	RED	6.X94-1	Drive W

X64 Wheel Motor Phase V [33465]

PIN#	WIRE	COLOR	TERM.	NAME
1	W181	RED	6.X93-1	Drive V

X210 Motor Commutation [ATM06-6S]

PIN#	WIRE	COLOR	TERM.	NAME
1	W186A	VIO-YEL	6.X196-1	Encoder U
2	W187A	VIO-ORG	6.X196-2	Encoder V
3	W188A	VIO-GRN	6.X196-3	Encoder W
4	W185A	RED-VIO	6.X196-4	+15V
5	N/A	SHIELD	6.X196-5	Shield Ground
6	W189A	GRY	6.X196-6	I/O Ground

X218 Wheel Brake [ATM04-2P]

PIN#	WIRE	COLOR	TERM.	NAME
1	W176A	GRY	6.X196-12	Brake-
2	W175A	BLU	6.X196-11	Brake+

X63 Wheel Motor Phase U [33465]

PIN#	WIRE	COLOR	TERM.	NAME
1	W180	RED	6.X92-1	Drive U

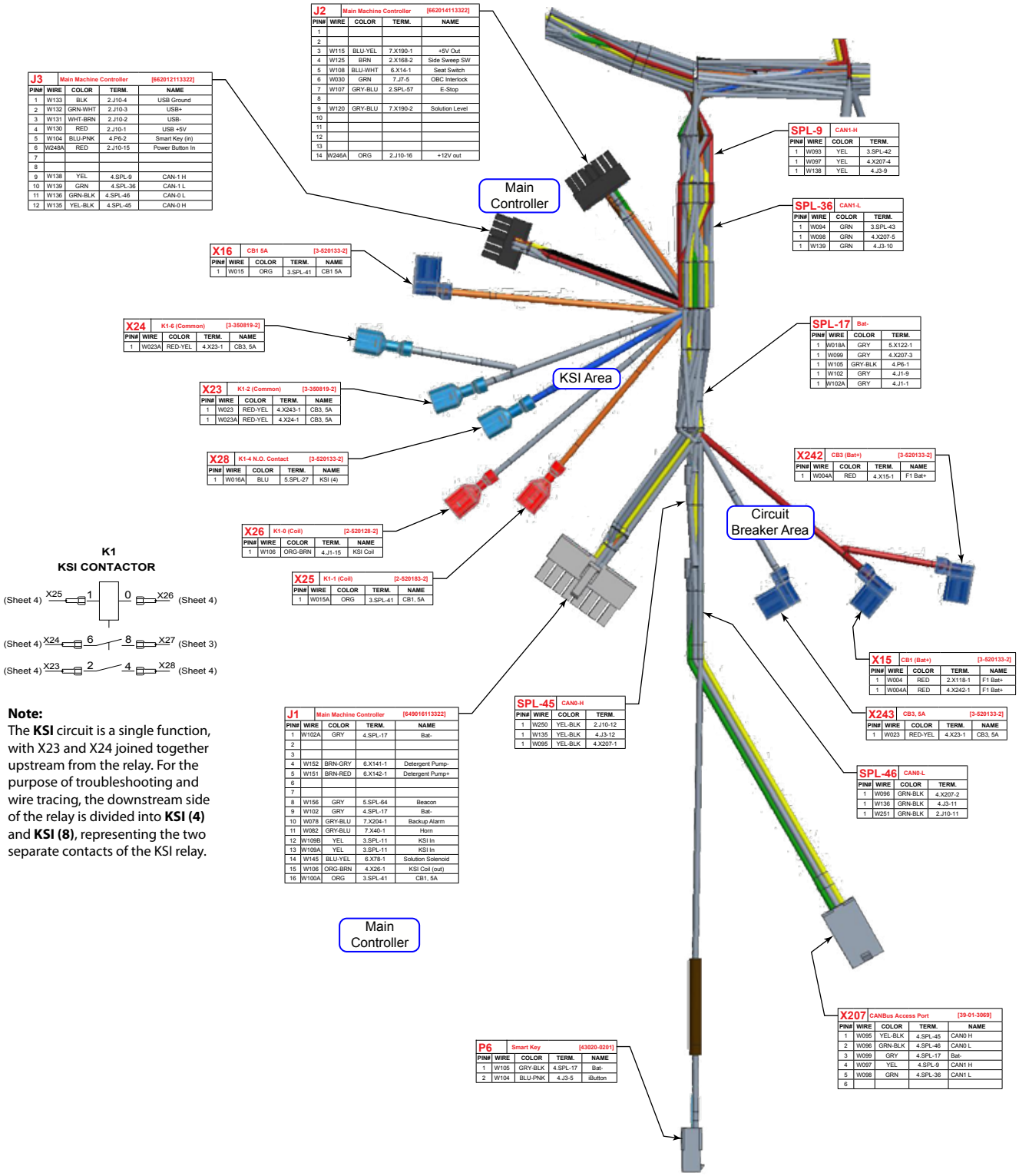
X226 Motor Temperature [ATM06-2S]

PIN#	WIRE	COLOR	TERM.	NAME
1	W173A	VIO	6.X196-10	Temperature
2	W174A	GRY	6.X196-9	B-

Sheet 4: Main Controller, KSI Relay Areas

Harness Diagram and To-From Tables

Sheet 4: Main Controller Area
KSI Relay Area



J3 Main Machine Controller [662012113322]

PIN#	WIRE	COLOR	TERM.	NAME
1	W133	BLK	2.J10-4	USB Ground
2	W132	GRN-WHT	2.J10-3	USB+
3	W131	WHT-BRN	2.J10-2	USB-
4	W130	RED	2.J10-1	USB +5V
5	W104	BLU-PNK	4.P6-2	Smart Key (in)
6	W248A	RED	2.J10-15	Power Button In
7				
8				
9	W138	YEL	4.SPL-9	CAN-1 H
10	W139	GRN	4.SPL-36	CAN-1 L
11	W136	GRN-BLK	4.SPL-46	CAN-0 L
12	W135	YEL-BLK	4.SPL-45	CAN-0 H

J2 Main Machine Controller [662014113322]

PIN#	WIRE	COLOR	TERM.	NAME
1				
2				
3	W115	BLU-YEL	7.X190-1	+5V Out
4	W125	BRN	2.X168-2	Side Sweep SW
5	W108	BLU-WHT	6.X14-1	Seat Switch
6	W030	GRN	7.J7-5	OBC Interlock
7	W107	GRY-BLU	2.SPL-57	E-Stop
8				
9	W120	GRY-BLU	7.X190-2	Solution Level
10				
11				
12				
13				
14	W246A	ORG	2.J10-16	+12V out

SPL-9 CAN1-H

PIN#	WIRE	COLOR	TERM.
1	W093	YEL	3.SPL-42
1	W097	YEL	4.X207-4
1	W138	YEL	4.J3-9

SPL-36 CAN1-L

PIN#	WIRE	COLOR	TERM.
1	W094	GRN	3.SPL-43
1	W098	GRN	4.X207-5
1	W139	GRN	4.J3-10

X16 CB1 5A [3-520133-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W015	ORG	3.SPL-41	CB1 5A

X24 K1-6 (Common) [3-350819-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W023A	RED-YEL	4.X23-1	CB3, 5A

SPL-17 Bat-

PIN#	WIRE	COLOR	TERM.
1	W018A	GRY	5.X122-1
1	W099	GRY	4.X207-3
1	W105	GRY-BLK	4.P6-1
1	W102	GRY	4.J1-9
1	W102A	GRY	4.J1-1

X23 K1-2 (Common) [3-350819-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W023	RED-YEL	4.X243-1	CB3, 5A
1	W023A	RED-YEL	4.X24-1	CB3, 5A

X28 K1-4 N.O. Contact [3-520133-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W016A	BLU	5.SPL-27	KSI (4)

X242 CB3 (Bat+) [3-520133-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W004A	RED	4.X15-1	F1 Bat+

X26 K1-0 (Coil) [2-520128-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W106	ORG-BRN	4.J1-15	KSI Coil

X25 K1-1 (Coil) [2-520183-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W015A	ORG	3.SPL-41	CB1, 5A

X15 CB1 (Bat+) [3-520133-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W004	RED	2.X118-1	F1 Bat+
1	W004A	RED	4.X242-1	F1 Bat+

X243 CB3, 5A [3-520133-2]

PIN#	WIRE	COLOR	TERM.	NAME
1	W023	RED-YEL	4.X23-1	CB3, 5A

J1 Main Machine Controller [649016113322]

PIN#	WIRE	COLOR	TERM.	NAME
1	W102A	GRY	4.SPL-17	Bat-
2				
3				
4	W152	BRN-GRY	6.X141-1	Detergent Pump-
5	W151	BRN-RED	6.X142-1	Detergent Pump+
6				
7				
8	W156	GRY	5.SPL-64	Beacon
9	W102	GRY	4.SPL-17	Bat-
10	W078	GRY-BLU	7.X204-1	Backup Alarm
11	W082	GRY-BLU	7.X40-1	Horn
12	W109B	YEL	3.SPL-11	KSI In
13	W109A	YEL	3.SPL-11	KSI In
14	W145	BLU-YEL	6.X78-1	Solution Solenoid
15	W106	ORG-BRN	4.X26-1	KSI Coil (out)
16	W100A	ORG	3.SPL-41	CB1, 5A

SPL-45 CAN0-H

PIN#	WIRE	COLOR	TERM.
1	W250	YEL-BLK	2.J10-12
1	W135	YEL-BLK	4.J3-12
1	W095	YEL-BLK	4.X207-1

SPL-46 CAN0-L

PIN#	WIRE	COLOR	TERM.
1	W096	GRN-BLK	4.X207-2
1	W136	GRN-BLK	4.J3-11
1	W251	GRN-BLK	2.J10-11

X207 CANBus Access Port [39-01-3069]

PIN#	WIRE	COLOR	TERM.	NAME
1	W095	YEL-BLK	4.SPL-45	CAN0 H
2	W096	GRN-BLK	4.SPL-46	CAN0 L
3	W099	GRY	4.SPL-17	Bat-
4	W097	YEL	4.SPL-9	CAN1 H
5	W098	GRN	4.SPL-36	CAN1 L
6				

P6 Smart Key [43020-0201]

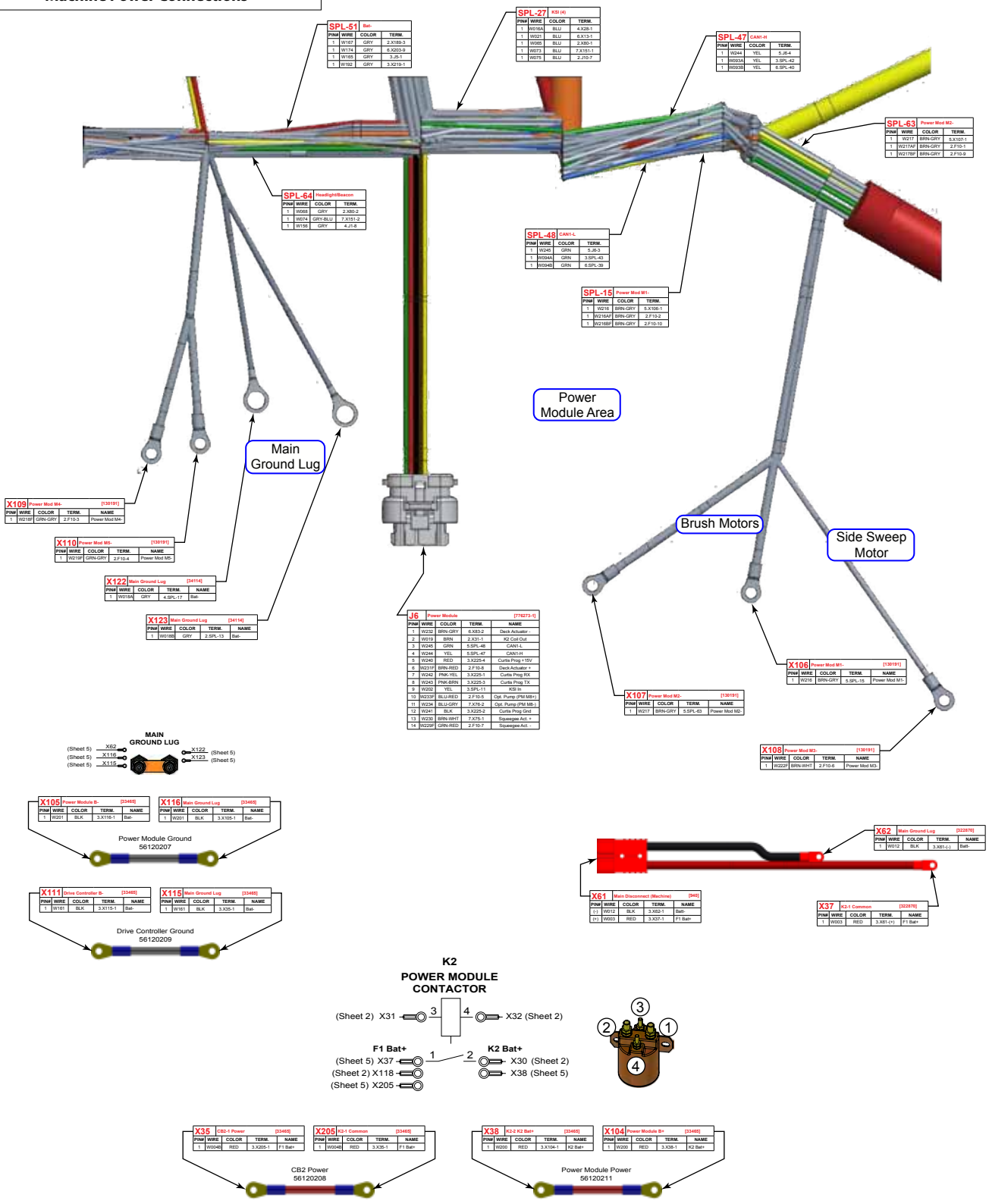
PIN#	WIRE	COLOR	TERM.	NAME
1	W105	GRY-BLK	4.SPL-17	Bat-
2	W104	BLU-PNK	4.J3-5	iButton

Note:
The **KSI** circuit is a single function, with X23 and X24 joined together upstream from the relay. For the purpose of troubleshooting and wire tracing, the downstream side of the relay is divided into **KSI (4)** and **KSI (8)**, representing the two separate contacts of the KSI relay.

Sheet 5: Power Module, Machine Power

Harness Diagram and To-From Tables

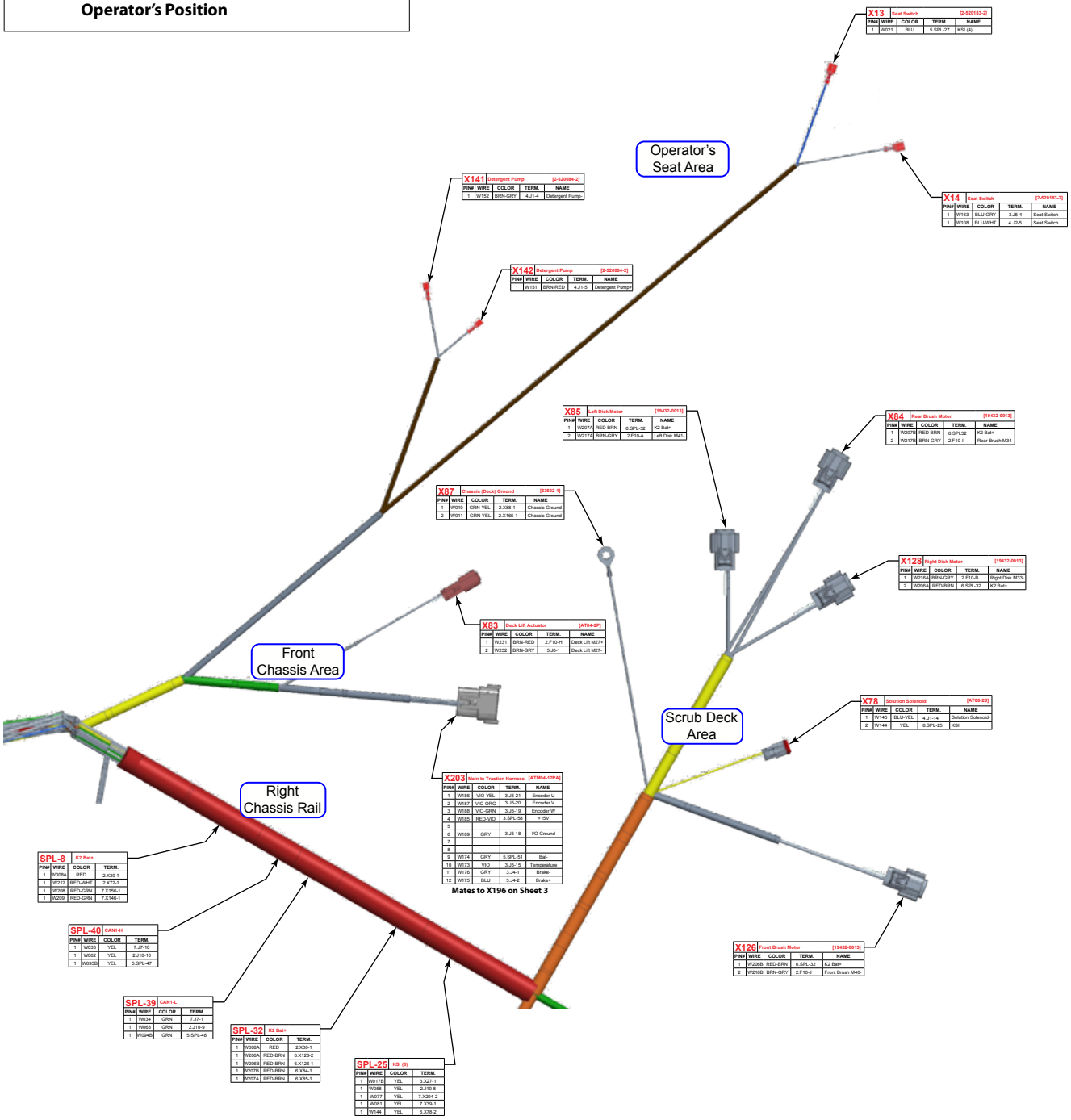
Sheet 5: Power Module
Machine Power Connections



Sheet 6: Lower Chassis and Scrub Deck Areas

Harness Diagram and To-From Tables

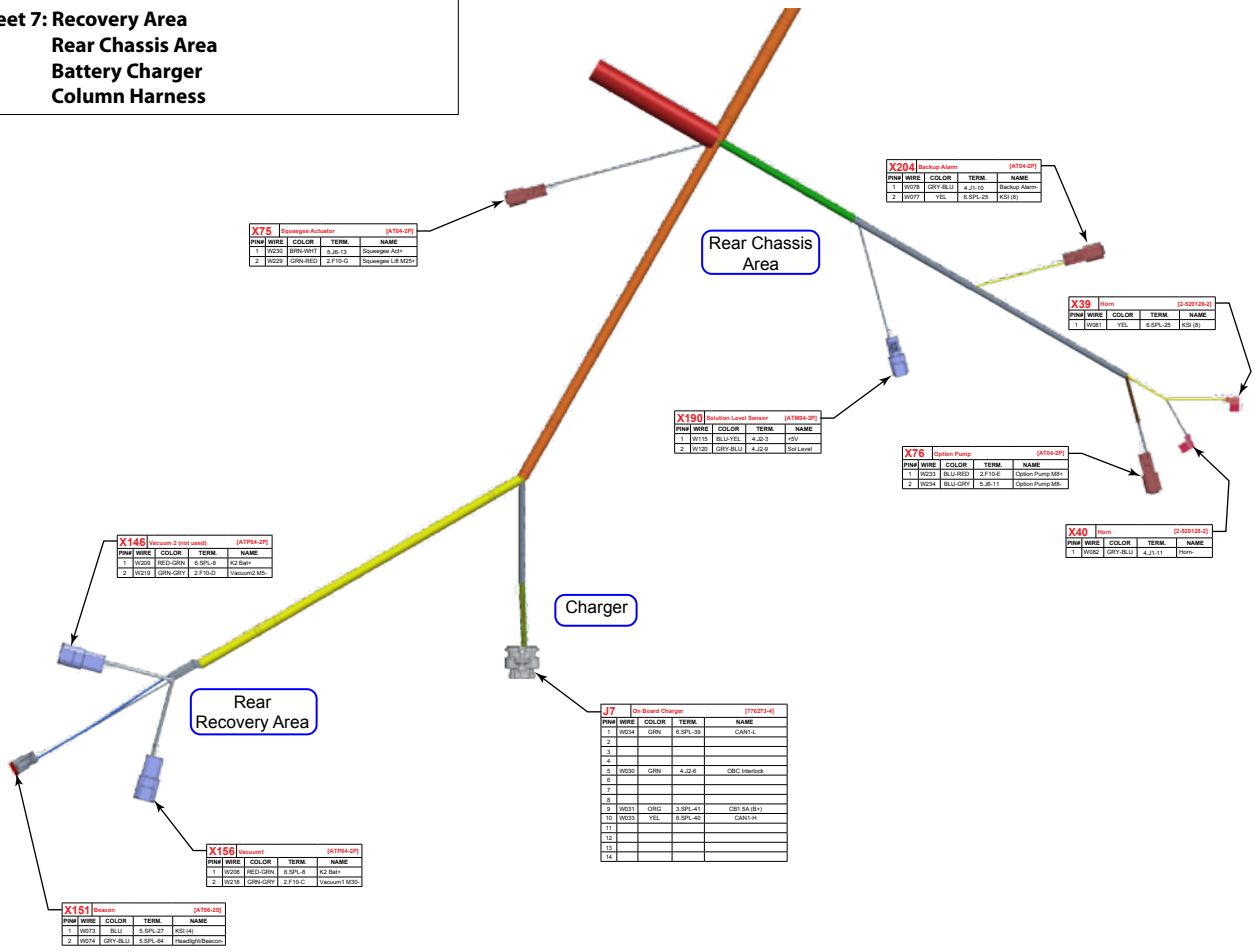
Sheet 6: Lower Front Chassis Area
Scrub Deck Area
Operator's Position

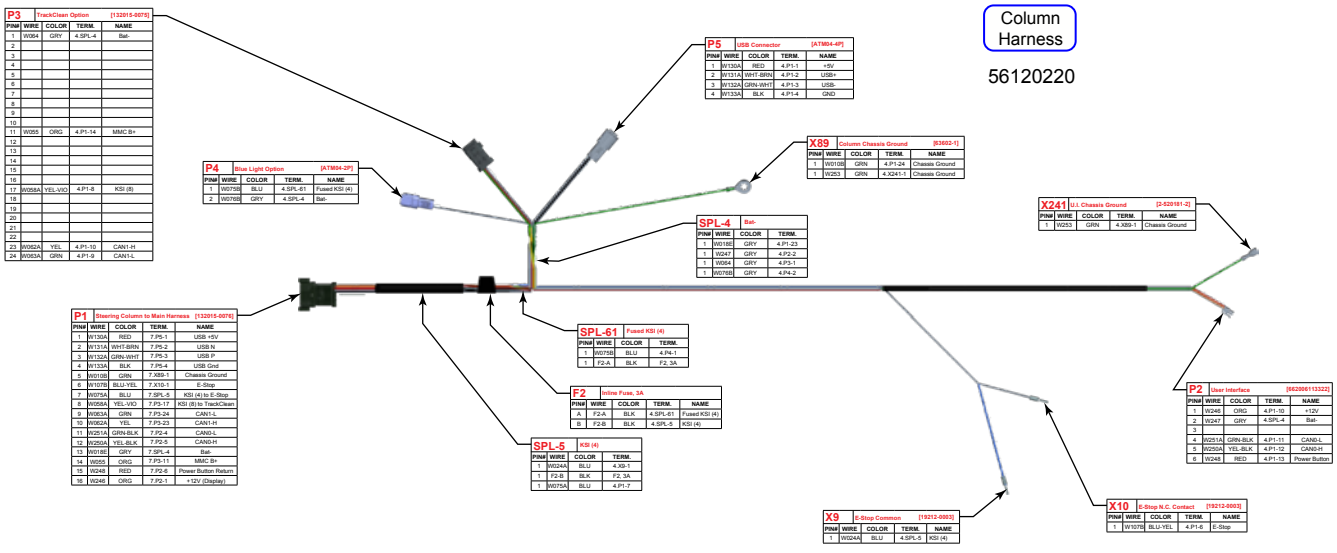


Sheet 7: Rear Chassis, Recovery, OBC, Column Harness

Harness Diagram and To-From Tables

Sheet 7: Recovery Area
Rear Chassis Area
Battery Charger
Column Harness

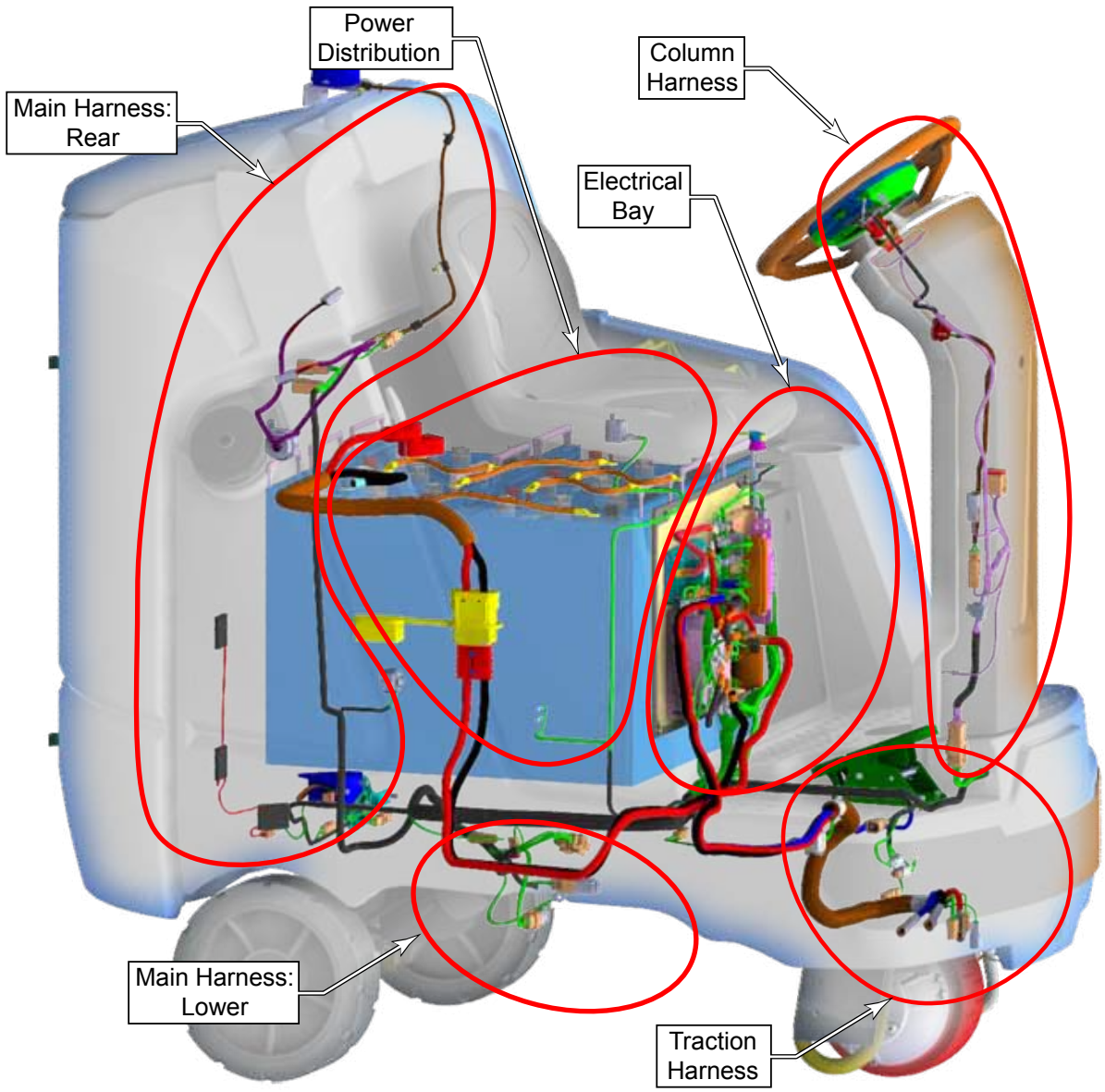




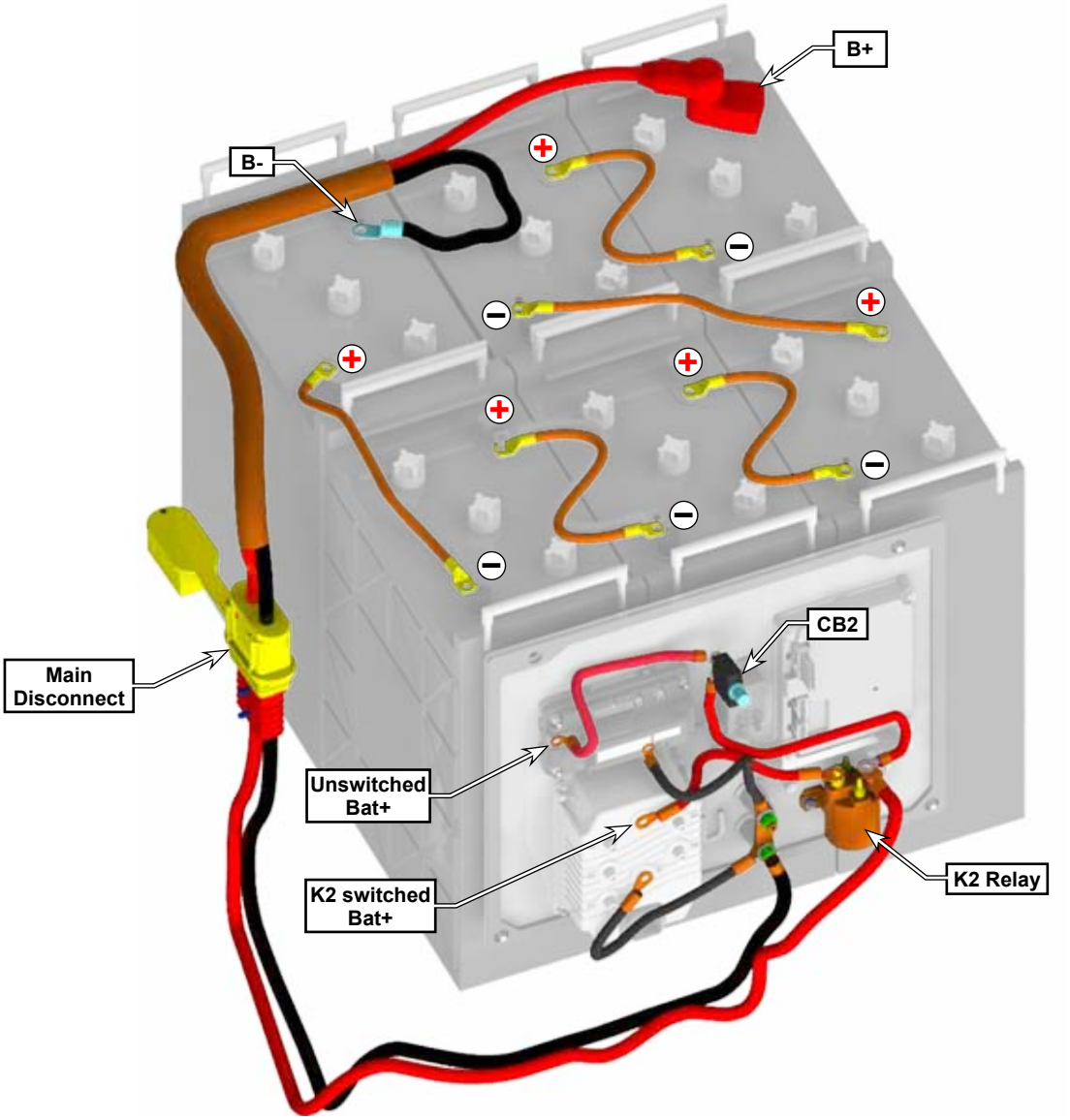
3D Harness Connector Diagrams

The following diagrams show the electrical harnesses and connectors within the machine. This can be used in conjunction with the "Electrical Connector Pin-Out Assignments" on page 153 to identify where connectors are located and how they appear.

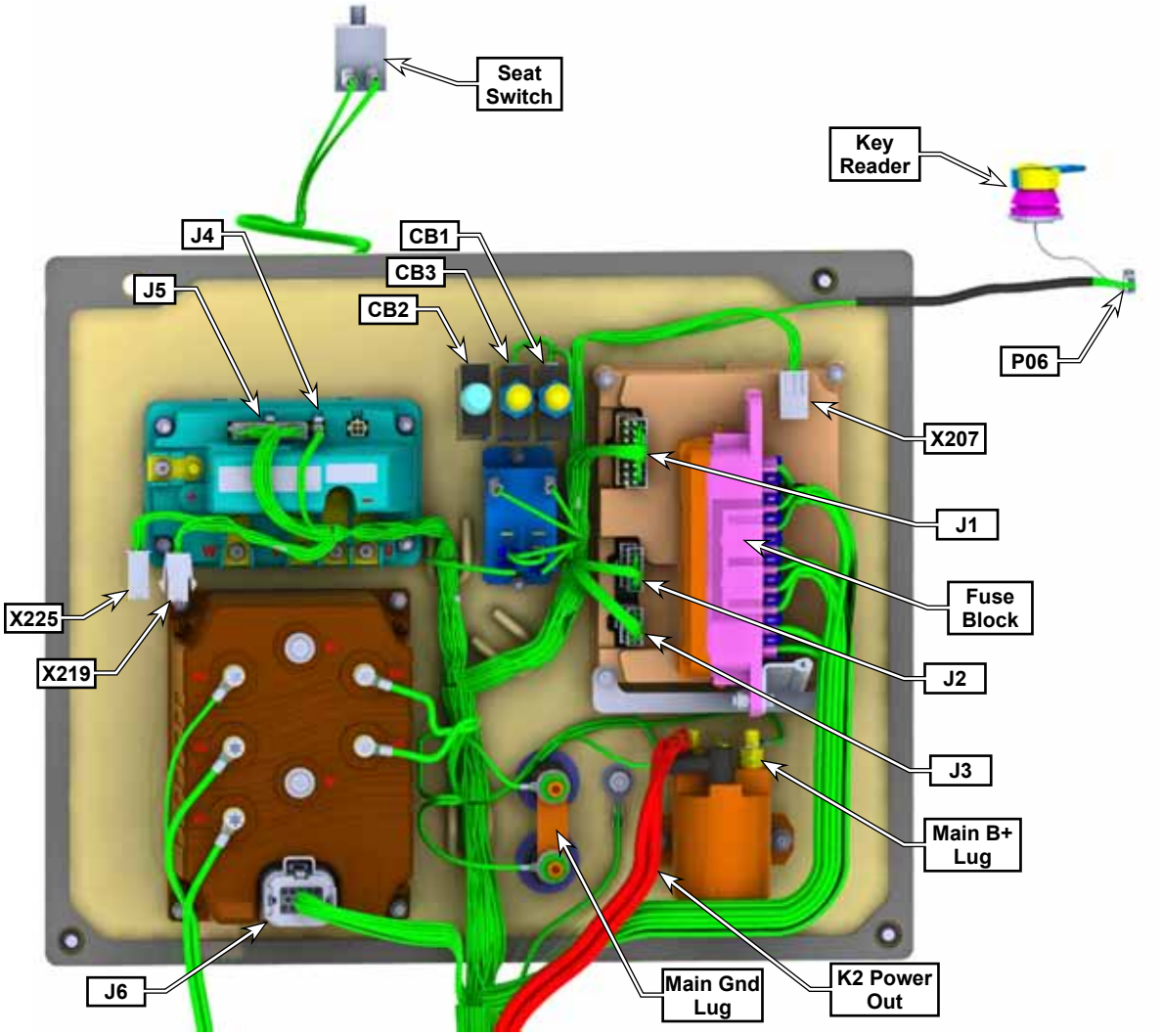
All Harnesses



Power Distribution

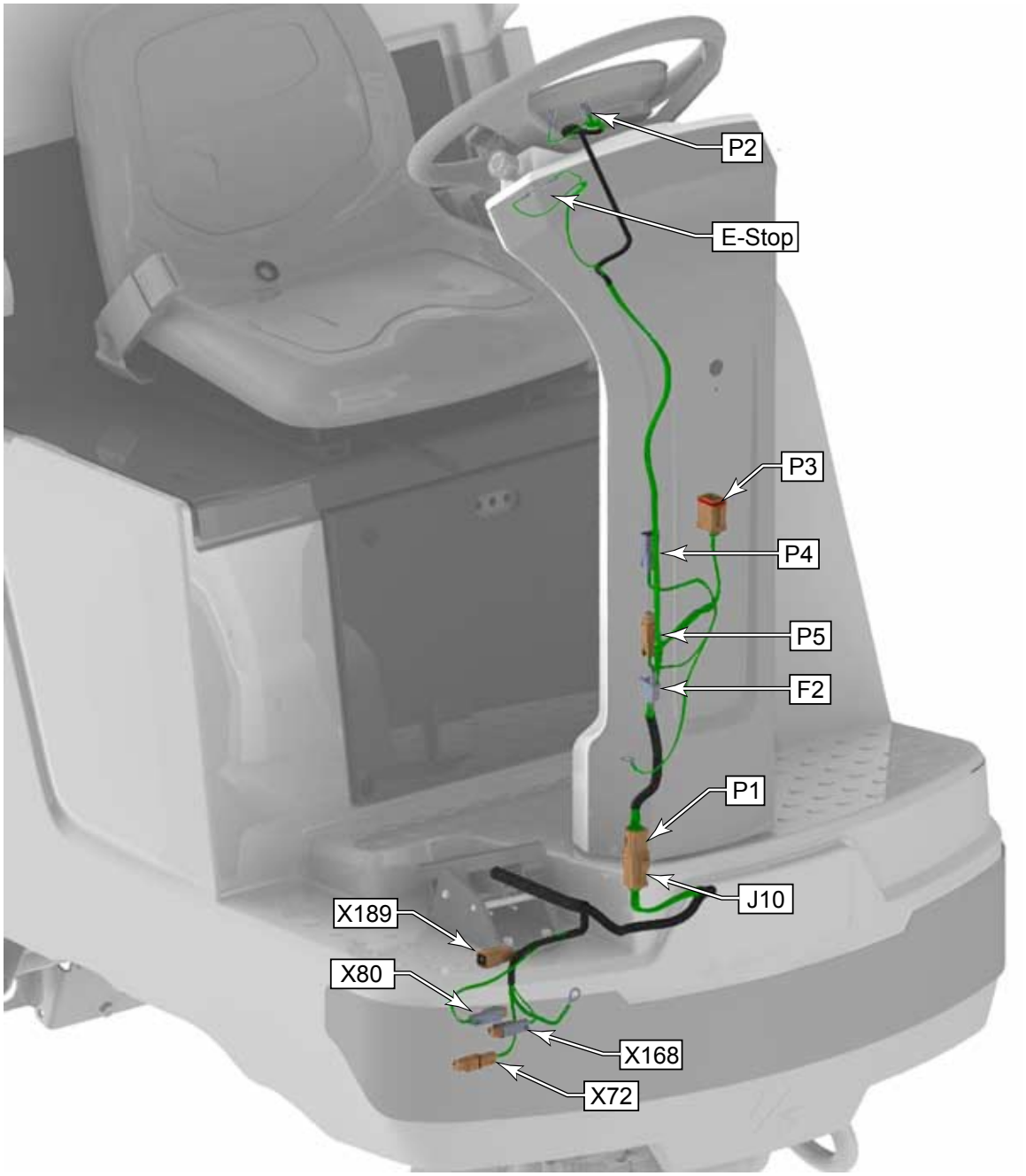


Main Harness, Electrical Bay



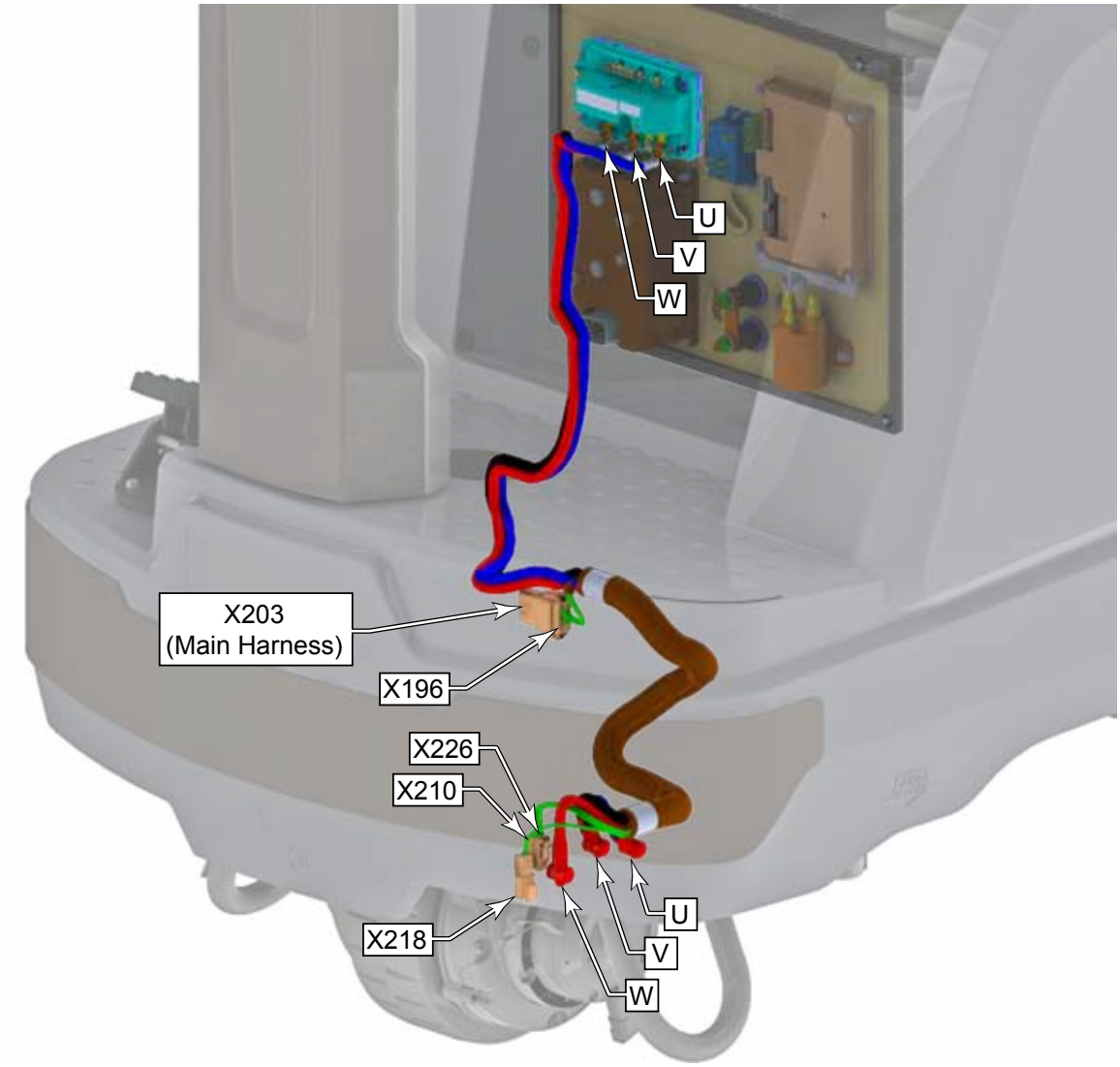
J1 Main Machine Controller 153
J2 Main Machine Controller 154
J3 Main Machine Controller 154
J4 Drive Controller Brake 154
J5 Drive Controller 155
J6 Power Module 156
P6 Smart Key 160
X207 CAN Bus Access Port 164
X219 Drive Controller Programmer 165
X225 Power Module Programmer 165

Column Harness and Main Harness-Front



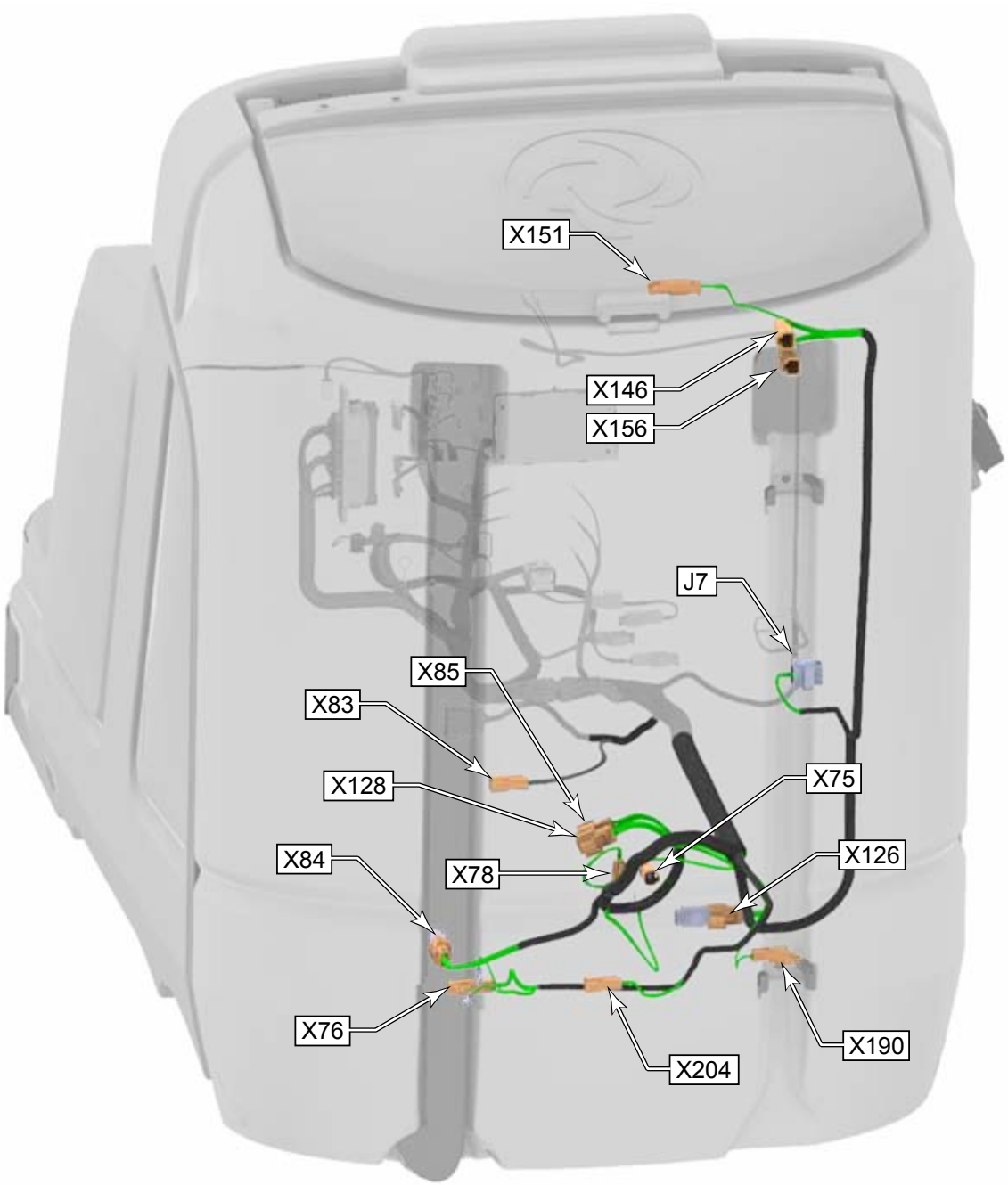
J10 Main to Steering Column Interconnect 157
P1 Steering Column to Main Interconnect 158
P2 User Interface 158
P3 TrackClean 159
P4 Blue Light 159
P5 USB Connector 160
X72 Side Sweep Motor 161
X80 Headlight Harness 162
X168 Side Sweep Switch 163
X189 Foot Pedal 164

Traction Harness



X196 Traction to Main Interconnect 160
X203 Main to Traction Interconnect 161
X210 Drive Motor Commutation 165
X218 Wheel Brake 165
X226 Drive Motor Temperature 165

Main Harness, Rear



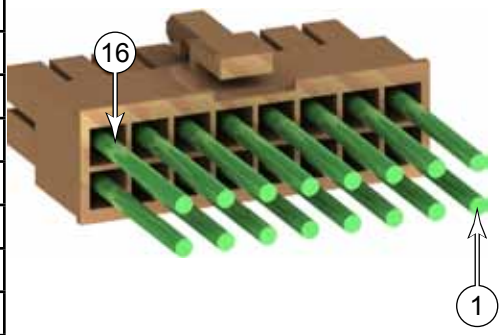
J7 Battery Charger 156
X75 Squeegee Actuator 161
X76 Wash Pump 161
X78 Solution Solenoid 162
X83 Deck Actuator 162
X84 Rear Cylindrical Motor 162
X85 Left Disk Motor 162
X126 Front Cylindrical Motor 162
X128 Right Disk Motor 163
X146 Vacuum Motor 2 163
X156 Vacuum Motor 1 163
X151 Beacon 163
X190 Solution Level Sensor 164
X204 Backup Alarm 164

Electrical Connector Pin-Out Assignments

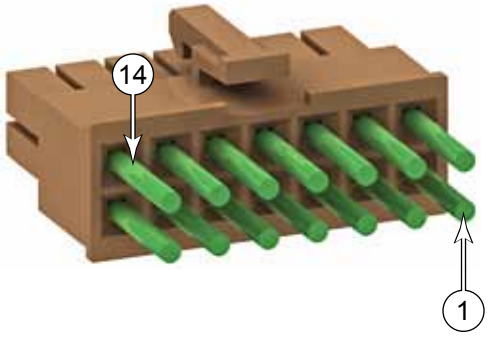
The machine uses a wide variety of electrical connectors, which vary depending on amperage passed, moisture encountered, and number of conductors present. Diagnosing machine problems, frequently involves examining the physical condition of the connectors, as well as the electrical signals passing through them.

The following tables list the individual connector pin-out assignments. The tables include connector illustrations to help you identify the various connectors on the machine. The connector pin-out information is organized by connector ID in alphabetical order.

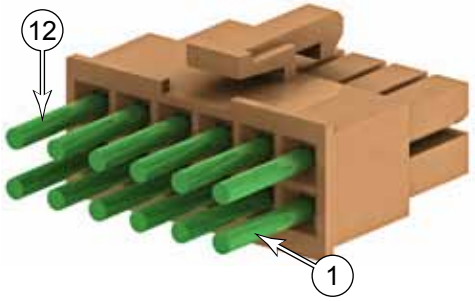
J1		Main Machine Controller		649016113322
Pin#	**Wire**	**Color**	**Function**	
1	W102	GRY	Ground	
2				
3				
4	W152	BRN-GRY	Detergent Pump	
5	W151	BRN-RED	Detergent Pump	
6				
7				
8	W074	GRY-BLU	Beacon	
9	W102	GRY	Ground	
10	W078	GRY-BLU	Backup Alarm	
11	W082	GRY-BLU	Horn	
12	W109	YEL	KSI In	
13	W109	YEL	KSI In	
14	W145	BLU-YEL	Solution Solenoid	
15	W106	ORN-BRN	KSI Coil Out	
16	W100	ORG	Bat+	



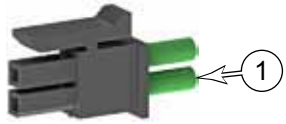
J2		Main Machine Controller		662014113322
Pin#	**Wire**	**Color**	**Function**	
1				
2				
3	W115	BLU-YEL	Solution Level +5V	
4	W125	BRN		
5	W108	BLU-WHT		
6	W030	GRN		
7	W107	GRY-BLU		
8				
9	W120	GRY-BLU	Solution Level Return	
10				
11				
12				
13				
14	W	ORG	+12V Out	



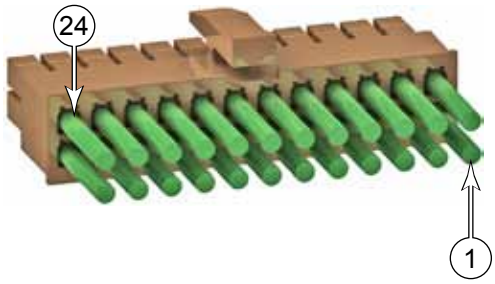
J3		Main Machine Controller		662012113322
Pin#	**Wire**	**Color**	**Function**	
1	W133	BLK	USB Ground	
2	W132	GRN-WHT	USB+	
3	W131	WHT-BRN	USB-	
4	W130	RED	USB +5V	
5	W104	BLU-PNK	Smart Key In	
6	W248	RED	Power Button In	
7				
8				
9	W138	YEL	CAN-1 H	
10	W139	GRN	CAN-1 L	
11	W136	GRN-BLK	CAN-0 L	
12	W135	YEL-BLK	CAN-0 H	



J4		Drive Controller Brake		794617-2
Pin#	**Wire**	**Color**	**Function**	
1	W176	GRY	Brake Ground	
2	W175	BLU	Brake +36V	

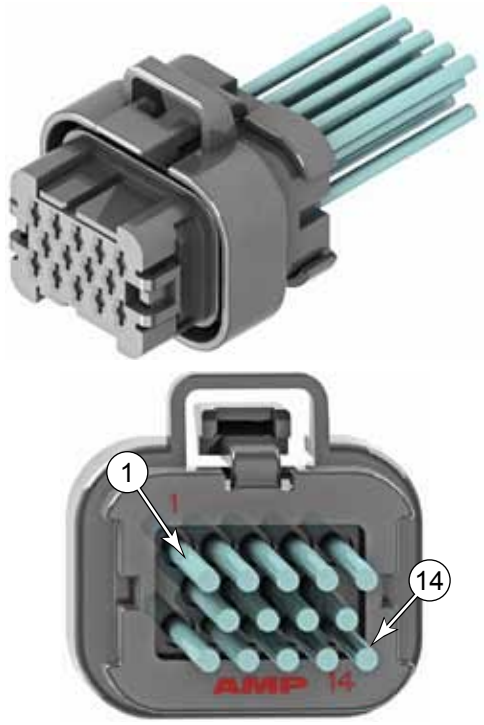


J5		Drive Controller		2-794617-4
Pin#	**Wire**	**Color**	**Function**	
1	W165	GRY	Potentiometer Gnd	
2	W195	YEL	CAN-1 H	
3	W196	GRN	CAN-1 L	
4	W163	BLU-GRY	Seat Switch In	
5				
6	W164	BLU-YEL	E-Stop In	
7				
8	W193	PNK-YEL	Programmer Data	
9	W194	PNK-BLU	Programmer Clock	
10	W166	RED	Potentiometer +5V	
11				
12	W198	RED-ORG	+15V Out	
13	W168	VIO	Throttle In (Pot Wiper)	
14				
15	W173	VIO	Motor Temperature In	
16				
17				
18	W189	GRY	I/O Ground	
19	W188	VIO-GRN	Encoder A	
20	W187	VIO-ORN	Encoder B	
21	W186	VIO-YEL	Encoder C	
22	W162	YEL	KSI In	
23				
24				



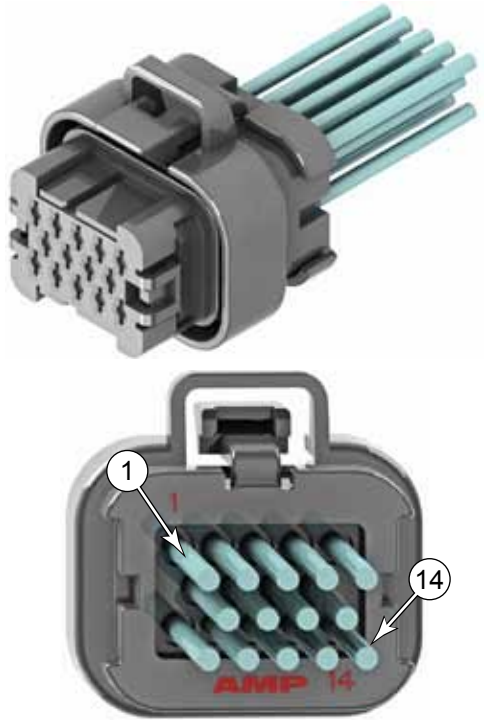
J6		Power Module	
Pin#	**Wire**	**Color**	**Function**
1	W232	BRN-GRY	Deck Actuator -
2	W019	BRN	K2 Coil Out
3	W245	GRN	CAN-1 L
4	W244	YRL	CAN-1 H
5	W240	RED	Curtis Prog +15V
6	W231F	BRN-RED	Deck Actuator +
7	W242	PNK-YEL	Curtis Prog RX
8	W243	PNK-BRN	Curtis Prog TX
9	W202	YEL	KSI In
10	W233F	BLU-RED	Opt. Pump +
11	W234	BLU-GRY	Opt. Pump -
12	W241	BLK	Curtis Prog Gnd
13	W230	BRN-WHT	Squeegee Act. +
14	W229F	GRN-RED	Squeegee Act. -

776273-1

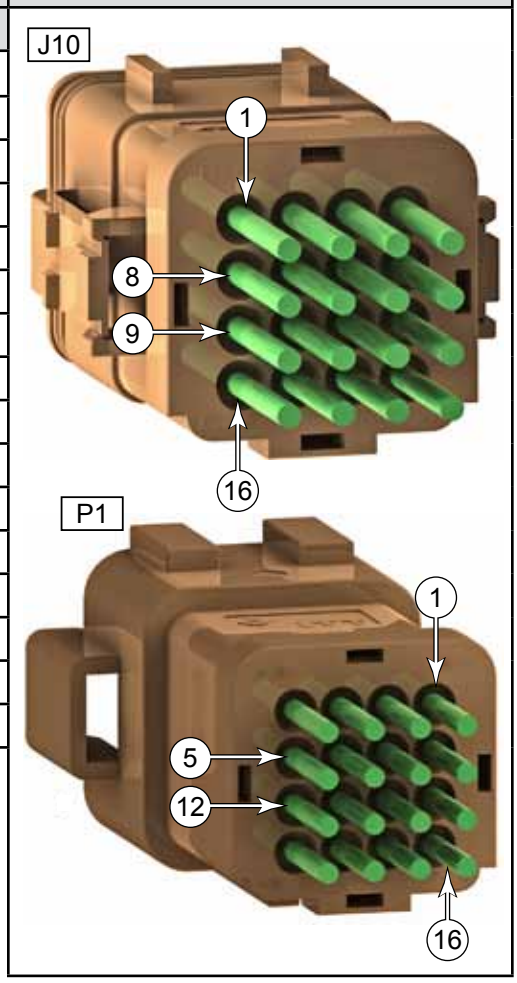


J7		Battery Charger	
Pin#	**Wire**	**Color**	**Function**
1	W034	GRN	CAN-1 L
2			
3			
4			
5	W030	GRN	Interlock Return
6			
7			
8			
9	W031	ORG	Interlock Bat+
10	W033	YEL	CAN-1 H
11			
12			
13			
14			

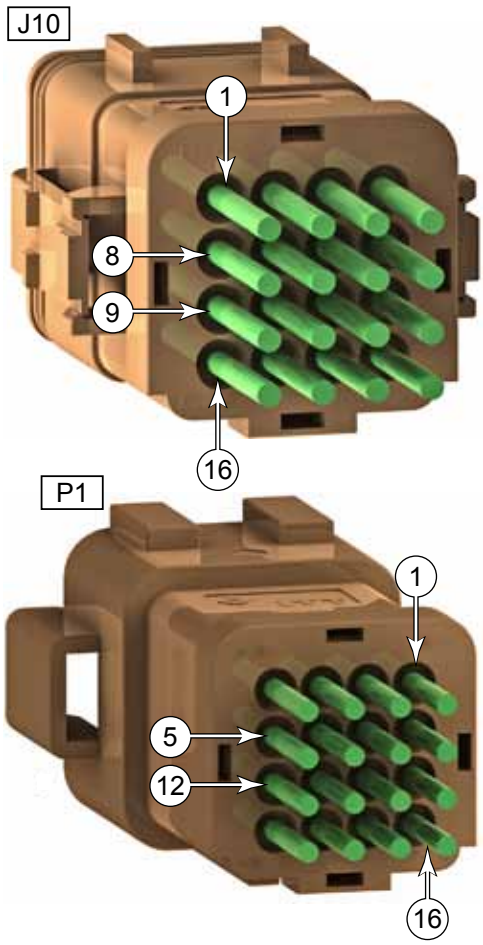
776273-4



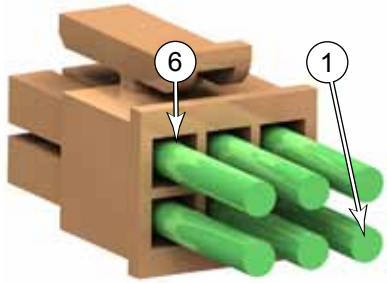
J10		Main to Steering Column Interconnect		132015-0115
Pin#	**Wire**	**Color**	**Function**	
1	W130	RED	USB +5V	
2	W131	WHT-BRN	USB N	
3	W132	GRN-WHT	USB P	
4	W133	BLK	USB Gnd	
5	W010A	GRN	Frame Ground	
6	W107A	BLU-YEL	E-Stop	
7	W075	BLU	KSI (E-Stop)	
8	W058	YEL-VIO	KSI (Trackclean)	
9	W063	GRN	CAN-1 L	
10	W062	YEL	CAN-1 H	
11	W251	GRN-BLK	CAN-0 L	
12	W250	YEL-BLK	CAN-0 H	
13	W018D	GRY	Gnd (Display)	
14	W015E	ORG	Bat+ (Trackclean)	
15	W248A	RED	Power Button Return	
16	W246A	ORG	+12V (Display)	



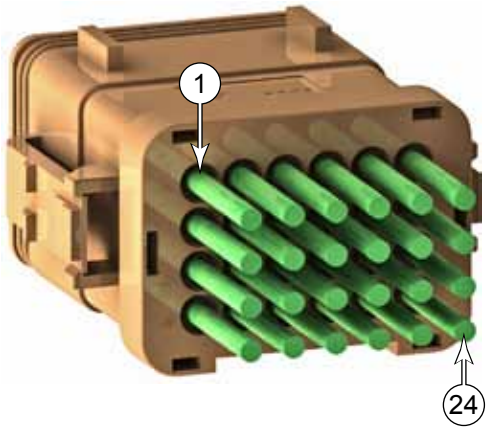
P1		Steering Column to Main Interconnect		132015-0074
Pin#	**Wire**	**Color**	**Function**	
1	W130A	RED	USB +5V	
2	W131A	WHT-BRN	USB N	
3	W132A	GRN-WHT	USB P	
4	W133A	BLK	USB Gnd	
5	W010B	GRN	Frame Ground	
6	W107B	BLU-YEL	E-Stop	
7	W075A	BLU	KSI (E-Stop)	
8	W058A	YEL-VIO	KSI (Trackclean)	
9	W063A	GRN	CAN-1 L	
10	W062A	YEL	CAN-1 H	
11	W251A	GRN-BLK	CAN-0 L	
12	W250A	YEL-BLK	CAN-0 H	
13	W018E	GRY	Gnd (Display)	
14	W015	ORG	Bat+ (Trackclean)	
15	W248	RED	Power Button Return	
16	W246	ORG	+12V (Display)	



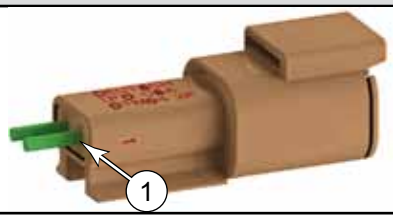
P2		User Interface		662006113322
Pin#	**Wire**	**Color**	**Function**	
1	W246	ORG	+12V	
2	W247	GRY	GND	
3				
4	W251A	GRN-BLK	CAN-0 L	
5	W250A	YEL-BLK	CAN-0 H	
6	W248	RED	Power Button Return	

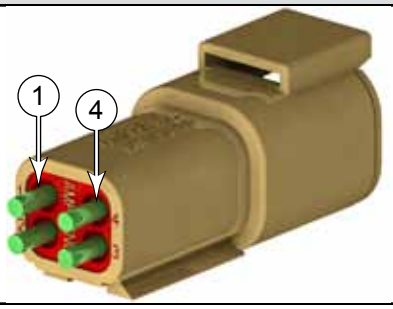


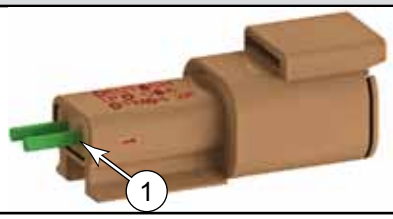
P3		TrackClean		132015-0075
Pin#	**Wire**	**Color**	**Function**	
1	W064	GRY	GND	
2				
3				
4				
5				
6				
7				
8				
9				
10				
11	W055	ORG	BAT+	
12				
13				
14				
15				
16				
17	W058A	YEL-VIO	KSI	
18				
19				
20				
21				
22				
23	W062A	YEL	CAN-1 H	
24	W063A	GRN	CAN-1 L	

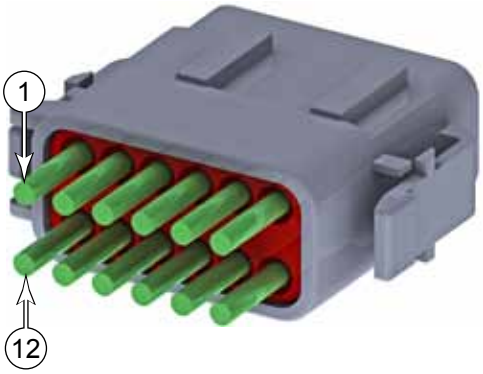


P4		Blue Light		ATM04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W075B	BLU	KSI	
2	W076B	GRY	GND	

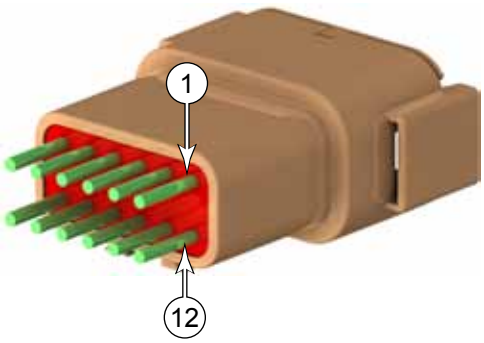


P5		USB Connector		ATM04-4P
Pin#	**Wire**	**Color**	**Function**	
1	W130A	RED	+5V	
2	W131A	WHT-BRN	USB+	
3	W132A	GRN-WHT	USB-	
4	W133A	BLK	GND	

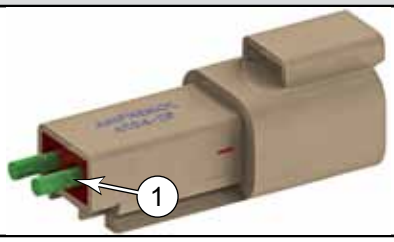
P6		Smart Key		ATM04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W105	GRY-BLK	GND	
2	W104	BLU-PNK	Smart Key to MMC	

X196		Traction to Main Interconnect		ATM06-12S
Pin#	**Wire**	**Color**	**Function**	
1	W186A	VIO-YEL	Encoder U	
2	W187A	VIO-ORG	Encoder V	
3	W188A	BLK	Encoder W	
4	W185A	RED-VIO	+15V	
5	N/A	Shield	Shield	
6	W189A	GRY	I/O Ground	
7				
8				
9	W174A	GRY	B-	
10	W173A	VIO	Temperature	
11	W176A	GRY	Brake-	
12	W175A	BLU	Brake+	

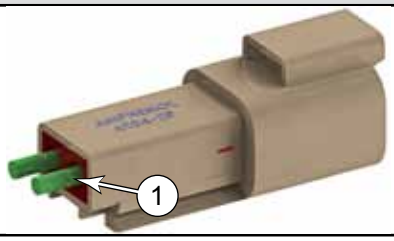
X203		Main to Traction Interconnect		ATM04-12P
Pin#	**Wire**	**Color**	**Function**	
1	W186	VIO-YEL	Encoder U	
2	W187	VIO-ORN	Encoder V	
3	W188	VIO-GRN	Encoder W	
4	W185	RED-VIO	+15V	
5				
6	W189	GRY	I/O Ground	
7				
8				
9	W174	GRY	B-	
10	W173	VIO	Temperature	
11	W176	GRY	Brake-	
12	W175	BLU	Brake+	



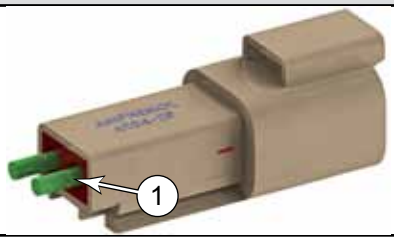
X72		Side Sweep Motor		AT04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W212	RED-WHT	+36V	
2	W222	BRN-WHT	M3	

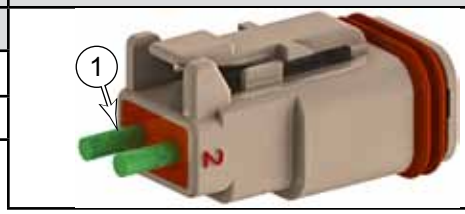


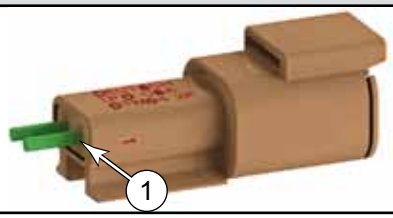
X75		Squeegee Actuator		AT04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W230	BRN-WHT	M6+	
2	W229	GRN-RED	M6-	

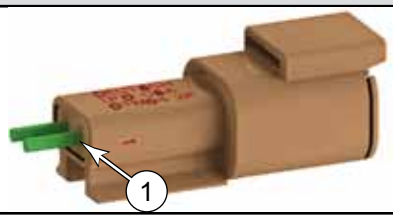


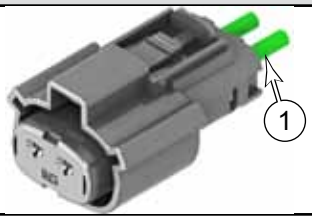
X76		Wash Pump		AT04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W233	BLU-RED	M10+	
2	W234	BLU-GRY	M10-	

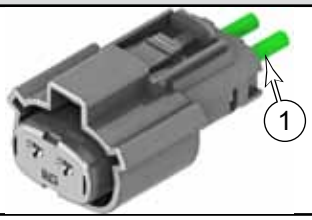


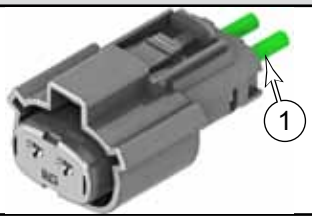
X78			Solution Solenoid	AT06-2S
Pin#	**Wire**	**Color**	**Function**	
1	W145	BLU-YEL	Solution Solenoid-	
2	W144	YEL	KSI +36V	

X80			Headlight Harness	ATM04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W065	BLU	KSI	
2	W068	GRY	GND	

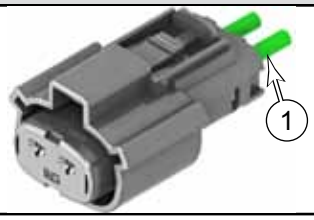
X83			Deck Actuator	ATM04-2P
Pin#	**Wire**	**Color**	**Function**	
1	W231	BRN-RED	M7+	
2	W232	BRN-GRY	M7-	

X84			Rear Cylindrical Motor	19432-0013
Pin#	**Wire**	**Color**	**Function**	
1	W207B	RED-BRN	K2 Power	
2	W217B	BRN-GRY	M2	

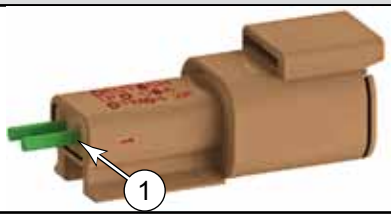
X85			Left Disk Motor	19432-0013
Pin#	**Wire**	**Color**	**Function**	
1	W207A	RED-BRN	K2 Power	
2	217AW	BRN-GRY	M2	

X126			Front Cylindrical Motor	19432-0013
Pin#	**Wire**	**Color**	**Function**	
1	W206B	RED-BRN	K2 Power	
2	W216B	BRN-GRY	M1	

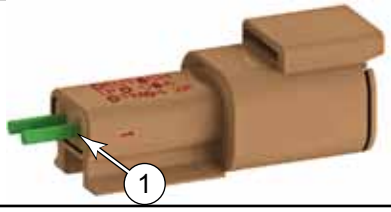
X128		Right Disk Motor	19432-0013
Pin#	**Wire**	**Color**	**Function**
1	W216A	BRN-GRY	M1
2	W206A	RED-BRN	K2 Power



X146		Vacuum Motor 2	ATP04-2P
Pin#	**Wire**	**Color**	**Function**
1	W209	RED-GRN	K2
2	W219	GRN-GRY	GND

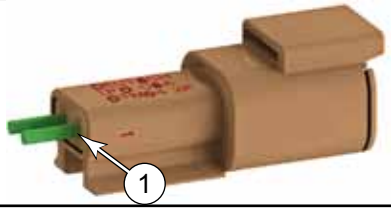


X156		Vacuum Motor 1	ATP04-2P
Pin#	**Wire**	**Color**	**Function**
1	W208	RED-GRN	K2
2	W218	GRN-GRY	GND

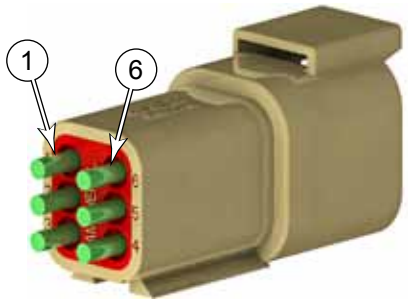


X151		Beacon	AT06-2S
Pin#	**Wire**	**Color**	**Function**
1	W073	BLU	KSI
2	W074	GRY-BLU	GND

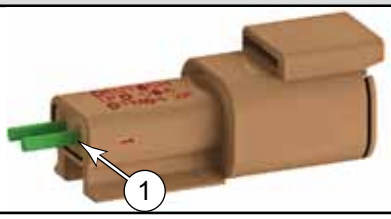
X168		Side Sweep Switch	ATM04-2P
Pin#	**Wire**	**Color**	**Function**
1	W126	GRY	GND
2	W125	BRN	Broom Up



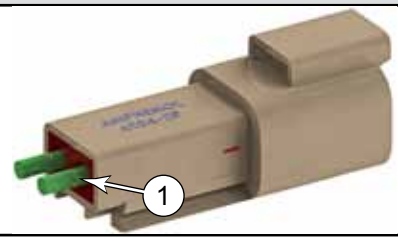
X189		Foot Pedal	ATM04-6P
Pin#	**Wire**	**Color**	**Function**
1	W166	RED	+5V
2	W168	VIO	Wiper
3	W167	GRY	Ground
4			
5			
6			



X190		Solution Level Sensor	ATM04-2P
Pin#	**Wire**	**Color**	**Function**
1	W115	BLU-YEL	+5V
2	W120	GRY-BLU	Sensor Return



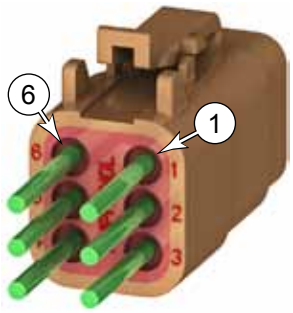
X204		Backup Alarm	AT04-2P
Pin#	**Wire**	**Color**	**Function**
1	W078	GRY-BLU	KSI +36V
2	W077	YEL	Backup Alarm-



X207		CAN Bus Access Port	39-01-3069
Pin#	**Wire**	**Color**	**Function**
1	W095	YEL-BLK	CAN0 H
2	W096	GRN-BLK	CAN0 L
3	W099	GRY	Battery-
4	W097	YEL	CAN1 H
5	W098	GRN	CAN1 L
6			

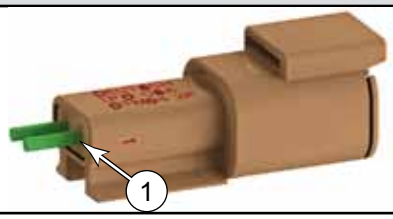
X210		Drive Motor Commutation	
Pin#	**Wire**	**Color**	**Function**
1	W186A	VIO-YEL	Encoder U
2	W187A	VIO-ORG	Encoder V
3	W188A	BLK	Encoder W
4	W185A	RED-VIO	+15V
5	N/A	Shield	
6	W189A	GRY	I/O Ground

ATM06-6S



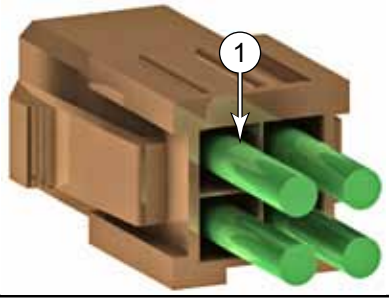
X218		Wheel Brake	
Pin#	**Wire**	**Color**	**Function**
1	GRN-YEL	GRN-YEL	Brake+
2	BLK-11	BLK	Brake-

ATM04-2P



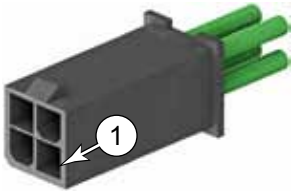
X219		Drive Controller Programmer	
Pin#	**Wire**	**Color**	**Function**
1	W192	GRY	Ground
2	W191	RED-VIO	KSI
3	W194	PNK-BLU	Clock
4	W193	PNK-YEL	Data

39-01-2041



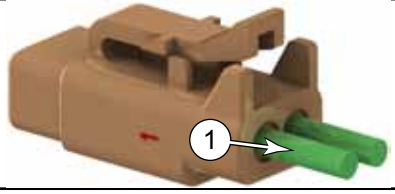
X225		Power Module Programmer	
Pin#	**Wire**	**Color**	**Function**
1	W242	PNK-YEL	Data Rx
2	W241	BLK	B-
3	W243	PNK-BRN	Data Tx
4	W240	RED	+15V

39-01-3049



X226		Drive Motor Temperature	
Pin#	**Wire**	**Color**	**Function**
1	W173A	VIO	Temperature
2	W174A	GRY	B+

ATM06-2S



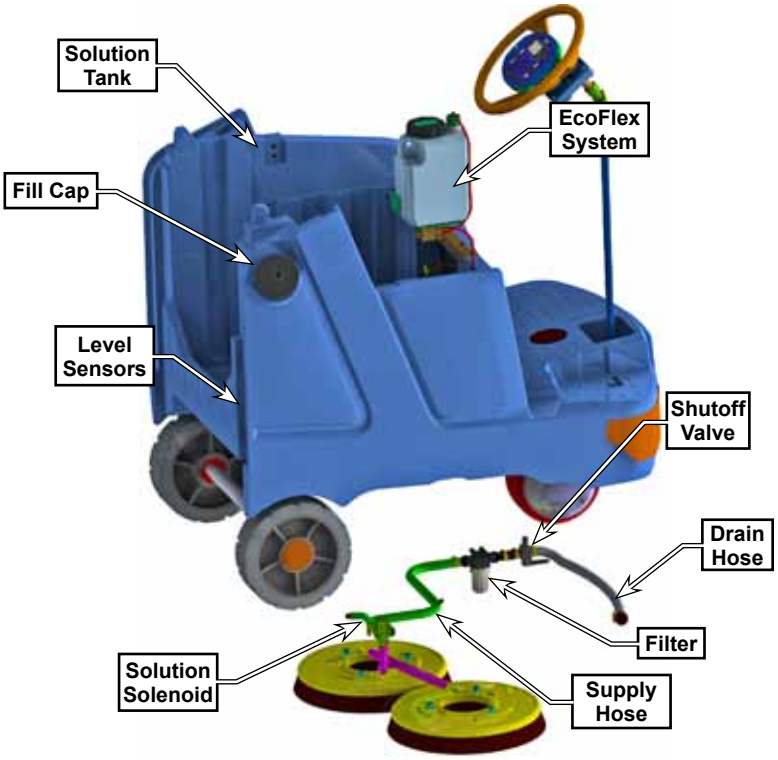
X220			Fuse Block		2-794617-4
Pin#	**Wire**	**Color**	**Fuse**	**Function**	
1	W217AF	BRN-GRY	F3 40A	In: Left Disk Motor	
A	W217A	BRN-GRY		40A Out: Left Disk Motor	
2	W216AF	BRN-GRY	F4 40A	In: Right Disk Motor	
B	W216A	BRN-GRY		40A Out: Right Disk Motor	
3	W218F	GRN-GRY	F5 25A	In: M4 Vacuum Motor 1	
C	W218	GRN-GRY		25A Out: M4 Vacuum Motor 1	
4	W219F	GRN-GRY	F6 25A	In: M5 Vacuum Motor 2	
D	W219	GRN-GRY		25A Out: M5 Vacuum Motor 2	
5	W233F	BLU-RED	F7 5A	In: M10 Wash Pump	
E	W233	BLU-RED		5A Out: M10 Wash Pump	
6	W222F	BRN-WHT	F8 10A	In: M3 Side Sweep	
F	W222	BRN-WHT		5A Out: M3 Side Sweep	
7	W229F	GRN-RED	F9 10A	In: M6 Squeegee Actuator	
G	W229	GRN-RED		10A Out: M6 Squeegee Actuator	
8	W231F	GRN-RED	F10 10A	In: M7 Deck Actuator	
H	W231	GRN-RED		10A Out: M7 Deck Actuator	
9	W217BF	BRN-GRY	F11 30A	In: Rear Cyl Motor	
I	W217B	BRN-GRY		30A Out: Rear Cyl Motor	
10	W216BF	BRN-GRY	F12 30A	In: Front Cyl Motor	
J	W216B	BRN-GRY		30A Out: Front Cyl Motor	

30 - Solution System

Functional Description

The SC5000 solution tank is incorporated directly into the main body of the machine. A series of 3 capacitive sensors serves as a level indicator for the amount of solution in the tank. The outlet of the tank has a manual shutoff valve so that components can be serviced without solution flowing out of the tank. Just downstream from the shutoff is a filter element to prevent debris from entering other components of the system.

The supply hose leads to the scrub deck, where the solution solenoid meters fluid delivery. The supply hose is a specially molded tube that also contains fittings for the optional EcoFlex detergent inlet and the option pump outlet.



Shutoff Valve

A bidirectional shutoff valve permits the solution flow to be shutoff, directed toward the scrub deck, or directed toward the drain hose. The flow is off when the handle is perpendicular to the body. When the handle is parallel to the body, it could be pointed either way, so it is best to confirm the desired position.

Solution Solenoid

The solution solenoid is located downstream from the solution filter, and activates to allow solution to flow to the scrub deck. To prevent pooling of excess water on the floor when the machine is stationary, the solenoid output from the controller is disabled when the wheel drive is not active. The rate of solution flow is controlled by cycling the solution solenoid on and off at varying duty cycles.

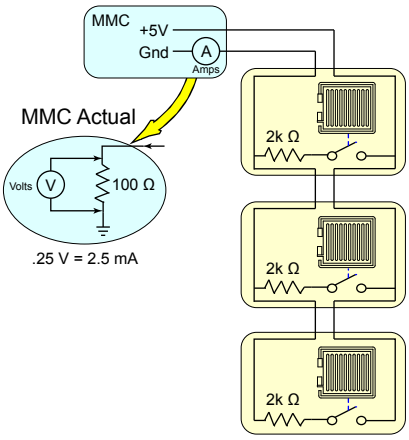
Solution Level Sensor

The solution level sensor is comprised of 3 discrete sensor bodies wired together to function as a single unit. The 3 sensor bodies are located on the right-rear corner of the solution tank, with the lower sensor (not visible) located just above the rear wheel.

The sensors operate by detecting the capacitance of the solution in the solution tank. This capacitive detection is similar to how some touch sensors work to detect a human touch. When the sensor's circuitry detects an increase in nearby capacitance, it activates a transistor switch, which connects a 2k Ω resistor between the positive and negative power terminals within the sensor.

The effect of switching this relatively small resistor into, and out of, the circuit, causes the sensor to consume more, or less amperage, which the Main Machine Controller can detect.

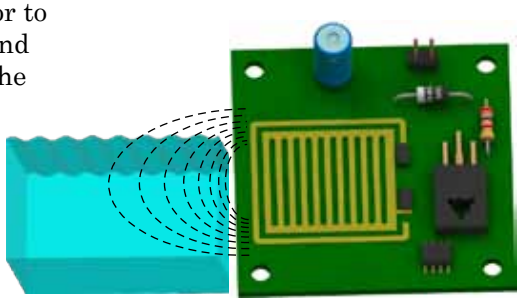
The senor's internal circuitry consumes only about 30 µA (10 µA per sensor body), but when the 2k Ω resistor is added, the consumption jumps to approximately 2.5 mA per sensor body. This amperage is cumulative, such that as each sensor body detects capacitance, the total consumed amperage increases approximately 2.5 mA each.



Operation at the MMC

The operation of the solution level sensor poses a unique situation for the Main Machine Controller, because it is a 2-wire device with 4 unique states. Therefore, the controller needs to provide power to the sensor, and monitor how much amperage is being consumed.

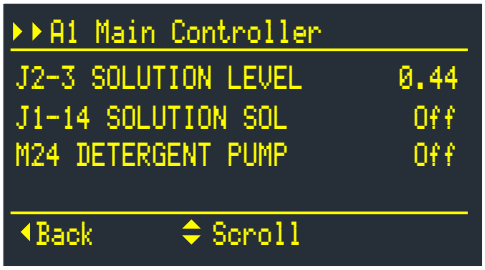
The most common method for an electrical system to monitor amperage, is to send the current through a known but small resistor to ground, and then measuring the voltage drop across that resistor and sending that signal to an analog-to-digital converter. In this case, the known resistor is 100 Ω.



Currently, the Service Menu is displaying the voltage drop across the resistor, instead of the amperage through it, but the only difference is a decimal point position. The table below summarizes the predicted versus actual values from an actual machine.

Note: The difference between predicted and actual values listed below is due to minor variations in such small resistance values. For this particular machine, the sensor's switching resistors were 2088 Ω, instead of 2000 Ω, and the MMC's sinking resistor was 101 Ω instead of 100 Ω.

Sensor Level	Predicted Amperage	Actual Amperage	Displayed Voltage
None	0.03 mA	0.03 mA	0.00 V
1 Sensor	2.50 mA	2.39 mA	0.24 V
2 Sensors	5.00 mA	4.51 mA	0.44 V
3 Sensors	7.50 mA	6.44 mA	0.64 V

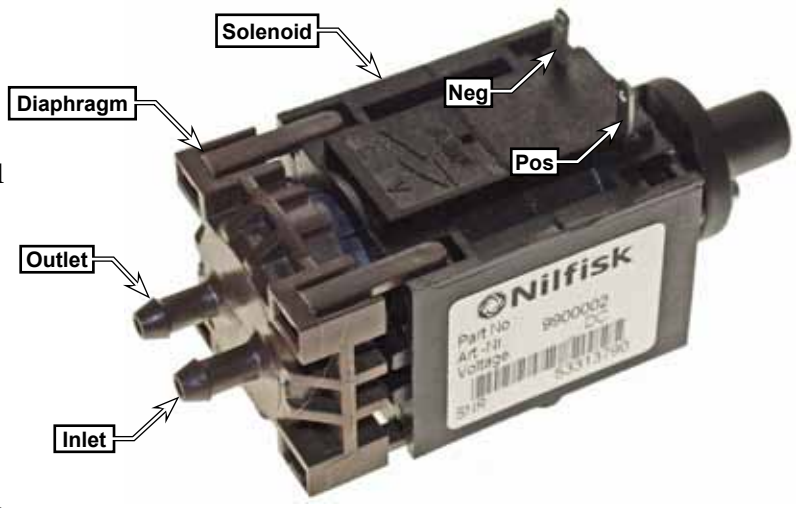


External Wash Options

The wash hose option and the scrub-n-vac option each use an on-demand fluid pump at the rear of the machine to drive pressurized water to the flexible wash hose. The pump itself monitors the output for fluid flow by pressure drop, and activates when the operator uses water. The inlet to this pump is in the solution hose, but upstream from the solution solenoid. A machine can use only one option or the other, but not both.

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 pump. The detergent pump draws the liquid from the detergent tank and injects it into the solution line before the solution solenoid. The flow rate of the detergent is controlled by the Main Machine Controller using PWM.



The detergent 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/extended stroke. The check valves allow fluid to enter only though the inlet port, and exit only through the outlet port.

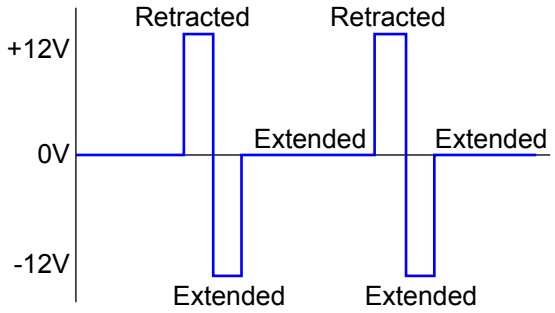
Unlike an AC solenoid that moves its plunger the same direction regardless of the electrical polarity, a DC solenoid changes its direction of travel depending on the electrical polarity of the coil. Even though the EcoFlex pump uses a DC solenoid, it still contains a mechanical return spring to return the plunger to its relaxed (extended) state when no power is present.

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. Because this is the compression stroke of the diaphragm, the pump can pump faster/harder against any resistance of the outlet tubing. This active-return also permits the pump to operate at a higher PWM frequency for higher flow rates.

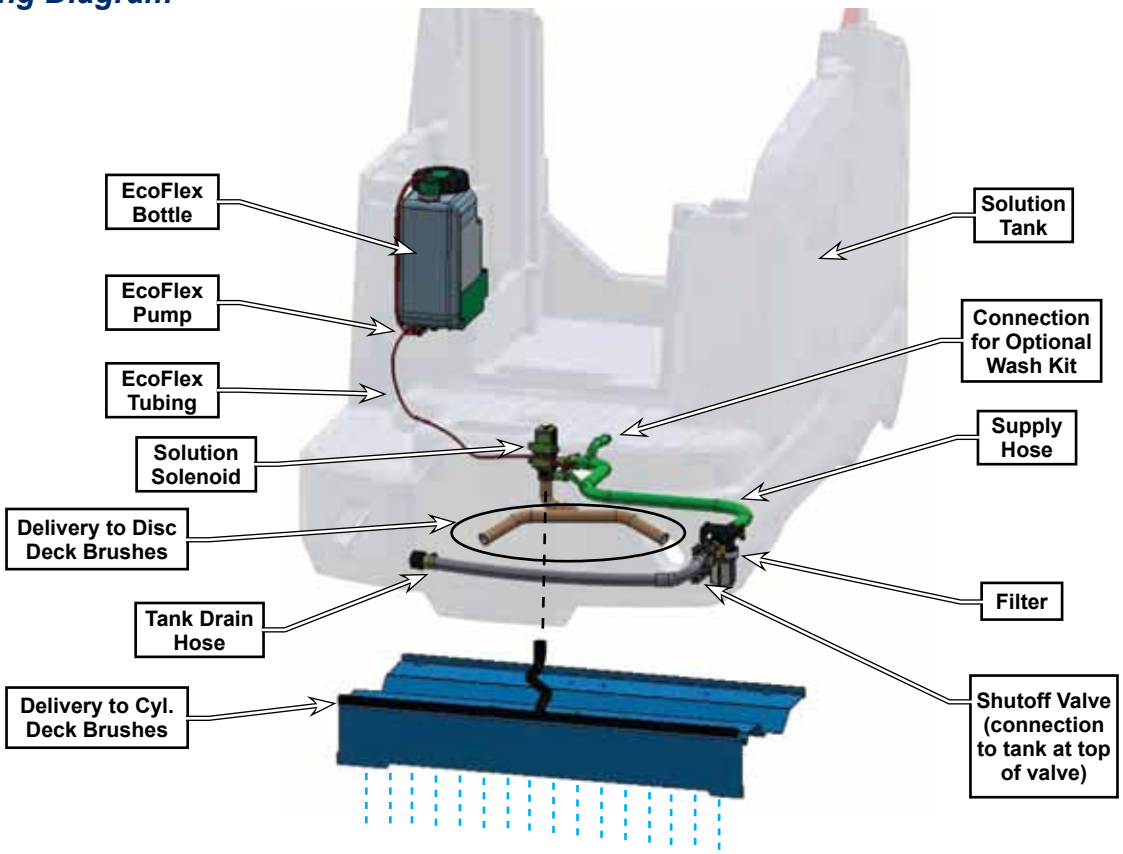
Pulse Train

The actual pulse train to the solenoid consists of a long duration Off signal, followed by a rapid Positive voltage, followed immediately by a rapid Negative voltage, and back to the long duration Off. Because the pulse train is a rapid off/plus/minus/off, the polarity of the pump's connection is still important to proper operation. If polarity was reversed (off/minus/plus/off), the initial pulse would have no effect on the plunger position, because it is already in the extended (relaxed) position due to the return spring.



Therefore, reversing the polarity of the pump wires will not show any outward sign of an error, but the volume of the detergent may be slightly diminished from normal.

Plumbing Diagram



Operational Mode Prerequisites

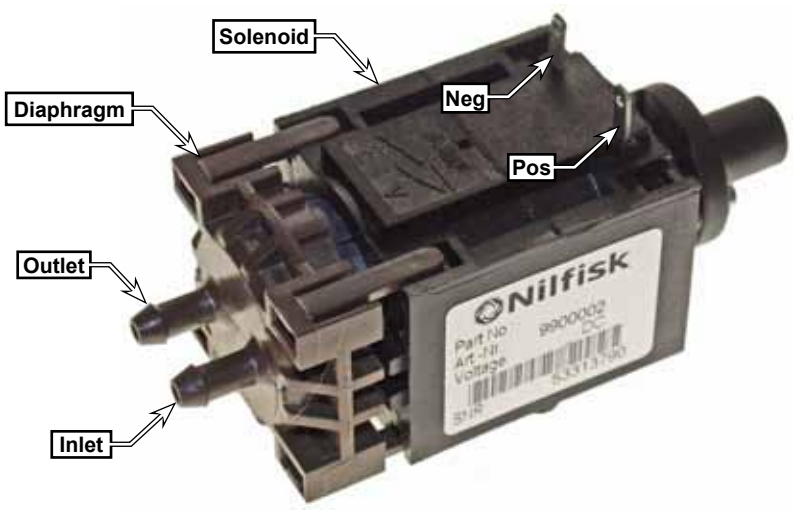
Before the main controller can activate any of the operational modes, it must first check that the appropriate prerequisites are met.

- **Solution System Outputs**
  - Solution Solenoid L7 –
    - Scrub system active
    - No solution solenoid fault
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (first or second stage)
    - No RTF inhibit
    - Not turned off with the membrane switch
    - Not momentarily turned off by the solution timed off paddle switch input
  - Spray wash pump M8
    - No spray wash pump M8 fault
    - Solution tank is not empty
    - Option (Opt) pump in configuration menu set to “Spray Wash”
- **Detergent System outputs**
  - Detergent Pump M9
    - Solution system is active
    - EcoFlex is enabled in the configuration menu
    - Not turned off with the control panel detergent switch

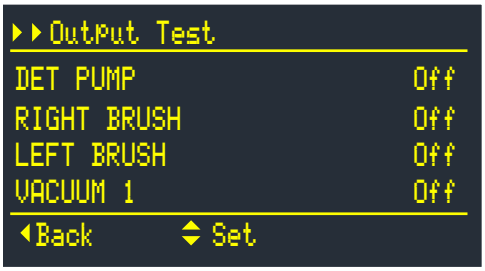
Troubleshooting

Detergent Not Flowing

1. Verify that the pickup tube in the detergent bottle is below the liquid level of detergent, and is not blocked.
2. Check the detergent tubing for cuts, damage, or loose connections, especially on the suction-side between the pump and bottle.
   - A leak on the pressure-side of the pump will likely show drips or detergent residue, but a leak on the suction-side won't show any outward signs.
3. Disconnect the outlet tube from the detergent pump.



4. Start the machine with Service Mode access, and navigate to the Service Menu, Output Test, Detergent Pump output.
5. Press the Left arrow to enter the detergent pump screen.
6. Press the up and down arrows to cycle through the 3 options of Off, Low, and High. Select High.



   - You should be able to hear and/or feel the solenoid cycling approximately every second. If you hear the solenoid cycling, but no fluid is exiting the outlet, then the pump's diaphragm is broken and the pump needs to be replaced.
   - If you do not feel/hear the solenoid cycling, continue below with a voltage check at the pump.
7. Manually operate the pump from the service menu in Low speed.
8. Place a voltmeter across the positive and negative terminals of the solenoid. (An analog voltmeter will be easier to read the short pulses.)
   - If voltage pulses are detected but the solenoid is not cycling, then replace the solenoid.
   - If no voltage pulses are detected, continue below to check the connections directly at the MMC.
9. Place the voltmeter probes between J1-4 and J1-5 at the MMC.
   - If voltage pulses are detected, repair or replace the wiring between the MMC and the detergent pump.
   - If no voltage pulses are detected, replace the Main Machine Controller.

Solution Level Indication is not Correct

The solution level sensor is comprised of 3 independent sensor bodies working together. This is important to understand for the purposes of troubleshooting, because one sensor can fail and not affect the other 2. This could give unexpected results on a machine, such as displaying less fluid than what is actually in the tank, but no error is detected.

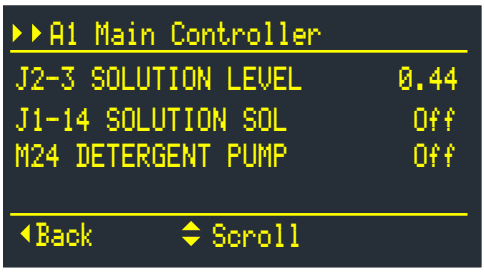
For example, if the bottom sensor were to fail, the MMC would report that the tank was empty until the 2nd sensor detected fluid, and even then, it would report that the tank was only 1/3 full. Then when the 3rd sensor was active, the MMC would report that the tank was only 2/3 full, when it is actually full.

Testing individual sensor bodies

Because the capacitive sensing technology is also used for touch-sense circuits, the easiest method for manually activating a sensor body is to use the capacitive nature of your own hand. The crosshair on the back of the sensor body represents the location of the sensing element, and if you simply place your fingers over the crosshair, you can see the display value on the Service menu change to indicate that the sensor is active.

In the event that you cannot safely put your hand over the sensor, you can also use a piece of conductive metal, such as a stainless steel ruler, a piece of wire, a screwdriver, or even a piece of tin foil; as long as you hold one end of the metal in your hand.

When you activate or deactivate a sensor body, keep in mind that the Controller intentionally slows down the change in voltage across the sensing resistor to avoid sloshing water from causing misleading results. So it may take several seconds for the value to completely change from one state to another.



Symptom: The controller indicates the tank is not full when the tank is actually full. (The Service Menu displays less than 0.55V or 5.5 mA)

- One or more of the sensor bodies is not functioning, so the entire assembly must be replaced. Because the replacement procedure requires the recovery tank to be removed, drain both the recovery and solution tanks, remove the recovery tank, and confirm the diagnosis by testing each sensor manually
- If all 3 sensor bodies appear to be functioning with manual activation, the most likely cause is corrosion in the electrical connector(s) causing a reduction in current flow.

Symptom: The controller reports the tank is empty when it is full. (The Service Menu displays zero volts/amps).

1. Disconnect the J2 connector from the Controller, and check for a short between J2-3 and Chassis ground (not J2-9).
   - A short between J2-3 and J2-9 is not suspected, because the controller would be reporting amperage flow and/or an error.
   - If a short is detected, repair/replace the harness between the Controller and X190.
   - Otherwise, continue.
2. Reconnect J2 and power the machine. Check the voltage between J2-3 and J2-9 for 5 volts.
   - If 5 volts is not present, replace the controller.
   - Note that a short circuit was already eliminated as a possible cause.

3. Check the voltage between pins 1 and 2 of the X190 connector for 5 volts.
    - If 5 volts is not present, repair or replace the wiring between the controller and connector.
    - If 5 volts is present, replace the sensor.

Symptom: The controller always reports a full tank regardless of the actual level.

1. Disconnect the sensor at the X190 connector, and check if the condition remains.
    - If the condition clears, replace the sensor.
    - If the condition persists, repair/replace the harness between the controller and the X190 connector.

Symptom: The Controller reports the tank has more solution than actual. (The service Menu never displays less than 0.25 volts or 2.5 mA even when the tank is empty.)

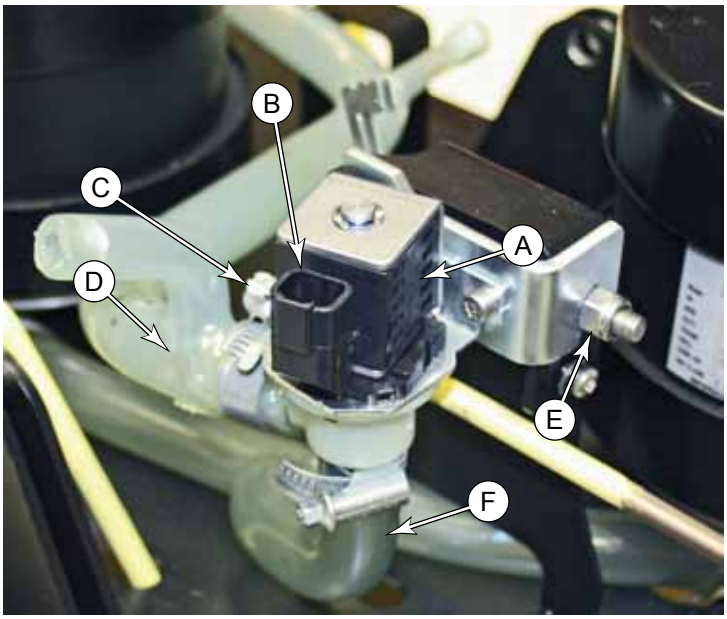
- One of the sensor bodies has failed and the whole sensor group must be replaced.
- In preparation for replacing the sensor, remove the recovery tank. If no obvious conductive obstruction is found in proximity to any of the sensor bodies, then replace the sensor.

Symptom: The Controller reports the tank has less solution than actual. (The service Menu never displays more than 0.55 volts or 5.5 mA even when the tank is full.)

- One of the sensor bodies has failed and the whole sensor group must be replaced.
- In preparation for replacing the sensor, remove the recovery tank and manually test each sensor to confirm the diagnosis. If no obvious conductive obstruction is found in proximity to any of the sensor bodies, then replace the sensor.

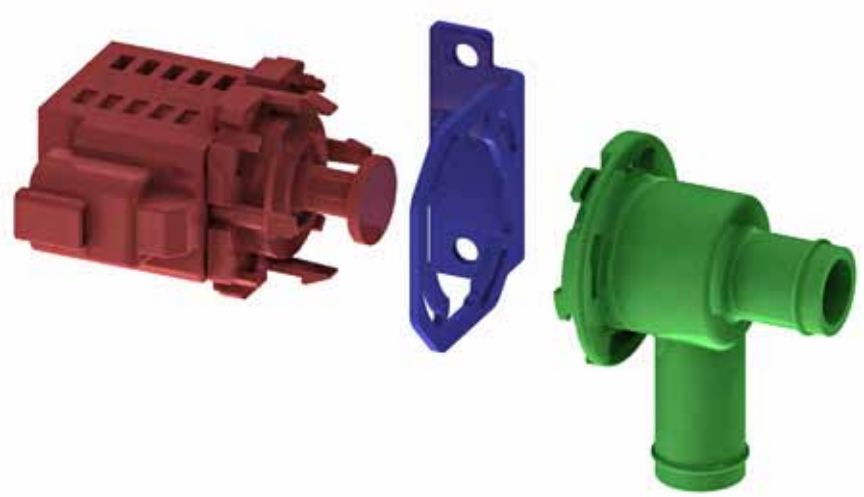
Removal and Installation

Solution Solenoid



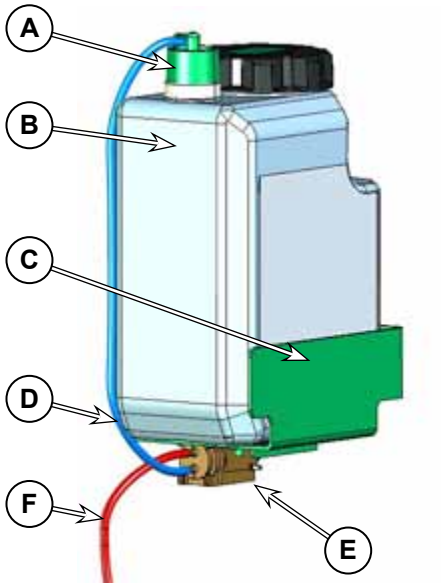
The solution solenoid is located in the center of the scrub deck on the rearward side of the deck. If the purpose for servicing the solenoid is to clean the valve seat, you may choose to separate the top and bottom while still in the machine, as described in step 5.

1. Close the manual shutoff valve located at the front-right side of the solution tank.
2. Disconnect the electrical connector **(B)** from the top of the solenoid.
3. Loosen the hose clamp **(C)** and remove the solution supply hose **(D)** from the solenoid inlet.
4. Loosen the nut **(E)** that secure the solenoid to the scrub deck frame, and lift the solenoid upward to remove it from the outlet hose **(F)**.
5. If necessary, separate the upper and lower halves of the solution solenoid by twisting the upper half counterclockwise. This permits cleaning of the valve seat.



Detergent Pump

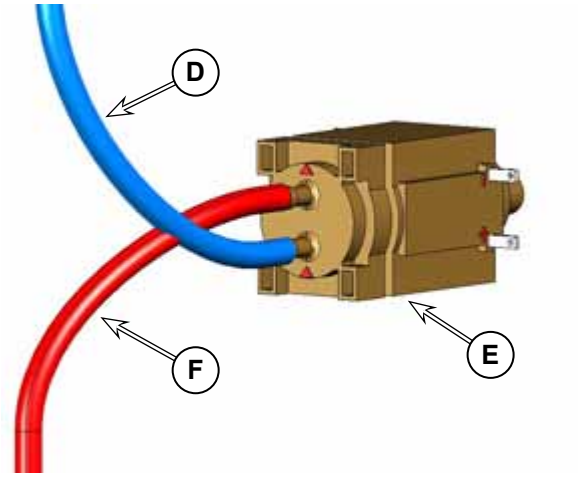
The detergent pump is located in the front right corner of the battery compartment, below the operator's seat, the EcoFlex bottle, and the bottle support bracket.

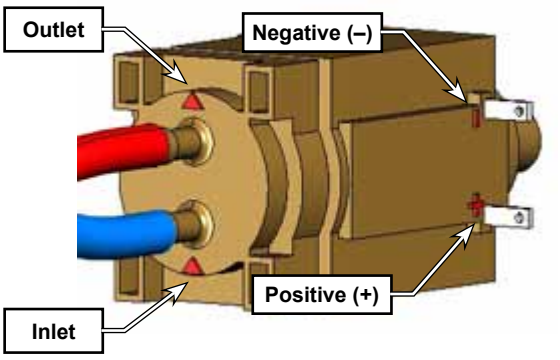


1. Remove the feed tube **(A)** from the detergent bottle **(B)**, then lift the bottle out of the support bracket **(C)**.
2. The bottle support bracket is secured with a screw and washer in a threaded insert at the bottom, center of the bracket. Remove the screw and washer then remove the bracket.
3. Disconnect the pump inlet tube **(D)** from the pump **(E)** and set it aside, then disconnect the outlet tube **(F)**, that passes down from the pump to the scrub deck.
4. Note which wire is connected to which pump terminal (the wire colors should match the table below) then disconnect the wires from the pump and remove the pump.

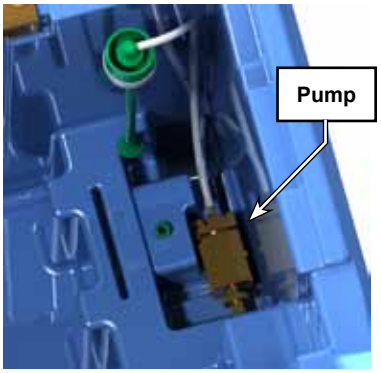
Positive	Negative
Brown/Red	Brown/Gray

During replacement, note the electrical and fluid polarity as shown below.





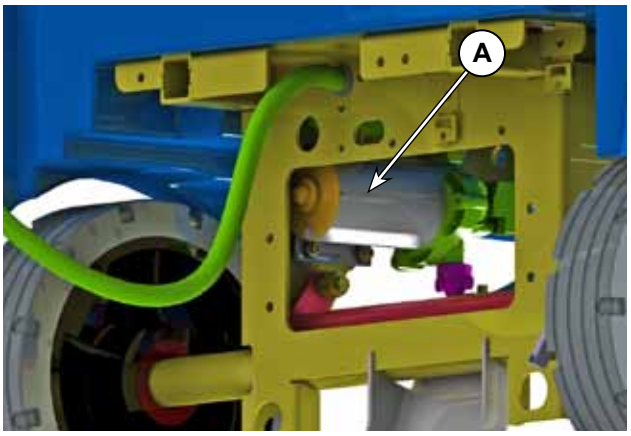
5. Position the new pump into the bottle space and connect the wiring to the pump as noted above.
6. Check that the inlet and outlet tubing are undamaged and can be reused. If either is damaged, replace it.
7. Connect the two tubes to the new pump at their correct connections as noted above then place the pump at the bottom of the bottle space as shown at right.
8. Replace the support bracket and fasten it with the screw and washer.
9. Replace the bottle in the support bracket and reinsert the feed tube **(A)** then tighten the cap.



Wash Hose Pump (Option)

Although not necessary, it is easier to remove/install the wash pump **(A)** when the squeegee is removed and the scrub deck and squeegee lift are lowered.

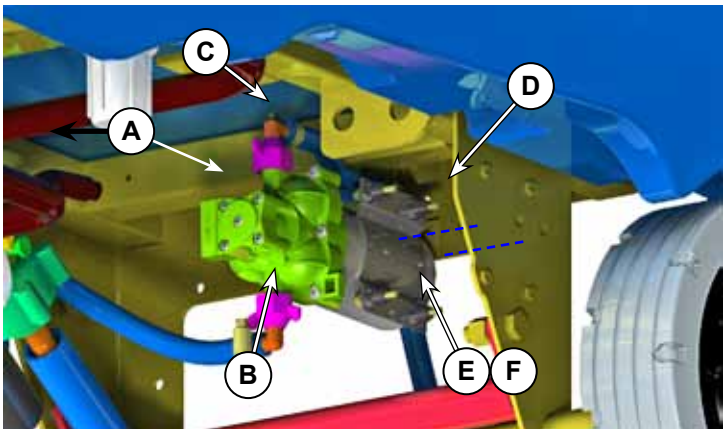
Lower the Squeegee and Scrub Deck



1. Remove the squeegee assembly from the squeegee lift.
2. Turn the machine on and press the vacuum button and scrub button. The scrub deck and squeegee lift will lower to the floor.
3. After they have lowered, press the emergency stop button. This will cause the vacuum to turn off, but the scrub deck and squeegee lift will remain lowered.
4. Raise the operator seat and disconnect the battery connector.
5. Close the shut off valve at the bottom of the solution tank.

Remove/Install the Pump

6. Note that the tube from the solution tank **(B)** is connected below the pump body and the tube to the sprayer **(C)** is connected above the body, then disconnect both tubes from the pump.



7. Disconnect the wash pump electrical connector from the X76 connector of the main harness **(D)**.
8. Loosen and remove the four screws **(E)** and washers **(F)** that secure the pump **(A)** to the chassis.
9. Connect the electrical connector of the new wash pump to the X76 connector of the main harness **(D)**.
10. Use the four screws **(E)** and washers **(F)** from step 7 to secure the new pump to the chassis.
11. Check that the two tubes for the pump are undamaged and can be reused. If either is damaged, replace it. Use the instructions in the wash hose kit to reroute new tubing if needed.
12. Connect the two tubes to the new pump in their correct locations as noted in step 6.
13. When new parts are all connected, open the solution tank shutoff valve, moving the valve handle toward the filter.
14. Reinstall the squeegee assembly on the squeegee lift.
15. Reconnect the battery connector and start the machine.
16. Test the wash hose system and check for fluid leaks.

Specifications

Parameter	Range
Solution Solenoid Resistance	• 108 Ω
Maximum Solution Flow	• 6 L/Min, unrestricted

34 - Scrub System, Disc

Functional Description

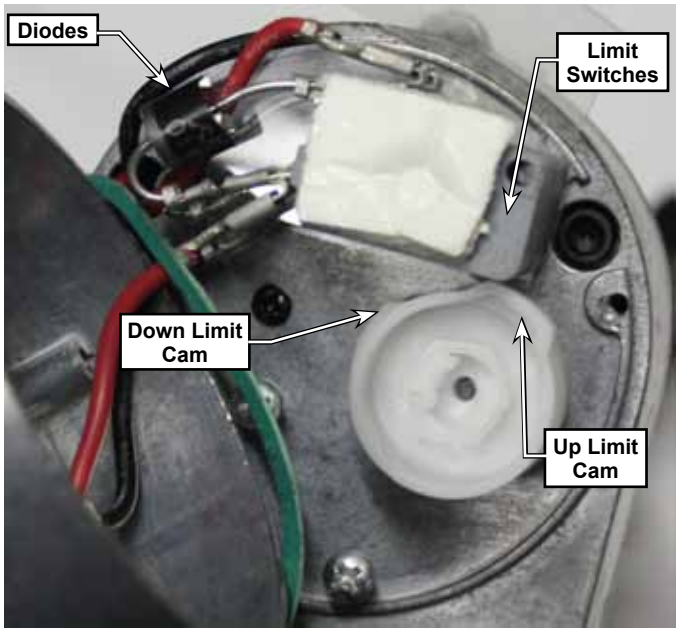
The disc deck is available in a 34-inch size. The deck uses two, gear-reduced, drive motors to drive the two brush or pad holder discs. The scrub deck is raised and lowered using a leadscrew actuator.

The deck also includes two removable side squeegees that help keep the scrub water contained within the path of the scrub deck, and subsequently within the rear squeegee path.

Deck Lift Actuator

The deck lift actuator controls the raising and lowering of the deck, as well as the amount of pressure the scrub disks apply to the floor.

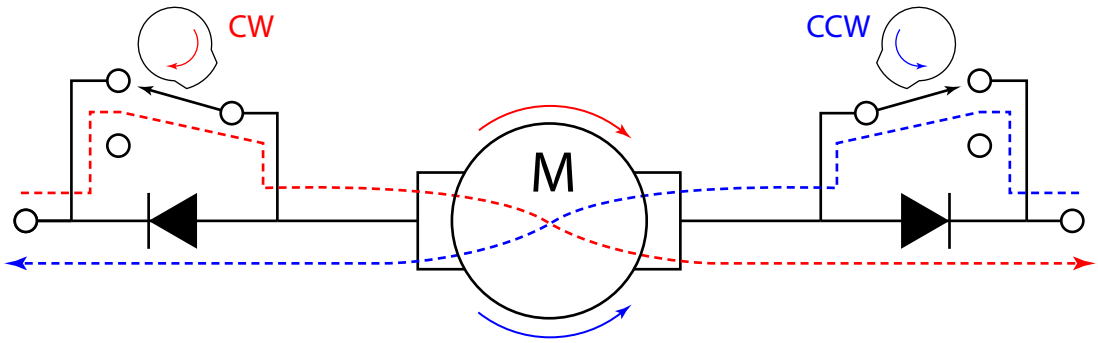
To extend or retract the actuator, the power module reverses polarity to the actuator. The actuator determines how long it should run to reach full extension or retraction. It accomplishes this with a pair of cams, limit switches, and diodes.



As each cam rotates, it opens the normally closed circuit and stops the motor's rotation. However each cam is functional only for its intended direction of rotation. This is accomplished with the diodes, which effectively short circuit the switch for one direction (polarity), but not the other.

In the diagram below, the clockwise cam/limit switch is effectively short circuited by its diode when the electrical polarity is driving the motor in the counterclockwise direction (and vice versa for the CCW). But the counterclockwise cam is not short circuited, so it will open the motor circuit when the cam lobe reaches the limit switch.

The down-limit cam isn't adjustable, but by adjusting the position of the up-limit cam, the actuator can control its length of travel for the leadnut along the leadscrew.



Scrub Control

Scrub pressure is controlled by monitoring the motor amperage from both brush motors. If the combined brush motor current is below its target amperage, the deck is lowered slightly to increase brush pressure. If the combined amperage is above the target amperage, the deck is raised slightly. Additionally, if either one of the motors is operating above its maximum allowed amperage, the deck is raised.

The motor amperage is sampled every 250ms, but adjustments are made only at 45 second intervals to filter out minor variations in the floor. The instantaneous amperage readings are averaged for the 45 second interval.

Deck Type	Floor Type	Scrub Level	Min Amps	Max Amps
34D 860D	Standard	Low	20	30
		High	30	40
		Extreme	40	50
	Smooth	Low	15	25
		High	25	35
		Extreme	35	45
	Individual Motor Max		25	

Operational Mode Prerequisites

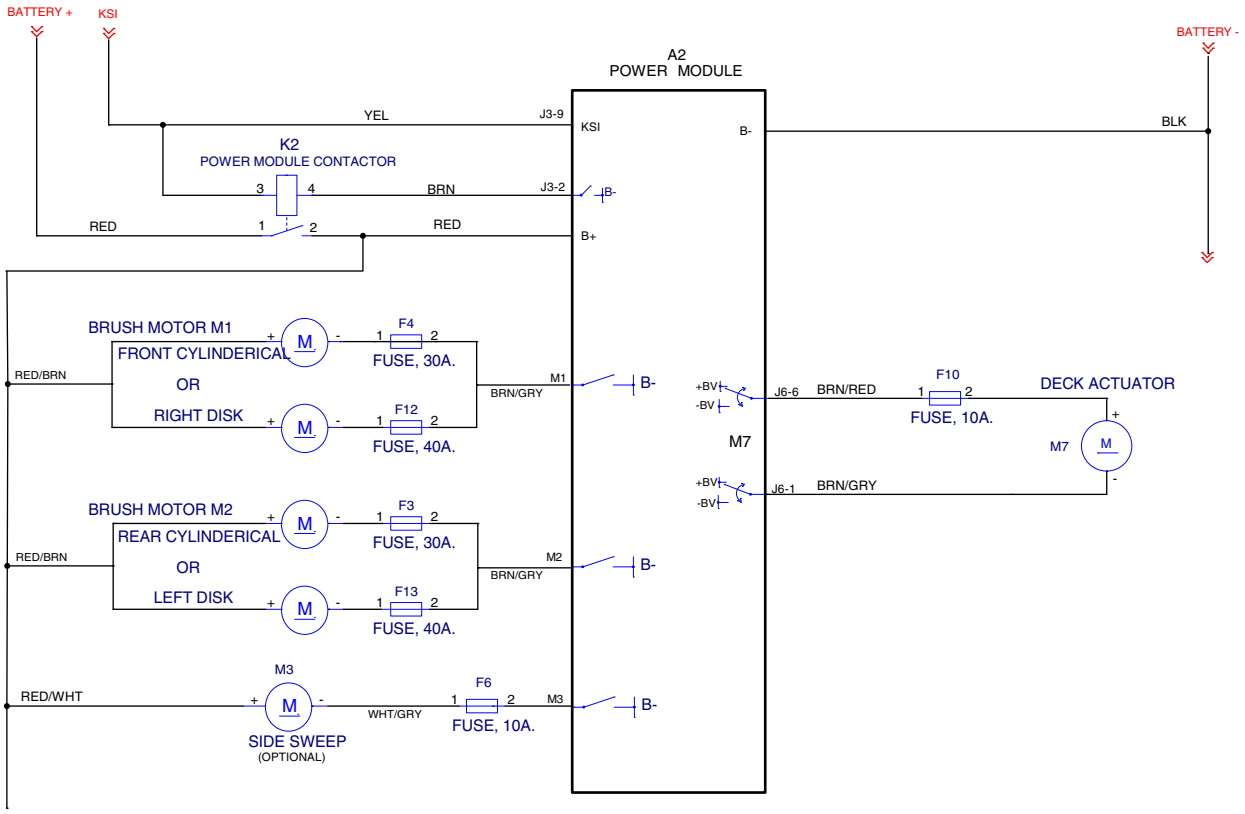
Before the main controller can activate any of the operational modes, it must first check that the appropriate prerequisites are met.

- **Scrub System Outputs**
  - Brush Motors M1 and M2 or Deck Actuator M7 (seat switch must be closed to enter scrub mode)
    - No scrub system fault (brush motors and actuator motor)
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (first or second stage)
    - No RTF inhibit

Circuit Overview

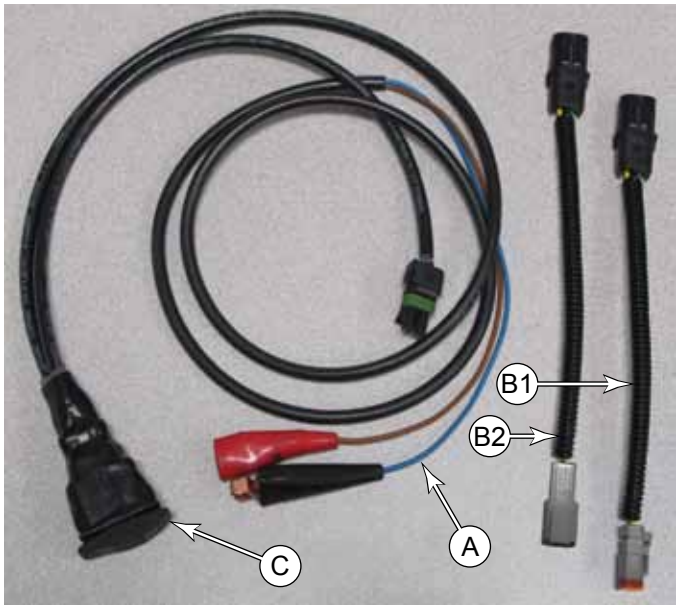
The brush motors are powered from the power module. The power module controls the K2 relay, which provides battery+ power to the motors. The power module then applies PWM control to the negative side of the motor, including soft-start at startup. The power module monitors the health and performance of the motors and reports this information back to the main controller. The optional side sweep motor is controlled in the same manner.

The deck lift actuator is powered from the power module, which needs to reverse the polarity to this motor in order to raise and lower the deck in very small amounts to maintain pressure. The signal from the controller is reversible Pulse-Width Modulated (PWM).



Maintenance and Adjustment

Lift Actuator Limit Adjustment



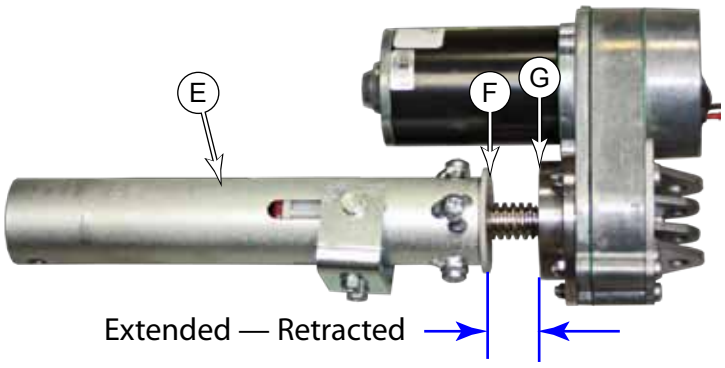
The power module commands the actuator to raise or lower, but the actuator itself determines when it should stop moving. This is accomplished by two cam lobes and two micro switches (limit switches). The lower cam is not adjustable, so the lower limit is adjusted by rotating the leadscrew nut. Then the upper limit is adjusted by turning the cam lobe until the actuator stops at the correct height.

To make the adjustment, you will need to manually power/control the actuator. If you don't have the (updated) Actuator Test Kit described on page 207, you can use the Deck Lift Output Test described on page 35. Just note that if you use the Output Test, you may periodically cause a controller fault, and have to reset the machine. For simplicity, this procedure is written for the test kit method.

This procedure is typically performed as part of replacing the actuator. If the actuator is not already removed from the machine, then remove it following the procedure on page 184.

1. Connect the tester **(A)** to the positive and negative terminals of the battery. (The full 36 volts must be used. Otherwise the motor speed will be too low and the results will be skewed.)
2. Using the adapter plug **(B)**, connect the tester to the actuator.
3. While preventing the actuator leadnut **(E)** from turning, use the switch **(C)** to extend the actuator until it stops.
4. Manually unscrew the leadnut **(E)** until there is at least 2.5" (60mm) distance between the leadnut and housing **(F&G)**.
   - The actual distance isn't import, so pick a number that is easy to work with.
   - Record this distance.

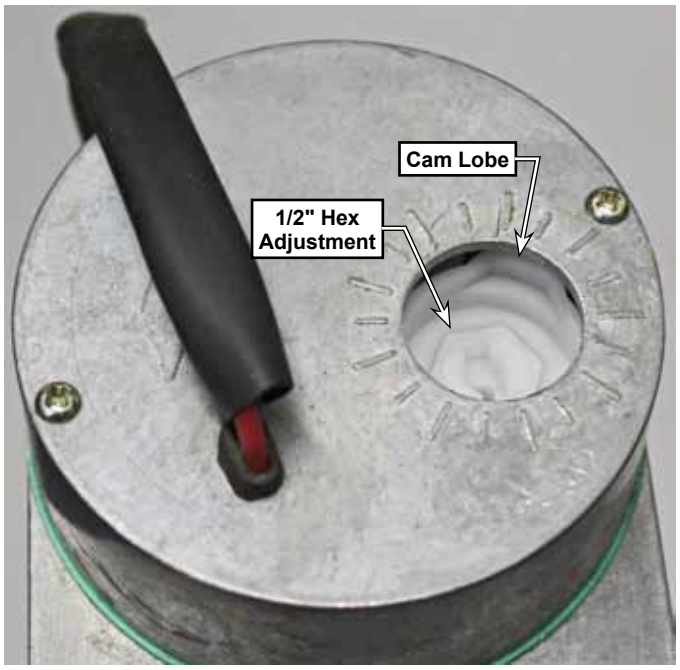
CAUTION: If while retracting the actuator with the "Output Test", it appears the leadnut is going to crash into the actuator housing, let go of the leadnut and let it spin.



5. While preventing the actuator leadnut **(E)** from turning, use the switch **(C)** to retract the actuator until it stops.
6. Measure the distance between the actuator gearbox at **(G)** and the top of the leadnut at **(F)**, and subtract it from the previous distance. This is the travel.
   - **The target travel is: 3.35 ± 0.09" (85 ± 2 mm)**
   - If the target travel is off, adjust it as described below.

Adjusting Travel

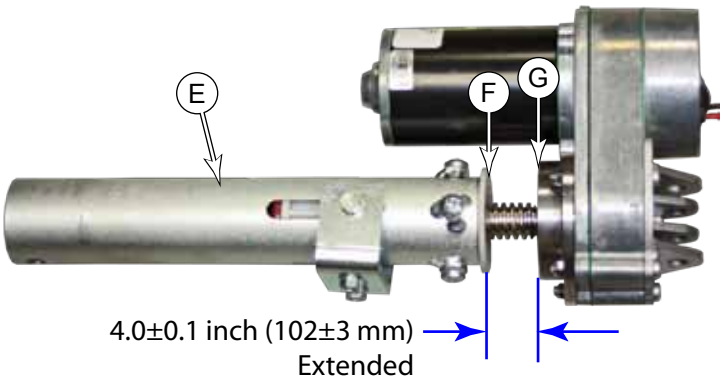
If the leadscrew travel needs to be adjusted, complete the steps below. Otherwise, skip down to Setting the Leadnut Position.



7. Remove the dust cap from the top of the actuator covering the adjustment cam.
8. Using a 1/2” socket, turn the adjustment cam:
   - Turn the cam only a couple of clicks at a time before rechecking the result.
   - Each click of the cam represents about 2mm of leadnut travel.
   - Turn the cam clockwise to raise the leadnut and increase the travel distance.
   - Turn the cam counterclockwise to lower the leadnut and decrease the travel distance.
   - **The target travel is: 3.35 ± 0.09” (85 ± 2 mm)**
9. After adjusting the cam, cycle the actuator and recheck the travel distance.

Setting Leadnut Position

After the leadscrew travel has been set, it is necessary to adjust the final position of the leadnut. You will notice that the leadnut position is less than the leadscrew travel. In the retracted position, the leadnut should be bottomed out and the spring slightly compressed.



10. Extend the actuator until it stops.
11. Manually turn the leadnut until the leadnut distance is 4.0±0.1 inch (102±3 mm).
12. While holding the leadnut from turning, cycle the actuator to confirm its motion.
13. After the adjustment is complete, make sure the leadnut does not turn while you are reinstalling the actuator.

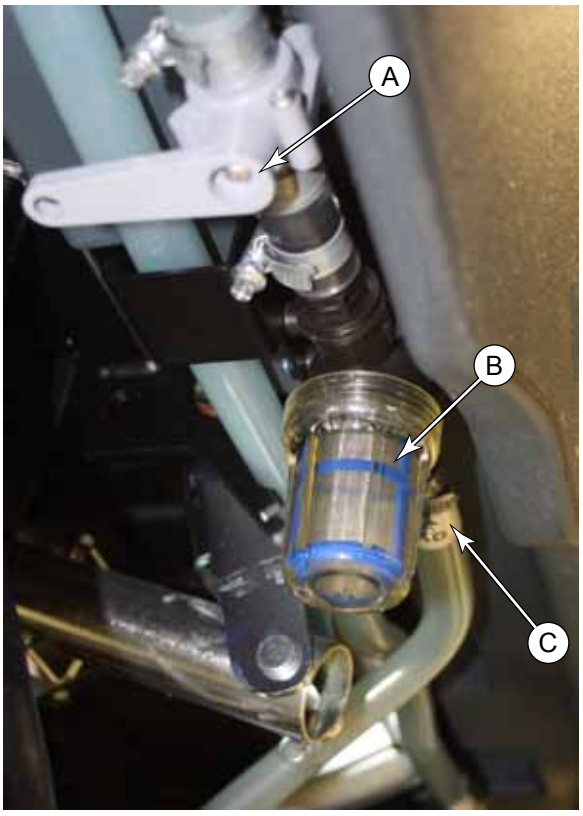
Troubleshooting Notes:

- If the actuator will neither raise nor lower, then both cams are activating their limit switches at the same time.
  - Rotate the cam clockwise several clicks.
  - **Do not hold the nut**, and raise and lower the actuator until it cycles normally again.
  - Go back and restart the adjustment with the extended limit adjustment.
- If you are using the “Output Test” method, and the main machine controller sees the actuator go active again after being stopped on a limit position, the controller will issue an error, and need to be reset. This may occur when you are turning the cam clockwise.

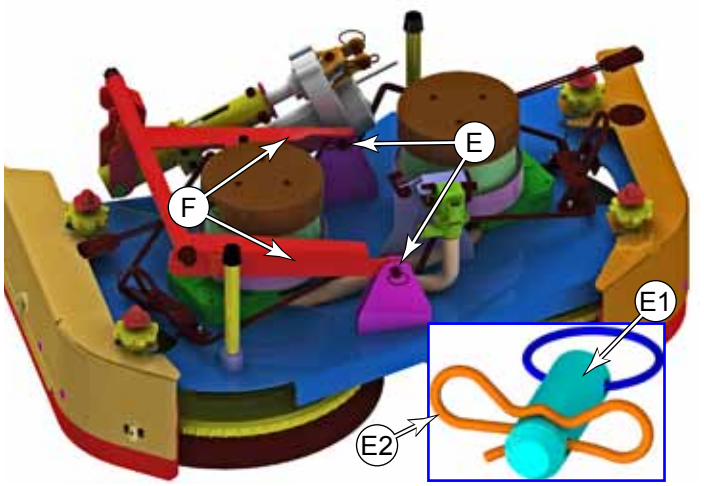
Removal and Installation

Scrub Deck

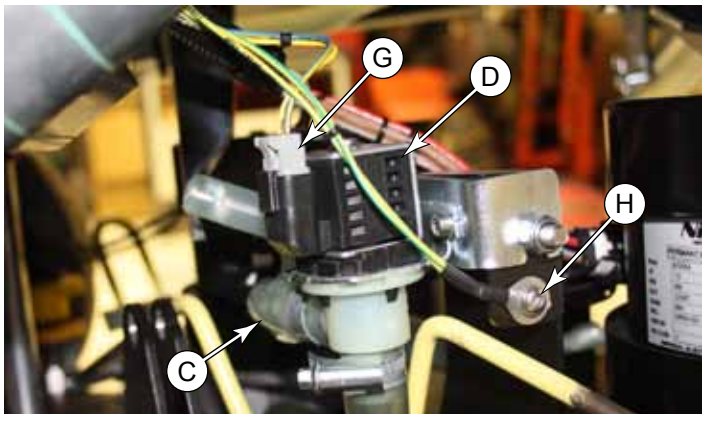
Removing the scrub deck is a prerequisite to completing other procedures, such as servicing the brush motors. The procedure is the same for all scrub deck types.



1. Optional: You may choose to place a sheet of cardboard under the scrub deck to make it easier to slide the deck in and out from under the machine.
2. Remove the scrub brushes, so the deck can be lowered without pressing on the floor.
3. From the service menu, lower the scrub deck, and then press the E-stop to lock out all motor functions, and then disconnect the main battery connector.
4. Close the solution shutoff valve **(A)**, by turning it perpendicular to the solution line.
5. Loosen the hose clamp and remove the solution line **(C)** from the solution filter **(B)**.
   - If the machine is equipped with either EcoFlex or the wash hose option, you will need to remove the solution hose at the solution solenoid **(D)** instead. (See image below.)

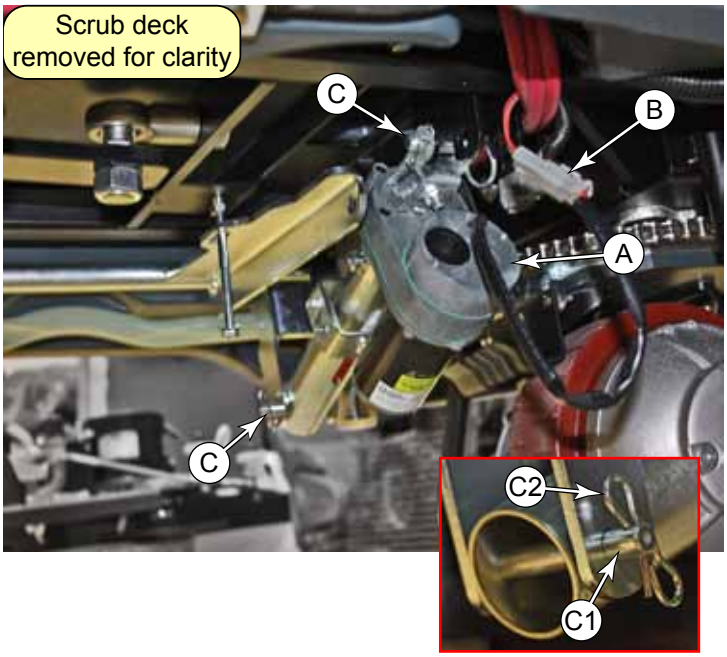


6. Remove the 2 bow-tie cotter pins **(E2)** and pivot pins **(E1)** that secure the scrub deck to the deck lift arms **(F)**.



7. Disconnect the solution solenoid connector **(G)** from the solenoid.
8. Disconnect the ground wire **(H)** from the scrub deck.
9. Disconnect the scrub brush motor power connectors.

Deck Lift Actuator

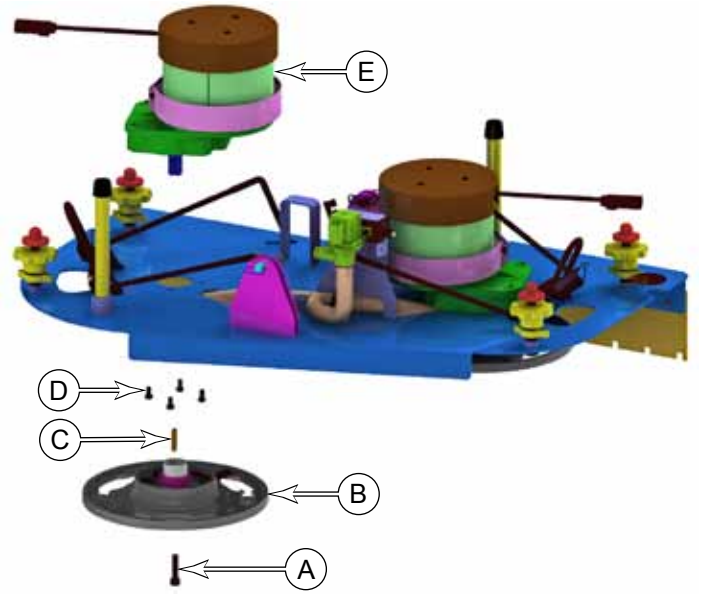


1. Remove the scrub brushes, so the deck can be lowered without pressing on the floor.
2. From the service menu, lower the scrub deck, and then press the E-stop to lock out all motor functions, and then disconnect the main battery connector.
3. As necessary, use blocks to take the weight off the scrub deck and deck lift mechanism.
4. Disconnect the actuator motor connector **(B)**.

Note: *Once the actuator is disconnected from either end, take care to not allow the nut housing to rotate with respect to the leadscrew.*

5. Remove the bow-tie cotter pin **(C2)** from the pivot pin **(C1)**, and remove the pivot pin.
6. Repeat for the second pivot pin, and remove the actuator.
7. During replacement, perform the Lift Actuator Limit Adjustment described on page 181.

Brush Motor

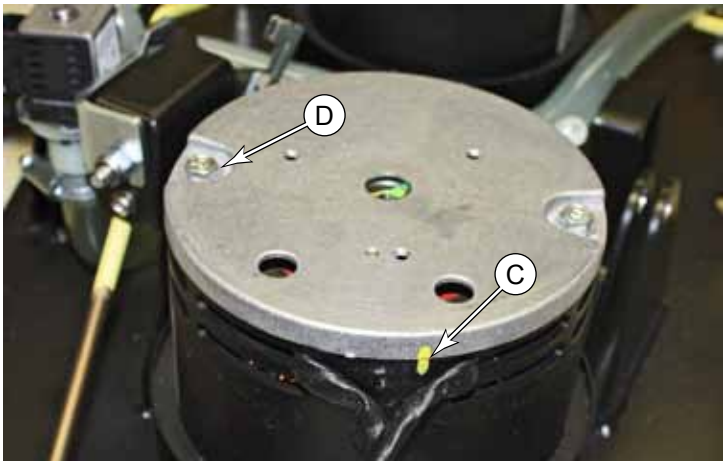


1. Remove the Scrub Deck described on page 183.
2. Remove the brushes or pad holders from the drive hub.
3. Remove the bolt **(A)** that secures the drive hub to the motor shaft, and remove the hub **(B)**. Take care not to lose the key **(C)** that aligns the hub and shaft.
4. Remove the four bolts **(D)** that secure the motor to the deck, and remove the motor **(E)**.

Brush Motor Brushes

1. Remove the Scrub Deck described on page 183.
2. Remove the 3 screws **(A)** that secure the splash cover **(B)** to the top of the motor, and remove the cover.

3. Make a witness mark **(C)** on the edge of the motor end bell to mark the rotational position of the end bell with respect to the motor housing.
4. Remove the two long bolts **(D)** that secure the motor end bell to the motor, and remove the end bell. Take care to not lose the wave washer resting between the motor bearing and end bell.



5. Remove the screw **(F)** that secures the brush wire.
6. Gently pull the brush **(E)** out of the brush holder. Note the position of the return spring **(G)** for later replacement.

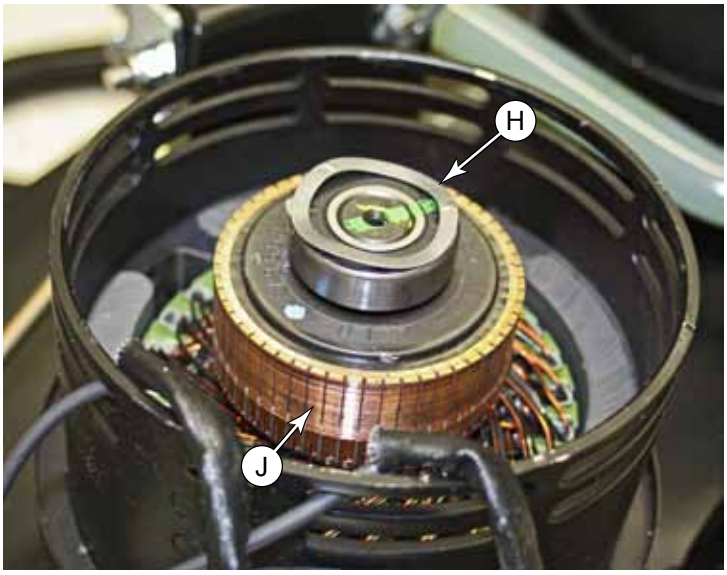
7. When replacing the brush with a new one, note the following:

   - The brush wire is toward the top of the motor.
   - You may find it easier to use the brush wire itself to help you hold the screw on the end of your screw driver as you get the screw started in the threads. But the downside is that it may be bore difficult getting the brush into the brush holder afterward.
   - When inserting the brush into the brush holder, use a small hook-type tool to pull the return spring away from the brush.

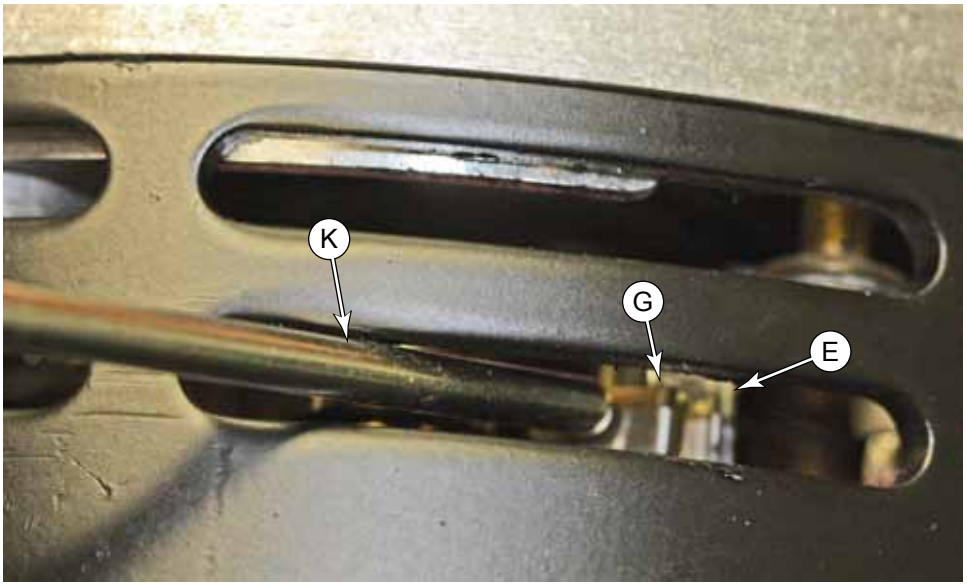
8. Repeat for the other 3 brushes.

Reassembly notes

1. Inspect the motor commutator bars **(J)** for damage or missing bars.
   - If any bar is missing, replace the motor.
   - If the bars are heavily carboned, use a fine Emory cloth to lightly polish the copper.
2. Place the wave washer on top of the motor bearing. Take care to not let it fall while replacing the end bell.
3. Retract all 4 brushes until their return springs slip off the end of the brush and hold the brush in the retracted position.(See image on previous page)
4. Make sure the witness marks line up, and replace the end bell on the motor.



5. Reinstall the 2 long bolts that secure the end bell to the motor.
6. Insert a small tool **(K)**, such as a screwdriver, through the vent opening behind each brush, and press on the back of the brush **(E)** until the spring **(G)** engages the back of the brush and presses it against the commutator.
7. Make sure all 4 brushes have been released, and are in the forward position.



Specifications

Parameter	Range
Brush Motor Amperage	31 amps max.
Lift Actuator Amperage	

Special Tools

Actuator Test Kit

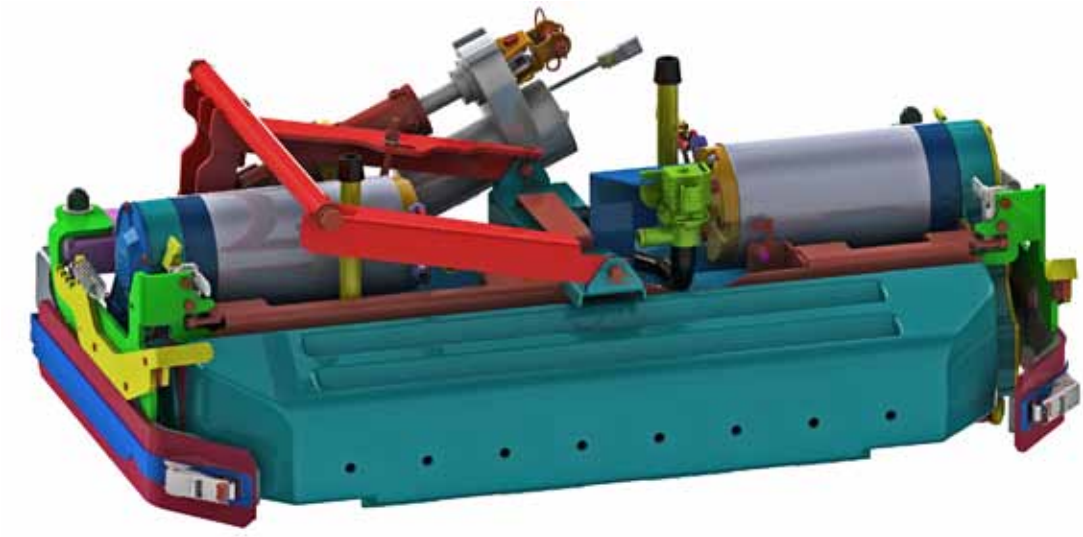
The actuator test kit (Pn 56407502) is used to manually control an actuator removed from the machine, but powered from a 36-volt battery. It contains alligator clips to connect to the battery, a reversing power switch, and a cable connector. If your test kit is prior to Rev I, you will also need a second adapter cable (Pn 56123352) to connect between the tester and the actuator. These adaptors, 1-male and 1-female, are included in kits Rev I and above.

34 - Scrub System, Cylindrical

Functional Description

The cylindrical deck is optimal in environments where floor debris is to be expected during the cleaning process. The cylindrical deck consists of two counter rotating cylindrical brushes for scrubbing the floor, as well as channeling debris up and into a hopper.

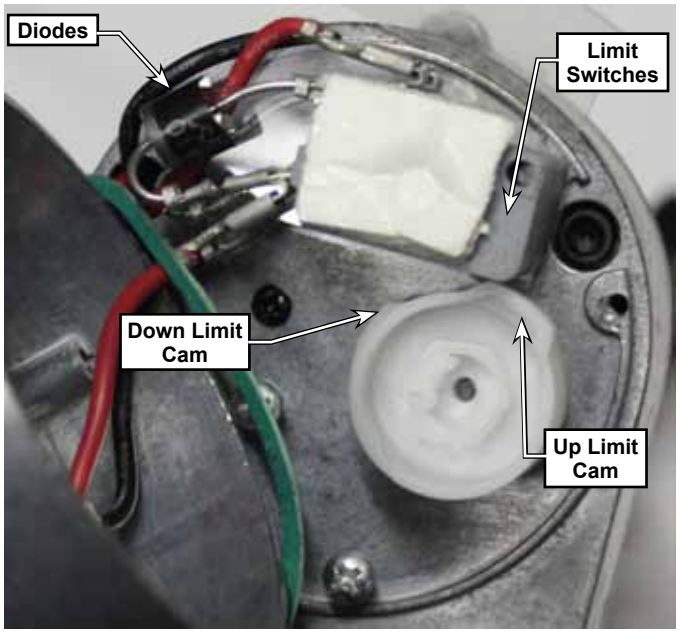
The deck also includes two removable side squeegees that help keep the scrub water contained within the path of the scrub deck, and subsequently within the rear squeegee path.



Deck Lift Actuator

The deck lift actuator controls the raising and lowering of the deck, as well as the amount of pressure the scrub disks apply to the floor.

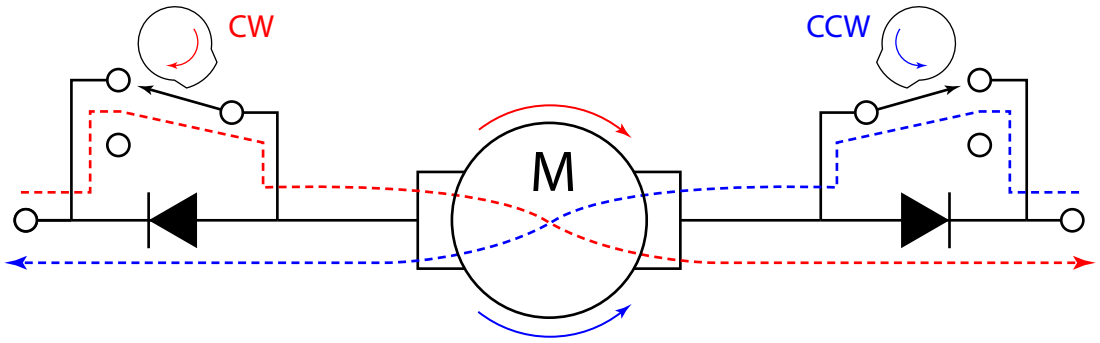
To extend or retract the actuator, the power module reverses polarity to the actuator. The actuator determines how long it should run to reach full extension or retraction. It accomplishes this with a pair of cams, limit switches, and diodes.



As each cam rotates, it opens the normally closed circuit and stops the motor's rotation. However each cam is functional only for its intended direction of rotation. This is accomplished with the diodes, which effectively short circuit the switch for one direction (polarity), but not the other.

In the diagram below, the clockwise cam/limit switch is effectively short circuited by its diode when the electrical polarity is driving the motor in the counterclockwise direction (and vice versa for the CCW). But the counterclockwise cam is not short circuited, so it will open the motor circuit when the cam lobe reaches the limit switch.

The down-limit cam isn't adjustable, but by adjusting the position of the up-limit cam, the actuator can control its length of travel for the leadnut along the leadscrew.



Scrub Control

Scrub pressure is controlled by monitoring the motor amperage from both brush motors. If the combined brush motor current is below its target amperage, the deck is lowered slightly to increase brush pressure. If the combined amperage is above the target amperage, the deck is raised slightly. Additionally, if either one of the motors is operating above its maximum allowed amperage, the deck is raised.

The motor amperage is sampled every 100ms and averaged over a period of several seconds, but adjustments are made only at 10 second intervals to filter out minor variations in the floor.

Deck Type	Floor Type	Scrub Level	Min Amps	Max Amps
Cylindrical	Standard	Low	20	30
		High	30	40
		Extreme	40	50
	Smooth	Low	15	25
		High	25	35
		Extreme	35	45
	Individual Motor Max		25	

Operational Mode Prerequisites

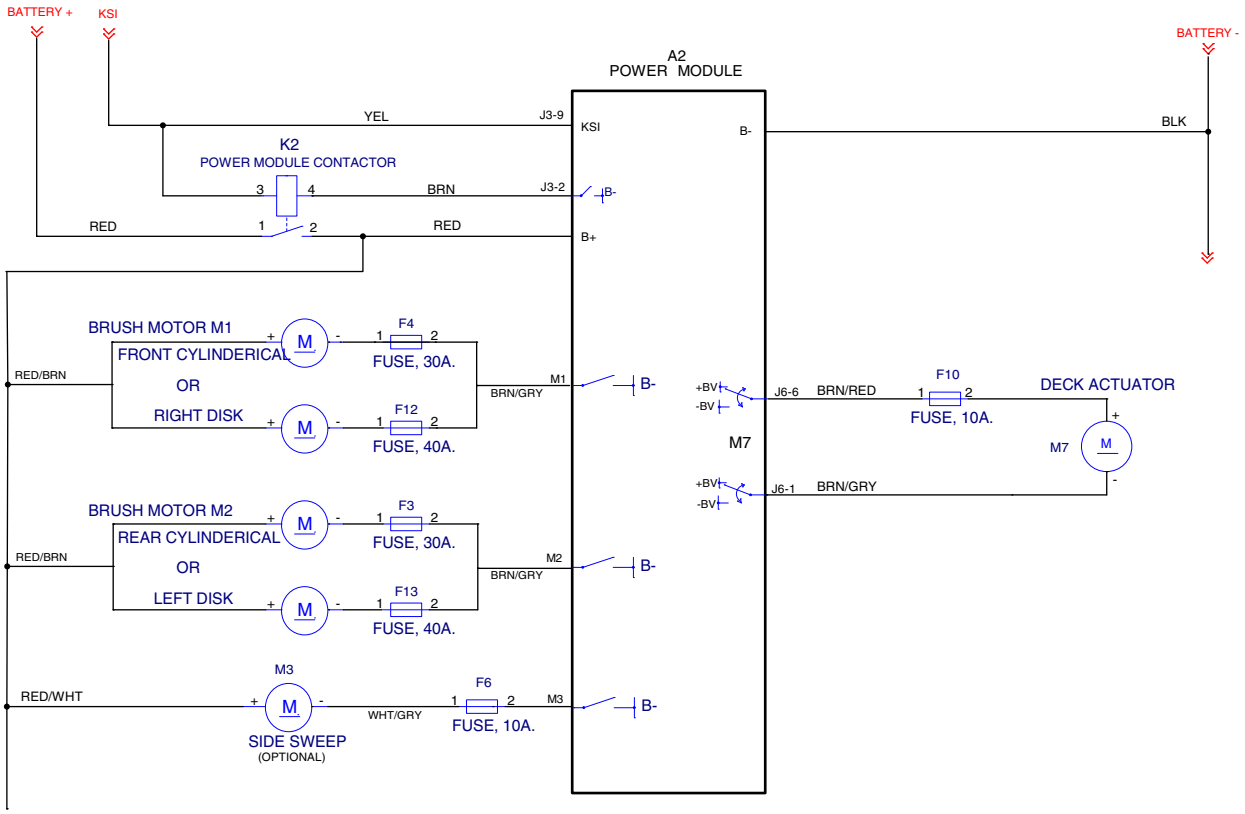
Before the main controller can activate any of the operational modes, it must first check that the appropriate prerequisites are met.

- **Scrub System Outputs**
  - Brush Motors (M1 and M2) or Deck Actuator (M7)
    - Seat switch must be closed to enter scrub mode
    - No scrub system fault (brush motors and actuator motor)
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (first or second stage)
    - No RTF inhibit

Circuit Overview

The brush motors are powered from the power module. The power module controls the K2 relay, which provide battery+ power to the motors. The power module then applies PWM control to the negative side of the motor, including soft-start at startup. The power module monitors the health and performance of the motors and reports this information back to the main controller. The optional side sweep motor is controlled in the same manner.

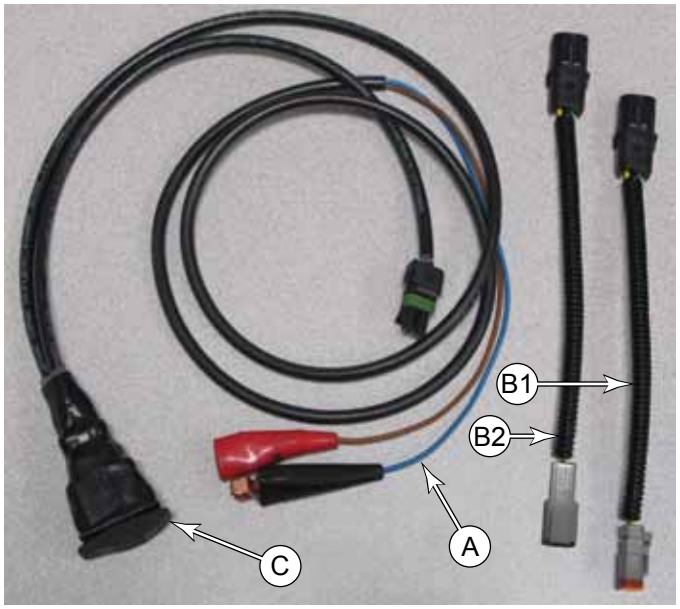
The deck lift actuator is powered from the power module, which needs to reverse the polarity to this motor in order to raise and lower the deck in very small amounts to maintain pressure. The signal from the controller is reversible Pulse-Width Modulated (PWM).



Maintenance and Adjustment

Lift Actuator Limit Adjustment

The power module commands the actuator to raise or lower, but the actuator itself determines when it should stop moving. This is accomplished by two cam lobes and two micro switches (limit switches). The lower cam is not adjustable, so the lower limit is adjusted by rotating the leadscrew nut. Then the upper limit is adjusted by turning the cam lobe until the actuator stops at the correct height.

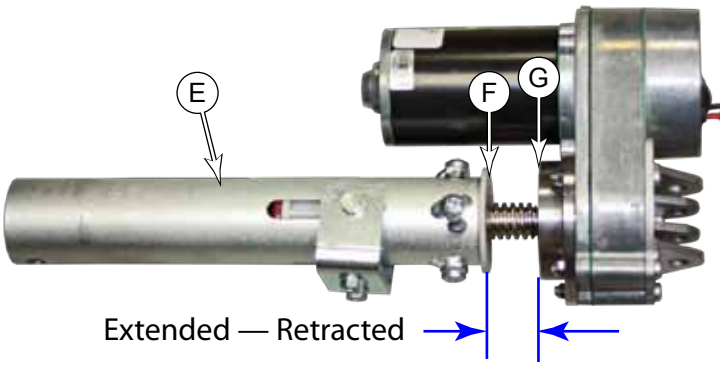


To make the adjustment, you will need to manually power/control the actuator. If you don't have the Actuator Test Kit described on page 200, you can use the Deck Lift Output Test described on page 35. Just note that if you use the Output Test, you may periodically cause a controller fault, and have to reset the machine. For simplicity, this procedure is written for the test kit method.

This procedure is typically performed as part of replacing the actuator. If the actuator is not already removed from the machine, then remove it following the procedure on page 184.

1. Connect the tester **(A)** to the positive and negative terminals of the battery. (The full 36 volts must be used. Otherwise the motor speed will be too low and the results will be skewed.)
2. Using the adapter plug **(B)**, connect the tester to the actuator.
3. While preventing the actuator leadnut **(E)** from turning, use the switch **(C)** to extend the actuator until it stops.
4. Manually unscrew the leadnut **(E)** until there is at least 2.5" (60mm) distance between the leadnut and housing **(F&G)**.
   - The actual distance isn't import, so pick a number that is easy to work with.
   - Record this distance.

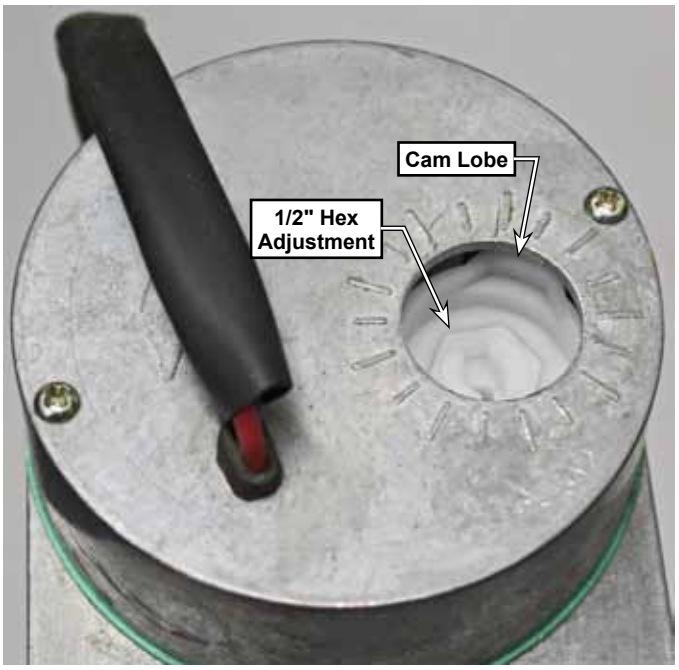
CAUTION: If while retracting the actuator with the "Output Test", it appears the leadnut is going to crash into the actuator housing, let go of the leadnut and let it spin.



5. While preventing the actuator leadnut **(E)** from turning, use the switch **(C)** to retract the actuator until it stops.
6. Measure the distance between the actuator gearbox at **(G)** and the top of the leadnut at **(F)**, and subtract it from the previous distance. This is the travel.
   - **The target travel is: 3.35 ± 0.09" (85 ± 2 mm)**
   - If the target travel is off, adjust it as described below.

Adjusting Travel

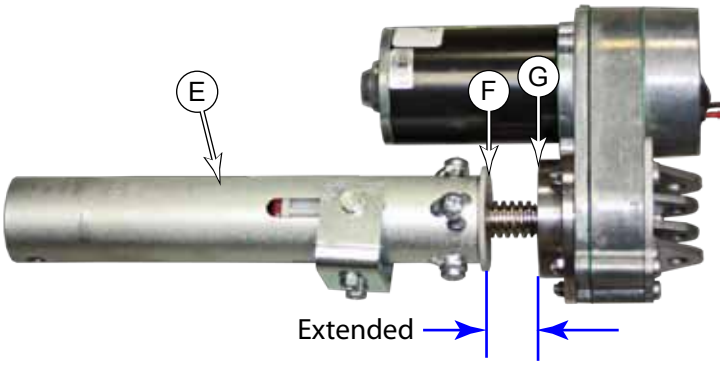
If the leadscrew travel needs to be adjusted, complete the steps below. Otherwise, skip down to Setting the Leadnut Position.



7. Remove the dust cap from the top of the actuator covering the adjustment cam.
8. Using a 1/2” socket, turn the adjustment cam:
   - Turn the cam only a couple of clicks at a time before rechecking the result.
   - Each click of the cam represents about 2mm of leadnut travel.
   - Turn the cam clockwise to raise the leadnut and increase the travel distance.
   - Turn the cam counterclockwise to lower the leadnut and decrease the travel distance.
   - **The target travel is: 3.35 ± 0.09” (85 ± 2 mm)**
9. After adjusting the cam, cycle the actuator and recheck the travel distance.

Setting Leadnut Position

After the leadscrew travel has been set, it is necessary to adjust the final position of the leadnut. You will notice that the leadnut position is less than the leadscrew travel. In the retracted position, the leadnut should be bottomed out and the spring slightly compressed.



10. Extend the actuator until it stops.
11. Manually turn the leadnut until the leadnut distance is is as follows:
    - 32C Deck: 3.85±0.1 (98±3 mm)
    - 36C Deck: 3.70±0.1 (94±3 mm)
12. While holding the leadnut from turning, cycle the actuator to confirm its motion.
13. After the adjustment is complete, make sure the leadnut does not turn while you are reinstalling the actuator.

Troubleshooting Notes:

- If the actuator will neither raise nor lower, then both cams are activating their limit switches at the same time.
  - Rotate the cam clockwise several clicks.
  - **Do not hold the nut**, and raise and lower the actuator until it cycles normally again.
  - Go back and restart the adjustment with the extended limit adjustment.
- If you are using the “Output Test” method, and the main machine controller sees the actuator go active again after being stopped on a limit position, the controller will issue an error, and need to be reset. This may occur when you are turning the cam clockwise.

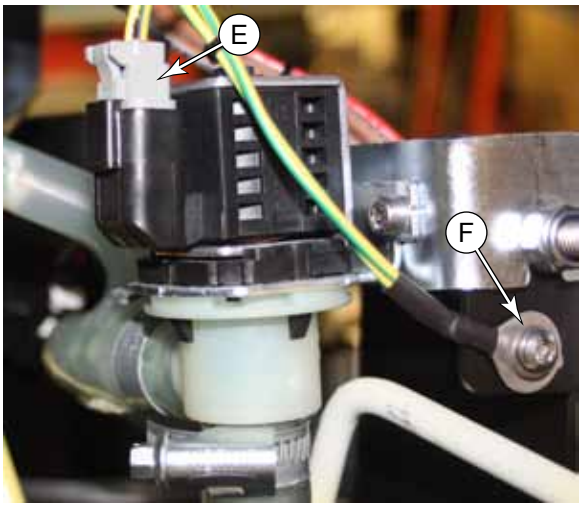
Removal and Installation

Scrub Deck

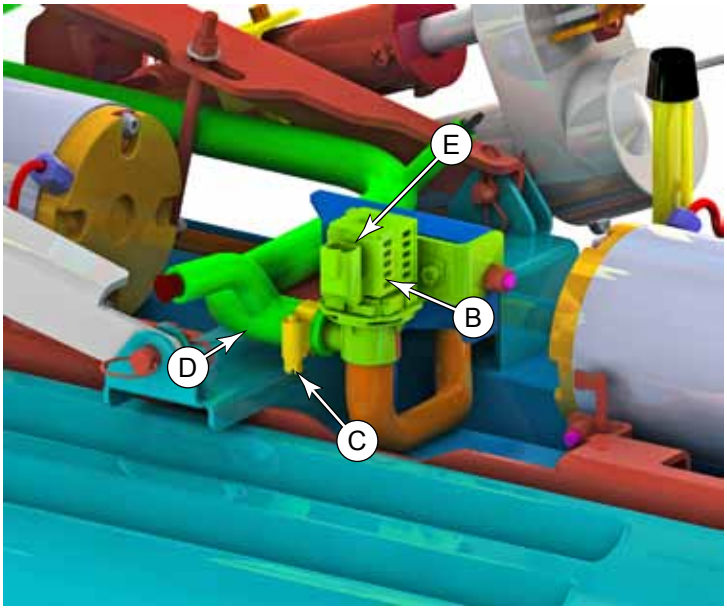
Removing the scrub deck is a prerequisite to completing other procedures, such as servicing the brush motors.

1. If available, position a furniture dolly, mechanic's creeper, or a sheet of cardboard below the scrub deck to make it easier to roll the deck out from under the machine.
2. From the service menu, lower the scrub deck to a neutral position, and then press the E-stop button to lock out all motor functions.
3. With the machine still powered, but in an E-Stop condition, unplug the main battery connector.
4. Close the solution shutoff valve (A), by turning it perpendicular to the solution line.

5. Disconnect the solution solenoid electrical connector **(E)** from the solenoid.
6. Disconnect the two scrub brush motor electrical connectors
7. Disconnect the ground wire from the scrub deck **(F)**.

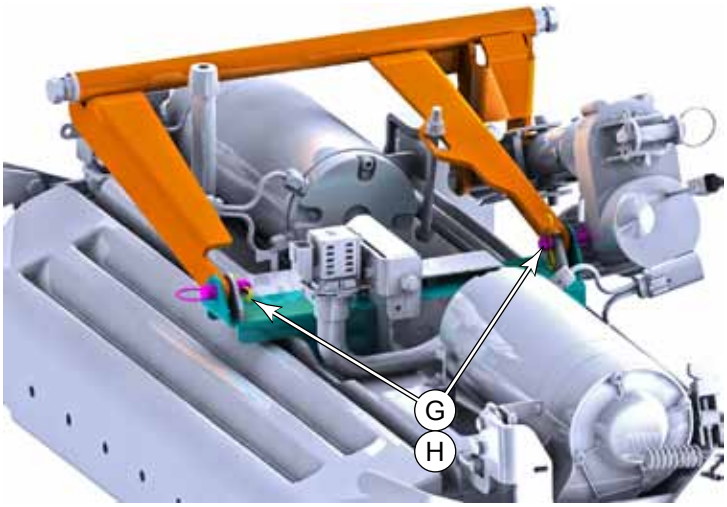


8. Loosen the hose clamp **(C)** and remove the solution line **(D)** from the solution solenoid **(B)**.



9. Remove the two link arm retaining clips **(G)** and pins **(H)** from the scrub deck.

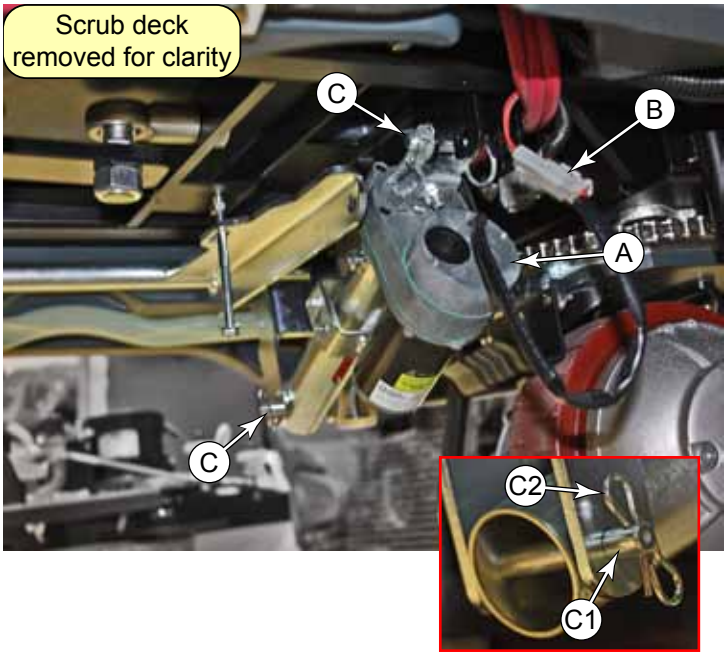
10. Slide the deck toward the rear of the machine so the deck lift linkage will clear the brush motor, and then slide the deck out from the right side of the machine.



Note: *During replacement, make sure to connect the brush motors to the correct connectors. The disc and cylindrical motors are fused differently.*

Deck Lift Actuator

1. Remove the scrub brushes, so the deck can be lowered without pressing on the floor.
2. From the service menu, lower the scrub deck, and then press the E-stop to lock out all motor functions, and then disconnect the main battery connector.
3. As necessary, use blocks to take the weight off the scrub deck and deck lift mechanism.
4. Disconnect the actuator motor connector **(B)**.



Note: *Once the actuator is disconnected from either end, take care to not allow the nut housing to rotate with respect to the leadscrew.*

5. Remove the bow-tie cotter pin **(C2)** from the pivot pin **(C1)**, and remove the pivot pin.
6. Repeat for the second pivot pin, and remove the actuator.
7. During replacement, perform the Lift Actuator Limit Adjustment described on page 191.

Brush Drive Belt
Brush Motor

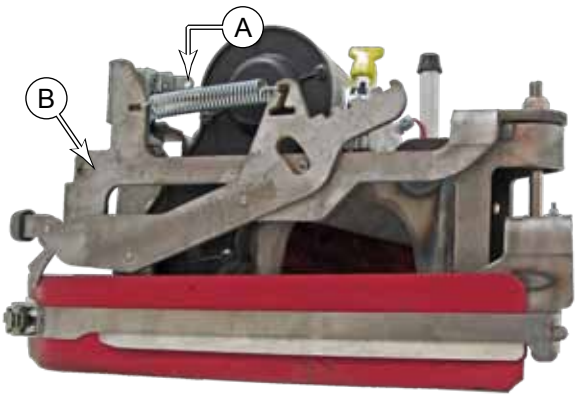
The initial procedure for removing the brush motor is the same as replacing the drive belt. Lowering the scrub deck is optional for replacing the belt, but it is required for removing the motor.

1. Although not required for belt removal, you may choose to lower the scrub deck to provide better visibility of the belt drive system and access to the motor.

   a. Press the scrub button to lower the scrub deck.

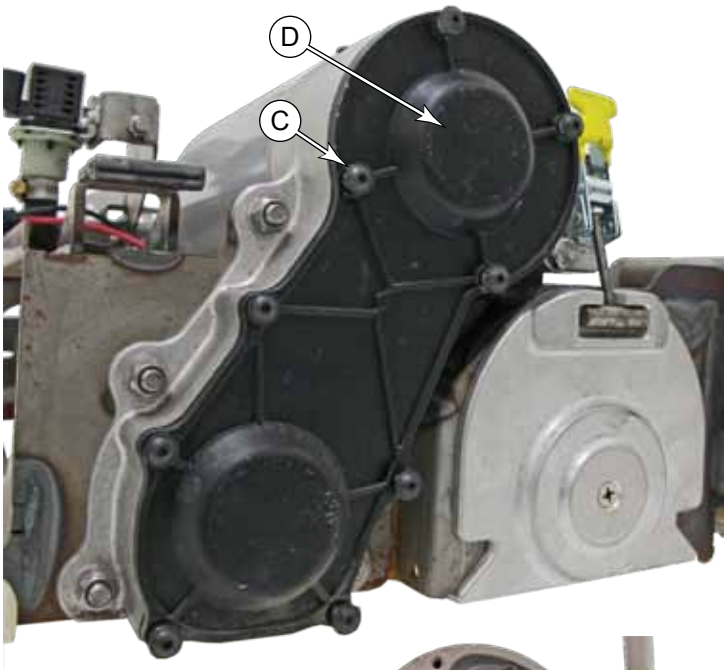
   b. When the deck is lowered, press the E-stop button to disable all motors.

   c. Disconnect the main battery connector under the seat.



2. Press down on the latch release **(A)**, and open the side squeegee **(B)**.

3. Remove the 9 screws **(C)** that secure the belt cover **(D)** to the drive housing, and remove the cover.

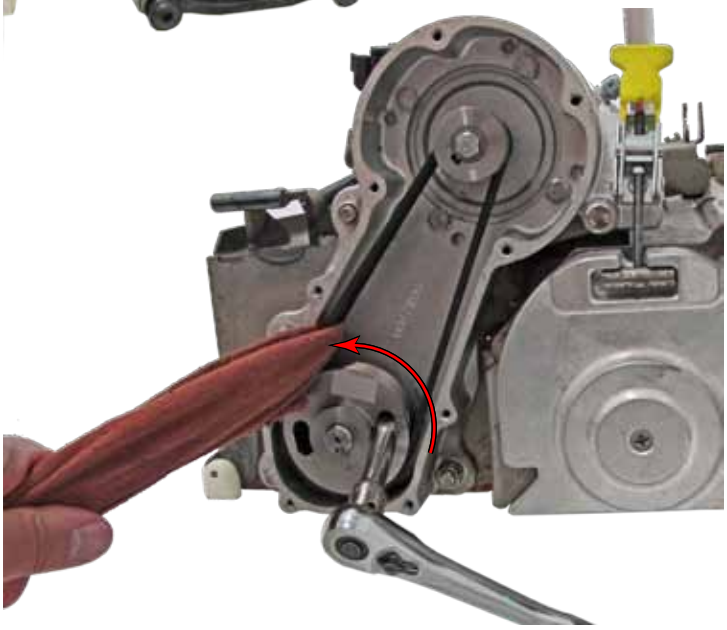


The drive belt is removed with a method frequently referred to as “Walking” the belt off. To get this process started, a shop towel is used to flex the belt away from the pulley.

4. Loop a shop towel around the drive belt above the lower pulley.

5. Using a 3/8” ratchet, turn the pulley counterclockwise, while simultaneously pulling back on the towel.

6. Continue turning the pulley while the towel follows the belt around the pulley, and flexes the trailing end of the belt off of the pulley.

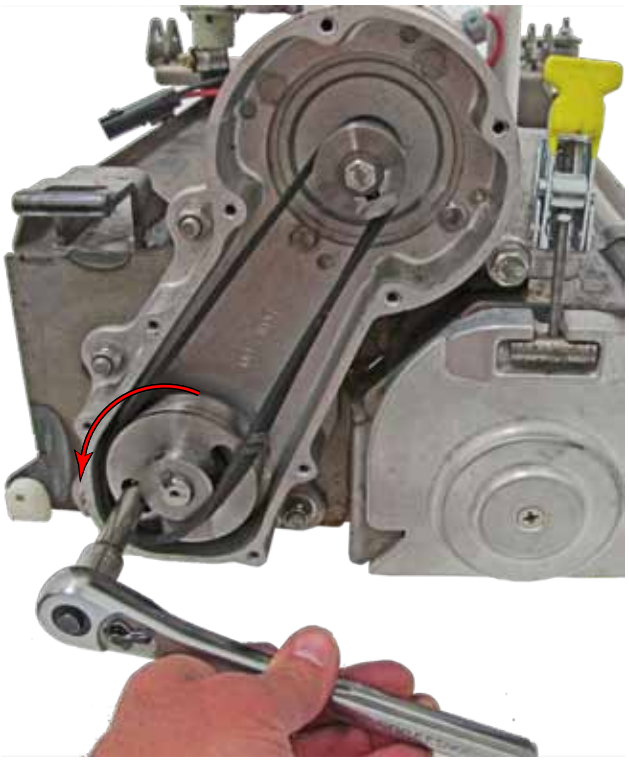


Removing the Motor

7. Disconnect the motor's electrical connector.
8. Remove the 4 screws **(J)** that secure the motor to the drive housing, and remove the motor.
9. After the motor has been replaced, continue below to reinstall the drive belt.

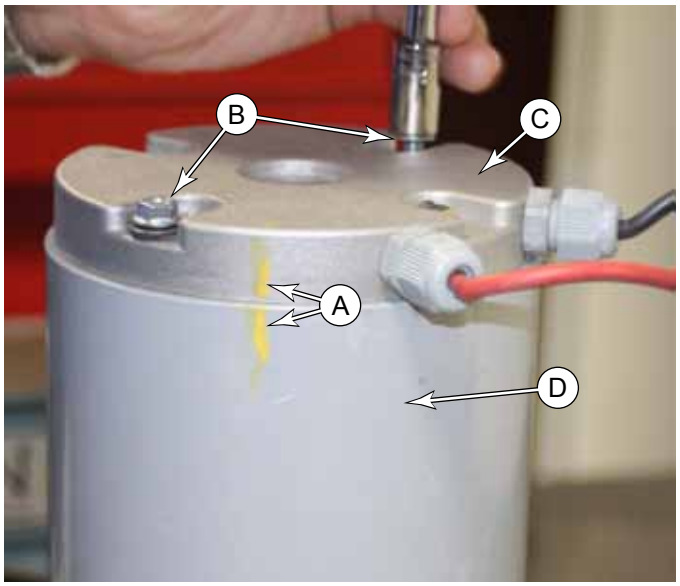
Reinstall the Drive Belt

10. To install a new belt, position it around the upper pulley, and begin to wrap it around the lower pulley.
11. Using the 3/8" ratchet, slowly rotate the lower pulley, and as necessary, guide the belt inward toward the pulley.
    - If you have difficulty getting the belt started, you can place a cable tie around the belt and through the oval hole of the pulley to hold the beginning engagement in place, before rotating the pulley.

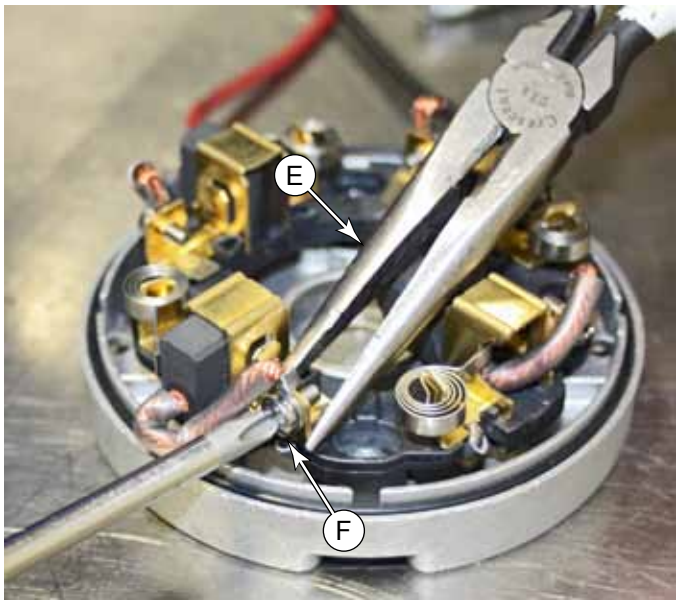


12. Insert all of the screws **(C)** through the cover and gasket. The friction of the gasket should hold them in position while you position the cover against the housing. This ensures that the gasket properly fits around each screw.
13. Tighten all 9 screws, and check to make sure the gasket hasn't slipped out of position.

Brush Motor Brushes



1. Remove the Brush Motor described on page 196.
2. Stand the motor up on a work bench.
3. Mark the orientation of the motor end cap **(C)** and motor housing **(D)** with a line **(A)** between them . It's also a good idea to mark the bottom end cap too, just in case the housing slips loose.
4. Remove the two nuts **(B)** that secure the top and bottom end caps to each other through the motor housing.
5. While taking care to not loosen the motor housing from the bottom end cap, remove the top end cap from the motor.
   - The motor's rear bearing is lightly pressed into the end cap. You may need to lightly tap on the end cap to get it started.
   - Carefully and evenly pry the end cap up, working all the way around, until it is free from the motor bearing.

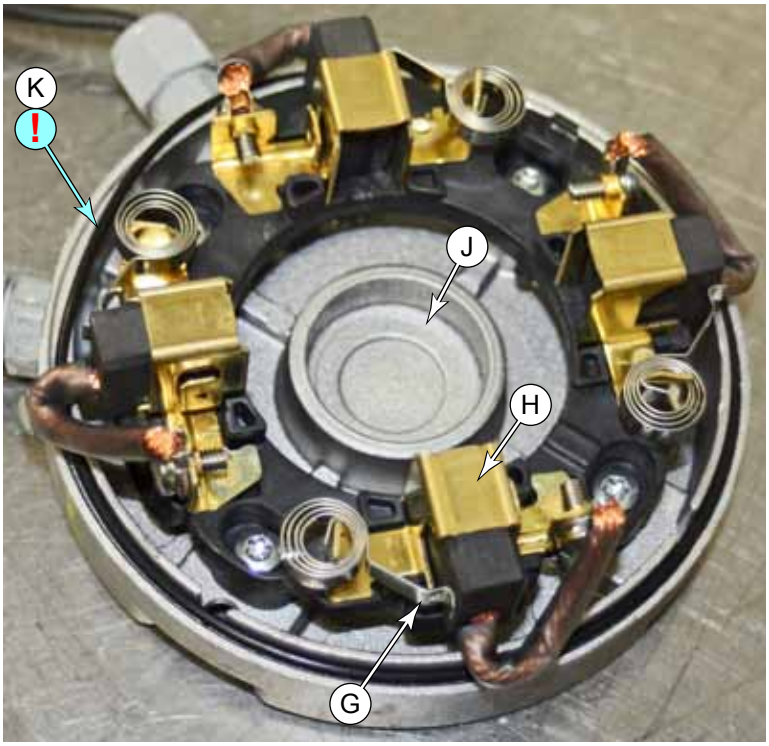


6. Hold the brass mounting bracket with a pliers **(E)** to keep it from twisting, and loosen the brush terminal screw **(F)**.
7. Slide the brush away from the center to remove it from the brush holder.
8. Remove the other three brushes.

9. Gently retract the brush spring **(G)**, and insert the new brush into the brush holder **(H)**. Note that the brush wire is closest to the end cap body.

10. Release the brush spring and allow it to push the brush all the way in toward the bearing pocket **(J)** to verify that the spring is properly positioned. (The brushes will later be retracted as shown in the image below.)

11. Reinstall the terminal screw **(F)**, and then repeat for the other 3 brushes.



12. Inspect the end cap O-ring **(K)** to ensure it is properly positioned in the O-ring grove. Note how the O-ring is out of position in the image to the right.

13. Inspect the motor commutator bars for damage or missing bars. If any bars are damaged or missing, replace the motor.
    - If the commutator bars are carboned up, you can lightly polish them with fine emery cloth.

14. Retract each of the 4 brushes away from the center, and until the brush spring **(G)** presses against the side of the brush, as shown.
    - This will hold the brushes retracted for reassembly, but will easily snap forward when complete.
    - If any of the brushes slip forward before you insert the cap over the motor's commutator, stop and re-retract the brushes. If you don't, you will damage the brushes.

15. Taking care to not allow any brushes to slip or the O-ring to move out of its slot, position the end cap back over the end of the motor. Make sure to line up the original orientation marks **(A)**.

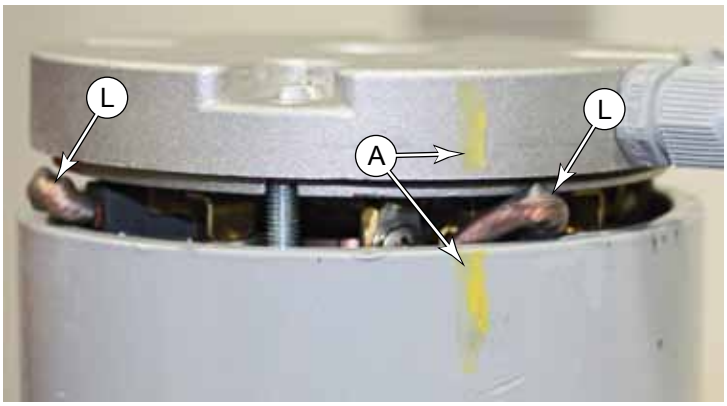
16. Lower the end cap down until the brush wires **(L)** are barely sticking out.

17. Gently push in on the brush wires, making sure you hear the brush snap forward and contact the commutator. Double check to make sure all 4 brushes are extended.

18. As necessary, gently tap on the top of the end cap until the motor bearing is seated in the bearing pocket **(J)**.

19. Reinstall the nuts **(B)**.

20. Reinstall the motor in the scrub deck.



Specifications

Parameter	Range
Brush Motor Amperage	19 amps max.
Lift Actuator Amperage	

Special Tools

Actuator Test Kit

The actuator test kit (Pn 56407502) is used to manually control an actuator removed from the machine, but powered from a 36-volt battery. It contains alligator clips to connect to the battery, a reversing power switch, and a cable connector. If your test kit is prior to Rev I, you will also need a second adapter cable (Pn 56123352) to connect between the tester and the actuator. These adaptors, 1-male and 1-female, are included in kits Rev I and above.

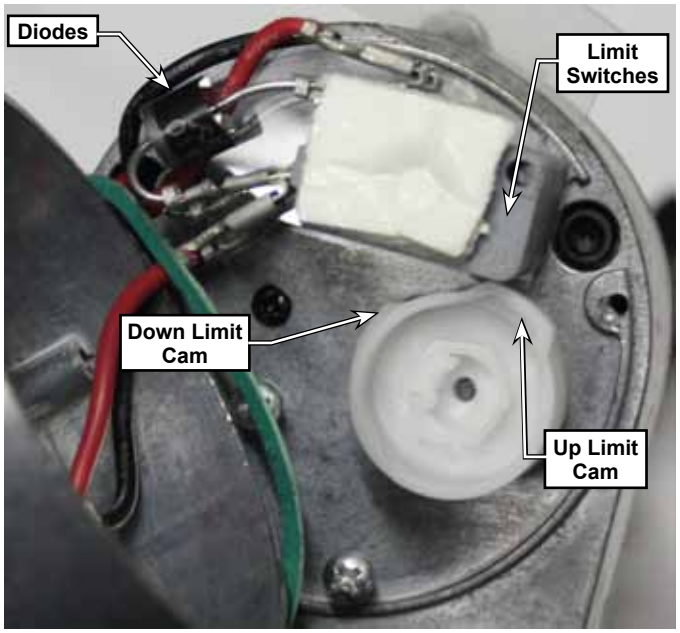
38 - Squeegee System

Functional Description

The squeegee tool collects wastewater from the floor for the recovery system to lift the water into the recovery tank. The floor squeegee is wider than the path of the scrub deck to ensure collection of all wastewater from the perimeter of the scrubbing area. The squeegee also pivots to the side to permit operation near walls and to keep the squeegee within the scrubbing path while turning the machine.

Squeegee Lift Actuator

The squeegee lift actuator operates on an offset arm that raises the squeegee assembly. When the actuator retracts, the arm pivots out of the way and allows the squeegee to lower. When the actuator is extended, the arm pivots the other way and raises the squeegee.

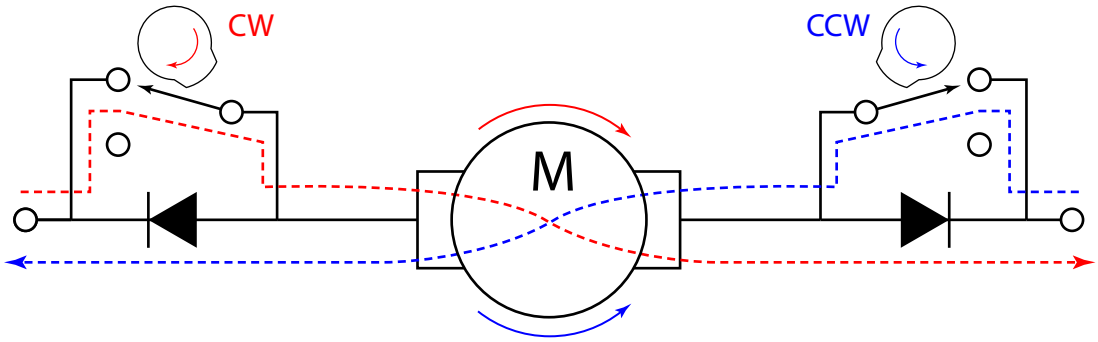


To extend or retract the actuator, the power module reverses polarity to the actuator. The actuator determines how long it should run to reach full extension or retraction. It accomplishes this with a pair of cams, limit switches, and diodes.

As each cam rotates, it opens the normally closed circuit and stops the motor's rotation. However each cam is functional only for its intended direction of rotation. This is accomplished with the diodes, which effectively short circuit the switch for one direction (polarity), but not the other.

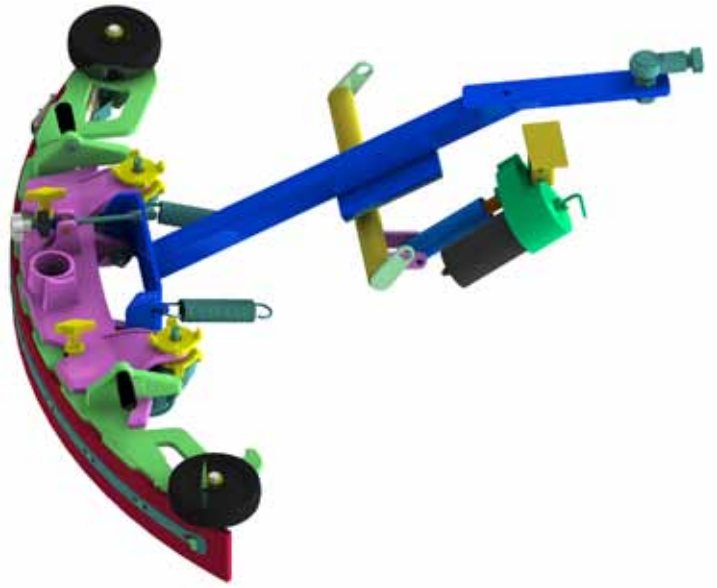
In the diagram below, the clockwise cam/limit switch is effectively short circuited by its diode when the electrical polarity is driving the motor in the counterclockwise direction (and vice versa for the CCW). But the counterclockwise cam is not short circuited, so it will open the motor circuit when the cam lobe reaches the limit switch.

The down-limit cam isn't adjustable, but by adjusting the position of the up-limit cam, the actuator can control its length of travel for the leadnut along the leadscrew.



Squeegee

The squeegee has a front and rear squeegee blade, creating a vacuum area in between where water can be drawn up from the fast moving airflow. The front squeegee blade is intended to permit wastewater to enter the middle of the squeegee's vacuum area, yet still maintain enough of a seal to not completely lose vacuum. The rear squeegee blade is intended to create a tighter seal to the floor, and also act as a wiper to prevent wastewater from being left behind the machine.

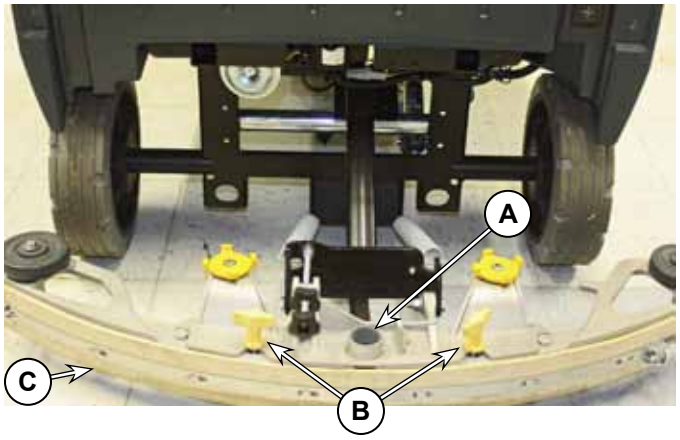


Maintenance and Adjustment

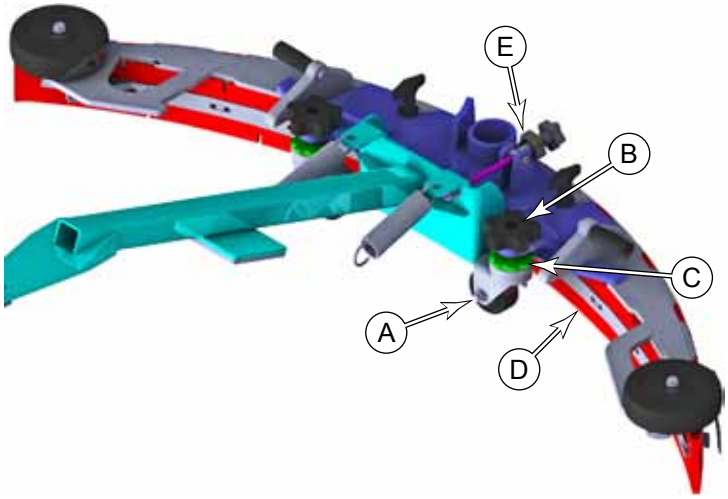
Squeegee Blade Cleaning and Inspection

Periodically clean and inspect the squeegee assembly and blades **(D)**.

1. Remove the squeegee hose **(A)** and move it off to the side.
2. Loosen the two thumb nuts **(B)** and slide the squeegee assembly off the lift mechanism.
3. Clean the squeegee blades **(C)** and suction area between the blades with soap and water.
4. Inspect the squeegee blades for nicks, tears, and worn leading edges. If a squeegee blade is worn or damaged, it may be turned around with a fresh edge facing down/forward up to four times before complete blade replacement is required.

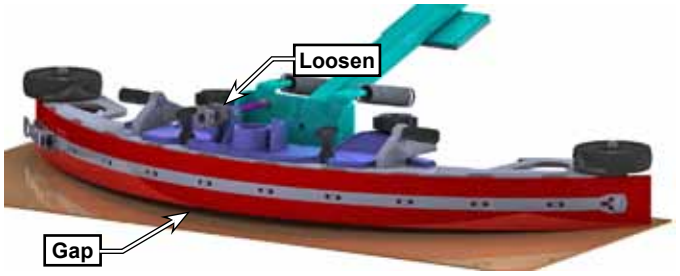


Squeegee Height and Tilt Adjustment

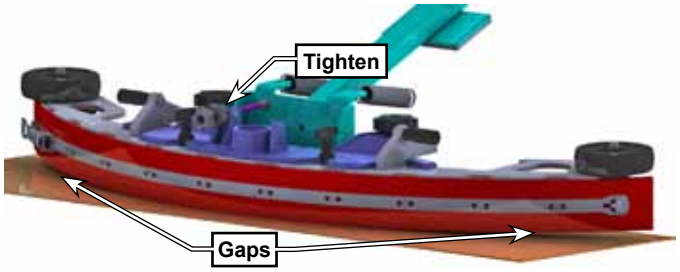


The squeegee height and tilt should be adjusted when the squeegee blades are replaced, or if the squeegee is not fully wiping the floor. Misadjustment symptoms include pooling in front of the squeegee or water streaks at the center or edges of the squeegee path.

1. Park the machine on a flat, even surface and lower the squeegee.
2. Without moving the machine (which will cause the rear squeegee blade to bend backward), inspect the interface between the edge of the rear squeegee blade and the floor. Inspect for gaps at either the center or the edges.

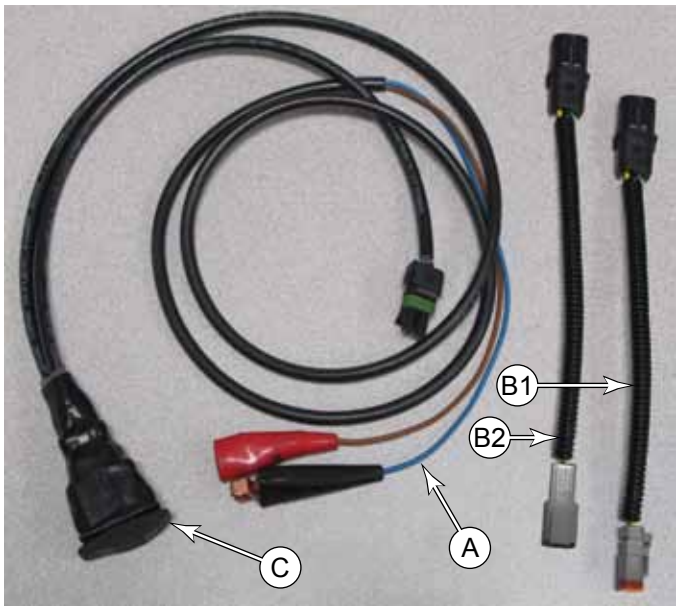


3. Tighten (clockwise) or loosen (counterclockwise) the squeegee tilt adjustment knob **(E)** to level the squeegee across its length.
   - If there is a gap in the center, loosen the adjustment knob.
   - If there are gaps at the outside, tighten the adjustment knob.
4. Move the machine forward slightly to cause the rear squeegee blade to bend back from friction with the floor.
   - Make sure the flare of the rear blade is even along the entire length of the blade.



5. Inspect the height of the front squeegee blade. When the casters **(A)** are touching the ground, the front squeegee blade **(D)** should barely be touching the floor. To adjust the height:
   a. Loosen the two clamping knobs **(B)**.
   b. Loosen the adjustment disk **(C)** to raise the squeegee, or tighten the adjustment disk to lower the squeegee.
   c. Make sure the height is the same across the width of the squeegee.
   d. Retighten the clamping knobs.
6. If the height was significantly changed, recheck the tilt adjustment in step 3.

Squeegee Actuator Limit Adjustment

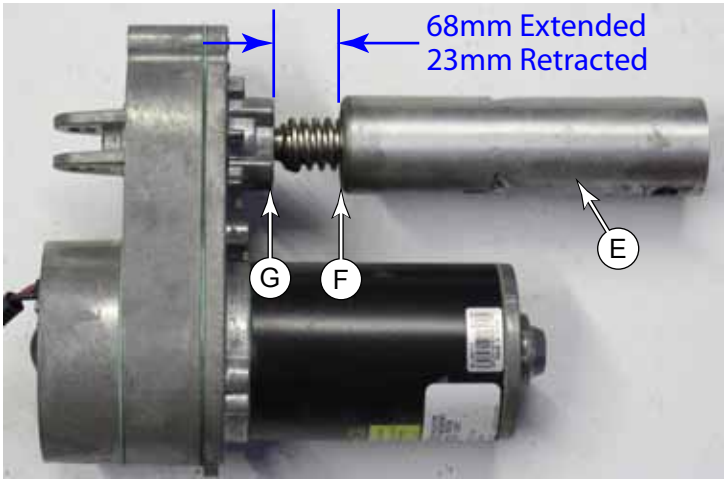


The power module commands the actuator to raise or lower, but the actuator itself determines when it should stop moving. This is accomplished by two cam lobes and two micro switches (limit switches). The lower cam is not adjustable, so the lower limit is adjusted by rotating the leadscrew nut. Then the upper limit is adjusted by turning the cam lobe until the actuator stops at the correct height.

To make the adjustment, you will need to manually power/control the actuator. If you don't have the Actuator Test Kit described on page 207, you can use the Squeegee Lift Output Test described on page 35. Just note that if you use the Output Test, you may periodically cause a controller fault, and have to reset the machine. For simplicity, this procedure is written for the test kit method.

This procedure is typically performed as part of replacing the actuator. If the actuator is not already removed from the machine, then remove it following the procedure on page 206.

1. Connect the tester **(A)** to the positive and negative terminals of the battery.
2. Using the adapter cable **(B)**, connect the tester to the actuator.
3. While preventing the actuator leadnut **(E)** from turning, use the switch **(C)**, extend the actuator until it stops.
4. Measure the distance between the actuator gearbox at **(G)** and the top of the leadnut at **(F)**.
5. Manually turn the leadnut until this distance is 68mm (2.7").



CAUTION: If while retracting the actuator with the "Output Test", it appears the leadnut is going to crash into the actuator housing, let go of the leadnut and let it spin.

6. While holding the leadnut from turning, retract the actuator until it stops.
7. Measure the retracted distance between **(G&F)**. The target is 23mm (.93").

8. Remove the dust cap from the top of the actuator covering the adjustment cam.
9. Using a 1/2" socket, turn the adjustment cam:
    - Turn the cam only a couple of clicks at a time before rechecking the result.
    - Each click of the cam represents about 2mm of leadnut travel.
    - Turn the cam clockwise to raise the leadnut and decrease the measured distance.
    - Turn the cam counterclockwise to lower the cam and increase the measured distance.
10. Before disconnecting the tester from the actuator, retract the actuator while holding the leadnut from turning. It is easiest to install the actuator when it is retracted.
11. After the adjustment is complete, make sure the leadnut does not turn while you are reinstalling the actuator.

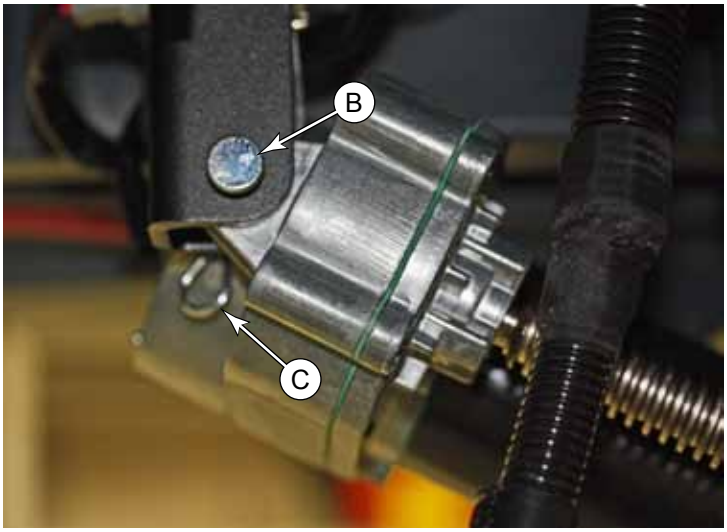
Troubleshooting Notes:

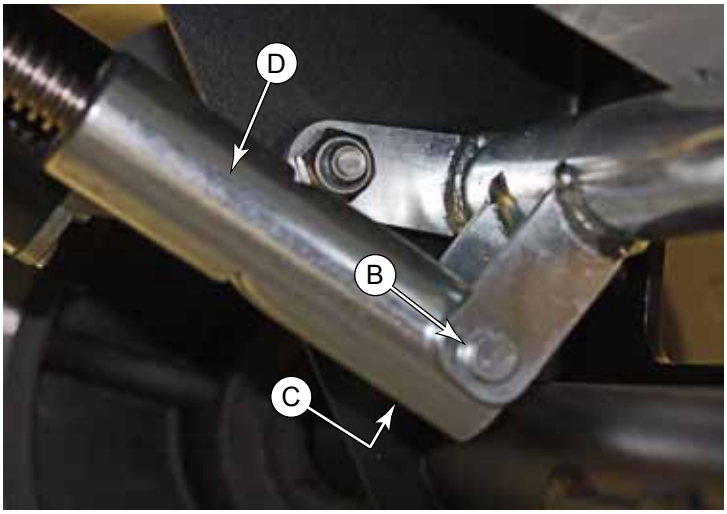
- If the actuator will neither raise nor lower, then both cams are activating their limit switches at the same time.
    - Rotate the cam clockwise several clicks.
    - **Do not hold the nut**, and raise and lower the actuator until it cycles normally again.
    - Go back and restart the adjustment with the extended limit adjustment.
- If you are using the “Output Test” method, and the main machine controller sees the actuator go active again after being stopped on a limit position, the controller will issue an error, and need to be reset. This may occur when you are turning the cam clockwise.

Removal and Installation

Squeegee Lift Actuator

1. Before turning off the machine,press the vacuum switch to lower the squeegee to the floor, then press the E-stop button to shut down all motors.
2. With the E-stop active and without turning the machine off, disconnect the battery connector under the operator's seat. This will cause the squeegee to remain lowered.
3. Disconnect the actuator electrical connector.
4. Remove the two retaining clips **(C)** from the upper and lower pivot pins **(B)**, and remove the pivot pins.





Note: *If the actuator is being removed for a reason other than replacement, do not allow the leadnut* **(D)** *to rotate with respect to the leadscrew. As long as the leadnut does not rotate, you can reinstall the actuator without performing the limit adjustment.*

5. For a new actuator or if the nut was repositioned with respect to the gear housing, perform the Actuator Limit Adjustment described on page 204.
6. Reinstall the actuator on the machine by reversing the procedure steps.

Specifications

Parameter	Range
M6 Squeegee Actuator Motor	No Load amps: 1.4 max. Full Load ams: 6.7 ±1.0

Special Tools

Actuator Test Kit

The actuator test kit (Pn 56407502) is used to manually control an actuator removed from the machine, but powered from a 36-volt battery. It contains alligator clips to connect to the battery, a reversing power switch, and a cable connector. If your test kit is prior to Rev I, you will also need a second adapter cable (Pn 56123352) to connect between the tester and the actuator. These adaptors, 1-male and 1-female, are included in kits Rev I and above.

40 - Recovery System

Functional Description

The recovery system extracts wastewater from the floor collected by the squeegee, and deposits it into the on-board recovery tank.

Vacuum Motor and Recovery Tank

The SC5000 machine has one standard vacuum motor, plus an optional second vacuum motor for higher vacuum draw. The vacuum motor generates airflow through the recovery tank and suction hose to the squeegee. The high velocity air at the squeegee pulls the wastewater off the floor and up through the suction hose. As the mixture of air and water enters the recovery tank, the airflow slows down due to the larger space, and the water drops out of the airflow and into the tank.

The airflow passes through an inlet screen to prevent debris from entering the impeller of the vacuum motor. The exhaust air is expelled through ducting in the machine toward the floor so it can be dispersed without blowing directly on the operator or the work environment.

Operational Mode Prerequisites

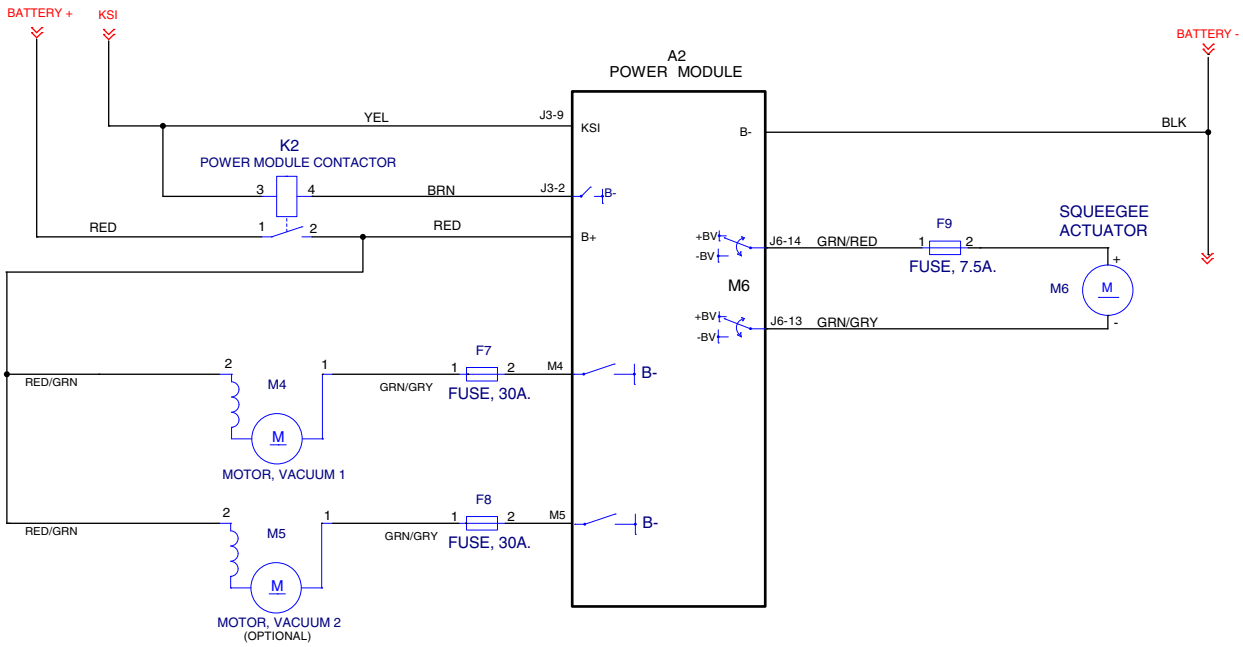
Before the main controller can activate any of the operational modes, it must first check that the appropriate prerequisites are met.

- **Recovery System Outputs**
  - Vac motors – Recovery mode (Seat switch closed upon entry) or Squeegee Actuator M6
    - No recovery system fault (vac motors and squeegee)
    - Throttle command not equal to zero (and not timed out)
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (second stage)
    - No RTF inhibit
    - Note M5 also requires Vacuum option set to dual in configuration menu
  - Vac motors M4 and M5 – Wand mode (seat switch open upon entry) or Squeegee Actuator M6
    - No recovery system fault (vac motors and squeegee)
    - No Estop inhibit
    - No impact lockout inhibit
    - No low voltage cut out inhibit (second stage)
    - No RTF inhibit
    - Note M5 also requires Vacuum option set to dual in the configuration menu

Vacuum Motor Control Circuit Overview

Power to the vacuum motor is controlled by the power module, which is commanded by the main controller. When the machine is enabled for operation, the power module activates the K2 power relay, that provides positive battery power to the vacuum motor, and other devices. To activate the vacuum motor, the power module uses PWM control to complete the battery circuit through the motor to ground.

The power module monitors the performance and health of the vacuum motor, and reports this information back to the main controller via the CAN Bus. The power module will detect open circuits, short circuits, and motor overloads.



Troubleshooting

Whenever there is a vacuum problem, it's best to check over the entire system. Use the checklist below as a guide to thoroughly check the vacuum system.

- Inspect the vacuum motor inlet screen and clean any built-up debris from the screen.
- Clean built-up dirt from the inside of the squeegee assembly.
- Replace the squeegee blades if they are nicked or torn.
- Inspect the hose between the squeegee and the recovery tank and rinse any built-up dirt from the hose. Replace the hose if it is kinked or damaged.
- Inspect and make sure the gasket on the recovery tank cover is sealing and not damaged.
- Make sure that the recovery tank drain hose cap seals airtight.

Problem	Cause	Correction
No suction	Vacuum motor not running	• Check the vacuum motor power connector
Poor suction	Unknown: Leak versus Clog	To determine whether the problem is a leak versus a clog, remove the suction hose from the squeegee and completely block the hose with your hand and observe the suction. Then tilt your hand to allow free airflow, and observe the speed of the airflow past your hand. Alternatively, you may complete the Vacuum Suction Test described on page 211. • Strong suction when blocked and weak airflow when unblocked indicates a clog. • Weak suction when blocked, but strong airflow when unblocked indicates a leak. • Weak suction and weak airflow indicate either a massive leak, or a failing vacuum motor.
	Clogged vacuum	• Inspect and clean the vacuum motor inlet filter • Inspect the suction hose between the squeegee and the recovery tank • Inspect and clean the squeegee
	Vacuum leaks	• Inspect the gasket on the recovery tank cover • Inspect the suction hose between the squeegee tool and recovery tank for loose connection, holes, or damage • Inspect the squeegee blades for nicks, cuts, and damage • Inspect the recovery tank drain hose and cap for leaks • Inspect the vacuum motor mount for leaks

Vacuum Suction Test

Use this procedure to verify that the vacuum system is performing within factory specifications. This procedure can also be used to isolate the cause of a vacuum problem between a clog or leak. It is a two-part procedure that verifies both static pressure and flow rate. This procedure requires a vacuum gauge (PN 56205281), a piece of 2" PVC (or similar) tube, a 1" hole saw, and some duct tape (or similar, for a seal).

1. Remove the suction hose **(A)** from the squeegee and then turn on the vacuum.
2. Place the vacuum gauge **(B)** on the hose so the taper **(C)** seals against the end of the hose.
3. Record the vacuum pressure reading from the gauge. This is the static pressure.
4. Turn the vacuum off while constructing and fitting the PVC restricter tube **(D)**.

5. Cut a piece of 2" PVC approximately 6" long, and clean off the burs. The outer diameter of the tube should be close to, but not larger than 2½".
6. Drill a 1" hole **(E)** approximately in the middle of the PVC tube, and clean off the burs.
7. As necessary, wrap duct tape around the tube so it fits snugly in the end of the end of the suction hose with no leaks.
8. Turn the vacuum on and place the vacuum gauge on the restricter tube.
9. Record the vacuum pressure reading from the gauge. This is the restricted flow pressure.

Results Summary

The first part of this procedure determined the static pressure of the vacuum system, and the second part determined the flow rate (by calculation). The flow rate through a restriction is determined by the pressure differential across the restriction. These two parameters may be used to determine if the vacuum system is functioning properly, and may also be used to isolate a possible cause for a problem.

- If the static pressure is at least 60 inches H_2O, then the vacuum motor(s) are functioning properly and there are no significant leaks in the system.
- If the 1” restricted flow pressure is at least 15 inches H_2O for a single vacuum or 25 inches H_2O for a dual vacuum, then there are no significant clogs in the system.
- If both parameters are below specifications, then one or both vacuum motors may be failing, or there may be a significant leak in the system.

Removal and Installation

Recovery Tank

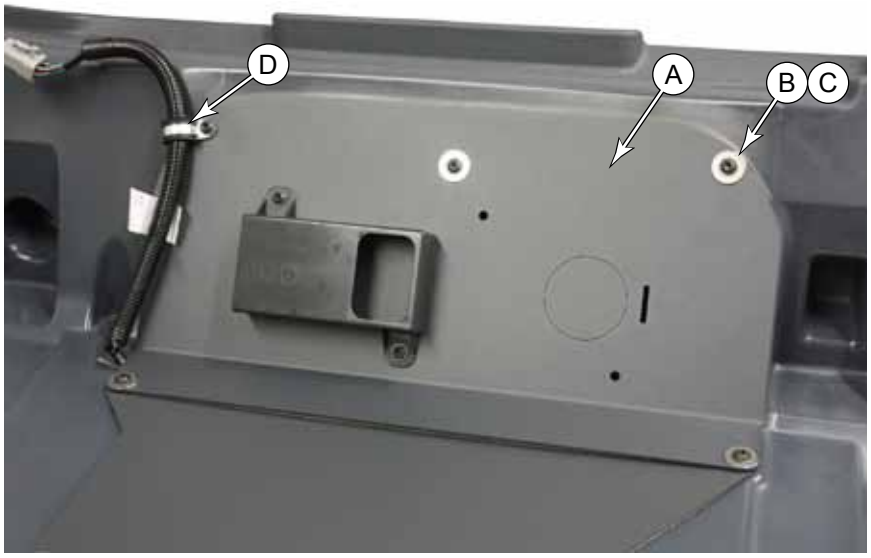
Removing the recovery tank is a prerequisite to performing other procedures on the machine, ro gain access to components otherwise not easily accessible.

1. Drain the recovery tank.
2. Raise the operator's seat and disconnect the vacuum motor electrical connector.
3. Disconnect the recovery hose from the squeegee mechanism.
4. Using either an overhead hoist, or at least 2 people, lift the recovery tank upward to remove it from the pins **(A)** on the top of the solution tank.

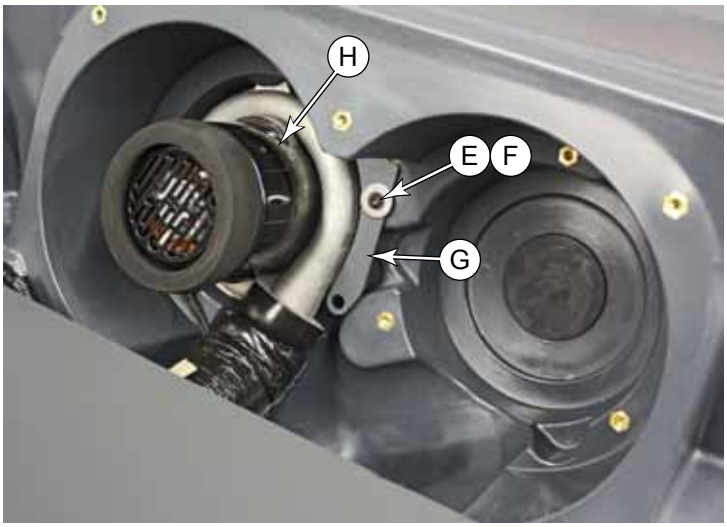
Vacuum Motor

This procedure may be completed with the recovery tank installed on the machine. However, removing the tank will make the procedure easier, as you won't need to work on the components from inside the battery bay. Refer to the procedure above for removing the tank.

1. Remove the 5 screws **(B)** and 4 washers **(C)** that secure the vacuum plate **(A)**, and remove the plate. Note: The screw securing the cable retainer **(D)** does not use a washer.



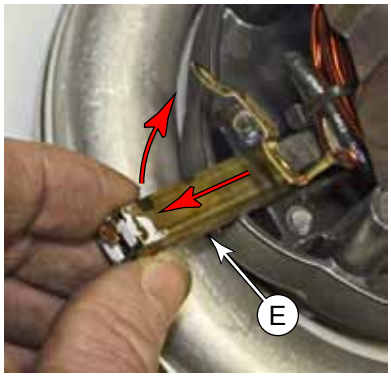
2. Remove the 3 screws **(E)** and washers **(F)** that secure the vacuum retaining plate **(G)**, and remove the plate.
3. Lift the vacuum motor assembly **(H)** out of the recovery tank recess.



Vacuum Motor Brushes

1. Remove the Vacuum Motor described on page 212.
2. Remove the two screws **(A)** that secure the motor cover to the motor, and remove the cover.

3. Remove the two screws **(C)** that secure the contact strap **(D)**, and remove the strap. Take care to not bend the wire any more than necessary.
4. Lift the outer end of the brush **(E)** up, and slide the brush out of the motor housing.
5. Repeat for the second brush.



6. When installing a new brush, tilt the brush assembly downward at the front so the carbon bar contacts the commutator bars, and then compress the spring to fully insert the brush.

Specifications

Parameter	Range
Motor Amperage	18.1A at 100%

Special Tools

Vacuum Pressure Gauge
part number 56205281

1-inch open hole adapter
Fabricated from PVC

90 - Options and Accessories

The SC5000 machine may be equipped with optional accessories depending on the needs of the owner. Some of these accessories don't directly impact servicing the machine, but some may. So it is good to know what accessories you may encounter and how they impact the machine.

Beacon	**MMC Setup**	Configuration & Options
Description	The beacon is located on the recovery tank and connects into the existing harness connector. The beacon function can be turned on or off in the options menu.	
Service Impact	Low; troubleshooting	

Headlights	**MMC Setup**	None
Description	The blue light is a safety device to alert pedestrians of the approaching machine, especially around corners, by casting a focused blue light onto the floor directly ahead of the machine. The blue light is active whenever the machine is powered (when KSI is active).	
Service Impact	Low; troubleshooting, light aiming	

Blue Light	**MMC Setup**	None
Description	The blue light is a safety device to alert pedestrians of the approaching machine, especially around corners, by casting a focused blue light onto the floor directly ahead of the machine. The blue light is active whenever the machine is powered (when KSI is active).	
Service Impact	Low; troubleshooting, light aiming	

On Board Charger (OBC)	**MMC Setup**	Configuration
Description	The on-board charger is located below the operator's seat in the battery bay. It is connected directly to the main battery terminals; so it is not disconnected when the Anderson connector is disconnected. The charger is connected to the CAN-0 bus to communicate with the MMC to receive battery-type information and charging algorithm.	
Service Impact	Low; troubleshooting, setting battery type	
Reference	Setting the battery type in "Battery Settings" on page 120	

EcoFlex	**MMC Setup**	Configuration and Options
Description	EcoFlex is a detergent injection system into the solution line. It is located under the operator's seat and consists of a detergent bottle, fluid tubing, and a small diaphragm pump.	
Service Impact	Low; troubleshooting, Periodic clean and flush	
Reference	The EcoFlex system is covered in "30 - Solution System" on page 167.	

Scrub-N-Vac Wash Hose	**MMC Setup**	Configuration
Description	The Wash Hose and Scrub-N-Vac are similar options, in that they both make use of the option pump. For this reason, only one of these options may be present on a machine at a time. The wash hose is a handheld spray hose for off-machine cleaning. Scrub-N-Vac is a remote cleaning wand with water spray and vacuum suction, to facilitate floor cleaning to areas not easily reached by the main machine. Either option consists of an on-demand solution pump located on the rear chassis below the solution tank, which operates when a drop in pressure is detected in the solution hose leading to the wand. The inlet to the option pump connects to the main solution line of the machine upstream from the solution solenoid, so that water is available without the scrub system being active. The Scrub-N-Vac wand and hose includes a water supply line and vacuum suction line.	
Service Impact	Low; troubleshooting	
Reference	The option pump is covered in “30 - Solution System” on page 167.	

TrackClean	**MMC Setup**	Configuration
Description	The TrackClean module provides machine operational and management information to the machine’s owner from remote connectivity. From a remote website, the machine’s owner is able to determine the machine’s location, who is operating the machine, and various operational and performance parameters. The TrackClean module is located inside the steering column and connects to an existing electrical connector. It uses the CAN Bus to communicate with the Main Machine Controller. The module includes an internal battery to provide operational power, even if the machine is not operational.	
Service Impact	Low; troubleshooting	

Dual Vacuum	**MMC Setup**	Configuration
Description	Adds a second vacuum motor (Vac 2) to the recovery tank.	
Service Impact	Low; Same procedures as for single vacuum	

Side Sweep	**MMC Setup**	Configuration
Description	Available only for 32” cylindrical models. Adds a side broom to the right-front of the deck area. The option also includes a proximity sensor to detect when the operator has manually raised the side broom out of operating position.	
Service Impact	Low; Broom pressure adjustment, troubleshooting	

Various Mechanical Kits	MMC Setup	None
Description	The following kits are mechanical in nature and do not pose a direct impact on serviceability beyond knowing they may be present.	
Battery Watering Kit	This kit includes tubing and caps necessary to facilitate adding water to all flooded batteries simultaneously.	
Mop Holder Kit	This provides a mounting bracket to hold a mop or broom to the side of the machine for off-machine usage.	
Arm Rest Kit-R/H Only	This is an operator comfort feature to add an arm rest to the operator's seat.	
Seat Belt Kit	This is an operator safety feature to add a seatbelt to the operator's seat.	
Drain Hose Extension	This is an extension of the machine's existing drain hose to facilitate draining the solution tank into a nearby floor drain.	
Solution Auto Fill Kit	This is a replacement cap for the existing solution tank cap to permit a direct connection of a filling hose to the solution tank, which includes an automatic shutoff of the water when the tank is filled.	
Vacuum Wand Kit	This is a mounting bracket and vacuum wand mounted on the recovery tank for off-machine water suction. For operation, the main squeegee hose is disconnected and reconnected to the wand, when the wand is used.	
Squeegee Guard Kit	This is a rear bumper attachment to protect the squeegee mechanism from collision while backing the machine.	
Foot Guard Kit	This is a guard surrounding the operator's foot pedal position to prevent unexpected interference from low hanging obstacles while the operator is driving the machine.	
Heavy Duty Front Bumper	Tubular steel front bumper that replaces the original flat bumper on the front of the machine.	
Overhead Guard	The overhead guard mounts to the solution tank and the heavy duty bumper. Therefore, the front bumper is required for the overhead guard	