



Explorer
Automated Synthesis



Discover
Focused Synthesis



Voyager™
Flow-Through Synthesis

Microwave Synthesis Instrumentation **Service Manual**

CEM's modular family of microwave synthesis instrumentation begins with the Discover module for focused synthesis.



The Explorer module expands the capabilities of the Discover module with high throughput reaction handling capabilities. The Explorer module installs on top of the Discover module.



The Voyager module, a flow-through reaction system, further expands the capabilities of the Discover module for rapidly synthesizing larger quantities of compounds for laboratory scale-up. Methods developed on the Discover or the Explorer transfer directly to the Voyager. The Voyager module also installs on top of the Discover module.



Introduction

The CEM Focused Microwave Synthesis System, Model Discover, is designed to enhance the ability to perform chemical reactions under controlled conditions on a laboratory scale. The CEM Automated Synthesis System, Model Explorer™, is designed to add automated reaction handling capabilities to the Discover™ instrument. The Focused™ Microwave family of instruments enhance the ability to perform chemical reactions under controlled conditions on a laboratory scale. These systems facilitate either homogeneous or heterogeneous solution phase chemistry, solid phase chemistry or chemistry conducted on solid supports. They accommodate vessels ranging in volume from 5mL to 125mL for reactions performed under atmospheric conditions and 10mL and 80mL sealed vessels for reactions performed at elevated temperatures and pressures. Primary uses of the Explorer and/or Discover are in the discovery and lead optimization phases of the drug development process.

Microwave energy is applied to the vessel contents (reactants, catalysts, salts, solvents and/or solid supports) to accelerate the chemical reaction. The microwave absorption properties of some liquid and solid materials, due to their polar and ionic characteristics, have the capability to significantly enhance chemical reactions relative to traditional energy application (heating) techniques. The microwave interaction properties with the reactants, intermediates, catalysts, solid supports and salts provide unique opportunities for the synthetic chemist.

The Discover System consists of:

- A continuous microwave power delivery system with operator selectable power output from 0 - 300 watts (+/- 30 watts) programmable in 3-watt increments.
- A self-adjusting, single mode microwave cavity that is manually accessed via one of two attenuator ports (both ports are included)
- A 4-line x 20-character vacuum fluorescent display with alphanumeric keypad and on-board computer for programming and operational control of the system. The memory will store and recall up to 20 methods
- 3 safety interlocks and an interlock monitoring system to prevent microwave emission when the attenuator port is not properly installed
- Two serial ports for computer interface and optional feature connections
- An ethernet port for network connection (optional configuration)
- An infrared Temperature Control System
- A pressure sensor for feedback control of the system
- A magnetic stirrer
- A cooling system to decrease the temperature of a 20mL solution in a 10mL Pyrex reaction vessel from approximately 150 °C to 40 °C in less than 20 seconds
- The Explorer Automation Module consists of:
 - A Discover Module
 - A software control package for programming and data management
 - An X, Y table that delivers 10 mL reaction vessels to the microwave chamber
 - Four (4) independent Vessel Racks with six (6) positions
 - A drive motor and table slide in each vessel rack, permitting independent movement and loading
 - A Z-axis mechanism that integrates a reaction vessel gripper to manipulate vessels
 - An attenuator locking mechanism to seal the reaction vessels in the microwave system
 - An external controller (computer) (optional purchase from CEM Corporation)

Both systems include application software and an accessory kit.

Optional features include:

- **Fiber Optic Temperature Control System** – This optional temperature control system, for use with large volume, open vessel applications, uses a fiber optic temperature probe for temperature measurement and control of the vessel contents. It is used only with manual operation of the Discover system. The fiber optic probe is an “invasive” measurement technique and thus requires access to the reaction container from the external environment. It connects to the instrument through the second serial port at the rear of the instrument. When connected, the Discover system automatically detects the temperature sensor and defaults to use this sensor for temperature measurement and control. Temperature is programmable from 25 - 250 °C.



Standard Attenuator (541125)



Open Vessel Attenuator (541130)

WARNING

This instrument utilizes high voltages and microwave radiation. Only technicians trained in repair and maintenance of high voltage and microwave power systems should perform instrument service and repair.

WARNING

Proper precautions must be taken to avoid contact with solvents or solvent vapors. Protective gear should be worn as outlined in the user's safety program for hazardous materials and the reagent manufacturer's material safety data sheet. Refer to these guidelines for proper handling and disposal of reagents.

Routine Maintenance and Cleaning

Interlocks – Weekly, examine the cavity edge and attenuator interlocks to verify that they are clean and working properly.

Cavity – Weekly, wipe the cavity liner with an alcohol wipe or equivalent.

Lubrication – Proper lubrication for the Explorer module is CEM part number BR199188 Superlube (a synthetic grease containing Teflon)

Microwave Leakage Measurement

The attenuator and cavity of the Discover are durable and are designed for reliable operation under severe laboratory conditions. External radiation checks are performed on the Discover System at several points in the manufacturing process, ensuring that leakage from the finished instrument is only a fraction of that allowed by U.S. law (5 mW/cm^2).

The attenuator is equipped with a safety interlock system to stop the generation of microwave energy when the attenuator is opened or ajar. If the interlock system fails, a monitoring mechanism will blow the fuse(s) through which power is supplied to the magnetron, rendering the microwave power system inoperable.

To verify that seals and interlocks are working properly, the Discover System should be tested periodically for microwave leakage. Use the following procedure to measure microwave leakage:

1. Create a standard method using 300 watts of power, 2 minutes run time, 95°C temperature set-point and 1-minute hold time.
2. Place a round bottom flask containing 50mL of demonized water into the cavity.
3. Attach the attenuator with RF stub to accept a 24/40 ground glass joint.
4. Load the created method and press "Start" to begin the method.
5. Use a suitable RF field strength meter (microwave detector) such as the Holaday Model HI-1500. Slowly move the RF probe around the attenuator perimeter and around the fan grills to check for microwave leakage. Check leakage around the cavity lid.

NOTE

CEM does not recommend use of meters available in electronics stores because they are prone to give erroneous readings and lack the necessary sensitivity to properly test an instrument for microwave leakage.

The U.S. Government defines excessive microwave leakage as 5 mW/cm^2 . If the instrument shows excessive microwave leakage, do not attempt further operation. Contact the CEM Corporation Service Department or the local CEM subsidiary or distributor for further instructions.

Microwave Power Measurement

Use the following procedure to determine actual power output in watts for a 300-watt setting.

1. Remove the 10mL attenuator (access) port.
2. Place the Teflon spacer on the floor of the cavity.
3. Create a power and time method using 300 watts of power and a run time of 60 seconds.
4. Place 100 mL of ambient temperature (18-22 °C) deionized water and a stirring bar, if available, in a 100 mL round bottom flask (with a ground glass joint of a size less than or equal to 24/40).
5. Using a thermometer with 0.1 °C gradations. Stir the water for at least 15 seconds, then measure and record the initial water temperature, T_i . Ensure that the thermometer is immersed to its indicated immersion line prior to reading the temperature.
6. Remove the thermometer from the flask. Carefully place the flask into the cavity.
7. Attach the attenuator with RF stub to accept a 24/40 ground glass joint.
8. Load the method created in step 3, and press “Start” to begin the method.
9. At the end of the programmed time (60 sec), stir the water thoroughly for 10 seconds, then quickly measure and record the peak temperature reading. This is the final temperature, T_f .
10. The microwave power output is calculated as follows:
$$\text{Power in Watts} = 6.97 (T_f - T_i)$$
11. If the measured power is below 270W, repeat the microwave power measurement. If the power remains less than 270W, the instrument is not producing adequate microwave power at the 300W selection.
12. Remove the Teflon spacer from the floor of the cavity.
13. Install the 10mL attenuator (access) port.

If the instrument is not producing sufficient wattage, refer to the Troubleshooting Guide in this manual.

Instrument Cold Start

While depressing the START key, position the instrument power switch in the “on” position.

Master Password

Login: Administrator

Password: cemdiscover

Troubleshooting Guide

Condition	Possible Cause
Instrument Inoperative	Instrument modules not plugged into electrical outlet Power switches not in “on” position Proper instrument not selected in system software Blown fuse(s) Loose connections to power switch(es) Faulty power switch(es) Faulty DC power switch
No Microwave Power	Instrument attenuator ajar Zero wattage selected Interlock(s) not properly adjusted or faulty Faulty controller board Faulty thermal switch Faulty high voltage component
Low Microwave Power	Low line voltage Incorrect wattage selected Faulty high voltage relay(s) Faulty high voltage component
Fuse Blows When Attenuator Is Opened	Interlock(s) not properly adjusted Faulty interlock(s)
Fuse Blows Repeatedly During Operation	Low line voltage Faulty high voltage component Faulty DC power supply Faulty controller board Faulty continuous power supply
No Display	Loose or broken wiring connections Loose or faulty interface cable Faulty display Faulty controller board
Inoperative Keyboard	Loose or faulty interface cable Faulty keyboard Faulty controller board
Inoperative Vessel Stirring Motor	Loose or broken stirring motor belt Faulty stirring motor Loose connector on controller board
Erratic Pressure	Incorrect A/D setting Leakage from vessel Loose connector Improper grounding connection Faulty load cell Faulty pressure transducer Blocked or faulty needle
Erratic Temperature	Lens blocked Faulty IR sensor Faulty controller board
Microwave Leakage	Damaged attenuator Pressure sensor unattached or faulty
No Rise in Temperature	Sample does not absorb microwave energy Faulty infrared temperature sensor Incorrect temperature calibration constants entered Lens blocked

Error Messages

Discover Module

Display Error:	Display is not functioning
A/D Error:	A/D is not functioning
Temperature Not Calibrated:	Temperature Device has not been calibrated
Pressure Not Calibrated:	Pressure Device has not been calibrated
Power Supply Low Voltage:	Line Voltage Below minimum level
Power Supply High Voltage:	Line Voltage Above maximum level
Power Supply Comm Timeout:	Power Supply Lost communication with Discover
Power Supply Shorted RTD:	RTD in Power Supply is shorted
Power Supply Open RTD:	RTD in Power Supply is open
Power Supply Temperature:	Power Supply Heat Sink temperature too high (65 °C)
Power Supply Sec. Max Range:	Secondary Current in Power Supply too high
Power Supply Hi Control:	Power Supply unable to generate enough power
Power Supply Lo Control:	Power Supply unable to generating too much power
Power Supply Delta Temp:	No temperature rise detected in Heat Sink
Power Supply RunAway:	Power Supply could not adjust to required power
Power Supply PS Comm Failure:	Discover lost communication with Power Supply
Power Supply PS Not OFF:	Power Supply is applying power when should be off
Power Supply Sec. Min Range:	Secondary current in Power Supply too low
Power Supply Thermal Overload:	No AC voltage to Power Supply (Thermal switch or Interlock)
Power Supply Ground Error:	Power Supply lost Earth Ground
Power Supply No Microwaves:	Power Supply could not start
Pressure Drop Error:	Pressure Dropped too rapidly
Temperature Drop Error:	Temperature Dropped too rapidly
No Pressure Error:	No pressure was detected (Plugged Needle, Defective Transducer, Bad Calibration)
Excess Pressure Error:	Pressure Exceeded Maximum allowed (300 psi)
Fiber Optic Timeout Error:	Lost Communication with Fiso
Fiber Optic Probe Failure:	Probe error received form Fiso

Explorer Module

Vessel Missing:	Vessel was not detected in required rack position
Vessel Dropped:	Vessel was dropped during insertion or removal
Vessel Stuck:	Vessel was not released
Time out:	Axis did not go to commanded position
Missed Z Axis Limit Switch:	Bottom Z Axis switch not actuated while at lock position
Bad Start Location:	Z Axis not at home when move began
Low Air:	Vessel clamp not operating

WARNING

Disconnect the instrument from the AC power source prior to performing any service procedure.

Prior to any troubleshooting or service procedures in the high voltage section or area, bridge the contacts of the high voltage capacitor using the metal shaft of a well-insulated screwdriver to discharge the residual voltage in the capacitor. This will prevent exposure to high voltage discharge during troubleshooting or service.

Before replacing the high voltage plate assembly after any service procedure involving the microwave generating components, visually check the magnetron, transformers, triac, and high voltage capacitor to ensure that the electrical connections are secure.

Any service to or inspection of the Discover™ System that requires

- removal of the power supply assembly or
- replacement of components in the
 - interlock mechanism,
 - microwave generation system, or
 - microwave transmission system

should be followed by a microwave leakage measurement to verify that leakage is less than 5 mW/cm².

Cavity Liner Cleaning/Replacement

The Discover System is equipped with a replaceable cavity liner positioned inside the cavity of the instrument. It protects the temperature sensor from debris in case of a vessel failure. If a vessel failure occurs, the cavity liner should be removed and cleaned or replaced if it is damaged.

WARNING

Proper precautions must be taken to avoid contact with solvents or solvent vapors. Protective gear should be worn as outlined in the user's safety program for hazardous materials and the reagent manufacturer's material safety data sheet. Refer to these guidelines for proper handling and disposal of reagents.

1. Carefully remove the cavity liner by grasping it and pulling it up and out of the cavity, using caution to prevent spillage through the opening.
2. Rinse the liner with an appropriate solvent to remove all debris.
3. Inspect the liner for damage. If the liner is damaged, especially the lens area, replace the liner.
4. Install the liner into the cavity, ensuring that the spout is positioned into the spill channel. **Note:** If the liner is not seated properly, the attenuator cannot be installed properly.
4. If the cavity liner is replaced, calibrate the temperature sensor as outlined in the System Setup section of this manual.



Cavity Liner

Spill Tray Cleaning

WARNING

Proper precautions must be taken to avoid contact with solvents or solvent vapors. Protective gear should be worn as outlined in the user's safety program for hazardous materials and the reagent manufacturer's material safety data sheet. Refer to these guidelines for proper handling and disposal of reagents.

1. Remove the screw securing the spill tray to the back of the instrument cover.
2. Carefully slide the spill tray out of the instrument.
3. Properly dispose of the contents of the tray.
4. Rinse the tray with an appropriate solvent.
5. Install the spill tray and secure it to the instrument with the screw.



Spill Tray

Adjustment of Interlock Switches

1. Place the attenuator inside the instrument cavity and rotate it clockwise.
2. Loosen the screws securing the interlock switches.
3. Press the left bracket against the attenuator until both switches of the left interlock are engaged.
4. Tighten the screws to secure the left bracket, ensuring that the bracket remains flat and flush to the instrument cavity. Do not overtighten the bracket to prevent bending of the bracket.
5. Perform steps 3 and 4 for the right side bracket.
6. Remove the attenuator from the instrument cavity by rotating it counterclockwise.

Temperature Calibration

NOTE

If a new E-PROM is installed, the temperature calibration data must be re-entered into the system setup information. If the calibration data is not known, calibration is required.

1. From the main menu, press EDIT.
2. Use the arrow keys to toggle and select "Temperature."
3. Press ENTER.

Enter Previous Calibration Values

4. Use the arrow keys and select "Enter Calibration." Press ENTER.
5. Press EDIT to highlight the slope calibration data. Using the numeric keypad, enter the previous slope constant. Press ENTER.

NOTE

If a new temperature sensor or cavity liner is installed, calibration of the temperature sensor is required due to the difference between the IR lenses designed into the cavity liner.

Calibrate Temperature Sensor

6. Place 3mL of dimethyl formamide in a 10mL reaction vessel with a stir bar. Place a cloth over the vessel to prevent splattering. Disconnect the cooling supply line. Using Power-Time control, program the system to irradiate the reaction vessel at 300W for 30 seconds (approximately 150 C).
7. Use the arrow keys and select "Calibrate Device." Press ENTER. The instrument will prompt to apply a heat source.
8. Press ENTER. Note: The instrument will not apply microwaves.
9. Place a thermometer in the vessel and stir the dimethyl formamide (2 - 3 seconds). Measure the temperature of the dimethyl formamide. Using the numeric keys, enter the actual temperature. Press ENTER.
10. Press HOME three times to return to the main menu.

IR Calibrator

When using an IR calibrator (CEM part number 541165), use the following settings:

IR Emissivity E = .75
IR Transmissivity T = .70

Pressure Calibration

NOTE

If a new E-PROM is installed, the pressure calibration data must be re-entered into the system setup information. If the calibration data is not known, calibration is required.

1. From the main menu, press EDIT.
2. Use the arrow keys to toggle and select "Pressure."
3. Press ENTER.

Enter Previous Calibration Values

4. Use the arrow key(s) and select "Enter Calibration." Press ENTER.
5. Press EDIT to highlight the slope calibration data. Using the numeric keypad, enter the previous value for the slope of the pressure curve. Press ENTER. The instrument highlights the intercept data.
6. Using the numeric keypad, enter the previous value for the intercept of the pressure curve. Press the ENTER key.

NOTE

If a new temperature sensor or cavity liner is installed, calibration of the temperature sensor is required.

Calibrate Pressure Sensor

7. Use the arrow key(s) and select "Calibrate Device." Press ENTER.
8. Upon the "Zero Pressure" prompt, ensure that there is no pressure applied to the pressure assembly. Press ENTER.
9. Upon the "Apply Pressure" prompt, apply a pressure source with a known pressure value to the pressure sensor assembly (maximum pressure 300 psi or 21 bar). Using the numeric keys, enter the applied pressure value. Press ENTER.
18. Press HOME to return to the main menu.

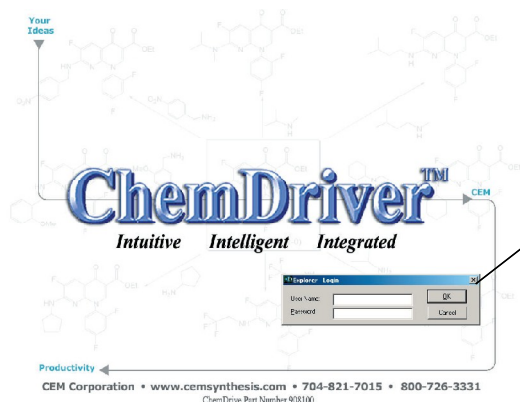
Explorer Module Assembly

1. Place the Discover module in an appropriate position as outlined previously in this manual.
2. Remove the top cover lid from the Discover module by pressing lightly on the secure tab at the rear center of the lid while slightly lifting and pulling backward on the lid to disengage the front insert tabs.
3. Remove the five (5) screws securing the top cover of the Discover module (two in front, one for the condenser location and two in the rear of the cover). Discard the screws, but retain the washers from the screws in the rear of the instrument for reinstallation.
4. Install the Explorer automation module attenuator. Turn the attenuator clockwise sufficiently for the switches to lock into position.
5. Place the Explorer automation module support plate on the Discover module, ensuring that the plate is positioned as far forward as possible to permit proper alignment of the Explorer automation module.
6. Secure the Explorer automation module support plate with the five (5) long screws included with the Explorer automation module, tightening the screw in the center of the plate first. Install the washers retained in step 3 on the two screws installed in the rear of the cover.

CAUTION

Never lift the Explorer automation module by the vertical arm or movable table that holds the racks.

7. Lift the Explorer automation module by the base and place it on the support plate. Loosely install one of the screws provided with the Explorer automation module in the exposed screw hole.
8. Remove the screws and two white positioning braces from the Explorer automation module. Reinstall the screws. Discard the positioning braces.
9. Connect the 7-pin pressure sensor connector to the 7-pin electrical connector in the rear of the Discover module.
10. Connect the serial cable (cream colored) between the bottom bottom 9-pin male connector of the Explorer automation module and the right serial port (comm port 2) of the Discover module (facing back of instrument).
11. Place the computer on a suitable work area preferably on the right side of the instrument for ease of operation.
12. Connect the serial cable (gray) between the computer and the left serial port (comm port 1) of the Discover module).
13. Plug the power cord of the Computer into the electrical outlet and boot the computer, ensuring the operating system loads properly.
14. Connect the power cord to the Discover module and plug it into an appropriate electrical outlet.
15. Connect the power cord to the Explorer automation module and plug it into an appropriate electrical outlet.
16. Position the power switches of both the Discover module and the Explorer automation module in the “on” position.
17. Using the keyboard on the Discover module, press the EDIT key. Press the right arrow key two times. The screen will display “System Options.” Press the ENTER key. The screen will display “Peripheral Settings.” Press the ENTER key.
18. Press the right arrow key two times. The screen will display “Mode - Explorer.” Press the ENTER key. Press the HOME key. The screen will display “Explorer.”
19. Double click the Discover icon on the computer screen. The instrument software requires a user name. Once the “User Name” screen appears, use the keyboard and type “cem” as the user name. Do not enter a password at this time.
20. The “Instrument Setup” will be displayed on the Computer screen followed by the “Automation Setup” screen.



Explorer - Login

User Name:

Password:

21. From the “Automation Setup” screen, highlight “Instrument” and select “Explorer Setup.”

Explorer Setup

Home:

Absolute Move:
Increment:

Waiting for First Query Response
Waiting
End Time: 6/18/2003 9:01:11 AM

Vessel Control:

Stage Position (1-24) or 0 for direct up and down:

EE Memory:
Address:
Data:

Zero Axis:

Z-Axis: Up (1000)
Rack Grip (9800)
Atten Drop (22200)
Atten Grip (22600)
Lock (26000)

ABCD-Offset (In/Out):
Offset (0)

Read All:

1 (1850)		☐		☐		☐		☐
2 (2442)		☐		☐		☐		☐
3 (3033)		☐		☐		☐		☐
4 (3625)		☐		☐		☐		☐
5 (4217)		☐		☐		☐		☐
6 (4809)		☐		☐		☐		☐

☐ ABCD Position (In/Out) ☐ Left/Right Position

(Default #) ☐ Subtract offset with move

22. Locate the “Absolute Move” section in the upper left side of the Explorer Setup screen. The “Ex_Sys_Status” should read “0,” indicating that the instrument components are communicating properly.

Absolute Move

Increment:

Ex_Sys_Status 0 (000000) SN: 0

Clamp: 0 S: Ex_Stopped

End Time: 6/18/2003 9:19:55 AM

☒ Z
☐ Y
☐ A
☐ B
☐ C
☐ D

Note: If the “Ex_Sys_Status” reads “20,” the instrument is not communicating properly. Turn off the computer, unplug all instrument modules, replug all modules, and check the serial port connections between the instrument and the computer. If the “Ex_Sys_Status” continues to read “20,” contact CEM.

23. Locate the “Home” section in the top left side of the Explorer Setup screen. Click the “All” key. The Explorer automation module arm will raise, the table will move to the right, and the racks will move in and out until all have reached the “home” position.
24. Remove the plastic protective cover from the gripper fingers.
25. Locate the “Z Axis” information in the upper right corner of the Explorer Setup screen.

The image shows a software interface titled "Z-Axis". It contains a grid of controls for different parts of the system. On the left is a button labeled "R" (Read). To its right are five rows, each with a label, a numerical input field, a "W" (Write) button, and a "GO" button. The rows are: "Up (1000)", "Rack Grip (8800)", "Atten Drop (22200)", "Atten Grip (22600)", and "Lock (26000)".

Component	Value	W	GO
Up (1000)			
Rack Grip (8800)			
Atten Drop (22200)			
Atten Grip (22600)			
Lock (26000)			

26. Click the “R” (read) button to read the instrument Z axis information. Wait until the data is displayed in all windows.
27. Locate “Atten Grip” (attenuator grip), and click the associated “GO” button. The pressure sensor assembly will lower.
28. Align the explorer module as outlined below:

IntelliVent

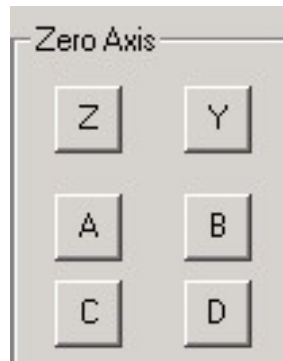
Note: Proceed to the next page for alignment if instrument is equipped with direct pressure.

- a. Using minimal force, close the gripper fingers. If necessary, adjust the position of the Explorer automation module so that the gripper fingers are centered around the port of the attenuator and reach the attenuator simultaneously.
- b. Locate “Up” in the Z Axis information, and click the associated “GO” button to raise the pressure sensor assembly.
- c. Open the pressure sensor assembly gripper fingers. Install (push) the alignment/calibration tool, supplied with the Explorer automation module, into the pressure sensor assembly.
- d. Install and tighten the two screws securing the left side of the Explorer automation module to the support plate.

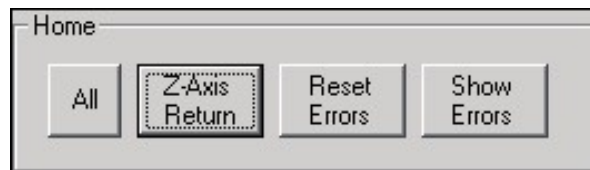
The image shows a software interface titled "Absolute Move". It includes an "Increment" input field set to "2000" and a "Move" button. Below these are three status display fields: "Ex_Sys_Status 0 (000000) SN: 0", "Clamp: 0 S: Ex_Stopped", and "End Time: 6/18/2003 9:19:55 AM". On the right side, there is a vertical column of radio buttons labeled Z, Y, A, B, C, and D. The "Z" radio button is currently selected.

- e. Locate the “Absolute Move” section of the screen. Select (left mouse click) the “Y” axis. Position the cursor in the “Increment” box. Using the computer keyboard, enter “2000.” Press ENTER.

- e. Locate the “Absolute Move” section of the screen. Select (left mouse click) the “Y” axis. Position the cursor in the “Increment” box. Using the computer keyboard, enter “2000.” Press ENTER.



- f. Install and tighten the screw securing the right side of the Explorer automation module.



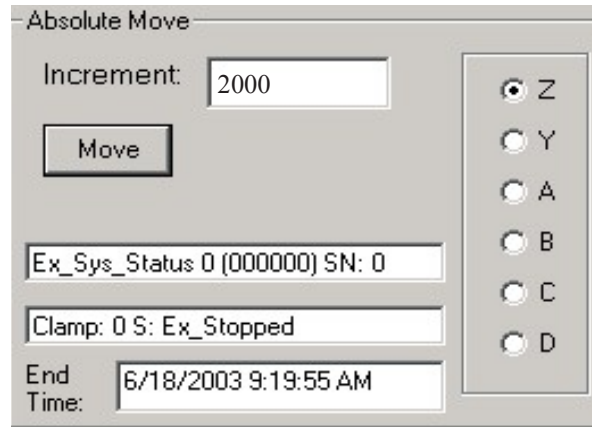
- g. Locate the Home information and click the “All” button to home the Explorer automation module.
- h. Verify alignment. as follows:
1. With the gripper fingers completely opened, locate “Atten Grip” (attenuator grip), and click the associated “GO” button. The pressure sensor assembly will lower. Close the gripper fingers to ensure that the fingers will clamp the attenuator at the same time. The gripper fingers should be completely parallel, vertically and horizontally. If necessary, carefully reposition the Explorer automation module so that the gripper fingers will be aligned.
 2. Locate “Up” in the “Z Axis” information and click the associated “GO” button to raise the pressure sensor assembly.

Note: If necessary, repeat the above steps to verify the automation module alignment.

- i. Proceed to step 29 to continue Explorer module assembly.

Direct Pressure

- a. Using a small screwdriver or small spatula, apply minimal force required to close the gripper fingers. If necessary, adjust the position of the Explorer automation module so that the gripper fingers are centered around the port of the attenuator.
- b. Locate “Up” in the Z Axis information, and click the associated “GO” button to raise the pressure sensor assembly.
- c. Open the pressure sensor assembly gripper fingers. Install (push) the alignment/calibration tool, supplied with the Explorer automation module, into the pressure sensor assembly.
- d. Locate “Atten Drop” (attenuator drop) in the Z axis information, and click the associated “GO” button. The pressure sensor assembly will lower, and the alignment tool will enter the attenuator. The alignment tool should be centered as it enters the attenuator. If necessary, carefully reposition the Explorer automation module so that the alignment tool is centered in the attenuator.
- e. Install and slightly tighten the two screws securing the left side of the Explorer automation module to the support plate.



- f. Locate the “Absolute Move” section of the screen. Position the cursor in the “Increment” box. Using the computer keyboard enter “2000.” Press ENTER
- g. Install and slightly tighten the screw securing the right side of the Explorer automation module.



- i. Locate the “Zero Axis” information and select (left mouse click) the “Y” button.
- j. Locate “Up” in the “Z Axis” information and click the associated “GO” button to raise the pressure sensor assembly.
- k. Remove the alignment tool from the pressure sensor assembly.
- l. With the gripper fingers completely opened, locate “Atten Grip” (attenuator grip), and click the associated “GO” button. The pressure sensor assembly will lower. Close the gripper fingers to ensure that the fingers will clamp the attenuator at the same time. The gripper fingers should be completely parallel, vertically and horizontally. If necessary, carefully reposition the Explorer automation module so that the gripper fingers will be aligned.
- m. Locate “Up” in the “Z Axis” information and click the associated “GO” button to raise the pressure sensor assembly.

Note: If necessary, repeat the above steps to verify the automation module alignment.

- n. Complete the tightening of the two screws securing the left side of the Explorer automation module to the support plate.
 - o. Locate the “Absolute Move” section of the screen. Position the cursor in the “Increment” box. Using the computer keyboard enter “2000.” Press ENTER.
 - p. Complete the tightening of the screw securing the right side of the Explorer automation module.
 - q. Locate the “Zero Axis” information and select (left mouse click) the “Y” button.
29. Install the vessel racks into the tagble with the rounded ends toward the front of the instrument.

30. Verify “In/Out” rack adjustment as follows.

- a. Locate the vial position table in the lower right side of the Explorer Setup screen.

	Read All	A (0)	B (1000)	C (2000)	D (3000)
1 (1850)		☒	☐	☐	☐
2 (2442)		☐	☐	☐	☐
3 (3033)		☐	☐	☐	☐
4 (3625)		☐	☐	☐	☐
5 (4217)		☐	☐	☐	☐
6 (4809)		☐	☐	☐	☐

☒ ABCD Position (In/Out)
 ☐ Left/Right Position

- b. Click the “Read All” button to read the vial position information. Wait until all data is displayed in the windows.
- c. Select (click) the small circle for vial position #A1.
- d. Select (click) “ABCD Position (In/Out).”
- e. Locate “Rack Grip” in the “Z Axis” information and click the associated “GO” button. The assembly will lower. The gripper fingers should be centered on the lip of the rack position A-1 from an in/out perspective.
- f. If necessary, adjust the position of the fingers by adjusting the value for position A1. Highlight the current value and type the new value, adjusting the value in increments of 10 (+10 to move the rack out or –10 to move the rack in).
- g. Click the “GO” button in the table portion of the screen. The fingers will move to the new position.
- h. Continue adjusting the value in increments of 10 until the gripper fingers are centered on the lip of the rack.
- i. If an adjustment was made to “ABCD Position” in A-1, enter that value into the “ABCD Offset (In/Out), and select (left mouse click) “W” to write the value to the instrument memory.

31. Verify “Left/Right” rack adjustment as follows.

- a. Locate the vial position table in the lower right side of the Explorer Setup screen.
- b. Click the “Read All” button to read the vial position information. Wait until all data is displayed in the windows.
- c. Select (left mouse click) the small circle for vial position #A1.
- d. Select (left mouse click) “Left/Right Position.”
- e. Locate “Rack Grip” in the “Z Axis” information and click the associated “GO” button. The assembly will lower. The gripper fingers should be centered on the lip of the rack position A-1 from a left/right perspective.
- f. If necessary, adjust the position of the fingers by adjusting the value for position A1. Highlight the current value and type the new value, adjusting the value in increments of 10 (+10 to move the rack to the left or –10 to move the rack to the right).
- g. Click the “GO” button in the table portion of the screen. The fingers will move to the new position.

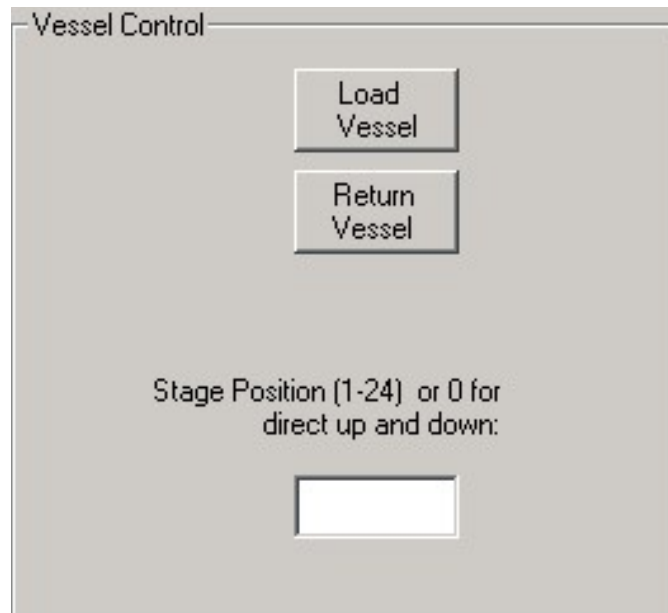
- h. Continue adjusting the value in increments of 10 until the gripper fingers are centered on the lip of the rack.
 - i. If an adjustment was made to the “Left/Right Position” in A-1, increase each rack position left/right value by the same amount and press (left mouse click) “W” to write each value to the instrument memory.
 - j. Repeat the above steps to verify the left/right alignment of racks B, C and D.
32. Connect the air regulator to the user supplied air source (clear compressed air or nitrogen).

NOTE

The air supply must be capable of delivering 30 psi.

33. Connect the 12” length of tubing supplied with the Explorer automation module between the connector on the right side of the Discover module (facing back of instrument) and one of the two connectors on the manifold of the Explorer module.
34. Connect the long length of tubing between the second connector on the manifold of the Explorer module and the air regulator.
35. Set the air regulator to 30 psi.
36. Verify the proper operation of the gripper finger switches as follows.
- a. Refer to the “Absolute Move” section of the Explorer Setup screen. The “Clamp” configuration should read “3” with the gripper fingers opened.

- b. Manually close the gripper fingers. The “Clamp” configuration should read “0” with the fingers closed.
 - c. Manually place and hold a vial in the gripper fingers. The “Clamp” configuration should read “2” while the vial is secure.
37. Ensure that all three (3) screws securing the Explorer automation module to the support plate are tightened securely.
38. Place a vial in position #1 of the racks.
- . Verify that the pressure sensor assembly properly loads vials into the attenuator and returns vials to the racks as follows:
- a. Place vials in positions 1, 6 and 24 of the racks. Click the “All” button in the “Home” section of the Explorer Setup screen to ensure that all components move to their “home” positions.
 - b. Locate the “Vessel Control” section in the lower left corner of the Explorer Setup screen.



- c. Using the keyboard, type "1" into the "Stage Position" entry area.
 - d. Click the "Load Vessel" button. The rack will move into position over the attenuator port. The Z axis arm will move down and the gripper fingers will grasp and lift the vial from rack position #1. The rack will move back into the "home" position. The Z axis arm will then move down and position the vial into the attenuator port. It will then move back into its "home" position.
 - e. Click the "Return Vessel" button. The pressure sensor assembly will lift the vial from the attenuator and return it to position #1 of the rack assembly.
 - f. Observe the movement of the vial into the attenuator and into the rack, ensuring that the vial is lifted properly by the gripper fingers and that the vial is centered as it enters the attenuator and rack position. Refer to the previous instructions and make any necessary adjustments.
 - f. Repeat steps c through f for position #6 and position #24.
39. Create a method and perform a complete cycle test with vials in all 24 positions to ensure proper operation.

Component Replacement

Infrared Sensor Assembly

1. Position the Discover System power switch in the “off” position and disconnect the power cord from the electrical source.
2. Facing the instrument, position it on its left side.
3. Remove the stirrer cover (162620) by removing the screw (BR128200) that secures the cover, then slightly tilting the cover away from the screw tab and lifting it outward to disengage the insert tabs securing the cover.
4. Using an Allen wrench, loosen the setscrew securing the IR assembly sensor head (541035) to the microwave cavity RF stub.
5. Using a downward force, pull the sensor head off of the RF stub. The sensor head will remain connected to the IR assembly cable.
6. Reposition the Discover upright onto its base.
7. Remove the top cover lid (162710) by pressing lightly on the secure tab at the rear center of the lid while slightly lifting and pulling backward on the lid to disengage the front's insert tabs.
8. Remove the four (4) screws securing the top cover assembly (660929).
9. Remove the two (2) screws (BR196077) securing the IR assembly (541035) to the base of the instrument.
10. Disconnect the IR assembly wiring from the CPU board by removing the 4-pin connector at the J6 location and the ground connector at the J4 location on the board.
11. Carefully feed the IR assembly cable up through the access hole in the bottom of instrument. Remove the IR assembly wiring from the wiring harness bundle.
12. Lift the IR assembly (cable, sensor head, calibration box and wiring harness) out of the instrument.
13. Carefully route the new IR assembly cable and sensor head gently through the access port in the base of the instrument.
14. Secure the IR assembly calibration box to the base with two screws. Tighten the screws until snug. **Note:** To prevent component damage, do not overtighten the screws.
15. Route the IR assembly wiring harness to the CPU board and connect the 4-pin connector at the J6 location and the ground connector at the J4 pin location.
16. Facing the instrument, position it on its left side.
17. Using steady, gentle pressure, install the IR assembly sensor head onto the RF stub until it stops. Using an Allen wrench, tighten the setscrew. **Note:** Do not overtighten the setscrew.
18. Install the new stirrer cover (162620) by tilting it slightly away from the screw tab, engaging the insert tabs, and then sliding it in until it stops. Install the screw that secures the cover (BR128200) and tighten it until it is snug.
19. Position the instrument upright on its base.
20. Install the top cover assembly (660929) and, using the four (4) screws, secure it to the base.
21. Install the Top Cover Lid (162710) by engaging the front insert tabs and sliding the lid forward until it stops. Lower the lid to engage the secure tab at the rear center of the lid until it snaps into place.
22. Plug the power cord into the electrical outlet. Position the on/off switch in the “on” position.
27. Calibrate the IR assembly using the calibration procedures outlined in this manual.

Stirrer Motor Belt

1. Position the Discover System power switch in the “off” position and disconnect the power cord from the electrical source.
2. Facing the instrument, position it on its left side.
3. Remove the stirrer cover (162620) by removing the screw (BR128200) that secures the cover, then slightly tilting the cover away from the screw tab and lifting it outward to disengage the insert tabs securing the cover.
4. Using a wrench, disconnect the fitting on the cooling gas inlet tubing and remove the tubing from the cavity assembly.
5. Using an Allen wrench, loosen the setscrew securing the IR assembly sensor head (541035) to the microwave cavity RF stub.
6. Using a downward force, pull the sensor head off of the RF stub. The sensor head will remain connected to the IR assembly cable.
7. Loosen the two screws (BR196439) with star washers (BR198650) that secure the stirrer motor (314105) to the instrument base.
8. Slide the stirrer motor pulley assembly forward, permitting slack in the belt.
9. Carefully remove the loose belt from the groove of the stirrer plate (162455). Remove the stirrer motor belt.
10. Position the new belt around the stirrer motor pulley assembly and into the groove of the stirrer plate (162455).
11. Move the stirrer motor pulley assembly backward with steady, even pressure until the belt feels tight.
12. Tighten the two screws (BR196439) with star washers (BR198650), securing the stirrer motor (314105) to the instrument base.
13. Test the belt tension by turning the stirrer plate manually. If binding occurs or the stirrer plate does not turn freely, slightly loosen one of the two screws securing the stirrer motor pulley assembly and move the assembly slightly forward. Tighten the screw and recheck the belt tension.
14. Using steady, gentle pressure, slide the IR assembly sensor head onto the RF stub..
15. Using an Allen wrench, tighten the setscrew until snug. Do not over tighten the setscrew.
16. Connect the cooling gas inlet tubing to the cavity assembly and, using a wrench, tighten the fitting until snug.
17. Install the stirrer cover (162620) by tilting it slightly away from the screw tab, engaging the insert tabs, and then sliding it in until it stops. Install the screw that secures the cover (BR128200) and tighten it until it is snug.
18. Position the instrument upright on its base.
19. Plug the power cord into the electrical outlet. Position the on/off switch in the “on” position.

Stirrer Motor

1. Position the Discover System power switch in the “off” position and disconnect the power cord from the electrical source.
2. Facing the instrument, position it on its left side.
3. Remove the stirrer cover (162620) by removing the screw (BR128200) that secures the cover, then slightly tilting the cover away from the screw tab and lifting it outward to disengage the insert tabs securing the cover.
4. Using a wrench, disconnect the fitting on the cooling gas inlet tubing and remove the tubing from the cavity assembly.
5. Using an Allen wrench, loosen the setscrew securing the IR assembly sensor head (541035) to the microwave cavity RF stub.
6. Using a downward force, pull the sensor head off of the RF stub. The sensor head will remain connected to the IR assembly cable.
7. Loosen the two screws (BR196439) with star washers (BR198650) that secure the stirrer motor (314105) to the instrument base.
8. Slide the stirrer motor pulley assembly forward, permitting slack in the belt.
9. Carefully remove the loose belt from the groove of the stirrer plate (162455). Remove the stirrer motor belt.
10. Remove the two Allen screws (162715) securing the stirrer motor pulley to the stirrer motor adapter (134720), and remove the stirrer motor pulley.
11. Remove the top cover lid (162710) by pressing lightly on the secure tab at the rear center of the lid while slightly lifting and pulling backward on the lid to disengage the front's insert tabs.
12. Remove the four (4) screws securing the top cover assembly (660929).
13. Disconnect the stirrer motor assembly from the CPU board by disconnecting the 2-pin connector at pin location J8. Remove the stirrer motor wiring from the wiring harness.
14. Position the instrument upright on its base.
15. Remove the stirrer motor.
16. Position the new stirrer motor assembly through the access in the instrument base.
17. Reposition the instrument upright on its base and loosely install the screws and star washers.
18. Install the stirrer motor pulley onto the stirrer motor adapter, and secure it with two Allen screws.
19. Position the belt around the stirrer motor pulley assembly and into the groove of the stirrer plate (162455).
20. Tighten the two screws (BR196439) with star washers (BR198650), securing the stirrer motor (314105) to the instrument base.
21. Test the belt tension by turning the stirrer plate manually. If binding occurs or the stirrer plate does not turn freely, slightly loosen one of the two screws securing the stirrer motor pulley assembly and move the assembly slightly forward. Tighten the screw and recheck the belt tension.
22. Position the instrument upright on its base.
23. Install the top cover assembly (660929) and, using the four (4) screws, secure it to the base.
24. Install the Top Cover Lid (162710) by engaging the front insert tabs and sliding the lid forward until it stops. Lower the lid to engage the secure tab at the rear center of the lid until it snaps into place.
25. Plug the power cord into the electrical outlet. Position the on/off switch in the “on” position.

Cooling Solenoid

1. Position the Discover System power switch in the “off” position and disconnect the power cord from the electrical source.
2. Remove the top cover lid (162710) by pressing lightly on the secure tab at the rear center of the lid while slightly lifting and pulling backward on the lid to disengage the front insert tabs.
3. Remove the four (4) screws securing the top cover assembly (660929).
4. Disconnect the cooling solenoid assembly (P/N 162550) from the solenoid wiring harness by disconnecting the wiring at the two Faston plugs (BR109931).
5. Facing the instrument, position it on its left side.
6. Disconnect the cooling gas inlet tubing.
7. Remove the cooling solenoid cover (162615) by removing the three screws (BR128200) that secure the cover. The cover can then be removed by pulling it gently away from the base.
8. Disconnect the internal cooling tube from the cooling solenoid.
9. Slide the cooling solenoid from its compartment in the base.
10. Connect the internal cooling gas tube to the new cooling solenoid.
11. Connect the two Faston plugs (BR109931) on the cooling solenoid assembly to the wiring harness.
12. Slide the cooling solenoid back into its compartment, using caution to prevent crimping the wiring connector or inlet cooling gas tubing.
13. Install the cooling solenoid cover and secure it to the instrument base with three screws.
14. Position the instrument upright on its base.
15. Install the top cover assembly (660929) and, using the four (4) screws, secure it to the base.
16. Install the top cover lid (162710) by engaging the front insert tabs and sliding the lid forward until it stops. Lower the lid to engage the secure tab at the rear center of the lid until it snaps into place.
17. Plug the power cord into the electrical outlet. Position the on/off switch in the “on” position.

High Voltage Supply

1. Position the Discover System power switch in the “off” position and disconnect the power cord from the electrical source.
2. Remove the top cover lid (162710) by pressing lightly on the secure tab at the rear center of the lid while slightly lifting and pulling backward on the lid to disengage the front's insert tabs.
3. Remove the four (4) screws securing the top cover assembly (660929).
4. Using an Allen wrench, remove the two Allen screws securing the right interlock switch assembly to the top microwave choke plate. Use extreme caution to prevent damage to the switch assembly wiring, which is still connected to the assembly.
5. Slide the right interlock pin out of the microwave cavity choke plate assembly.
6. Remove the AC power connector from the high voltage power supply located on the front left corner of the top cover of the HV supply.
7. Using an Allen wrench, remove the two Allen screws securing the communications connector located on the front right corner of the top of the HV Supply. Remove the connector.
8. Using an 11/32” hex nut driver, remove the grounding strap connecting the HV supply cover to the top of the waveguide.
9. Using a Phillips screwdriver, remove the four screws securing the HV supply to the instrument base. **Note:** Eight (8) screws are visible on the top of the HV supply. The four (4) screws securing the supply to the base are located closest to the outside of the supply. The 4 screws located toward the center of the supply secure the internal boards to the supply assembly and should not be removed.
10. Remove the two wires, which connect the HV supply cooling fan to the CPU board, from the HV supply cooling fan. Route the wires through the access in the HV supply cover located at the right rear of the instrument. Remove the two wires, which connect the magnetron cooling fan to the CPU board, from the magnetron cooling fan. Route the wires through the access in the magnetron cooling fan cover located at the left rear of the instrument. Label each wire for its proper installed position.
11. Using a Phillips screwdriver, remove the two screws securing the magnetron cooling fan cover located at the left rear of the instrument. Remove the cover.

CAUTION

Ensure the instrument power cord is disconnected. Failure to disconnect the power cord could lead to extreme electrical shock. Only technicians trained in high voltage component repair should attempt this repair.

12. Locate the two HV wires (one black, one white) connecting the HV supply to the magnetron. Using a pair of needlenose pliers, remove these wires from the magnetron by pulling the wiring connectors from the magnetron wiring tabs.
13. Remove the HV ground strap connecting the internal supply to the waveguide. This strap is located below the HV supply cover ground strap on the waveguide. **Note:** There are three ground straps located on the same tap.
14. Remove the HV supply assembly from the instrument base by grasping the front and back of the supply and tilting it toward the back of the instrument while lifting it upward.
15. Install the new HV supply on the instrument base.
16. Connect the HV wires to the magnetron (white wire on top tap, black on bottom tap).
17. Connect the two ground straps to the waveguide tap. Using an 11/32” hex nut driver, tighten the hex nut.
18. Install the magnetron cooling fan cover and secure it with the two screws.
19. Connect the two wires extending from the CPU board to the magnetron cooling fan.
20. Connect the two wires extending from the CPU board to the HV supply cooling fan.

21. Secure the HV supply to the instrument base by installing the four screws into HV supply cover.
22. Install the communications connector in the right front corner of the HV supply. Install the two Allen screws to secure the connector.
23. Connect the AC power connector to the HV supply in the left front corner of the HV supply.
24. Install the right interlock pin into the choke plate assembly.
25. Install the right interlock switch assembly bracket to the top choke plate and secure it using the two Allen screws.
26. Install the right interlock switch assembly bracket to the top choke plate and secure it using the two Allen screws. Ensure that the interlock switch is adjusted for proper engagement. Take care to adjust the Interlock Switch for proper engagement. Refer to procedures in this manual for interlock switch adjustment.
27. Plug the power cord into the electrical outlet. Position the on/off switch in the “on” position.

Discover System Specifications

Electrical Requirements	120 VAC (90-140 VAC), 60 Hz, 10A @ 120 VAC; 220/240 VAC (202-250 VAC), 50 Hz, 15A @ 240VAC; Detachable Power Cord, I.E.C. and U.L. approved; Variance in line voltage can affect microwave power output.
Safety Features	Three independent safety interlocks, including interlock monitoring system, plus two independent thermal switches used in each instrument to prevent instrument operation and microwave emissions in case of improper attenuator closure or misalignment. Instrument complies with HHS standards under 21 CFR, Part 1030.10, Subparts (C)(1), (C)(2), and (C)(3).
Magnetron Frequency	2455 MHz
Power Output	300 watts $\pm$ 10%
Magnetron Protection	Wave Guide Design (Patent Pending) to protect magnetron from reflected energy, ensuring constant power output.
Microwave Cavity	Heavy-duty, multi-layer stainless steel
Dimensions (Overall)	16-3/4" x 14" x 8-1/2" (42.5 cm x 35.5 cm x 22.2 cm) -D x W x H
Weight	28 lbs. or 12.6 kg
Printer Port	25-Pin, Epson and IBM Compatible
Computer Compatibility	80C188 on-board computer controls all system functions. System can perform all functions with or without connection to external PC. RS 232, 9-Pin, IBM PC compatible.
Internal Diagnostic Software	BITS System (Built-In Test System) Checks/monitors line voltage, magnetron life, temperature control, status/operation, safety interlocks.
Pressure Control System	Inboard pressure control system to monitor and control System equilibrium/reaction pressure. Pressure sensed 200 times per minute. Internal pressure control system able to monitor and control vessel pressures up to 300 psi (21 bar).
Temperature Control System	Non-contact sensor for temperature measurement of vessel contents. Temperature sensor independent of vessel volume. Temperature measurement range from 15°C to 430 °C with an upper control limit of 250 °C.
Service Accessibility	One panel access to system main circuitry for convenient service and upgrading capability.
Patents	CEM Microwave Systems may be covered by any one of the following U.S. patents: 04835354, 04080168, 05369034, 04672996, RE034373, 05230865, 04877624, 04672996, 05206479, 05427741. Other patents pending.

Specifications

Electrical Requirements	90 - 264 VAC 50/60 Hz, 1 Amp @ 120 VAC, 0.5 Amp @ 220 VAC Detachable Power Cord with U.L., CSA and CE approvals; Variance in line voltage can affect microwave power output.
Instrument Classification	Class 1, Continuous Operation, IPX0 Protection
Dimensions (Explorer Mounted on Discover)	20-3/4" D x 14-1/2" W x 30" H (52.7 cm x 36.8 cm x 76.2 cm)
Weight	40 lbs. or 18.1 kg (Shipping Wt. 46 lbs. or 20.9 kg) Combined Weight Explorer and Discover (68 lbs. or 30.8 kg)
Printer Port	25-Pin, Epson and IBM Compatible
Computer Compatibility	80C188 on-board computer controls all system functions. System can perform all functions with or without connection to external PC. RS 232, 9-Pin, IBM PC compatible.
Internal Diagnostic Software	BITS System (Built-In Test System) Checks/monitors line voltage, magnetron life, temperature control, status/operation, safety interlocks.
Operating Temperature	50°F (10°C) to 85°F (29.4°C)
Ethernet and Serial Ports	(2) RS-232, 9 pin IBM PC compatible
Fuses	2 AMP Fuse (F2A - 250V, 1-1/4" Type, Littlefuse #312002 3AG, CEM #BR188250) P/S Board (F4A - 250V)
Service Accessibility	One panel access to system main circuitry for convenient service and upgrading capability.
Patents	CEM Microwave Systems may be covered by any one of the following U.S. patents: 04835354, 04080168, 05369034, 04672996, RE034373, 05230865, 04877624, 04672996, 05206479, 05427741. Other patents pending.

Discover Debug Screens

To access the debug information screens, turn the instrument power on while depressing the “EDIT” key until an audible “BEEP” is heard. Then release the “Edit” key. The unit will enter the debug code entry mode. Enter the Access Code and press the “ENTER” key.

Access Code: **456**

CH0: XXXX	CH4: XXXX
CH1: XXXX	CH5: XXXX
CH2: XXXX	CH6: XXXX
CH3: XXXX	CH7: XXXX

The above screen is the analog screen. Each channel is listed below.

CH0: Resistor ID 1 should read 0 on current board rev. 019611

CH1: Resistor ID 2 with pressure device connected, channel should read as follows:

4095 = Standard Pressure Device

3500 = Pneumatic locking pressure device

3100 = Intelli-vent Sensor with VIP switch actuated

2500 = Intelli-vent Pressure Sensor

2000 = 80 ml vessel option

1500 = unassigned

1000 = unassigned

0500 = unassigned

0000 = No pressure device connected

CH2: Raw Pressure Reading

CH3: SPARE not used at this time

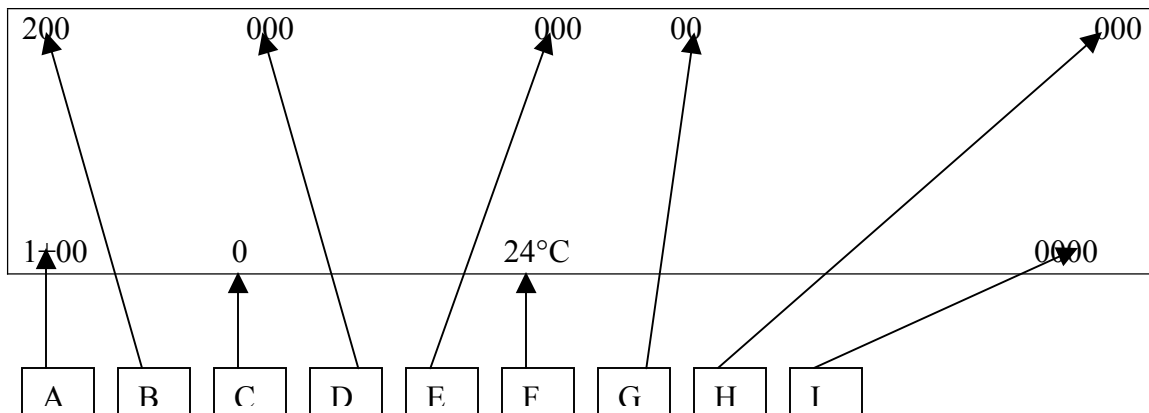
CH4: SPARE not used at this time

CH5: SPARE not used at this time

CH6: Raw IR Hi Range (approx. 1 count/ 1°C)

CH7: Raw IR Low Range (approx.10 count /1°C)

Access Code: **123**



NOTE: If the unit resets to the power test rather than accessing the debug screen, it is not communicating with the high voltage power supply. This is typically indicative of a bad high voltage assembly.

The above screen is the high voltage power supply debug screen.

- A. Power Table index - displays which table entry is currently in use.
- B. Ramp counter - decreases from 200 until power delivered is within the required range, then will reset to 200. Should not fall below 100.
- C. Ramp Done Flag - will be set to 1 when power supply ramps to desired power level.
- D. Runaway Counter - will be incremented each time the power supply is unable to reach desired power in the prescribed time. If 5 is reached, an error will occur.
- E. Line Voltage - measured input line voltage. Not calibrated. Will read zero if interlocks are open.
- F. Heat sink temperature - measured temperature of power supply heat sink. Will cause error if exceeds 65 °C. Normal operation temperature is 40-45 °C.
- G. Status Byte 2. Bit coded status value.
 - 0x80 = New version power supply
 - 0x01 = No Microwaves
 - 0x02 = Start-up Sequence OK
- H. Secondary Current - displays secondary current feedback. 300 watts = 720 counts, 150 watts = 360 counts.
- I. Status Byte 1 - bit code status value
 - 0x8000 = Earth Ground Missing Flag (Eliminated from current Software revision (07/28/04))
 - 0x4000 = Thermal Overload Flag (Attenuator Open)
 - 0x2000 = Minimum Secondary Current Error Flag
 - 0x1000 = Attenuator Closed

- 0x0800 = Power Supply Runaway Flag
- 0x0400 = Temperature Stuck Flag. (heat sink temperature did not change)
(Removed from current software revision 07/28/04)
- 0x0200 = Low Control Error Flag
- 0x0100 = Hi Control Error Flag
- 0x0080 = Secondary Current Range Error Flag
- 0x0040 = Temperature Recover Flag
- 0x0020 = Open RTD Error Flag
- 0x0010 = Shorted RTD Error Flag
- 0x0008 = Communications Time-out Flag
- 0x0004 = High Voltage Error Flag
- 0x0002 = Low Voltage Error Flag
- 0x0001 = Filament On Flag

Under **normal operating conditions after powering the unit on** all above readings should be as follows:

	1	2	3	4
A	1+00	1+00	1+00	4-11
B	200	200	200	200*
C	0	0	0	1
D	000	000	000	000
E	000	110 or 220	000	110 or 220
F	22-24^C	22-24^C	22-24^C	29-45^C
G	00	00	00	02
H	000-010	000-010	000-010	720 or 360 (approx)
I	4002	1000	4002	1001

1. = Attenuator open with no microwaves present
2. = Attenuator closed with no microwaves present
3. = Attenuator open attempting to Microwave
4. = Attenuator closed producing microwaves

HIGH VOLTAGE TEST PROTOCOL

High Voltage Board Test Protocol

This document can be printed in color.

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High Voltage Board Test Protocol

TEST PROCEDURE

- 1) **Always wear safety glasses when testing!**
- 2) Study the accompanying Figures 1 thru 5 to become familiar with the possible high voltage waveforms to be encountered during the testing of the high voltage boards. **Read the test procedure completely prior to any testing.**
- 3) Study Figure 6 to become aware of the high voltages that are present on the board.
- 4) Connect the high voltage probe connector box to an oscilloscope, using the supplied BNC connector lock ring. Set the scope for 2 volts/div and 2 milliseconds. The high voltage probe is 1000:1.
- 5) Determine the test voltage for the board(s) to be tested.
- 6) Set the voltage select switch (located behind the small current meter) appropriately (120V=Up, 230V=Down). **This switch is only read when the AC power is switched on.**
- 7) If testing 230V boards, connect to the supplied step-up transformer. **Do not plug into the rear of the Discover unit at this time.**
- 8) Ensure that the AC power switch on the left rear of the Discover unit is on and the AC power switch on the right front is off (down).
- 9) Before connecting the DUT, visually inspect the board to ensure that:
 - all four (4) of the high voltage transformer leads are soldered to the board.
 - the thermal pad under Q2 (left end of heat sink) is pink
 - Q2 value by board voltage 120V=>1MBH30D-060, 230V=>1MB25D-120. **Ensure that the 'D' is in the part number.**
 - the thermal pad under Q4 (center of heat sink) is black
 - Q4 value by board voltage 120V=>1MBH50D-060, 230V=>1MB25D-120. **Ensure that the 'D' is in the part number.**
 - C1 value by board voltage 120V=>0.15 uf, 230V=>0.033uf
 - U11 value by board voltage 120V=>IR2113, 230V=>IR2213
 - the jumper wire is from PD1 to PG1
 - R45 & R46 are 10 ohms
 - T4 mounting polarity. See Assembly drawing
- 10) Connect the high voltage board to be tested. a) control cable, b) AC power, c) high voltage wire. Ensure that the board clamp on the right side of the test fixture is secured in the down position. **Lower the safety shield.**
- 11) The door switch should be in the closed (up) position.
- 12) Plug the line cord into the power entry module on the rear panel of the Discover unit.
- 13) **Ensure that the safety shield is down.** Using the right front AC power switch, turn on the AC power. If there is a transistor or driver problem on the board being tested, the fuses may blow at this time. If the setting of the voltage select switch and the actual measured line voltage do not match, a low or high volts alarm will be given.
- 14) Check the heat sink temperature. It should read the current room temperature. Refer to the Debug Display Data list for the location of the heat sink temperature on the Discover display.
- 15) Follow the directions on the display to begin the test. When 'PLAY' is pressed, the filament drive will be energized. A 2 KHz tone may be audible from inside the Discover unit. There will be a three (3) second delay from the time the filament is energized until the time that the high voltage transformer is energized. When the high voltage starts up, if the transistor(s)/driver are going to be a problem they and the fuse(s) will be gone immediately. There may be a slight audible sound (buzz) generated during the time that the high voltage transformer is energized. The high voltage test can be stopped in one of the following four ways.
 - Turn off the door switch (the fastest method).
 - Press 'STOP' on the Discover keypad (has □ second communications time delay).
 - Wait for the automatic 15-second timeout.
 - Turn off the AC power switch (least preferred).

Things to be vigilant about:

- First, watch the oscilloscope and be ready to turn off the door switch in case the waveform is not as shown in Figure 1. **Know the waveforms!!!!** Once the waveform is determined to be good, focus attention on the current meter to observe the ramp-up in current.
- The current level will ramp up to approximately midscale at 150 mA. If the current continues to increase toward 180-200 mA, turn off the door switch. There may be a problem in the current measurement path.

High Voltage Board Test Protocol

- 16) When the test is completed,
- Turn off the AC power using the right front AC power switch.
 - Unplug the power cord from the power entry module on the rear panel of the Discover unit. Remove the test board.

High Voltage Board Test Protocol

Good Waveform at Startup

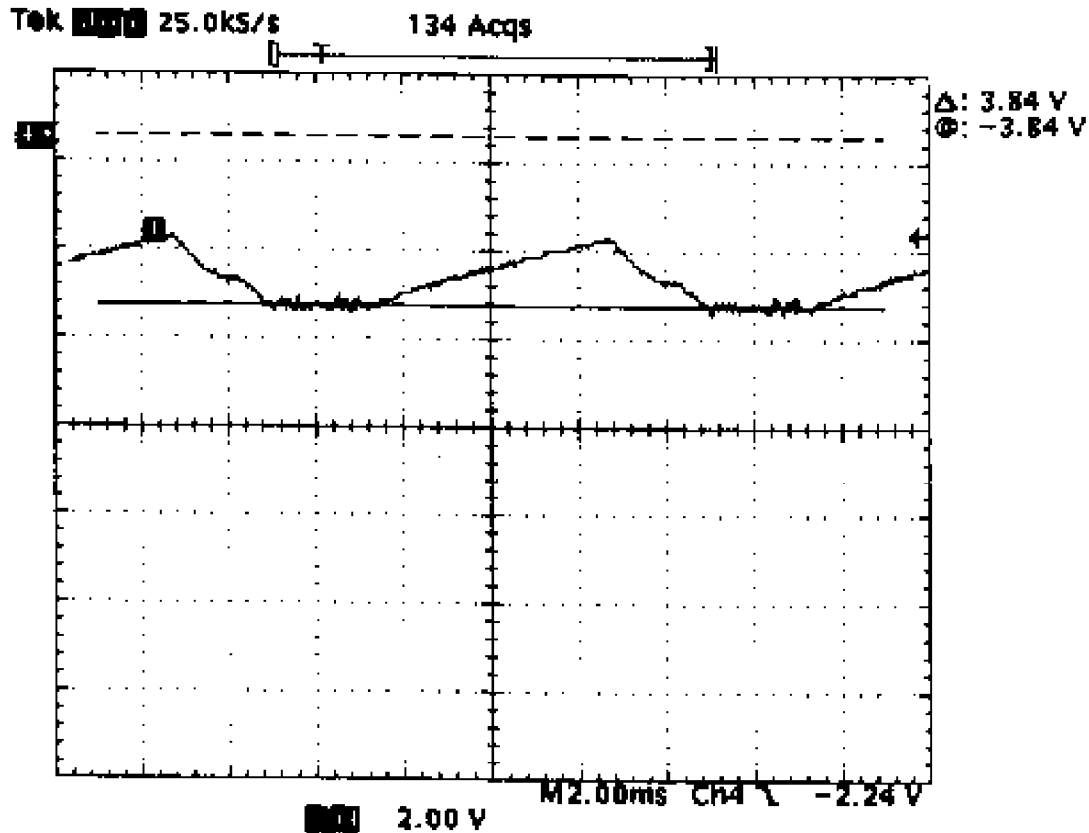


Figure 1

This frame is made using a correctly assembled high voltage transformer.

Good high voltage waveform at startup. This waveform should be immediate as the high voltage starts up. The width of the negative, flat portion is representative of the minimal waveform timing used at startup. The magnetron is drawing current and acting like a zener diode. As the power ramps up to 300 watts, the width of the negative, flat portion will increase as the waveform ON timing is increased. This is apparent in figure 2.

Good Waveform at 300 Watts

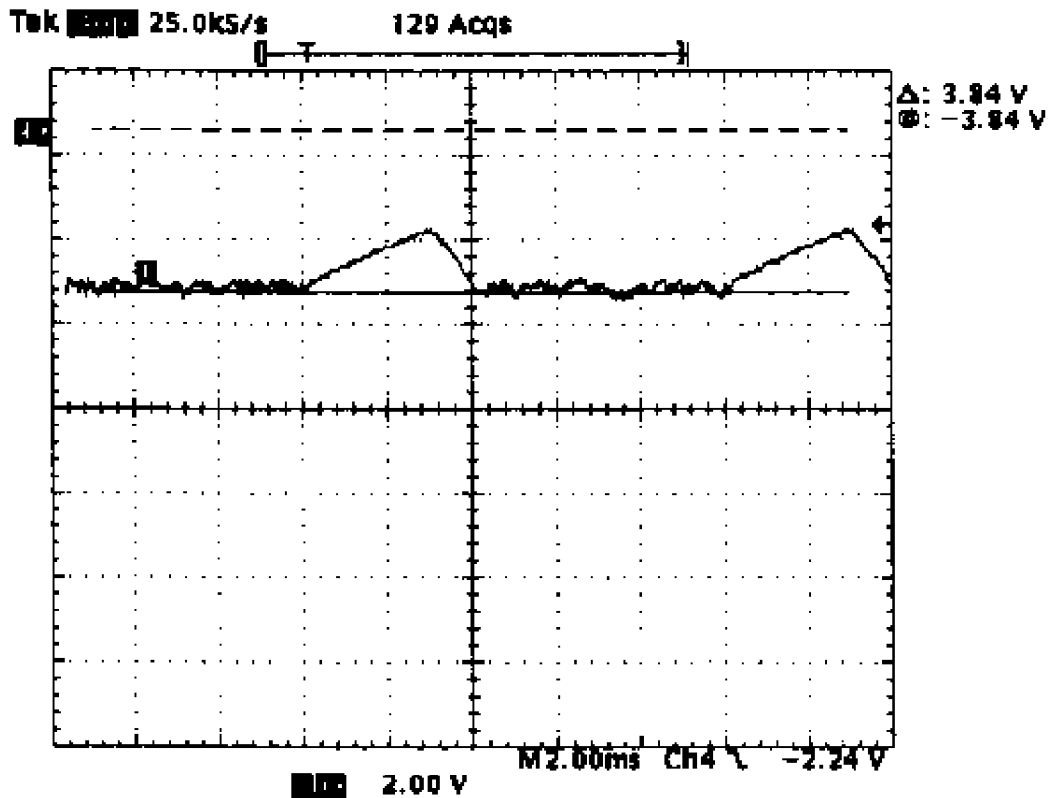


Figure 2

This frame is made using a correctly assembled high voltage transformer.

Good high voltage waveform at full power (300 watts in this case). The increased width of the negative, flat portion is representative of the full waveform timing used to achieve full power. The changing width can be seen as the power ramps up from the startup power of 40 watts (Figure 1) to the full power of 300 watts.

Waveform with Slug and Gap Reversed in the Winding Leg at Startup

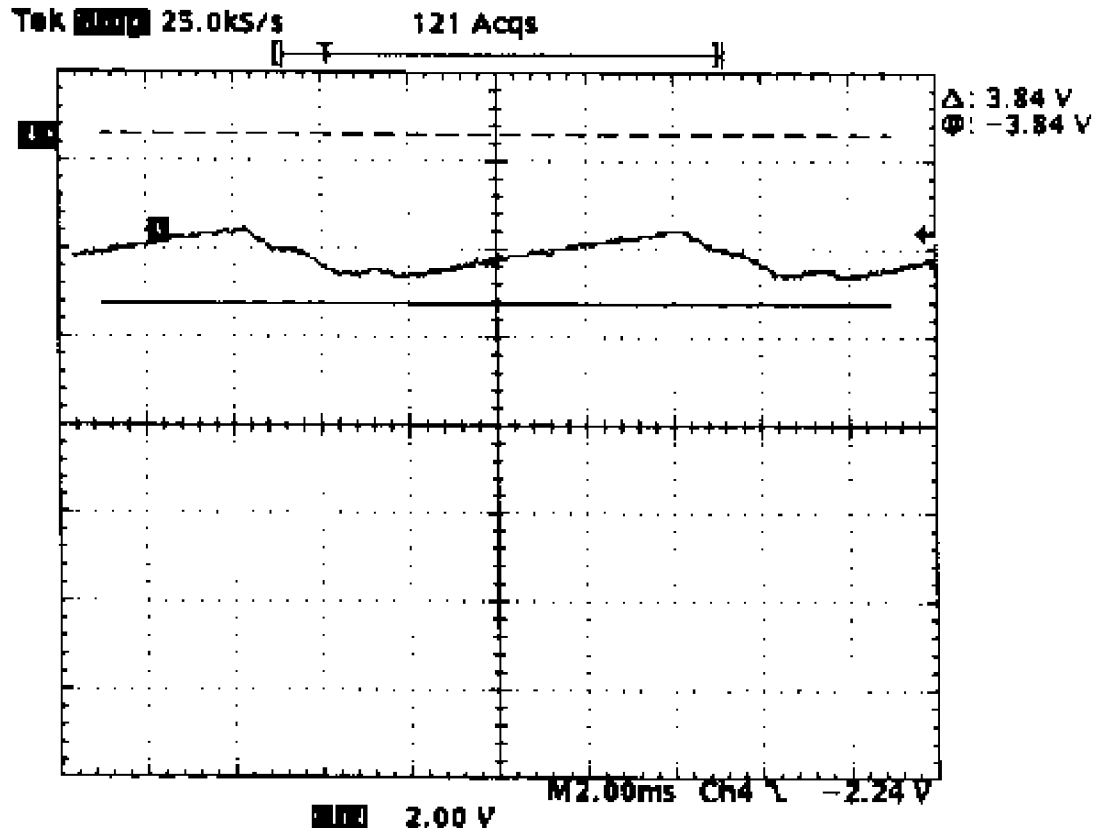


Figure 3

This frame is made using an incorrectly assembled high voltage transformer. The ferrite slug and the gap spacer are reversed in the winding leg.

Bad high voltage waveform at startup. This waveform appears as the high voltage starts up. **Note the lack of the negative, flat portion as seen in Figure 1.** As the power ramps up to 300 watts, the negative, flat portion will not occur. This is apparent in Figure 4. Also, the magnetron current level will likely be zero or very low since there is not enough high voltage to cause the magnetron to conduct current.

ACTION: Turn off the door switch to stop the power supply when this waveform is seen. Turn off AC power, unplug the unit and disassemble the high voltage transformer to check for improper assembly. See Ferrite Core Assembly.

Waveform with Slug and Gap Reversed in the Winding Leg at 300 watts

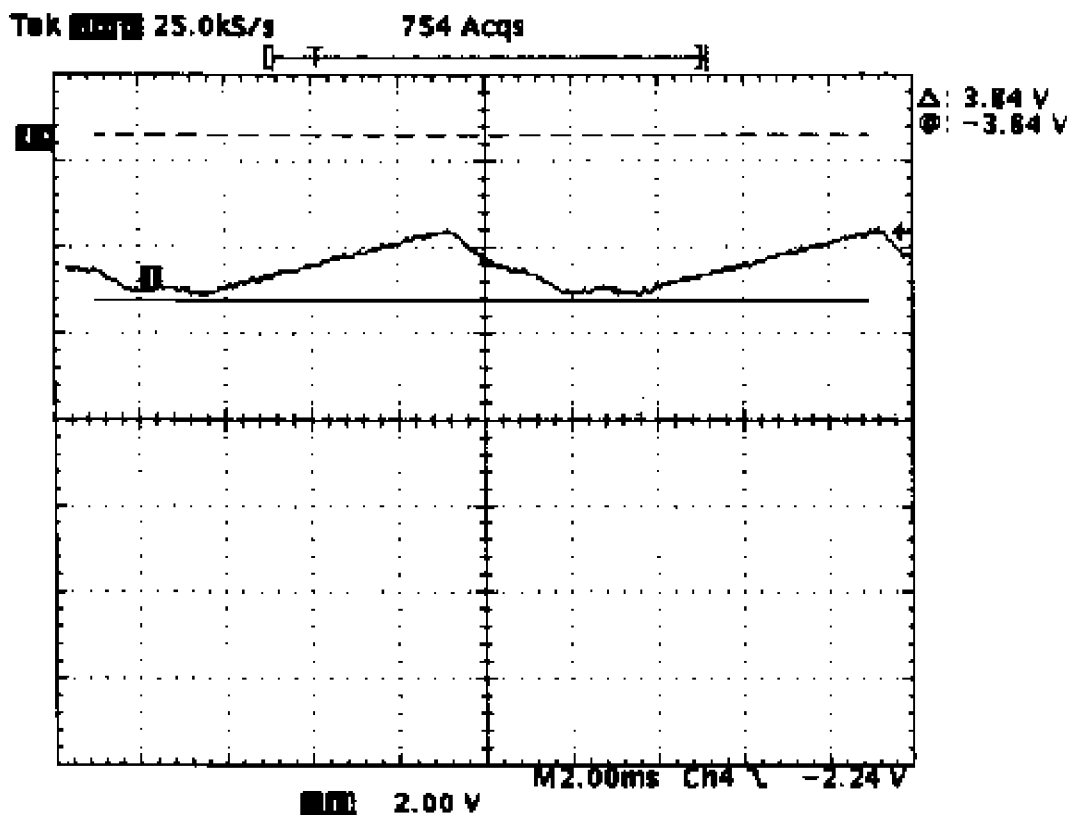


Figure 4

This frame is made using an incorrectly assembled high voltage transformer. The ferrite slug and the gap spacer are reversed in the winding leg.

Bad high voltage waveform at full power (300 watts). **Note the lack of a negative, flat portion even as the power has ramped up to 300 watts.** Also, the magnetron current level will likely continue to be zero or very low since there is not enough high voltage to cause the magnetron to conduct current. If the magnetron were conducting current, then the negative portion would be flat, depicting the zenering action of a conducting magnetron.

ACTION: Turn off the door switch to stop the power supply when this waveform is seen. Turn off AC power, unplug the unit and disassemble the high voltage transformer to check for improper assembly. See Ferrite Core Assembly.

Waveform with Slug Missing in the Winding Leg at Startup

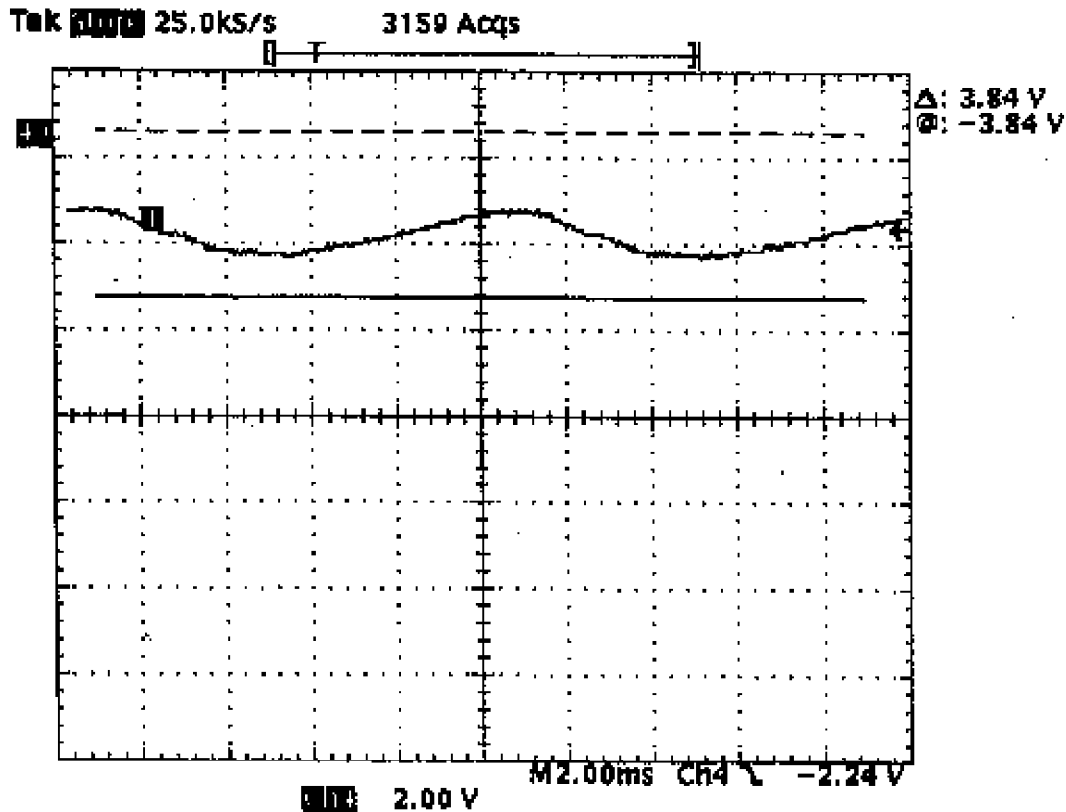


Figure 5

This frame is made using an incorrectly assembled high voltage transformer. The ferrite slug is missing in the winding leg.

Very bad high voltage waveform at startup. This waveform appears as the high voltage starts up. **Note the difference of the negative portion as seen in Figure 3.** The negative portion is smooth with no bumps, sort of sinusoidal.

ACTION: Turn off the door switch immediately to stop the power supply when this waveform is seen. Do not permit the power supply to ramp up to full power. Turn off AC power, unplug the unit and disassemble the high voltage transformer to check for improper assembly. See Ferrite Core Assembly.

Ferrite Core Assembly

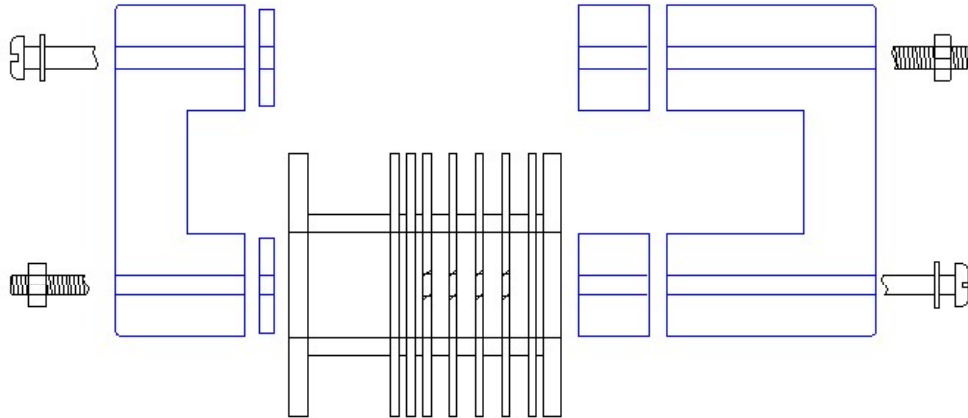


Figure 6

High Voltage Board Test Protocol

Debug Display Data

Line 1 RRR 000 VVV FF CCC

Line 4 T+SS D HH GGKK

Line 1

RRR Runaway counter. Starts at 200 when high voltage starts. Supply stops at RRR=000 since current cannot be kept in control window.

000 Always 000

VVV represents line volts. ~120 @ 120V, ~216@230V

FF Error flag Byte 2. See below for bit values

CCC Magnatron A/D current level. CCC=720 at 300 watts.

Line 4

T Current high voltage transformer timing table(1 thru A)

+ can be + or –

SS Servo control register to adjust timing(+ or -)out of the table T.
This is how current is regulated.

D Ramp done flag. D=1 once the ramp to the current power is done.

HH Heat sink temperature.

GG Error flag byte 1. See below for bit values.

KK Error flag byte 0. See below for bit values.

High Voltage Board Test Protocol

Bit Assignments for Error Flag Byte 0

FIL_ON_FLAG	EQU	0x00	;1=FIL ON
VOLTS_LO_FLAG	EQU	0x01	
VOLTS_HI_FLAG	EQU	0x02	
COMM_TIME_FLAG	EQU	0x03	
SHORT_RTD_FLAG	EQU	0x04	
OPEN_RTD_FLAG	EQU	0x05	
TEMP_RECVR_FLAG	EQU	0x06	;1=HS TEMP MUST RECOVER
ISEC_RANGE_FLAG	EQU	0x07	

Bit Assignments for Error Flag Byte 1

HI_CONTROL_FLAG	EQU	0x00
LO_CONTROL_FLAG	EQU	0x01
TEMP_STUCK_FLAG	EQU	0x02
RUNAWAY_FLAG	EQU	0x03
DOOR_OPEN_FLAG	EQU	0x04
MIN_I_SEC_FLAG	EQU	0x05
THML_OVLD_FLAG	EQU	0x06
EGND_SENSE_FLAG	EQU	0x07

Bit Assignments for Error Flag Byte 2

NO_UWAVES_FLAG	EQU	0x00	
START_END_FLAG	EQU	0x01	
;	EQU	0x02	
;	EQU	0x03	
;	EQU	0x04	
;	EQU	0x05	
;	EQU	0x06	
VOLTS_SW_FLAG	EQU	0x07	;1=230 VOLTS

High Voltage Areas on the Board

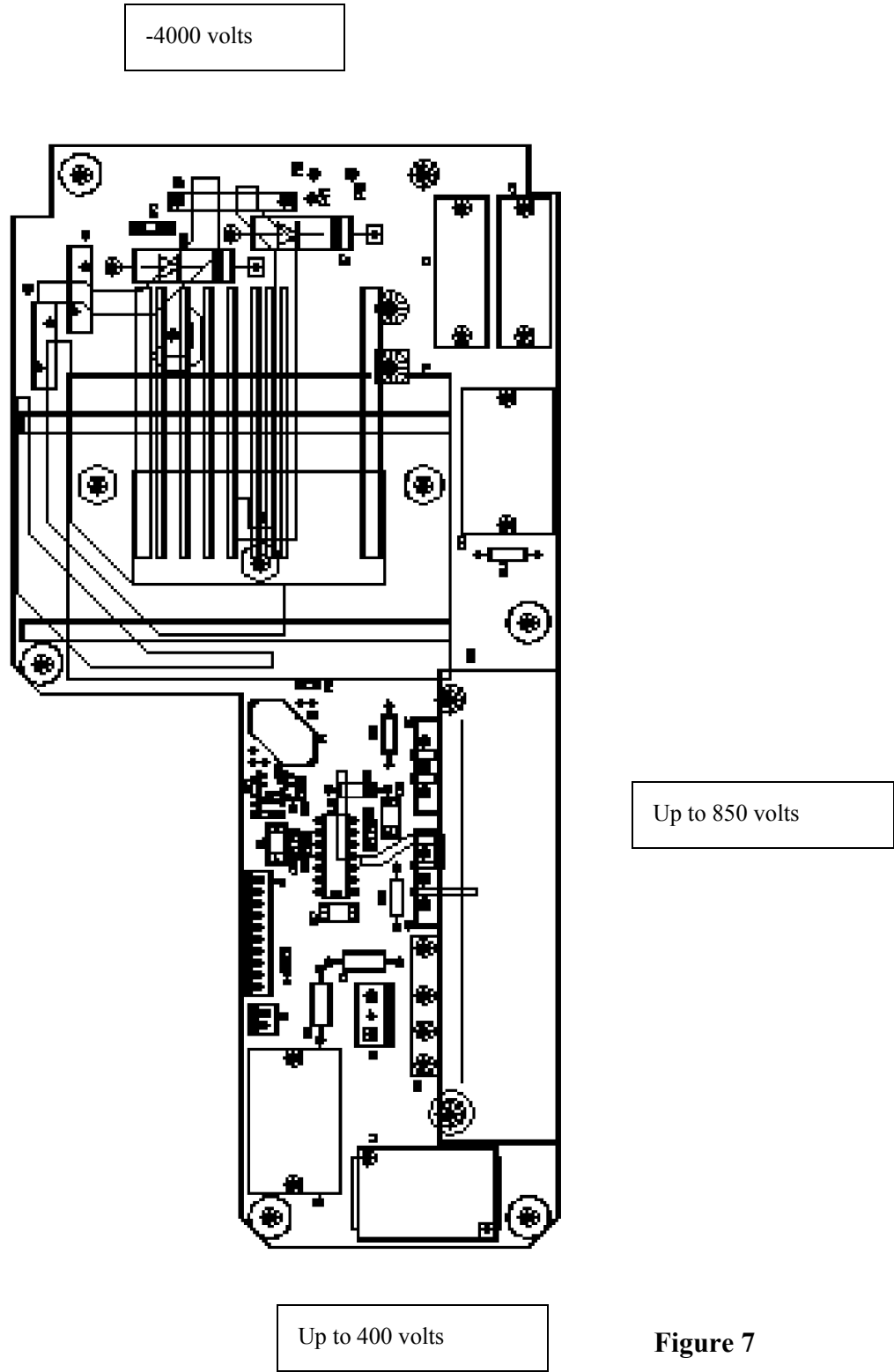
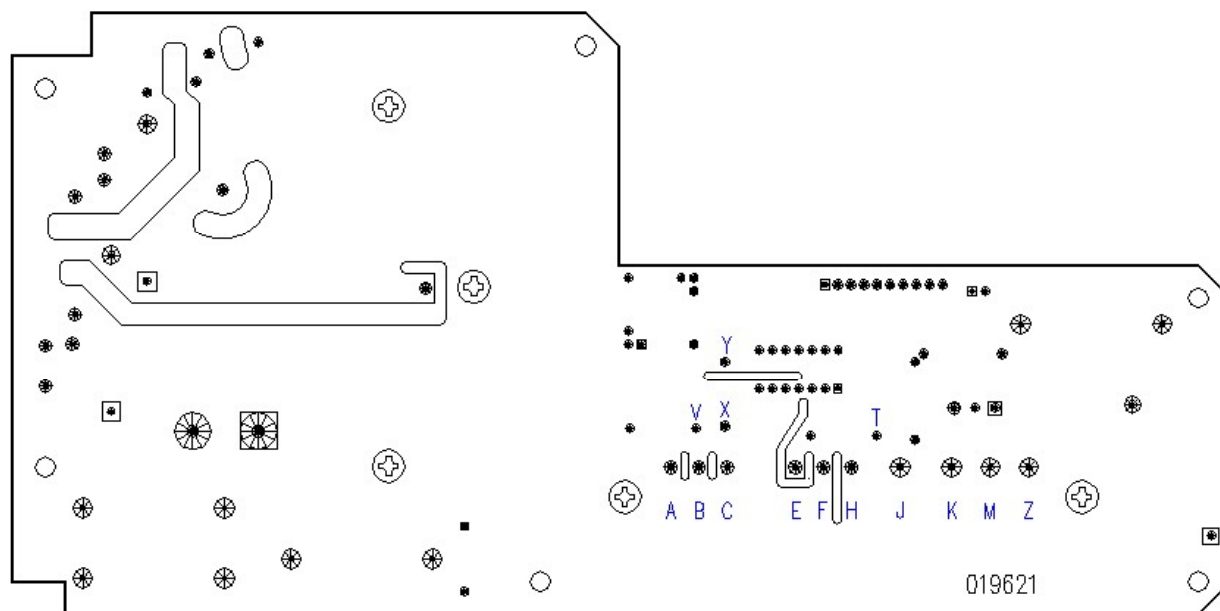


Figure 7

Bottom Side Test Points and Measurements



A Fluke 87 True RMS meter was used for the following measurements.

Figure 8

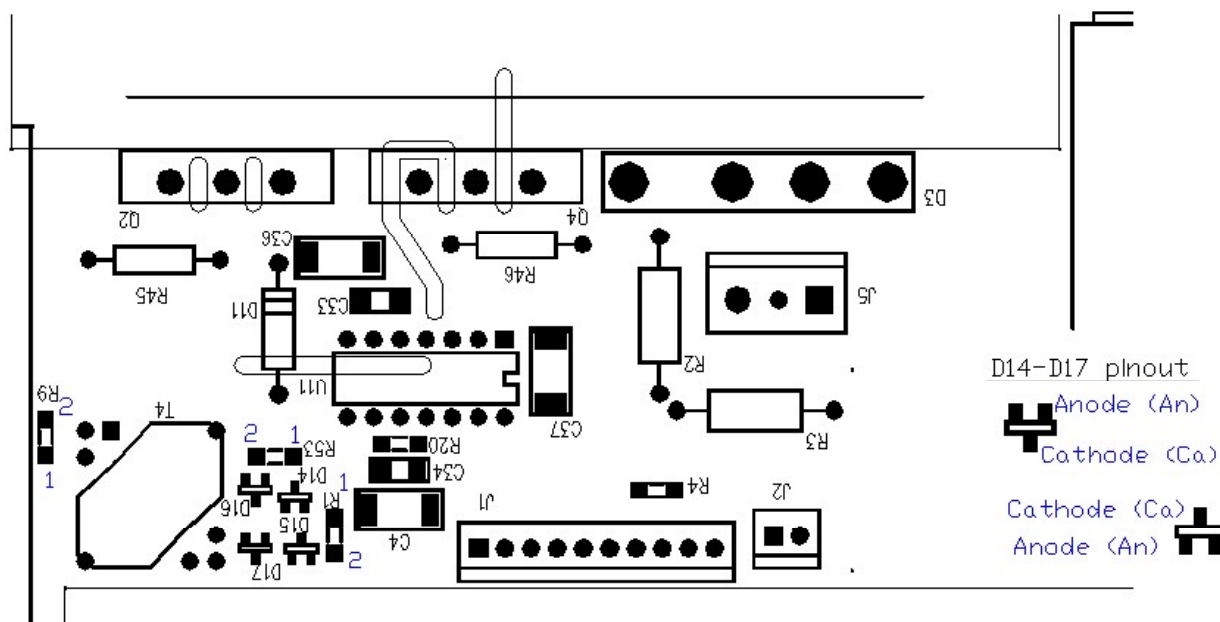
Step	Meter Function	Point to Point	Correct Readings		Incorrect
		(Red-Black)	U11 installed	U11 removed	U11 installed
1	diode(→ ←)	F-H	.OL	.OL	0V
2	diode(→ ←)	H-F	0.4-0.6V	0.4-0.6V	0V
3	diode(→ ←)	E-H	1.7-1.9V(ramp up)	.OL	?
4	diode(→ ←)	J-K	.OL	.OL	0V
5	diode(→ ←)	J-M	.OL	.OL	0V
6	diode(→ ←)	K-Z	.OL	.OL	0V
7	diode(→ ←)	M-Z	.OL	.OL	0V
8	diode(→ ←)	K-J	0.4-0.6V	0.4-0.6V	0V
9	diode(→ ←)	M-J	0.4-0.6V	0.4-0.6V	0V
10	diode(→ ←)	Z-K	0.4-0.6V	0.4-0.6V	0V
11	diode(→ ←)	Z-M	0.4-0.6V	0.4-0.6V	0V
12	diode(→ ←)	B-C	.OL	.OL	0V
13	diode(→ ←)	C-B	0.4-0.6V	0.4-0.6V	0V
14	diode(→ ←)	A-C	1.7-1.9V(ramp up)	.OL	?
15	diode(→ ←)	Y-X	0.4-0.6V	0.4-0.6V	0V
16	diode(→ ←)	X-Y	.OL	.OL	0V
17	ohms (Ω)	A-V	10 Ω	10 Ω	R>11 Ω
18	ohms (Ω)	E-T	10 Ω	10 Ω	R>11 Ω

General Debug Guidelines for Power Transistors

Generally:

1. As a part is determined to be faulty, remove it immediately. **Otherwise any remaining measurements may be skewed.**
2. Check Q4, D3, Q2 in that order.
3. If the fuses were blown, Q4 most certainly will be shorted.
4. When replacing Q4 or Q2, replace U11 since it is likely compromised.
5. If Q4 is shorted, $\rightarrow$ measurements of either polarity on a good D3 will produce a single diode drop.
6. If diode bridge D3 has a shorted diode, probably Q4 will be shorted.
7. If D3 checks OK, it is OK, whether or not Q4 had a problem.
8. If Q4 & D3 both have to be replaced, it is best to replace Q2, otherwise you may have to replace Q2 later and also Q4/D3 a second time.
9. If Q4 is faulty and D3 is OK, and Q2 appears OK, not replacing Q2 may be OK (if Q2 were compromised, it may not show up with the voltage levels of a Fluke meter, but will when hundreds of volts come into play).
10. Check D11
11. Check R45 & R46
12. When replacing parts mounted on the heat sink, consult the mounting screw torque specifications provided on the assembly drawing.

Top Side Test Points and measurements



A Fluke 87 True RMS meter was used for the following measurements.

Figure 9

Step	Meter Function	Point to Point (Red-Black)	Correct Readings	Incorrect	
20	ohms (Ω)	R53.1-R53.2	34.8K Ω +/- 1%	<34 K Ω	
21	ohms (Ω)	R53.2-R53.1	34.8K Ω +/- 1%	<34 K Ω	
22	ohms (Ω)	R1.1-R1.2	0.3-0.5 Ω		
23	ohms (Ω)	R1.2-R1.1	0.3-0.5 Ω		
24	ohms (Ω)	R9.1-R9.2	0 Ω	10 Ω	
25	ohms (Ω)	R9.2-R9.1	0 Ω	10 Ω	
26	diode(→ ←)	D14.An-D14.Ca	0.45-0.65 V		
27	diode(→ ←)	D14.Ca-D14.An	.OL	>1V	
28	diode(→ ←)	D15.An-D15.Ca	0.45-0.65 V		
29	diode(→ ←)	D15.Ca-D15.An	.OL	>1V	
30	diode(→ ←)	D16.An-D16.Ca	0.45-0.65 V		
31	diode(→ ←)	D16.Ca-D16.An	.OL	>1V	
32	diode(→ ←)	D17.An-D17.Ca	0.45-0.65 V		
33	diode(→ ←)	D17.Ca-D17.An	.OL	>1V	

General Debug Guidelines for Mag Current Measurement

If any of the diodes D14-D17 are bad, the current feedback will likely be low in the 'CCC' field on the display and the feedback value will not make it to the 720 level for 300 watts. Since the feedback level that the microcontroller sees is low, the timing to the high voltage transformer will be increased above normal in an effort to get this level to the 720 vlaue. In contrast, the DC milliammeter in series with the magnetron ground connection will be showing a level greater than 150 mA(at 300 watts) and will be heading toward 200 mA as the power level ramps up from the startup level of 40 watts to the final level of 300 watts. The MAX secondary current detection will not automatically shut the unit down since the current path has a problem and the feedback level is reduced. This is why the test operator keeps his attention on the current meter and is ready to abort the test by opening the door switch.

If any of the diodes D14-D17 are bad, (not open & not shorted, possibly a diode drop in the reverse direction), R53, 34.8K will be paralld and give a low resistance reading. Trying to measure one of the diodes in reverse will give perhaps two diode drops(>1V) instead of '.OL'. Since this is a bridge connection, without special equipment, it may not be possible to determine which diode(s) is(are) bad. The best course of action maybe to replace all four diodes.

Make sure the mounting polarity of current transformer T4 is correct. See the Assembly Drawing.

Resistance across R1 measures low due to being paralld by the secondary of current transformer T4. If the resistance across R1 $> 1 \Omega$ then T4 secondary maybe open or unsoldered(on the board or at the bobbin pins).

Resistance across R9 measures low due to being paralld by the primary of current transformer T4. If the resistance across R1 is not very nearly 0Ω then T4 primary maybe open or unsoldered(on the board or at the bobbin pins).

High Voltage Board Test Protocol

High Voltage will not start or run due to Error

Error on Display	Possible Problem
No Microwaves	AC not plugged into high voltage board or 3 pin AC connector/header registration is off.
Low Voltage	Select switch set for 230V but unit powered with 120V.
High Voltage	Select switch set for 120V but unit powered with 230V.
Shorted RTD	Defective thermistor on heat sink. Short on the circuit board.
Open RTD	Thermistor on heat sink is not plugged in properly. Open trace on circuit board. Defective thermistor on heat sink.
Sec. Min Range	Current transformer, T4 bad. Check D14-D17. R53, R1, R9
Sec. Max Range	

High Voltage Board Test Protocol

Thermistor Temperature vs Resistance Table

Temp(C)	Rt(ohms)	Temp(C)	Rt(ohms)	Temp(C)	Rt(ohms)
0	32651	34	6807	68	1876
1	31031	35	6530	69	1813
2	29501	36	6266	70	1752
3	28054	37	6014	71	1693
4	26688	38	5774	72	1637
5	25395	39	5544	73	1582
6	24173	40	5325	74	1530
7	23016	41	5116	75	1480
8	21921	42	4916	76	1432
9	20885	43	4724	77	1385
10	19903	44	4542	78	1341
11	18973	45	4367	79	1298
12	18092	46	4200	80	1256
13	17257	47	4040	81	1216
14	16465	48	3887	82	1178
15	15714	49	3741	83	1141
16	15001	50	3601	84	1105
17	14325	51	3467	85	1071
18	13682	52	3339	86	1037
19	13073	53	3216	87	1005
20	12493	54	3098	88	974
21	11943	55	2985	89	945
22	11420	56	2877	90	916
23	10923	57	2773	91	888
24	10450	58	2674	92	862
25	10000	59	2579	93	836
26	9572	60	2487	94	811
27	9165	61	2399	95	787
28	8777	62	2315	96	764
29	8408	63	2234	97	741
30	8056	64	2157	98	720
31	7721	65	2082	99	699
32	7402	66	2011		
33	7097	67	1942		

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High Voltage Board Test Protocol

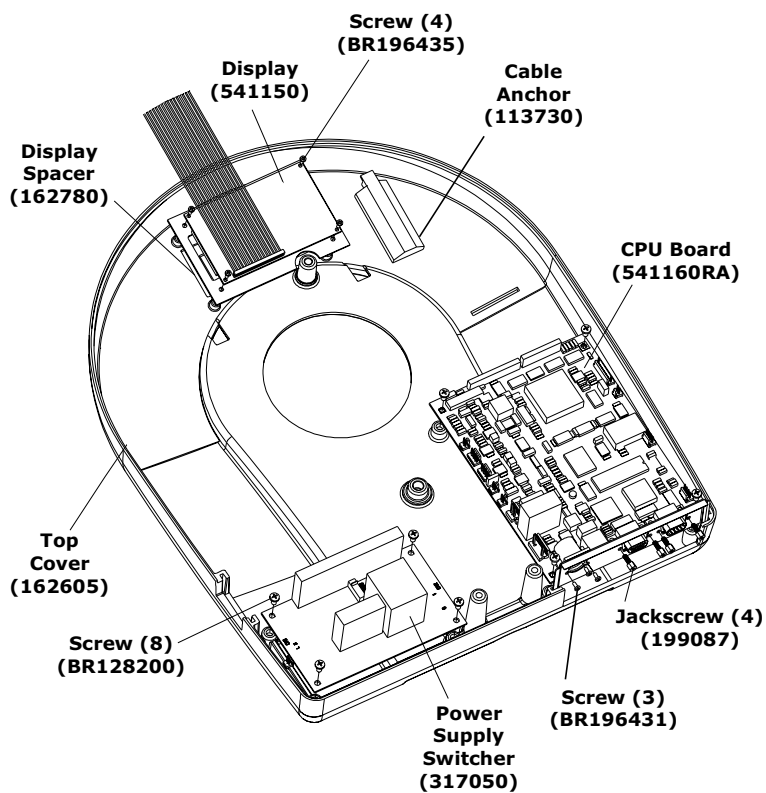
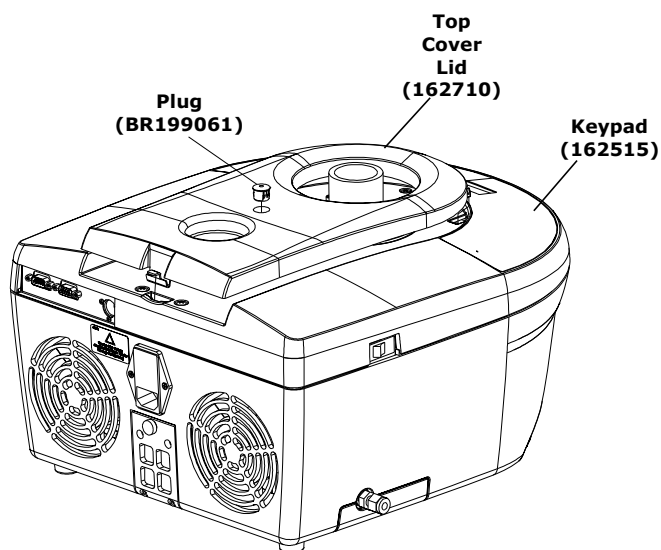
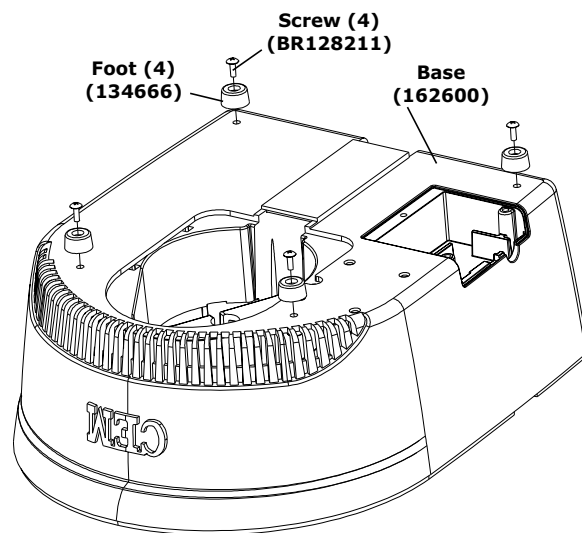
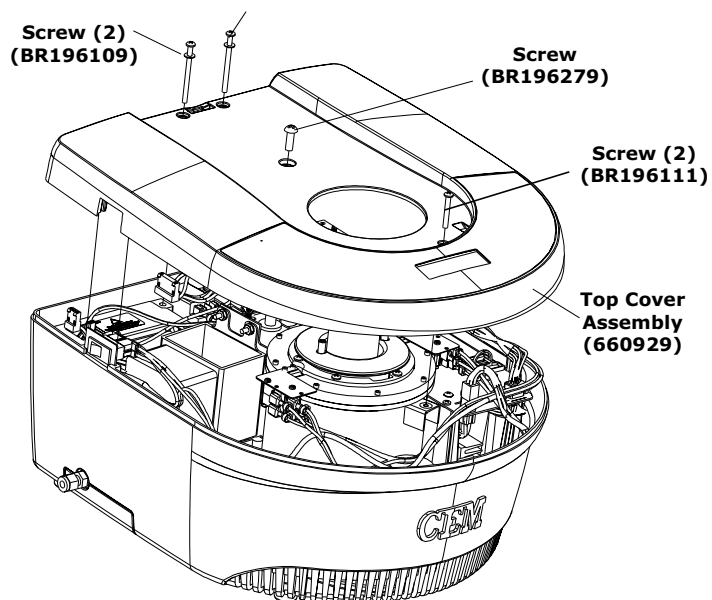
Temperature Conversion Table

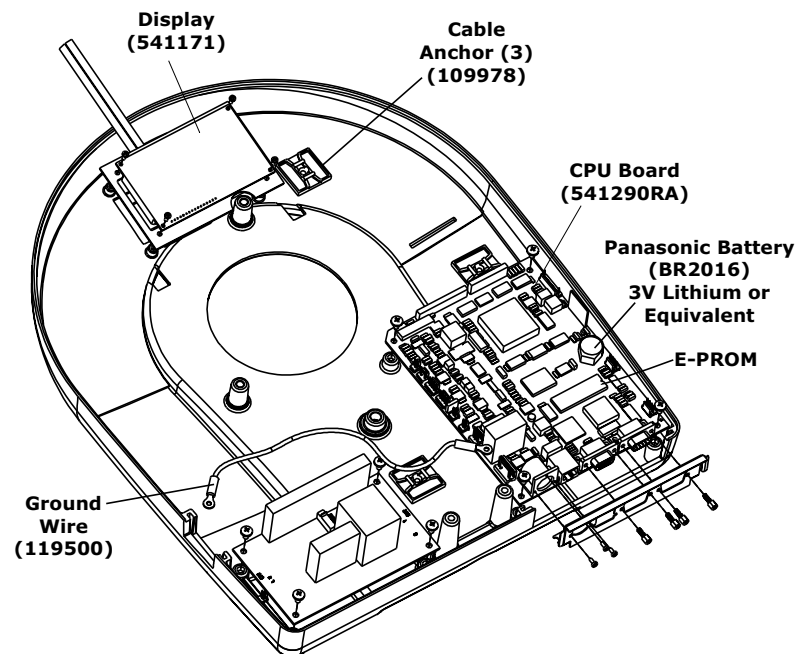
Temp(C)	Temp(F)	Temp(C)	Temp(F)	Temp(C)	Temp(F)
0	32.0	34	93.2	68	154.4
1	33.8	35	95.0	69	156.2
2	35.6	36	96.8	70	158.0
3	37.4	37	98.6	71	159.8
4	39.2	38	100.4	72	161.6
5	41.0	39	102.2	73	163.4
6	42.8	40	104.0	74	165.2
7	44.6	41	105.8	75	167.0
8	46.4	42	107.6	76	168.8
9	48.2	43	109.4	77	170.6
10	50.0	44	111.2	78	172.4
11	51.8	45	113.0	79	174.2
12	53.6	46	114.8	80	176.0
13	55.4	47	116.6	81	177.8
14	57.2	48	118.4	82	179.6
15	59.0	49	120.2	83	181.4
16	60.8	50	122.0	84	183.2
17	62.6	51	123.8	85	185.0
18	64.4	52	125.6	86	186.8
19	66.2	53	127.4	87	188.6
20	68.0	54	129.2	88	190.4
21	69.8	55	131.0	89	192.2
22	71.6	56	132.8	90	194.0
23	73.4	57	134.6	91	195.8
24	75.2	58	136.4	92	197.6
25	77.0	59	138.2	93	199.4
26	78.8	60	140.0	94	201.2
27	80.6	61	141.8	95	203.0
28	82.4	62	143.6	96	204.8
29	84.2	63	145.4	97	206.6
30	86.0	64	147.2	98	208.4
31	87.8	65	149.0	99	210.2
32	89.6	66	150.8		
33	91.4	67	152.6		

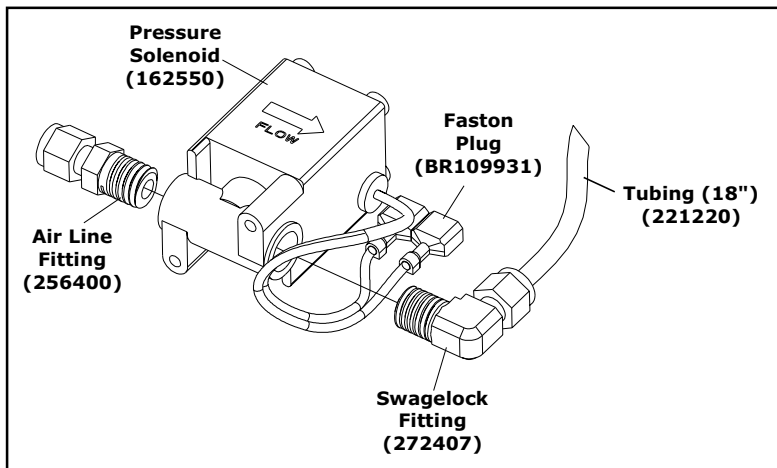
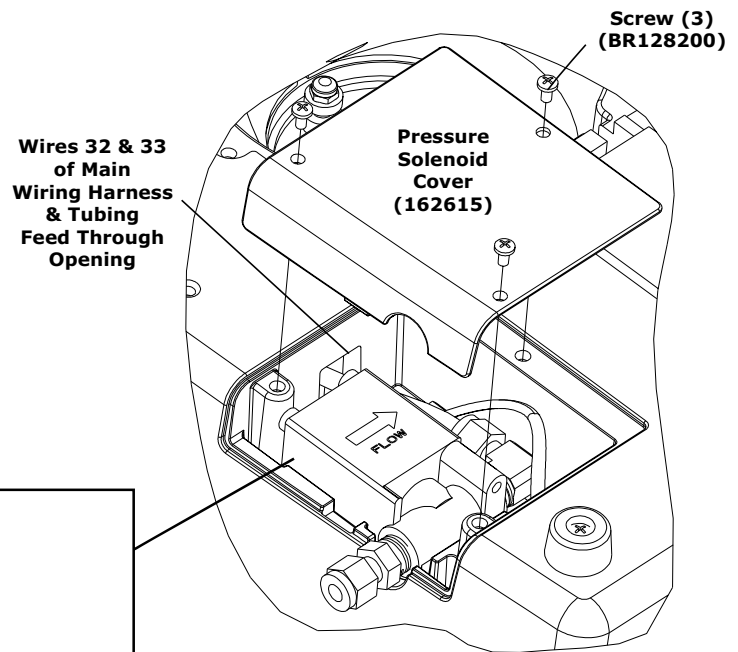
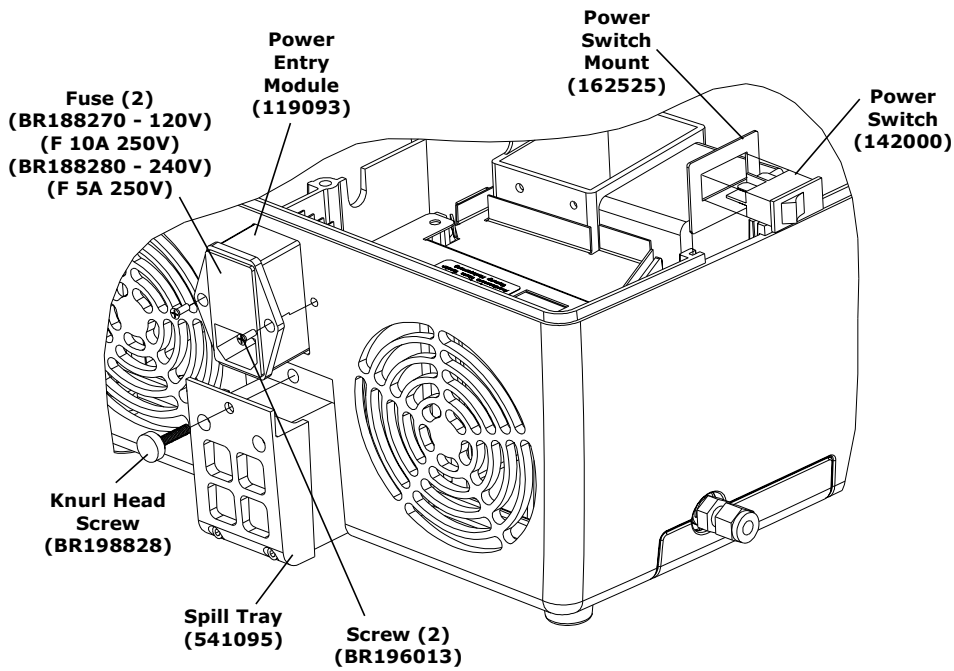
High Voltage Board Test Protocol

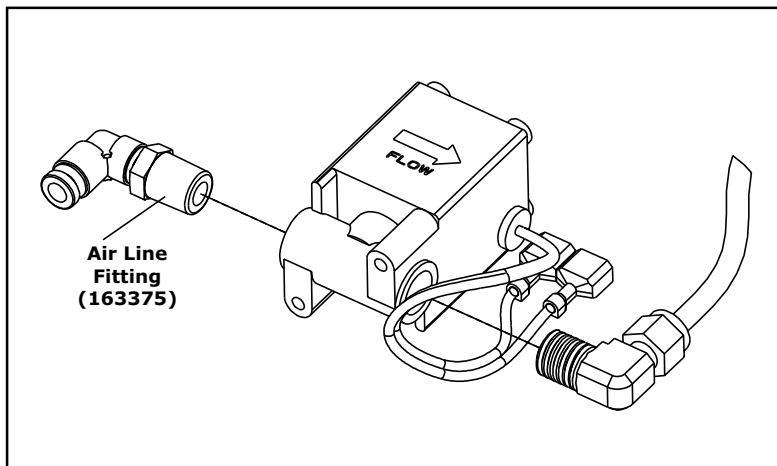
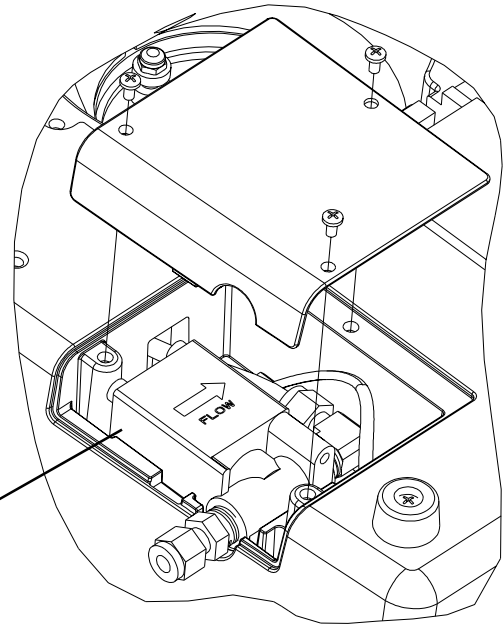
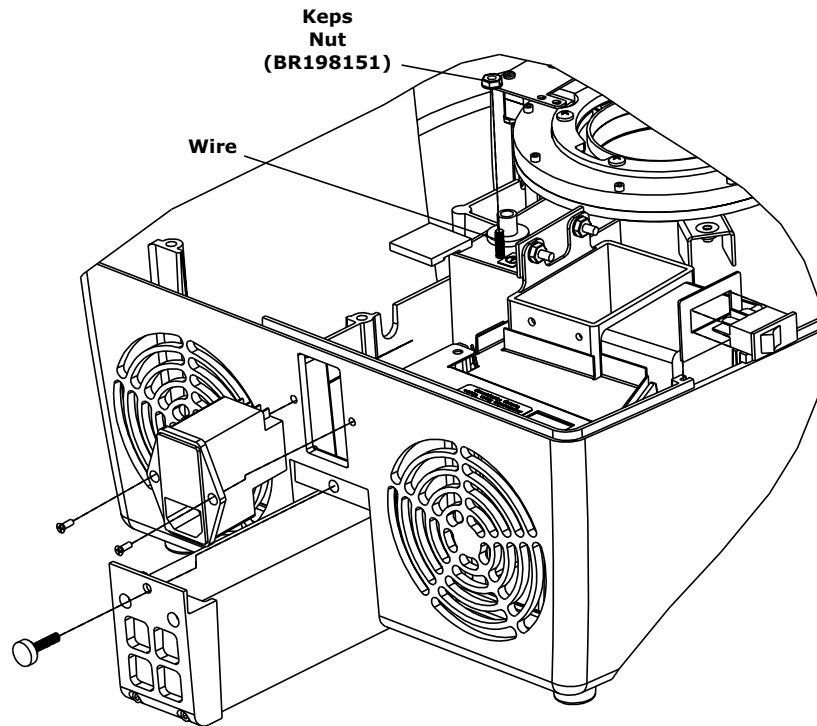
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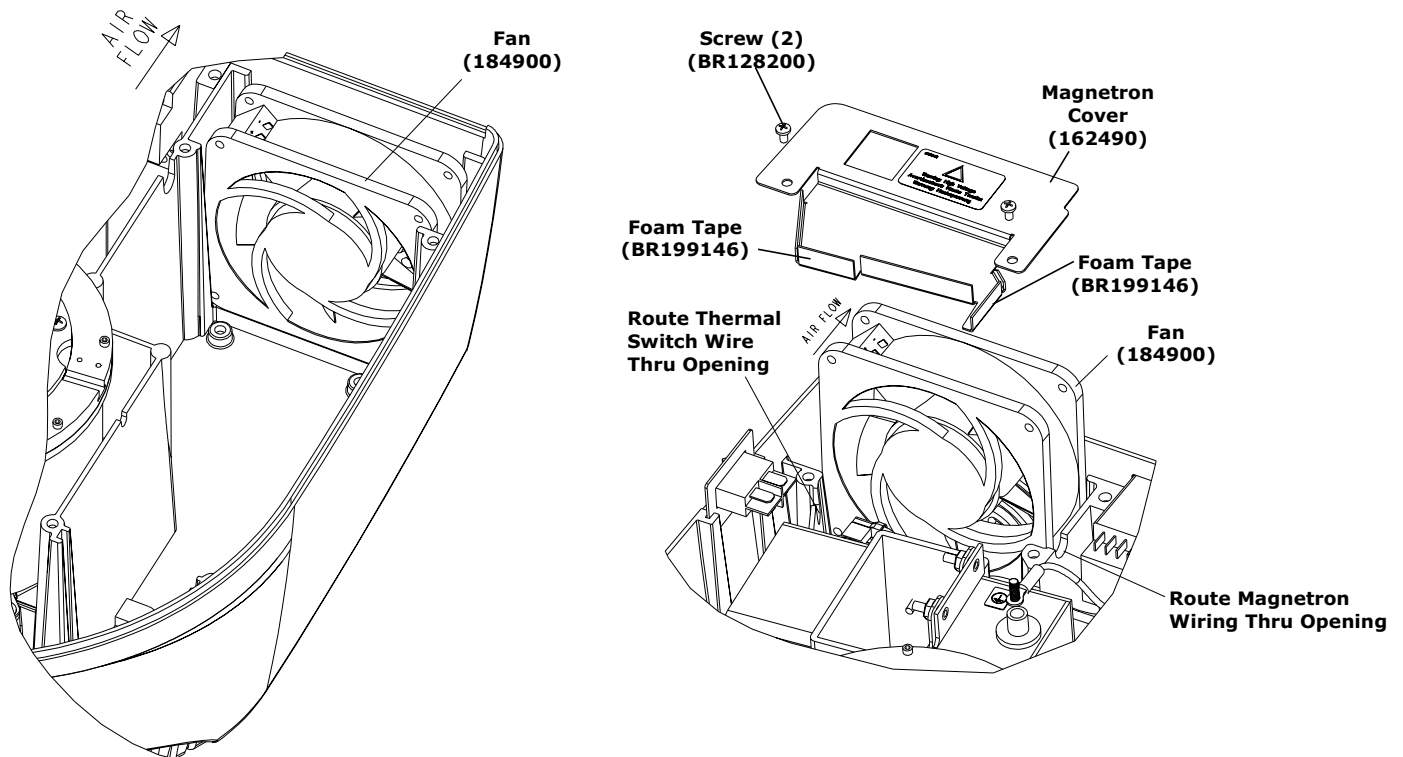
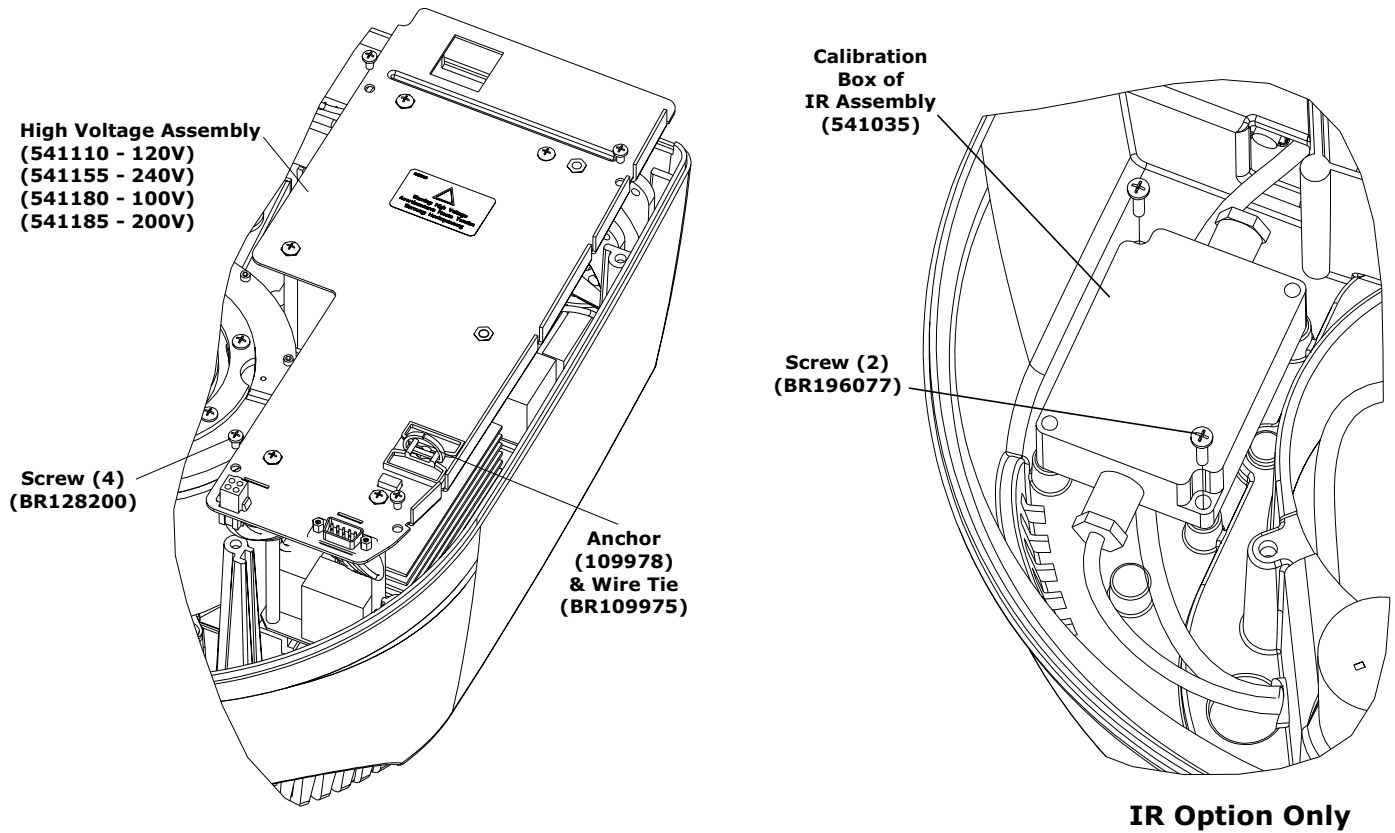
01-09-04 Step 10 & 11 changed on Page 14,Bottom Side Test Points and Measurements.
Add revisions to TOC.

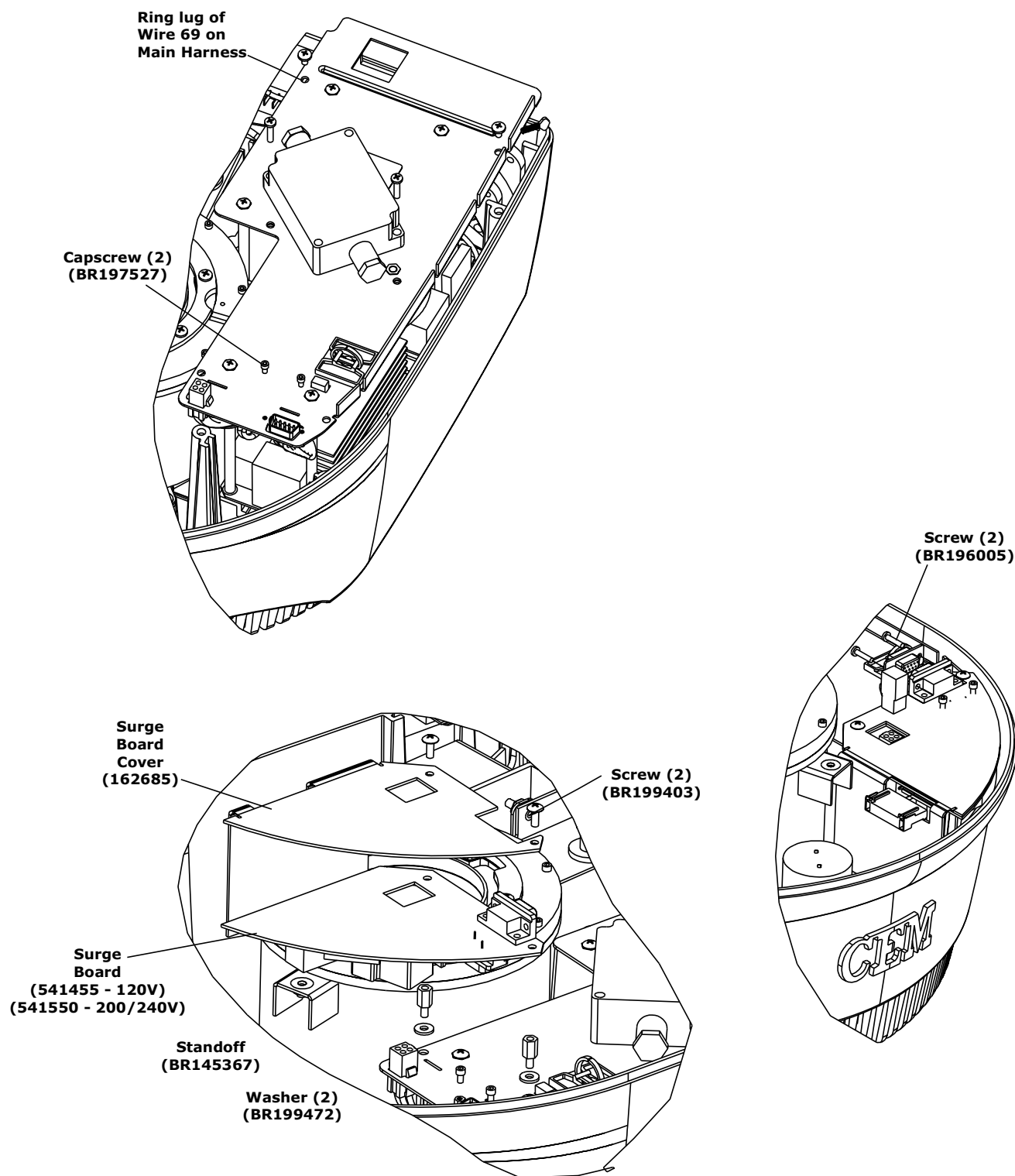


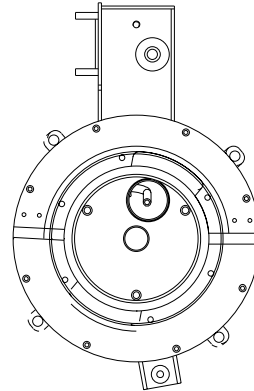
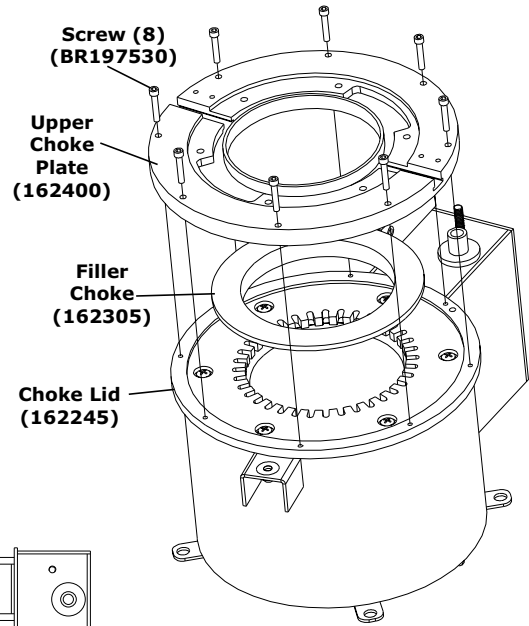
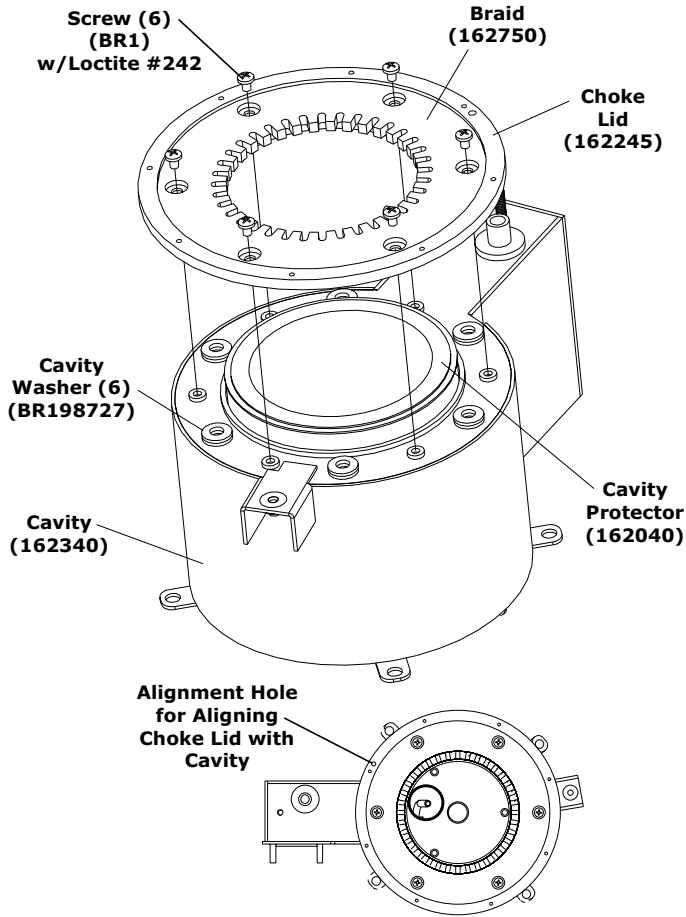




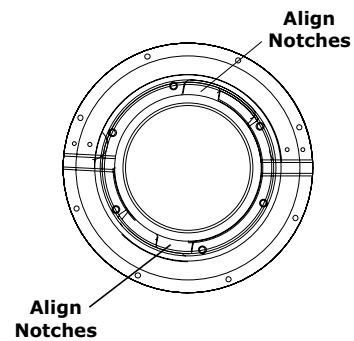
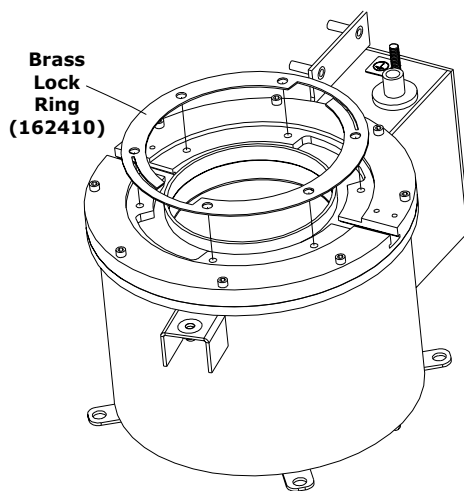


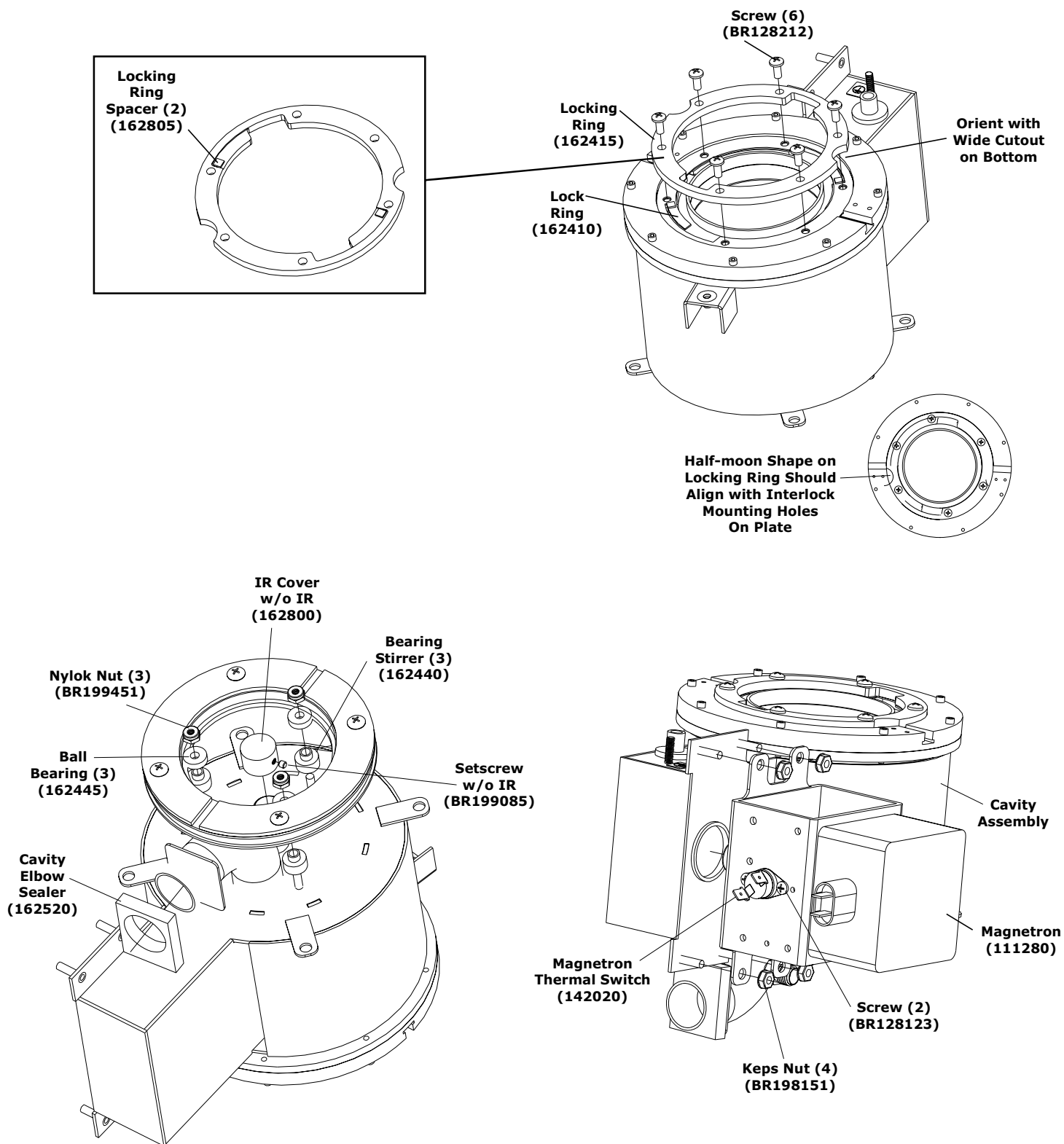


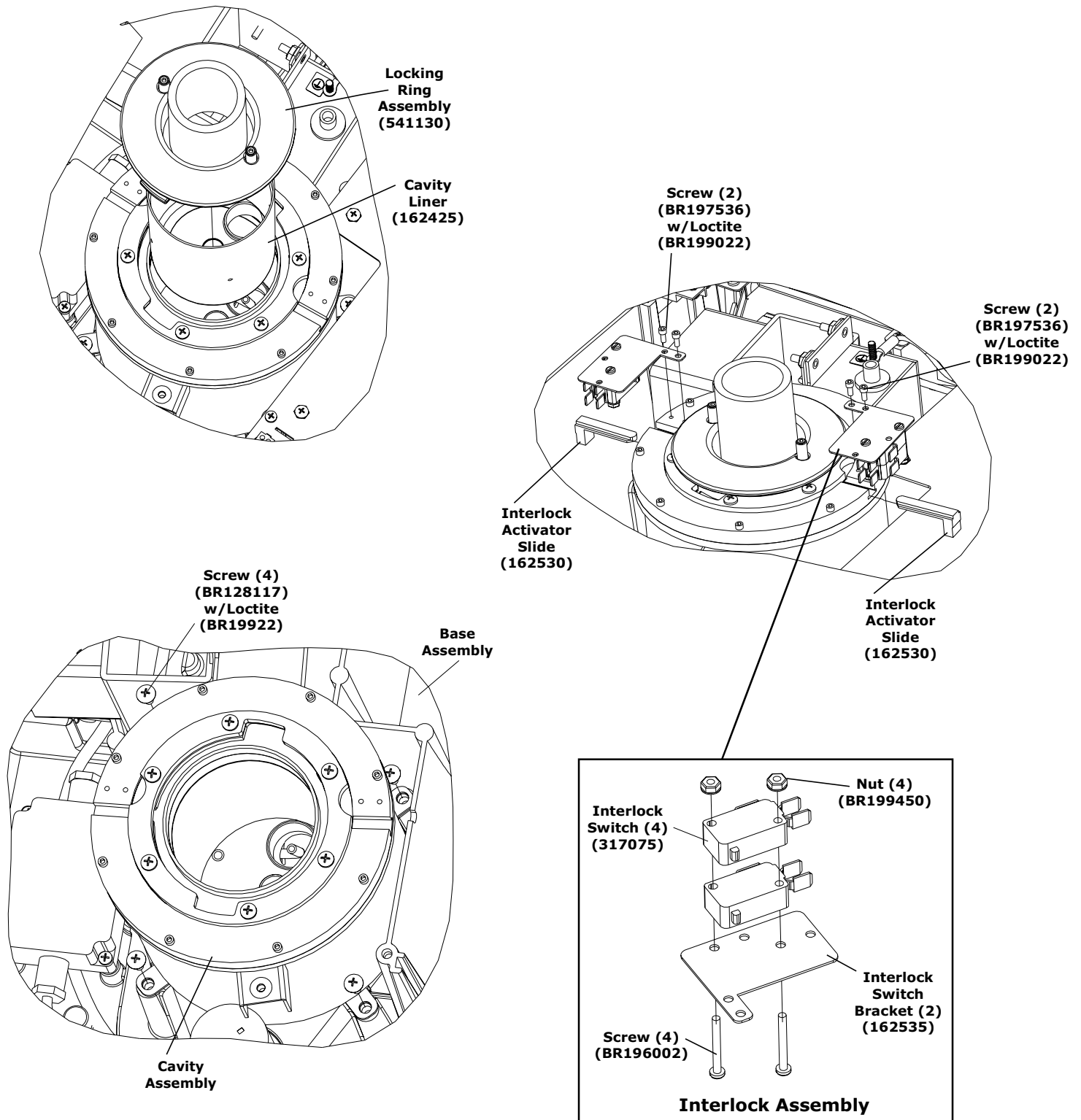


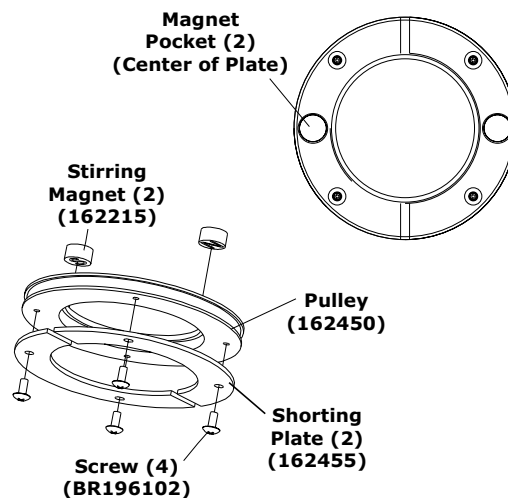
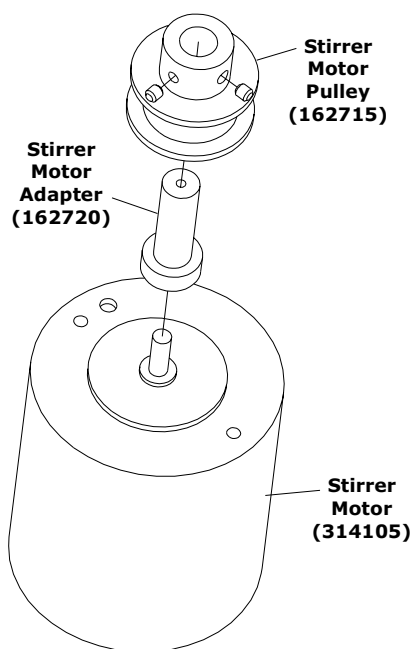
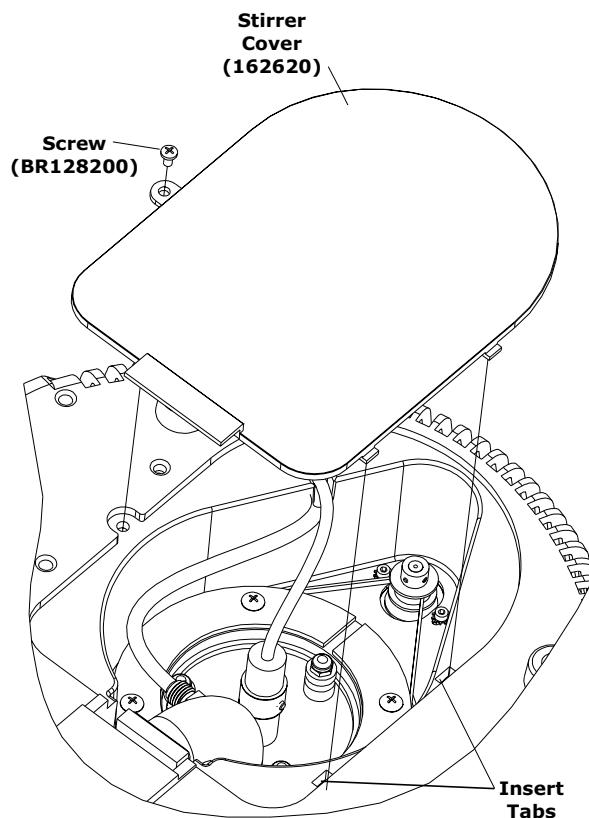
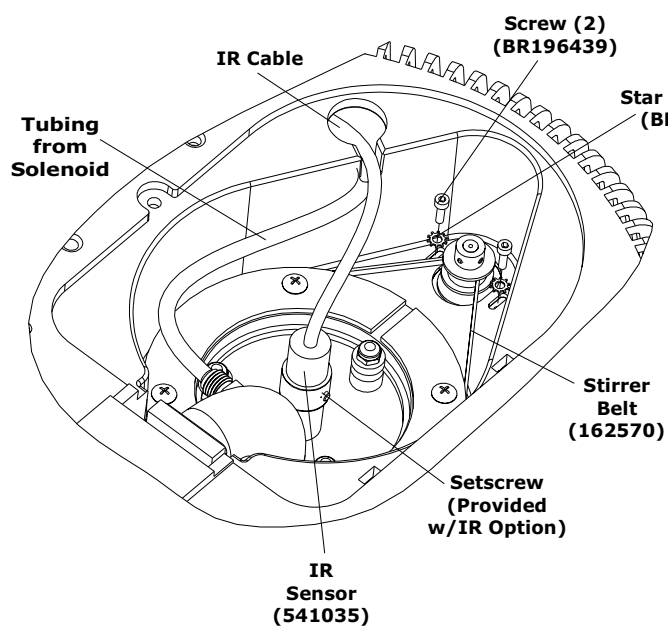


Orient Choke Plate as Shown

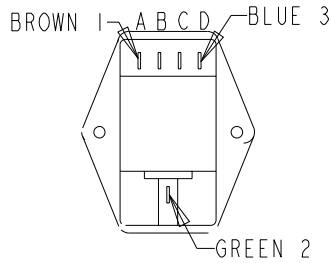




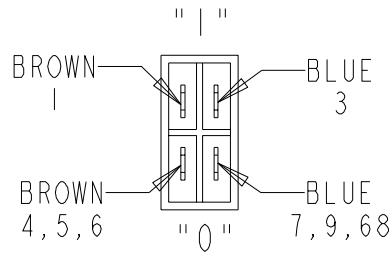




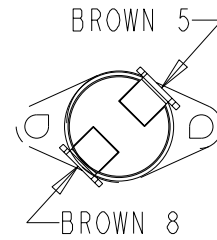
POWER ENTRY MODULE



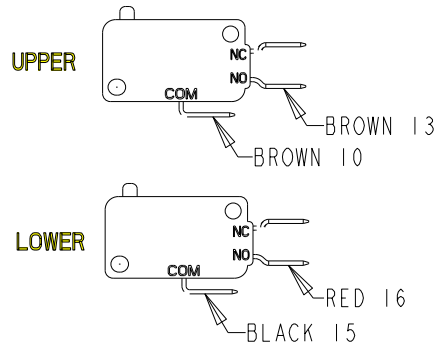
POWER SWITCH



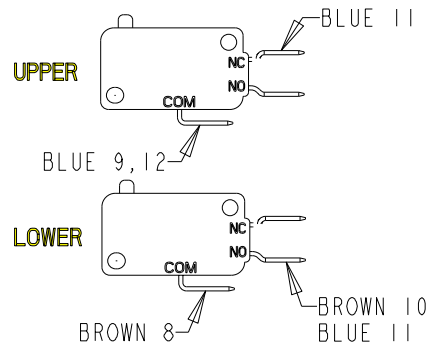
THERMAL SWITCH



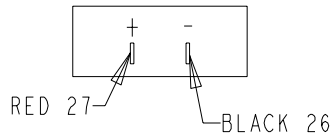
LEFT SIDE INTERLOCKS



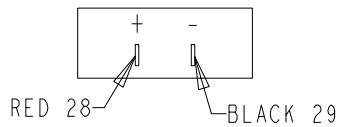
RIGHT SIDE INTERLOCKS



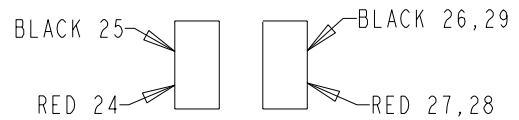
MAGNETRON FAN



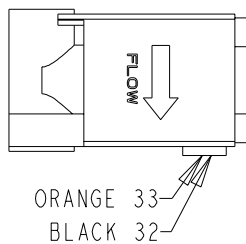
POWER SUPPLY FAN



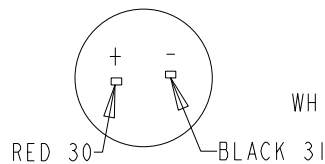
FAN WIRES



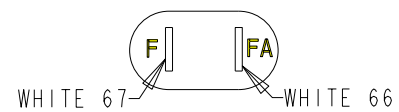
COOLING SOLENOID



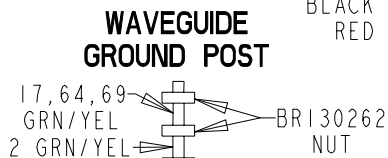
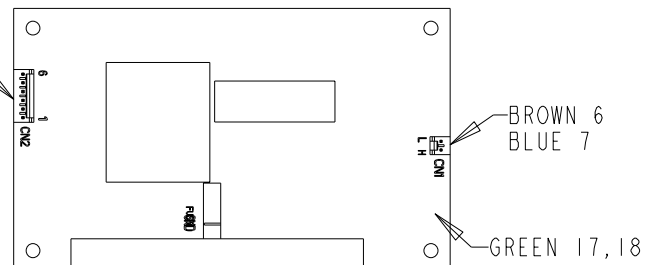
STIRRER MOTOR



MAGNETRON



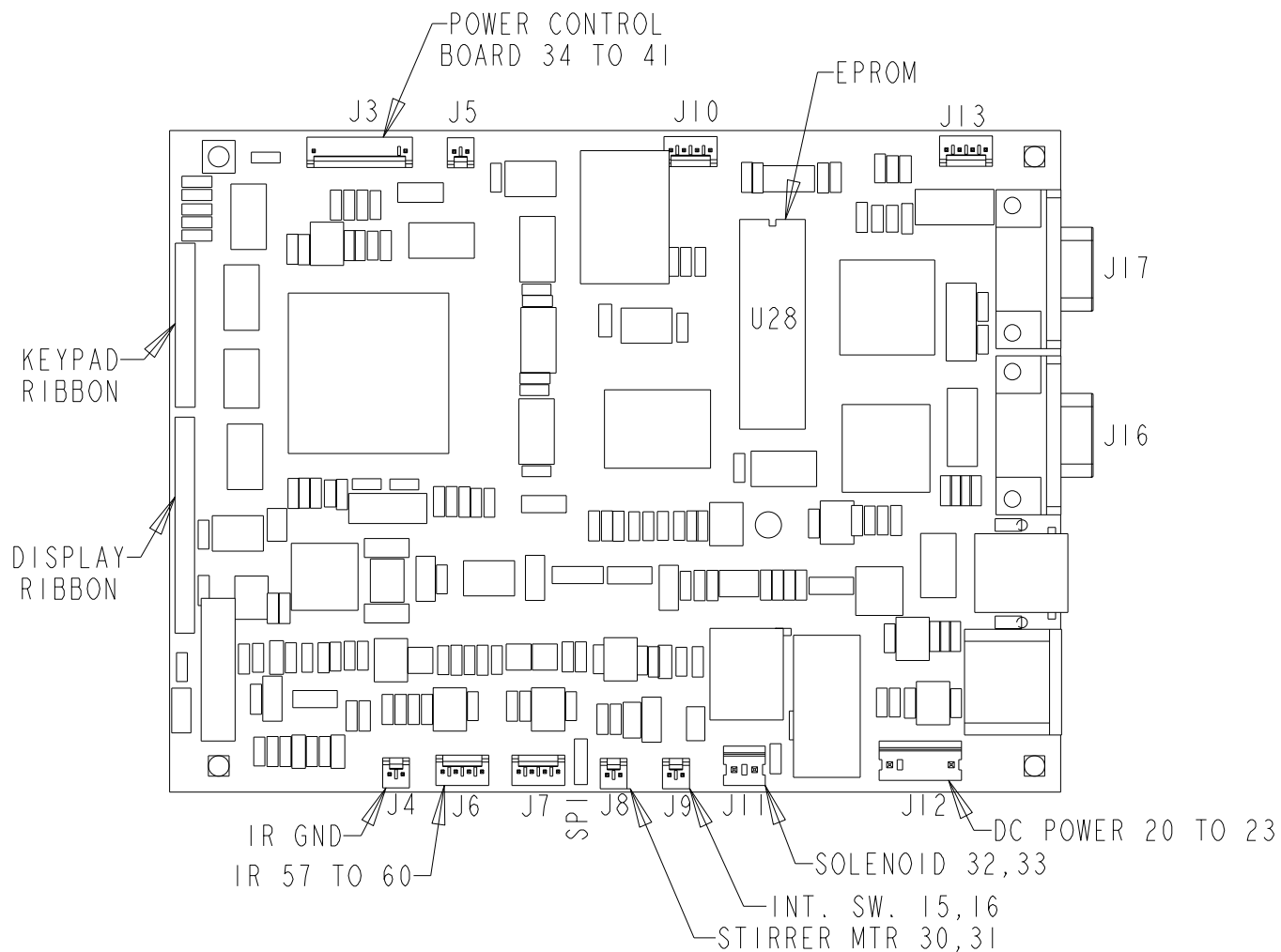
DC POWER SUPPLY



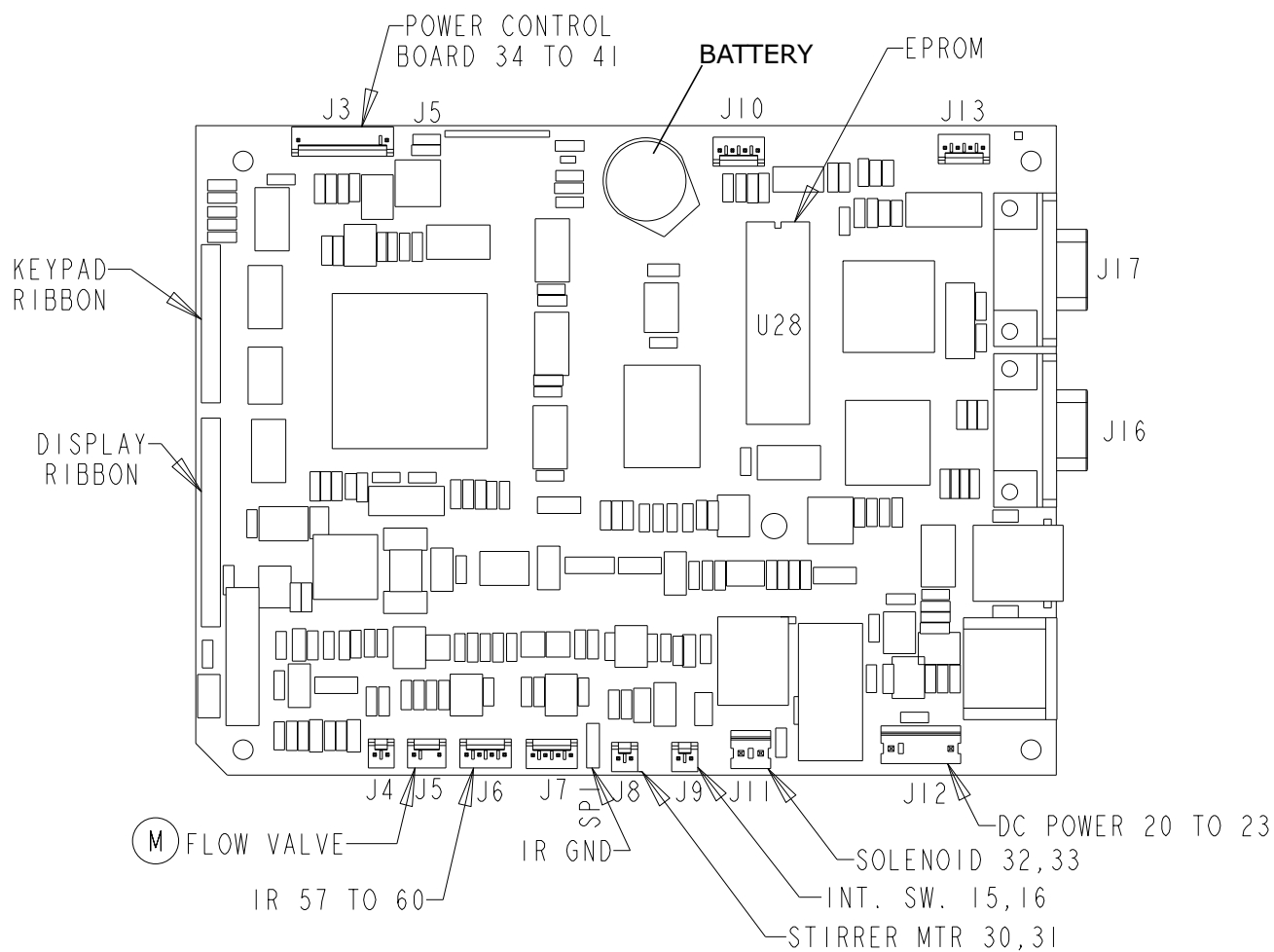
BLACK 19, 22, 25
RED 21, 23, 24

BR130262
NUT

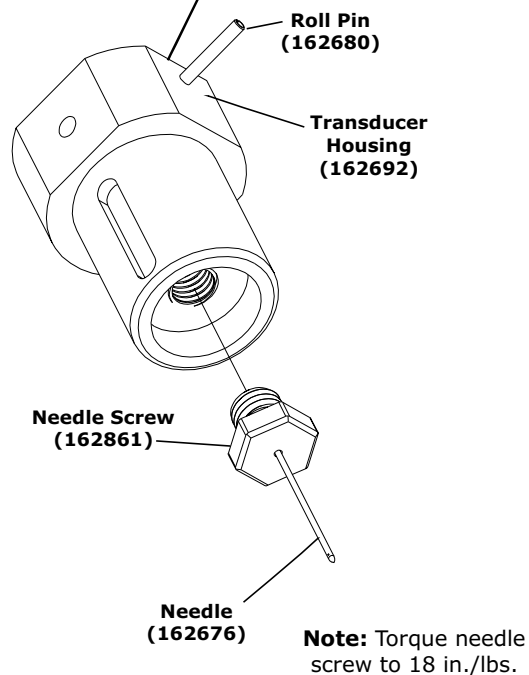
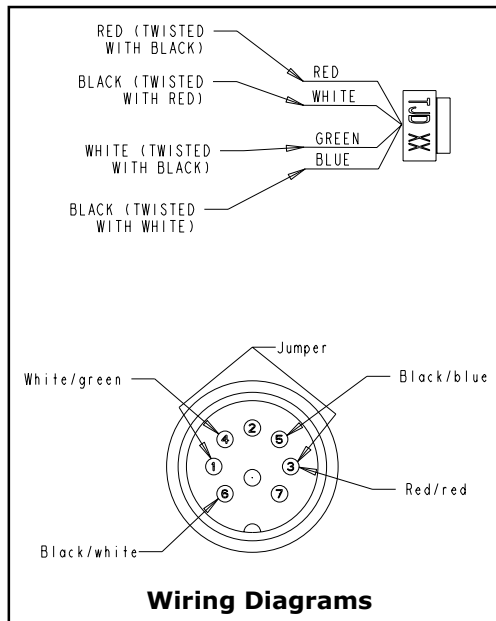
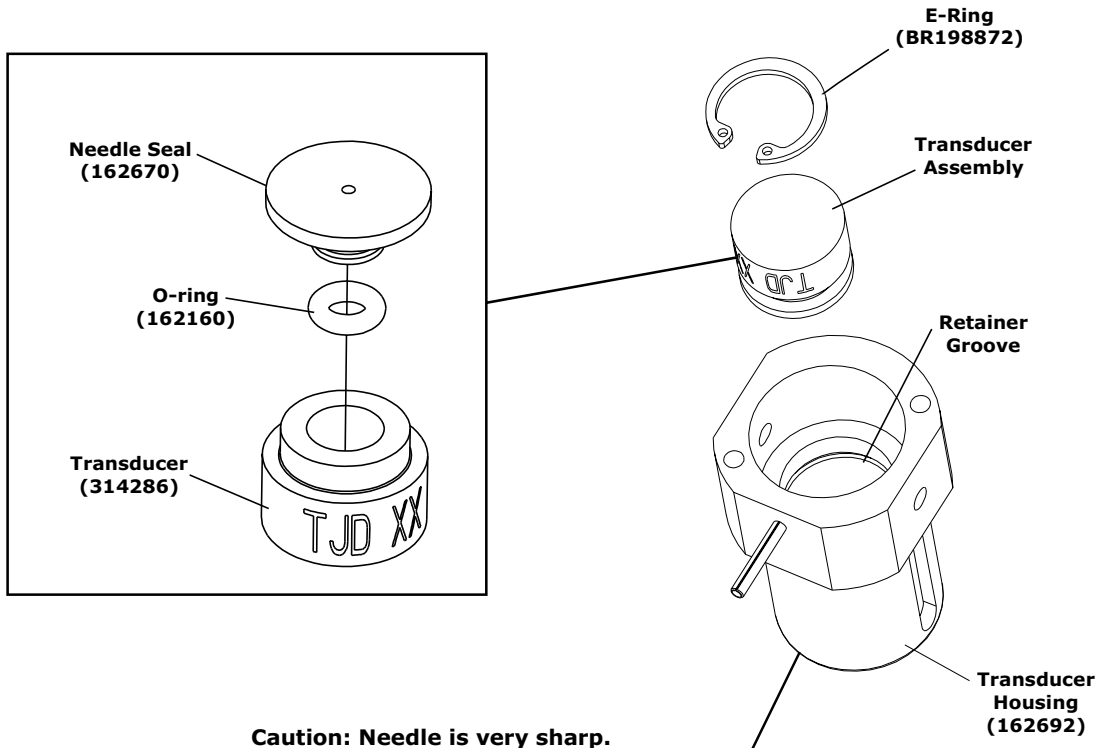
CPU BOARD



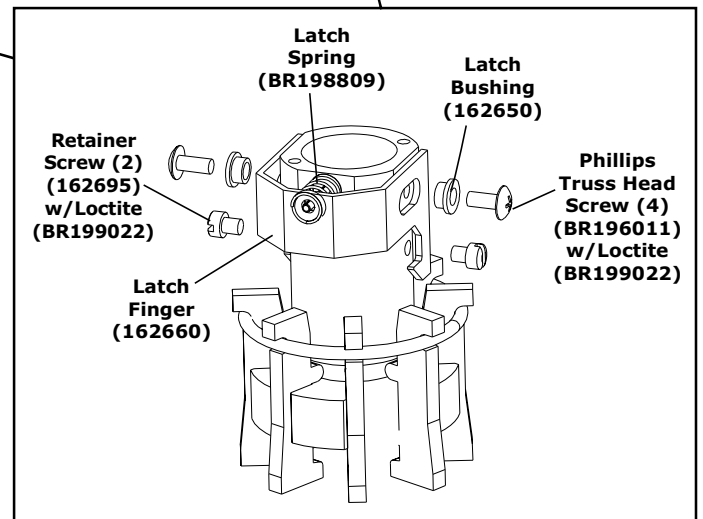
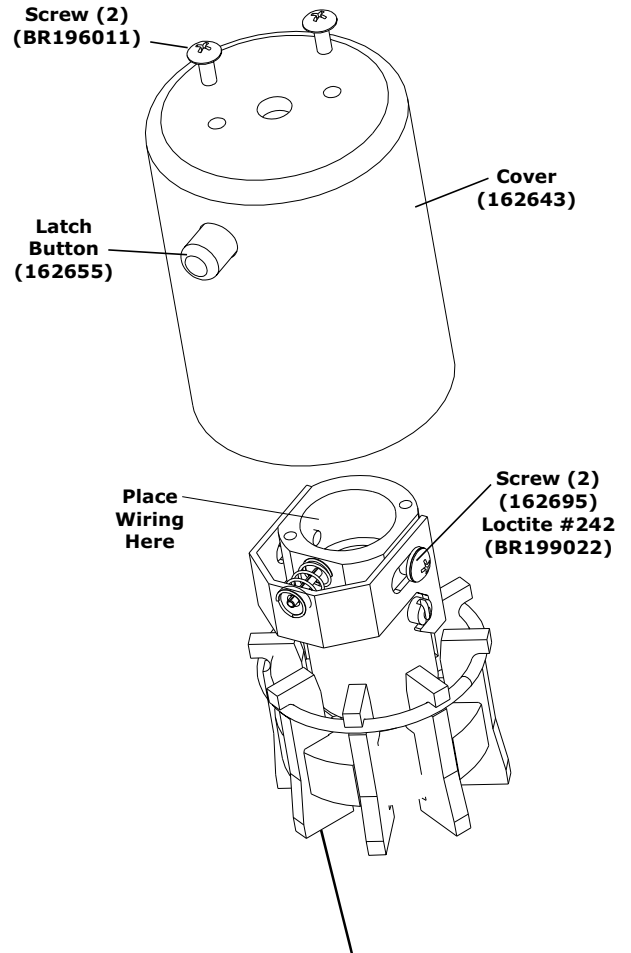
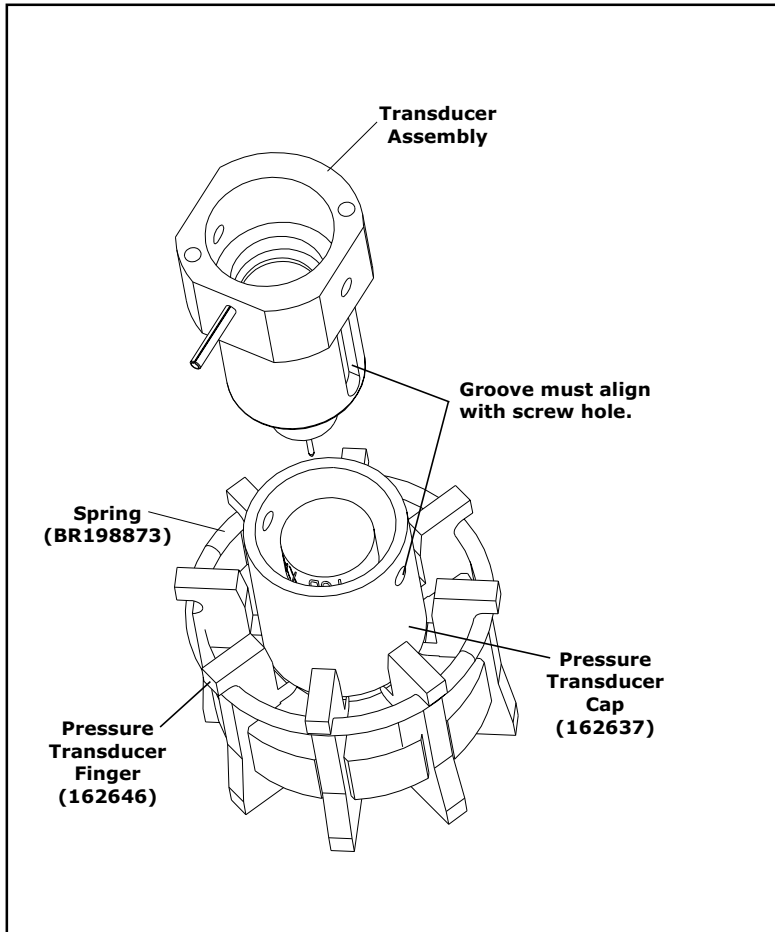
CPU BOARD

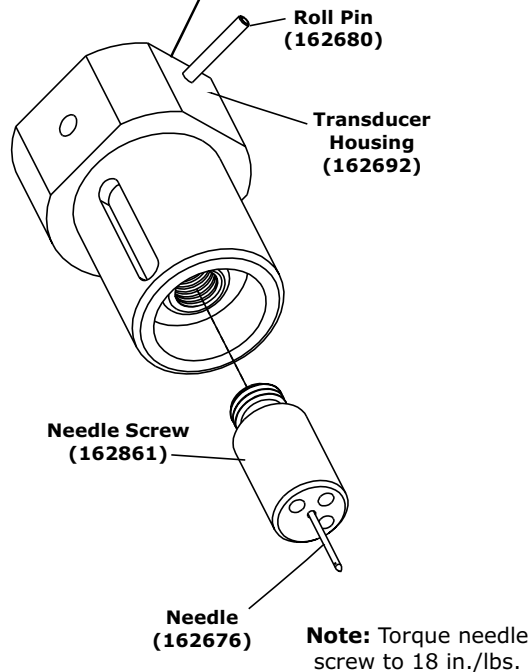
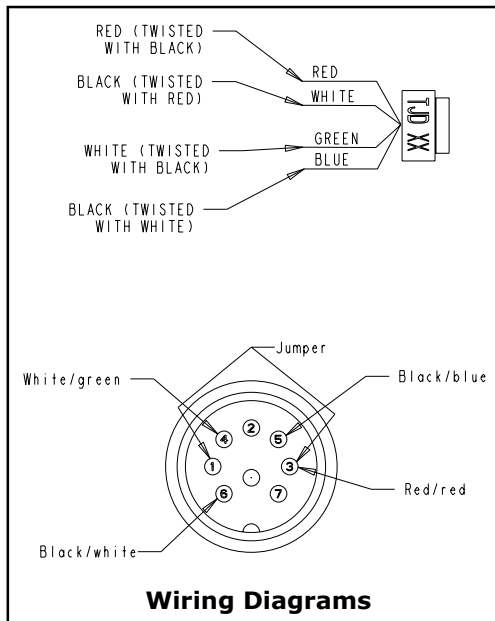
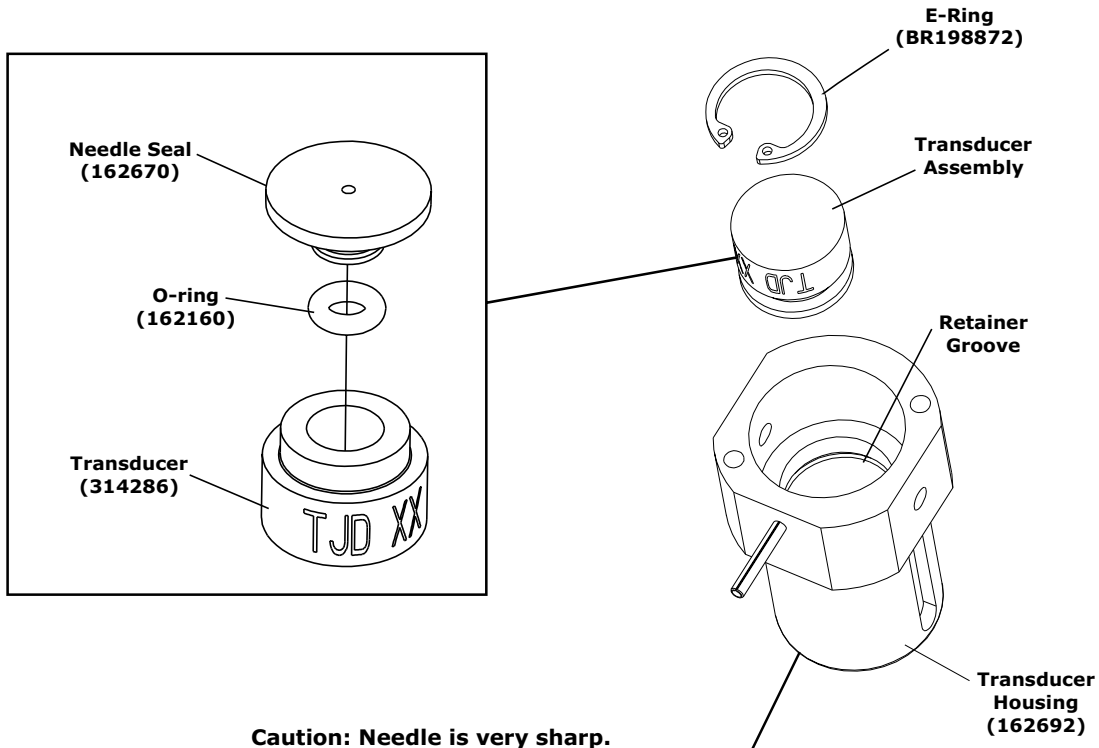


Battery = 3V Lithium or Equivalent

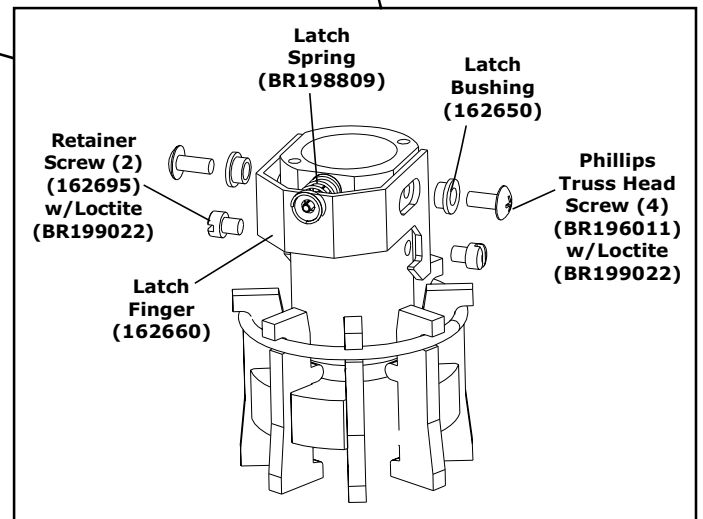
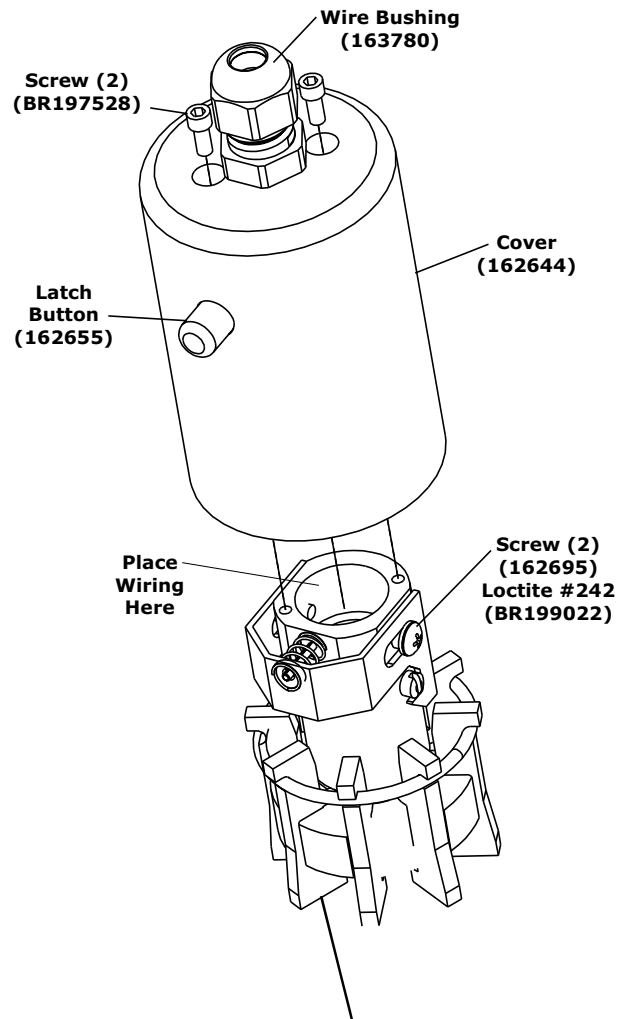
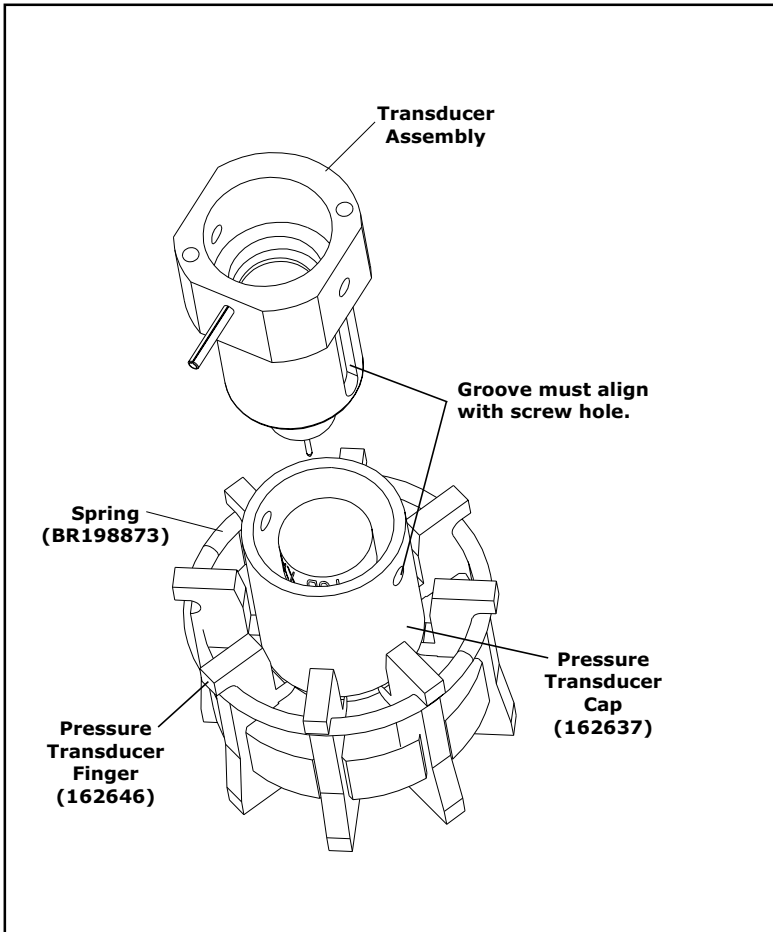


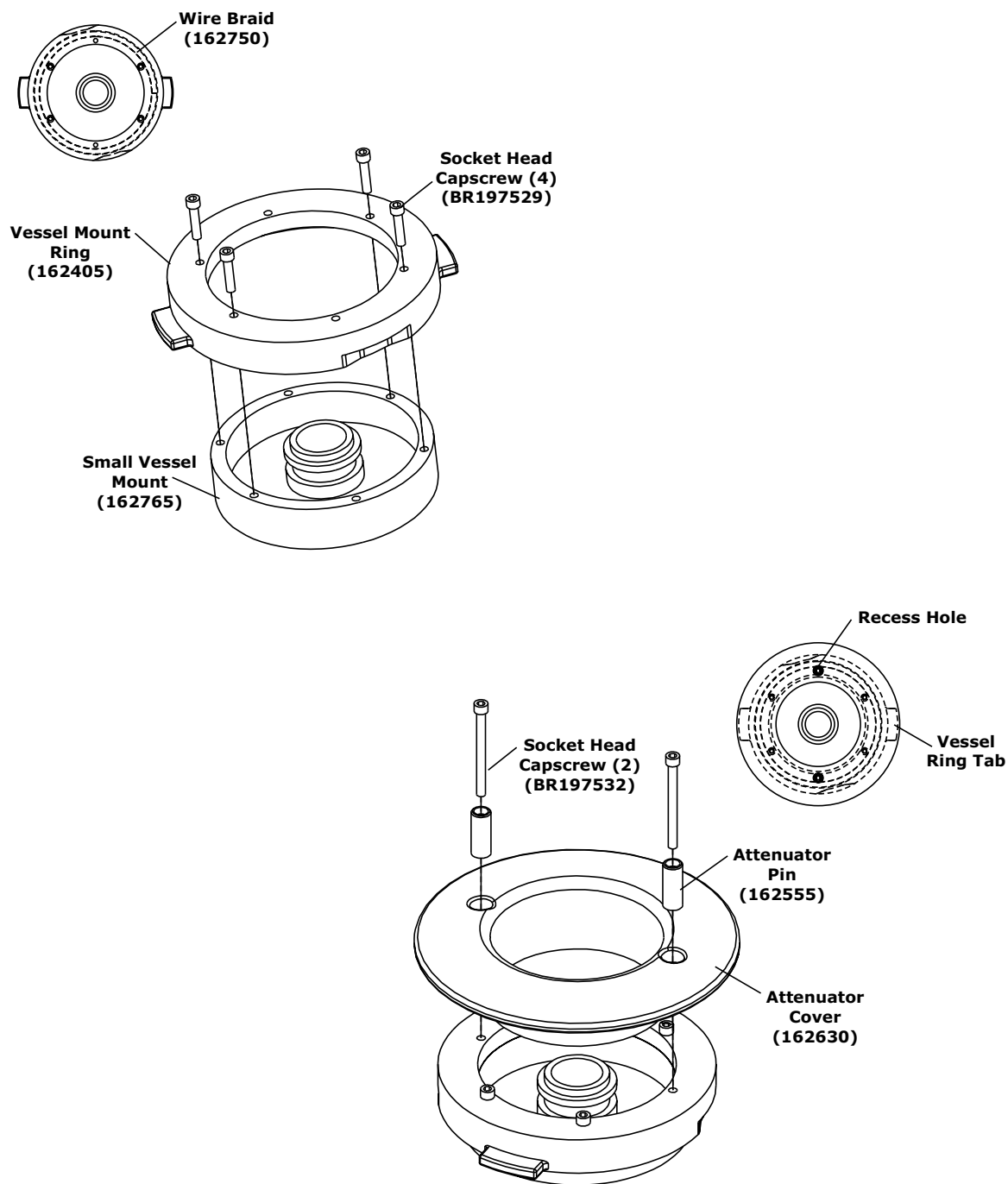
Caution: Needle protruding through bottom of assembly is very sharp.



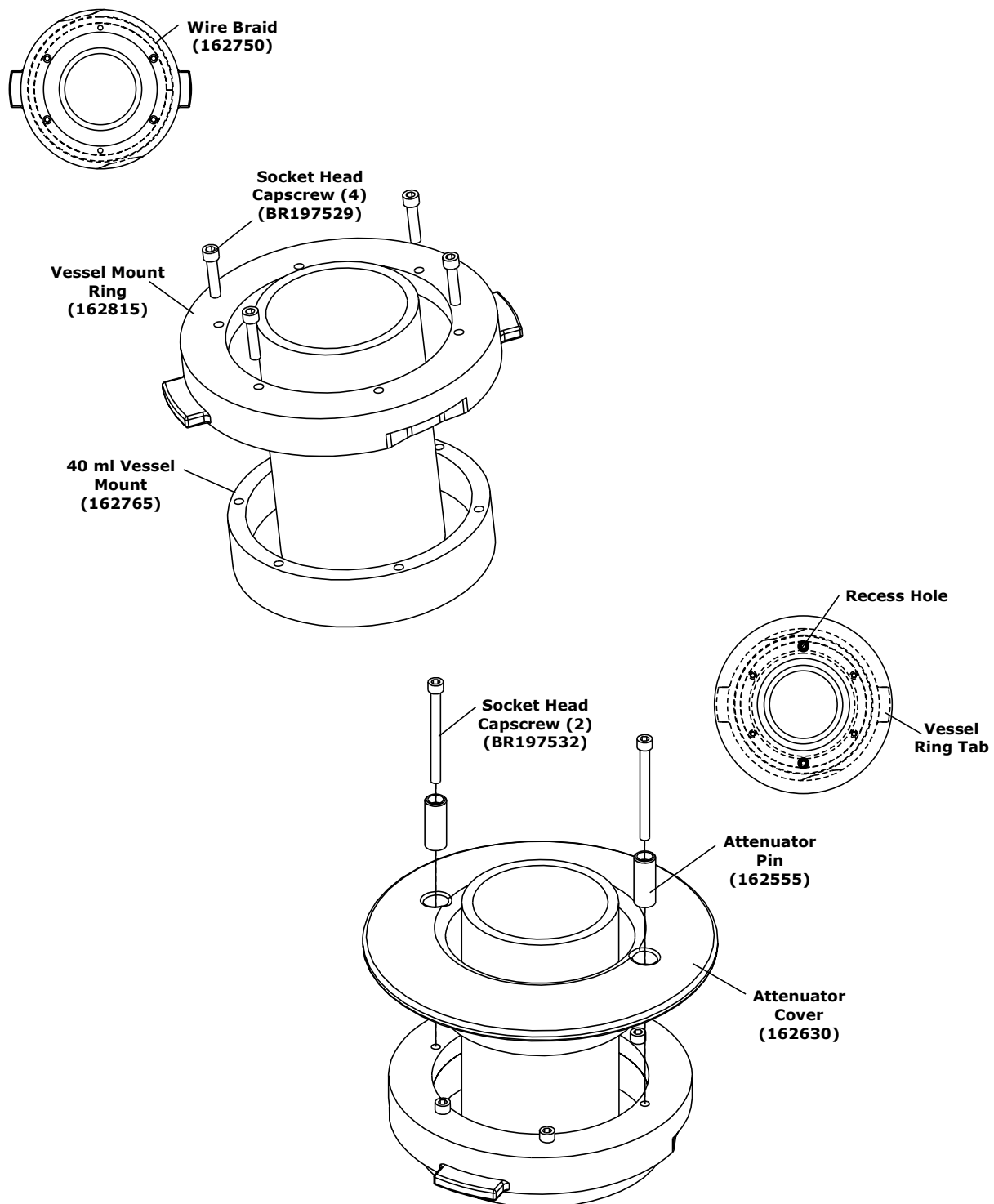


Caution: Needle protruding through bottom of assembly is very sharp.

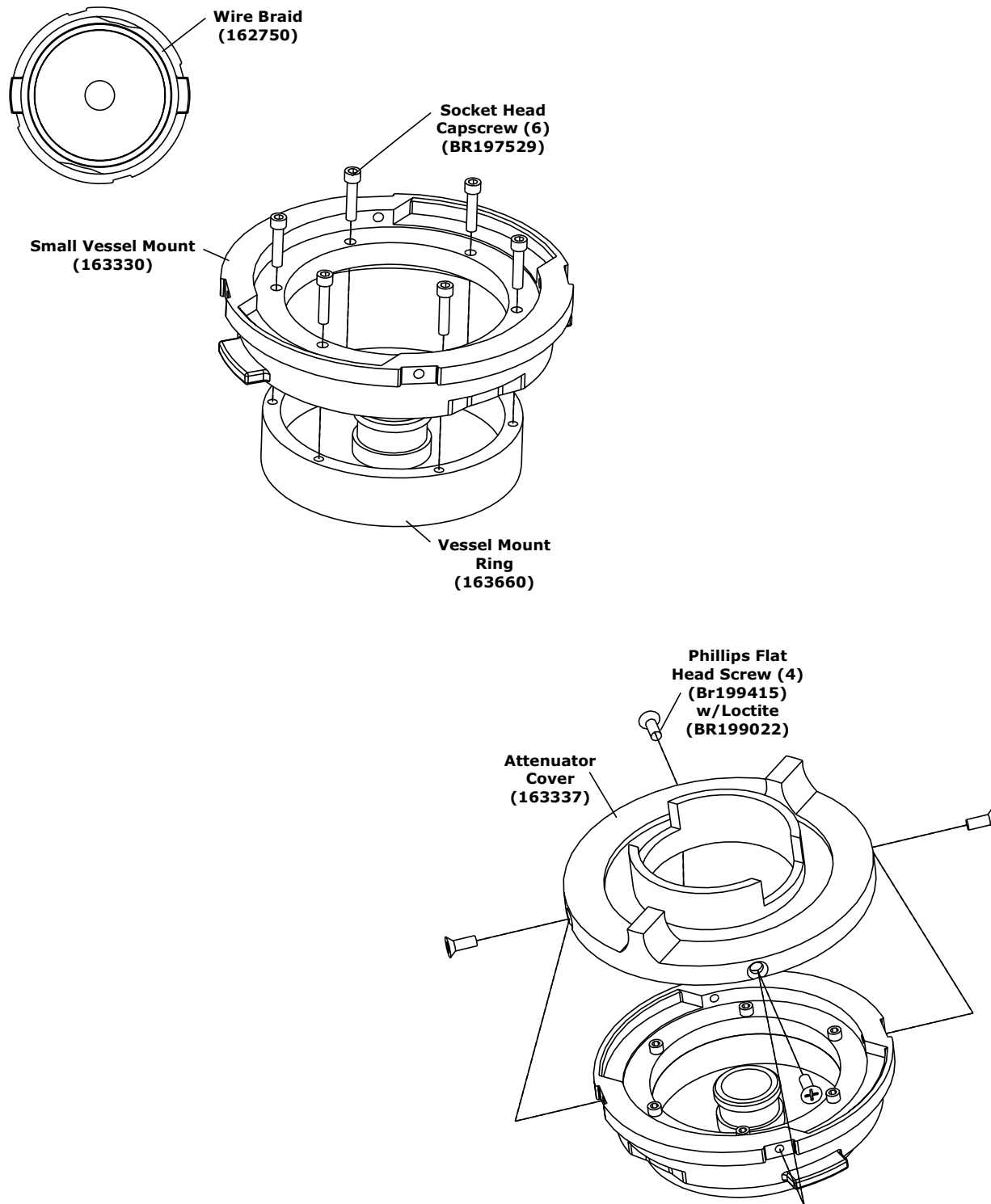




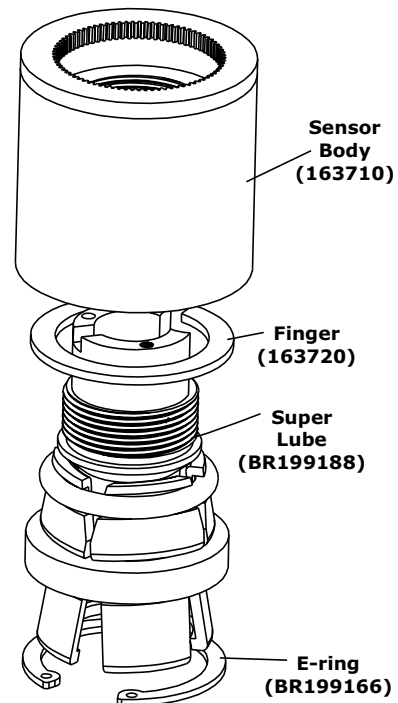
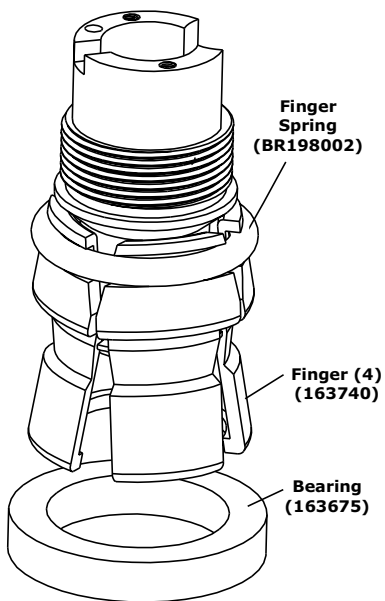
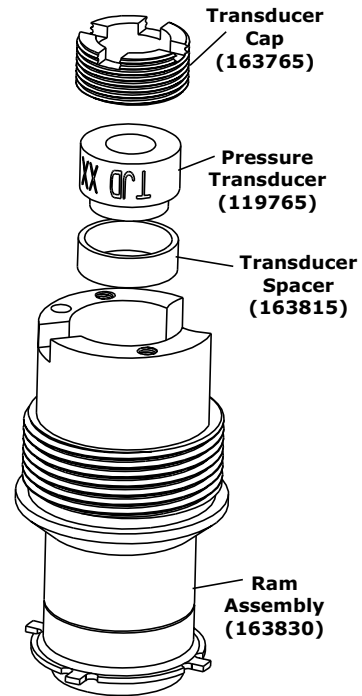
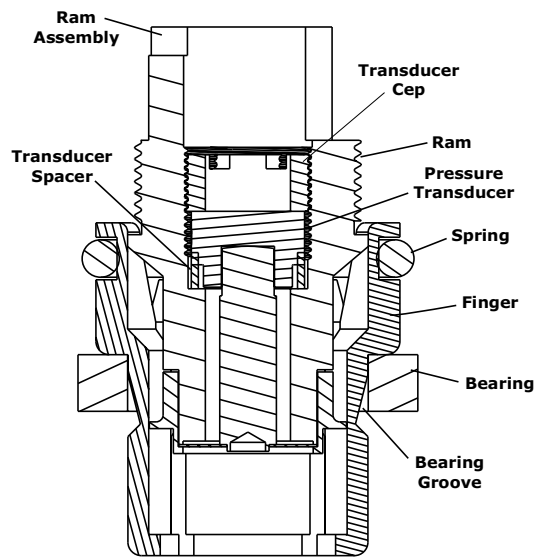
**Attenuator Assembly
(Discover with Direct Pressure System)
541125 (Sheet 1 of 1)**

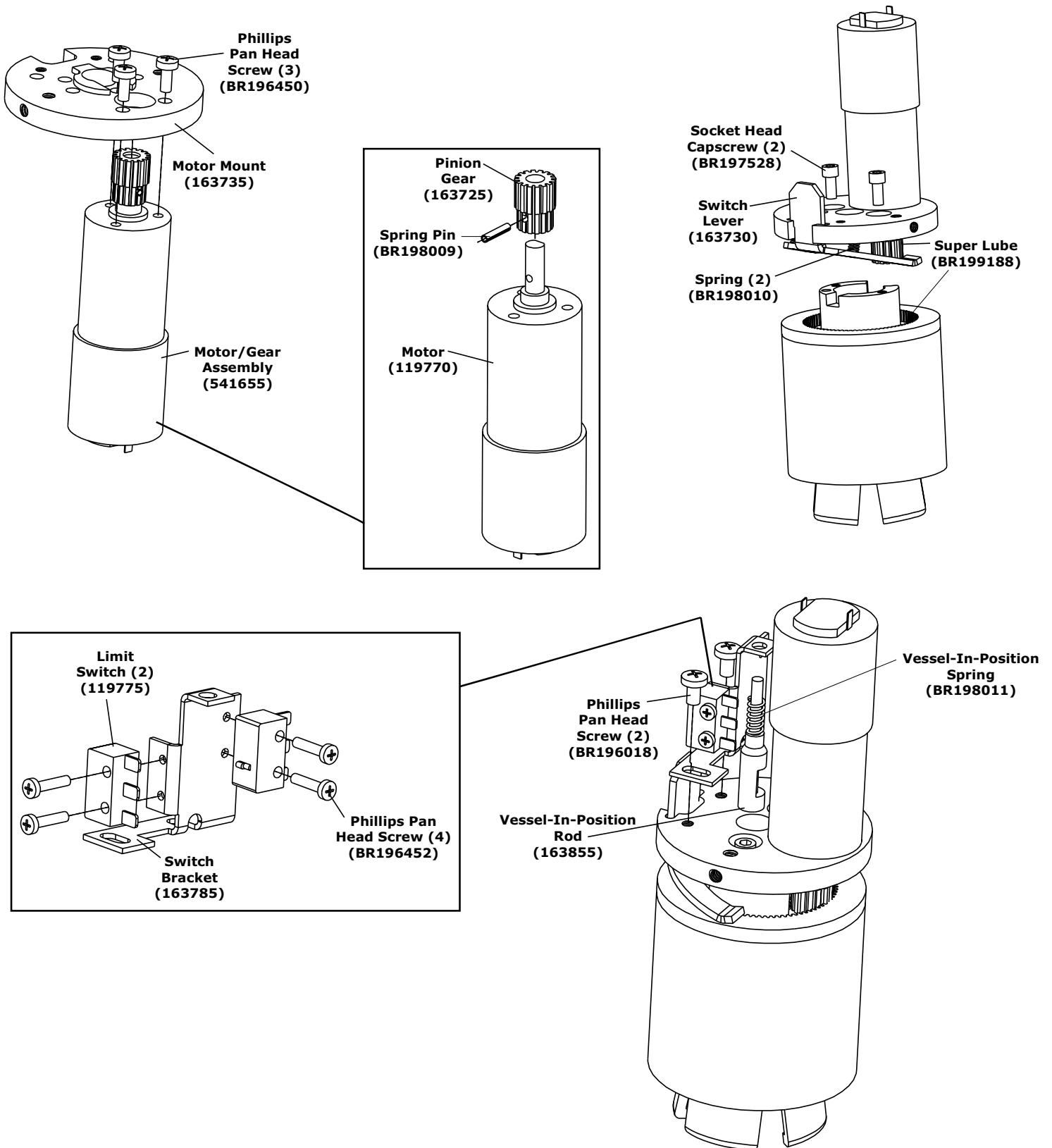


**Attenuator Assembly
(Standard Open Vessel Discover)
541130 (Sheet 1 of 1)**

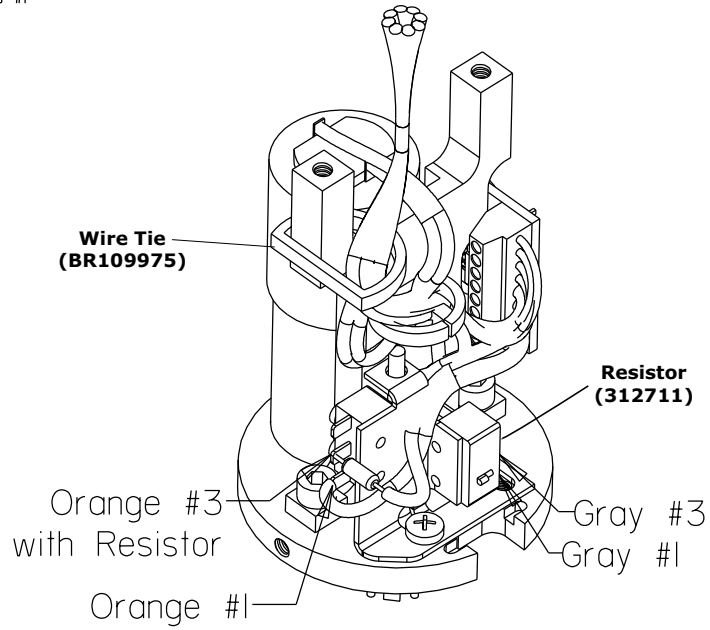
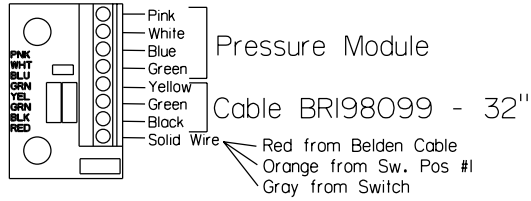


**Attenuator Assembly
(Discover with IntelliVent Pressure Systemj)
541615 (Sheet 1 of 1)**

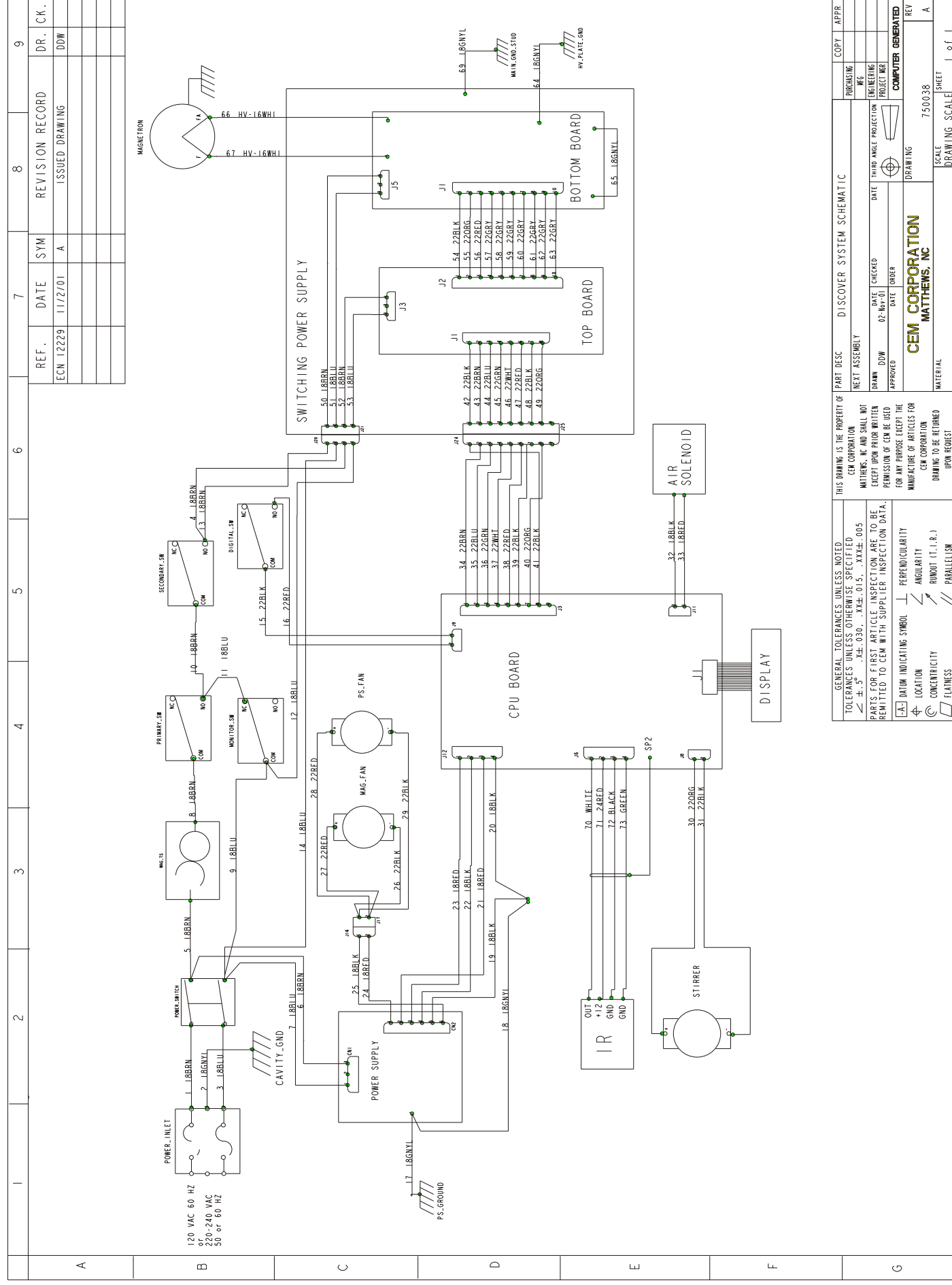


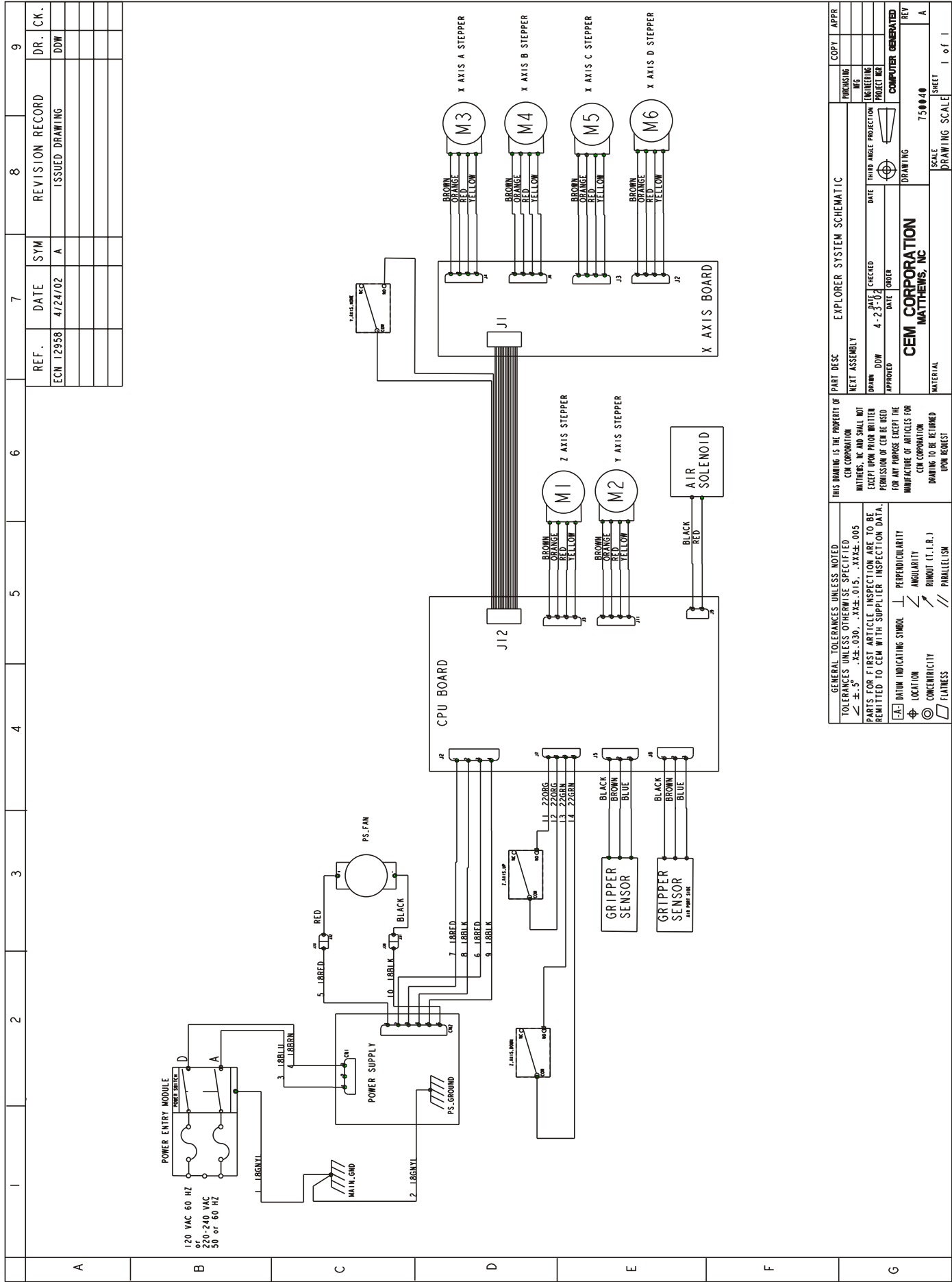




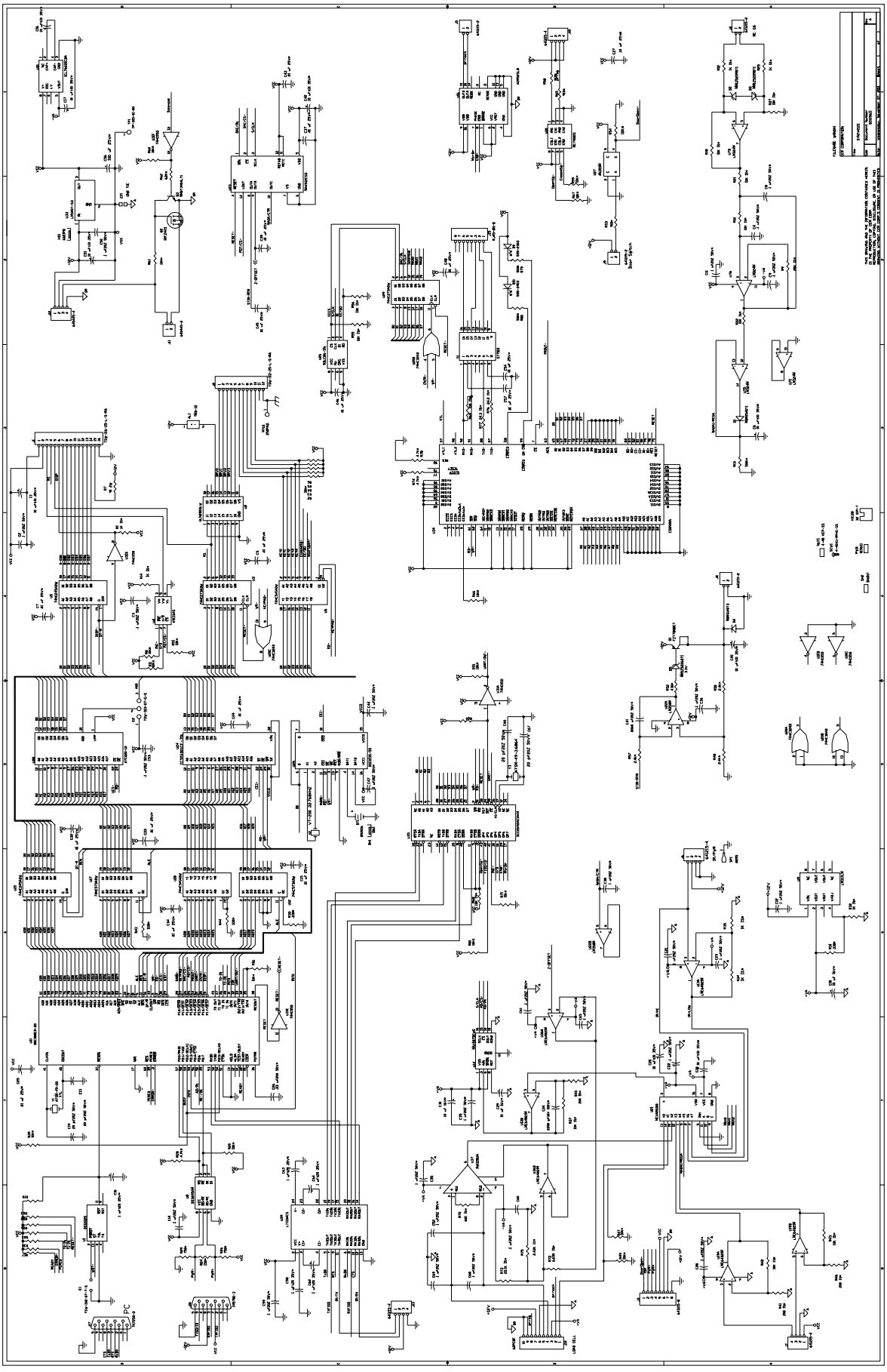


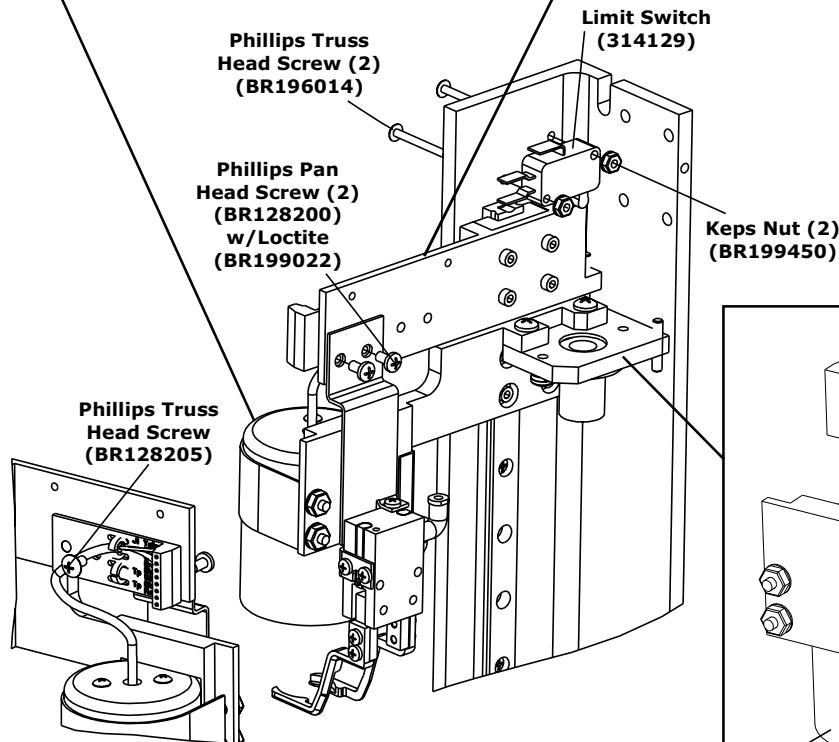
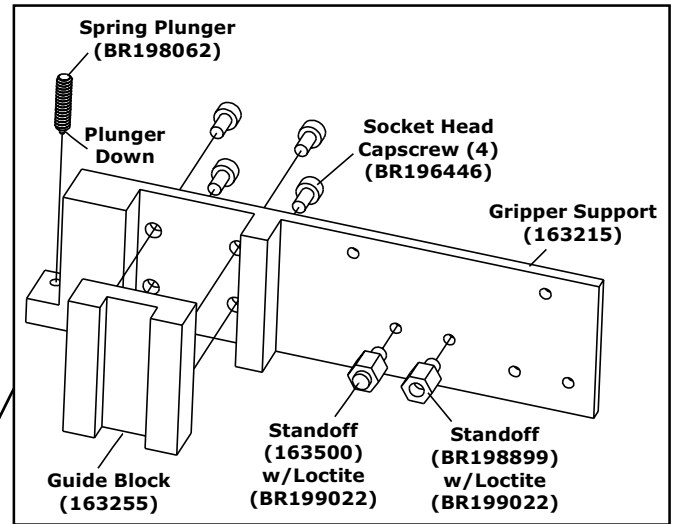
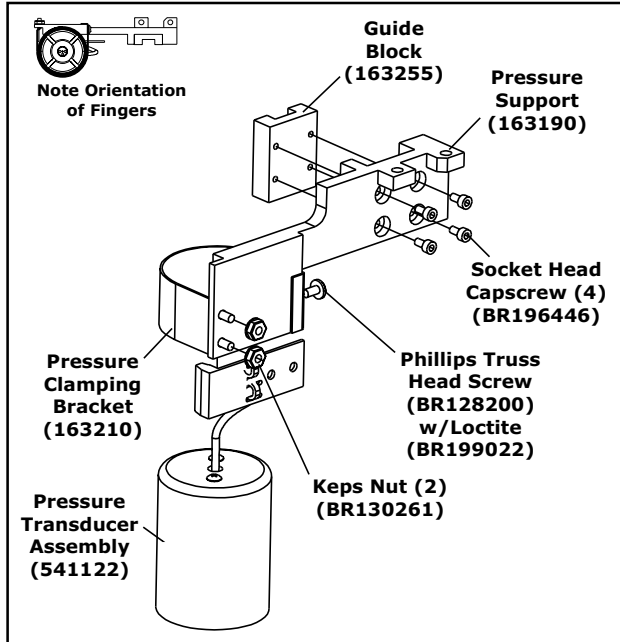
Belden Cable	Black == Board
	Green == Board
	Yellow == Board
	Red == Solder to Solid Wire with ORG #1 and GRY #3
	Violet == Solder to Gray #1
	Brown == Solder to Black Motor
	Blue == Solder to Red Motor
	White == Solder to Orange #3



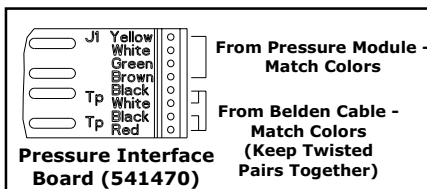
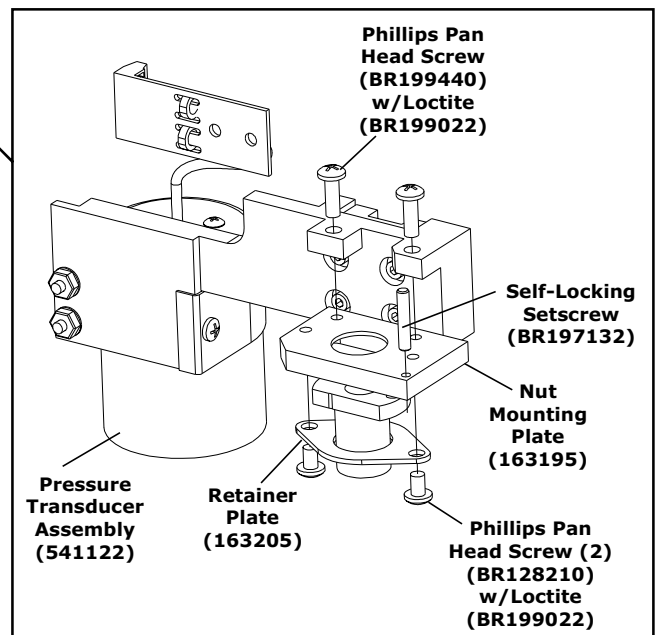


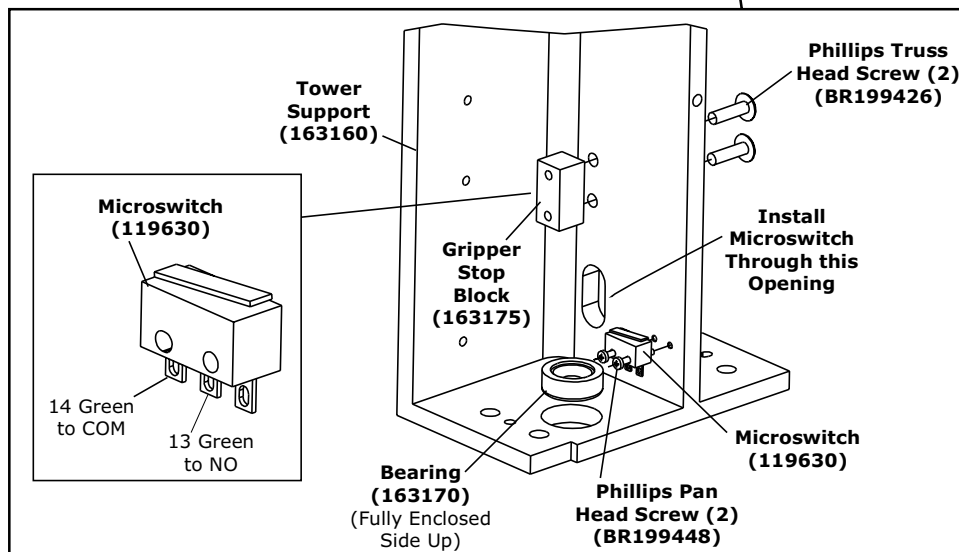
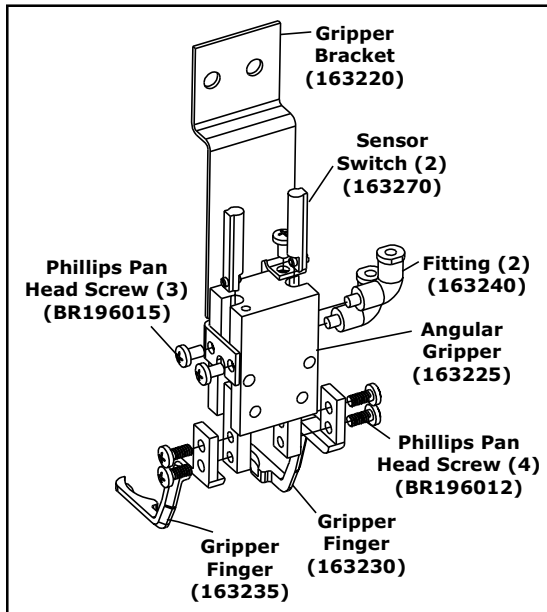
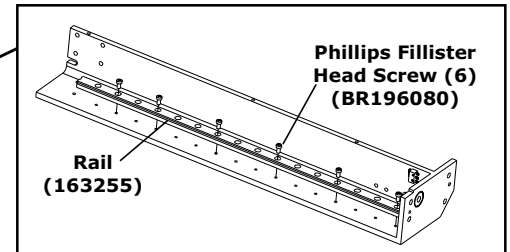
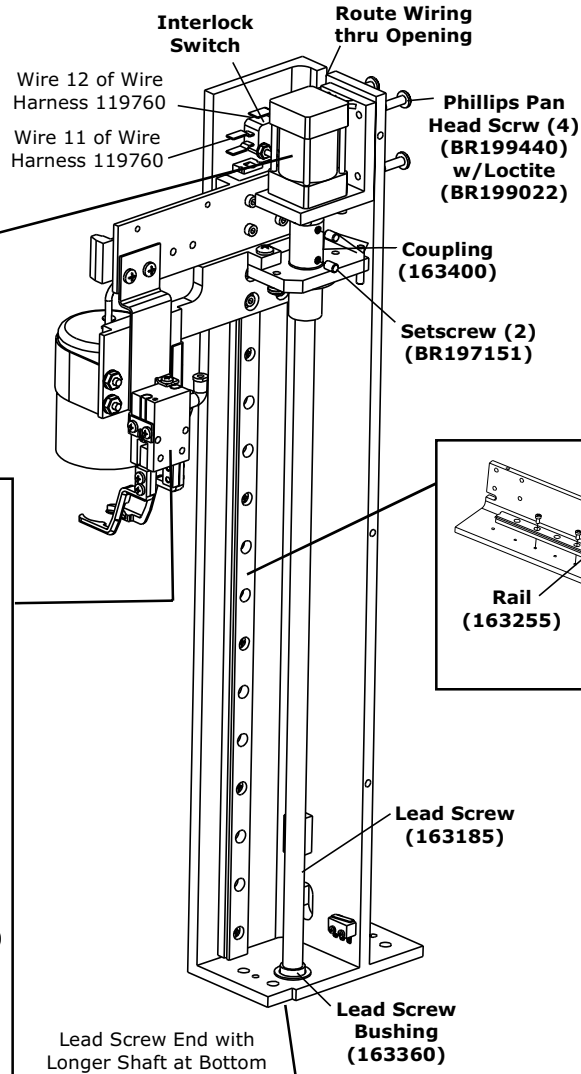
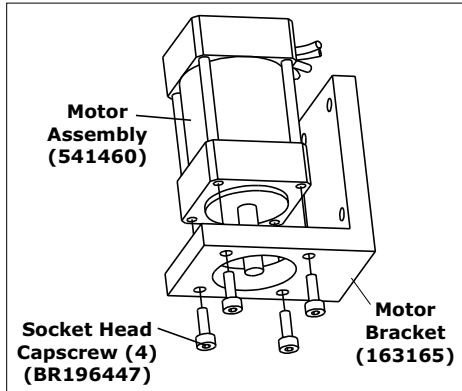
133

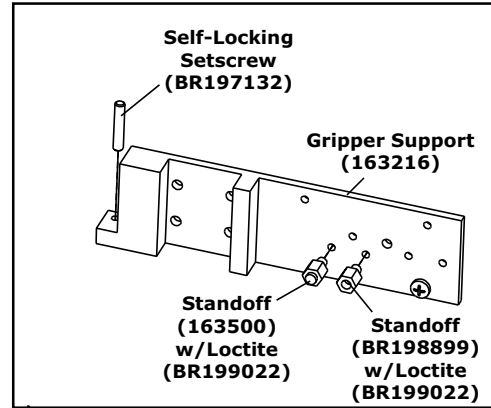
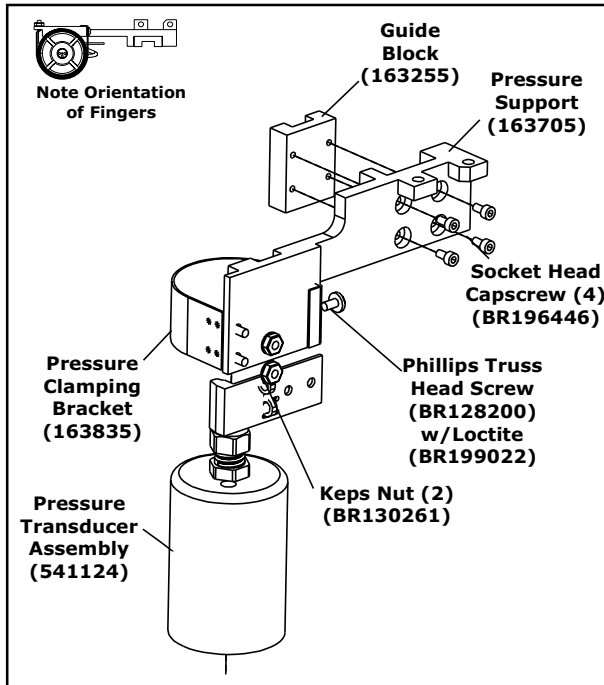




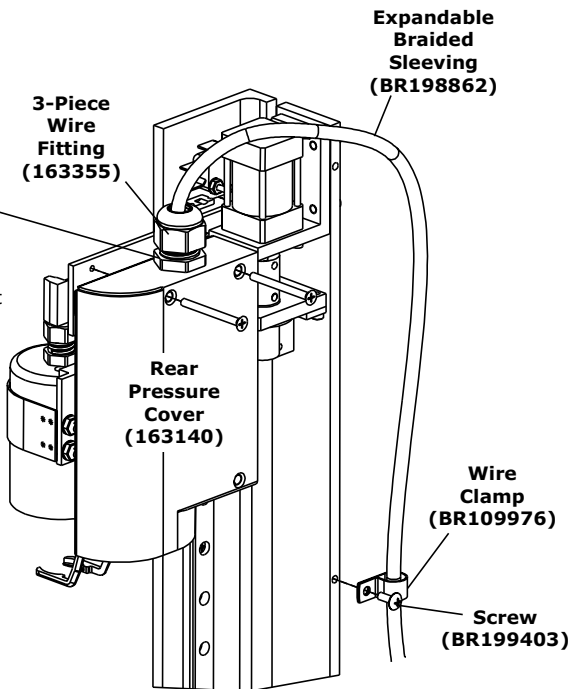
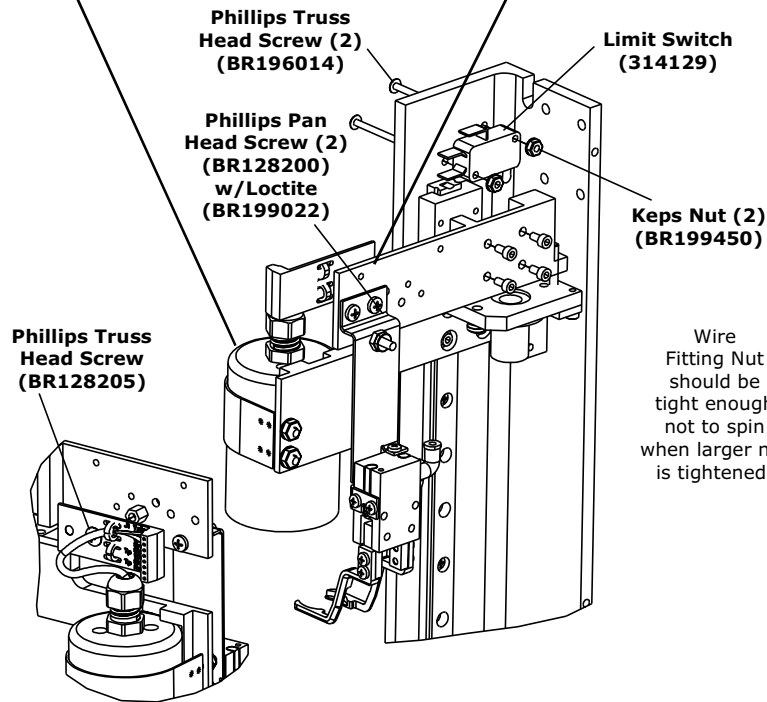
Caution: Needle protruding through bottom of pressure transducer assembly is very sharp.





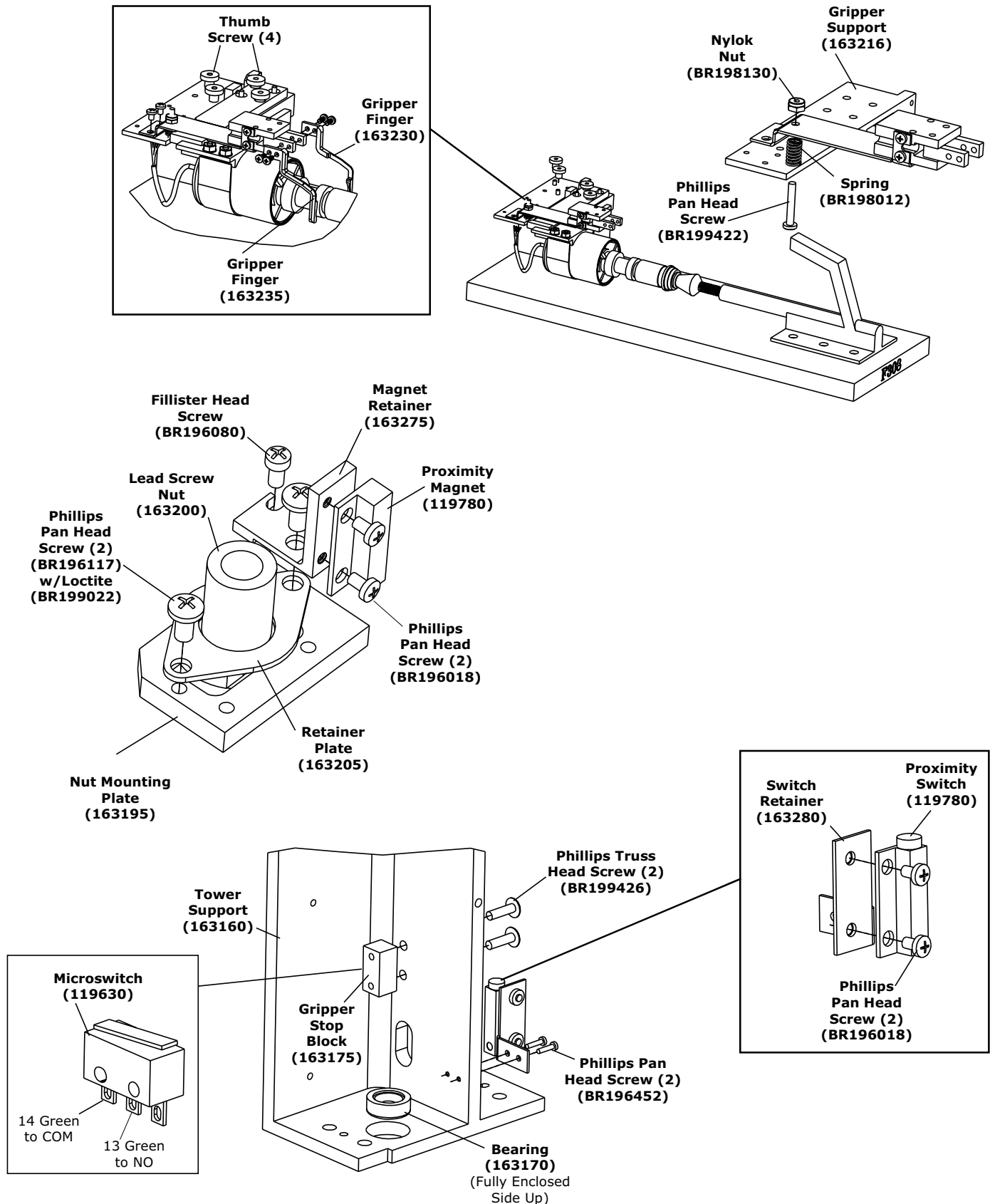


Caution: Needle protruding through bottom of pressure transducer assembly is very sharp.

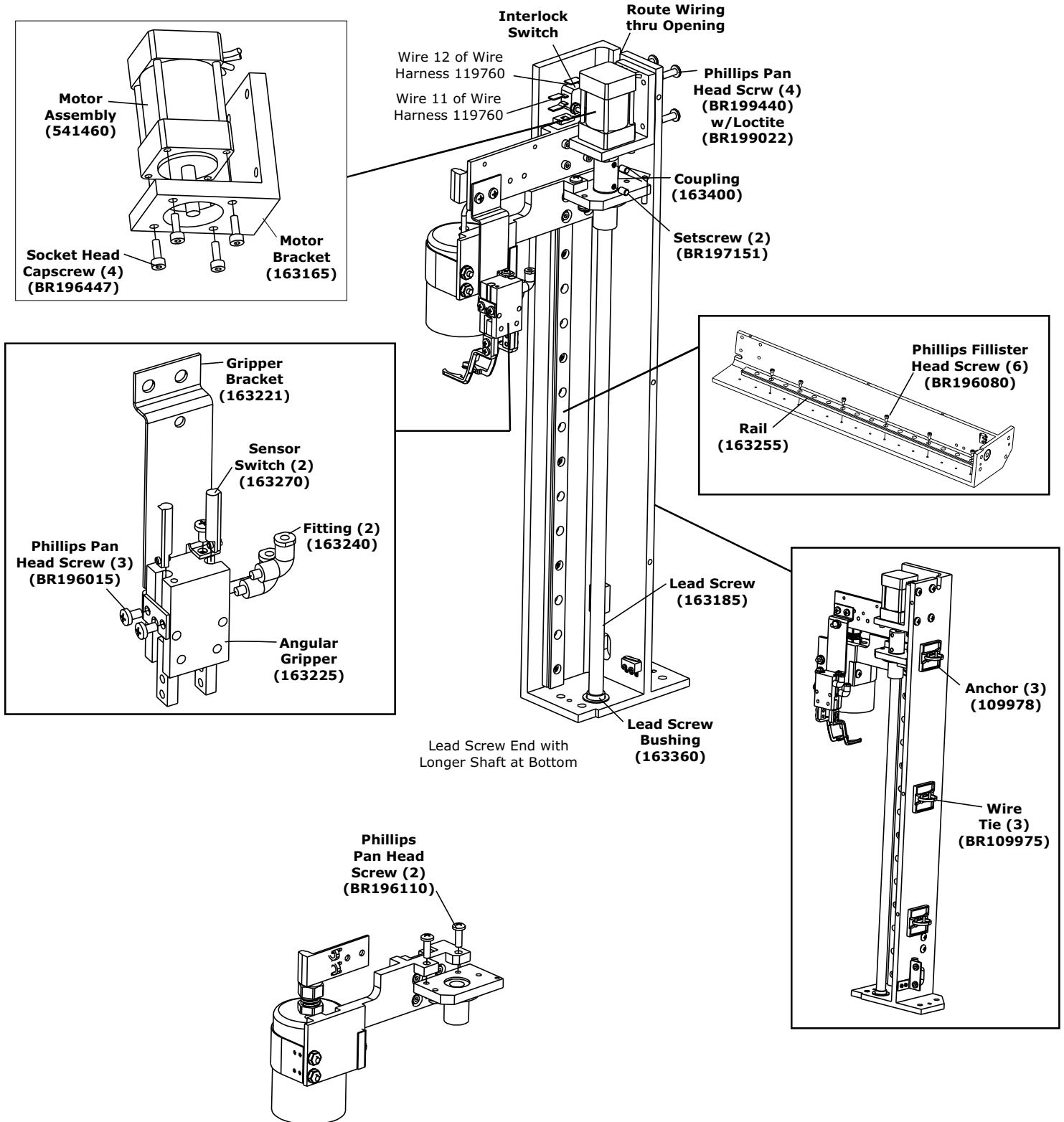


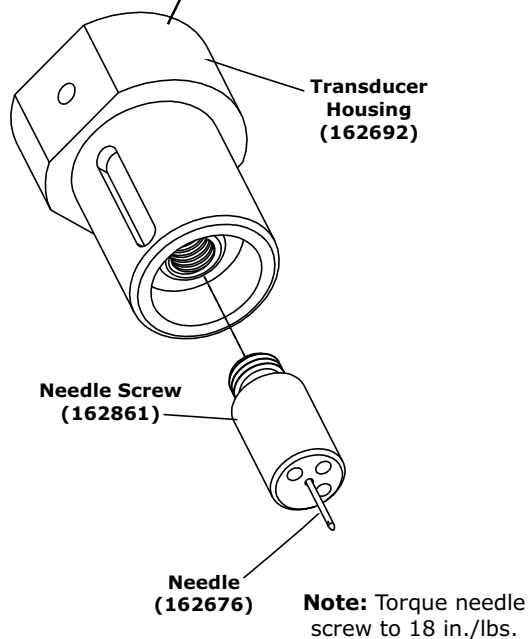
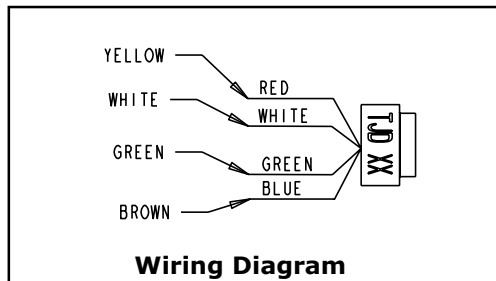
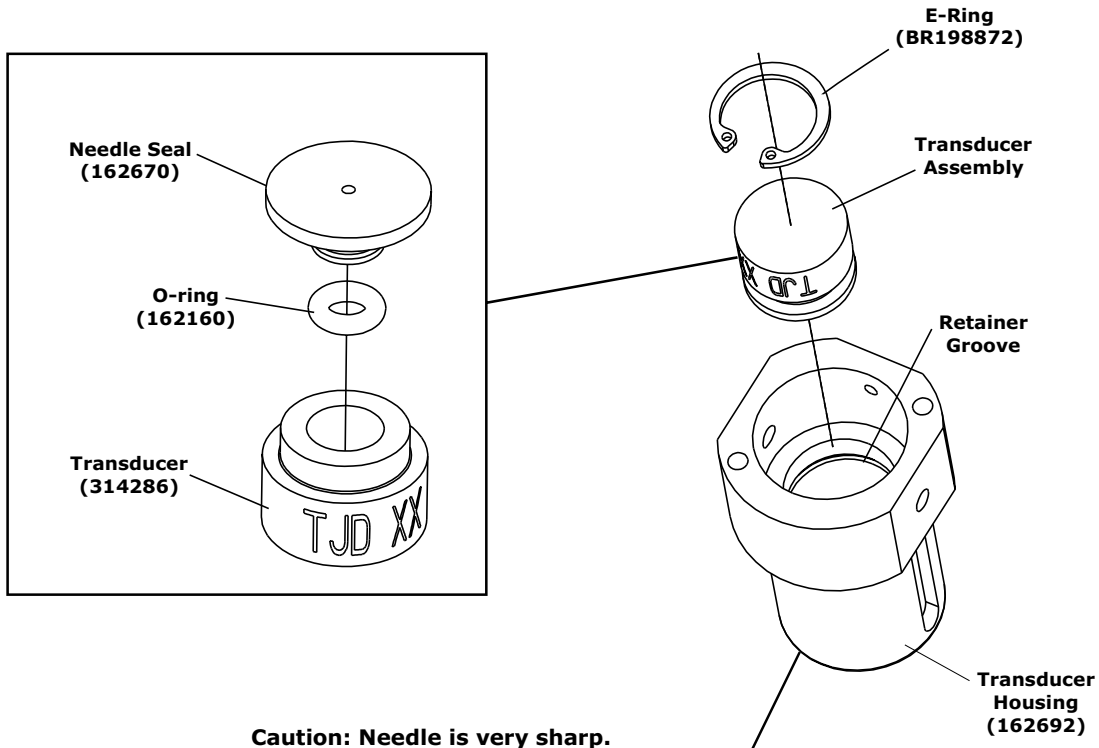
J1	Yellow	○	From Pressure Module - Match Colors
	White	○	
	Green	○	
	Brown	○	
	Black	○	
TP	White	○	From Belden Cable - Match Colors (Keep Twisted Pairs Together)
	Black	○	
TP	Red	○	

Pressure Interface Board (541470)

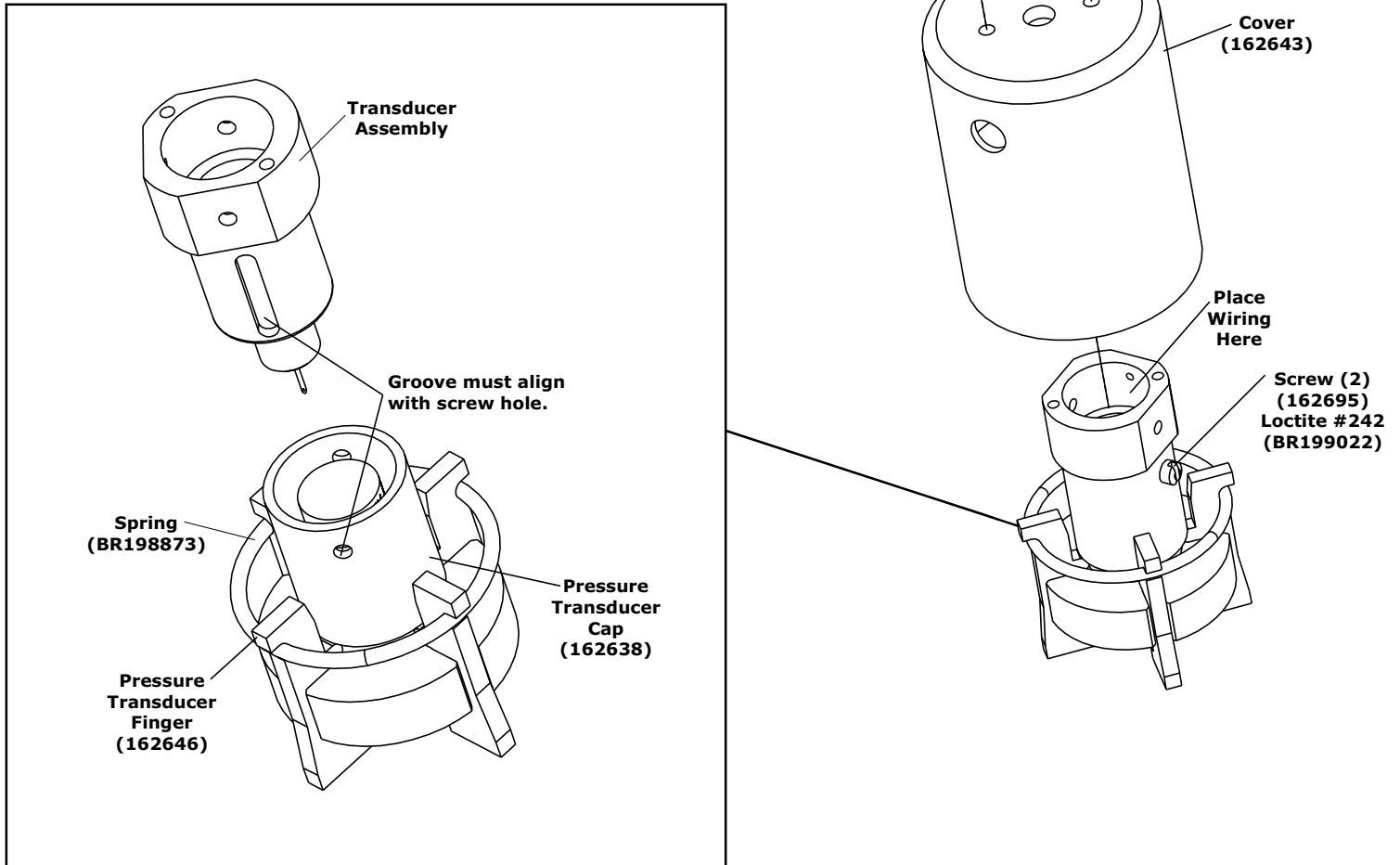


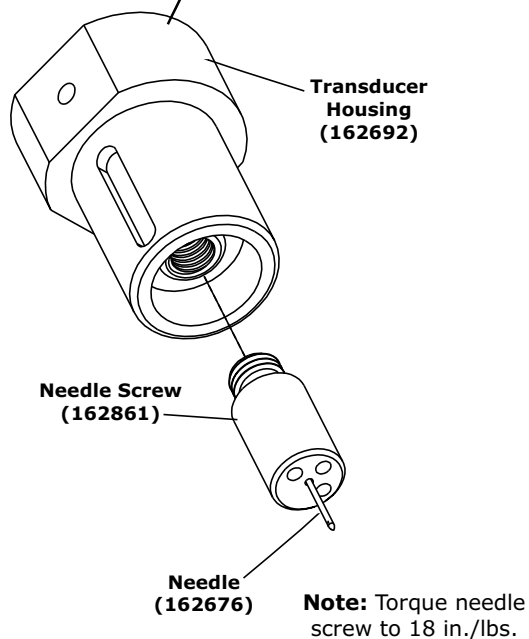
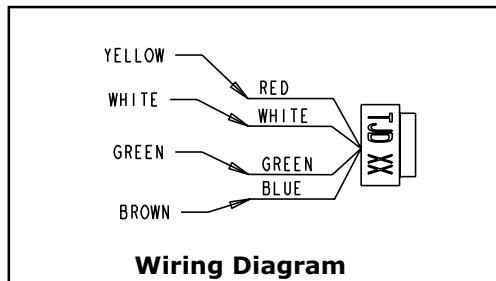
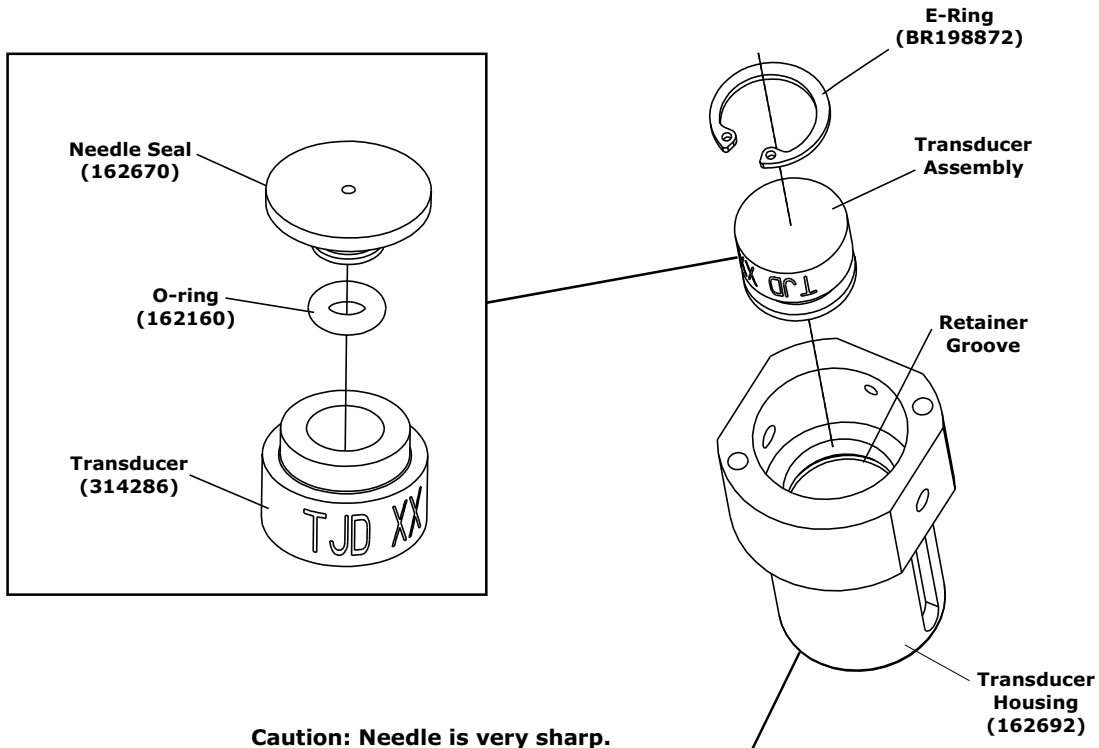
**Z Axis Tower Assembly with IntelliVent
541425 (Sheet 2 of 3)**



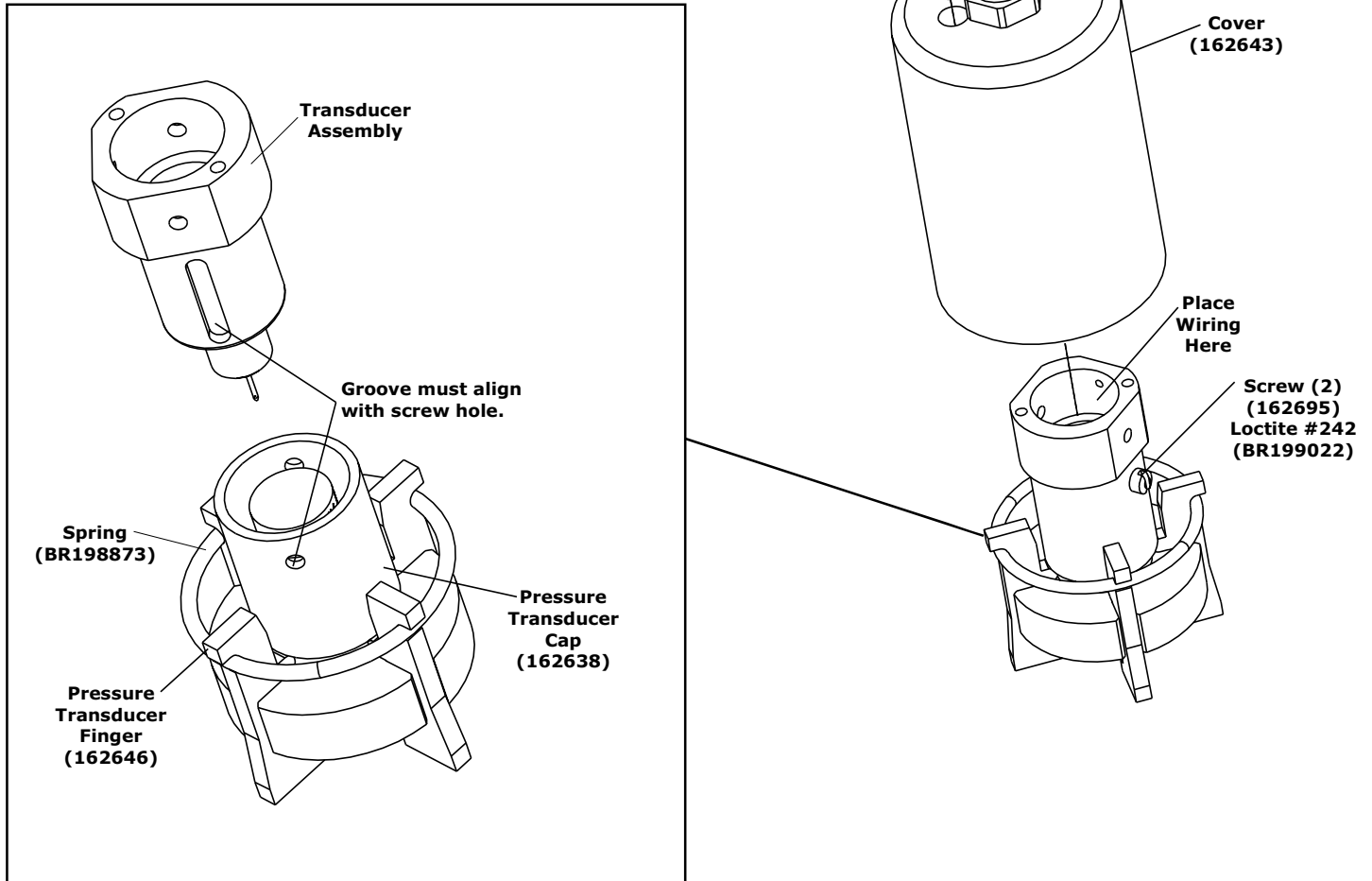


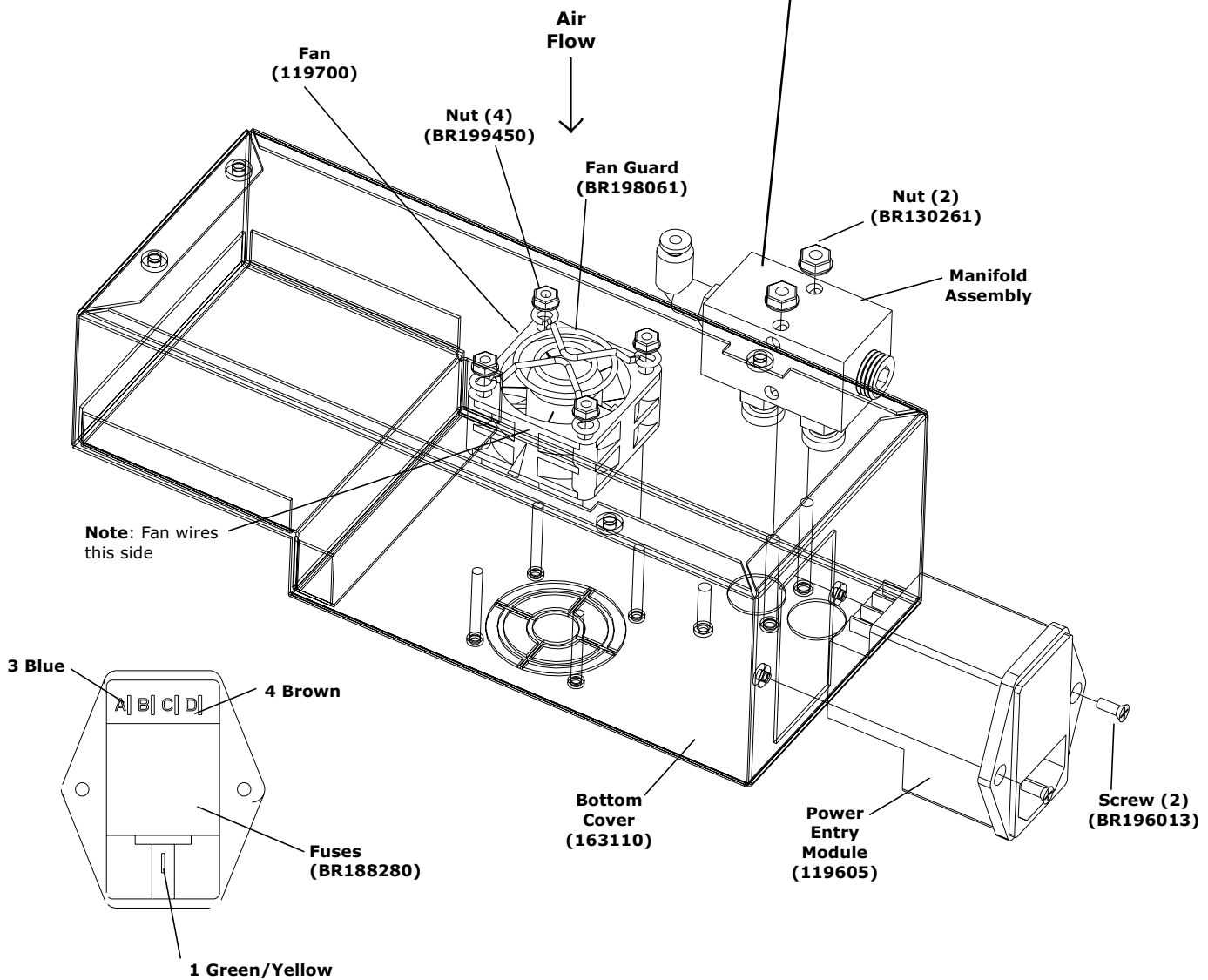
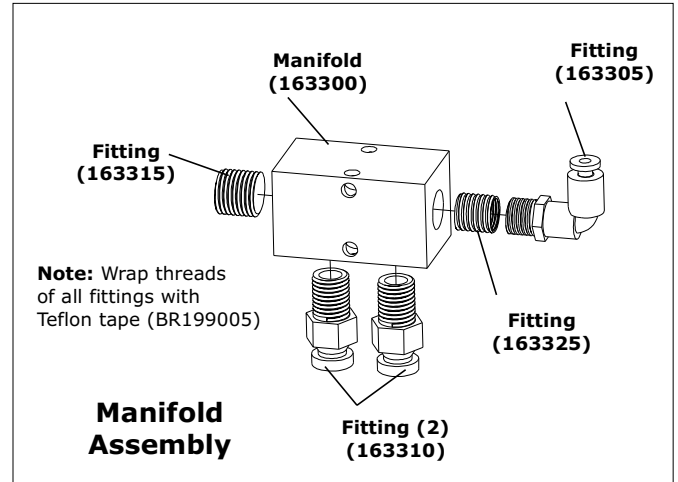
Caution: Needle protruding through bottom of assembly is very sharp.

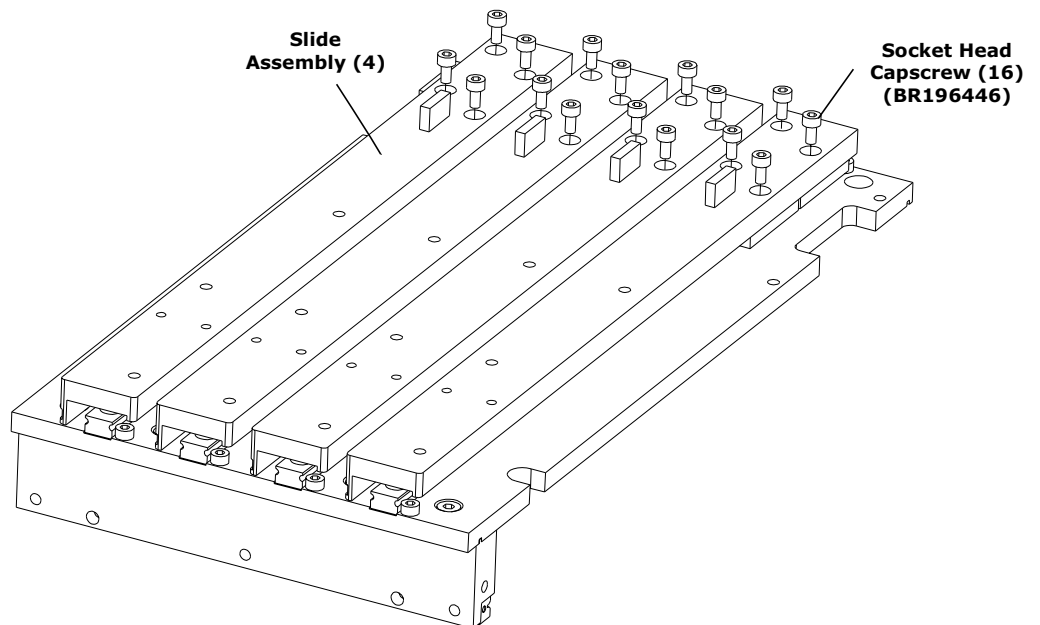
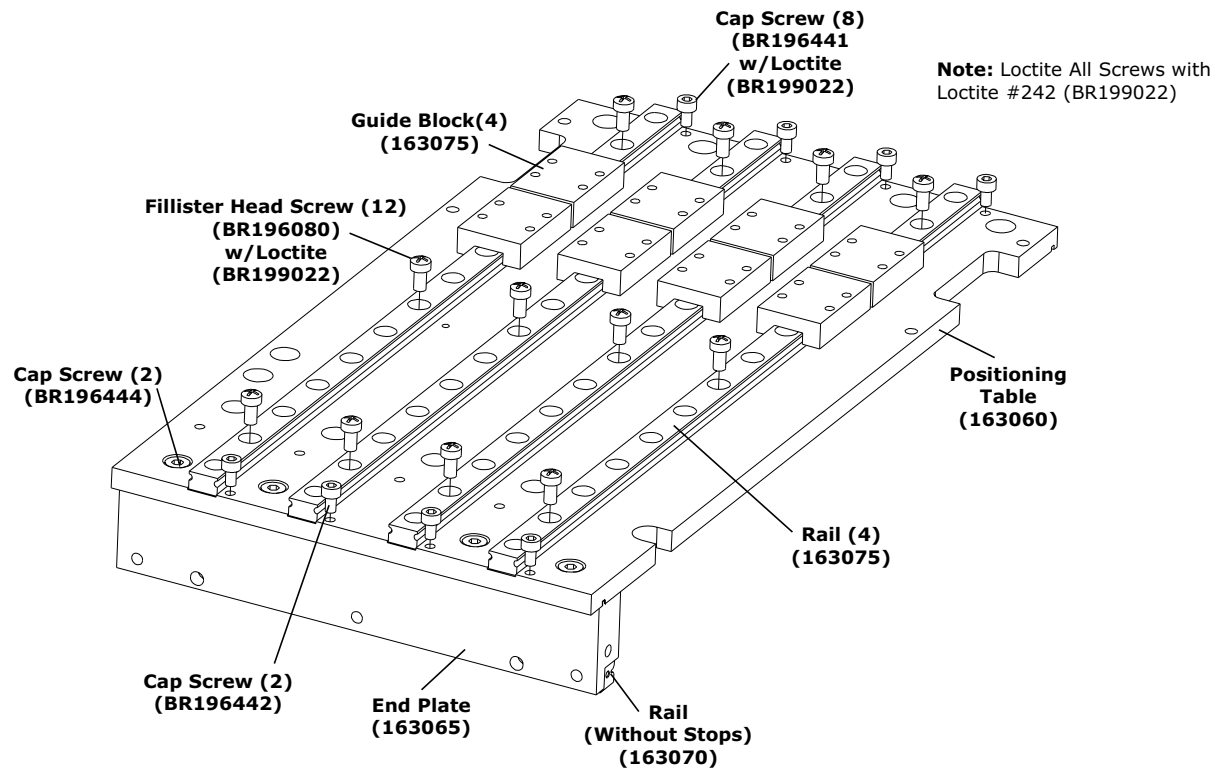


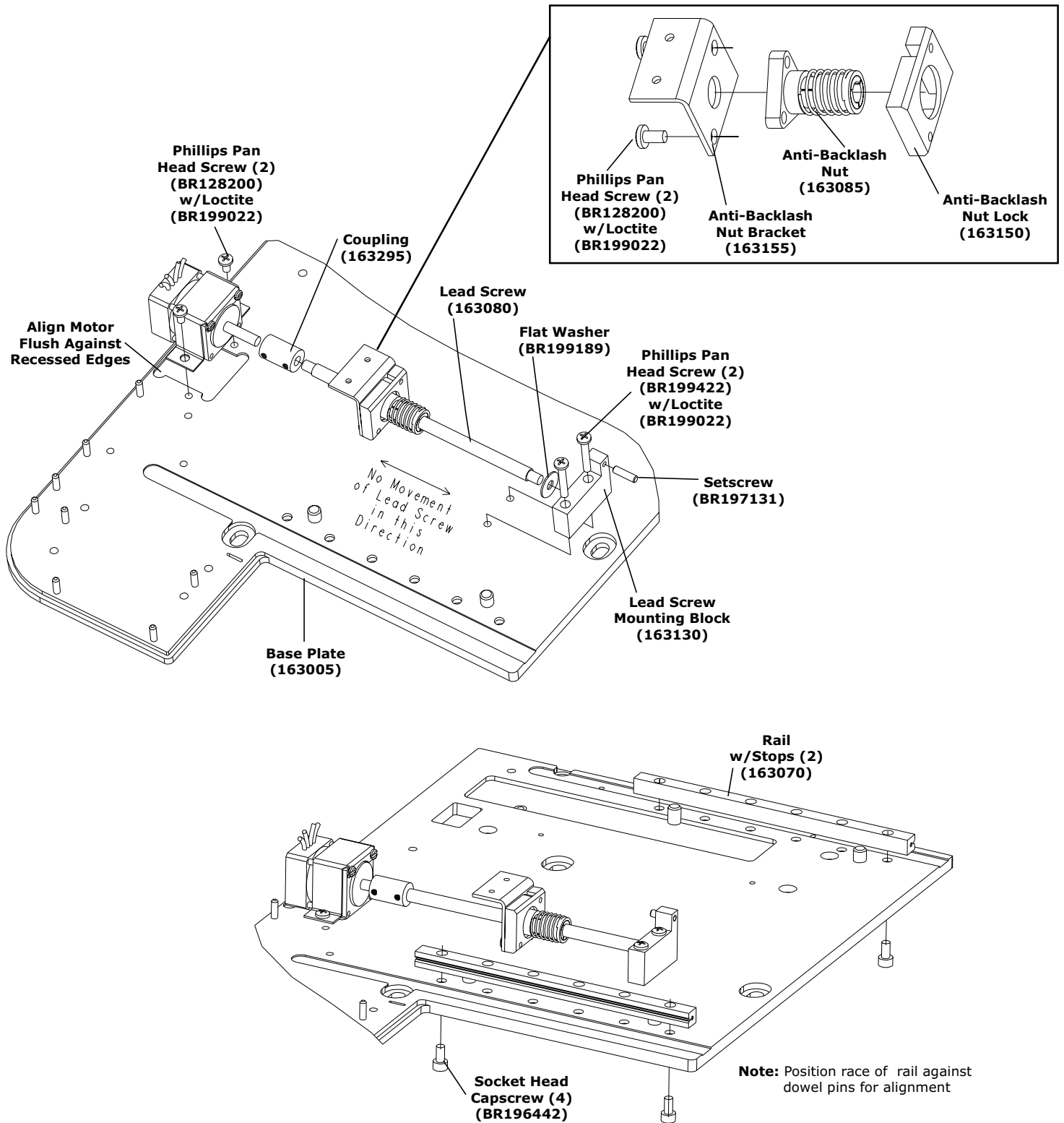


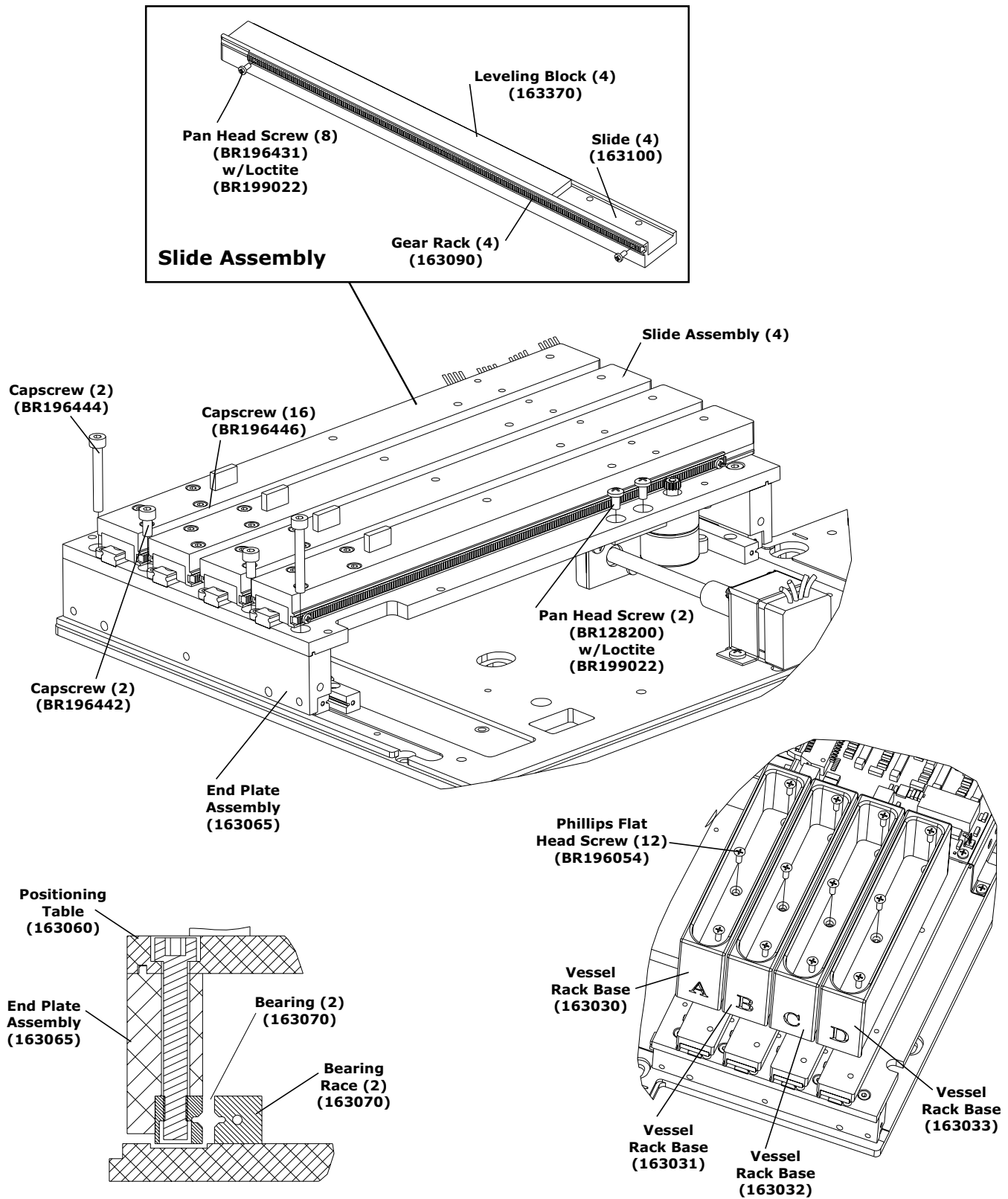
Caution: Needle protruding through bottom of assembly is very sharp.

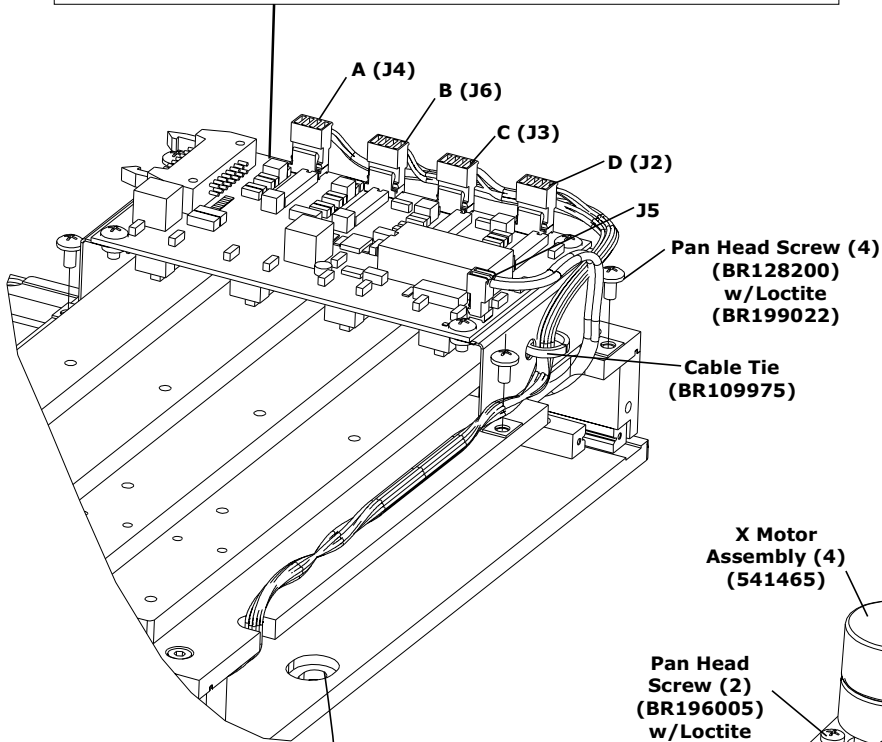
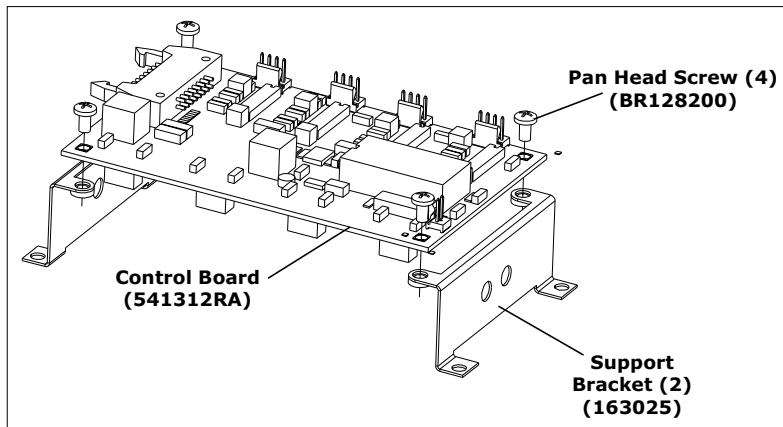




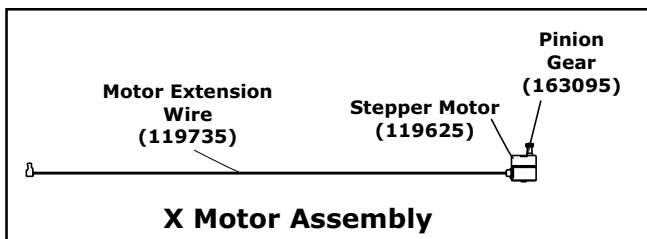
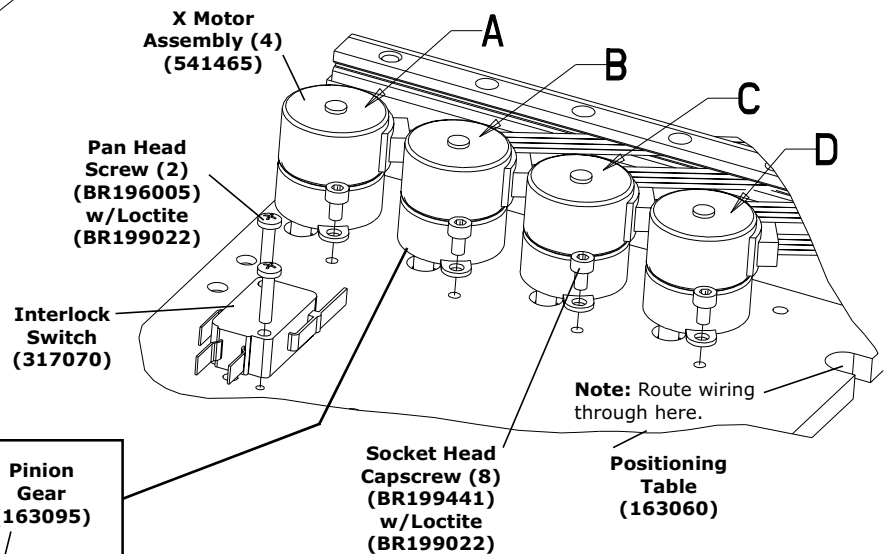


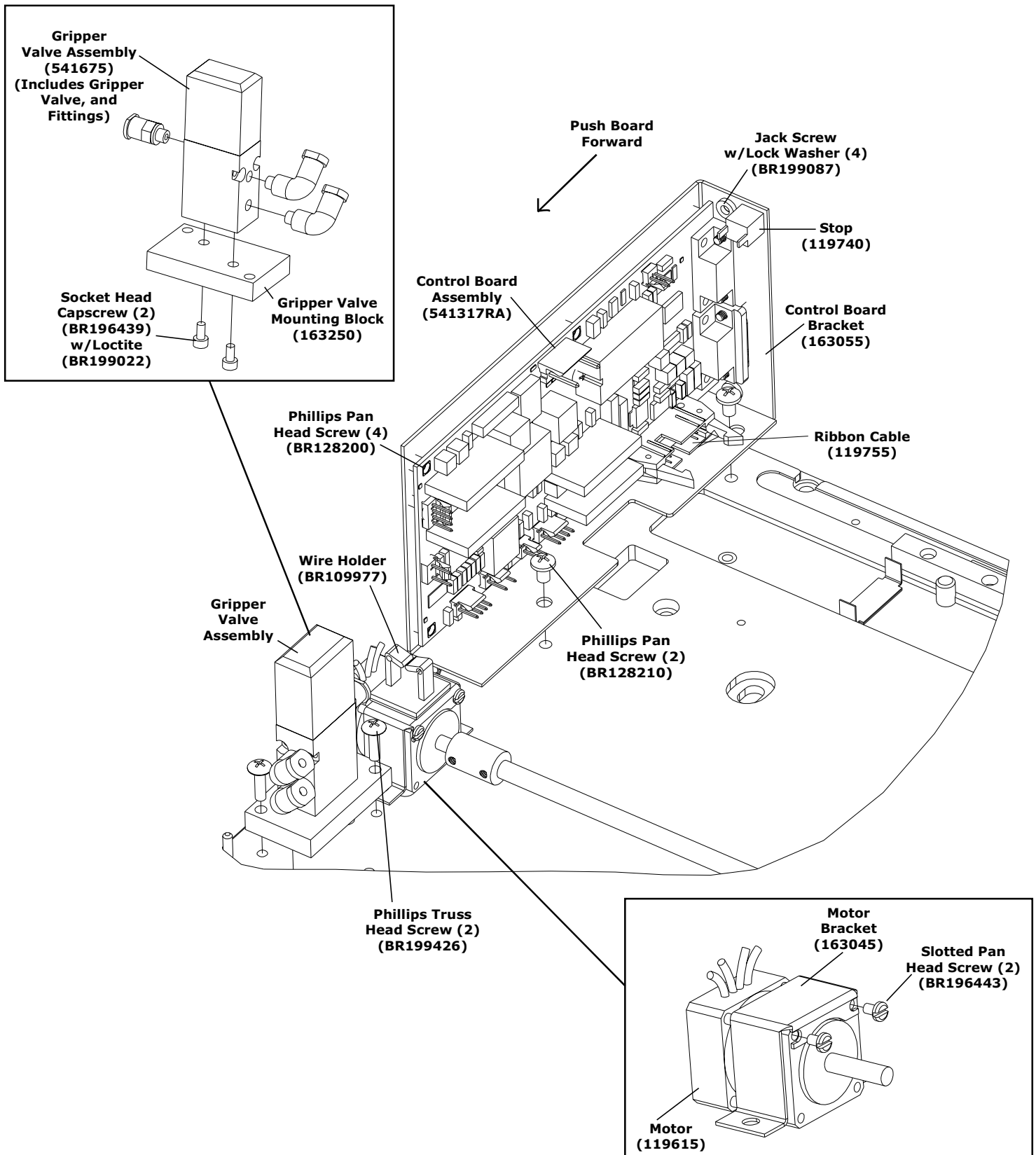


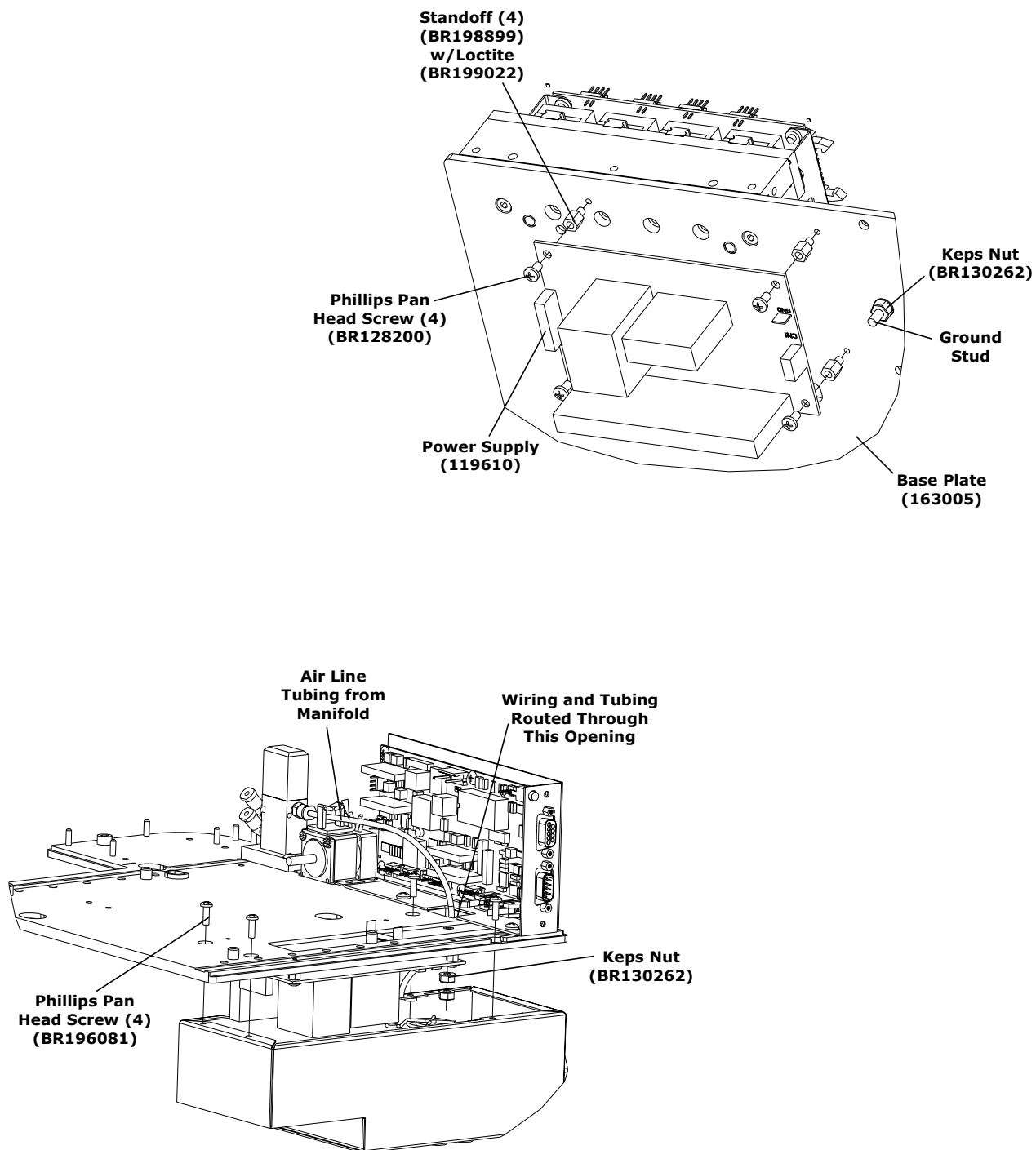


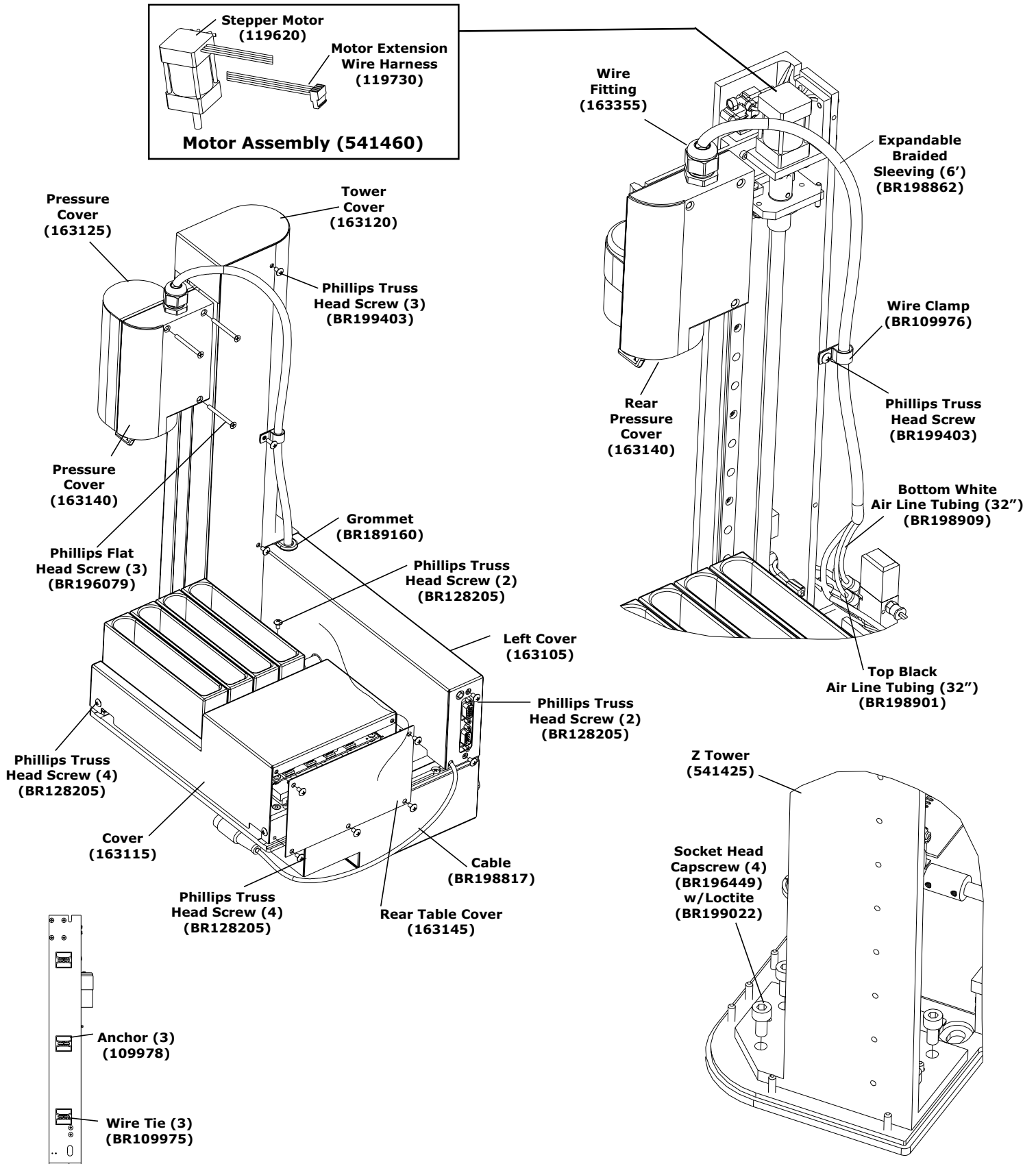


Note: Motor wires route through this channel.



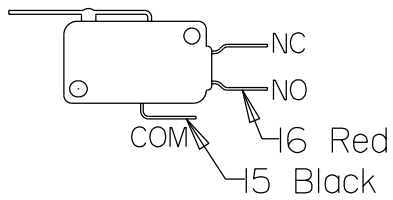




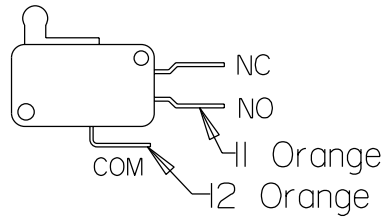


**Explorer Base Assembly
541415 (Sheet 8 of 10)**

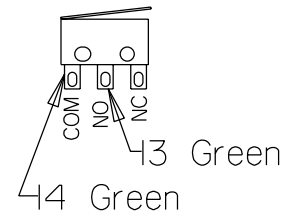
Positioning Table Switch



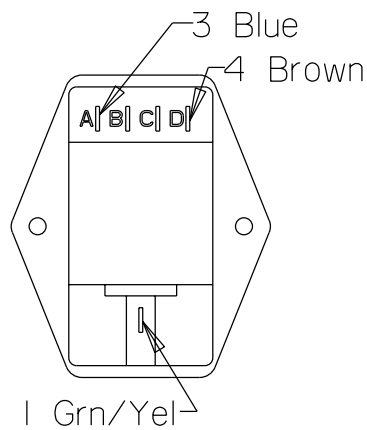
Top Z Tower Switch



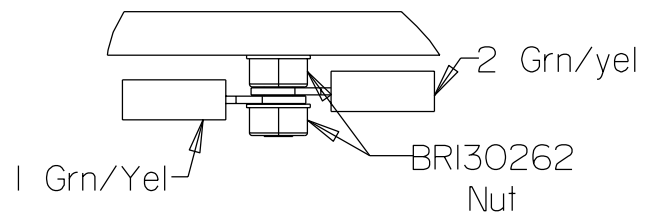
Bottom Z Tower Switch



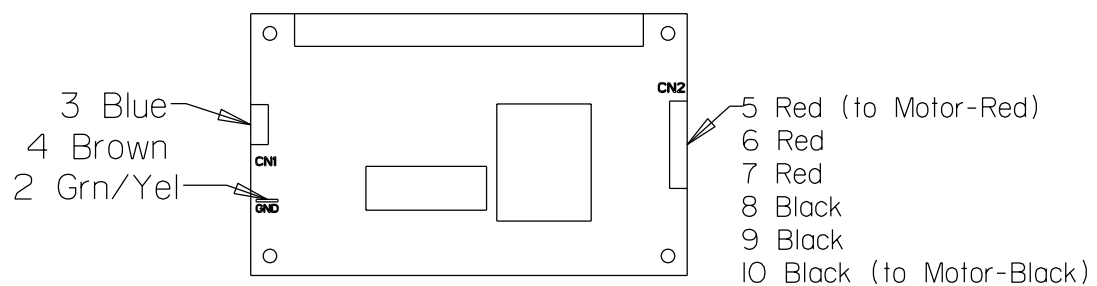
Power Entry Module

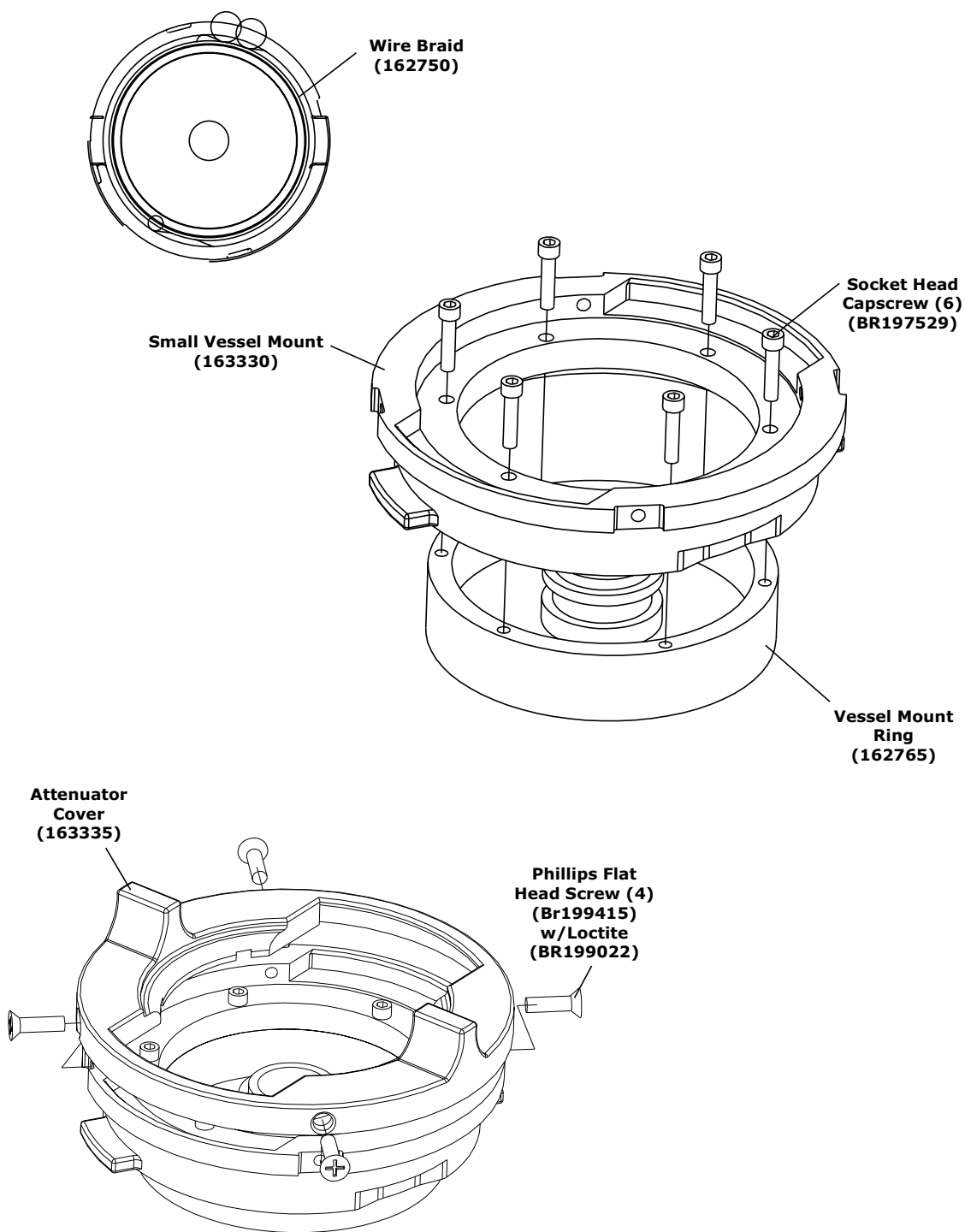


Base Ground Stud

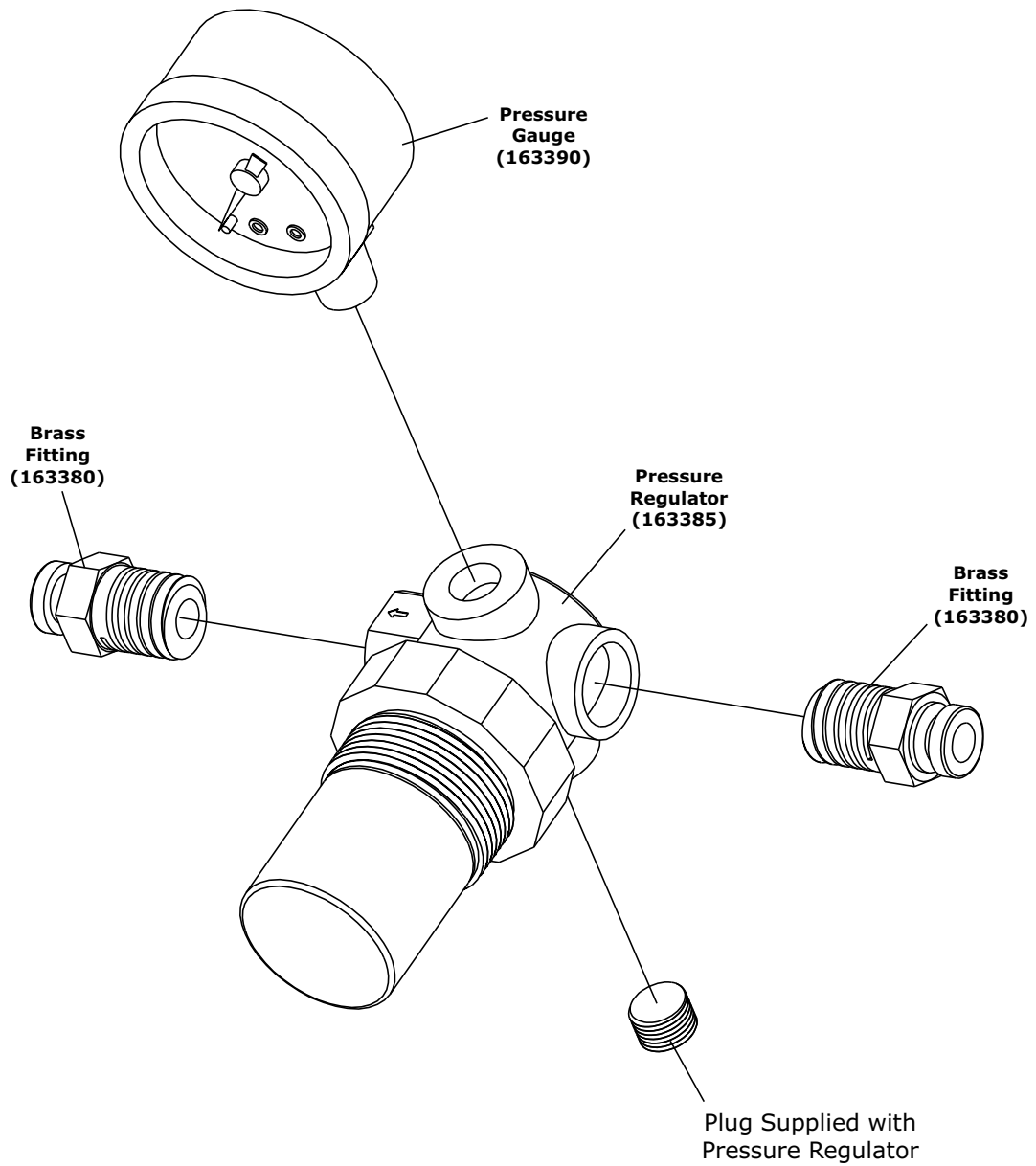


Power Supply

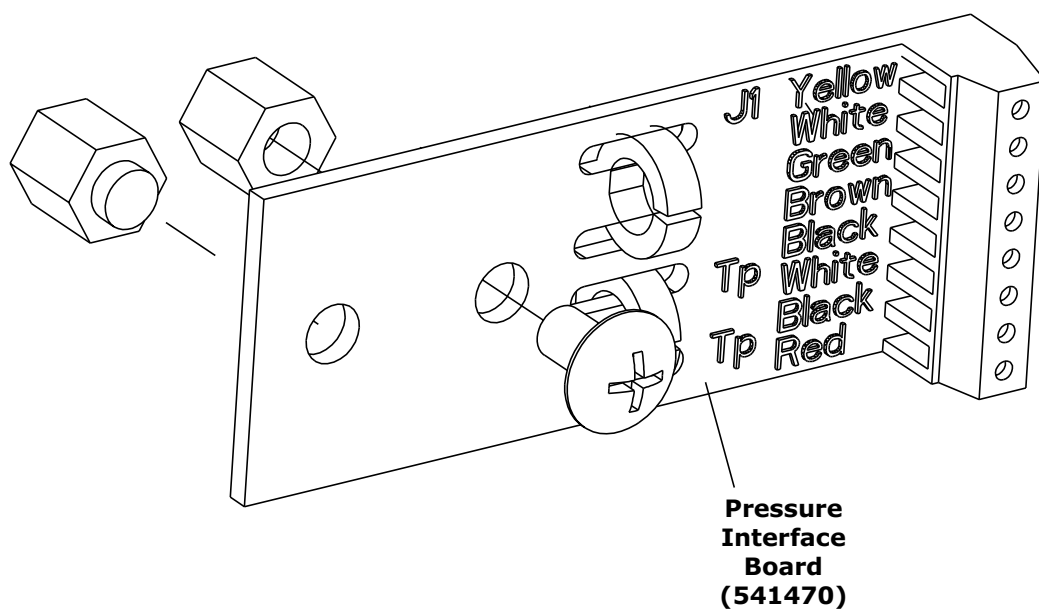


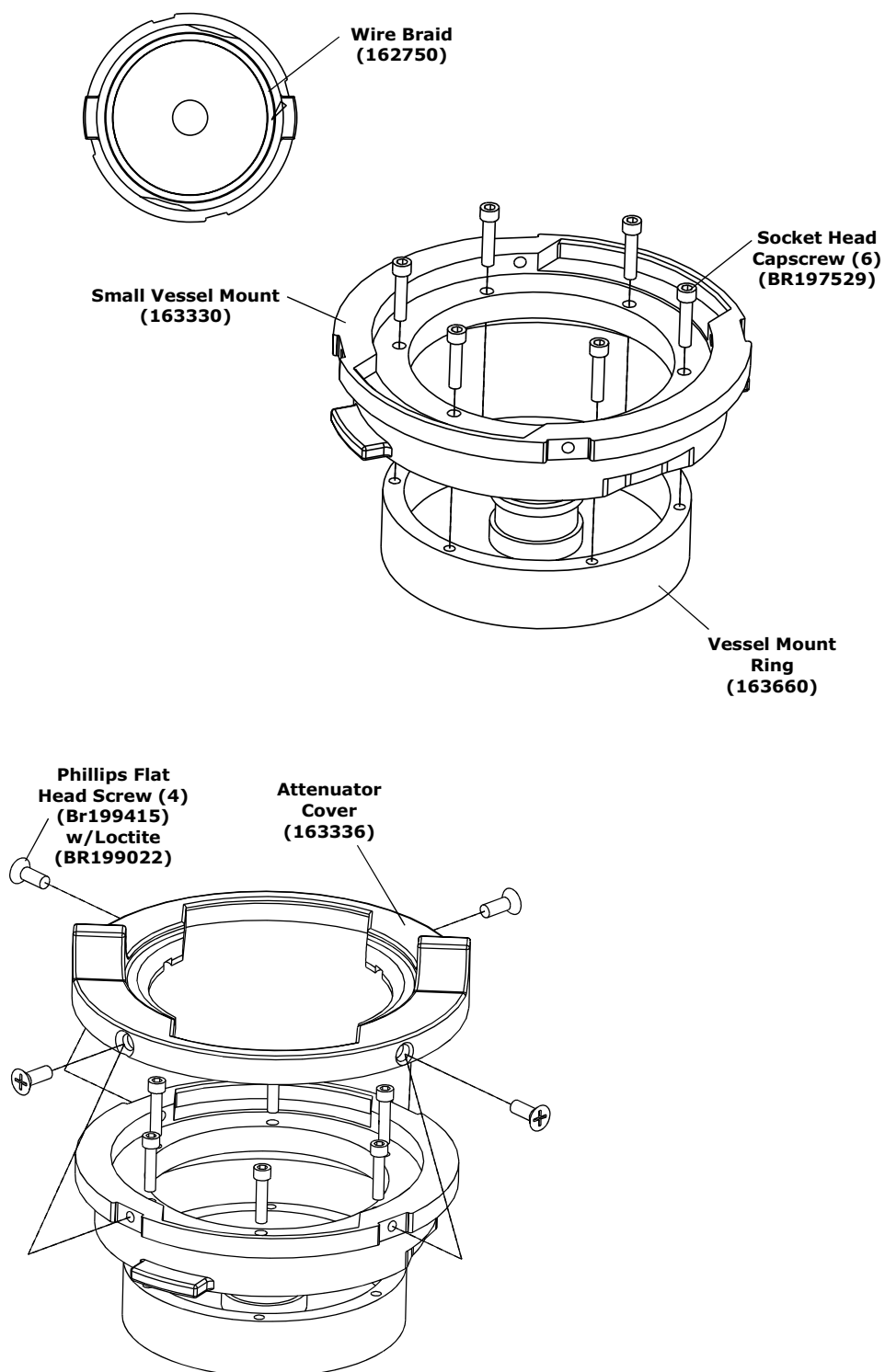


**Attenuator Assembly
(Discover and Explorer Direct Pressure System)
541450
(Implemented June 18, 2003)**

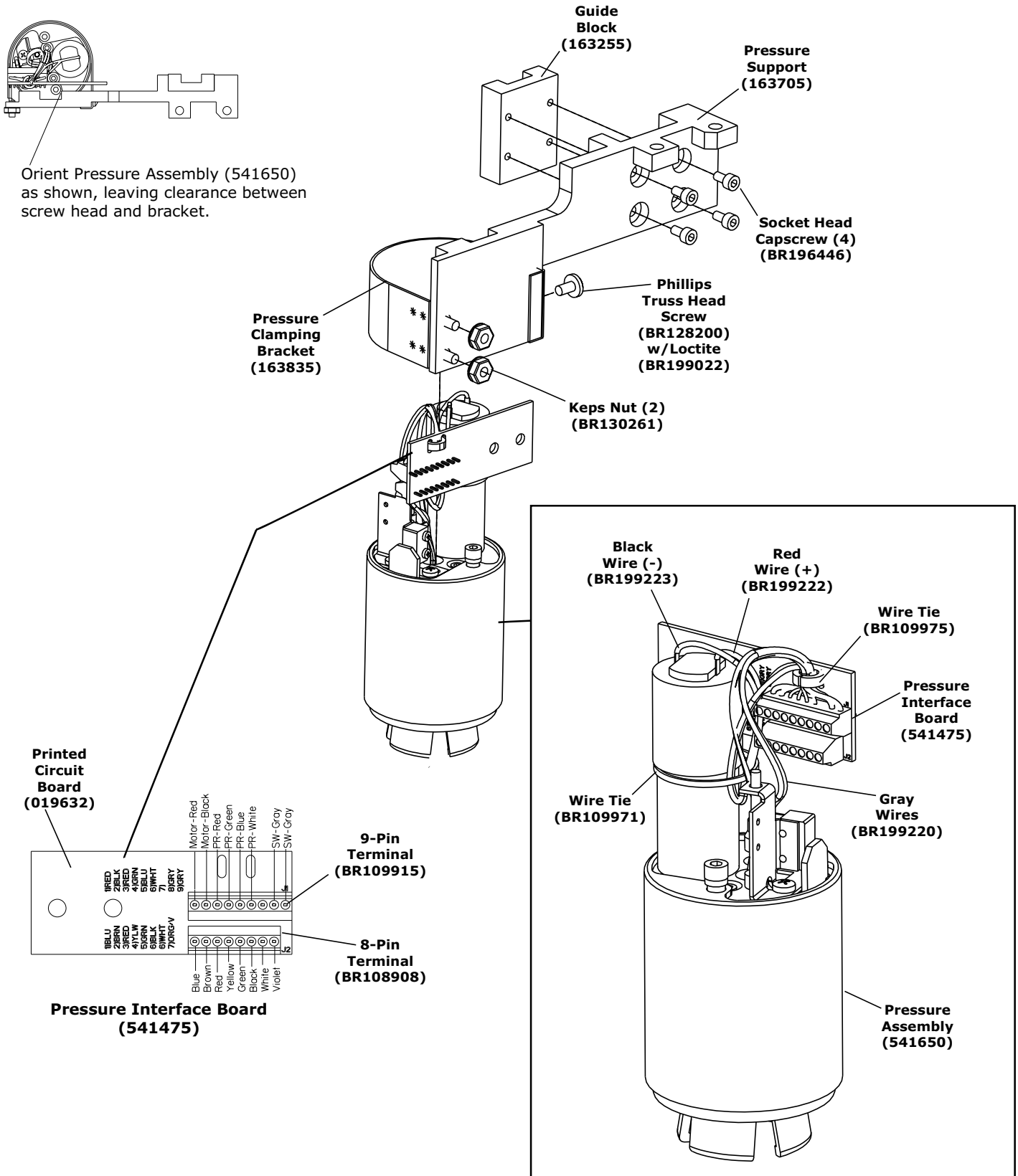


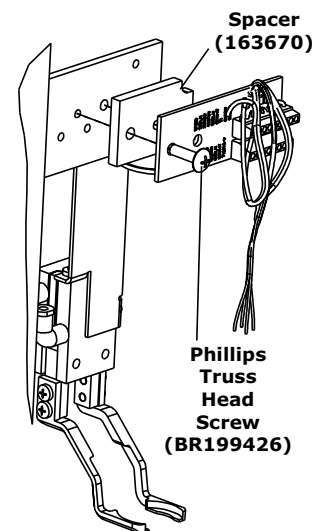
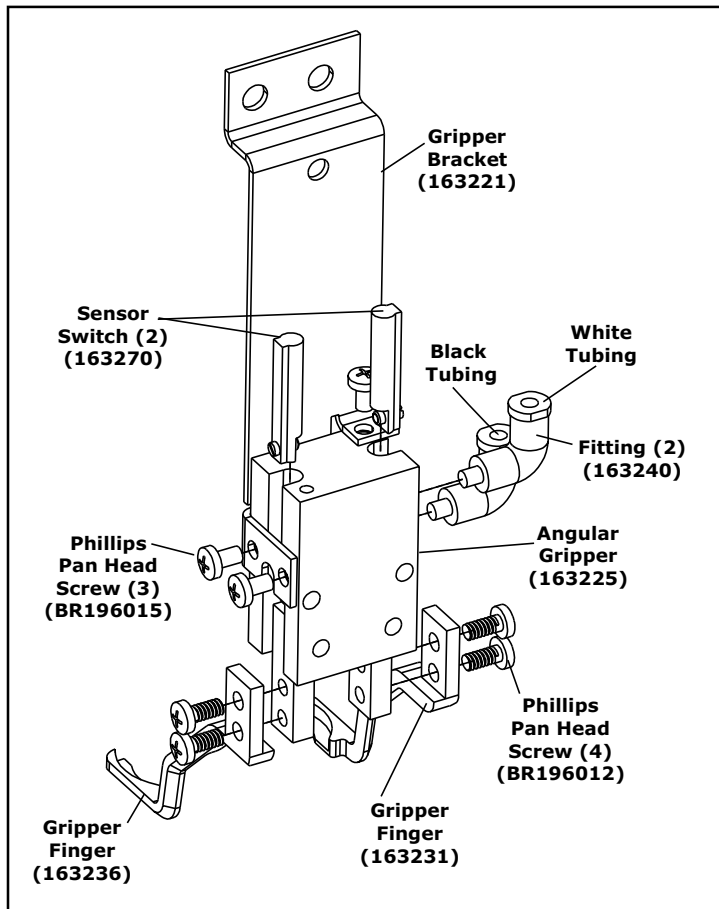
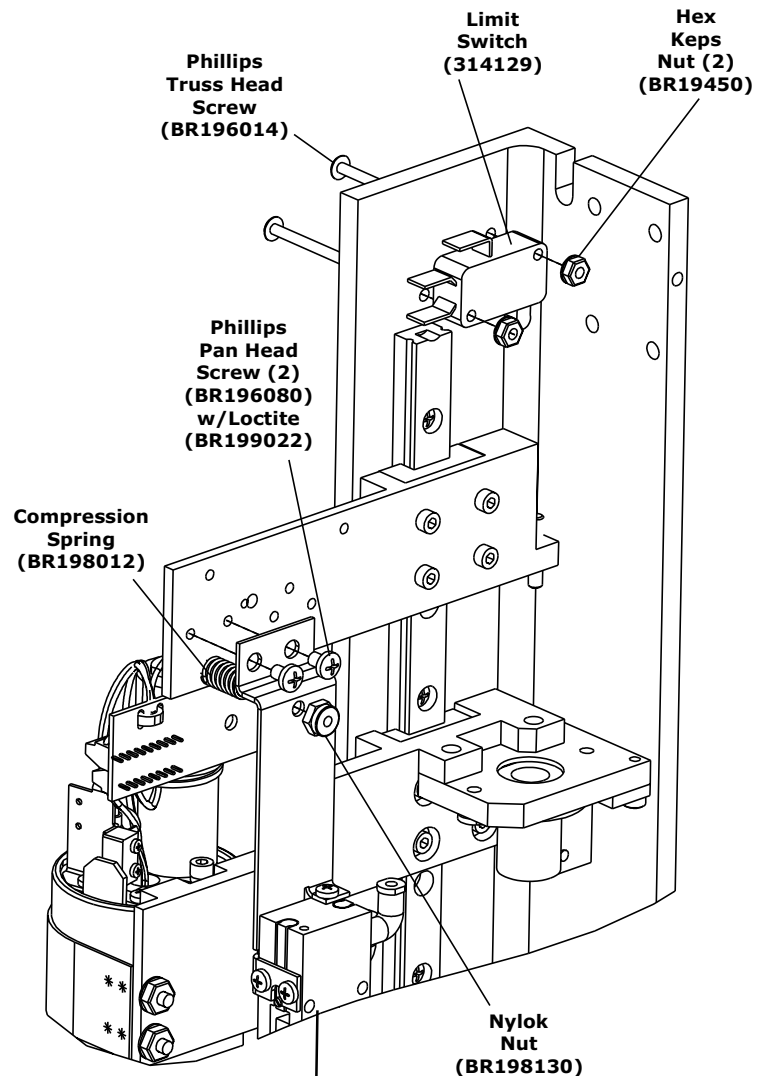
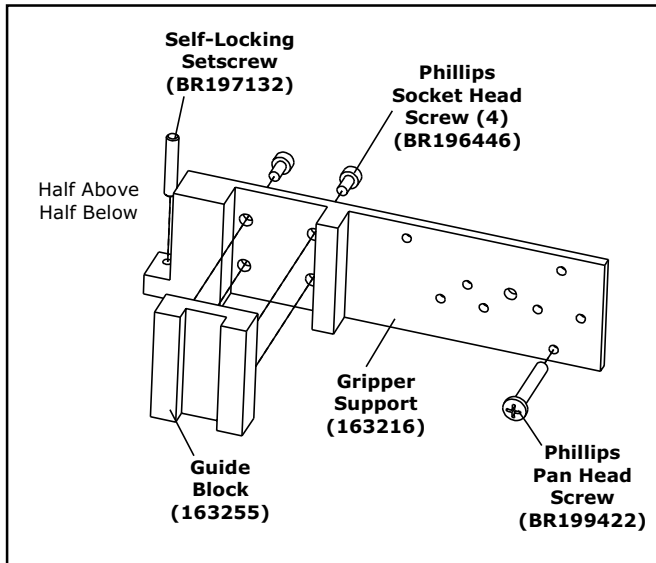
**Pressure Regulator Assembly
541455**

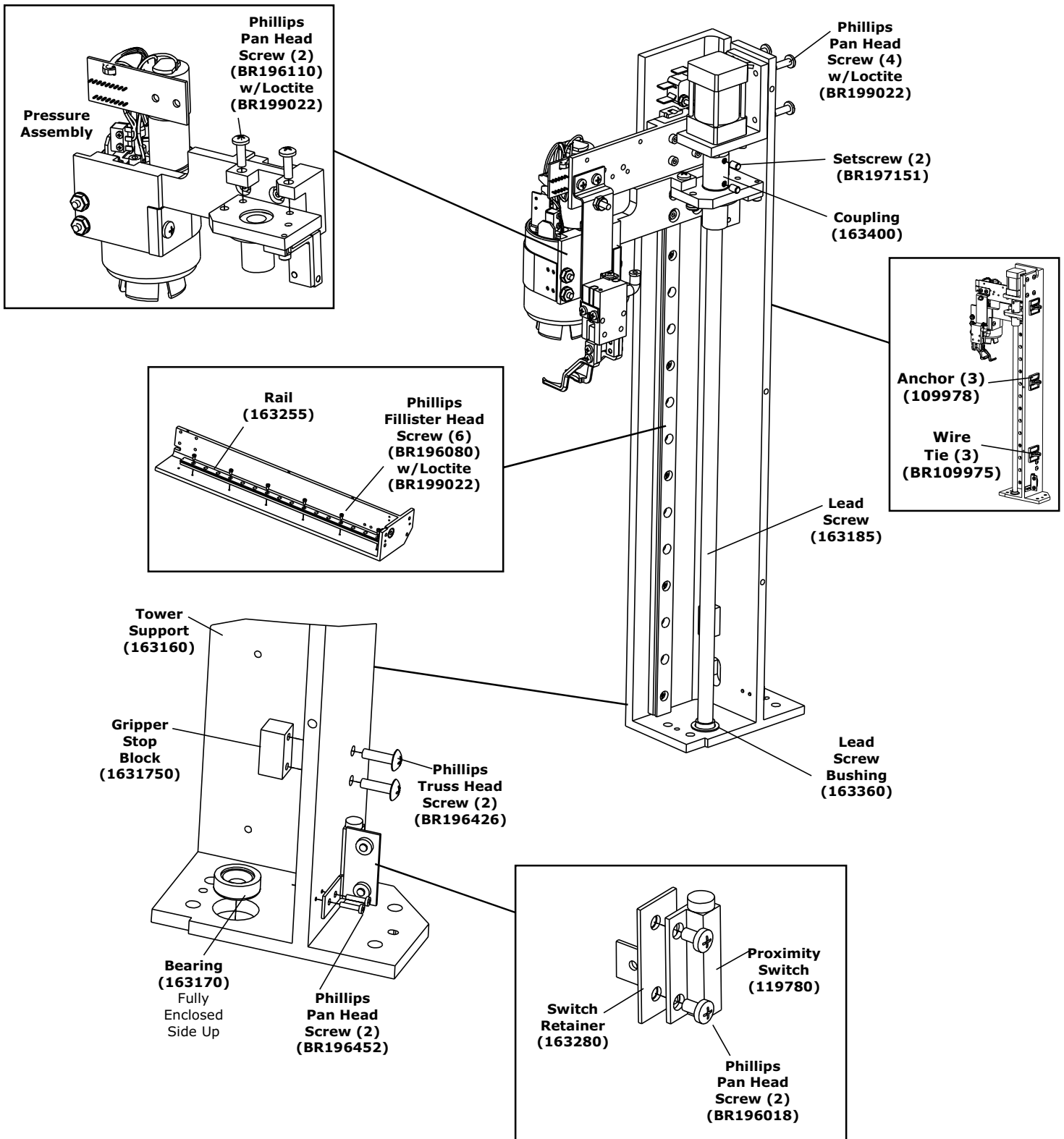


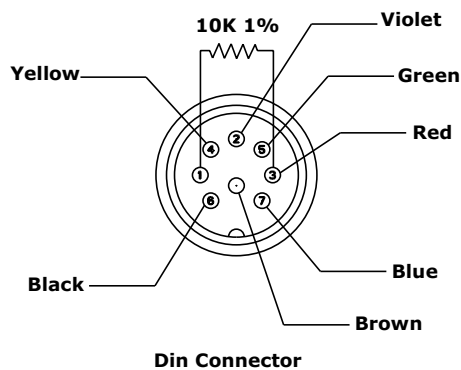
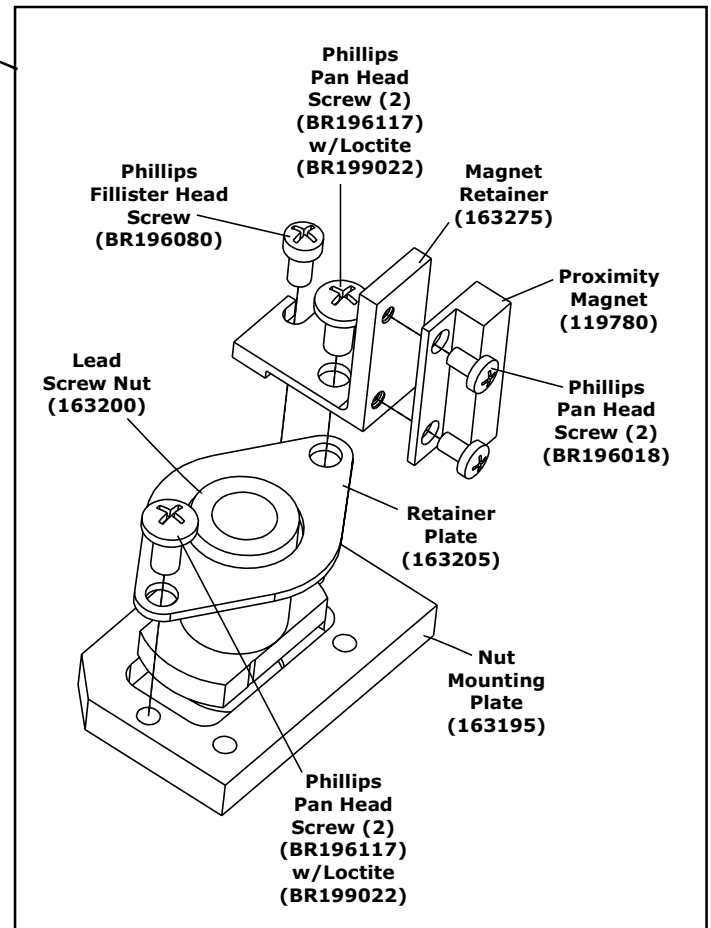
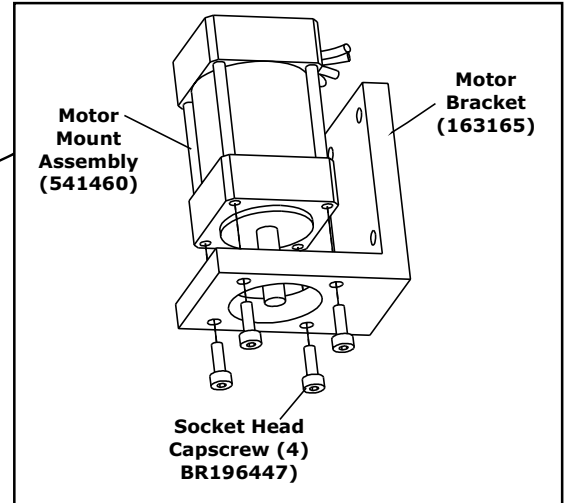
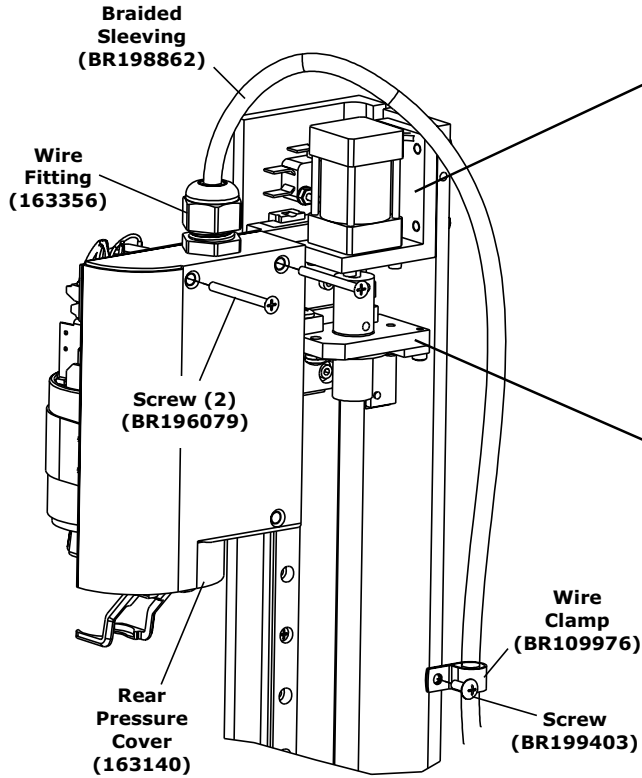


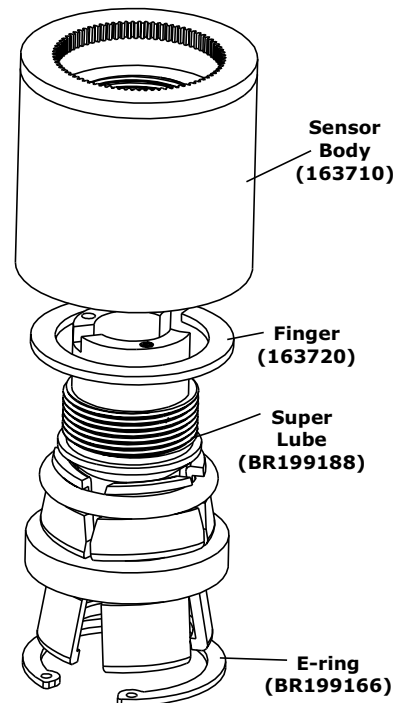
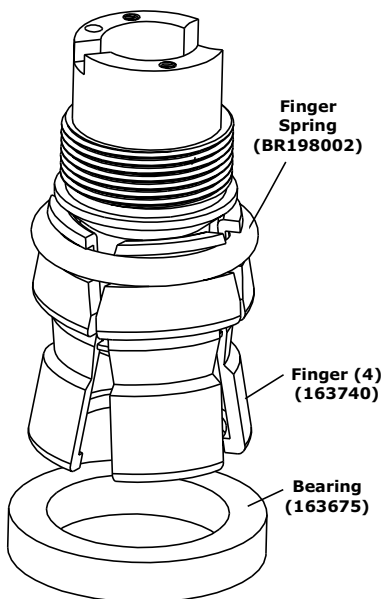
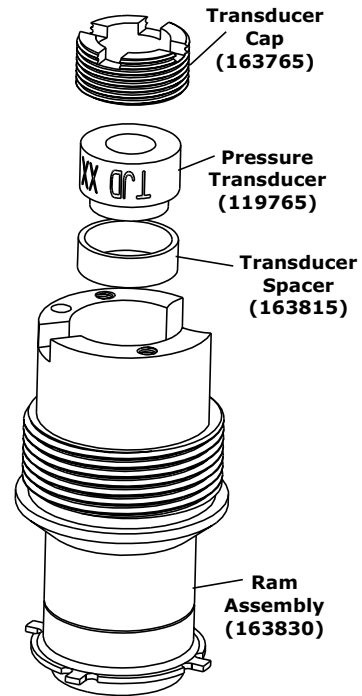
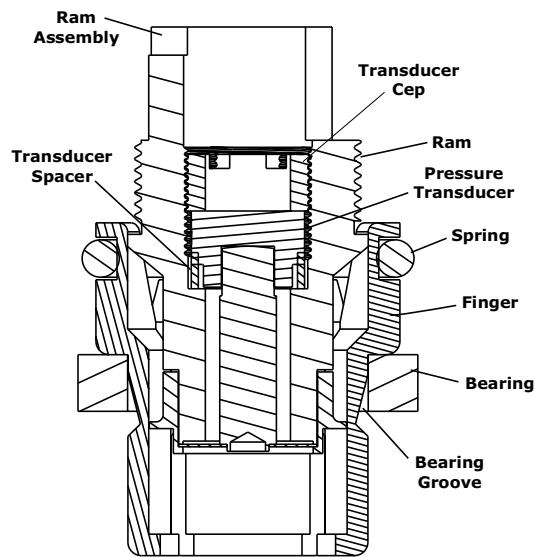
**Attenuator Assembly
(Explorer with IntelliVent Pressure System)
541605**

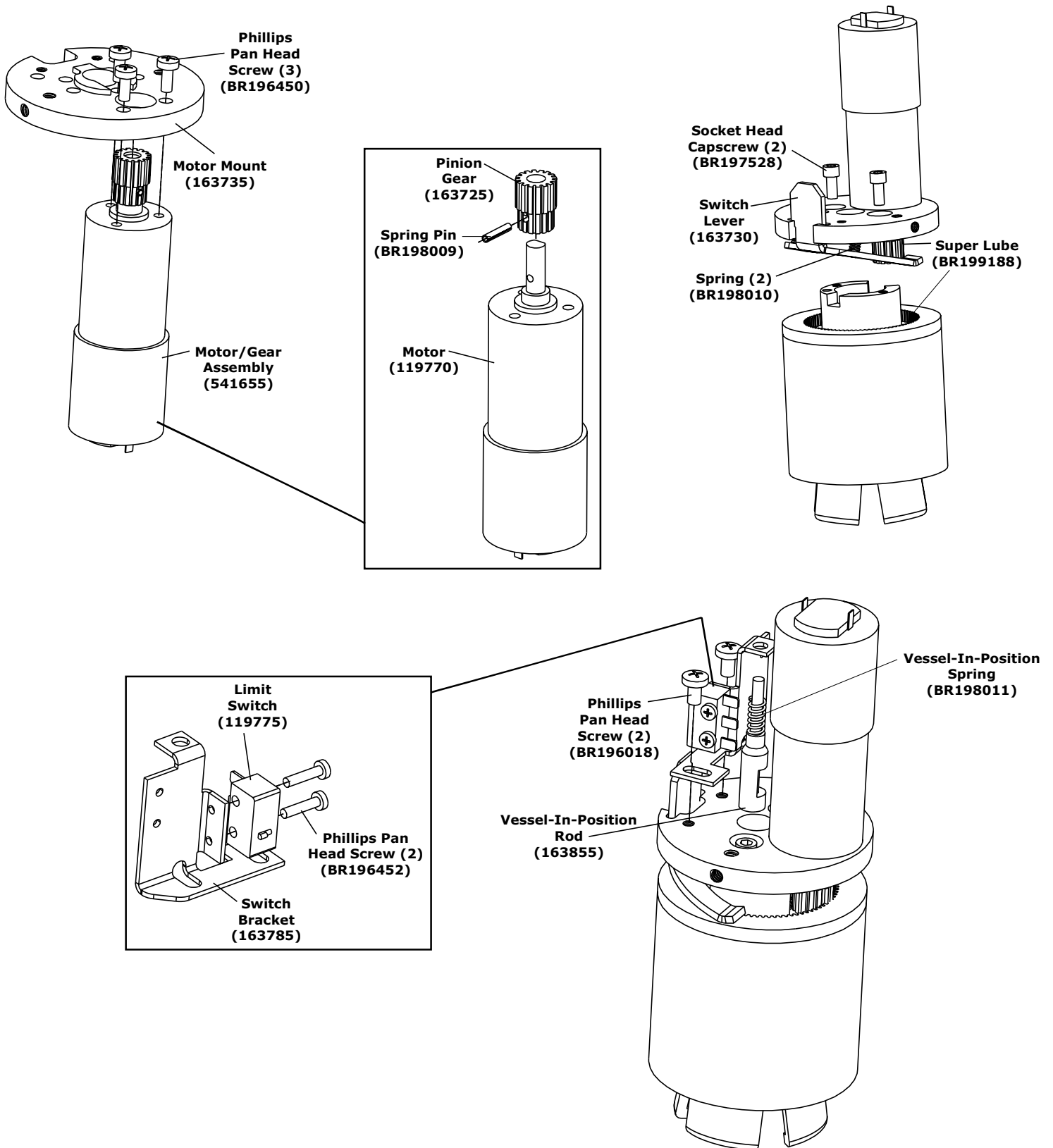


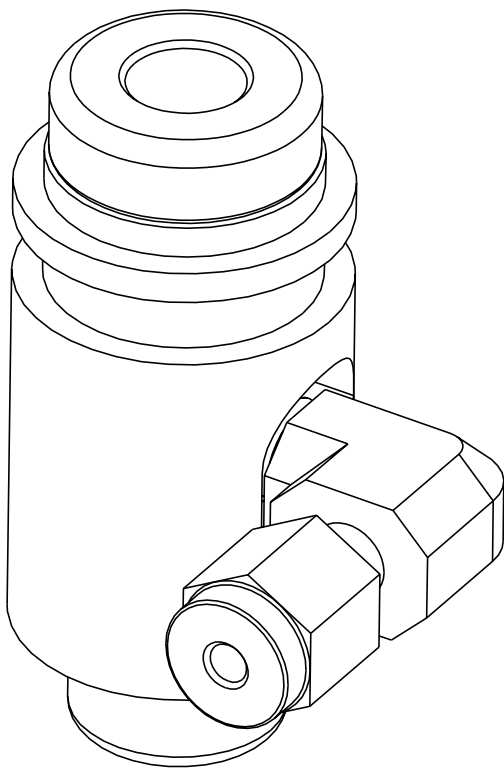




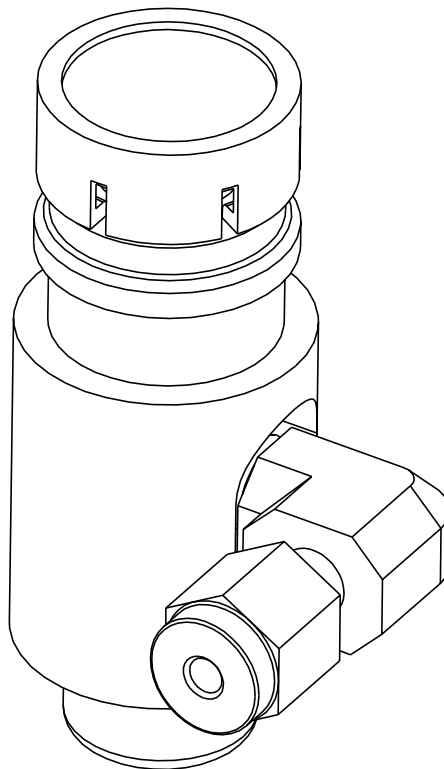








**Pressure Calibrator Assembly
for Direct Pressure Transducer
541355**



**Pressure Calibrator Assembly
for IntelliVent Pressure System
(541356)**

