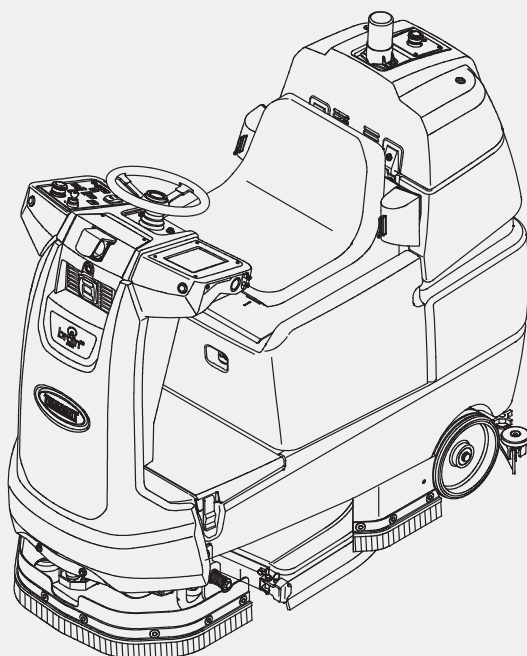




# T7AMR

Rider-Scrubber

English **(EN)**  
Service Manual



**Hygenic® Fully Cleanable Recovery Tank**  
**TennantTrue® Parts**



**ATTENTION: DO NOT tip the machine onto its side to replace parts or perform 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](http://www.tennantco.com/manuals)

**9018143**  
**Rev. 03 (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](http://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  
[www.tennantco.com](http://www.tennantco.com)

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Specifications and parts are subject to change without notice.

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## INTENDED USE

The T7AMR is an industrial/commercial autonomous 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. - \_\_\_\_\_

Installation Date - \_\_\_\_\_

### SERIAL NUMBER LABEL LOCATION



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## SAFETY PRECAUTIONS

### 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.**

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.

**WARNING: This machine contains chemicals known to the state of California to cause cancer, birth defects, or other reproductive harm.**

#### 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% grade or transport (GVWR) on ramp inclines that exceed 10.5% 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. When using machine in robotic mode:
  - Use only as described in this manual.
  - As the machine begins robotic operation, observe scrubbing performance to ensure that all components are functioning properly.
  - Remove the key from the ON/OFF key switch without turning it to the off position. This will not disrupt the robotic route and prevents it from being stolen or lost.
  - 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 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.
  - 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.

## SAFETY PRECAUTIONS

---

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:
  - Drain tanks before loading machine.
  - Lower scrub head and squeegee before tying down machine.
  - Block machine tires.
  - Use ramp, truck or trailer that will support the weight of the machine and operator.
  - Do not drive on a slippery ramp.
  - Use caution when operating on a ramp.
  - Use winch. Do not push the machine onto/off the truck or trailer unless the load height is 380 mm (15 in) or less from the ground.
  - Do not load/unload on ramp inclines that exceed 15.8% grade.
  - Turn off machine and remove key.
  - Use tie-down straps to secure machine.

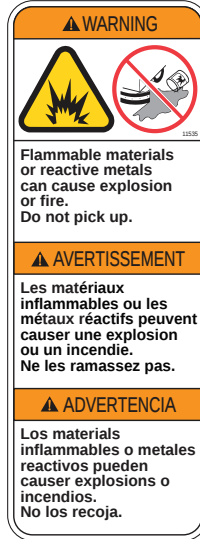
The following safety labels are mounted on the machine in the locations indicated. Replace damaged/missing labels.

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



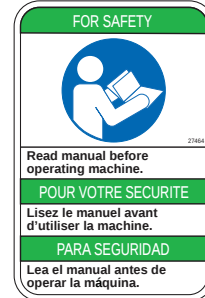
Located on seat panel.

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



Located on seat panel.

**FOR SAFETY LABEL -**  
Read manual before operating machine.



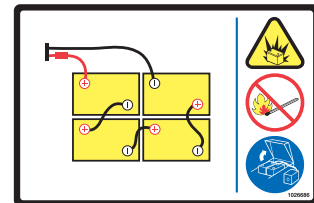
Located on seat panel.

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



Located on electrical panel under the seat.

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

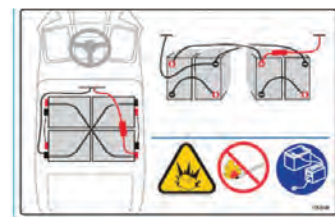


Lead Acid batteries

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



Located under the solution fill port and next to foot pedals.

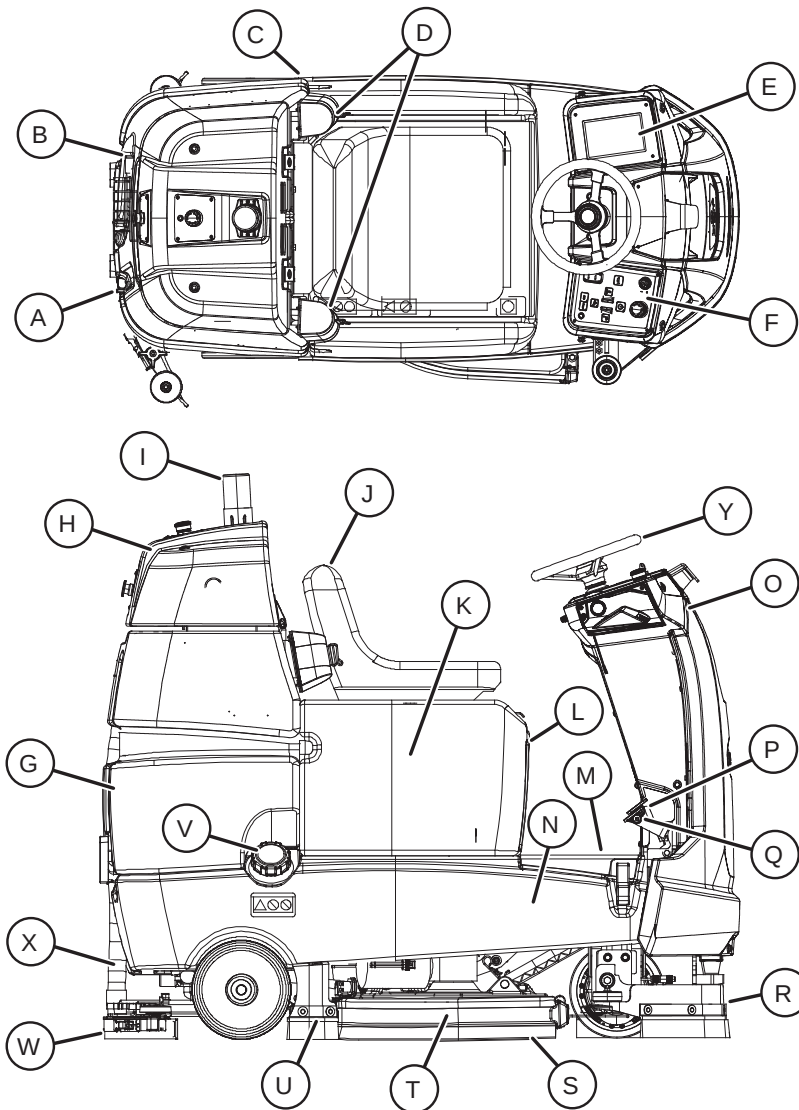


TPPL batteries

Located on bottom of seat panel.

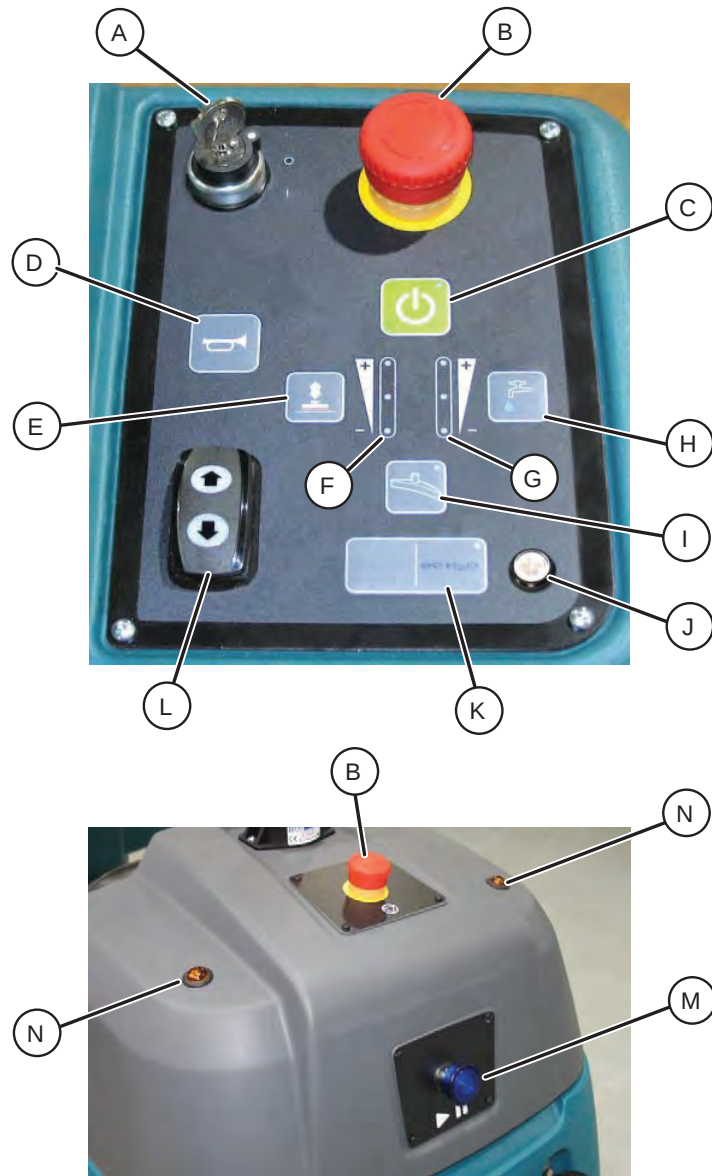
## GENERAL INFORMATION

### MACHINE COMPONENTS



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

## CONTROLS AND INSTRUMENTS



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

### CAMERAS AND SENSORS

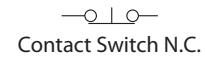
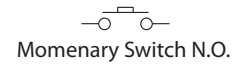
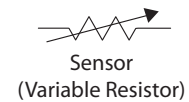
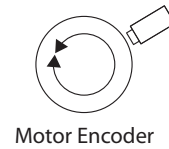
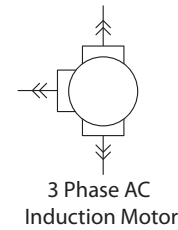
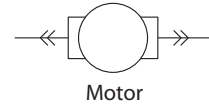
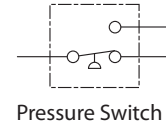
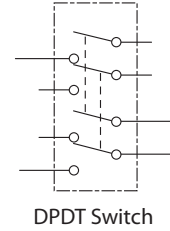
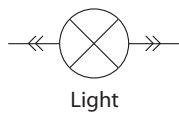
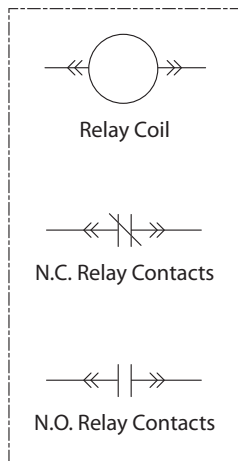
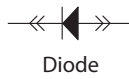
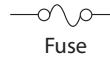
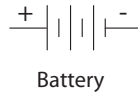
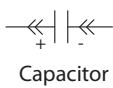
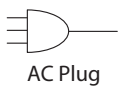
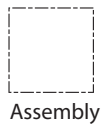
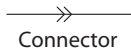
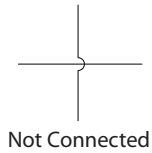
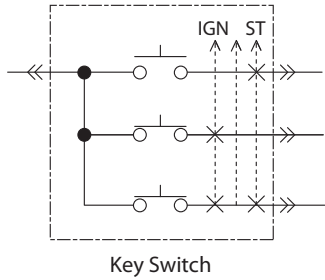


- A. Sensors - Upper LIDAR
- B. Signal lights (Front)
- C. Sensors – Front 2D camera
- D. Sensors – Front 3D camera
- E. Sensors - Side 2D camera (located on each side of machine)
- F. Sensors - Side 3D camera (located on each side of machine)
- G. Sensors - Lower LIDAR



## GENERAL INFORMATION

### ELECTRICAL SCHEMATIC SYMBOLS

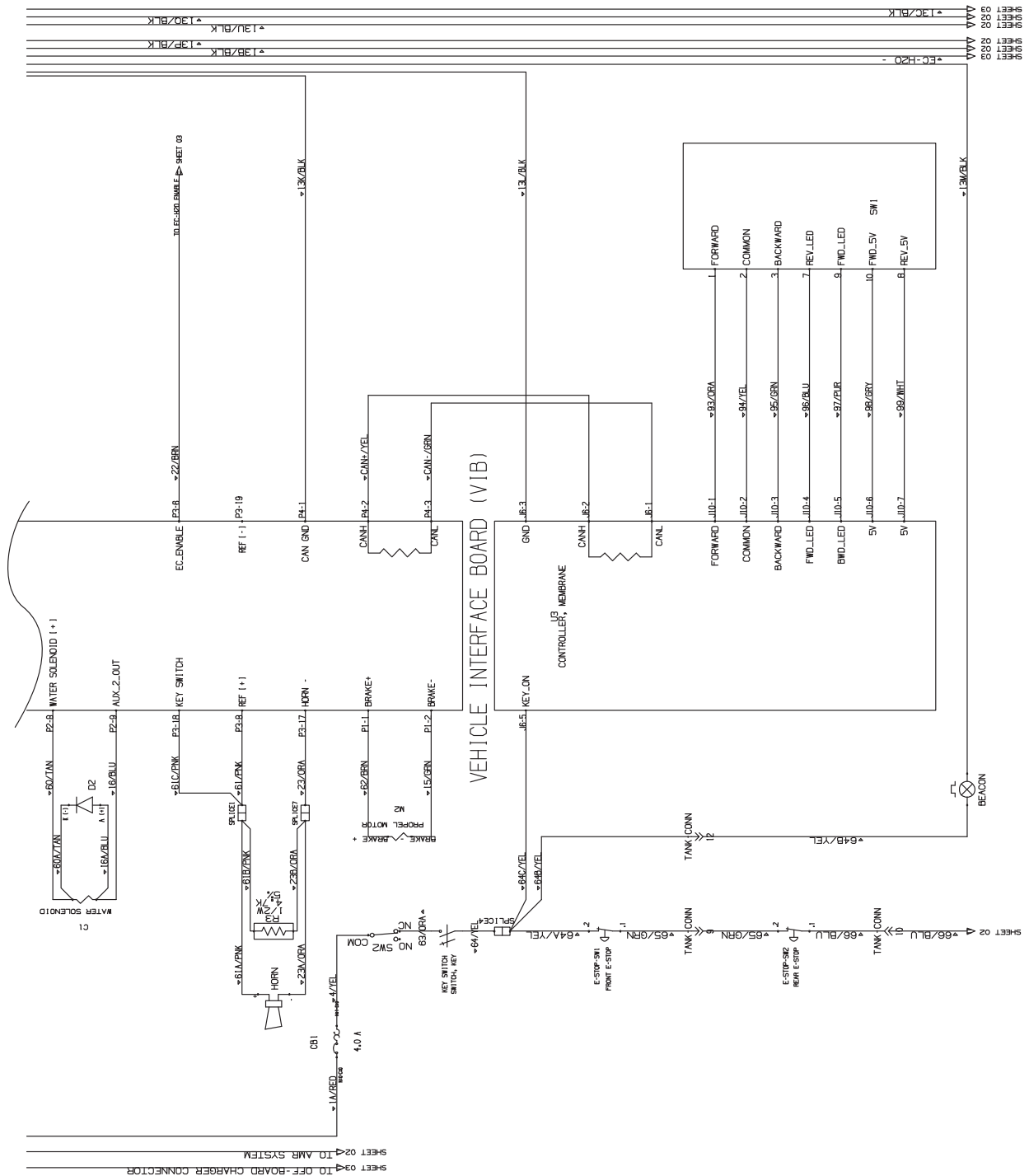






**ELECTRICAL SCHEMATIC**  
**NA/APAC S/N (10000000-10962697)**

NA/APAC S/N (10000000-10962697)



Sheet 01 – Continued

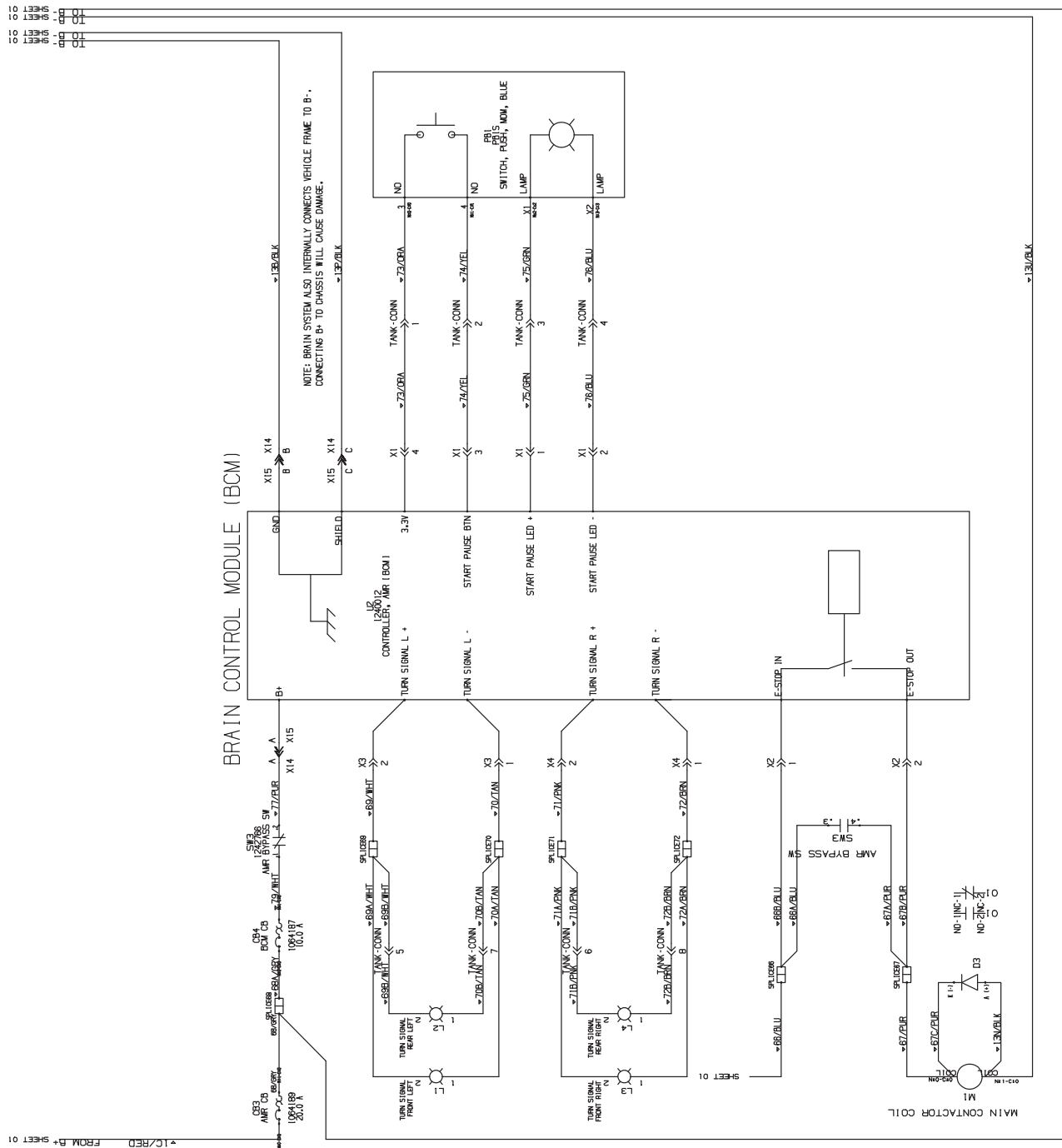
1076546 – 356927

## GENERAL INFORMATION

**ELECTRICAL SCHEMATIC**  
**NA/APAC S/N (10000000-10962697)**

NA/APAC S/N (10000000-10962697)

NA/APAC S/N (10000000-10962697)



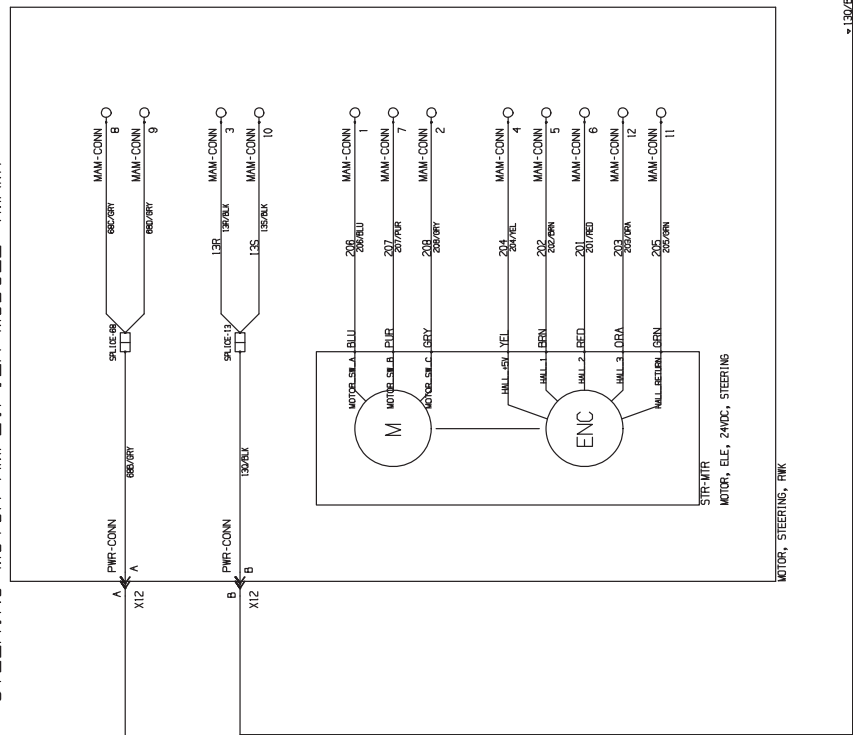
Sheet 02

1076546 – 356927

ELECTRICAL SCHEMATIC  
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NA/APAC S/N (10000000-10962697)

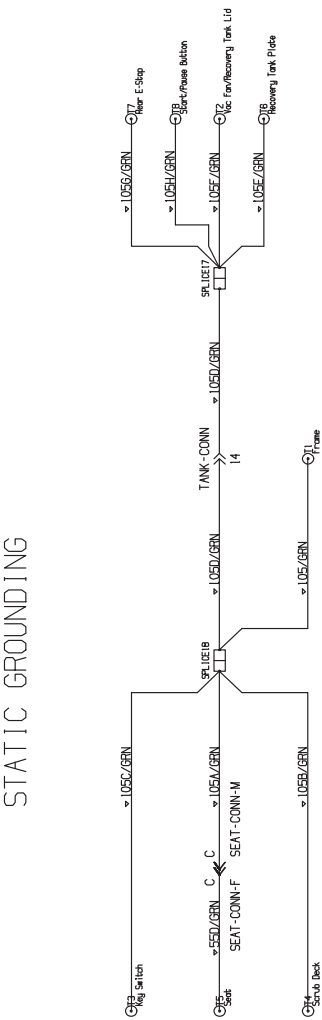
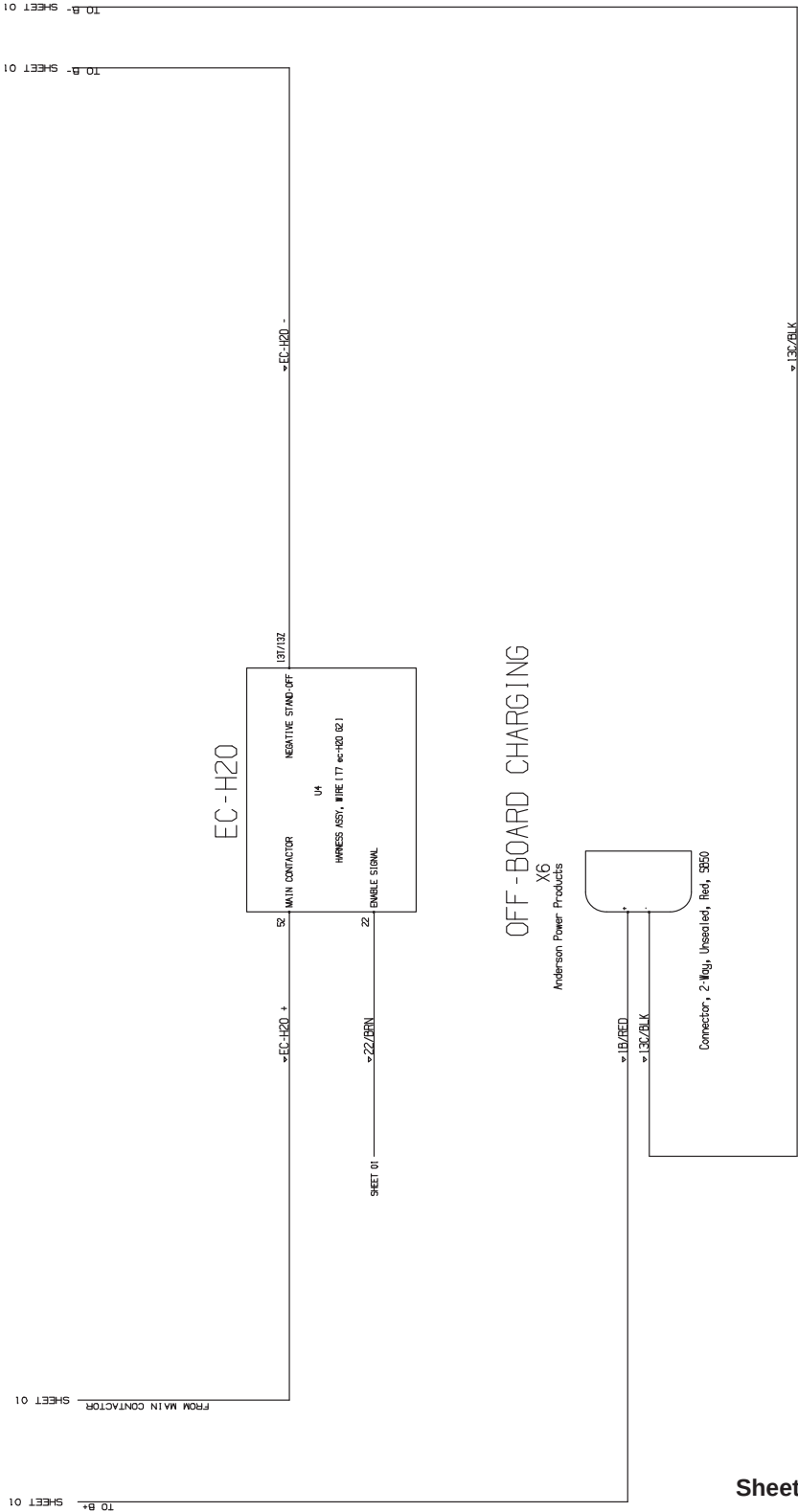
STEERING MOTOR AMPLIFIER MODULE (MAM)



GENERAL INFORMATION

ELECTRICAL SCHEMATIC  
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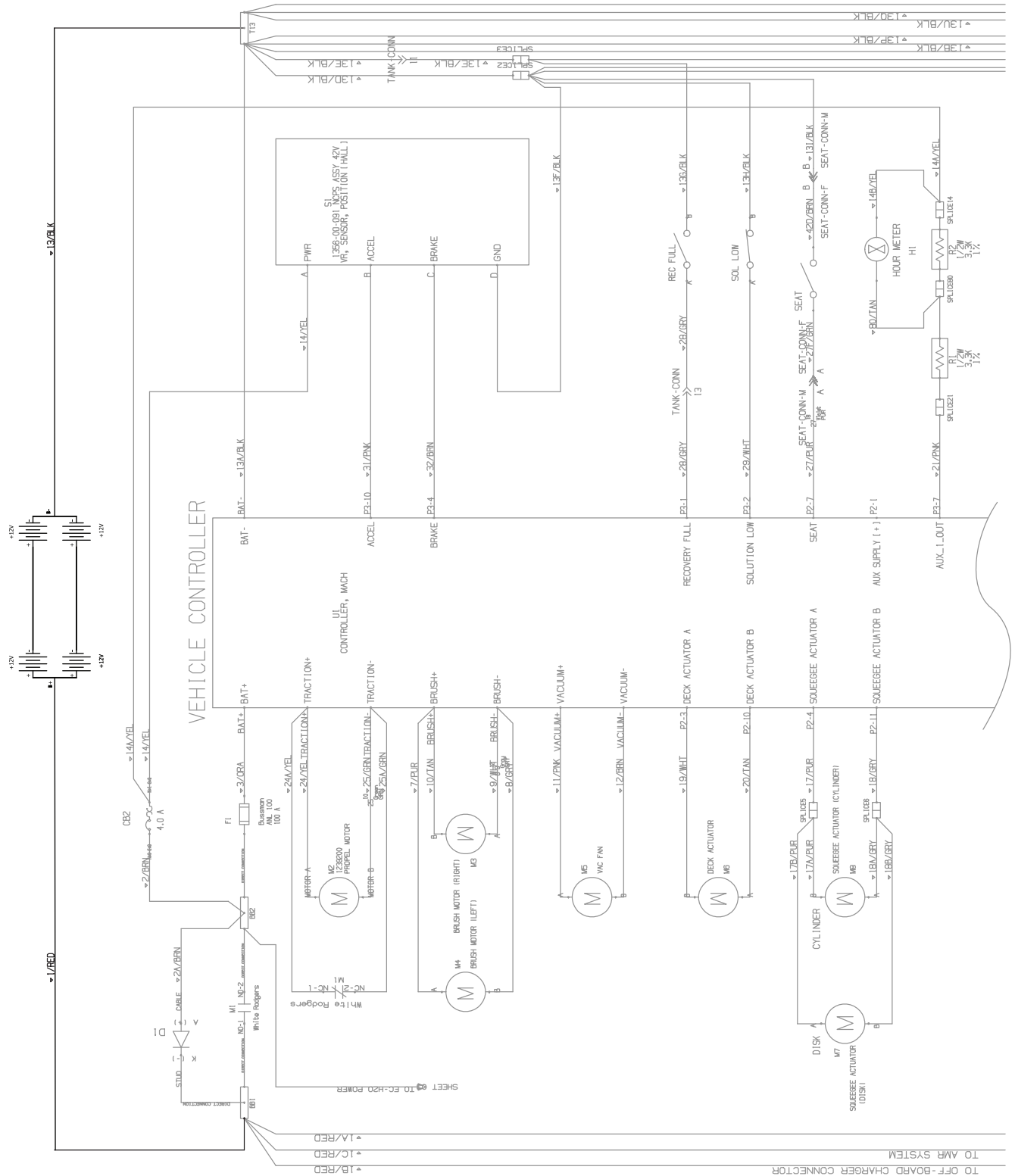
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1076546 - 356927

ELECTRICAL SCHEMATIC  
NA/APAC S/N (10962698- )  
EMEA S/N (10000000- )

MACHINES W/ TPPL BATTERIES



1076995

## GENERAL INFORMATION

### ELECTRICAL SCHEMATIC

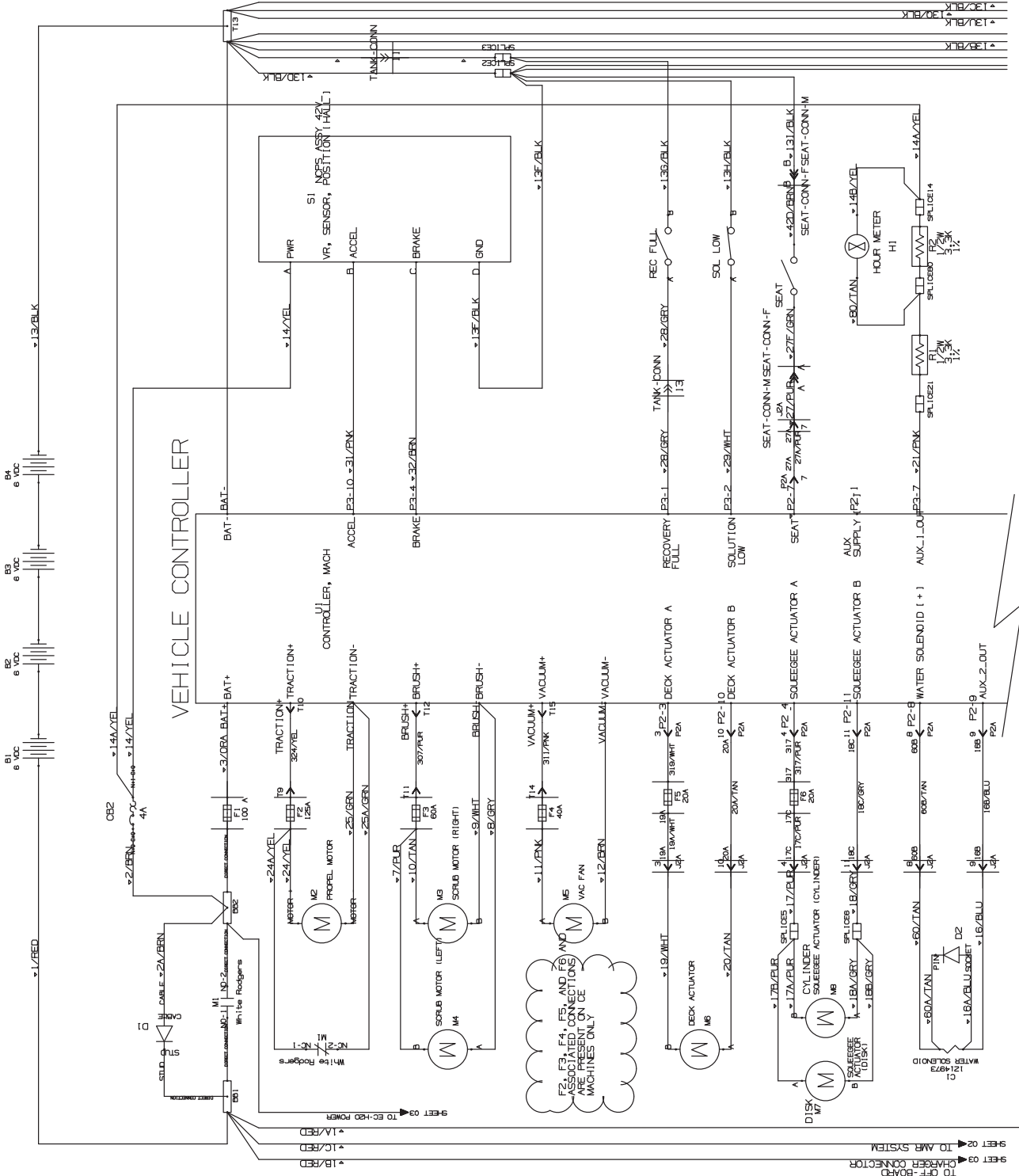
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EMEA S/N (10000000- )

NA/APAC S/N (10962698- )

EMEA S/N (10000000- )

MACHINES W/ FLA BATTERIES



Sheet 01

1076662- 356927

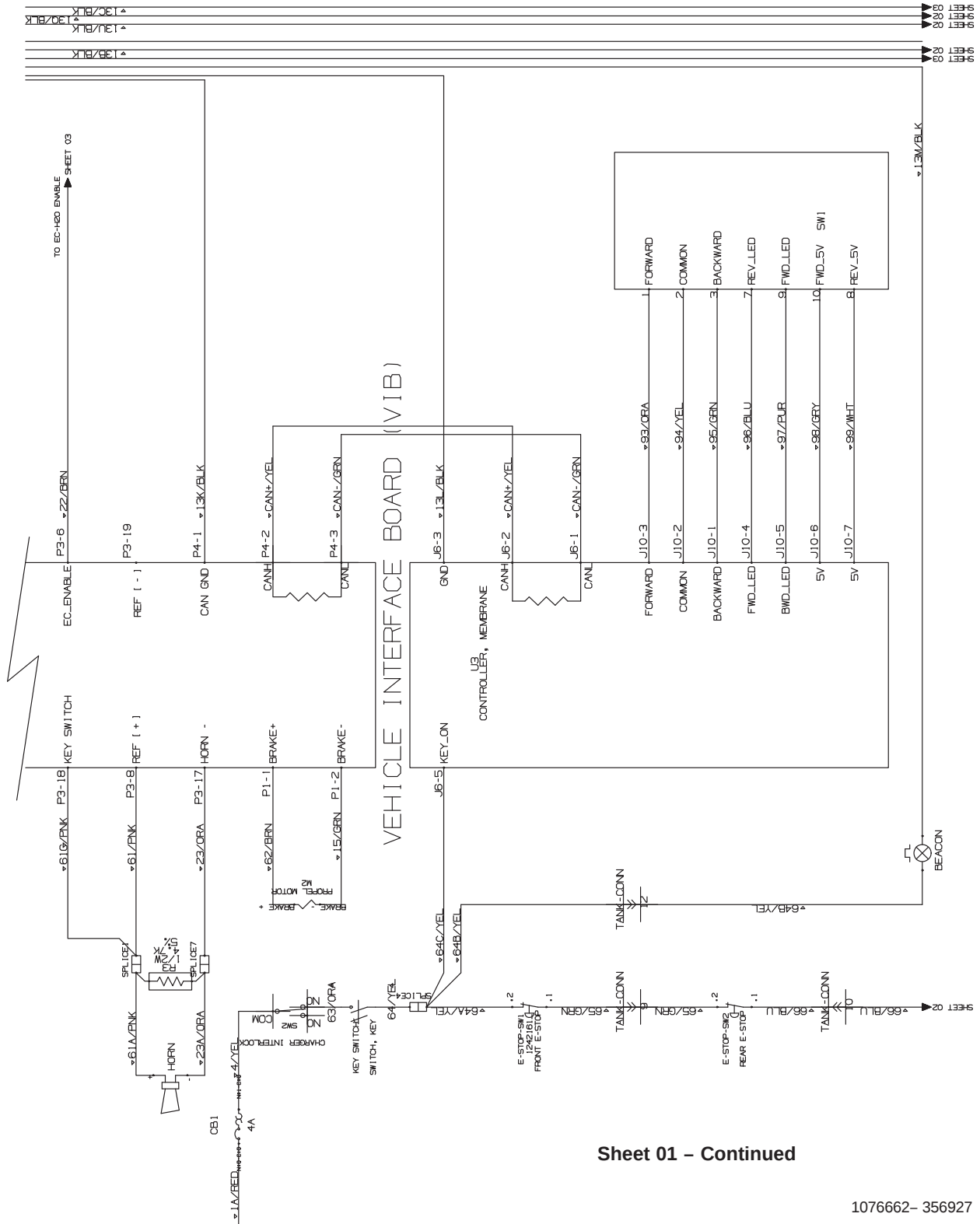
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EMEA S/N (10000000- )



Sheet 01 – Continued

1076662- 356927

## GENERAL INFORMATION

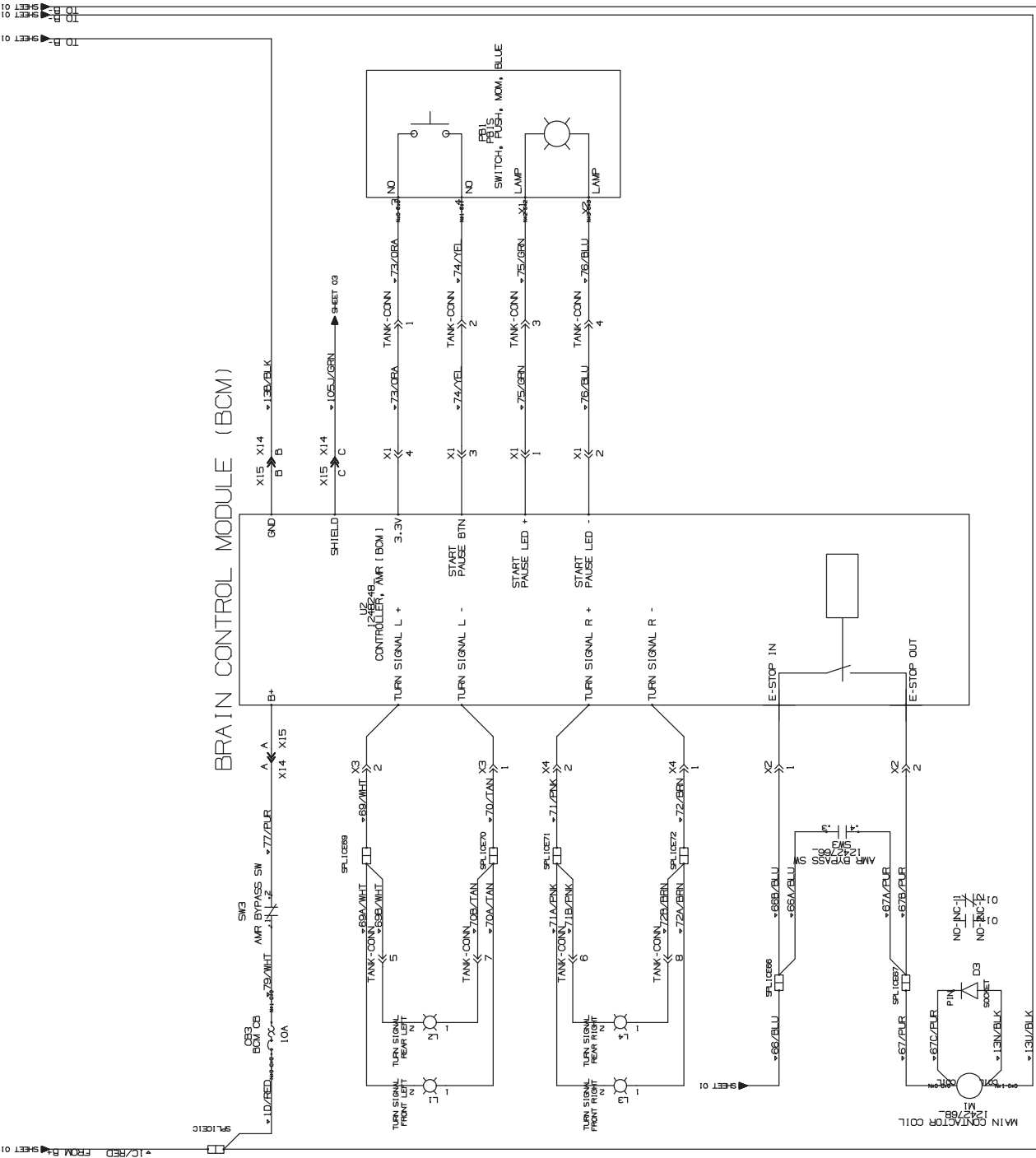
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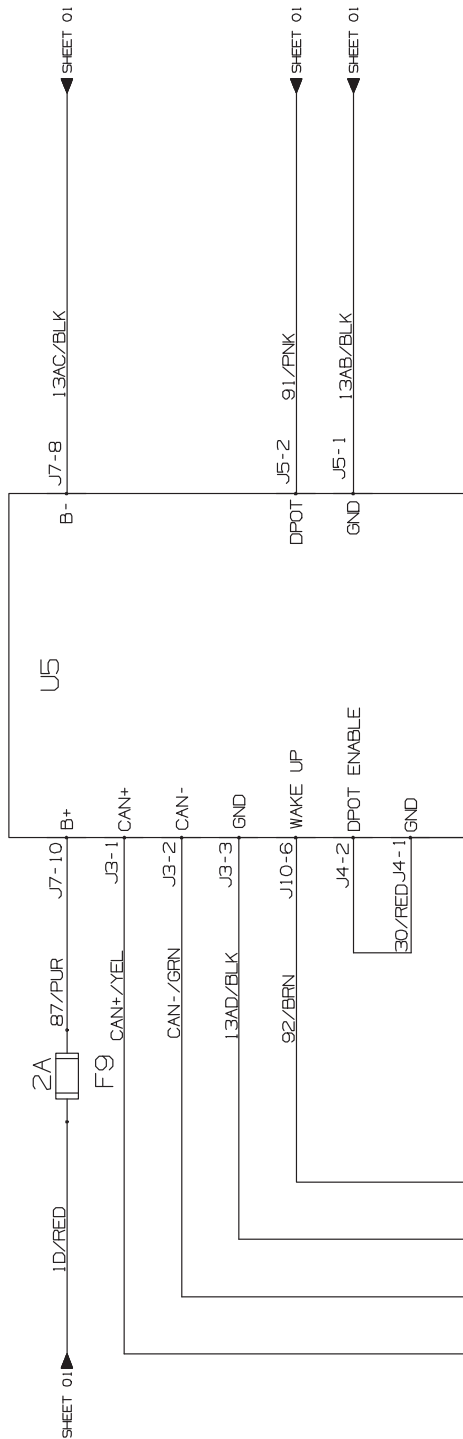




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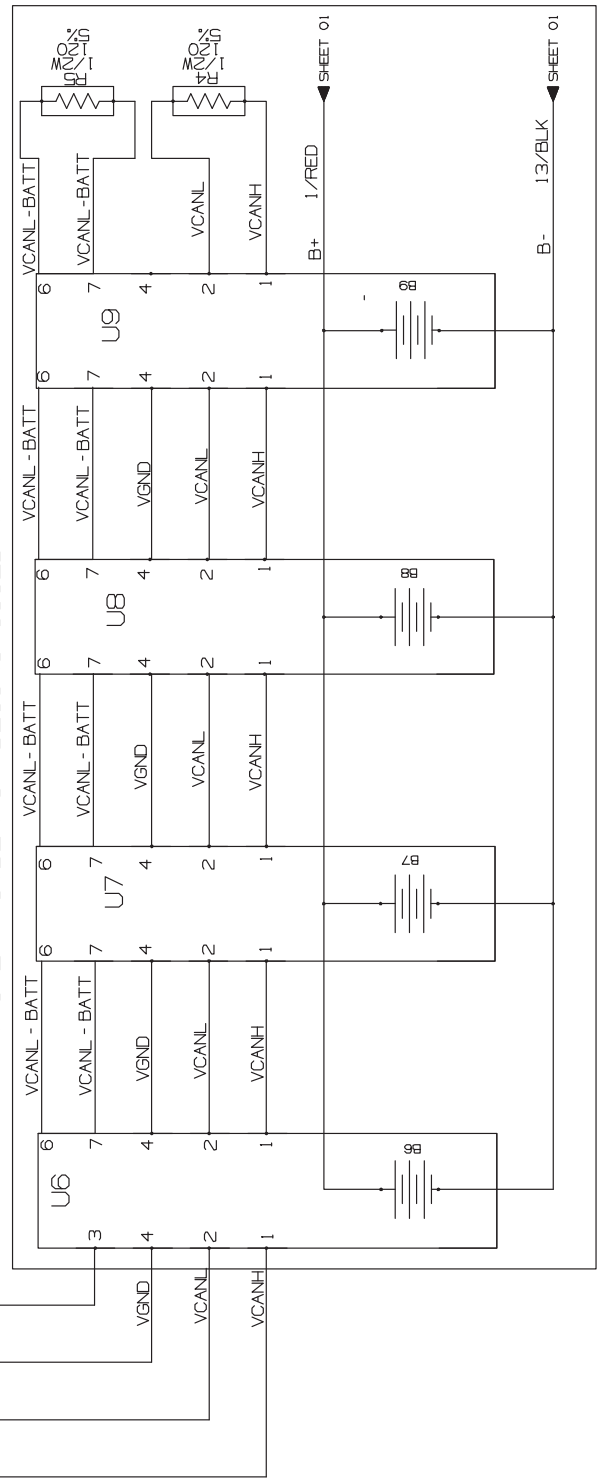
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## TENNANT GATEWAY BOARD (OPTIONAL)



## INVENTUS LITHIUM BLOCKS (OPTIONAL)

(NOTE: NUMBER OF BLOCKS COULD VARY)

**Sheet 03 – Continued**

1076546 – 356927

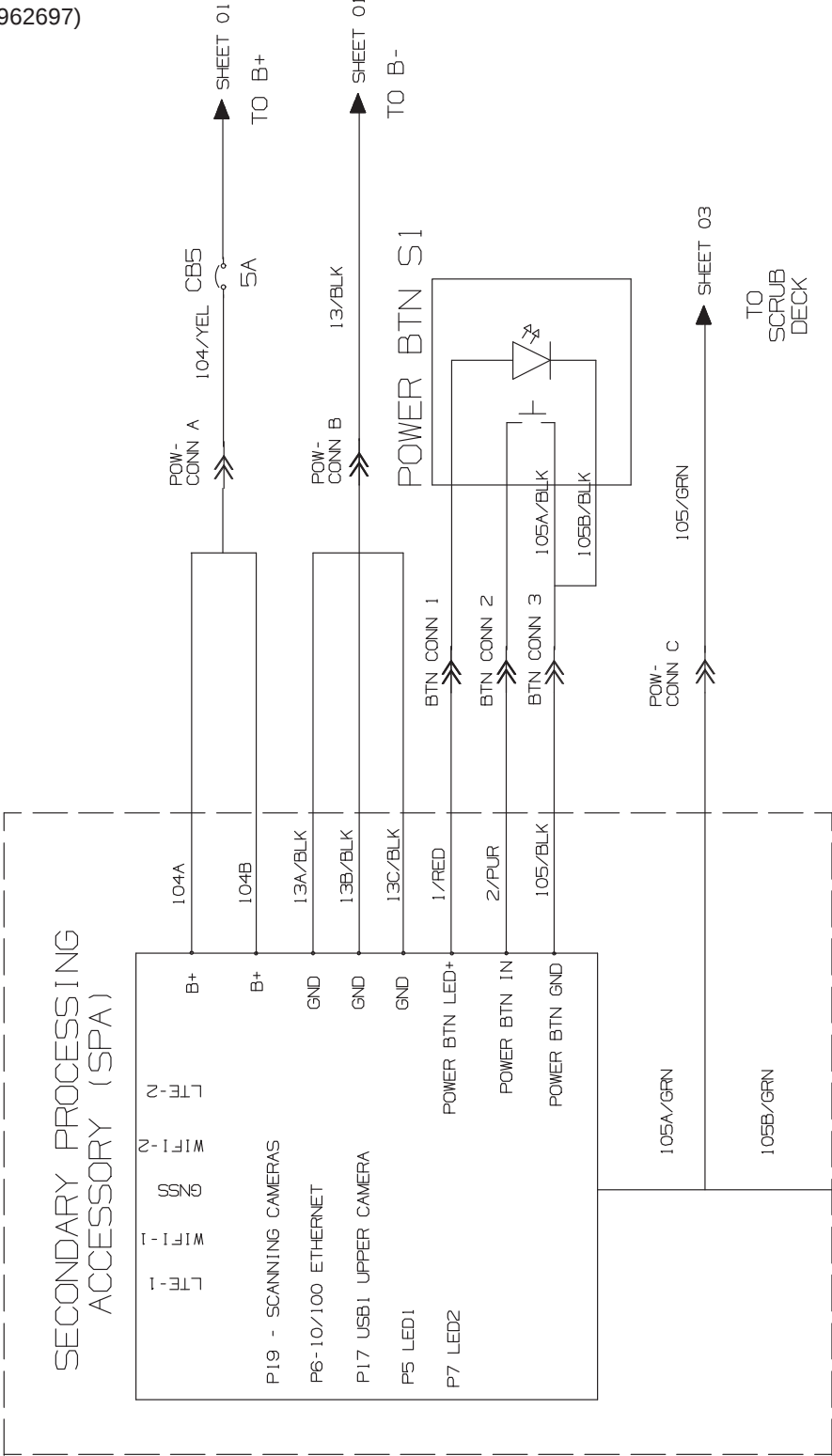
GENERAL INFORMATION

ELECTRICAL SCHEMATIC  
NA/APAC S/N (10962698- )

NA/APAC S/N (10000000–10962697)

02

SCANNING TOWER (OPTIONAL)



1076546 – 356927

## GENERAL INFORMATION

### 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 INFORMATION

### GENERAL MACHINE DIMENSIONS/CAPACITIES/ PERFORMANCE

| Item                                   | Dimension / Capacity |
|----------------------------------------|----------------------|
| Length                                 | 1645 mm (65 in)      |
| Height (to light)                      | 1450 mm (57 in)      |
| Width/frame                            | 740 mm (29 in)       |
| Width/machine with scrub head          | 800 mm (31.5 in)     |
| Width/rear squeegee (roller to roller) | 850 mm (33.25 in)    |
| Brush diameter                         | 330 mm (13 in)       |
| Scrubbing path width                   | 650 mm (26 in)       |
| Track                                  | 724 mm (28.5 in)     |
| Wheel base                             | 971 mm (31.2 in)     |
| Solution tank capacity                 | 110 L (29 gallons)   |
| Recovery tank capacity                 | 110 L (29 gallons)   |
| Demisting chamber                      | 23 L (6 gallons)     |
| Weight/net less batteries              | 311 Kg (685 lbs)     |
| Weight/with standard battery package   | 492 Kg (1085 lbs)    |
| GVWR                                   | 714 Kg (1575 lbs)    |
| Protection Grade                       | IPX3                 |

| Values determined as per IEC 60335-2-72 | Measure               |
|-----------------------------------------|-----------------------|
| Sound pressure level LpA                | 68.82 dB(A)           |
| Sound pressure uncertainty KpA          | 2.97 dB(A)            |
| Sound power level LWA + Uncertainty KWA | 82.71 dB(A) + 2.98 dB |
| Vibration - Hand-arm                    | <2.5 m/s <sup>2</sup> |
| Vibration - Whole body                  | <0.5 m/s <sup>2</sup> |

### GENERAL MACHINE PERFORMANCE

| Item                                                                 | Measure            |
|----------------------------------------------------------------------|--------------------|
| Aisle turnaround (right)                                             | 1732 mm (68 in)    |
| Aisle turnaround (left)                                              | 1818 mm (72 in)    |
| Travel Speed Forward (maximum) - Manual Mode                         | 6.4 Km/h (4 mph)   |
| Travel Speed Forward (maximum) - Robotic Mode                        | 4.0 Km/h (2.5 mph) |
| 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) | 4 in series          | 6     | 360@20 hr rate | 44.5 kg (97.5 lb) |
| Batteries (TPPL)                 | 4 in series-parallel | 12    | 256@20 hr rate | 43.2kg (95 lb)    |
| Batteries (Lithium-Ion)          | 4 in parallel        | 24    | 90Ah           | 21kg (47 lb)      |

| Type            | Use         | VDC | kW (hp)           |
|-----------------|-------------|-----|-------------------|
| Electric Motors | Scrub brush | 24  | 0.45 kW (0.6 hp)  |
|                 | Vacuum fan  | 24  | 0.45 kW (0.6 hp)  |
|                 | Propelling  | 24  | 0.85 kW (1.1 hp)S |

| Type            | VDC | amp  | Hz    | Phase | VAC     |
|-----------------|-----|------|-------|-------|---------|
| Charger (Smart) | 24  | 41.3 | 50/60 | 1     | 100-240 |

## 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

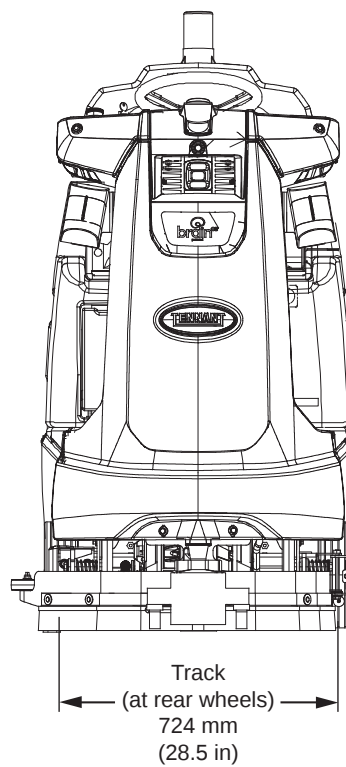
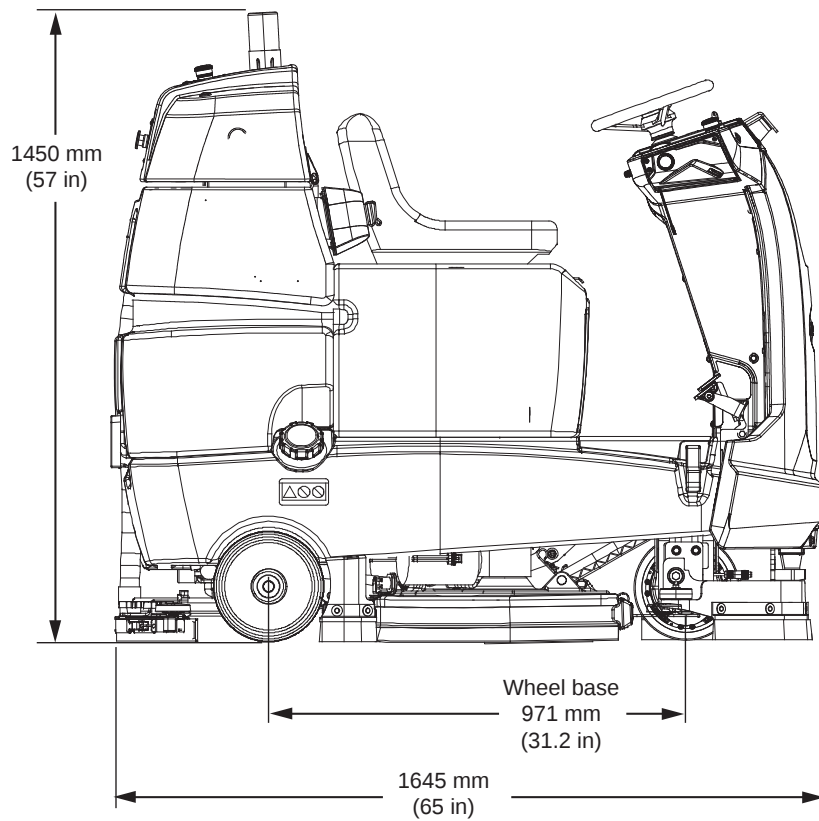
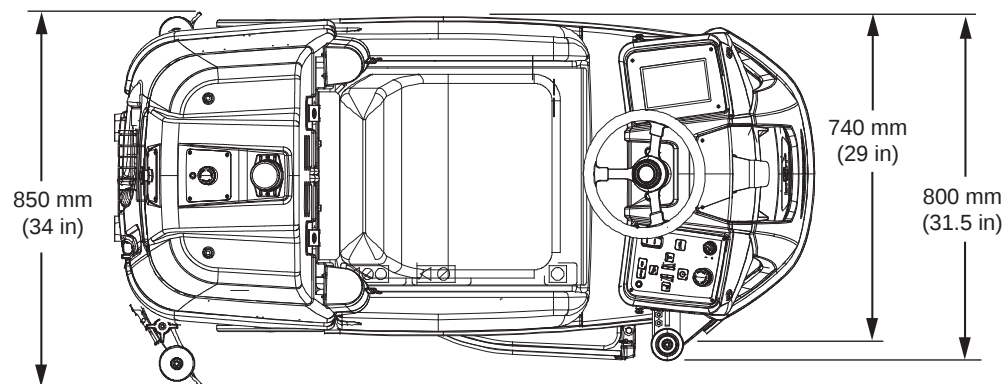
| Item               | Measure          |
|--------------------|------------------|
| Solution flow rate | Low: 0.20 gpm    |
|                    | Medium: 0.35 gpm |
|                    | High: 0.45 gpm   |

ec-H<sub>2</sub>O 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: 0.14 gpm                                                      |
|                    | Medium: 0.25 gpm                                                   |
|                    | High: 0.35 gpm                                                     |

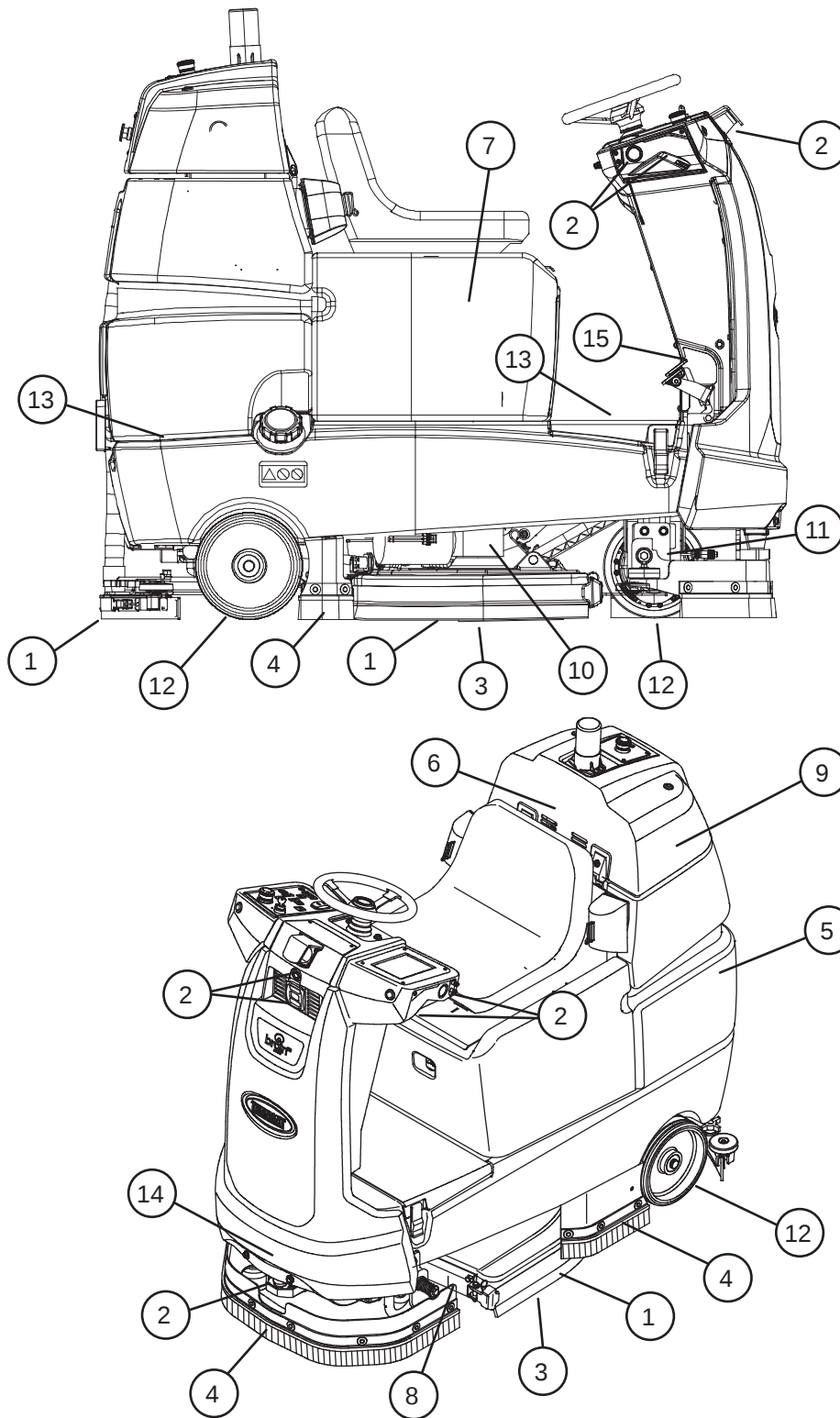
## GENERAL INFORMATION

### 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            | 1   | Side and rear squeegees                                     | Check, flip or replace                                                             | -                | 3                     |
|           |              |     |                                                             | Check deflection and leveling                                                      | -                | 6                     |
|           | O            | 2   | Front/side 2D and 3D sensors and upper/ lower LIDAR sensors | Check for damage. Clean with provided microfiber cloth                             | -                | 8                     |
|           | O            | 3   | Scrub brushes/pads                                          | Check for damage, wear, debris                                                     | -                | 2                     |
|           | O            | 4   | Perimeter guards (left, right, and front)                   | Check for debris, damage, and wear                                                 | -                | 3                     |
|           | O            | 5   | Recovery tank                                               | Clean tank, screen filter, and float sensor                                        | -                | 1                     |
|           | O            | 6   | Vacuum fan filter                                           | Clean                                                                              | -                | 1                     |
| Weekly    | T            | 7   | Battery cells                                               | Check electrolyte level (Lead Acid)                                                | DW               | 3                     |
| 50 Hours  | O            | 8   | Scrub head floor skirt                                      | Check for damage and wear                                                          | -                | 2                     |
| 100 Hours | T            | 9   | Vacuum fan and recovery tank seals                          | Check for damage and wear                                                          | -                | 3                     |
|           | O            | 13  | Solution tank seals                                         | 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            | 14  | Steering gear chain                                         | Lubricate, check tension, and check for damage and wear.                           | GL               | 1                     |
|           | T            | 15  | Steering u-joint                                            | Lubricate and check for damage and wear.                                           | GL               | 1                     |
| 500 Hours | T            | 6   | Vacuum fan motor(s)                                         | Check motor brushes<br><b>(Check every 100 hours after initial 500 hour check)</b> | -                | 1                     |
|           | T            | 10  | Scrub brush motors                                          | Check motor brushes<br><b>(Check every 100 hours after initial 500 hour check)</b> | -                | 2                     |
|           | T            | 11  | Propelling motor                                            | Check motor brushes<br><b>(Check every 100 hours after initial 500 hour check)</b> | -                | 1                     |
|           | T            | 12  | Tires                                                       | Check for damage and wear                                                          | -                | 3                     |

### LUBRICANT/FLUID

DW Distilled water

GL SAE 90 weight gear lubricant

## MAINTENANCE

### BATTERIES

**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 leave the battery partially discharged for long period of time.
- For best charging performance, charge the battery pack in temperatures below 80°F/27°C and above 32°F/0°C
- Maintain the proper electrolyte levels of the flooded (wet) battery by checking levels weekly.

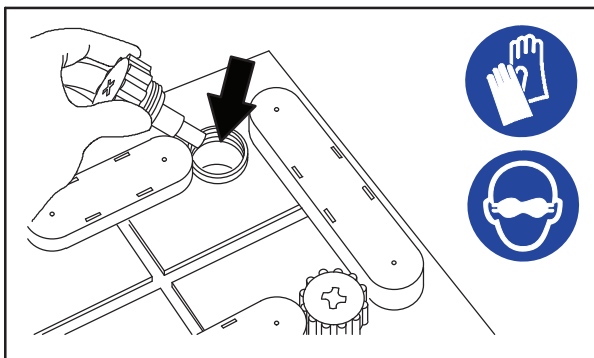
The following steps do not apply if Opportunity charging (See *OPPORTUNITY CHARGING* section).

- Do not charge the battery more than once a day and only after running the machine for a minimum of 15 minutes.
- Allow the charger to completely charge the battery before reusing the machine.

#### CHECKING THE ELECTROLYTE LEVEL

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

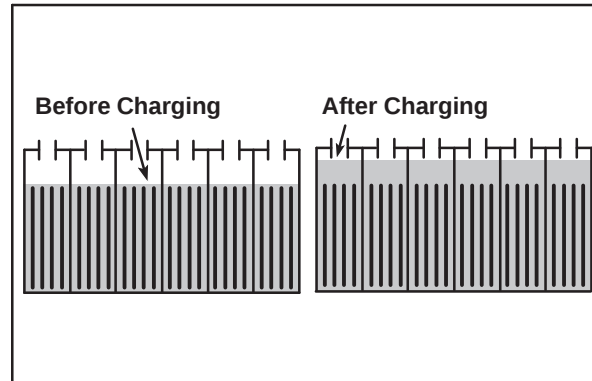
**NOTE: Do Not** check the electrolyte level if the machine is equipped with a battery watering system.



08247

**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 Lithium-ion battery contains a power button to turn on/off the battery power supply. The battery discharge indicator (BDI) displays 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.

## MAINTENANCE

### 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.

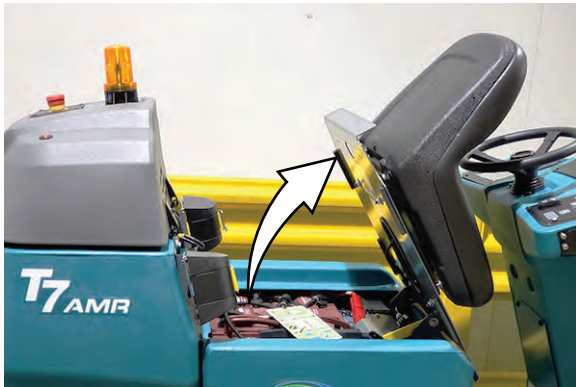
**FOR SAFETY:** The use of incompatible battery chargers may damage battery packs and potentially cause a fire hazard.

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

1. Transport the machine to a well-ventilated area.



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



2. Park the machine on a flat, dry surface, turn off machine and remove key.

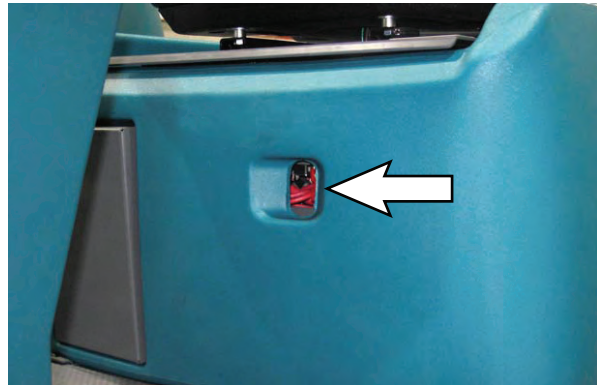
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

3. 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.

4. 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 electrical damage may occur.



5. 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.

6. After charging batteries unplug the AC power supply cord from the outlet before disconnecting the charger from the machine.
7. Disconnect the battery charger from the machine.

## OPPORTUNITY CHARGING (OPTION)

**NOTE:** The machine must be equipped with a TPPL battery or a battery capable of being opportunity charged. Do not opportunity charge standard batteries since doing so can shorten battery life.

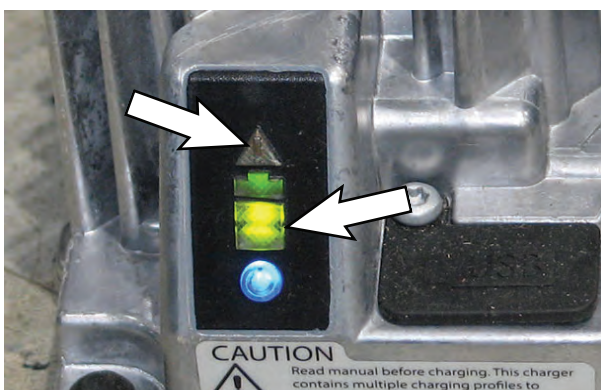
Opportunity charging is used to extend machine run time and productivity by allowing batteries to be charged during breaks, lunch, between shifts, or whenever there is an “opportunity” to charge.

Opportunity charging (i.e. partial charge cycle of a half hour or more) is only recommended if discharge level is below 80% (i.e. when discharge indicator is at or beyond second green light).

**IMPORTANT:** Before charging, make sure that the machine and charger settings are properly set for the battery type.

## BATTERY CHARGING STATUS

The table below shows the status of the battery charger.

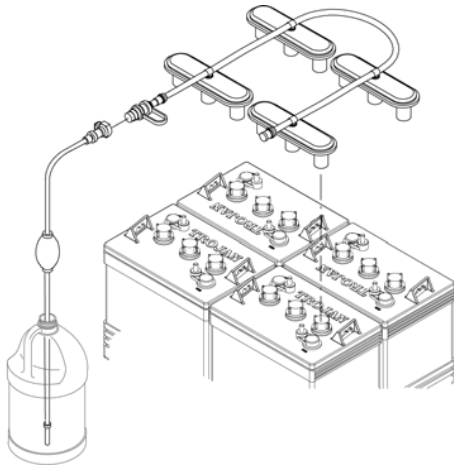


| LED Pattern                                                                     | Description                                                      | Comments                                                                              |
|---------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 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 displays this LED pattern when first plugged into AC power then LED turns off |
| Slow Green Blinking (1 second ON; 0.2 second OFF)                               | Charging but batteries are less than 80% State of Charge         | Normal operation. Allow charger to finish charging                                    |
| 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                                      | Battery Issue. See troubleshooting section.                                           |
| Solid RED                                                                       | Charger internal failure                                         | Charger issue. See troubleshooting section.                                           |

## MAINTENANCE

### 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.

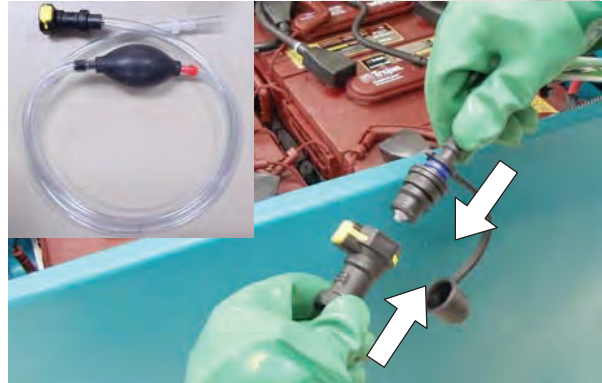
**FOR SAFETY: When servicing machine, wear personal protection equipment as needed. Avoid contact with battery acid.**

Before using the battery watering system 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.



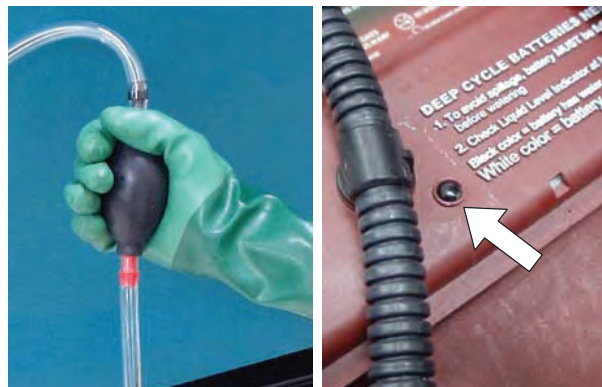
3. Locate the battery fill hose coupler inside the battery compartment. Remove the dust cap and connect the hand pump hose.



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



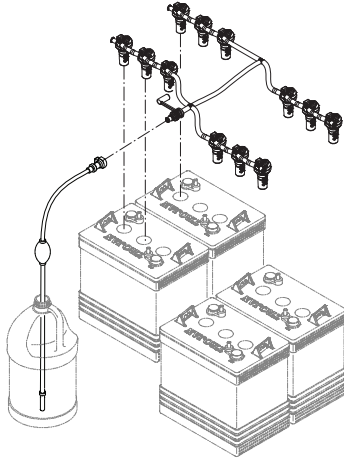
5. Squeeze the bulb on the hand pump hose until firm. The level indicators will turn black when full.



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.

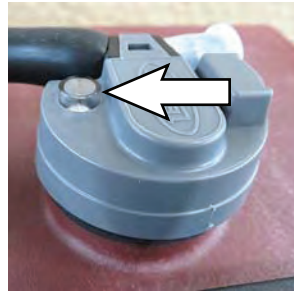
**FOR SAFETY: When servicing machine, wear personal protection equipment as needed. Avoid contact with battery acid.**

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

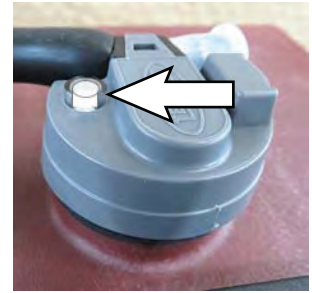
1. Fully charge batteries prior to using the battery watering system. Do not add water to batteries before charging, the electrolyte level will expand and may overflow when charging.
2. After charging batteries, check the battery electrolyte level indicators located on the battery covers.



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

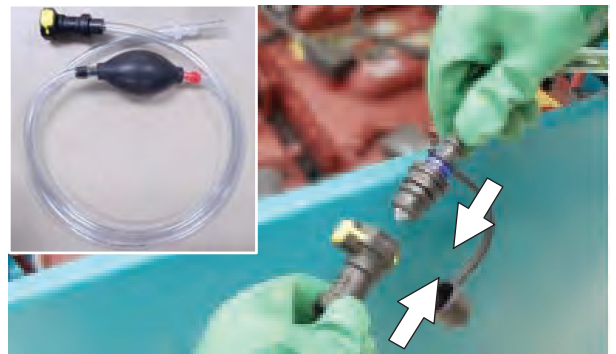


Low Float = Add Water

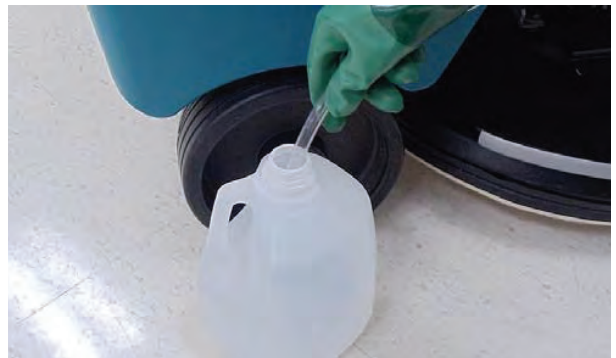


High Float = Full

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



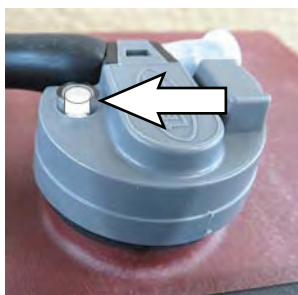
5. Submerge the other end of the hand pump hose into a bottle of distilled water



## MAINTENANCE

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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.

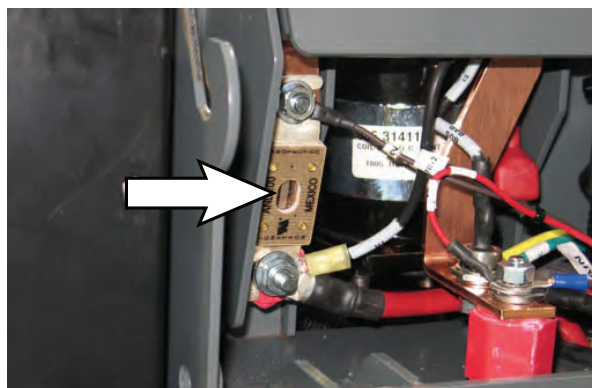
The chart shows the circuit breakers and the electrical components they protect.

| Circuit Breaker | Rating | Circuit Protected                       |
|-----------------|--------|-----------------------------------------|
| CB1             | 4 A    | Instrument panel - power                |
| CB2             | 4 A    | Accessories                             |
| CB3             | 20 A   | AMR system<br>(S/N 1000000000-10962697) |
| CB4             | 10A    | AMR system<br>(S/N 10962698- )          |
| 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 seat support column 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.**

The carbon brushes in the vacuum fan motor, the propelling motor, and the scrub brush motors should be inspected after the initial 500 hours of machine operation and then every 100 hours after the initial 500 hours.

### CAMERAS AND SENSORS

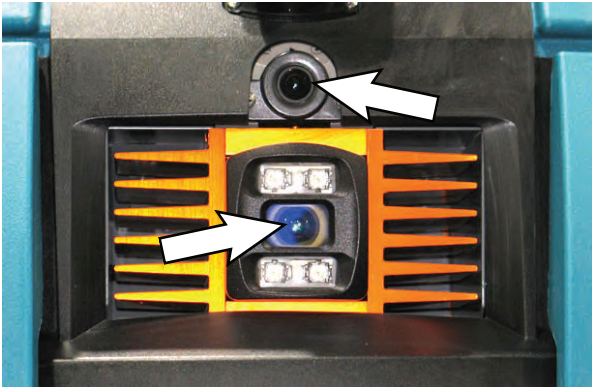
#### FRONT AND SIDE 2D AND 3D CAMERAS

**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 water spots, 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 was included with the home location markers). In extreme cases, a lense 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.

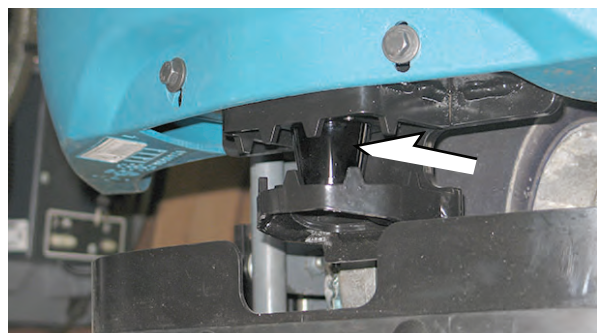
Check the upper and lower LIDAR sensors for dirt, dust, smudges, and damage daily (or before each robotic run). Debris, streaks, or smudges could deliver false environmental information to the machine.

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.*



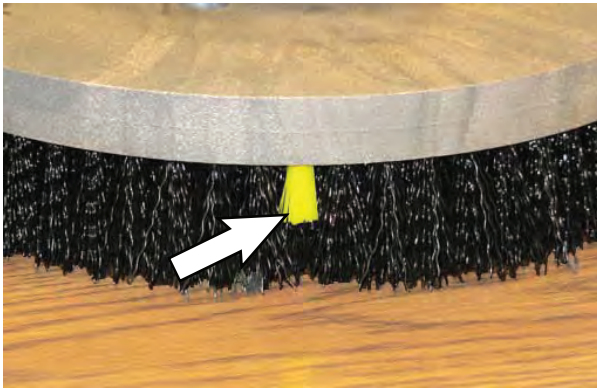
*NOTE: Due to the lower LIDAR sensor being located near the cleaning surface, pay particular attention to ensure the front, side, back, and bottom surfaces are completely clear of all dirt, smudges, and/or other debris. Use a flashlight to inspect these sensor surfaces and ensure they are thoroughly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

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. When changing the scrub brush located on the left side of the machine only: Remove the pin from the left perimeter guard and open the perimeter guard to access the scrub brush.



4. Pull the pin from the side squeegee retainer pivot.



## MAINTENANCE

5. Open the side squeegee retainer pivot toward the front of the machine, then pull the side squeegee toward the rear of the machine to access the scrub brushes or pads.



6. Press the spring clip together with the thumb and index finger. The brush/pad driver will drop off the drive hub. Remove the brush from under the machine.



7. Set the yellow spring clip to the open position to make brush installation easier. Press spring clip together and downward to set.

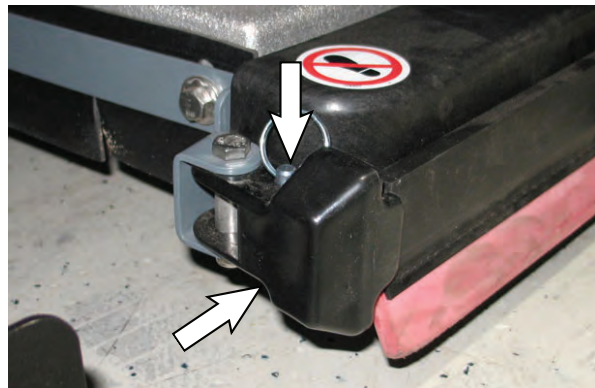


8. Align the pad driver or brush under the motor hub and push it upward to engage hub. Ensure that it is securely mounted onto the motor hub.



9. Close the side squeegee and the retainer pivot, then insert the pin.

*NOTE: Be sure the pin is inserted completely through the bottom.*



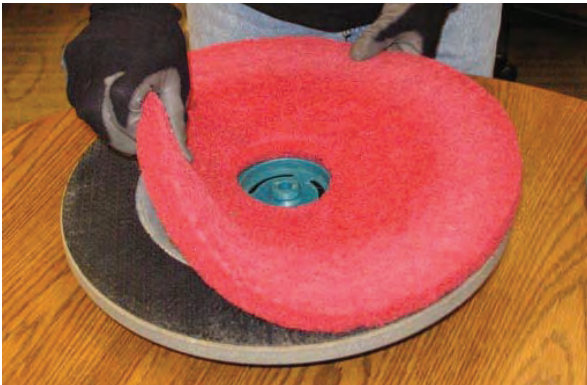
10. If the scrub brush located on the left side of the machine was changed/removed: Close and resecure the left perimeter guard.

**REPLACING DISK PADS**

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.

## MAINTENANCE

### ec-H2O SYSTEM

#### ec-H2O WATER CONDITIONING CARTRIDGE REPLACEMENT

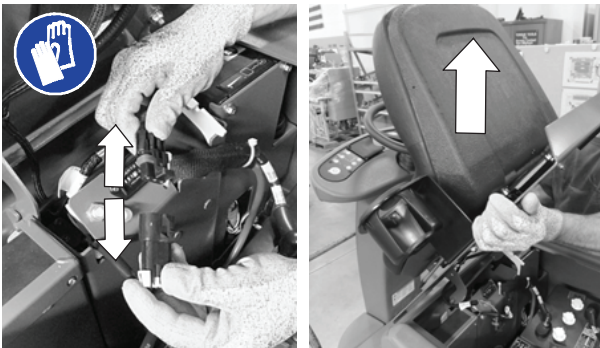
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

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.

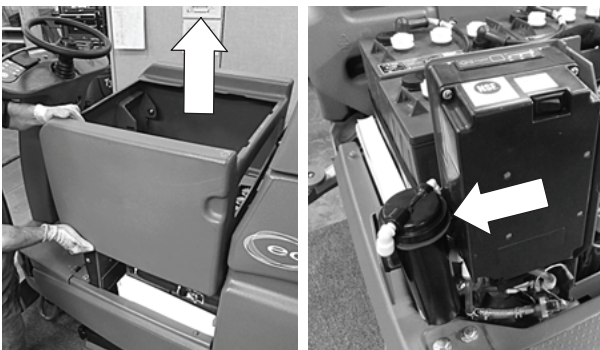
Depending on machine usage, on average, a new cartridge can last anywhere from 12 months for heavy machine usage to 24 months for light machine usage.

*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.*

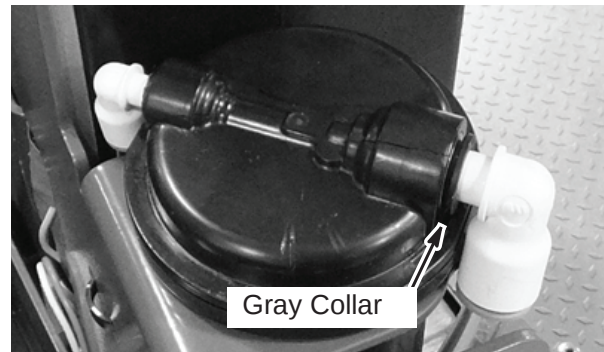
1. Disconnect the wire harness from operator seat and carefully remove seat from machine.



2. Remove the battery compartment shroud from machine to access cartridge.



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



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

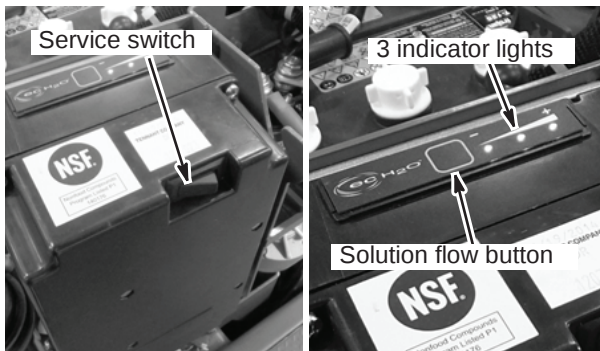


5. Install the new cartridge and reconnect the two hoses. Make sure the hose connectors are fully inserted into new cartridge.

## 6. Reset timer for new cartridge.

Carefully read and understand all steps first before performing procedure.

- Turn the *ON/OFF key switch* on.
- 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.
- 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.



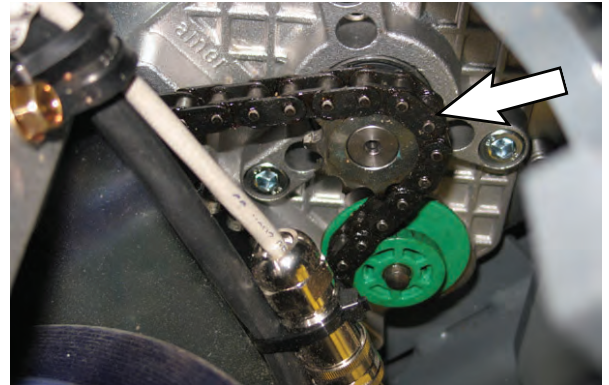
## 7. Reinstall the battery compartment shroud and operator seat.

## LUBRICATION

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

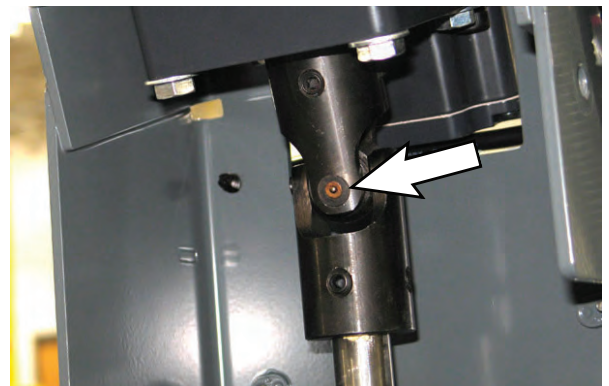
### STEERING GEAR CHAIN

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.



## MAINTENANCE

### 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 REAR 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.

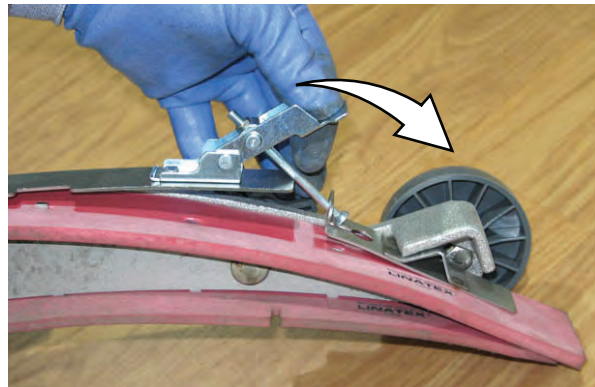
**FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.**

3. Remove the squeegee vacuum hose from the rear squeegee assembly. Then loosen both rear squeegee assembly mounting knobs.

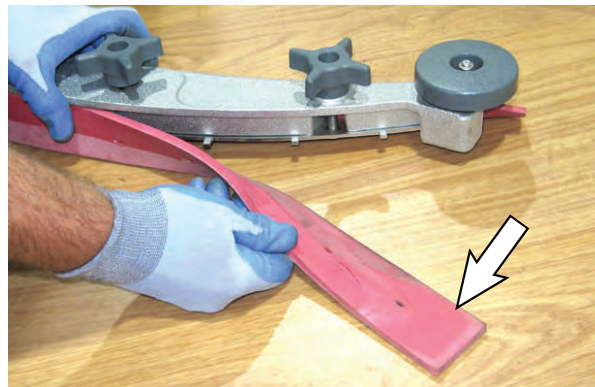


4. Pull the rear squeegee assembly from the machine.

5. Loosen the rear squeegee retaining band tension latch and remove the retaining band.



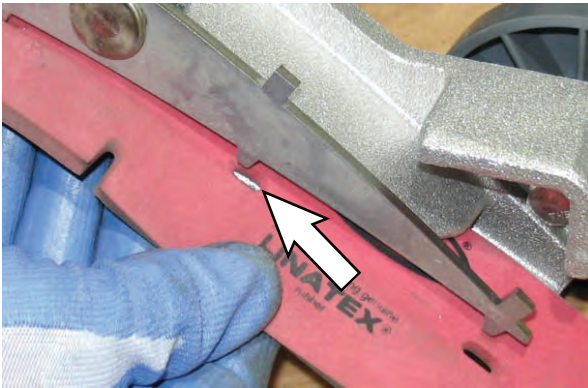
6. Remove rear squeegee blade from the rear squeegee assembly.



7. Loosen the two outer knobs on the rear squeegee assembly. Remove the front squeegee blade from the squeegee assembly.



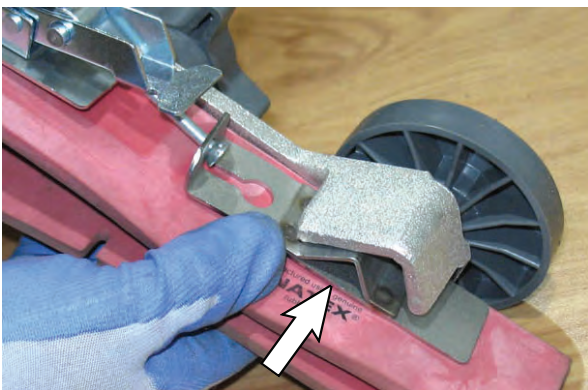
8. Install the new front squeegee blade or rotate the existing blade to the new edge. Be sure the holes in the front squeegee blade are hooked onto the tabs on the front blade clamp.



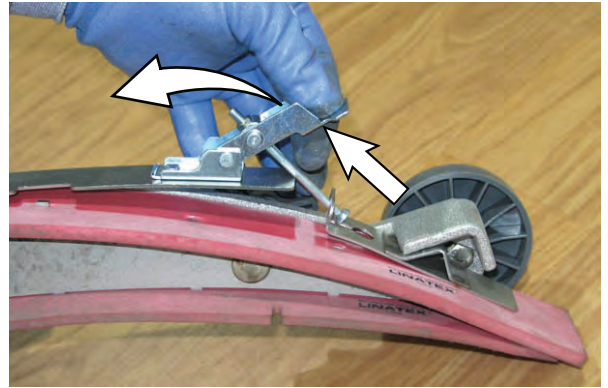
9. Lightly tighten the two outer knobs.
10. Install the new rear squeegee blade or rotate the existing blade to the new edge. Be sure the holes in the squeegee blade are hooked onto the tabs on the squeegee assembly.



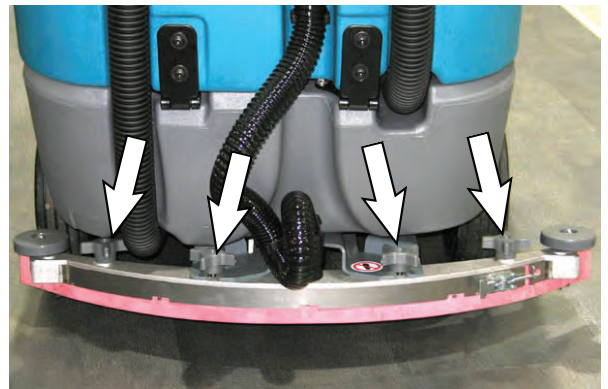
11. Reinstall the rear squeegee retaining band onto the squeegee assembly. Be sure each of the flanges on the retaining band are seated in the cut outs in the rear squeegee assembly.



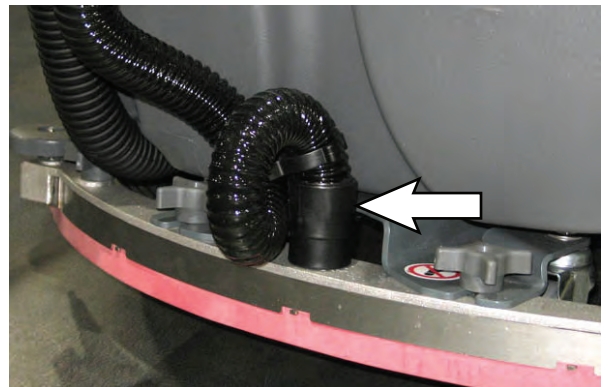
12. Tighten the rear squeegee retaining band tension latch.



13. Reinstall the rear squeegee under the squeegee mount bracket and tighten all four knobs.



14. Reinstall the squeegee vacuum hose onto the rear squeegee assembly.



## MAINTENANCE

### REPLACING THE SIDE SQUEEGEE BLADES

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

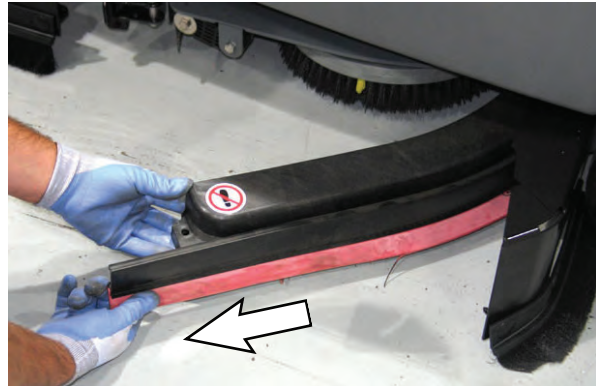
1. When changing the left side squeegee only: Remove the pin from the left perimeter guard and open the left perimeter guard to access the squeegee.



2. Open the side squeegee.



3. Pull the old side squeegee blade from the side squeegee retainer. Slide the new blade onto the retainer.

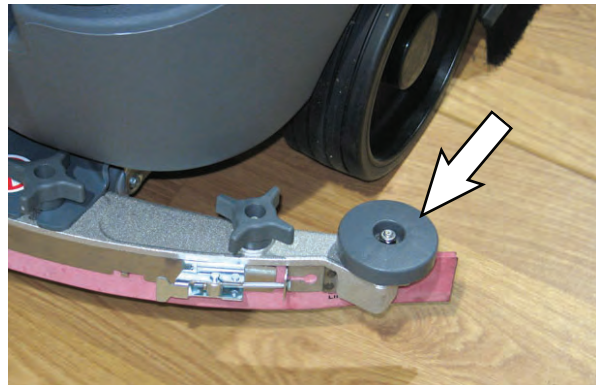


4. Close the side squeegee.
5. If the side squeegee located on the left side of the machine was changed: Close and resecure the left perimeter guard.

### ADJUSTING THE SQUEEGEE GUIDE ROLLER

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

The squeegee guide rollers are located on both ends of the rear squeegee. The rollers guide the squeegee blade end along a wall. Loosen the nut located at the top of the guide roller and move the roller in or out to adjust how close the end of the squeegee blade is to the wall. The squeegee blade end should be further away from the wall when the floor curves up into the wall.



## LEVELING THE REAR SQUEEGEE

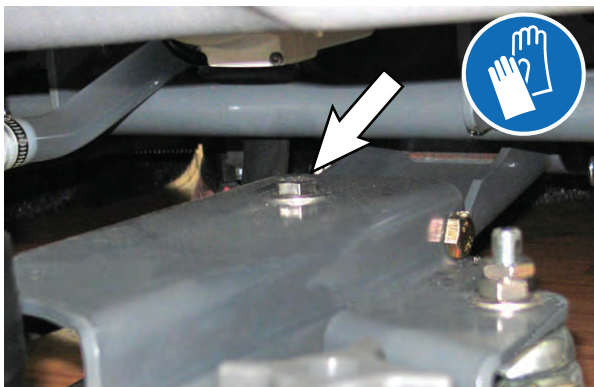
Leveling of the squeegee assures the entire length of the squeegee is in even contact with the surface being scrubbed. Perform this adjustment on an even and level floor.

1. Lower the squeegee and drive the machine forward a few feet.
2. Turn off the machine ON/OFF key switch.

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

3. Look at the deflection of the squeegee over the full length of the squeegee blade.
4. If the deflection is not the same over the full length of the blade, turn the squeegee leveling bolt to make adjustments.

The squeegee leveling bolt is located directly behind the squeegee suction hose. **DO NOT** disconnect the suction hose from the squeegee frame when leveling squeegee.



Turn the squeegee leveling bolt counter-clockwise to increase the deflection at the ends of the squeegee.

Turn the squeegee leveling bolt clockwise to decrease the deflection at the ends of the squeegee blade.

5. Drive the machine forward with the squeegee down to recheck the squeegee blade deflection if adjustments were made.
6. Readjust the squeegee blade deflection if necessary.

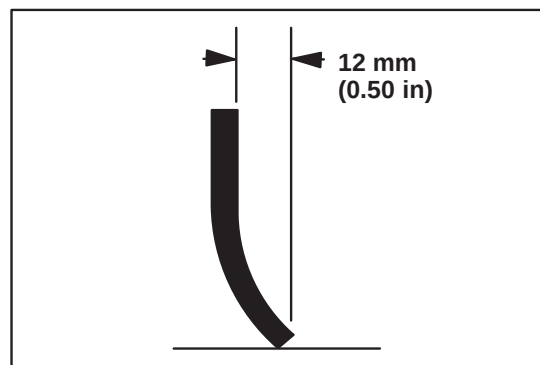
## ADJUST REAR SQUEEGEE BLADE DEFLECTION

Deflection is the amount of curl the overall squeegee blade has when the machine moves forward. The best deflection is when the squeegee wipes the floor dry with a minimal amount of deflection.

1. Lower the squeegee and drive the machine forward a few meters (feet).
2. Turn off the machine ON/OFF key switch.

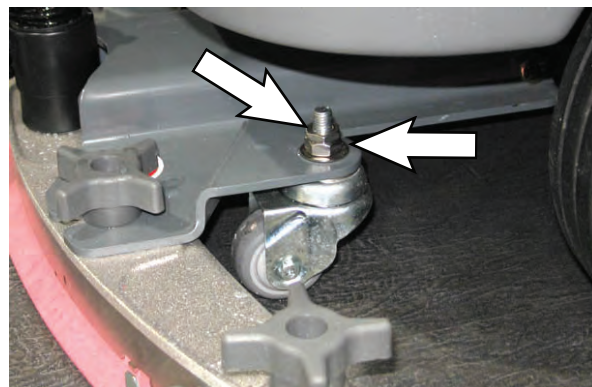
**FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.**

3. Look at the amount of deflection or "curl" of the squeegee blade. The correct amount of deflection is 12 mm (0.50 in) for scrubbing smooth floors and 15 mm (0.62 in) for rough floors.



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4. If the overall squeegee blade deflection needs to be adjusted, loosen the jam nuts on the squeegee casters and adjust the height.



5. Drive the machine forward again to recheck the squeegee blade deflection after adjustments are made.
6. Readjust the squeegee blade deflection if necessary.

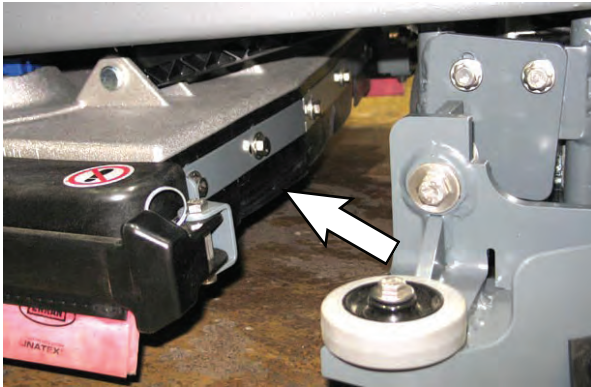
## MAINTENANCE

### SKIRTS AND SEALS

#### SCRUB HEAD FLOOR SKIRT

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

The skirt is located in front of the scrub head. Check the skirt for damage and wear after every 50 hours of operation.

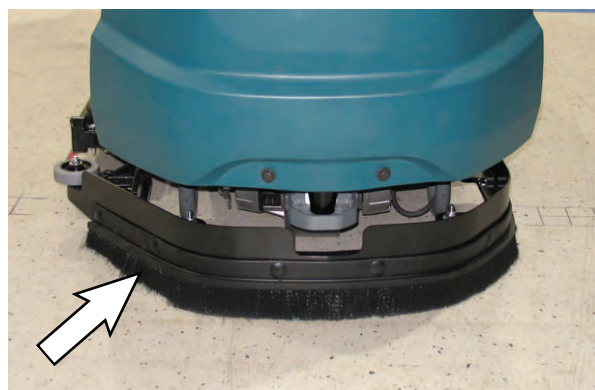


The skirts should clear the floor by 0 to 6 mm (0 to 0.25 in) when the scrub brushes are new and the scrub head is down.

#### LEFT PERIMETER GUARD, RIGHT PERIMETER GUARD, AND FRONT PERIMETER GUARD

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

Check the left perimeter guard, right perimeter guard, front perimeter guard, and perimeter guard bristles for debris, damage, and wear daily.



The bristles should lightly touch the floor. Replace damaged and/or worn bristle assemblies.

## 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 100 hours of operation.

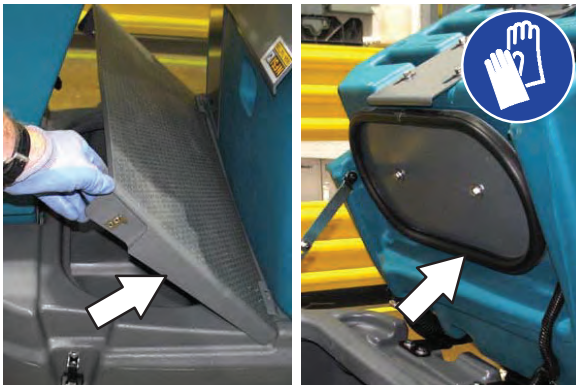


## SOLUTION TANK SEALS

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

There are two solution tank seals. Check the seal for damage and wear after every 100 hours of operation.

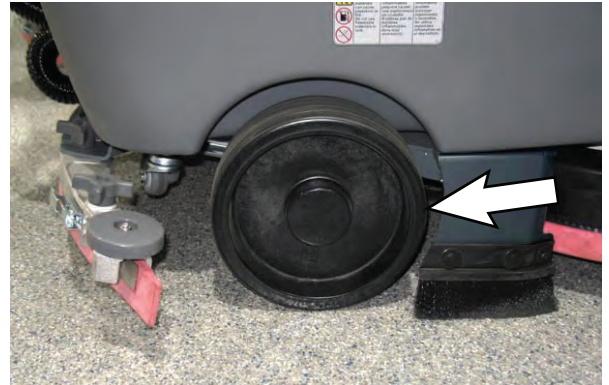
A front seal is located on the bottom of the solution tank cover. A rear seal is located on the bottom of the recovery tank.



## 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 rear squeegee from the machine.
3. 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.**

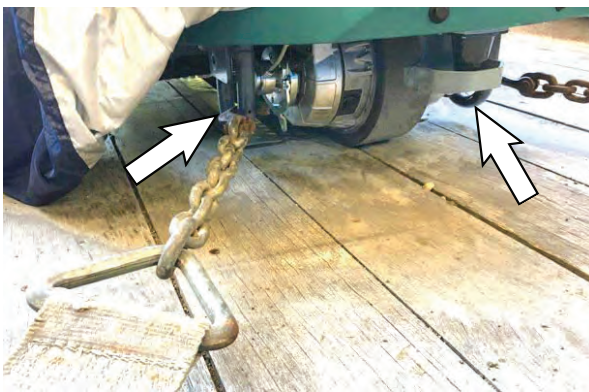
**NOTE:** The machine ability to climb a ramp is affected by tire wear, ramp surface, weather conditions, and other factors. Trailering should only be performed by personnel trained on how to safely load a machine.

4. 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.



5. Lower the scrub head and squeegee after the machine is positioned on the trailer or truck.
6. Turn off the machine.
7. Place a block behind each wheel to prevent the machine from rolling.
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.

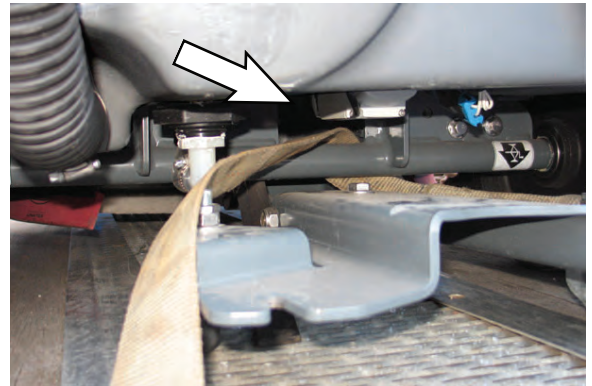
**Do Not** wrap the tie-down straps around the lower LIDAR sensor or route the tie-down straps over the front of the LIDAR sensor.



**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. Route the rear tie-down straps through the opening at the center part of the rear axle and secure the tie-downs to the trailer or truck to prevent the machine from tipping.



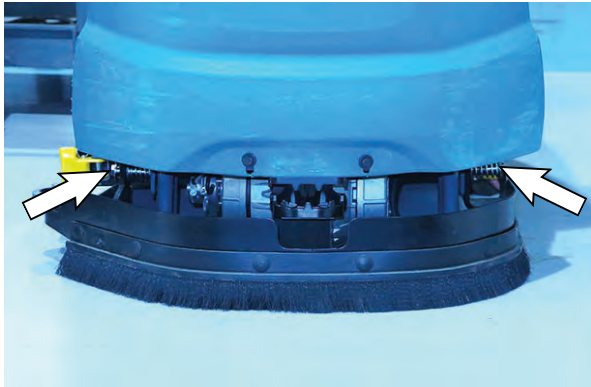
10. Ensure all tie-down straps are fully tightened and machine is completely secure on the trailer or truck.
11. Stow/secure all parts removed from the machine in a safe place where they will not be lost or damaged.

### JACKING UP THE MACHINE

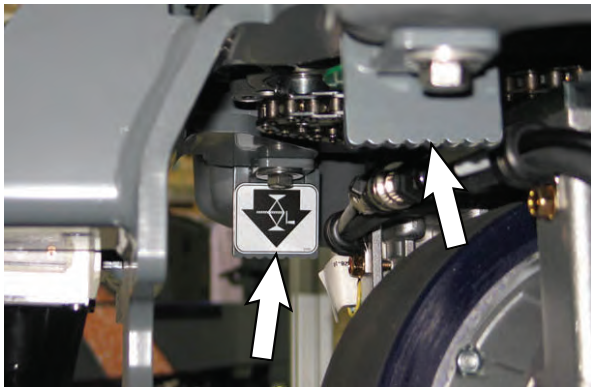
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

Empty the recovery and solution tanks before jacking the machine.

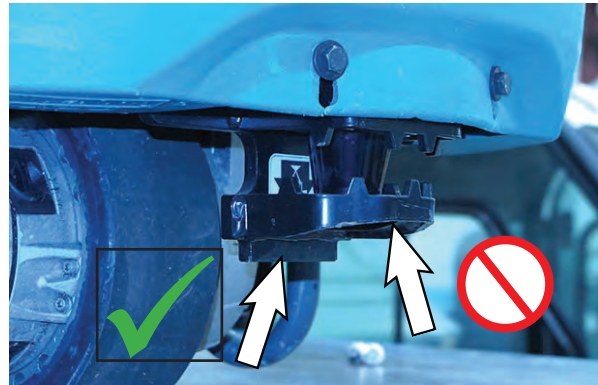
Remove the front perimeter guard from the front perimeter guard brackets located at the front of the machine before jacking up the front end of the machine.



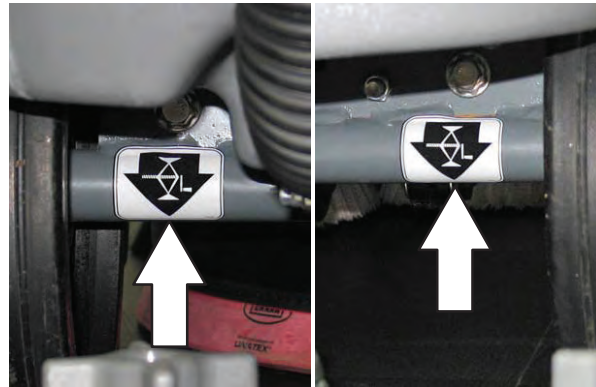
Two front jacking locations are located on the sides of the machine.



A third 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.

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## STORAGE INFORMATION

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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(s) 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              | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 18V (all batteries)</li> <li>• Operator in seat</li> <li>• Propel pedal pressed</li> <li>• E-Stops not engaged</li> <li>• No faults on propel motor output</li> </ul>                                                                                                                                                                                                                                                                                                                                               | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 18V (all batteries)</li> <li>• Operator not in seat</li> <li>• Propel pedal not pressed</li> <li>• E-Stops engaged</li> <li>• Faults on propel motor output</li> </ul>                                                                                                                                                                      |
| Vacuum Fan          | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step or water-pickup enabled</li> <li>• Directional switch set to forward</li> <li>• Vacuum fan continues to operate for a period of time after disabling</li> <li>• Adjusts during scrubbing to maintain down pressure</li> <li>• Recovery tank not full</li> <li>• E-Stops not engaged</li> <li>• No faults on vacuum fan output</li> </ul>                                                        | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step or water-pickup not enabled</li> <li>• Directional switch set to reverse</li> <li>• Vacuum off timer expired</li> <li>• Recovery tank full</li> <li>• E-Stops engaged</li> <li>• Faults on vacuum fan output</li> </ul> |
| Scrub Head Actuator | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step enabled/disabled</li> <li>• Lifts until current limits are reached on power-up and end of scrub</li> <li>• Lowers for fixed time duration at beginning of scrub</li> <li>• Adjusts during scrubbing to maintain down pressure</li> <li>• Solution tank not empty</li> <li>• Recovery tank not full</li> <li>• E-Stops not engaged</li> <li>• No faults on scrub deck actuator output</li> </ul> | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step not enabled</li> <li>• Lifting current limit is reached</li> <li>• Machine scrubbing at desired down pressure target</li> <li>• E-Stops engaged</li> <li>• Faults on scrub deck actuator output</li> </ul>              |

| Function                                       | Enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Squeegee Actuator                              | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step or water pickup is enabled/disabled</li> <li>• Directional switch set to forward</li> <li>• Lifts when directional switch is set to reverse</li> <li>• Lifts until internal limit switch is hit on power-up and at end of 1-Step/water pickup</li> <li>• Lowers until internal limit switch is hit at beginning of 1-Step/water pickup</li> <li>• Recovery tank not full</li> <li>• E-Stops not engaged</li> <li>• No faults on squeegee actuator output</li> </ul> | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step or Water Pickup are not enabled</li> <li>• Will not lower if directional switch is set to reverse</li> <li>• Internal limit switches are hit</li> <li>• Recovery tank full</li> <li>• E-Stops engaged</li> <li>• Faults on squeegee actuator output</li> </ul> |
| Scrub Motor(s)                                 | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step enabled</li> <li>• Scrub deck lowered</li> <li>• Machine is propelling</li> <li>• Solution tank not empty</li> <li>• Recovery tank not full</li> <li>• E-Stops not engaged</li> <li>• No faults on scrub motor output</li> </ul>                                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step disabled</li> <li>• Scrub deck raised/raising</li> <li>• Machine not propelling</li> <li>• Solution tank empty</li> <li>• Recovery tank full</li> <li>• E-Stops engaged</li> <li>• Faults on scrub motor output</li> </ul>                                     |
| Solution Control (Conventional)                | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step enabled</li> <li>• ec-H2O (if equipped) not enabled</li> <li>• Machine is scrubbing</li> <li>• Solution tank not empty</li> <li>• Recovery tank not full</li> <li>• E-Stops not engaged</li> <li>• No faults on water pump output</li> </ul>                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step not enabled</li> <li>• ec-H2O (if equipped) is enabled</li> <li>• Machine not scrubbing</li> <li>• Solution tank empty</li> <li>• Recovery tank full</li> <li>• E-Stops engaged</li> <li>• Faults on water pump output</li> </ul>                              |
| Solution Control (ec-H2O NanoClean - Optional) | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step enabled</li> <li>• ec-H2O enabled</li> <li>• Machine is scrubbing</li> <li>• Solution tank not empty</li> <li>• Recovery tank not full</li> <li>• E-Stops not engaged</li> <li>• No faults on ec-H2O enable output</li> </ul>                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>• 1-Step not enabled</li> <li>• ec-H2O disabled</li> <li>• Machine not scrubbing</li> <li>• Solution tank empty</li> <li>• Recovery tank full</li> <li>• E-Stops engaged</li> <li>• Faults on ec-H2O enable output</li> </ul>                                           |

\* 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 into the Kinetek Control Module if there are issues/errors with the machine configuration software.

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 behind the seat shroud, 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.

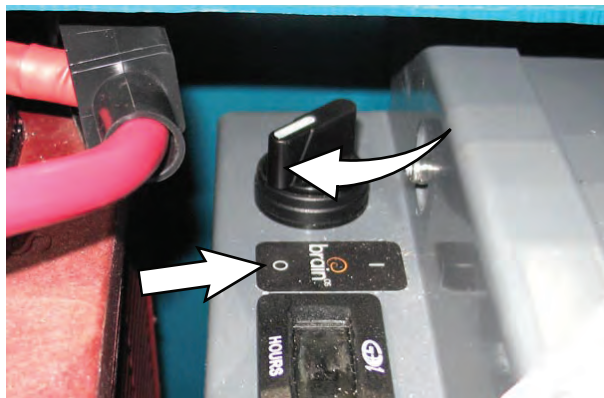
## ISOLATING THE MACHINE FROM THE AMR SYSTEM

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 key switch OFF.
2. Lift and lock the operator seat open to access the hour meter/circuit breaker bracket located at the front of the battery compartment.

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



4. Lower the operator seat.
5. Turn the 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 T7 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.



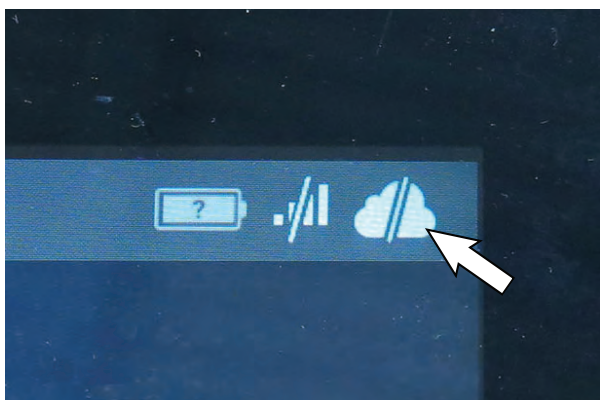
## PREPARE THE MACHINE FOR TROUBLESHOOTING/DIAGNOSTICS/FILE TRANSFERS

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.

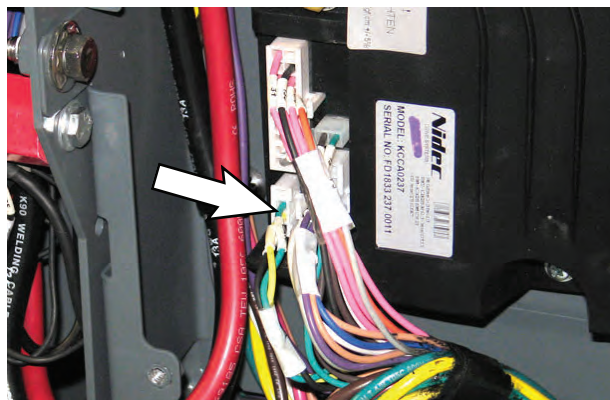
## CHECK THE KINETEK CONTROL MODULE/ MACHINE DIAGNOSTICS

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

1. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/REINSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
2. Remove the controller cover plate from the machine.

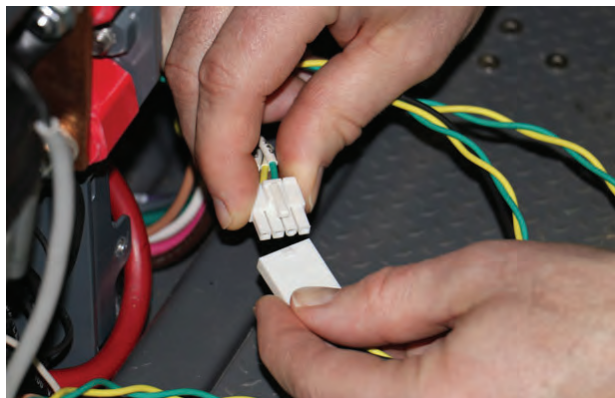


3. Disconnect the main wire harness SCRUB CONTROLLER connector from the Kinetek Control Module P4: CAN/Programming terminal.

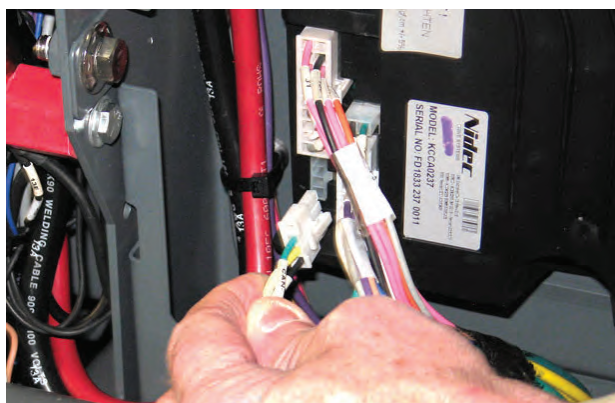


4. Connect the AMR SERVICE CONNECTOR to the service device.

- Connect the AMR Service Connector to the main wire harness SCRUB CONTROLLER connector previously connected to the Kinetek Control Module P4: CAN/Programming terminal.



- Connect the AMR Service Connector to the Kinetek Control Module P4: CAN/Programming terminal where the main wire harness SCRUB CONTROLLER connector was previously connected.



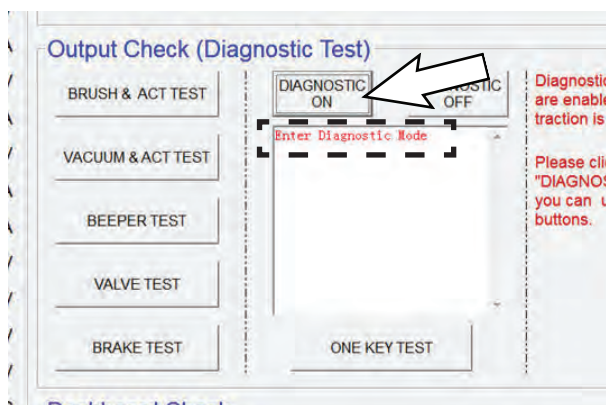
- Remove the front perimeter guard from the machine.
- Chock the rear wheels to prevent the machine from rolling.
- Position a jack under the front jack point at the back of the LIDAR bracket. **Do Not** position the jack at the front of the LIDAR bracket.
- Jack the front end of the machine approximately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

- Turn the key switch ON.
- Insert a jumper between seat switch connector pins 1 and 2 to bypass the seat switch harness.
- Click the desktop icon start menu to open the SERVICE CONNECTION diagnostics software application.
- Check the ERROR VALUES located at the bottom of the Current and Volts column for an error code. See OUTPUT INFORMATION/CURRENT AND VOLTS.

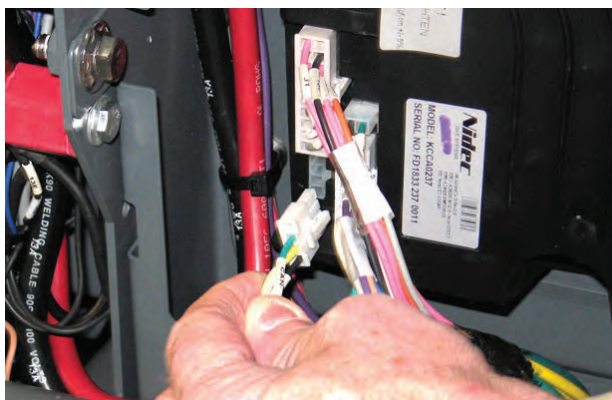
|                  |        |   |
|------------------|--------|---|
| HEATSINK V(Tra): | 25.3   | V |
| HEATSINK V(Oth): | 25.3   | V |
| MCU Temp:        | 24.4   | C |
| MOSFET Temp:     | 24.9   | C |
| VEHICLE STATE    | 0 X 20 |   |
| ERROR VALUE      | 0 X 31 |   |

- Proceed to FAULT CODES for fault codes, fault code conditions, cause(s) for the fault code(s), and corrective actions to be taken.
- 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).



- Observe the diagnostics status box for error codes.
- 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.

19. If further diagnostic testing is required, conduct a dashboard Check. See DASHBOARD CHECK.
20. 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.
21. Disconnect the AMR SERVICE CONNECTOR from the Kinetek controller.
22. Turn the key switch OFF.
23. Reconnect the main wire harness SCRUB CONTROLLER connector to the Kinetek Control Module P4: CAN/Programming terminal.



24. Reinstall the controller cover plate onto the machine.
25. Reinstall the battery box cover and operator seat/ seat plate onto the machine. See REMOVE/ INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
26. 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

**Tennant T16 Diagnostic Tool V1.6**

**CAN Information**  
CAN Startup Successfully

**Controller General Information (Configuration Group: KCGC0237-0028)**  
Firmware Rev 2.30.25 STM32 App Checksum 0xF85D Stu Checksum 0x191A

**Current and Volts**

|                   |        |   |
|-------------------|--------|---|
| TRACT DIRECTION   | FWD    |   |
| TRACT CURRENT     | 0      | A |
| TRACTION VOLTAGE  | 0      | V |
| BRUSH CURRENT     | 0      | A |
| BRUSH VOLTAGE     | -0.4   | V |
| VACUUM CURRENT    | 0      | A |
| VACUUM VOLTAGE    | -0.2   | V |
| SQU ACT CURRENT   | 0      | A |
| SCRUB ACT CURRENT | 0      | A |
| ACCEL VOLTAGE     | 0      | V |
| BATTERY VOLTAGE   | 35.1   | V |
| HEATSINK V(Tra):  | 35     | V |
| HEATSINK V(Oth):  | 34.8   | V |
| MCU Temp:         | 21.7   | C |
| MOSFET Temp:      | 23.6   | C |
| VEHICLE STATE     | 0 X 20 |   |
| ERROR VALUE       | 0 X 0  |   |

**Input Check**

Seat SW Dirty Water SW Clean Water SW Service Pedal Accel Pedal

**Output Check (Diagnostic Test)**

BRUSH & ACT TEST 1 + -

VACUUM & ACT TEST

HORN TEST

PUMP TEST 5 + -

BRAKE TEST

ONE KEY TEST

DIAGNOSTIC ON DIAGNOSTIC OFF

Diagnostic commands are enabled when traction is not running. Please click button "DIAGNOSTIC ON", then you can use the test buttons.

Diagnostic Off Mode use below buttons

RVS Alarm On RVS Alarm Off

ECH2O On ECH2O Off

**Dashboard Check**

BEEPER SW ONE KEY SW SQUEGEE SW VALVE SW PRESSURE SW ECH2O SW

**Output Information**

|                     |   |
|---------------------|---|
| Tract Running       | 0 |
| Tract Open          | 0 |
| Tract Short         | 0 |
| Brush Running       | 0 |
| Brush Open          | 0 |
| Brush Short         | 0 |
| Vacuum Running      | 0 |
| Vacuum Open         | 0 |
| Vacuum Short        | 0 |
| Squ Act Running     | 0 |
| Squ Act Open        | 1 |
| Squ Act Short       | 0 |
| Scrub Act Running   | 0 |
| Scrub Act Open      |   |
| Scrub Act Short     | 0 |
| HM Running          | 0 |
| HM Open             | 1 |
| HM Overload         | 0 |
| Pump Running        | 0 |
| Pump Open           | 0 |
| Pump Overload       | 0 |
| Horn Running        | 0 |
| Horn Open           | 1 |
| Horn Overload       | 0 |
| Brake Running       | 0 |
| Brake Open          | 0 |
| Brake Overload      | 0 |
| Accel SRO           | 0 |
| Scrub Act Direction | 0 |
| Squ Act Direction   | 0 |

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

Tennant T16 Diagnostic Tool V1.6

CAN Information  
CAN Startup Successfully

Controller General Information (Configuration Group: KCGC0237-0028)  
Firmware Rev 2.30.25 STM32 App Checksum 0xF85D Stu Checksum 0x191A

**Current and Volts**

|                   |        |   |
|-------------------|--------|---|
| TRACT DIRECTION   | FWD    |   |
| TRACT CURRENT     | 0      | A |
| TRACTION VOLTAGE  | 0      | V |
| BRUSH CURRENT     | 0      | A |
| BRUSH VOLTAGE     | -0.4   | V |
| VACUUM CURRENT    | 0      | A |
| VACUUM VOLTAGE    | -0.2   | V |
| SQU ACT CURRENT   | 0      | A |
| SCRUB ACT CURRENT | 0      | A |
| ACCEL VOLTAGE     | 0      | V |
| BATTERY VOLTAGE   | 35.1   | V |
| HEATSINK V(Tra):  | 35     | V |
| HEATSINK V(Oth):  | 34.8   | V |
| MCU Temp:         | 21.7   | C |
| MOSFET Temp:      | 23.6   | C |
| VEHICLE STATE     | 0 X 20 |   |
| ERROR VALUE       | 0 X 0  |   |

**Input Check**

Seat SW Dirty Water SW Clean Water SW Service Pedal Accel Pedal

**Output Check (Diagnostic Test)**

BRUSH & ACT TEST 1 + - DIAGNOSTIC ON DIAGNOSTIC OFF

VACUUM & ACT TEST

HORN TEST

PUMP TEST 5 + -

BRAKE TEST ONE KEY TEST

Diagnostic commands are enabled when traction is not running. Please click button "DIAGNOSTIC ON", then you can use the test buttons.

Diagnostic Off Mode use below buttons

RVS Alarm On RVS Alarm Off

ECH2O On ECH2O Off

**Dashboard Check**

BEEPER SW ONE KEY SW SQUEEGEE SW VALVE SW PRESSURE SW ECH2O SW

**Output Information**

|                     |   |
|---------------------|---|
| Tract Running       | 0 |
| Tract Open          | 0 |
| Tract Short         | 0 |
| Brush Running       | 0 |
| Brush Open          | 0 |
| Brush Short         | 0 |
| Vacuum Running      | 0 |
| Vacuum Open         | 0 |
| Vacuum Short        | 0 |
| Squ Act Running     | 0 |
| Squ Act Open        | 1 |
| Squ Act Short       | 0 |
| Scrub Act Running   | 0 |
| Scrub Act Open      | 0 |
| Scrub Act Short     | 0 |
| HM Running          | 0 |
| HM Open             | 1 |
| HM Overload         | 0 |
| Pump Running        | 0 |
| Pump Open           | 0 |
| Pump Overload       | 0 |
| Horn Running        | 0 |
| Horn Open           | 1 |
| Horn Overload       | 0 |
| Brake Running       | 0 |
| Brake Open          | 0 |
| Brake Overload      | 0 |
| Accel SRO           | 0 |
| Scrub Act Direction | 0 |
| Squ Act Direction   | 0 |

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.

CAN Information  
CAN Startup Successfully

Controller General Information (Configuration Group: KCGC0237-0028)  
Firmware Rev 2.30.25 STM32 App Checksum 0xF85D Stu Checksum 0x191A

**Current and Volts**

|                  |      |   |
|------------------|------|---|
| TRACT DIRECTION  | FWD  |   |
| TRACT CURRENT    | 5    | A |
| TRACTION VOLTAGE | 22.3 | V |
| BRUSH CURRENT    | 0    | A |
| BRUSH VOLTAGE    | 0    | V |

**Input Check**

Seat SW

**Output Check (Diagnostic Test)**

BRUSH & ACT TEST 1 + - DIAGNOSTIC ON DIAGNOSTIC OFF

VACUUM & ACT TEST

HORN TEST

PUMP TEST 5 + -

BRAKE TEST ONE KEY TEST

Diagnostic commands are enabled when traction is not running. Please click button "DIAGNOSTIC ON", then you can use the test buttons.

Diagnostic Off Mode use below buttons

RVS Alarm On RVS Alarm Off

ECH2O On ECH2O Off

**Dashboard Check**

BEEPER SW ONE KEY SW SQUEEGEE SW VALVE SW PRESSURE SW ECH2O SW

**Output Information**

|                     |   |
|---------------------|---|
| Tract Running       | 0 |
| Tract Open          | 0 |
| Tract Short         | 0 |
| Brush Running       | 0 |
| Brush Open          | 0 |
| Brush Short         | 0 |
| Vacuum Running      | 0 |
| Vacuum Open         | 0 |
| Vacuum Short        | 0 |
| Squ Act Running     | 0 |
| Squ Act Open        | 1 |
| Squ Act Short       | 0 |
| Scrub Act Running   | 0 |
| Scrub Act Open      | 0 |
| Scrub Act Short     | 0 |
| HM Running          | 0 |
| HM Open             | 1 |
| HM Overload         | 0 |
| Pump Running        | 0 |
| Pump Open           | 0 |
| Pump Overload       | 0 |
| Horn Running        | 0 |
| Horn Open           | 1 |
| Horn Overload       | 0 |
| Brake Running       | 0 |
| Brake Open          | 0 |
| Brake Overload      | 0 |
| Accel SRO           | 0 |
| Scrub Act Direction | 0 |
| Squ Act Direction   | 0 |

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.

CAN Information  
CAN Startup Successfully

Controller General Information (Configuration Group: KCGC0237-0028)  
Firmware Rev 2.30.25 STM32 App Checksum 0xF85D Stu Checksum 0x191A

**Current and Volts**

|                  |      |   |
|------------------|------|---|
| TRACT DIRECTION  | FWD  |   |
| TRACT CURRENT    | 5    | A |
| TRACTION VOLTAGE | 22.3 | V |
| BRUSH CURRENT    | 0    | A |
| BRUSH VOLTAGE    | 0    | V |

**Input Check**

Seat SW

**Output Check (Diagnostic Test)**

BRUSH & ACT TEST 1 + - DIAGNOSTIC ON DIAGNOSTIC OFF

VACUUM & ACT TEST

HORN TEST

PUMP TEST 5 + -

BRAKE TEST ONE KEY TEST

Diagnostic commands are enabled when traction is not running. Please click button "DIAGNOSTIC ON", then you can use the test buttons.

Diagnostic Off Mode use below buttons

RVS Alarm On RVS Alarm Off

ECH2O On ECH2O Off

**Dashboard Check**

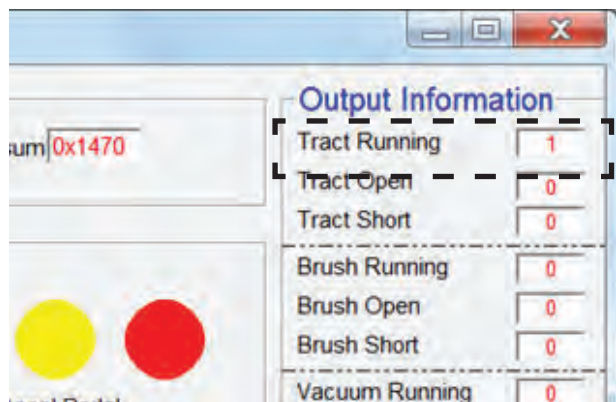
BEEPER SW ONE KEY SW SQUEEGEE SW VALVE SW PRESSURE SW ECH2O SW

**Output Information**

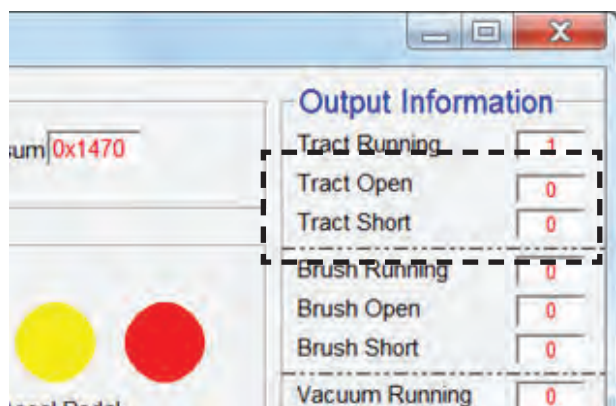
|                     |   |
|---------------------|---|
| Tract Running       | 0 |
| Tract Open          | 0 |
| Tract Short         | 0 |
| Brush Running       | 0 |
| Brush Open          | 0 |
| Brush Short         | 0 |
| Vacuum Running      | 0 |
| Vacuum Open         | 0 |
| Vacuum Short        | 0 |
| Squ Act Running     | 0 |
| Squ Act Open        | 1 |
| Squ Act Short       | 0 |
| Scrub Act Running   | 0 |
| Scrub Act Open      | 0 |
| Scrub Act Short     | 0 |
| HM Running          | 0 |
| HM Open             | 1 |
| HM Overload         | 0 |
| Pump Running        | 0 |
| Pump Open           | 0 |
| Pump Overload       | 0 |
| Horn Running        | 0 |
| Horn Open           | 1 |
| Horn Overload       | 0 |
| Brake Running       | 0 |
| Brake Open          | 0 |
| Brake Overload      | 0 |
| Accel SRO           | 0 |
| Scrub Act Direction | 0 |
| Squ Act Direction   | 0 |

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. Numeral 1 appears in the corresponding cell if the cell is active. Numeral 0 appears in the cell if the cell is inactive. In the below example numeral 1 is in the Tract Running cell, indicating the Tract Running cell is active and there are no faults.



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



## 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          |                                          | 110           | Amps      |
|              | Traction Voltage (Forward)                              | 0             |                                          | 87            | % of VBat |
|              | Traction Voltage (Reverse)                              | 0             |                                          | 56            | % 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                                 |               | 18                                       |               | Volts     |
| Scrub        | Combined Scrub Motor Current (High Down Pressure)       | 38            | 41                                       | 44            | Amps      |
|              | Combined Scrub Motor Current (Medium Down Pressure)     | 28            | 31                                       | 34            | Amps      |
|              | Combined Scrub Motor Current (Low Down Pressure)        | 21            | 24                                       | 27            | Amps      |
|              | Scrub Motor Voltage                                     | 0             |                                          | 22            | Volts     |
|              | Scrub Actuator Current (Lowering)                       | 0             |                                          | 5             | Amps      |
|              | Scrub Actuator Current (Raising)                        | 0             |                                          | 3             | Amps      |
|              | Scrub Actuator Voltage (Lowering)                       | 0             | 9                                        | 9             | Volts     |
|              | Scrub Actuator Voltage (Raising)                        | 0             | 9                                        | 9             | Volts     |
|              | Scrub Actuator Voltage (Adjusting for Down Pressure)    | 3             |                                          | 11            | Volts     |
|              | Scrubbing Disabled Voltage (Propel Only)                |               | 21 FLA/<br>23.1V<br>TPPL/5%<br>SOC Lith. |               | Volts     |
|              | Water Pump (Conventional)                               |               | 24                                       |               | Volts     |
| Water Pickup | ec-H2O Enable (Active)                                  | 0             |                                          |               | Volts     |
|              | ec-H2O Enable (Inactive)                                |               | 12                                       |               | Volts     |
|              | Vacuum Current                                          | 0             |                                          | 42            | Amps      |
|              | Vacuum Voltage                                          | 0             |                                          | 22            | Volts     |
|              | Squeegee Actuator Current (Lowering)                    | 0             |                                          | 7             | Amps      |
|              | Squeegee Actuator Current (Raising)                     | 0             |                                          | 7             | Amps      |
|              | Squeegee Actuator Voltage (Lowering)                    | 0             | 12                                       | 12            | Volts     |
|              | Squeegee Actuator Voltage (Raising)                     | 0             | 12                                       | 12            | Volts     |
|              | Horn Voltage (Active)                                   |               | 24                                       |               | Volts     |
|              | Vehicle State                                           |               | 0x20                                     |               |           |
|              | Error Value (See FAULTS AND ERRORS for all error codes) |               | 0x00                                     |               | No Errors |

## INPUT CHECK/OUTPUT CHECK (DIAGNOSTIC TEST)

Tennant T16 Diagnostic Tool V1.6

CAN Information  
CAN Startup Successfully

Controller General Information (Configuration Group: KCGC0237-0028)  
Firmware Rev 2.30.25 STM32 App Checksum 0xF85D Stu Checksum 0x191A

Current and Volts

|                   |        |
|-------------------|--------|
| TRACT DIRECTION   | FWD    |
| TRACT CURRENT     | 0 A    |
| TRACTION VOLTAGE  | 0 V    |
| BRUSH CURRENT     | 0 A    |
| BRUSH VOLTAGE     | -0.4 V |
| VACUUM CURRENT    | 0 A    |
| VACUUM VOLTAGE    | -0.2 V |
| SQU ACT CURRENT   | 0 A    |
| SCRUB ACT CURRENT | 0 A    |
| ACCEL VOLTAGE     | 0 V    |
| BATTERY VOLTAGE   | 35.1 V |
| HEATSINK V(Tra):  | 35 V   |
| HEATSINK V(Oth):  | 34.8 V |
| MCU Temp:         | 21.7 C |
| MOSFET Temp:      | 23.6 C |
| VEHICLE STATE     | 0 X 20 |
| ERROR VALUE       | 0 X 0  |

Input Check

Seat SW Dirty Water SW Clean Water SW Service Pedal Accel Pedal

Output Check (Diagnostic Test)

BRUSH & ACT TEST 1 + -

VACUUM & ACT TEST

HORN TEST

PUMP TEST 5 + -

BRAKE TEST

ONE KEY TEST

DIAGNOSTIC ON

DIAGNOSTIC OFF

Diagnostic commands are enabled when traction is not running. Please click button "DIAGNOSTIC ON", then you can use the test buttons.

Diagnostic Off Mode use below buttons

RVS Alarm On RVS Alarm Off

ECH2O On ECH2O Off

Dashboard Check

BEEPER SW ONE KEY SW SQUEEGEE SW VALVE SW PRESSURE SW ECH2O SW

Output Information

|                     |   |
|---------------------|---|
| Tract Running       | 0 |
| Tract Open          | 0 |
| Tract Short         | 0 |
| Brush Running       | 0 |
| Brush Open          | 0 |
| Brush Short         | 0 |
| Vacuum Running      | 0 |
| Vacuum Open         | 0 |
| Vacuum Short        | 0 |
| Squ Act Running     | 0 |
| Squ Act Open        | 1 |
| Squ Act Short       | 0 |
| Scrub Act Running   | 0 |
| Scrub Act Open      | 0 |
| Scrub Act Short     | 0 |
| HM Running          | 0 |
| HM Open             | 1 |
| HM Overload         | 0 |
| Pump Running        | 0 |
| Pump Open           | 0 |
| Pump Overload       | 0 |
| Horn Running        | 0 |
| Horn Open           | 1 |
| Horn Overload       | 0 |
| Brake Running       | 0 |
| Brake Open          | 0 |
| Brake Overload      | 0 |
| Accel SRO           | 0 |
| Scrub Act Direction | 0 |
| Squ Act Direction   | 0 |

**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.

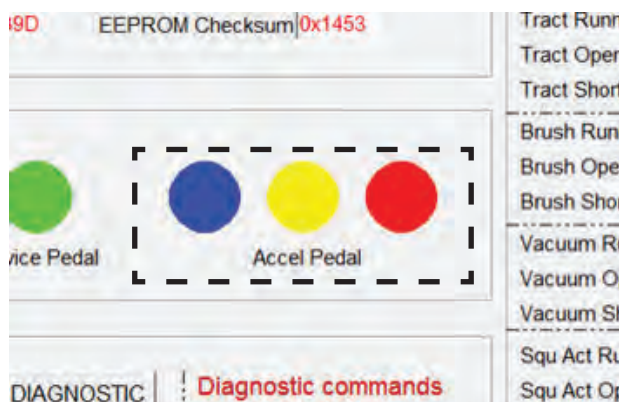
**Seat SW:** The seat switch indicator is green when the seat switch recognizes there is an operator sitting in the operator seat. The indicator is red to indicate there is no operator in the operator seat.

**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.

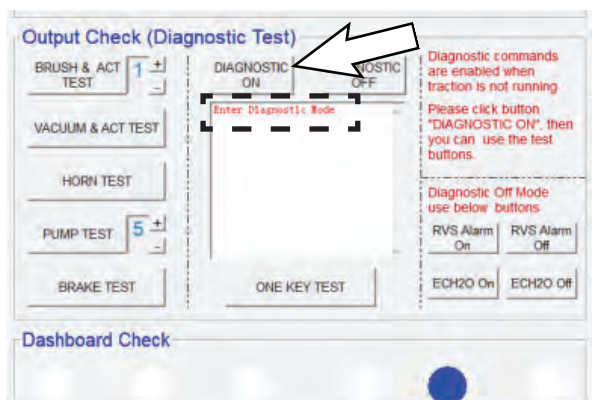
**Clean Water SW.** The Clean Water switch (solution tank) indicator is green when there is solution for cleaning in the solution tank. The indicator is red when the solution tank is empty.

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

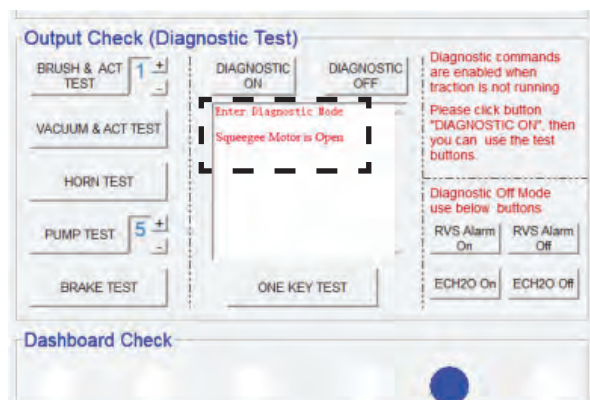
Accel Pedal: The three Accel Pedal (propel pedal) indicators illuminate to indicate low, medium, and high travel speed. The first indicator is blue when the machine is travelling at low speed. The next indicator is yellow when the machine is travelling at medium speed (the blue light low speed indicator 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.

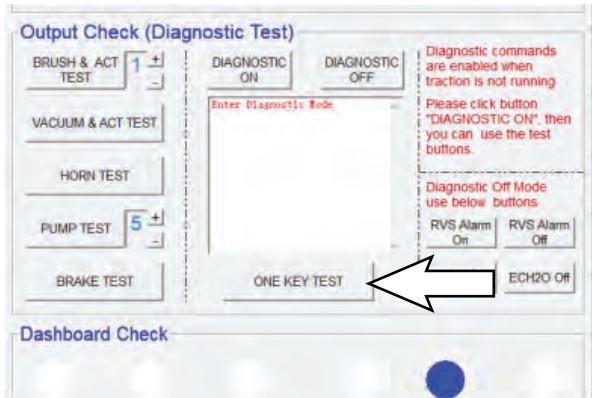
Press the PUMP TEST button to test the solution control system. Use the + button or - button to change the pump activation time (1-5 seconds) if necessary to test pump at different activation times.

Press the BRAKE TEST button to test the service brakes.

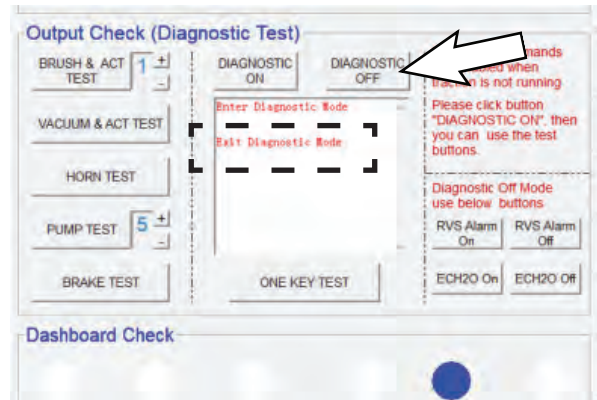
**NOTE:** There is no indicator that the test is completed if no fault is noted in the diagnostic status box. Check the Output Information column to confirm the tests are completed. If all cells in the Output Information column are 0 (zero), then no tests are active.

## TROUBLESHOOTING

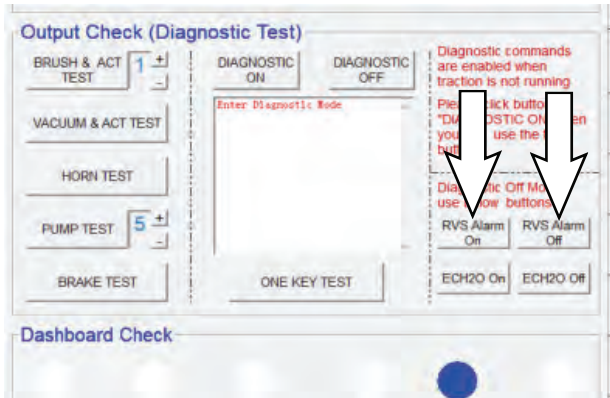
Press the ONE KEY TEST button to test all previously mentioned systems. All systems will briefly activate separately in sequential order after the button is pressed.



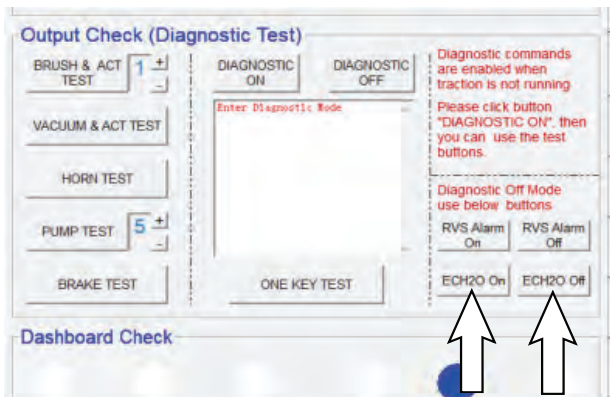
Press the DIAGNOSTICS OFF button when through testing machine diagnostics. Exit Diagnostics Mode will appear in the diagnostics status box.



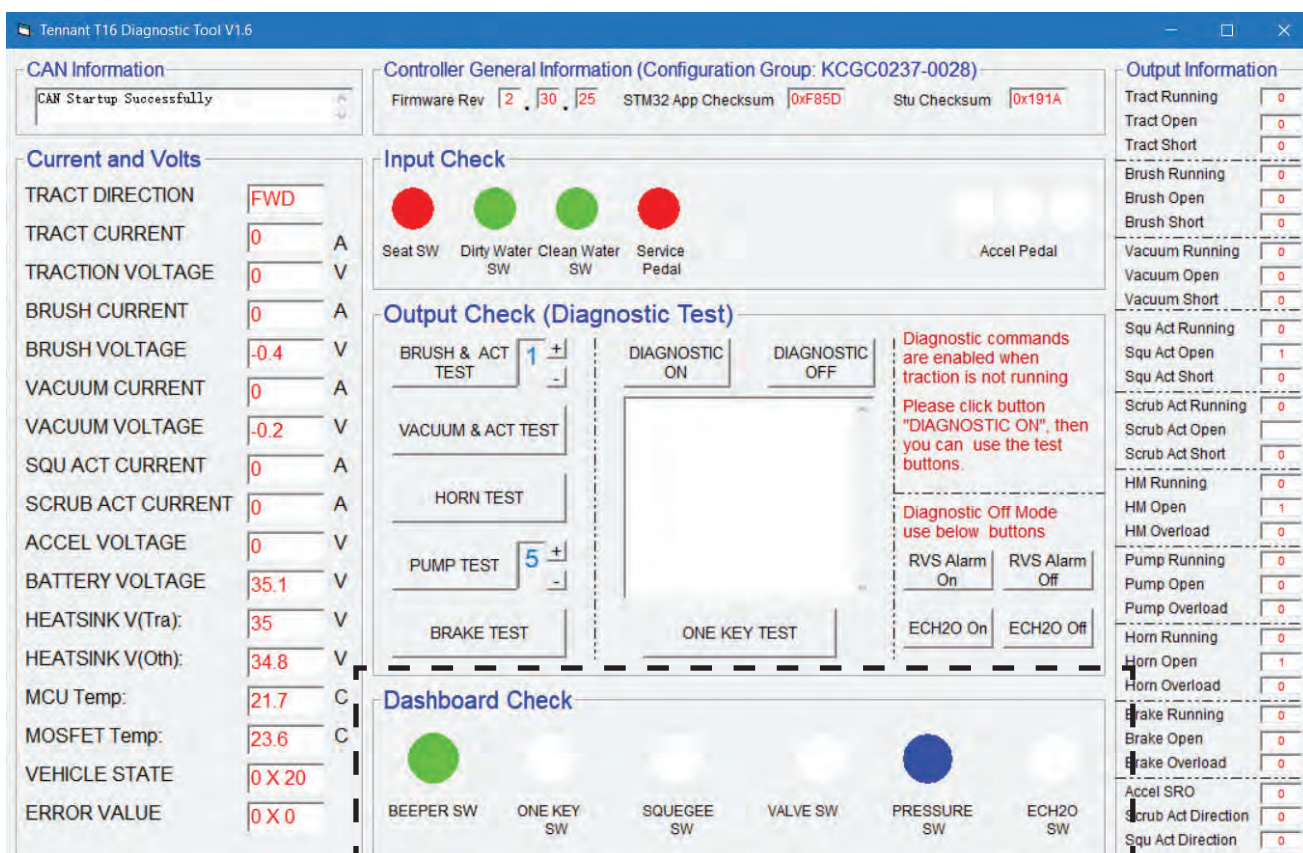
Press the RVS Alarm On button to test the reverse alarm. The reverse alarm will continue to sound until the RVS Alarm Off button is pressed.



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.



## 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.

**SQUEEGEE SW:** When the squeegee is activated the indicator will be green.

**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.<br>2. Controller Problem (EEPROM fault).                                                                    |                                                                                                    |
| 0x17       | E-Stop Active                        | 1. E-Stop button is engaged.                                                                                                                              | 1. Disengage E-Stop button                                                                         |
| 0x1A       | Battery Low<br>(All Functions Off)   | 1. Battery voltage is less than 18V.<br>2. Controller hardware fault.                                                                                     | 1. Charge batteries.<br>2. Power cycle machine.<br>3. Contact Tennant Customer Service Department. |
| 0x21       | Battery Low<br>(Traction Only)       | 1. Battery voltage is less than set parameter value (Class 0 Volt for FLA batteries or Class 1 Volt for TPPL batteries).<br>2. Controller hardware fault. | 1. Charge batteries.<br>2. Power cycle machine.<br>3. Contact Tennant Customer Service Department. |
| 0x23       | MCU Over Temperature                 | 1. Controller is over temperature.                                                                                                                        | 1. Power cycle machine.<br>3. Contact Tennant Customer Service Department.                         |
| 0x26       | Precharge Failure<br>(Traction)      | 1. Wiring problem.<br>2. Controller hardware fault.                                                                                                       | 1. Power cycle machine.<br>2. Contact Tennant Customer Service Department.                         |
| 0x29       | Traction Left Null Error             | 1. Controller firmware fault.<br>2. Controller hardware fault.                                                                                            | 1. Contact Tennant Customer Service Department.                                                    |
| 0x2D       | Brush Null Error                     | 1. Controller firmware fault.<br>2. Controller hardware fault.                                                                                            | 1. Contact Tennant Customer Service Department.                                                    |
| 0x2E       | Vacuum Null Error                    | 1. Controller firmware fault.<br>2. Controller hardware fault.                                                                                            | 1. Contact Tennant Customer Service Department.                                                    |
| 0x2F       | Squeegee Null Error                  | 1. Controller firmware fault.<br>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.<br>2. Power cycle machine.                                               |
| 0x32       | Solenoid Welded<br>(Traction)        | 1. Controller hardware fault.                                                                                                                             | 1. Contact Tennant Customer Service Department.                                                    |
| 0x33       | Solenoid Did Not Close<br>(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.<br>2. Troubleshoot propel pedal/brake pedal sensor.                        |
| 0X3A       | Brake Fault                          | 1. Brake output over current.<br>2. Controller hardware fault.                                                                                            | 1. Power cycle machine.<br>2. Troubleshoot brake circuit.                                          |
| 0X3B       | Alarm Fault                          | 1. Alarm output over current.<br>2. Controller hardware fault.                                                                                            | 1. Power cycle machine.<br>2. Troubleshoot horn circuit.                                           |
| 0X3C       | Aux1 Fault                           | 1. Aux1 output over current.<br>2. Controller hardware fault.                                                                                             | 1. Power cycle machine.<br>2. Troubleshoot hour meter circuit.                                     |
| 0X3D       | Aux2 Fault                           | 1. Aux2 output over current.<br>2. Controller hardware fault.                                                                                             | 1. Power cycle machine.<br>2. Troubleshoot conventional solution valve circuit.                    |
| 0x3F       | Brush Deck Null Error                | 1. Controller firmware fault.<br>2. Controller hardware fault.                                                                                            | 1. Contact Tennant Customer Service Department.                                                    |

| Error Code | Fault Condition                           | Reason                                                                     | Correction                                                                      |
|------------|-------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| 0x42       | Traction Motor Stalled                    | 1. Traction motor stalled.<br>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.<br>2. Troubleshoot propel circuit.                      |
| 0x4C       | Traction Forward Short Circuit Protection | 1. Traction motor short circuit.                                           | 1. Power cycle machine.<br>2. Troubleshoot propel circuit.                      |
| 0x4D       | Brush Over Current Protection             | 1. Brush motor peak current more than 150A.                                | 1. Power cycle machine.<br>2. Troubleshoot scrub motor circuit.                 |
| 0x4E       | Brush Short Circuit Protection            | 1. Brush motor short circuit.                                              | 1. Power cycle machine.<br>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.<br>2. Troubleshoot propel circuit.                      |
| 0x5D       | Traction Forward Over Current Protection  | 1. Traction motor peak current greater than 190A.                          | 1. Power cycle machine.<br>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.<br>2. Troubleshoot scrub head lift/lower circuit.       |
| 0x65       | Vacuum Short Circuit Protection           | 1. Vacuum motor short circuit.                                             | 1. Power cycle machine.<br>2. Troubleshoot vacuum circuit.                      |
| 0x66       | Brush Deck Short Circuit Protection       | 1. Brush deck motor short circuit.                                         | 1. Power cycle machine.<br>2. Troubleshoot scrub head lift/lower circuit.       |
| 0x67       | Squeegee Over Current Protection          | 1. Squeegee motor peak current greater than 9A.                            | 1. Power cycle machine.<br>2. Troubleshoot squeegee lift/lower circuit.         |
| 0x68       | Vacuum Over Current Protection            | 1. Vacuum motor peak current greater than 60A.                             | 1. Power cycle machine.<br>2. Troubleshoot vacuum circuit.                      |
| 0x69       | Squeegee Short Circuit Protection         | 1. Squeegee motor short circuit.                                           | 1. Power cycle machine.<br>2. Troubleshoot squeegee lift/lower circuit.         |
| 0x6A       | Valve Fault                               | 1. Valve output over current.<br>2. Controller hardware fault.             | 1. Power cycle machine.<br>2. Troubleshoot conventional solution valve circuit. |
| 0x6C       | Traction Right Null Error                 | 1. Controller firmware fault.<br>2. Controller hardware fault.             | 1. Contact Tennant Customer Service Department.                                 |
| 0x71       | Trial Timeout                             | 1. Controller set to trial mode and hours exceeded.                        | 1. Power cycle machine.<br>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.<br>2. Parameter "Squeegee Current Limit" set too low.                                                        | 1. Power cycle machine.<br>2. Troubleshoot squeegee lift/lower circuit.    |
| 0x75       | Brush Deck Motor Stalled    | 1. Brush deck motor stalled.<br>2. Parameter "Bru-D Current Limit" set too low.                                                         | 1. Power cycle machine.<br>2. Troubleshoot scrub head lift/lower circuit.  |
| 0x76       | Precharge Failure (Others)  | 1. Wiring problem.<br>2. Controller hardware fault.                                                                                     | 1. Power cycle machine.<br>2. Contact Tennant Customer Service Department. |
| 0x77       | Brush Motor Stalled         | 1. Brush motor stalled.<br>2. Parameter "Brush Current Limit" set too low.                                                              | 1. Power cycle machine.<br>2. Troubleshoot scrub motor circuit.            |
| 0x78       | Vacuum Motor Stalled        | 1. Vacuum motor stalled.<br>2. Parameter "Vacuum Current Limit" set too low.                                                            | 1. Power cycle machine.<br>2. Troubleshoot vacuum circuit.                 |
| 0x79       | Traction Temp Switch        | 1. Traction motor over temperature.                                                                                                     | 1. Power cycle machine.<br>2. Contact Tennant Customer Service Department. |
| 0x7B       | Brush Temp Switch           | 1. Brush motor over temperature.                                                                                                        | 1. Power cycle machine.<br>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.<br>2. Controller heat dissipation not good (installation baseplate, etc...)<br>3. Controller hardware fault. | 1. Power cycle machine.<br>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.<br>2. Parameter "Battery Voltage" set to 0 but battery 36V.<br>3. Controller Hardware fault.       | 1. Power cycle machine.<br>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.                            |

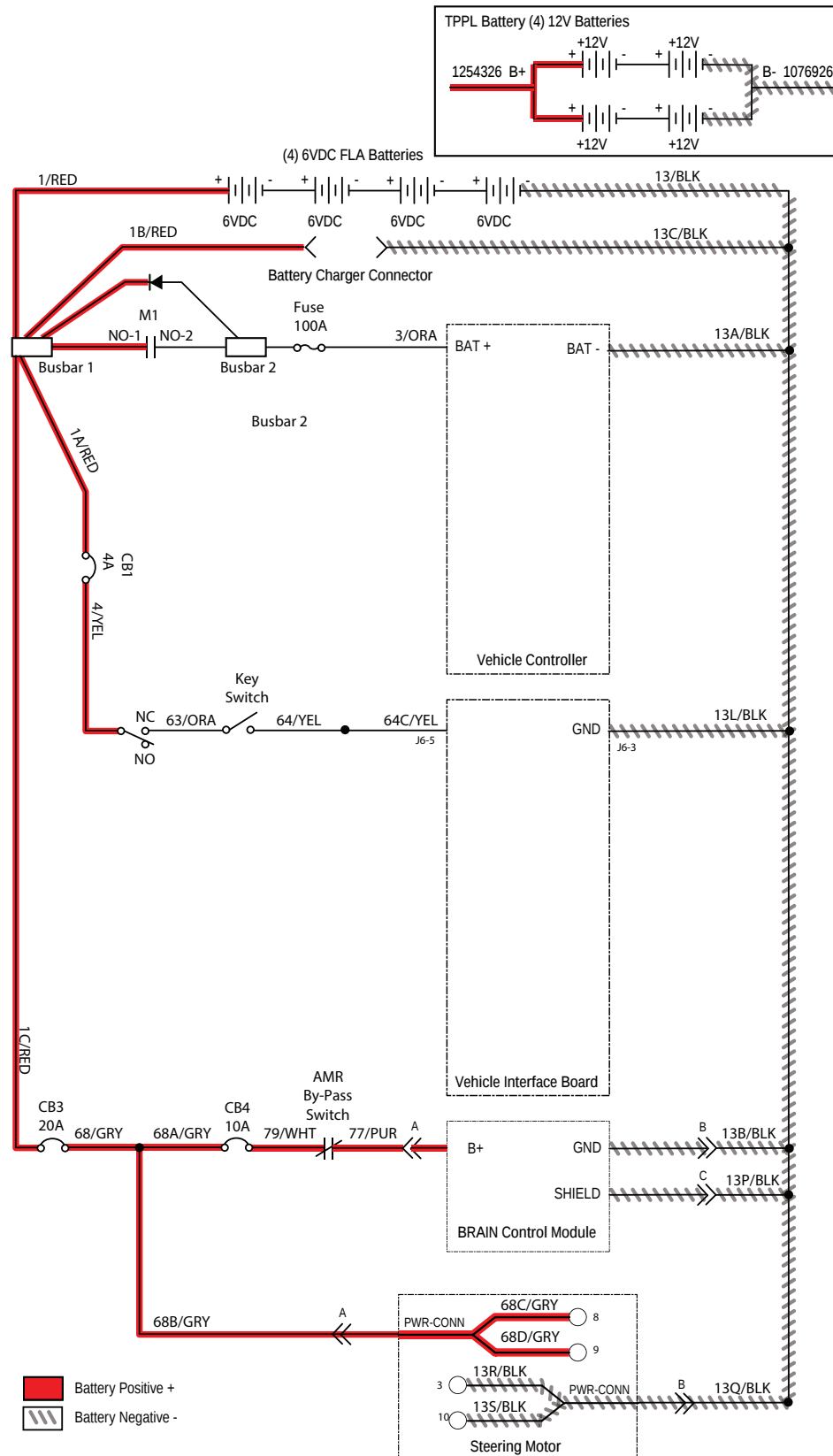
## ec-H2O NANOCLEAN ICON FAULTS



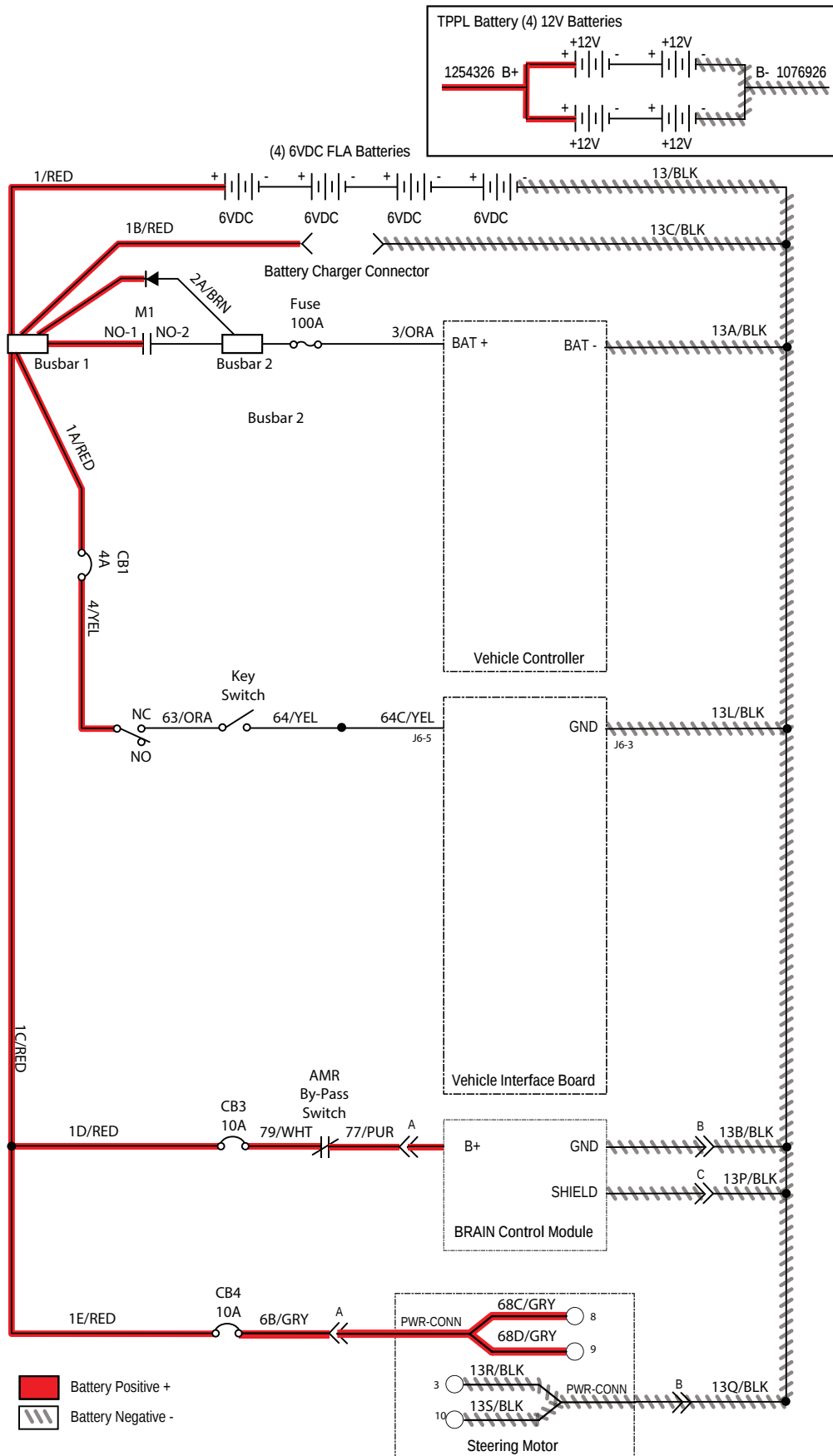
| Machine Indicator | Module Status | Fault Code | Fault Condition                       | Cause                                                                                | Correction                                                                                                       |
|-------------------|---------------|------------|---------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| 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<br>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.<br>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<br>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.<br>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<br>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/<br>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-<br>Green/<br>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.  |

## SYSTEM TROUBLESHOOTING

OFF-BOARD BATTERY CHARGING ON  
NA/APAC S/N (10000000 -10962697)

**OFF-BOARD BATTERY CHARGING ON**  
**NA/APAC S/N (10962698- )**  
**EMEA S/N (10000000- )**



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

| Step | Action                                                                                                                                                                                                                                               | Value(s) | Yes                                              | No                                                             |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------|----------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>• Key OFF</li> <li>• Are batteries disconnected?</li> </ul>                                                                                                                                                   |          | Connect the batteries                            | Proceed to STEP 2                                              |
| 2    | <ul style="list-style-type: none"> <li>• Key OFF</li> <li>• Check AC power supply</li> <li>• Is the rated AC supply voltage present?</li> </ul>                                                                                                      |          | Proceed to STEP 4                                | Check AC supply circuit protection                             |
| 3    | <ul style="list-style-type: none"> <li>• Key OFF</li> <li>• Inspect battery and charger cables for damage/corrosion/contamination/terminal problems</li> </ul>                                                                                       |          | Repair or replace battery/battery charger cables | Proceed to STEP 4                                              |
| 4    | <ul style="list-style-type: none"> <li>• Key OFF</li> <li>• Disconnect batteries</li> <li>• Check water level in all battery cells</li> <li>• Are the lead plates submerged?</li> </ul>                                                              |          | Proceed to STEP 5                                | Add distilled water as necessary until lead plates are covered |
| 5    | <ul style="list-style-type: none"> <li>• Key OFF</li> <li>• Use a hydrometer or refractometer to test specific gravity of each cell (Lead-Acid)</li> <li>• Are all battery cells within 0.050 (50 points) specific gravity of each other?</li> </ul> |          | Replace battery charger                          | Replace battery charger or batteries                           |

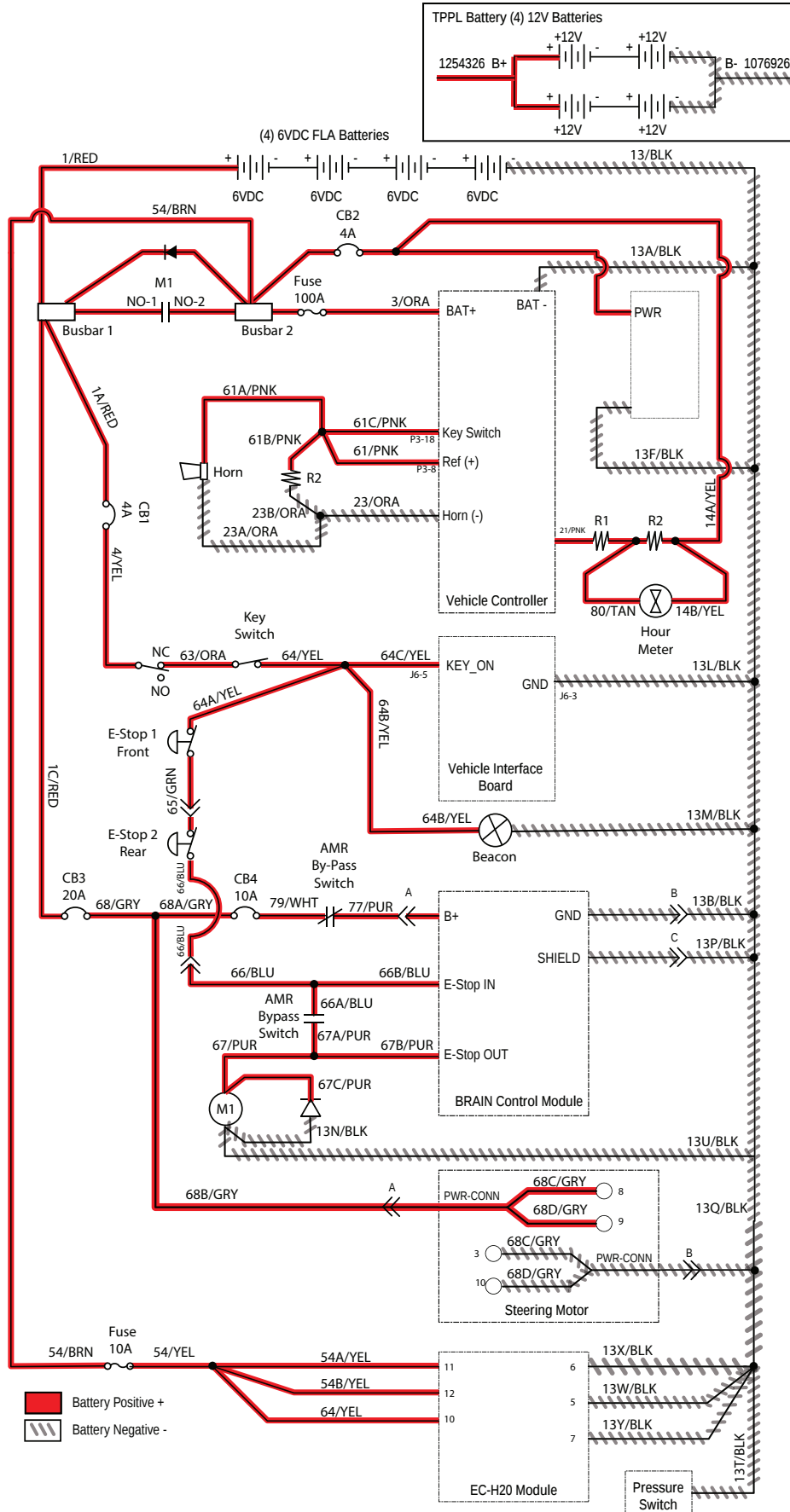
Terms:

AC = Alternating Current

AGM = Absorbed Glass Mat

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

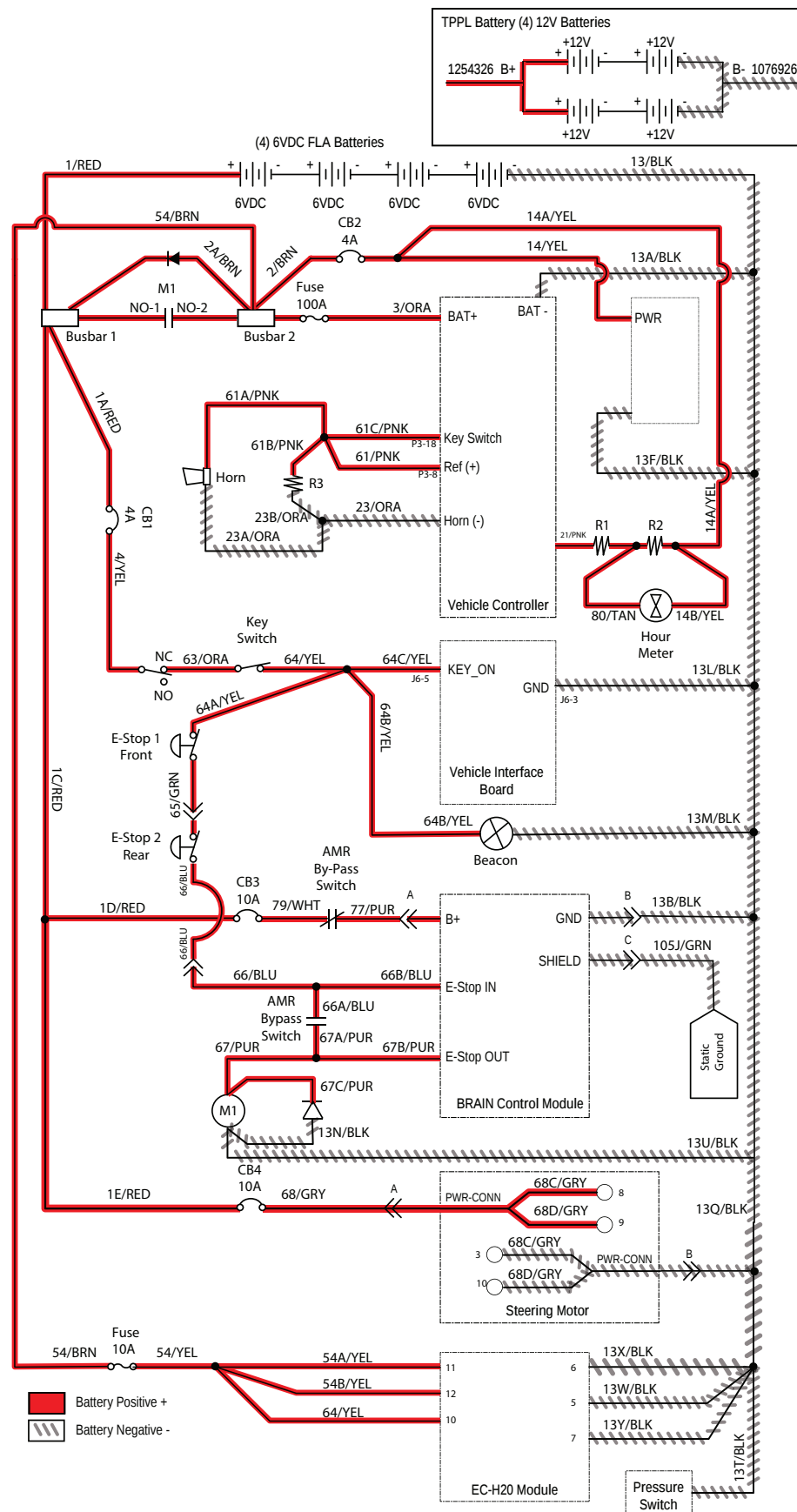
**POWER UP ON**  
**NA/APAC S/N (10000000 -10962697)**



## POWER UP ON

NA/APAC S/N (10962698- )

EMEA S/N (10000000- )



## MACHINE POWER OPERATIONAL MATRIX

| Function | Enabled                                                                                                                                                                                                                   | Disabled                                                                                                                                                                                                                 |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power Up | <ul style="list-style-type: none"> <li>• Key ON (I)</li> <li>• Circuit breaker #1 not tripped</li> <li>• Charger interlock not engaged</li> <li>• Batteries adequately charged/connected to machine/functional</li> </ul> | <ul style="list-style-type: none"> <li>• Key OFF (O)</li> <li>• Circuit breaker #1 tripped</li> <li>• Charger interlock engaged</li> <li>• Batteries fully discharged/not connected to machine/not functional</li> </ul> |

## MACHINE FAILED TO POWER UP

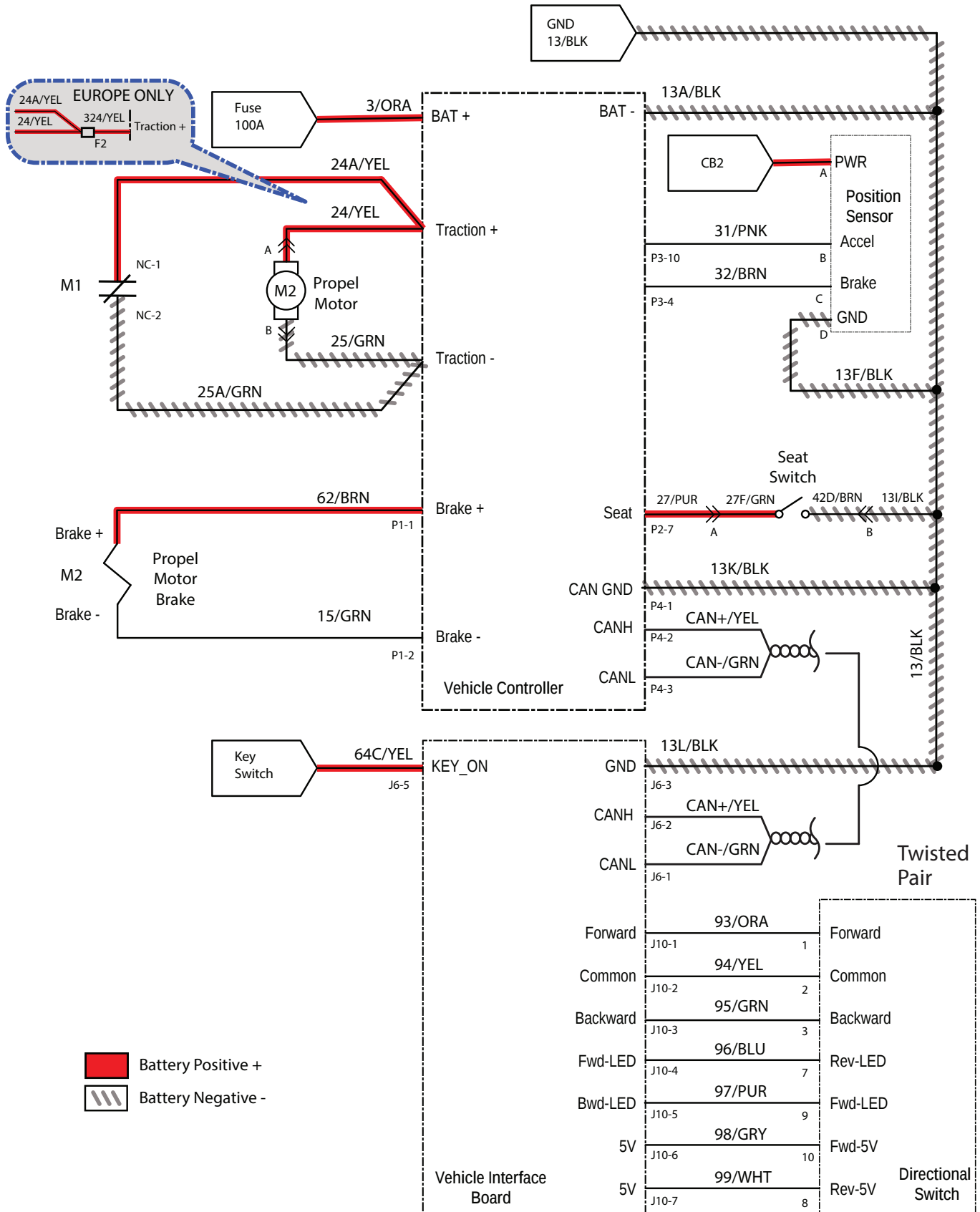
| Step | Action                                                                                                                                                                                                                                                                                      | Value(s) | Yes                                                                | No                                                                        |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• AMR Bypass Switch in "I" (ON) position</li> <li>• Use a voltmeter to test the total battery voltage</li> <li>• Is total battery voltage greater than 23.5 VDC?</li> </ul>                                                        |          | Proceed to STEP 2                                                  | Recharge batteries and test power-up circuit operation                    |
| 2    | <ul style="list-style-type: none"> <li>• Key OFF</li> <li>• AMR Bypass Switch in "I" (ON) position</li> <li>• Firmly press circuit breaker #1 to reset</li> <li>• Is circuit breaker #1 tripped?</li> </ul>                                                                                 |          | Reset and test power-up circuit operation                          | Proceed to STEP 3                                                         |
| 3    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• AMR Bypass Switch in "I" (ON) position</li> <li>• Test voltage applied to power-up subsystem as shown on electrical schematic</li> <li>• Are electrical circuits operating as shown on electrical schematic?</li> </ul>          |          | Repeat STEP 1                                                      | Identify voltage drop location and repair or replace necessary components |
| 4    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• Move the AMR Bypass Switch to "O" (OFF) position</li> <li>• Test voltage applied to power-up subsystem as shown on electrical schematic</li> <li>• Are electrical circuit operating as shown on electrical schematic?</li> </ul> |          | 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 SYSTEM



## PROPEL SYSTEM OPERATIONAL MATRIX

| Enabled                                                                                                                                                                                                   | Disabled                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 18V</li> <li>Operator in seat</li> <li>Propel pedal pressed</li> <li>E-Stops not engaged</li> <li>No faults on propel motor output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 18V</li> <li>Operator not in seat</li> <li>Propel pedal not pressed</li> <li>E-Stops engaged</li> <li>Faults on propel motor output</li> </ul> |

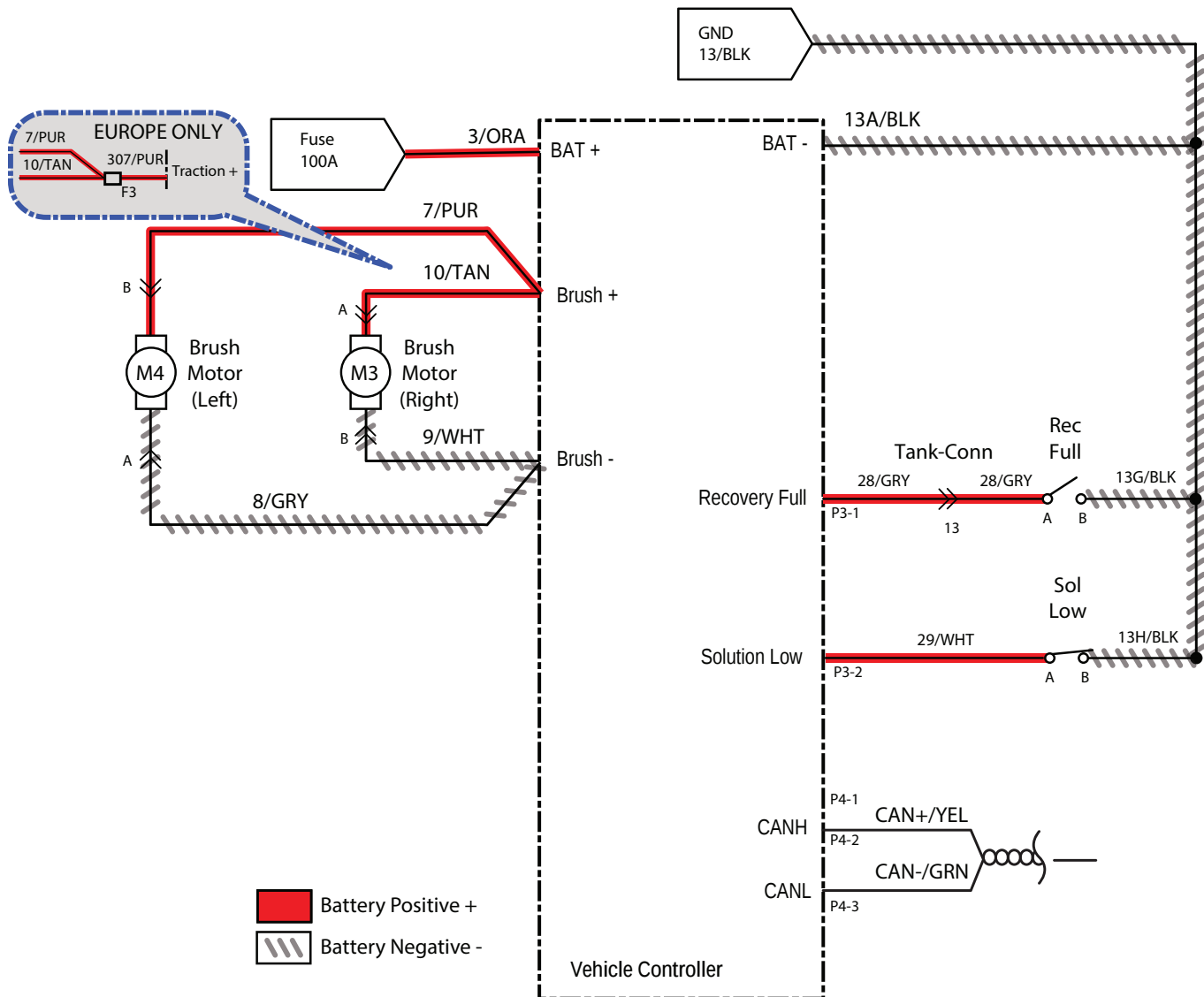
## MACHINE FAILED TO PROPEL

| Step | Action                                                                                                                                                                                                                                                                                                                                | Value(s) | Yes                                                           | No                                                                        |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------|---------------------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Are all interlocks in the proper state to enable manual propel?               <ul style="list-style-type: none"> <li>* Front E-stop not engaged</li> <li>* Rear E-stop not engaged</li> <li>* Operator in seat</li> </ul> </li> </ul>                                         |          | Proceed to STEP 2                                             | Ensure all interlocks are in the proper state to enable manual propel     |
| 2    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Firmly press circuit breaker #1 to reset</li> <li>Is circuit breaker #1 tripped?</li> </ul>                                                                                                                                                                                   |          | Reset and test power-up circuit operation                     | Proceed to STEP 3                                                         |
| 3    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Firmly press circuit breaker #2 to reset</li> <li>Is circuit breaker #2 tripped?</li> </ul>                                                                                                                                                                                   |          | Reset and test power-up circuit operation                     | Proceed to STEP 4                                                         |
| 4    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Use a voltmeter to test the total battery voltage</li> <li>Is total battery voltage greater than 18 VDC?</li> </ul>                                                                                                                                                            |          | Proceed to STEP 5                                             | Recharge batteries and test power-up circuit operation                    |
| 5    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Place machine on blocks so drive wheel is lifted from floor</li> <li>Key ON</li> <li>Enable propel</li> <li>Test voltage applied to propel subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | 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                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step enabled</li> <li>Scrub deck lowered</li> <li>Machine is propelling</li> <li>Solution tank not empty</li> <li>Recovery tank not full</li> <li>E-Stops not engaged</li> <li>No faults on scrub motor output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step disabled</li> <li>Scrub deck raised/raising</li> <li>Machine not propelling</li> <li>Solution tank empty</li> <li>Recovery tank full</li> <li>E-Stops engaged</li> <li>Faults on scrub motor output</li> </ul> |

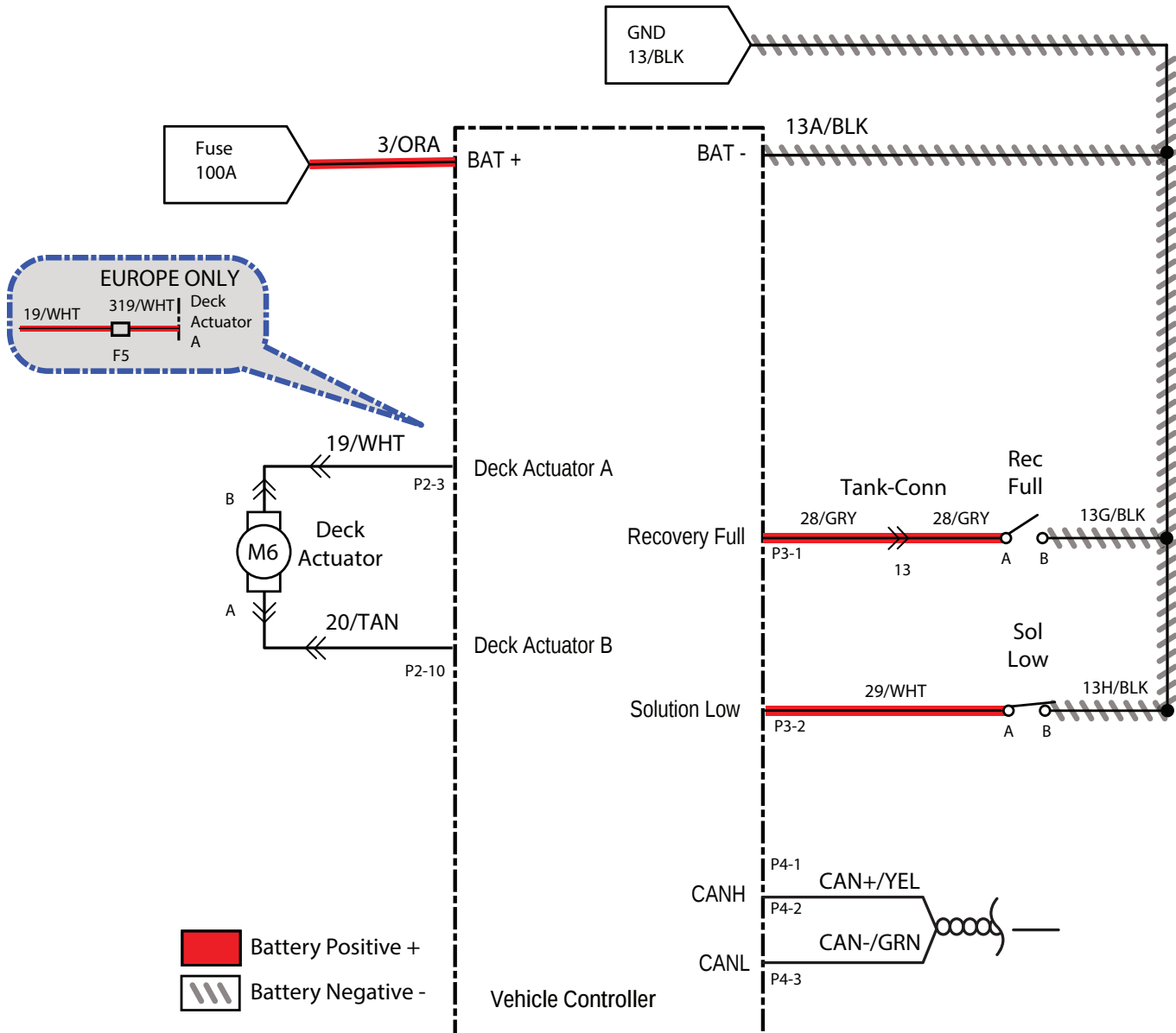
\* SOC = State of Charge

\*\* 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    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable scrub motor</li> <li>Is there a fault on the membrane panel?</li> </ul>                                                                                                                     |          | Use AMR Service Connection to read error code from controller | Proceed to STEP 2                                                         |
| 2    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable scrub motor</li> <li>Test voltage applied to scrub motor subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | Repeat STEP 1                                                 | Identify voltage drop location and repair or replace necessary components |

## SCRUB HEAD LIFT



## SCRUB HEAD ACTUATOR OPERATIONAL MATRIX

| Enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Disabled                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step enabled/disabled</li> <li>Lifts until current limits is reached on power-up and end of scrub</li> <li>Lowers for fixed time duration at beginning of scrub</li> <li>Adjusts during scrubbing to maintain down pressure</li> <li>Solution tank not empty</li> <li>Recovery tank not full</li> <li>E-Stops not engaged</li> <li>No faults on scrub deck actuator output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step not enabled</li> <li>Lifting current limit is reached</li> <li>Machine is scrubbing at desired down pressure target</li> <li>E-Stops engaged</li> <li>Faults on scrub deck actuator output</li> </ul> |

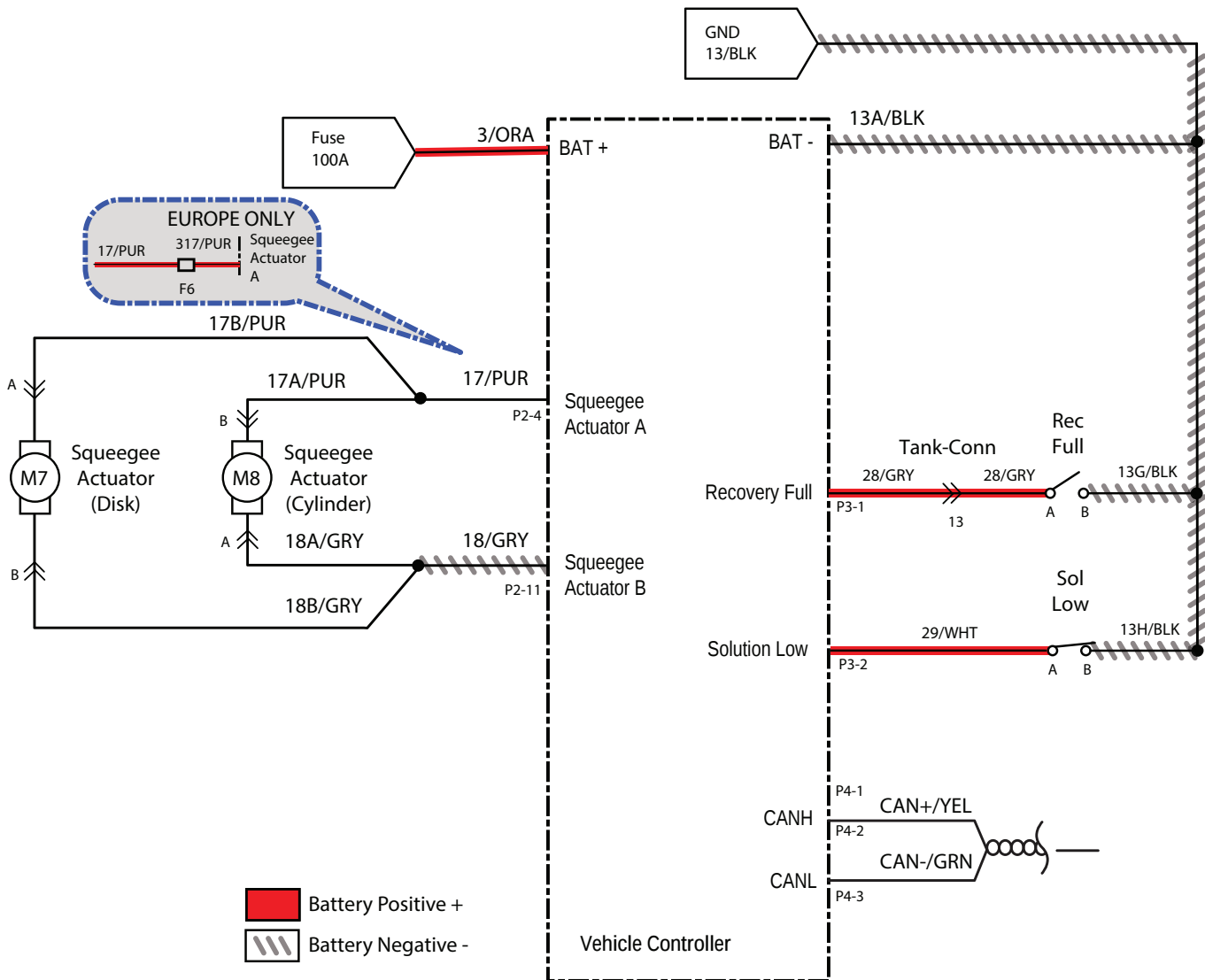
\* SOC = State of Charge

\*\* 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    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable lift actuator</li> <li>Is there a fault on the membrane panel?</li> </ul>                                                                                                                |          | Use AMR Service Connection to read error code from controller | Proceed to STEP 2                                                         |
| 2    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Inspect actuator and lift mechanism</li> <li>Is there anything causing the actuator or lift linkage to bind?</li> </ul>                                                                        |          | Remove anything causing the actuator/ lift linkage to bind    | Proceed to STEP 3                                                         |
| 3    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable scrub motor</li> <li>Test voltage applied to actuator subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | Repeat STEP 1                                                 | Identify voltage drop location and repair or replace necessary components |

## REAR SQUEEGEE LIFT



## REAR SQUEEGEE ACTUATOR OPERATIONAL MATRIX

| Enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Disabled                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step or water-pickup enabled</li> <li>Directional switch set to forward</li> <li>Lifts when directional switch is set to reverse</li> <li>Lifts until internal limit switch is hit on power-up and at end of 1-Step/water pickup</li> <li>Lowers until internal limit switch is hit at beginning of 1-Step/water pickup</li> <li>Recovery tank not full</li> <li>E-Stops not engaged</li> <li>No faults on squeegee actuator output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step or water-pickup not enabled</li> <li>Will not lower if directional switch set to reverse</li> <li>Internal limit switches are hit</li> <li>Recovery tank full</li> <li>E-Stops engaged</li> <li>Faults on squeegee actuator output</li> </ul> |

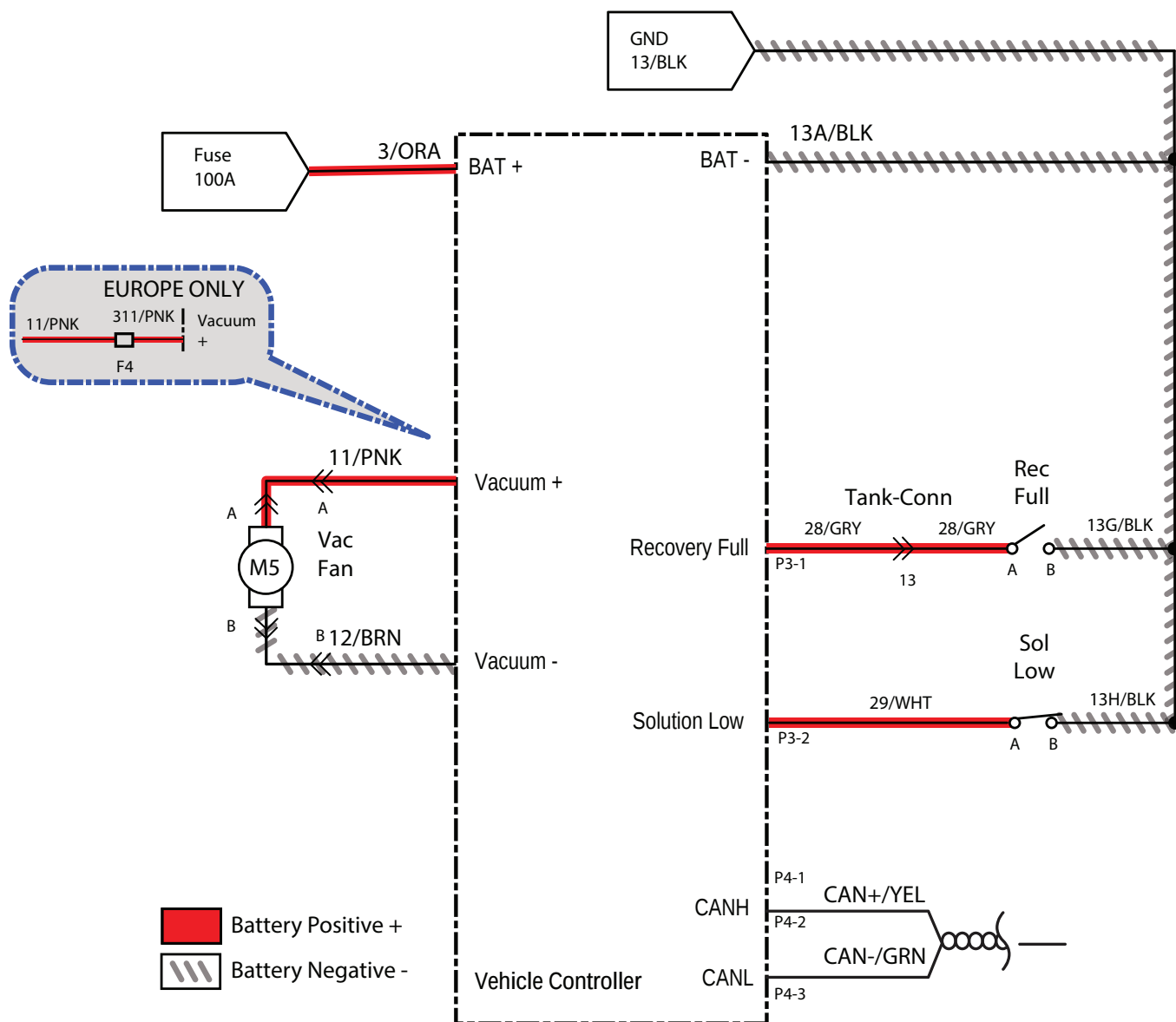
\* SOC = State of Charge

\*\* 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.

## REAR SQUEEGEE FAILED TO LIFT/LOWER

| Step | Action                                                                                                                                                                                                                                                   | Value(s) | Yes                                                           | No                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------|---------------------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable lift actuator</li> <li>Is there a fault on the membrane panel?</li> </ul>                                                                                                                  |          | Use AMR Service Connection to read error code from controller | Proceed to STEP 2                                                         |
| 2    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Inspect actuator and lift mechanism</li> <li>Is there anything causing the actuator or lift linkage to bind?</li> </ul>                                                                          |          | Remove anything causing the actuator/ lift linkage to bind    | Proceed to STEP 3                                                         |
| 3    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable lift actuator</li> <li>Test voltage applied to actuator subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | Repeat STEP 1                                                 | Identify voltage drop location and repair or replace necessary components |

## VACUUM FAN ON



## VACUUM FAN OPERATIONAL MATRIX

| Enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Disabled                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step or water-pickup enabled</li> <li>Direction switch set to forward</li> <li>Vacuum fan continues to operate for a period of time after disabling</li> <li>Adjusts during scrubbing to maintain down pressure</li> <li>Recovery tank not full</li> <li>E-Stops not engaged</li> <li>No faults on vacuum fan output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step or water-pickup not enabled</li> <li>Direction switch set to reverse</li> <li>Vacuum off timer expired</li> <li>Recovery tank full</li> <li>E-Stops engaged</li> <li>Faults on vacuum fan output</li> </ul> |

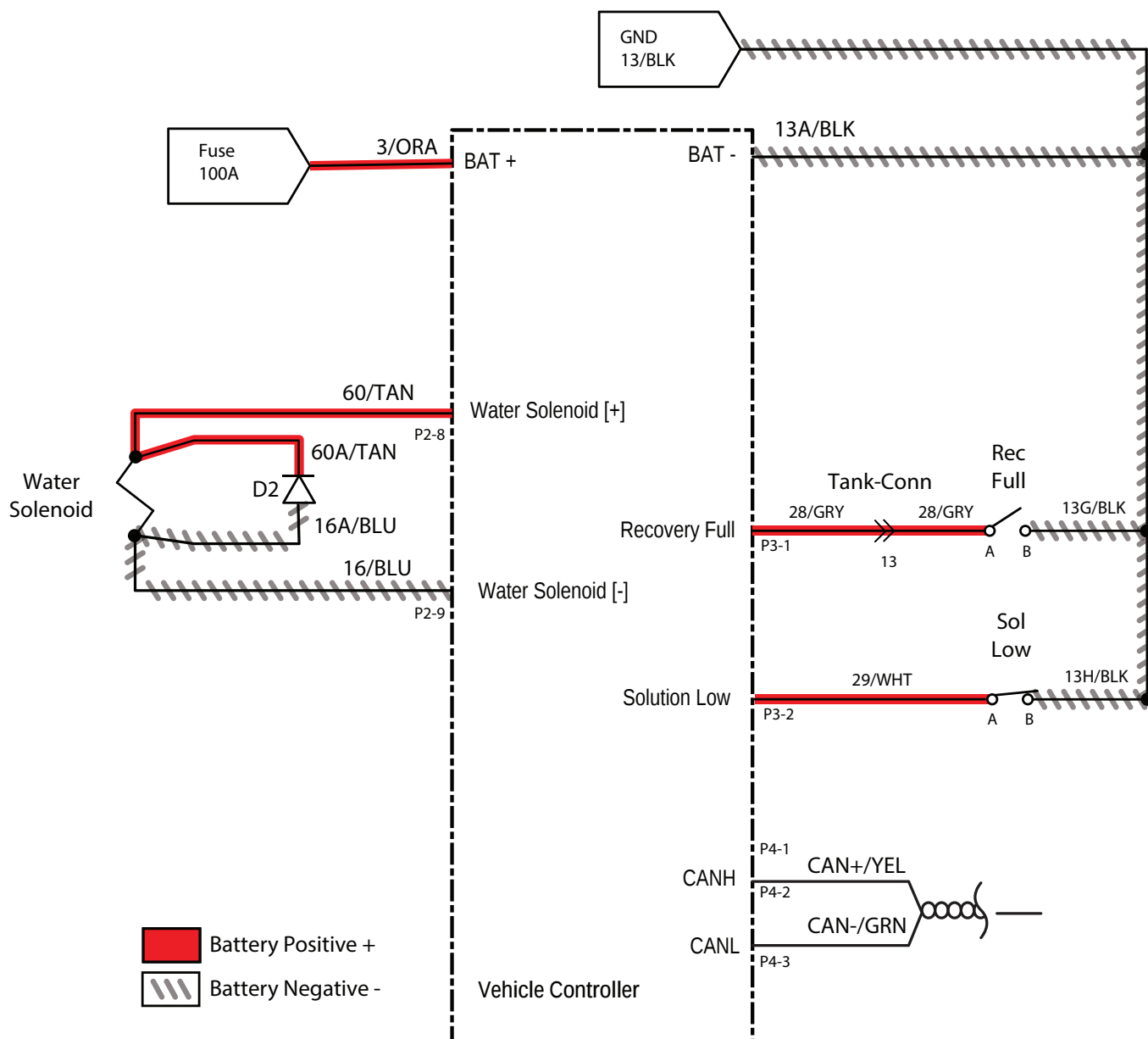
\* SOC = State of Charge

\*\* 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    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable vacuum fan</li> <li>Is there a fault on the membrane panel?</li> </ul>                                                                                                                     |          | Use AMR Service Connection to read error code from controller | Proceed to STEP 2                                                         |
| 2    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable vacuum fan</li> <li>Test voltage applied to scrub motor subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | Repeat STEP 1                                                 | Identify voltage drop location and repair or replace necessary components |

## SOLUTION CONTROL ON (CONVENTIONAL)



## SOLUTION CONTROL OPERATIONAL MATRIX

| Enabled                                                                                                                                                                                                                                                                                                                                                                                                         | Disabled                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step enabled</li> <li>ec-H2O (if equipped) not enabled</li> <li>Machine is scrubbing</li> <li>Solution tank not empty</li> <li>Recovery tank not full</li> <li>E-Stops not engaged</li> <li>No faults on water valve output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step not enabled</li> <li>ec-H2O (if equipped) is enabled</li> <li>Machine not scrubbing</li> <li>Solution tank empty</li> <li>Recovery tank full</li> <li>E-Stops engaged</li> <li>Faults on water valve output</li> </ul> |

\* 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.

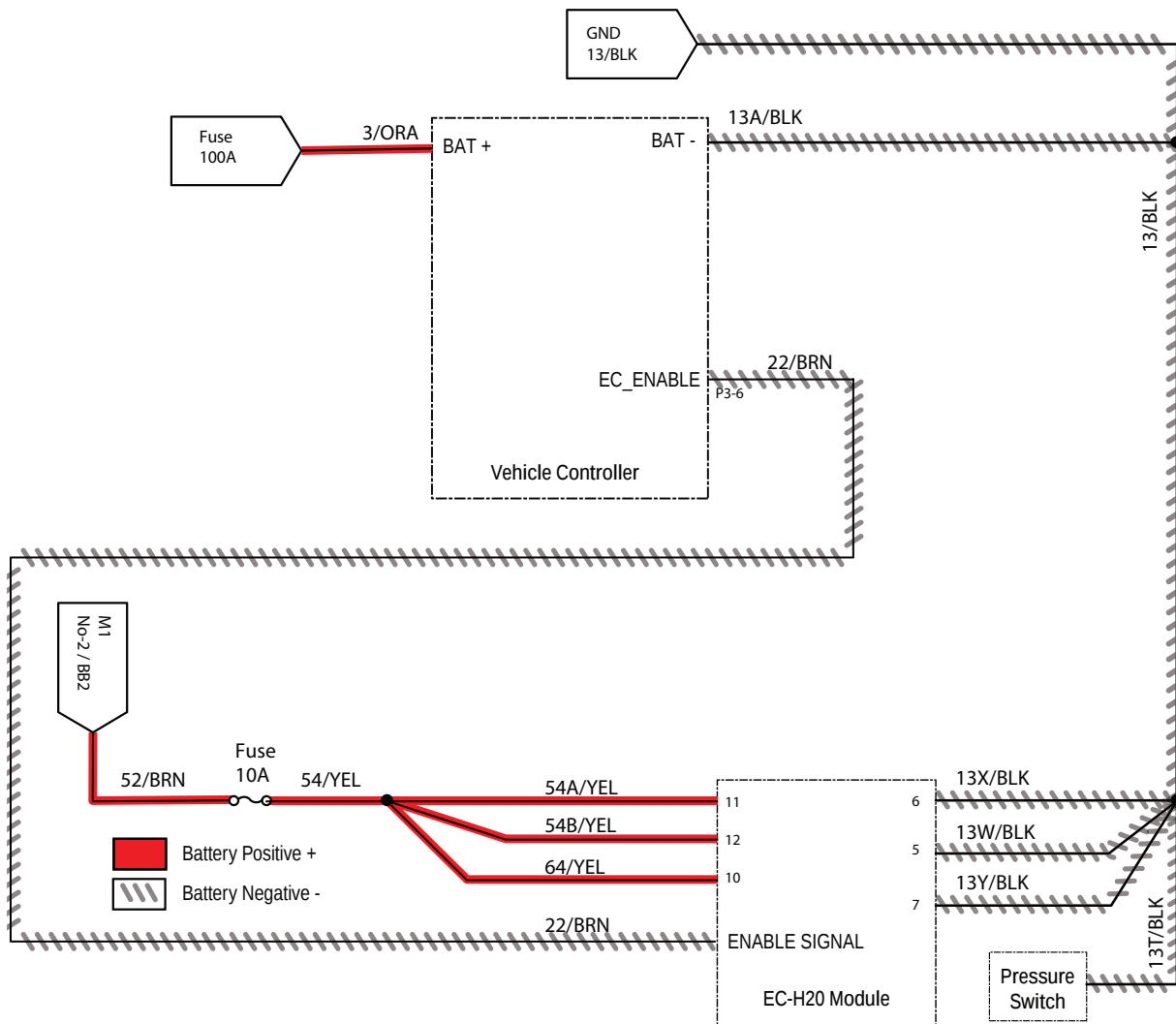
## SOLUTION CONTROL DUTY CYCLE

| SV-2 Level      | On Time % | Period 2.0 SEC       |
|-----------------|-----------|----------------------|
| Off (No LEDs)   | 0%        | 0.0 S On / 2.0 S Off |
| Low (1 LED)     | 50%       | 1.0 S On / 1.0 S Off |
| Medium (2 LEDs) | 78%       | 1.6 S On / 0.4 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    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable solution control (conventional)</li> <li>Is there a fault on the membrane panel?</li> </ul>                                                                                                                                         |          | Use AMR Service Connection to read error code from controller | Proceed to STEP 2                                                         |
| 2    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable solution control (conventional)</li> <li>Test voltage applied to solution control (conventional) subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | 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                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Battery voltage &gt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step enabled</li> <li>ec-H2O enabled</li> <li>Machine is scrubbing</li> <li>Solution tank not empty</li> <li>Recovery tank not full</li> <li>E-Stops not engaged</li> <li>No faults on ec-H2O enable output</li> </ul> | <ul style="list-style-type: none"> <li>Battery voltage &lt; 21V for FLA batteries, or 23.1V for TPPL batteries, or 5% SOC* for lithium batteries (Inventus)**</li> <li>1-Step not enabled</li> <li>ec-H2O disabled</li> <li>Machine not scrubbing</li> <li>Solution tank empty</li> <li>Recovery tank full</li> <li>E-Stops engaged</li> <li>Faults on ec-H2O enable output</li> </ul> |

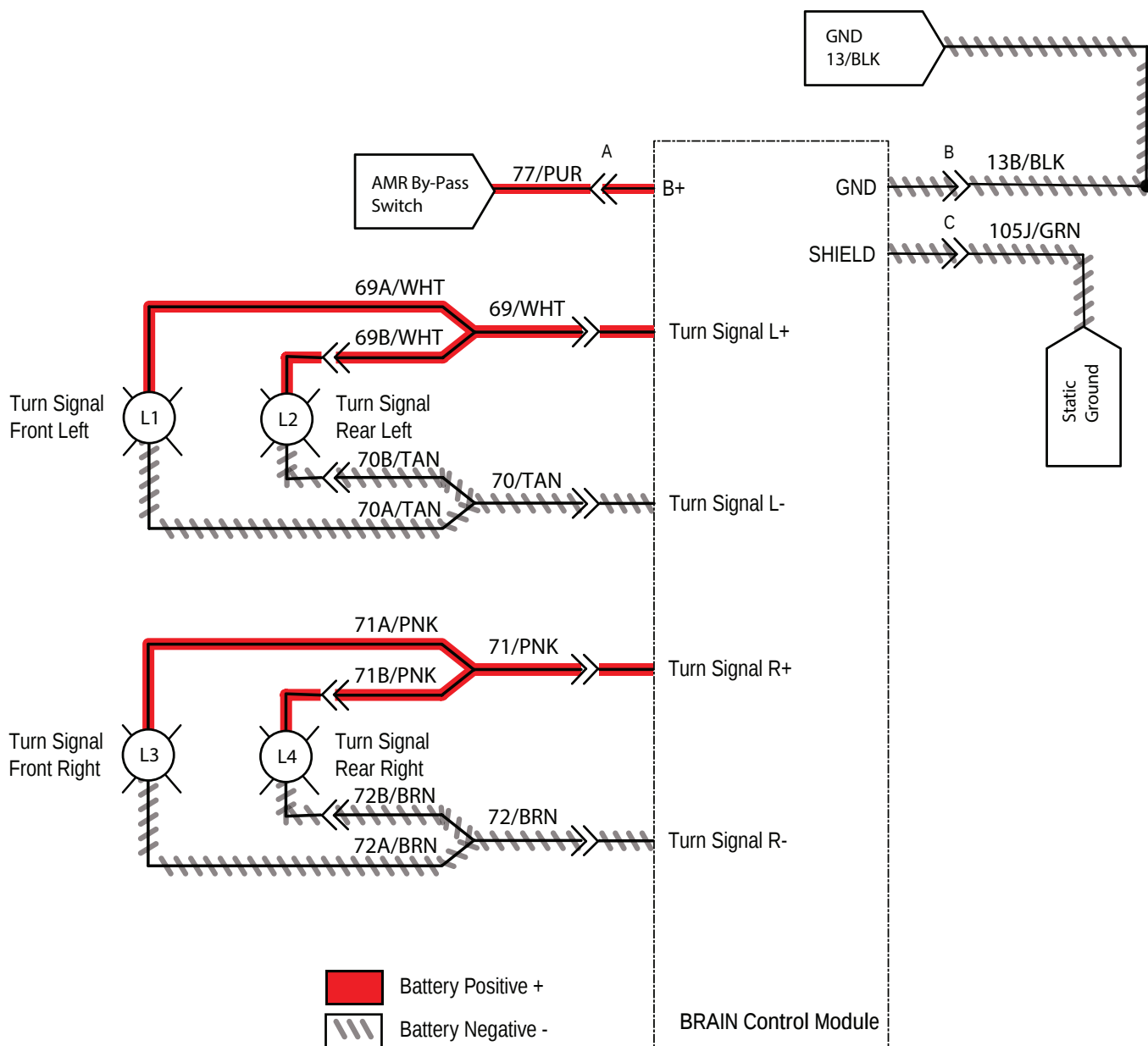
\* SOC = State of Charge

\*\* 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    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable solution control (ec-H2O)</li> <li>Is there a fault on the membrane panel?</li> </ul>                                                                                                                                   |          | Use AMR Service Connection to read error code from controller | Proceed to STEP 2                                                         |
| 2    | <ul style="list-style-type: none"> <li>Key OFF</li> <li>Is the in-line ec-H2O fuse blown?</li> </ul>                                                                                                                                                                                  |          | Replace fuse                                                  | Proceed to STEP 3                                                         |
| 3    | <ul style="list-style-type: none"> <li>Key ON</li> <li>Enable solution control (ec-H2O)</li> <li>Test voltage applied to solution control (ec-H2O) subsystem as shown on electrical schematic</li> <li>Are electrical circuits operating as shown on electrical schematic?</li> </ul> |          | Repeat STEP 1                                                 | Identify voltage drop location and repair or replace necessary components |

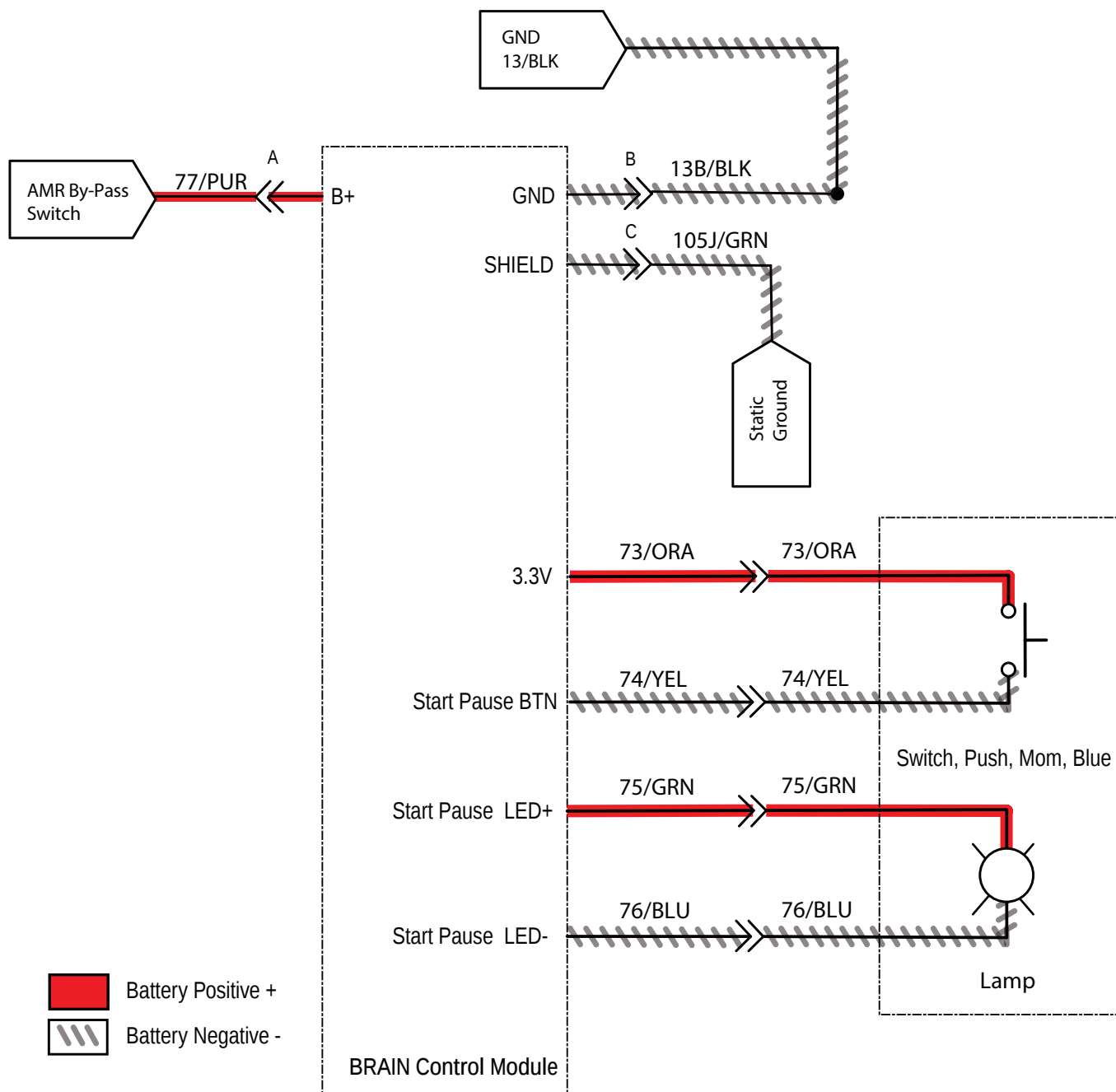
## TURN SIGNALS



## TURN SIGNALS FAIL

| Step | Action                                                                                                                                                                                             | Value(s) | Yes              | No                                                                                                 |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------|----------------------------------------------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• Remove the membrane panel.</li> <li>• Enable LH turn signal.</li> <li>• Disconnect BCM (2-pin connector for LH turn signal).</li> </ul> |          | Check continuity | Identify voltage drop location and repair or replace necessary components<br><br>Proceed to STEP 2 |
| 2    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• Enable RH turn signal</li> <li>• Disconnect BCM (2-pin connector for RH turn signal).</li> </ul>                                        |          | Check continuity | Identify voltage drop location and repair or replace necessary components                          |

## START/PAUSE SWITCH



**START/PAUSE SWITCH FAIL TO OPERATE  
(NON-WALMART ONLY)**

| Step | Action                                                                                                                                                                                                                                                                                                 | Value(s) | Yes              | No                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------|---------------------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• Remove front shroud</li> <li>• Locate BCM (4-pin connector that contains both the start/pause LED and the start/pause switch signal.</li> <li>• Disconnect one spade terminal at switch-side to remove the led from the circuit.</li> </ul> |          | Check continuity | Identify voltage drop location and repair or replace necessary components |

**START/PAUSE SWITCH FAIL TO OPERATE  
WALMART MACHINES**

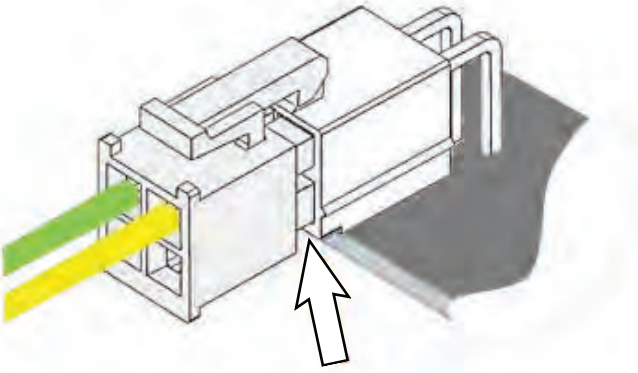
| Step | Action                                                                                                                                                                                                                                                 | Value(s) | Yes                                                                                                 | No                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1    | <ul style="list-style-type: none"> <li>• Key ON</li> <li>• Remove front shroud</li> <li>• Locate BCM (4-pin connector that contains both the start/pause LED and the start/pause switch signal.</li> <li>• Leave switch terminals connected</li> </ul> |          | Check continuity (There should be continuity when button is pressed, and open/OL when not pressed). | Identify voltage drop location and repair or replace necessary components |

## CAN OPEN NETWORK ISSUES

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

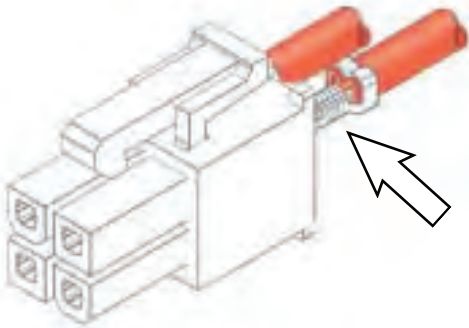
### CONNECTOR FULLY SEATED

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

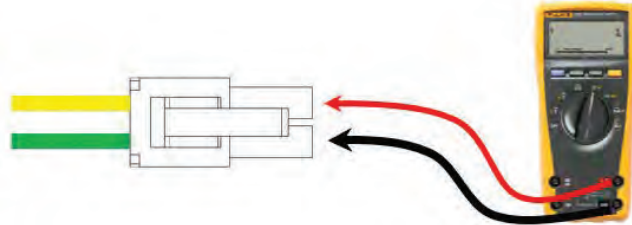
A pin within the harness side of the connector may not be fully seated or may come loose over time causing a fault. If the pin is not fully seated, push it back in and power cycle the machine to see if the fault clears.



## NETWORK RESISTANCE

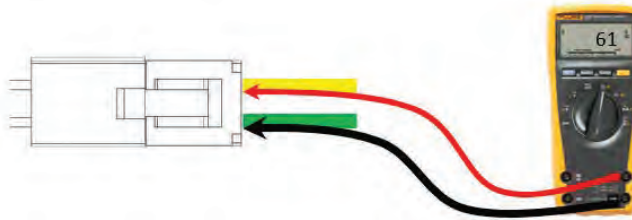
The network resistance must be correct for the network to operate correctly. Depending on which node the measurement is taken at and the method of measurement, the resistance may be one of two values: 121Ω or 61Ω. Any value other than these two means something is wrong with the network.

### 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



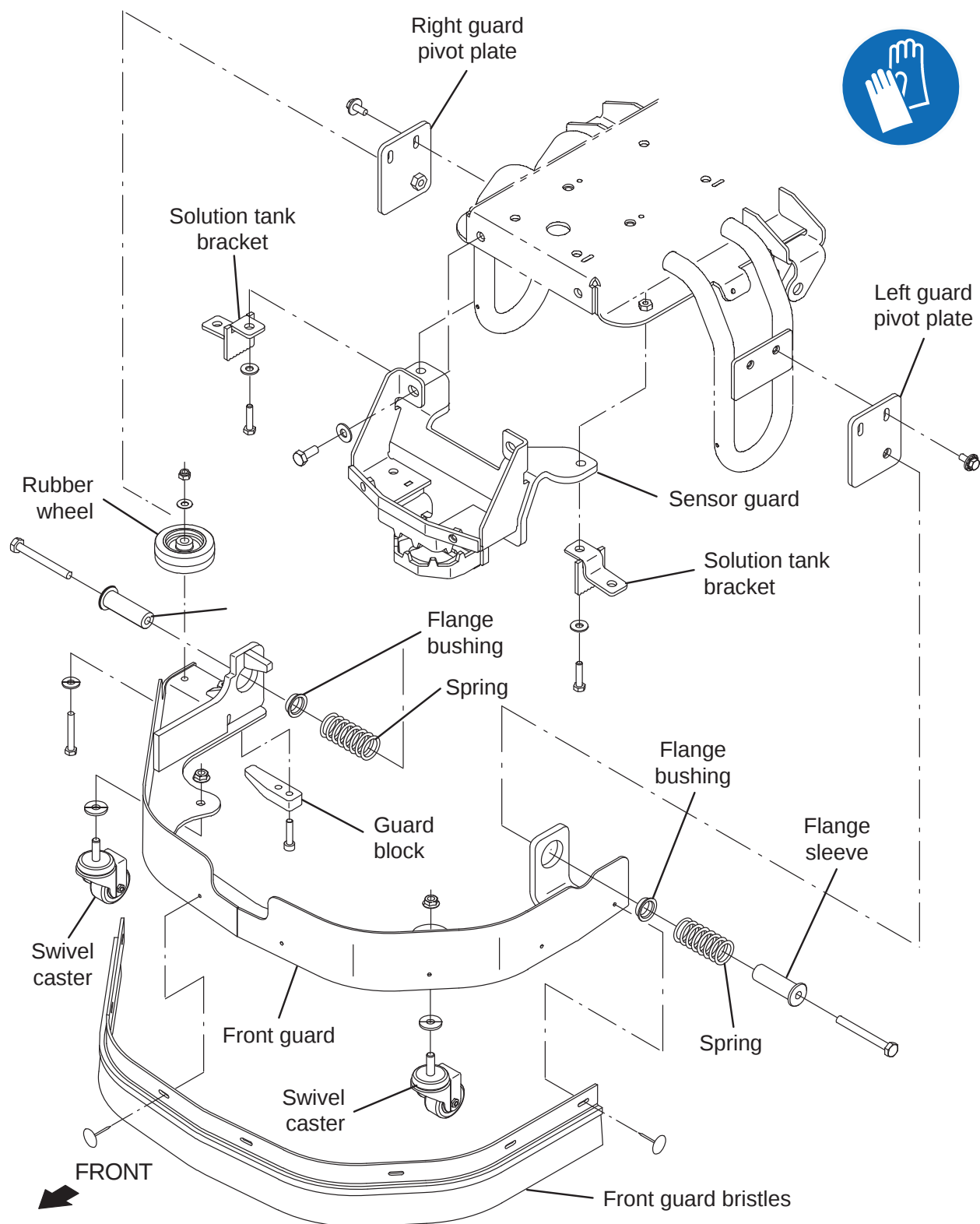
1. Turn off the machine.
2. Locate a CAN node location on the machine.
3. Carefully push probes into the back of the connector containing the CAN wires.
4. Since the network remains connected in this node, resistance should measure approximately 61Ω.



## SERVICE

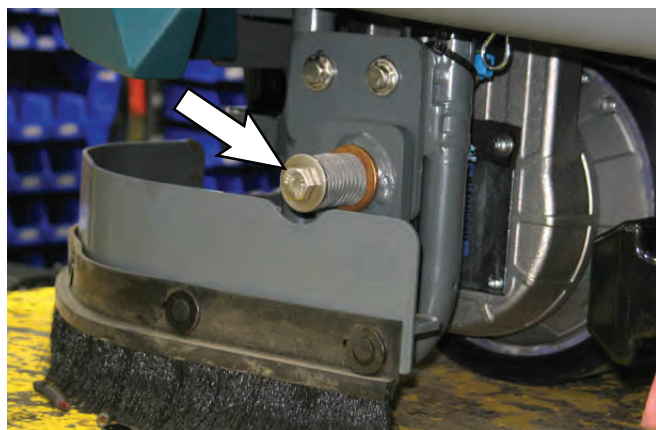
COVERS/SHROUDS/SUPPORT BRACKET/  
OPERATOR SEAT/CHASSIS

## 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 ON/OFF key switch OFF.
3. Remove all hardware (hex screws, springs, flat washers, and pins) securing the support bracket to the mounting bracket installed on the stabilizer located on the front left side of the machine.

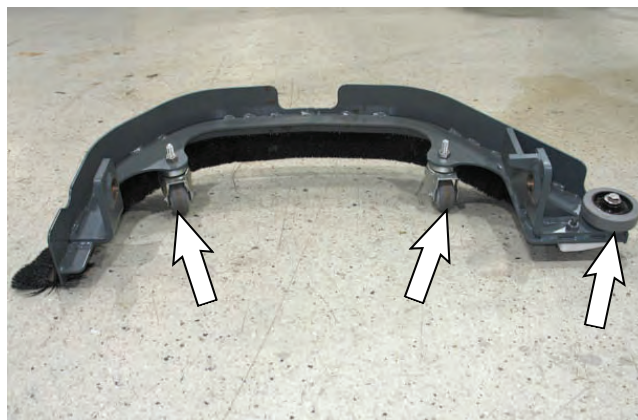


4. Remove all hardware (hex screws, springs, flat washers, and pins) securing the support bracket to the mounting bracket installed on the stabilizer located on the front right side of the machine.



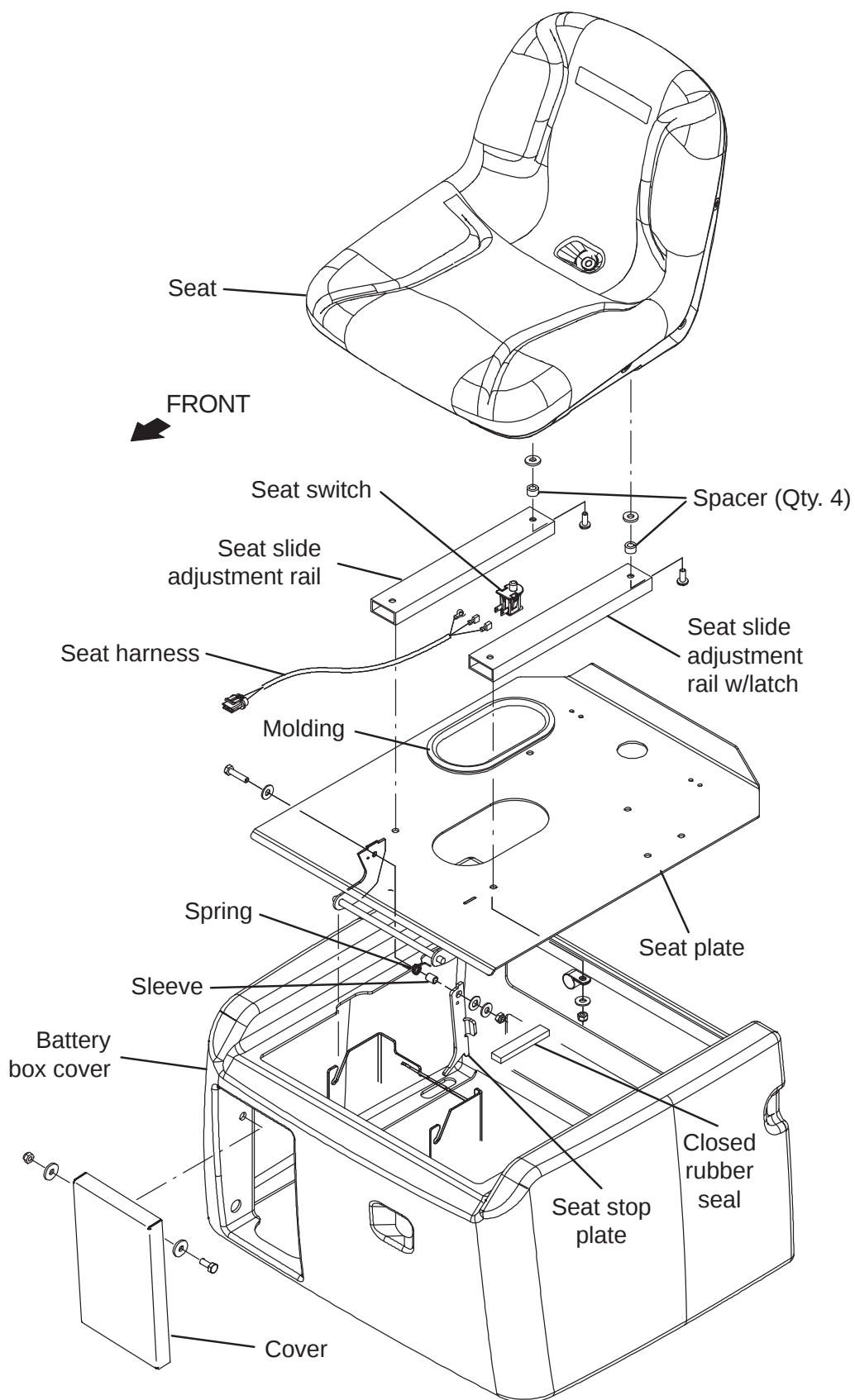
5. Pull the support bracket assembly from under the machine.

6. If replacing the support bracket assembly, remove both caster wheels and the bumper wheel from the support bracket assembly.



7. Install the caster wheels and the bumper wheel 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.

REMOVE/REINSTALL OPERATOR SEAT/BATTERY  
BOX COVER



**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 ON/OFF key switch OFF.
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 main wire harness from the operator seat switch harness.



5. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



6. Remove the operator seat/seat plate from the machine.

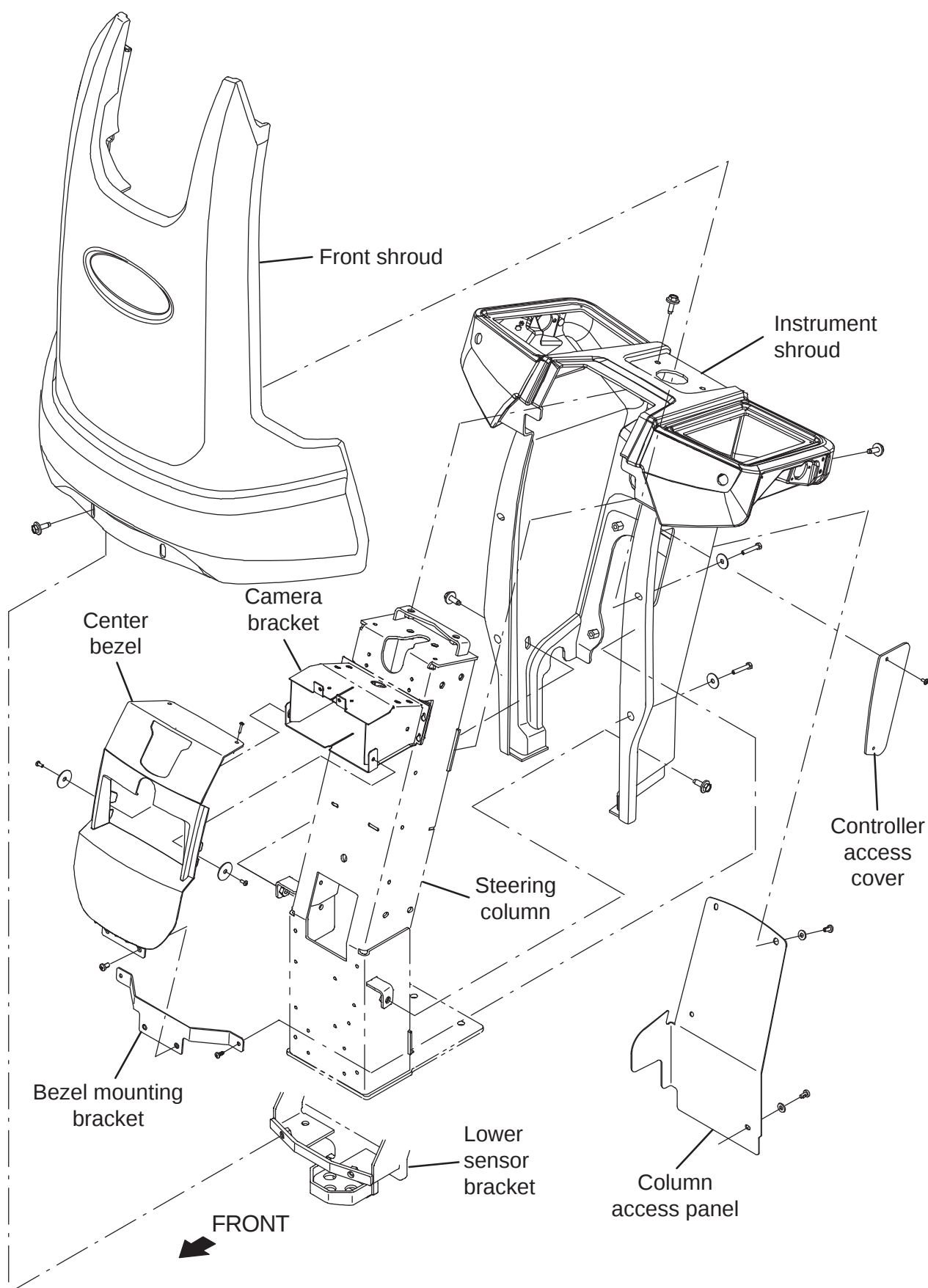


7. Remove the battery box cover from the machine.

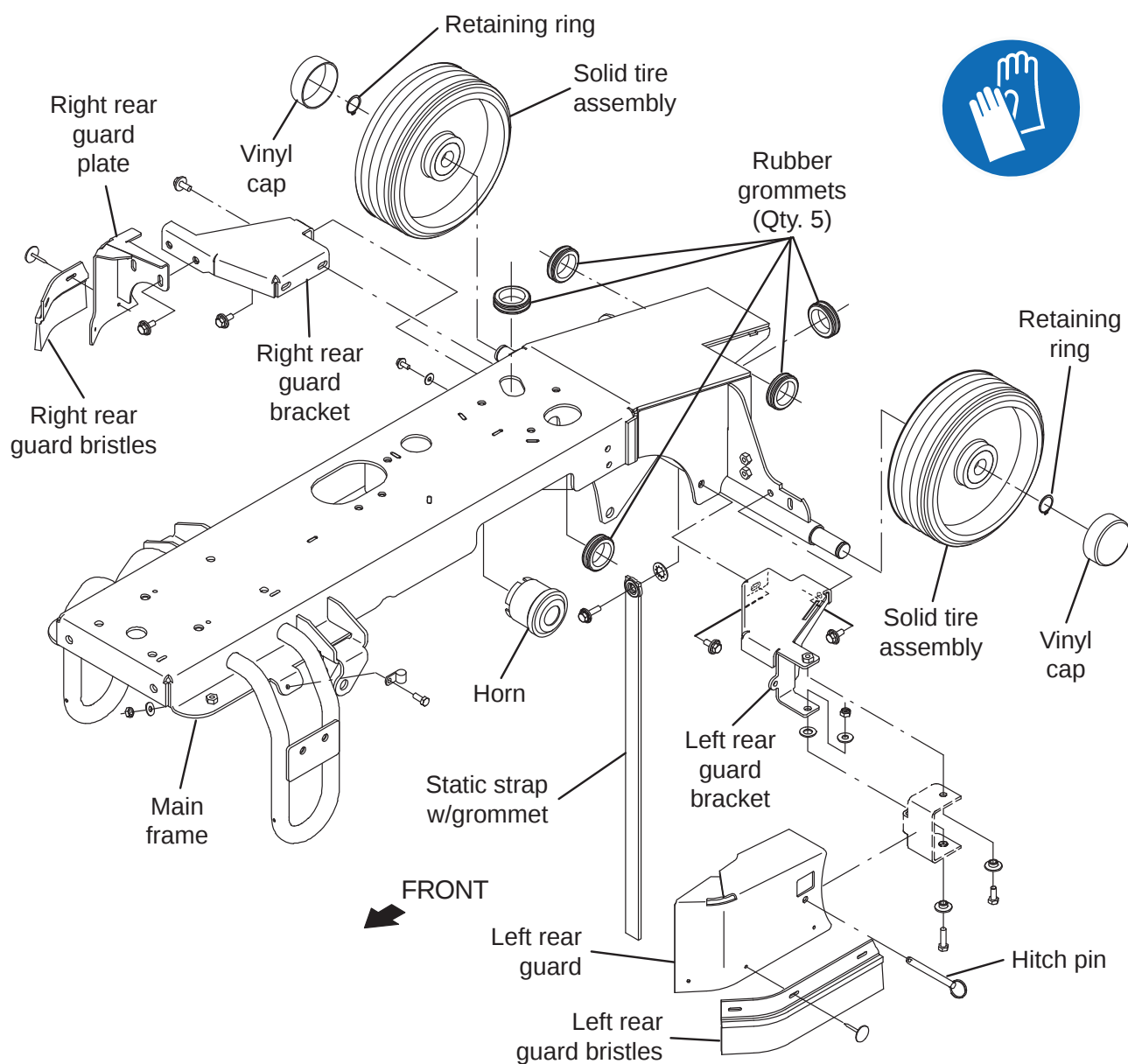


8. Reinstall removed items in reverse order of disassembly.

FRONT COVERS GROUP

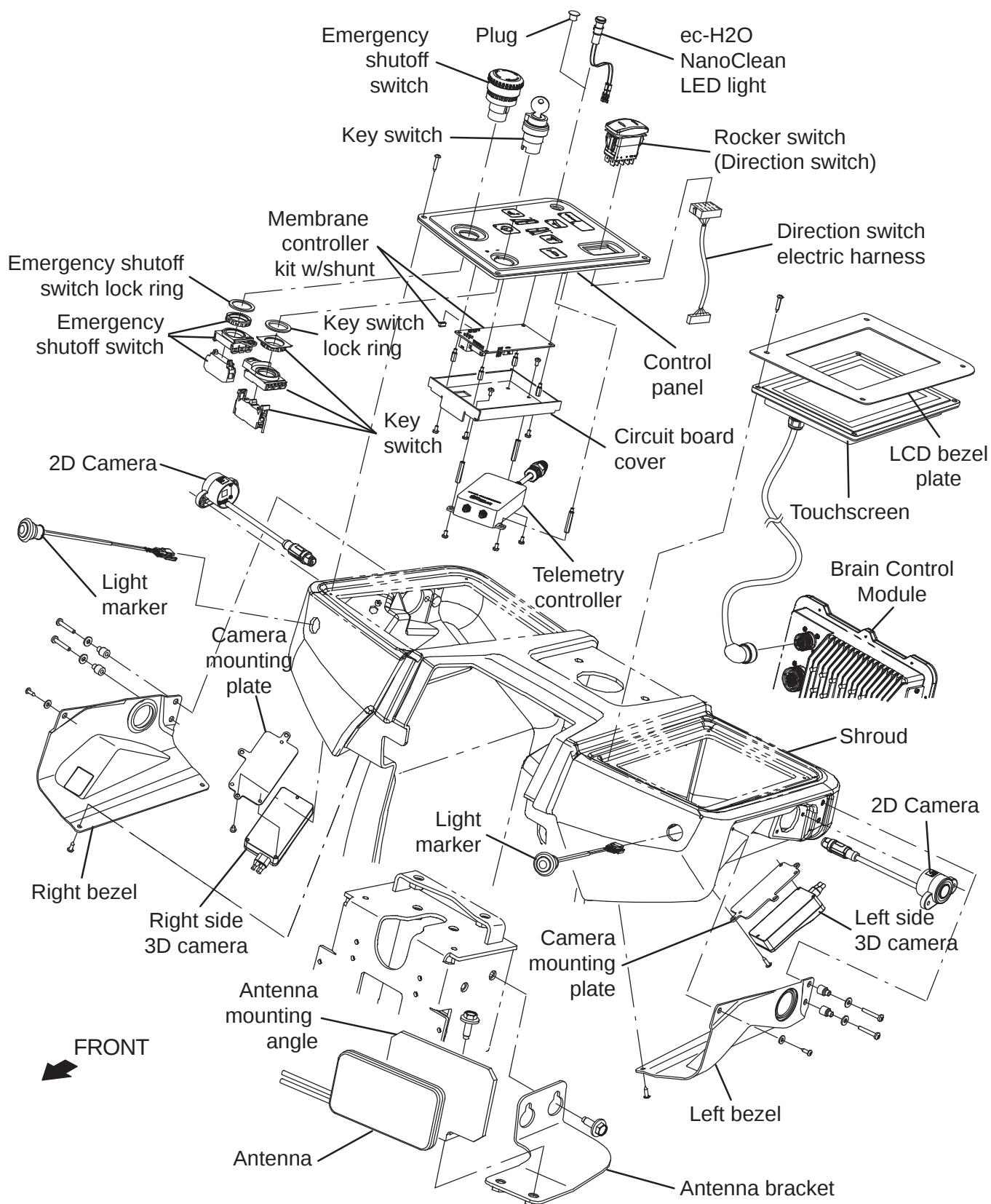


## MAIN FRAME GROUP



CONTROLS/SENSORS/CAMERAS

INSTRUMENT PANEL GROUP



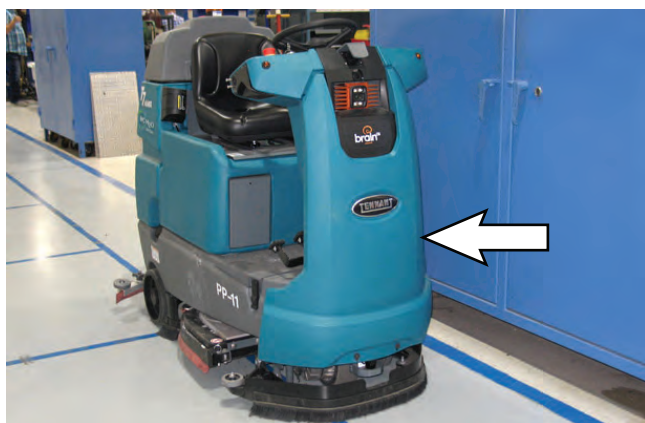
**REMOVE/REINSTALL/REPLACE THE TOUCH-SCREEN**

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

1. Turn the ON/OFF 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 FRONT COVERS GROUP.



*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. Remove the hardware securing the touchscreen to the machine.
6. Carefully lift the touchscreen from the steering shroud. Do not break any wire or cable connections when lifting the touchscreen from the steering shroud.
7. 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.
8. Reinstall the touchscreen onto the steering shroud.
9. 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 ON/OFF 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.

*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 if 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 on/off key switch, directional switch, and emergency shutoff button from the control panel.
7. If replacing the control panel, install the on/off key switch, directional switch, and emergency shutoff 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 ON/OFF KEY SWITCH, DIRECTIONAL SWITCH, ec-H2O LIGHT, AND E-STOP (EMERGENCY STOP) BUTTON

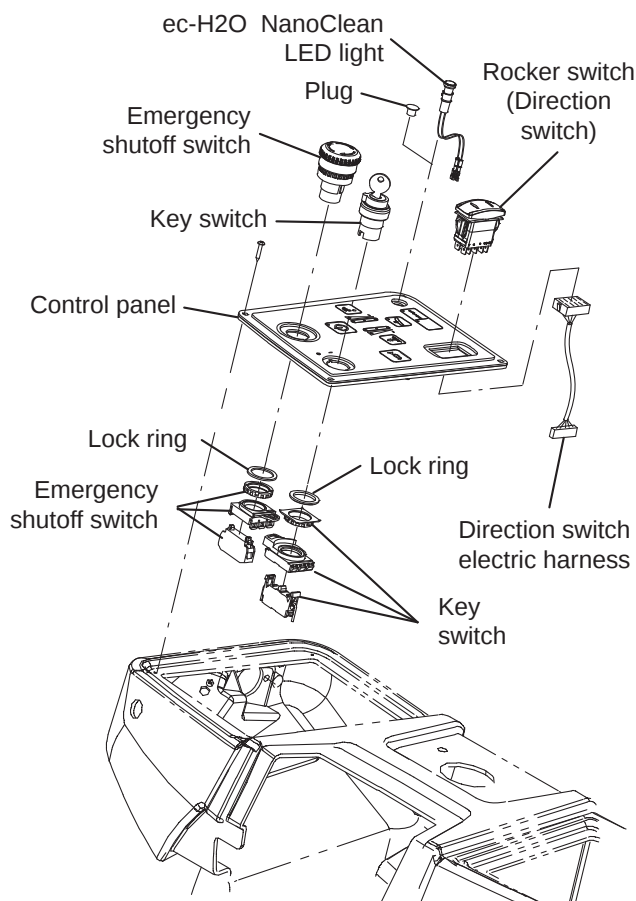
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

1. Turn the ON/OFF 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.

*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 ON/OFF 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.

*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**

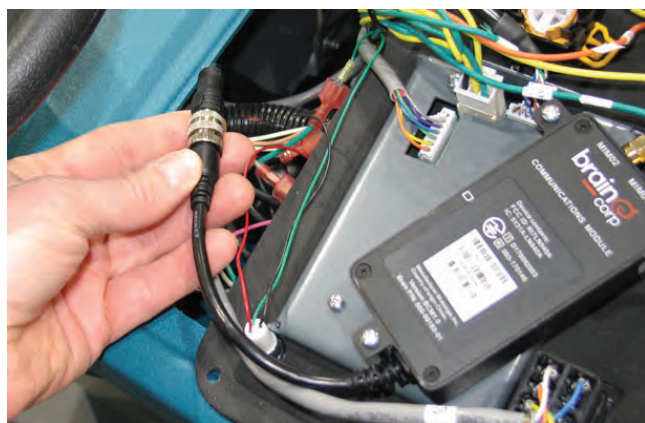
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

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

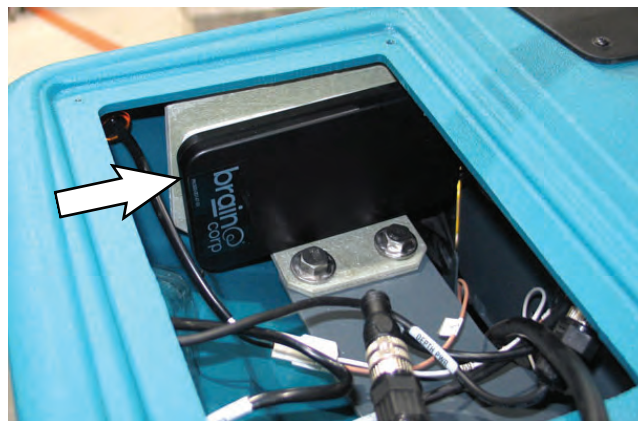
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

*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 from the removed antenna from the antenna bracket.
9. Install the new antenna bracket 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

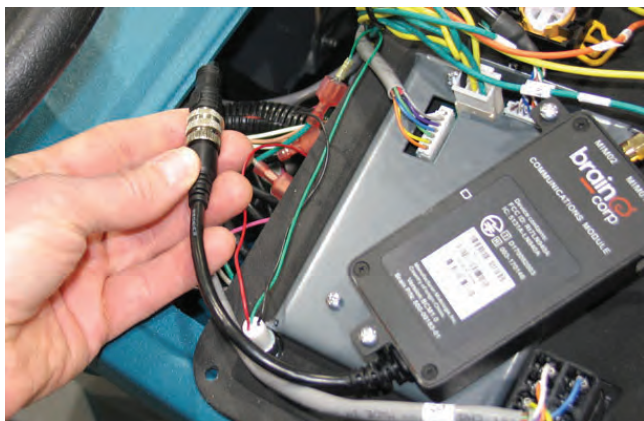
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

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

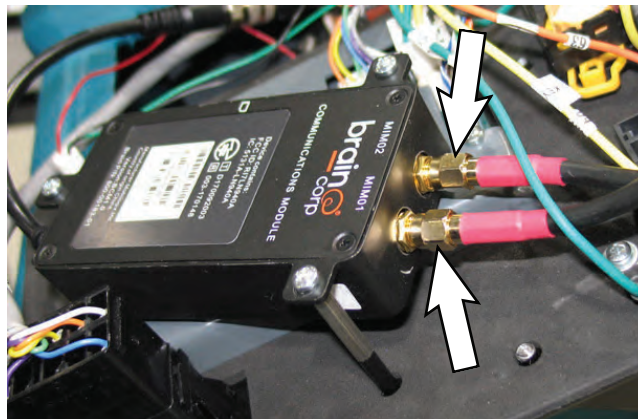
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

*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. Disconnect the antenna cable from the telemetry controller.



5. Disconnect the wire harness 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. Reinstall components removed to access the telemetry controller 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 MEMBRANE CONTROLLER

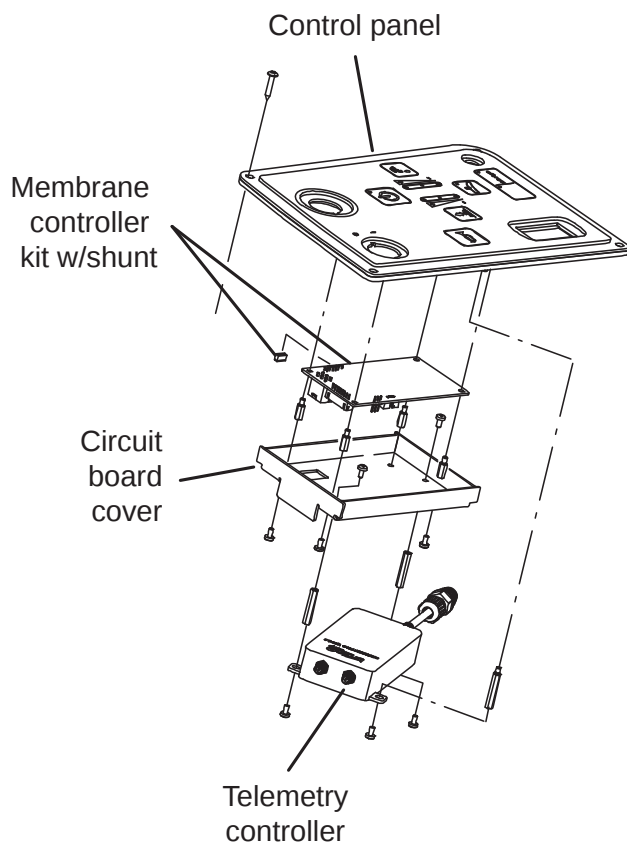
**FOR SAFETY:** Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.

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

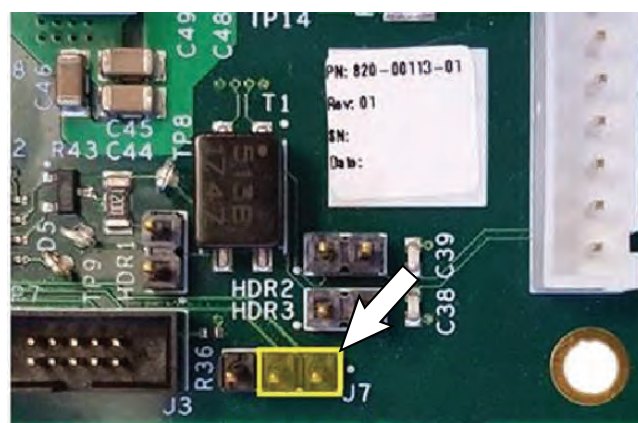
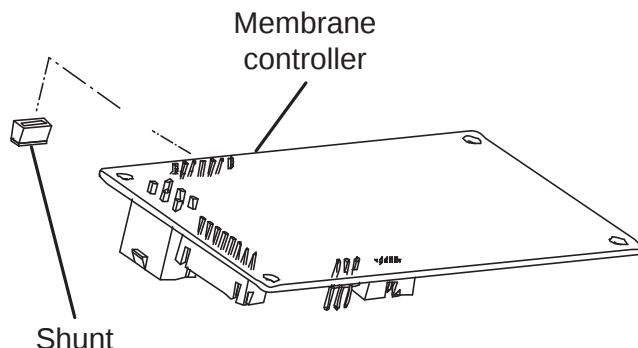
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

*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

*NOTE: 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.*

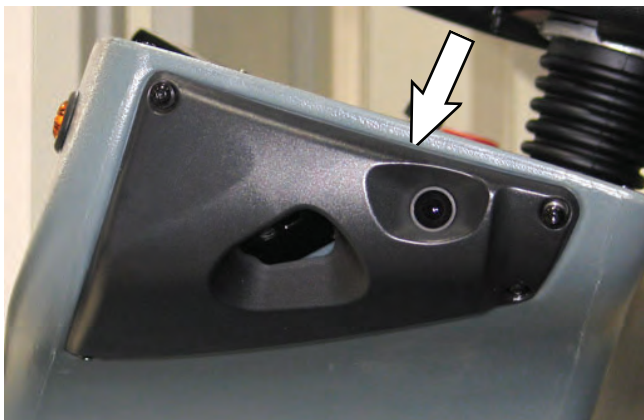
**FOR SAFETY: Before leaving or servicing machine, stop on level surface, turn off machine, and remove key.**

1. Turn the ON/OFF 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.**

*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.*

## MAINTAINING THE SIDE 3D CAMERAS

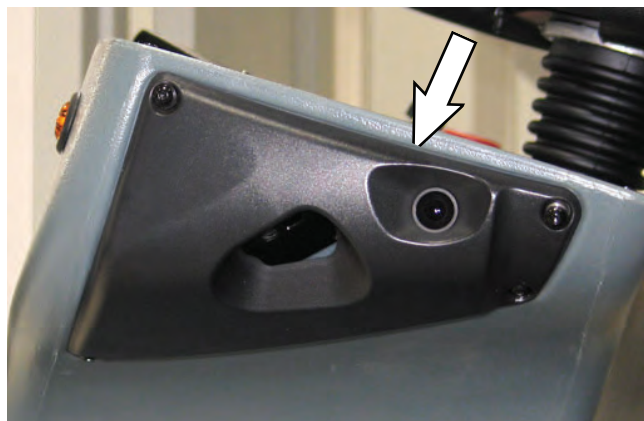
*NOTE: Clean the side 3D cameras after completing all maintenance/service. Debris, streaks, or smudges could deliver false environmental information to the machine. Use a microfiber cloth to clean the cameras. Do not apply water to the cameras or the microfiber cloth.*

*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.*

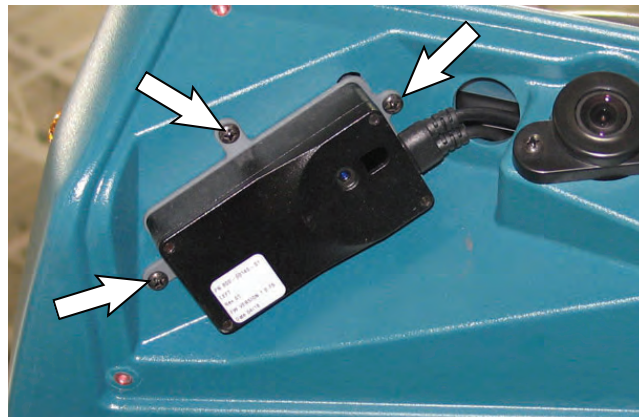
1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

**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.



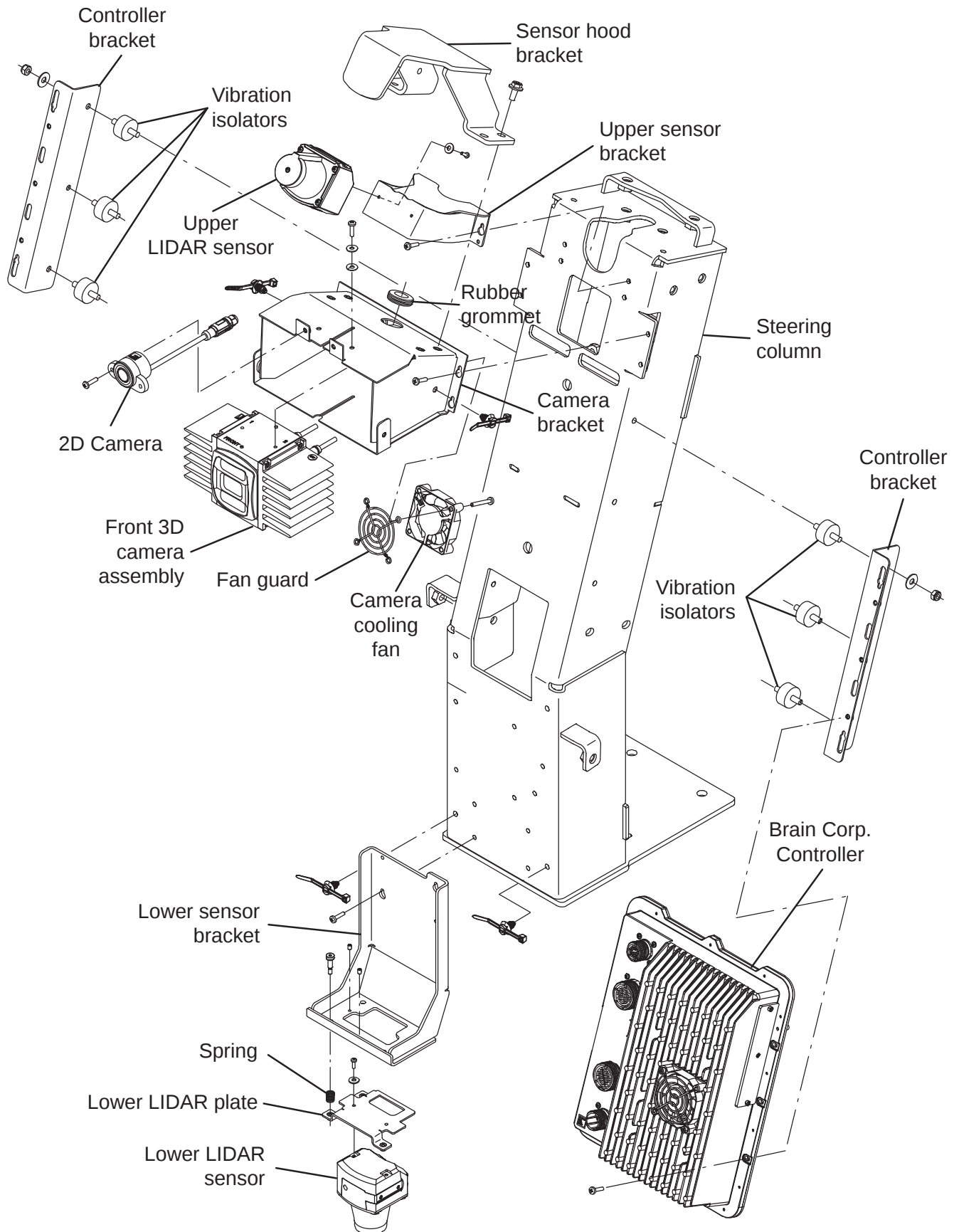
7. Remove the side 3D camera assembly from the machine.

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.*



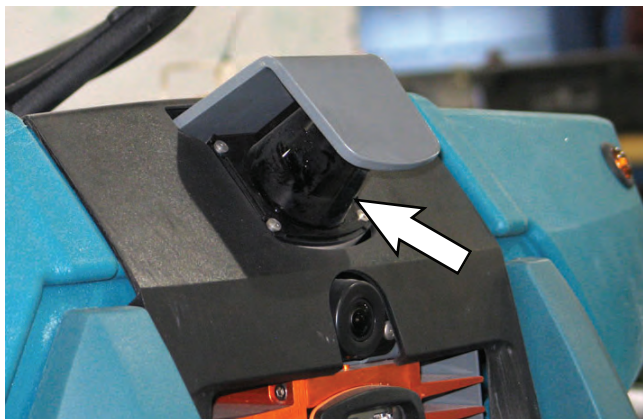
## FRONT CAMERAS AND SENSORS



## 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.



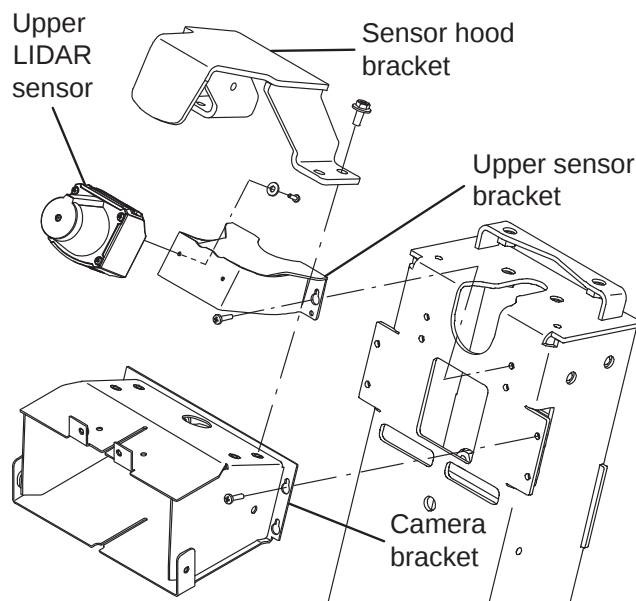
1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

**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 FRONT COVERS GROUP.
4. Remove the front 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.



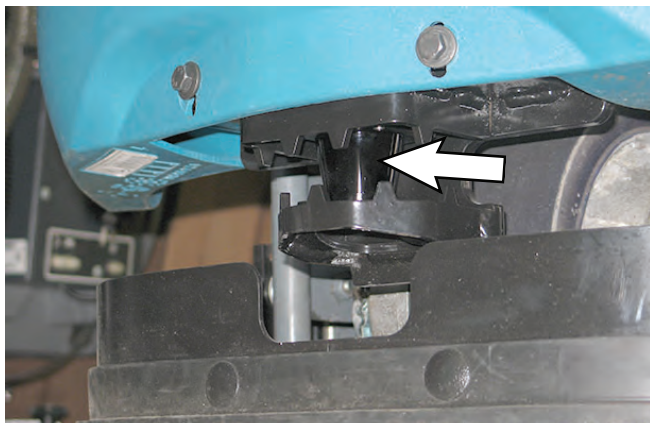
8. Remove the upper LIDAR from the sensor hood bracket.
9. Install the new upper LIDAR/reinstall the removed upper LIDAR onto the machine in reverse order of disassembly.
10. Reconnect the battery cable to the machine.
11. Calibrate the upper LIDAR. See the Front Upper Range Sensor (LIDAR) Adjustment/Calibration 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.

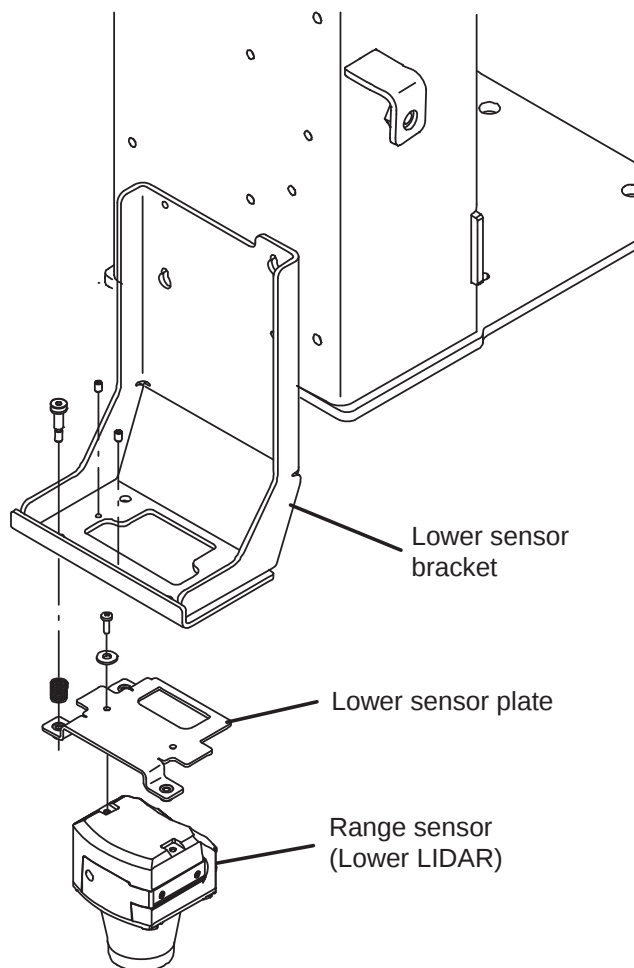


1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

**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 FRONT COVERS GROUP.
4. Disconnect the wire harness from the lower LIDAR.

5. Remove the lower LIDAR from the lower sensor bracket.



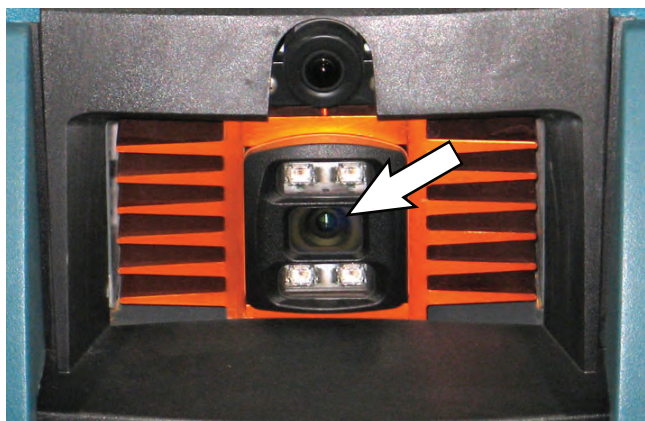
6. Install the new lower LIDAR/reinstall the removed lower LIDAR onto the machine in reverse order of disassembly.
7. Reconnect the battery cable to the machine.
8. Calibrate the lower LIDAR. See the Front Lower Range Sensor (LIDAR) Adjustment/Calibration document for instructions how to calibrate/adjust the lower LIDAR.
9. Reinstall the lower shroud 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.



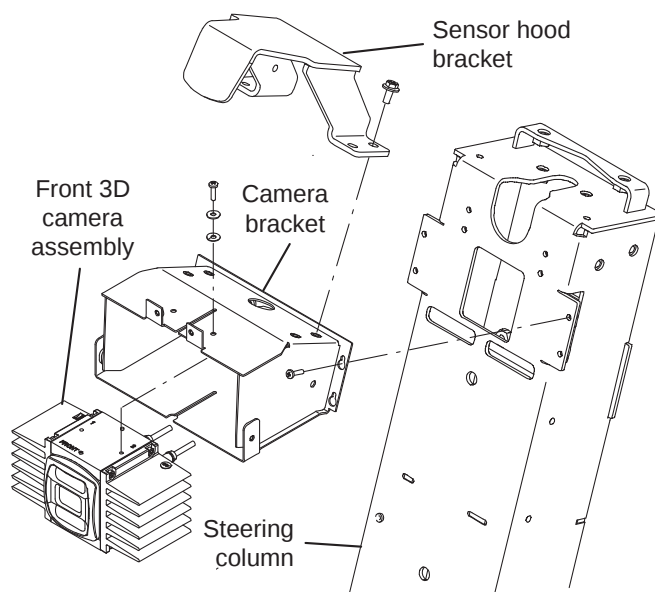
1. Turn the key switch OFF.
2. Disconnect the battery cable from the machine.

**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 FRONT COVERS GROUP.
4. Remove the front 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

*NOTE: 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 ON/OFF 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.**

*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 FRONT COVERS GROUP.
4. Remove the front bezel from 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 ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

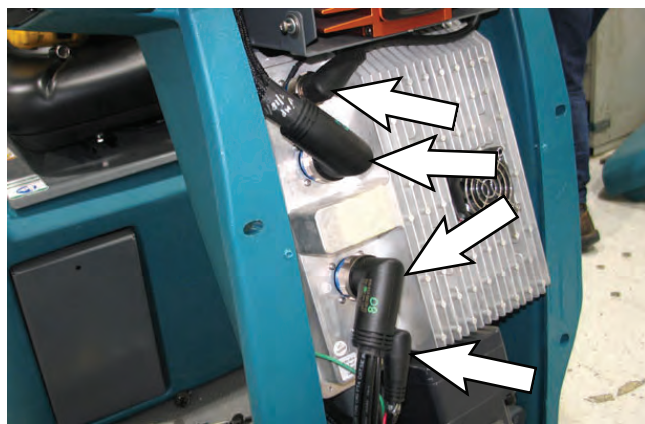
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

*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 FRONT COVERS GROUP.
4. Remove the front bezel from the machine.



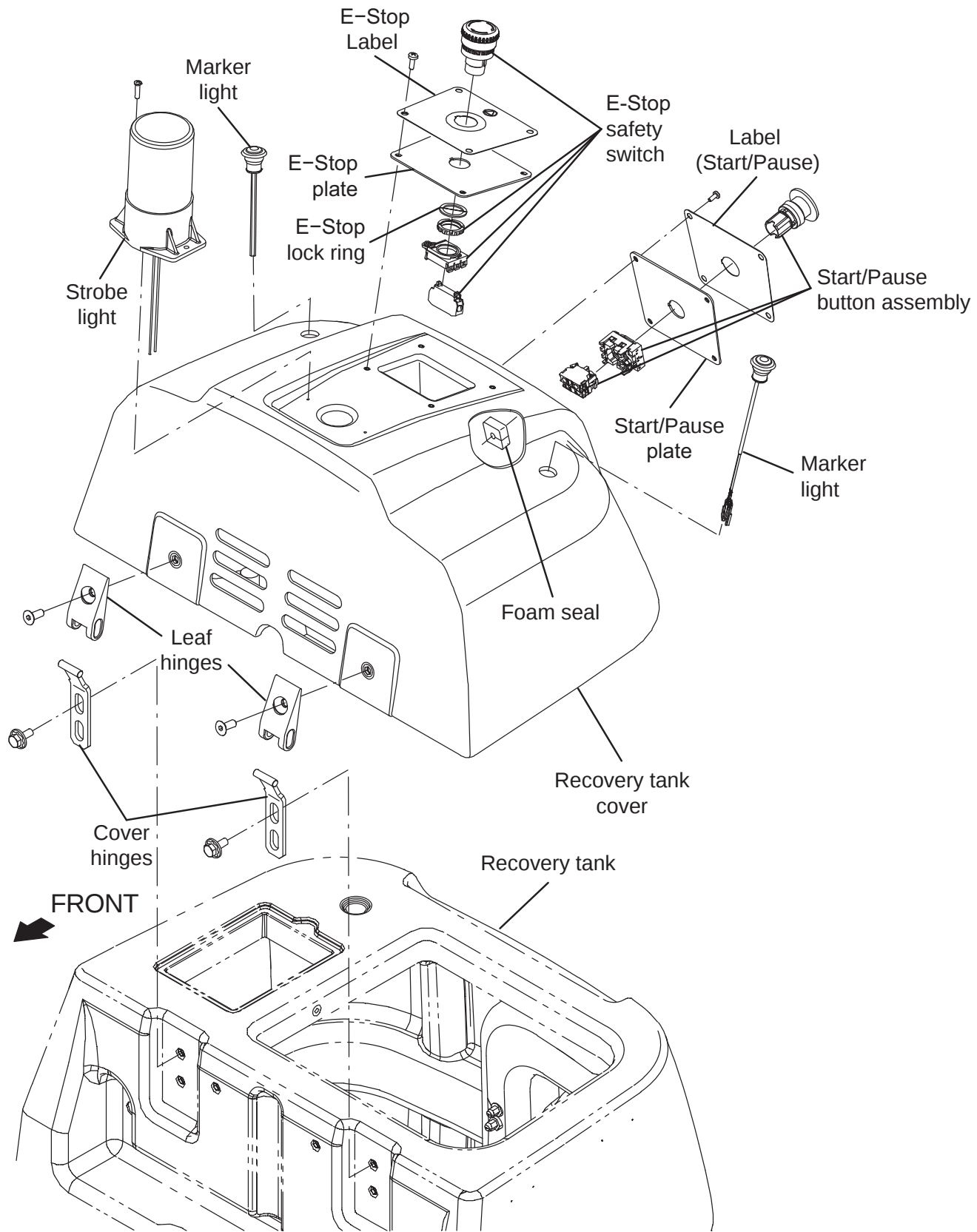
5. Disconnect all wire harness connections from the Brain controller.



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.*

RECOVERY TANK COVER CONTROLS/  
COMPONENTS



## REMOVE/REINSTALL/REPLACE THE START/PAUSE BUTTON

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

1. Turn the ON/OFF 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.

*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.

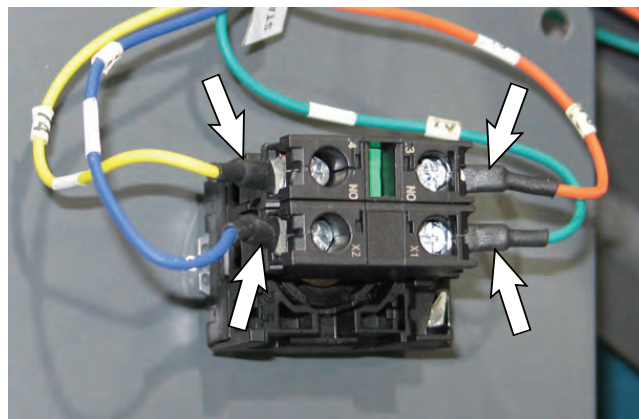
3. Remove the hardware securing the start/pause button assembly to the recovery tank cover.



4. Carefully pull the blue start/pause button assembly from the recovery tank cover. Do Not break or damage wire/cable connections when pulling the blue start/pause button assembly from the recovery tank cover.



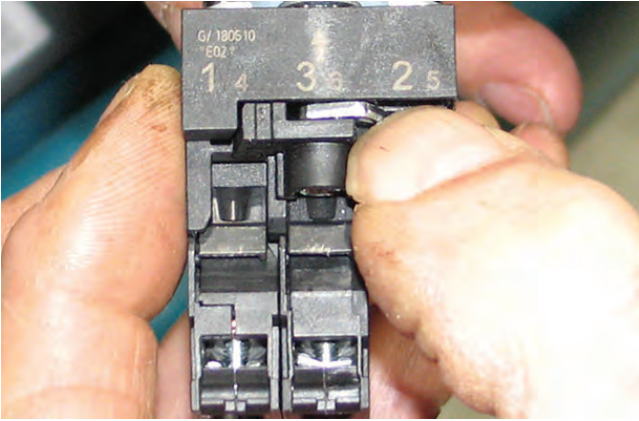
5. Disconnect the harness connections from the blue start/pause button assembly.



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



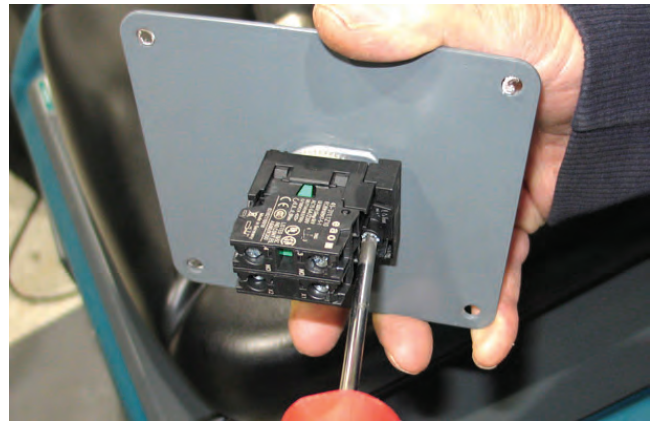
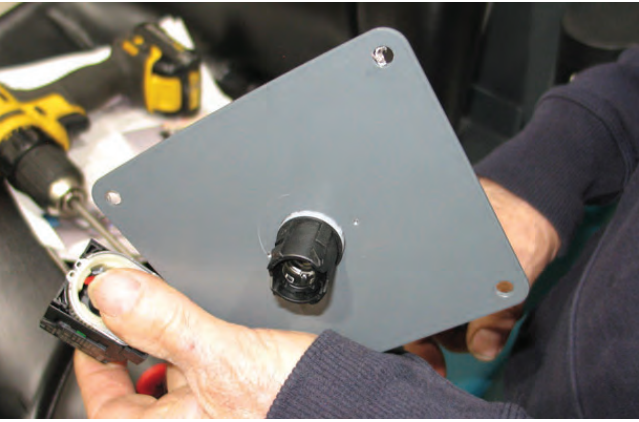
7. Press the retainer lever and remove the start/pause button assembly from the start/pause button plate.



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



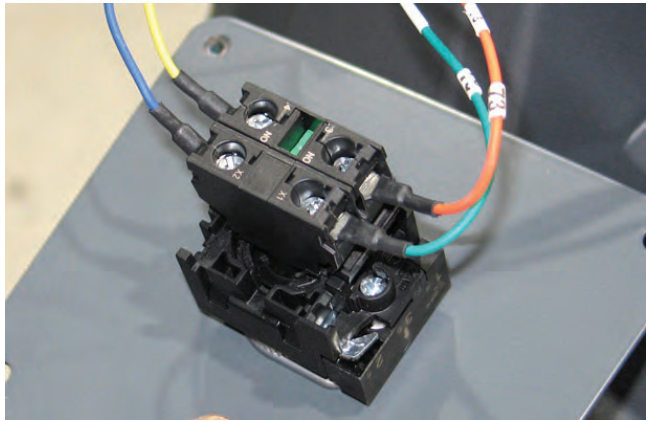
10. Install the new start/pause button assembly onto the start/pause button plate and tighten the retainer screw to secure the start/pause button assembly into place.



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



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



12. Install the start/pause button assembly onto the recovery tank cover.

13. Install the start/pause button assembly onto the recovery tank cover.

## 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 ON/OFF 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.

*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.

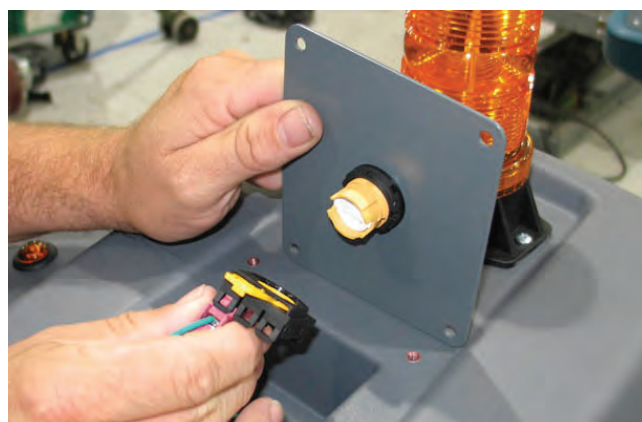
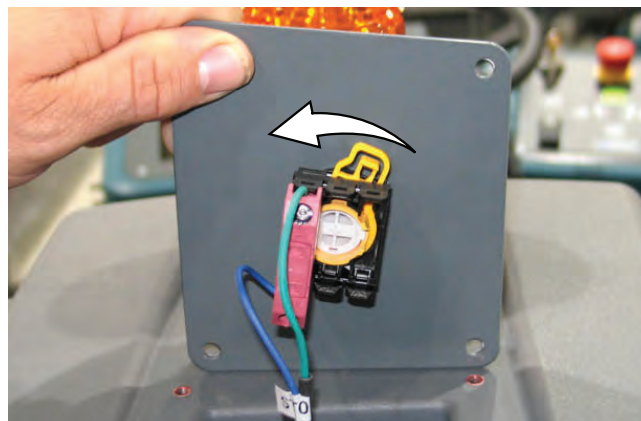
3. Remove the hardware securing the E-Stop button assembly to the recovery tank cover.



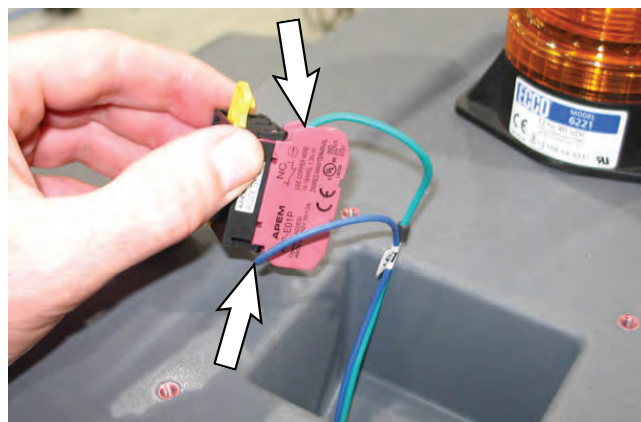
4. Carefully pull the E-Stop button assembly from the recovery tank cover. Do Not break or damage wire/ cable connections when pulling the E-Stop button assembly from the recovery tank cover.



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

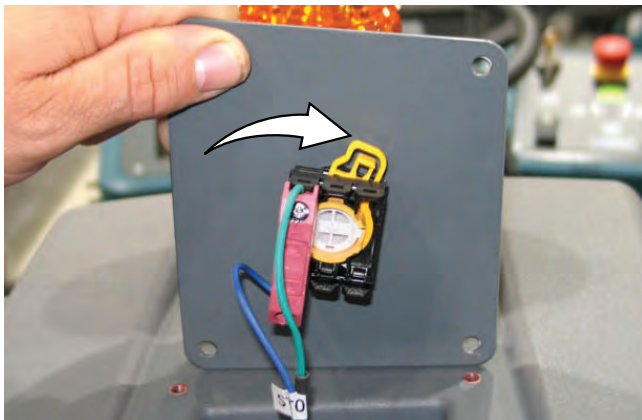


6. Disconnect the harness connections from the E-Stop button connector.



7. Remove the E-Stop button from the E-Stop mounting plate.

8. Connect the harness connections to the new E-Stop button connector.
9. Install the new E-Stop button/removed E-Stop button onto the E-Stop mounting plate.



10. Push the lever to connect the E-Stop button to the E-Stop button connector.
11. Install the E-Stop button assembly onto the recovery tank cover.

### 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 ON/OFF 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.

*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 recovery tank cover to the fan mounting plate.
4. Tilt the recovery tank cover from the fan mounting plate and toward the front of the machine.

*NOTE: Do not completely remove the recovery tank cover from the machine. All components mounted to the recovery tank cover can be easily accessed with the recovery tank cover installed on the machine.*

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.

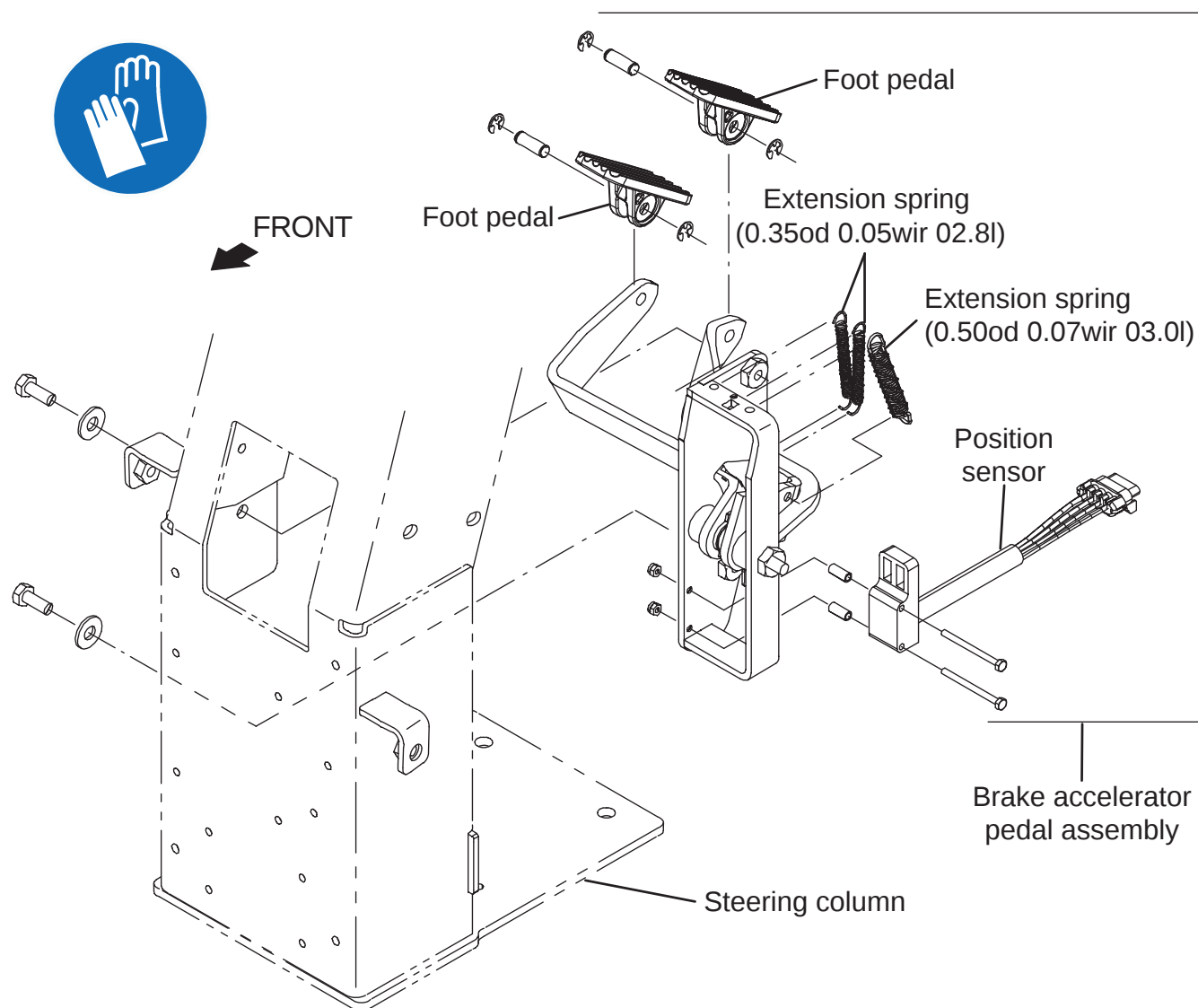
1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

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

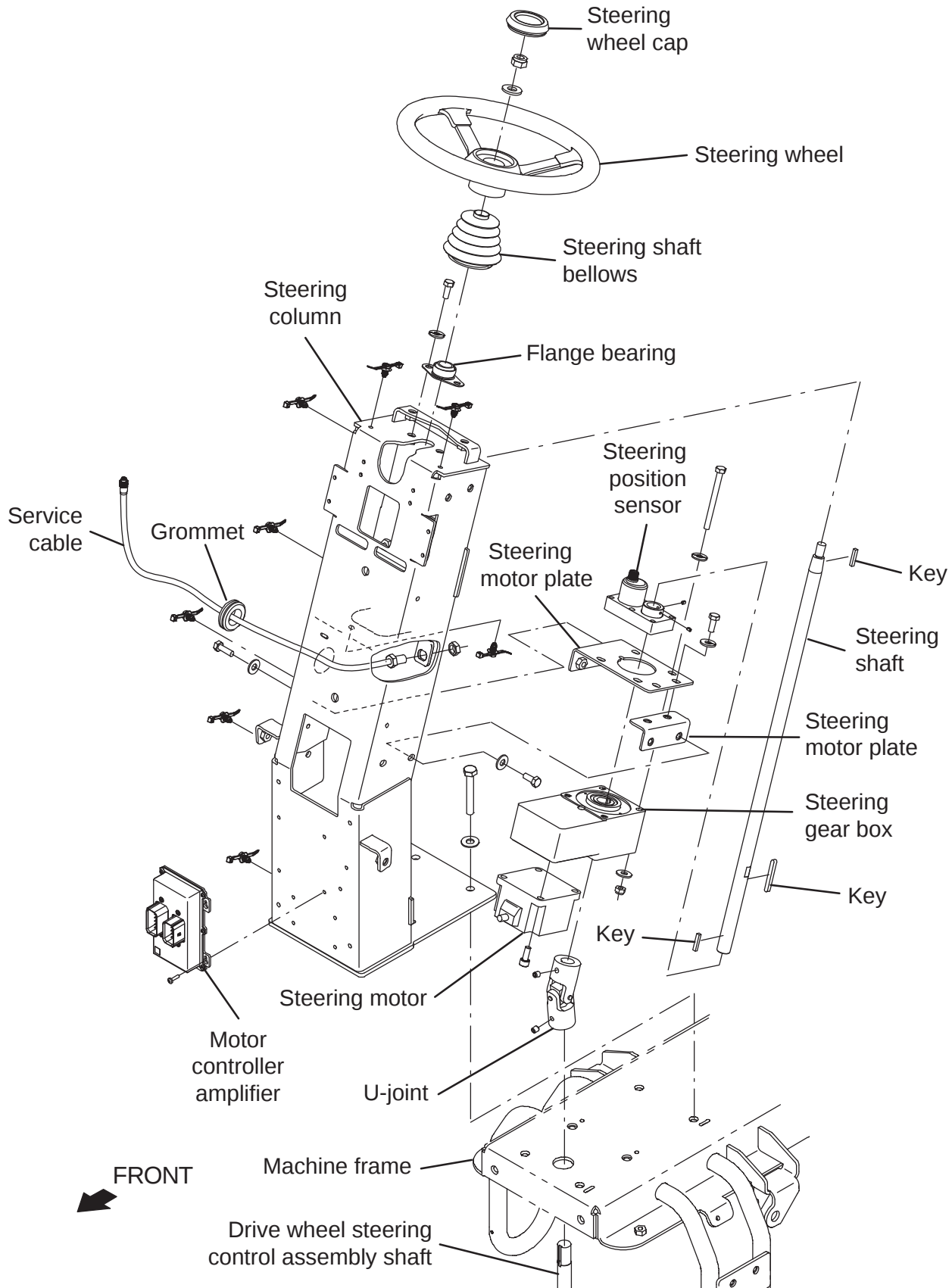
*NOTE: To avoid damaging electronic components, a static ground strap must be worn at all times while handling electrical components. Attach the other end of the static ground strap to the machine chassis.*

3. Remove the hardware securing the strobe light to the recovery tank cover and carefully lift the strobe light from the recovery tank cover.
4. Disconnect the wire harness from the strobe light.
5. Connect the wire harness to the new strobe light/removed strobe light.
6. Install the strobe light onto the recovery tank cover.

## PEDALS GROUP



STEERING



## 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 ON/OFF 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.

*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 FRONT COVERS GROUP.



4. Remove the column access panel from the steering column. See FRONT COVERS GROUP.

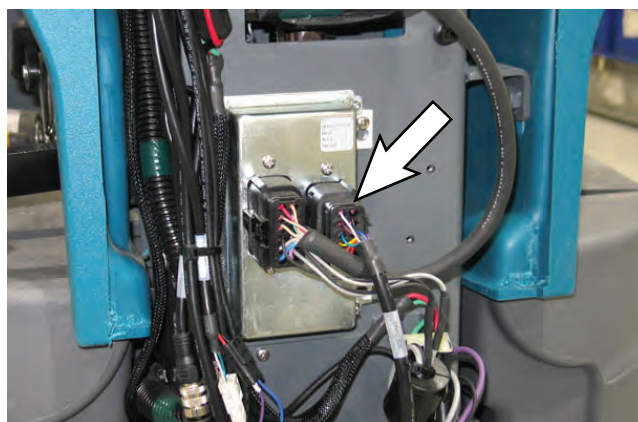


5. Loosen the upper set screws securing the steering shaft into the u-joint.
6. Loosen both set screws securing the steering shaft in the steering position sensor.
7. Slide the steering wheel/steering shaft up, through the flange bearing enough to clear the steering gear box and the steering position sensor.

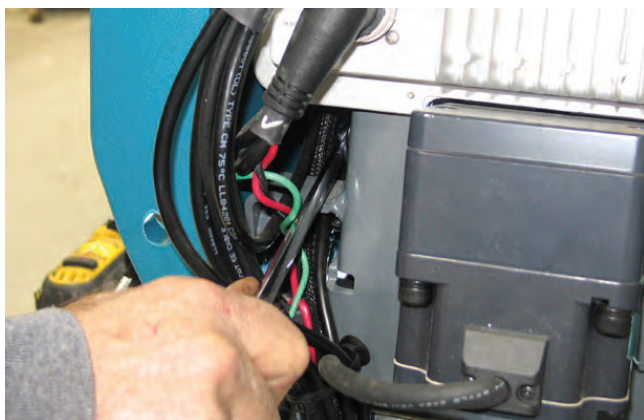
*NOTE:* Do Not lose either of the keys in the steering shaft when sliding the steering wheel/steering shaft from the u-joint and steering gear box.

*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/steering gear box:** Remove the steering motor/steering gear box from the steering motor plates.

13. Reinstall the steering position sensor and/or steering motor/steering gear box onto the machine.
14. 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.*

15. Tighten the upper set screws in the u-joint to secure the steering shaft into the u-joint.
16. 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.
17. Tighten the hardware securing the steering motor plates to the steering column.
18. 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.
19. Reassemble parts and components removed from the machine to access the steering system back onto the machine in reverse order of disassembly.
20. 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 ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

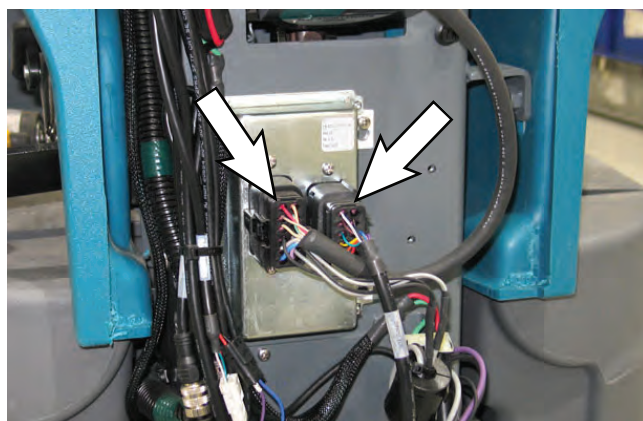
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

*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 FRONT COVERS GROUP.



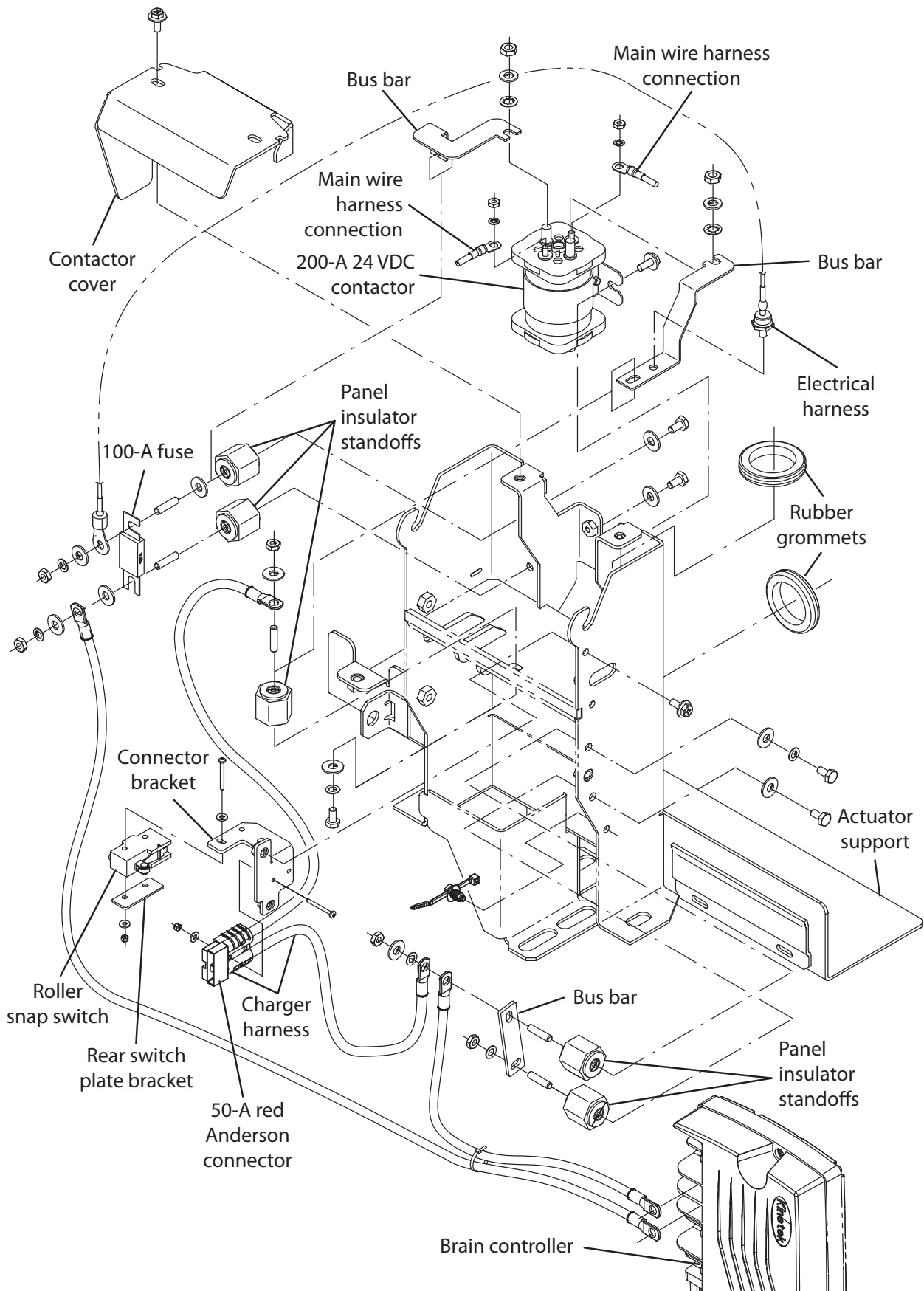
4. Disconnect the harness connector and steering motor from the steering amplifier module.



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



**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 ON/OFF 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.

*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 operator seat/seat plate and battery box cover from the machine. See REMOVE/REINSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Confirm the machine battery cable is disconnected from the batteries.

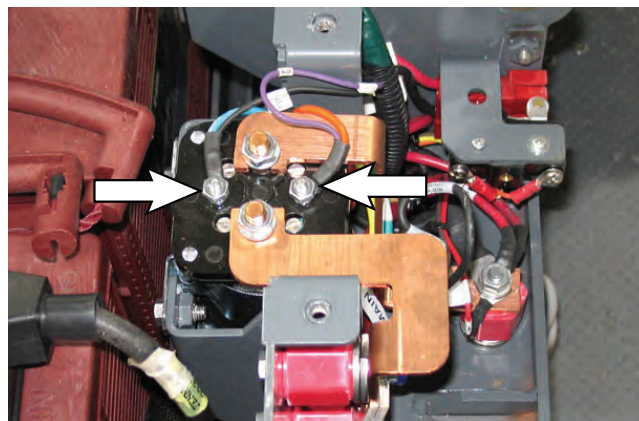
**ATTENTION:** Potential electrical hazard if the battery cable is left connected to the batteries. The machine battery cable must be disconnected from the batteries before accessing/performing maintenance on the 200-A 24 VDC contactor.

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

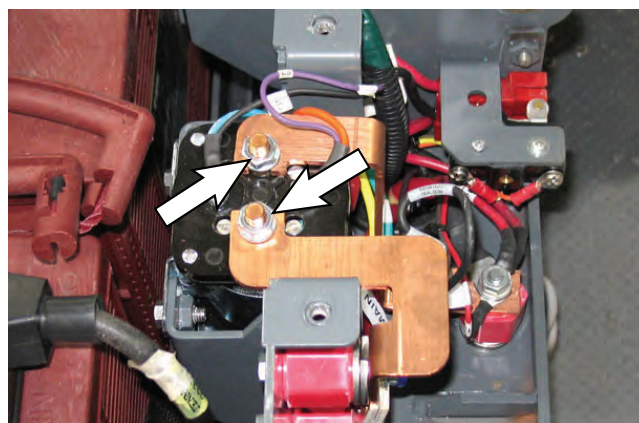
5. Remove the contactor cover from the actuator support.



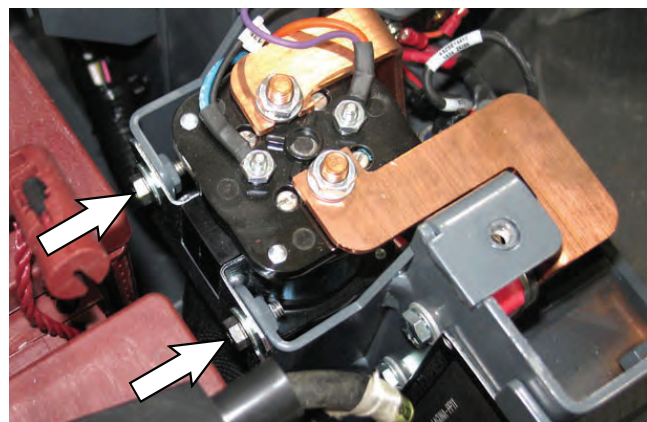
6. Disconnect wire harness connections from the top terminals of the contactor.



7. Remove both bus bars from the 200-A 24 VDC contactor and the corresponding panel insulator standoffs.



8. Loosen the hardware securing the 200-A 24 VDC contactor to the actuator support enough to be able to remove the contactor from the machine.



*NOTE: If necessary, remove the batteries from the machine to make access to the hardware securing the 200-A 24 VDC contactor to the actuator support easier.*

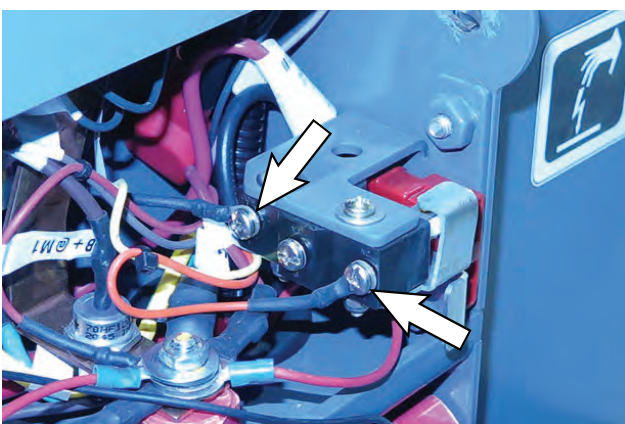
9. Carefully lift the 200-A 24 VDC contactor from the actuator support and disconnect the wire harness connections from the bottom terminals of the contactor.
10. Connect the wire harness to the terminals located on the bottom of the new 200-A 24 VDC contactor/ removed 200-A 24 VDC contactor.
11. Install the 200-A 24 VDC contactor onto the actuator support.
12. Install the bus bars, and all cable connections removed when the bus bars were removed, onto the 200-A 24 VDC contactor and panel insulator standoffs.
13. Connect the wire harness connections to the terminals located on the top of the 200-A 24 VDC contactor.
14. Install the contactor cover onto the actuator support.
15. Reconnect the battery cable to the batteries.
16. Reinstall the operator seat/seat plate and battery box cover onto the machine.

## REMOVE/REINSTALL/REPLACE THE CHARGER INTERLOCK SNAP SWITCH

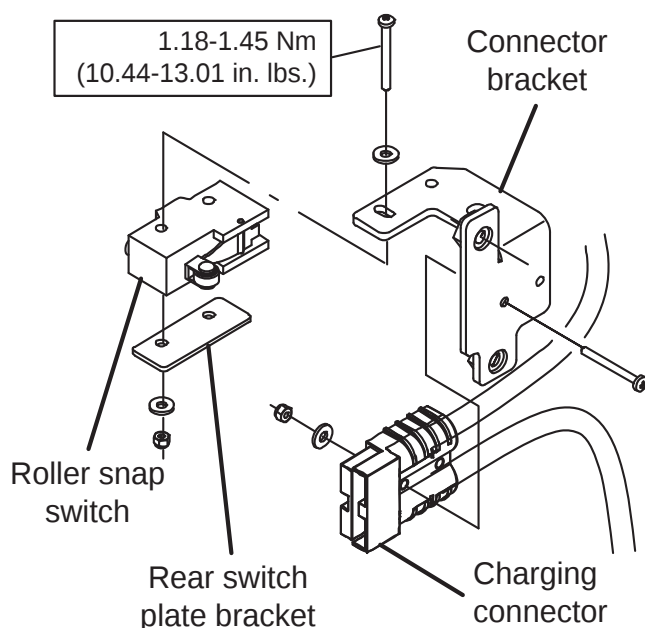
1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

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

3. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/REINSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Disconnect the two harness connections from the charger interlock snap switch.

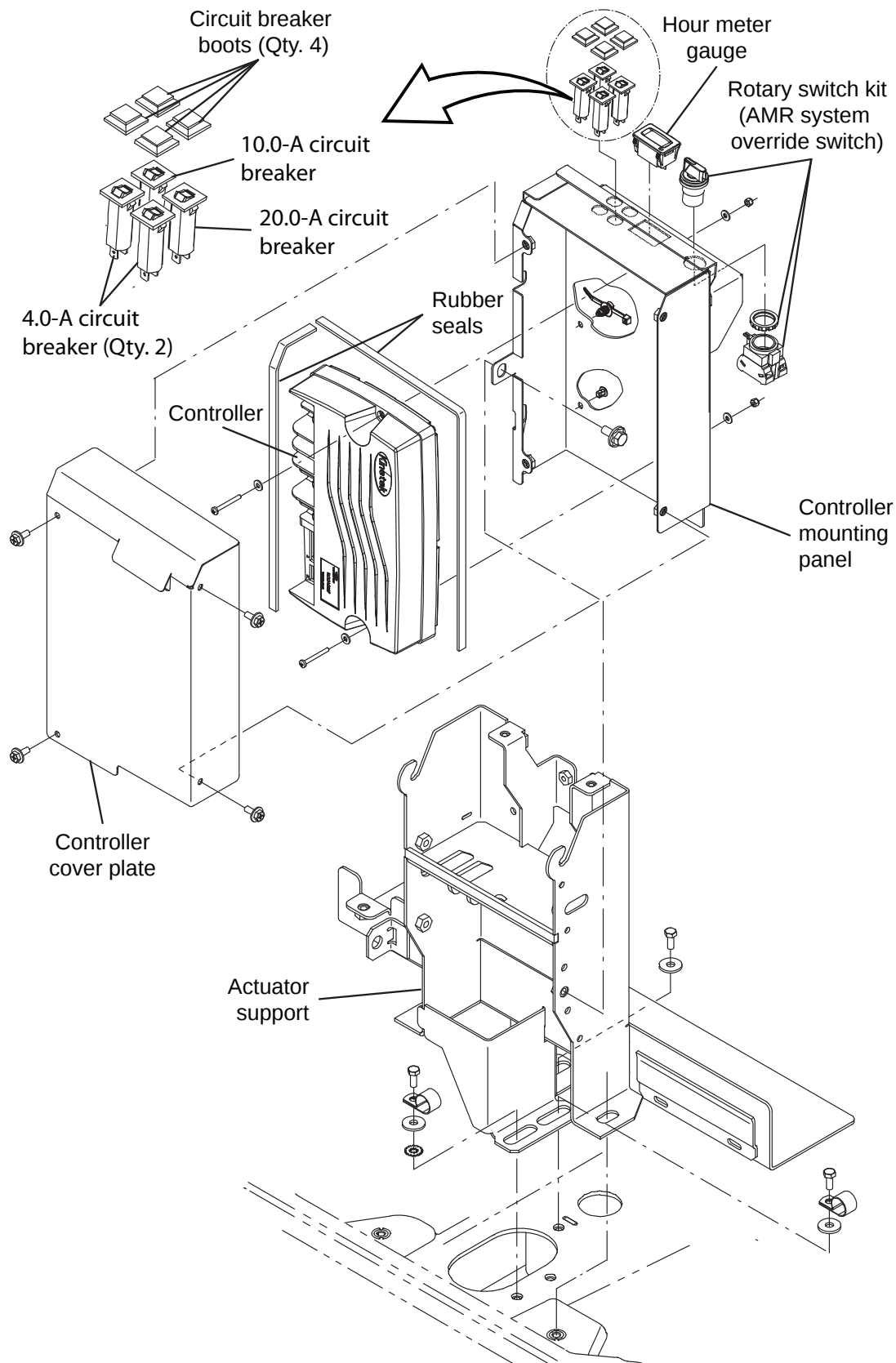


5. Remove the hardware securing the charger interlock snap switch to the connector bracket and the rear switch plate bracket.



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 ON/OFF key switch OFF.
2. Raise the seat and lock the seat into the fully raised position.
3. Disconnect the battery cable from the batteries.

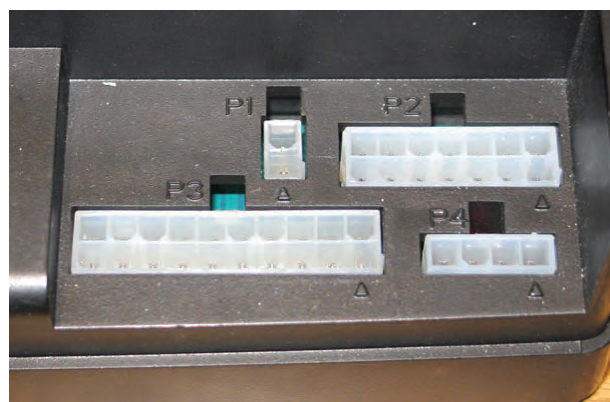
**FOR SAFETY: When servicing machine, disconnect battery connection and charger cord before working on machine.**

4. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Remove the controller cover plate from the machine.



6. Disconnect all wire harness connections from the Kinetek controller.
7. Remove the Kinetek controller from the machine.
8. Install the new Kinetek controller/removed Kinetek controller onto the machine.

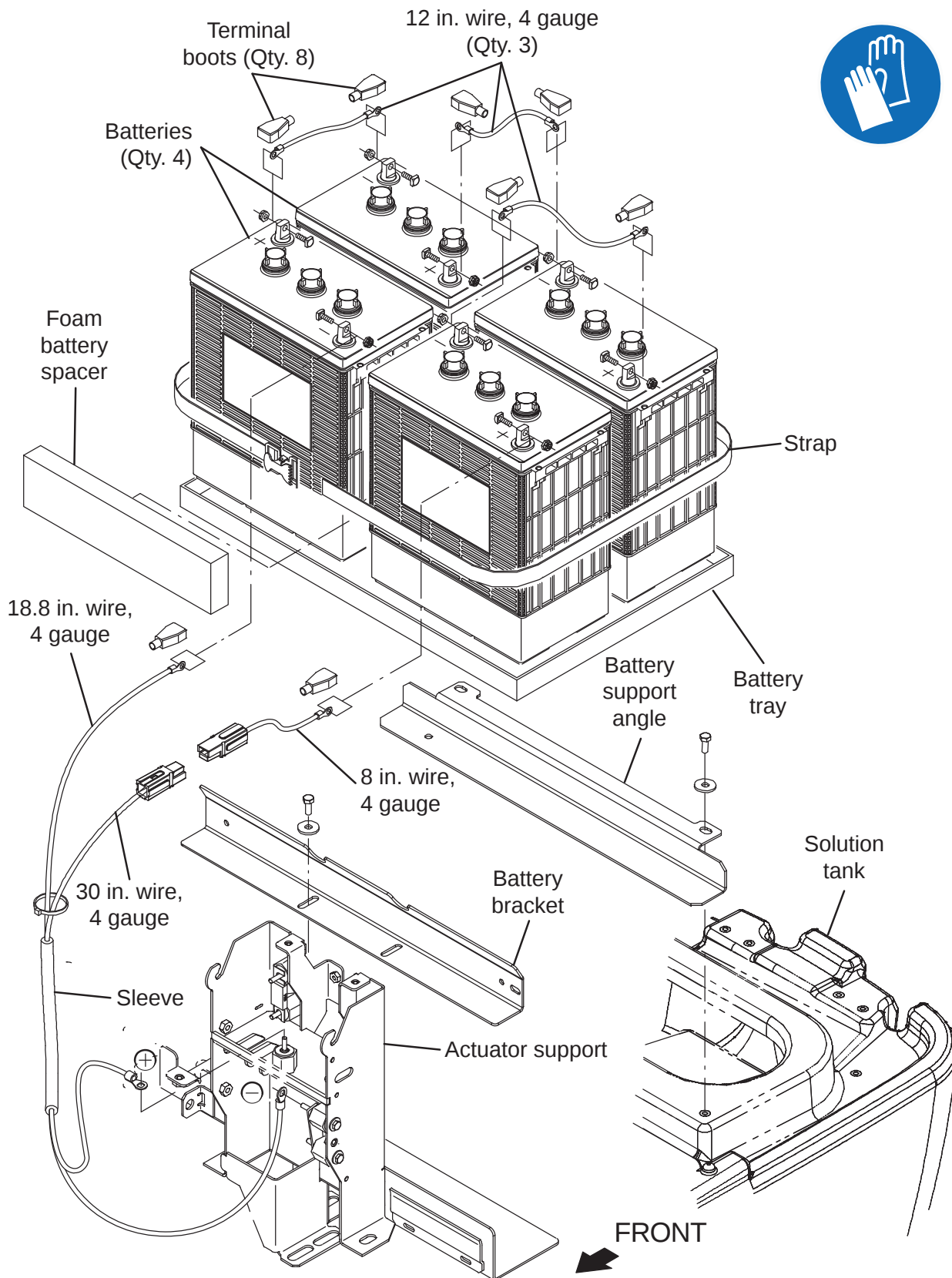
9. Connect wire harness connections to the Kinetek controller.



10. Reassemble all items back onto the machine in reverse order of removal.
11. Reconnect the battery cable to the batteries.
12. 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.
13. Contact Tennant Customer Service Department for instructions for returning components for inspection and tracking.

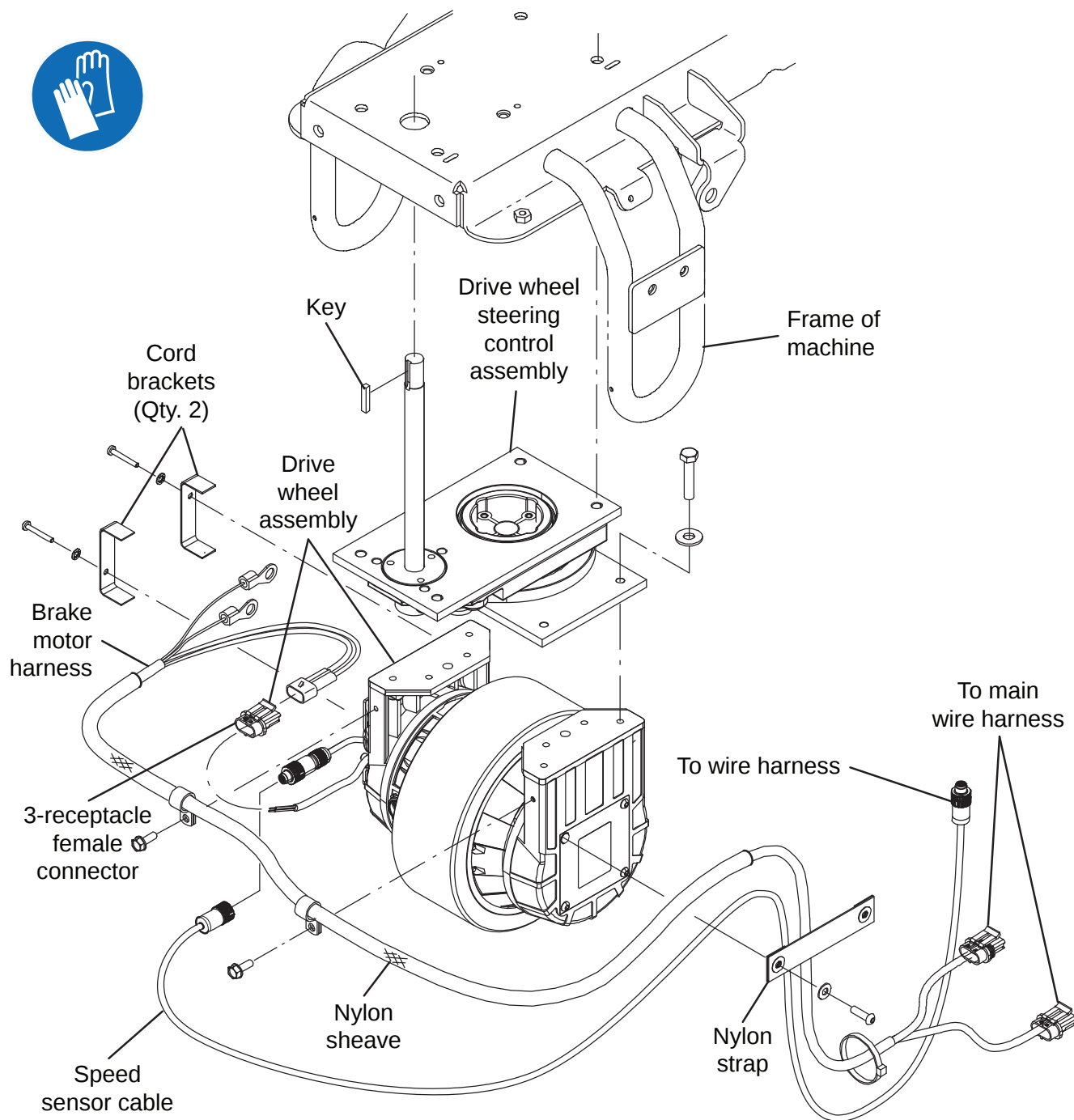
**NOTE:** Do Not discard AMR components replaced in this procedure. All AMR components must be returned for inspection and tracking purposes.

BATTERY GROUP





## DRIVE WHEEL GROUP



**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.

## 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 ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

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

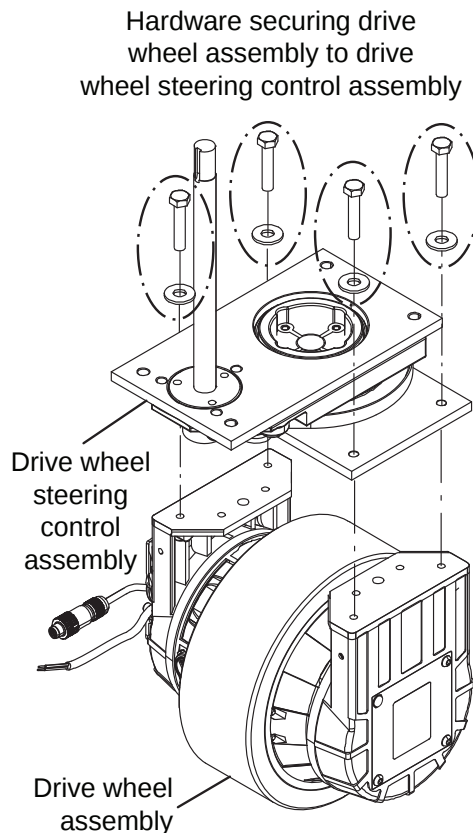
4. Remove the front guard from the front of the machine. See REMOVE/INSTALL THE FRONT GUARD.
5. Chock both rear tires.
6. Jack up the front end of the machine enough to access steering components/remove steering components from under the machine. Place jack stands under the machine and lower the machine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

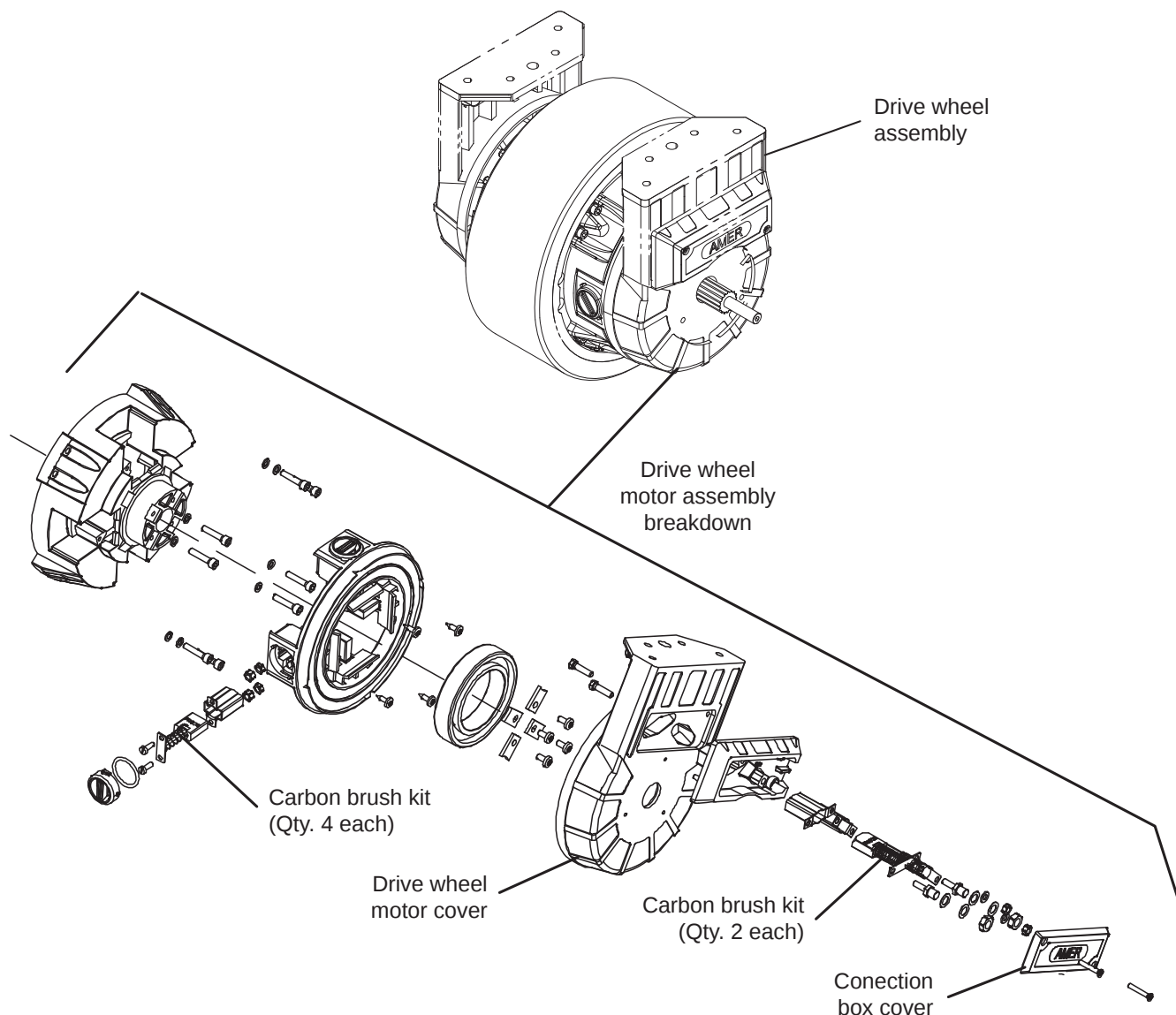
**NOTE:** Use care when removing the drive wheel assembly from the machine. The drive wheel weighs approximately 140 lbs (64 kg). If necessary, seek help to remove the drive wheel assembly from the machine.

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.**

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. If jacking up the machine to access the encoder/ brake assembly: Place chocks behind both rear wheels.

4. If jacking up the machine to access the 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, be sure to chock both rear tires prior to jacking up machine.

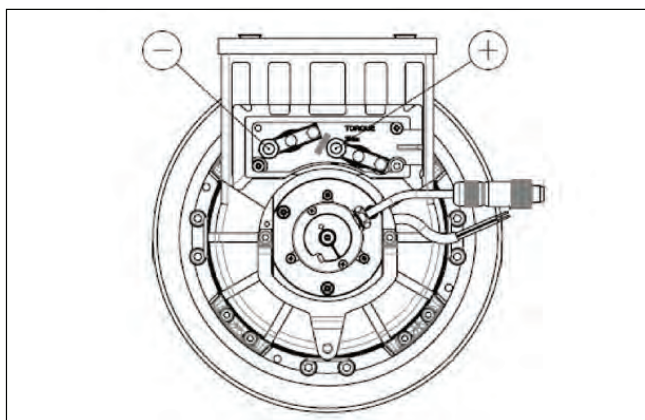
**FOR SAFETY: When servicing machine, block machine tires before jacking machine up. Use a hoist or jack that will support the weight of the machine. Jack machine up at designated locations only. Support machine with jack stands.**

5. Remove the front perimeter guard from the machine. See REMOVE/REINSTALL THE FRONT PERIMETER GUARD.

6. Turn steering wheel so the drive wheel motor assembly installed on the drive wheel assembly can be easily accessed.

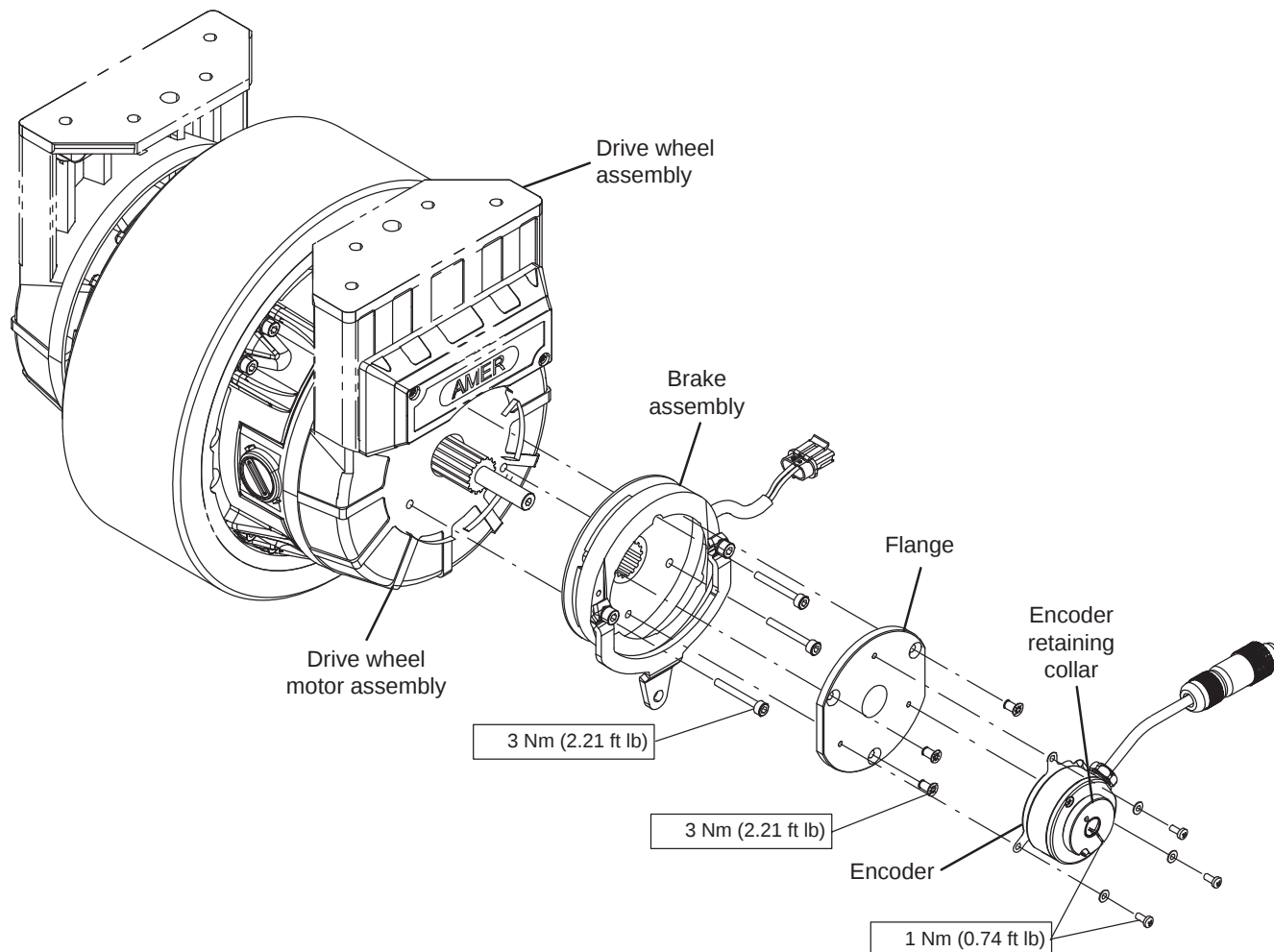
*NOTE: Carbon brushes should be replaced as sets.*

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



11. Inspect carbon brushes. Replace carbon brushes if they are stuck or are less than 10 mm (0.375 in.) in length.
12. Use compressed air to clean any dust from inside the drive motor assembly.
13. 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.
14. Reinstall the connection box cover onto the drive motor assembly connection box
15. Reconnect the Positive (+) and Negative (-) cable connections to the drive motor assembly.
16. Reinstall the front perimeter guard onto the machine.

## REMOVE/REINSTALL/REPLACE THE ENCODER AND PARKING BRAKE



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

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

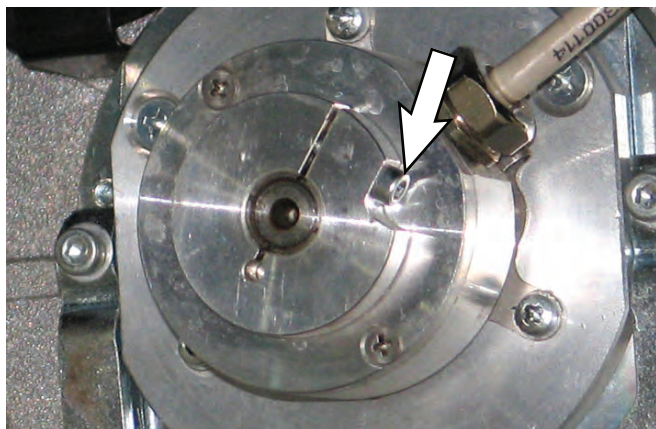
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

3. 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.

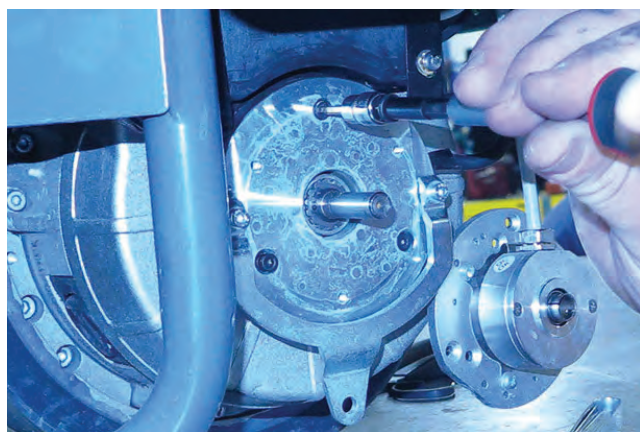


8. Remove the encoder retaining collar from the drive wheel assembly.
9. If only replacing the encoder: Remove the encoder from the flange.
10. If only replacing the encoder: Disconnect the encoder cable from the wire harness.
11. If only replacing the encoder: Connect the new encoder cable to the wire 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.

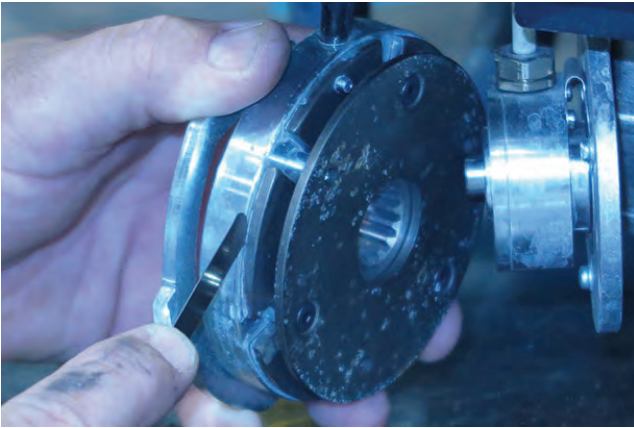
*NOTE: To prevent the bushings from falling from the brake assembly during reassembly, reinsert the socket screws into the brake assembly to hold the bushings into place in the brake assembly before reinstalling it onto the drive wheel motor assembly.*

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.

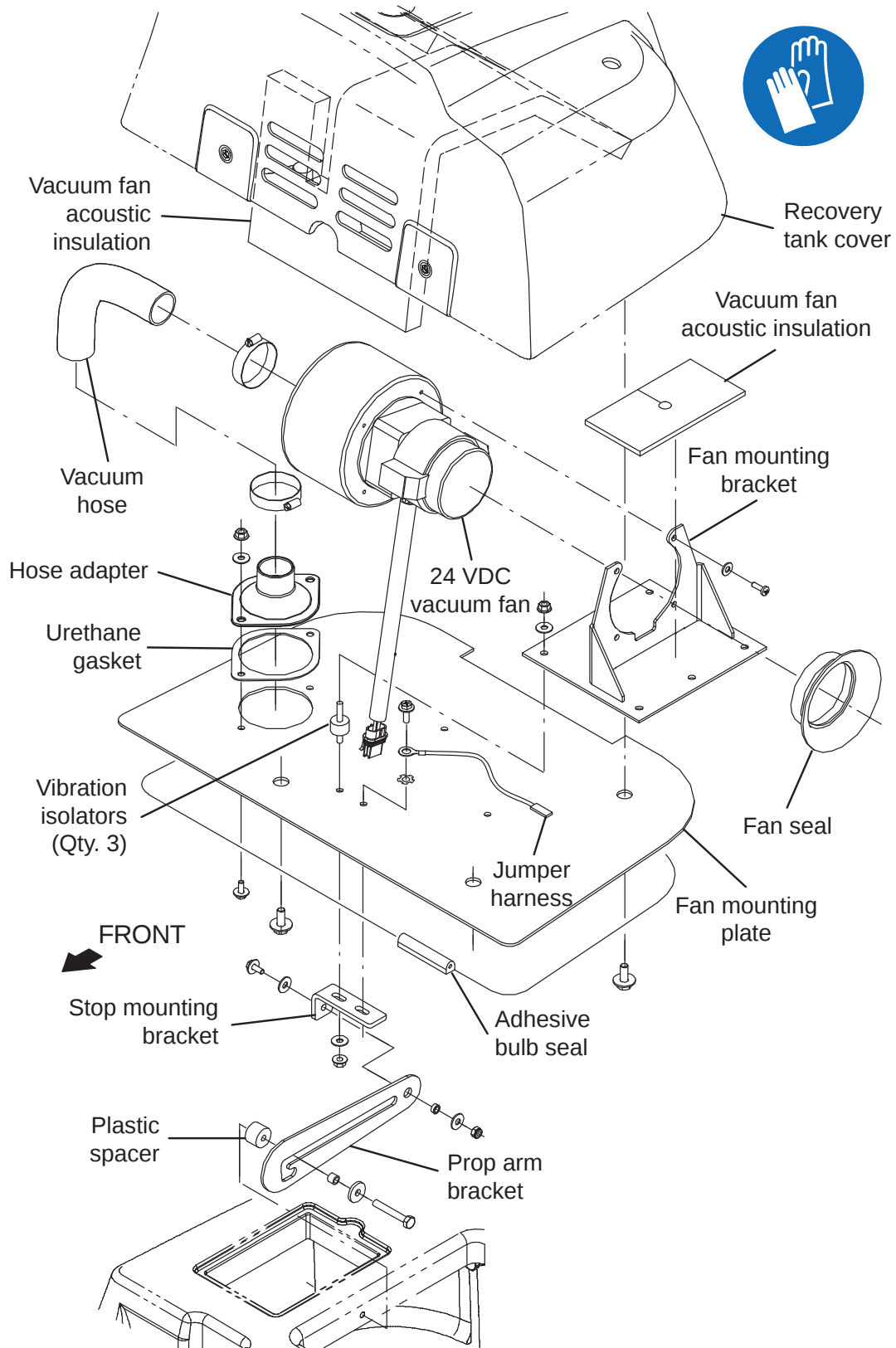
1. Disassemble the brake assembly from the drive wheel assembly. See REMOVE/REINSTALL/REPLACE THE ENCODER AND PARKING BRAKE.
2. Use a 0.35 mm thickness gauge to check the air gap. The brake air gap is  $0.2 \pm 0.05$  mm nominal. If it is possible to fit the 0.35 mm thickness gauge into the air gap the 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



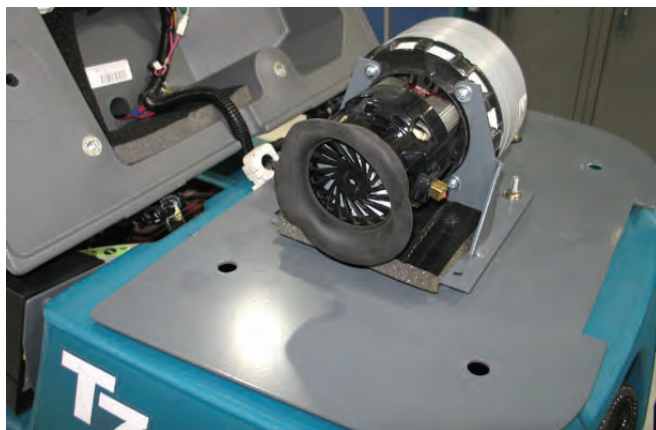
**REMOVE/REINSTALL/REPLACE THE VACUUM FAN**

**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 ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

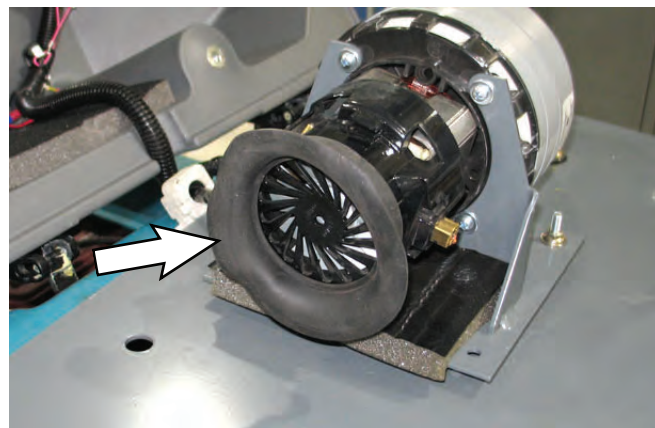
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

4. Remove the hardware securing the recovery tank cover to the fan mounting plate and lower the fan mounting plate onto the recovery tank opening, allowing access to the vacuum fan.



*NOTE: Do not completely remove the recovery tank cover from the machine. All components mounted to the recovery tank cover can be easily accessed with the recovery tank cover installed on the machine.*

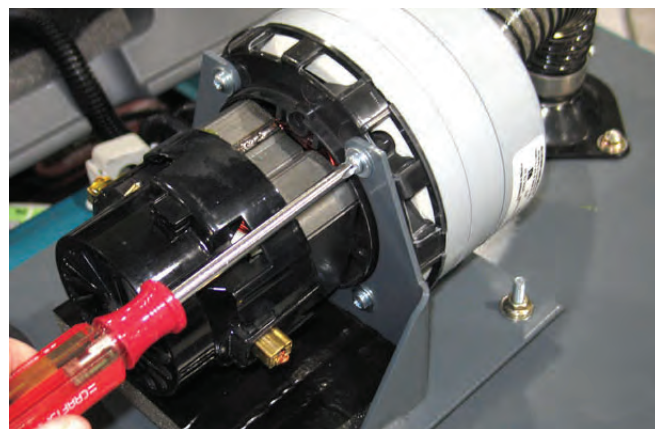
5. Remove the fan seal from the vacuum fan.



6. Disconnect the main wire harness from the vacuum fan.
7. Disconnect the vacuum hose from the vacuum fan



8. Remove the vacuum fan from the fan mounting bracket.



9. Install the fan seal onto the new vacuum fan/ removed vacuum fan .
10. Install the new vacuum fan/removed vacuum fan onto the fan mounting bracket.

11. Connect the vacuum hose to the vacuum fan.
12. Reconnect the main wire harness to the vacuum fan.
13. Reinstall the vacuum fan cover onto the fan mounting plate.

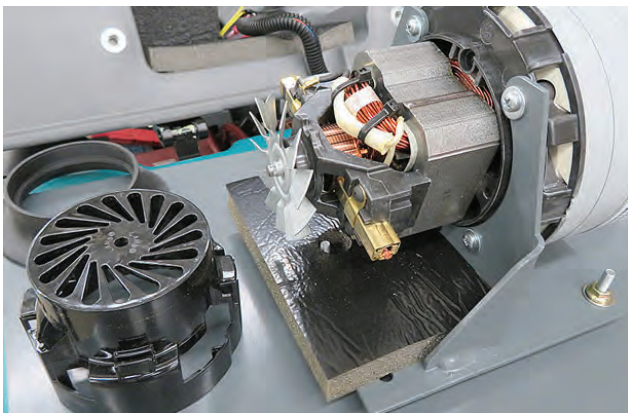
### REMOVE/INSPECT/REPLACE THE RECOVERY TANK VACUUM FAN CARBON BRUSHES

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

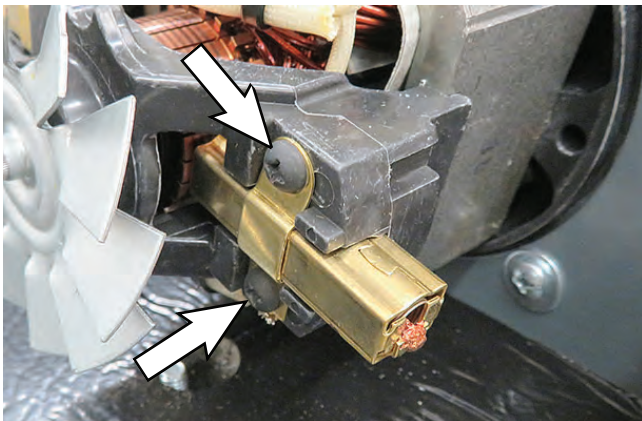
**FOR SAFETY:** When servicing machine, disconnect battery connection and charger cord before working on machine.

*NOTE: Carbon brushes should be replaced as sets.*

1. Remove the fan seal from the vacuum fan.
2. Remove the vacuum fan cover from the vacuum fan.



3. Loosen the carbon brush retainer mounting hardware.



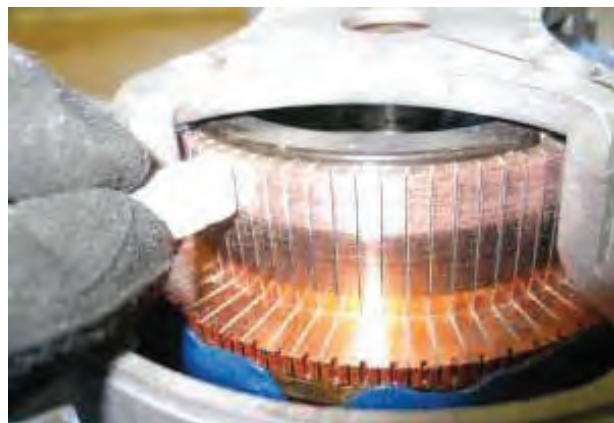
4. Remove the carbon brush from the vacuum fan motor.



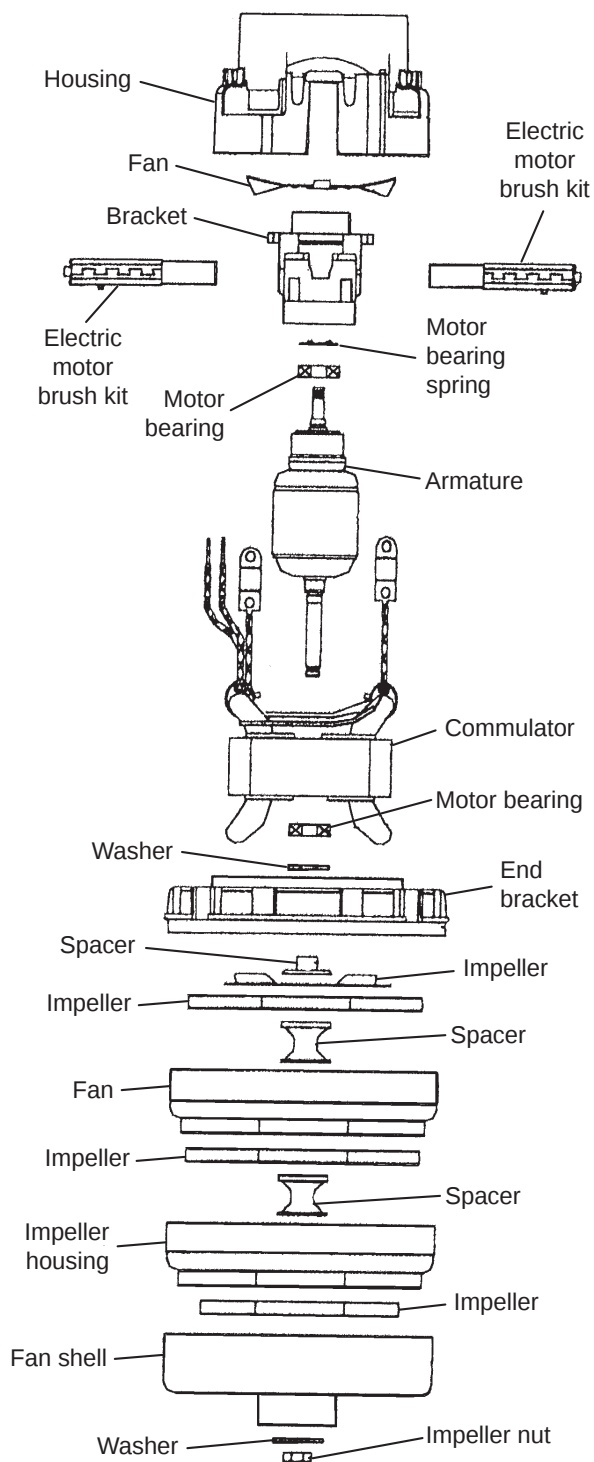
5. Inspect carbon brushes. Replace carbon brushes if they are stuck or are less than 10 mm (0.375 in.) in length.



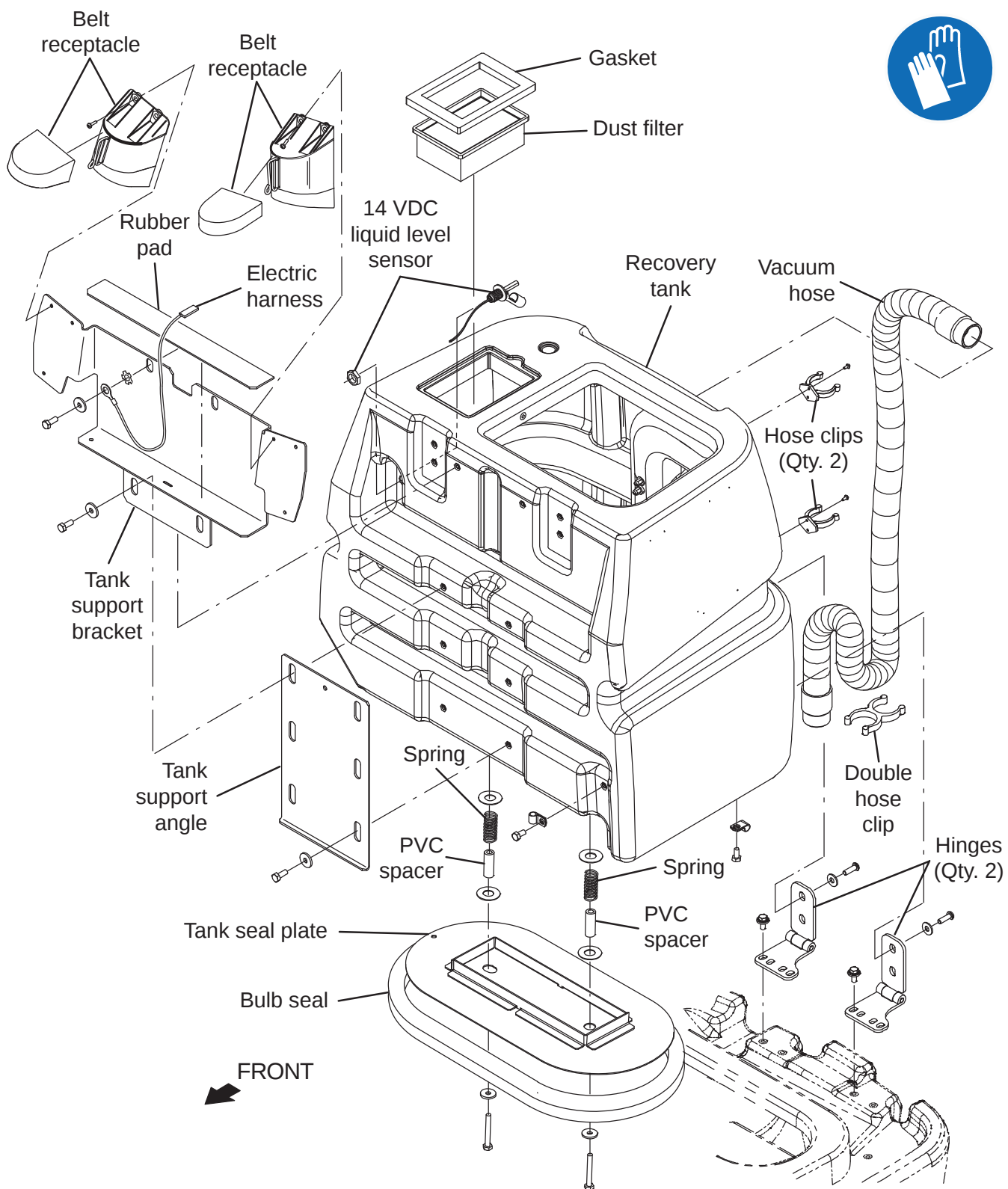
6. Use a stone to clean the commutator.



7. Use compressed air to clean dust from inside the vacuum fan motor.
8. Reinstall the removed vacuum fan brushes/install the new vacuum fan brushes in reverse order of disassembly.
9. Repeat procedure to remove or replace remaining vacuum fan carbon brushes.



RECOVERY TANK GROUP



## REMOVE/REINSTALL/REPLACE 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 ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

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

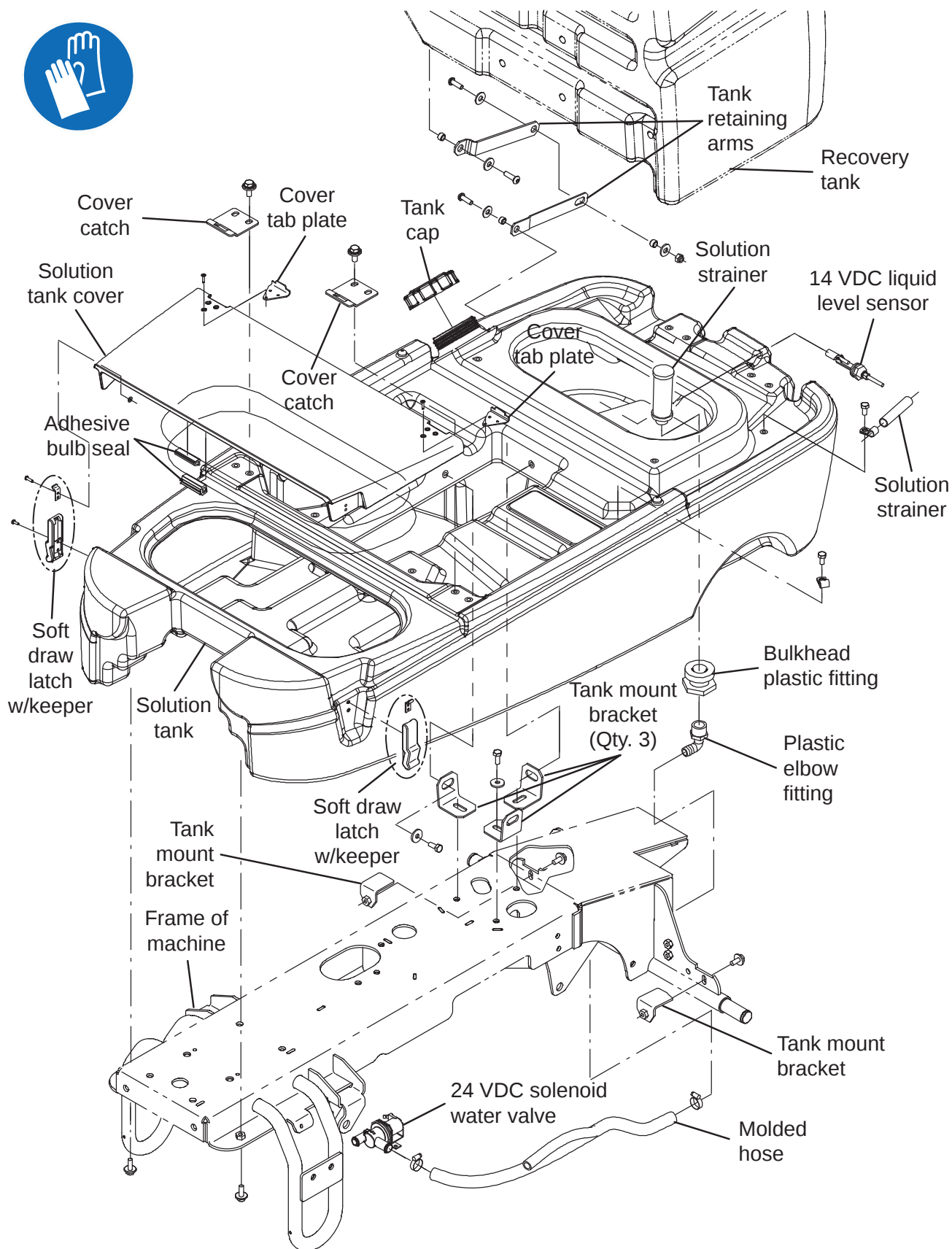
4. Remove the operator seat/seat plate from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



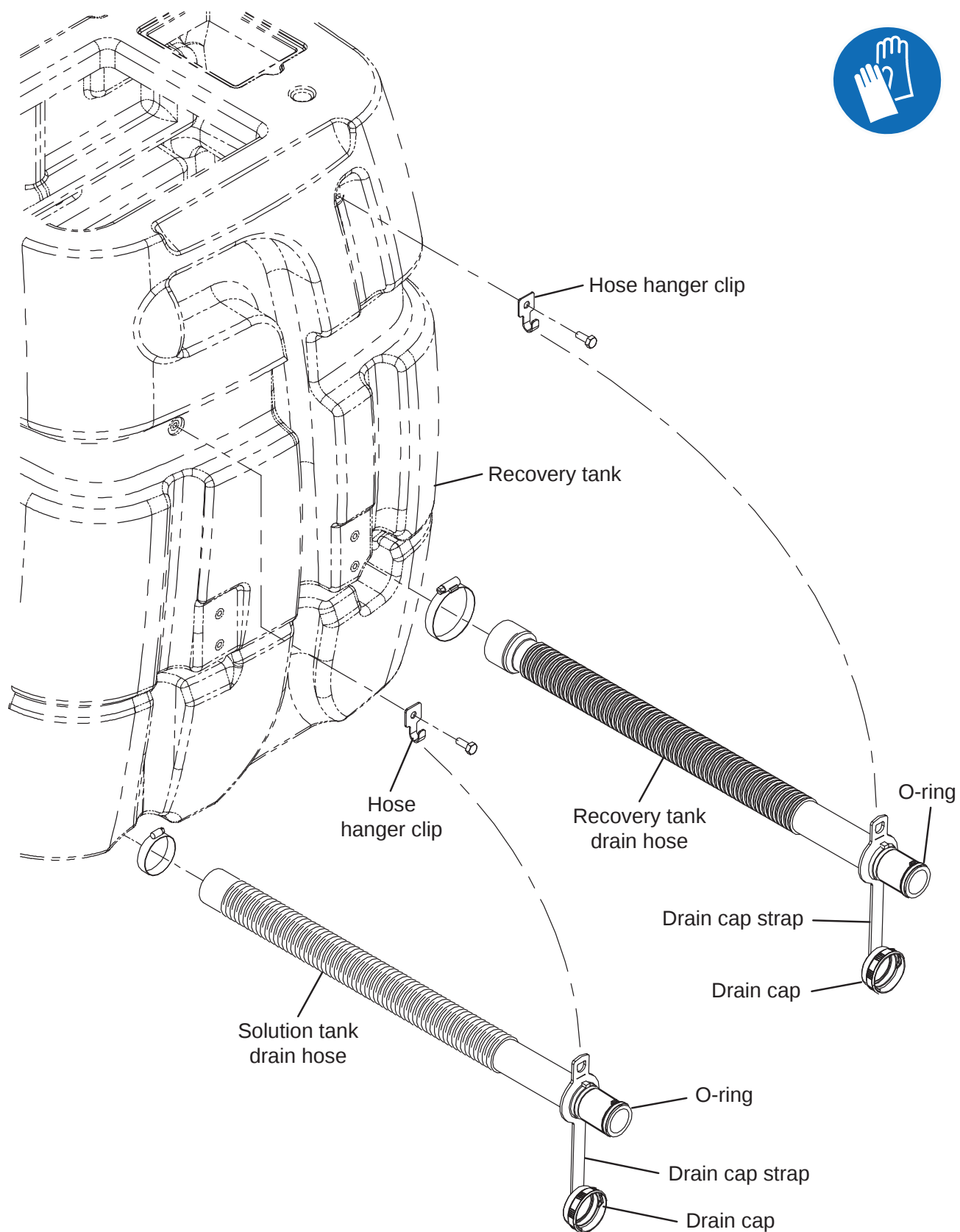
6. Remove the tank support bracket and tank support angle from the machine.
7. Disconnect the main wire harness from the recovery tank cover assembly and the liquid level sensor.
8. Remove the gasket and dust filter from the recovery tank.
9. Remove all hose clips from the recovery tank.
10. Remove the belt receptacles from the recovery tank.
11. Remove the recovery tank cover assembly from the machine.

12. Remove the level sensor from the recovery tank.
13. Remove all hose clamps from the recovery tank.
14. Remove the hardware securing the recovery tank to the tank seal plate.
15. Remove the hardware securing the recovery tank to the hinges installed on the solution tank.
16. Install the new recovery tank onto the tank seal plate and solution tank.
17. Install the liquid level sensor into the recovery tank.
18. Install the recovery tank cover assembly onto the recovery tank.
19. Connect the main wire harness to the liquid level sensor and the recovery tank cover assembly.
20. Install all removed components onto the recovery tank in reverse order of disassembly.
21. Pour water into the recovery tank and observe around the area where the recovery tank is secured to the tank seal plate. There should be no leaks.
22. Reinstall the operator seat/seat plate onto the machine.

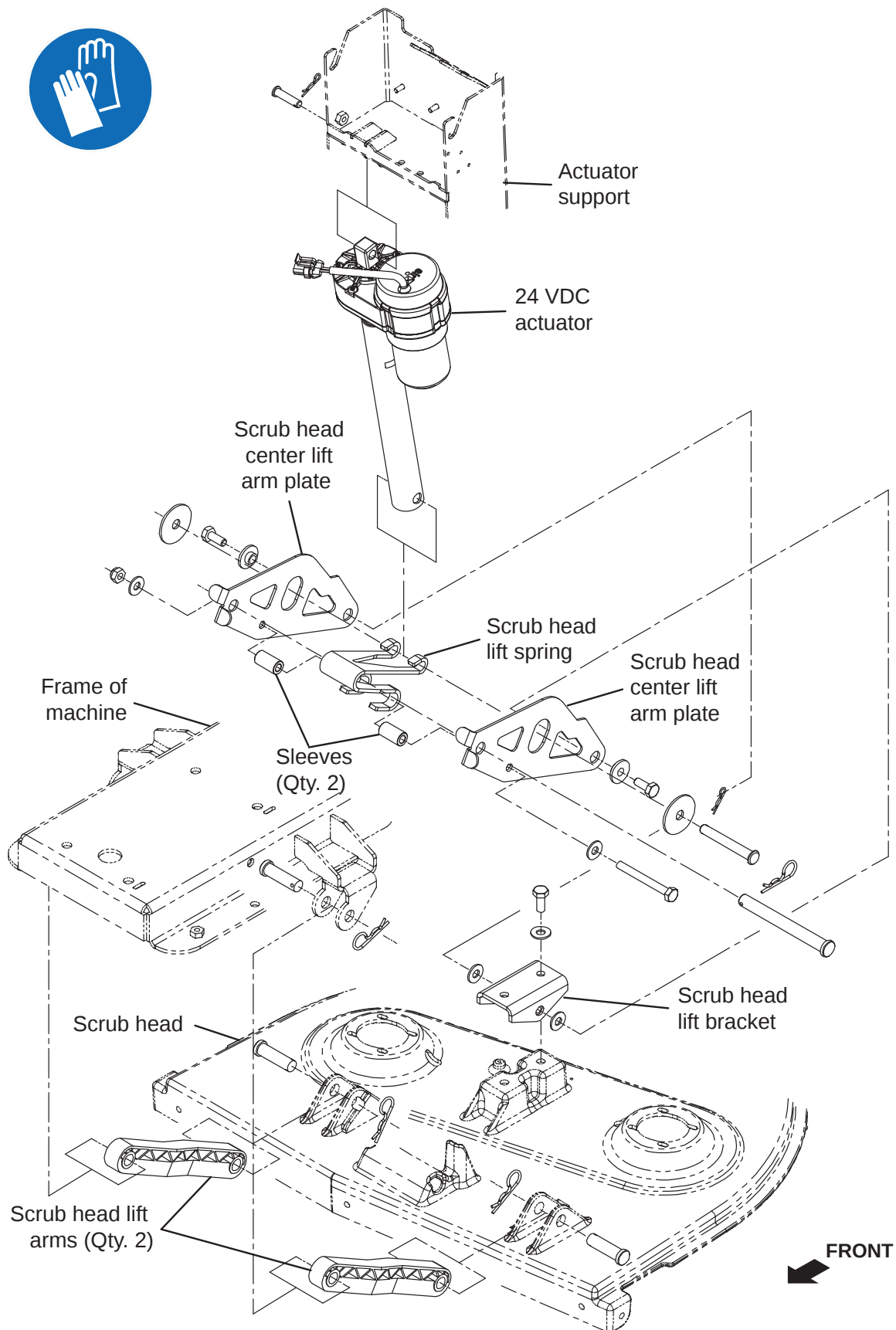
## SOLUTION TANK GROUP



## SOLUTION TANK/RECOVERY TANK DRAIN HOSES



SCRUBBING SYSTEMS



**REMOVE/REINSTALL/REPLACE THE SCRUB HEAD**

1. Completely empty the solution tank and recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Remove the brushes from the scrub head.
4. Turn ON the machine, completely lower the scrub head to the floor, turn OFF the machine, and remove the key.

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

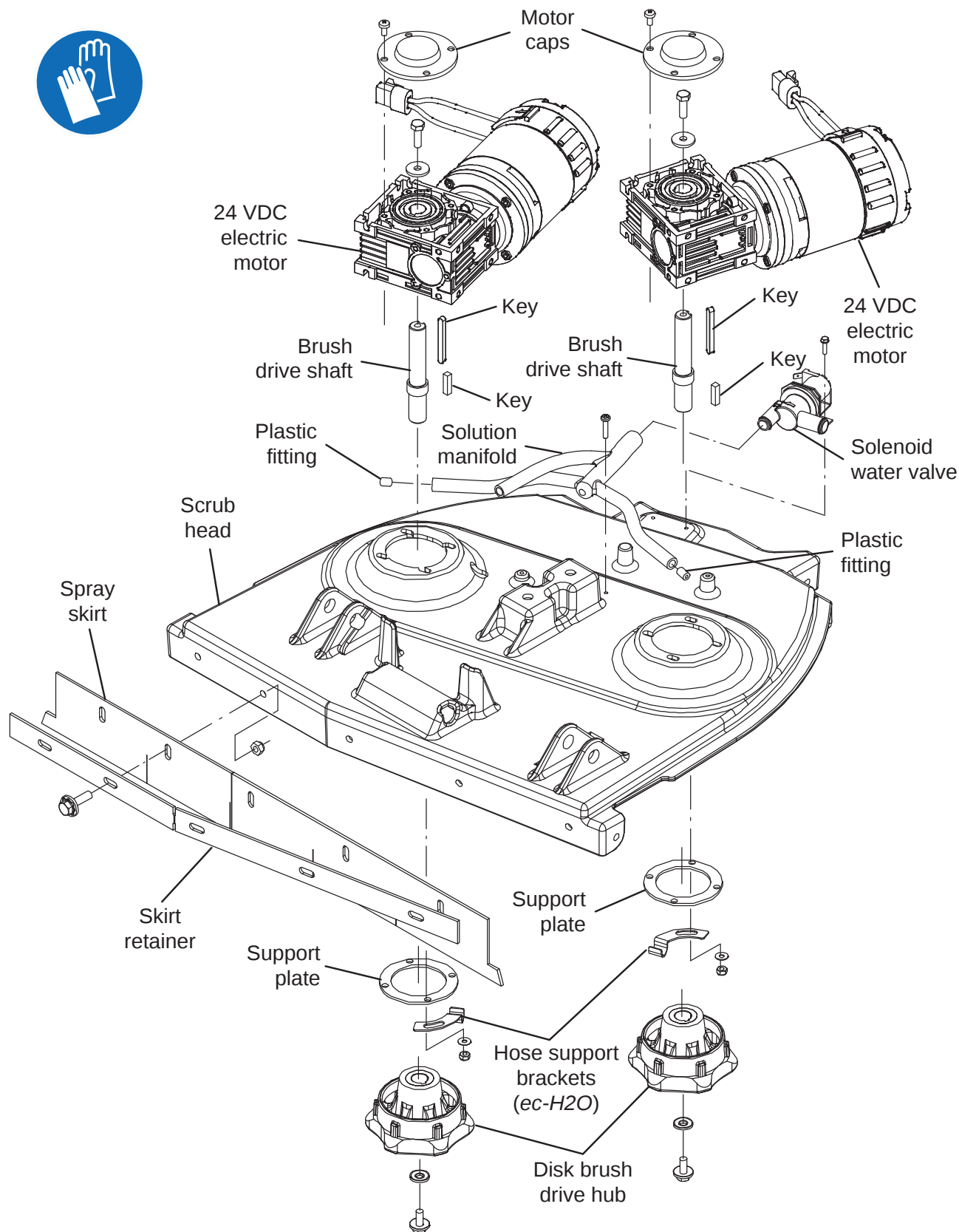
5. Remove either the right rear guard or the left rear guard from the machine, depending on the side of the machine from which the scrub head is being removed. See MAIN FRAME GROUP for right rear guard/left rear guard.
6. Disconnect the battery cable from the machine.

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

7. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
8. Remove the clevis pin/cotter pin securing the scrub actuator to the actuator support.
9. Remove the clevis pins/cotter pins securing the scrub head lift arms to the frame of the machine and the scrub head.
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 water solenoid valve located at the rear of the scrub head.
12. Remove the hardware securing the scrub actuator to the scrub head.

13. Remove the scrub head from under the machine.
14. If replacing the scrub brush motor carbon brushes, proceed to REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTOR CARBON BRUSHES.
15. If replacing scrub head motor(s), proceed to REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTORS.
16. Reinstall the scrub head onto the machine in reverse order of disassembly.

## REMOVE/REINSTALL/REPLACE THE SCRUB HEAD MOTORS



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

1. Turn the ON/OFF 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 operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Remove the scrub head from the machine. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD.
5. Remove the disk brush drive hub from the removed scrub brush motor. Do Not lose/misplace the smaller key. This key is needed to install the disk drive hub onto the new scrub brush motor.
6. Remove the scrub brush motor from the scrub head.
7. Install the new scrub brush motor onto the scrub head.
8. Place the saved key into the notch in the brush drive shaft and install the disk brush drive hub onto the new scrub brush motor.
9. Repeat procedure if replacing the other scrub brush motor.
10. Reinstall the scrub head onto the machine in reverse order of disassembly.

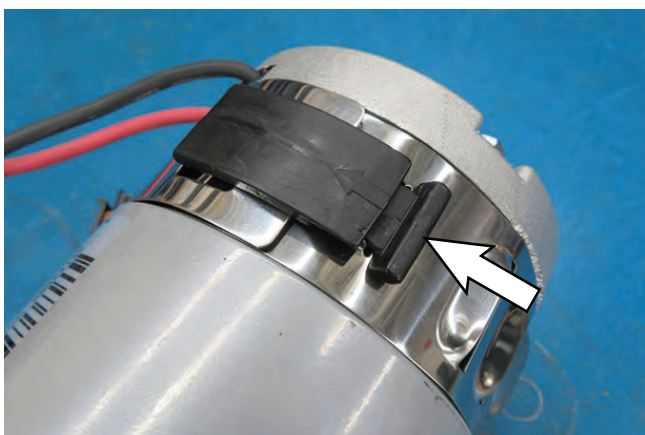
## REMOVE/REINSTALL/REPLACE THE DISK SCRUB HEAD MOTOR CARBON BRUSHES

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

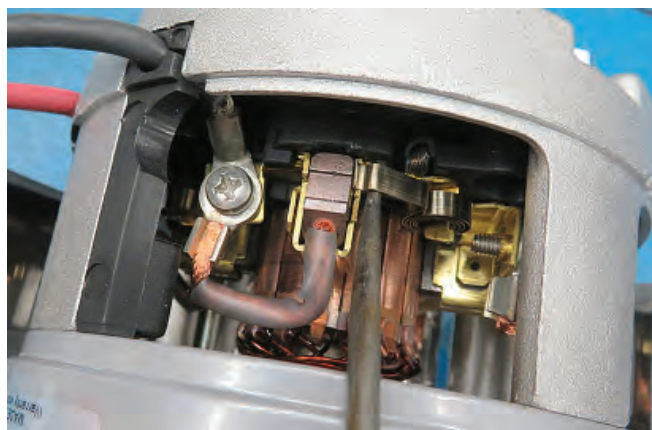
1. Turn the ON/OFF key switch OFF.
2. Disconnect the battery cable from the machine.

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

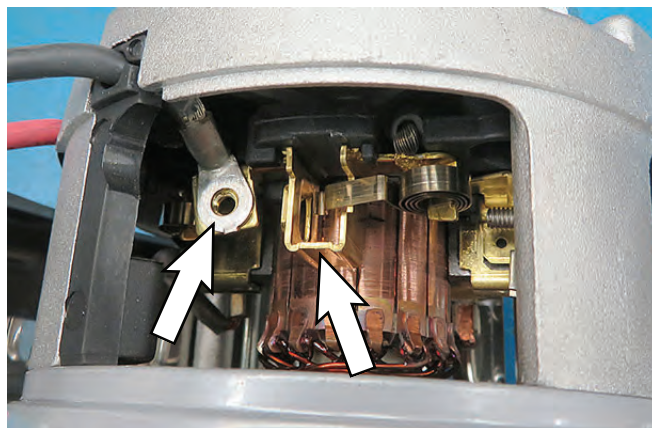
3. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
4. Remove the scrub head from the machine. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD.
5. Remove the scrub brush motor(s) from the scrub head. See REMOVE/INSTALL/REPLACE THE SCRUB HEAD MOTORS.
6. Loosen and remove the band covering the carbon brushes from the scrub brush motor.



7. Lift the clip securing the carbon brush inside the scrub brush motor and pull the carbon brush from the retainer.



8. Remove the hardware securing the carbon brush cable to the scrub brush motor and remove the carbon brush from the motor.



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

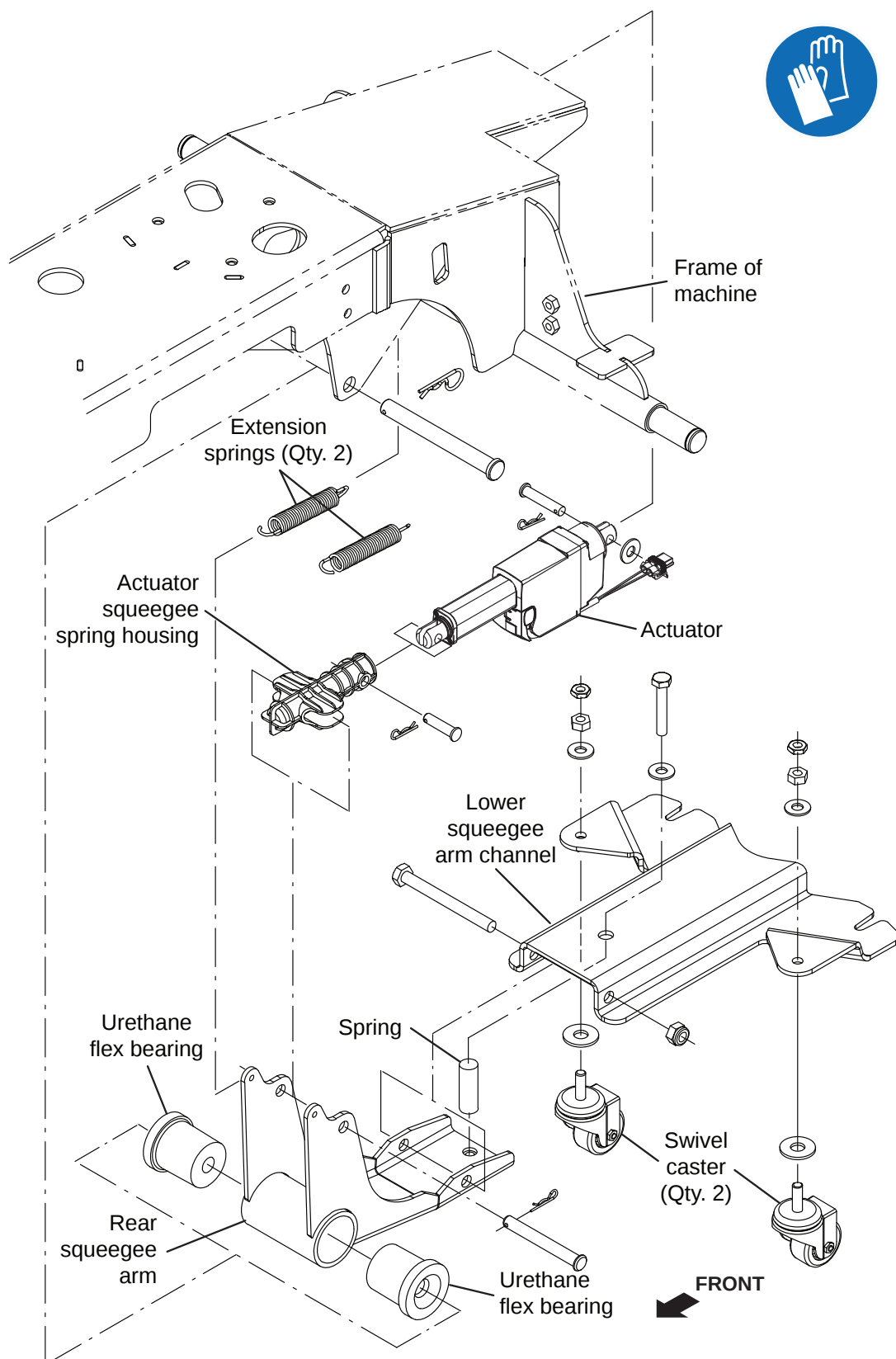


10. Install a new carbon brush/reinstall the removed carbon brush into the scrub brush motor in reverse order of disassembly.
11. Repeat procedure to remove or replace the remaining scrub brush motor carbon brushes.
12. Reinstall the retaining band onto the motor.
13. Reinstall the scrub brush motor onto the scrub head.
14. Reinstall the scrub head onto the machine.





## REAR SQUEEGEE LIFT GROUP



**ATTENTION: DO NOT** tip the machine onto its side to replace the rear squeegee actuator. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.

## REMOVE/REINSTALL/REPLACE THE REAR SQUEEGEE ACTUATOR

1. Completely empty the solution tank and the recovery tank.

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

2. Turn the ON/OFF key switch OFF

**ATTENTION: DO NOT tip the machine onto its side to replace the rear squeegee actuator. Sensitive robotic components could be damaged or bumped out of adjustment if the machine is tipped onto its side.**

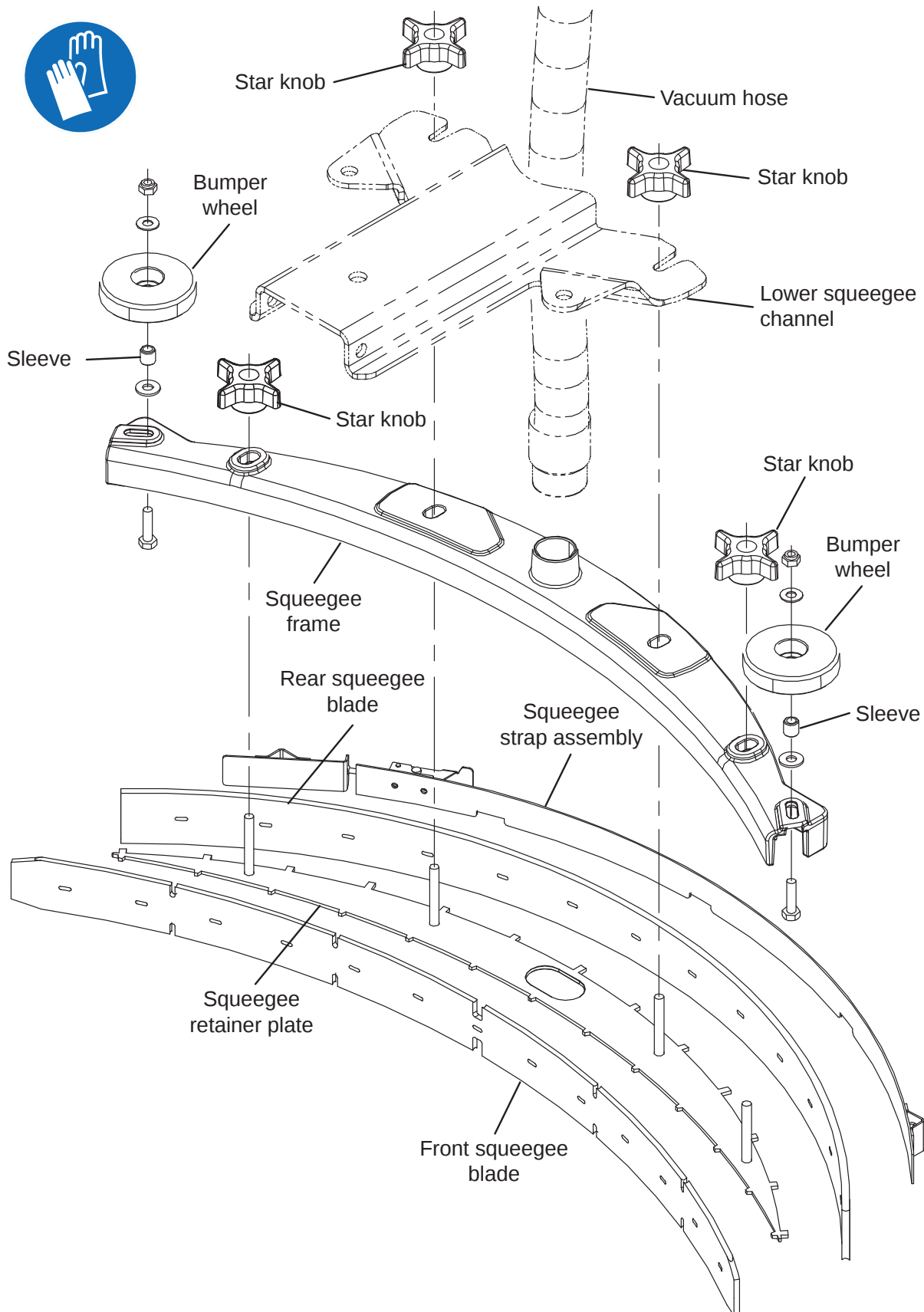
3. Remove the front guard from the machine. See REMOVE/INSTALL THE FRONT GUARD
4. Disconnect the vacuum hose from the rear squeegee assembly and remove the rear squeegee assembly from the machine.
5. Place a chock in front of the drive wheel.
6. Jack up the rear end of the machine high enough to access/remove the squeegee actuator from the machine and place jack stands/blocks under both rear jacking locations.

**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.**

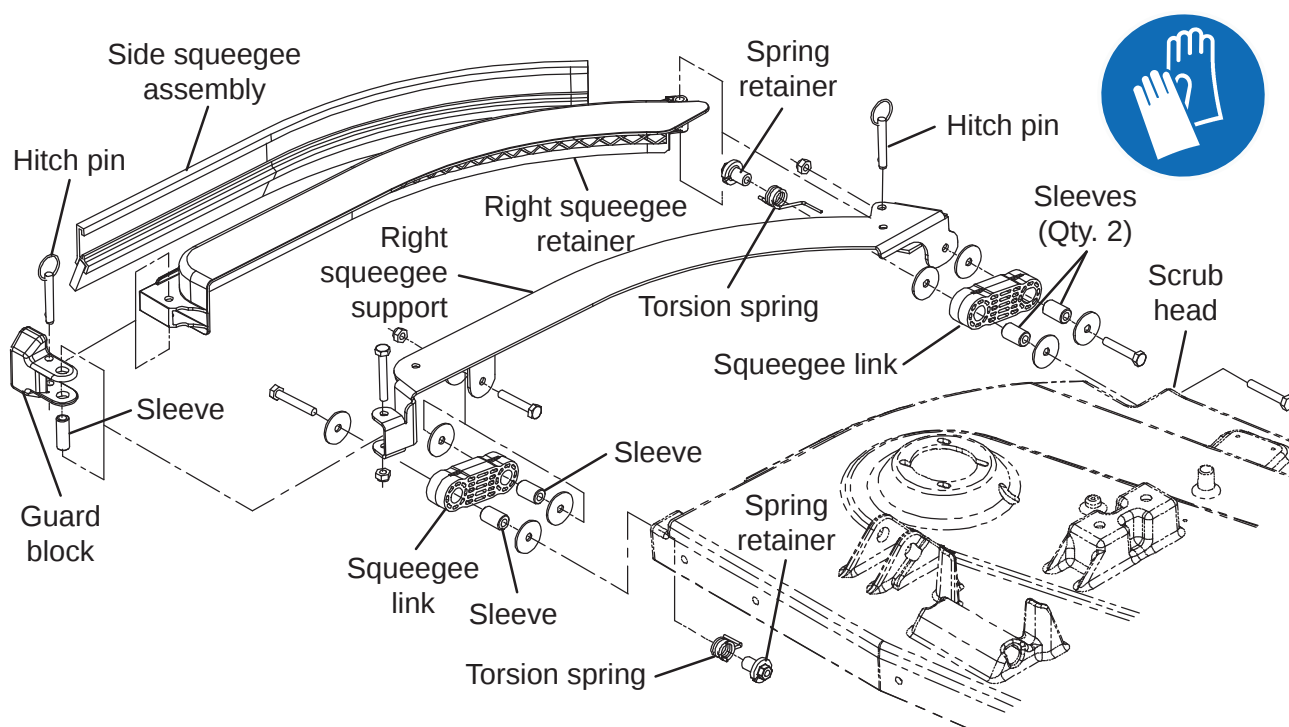
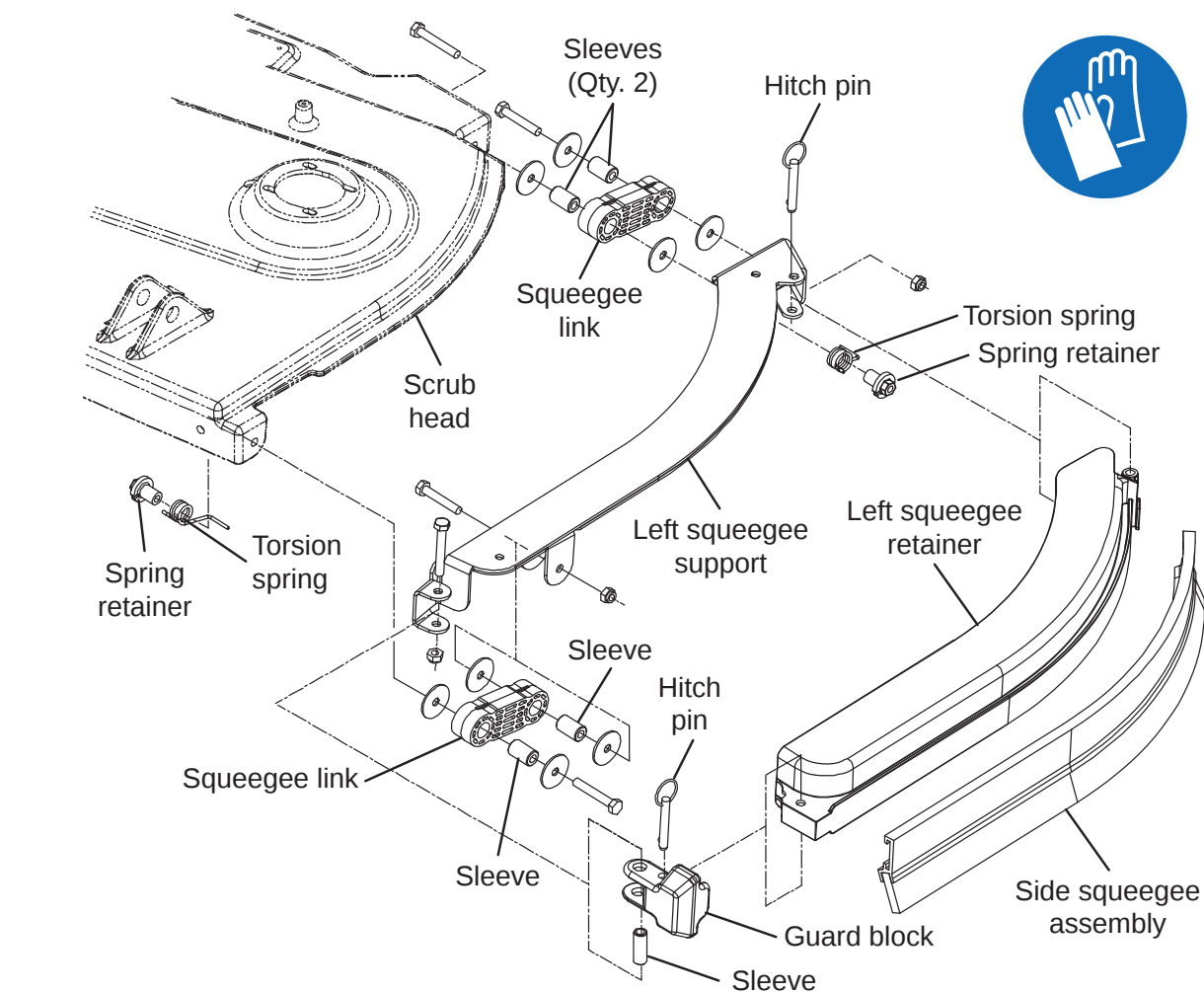
7. Turn the ON/OFF key switch ON.
8. Completely lower the squeegee so the actuator is fully extended.
9. Turn the ON/OFF key switch OFF.
10. Disconnect the battery cable from the machine.
11. Disconnect the main wire harness from the actuator.

12. Remove the cotter pin/clevis pin securing the rear squeegee arm to the actuator squeegee spring housing,
13. Disconnect the extension springs from the rear squeegee arm.
14. Remove the cotter pin/clevis pin securing the rear squeegee arm to the frame of the machine.
15. Remove the rear squeegee arm/lower squeegee arm channel from under the machine.
16. Remove the cotter pin/clevis pin securing the actuator to the frame of the machine.
17. Install the new actuator onto the frame of the machine.
18. Reinstall all rear squeegee components removed to remove the actuator in reverse order of disassembly.
19. Jack machine off from jack stands/blocks, remove jack stands/blocks from under the machine, and lower the machine to the floor.
20. Install the rear squeegee onto the machine.

REAR SQUEEGEE

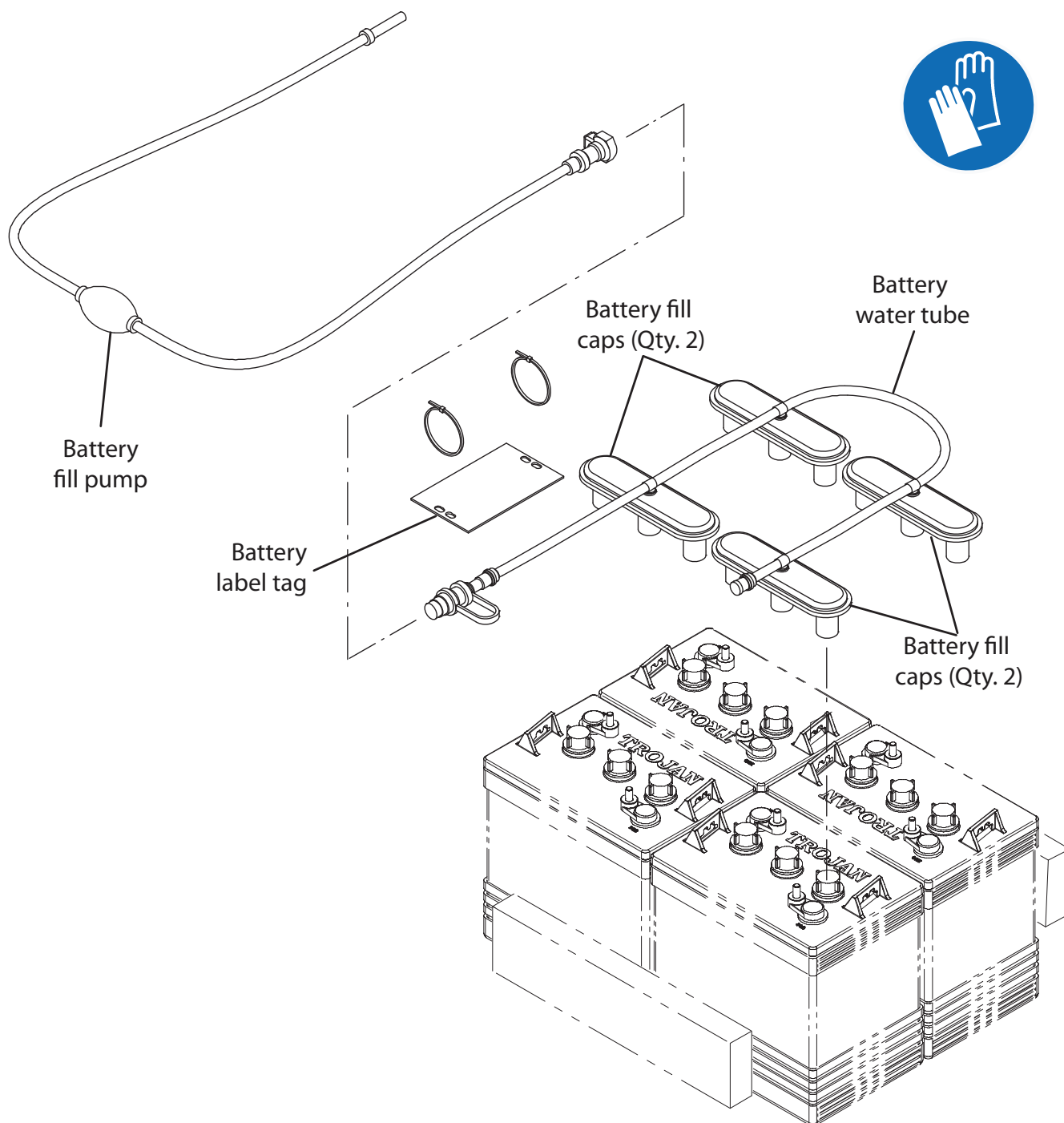


## SIDE SQUEEGEES



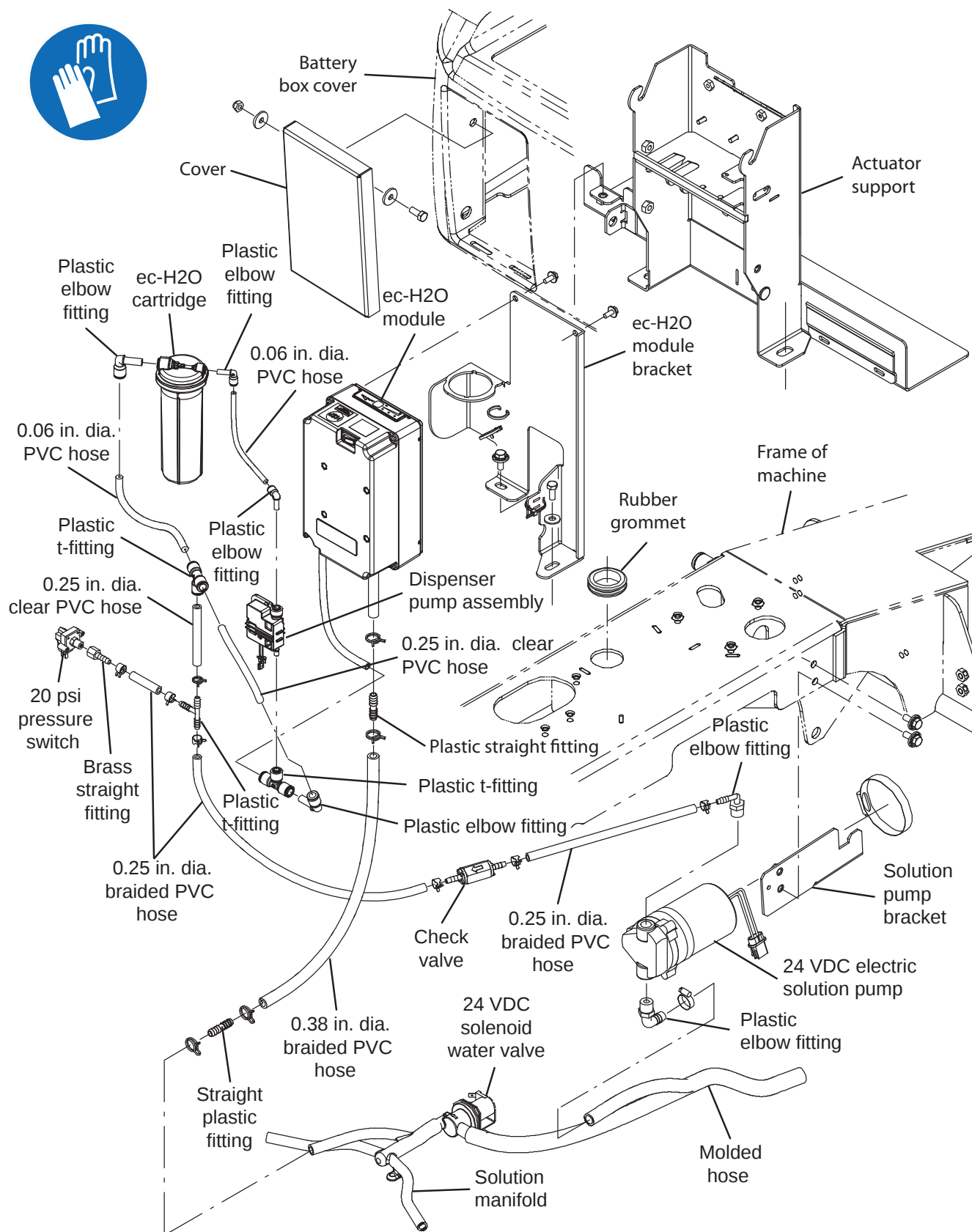
OPTIONS

BATTERY WATERING SYSTEM (OPTION)





ec-H2O NanoClean GROUP



**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. Completely lower the scrub head.
3. Turn the ON/OFF key switch OFF.
4. Disconnect the battery cable from the machine.

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

5. If necessary, jack up the back end of the machine to allow easier access to the ec-H2O solution pump.

**FOR SAFETY:** When servicing machine, jack machine up at designated locations only. Support machine with jack stands. Use jack or hoist that will support the weight of the machine.

6. If machine is jacked up off the floor, position jack stands under the back end of the machine and lower the machine onto the jack stands.
7. Loosen the hose clamp securing the ec-H2O pump to the pump mounting bracket and remove the ec-H2O pump from the pump mounting bracket.
8. Disconnect both solution hoses from the ec-H2O pump.
9. Disconnect the main wire harness from the ec-H2O pump.
10. Connect the solution hoses and main wire harness to the new/removed ec-H2O pump.
11. Reinstall the ec-H2O pump onto the pump mounting bracket.
12. Remove the jack stands from under the machine and lower the machine to the floor.

**REMOVE/REINSTALL/REPLACE THE ec-H2O PRESSURE SWITCH (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 ON/OFF key switch OFF.
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 operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Disconnect the main wire harness from the pressure switch.
6. Remove the pressure switch from the brass straight fitting.
7. Install the new/removed pressure switch onto the brass straight fitting.
8. Connect the main wire harness to the pressure switch.
9. Reinstall all items removed from the machine to access the pressure switch.

### 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.

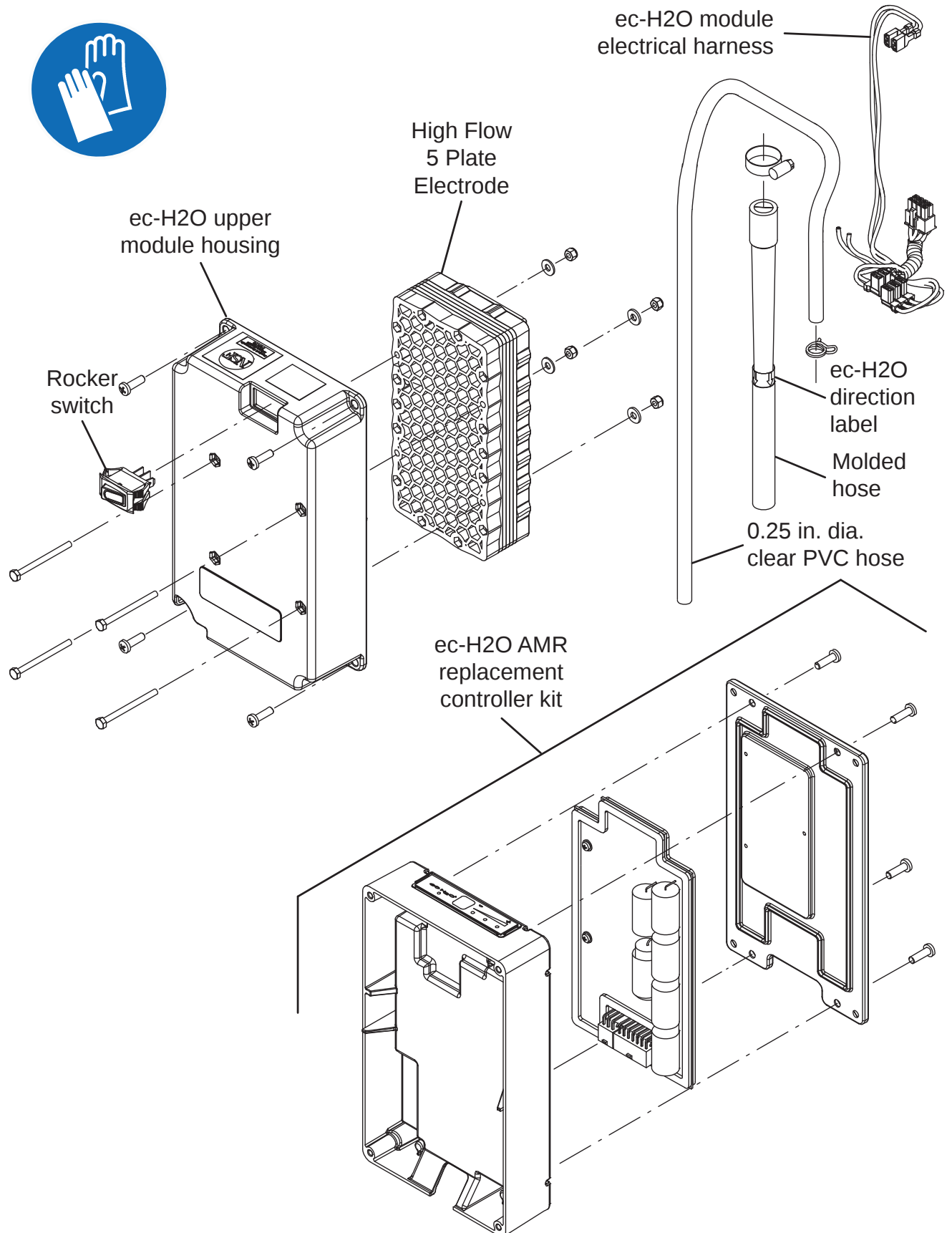
1. Completely drain the solution tank and the recovery tank.
2. Turn the ON/OFF key switch OFF.
3. Disconnect the battery cable from the machine.

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

4. Remove the operator seat/seat plate and battery box cover from the machine. See REMOVE/INSTALL THE OPERATOR SEAT/BATTERY BOX COVER.
5. Remove the hardware securing the ec-H2O module to the ec-H2O module bracket.
6. Disconnect all main wire harness connections from the ec-H2O module.
7. Disconnect all solution hoses from the ec-H2O module.
8. Carefully remove the ec-H2O module from the machine.
9. Reinstall removed ec-H2O module/install new ec-H2O module in the reverse order of disassembly.
10. Install all items removed from the machine to access the ec-H2O module.



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.



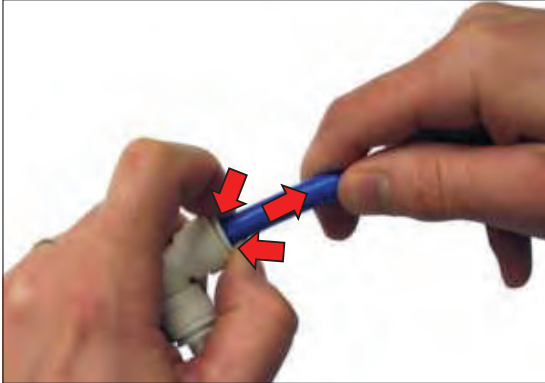
4. Pull on the fitting to ensure the hose connection is secure.



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. Turn the key switch OFF.
2. Lift the operator seat open and disconnect the main wire harness from the operator seat switch harness.



3. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



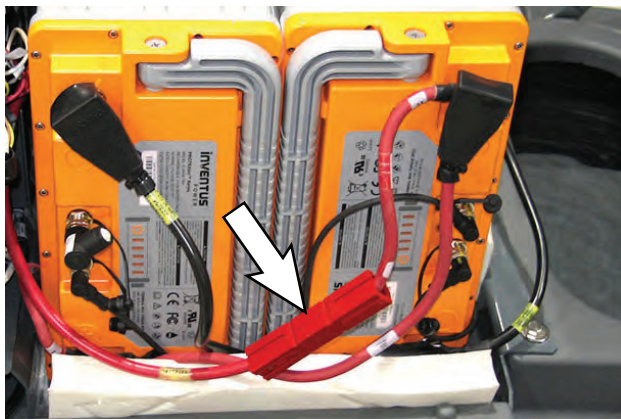
4. Remove the operator seat/seat plate from the machine.



5. Remove the battery box cover from the machine.



6. Disconnect the battery cable from the machine.



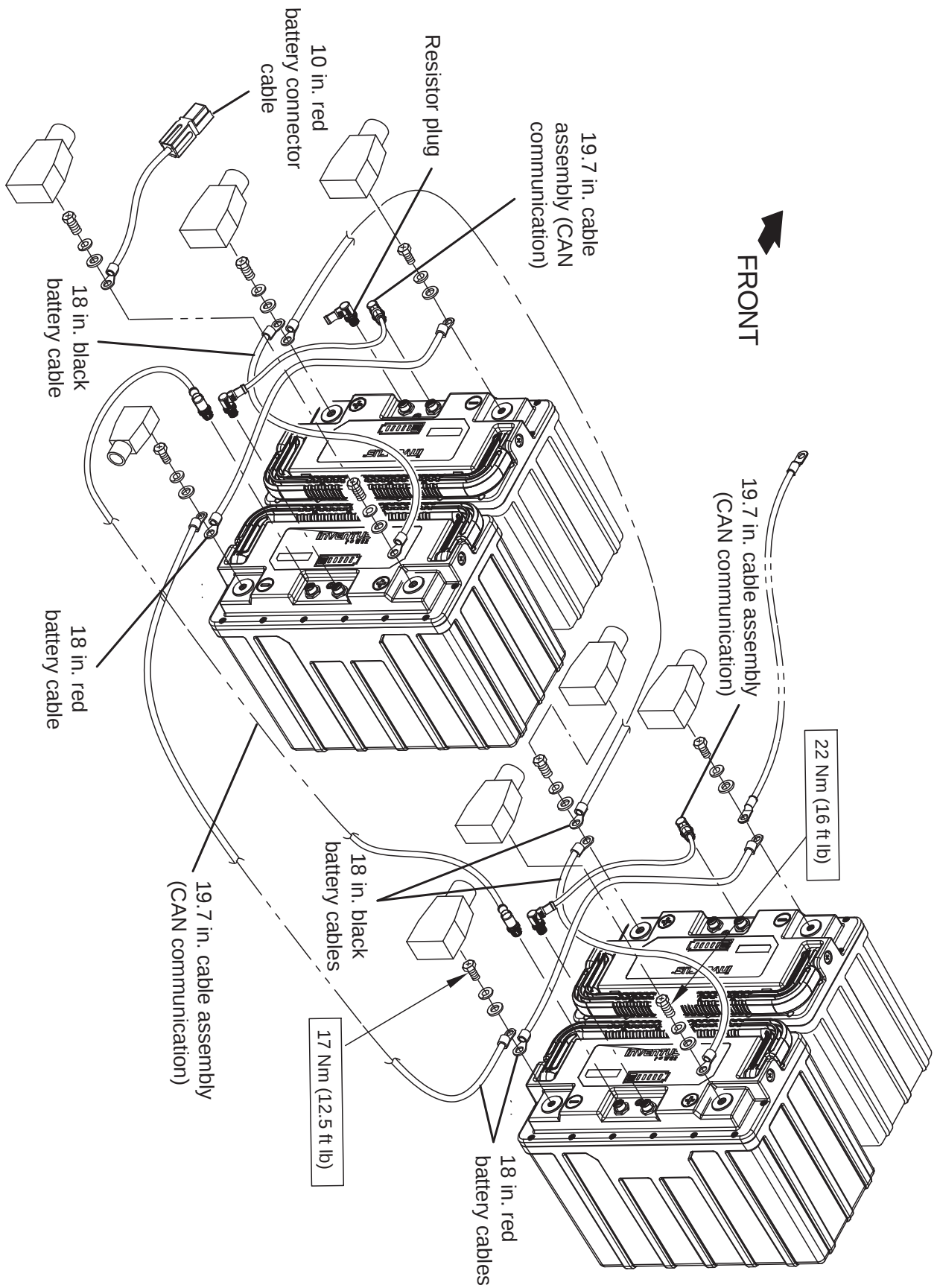
7. Inspect all red (+) cables and black (-) cables for damage.
8. Repair/replace damaged red (+) cables and black cables (-). Ensure cables are all correctly torqued to the batteries.

Torque red (+) connections to 22 Nm (16 ft. lbs.)

Torque black (-) connections to 17 Nm (12.5 ft. lbs.)

9. Proceed to TROUBLESHOOT UI POWER ELECTRIC HARNESS (J7-8/J7-10) if issue persists.
10. Inspect the lithium battery CAN communication cables for obvious damage.
11. 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.).
12. 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. Turn the key switch OFF.
2. Lift the operator seat open and disconnect the main wire harness from the operator seat switch harness.



3. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



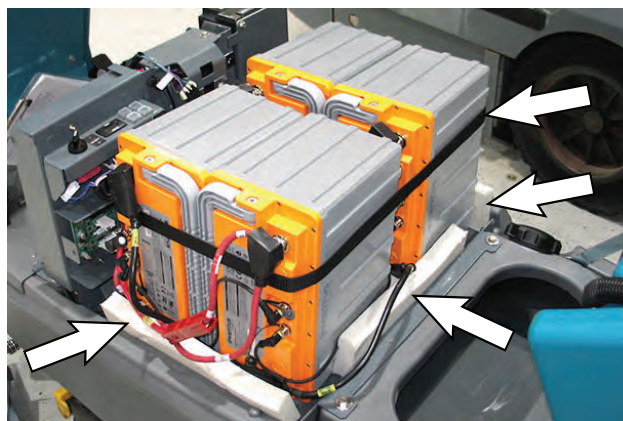
4. Remove the operator seat/seat plate from the machine.



5. Remove the battery box cover from the machine.



6. Loosen the strap from around the batteries and remove the foam dividers from around and between the batteries.

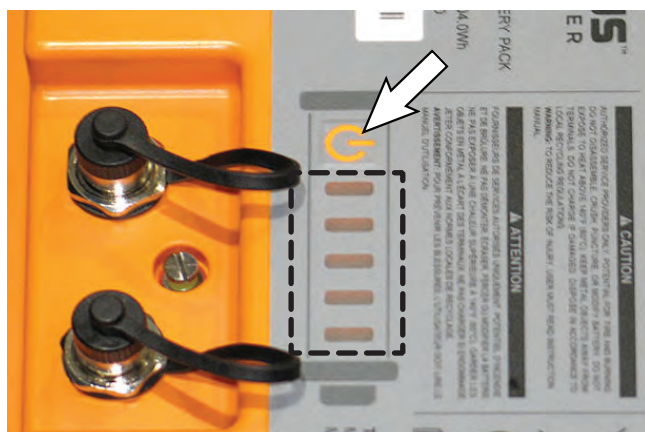


7. Move the batteries around in the battery compartment as necessary to allow access to/ view the individual battery power buttons, indicator lights, and terminals.

*NOTE: If necessary, slightly prop the batteries enough to allow easier access to/view the power buttons, indicator lights, and terminals during troubleshooting. To avoid arcing/damaging the batteries, **Do Not** use a conductive tool or object to prop batteries.*



8. Press power button for 1 second on each battery to see the battery status. Observe the indicator lights on each battery.



If the indicator 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.<br>2. If fault persists, contact T.A.C. for further assistance.                                                                                                                                                                                                         |
| F1       |                                 | Over Temperature (BMS)                           | 1. Allow temperature to lower into acceptable operating range.<br>2. If fault persists, contact T.A.C. for further assistance.                                                                                                                                                                                                         |
| F2       |                                 | Under Temperature (Charge)                       | 1. Allow temperature to raise into acceptable operating range.<br>2. If fault persists, contact T.A.C. for further assistance.                                                                                                                                                                                                         |
| F3       |                                 | Over Current (Recoverable)                       | If charging:<br>1. Power cycle charger.<br>2. Replace charger if fault persists.<br>If discharging:<br>1. Disconnect battery cable from batteries.<br>2. Reconnect battery cable to batteries.<br>3. Battery should resume operation after discharge has been stopped.<br>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.<br>2. Repair electrical connections as necessary.<br>3. If fault persists, contact T.A.C. for further assistance.                                                                                                                                                                |
| F6       |                                 | Cell Under Voltage-During Discharge Only         | 1. Recharge battery.<br>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.<br>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.<br>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.<br>2. If fault persists, replace charger.                                                                                                                                                        |
| F11      |  | Charge Fault                  | 1. Power cycle charger.<br>2. If fault persists, replace charger.                                                                                                                                                        |
| F12      |  | Under Temperature (Discharge) | 1. Allow temperature to raise into acceptable operating range.<br>2. If fault persists, contact T.A.C. for further assistance.                                                                                           |
| F13      |  | Miscellaneous Fault           | 1. Power cycle battery.<br>2. If fault persists, replace battery.                                                                                                                                                        |
| F14      |  | Pre-Discharge Fault           | 1. Disconnect cables from battery.<br>2. Observe indicator lights for a fault.<br>3. If no fault, reconnect cables to battery.<br>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

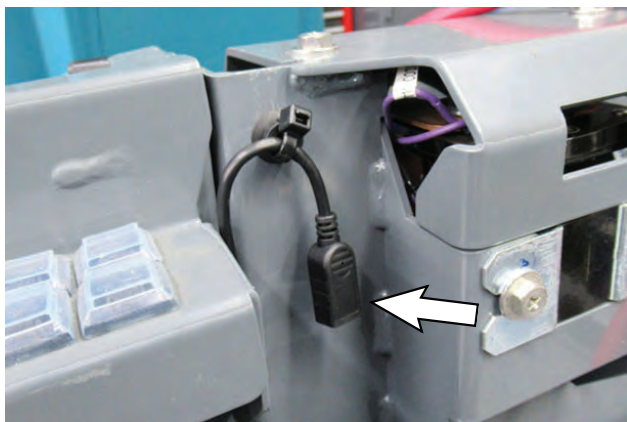
1. Disconnect the main wire harness from the seat switch and remove the operator seat from the machine.



2. Connect a USB cable to the service device.

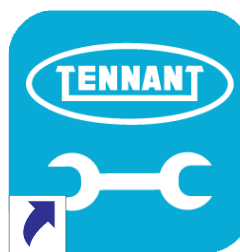
**ATTENTION:** *Never allow the metallic tip on the loose end of the service USB cable to touch a lithium battery positive (+) terminal when connecting the USB cable to the service device/lithium battery control board USB cable. USB cables, service device, and/or lithium battery control board could be damaged if loose metallic end of the service USB cable touches a lithium battery positive (+) terminal.*

3. 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.



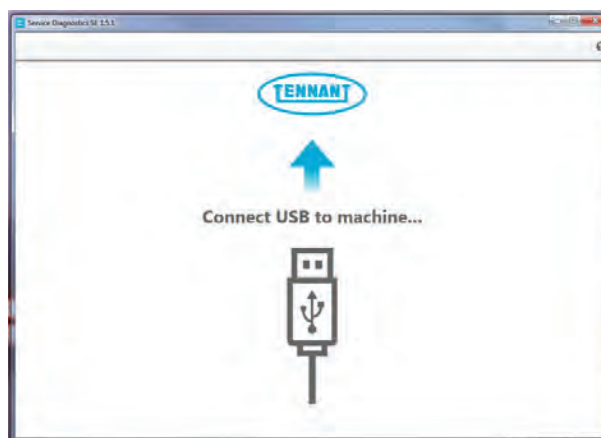
4. Turn the key switch ON.

5. Double click the Service Diagnostics desktop shortcut or find the software in All Programs to launch the software.



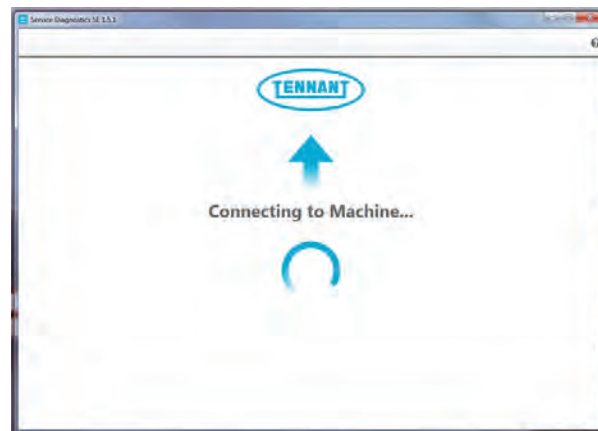
## Service Diagnostics

**NOTE:** *Confirm key switch is ON and check USB cable connection to the machine if the screen below appears on the service device.*

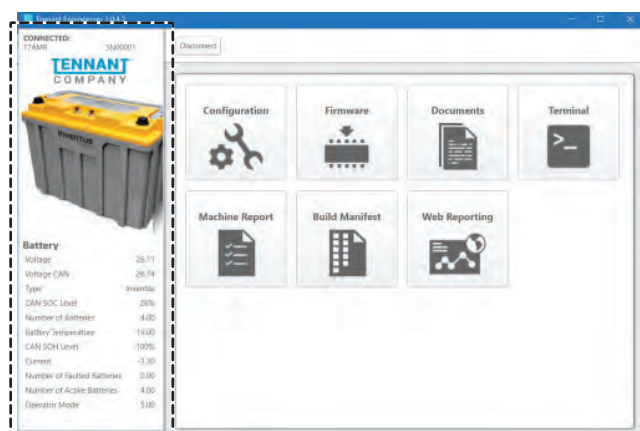


**NOTE:** *If Service Diagnostics does not move beyond the above screen, proceed to TROUBLESHOOT SERVICE DIAGNOSTIC CONNECTION.*

6. The Service Diagnostics tool now connects to the lithium ion battery network.



7. The lithium battery service screen opens.



8. 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         | 4.00     |
| Battery Temperature         | 19.00    |
| CAN SOH Level               | 100%     |
| Current                     | -3.30    |
| Number of Faulted Batteries | 0.00     |
| Number of Active Batteries  | 4.00     |
| 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 | <b>Voltage</b>                     | 20            |               | 28            | Volts            |
|                 | <b>Voltage CAN*</b>                | 20            |               | 28            | Volts            |
|                 | <b>Type</b>                        | Inventus      |               |               | NA               |
|                 | <b>CAN SOC Level</b>               | 0             |               | 100           | Percent (%)      |
|                 | <b>Number of Batteries</b>         | 0             | 4             | 4             | Quantity         |
|                 | <b>Battery Temperature</b>         | -20°C (-4°F)  |               | 55°C (131°F)  | Temperature      |
|                 | <b>CAN SOH Level</b>               | 80            |               | 100           | Percent (%)      |
|                 | <b>Current</b>                     | -150          |               | 90            | Amps             |
|                 | <b>Number of Faulted Batteries</b> | 0             | 0             | 4             | Quantity         |
|                 | <b>Number of Active Batteries</b>  | 0             | 4             | 4             | Quantity         |
|                 | <b>Operator Mode</b>               | 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 four (4.00). If number is less than four, 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 four (4.00). 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.

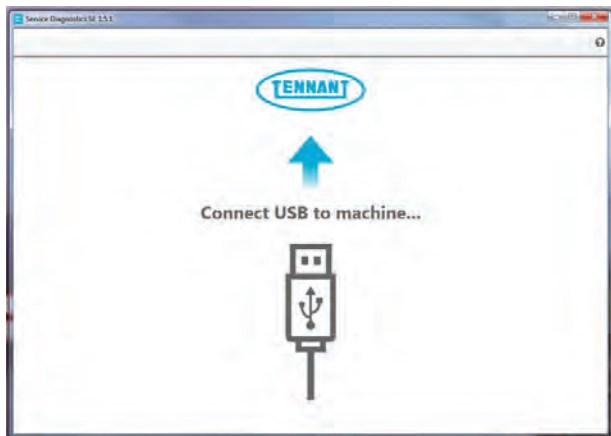
See TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4) to further troubleshoot if issue persists.

**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.

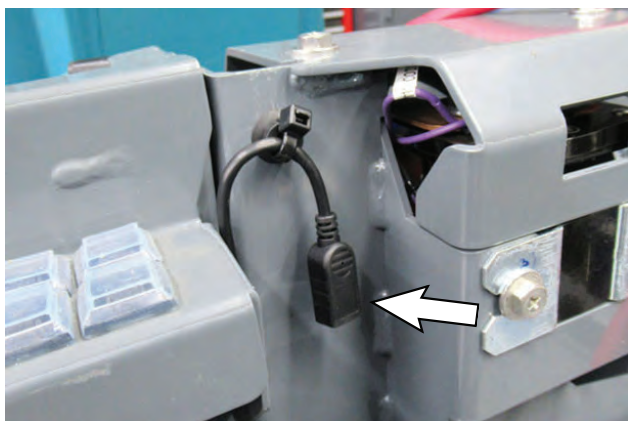
*NOTE: In some circumstances, if the battery pack is operating outside acceptable minimum/maximum range(s), not only will these issues appear on the lithium battery operational status screen, but could also appear as a fault on the UI (User Interface), and prevent the machine from being operated (flashing operator controls and indicators).*

## TROUBLESHOOT SERVICE DIAGNOSTIC CONNECTION

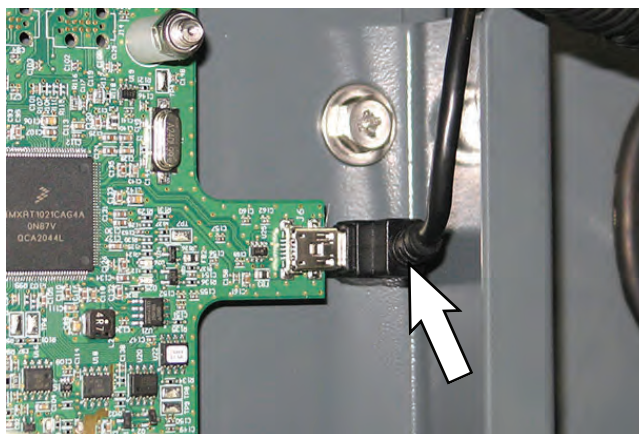
Proceed with this procedure if Service Diagnostics does not advance beyond the "Connect USB to machine..." screen.



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.



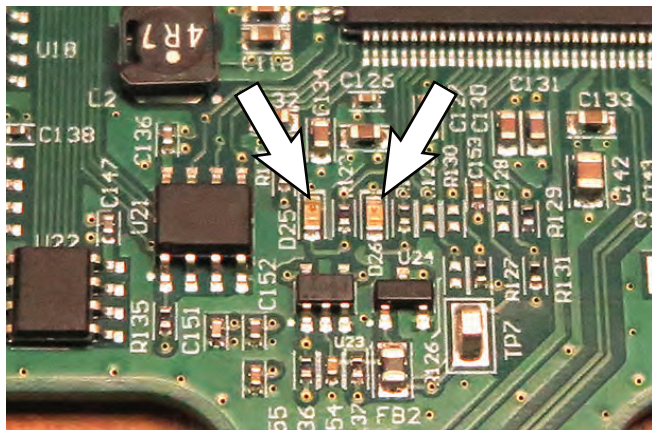
2. Attempt again to connect to the machine/access the lithium ion service screen. If issue persists, use another USB cable to connect the service device to the lithium battery control board USB cable.
3. If there is still no connection to the machine/access the lithium battery service screen, proceed 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.

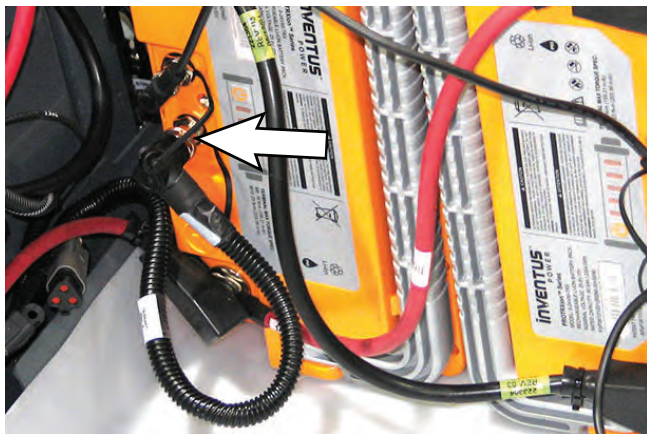
If only the green LED D25 is flashing (indicating there is power to the lithium battery circuit board), but the yellow LED D26 (indicating there is CAN communication to the lithium battery circuit board) is not flashing, troubleshoot the lithium battery CAN (Controller Area Network) communication. See 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.

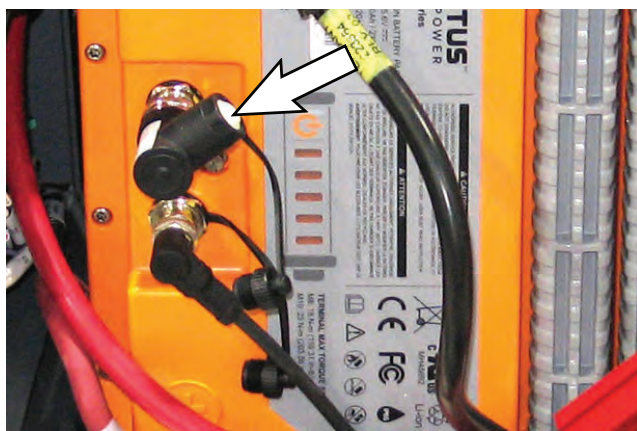
## INSPECT/TROUBLESHOOT LITHIUM BATTERY PACK

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.

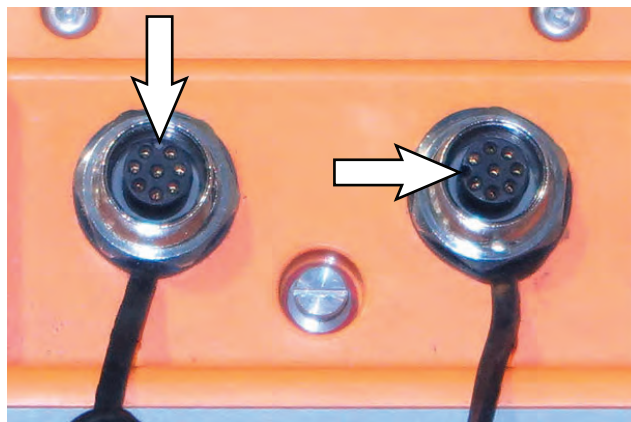
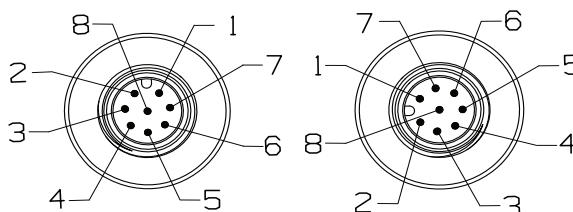


4. Check continuity between the corresponding pins at the lithium battery communication terminals (continuity is measured across entire battery pack from the UI to BMS electrical harness communication terminal to the termination resistor communication terminal).

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.

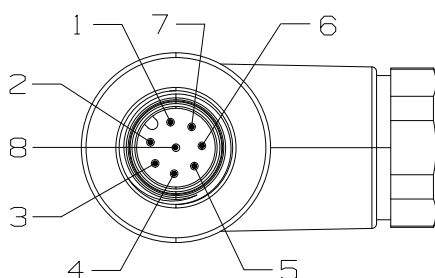


**NOTE:** Note locations of terminal notches when checking continuity between lithium battery terminal pins. The terminals are not oriented the same.

8. Inspect the resistor plug for obvious damage. Inspect resistor plug pins for damage. Replace the resistor plug if damaged.



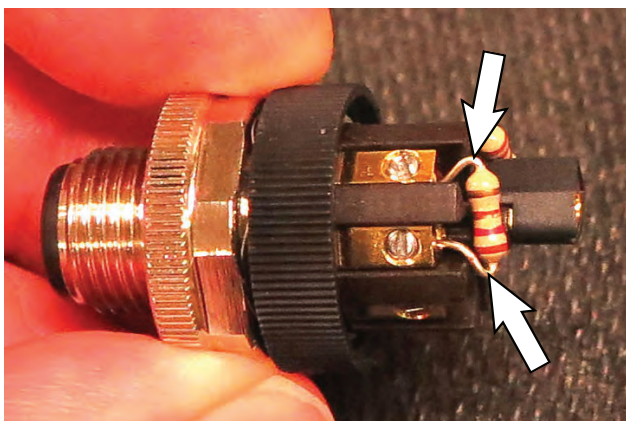
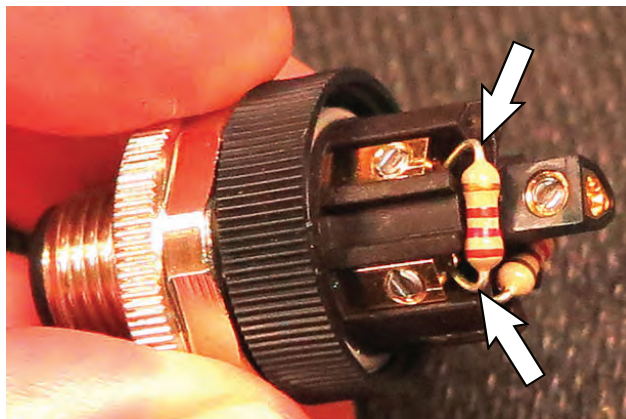
9. Check resistance between resistor plug pins 1 and 2 and pins 6 and 7. Resistance between pins 1 and 2 and pins 6 and 7 should be  $120\Omega$ . Replace the resistor plug if no resistance/excessive resistance.



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.

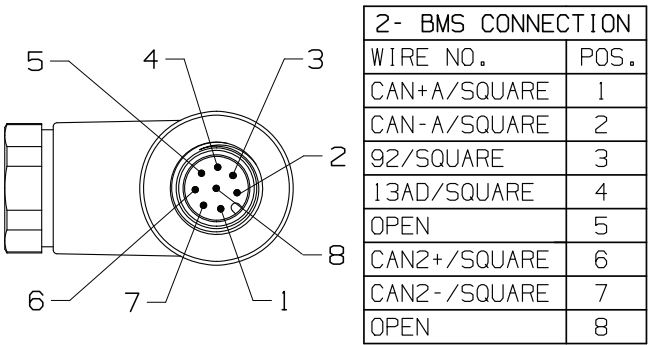


12. Check resistance between the resistor at terminals 1 and 2 and the resistor at terminals 6 and 7. Resistance between terminals 1 and 2 and terminals 6 and 7 should be  $120\Omega$ . Replace the resistor plug if no resistance/excessive resistance at either resistor.
13. If plug resistor is good, reassembly 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.



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.

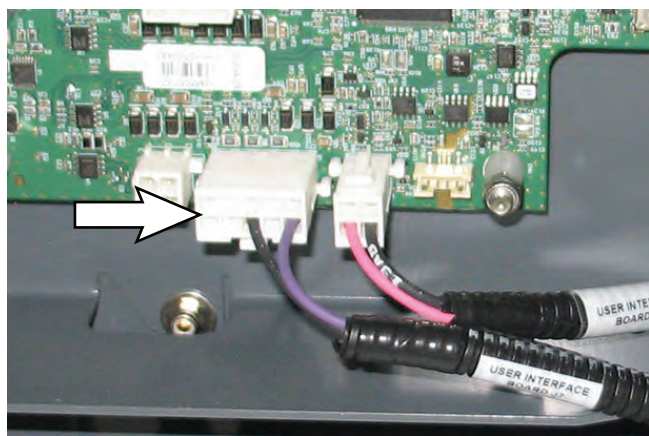


## TROUBLESHOOT UI POWER ELECTRIC HARNESS (J7-8/J7-10)

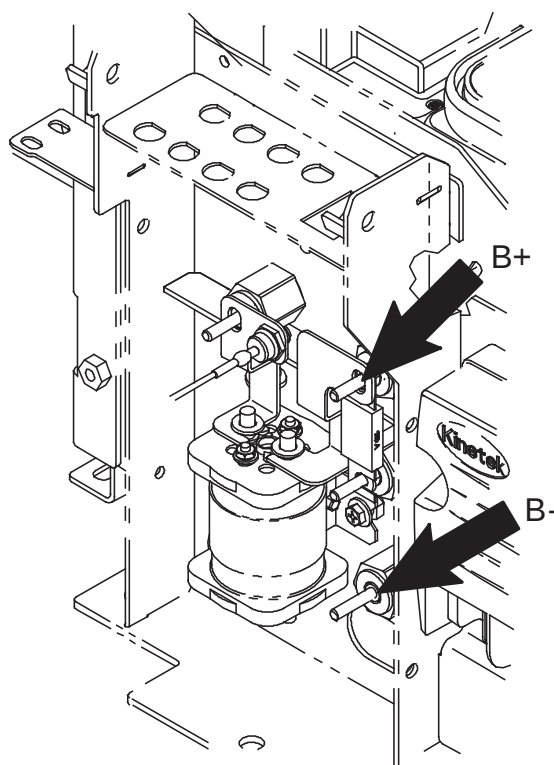
Proceed with this procedure if there is no CAN communication/power at the lithium battery control board.

**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.



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+ switch terminal. Replace 2-Amp fuse if fuse is blown.



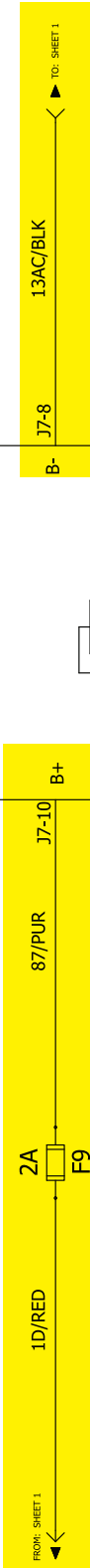
If neither LED (D25 and D26) is flashing, or if just the Yellow LED D26 is flashing, replace the lithium battery circuit board. See **REPLACE LITHIUM BATTERY CIRCUIT BOARD**.

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.

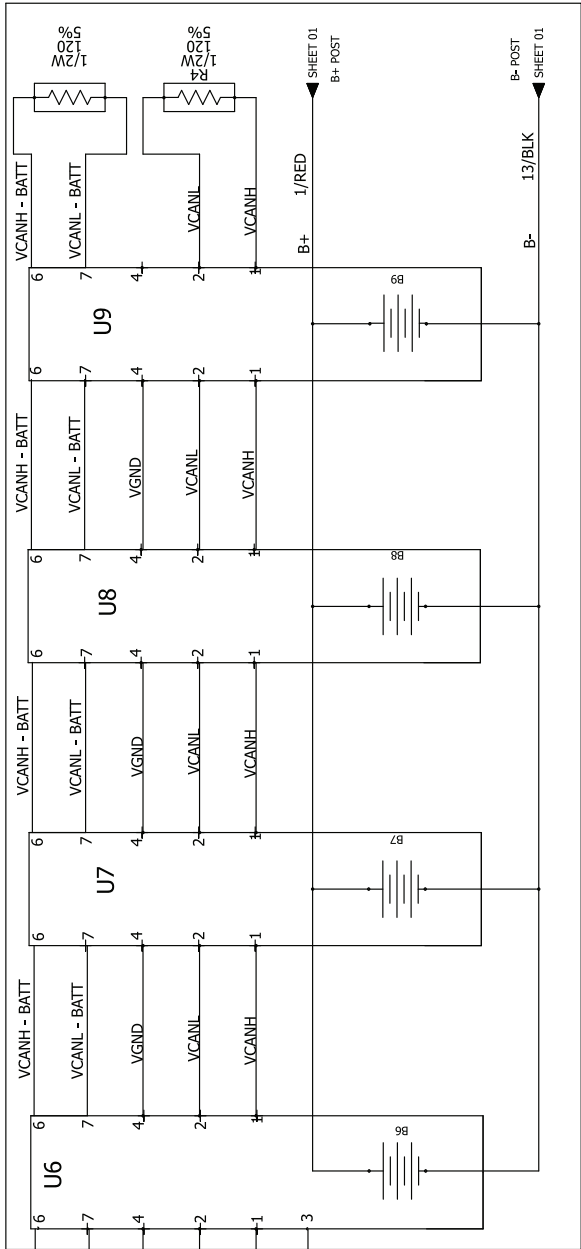
| J7-8 (13AC/BLK)     | Result                                                  |
|---------------------|---------------------------------------------------------|
| If open             | Board reports to system battery pack has a problem*     |
| If short to B-      | B- is the connection                                    |
| 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            |

## T7AMR 9018143 (09-2022)



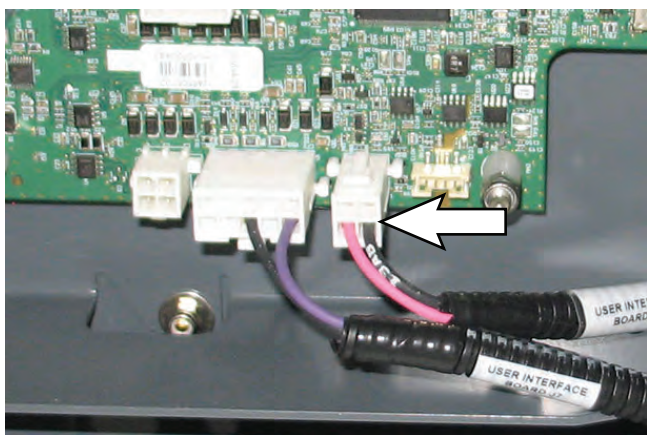
**(NOTE: NUMBER OF BLOCKS COULD VARY)**



**TROUBLESHOOT LEG ELECTRIC HARNESS (J5-1/J5-2)**

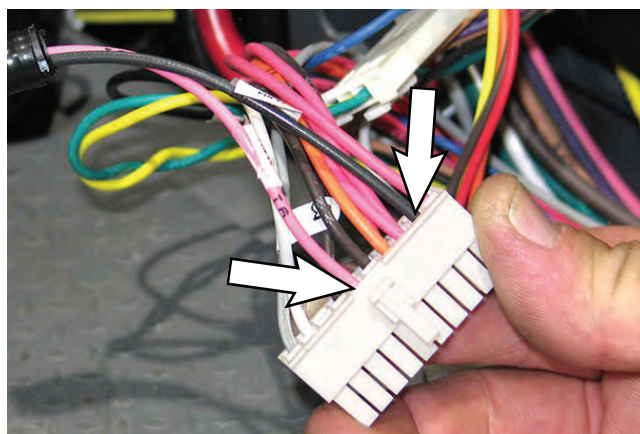
The lithium battery circuit board will be unable to communicate with the Kinetek controller if there is an issue with these connections. The machine will still propel, but all automated/scrubbing systems will be inoperable, there may be a battery fault code displayed on the UI (User Interface), and all 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.



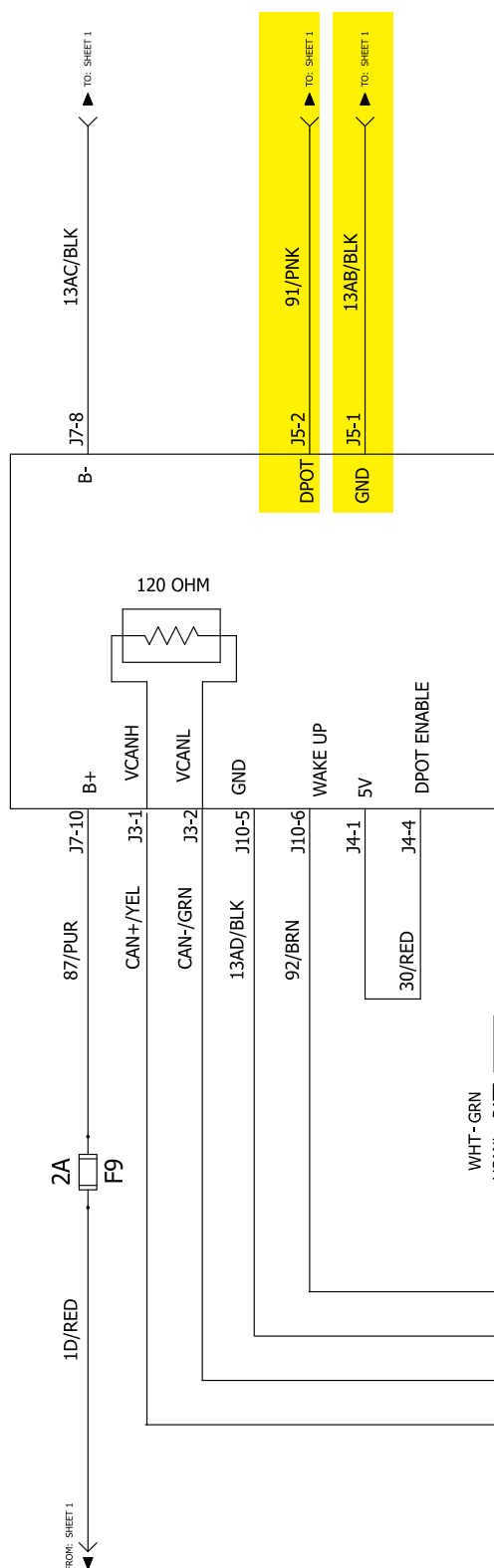
| J5-2 (91/PNK)       | Result                                                                                                                                                                            |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.



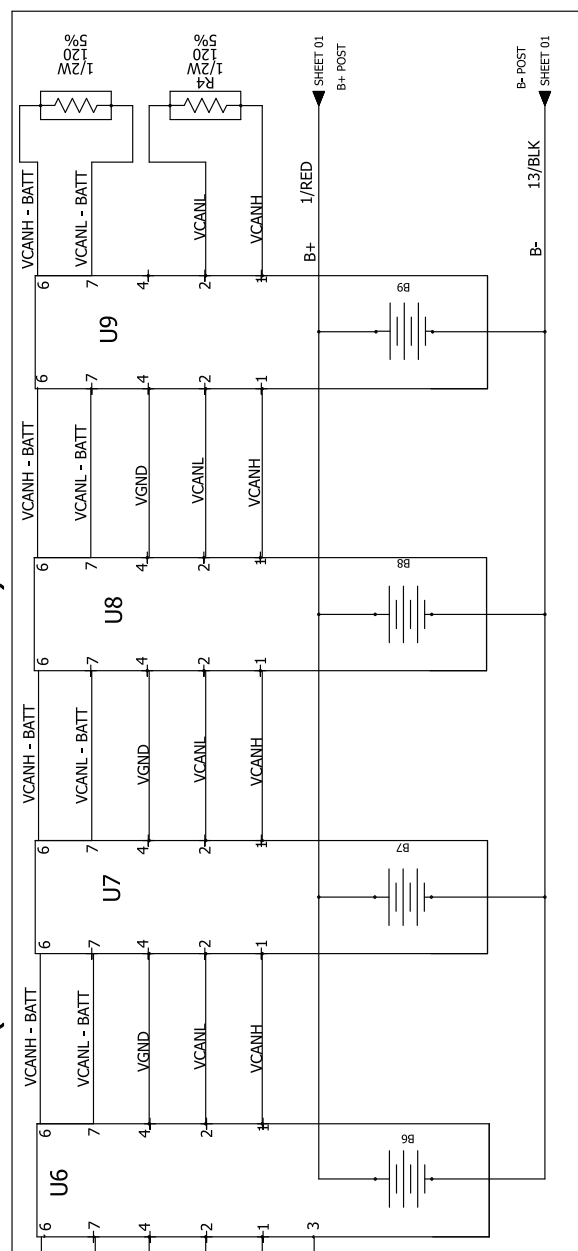
5. If the cable/connections are good and issue persists, replace the lithium battery control board. See REPLACE LITHIUM BATTERY CONTROL BOARD.
6. Contact T.A.C. for further troubleshooting guidance if issue persists.

| 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        |



## INVENTUS LITHIUM BLOCKS (OPTIONAL)

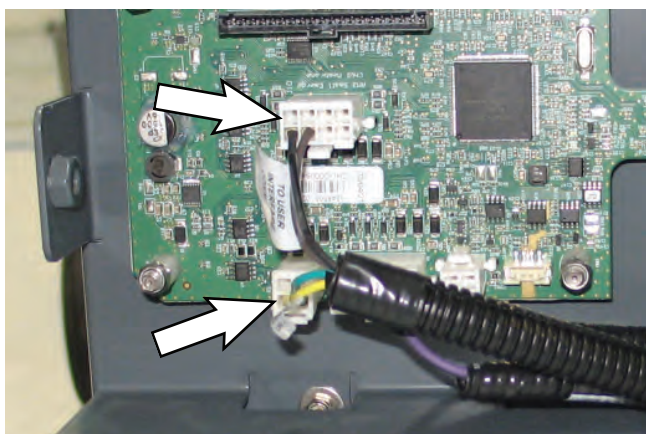
**(NOTE: NUMBER OF BLOCKS COULD VARY)**



## 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.



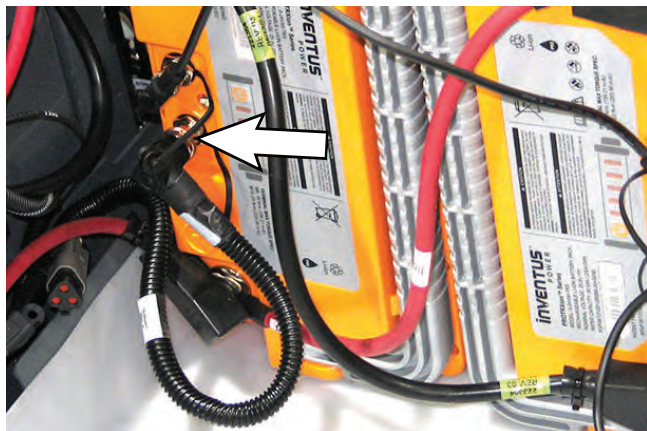
| J3-1 (CAN+/YEL)     | Result                                              |
|---------------------|-----------------------------------------------------|
| If open             | Board reports to system battery pack has a problem  |
| If short to B-      | Board reports to system battery pack has a 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        |

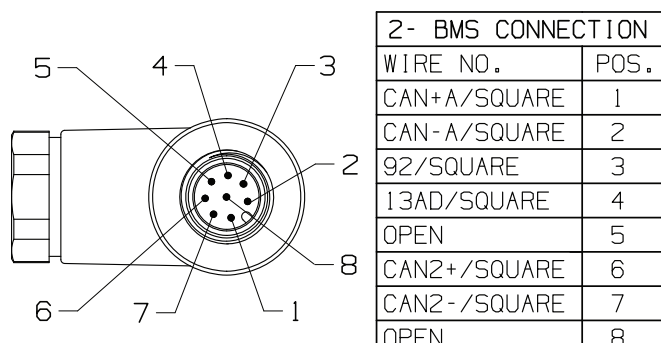
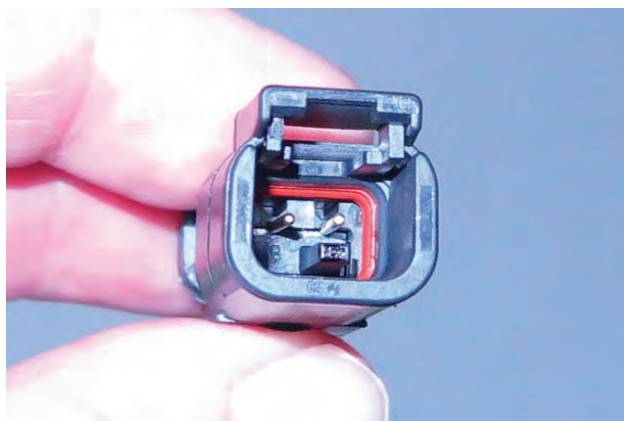
| J10-5 (13AD/BLK)    | Result                                                  |
|---------------------|---------------------------------------------------------|
| If open             | Board reports to system battery pack has a problem      |
| If short to B-      | B- is the connection                                    |
| 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.



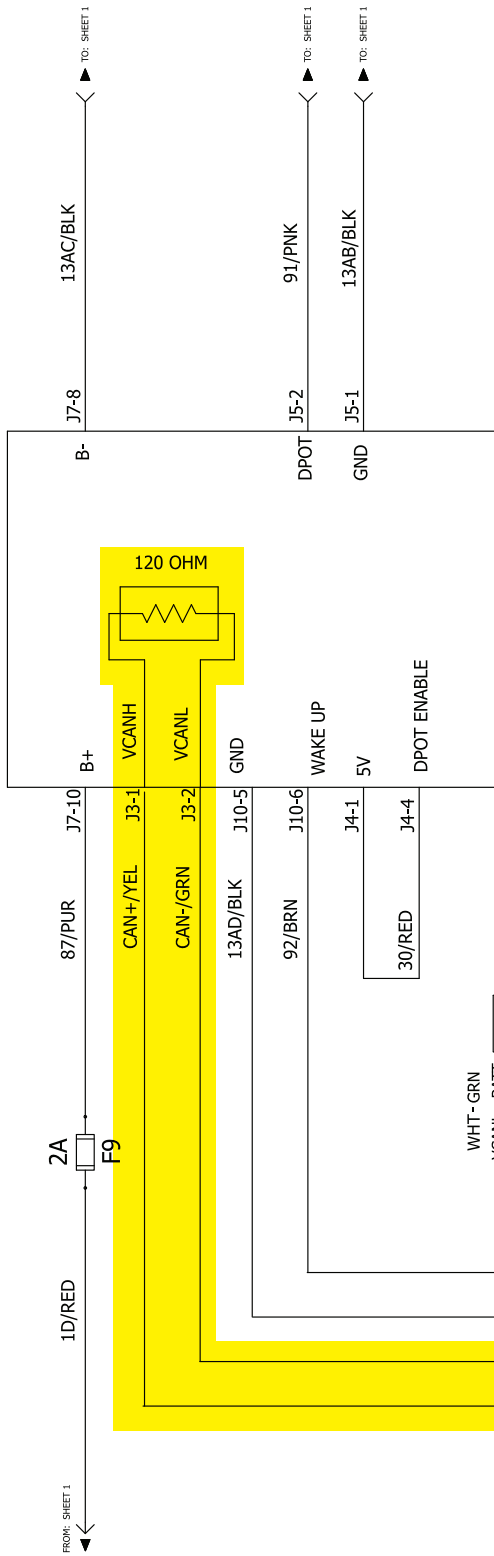
6. Inspect the resistor for damaged pins. Replace the resistor if pins are damaged/broken.



4. Remove the resistor from the UI to BMS electrical harness.

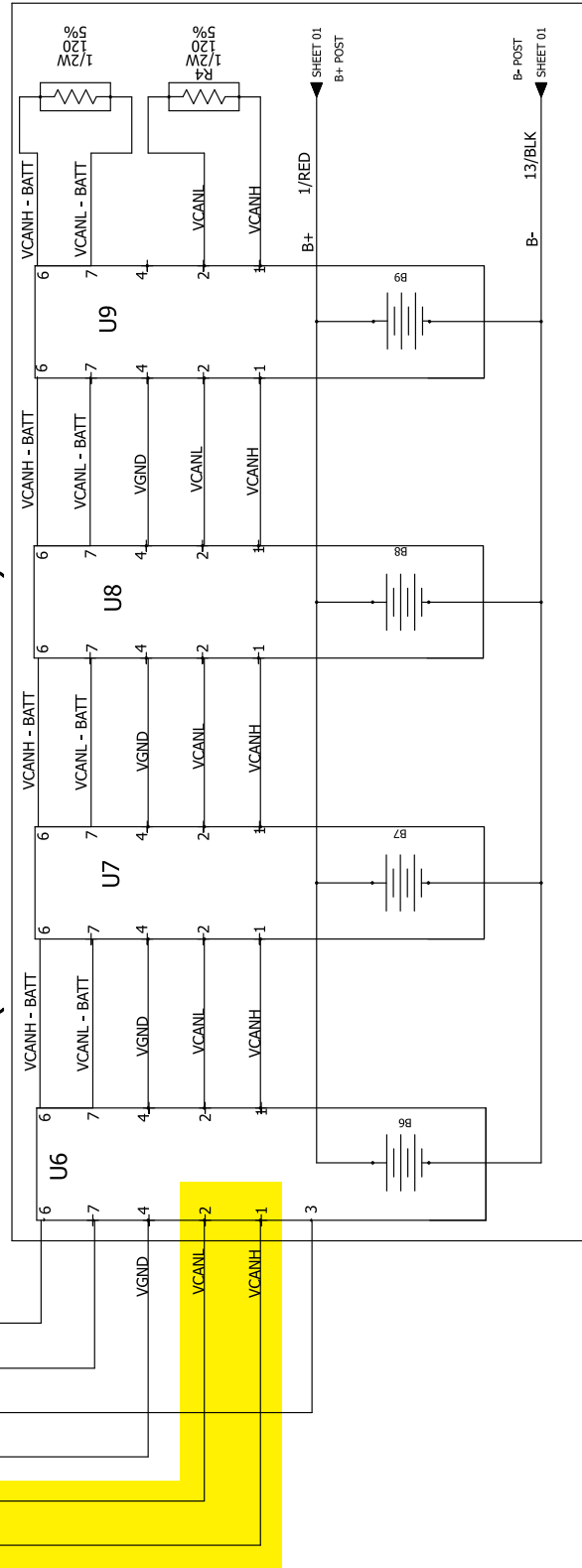
7. Check the resistance at the resistor pins. Should be 120Ω. Replace the resistor if no resistance/excessive resistance.
8. Reconnect the UI to BMS electrical harness to the lithium battery. Torque the UI to BMS electrical harness connection to 0.6 Nm (0.44 ft. lbs.).
9. Contact T.A.C. for further troubleshooting guidance if issue persists.

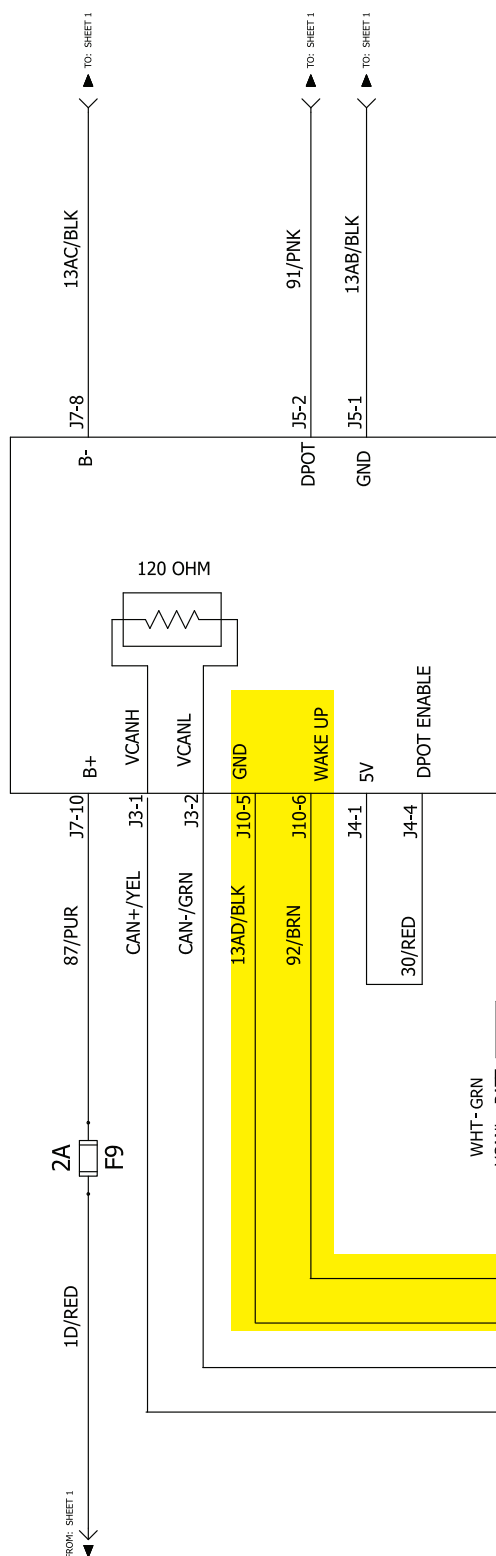
# TENNANT GATEWAY BOARD



## INVENTUS LITHIUM BLOCKS (OPTIONAL)

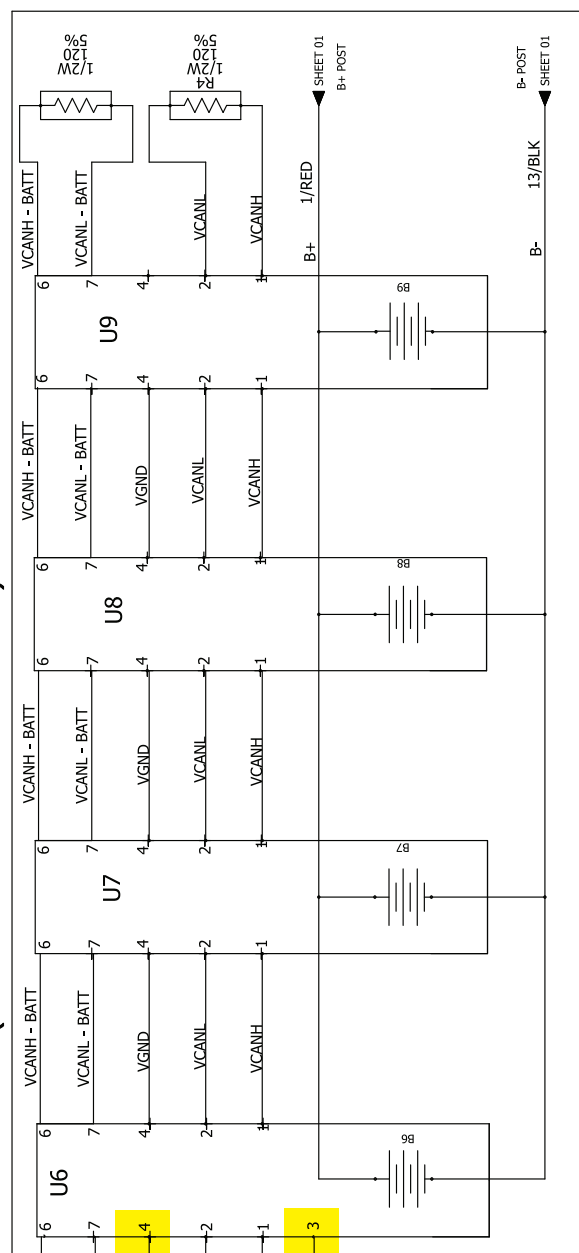
(NOTE: NUMBER OF BLOCKS COULD VARY)



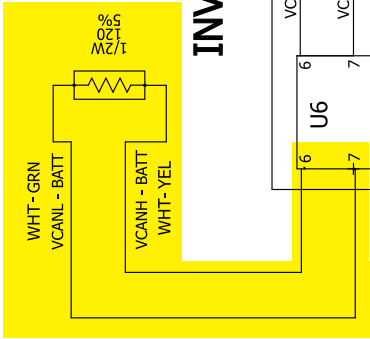
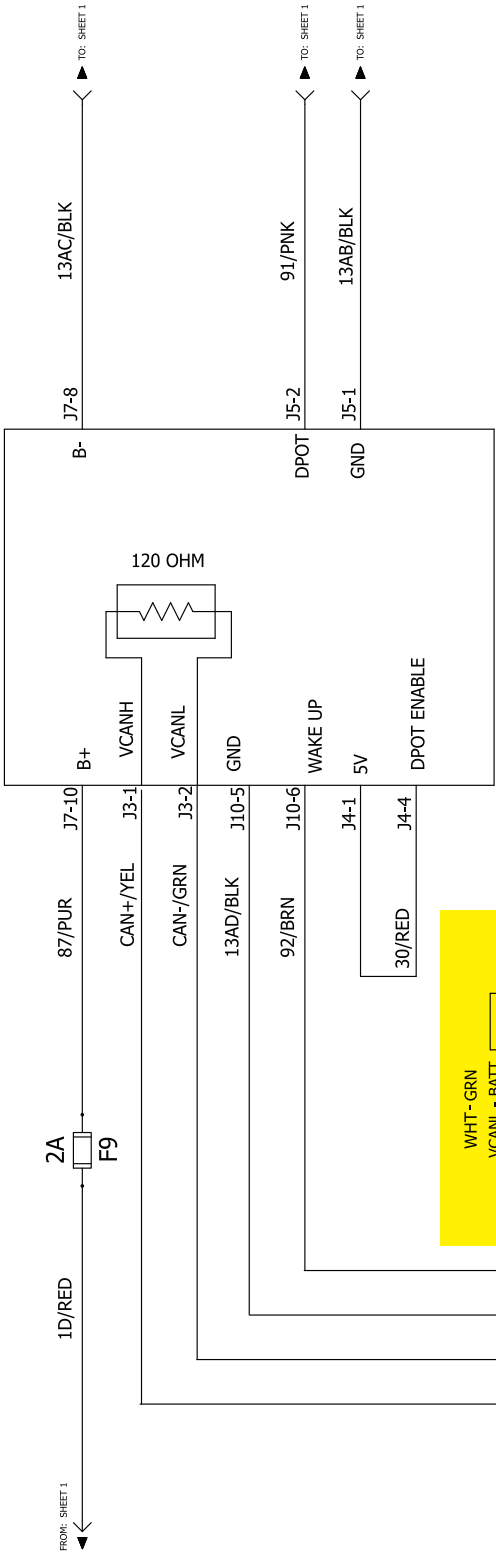


## INVENTUS LITHIUM BLOCKS (OPTIONAL)

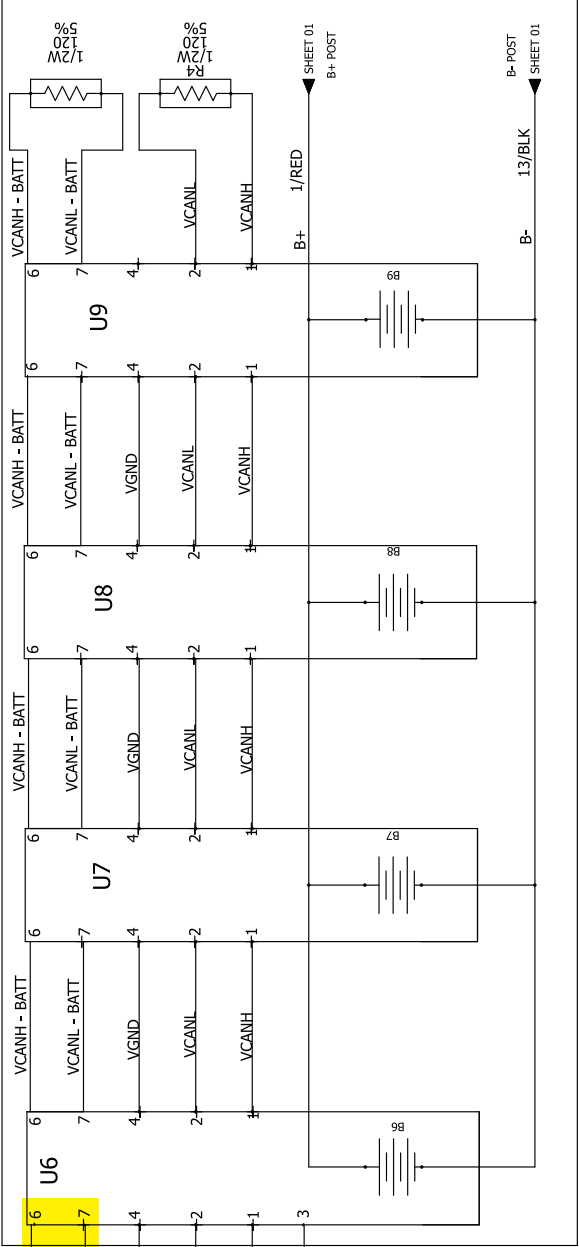
(NOTE: NUMBER OF BLOCKS COULD VARY)



TENNANT GATEWAY BOARD



INVENTUS LITHIUM BLOCKS (OPTIONAL)  
(NOTE: NUMBER OF BLOCKS COULD VARY)

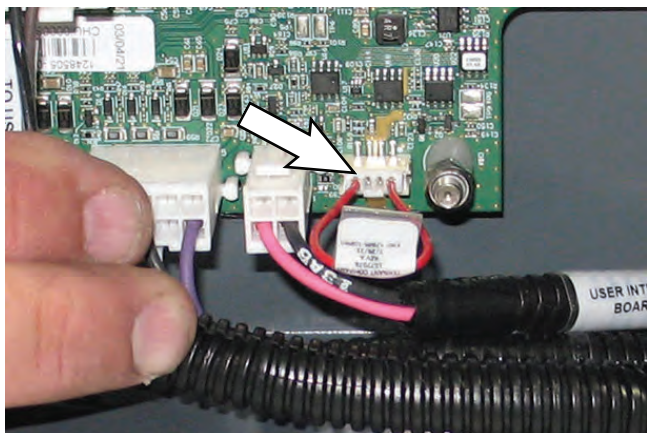




### TROUBLESHOOT DIGITAL POT 5V ENABLE ELECTRIC HARNESS (J4-1/J4-4)

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.

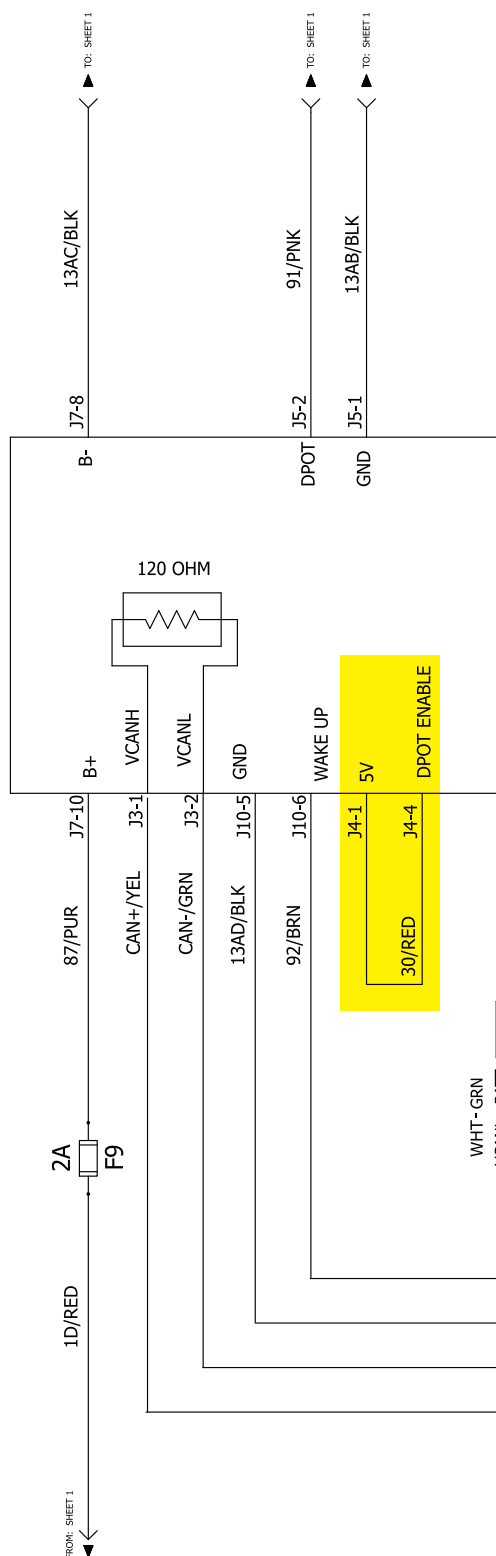
1. Inspect the digital pot 5V enable electric harness connection to lithium battery control board terminal J4. Disconnect the digital pot 5V enable electric harness from the lithium battery control board and verify connector and connector pins are fully seated and are not damaged. Repair pins/replace harness as necessary.



| J4-4 (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        |

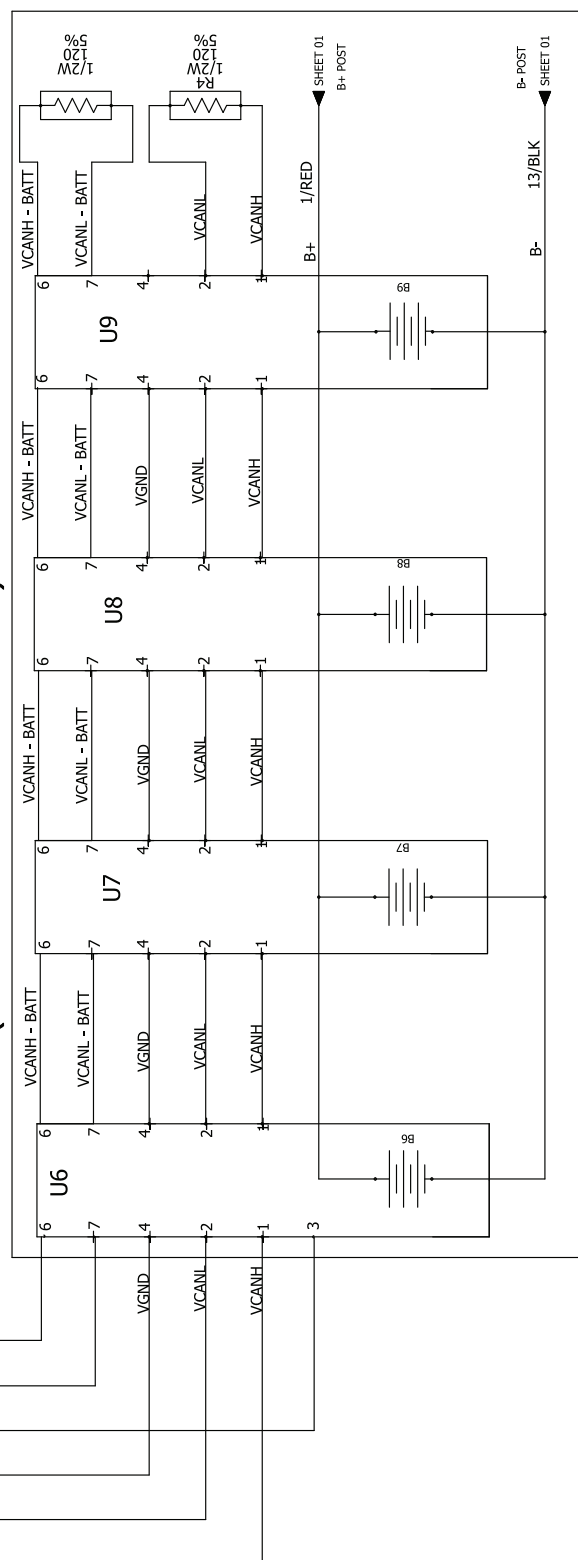
2. Reconnect the digital pot 5V enable electric harness to lithium battery control board terminal J4. Continue testing/troubleshooting if there is still no CAN communication at the lithium battery control board.
3. Contact T.A.C. for further troubleshooting guidance if issue persists.

| 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        |



## INVENTUS LITHIUM BLOCKS (OPTIONAL)

**(NOTE: NUMBER OF BLOCKS COULD VARY)**



## 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. Turn the key switch OFF.
2. Lift the operator seat open and disconnect the main wire harness from the operator seat switch harness.



3. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



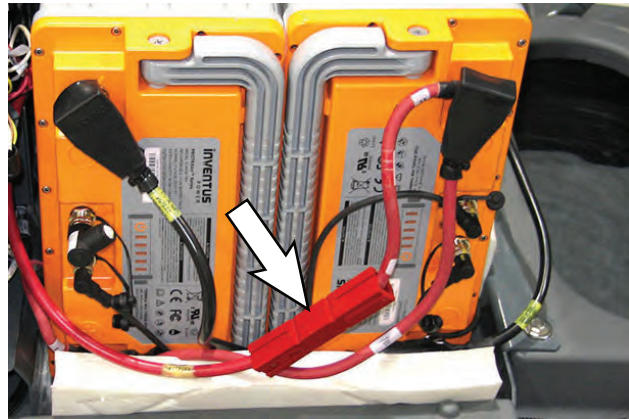
4. Remove the operator seat/seat plate from the machine.



5. Remove the battery box cover from the machine.

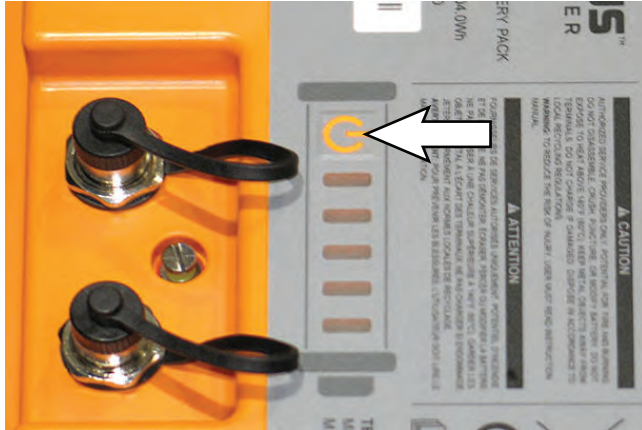


6. Disconnect the battery cable from the machine.



7. Connect the battery charger to the battery cable disconnected in the previous step.

8. 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.

9. The charger will begin charging the batteries. Wait for batteries to complete charging.
10. 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.
11. Reinstall all previously removed parts and components onto the machine.

## SERVICE

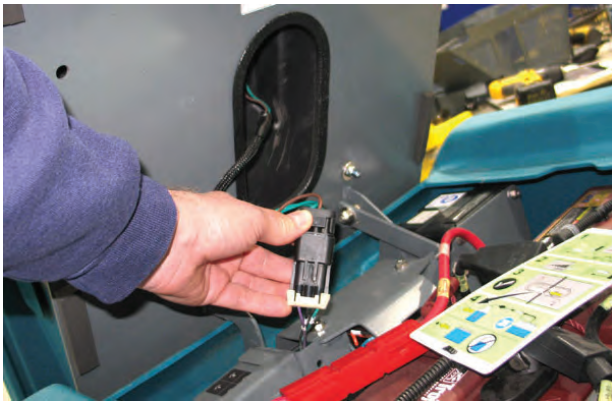
### REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES

**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.

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

3. Lift the operator seat open and disconnect the main wire harness from the operator seat switch harness.



4. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



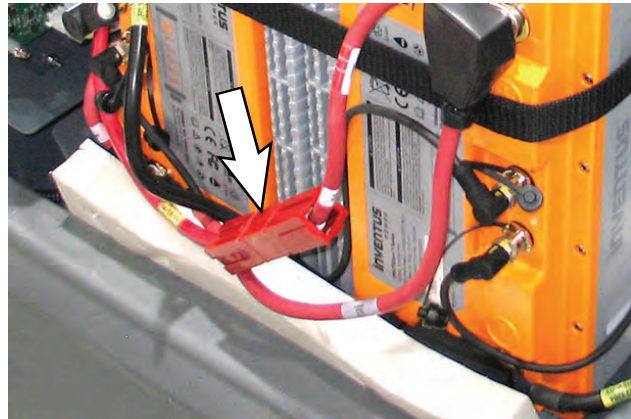
5. Remove the operator seat/seat plate from the machine.



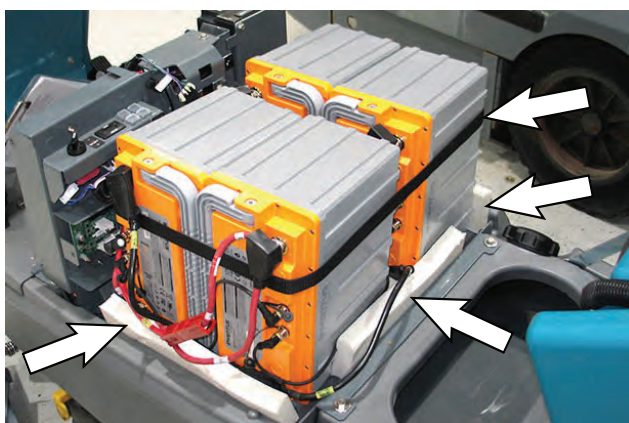
6. Remove the battery box cover from the machine.



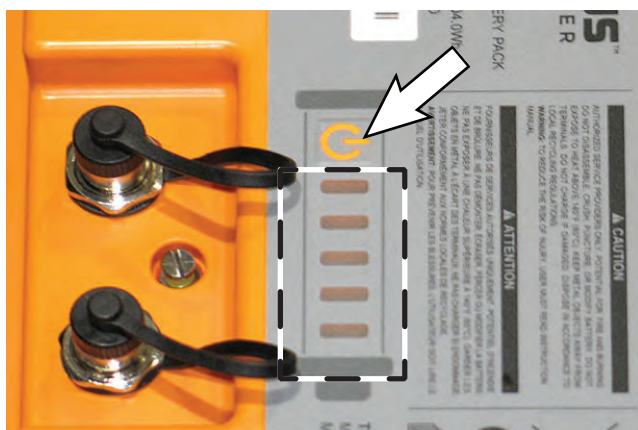
7. Disconnect the battery cable from the machine.



8. Remove the strap from around the batteries and the foam dividers securing the batteries into place from the battery compartment.



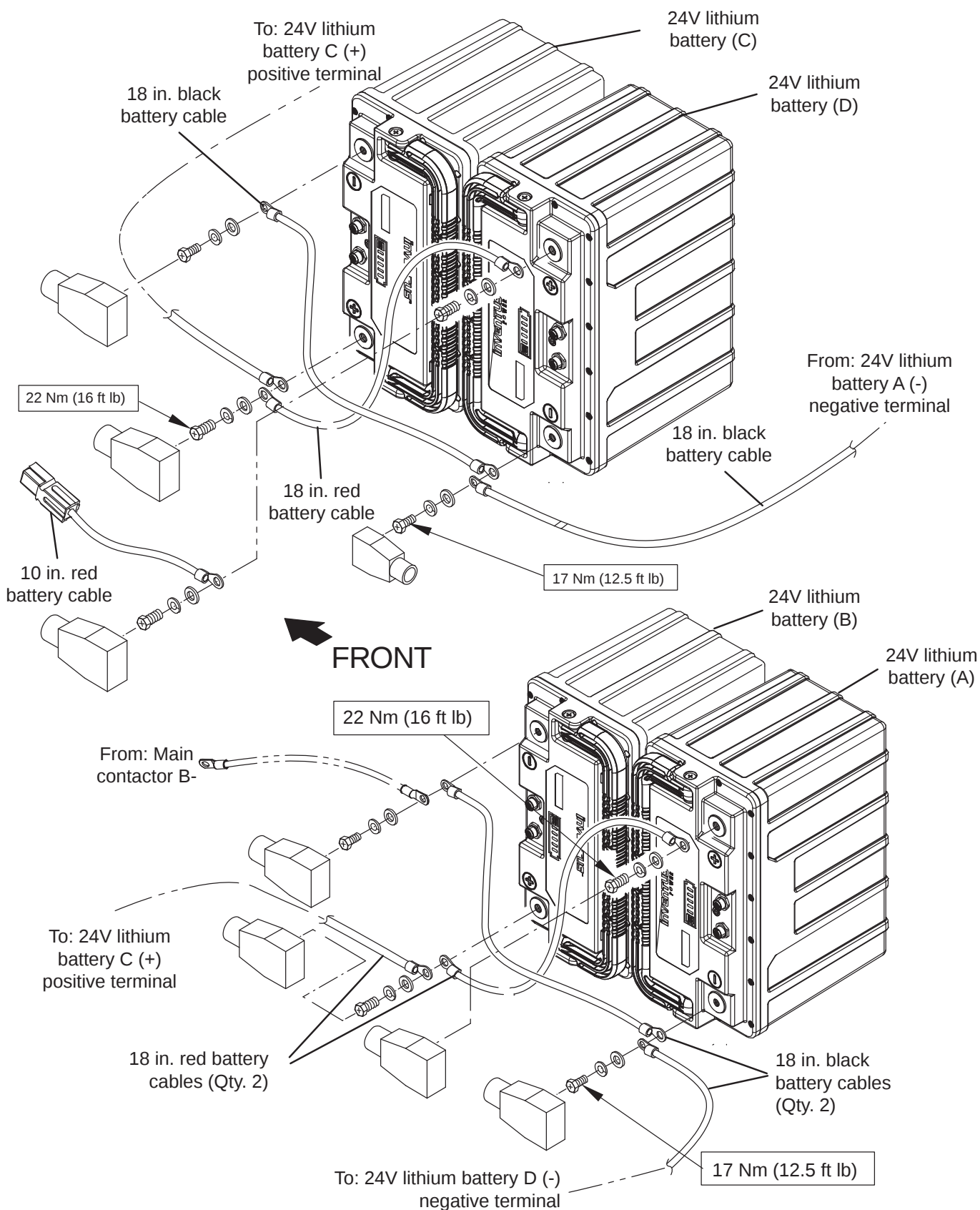
9. Turn off the lithium batteries. Hold the power button on one lithium battery for 20 seconds to turn off all four batteries.



10. Quickly press the power button again and observe the indicator lights near the button. None of the indicator lights should be illuminated.
11. Quickly press the power button on the remaining batteries and observe the indicator lights near the button. None of the indicator lights should be illuminated.

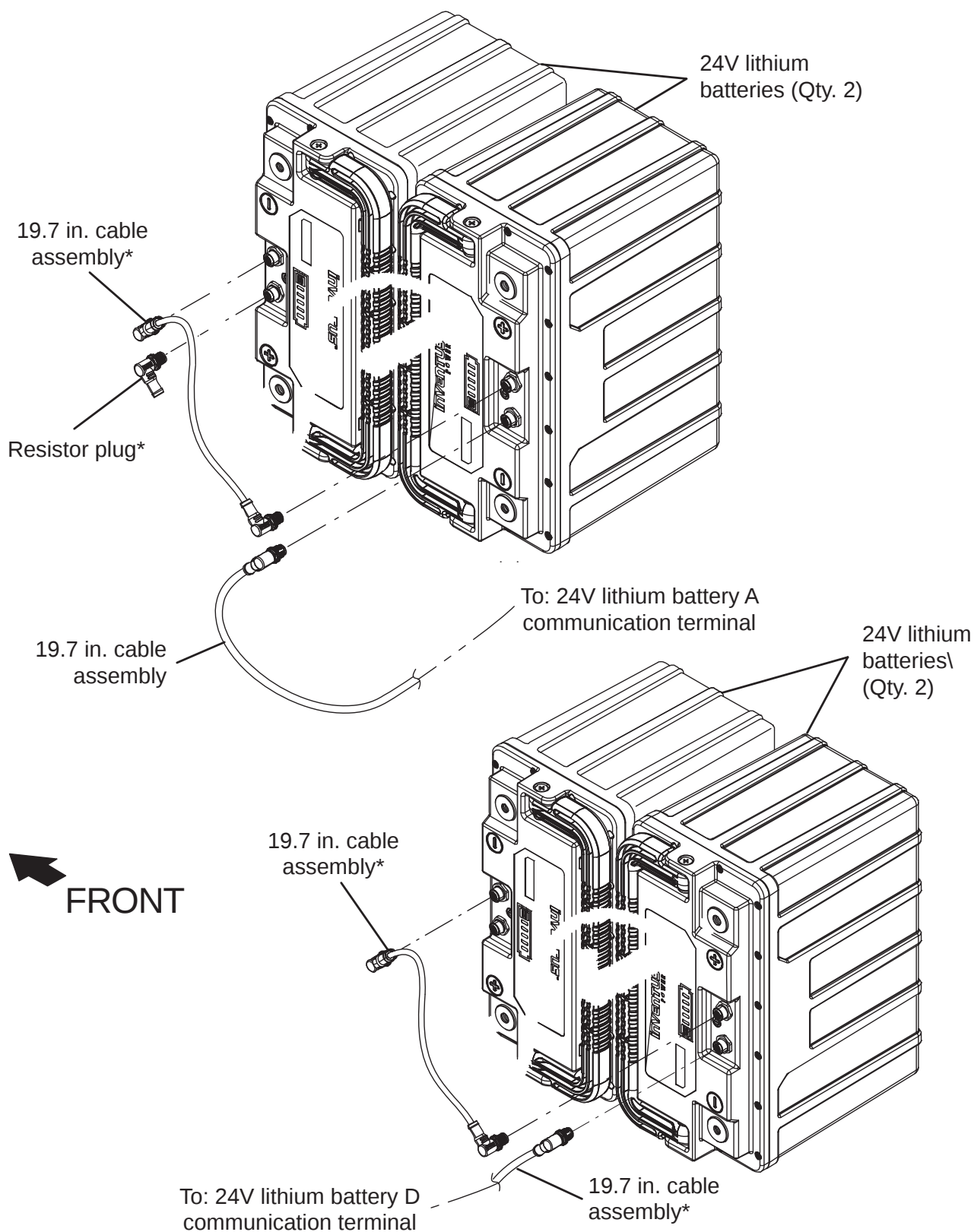
**NOTE:** All lithium batteries must be turned off prior to removing the batteries from the machine.

12. Disconnect the battery cables and battery connector assembly from the lithium battery positive (+) and negative (-) terminals.



13. Disconnect the UI to BMS electrical harness and all communication cables from the lithium battery communication terminals.

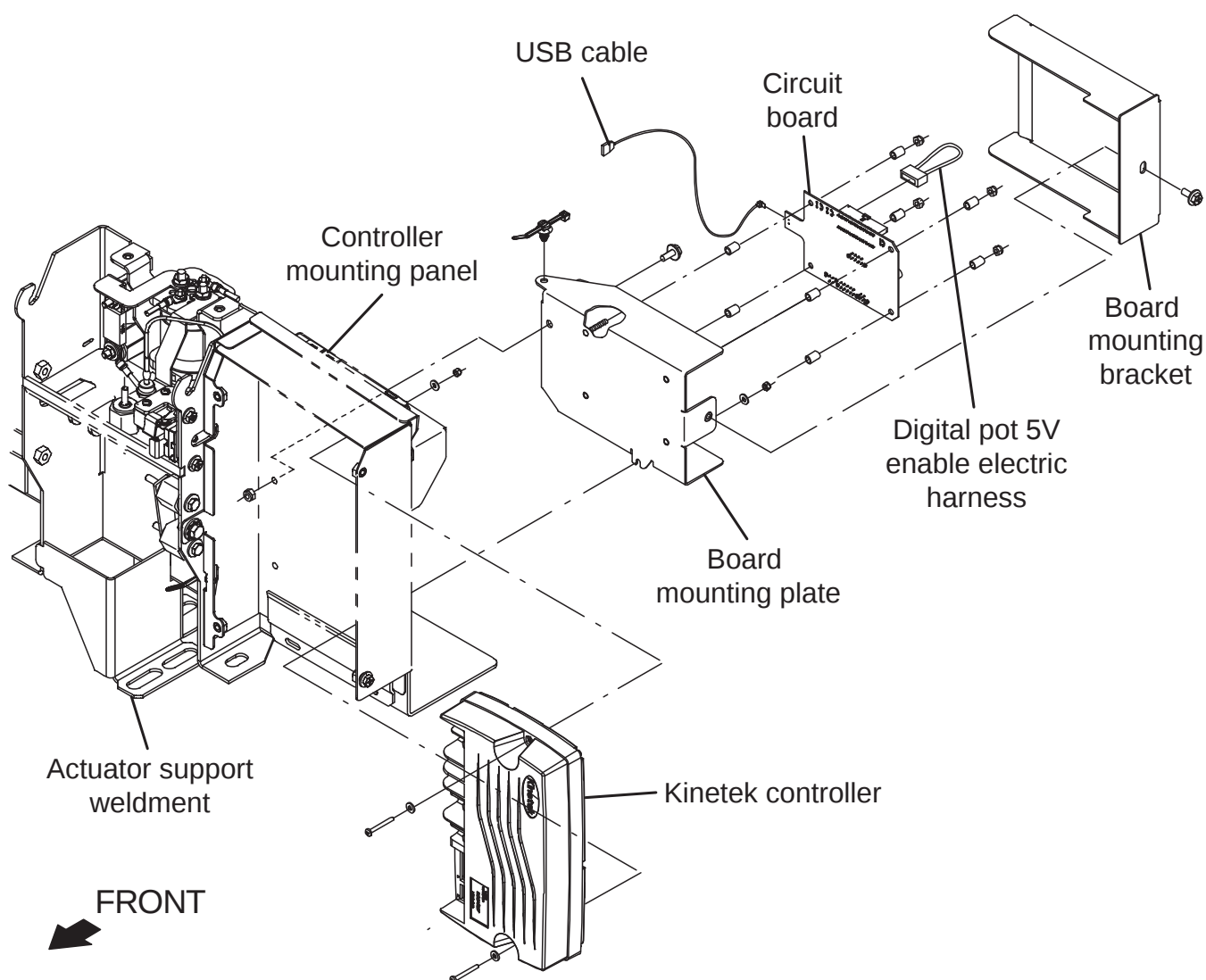
14. If replacing lithium battery with the resistor plug installed, remove the resistor plug from the battery.



\*Torque lithium battery CAN communication cable, resistor plug, and UI to BMS electrical harness connections to 0.6 Nm (0.44 ft. lbs.)

15. If removing/replacing all lithium batteries, remove the lithium batteries from the battery compartment.
16. If not removing/replacing all lithium batteries, remove only the battery/batteries to be replaced from the battery compartment.
17. Install the removed/new battery/batteries into the battery compartment.
18. 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.).
19. Reconnect the battery cable to the machine.
20. Reinstall the foam dividers and strap to secure the batteries inside the battery compartment.
21. Turn on the batteries. Hold the power button on one lithium battery for 5 seconds to turn on all batteries.
22. Quickly press the power button again and observe the indicator lights near the button. The indicator lights should be illuminated.
23. Quickly press the power button on the remaining batteries and observe the indicator lights near the button. The indicator lights should be illuminated.
24. Reinstall the battery box cover and operator seat/seat plate onto the machine.
25. 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.
3. Lift the operator seat open and disconnect the main wire harness from the operator seat switch harness.
4. Tilt the recovery tank back. Ensure the recovery tank is empty before tilting.



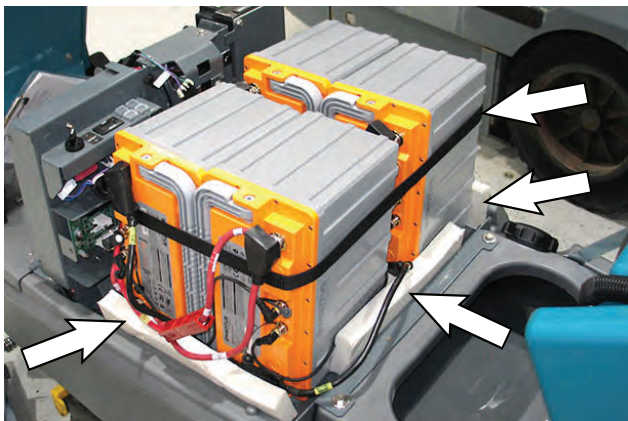
5. Remove the operator seat/seat plate from the machine.



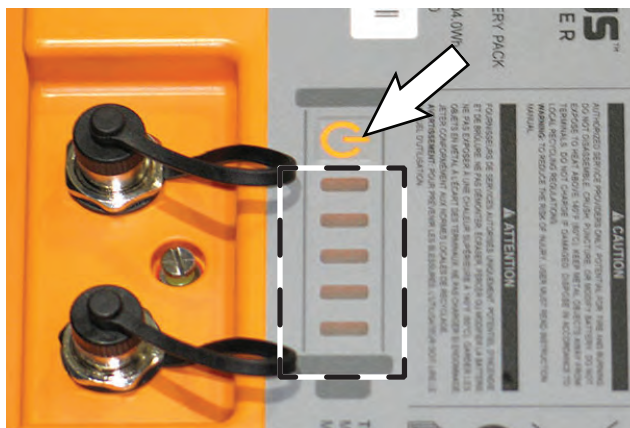
6. Remove the battery box cover from the machine.



7. To allow easier access to the lithium battery circuit board, remove the strap from around the batteries and the foam dividers securing the batteries into place from the battery compartment.



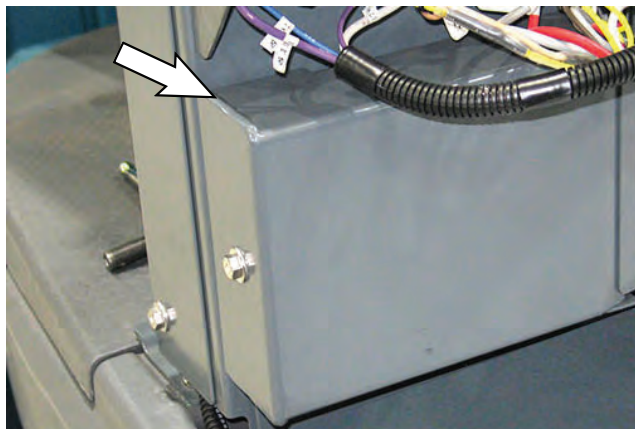
8. Turn off the lithium batteries. Hold the power button on one lithium battery for 20 seconds to turn off all four batteries.



9. Quickly press the power button again and observe the indicator lights near the button. None of the indicator lights should be illuminated.
10. Quickly press the power button on the remaining batteries 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 any batteries from the machine.*

11. If necessary, remove the lithium batteries/ lithium battery possibly obstructing access to the lithium battery circuit board from the machine. See REMOVE/REINSTALL/REPLACE LITHIUM BATTERIES.
12. Remove the board mounting bracket from the board mounting plate.



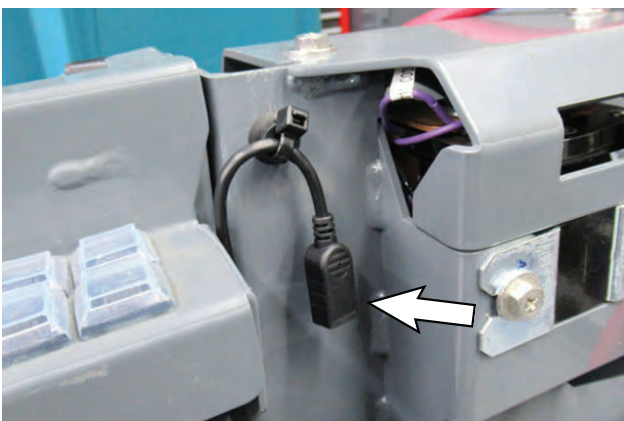
13. Disconnect all harness/wire connections from the control board.
14. Remove the control board from the board mounting plate.

15. Install the new control board onto the board mounting plate.
16. Connect all cable/wire connections to the new control board.
17. Reinstall the board mounting bracket onto the board mounting plate.
18. If lithium batteries were removed, reinstall the lithium batteries into the battery compartment.
19. Reinstall the strap and foam spacers to secure the lithium batteries inside the battery compartment.
20. Reconnect all cables to the batteries.
21. Reconnect the battery cable to the machine.
22. Turn on the batteries. Hold the power button on one lithium battery for 5 seconds to turn on all batteries.
23. Quickly press the power button again and observe the indicator lights near the button. The indicator lights should be illuminated.
24. Quickly press the power button on the remaining batteries and observe the indicator lights near the button. The indicator lights should be illuminated.

25. 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/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.*

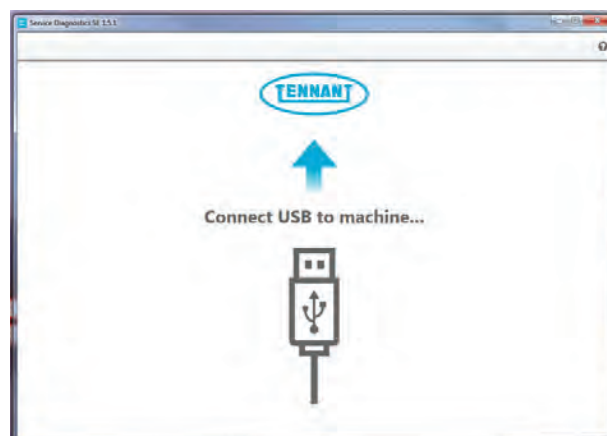
26. Connect the other end of the USB cable connected to the service device in the previous step to the USB cable installed on the lithium battery control board.



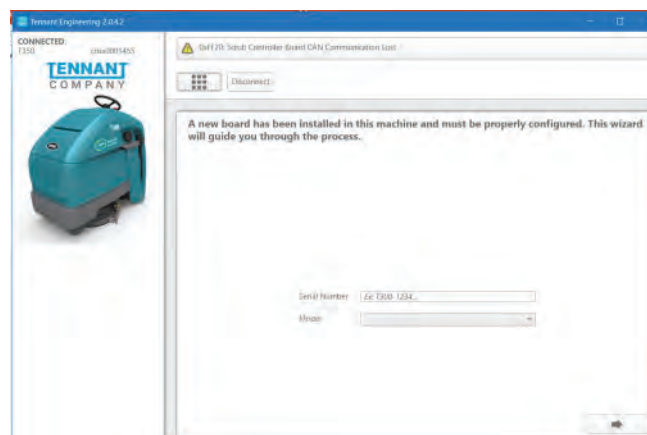
27. Turn the key switch ON.

**SYSTEM REQUIREMENTS:** Windows® 7 Operating System, Microsoft .NET 4.5 or later, USB to Mini-USB cable.

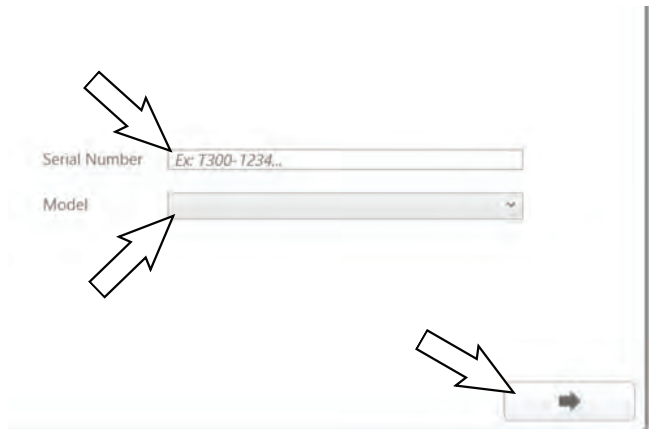
28. Double click the Service Diagnostics desktop shortcut or find the software in All Programs to launch the software.
29. Allow the Service Diagnostics tool to connect to the lithium battery control board network.



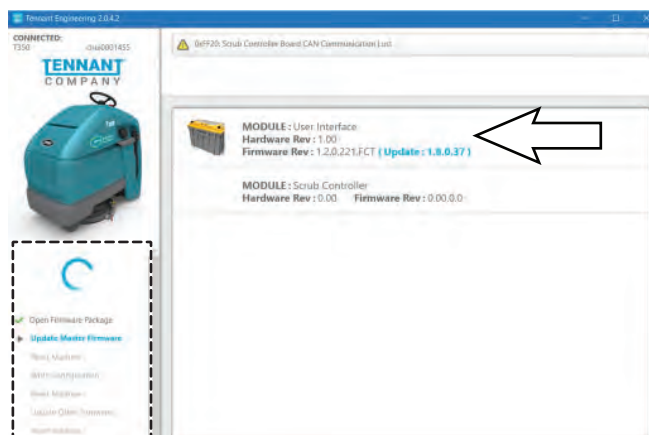
30. The Service Diagnostics tool automatically detects a new board was installed. A Service Diagnostic window with text "A new board has been installed in this machine and must be properly configured. This wizard will guide you through the process." appears on the screen.



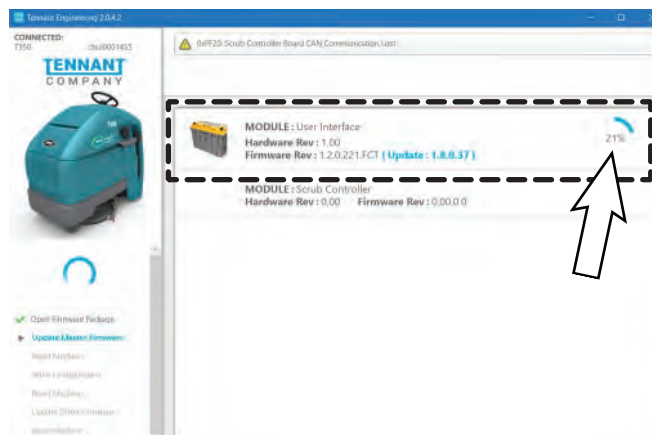
31. Enter the serial number, select the model from the pull down menu, and click the arrow button to proceed with reconfiguring the machine for the new lithium battery control board.



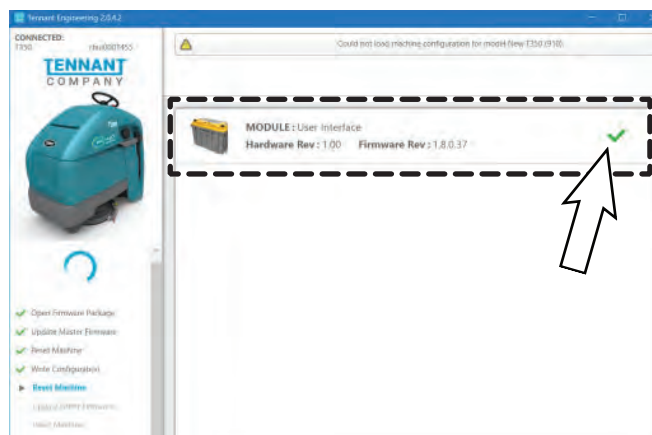
32. The firmware update screen appears and will begin programming the machine. The process status indicator and firmware update status box appear on the left side of the screen.



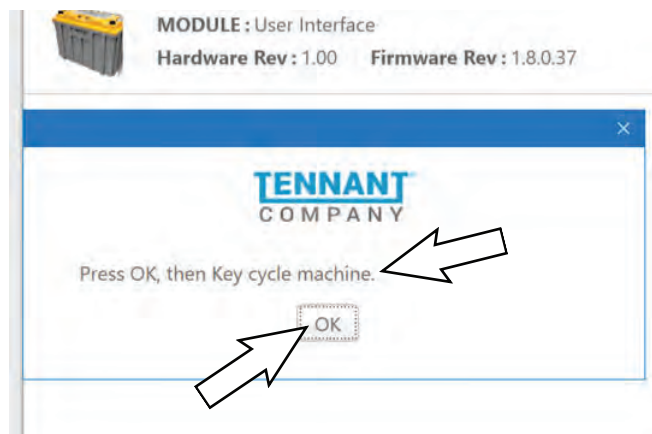
33. Allow the firmware update to proceed. A process status indicator with a percent (%) status of the update also appears next to the selected firmware update. Firmware update process typically takes 2 or 3 minutes.



34. A check appears where the process status indicator with the percent status was previously located when the firmware update is complete.



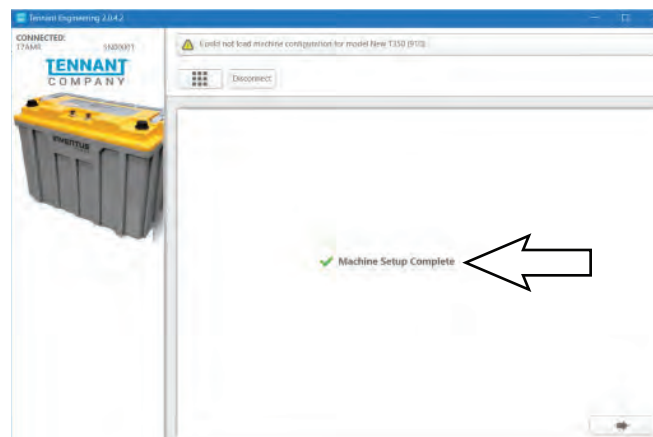
35. A text box with "Press OK, then Key cycle machine." appears. Select the OK button and then key cycle the machine to complete the firmware update.



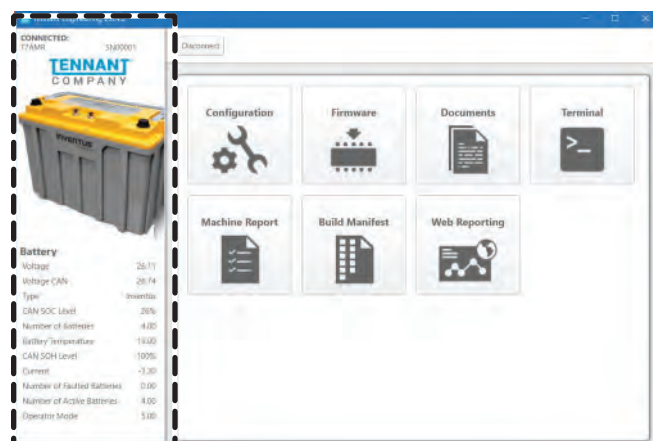
**NOTE:** Firmware update status box on left side of the screen will be at “Reset Machine” when text box to key cycle machine appears. All previous listed items are checked/completed.



36. A screen with “Machine Setup Complete” appears when the firmware update is complete.



37. Use the Service Diagnostics tool to access the lithium battery screen.



38. Observe the lithium battery information pane on the left side of the screen. The “Number of Batteries” and “Number of Active Batteries” should be four (4.00), and the number of “Number of Faulted Batteries” should be zero (0.00).



See LITHIUM BATTERY SYSTEM VALUES/ RANGES for battery status and battery/battery system operating range information.