ENGINEERING
TOMORROW

Service Manual

Danfoss Turbocor® **Variable Twin Turbo (VTT)** Series Compressors

VTT Series Compressors

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TURBOCOR®

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This section provides a brief introduction to the Service Manual including the Purpose, Organization, Document Conventions used, Safety Information, and the DTC Quality Policy.

1.1 Purpose

This Service Manual is intended to provide service procedures specific to the Danfoss Turbocor Variable Twin Turbo (VTT) compressors. It is not intended to teach basic fundamental safety, refrigeration, electrical or fitting skills. It is assumed persons using this manual will be appropriately certified and have detailed knowledge, experience, and skills in respect to working with high-pressure refrigerants and medium voltage electrical components to 1 Kilovolt (kV) high-power alternating current (AC) and direct current (DC).

Some potential safety situations may not be foreseen or covered in this manual. DTC expects personnel using this manual and working on Danfoss Turbocor compressors to be familiar with, and carry out, all safe work practices necessary to ensure safety for personnel and equipment.

The purpose of this manual is to provide:

- A general description of the compressor design
- A functional description of the various components of the compressor
- Information regarding procedures necessary to detect the source of a problem within the compressor
- The procedures for disassembling and assembling various components of the compressor
- Fault and calibration interpretations
- System troubleshooting suggestions
- Maintenance tasks that should be followed

This manual gives only general procedures for servicing and does not provide part numbers of single products or single components. If this information is required, please contact a recognized Danfoss Turbocor original equipment manufacturer (OEM) customer.

1.2 Organization

This manual is organized in the following manner:

- **Section 1: Introduction** – this section describes the purpose of the manual, its organization, conventions used in the manual, and a safety summary which describes the use of Danger, Caution, and Notes symbols
- **Section 2: Compressor Fundamentals** – this section identifies the parts of the compressor and provides fundamental knowledge of the role each component plays in the main fluid path, motor-cooling system, and in the energy and signal flow
- **Section 3: Compressor Components** – this section describes in depth component information, the steps necessary to obtain measurements that verify a component is functional and the steps necessary to replace a compressor component
- **Section 4: Variable Frequency Drive (VFD) Components** – this section describes in depth component information, the steps necessary to obtain measurements that verify a component is functional and the steps necessary to replace a VFD component
- **Section 5: OEM Module Components** – this section describes in depth information regarding the DC-DC Module and the Compressor Interface Module (CIM), the steps necessary to obtain measurements that verify those components are functional and the steps necessary to replace those components
- **Appendix A: Acronyms/Terms** – this section provides definitions of terms and acronyms used in this manual
- **Appendix B: Special Tooling Specifications** – this section provides drawings for special tools that are required in order to disassemble/assemble internal VTT components

The following conventions are used in this manual:

- Procedures – all user procedures are listed in numerical steps, unless it is a one-step procedure. A one-step procedure is shown as a bullet.
- User Action Required (software) – if a user is required to take action in a software procedure, the action will be shown in bold. Example; When the Login window opens, type in **your name and password**.
- Monitoring Program Window Names – all window names will be in italic. Example *Compressor Controller window*.
- Internal References – references to sections within this manual are encapsulated in quotes. Example, Isolate VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
- External References – references to items not within this manual are underlined. Example; Refer to the Installation and Operation Manual for installation procedures.

1.3 Commitment to Quality

DTC is committed to quality service and customer satisfaction as outlined by our Quality Policy: *Danfoss Turbocor is dedicated to satisfying our customers by providing "Best in Class" in terms of quality, value, and on-time delivery while striving for continuous improvement.*

1.4 Safety Summary

Safety precautions must be observed during installation, start-up, and service of the compressor due to the presence of pressure and voltage hazards. Only qualified and trained personnel should install, start up, and service Danfoss Turbocor compressors. Safety information is located throughout the manual to alert service personnel of potential hazards and is identified by the headings **DANGER** and **CAUTION**.

1.4.1 Danger Notification

A **DANGER** notification signifies an essential operation or maintenance procedure, practice, or condition which, if not strictly observed, could result in injury to or death of personnel or long-term health hazards. A Danger notification is displayed in the format shown in Figure 1 (Danger Notification Example).

Figure 1 - Danger Notification Example

• • • DANGER • • •

1.4.2 Caution Notification

A **CAUTION** notification signifies an essential operation or maintenance procedure, practice, or condition which, if not strictly observed, could result in damage to or destruction of equipment or potential problems in the outcome of the procedure being performed. A Caution notification is displayed in the format shown in Figure 2 (Caution Notification Example).

Figure 2 - Caution Notification Example

⚠ • • • CAUTION • • •

1.4.3 Note

A **NOTE** provides additional information such as a tip, comment, or other useful, but not imperative information. A Note is displayed in the format shown in Figure 3 (Note Example).

Figure 3 - Note Example

NOTE

1.5 Precautions

Consideration for personal safety and equipment safety is very important. The following sections cover safety precautions and methods that must be followed when servicing the compressor.

1.6 Refrigerant Type

VTT series compressors are totally oil-free and optimized for use with refrigerant HFC-134a.

1.7 Electrical Isolation of the VFD

Before servicing either the Compressor or VFD, isolate the VFD power by completing the following steps:

• • • DANGER • • •

- This equipment contains hazardous voltages that can cause serious injury or death. Only qualified and trained personnel should work on DTC equipment.
- Always wear appropriately-rated safety equipment when working around equipment and/or components energized with high voltage.
- Removing the Motor Power Cover will expose the technician to a high voltage hazard of up to 632 VAC. Ensure the Mains Input power is turned off and locked out before removing the Motor Power Cover.

1. Turn off the Mains Input power to the VFD.
2. Lock Out/Tag Out (LOTO) the mains disconnect to ensure no accidental or unauthorized re-application of the Mains Input power can occur.

• • • DANGER • • •

Do not touch any components when removing the either Motor Power Cover or the VFD Cover.

3. Remove the Compressor Motor Power Cover only and the VFD cover.
4. Using an appropriately rated voltage meter, confirm that the AC voltage is isolated.
5. Wait at least 20 minutes for the DC bus capacitors to discharge.
6. Open the VFD door taking particular care not to touch ANY components inside the VFD.
7. Using an appropriately rated voltage meter, check the DC bus at the terminals marked #81 and #82 that feed the DC-DC for DC voltage level. If the voltage is above 5 volts direct current (VDC), wait five (5) minutes and recheck until voltage is below 5 VDC.

1.8 Handling Electronic Static Sensitive Devices

Figure 4 - Danger Notification Example

Active electronic components are susceptible to damage when exposed to static electrical charges. Damage to such components may lead to outright failure or reduction in service life. Since the presence of static charges is not always evident, it is essential that service personnel follow static

control procedures at all times when handling sensitive electronic components.

This section outlines static control precautions that must be followed when providing service support in the field. Service support personnel should create a safe, static-free environment.

Service personnel must use a commercially available service kit for handling static-sensitive devices. The kit typically includes:

- Ground cord assembly
- Alligator clip
- Grounding wrist strap
- Wrist strap tester

If a safe, static control environment cannot be created for a specific reason, the operator will ensure that electrostatic discharge (ESD) items and personnel are at the same electrical potential as the equipment.

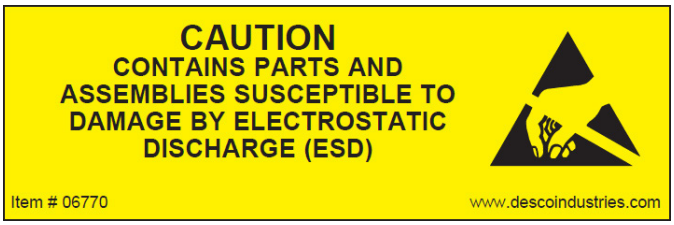
The electronic modules should only be removed from the ESD protective bag at the last moment, just before installation when the operator is ready to do the replacement.

The operator should avoid touching any components or connectors on the module and should hold the module by its edge or enclosure, as applicable.

1.8.1 ESD Protection/ Grounding

All parts that are susceptible to damage by ESD will be marked using the following label. See Figure 5 (ESD Label). Please follow the instructions below to ensure safety and to protect the parts from ESD damage.

Figure 5 - ESD Label



1.9 Testing Voltages of the Power Electronics

When testing the voltages of the Compressor's power electronics without mains supply available, a 24 VDC power supply must be used. It is essential that the power supply not be left connected to the Compressor during normal operation. When checks are complete, disconnect and remove the power supply.

1.10 VTT/VFD Fasteners

All factory installed fasteners are metric.

1.11 VTT O-rings

Various O-rings are utilized throughout the VTT Compressor to contain the refrigerant. Prior the removal of any component utilizing an O-ring, the refrigerant must be properly recovered per industry-standard procedures. Upon O-ring replacement, a leak test should be performed. The following O-ring-specific steps are required when replacing any VTT O-ring:

1. Remove each O-ring to be installed from its package and inspect for defects such as blemishes, abrasions, cuts, or punctures.
2. Slight stretching of the O-ring when it is rolled inside out will help to reveal some defects not otherwise visible.
3. After inspection and prior to installation, lubricate the O-ring with a light coat of Super-O-Lube.
4. Avoid rolling or twisting the O-ring when maneuvering it into place.
5. Keep the position of the O-ring mold line constant.

NOTE

It is strongly suggested that anytime an O-ring is removed, that a new O-ring is used in its place.

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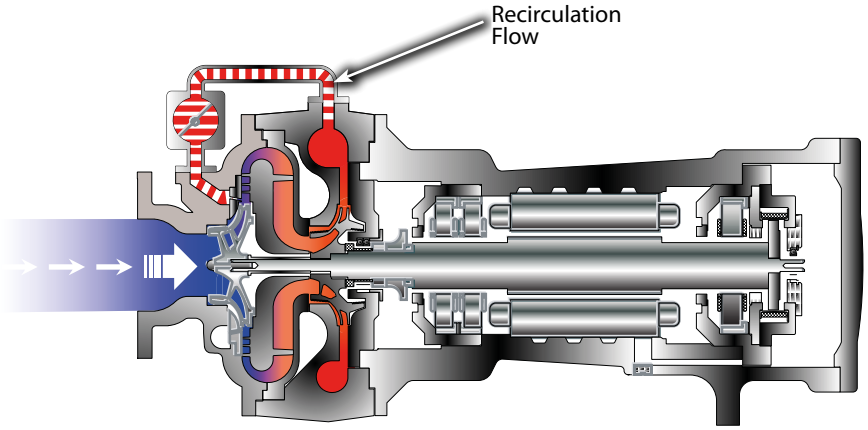
Compressor operation begins with a demand signal applied to the Compressor through the CIM. The startup sequence is configurable in the startup settings. Refer to the OEM Programming Guide for further details.

2.1 Main Fluid Path

The VTT Compressor is a two-stage centrifugal type compressor utilizing patent-pending IntraFlow™ technology. This new technology eliminates the need for Inlet Guide Vanes or variable geometry diffusers.

Using on-board sensors, the Compressor Control Module (CCM) can predict where the Compressor is operating within the aero map with respect to surge power, thus commanding the IntraFlow™ Valve (IFV) to open or close to avoid surge. Refer to Figure 6 (IFV Flow) for an illustration of the recirculation flow.

Figure 6 - IFV Flow



2.2 Economizer

The VTT Compressors are designed with an economizer input option. The following are two (2) types of economizer arrangements that can be used:

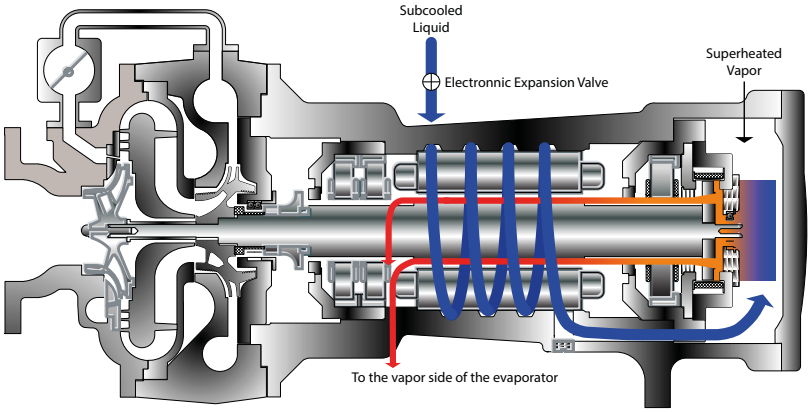
- Sub-cooler (closed)
- Flash tank (open)

For further details, refer to the VTT Applications Manual.

2.3 Compressor Cooling

Refer to Figure 7 (Motor Cooling Path) for the illustration of the internal cooling path.

Figure 7 - Motor Cooling Path



2.4 Compressor and VFD Cooling

Liquid refrigerant, having at least 2°C (Kelvin)/ 3.6°F (Rankine) sub-cooling at connection point, must be piped to both the Compressor cooling inlet connection and the VFD cooling inlet connection. Refer to the VTT Applications Manual for cooling connections sizes.

To cool the motor, sub-cooled liquid refrigerant enters the Compressor through the EXV and passes through a groove surrounding the motor Stator. At the groove outlet, the superheated refrigerant gas is channeled back to the exit port via the motor cavity, thereby cooling the Rotor.

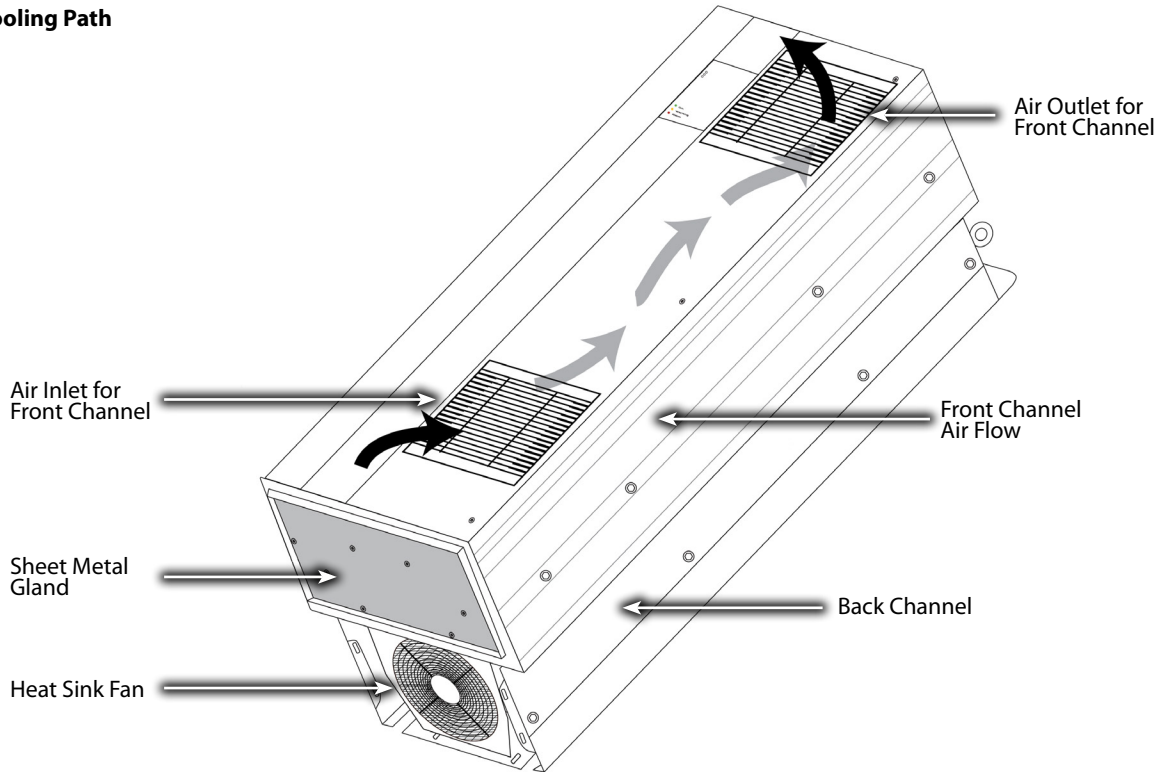
The superheat level of the gas entering the motor cavity is measured using a temperature sensor inside the end cap and the saturated temperature of the suction gas is measured at the suction inlet of the Compressor. The expansion valve at the motor cooling inlet modulates to maintain a pre-determined superheat level based off of this reading.

2.5 VFD Cooling

The VFD is cooled through a combination of air flow and refrigerant cooling of the back plate. Under most operating conditions, all heat is removed by air flow through the VFD heat sinks. Monitoring the insulated-gate bipolar transistor (IGBT) temperatures indicate peak power requirements which activates additional refrigerant cooling when required.

The VFD module is equipped with cooling fans to provide airflow along the heat sink. Units have a fan mounted in the enclosure door to provide additional airflow to the unit. Each fan has tachometer feedback to the VFD Control Card to confirm that the fan is operating correctly. On/off and speed control of the fans is provided to reduce overall acoustical noise and extend the life of the fans. The fans are activated as needed by VFD module control logic. Figure 8 (VFD Cooling Path) illustrates the air flow through the VFD.

Figure 8 - VFD Cooling Path



2.6 Compressor Energy and Signal Flow

During normal operation, 3-phase power is required to be connected to the VFD at all times, even if it is not running. Power is distributed through the following components to maintain compressor operation:

- CCM Board
- PWM Board
- Stator
- CIM
- DC-DC Module

The order of power flow through the VFD components is as follows:

1. A 3-phase voltage source is provided to the VFD through the mains input terminal.
2. AC voltage enters the silicon rectifier diodes (SCRs).
3. The Soft Start Board limits the in-rush current at power-up by controlling the SCR gates.
4. DC bus voltage from the SCRs charges the capacitors.
5. The DC bus provides DC voltage to Inverter.
6. The Inverter converts the DC bus voltage into a variable frequency, 3-phase simulated AC voltage to the Stator.
7. The VFD provides 462-683 VDC to the DC-DC Module.
8. The DC-DC Module provides 24 VDC to the CCM and 250 VDC to the Pulse Width Modulation (PWM) Board.
9. The CCM provides 24 VDC to the CIM.

Refer to Figures 9 (System Architecture and Control Interface (Revisions A and B)) and 10 (System Architecture and Control Interface (Revisions C and Later)) for a block diagram summary of the energy and voltage signal flow through the Compressor.

Figure 9 - System Architecture and Control Interface (Revisions A and B)

Revisions A and B

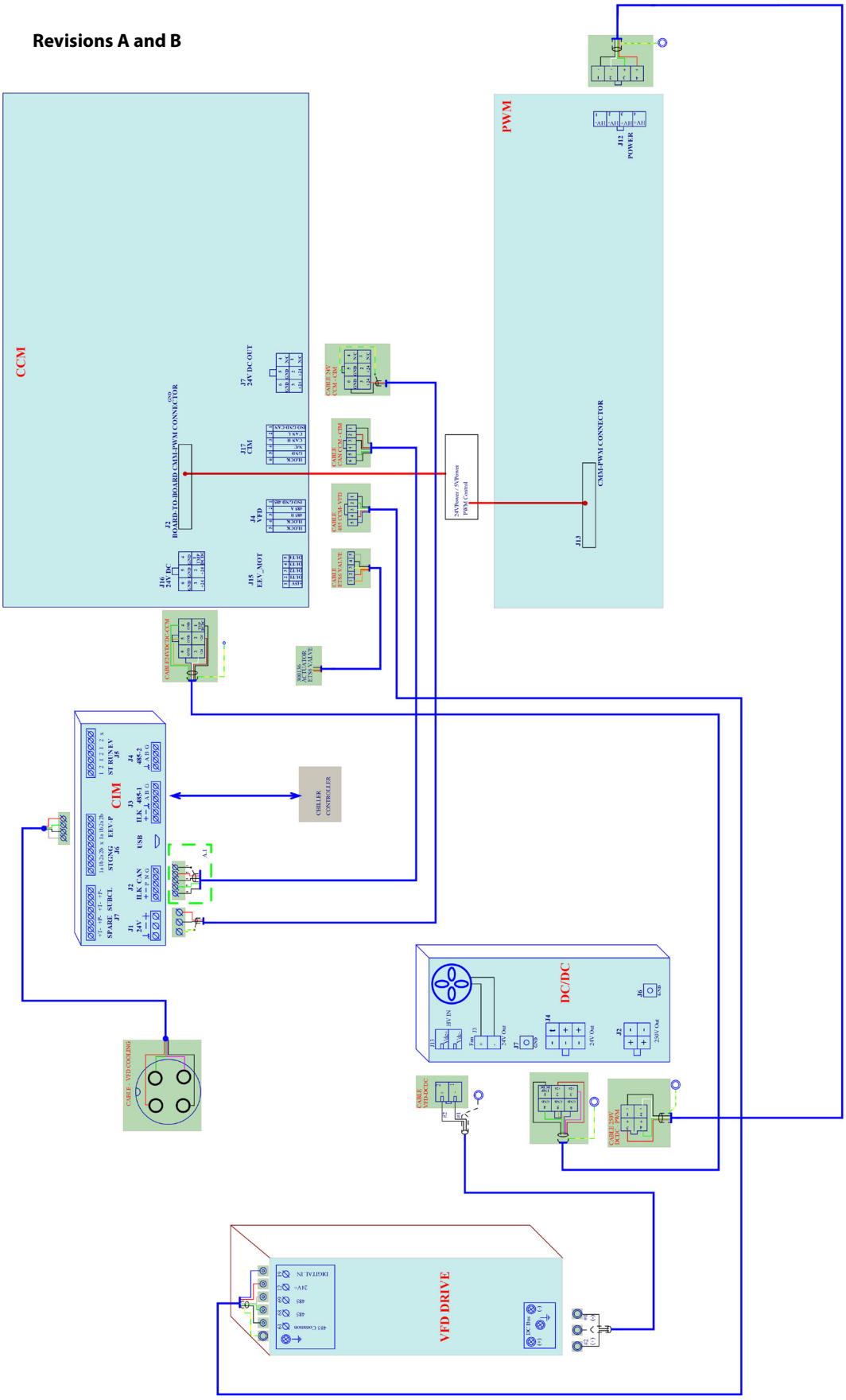
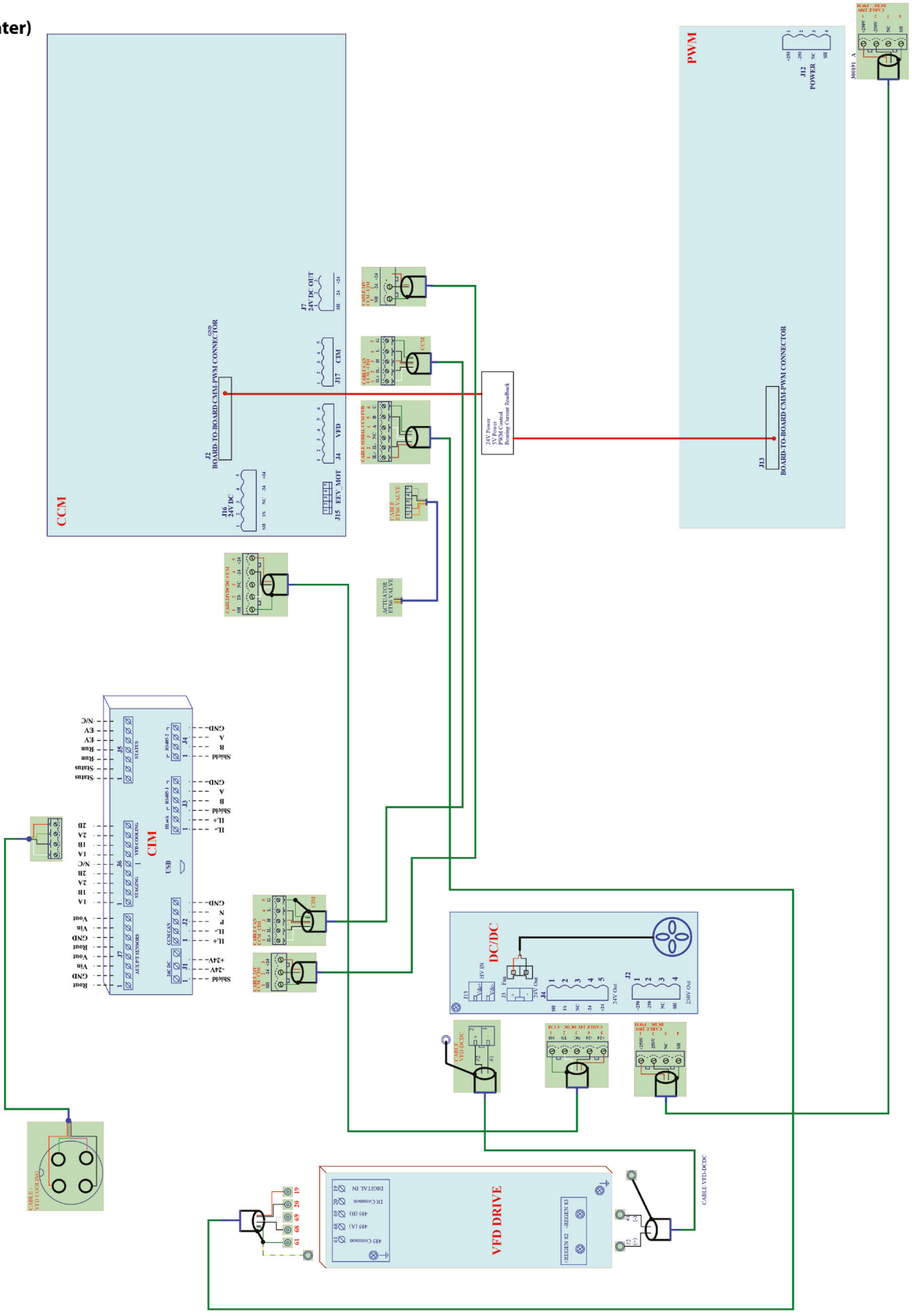


Figure 10 - System Architecture and Control Interface (Revisions C and Later)

Revisions C and Later



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This section provides Compressor component locations and functional descriptions, verification and troubleshooting methods, cable connection identification, and steps necessary to replace a component.

At the time of this publication, there have been three (3) major revisions of the VTT Compressor. Throughout this section, the various component differences are identified if applicable. The most recent revision of this Compressor, Major Revision "C," allows for the use of some customer-supplied cabling for the electronics. For details on the required cable type and maximum length, refer to the VTT Applications Manual.

3.1 Component Identification

This section identifies the major parts of the Compressor.

Figure 11 - Compressor External Component Identification – Service Side

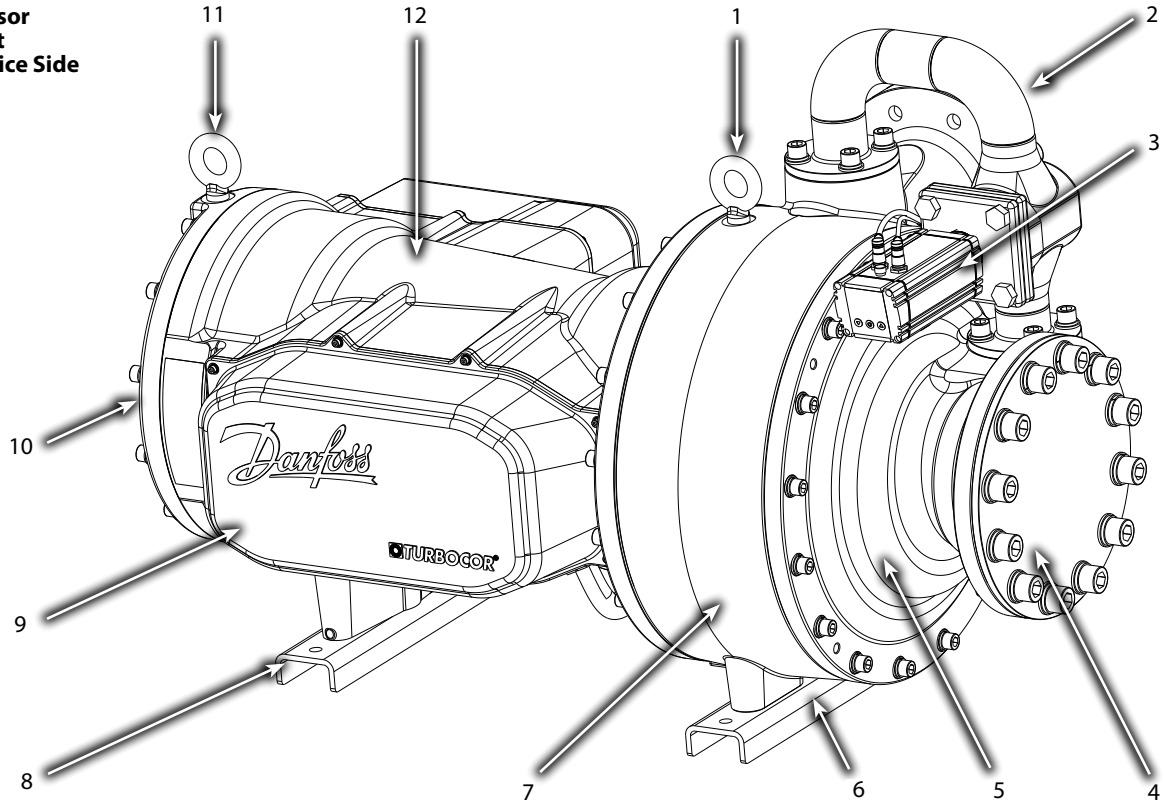


Table 1 - Compressor Component Identification (Service Side)

No.	Component	No.	Component
1	Lift Anchor (Front)	7	Volute (Second Stage Fluid Assembly)
2	IFV Pipe Assembly	8	Rear Support Base
3	IFV Actuator ICAD 1200A	9	Service Side Cover
4	Suction Flange	10	End Cap
5	Suction Housing	11	Lift Anchor (Rear)
6	Front Support Base	12	Motor Housing

Figure 12 - Compressor External Component Identification – Power Side

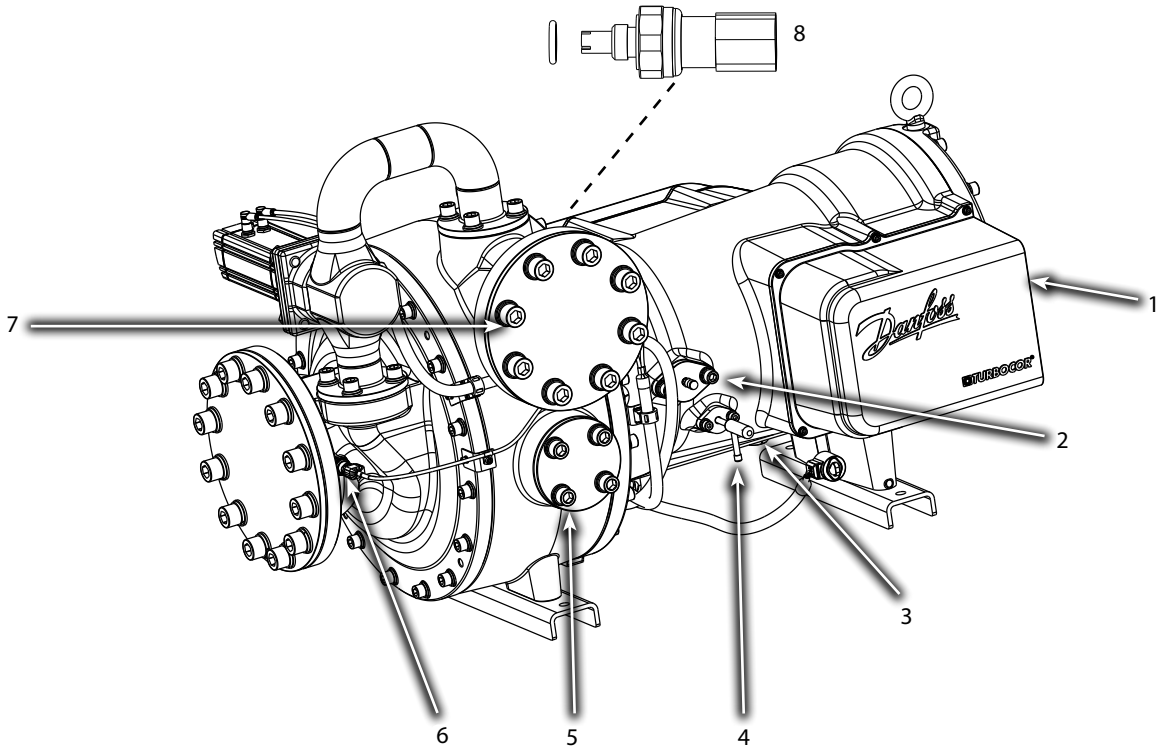


Table 2 - Compressor Component Identification (Power Side)

No.	Component	No.	Component
1	Power Cover	5	Economizer Port
2	Motor Cooling Exit Port	6	P/T Sensor (Suction)
3	Motor Cooling Electronic Expansion Valve (EXV)	7	Discharge Flange
4	Motor Cooling Inlet Port	8	P/T Sensor (Discharge)

Figure 13 - Compressor Component Identification – Service Side (Cover Off)

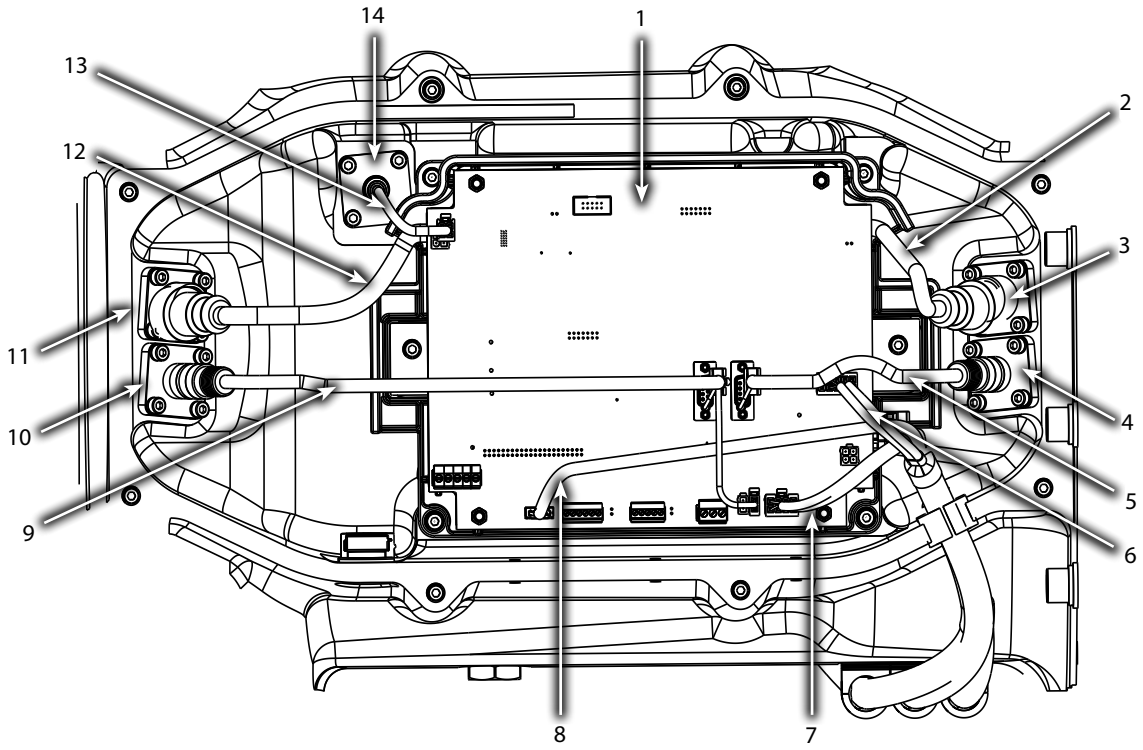


Table 3 - Compressor Component Identification (Service Side - Cover Off)

No.	Component	No.	Component
1	VTT Service Electronics Module	8	Motor Cooling Valve Cable
2	Front Bearing Power Cable	9	Rear Bearing Sensor Cable
3	Front Bearing Power Feed Through	10	Rear Bearing Sensor Feed Through
4	Front Bearing Sensor Feed Through	11	Rear Bearing Power Feed Through
5	Front Bearing Sensor Cable	12	Rear Bearing Power Cable
6	Suction/Discharge Pressure/Temperature Sensor Cable	13	Motor Temperature Sensor Cable
7	IFV Cable	14	Motor Temperature Sensor Feed Through

Figure 14 - Compressor Component Identification – Power Side (Cover Off)

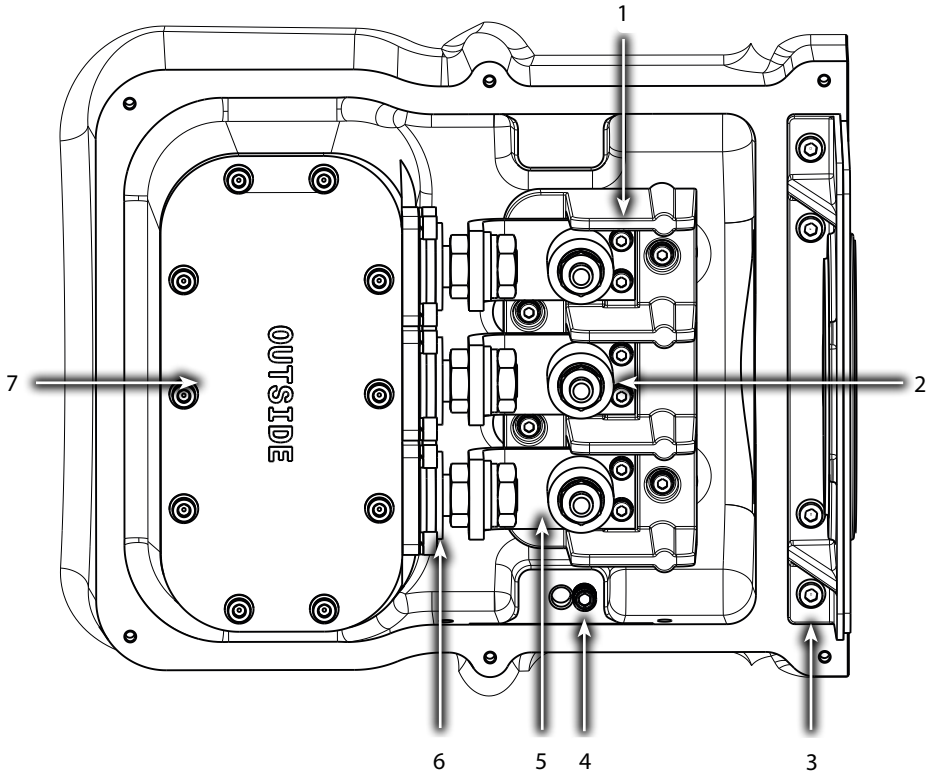


Table 4 - Compressor Component Identification (Power Side - Cover Off)

No.	Component	No.	Component
1	Motor Terminal Block	5	Bus Bar
2	Spacer – Bus Bar	6	Motor Power Feed Through
3	Mains Input Bracket	7	Tower Plate
4	Ground Cable Stud		

Figure 15 - Compressor Sensors and Cables Topside

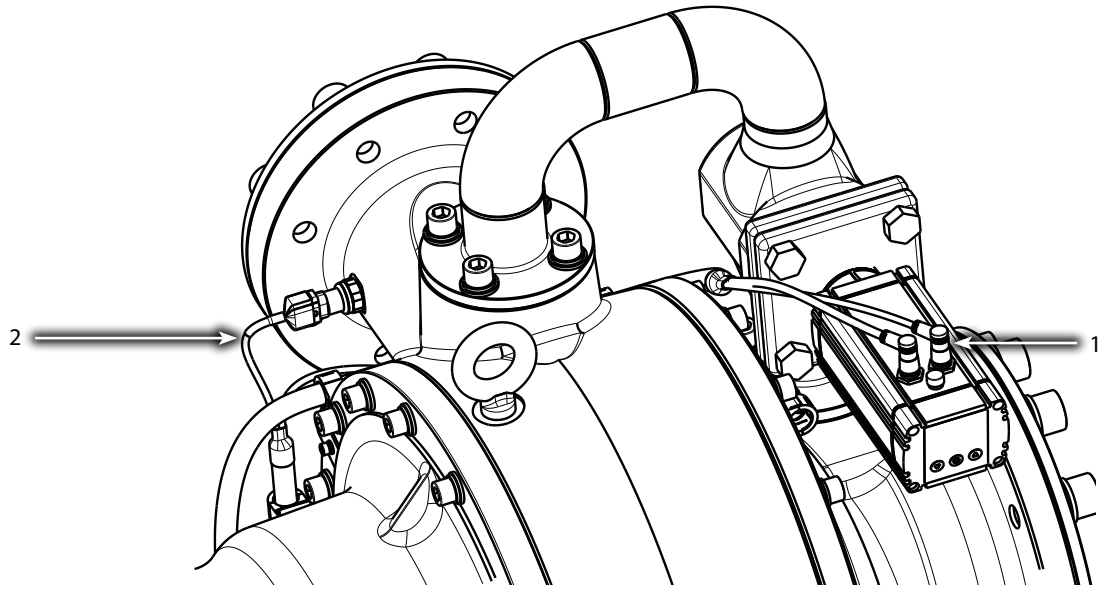


Figure 16 - Compressor Sensors and Cables Topside

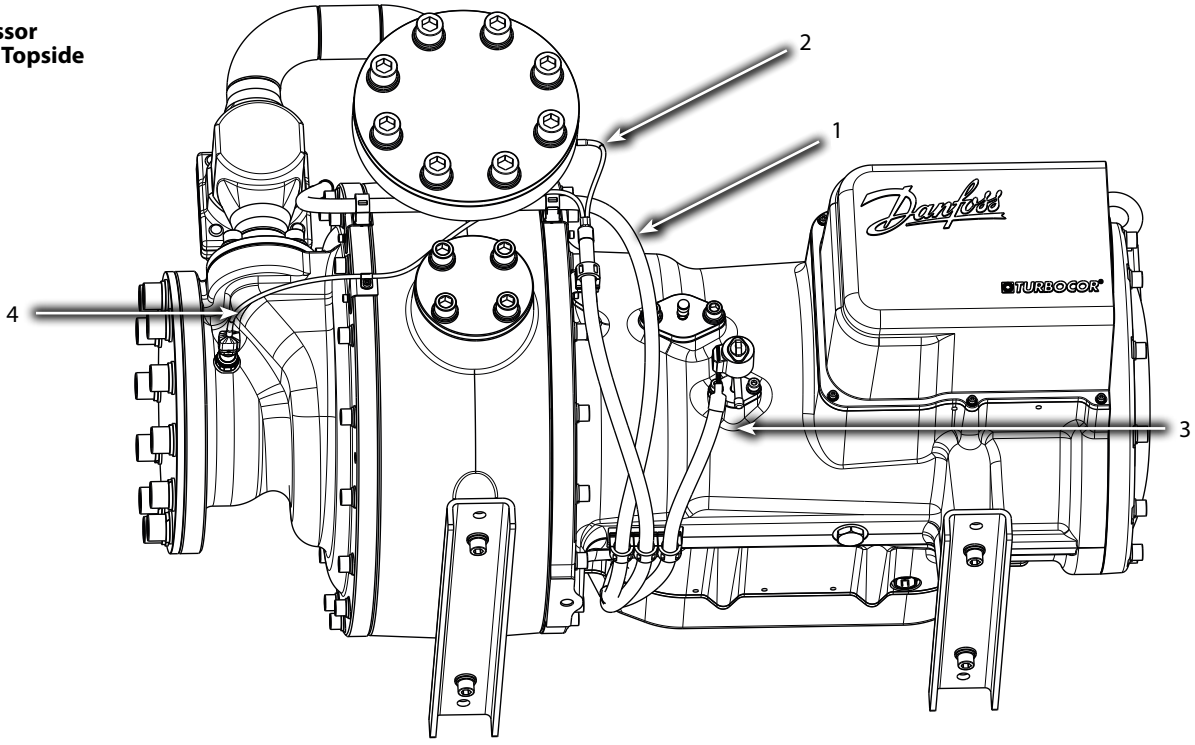


Table 5 - Compressor Component Identification (Power Side - Cables)

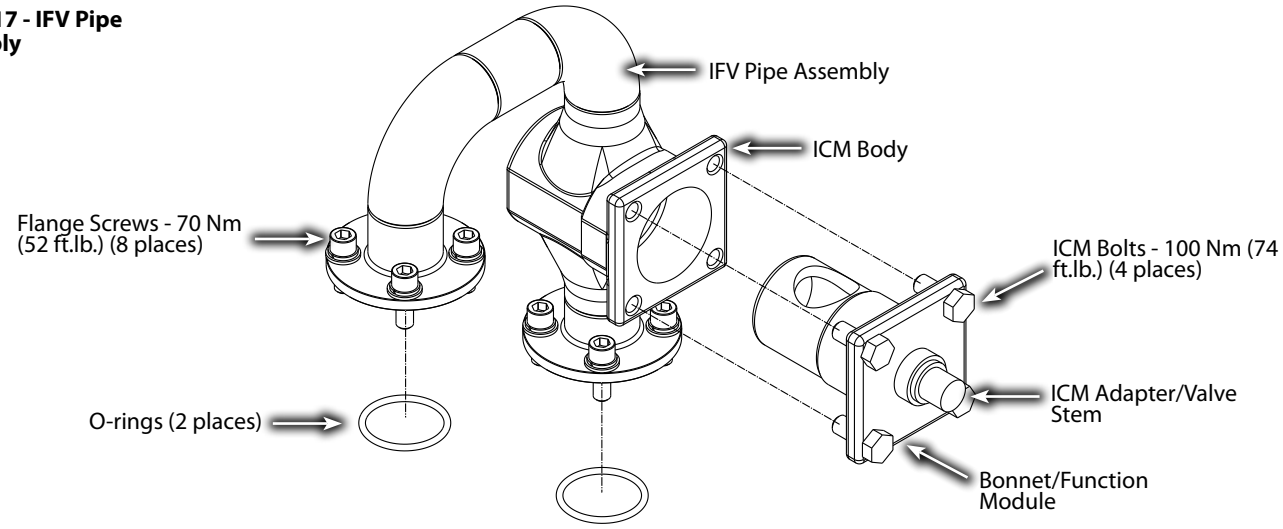
No.	Component	No.	Component
1	IFV Cables	3	EXV Cable
2	Discharge P/T Sensor Cable	4	Suction P/T Sensor Cable

3.2 External Components

3.2.1 IFV Pipe Assembly

The IFV directs a small fraction of the flow from the second stage Volute exit to the inlet of the first stage diffuser through the IFV Pipe.

Figure 17 - IFV Pipe Assembly



3.2.1.1 Removal and Installation

IFV Pipe Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and recover refrigerant.
3. Remove the wires from the IFV Actuator by turning the collar, located on the cable end, in a counter-clockwise rotation
4. Remove the three (3) set screws from the IFV Actuator base where it attaches to the Bonnet/ Function Module.
5. Remove the IFV Actuator from the Bonnet/Function Module.
6. Loosen all eight (8) screws from the suction and discharge side of the IFV pipe assembly.

⚠ • • • CAUTION • • •

Failure to loosen all eight (8) screws first may lead to damaging the threads in the Suction Housing and /or the Volute. Do not attempt to remove the screws from only one (1) side while the other side is still secure!

7. Remove the eight (8) screws from the suction and discharge side of the IFV pipe assembly.
8. Remove the IFV pipe assembly and O-rings.

IFV Pipe Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Lubricate the new O-rings and place them on the IFV suction and discharge side flanges.
3. Place the IFV pipe in its proper location.
4. Loosely install all eight (8) screws from the suction and discharge side of the IFV pipe assembly.
5. Tighten all eight (8) screws from the suction and discharge side of the IFV pipe assembly evenly and torque to specification.
6. Install the IFV Actuator to the Bonnet/Function Module ensure the actuator is fully inserted with the wire connection ports facing up.
7. Install the three (3) set screws to the Bonnet/Function Module and torque to specification.
8. Attach the wires to the color coded ports on the IFV Actuator by turning the collar, located on the cable end, in a clockwise rotation.
9. Leak test the Compressor to the appropriate pressure and industry standards.
10. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
11. Charge the Compressor with refrigerant.
12. Restore power to the Compressor.

3.2.1.2 IFV Pipe Assembly Verification

1. When power is applied to the Compressor, the IFV Actuator drives the valve fully closed and then to the start position.
2. A warning will be generated if the IFV Actuator is unable to adjust the IFV position.

3.2.1.3 Torque Specifications

Table 6 - IFV Pipe Assembly Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
IFV Set Screws	3	-	27
Industrial Control Motor (ICM) Body Bolts	100	74	885
SHCS to suction and discharge sides of IFV pipe	70	52	620

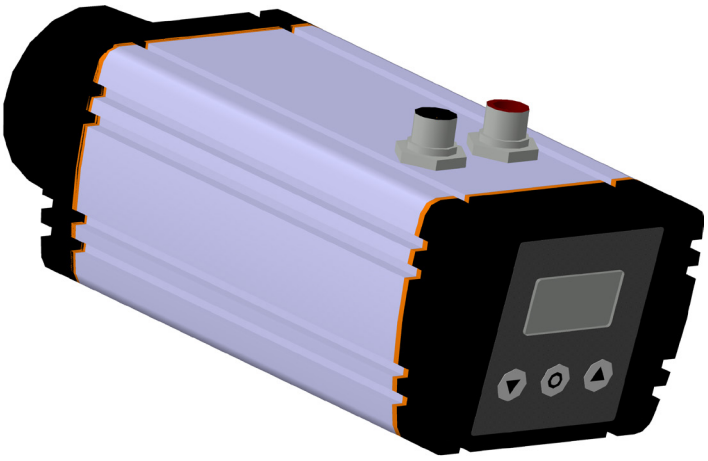
3.2.2 IFV Actuator

The Industrial Control Actuator with Display (ICAD) 1200A controls the IFV position based on signals from the CCM.

Functional Details

- Opening the IFV enables internal flow recirculation and increases the Compressor turn-down capability by aerodynamic incidence control of the 1st stage diffuser and increases the flow through the 2nd stage of the Compressor.
- The IFV has 1000 steps from open to close with a speed of 80 steps per second.
- The valve position is monitored by an optical counter device (Encoder) in the ICAD, and the position is then fed back to the Compressor as an analog signal. The ICAD will automatically calibrate at every power cycle. It can also be manually calibrated through the VTT Service Monitoring Tool (SMT).

Figure 18 - IFV Actuator

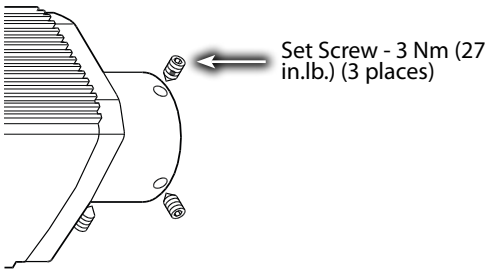


3.2.2.1 Removal and Installation

IFV Actuator Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Disconnect the Red (power) and Black (signal) cables from the IFV by turning the collars, located on the cable ends, in a counter-clockwise rotation.
3. Using a 2.5 mm hex bit, loosen the three (3) set screws that attach the IFV Actuator to the Bonnet/Function Module.
4. Remove the IFV Actuator.

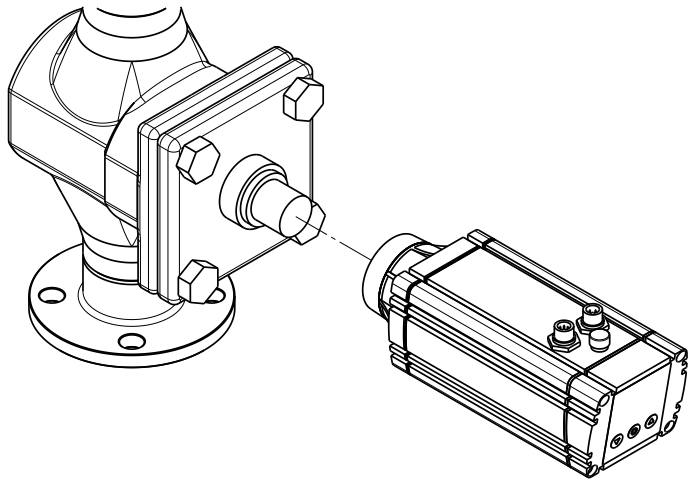
Figure 19 - IFV Actuator Mounting Set Screws



IFV Actuator Installation

1. Generously lubricate the O-ring groove on the adapter/valve stem and on the new O-ring with the Molykote G 4500 grease provided.
2. Install the IFV Actuator to the Bonnet/Function Module ensure the actuator is fully inserted with the wire connection ports facing up.
3. Secure the IFV Actuator to the Bonnet/Function Module using the three (3) set screws and a 2.5 mm hex bit. Torque to specification.
4. Attach the Red (power) and Black (signal) cables to the IFV by turning the collars, located on the cable ends, in a clockwise rotation.
5. Restore power to the Compressor.

Figure 20 - IFV Actuator Install



3.2.2.2 Programming (Required)

⚠ • • • CAUTION • • •

The ICM valve must not be in its fully opened position while the ICAD motor is calibrated with the valve. Therefore, if the opening degree of the ICM valve was changed from the factory setting, it should be set to an opening degree between 0% and 75% using the manual magnet tool. To easily ensure correct positioning, turn the manual tool counter-clockwise until it is clear that it cannot be turned further.

Programming is required anytime the IFV Controller is replaced.

1. Hold the **Edit/Enter** button for 2 seconds to enter the programming mode.
2. Press the **Up Arrow** button until you reach Parameter 04.
3. Press the **Enter/Edit** button.
4. Press the **Up Arrow** button to select 10.
5. Press the **Enter/Edit** button.
6. Press the **Up Arrow** button and go to Parameter 10.
7. Press the **Edit/Enter** button.
8. Press the **Up Arrow** button until you reach 11 (Password).
9. Press the **Enter/Edit** button.

10. Press the **Up Arrow** button until you reach Parameter 26.
11. Press the **Enter/Edit** button.
12. Press the **Up Arrow** button to select 5.
13. Press the **Enter/Edit** button.
14. Hold the **Enter/Edit** button for 2 seconds to exit the programming mode.

3.2.2.3 Calibration

1. Connect to the Compressor with the SMT.
2. Open the **Valve Control Setup Tool.**
3. Under the IFV tab, click on **Calibrate IFV.**

NOTE

IFV calibration may take up to several minutes.

4. A pop-up window in the SMT should state that the IFV calibrated successfully.

3.2.2.4 Torque Specifications

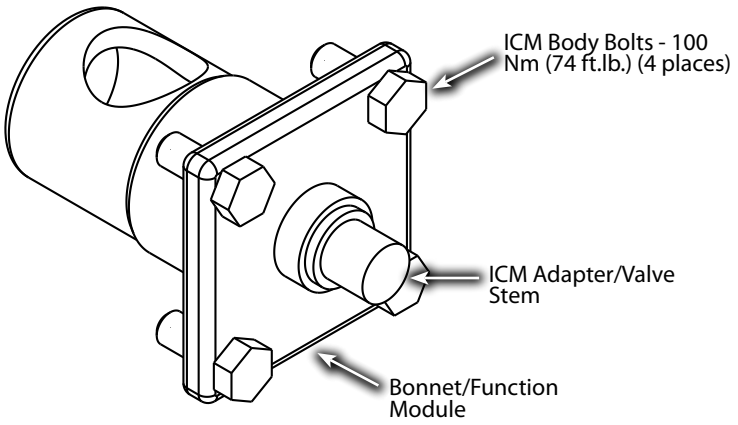
Table 7 - IFV Actuator Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
IFV Set Screws	3	-	27

3.2.3 ICM Body

The ICM attaches to the IFV Pipe Assembly. The driving force from the IFV is transferred via a magnetic coupling through the stainless steel valve stem on the Bonnet/Function Module. This action permits the regulation of the refrigerant flow to the inlet of the first stage diffuser.

Figure 21 - ICM Body

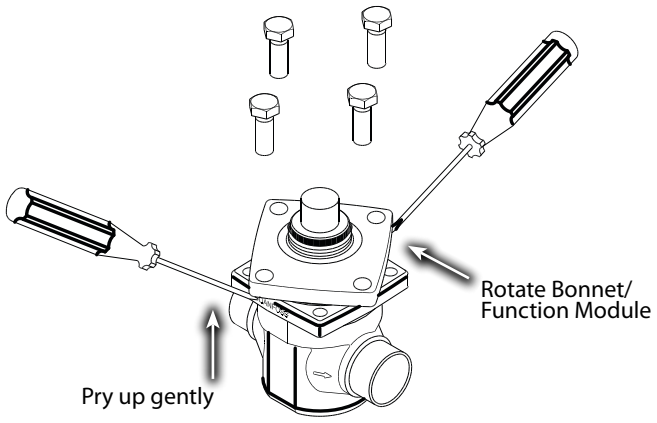


3.2.3.1 Removal and Installation

ICM Body Removal:

1. Remove the IFV Actuator as described in the previous section.
2. Isolate the compressor and recover refrigerant.
3. Remove the four (4) hex bolts.
4. Rotate the Bonnet/Function Module as shown in Figure 22 (Bonnet/Function Module Removal).
5. Carefully pry the Bonnet/Function Module out of the ICM Body by using screw drivers between the Bonnet/Funtion Module and ICM Body.

Figure 22 - Bonnet/Function Module Removal



ICM Body Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Remove any debris from the ICM body.
3. Install the new ICM Bonnet gasket. Refer to Figure 23 (Bonnet/Function Module O-ring Placement) for this and all remaining steps within this installation section)).
4. Lubricate and install the ICM Adapter O-ring into the Bonnet/Function Module O-ring groove.
5. Install the Guide Ring into the Bonnet/Function Module groove.
6. Lubricate and install the two (2) lower Bonnet/Function Module O-rings into their respective grooves.
7. Install the Bonnet/Function Module and install the four (4) hex bolts (finger-tighten only).
8. Torque the four (4) hex screws in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 50 Nm (37 ft.lb.)
   - Stage 2: Tighten to a final torque of 100 Nm (74 ft.lb.)
9. Leak test the compressor to the appropriate pressure and industry standards.
10. Evacuate the compressor to the appropriate pressure and industry accepted standards.
11. Charge the compressor with refrigerant.
12. Restore power to the compressor.

NOTE

For applications below freezing, the ICM adapter O-ring (Refer to #1 in Figure 23 (Bonnet/Function Module O-Ring Replacement)) must be coated with Molykote G 4500 grease (supplied with ICAD motor). The grease must also be applied in the O-ring groove on the adapter. The Molykote grease ensures a good seal between the ICAD motor and the ICM adapter to prevent moisture from entering the ICAD magnets.

Figure 23 - Bonnet/Function Module O-ring Placement

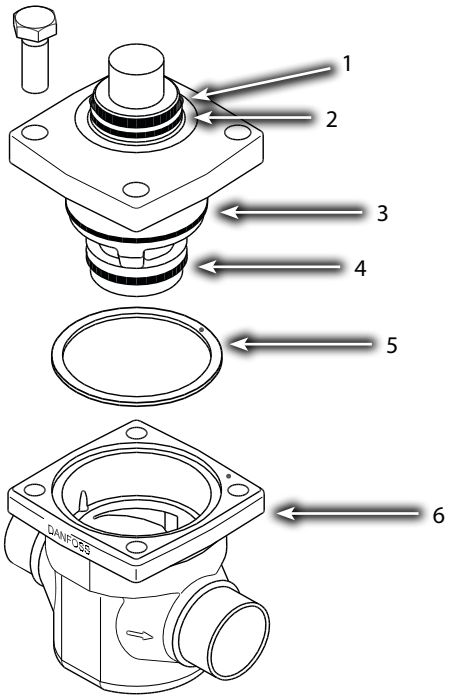


Table 8 - Bonnet/Function Module O-ring Descriptions

No.	Component	No.	Component
1	Guide Ring	4	O-ring for bonnet/function module
2	ICM adapter O-ring for sealing ICAD motor with ICM valve	5	ICM Bonnet Gasket
3	O-ring for bonnet/function module	6	ICM Body

3.2.3.2 Torque Specifications

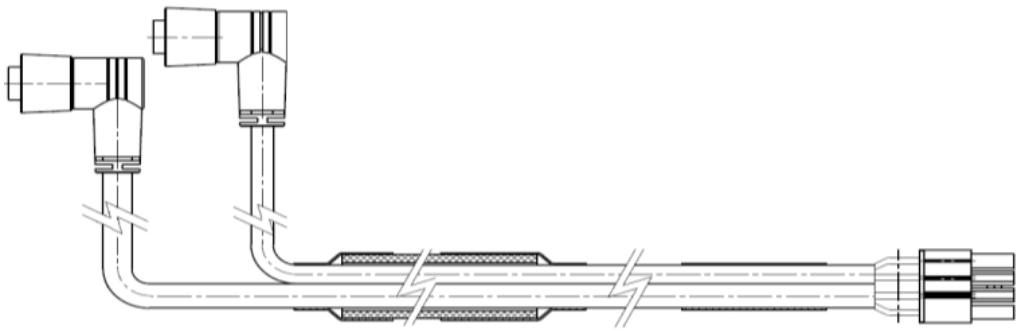
Table 9 - ICM Body Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
IFV Set Screws	3	-	27
Industrial Control Motor (ICM) Body Bolts	100	74	885

3.2.4 IFV Cable

The IFV Cable provides a connection for power and communication between the CCM and the IFV.

Figure 24 - IFV Cable

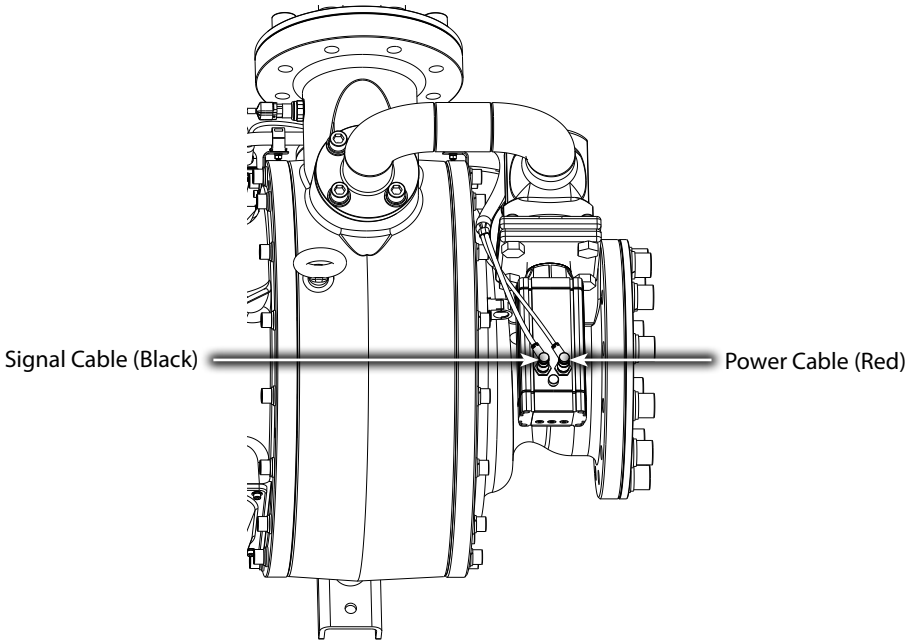


3.2.4.1 Removal and Installation

IFV Cable Removal:

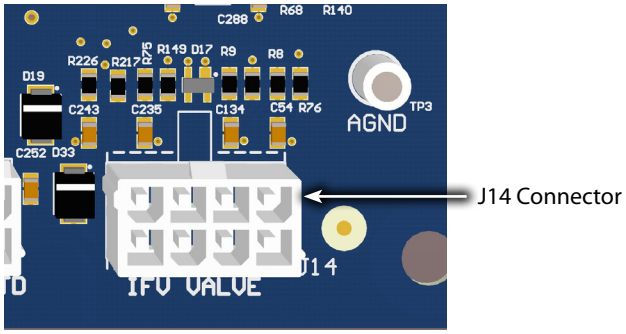
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Disconnect the Red (power) and Black (signal) cables from the IFV Valve by turning the collars, located on the cable ends, in a counter-clockwise rotation.

Figure 25 - IFV Cable Connection



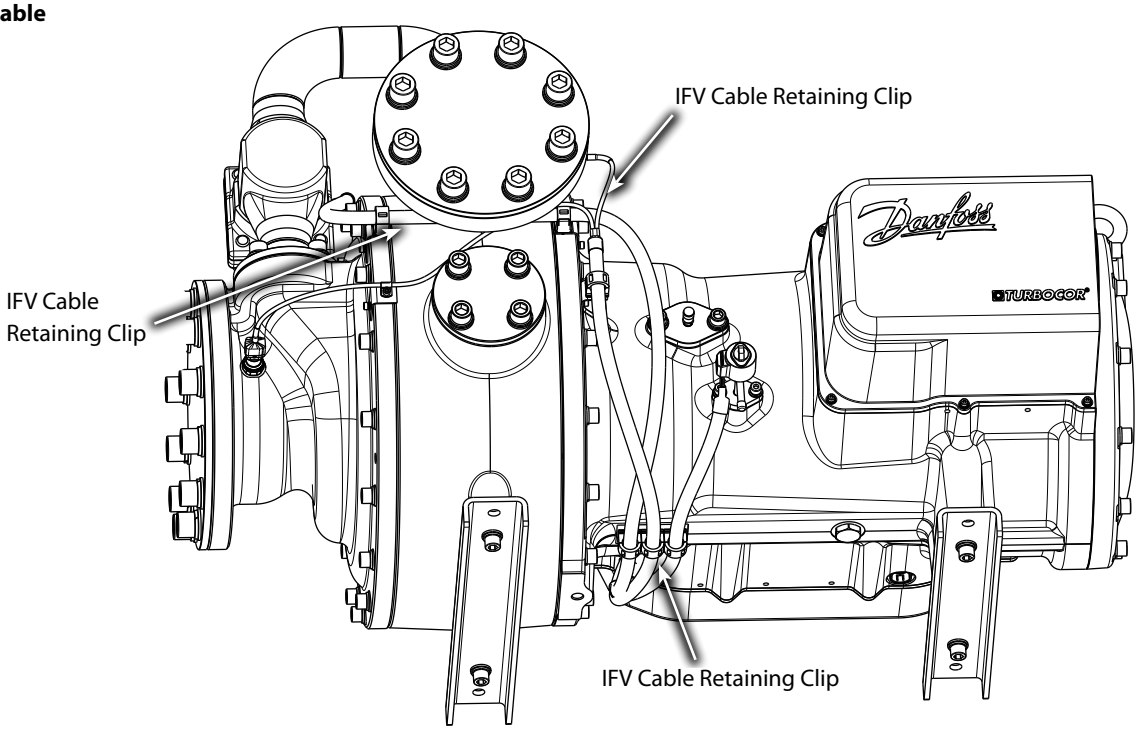
3. Remove the Compressor Service Side Cover.
4. Locate J14 (IFV Valve) on the CCM Board and remove the connector. Refer to Figure 26 (J14 CCM Board Connector).

Figure 26 - J14 CCM Board Connector



5. Remove the cable from the retaining clips. Refer to Figure 27 (IFV Cable Retaining Clips).

Figure 27 - IFV Cable Retaining Clips



IFV Cable Installation:

1. Attach the Red (power) and Black (signal) cables to the IFV Valve by turning the collars, located on the cable ends, in a clockwise rotation.
2. Route the cable from IFV Actuator to the Compressor service side and attach it to the retaining clips.
3. Plug the connector into J14 (IFV Valve) on the CCM Board.
4. Ensure the connections are tight and secure.
5. Replace the Service Side Cover.
6. Restore power to the Compressor.

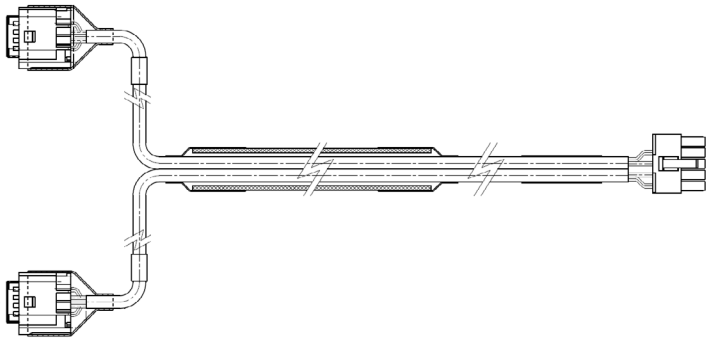
3.2.4.2 Verification

1. Verify proper functionality during Compressor operation.

3.2.5 Pressure/ Temperature Sensor Cable Harness

The Pressure/Temperature Sensor Cable Harness connects the two (2) combination pressure/ temperature sensors to the CCM.

Figure 28 - Pressure/ Temperature Harness

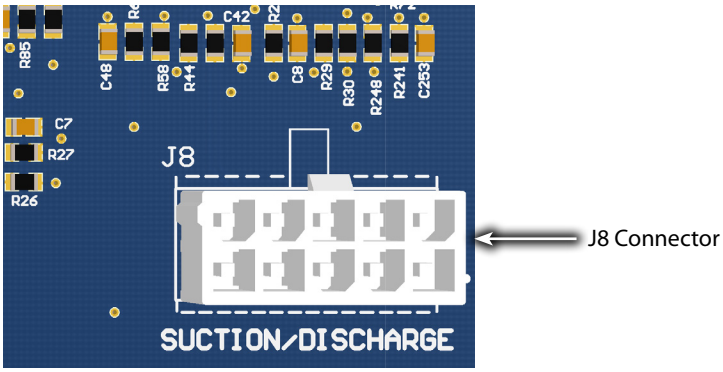


3.2.5.1 Removal and Installation

Pressure/Temperature Sensor Cable Harness Removal:

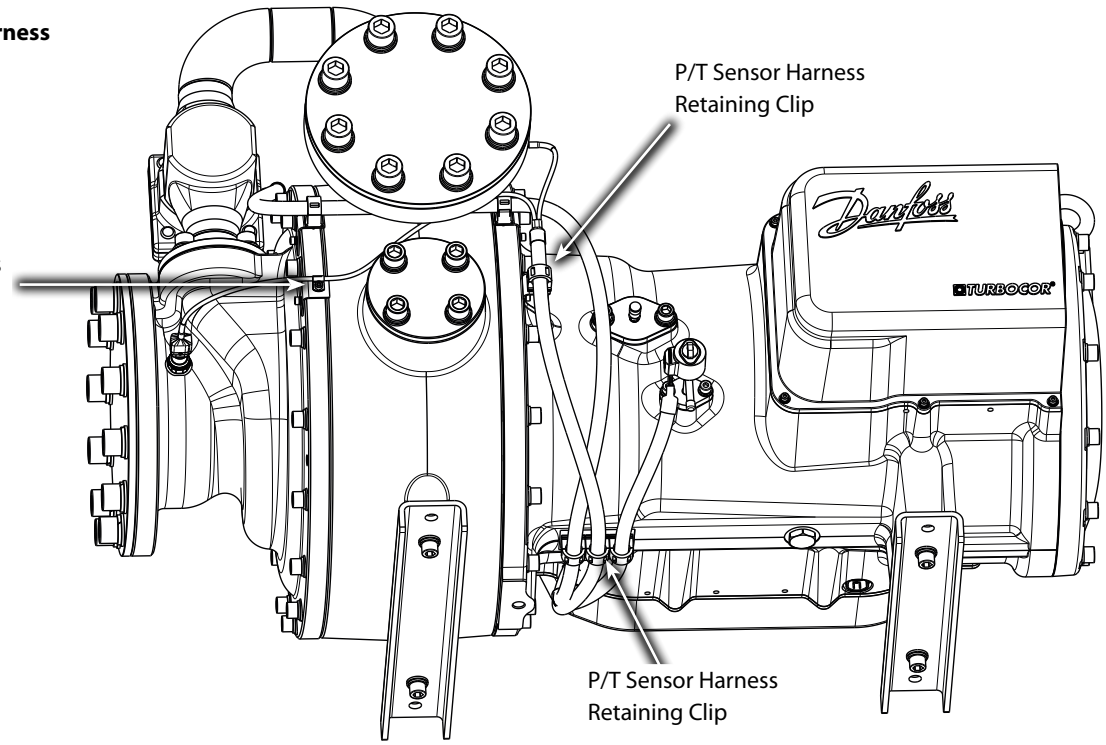
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Unplug the cable harness connector from the suction and discharge sensors.
4. Unplug the cable harness connector from J8 on the CCM. Refer to Figure 29 (J8 CCM Board Connector).

Figure 29 - J8 CCM Board Connector



5. Remove the cable harness from the Compressor retaining clips. Refer to Figure 30 (Pressure/ Temperature Sensor Harness Retaining Clips).

Figure 30 - Pressure/ Temperature Sensor Harness Retaining Clips



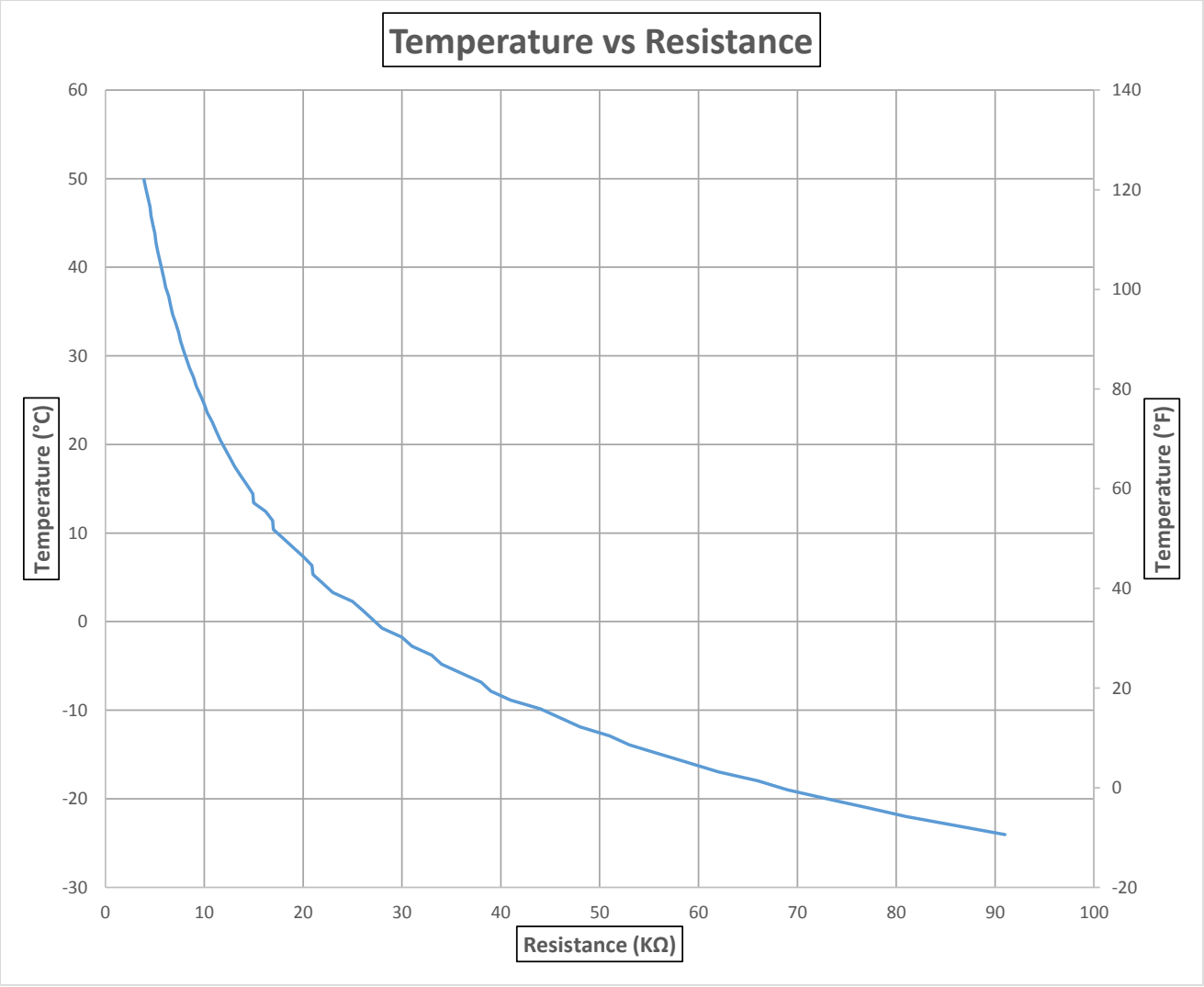
Installation Instructions:

1. Plug the cable harness connector into the suction sensor and discharge sensor.
2. Route the Pressure/Temperature cable to the service side and attach it to the Compressor mounting brackets.
3. Plug the cable harness connector into J8 on the CCM.
4. Replace the Service Side Cover.
5. Restore power to the Compressor.

3.2.5.2 Verification

1. Connect the SMT to the compressor.
2. Verify that the suction and discharge pressures are to specification. Refer to the "Temperature/ Pressure Sensor Verification" section of this manual for the appropriate values.
3. Verify that the temperature values are as expected. Refer to Figure 31 (Pressure/Temperature Sensor R/T Curve) below for both the Suction and Discharge sensors.
4. If either sensor is found to be out of specification, refer to the "High and Low Pressure Temperature Sensors" section of this manual regarding the replacement steps.

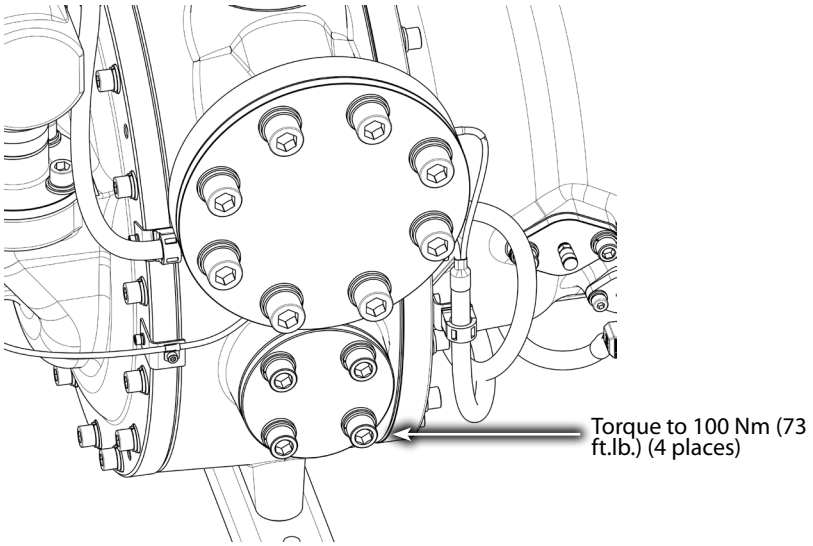
Figure 31 - Pressure/ Temperature Sensor R/T Curve



3.2.6 Economizer Blank

The Economizer Blank is used when the economizer option is not being utilized. This is also used anytime the Compressor is removed from the chiller to prevent contamination ingress.

Figure 32 - Economizer Blank



3.2.6.1 Removal and Installation

Economizer Blank Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and recover refrigerant.
3. Remove the four (4) Economizer screws.

Economizer Blank Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Lubricate the new O-ring and place it onto the Compressor housing O-ring groove.
3. Using the four (4) M16 screws, install the Economizer Blank. Finger-tighten and then tighten in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 30 Nm (22 ft.lb.)
   - Stage 2: Tighten to a final torque of 100 Nm (73 ft.lb.)
4. Leak test the Compressor to the appropriate pressure and industry standards.
5. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
6. Charge the Compressor with refrigerant.
7. Restore power to the Compressor.

NOTE

The same torque would apply if the Economizer option is used and a pipe flange is attached to the Compressor.

3.2.6.2 Torque Specifications

Table 10 - Economizer Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Economizer, SHCS, M16x40	100	73	-

3.2.7 Motor Cooling EXV Assembly

The Motor Cooling EXV controls the flow of refrigerant to cool the Compressor motor and bearing sections.

The motor cooling flow enters the Compressor in the Stator cooling groove through the expansion valve, the flow then spirals around the motor Stator and into the rear of the Compressor. At this point the temperature is measured and is used to ensure the refrigerant is superheated to a set level. The cooling logic for the valve control is hence minimum superheat control. This control strategy ensures that an optimal amount of refrigerant is inside the Stator with two-phase cooling (wetted surface). The superheated gas is then used to cool the Rotor on the return to the exit via the airgap between the Stator and Rotor.

There are two (2) variants of the EXV, both perform the same function but are not interchangeable due to the mounting flange design. The O-ring is identical between the two (2) variants.

Figure 33 - EXV (Revision A Only)

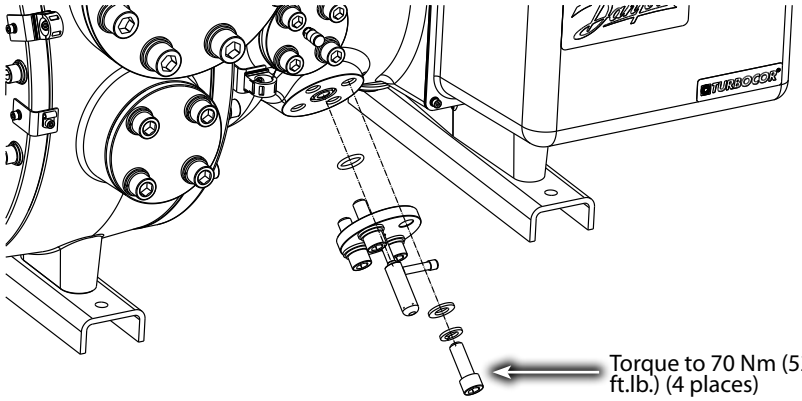
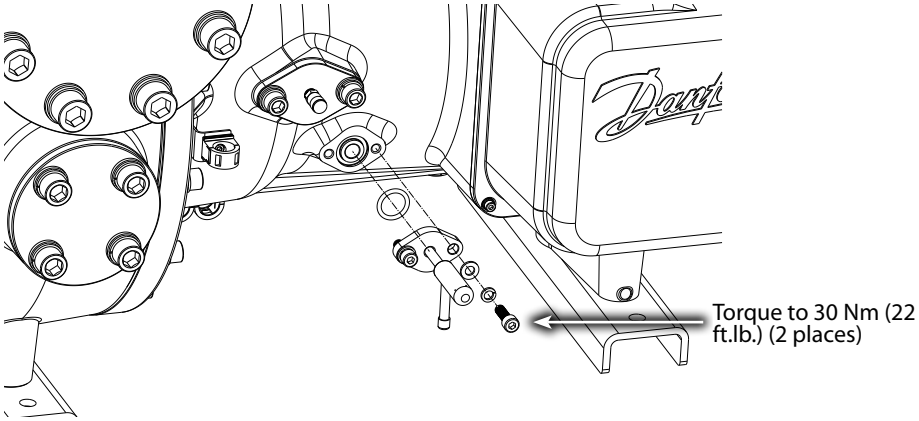


Figure 34 - EXV (Revisions B and Later)



3.2.7.1 Removal and Installation

EXV Removal:

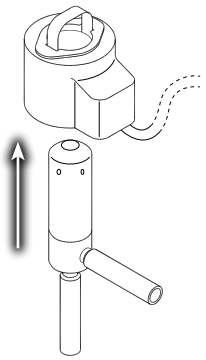
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and liquid line to the EXV and recover the refrigerant.

⚠ • • • CAUTION • • •

Refrigerant may remain in the liquid line; ensure full recovery from high and low side of valve is complete.

3. Remove the actuator coil from the EXV. The actuator coil is held on by a clip and it can be removed by pulling straight away from the EXV.

Figure 35 - Actuator Coil Removal



4. Disconnect the liquid line connection at the EXV.
5. Remove the flange screws that attach the EXV to the Compressor housing. Note the orientation of the valve assembly.
6. Remove the O-ring from the Compressor housing.

EXV Installation:

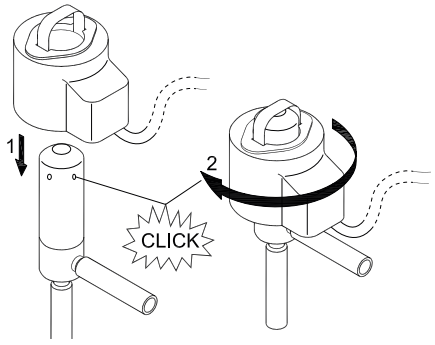
1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Compressor housing.
3. Install the EXV in same orientation noted at removal.
4. Tighten the flange screws evenly in a crisscross pattern (Revision A only) and torque to specification.
5. Heat and remove the cap from the EXV assembly inlet line and attach liquid line. Refer to the "EXV Protection" within this section.

⚠ • • • CAUTION • • •

Protect the valve from heat during installation.

6. Re-install the actuator coil onto the EXV assembly. Refer to Figure 36 (Actuator Coil Installation).
7. Leak test the Compressor to the appropriate pressure and industry standards.
8. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
9. Charge the Compressor with refrigerant.
10. Restore power to the Compressor.

Figure 36 - Actuator Coil Installation



3.2.7.2 Verification

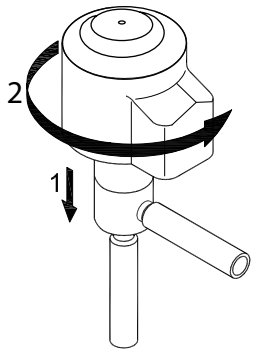
1. Verify proper EXV function by operating the Compressor and monitoring motor temperatures.

3.2.7.3 EXV Protection

The following steps, when performed properly, will help ensure that the EXV is not damaged when brazing the copper line to the valve.

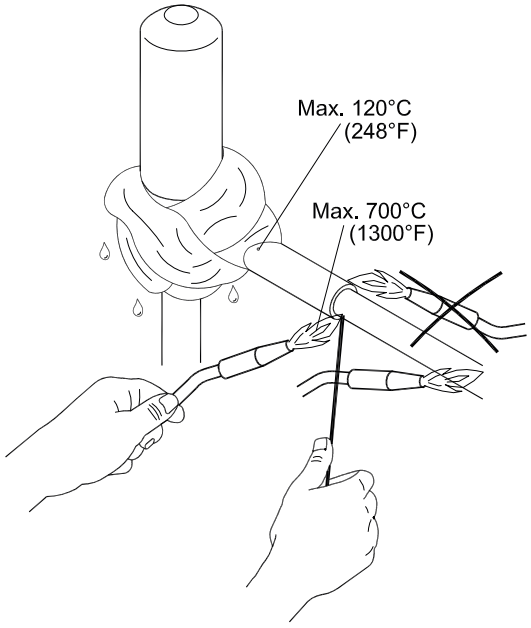
1. Ensure the actuator coil has been removed from the EXV.
2. The new valve should be shipped in the open position but to ensure that the valve is completely open, use ETS 6 manual coil part number 034G5119 (purchase through local Danfoss supplier) and manually open the valve by turning the manual coil 20 times in the counter-clockwise rotation. (If an ETS 6 manual coil is not available, the actuator coil can be used if the retaining clip is removed so that it can spin freely on the valve stem. If using the power head, take special care to protect the electrical wires extending from the actuator coil.)

Figure 37 - Opening Valve Manually



3. Remove the ETS6 manual coil or actuator coil.
4. Wrap the valve in cool wet towels to help prevent excessive heat from damaging the valve.
5. Using a MAPP and AIR mixture torch, NOT MAPP gas and oxygen, nor an Oxy Acetylene torch, heat the shipping cap on the stub end of the valve until the solder becomes liquefied. While the solder is still liquefied, carefully remove the cap with pliers.
6. Clean the now open copper tube with a sanding cloth and then apply soldering flux to the exterior of the clean copper tube. Do the same to the mating copper pipe that will connect from the system to the motor cooling valve.
7. Slide the system-side pipe over the stub of the EXV ensuring a minimum of a 9.5 mm (3/8") connecting joint.
8. Make sure the towels around the motor cooling valve are still cool and wet, re-wet and re-wrap if needed.
9. Using a MAPP and AIR mixture torch, heat the two (2) sections of pipe and apply a (6% silver 94% tin) type solder ensuring the two (2) pipe connections are properly sealed.
10. Leak test the cooled joint to ensure leak tightness.

Figure 38 - Brazing the EXV



11. Once the valve has cooled back down, reinstall the electronic power head and retaining clip if removed.

3.2.7.4 Torque Specifications

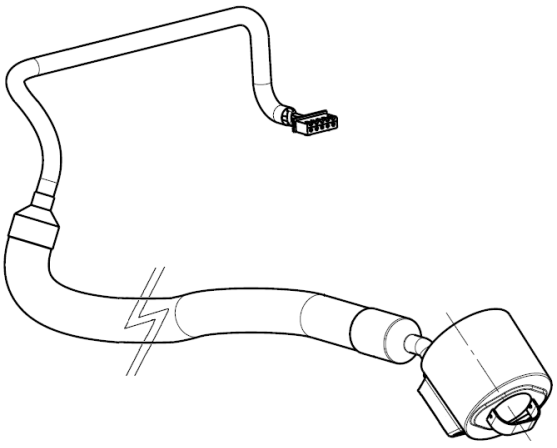
Table 11 - EXV Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Flange, SHCS, M14x40 (Revision A)	70	52	620
Flange, SHCS, M8x25 (Revisions B and later)	30	22	266

3.2.8 EXV Cable

The EXV Cable connects the CCM to the EXV.

Figure 39 - EXV Cable

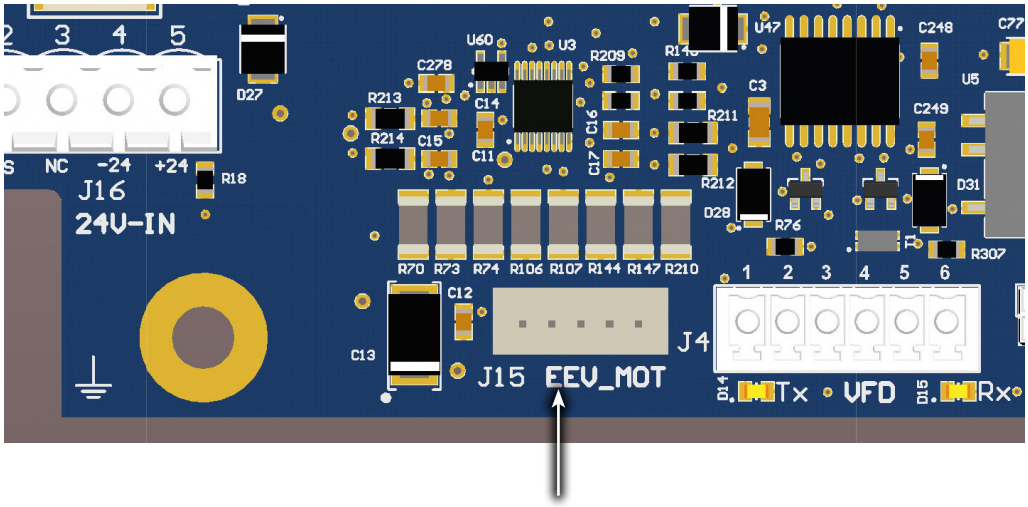


3.2.8.1 Removal and Installation

EXV Cable Removal:

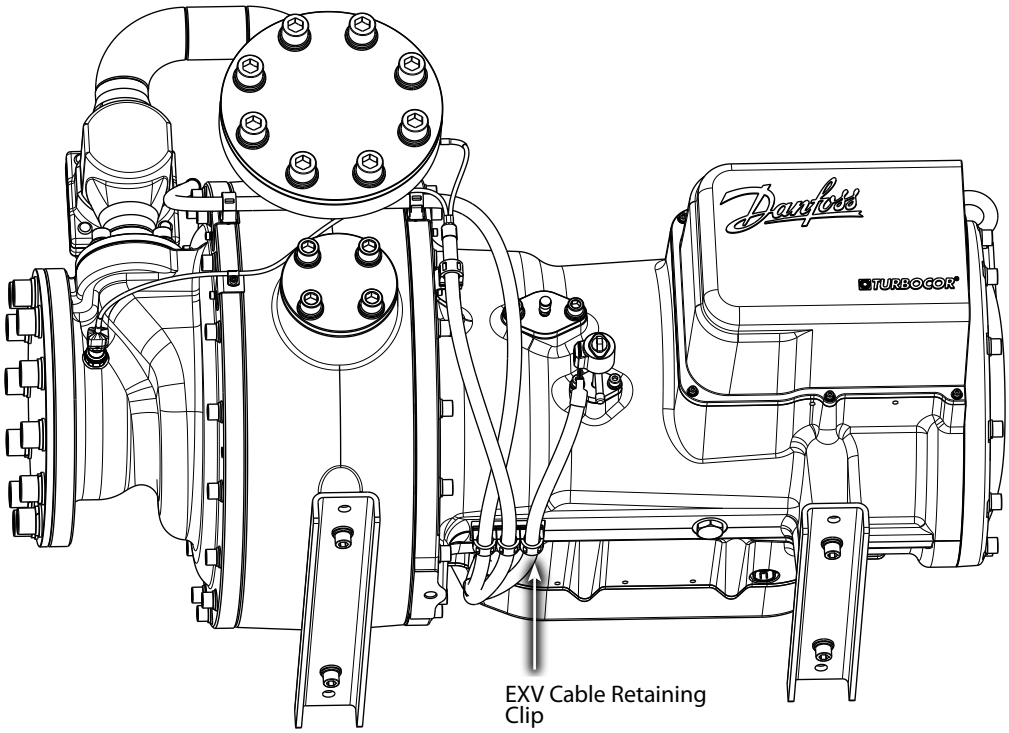
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Remove connector J15 EEV_MOT from the CCM.

Figure 40 - CCM J15 Connector



4. Remove the Valve Actuator from the EXV on the discharge side of Compressor.
5. Route the cable out of the service side.
6. Release the cable from the retaining clip located underneath the Compressor. Refer to Figure 36 (EXV Cable Retaining Clip) for the exact location of the clip.

Figure 36 - EXV Cable Retaining Clip



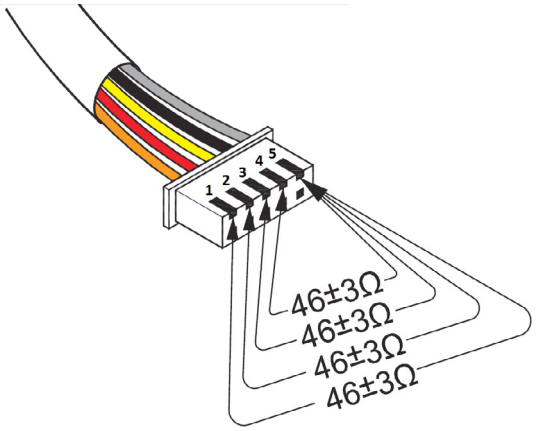
EXV Cable Installation:

1. Attach the Valve Actuator to the EXV.
2. Route the cable into the service side.
3. Connect the cable to the J15 EEV_MOT terminal on the CCM.
4. Secure the cable in the retaining clip.
5. Reinstall the Service Side Cover.
6. Restore power to the Compressor.

3.2.8.2 Verification

1. The Motor Cooling Valve Cable continuity and Actuator coil resistance can be measured by checking the resistance from the Gray #5 wire to each of the four (4) other wires.

Figure 42 - Cable Pinout for Continuity/Resistance Verification



3.2.8.3 Running Check

1. The valve resets to 0% when power is first applied to the Compressor.
2. The valve opens to 15% for two (2) minutes at Compressor startup.
3. While running, it is controlled based on superheat temperature as refrigerant exits the motor.

3.2.9 Motor Cooling Exit Flange

The motor cooling flow exits the Compressor in the Motor Cooling Exit Flange.

There are two (2) variants of the Motor Cooling Exit Flange, both perform the same function but are not interchangeable due to the mounting flange design. The O-ring is identical between the two (2) variants.

Figure 43 - Motor Cooling Exit Flange (Revision A Only)

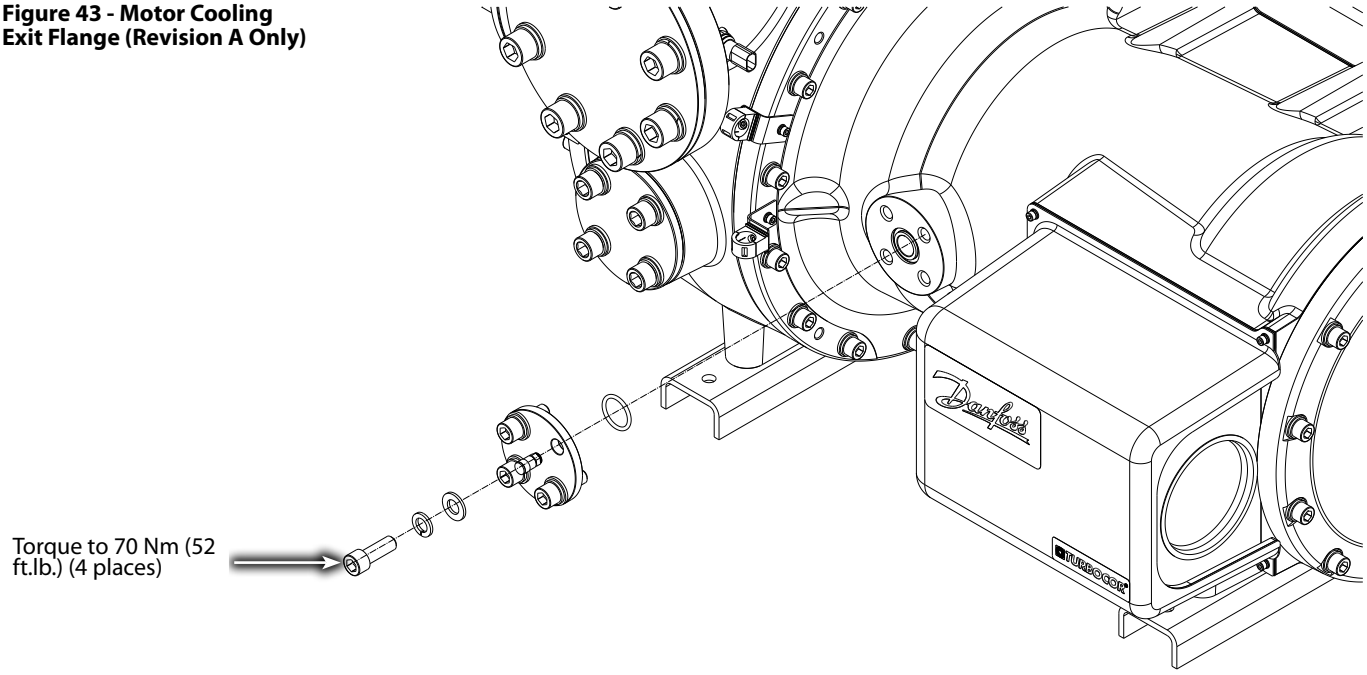
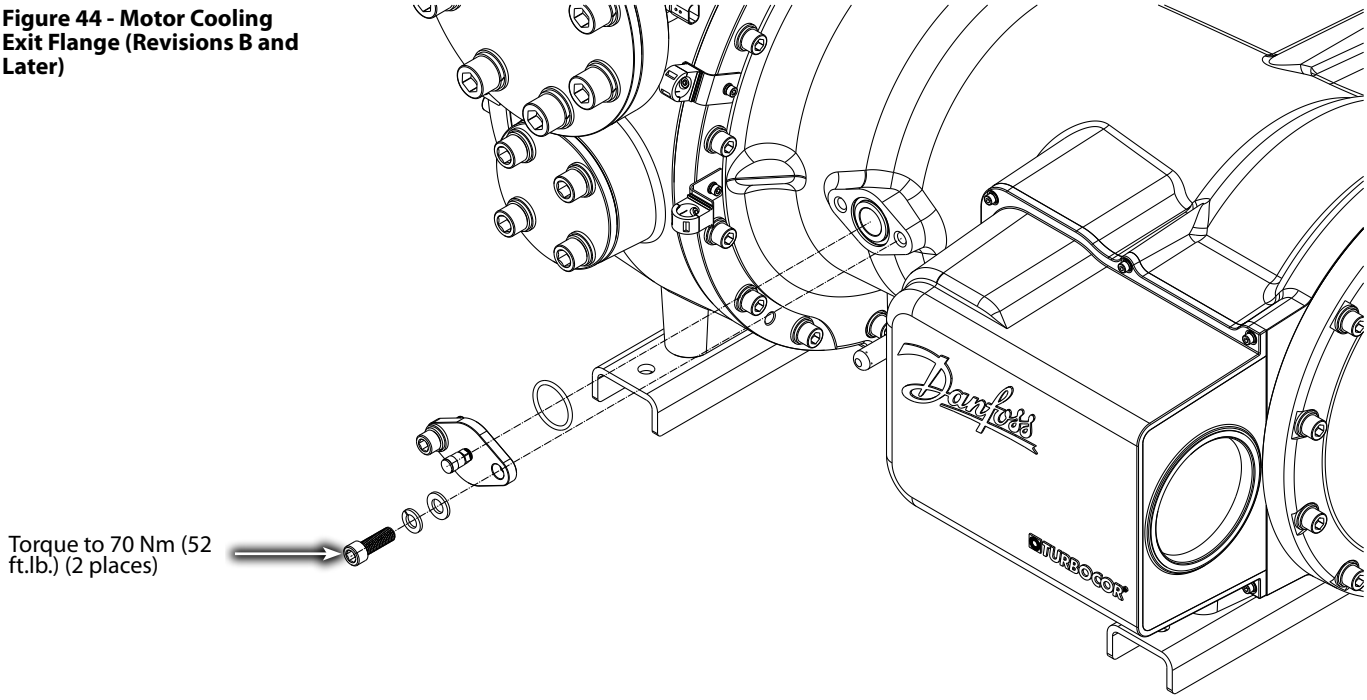


Figure 44 - Motor Cooling Exit Flange (Revisions B and Later)



3.2.9.1 Removal and Installation

Motor Cooling Exit Flange Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and liquid line to the Motor Cooling Exit and recover the refrigerant.

⚠ • • • CAUTION • • •

Refrigerant may remain in the liquid line; ensure full recovery from high and low side of valve is complete.

3. Remove the flange screws that attach the Motor Cooling Exit to the Compressor housing.
4. Remove the O-ring from Compressor housing.

Motor Cooling Exit Flange Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Compressor housing.
3. Install the Motor Cooling Exit Flange (not the shipping flange) and tighten the flange screws evenly in a crisscross pattern (Revision A only) and torque to specification.
4. Leak test the Compressor to the appropriate pressure and industry standards.
5. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
6. Charge the Compressor with refrigerant.
7. Restore power to the Compressor.

NOTE

The motor cooling exit shipping flange is not intended to be used as the motor cooling exit flange during Compressor operation. This must be replaced with a flange that has a 1 1/8" connection for proper cooling to take place.

3.2.9.2 Torque Specifications

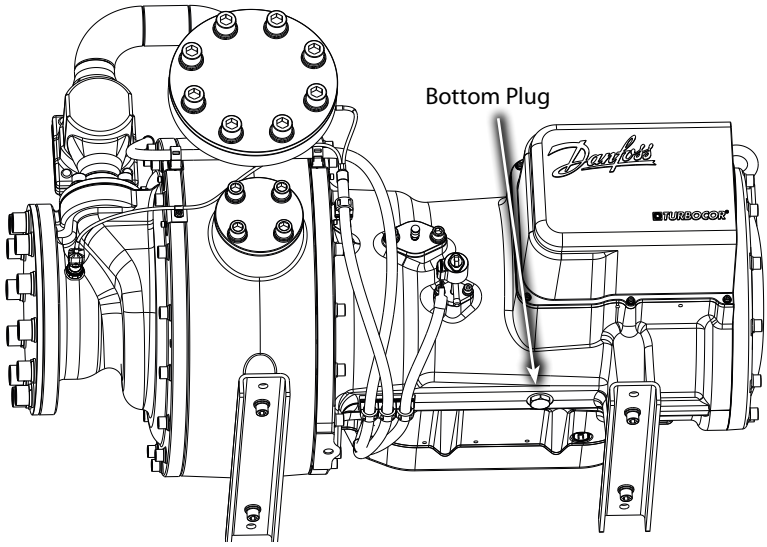
Table 12 - Motor Cooling Exit Flange Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Flange, SHCS, M14x40 (Revision A)	70	52	620
Flange, SHCS, M12x35 (Revisions B and later)	70	52	620

3.2.10 Bottom Plug

The hole in the bottom of the compressor housing was designed to aid in the manufacturing of the compressor. A plug has been inserted at the factory and should not be removed in the field unless it is determined that the O-ring has failed and needs to be replaced.

Figure 45 - Bottom Plug



3.2.10.1 Removal and Installation

Bottom Plug Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and recover refrigerant.
3. Remove the bottom plug.

Bottom Plug Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Lubricate the new O-ring and place it onto the groove on the plug.
3. Tighten the plug to specification.
4. Leak test the Compressor to the appropriate pressure and industry standards.
5. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
6. Charge the Compressor with refrigerant.
7. Restore power to the Compressor.

3.2.10.2 Torque Specifications

Table 13 - Bottom Plug Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Bottom Plug, M16x2	70	52	620

3.3 Power Side

3.3.1 Motor Power Cover

The Motor Power Cover provides protection for the connection of the cables from the VFD to the Compressor motor. There are two (2) variants of this cover as shown below. The most noticeable difference is there are four (4) mounting screws for the "A" Revision while the later revisions have six (6) mounting screws.

Figure 46 - Motor Power Cover (Revision A)

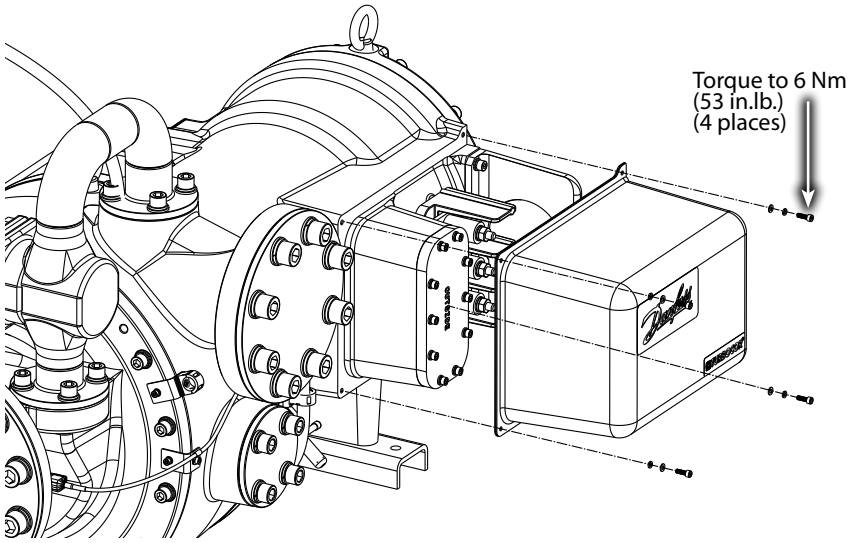
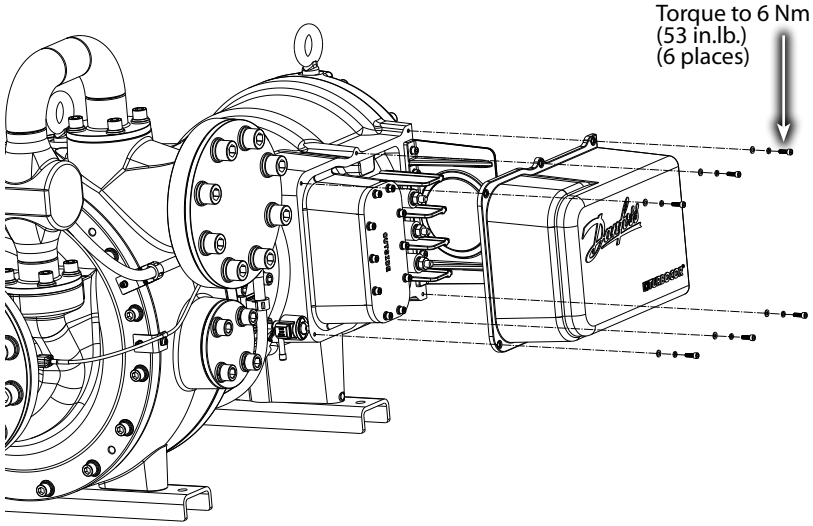


Figure 47 - Motor Power Cover (Revisions B and Later)



3.3.1.1 Removal and Installation

Motor Power Cover Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the four (4) or six (6) screws that hold the Motor Power Cover in place.
3. Remove the Motor Power Cover.

Motor Power Cover Installation:

1. Verify all sealing surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Install the gasket on the sealing surface of the cover.
3. Place the cover over the motor power side.
4. Install the screws to secure the Motor Power Cover and torque to specification.
5. Restore power to the Compressor.

3.3.1.2 Torque Specifications

Table 14 - Motor Power Cover Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53

3.3.2 Mains Input Bracket

The Mains Input Bracket provides support for the conduit of the cables from the VFD to the compressor motor. There are two (2) variants of this bracket with the Revision A utilizing two (2) mounting holes where as the Revisions C and later, utilize four (4) mounting holes.

Figure 48 - Mains Input Bracket (Revision A)

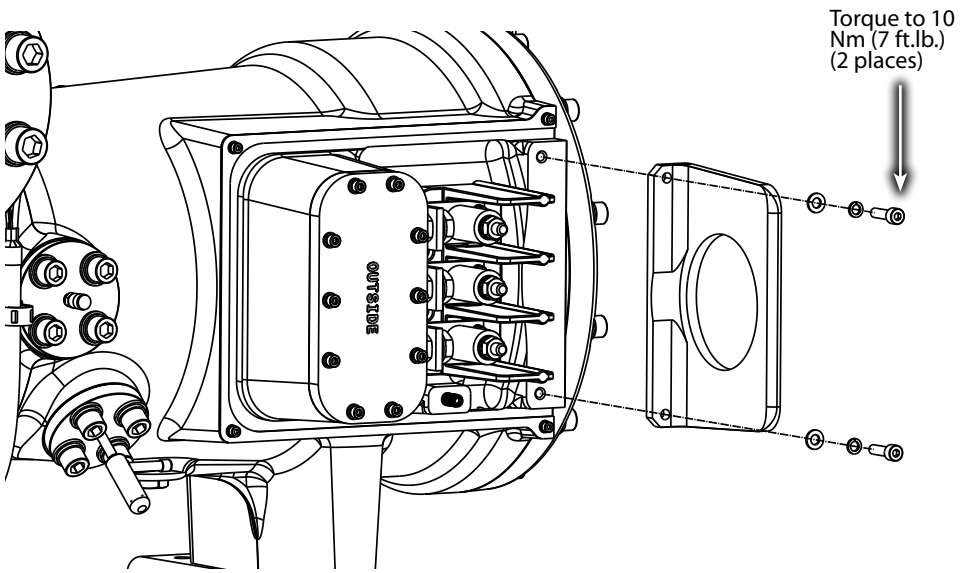
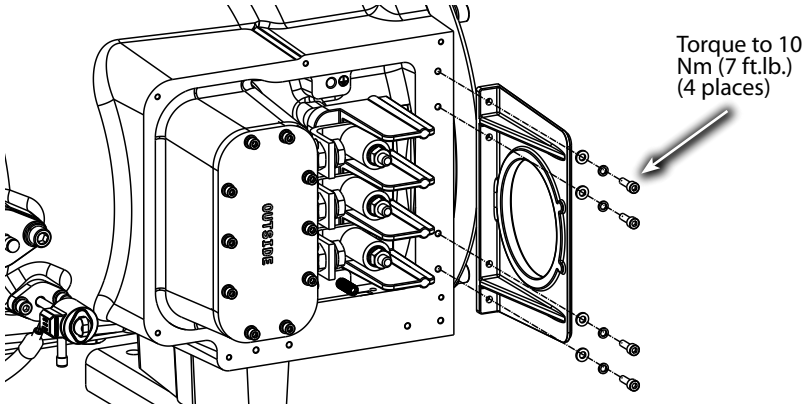


Figure 49 - Mains Imput Bracket (Revisions C and Later)



3.3.2.1 Removal and Installation

Mains Input Bracket Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Motor Power Cover.
3. Remove the three (3) M10 nuts, flat washers, and lock washers off the top of the copper spacers.
4. Remove the six (6) motor power cables (two (2) cables per phase). Protect/isolate the cable ends.
5. Remove the conduit locknut(s) and remove the conduit and cables away from the Mains Input Bracket.
6. Remove the two (2) or four (4) screws that hold the Mains Input Bracket in place.
7. Remove the Mains Input Bracket.

Mains Input Bracket Installation:

1. Place the Mains Input Bracket into position.
2. Install the screws to secure the Mains Input Bracket and torque to specification.
3. Insert the cables through the Mains Input Bracket and push the conduit through, exposing enough threads to attach the locknut(s).
4. Install the locknut(s).
5. Connect the six (6) motor power cables (two (2) cables per phase).
6. Install the three (3) M10 nuts, flat washers, and lock washers on the studs above the copper spacers and power cables and torque to specification.
7. Install the Motor Power Cover.
8. Restore power to the compressor.

3.3.2.2 Torque Specifications

Table 15 - Mains Input Bracket Torque Specifications

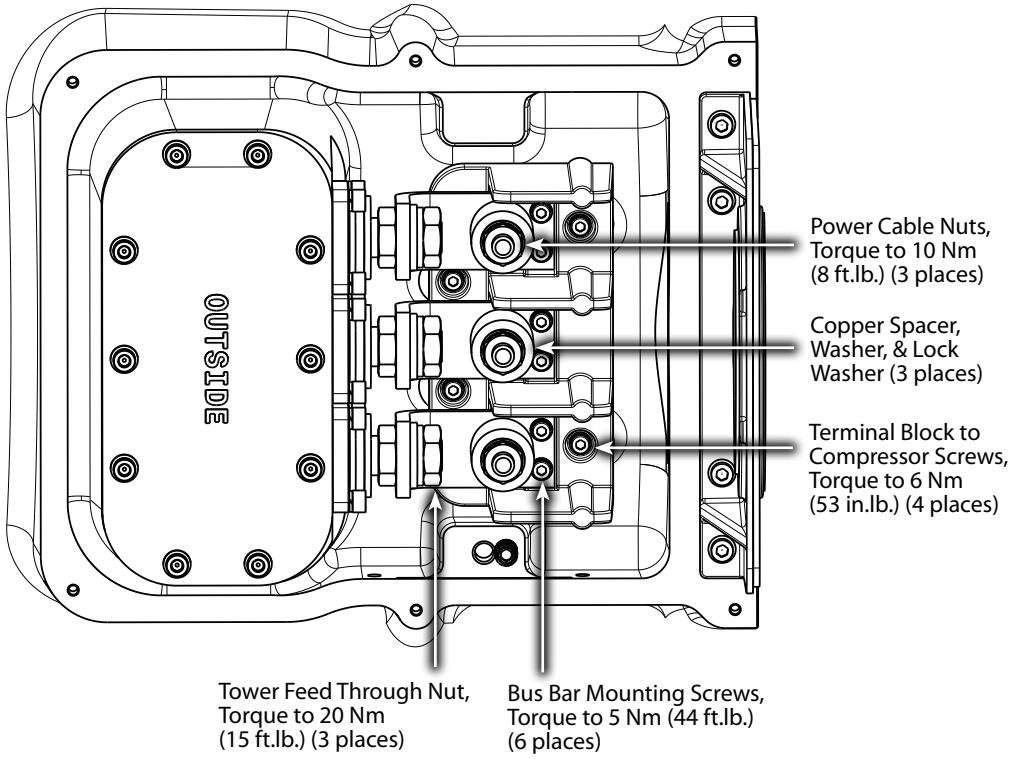
Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	5	53
Mains Input Bracket, SHCS, M8x30 (Revision A)	10	7	89
Mains Input Bracket, SHCS, M6x20 (Revisions B and Later)	10	7	89
Power Cable Nut, Brass M10x1.5	10	8	89

3.3.3 Motor Terminal Block

The Motor Terminal Block supports and separates the Motor Bus Bars and connects the VFD cables to the Compressor motor. This is the location where the Compressor receives 3-Phase AC voltage.

Refer to Figure 50 (Motor Terminal Block) to locate the AC voltage input to the motor.

Figure 50 - Motor Terminal Block



3.3.3.1 Removal and Installation

Motor Terminal Block Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Motor Power Cover.
3. Remove the three (3) M10 nuts, flat washers, and lock washers off the top of the copper spacers.
4. Remove the six (6) motor power cables (two (2) cables per phase). Protect/isolate the cable ends.
5. Remove the three (3) copper spacers.
6. Remove the three (3) M16 brass nuts, lock washers, and flat washers from the Motor Tower Feed Through.
7. Remove the four (4) M5 screws, lock washers, and flat washers that attach the terminal block to the Compressor.
8. Remove the six (6) M5 screws, lock washers, and flat washers that attach the bus bar to the Motor Terminal Block.
9. Remove the Motor Terminal Block from the Compressor.

Motor Terminal Block Installation:

1. Place the Motor Terminal Block on the Compressor by aligning the bus bars onto the Motor Tower Feed Throughs.
2. Secure the terminal block to the Compressor with the four (4) M5 screws and washers and torque to specification.
3. Install the three (3) M16 brass nuts, flat washers, and lock washers from the Motor Tower Feed Through.
4. Install the three (3) copper bus bars onto the studs on the terminal block.
5. Install the three (3) copper spacers.
6. Connect the six (6) motor power cables (two (2) cables per phase).
7. Install the three (3) M10 nuts, flat washers, and lock washers on the studs above the copper spacers and power cables and torque to specification.
8. Restore power to the Compressor.

3.3.3.2 Verification

• • • DANGER • • •

- This equipment contains hazardous voltages that can cause injury or death. Exercise extreme caution when working on energized circuits.
- Always wear safety glasses when working around components energized by high voltages. Faulty components can explode and cause serious eye injuries.

Connecting the AC Input Cables:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Ensure the AC cables are securely fastened to the Motor Terminal Block.
3. If the cables cannot be securely fastened to the input terminal, the Motor Terminal Block is damaged and needs to be replaced.

Verifying the 3-Phase AC Input:

1. Turn ON the AC input power.
2. Set the multimeter for AC voltage measurements.

3. Place the meter probe on one phase of the AC input posts and the other meter probe on another phase of the AC input as shown in Figure 51 (Measuring AC Input Voltage).
4. Verify that the meter shows the expected AC measurement within the range as indicated in Table 16 (Expected AC Voltage Range).

Figure 51 - Measuring AC Input Voltage

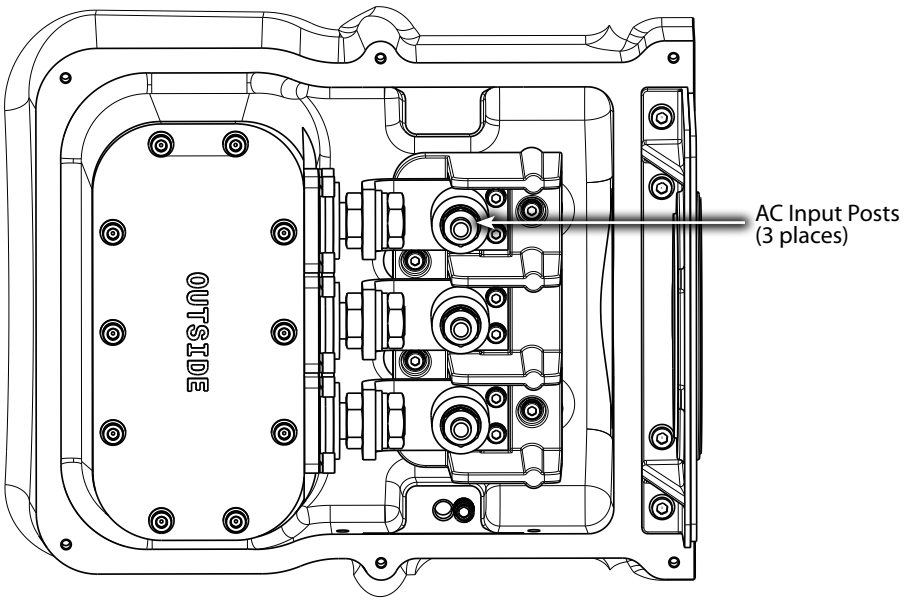


Table 16 - Expected AC Voltage Range

VFD Module	Nominal Voltage	Acceptable Voltage Range
N165 T5	380	342-418
	400	360-440
	460	414-506
N232 T5	380	342-418
	400	360-440
	460	414-506
N262 T5	380	342-418
	400	360-440
	460	414-506

5. If the meter does not show any reading, it is possible that there is no power from the VFD. Measure again but this time verify the 3-phase output at the VFD.
6. If the meter still does not show any reading, ensure the AC power source is turned ON and try again.
7. If the measured values correspond to the specified values for all phases, the AC input voltage is okay.

3.3.3.3 Torque Specifications

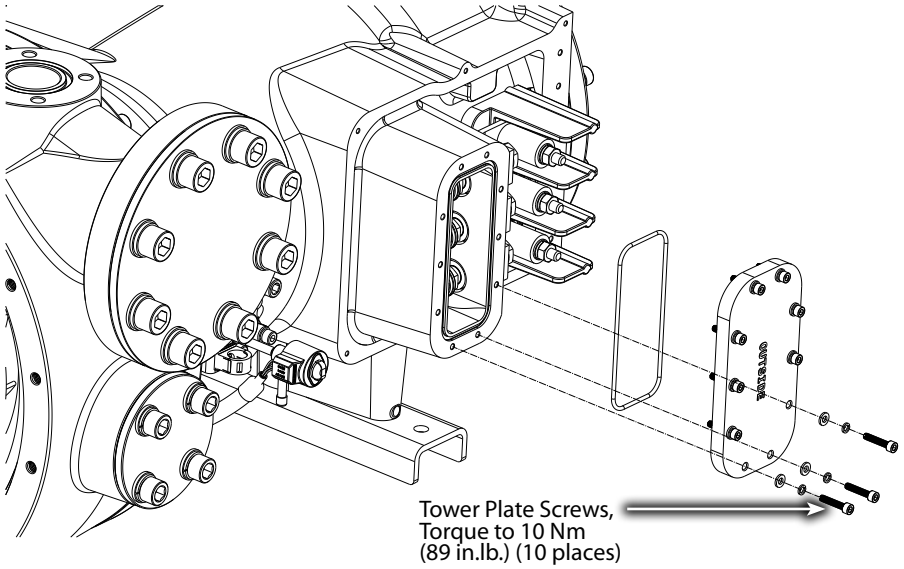
Table 17 - Motor Terminal Block Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	5	53
Motor Terminal Block to Compressor, SHCS, M5x20	6	5	53
Tower Feed Through Nut, Brass M16x1.5	20	15	177
Power Cable Nut, Brass M10x1.5	10	8	89
Bus Bar Mounting, SHCS, M5x16	5	4	44
Ground Cable Nut, M10x1.5, Brass	20	15	177

3.3.4 Tower Plate

The Tower Plate covers access to the motor power connection of the internal motor cables while preventing refrigerant pressure from escaping.

Figure 52 - Tower Plate



3.3.4.1 Removal and Installation

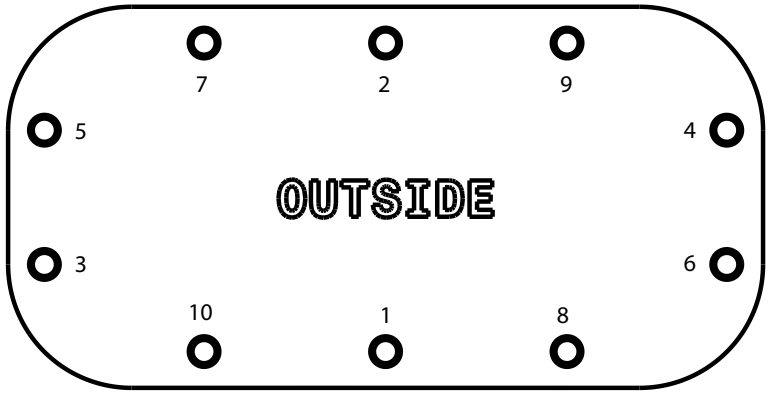
Tower Plate Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and recover refrigerant.
3. Remove the Motor Power Cover.
4. Remove the screws from the Tower Plate.
5. Remove the plate and O-ring.

Tower Plate Installation:

1. Verify all sealing and internal surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Clean the O-ring groove.
3. Ensure no parts, tools, or debris are left in the Motor Tower.
4. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Compressor tower.
5. Place the Tower Plate over Motor Tower with the writing "OUTSIDE" facing away from the tower.
6. Finger-tighten the 10 M6 screws.
7. Tighten the 10 M6 screws in a crisscross pattern in two (2) stages. Refer to Figure 53 (Tower Plate Torque Pattern).
   - Stage 1: Tighten to 5 Nm (44 in.lb.)
   - Stage 2: Tighten to a final torque of 10 Nm (88 in.lb.)

Figure 53 - Tower Plate Torque Pattern



8. Leak test the Compressor to the appropriate pressure and industry standards.
9. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
10. Charge the Compressor with refrigerant.
11. Restore power to the Compressor

3.3.4.2 Torque Specifications

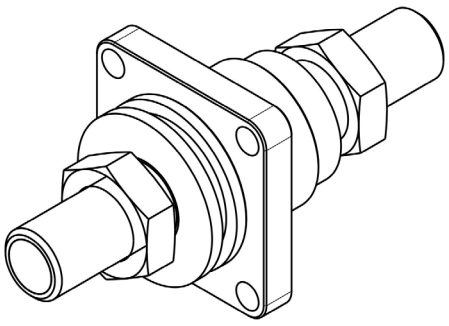
Table 18 - Tower Plate Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Tower Plate, SHCS, M6x30	10	7	89

3.3.5 Motor Power Feed Through

The Motor Power Feed Through connects the Motor Bus Bars to the internal motor leads while preventing refrigerant pressure from escaping.

Figure 54 - Motor Power Feed Through



⚠ • • • CAUTION • • •

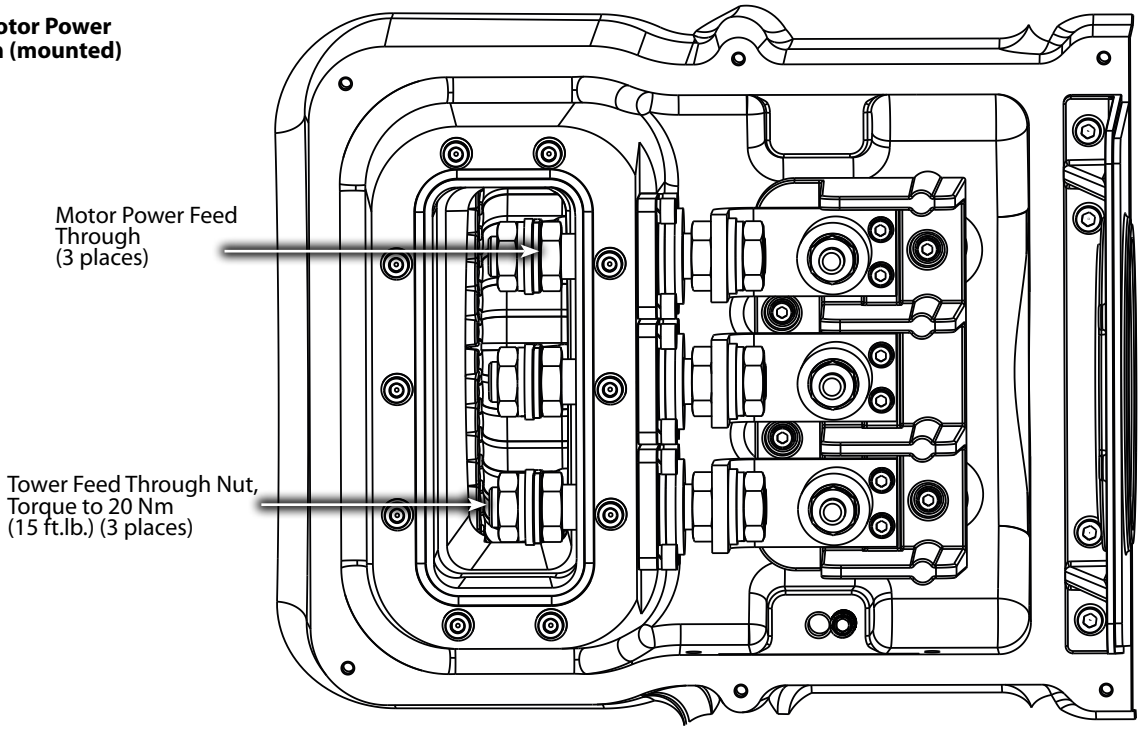
Disassembling the Motor Power Feed Through poses a risk that can lead to permanent damage. All hardware and tools *must* be accounted for prior to restarting the Compressor.

3.3.5.1 Removal and Installation

Motor Power Feed Through Removal:

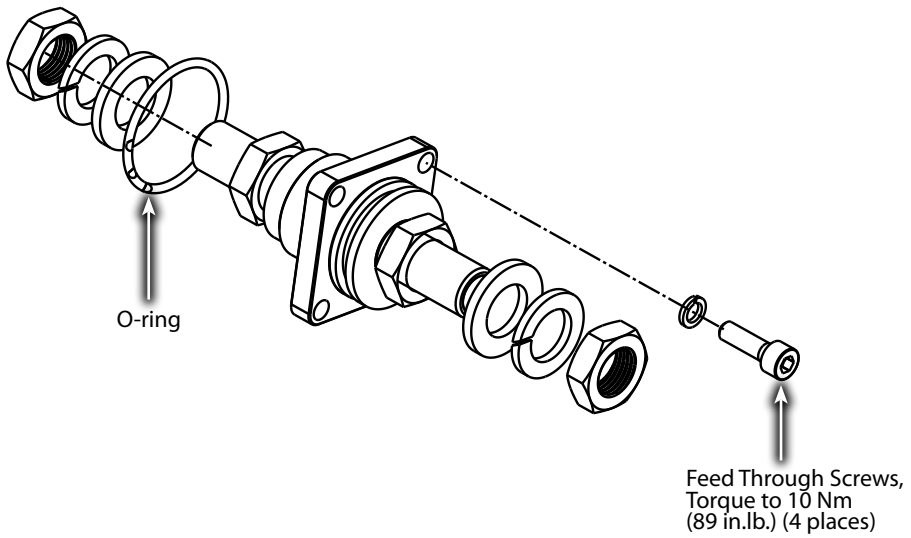
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor from the refrigerant circuit and recover refrigerant.
3. Remove the Motor Side Cover.
4. Disconnect the VFD motor cables from Motor Bus Bars.
5. Remove the motor bus bar fasteners from the Motor Power Feed Through Stud.

Figure 55 - Motor Power Feed Through (mounted)



6. Remove the terminal block assembly from the Compressor housing. Refer to the "Motor Terminal Block" section of this manual.
7. Remove the Tower Plate. Refer to the "Tower Plate" section of this manual.
8. Carefully remove the internal nuts and motor cables from the Motor Power Feedthrough.
9. Remove the screws that hold the Motor Power Feed Throughs to the Motor Tower.
10. Remove the Motor Power Feed Through(s) and O-ring(s).

Figure 56 - Motor Power Feed Through Exploded View



Motor Power Feed Through Installation:

1. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Motor Power Feed Through.
2. Insert the Motor Power Feed Through to the Motor Tower.
3. Install the M6 screws and lock washers that hold the Motor Power Feed Throughs to the Motor Tower and finger-tighten.
4. Torque the M6 screws in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 5 Nm (44 in.lb.)
   - Stage 2: Tighten to a final torque of 10 Nm (89 in.lb.)
5. Position the motor cables so they do not touch each other and that they do not touch the Compressor housing.
6. Carefully secure internal fasteners and motor cables to Motor Power Feed Throughs and torque to specification.
7. Perform a final verification that the motor cables are not touching each other or the Compressor housing.
8. Ensure no parts, tools, or debris are left in Motor Tower.
9. Ensure the sealing surface of the plate is clean and free of damage or debris.
10. Clean the O-ring groove.
11. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Motor Tower.
12. Place the Tower Plate over Motor Tower with the writing "OUTSIDE" facing away from the tower.
13. Finger-tighten the 10 M6 screws.
14. Tighten the 10 M6 screws in a crisscross pattern in two (2) stages. Refer to Figure 53 (Tower Plate Torque Pattern).
    - Stage 1: Tighten to 5 Nm (44 in.lb.)
    - Stage 2: Tighten to a final torque of 10 Nm (88 in.lb.)
15. Install the Motor Terminal Block assembly to the housing and torque to specification.
16. Secure the motor bus bar fasteners to the Motor Power Feed Though screws and torque to specification.
17. Connect the VFD motor cables to the Motor Bus Bars and torque to specification.

18. Install the Motor Side Cover.
19. Leak test the Compressor to the appropriate pressure and industry standards.
20. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
21. Charge the Compressor with refrigerant.
22. Restore power to the Compressor.

3.3.5.2 Verification

1. Before connecting the VFD motor cables, using an ohmmeter, check the resistance between the motor phases and each phase to ground.
2. While the Compressor is running under a steady load, using a clamp-on ammeter, verify the 3-phases measure a similar amperage.

3.3.5.3 Torque Specifications

Table 19 - Motor Power Feed Through Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	5	53
Motor Terminal Block to Compressor, SHCS, M5x20	6	5	53
Tower Feed Through Nut, Brass, M16x1.5	20	15	177
Power Cable Nut, Brass, M10x1.5	10	8	89
Bus Bar Mounting, SHCS, M5x16	5	4	44
Motor Power Feed Through, SHCS, M6x20	20	15	177

3.3.6 Motor

The motor type employed is a permanent magnet, synchronous speed motor. The winding section of the motor is similar in design to a standard 3-phase star-connected Stator.

Stator

The Stator operates as the force that drives the shaft, utilizing the high voltage (HV) DC pulses provided to the motor windings by the Inverter located in the VFD.

Rotor

The Rotor is an integral part of the motor shaft and is a permanent magnet design that allows the synchronous characteristic required for broad range speed control.

Motor Protection

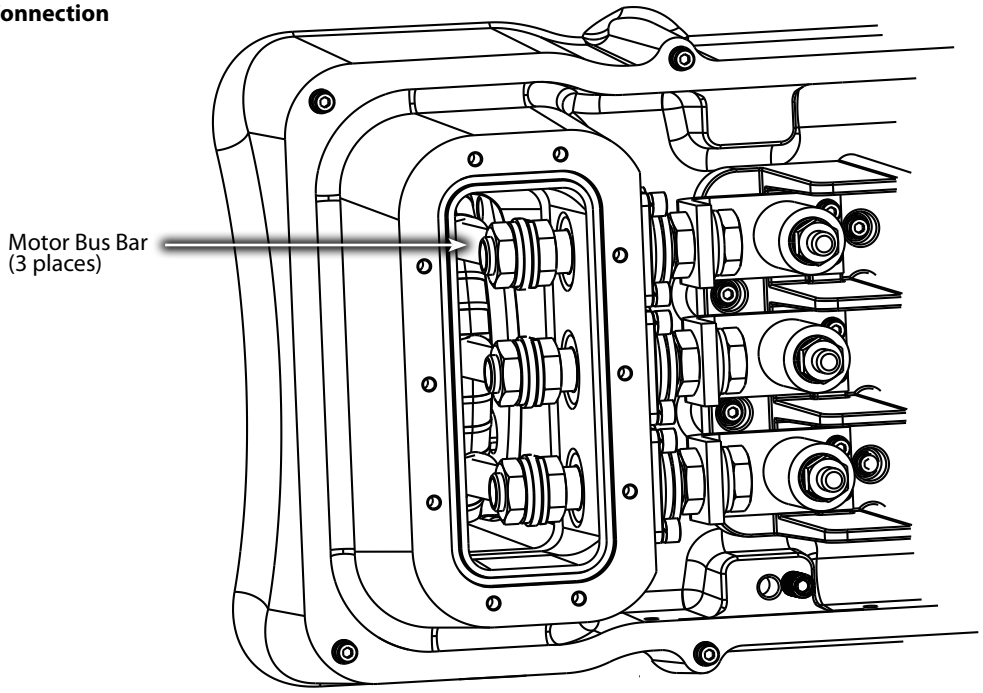
Conventional motor protection based on incoming 3-phase currents and voltage conditions are inadequate to protect the motor and electronics in the event of mishap due to the total separation of the motor windings from the incoming 3-phase current by the DC conversion. Therefore, the bulk of protection is based on measurements taken by the Inverter and calculations derived from those measurements. Motor currents and voltages displayed in the SMT cannot be directly compared or correlated to incoming 3-phase AC values.

All Stators employ overheat cutout protection utilizing two (2) separate thermistors embedded in the windings. In the event that the one of the Stator Thermistors has failed, the Compressor can continue to run. However, if both thermistors have failed, the Stator assembly must be replaced by DTC.

3.3.6.1 Connections

Refer to Figure 57 (Connection to Stator) to identify connections to the motor.

Figure 57 - Connection to Stator



3.3.6.2 Motor Verification

Stator Insulation Verification

⚠ • • • CAUTION • • •

Do not attempt to perform an insulation test on a component under vacuum. This can cause insulation breakdown or failure during the testing process.

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Motor Power Cover.
3. Remove the three (3) M10 nuts and flat washers off the top of the copper spacers.
4. Remove the motor power cables.

⚠ • • • CAUTION • • •

A faulty Stator can cause the Inverter to fail.

5. Using a mega-ohm meter set for 1000 VDC measurements, connect the red (+) mega-ohm meter lead to one of the three (3) Motor Bus Bars and the black (-) mega-ohm meter lead to the Compressor housing. The measured value should be greater than 100 mega-ohms . If the measured value does not correspond to the expected resistance, then the Stator insulation is faulty and the Compressor needs to be replaced.
6. Repeat Step five (5) for the remaining two (2) Motor Bus Bars to ensure all windings are intact.

Stator Resistance Verification

To verify the Stator resistance, complete the following steps:

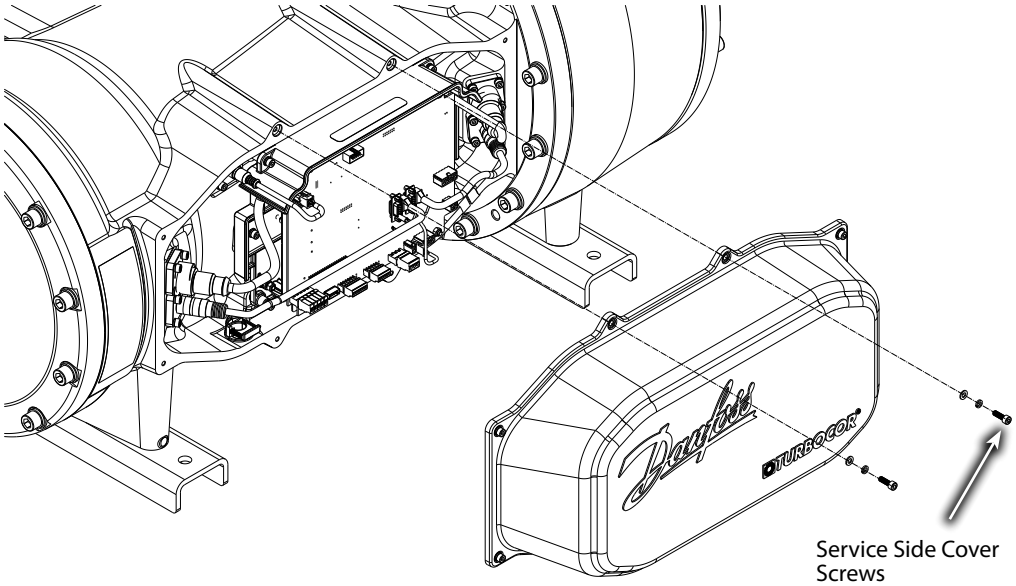
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Motor Power Cover.
3. Remove the three (3) M10 nuts and flat washers off the top of the copper spacers.
4. Remove motor power cables. Protect/isolate the cable ends.
5. Using a multimeter, set for resistance measurements and place the red (+) multimeter lead on one of the three (3) motor bus bar posts and the black (-) multimeter lead on another motor bus bar post and record the results. The measured value should be less than 1Ω but not zero. If the measured value is 0.0Ω or greater than 1Ω, then the Stator winding is faulty and the Compressor must be replaced.
6. Repeat Step 5 for the remaining combinations of Motor Bus Bars to ensure all windings are intact.
7. Connect the motor power cables.
8. Install the three (3) M10 nuts and washers on the studs above the copper spacers and power cables, then torque to specification.
9. Restore power to the Compressor.

Stator Thermistor Resistance Verification

Two (2) resistance temperature detectors (RTDs) are embedded into the Stator in separate locations. Each of these sensors contain a distinct circuit (circuit one and circuit two) that must be tested individually. These embedded RTDs are permanently mounted in the Stator and cannot be serviced in the field.

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.

Figure 58 - Service Side Cover



3. Unplug the winding temperature harness from the J12 connector on the CCM.
4. Verify the resistance of each circuit at the external connector to CCM J12.

Figure 59 - Stator Temperature Sensor Cable Connector

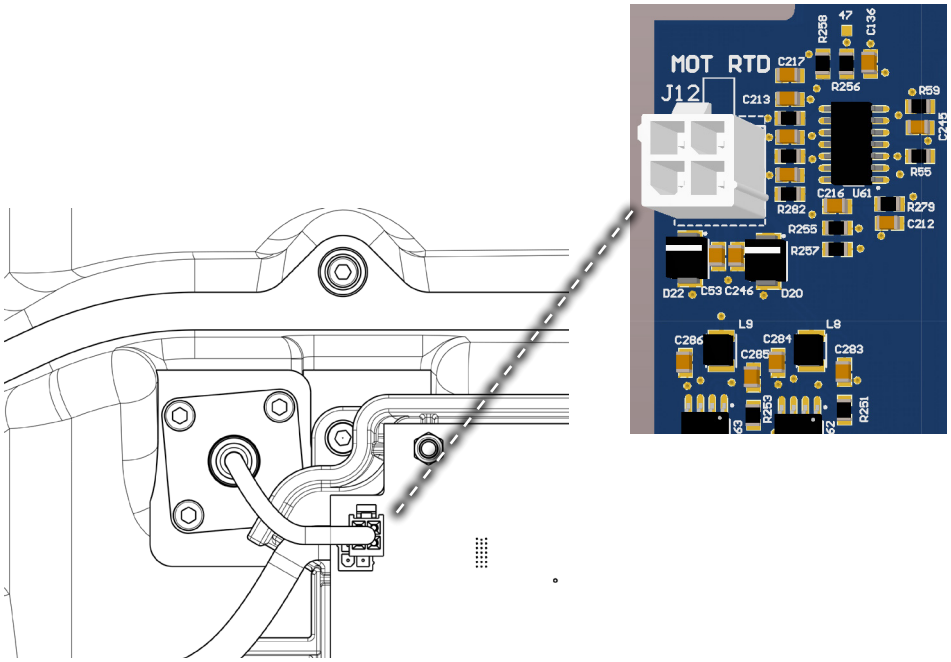
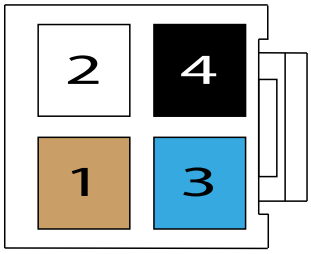


Figure 60 - Stator Temperature Sensor Cable External Connector



5. Circuit one, pins 1 and 3, are brown and blue.
6. Circuit two, pins 2 and 4, are white and black.
7. Using a multimeter set for resistance measurements, place the red (+) multimeter lead on pin 1 and the black (-) multimeter lead on pin 3 of the external connector and record the measurement.
8. Perform the same resistance measurement for pins 2 and 4 of the external connector. If the measured value does not correspond to the expected resistance, then the internal connector must be checked in order to verify if the problem exists in the feed through or the Stator itself. Refer to section "Stator Temperature Sensor Feed Through" for details regarding accessing the internal connector.

NOTE

Both are approximately 1.09kΩ at 22°C (72°F). Refer to Table 20 (Stator Thermistor R/T Curve) for further values.

Table 20 - Stator Thermistor R/T Curve

Temperature °C	Resistance Ω	Temperature °C	Resistance Ω	Temperature °C	Resistance Ω
-50	803.1	40	1155.4	130	1498.3
-40	842.7	50	1194.0	140	1535.8
-30	882.2	60	1232.4	150	1573.3
-20	921.6	70	1270.8	160	1610.5
-10	960.9	80	1309.0	170	1647.7
0	1000.0	90	1347.1	180	1684.8
10	1039.0	100	1385.1	190	1721.7
20	1077.9	110	1422.9	200	1758.6
30	1116.7	120	1460.7		

NOTE

Measured values must be within ± 10% of the values in Table 20 (Stator Thermistor R/T Curve).

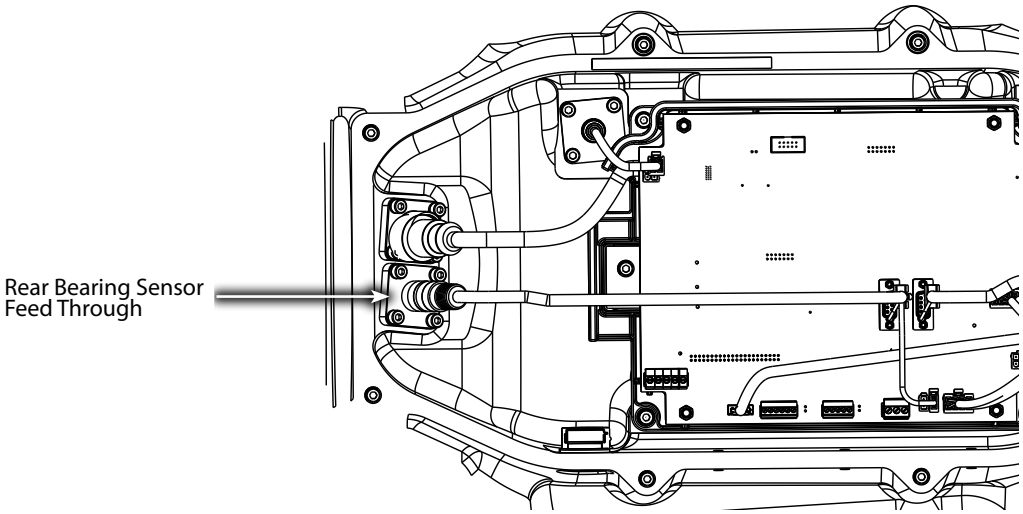
9. Verify resistance of each circuit at the external connector to housing (ground).
   - Should be "open."
10. If the Stator Temperature Sensor Feed Through is suspected to have a problem, remove it and test as above directly at the internal connector. Refer to the "Stator Temperature Sensor Feed Through" section of this manual.
11. Restore power to the Compressor.

Stator Cooling Temperature Sensor Resistance Verification

There is a Stator Cooling Temperature Sensor located in the rear of the Compressor. It is mounted to the Radial Bearing Assembly. This sensor contains a single circuit. Refer to Figure 160 (Stator Cooling Temperature Sensor) for details on the exact location of this sensor.

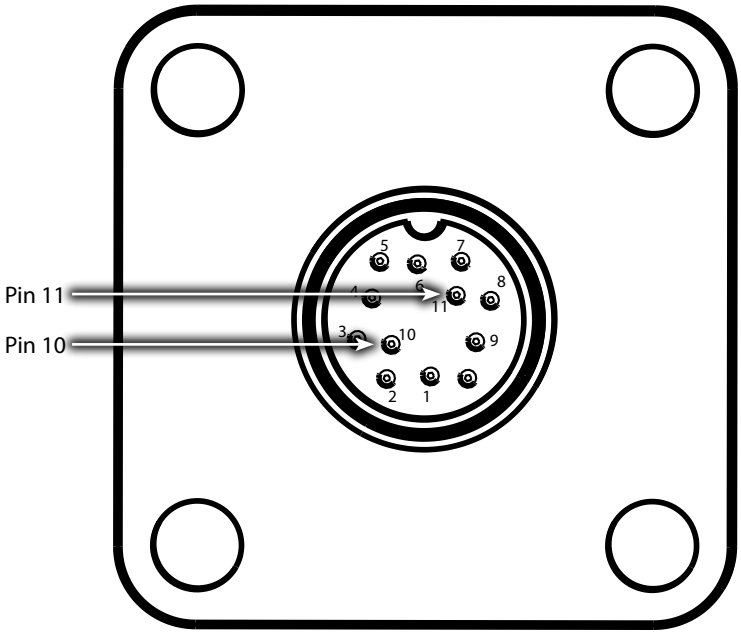
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Disconnect the external bearing sensor cable from the feed through. Refer to Figure 61 (Rear Bearing Sensor Feed Through) for details on the location.

Figure 61 - Rear Bearing Sensor Feed Through



3. Use a multimeter set to resistance, verify the resistance of the circuit at the feed through. Resistance should be measured between Pins 10 and 11and the measured value should be within ± 10% of the resistance values listed in the chart in Table 20 (Stator Thermistor R/T Curve**)**.
4. If the value is out of tolerance, the sensor will need to be tested internally. If the sensor is still not within tolerance, it will need to be replaced. Refer to the "Rear Bearings" section for details on how to access the internal Rear Bearing Sensor connector.
5. Restore power to the Compressor.

Figure 62 - Stator Cooling Temperature Sensor Pinout

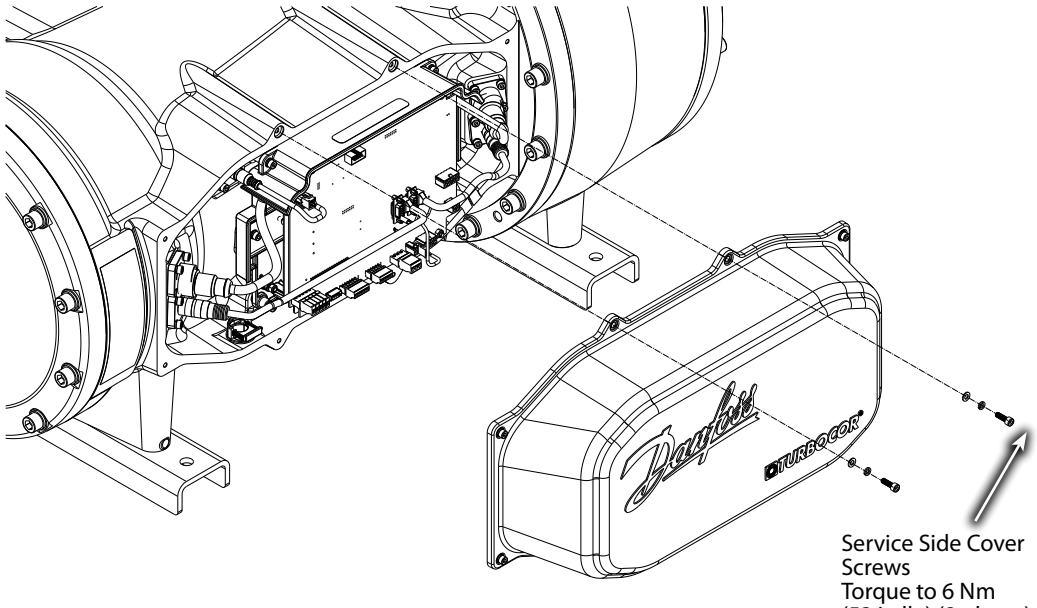


3.4 Service Side

3.4.1 Service Side Cover

The Service Side Cover provides protection for the PWM, CCM, feed throughs, and cabling.

Figure 63 - Service Side Cover



3.4.1.1 Removal and Installation

Service Side Cover Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the eight (8) M5x16 screws that hold the Service Side Cover in place.
3. Remove the Service Side Cover.

Service Side Cover Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Place the gasket on the sealing surface of the cover.
3. Place the cover over the service side.
4. Install the eight (8) M5x16 screws to secure the Service Side Cover.
5. Restore power to the Compressor.

3.4.1.2 Torque Specifications

Table 21 - Motor Power Cover Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Service Side Cover, SHCS, M5x16	6	-	53

3.5.1 Front Bearing Power and Sensor Feed Throughs

The Front Bearing Power Feed Through supplies power from the PWM to the front radial magnetic bearing actuators, while keeping refrigerant pressure from escaping. The Front Bearing Sensor Feed Through supplies shaft position signals from the bearing sensors to the CCM, while keeping refrigerant pressure from escaping.

Figure 64 - Front Bearing Sensor Feed Through

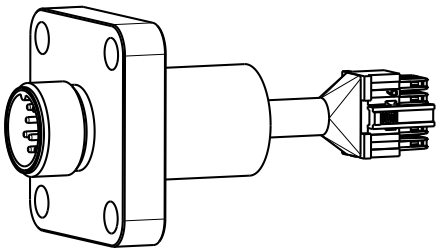
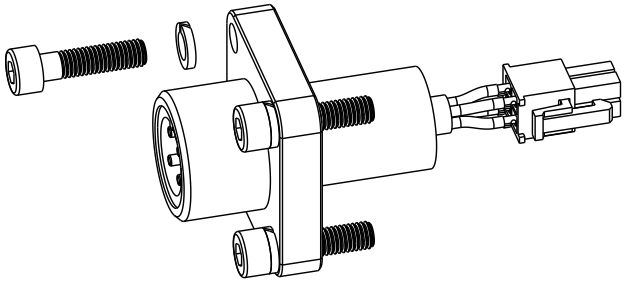


Figure 65 - Front Bearing Power Feed Through



3.5.1.1 Removal and Installation

Front Bearing Power and Sensor Feed Through Removal:

- Refer to the "Front Bearings" section of this manual.

3.6.1 Rear Bearing Power and Sensor Feed Throughs

The Rear Bearing Power Feed Through supplies power from the PWM to the front radial magnetic bearing actuators, while keeping refrigerant pressure from escaping. The Rear Bearing Sensor Feed Through supplies shaft position signals from the bearing sensors to the CCM, while keeping refrigerant pressure from escaping.

Figure 66 - Rear Bearing Sensor Feed Through

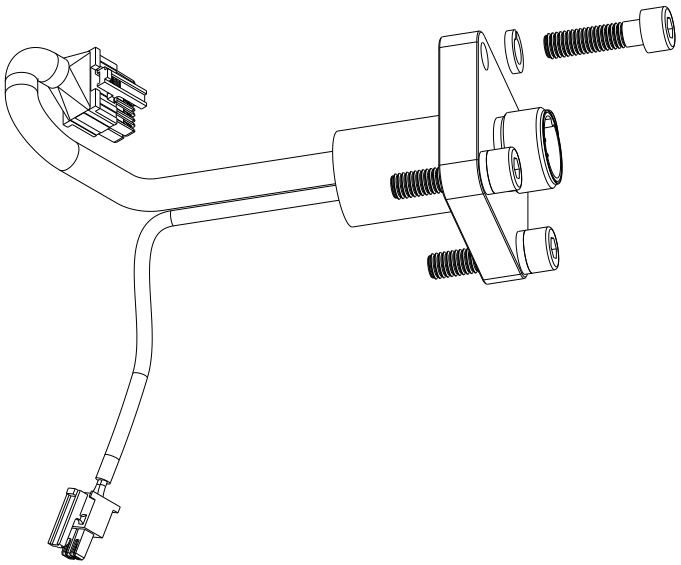
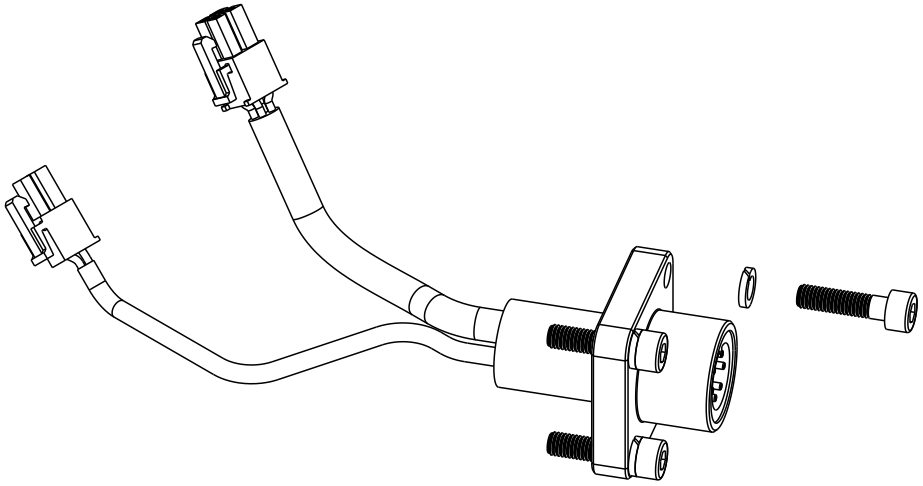


Figure 67 - Rear Bearing Power Feed Through



3.6.1.1 Removal and Installation

Rear Bearing Power and Sensor Feed Through Removal:

- Refer to the "Rear Bearings" section of this manual.

3.7.1 VTT Service Electronics Assembly

The VTT Service Electronics is an assembly that includes the CCM and PWM Amplifier. There are two (2) major revisions of the VTT Service Electronics assembly and these revisions are not interchangeable. Revisions "A" and "B" use Molex style connectors (Figure 68 (VTT Service Electronics (Revisions A and B)), while "C" Revision and later Compressors utilize a mixture of terminal block style connectors and Molex connectors (Figure 69 (VTT Service Electronics (Revisions C and Later)). When necessary, the two (2) styles are pictured in this section.

Figure 68 - VTT Service Electronics (Revisions A and B)

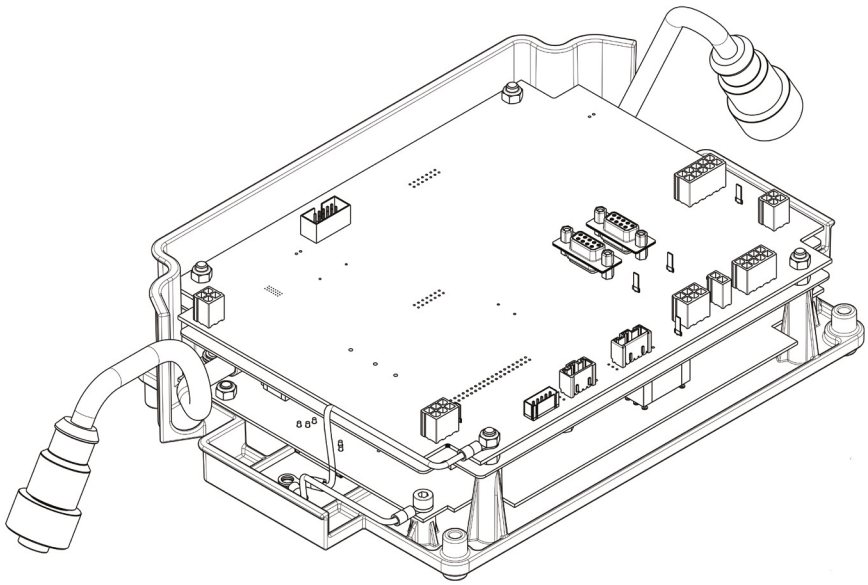
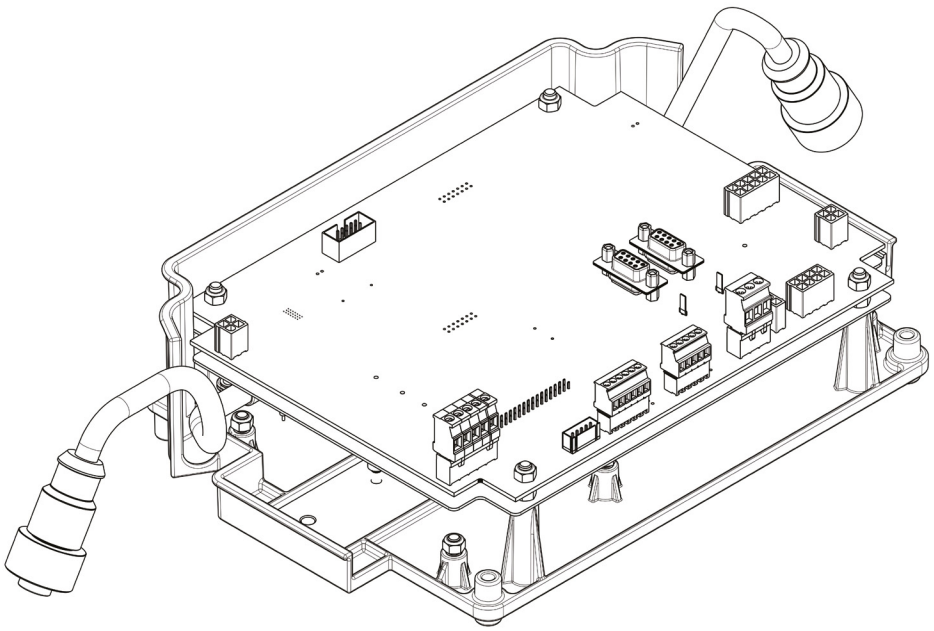


Figure 69 - VTT Service Electronics (Revisions C and Later)



⚠ • • • CAUTION • • •

Follow established ESD procedures to prevent damage to sensitive electronic components when working on the Service Electronics Assembly.

The CCM and PWM Boards cannot be serviced separately, therefore the Service Electronics Assembly will need to be replaced should there be a fault with either the CCM or the PWM.

3.7.1.1 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Disconnect the power and communications cables from the CCM and PWM.
4. Disconnect all cables going to the VTT Service Electronics Assembly.
5. Remove the PWM heat sink fasteners and ground wires (if applicable).

NOTE

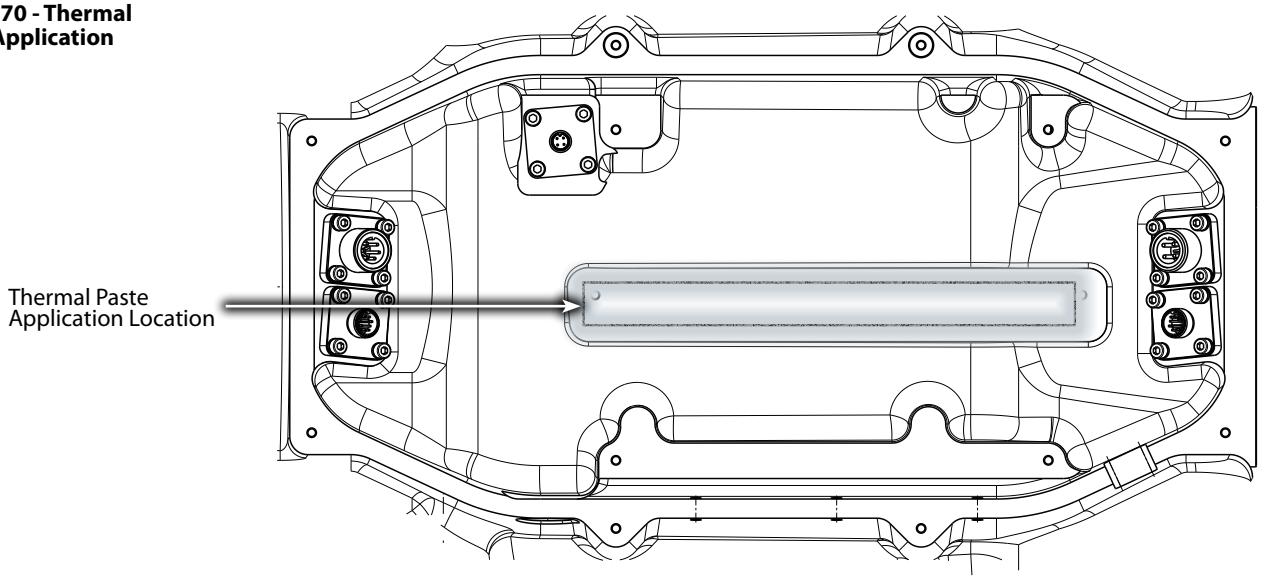
The various connections are illustrated throughout this section.

6. Remove the fasteners that secure the Service Electronics Assembly plastic frame to the main housing and then remove the Service Electronics Assembly.

Installation:

1. Clean the Compressor housing and apply a thin layer of thermal paste to the PWM heat sink surface of the main housing. Refer to Figure 70 (Thermal Paste Application).

Figure 70 - Thermal Paste Application



2. Attach the Service Electronics Assembly to the main housing using two (2) screws located at the heat sink but do not tighten. Be sure to include the two (2) ground wires on the left and the one (1) 250 VDC ground wire on the right.
3. Install the remaining four (4) screws into the Service Electronics Assembly and torque to specification.
4. Reconnect all applicable cables.
5. Reconnect the power and communication cables to the CCM and PWM.
6. Restore power to the Compressor.
7. Using the SMT, perform a calibration and save to electrically erasable programmable read-only memory (EEPROM).

3.7.1.2 CCM

3.7.1.2.1 CCM Function

The CCM is the center point for all electronics in the Compressor and performs the following functionalities:

- Compressor monitoring and control
- Communication with the VFD module and CIM
- Bearing monitoring and Control
- Motor cooling EXV (EEV_MOT)
- IFV control
- Interlock
- Sensors monitoring

The CCM holds the computational power needed to operate the entire Compressor electronics. It has all of the bearing and Compressor functional logic to provide the bearing PWM output. The EEPROM holds the parameter settings for the particular Compressor modules. The flash memory holds the firmware and data storage for the logs.

Figure 71 - CCM (Revisions A and B)

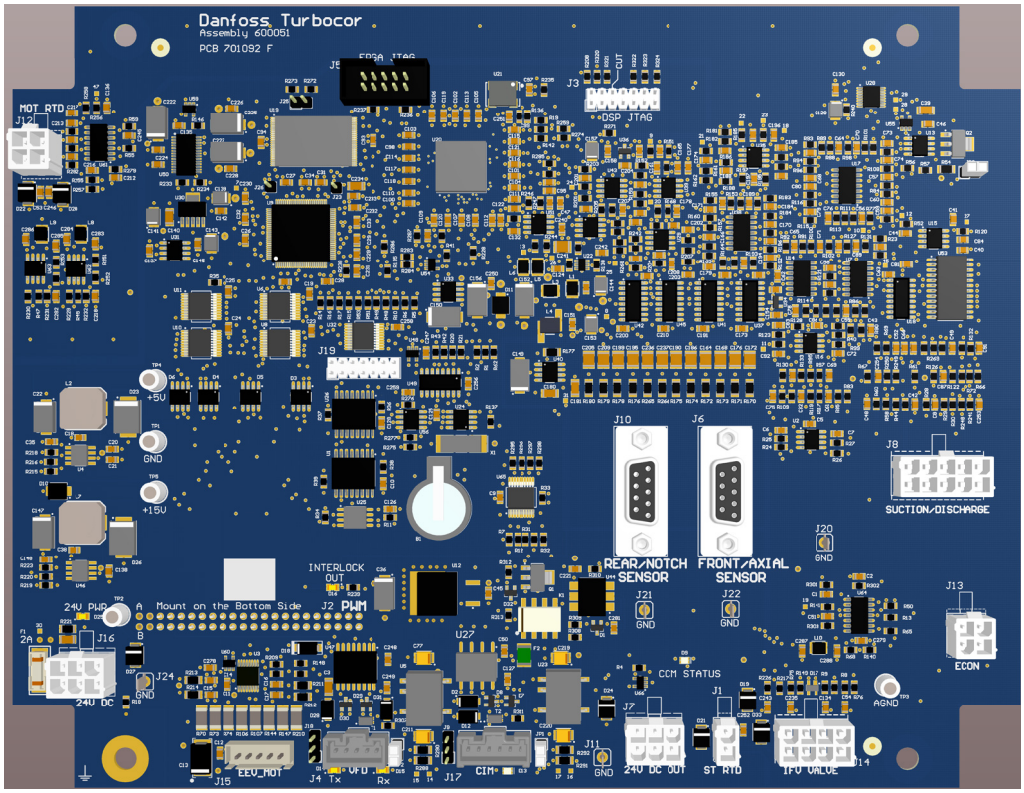
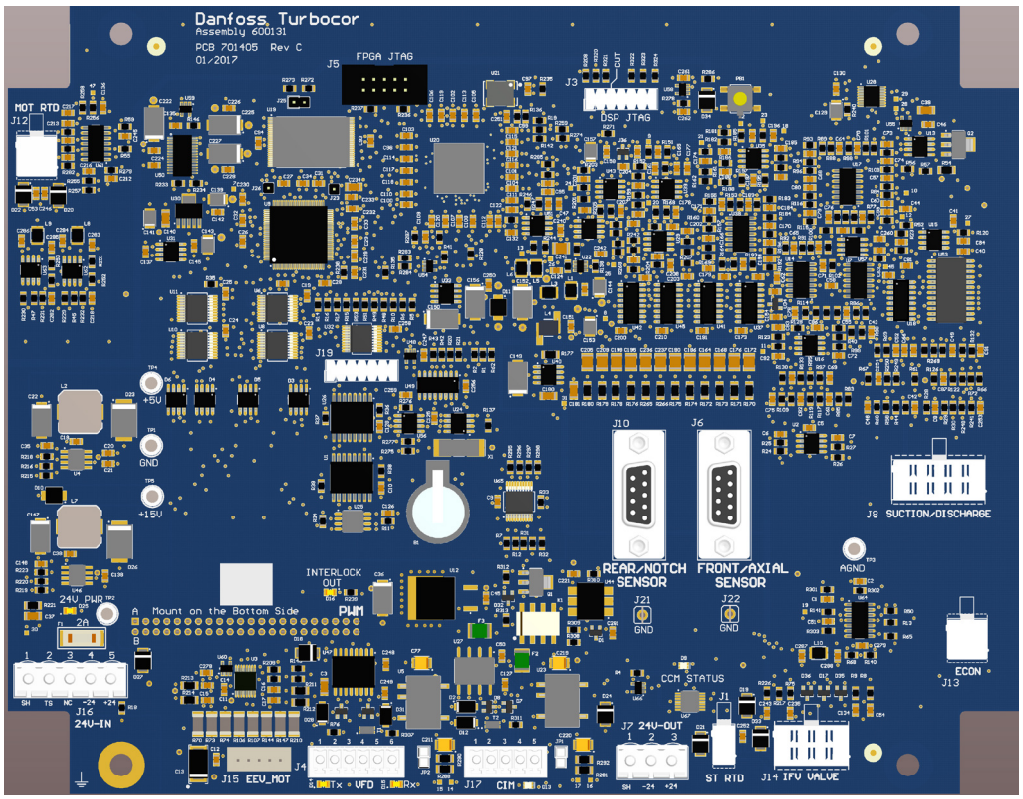


Figure 72 - CCM (Revisions C and Later)



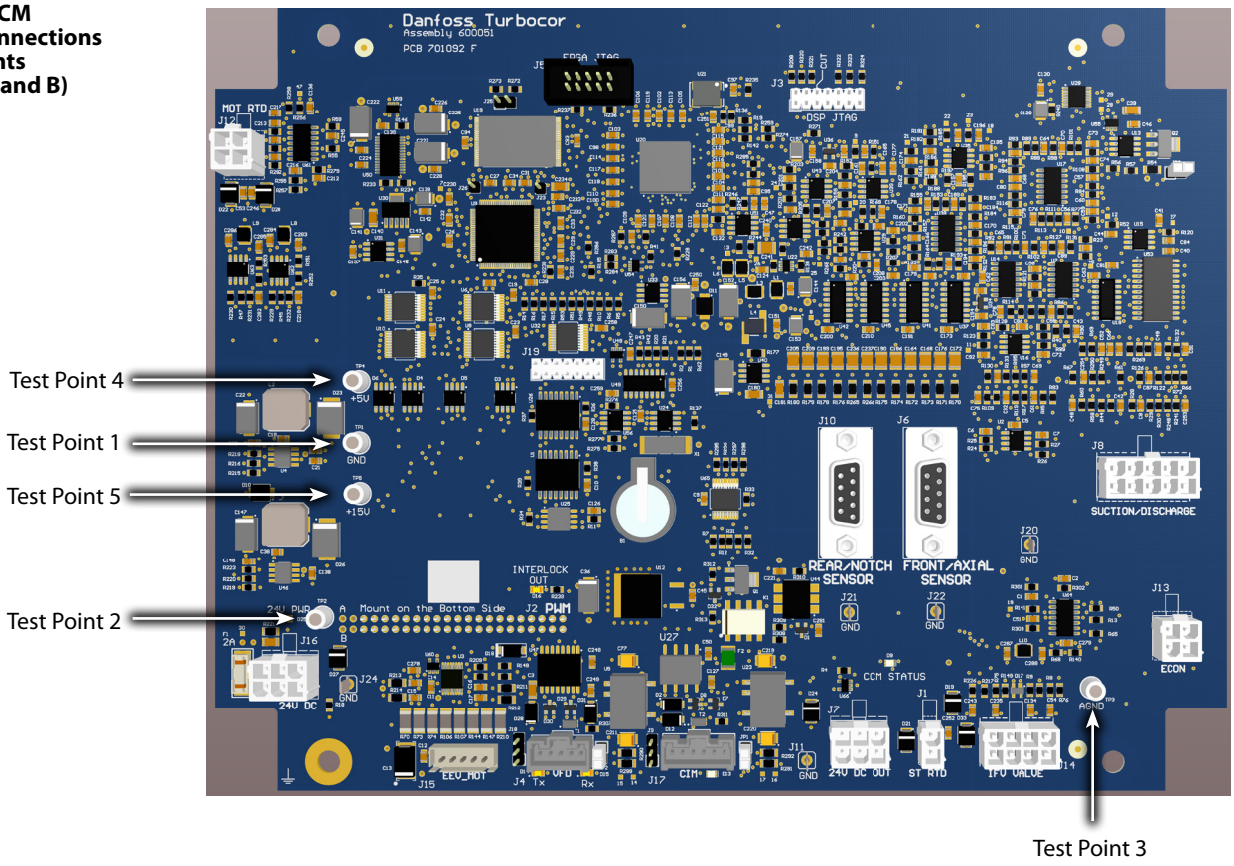
The CCM receives the following voltages from the VTT VFD:

- 5 VDC
- 15 VDC
- 24 VDC

3.7.1.2.2 CCM Connections

- J12 – Motor Temperature – upper left
- J16 – 24V DC In and J24 ground– lower left
- J15 – Motor Cooling EEV – bottom left
- J4 – VFD Communication – bottom left
- J17 – CIM Communication – bottom middle
- J7 – 24 V DC Out to CIM and J11 Ground – bottom right
- J10 and J6 – Bearing Sensor Cables – center right
- J1 – ST RTD – bottom right
- J14 – IFV Valve – bottom right
- J13 – Economizer EEV (if available) – lower right
- J8 – Suction/Discharge P/T sensors – mid right

Figure 73 - CCM Electrical Connections and Test Points (Revisions A and B)



NOTE

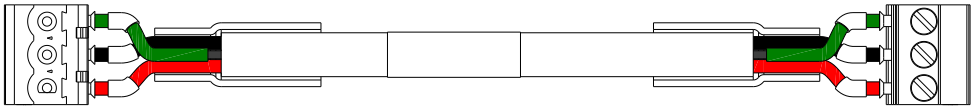
The location is the same for the Test Points for all revision CCM Board assemblies.

3.7.1.3 CCM-CIM 24V Cable

The CCM-CIM 24V Cable passes 24V DC from the CCM to the CIM.

Figure 74 - CCM-CIM 24V Cable (Revisions A and B)

Figure 75 - CCM-CIM 24V Cable (Revisions C and Later)



3.7.1.3.1 Removal and Installation

Removal:

1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Locate J7 on the CCM Board and unplug the connector.

Figure 76 - CCM J7 Connector (Revisions A and B)

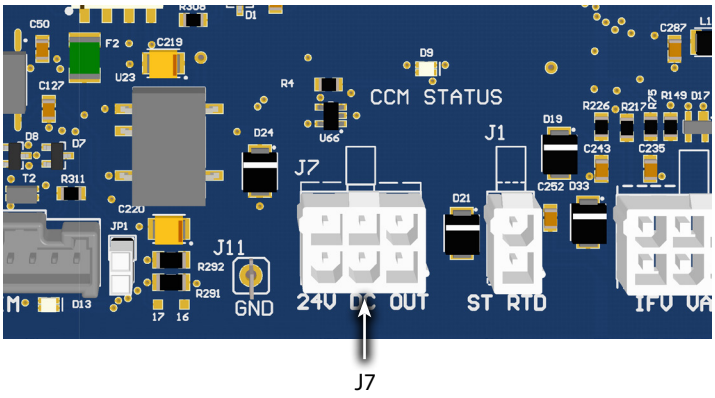
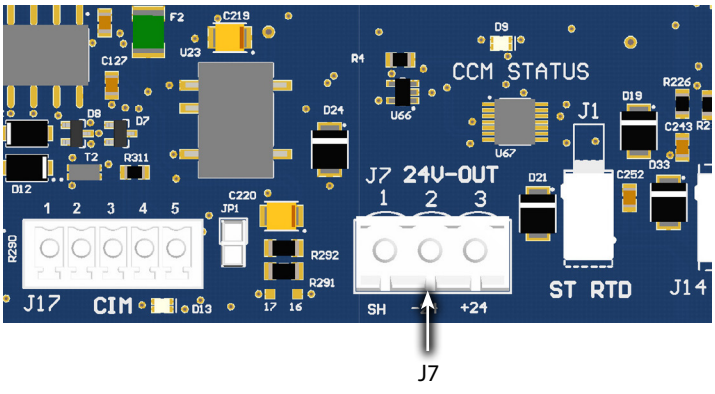
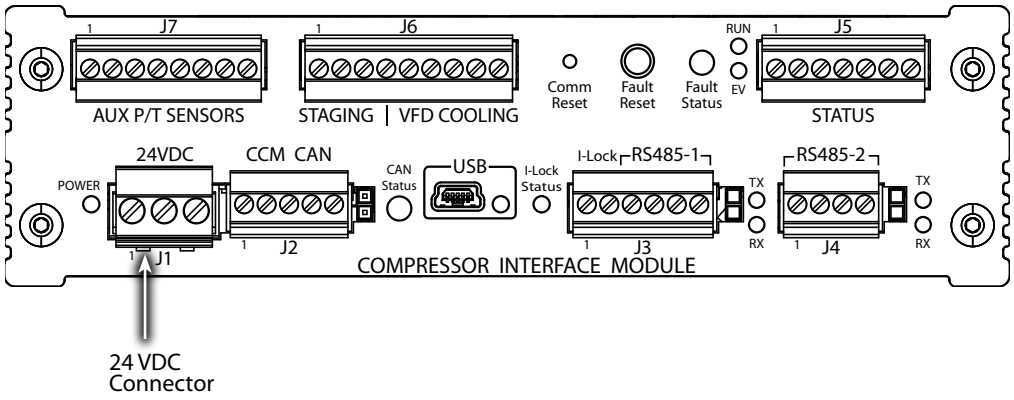


Figure 77 - CCM J7 Connector (Revisions C and Later)



4. Remove the cover to the controls panel where the CIM is located.
5. Remove the 24 VDC connector from the CIM.

Figure 78 - 24 VDC Connector at CIM



NOTE

There are two (2) variants of the CIM. Revisions A and B do not contain the connector numbers (e.g., J5). The "Pin 1" indicators are also not present on the A and B revisions.

6. Route the cable out of the service side and CIM boxes.

Installation:

1. Route the new cable between the CCM and CIM.
2. Insert the 24 VDC connector to the CIM.
3. Insert the 24 VDC connector into J7 on the CCM Board.
4. Replace the covers.
5. Restore power to the Compressor.

3.7.1.3.2 24 VDC CCM-CIM Cable Verification

After power is applied to the Compressor, ensure the light emitting diodes (LEDs) on the CIM are on and communication is established.

3.7.1.4 DC-DC-CCM 24V Cable

The DC-DC-CCM 24V Cable passes 24 VDC from the DC-DC to the CCM.

Figure 79 - DC-DC-CCM Cable (Revisions A and B)

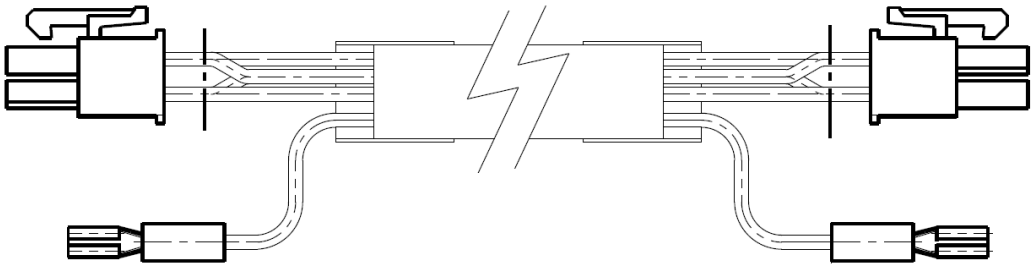
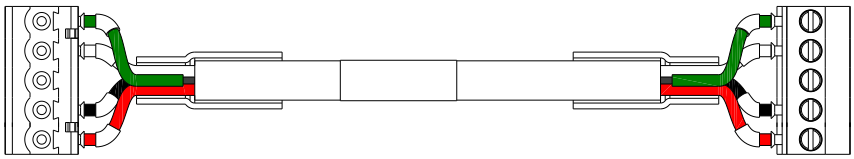


Figure 80 - DC-DC-CCM Cable (Revisions C and Later)

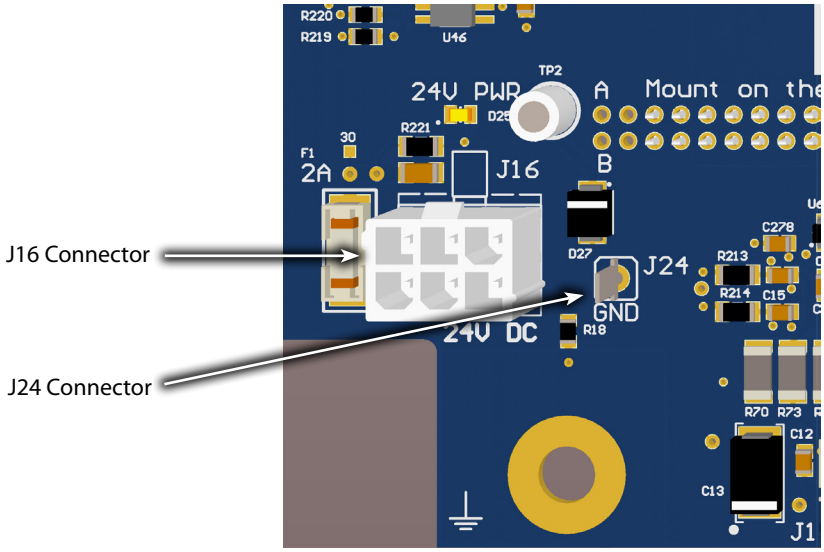


3.7.1.4.1 Removal and Installation

Removal (Revisions A and B):

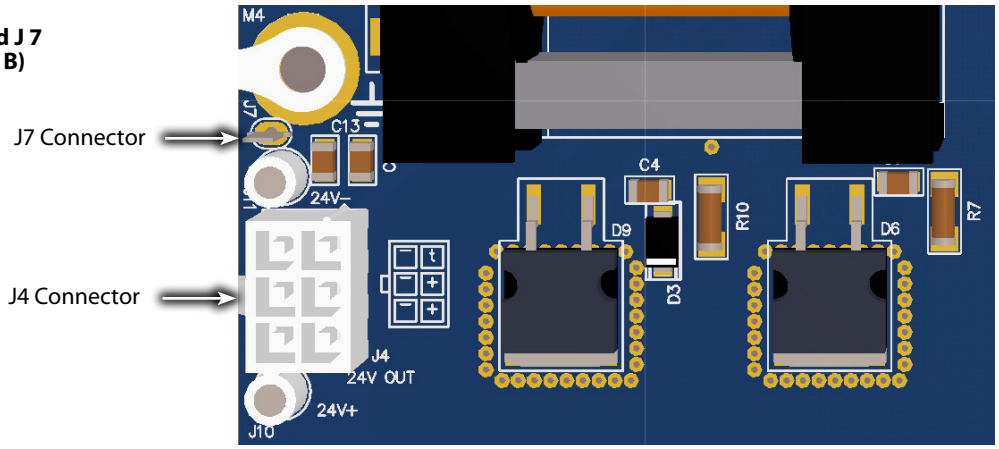
1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Disconnect the 24 VDC (J16) and GND (J24) connectors from the CCM Board.

Figure 81 - J16 and J24 (Revisions A and B)



4. Remove 24 VDC (J4) and GND (J7) from DC-DC Board.

Figure 82 - J4 and J 7 (Revisions A and B)

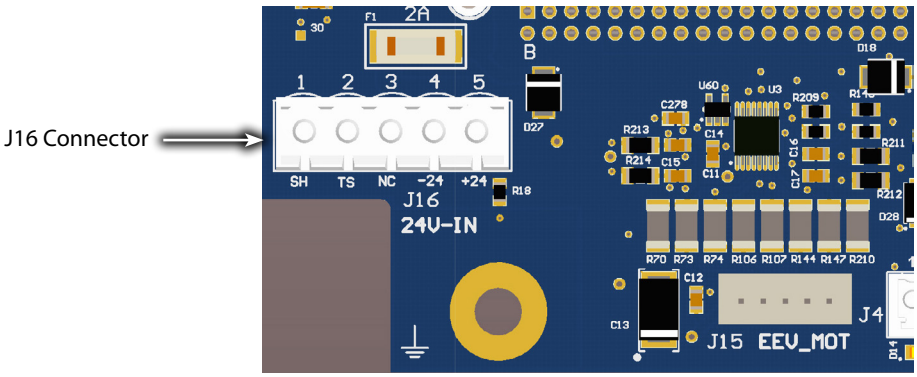


5. Remove the cable between the CCM and DC-DC.

Removal (Revisions C and Later):

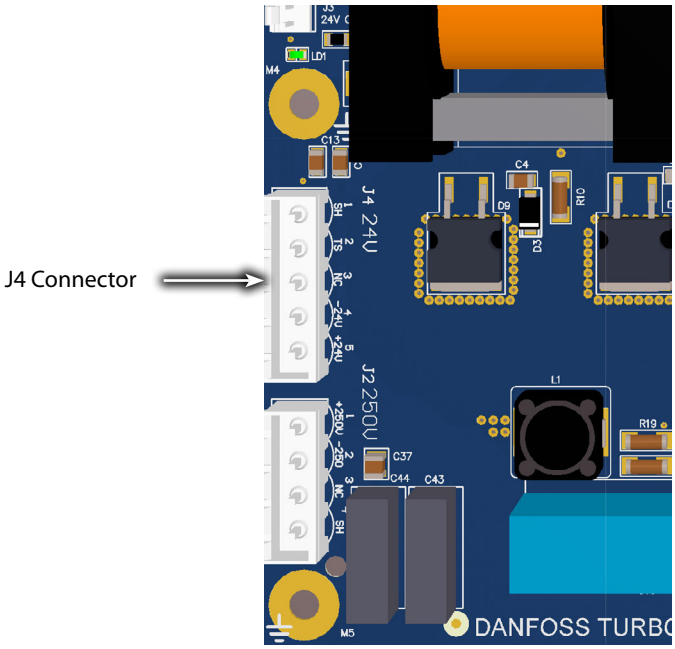
1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Disconnect the J16 connector from the CCM Board.

Figure 83 - J16 (Revisions C and Later)



4. Remove J4 from the DC-DC Board.

Figure 84 - J4 (Revisions C and Later)



5. Remove the cable between the CCM and the DC-DC.

Installation (Revisions A and B):

1. Route the cable into the service side and into the DC-DC panel.
2. Connect the plugs on the CCM Board at 24 VDC (J16) and GND (J24).
3. Terminate the connectors on the DC-DC Board at 24 VDC (J4) and GND (J7).
4. Secure the cables in place.
5. Install the Service Side Cover.
6. Restore power to the Compressor.

Installation (Revisions C and Later):

1. Route the cable into the service side and into the DC-DC panel.
2. Connect the plug to the J4 connector on the CCM Board.
3. Terminate the connector on DC-DC Board at 24 VDC (J4).
4. Secure the cables in place.
5. Install the Service Side Cover.
6. Restore power to the Compressor.

3.7.1.4.2 DC-DC-CIM 24V Cable Verification

After power is applied to the Compressor, ensure the LEDs on the CIM are illuminated and communication is established.

3.7.1.5 CCM-CIM Cable

The CCM-CIM Cable provides a connection for communication between the CCM and the CIM.

Figure 85 - CCM-CIM Cable (Revisions A and B)

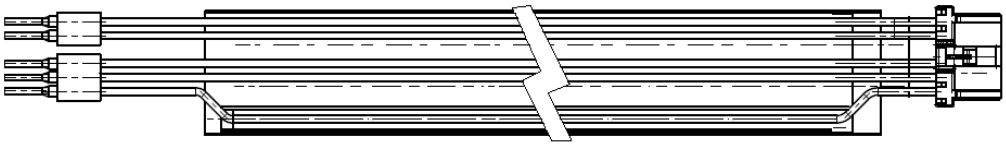
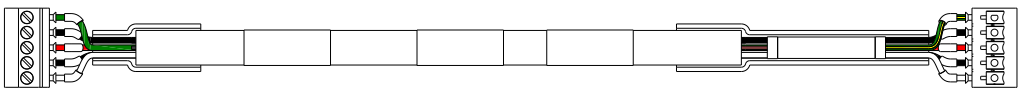


Figure 86 - CCM-CIM Cable (Revisions C and Later)

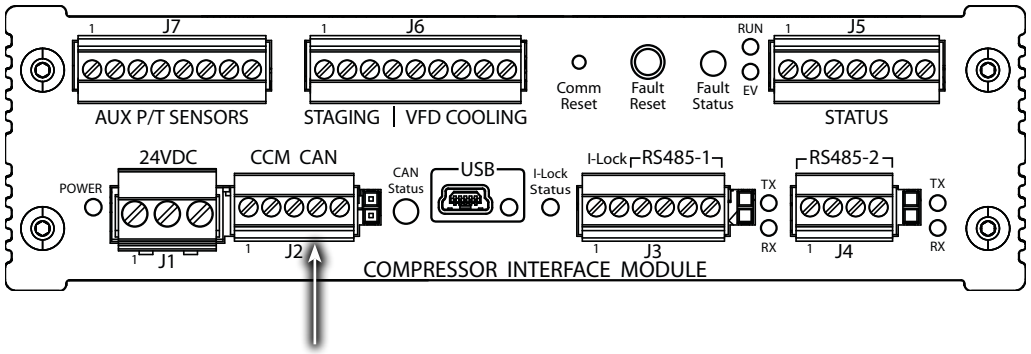


3.7.1.5.1 Removal and Installation

Removal:

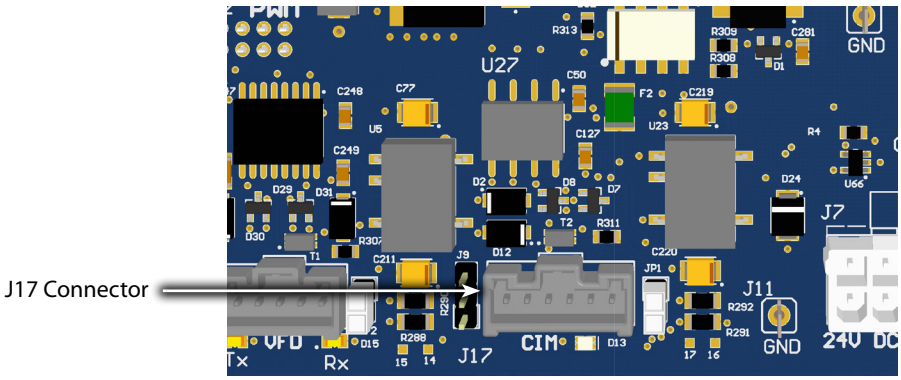
1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the cover to the controls panel.
3. Disconnect the J2 CCM CAN terminals from the CIM.

Figure 87 - J2 Connection at CIM



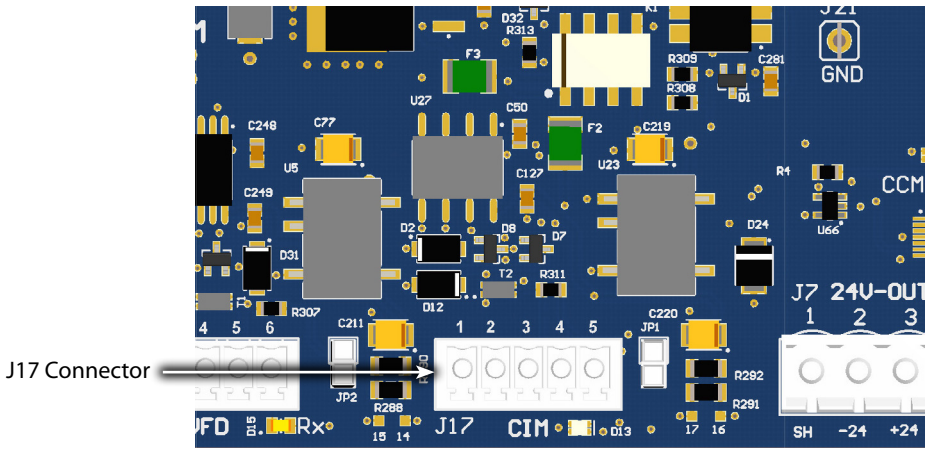
4. Remove the Compressor Service Side Cover.
5. Disconnect the J17 connector from the CCM Board.

Figure 88 - J17 (Revisions A and B)



6. Remove the cable between the CIM and the CCM Boards.

Figure 89 - J17 (Revisions C and Later)



Installation:

1. Route cable between the CCM and CIM.
2. Connect cable to J2 CCM/CAN termination on the CIM.
3. Connect opposite end of cable to J17 CIM on CCM Board.
4. Secure cables in location.
5. Reinstall the covers.
6. Restore power to the Compressor and verify proper operation.

3.7.1.5.2 CCM-CIM Cable Verification

1. With Power applied to the Compressor, connect to the CIM using the SMT and enter the User ID and Access Code.
2. Open the Warnings and Faults Tool.
3. Verify that the CIM Compatibility, CAN Communications and VFD Communications Faults are not active.

3.7.1.6 CCM-VFD Cable

The VFD Cable provides a connection for communication between the CCM and the VFD.

Figure 90 - CCM-VFD Cable (Revisions A and B)

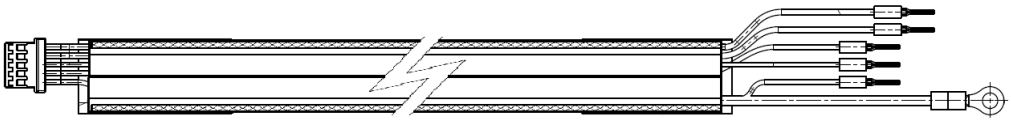
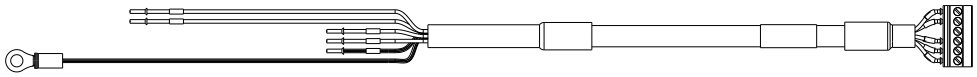


Figure 91 - CCM-VFD Cable (Revisions C and Later)



3.7.1.6.1 Removal and Installation

Removal:

1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Compressor Service Side Cover.

Figure 92 - J4 Connector (Revisions A and B)

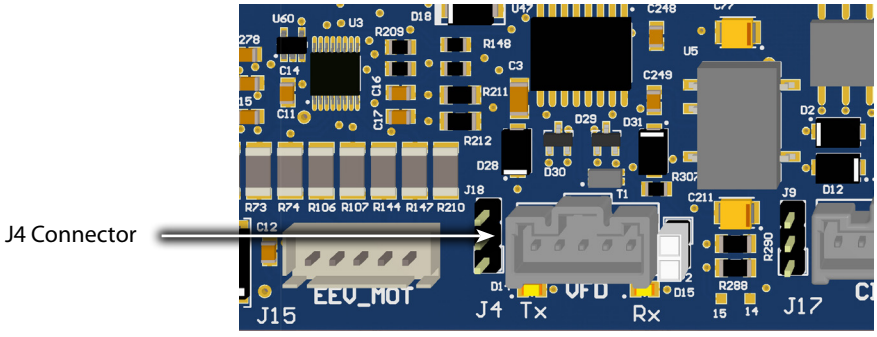
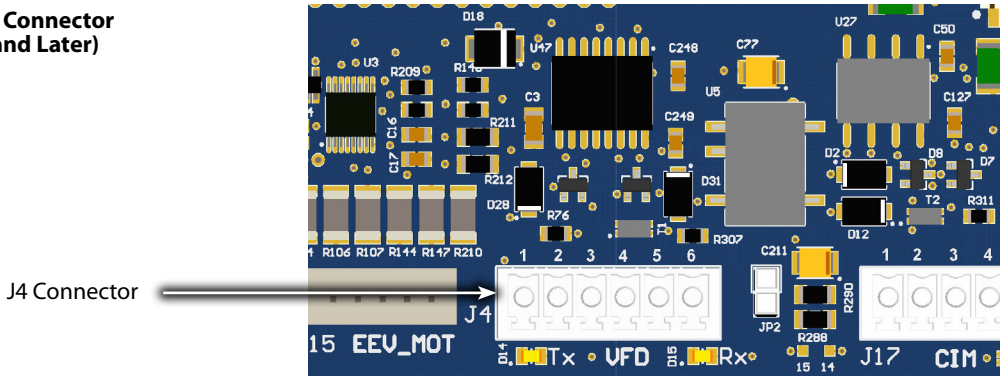


Figure 93 - J4 Connector (Revisions C and Later)



3. Remove the connector J4 from the CCM.
4. Open the VFD front panel.
5. Remove wires from terminals 61, 68, 69, 12, and 19.

Figure 94 - Terminal Identification

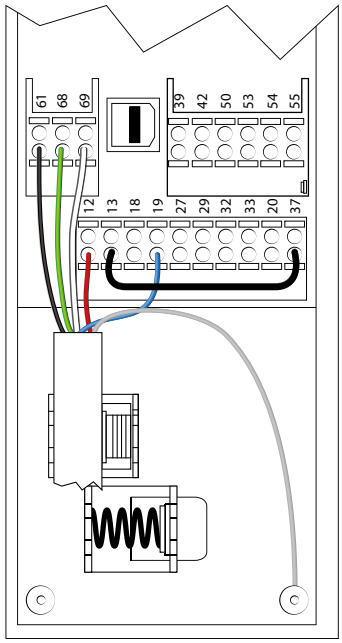


Table 22 - Terminal to Wire Color

Wire Color	Terminal Number
Black	61
Green	68
White	69
Red	12
Blue	19
Silver	Screw

6. Remove the cable.

Installation:

1. Attach wires to terminals 61, 68, 69, 12, and 19.
2. Route Cable into service side box.
3. Connect plug to (J4) on CCM.
4. Replace the covers.
5. Restore power to the Compressor.

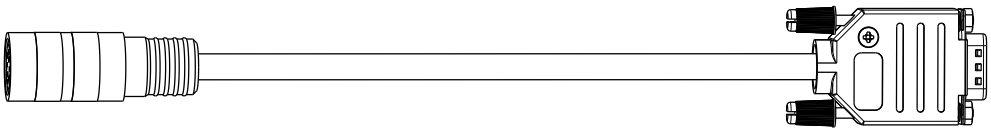
3.7.1.6.2 CCM-VFD Cable Verification

1. With Power applied to the Compressor, connect to the CIM using the SMT and enter the User ID and Access Code.
2. Open the Warnings and Faults Tool.
3. Verify that the CIM Compatibility, CAN Communications and VFD Communications Faults are not active.

3.7.1.7 Front Bearing Sensor Cable

The Front Bearing Sensor Cable provides shaft position information from the Front Bearing Sensor Feed Through to the CCM.

Figure 95 - Front Bearing Sensor Cable

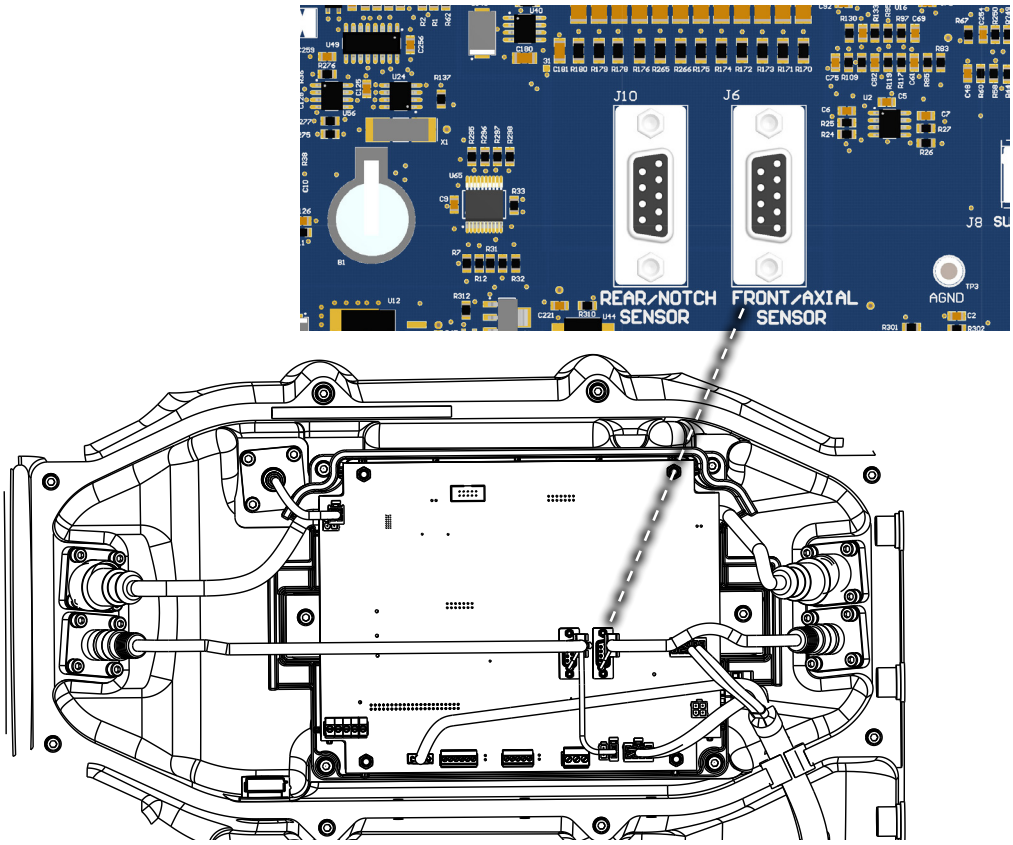


3.7.1.7.1 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Remove the 9-pin connector from J6 on the CCM Board.
4. Twist and pull to remove the sensor cable connection from the feed through.

Figure 96 - Front Bearing Sensor Connections



Installation:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Connect the 9-pin connector into J6 on the CCM Board.
3. Twist and push to connect the sensor cable connection to the feed through.
4. Install the Service Side Cover.
5. Restore power to the Compressor.

3.7.1.7.2 Front Bearing Sensor Cable Verification

1. Using a multimeter set for resistance measurements, check the resistance at the 9-pin connector to verify connection to the sensor ring. Refer to Table 23 (Front Bearing Sensor Pin Verification) for the resistance specifications. Refer to Figure 97 (9-Pin Connector) for the pinout.
2. If the results do no match the specifications listed, remove the cable and check the resistances at the feed through. Refer to Figure 98 (Feed Through Connector) for the pinout.
3. If the results still do not match the listed specifications, the feed through will need to be tested for continuity. Refer to the "Rear Bearings" section for details on how to remove the feed through.

Table 23 - Front Bearing Sensor Pin Verification

Pins	Sensor Type	Resistance
6-7	Radial	2.0 Ω to 3.5 Ω
6-8	Radial	2.0 Ω to 3.5 Ω
9-1	Rotation	2.0 Ω to 3.5 Ω
1-4	Rotation	2.0 Ω to 3.5 Ω
2-3	Radial	2.0 Ω to 3.5 Ω
3-5	Radial	2.0 Ω to 3.5 Ω

Figure 97 - 9-Pin Connector

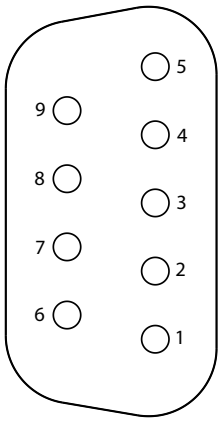
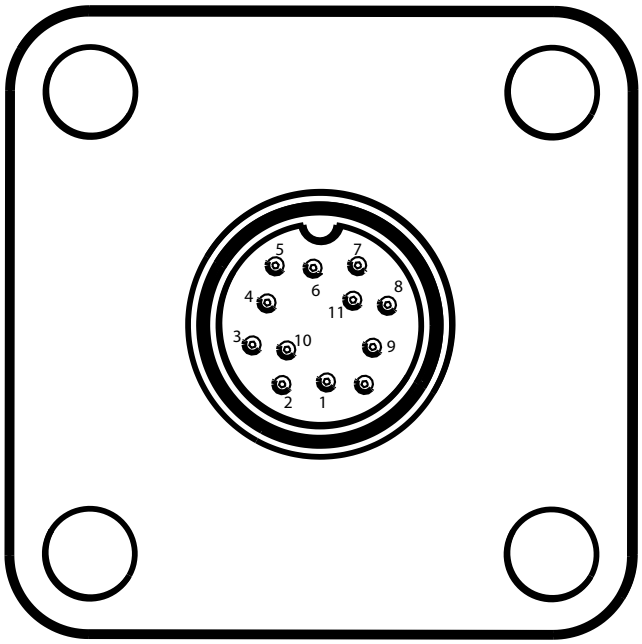


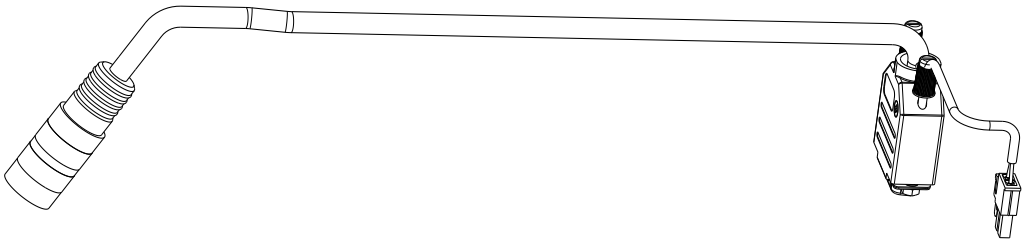
Figure 98 - Feed Through Connector



3.7.1.8 Rear Bearing Sensor Cable

The Rear Bearing Sensor Cable provides shaft position information from the Rear Bearing Sensor Feed Through to the CCM. The Rear Bearing Sensor Cable also receives a signal from the Stator Cooling Temperature Sensor.

Figure 99 - Rear Bearing Sensor Cable

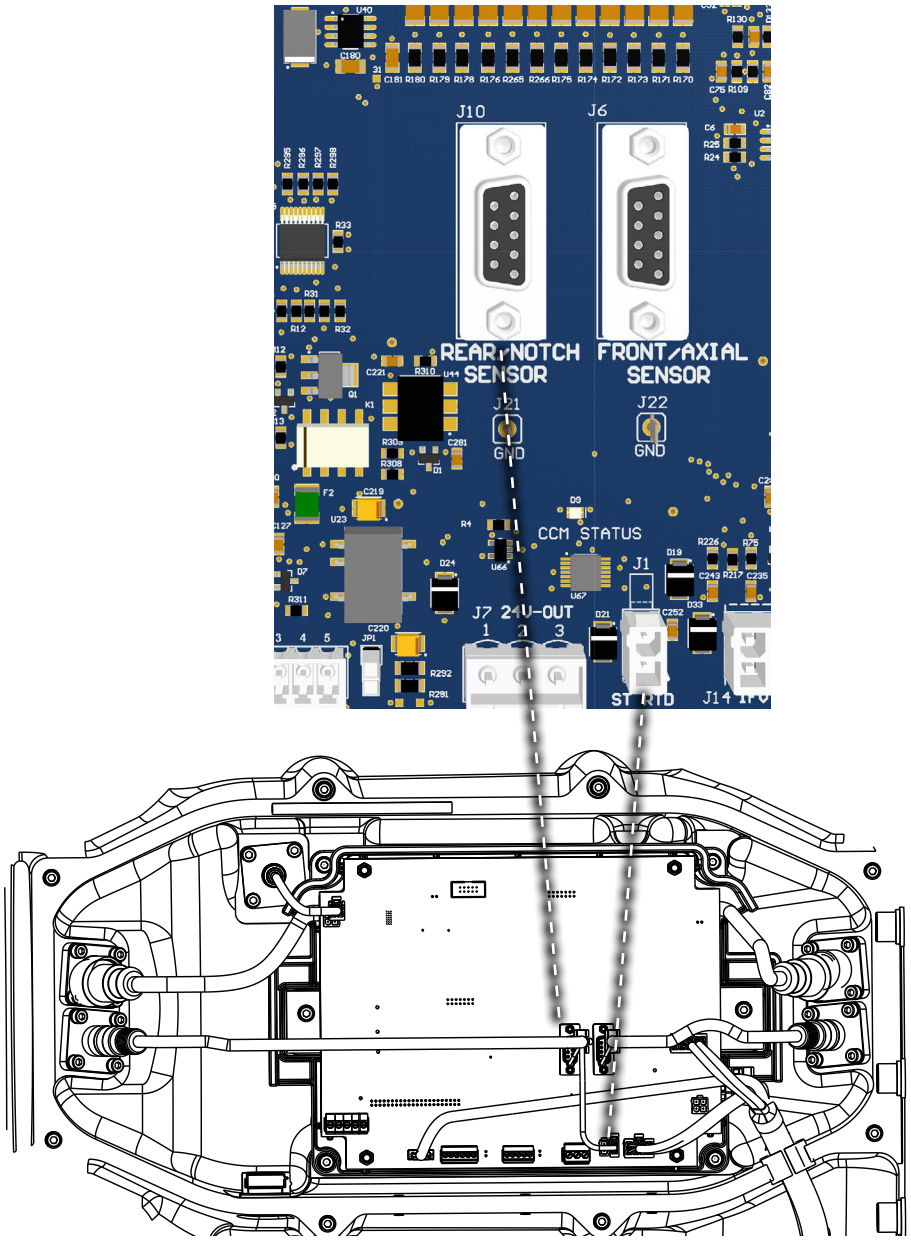


3.7.1.8.1 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Remove the 9-pin connector from J10 on the CCM Board.
4. Remove the Molex connector from J1 on the CCM Board.
5. Twist and pull to remove the sensor cable connection from the feed through.

Figure 100 - Rear Bearing Sensor Connections



Installation:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Connect the 9-pin connector into J10 on the CCM Board.
3. Install the Molex connector into J1 on the CCM Board.
4. Twist and push to connect the sensor cable connection to the feed through.
5. Install the Service Side Cover.
6. Restore power to the compressor.

3.7.1.8.2 Rear Bearing Sensor Cable Verification

1. Using a multimeter set for resistance measurements, check the resistance at the 9-pin connector to verify connection to the sensor ring. Refer to Table 24 (Rear Bearing Sensor Pin Verification) for the resistance specifications. Refer to Figure 101 (9-Pin Connector) for the pinout.
2. If the results do no match the specifications listed, remove the cable and check the resistances at the feed through. Refer to Figure 102 (Feed Through Connector) for the pinout.
3. If the results still do not match the listed specifications, the feed through will need to be tested for continuity. Refer to the "Rear Bearings" section for details on how to remove the feed through.

Table 24 - Rear Bearing Sensor Pin Verification

Pins	Sensor Type	Resistance
6-7	Radial	2.0 Ω to 3.5 Ω
6-8	Radial	2.0 Ω to 3.5 Ω
9-1	Axial	2.0 Ω to 3.5 Ω
1-4	Axial	2.0 Ω to 3.5 Ω
2-3	Radial	2.0 Ω to 3.5 Ω
3-5	Radial	2.0 Ω to 3.5 Ω

Figure 101 - 9-Pin Connector

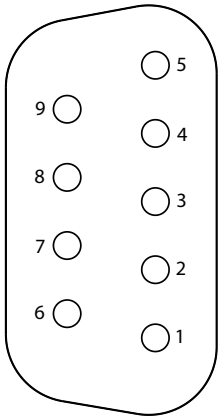
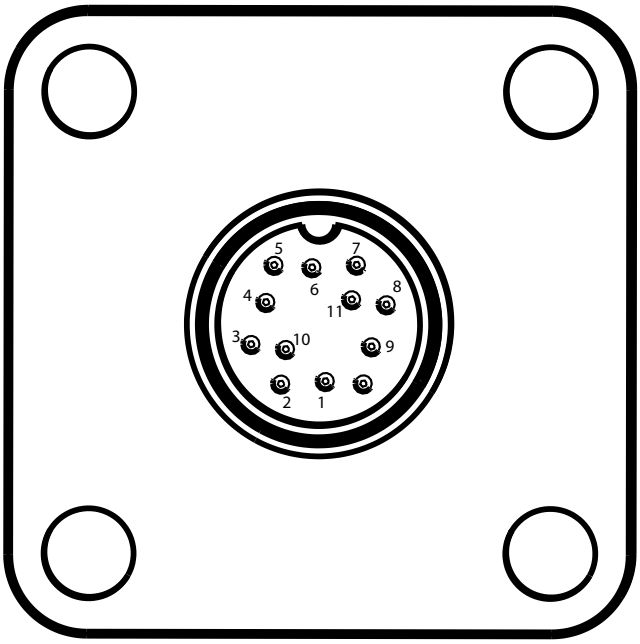


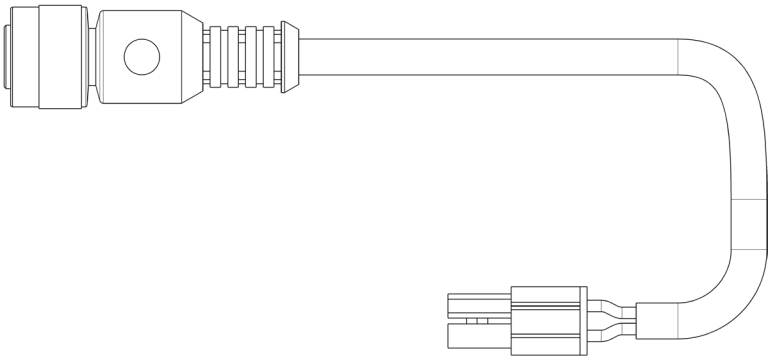
Figure 102 - Feed Through Connector



3.7.1.9 Motor Temperature Sensor Cable

The motor temp sensor cable connects the motor temperature sensor to the CCM.

Figure 103 - Motor Temperature Sensor Cable

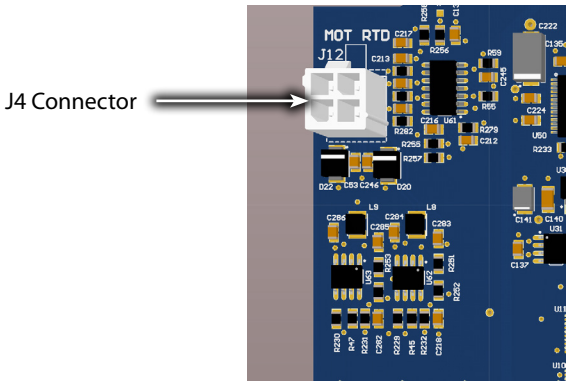


3.7.1.9.1 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Locate and remove the connector from MOT RTD (J12) located on the top-left corner of the CCM Board.

Figure 104 - CCM J12 Connection



4. Locate the feed through for the motor temp sensor and remove the connector.

Installation:

1. Install the sensor on the feed through.
2. Attach the connector to MOT RTD (J12) on the CCM Board.
3. Install the Service Side Cover.
4. Restore power to the Compressor.

3.7.1.9.2 Motor Temperature Sensor Cable Verification

With power applied to the Compressor, using a DC voltage meter, place the negative (-) test lead in the TP1 - GND test point and verify the voltages at the test points listed in Table 25 (CCM Test Point Values).

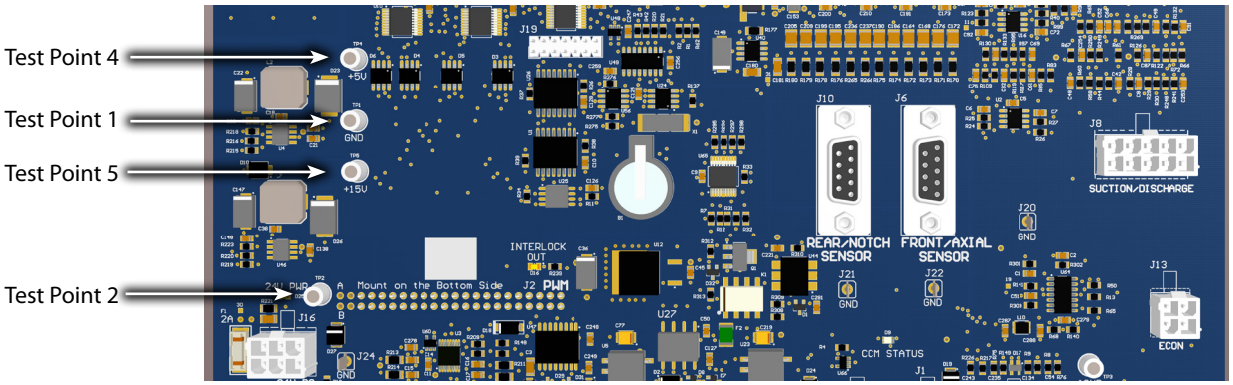


Table 25 - CCM Test Point Values

Test Point Number	Test Point Voltage Value	DC Voltage Range
TP2	24+	21.6-26.4
TP5	15+	13.5-16.5
TP4	5+	4.5-5.5
TP1	Ground	

3.7.1.10 PWM

1. The PWM Board is mounted parallel to the CCM with a heat sink connected to the Compressor housing.
2. The PWM Board provides circuitry with the following functionalities:
   - Supplies current to the axial and radial magnetic bearing actuators
   - Provides bearing current sensor feedback

Figure 105 - Pulse Width Modulation Amplifier (Revisions A and B)

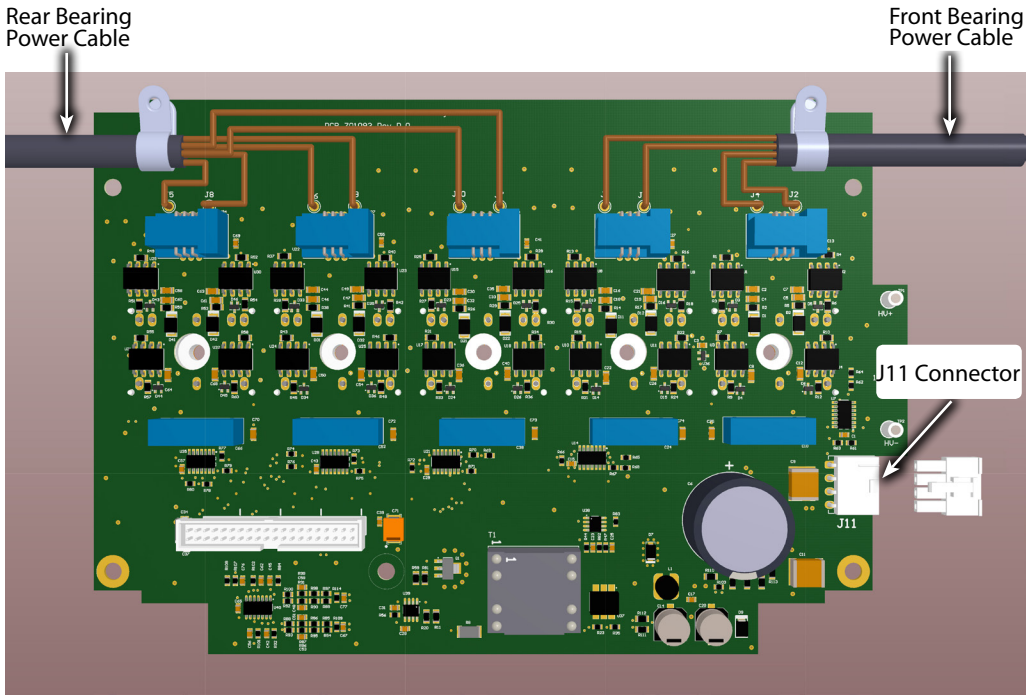
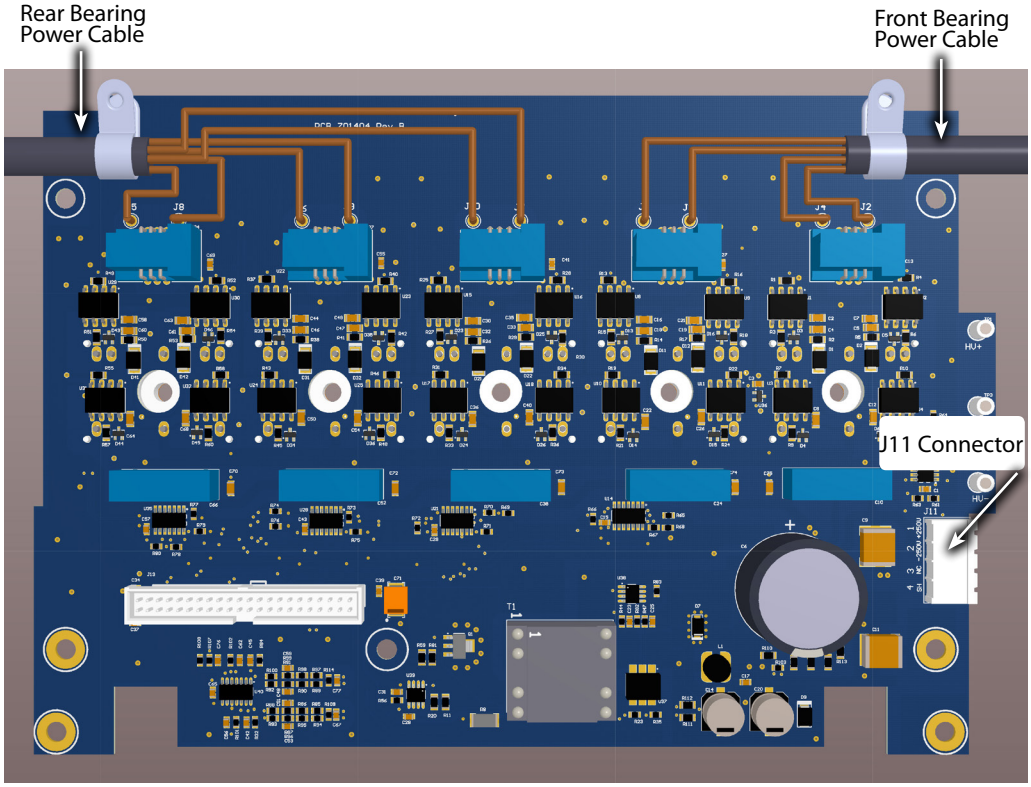


Figure 106- Pulse Width Modulation Amplifier (Revisions C and Later)



3.7.1.10.1 PWM Connections

- J11 – 250V DC In and Ground – mid right
- Bearing Power Cables front and rear

3.7.1.11 250V DC-DC PWM Cable

The 250V DC-DC-PWM Cable provides a power connection between the DC-DC and the PWM.

Figure 107 - 250V DC-DC-PWM Cable (Revisions A and B)

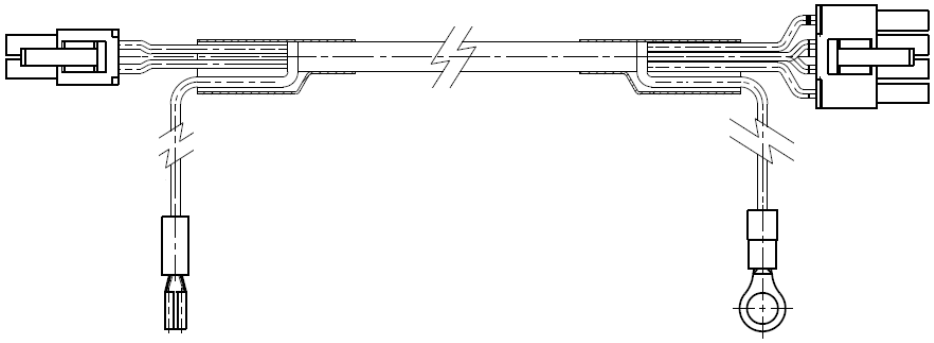
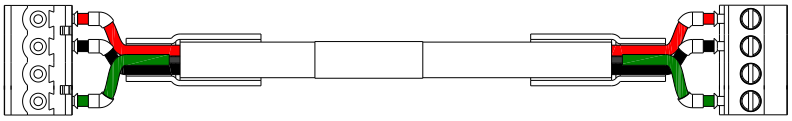


Figure 108 - 250V DC-DC-PWM Cable (Revisions C and Later)

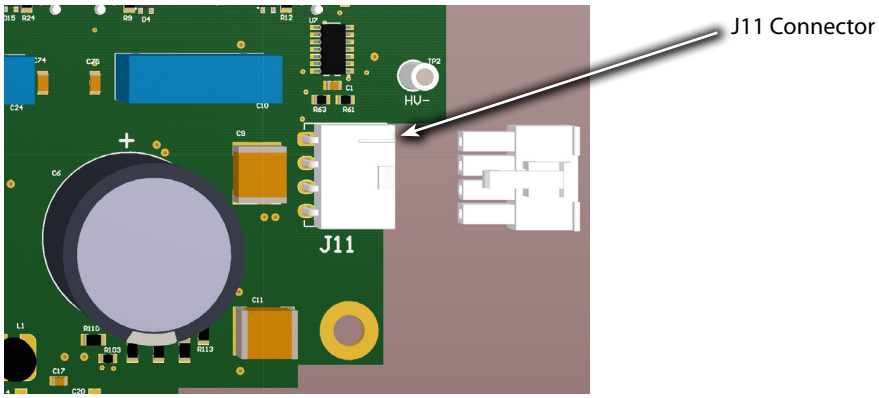


3.7.1.11.1 Removal and Installation

Removal (Revision A and B Cables):

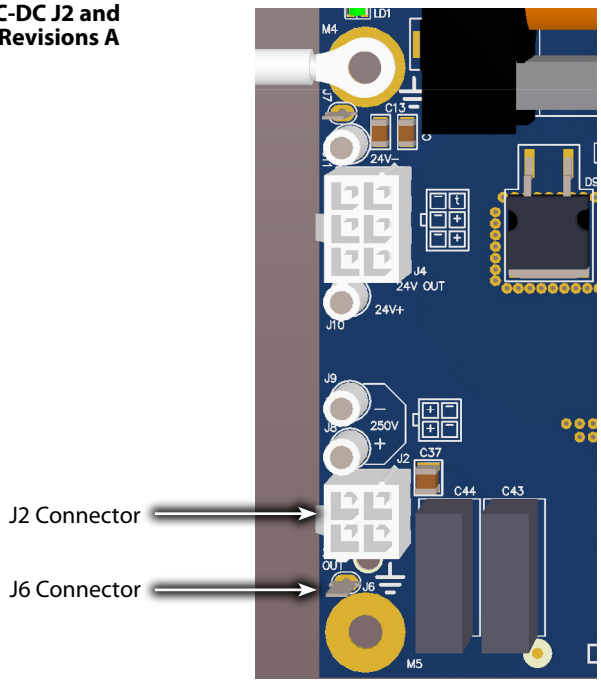
1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Disconnect the J11 connector from the PWM.

Figure 109 - PWM J11 Connector (Revisions A and B)



4. Remove the 250V PWM ground wire from the service side.
5. Remove the cable from the service side.
6. Open the panel containing the DC-DC.
7. Disconnect the 250 V (J2) clip from DC-DC.

Figure 110 - DC-DC J2 and J6 Connector (Revisions A and B)

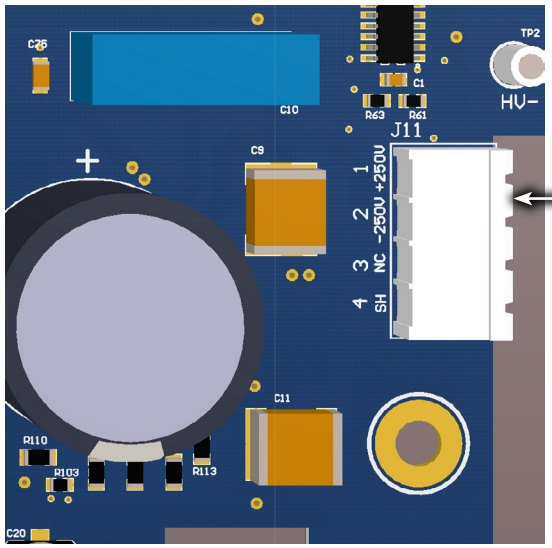


8. Disconnect the 250V DC-DC ground wire from the DC-DC.
9. Remove the cable from the DC-DC panel.

Removal (Revisions C and Later Cables):

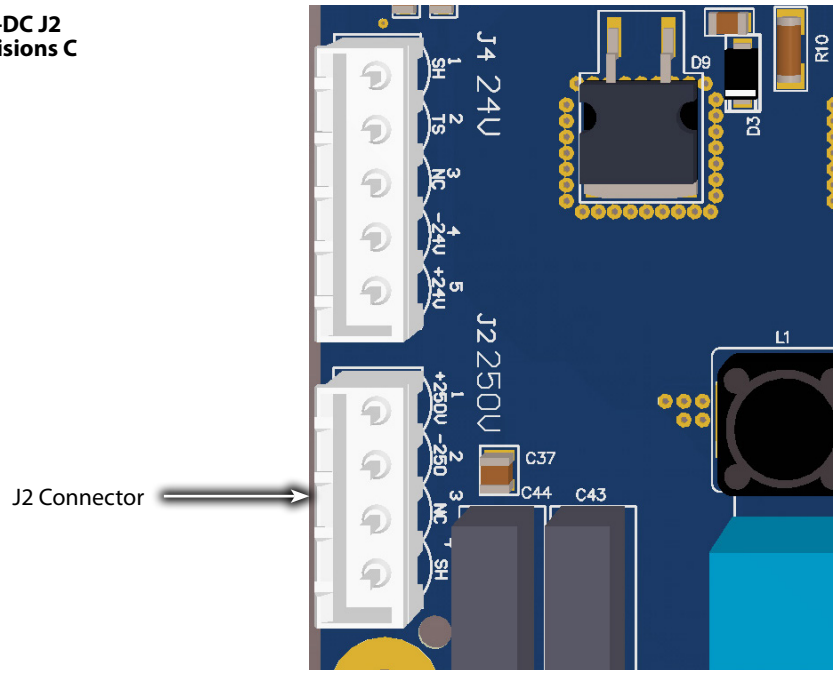
1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Service Side Cover.
3. Disconnect the J11 connector from the PWM.

Figure 111 - PWM J11 Connector (Revisions C and Later)



4. Remove the cable from the service side.
5. Open the panel containing the DC-DC.
6. Disconnect the 250 V (J2) connector from the DC-DC.

Figure 112 - DC-DC J2 Connector (Revisions C and Later)



Installation (Revisions A and B):

1. Route the cable into the service side.
2. Secure the ground cable to the service side.
3. Insert the connector to J11 on the PWM Board.
4. Secure the cable where it enters the service side.

5. Replace the Service Side Cover.
6. Route the cable into the DC-DC panel.
7. Connect the ground cable to the J6 connector on the DC-DC.
8. Insert the connector to J2 on the DC-DC Board.
9. Close the DC-DC panel.
10. Restore power to the Compressor.

Installation (Revisions C and Later):

1. Route the cable into the service side.
2. Insert the connector to J11 on the PWM Board.
3. Secure the cable where it enters the service side.
4. Replace the Service Side Cover.
5. Route the cable into the DC-DC panel.
6. Insert the connector to J2 on the DC-DC Board.
7. Close the DC-DC panel.
8. Restore power to the Compressor.

3.7.1.11.2 Verification

250V DC-DC - PWM Cable Verification

1. With power applied to the Compressor, using a DC voltage meter, verify the 250 VDC test points on the DC-DC for correct voltage. Place the negative (-) test lead on -250 VDC and the positive (+) test lead on +250 VDC.

Figure 113 - DC-DC 250 VDC Test Points (Revisions A and B)

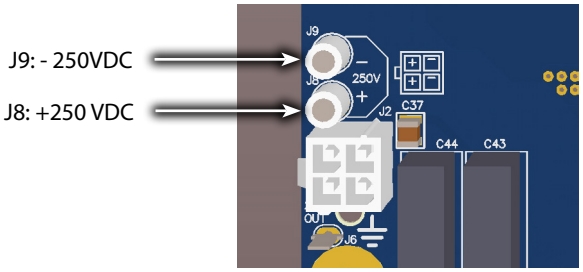
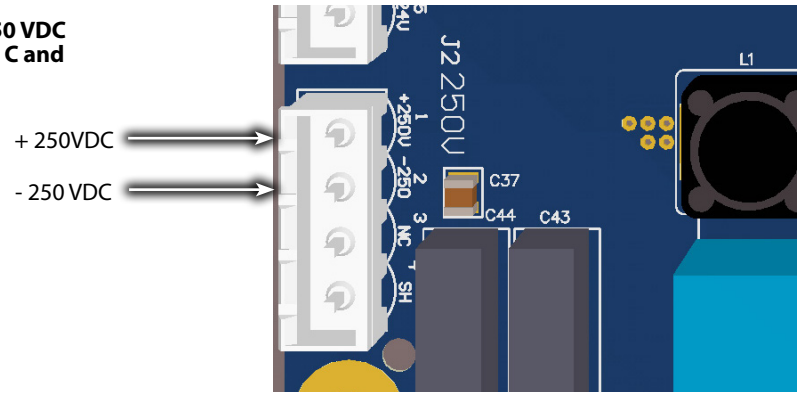


Figure 114 - DC-DC 250 VDC Test Points (Revisions C and Later)



2. Place the negative (-) test lead in the HV- test point and verify the following test points on the PWM for correct voltages. Refer to Figure 116 (PWM Test Points).
   - TP1: HV+ (should measure between 225 -275 VDC)
   - TP3: 17V (should measure between 15.3 - 18.7 VDC)

Diode Test

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Disconnect the PWM Bearing Power Cables from the Compressor bearing feed throughs.
3. Unplug the 250V DC input to the PWM.
4. Using a Multimeter, set to measure Diode, place the positive(+) test lead on the HV- test point of the PWM and negative(-) lead in the first pin hole of the rear PWM Bearing Power Cable.
5. The measured voltage drop should be 0.33-0.46 VDC.
6. Repeat in a clockwise rotation for all the outer pin holes of the rear Bearing Power Cable and the 4 pins of the front Bearing Power Cable (The center pin of the rear Bearing Power Cable does not have a test value.).
7. Place the negative (-) test lead on the HV+ test point of the PWM and the positive(+) lead in the first pin hole of the PWM Bearing Power Cable.
8. Repeat in a clockwise rotation for all the outer pin holes of the rear Bearing Power Cable and the 4 pins of the front Bearing Power Cable. (The center pin of the rear Bearing Power Cable does not have a test value.)

Figure 115 - PWM Connector - 6 Pin

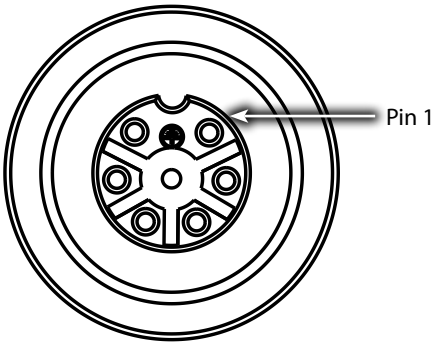
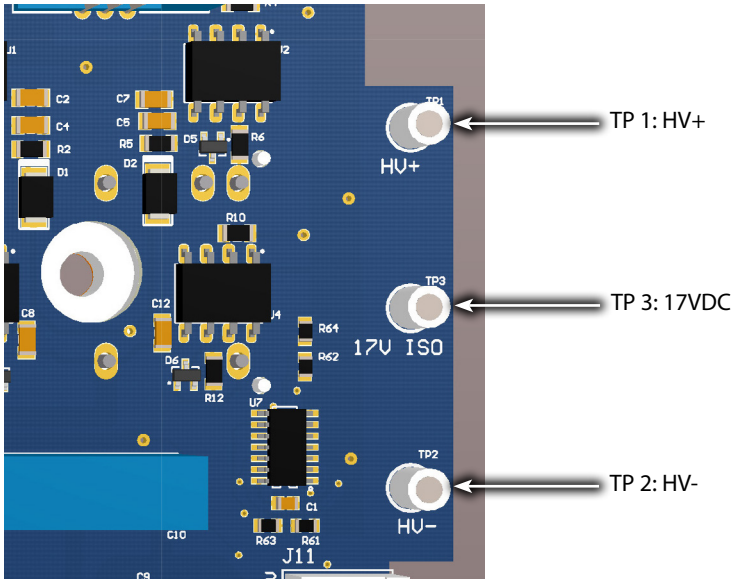
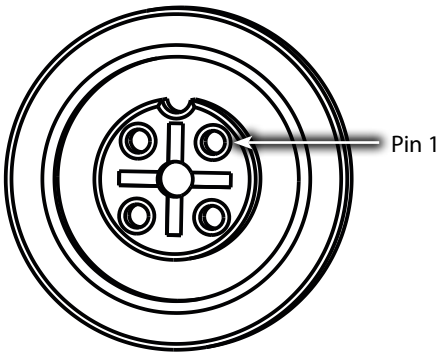


Figure 116 - PWM Test Points



9. The measured voltage drop should be 0.33-0.46 VDC.

Figure 117 - PWM Connector - 4 Pin



Communication

1. Connect to the CCM using the SMT and enter the User ID and Access Code.
2. Open the Warnings and Faults Tool.
3. Verify that the CIM Compatibility, controller area network (CAN) Communications and VFD Communications Faults are not active.

Calibration

A calibration should only be saved to EEPROM if there is a known bearing problem or when a new/different Service Electronics Assembly is replaced.

1. Power on the Compressor.
2. Using the SMT, perform a compressor bearing calibration and save to EEPROM.
3. Select validation to test bearing levitation control.
4. Create and save a calibration report for records and review.

⚠ • • • CAUTION • • •

When replacing the Service Electronics Assembly, a bearing calibration must be performed and saved to the EEPROM. The Service Electronics Assembly will then use the new values stored in EEPROM to operate the compressor. Using default calibration data from a newly installed Service Electronics Assembly to operate a compressor could cause erratic behavior.

3.7.1.11.3 Torque Specifications

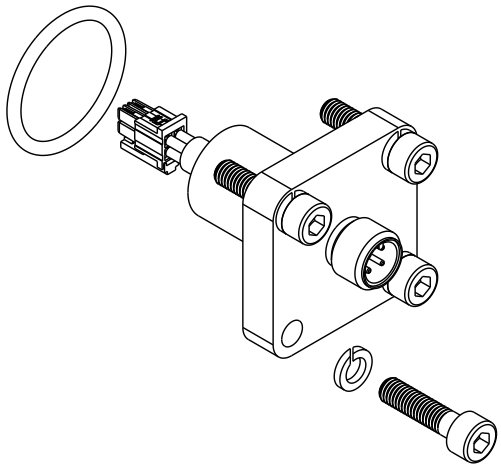
Table 26 - Electronics Side Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Service Electronics Assembly fasteners	6	-	53
Service Electronics ground wires at left and 250 VDC ground wire at right	6	-	53

3.7.1.12 Stator Temperature Sensor Feed Through

The Stator temperature sensor feed through passes the reading of the Stator temperature thermistors to the CCM for conversion to a digital signal used to determine actual motor winding temperature, while keeping refrigerant pressure from escaping.

Figure 118 - Stator Temperature Sensor Feed Through



3.7.1.12.1 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the compressor and recover refrigerant.
3. Remove the Service Side Cover (Refer to the "Service Side" section in this manual).
4. Disconnect the Stator temperature sensor cable from CCM J12.
5. Remove the Stator temperature sensor cable from the feed through.
6. Remove the Service Electronics Assembly. Refer to the "VTT Service Electronics Assembly" section in this manual.
7. Refer to the "Rear Bearings" section of this manual regarding access to the internal connector.
8. Remove the fasteners holding the Stator Temperature Sensor Feed Through to the housing.
9. Disconnect the Stator Temperature Sensor Feed Through wire from the internal connector.
10. Carefully remove the Stator Temperature Sensor Feed Through from the housing.

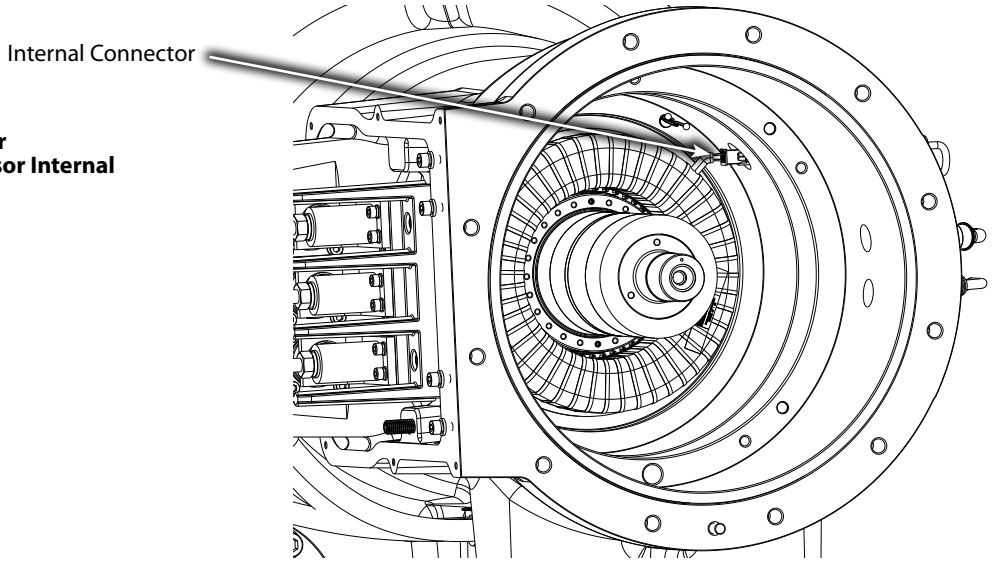


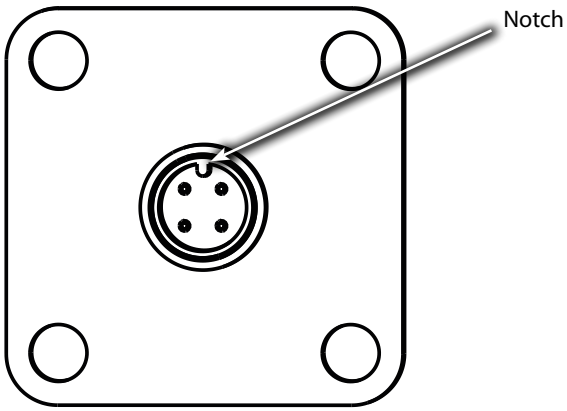
Figure 119 - Stator Temperature Sensor Internal Connector

11. Remove the O-ring.

Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Stator Temperature Sensor Feed Through.
3. Connect the Stator Temperature Sensor Feed Through wire to the internal connector.
4. Carefully slide the connector into the housing and rotate until the internal notch in the Stator Temperature Sensor Feed Through is facing up (towards the top of the compressor).

Figure 120 - Stator Temperature Feed Through Orientation

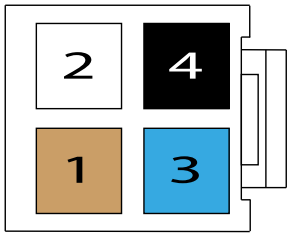


5. Verify the internal harness remains in the twist lock support. If not, reposition the harness into the twist lock support.
6. Install the four (4) M5 screws holding the Stator Temperature Sensor Feed Through to the housing and tighten in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 3 Nm (26 in.lb.)
   - Stage 2: Tighten to a final torque of 6 Nm (53 in.lb.)
7. Install the Service Electronics Assembly.
8. Connect the Stator Temperature Sensor Feed Through cable to CCM J12.
9. Install the Service Side Cover.
10. Leak test the compressor to the appropriate pressure and industry standards.
11. Evacuate the compressor to the appropriate pressure and industry accepted standards.
12. Charge the compressor with refrigerant.
13. Restore power to the compressor.

3.7.1.12.2 Stator Temperature Sensor Verification

1. The Stator Temperature Sensor has two (2) circuits.
2. Verify the resistance of each circuit at the external connector to CCM J12
3. Circuit one, pins 1 and 3, are brown and blue.
4. Circuit two, pins 2 and 4, are white and black.

Figure 121 - Stator Temperature Sensor Feed Through Connector



Running Check

1. Before starting the compressor, with the power on, using the SMT, verify Stator temperature reading is an acceptable value.
2. While the compressor is running, verify the Stator temperature fluctuates to expected values during operation.

3.7.1.12.3 Torque Specifications

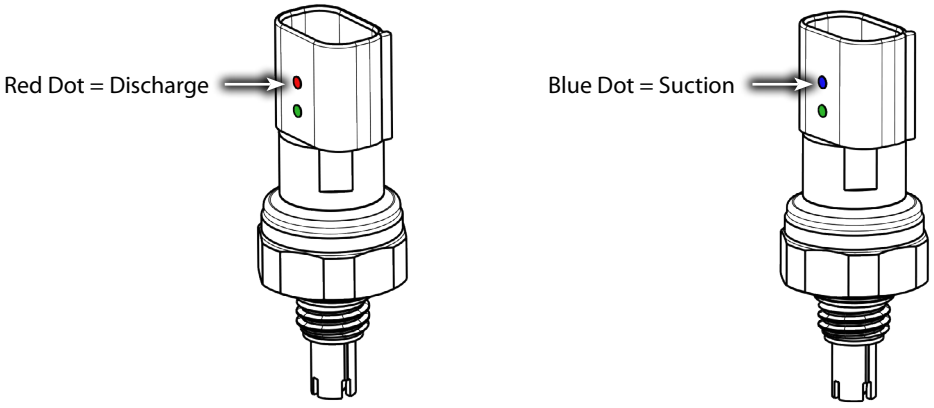
Table 27 - Stator Temperature Sensor Feed Through Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Service Electronics Assembly fasteners	6	-	53
Service Electronics ground wires at left and 250 VDC ground wire at right	6	-	53
Stator Temperature Sensor Feed Through, SHCS, M5x20	6	-	53

3.7.1.13 High and Low Pressure Temperature Sensors

The high and low pressure temperature sensors (Figure 122 (High and Low Pressure Temperature Sensors)) are used to signal the operating pressures and temperatures at the suction and discharge ports to the CCM. These values are used to calculate pressure ratios and saturated temperatures. The high and low pressure temperature sensors are located just behind the suction and discharge flanges. Refer to Figures 123 (Suction Temperature Sensor Location) and 124 (Discharge Temperature Sensor Location) for further details on the exact locations.

Figure 122 - High and Low Pressure/Temperature Sensors



NOTE

The "green" dot denotes R1234ze compatibility. Early versions of the sensors may contain only the "red" and "blue" identifiers.

Figure 123 - Suction Temperature Sensor Location

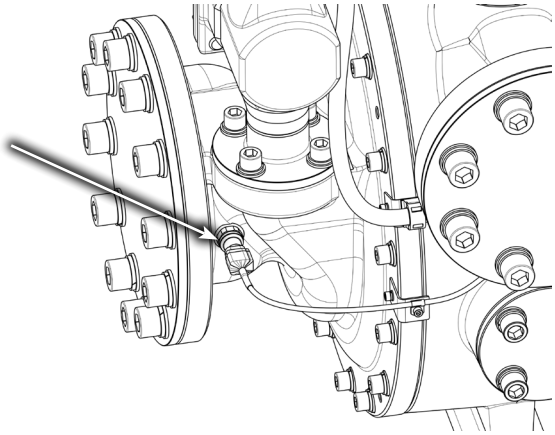
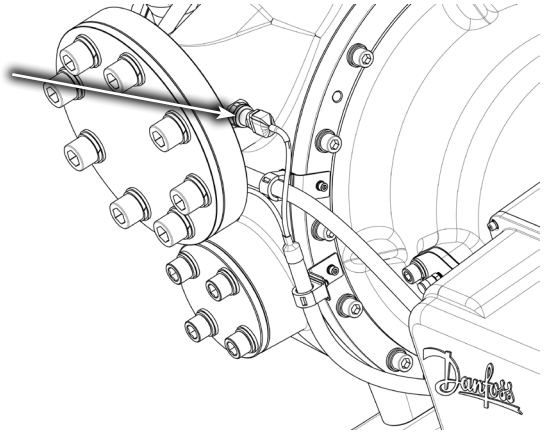


Figure 124 - Discharge Temperature Sensor Location



3.7.1.13.1 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Recover refrigerant from compressor.
3. Disconnect the sensor cable connector.
4. Using a deep socket, remove the sensor.

Installation:

1. Check and clean the threads in the compressor housing.
2. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
3. Apply lube to new sensor O-ring.
4. Insert the sensor and engage the first few threads by hand.
5. Using a deep socket, tighten sensor and torque to specification.
6. Reconnect the sensor connector.
7. Leak test the Compressor to the appropriate pressure and industry standards.
8. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
9. Charge the Compressor with refrigerant.
10. Restore power to the Compressor.

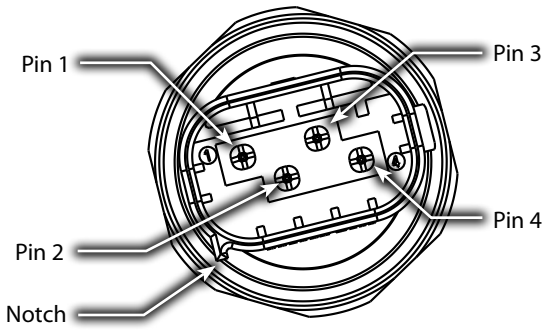
3.7.1.13.2 Temperature/ Pressure Sensor Verification

⚠ • • • CAUTION • • •

Do not connect Mega Ohmmeter while the compressor is under a vacuum; this may cause damage.

1. Place the leads on terminal 1 & 3 of the pressure/temperature sensor.
2. The temperature sensor is a 10KΩ @ 77°F (25°C) negative temperature coefficient (NTC) thermistor.

Figure 125 - Temperature/ Pressure Sensor Pin Location



3. Compare the compressor pressure readout to the gauge pressure value.
4. The values should not be greater than the following:
   - Suction Sensor - 1.7psi (12kPa)
   - Discharge Sensor - 7.25psi (50kPa)

Running Check

1. Connect to the compressor with the SMT.
2. Compare pressure and temperature readout from compressor to readings from a calibrated gauge set and thermometer placed as close to the sensor location as possible.

Table 28 - Temperature/ Pressure Sensor Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Suction Temperature Sensor	10	7	89
Discharge Temperature Sensor	10	7	89

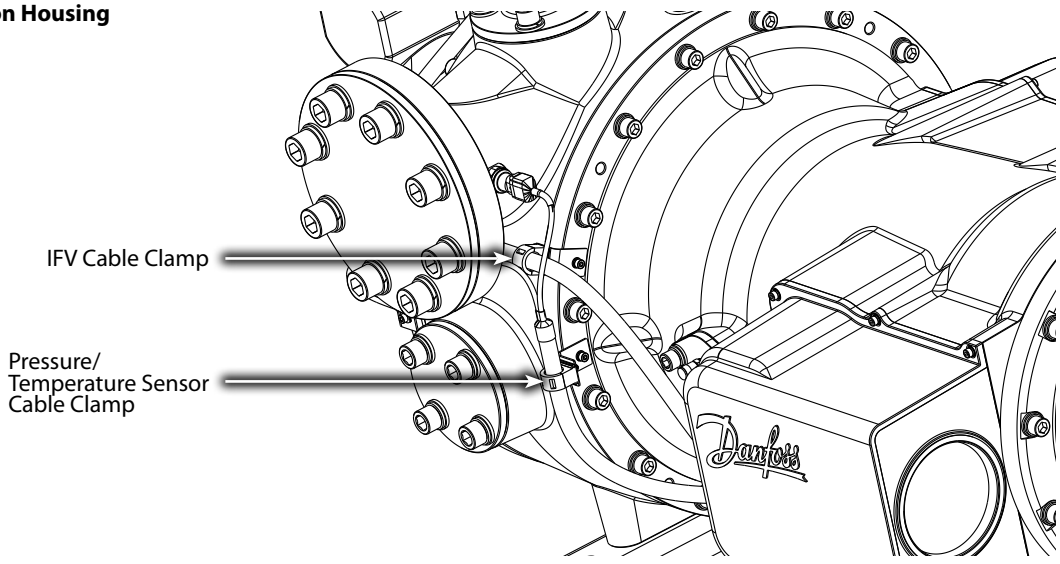
3.7.2 Internal Components

3.7.2.1 Front Bearings

Front Bearing Power and Sensor Feed Through Removal:

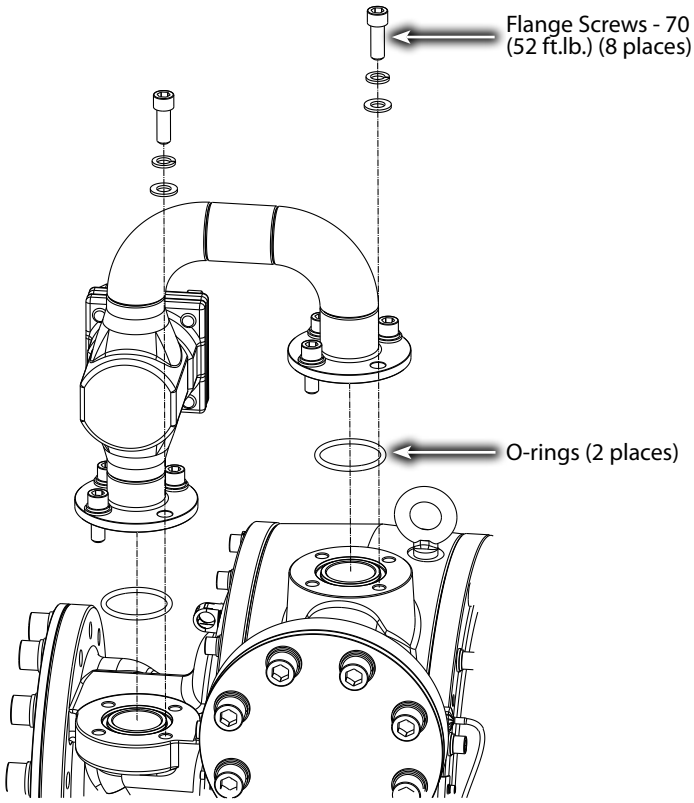
1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the compressor and recover refrigerant.
3. Remove the eight (8) M5x16 screws that hold the Service Side Cover in place.
4. Remove the Service Side Cover.
5. Disconnect the IFV Cables and remove them from the clamp located on the Suction Housing. See Figure 126 (Suction Housing Cable Clamps).
6. Carefully lay the IFV Cable harness over the rear of the compressor to prevent it from being damaged.
7. Remove the cable harness from the pressure/temperature sensor on the Suction Housing.
8. Remove the retaining clip from the Suction Housing as shown in Figure 126 (Suction Housing Cable Clamps).
9. Carefully lay the pressure/temperature sensor harness out of the way to prevent it from being damaged.
10. Remove the IFV Assembly.

Figure 126 - Suction Housing Cable Clamps



11. The compressor will need to be lifted up to gain clearance for the Volute removal. A 5x5 wood block under the rear foot and a piece of 6" u-channel under the front. This u-channel needs to be

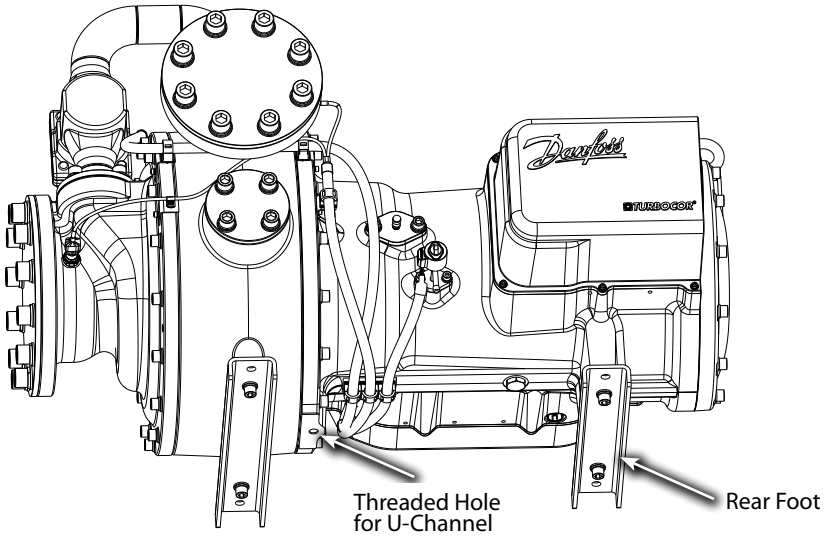
Figure 127 - IFV Assembly Removal



12" long with a 12.5mm hole drilled in the center. There is a threaded hole under the compressor where the Volute meets the main compressor housing. Fasten the u-channel to the compressor with a 12mm bolt (2.5 inches long).

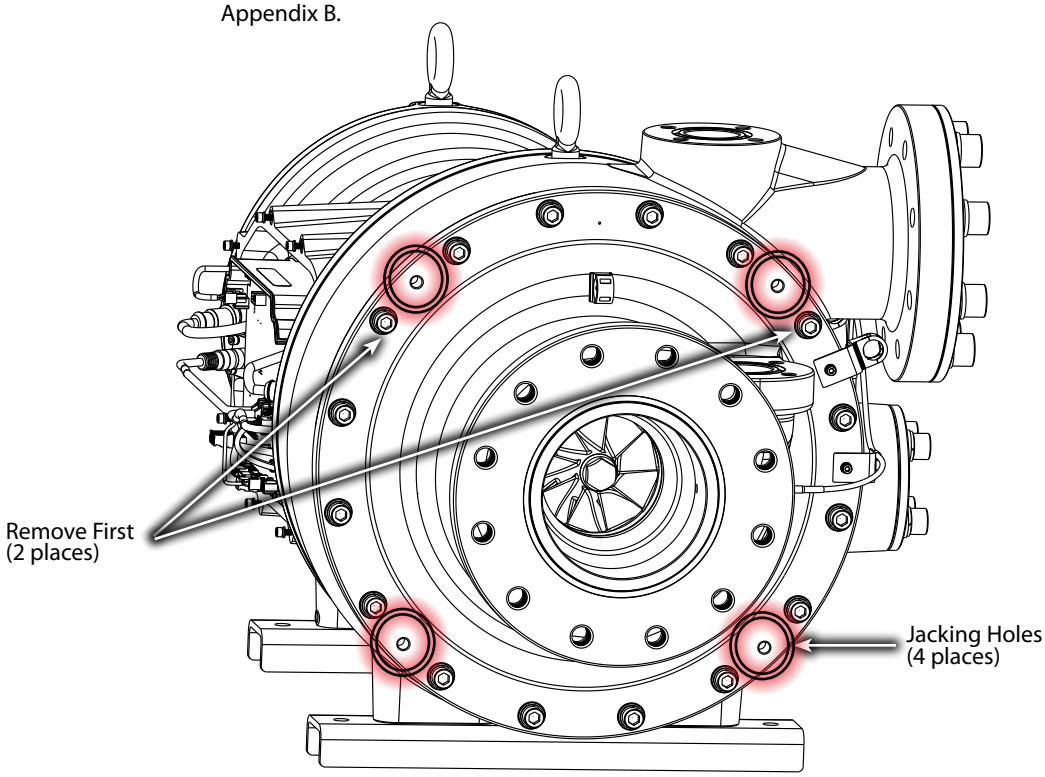
12. Remove the screws at the 10 o'clock and 2 o'clock positions from the Suction Cover.

Figure 128 - Support Locations



13. Install the Short Guide Pins in these positions. Refer to the "Short Guide Pin" example in Appendix B.

Figure 129 - Suction Cover Removal



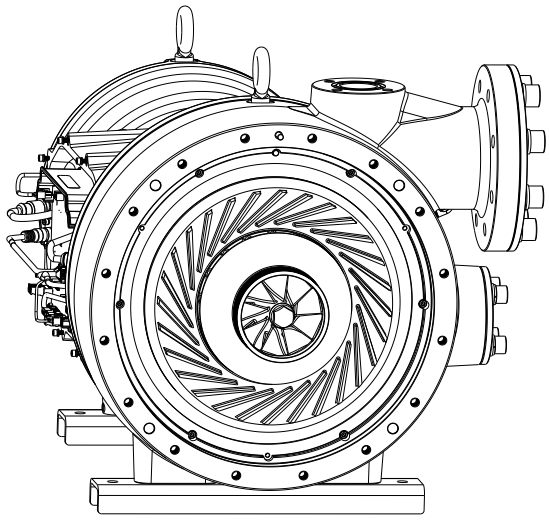
14. Remove the remaining screws from the Suction Cover, use four (4) of the removed screws for jacking screws.
15. Locate the jacking screw holes on the flange and install the four (4) removed screws. Tighten them evenly in a crisscross pattern. This will slowly push the Suction Cover away from the Volute.

⚠ • • • CAUTION • • •

The Suction Cover must come off straight. Failure to tighten the screws evenly, will result in binding, thus potentially damaging the Suction Cover and or Volute.

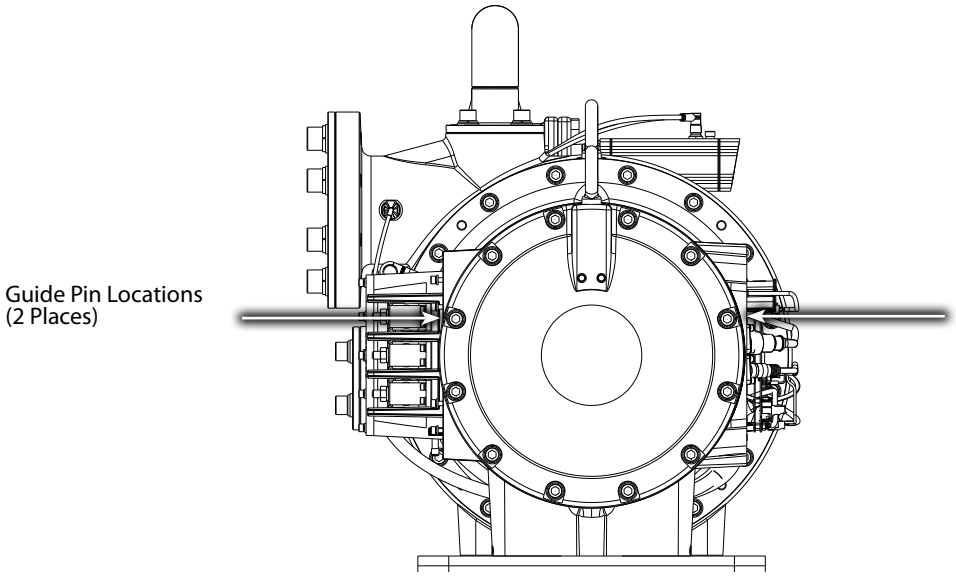
16. Set the Suction Cover aside and remove the four (4) screws from the jacking screw holes.

Figure 130 - Suction Cover Removed



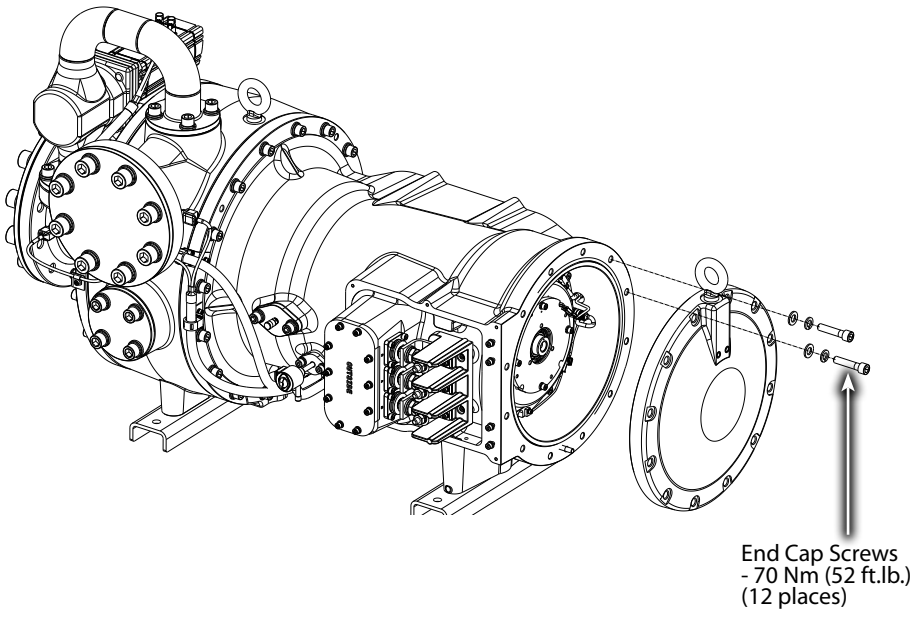
17. Remove the two (2) M12x55 screws located at the 10 and 2 o'clock position on the End Cap.
18. Insert the Short Guide Pins in these locations. Refer to Figure 131 (Guide Pin Locations).

Figure 131 - Guide Pin Locations



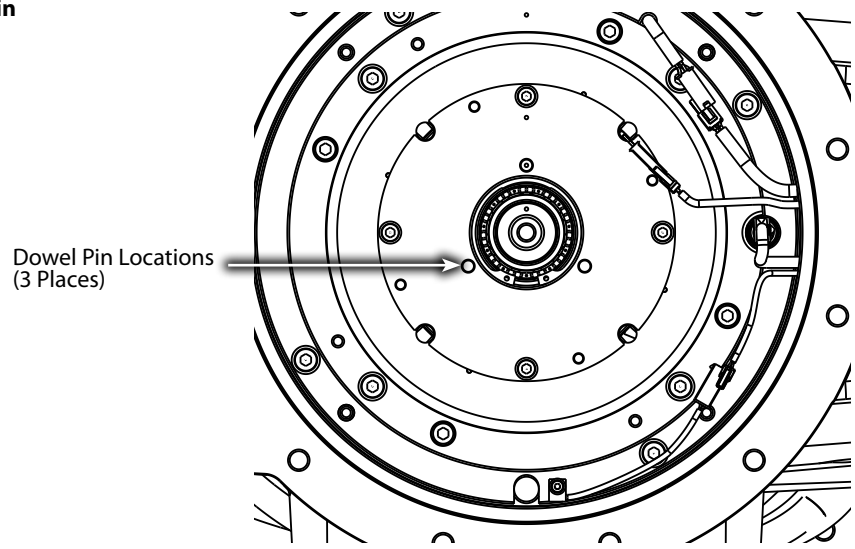
19. Remove the remaining screws and use a rubber mallet to tap off the End Cap.
20. Gently slide the End Cap away from the compressor housing and set aside the End Cap.

Figure 132 - End Cap Removal



21. Install three (3) Shaft Bolt Torquing Pins in the three (3) holes in the Axial Bearing Assembly. It will be necessary to turn the shaft bolt on the front of the compressor in order to engage the pins. These pins will then hold the shaft in place for the removal of the shaft bolt. Refer to the "Shaft Bolt Torquing Pin" example in Appendix B.

Figure 133 - Shaft Dowel Pin Placement

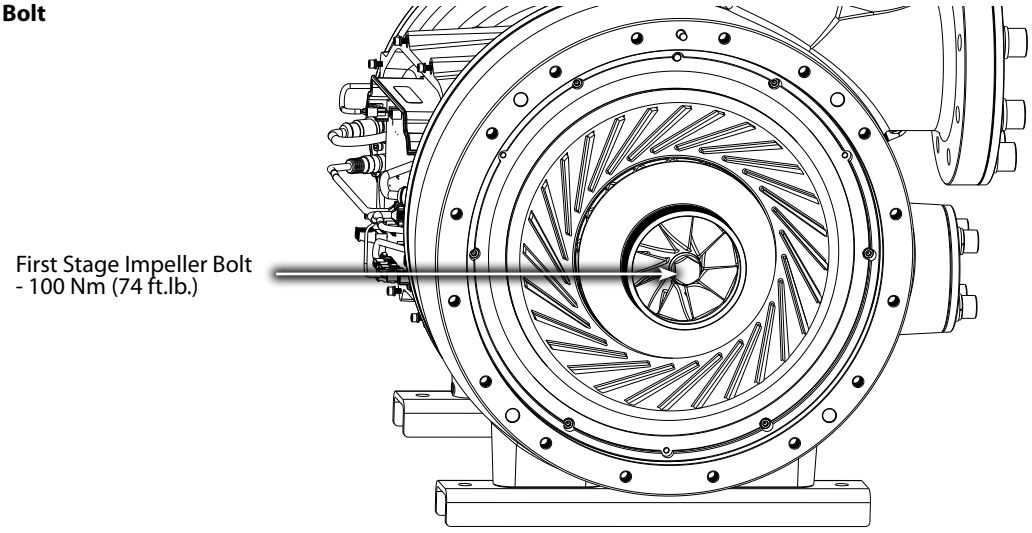


22. Remove the shaft bolt from the First Stage Impeller.

NOTE

This is a left-hand thread; to remove, the bolt must be loosened by turning it to the right.

Figure 134 - Impeller Bolt

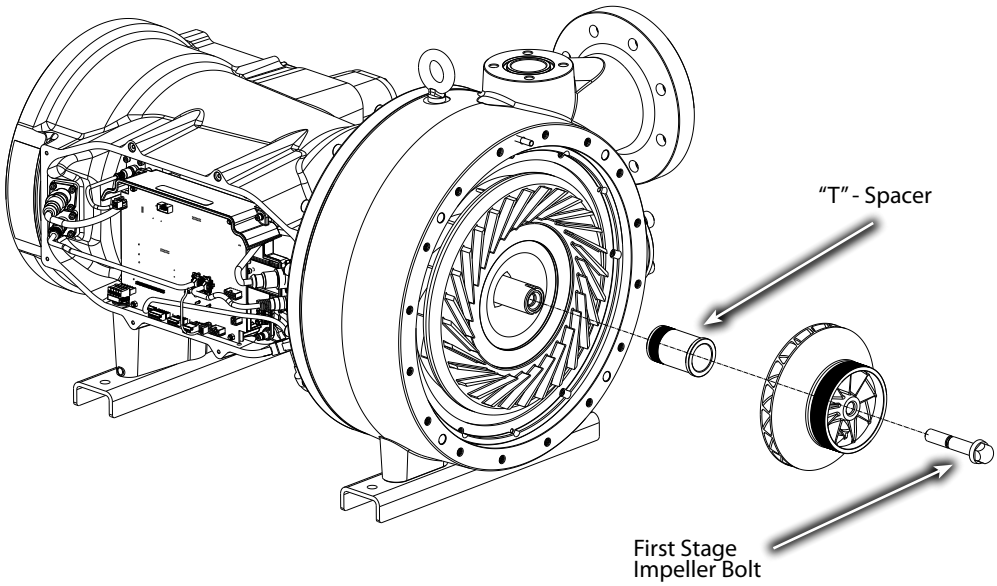


23. Remove the First Stage Impeller. This will require the use of a heat gun to heat up the impeller. **Do not use a torch!**

⚠ • • • CAUTION • • •

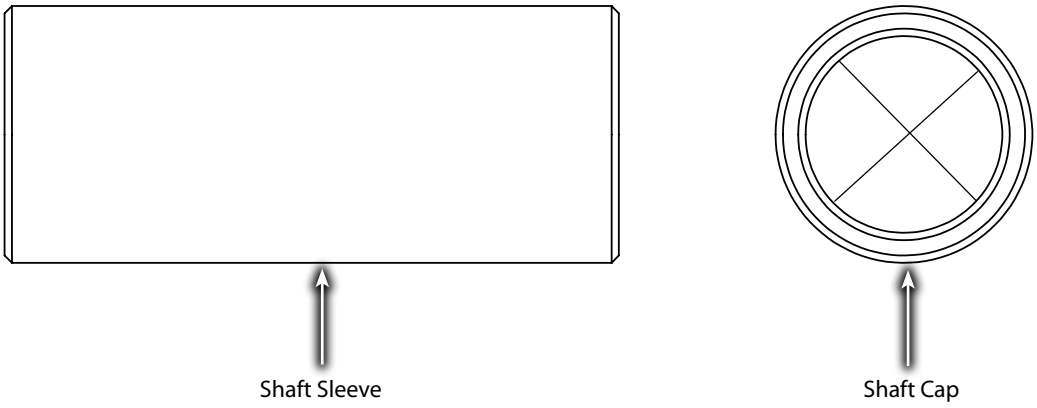
- Note the alignment/orientation of all fluid module components prior to removal
- Do not use anything with a flame (e.g., torch) to heat up the impeller

Figure 135 - First Stage Impeller Removal



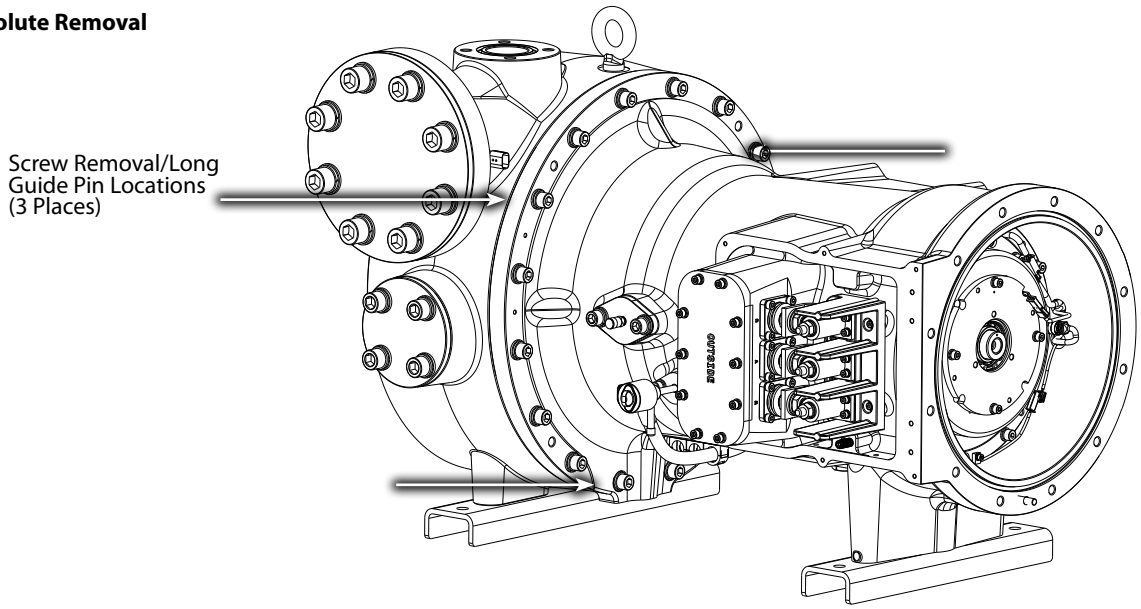
24. Remove the "T"- Spacer.
25. Install a nylon shaft protector and cap over the end of the compressor shaft. Refer to the "Volute Assembly Sleeve" example in Appendix B. This is also shown in Figure 134 (Nylon Shaft Protector and Cap).

Figure 136 - Nylon Shaft Protector and Cap



26. Remove the screws from the Volute at the 10 o'clock, 2 o'clock, and 6 o'clock positions, and install the Long Guide Pins in these locations. Refer to the "Long Guide Pin" example in Appendix B.

Figure 137 - Volute Removal - Step One



27. Remove the remaining screws from the Volute; use four (4) of these flange screws as jacking screws to push the Volute off the housing.
28. Take a 3' strap with a clevis hook on one end and attach the clevis to the lifting eye on the Volute.
29. Install the jacking screws into the Volute to push it off the housing, being mindful of the nylon shaft cover to ensure it doesn't slide off when you pull off the Volute.

Figure 138 - Volute Removal - Step Two

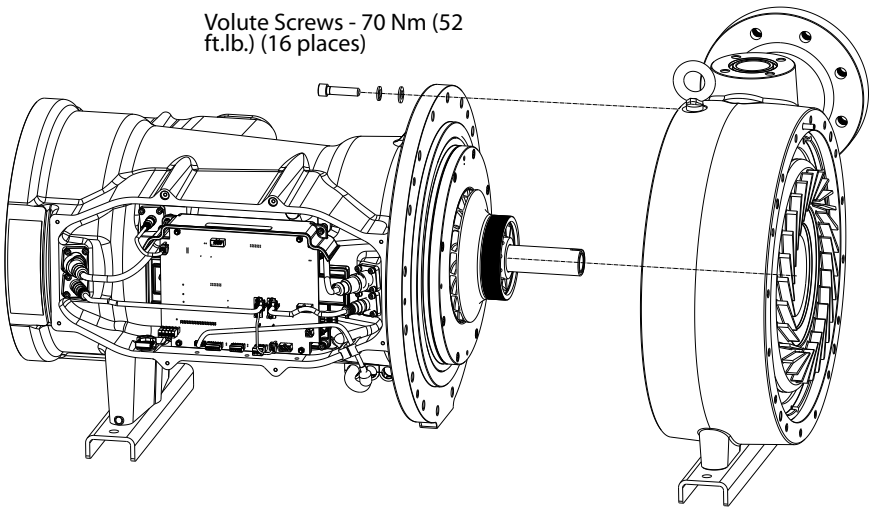
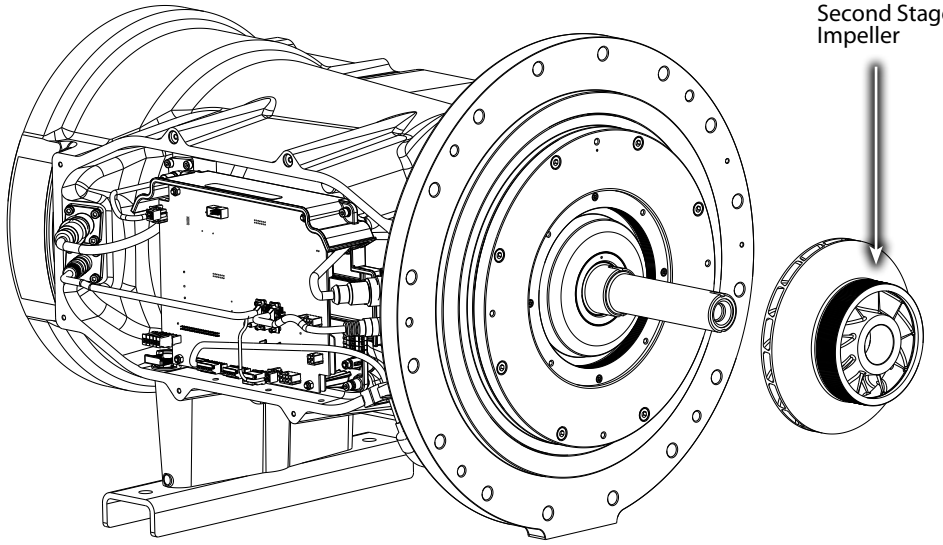


Figure 139 - Second Stage Impeller Removal

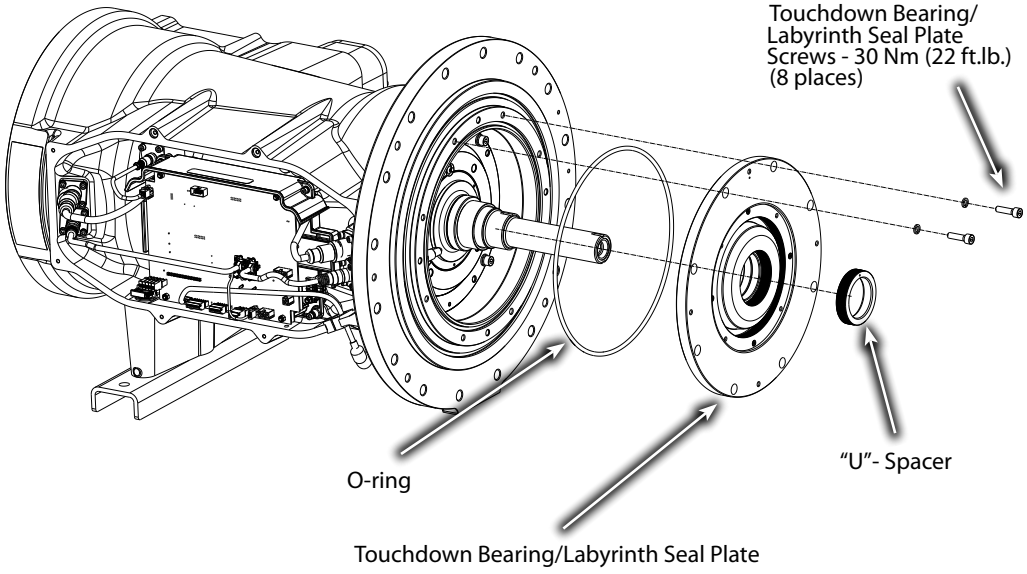


30. Carefully lower the Volute to the floor.
31. Remove the Second Stage Impeller. This will require the use of a heat gun to heat up the impeller. **Do not use a torch!**
32. Remove the eight (8) screws and remove the front touchdown bearing/labyrinth seal plate with the "U"- Spacer.

⚠ • • • CAUTION • • •

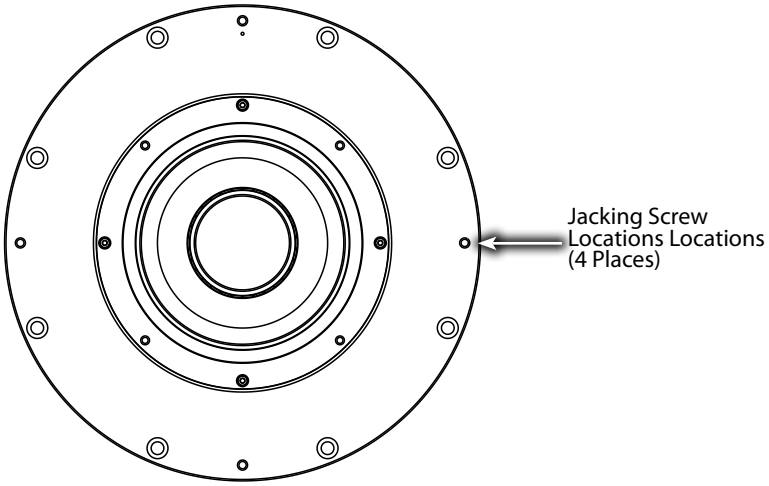
Do not use anything with a flame (e.g., torch) to heat up the impeller.

Figure 140 - Touchdown Bearing/Labyrinth Seal Plate Removal



33. Once all of the eight (8) screws have been removed, insert four (4) of the removed screws into the Touchdown Bearing/Labyrinth Seal Plate jacking screw locations. Tighten them evenly in a crisscross pattern. This will slowly push the Touchdown Bearing/Labyrinth Seal Plate away from the compressor housing.

Figure 141 - Front Touchdown Bearing



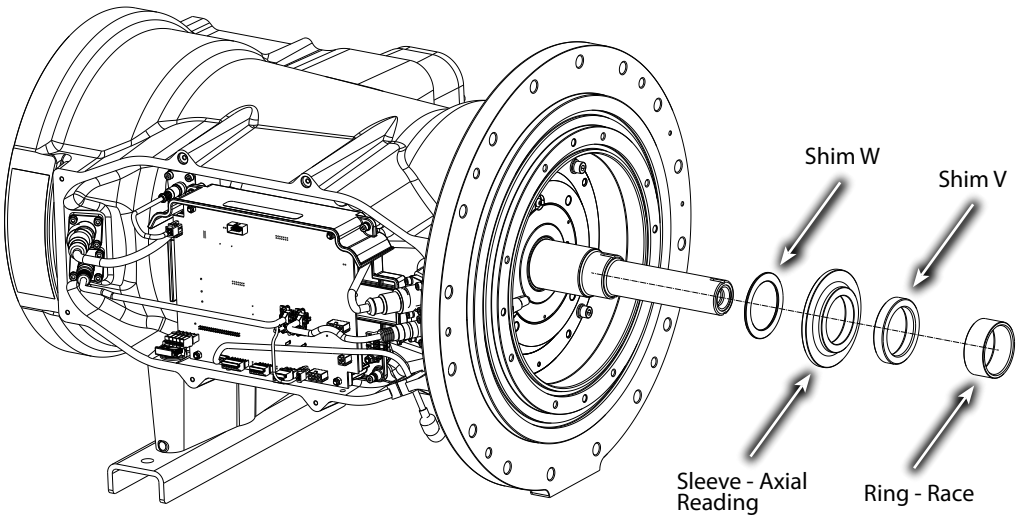
⚠ • • • CAUTION • • •

The Shaft of the Compressor will now be sitting directly on the front bearing. Do not try to move the shaft around or damage may occur to the shaft or front bearing.

⚠ • • • CAUTION • • •

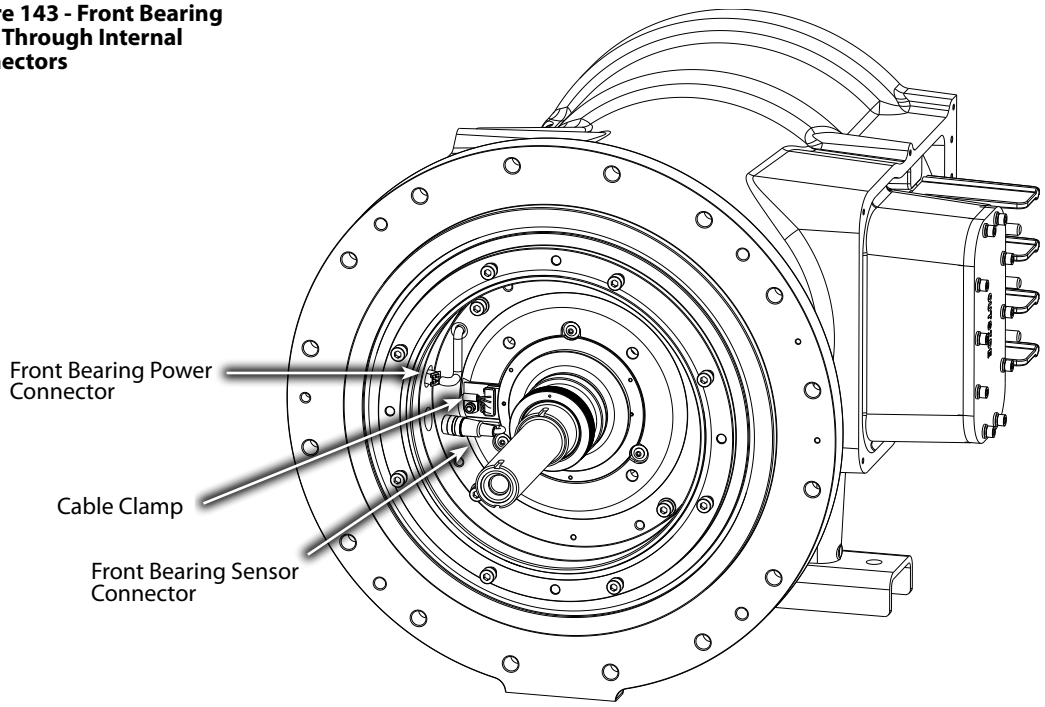
Label the shims for order and orientation! Failure to maintain the order of the shims could result in operability problems and in some cases, damage to internal components.

Figure 142 - Shim Example



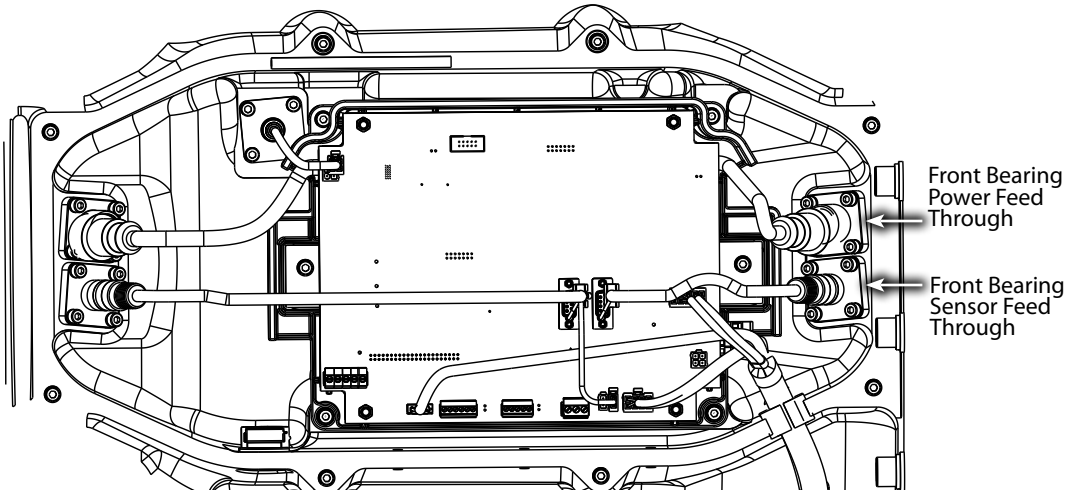
34. Remove the four (4) shims that are located behind the front touchdown bearing.
35. Release the internal cable tie from the bearing sensor feed through cable.
36. Disconnect the internal connectors from the Front Bearing Sensor Feed Through and the Front Bearing Power Feed Through.

Figure 143 - Front Bearing Feed Through Internal Connectors



37. Disconnect the external bearing sensor cable from the feed through.
38. Remove the eight (8) M5 screws holding the feed throughs to the housing.
39. Carefully remove both feed throughs from the housing. Gently pull the internal connectors through the housing.
40. Remove the O-rings.

Figure 144 - Front Bearing Sensor and Power Bearing Feed Throughs



Front Bearing Power and Sensor Feed Through Installation:

1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new feed through O-rings and then fit them into the O-ring grooves.
3. Carefully insert both feed throughs into the housing. Reconnect the internal connectors.

Figure 145 - Front Bearing Sensor Feed Through

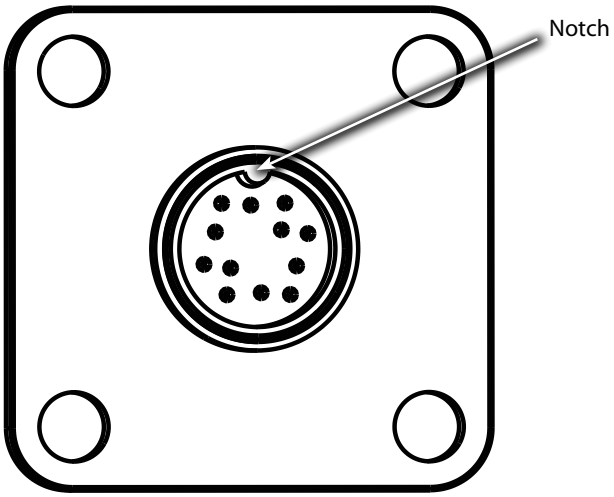
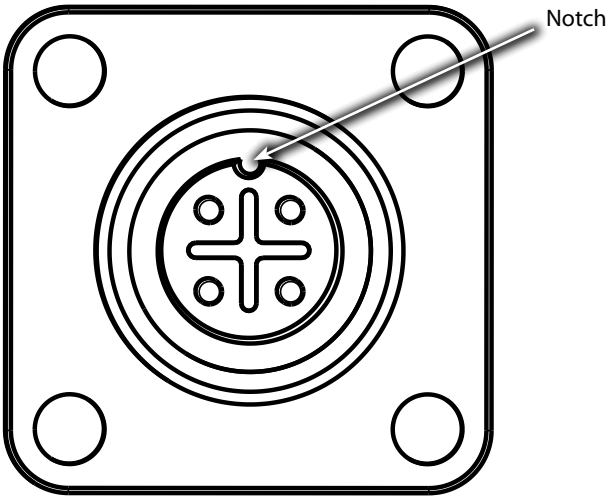


Figure 146 - Front Bearing Power Feed Through



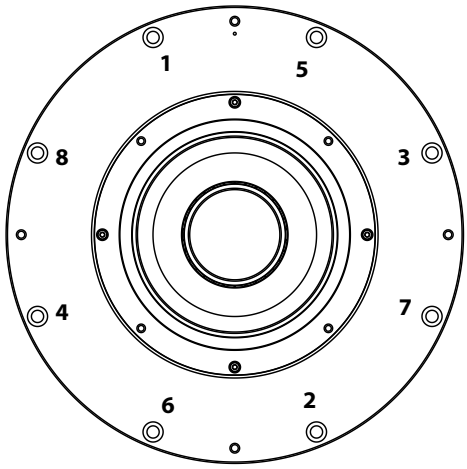
4. Install a new internal cable tie to secure the bearing sensor feed through cable.
5. Install the eight (8) M5x20 feed through screws and tighten in a crisscross pattern in two (2) stages:
   - Stage 1: Tighten to 3 Nm (26 in.lb.)
   - Stage 2: Tighten to a final torque of 6 Nm (53 in.lb.)

6. Reconnect the external bearing sensor and power cables to the feed throughs.
7. Install the four (4) shims that are located behind the front touchdown bearing.
8. Install the Touchdown Bearing/Labyrinth Seal Plate. Finger-tighten all eight (8) M8x30 screws evenly in a crisscross pattern in two (2) stages. This will slowly seat the Touchdown Bearing/ Labyrinth Seal Plate to the Compressor housing.
   - Stage 1: Tighten to 15 Nm (11 ft.lb.)
   - Stage 2: Tighten to a final torque of 30 Nm (22 ft.lb.)

⚠ • • • CAUTION • • •

The shims must be installed in the same order and orientation! Failure to maintain the order of the shims could result in operability problems and in some cases, damage to internal components.

Figure 147 - Touchdown Bearing/Labrynth Seal Plate Torque Pattern



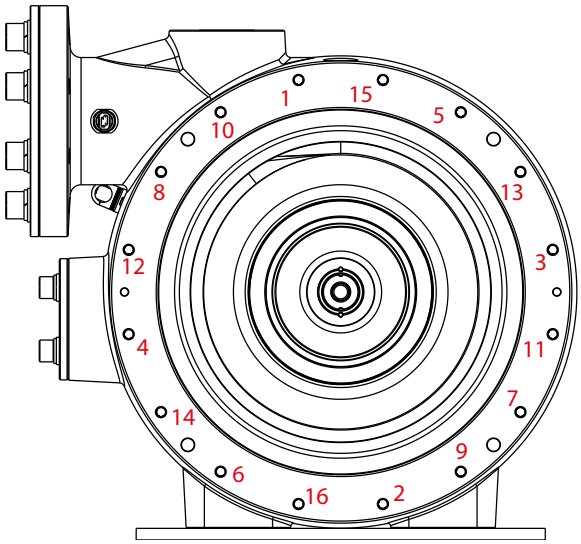
9. Install the "U" - Spacer on the shaft. If necessary, rotate the shim in order to seat the it against the race ring (located inside the Touchdown Bearing/Labyrinth Seal Plate).

⚠ • • • CAUTION • • •

Do not force the shim, otherwise damage could occur.

10. Install the Second Stage Impeller. This may require the use of a heat gun to heat up the impeller. **Do not use a torch!**
11. Install the "T" - Spacer.
12. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
13. Apply Super-O-Lube to the new O-ring and then fit it into the Volute O-ring groove.
14. Verify that the nylon shaft cover and cap and the Long Guide Pins are still in place.
15. Carefully move the Volute into place.
16. Once in place, install lock washers and flat washer on all 16 screws.
17. Finger tighten all 16 screws until seated and then, using the pattern in Figure 146 (Volute Torque Pattern), torque the fasteners in two (2) stages.
    - Stage 1: Tighten to 35 Nm (26 ft.lb.)
    - Stage 2: Tighten to a final torque of 70 Nm (52 ft.lb.)

Figure 148 - Volute Torque Pattern



NOTE

Figure 148 (Volute Torque Pattern) has the Volute removed in order to provide better clarity.

18. Install the First Stage Impeller and align it to the witness marks. This will require the use of a heat gun to heat up the impeller. **Do not use a torch!**
19. Install the First Stage Impeller bolt and torque to specification.

⚠ • • • CAUTION • • •

This is a left-hand thread bolt; to install, it must be tightened by turning it to the left.

20. Verify all contact surfaces are clean and dry between the Suction Housing and the Volute. If not, clean with a lint-free cloth.
21. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Suction Housing.
22. Insert the Short Guide Pins in the 10 o'clock, 2 o'clock, and 6 o'clock positions on the Volute.
23. Carefully install the Suction Housing.

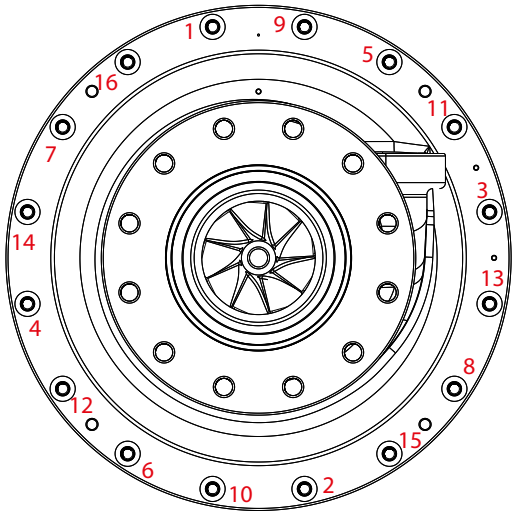
⚠ • • • CAUTION • • •

Be sure to locate the Short Guide Pin at 3 o'clock position to ensure the IFV pipe is lined up properly.

24. Prepare all 16 screws with the lock washer and flat washer.
25. Finger tighten at least four (4) screws before removing the guide pins.
26. Remove the guide pins and finger tighten the remaining screws.

27. Move from corner to corner (four (4) positions 90° apart), moving 180° then 90° and tighten these four (4) screws ONLY two (2) turns each, until those four (4) screws have seated the Suction Housing against the Volute. Performing this tightening sequence prevents damage to the O-Ring.
28. Remove the nylon shaft protector and cap.
29. Tighten all remaining screws until seated and then, using the pattern in Figure 149 (Suction Housing Torque Pattern), torque the fasteners in two (2) stages.
    - Stage 1: Tighten to 35 Nm (26 ft.lb.)
    - Stage 2: Tighten to a final torque of 70 Nm (52 ft.lb.)

Figure 149 - Suction Housing Torque Pattern



30. Remove the Compressor motor housing support.
31. Install the IFV Assembly and finger-tighten all screws evenly. Torque to specification.
32. Remove the three (3) guide pins previously inserted in the three (3) holes of the Axial Bearing Assembly.
33. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
34. Apply Super-O-Lube to the new End Cap O-ring and then fit it into the O-ring groove.
35. Insert 3" guide screws into the 10 and 2 o'clock position.
36. Gently slide the End Cap into the Compressor housing.
37. Assemble all 12 of the M12x55 screws with the flat and lock washers.
38. Insert the screws in the available locations.
39. Remove the two (2) guide screws and insert the remaining screws.
40. Finger-tighten all 12 screws and ensure that the End Cap is seated evenly into the Compressor housing.
41. Tighten the 12 M5 screws in a crisscross pattern in two (2) stages.
    - Stage 1: Tighten to 35 Nm (25.8 ft.lb.)
    - Stage 2: Tighten to a final torque of 70 Nm (52 ft.lb.)
42. Install the Service Side Cover.
43. Connect the motor power cables.
44. Install the three (3) M10 nuts and washers on the studs above the copper spacers and power cables, then torque to specification.
45. Install the Motor Power Cover.

46. Leak test the Compressor to the appropriate pressure and industry standards.
47. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
48. Charge the Compressor with refrigerant.
49. Restore power to the Compressor.

3.7.2.1.1 Verification

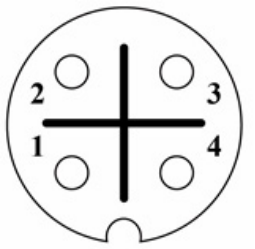
1. Disconnect the PWM connector from the bearing power feed through.
2. Verify bearing coil resistance at the feed through pins according to Table 29 (Front Bearing Coil Resistance).
3. Verify that the resistance of each pin to ground is open.

Table 29 - Front Bearing Coil Resistance

Bearing Identification	Feed Through Pin Identification	Expected Value
Front Radial Coil	1 & 3	2.6 - 3.5 Ω
	2 & 4	2.6 - 3.5 Ω

Note: Resistance to ground and between coils should be > 100Mohms @ 1kV

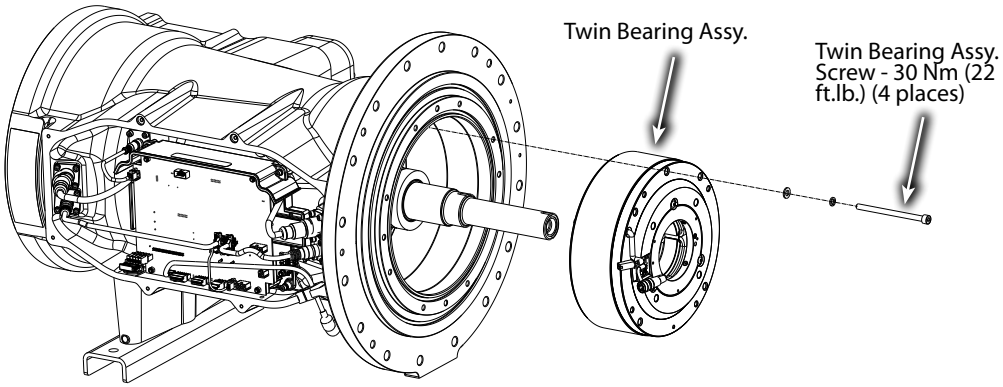
Figure 150 - Front Bearing Power Feed Through Pinout



3.7.2.2 Front Twin Bearing Assembly

The Front Twin Bearing maintains the shaft position during Compressor operation. Power is sent from the PWM to allow the bearing to levitate the shaft. The Front Twin Bearing sends position signals back to the CCM.

Figure 151 - Front Twin Bearing Assembly



3.7.2.2.1 Removal and Installation

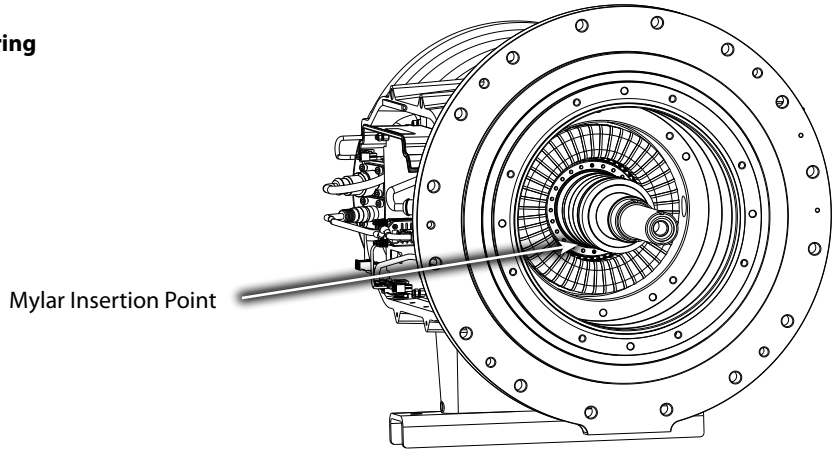
Front Twin Bearing Assembly Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Isolate the Compressor and recover refrigerant.
3. Remove the four (4) or six (6) (depending on revision) M5x16 screws that hold the Motor Power Cover in place.
4. Remove the Motor Power Cover.
5. Remove the three (3) M10 nuts and flat washers off the top of the copper spacers.
6. Remove motor power cables. Protect/isolate the cable ends.
7. Remove the eight (8) M5x16 screws that hold the Service Side Cover in place.
8. Remove the Service Side Cover.
9. Disconnect the IFV Cables and remove them from the clamp located on the Suction Housing (see Figure 126 Suction Housing Cable Clamps).
10. Carefully lay the IFV Cable harness over the rear of the Compressor to prevent it from being damaged.
11. Remove the cable harness from the pressure/temperature sensor on the Suction Housing.
12. Remove the retaining clip from the Suction Housing as shown in Figure 126 (Suction Housing Cable Clamps).
13. Carefully lay the pressure/temperature sensor harness out of the way to prevent it from being damaged.
14. Remove the IFV Assembly.
15. The Compressor will need to be lifted up to gain clearance for the Volute removal. A 5x5 wood block under the rear foot and a piece of 6" u-channel under the front. This u-channel needs to be 12" long with a 12.5mm hole drilled in the center. There is a threaded hole under the Compressor where the Volute meets the main Compressor housing. Fasten the u-channel to the Compressor with a 12mm bolt (2.5 inches long).
16. Remove the screws at 10 o'clock, 2 o'clock, and 6 o'clock positions from the Suction Cover.
17. Install the Short Guide Pins in these positions. Refer to the "Short Guide Pin" example in Appendix B.

18. Remove the remaining screws from the Suction Cover, use four (4) of the removed screws for jacking screws.
19. Locate the jacking screw holes on the flange and install the four (4) removed screws. Tighten them evenly in a crisscross pattern. This will slowly push the Suction Cover away from the Volute.
20. Set the Suction Cover aside and remove the four (4) screws from the jacking screw holes.
21. Remove the two (2) M12x55 screws located at the 10 and 2 o'clock position on the End Cap.
22. Insert the Short Guide Pins in these locations. Refer to Figure 153 (Guide Pin Locations).
23. Remove remaining screws and use a rubber mallet to tap off the End Cap.
24. Gently slide the End Cap away from the Compressor housing and set aside the End Cap.
25. Install three (3) Shaft Bolt Torquing Pins in the three (3) holes in the Axial Bearing Assembly. Refer to the "Shaft Bolt Torquing Pin" example in Appendix B. It will be necessary to turn the shaft bolt on the front of the Compressor in order to engage the pins. These pins will then hold the shaft in place for the removal of the shaft bolt.
26. Remove the shaft bolt from the First Stage Impeller.
27. Remove the First Stage Impeller. This will require the use of a heat gun to heat up the impeller. **Do not use a torch!**
28. Remove the "T"- Spacer.
29. Install a nylon shaft protector and cap.
30. Remove the screws from the Volute at the 10, 2, and 6 o'clock positions, and install Long Guide Pins in these locations. Refer to the "Long Guide Pin" example in Appendix B.
31. Remove the remaining screws from the Volute; use four (4) of these flange screws as jacking screws to push the Volute off the housing.
32. Take a strap rated at a minimum of 136 kg. (300 lbs.) with a clevis hook on one end and attach the clevis to the lifting eye on the Volute.
33. Install the jacking screws into the Volute to push it off the housing, being mindful of the nylon shaft cover to ensure it doesn't slide out when you pull off the Volute.
34. Carefully lower the Volute to the floor.
35. Remove the Second Stage Impeller. This will require the use of a heat gun to heat up the impeller. **Do not use a torch!**
36. Remove the eight (8) screws and remove the front touchdown bearing/labyrinth seal plate with the "U"- Spacer.
37. Once all of the eight (8) screws have been removed, insert four (4) of the removed screws into the Touchdown Bearing/Labyrinth Seal Plate jacking screw locations. Tighten them evenly in a crisscross pattern. This will slowly push the Touchdown Bearing/Labyrinth Seal Plate away from the Compressor housing.
38. Remove the four (4) shims that are located behind the front touchdown bearing.
39. Release the internal cable tie from the bearing sensor feed through cable.
40. Disconnect the internal connectors from the Front Bearing Sensor Feed Through and the Front Bearing Power Feed Through.
41. Disconnect the external bearing sensor cable from the feed through.
42. Remove the eight (8) M5 screws holding the feed throughs to the housing.
43. Carefully remove both feed throughs from the housing. Gently pull the internal connectors through the housing.
44. Remove the O-rings.
45. Remove the four (4) M8x120 screws from the Twin Bearing Assembly.
46. Install the four (4) jacking screws into the Twin Bearing assembly to push it away from the housing.

47. Slowly tighten the four (4) jacking screws evenly, in a crisscross pattern. Continue this until the Twin Bearing Assembly can be removed by hand.
48. While supporting the shaft, carefully slide out the Twin Bearing Assembly
49. Slide a small piece of Mylar underneath the shaft and gently lower the shaft onto the Stator.

Figure 152 - Twin Bearing Mylar Insertion



⚠ • • • CAUTION • • •

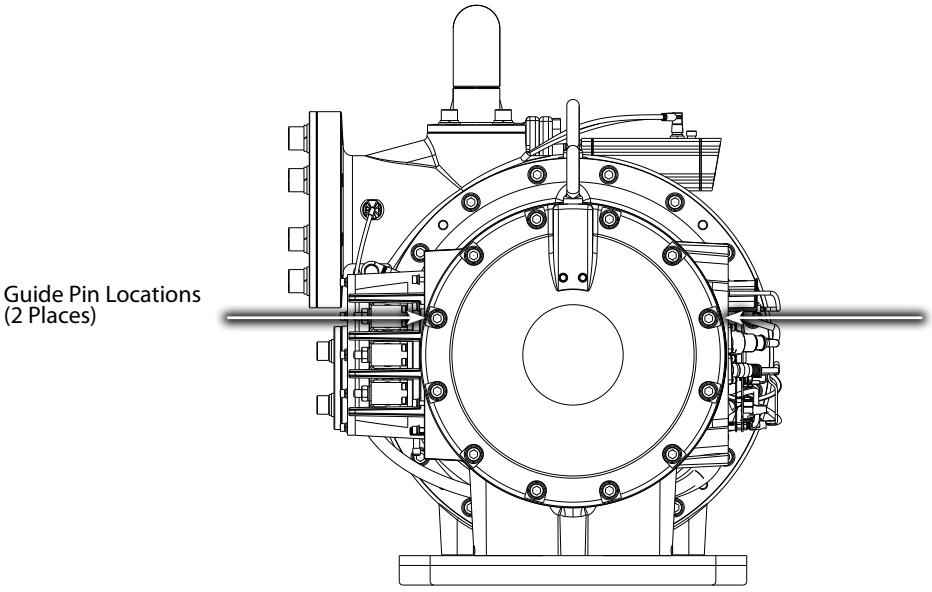
Do not allow the Twin Bearing Assembly to contact/rub the Compressor shaft during removal. Damage to the shaft and or bearing assembly may occur.

3.7.2.2 Rear Bearings

Rear Compressor Disassembly

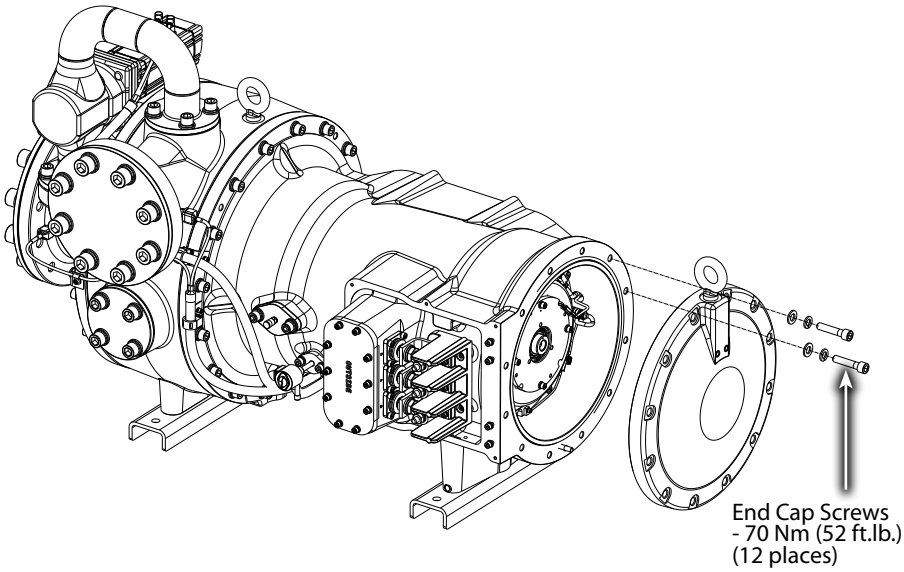
1. Remove the two (2) M12x55 screws located at the 10 and 2 o'clock positions on the End Cap.
2. Insert the Short Guide Pins in these locations (refer to the "Short Guide Pin" example in Appendix B). Refer to Figure 153 (Guide Pin Locations) for the locations of the pins.

Figure 153 - Guide Pin Locations



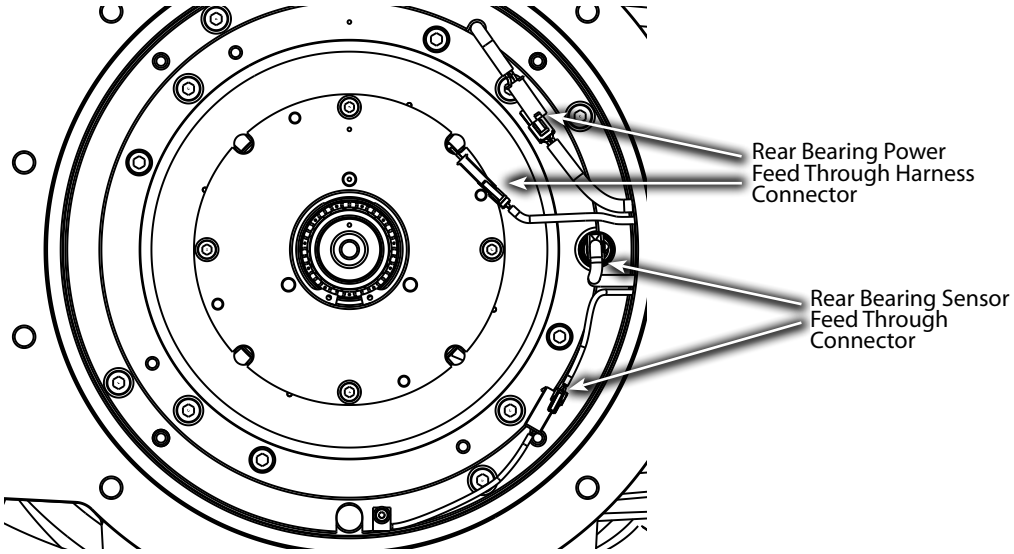
3. Remove remaining screws and use a rubber mallet to tap off the End Cap.
4. Gently slide the End Cap away from the Compressor housing and set aside the End Cap.

Figure 154 - End Cap Removal



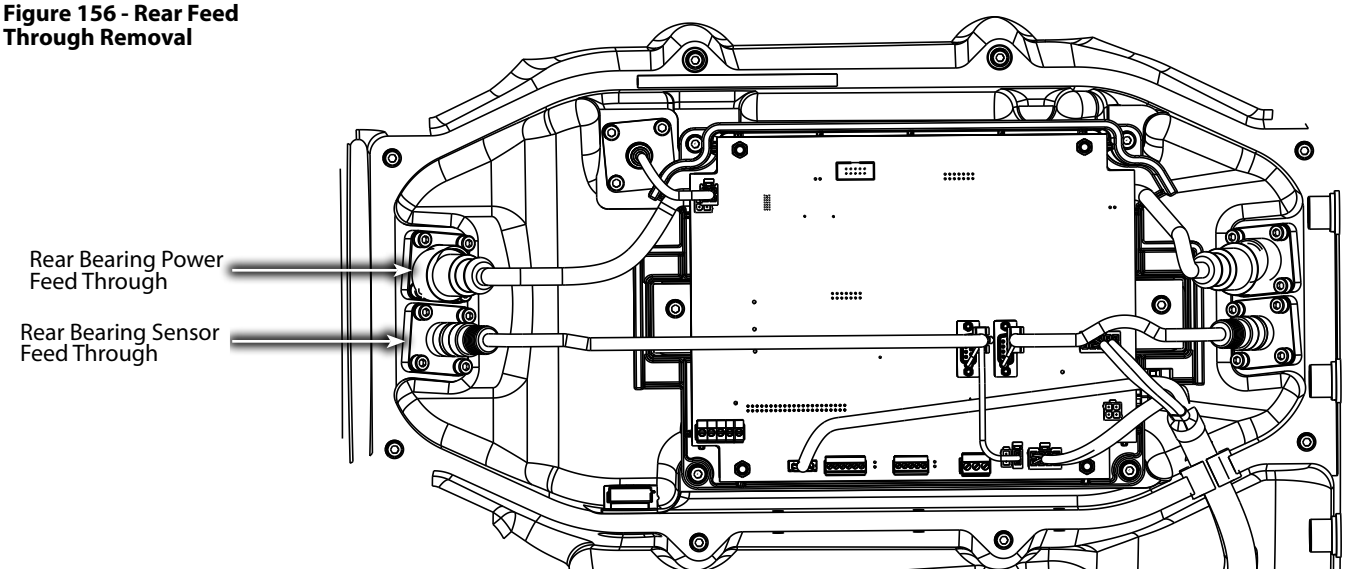
5. Disconnect the Rear Bearing Sensor and Rear Bearing Power connectors. Refer to Figure 155 (Rear Bearing Sensor and Rear Bearing Power Harness).

Figure 155 - Rear Bearing Sensor and Rear Bearing Power Harness



6. Disconnect the external bearing sensor and power cables from the feed throughs.
7. Remove the eight (8) M5 screws holding the feed throughs to the housing.
8. Carefully remove both feed throughs from the housing. Gently pull the internal connectors through the housing.
9. Remove the O-rings.

Figure 156 - Rear Feed Through Removal

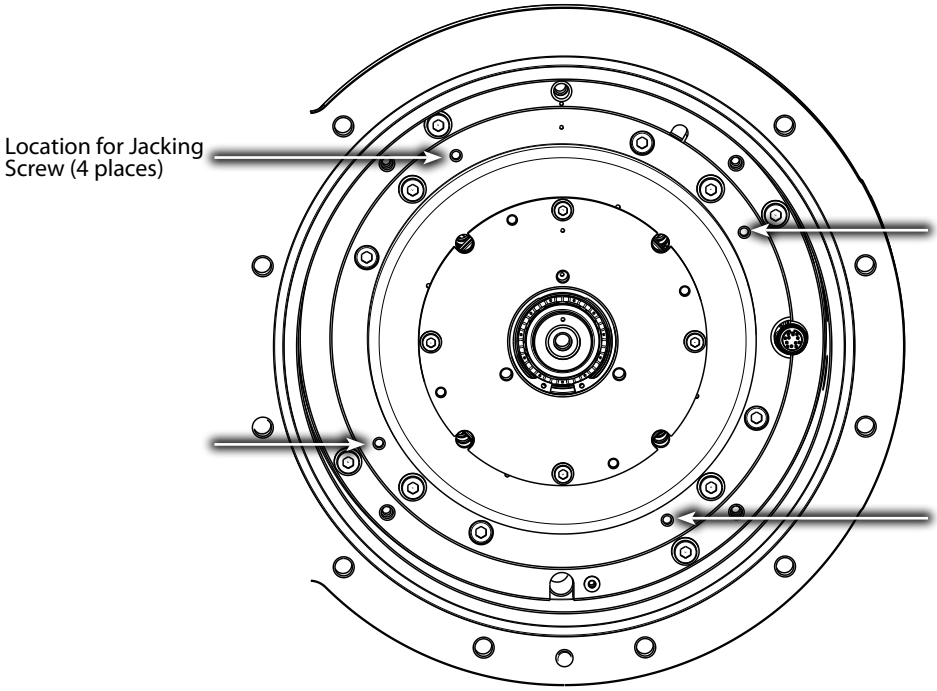


10. Remove the four (4) screws that secure the Axial Bearing Assembly.
11. Insert four (4) 6 mm jacking screws to aid in the removal of the Axial Bearing Assembly. This will be required due to the magnetic force keeping the assembly in place. Once the magnetic force decreases, gently slide away the Axial Bearing Assembly away from the Compressor.

⚠ • • • CAUTION • • •

All magnetic parts should be separated and placed in individual bags that can be sealed to prevent contamination to the parts. Metal debris can and will lead to premature failure of the Compressor components.

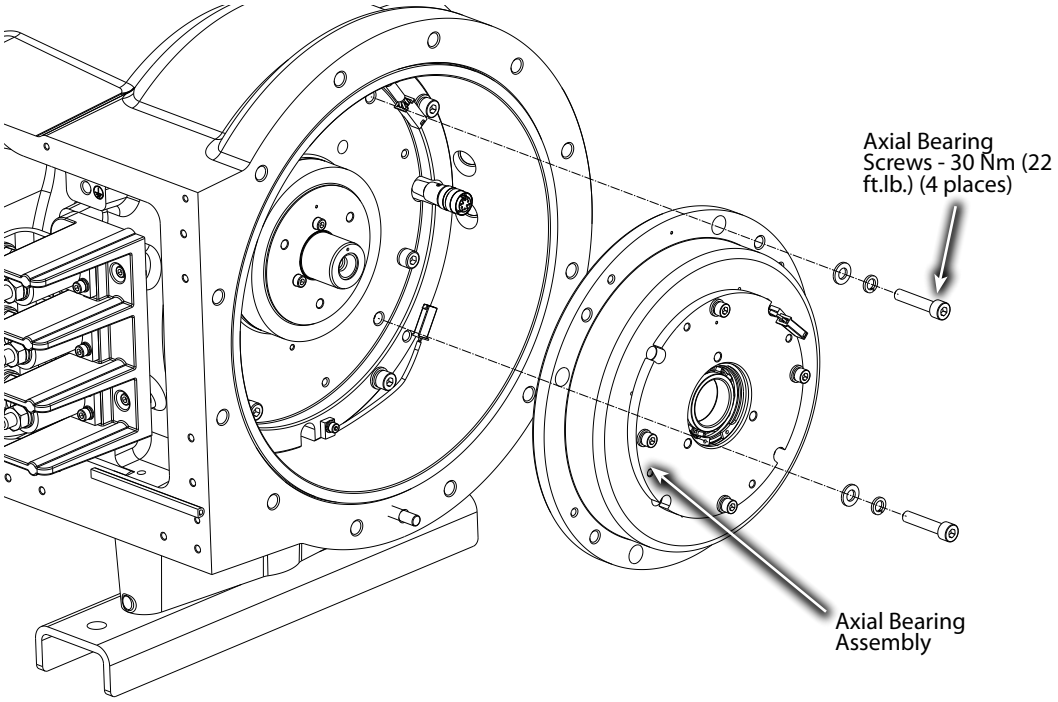
Figure 157 - Axial Bearing Assembly Jacking Screw Locations



NOTE

For clarity, all wire harnesses were removed from Figure 157 (Axial Bearing Assembly Jacking Screw Locations).

Figure 158 - Axial Bearing Removal

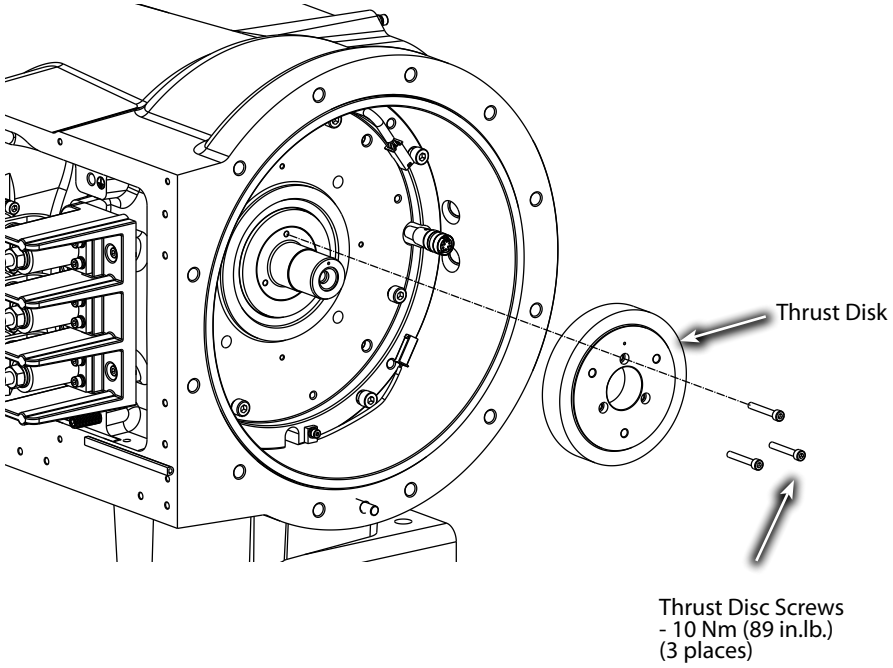


12. Remove the three (3) M5x35 screws that secure the Thrust Disk and carefully slide the Thrust Disk off the Compressor shaft.

⚠ • • • CAUTION • • •

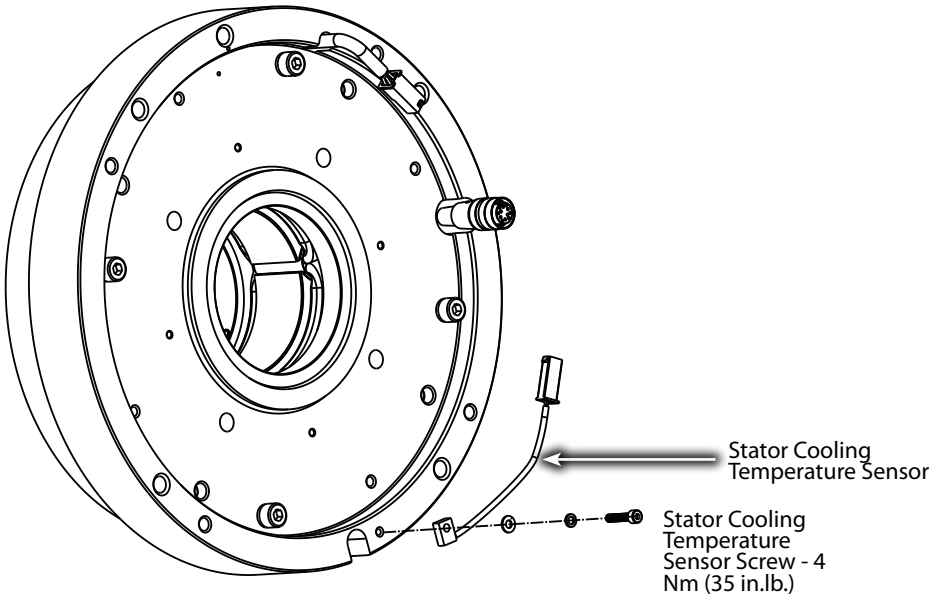
All magnetic parts MUST be separated and placed in individual bags that can be sealed to prevent contamination to the parts. Metal debris can and will lead to premature failure of the Compressor components.

Figure 159 - Thrust Disk Removal



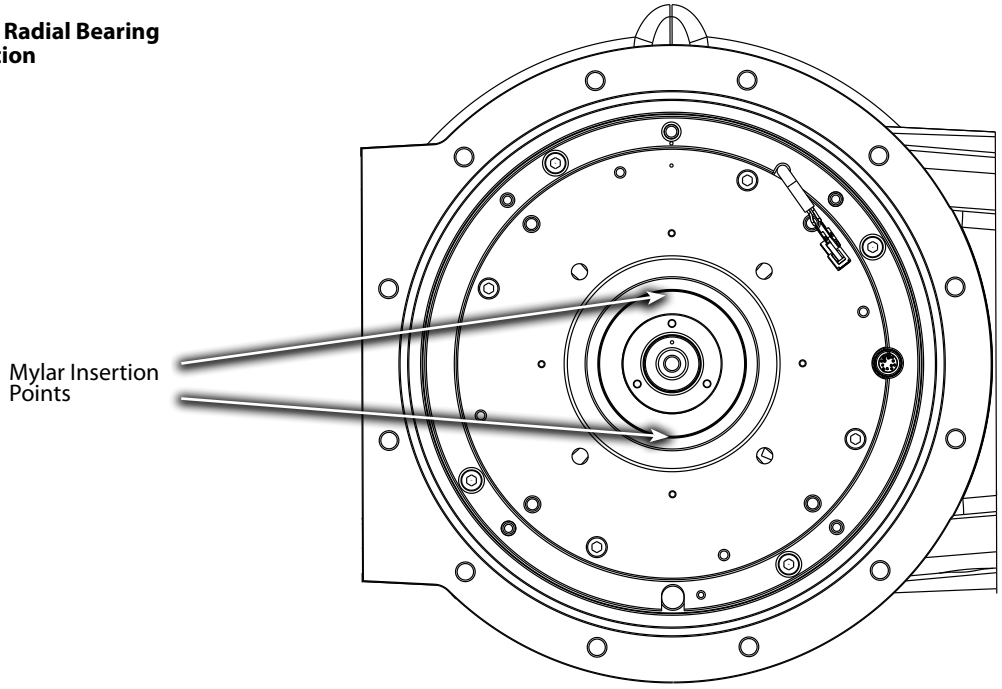
13. Remove the M4x20 screw, washer, and lock washer that secure the Stator Cooling Temperature Sensor.

Figure 160 - Stator Cooling Temperature Sensor



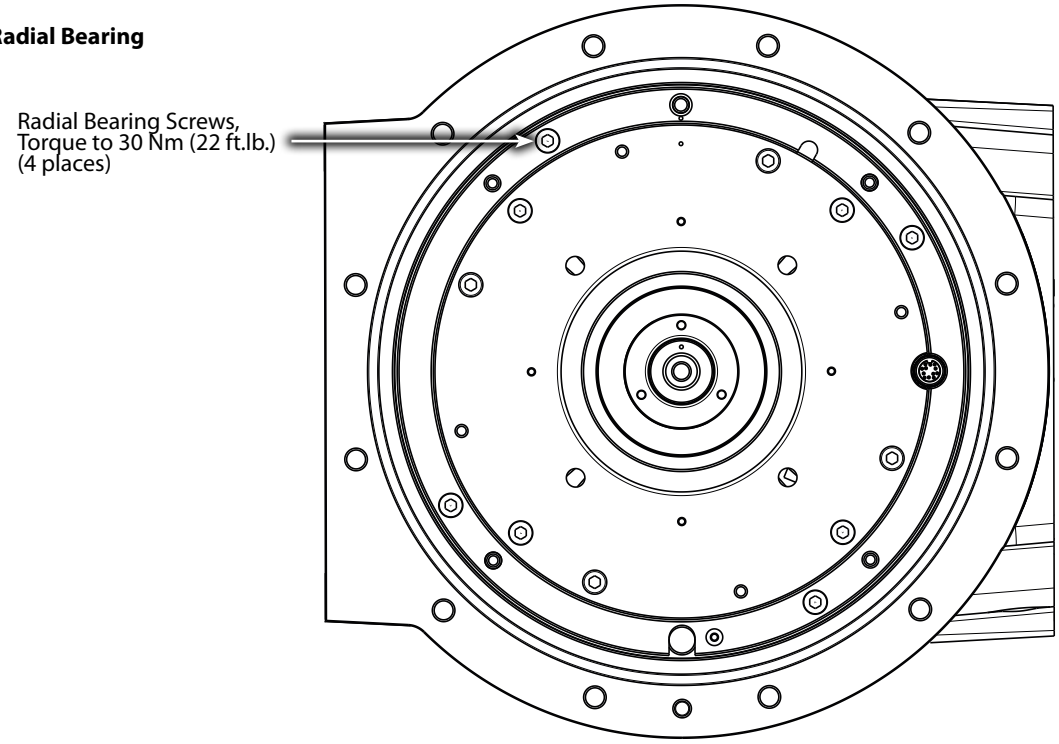
14. Insert two (2) pieces of Mylar between the Compressor shaft and the Rear Radial Bearing Assembly.

Figure 161 - Radial Bearing Mylar Insertion



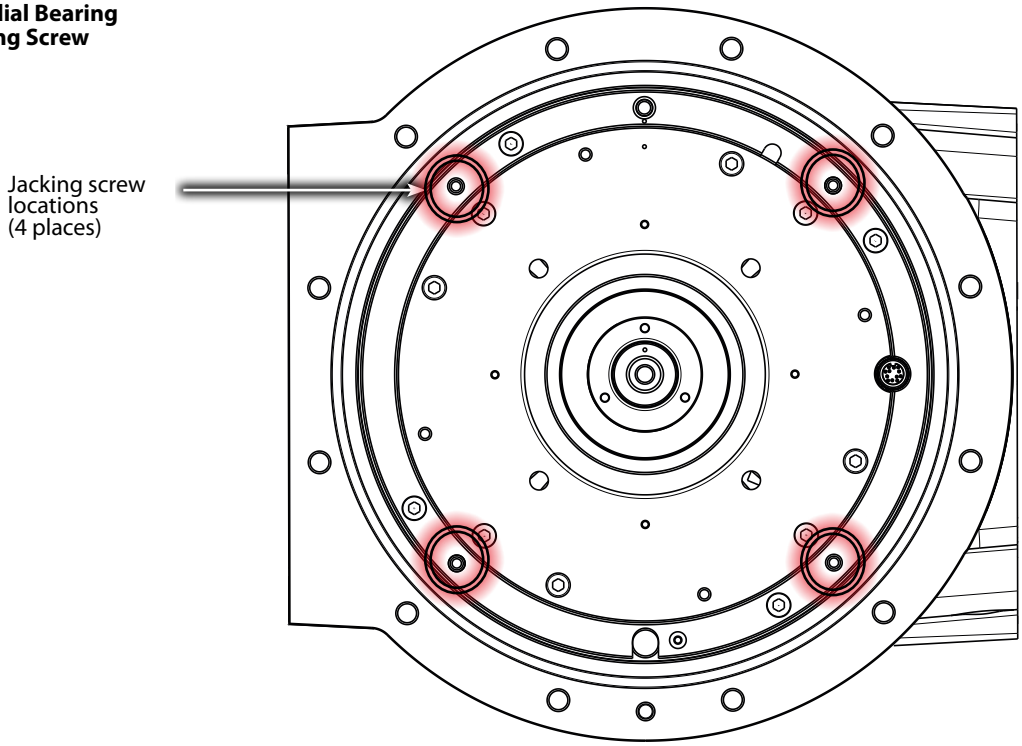
15. Remove the four (4) M8x65 screws that secure the Radial Bearing Assembly.

Figure 162 - Radial Bearing Screws



16. Insert the four (4) jacking screws into the jacking screw locations as indicated in Figure 163 (Radial Bearing Assembly Jacking Screw Locations).

Figure 163 - Radial Bearing Assembly Jacking Screw Locations

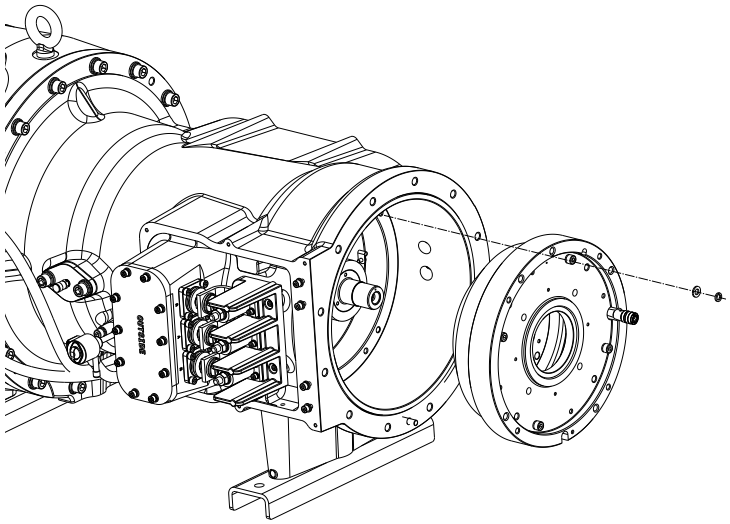


17. Slowly tighten the four (4) jacking screws evenly, in a crisscross pattern. Continue this until the Radial Bearing Assembly can be removed by hand.
18. While supporting the shaft, carefully slide out the Radial Bearing Assembly.

⚠ • • • CAUTION • • •

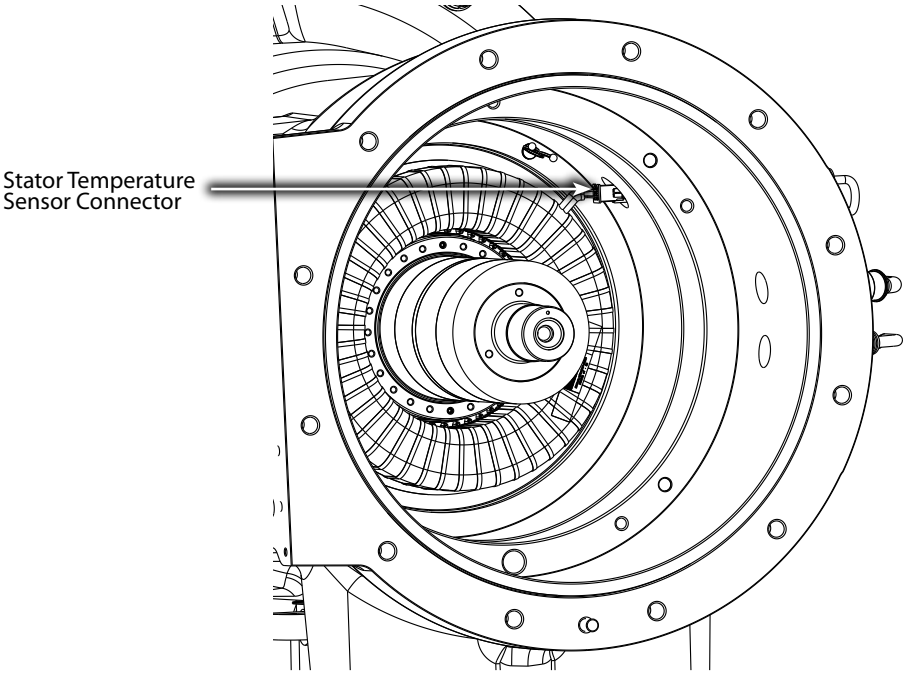
Do not allow the Radial Bearing Assembly to contact/rub the Compressor shaft during removal. Damage to the shaft and or bearing assembly may occur.

Figure 164 - Radial Bearing Assembly Removal



19. Slide a small piece of Mylar underneath the shaft and gently lower the shaft onto the Stator.
20. Disconnect the internal Stator harness connector and test as described in the "Stator Thermistor Resistance Verification" section of this manual.

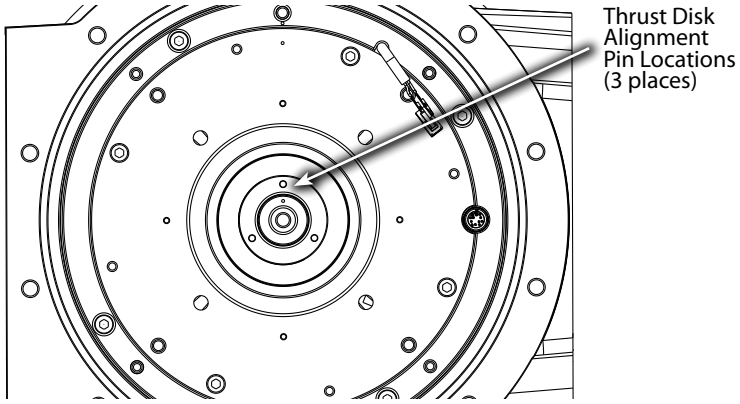
Figure 165 - Stator View



Rear Compressor Assembly

1. Reconnect the internal Stator harness connector.
2. While supporting the shaft, remove the Mylar and carefully insert the Radial Bearing Assembly into place.
3. Install the four (4) M8x65 screws that secure the Radial Bearing Assembly and tighten them in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 15 Nm (11 ft.lb.)
   - Stage 2: Tighten to a final torque of 30 Nm (22 ft.lb.)
4. Install the Stator Cooling Temperature Sensor. Tighten the M4x20 screw, washer, and lock washer that secures the sensor and torque to specification.
5. Insert at least two (2) Thrust Disk Alignment Pins (refer to the "Thrust Disk Alignment Pin" example in Appendix B) into the threaded holes in the Compressor shaft. Refer to Figure 166 (Thrust Disk Alignment Pins) for the pin location. These pins are necessary due to the magnetized shaft.
6. Carefully slide the Thrust Disk into place over the Compressor shaft and align it with the inserted pins.
7. Remove all of the Thrust Disk Alignment Pins.

Figure 166 - Thrust Disk Alignment Pins



8. Insert the three (3) M5x35 screws that secure the Thrust Disk and torque to specification.
9. Carefully slide the Axial Bearing Assembly into place over the Compressor shaft.
10. Install the four (4) M8x40 screws that secure the Axial Bearing Assembly and tighten them in a crisscross pattern in two (2) stages.
    - Stage 1: Tighten to 15 Nm (11 ft.lb.)
    - Stage 2: Tighten to a final torque of 30 Nm (22 ft.lb.)
11. Verify all feed through contact surfaces are clean and dry. If not, clean with a lint-free cloth.
12. Apply Super-O-Lube to the new O-rings and then fit them into the O-ring grooves.
13. Orient the feed throughs with the notch at the top as shown in Figure 167 (Rear Bearing Sensor Feed Through) and Figure 168 (Rear Bearing Power Feed Through).

Figure 167 - Rear Bearing Sensor Feed Through

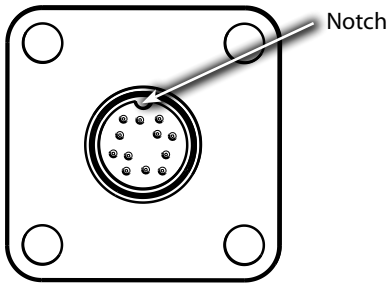
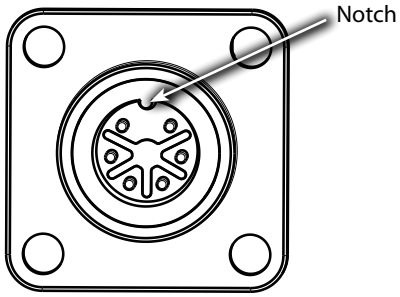


Figure 168 - Rear Bearing Power Feed Through



14. Carefully insert both feed throughs into the housing and reconnect the internal connectors.
15. Install the eight (8) M5x20 feed through screws and tighten in a crisscross pattern in two (2) stages.
    - Stage 1: Tighten to 3 Nm (26 in.lb.)
    - Stage 2: Tighten to a final torque of 6 Nm (53 in.lb.)
16. Reconnect the external bearing sensor and power cables to the feed throughs.
17. Verify all End Cap contact surfaces are clean and dry. If not, clean with a lint-free cloth.
18. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove.
19. Insert two (2) Short Guide Pins into the 10 and 2 o'clock position.
20. Gently slide the End Cap into the Compressor housing.
21. Assemble all 12 of the M12x55 screws with the flat and lock washers.
22. Insert the screws in the available locations.
23. Remove the two (2) Short Guide Pins and insert the remaining screws.
24. Finger-tighten all 12 screws and ensure that the End Cap is seated evenly into the Compressor housing.
25. Tighten the 12 M5 screws in a crisscross pattern in two (2) stages.
    - Stage 1: Tighten to 35 Nm (25.8 ft.lb.)
    - Stage 2: Tighten to a final torque of 70 Nm (52 ft.lb.)
26. Install the Service Side Cover.
27. Connect the motor power cables.
28. Install the three (3) M10 nuts and washers on the studs above the copper spacers and power cables, then torque to specification.
29. Install the Motor Power Cover.
30. Leak test the Compressor to the appropriate pressure and industry standards.
31. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
32. Charge the Compressor with refrigerant.
33. Restore power to the Compressor.

3.7.2.2.1 Bearing Verification

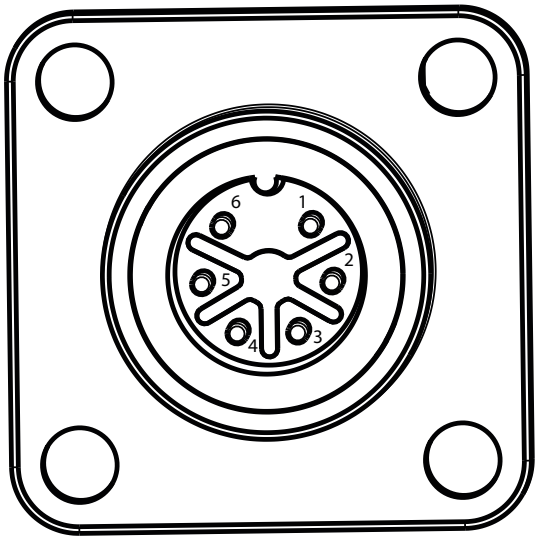
1. Disconnect the PWM connector from the bearing power feed through.
2. Verify bearing coil resistance at the feed through pins according to Table 30 (Rear Bearing Coil Resistance). Refer to Figure 169 (Rear Bearing Power Feed Through Pin Identification).
3. Verify that the resistance of each pin to ground is open.

Table 30 - Rear Bearing Coil Resistance

Bearing Identification	Feed Through Pin Identification	Expected Value
Rear Radial Coil	1 & 3	2.6 - 3.5 Ω
	2 & 4	2.6 - 3.5 Ω
Axial Coil	5 & 6	3.6-4.5 Ω

Note: Resistance to ground and between coils should be > 100Mohms @ 1kV

Figure 169 - Rear Bearing Power Feed Through Pin Identification



3.7.2.2.2 Stator Temperature Verification

1. Before starting the Compressor, with the power on and using the SMT, verify Stator temperature reading is an acceptable value. Refer to Table 20 (Stator Thermistor R/T Curve).
2. While the Compressor is running, verify the Stator temperature fluctuates to expected values during operation.

3.7.2.2.3 Torque Specifications

Table 31 - Internal Components Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Rear Bearing Power Feed Through, SHCS, M6x20	6	-	53
Rear Bearing Sensor Feed Through, SHCS, M6x20	6	-	53
Stator Temperature Sensor Feed Through, SHCS, M6x20	6	-	53
End Cap, SHCS, M12x55	70	52	620
Axial Bearing Assembly, SHCS, M8x40	30	22	266
Stator Cooling Temperature Sensor, SHCS, M4x20	4	-	35
Thrust Disk, SHCS, M5x35	10	7	88
Radial Bearing Assembly, SHCS, M8x65	30	22	266

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A VFD is an electronic motor controller that converts DC into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The VFD can vary the speed of the motor in response to commands from the CCM.

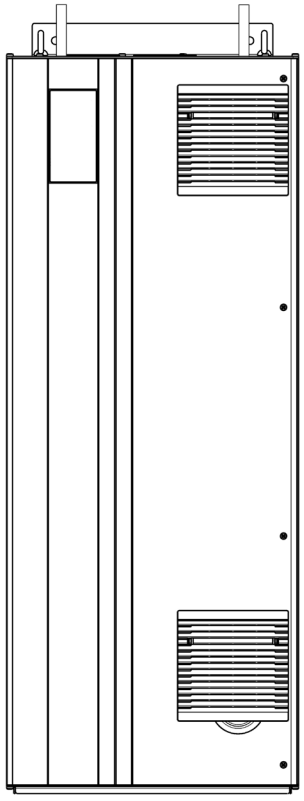
4.1 VFD Modules

There are three (3) VTT VFD Modules specifically designed and programmed to operate with the VTT Compressor Module and cannot be replaced by a generic drive. The following VFDs are designed to be used with the VTT Compressor Module:

- N165
- N232
- N262

For detailed VFD information, refer to the VFD Service Manual.

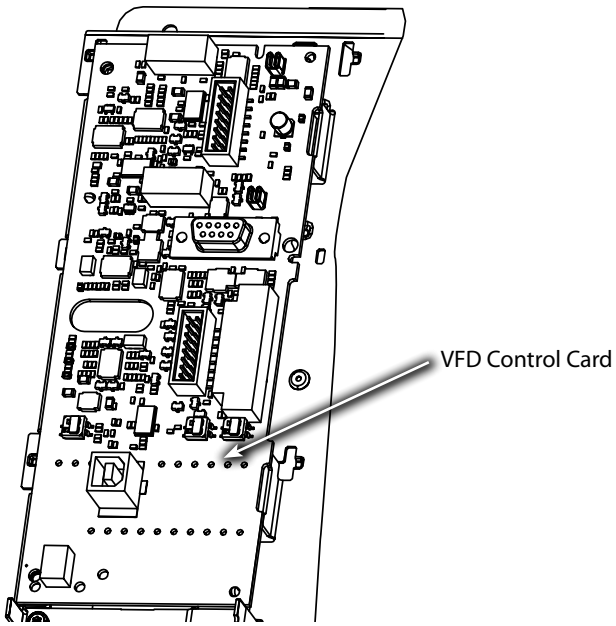
Figure 170 - VFD



4.2 VFD Control Card

The VFD Control Card contains most of the logic section. The primary logic element of the VFD Control Card is a microprocessor, which supervises and controls all functions of frequency converter operation.

Figure 171 - VFD Control Card



4.2.1 VFD Card Connections

The VFD Control Card is connected to the CCM via an RS-485 cable. Figure 172 (RS-485 and Interlock Connection Details) illustrates the connection to the VFD Control Card. Refer to the "VTT Service Electronics Assembly" section for the details on the CCM connection.

Figure 172 - RS 485 and Interlock Connection Details

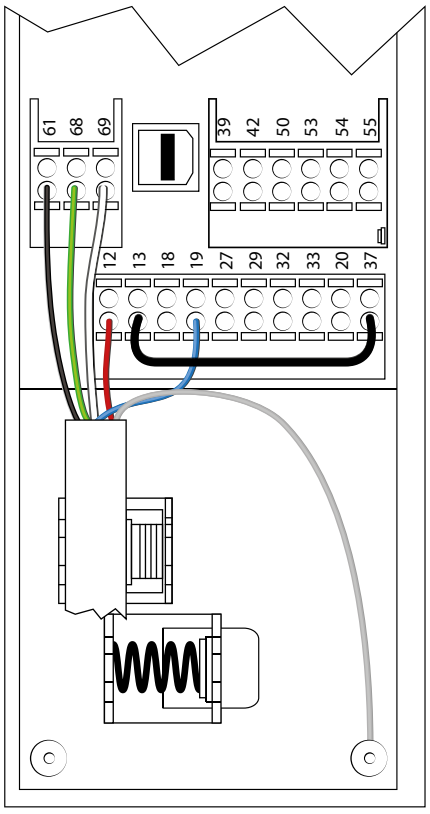


Table 32 - RS485 Details

Wire Color	Terminal Number
Black	61
Green	68
White	69
Red	12
Blue	19
Silver	Screw

NOTE

There is an option for customer-supplied cabling, if the colors do not match, make a note of the terminal number to the color wire.

4.2.2 Removal and Installation

Removal:

1. Isolate the VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Open the front panel of the VFD and locate the plastic housing that is displayed through the front panel door.
3. Remove the plastic housing so that you can see the metal mounting bracket.
4. Remove the control wiring terminal blocks located at bottom of the VFD Control Card.
5. Remove the four (4) screws that hold metal cradle in to the card holder.
6. Carefully pull the card off the metal retainer bracket. The VFD Control Card has a plug on the backside that connects it to the ribbon cable.

Installation:

1. Carefully attach card to the retainer bracket. Be sure that the plug on the back of card is inserted into ribbon cable holder properly.
2. Attach the metal cradle to the front side of the VFD Control Card and secure it with the four (4) screws and torque to specification.
3. Install the terminal blocks to their original location.
4. Replace the plastic housing back over the 9 pin connector and place gasket around it.
5. Close the door on the panel making sure gasket is in place to ensure a watertight seal.
6. Restore power to the VFD.

4.2.3 VFD Control Card Verification

Apply power to the VFD and verify proper operation via the SMT.

4.2.4 Torque Specifications

Table 33 - VFD Card Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
VFD Control Card Mounting Screws	1	-	10

4.3 VFD Orifice

The VFD orifice must be fitted to the VFD VFD module at the cold plate tube refrigerant inlet. This orifice controls flow of refrigerant to the VFD module.

Figure 173 - VFD Orifice

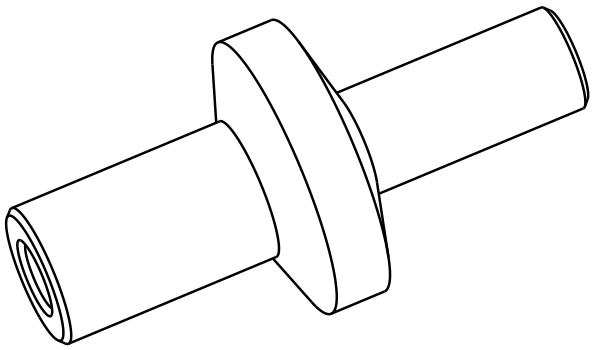
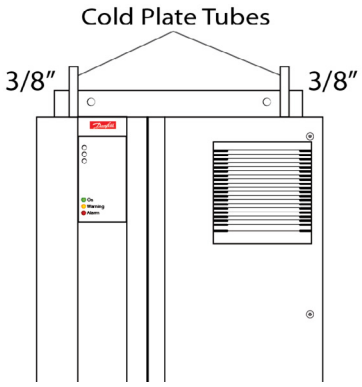


Figure 174 - Cold Plate Tubes



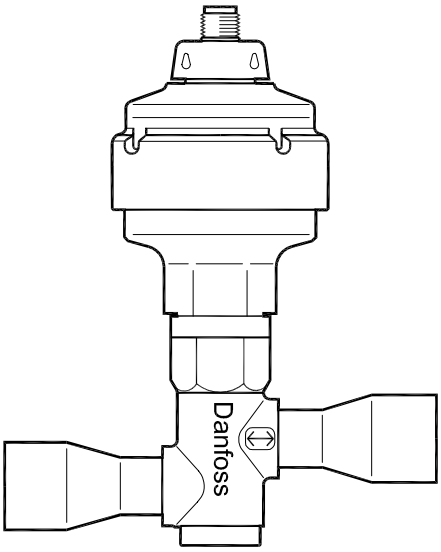
4.3.1 VFD Orifice Specifications

- Inlet - 12.5 mm (1/2″) OD, Male
- Outlet - 9.3 mm (3/8″) OD, Male

4.4 VFD Valve

The VFD Valve must be fitted to the VFD at the cold plate tube refrigerant outlet. This valve regulates refrigerant pressure and temperature.

Figure 175 - VFD Valve



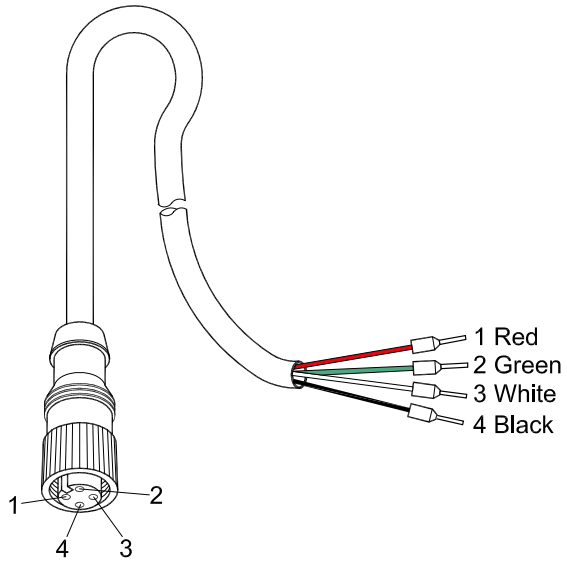
4.4.1 VFD Valve Specifications

- Inlet - 16 mm (5/8 in.) Female
- Outlet - 16 mm (5/8 in.) Female

4.5 VFD Pressure Control Valve Cable

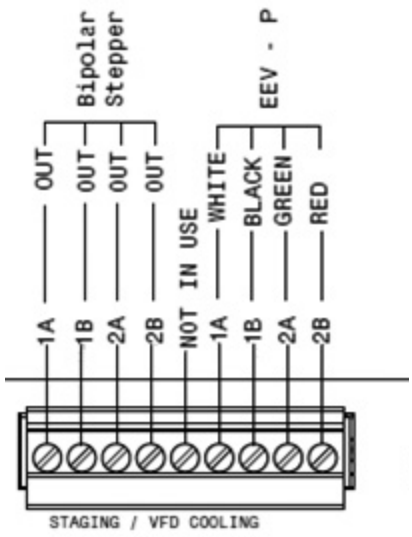
The VFD Pressure Control Valve Cable connects the CIM to the VFD Pressure Control Valve Motor.

Figure 176 - VFD Pressure Control Valve Cable



4.5.1 VFD Pressure Control Valve Pin Connections

Figure 177 - VFD Pressure Control Valve Pin Identification

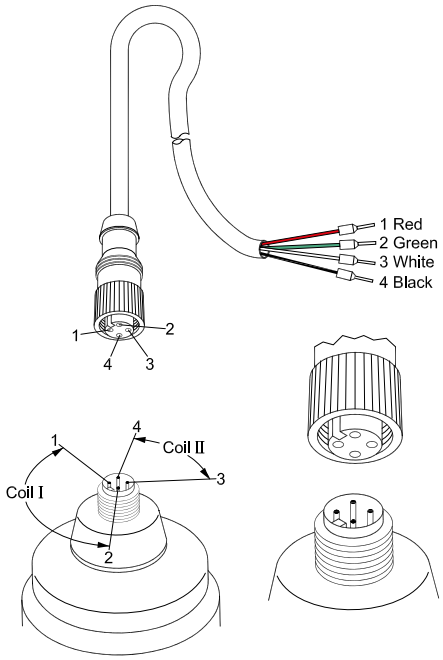


4.5.2 VFD Pressure Control Valve Removal and Installation

Removal:

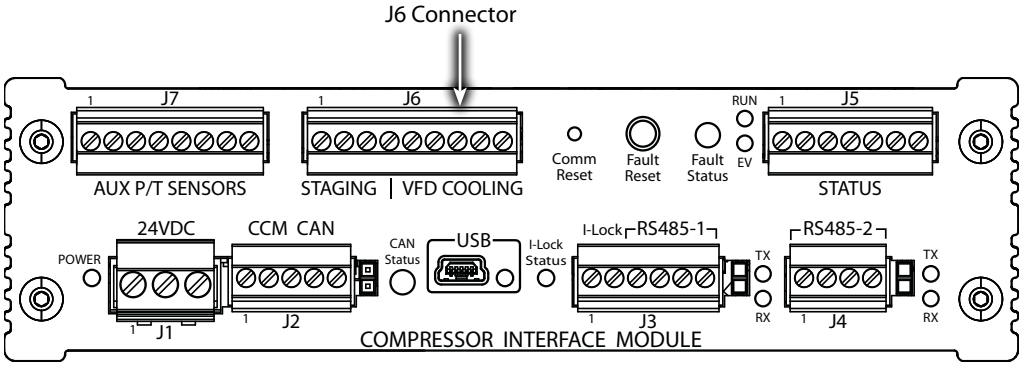
1. Isolate the VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Unscrew the M12 connector from the top of the VFD cooling valve.

Figure 178 - VFD Pressure Control Valve M12 Connection



3. Remove the controls panel cover where CIM is located.
4. Remove VFD Pressure Control Valve Cable from the CIM at J6 (VFD Cooling). The numbers referenced in Figure 180 (CIM (Revisions A and B) Wire Diagram) correspond to the numbers/ colors listed in Figure 178 (VFD Pressure Control Valve M12 Connection).

Figure 179 - CIM (Revisions A and B) J6 Connection



NOTE

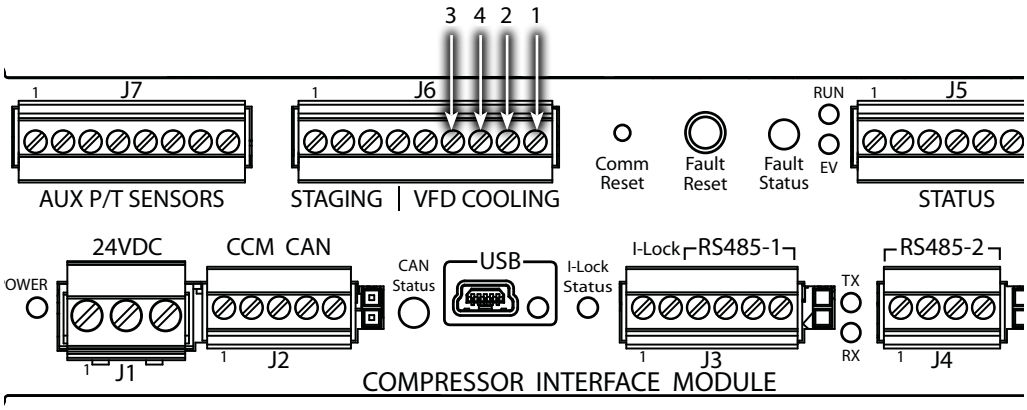
A figure representing CIM Revision C is not shown. The order of connectivity is the same between the two (2)revisions.

5. Remove the cable.

Installation:

1. Screw the M12 connector on top of the VFD Pressure Control Valve.
2. Terminate the cable to J6 on the CIM.
3. Secure the cable.
4. Restore power to the VFD.

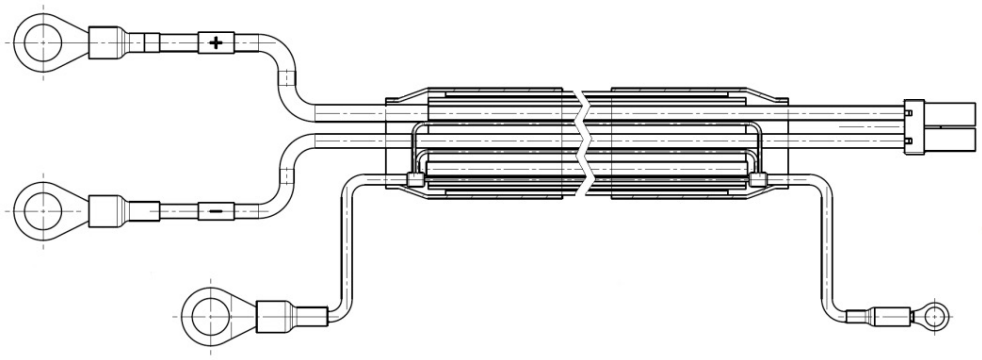
Figure 180 - CIM (Revisions A and B) Wire Diagram



4.6 VFD DC-DC Cable

The VFD DC-DC Cable passes High Voltage DC from the VFD to the DC-DC.

Figure 181 - VFD DC-DC Cable

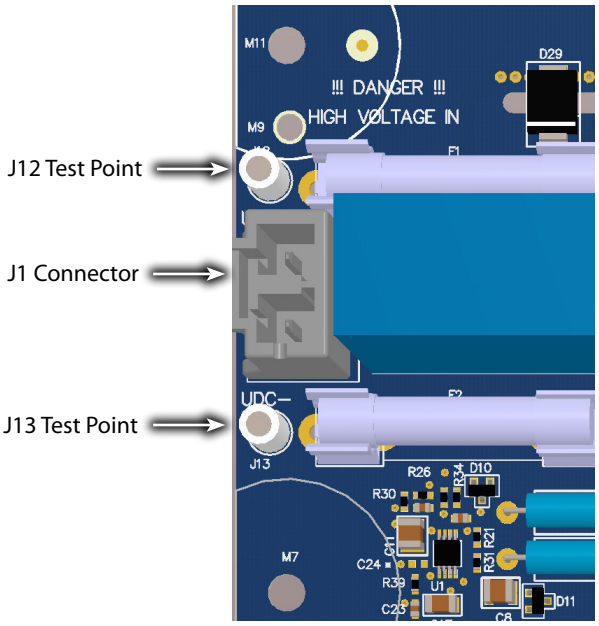


4.6.1 Removal and Installation

Removal:

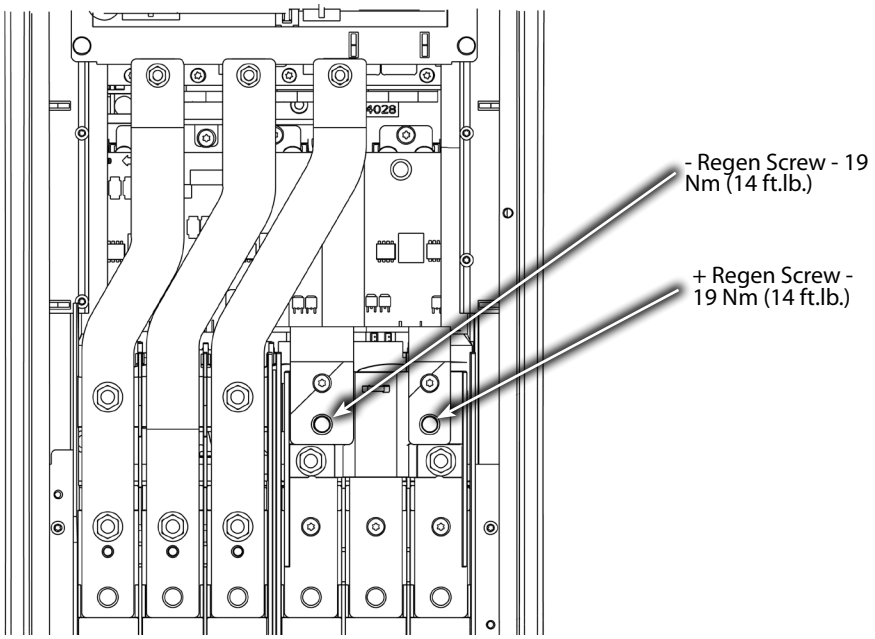
1. Isolate the VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Open the panel containing the DC-DC. Verify the HV DC input from the VFD is below 5 VDC by checking at VDC+ (J12) and VDC- (J13) test points on the DC-DC with a DC voltage meter.
3. Disconnect (J1) HV DC In connector on the DC-DC Board.

Figure 182 - DC-DC J1 Connector



4. Disconnect the HV DC Ground cable from the DC-DC Board.
5. Remove the cover from the VFD.
6. Disconnect the cables from + Regen 82 and – Regen 83.

Figure 183 - VFD + Regen 82 and – Regen 83



7. Disconnect the HV DC Ground cable from the VFD.
8. Remove the cable.

Installation:

1. Route the cable into the DC-DC box.
2. Connect to (J1) HV IN on the DC-DC Board.
3. Connect the HV DC Ground cable to the DC-DC Board.
4. Secure the cable where it goes into the box.
5. Route the cable into the bottom of the VFD.
6. Connect to + Regen 82 and – Regen 83.
7. Secure the cable where it goes into the power module.
8. Replace all covers.
9. Reconnect power to the VFD.

4.6.2 VFD DC-DC Cable Verification

1. Apply power to the VTT VFD.
2. Verify the LEDs on CIM are on.
3. On the DC-DC, using an appropriately rated voltage meter, verify HV DC input is correct for the applied voltage by checking at VDC+ (J12) and VDC- (J13) test points.
4. The measured voltage should be around 1.35 x the AC input voltage.
5. Verify 24 V DC output is correct by checking at J10 and J11 test points.
6. Verify 250 V DC output is correct by checking at J8 and J9 test points.

4.6.3 Torque Specifications

Table 34 - Regen Cable Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
+ and - Regen Screws, M5	19	14	168

5.1 DC-DC Module

The DC-DC converter provides the compressor with +24V DC (with respect to 0V) and HV+ (+250V DC with respect to HV-) for the bearing PWM amplifier. The DC-DC Converter receives a high voltage DC supply from the VFD module.

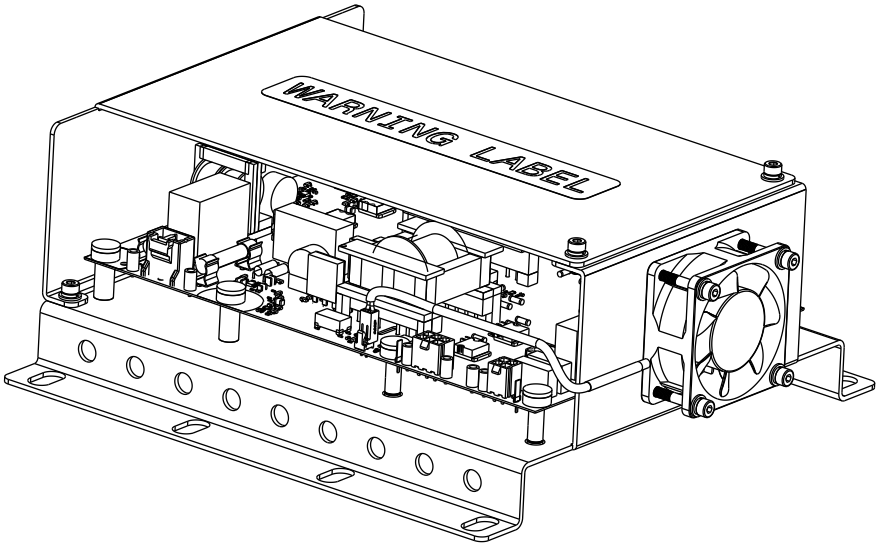


Figure 184 - DC-DC (Revisions A and B)

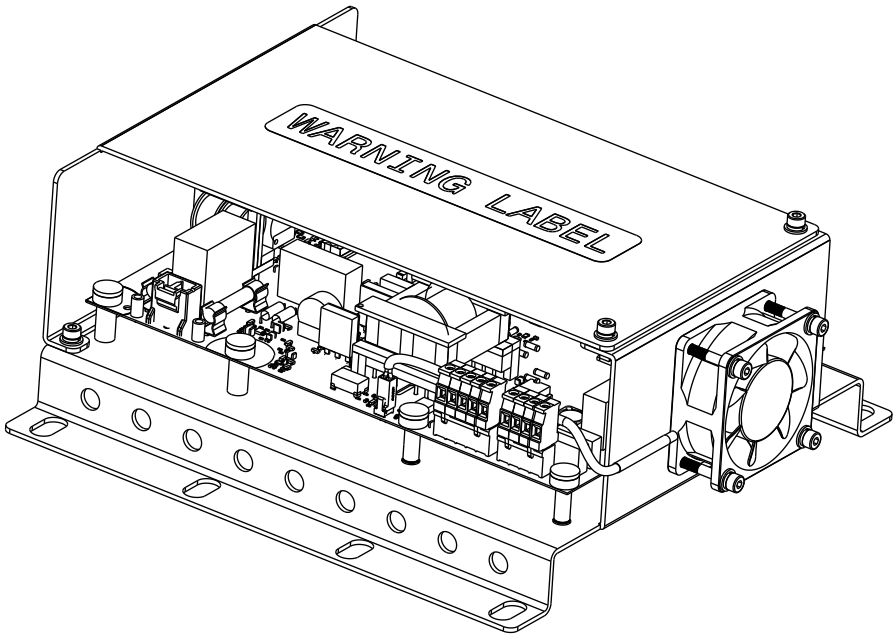


Figure 185 - DC-DC (Revisions C and Later)

5.1.1 DC-DC Connections

1. HV DC IN J1
2. 250 V DC OUT J2
3. 24 V DC OUT J4
4. Ground M4, M5, J6, and J7

5.1.2 Removal and Installation

Removal (Revisions A and B):

1. Isolate the VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Open the panel containing the DC-DC. Verify the HV DC input from VFD is below 5 VDC by checking at VDC+ (J12) and VDC- (J13) test points on DC-DC with a DC voltage meter.
3. Disconnect the HV DC input cable from J1; 24 VDC output cable from J4; and 250 VDC output cable from J2. Refer to Figures 186 (DC-DC J1 Connection and J12-J13 Test Points) and 2 (DC-DC J2 and J4 Connections).

Figure 186 - DC-DC J1 Connection and J12 -J13 Test Points

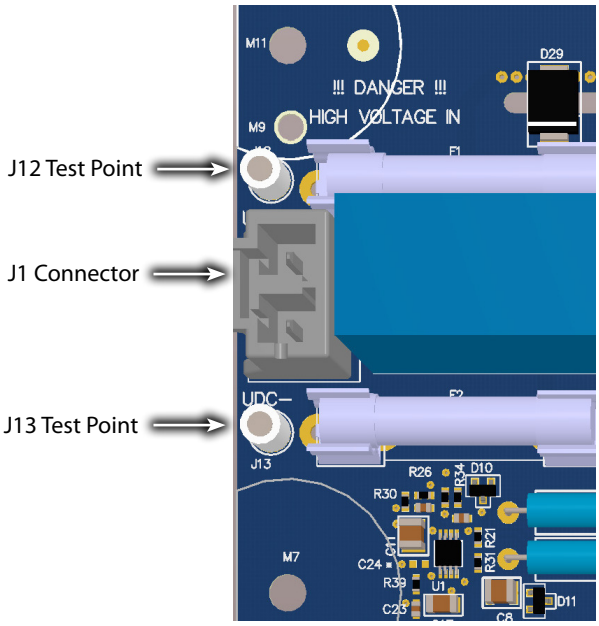
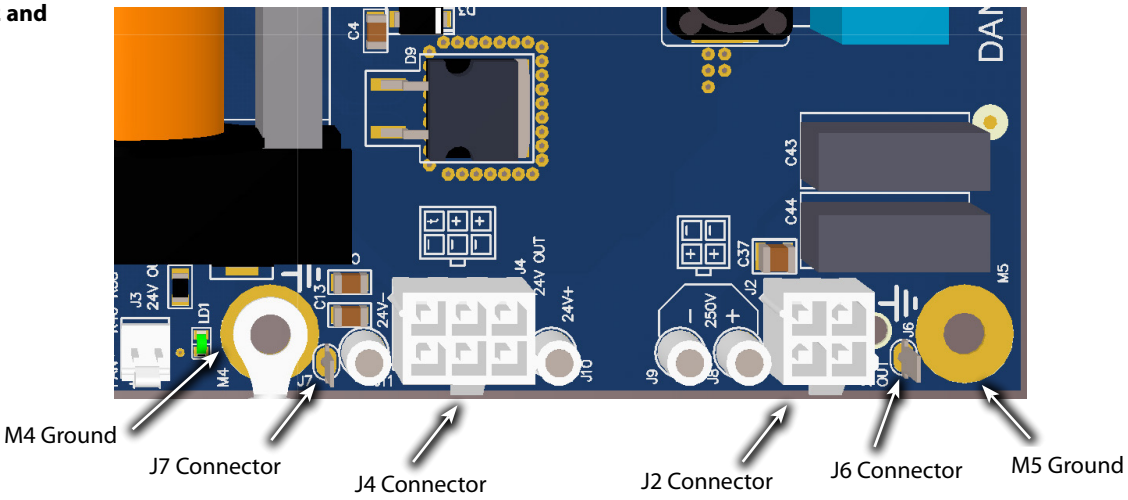


Figure 187 - DC-DC J2 and J4 Connections



4. Disconnect the grounding wires from M4, M5, J6, and J7.
5. Remove the securing hardware holding the DC-DC frame to the panel.
6. Remove the DC-DC from the panel.

Removal (Revisions C and Later):

1. Isolate the VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Open the panel containing the DC-DC. Verify the HV DC input from VFD is below 5 VDC by checking at VDC+ (J12) and VDC- (J13) test points on DC-DC with a DC voltage meter.
3. Disconnect the HV DC input cable from J1; 24 VDC output cable from J4; and 250 VDC output cable from J2.

Figure 188 - DC-DC J1 Connection and J12 -J13 Test Points

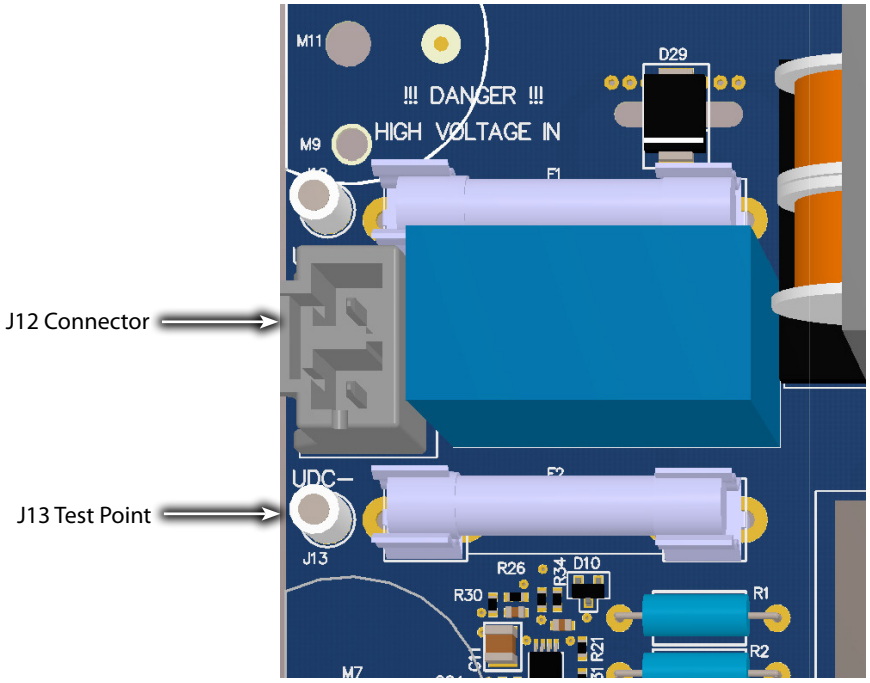
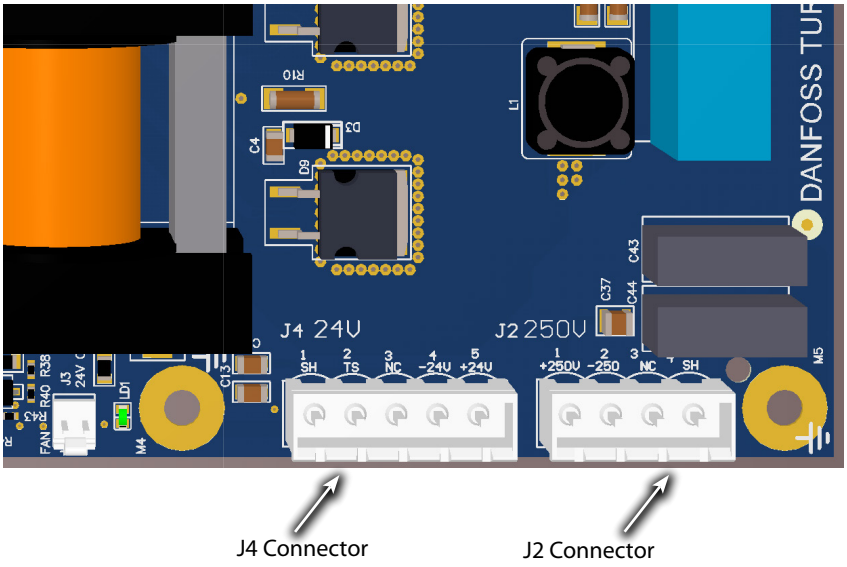


Figure 189 - DC-DC J2 and 4 Connections



4. Remove the securing hardware holding the DC-DC frame to the panel.
5. Remove the DC-DC from the panel.

Installation (Revisions A and B):

1. Place the DC-DC in the panel and secure in place.
2. Connect the HV DC input cable to J1; 24 VDC output cable to J4; and 250 VDC output cable to J2.
3. Connect the grounding wires to M4, M5, J6, and J7.
4. Close the panel.
5. Restore power to the VFD.

Installation (Revisions C and Later):

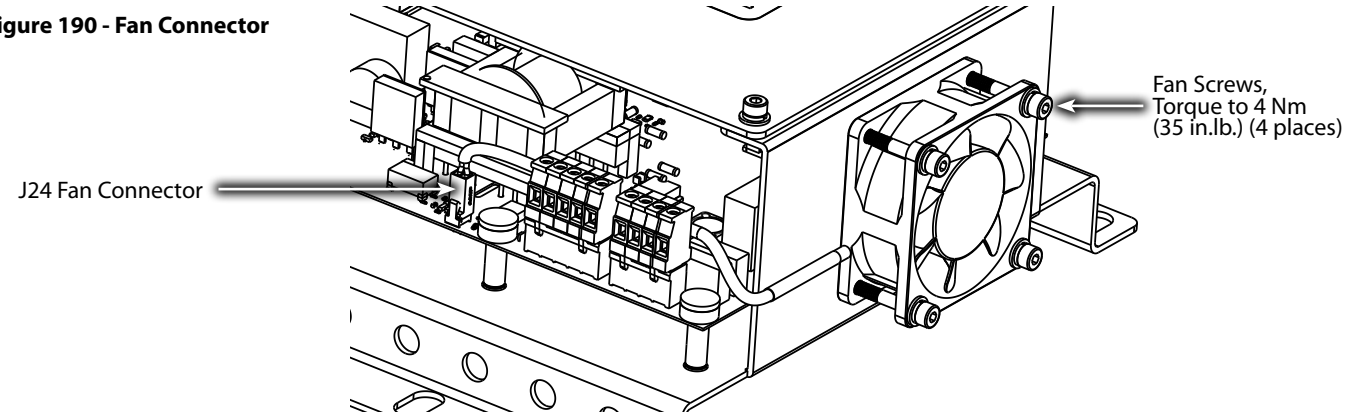
1. Place the DC-DC in panel and secure in place.
2. Connect the HV DC input cable to J1; 24 VDC output cable to J4; and 250 VDC output cable to J2.
3. Close the panel.
4. Restore power to the VFD.

5.1.2.1 Fan Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the four (4) M4x35 socket head cap screws with a 3 mm hex bit.
3. Remove the fan connector from J24 on the DC-DC Board. Refer to Figure 190 (Fan Connector).

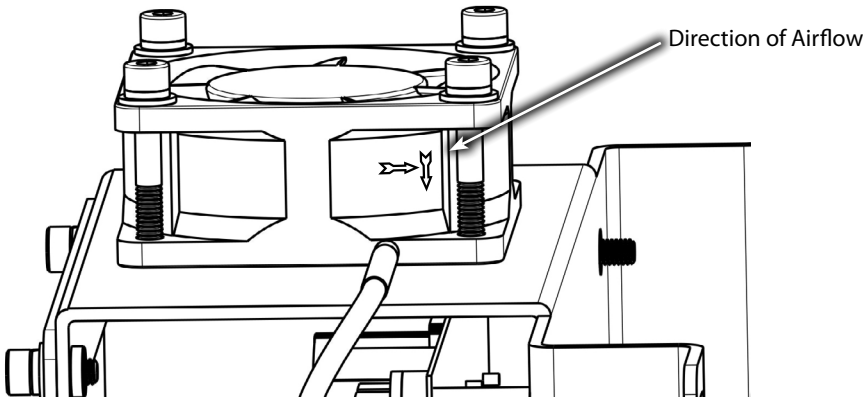
Figure 190 - Fan Connector



Installation:

1. Assemble the four (4) new M4x35 screws along with the four (4) new flat and split washers.
2. Mount the fan to the DC-DC in the proper direction. There is an arrow on the fan housing that should be pointing towards the DC-DC. Refer to Figure 191 (Fan Orientation).
3. Using a 3 mm hex bit, attach the new fan to the DC-DC with the new four (4) M4x35 screws and torque to specification.
4. Install the connector for the new fan to J24 on the DC-DC Board.
5. Reconnect power to the compressor.

Figure 191 - DC-DC Fan Orientation



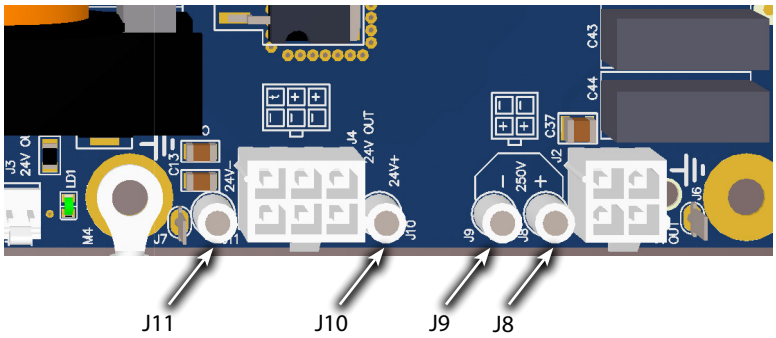
5.1.3 DC-DC Verification

Verification (Revisions A and B):

1. Ensure all connections are correctly installed.
2. Apply power to the VTT VFD.
3. Verify the LEDs on the CIM are illuminated.

4. On the DC-DC, using an appropriately rated voltage meter, verify HV DC input is correct for the applied voltage by checking at VDC+ (J12) and VDC- (J13) test points.
   - The measured voltage should be at least 1.35 x the AC input voltage
5. Verify the 24 V DC output is correct by checking at J10 and J11 test points.
6. Verify the 250 V DC output is correct by checking at J8 and J9 test points.

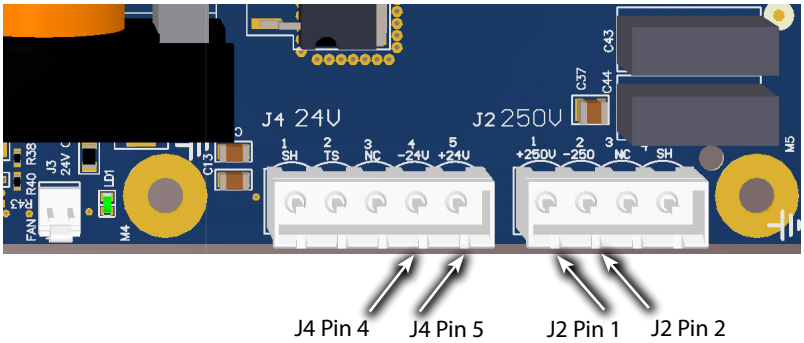
Figure 192 - DC-DC 24 and 250 VDC Output (Revisions A and B)



Verification (Revisions C and Later):

1. Ensure all connections are correctly installed.
2. Apply power to the VTT VFD.
3. Verify the LEDs on the CIM are illuminated.
4. On the DC-DC, using an appropriately rated voltage meter, verify HV DC input is correct for the applied voltage by checking at VDC+ (J12) and VDC- (J13) test points.
   - The measured voltage should be at least 1.35 x the AC input voltage
5. Verify the 24 VDC output is correct by checking Pins 4 and 5 at J4.
6. Verify the 250 VDC output is correct by checking Pins 1 and 2 at J2.

Figure 193 - DC-DC 24 and 250 VDC Output (Revisions C and Later)



5.1.4 Torque Specifications

Table 35 - DC-DC Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
DC-DC Fan, SHCS, M4x35	4	-	35
Ground Screw	6	-	53

6.1 Compressor Interface Module (CIM)

The CIM is where all field connections, such as RS485, EXV and analog/digital wiring, is made to communicate with the compressor. As previously stated, there are two (2) variants of the CIM. Revisions A and B do not contain the connector numbers on the front plate (e.g., J5). The "Pin 1" indicators are also not present on the A and B revisions.

Figure 194 - CIM (Revision C Shown)

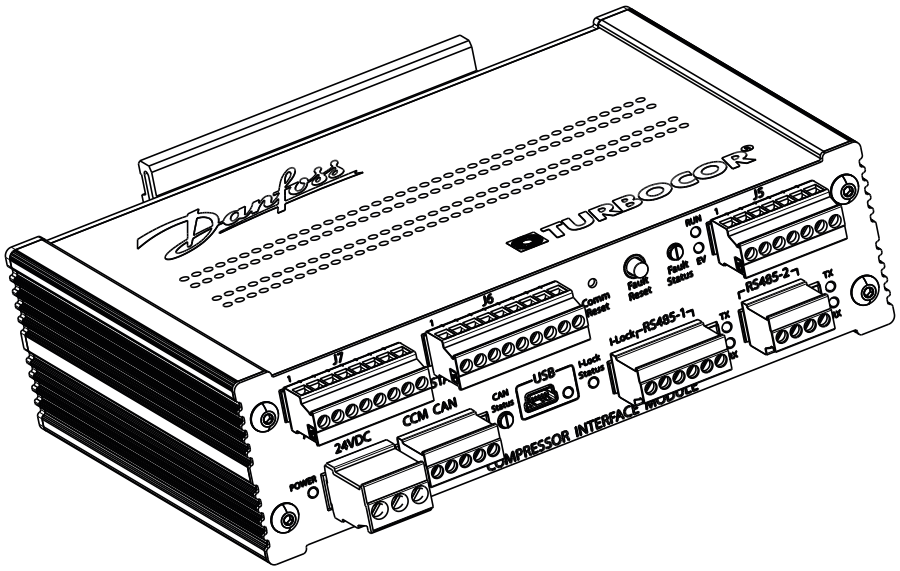


Figure 195 - CIM Faceplate (Revisions A and B)

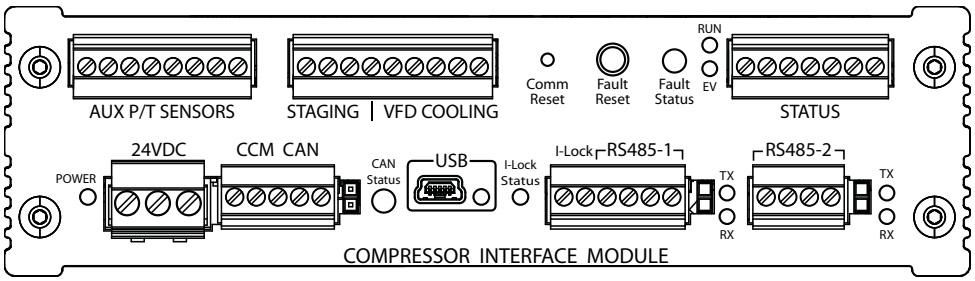


Figure 196 - CIM Faceplate (Revisions C and Later)

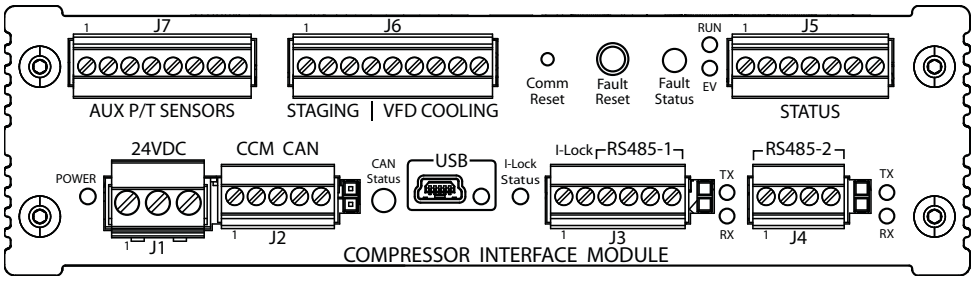


Figure 197 - CIM Connectivity (Revisions A and B)

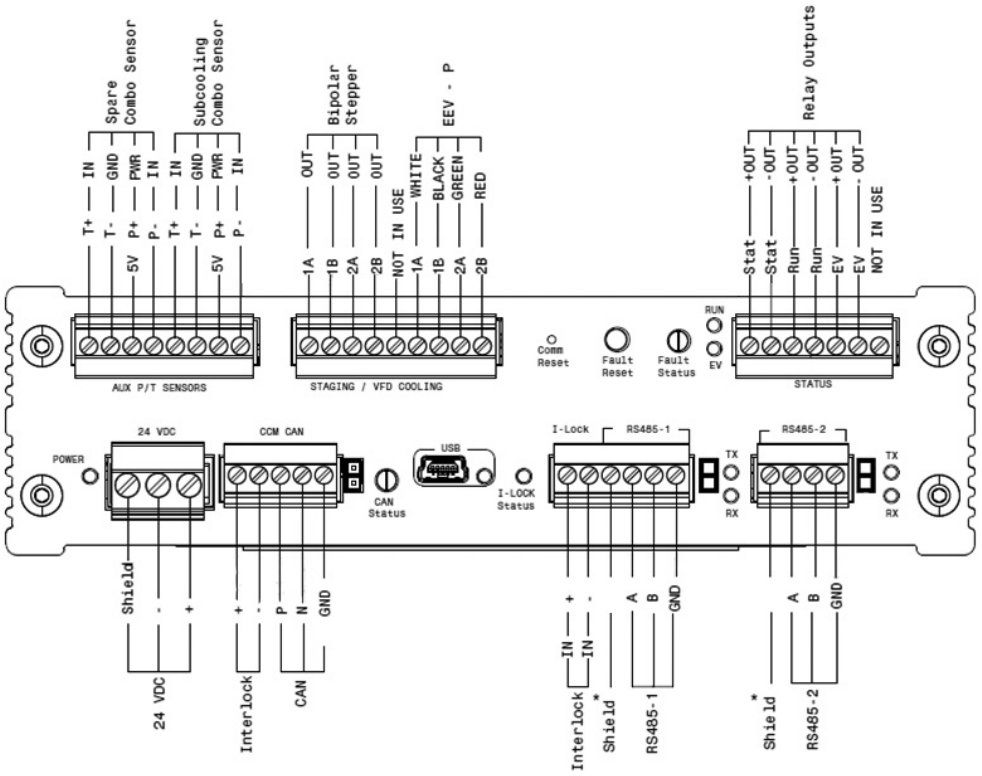
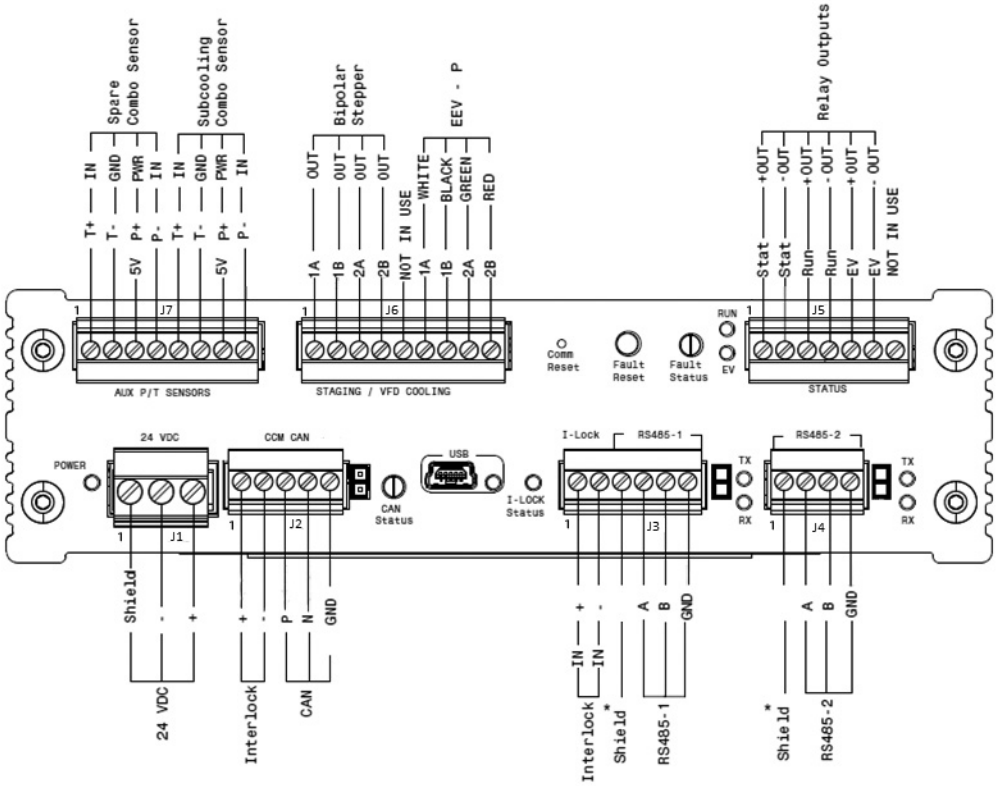


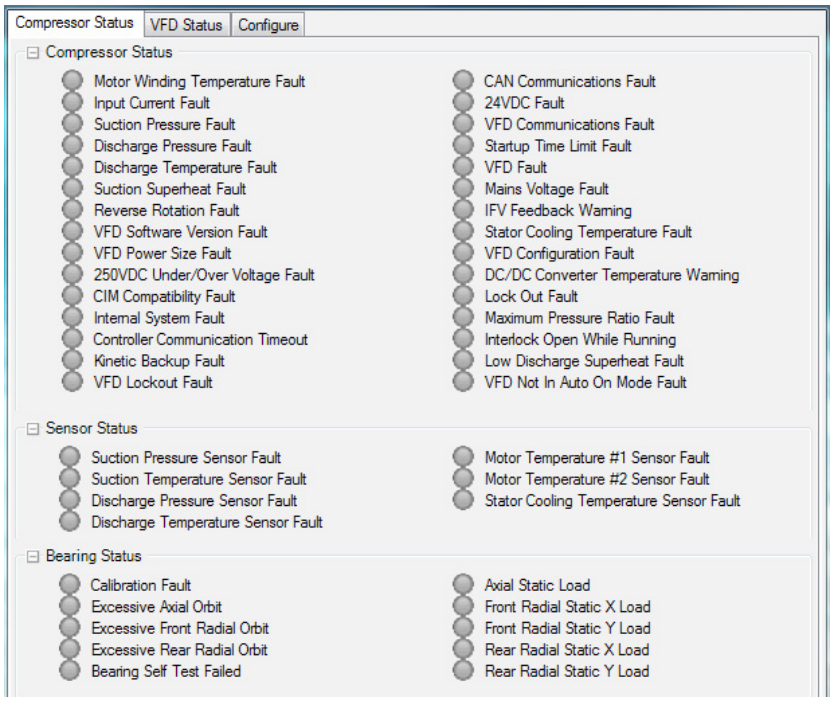
Figure 198 - CIM Connectivity (Revisions C and Later)



6.1.1 CIM Verification

1. With power applied to the compressor, connect to the CIM using the SMT and enter the User ID and Access Code.
2. Open the Warnings and Faults Tool.
3. Verify that the CIM Compatibility, CAN Communications, and VFD Communications Faults are not active.

Figure 199 - Active Alarm/ Fault Viewer



6.1.2 Removal and Installation

Removal:

1. Isolate the Compressor power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove all terminal connectors from the original CIM, leaving all wires connected to the screw terminals.
3. Remove the CIM from the DIN Rail (or other mounting method).
4. Remove the DIN Rail clip (or other mounting method) from the CIM.

Installation:

1. If used with the original CIM, install the DIN Rail clip (or other mounting method) on the new CIM, using the original hardware.
2. Mount the new CIM in place.
3. Reinstall all terminal connectors to their proper location.
4. Reconnect power to the compressor.

6.1.3 Torque Specifications

Table 36 - CIM Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
DIN Rail Clip, SHCS, M4x10	3	-	27
Ground Screw	6	-	53

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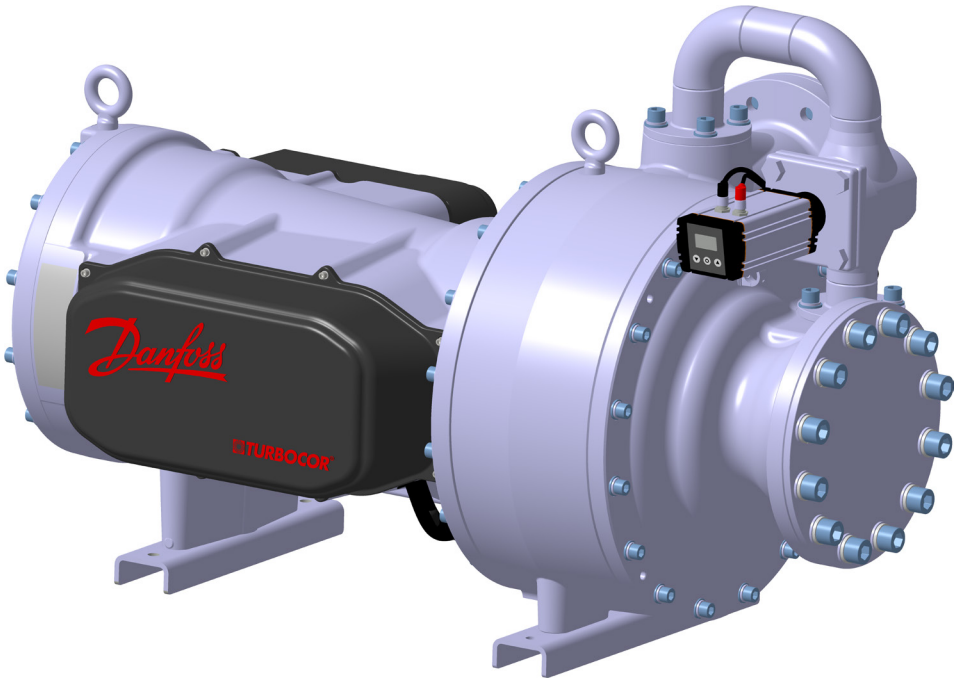
Figure 200 - Compressor Assembly



7.1 Refrigerant Containment

⚠ • • • CAUTION • • •

Isolation and recovery of the refrigerant must be performed by a qualified service technician adhering to industry/ASHREAE standards.

1. Close the suction, discharge, and economizer isolating valves as appropriate.
2. Close the motor-cooling liquid line shut-off valve.
3. Manually open the EXV. Refer to the "Motor Cooling EXV Assembly" section.
4. Connect a refrigerant recovery system to the compressor as per industry-standard procedures and transfer the refrigerant to an appropriate containment vessel.

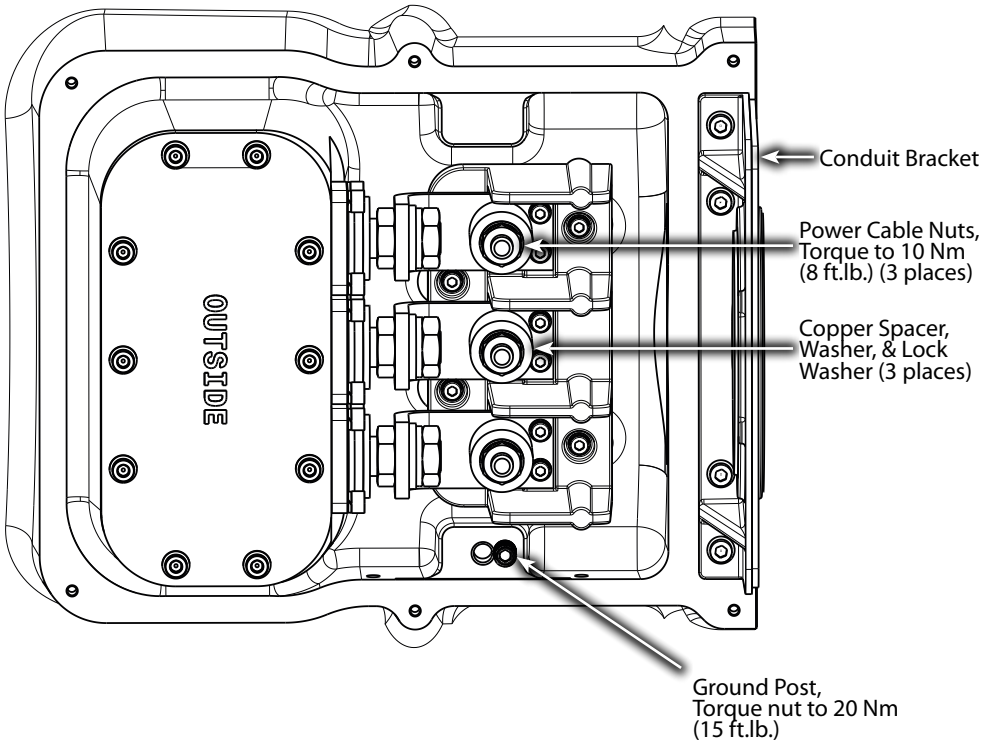
7.2 Compressor Removal

⚠ • • • CAUTION • • •

Ensure that there is no secondary power source connected to the compressor before disconnecting the following cables:

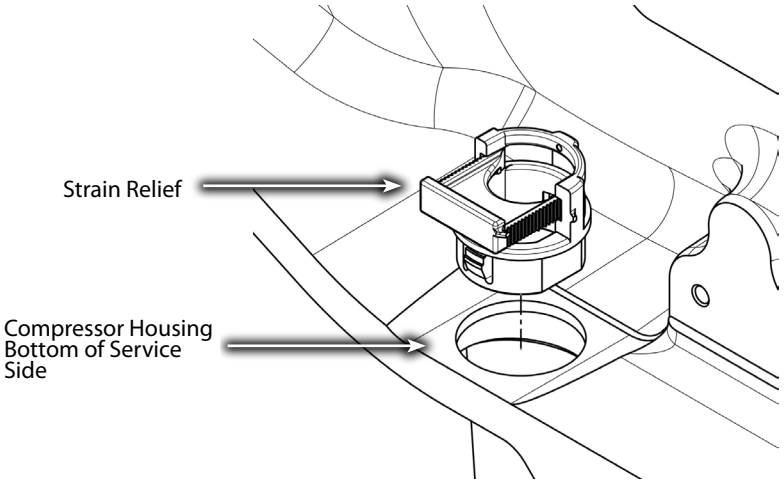
1. Isolate the Compressor and VFD power as described in the "Electrical Isolation of the Compressor/VFD" section of this manual.
2. Remove the Motor Power Cover.
3. Remove the M10 nuts, flat washers, and lock washers off the top of the copper spacers.
4. Remove the motor power cables. Protect/isolate the cable ends.
5. Remove the three (3) copper spacers.
6. Remove the ground wire from the ground post.

Figure 201 - Compressor Power Cable Removal



7. Remove the cable gland that secures the motor power cable conduit to the Conduit Bracket.
8. Reinstall the Motor Power Cover.
9. Remove the Service Side Cover.
10. Disconnect the interface cables, CIM, DC-DC, and VFD Module to the relevant connection points on the CCM and PWM.
11. Remove the strain relief from the compressor housing as shown in Figure 202 (Strain Relief).

Figure 202 - Strain Relief



12. Reinstall the Service Side Cover.
13. Once the transfer of refrigerant is complete, bring the compressor back to atmospheric pressure according to industry standards using dry nitrogen.
14. Disconnect the motor cooling inlet and exit lines.
15. Remove the 12 M20x2.5 screws between the suction pipe flange and the compressor suction flange.
16. Remove the eight (8) M20x2.5 screws between the discharge pipe flange and the compressor discharge flange.
17. Position the lifting hoist/crane with the 2-point spreader bar directly above the lifting points.
18. Using a properly rated chain/cable, connect the spreader bar to the compressor lifting points.
19. Confirm that all lifting points are secured in accordance with relevant safety procedures and standards.
20. Loosen the four (4) compressor mounting bolts but do not remove.
21. Using a 454 kg (1 ton) (minimum) crane, lift to remove the slack from the chains/cables.
22. Remove the four (4) compressor mounting bolts and associated hardware.
23. Lift the compressor approximately 100 mm (4″). Confirm that the compressor and spreader bar are properly balanced between the lifting points and the lifting hoist.
24. Continue the removal of the compressor and lower to the desired location in order to remove the chains/cables.
25. Using the blanking plates and bolts provided with the new compressor, seal the compressor and charge to approximately 25-50 psi with a nontoxic inert gas (e.g., helium, nitrogen) for shipment (this will prevent moisture and foreign material from entering the compressor)

7.3 Compressor Installation

NOTE

Blanking plates should not be removed from the new compressor until you are ready to place the new compressor in position. New compressors are pressurized with helium to (50 psi). Pressure should be relieved through the Schrader valve, located next to the motor cooling connection, prior to removing the blanking plates. Isolation and recovery of the refrigerant must be performed by a qualified technician. Always wear proper safety equipment when handling refrigerants.

1. Relieve the inert gas pressure through the motor cooling exit port Schrader valve.
2. Remove the suction, discharge, and economizer (if applicable) blanking plates from the compressor.
3. Ensure that all connections have protective connections to prevent foreign object damage.
4. Attach the spreader bar to the two (2) lifting hooks (eye bolts) on the top of the compressor.
5. Confirm that all lifting points are secured in accordance with relevant safety procedures and standards.
6. Position the lifting hoist/crane with the 2-point spreader bar directly above the lifting points.
7. Using a 454 kg (1 ton) (minimum) crane, lift the compressor approximately 100 mm (4″). Confirm that the compressor and spreader bar are properly balanced between the lifting points and the lifting hoist.
8. Slowly lower the compressor until it is positioned within approximately 5 mm (¼″) of the compressor mounts.
9. Loosely install the mounting bolts, nuts, and washers.
10. Loosely fit the gasket and M20x2.5 screws between the suction pipe flange and the compressor suction flange.

11. Repeat Step 10 for the discharge pipe flange and the compressor discharge flange.
12. Slowly release the load from the crane so that compressor weight is supported by the compressor mounts.
13. Confirm that there are no axial, radial, or torque loads on the compressor flanges.
14. Torque the four (4) compressor mounting bolts to specification.
15. Install the 12 M20x2.5 screws and torque to specification.
16. Install the eight (8) M20x2.5 screws between the discharge pipe flange and the compressor discharge flange and torque to specification.
17. Install the motor cooling inlet and exit lines.
18. Using the new O-rings supplied with the compressor, attach all refrigerant line connections.
19. Remove the Service Side Cover.
20. Reinstall the strain relief from the compressor housing.
21. Connect the interface cables, CIM, DC-DC, and VFD Module to the relevant connection points on the CCM and PWM.
22. Reinstall the Service Side Cover.

• • • DANGER • • •

Ensure that electrical power is isolated from the AC mains cables before handling them.

23. Remove the Motor Power Cover.
24. Connect the cable gland that secures the power cable conduit to the Conduit Bracket.
25. Install the Mains Input ground wire to the ground post and torque to specification.
26. Install the three (3) copper spacers.
27. Attach the AC mains cables to the terminals and torque to specification.
28. Re-install the Motor Power Cover and torque to specification.
29. Leak test the compressor to appropriate pressure and industry accepted standards.
30. Evacuate compressor to appropriate pressure and industry accepted standards.
31. Charge the compressor with refrigerant.
32. Apply power to the compressor.

⚠ • • • CAUTION • • •

A filter drier must be installed in the motor cooling liquid line as shown in the refrigeration schematics.

7.3.1 Torque Specifications

Table 37 - Motor Terminal Block Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Ground Screw	6	-	53
Ground Cable Nut, M10x1.5, Brass	20	15	177
Suction Flange, SHCS, M20x2.5	6	5	53
Discharge Flange, SHCS, M20-2.5	6	5	53
Economizer Flange, SHCS, M16x2	20	15	177
Motor Cooling Exit Flange, SHCS, M14x2	10	8	89
Motor Cooling Inlet Flange	5	4	44
Base Mounting, SHCS, M12x1.75	20	15	177

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Table A1 - Acronym/Terms

Acronym / Term	Definition
AC	Alternating Current
CAN	Controller Area Network
CCM	Compressor Control Module
CIM	Compressor Interface Module
DC	Direct Current
DC-DC	DC to DC Converter
DIN	Deutsches Institut für Normung
DTC	Danfoss Turbocor Compressors Inc.
ECON	Economizer
EEPROM	Electrically Erasable Programmable Read-Only Memory
EEV	Electronic Expansion Valve
ESD	Electostatic Discharge
EXV	Electronic Expansion Valve
HV	High Voltage
ICAD	Industrial Control Actuator with Display
ICM	Industrial Control Motor
IFV	IntraFlow™ Valve
IGBT	Insulated Gate Bipolar Transistor
kV	Kilovolt
LED	Light Emitting Diode
LOTO	Lockout/Tagout
MAPP	Methylacetylene-Propadiene Propane
MOT	Motor
NTC	Negative Temperature Coefficient
° C	Degrees Celsius
° F	Degrees Fahrenheit
OEM	Original Equipment Manufacturer
P/T	Pressure/Temperature
PWM	Pulse Width Modulation
R/T	Resistance/Temperature
Regen	Regenerative Terminals
RTD	Resistance Temperature Detectors
SCR	Silicon Rectifier Diode
SHCS	Socket Head Cap Screw
SMT	Service Monitoring Tool
VDC	Volts Direct Current or Volts DC
VFD	Variable Frequency Drive
VTT	Variable Twin Turbo
Ω	Ohm

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Figure B1 - Volute Assembly Sleeve

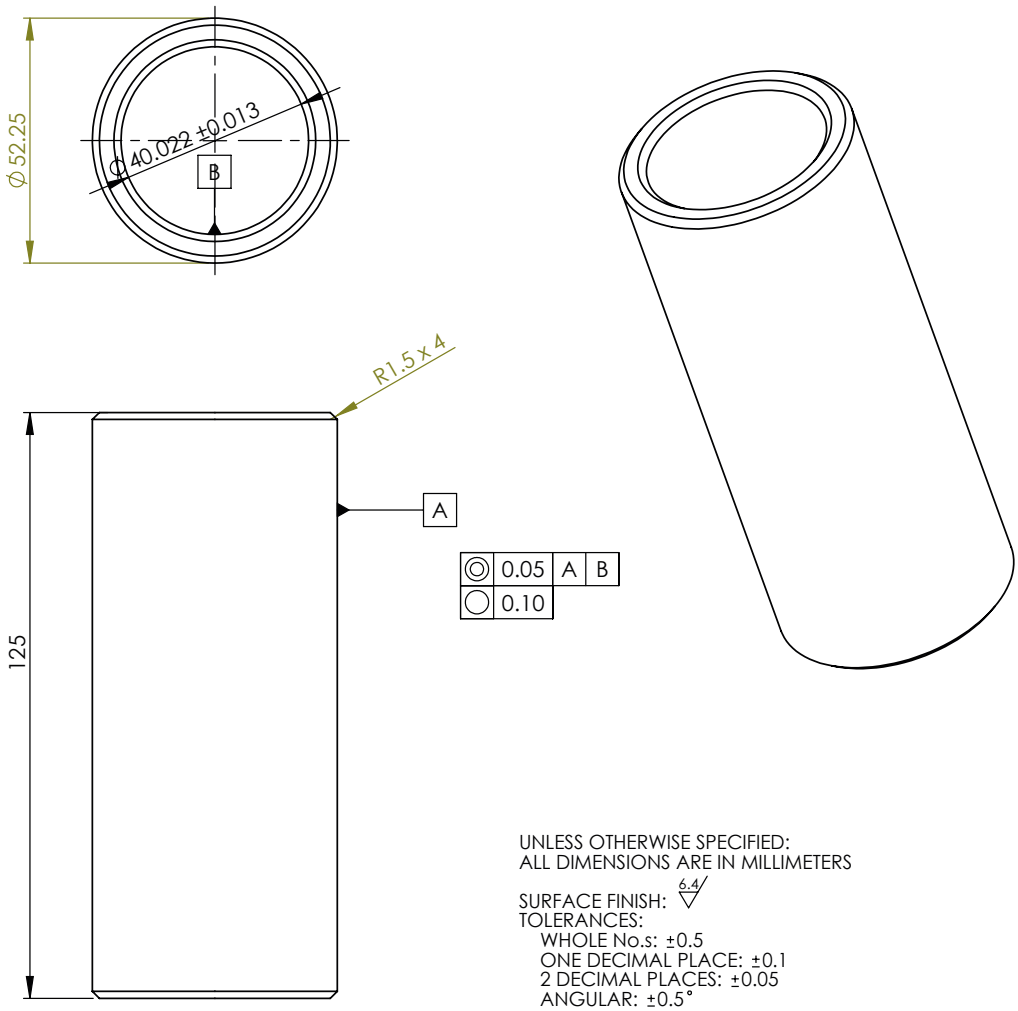


Figure B2 - Long Guide Pin

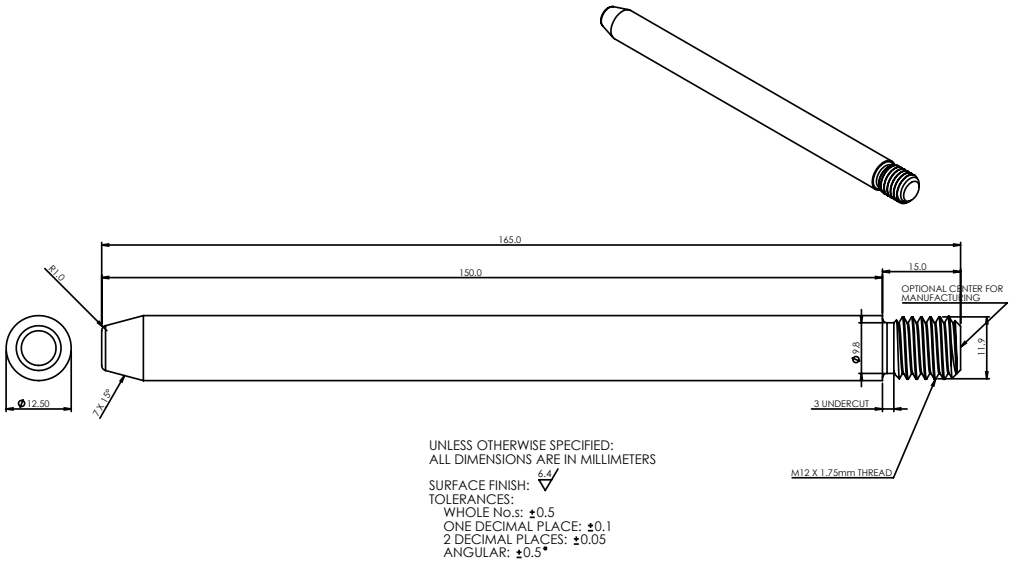


Figure B3 - Short Guide Pin

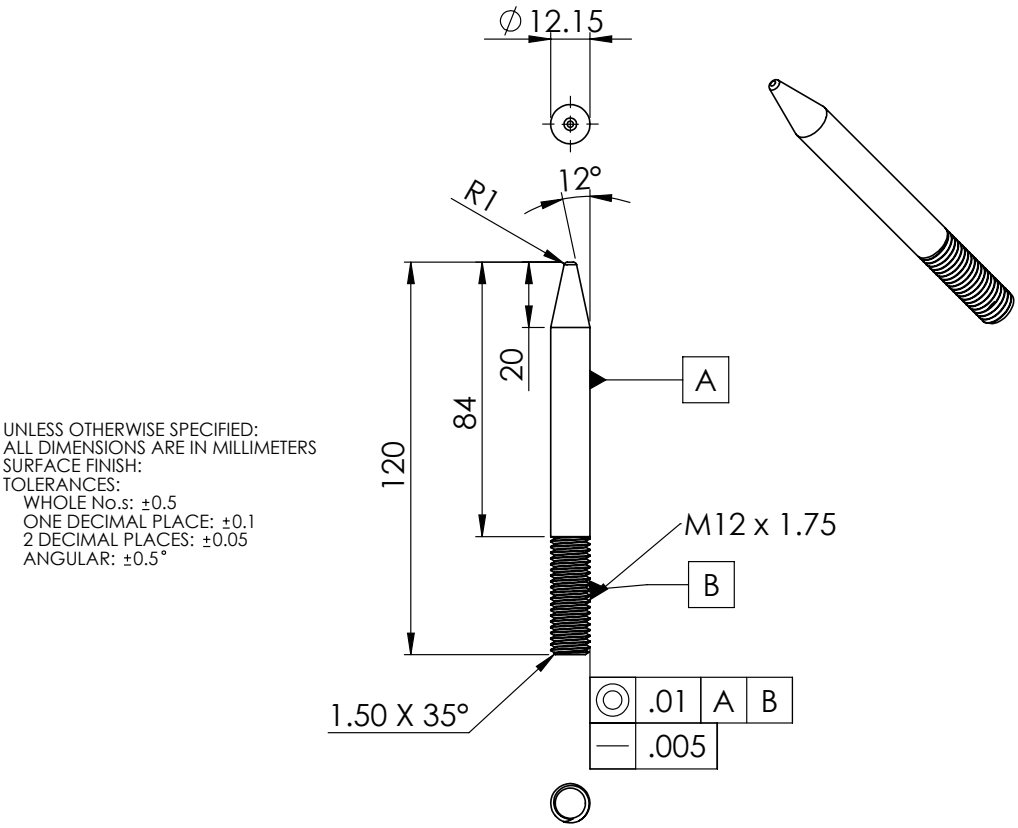


Figure B4 - Thrust Disk Alignment Pin

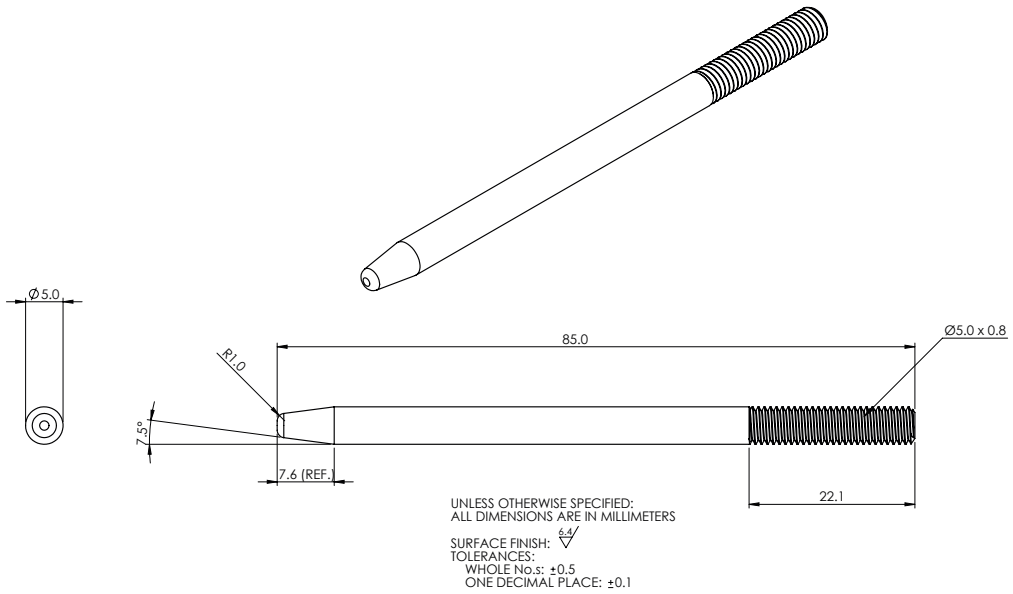
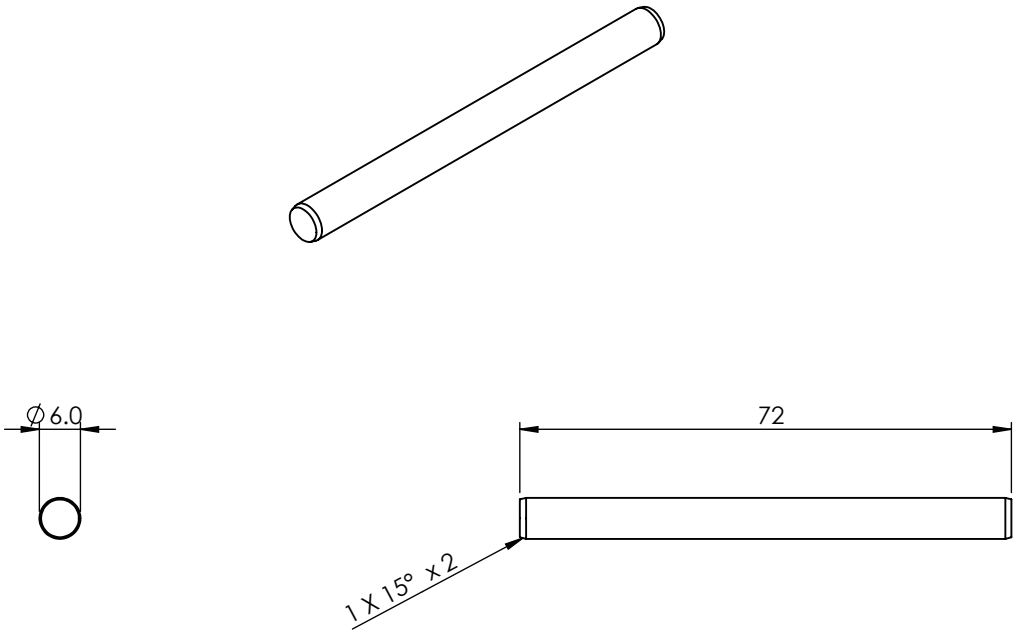


Figure B5 - Shaft Bolt Torquing Pin



UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH: 6.4
TOLERANCES:
WHOLE No.s: ±0.5
ONE DECIMAL PLACE: ±0.1
2 DECIMAL PLACES: ±0.05
ANGULAR: ±0.5°

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