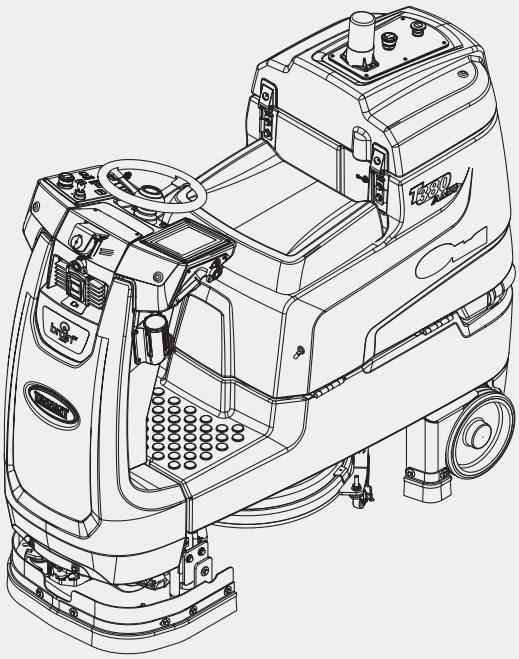
T380AMR

Rider-Scrubber

English EN
Service Manual



Hygenic® Fully Cleanable Recovery Tank
Tennant*True®* *Parts*
Insta-Click™ Magnetic Disk

ec H2O® NanoClean

ATTENTION: DO NOT tip the machine onto its side to replace parts or perform any maintenance procedures. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

For the latest Parts Manuals and other language Operator Manuals, visit:

www.tennantco.com/manuals

9021011
Rev. 01 (09-2022)

INTRODUCTION

This manual is available for each new model. It provides necessary operation and maintenance instructions.

Read this manual completely and understand the machine before operating or servicing it.

This machine will provide excellent service. However, the best results will be obtained at minimum costs if:

- The machine is operated with reasonable care.
- The machine is maintained regularly - per the machine maintenance instructions provided.
- The machine is maintained with manufacturer supplied or equivalent parts.

To view, print or download manuals online visit www.tennantco.com/manuals

PROTECT THE ENVIRONMENT

Please dispose of packaging materials and used machine components such as batteries in an environmentally safe way according to your local waste disposal regulations.

Always remember to recycle.

Tennant Company
10400 Clean Street
Eden Prairie, MN 55344-2650
Phone: (800) 553- 8033 or (763) 513- 2850
www.tennantco.com

INTENDED USE

The T380AMR is an industrial/commercial autononmous rider machine designed to wet scrub both rough and smooth hard surfaces (concrete, tile, stone, synthetic, etc). This machine can be operated in either autonomous mode (without driver) or manual mode (with driver). Typical applications include schools, office buildings, and retail centers. Do not use this machine on soil, grass, artificial turf, or carpeted surfaces. This machine is intended for indoor use only. This machine is not intended for use on public roadways. Do not use this machine other than described in this Operator Manual.

MACHINE DATA

Please fill out at time of installation for future reference.

Model No. - _____

Serial No. - _____

RIN No. -- _____

Installation Date - _____

SERIAL NUMBER LABEL LOCATION

CONTENTS

IMPORTANT SAFETY INSTRUCTIONS - SAVE THESE INSTRUCTIONS

The following precautions are used throughout this manual as indicated in their descriptions:

WARNING: To warn of hazards or unsafe practices that could result in severe personal injury or death.

FOR SAFETY: To identify actions that must be followed for safe operation of equipment.

The following information signals potentially dangerous conditions to the operator. Know when these conditions can exist. Locate all safety devices on the machine. Report machine damage or faulty operation immediately.

WARNING: Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.

WARNING: Flammable materials can cause an explosion or fire. Do not use flammable materials in tank(s).

WARNING: Flammable materials or reactive metals can cause an explosion or fire. Do not pick up.

WARNING: Spinning brush. Keep hands away.

WARNING: Magnetic Field Hazard. Magnetic pad driver/brush can be harmful to those with pacemakers or medical implants.

This machine is equipped with technology that automatically communicates over the cellular network. This machine is equipped with BrainOS software that is accessible via the BrainOS User Interface (UI) Touch Screen. Avoid operating machine in areas where other equipment that may be sensitive to electromagnetic noise is located.

FOR SAFETY:

1. Do not operate machine:
   - Unless trained and authorized.
   - Unless operator manual is read and understood.
   - Under the influence of alcohol or drugs.
   - In Manual Mode: While using a cell phone or other types of electronic devices.
   - Unless mentally and physically capable of following machine instructions.
   - With brake disabled.
   - Without filters in place or with clogged filters.
   - If it is not in proper operating condition.
   - In areas where flammable vapors/liquids or combustible dusts are present.
   - In outdoor areas. This machine is for indoor use only.
   - In areas that are too dark to safely see the controls or operate the machine.
   - In areas with possible falling objects.
   - With pads or accessories not supplied or approved by Tennant. The use of other pads may impair safety.
2. Before Starting Machine:
   - Check machine for fluid leaks.
   - Make sure all safety devices are in place and operate properly.
   - Check brakes and steering for proper operation.
   - In Manual Mode: Adjust seat and fasten seat belt (if equipped).
3. When using machine in manual mode:
   - Use only as described in this manual.
   - Use brakes to stop machine.
   - Reduce speed when turning.
   - Go slowly on inclines and slippery surfaces.
   - Do not scrub on ramp inclines that exceed 7% / 4° grade or transport (GVWR) on ramp inclines that exceed 10.5% / 6° grade.
   - Drive slowly through doorways and narrow openings.
   - Be cautious of the squeegee near bystanders and obstacles.
   - Keep all parts of body inside operator station while machine is moving.
   - Always be aware of surroundings while operating machine.
   - Use care when reversing machine.
   - Keep children and unauthorized persons away from machine.
   - Do not allow machine to be used as a toy.
   - Do not carry passengers on any part of the machine.
   - Always follow safety and traffic rules.
   - Report machine damage or faulty operation immediately.
   - Follow mixing, handling and disposal instructions on chemical containers.
   - Place proper floor cleaning signage in areas where the machine is operating and people are present, in accordance with standard floor cleaning practices.
   - Follow site safety guidelines concerning wet floors.

4. While machine is operating in robotic mode:
   - Use only as described in this manual.
   - Remove key from ON/OFF key switch to prevent unauthorized use without disrupting robotic route.
   - Do not attempt to ride machine.
   - Do not grab steering wheel or put hands or arms through the holes of the steering wheel. Steering wheel may move rapidly and unexpectedly while in robotic mode.
   - Do not operate machine in environments requiring fail−safe performance (areas where machine failure could lead to personal injury or property damage).
   - Guard sudden drops, stairs, escalators, or moving platforms in area of machine operation with a physical barrier.
   - Do not use ladders, scaffolds, or other temporary constructed structures in area of machine operation.
   - Only scrub flat, hard surfaces of 0% incline.
   - Do not operate machine in low traction environments (ice, oil, etc...).
   - Do not leave electrical cords or low profile items (anything having a height of less than 10 cm from ground) in area of machine operation.
   - Always operate machine in manual mode when going into elevators or through automatic doors. Robotic routes should never include going into elevators or through automatic doors.
   - Keep children and unauthorized persons away from machine.
   - Do not allow machine to be used as a toy.
   - Do not carry passengers on any part of the machine.
   - Always follow safety and traffic rules.
   - Report machine damage or faulty operation immediately.
   - Follow mixing, handling and disposal instructions on chemical containers.
   - Place proper floor cleaning signage in areas where the machine is operating and people are present, in accordance with standard floor cleaning practices.
   - Follow site safety guidelines concerning wet floors.

5. Before leaving or servicing machine:
   - Stop on level surface.
   - Turn off machine and remove key.

6. When servicing machine:
   - All work must be done with sufficient lighting and visibility.
   - Keep work area well ventilated.
   - Avoid moving parts. Do not wear loose clothing, jewelry and secure long hair.
   - Block machine tires before jacking machine up.
   - Jack machine up at designated locations only. Support machine with jack stands.
   - Use hoist or jack that will support the weight of the machine.
   - Do not push or tow the machine without an operator in the seat controlling the machine.
   - Do not push or tow the machine on inclines with the brake disabled.
   - Do not power spray or hose off machine. Electrical malfunction may occur. Use damp cloth.
   - Plug the off-board charger into a properly rated outlet only.
   - Do not disconnect the off−board charger's DC cord from the machine's receptacle when the charger is operating. Arcing may result. If the charger must be interrupted during charging cycle, disconnect the AC power supply cord first.
   - Disconnect battery connections before working on machine.
   - Do not pull on battery charger cord to unplug. Grasp plug at outlet and pull.
   - Do not use incompatible battery chargers as this may damage battery packs and potentially cause a fire.
   - Do not charge frozen batteries.
   - Inspect charger cord regularly for damage.
   - Avoid contact with battery acid.
   - Keep all metal objects off batteries.
   - Use a non-conductive battery removal device.
   - Use a hoist and adequate assistance when lifting batteries.
   - Battery installation must be done by trained personnel.
   - Follow site safety guidelines concerning battery removal.
   - All repairs must be performed by trained personnel.
   - Do not modify the machine from its original design.
   - Use Tennant supplied or approved replacement parts.

When servicing machine (continued)

- Wear personal protective equipment as needed and where recommended in this manual.

For Safety: wear hearing protection.

For Safety: wear protective gloves.

For Safety: wear eye protection.

For Safety: wear protective dust mask.

7. When loading/unloading machine onto/off truck or trailer:
   - Use ramp, truck or trailer that will support the weight of the machine and operator.
   - Drain tanks before loading machine.
   - Do not drive on a slippery ramp.
   - Use caution when operating on a ramp.
   - Do not load/unload on ramp inclines that exceed 15.8% / 9° grade.
   - Lower scrub head and squeegee before tying down machine.
   - Turn off machine and remove key.
   - Block machine tires.
   - Use tie-down straps to secure machine.

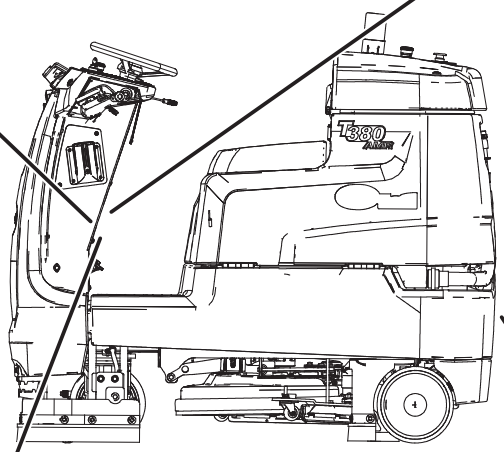
The following safety labels are mounted on the machine in the locations indicated. Replace damaged/missing labels.

WARNING LABEL - Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.

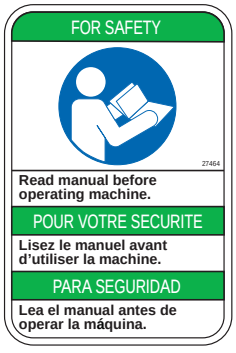
Located on front electrical access panel.

WARNING LABEL - Flammable materials or reactive metals can cause explosion or fire. Do not pick up.

Located on front electrical access panel.

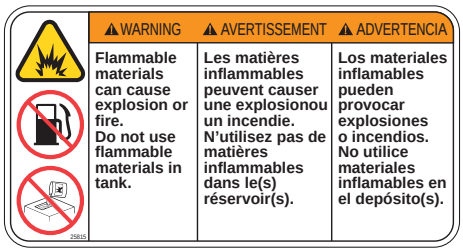


FOR SAFETY LABEL - Read manual before operating machine.



Located on front electrical access panel.

WARNING LABEL - Flammable materials can cause explosion or fire. Do not use flammable materials in tank.

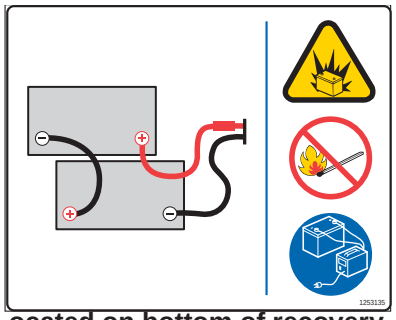


Located on solution tank near solution tank fill port.

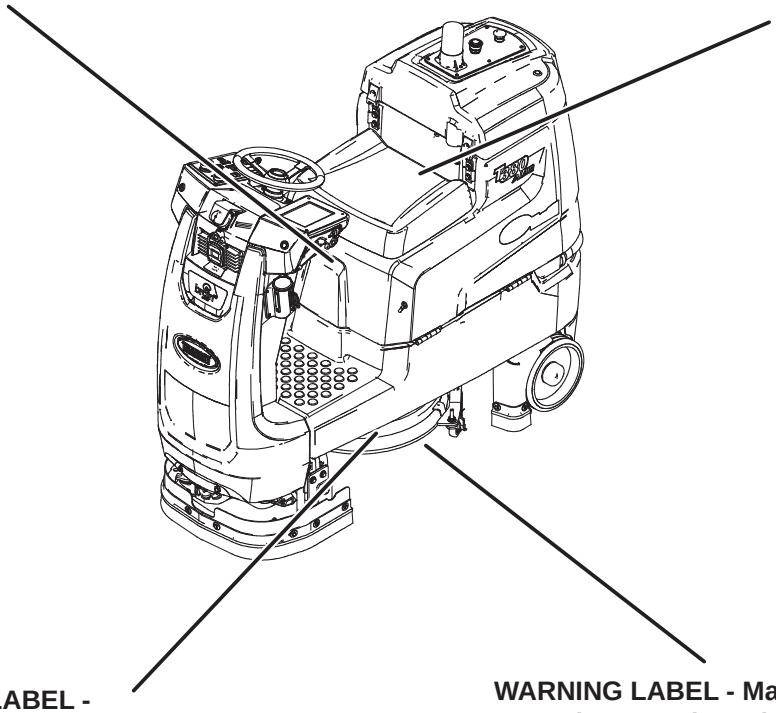
FOR SAFETY LABEL - Electrical components, use grounding strap before opening panel.

Located on controller cover.

WARNING LABEL - Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.



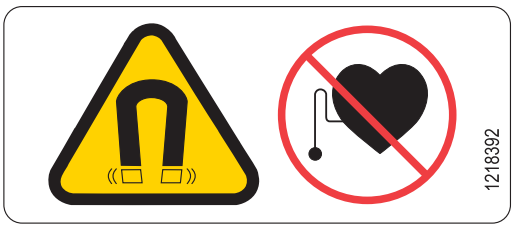
Located on bottom of recovery tank.



WARNING LABEL - Spinning brush. Keep hands away.

Located on top of scrub head.

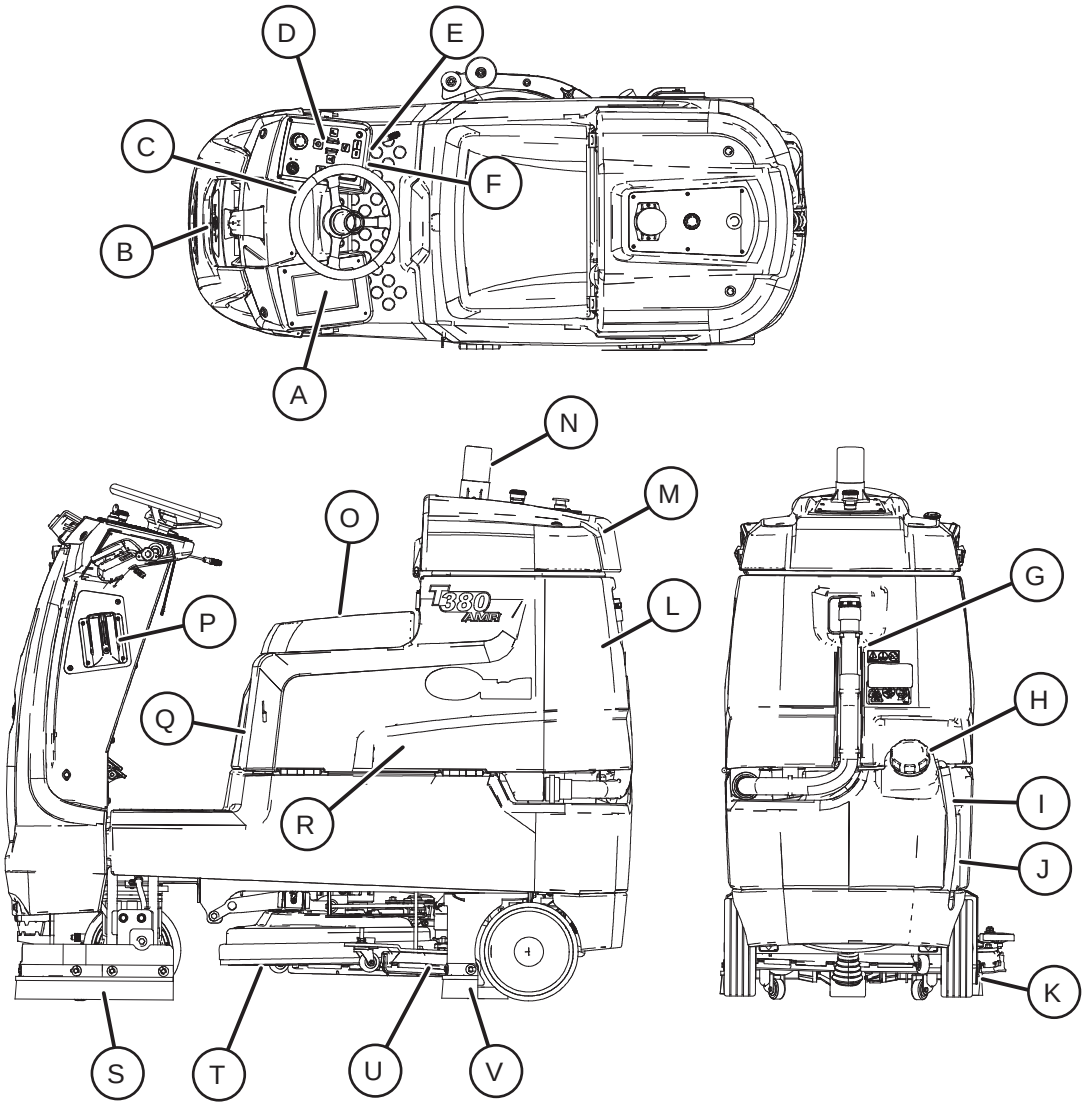
WARNING LABEL - Magnetic Field Hazard. Magnetic pad driver/brush can be harmful to those with pacemakers or medical implants.



Located on Insta-Click magnetic pad driver/brush.

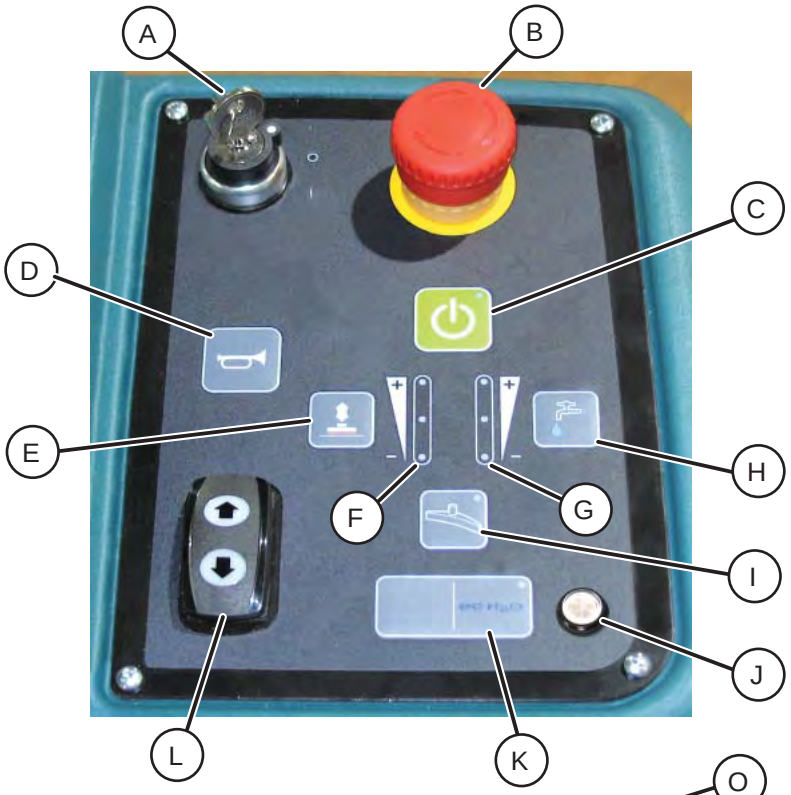
GENERAL INFORMATION

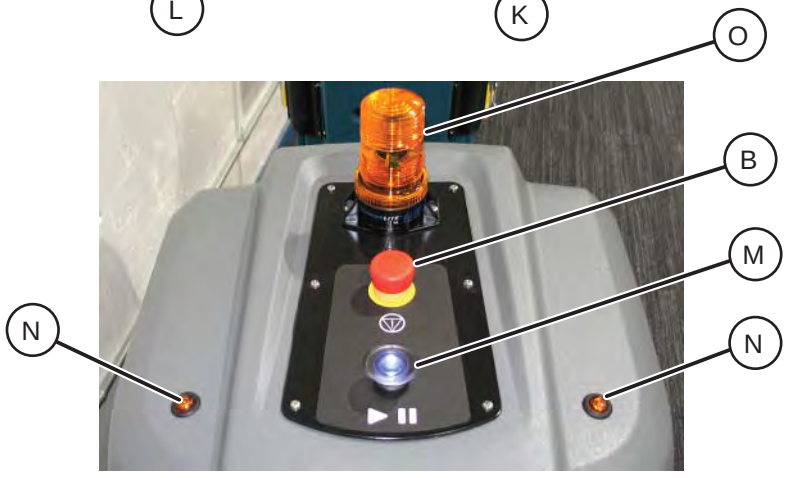
MACHINE COMPONENTS



A. User Interface (UI) touchscreen
B. Sensor panel
C. Steering wheel
D. Control panel
E. Propel pedal
F. Brake pedal
G. Recovery tank drain hose
H. Solution tank fill cap
I. Solution tank drain hose
J. Solution tank
K. Right perimeter guard
L. Recovery tank
M. Recovery tank cover
N. Flashing light
O. Operator seat
P. Retractable straps (Anti-Joyride)
Q. Battery charging connector
R. Batteries
S. Front perimeter guard
T. Scrub head
U. Squeegee
V. Left perimeter guard

CONTROLS AND INSTRUMENTS



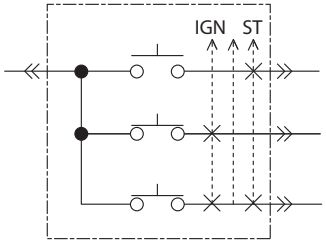


A. ON/OFF key switch
B. Emergency Stop Button (located on control panel and back of machine)
C. 1-Step button
D. Horn button
E. Brush pressure button
F. Brush pressure indicator lights
G. Solution flow indicator lights
H. Solution flow button
I. Vacuum fan/squeegee button
J. ec-H2O system indicator light (option)
K. ec-H2O system on/off button (option)
L. Directional switch
M. Blue start/pause button
N. Signal lights (Rear)
O. Flashing light

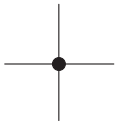
CAMERAS AND SENSORS

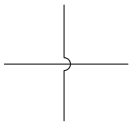
A. Sensors - Upper LIDAR
B. Signal lights (Front)
C. Sensors – Front 2D camera
D. Sensors – Front 3D camera
E. Sensors - Side 2D camera (located on each side of machine)
F. Sensors - Side 3D camera (located on each side of machine)
G. Sensors - Lower LIDAR

ELECTRICAL SCHEMATIC SYMBOLS



Key Switch


Connected


Not Connected

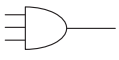
Connector

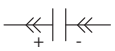

Energized


Adaptor Harness


Notes


Assembly


AC Plug



Capacitor

Battery

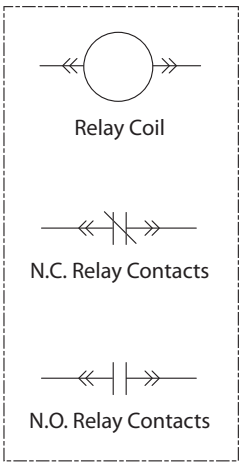

Circuit Breaker

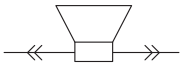

Fuse

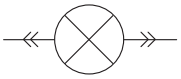

Diode

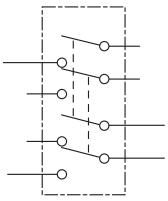

Single Continuation Tab

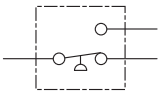

Double Continuation Tab

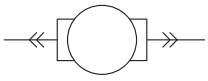


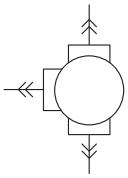

Horn or Alarm

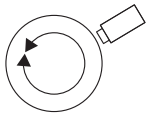

Light


DPDT Switch


Pressure Switch


Motor


3 Phase AC
Induction Motor


Motor Encoder


Sensor
(Variable Resistor)

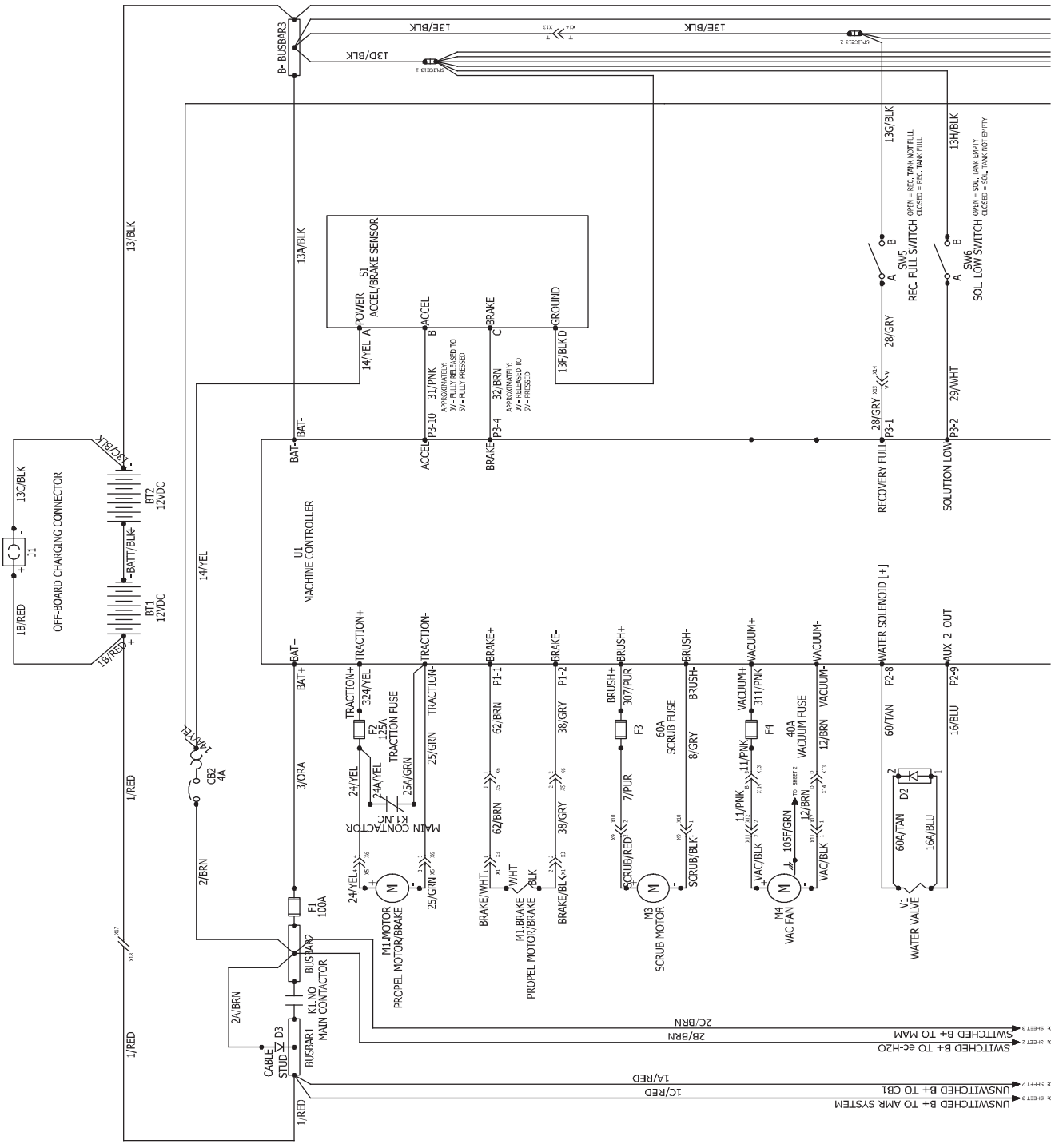

Momenary Switch N.O.

Contact Switch N.C.


Solenoid Valve

ELECTRICAL SCHEMATIC
NA/APAC S/N (10000000-20000000)

1076753_00



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NA/APAC S/N (10000000-20000000)

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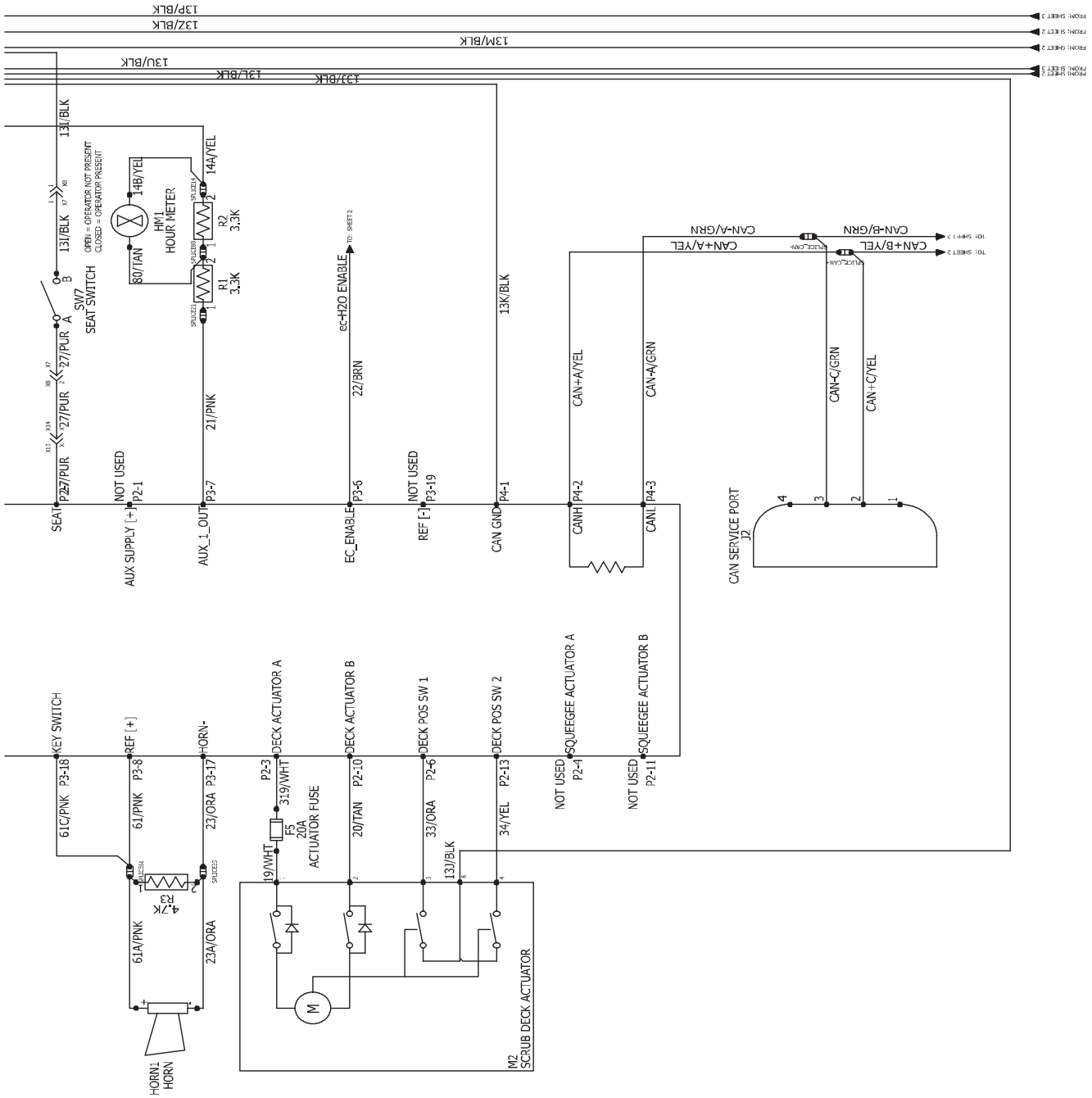

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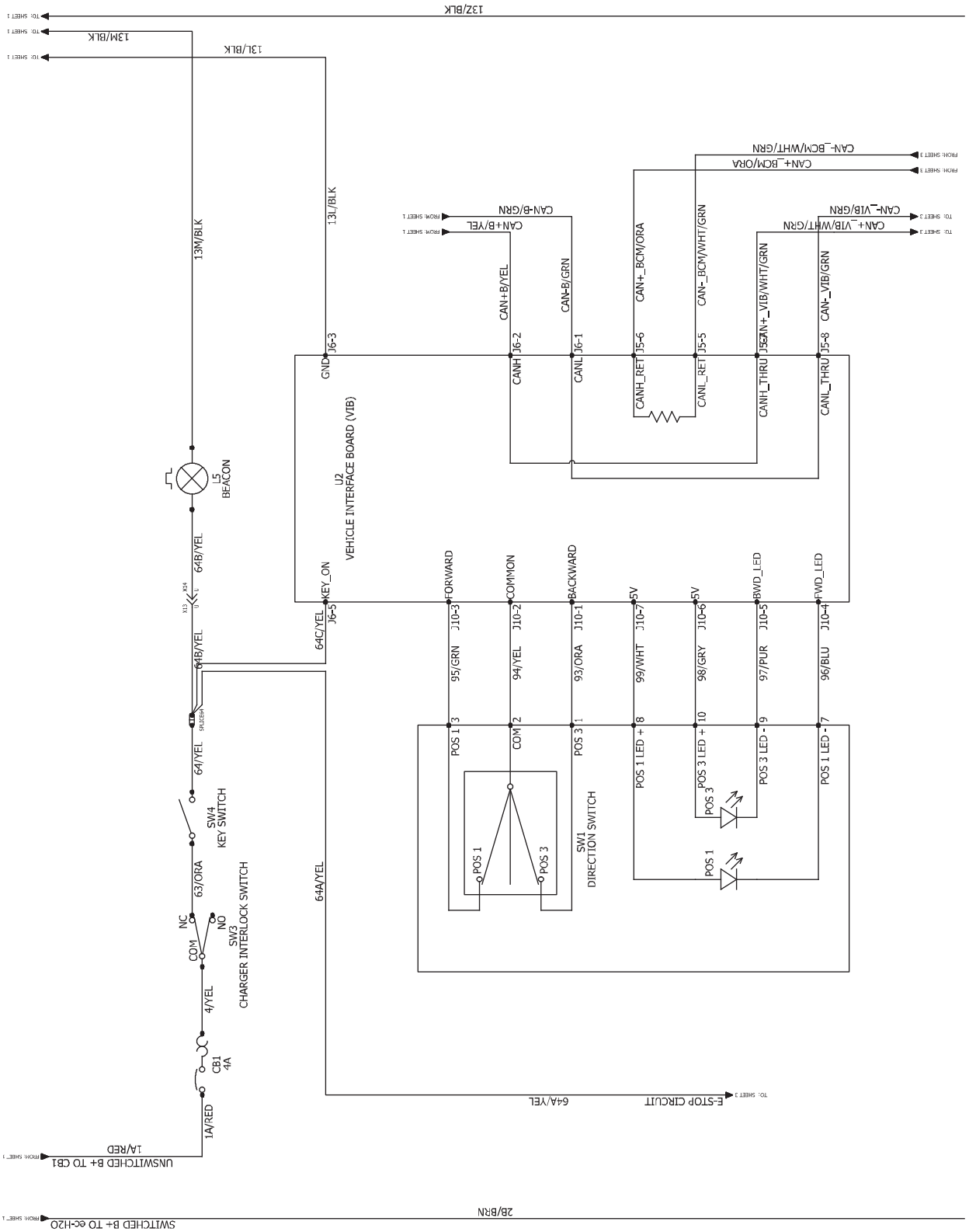

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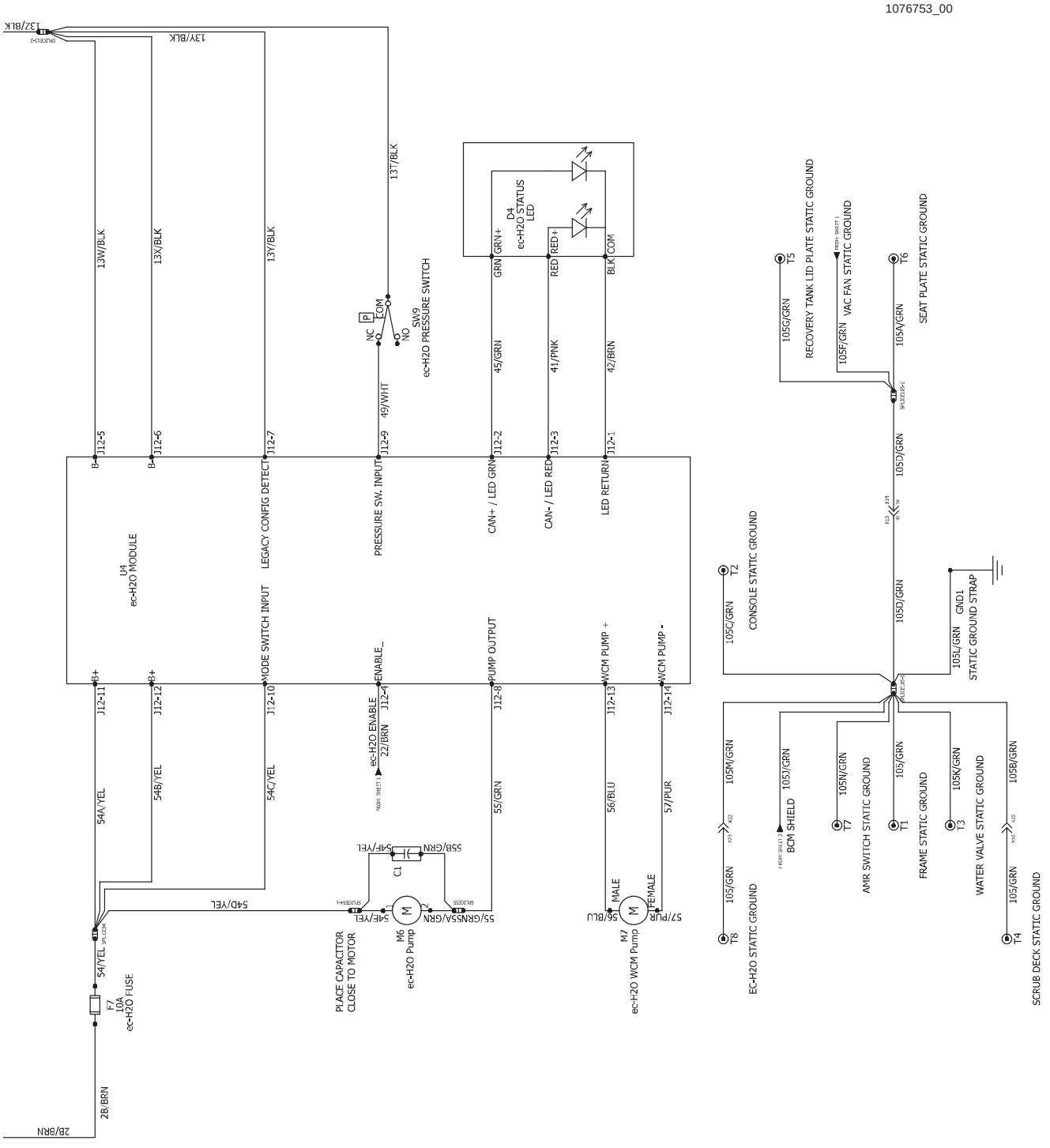

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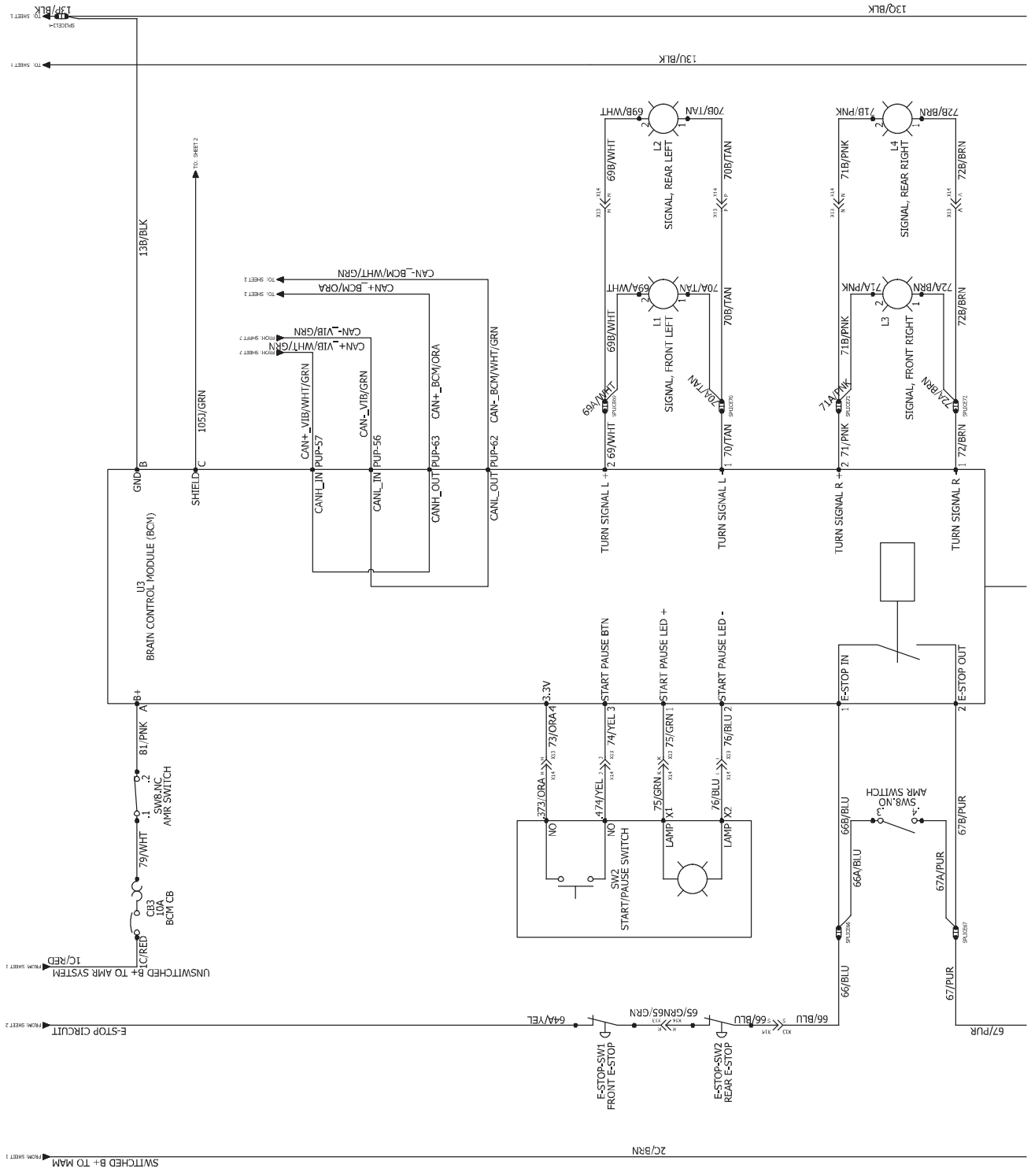

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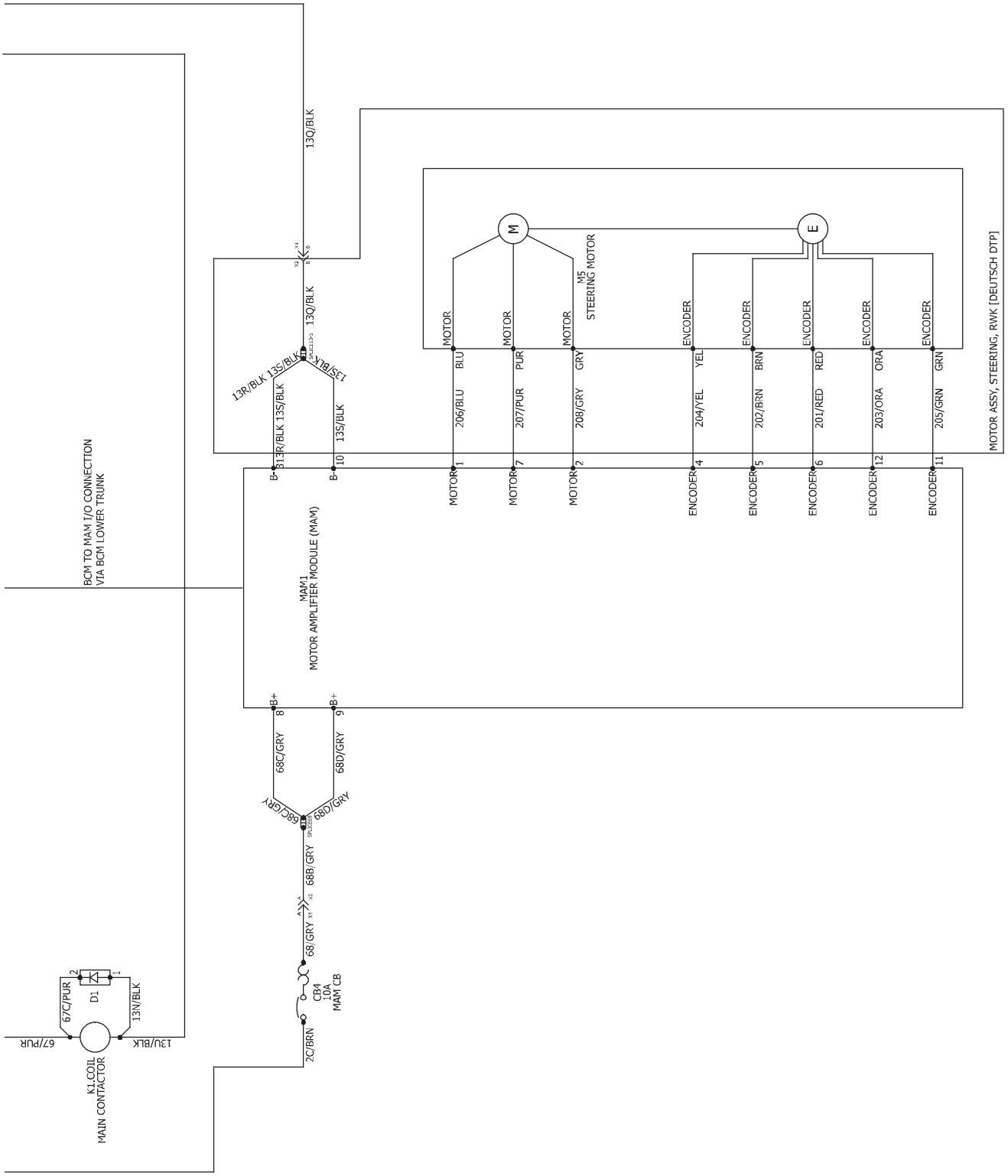


FASTENER TORQUE

SAE (STANDARD)

Thread Size	SAE Grade 1	SAE Grade 2 Carriage Bolts	Thread Cutting Thread Rolling	SAE Grade 5 Socket & Stainless Steel	SAE Grade 8	Headless Socket Set Screws	Square Head Set Screws	
4 (.112)	(5) - (6.5)					(4) - (6)		Inch Pounds
5 (.125)	(6) - (8)					(9) - (11)		
6 (.138)	(7) - (9)		(20) - (24)			(9) - (11)		
8 (.164)	(12) - (16)		(40) - (47)			(17) - (23)		
10 (.190)	(20) - (26)		(50) - (60)			(31) - (41)		
1/4 (.250)	4 - 5	5 - 6	7 - 10	7 - 10	10 - 13	6 - 8	17 - 19	Foot Pounds
5/16 (.312)	7 - 9	9 - 12	15 - 20	15 - 20	20 - 26	13 - 15	32 - 38	
3/8 (.375)	13 - 17	16 - 21		27 - 35	36 - 47	22 - 26	65 - 75	
7/16 (.438)	20 - 26	26 - 34		43 - 56	53 - 76	33 - 39	106 - 124	
1/2 (.500)	27 - 35	39 - 51		65 - 85	89 - 116	48 - 56	162 - 188	
5/8 (.625)		80 - 104		130 - 170	171 - 265		228 - 383	
3/4 (.750)		129 - 168		215 - 280	313 - 407		592 - 688	
1 (1.000)		258 - 335		500 - 650	757 - 984		1281 - 1489	

METRIC

Thread Size	4.8/5.6	8.8 Stainless Steel	10.9	12.9	Set Screws
M3	43 - 56 Ncm	99 - 128 Ncm	139 - 180 Ncm	166 - 215 Ncm	61 - 79 Ncm
M4	99 - 128 Ncm	223 - 290 Ncm	316 - 410 Ncm	381 - 495 Ncm	219 - 285 Ncm
M5	193 - 250 Ncm	443 - 575 Ncm	624 - 810 Ncm	747 - 970 Ncm	427 - 554 Ncm
M6	3.3 - 4.3 Nm	7.6 - 9.9 Nm	10.8 - 14 Nm	12.7 - 16.5 Nm	7.5 - 9.8 Nm
M8	8.1 - 10.5 Nm	18.5 - 24 Nm	26.2 - 34 Nm	31 - 40 Nm	18.3 - 23.7 Nm
M10	16 - 21 Nm	37 - 48 Nm	52 - 67 Nm	63 - 81 Nm	
M12	28 - 36 Nm	64 - 83 Nm	90 - 117 Nm	108 - 140 Nm	
M14	45 - 58 Nm	102 - 132 Nm	142 - 185 Nm	169 - 220 Nm	
M16	68 - 88 Nm	154 - 200 Nm	219 - 285 Nm	262 - 340 Nm	
M20	132 - 171 Nm	300 - 390 Nm	424 - 550 Nm	508 - 660 Nm	
M22	177 - 230 Nm	409 - 530 Nm	574 - 745 Nm	686 - 890 Nm	
M24	227 - 295 Nm	520 - 675 Nm	732 - 950 Nm	879 - 1140 Nm	

GENERAL MACHINE DIMENSIONS/CAPACITIES/ PERFORMANCE

GENERAL MACHINE DIMENSIONS / CAPABILITIES

Item	Dimension / Capacity
Length	1588 mm (62.5 in)
Height (to light)	1400 mm (55 in)
Width/frame	635 mm (25 in)
Width/machine with scrub head	750 mm (29.5 in)
Brush diameter	508 mm (20 in)
Scrubbing path width	500 mm (20 in)
Track	555 mm (21.8 in)
Wheel base	1006 mm (39.6 in)
Solution tank capacity	75L (20 gallons)
Recovery tank capacity	75L (20 gallons)
Demisting chamber	37.5L (9.9 gallons)
Weight/net less batteries	264 Kg (582 lb)
Weight/with standard battery package	385 Kg (850 lb)
GVWR	533 Kg (1175 lb)
Protection Grade	IPX3

Values determined as per IEC 60335-2-72	Measure
Sound pressure level LpA	66.07 dB(A)
Sound pressure uncertainty KpA	2.99 dB(A)
Sound power level LWA + Uncertainty KWA	85.97 dB(A)
Vibration - Hand-arm	<2.5 m/s^2
Vibration - Whole body	<0.5 m/s^2

GENERAL MACHINE PERFORMANCE

Item	Measure
Aisle turnaround (right)	1600 mm (63 in)
Aisle turnaround (left)	1702 mm (67 in)
Brush down pressure	28 Kg (62 lb) 41 Kg (90 lb)
Travel Speed Forward (maximum) - Manual Mode	6.0 Km/h (3.75 mph)
Travel Speed Forward (maximum) - Robotic Mode	N/A
Travel Speed Reverse - Manual Mode Only	4.0 Km/h (2.5 mph)
Maximum rated climb and descent angle with full tanks (Robotic Mode)	0%
Maximum ramp incline for scrubbing - (Robotic mode)	0%
Maximum ramp incline for transporting (GVWR - Manual mode only)	10.5% / 6°
Maximum ramp incline for loading – Empty (Manual mode only)	15.8% / 9°
Maximum ramp incline for scrubbing - (Manual mode)	7% / 4°
Maximum ambient temperature for machine operation	40° C (104° F)
Minimum temperature for operating machine scrubbing functions	2° C (36° F)

POWER TYPE

Type	Quantity	Volts	Ah Rating	Weight (each)
Batteries (heavy duty lead acid)	2	12	225@20 hr rate	58.1 kg (128 lb)
Batteries (Lithium-Ion)	2	24	90Ah	21kg (47 lb)

Type	Use	VDC	kW (hp)
Electric Motors	Scrub brush	24	0.65 kW (0.9 hp)
	Vacuum fan	24	0.46 kW (0.6 hp)
	Propelling	24	0.85 kW (1.1 hp)

Type	VDC	amp	Hz	Phase	VAC
Charger (Smart)	24	27.1	50/60	1	85-270

TIRES

Location	Type	Size
Front (1)	Solid	90 mm wide x 260 mm OD (3.5 in wide x 10 in OD)
Rear (2)	Solid	80 mm wide x 260 mm OD (3.0 in wide x 10 in OD)

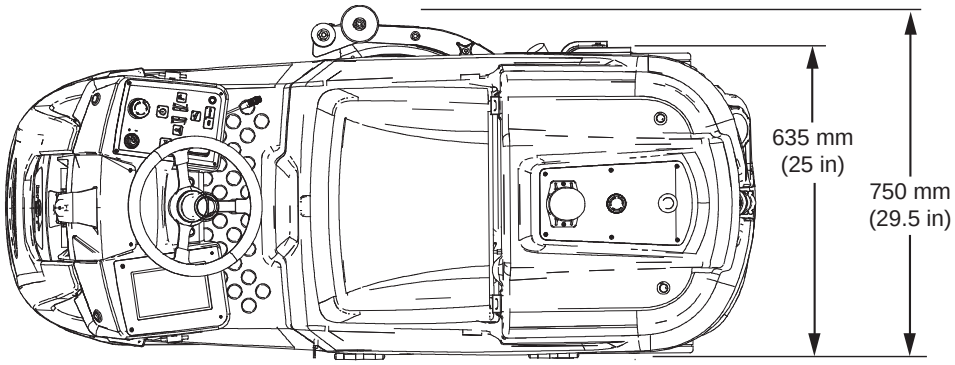
CONVENTIONAL SCRUBBING

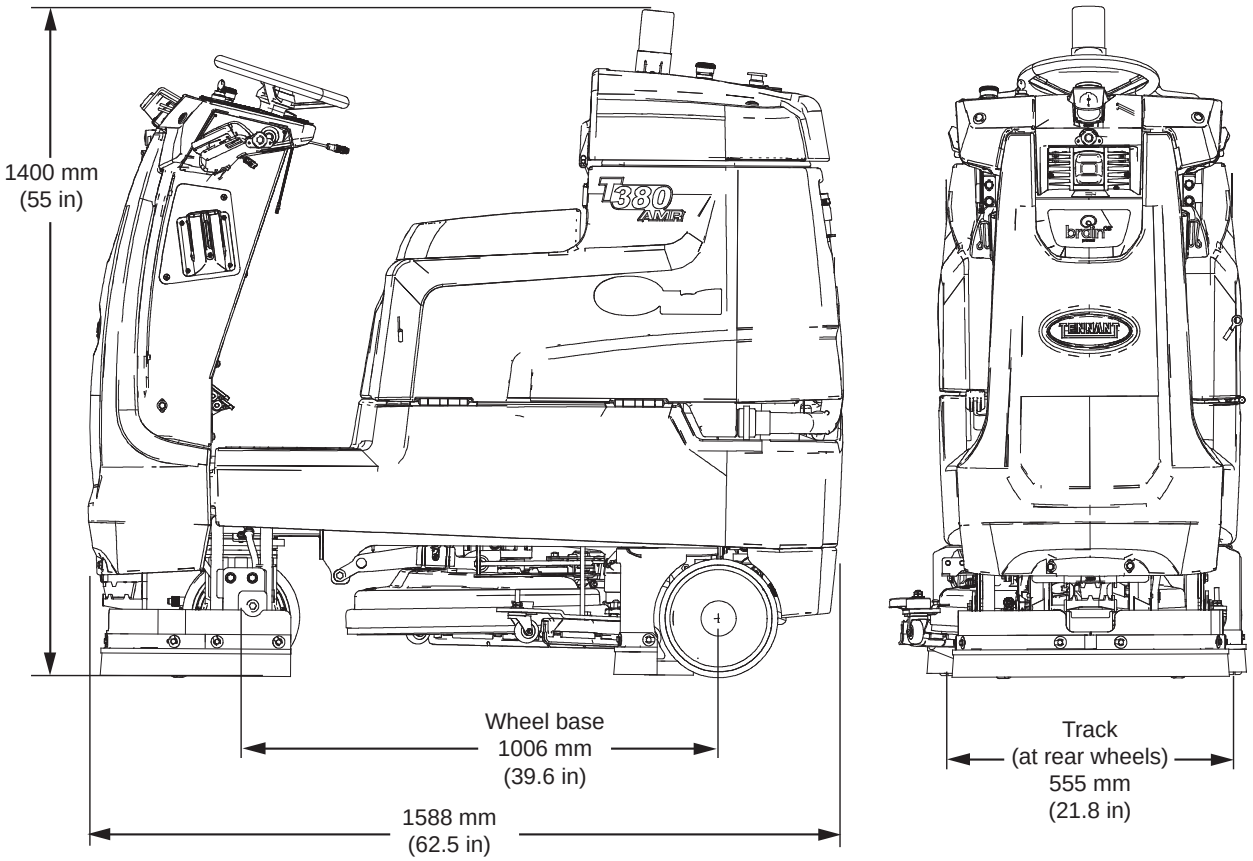
Item	Measure
Solution pump	Gravity N/A
Solution flow rate	Low: 0.15 gpm
	Medium: 0.35 gpm
	High: 0.50 gpm

***ec−H2O* SYSTEM**

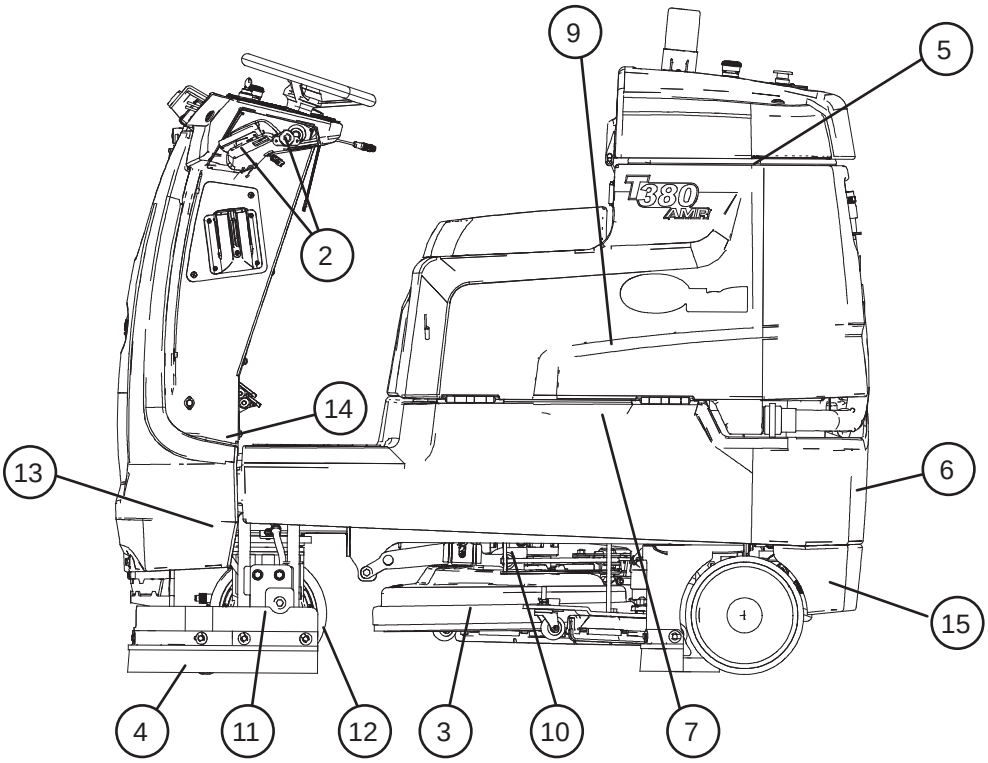
Item	Measure
Solution pump	24 Volt DC, 5A, 5.7 LPM (1.5 GPM) open flow, 70 psi bypass setting
Solution flow rate	Low: 0.12 gpm
	Medium: 0.25 gpm
	High: 0.35 gpm

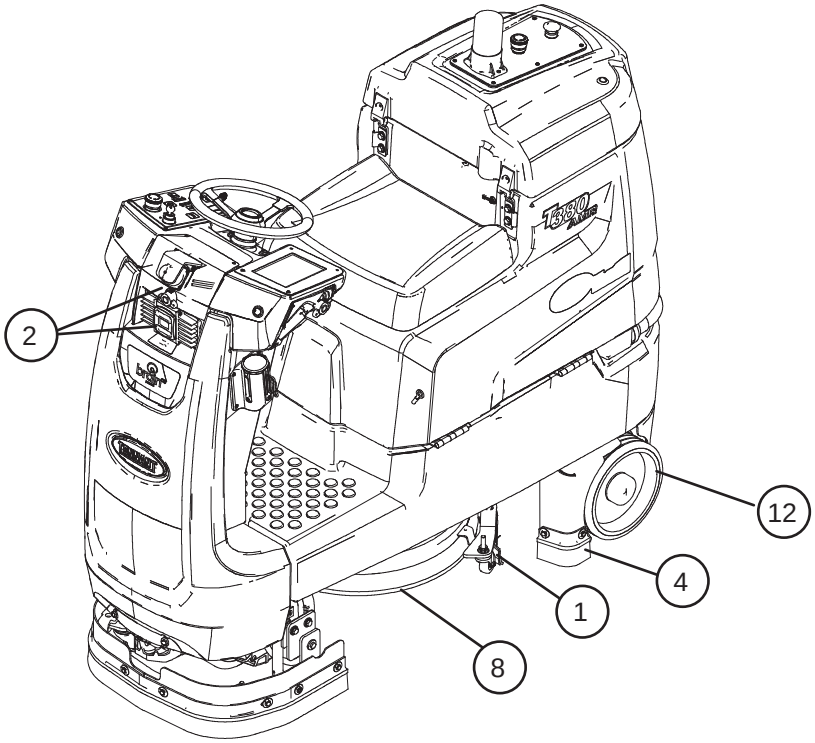
MACHINE DIMENSIONS





MAINTENANCE





MAINTENANCE CHART

The table below indicates the Person Responsible for each procedure.

O = Operator.
T = Trained Personnel.

Interval	Person Resp.	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	O	3	Pad	Check, flip or replace		1
	O	3	Scrub brush	Check for damage, wear, debris		1
	O	1	Squeegee	Check, flip or replace	-	3
				Check deflection and leveling	-	6
	O	8	Scrub head floor skirt	Check for damage and wear		1
	O	2	Front/side 2D and 3D sensors and upper/ lower LIDAR sensors	Check for damage. Clean with provided microfiber cloth	-	8
	O	4	Perimeter guards (left, right, and front)	Check for debris, damage, and wear	-	3
	O	5	Recovery tank	Clean tank, screen filter, basket, vacuum hose, and float sensor	-	5
	O	6	Solution tank	Drain and rinse as necessary	-	1
Weekly	O	7	Battery cells	Check electrolyte level	DW	18
	T	4	Front perimeter guard	Inspect adjustment plates for slipping. Adjust as necessary		1
50 Hours	O	5	Recovery tank lid seal	Check for wear and damage		1
	O	15	Solution tank in-line filter	Remove and clean	-	1
100 Hours	T	9	Vacuum fan seal and squeegee seal	Check for damage and wear	-	2
	O	7	Battery watering system (option)	Check hoses for damage and wear	-	All
200 Hours	T	7	Battery terminals and cables	Check and clean	-	12
	T	13	Steering gear chain	Lubricate, check tension, and check for damage and wear.	GL	1
	T	14	Steering u-joint	Lubricate and check for damage and wear.	GL	1
500 Hours	T	11	Propelling motor	Check carbon brushes **(Check every 100 hours after initial 500 hour check)**	-	1
	O	12	Tires	Check for damage and wear	-	3
750 Hours	T	9	Vacuum fan motor(s)	Replace carbon brushes	-	1
1250 Hours	T	10	Scrub brush motors	Replace carbon brushes	-	1

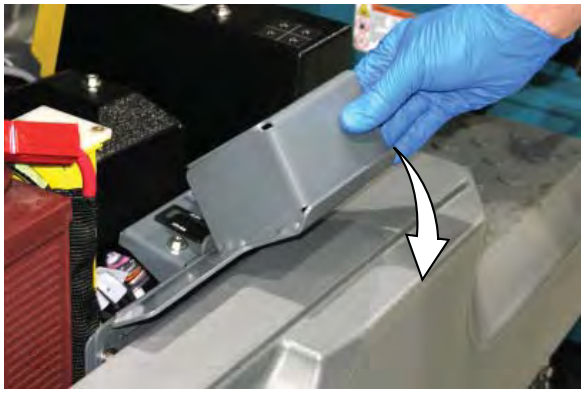
LUBRICANT/FLUID
DW Distilled water
GL SAE 90 weight gear lubricant

BATTERIES

The recovery tank/seat can be opened to two battery ventilation levels, depending on how much room is available to open the recovery tank/seat to allow the batteries to vent while charging. Use the recovery tank prop bracket in areas where there is not enough room to have the recovery tank/seat completely propped open with the recovery tank prop arm.

NOTE: Recovery tank must be emptied before it is propped open.

To engage the lower level, raise the recovery tank/seat, pull the recovery tank prop bracket out from the battery compartment and onto the edge of the battery compartment, and lower the recovery tank/seat onto the prop bracket. The recovery tank prop bracket holds the recovery tank/seat open enough to provide ventilation for charging the batteries.



To engage the higher level, raise the recovery tank/seat and engage the recovery tank prop arm. This level also provides adequate space to perform maintenance to components located inside the battery compartment.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

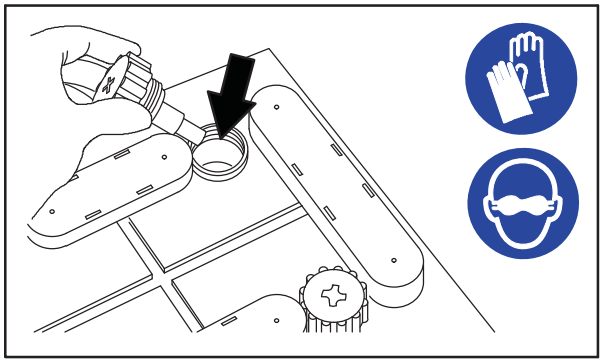
The lifetime of the batteries depends on their proper maintenance. To get the most life from the batteries;

- Do not charge the batteries more than once a day and only after running the machine for a minimum of 15 minutes.
- Do not leave the batteries partially discharged for long period of time.
- Only charge the batteries in a well-ventilated area to prevent gas build up. Charge batteries in areas with ambient temperatures 27°C (80°F) or less.
- Allow the charger to complete charging the batteries before re-using the machine.
- Maintain the proper electrolyte levels of flooded (wet) batteries by checking levels weekly.

CHECKING THE ELECTROLYTE LEVEL

The flooded (wet) lead-acid batteries require routine watering as described below. Check the battery electrolyte level weekly.

*NOTE: **Do Not** check the electrolyte level if the machine is equipped with a battery watering system.*



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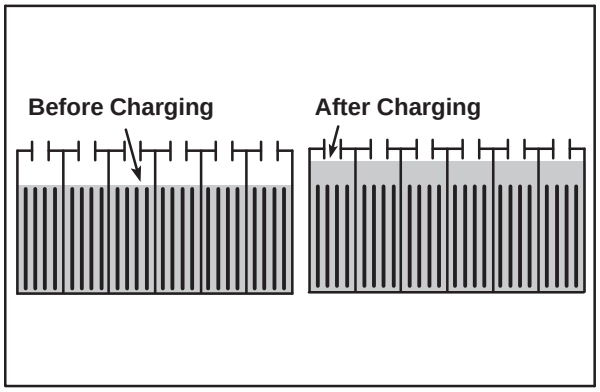
FOR SAFETY: When servicing machine, keep all metal objects off batteries. Avoid contact with battery acid.

The electrolyte level should be slightly above the battery plates as shown before charging. Add distilled water if low. DO NOT OVERFILL. The electrolyte will expand and may overflow when charging. After charging, distilled water can be added up to about 3 mm (0.12 in) below the sight tubes.



NOTE: Make sure the battery caps are in place while charging. There may be a sulfur smell after charging batteries. This is normal.

CHECKING CONNECTIONS / CLEANING

After every 200 hours of use check for loose battery connections and clean the surface of the batteries, including terminals and cable clamps, with a strong solution of baking soda and water. Replace any worn or damaged wires. Do not remove battery caps when cleaning batteries.

LITHIUM-ION BATTERY

The lithium−ion battery is a maintenance−free battery protected by a battery management system (BMS). To achieve the maximum battery life, carefully follow the instructions below:

– Lithium-Ion batteries must be charged prior to initial use.

– Carefully follow the Important Safety Instructions section in the manual when using the Lithium−ion Battery Model.

– Only use the lithium−ion battery charger supplied with machine.

– Charge battery pack in well−ventilated areas. For best charging performance, charge the battery pack in temperatures below 104°F/40°C and above 32°F/0°C. Battery pack may shut down and not take a charge in elevated or freezing temperatures.

– It is recommended to only recharge battery pack when discharge indicator level reaches the last bar. Do not store the machine for an extended period if battery is discharged to the last bar, the battery may further discharge to a level that is unrecoverable.

– Allow charge cycle to completely charge battery pack.

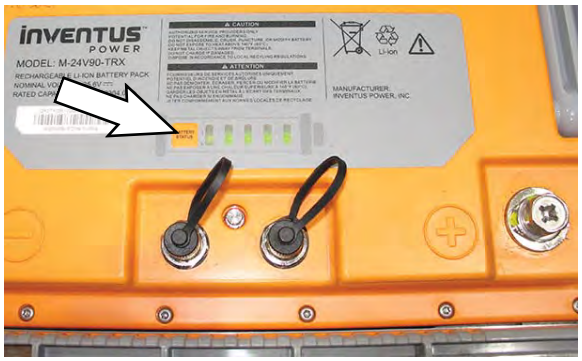
– Opportunity charging (i.e. partial charge cycle of a half hour or more) is only recommended if discharge level is below 80%.

– Do not operate machine in temperatures above 131°F / 55°C or below −4°F / −20°C. Machine may shutdown if exceed these temperatures.

– Contact Tennant Service for lithium−ion battery service and replacement.

BATTERY POWER BUTTON / BATTERY DISCHARGE INDICATOR

Each lithuim-ion battery contains a power button to turn off the battery power supply. The battery discharge indicator (BDI) display the current state of the battery.



To display the battery charge status or fault state (while the batteries are active), press and hold the power button of any battery for **one second**. When the batteries are fully charged, all five green indicators are lit. As the battery discharges, the indicator levels decreases. If the indicators flash red the battery is getting very low. If the indicators display solid red along with green, the battery has a fault. Contact Tennant Service to fix the fault.

LED Indicator Status	Battery State of Charge
	81-100%
	61-80%
	41-60%
	21-40%
	11-20%
	1-10%
	See CHECK LITHIUM BATTERY STATUS/FAULT CODES section of this manual

To turn off the battery power (while the batteries are active), press and hold the battery power button of any battery for **20 seconds**. The battery discharge indicators will turn off. Turning off one battery will shut down power to all connected batteries. Batteries should be shut down before any service is completed on the battery modules.

To turn on the battery power (when the batteries are shutdown), press and hold the power button on each battery for **5 seconds**. The battery discharge green indicators will illuminate when turned on.

CHARGING THE BATTERIES

The charging instructions in this manual are intended for the battery charger supplied with the machine. The use of other battery chargers that are not supplied and approved by Tennant are prohibited. Refer to the charger owners manual for additional information. Contact distributor or Tennant for battery charger recommendations.

FOR SAFETY: The use of incompatible battery chargers may damage battery packs and potentially cause a fire hazard.

IMPORTANT NOTICE: The battery charger is set to charge the battery type supplied with the machine.

1. Ensure recovery tank is empty.
2. Drive the machine to a well-ventilated area.
3. Park the machine on a flat, dry surface, turn off machine and remove key.
4. Open the recovery tank and prop the tank open to the level allowed by room available to raise the recovery tank/seat.

WARNING: Batteries emit hydrogen gas. Explosion or fire can result. Keep sparks and open flame away. Keep covers open when charging.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

5. Check the battery electrolyte level weekly before charging. For models equipped with the automatic battery watering system, check electrolyte the level indicators located on the battery covers. Add distilled water as needed.
6. Set the recovery tank to either level to allow adequate ventilation for the charging the batteries.
7. Connect the charger DC cord into the machine battery charge receptacle then plug the AC power supply cord into a properly grounded wall outlet. Refer to the off-board battery charger owners manual for operating instructions.

FOR SAFETY: Do not disconnect the off-board charger's DC cord from the machine's receptacle when the charger is operating. Arcing may result. If the charger must be interrupted during charging, disconnect the AC power supply cord first.

FOR SAFETY: Do not disconnect battery connections while machine is charging. Machine eklectrical damage may occur.

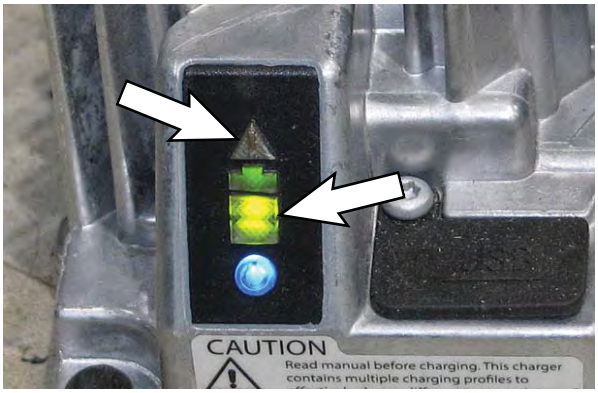
8. The charger will automatically begin charging and shut off when fully charged. The maximum charging cycle may take up to 6-12 hours depending on battery type.

*NOTE: **Do Not** disconnect battery cables while charger is plugged in, circuit board damage may result.*

9. After charging batteries unplug the AC power supply cord from the outlet before disconnecting the charger from the machine.
10. Disconnect the battery charger from the machine.
11. Lift the recovery tank, reposition the prop bracket back into the storage position inside the battery compartment or disengage the recovery tank prop arm, and lower the recovery tank.

BATTERY CHARGING STATUS

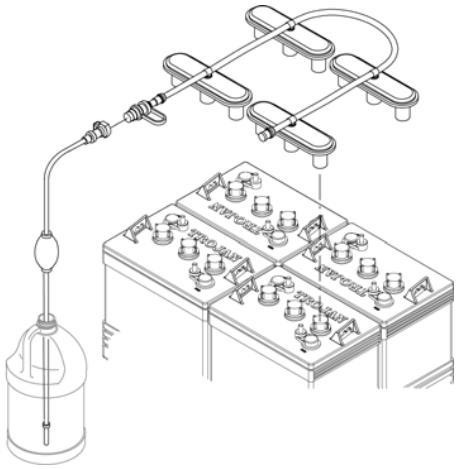
The table below shows the status of the battery charger.



LED Pattern	Description	Comments
LED is OFF	No AC Power Connected	Charger not plugged into the wall
LED flashes RED followed by AMBER for few seconds and Turns OFF (and stays OFF)	AC Power Connected to the charger but No Batteries are connected	Charger not plugged into the wall
Slow Green Blinking (1 second ON; 0.2 second OFF)	Charging but batteries are less than 80% State of Charge	Charger displays this LED pattern when first plugged into AC power then LED turns off
Fast GREEN Blinking (0.4 second ON; 0.1 second OFF)	Charging but batteries are greater than 80% State of Charge	Normal operation. Allow charger to finish charging
Solid GREEN	Charge Complete	Machine ready for use
Rapid AMBER flashing (0.5 second ON; 0.5 second OFF)	Issue with Battery Detected	Contact Service
Solid RED	Charger internal failure	Contact Service

HYDROLINK® BATTERY WATERING SYSTEM (Trojan® Battery OPTION)

The following instructions are for models equipped with the HydroLink battery watering system option.



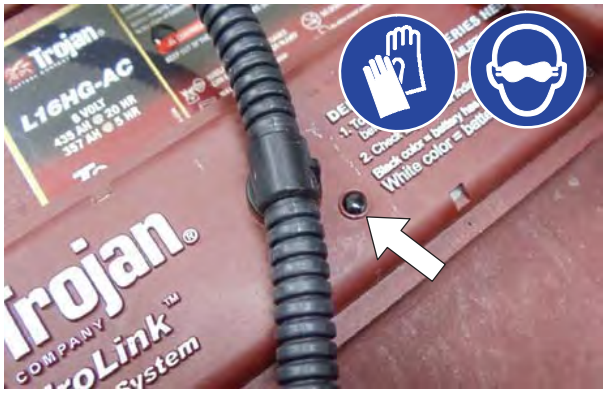
The optional HydroLink battery watering system provides a safe and easy way to maintain the proper electrolyte levels in the batteries. It is designed exclusively for Trojan flooded (wet) lead-acid batteries.

FOR SAFETY: When servicing machine, wear personal protection equipment as needed. Avoid contact with battery acid.

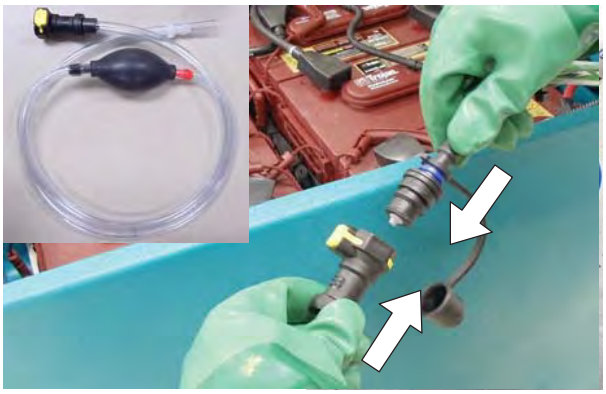
Before using the battery watering system, and after every 100 hours, check hoses and connections for damage or wear.

1. Fully charge batteries prior to using the battery watering system. Do not add water to batteries before charging, the electrolyte level will expand and may overflow when charging.

2. After charging batteries, check the battery electrolyte level indicators located on the battery covers. If the level indicators are white add water as described in the following instructions. If the level indicators are black the electrolyte is at the correct level, no water is required.

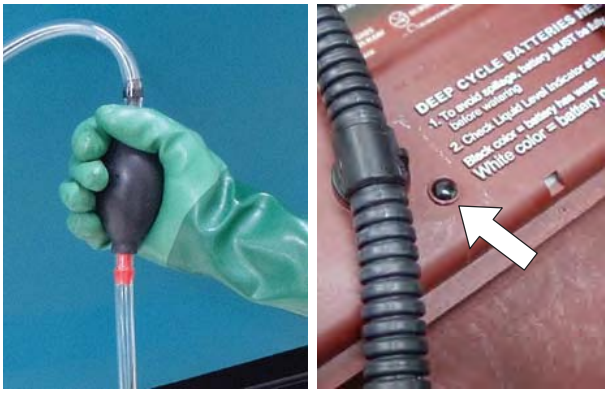


3. Locate the battery fill hose coupler inside the battery compartment. Remove the dust cap and connect the hand pump hose.



4. Submerge the other end of the hand pump hose into a bottle of distilled water.

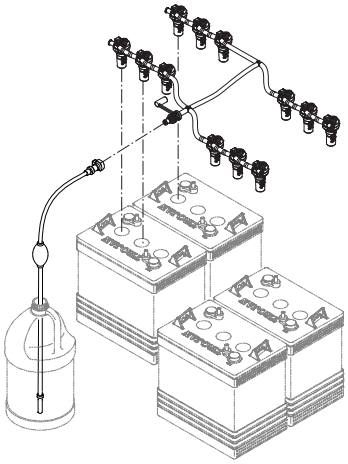
5. Squeeze the bulb on the hand pump hose until firm. The level indicators will turn black when full.



6. After adding water, replace the dust cap on the battery fill hose and store the hand pump hose inside the machine's battery compartment for future use.

MANUAL BATTERY WATERING SYSTEM (Trojan® Battery OPTION)

The following instructions are for models equipped with the manual battery watering system option.



The optional manual battery watering system provides a safe and easy way to maintain the proper electrolyte levels in your batteries. It is designed exclusively for Trojan flooded (wet) lead-acid batteries.

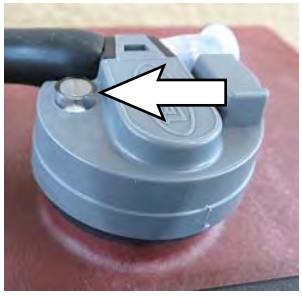
FOR SAFETY: When servicing machine, wear personal protection equipment as needed. Avoid contact with battery acid.

Before using the battery watering system check hoses and connections for damage or wear.

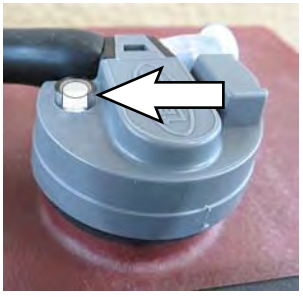
1. Fully charge batteries prior to using the battery watering system. Do not add water to batteries before charging, the electrolyte level will expand and may overflow when charging.

2. After charging batteries, check the battery electrolyte level indicators located on the battery covers.

3. If the level indicator has a low white float add water as described in the following instructions.

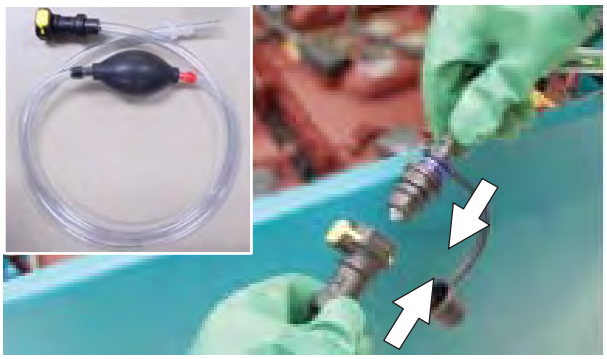


Low Float = Add Water



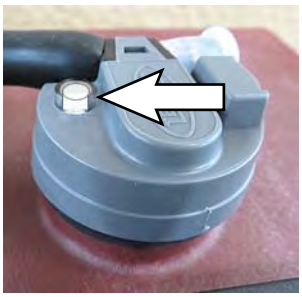
High Float = Full

4. Locate the battery fill hose coupler inside the battery compartment. Remove the dust cap and connect the hand pump hose.



5. Submerge the other end of the hand pump hose into a bottle of distilled water

6. Squeeze the bulb on the hand pump hose until firm. The white float will rise when full.



High Float = Full

7. After adding water, replace the dust cap on the battery fill hose and store the hand pump hose inside the machine's battery compartment for future use.

CIRCUIT BREAKERS AND FUSES

CIRCUIT BREAKERS

Circuit breakers are resettable electrical circuit protection devices that stop the flow of current in the event of a circuit overload. Once a circuit breaker is tripped, allow breaker to cool and then press the reset button to manually reset the breaker.

If the overload that caused the circuit breaker to trip is still there, the circuit breaker will continue to stop current flow until the problem is corrected.

The circuit breakers are located inside the battery compartment next to the hour meter.

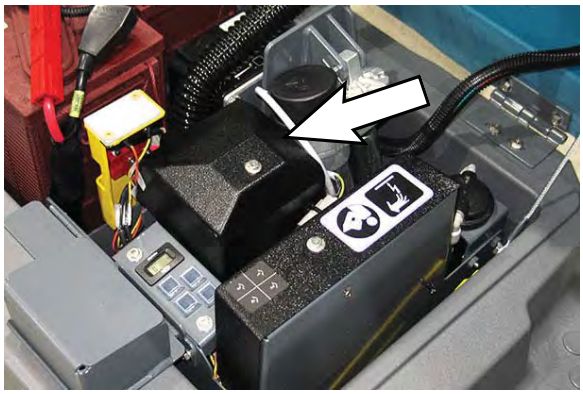
The chart shows the circuit breakers and the electrical components they protect.

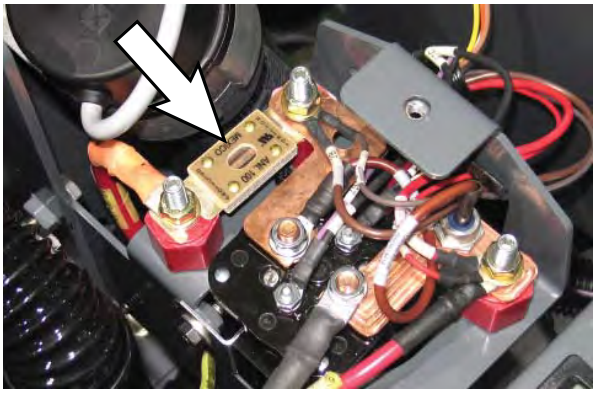
Circuit Breaker	Rating	Circuit Protected
CB1	4 A	Instrument panel - power
CB2	4 A	Accessories
CB3	20 A	AMR system
CB4	10 A	Brain module

FUSES

The fuse is a one-time protection device designed to stop the flow of current in the event of a circuit overload. The 100 A fuse is located in the electrical box near the scrub head actuator. The fuse protects the machine controller.

NOTE: Always replace the fuse with a fuse of the same amperage.





ELECTRIC MOTORS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Replace or check the motor carbon brushes as indicated. Contact trained personnel to check or replace carbon brushes.

Carbon Brush Replacement/ Check	Hours
Vacuum motor (replace)	750
Propel motor (check)	500
Brush motor (replace)	1250

CAMERAS AND SENSORS

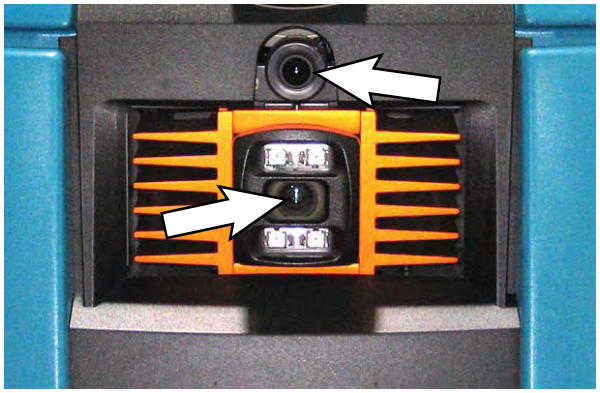
FRONT AND SIDE 2D AND 3D CAMERAS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

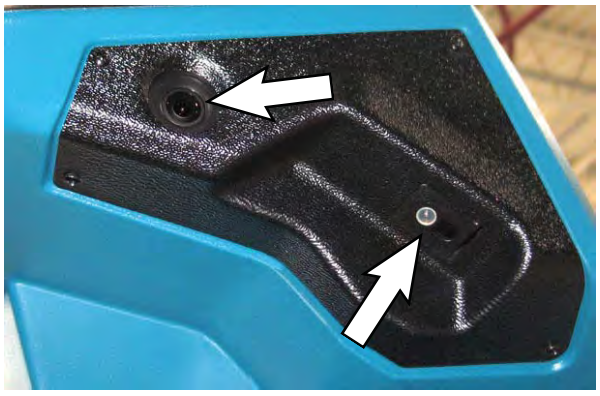
Check the front and side 2D and 3D cameras for dirt, dust, smudges, and damage daily (or before each robotic run). Debris, streaks, or smudges could deliver false environmental information to the machine.

Cleaning camera lenses should only be done with microfiber cleaning cloths designed for sensitive optical surfaces (one is included with the home location markers). In extreme cases, a lens cleaning solution formulated for optical polycarbonate lenses may be used. Do not spray camera lenses with solution. If a lens cleaning solution is required, wet the cleaning cloth sparingly - do not spray cleaning solution onto the camera unit.

NOTE: Do not scratch or damage the 2D or 3D camera lenses. Robotic machine performance could be adversely affected if camera lenses are scratched or damaged.



Side 2D and 3D cameras are located on each side of the machine.



UPPER AND LOWER LIDAR SENSORS

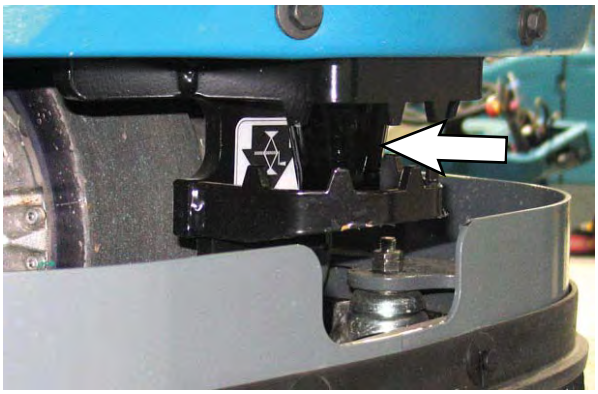
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Check the upper and lower LIDAR sensors for dirt, dust, smudges, and damage daily (or before each robotic run). Debris, streaks, or smudges could deliver false environmental information to the machine.

Cleaning LIDAR sensors should only be done with microfiber cleaning cloths designed for sensitive optical surfaces (one is included with the home location markers). In extreme cases, a lens cleaning solution formulated for optical polycarbonate lenses may be used. Do not spray LIDAR sensors with solution. If a lens cleaning solution is required, wet the cleaning cloth sparingly - do not spray cleaning solution onto the LIDAR sensors.

NOTE: Do not scratch or damage the upper or lower LIDAR sensor surfaces. Robotic machine performance could be adversely affected if sensor surfaces are scratched or damaged.

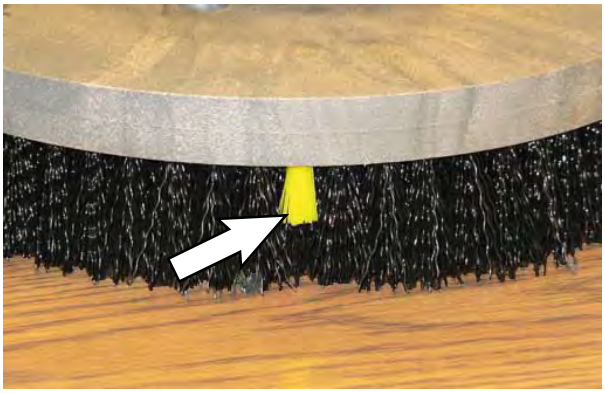
NOTE: Due to the lower LIDAR sensor being located near the cleaning surface, pay particular attention to ensure the front, side, back, and bottom surfaces are completely clear of all dirt, smudges, and/or other debris. Use a flashlight to inspect these sensor surfaces and ensure they are thoroughly cleaned.



SCRUB BRUSHES AND PADS

Check scrub brushes daily for wire or string tangled around the brush or brush drive hub. Also check brushes for damage and wear.

Replace the pads when they no longer clean effectively. Replaces the brushes when they no longer clean effectively or when the bristles are worn to the yellow indicator.



Cleaning pads must be placed on pad drivers before they are ready to use. The cleaning pad is held in place by a pad holder.

Cleaning pads need to be cleaned immediately after use with soap and water. Do not wash the pads with a pressure washer. Hang pads, or lie pads flat to dry.

NOTE: Always replace brushes and pads in sets. Otherwise one brush or pad will clean more aggressively than the other.

REPLACING THE BRUSH OR PAD DRIVER

1. Stop machine on a level surface. Make sure the scrub head is in the raised position.
2. Turn the machine *ON/OFF key switch* off.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. Pull the brush release handle to release the brush from the scrub head.

4. Remove the brush/pad driver from under the scrub head.

5. Push the new brush or pad driver under the scrub head and lift the brush or pad driver until the magnet secures the brush or pad to the drive hub.

WARNING: Magnetic Field Hazard. Magnetic pad driver/brush can be harmful to those with pacemakers or medical implants.

6. Ensure the brush or pad driver is securely mounted on the brush drive hub.

7. Ensure the scrub head skirt is properly positioned on the scrub head.

REPLACING THE DISK PAD

1. Remove the pad driver from the machine.
2. Squeeze the spring clip together to remove the center disk.

3. Flip or replace the scrub pad, center the scrub pad on the pad driver. Then reinstall the center disk to secure the pad in place on the pad driver.

4. Reinsert the pad driver into the machine.

ec-H2O SYSTEM

ec-H2O WATER CONDITIONING CARTRIDGE REPLACEMENT

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

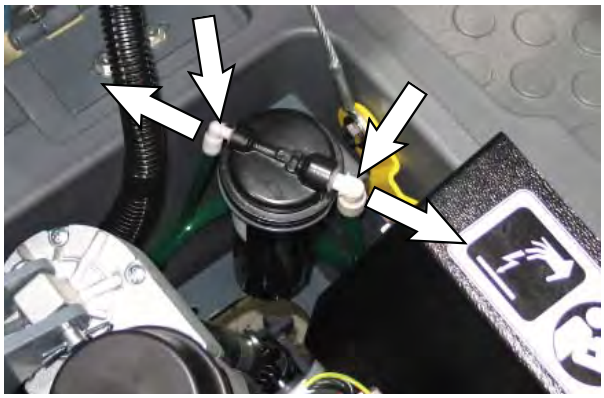
The water conditioning cartridge is required to be replaced when it reaches its maximum water usage or expiration time of when the cartridge was activated, which ever comes first. The *ec-H2O* system indicator light will blink green/red when it is time to replace cartridge.

Depending on machine usage, on average, a new cartridge can last anywhere from 12 months for heavy machine usage to 24 months for light machine usage.

NOTE: During first time use and after replacing the water conditioning cartridge, the ec-H2O system will automatically override the selected solution flow rate for up to 75 minutes.

1. Lift the recovery tank/seat open and engage prop arm to access the ec-H2O cartridge.

2. Disconnect the two hose connectors from cartridge by pressing the gray collars inward and pulling the connectors outward. Lift cartridge to remove.

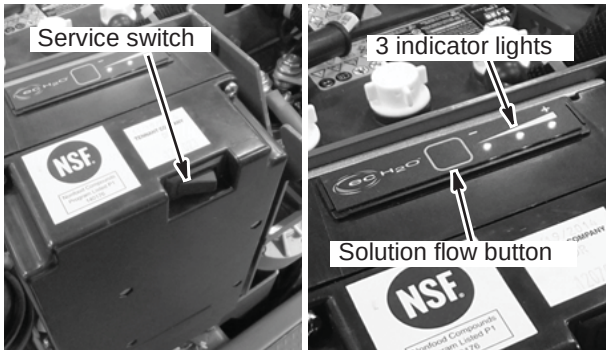


3. Fill in the installation date on the new cartridge label.

4. Install the new cartridge and reconnect the two hoses. Make sure the hose connectors are fully inserted into new cartridge.

5. Reset timer for new cartridge.

   Carefully read and understand all steps first before performing procedure.
   a. Turn the *ON/OFF key switch* on.
   b. Press and hold the service switch, located on the *ec-H2O* module, for 10 seconds. After releasing service switch, the three solution flow indicator lights will begin to (ripple) move back and forth.
   c. Within 5 seconds after releasing the service switch, while the three indicator lights are moving back and forth, quickly press and release the solution flow button located on *ec-H2O* module.
   The three indicator lights will then blink three times to indicate timer has been reset. Repeat process if the three indicator lights do not blink three times.



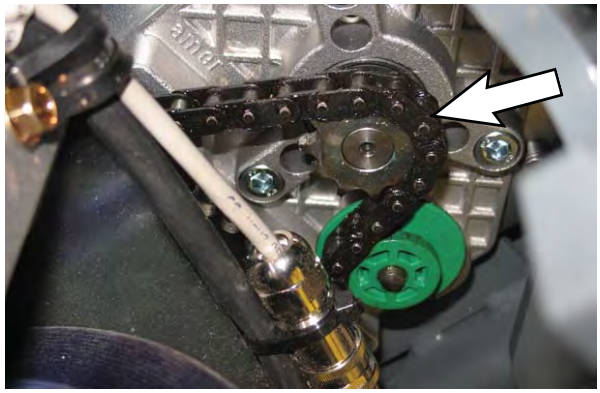
7. Lower the recovery tank.

LUBRICATION

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

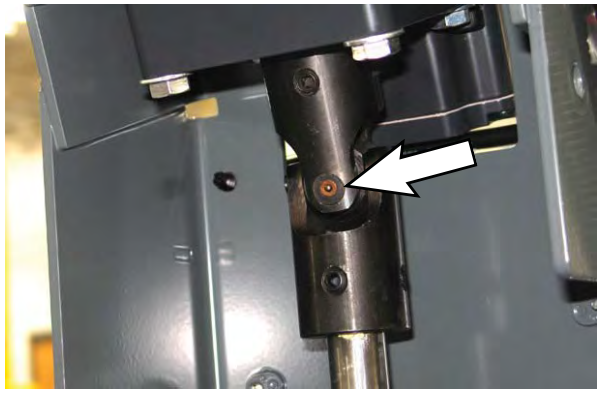
STEERING GEAR CHAIN

The steering gear chain is located directly above the front tire. Check for damage or wear and lubricate the steering gear chain after every 200 hours.



STEERING U-JOINT

The steering u-joint is located directly below the steering motor. Check for damage or wear and lubricate the steering u-joint after every 200 hours.



SQUEEGEE BLADES

Check the squeegee blades for damage and wear daily. When the blades become worn, rotate the blades end-for-end or top-to-bottom to a new wiping edge. Replace blades when all edges are worn.

Check the deflection of the squeegee blades daily or when scrubbing a different type of surface. Check the leveling of the rear squeegee every 50 hours of operation.

The rear squeegee assembly can be removed from the squeegee pivot to prevent damage during transport of the machine.

REPLACING (OR ROTATING) THE SQUEEGEE BLADES

1. Stop machine on a level surface. Make sure the scrub head is in the raised position.
2. Turn the machine ON/OFF key switch off.

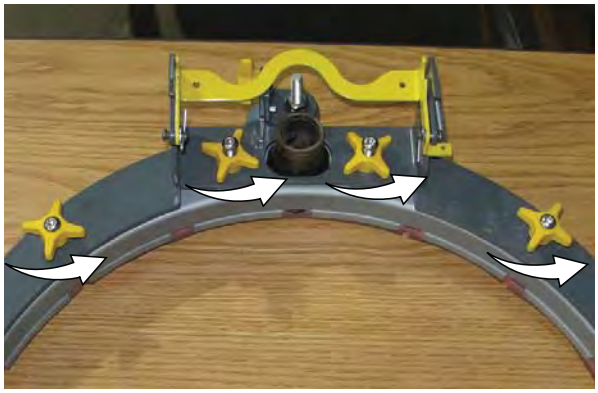
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. Rotate the squeegee assembly to the right side of the machine and loosen the hook-and-loop fastener securing the vacuum hose to the squeegee assembly.

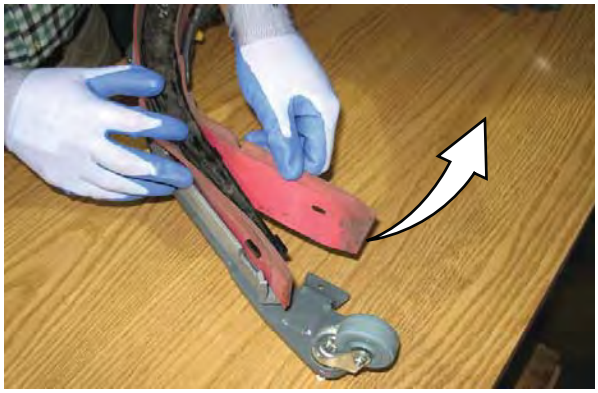
4. Disconnect the vacuum hose from the squeegee assembly.

5. Squeeze the squeegee retainer lever and remove the squeegee assembly from the machine.

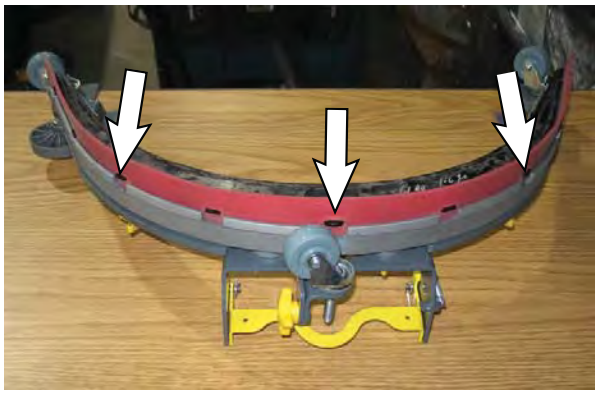
6. Fully loosen the four knobs on squeegee assembly. This will separate the spring loaded blade retainer from squeegee frame.



7. Remove worn blade(s) from the blade retainer.

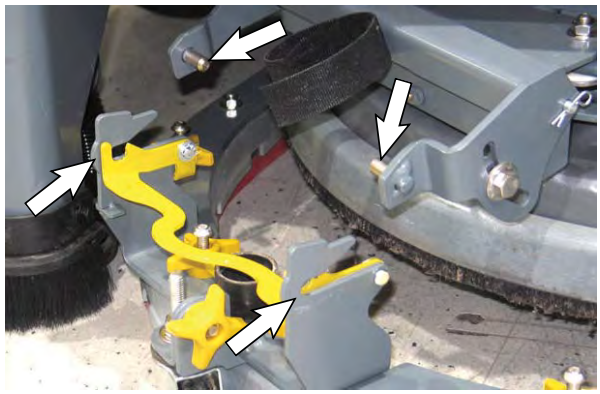


8. Rotate the rear blade(s) to a new wiping edge and reinstall blade(s). Make sure to align the slots in the blade(s) with retainer tabs.

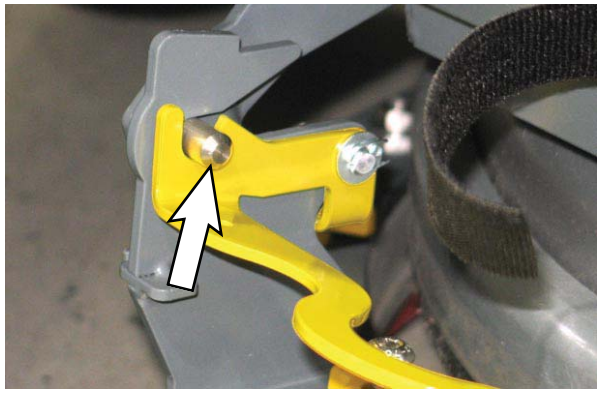


9. Squeeze the squeegee frame and blade retainer together and re-tighten the four knobs.

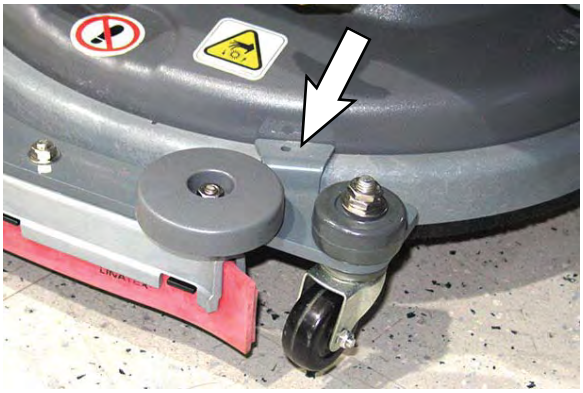
10. Align the squeegee carriage pins into the squeegee assembly bracket.



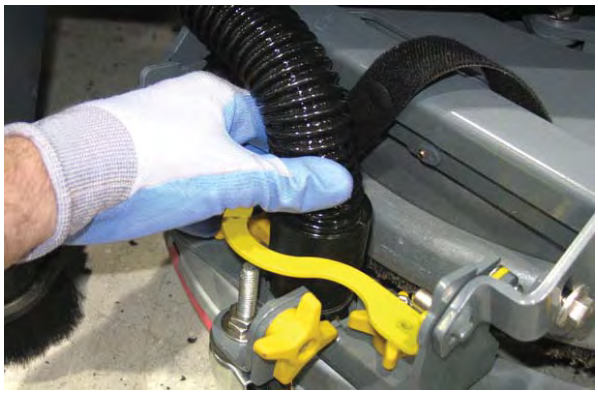
11. Slide the squeegee assembly onto the squeegee carriage until both squeegee carriage pins are secured in the bracket.



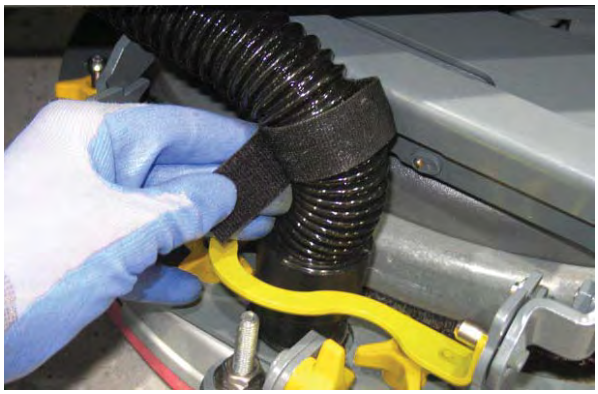
12. Be sure both squeegee tabs are positioned above the scrub head skirt.



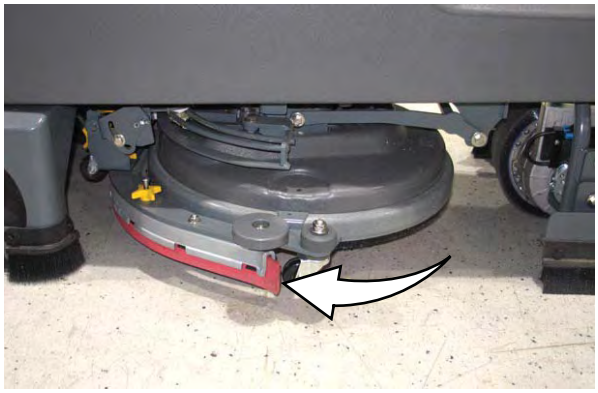
13. Connect the vacuum hose to the squeegee assembly.



14. Use the hook-and-loop fastener to secure the vacuum hose to the squeegee assembly.



15. Rotate and center the squeegee assembly underneath the machine.

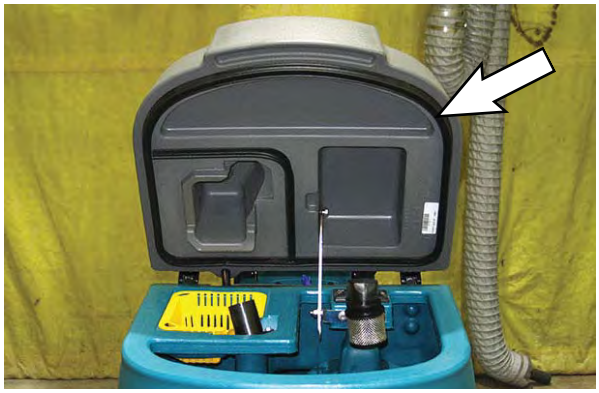


SKIRTS AND SEALS

RECOVERY TANK SEAL

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

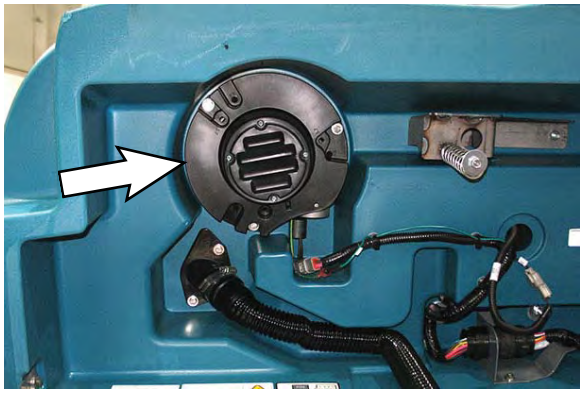
The recovery tank seal is located on the bottom of the recovery tank cover. Check the seal for damage and wear after every 50 hours of operation.



VACUUM FAN SEAL

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

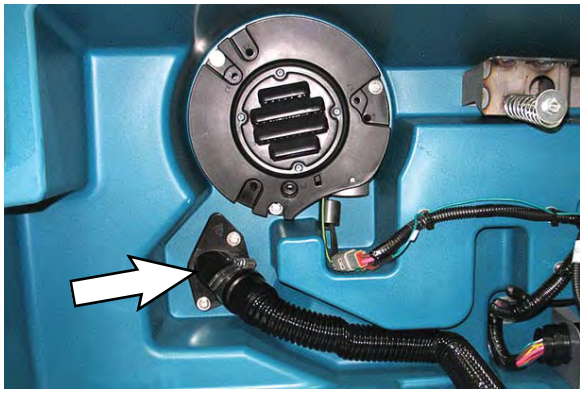
Check the vacuum fan seal for damage and wear after every 100 hours of operation.



SQUEEGEE SEAL

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Check the squeegee seal for damage and wear after every 100 hours of operation.

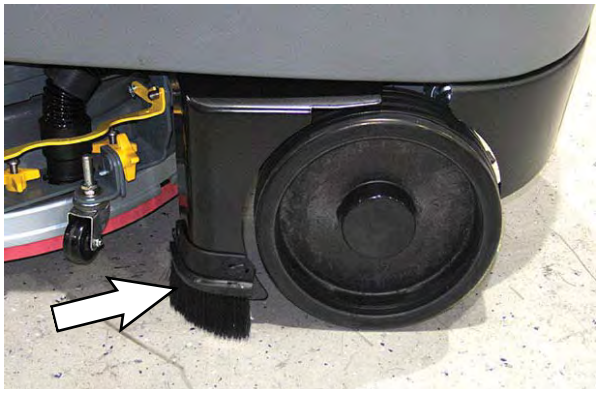


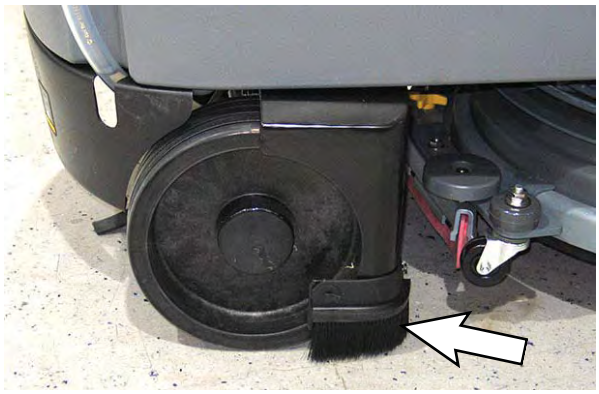
PERIMETER GUARDS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Check perimeter guard bristles for debris, damage, and wear daily. The bristles should lightly touch the floor. Replace damaged and/or worn bristle assemblies.

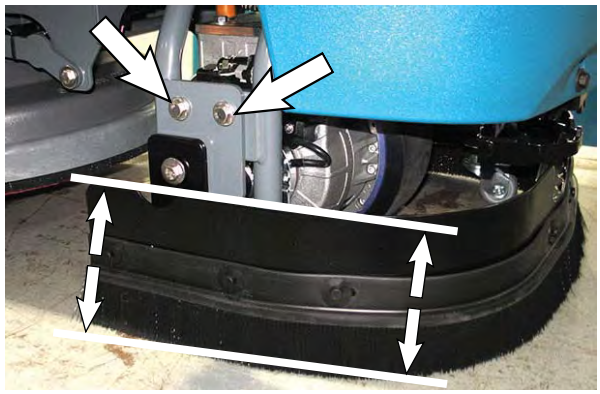
Left and right perimeter guards.

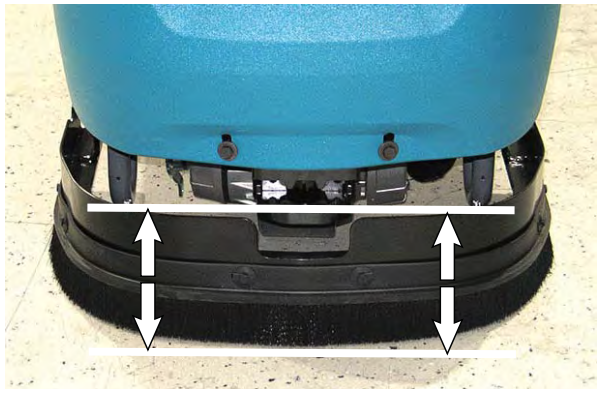




Front perimeter guard.

Inspect front perimeter guard adjustment plates located on both sides of the perimeter guard for slipping weekly. The entire top edge of the front perimeter guard must be parallel with the floor. Adjust the adjustment plates as necessary.

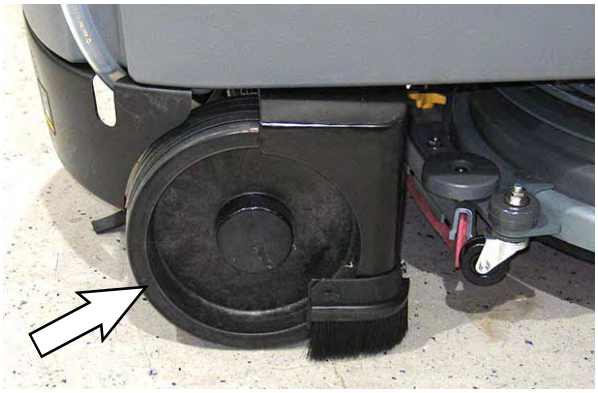




TIRES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

The machine has three solid rubber tires: one tire is front and two are in the rear. Check the tires for damage and wear after every 500 hours of operation.



PUSHING, TOWING, AND TRANSPORTING THE MACHINE

PUSHING OR TOWING THE MACHINE

If the machine becomes disabled, it can be pushed from the front or rear, but only tow it from the front.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Before attempting to push or tow the machine, disengage the brake as described below.

To disengage the brake, insert the tip of a small screw driver between the brake release lever and the body of the encoder.

Only push or tow the machine for a very short distance and do not exceed 3.2 kp/h (2 mph). It is NOT intended to be pushed or towed for a long distance or at a high speed.

*NOTE: **Do** **Not** push or tow machine for a long distance or damage may occur to the propelling system.*

Immediately after pushing the machine, remove the screw driver from between the brake release lever and the body of the encoder. NEVER operate the machine with the parking brake disabled.

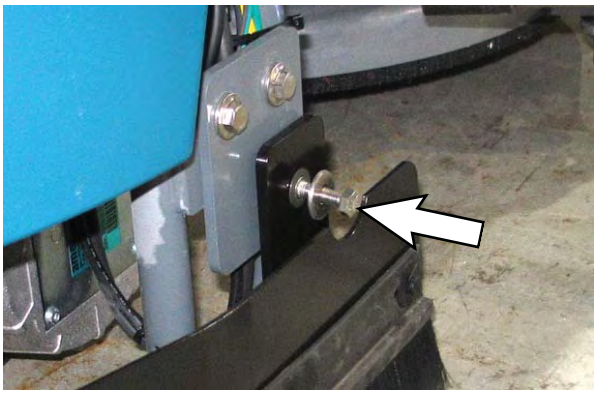
FOR SAFETY: Do not operate machine with the brake disabled.

TRANSPORTING THE MACHINE

When transporting the machine by trailer or truck, be certain to follow the tie-down procedure below:

FOR SAFETY: When loading/unloading machine onto/off truck or trailer, drain tanks before loading machine.

1. Raise the squeegee and scrub head.
2. Remove the hardware securing the front perimeter guard from the front perimeter guard brackets and remove the front perimeter guard from the machine.

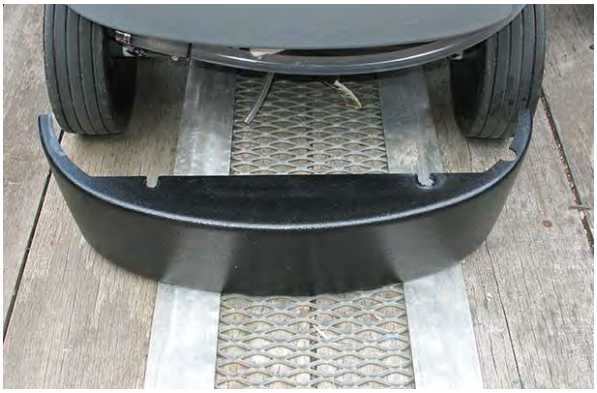


FOR SAFETY: When loading/unloading machine onto/off truck or trailer, use ramp, truck or trailer that will support the weight of the machine and operator.

FOR SAFETY: When loading/unloading machine onto/off truck or trailer, do not load/unload on ramp inclines that exceed 15.8% / 9° grade.

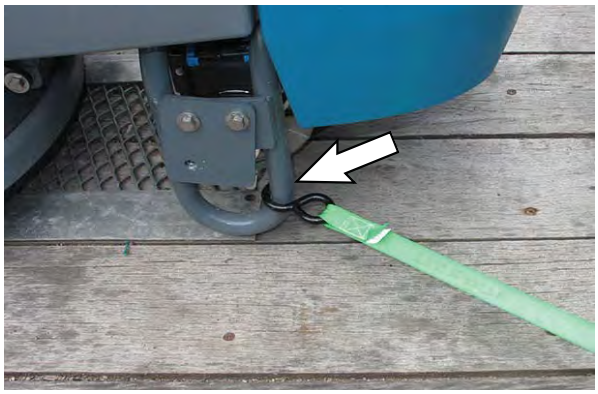
NOTE: The machine ability to climb a ramp is affected by tire wear, ramp surface, weather conditions, and other factors. Trailering should only be performed by personnel trained on how to safely load a machine.

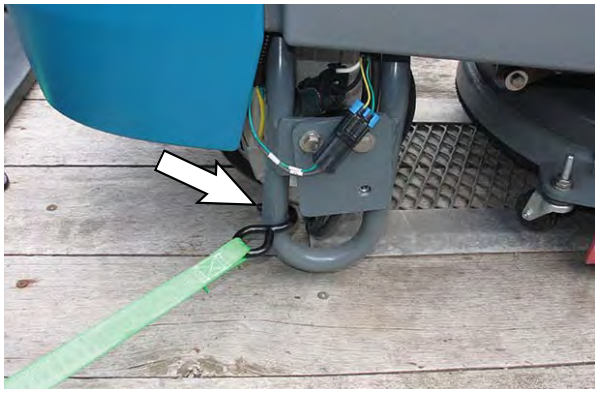
3. Drive the machine onto the trailer or truck. Position the machine so the weight of the machine is safely distributed and can be safely strapped down to the trailer or truck.
4. Lower the scrub head and squeegee after the machine is positioned on the trailer or truck.
5. Turn off the machine.
6. Place a block behind each wheel to prevent the machine from rolling.
7. Remove the lower rear shroud from the machine.

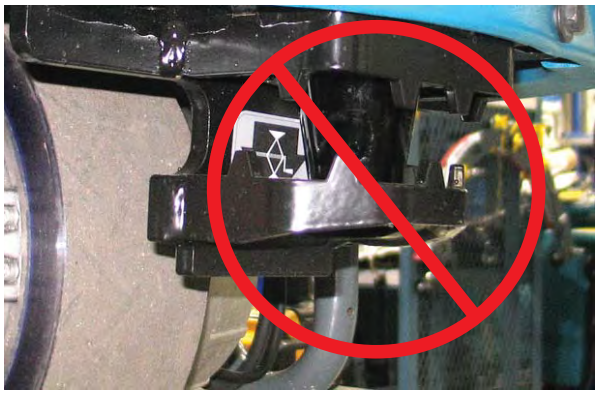


8. Hook the tie-down straps to the stabilizer arms and then secure the tie-downs to the trailer or truck to prevent the machine from tipping.

   Do Not wrap the tie-down straps around the lower LIDAR sensor or route the tie-down straps over the front of the LIDAR sensor.



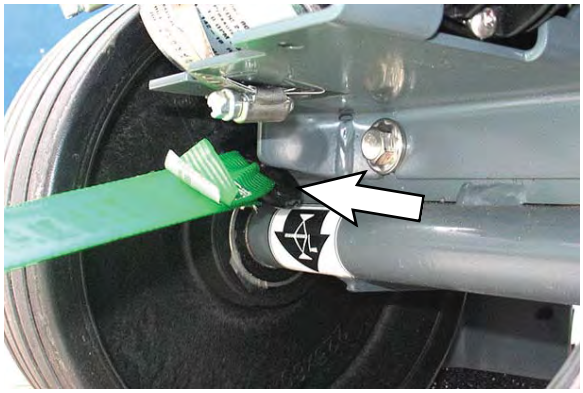




NOTE: It may be necessary to install tie-down brackets to the floor of the trailer or truck.

FOR SAFETY: When loading/unloading machine onto/off truck or trailer, use tie-down straps to secure machine.

9. Hook the tie-down straps to the frame of the machine and then secure the tie-downs to the trailer or truck to prevent the machine from tipping.



10. Ensure all tie-down straps are fully tightened and machine is completely secure on the trailer or truck.

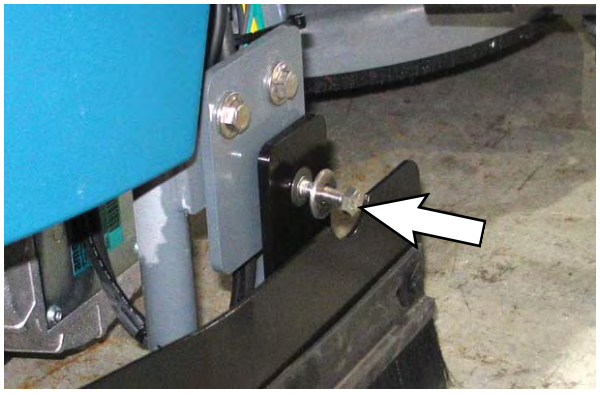
11. Stow/secure all parts removed from the machine in a safe place where they will not be lost or damaged.

JACKING UP THE MACHINE

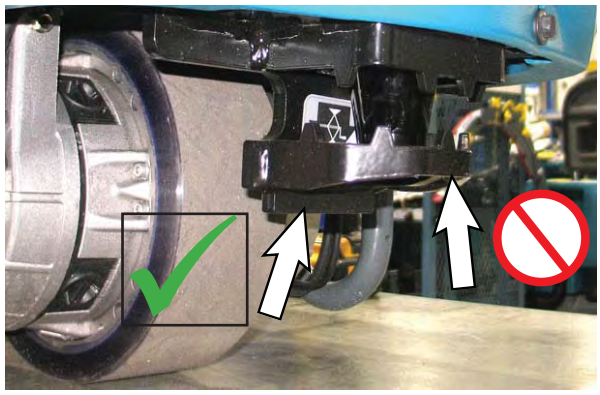
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Empty the recovery and solution tanks before jacking the machine.

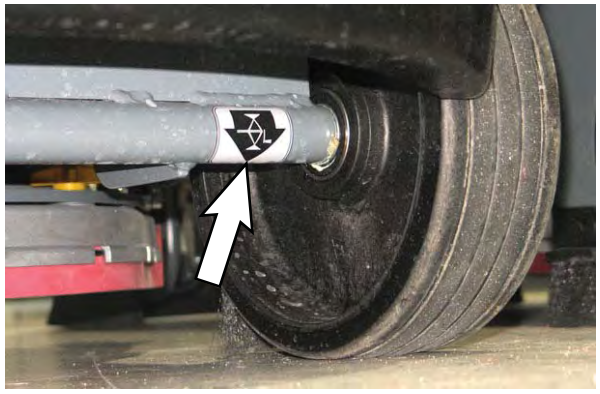
Remove the front perimeter guard from the front perimeter guard brackets located at the front of the machine before jacking up the front end of the machine.



The jacking location at the front of the machine is located on the back of the LIDAR bracket. **Do Not** position the jack or jack stand at the front of the LIDAR bracket.



Rear jacking locations are located on both sides of the machine at the axles.



FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Block machine up with jack stands.

STORAGE INFORMATION

The following steps should be taken when storing the machine for extended periods of time.

1. Drain and clean the solution and recovery tanks. Open the recovery tank cover to promote air circulation.
2. Charge the batteries before storing machine to prolong the life of the batteries. Recharge flooded batteries once a month. Recharge Lithium-ion batteries stored at approximately 77°F/25°C once a year or 113°F/45°C once every two years.
3. Disconnect batteries before storing.
4. Lithium-ion batteries: Turn off battery power with the battery power button.
5. Park the machine in a cool, dry area. Do not expose the machine to rain. Store indoors.

FREEZE PROTECTION

FOR SAFETY: When storing Lithium-ion Battery model, do not expose battery to temperatures below -4°F/-20°C, above 104°F/40°C.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Drain the solution tank and recovery tank of all water.
2. Pour 2 gallons (8 liters) of full strength Propylene Glycol Based/Recreational Vehicle (RV) antifreeze into the solution tank. Do not dilute.

FOR SAFETY: Avoid eye contact with antifreeze. Wear safety glasses.

3. Turn the machine power on and operate the solution flow system. Turn the machine off when the antifreeze appears at the scrub head.

Continue with the freeze protection procedure if machine is equipped with the *ec-H2O* system.

***ec-H2O* MODELS**

Operate machine in the *ec-H2O* mode to cycle antifreeze through *ec-H2O* system.

After storing machine in freezing temperatures, drain any remaining antifreeze from the solution tank. Add clean water to solution tank and operate the machine to flush system.

TROUBLESHOOTING

TROUBLESHOOTING/DIAGNOSTICS

INITIAL TROUBLESHOOTING MATRIX

Use the Initial Troubleshooting Matrix to conduct preliminary troubleshooting. Some errors may be caused by a blocked vacuum hose or debris preventing the actuator from moving in the complete range of motion. Always check these items before conducting more labor intensive troubleshooting requiring the machine to be disassembled and the AMR SERVICE CONNECTION diagnostics software application to be used.

Function	Enabled	Disabled
Propel	• Key ON (I) • Battery voltage > 18V (all batteries) • Operator in seat • Propel pedal pressed • E-Stop button(s) not engaged • No faults on propel motor output	• Key OFF (O) • Battery voltage < 18V (all batteries) • Operator not in seat • Propel pedal not pressed • E-Stop button(s) engaged • Faults on propel motor output
Vacuum Fan	• Key ON (I) • Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* or water-pickup enabled • Directional switch set to forward • Vacuum fan continues to operate for a period of time after disabling • Adjusts during scrubbing to maintain down pressure • Recovery tank not full • E-Stop button(s) not engaged • No faults on vacuum fan output	• Key OFF (O) • Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* or water-pickup not enabled • Directional switch set to reverse • Vacuum off timer expired • Recovery tank full • E-Stop button(s) engaged • Faults on vacuum fan output
Scrub Head Actuator	• Key ON (I) • Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* or water-pickup enabled/disabled • Lifts until up limit switch is reached on power-up and end of scrub or water-pickup • Lowers to position switches or down limit switch at beginning of scrub or water-pickup • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • Lifts to transport position when machine is in reverse • No faults on scrub deck actuator output	• Key OFF (O) • Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* and water-pickup not enabled • Scrub deck is at desired position • Internal limit switches are hit • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Will not lower if directional switch is set to reverse • Faults on scrub deck actuator output

Function	Enabled	Disabled
Scrub Motor	• Key ON (I) • Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* enabled • Scrub deck lowered • Machine is propelling • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • No faults on scrub motor output	• Key OFF (O) • Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* disabled • Scrub deck raised/raising • Machine not propelling • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Faults on scrub motor output
Solution Control (Conventional)	• Key ON (I) • Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* enabled • *ec-H2O* (if equipped) not enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • No faults on water valve output	• Key OFF (O) • Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* not enabled • *ec-H2O* (if equipped) is enabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Faults on water valve output
Solution Control (*ec-H2O* NanoClean - Optional)	• Key ON (I) • Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* enabled • *ec-H2O* enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • No faults on *ec-H2O* enable output	• Key OFF (O) • Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* not enabled • *ec-H2O* disabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Faults on *ec-H2O* enable output
Steering Control	• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • E-Stop button(s) not engaged • No faults on steering system	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • E-Stop button(s) engaged • Faults on steering system

* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

SERVICE DIAGNOSTICS TOOL

Machine configuration software is stored in the Kinetek Control Module. It may be necessary to reload the machine configuration software if there are issues/ errors with the machine configuration software requiring the software to be reloaded into the Kinetek Control Module.

Authorized service providers can download the Service Diagnostics software. Tennant Service personnel have this software installed on their service devices.

Use the AMR Service Connector to connect the service device to the Kinetek Control Module. The Kinetek Control Module stores configuration data and communicates via the AMR SERVICE CONNECTOR communication with the Kinetek Control Module.

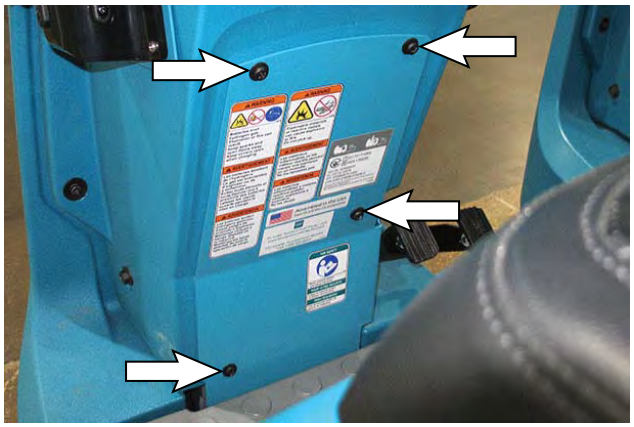
- **VIB (Vehicle Interface Board):** The VIB interface module is located in the operator console.
- **Kinetek Vehicle Controller:** The machine controller is located beneath on the controller mounting panel located at the front of the battery compartment.
- **BCM (Brain Control Module):** The BCM is located under the shroud on the front of the steering support.
- ***ec-H2O* NanoClean Module (option):** The *ec-H2O* module is located at the front of the battery compartment.

ISOLATING THE MACHINE FROM THE AMR SYSTEM

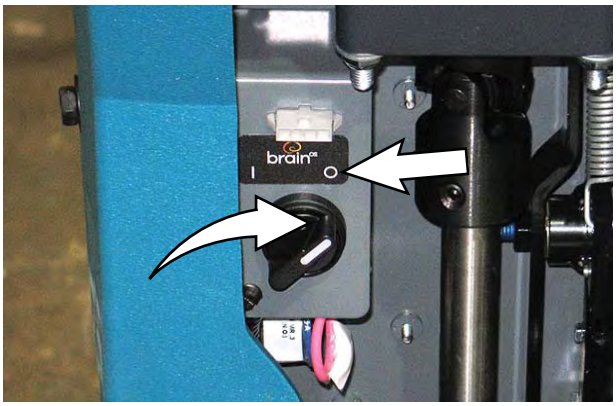
Initial machine troubleshooting is required to determine whether a malfunction/error code is an AMR related or non-AMR issue. To begin troubleshooting the machine the machine must first be isolated from the AMR system.

NOTE: Use the AMR bypass switch only when performing machine diagnostics/maintenance procedures. Do Not leave the machine isolated from the AMR system during regular use.

1. Turn the ON/OFF key switch OFF.
2. Remove the column access panel from the instrument shroud.



3. Turn the AMR bypass switch clockwise to isolate the machine from the AMR system.

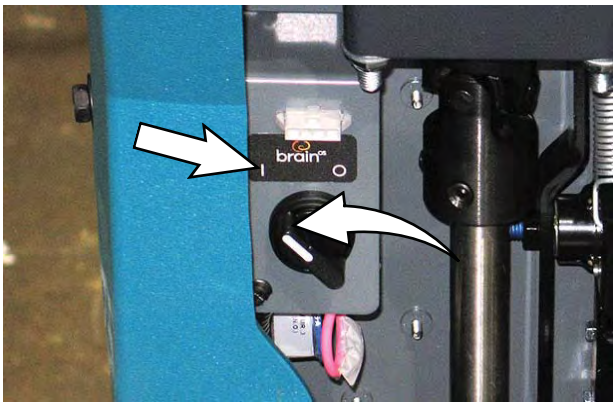


4. Lower the operator seat.
5. Turn the ON/OFF key switch ON.
6. Operate the machine in the Manual Mode.

   Are all scrubbing functions fully operational while the machine is in the manual mode? If yes, there is an issue with the AMR system. Proceed to PREPARING THE MACHINE FOR EXTERNAL TROUBLESHOOTING/DIAGNOSTICS/FILE TRANSFERS.

   Are there scrubbing function issues while the machine is in the Manual Mode? If yes there is an issue with the T380 portion of the machine. Troubleshoot the machine to determine possible issues. Make necessary repairs and/ or adjustments. Proceed to PREPARE THE MACHINE FOR TROUBLESHOOTING/ DIAGNOSTICS/FILE TRANSFERS and CHECK THE KINETEK CONTROL MODULE/MACHINE DIAGNOSTICS.

7. Turn the AMR bypass switch counterclockwise to link the machine to the AMR system if finished with diagnostic procedures.

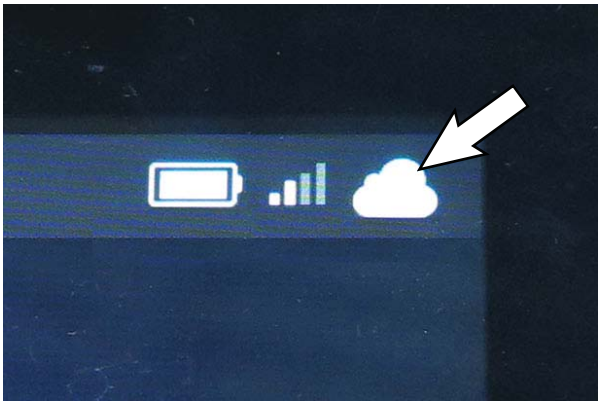


8. Reinstall the column access panel back onto the machine after machine diagnostics are complete.

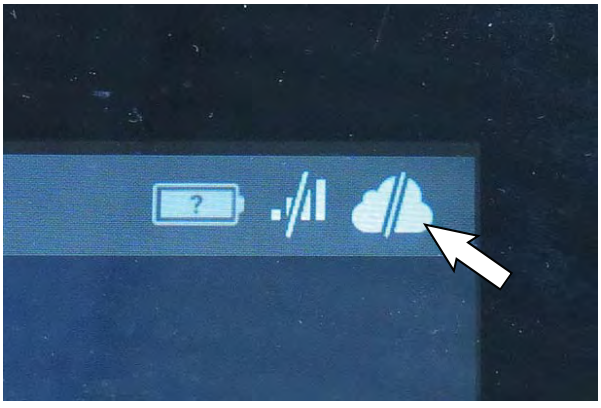
PREPARE THE MACHINE FOR TROUBLESHOOTING/DIAGNOSTICS/FILE TRANSFERS

There will be instances when troubleshooting/diagnostics/file transfers will be necessary to get the machine functioning. The ROC (Robotics Operation Center) allows external entities (Tennant Service/Brain Corp.) to communicate with the machine to troubleshoot problems, provide diagnostic information, and transfer files that may be required to update/fix malfunctioning robotic functions.

1. Turn the key switch ON.
2. If necessary, drive the machine to an area where the ROC indicator located on the user interface touchscreen is illuminated. The ROC indicator must be illuminated for there to be any external troubleshooting/diagnostics/file transfers completed.



If the ROC light is gray/slashed, the ROC is not connected and cannot be paired with cell phone nor used for external troubleshooting/diagnostics/file transfers.

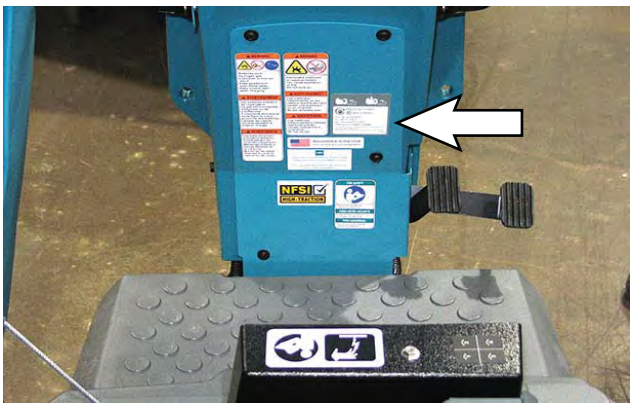


3. Contact the Tennant Customer Service Department for additional troubleshooting/diagnostic guidance.

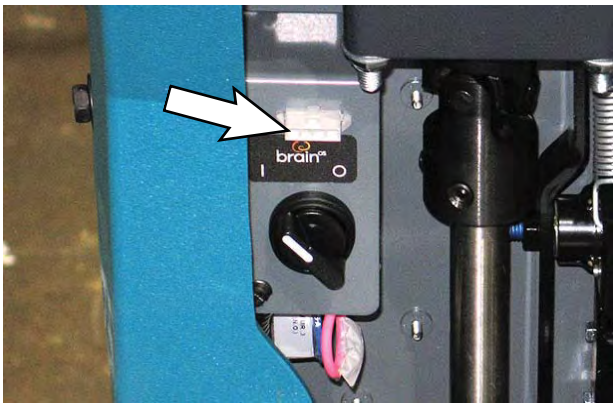
CHECK THE KINETEK CONTROL MODULE/ MACHINE DIAGNOSTICS

SYSTEM REQUIREMENTS: Windows® 7 Operating System or newer version.

1. Remove the access panel from the steering column.



2. Connect the AMR SERVICE CONNECTOR to the service device.
3. Connect the AMR Service Connector to the service terminal above the AMR bypass switch.

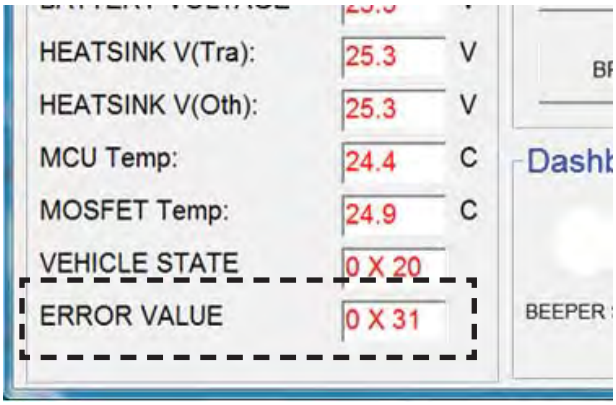


4. Remove the front perimeter guard from the machine.
5. Chock the rear wheels to prevent the machine from rolling.
6. Position a jack under the front jack point at the back of the LIDAR bracket. **Do Not** position the jack at the front of the LIDAR bracket.

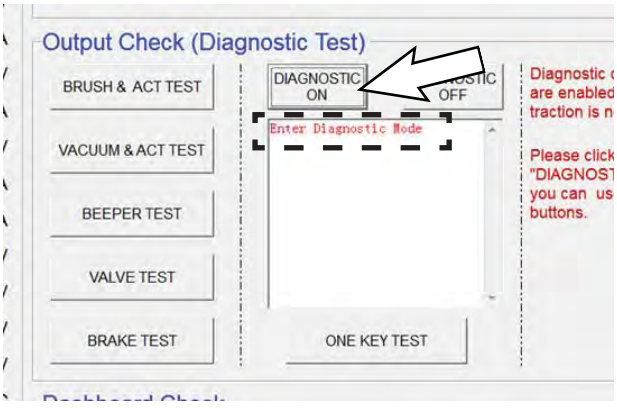
7. Jack the front end of the machine approximately 12.7 mm (0.50 in) from the floor (high enough so the front drive wheel moves freely when the propel pedal is pressed).

FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only.

8. Turn the ON/OFF key switch ON.
9. Bypass the seat switch harness.
10. Click the desktop icon start menu to open the AMR SERVICE CONNECTION diagnostics software application.
11. Check the ERROR VALUES located at the bottom of the Current and Volts column for an error code. See OUTPUT INFORMATION/CURRENT AND VOLTS.



12. Proceed to FAULT CODES for fault codes, fault code conditions, cause(s) for the fault code(s), and corrective actions to be taken.
13. Press the DIAGNOSTIC ON button to activate the Output Check (Diagnostic Test) function of the AMR Diagnostic Test application. See INPUT CHECK/ OUTPUT CHECK (DIAGNOSTIC TEST).

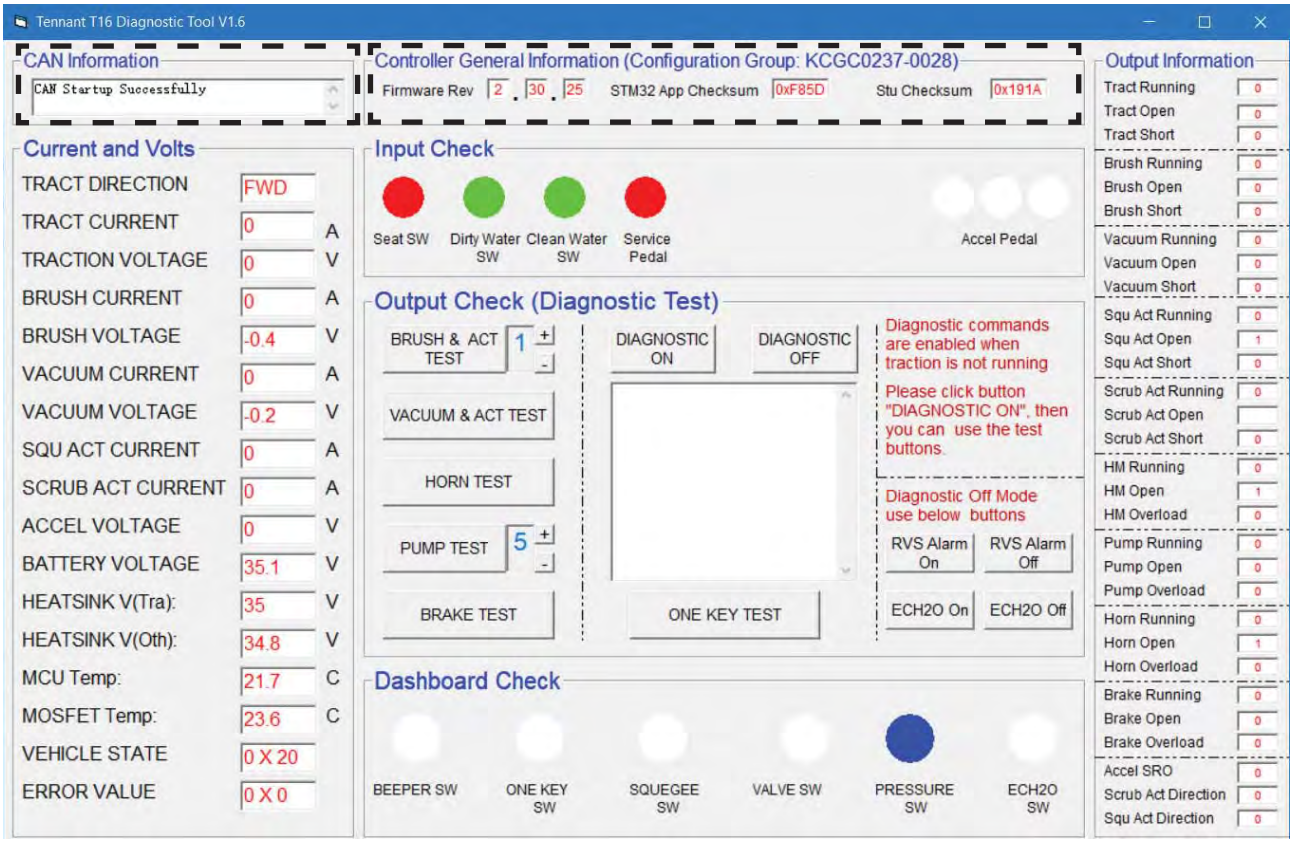


14. Observe the diagnostics status box for error codes.
15. Observe the Output Information column for possible short circuits and open circuits. Check the Current and Volts column to ensure circuits being tested are operating within the correct voltage and amp ranges. See OUTPUT INFORMATION/ CURRENT AND VOLTS.
16. If further diagnostic testing is required, conduct a dashboard Check. See DASHBOARD CHECK.
17. If necessary,perform diagnostics tests to find where there may be machine operation/performance issues. See FAULTS CODES for fault codes. See DIAGNOSTIC TOOLS for diagnostic tool information.
18. Disconnect the AMR SERVICE CONNECTOR from the service terminal above the AMR bypass switch.
19. Turn the ON/OFF key switch OFF.
20. Reinstall the access panel onto the steering column.
21. Reconnect the main wire harness to the operator seat switch cable.

DIAGNOSTIC TOOLS

The AMR SERVICE CONNECTION diagnostics software application provides detailed information for testing the machine for open circuits, shorts, and current and volt information for all machine operating and scrubbing systems. This information can be used for troubleshooting the various machine circuits and finding any problems that could be adversely affecting machine operation and performance.

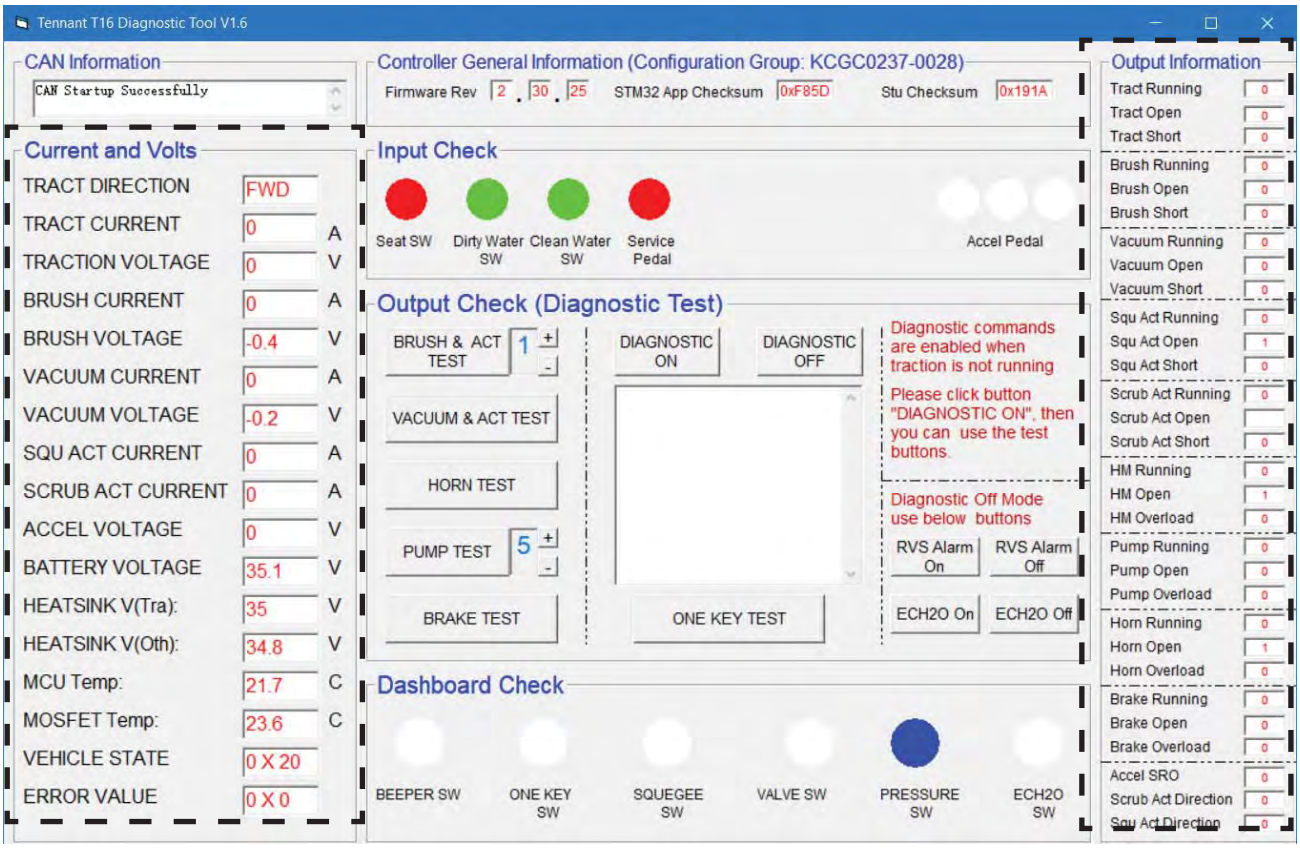
CAN INFORMATION/CONTROLLER GENERAL INFORMATION



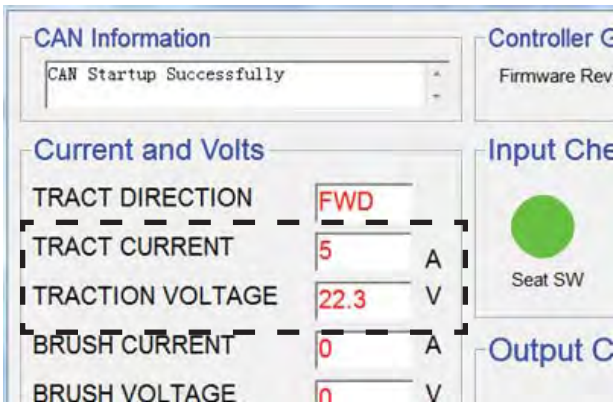
CAN Information: Indicates CAN system is operational.

Controller General Information: Indicates the controller firmware version, the Firmware Rev (firmware revision), Code Checksum, and EEPROM (Electrically Erasable Programmable Read-Only Memory) Checksum are listed. Confirm these three numbers to ensure the latest version of the firmware is installed on the machine. Contact the Tennant Customer Service Department for the latest controller firmware version, Firmware Rev, and EEPROM.

OUTPUT INFORMATION/CURRENT AND VOLTS

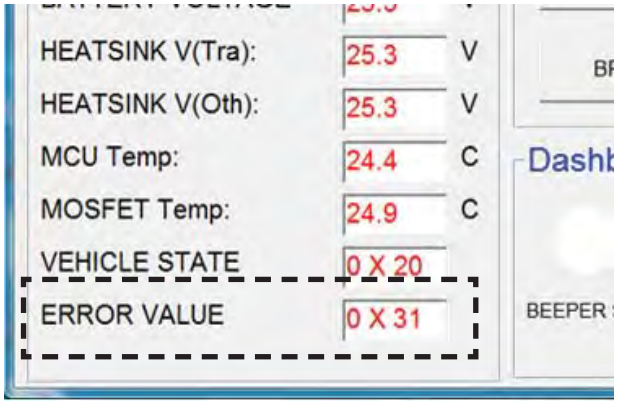


Current and Volts: This column indicates the current and volt ranges for the listed machine operating systems. In the below example the TRACT CURRENT A (Amps) and TRACT VOLTAGE V (Voltage) measure are displayed. See MACHINE SYSTEM RANGES for normal voltage and amp ranges.



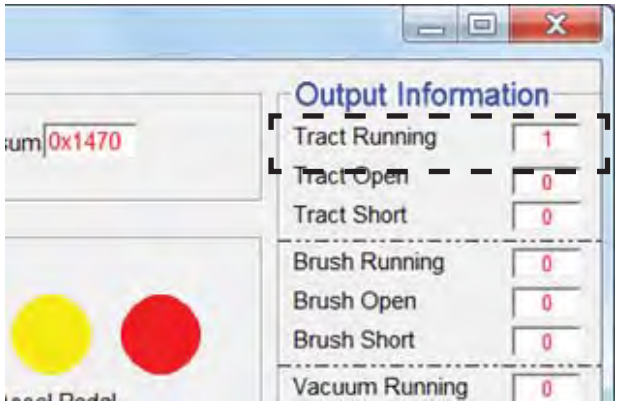
NOTE: The letters FWD in the TRACT DIRECT cell indicate the machine is in the forward direction for the testing being conducted.

ERROR VALUE: Error codes are located at the bottom for the Currents and Volts column. See FAULTS AND WARNINGS for error code and further troubleshooting information.

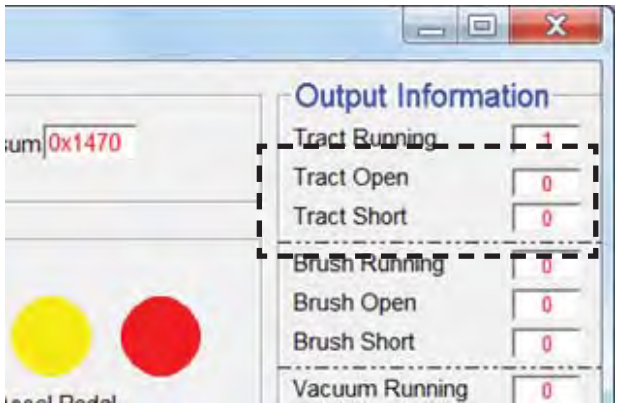


In the above example the error code of 0X31 shows there is a brush adjustment time out error.

Output Information: This column indicates whether a system is running, open, or short. A numeral 1 appears in the corresponding cell if the cell is active. A numeral 0 appears in the cell if the cell is inactive. In the below example the numeral 1 is in the Tract Running cell, indicating the Tract Running cell is active and there are no faults.



If the numeral 1 was in either the Tract Open or Tract Short cell, this would indicated there was either an Open or Short fault condition with that system and additional troubleshooting is required.



NOTE: Since the squeegee is part of the scrub head assembly on the T380AMR, there is no squeegee actuator. Disregard the SQU ACT CURRENT measures in Current And Volts information and the SQU ACT RUNNING, SQU ACT OPEN, and SQU ACT SHORT measures in Output Information.

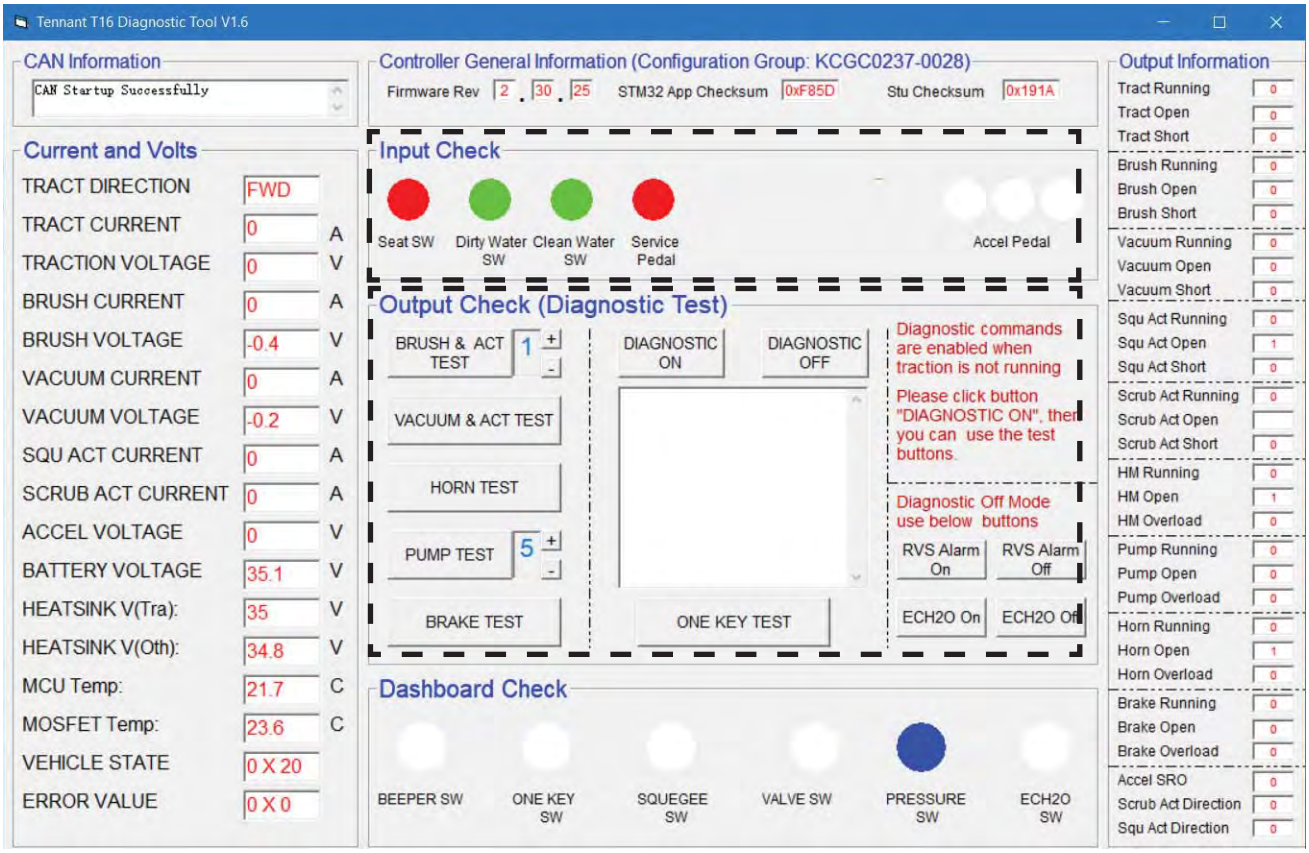
MACHINE SYSTEM RANGES

Refer to the below table to confirm voltage/amp when using the AMR SERVICE CONNECTION diagnostics software application for machine troubleshooting.

System	Component	Minimum Value	Nominal Value	Maximum Value	Measure
Propel	Traction Current	-120		100	Amps
	Traction Voltage (Forward)	0		81	% of VBat
	Traction Voltage (Reverse)	0		55	% of VBat
	Traction Voltage (Low Battery)	0		30	% of VBat
	Propel Pedal Voltage (Released)	0.2	0.3	0.5	Volts
	Propel Pedal Voltage (Fully Pressed)	3.8	4.2	4.6	Volts
	Brake Pedal Voltage (Released)	0.2	0.3	0.5	Volts
	Brake Pedal Voltage (Pressed)	3.8	4.2	4.6	Volts
	Parking Brake Voltage (Applied)	0			Volts
	Parking Brake Voltage (Released)		24		Volts
	Propel Disabled Voltage		20.8		Volts
Scrub	Scrub Motor Current (Low DP)		25*	60	Amps
	Scrub Motor Current (High DP)		30*	60	Amps
	Scrub Motor Voltage	0		23	Volts
	Scrub Actuator Current (Lowering)	0		7	Amps
	Scrub Actuator Current (Raising)	0		7	Amps
	Scrub Actuator Voltage (Moving)		23	23	Volts
	Scrub Actuator Voltage (Adjusting)		7	7	Volts
	Scrubbing Disabled Voltage (Propel Only)		21.9		Volts
	Water Valve (Conventional)		24		Volts
	ec-H2O Enable (Active)	0			Volts
	ec-H2O Enable (Inactive)		12		Volts
Water Pickup	Vacuum Current	0		42	Amps
	Vacuum Voltage	0	19	19	Volts
	Horn Voltage (Active)		24		Volts
	Vehicle State		0x20		
	Error Value (See FAULTS AND ERRORS for all error codes)		0x00		No Errors

**These Scrub Motor Current numbers are for reference only.*

INPUT CHECK/OUTPUT CHECK (DIAGNOSTIC TEST)



Input Check: When these indicators are green the machine is ready for operation. If any indicator is red, the machine is not ready for operation and corrective action must be taken to correct the problem before the machine can be operated. If any of the Input Check indicators is showing a “false red” (indicating an error or action is occurring that is not occurring) further troubleshooting will be necessary to find what is causing the indicator to turn red.

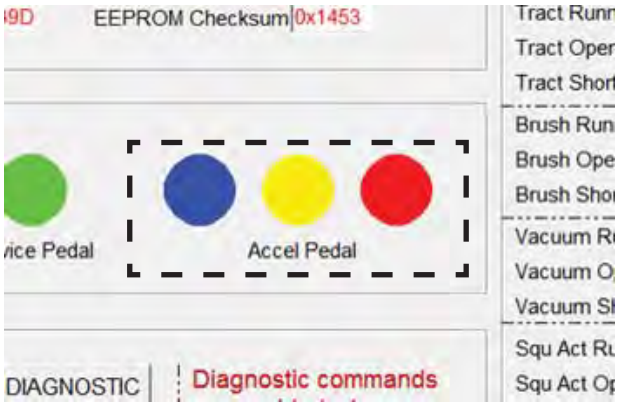
Seat SW: The seat switch indicator is green when the seat switch recognizes there is an operator sitting in the operator seat. The indicator is red to indicate there is no operator in the operator seat.

Dirty Water SW: The Dirty Water (recovery tank) indicator is green to indicate the recovery tank is not full. The indicator is red when the recovery tank is full.

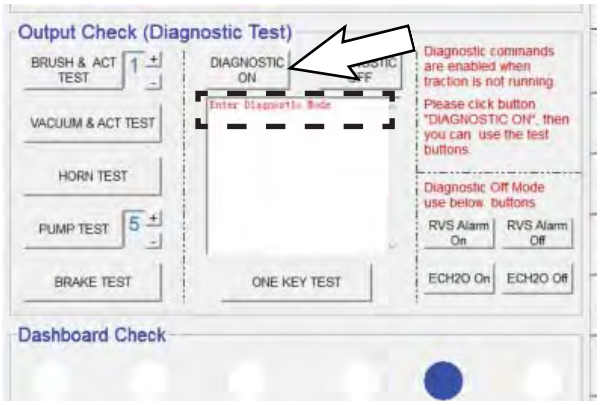
Clean Water SW. The Clean Water SW (solution tank) indicator is green when there is solution for cleaning in the solution tank. The indicator is red when the solution tank is empty.

Service Pedal: The Service Pedal indicator is green when the service brake is not pressed. The indicator is red when the brake pedal is pressed.

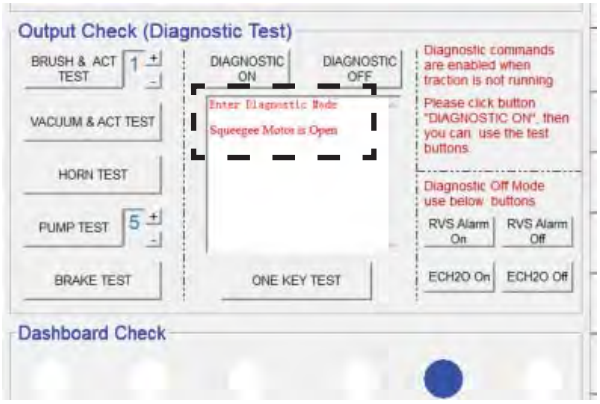
Accel Pedal: The three Accel Pedal (propel pedal) indicators illuminate to indicate low, medium, and high travel speed. The first indicator is blue when the machine is travelling at low speed. The next indicator is yellow when the machine is travelling at medium speed (the blue light low speed indicator is also illuminated). The last button is red when the machine is travelling at high speed (the previous two lower speed lights are also illuminated).



Output Check (Diagnostic Test): Press the DIAGNOSTIC ON button to activate the Output Check (Diagnostic Test) function Enter Diagnostics Mode will appear in the diagnostics status box.



Text appears in the diagnostic status box indicating the diagnostics on/off status and the result(s) of the diagnostic test(s).



NOTE: Allow the diagnostic results of the previously chosen test to appear in diagnostic status box before initiating another test.

Press the BRUSH & ACT TEST button to test the scrub brush and scrub head actuator function. Use the + button or - button to change the down pressure settings if necessary to test machine at the low, medium, or high settings.

Press the VACUUM & ACT TEST button to test the squeegee actuator and vacuum functions.

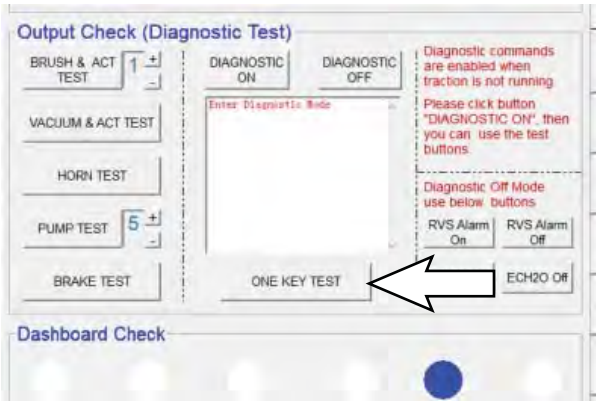
Press the BEEPER TEST button to test the horn and audible alarm.

Press the PUMP TEST button to test the solution control system. Use the + button or - button to change the pump activation time (1-5 seconds) if necessary to test pump at different activation times.

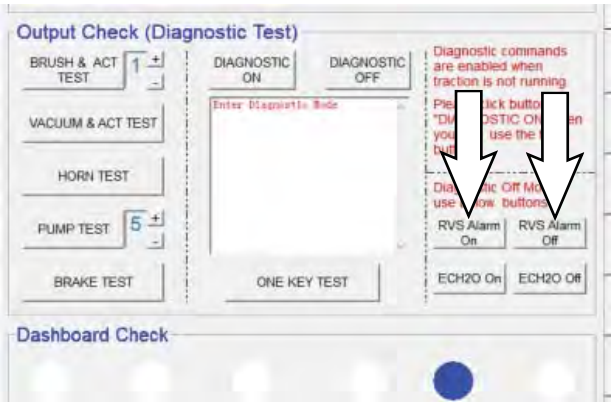
Press the BRAKE TEST button to test the service brakes.

NOTE: There is no indicator that the test is completed if no fault is noted in the diagnostic status box. Check the Output Information column to confirm the tests are completed. If all cells in the Output Information column are 0 (zero), then no tests are active.

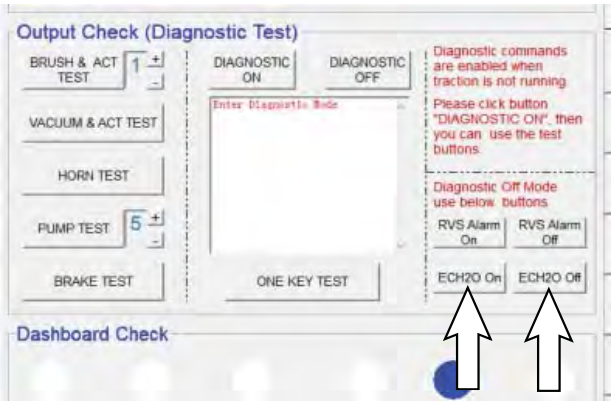
Press the ONE KEY TEST button to test all previously mentioned systems. All systems will briefly activate separately in sequential order after the button is pressed.



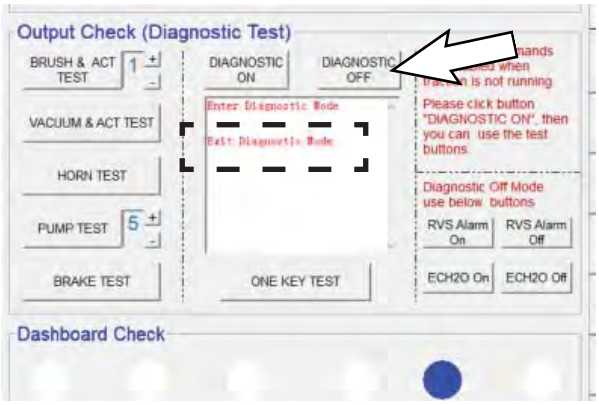
Press the RVS Alarm On button to test the reverse alarm. The reverse alarm will continue to sound until the RVS Alarm Off button is pressed.



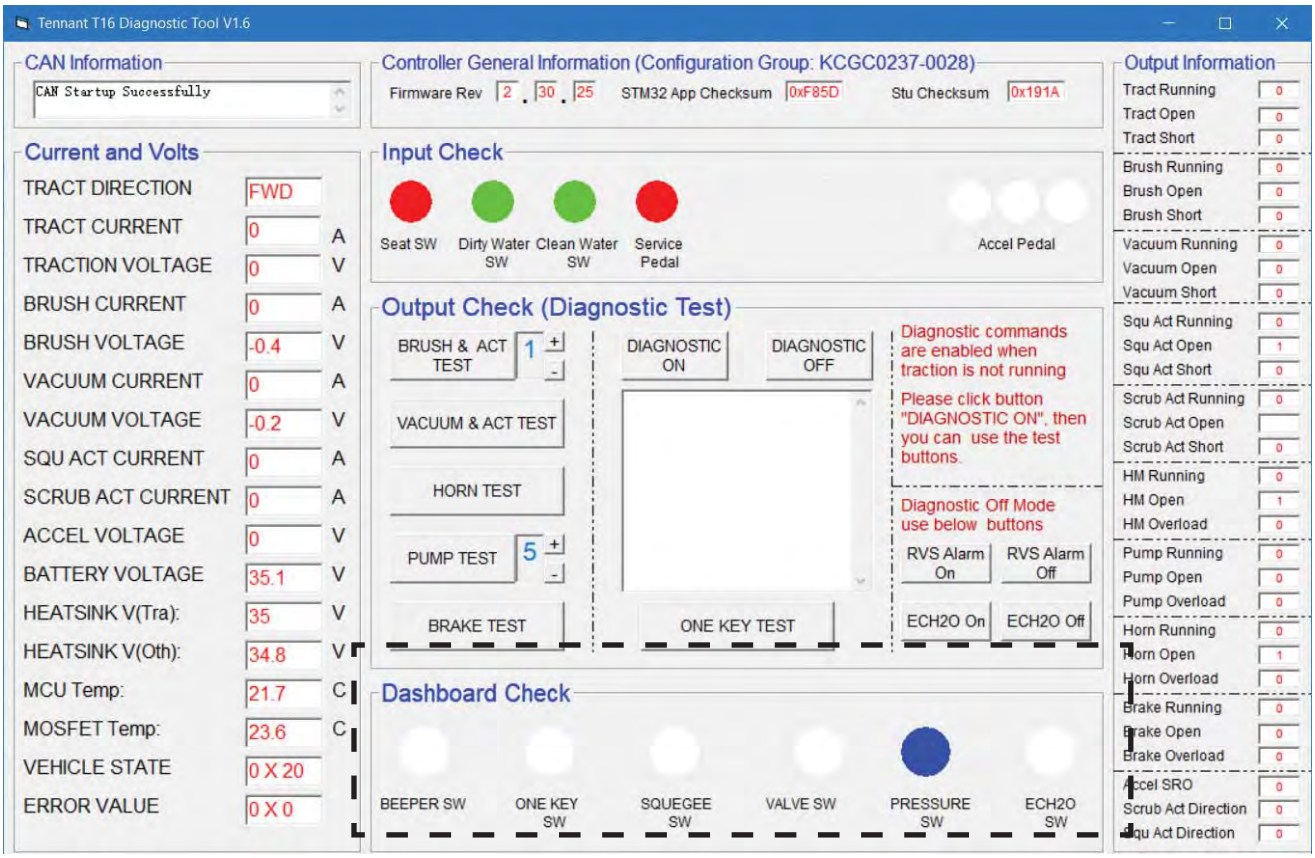
Press the ECH2O On button to test the ec-H2O system. The ec-H2O system will continue to function until the ECH2O Off button is pressed.



Press the DIAGNOSTICS OFF button when through testing machine diagnostics. Exit Diagnostics Mode will appear in the diagnostics status box.



DASHBOARD CHECK



Dashboard Check: Each of these indicators will change colors, depending on the input from the button being pushed to activate a particular system and at what level the chosen system is functioning at in the case of systems that have different operating levels. If one of the indicators does not turn green in the case of single function button or blue, yellow, red in the case of multifunction buttons, further troubleshooting is needed to determine why the button is not functioning.

BEEPER SW: When the beeper/alarm is activated the indicator will be green.

ONE KEY SW: When the *1-Step* button is activated the indicator will be green.

NOTE: Since the squeegee is part of the scrub head assembly on the T380AMR, there is no dedicated squeegee switch/actuator. Disregard the SQUEEGEE SW Dashboard Check.

VALVE SW: When the solution flow is activated the indicator will be blue when the flow is set to the lowest level, yellow when the solution flow is set to the medium level, and red when the solution flow is at the high level.

PRESSURE SW: The pressure is always illuminated blue, yellow, or red. The pressure cannot be turned off like the other machine functions. Blue indicates the lowest pressure setting, yellow indicated the medium pressure setting, and red indicates the high pressure setting.

ECH2O SW: This indicator turns green after the machine is moving and all other scrubbing functions are active.

FAULT CODES

When the machine or battery charger detects a fault, the service indicator will flash. A fault code is provided to determine problem. Refer to the Faults and Warnings table for fault codes, conditions, reasons, and corrective action for the various fault codes.

Error Code	Fault Condition	Reason	Correction
0x12	EEPROM Error	1. Controller parameter setting out of range. 2. Controller Problem (EEPROM fault).	
0x1A	Battery Low (All Functions Off)	1. Battery voltage is less than 18V. 2. Controller hardware fault.	1. Charge batteries. 2. Power cycle machine. 3. Contact Tennant Customer Service Department.
0x17	E-Stop Active	1. An E-Stop button is engaged	1. Disengage the E-Stop button(s)
0x21	Battery Low (Traction Only)	1. Battery voltage is less than set parameter value (Class 0 Volt). 2. Controller hardware fault.	1. Charge batteries. 2. Power cycle machine. 3. Contact Tennant Customer Service Department.
0x23	MCU Over Temperature	1. Controller is over temperature.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x26	Precharge Failure (Traction)	1. Wiring problem. 2. Controller hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x29	Traction Left Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x2D	Brush Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x2E	Vacuum Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x2F	Squeegee Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x31	Brush Adjustment Time Out	1. Brush pressure adjustment parameters setting not reasonable.	1. Adjust brush pressure. 2. Power cycle machine.
0x32	Solenoid Welded (Traction)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x33	Solenoid Did Not Close (Traction)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x37	Throttle Fault	1. Hall accelerator output more than 5V.	1. Power cycle machine. 2. Troubleshoot propel pedal/brake pedal sensor.
0X3A	Brake Fault	1. Brake output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot brake circuit.
0X3B	Alarm Fault	1. Alarm output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot horn circuit.
0X3C	Aux1 Fault	1. Aux1 output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot hour meter circuit.
0X3D	Aux2 Fault	1. Aux2 output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot conventional solution valve circuit.
0x3F	Brush Deck Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.

Error Code	Fault Condition	Reason	Correction
0x42	Traction Motor Stalled	1. Traction motor stalled. 2. Parameter ”Traction I Limit” set too low.	1. Power cycle machine.
0x44	Traction Reverse Short Circuit Protection	1. Traction motor short circuit.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x4C	Traction Forward Short Circuit Protection	1. Traction motor short circuit.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x4D	Brush Over Current Protection	1. Brush motor peak current more than 150A.	1. Power cycle machine. 2. Troubleshoot scrub motor circuit.
0x4E	Brush Short Circuit Protection	1. Brush motor short circuit.	1. Power cycle machine. 2. Troubleshoot scrub motor circuit.
0x59	Traction Left Drain Fault	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x5B	Traction Right Drain Fault	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x5C	Traction Reverse Over Current Protection	1. Traction motor peak current greater than 190A.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x5D	Traction Forward Over Current Protection	1. Traction motor peak current greater than 190A.	1. Power cycle machine. 2. Troubleshoot propel circuit.
0x61	Brush Drain Fault	1. Controller hardware fault	1. Contact Tennant Customer Service Department.
0x62	Supply Out Of Range	1. Controller hardware fault	1. Contact Tennant Customer Service Department.
0x64	Brush Deck Over Current Protection	1. Brush deck motor peak current greater than 9A.	1. Power cycle machine. 2. Troubleshoot scrub head lift/lower circuit.
0x65	Vacuum Short Circuit Protection	1. Vacuum motor short circuit.	1. Power cycle machine. 2. Troubleshoot vacuum circuit.
0x66	Brush Deck Short Circuit Protection	1. Brush deck motor short circuit.	1. Power cycle machine. 2. Troubleshoot scrub head lift/lower circuit.
0x67	Squeegee Over Current Protection	1. Squeegee motor peak current greater than 9A.	1. Power cycle machine. 2. Troubleshoot squeegee lift/lower circuit.
0x68	Vacuum Over Current Protection	1. Vacuum motor peak current greater than 60A.	1. Power cycle machine. 2. Troubleshoot vacuum circuit.
0x69	Squeegee Short Circuit Protection	1. Squeegee motor short circuit.	1. Power cycle machine. 2. Troubleshoot squeegee lift/lower circuit.
0x6A	Valve Fault	1. Valve output over current. 2. Controller hardware fault.	1. Power cycle machine. 2. Troubleshoot conventional solution valve circuit.
0x6C	Traction Right Null Error	1. Controller firmware fault. 2. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x71	Trial Timeout	1. Controller trial use is timeout (when trial use function is enabled).	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x72	Solenoid Welded (Others)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x73	Solenoid Did Not Close (Others)	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.

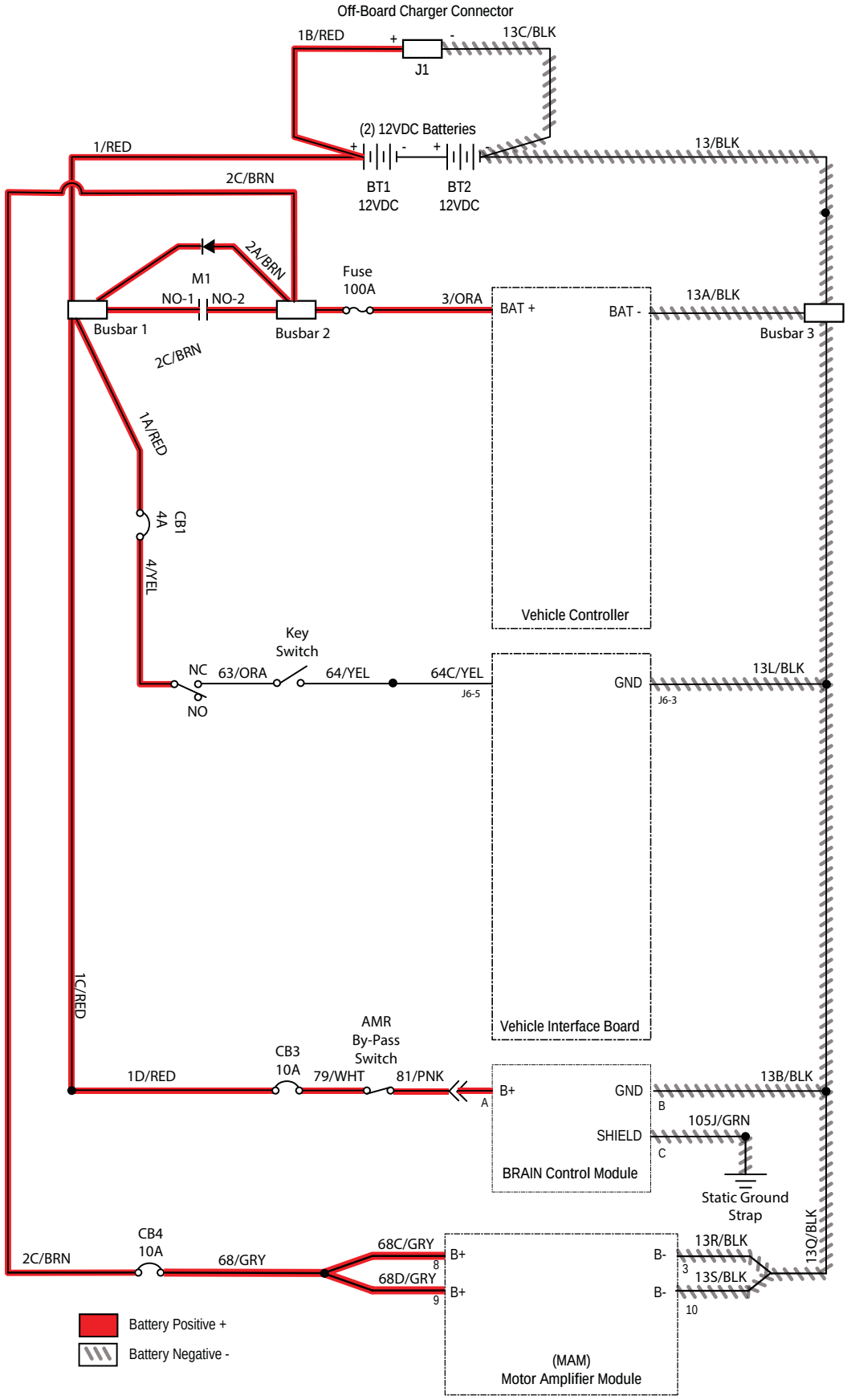
Error Code	Fault Condition	Reason	Correction
0x74	Squeegee Motor Stalled	1. Squeegee motor stalled. 2. Parameter ”Squeegee Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot squeegee lift/lower circuit.
0x75	Brush Deck Motor Stalled	1. Brush deck motor stalled. 2. Parameter ”Bru-D Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot scrub head lift/lower circuit.
0x76	Precharge Failure (Others)	1. Wiring problem. 2. Controller hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x77	Brush Motor Stalled	1. Brush motor stalled. 2. Parameter ”Brush Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot scrub motor circuit.
0x78	Vacuum Motor Stalled	1. Vacuum motor stalled. 2. Parameter ”Vacuum Current Limit” set too low.	1. Power cycle machine. 2. Troubleshoot vacuum circuit.
0x79	Traction Temp Switch	1. Traction motor over temperature limit.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x7B	Brush Temp Switch	1. Brush motor over temperature limit.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x7E	Tract_Left_Low_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0X83	MOSFET Over Temperature	1. Output current too big. 2. Controller heat dissipation not good (installation baseplate, etc...). 3 Controller hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x8E	Tract_Left_High_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0xA2	High Battery Protection	1. Battery voltage greater than 45V. 2. Parameter ”Battery Voltage” set to 0 but battery 36V. 3. Controller hardware fault.	1. Power cycle machine. 2. Contact Tennant Customer Service Department.
0x9A	Tract_Right_Low_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x9B	Tract_Right_High_FET_ Short	1. Controller hardware fault.	1. Contact Tennant Customer Service Department.
0x9C	Brush_Negative_Short_ To_Gnd	1. Brush negative J42 short to ground.	1. Contact Tennant Customer Service Department.
0x9D	Vac_Negative_Short_To_ Gnd	1. Vacuum negative J42 short to ground.	1. Contact Tennant Customer Service Department.
0x9E	Bru_Deck_Act_SW1_ Error	1. Incorrect configuration file installed.	1. Contact Tennant Customer Service Department.
0x9F	Bru_Deck_Act_SW2_ Error	1. Incorrect configuration file installed.	1. Contact Tennant Customer Service Department.

ec-H2O NANOCLEAN ICON FAULTS

Machine Indicator	Module Status	Fault Code	Fault Condition	Cause	Correction
Solid Red	Off	0x0711	*ec-H2O* Pump Open Fault	1. *ec-H2O* pump wiring, connector or control board issue.	Control board is not detecting pump current. Check connections for voltage and verify pump is operating.
	Off	0x0713	*ec-H2O* Pump Over Current Fault	1. Current draw higher than expected.	Check pump operating current.
	Off	0x0716	*ec-H2O* Pump Short Fault	1. Shorted load condition 2. Higher current draw than hardware design limit.	Refer to *ec-H2O* NanoClean Troubleshooting Guide.
	Off	0x0717	*ec-H2O* Pump FET Short	1. Current detected on pump drive circuit when not actively operating.	Refer to *ec-H2O* NanoClean Troubleshooting Guide.
	Off	0x0727	*ec-H2O* Cell FET Faults	1. Control board problem. 2. Power/battery issue on startup.	Replace control board. FET detection includes motor, actuator, detergent pump, vacuum and battery watering pump.
	Off	0x0741	*ec-H2O* WCM Pump Open Warning	1. Wiring, connector or control board issue on *ec-H2O* pump.	Verify the water conditioning module micro pump is connected to machine harness and pump is functional.
	Off	0x0746	*ec-H2O* WCM Pump Short Warning	1. Shorted load condition 2. Some higher current draw than hardware design limit.	Check harness. Verify water conditioning module micro pump is functional.
Flashing Red	Off	0x0702	*ec-H2O* Pressure Switch Active	1. The system pressure switch is detecting a trip or unconnected.	1. System pressure too high. 2. Check connections. Connectors possibly wired to incorrect switches.
	Fast blink	0x0708	*ec-H2O* System Over Regulation Warning	1. Cell has operated over target current condition for last 50 treated gallons.	Check water in solution tank for presence of detergents.
	Slow blink	0x0721	*ec-H2O* Cell Open Fault	1. *ec-H2O* cell wiring, connector or control board issue.	Check connector/wire connections.
	Slow blink	0x072A	*ec-H2O* Cell Electrode Fault	1. Cell current is operating below allowed operating condition.	Refer to *ec-H2O* NanoClean Troubleshooting Guide.
	Fast blink	0x0726	*ec-H2O* Cell Short Warning	1. Shorted load condition 2. Higher current draw than hardware design limit.	Refer to *ec-H2O* NanoClean Troubleshooting Guide

Machine Indicator	Module Status	Fault Code	Fault Condition	Cause	Correction
Green/ Blue	Fast blink	0x0728	*ec-H2O* Cell Over Regulation	1. Cell current exceeds set point for expected operation. Fault is indicated via a flashing blue light on *ec-H2O* module.	Refer to *ec-H2O* NanoClean Troubleshooting Guide.
	Fast blink	0x072B	*ec-H2O* Cell Over Current Warning	1. Cell current is exceeding set point during the first 60 seconds when machine is powered on. Will most likely lead to a cell short fault if conditions persists.	Refer to *ec-H2O* NanoClean Troubleshooting Guide.
	Slow blink	0x0729	*ec-H2O* Cell Under Regulation	1. Cell Current under set point for expected operation. Fault is indicated via a flashing blue light on *ec-H2O* module.	Refer to *ec-H2O* NanoClean Troubleshooting Guide.
Red-Green/ Red-Blue	-	0x0707	*ec-H2O* Water Conditioning Cartridge Expired Warning	1. *ec-H2O* water cartridge has expired due to either gallons of usage or 2 years of use.	1. Replace *ec-H2O* water conditioning cartridge.

OFF-BOARD BATTERY CHARGING ON



BATTERIES FAIL TO CHARGE/REDUCED RUN TIME (OFF-BOARD CHARGER)

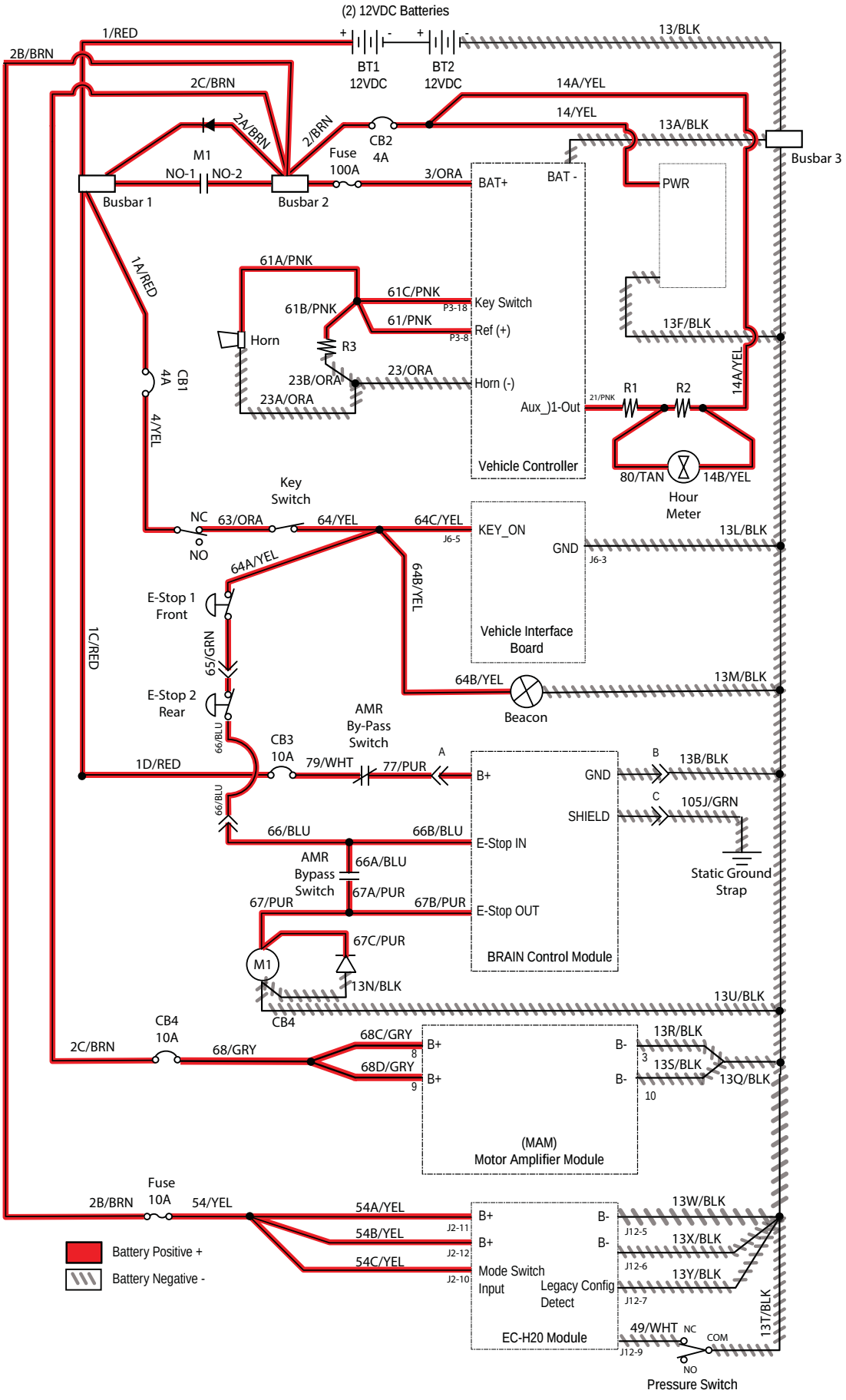
Step	Action	Value(s)	Yes	No
1	• Key OFF • Are batteries disconnected?		Connect the batteries	Proceed to STEP 2
2	• Key OFF • Check AC power supply • Is the rated AC supply voltage present?		Proceed to STEP 3	Check AC supply circuit protection
3	• Key OFF • Inspect battery and charger cables for damage/ corrosion/contamination/terminal problems		Repair or replace battery/battery charger cables	Proceed to STEP 4
4	• Key OFF • Disconnect batteries • Check water level in all battery cells • Are the lead plates submerged?		Proceed to STEP 5	Add distilled water as necessary until lead plates are covered
5	• Key OFF • Use a hydrometer or refractometer to test specific gravity of each cell (Lead-Acid) • Are all battery cells within 0.050 (50 points) specific gravity of each other?		Replace battery charger	Replace battery charger or batteries

Terms:

AC = Alternating Current

Specific Gravity = Relative density of a substance compared to water (1.000 specific gravity)

POWER UP ON


(2) 12VDC Batteries
1/RED
2B/BRN
BT1 12VDC
BT2 12VDC
13/BLK
2C/BRN
14A/YEL
14/YEL
13A/BLK
Busbar 3
2A/BRN
2/BRN
M1
NO-1
NO-2
Fuse 100A
CB2 4A
3/ORA
Busbar 1
Busbar 2
BAT+
BAT -
PWR
1A/RED
61A/PNK
61C/PNK
61B/PNK
61/PNK
Key Switch
P3-18
Ref (+)
P3-8
Horn
R3
13F/BLK
14A/YEL
CB1 4A
4/YEL
23B/ORA
23/ORA
23A/ORA
Horn (-)
Aux_)1-Out
21/PNK
R1
R2
Vehicle Controller
80/TAN
14B/YEL
Hour Meter
Key Switch
NC
NO
63/ORA
64/YEL
64C/YEL
J6-5
KEY_ON
GND
J6-3
13L/BLK
64A/YEL
64B/YEL
E-Stop 1 Front
E-Stop 2 Rear
65/GRN
1C/RED
Vehicle Interface Board
64B/YEL
13M/BLK
Beacon
AMR By-Pass Switch
66/BLU
CB3 10A
1D/RED
79/WHT
77/PUR
A
B
B+
GND
13B/BLK
C
SHIELD
105J/GRN
Static Ground Strap
66/BLU
66B/BLU
E-Stop IN
AMR Bypass Switch
66A/BLU
67A/PUR
67/PUR
67B/PUR
E-Stop OUT
67C/PUR
M1
13N/BLK
BRAIN Control Module
13U/BLK
CB4
CB4 10A
2C/BRN
68/GRY
68C/GRY
68D/GRY
8
9
B+
B-
13R/BLK
3
13S/BLK
13Q/BLK
10
(MAM)
Motor Amplifier Module
Fuse 10A
2B/BRN
54/YEL
54A/YEL
54B/YEL
54C/YEL
J2-11
J2-12
J2-10
13W/BLK
13X/BLK
13Y/BLK
J12-5
J12-6
J12-7
Mode Switch Input
Legacy Config Detect
EC-H20 Module
49/WHT
NC
COM
NO
J12-9
13T/BLK
Pressure Switch
Battery Positive +
Battery Negative -

MACHINE POWER OPERATIONAL MATRIX

Function	Enabled	Disabled
Power Up	• Key ON (I) • Circuit breaker #1 not tripped • Charger interlock not engaged • Batteries adequately charged/connected to machine/functional/undamaged	• Key OFF (O) • Circuit breaker #1 tripped • Charger interlock engaged • Batteries fully discharged/not connected to machine/not functional/damaged

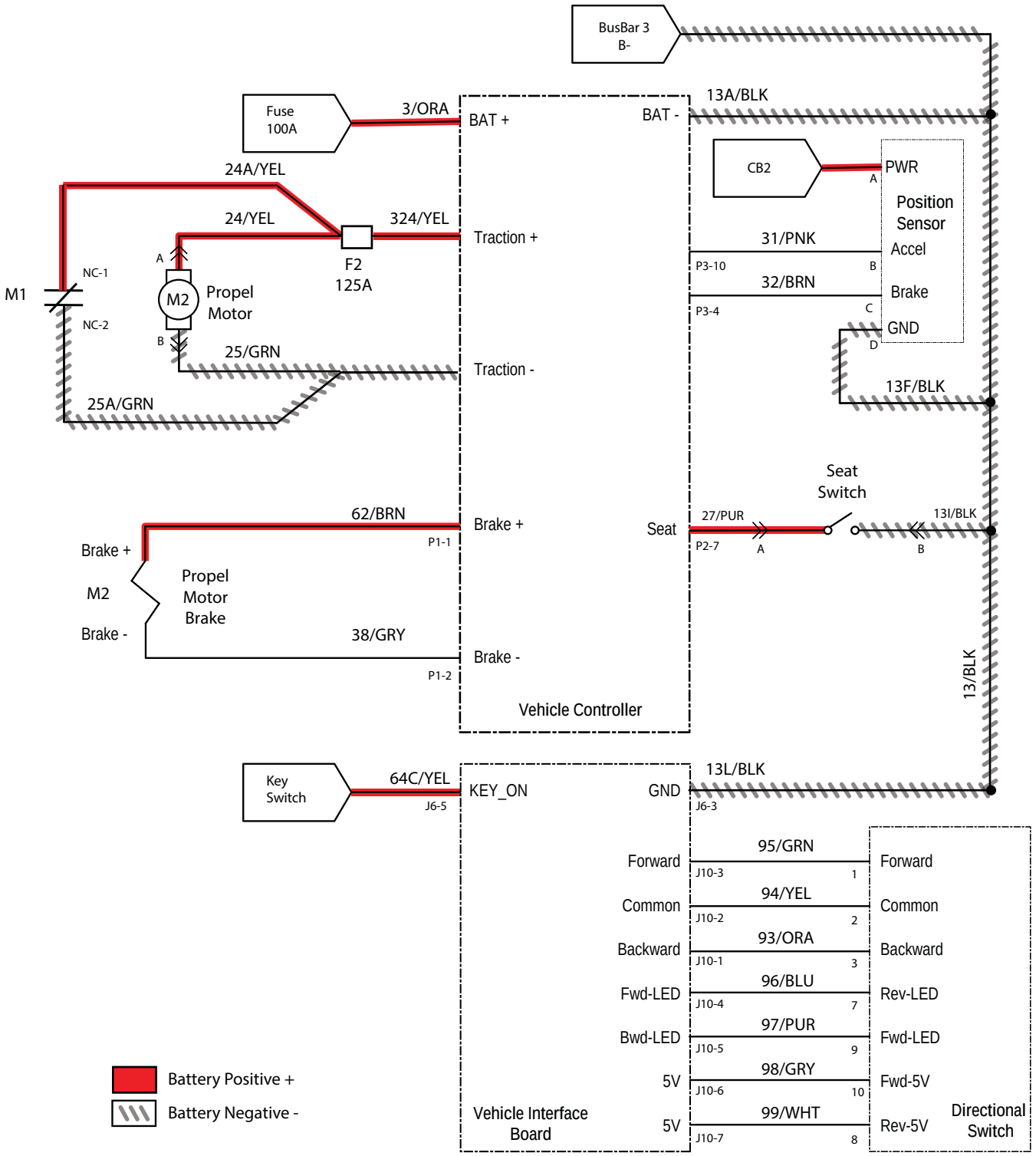
MACHINE FAILED TO POWER UP

Step	Action	Value(s)	Yes	No
1	• Key ON • AMR Bypass Switch in “I” (ON) position • Use a voltmeter to test the total battery voltage • Is total battery voltage greater than 23.5 VDC?		Proceed to STEP 2	Recharge batteries and test power-up circuit operation
2	• Key OFF • AMR Bypass Switch in “I” (ON) position • Is circuit breaker #1 tripped? • Firmly press circuit breaker #1 to reset		Reset and test power-up circuit operation	Proceed to STEP 3
3	• Key ON • AMR Bypass Switch in “I” (ON) position • Test voltage applied to power-up subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components
4	• Key ON • Move the AMR Bypass Switch to “O” (OFF) position • Test voltage applied to power-up subsystem as shown on electrical schematic • Are electrical circuit operating as shown on electrical schematic?		Replace Brain Control Module or Brain Control Module lower harness	Identify voltage drop location and repair or replace necessary components

Terms:

VDC = DC Voltage

PROPEL SUBSYSTEM



NOTE: M1 contactor de-energizes (shorting the drive motor) to quickly stop the machine when E-Stop(s) are engaged or while machine is running autonomously.

PROPEL SUBSYSTEM OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 20.8V, or 9% SOC* for lithium batteries (Inventus)**	• Battery voltage < 20.8V, or 9% SOC* for lithium batteries (Inventus)**
• Operator in seat	• Operator not in seat
• Charger not connected	• Charger connected
• Propel pedal pressed	• Propel pedal not pressed
• E-Stop button(s) not engaged	• E-Stop button(s) engaged
• No faults on propel motor output	• Faults on propel motor output

* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

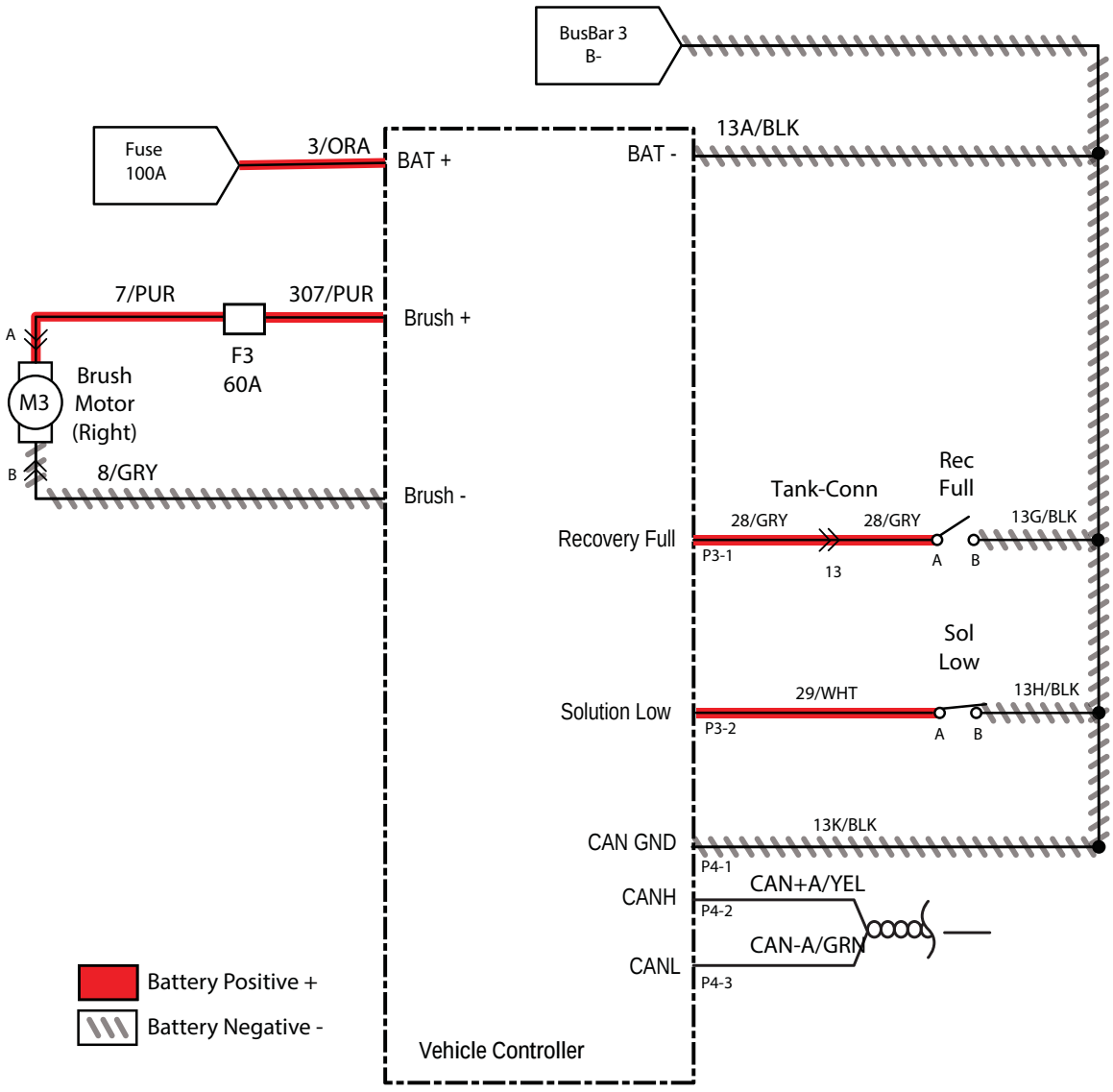
MACHINE FAILED TO PROPEL

Step	Action	Value(s)	Yes	No
1	• Key OFF • Are all interlocks in the proper state to enable manual propel? * Front E-Stop button not engaged * Rear E-Stop button not engaged * Operator in seat		Proceed to STEP 2	Ensure all interlocks are in the proper state to enable manual propel
2	• Key OFF • Is circuit breaker #1 tripped? • Firmly press circuit breaker #1 to reset		Reset and test power-up circuit operation	Proceed to STEP 3
3	• Key OFF • Is circuit breaker #2 tripped?] • Firmly press circuit breaker #2 to reset		Reset and test power-up circuit operation	Proceed to STEP 4
4	• Key ON • Use a voltmeter to test the total battery voltage • Is total battery voltage greater than 20.8 VDC?		Proceed to STEP 5	Recharge batteries and test power-up circuit operation
5	• Key OFF • Place machine on blocks so drive wheel is lifted from floor • Key ON • Enable propel • Test voltage applied to propel subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Use AMR Service Connection to read error code from controller	Identify voltage drop location and repair or replace necessary components

Terms:

VDC = DC Voltage

SCRUB MOTOR ON



SCRUB MOTOR OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)**	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)**
• *1-Step* enabled	• *1-Step* disabled
• Scrub deck lowered	• Scrub deck raised/raising
• Machine is propelling	• Machine not propelling
• Solution tank not empty	• Solution tank empty
• Recovery tank not full	• Recovery tank full
• E-Stop button(s) not engaged	• E-Stop button(s) engaged
• Machine is not in reverse	• Machine is in reverse
• No faults on scrub motor output	• Faults on scrub motor output

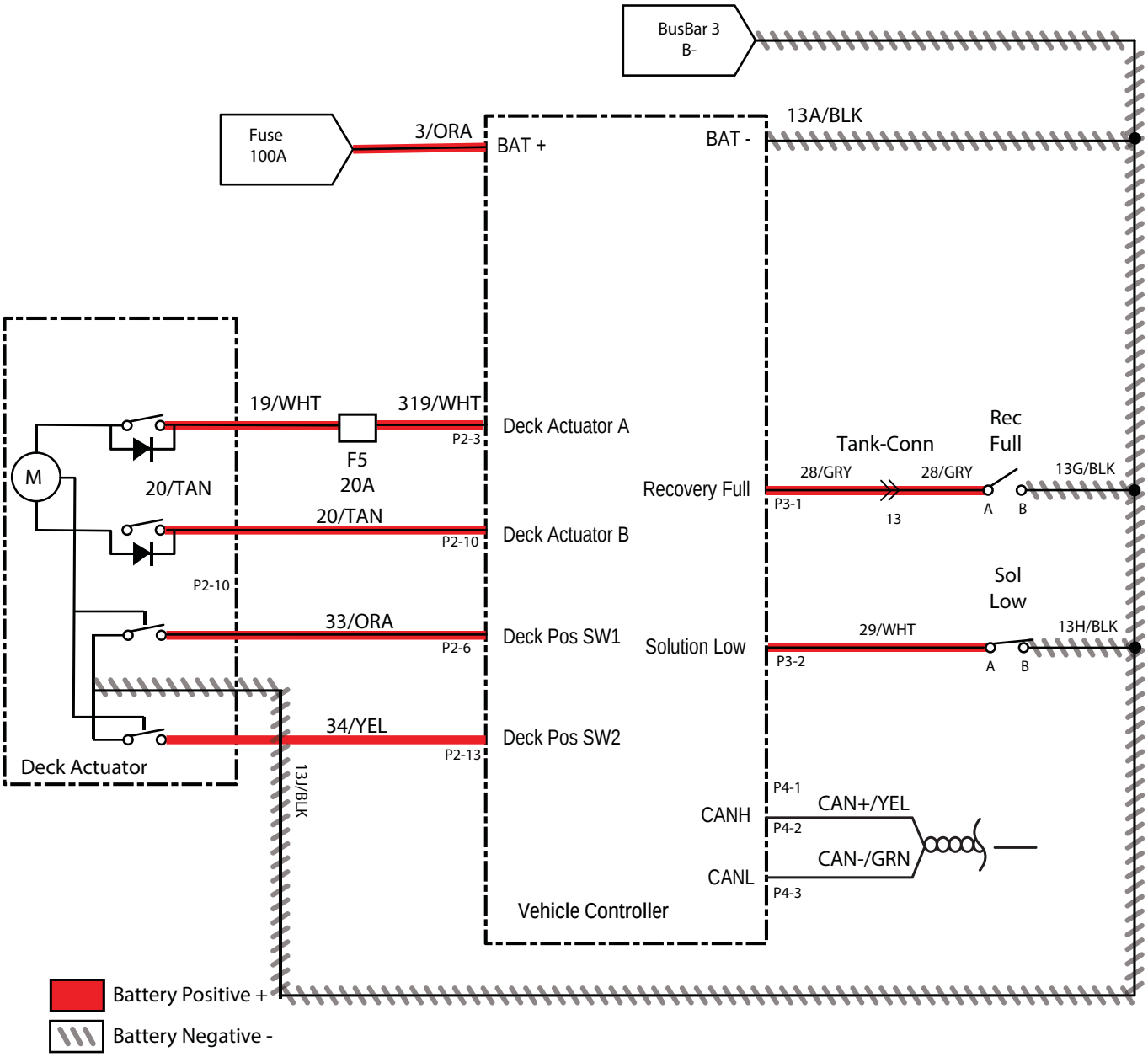
* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

SCRUB MOTOR FAILED TO TURN ON

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable scrub motor • Is there a fault on the membrane panel?		Use AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key ON • Enable scrub motor • Test voltage applied to scrub motor subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

SCRUB HEAD LIFT



SCRUB HEAD ACTUATOR OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* or water-pickup enabled/disabled • Lifts until up limit switch is reached on power-up and end of scrub or water-pickup • Lowers to position switches or down limit switch at beginning of scrub or water-pickup • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • Lifts to transport position when machine is in reverse • No faults on scrub deck actuator output	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* and water-pickup not enabled • Scrub deck is at desired position • Internal limit switches are hit • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Will not lower if directional switch is set to reverse • Faults on scrub deck actuator output

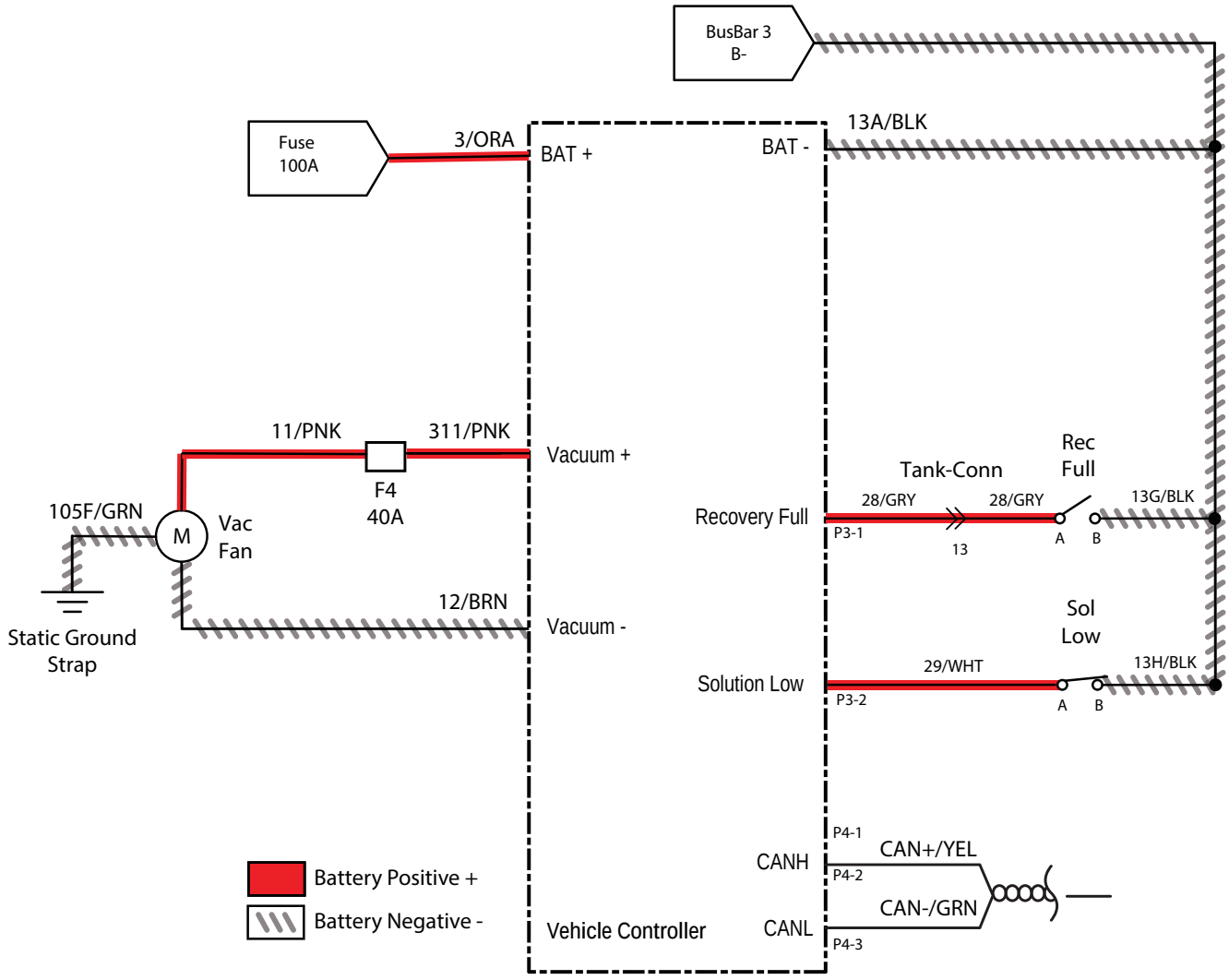
* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

SCRUB HEAD FAILED TO LIFT/LOWER

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable lift actuator • Is there a fault on the membrane panel?		Use AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key OFF • Inspect actuator and lift mechanism • Is there anything causing the actuator or lift linkage to bind?		Remove anything causing the actuator/ lift linkage to bind	Proceed to STEP 3
3	• Key ON • Enable scrub motor • Test voltage applied to actuator subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

VACUUM FAN ON



VACUUM FAN OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* or water-pickup enabled • Direction switch set to forward • Vacuum fan continues to operate for a period of time after disabling or reverse is selected • Recovery tank not full • E-Stop button(s) not engaged • No faults on vacuum fan output	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* or water-pickup not enabled • Direction switch set to reverse • Vacuum off timer expired • Recovery tank full • E-Stop button(s) engaged • Faults on vacuum fan output

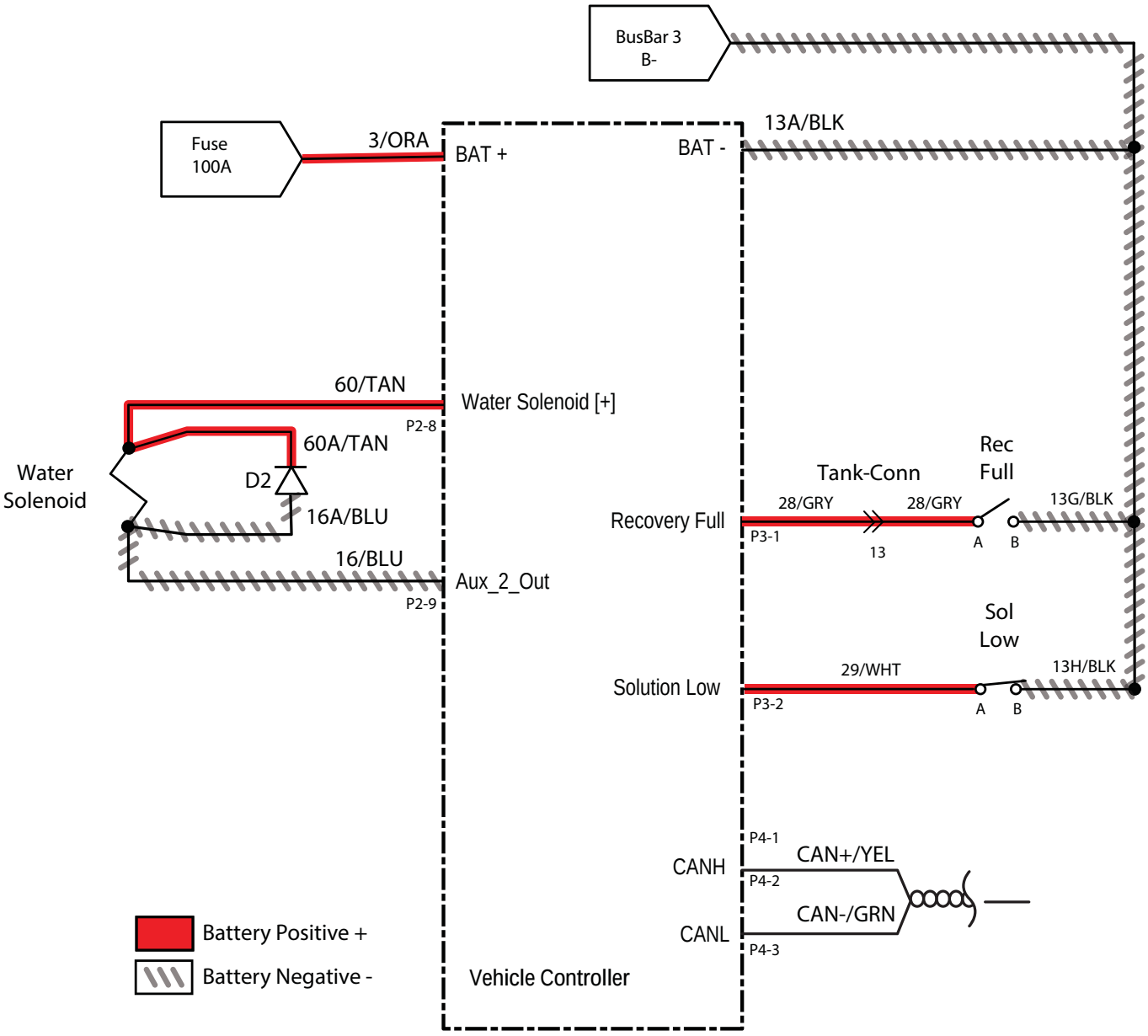
* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

VACUUM FAN FAILED TO TURN ON

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable vacuum fan • Is there a fault on the membrane panel?		Use AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key ON • Enable vacuum fan • Test voltage applied to scrub motor subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

SOLUTION CONTROL ON (CONVENTIONAL)



SOLUTION CONTROL OPERATIONAL MATRIX

Enabled	Disabled
• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* enabled • *ec-H2O* (if equipped) not enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • No faults on water valve output	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* not enabled • *ec-H2O* (if equipped) is enabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Faults on water valve output

* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

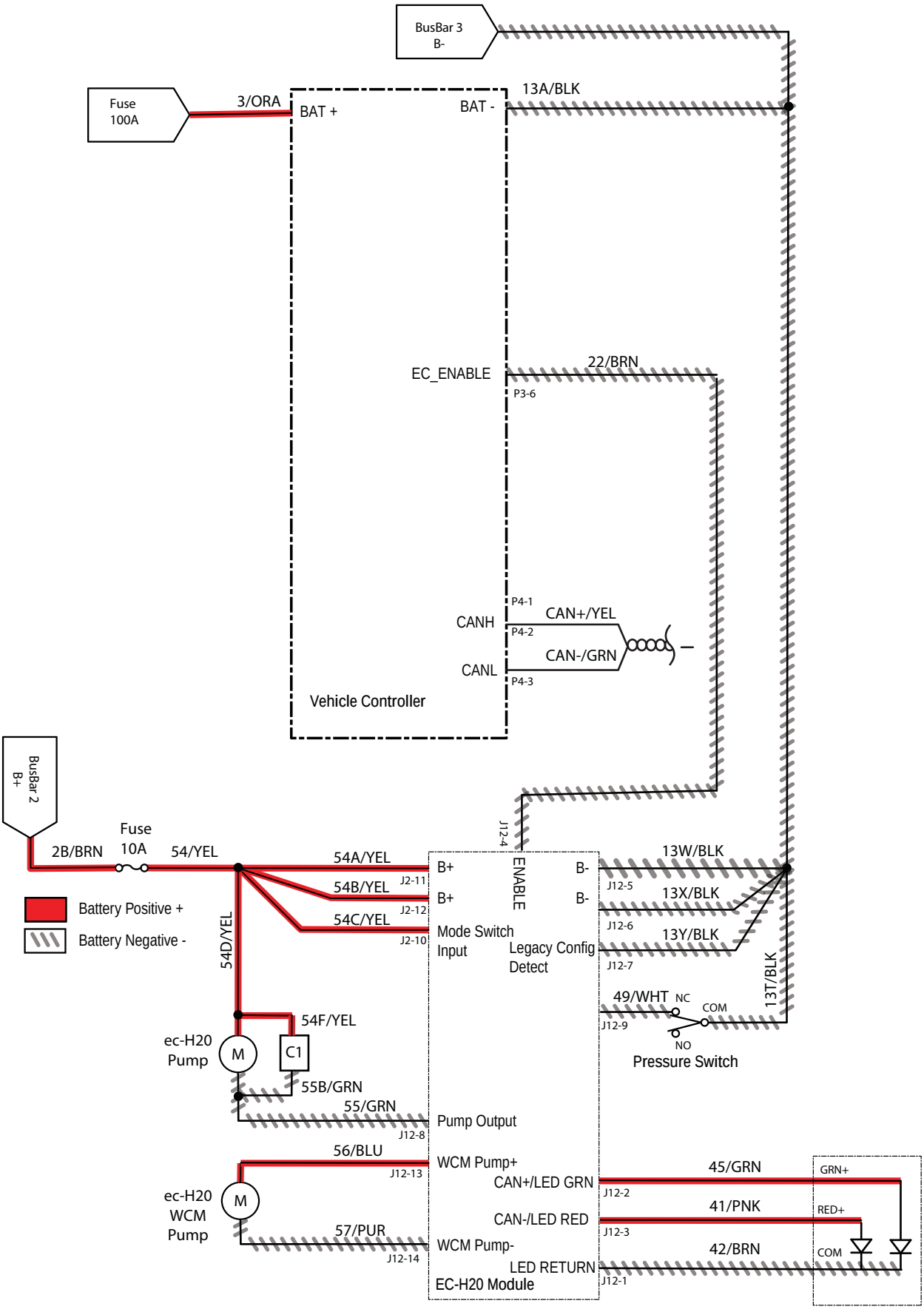
SOLUTION CONTROL DUTY CYCLE

SV-2 Level	On Time %	Period 2.0 SEC
Off (No LEDs)	0%	0.0 S On / 2.0 S Off
Low (1 LED)	35%	0.7 S On / 1.3 S Off
Medium (2 LEDs)	75%	1.5 S On / 0.5 S Off
High (3 LEDs)	100%	2.0 S On / 0.0 S Off

SOLUTION CONTROL FAILED TO TURN ON

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable solution control (conventional) • Is there a fault on the membrane panel?		Use AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key ON • Enable solution control (conventional) • Test voltage applied to solution control (conventional) subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

SOLUTION CONTROL ON (*ec-H2O*) (OPTION)



SOLUTION CONTROL (*ec-H2O*) OPERATIONAL MATRIX (OPTIONAL)

Enabled	Disabled
• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* enabled • *ec-H2O* enabled • Machine is scrubbing • Solution tank not empty • Recovery tank not full • E-Stop button(s) not engaged • No faults on *ec-H2O* enable output	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • *1-Step* not enabled • *ec-H2O* disabled • Machine not scrubbing • Solution tank empty • Recovery tank full • E-Stop button(s) engaged • Faults on *ec-H2O* enable output

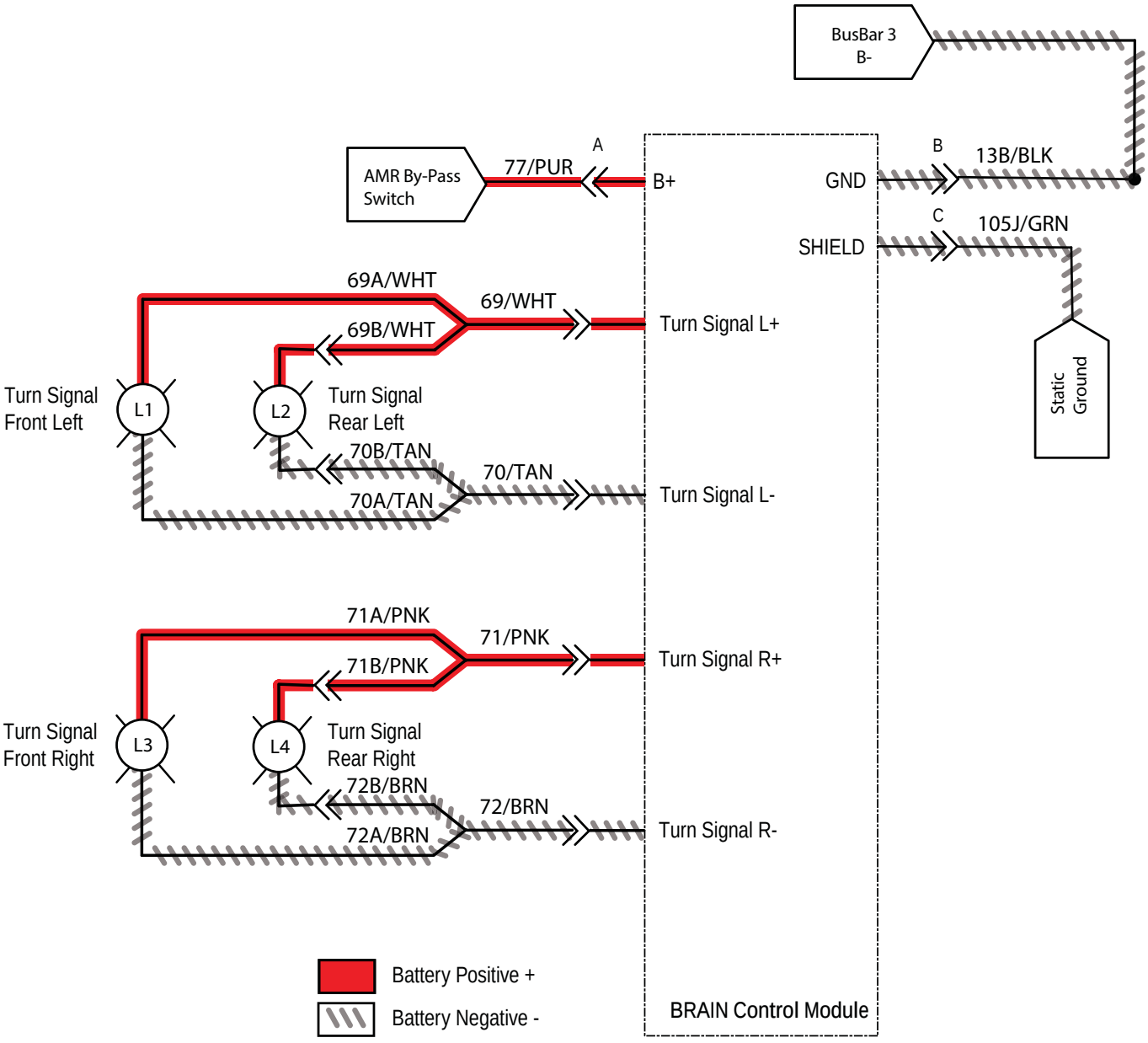
* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

SOLUTION CONTROL FAILED TO TURN ON (*ec-H2O*) (OPTIONAL)

Step	Action	Value(s)	Yes	No
1	• Key ON • Enable solution control (*ec-H2O*) • Is there a fault on the membrane panel?		Use AMR Service Connection to read error code from controller	Proceed to STEP 2
2	• Key OFF • Is the in-line *ec-H2O* fuse blown?		Replace fuse	Proceed to STEP 3
3	• Key ON • Enable solution control (*ec-H2O*) • Test voltage applied to solution control (*ec-H2O*) subsystem as shown on electrical schematic • Are electrical circuits operating as shown on electrical schematic?		Repeat STEP 1	Identify voltage drop location and repair or replace necessary components

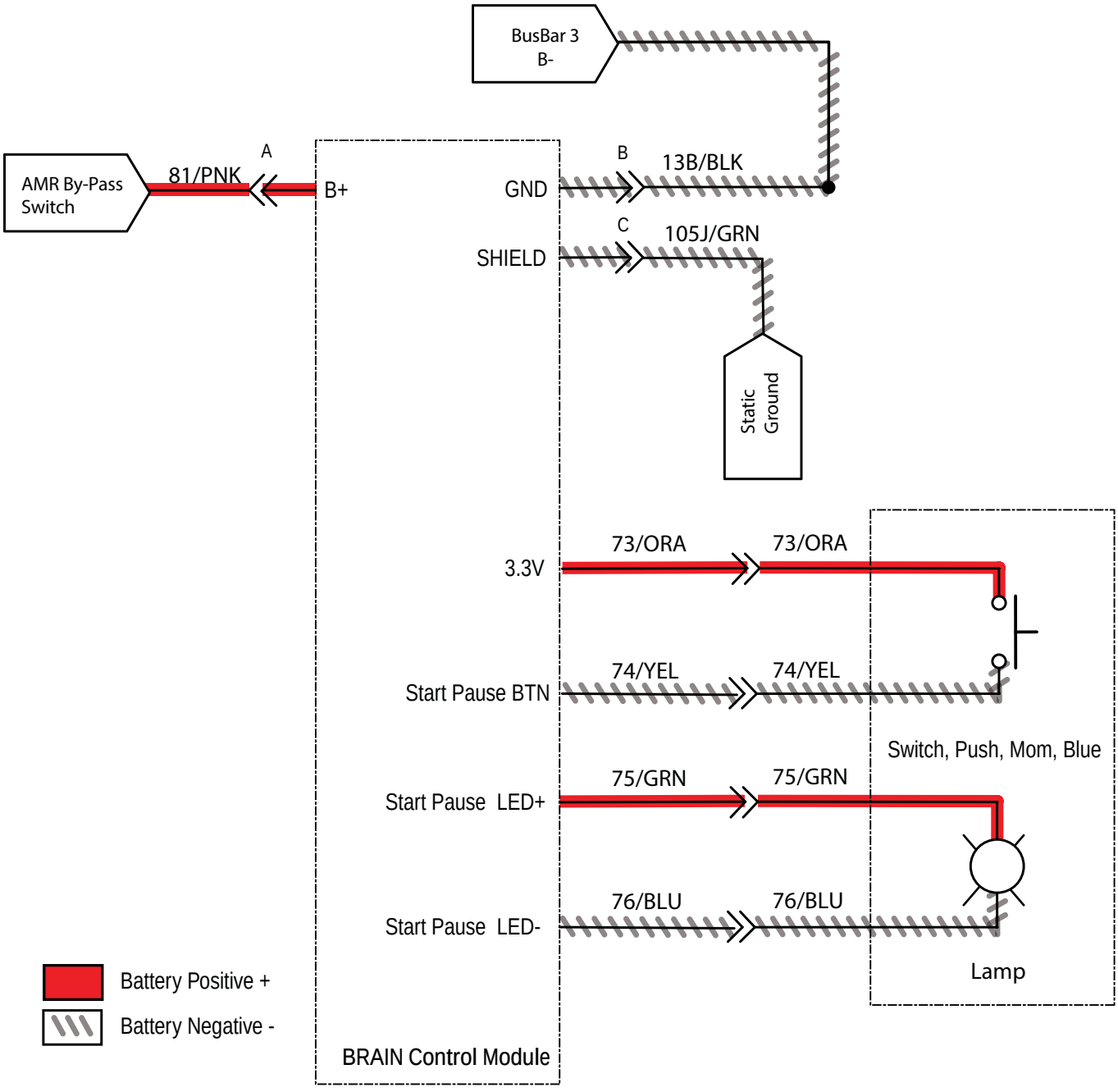
TURN SIGNALS



TURN SIGNALS FAILED TO FUNCTION

Step	Action	Value(s)	Yes	No
1	• Key ON • Remove the membrane panel. • Enable LH turn signal. • Disconnect BCM (2-pin connector for LH turn signal).		Check continuity	Identify voltage drop location and repair or replace necessary components Proceed to STEP 2
2	• Key ON • Enable RH turn signal • Disconnect BCM (2-pin connector for RH turn signal).		Check continuity	Identify voltage drop location and repair or replace necessary components

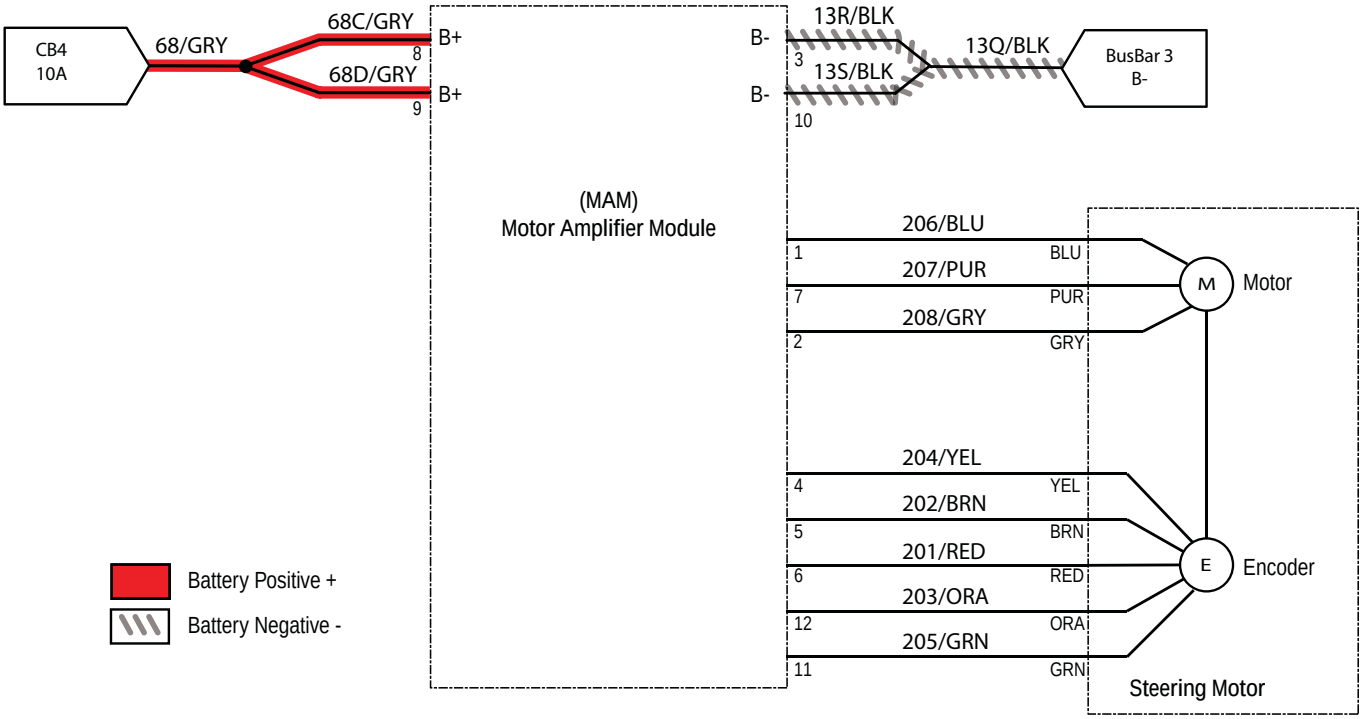
START/PAUSE SWITCH



START/PAUSE SWITCH FAILED TO OPERATE

Step	Action	Value(s)	Yes	No
1	• Key ON • Remove front shroud • Locate BCM (4-pin connector) that contains both the start/pause LED and the start/pause switch signal. • Disconnect one spade terminal at switch-side to remove the led from the circuit.		Check continuity	Identify voltage drop location and repair or replace necessary components

STEERING SUBSYSTEM



STEERING MATRIX (OPTIONAL)

Enabled	Disabled
• Battery voltage > 21.9V, or 9% SOC* for lithium batteries (Inventus)** • E-Stop button(s) not engaged • No faults on steering system	• Battery voltage < 21.9V, or 9% SOC* for lithium batteries (Inventus)** • E-Stop button(s) engaged • Faults on steering system

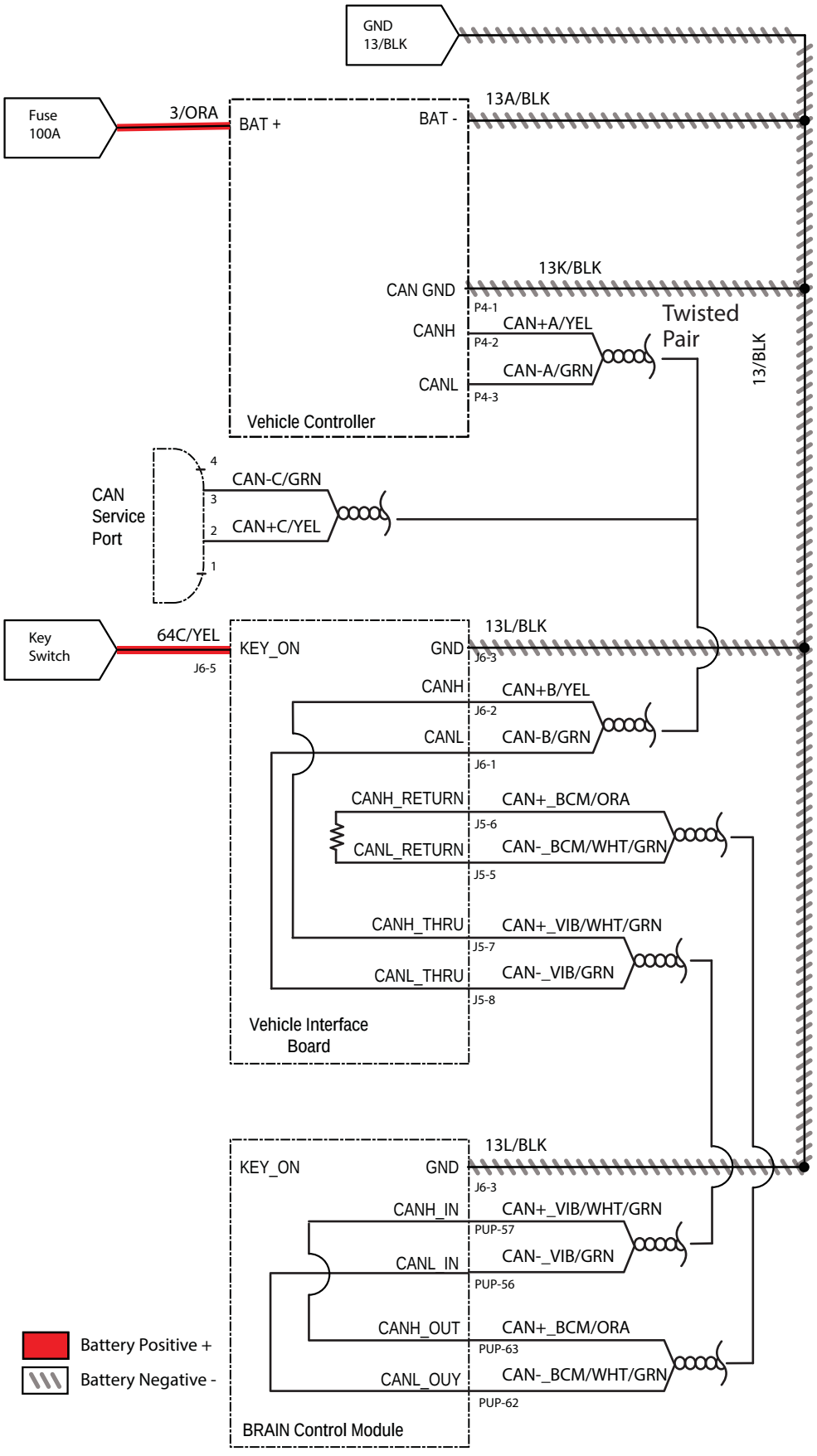
* SOC = State of Charge

** SOC percentages shown when service device is connected to service terminal may not be accurate. Service device must be connected to the lithium battery control board USB cable for accurate SOC percentage. See *ACCESS LITHIUM BATTERY SERVICE SCREEN* in *LITHIUM BATTERIES* section.

STEERING MOTOR FAILED TO OPERATE

Step	Action	Value(s)	Yes	No
1	• Key OFF • Are all interlocks in the proper state to enable the steering system? * Front E-Stop button not engaged * Rear E-Stop button not engaged * Charger not connected		Proceed to STEP 2	Ensure all interlocks are in proper state to enable steering motor
2	• Key OFF • Is circuit breaker #4 tripped? • Firmly press circuit breaker #4 to reset		Reset and test power-up circuit operation	Proceed to STEP 3
3	• Key ON • Test voltage applied to steering subsystem as shown on electrical schematic • Are electrical circuit operating as shown on electrical schematic?			Identify voltage drop location and repair or replace necessary components

CAN (CONTROLLER AREA NETWORK) SYSTEM

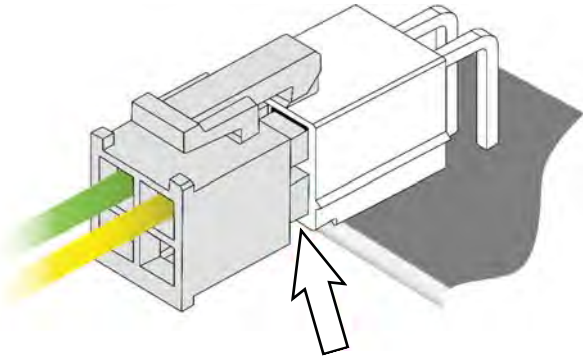


CAN (CONTROLLER AREA NETWORK) OPEN NETWORK ISSUES/TROUBLESHOOTING

The following items include procedures to investigate a fault related to a CAN open network.

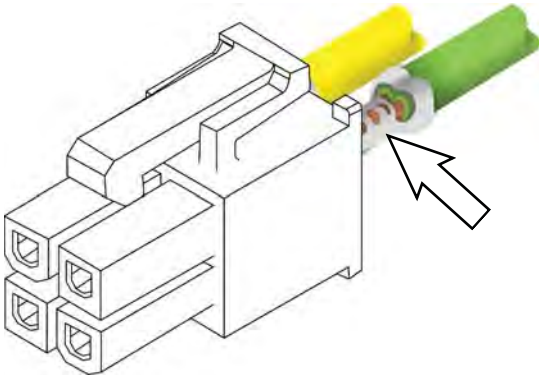
CONNECTOR FULLY SEATED

Each node on the network has a connector for the CAN communication wires. A loose connection could cause a fault code error. Check each board individual to ensure the connectors are fully seated. There may also be other connectors within the harness that should be checked. If the connector is not fully seated, fully seat the connector and power cycle the machine to see if the fault clears.



PIN FULLY SEATED

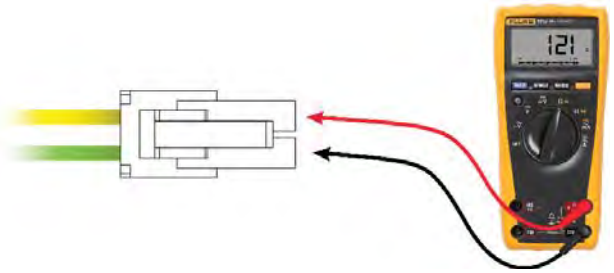
A pin within the harness side of the connector may not be fully seated or may come loose over time causing a fault. If the pin is not fully seated, push it back in and power cycle the machine to see if the fault clears.



NETWORK RESISTANCE

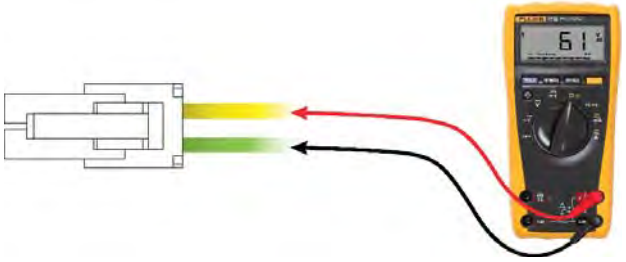
The network resistance must be correct for the network to operate correctly. Depending on which node the measurement is taken at and the method of measurement, the resistance may be one of two values: 121Ω or 61Ω. Any value other than these two means something is wrong with the network.

Method 1



1. Turn off the machine.
2. Locate a CAN node location on the machine.
3. Disconnect the connector containing the CAN wires.
4. Measure the resistance between the green and yellow wires.
5. Depending which nodes are still connected, resistance should be 61Ω or 121Ω.

Method 2



1. Turn off the machine.
2. Locate a CAN node location on the machine.
3. Carefully push probes into the back of the connector containing the CAN wires.
4. Since the network remains connected in this node, resistance should measure approximately 61Ω.

SERVICE

SETTING THE RECOVERY TANK INTO THE SERVICE POSITION

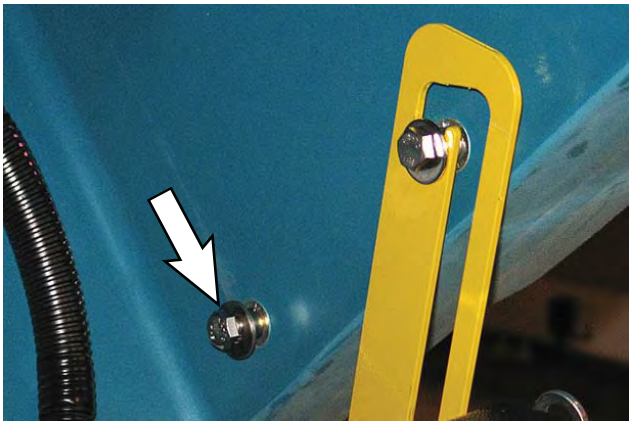
Set the recovery tank into the service position when necessary to access/remove components in the battery/electrical compartment.

1. Turn the key switch OFF and remove the key.

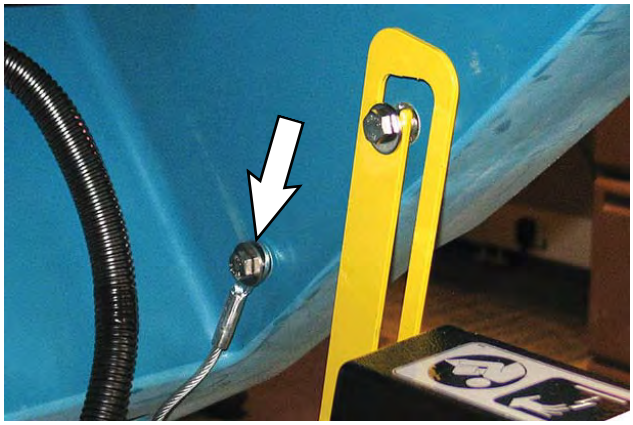
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

2. Lift the recovery tank completely open and engage the recovery tank prop arm.

3. Remove the hardware for the service cable from the recovery tank.\

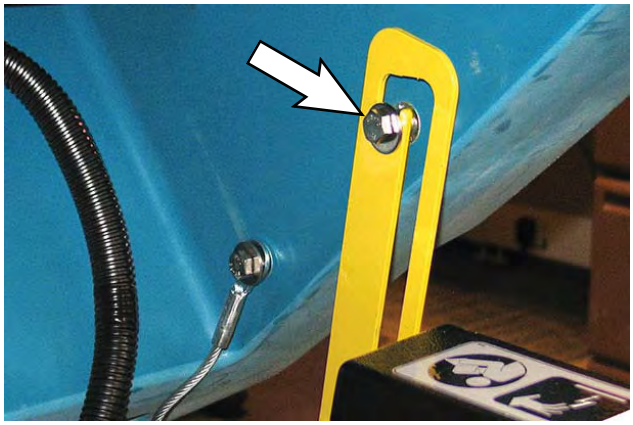


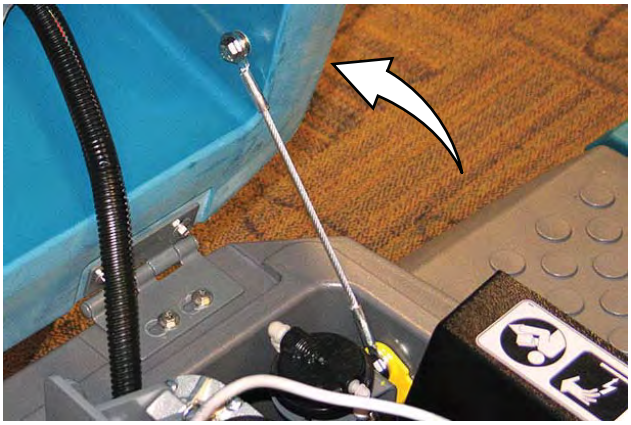
4. Use the hardware removed from the recovery tank in the previous step to secure the service cable to the recovery tank.



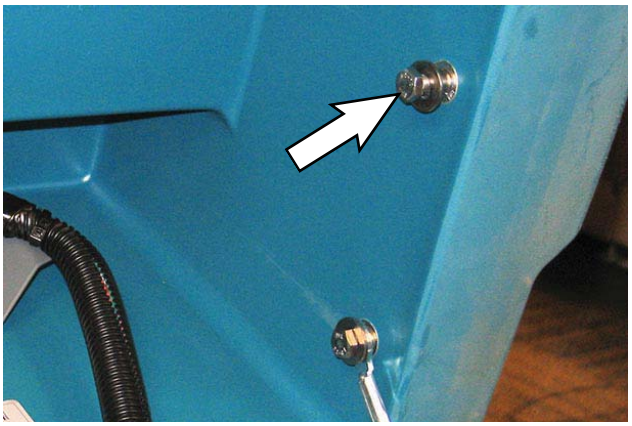
*NOTE: **Do** **Not** remove the hardware securing the prop arm to the recovery tank before securing the service cable to the recovery tank.*

5. Remove the hardware securing the prop arm to the recovery tank and lift the recovery tank open to the service position.





6. Thread the hardware removed in the previous step back into the recovery tank.



7. Complete the necessary maintenance/repairs.

NOTE: The recovery tank must never be left open to the service position after service/repairs are completed. Immediately reinstall the recovery tank prop arm onto the recovery tank when service/repairs are completed.

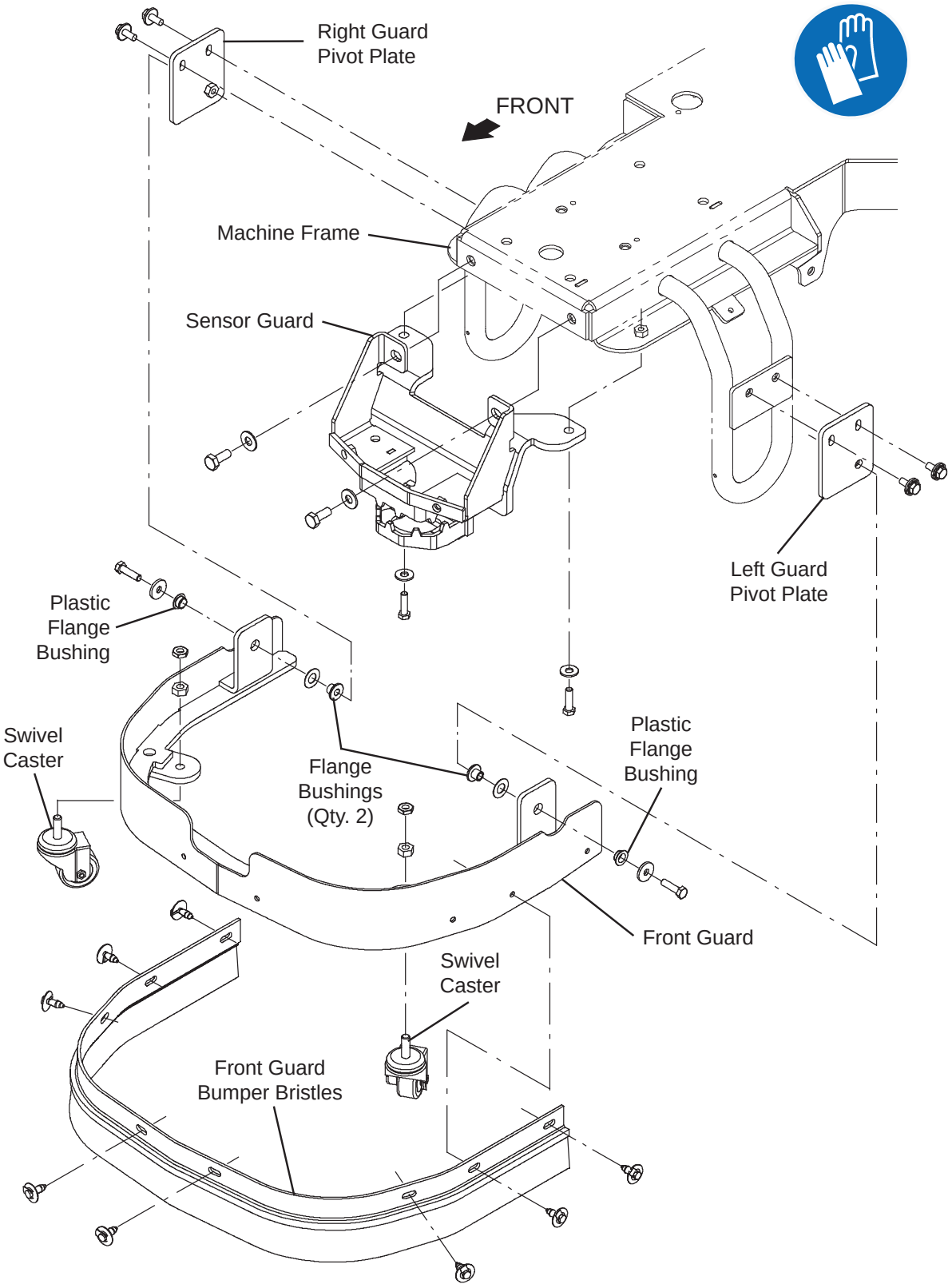
8. When finished with maintenance/repairs, remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.

9. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

10. Thread the hardware removed in the previous step back into the recovery tank.

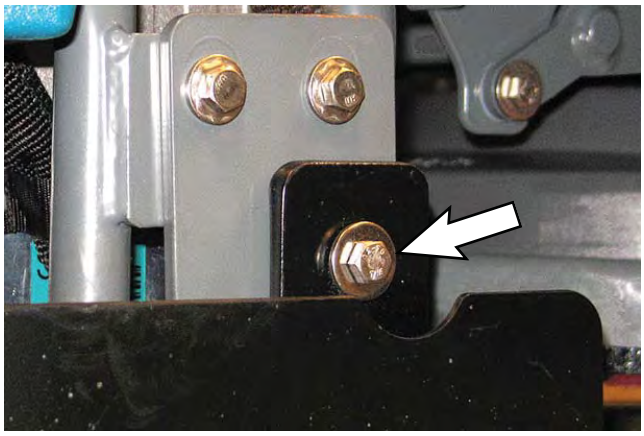
COVERS/SHROUDS/SUPPORT BRACKET/ CHASSIS

REMOVE/REINSTALL THE FRONT GUARD

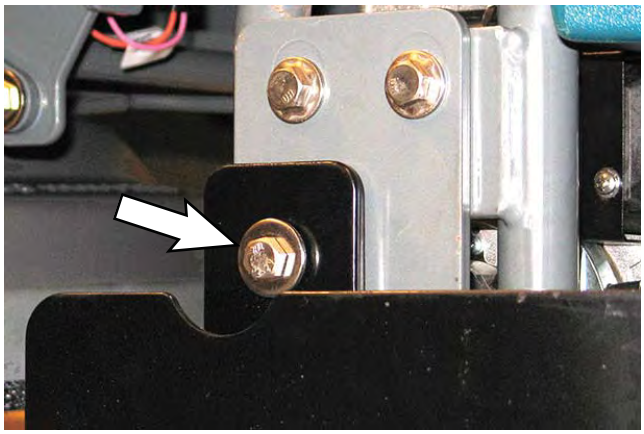


FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely lower the scrub head.
2. Turn the key switch OFF and remove the key.
3. Remove all hardware (hex screws/flat washers/ bushings) securing the support bracket to the mounting bracket.



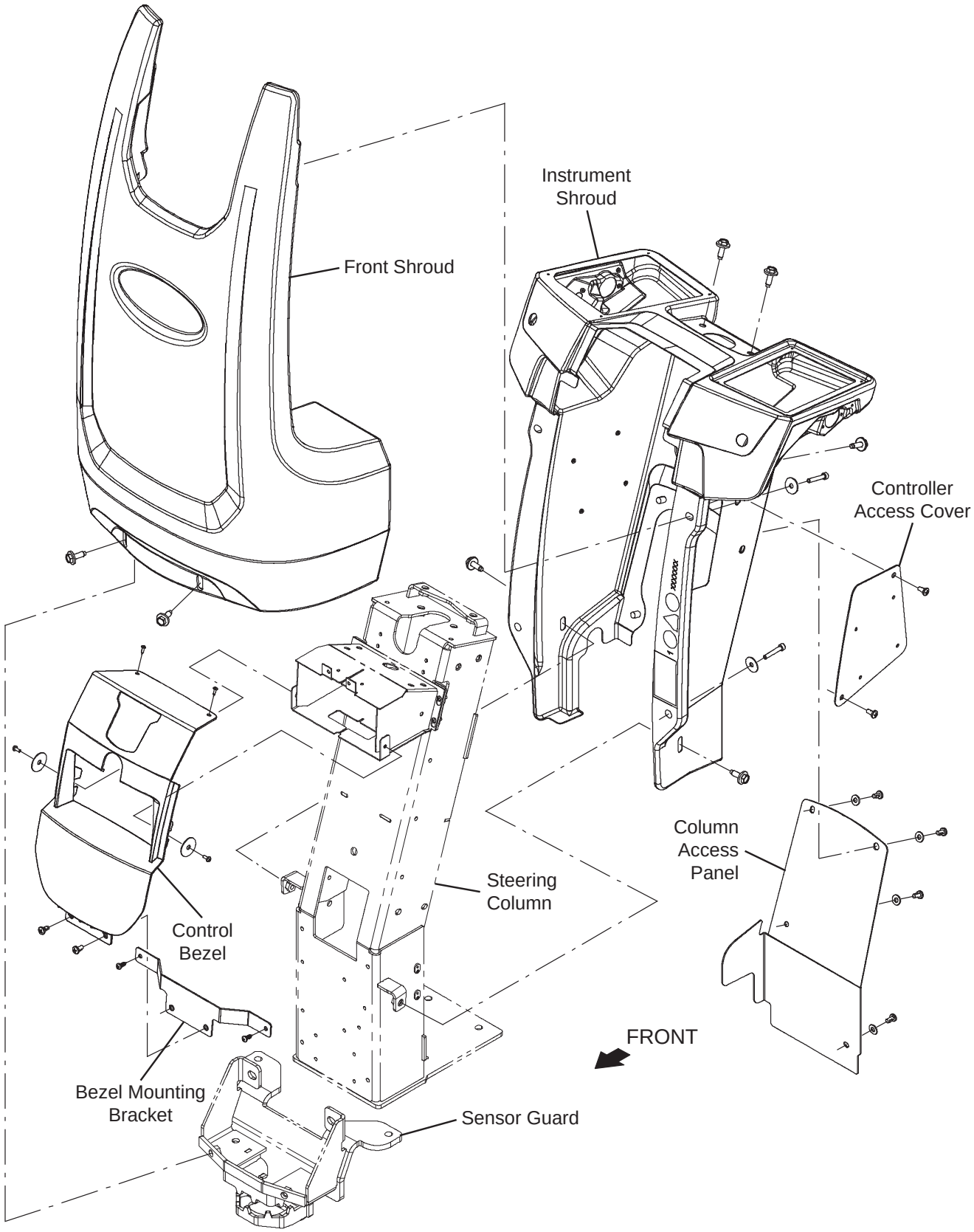
4. Remove all hardware (hex screws/flat washers/ bushings) securing the support bracket to the mounting bracket.



5. Pull the support bracket assembly from under the machine.
6. If replacing the support bracket assembly, remove both caster wheels from the support bracket assembly.

7. Install the caster wheels removed from the removed support bracket assembly onto the new support bracket assembly.
8. Reinstall the removed support bracket assembly/ new support bracket assembly onto the machine in the reverse order of disassembly.

FRONT COVERS GROUP

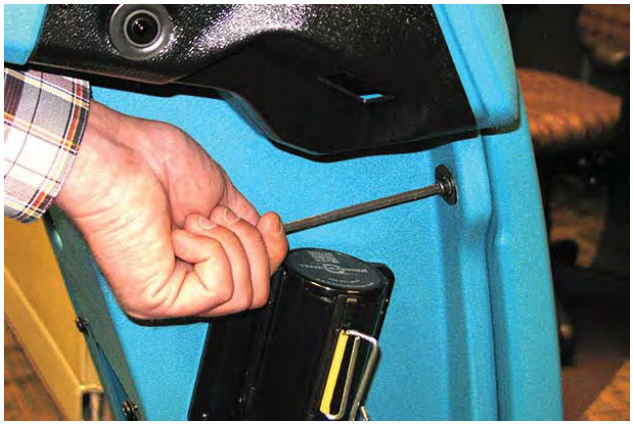


REMOVE THE FRONT COVER FROM THE MACHINE

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Remove the hardware securing the front cover to the lower frame of the machine.

3. Remove the hardware securing the front cover to the instrument shroud.



4. Remove the front shroud from the machine.
5. Reinstall the front shroud onto the machine is reverse order of disassembly.

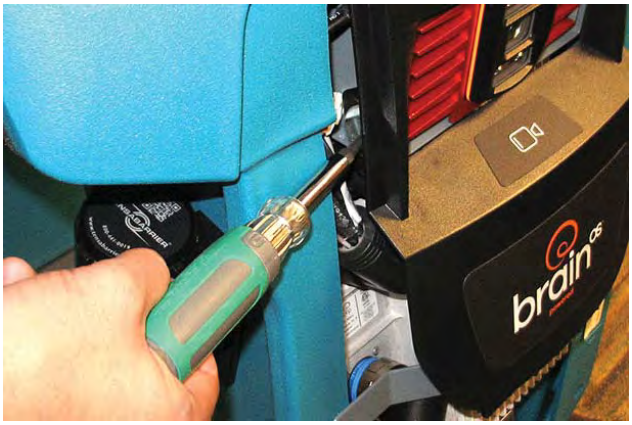
REMOVE THE CONTROL BEZEL FROM THE MACHINE

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Remove the front cover from the machine. See *REMOVE THE FRONT COVER FROM THE MACHINE*.
3. Remove the hardware securing the control bezel to the top of the instrument shroud.

4. Remove the hardware securing the control bezel to the front of the instrument shroud.

5. Loosen the hardware securing the control bezel to the steering column. Do not completely remove this hardware since reinstalling this hardware can be difficult if removed.



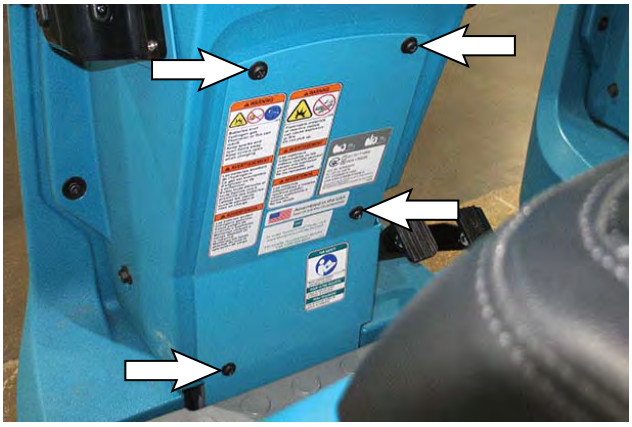
6. Remove the control bezel from the machine.

7. Reinstall the control bezel onto the machine in reverse order of disassembly.

REMOVE THE COLUMN ACCESS PANEL FROM THE MACHINE

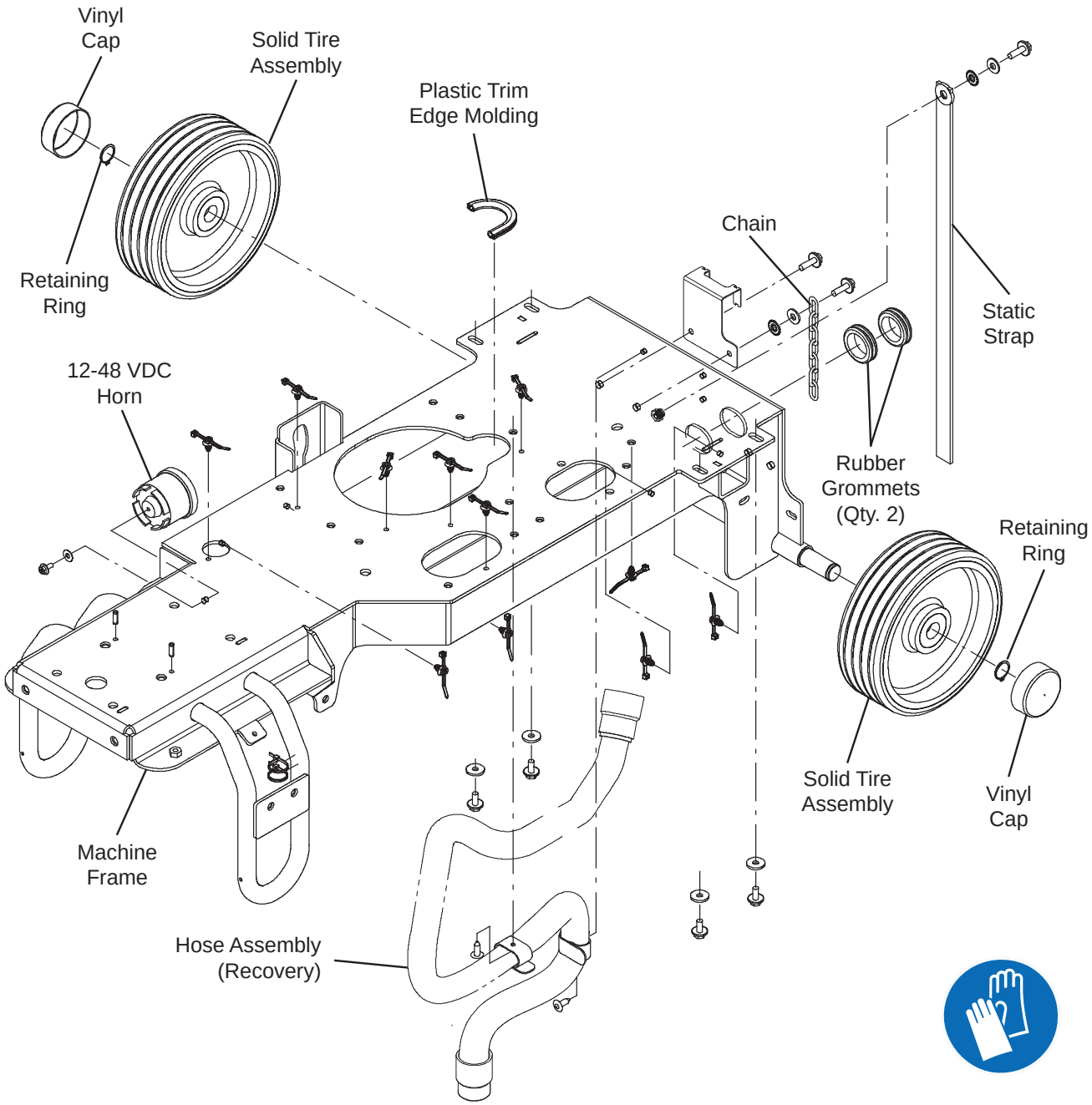
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Remove the hardware securing the column access panel from the instrument shroud.



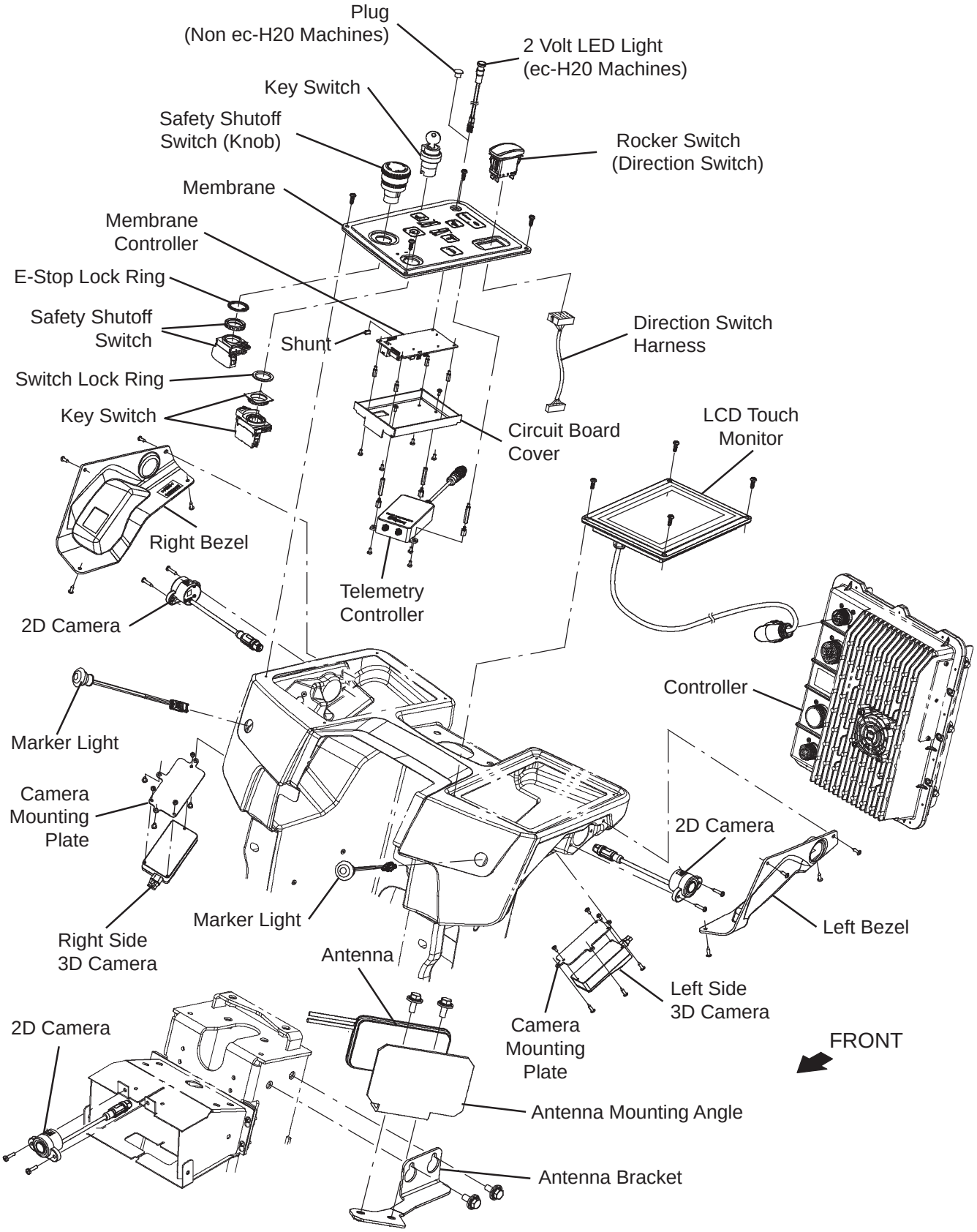
3. Reinstall the column access panel in reverse order of disassembly.

MAIN FRAME GROUP



CONTROLS/SENSORS/CAMERAS

INSTRUMENT PANEL GROUP



REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

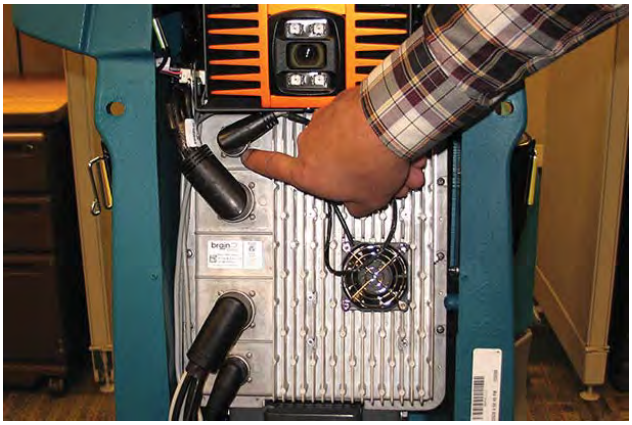
1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

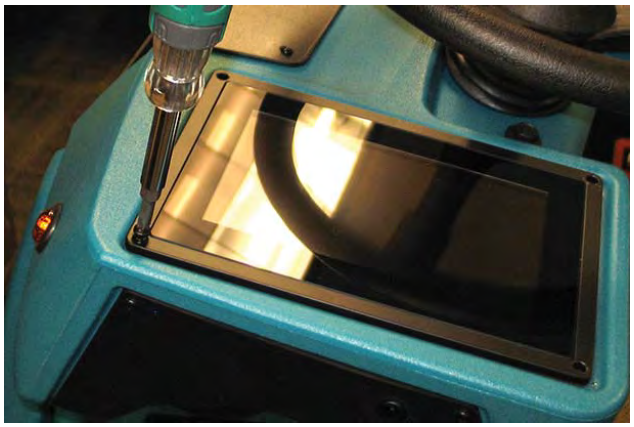
3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

4. Disconnect the touchscreen cable from the Brain Control Module.



5. Cut all cable ties securing the touch screen cable to the machine.
6. Remove the hardware securing the touchscreen to the machine.



7. Carefully lift the touchscreen from the instrument shroud. Carefully pull the touch screen cable up out of the shroud while removing the touch screen.

8. If replacing the touchscreen or if the touchscreen must be completely removed to service or replace other components, disconnect all wire and cable connections from the touchscreen and set the touchscreen aside somewhere where it cannot be damaged.
9. If cable/wire connections were disconnected from the removed touchscreen, connect cable/wire connections to the touchscreen.
10. Reinstall the touchscreen/install the new touchscreen onto the steering shroud.
11. Connect the touchscreen cable to the Brain Control Module.

REMOVE/REINSTALL/REPLACE THE CONTROL PANEL

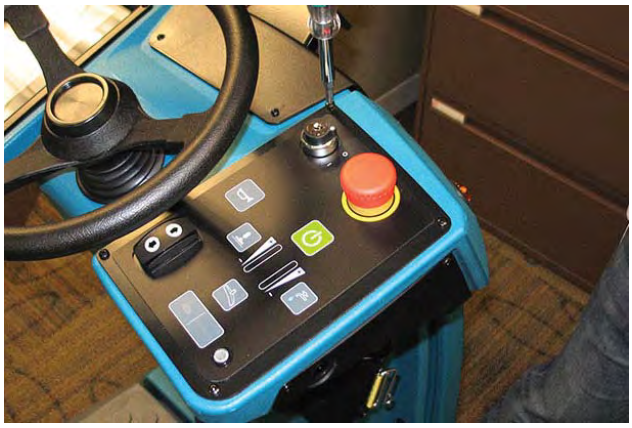
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

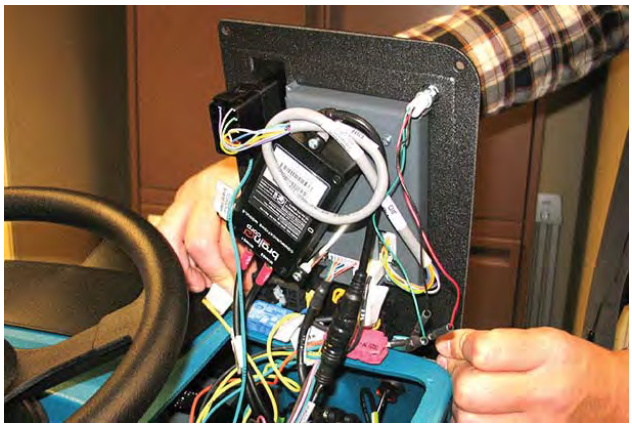
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the machine.



4. Carefully lift the control panel from the steering shroud. Do not break any wire or cable connections when lifting the control panel from the steering shroud.



5. If replacing the control panel or removing the control panel to access/remove/replace other components disconnect all wire and cable connections from the control panel.
6. If replacing the control panel, remove the key switch, directional switch, and E-Stop button from the control panel.
7. If replacing the control panel, install the key switch, directional switch, and E-Stop button removed from the control panel in the previous step onto the new control panel.
8. Connect wire and cable connections to the new control panel/previously removed control panel.
9. Reinstall the control panel onto the steering shroud.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE KEY SWITCH, DIRECTIONAL SWITCH, *ec-H2O* LIGHT, AND E-STOP (EMERGENCY STOP) BUTTON

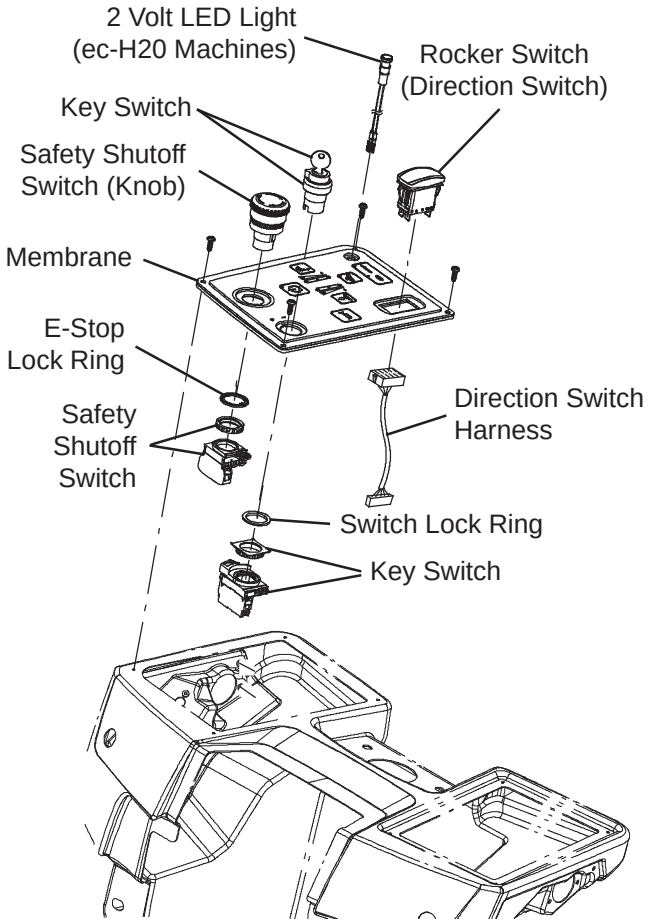
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the control panel from the steering shroud. See REMOVE/REINSTALL/REPLACE THE CONTROL PANEL for additional information.
4. Disconnect the main wire harness connections from the control panel control(s) being replaced.
5. Remove the control panel control(s) being replaced from the control panel.



6. Install the new control panel control(s) into the control panel.
7. Connect the main wire harness connections to the new control panel control(s).
8. Reinstall the control panel onto the shroud.

REMOVE/REINSTALL/REPLACE THE FRONT MARKER LIGHTS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel and/or touchscreen to the steering shroud and carefully lift the control panel and/or touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN and/or REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Disconnect the main wire harness from the marker light(s).
5. Remove the marker light(s) from the shroud.
6. Install the new marker light(s)/removed marker light(s) into the shroud.
7. Connect the main wire harness to the marker light(s).
8. Reinstall the control panel and/or touchscreen onto the shroud.

REMOVE/REINSTALL/REPLACE THE ANTENNA

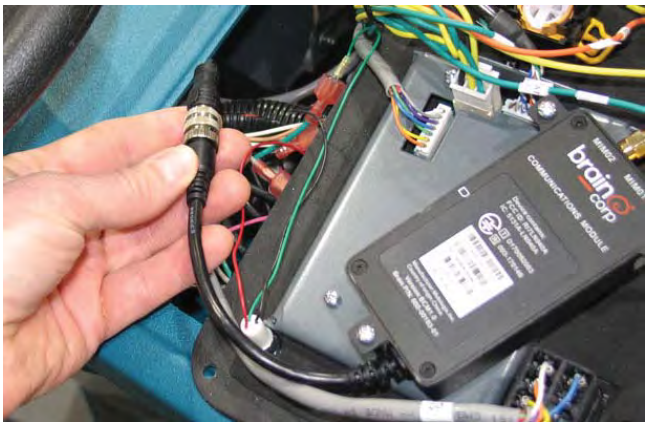
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

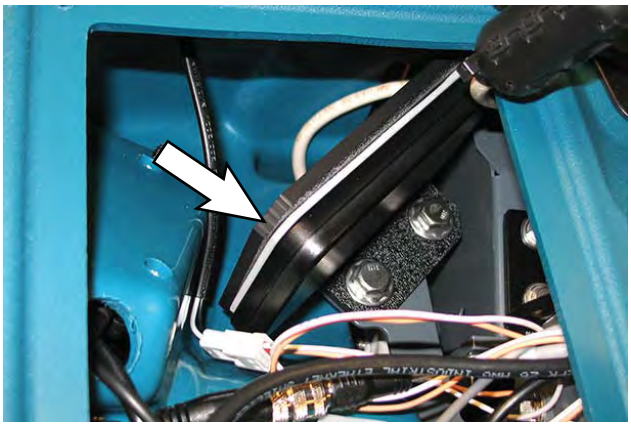
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the steering shroud and carefully lift the control panel touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Remove the hardware securing the touchscreen to the steering shroud and carefully lift the touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN.
5. Disconnect the antenna cable from the telemetry controller.



6. Remove the antenna/antenna bracket from inside the steering shroud.



7. Remove the antenna from the antenna bracket.
8. Clean all remaining adhesive left from the removed antenna from the antenna bracket.
9. Install the new antenna onto the antenna bracket.
10. Install antenna/antenna bracket into the steering shroud.
11. Connect the antenna cable to the telemetry controller.
12. Reinstall components removed to access the antenna in reverse order of disassembly.
13. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE TELEMETRY CONTROLLER

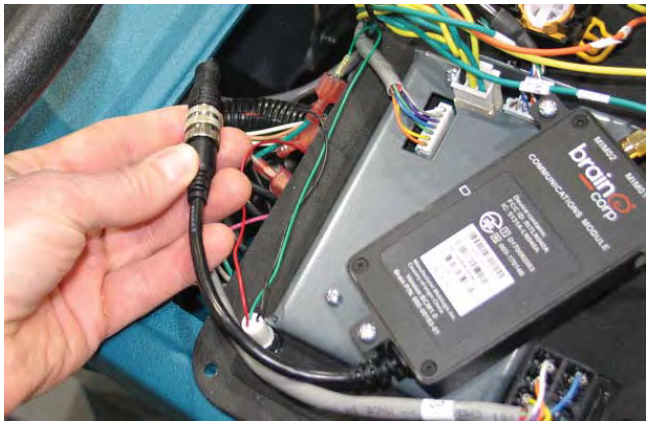
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

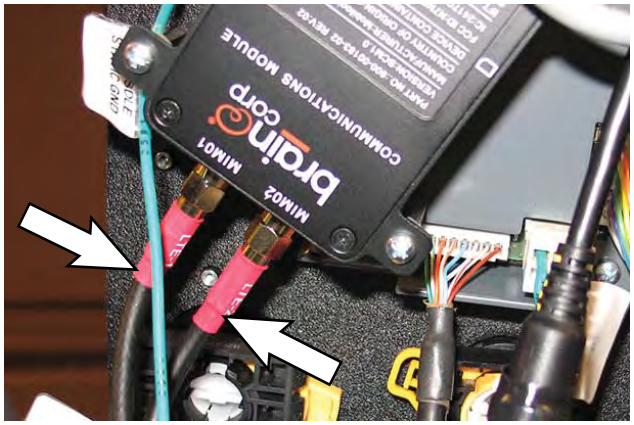
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

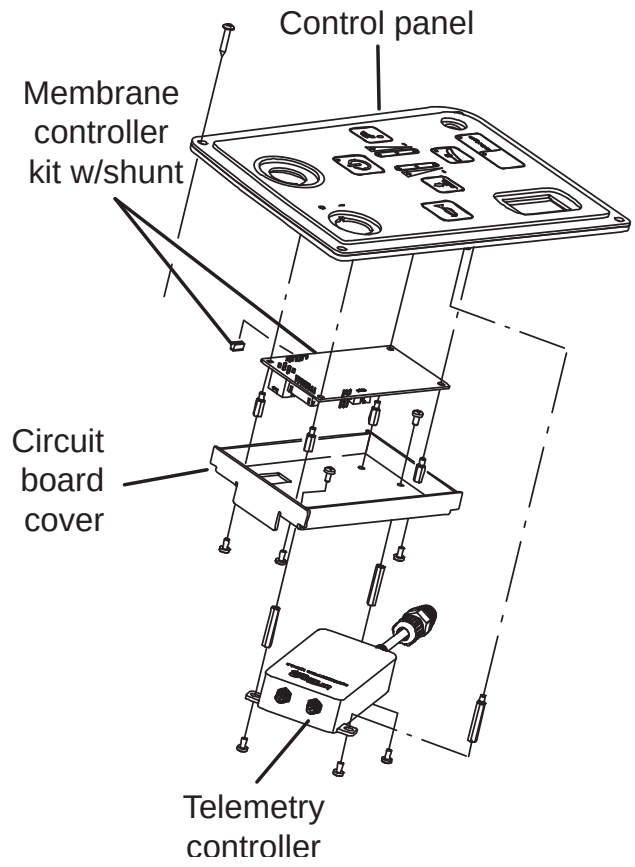
3. Carefully lift the control panel touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Disconnect the wire harness from the telemetry controller.



5. Disconnect the antenna cable connections from the telemetry controller.



6. Remove the telemetry controller from the touch panel assembly.



7. Install the new telemetry controller/removed telemetry controller onto the touch panel assembly.
8. Connect the wire harness to the telemetry controller.
9. Connect the antenna cable to the telemetry controller.
10. Wrap electrical tape around the telemetry controller connections.
11. Reinstall components removed to access the telemetry controller in reverse order of disassembly.
12. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE MEMBRANE CONTROLLER

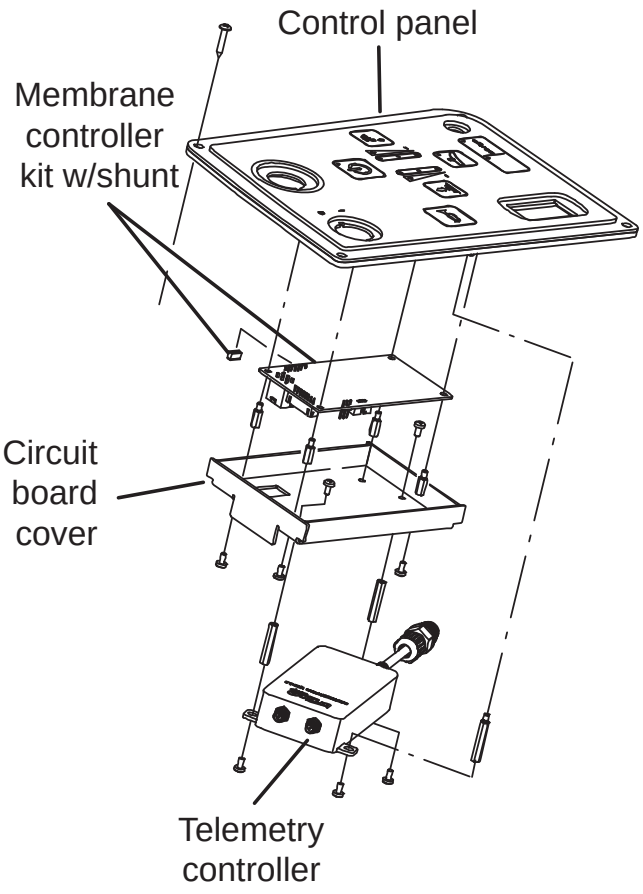
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

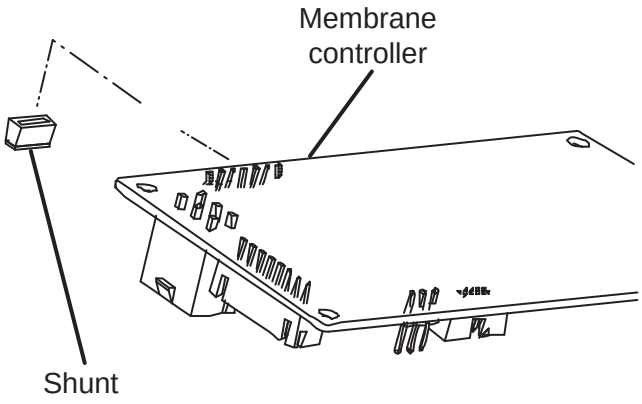
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

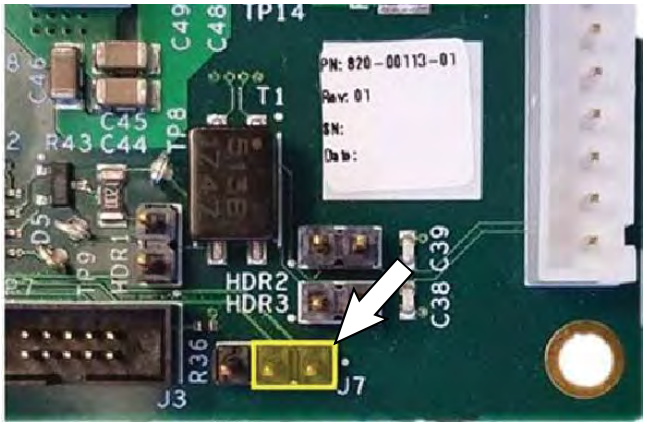
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the control panel to the steering shroud and carefully lift the control panel touchscreen from the shroud. See REMOVE/REINSTALL/REPLACE THE TOUCH PANEL.
4. Remove the telemetry controller from the circuit board cover/control panel. See REMOVE/REINSTALL/REPLACE THE TELEMETRY CONTROLLER.



5. Disconnect the wire harness from the membrane controller assembly.
6. Remove the circuit board cover/membrane controller from the control panel.
7. Remove the membrane controller from the circuit board cover.
8. Machines equipped with *ec-H2O* option ONLY: Install the shunt onto the new membrane controller. Note position of the shunt in terminal J7 on the membrane controller terminal.





9. Install the new membrane controller onto the circuit board cover.
10. Install the circuit board cover/membrane controller onto the control panel.
11. Connect the wire harness to the membrane controller.
12. Reinstall components removed to access the membrane controller in reverse order of disassembly.

REMOVE/REINSTALL/REPLACE THE SIDE 2D CAMERAS

Clean the side 2D cameras after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the cameras. Do not apply water to the cameras or the microfiber cloth.

NOTE: Do not scratch or damage the side 2D camera lenses. Robotic machine performance could be adversely affected if the camera lenses is scratched or damaged.

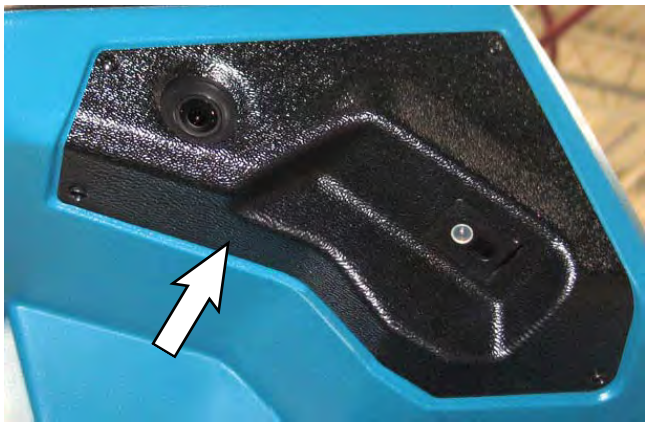
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

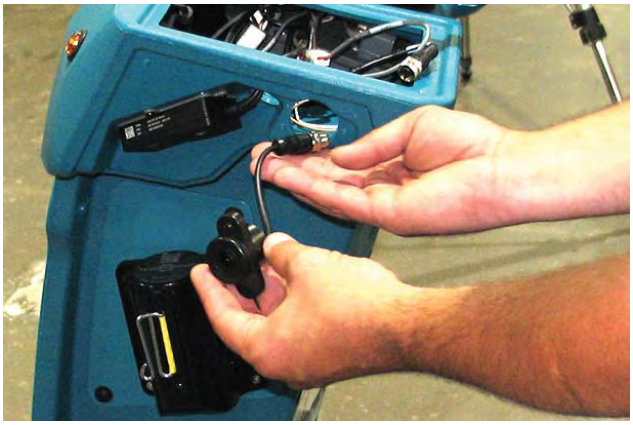
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the touchscreen and/or the control panel (depending on which camera(s) are being replaced) from the machine. See REMOVE/REINSTALL/REPLACE THE CONTROL PANEL and/or REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN for additional information.
4. Remove the side cover from the steering shroud.



5. Disconnect the main wire harness from the camera.
6. Remove the 2D camera from the steering shroud.



7. Install the new 2D camera into the steering shroud.
8. Connect the main wire harness to the new 2D camera.
9. Reinstall components removed to access the 2D camera in reverse order of disassembly.
10. Repeat procedure if replacing the 2D camera located on the other side of the steering shroud.
11. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE SIDE 3D CAMERAS

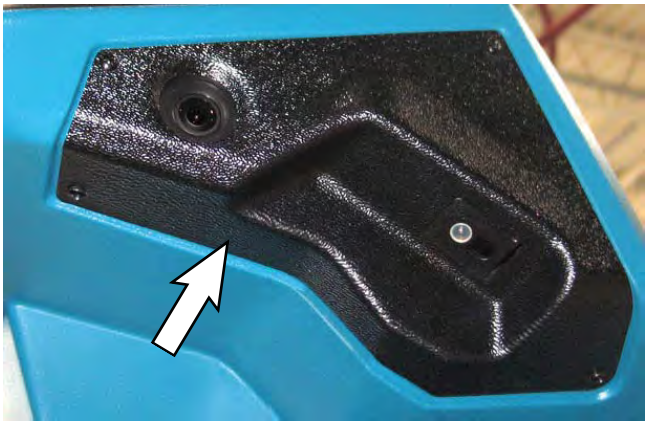
NOTE: Clean the side 3D camera(s) after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the cameras. Do not apply water to the cameras or the microfiber cloth.

NOTE: Do not scratch or damage the side 3D camera lens. Robotic machine performance could be adversely affected if the camera lens is scratched or damaged.

1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the touchscreen/control panel from the steering shroud to allow access to harness connection inside the steering shroud. See REMOVE/REINSTALL/REPLACE THE TOUCHSCREEN or CONTROL PANEL.
4. Remove the side cover from the steering shroud.



5. Remove the hardware securing the side 3D camera to the steering shroud.

6. Disconnect the wire harness from the side 3D camera.

7. Remove the side 3D camera assembly from the machine.

8. If replacing the side 3D camera, remove the side 3D camera from the camera mounting plate.

9. If replacing the side 3D camera, install the new side 3D camera onto the camera mounting plate.

10. Install the new side 3D camera/reinstall removed side 3D camera onto the steering shroud in reverse order of disassembly.

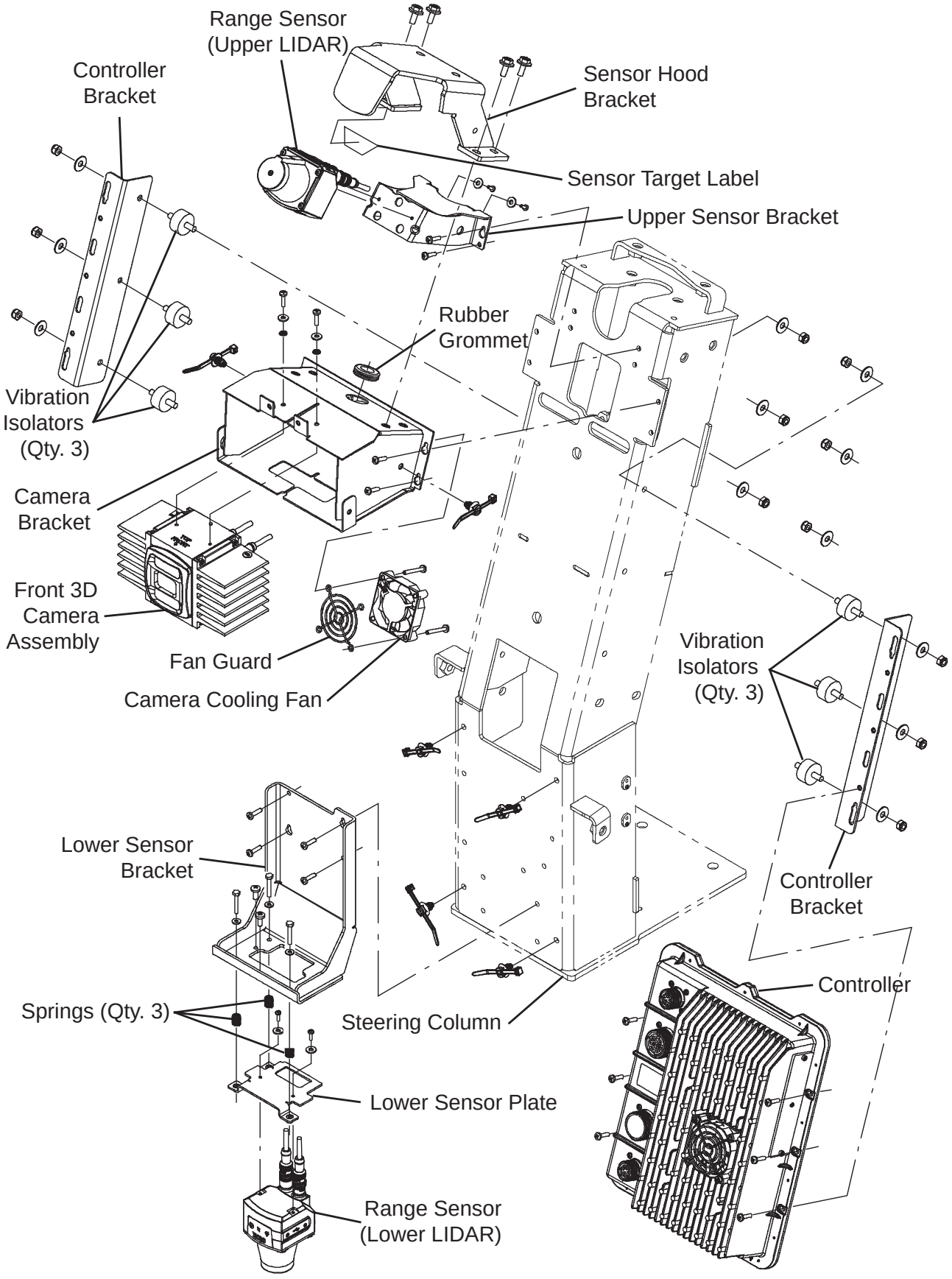
11. Calibrate the side 3D camera. See the Side 3D Camera Adjustment/Calibration document for instructions how to calibrate/adjust the side 3D cameras.

12. Repeat procedure if replacing the side 3D camera located on the other side of the steering shroud.

13. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

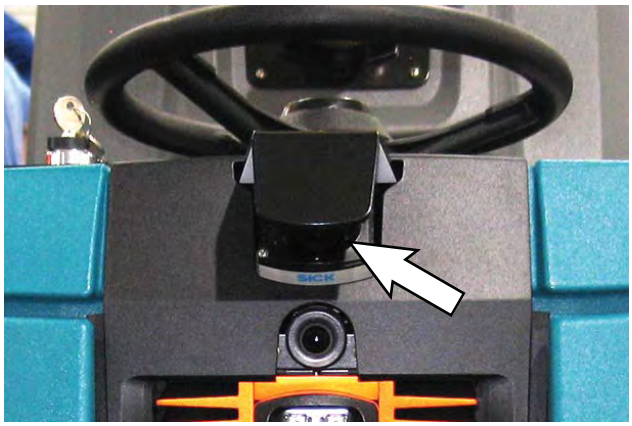
FRONT CAMERAS AND SENSORS



REMOVE/REINSTALL/REPLACE THE FRONT UPPER RANGE SENSOR (LIDAR)

NOTE: Clean the front upper LIDAR after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the LIDAR. Do not apply water to the LIDAR or the microfiber cloth.

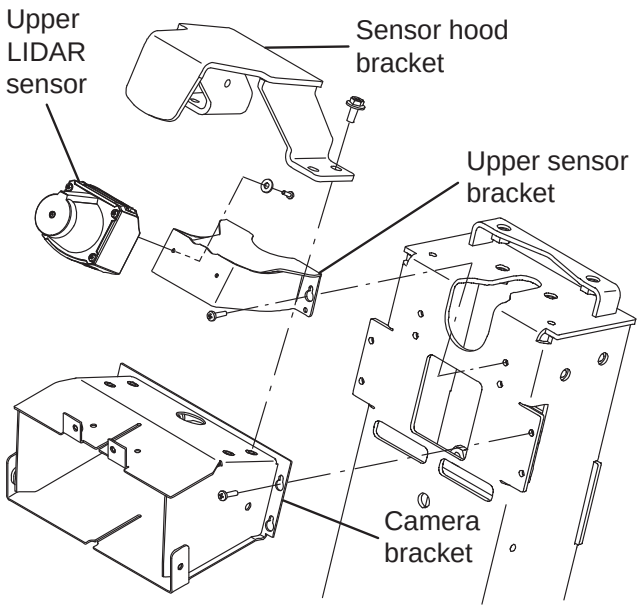
NOTE: Do not scratch or damage the front upper LIDAR . Robotic machine performance could be adversely affected if the LIDAR is scratched or damaged.



1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Remove the control bezel from the machine. See REMOVE THE CONTROL BEZEL FROM THE MACHINE.
5. Remove the hardware securing the sensor hood bracket to the camera bracket.
6. Disconnect the wire harness from the upper LIDAR.
7. Remove the sensor hood bracket/upper LIDAR from the machine.



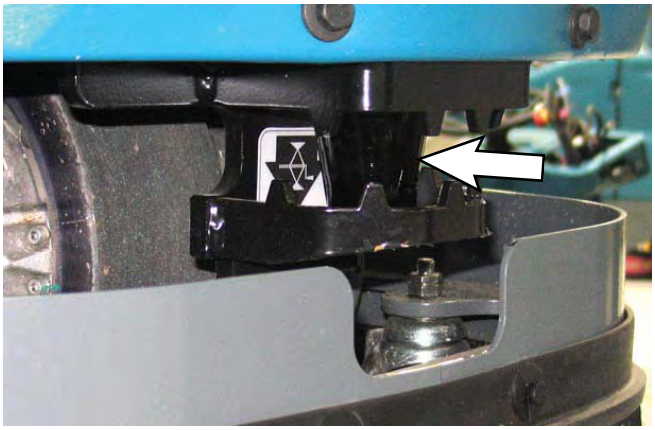
8. Remove the upper LIDAR from the sensor hood bracket.
9. Install the new upper LIDAR/reinstall the removed upper LIDAR onto the machine in reverse order of disassembly.
10. Reconnect the battery cable to the machine.
11. Calibrate the upper LIDAR. See the Front Upper Range Sensor (LIDAR) Adjustment/Calibration document for instructions how to calibrate/adjust the upper LIDAR.
12. Reinstall the center bezel and front shroud onto the machine in reverse order of disassembly.
13. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE FRONT LOWER RANGE SENSOR (LIDAR)

NOTE: Clean the front lower LIDAR after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the LIDAR. Do not apply water to the LIDAR or the microfiber cloth.

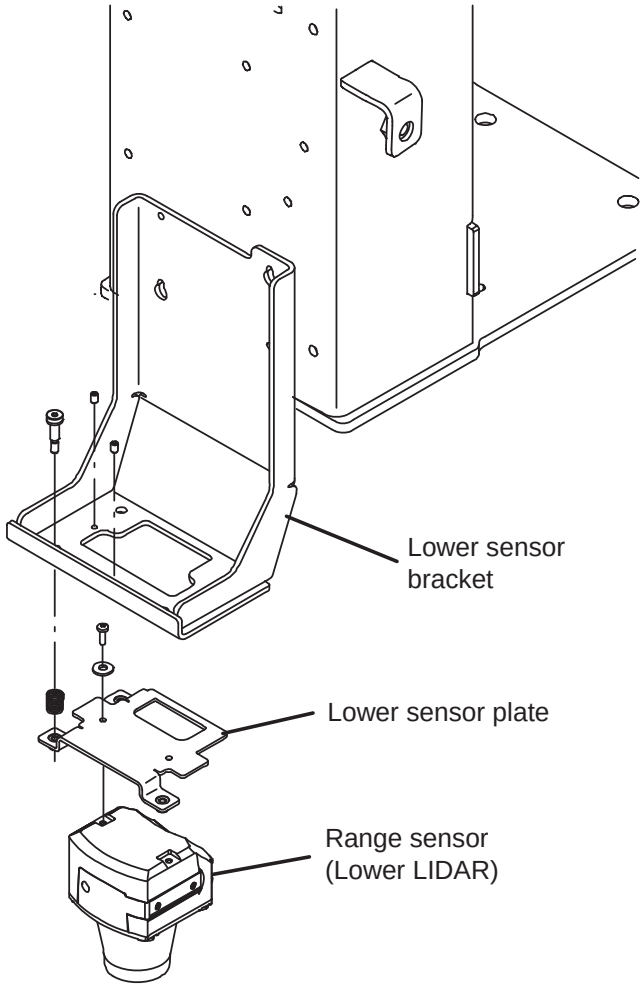
NOTE: Do not scratch or damage the front lower LIDAR . Robotic machine performance could be adversely affected if the LIDAR is scratched or damaged.



1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Disconnect the wire harness from the lower LIDAR.
5. Remove the lower LIDAR from the lower sensor bracket.



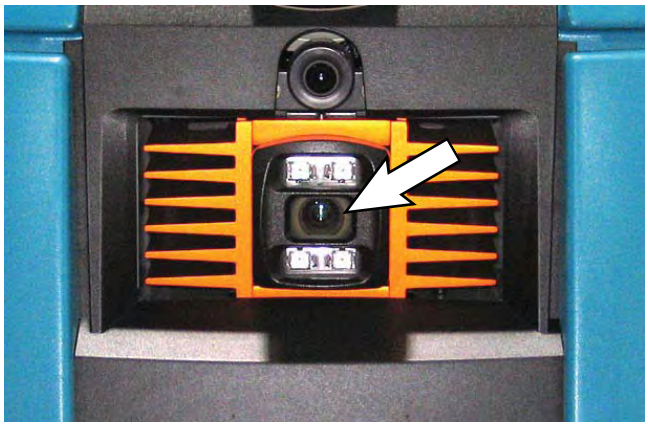
6. Install the new lower LIDAR/reinstall the removed lower LIDAR onto the machine in reverse order of disassembly.
7. Reconnect the battery cable to the machine.
8. Calibrate the lower LIDAR. See the Front Lower Range Sensor (LIDAR) Adjustment/Calibration document for instructions how to calibrate/adjust the lower LIDAR.
9. Reinstall the front cover onto the machine in reverse order of disassembly.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE FRONT 3D CAMERA

NOTE: Clean the front 3D camera after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the camera. Do not apply water to the camera or the microfiber cloth

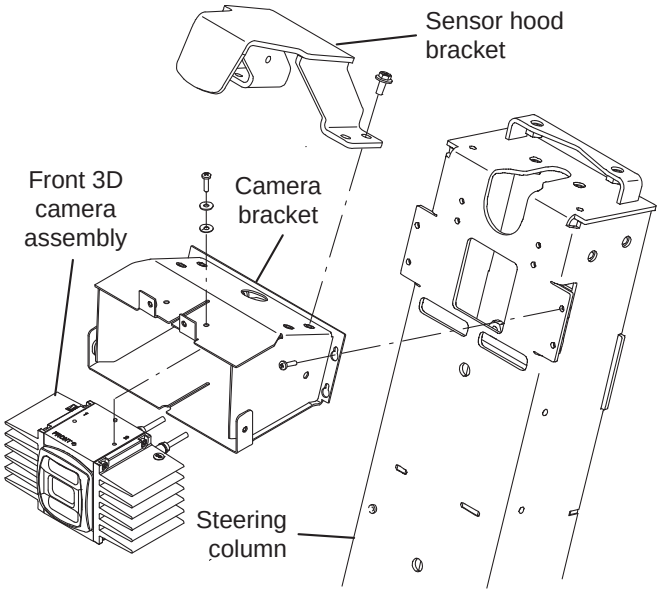
NOTE: Do not scratch or damage the front 3D camera lens when removing/installing the camera. Robotic machine performance could be adversely affected if the camera lens is scratched or damaged during disassembly/assembly.



1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Remove the control bezel from the machine. See REMOVE THE CONTROL BEZEL FROM THE MACHINE.
5. Remove the hardware securing the front 3D camera to the camera bracket.



6. Carefully pull the front 3D camera from the camera bracket, disconnect the harness from the camera, and completely remove the camera from the bracket.
7. Install the new front 3D camera/reinstall the removed front 3D camera into the camera bracket in reverse order of disassembly.
8. Reconnect the battery cable to the machine.
9. Calibrate the front 3D camera. See the Front 3D Camera Adjustment/Calibration document for instructions how to calibrate/adjust the front 3D camera.
10. Reinstall the center bezel and front shroud onto the machine in reverse order of disassembly.
11. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE FRONT 2D CAMERA

Clean the front 2D camera after completing maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the camera. Do not apply water to the camera or the microfiber cloth.

NOTE: Do not scratch or damage the 2D camera lens. Robotic machine performance could be adversely affected if the camera lens is scratched or damaged.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Remove the front bezel from the machine. See REMOVE THE CONTROL BEZEL FORM THE MACHINE.
5. Remove the front 2D camera from the camera bracket.

6. Disconnect the wire harness from the front 2D camera.
7. Install the new front 2D camera/removed front 2D camera onto the camera bracket.
8. Connect the wire harness to the front 2D camera.
9. Reinstall components removed to access the front 2D camera in reverse order of disassembly.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE BRAIN CONTROLLER

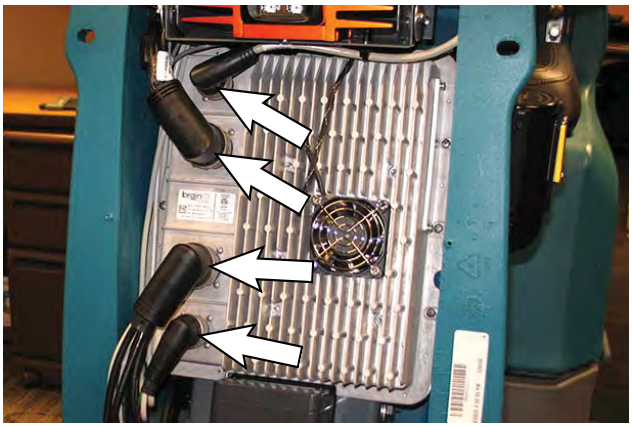
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Remove the front bezel from the machine. See REMOVE THE CONTROL BEZEL FORM THE MACHINE.
5. Disconnect all wire harness connections from the Brain controller.



6. Remove the Brain controller from the steering column.
7. Install the new Brain controller/removed Brain controller onto the steering column.
8. Connect the wire harness connections to the Brain controller.
9. Reinstall components removed to access the Brain controller in reverse order of disassembly.
10. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

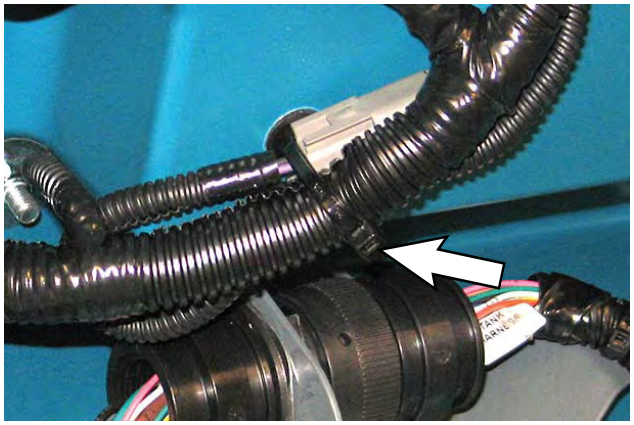
REMOVE/REINSTALL/REPLACE THE OPERATOR SEAT/OPERATOR SEAT SWITCH

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
3. Disconnect the battery cable from the machine.

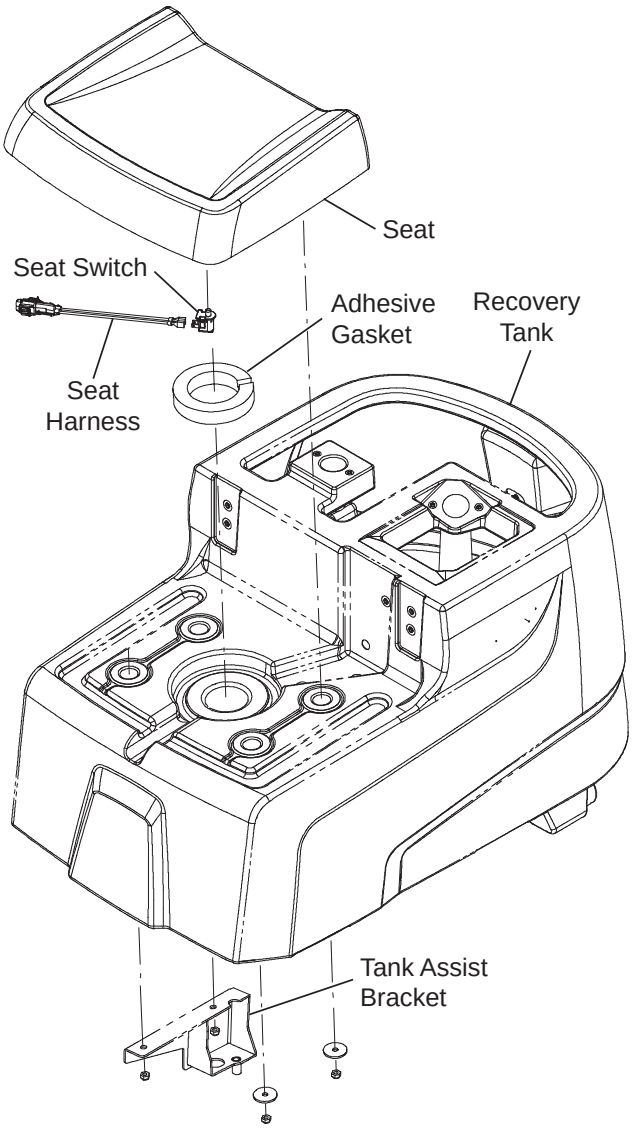
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

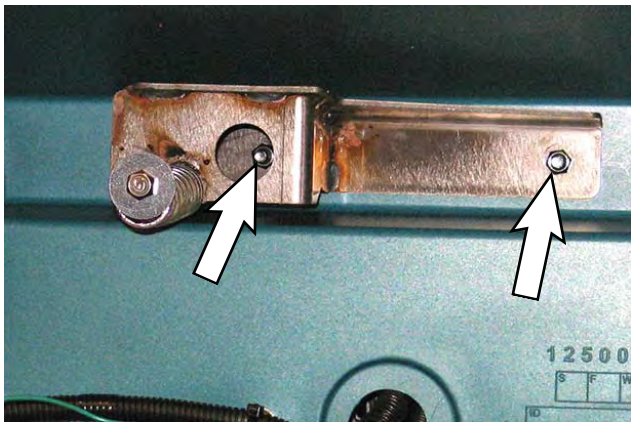
4. Cut the cable tie securing the seat switch harness to the main wire harness.

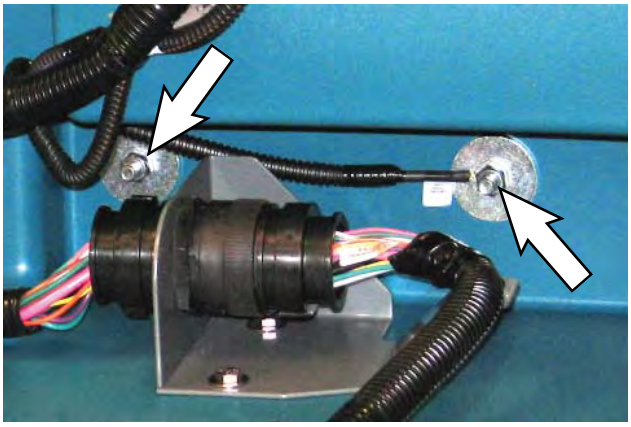


5. Disconnect the seat switch harness from the main wire harness.

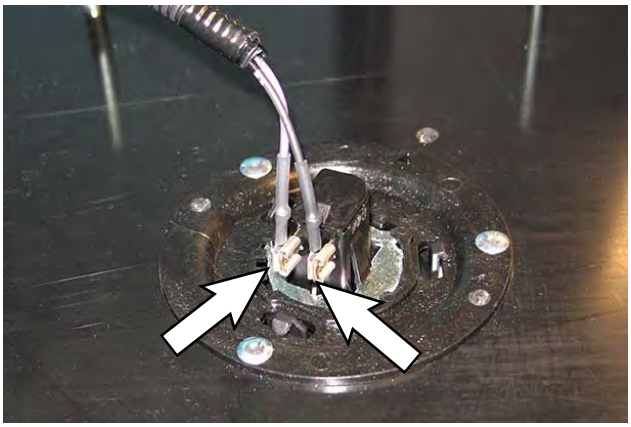
6. Remove the hardware securing the seat to the recovery tank.



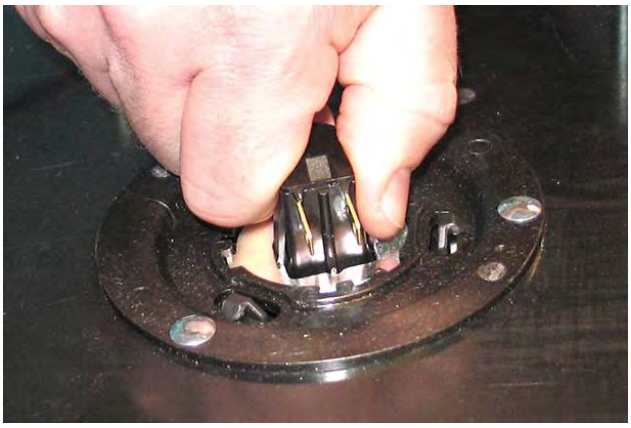




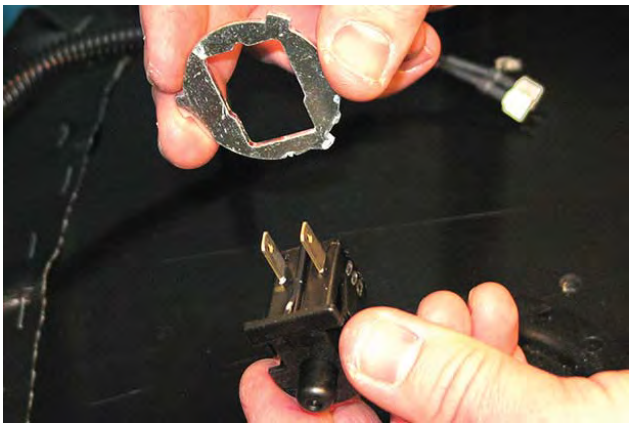
7. Carefully remove the seat from the recovery tank.
8. Disconnect the seat switch harness connections from the seat switch.



9. If replacing the seat switch, twist the seat switch from the seat.

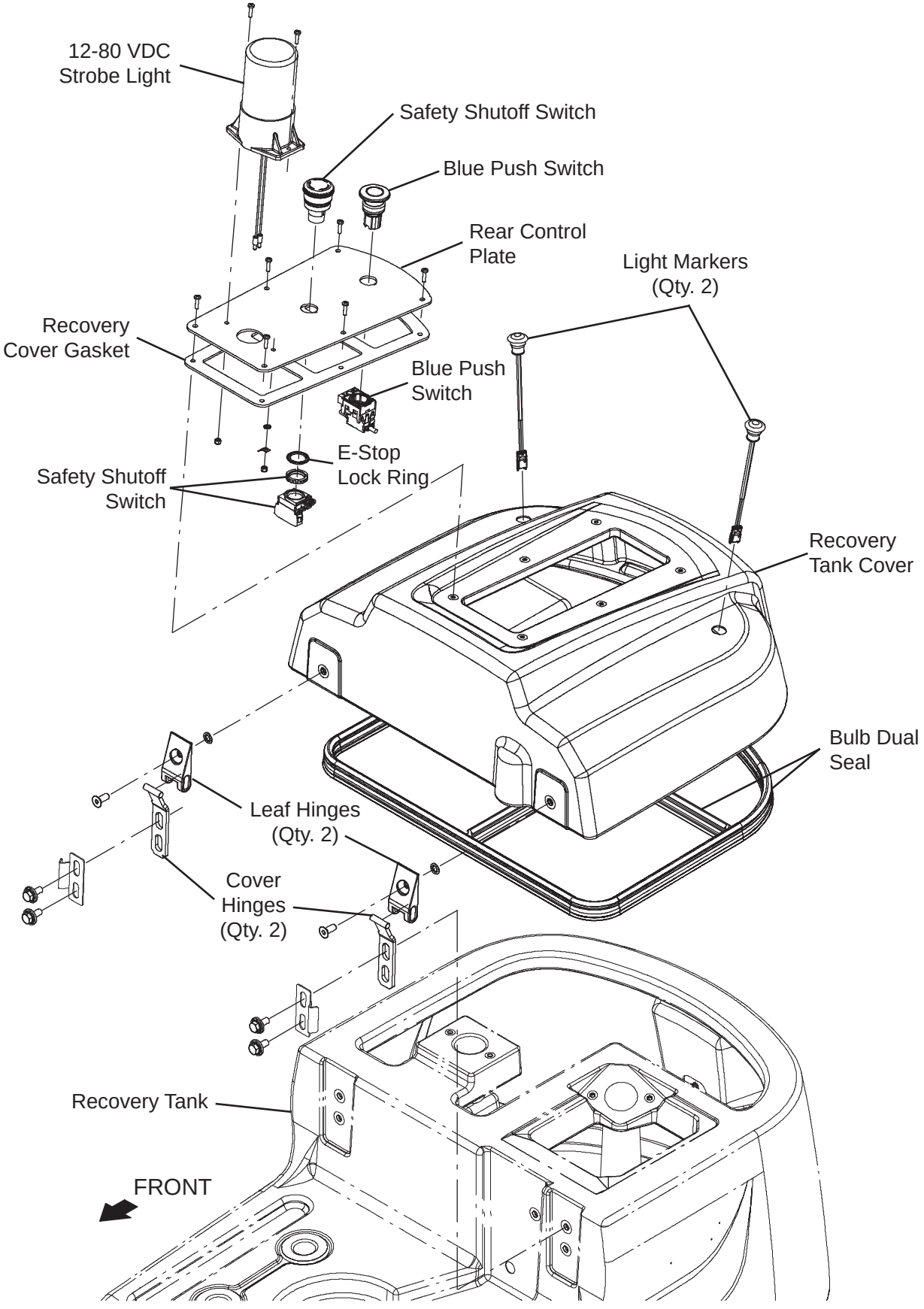


10. If replacing the seat switch, remove the adapter from the seat switch.



11. If replacing seat switch, install the adapter onto the new seat switch.
12. Install the new seat switch/reinstall seat switch onto the seat in reverse order of disassembly.
13. Install the seat/main harness ground connection onto the recovery tank. Torque the seat hardware to 4.25 Nm (3.13 ft lb).
14. Connect seat switch harness to the main wire harness.
15. Use a cable tie to secure the seat switch harness to the main wire harness.
16. Reconnect the battery cable to the machine.
17. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.
18. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

RECOVERY TANK COVER CONTROLS/ COMPONENTS



REMOVE/REINSTALL/REPLACE THE REAR START/ PAUSE BUTTON

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

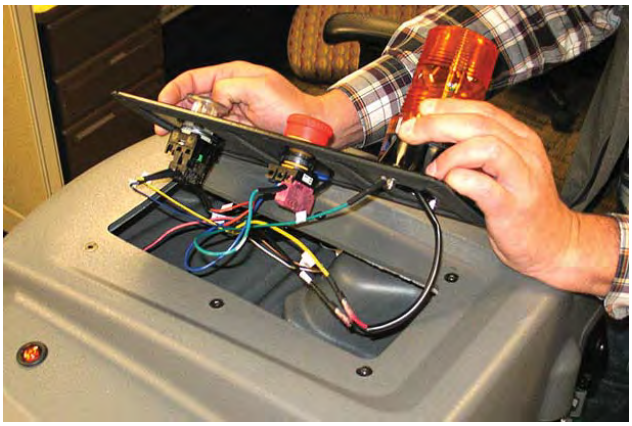
1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

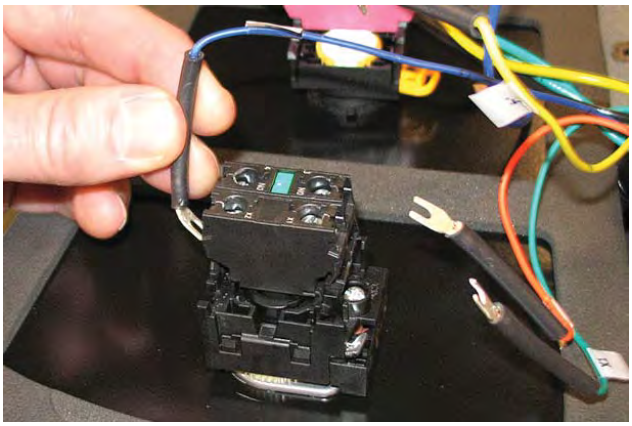
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the rear control plate to the recovery tank cover.

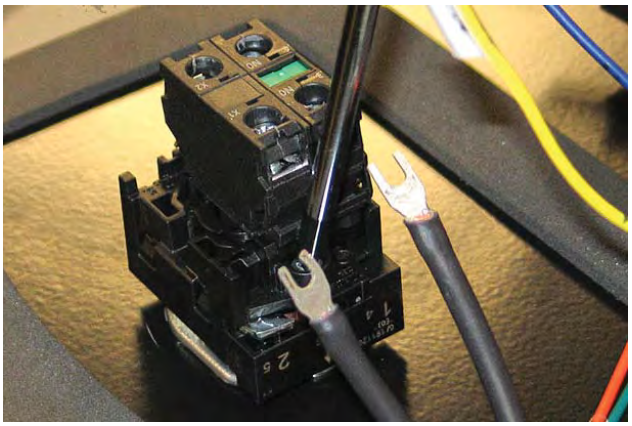
4. Carefully pull the rear control plate from the recovery tank cover. Do Not break or damage wire/ cable connections when pulling the rear control plate from the recovery tank cover.



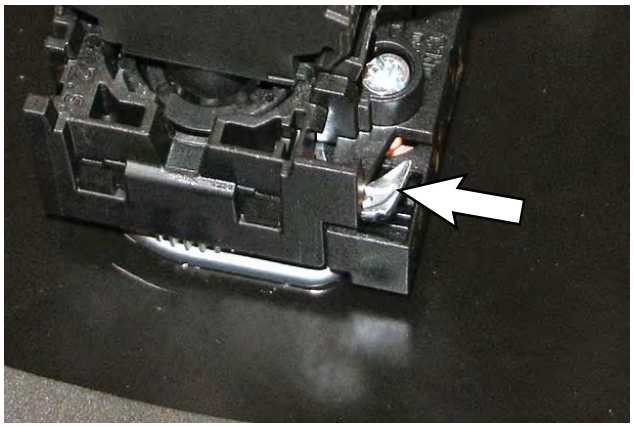
5. Loosen the connection screws and disconnect the harness connections from the blue start/pause button assembly.



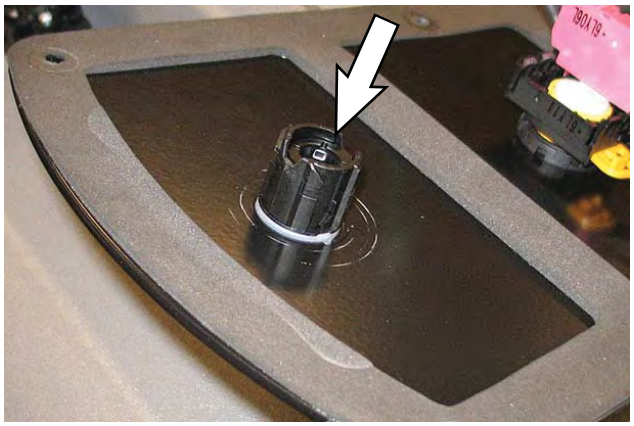
6. Loosen the retainer screw securing the start/pause button assembly to the rear control plate.



7. Press the retainer lever and remove the start/pause button assembly from the start/pause button plate.



8. Remove the button from the rear control panel.



9. Loosen the new retainer screw on the start/pause button body.

10. Install the new start/pause button assembly onto the start/pause button plate and tighten the retainer screw to secure the start/pause button assembly into place.

11. Connect the harness connections to the start/pause button assembly.

12. Install the start/pause button assembly onto the rear control panel.

REMOVE/REINSTALL/REPLACE THE REAR E-STOP (EMERGENCY STOP) BUTTON

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

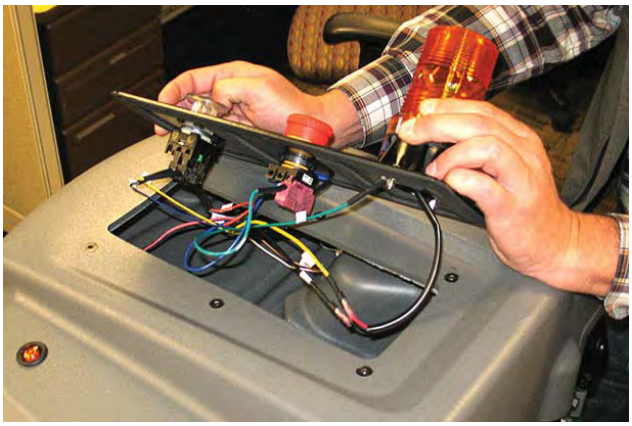
1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

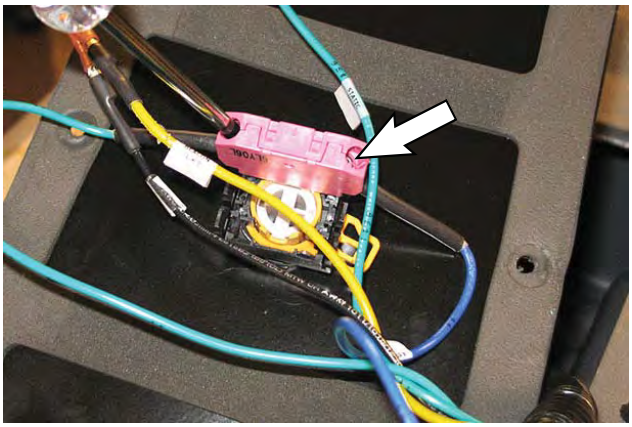
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the rear control plate to the recovery tank cover.

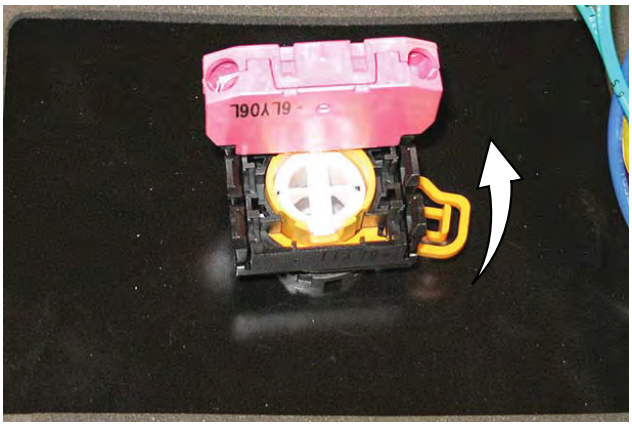
4. Carefully pull the rear control plate from the recovery tank cover. Do Not break or damage wire/cable connections when pulling the rear control plate from the recovery tank cover.

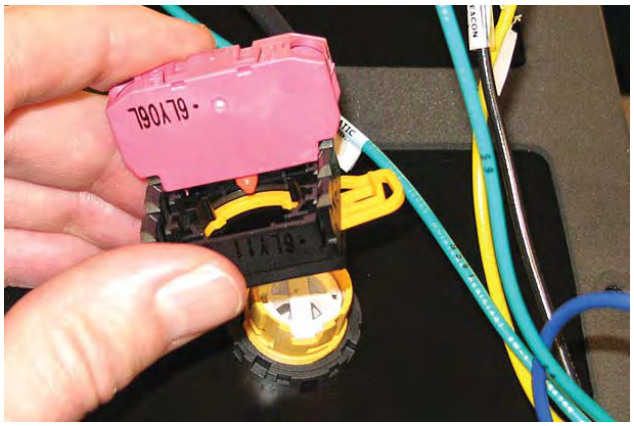


5. Disconnect the harness connections from the E-Stop button connector.

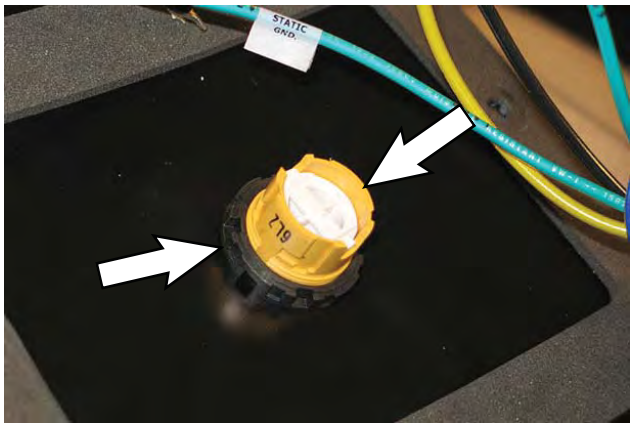


6. Push the lever to disconnect the E-Stop button connector from the E-Stop button.





7. Remove the E-Stop button/E-stop lock ring from the rear control plate.



8. Reinstall E-Stop button assembly/install new E-Stop button assembly onto the rear control plate in reverse order of disassembly.

REMOVE/REINSTALL/REPLACE THE REAR MARKER LIGHTS

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

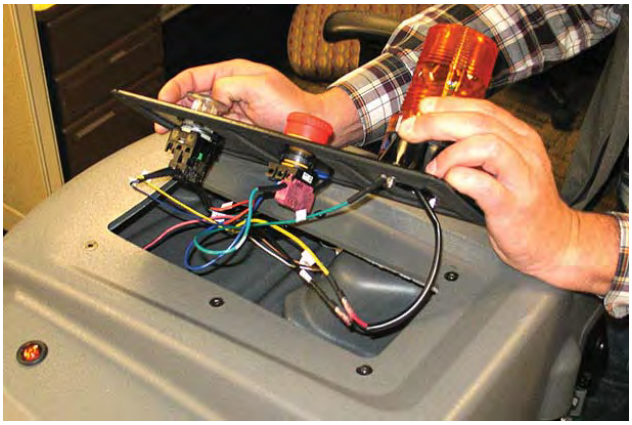
1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

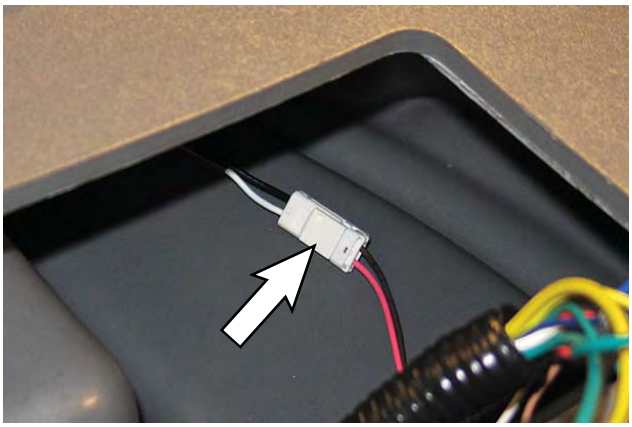
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the rear control plate to the recovery tank cover.

4. Carefully pull the rear control plate from the recovery tank cover. Do Not break or damage wire/cable connections when pulling the rear control plate from the recovery tank cover.



5. Disconnect the main wire harness from the marker light(s).



6. Pull the marker light(s) from the recovery tank cover.
7. Install the new marker light(s)/removed marker light(s) into the recovery tank cover.
8. Connect the main wire harness to the marker light(s).
9. Install the recovery tank cover onto the fan mounting plate.

REMOVE/REINSTALL/REPLACE THE STROBE LIGHT

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

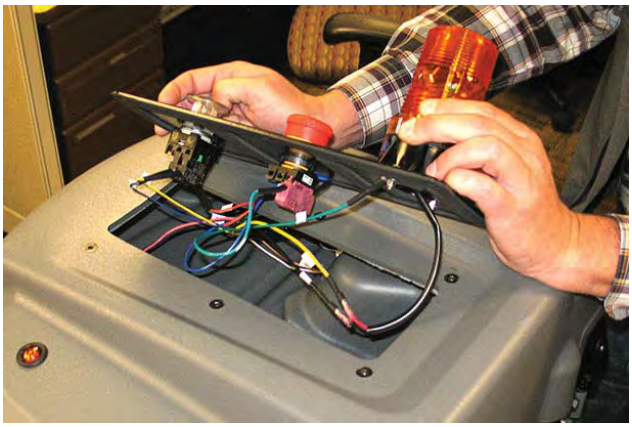
1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

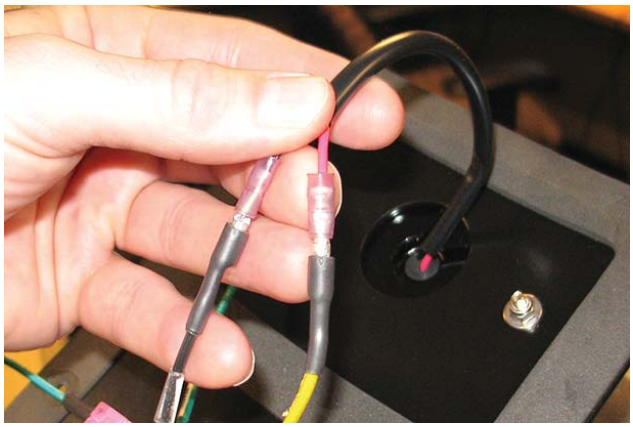
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the hardware securing the rear control plate to the recovery tank cover.

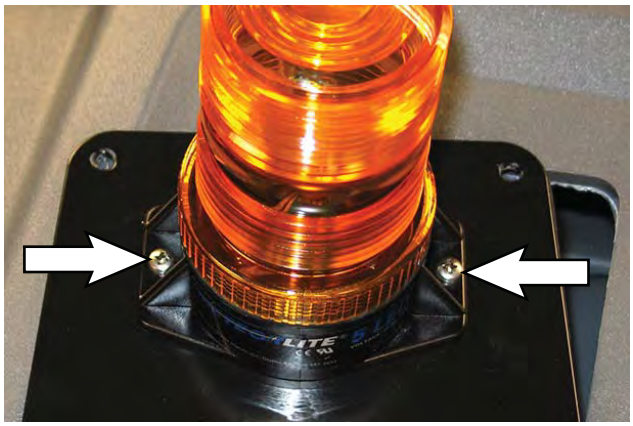
4. Carefully pull the rear control plate from the recovery tank cover. Do Not break or damage wire/cable connections when pulling the rear control plate from the recovery tank cover.

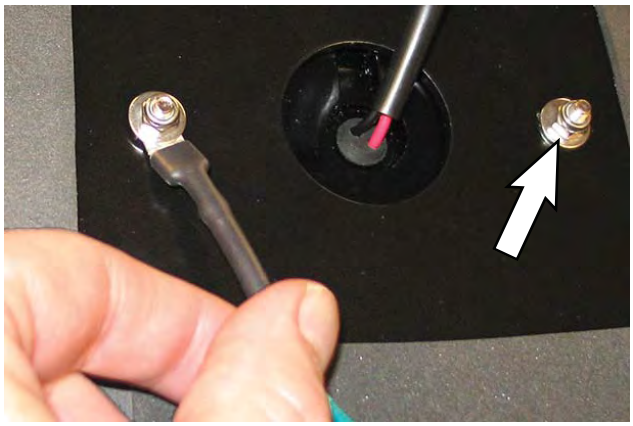


5. Disconnect both wire harness connections from the strobe light.



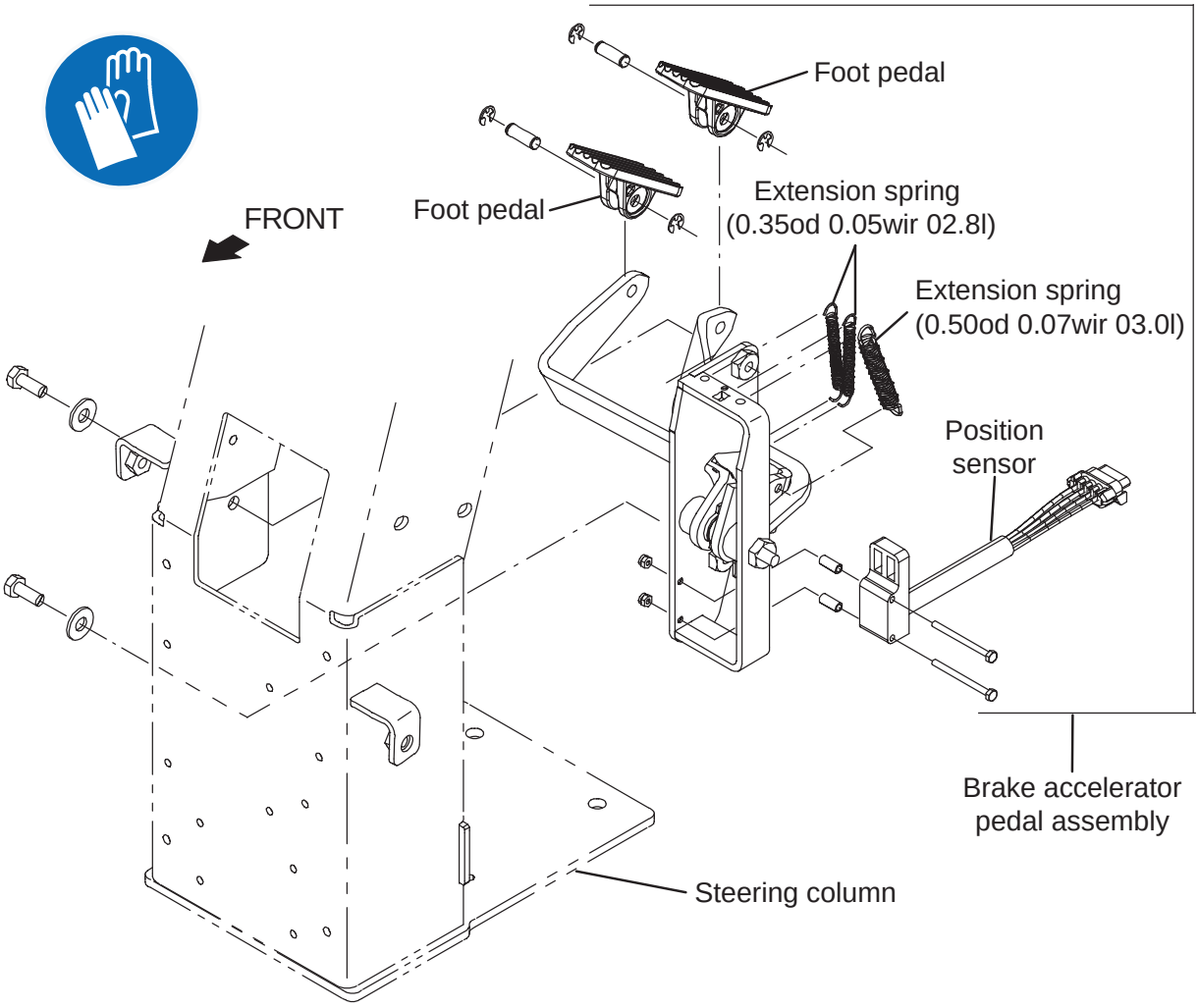
6. Remove the hardware securing the strobe light and ground wire to the rear control panel and remove the strobe light from the rear control panel.



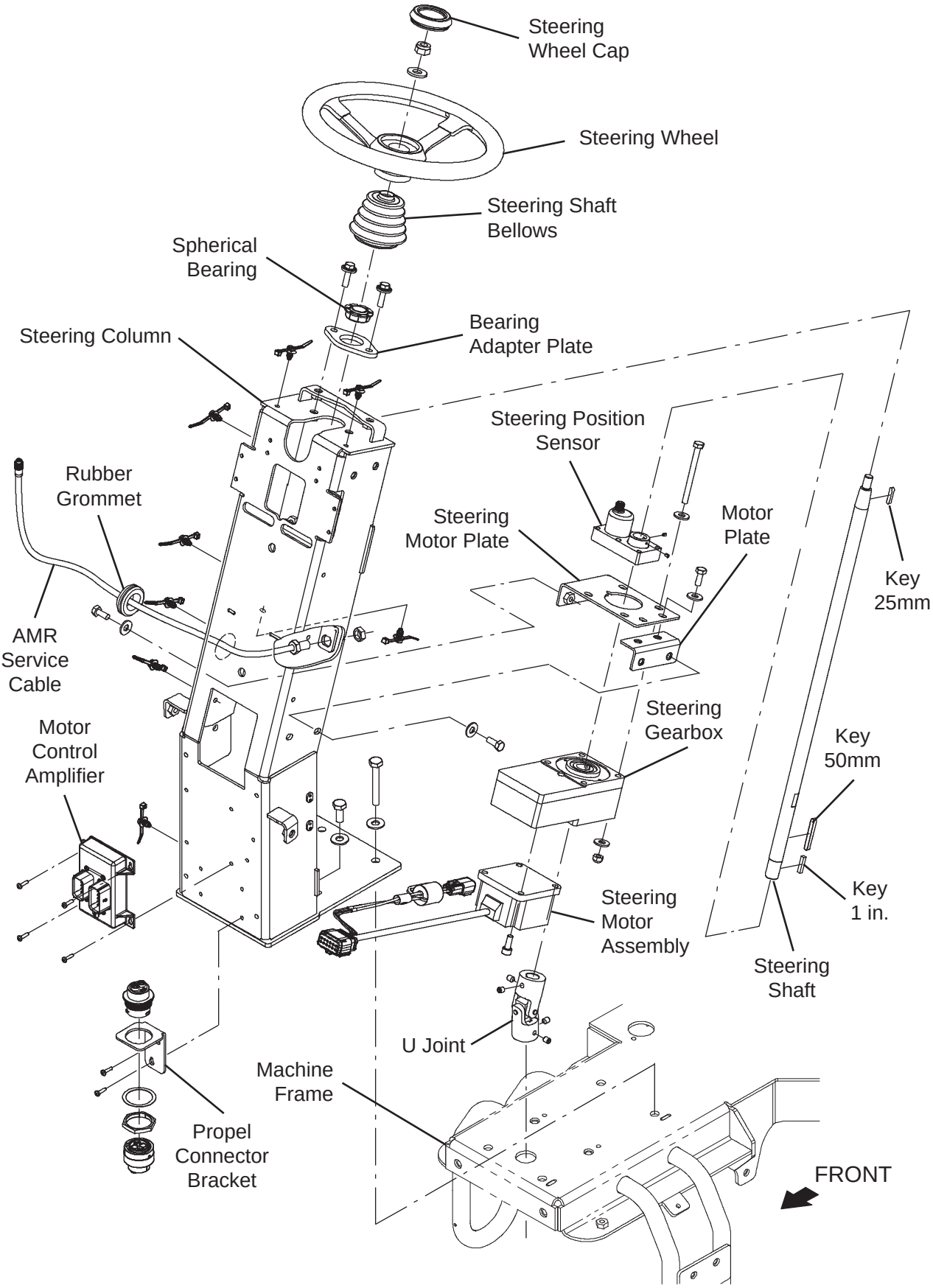


7. Reinstall the strobe light/install the new strobe light onto the rear control plate in reverse order of disassembly.

PEDALS GROUP



STEERING


Steering
Wheel Cap
Steering Wheel
Steering Shaft
Bellows
Spherical
Bearing
Steering Column
Bearing
Adapter Plate
Steering Position
Sensor
Rubber
Grommet
Steering
Motor Plate
Motor
Plate
Key
25mm
AMR
Service
Cable
Steering
Gearbox
Motor
Control
Amplifier
Key
50mm
Key
1 in.
Steering
Motor
Assembly
Steering
Shaft
U Joint
Machine
Frame
Propel
Connector
Bracket
FRONT

REMOVE/REINSTALL/REPLACE THE STEERING MOTOR/STEERING GEAR BOX/STEERING POSITION SENSOR

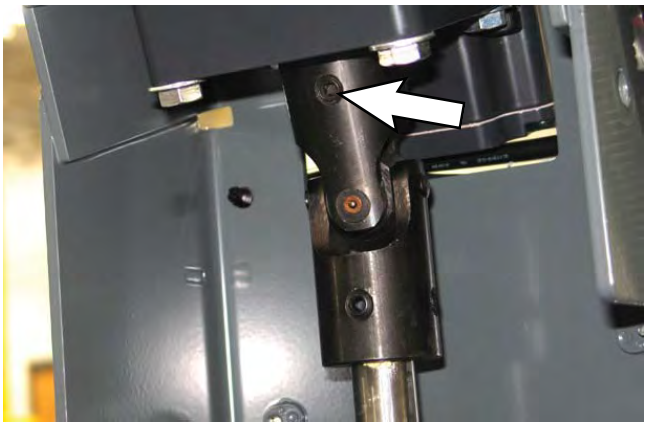
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

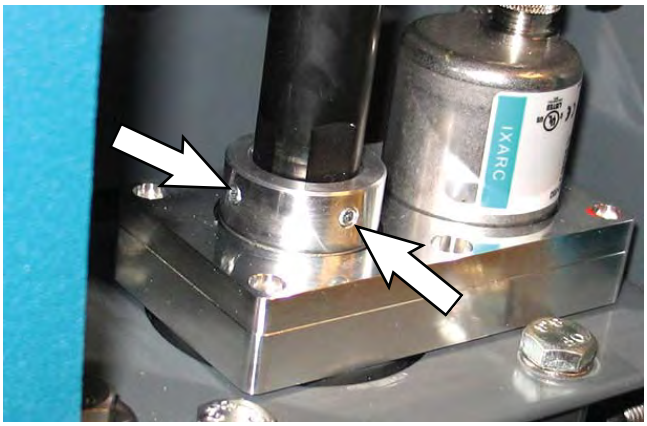
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electronic components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Remove the column access panel from the machine. See REMOVE THE COLUMN ACCESS PANEL FROM THE MACHINE.
5. Loosen the upper set screws securing the steering shaft into the u-joint.



6. Loosen both set screws securing the steering shaft into the steering position sensor.

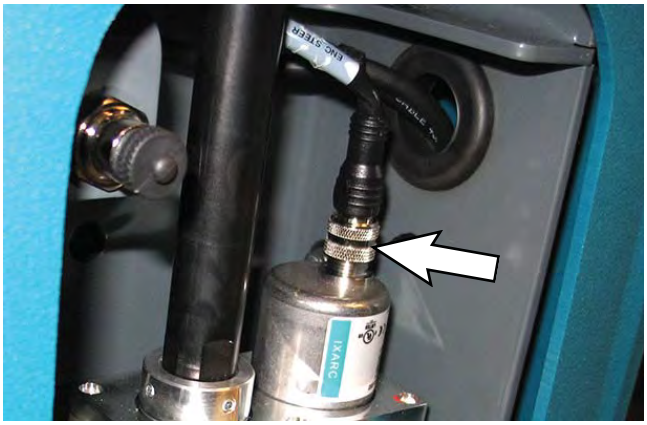


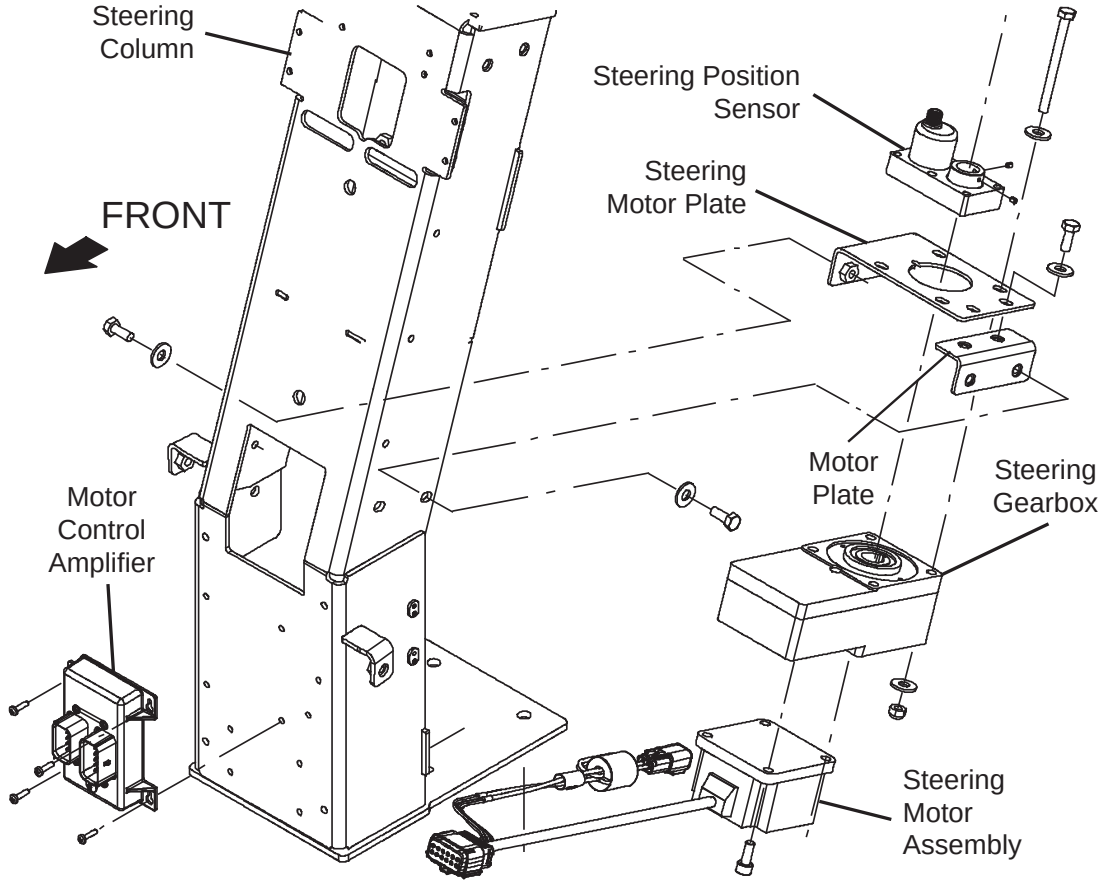
7. Slide the steering wheel/steering shaft up, through the flange bearing enough to clear the steering gear box and the steering position sensor.

NOTE: Do Not lose either of the keys in the steering shaft when sliding the steering wheel/steering shaft from the u-joint and steering gear box.

NOTE: If only replacing the steering position sensor, Do Not loosen the hardware securing the steering gear box to the steering motor plate.

8. **If replacing/removing the steering position sensor:** Disconnect the wire harness from the steering position sensor.

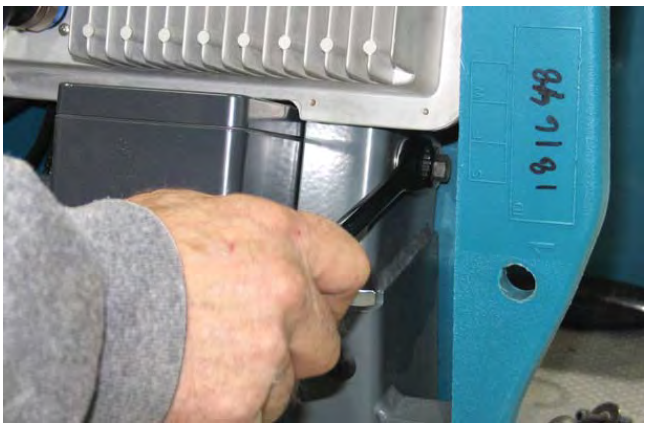


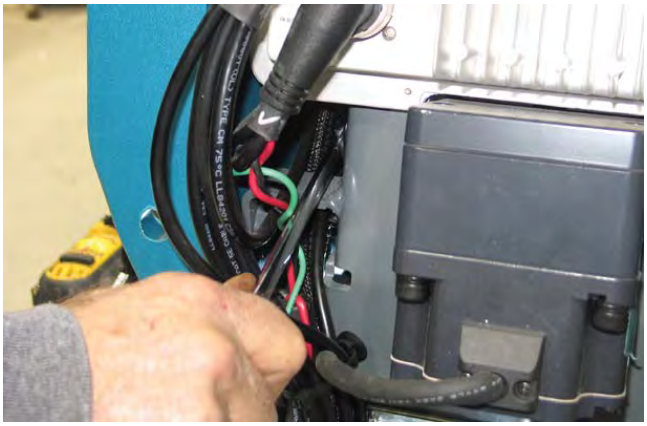


9. **If replacing/removing the steering position sensor:** Remove the steering position sensor from the machine.

10. **If replacing/removing the steering motor/ steering gear box:** Disconnect the steering motor cable from the motor control amplifier and wire harness.

11. **If replacing/removing the steering motor/ steering gear box:** Loosen the hardware securing the steering motor plates to the steering column. Do Not remove the hardware securing the steering motor plates to the steering column.





12. **If replacing/removing the steering motor assembly/steering gearbox:** Remove the steering motor assembly/steering gearbox from the steering motor plates.

13. **If replacing the steering motor assembly or steering gearbox:** Disassemble the steering motor assembly from the steering gearbox.

14. **If replacing the steering motor assembly or steering gearbox:** Assemble the new steering motor assembly and/or new steering gearbox.

15. Reinstall the steering position sensor and/or steering motor/steering gear box onto the machine.

16. Install the keys into the steering shaft and slide the steering wheel/steering shaft down through the steering position sensor, the steering gear box, and into the u-joint.

NOTE: The steering shaft must be properly aligned before set screws and hardware are tightened. Damage to u-joint may result if steering shaft is not properly aligned.

17. Tighten the upper set screws in the u-joint to secure the steering shaft into the u-joint.

18. Turn the steering wheel in the complete range of motion in both directions to allow the steering gear box and steering position sensor to self align.

19. Tighten the hardware securing the steering motor plates to the steering column.

20. If the steering position sensor was replaced or removed, position the steering position sensor 2 mm (0.078 in.) above the steering gear box and tighten both steering position sensor set screws against the flat areas on the steering shaft to secure the steering position sensor onto the steering shaft.

NOTE: If the steering position sensor or steering motor assembly were replaced/removed/reinstalled, the steering system must be recalibrated. Refer to the calibration instructions located in the STEERING TROUBLESHOOTING GUIDE located on the T.A.C. Share Point site for additional information.

21. Reassemble parts and components removed from the machine to access the steering system back onto the machine in reverse order of disassembly.

22. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

REMOVE/REINSTALL/REPLACE THE STEERING AMPLIFIER MODULE

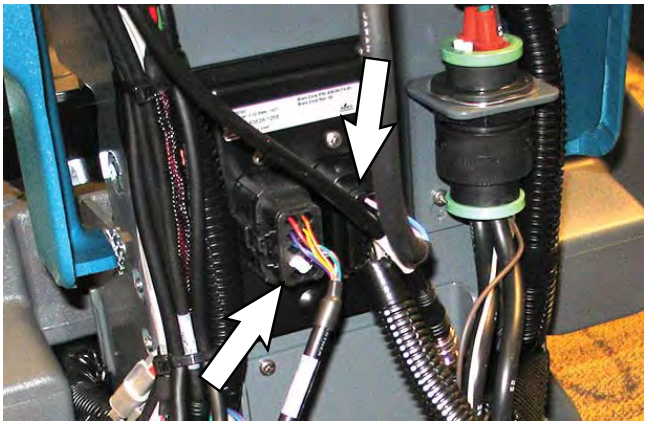
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

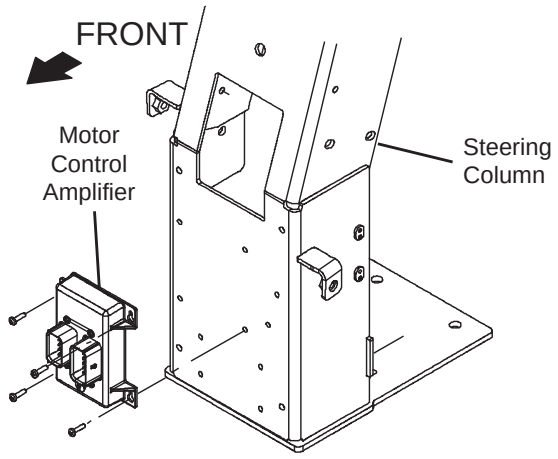
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electronic components. Attach the other end of the static ground strap to the machine chassis.

3. Remove the front cover from the steering column. See REMOVE THE FRONT COVER FROM THE MACHINE.
4. Disconnect the harness connector and steering motor from the steering amplifier module.



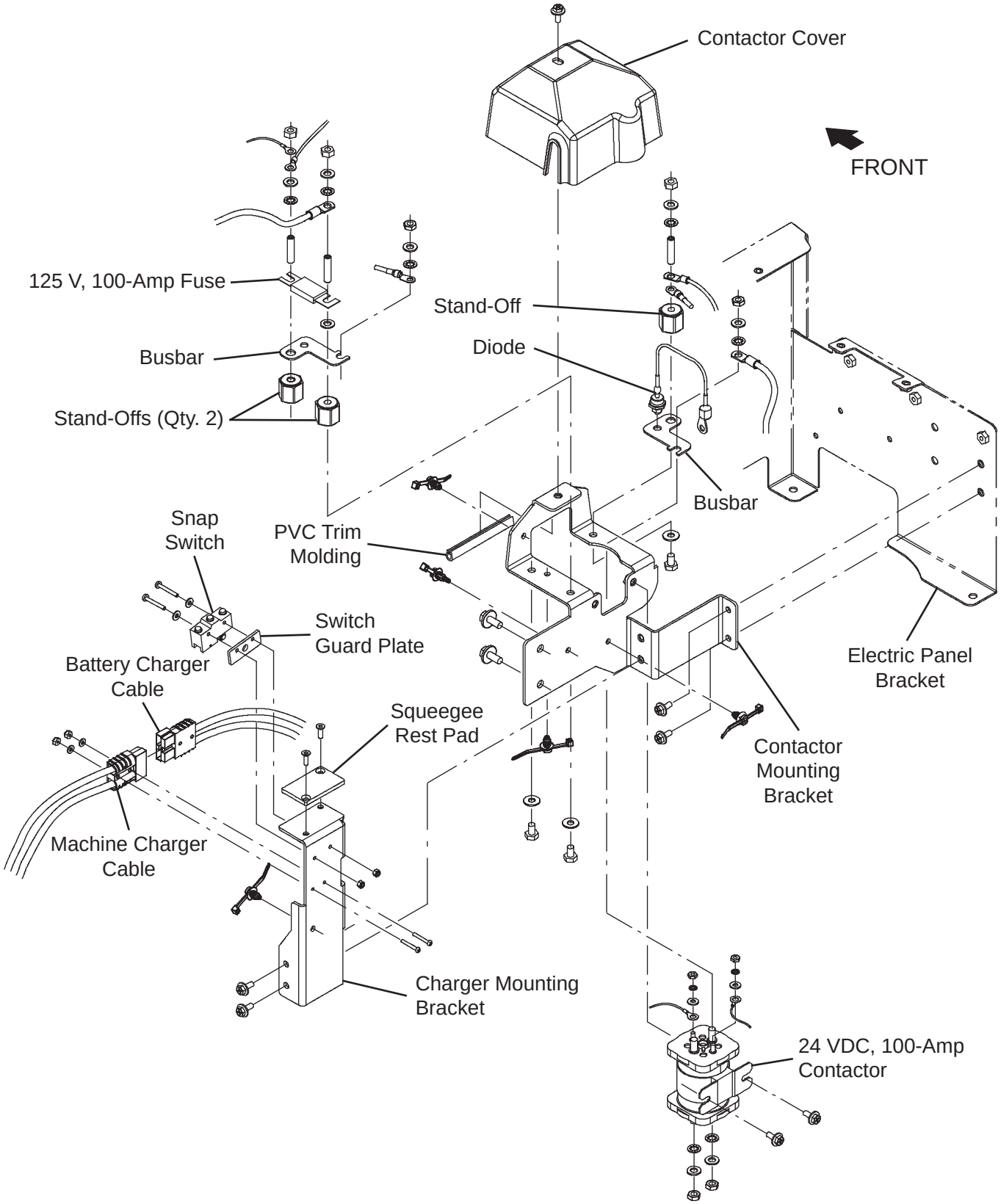
5. Remove the steering amplifier module from the steering column.



6. Reinstall the removed steering amplifier module/ install the new steering amplifier module onto the machine.
7. Connect the harness connections to the steering amplifier module.
8. Reassemble all items removed to access the steering amplifier module onto the machine in the reverse order of disassembly.
9. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

ELECTRICAL


Contactor Cover
FRONT
125 V, 100-Amp Fuse
Busbar
Stand-Offs (Qty. 2)
Stand-Off
Diode
Busbar
Snap Switch
PVC Trim Molding
Switch Guard Plate
Battery Charger Cable
Squeegee Rest Pad
Machine Charger Cable
Charger Mounting Bracket
Electric Panel Bracket
Contactor Mounting Bracket
24 VDC, 100-Amp Contactor

REMOVE/REINSTALL/REPLACE THE CONTACTOR

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch ON, press the *1-Step button* to completely lower the scrub head, turn the key switch OFF, and remove the key.
2. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

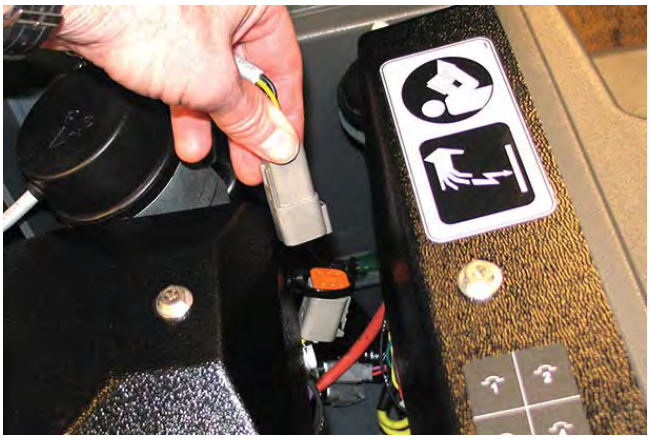
NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.

4. Confirm the machine battery cable is disconnected from the batteries.

ATTENTION: Potential electrical hazard if the battery cable is left connected to the batteries. The machine battery cable must be disconnected from the batteries before accessing/performing maintenance on the 100-A 24 VDC contactor.

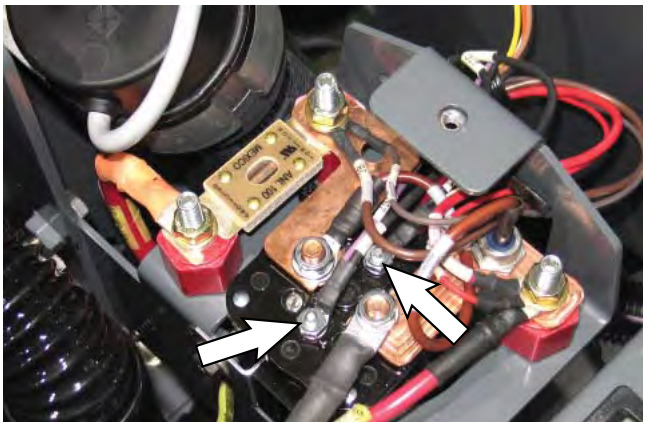
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

5. Disconnect the actuator cable secured to the contactor cover from the main wire harness.

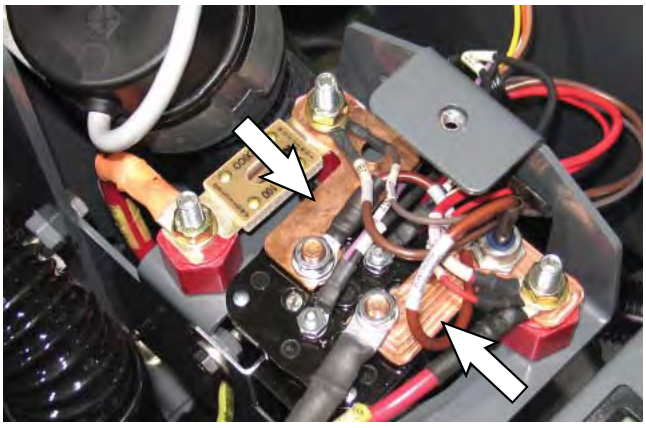


6. Remove the contactor cover from the contact mounting bracket to access the main contactor.

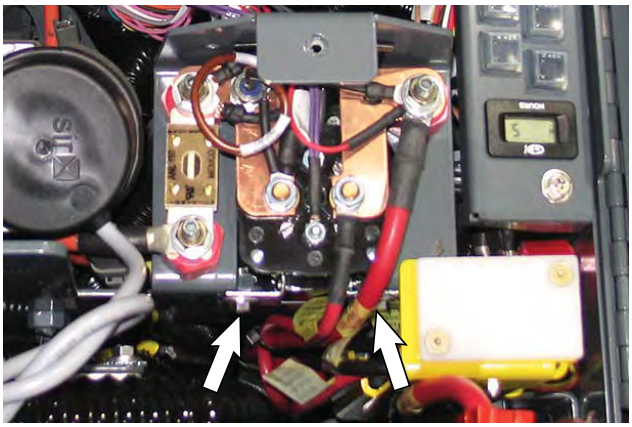
7. Disconnect wire harness connections from the top terminals of the contactor.



8. Remove both bus bars from the 100-A 24 VDC contactor and the corresponding panel insulator standoffs.



9. Loosen the hardware securing the 100-A 24 VDC contactor to the actuator support enough to be able to remove the contactor from the machine.



NOTE: If necessary, remove the actuator and battery charger receptacle bracket from the machine to make access to the hardware securing the 100-A 24 VDC contactor to the machine easier. See REMOVING/ REPLACING THE SCRUB HEAD ACTUATOR.

10. Carefully lift the 100-A 24 VDC contactor from the actuator support and disconnect the wire harness connections from the bottom terminals of the contactor.

11. Connect the wire harness to the terminals located on the bottom of the new 100-A 24 VDC contactor/ removed 100-A 24 VDC contactor.

12. Install the 100-A 24 VDC contactor onto the actuator support.

13. Install the bus bars, and all cable connections removed when the bus bars were removed, onto the 100-A 24 VDC contactor and panel insulator standoffs.

14. Connect the wire harness connections to the terminals located on the top of the 100-A 24 VDC contactor.

15. Install the contactor cover onto the actuator support.

16. Reconnect the battery cable to the batteries.

17. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.

18. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

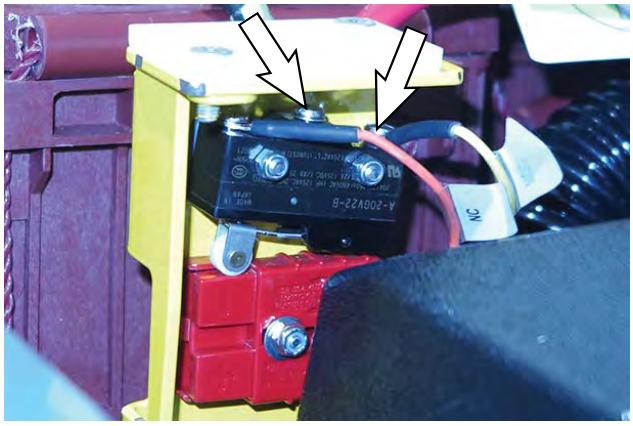
19. Thread the hardware removed in the previous step back into the recovery tank.

REMOVE/REINSTALL/REPLACE THE CHARGER INTERLOCK SNAP SWITCH

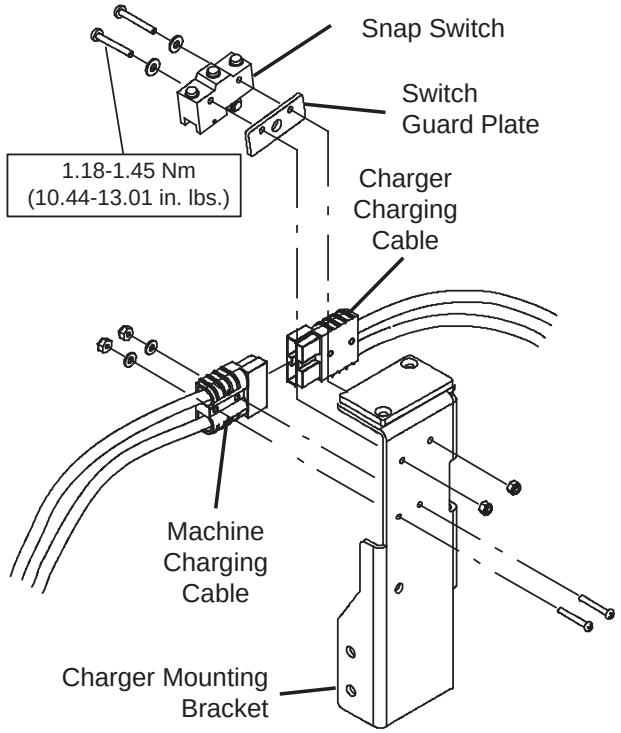
1. Turn the ON/OFF key switch OFF.
2. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Disconnect the two harness connections from the charger interlock snap switch.

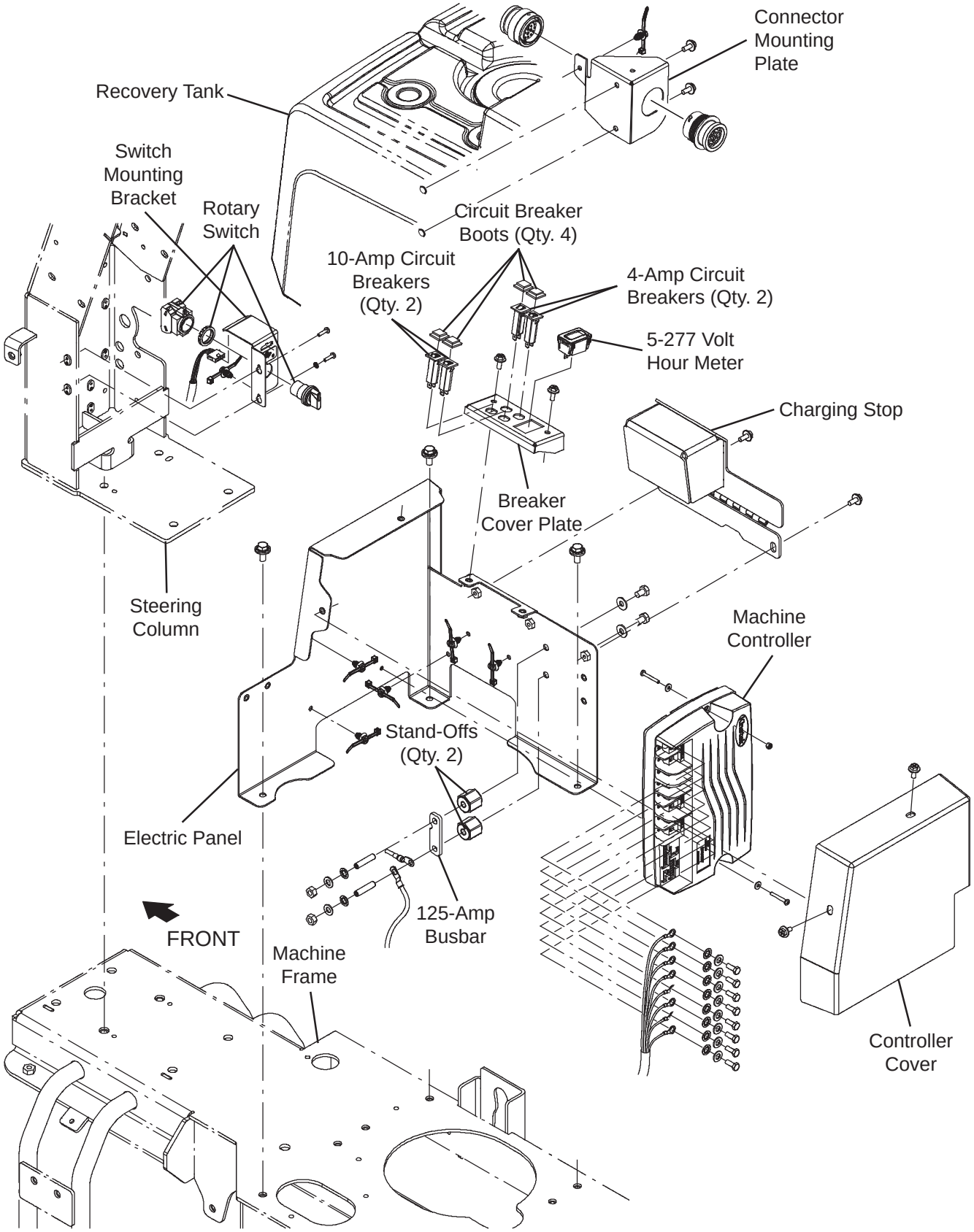


5. Remove the hardware securing the charger interlock snap switch to the connector bracket and the rear switch plate bracket.



6. Install the new charger interlock snap switch/ reinstall the removed charger interlock snap switch onto the connector bracket. Torque hardware to 1.18-1.45 Nm (10.44-13.01 in. lbs.).
7. Plug the charger cable into the machine charging connector and observe the charger interlock roller as the charger cable is connected to the charging connector. The charger interlock roller should engage when the charger connector is connected to the charging connector.
8. If necessary, adjust the charger interlock snap switch so the roller is engaged (pressed in) when the charger cable is connected to the charger connector.
9. Unplug the charger cable from the charging connector and observe the roller as the charger cable is being unplugged from the charging connector. The charger interlock roller should disengage (return to space where it was positioned before charger cable was connected to the charging connector) when the charger cable is disconnected to the charging connector.
10. If necessary, adjust the charger interlock snap switch so the roller is disengaged (returns out) when the charger cable is disconnected from the charging connector.
11. Reconnect the two harness connections to the charger interlock snap switch. Torque hardware to 0.78-1.18 Nm (6.90-10.44 in. lbs.).
12. Reinstall the operator seat/seat plate and battery box cover onto the machine. See REMOVE/ REINSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
13. Connect the battery charger cable to the machine and turn on the machine. The machine should not turn on.
14. Disconnect the battery charger cable from the machine and turn the machine on. The machine should turn on.
15. Adjust the charger interlock snap switch on the connector bracket as necessary so machine does not turn on when the charger cable is connected to the machine and turns on when the charger cable is disconnected from the machine.

REMOVE/REINSTALL/REPLACE THE KINETEK CONTROLLER



FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch ON, press the *1-Step button* to completely lower the scrub head, turn the key switch OFF, and remove the key.

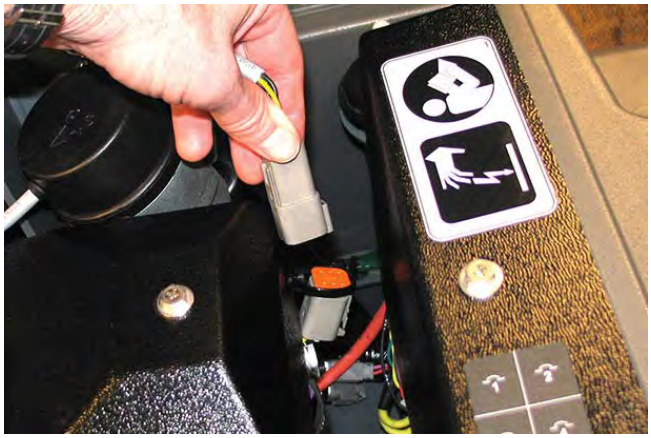
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

2. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*

3. Disconnect the battery cable from the batteries.

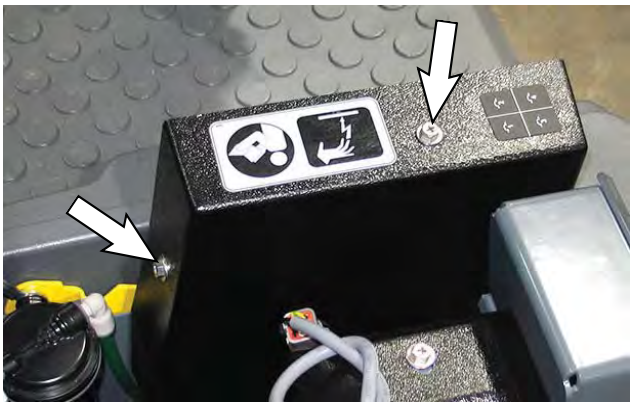
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Disconnect the actuator cable secured to the contactor cover from the main wire harness.

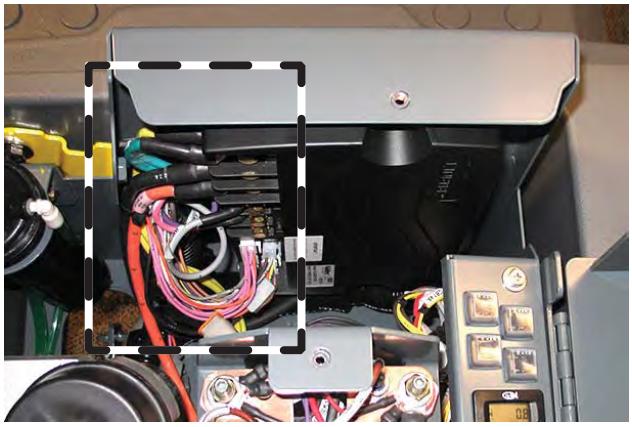


5. Remove the contactor cover from the contact mounting bracket to access the main contactor.

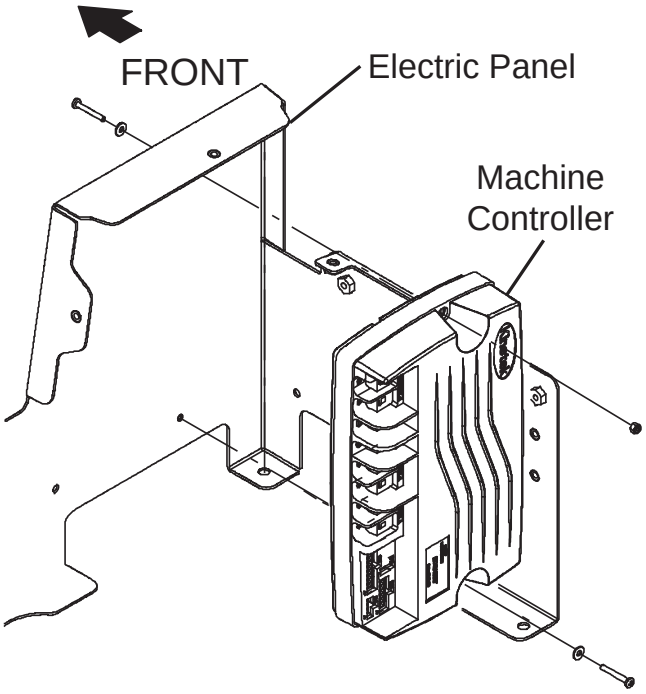
6. Remove the controller cover from the electric panel/machine controller.

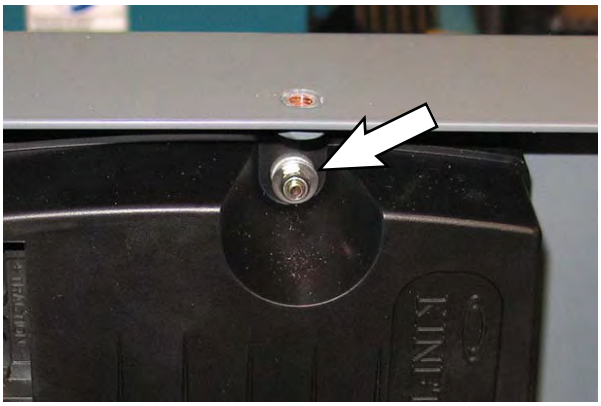


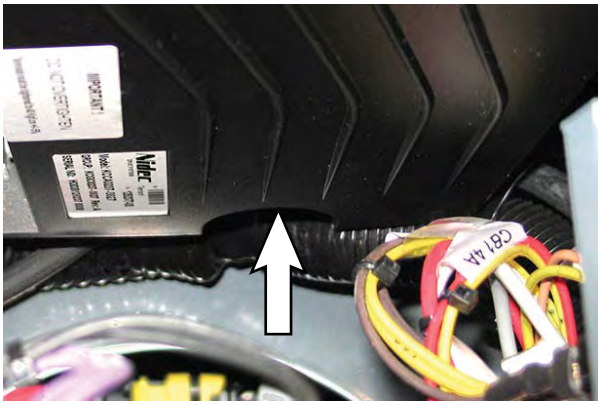
7. Disconnect all wire harness connections from the Kinetek controller.



8. Remove the Kinetek controller from the machine.

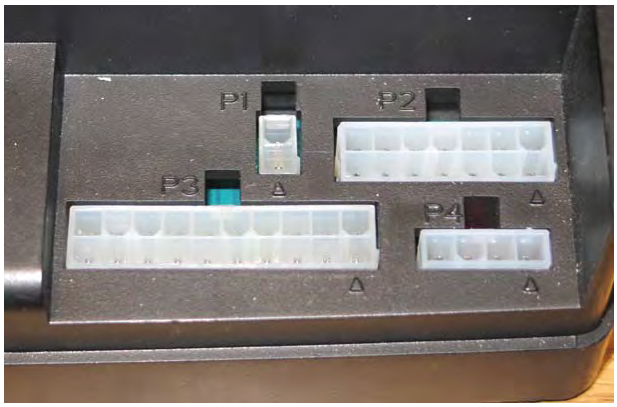






9. Install the new Kinetek controller/removed Kinetek controller onto the machine.

10. Connect wire harness connections to the Kinetek controller.



11. Reassemble all items back onto the machine in reverse order of removal.

12. Reconnect the battery cable to the batteries.

13. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.

14. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

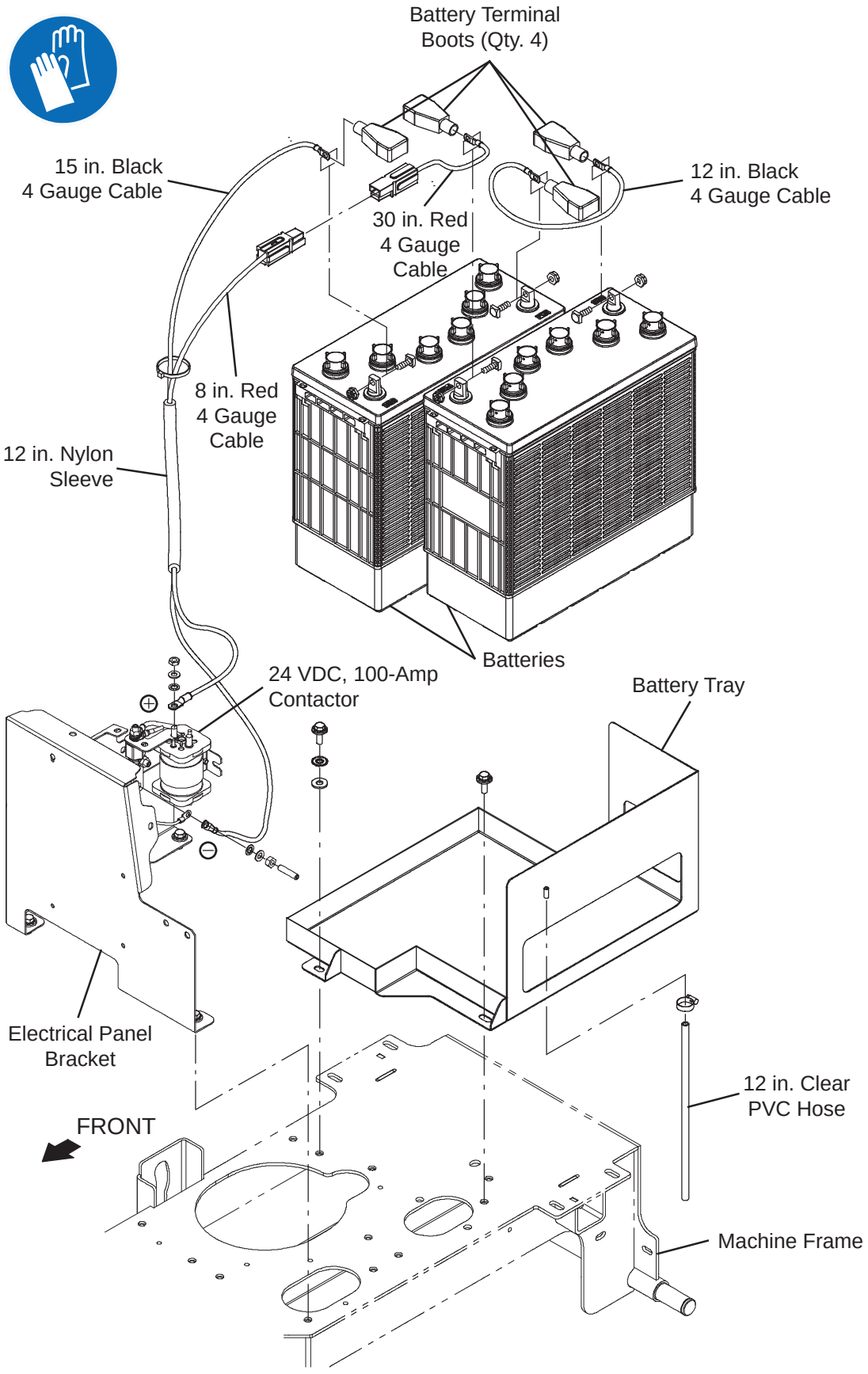
15. Thread the hardware removed in the previous step back into the recovery tank.

16. Start and test the machine to ensure the machine functions correctly. All machine functions should be fully operational when the corresponding buttons/ switches are activated.

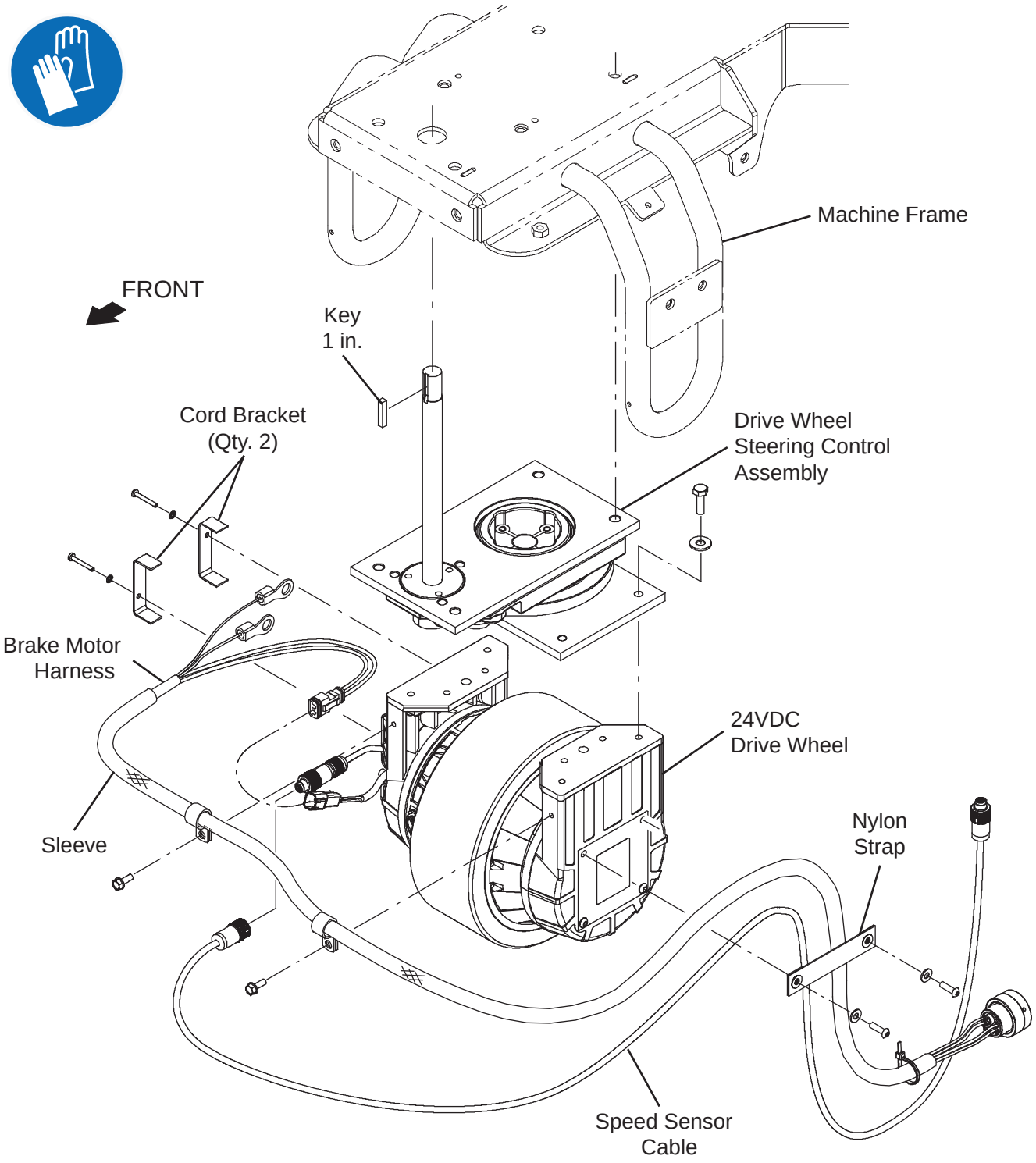
17. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

NOTE: Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

BATTERY GROUP



DRIVE WHEEL GROUP



REMOVE/REINSTALL/REPLACE THE DRIVE WHEEL ASSEMBLY

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

ATTENTION: DO NOT tip the machine onto its side to replace the drive wheel assembly. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

1. Completely drain the solution tank and the recovery tank.
2. Turn the key switch OFF and remove the key.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

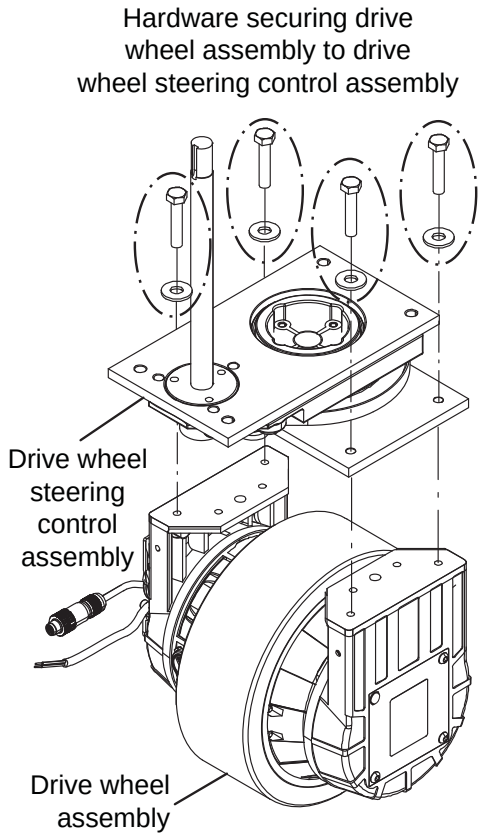
4. Remove the front guard from the front of the machine. See REMOVE/INSTALL THE FRONT GUARD.
5. Chock both rear tires.
6. Jack up the front end of the machine enough to access steering components/remove steering components from under the machine. Place jack stands under the machine and lower the machine onto the jack stands.

FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Support machine with jack stands.

7. Disconnect the speed sensor cable and all brake motor harness connections from the drive wheel assembly and encoder.

NOTE: Use care when removing the drive wheel assembly from the machine. The drive wheel weighs approximately 140 lbs (64 kg). If necessary, seek help to remove the drive wheel assembly from the machine.

8. Remove the hardware securing the drive wheel assembly to the drive wheel steering control assembly. Turn drive wheel assembly to the right and left as necessary to access/remove hardware.



9. Remove the drive wheel assembly from under the machine.
10. Reinstall drive motor/install new drive motor in reverse order of disassembly.

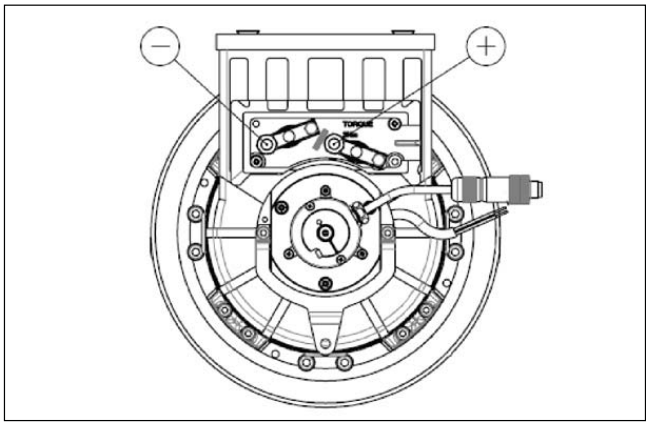
REMOVE/REINSTALL/REPLACE THE DRIVE MOTOR CARBON BRUSHES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

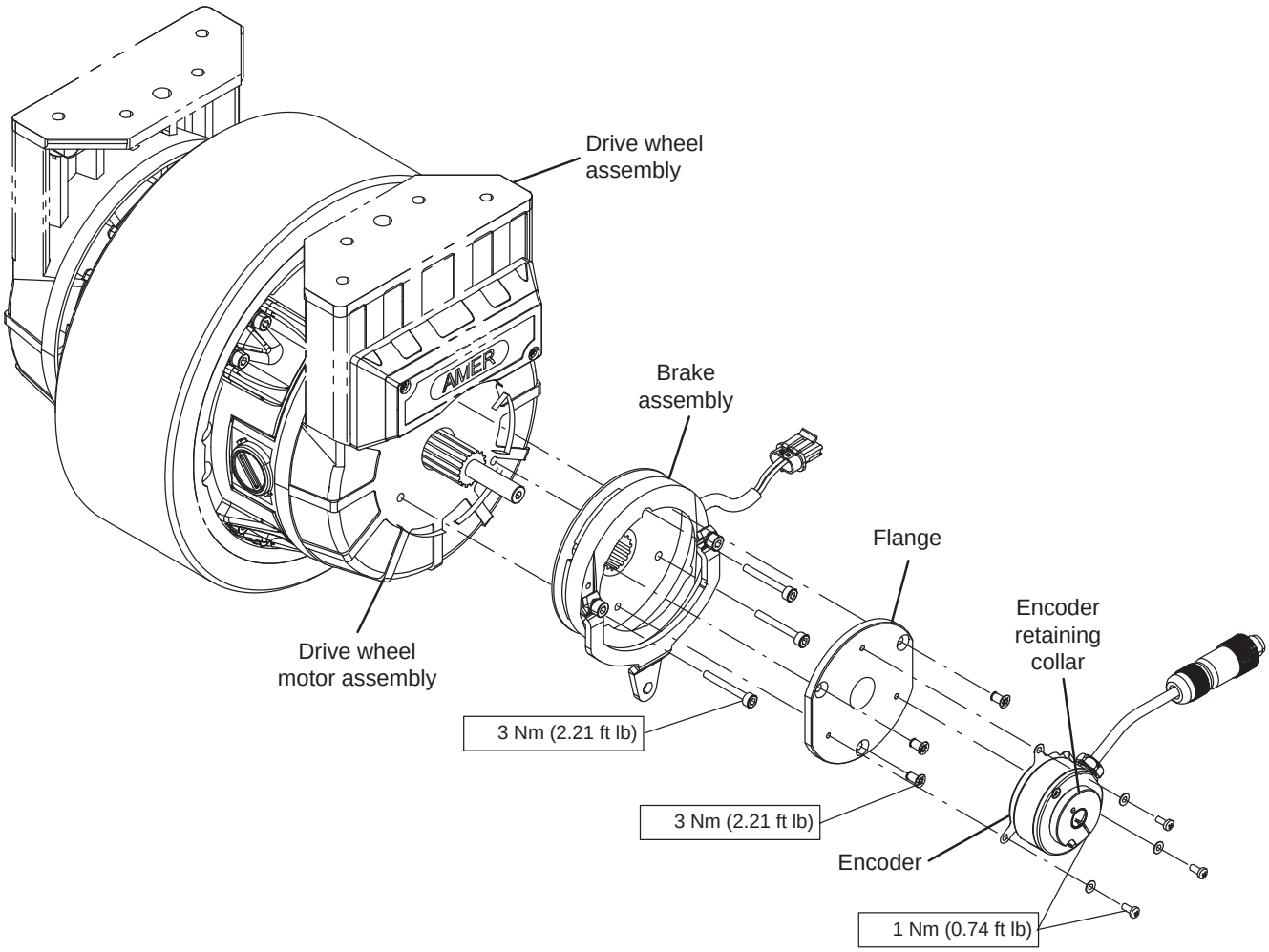
NOTE: Carbon brushes should be replaced as sets.

1. Remove the front guard from the machine. See REMOVE/INSTALL THE FRONT GUARD
2. Disconnect the Positive (+) and Negative (-) cable connections from the drive motor assembly.
3. Remove the connection box cover from the drive motor assembly connection box.
4. Loosen the clips from the carbon brushes located at the Positive (+) and Negative (-) connections and remove the carbon brushes from the drive motor assembly.



5. Inspect carbon brushes. Replace carbon brushes if they are stuck or are less than 10 mm (0.375 in.) in length.
6. Use compressed air to clean any dust from inside the drive motor assembly.
7. Install the new carbon brushes/removed carbon brushes into the Positive (+) and Negative (-) connections and use clips to secure the carbon brushes inside the drive motor assembly.
8. Reinstall the connection box cover onto the drive motor assembly connection box
9. Reconnect the Positive (+) and Negative (-) cable connections to the drive motor assembly.
10. Reinstall the front perimeter guard onto the machine.

REMOVE/REINSTALL/REPLACE THE PARKING BRAKE AND ENCODER



FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

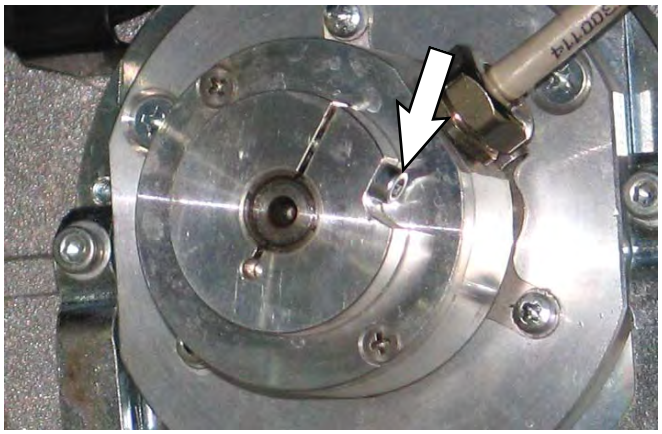
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. If jacking up machine to access encoder/brake assembly: Place chocks behind both rear wheels.
4. If jacking up machine to access encoder/brake assembly: Jack up the front end of the machine enough to access the parking brake and encoder. Place jack stands under the machine and lower the machine onto the jack stands. If jacking up machine.

FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Support machine with jack stands.

5. Remove the front perimeter guard from the machine. See REMOVE/REINSTALL THE FRONT PERIMETER GUARD.
6. Turn steering wheel so the encoder and brake assembly installed on the drive wheel assembly can be easily accessed.

7. Loosen the hardware securing the encoder retaining collar to the drive wheel shaft.



8. Remove the encoder retaining collar from the drive wheel assembly.

9. If only replacing the encoder: Remove the encoder from the flange.

10. If only replacing the encoder: Disconnect the encoder cable from the wire harness.

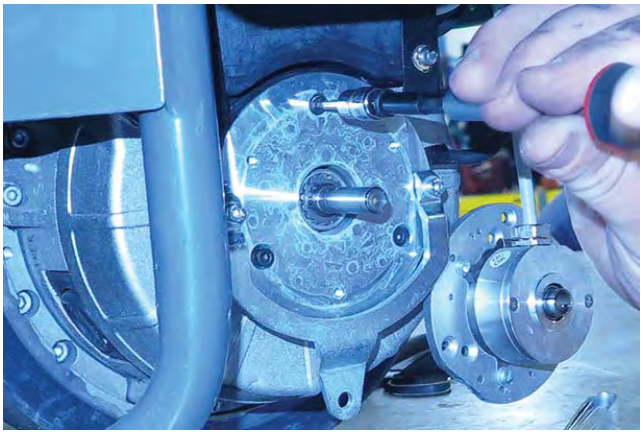
11. If only replacing the encoder: Connect the new encoder cable to the wire harness, install the new encoder onto the flange, and install the encoder/flange onto the drive wheel assembly. Note torque settings in exploded view on the previous page.

NOTE: It may be necessary to cut wire ties to allow more slack for removing the encoder/flange from the brake assembly.

12. Remove the encoder/flange from the brake assembly.

13. Remove the brake assembly from the drive wheel motor assembly.

NOTE: Bushings may fall from the brake assembly when it is removed from the drive wheel motor assembly. Do not lose the bushings if they should fall loose during disassembly.



14. If replacing the brake assembly: Disconnect the wire harness from the brake assembly.

15. If replacing the brake assembly: Connect the new brake assembly cable to the wire harness and install the new brake assembly onto the drive wheel assembly. Note torque settings in exploded view on the previous page.

16. Reinstall the brake assembly onto the drive wheel motor assembly. Note torque settings in exploded view on the previous page.

NOTE: To prevent the bushings from falling from the brake assembly during reassembly, reinsert the socket screws into the brake assembly to hold the bushings into place in the brake assembly before reinstalling it onto the drive wheel motor assembly.

17. Reinstall items previously removed from drive wheel assembly in reverse order of disassembly. Note torque settings in exploded view on the previous page.

18. Replace any cable ties cut to allow easier removal of the encoder/flange from the brake assembly.

19. Reinstall the front perimeter guard onto the machine.

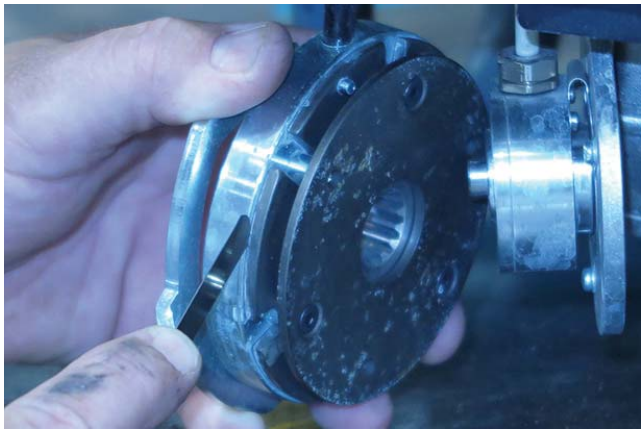
20. If machine was jacked up to access the encoder/brake assembly: Jack the machine up off the jack stands, remove the jack stands from under the machine, and lower the machine to the floor.

INSPECT THE BRAKE ASSEMBLY AIR GAP

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

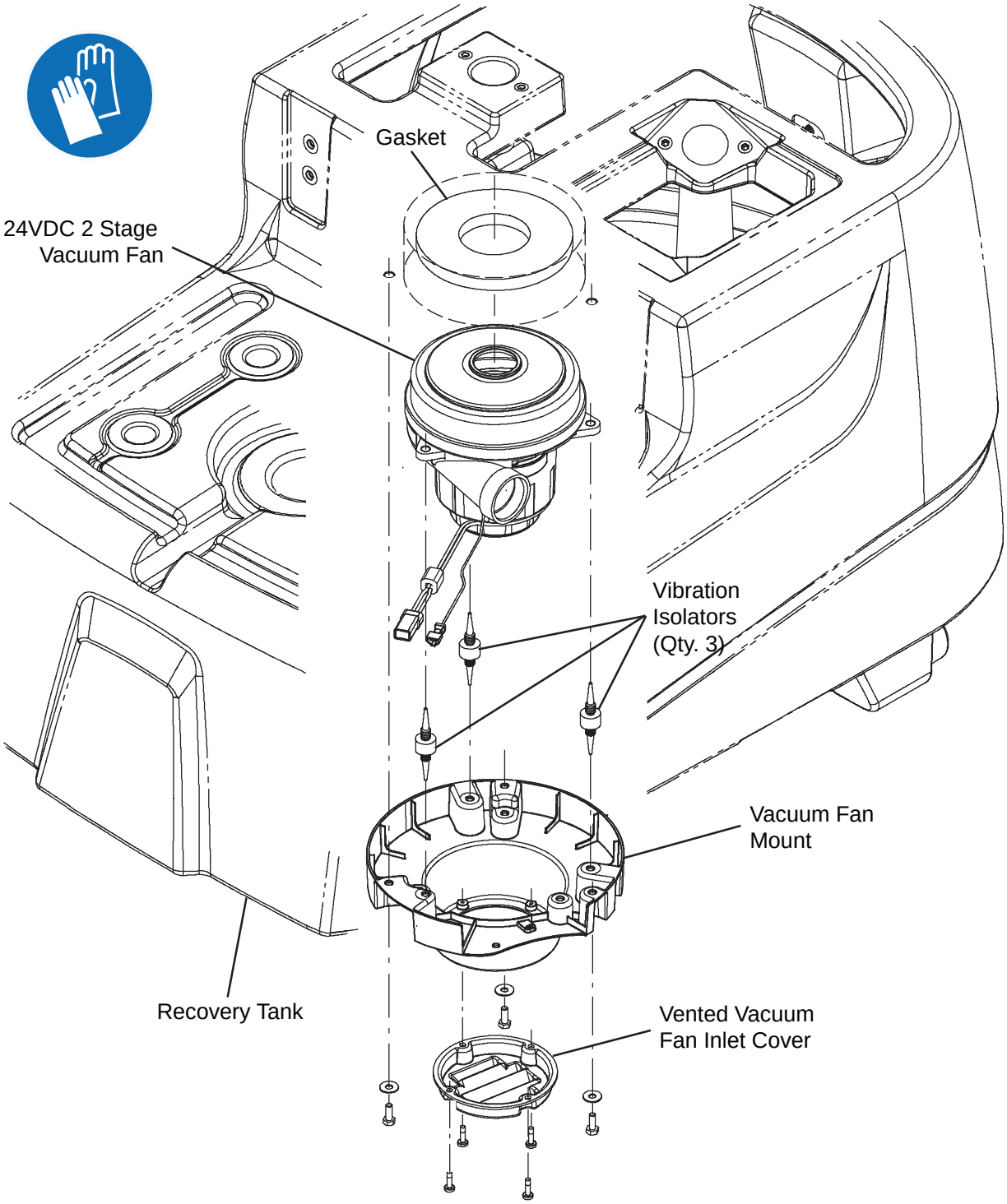
1. Disassemble the brake assembly from the drive wheel assembly. See REMOVE/REINSTALL/ REPLACE THE ENCODER AND PARKING BRAKE.

2. Use a 0.35 mm thickness gauge to check the air gap. The brake air gap is 0.2 ±0.05 mm nominal. If it is possible to fit the 0.35 mm thickness gauge into the air gap the brake assembly must be replaced. See REMOVE/REINSTALL/REPLACE THE PARKING BRAKE AND ENCODER.



3. Reinstall brake assembly and other components removed to check brake assembly air gap back onto the drive wheel assembly in reverse order of disassembly. See REMOVE/REINSTALL/ REPLACE THE PARKING BRAKE AND ENCODER.

SOLUTION SYSTEMS



REMOVE/REINSTALL/REPLACE THE VACUUM FAN

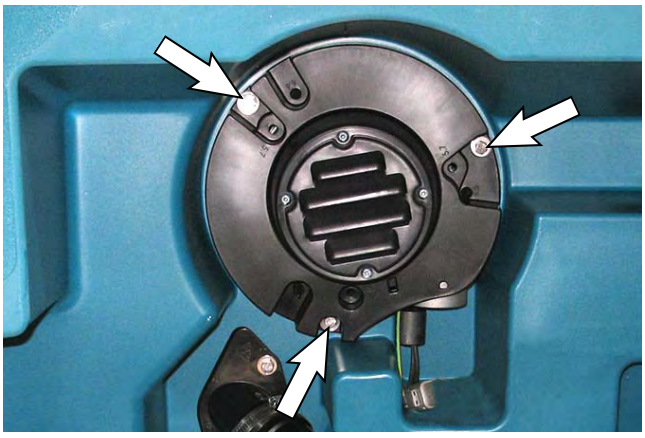
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely drain the recovery tank.
2. Turn the key switch OFF and remove the key.
3. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
4. Disconnect the battery cable from the machine.

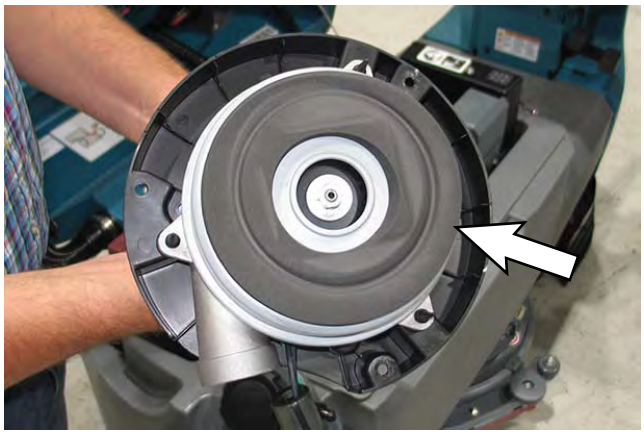
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

5. Disconnect the recovery tank harness from the vacuum fan.

6. Remove the vacuum fan from the recovery tank .



7. Remove the gasket from the vacuum fan.



8. If replacing the vacuum fan, install the gasket onto the new vacuum fan/removed vacuum fan.

   If replacing the gasket, install the new gasket onto the vacuum fan.

   If removing/inspecting/replacing carbon brushes, proceed to REMOVE/INSPECT/REPLACE THE RECOVERY TANK VACUUM FAN CARBON BRUSHES.

9. Install the new vacuum fan/removed vacuum fan onto the fan mounting bracket.
10. Reinstall the vacuum fan/install the new vacuum fan onto the recovery tank.
11. Reconnect the main wire harness to the vacuum fan.
12. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.
13. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.
14. Thread the hardware removed in the previous step back into the recovery tank.

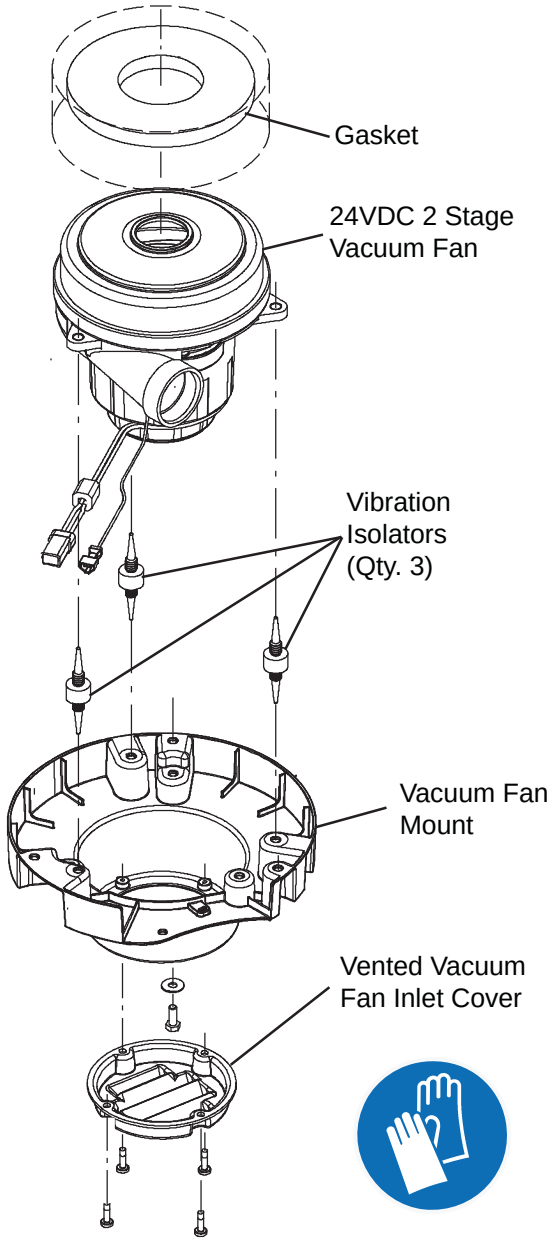
REMOVE/INSPECT/REPLACE THE RECOVERY TANK VACUUM FAN CARBON BRUSHES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

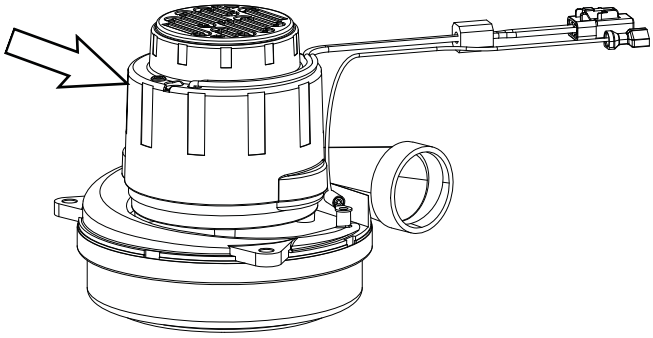
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

NOTE: Carbon brushes should be replaced as sets.

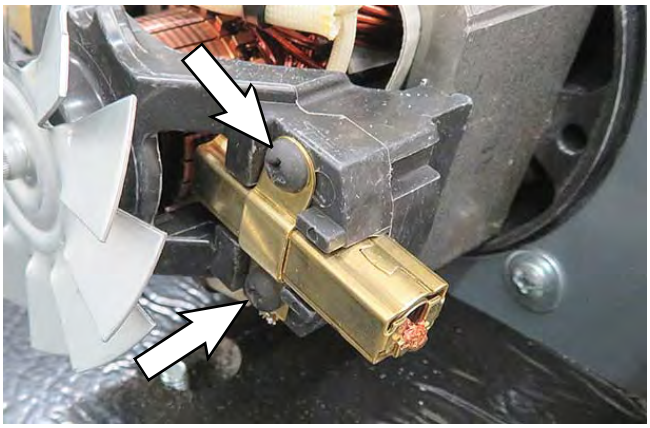
1. Remove the vacuum fan from the recovery tank. See REMOVE/REINSTALL/REPLACE THE VACUUM FAN.
2. Remove the gasket from the vacuum fan.



3. Remove the vented vacuum fan inlet cover and vacuum fan mount from the vacuum fan.
4. Remove the vacuum fan cover from the vacuum fan.

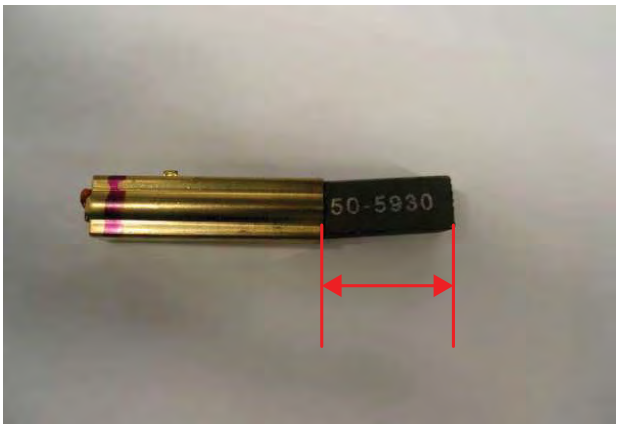


5. Loosen the carbon brush retainer mounting hardware.

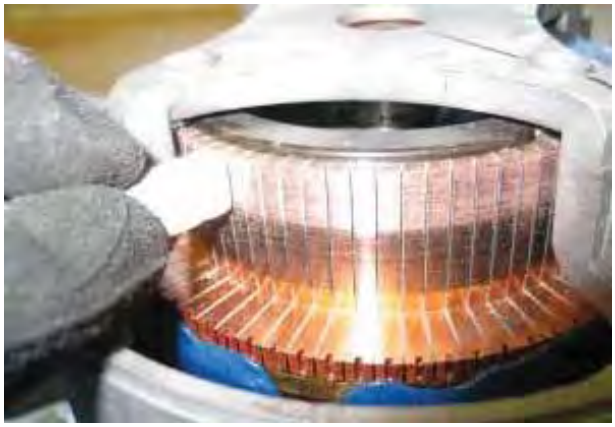


6. Remove the carbon brush from the vacuum fan motor.

7. Inspect carbon brushes. Replace carbon brushes if they are stuck or are less than 10 mm (0.375 in.) in length.



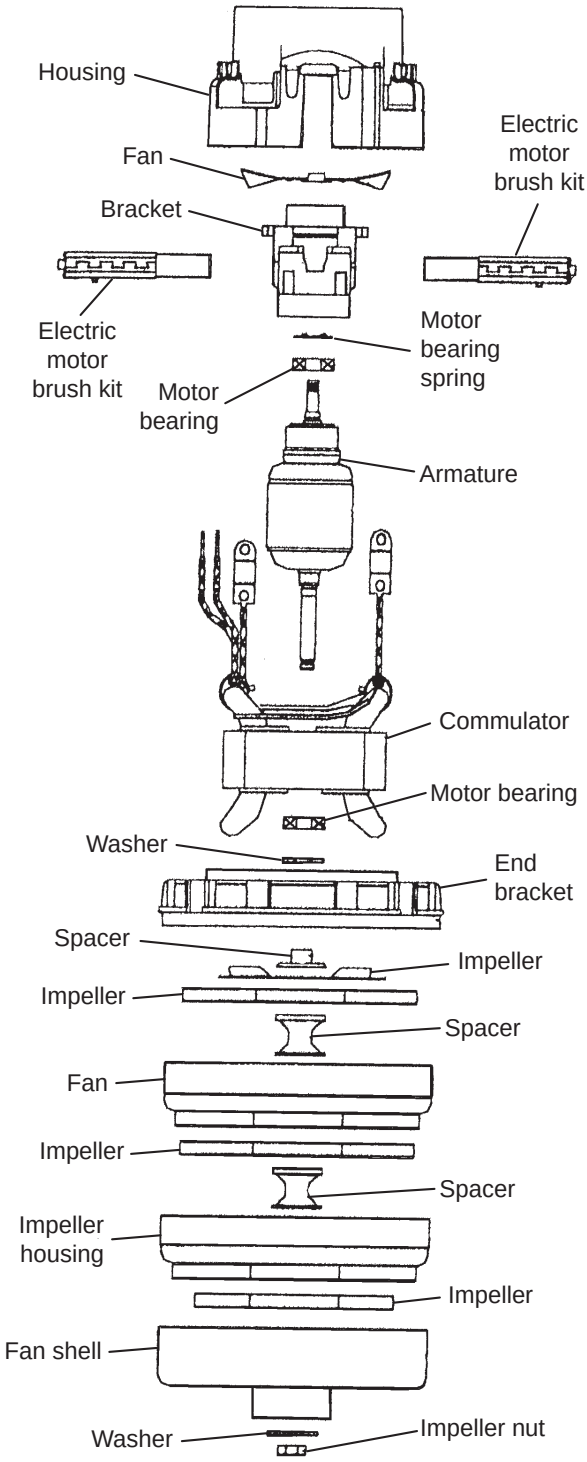
8. Use a stone to clean the commutator.



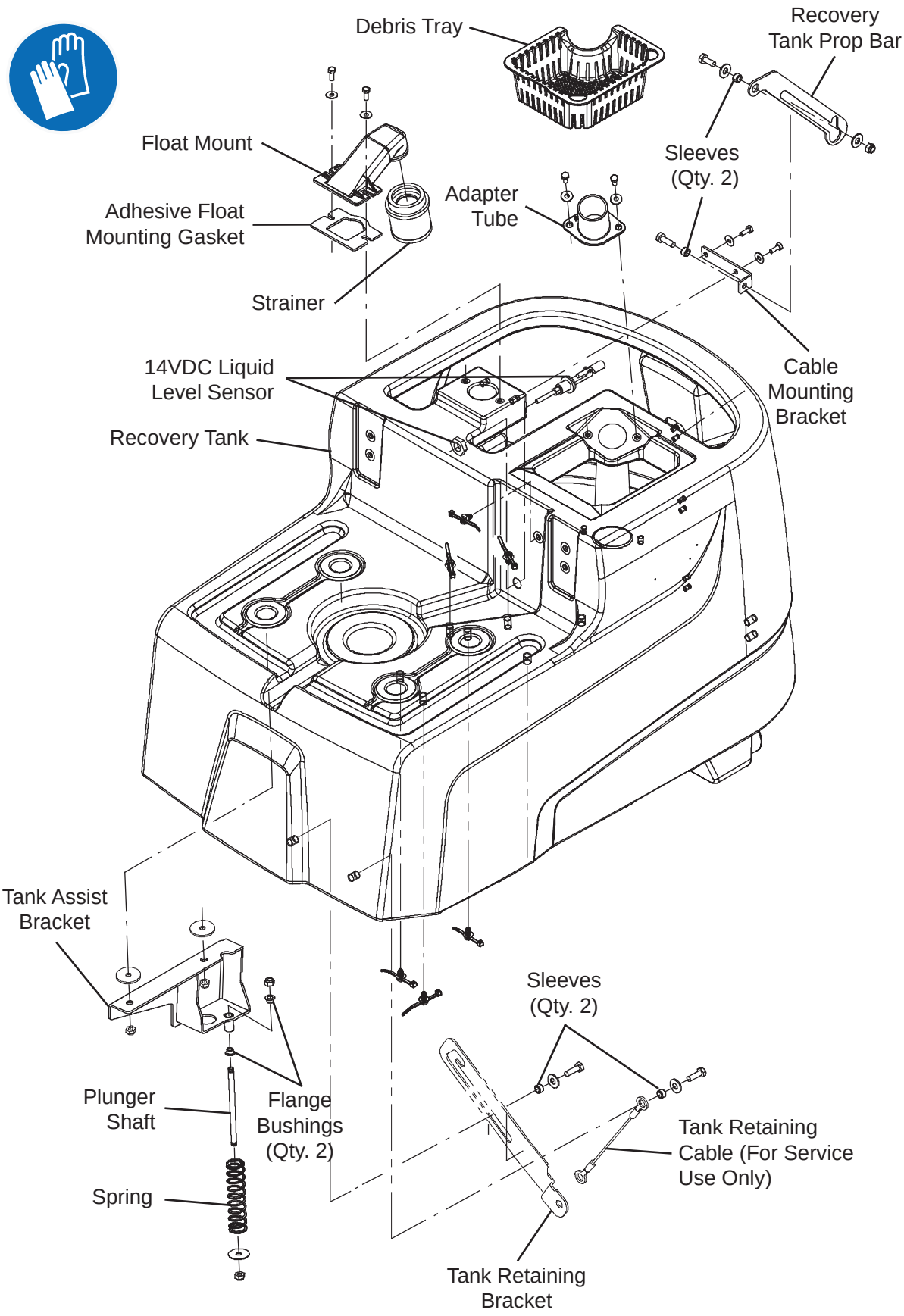
9. Use compressed air to clean dust from inside the vacuum fan motor.

10. Reinstall the removed vacuum fan brushes/install the new vacuum fan brushes in reverse order of disassembly.

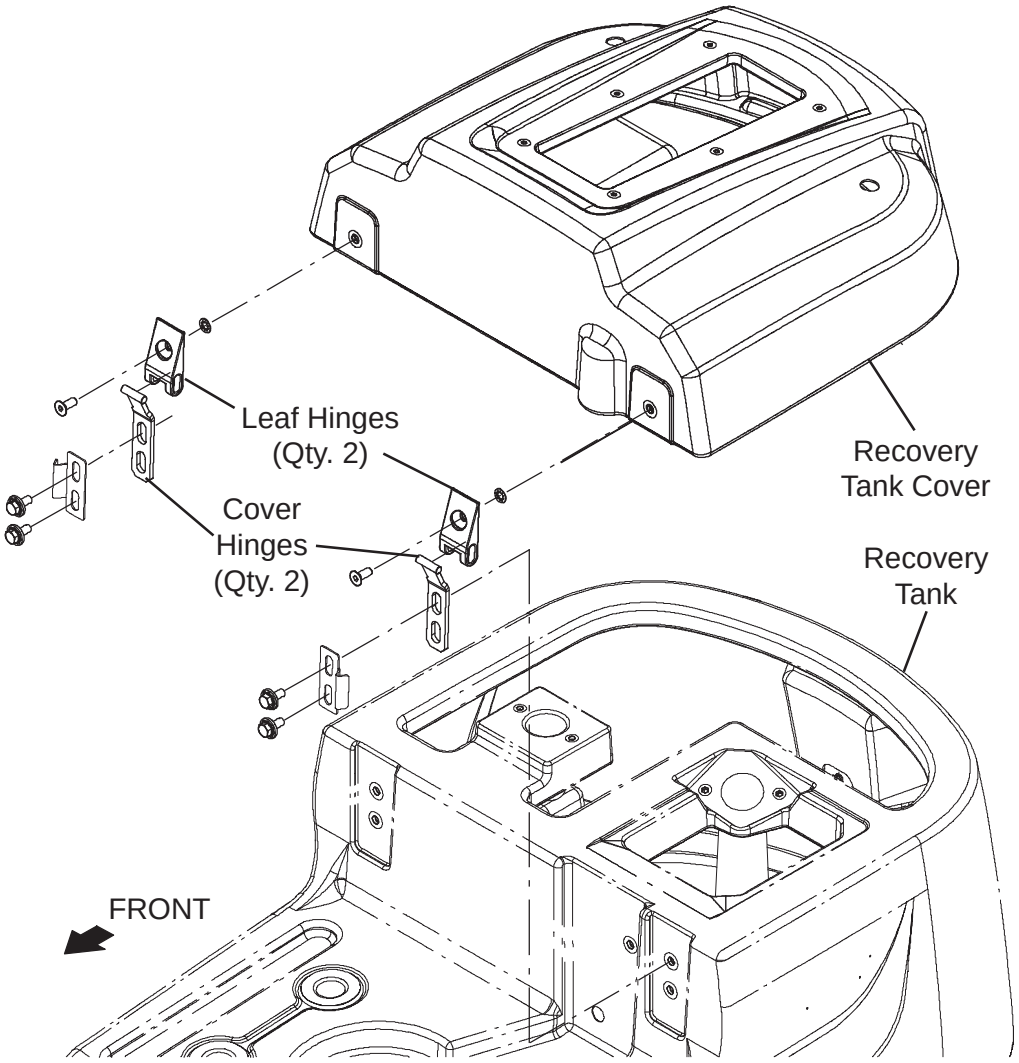
11. Repeat procedure to remove or replace remaining vacuum fan carbon brushes.



RECOVERY TANK GROUP



REPLACING THE RECOVERY TANK



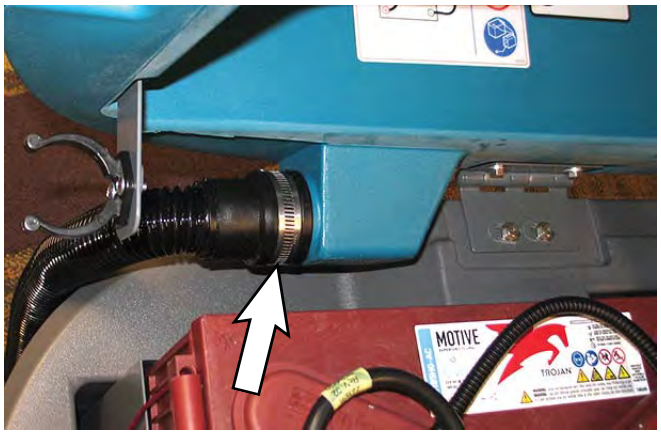
1. Completely drain the recovery tank.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

2. Turn the key switch OFF and remove the key.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

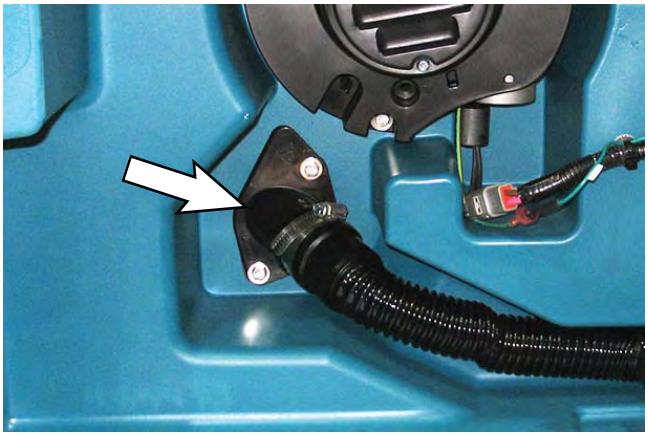
4. Disconnect the tank harness connections from the strobe light, both turn signals, the E-Stop button , and the rear start/pause button.
5. Remove the hardware securing the recovery tank cover to the recovery tank.
6. Carefully remove the recovery tank cover from the recovery tank.
7. Loosen the clamp securing the drain hose to the recovery tank and remove the drain hose from the recovery tank.



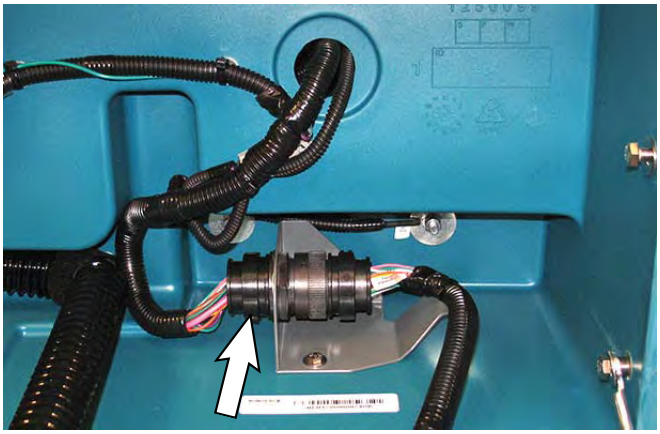
8. Remove the debris tray, float mount/strainer, and adapter tube from the recovery tank.

9. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*

10. Disconnect the vacuum hose/hose adapter tube from the recovery tank and loosen/remove any hardware securing the hose to the recovery tank.



11. Disconnect the tank wire harness from the main wire harness.



12. Remove the hardware securing the tank retaining cable from the recovery tank.

13. Remove the recovery tank from the machine. See REMOVE/REINSTALL/REPLACE THE OPERATOR SEAT/OPERATOR SEAT SWITCH.

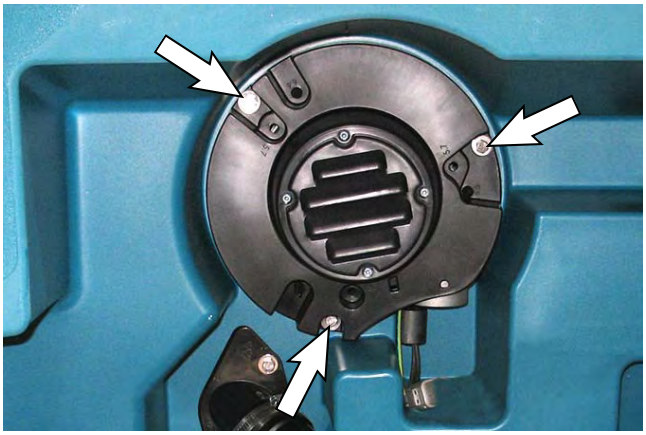
14. Remove the hardware securing the operator seat to the recovery tank.

15. Disconnect the recovery tank harness from the seat switch.

16. Remove the operator seat from the recovery tank.

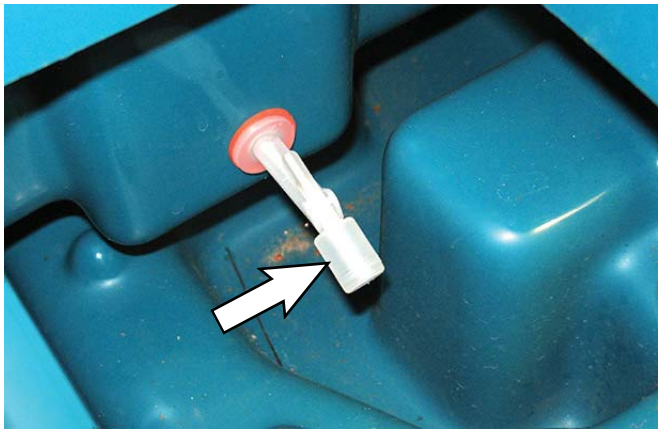
17. Disconnect the recovery tank harness from the vacuum fan.

18. Remove the vacuum fan from the recovery tank .



19. Disconnect the recovery tank harness from the 14VDC liquid level sensor.

20. Remove the 14VDC liquid level sensor from the recovery tank.

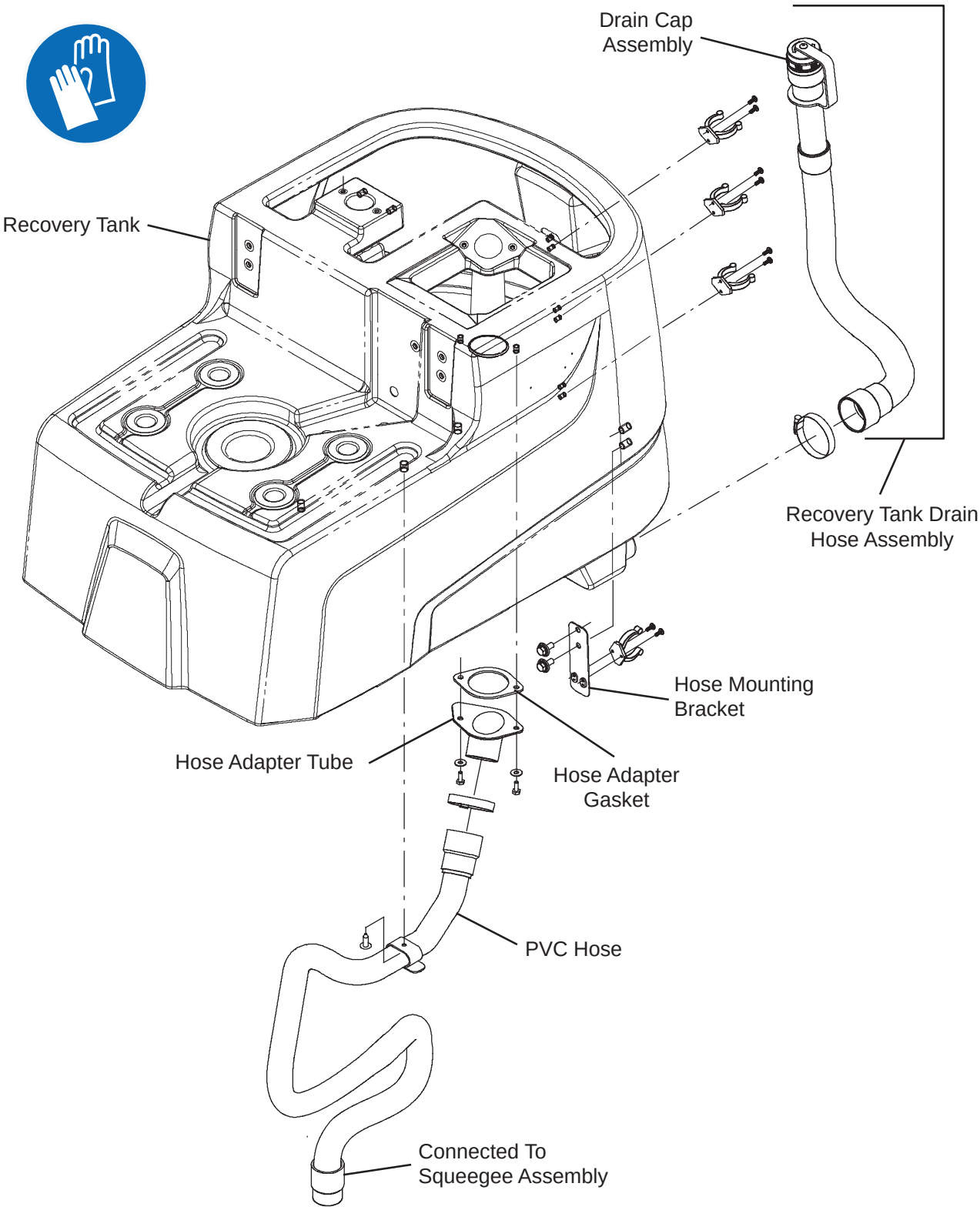


21. Remove the recovery tank harness, and any hardware securing the harness to the recovery tank, from the recovery tank.

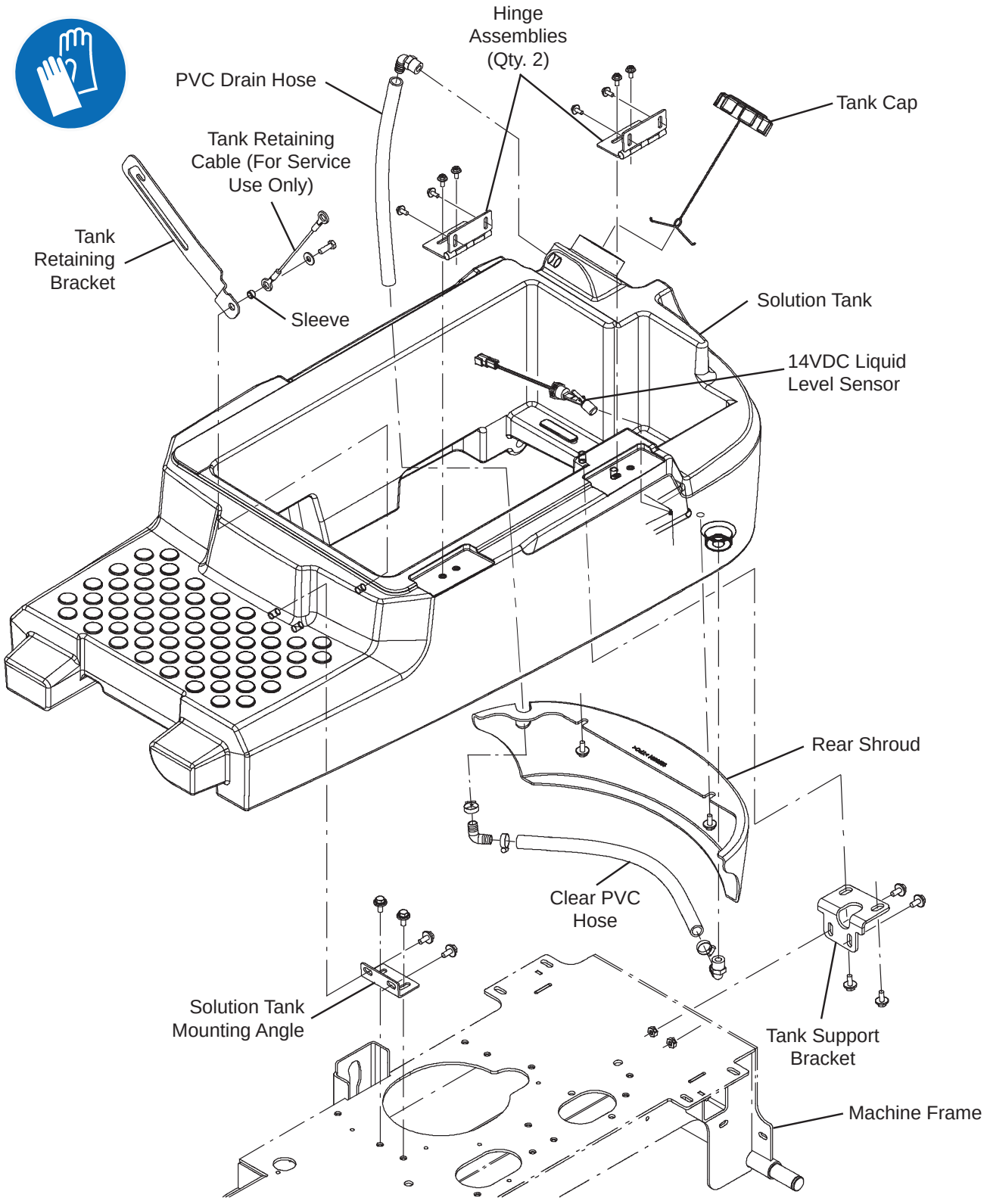
22. Remove all remaining parts, components, and hardware from the recovery tank.

23. Assemble parts and components removed from the old recovery tank onto the new recovery tank and assemble/install the recovery tank onto the machine in reverse order of disassembly.

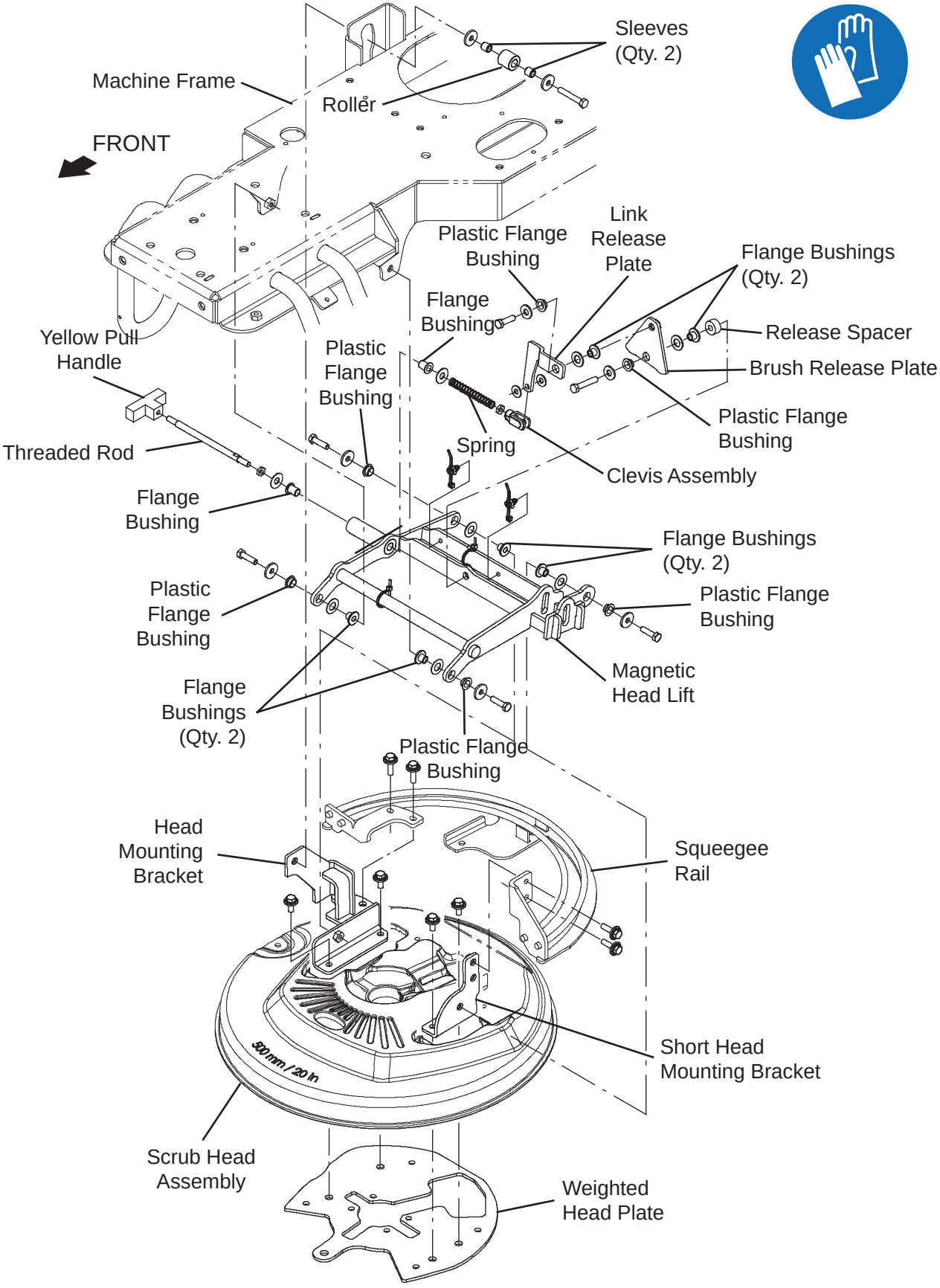
RECOVERY TANK HOSE GROUP



SOLUTION TANK GROUP



SCRUBBING SYSTEMS



REMOVE/REINSTALL/REPLACE THE SCRUB HEAD

1. Completely empty the solution tank and recovery tank.
2. Turn the key switch OFF and remove the key.
3. Remove the brush from the scrub head.
4. Turn the key switch ON, press the *1-Step button* to completely lower the scrub head, turn the key switch OFF, and remove the key.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

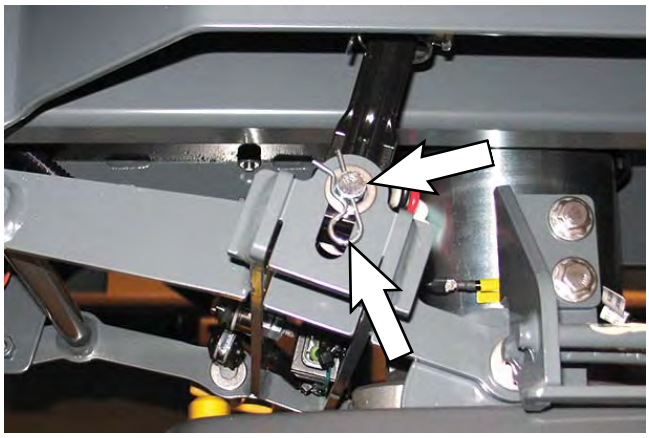
5. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
6. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

7. Jack up the front end of the machine enough to access the scrub head components/remove the scrub head from under the machine. Place jack stands under the machine and lower the machine onto the jack stands.

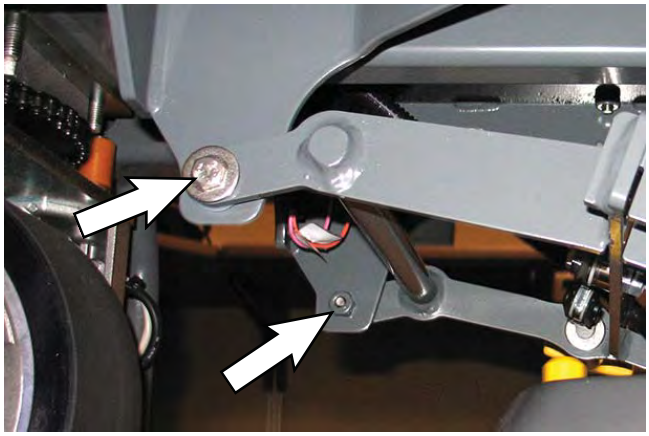
FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Support machine with jack stands.

8. Remove the clevis pin/cotter pin securing the scrub actuator to the scrub head lift.



NOTE: Do Not turn the actuator barrel after it has been disconnected from the scrub head lift. Turning the actuator barrel will place the actuator out of its factory adjusted setting. See the actuator adjustment instructions in REMOVING/REPLACING THE SCRUB HEAD ACTUATOR if the actuator is no longer in its factory adjusted setting.

9. Remove the hardware securing the scrub head lift to the frame of the machine.



10. Disconnect all wire and cable connections from the scrub head/scrub brush motors/solenoid water valve.
11. Disconnect the solution supply hose from the scrub head.
12. Remove the scrub head from under the machine.

13. If replacing the scrub brush motor carbon brushes, proceed to REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTOR CARBON BRUSHES.

14. If replacing scrub head motor, proceed to REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTOR.

15. Reinstall the scrub head onto the machine in reverse order of disassembly.

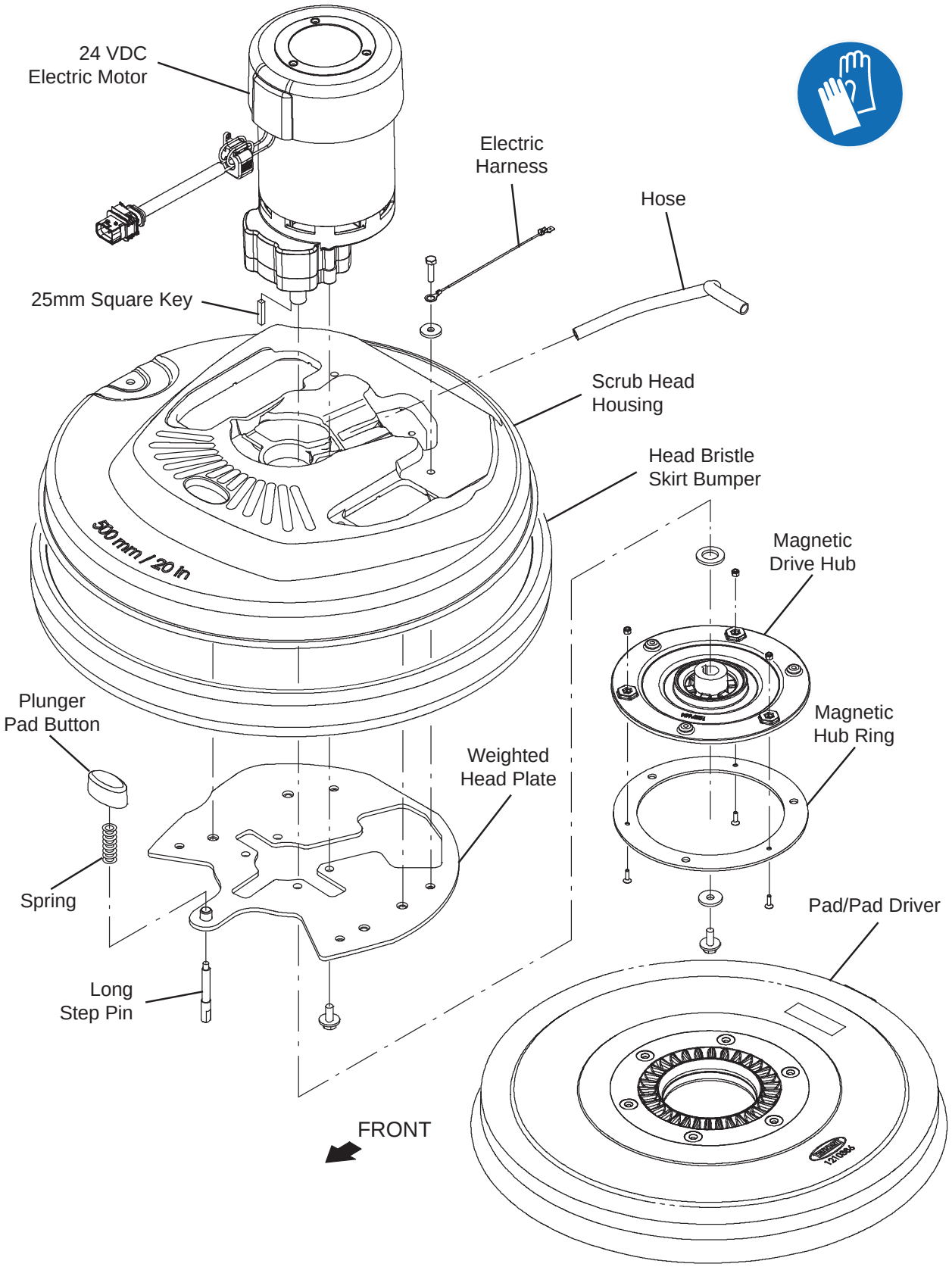
16. Reconnect the battery cable to the machine.

17. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.

18. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

19. Thread the hardware removed in the previous step back into the recovery tank.

REMOVE/REINSTALL/REPLACE THE SCRUB HEAD MOTOR



FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, rand remove key.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the scrub head from the machine. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD.
4. Remove the scrub brush motor from the scrub head. Do Not lose/misplace the key. This key is needed to install the new scrub brush motor onto the scrub head.
5. Remove the scrub brush motor from the scrub head.
6. Place the new scrub brush motor onto the scrub head.
7. Insert the key into the notch in the brush drive shaft and install the magnetic drive hub/magnetic hub ring onto the new scrub brush motor.
8. Reinstall the scrub head onto the machine in reverse order of disassembly.

REMOVING/INSTALLING THE SCRUB HEAD MOTOR CARBON BRUSHES

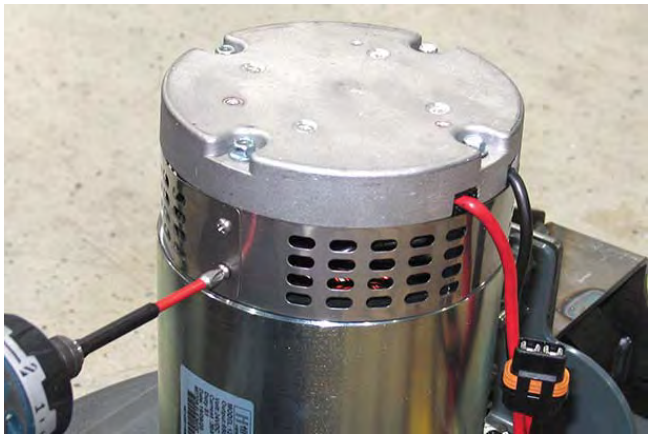
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, remove key, and set parking brake if equipped.

1. Turn the key switch OFF and remove the key.
2. Disconnect the battery cable from the machine.

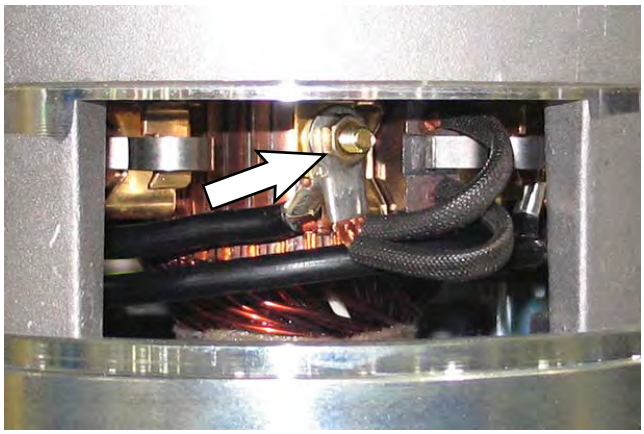
FOR SAFETY: When servicing machine, Disconnect battery connection and charger cord before working on machine.

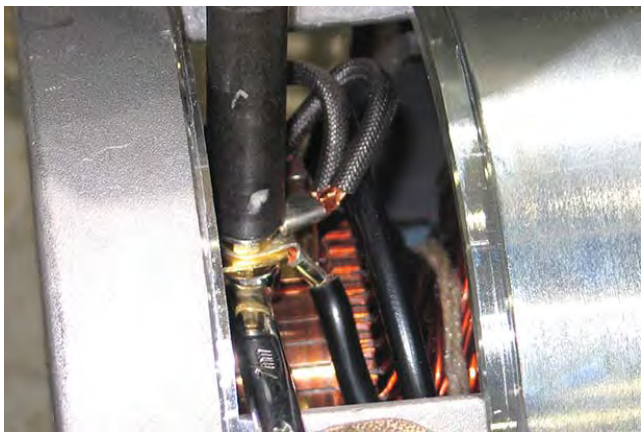
3. Remove the scrub head from the machine. Refer to REMOVE/INSTALL/REPLACE THE SCRUB HEAD ASSEMBLY.
4. Remove the cap from the scrub brush motor.

5. Remove the band from the scrub brush motor to access the scrub brush motor carbon brushes.

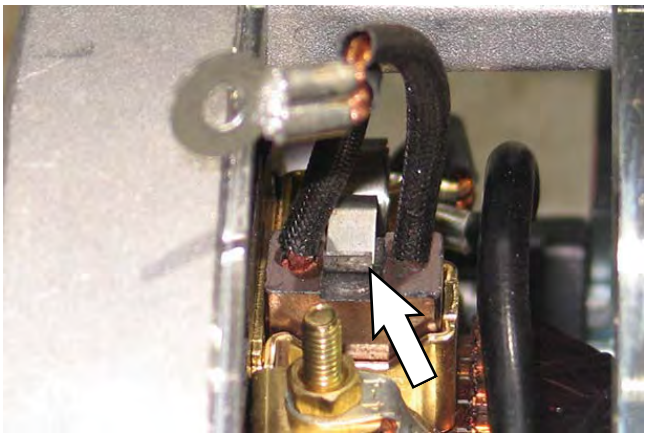


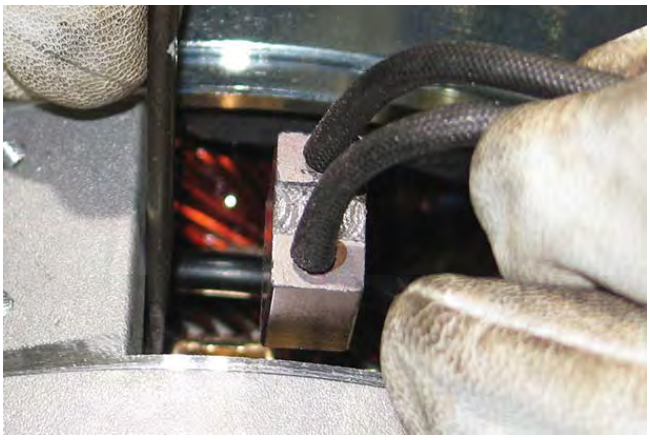
6. Remove the hardware securing the carbon brush cable to the scrub brush motor.



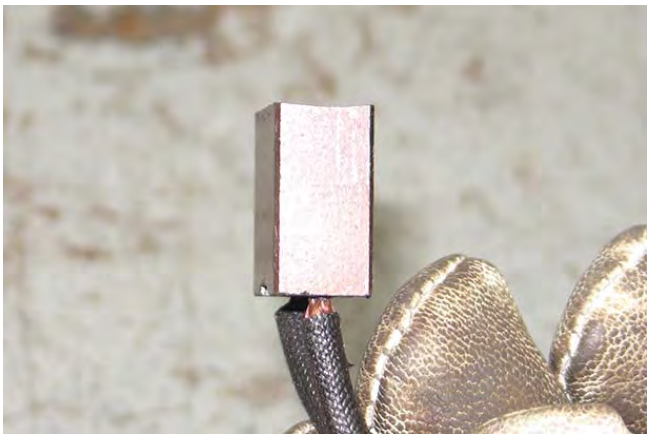


7. Push/lift the retainer spring from the carbon brush and remove the carbon brush from the scrub brush motor.





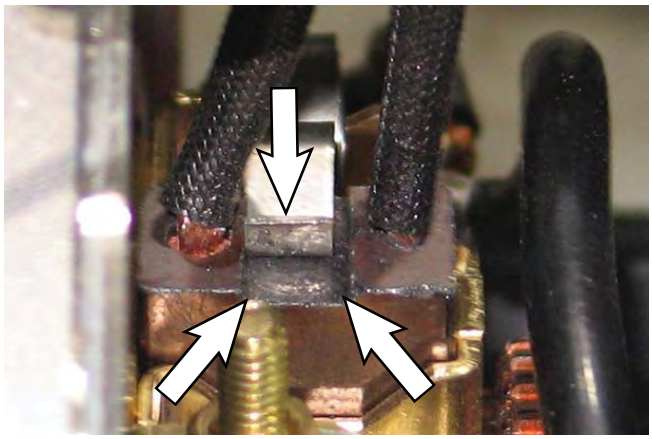
8. Inspect the scrub brush motor carbon brush.



9. Repeat procedure to remove remaining carbon brushes from the scrub brush motor.

10. Use compressed air to clean any dust from inside the motor.

11. Pull the retainer spring and insert the new carbon brush/previously removed carbon brush into the scrub brush motor. Ensure the spring is positioned in the notch at the top of the carbon brush and the carbon is firmly secured into place.

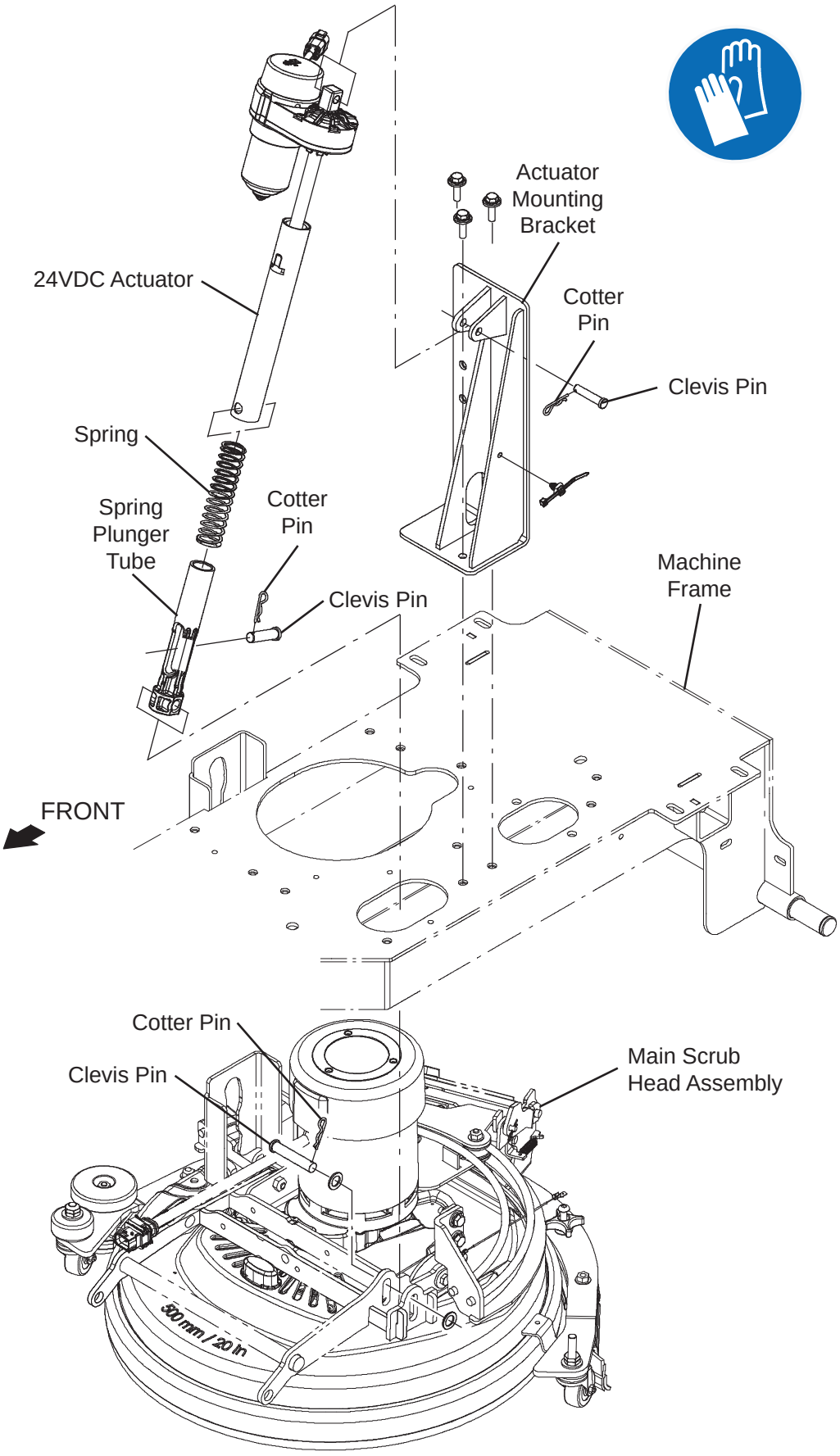


NOTE: Carbon brushes should be replaced as sets.

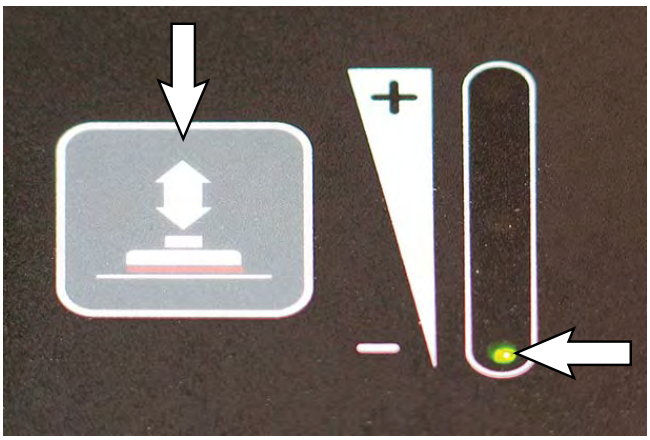
12. Reinstall the cap onto the disk brush motor and reinstall the scrub head onto the machine in the reverse order of removal.

13. Reinstall the scrub head onto the machine. REMOVE/INSTALL/REPLACE THE SCRUB HEAD ASSEMBLY.

REMOVING/REPLACING THE SCRUB HEAD ACTUATOR



1. Completely empty the recovery tank.
2. Ensure there is a pad/pad driver/brush installed on the scrub head.
3. Press the *brush pressure button* to set the brush pressure to the lowest pressure (only bottom brush pressure indicator light illuminated).



4. Press the *1-Step button* to completely lower the main scrub brush to the floor.

NOTE: If it is not possible to lower the scrub head due to the actuator being inoperable, pry the scrub head enough to relieve pressure on the clevis pin/cotter pin securing the actuator barrel to the disk head lift and place a block of wood under the scrub head to keep the pressure from the clevis pin/cotter pin.

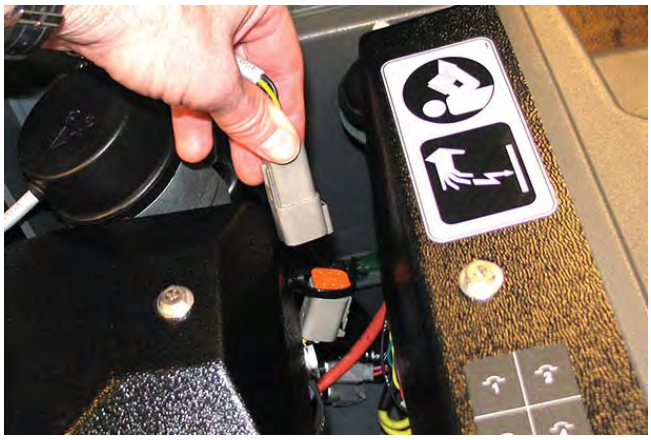
5. Turn the key switch OFF and remove the key.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

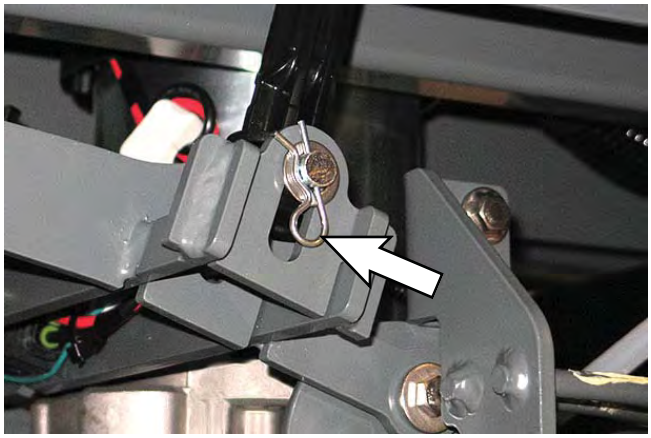
6. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
7. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

8. Disconnect the main wire harness from the actuator.

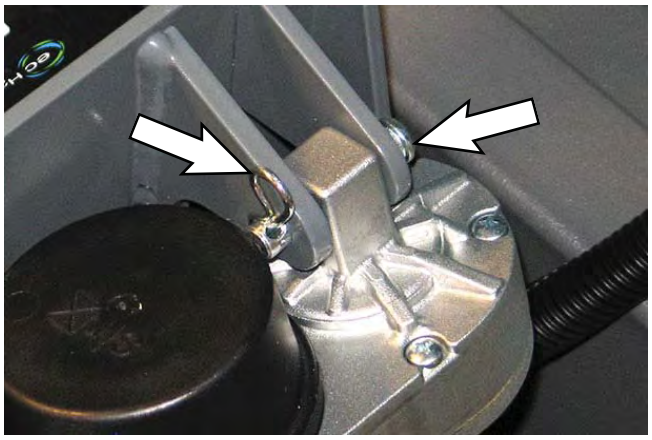


9. Remove the cotter pin/clevis pin securing the actuator to the scrub head assembly.



NOTE: If removing the actuator to perform other maintenance, Do Not turn the actuator barrel after it has been disconnected from the scrub head lift. Turning the actuator barrel will place the actuator out of its factory adjusted setting. See the actuator adjustment instructions in RESET THE SCRUB HEAD ACTUATOR TO FACTORY SETTING if the actuator is no longer in its factory adjusted setting.

10. Remove the cotter pin/clevis pin securing the actuator to the mounting bracket.



11. Remove the actuator from the machine.

12. If a block of wood was used to raise the scrub head, remove the block of wood from under the scrub head and position the scrub head so it is setting flat on the floor.

*NOTE: If installing a new actuator: **DO** **NOT** remove the red lock clip from the actuator tube or attempt to connect the lower tube end to the scrub head. Tube is installed onto scrub head later in this procedure.*

13. If installing new actuator, remove the red lock clip from the actuator.

14. Set the actuator to the factory setting (26.5 mm (1.04 in)). See RESET THE SCRUB HEAD ACTUATOR TO FACTORY SETTING and proceed to following step after setting the actuator to the factory setting.

15. Connect the main wire harness to the new actuator.

16. Reconnect the battery cable to the machine.

17. Turn the key switch ON.

18. Ensure the brush pressure is still at the lowest setting. Press the *brush pressure button* to set the brush pressure to the lowest pressure if it is not already at the lowest pressure setting (only bottom brush pressure indicator light illuminated)

19. Hold the actuator housing and actuator barrel so the barrel does not spin while extending the actuator and press the *1-Step button* to extend the barrel. The actuator barrel will completely extend and then retract slightly.

20. Turn the key switch OFF and remove the key.

21. Use the clevis pin/cotter pin to reinstall the actuator onto the actuator mounting bracket.

22. Use the clevis pin/cotter pin to secure the barrel of the actuator to the disk head lift.

23. Verify the following machine operations function properly:

    - Squeegee wheels are on the floor and rotating when the machine is moving and in the vacuum only mode.
    - Scrub head is level on the floor.
    - Actuator motor turns off before the barrel of the actuator touches the actuator motor housing.

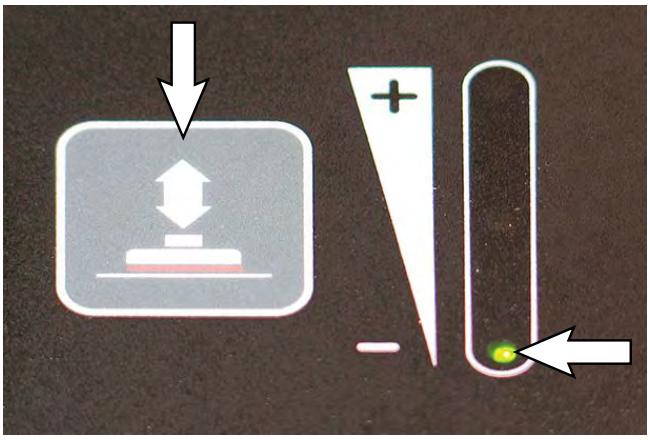
24. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.

25. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

26. Thread the hardware removed in the previous step back into the recovery tank.

RESET THE SCRUB HEAD ACTUATOR TO FACTORY SETTING

1. Remove the actuator from the machine. See REMOVING/REPLACING THE SCRUB HEAD ACTUATOR.
2. Connect the main wire harness to the actuator.
3. Extend the actuator barrel by hand approximately 101.6 mm (4 in) to allow clearance when retracting the actuator in the following step.
4. Turn the key switch ON.
5. Press the *brush pressure button* to set the brush pressure to the lowest pressure (only bottom brush pressure indicator light illuminated).

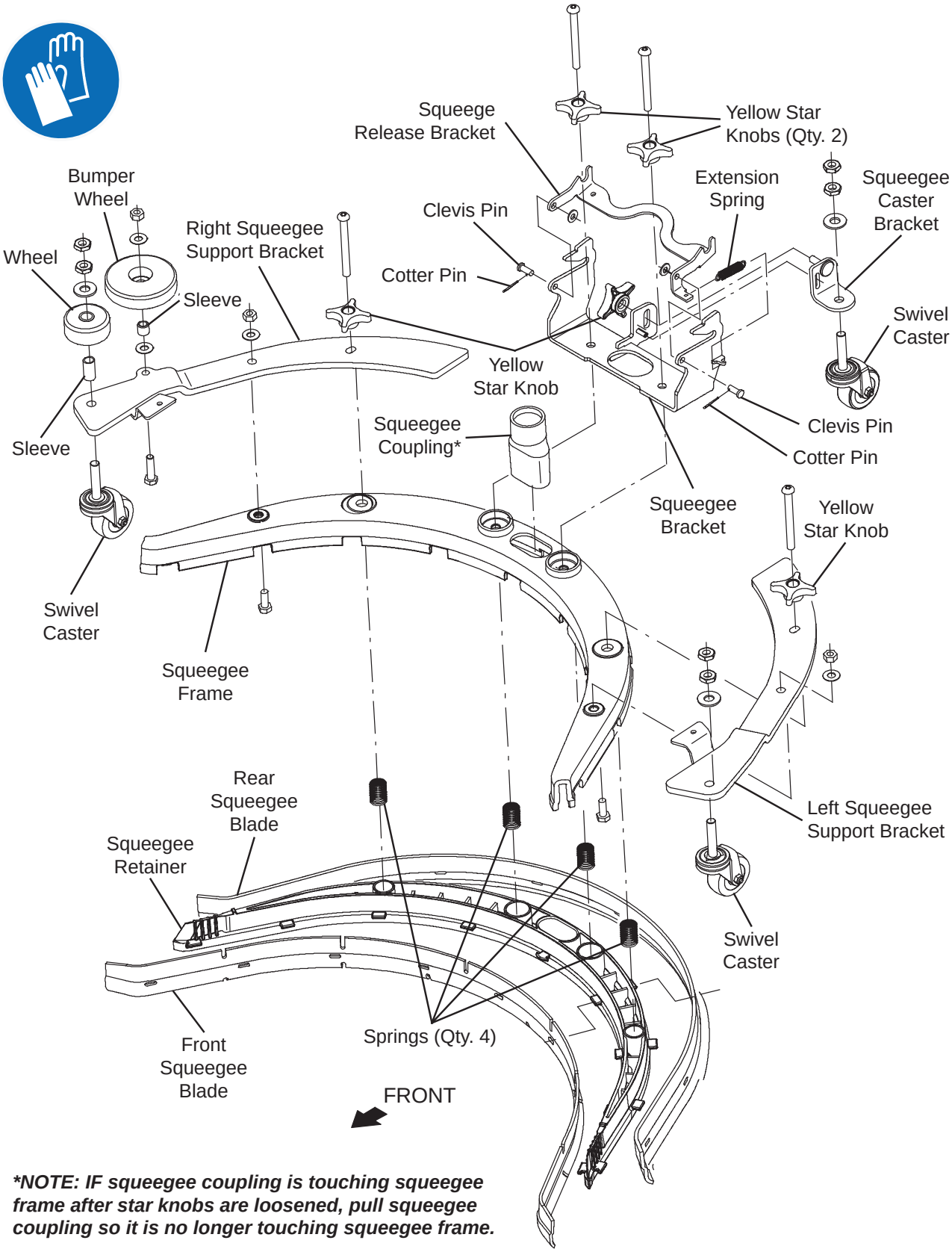


6. Press the *1-Step button* and allow the actuator barrel to spin freely. Do Not allow the actuator barrel to come in contact with the actuator housing.
7. Turn the key switch OFF.
8. To reset the actuator to the factory setting, turn the actuator barrel by hand until the top of barrel is approximately 26.5 mm (1.04 in) from the bottom of the actuator housing.

NOTE: The following step may require assistance.

9. Firmly hold both the actuator housing and the barrel to ensure the actuator barrel does not spin freely.
10. Turn the key switch ON.
11. Ensure the brush pressure is still at the lowest setting. Press the *brush pressure button* to set the brush pressure to the lowest pressure if it is not already at the lowest pressure setting (only bottom brush pressure indicator light illuminated).
12. Press the *1-Step button*.
13. Continue holding the actuator housing and barrel and allow the actuator to fully extend.
14. Turn the key switch OFF and remove the key.
15. Install the actuator onto the machine. See REMOVING/REPLACING THE SCRUB HEAD ACTUATOR.

ADJUSTING THE SQUEEGEE ASSEMBLY



NOTE: IF squeegee coupling is touching squeegee frame after star knobs are loosened, pull squeegee coupling so it is no longer touching squeegee frame.

1. Confirm the scrub head actuator is properly installed and adjusted. See REMOVING/ REPLACING THE SCRUB HEAD ACTUATOR.

NOTE: The adjustment for the squeegee assembly must be checked whenever the scrub head is changed and whenever any parts or components of the squeegee rail group (squeegee adjustment linkage/ squeegee adjustment bracket/squeegee bearing linkage/squeegee rail) are removed or replaced.

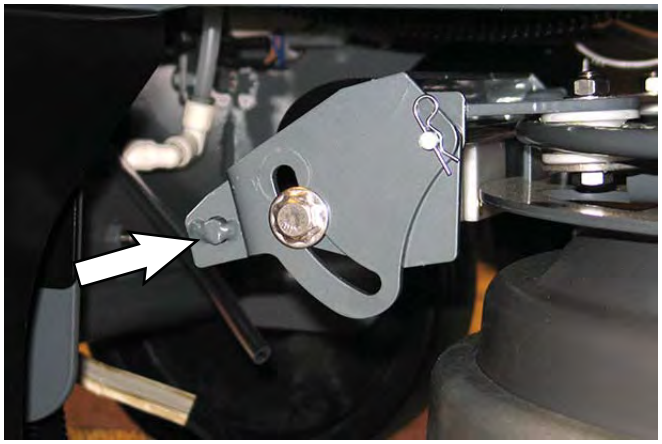
2. Remove the squeegee assembly from the squeegee carriage assembly.

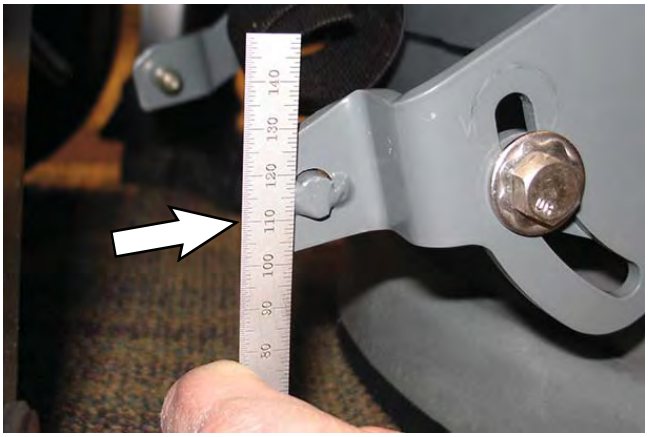
3. Turn the key switch ON, press the *vacuum fan/ squeegee button* and wait for the scrub head to lower, and then slightly raise, turn the key switch OFF, and remove the key.

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

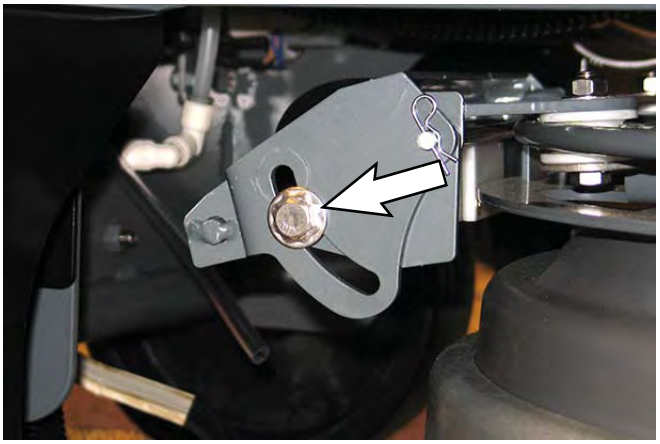
4. Center the squeegee carriage assembly underneath the machine.

5. Measure from the bottom of the pin located on the right side of the squeegee adjustment bracket. The center of the pin should be 114.5 mm +/- 4 mm (4.51 in. +/- 0.16 in.) from the floor.





6. If the bottom of the pin is not at the correct measurement, loosen the hex screw and adjust the location of the squeegee adjustment bracket in the squeegee adjustment linkage and retighten the hex screw.



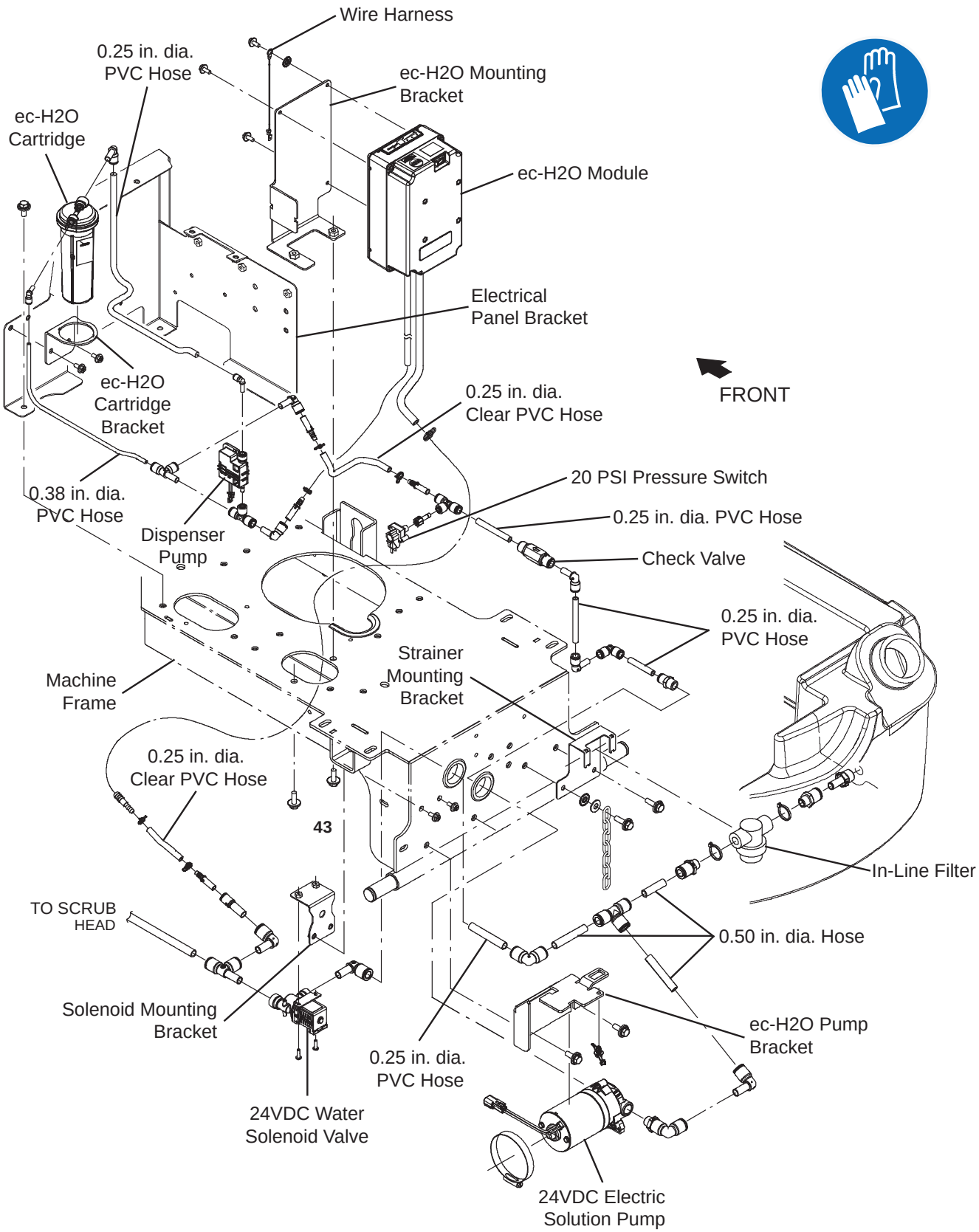
7. Recheck the pin measurement. Adjust as necessary.

8. Turn the Key switch ON and allow the scrub head to raise. Turn the key switch OFF and remove the key.

9. Reinstall the squeegee assembly onto the squeegee carriage assembly.

OPTIONS

ec-H2O NANOCLEAN GROUP



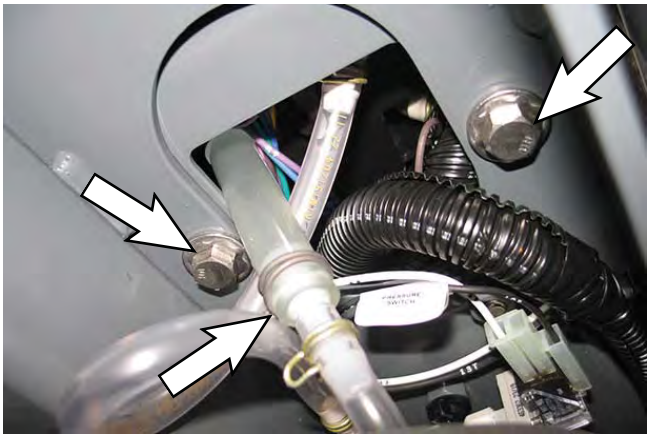
REMOVE/REINSTALL/REPLACE THE *ec-H2O* MODULE (OPTION)

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

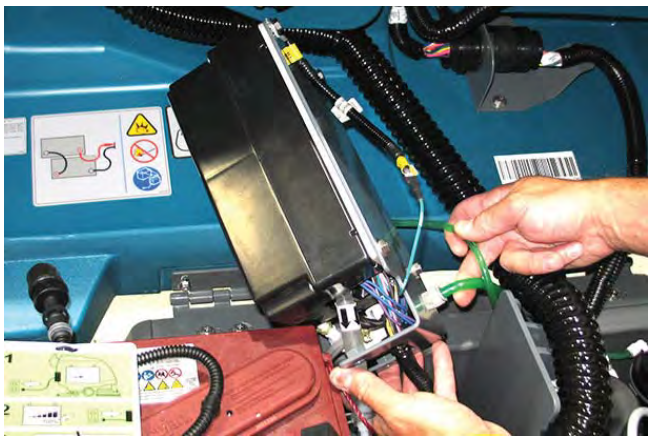
1. Completely drain the solution tank and the recovery tank.
2. Press the *1-Step button* to completely lower the scrub head.
3. Turn the key switch OFF and remove the key.
4. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

5. Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*
6. Remove the hardware securing the *ec-H2O* mounting bracket to the frame of the machine.



7. Disconnect the PVC hose connected to the *ec-H2O* module near where the hardware was removed in the previous step from the *ec-H2O* module.
8. Carefully lift the *ec-H2O* module/*ec-H2O* mounting bracket out from the machine.
9. Disconnect all main wire harness connections and ground connections from the *ec-H2O* module.
10. Disconnect all solution hoses from the *ec-H2O* module.



11. Remove the *ec-H2O* module from the *ec-H2O* mounting bracket.
12. Reinstall the removed *ec-H2O* module/install the new *ec-H2O* module in the reverse order of disassembly.
13. Reconnect the battery cable to the machine.
14. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.
15. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.
16. Thread the hardware removed in the previous step back into the recovery tank.

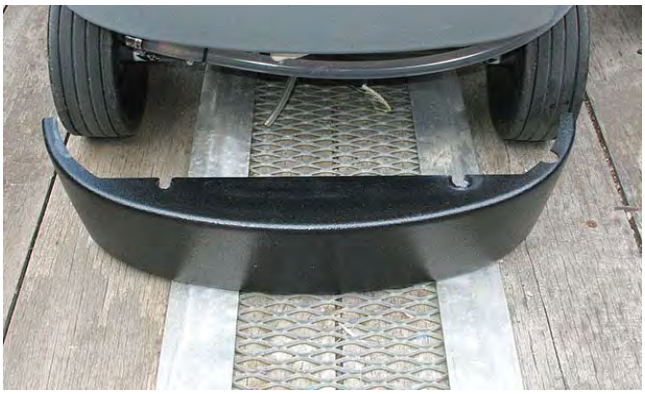
REMOVE/REINSTALL/REPLACE THE *ec-H2O* SOLUTION PUMP (OPTION)

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

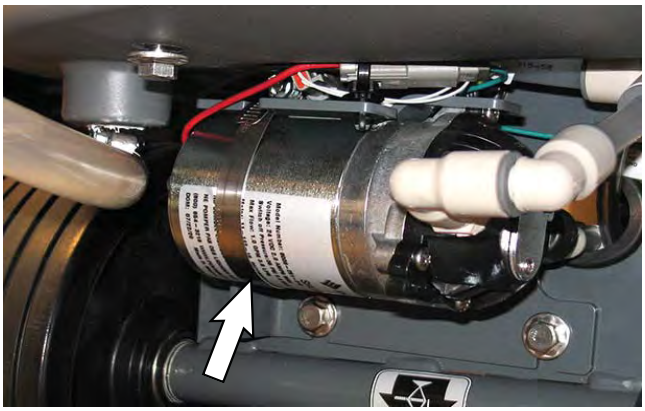
1. Completely drain the solution tank and the recovery tank.
2. Turn the key switch OFF and remove the key.
3. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

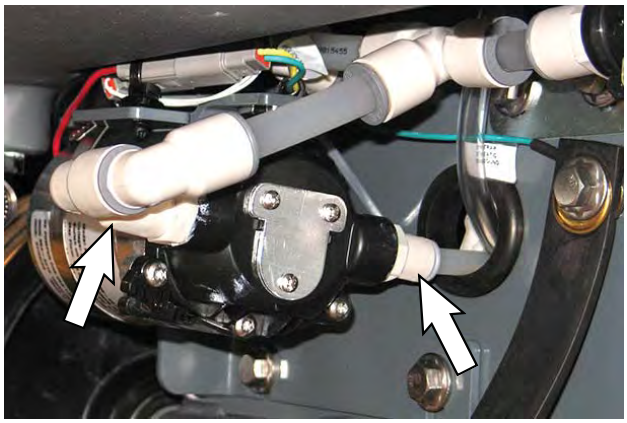
4. Remove the lower rear shroud from the machine.



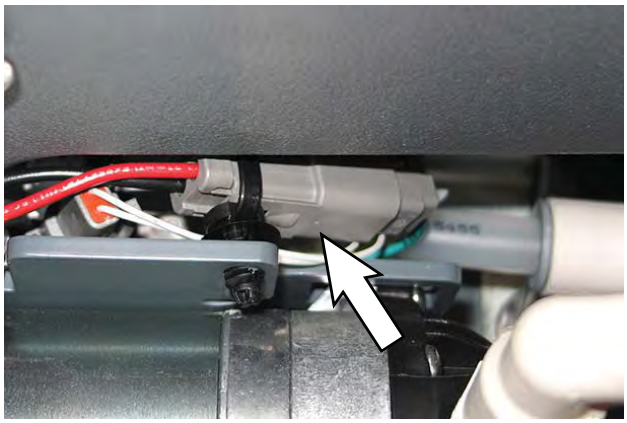
5. Remove the hose clamp securing the *ec-H2O* pump to the pump mounting bracket.



6. Disconnect both solution hoses from the *ec-H2O* pump.



7. Disconnect the main wire harness from the *ec-H2O* pump.



8. Connect the solution hoses and main wire harness to the new/removed *ec-H2O* pump.
9. Reinstall the *ec-H2O* pump onto the pump mounting bracket.

REMOVE/REINSTALL/REPLACE THE *ec-H2O* PRESSURE SWITCH/DISPENSER PUMP/WATER SOLENOID VALVE (OPTION)

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Completely drain the solution tank and the recovery tank.
2. Press the *1-Step button* to completely lower the scrub head.

3. Turn the key switch OFF and remove the key.

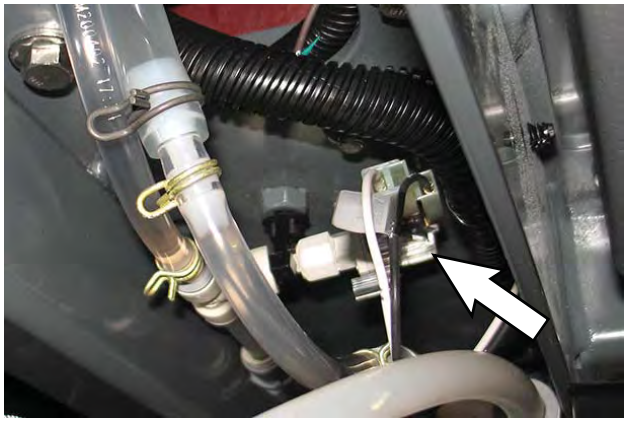
4. **If removing the dispenser pump from the ec-H2O mounting bracket:** Set the recovery tank into the service position. See *SETTING RECOVERY TANK INTO SERVICE POSITION.*

5. Disconnect the battery cable from the machine.

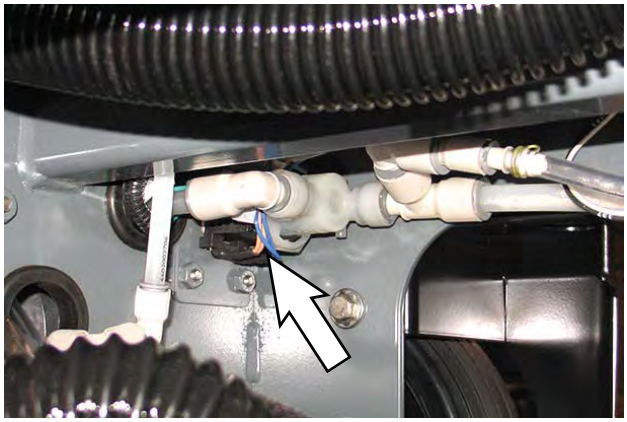
FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

6. Disconnect the main wire harness and hoses from the pressure switch/dispenser pump/water solenoid valve.

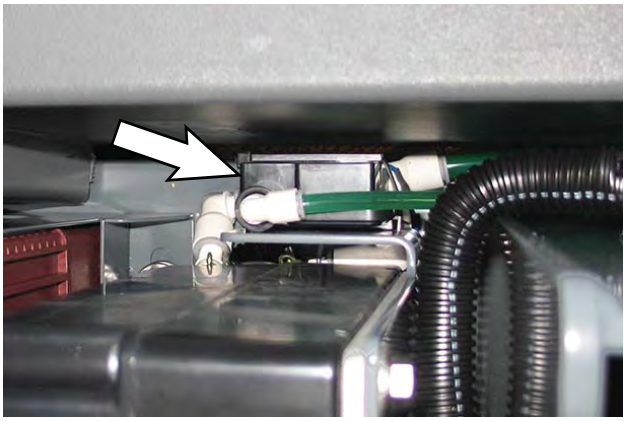
7. Remove the pressure switch from the machine.



Remove the water solenoid valve from the machine.



Remove the dispenser pump from the ec-H2O mounting bracket. See REMOVE/REINSTALL/REPLACE THE *ec-H2O* MODULE (OPTION) for instructions how to remove the *ec-H2O* mounting bracket to access the pressure switch.



8. Install the new/reinstall the removed pressure switch/dispenser pump/solenoid valve.

9. Connect the main wire harness to the pressure switch/dispenser pump/solenoid valve.

10. Reconnect the battery cable to the machine.

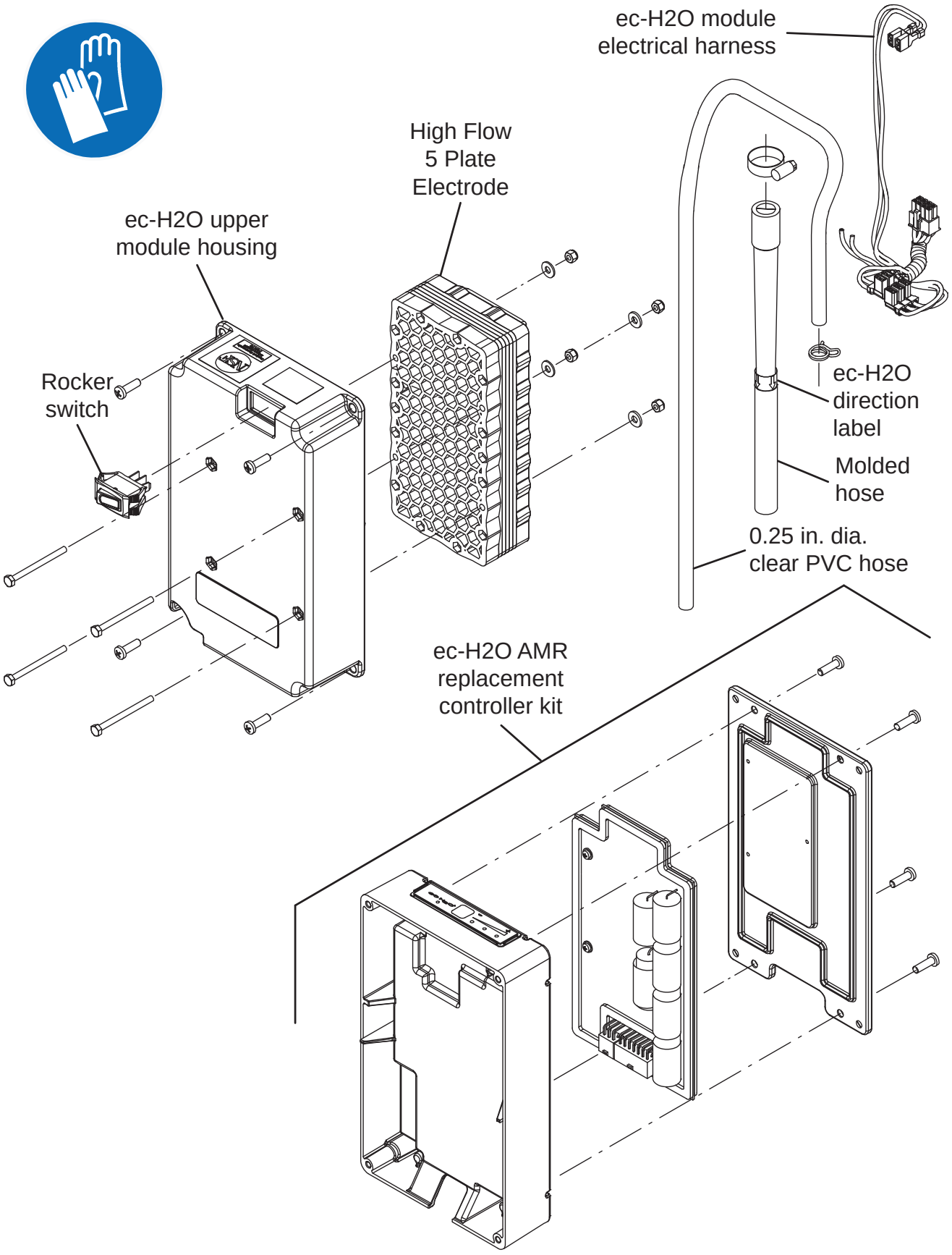
If the dispenser pump was removed from the ec-H2O mounting bracket:

11. Remove the hardware previously used for securing the prop arm to the recovery tank from the recovery tank and reinstall the prop arm onto the recovery tank.

12. Remove the hardware securing the service cable to the recovery tank and reinstall the removed hardware into the recovery tank. Place the end of the service cable into the interior of the electrical compartment.

13. Thread the hardware removed in the previous step back into the recovery tank.

SERVICE THE *ec-H2O* MODULE (OPTION)



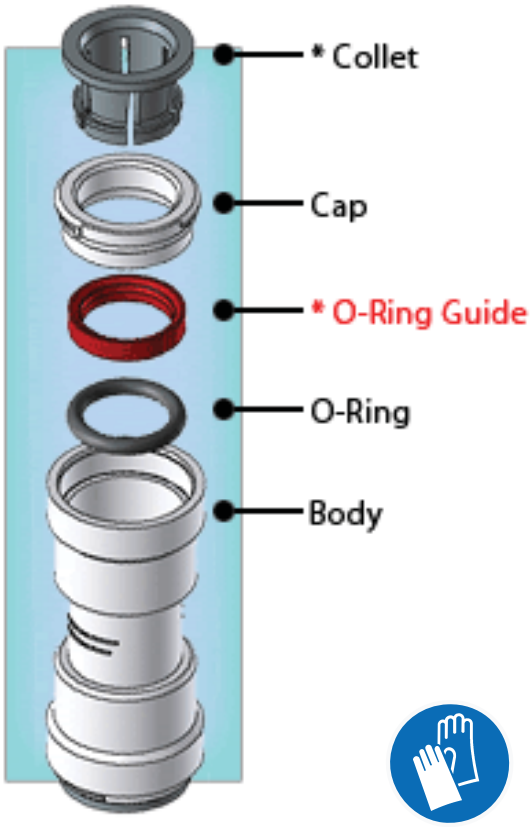
FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the key to the OFF position.
2. Disconnect the battery cable from the machine.

FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.

3. Remove the *ec-H2O* module from the machine. See REMOVING/INSTALLING THE *ec-H2O* MODULE (OPTION).
4. Remove the *ec-H2O* upper module housing from the *ec-H2O* module.
5. Further disassemble the *ec-H2O* module as necessary to access and replace parts.
6. Reassemble the *ec-H2O* module in the reverse order of disassembly.
7. Reinstall the *ec-H2O* module onto the machine. See REMOVING/INSTALLING THE *ec-H2O* MODULE (OPTION).

CONNECT HOSES TO PTC (PUSH-TO-CONNECT) FITTINGS



1. Cut the tube square. The outer diameter of the tubing must be free of score marks, burrs, or sharp edges.

2. Insert tube into the fitting. The fitting will grip the hose before it seals.

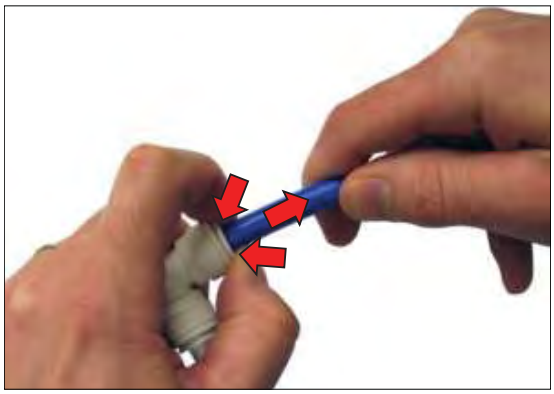
3. Push into the tube stop. The stainless steel teeth inside the collet firmly hold the tube in position and the o-ring provides a permanent leak-proof seal.

4. Pull on the fitting to ensure the hose connection is secure.

5. Test the fitting/hose connections for leaks prior to leaving the site.

DISCONNECT HOSES FROM PTC (PUSH-TO-CONNECT) FITTINGS

1. Push the hose into the fitting and push the collet squarely in against face of fitting to release the hose from the fitting. Continue to hold the collet held in against the fitting and pull the hose from the fitting.



NOTE: Be sure there is no pressure in the system and the system is emptied of all solution before disconnecting hose(s) from the fitting.

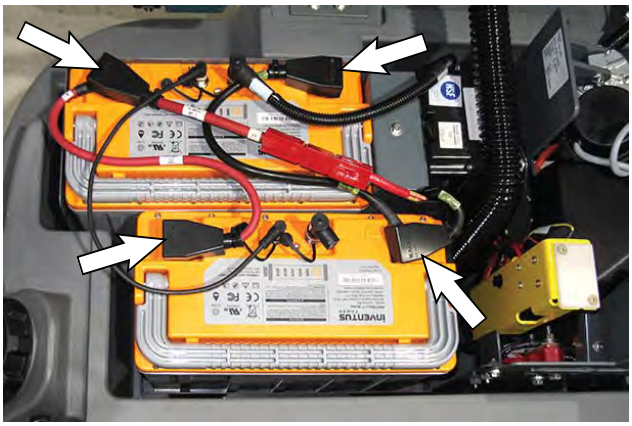
LITHIUM BATTERIES

TROUBLESHOOTING

INSPECT LITHIUM BATTERY CABLES

The battery red (+) cables, black (-) cables, and lithium battery CAN communication cables must be undamaged and correctly torqued to the lithium batteries.

1. Inspect all red (+) cables and black (-) cables for damage.



2. Repair/replace damaged red (+) cables and black cables (-). Ensure cables are all correctly torqued to the batteries.

   Torque red (+) connections to 22 Nm (16 ft. lbs.)

   Torque black (-) connections to 17 Nm (12.5 ft. lbs.)

3. Proceed to TROUBLESHOOT UI POWER ELECTRIC HARNESS (J7-8/J7-10) if issue persists.

4. Inspect the lithium battery CAN communication cables for obvious damage.

5. Repair/replace damaged lithium battery CAN communication cables. Ensure cables are all correctly torqued to the batteries.

   Torque lithium battery CAN communication cable connections to 0.6 Nm (0.44 ft. lbs.).

6. Proceed to INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK if issue persists.

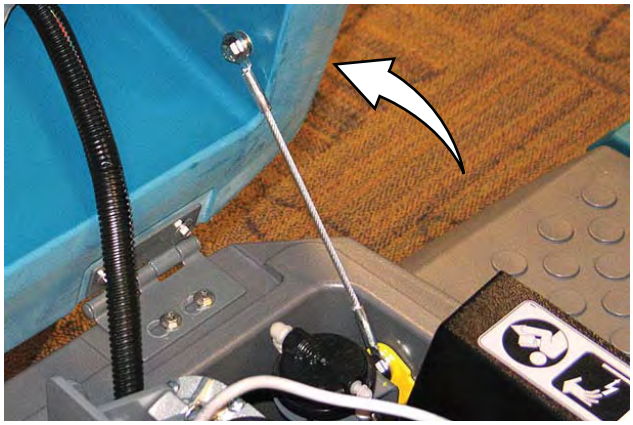
CHECK LITHIUM BATTERY STATUS/FAULT CODES

Check the lithium battery status and for battery error codes if there are issues with machine short run times/ battery pack not retaining charge.

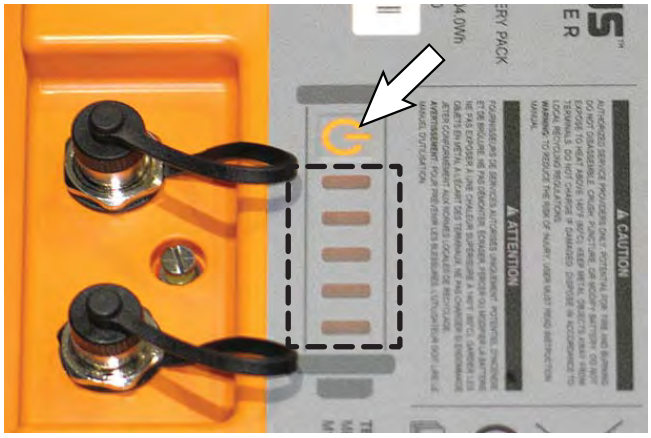
1. Completely empty the recovery tank.

*NOTE: **Do** **Not** empty the solution tank before troubleshooting the lithium batteries/performing lithium battery maintenance. The solution tank must be full so the machine does not tip over.*

2. Set the recovery tank into the service position.



3. Press power button for 1 second on each battery to see the battery status. Observe the indicator lights on each battery.



If the indictor lights do not illuminate, the batteries may not be turned on. Press the battery power button on one battery for 5 seconds to turn on all batteries (may take up to approximately 30 seconds for all batteries to come on). Press the power button for 1 second on each battery again and observe the indicator lights to ensure each battery is on.

All indicator lights should be flashing green to display the battery charge level if the batteries are in normal operating status (no faults). Charge batteries as necessary if all indicators are not flashing green or there is a fault code requiring the batteries be charged.

If the indicator lights are flashing red, there is an issue generating a fault code. Refer to the lithium battery fault codes table for the Fault ID, Battery Indicator Light Pattern, Fault Description, and Correction for the fault.

If fault still persists after initial battery maintenance procedures, proceed to ACCESS LITHIUM BATTERY SERVICE SCREEN to further troubleshoot the lithium battery system.

NOTE: Some battery faults will not only appear as faults on the battery indicator lights, but could also appear as a fault on the UI (User Interface), and also prevent the machine from being operated (flashing operator controls and indicators).

Fault ID	Battery Indicator Light Pattern	Fault Description	Correction
F0		Over Temperature (Cells)	1. Allow temperature to lower into acceptable operating range. 2. If fault persists, contact T.A.C. for further assistance.
F1		Over Temperature (BMS)	1. Allow temperature to lower into acceptable operating range. 2. If fault persists, contact T.A.C. for further assistance.
F2		Under Temperature (Charge)	1. Allow temperature to raise into acceptable operating range. 2. If fault persists, contact T.A.C. for further assistance.
F3		Over Current (Recoverable)	If charging: 1. Power cycle charger. 2. Replace charger if fault persists. If discharging: 1. Disconnect battery cable from batteries. 2. Reconnect battery cable to batteries. 3. Battery should resume operation after discharge has been stopped. 4. If fault persists, contact T.A.C. for further assistance.
F4		Over Current (Permanent Fault)	1. Replace battery. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.
F5		Short Circuit	1. Inspect all battery system electrical connections. 2. Repair electrical connections as necessary. 3. If fault persists, contact T.A.C. for further assistance.
F6		Cell Under Voltage-During Discharge Only	1. Recharge battery. 2. If fault persists, contact T.A.C. for further assistance.
F7		Cell Over Voltage-During Charge Only (Primary)	1. Discharge battery down to 20% SOC (State of Charge) and recharge battery. 2. If fault persists, contact T.A.C. for further assistance.
F8		Cell Over Voltage-During Charge Only (Secondary)	1. Replace battery.
F9		Safety Under Voltage	1. Recharge battery. 2. If fault persists, contact T.A.C. for further assistance.

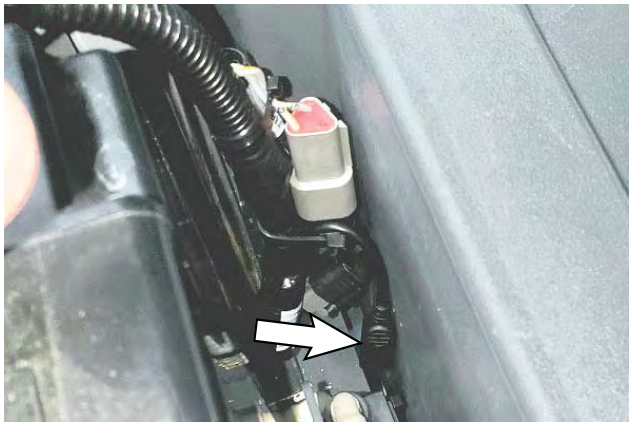
Fault ID	Battery Indicator Light Pattern	Fault Description	Correction
F10		Cell Pre-Charge Fault	1. Power cycle charger. 2. If fault persists, replace charger.
F11		Charge Fault	1. Power cycle charger. 2. If fault persists, replace charger.
F12		Under Temperature (Discharge)	1. Allow temperature to raise into acceptable operating range. 2. If fault persists, contact T.A.C. for further assistance.
F13		Miscellaneous Fault	1. Power cycle battery. 2. If fault persists, replace battery.
F14		Pre-Discharge Fault	1. Disconnect cables from battery. 2. Observe indicator lights for a fault. 3. If no fault, reconnect cables to battery. 4. If fault persists, replace battery. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.
F15		Permanent Fault	1. Replace battery. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.

ACCESS LITHIUM BATTERY SERVICE SCREEN

1. Connect a USB cable to the service device.

ATTENTION: *Never allow the metallic tip on the loose end of the service USB cable to touch a lithium battery positive (+) terminal when connecting the USB cable to the service device/lithium battery control board USB cable. USB cables, service device, and/or lithium battery control board could be damaged if loose metallic end of the service USB cable touches a lithium battery positive (+) terminal.*

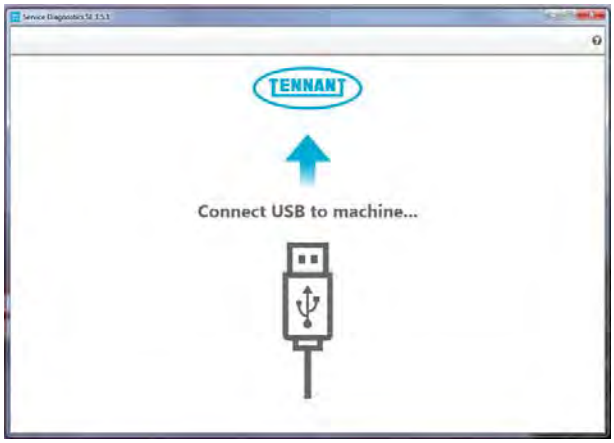
2. Connect the other end of the USB cable connected to the service device in the previous step to the lithium battery control board USB cable.



3. Turn the key switch ON.

4. Double click the Service Diagnostics desktop shortcut or find the software in All Programs to launch the software.

NOTE: Confirm key switch is ON and check USB cable connection to the machine if the screen below appears on the screen.

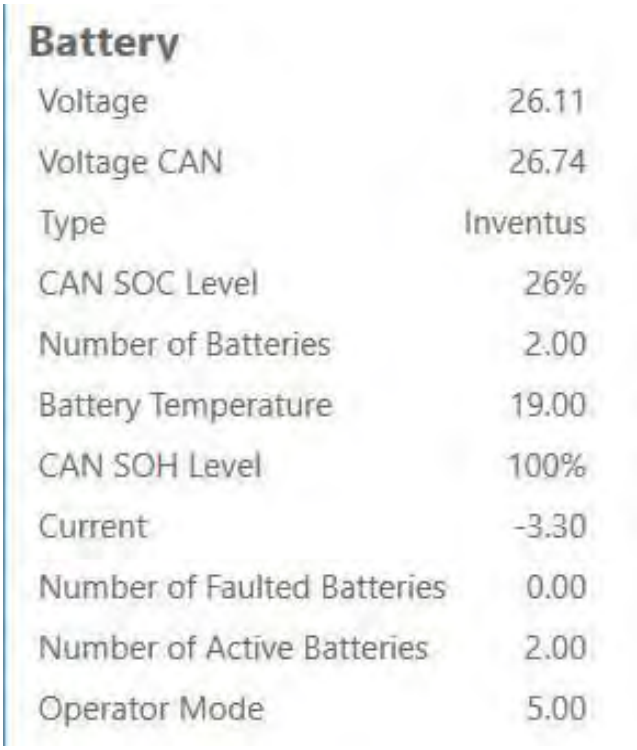


NOTE: If Service Diagnostics does not move beyond the above screen, proceed to TROUBLESHOOT SERVICE DIAGNOSTIC CONNECTION.

5. The Service Diagnostics tool now connects to the lithium ion battery network.

6. The lithium battery service screen opens.

7. Observe the lithium battery operational status in the lithium battery status column. See LITHIUM BATTERY SYSTEM RANGES for lithium battery operational values/ranges.



Battery	
Voltage	26.11
Voltage CAN	26.74
Type	Inventus
CAN SOC Level	26%
Number of Batteries	2.00
Battery Temperature	19.00
CAN SOH Level	100%
Current	-3.30
Number of Faulted Batteries	0.00
Number of Active Batteries	2.00
Operator Mode	5.00

Proceed to LITHIUM BATTERY SYSTEM VALUES/ RANGES for battery status battery/battery system operating range information.

LITHIUM BATTERY SYSTEM VALUES/RANGES

Refer to the table to confirm lithium battery operating values observed on the AMR SERVICE CONNECTION are within the minimum/maximum operating ranges.

System	Operating Parameter	Minimum Value	Nominal Value	Maximum Value	Measure
Lithium Battery	**Voltage**	20		28	Volts
	Voltage CAN*	20		28	Volts
	Type	Inventus			NA
	CAN SOC Level	0		100	Percent (%)
	Number of Batteries	0	2	2	Quantity
	Battery Temperature	-20°C (-4°F)		55°C (131°F)	Temperature
	CAN SOH Level	80		100	Percent (%)
	Current	-150		90	Amps
	Number of Faulted Batteries	0	0	2	Quantity
	Number of Active Batteries	0	4	2	Quantity
	Operator Mode	5	5	5	Charge/Discharge

**CAN (Controller Area Network) communication bus between the BMS (Battery Management System) and battery board.*

Voltage: Minimum/maximum voltage range necessary for normal machine operation as measured by the lithium circuit battery board. Battery terminals will shut down when below the minimum value and will need to be recovered. Proceed to following troubleshooting sections to further investigate/correct issue:

See LITHIUM BATTERY HARD RESET to turn on batteries if they are in shutdown mode due to low voltage (being allowed to discharge beyond minimum voltage value).

See TROUBLESHOOT UI POWER ELECTRIC HARNESS (J7-8/J7-10) to further troubleshoot issue.

Voltage CAN (Control Area Network): Minimum/maximum voltage range necessary for normal operation, as reported over the CAN by the BMS. Charge battery pack if voltage is below the minimum value. Proceed to following troubleshooting sections if issue persists:

See *INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK* to troubleshoot issue.

See *TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6)* to further troubleshoot issue if issue persists.

See *TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4)* to further troubleshoot if issue persists.

Type: Battery Manufacturer - Inventus.

CAN SOC Level (State of Charge): Percent of remaining available battery pack capacity. At 100% the battery pack is fully charged. A lower SOC value signifies less remaining available battery pack capacity. Proceed to following troubleshooting sections to further investigate/correct issue:

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) to further troubleshoot issue.

See TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4) to further troubleshoot if issue persists.

Number of Batteries: Number of batteries must be two (2.00). If number is less than two, inspect all CAN communication cables and connections. Proceed to following troubleshooting sections to further troubleshoot issue:

See INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK to troubleshoot issue.

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) to further troubleshoot if issue persists.

See TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4) to further troubleshoot if issue persists.

Battery Temperature: Current battery pack temperature. Stop operating machine and allow the battery pack temperature to raise/lower within the acceptable temperature range. Observe the batteries for over/under temperature fault codes. Proceed to following troubleshooting sections to further troubleshoot issue:

See lithium battery fault code table in CHECK LITHIUM BATTERY STATUS/FAULT CODES for lithium battery fault code information.

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) to further troubleshoot issue.

CAN SOH Level (State of Health): Condition of battery pack when compared to a new battery pack. This value should always be above the minimum. Battery pack performance deteriorates as number drops below minimum value, and battery pack will eventually need to be replaced. Proceed to following troubleshooting sections to further investigate/correct issue:

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) to troubleshoot issue.

See TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4) to further troubleshoot if issue persists.

Current: Minimum/maximum battery amperage values. Performance and operational expectancy is adversely affected if battery pack is outside the acceptable range. Proceed to following troubleshooting section to further troubleshoot issue:

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) to troubleshoot issue.

Number of Faulted Batteries: If there is any number other than zero (0.00) in Number of Faulted Batteries observe the battery indicator lights on each battery to find which battery/batteries are displaying a fault condition. Proceed to following troubleshooting sections to further troubleshoot issue:

See lithium battery fault code table in CHECK LITHIUM BATTERY STATUS/FAULT CODES for lithium battery fault code information.

See INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK if issue persists after battery faults are cleared.

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) if issue persists. Proceed to following troubleshooting sections to further troubleshoot issue:

Number of Active Batteries: Number of batteries available to power the machine. This value should be two (2.00). The number of active batteries decreases as the number of faulted batteries increases. Proceed to following troubleshooting sections to further troubleshoot issue:

See INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK to troubleshoot issue.

See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) to further troubleshoot if issue persists.

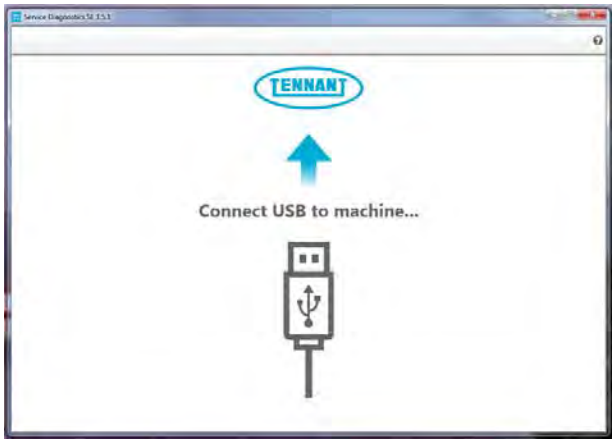
See TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4) to further troubleshoot if issue persists.

Operator Mode: Usually machine will not function unless the Operator Mode is 5 (discharging). If the machine does power up and any number other than 5 appears in Operator Mode on the service device, contact T.A.C. for further troubleshooting guidance.

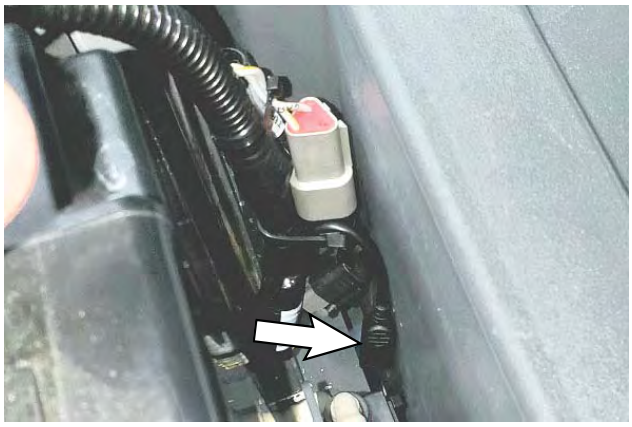
NOTE: In some circumstances, if the battery pack is operating outside acceptable minimum/maximum range(s), not only will these issues appear on the lithium battery operational status screen, but could also appear as a fault on the UI (User Interface), and prevent the machine from being operated (flashing operator controls and indicators).

TROUBLESHOOT SERVICE DIAGNOSTIC CONNECTION

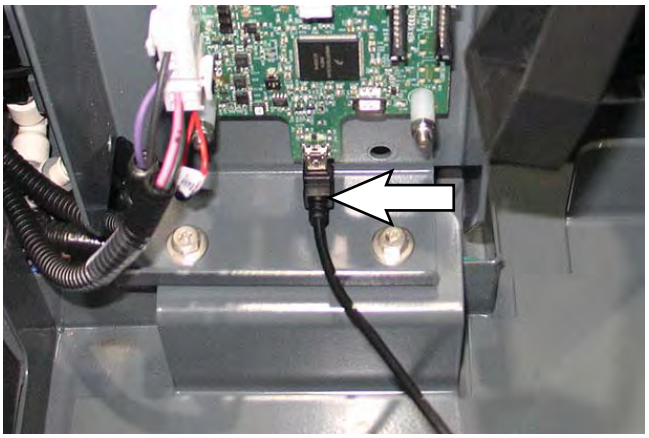
Proceed with this procedure if Service Diagnostics does not advance beyond the “Connect USB to machine...” screen.



1. Check the USB connection from service device to the lithium battery control board USB cable. Ensure the USB cable is completely connected to the service device and lithium battery control board USB cable.



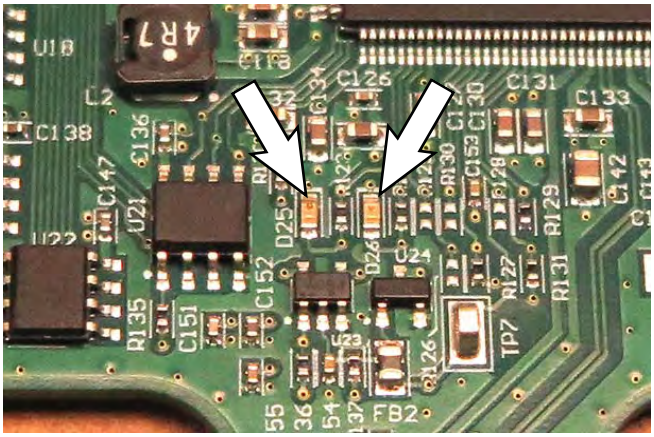
2. Attempt again to connect to the machine/access the lithium ion service screen. If issue persists, use another USB cable to connect the service device to the lithium battery control board USB cable.
3. If there is still no connection to the machine/access the lithium battery service screen, proceed to the following step.
4. Disconnect the USB cable/service device from the lithium circuit board USB cable.
5. Remove the board mounting bracket from the board mounting plate.
6. Ensure the lithium battery control board USB cable is completely connected to the lithium battery circuit board.



7. Reconnect the USB cable/service device to the lithium circuit board USB cable.
8. Attempt again to connect to the machine/ access the lithium ion service screen. If there is still no connection to the machine/access the lithium battery service screen, proceed to TROUBLESHOOT LITHIUM BATTERY CONTROL BOARD.

TROUBLESHOOT LITHIUM BATTERY CONTROL BOARD

1. Observe the indicator lights (Green LED D25 indicating there is power to the lithium battery circuit board and Yellow LED D26 indicating there is CAN (Controller Area Network) communication to the lithium battery circuit board) on the lithium battery circuit board. Both LEDs should be flashing.



   If neither LED (D25 and D26) is flashing troubleshoot the power to the lithium battery circuit board. Replace the UI power electric harness if it is damaged. See TROUBLESHOOT UI POWER ELECTRIC HARNESS (J7-8 / J7-10).

   If neither LED (D25 and D26) is flashing, and the UI power electric harness is fully functional/ undamaged, inspect the lithium battery circuit board for obvious damage. Replace the lithium battery circuit board if it is damaged. See REPLACE LITHIUM BATTERY CIRCUIT BOARD.

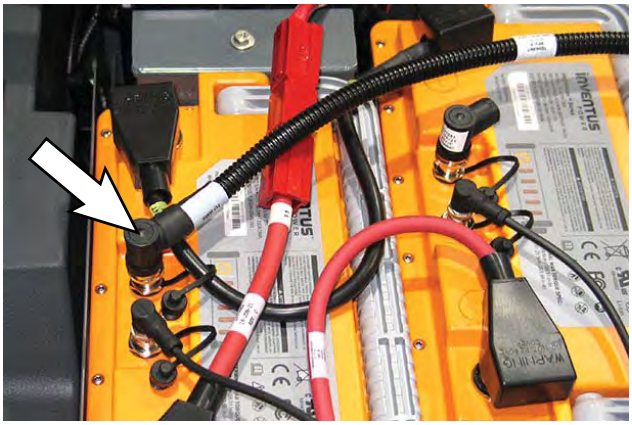
   If only the green LED D25 is flashing (indicating there is power to the lithium battery circuit board), but the yellow LED D26 (indicating there is CAN communication to the lithium battery circuit board) is not flashing, troubleshoot the lithium battery CAN (Controller Area Network) communication. See TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) and TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4).

2. Contact T.A.C. for further troubleshooting guidance if issue persists.

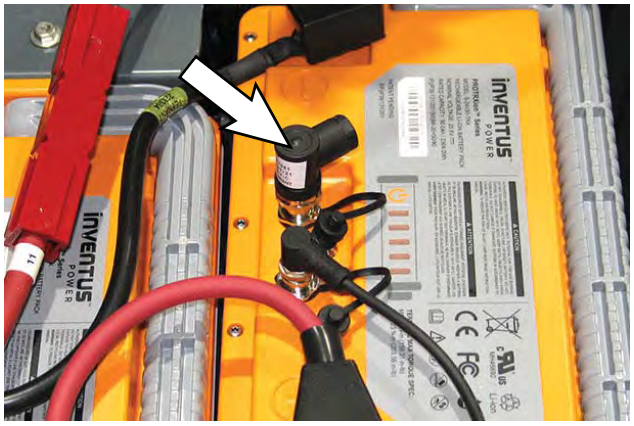
INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK

The lithium battery CAN communication cables and lithium battery communication terminals must be undamaged and functional for the lithium batteries to communicate via the CAN system. The lithium battery CAN communication cables must also be completely tightened onto the lithium battery communication terminals.

1. Inspect the lithium battery CAN communication cables for obvious damage. Replace damaged cables.
2. Disconnect the UI to BMS electrical harness from the battery pack.



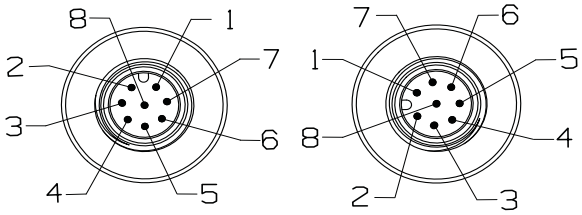
3. Disconnect the termination resistor from the battery pack.

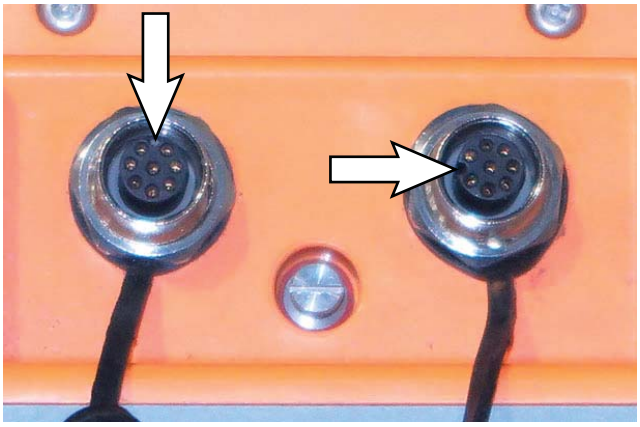


4. Check continuity between the corresponding pins at the lithium battery communication terminals (continuity is being measured across entire battery pack from the UI to BMS electrical harness communication terminal to the termination resistor communication terminal).

   If continuity across battery pack is good, proceed to TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6) and TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4).

   If there is no continuity across battery pack, proceed to the following step.
5. Disconnect all lithium battery CAN communication cables from the lithium batteries.
6. Inspect all lithium battery communication terminals for damage. Replace a lithium battery if the battery communication terminals are damaged. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.
7. Check continuity between the corresponding communication terminal pins on each lithium battery. Replace the lithium battery if there is continuity between the corresponding communication terminal pins. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.

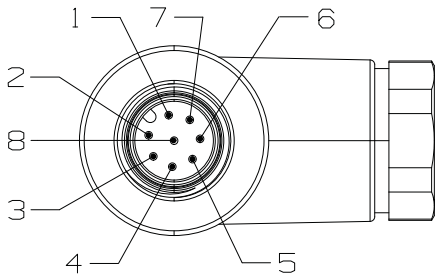




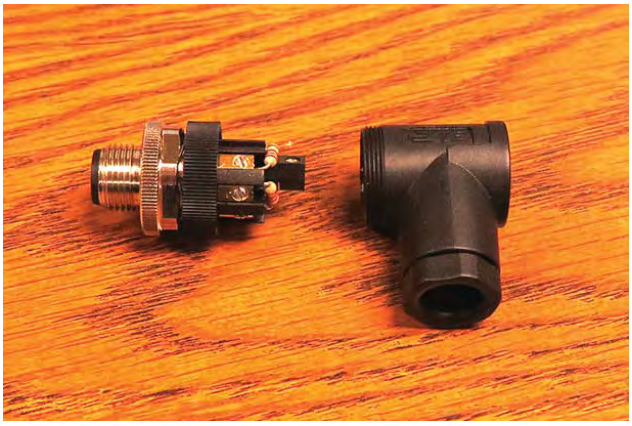
NOTE: Note locations of terminal notches when checking continuity between lithium battery terminal pins. The terminals are not oriented the same.

8. Inspect the resistor plug for obvious damage. Inspect resistor plug pins for damage. Replace the resistor plug if damaged.

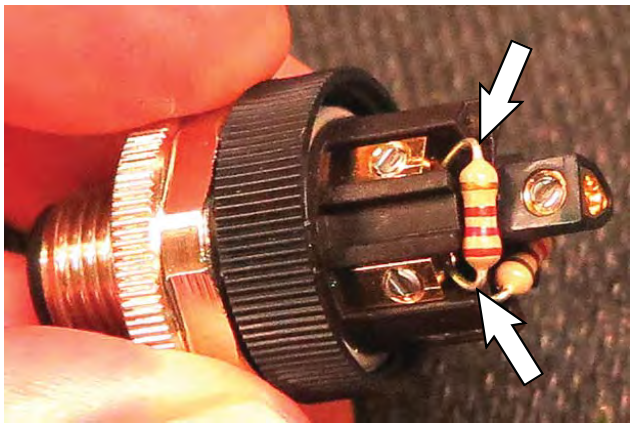
9. Check resistance between resistor plug pins 1 and 2 and pins 6 and 7. Resistance between pins 1 and 2 and pins 6 and 7 should be 120Ω. Replace the resistor plug if no resistance/excessive resistance.

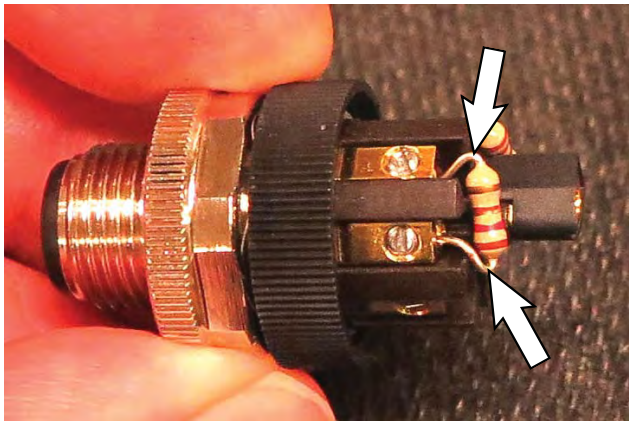


10. Remove the resistor plug connector from the resistor plug.



11. Inspect the resistor connections at the terminals inside the resistor plug. Both resistors should be undamaged and both ends of the resistors firmly secured inside the plug terminals.

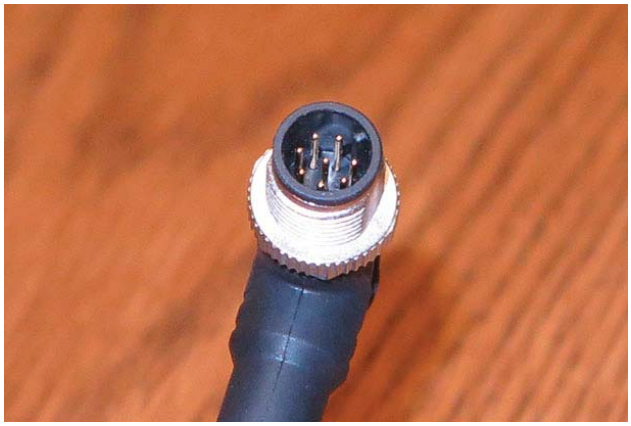




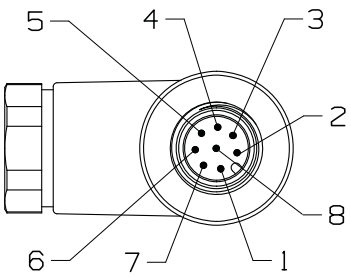
12. Check resistance between the resistor at terminals 1 and 2 and the resistor at terminals 6 and 7. Resistance between terminals 1 and 2 and terminals 6 and 7 should be 120Ω. Replace the resistor plug if no resistance/excessive resistance at either resistor.

13. If plug resistor is good, reassembly the resistor plug connector onto the resistor plug.

14. Inspect the lithium battery CAN communication cable connector/connector pins for damage. Replace the lithium battery communication cable if connector/connector pins are damaged or any other part of cable is damaged.



15. Check the resistance between the corresponding pins in the lithium battery CAN communication cable connectors on each end of each cable. Resistance between the corresponding pins should be 120Ω. Replace the cable if no resistance/ excessive resistance.



2- BMS CONNECTION	
WIRE NO.	POS.
CAN+A/SQUARE	1
CAN-A/SQUARE	2
92/SQUARE	3
13AD/SQUARE	4
OPEN	5
CAN2+/SQUARE	6
CAN2-/SQUARE	7
OPEN	8

16. Reinstall the lithium battery CAN communication cables/install new lithium battery CAN communication cables onto the battery pack. Torque lithium battery CAN communication cable connections to 0.6 Nm (0.44 ft. lbs.).

17. Recheck continuity between the corresponding pins at the lithium battery communication terminals (continuity is being measured across entire battery pack from the UI to BMS electrical harness communication terminal to the termination resistor communication terminal).

    If continuity between the corresponding pins at the lithium battery communication terminals is good, reconnect the termination resistor and UI to BMS electrical harness to the battery pack. Torque the resistor plug and UI to BMS electrical harness connections to 0.6 Nm (0.44 ft. lbs.).

    Contact T.A.C. for further troubleshooting guidance if there are still continuity issues at the battery pack.

18. Recheck the lithium battery operational status in the lithium battery status column on the service device. See LITHIUM BATTERY SYSTEM RANGES for lithium battery operational values/ ranges.

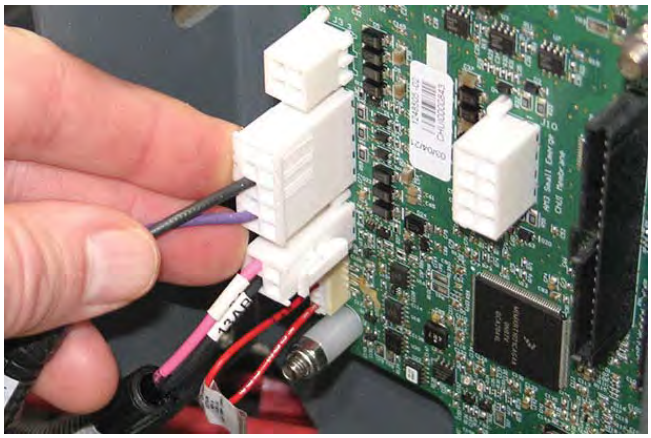
19. Proceed to TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/ J10-6) and TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4) for further troubleshooting if issue persists.

TROUBLESHOOT UI POWER ELECTRIC HARNESS (J7-8/J7-10)

Proceed with this procedure if there is no CAN communication/power at the lithium battery control board.

NOTE: See TROUBLESHOOT LITHIUM BATTERY CONTROL BOARD if the indicator light (Green LED D25 indicating there is power to the lithium battery circuit board) is not flashing.

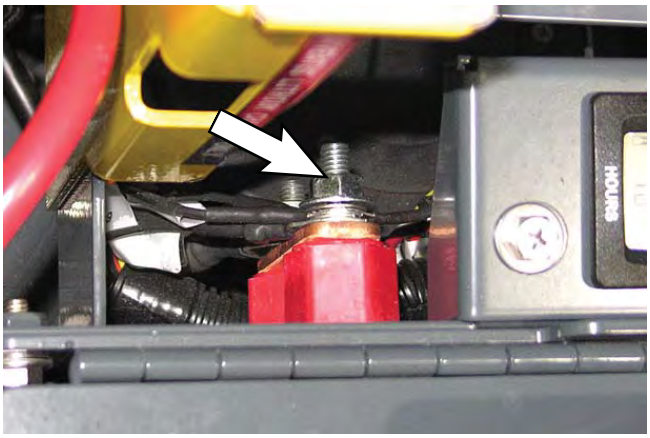
1. Inspect the UI power electric harness connected to lithium battery circuit board terminal J7. Disconnect the UI power electric harness connector from the lithium battery circuit board. Check for battery voltage at the connector. Verify connector and connector pins are fully seated and are not damaged. Repair pins/replace connector/cable as necessary.

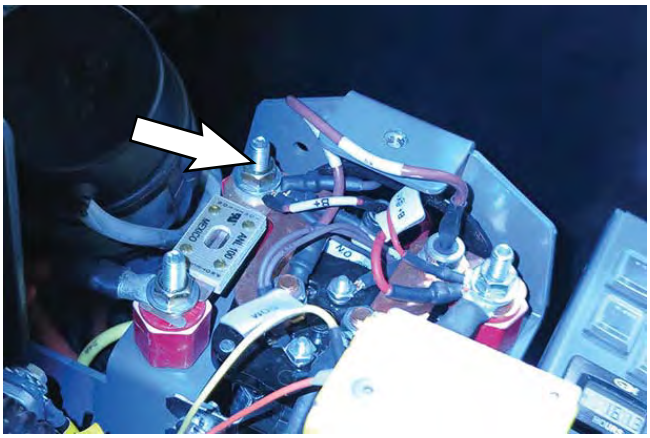


J7-8 (13AC/BLK)	Result
If open	Board reports to system battery pack has a problem*
If short to B-	B- is the connection
If short to chassis	Short to chassis may cause non-obvious issues
If short To B+	Damage to wiring on power on. Possible damage to board*
*Notes	High probability of irreparable board damage

J7-10 (87/PUR)	Result
If open	No power to board
If short To B-	Damage to wiring on power on. Possible damage to board*
If short to chassis	Short to chassis may cause non-obvious issues
If short to B+	B+ is the connection
*Notes	High probability of irreparable board damage

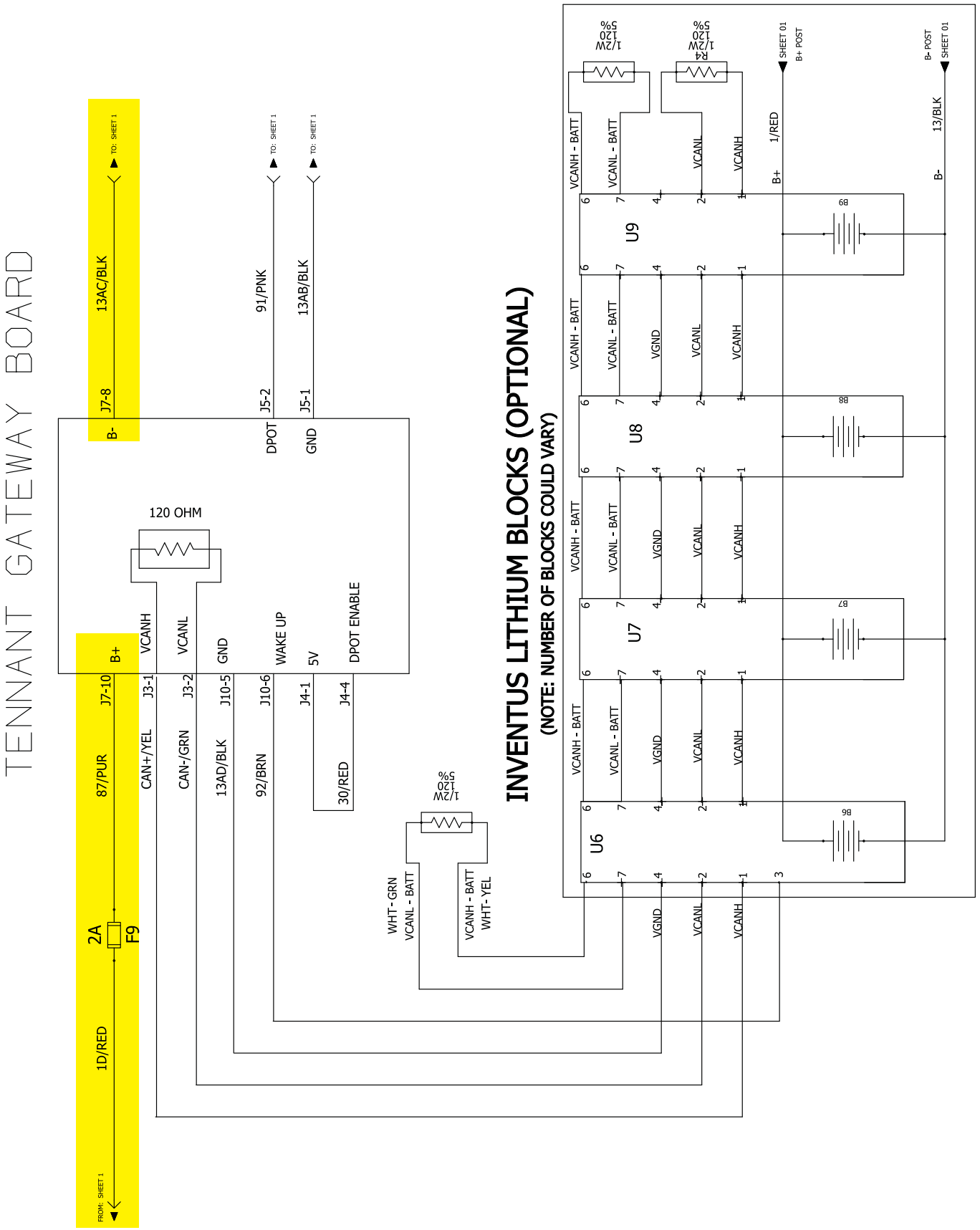
2. Reconnect the UI power electric harness to lithium battery circuit board terminal J7. Continue testing/ troubleshooting if still no power at the lithium battery circuit board.
3. Remove the seat shroud cover from the machine.
4. Inspect the UI power electric harness connections at the B+ switch terminal and B- standoff. Secure/ repair connections. Test/inspect the 2-Amp fuse on the UI power electric harness lead to the B+ switched terminal. Replace 2-Amp fuse if fuse is blown.





If neither LED (D25 and D26) is flashing, or if just the Yellow LED D26 is flashing, replace the lithium battery circuit board. See REPLACE LITHIUM BATTERY CIRCUIT BOARD.

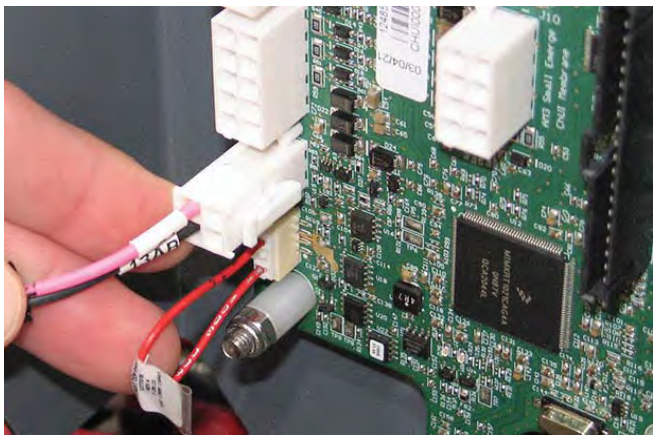
5. If the cable/connections are good and issue persists (neither LED (D25 and D26) is flashing is flashing) contact T.A.C. for further troubleshooting guidance.


TENNANT GATEWAY BOARD
INVENTUS LITHIUM BLOCKS (OPTIONAL)
(NOTE: NUMBER OF BLOCKS COULD VARY)
TO: SHEET 1
FROM: SHEET 1
B-
J7-8
13AC/BLK
91/PNK
13AB/BLK
DPOT
GND
J5-2
J5-1
120 OHM
B+
J7-10
87/PUR
1D/RED
2A
F9
VCANH
VCANL
GND
WAKE UP
5V
DPOT ENABLE
J3-1
J3-2
J10-5
J10-6
J4-1
J4-4
CAN+/YEL
CAN-/GRN
13AD/BLK
92/BRN
30/RED
1/2W
5%
120
WHT - GRN
VCANL - BATT
VCANH - BATT
WHT- YEL
U6
U7
U8
U9
VCANH - BATT
VCANL - BATT
VGND
VCANL
VCANH
B6
B7
B8
B9
R4
SHEET 01
B+ POST
B- POST
1/RED
13/BLK

TROUBLESHOOT LEG ELECTRIC HARNESS (J5-1/ J5-2)

The lithium battery circuit board will be unable to communicate with the Kinetek controller if there is an issue with these connections. The machine will still propel, but all automated/scrubbing systems will be inoperable, there may be a battery fault code displayed on the UI (User Interface), and all operator controls/ indicators will be flashing.

1. Inspect the leg electric harness connection to lithium battery control board terminal J5. Disconnect the leg electric harness from the lithium battery control board and verify connector and connector pins are fully seated and are not damaged. Repair pins/replace connector/harness as necessary.



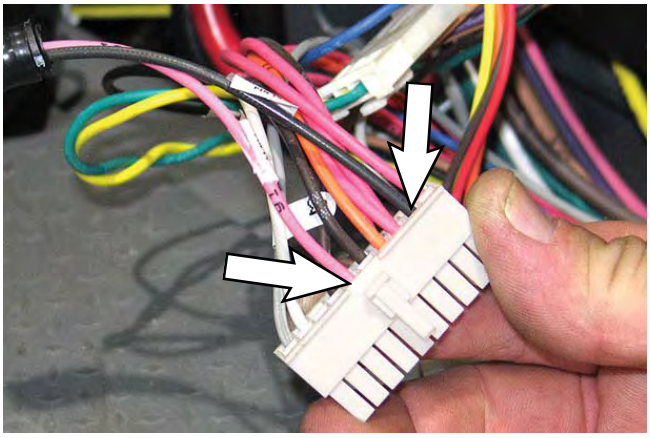
J5-1 (13AB/BLK)	Result
If open	Board reports to system battery pack has a problem
If short to B-	B- is connection
If short to chassis	Board reports to system battery pack has a problem
If short to B+	Board reports to system battery pack has a problem*
*Notes	High probability of irreparable board damage

J5-2 (91/PNK)	Result
If open	Board reports to system battery pack has a problem**
If short to B-	Board reports to system battery pack has a problem**
If short to chassis	Board reports to system battery pack has a problem**
If short to B+	Board reports to system battery pack has a problem*
*Notes	High probability of irreparable board damage. If J5-2 is B+ shorted Kinetek will send message to UI that battery pack is good, but service device might show battery pack as bad.
**Notes	Kinetek will send message to UI that battery pack is bad, but service device might show battery pack as good.

2. Reconnect the leg electric harness to lithium battery control board terminal J5. Continue testing/troubleshooting if there is still no CAN communication at the lithium battery control board.

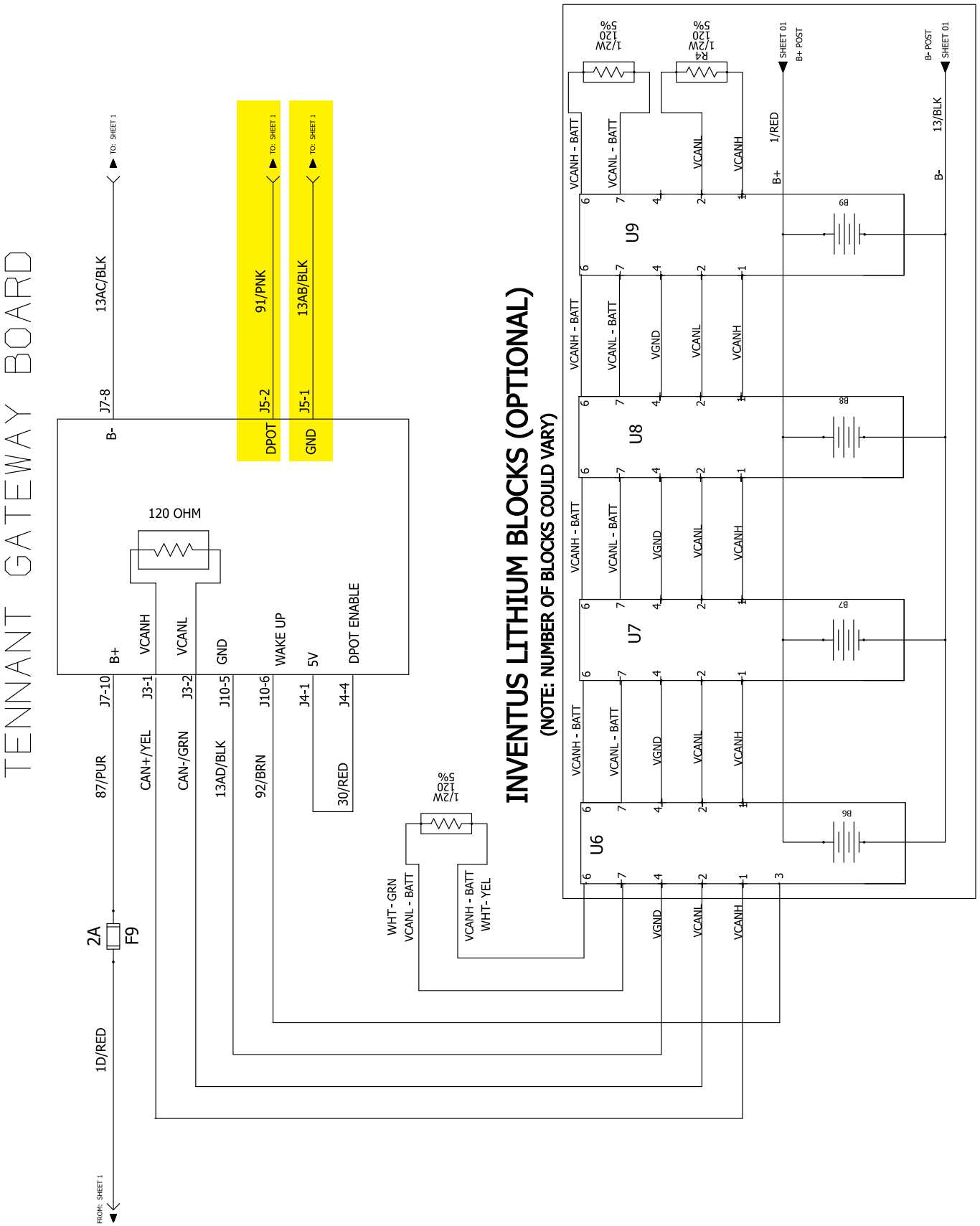
3. Disconnect the main wire harness P3 20-pin connector from the Kinetek controller.

4. Inspect the leg electric harness connections to the main wire harness P3 20-pin connector terminals 15 and 19. Verify the connections are secure and pins are not damaged. Repair pins/replace connector/cable as necessary.



5. If the cable/connections are good and issue persists, replace the lithium battery control board. See REPLACE LITHIUM BATTERY CONTROL BOARD.

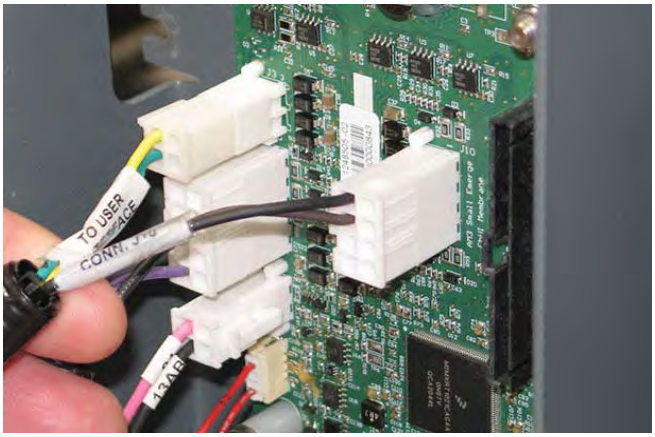
6. Contact T.A.C. for further troubleshooting guidance if issue persists.


TENNANT GATEWAY BOARD
INVENTUS LITHIUM BLOCKS (OPTIONAL)
(NOTE: NUMBER OF BLOCKS COULD VARY)
TO: SHEET 1
FROM: SHEET 1
13AC/BLK
J7-8
B-
91/PNK
J5-2
DPOT
13AB/BLK
J5-1
GND
120 OHM
B+
VCANH
VCANL
GND
WAKE UP
5V
DPOT ENABLE
J7-10
J3-1
J3-2
J10-5
J10-6
J4-1
J4-4
87/PUR
CAN+/YEL
CAN-/GRN
13AD/BLK
92/BRN
30/RED
2A
F9
1D/RED
1/2W
120
5%
R4
WHT - GRN
VCANL - BATT
VCANH - BATT
WHT- YEL
U6
U7
U8
U9
VCANH - BATT
VCANL - BATT
VGND
VCANL
VCANH
B6
B7
B8
B9
SHEET 01
B+ POST
B-
13/BLK
1/RED

TROUBLESHOOT UI TO BMS ELECTRICAL HARNESS (J3-1/J3-2 AND J10-5/J10-6)

If the Yellow LED indicating there is CAN (Controller Area Network) communication to the lithium battery control board is not flashing, there are CAN communication issues/faults. Troubleshoot the UI to BMS electrical harness connections to the board.

1. Inspect the UI to BMS electrical harness connection to lithium battery control board terminals J3 and J10. Disconnect the UI to BMS electrical harness connectors from the lithium battery control board and verify connectors and connector pins are fully seated and are not damaged. Repair pins/replace connector/harness as necessary.



J3-1 (CAN+/YEL)	Result
If open	Board reports to system battery pack has a problem
If short to B-	Board reports to system battery pack has a problem
If short to chassis	Board reports to system battery pack has a problem
If short to B+	Board reports to system battery pack has a problem*
*Notes	High probability of irreparable board damage

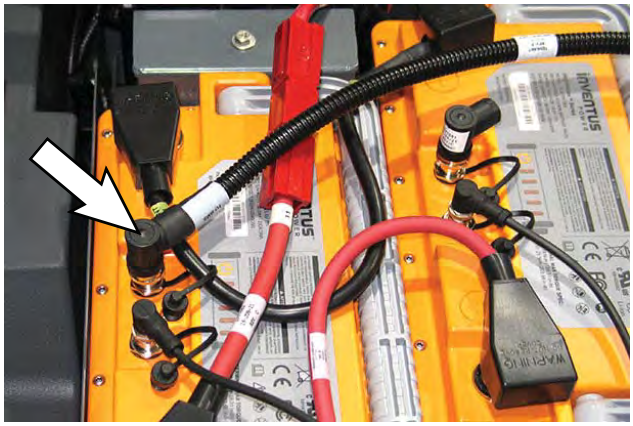
J3-2 (CAN-/GRN)	Result
If open	Board reports to system battery pack has a problem
If short to B-	Board reports to system battery pack has a problem
If short to chassis	Board reports to system battery pack has a problem
If short to B+	Board reports to system battery pack has a problem*
*Notes	High probability of irreparable board damage

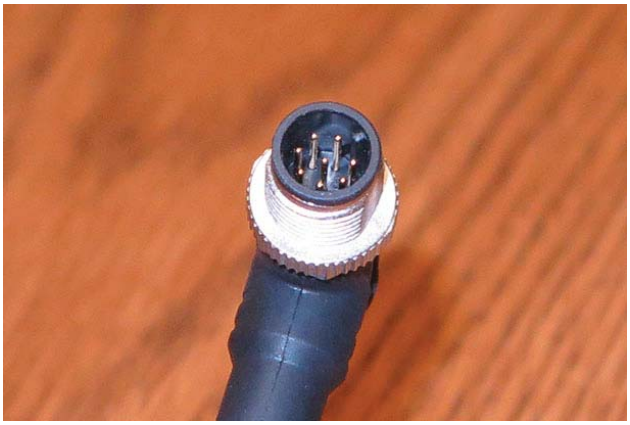
J10-5 (13AD/BLK)	Result
If open	Board reports to system battery pack has a problem
If short to B-	B- is the connection
If short to chassis	Short to chassis may cause non-obvious issues
If short to B+	Damage to wiring on power on. Possible damage to board*
*Notes	High probability of irreparable board damage

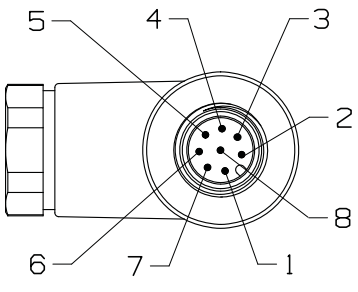
J10-6 (92/BRN)	Result
If open	Board reports to system battery pack has a problem
If short to B-	Battery will not go into sleep mode
If short to chassis	Short to chassis may cause non-obvious issues
If short to B+	Damage to wiring when waking up battery. Possible damage to board*
*Notes	High probability of irreparable board damage

2. Reconnect the UI to BMS electrical harness to lithium battery control board terminals J3 and J10. Continue testing/troubleshooting if there is still no CAN communication at the lithium battery control board.

3. Disconnect the UI to BMS electrical harness from the lithium battery. Verify the connector pins are fully seated and are not damaged. Repair pins/ replace connector/harness as necessary.





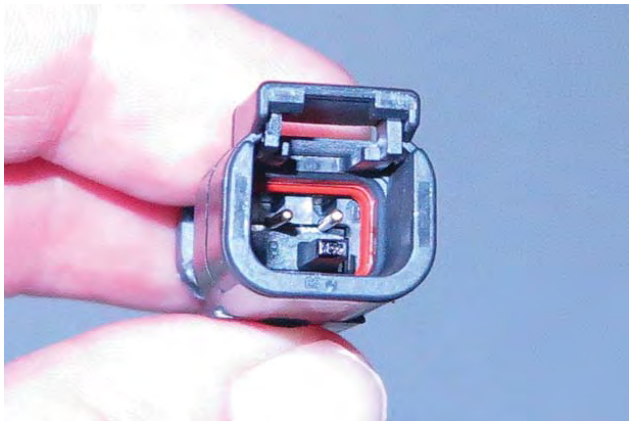


2- BMS CONNECTION	
WIRE NO.	POS.
CAN+A/SQUARE	1
CAN-A/SQUARE	2
92/SQUARE	3
13AD/SQUARE	4
OPEN	5
CAN2+/SQUARE	6
CAN2-/SQUARE	7
OPEN	8

4. Remove the resister from the UI to BMS electrical harness.

5. Check the resistance from connector disconnected from battery back pin CAN2+/SQUARE and pin CAN2-/SQUARE with the UI to BMS electrical harness resistor connector CAN+C/CIRCLE pin 1 and CAN-C/CIRCLE pin 2. Should be 120Ω. Replace the UI to BMS electrical harness if no resistance/excessive resistance.

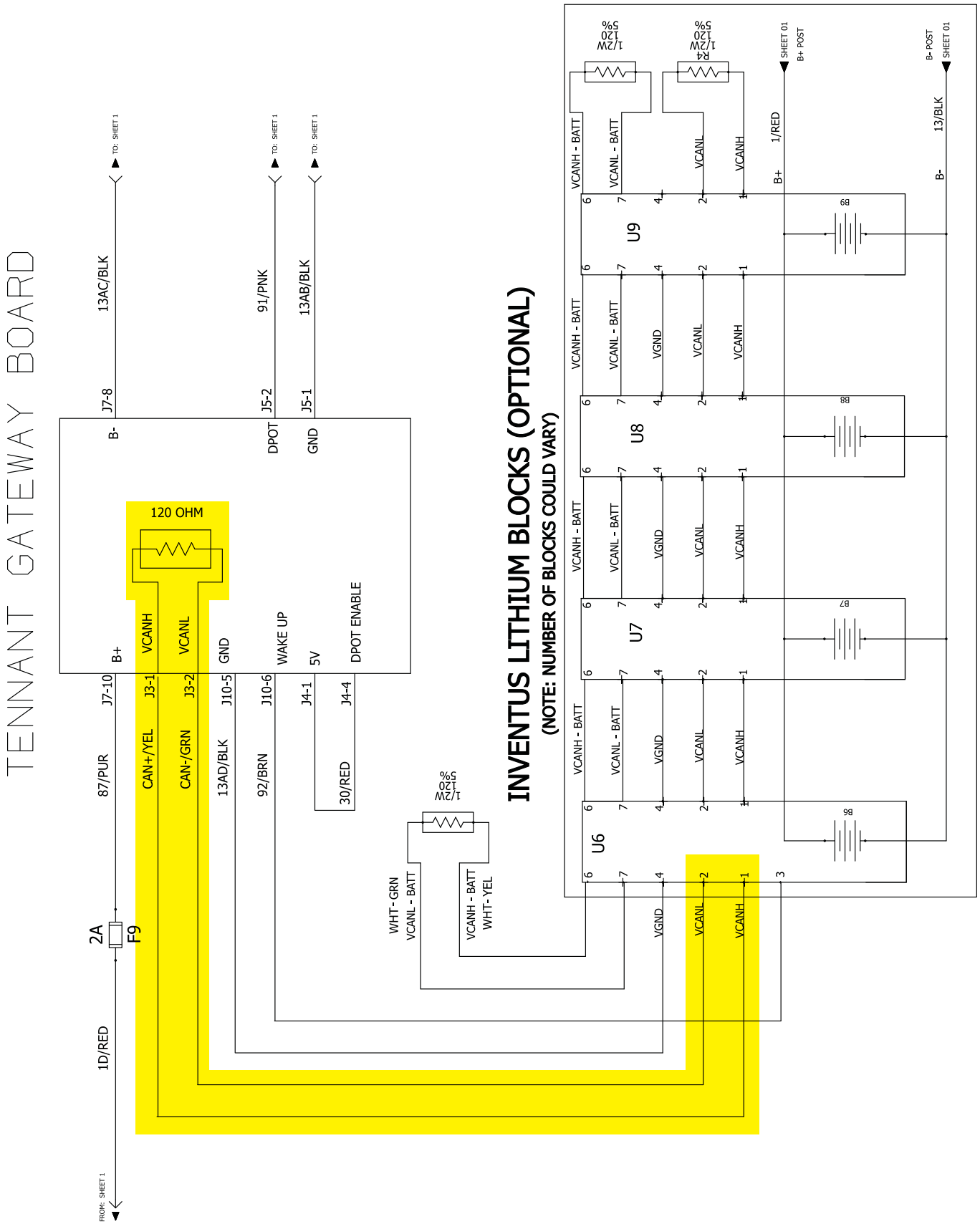
6. Inspect the resistor for damaged pins. Replace the resistor if pins are damaged/broken.

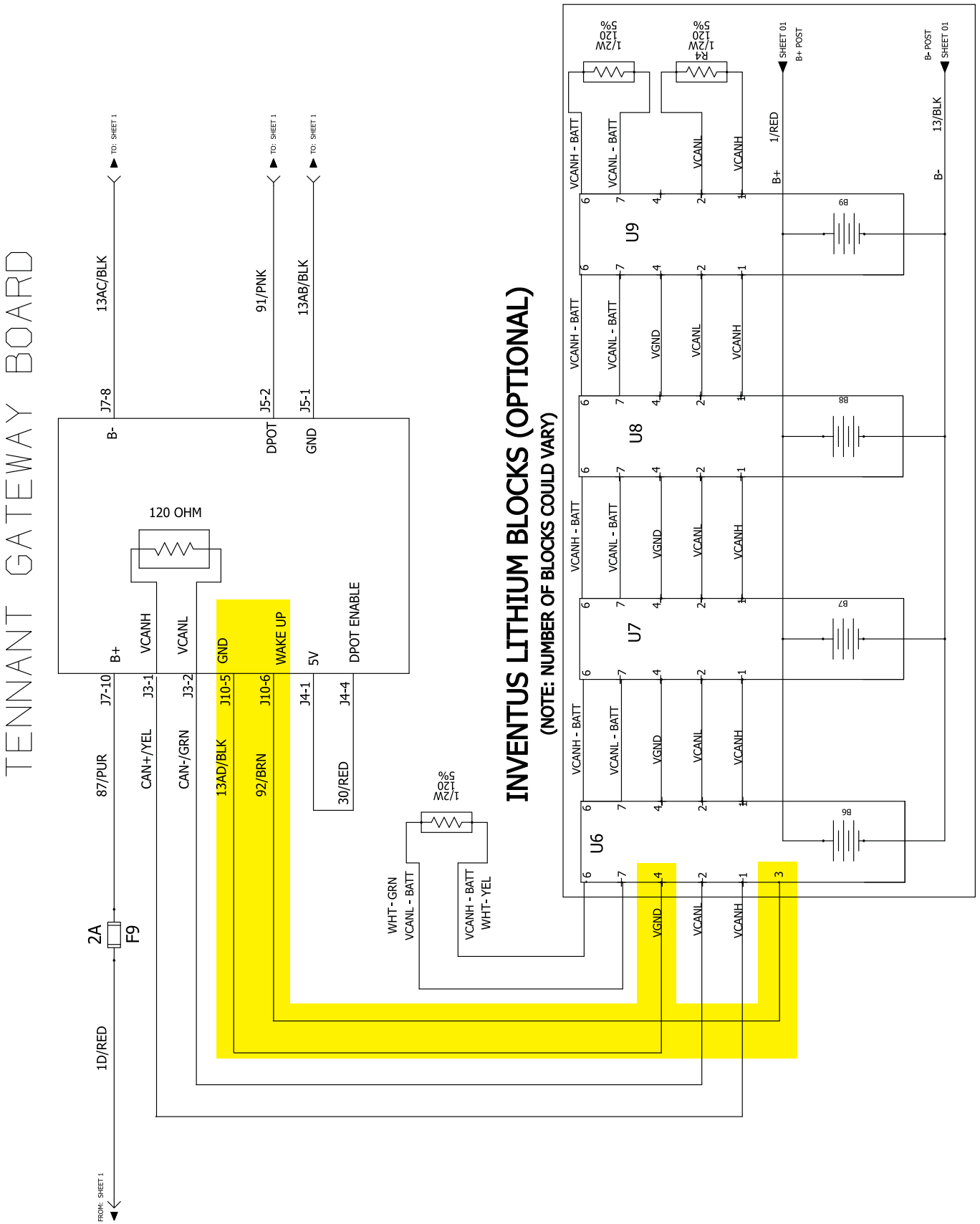


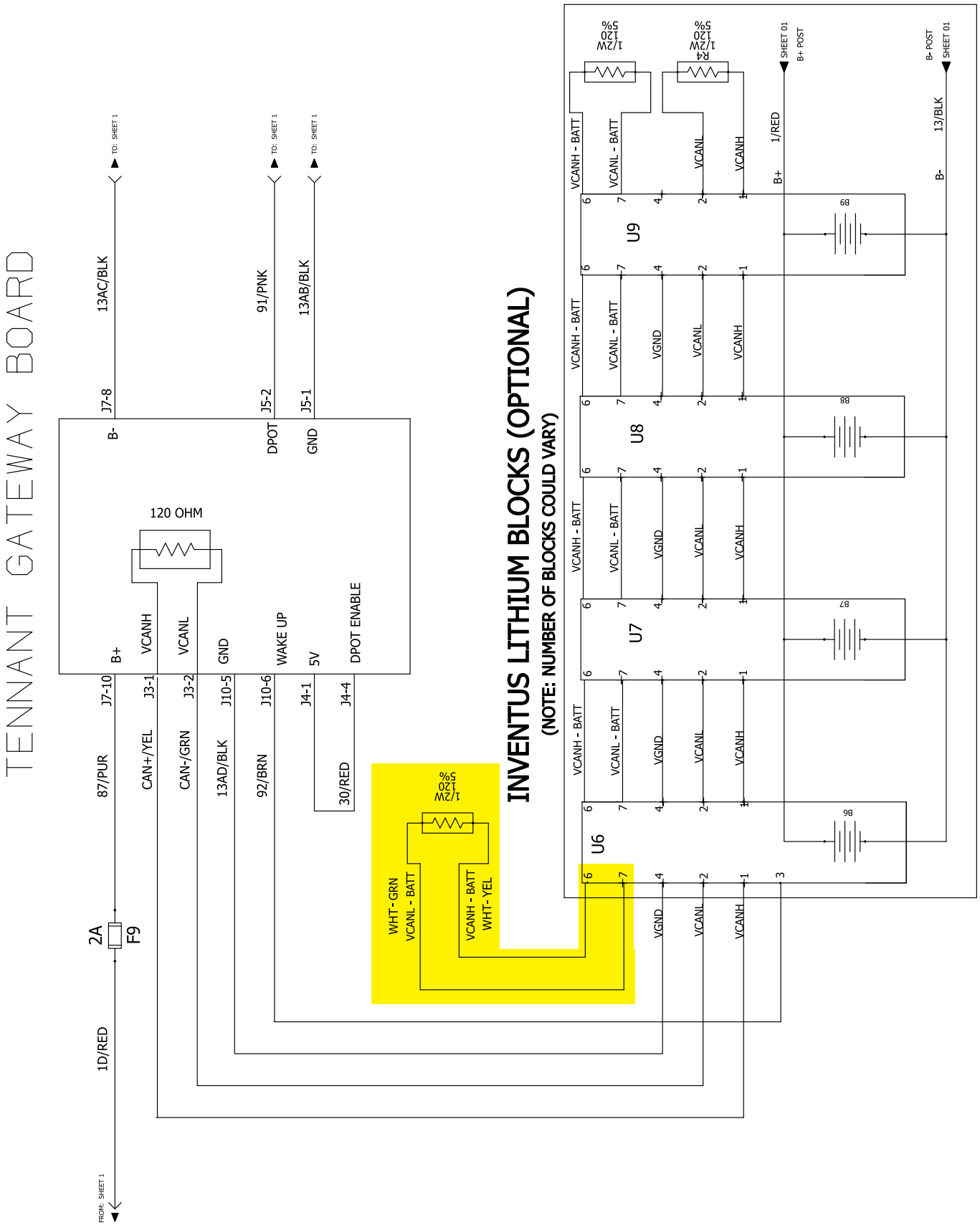
7. Check the resistance at the resistor pins. Should be 120Ω. Replace the resistor if no resistance/ excessive resistance.

8. Reconnect the UI to BMS electrical harness to the lithium battery. Torque the UI to BMS electrical harness connection to 0.6 Nm (0.44 ft. lbs.).

9. Contact T.A.C. for further troubleshooting guidance if issue persists.


TENNANT GATEWAY BOARD
INVENTUS LITHIUM BLOCKS (OPTIONAL)
(NOTE: NUMBER OF BLOCKS COULD VARY)
TO: SHEET 1
FROM: SHEET 1
SHEET 01
B+ POST
B- POST
13AC/BLK
91/PNK
13AB/BLK
1D/RED
87/PUR
13AD/BLK
92/BRN
30/RED
13/BLK
1/RED
J7-8
J5-2
J5-1
J7-10
J3-1
J3-2
J10-5
J10-6
J4-1
J4-4
B-
DPOT
GND
B+
VCANH
VCANL
WAKE UP
5V
DPOT ENABLE
120 OHM
CAN+/YEL
CAN-/GRN
2A
F9
WHT-GRN
VCANL - BATT
VCANH - BATT
WHT-YEL
1/2W
5%
120
R4
U6
U7
U8
U9
VCANH - BATT
VCANL - BATT
VGND
VCANL
VCANH
B6
B7
B8
B9

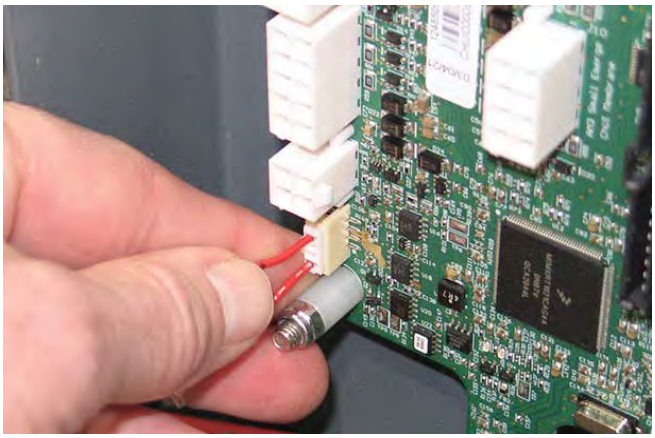

TENNANT GATEWAY BOARD
INVENTUS LITHIUM BLOCKS (OPTIONAL)
(NOTE: NUMBER OF BLOCKS COULD VARY)
TO: SHEET 1
FROM: SHEET 1
13AC/BLK
91/PNK
13AB/BLK
J7-8
J5-2
J5-1
B-
DPOT
GND
120 OHM
B+
VCANH
VCANL
GND
WAKE UP
5V
DPOT ENABLE
J7-10
J3-1
J3-2
J10-5
J10-6
J4-1
J4-4
87/PUR
CAN+/YEL
CAN-/GRN
13AD/BLK
92/BRN
30/RED
2A
F9
1D/RED
1/2W 120 5%
WHT - GRN
VCANL - BATT
VCANH - BATT
WHT - YEL
U6
U7
U8
U9
VCANH - BATT
VCANL - BATT
VGND
VCANL
VCANH
B6
B7
B8
B9
R4
SHEET 01
B+ POST
B- POST
1/RED
13/BLK
B+
B-


TENNANT GATEWAY BOARD
INVENTUS LITHIUM BLOCKS (OPTIONAL)
(NOTE: NUMBER OF BLOCKS COULD VARY)
TO: SHEET 1
FROM: SHEET 1
SHEET 01
B+ POST
B- POST
13AC/BLK
91/PNK
13AB/BLK
1D/RED
87/PUR
CAN+/YEL
CAN-/GRN
13AD/BLK
92/BRN
30/RED
13/BLK
1/RED
2A
F9
J7-8
J5-2
J5-1
J7-10
J3-1
J3-2
J10-5
J10-6
J4-1
J4-4
B-
DPOT
GND
B+
VCANH
VCANL
GND
WAKE UP
5V
DPOT ENABLE
120 OHM
U6
U7
U8
U9
VCANH - BATT
VCANL - BATT
VGND
VCANL
VCANH
WHT - GRN
WHT - YEL
1/2W
120
5%
R4
B6
B7
B8
B9

TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4)

If the digital pot 5V enable electric harness connected to terminal J4 on the lithium battery control board is damaged there will be SOC (State of Charge)/voltage issues with the batteries. The machine will still propel, but all automated/scrubbing systems will be inoperable, there may be a battery fault code displayed on the UI (User Interface), and all operator controls/indicators will be flashing.

1. Inspect the digital pot 5V enable electric harness connection to lithium battery control board terminal J4. Disconnect the digital pot 5V enable electric harness from the lithium battery control board and verify connector and connector pins are fully seated and are not damaged. Repair pins/replace harness as necessary.

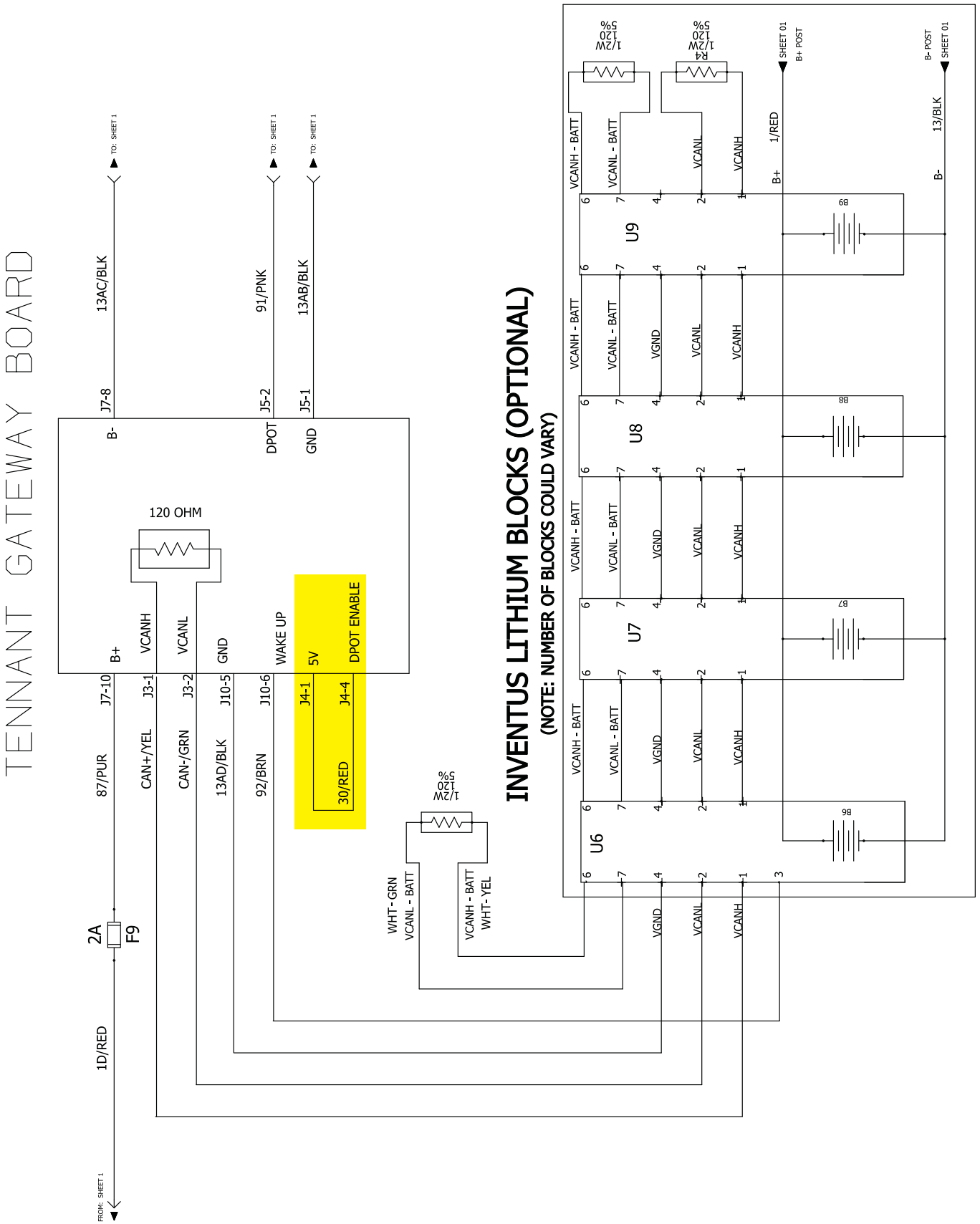


J4-1 (30/RED)	Result
If open	Board reports to system battery pack has a problem
If short to B-	Board reports to system battery pack has a problem
If short to chassis	Board reports to system battery pack has a problem
If short to B+	Board reports to system battery pack has a problem*
*Notes	High probability of irreparable board damage

J4-4 (30/RED)	Result
If open	Board reports to system battery pack has a problem
If short to B-	Board reports to system battery pack has a problem
If short to chassis	Board reports to system battery pack has a problem
If short to B+	Board reports to system battery pack has a problem*
*Notes	High probability of irreparable board damage

2. Reconnect the digital pot 5V enable electric harness to lithium battery control board terminal J4. Continue testing/troubleshooting if there is still no CAN communication at the lithium battery control board.

3. Contact T.A.C. for further troubleshooting guidance if issue persists.


TENNANT GATEWAY BOARD
INVENTUS LITHIUM BLOCKS (OPTIONAL)
(NOTE: NUMBER OF BLOCKS COULD VARY)
TO: SHEET 1
FROM: SHEET 1
13AC/BLK
91/PNK
13AB/BLK
J7-8
J5-2
J5-1
B-
DPOT
GND
120 OHM
B+
VCANH
VCANL
GND
WAKE UP
5V
DPOT ENABLE
J7-10
J3-1
J3-2
J10-5
J10-6
J4-1
J4-4
87/PUR
CAN+/YEL
CAN-/GRN
13AD/BLK
92/BRN
30/RED
2A
F9
1D/RED
1/2W 120 5%
WHT - GRN
VCANL - BATT
VCANH - BATT
WHT - YEL
U6
U7
U8
U9
VCANH - BATT
VCANL - BATT
VGND
VCANL
VCANH
B6
B7
B8
B9
R4
SHEET 01
B+ POST
B- POST
1/RED
13/BLK
B+
B-

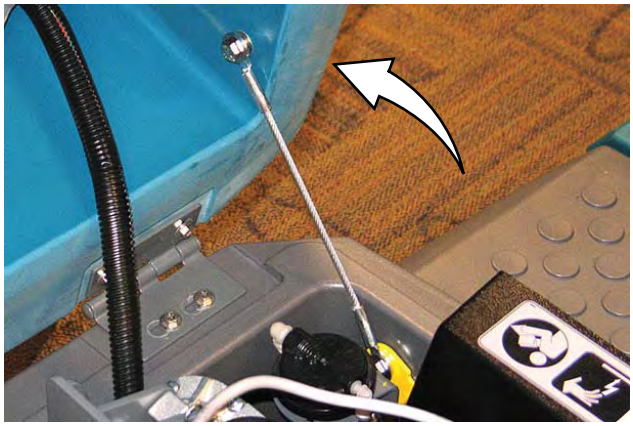
LITHIUM BATTERY HARD RESET

Perform a “hard reset” if all four lithium batteries go into a low power shutdown mode (0% charge level). This procedure will be necessary if the machine is operated for too long after the low voltage warning is displayed, or the machine is left on for too long while unattended.

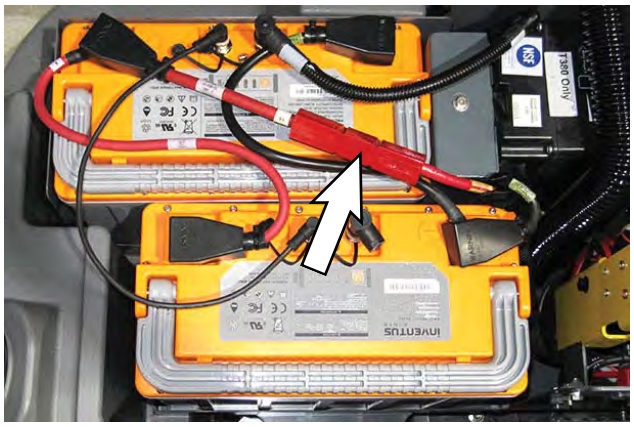
1. .Completely empty the recovery tank.
2. Turn the key switch OFF.

*NOTE: **Do** **Not** empty the solution tank before troubleshooting the lithium batteries/performing lithium battery maintenance. The solution tank must be full so the machine does not tip over.*

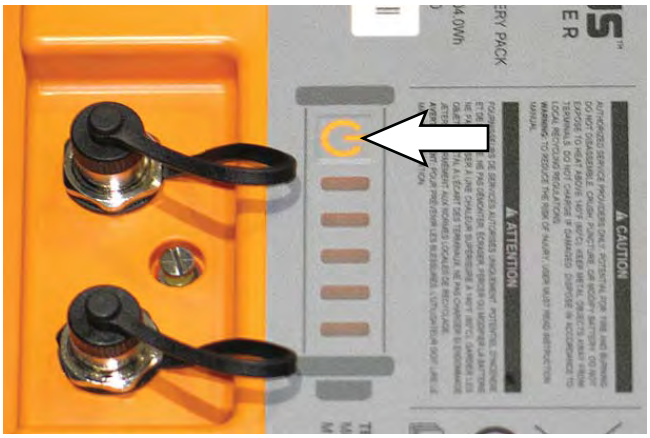
3. Set the recovery tank into the service position.



4. Disconnect the battery cable from the machine.



5. Connect the battery charger to the battery cable disconnected from the machine in the previous step.
6. Press the power button on one of the lithium batteries for 5 seconds.



All connected batteries will activate “wake up” from the low power shutdown mode.

7. The charger will begin charging the batteries. Wait for batteries to complete charging.
8. Disconnect the battery charger from the battery cable and reconnect battery cable to the machine after the batteries are completely charged. The machine is now ready for operation.

SERVICE

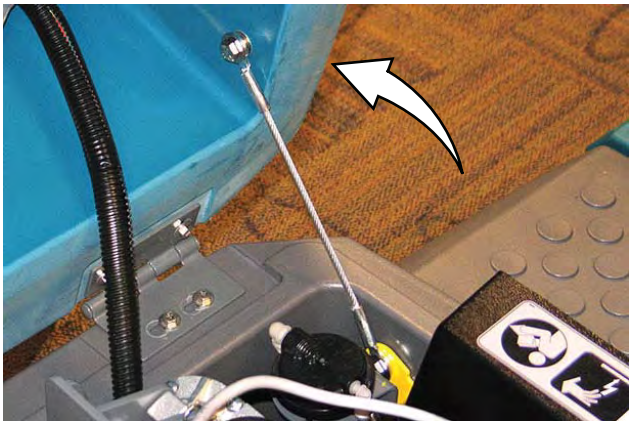
REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES

FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

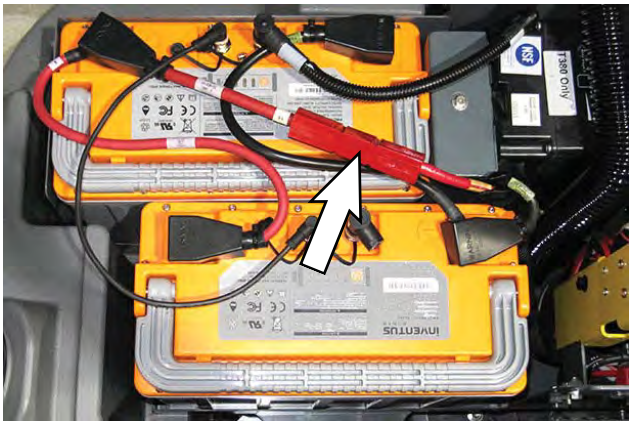
1. Completely empty the recovery tank.
2. Turn the key switch OFF.

*NOTE: **Do Not** empty the solution tank before troubleshooting the lithium batteries/performing lithium battery maintenance. The solution tank must be full so the machine does not tip over.*

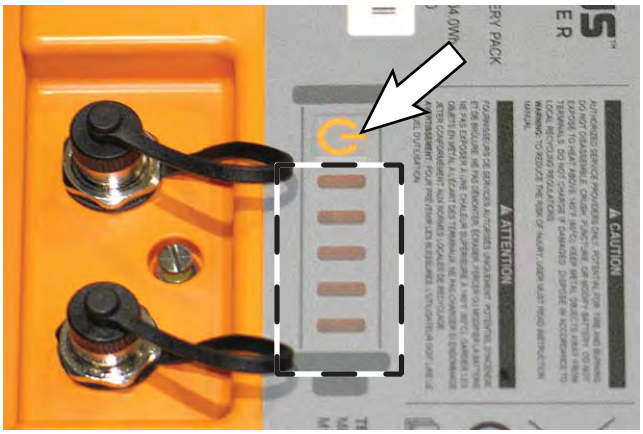
3. Set the recovery tank into the service position.



4. Disconnect the battery cable from the machine.

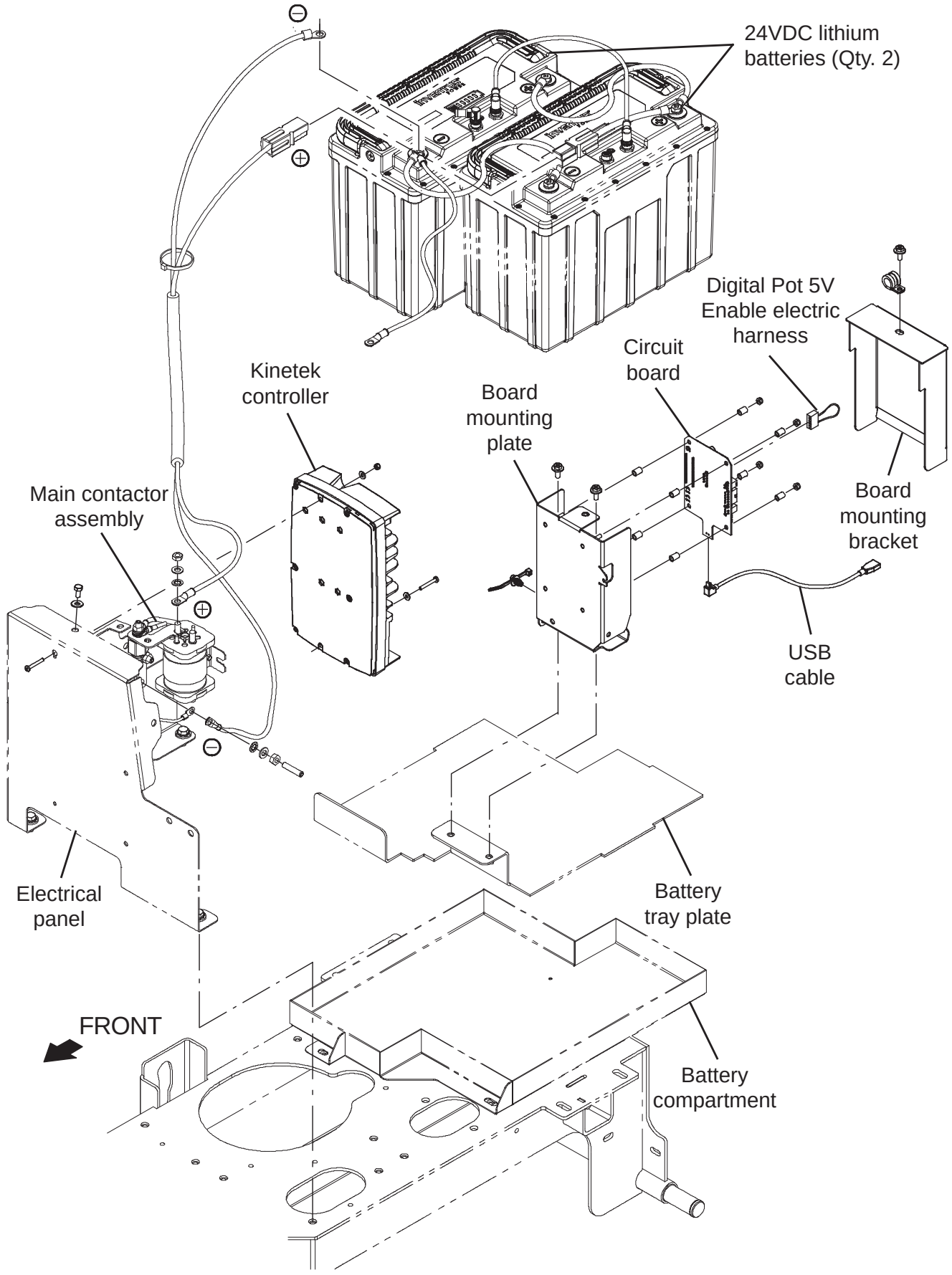


5. Turn off the lithium batteries. Hold the power button on one lithium battery for 20 seconds to turn off both batteries.

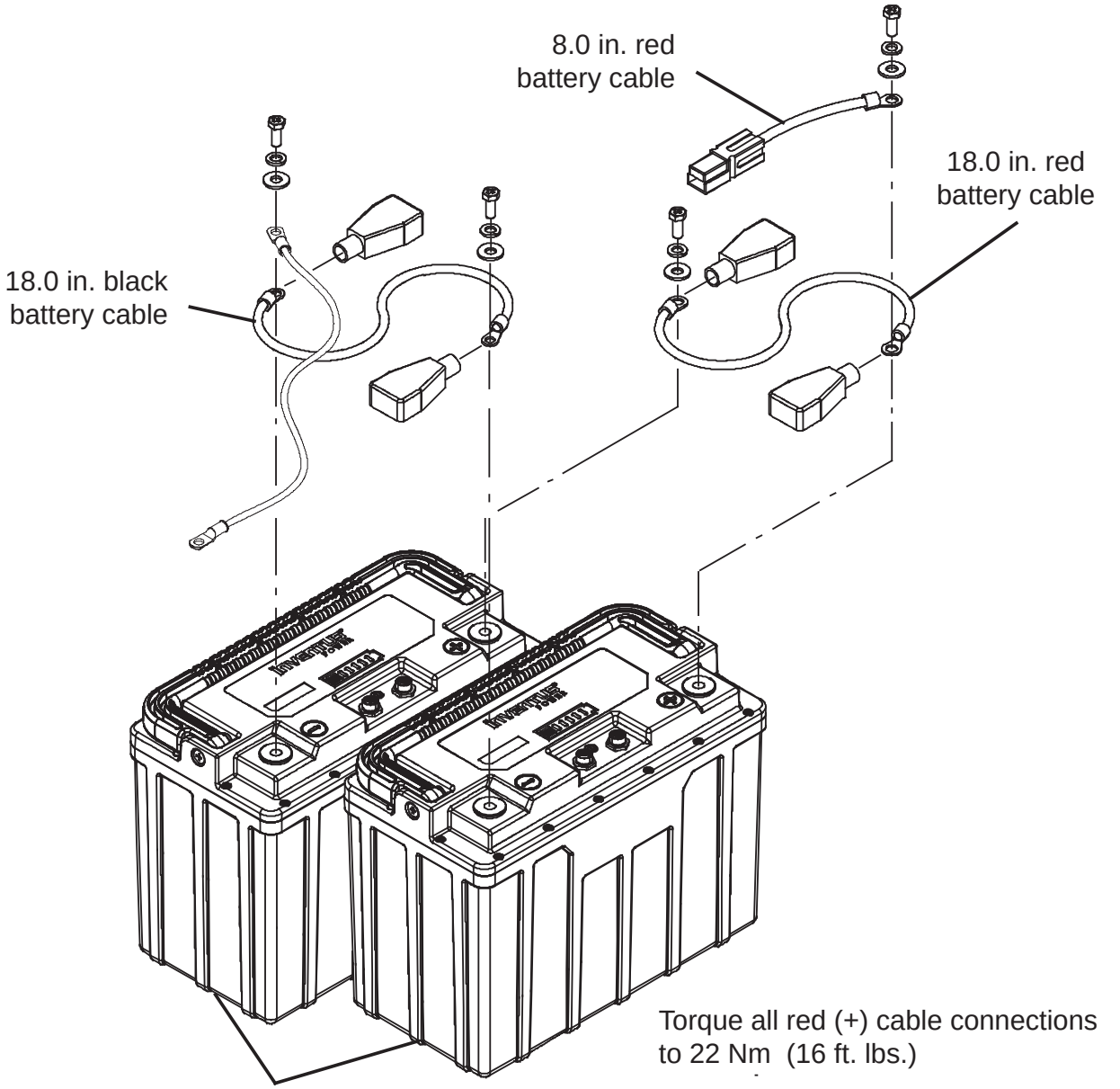


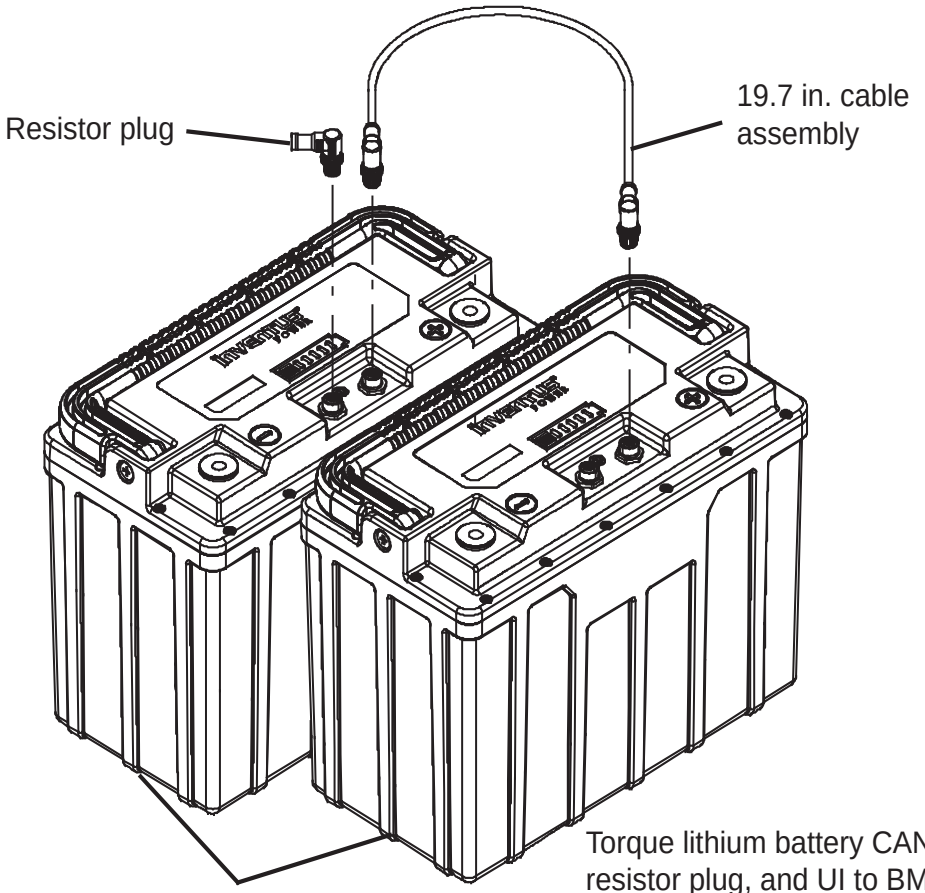
6. Quickly press the power button again and observe the charge indicator lights near the button. None of the charge indicator lights should be illuminated.
7. Quickly press the power button on the other battery and observe the charge indicator lights near the button. None of the charge indicator lights should be illuminated on this battery.

NOTE: All lithium batteries must be turned off prior to removing the batteries from the machine.


24VDC lithium batteries (Qty. 2)
Digital Pot 5V Enable electric harness
Circuit board
Kinetek controller
Board mounting plate
Board mounting bracket
Main contactor assembly
USB cable
Electrical panel
Battery tray plate
FRONT
Battery compartment

8. Disconnect the battery cables and battery connector assembly from the lithium battery positive (+) and negative (-) terminals.





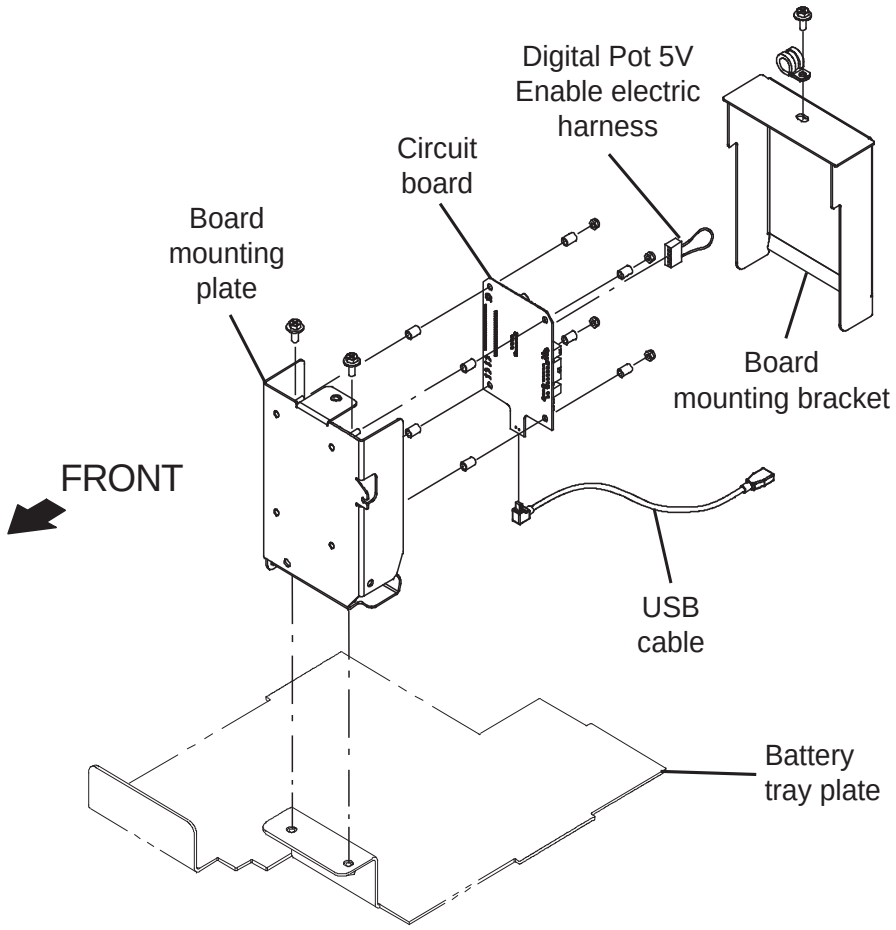
9. Disconnect the UI to BMS electrical harness and all communication cables from the lithium battery communication terminals.
10. If replacing lithium battery with the resistor plug installed, remove the resistor plug from the battery.
11. Remove the lithium batteries from the battery compartment.
12. Remove the battery/batteries to be replaced.
13. Install the new battery/batteries into the battery compartment.
14. Reinstall the battery cables and lithium battery CAN communication cables onto the batteries.

    Torque all red (+) connections to 22 Nm (16 ft. lbs.).

    Torque all black (-) connections to 17 Nm (12.5 ft. lbs.).

    Torque lithium battery CAN communication cable, resistor plug, and UI to BMS electrical harness connections to 0.6 Nm (0.44 ft. lbs.).
15. Turn on the batteries. Hold the power button on one lithium battery for 5 seconds to turn on both batteries.
16. Quickly press the power button again and observe the indicator lights near the button. The indicator lights should be illuminated.
17. Quickly press the power button on the remaining battery and observe the indicator lights near the button. All indicator lights should be illuminated.
18. Reinstall the removed support bracket assembly onto the machine in reverse order of disassembly.
19. Reinstall the seat shroud onto the machine.
20. Reinstall the operator seat onto the machine and reconnect the main wire harness to the seat switch.

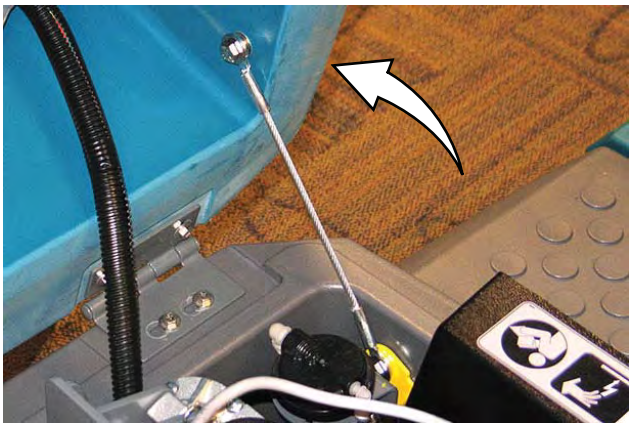
REPLACE LITHIUM BATTERY CIRCUIT BOARD



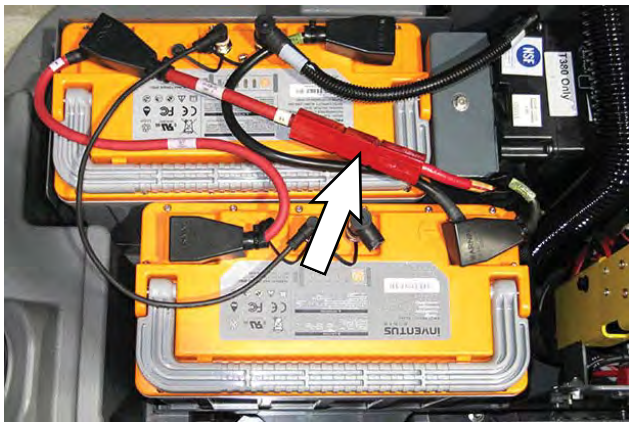
1. Completely empty the recovery tank.
2. Turn the key switch OFF.

*NOTE: **Do** **Not** empty the solution tank before troubleshooting the lithium batteries/performing lithium battery maintenance. The solution tank must be full so the machine does not tip over.*

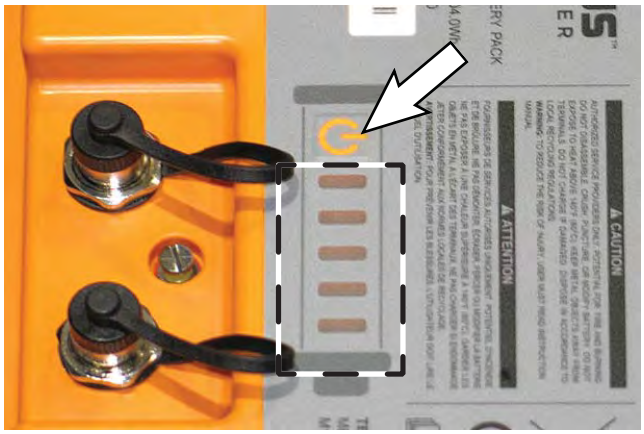
3. Set the recovery tank into the service position.



4. Disconnect the battery cable from the machine.



5. Turn off the lithium batteries. Hold the power button on one lithium battery for 20 seconds to turn off both batteries.



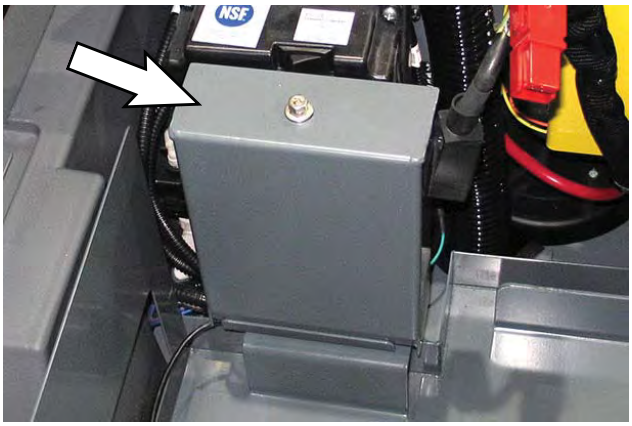
6. Quickly press the power button again and observe the indicator lights near the button. None of the indicator lights should be illuminated.

7. Quickly press the power button on the remaining battery and observe the indicator lights near the button. None of the indicator lights should be illuminated.

NOTE: All lithium batteries must be turned off prior to removing the batteries from the machine.

8. Remove the lithium batteries from the machine. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.

9. Remove the board mounting bracket/cable clamp from the board mounting plate.



10. Disconnect all harness/wire connections from the control board.

11. Remove the control board from the board mounting plate.

12. Install the new control board onto the board mounting plate.

13. Connect all cable/wire connections to the new control board.

14. Reinstall the board bracket onto the board mounting plate.

15. Reinstall the lithium batteries into the battery compartment and reconnect all cables to the batteries.

16. Reconnect the battery cable to the machine.

17. Turn on the batteries. Hold the power button on one lithium battery for 5 seconds to turn on both batteries.

18. Quickly press the power button again and observe the indicator lights near the button. The indicator lights should be illuminated.

19. Quickly press the power button on the remaining battery and observe the indicator lights near the button. All indicator lights should be illuminated.

20. Connect a USB cable to the service device.

ATTENTION: *<u>Never</u> allow the metallic tip on the loose end of the service USB cable to touch a lithium battery positive (+) terminal when connecting the USB cable to the service device/USB cable connected to the lithium battery control board. USB cables, service device, and/or lithium battery control board could be damaged if loose metallic end of the service USB cable touches a lithium battery positive (+) terminal.*

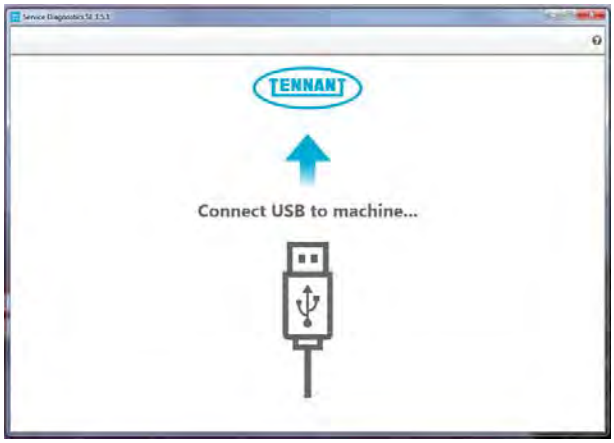
21. Connect the other end of the USB cable connected to the service device in the previous step to the USB cable installed on the lithium battery control board.

22. Turn the key switch ON.

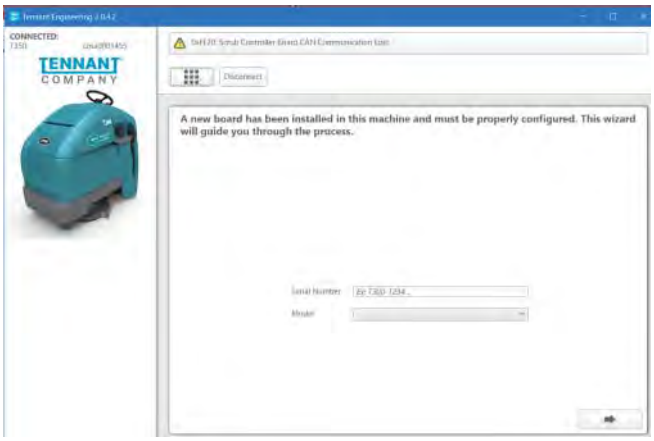
SYSTEM REQUIREMENTS: Windows® 7 Operating System, Microsoft .NET 4.5 or later, USB to Mini-USB cable.

23. Double click the Service Diagnostics desktop shortcut or find the software in All Programs to launch the software.

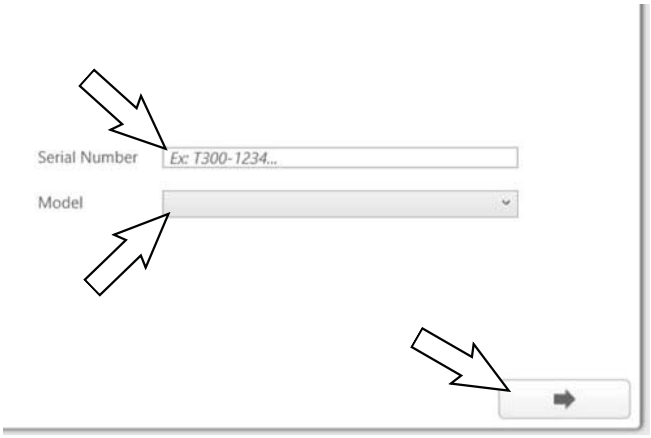
24. Allow the Service Diagnostics tool to connect to the lithium battery control board network.



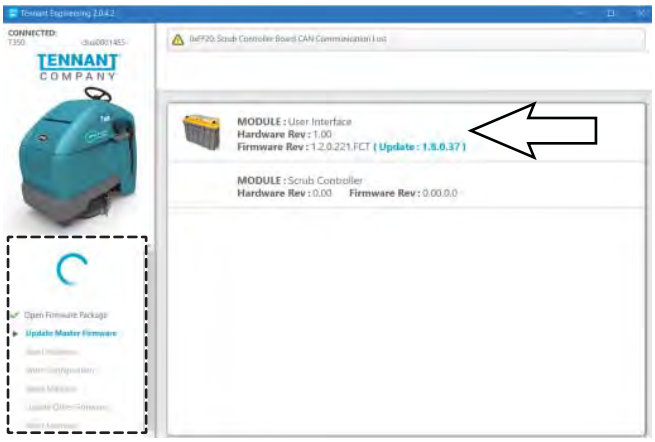
25. The Service Diagnostics tool automatically detects a new board was installed. A Service Diagnostic window with text “A new board has been installed in this machine and must be properly configured. This wizard will guide you through the process.” appears on the screen.



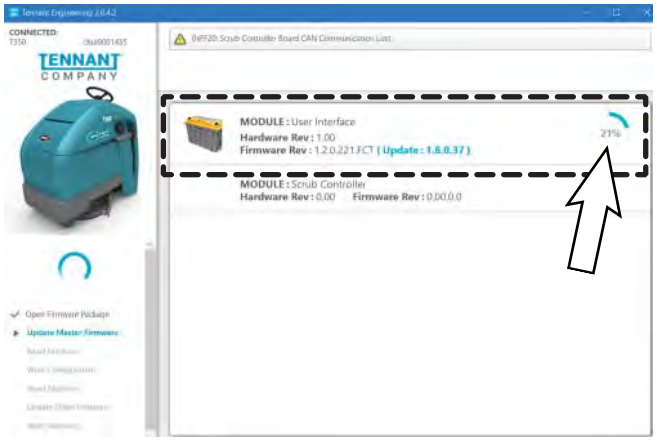
26. Enter the serial number, select the model from the pull down menu, and click the arrow button to proceed with reconfiguring the machine for the new lithium battery control board.



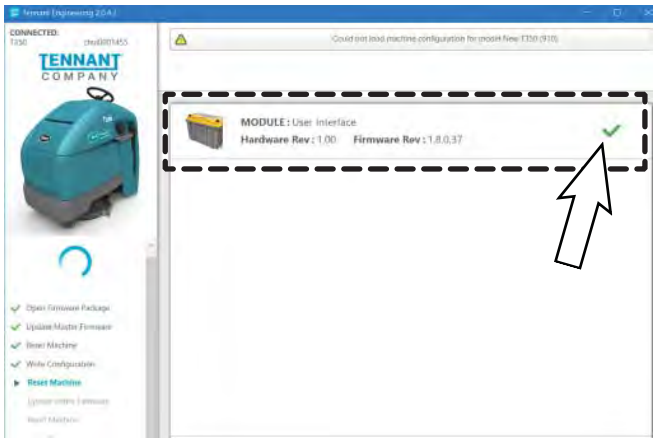
27. The firmware update screen appears and will begin programming the machine. The process status indicator and firmware update status box appear on the left side of the screen.



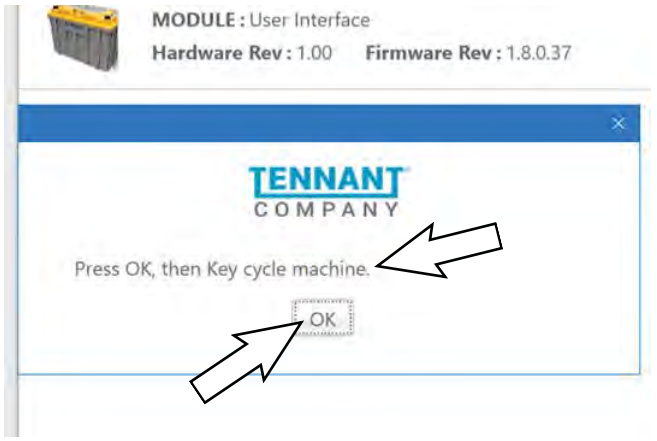
28. Allow the firmware update to proceed. A process status indicator with a percent (%) status of the update also appears next to the selected firmware update. Firmware update process typically takes 2 or 3 minutes.



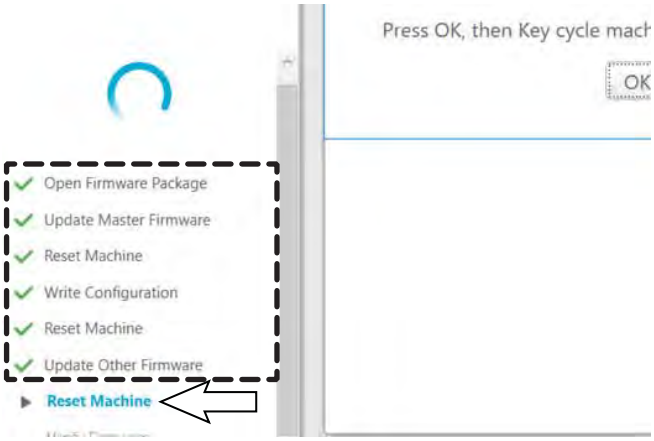
29. A check appears where the process status indicator with the percent status was previously located when the firmware update is complete.



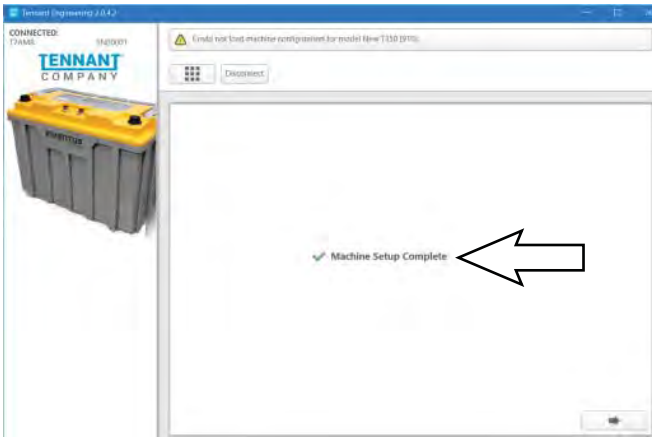
30. A text box with “Press OK, then Key cycle machine.” appears. Select the OK button and then key cycle the machine to complete the firmware update.



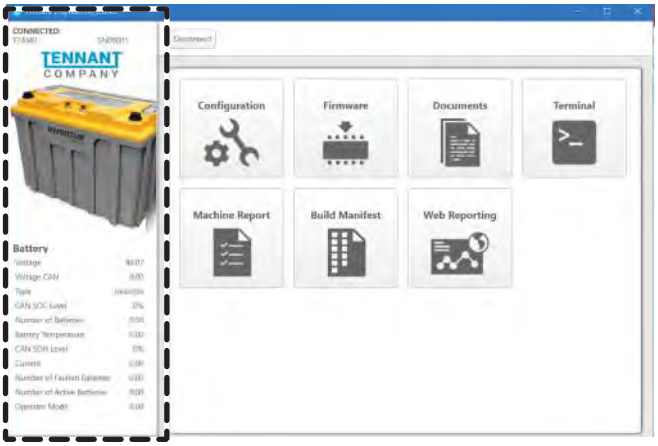
NOTE: Firmware update status box on left side of the screen will be at “Reset Machine” when text box to key cycle machine appears. All previous listed items are checked/completed.



31. A screen with “Machine Setup Complete” appears when the firmware update is complete.



32. Use the Service Diagnostics tool to access the lithium battery screen.



33. Observe the lithium battery information pane on the left side of the screen. The “Number of Batteries” and “Number of Active Batteries” should be two (2.00), and the number of “Number of Faulted Batteries” should be zero (0.00).

See LITHIUM BATTERY SYSTEM VALUES/ RANGES for battery status battery/battery system operating range information.