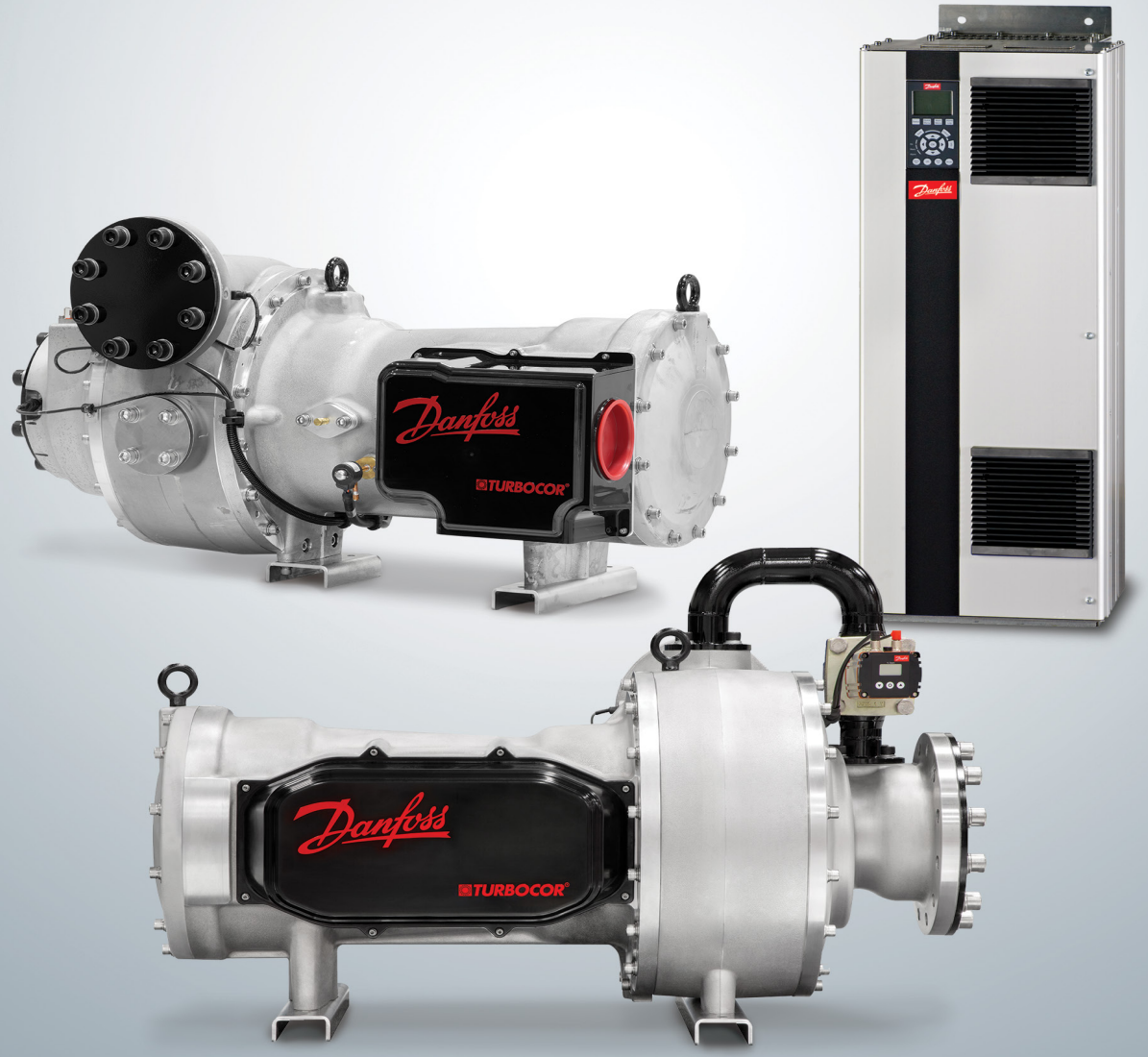
ENGINEERING
TOMORROW

Service Manual - Revision C

Danfoss Turbocor® **VTT & VTX** Series Centrifugal Compressors

VTT & VTX Series Compressors



http://turbocor.danfoss.com

TURBOCOR®

This manual covers VTT Major Revision "C" compressors and all VTX compressor. If you have a Major Revision "B" or earlier VTT Compressor, we suggest downloading VTT Service Manual Revision A from our website since there are some design differences that impact the various repair steps.

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Proprietary Notice

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Encounter an error or see opportunity for improvements while reading this manual? Email us at turbocor.contact@danfoss.com with a brief description.

* Subject to change without notice.

* Danfoss LLC's commitment to excellence ensures continuous product improvements.

List of Changes

Revision	Date	Page	Description of Change
A	06-30-2017	-	Initial release.
B	05-27-2020	-	Updated to include VTX compressors.
C	03-23-2021	-	Updated for Major Revision D VTX Compressors.

Chapter 1: Compressor Introduction

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Chapter 1.0 Introduction

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

This manual covers both the VTT and VTX Compressors. The primary difference between the VTT and VTX Compressors are the IFV, which is only on the VTT Compressors, and the IGV, which is only on the VTX Compressors. When necessary, this manual will illustrate the differences between the two variants. In many cases, the differences are subtle and a general illustration is used.

At the time of this publication, there have been three (3) major revisions of the VTT Compressor. Throughout this manual, 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. The VTX Compressors also allow for customer-supplied cabling. For details on the required cable type and maximum length, refer to the VTT/VTX Applications Manual.

1.1 Purpose

This Service Manual is intended to provide service procedures specific to the Danfoss Turbocor Variable Twin Turbo VTT and VTX 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. Danfoss LLC 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 variable frequence drive (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 VTX 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 Application and Installation Manual for installation procedures.

1.3 Commitment to Quality

Danfoss LLC is recognized for excellence in quality. This means we:

- support our customers in achieving their business goals through committed leadership and a highly skilled, innovative, and agile staff.
- create and execute effective and aligned processes, and continually improve them to prevent failures.
- ensure continuous improvement of all products, processes, and services.
- comply with statutory and regulatory requirements and agreed requirements from customers and other interested parties.
- ensure ISO 9001 certification and IATF 16949 compliance at all Danfoss Turbocor production locations.

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**.

1.5 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.

1.5.1 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 1-1 Danger Notification Example" on page 17).

Figure 1-1 Danger Notification Example

• • • DANGER ! • • •

1.5.2 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 1-2 Caution Notification Example".

Figure 1-2 Caution Notification Example

⚠ • • • CAUTION • • •

1.5.3 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 1-3 Note Example".

Figure 1-3 Note Example

NOTE

1.6 Refrigerant Type

VTT and VTX 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! • • •
Wait for the capacitors to fully discharge before performing any service or repair work. **Wait time is a minimum of 20 minutes and voltage level of DC bus voltage should be checked and confirmed that it is below national and local safe handling voltage requirements to allow safe access. Failure to wait the specified time after power has been removed before doing service or repair could** result in death or serious injury.

1. Turn off the Mains Input power to the VFD.
2. Lockout/Tagout (LOTO) the mains disconnect to ensure no accidental or unauthorized re-application of the Mains Input power can occur.
3. Carefully open the VFD door and look for the light to go out on the Drive.
4. Shut the door once it is verified that the lights are no longer illuminated.
5. Using an appropriately rated voltage meter, confirm that the AC voltage is isolated.
6. Wait at least 20 minutes for the DC bus capacitors to discharge.
7. Open the VFD door taking particular care not to touch ANY components inside the VFD.
8. 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 1-4 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.

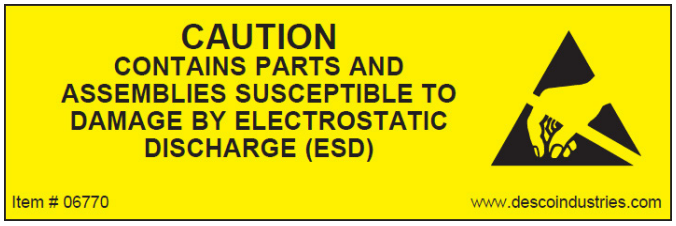
The electronic modules should only be removed from the ESD protective bag at the last moment, just before installation when the operator is ready to do the replacement.

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. Refer to "Figure 1-5 ESD Label" Please follow the instructions below to ensure safety and to protect the parts from ESD damage.

Figure 1-5 ESD Label



1.9 VTT/VTX O-rings

Various O-rings are utilized throughout the VTT and VTX Compressors to contain the refrigerant. Prior to 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 O-ring:

1. Remove each new O-ring 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 and VTX Compressors are a two-stage centrifugal type compressor. They differ as to how they handle the refrigerant flow as it enters the suction side of the Compressor. VTT Compressors utilize IntraFlow™ technology. This technology does not require Inlet Guide Vanes (IGVs) or variable geometry diffusers.

The VTT Compressor uses on-board sensors to 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 2-1 VTT Fluid Path" for an illustration of the recirculation flow.

VTX Compressors utilize variable speed as the principle means of capacity control with IGVs assisting when required. Refrigerant enters the first stage suction side of the Compressor as a low-pressure, low-temperature, superheated vapor. It then passes through variable IGVs that assist Compressor control at part-load conditions.

Both impellers are mounted on a common shaft. Vapor passes through the first-stage impeller where velocity energy is added to the refrigerant. This is converted to an intermediate pressure in the first-stage volute. Vapor then enters the second-stage impeller through a diffuser. In the second stage, impeller velocity energy is again added to the refrigerant and converted to the final discharge pressure in the discharge diffuser and volute. From the second-stage impeller, refrigerant passes as a high pressure, superheated vapor to the system discharge line.

Figure 2-1 VTT Fluid Path

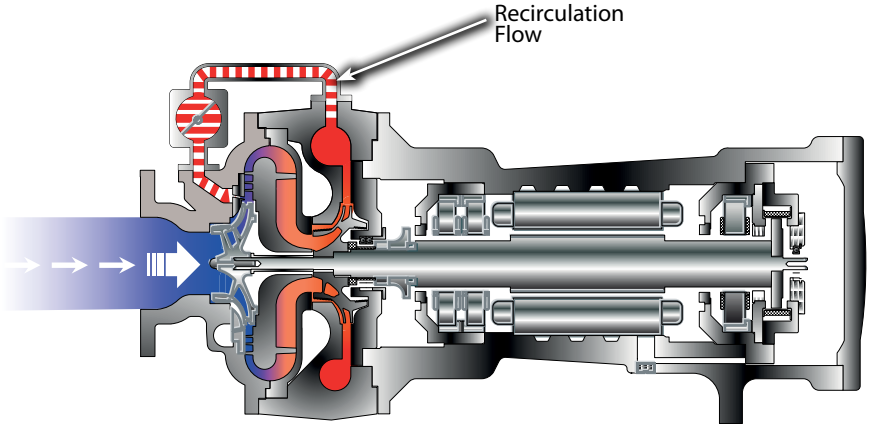
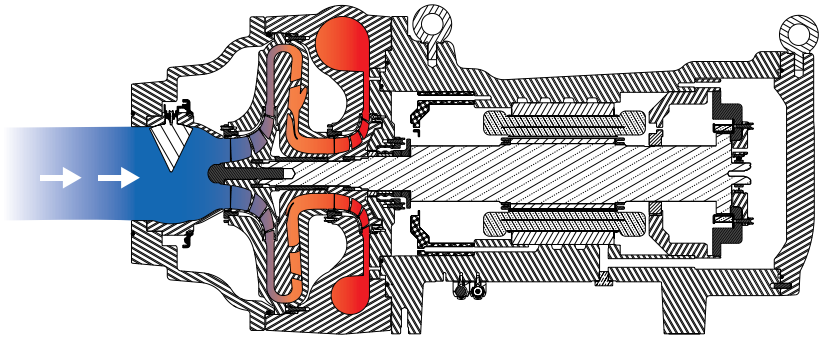


Figure 2-2 VTX Fluid Path



2.2 Economizer

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

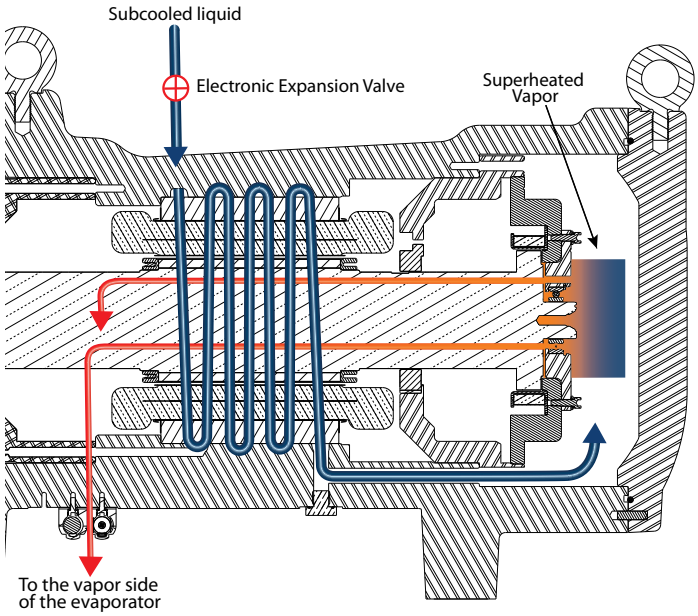
- Sub-cooler (closed)
- Flash tank (open)

For further details, refer to the VTT/VTX Applications Manual.

2.3 Compressor Cooling

Refer to "Figure 2-3 VTT/VTX Motor Cooling Path" for the illustration of the internal cooling path.

Figure 2-3 VTT/VTX Motor Cooling Path



2.4 Compressor Cooling

Liquid refrigerant, having at least 2^{0} Kelvin)/ 3.6° 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/VTX Applications Manual for cooling connections sizes.

To cool the motor, sub-cooled liquid refrigerant enters the Compressor through the Electronic Expansion Valve (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.

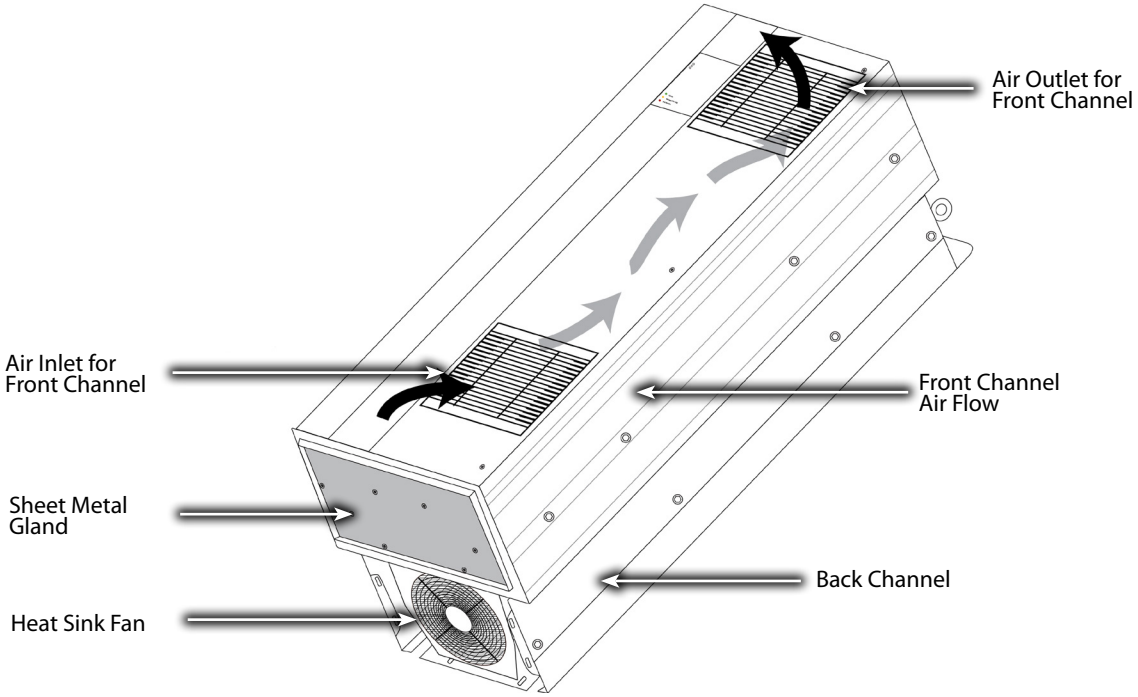
The superheat level of the gas entering the motor cavity is measured using a temperature sensor inside the end cap and the saturated temperature of the suction gas is measured at the suction inlet of the Compressor. The expansion valve at the motor cooling inlet modulates to maintain a pre-determined 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 inverter 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. Refer to "Figure 2-4 VFD Cooling Path" for an illustration of the air flow through the VFD.

Figure 2-4 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:

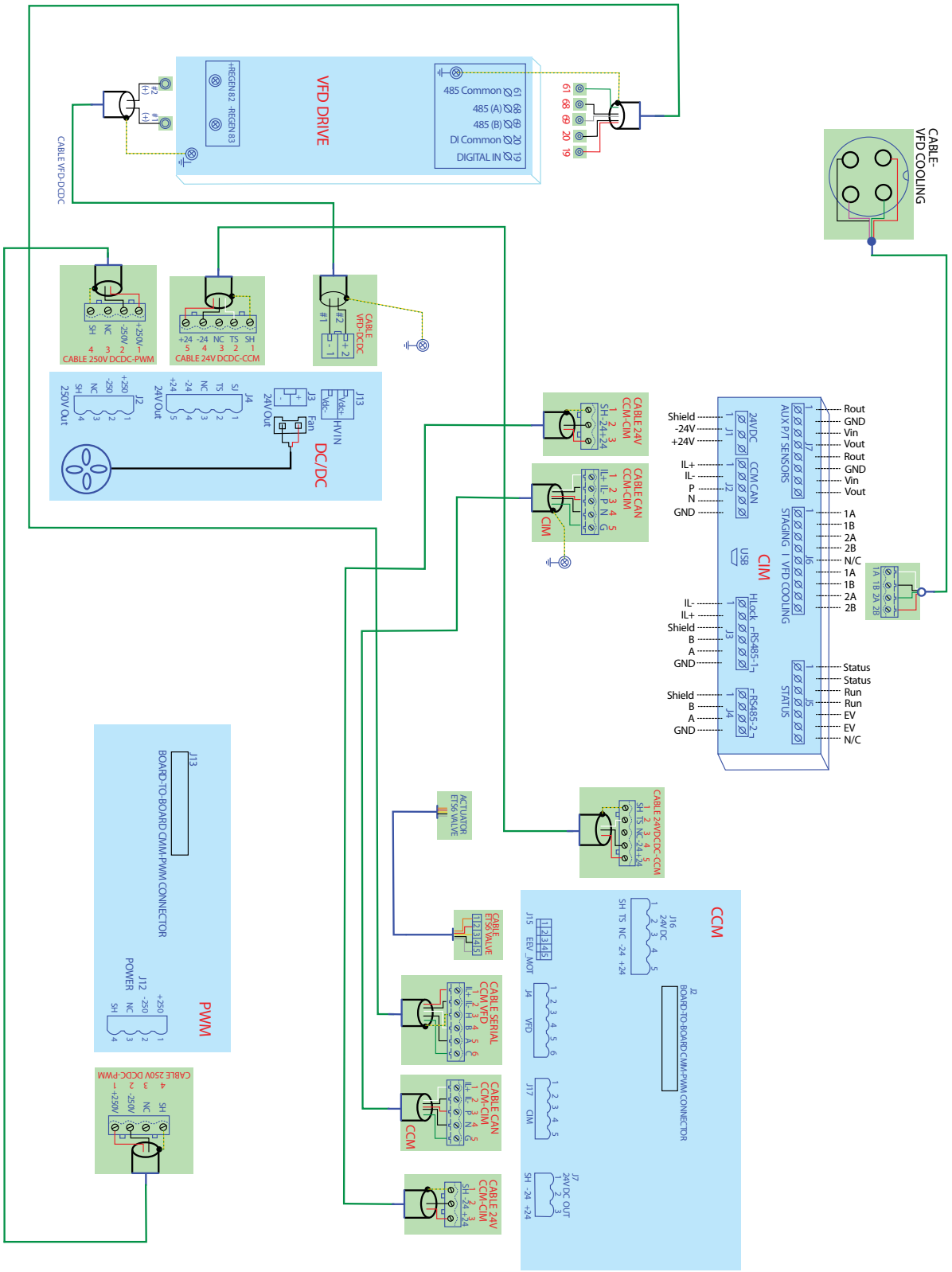
- Compressor Control Module (CCM) Board
- Pulse Width Modulation (PWM) Board
- Stator
- CIM
- DC-DC Module

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-controlled rectifiers (SCRs).
3. The inrush circuit controls the SCRs. When power is applied, the SCRs limit the charging rate of the DC capacitors.
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 AC voltage to the Compressor.
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 "Figure 2-5 System Architecture and Control Interface" on page 26 for a block diagram summary of the energy and voltage signal flow through the Compressor.

Figure 2-5 System Architecture and Control Interface



Chapter 3: Component Identification

Chapter 3.0 Compressor Components

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

3.1 Component Identification

This section identifies the major parts of the Compressor.

Figure 3-1 Compressor External Component Identification – VTT Service Side

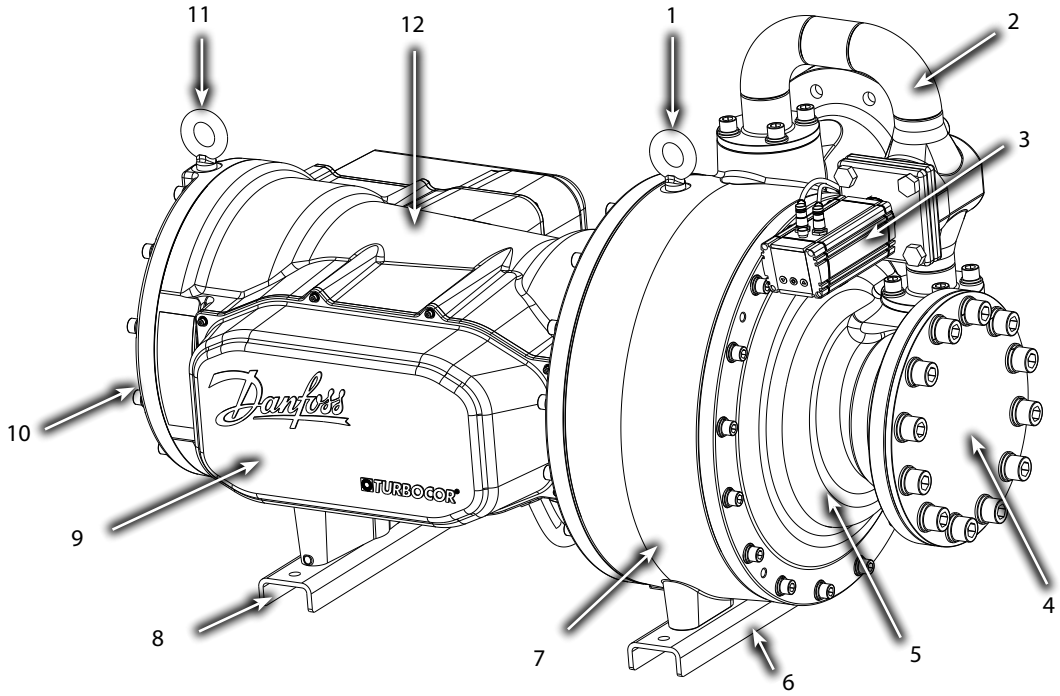


Figure 3-2 Compressor External Component Identification – VTX Service Side

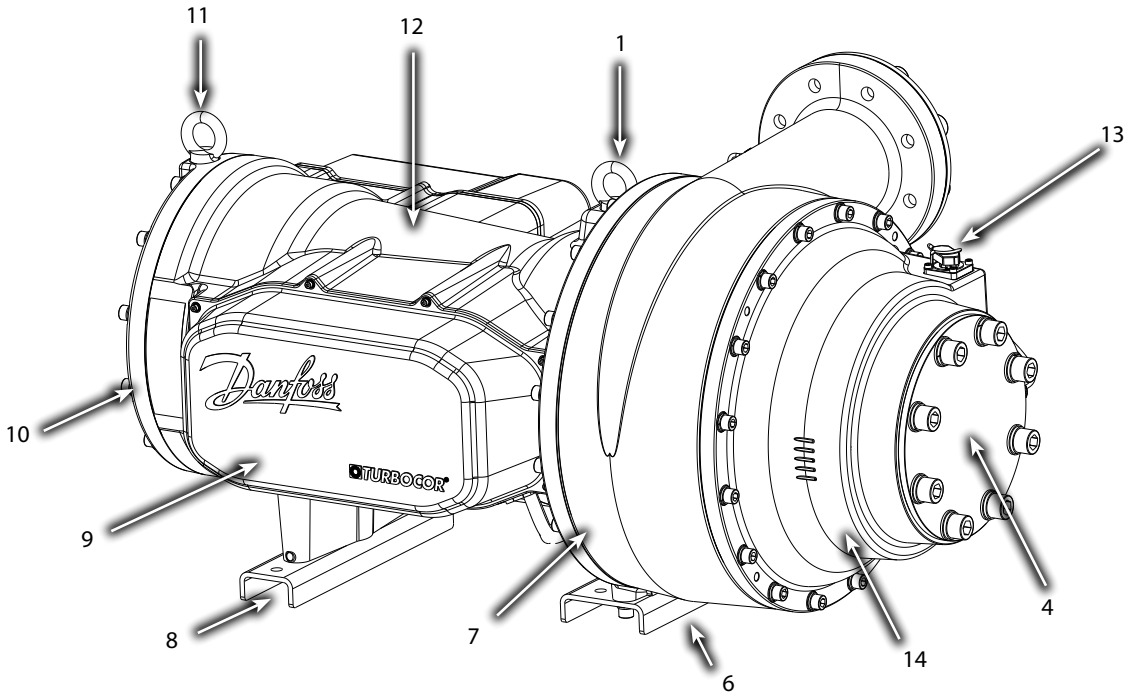


Table 3-1 Compressor Component Identification (Service Side)

No.	Component	No.	Component
1	Lift Anchor (Front)	8	Rear Support Base
2	IFV Pipe Assembly	9	Service Side Cover
3	IFV Actuator ICAD 1200A	10	End Cap
4	Suction Flange	11	Lift Anchor (Rear)
5	Suction Housing	12	Motor Housing
6	Front Support Base	13	IGV Motor Feedthrough
7	Volute (Second Stage Fluid Assembly)	14	Suction Housing

Figure 3-3 Compressor External Component Identification – VTT Power Side

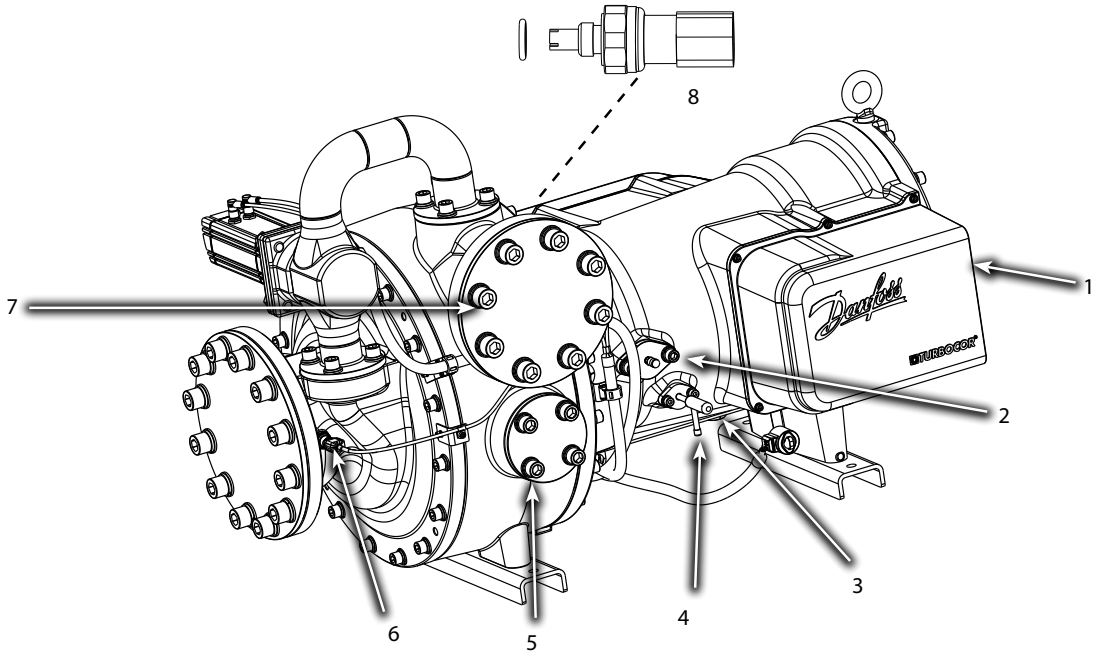


Figure 3-4 Compressor External Component Identification – VTX Power Side

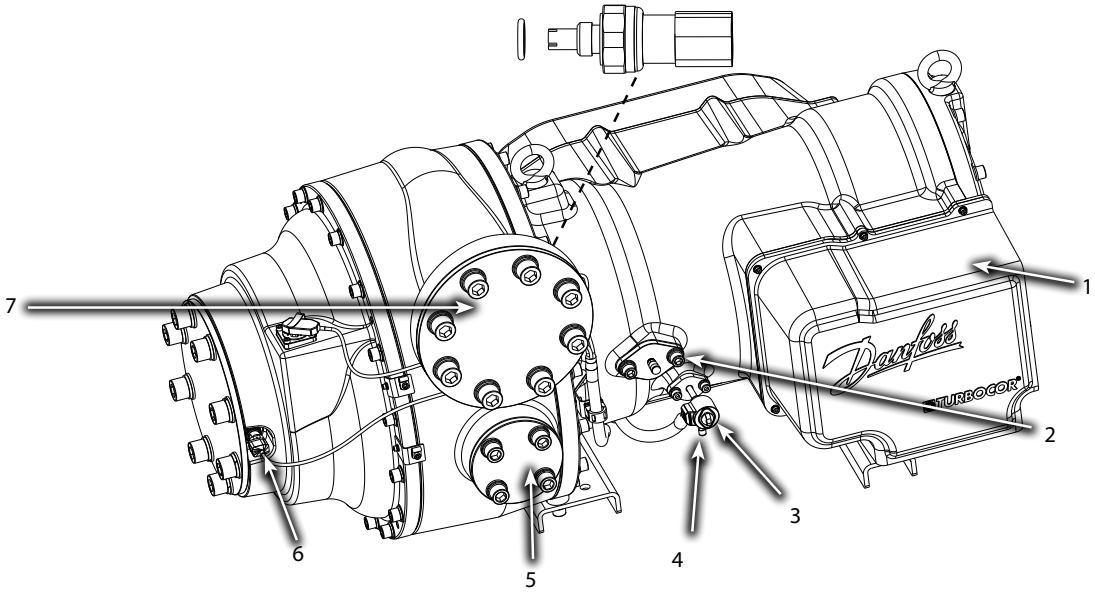


Table 3-2 Compressor Component Identification (Power Side)

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 3-5 Compressor Component Identification – VTT Service Side (Cover Off)

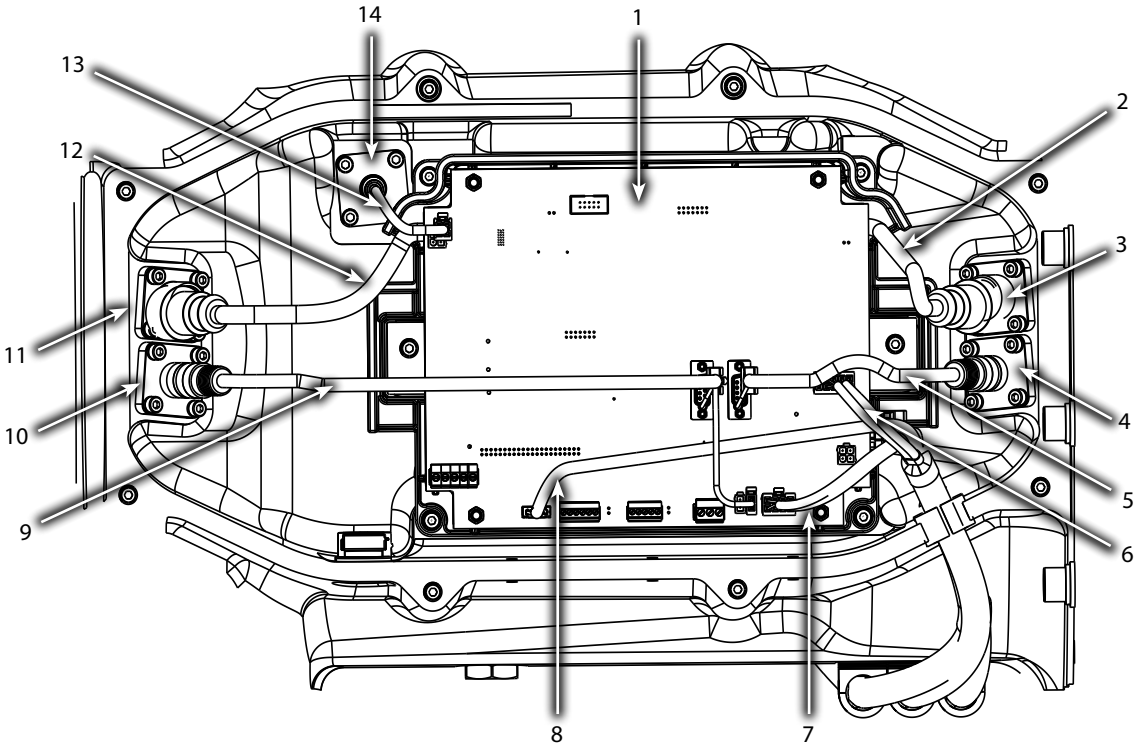


Table 3-3 VTT Compressor Component Identification (Service Side - Cover Off)

No.	Component	No.	Component
1	VTT Service Electronics	8	Motor Cooling Valve Cable
2	Front Bearing Power Cable	9	Rear Bearing Sensor Cable
3	Front Bearing Power Feedthrough	10	Rear Bearing Sensor Feedthrough
4	Front Bearing Sensor Feedthrough	11	Rear Bearing Power Feedthrough
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 Feedthrough

Figure 3-6 Compressor Component Identification – VTX Service Side (Cover Off)

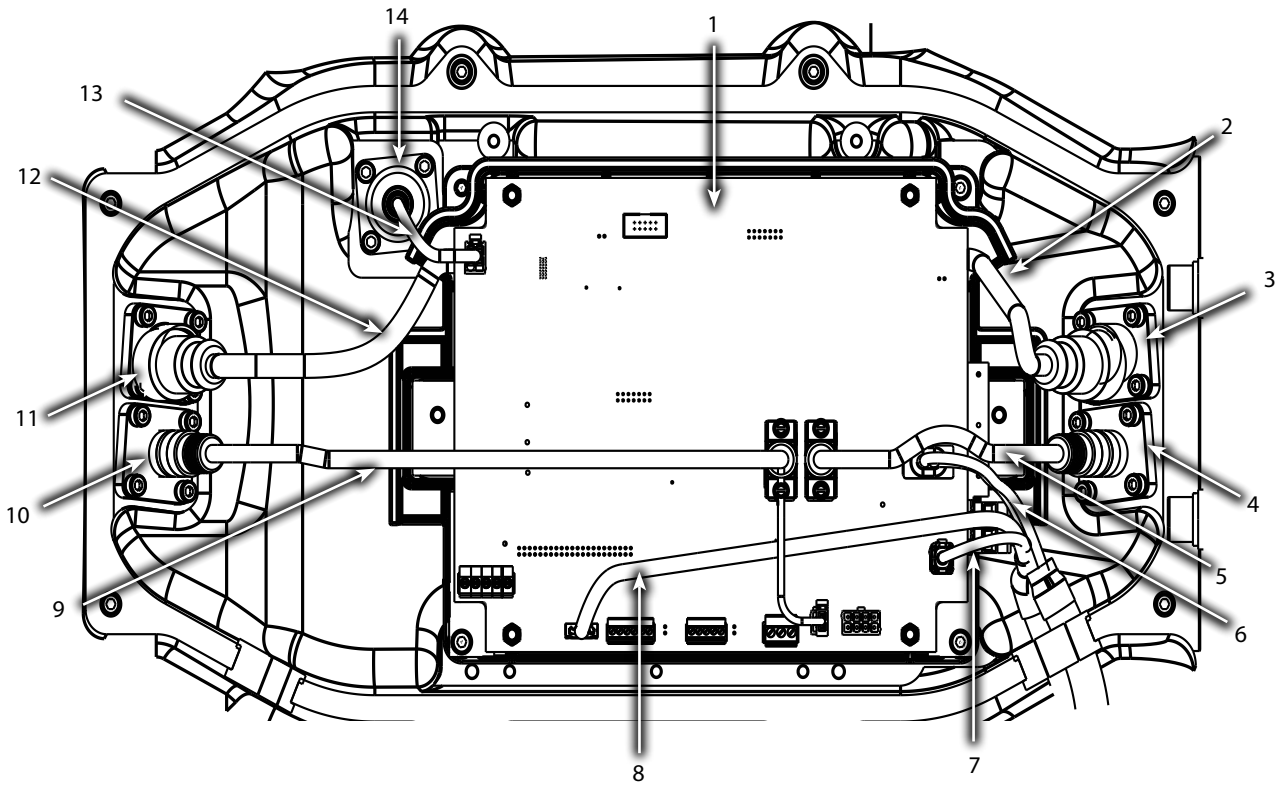


Table 3-4 VTX Compressor Component Identification (Service Side - Cover Off)

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

Figure 3-7 Compressor Component Identification – VTT Power Side (Cover Off)

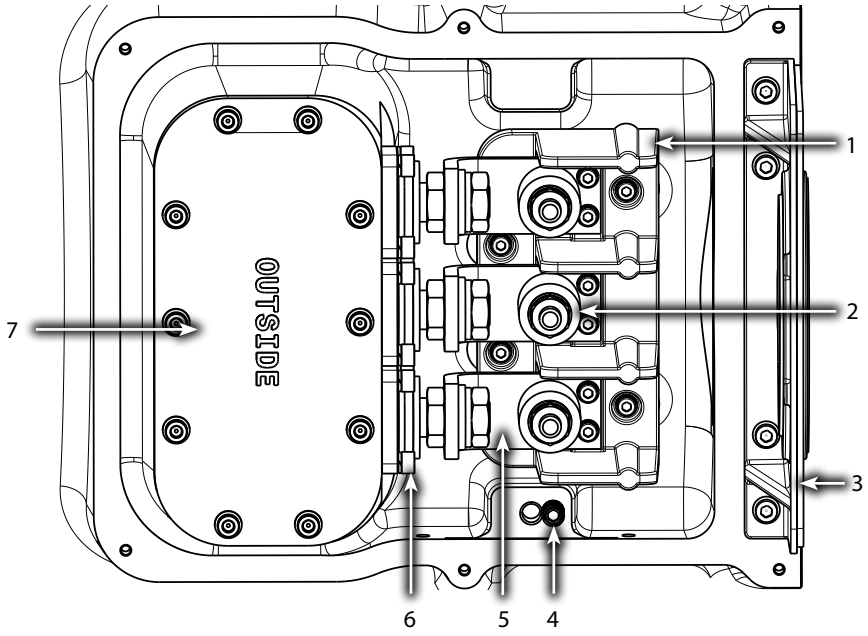


Figure 3-8 Compressor Component Identification – VTX Power Side (Cover Off)

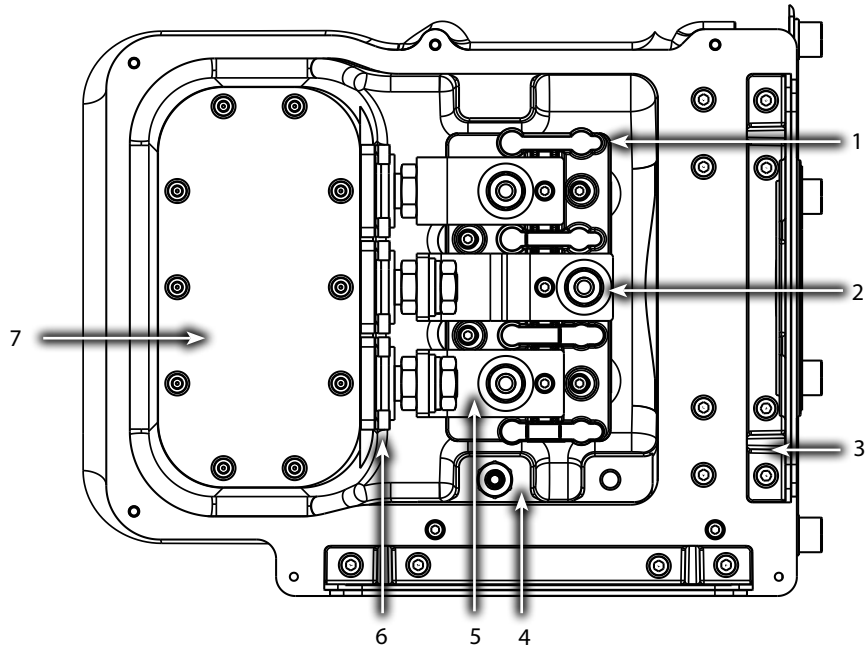


Figure 3-9 Compressor Component Identification (Power Side - Cover Off)

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

Figure 3-10 Compressor Sensors and Cables Topside - VTT

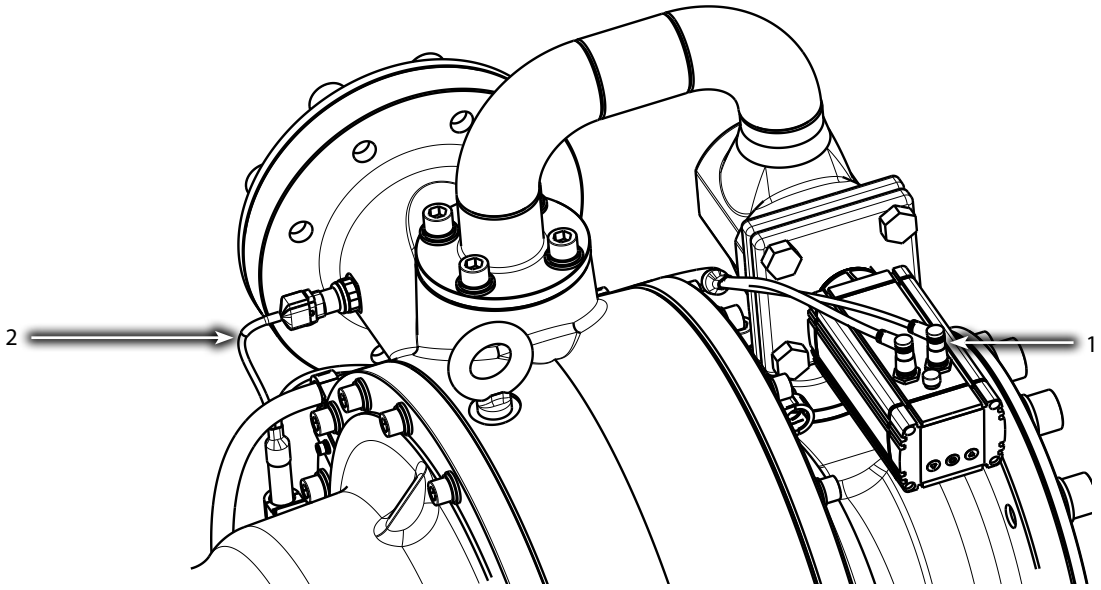


Figure 3-11 Compressor Sensors and Cables Topside - VTT

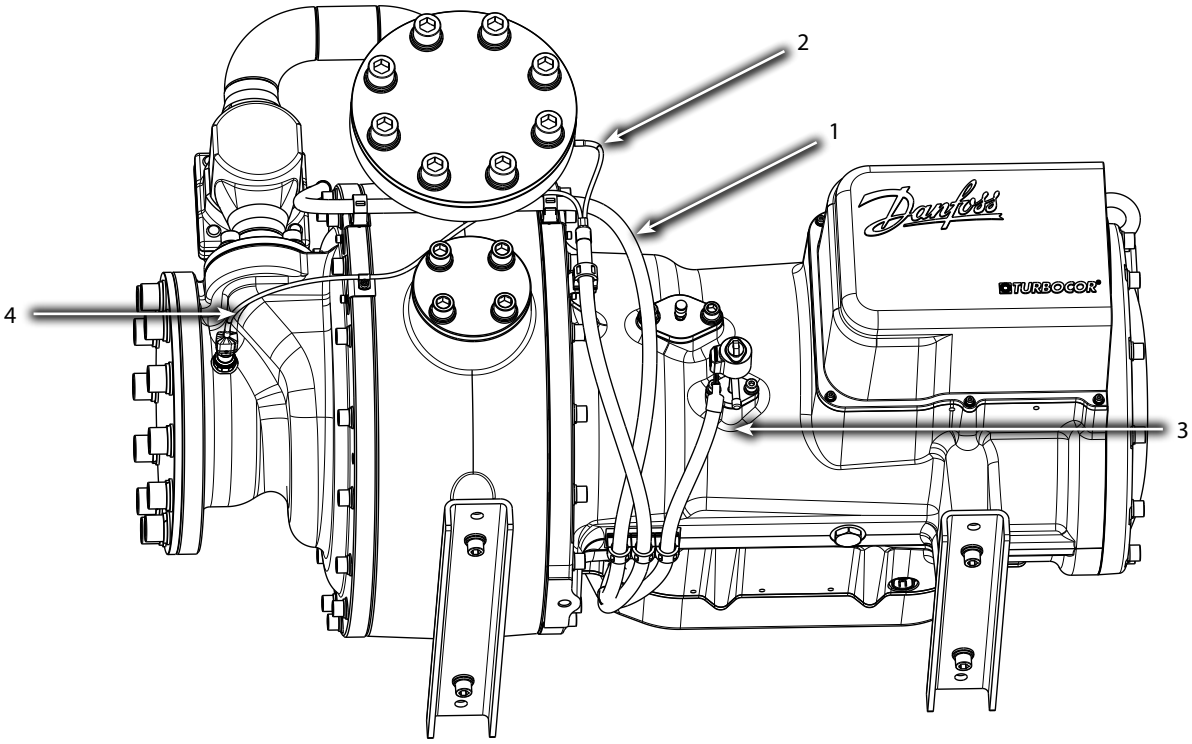


Table 3-5 Compressor Component Identification (VTT Power Side - Cables)

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

Figure 3-12 Compressor Sensors and Cables Topside - VTX

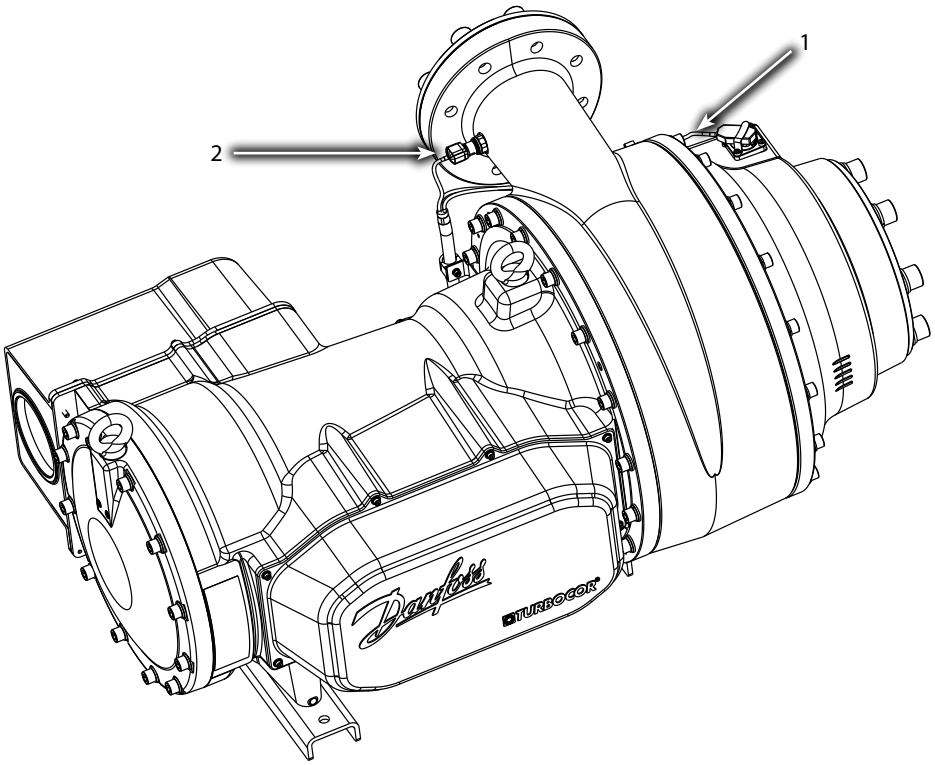


Figure 3-13 Compressor Sensors and Cables Topside - VTX

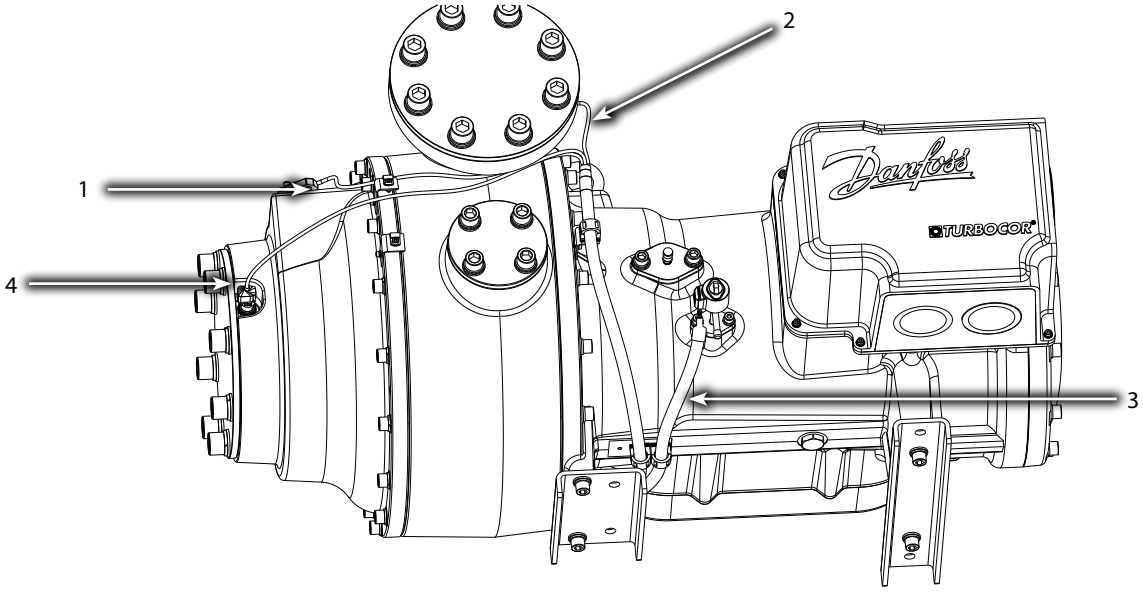


Table 3-6 Compressor Component Identification (VTX Power Side - Cables)

No.	Component	No.	Component
1	IGV Cable	3	Motor Cooling EXV Cable
2	Discharge P/T Sensor Cable	4	Suction P/T Sensor Cable

3.2 External Components

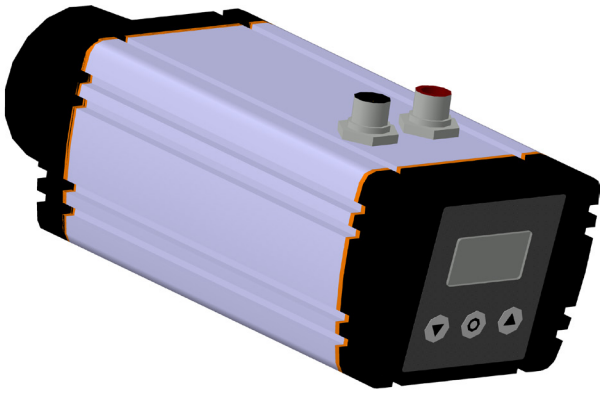
3.2.1 VTT IFV Actuator

This section applies only to VTT Compressors. 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 Service Monitoring Tool (SMT).

Figure 3-14 IFV Actuator

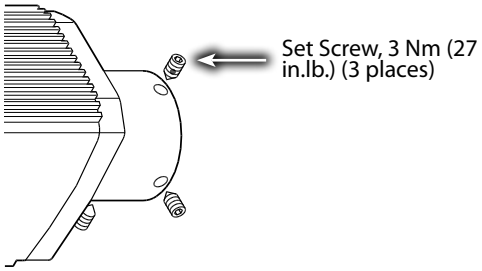


3.2.1.1 IFV Removal and Installation

IFV Actuator Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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. Refer to "Figure 3-15 IFV Actuator Mounting Set Screws".
4. Remove the IFV Actuator.

Figure 3-15 IFV Actuator Mounting Set Screws

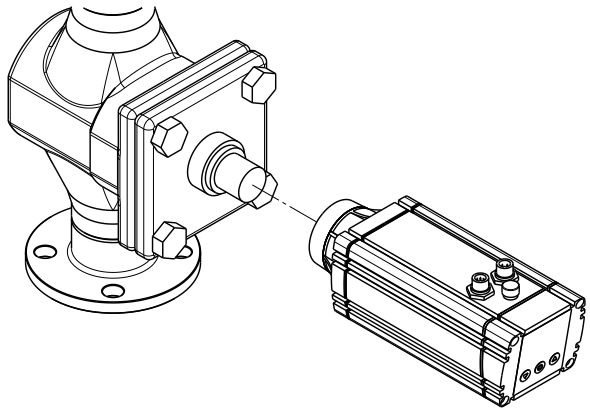


IFV Actuator Installation

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. Refer to "Figure 3-16 IFV Actuator Install".

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 3 Nm (27 in.lb).
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. Return the Compressor to normal operation.

Figure 3-16 IFV Actuator Install



3.2.1.2 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 two (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 two (2) seconds to exit the programming mode.

3.2.1.3 IFV Actuator Calibration

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

3.2.1.4 IFV Actuator Torque Specifications

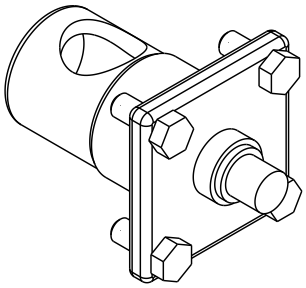
Table 3-7 IFV Actuator Torque Specifications

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

3.2.2 ICM Body

This section applies only to VTT Compressors. 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 3-17 ICM Body



3.2.2.1 ICM Removal and Installation

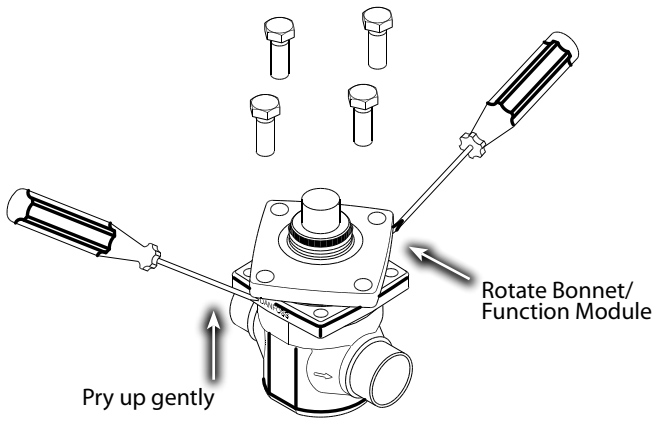
ICM Body Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual. Remove the IFV Actuator as described in the previous section.
2. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
3. Remove the four (4) hex bolts.
4. Rotate the Bonnet/Function Module as shown in "Figure 3-18 Bonnet/Function Module Removal". Carefully pry the Bonnet/Function Module out of the ICM Body by using screwdrivers between the Bonnet/Funtion Module and ICM Body.

⚠ • • • CAUTION • • •

Use care as not to damage the Gasket / O-ring sealing surfaces.

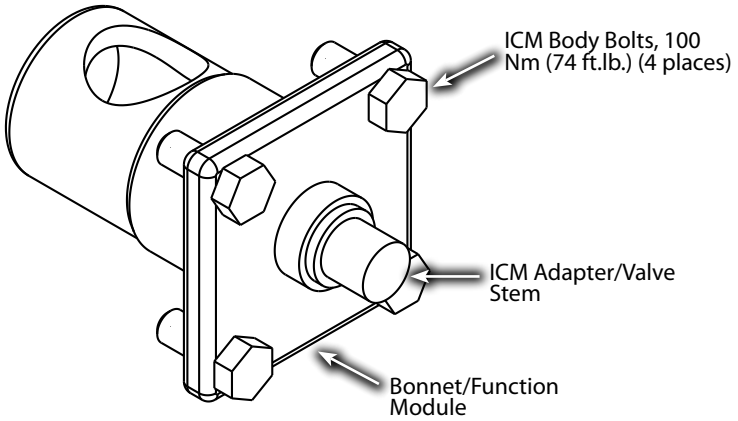
Figure 3-18 Bonnet/Function Module Removal



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 3-20 Bonnet/Function Module O-ring Placement" on page 39 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).

Figure 3-19 ICM Body Installation



8. Torque the four (4) hex fasteners 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 and evacuate Compressor in accordance with standard industry practices.
10. Return the Compressor to normal operation.

Figure 3-20 Bonnet/Function Module O-ring Placement

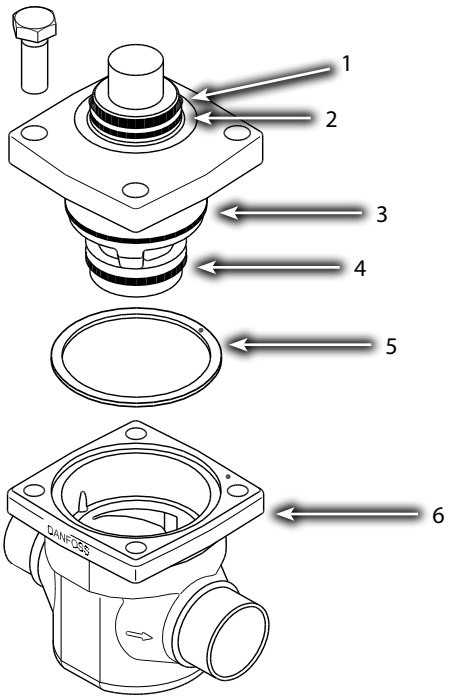


Table 3-8 Bonnet/Function Module O-ring Descriptions

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

3.2.2.2 ICM Torque Specifications

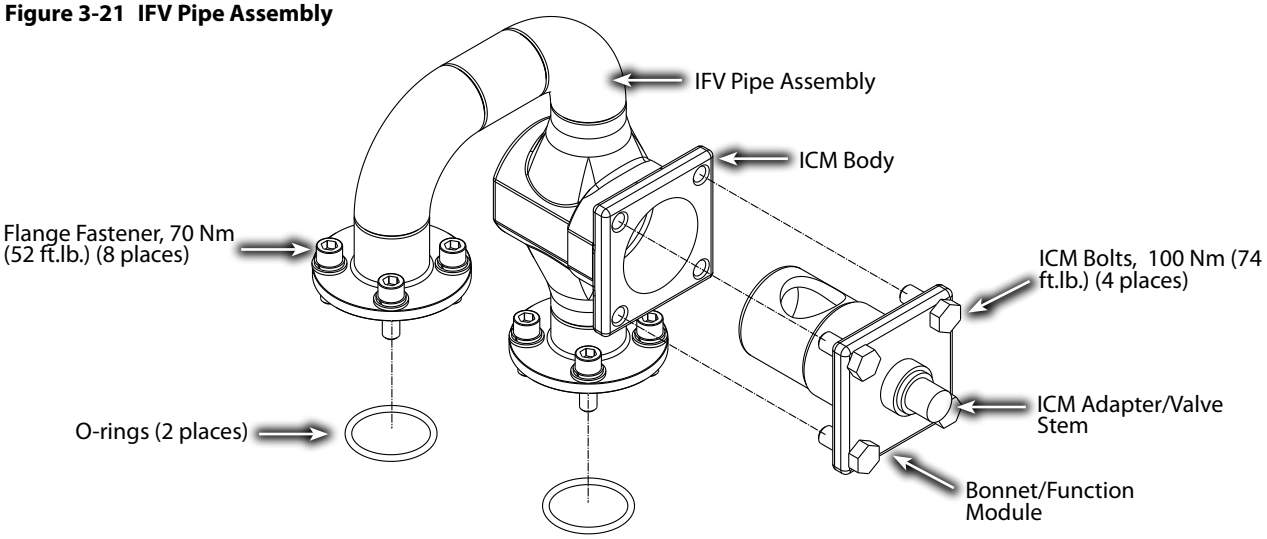
Table 3-9 ICM Body Torque Specifications

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

3.2.3 VTT IFV Pipe Assembly

This section applies only to VTT Compressors. 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 3-21 IFV Pipe Assembly



3.2.3.1 IFV Pipe Assembly Removal and Installation

IFV Pipe Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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) fasteners from the suction and discharge side of the IFV pipe assembly.
7. Remove the eight (8) fasteners from the suction and discharge side of the IFV pipe assembly.
8. Remove the IFV pipe assembly and O-rings.

⚠ • • • CAUTION • • •

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

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) M14x40 fasteners on the suction and discharge side of the IFV pipe assembly.
5. Tighten all eight (8) M14x40 fasteners on the suction and discharge side of the IFV pipe assembly evenly and torque to 70 Nm (52 ft.lb.).
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 3 Nm (27 in.lb.).
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 and evacuate Compressor in accordance with standard industry practices.
10. Return the Compressor to normal operation.

3.2.3.2 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.

3.2.3.3 IFV Pipe Torque Specifications

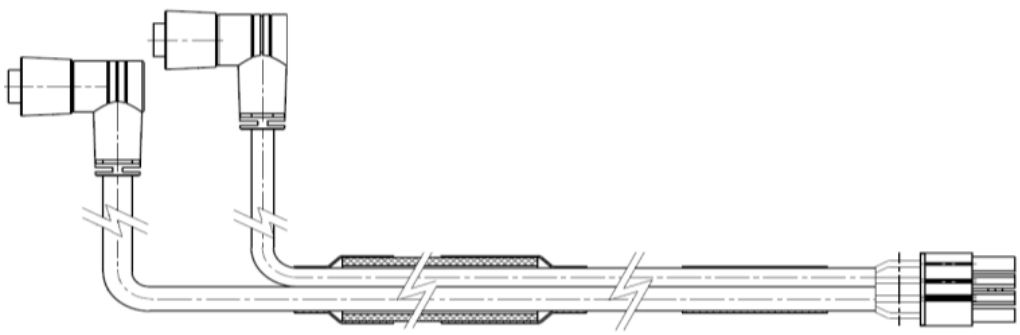
Table 3-10 IFV Pipe Assembly Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
IFV Set Screws	3	-	27
Industrial Control Motor (ICM) Body Bolts	100	74	885
Socket Head Cap Screw (SHCS) to Suction and Discharge Sides of IFV Pipe	70	52	620

3.2.4 IFV Cable

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

Figure 3-22 IFV Cable

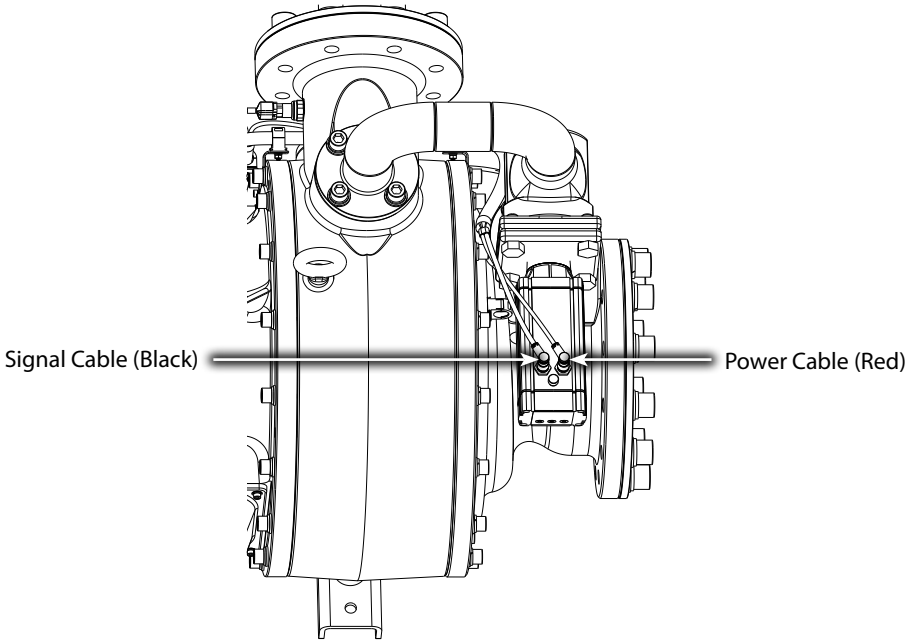


3.2.4.1 IFV Cable Removal and Installation

IFV Cable Removal:

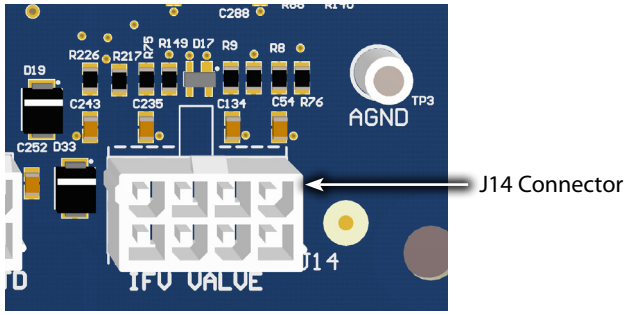
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Disconnect the Red (power) and Black (signal) cables from the IFV Valve by turning the collars, located on the cable ends, in a counter-clockwise rotation.

Figure 3-23 IFV Cable Connection



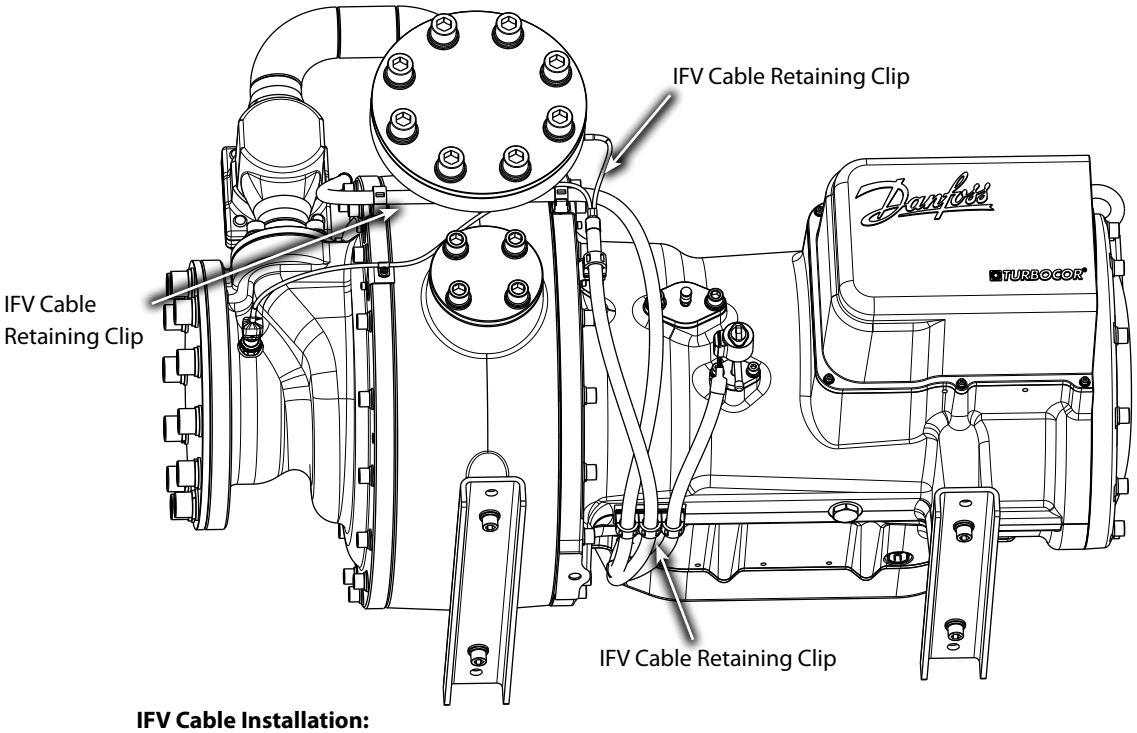
3. Remove the Compressor Service Side Cover.
4. Locate J14 (IFV Valve) on the CCM Board and remove the connector. Refer to "Figure 3-24 J14 CCM Board Connector" on page 42.

Figure 3-24 J14 CCM Board Connector



5. Remove the cable from the retaining clips. Refer to "Figure 3-25 IFV Cable Retaining Clips".

Figure 3-25 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.

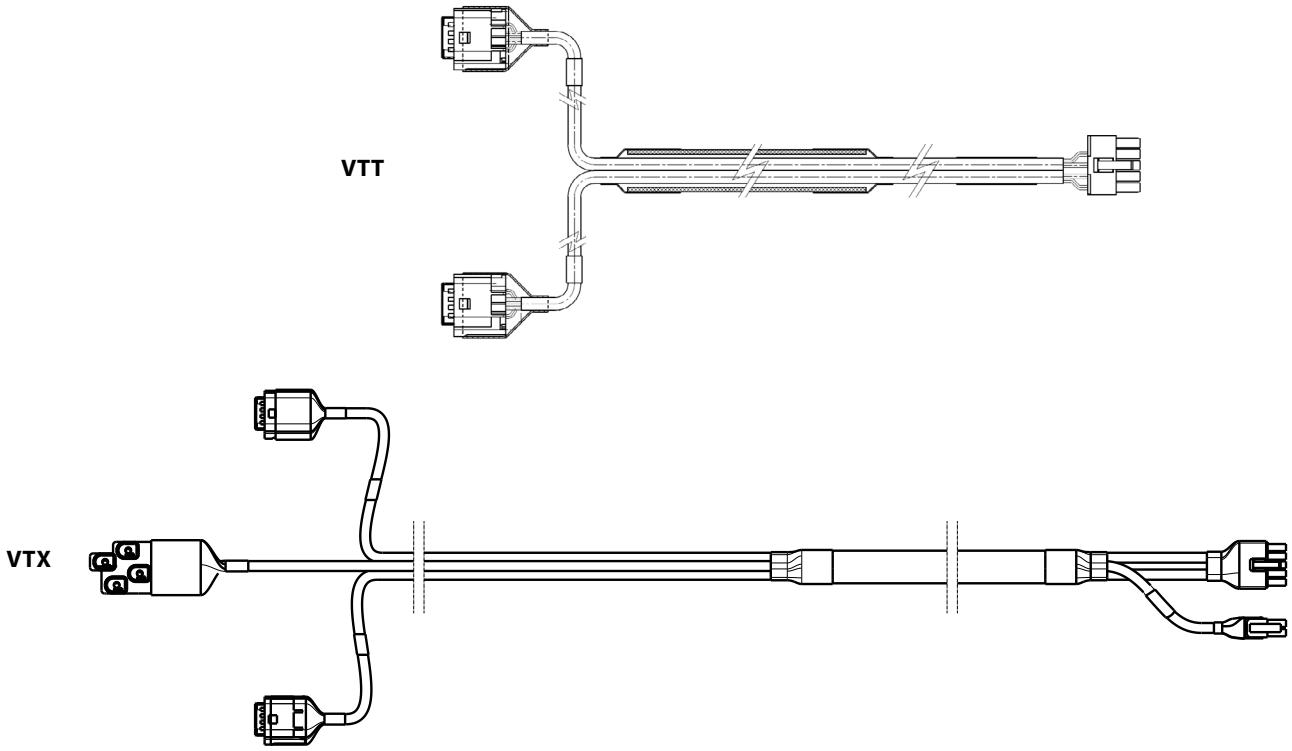
3.2.4.2 IFV Cable Verification

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. The VTX Compressors also include the IGV cables in the Pressure/Temperature Sensor Cable Harness. Refer to "Figure 3-26 Pressure/Temperature Harness" on page 44 for the examples of the two (2) cable variants.

Figure 3-26 Pressure/Temperature Harness

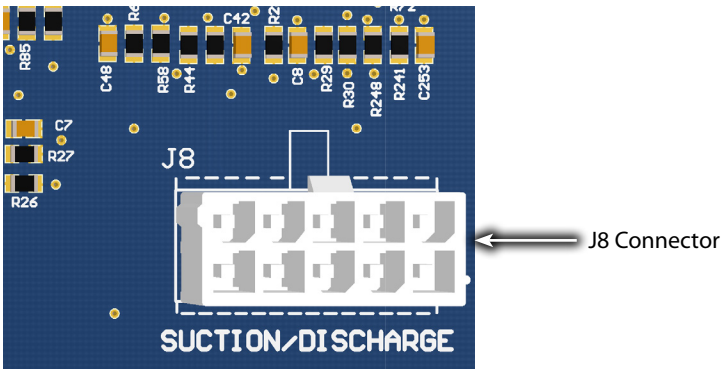


3.2.5.1 Pressure/Temperature Harness Removal and Installation

Pressure/Temperature Sensor Cable Harness Removal:

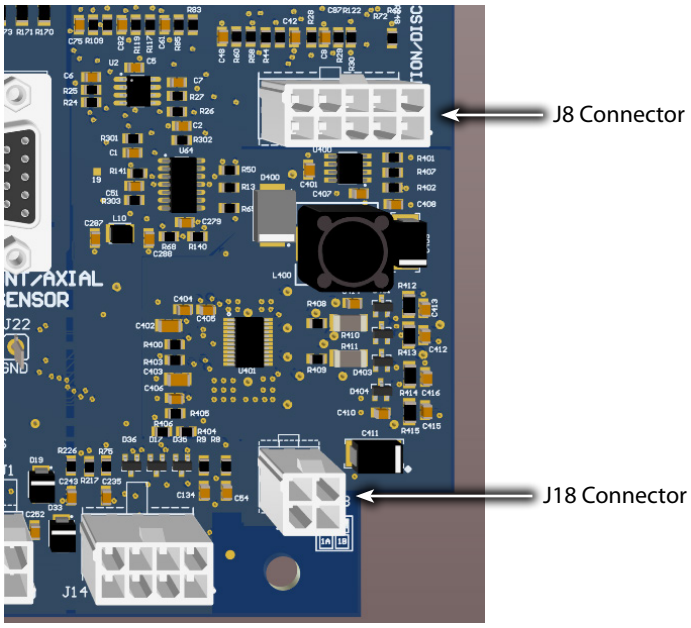
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover.
3. Unplug the cable harness connector from the suction and discharge sensors.
4. Unplug the cable harness connector from the IGV Feedthrough (VTX only).
5. Unplug the P/T Sensor harness connector from J8 on the CCM. Refer to "Figure 3-27 VTT J8 CCM Board Connector" for VTT Compressors. Refer to Figure "Figure 3-28 VTX J8 and J18 CCM Board Connector" on page 45 for VTX Compressors.

Figure 3-27 VTT J8 CCM Board Connector



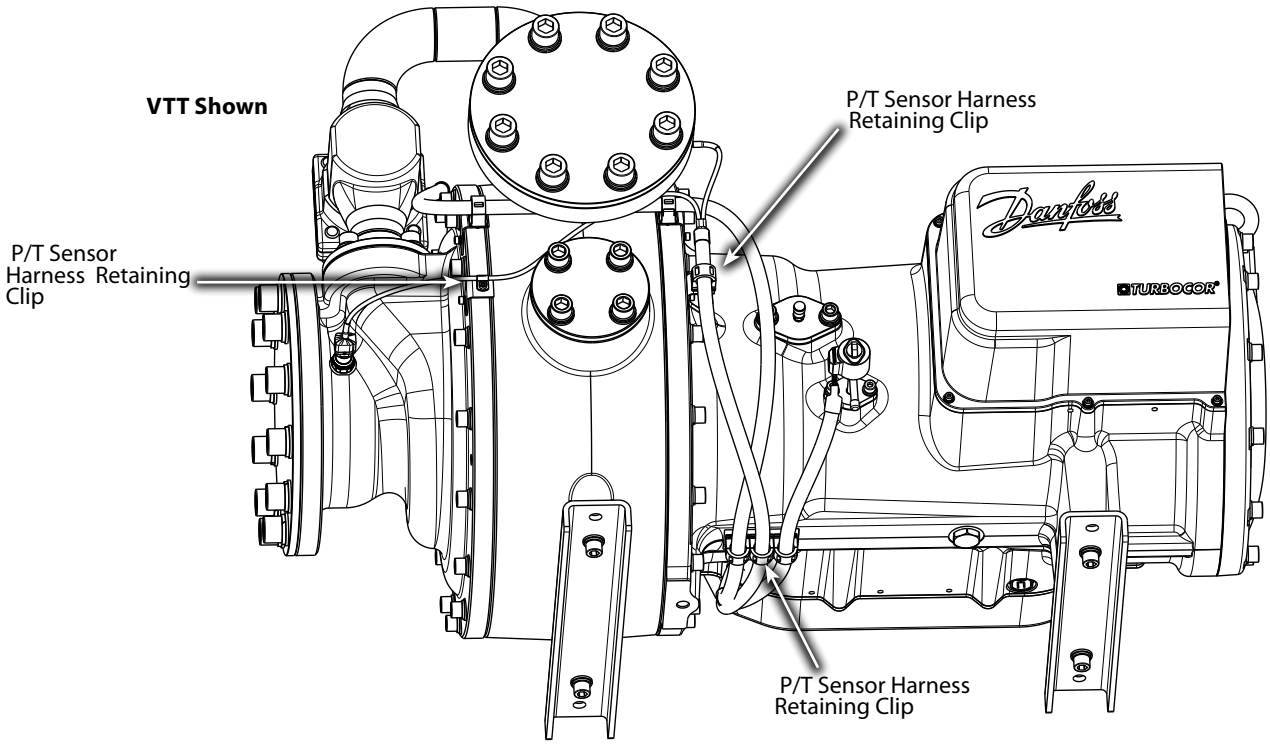
6. For VTX Compressors, unplug the IGV harness connector from J18 on the CCM. Refer to Figure "Figure 3-28 VTX J8 and J18 CCM Board Connector" for VTX Compressors.

Figure 3-28 VTX J8 and J18 CCM Board Connector



7. Remove the cable harness from the Compressor retaining clips. Refer to "Figure 3-29 Pressure/Temperature Sensor Harness Retaining Clips" on page 45**.**

Figure 3-29 Pressure/Temperature Sensor Harness Retaining Clips



Installation Instructions:

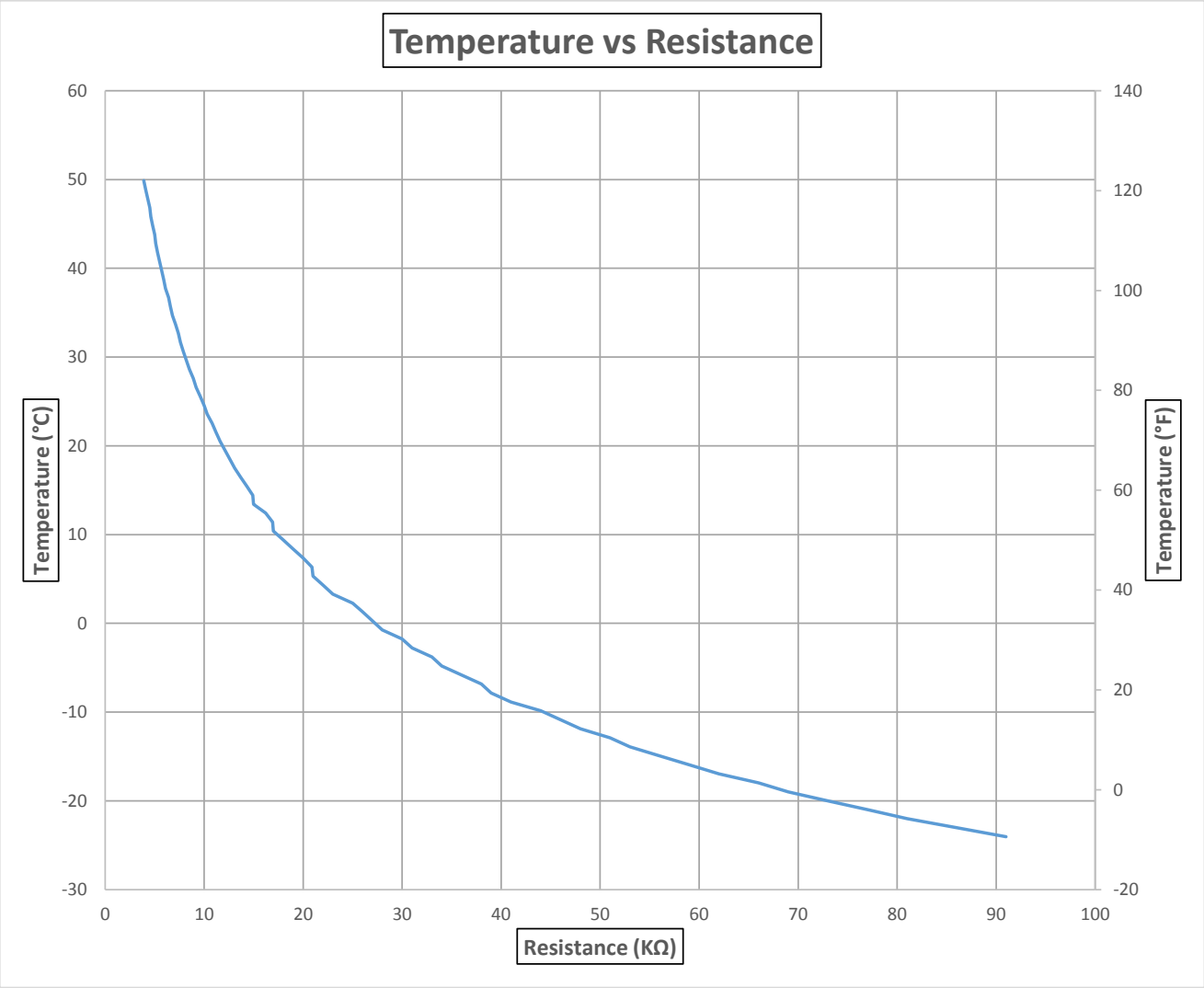
1. Plug the cable harness connector into the suction sensor and discharge sensor.
2. Plug the cable harness connector into the IGV Feedthrough (VTX only).
3. Route the Pressure/Temperature cable to the service side and attach it to the Compressor retaining clips.
4. Plug the cable harness connector into J8 on the CCM.

5. For VTX Compressors, plug the IGV harness connector into J18 on the CCM.
6. Replace the Service Side Cover.
7. Restore power to the Compressor.

3.2.5.2 Pressure/Temperature Harness Verification

1. Connect the SMT to the Compressor.
2. Verify that the suction and discharge pressures are to specification. Refer to section "3.4.4.13.2 Temperature/Pressure Sensor Verification" on page 105 of this manual for the appropriate values.
3. Verify that the temperature values are as expected. Refer to "Figure 3-30 Pressure/Temperature Sensor Resistance/Temperature (R/T) Curve" on page 46 for information on both the Suction and Discharge sensors.
4. If either sensor is found to be out of specification, refer to "3.4.4.13 High and Low Pressure Temperature Sensors" on page 104 regarding the replacement steps.

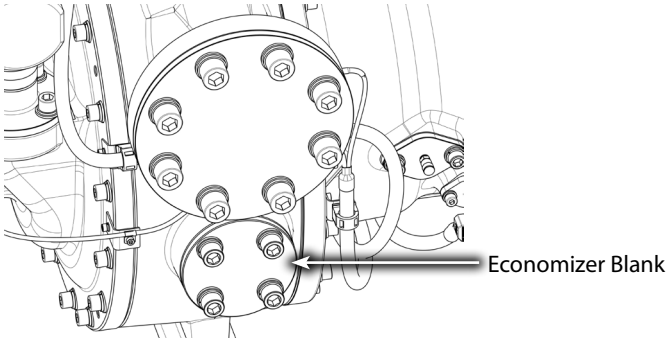
Figure 3-30 Pressure/Temperature Sensor Resistance/Temperature (R/T) Curve



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 3-31 Economizer Blank



3.2.6.1 Economizer Blank Removal and Installation

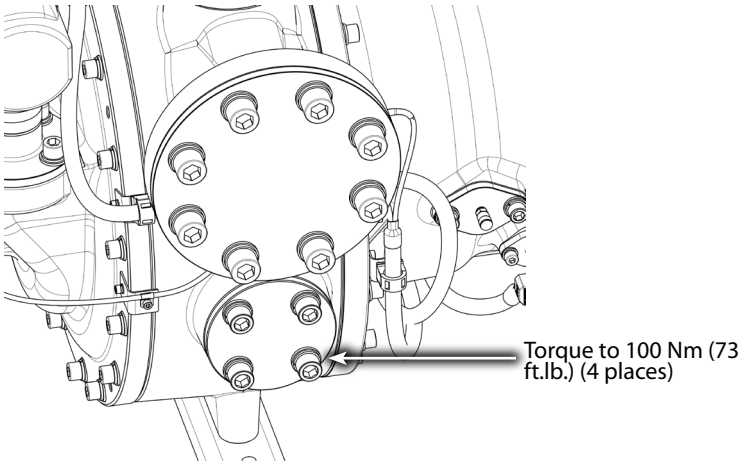
Economizer Blank Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Isolate the Compressor and recover refrigerant.
3. Remove the four (4) Economizer fasteners.

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 fasteners, 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.)

Figure 3-32 Economizer Blank Installation



4. Leak test and evacuate Compressor in accordance with standard industry practices.
5. Return the Compressor to normal operation.

3.2.6.2 Economizer Blank Torque Specifications

NOTE

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

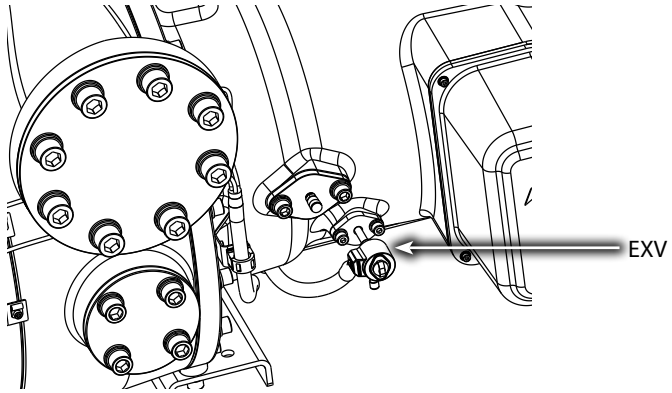
Table 3-11 Economizer Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Economizer, SHCS, M16x40	100	74	885

3.2.7 EXV Assembly

The Motor Cooling EXV controls the flow of refrigerant to cool the Compressor motor and bearing sections For further information, refer to "2.4 Compressor Cooling" on page 24.

Figure 3-33 EXV



3.2.7.1 EXV Removal and Installation

EXV Removal:

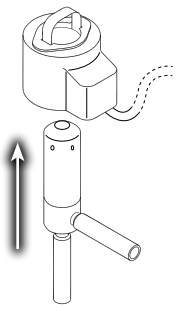
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Isolate the Compressor and liquid line to the EXV and recover the refrigerant.

⚠ • • • 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.

Figure 3-34 Actuator Coil Removal

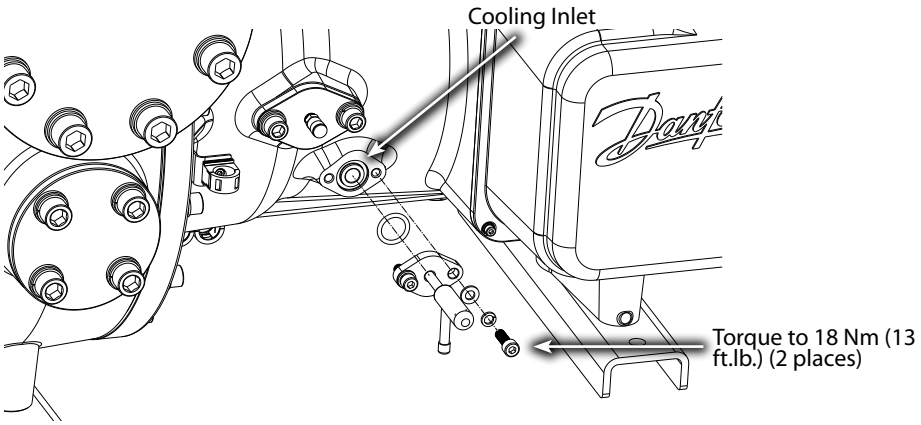


4. Disconnect the liquid line connection at the EXV.
5. Remove the flange fasteners that attach the EXV to the Compressor housing. Note the orientation of the valve assembly.
6. Remove the O-ring from the Compressor housing.

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 fasteners evenly and torque to 18 Nm (13 ft.lb.).

Figure 3-35 EXV Installation



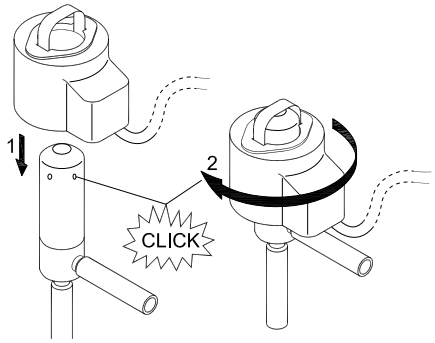
5. Heat and remove the cap from the EXV assembly inlet line and attach liquid line. Refer to section "3.2.7.3 EXV Protection" on page 49.

⚠ • • • CAUTION • • •

Protect the valve from heat during installation.

6. Reinstall the actuator coil onto the EXV assembly. Push the actuator coil into place and roatate until the detents are engaged. Refer to "Figure 3-36 Actuator Coil Installation" on page 49.
7. Leak test and evacuate Compressor in accordance with standard industry practices.
8. Return the Compressor to normal operation.

Figure 3-36 Actuator Coil Installation



3.2.7.2 EXV Verification

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

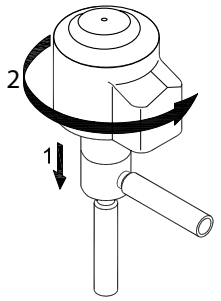
3.2.7.3 EXV Protection

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.

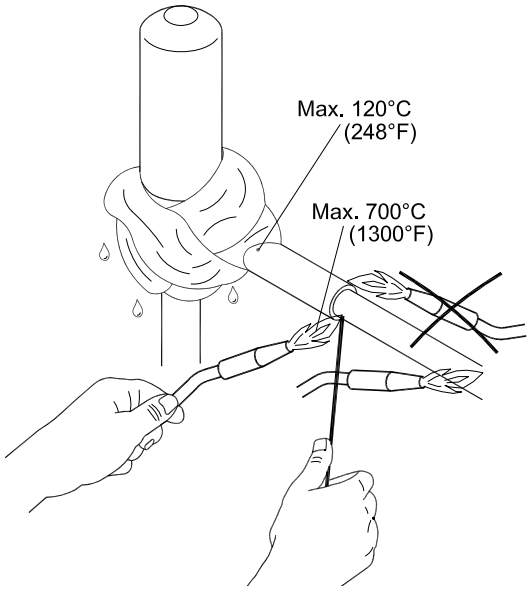
2. The new valve should be shipped in the open position but to ensure that the valve is completely open, use ETS 6 manual coil part number 034G5119 (purchase through local Danfoss supplier) and manually open the valve by turning the manual coil 20 times in a counter-clockwise rotation. (If an ETS 6 manual 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 3-37 Opening Valve Manually



3. Remove the ETS 6 manual coil or actuator coil.
4. Wrap the valve in cool wet towels to help prevent excessive heat from damaging the valve.
5. 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; rewet and rewrap if needed.
9. 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 3-38 Brazing the EXV



11. Once the valve has cooled back down, reinstall the actuator coil.

3.2.7.4 EXV Torque Specifications

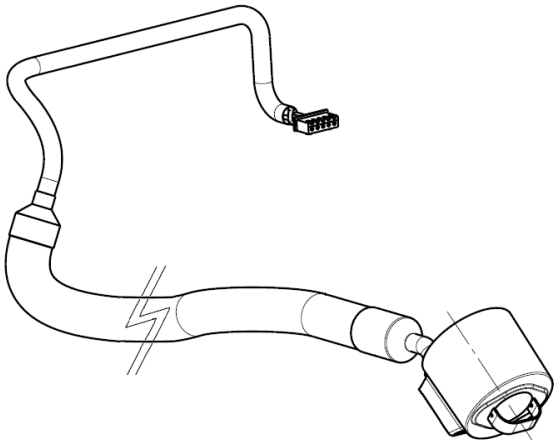
Table 3-12 EXV Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Flange, SHCS, M8x25 (VTT Revisions B and Later and VTX Revisions A & B)	18	13	159

3.2.8 EXV Cable

The EXV Cable connects the CCM to the EXV.

Figure 3-39 EXV Cable

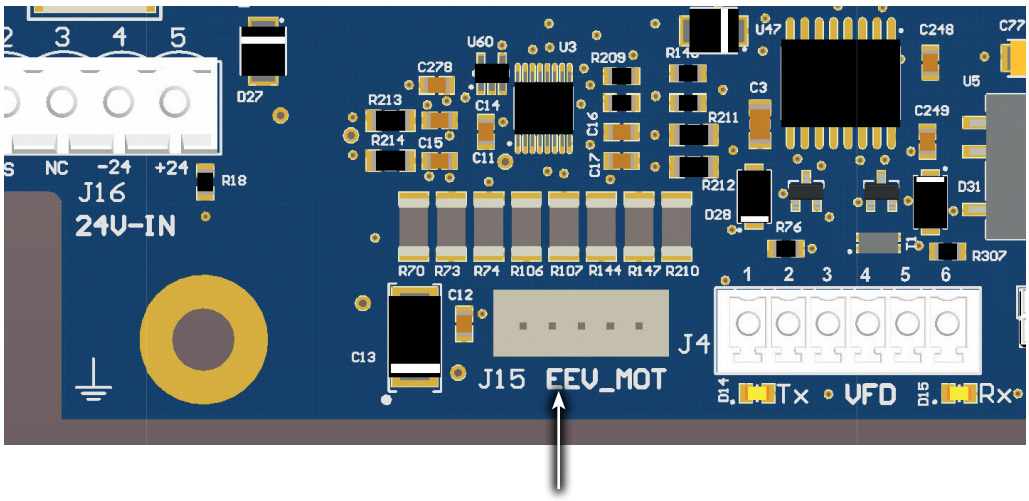


3.2.8.1 EXV Cable Removal and Installation

EXV Cable Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover.
3. Remove connector J15 EEV_MOT from the CCM.

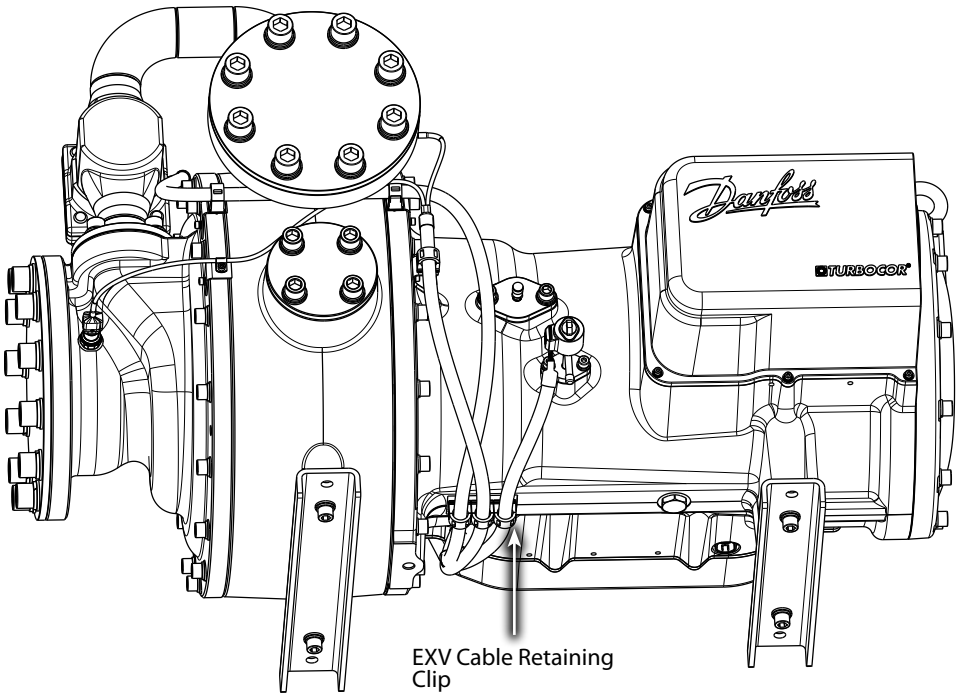
Figure 3-40 CCM J15 Connector



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 3-41 EXV Cable Retaining Clip".

Figure 3-41 EXV Cable Retaining Clip

VTT Shown



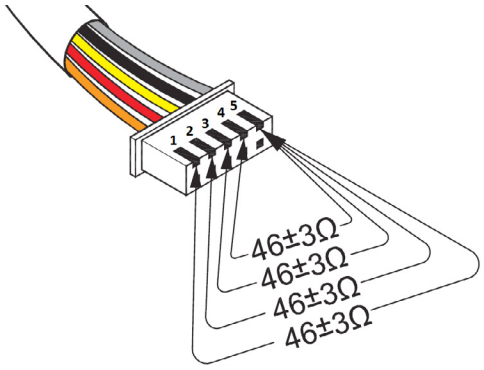
EXV Cable Installation:

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.

3.2.8.1 EXV Cable 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 3-42 Cable Pinout for Continuity/Resistance Verification



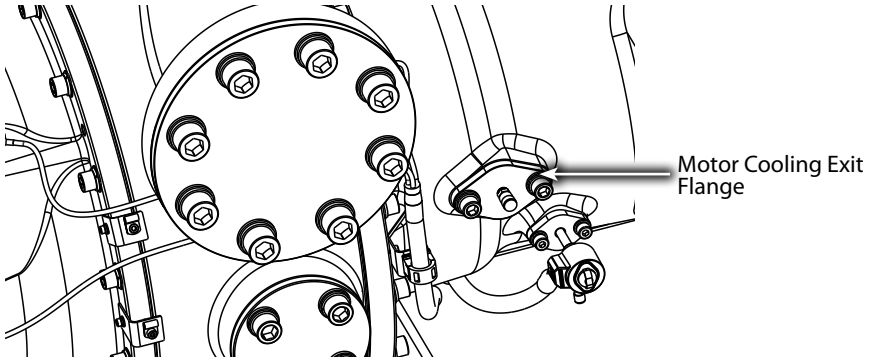
3.2.8.2 Running Check

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.

Figure 3-43 Motor Cooling Exit Flange



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.

3.2.9.1 Removal and Installation

Motor Cooling Exit Flange Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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.

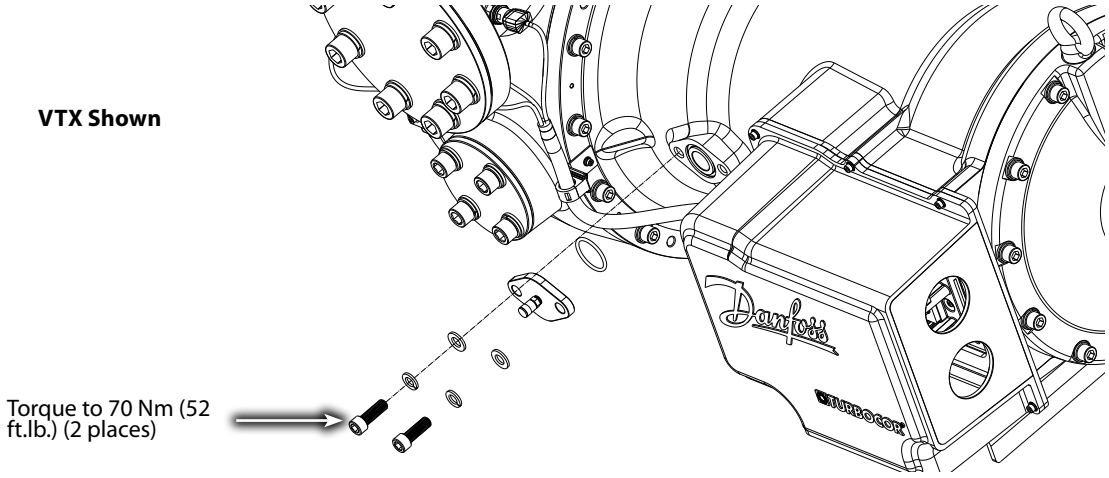
3. Remove the flange fasteners that attach the Motor Cooling Exit to the Compressor housing.
4. Remove the O-ring from Compressor housing.

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 torque to 70 Nm (52 ft.lb).

Figure 3-44 Motor Cooling Exit Flange

VTX Shown



4. Leak test and evacuate the Compressor in accordance with standard industry practices.
5. Return the Compressor to normal operation.

3.2.9.2 Motor Cooling Exit Flange Torque Specifications

Table 3-13 Motor Cooling Exit Flange Torque Specifications

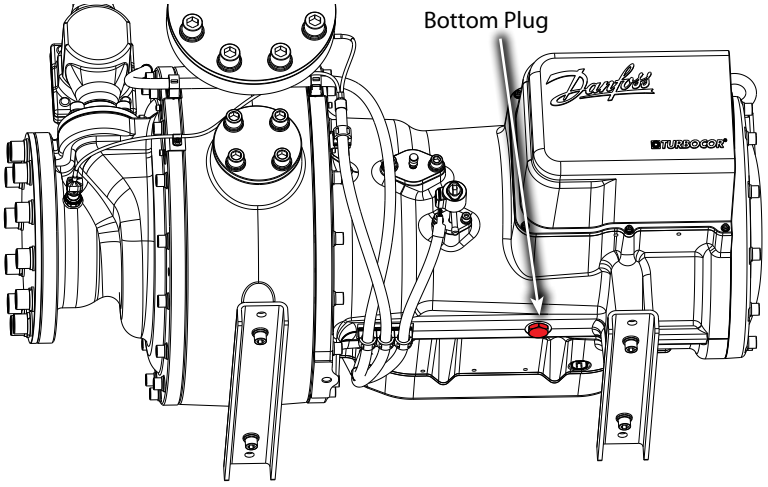
Description	Nm	Ft.Lb.	In.Lb.
Flange, SHCS, M12x35	70	52	620

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 3-45 Bottom Plug

VTT Shown



3.2.10.1 Bottom Plug Removal and Installation

Bottom Plug Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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 70 Nm (52 ft.lb.).
4. Leak test and evacuate the Compressor in accordance with standard industry practices.
5. Return the Compressor to normal operation.

3.2.10.2 Bottom Plug Torque Specifications

Table 3-14 Bottom Plug Torque Specifications

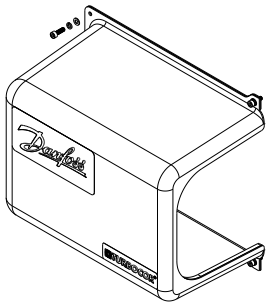
Description	Nm	Ft.Lb.	In.Lb.
Bottom Plug, M16x2	70	52	620

3.3 Power Side

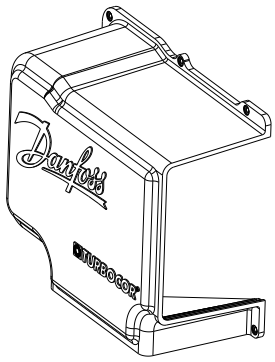
3.3.1 Motor Power Cover

The Motor Power Cover provides protection for the connection of the cables from the VFD to the Compressor motor.

Figure 3-46 VTT/VTX Motor Power Covers



VTT Motor Power Cover (Rev B and C)



VTX Motor Power Cover

3.3.1.1 Motor Power Cover Removal and Installation

Motor Power Cover Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the six (6) fasteners that hold the Motor Power Cover in place.
3. Remove the Motor Power Cover.

Motor Power Cover Installation:

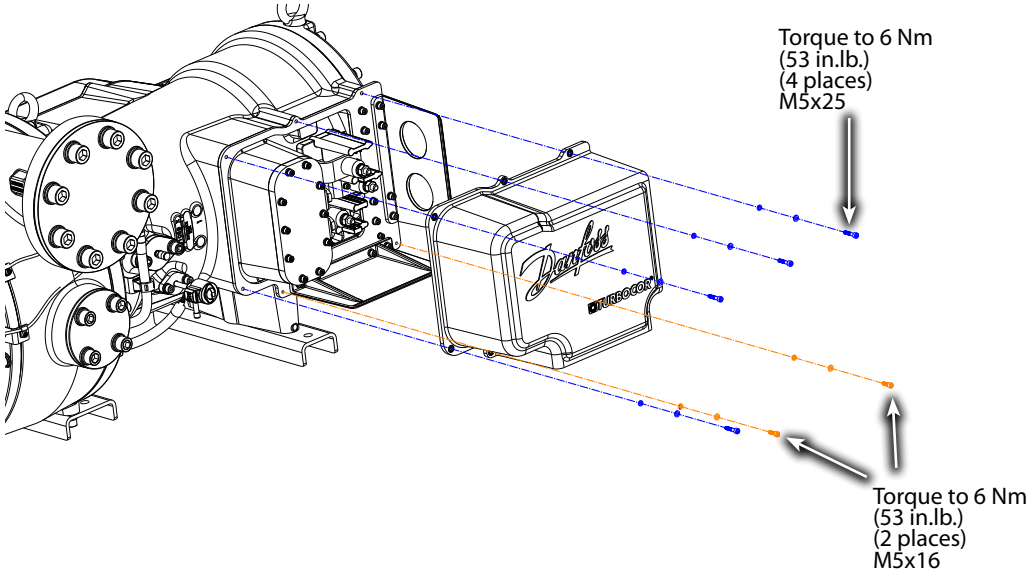
1. Verify all sealing surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Install the gasket on the sealing surface of the cover.
3. Place the cover over the motor power side.

4. Install the M5 fasteners to secure the Motor Power Cover and torque to 6 Nm (53 in.lb).

⚠ • • • CAUTION • • •

The VTX Compressor Motor Power Covers have two (2) different length fasteners. The two (2) at the bottom are M5x16 where as the other fasteners are M5x25. Never attempt to install the shorter M5x16 fasteners in any locations other than the two (2) lower positions as thread damage could occur .

Figure 3-47 VTX Motor Power Cover Installation



5. Restore power to the Compressor.

3.3.1.2 Motor Power Cover Torque Specifications

Table 3-15 Motor Power Cover Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover Fastener, M5x16	6	-	53
Power Cover Fastener, M5x25	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 several different Mains Input Bracket styles for the VTT and VTX Compressors.

The VTX Compressors come with a factory-installed two-hole mains bracket. This two-hole bracket is required for CE compliance. If CE compliance is not a requirement, an optional 4" single-hole mains bracket is available. On the VTX, the entry point for the mains cables can be at the side of the Power Cover, or at the bottom. If the entry point is desired at the bottom of the Power Cover, the solid bracket will need to be swapped with either the single or two-hole mains bracket.

The VTT Compressors come with a factory-installed 4" single-hole bracket. The two-hole mains bracket will also fit on the VTT Compressors.

Figure 3-48 VTT Mains Input Bracket (Revision C)

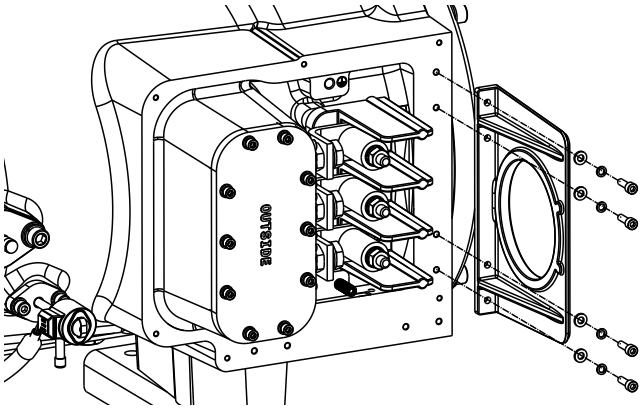
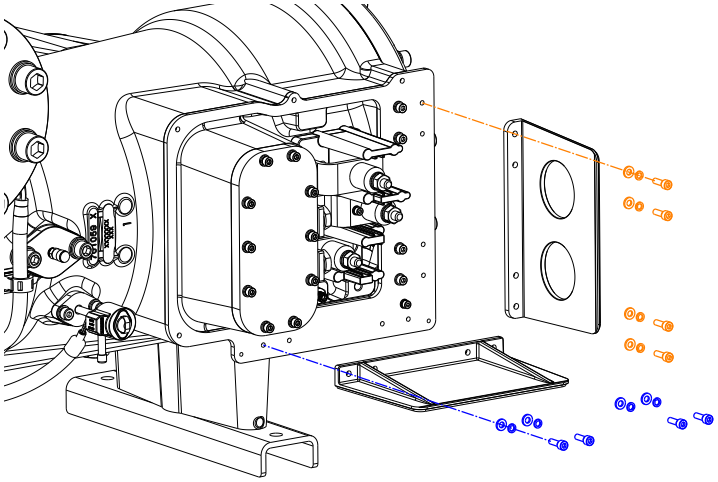


Figure 3-49 VTX Mains Input Brackets



3.3.2.1 Mains Input Bracket Removal and Installation

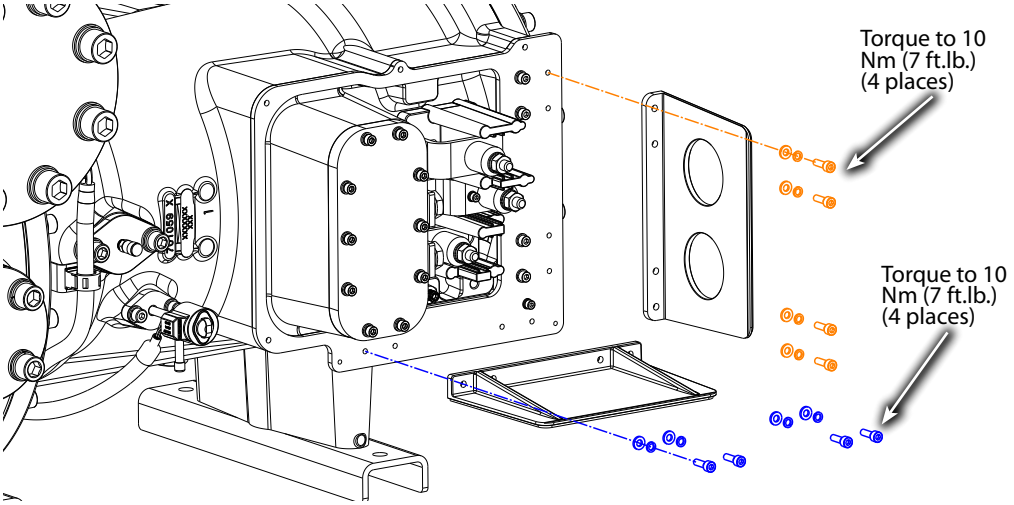
Mains Input Bracket Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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).
5. Remove the conduit locknut(s) and remove the conduit and cables away from the Mains Input Bracket.
6. Remove the four (4) fasteners 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 fasteners to secure the Mains Input Bracket and torque to 10 Nm (7 ft.lb.).

Figure 3-50 VTX Mains Input Bracket Installation



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. Attach the motor power cables to the terminals and torque to 20 Nm (15 ft.lb.).
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 10 Nm (7 ft.lb.).
7. Install the Motor Power Cover.
8. Restore power to the Compressor.

3.3.2.2 Mains Input Bracket Torque Specifications

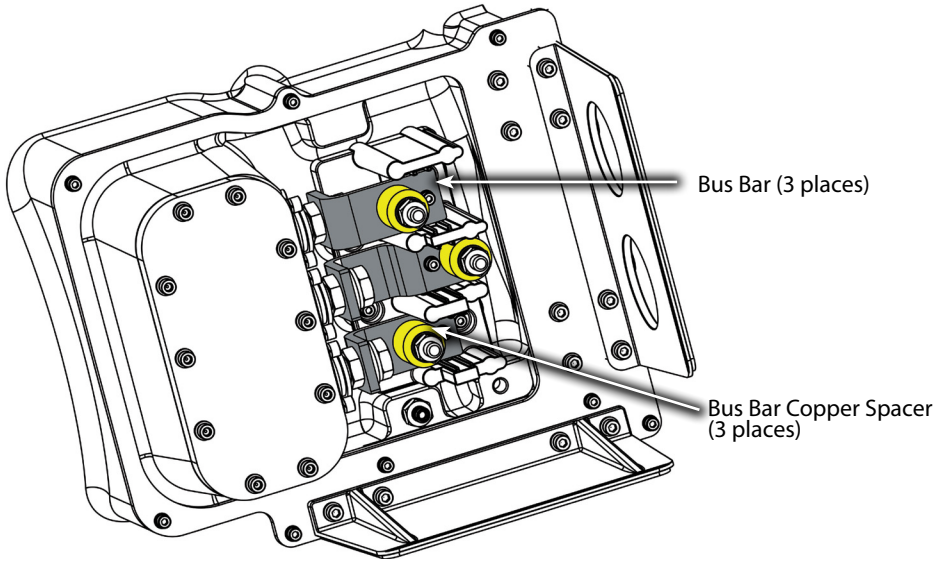
Table 3-16 Mains Input Bracket Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Mains Input Bracket, SHCS, M6x20	10	7	89
Power Cable Nut, Brass M10x1.5	10	7	89

3.3.3 Bus Bar Spacers & Bus Bars

The illustrations shown in this section depict the VTX Compressor. However, the VTT Compressor is of similar design and the required removal and installation steps are the same.

Figure 3-51 VTX Bus Bar Copper Spacers and Bus Bars

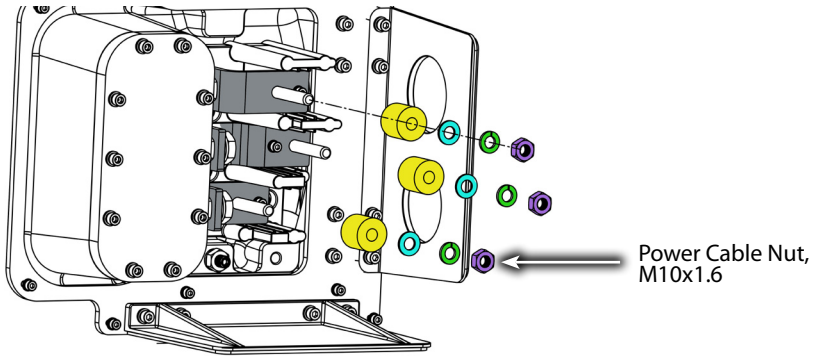


3.3.3.1 Bus Bar and Bus Bar Spacer Removal and Installation

Bus Bar Spacer and Bus Bar Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Motor Power Cover. Refer to "3.3.1 Motor Power Cover" on page 55.
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).
5. Remove the three (3) copper spacers.

Figure 3-52 VTX Bus Bar Spacer Removal



6. Remove the three (3) M16 brass nuts, lock washers, and flat washers from the Motor Tower Feedthrough.
7. Remove the bus bar fasteners. There are three (3) M5x16 fasteners for the VTX Compressors and six (6) M5x16 fasteners for the VTT Compressors.
8. Remove the Bus Bars.

Figure 3-53 VTX Bus Bar Removal

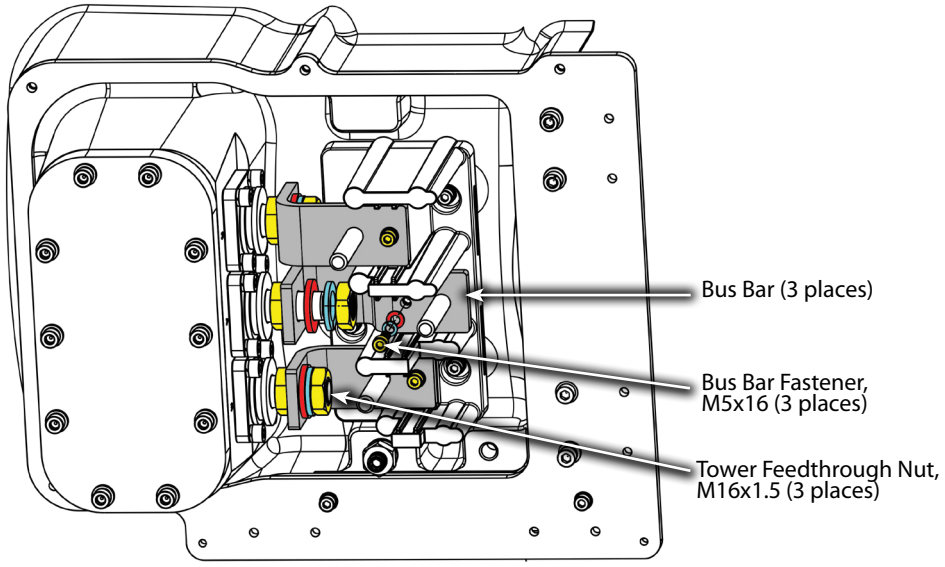
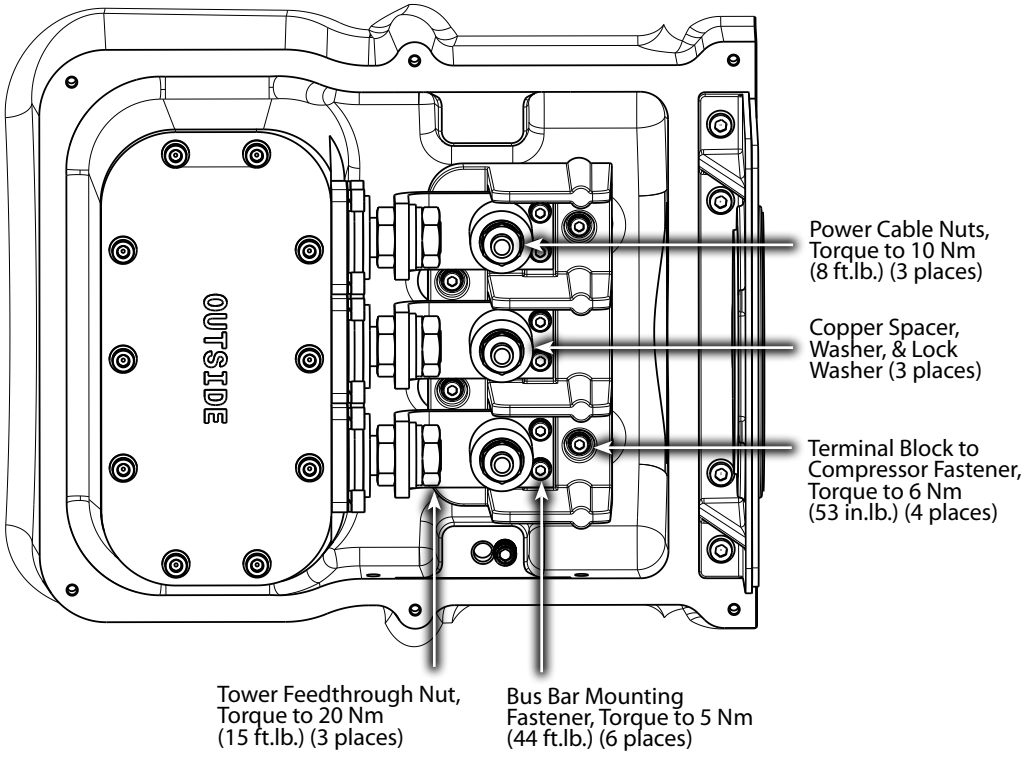


Figure 3-54 VTT Bus Bar Removal



Bus Bar Spacer and Bus Bar Installation:

1. Place the bus bars into position.
2. Loosly install the three (3) M16 brass nuts, lock washers, and flat washers onto the Motor Tower Feedthrough.
3. Install the M5x16 bus bar fasteners and torque to 5 Nm (44 in.lb). Three (3) M5x16 fasteners for the VTX Compressors and six M5x16 fasteners for the VTT Compressors.
4. Rotate the three (3) inner tower feedthrough nuts until they rest against the bus bars.
5. Tighten the three (3) outer M16 brass nuts to 20 Nm (15 ft.lb).

6. Install the three (3) copper spacers.

Figure 3-55 VTX Bus Bar

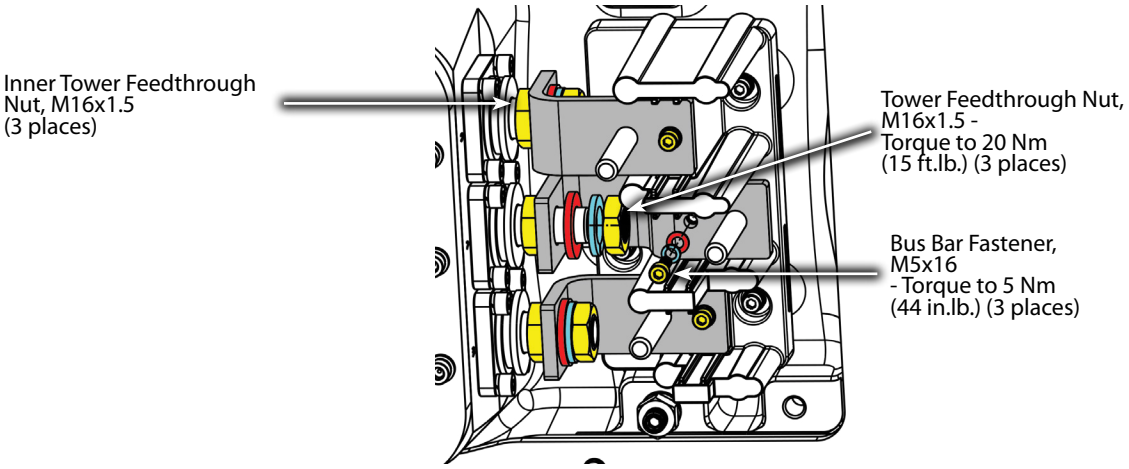
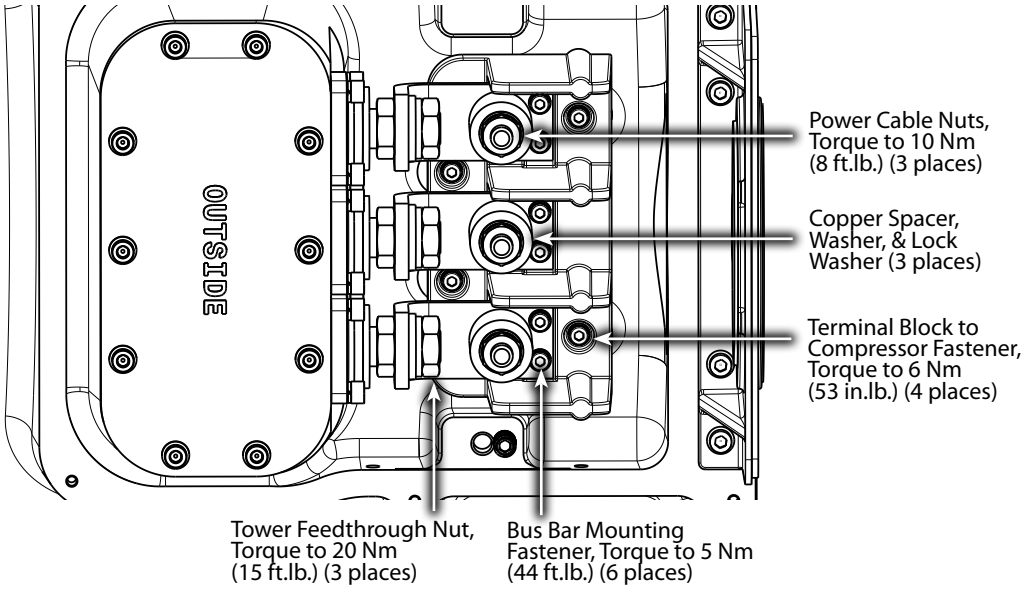


Figure 3-56 VTT Bus Bar



7. Attach the motor power cables to the terminals and torque to 20 Nm (15 ft.lb.).
8. Install the power cable washers and torque the three (3) M10 brass nuts to 10 Nm (8 ft.lb.).
9. Install the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
10. Return the Compressor to normal operation.

3.3.4 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 variable frequency 3-Phase. The VTX Compressors use a slightly different Terminal Block, but the overall removal process is the same and all torque values are the same between the two (2) variants.

Refer to "Figure 3-57 VTT Motor Terminal Block)" and "Figure 3-58 VTX Motor Terminal Block" for examples of the AC voltage input to the motor.

Figure 3-57 VTT Motor Terminal Block)

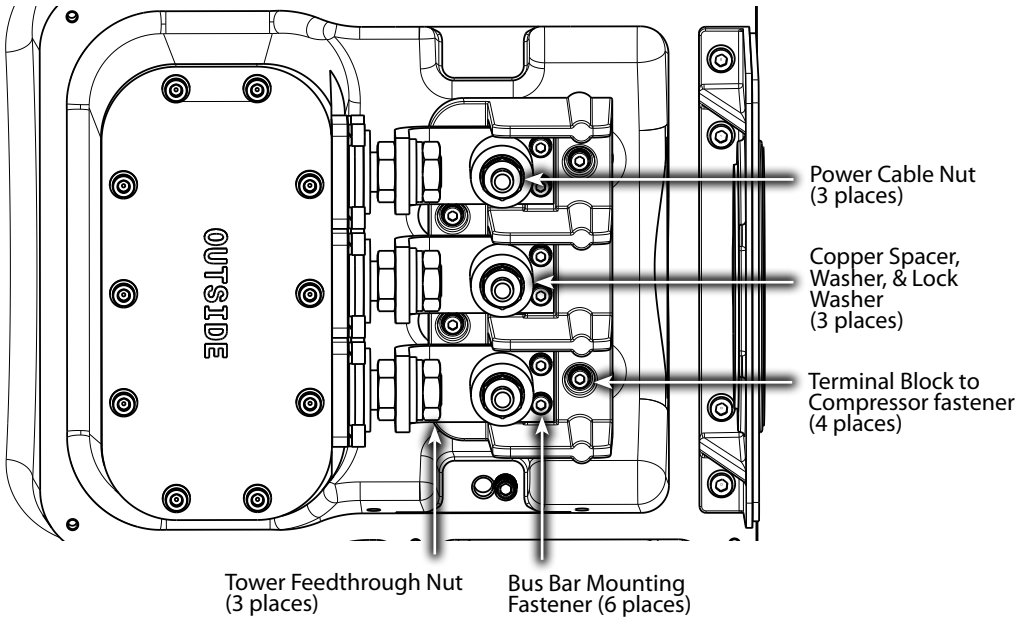
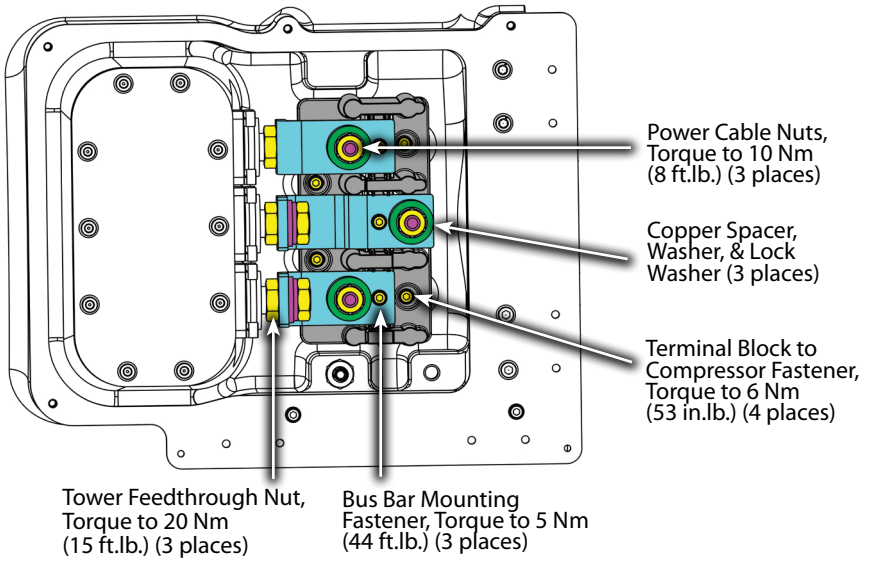


Figure 3-58 VTX Motor Terminal Block



3.3.4.1 Motor Terminal Block Removal and Installation

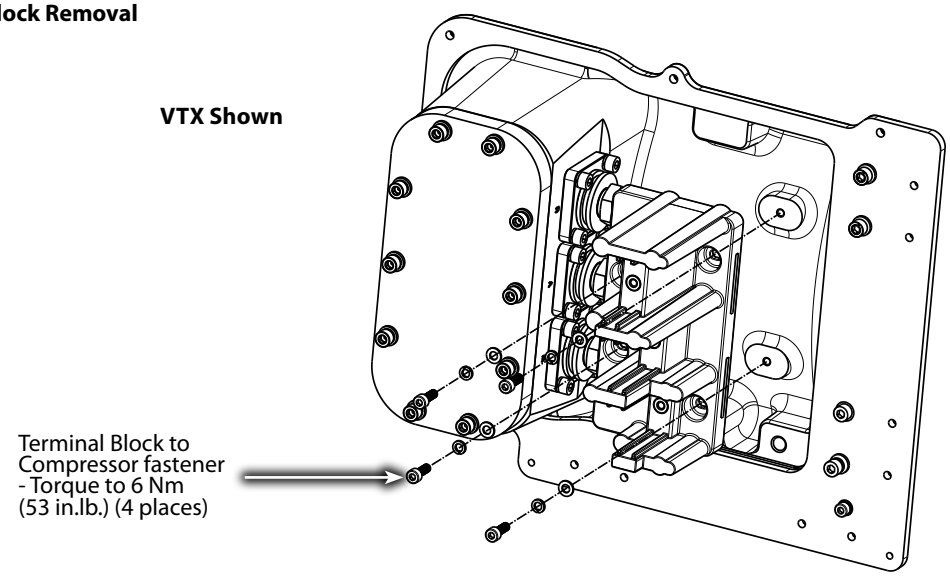
Motor Terminal Block Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.

2. Remove the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
3. Remove the three (3) bus bars. Refer to "3.3.3.1 Bus Bar and Bus Bar Spacer Removal and Installation" on page 59.
4. Remove the four (4) M5 fasteners, lock washers, and flat washers that attach the terminal block to the Compressor.
5. Remove the Motor Terminal Block from the Compressor.

Figure 3-59 Terminal Block Removal

VTX Shown



Motor Terminal Block Installation:

1. Secure the terminal block to the Compressor with the four (4) M5 fasteners and washers and torque to 6 Nm (53 in.lb.).
2. Install the three (3) bus bars. Refer to "3.3.3.1 Bus Bar and Bus Bar Spacer Removal and Installation" on page 59.
3. Install the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
4. Return the Compressor to normal operation.

Figure 3-60 VTT Terminal Block Installation

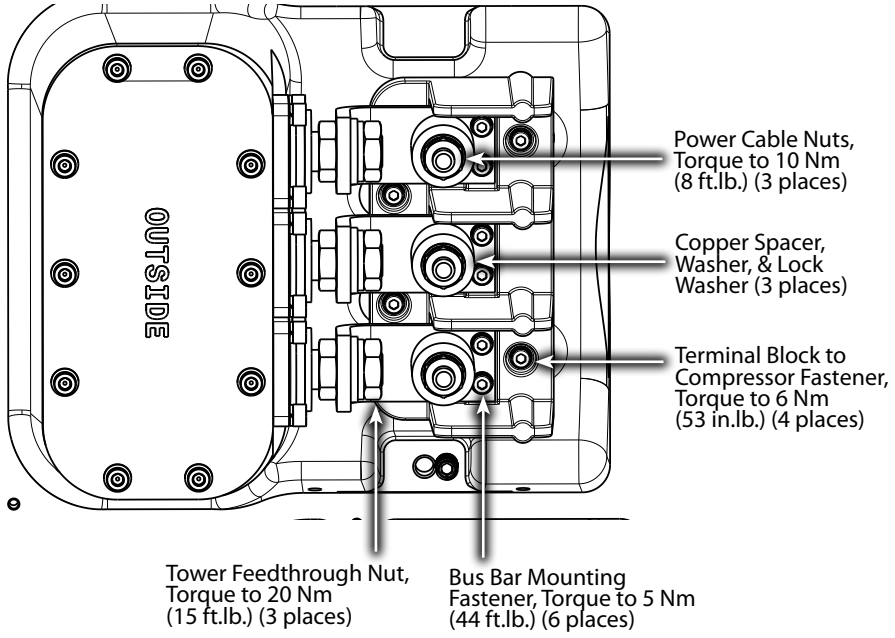
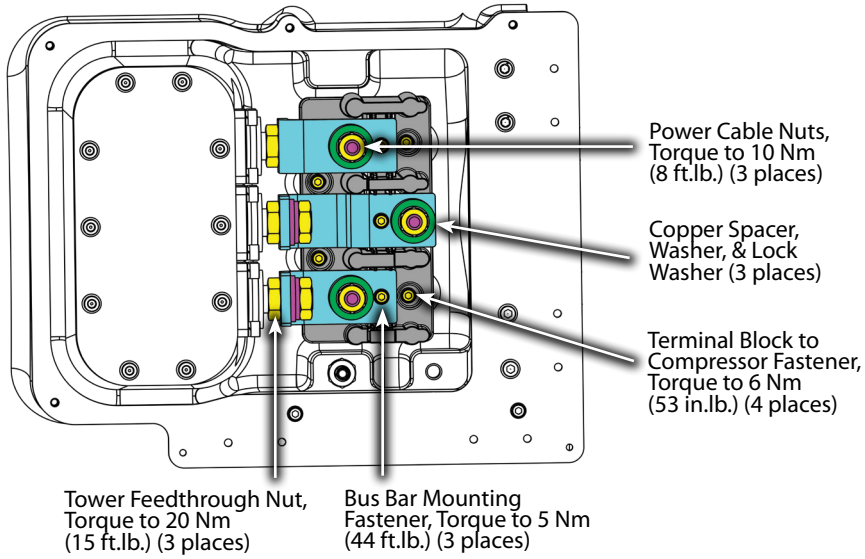


Figure 3-61 VTX Terminal Block Install



3.3.4.2 Motor Terminal Block Torque Specifications

Table 3-17 Motor Terminal Block Torque Specifications

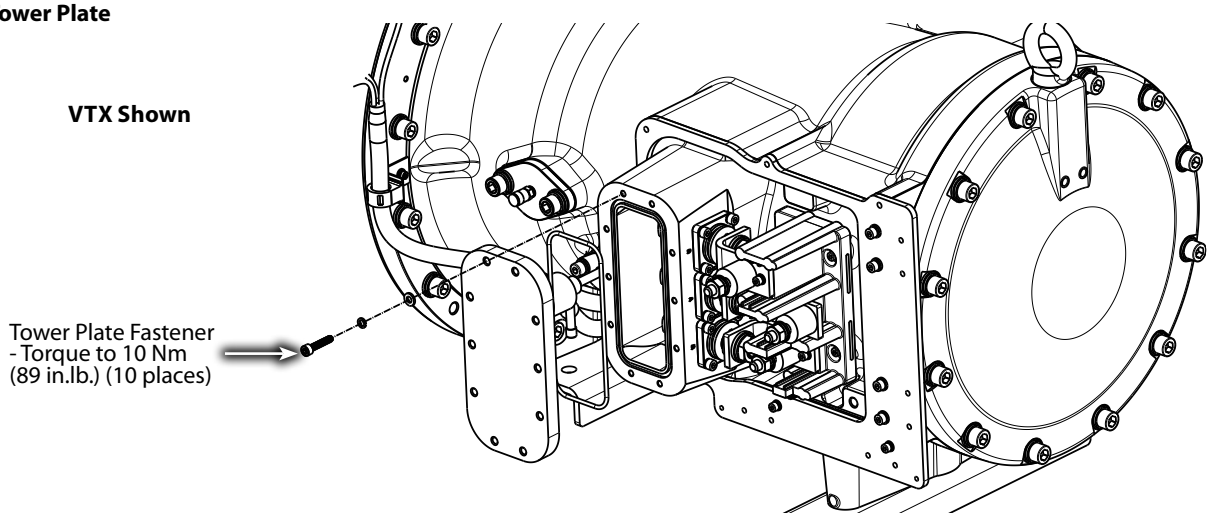
Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Motor Terminal Block to Compressor, SHCS, M5x20	6	-	53
Tower Feedthrough Nut, Brass M16x1.5	20	15	177
Power Cable Nut, Brass M10x1.5	10	7	89
Bus Bar Mounting, SHCS, M5x16	5	-	44
Ground Cable Nut, M10x1.5, Brass	20	15	177

3.3.5 Tower Plate

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

There are two (2) different variations of the Tower Plates but both are interchangable across all of the VTT/VTX Compressors. Many VTT Compressors have a Tower Plate with the wording "OUTSIDE" on the external side of the plate and the wording must face the outside. All VTX Compressors will have a Tower Plate that has no wording on the top of the plate and either side can be placed against the Compressor. Unless the Tower Plate is new, it is best to keep the same side facing the Compressor housing as this side will allow for a better sealing surface.

Figure 3-62 Tower Plate



3.3.5.1 Tower Plate Removal and Installation

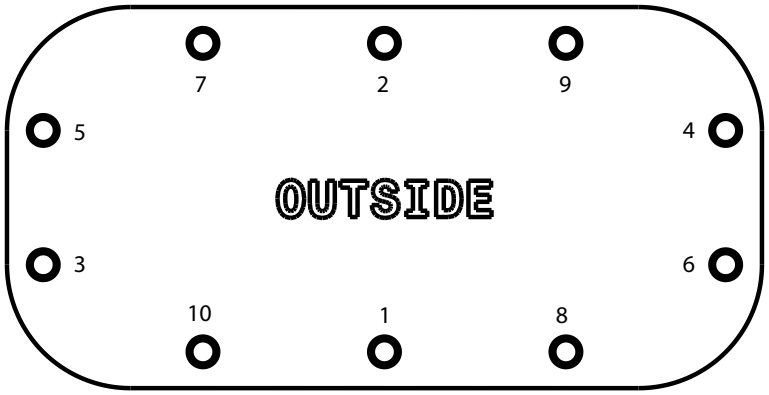
Tower Plate Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
3. Remove the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
4. Remove the 10 fasteners 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.
6. Finger-tighten the 10 M6x30 fasteners.
7. Tighten the 10 M6 fasteners in a crisscross pattern in two (2) stages. Refer to "Figure 3-63 Tower Plate Torque Pattern" on page 66.
   - Stage 1: Tighten to 5 Nm (44 in.lb.)
   - Stage 2: Tighten to a final torque of 10 Nm (88 in.lb.)

Figure 3-63 Tower Plate Torque Pattern



8. Leak test and evacuate in accordance with standard industry practices.
9. Install the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
10. Return the Compressor to normal operation.

3.3.5.2 Tower Plate Torque Specifications

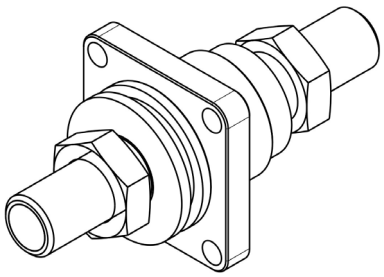
Table 3-18 Tower Plate Torque Specifications

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

3.3.6 Motor Power Feedthrough

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

Figure 3-64 Motor Power Feedthrough



⚠ • • • CAUTION • • •

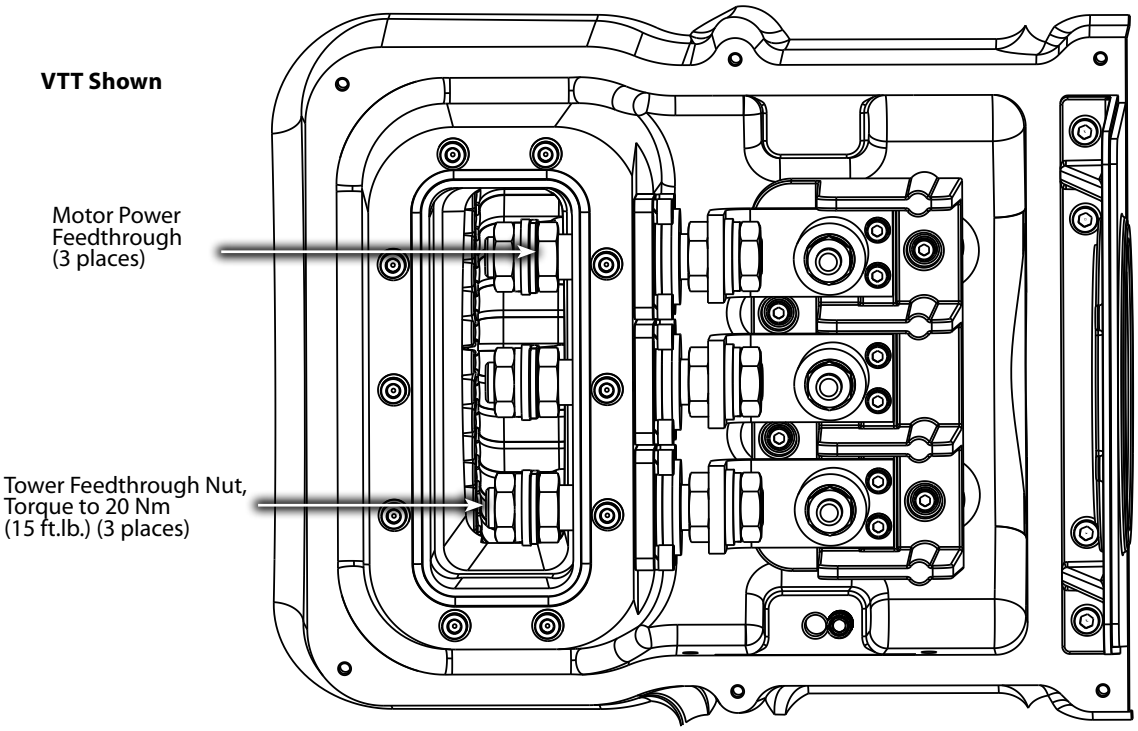
Disassembling the Motor Power Feedthrough poses a risk that can lead to permanent damage. All hardware and tools *must* be accounted for prior to restarting the Compressor.

3.3.6.1 Motor Power Feedthrough Removal and Installation

Motor Power Feedthrough Removal:

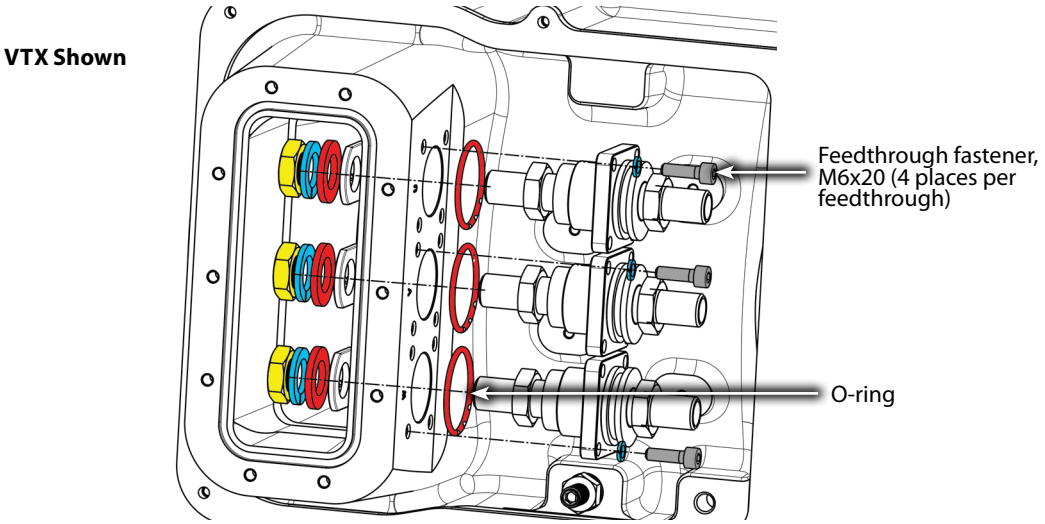
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
3. Remove the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.

Figure 3-65 Motor Power Feedthrough (mounted)



4. Remove the terminal block assembly from the Compressor housing. Refer to "3.3.4.1 Motor Terminal Block Removal and Installation" on page 62.
5. Remove the Tower Plate. Refer to "3.3.5.1 Tower Plate Removal and Installation" on page 65.
6. Carefully remove the internal nuts and motor cables from the Motor Power Feedthrough.
7. Remove the M6x20 fasteners that secure the Motor Power Feedthroughs to the Motor Tower.
8. Remove the Motor Power Feedthrough(s) and O-ring(s).

Figure 3-66 Motor Power Feedthrough Exploded View

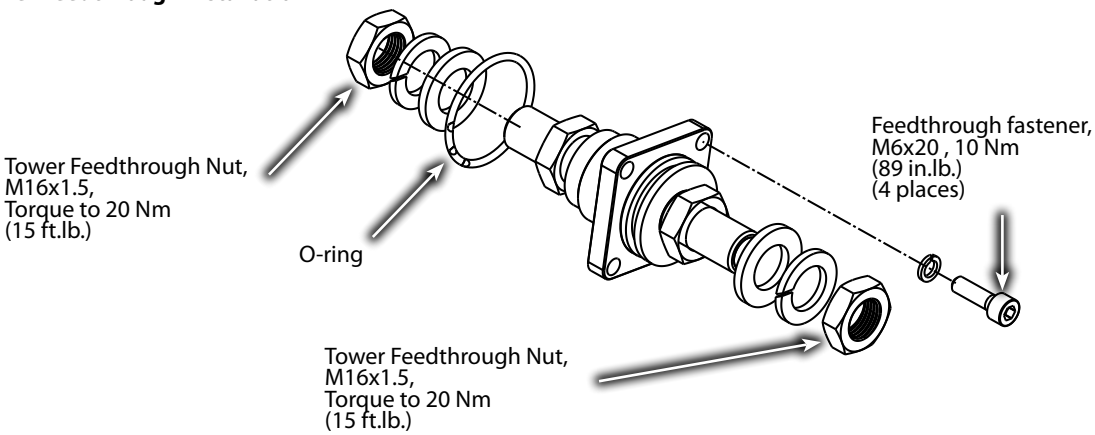


Motor Power Feedthrough Installation:

1. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Motor Power Feedthrough.
2. Insert the Motor Power Feedthrough to the Motor Tower.

3. Install the M6 fasteners and lock washers that hold the Motor Power Feedthroughs to the Motor Tower and finger-tighten.
4. Torque the M6 fasteners 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 the internal nuts and motor cables to the Motor Power Feedthroughs and torque to 20 Nm (15 ft.lb.).
7. Perform a final verification that the motor cables are not touching each other or the Compressor housing.

Figure 3-67 Motor Power Feedthrough Installation



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. Install the Tower Plate. Refer to "3.3.5.1 Tower Plate Removal and Installation" on page 65.
12. Leak test and evacuate in accordance with standard industry practices.
13. Install the Motor Terminal Block assembly. Refer to "3.3.4.1 Motor Terminal Block Removal and Installation" on page 62.
14. Secure the motor bus bars to the Motor Power Feedthoughs and torque to 20 Nm (15 ft.lb.).
15. Attach the motor power cables to the terminals and torque to 20 Nm (15 ft.lb.).
16. Install the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
17. Return the Compressor to normal operation.

3.3.6.2 Motor Power Feedthrough Verification

Before connecting the motor power cables, using an ohmmeter, check the resistance between the motor phases and each phase to ground.

While the Compressor is running under a steady load, using a clamp-on ammeter, verify that the 3-phases to the motor measure a similar amperage.

3.3.6.3 Motor Power Feedthrough Torque Specifications

Table 3-19 Motor Power Feedthrough Torque Specifications

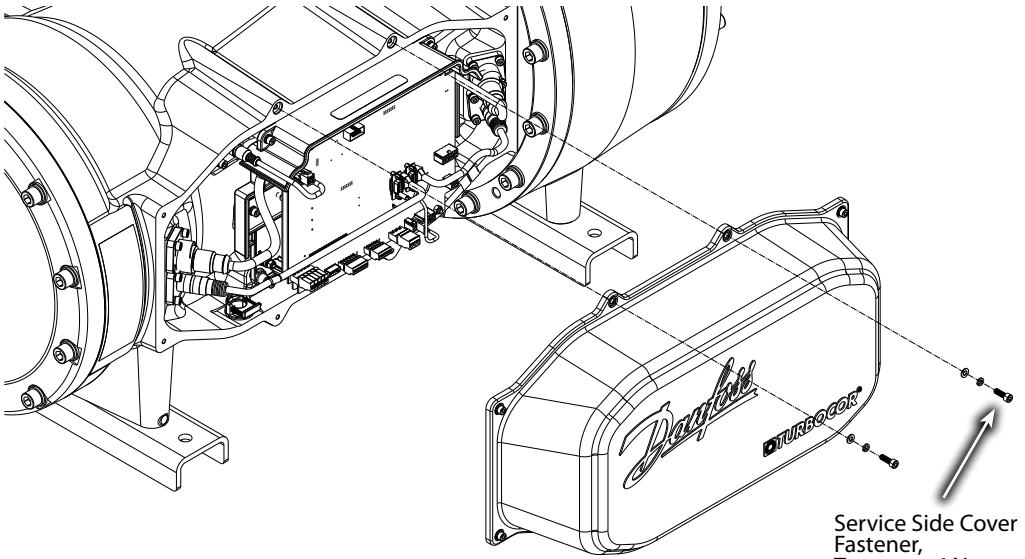
Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Tower Plate, M6x30	10	8	89
Motor Terminal Block to Compressor, SHCS, M5x20	6	5	53
Tower Feedthrough Nut, Brass, M16x1.5	20	15	177
Power Cable Nut, Brass, M10x1.5	10	7	89
Bus Bar Mounting, SHCS, M5x16	5	4	44
Motor Power Feedthrough, SHCS, M6x20	20	15	177

3.4 Service Side

3.4.1 Service Side Cover

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

Figure 3-68 Service Side Cover



3.4.1.1 Service Side Cover Removal and Installation

Service Side Cover Removal:

1. Remove the eight (8) M5x16 fasteners that hold the Service Side Cover in place.
2. 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 fasteners to secure the Service Side Cover.
5. Return the Compressor to normal operation.

3.4.1.2 Service Side Cover Torque Specifications

Table 3-20 Service Side Cover Torque Specifications

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

3.4.2 Front Bearing Power and Sensor Feedthroughs

The Front Bearing Power Feedthrough supplies power from the Pulse Width Modulation (PWM) to the front radial magnetic bearing actuators, while keeping refrigerant pressure from escaping. The Front Bearing Sensor Feedthrough supplies shaft position signals from the bearing sensors to the CCM, while keeping refrigerant pressure from escaping.

Figure 3-69 Front Bearing Sensor Feedthrough

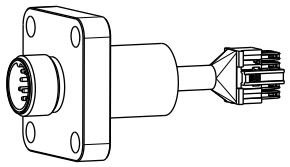
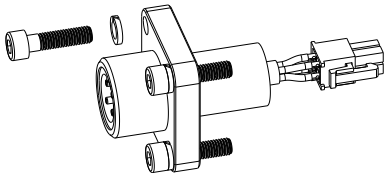


Figure 3-70 Front Bearing Power Feedthrough

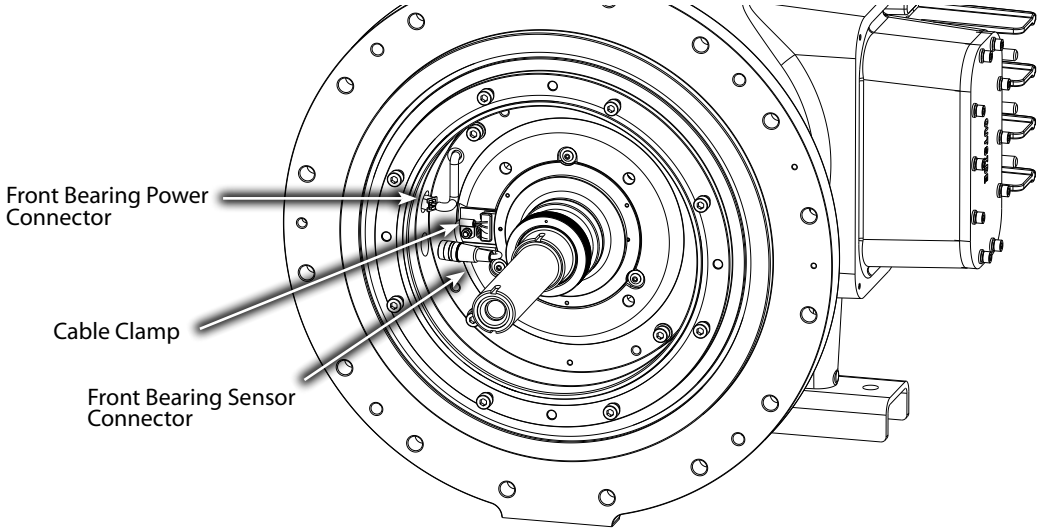


3.4.2.1 Front Bearing Power and Sensor Feedthrough Removal and Installation

Front Bearing Power and Sensor Feedthrough Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
3. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
4. For VTX Compressors continue to Step 5, otherwise continue to Step 6 for VTT Compressors.
5. Remove the IGV assembly and continue to Step 7. Refer to "3.6.3 IGV Housing Removal and Installation" on page 142.
6. Remove the IFV Assembly if applicable. Refer to "3.2.3 VTT IFV Pipe Assembly" on page 40.
7. Remove the Front Touchdown Bearing/Labyrinth Seal. Refer to "3.5.3 Front Touchdown Bearing/Labyrinth Seal" on page 113.
8. Release the internal cable tie from the Bearing Sensor Feedthrough cable.
9. Disconnect the internal connectors from the Front Bearing Sensor Feedthrough and the Front Bearing Power Feedthrough.

Figure 3-71 Front Bearing Feedthrough Internal Connectors



10. Disconnect the external bearing sensor cable from the feedthrough.
11. Remove the eight (8) M5 fasteners holding the feedthroughs to the housing.
12. Carefully remove both feedthroughs from the housing. Gently pull the internal connectors through the housing.
13. Remove the O-rings.

Front Bearing Power and Sensor Feedthrough 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 feedthrough O-rings and then fit them into the O-ring grooves.

Figure 3-72 Front Bearing Sensor Feedthrough

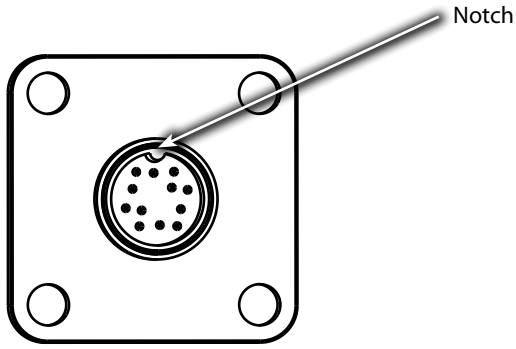
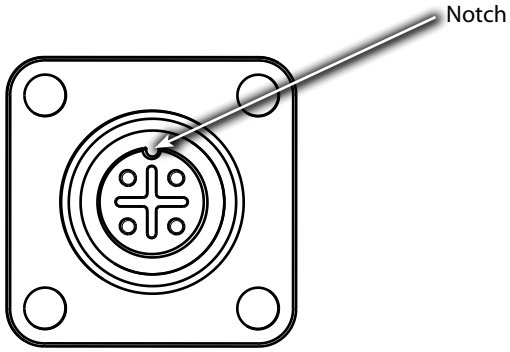


Figure 3-73 Front Bearing Power Feedthrough



3. Carefully insert both feedthroughs into the housing. Reconnect the internal connectors.
4. Install a new internal cable tie to secure the Bearing Sensor Feedthrough cable.
5. Install the eight (8) M5x20 feedthrough fasteners 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 feedthroughs.
7. Install the Touchdown Bearing/Labyrinth Seal Plate. Refer to "3.5.3 Front Touchdown Bearing/ Labyrinth Seal" on page 113 for the installation steps.
8. Install the Service Side Cover.
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.

3.4.3 Rear Bearing Power and Sensor Feedthroughs

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

Figure 3-74 Rear Bearing Sensor Feedthrough

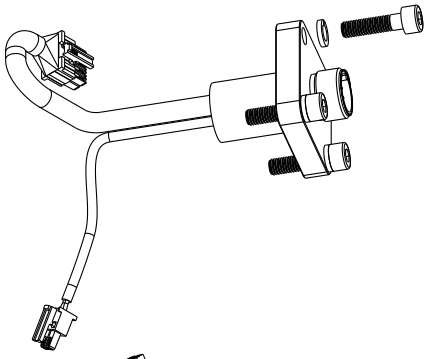
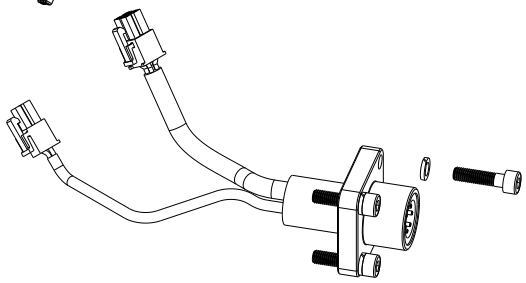


Figure 3-75 Rear Bearing Power Feedthrough

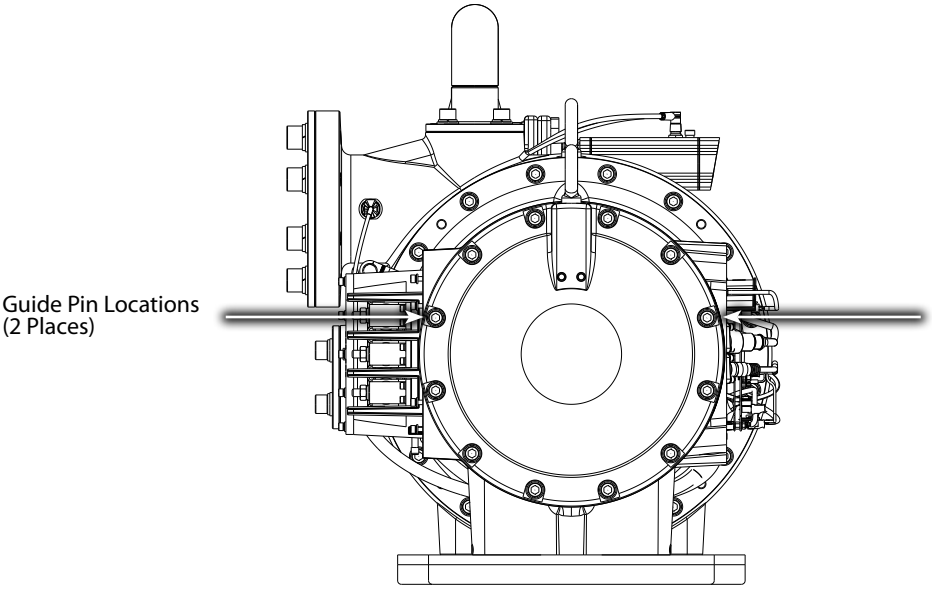


3.4.3.1 Rear Bearing Power and Sensor Removal and Installation

Rear Bearing Power and Sensor Feedthrough Removal:

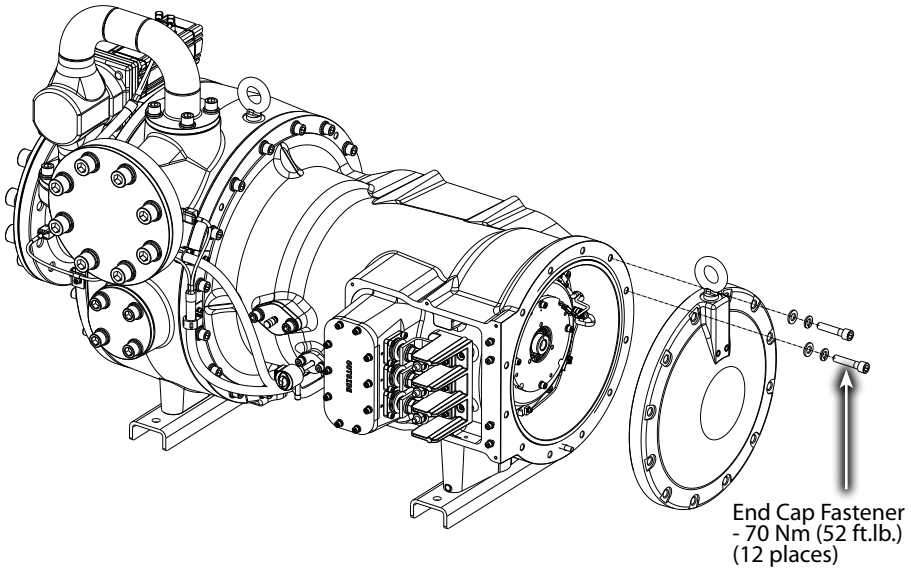
1. Remove the two (2) M12x55 fasteners located at the 10 o'clock and 2 o'clock positions on the End Cap.
2. Insert the Guide Pins in these locations (refer to "Figure C-2 - Guide Pin" on page 189 in Appendix B). Refer to "Figure 3-76 Guide Pin Locations" for the locations of the pins.

Figure 3-76 Guide Pin Locations



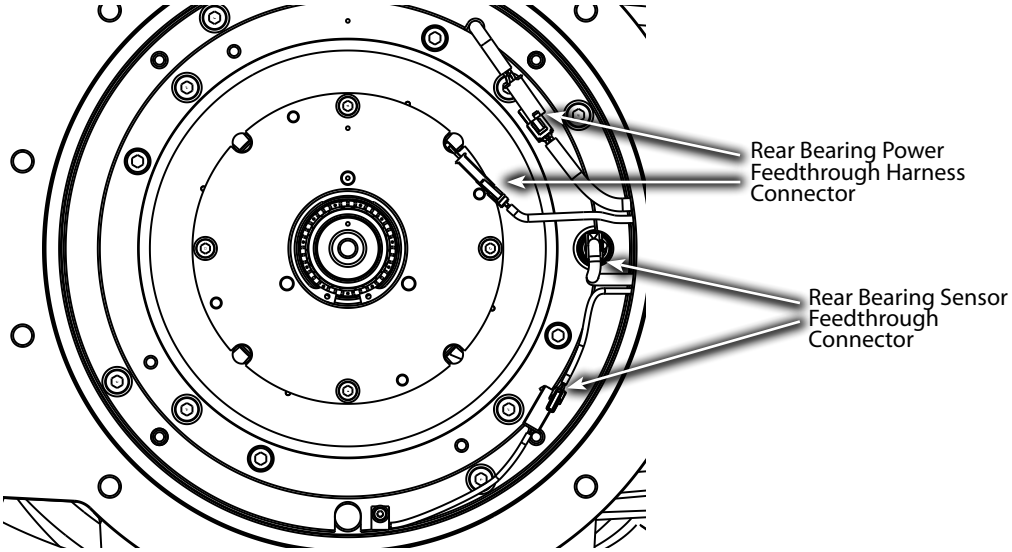
3. Remove remaining fasteners and use a rubber mallet to tap off the End Cap.
4. Gently slide the End Cap away from the Compressor housing and set aside the End Cap.

Figure 3-77 End Cap Removal



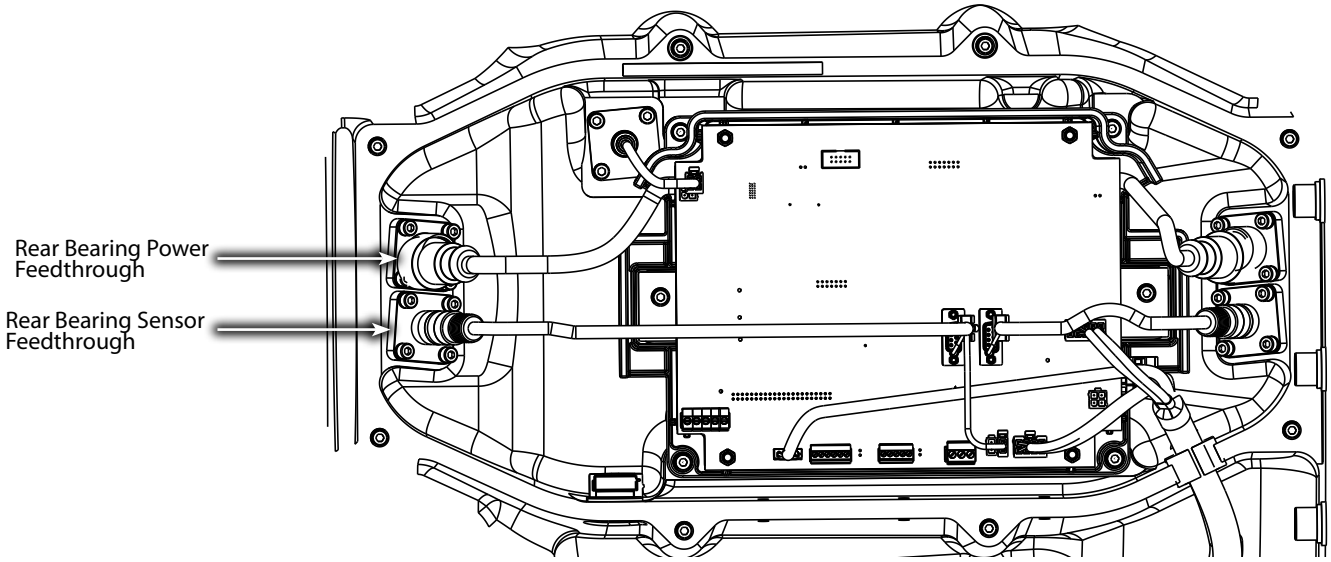
5. Disconnect the Rear Bearing Sensor and Rear Bearing Power connectors. Refer to "Figure 3-78 Rear Bearing Sensor and Rear Bearing Power Harness".

Figure 3-78 Rear Bearing Sensor and Rear Bearing Power Harness



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

Figure 3-79 Rear Feed Through Removal



Rear Bearing Power and Sensor Feedthrough Installation:

1. Verify all feedthrough contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new O-rings and then fit them into the O-ring grooves.
3. Orient the feedthroughs with the notch at the top as shown in "Figure 3-80 Rear Bearing Sensor Feedthrough" and "Figure 3-81 Rear Bearing Power Feedthrough".

Figure 3-80 Rear Bearing Sensor Feedthrough

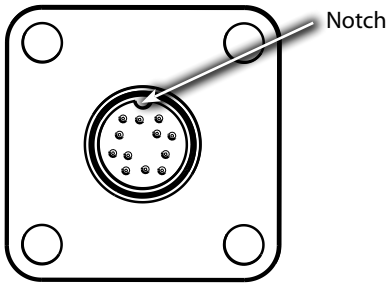
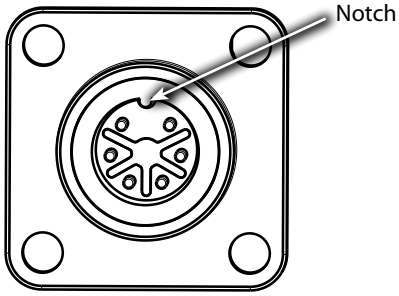


Figure 3-81 Rear Bearing Power Feedthrough



4. Carefully insert both feedthroughs into the housing and reconnect the internal connectors.
5. Install the eight (8) M5x20 feedthrough fasteners 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 feedthroughs.
7. Verify all End Cap contact surfaces are clean and dry. If not, clean with a lint-free cloth.
8. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove.
9. Insert two (2) Guide Pins into the 10 o'clock and 2 o'clock position.
10. Gently slide the End Cap into the Compressor housing.
11. Assemble all 12 of the M12x55 fasteners with the flat and lock washers.
12. Insert the fasteners in the available locations.
13. Remove the two (2) Guide Pins and insert the remaining fasteners.
14. Finger-tighten all 12 fasteners and ensure that the End Cap is seated evenly into the Compressor housing.
15. Tighten the 12 M5 fasteners 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.)
16. Install the Service Side Cover.
17. Leak test the Compressor to the appropriate pressure and industry standards.
18. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
19. Charge the Compressor with refrigerant.
20. Restore power to the Compressor.

3.4.3.1.1 Torque Specifications

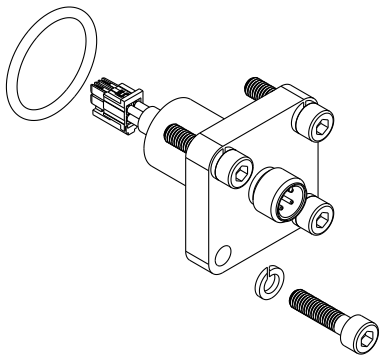
Table 3-21 Internal Components Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Rear Bearing Power Feedthrough, SHCS, M6x20	6	-	53
Rear Bearing Sensor Feedthrough, SHCS, M6x20	6	-	53
Stator Temperature Sensor Feedthrough, 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

3.4.3.2 Stator Temperature Sensor Feedthrough

The Stator temperature sensor feedthrough 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 3-82 Stator Temperature Sensor Feedthrough



3.4.3.2.1 Stator Temperature Sensor Feedthrough Removal

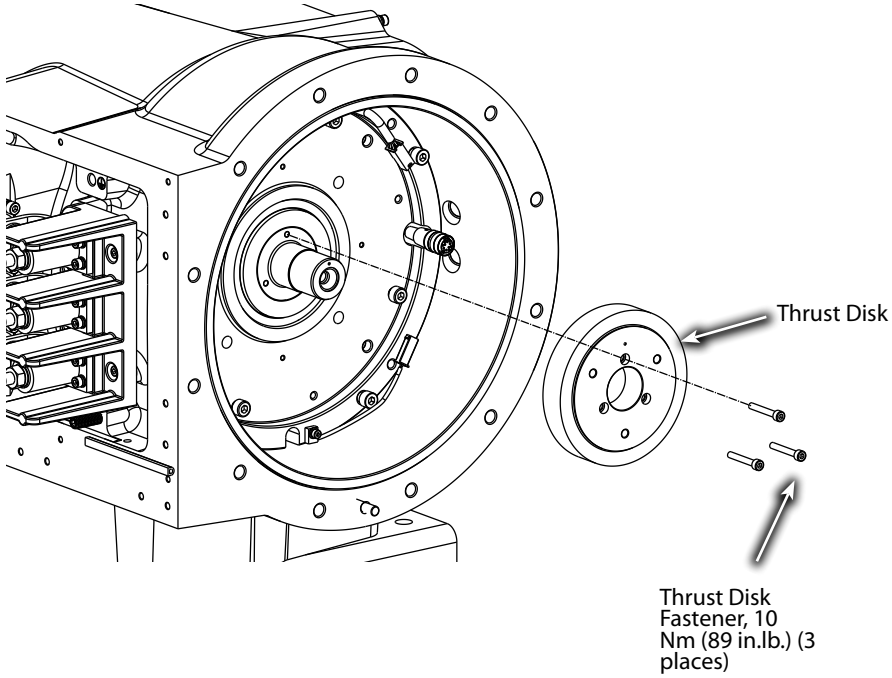
1. Prior to teardown, a bearing calibration must be performed. Using the SMT, perform a calibration and save to electrically erasable programmable read-only memory (EEPROM). Refer to "3.4.4.12.2 Verification" on page 102.
2. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
3. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
4. Remove the Service Side Cover Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
5. Disconnect the Stator temperature sensor cable from CCM J12.
6. Remove the Stator temperature sensor cable from the feedthrough.
7. Remove the Service Electronics Assembly. Refer to "3.4.4.1 Service Electronics Removal and Installation" on page 81.

8. Remove the Axial Bearing. Refer to "3.5.5 Axial Bearing" on page 130.
9. Remove the three (3) M5x35 fasteners that secure the Thrust Disk and carefully slide the Thrust Disk off the Compressor shaft. Refer to "Figure 3-83 Thrust Disk Removal".

⚠ • • • CAUTION • • •

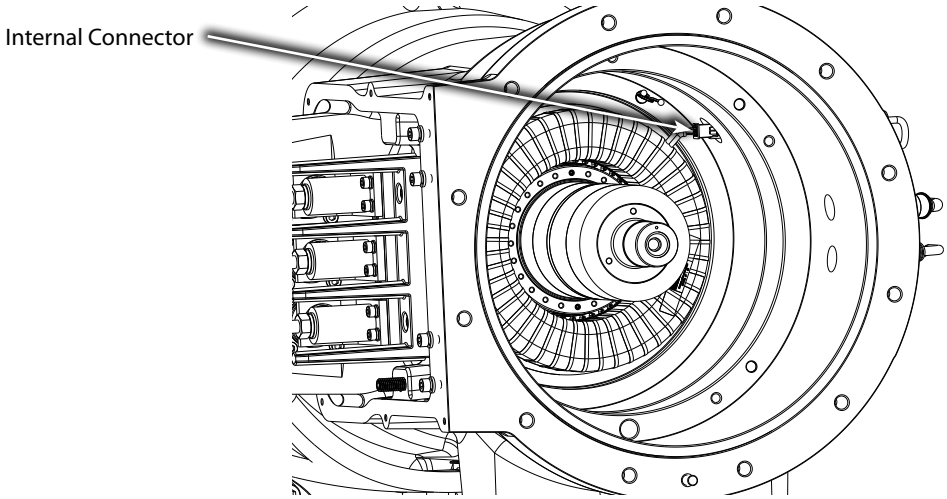
All magnetic parts MUST be separated and placed in individual bags that can be sealed to prevent contamination to the parts. Metal debris can and will lead to premature failure of the Compressor components.

Figure 3-83 Thrust Disk Removal



10. Remove the Rear Radial Bearing. Refer to "3.5.6 Rear Radial Bearing" on page 134.
11. Remove the fasteners holding the Stator Temperature Sensor Feedthrough to the housing.
12. Disconnect the Stator Temperature Sensor Feedthrough wire from the internal connector.
13. Carefully remove the Stator Temperature Sensor Feedthrough from the housing.

Figure 3-84 Stator Temperature Sensor Internal Connector

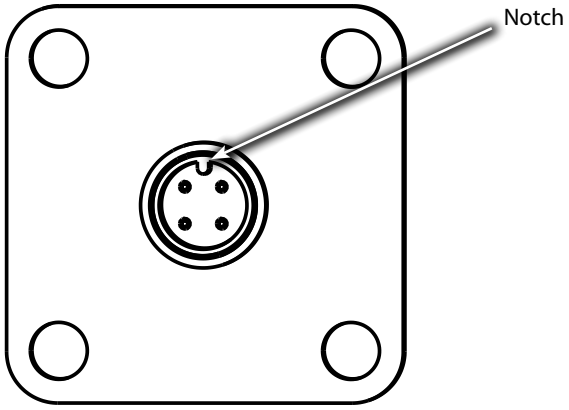


14. Remove the O-ring.

3.4.3.2.2 Stator Temperature Sensor Feedthrough Installation

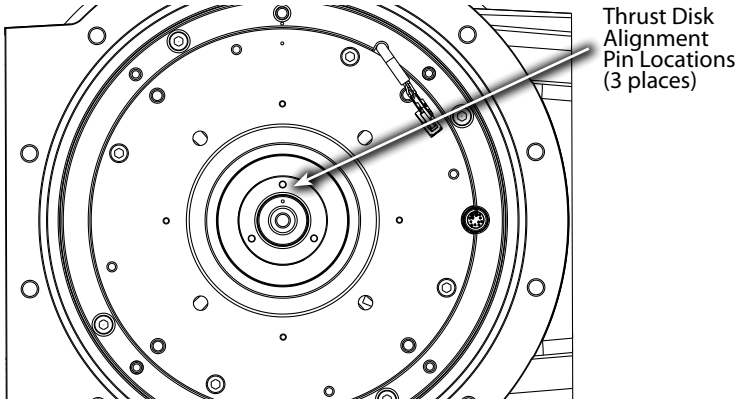
1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove on the Stator Temperature Sensor Feedthrough.
3. Carefully slide the connector into the housing and rotate until the internal notch in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

Figure 3-85 Stator Temperature Feedthrough Orientation



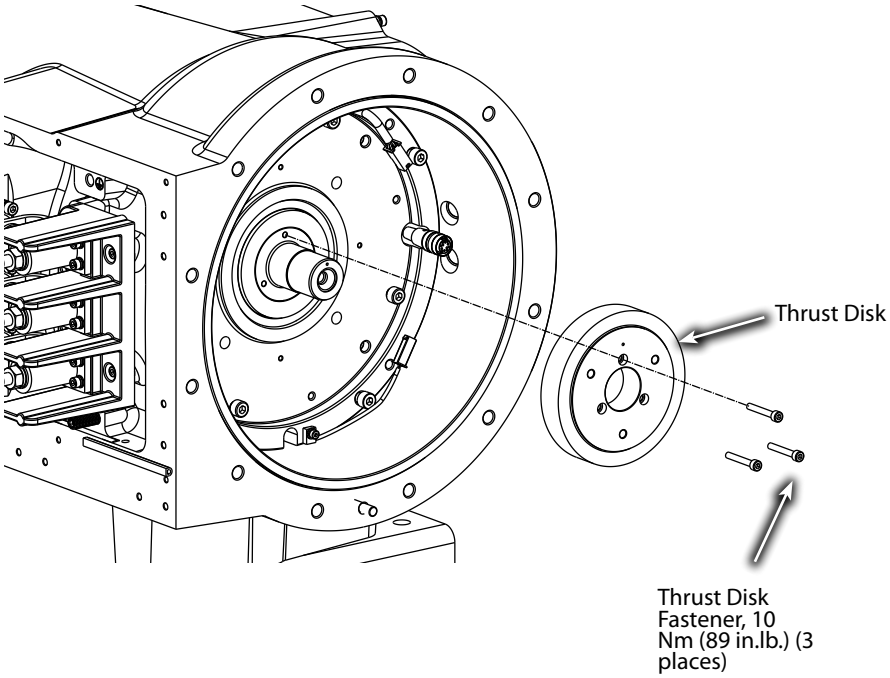
5. Verify the internal harness remains in the twist lock support. If not, reposition the harness into the twist lock support.
6. Install the four (4) M5 fasteners holding the Stator Temperature Sensor Feedthrough to the housing and tighten in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 3 Nm (26 in.lb.)
   - Stage 2: Tighten to a final torque of 6 Nm (53 in.lb.)
7. Install the Radial Bearing. Refer to "3.5.6 Rear Radial Bearing" on page 134 for this and the following step.
8. Insert at least two (2) Thrust Disk Alignment Pins into the threaded holes in the Compressor shaft. Refer to "Figure 3-187 Thrust Disk Alignment Pins" for the pin location. These pins are necessary due to the magnetized shaft.
9. Carefully slide the Thrust Disk into place over the Compressor shaft and align it with the inserted pins.
10. Remove all of the Thrust Disk Alignment Pins. Refer to "Figure 3-86 Thrust Disk Alignment Pins"

Figure 3-86 Thrust Disk Alignment Pins



11. Insert the three (3) M5x35 fasteners that secure the Thrust Disk and torque to 10 Nm (7 ft.lb.). Refer to "Figure 3-87 Thrust Disk Installation".

Figure 3-87 Thrust Disk Installation

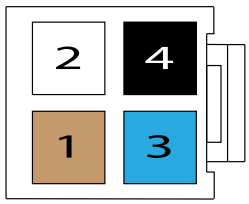


12. Install the Axial Bearing. Refer to "3.5.5 Axial Bearing" on page 130.
13. Install the Service Electronics Assembly. Refer to "3.4.4.1 Service Electronics Removal and Installation" on page 81.
14. Connect the Stator temperature sensor cable to the feedthrough.
15. Connect the Stator Temperature Sensor Feedthrough cable to CCM J12.
16. Install the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
17. Leak test and evacuate Compressor in accordance with standard industry practices.
18. Return the Compressor to normal operation.
19. Using the SMT, perform a calibration and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.

3.4.3.2.3 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 3-88 Stator Temperature Sensor Feedthrough 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.

NOTE

Both circuits are approximately 1.09kΩ at 22°C (72°F). Refer to "Table 3-29 Stator Thermistor R/T Curve" on page 106 for further values.

3.4.3.2.4 Stator Temperature Sensor Feedthrough Torque Specifications

Table 3-22 Stator Temperature Sensor Feedthrough Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Service Electronics Assembly Fastener	6	-	53
Service Electronics Ground Wires at Left and 250 VDC Ground Wire at Right	6	-	53
Stator Temperature Sensor Feedthrough, SHCS, M5x20	6	-	53

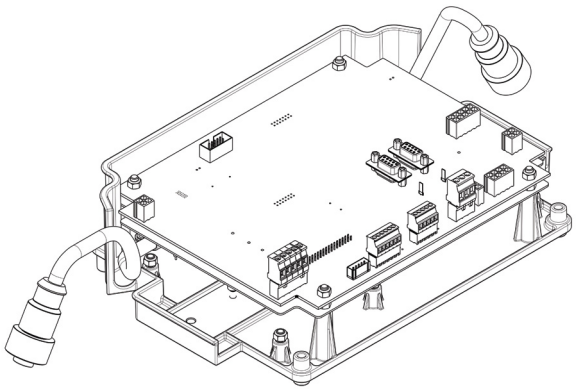
3.4.4 VTT/VTX Service Electronics Assembly

The VTT/VTX Service Electronics is an assembly that includes the CCM and PWM Amplifier.

NOTE

The Service Electronics for the VTX is the same design as the Major Revision "C" VTT Compressors.

Figure 3-89 VTT/VTX Service Electronics Assembly



⚠ • • • CAUTION • • •

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

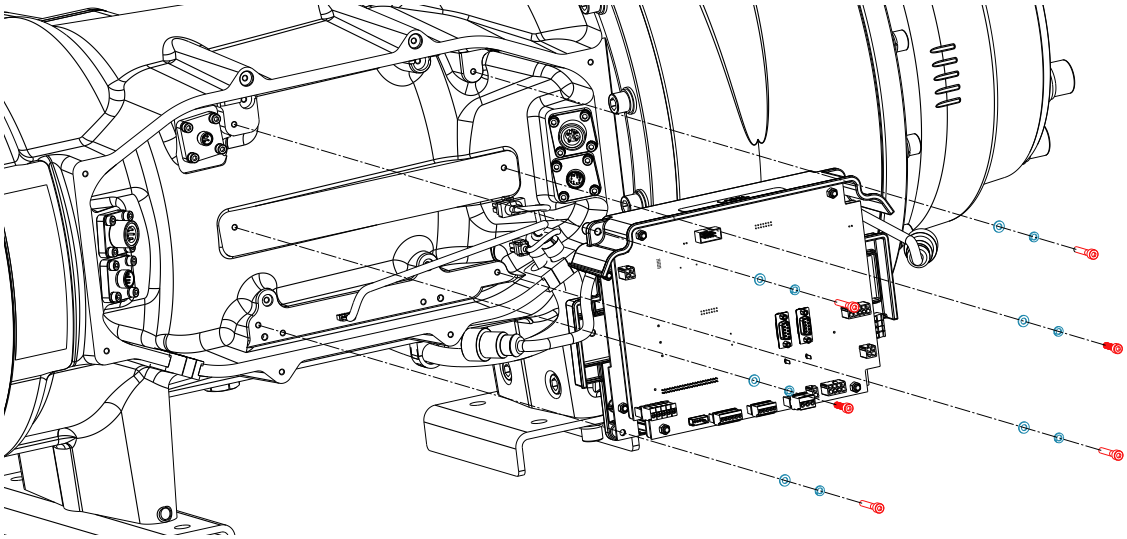
The CCM and PWM Boards cannot be serviced separately, therefore the VTT/VTX Service Electronics Assembly will need to be replaced should there be a fault with either the CCM or the PWM.

3.4.4.1 Service Electronics Removal and Installation

Service Electronics Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Disconnect the power and communications cables from the CCM and PWM.
4. Disconnect all cables going to the VTT/VTX Service Electronics Assembly.
5. Remove the PWM heat sink fasteners and ground wires (if applicable).
6. Remove the fasteners that secure the VTT/VTX Service Electronics Assembly plastic frame to the main housing and then remove the VTT/VTX Service Electronics Assembly.

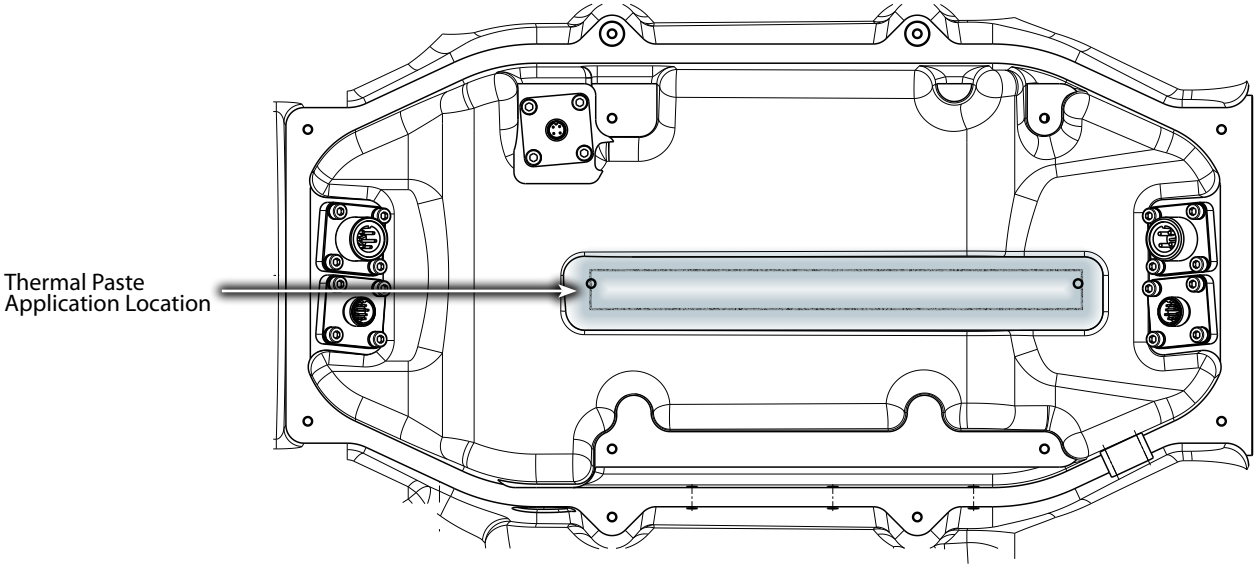
Figure 3-90 Service Electronics Removal



VTT/VTX 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 3-91 Thermal Paste Application".

Figure 3-91 Thermal Paste Application



2. Attach the VTT/VTX Service Electronics Assembly to the main housing using two (2) fasteners 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) M5x30 fasteners into the VTT/VTX Service Electronics Assembly and torque to 6 Nm (53 in.lb.).
4. Torque the two (M5x20) heat sink fasteners and torque to 6 Nm (53 in.lb.).
5. Reconnect the power and communication cables to the CCM and PWM.
6. Return the Compressor to normal operation.
7. If replacing the Service Electronics Assembly, perform a calibration with the SMT and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.

3.4.4.2 CCM

3.4.4.3 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 (VTT)
- IGV Control (VTX)
- 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 3-92 CCM (VTT Revision C)

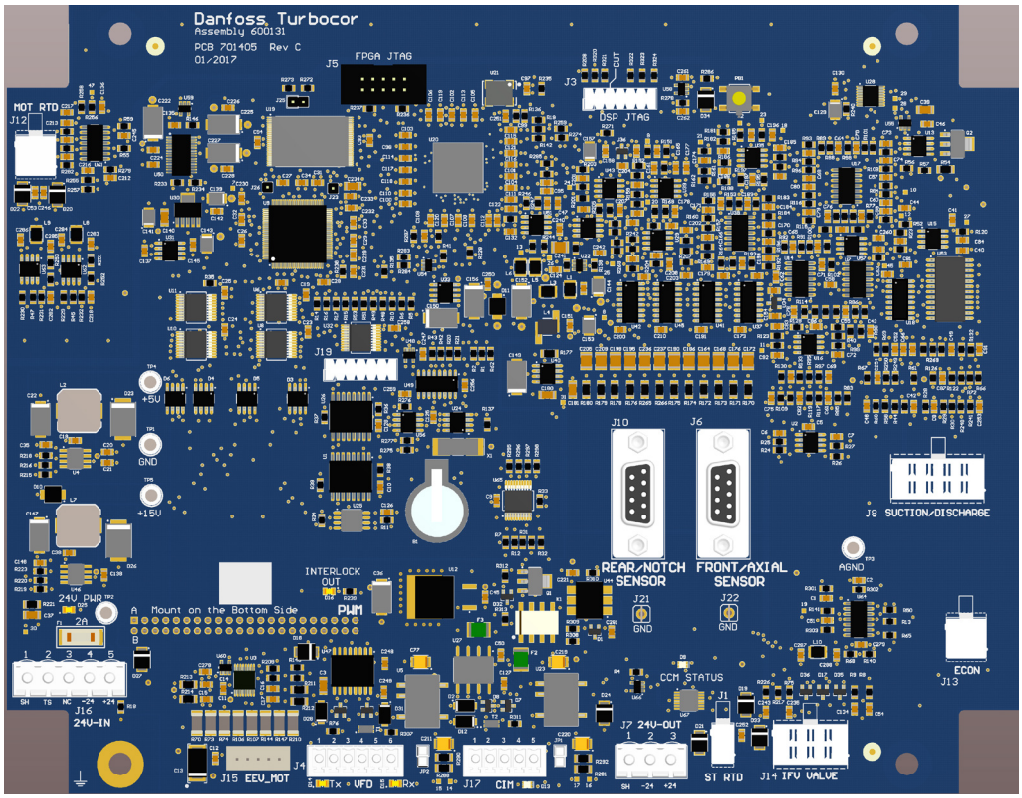
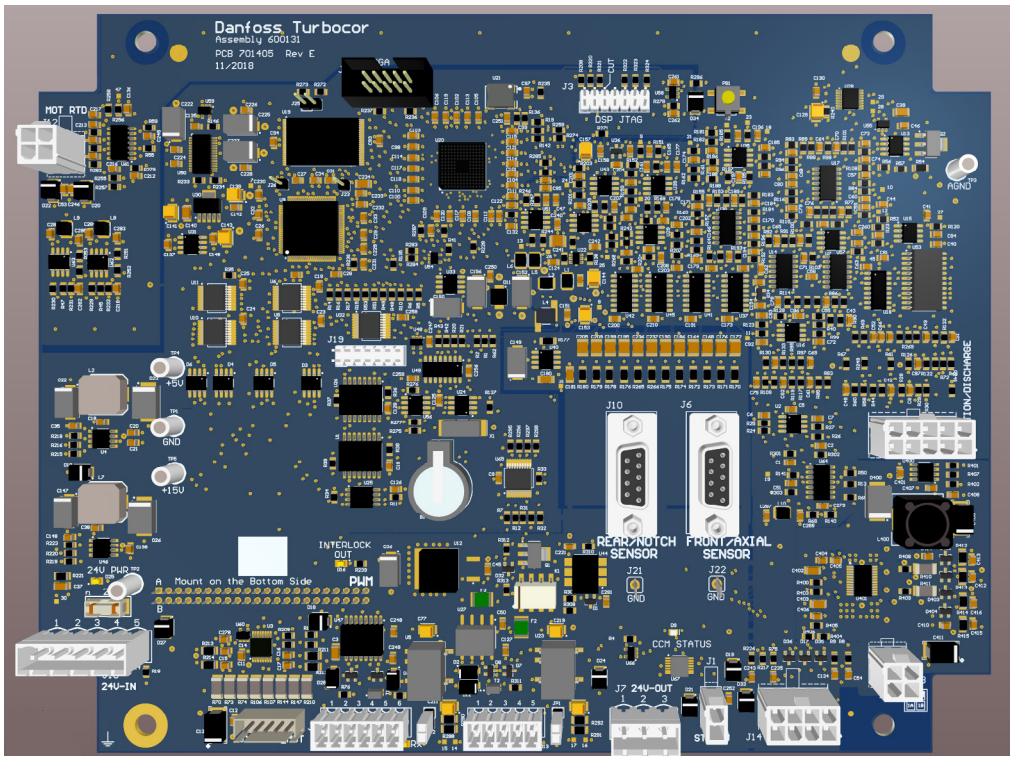


Figure 3-93 CCM (VTX)



The CCM receives 24 VDC from the High Voltage (HV) DC-DC and then converts that voltage to 5 Volts Direct Current (VDC) and 15 VDC.

3.4.4.3.1 CCM Battery and Verification

All CCMs include a real-time clock integrated circuit (RTC-IC) for the purpose of maintaining the time and date of Compressor events. While power is applied to the Compressor, the CCM receives a 5V supply to power the RTC-IC. The battery becomes the RTC-IC power supply and maintains the date and time only when power is not applied to the CCM.

The backup battery does not affect the operation of the Compressor in any way, shape, or form nor does it have any adverse effects on the software within the CCM. In fact, the only way to know if the battery may be defective is to verify the correct time was kept after the CCM lost its 5V supply for whatever reason.

Battery Safety

• • • DANGER! • • •

Please follow the safety warnings listed in this section.

The battery used in the CCM is a coin type lithium style. The part number is BR1225. This battery is not sold by Danfoss LLC but can be locally sourced at most stores that sell coin-type batteries.

Please observe the following safety warnings:

- Verify the battery is properly installed ("+" side facing up, away from the printed circuit board).
- Do not attempt to charge the battery.
- Do not deform, short, or heat up the battery.
- Keep the battery away from small children and pets. A physician should be contacted immediately if the battery is swallowed.
- Wrap insulating tape, such as electricians tape, around the battery prior to disposal.
- Always refer to local requirements in your area to ensure the battery is properly disposed.

Defective Battery Symptoms

If the CCM battery is good and no CCM problems exist, the CCM will retain the current time after a power cycle. However, if after syncing the CCM time with the current time from the computer that is connected to the CCM, the CCM does not retain the current time after a power cycle, the battery may need to be replaced.

If a new battery does not resolve the problem, the CCM should be replaced.

⚠ • • • CAUTION • • •

The VTT/VTX Electronics are sensitive to ESD, which can render the assembly useless. When attempting to verify the condition of the backup battery, refer to section "1.8 Handling Electronic Static Sensitive Devices" on page 18.

Set the multimeter for voltage measurements and place the red (+) probe on the battery itself (top) and the black (-) probe on the ground test point #1 shown in "Figure 3-94 CCM Electrical Connections and Test Points (VTT Revision C)".

The measurement should be between 2.85V and 3.15V.

NOTE

This should only be performed when warranty has expired.

3.4.4.3.2 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 (only used on VTT)
- J13 – Economizer EEV (if available) – lower right
- J8 – Suction/Discharge P/T sensors – mid right
- J18 - IGV - Bottom right (only used on VTX)

Figure 3-94 CCM Electrical Connections and Test Points (VTT Revision C)

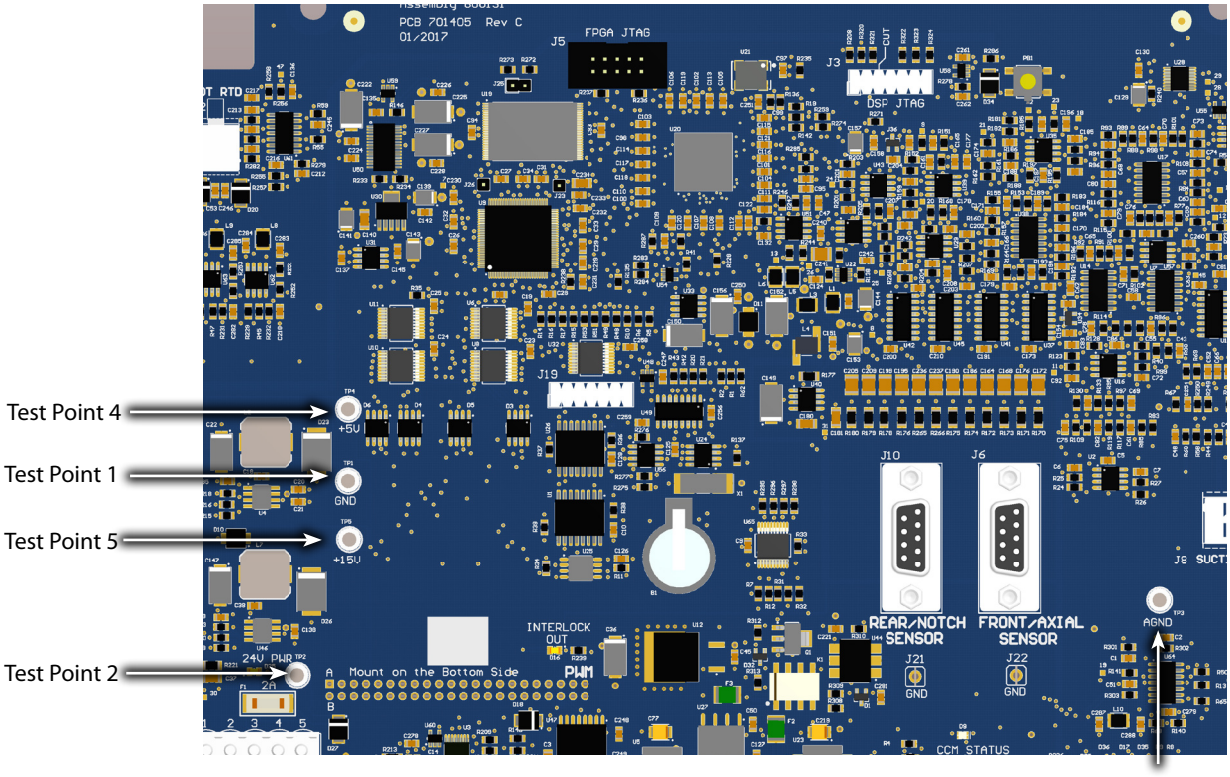
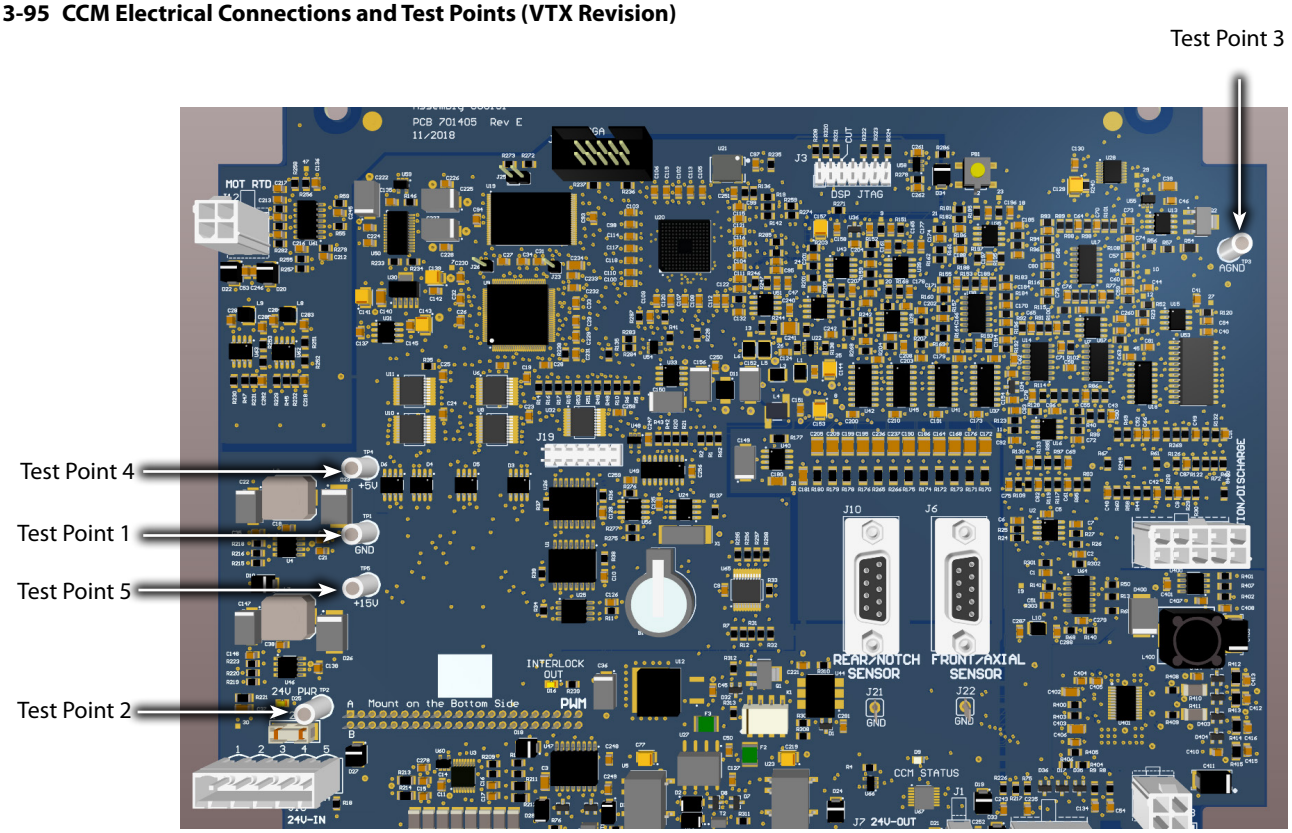


Figure 3-95 CCM Electrical Connections and Test Points (VTX Revision)



3.4.4.4 CCM-CIM 24V Cable

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

NOTE

Some VTX Compressors use Ferrite Chokes in order to be CE Compliant. When used, there are a total of five installed with one installed around all five of the communications cables and the remaining four around all except for the CCM-CIM CAN Cable assembly. Refer to "Figure 3-96 Ferrite Choke Locations" for an approxminate placement location for the Ferrite Chokes.

Figure 3-96 Ferrite Choke Locations

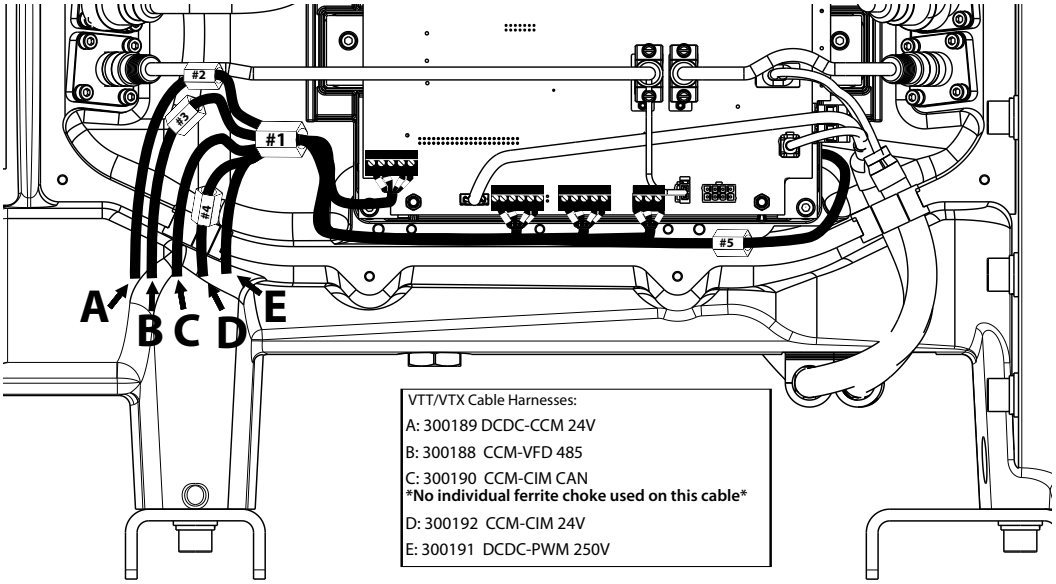
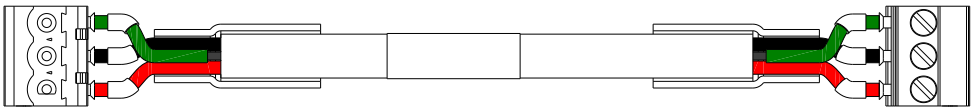


Figure 3-97 CCM-CIM 24V Cable

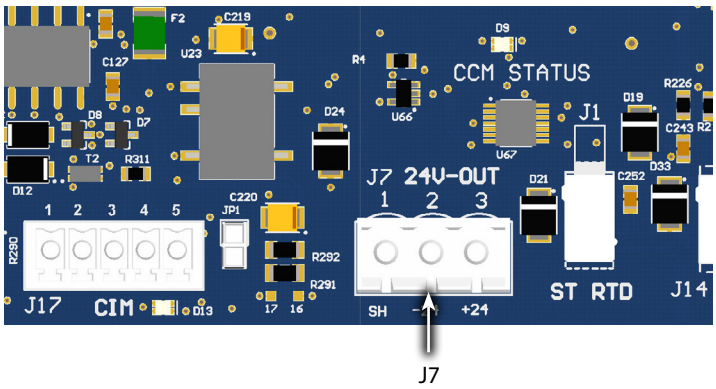


3.4.4.4.1 CCM-CIM 24V Cable Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Locate J7 on the CCM Board and unplug the connector.

Figure 3-98 CCM J7 Connector



4. Remove the cover to the controls panel where the CIM is located.
5. Remove the 24 VDC connector from the CIM.
6. If there are Ferrite Chokes installed, remove the individual Ferrite Choke from the CCM-CIM 24V Cable and remove the other Ferrite Choke that is clamped around all of the cables. Refer to "Figure 3-99 Ferrite Choke" for an example of the Ferrite Chokes. Once removed, place the Ferrite Chokes in a safe location so they can be re-installed.

Figure 3-99 Ferrite Choke

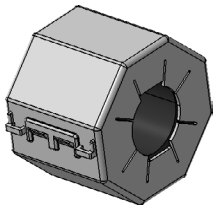
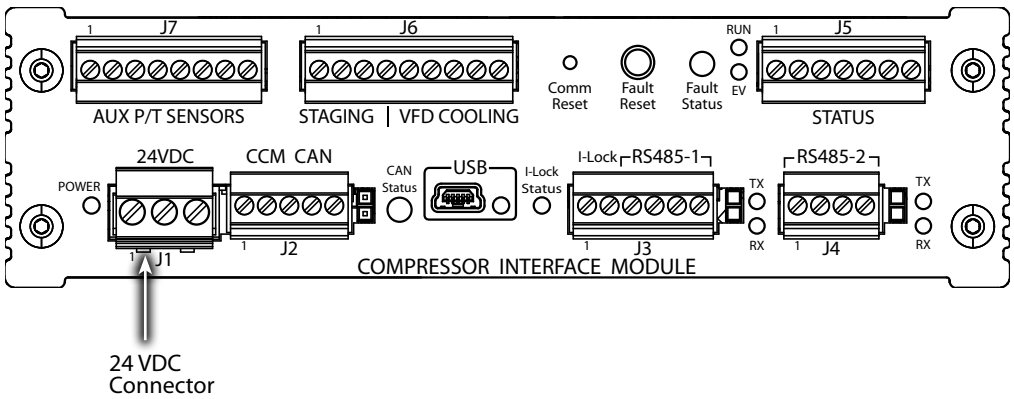


Figure 3-100 24 VDC Connector at CIM



7. 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. Install both Ferrite Chokes (if previously removed) and ensure they snap closed.
5. Replace the covers. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55 and "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
6. Return the Compressor to normal operation.

3.4.4.4.2 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.

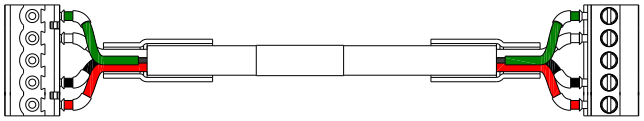
3.4.4.5 DC-DC-CCM 24V Cable

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

NOTE

Some VTX Compressors use Ferrite Chokes in order to be CE Compliant. When used, there are a total of five installed with one installed around all five of the communications cables and the remaining four around all except for the CCM-CIM CAN Cable assembly. Refer to "Figure 3-96 Ferrite Choke Locations" on page 86 for an approxminate placement location for the Ferrite Chokes.

Figure 3-101 DC-DC-CCM 24V Cable

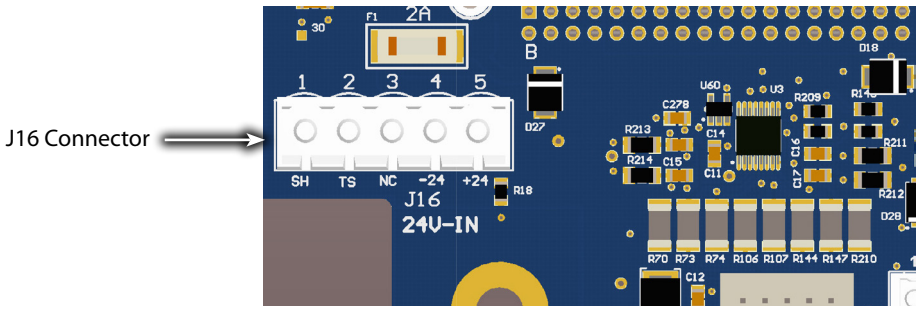


3.4.4.5.1 DC-DC-CCM 24V Cable Removal and Installation

Removal:

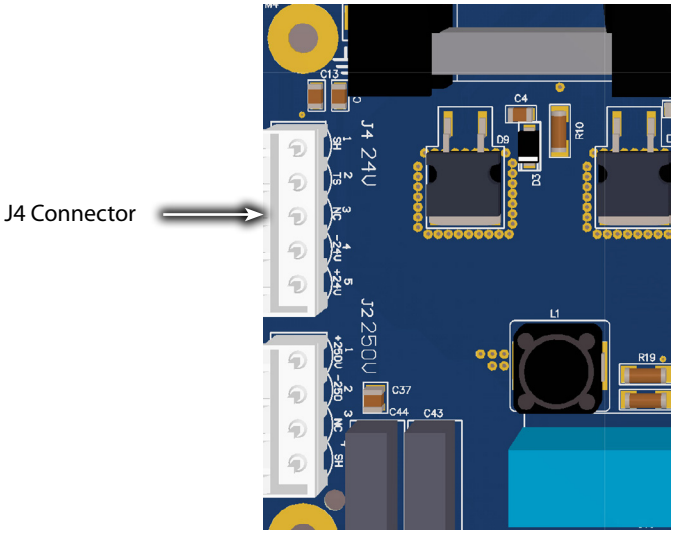
1. Isolate the Compressor and VFD power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Disconnect the J16 connector from the CCM Board.

Figure 3-102 J16 Connector



4. Remove J4 from the DC-DC Board.
5. If there are Ferrite Chokes installed, remove the individual Ferrite Choke from the DC-DC-CCM 24V Cable and remove the other Ferrite Choke that is clamped around all of the cables. Refer to "Ferrite Choke" on page 87 for an example of the Ferrite Chokes. Once removed, place the Ferrite Chokes in a safe location so they can be re-installed.

Figure 3-103 J4 Connector



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

Installation:

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. Insert the connector onto the DC-DC Board at 24 VDC (J4).
4. Secure the cables in place.
5. Install both Ferrite Chokes (if previously removed) and ensure they snap closed.
6. Install the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
7. Return the Compressor to normal operation.

3.4.4.5.2 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.

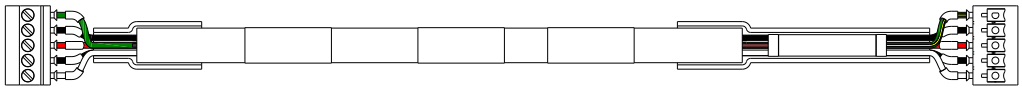
3.4.4.6 CCM-CIM CAN Cable

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

NOTE

Some VTX Compressors use Ferrite Chokes in order to be CE Compliant. When used, there are a total of five installed with one installed around all five of the communications cables and the remaining four around all except for the CCM-CIM CAN Cable assembly. Refer to "Figure 3-96 Ferrite Choke Locations" on page 86 for an approxminate placement location for the Ferrite Chokes.

Figure 3-104 CCM-CIM CAN Cable

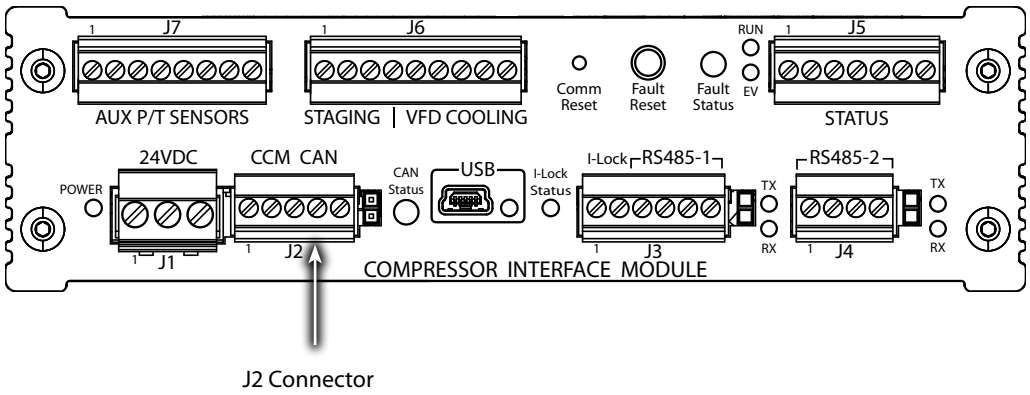


3.4.4.6.1 CCM-CIM CAN Cable Removal and Installation

Removal:

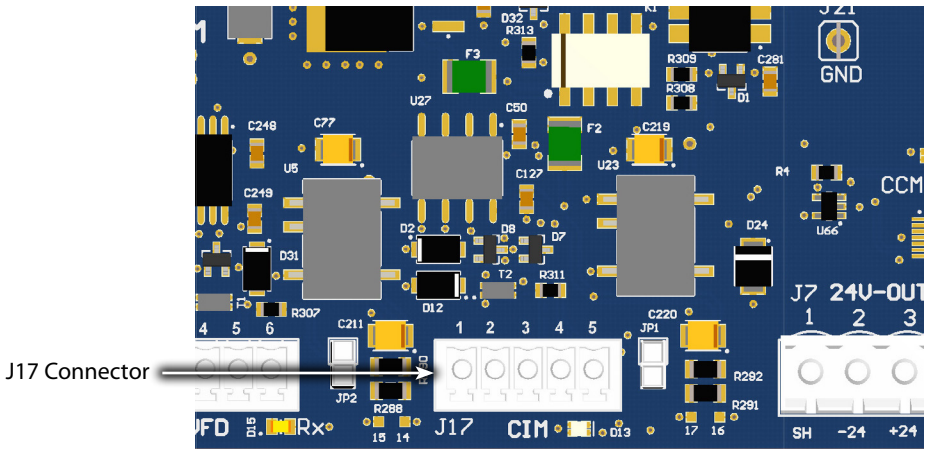
1. Isolate the Compressor and VFD power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the cover to the controls panel.
3. Disconnect the J2 CCM controller area network (CAN) terminals from the CIM. Refer to "Figure 3-105 J2 Connection at CIM" on page 90.

Figure 3-105 J2 Connection at CIM



4. Remove the Compressor Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
5. Disconnect the J17 connector from the CCM Board.
6. If there are Ferrite Chokes installed, remove the Ferrite Choke that is clamped around all of the cables. Refer to "Figure 3-99 Ferrite Choke" for an example of the Ferrite Chokes. Once removed, place the Ferrite Choke in a safe location so it can be re-installed.
7. Remove the cable between the CIM and the CCM Boards.

Figure 3-106 J17



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. Install the Ferrite Choke (if previously removed) around all of the cables and ensure it snaps closed.
6. Reinstall the covers. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55 and "3.4.1.1 Service Side Cover Removal and Installation" on page 69.

7. Return the Compressor to normal operation.
8. Verify proper operation.

3.4.4.6.2 CCM-CIM CAN 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.

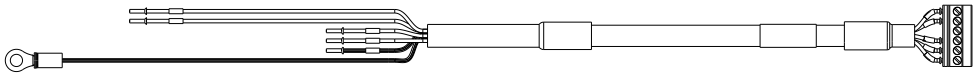
3.4.4.7 CCM-VFD Cable

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

NOTE

Some VTX Compressors use Ferrite Chokes in order to be CE Compliant. When used, there are a total of five installed with one installed around all five of the communications cables and the remaining four around all except for the CCM-CIM CAN Cable assembly. Refer to "Figure 3-96 Ferrite Choke Locations" on page 86 for an approxminate placement location for the Ferrite Chokes.

Figure 3-107 CCM-VFD Cable

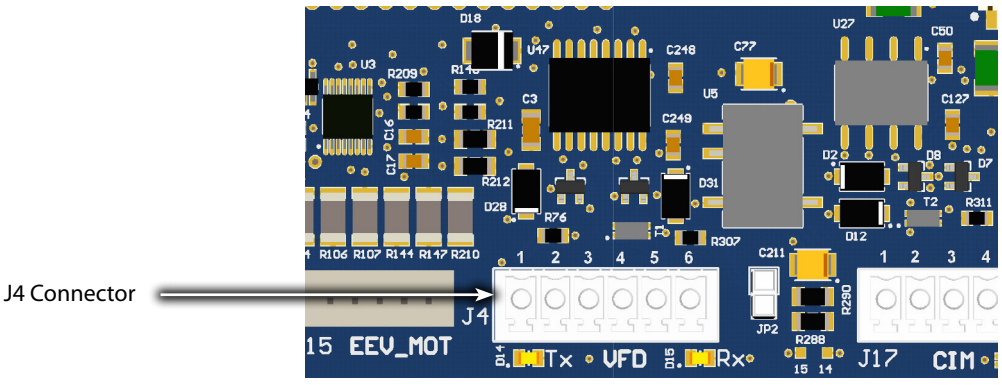


3.4.4.7.1 CCM-VFD Cable Removal and Installation

Removal:

1. Isolate the Compressor and VFD power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Compressor Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Remove the connector J4 from the CCM.

Figure 3-108 J4 Connector



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

Figure 3-109 Terminal Identification

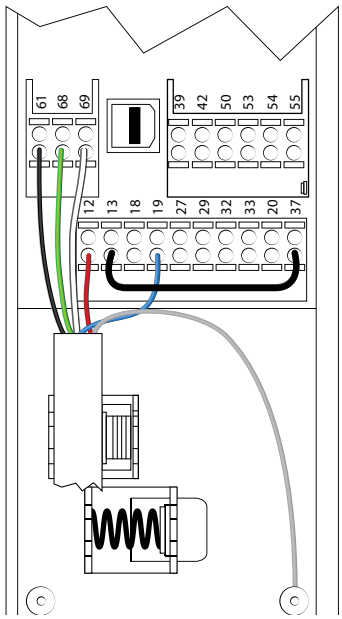


Table 3-23 Terminal to Wire Color

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

6. If there are Ferrite Chokes installed, remove the individual Ferrite Choke from the CCM-VFD Cable and remove the other Ferrite Choke that is clamped around all of the cables. Refer to "Ferrite Choke" on page 87 for an example of the Ferrite Chokes. Once removed, place the Ferrite Chokes in a safe location so they can be re-installed.
7. 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. Install both Ferrite Chokes (if previously removed) and ensure they snap closed.
5. Replace the covers. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
6. Return the Compressor to normal operation.

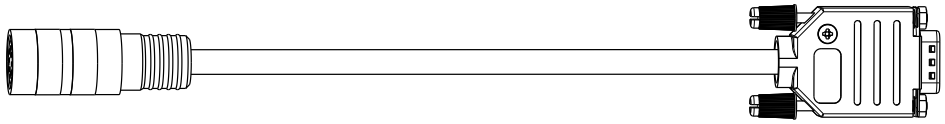
3.4.4.7.2 CCM-VFD Cable Verification

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.

3.4.4.8 Front Bearing Sensor Cable

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

Figure 3-110 Front Bearing Sensor Cable

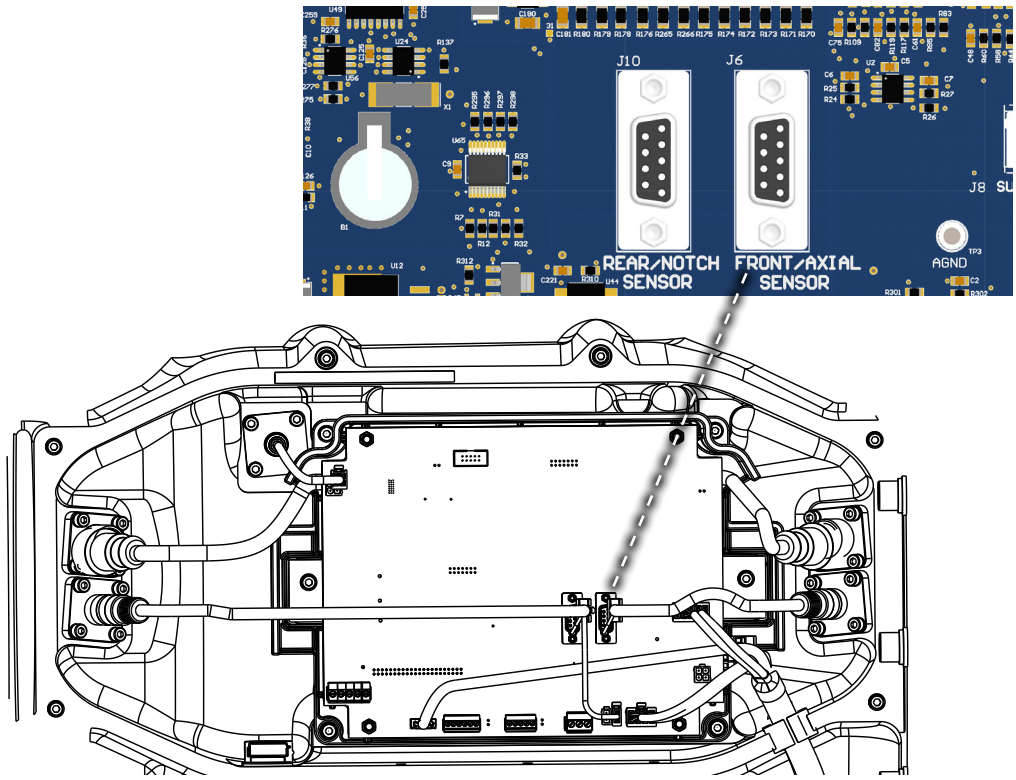


3.4.4.8.1 Front Bering Sensor Cable Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Remove the 9-pin connector from J6 on the CCM Board.
4. Twist and pull to remove the sensor cable connection from the feedthrough.

Figure 3-111 Front Bearing Sensor Connections



Installation:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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 feedthrough.

4. Install the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
5. Return the Compressor to normal operation.

3.4.4.8.2 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 3-24 Front Bearing Sensor Pin Verification" for the resistance specifications. Refer to "Figure 3-112 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 feedthrough. Refer to "Figure 3-113 Feedthrough Connector" on page 95 for the pinout.
3. If the results still do not match the listed specifications, the feedthrough will need to be tested for continuity. Refer to "3.4.2 Front Bearing Power and Sensor Feedthroughs" on page 70 for details on how to remove the feedthrough.

Table 3-24 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	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 3-112 9-Pin Connector

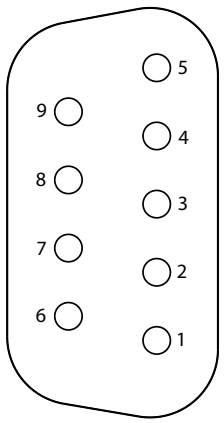
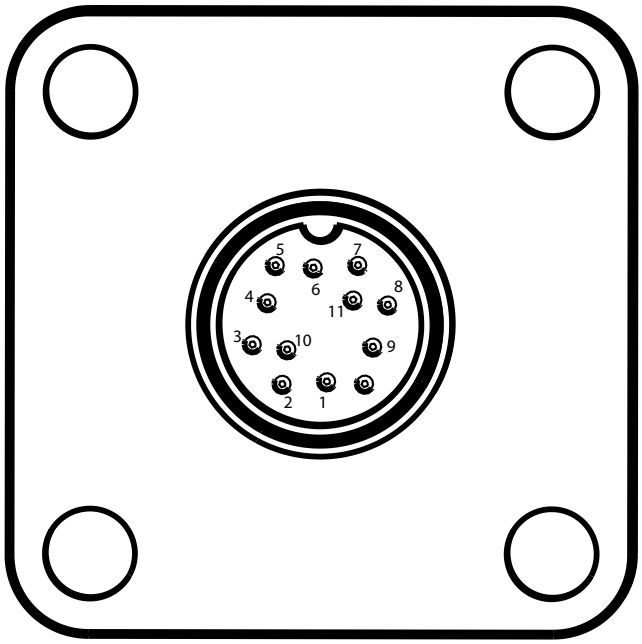


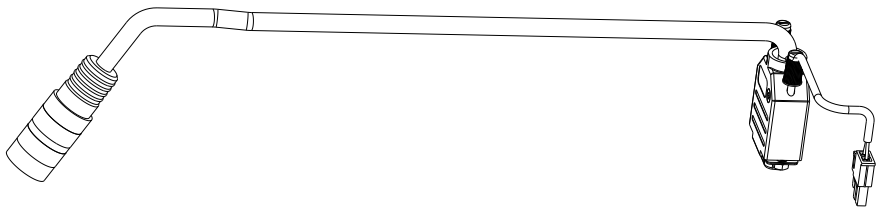
Figure 3-113 Feedthrough Connector



3.4.4.9 Rear Bearing Sensor Cable

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

Figure 3-114 Rear Bearing Sensor Cable

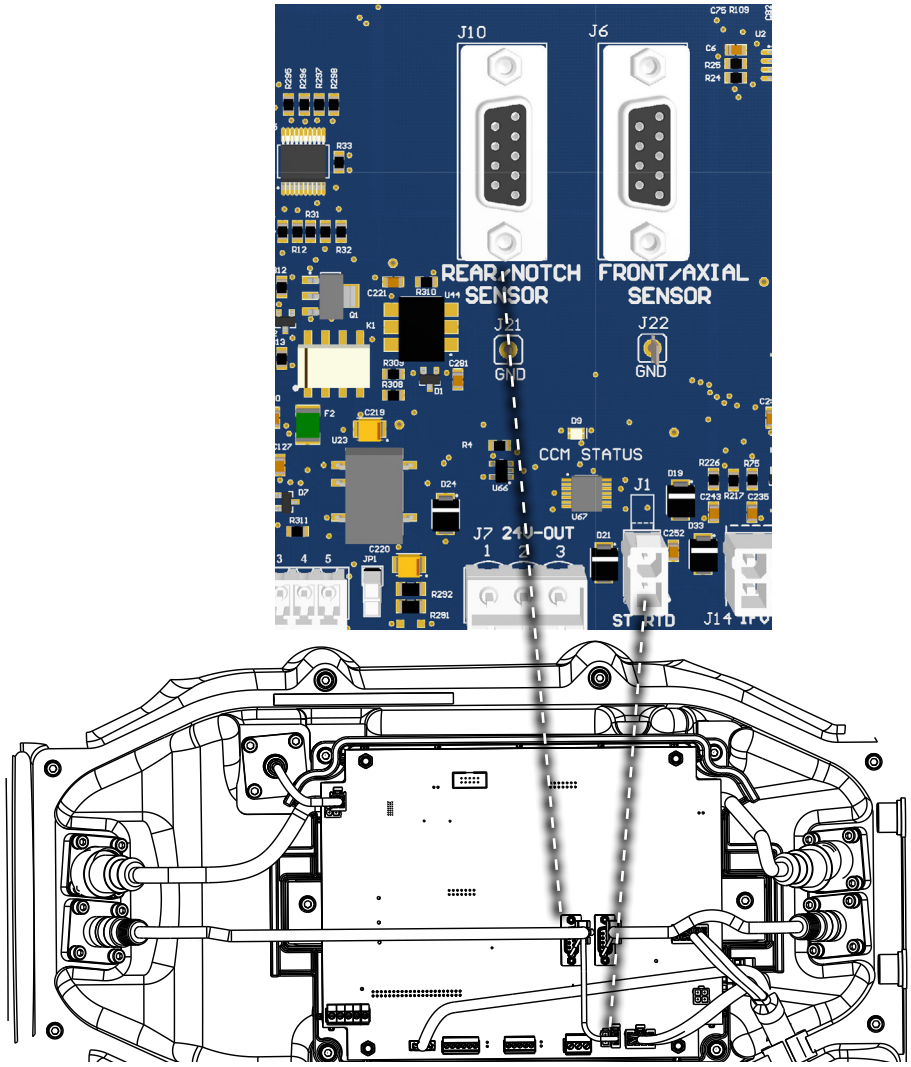


3.4.4.9.1 Rear Bearing Sensor Cable Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
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 feedthrough.

Figure 3-115 Rear Bearing Sensor Connections



Installation:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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 feedthrough.
5. Install the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
6. Return the Compressor to normal operation.

3.4.4.9.2 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 3-25 Rear Bearing Sensor Pin Verification" on page 97 for the resistance specifications. Refer to "Figure 3-116 9-Pin Connector" on page 97 for the pinout.
2. If the results do no match the specifications listed, remove the cable and check the resistances at the feedthrough. Refer to "Figure 3-117 Feedthrough Connector" on page 97 for the pinout.
3. If the results still do not match the listed specifications, the feedthrough will need to be tested for continuity. Refer to "3.5.5 Axial Bearing" on page 130 for details on how to remove the feedthrough.

Table 3-25 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	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 3-116 9-Pin Connector

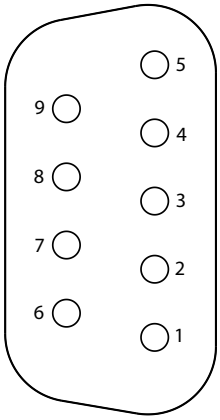
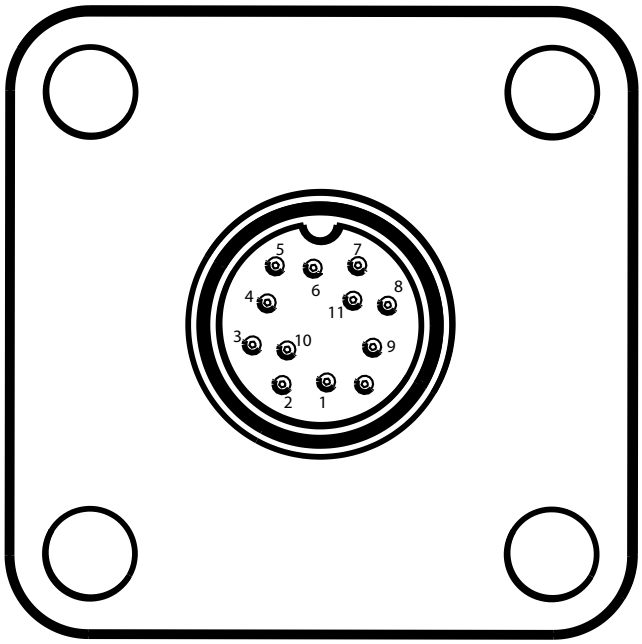


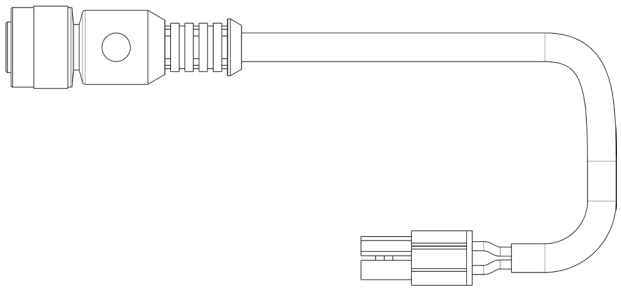
Figure 3-117 Feedthrough Connector



3.4.4.10 Stator Temperature Sensor Cable

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

Figure 3-118 Stator Temperature Sensor Cable

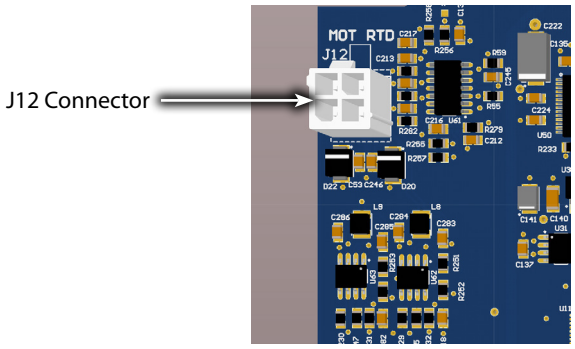


3.4.4.10.1 Stator Temperature Sensor Cable Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Locate and remove the connector from MOT RTD (J12) located on the top-left corner of the CCM Board.

Figure 3-119 CCM J12 Connection



4. Locate the feedthrough for the motor temp sensor and remove the connector.

Installation:

1. Install the sensor cable onto the feedthrough.
2. Attach the connector to MOT RTD (J12) on the CCM Board.
3. Install the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
4. Return the Compressor to normal operation.

3.4.4.10.2 Stator 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 3-26 CCM Test Point Values" on page 99.

Figure 3-120 CCM Test Point Values

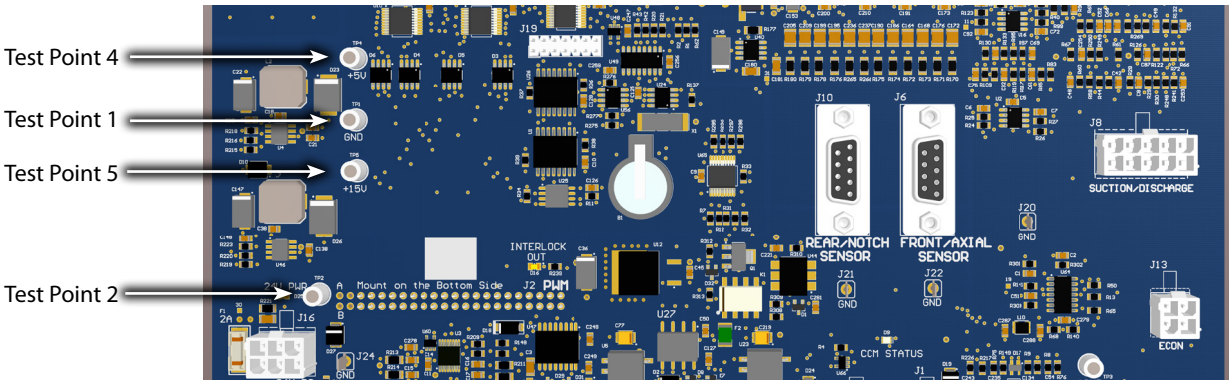


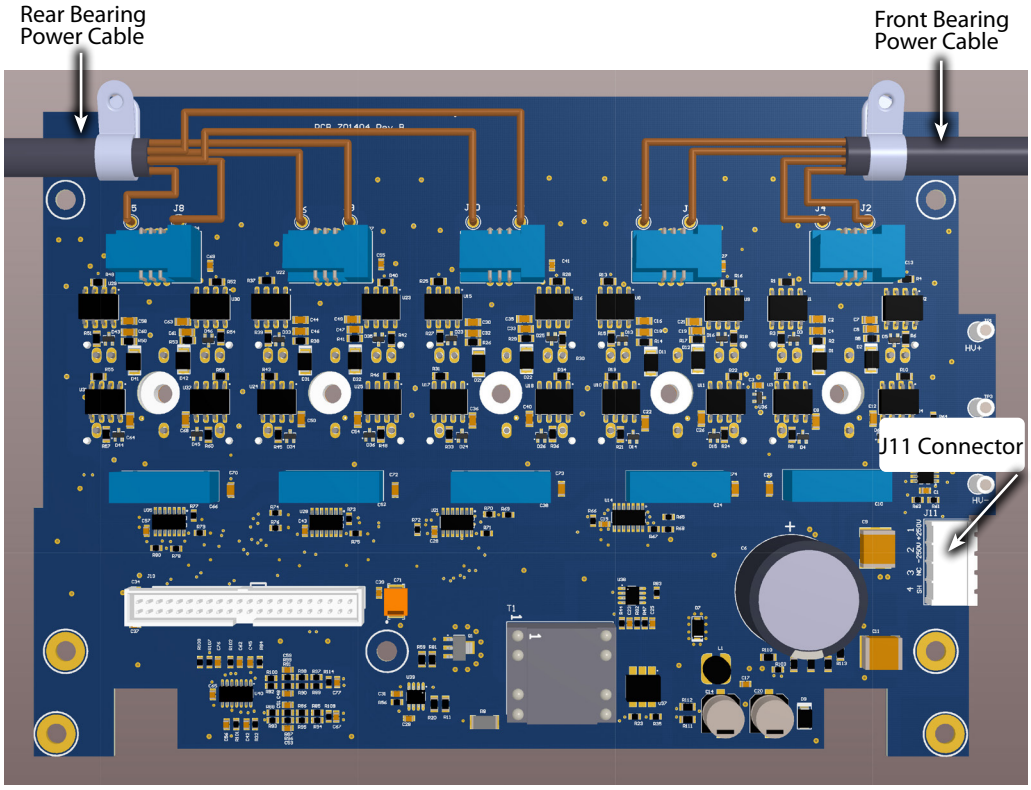
Table 3-26 CCM Test Point Values

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	

3.4.4.11 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 3-121 Pulse Width Modulation Amplifier



3.4.4.11.1 PWM Connections

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

Diode Test

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Disconnect the PWM Bearing Power Cables from the Compressor bearing feedthroughs.
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 four (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 four (4 pins of the front Bearing Power Cable. (The center pin of the rear Bearing Power Cable does not have a test value.)

Figure 3-122 PWM Connector - 6 Pin

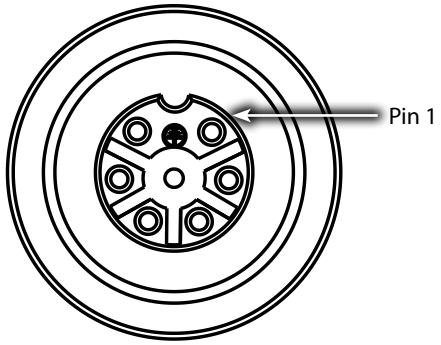
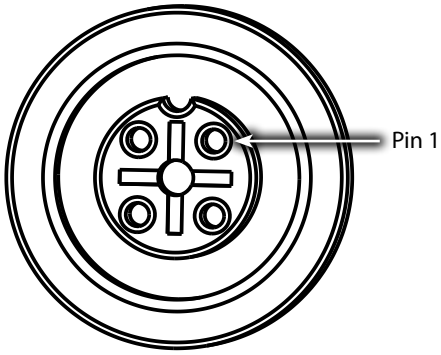


Figure 3-123 PWM Connector - 4 Pin



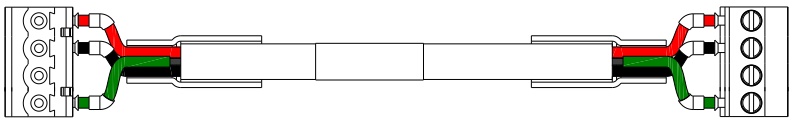
3.4.4.12 250V DC-DC PWM Cable

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

NOTE

Some VTX Compressors use Ferrite Chokes in order to be CE Compliant. When used, there are a total of five installed with one installed around all five of the communications cables and the remaining four around all except for the CCM-CIM CAN Cable assembly. Refer to "Figure 3-96 Ferrite Choke Locations" for an approxminate placement location for the Ferrite Chokes.

Figure 3-124 250V DC-DC-PWM Cable (VTT Revision C and All VTX)

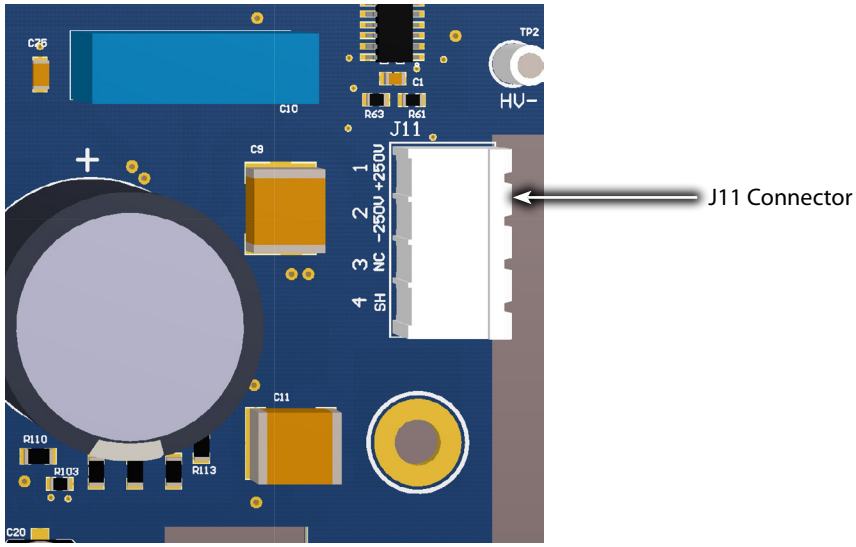


3.4.4.12.1 250V DC-DC PWM Cable Removal and Installation

Removal:

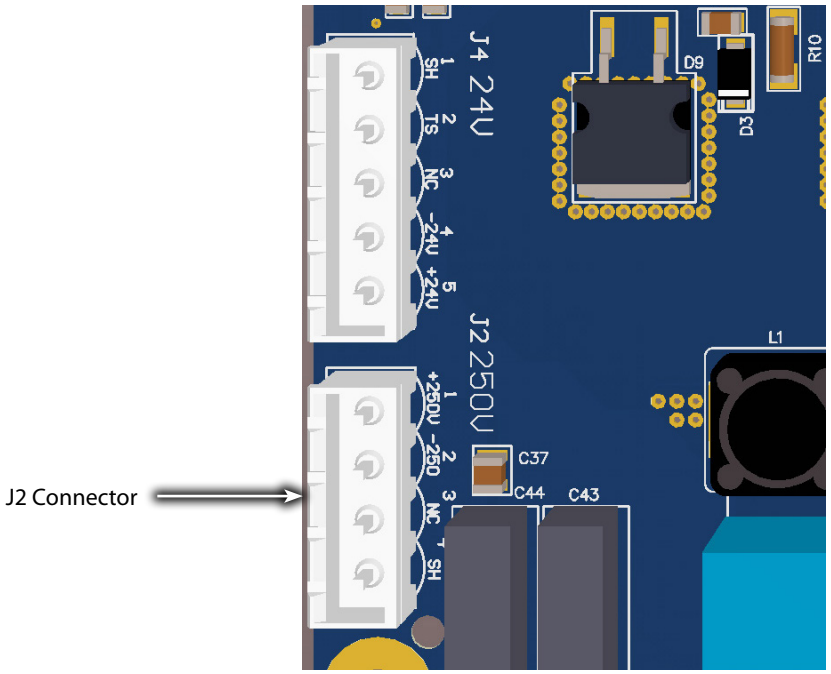
1. Isolate the Compressor and VFD power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
3. Disconnect the J11 connector from the PWM.

Figure 3-125 PWM J11 Connector



4. If there are Ferrite Chokes installed, remove the individual Ferrite Choke from the DC-DC-PWM Cable and remove the other Ferrite Choke that is clamped around all of the cables. Refer to "Ferrite Choke" on page 87 for an example of the Ferrite Chokes. Once removed, place the Ferrite Chokes in a safe location so they can be re-installed.
5. Remove the cable from the service side.
6. Open the panel containing the DC-DC.
7. Disconnect the 250 V (J2) connector from the DC-DC.

Figure 3-126 DC-DC J2 Connector



Installation:

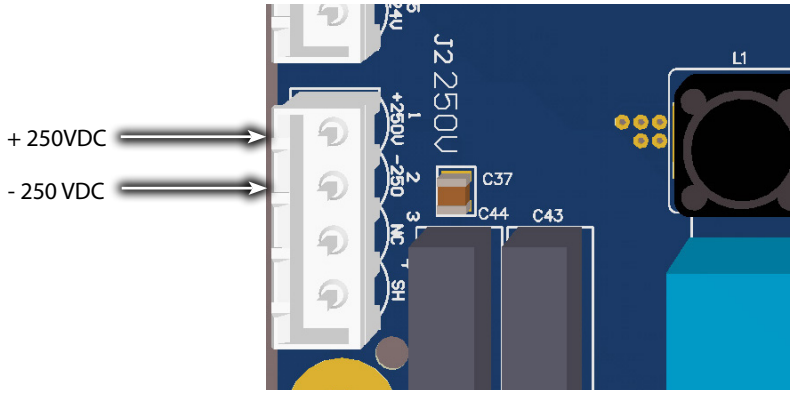
1. Route the cable into the service side.
2. Insert the connector to J11 on the PWM Board.
3. Secure the cable where it enters the service side.
4. Install both Ferrite Chokes (if previously removed) and ensure they snap closed.
5. Replace the Service Side Cover.
6. Route the cable into the DC-DC panel.
7. Insert the connector to J2 on the DC-DC Board.
8. Close the DC-DC panel.
9. Return the Compressor to normal operation.

3.4.4.12.2 Verification

250V DC-DC - PWM Cable Verification

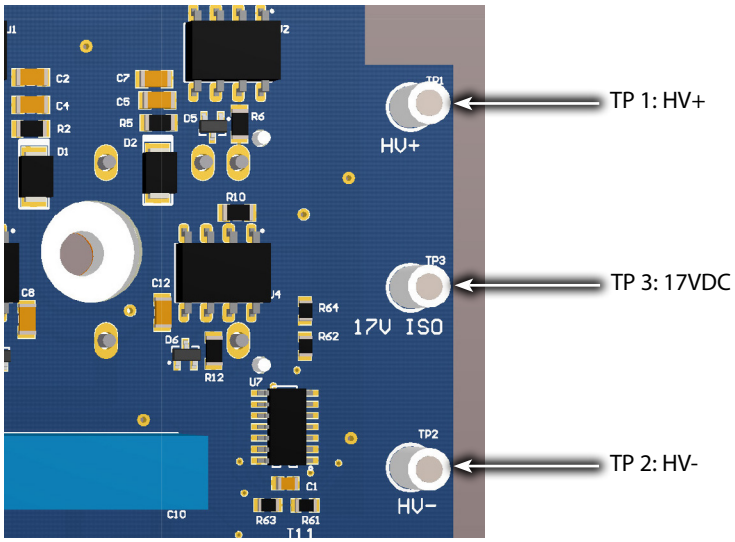
1. With power applied to the Compressor, using a DC voltage meter, verify the 250 VDC test points on the DC-DC for correct voltage. Place the negative (-) test lead on -250 VDC and the positive (+) test lead on +250 VDC.

Figure 3-127 DC-DC 250 VDC Test Points



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 3-128 PWM Test Points" on page 103.
   - TP1: HV+ (should measure between 225 -275 VDC)
   - TP3: 17V (should measure between 15.3 - 18.7 VDC)

Figure 3-128 PWM Test Points



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

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, 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, if required, save to EEPROM. Refer to the SMT User Manual for calibration instructions.
3. Select validation to test bearing levitation control.
4. Create and save a calibration report for records and review.

3.4.4.12.3 Electronics Side Torque Specifications

Table 3-27 Electronics Side Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Service Side Cover, SHCS, M5x16	6	-	53
Service Electronics Assembly Fastener	6	-	53
Service Electronics Ground Wires at Left and 250 VDC Ground Wire at Right	6	-	53

3.4.4.13 High and Low Pressure Temperature Sensors

The high and low pressure temperature sensors ("Figure 3-129 High and Low Pressure/Temperature Sensors" on page 104) 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 "Figure 3-130 Suction Temperature Sensor Location" and "Figure 3-131 Discharge Temperature Sensor Location" for further details on the exact locations.

Figure 3-129 High and Low Pressure/Temperature Sensors

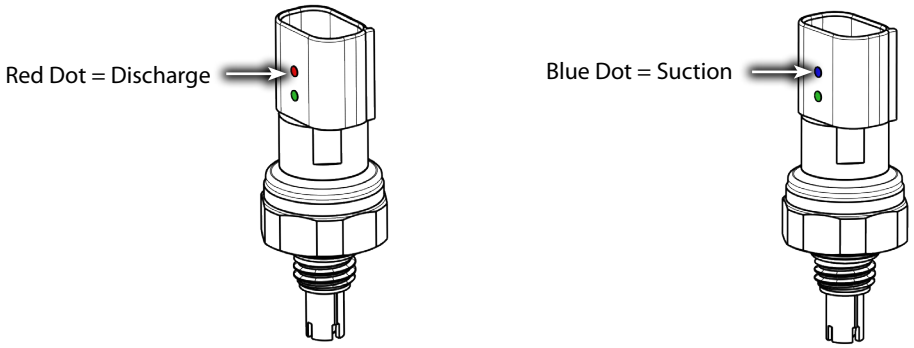


Figure 3-130 Suction Temperature Sensor Location

VTT Shown

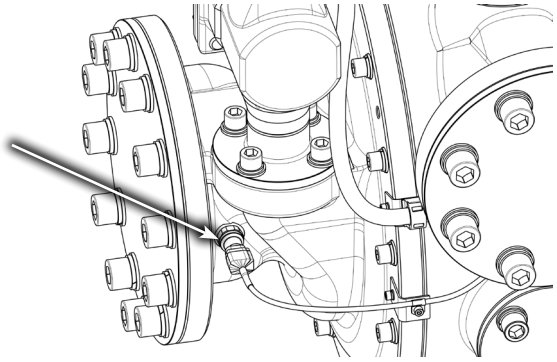
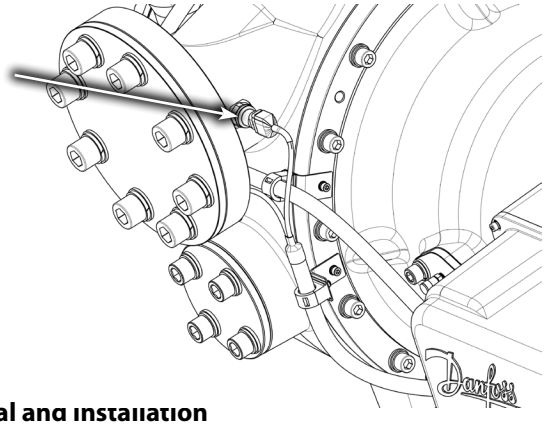


Figure 3-131 Discharge Temperature Sensor Location



3.4.4.13.1 Presure/Temperature Sensor Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.

2. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
3. Disconnect the sensor cable connector.
4. Use a deep socket to remove the sensor.

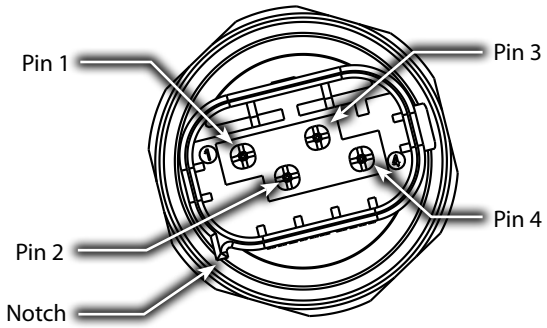
Installation:

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 the new sensor O-ring.
4. Insert the sensor and engage the first few threads by hand.
5. Use a deep socket, tighten sensor and torque to 10 Nm (7 ft.lb.).
6. Reconnect the sensor connector.
7. Leak test and evacuate Compressor in accordance with standard industry practices.
8. Return the Compressor to normal operation.

3.4.4.13.2 Temperature/Pressure Sensor Verification

1. Using a multimeter set for resistance measurements, place the leads on terminal 1 and 3 of the pressure/temperature sensor.
2. The temperature sensor is a 10KΩ @ 77°F (25°C) negative temperature coefficient (NTC) thermistor.
3. Refer to "Figure 3-30 Pressure/Temperature Sensor Resistance/Temperature (R/T) Curve" on page 46 for information on both the Suction and Discharge sensors.

Figure 3-132 Temperature/Pressure Sensor Pin Location



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 3-28 Temperature/Pressure Sensor Torque Specifications

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

3.5 Internal Components

3.5.1 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

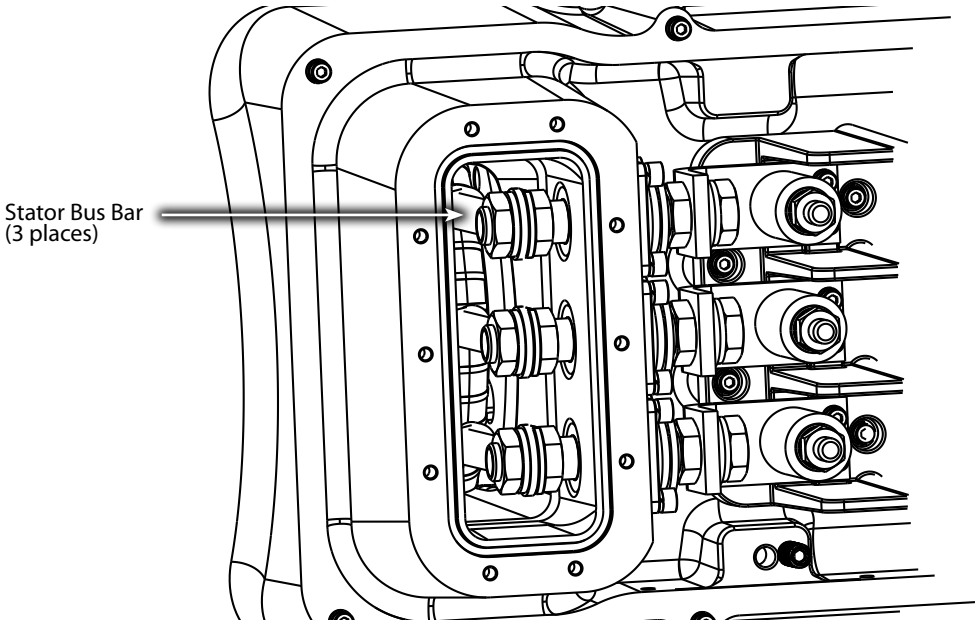
Conventional motor protection based on incoming 3-phase currents and voltage conditions are inadequate to protect the motor and electronics in the event of mishap due to the total separation of the motor windings from the incoming 3-phase current by the DC conversion. Therefore, the bulk of protection 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 VTT/VTX 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 Danfoss LLC.

3.5.1.1 Motor Connections

Refer to "Figure 3-133 Connection to Stator" to identify connections to the stator.

Figure 3-133 Connection to Stator



3.5.1.2 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 "1.7 Electrical Isolation of the VFD" on page 17.
2. Remove the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
3. Remove the six (6) motor power cables (two (2) cables per phase).

⚠ • • • CAUTION • • •

A faulty Stator can cause the Inverter to fail.

4. 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.
5. Repeat Step four (4) 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:

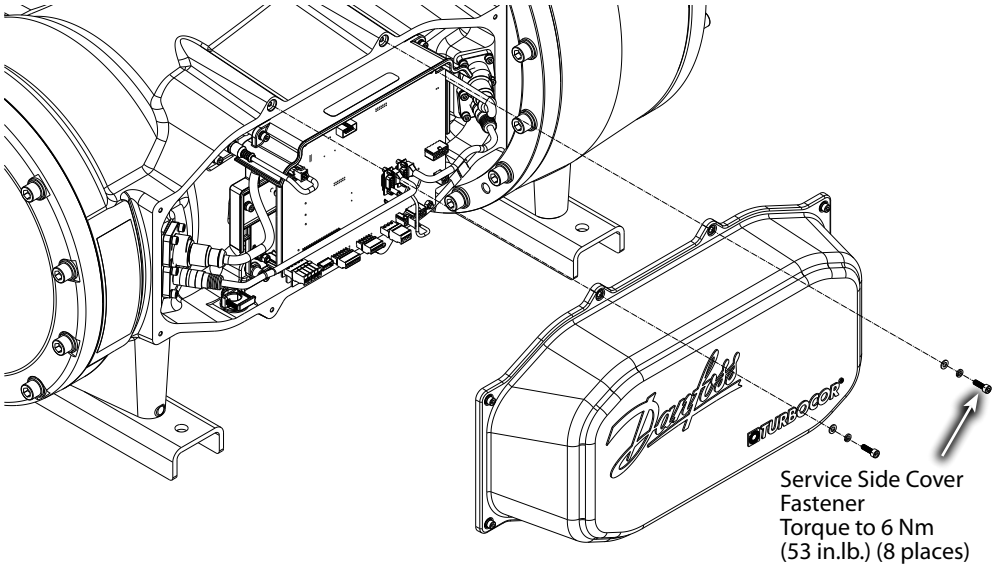
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Motor Power Cover. Refer to "3.3.1.1 Motor Power Cover Removal and Installation" on page 55.
3. Remove the six (6) motor power cables (two (2) cables per phase).
4. Using 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.
5. Repeat Step four (4) for the remaining combinations of Motor Bus Bars to ensure all windings are intact.
6. Attach the motor power cables to the terminals and torque to 20 Nm (15 ft.lb.).
7. Install the three (3) M10 nuts and washers on the studs above the copper spacers and power cables, then torque to 10 Nm (8 ft.lb.).
8. Install the Motor Power Cover. Refer to "3.3.1 Motor Power Cover" on page 55.
9. Return the Compressor to normal operation.

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 section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.

Figure 3-134 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 3-135 Stator Temperature Sensor Cable Connector

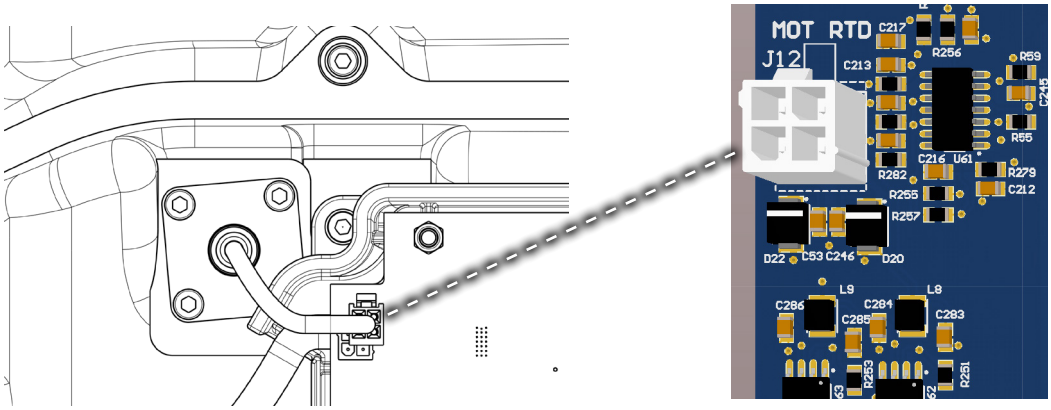
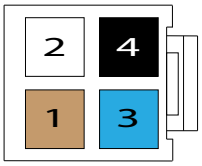


Figure 3-136 Stator Temperature Sensor Cable External Connector



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 feedthrough or the Stator itself.

Refer to section "Stator Temperature Sensor Feedthrough" for details regarding accessing the internal connector.

NOTE

Both are approximately 1.09kΩ at 22°C (72°F). Refer to "Table 3-29 Stator Thermistor R/T Curve" for further values.

Table 3-29 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).

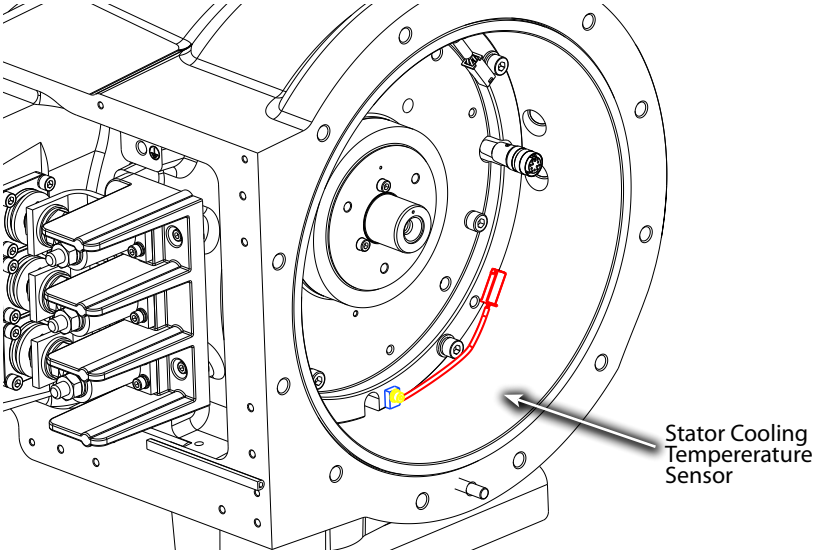
9. Verify resistance of each circuit at the external connector to housing (ground).
   - Should be "open."
10. If the Stator Temperature Sensor Feedthrough is suspected to have a problem, remove it and test as above directly at the internal connector. Refer to "3.4.3.2 Stator Temperature Sensor Feedthrough" on page 76.
11. Return the Compressor to normal operation.

3.5.2 Stator Cooling Temperature Sensor

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 3-137 Stator Cooling Temperature Sensor" for details on the exact location of this sensor.

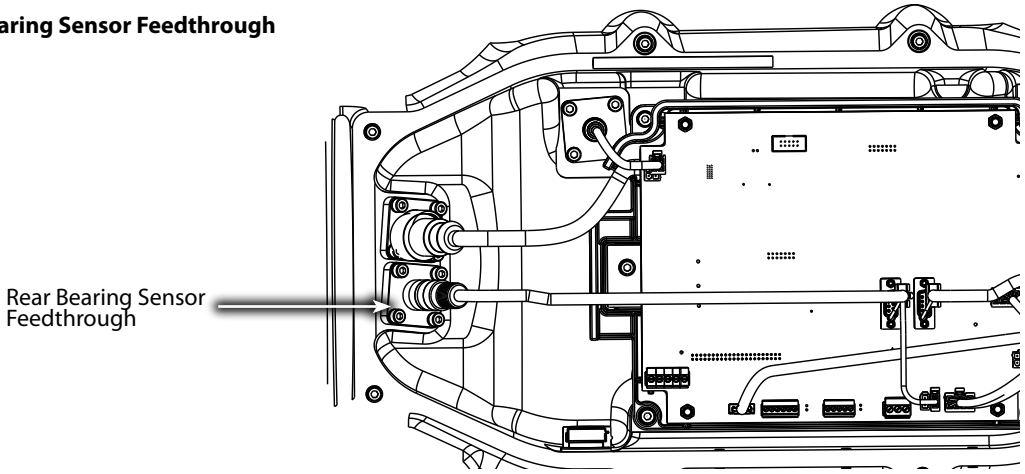
Stator Cooling Temperature Sensor Resistance Verification

Figure 3-137 Stator Cooling Temperature Sensor



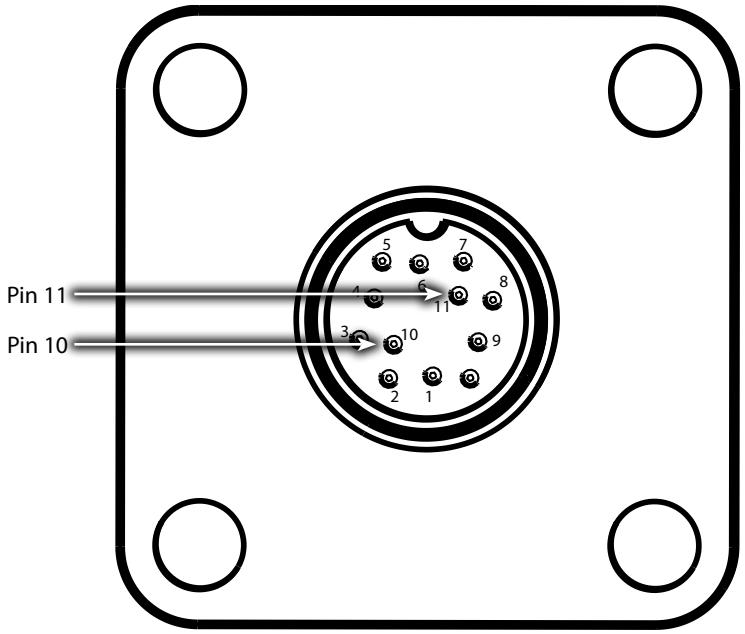
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Disconnect the external bearing sensor cable from the feedthrough. Refer to "Figure 3-138 Rear Bearing Sensor Feedthrough" for details on the location.

Figure 3-138 Rear Bearing Sensor Feedthrough



3. Use a multimeter set to resistance, verify the resistance of the circuit at the feedthrough. Resistance should be measured between Pins 10 and 11 and the measured value should be within ± 10% of the resistance values listed in the chart in "Table 3-29 Stator Thermistor R/T Curve" on page 109.
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 "3.5.5 Axial Bearing" on page 130 for details on how to access the internal Rear Bearing Sensor connector.
5. Return the Compressor to normal operation.

Figure 3-139 Stator Cooling Temperature Sensor Pinout



3.5.2.1 Stator Cooling Temperature Sensor Removal and Installation

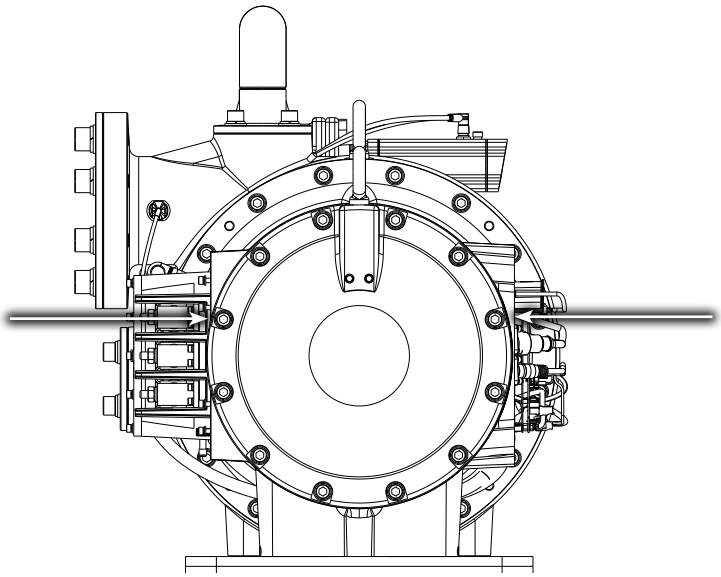
Stator Cooling Temperature Sensor Removal

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
3. Remove the two (2) M12x55 fasteners located at the 10 o'clock and 2 o'clock position on the End Cap.
4. Insert the Guide Pins in these locations. Refer to Figure 131 (Guide Pin Locations).

Figure 3-140 Guide Pin Locations

VTT Shown

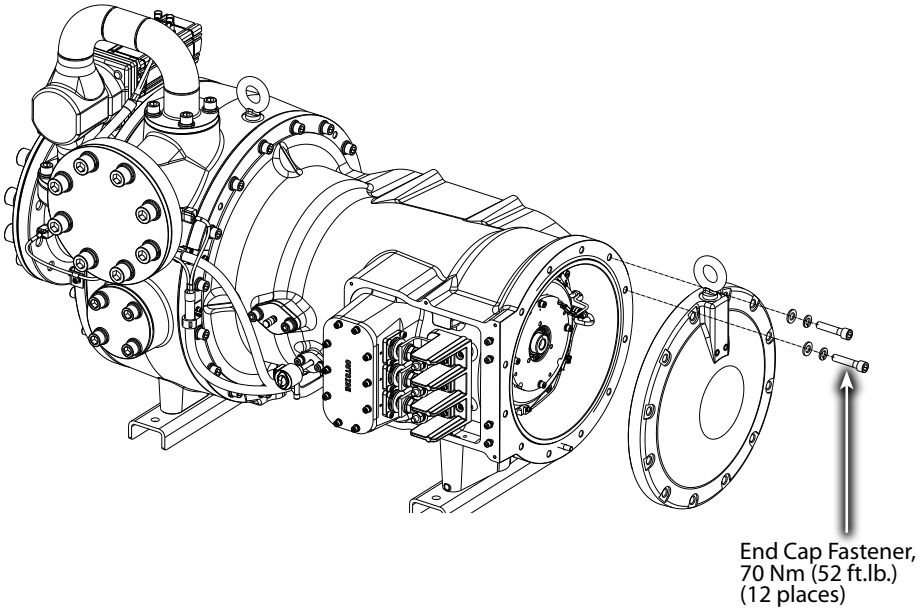
Guide Pin Locations
(2 Places)



5. Remove the remaining fasteners and use a rubber mallet to tap off the End Cap.
6. Gently slide the End Cap away from the Compressor housing and set aside the End Cap.

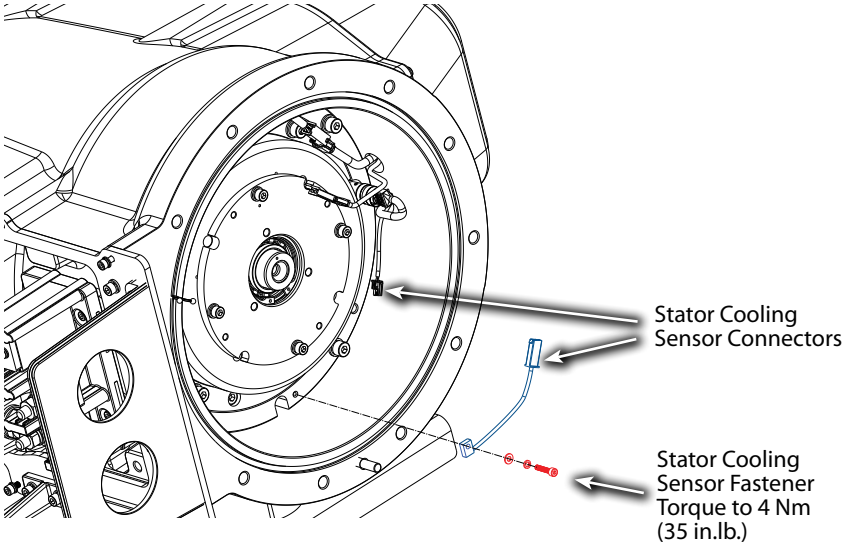
Figure 3-141 End Cap Removal

VTT Shown



7. Remove the internal sensor connector and the fastener as shown in "Figure 3-142 Stator Cooling Temperature Sensor Removal".

Figure 3-142 Stator Cooling Temperature Sensor Removal



Stator Cooling Temperature Sensor Installation

1. Carefully install the internal sensor connector and the fastener as shown in "Figure 3-142 Stator Cooling Temperature Sensor Removal".
2. Verify all End Cap contact surfaces are clean and dry. If not, clean with a lint-free cloth.
3. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove.
4. Insert two (2) Guide Pins into the 10 o'clock and 2 o'clock position.
5. Gently slide the End Cap into the Compressor housing.
6. Assemble all 12 of the M12x55 fasteners with the flat and lock washers.
7. Insert the fasteners in the available locations.

8. Remove the two (2) Guide Pins and insert the remaining fasteners.
9. Finger-tighten all 12 fasteners and ensure that the End Cap is seated evenly into the Compressor housing.
10. Tighten the 12 M5 fasteners 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.)
11. Leak test the Compressor to the appropriate pressure and industry standards.
12. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
13. Charge the Compressor with refrigerant.
14. Restore power to the Compressor.

3.5.2.1.1 Stator Cooling Temperature Sensor Torque Specifications

Table 3-30 Stator Cooling Temperature Sensor Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
End Cap, SHCS, M12x55	70	52	620
Stator Cooling Temperature Sensor, SHCS, M4x20	4	-	35

3.5.3 Front Touchdown Bearing/Labyrinth Seal

3.5.3.1 Front Touchdown Bearing/Labyrinth Seal Removal

1. Prior to teardown, a bearing calibration must be performed. Using the SMT, perform a calibration and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.
2. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
3. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
4. Remove the Service Side Cover. Refer to "3.4.1.1 Service Side Cover Removal and Installation" on page 69.
5. For VTX Compressors continue to Step 6; otherwise continue to Step 7 for VTT Compressors.
6. Remove the IGV assembly and continue to Step 14. Refer to "3.6.3 IGV Housing Removal and Installation" on page 142.
7. Disconnect the IFV Cables and remove them from the clamp located on the Suction Housing. Refer to "Figure 3-143 Suction Housing Cable Clamps". Continue to Step 12.
8. Carefully lay the IFV Cable harness over the rear of the Compressor to prevent the harness from being damaged.
9. Remove the cable harness from the pressure/temperature sensor on the Suction Housing.
10. Remove the retaining clip from the Suction Housing as shown in "Figure 3-143 Suction Housing Cable Clamps".
11. Carefully lay the pressure/temperature sensor harness out of the way to prevent it from being damaged.
12. Remove the IFV Assembly.

Figure 3-143 Suction Housing Cable Clamps

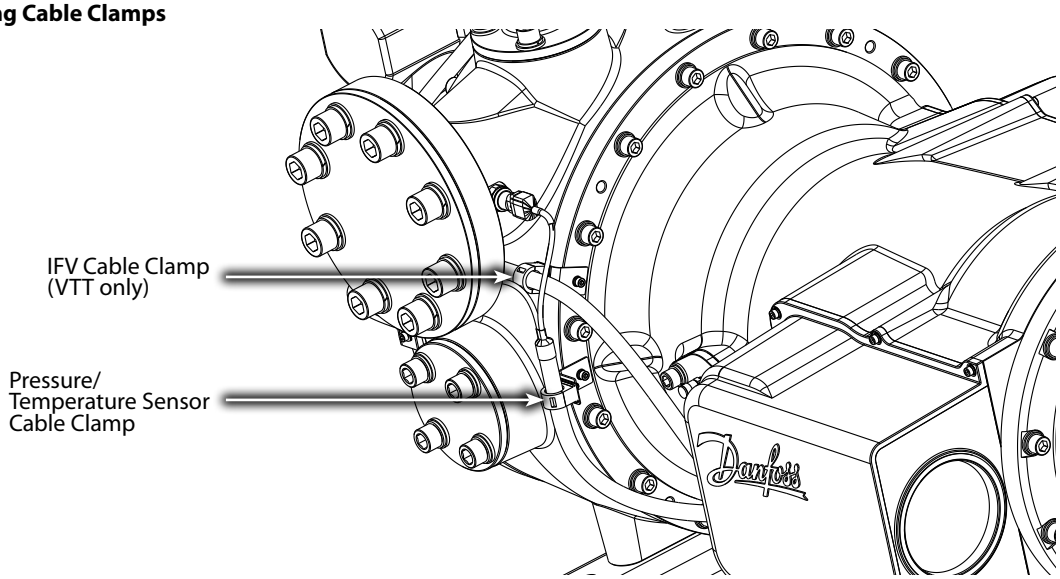
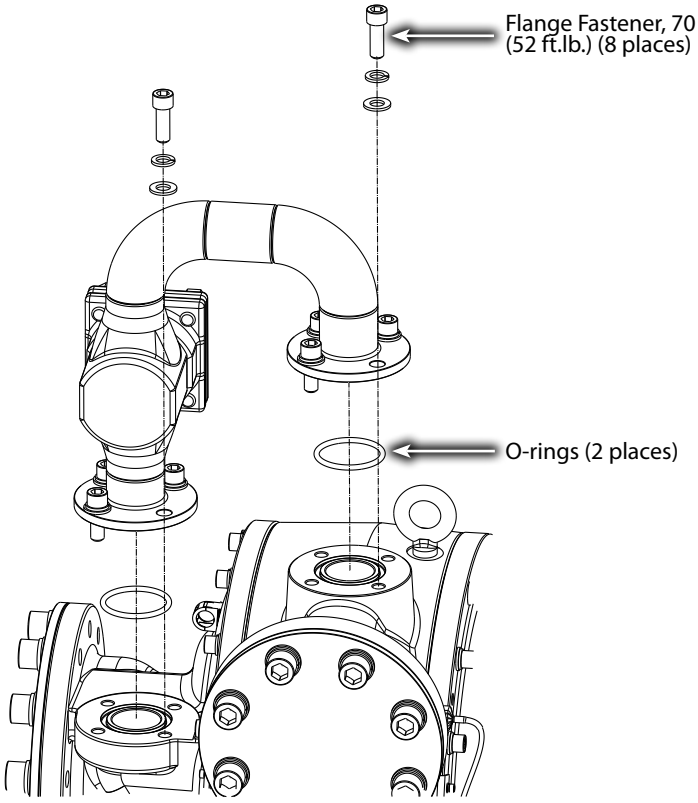


Figure 3-144 IFV Assembly Removal



13. The VTT 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).
14. Remove the fasteners at the 10 o'clock and 2 o'clock positions from the VTT Suction Cover or from the VTX IGV Suction Housing.

Figure 3-145 VTT Support Locations

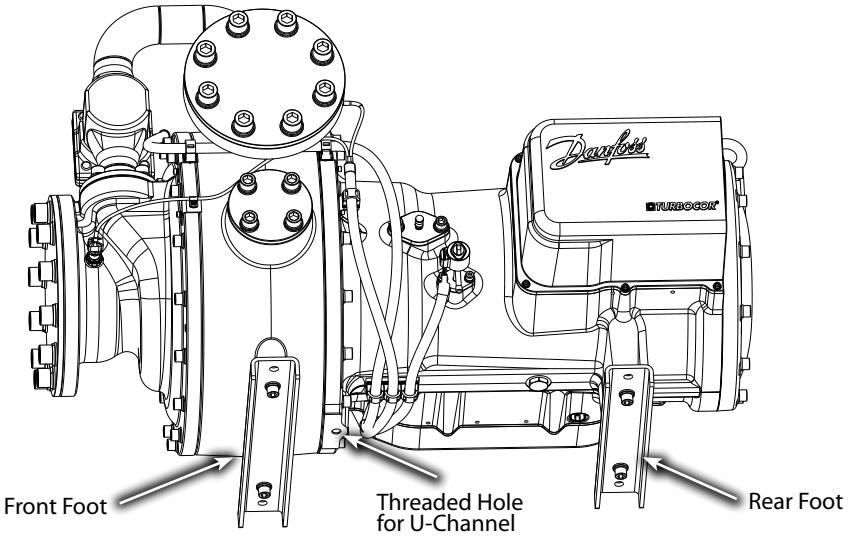
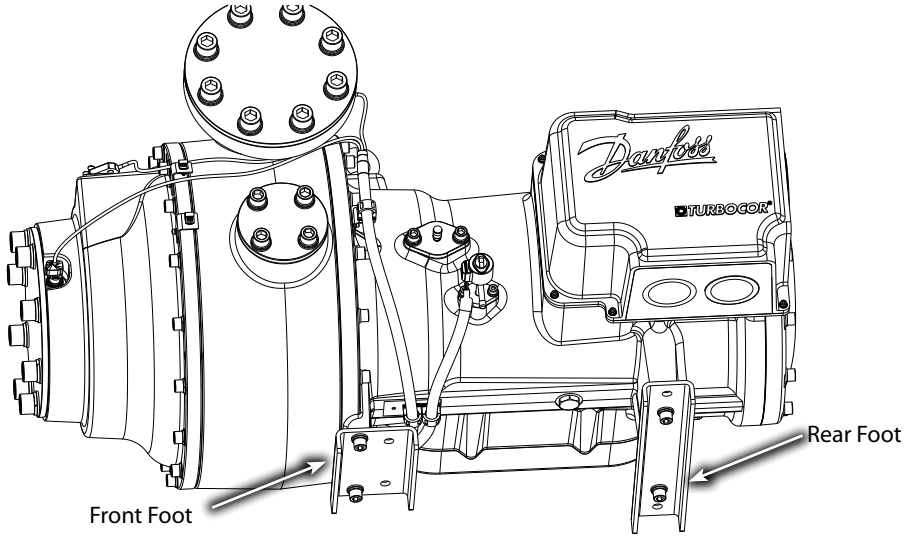
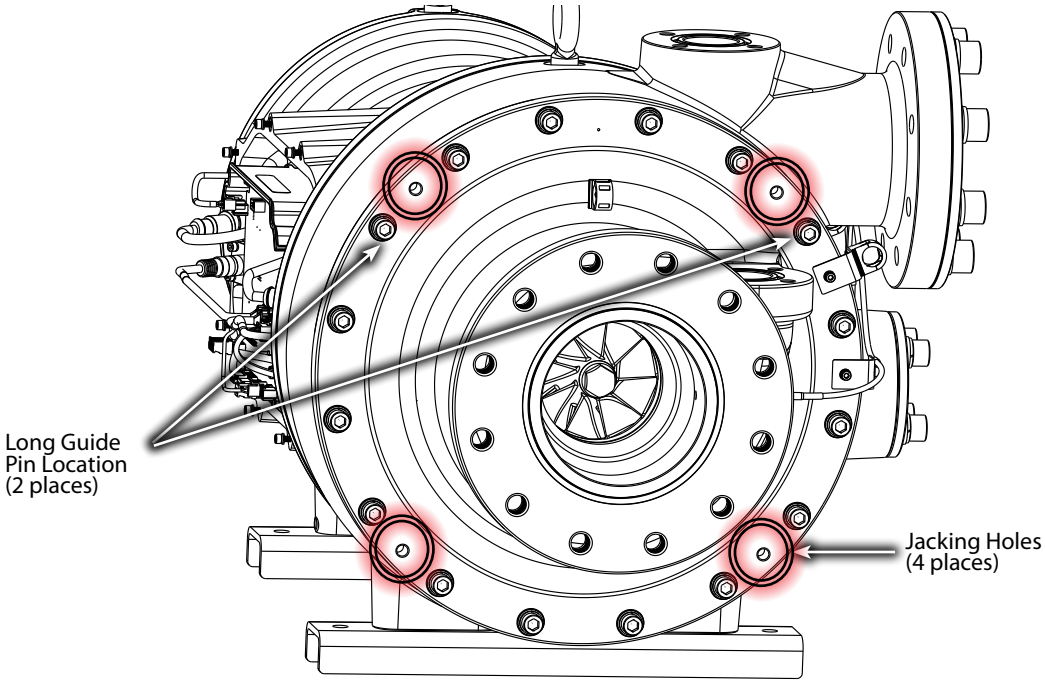


Figure 3-146 VTX Support Locations



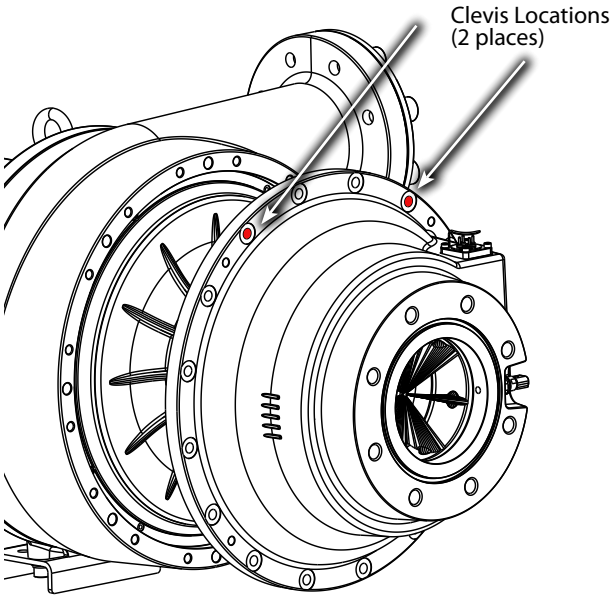
15. Remove two (2) M12x50 Suction Housing fasteners and install the Guide Pins in their place. Refer to "Figure 3-147 Suction Housing Guide Pin Locations" for where the Guide Pins should be placed. For details of the Guide Pins, refer to "Figure C-2 - Guide Pin" on page 189 in Appendix B.

Figure 3-147 Suction Housing Guide Pin Locations



16. Remove the remainder of the M12x50 Suction Housing fasteners.
17. Locate the jacking screw holes on the flange (refer to "Figure 3-147 Suction Housing Guide Pin Locations" and install four (4) of the removed fasteners. Tighten them evenly in a crisscross pattern. This will slowly push the Suction Housing away from the Volute.
18. Once there is enough room to install a clevis hook, stop and connect the clevis, along with the lifting strap, and then proceed to remove the Suction Housing.

Figure 3-148 Suction Housing Lifting Points



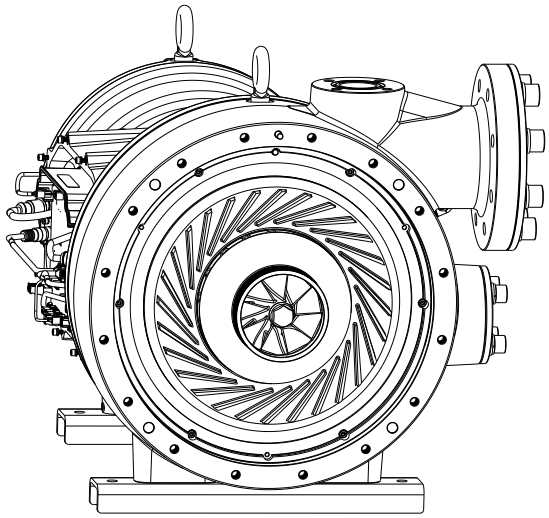
⚠ • • • CAUTION • • •

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

19. Set the Suction Housing aside and remove the four (4) fasteners from the jacking screw holes.
20. Remove the Guide Pins for later use.

Figure 3-149 Suction Housing Removed

VTT Shown

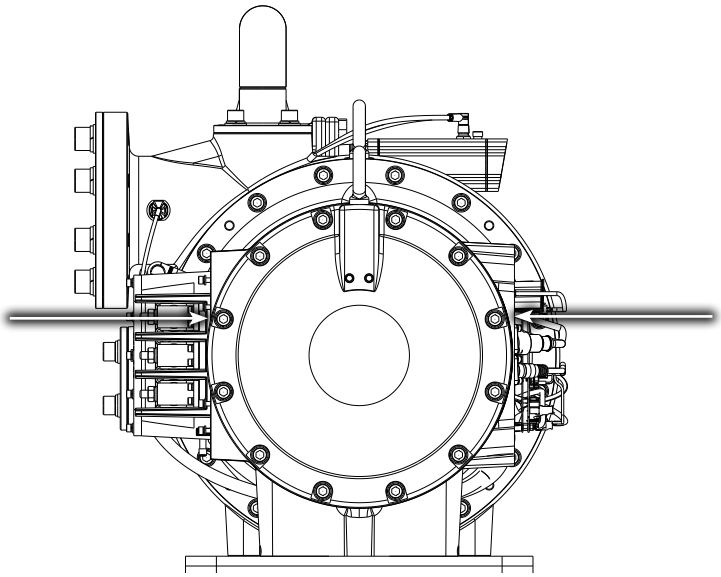


21. Remove the two (2) M12x55 fasteners located at the 10 o'clock and 2 o'clock position on the End Cap.
22. Insert the Guide Pins in these locations. Refer to Figure 131 (Guide Pin Locations).

Figure 3-150 Guide Pin Locations

VTT Shown

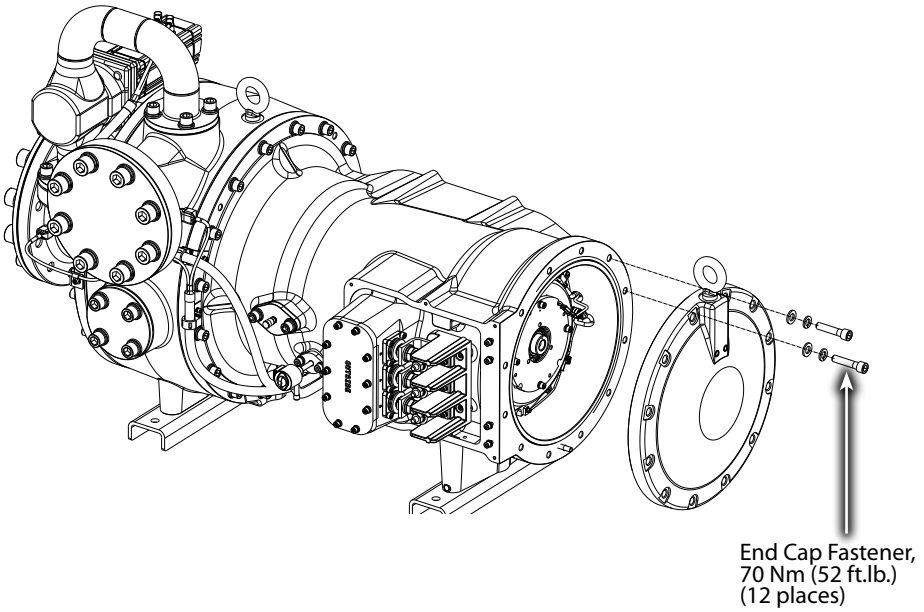
Guide Pin Locations (2 Places)



23. Remove the remaining fasteners 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.

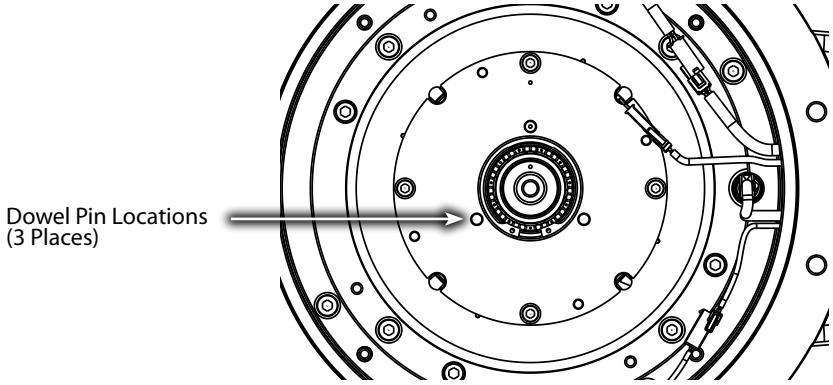
Figure 3-151 End Cap Removal

VTT Shown



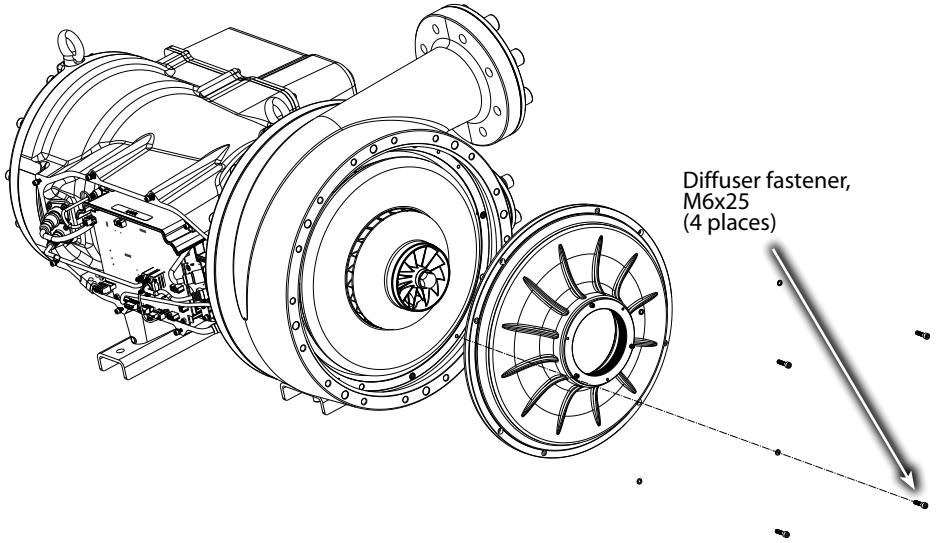
25. Install three (3) Shaft Bolt Torquing Pins in the three (3) holes in the Axial Bearing Assembly. Refer to "Figure 3-152 Shaft Dowel Pin Placement" on page 118 for the placement of the pins. It will be necessary to turn the shaft bolt on the front of the Compressor in order to engage the pins. These pins will then hold the shaft in place for the removal of the shaft bolt. Refer to "Figure C-4 Shaft Bolt Torquing Pin" on page 190 example in Appendix B.
26. For VTX Compressors, continue to Step 27, otherwise, continue to Step 28 for VTT Compressors.

Figure 3-152 Shaft Dowel Pin Placement



27. Remove the four (4) M6x25 fasteners from the Diffuser and carefully slide the Diffuser away from the Compressor. Refer to "Figure 3-153 VTX Diffuser".

Figure 3-153 VTX Diffuser

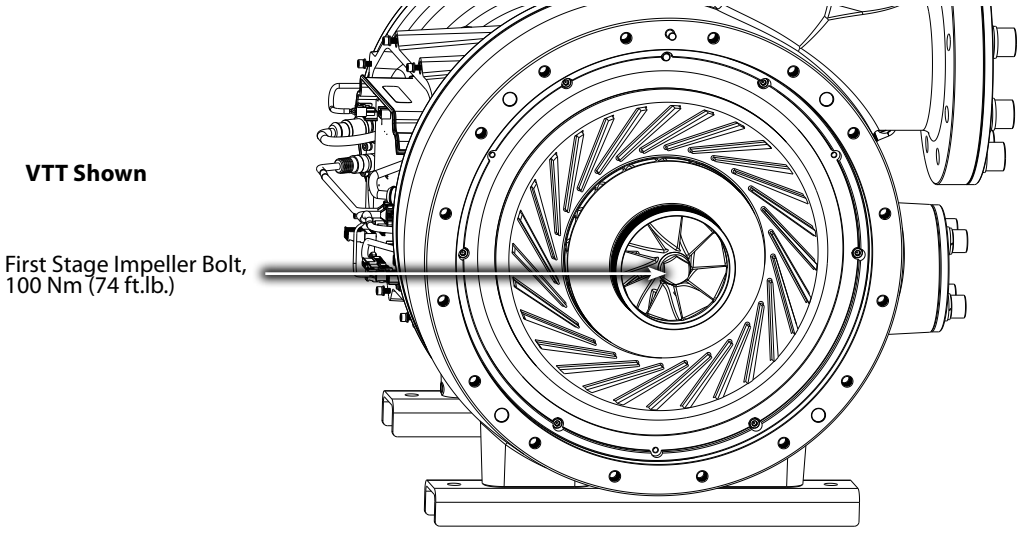


28. Remove the shaft bolt from the First Stage Impeller.

NOTE

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

Figure 3-154 Impeller Bolt



29. Remove the First Stage Impeller. This will require the use of a heat gun to heat up the impeller. **Do not use an open flame!**

⚠ • • • CAUTION • • •

- Note the alignment/orientation of all fluid module components prior to removal
- Do not use anything with an open flame to heat up the impeller

Figure 3-155 VTT First Stage Impeller Removal

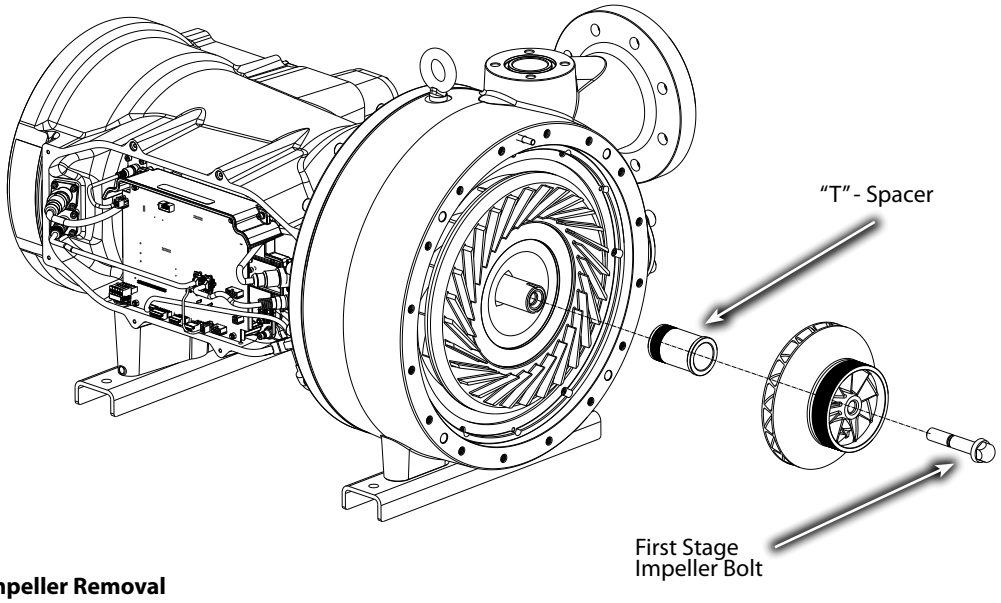
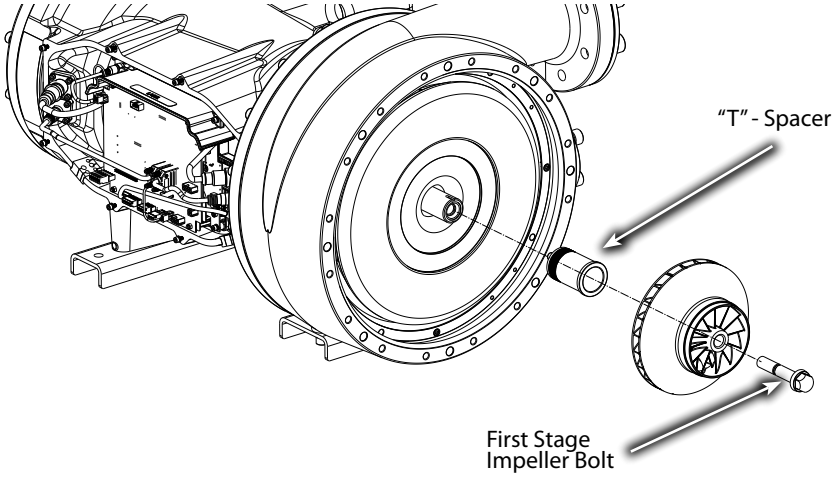
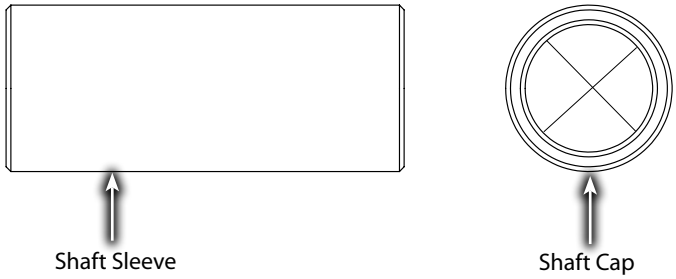


Figure 3-156 VTX First Stage Impeller Removal



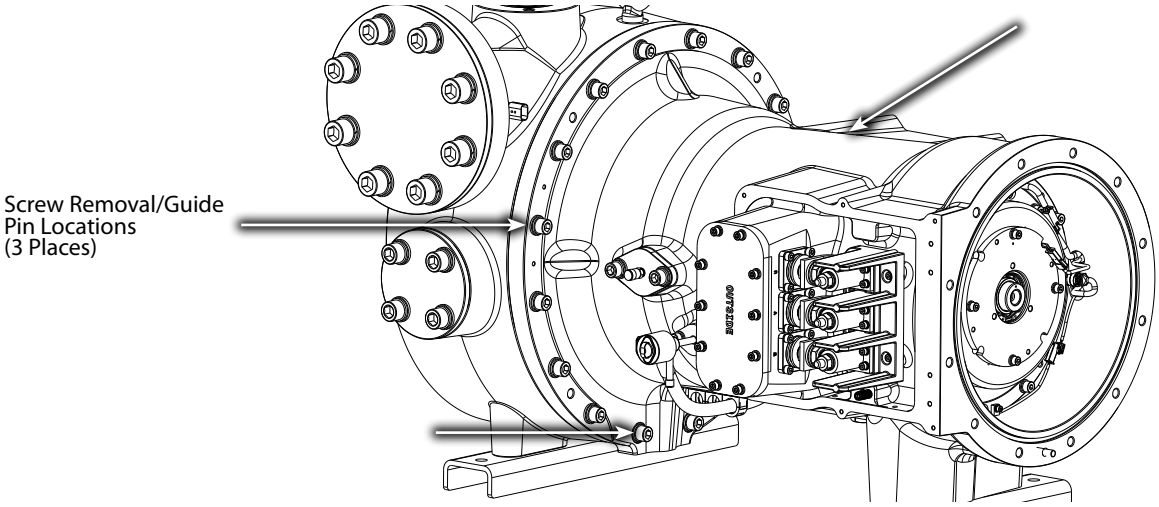
30. Remove the "T"- Spacer.
31. Install a nylon shaft protector and cap over the end of the Compressor shaft. Refer to "Figure C-1 Volute Assembly Sleeve" on page 189 in Appendix B. This is also shown in "Figure 3-157 Nylon Shaft Protector and Cap".

Figure 3-157 Nylon Shaft Protector and Cap



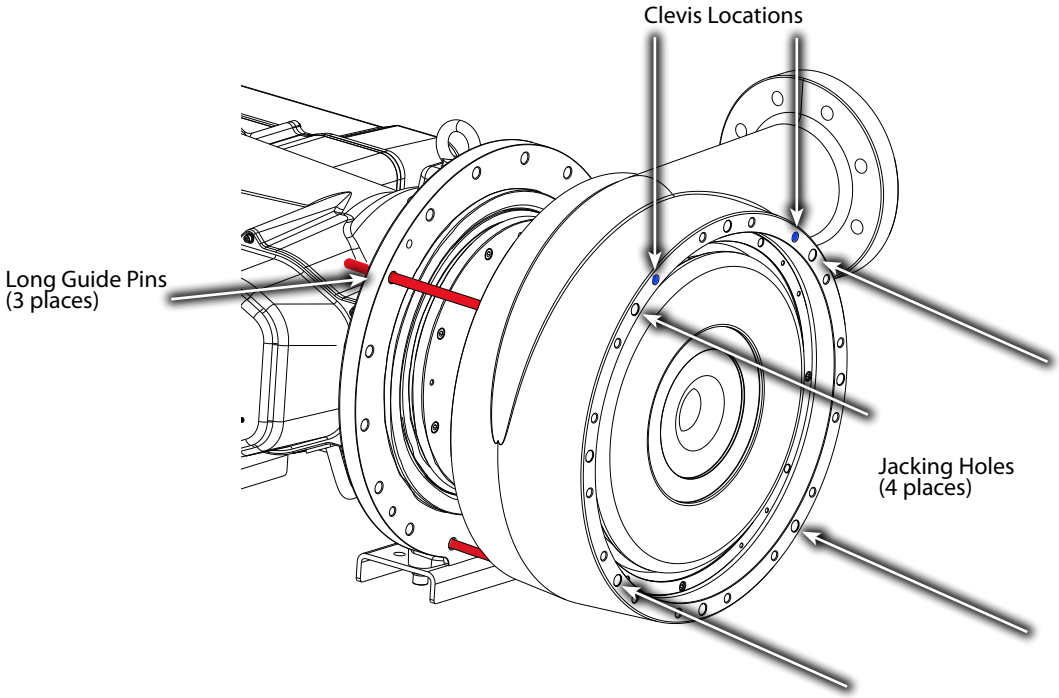
32. Remove the M12x50 fastener from the Volute at the 10 o'clock, 2 o'clock, and 6 o'clock positions, and install the Guide Pins in these locations. Refer to "Figure C-2 - Guide Pin" on page 189 in Appendix B.

Figure 3-158 Volute Removal - Step One



33. For VTT Compressors with a lifting eye mounted to the Volute, take a 3' strap with a clevis hook on one end and attach the clevis to the lifting eye on the Volute. For VTX Compressors and those VTT compressors without a lifting eye mounted to the Volute, the lifting points are identified in Step 34.
34. Remove the remaining M12x50 fasteners from the Volute; use four (4) of these flange fasteners as jacking screws in the next step.

Figure 3-159 Volute Support without Lifting Eye



35. 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.
36. For VTT and VTX compressors without a lifting eye on the Volute, only slide the Volute away from the housing just enough in order to install the clevis hooks. Refer to Step 36 if there is a lifting eye on the Volute.
37. Use two M12x50 fasteners to secure the clevis hooks at each side of the Volute.

Figure 3-160 VTT Volute Removal - Step Two

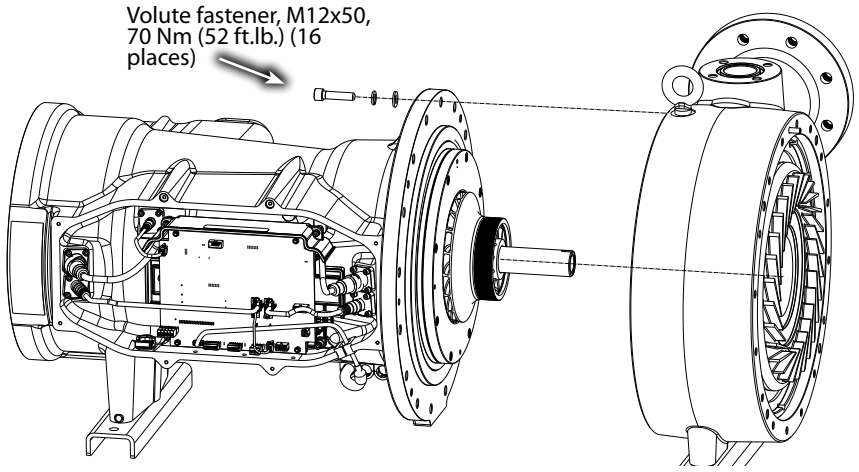
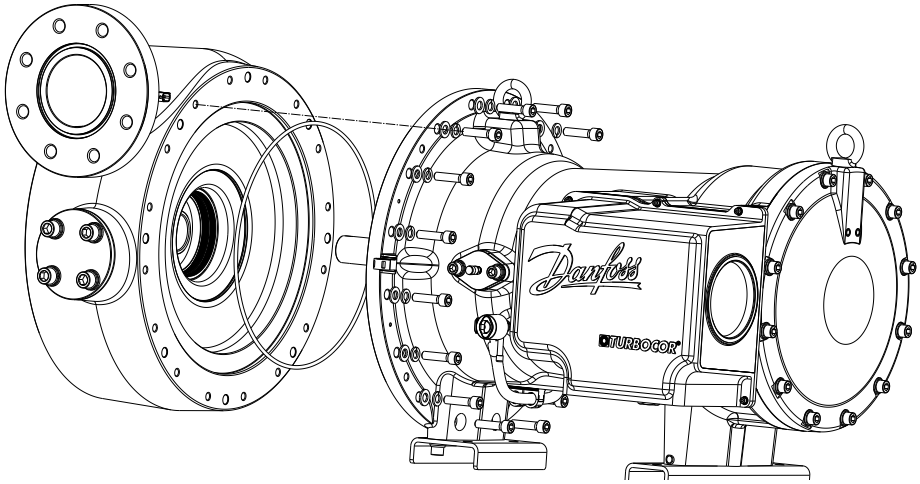


Figure 3-161 VTX Volute Removal - Step Two

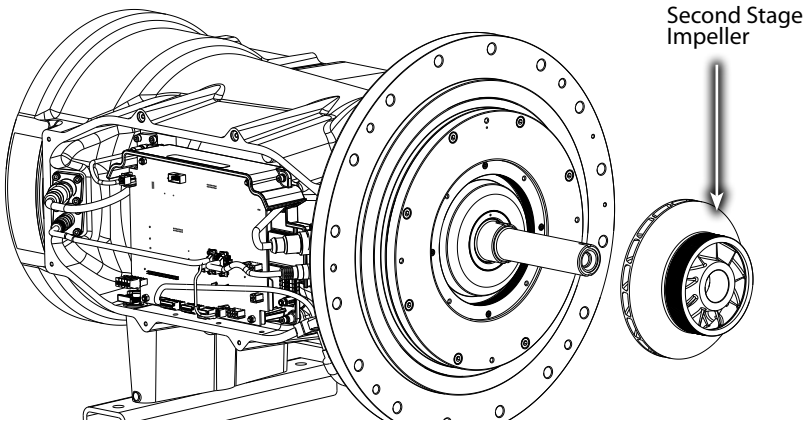


38. Carefully lower the Volute to the floor.
39. Remove the O-ring from the Volute.
40. Remove the Second Stage Impeller. This will require the use of a heat gun to heat up the impeller. **Do not use an open flame!**

⚠ • • • CAUTION • • •

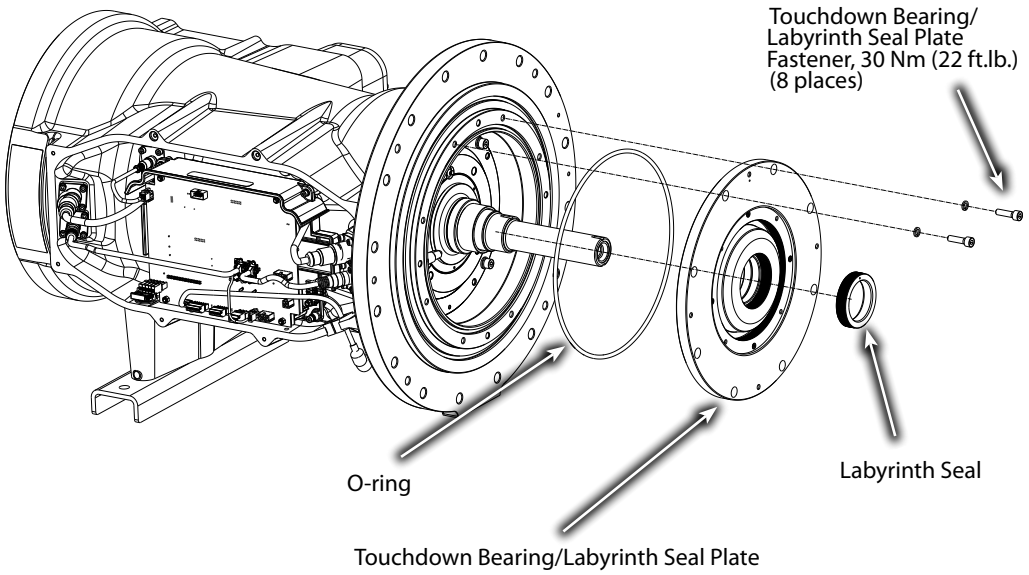
Do not use anything with an open flame to heat up the impeller.

Figure 3-162 Second Stage Impeller Removal



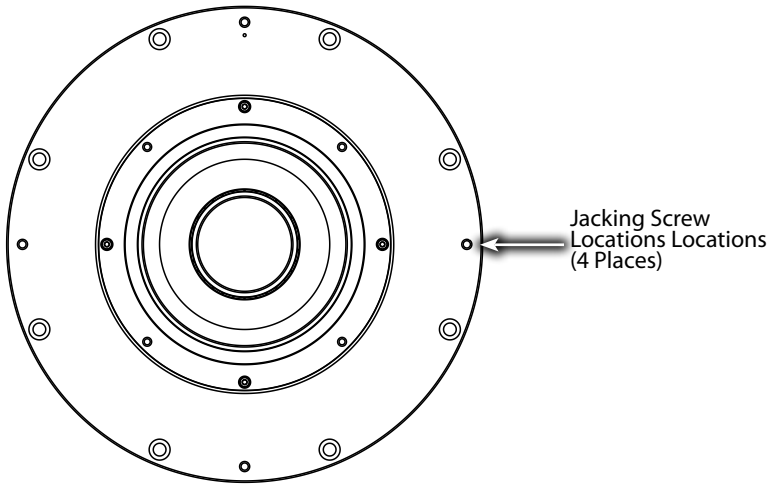
41. Remove the eight (8) fasteners and remove the Touchdown Bearing/Labyrinth Seal Plate with the Labyrinth Seal.

Figure 3-163 Touchdown Bearing/Labyrinth Seal Plate Removal



42. Once all of the eight (8) fasteners have been removed, insert four (4) of the removed fasteners 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 3-164 Front Touchdown Bearing

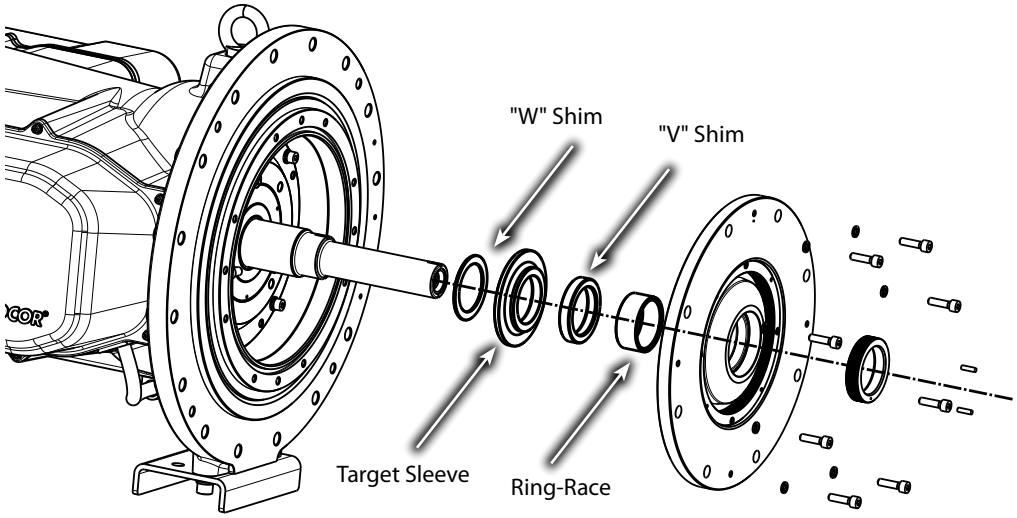


⚠ • • • CAUTION • • •

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.

43. Verify that the components shown in "Figure 3-165 Bearing Race and Shim Behind Touchdown Bearing/Labyrinth Seal Plate" on page 124 remain in place. It is possible that the Ring-Race may slide out with the Touchdown Bearing/Labyrinth Seal Plate. If this occurs, carefully slide the Ring-Race back into position.

Figure 3-165 Bearing Race and Shim Behind Touchdown Bearing/Labyrinth Seal Plate



3.5.3.2 Front Touchdown Bearing/Labyrinth Seal Installation

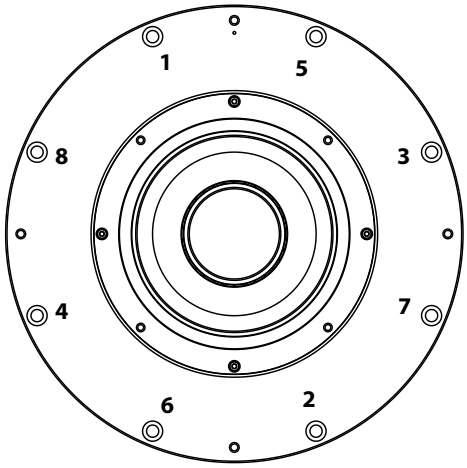
1. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
2. Apply Super-O-Lube to the new O-rings and then fit them into the O-ring grooves.

NOTE

Inspect both the Front Bearing Sensor and the Front Power Bearing Feedthroughs for any damage prior to assembling the Touchdown Bearing/Labrynth Seal Plate. Replace any components if damage is present. Also be sure that the harness is properly secured in the cable tie.

3. As previously mentioned, be sure that the Ring-Race is installed into the Touchdown Bearing/ Labyrinth Seal Plate.
4. Install the Touchdown Bearing/Labyrinth Seal Plate. Finger-tighten all eight (8) M8x30 fasteners 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.)

Figure 3-166 Touchdown Bearing/Labrynth Seal Plate Torque Pattern



5. Install the Labyrinth Seal on the shaft. If necessary, rotate the seal in order to seat the it against

the race ring (located inside the Touchdown Bearing/Labyrinth Seal Plate).

⚠ • • • CAUTION • • •

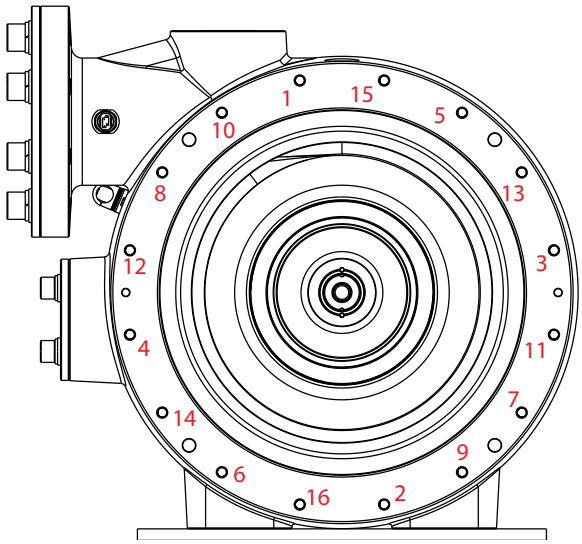
Do not force the Labyrinth Seal, otherwise damage could occur.

⚠ • • • 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.

6. Install the Second Stage Impeller. This may require the use of a heat gun to heat up the impeller. **Do not use an open flame!**
7. Install the "T" - Spacer.
8. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
9. Apply Super-O-Lube to the new O-ring and then fit it into the Volute O-ring groove.
10. Verify that the nylon shaft cover and cap and the Long Guide Pins are still in place.
11. Carefully move the Volute into place.
12. Once in place, install lock washers and flat washer on all 16 fasteners.
13. Finger tighten all 16 fasteners 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 3-167 Volute Torque Pattern



NOTE

"Figure 3-167 Volute Torque Pattern"has the Volute removed in order to provide better clarity.

14. Remove the nylon shaft protector and cap.
15. 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 an open flame!**

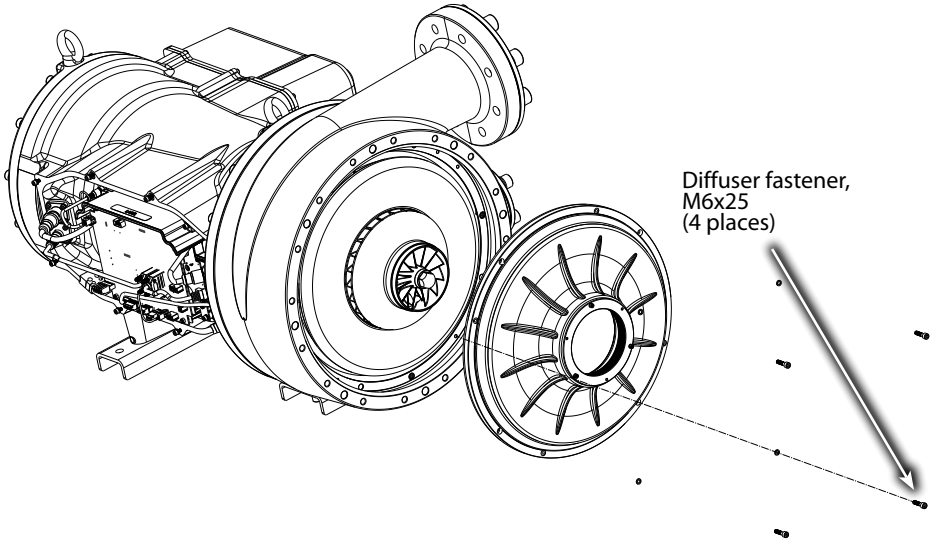
⚠ • • • CAUTION • • •

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

16. Install the First Stage Impeller bolt and torque to 100 Nm (74 ft.lb.).

17. For VTX Compressors, continue to Step 18, otherwise, continue to Step 19 for VTT Compressors.
18. Slide the Diffuser into place and install using the four (4) M6x25 fasteners. Torque to 6 Nm (53 in.lb.).

Figure 3-168 VTX Diffuser Installation



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

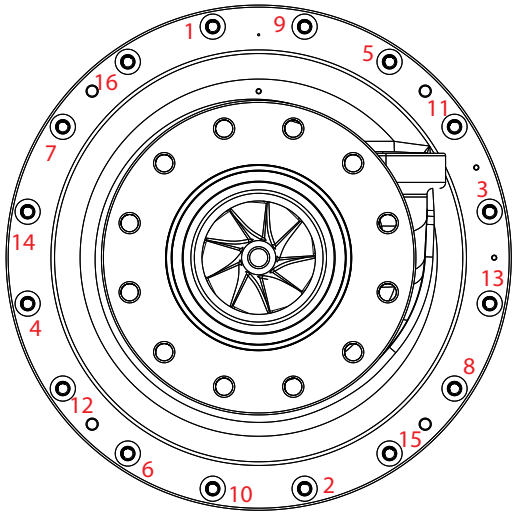
⚠ • • • CAUTION • • •

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

22. Carefully install the Suction Housing.
23. Prepare all 16 fasteners with the lock washer and flat washer.
24. Finger tighten at least four (4) fasteners before removing the guide pins.
25. Remove the guide pins and finger tighten the remaining fasteners.
26. Move from corner to corner (four (4) positions 90° apart), moving 180° then 90° and tighten these four (4) fasteners ONLY two (2) turns each, until those four (4) fasteners have seated the Suction Housing against the Volute. Performing this tightening sequence prevents damage to the O-Ring.
27. Tighten all remaining fasteners until seated and then, using the pattern in "Figure 3-169 Suction Housing Torque Pattern" on page 127, 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 3-169 Suction Housing Torque Pattern

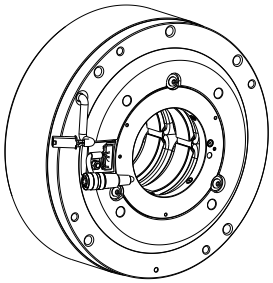


28. Remove the Compressor motor housing support.
29. Install the IFV Assembly and finger-tighten all fasteners evenly. Refer to "3.2.3.1 IFV Pipe Assembly Removal and Installation" on page 40.
30. Remove the three (3) guide pins previously inserted in the three (3) holes of the Axial Bearing Assembly.
31. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
32. Apply Super-O-Lube to the new End Cap O-ring and then fit it into the O-ring groove.
33. Insert 3" guide fasteners into the 10 o'clock and 2 o'clock position.
34. Gently slide the End Cap into the Compressor housing.
35. Assemble all 12 of the M12x55 fasteners with the flat and lock washers.
36. Insert the fasteners in the available locations.
37. Remove the two (2) guide fasteners and insert the remaining fasteners.
38. Finger-tighten all 12 fasteners and ensure that the End Cap is seated evenly into the Compressor housing.
39. Tighten the 12 M5 fasteners 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.)
40. Install the Service Side Cover.
41. Attach the motor power cables to the terminals and torque to 20 Nm (15 ft.lb.).
42. Install the three (3) M10 nuts and washers on the studs above the copper spacers and power cables, then torque to 10 Nm (7 ft.lb.).
43. Install the Motor Power Cover.
44. Leak test the Compressor to the appropriate pressure and industry standards.
45. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
46. Charge the Compressor with refrigerant.
47. Restore power to the Compressor.
48. Using the SMT, perform a calibration and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.

3.5.4 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.

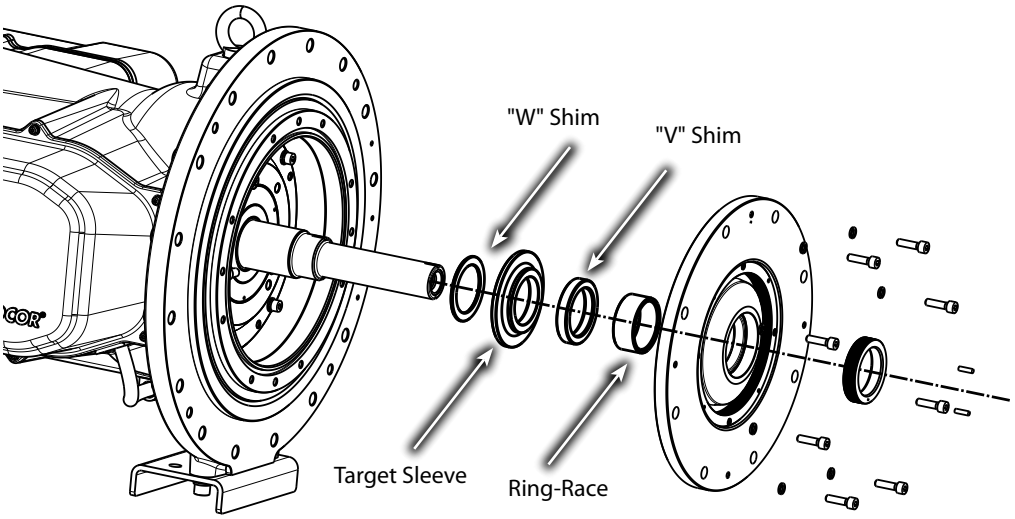
Figure 3-170 Front Twin Bearing Assembly



3.5.4.1 Front Twin Bearing Assembly Removal

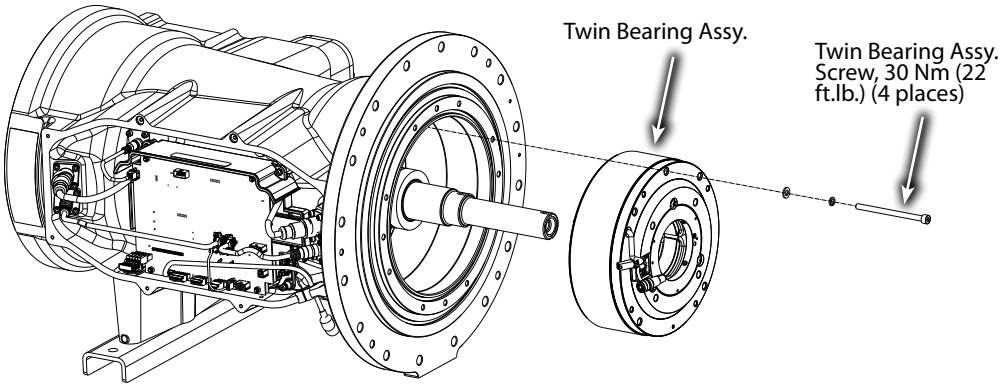
1. Refer to "3.5.3 Front Touchdown Bearing/Labyrinth Seal" on page 113 for all of the removal steps prior to the removal of the Front Twin Bearing Assembly.
2. Remove the following components if they are still installed on the shaft:
   - Ring-Race
   - "V" Shim
   - Target Sleeve
   - "W" Shim

Figure 3-171 Bearing Race and Shim Behind Touchdown Bearing/Labyrinth Seal Plate



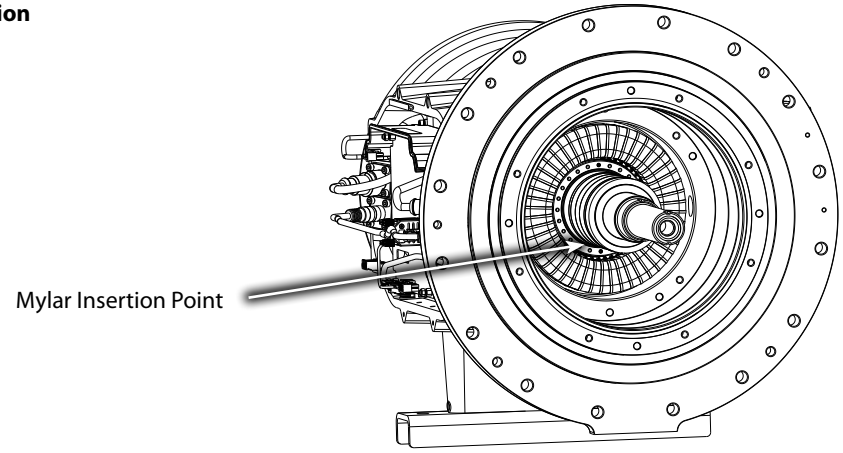
3. Remove the internal cable tie from the Bearing Sensor Feedthrough cable.
4. Disconnect the internal connectors from the Front Bearing Sensor Feedthrough and the Front Bearing Power Feedthrough.
5. Disconnect the external bearing sensor and power cable from the feedthroughs.
6. Remove the eight (8) M5 fasteners holding the feedthroughs to the housing.
7. Carefully remove both feedthroughs from the housing. Gently pull the internal connectors through the housing.
8. Remove the O-rings.
9. Remove the four (4) M8x120 fasteners from the Twin Bearing Assembly.

Figure 3-172 Front Twin Bearing Assembly Removal



10. Install the four (4) jacking screws into the Twin Bearing assembly to push it away from the housing.
11. Slowly tighten the four (4) jacking screws evenly, in a crisscross pattern. Continue this until the Twin Bearing Assembly can be removed by hand.
12. While supporting the shaft, carefully slide out the Twin Bearing Assembly.
13. Slide a small piece of Mylar underneath the shaft and gently lower the shaft onto the Stator.

Figure 3-173 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.

3.5.4.2 Front Twin Bearing Assembly Installation

1. Carefully lift the shaft and remove the piece of Mylar.
2. While still supporting the shaft, carefully install the Twin Bearing Assembly.
3. Install the four (4) M8x120 fasteners 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 30 Nm (22 ft.lb.)
4. Verify all contact surfaces are clean and dry. If not, clean with a lint-free cloth.
5. Apply Super-O-Lube to the new feedthrough O-rings and then fit them into the O-ring grooves.
6. Carefully insert both feedthroughs into the housing. Reconnect the internal connectors.
7. Install a new internal cable tie to secure the bearing sensor feedthrough cable.

8. Install the eight (8) M5x20 feedthrough fasteners 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.)
9. Reconnect the external bearing sensor and power cables to the feedthroughs.
10. Install a new internal cable tie to secure the bearing sensor feedthrough cable.
11. Install the "W" Shim, Target Sleeve, and "V" Shim in the order that they were removed. Refer to "Figure 3-171 Bearing Race and Shim Behind Touchdown Bearing/Labyrinth Seal Plate" on page 128.
12. Refer to "3.5.3 Front Touchdown Bearing/Labyrinth Seal" on page 113 for the remainder of the assembly steps.
13. Leak test the Compressor to the appropriate pressure and industry standards.
14. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
15. Charge the Compressor with refrigerant.
16. Restore power to the Compressor.

3.5.4.2.1 Front Twin Bearing Assembly Verification

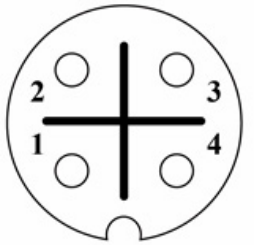
1. Disconnect the PWM connector from the Bearing Power Feedthrough.
2. Verify bearing coil resistance at the feedthrough pins according to "Table 3-31 Front Bearing Coil Resistance".
3. Verify that the resistance of each pin to ground is open.

Table 3-31 Front Bearing Coil Resistance

Bearing Identification	Feedthrough 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 3-174 Front Bearing Power Feedthrough Pinout

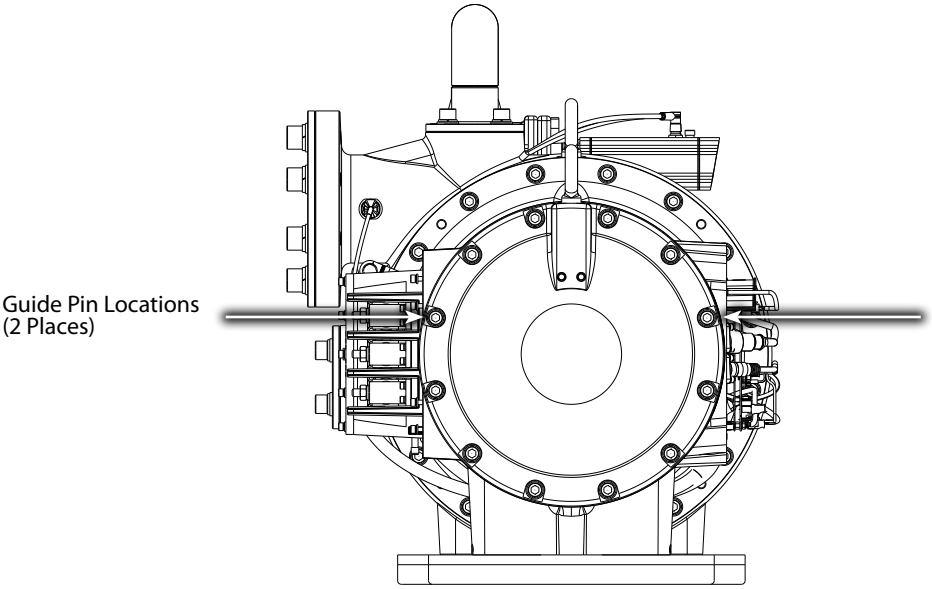


3.5.5 Axial Bearing

3.5.5.1 Axial Bearing Disassembly

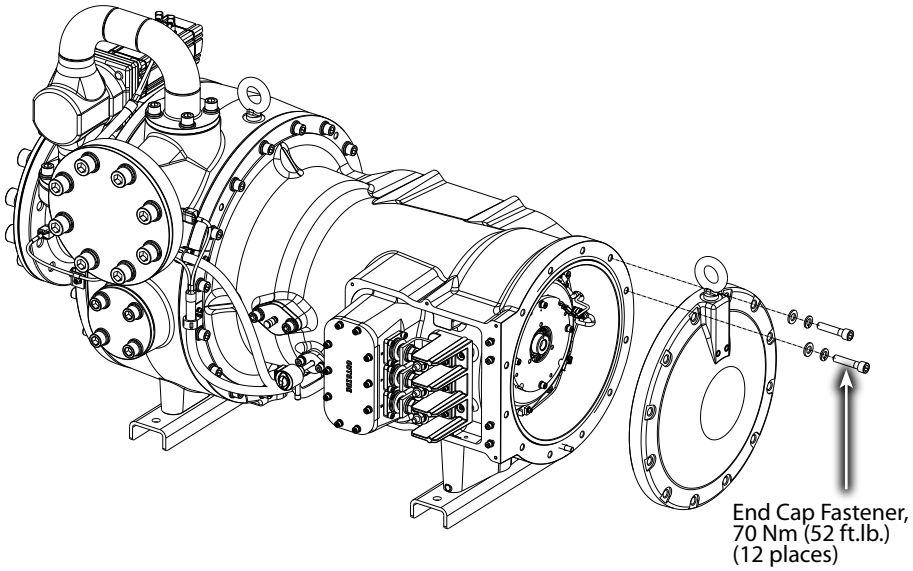
1. Prior to teardown, a bearing calibration must be performed. Using the SMT, perform a calibration and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.
2. Remove the two (2) M12x55 fasteners located at the 10 o'clock and 2 o'clock positions on the End Cap.
3. Insert the Guide Pins in these locations (refer to "Figure C-2 - Guide Pin" on page 189 in Appendix B). Refer to "Figure 3-175 Guide Pin Locations" for the locations of the pins.

Figure 3-175 Guide Pin Locations



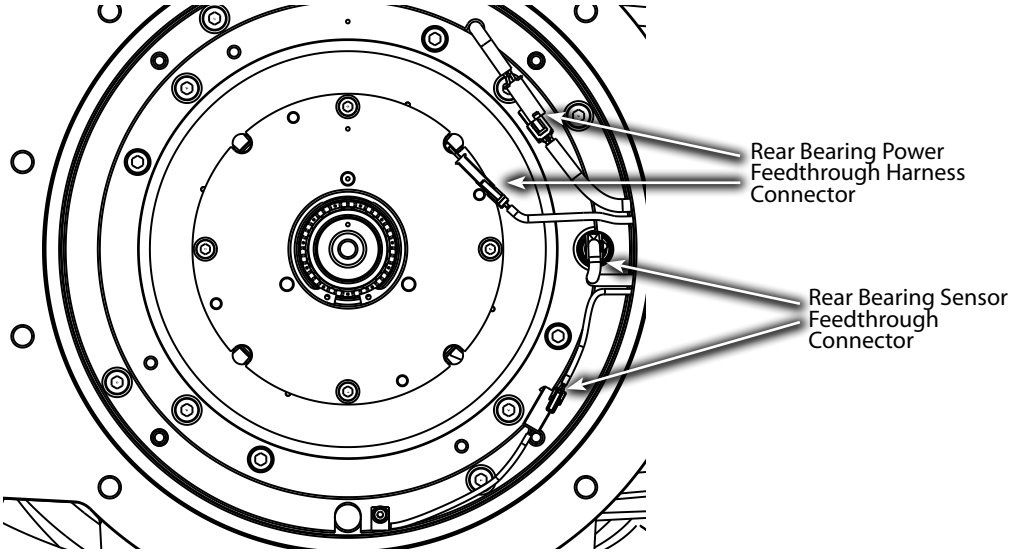
4. Remove remaining fasteners and use a rubber mallet to tap off the End Cap.
5. Gently slide the End Cap away from the Compressor housing and set aside the End Cap.

Figure 3-176 End Cap Removal



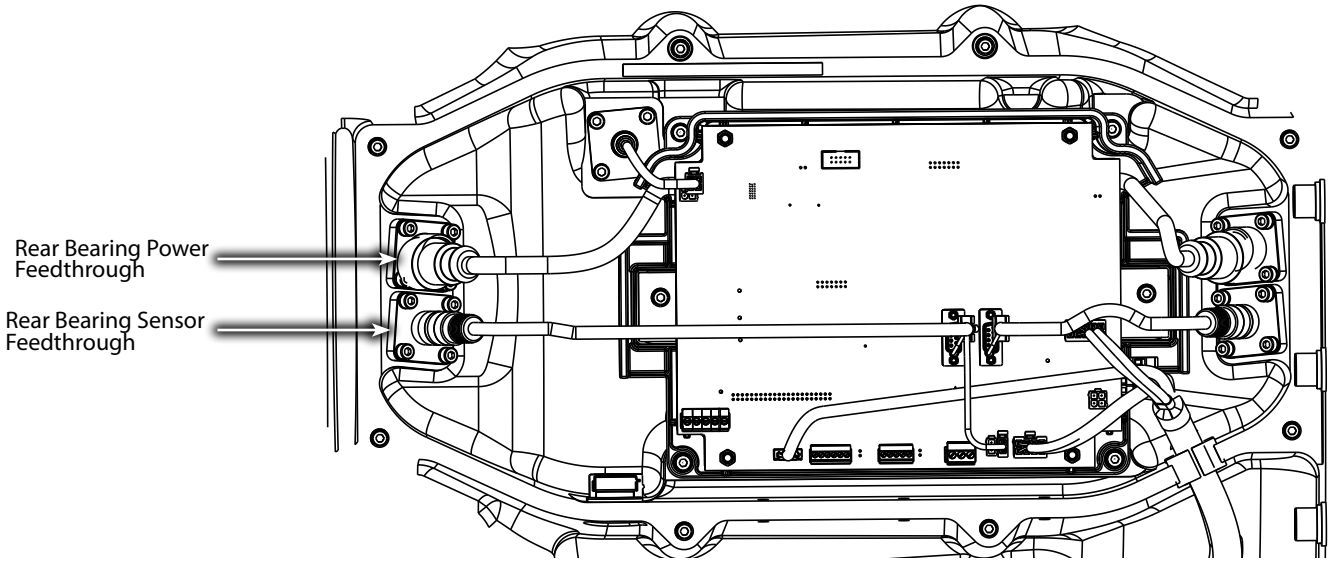
6. Disconnect the Rear Bearing Sensor and Rear Bearing Power connectors. Refer to "Figure 3-177 Rear Bearing Sensor and Rear Bearing Power Harness".

Figure 3-177 Rear Bearing Sensor and Rear Bearing Power Harness



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

Figure 3-178 Rear Feed Through Removal

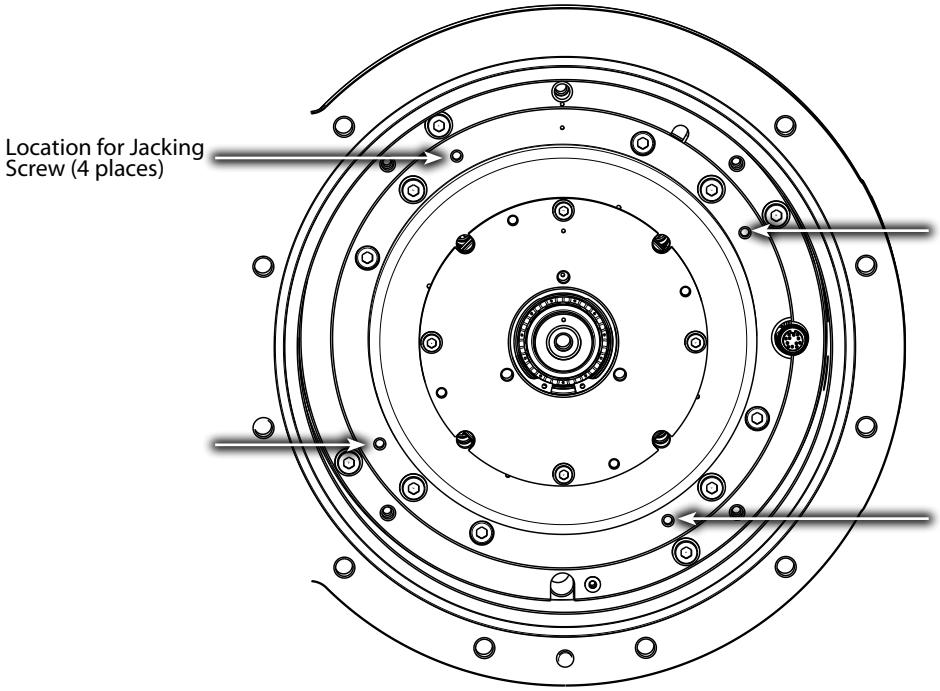


11. Remove the four (4) fasteners that secure the Axial Bearing Assembly.
12. Insert four (4) 6 mm jacking screws to aid in the removal of the Axial Bearing Assembly. This will be required due to the magnetic force keeping the assembly in place. Once the magnetic force decreases, gently slide away the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

⚠ • • • CAUTION • • •

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

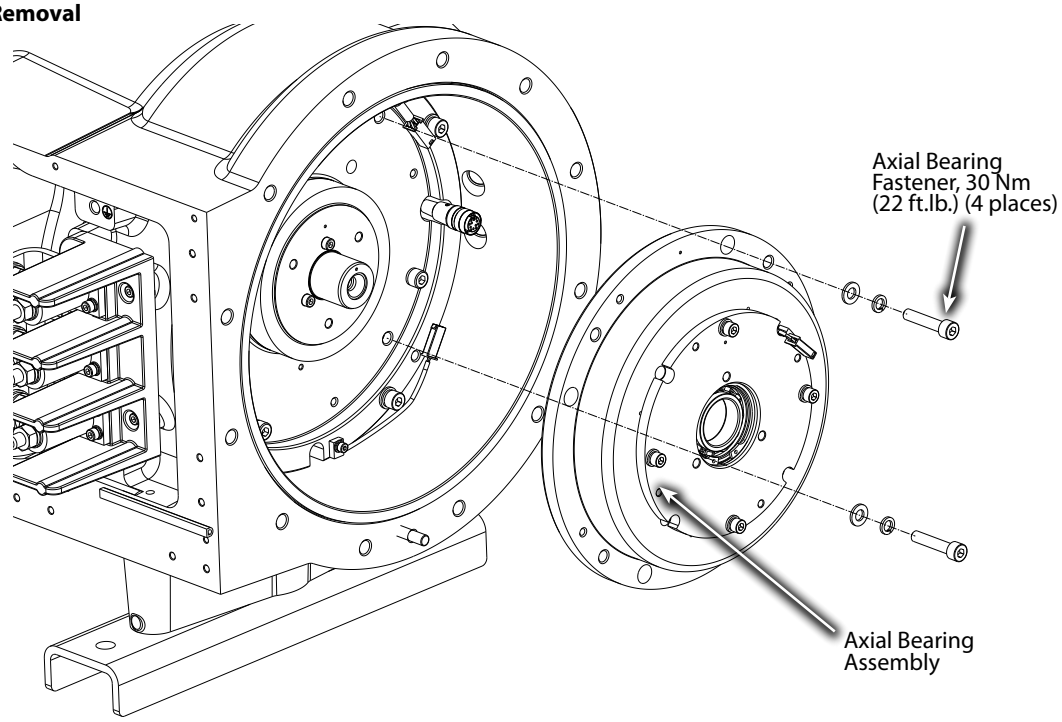
Figure 3-179 Axial Bearing Assembly Jacking Screw Locations



NOTE

For clarity, all wire harnesses were removed from "Figure 3-179 Axial Bearing Assembly Jacking Screw Locations".

Figure 3-180 Axial Bearing Removal



3.5.5.2 Axial Bearing Assembly

1. Remove the four (4) 6 mm jacking screws from the Axial Bearing Assembly.
2. Carefully slide the Axial Bearing Assembly into place over the Compressor shaft.

⚠ • • • CAUTION • • •

Magnetic force can pull the Axial Bearing into place with force, always avoid pinch points.

3. Install the four (4) M8x40 fasteners 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.)
4. Carefully install both feedthroughs into the compressor housing. Refer to "3.4.3 Rear Bearing Power and Sensor Feedthroughs" on page 72.
5. Reconnect the external bearing sensor and power cables to the feedthroughs.
6. Connect the Rear Bearing Sensor and Rear Bearing Power connectors.
7. Verify all End Cap contact surfaces are clean and dry. If not, clean with a lint-free cloth.
8. Apply Super-O-Lube to the new O-ring and then fit it into the O-ring groove.
9. Insert two (2) Guide Pins into the 10 o'clock and 2 o'clock position.
10. Gently slide the End Cap into the Compressor housing.
11. Assemble all 12 of the M12x55 fasteners with the flat and lock washers.
12. Insert the fasteners in the available locations.
13. Remove the two (2) Guide Pins and insert the remaining fasteners.
14. Finger-tighten all 12 fasteners and ensure that the End Cap is seated evenly into the Compressor housing.
15. Tighten the 12 M5 fasteners 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.)
16. Install the Service Side Cover. Refer to "3.4.1 Service Side Cover" on page 69.
17. Leak test the Compressor to the appropriate pressure and industry standards.
18. Evacuate the Compressor to the appropriate pressure and industry accepted standards.
19. Charge the Compressor with refrigerant.
20. Restore power to the Compressor.
21. Using the SMT, perform a calibration and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.

3.5.6 Rear Radial Bearing

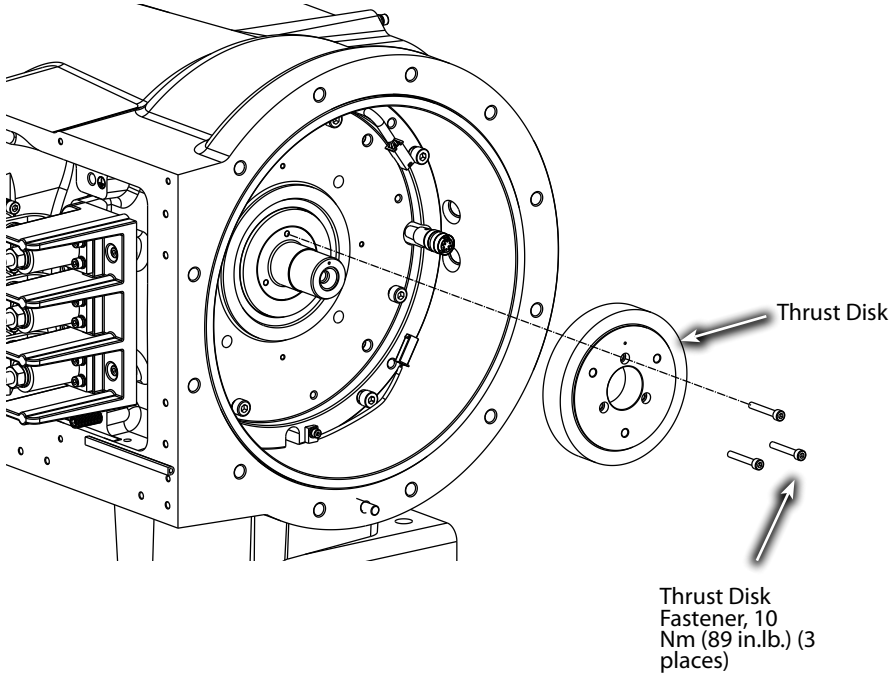
3.5.6.1 Rear Radial Bearing Disassembly

1. Refer to "3.5.5 Axial Bearing" on page 130 for all removal steps prior to the Radial Bearing removal.
2. Remove the three (3) M5x35 fasteners that secure the Thrust Disk and carefully slide the Thrust Disk off the Compressor shaft. Refer to "Figure 3-181 Thrust Disk Removal".

⚠ • • • CAUTION • • •

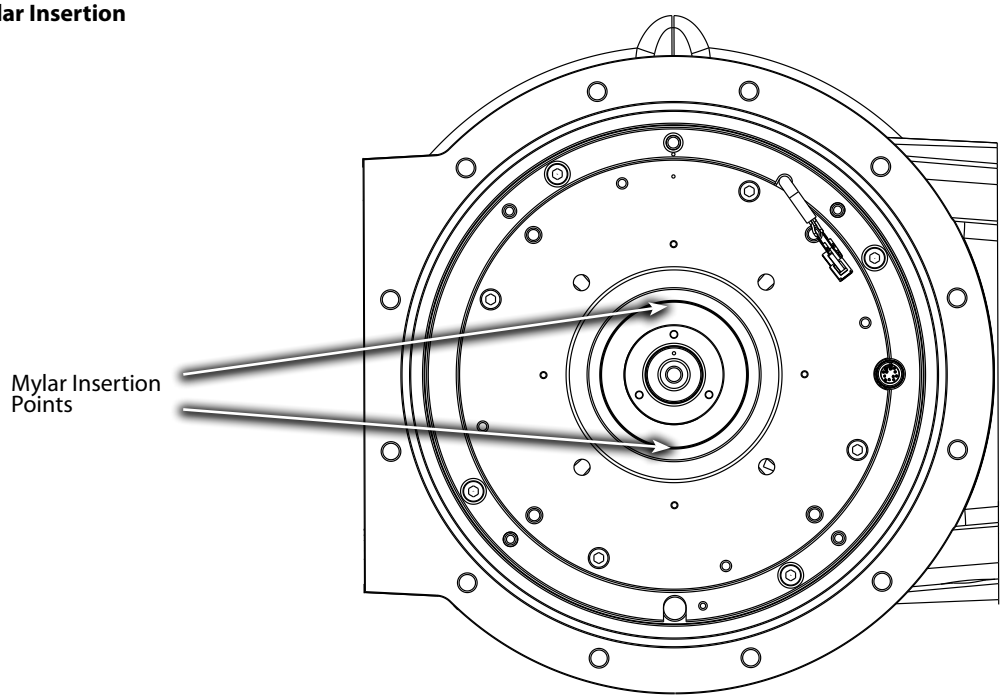
All magnetic parts MUST be separated and placed in individual bags that can be sealed to prevent contamination to the parts. Metal debris can and will lead to premature failure of the Compressor components.

Figure 3-181 Thrust Disk Removal



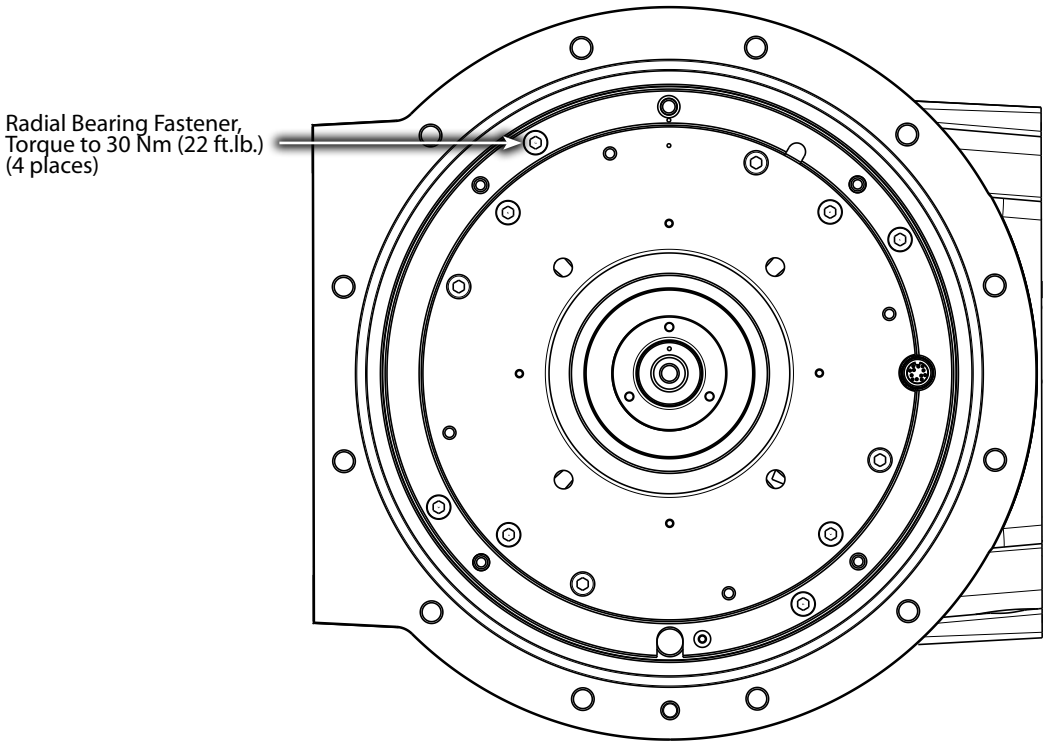
3. Insert two (2) pieces of Mylar between the Compressor shaft and the Rear Radial Bearing Assembly.

Figure 3-182 Radial Bearing Mylar Insertion



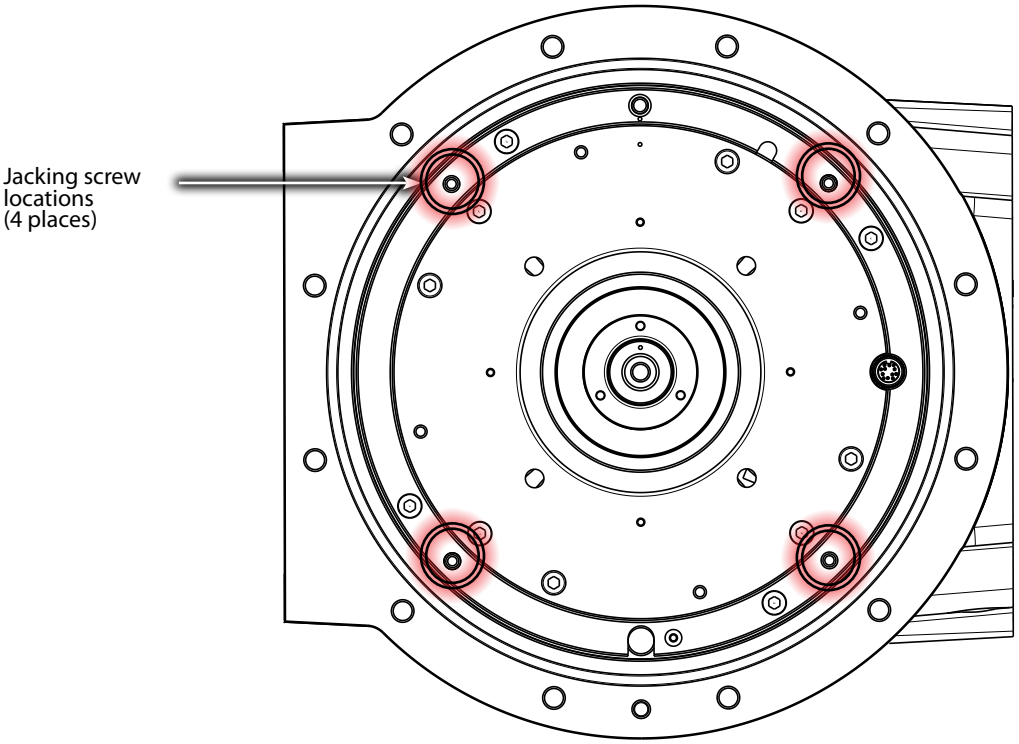
4. Remove the four (4) M8x65 fasteners that secure the Radial Bearing Assembly.

Figure 3-183 Radial Bearing Fasteners



5. Insert the four (4) jacking screws into the jacking screw locations as indicated in "Figure 3-184 Radial Bearing Assembly Jacking Screw Locations" on page 136.

Figure 3-184 Radial Bearing Assembly Jacking Screw Locations



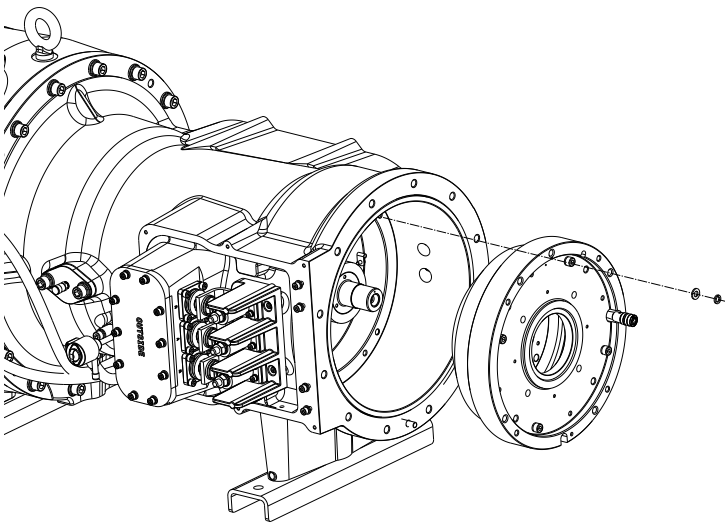
6. Slowly tighten the four (4) jacking screws evenly, in a crisscross pattern. Continue this until the Radial Bearing Assembly can be removed by hand.

7. While supporting the shaft, carefully slide out the Radial Bearing Assembly.

⚠ • • • CAUTION • • •

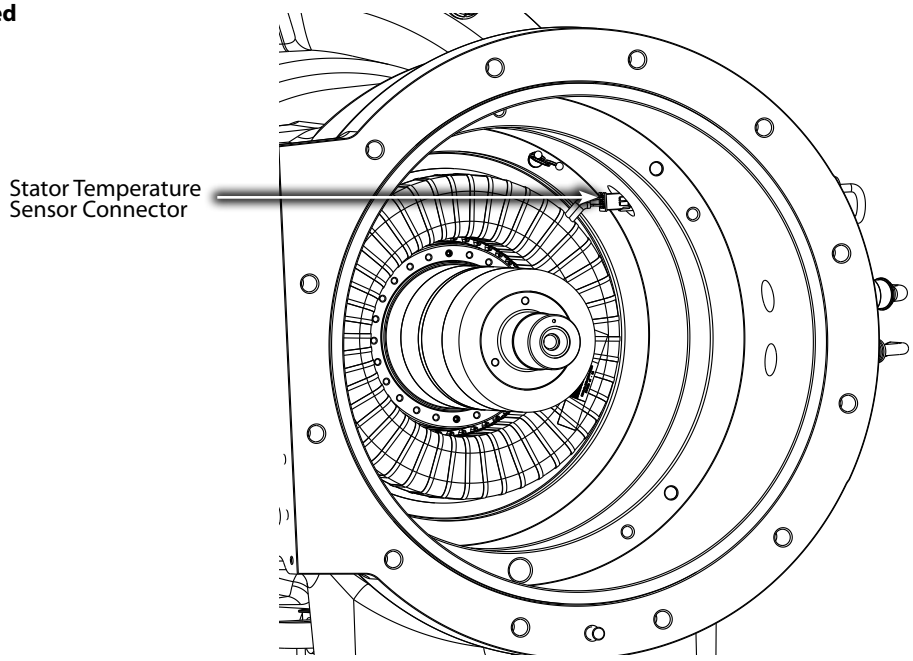
Do not allow the Radial Bearing Assembly to contact/rub the Compressor shaft during removal. Damage to the shaft and or bearing assembly may occur.

Figure 3-185 Radial Bearing Assembly Removal



8. Slide a small piece of Mylar underneath the shaft and gently lower the shaft onto the Stator.

Figure 3-186 Radial Bearing Removed



3.5.6.2 Radial Bearing Assembly

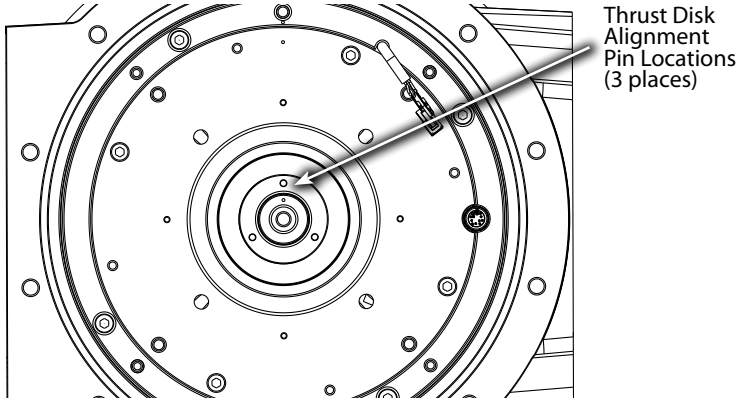
1. Support the shaft and remove the Mylar, then carefully insert the Radial Bearing Assembly into place.

⚠ • • • 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.

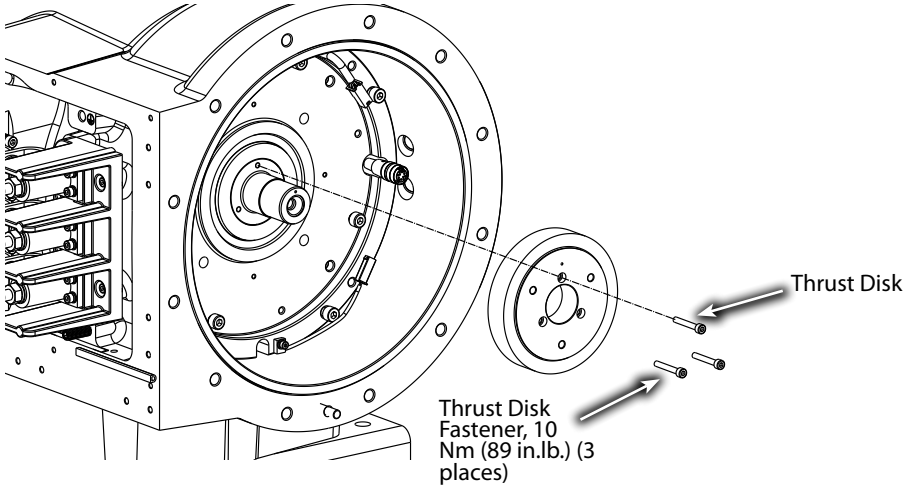
2. Install the four (4) M8x65 fasteners that secure the Radial Bearing Assembly and tighten them in a crisscross pattern in two (2) stages.
   - Stage 1: Tighten to 15 Nm (11 ft.lb.)
   - Stage 2: Tighten to a final torque of 30 Nm (22 ft.lb.)
3. Insert at least two (2) Thrust Disk Alignment Pins into the threaded holes in the Compressor shaft. Refer to "Figure 3-187 Thrust Disk Alignment Pins" for the pin location. These pins are necessary due to the magnetized shaft.
4. Carefully slide the Thrust Disk into place over the Compressor shaft and align it with the inserted pins.
5. Remove all of the Thrust Disk Alignment Pins.

Figure 3-187 Thrust Disk Alignment Pins



6. Insert the three (3) M5x35 fasteners that secure the Thrust Disk and torque to 10 Nm (7 ft.lb.). Refer to "Figure 3-188 Thrust Disk Installation".

Figure 3-188 Thrust Disk Installation



7. Install the Axial Bearing. Refer to "3.5.5 Axial Bearing" on page 130 for the remainder of the assembly steps.
8. Using the SMT, perform a calibration and save to EEPROM. Refer to "3.4.4.12.2 Verification" on page 102. Refer to the SMT User Manual for calibration instructions.

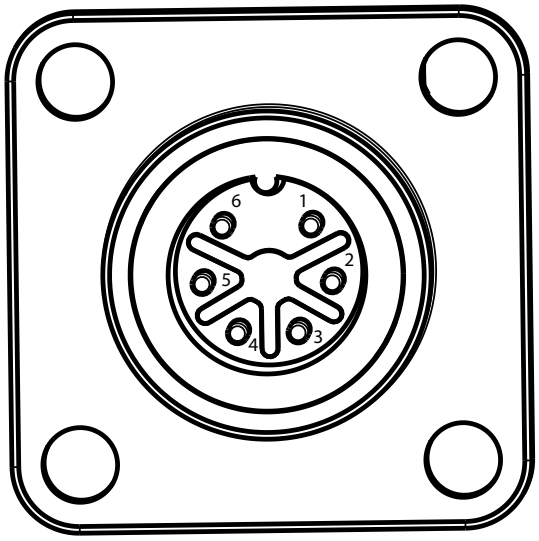
3.5.6.2.1 Bearing Verification

1. Disconnect the PWM connector from the Bearing Power Feedthrough.
2. Verify bearing coil resistance at the feedthrough pins according to "Table 3-32 Rear Bearing Coil Resistance" on page 139. Refer to "Figure 3-189 Rear Bearing Power Feedthrough Pin Identification" on page 139.
3. Verify that the resistance of each pin to ground is open.

Table 3-32 Rear Bearing Coil Resistance

Bearing Identification	Feedthrough 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 3-189 Rear Bearing Power Feedthrough Pin Identification



3.5.6.2.2 Radial Bearing Torque Specifications

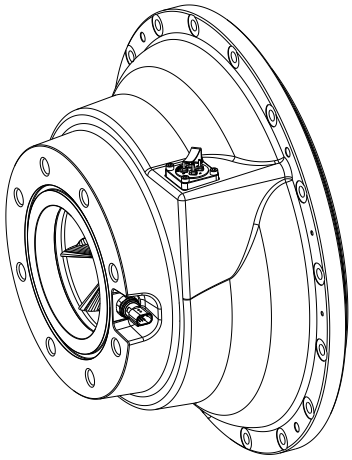
Table 3-33 Radial Bearing Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
Power Cover, SHCS, M5x16	6	-	53
Power Cover, SHCS, M5x25	6	-	53
Service Side Cover, SHCS, M5x16	6	-	53
Power Cable Nut, Brass M10x1.5	10	8	89
Rear Bearing Power Feedthrough, SHCS, M6x20	6	-	53
Rear Bearing Sensor Feedthrough, SHCS, M6x20	6	-	53
Stator Temperature Sensor Feedthrough, 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

3.6 VTX IGV

The IGV assembly consists of movable vanes and a motor. The IGV assembly is a variable-angle guiding device that is used to control the capacity at low-load conditions. The IGV position can vary between approximately 0% (closed/perpendicular to flow) and 100% (open/parallel to flow). The vane angle is determined by the CCM. The CCM will send the +15VDC signal to the IGV stepper motor to control the angle of the blades.

Figure 3-190 VTX IGV Assembly



3.6.1 IGV Connections

Refer to "Figure 3-191 IGV Connections" for the location of the IGV connections.

Figure 3-191 IGV Connections

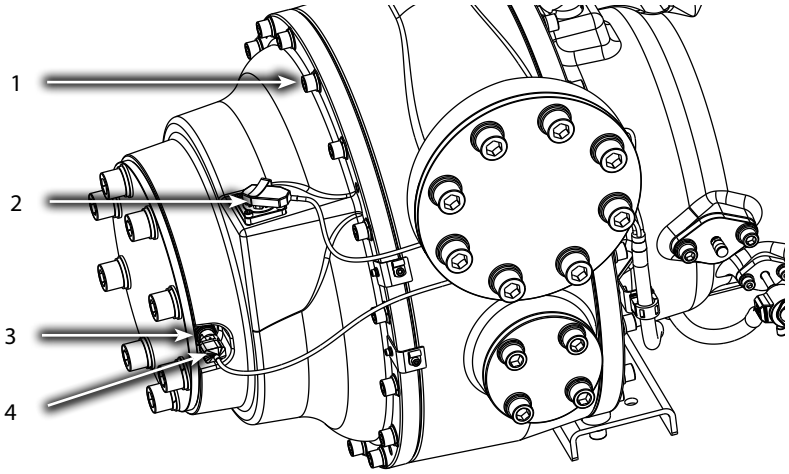


Table 3-34 IGV Components

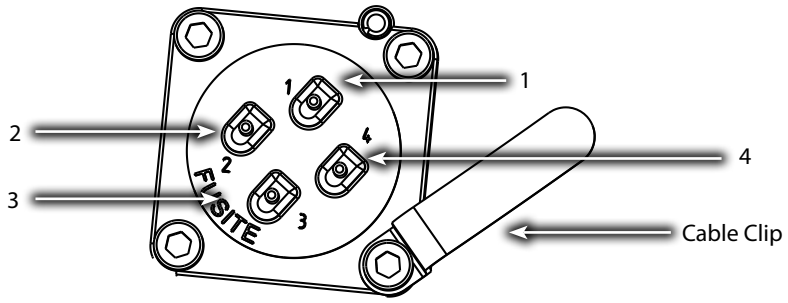
No.	Component
1	The IGV assembly is bolted to the compressor housing.
2	The compressor controller cable is held to the IGV Motor Feedthrough by the cable clip.
3	The suction pressure/temperature sensor is connected to the IGV Housing.
4	The compressor controller cable connects to the suction pressure/temperature sensor.

3.6.2 IGV Verification

3.6.2.1 IGV Stepper Motor Verification

1. Isolate Compressor power. Refer to "1.7 Electrical Isolation of the VFD" on page 17.
2. Disconnect the IGV Motor Cable from the suction pressure/temperature sensor and the IGV Motor power feedthrough. Refer to "Figure 3-192 IGV Motor Feedthrough" for this and the following step.
3. Measure the resistance between terminals 1 and 2, and 3 and 4 of the IGV Motor Feedthrough. The measured value should be between 46Ω and 59Ω.
4. Measure the resistance between the IGV Motor Feedthrough terminals and the IGV Housing. The measured value should be open or infinity.

Figure 3-192 IGV Motor Feedthrough

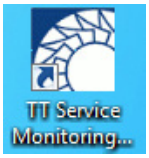


3.6.2.2 IGV Operation Verification

Some of the steps contained within this section require the use of the SMT. Refer to the Service Monitor Tool Manual regarding the proper usage of the SMT.

1. Remove the Service Side Cover. Refer to "3.4.1 Service Side Cover" on page 69.
2. Measure the +15V test point on the CCM to verify voltage is supplied to the IGV stepper motor.
3. Place a strong magnet on the outside of the IGV housing. It should attract itself to the side of the IGV housing near the raised marks.
4. Note the current location of the magnet.
5. Open the SMT installed on your computer and connect to the Compressor. Refer to "Figure 3-193 SMT Icon".

Figure 3-193 SMT Icon

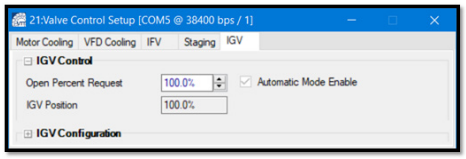


6. Log in at OEM or Technician access level.
7. Verify the compressor is not running. If the compressor is running, shut it down
8. Remove the RS485 PLC control wiring and Interlock wiring to ensure the compressor cannot receive demand from the PLC while manually controlling the valve.
9. Open the Valve Control tool. Refer to "Figure 3-194 Valve Control Tool".

Figure 3-194 Valve Control Tool

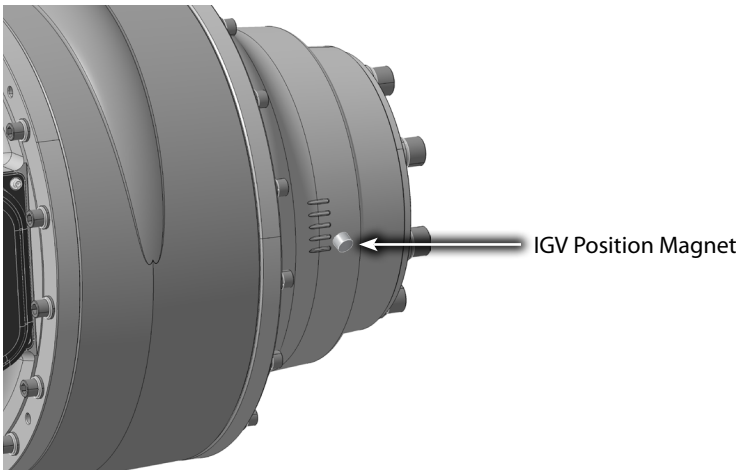
10. Select the IGV tab. Refer to"Figure 3-195 IGV Tab".

Figure 3-195 IGV Tab



11. In the Open Percent Request, set the value to 0%. The Automatic Mode Enable check box will automatically become unchecked and the IGV position will begin to descend to 0%.

Figure 3-196 IGV Open Position



12. Verify the current location of the magnet has moved from the previous location on the housing to the one shown in "Figure 3-196 IGV Open Position".

3.6.3 IGV Housing Removal and Installation

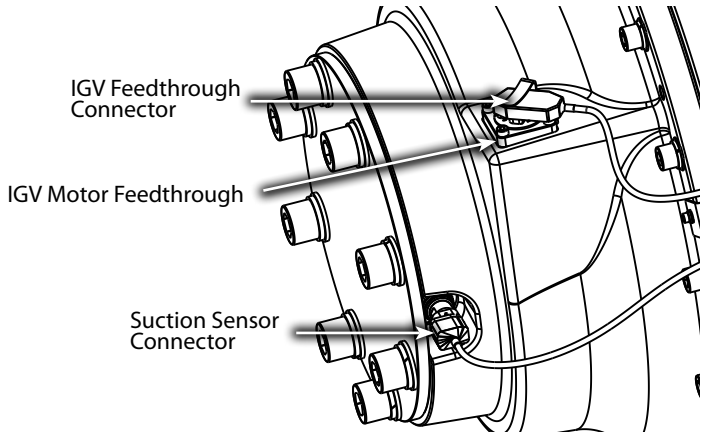
⚠ • • • CAUTION • • •

Removal of the IGV mounting fasteners will release refrigerant. Isolation and recovery of the refrigerant must be performed by a qualified service technician adhering to industry/ASHRAE standards.

3.6.3.1 IGV Housing Assembly Removal

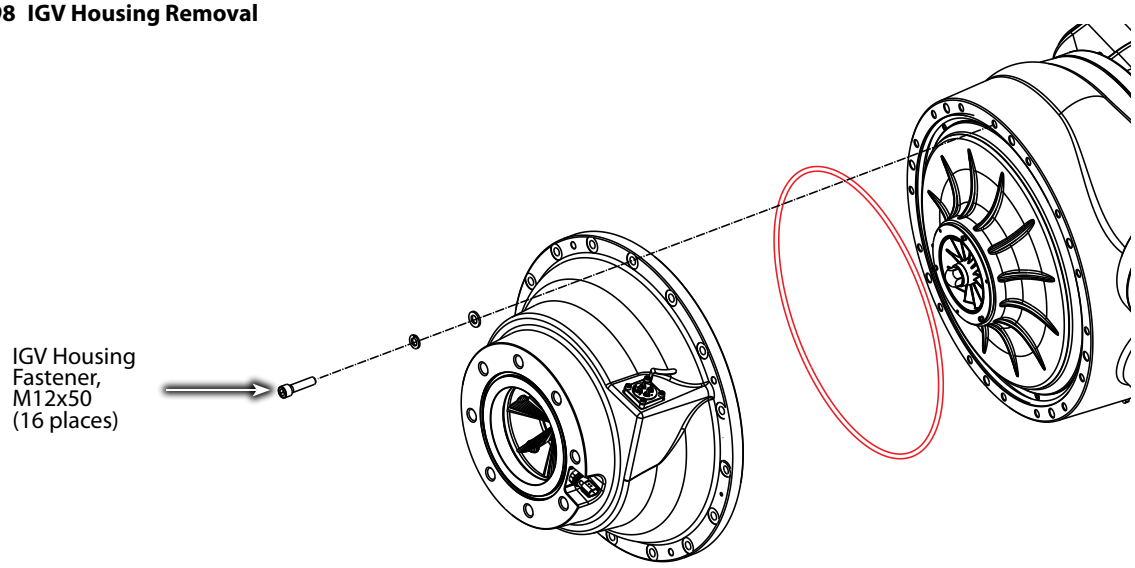
1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the clamp securing the IGV Connector. Refer to "Figure 3-197 IGV Harness Removal" for this and the following step.
3. Disconnect the IGV Motor Cable and Suction Sensor connector.

Figure 3-197 IGV Harness Removal



4. Isolate the Compressor and recover the refrigerant according to industry standards. Refer to "6.1 Refrigerant Containment" on page 175.
5. Remove the fasteners at the 10 o'clock and 2 o'clock positions from the VTX IGV Suction Housing.
6. Install the Guide Pins in these positions. Refer to "Figure C-2 - Guide Pin" on page 189 in Appendix B.
7. Remove the remaining fasteners from the VTX IGV Suction Housing. Refer to "Figure 3-198 IGV Housing Removal".
8. Locate the jacking screw holes on the flange and install the four (4) removed fasteners. Tighten them evenly in a crisscross pattern. This will slowly push the Suction Housing away from the Volute.
9. Set the VTX IGV Suction Housing aside and remove the four (4) fasteners from the jacking screw holes.
10. Remove the Guide Pins for later use.

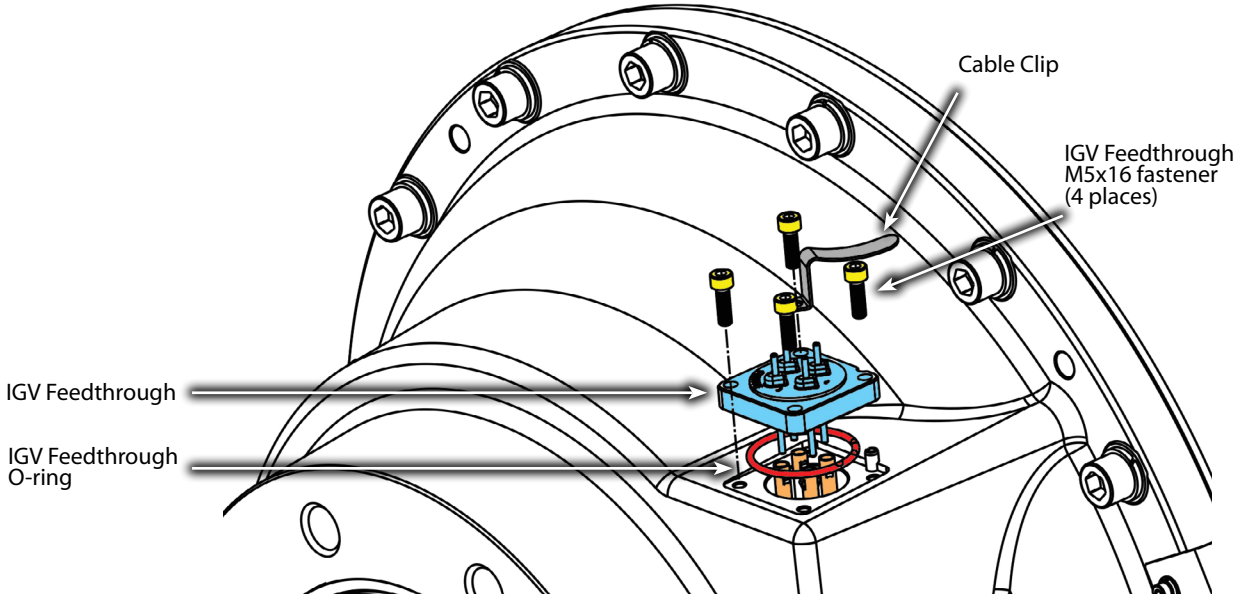
Figure 3-198 IGV Housing Removal



3.6.3.2 IGV Assembly Teardown.

1. Remove the IGV Housing Assembly.
2. Remove the four (4) M5x16 fasteners and separate the four-pin feedthrough from the IGV Housing. Refer to "Figure 3-199 IGV Feedthrough Removal".

Figure 3-199 IGV Feedthrough Removal



3. Disconnect the four (4) wires from the four-pin feedthrough. Note and record position of wire colors to their corresponding pins. Expected: 1 = Red, 2 = Gray, 3 = Yellow, and 4 = Black. Refer to "Table 3-35 IGV Feedthrough Wiring Order".

NOTE

The colors associated with each pin could vary, so be sure to identify those on the respective compressor.

Table 3-35 IGV Feedthrough Wiring Order

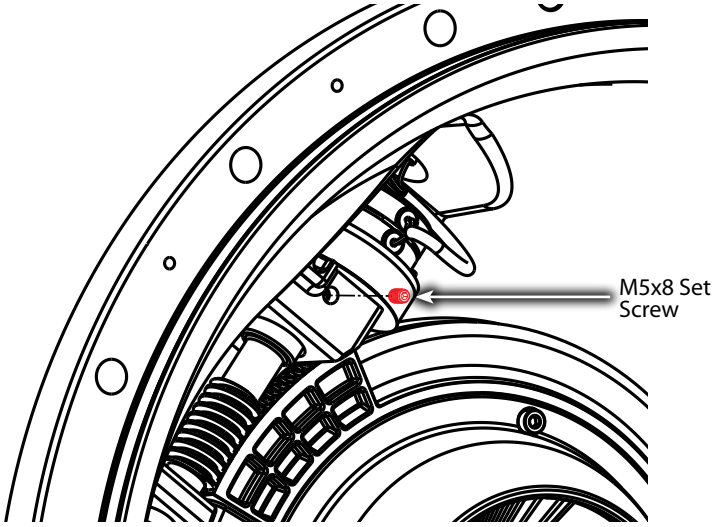
Color	Pin #
Red	1
Gray	2
Yellow	3
Black	4

4. Using a Stepper Motor Driver, turn the worm shaft and Vane Drive assembly to position the motor shaft so that locking set screw is aligned with the hole shown in "Figure 3-200 Set Screw Removal" on page 144. Use needle-nose pliers or similar tool to turn the worm gear if a Stepper Motor Driver is not available.
5. Remove the set screw completely using a 2.5 mm hex bit to release the motor from the worm gear.

Figure 3-200 Set Screw Removal

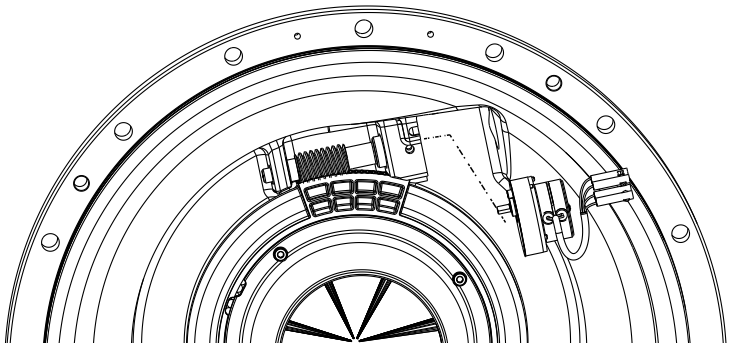
NOTE

The set screw may be difficult to release as it will have threadlocker applied. For proper engagement into the set screw, do not use a ball-end hex wrench.



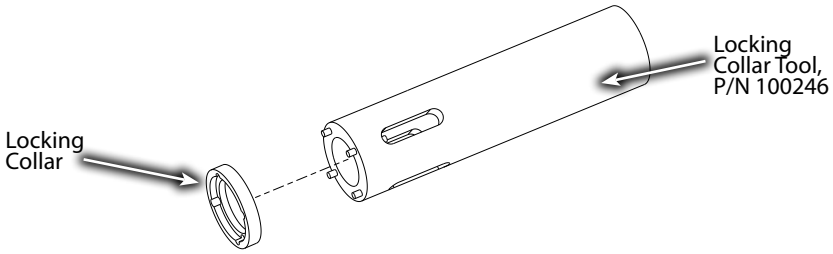
6. Remove the IGV Motor assembly by pulling away from worm shaft. Refer to "Figure 3-201 IGV Motor Assembly Removal". Support the bottom of the IGV Motor to prevent damage to the motor shaft. A light tap on the motor locating screw with a hammer may help release the motor shaft from the worm gear.

Figure 3-201 IGV Motor Assembly Removal



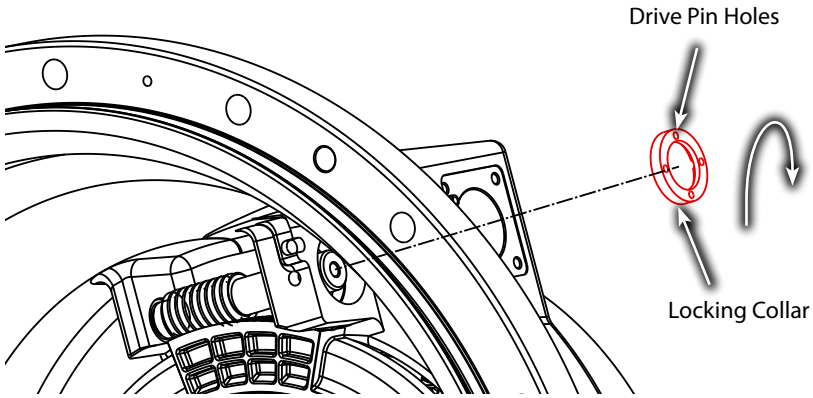
7. Slide the Locking Collar Tool (P/N 100246) into the housing and over the worm shaft. Ensure the drive pins are engaged in the Locking Collar. Refer to "Figure 3-202 Locking Collar Tool".

Figure 3-202 Locking Collar Tool



8. Turn the Locking Collar clockwise to remove. Refer to "Figure 3-203 Locking Collar Removal".

Figure 3-203 Locking Collar Removal

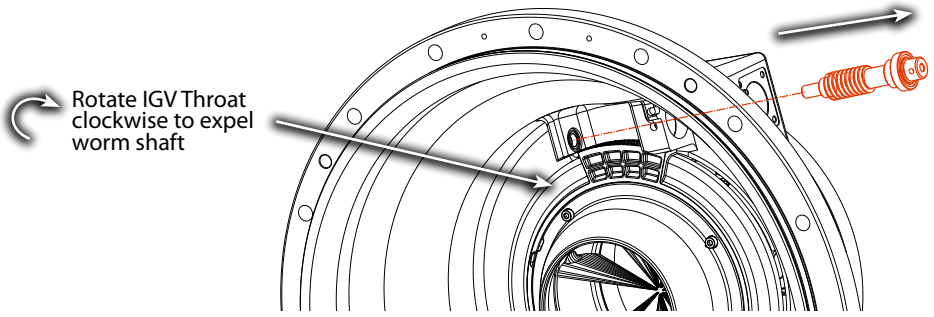


NOTE

The Locking Collar contains a left-hand thread. To remove, turn clockwise when viewing from the motor end.

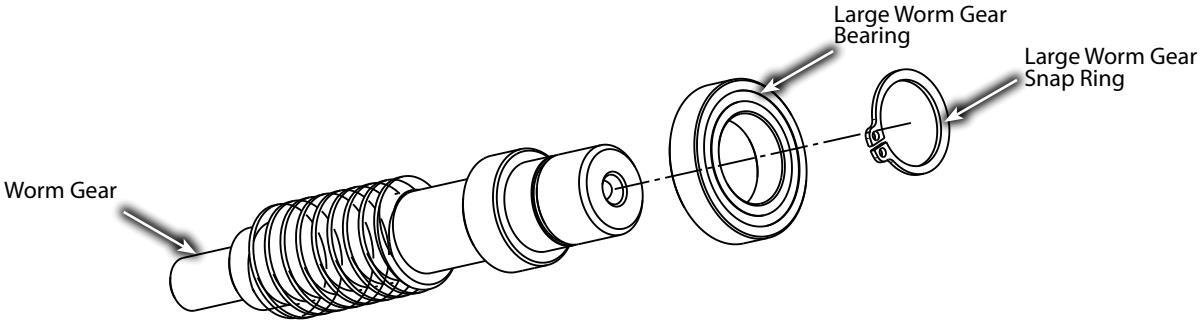
9. Remove the worm gear by rotating the IGV Throat clockwise by hand or rotate the worm shaft by hand. Refer to"Figure 3-204 Worm Gear Removal".

Figure 3-204 Worm Gear Removal



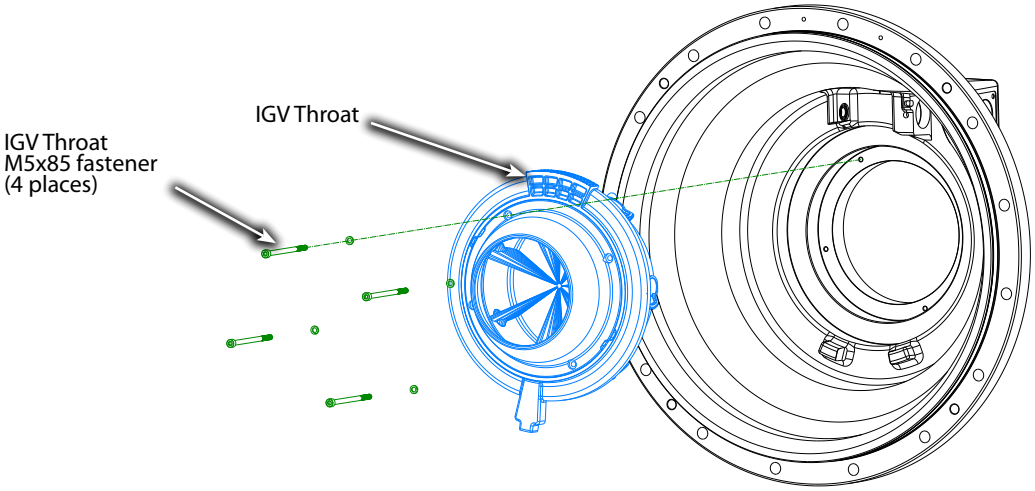
10. Remove the snap ring from the worm gear shaft. Refer to "Figure 3-205 Large Worm Gear Bearing Removal" on page 146 for this and the following step.
11. Remove the upper (large) bearing from the worm gear.

Figure 3-205 Large Worm Gear Bearing Removal



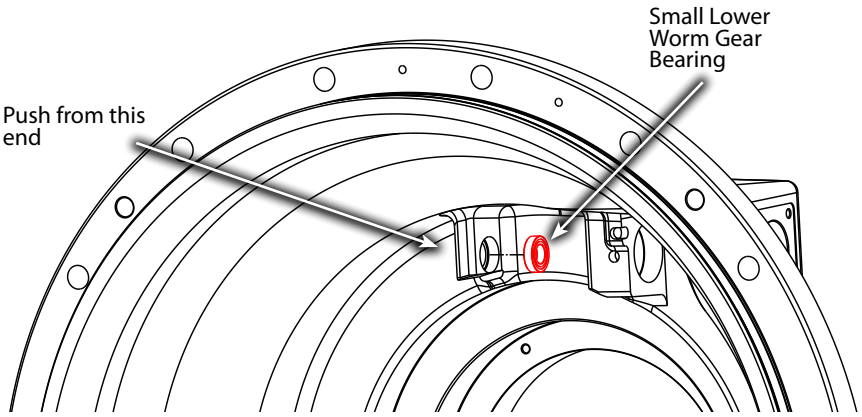
12. Remove the four (4) M5x85 fasteners that retain the IGV Throat assembly and lift the entire assembly from the IGV Housing. Refer to "Figure 3-206 IGV Throat Removal".

Figure 3-206 IGV Throat Removal



13. Inspect the IGV Housing assembly for residue/contamination or foreign objects.
14. Remove the small lower worm gear bearing from the housing. Perform this step by pushing the bearing out from the port below the bearing. Refer to "Figure 3-207 Small Worm Gear Bearing Removal".

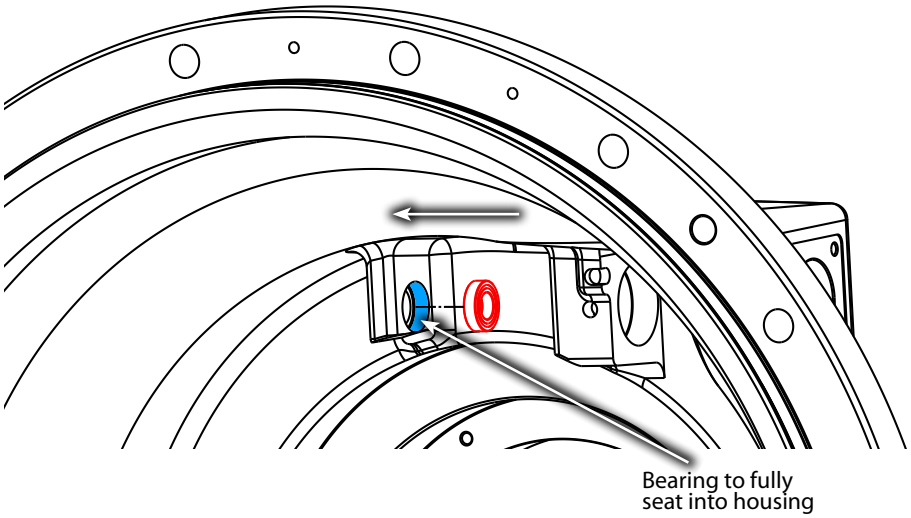
Figure 3-207 Small Worm Gear Bearing Removal



3.6.3.3 IGV Assembly Installation

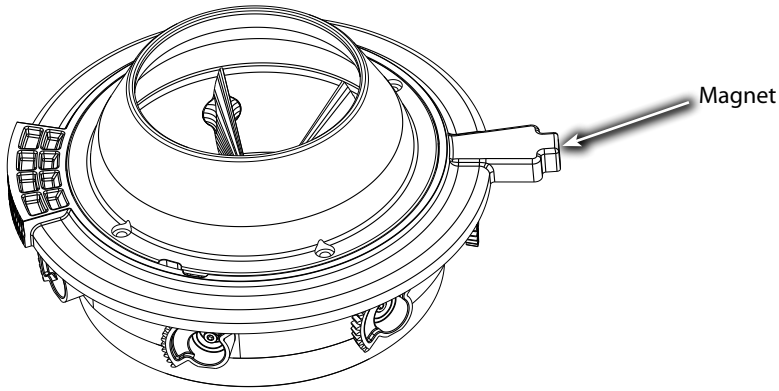
1. Ensure that all components and threads are clear, clean, and oil free.
2. Install the lower (small) worm gear bearing into the housing. This may require a very light tap with a hammer. Ensure the lower worm gear bearing is fully seated into the housing. Refer to "Figure 3-208 Small Worm Gear Bearing Installation".

Figure 3-208 Small Worm Gear Bearing Installation



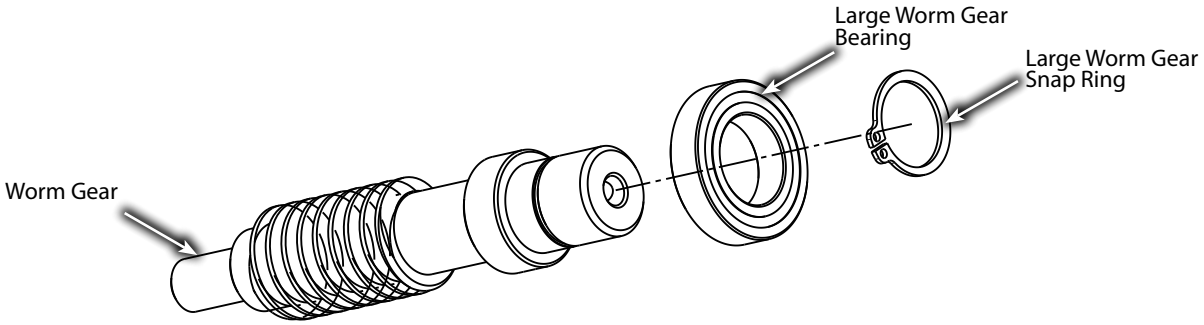
3. Ensure the IGV position indicator magnet is in place in the IGV Throat assembly. Refer to "Figure 3-209 Position Indicator Magnet".

Figure 3-209 Position Indicator Magnet



4. Place the IGV Throat assembly into the IGV Housing orientating the IGV Throat threads directly below the IGV Motor Mount.
5. Add one (1) drop of threadlocker (Loctite 243 blue or equivalent) to the four (4) M5x85 IGV Throat fastener threads and install. Torque to 5 Nm (44 in.lb.).
6. Rotate the outer ring of the drive assembly and ensure that the guide vanes move freely. The assembly must rotate over a span where the vanes are open (parallel to gas flow) and fully closed.
7. Fit the upper (large) bearing to the worm gear and install the snap ring. Refer to "Figure 3-210 Large Worm Gear Bearing Installation".

Figure 3-210 Large Worm Gear Bearing Installation



8. Install the worm gear into the housing by "screwing" the worm gear along the IGV Throat Gear. Locate the worm gear shaft into the bottom (small) bearing.
9. Place the threaded Locking Collar on the four (4) pins of the Collar tool and install into the housing.

NOTE

Ensure the flat side of the collar is against the tool.

10. Turn the Locking Collar counter-clockwise and torque to 5 Nm (44 in.lb.).

NOTE

Locking collar is a left-hand thread. Turn counter-clockwise when viewed from motor end to tighten (do not use threadlocker on collar).

Figure 3-211 Locking Collar Installation

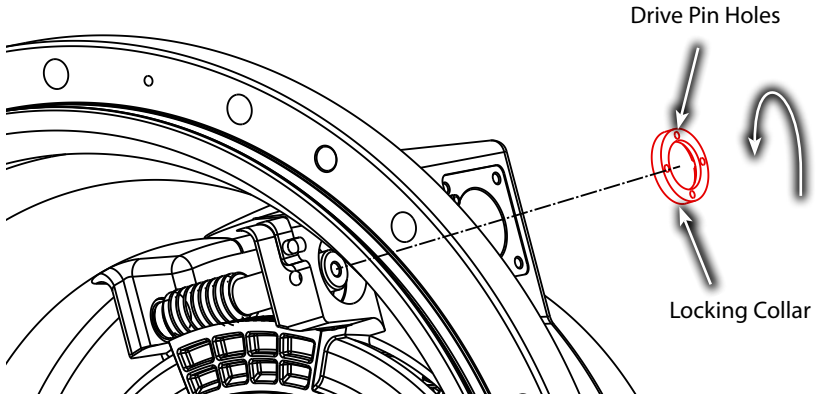
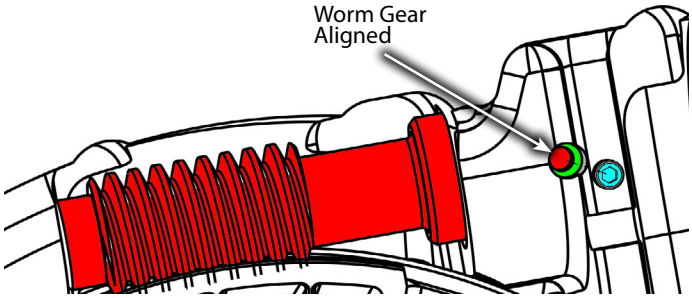
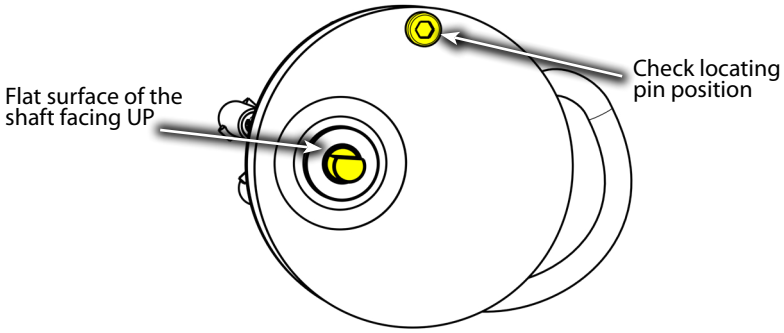


Figure 3-212 IGV Worm Gear Alignment



11. Insert the IGV Motor wires through the feedthrough hole.
12. Check the position of the flat surface of the shaft relative to the locating pin. The flat surface should be oriented facing up, ready to be inserted in the worm gear. Refer to "Figure 3-213 Shaft Position".

Figure 3-213 Shaft Position

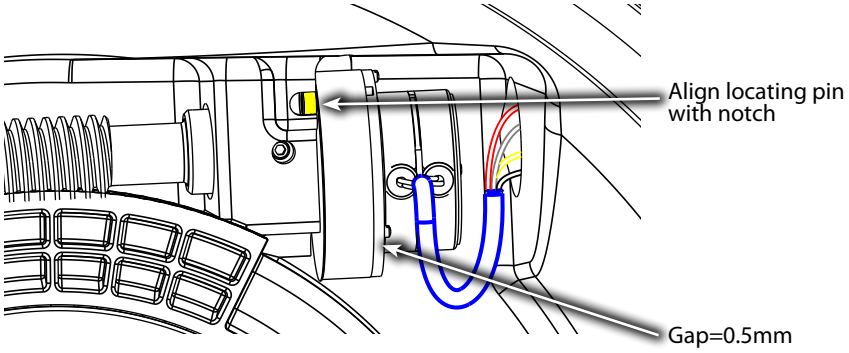


13. Install the motor into the housing and align the motor shaft flat surface with worm gear adapter.
14. Ensure the motor locating pin is aligned with the notch in the housing flange. Refer to "Figure 3-214 IGV Motor Alignment".

⚠ • • • CAUTION • • •

Check that wiring is clear of housing and edges of motor.

Figure 3-214 IGV Motor Alignment



15. Put one (1) drop of threadlocker (Loctite 243 blue or equivalent) on the threads of the small set screw. While pushing in, on the backside of the motor, secure the worm gear to the flat surface of the motor shaft using a 2.5 mm hex bit. Rock the motor backwards and forwards while tightening to ensure full and correct engagement of the screw. Torque the set screw to 5 Nm

(44 in.lb.). Refer to "Figure 3-212 IGV Worm Gear Alignment" on page 149.

16. Clean, lubricate, and install the O-ring on the feedthrough before connecting the wires.
17. Insert the motor wires onto the feedthrough pins in accordance with "Table 3-35 IGV Feedthrough Wiring Order". Also reference your notes from removal.

NOTE

The wire colors associated with each pin could vary, so be sure to refer to notes taken during removal.

18. Position the wires as shown in "Figure 3-215 Motor Wire Position" and "Figure 3-216 IGV Motor Wires Connected".

Figure 3-215 Motor Wire Position

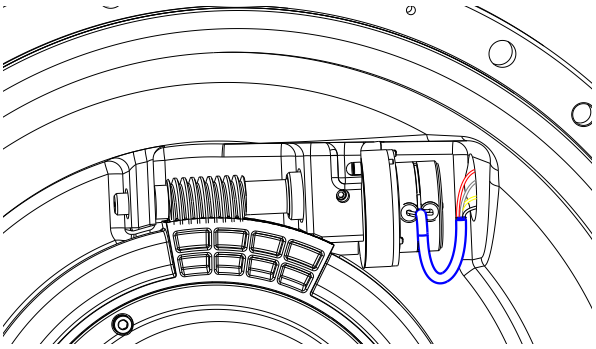
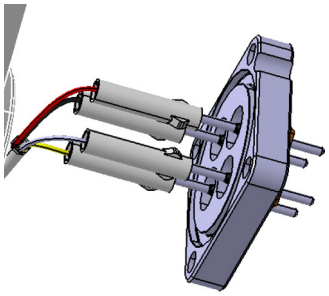
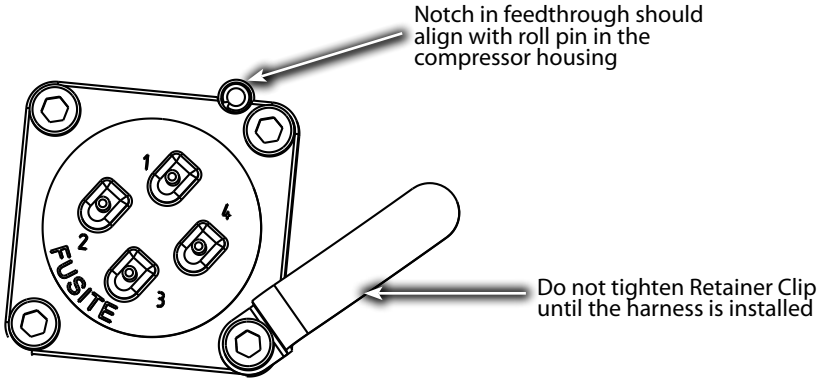


Figure 3-216 IGV Motor Wires Connected



19. Install the feedthrough using the four (4) M5x16 fasteners and install the IGV Motor Cable Retainer Clip under one of the fasteners. Tighten only three (3) of the fasteners to 5 Nm (44 in.lb.) while leaving the fourth fastener with the retainer clip slightly loose. Refer to "Figure 3-217 Feedthrough Orientation".

Figure 3-217 Feedthrough Orientation

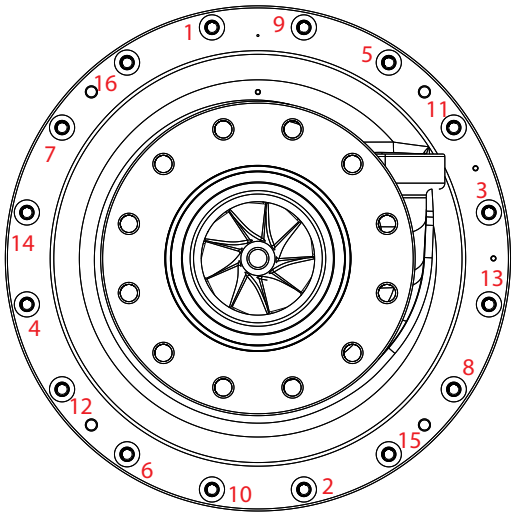


20. If available, test the motor operation with a stepper motor driver. Operation of the IGV can also be tested using the SMT driving the IGV manually (once the IGV has been mounted on the Compressor).

3.6.3.4 IGV Housing Assembly Installation

1. Verify all contact surfaces are clean and dry between the IGV Suction Housing and the Volute. 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 Suction Housing.
3. Insert the Guide Pins in the 10 o'clock, 2 o'clock, and 6 o'clock positions on the Volute.
4. Carefully install the IGV Suction Housing.
5. Prepare all 16 fasteners with the lock washer and flat washer.
6. Finger tighten at least four (4) fasteners before removing the guide pins.
7. Remove the guide pins and finger tighten the remaining fasteners.
8. Move from corner to corner (four (4) positions 90° apart), moving 180° then 90° and tighten these four (4) fasteners ONLY two (2) turns each, until those four (4) fasteners have seated the Suction Housing against the Volute. Performing this tightening sequence prevents damage to the O-ring.
9. Tighten all remaining fasteners until seated and then, using the pattern in "Figure 3-218 Suction Housing Torque Pattern", torque the fasteners in two (2) stages.

Figure 3-218 Suction Housing Torque Pattern



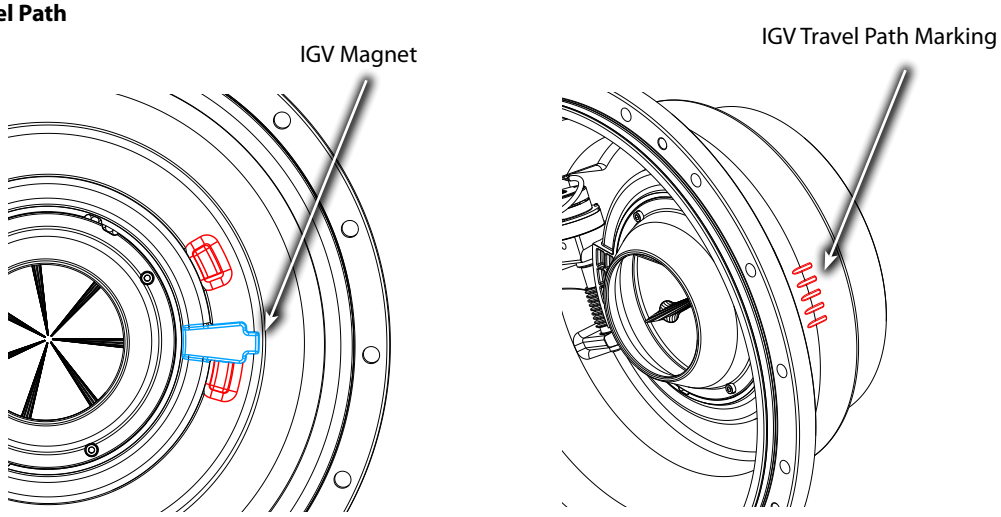
- Stage 1: Tighten to 35 Nm (26 ft.lb.)
- Stage 2: Tighten to a final torque of 70 Nm (52 ft.lb.)

10. Plug in the IGV Feedthrough Connector and the Suction Pressure Temperature Sensor Harness.
11. Torque the remaining feedthrough fastener (the one securing the Motor Harness Retainer Clip) to 5 Nm (44 in.lb.).
12. Leak test and evacuate the Compressor in accordance with standard industry practices.
13. Return the Compressor back to normal operation.
14. Test run the Compressor to verify proper operation and movement of the IGV assembly. Refer to "3.6.3.4.1 IGV Position Identification" for details.

3.6.3.4.1 IGV Position Identification

When the IGV position needs to be verified, a magnet will need to be placed onto the Suction Housing in order to verify the position of the internal IGV. The outside of the Suction Housing contains five (5) slots indicating the possible travel path of the IGV. Refer to "Figure 3-219 IGV Position Travel Path" for the illustration of the internal magnet and the exterior slots in the housing.

Figure 3-219 IGV Position Travel Path

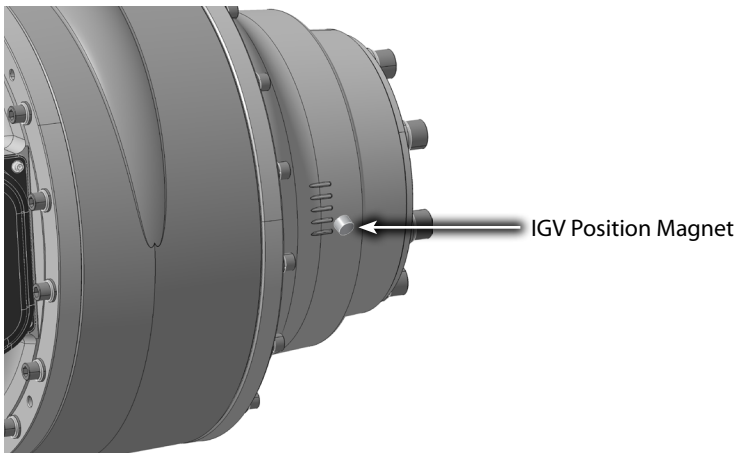


1. Place the flat side of the IGV Magnet on the suction housing and slide it along the IGV Travel Path Marking. The magnet will stay in place once it is directly over the interior magnet. Refer to "Figure 3-220 IGV Open Position" for an example of how the IGV Magnet will be placed.
2. Run the Compressor and veryify the IGV position.
3. Remove and store the IGV Magnet when finished.

NOTE

All IGV assemblies are fully open when the Position Magnet is at the bottom.

Figure 3-220 IGV Open Position



3.6.3.5 IGV Torque Specifications

Table 3-36 IGV Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
IGV Housing Fastener, M12x50	70	52	620
IGV Feedthrough Fastener, M5x16	5	-	44
IGV Motor Setscrew, M5x8	5	-	44
IGV Throat Fastener, M5x85	5	-	44
Locking Collar	5	-	44

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Chapter 4.0: Variable Frequency Drive Components

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Chapter 4.0 Variable Frequency Drive (VFD) Components

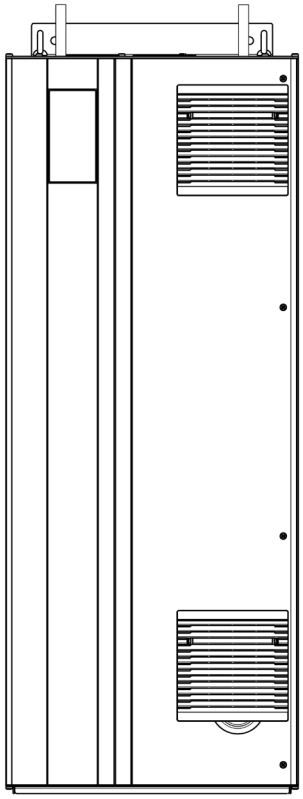
A VFD is an electronic motor controller that converts DC into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The VFD can vary the speed of the motor in response to commands from the CCM.

4.1 VFD Module

The N262 VFD Module has been specifically designed and programmed to operate with the VTT and VTX Compressor Module and cannot be replaced by a generic drive.

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

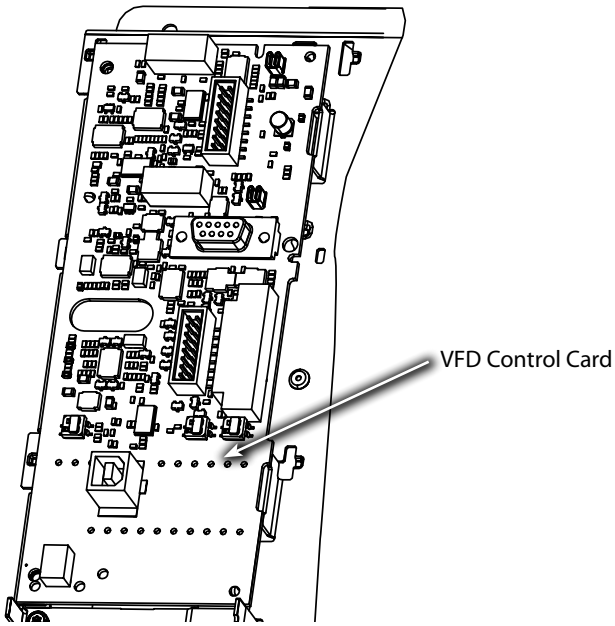
Figure 4-1 VFD



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 4-2 VFD Control Card



4.2.1 VFD Card Connections

The VFD Control Card is connected to the CCM via an RS-485 cable. "Figure 4-3 RS 485 and Interlock Connection Details" illustrates the connection to the VFD Control Card. Refer to section "3.4.4 VTT/VTX Service Electronics Assembly" on page 80 for the details on the CCM connection.

Figure 4-3 RS 485 and Interlock Connection Details

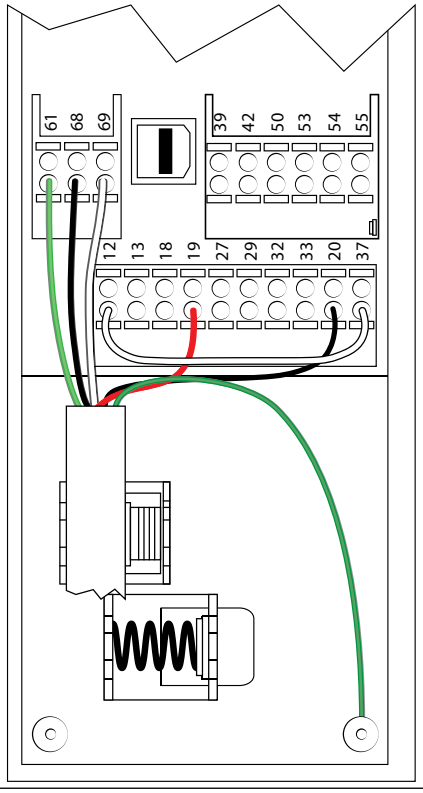


Table 4-1 RS485 Details

Wire Color	Terminal Number
Black	68
Green	61
White	69
Red	19
Black	20
Green	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 section "1.7 Electrical Isolation of the VFD" on page 17 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) fasteners 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) fasteners and torque to 1 Nm (10 in.lb.).
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 4-2 VFD Card Torque Specifications

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

4.3 VFD Orifice

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

Figure 4-4 VFD Orifice

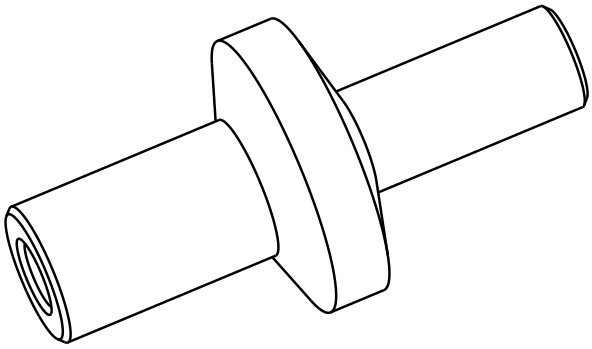
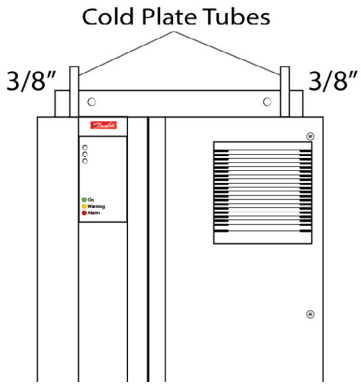


Figure 4-5 Cold Plate Tubes



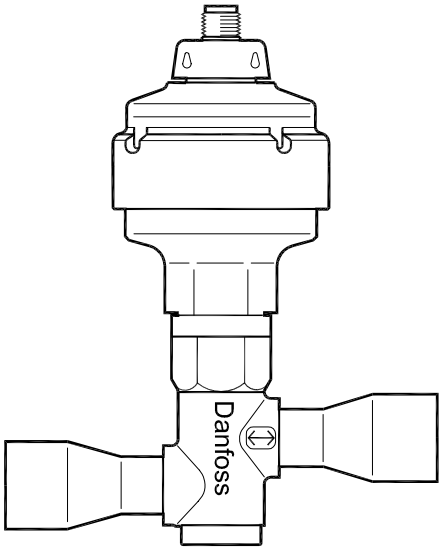
4.3.1 VFD Orifice Specifications

- 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 4-6 VFD Valve



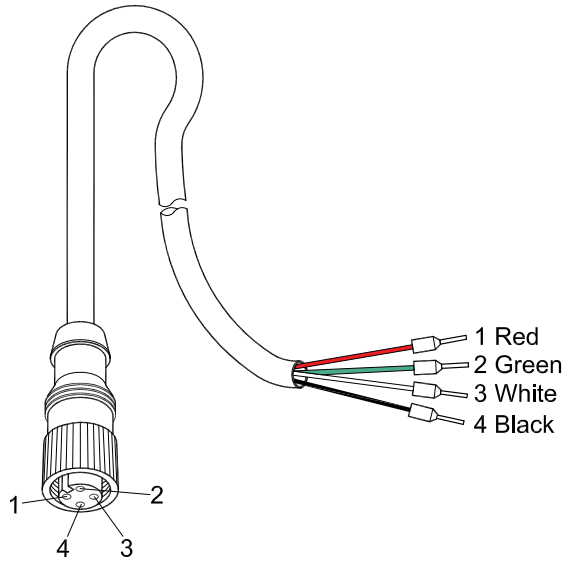
4.4.1 VFD Valve Specifications

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

4.5 VFD Pressure Control Valve Cable

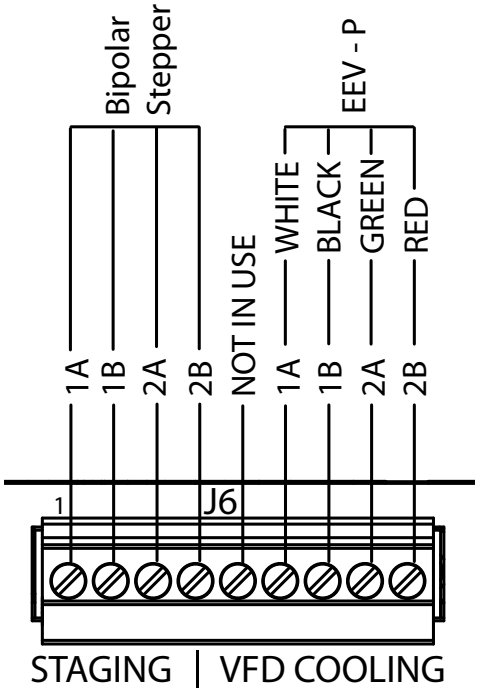
The VFD Pressure Control Valve Cable connects the CIM to the VFD Pressure Control Valve Motor.

Figure 4-7 VFD Pressure Control Valve Cable



4.5.1 VFD Pressure Control Valve Pin Connections

Figure 4-8 VFD Pressure Control Valve Pin Identification

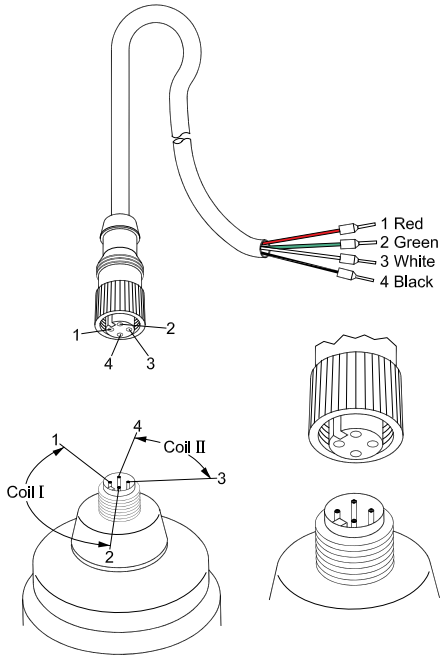


4.5.2 VFD Pressure Control Valve Removal and Installation

Removal:

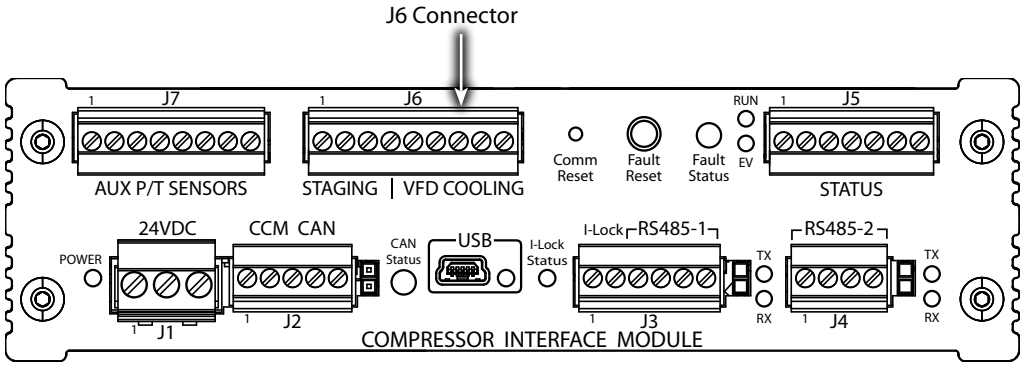
1. Isolate the VFD power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Unscrew the M12 connector from the top of the VFD cooling valve.

Figure 4-9 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 4-11 CIM J6 Wire Diagram" on page 163 correspond to the numbers/ colors listed in "Figure 4-9 VFD Pressure Control Valve M12 Connection".

Figure 4-10 Figure 179 - CIM J6 Location

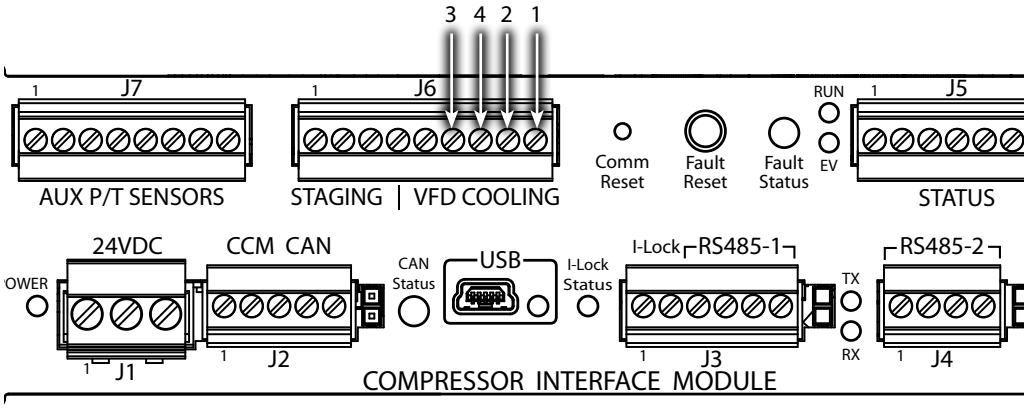


5. Remove the cable.

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.

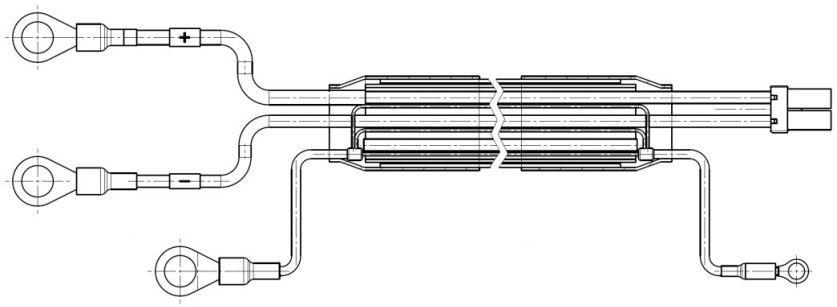
Figure 4-11 CIM J6 Wire Diagram



4.6 VFD DC-DC Cable

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

Figure 4-12 VFD DC-DC Cable

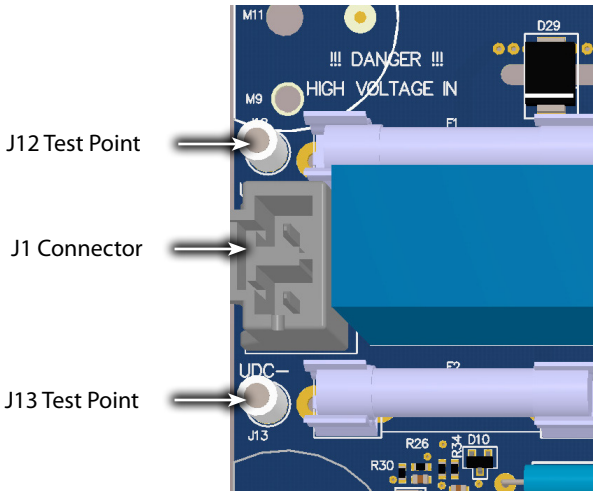


4.6.1 Removal and Installation

Removal:

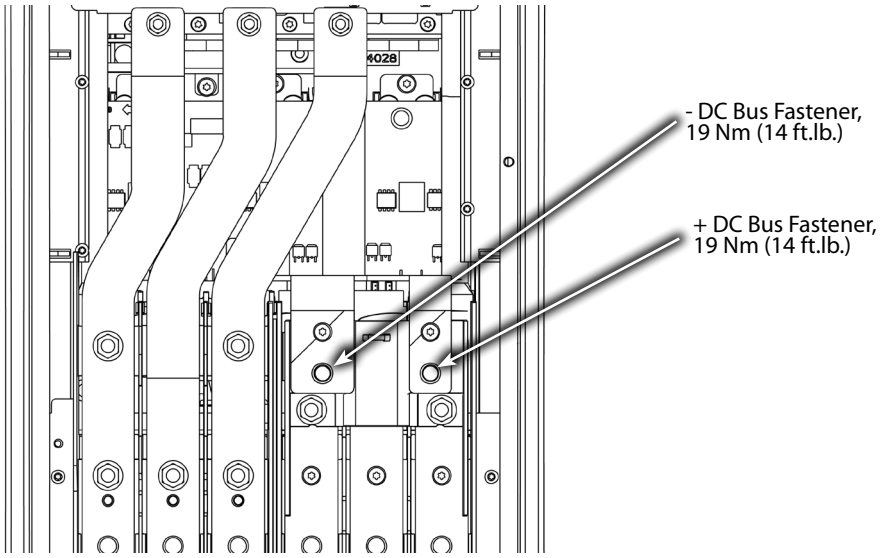
1. Isolate the VFD power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Open the panel containing the DC-DC. Verify the HV DC input from the VFD is below 5 VDC by checking at VDC+ (J12) and VDC- (J13) test points on the DC-DC with a DC voltage meter.
3. Disconnect (J1) HV DC In connector on the DC-DC Board.

Figure 4-13 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 the DC Bus + and - terminals.

Figure 4-14 VFD DC Bus + and - Terminals



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 the DC Bus + and - terminals and ground cables.
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 4-3 DC Bus Cable Torque Specifications

Description	Nm	Ft.Lb.	In.Lb.
+ and - DC Bus Fastener, M5	19	14	168

Chapter 5.0: OEM Module Components

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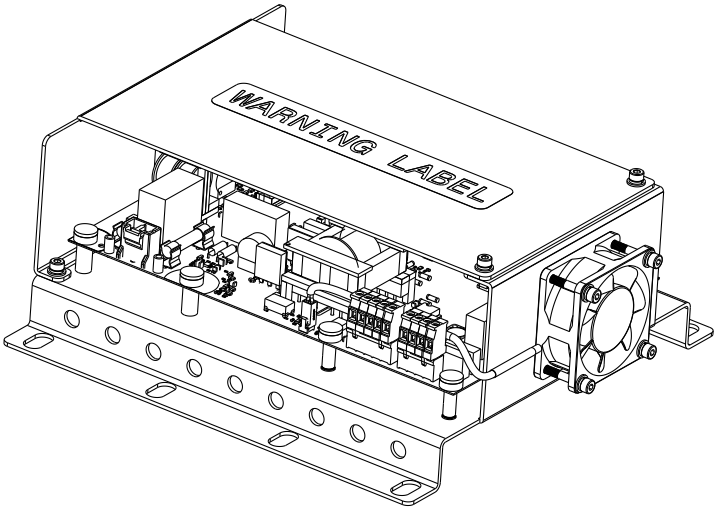
5.1 DC-DC Module

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 5-1 DC-DC



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

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 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 5-2 DC-DC J1 Connection and J12 -J13 Test Points

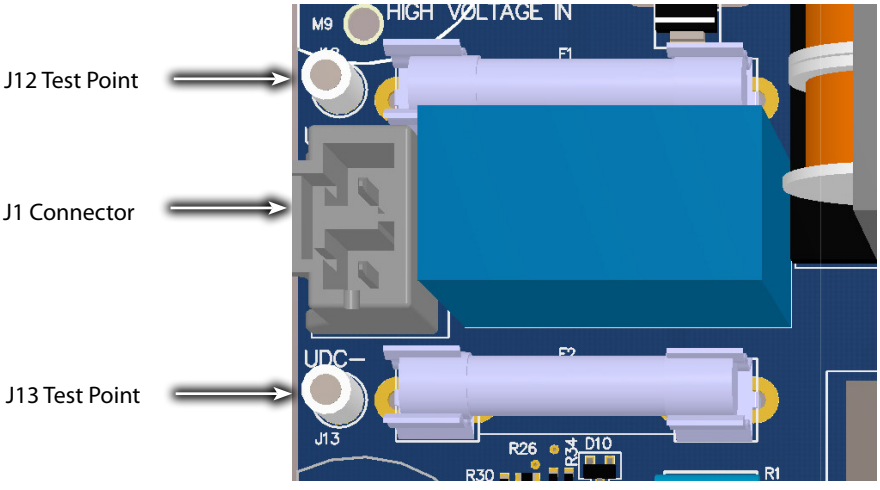
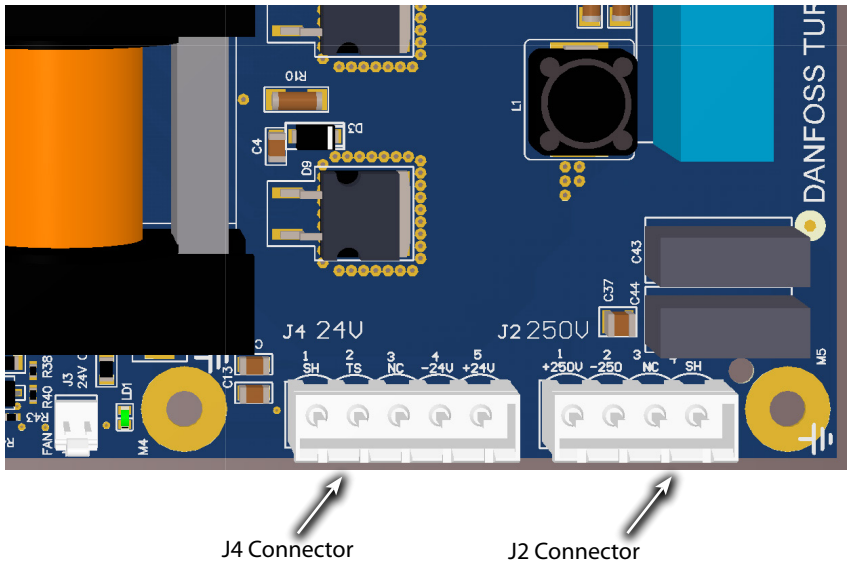


Figure 5-3 DC-DC J2 and 4 Connections



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

Installation

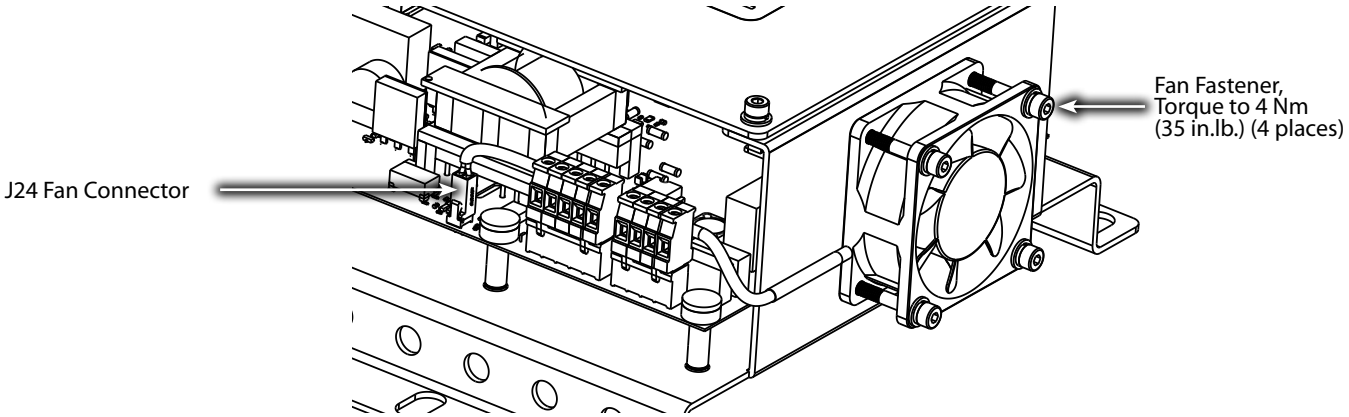
1. Place the DC-DC in panel and secure in place.
2. Connect the HV DC input cable to J1; 24 VDC output cable to J4; and 250 VDC output cable to J2.
3. Close the panel.
4. Restore power to the VFD.

5.1.2 Fan Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 of this manual.
2. Remove the four (4) M4x35 socket head cap fasteners with a 3 mm hex bit.
3. Remove the fan connector from J24 on the DC-DC Board. Refer to "Figure 5-4 Fan Connector".

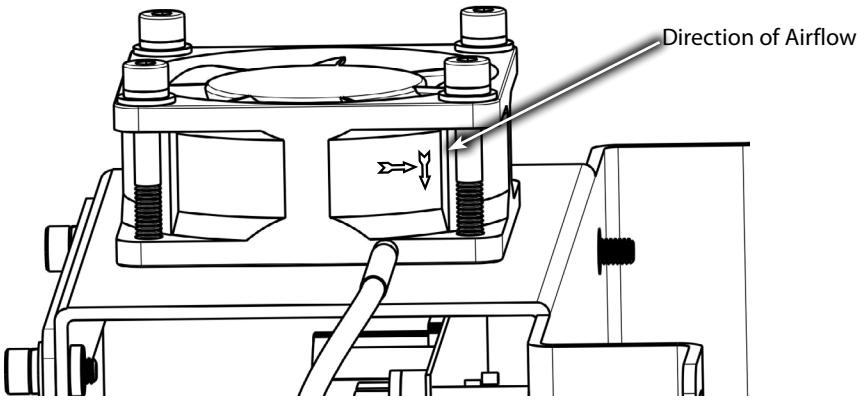
Figure 5-4 Fan Connector



Installation:

1. Assemble the four (4) new M4x35 fasteners 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 5-5 DC-DC Fan Orientation".
3. Using a 3 mm hex bit, attach the new fan to the DC-DC with the new four (4) M4x35 fasteners and torque to 4 Nm (35. in.lb.).

Figure 5-5 DC-DC Fan Orientation



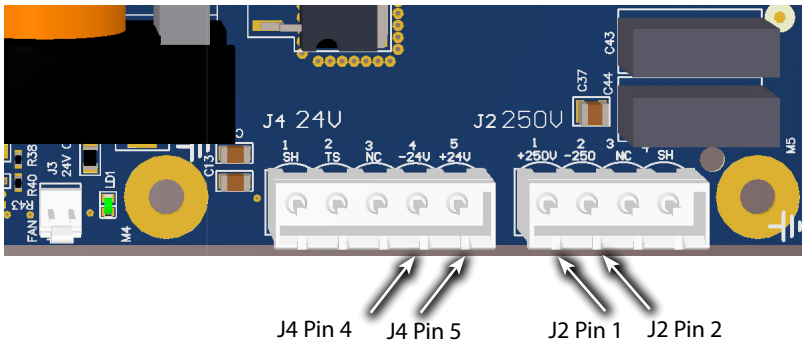
4. Install the connector for the new fan to J24 on the DC-DC Board.
5. Reconnect power to the compressor.

5.1.3 DC-DC Verification

Verification

1. Ensure all connections are correctly installed.
2. Apply power to the 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 5-6 DC-DC 24 and 250 VDC Output



5.1.4 Torque Specifications

Table 5-1 DC-DC Torque Specifications

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

5.2 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.

Figure 5-7 CIM

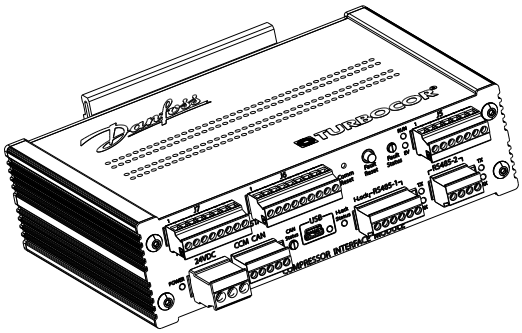


Figure 5-8 CIM Faceplate

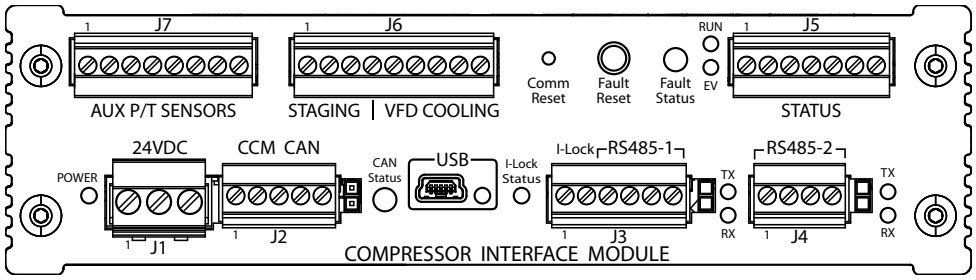
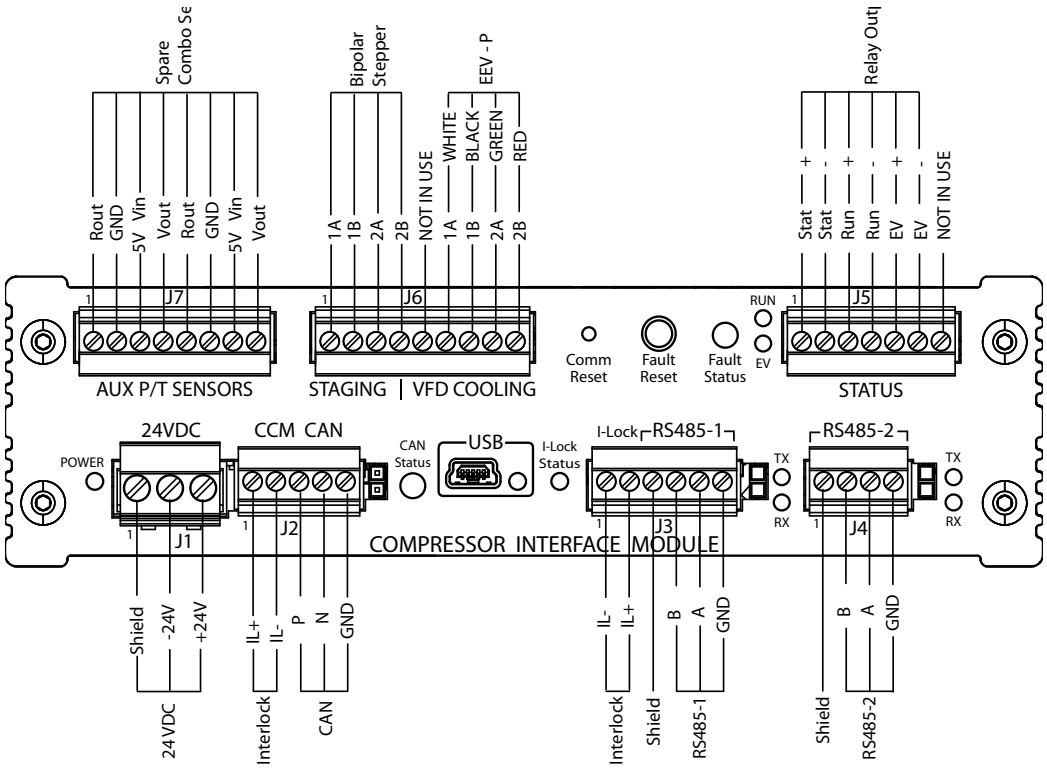


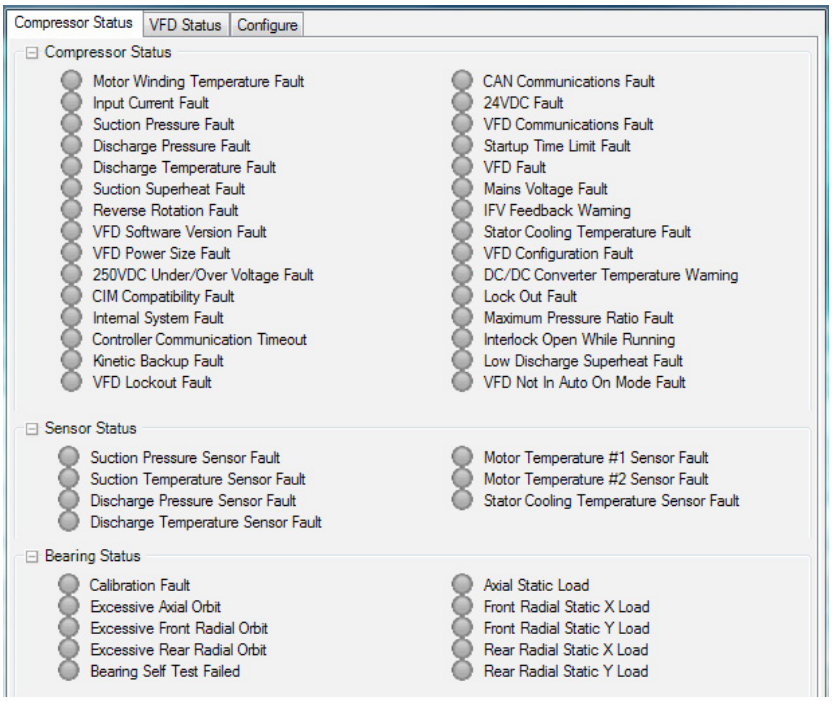
Figure 5-9 CIM Connectivity



5.2.1 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, Controller Area Network (CAN) Communications, and VFD Communications Faults are not active.

Figure 5-10 Active Alarm/Fault Viewer



5.2.2 CIM Removal and Installation

Removal:

1. Isolate the Compressor power as described in section "1.7 Electrical Isolation of the VFD" on page 17 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 Deutsches Institut für Normung (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.

5.2.3 CIM Torque Specifications

Table 5-2 CIM Torque Specifications

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

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Chapter 6.0: Compressor Removal and Installation

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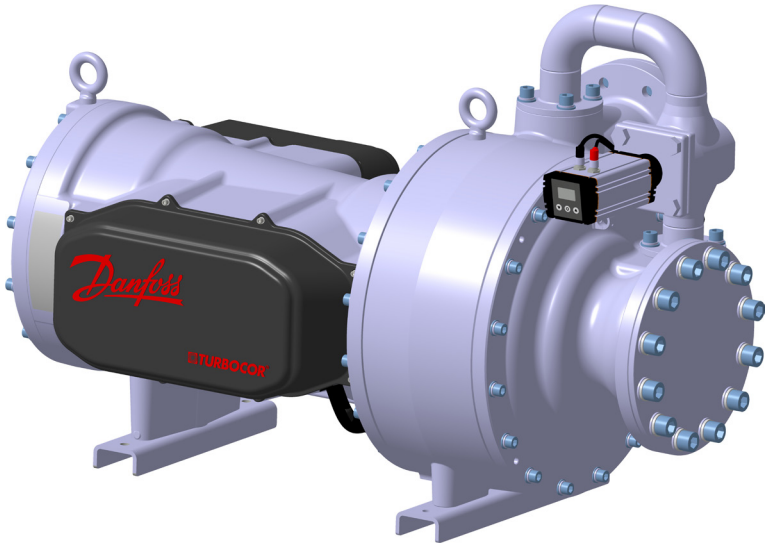
Chapter 6.0 Compressor Removal and Installation

Figure 6-1 Compressor Assembly

VTT Shown



6.1 Refrigerant Containment

⚠ • • • CAUTION • • •

Isolation and recovery of the refrigerant must be performed by a qualified service technician adhering to industry/ASHREAE standards. Always wear proper safety equipment when handling refrigerants.

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 Motor Cooling EXV. Refer to "3.2.7 EXV Assembly" on page 48.
4. Connect a refrigerant recovery system to the compressor as per industry-standard procedures and transfer the refrigerant to an appropriate containment vessel.

6.2 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 section "1.7 Electrical Isolation of the VFD" on page 17 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 six (6) motor power cables (two (2) cables per phase).
5. Remove the three (3) copper spacers.
6. Remove the ground wire from the ground post.

NOTE

Due to the flexibility of the power cable routing on the VTX, there are two (2) locations for the ground post. Refer to "Figure 6-3 Compressor Ground Post".

Figure 6-2 Compressor Power Cable Removal

VTT Shown

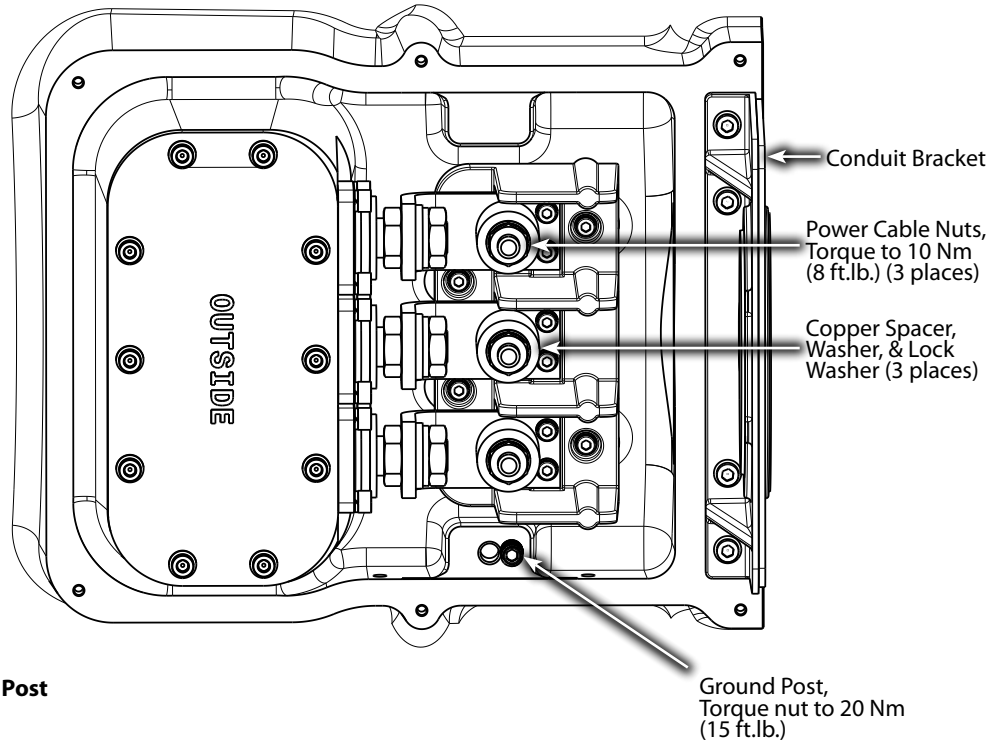
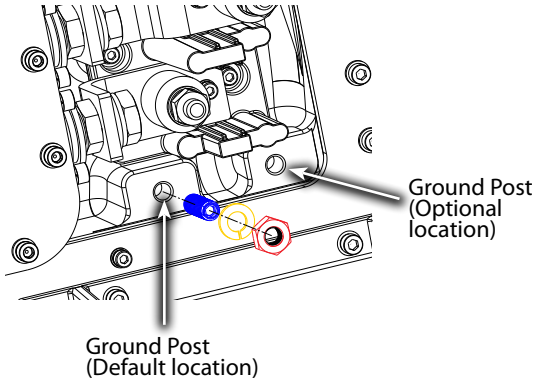


Figure 6-3 Compressor Ground Post

VTX Shown



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 either the the strain relief or grommet from the compressor housing. Refer to "Figure 6-4 Strain Relief" and "Figure 6-5 Grommet".

NOTE

While VTT compressors may contain either the grommet or strain releif, all VTX compressors utilize the grommet only.

Figure 6-4 Strain Relief

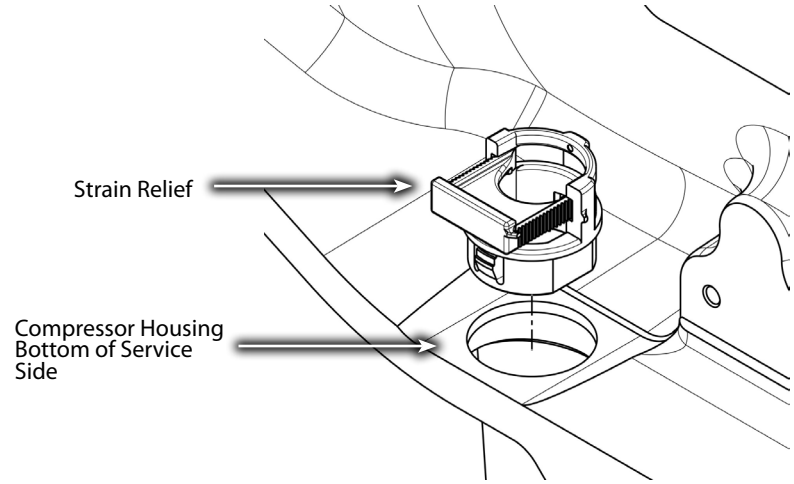
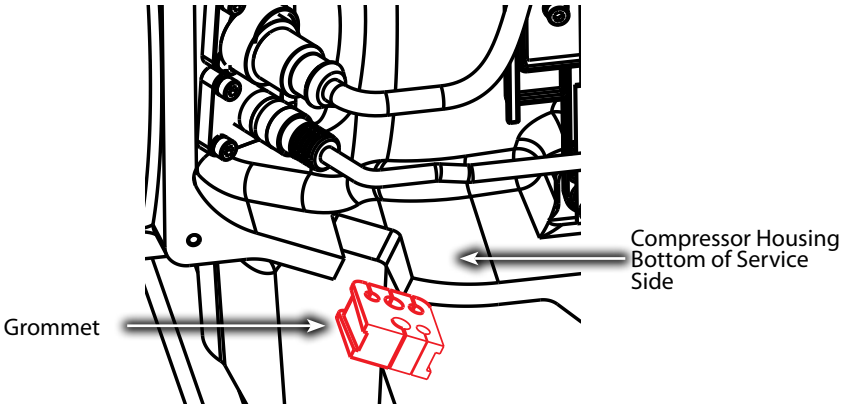


Figure 6-5 Grommet



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 fasteners between the suction pipe flange and the compressor suction flange.
16. Remove the eight (8) M20x2.5 fasteners 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. Refer to the VTT/VTX Applications Manual ("Rigging Requirements") for details.
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 15 psi with a nontoxic inert gas (e.g., helium) for shipment (this will prevent moisture and foreign material from entering the compressor)

6.3 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 nitrogen to 15 psi. Pressure should be relieved through the Schrader valve, located next to the motor cooling connection, prior to removing the blanking plates.

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. Contine lifting the compressor until it is positioned over the desired location, then 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 fasteners 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 fasteners between the suction pipe flange and the compressor suction flange and torque to 70 Nm (52 ft.lb.).
16. Install the eight (8) M20x2.5 fasteners between the discharge pipe flange and the compressor discharge flange and torque to 70 Nm (52 ft.lb.).
17. Install the motor cooling inlet and exit lines with new O-rings.
18. Remove the Service Side Cover.
19. Reinstall either the the strain relief or grommet into the compressor housing.
20. Connect the interface cables, CIM, DC-DC, and VFD Module to the relevant connection points on the CCM and PWM.
21. Reinstall the Service Side Cover.

• • • DANGER! • • •

Ensure that electrical power is isolated from the Motor Power cables before handling them.

22. Remove the Motor Power Cover.
23. Connect the cable gland that secures the power cable conduit to the Conduit Bracket.
24. Install the Mains Input ground wire to the ground post and torque to 20 Nm (15 ft.lb.).
25. Install the three (3) copper spacers.
26. Attach the motor power cables to the terminals and torque to 10 Nm (7 ft.lb.).
27. Reinstall the Motor Power Cover and torque to 6 Nm (53 in.lb.).
28. Leak test the compressor to appropriate pressure and industry accepted standards.
29. Evacuate compressor to appropriate pressure and industry accepted standards.
30. Charge the compressor with refrigerant.
31. Apply power to the compressor.

NOTE

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

6.3.1 Installation Torque Specifications

Table 6-1 Installation 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, M20	70	52	620
Discharge Flange, SHCS, M20	70	52	620
Economizer Flange, SHCS, M16	100	74	885
Motor Cooling Exit Flange, SHCS, M14	100	74	885
Motor Cooling Exit Flange, SHCS, M12	70	52	620
Motor Cooling Inlet Flange	18	13	159
Base Mounting, SHCS, M12x1.75	70	52	620

6.3.1.1 Flange Fasteners

The below section outlines the general specifications for the flange fasteners and the base mounting fasteners. These are general guidelines to ensure that customer-supplied fasteners are adequate for the particular application.

⚠ • • • CAUTION • • •

It is a requirement that you have at least 1-1.5 times the screw diameter engaged into the compressor housing in order to achieve optimum joint strength. Anything less can lead to thread failure in the compressor housing.

Table 6-2 Flange & Base Mounting Fastener Torque Specifications

Description	Fastener Thread Spec	Thread Depth (mm)	Recommended Torque
Suction Flange	M20	28 mm	70 Nm (52 ft. lb.)
Discharge	M20	36 mm	70 Nm (52 ft. lb.)
Economizer	M16	29 mm	100 Nm (74 ft. lb.)
Motor Cooling Inlet (2 Bolt)	M8	15 mm	18 Nm (13 ft. lb.)
Motor Cooling Exit (2 Bolt)	M12	25 mm	70 Nm (52 ft. lb.)
Base Mounting	M12	34 mm	70 Nm (52 ft. lb.)

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Appendix A - Acronyms

Table A-1 - 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
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
IGV	Inlet Guide Vanes
kV	Kilovolt
LED	Light Emitting Diode
LOTO	Lockout/Tagout
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
RTC-IC	Real-Time Integrated Circuit
RTD	Resistance Temperature Detectors
SCR	Silicon-Controlled Rectifier
SHCS	Socket Head Cap Screw
SMT	Service Monitoring Tool
VAC	Volts Alternating Current or Volts AC
VDC	Volts Direct Current or Volts DC
VFD	Variable Frequency Drive
VTT	Variable Twin Turbo
Ω	Ohm

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Appendix B - VFD Maintenance

Electrical Isolation of the VFD

Before servicing the Variable Frequency Drive (VFD), a qualified technician must isolate the power by following the below procedure.

• • • DANGER !• • •

- This equipment contains hazardous voltages that can cause serious injury or death. Only qualified and trained personnel should work on Danfoss LLC equipment.
- Always wear appropriately rated safety equipment when working around equipment and/or components energized with high voltage.
- Ensure the Mains Input power is turned off and locked out before servicing the VFD.

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 reapplication of the Mains Input power can occur.
3. Using an appropriately rated voltage meter, confirm that the AC voltage is isolated.
4. Wait at least 20 minutes for the DC bus capacitors to discharge.

Drive Cleaning

1. Vacuum dust and dirt from the external heat sink fins.
2. Check ventilation fans for proper operation and clean as needed. Confirm VFD's ventilation ports have not been obstructed.
3. Clean the interior of the VFD.
   a. Dirt/dust coating on drive circuit boards and other components can interfere with proper cooling, and even provide a path for electricity to short out along unintended paths. This can cause erratic operation and possible damage to drive components.
   b. Corroded electrical connections can cause excess heat build-up, short circuits, erratic drive operation, and component damage.
   c. This should be done after the installation of the drive is complete and before power is applied to the drive. The main point here is to ensure that no metal filings or other installation-related debris are inside the drive or its option enclosure.
   d. If the VFD is installed in an area where a lot of construction work will be performed, it is best to keep the drive covered while it is not in operation. If the VFD is being used, it must be uncovered so that airflow to the drive is not obstructed. After the construction is complete, it will be important to clean the interior of the drive. Low pressure, clean, dry air, or similar commercial products can be used to clean dirt off the circuit boards. While a vacuum (e.g., shop vacuum) can be used to collect falling dirt. It is important to ensure that a vacuum is not used to directly clean the circuit board surfaces as damage could occur. A soft-bristle ESD safe brush can be used to remove any debris on circuit boards. During this time, inspect VFD connectors for dirt or corrosion and clean as necessary.
   e. In a normal environment, the VFD interior should be inspected every six (6) months and cleaned if necessary. In dirty environments, more frequent inspection is required. The level of dirt found inside the VFD can be used to dictate the frequency of inspections and cleanings that is required.
4. Clean/replace air filters.
   a. Because the service life of the air filters can vary dramatically from one installation to another, it is important to initially check the air filters frequently to establish the required inspection interval.

Cooling Fan Check

Cooling fans are used to remove heat from the VFD. Proper operation of the cooling fans helps ensure long drive life by keeping the drive's components cool. The cooling system should be inspected every six (6) months at a minimum and more frequently when the drive is exposed to extreme conditions.

a. Inspect the heat sinks, air inlets, and air outlets to ensure that there is an open path for air flow.
b. To check for proper fan operation if the fans are not running, remove power from the VFD. When power is reapplied, the fans should start and run for a few seconds.
c. Listen for unusual noises from the fans when they are running.
d. VFDs use a heat sink temperature sensor to help indicate if there is a problem with the cooling system. If the drive issues a HEAT SINK OVERTEMP warning or alarm, check the cooling system carefully.

NOTE

The cooling fans are rated for the life of the Drive, however, if there are any problems found with the fan operation, it should be replaced.

Electrical Connection Check

Check the tightness of electrical connections and re-torque as needed. If possible, perform an IR thermal scan of the VFD power input and power output to determine if there is excessive resistance at the connections. VFD terminal blocks are rated for 75°C. Any temperature above this can cause deformation of the terminal block which can lead to further electrical damage.

For details on the fastener locations and torque specifications, refer to "Table B-1 - VFD Electrical Connections Torque Ratings" on page 187, Table 1 – VFD Electrical Connections Torque Ratings, "Figure B-1 VFD Torque Specifications with RFI Filter" on page 185, and "Figure B-2 VFD Torque Specifications Without RFI Filter" on page 186.

a. Loose power connections can cause extra heating and/or arcing. The heating reduces efficiency and can meltdown connectors. The arcing can cause intermittent currents and electrical noise. These can disrupt the operation of the drive.
b. Loose or corroded ground connections can cause electrical noise problems. All VFD drives have some degree of electrical noise filtering. Some of this electrical noise is sunk to earth ground. Without a reliable ground connection, the noise filters cannot operate as designed. In addition, a poor ground connection can become a safety issue.
c. Loose control wires can cause intermittent operation of equipment. Loose or missing shielding for signal wires can cause erratic operation of the drive. In extreme cases, this can even cause the drive to trip off.
d. This should be performed once the drive is installed and at least every six (6) months afterwards. If the Drive is subjected to vibration or wide temperature variations, it should be checked more frequently.

Figure B-1 VFD Torque Specifications with RFI Filter

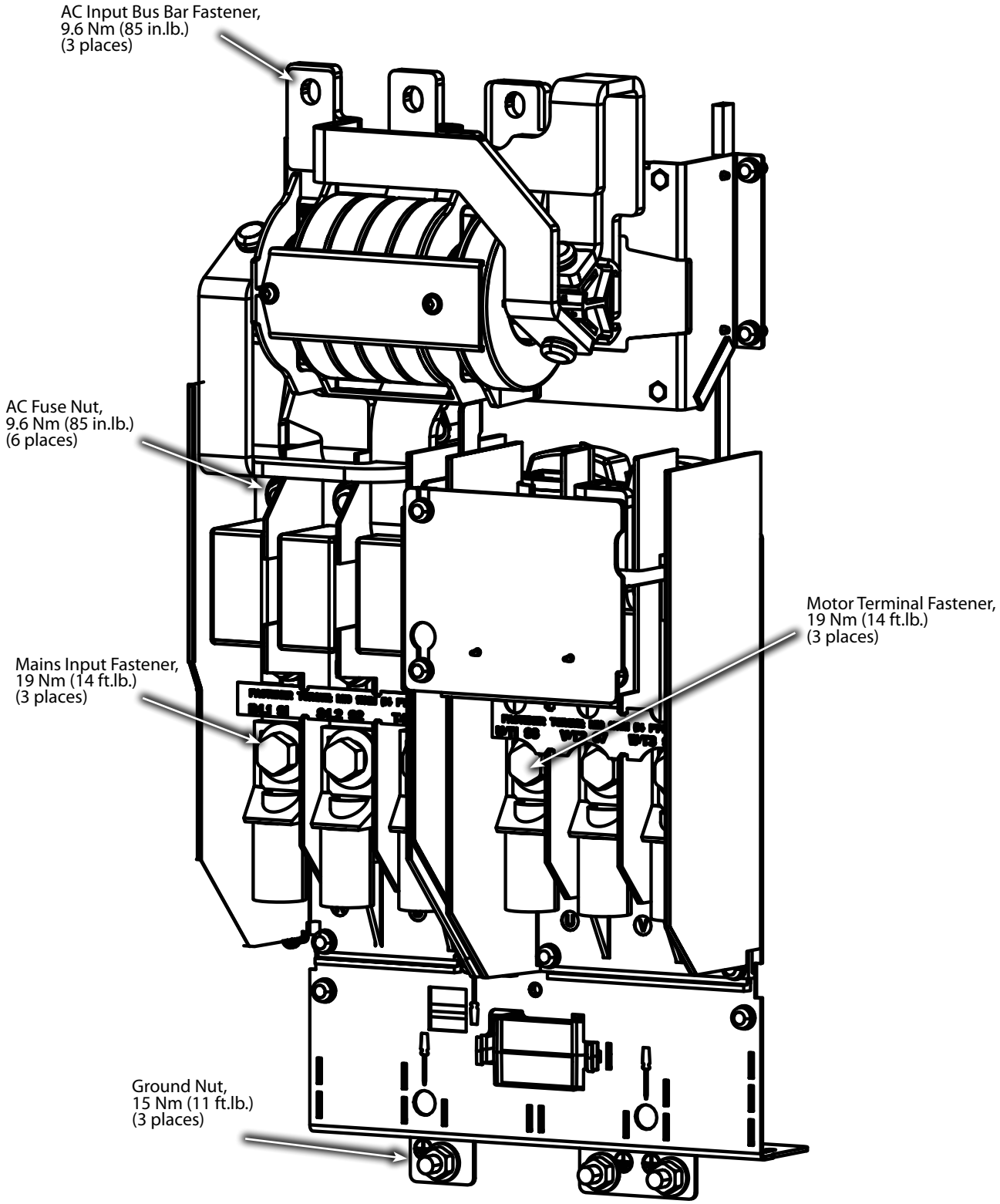

Figure B-2 VFD Torque Specifications Without RFI Filter

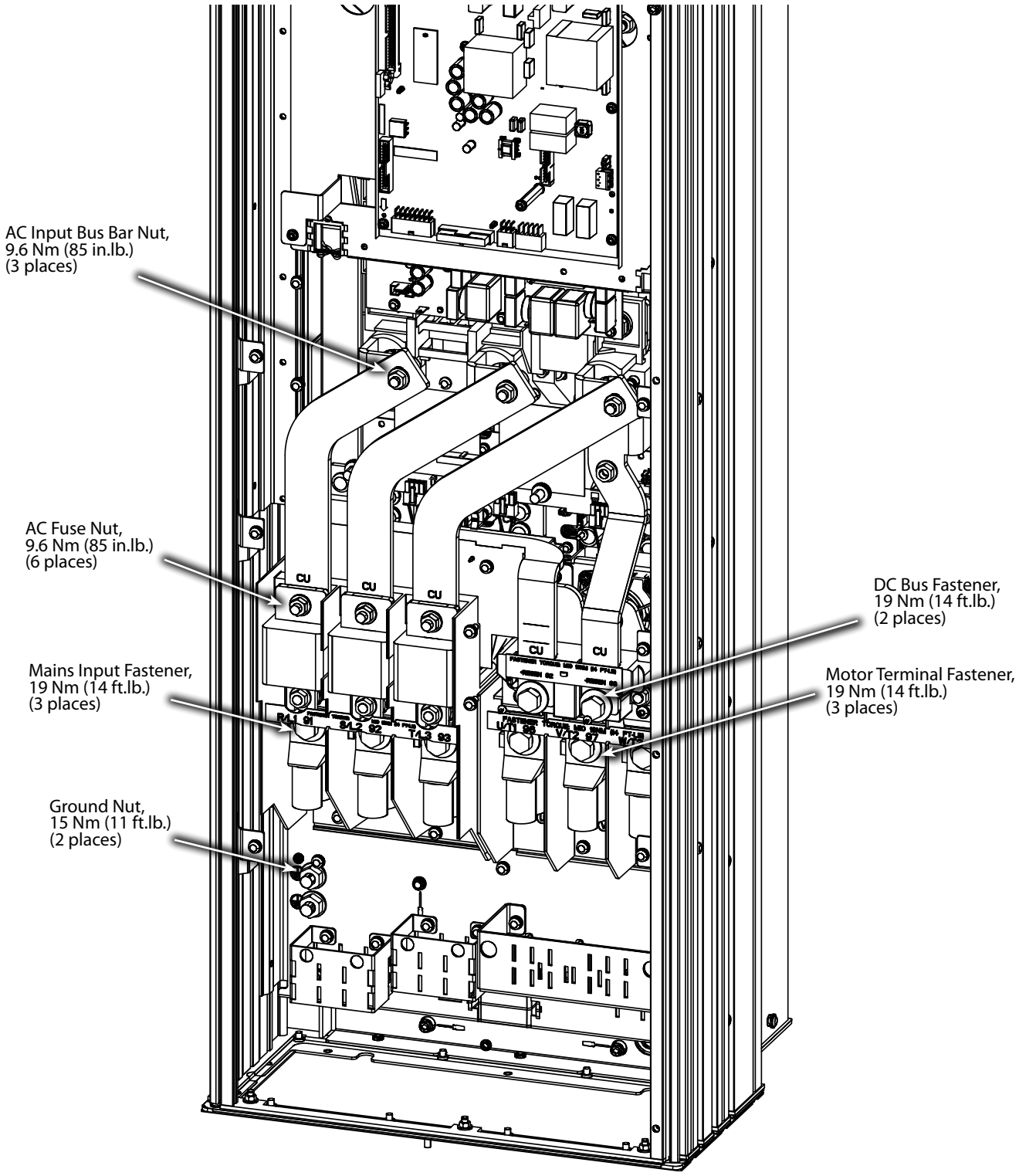

Table B-1 - VFD Electrical Connections Torque Ratings

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
Base Mounting, SHCS, M12x1.75	70	52	620

Table B-2 - VFD Preventative Maintenance Checklist

VFD Electrical Connections Torque Ratings				
Description	Frequency (months)			
	At Commissioning	6	12	Other
Check physical condition of VFD	✓	✓		
Check mains supply voltages	✓	✓		
Check motor and output phase balance	✓	✓		
Check for signs of hot spots/discoloration on power cables		✓		
Check amperages during operation and verify they are within specification	✓	✓		
Check electrical connections and re-torque as needed.	✓	✓		
Check DC bus voltage	✓		✓	
Inspect DC Bus Capacitors	✓		✓	
Check operation of all system safety devices and interlocks	✓		✓	
Perform moisture-prevention measures	✓		✓	
Confirm VFD's ventilation clearances have not been obstructed	✓	✓		
Vacuum dust and dirt from heat sink fins (Environment quality may require more frequent inspections)	✓	✓		
Inspect VFD fans and clean as needed (Environment quality may require more frequent inspections)		✓		
Clean or replace intake air filters (Environment quality may require more frequent inspections)		✓		
Check physical conditions of all circuit boards		✓		
Confirm the VFD doors and covers are in place and properly closed	✓	✓		

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Appendix C - Special Tooling Specifications

Figure C-1 Volute Assembly Sleeve

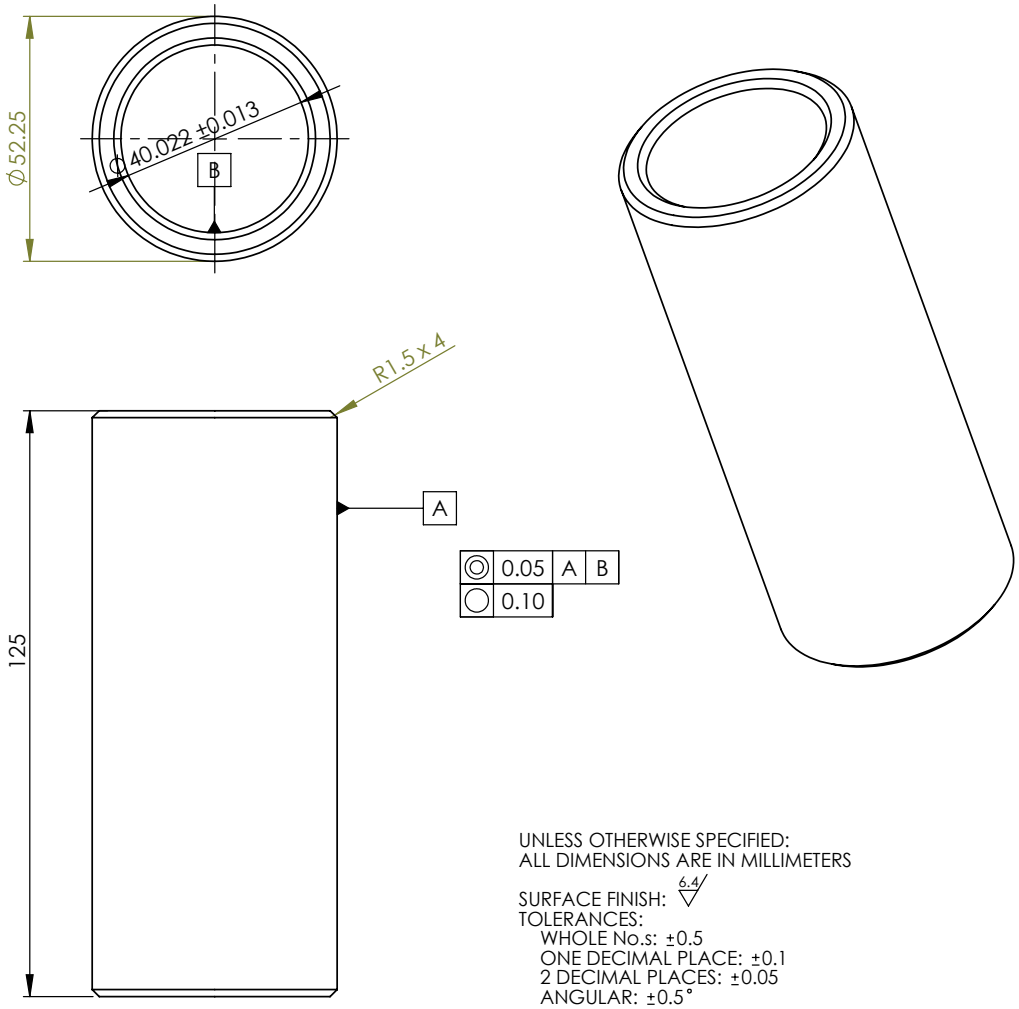


Figure C-2 - Guide Pin

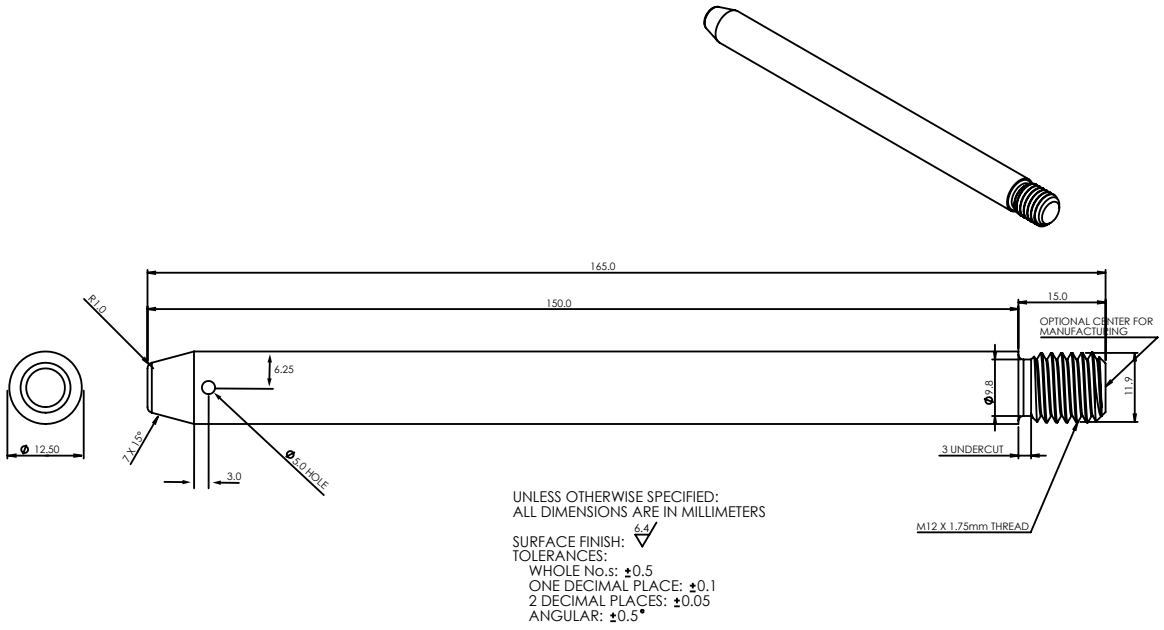


Figure C-3 - Thrust Disk Alignment Pin

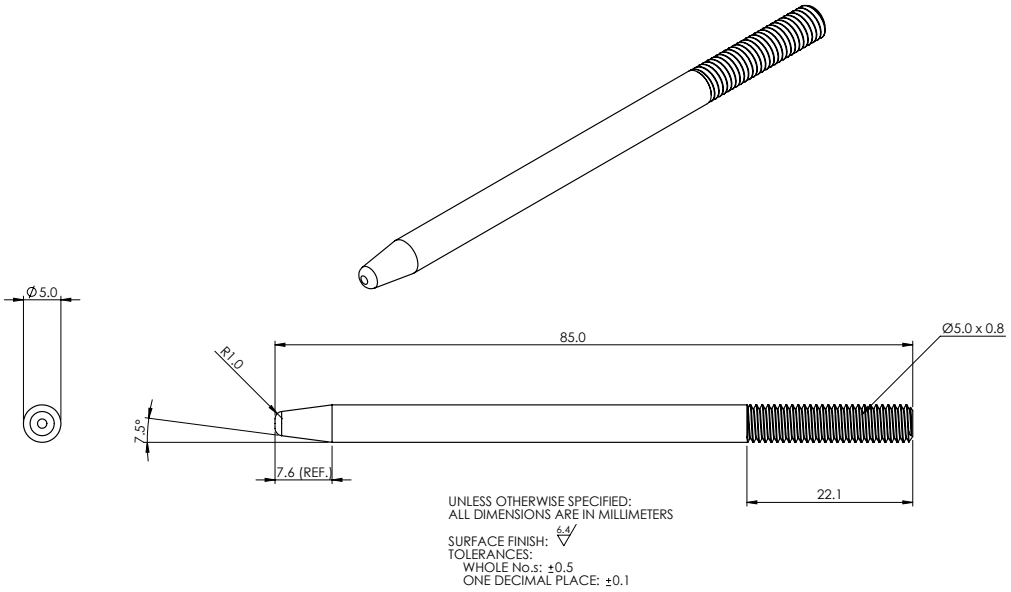
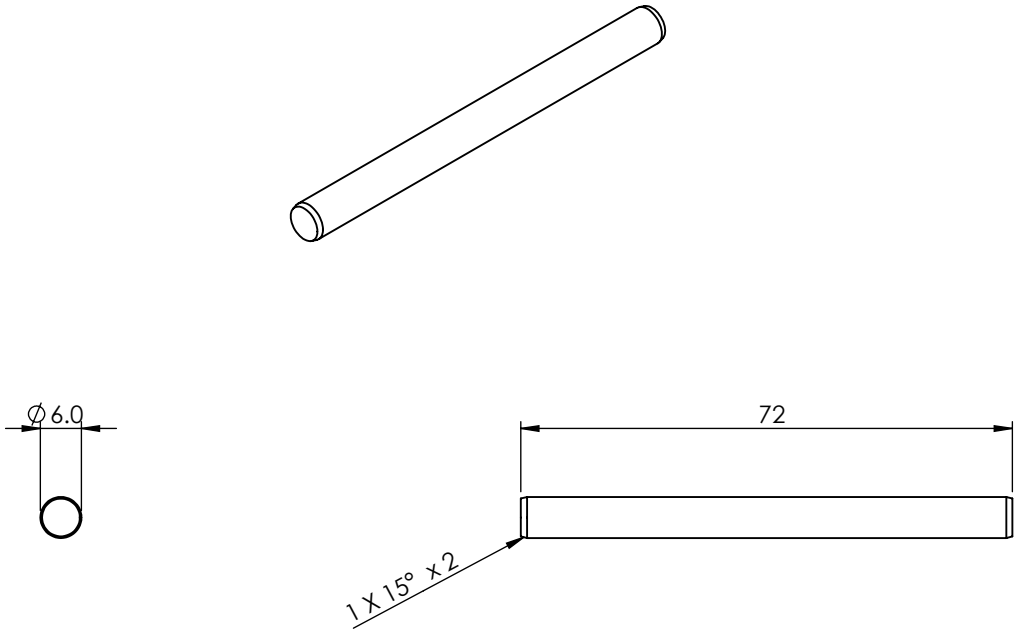


Figure C-4 Shaft Bolt Torquing Pin



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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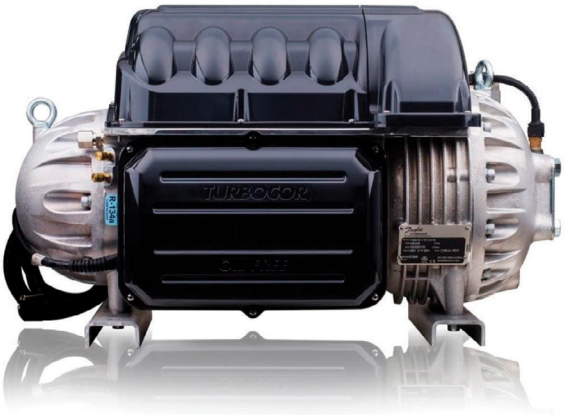

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