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Rockwell Automation + Schlumberger

INSTRUCT LIFT CONTROL SYSTEMS

E30 Low Voltage VSD

Installation, Operation & Maintenance Manual

MODEL: INSTRUCT E30 INTELLIGENT VSD

Manual No: LCS-ENG-M0006, Rev. 04

Publisher Notes

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REVISION HISTORY

REVISION:	DESCRIPTION OF CHANGE:	SENSIA ISSUER:	DATE:
01	Initial Release	Lift Control Systems	30 Nov 2021
02	Added/Updated Section 1.3, 1.4, 4.3, 5.5.3, 5.5.4, 5.5.5, 7.5, 7.6,8.4.1 and 9.3	Lift Control Systems	31 Mar 2022
03	Updated IP/NEMA rating of the enclosure, Figure 5.5. Added relevant part numbers to 10.5 and 10.6. Added Section 4.3,4.5, 9.4, 10.6.2, 10.6.6,10.7,10.8,10.9.	Lift Control Systems	2 Feb 2023
04	Added 5.8 for details of voltage taps/selector of CPT and heat exchanger. Added 11.6 for diode and IGBT test	Lift Control Systems	12 Jul 2023

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GENERAL

WARNING!

To avoid the risk of electric shock and fire, the following safety instructions must be observed, and the guidelines followed.

The specifications must not be exceeded, and the device must only be applied as described in the following.

Prior to the installation and commissioning of the unit, the installation guide must be examined carefully.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

GENERAL

AVERTISSEMENT!

Pour éviter tout risque de choc électrique et d'incendie, les consignes de sécurité de ce manuel doivent être observées, et les instructions suivies.

Les spécifications ne doivent pas être dépassées, et l'unité ne doit être appliquée que comme décrit dans le texte suivant.

Ce manuel doit être examiné avec soin, avant l'installation et la mise en service de l'unité.

Si l'équipement est utilisé d'une manière non spécifiée par le fabricant, la protection assurée par l'équipement peut être altérée.

INSTALLATION

WARNING!

Installation may only be carried out by electrically skilled and instructed personnel in accordance with national legislation, including the relevant standards.

All technical data on the instrument is to be observed.

Changes to the design and modifications to the equipment are not permitted.

The equipment shall only be operated as intended and only in undamaged and perfect condition.

Sufficient segregation must exist between different cables and wires carrying different types of signals or power and all other circuits.

All wires must be terminated, complete with crimping lugs. Unused cores should be terminated to the earth bus bar.

INSTALLATION

AVERTISSEMENT!

L’installation ne peut être effectuée que par un électricien qualifié, conformément à la législation nationale, y compris les normes pertinentes.

Toutes les données techniques sur l'instrument doivent être observées.

Modifications de l'équipement ne sont pas autorisés.

L'équipement ne doit être utilisé comme prévu par le fabriquant et uniquement si il est en parfait état.

Une séparation suffisante doit exister entre les différents câbles et les fils transportant différents types de signaux ou de puissance et tous les autres circuits.

Tous les fils doivent être terminés, avec pattes de sertissage. Les noyaux non-utilisés doivent être terminés au jeu de barres de la terre.

Section 1: **Product Description**

The INSTRUCT E30 Intelligent VSD is Sensia's low voltage variable speed drive (VSD) system that provides high performance and sophisticated power and motor control at the surface. It comes with a sine wave filter to mitigate harmonics and voltage spikes at the output, making it well suited for the electrical submersible pumping (ESP) downhole installations. The drive has slot-based hardware architecture that reduces unnecessary add-ons and provides users more flexibility to select option modules that suit their application.

The E30 VSD is safety-focused and various safety considerations have been incorporated in the drive design. The drive package has a separate low voltage (LV) compartment for the controller and its wirings, as well as respective junction box for power and instrument connections. This design aims to separate the hazardous high voltages thus ensuring users are isolated from high voltages when they are working at the LV compartments. The doors to the main cabinets of the drive are also interlocked and cannot be accessed until the drive is de-energized. In addition, a provision is provided in the controller to trip the drive when the step-up transformer door is opened.

The drives are protected from extreme outdoor conditions. All sections of the drive enclosure are rated to NEMA4 except the transformer section which is rated to NEMA3R. There is no direct external air exchange to the compartments where the sensitive electronics are located. The lifespan of the drives can therefore be prolonged. In general, the standard drives are designed to two different ambient temperatures: 40°C for drive of Frame 8 and above, and 50°C for the smaller drives. Derating is required when operating the drives at a temperature higher than the designed temperature.

The enclosure of the E30 drive contains:

- a motor controller (refer Section 1.1)
- a power converter
- other associated power components, such as control power transformers, circuit breakers, fuses, a magnetic contactor, surge suppression devices (SPD), and a sine wave filter (SWF)
- a power analyzer kit (supplied loose, refer Section 1.3) which consists of an INSTRUCT Power Analyzer 5kV Voltage Sensor, an INSTRUCT Power Analyzer Card, and an 8m INSTRUCT Power Analyzer Cable
- a limit switch (supplied loose, refer Section 1.4) for interlocking with the step-up transformer doors

External to the E30 drives, optional equipment may be installed and combined at the wellsite. This equipment is application dependent and is outside the scope of this manual. However, connection to the E30 drives is described to ensure proper use and application of the optional equipment with the E30 drives.

Communication equipment used in interfacing with the E30 series is mentioned only in the context of basic connection and communication instructions along with some troubleshooting procedures. For specific details and instructions, refer to the product documentation of the communication equipment.

NOTE	It is important to know the type of Sensia drive at the time of commissioning or troubleshooting since several of the drive components are not interchangeable and troubleshooting procedures are different. It is essential to check the proper spare parts list for the drive on the engineering drawings and contact Lift Control Systems when ordering spares since some parts are not interchangeable between drive lines.

The following figures illustrate the drives' major internal components. Refer to Appendix F: Parts Identification for E30 Drive for more information.

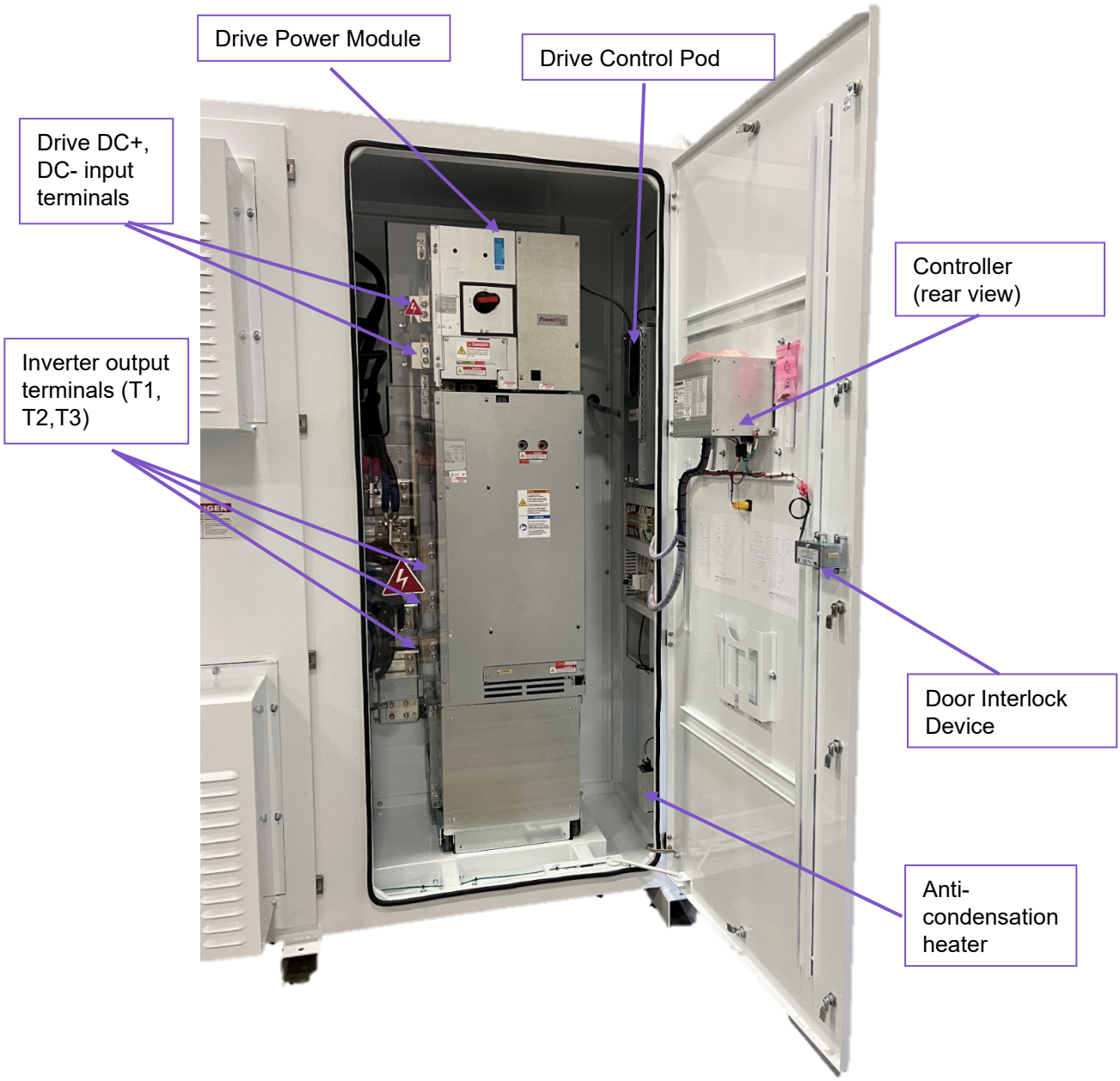


Figure 1-1: Drive Section Components (18 pulse SWD, 500 kVA, Frame 8 shown)

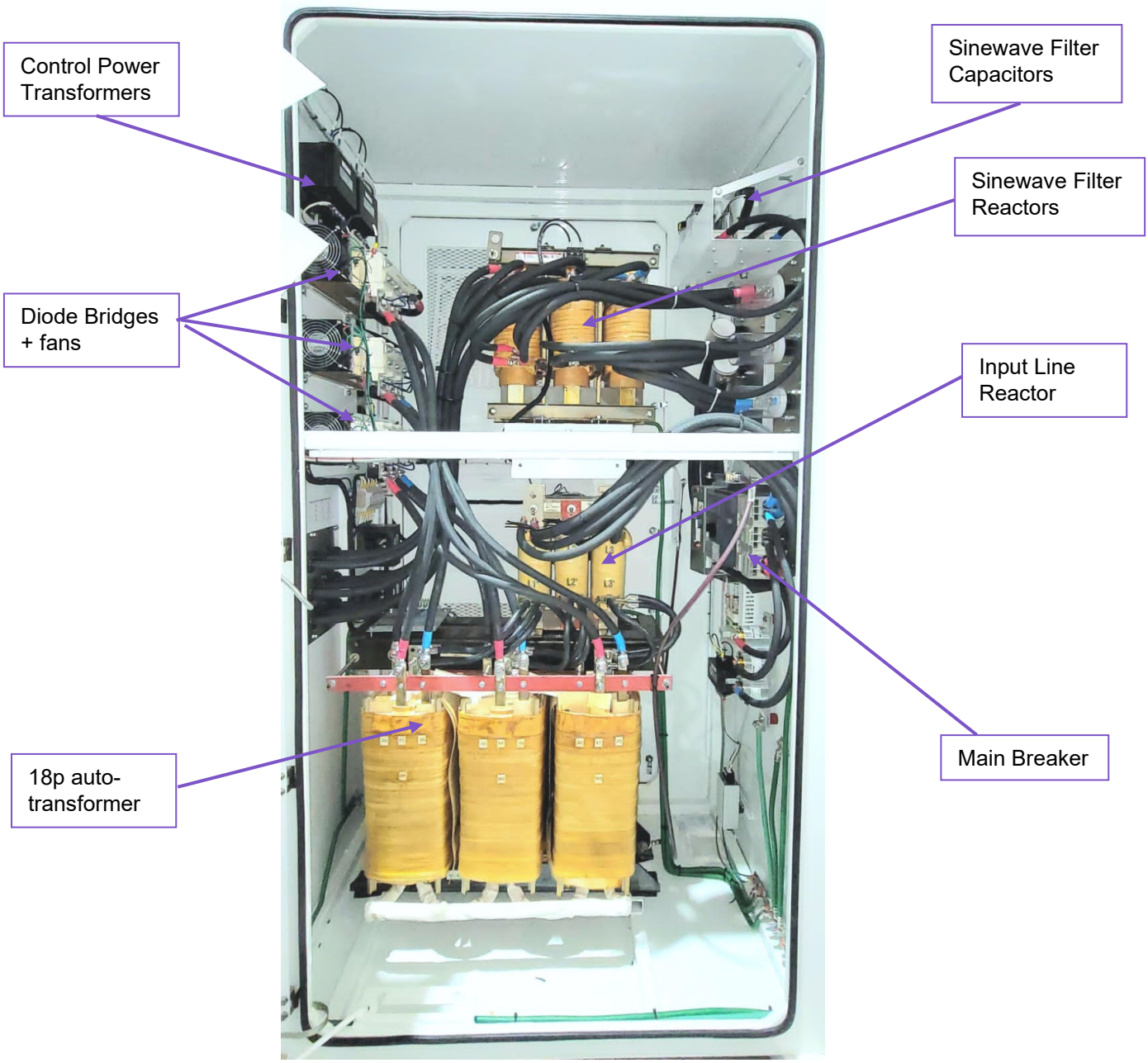


Figure 1-2: Transformer Section Components
(18 pulse SWD, 500 kVA, Frame 8 shown, Rear view)

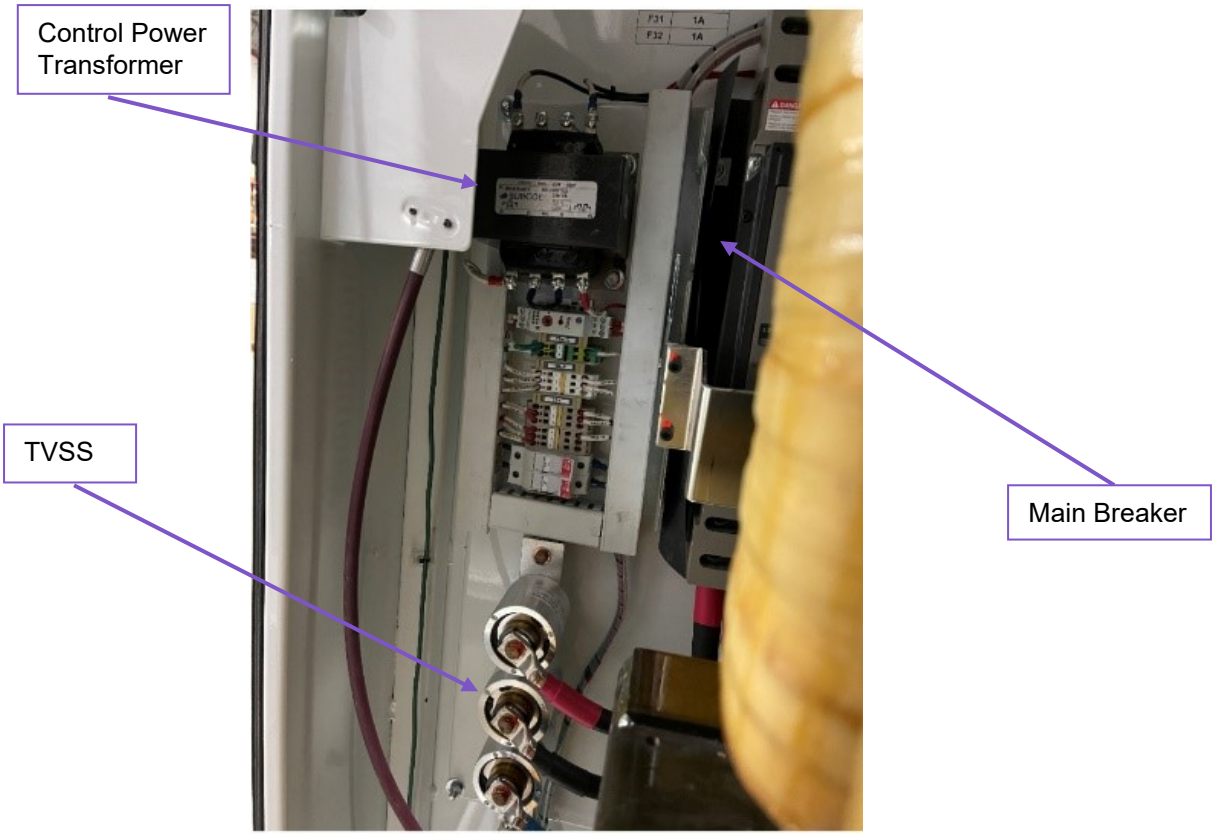


Figure 1-3: Main Breaker Back-pan (18 pulse SWD, 500 kVA, Frame 8 shown)

1.1 MOTOR CONTROLLER

The E30 drive is equipped with INSTRUCT ESP Intelligent Controller. The controller provides motor protection, monitors motor operating parameters and performance, and can interface with external devices and SCADA (Supervisory Control And Data Acquisition) systems. For the details of the controller, refer to the *INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576)

1.2 SINE WAVE FILTER (SWF)

The E30 drive has an output filter that is incorporated within the enclosure of the drive. The result is a voltage similar to a rotating generator output that has no application concerns for any submersible pump at any cable length. Refer to Figure 1-4: Sine Wave Drive Output Comparison.

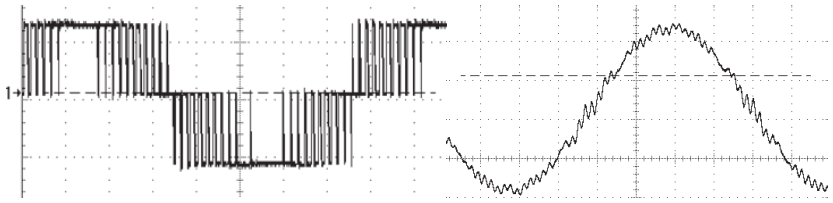


Figure 1-4: Sine Wave Drive Output Comparison

The left image shows the sine wave drive output before a sine wave filter, and the right image shows the result after the filter.

This improved wave form eliminates the significant voltage stress that can cause premature insulation failure. Installation of a sine wave drive will not aggravate a premature failure on weak or compromised insulation in an older well. It will increase the mean time before the well requires replacement of equipment due to electrical stress-related failures.

1.3 POWER ANALYZER (PA) KIT

The E30 VSD comes with a power analyzer kit as standard which consists of an INSTRUCT Power Analyzer 5kV Voltage Sensor, an INSTRUCT Power Analyzer Card and an 8m INSTRUCT Power Analyzer Cable. While the Power Analyzer Card will be pre-installed in the controller, the PA Voltage Sensor and 8m signal cable are delivered loose with the VSD and must be installed on the secondary side of the step-up transformer.

This kit enables the display and recording of live motor phase-to-phase and phase-to-ground voltages, thereby eliminating the need to manually check these voltages. Further, it provides more real-time data about the health and operating efficiency of the ESP system to optimize performance and extend run life.

DESCRIPTION	SENSIA PART NO.	QTY
INSTRUCT Power Analyzer Card	100840440	1
INSTRUCT Power Analyzer 5kV Voltage Sensor	100840441	1
INSTRUCT Power Analyzer Cable (8m)	101947905	1

1.4 DOOR INTERLOCK SWITCH FOR STEP-UP TRANSFORMER

To further improve the safety of the drive operation, the controller can be equipped to trip the drive when the transformer door is opened. A limit switch with adjustable lever will be free-issued and supplied loose in the E30 VSDs as standard. Mount and secure this switch in the step-up transformer, near the door, to detect the opening of the door.

DESCRIPTION	SENSIA PART NO.	QTY
Limit Switch Adjustable Lever 1NO,1NC	77027099	1

Section 2: **QHSE**

The following safety precautions should be followed when installing, operating, or maintaining a Sensia VSD.

2.1 OPERATING SAFETY PRECAUTIONS

1. Do not power up the VSD until this entire operation manual is reviewed.
2. The input voltage must be within ±10% of the specified input voltage. Voltages outside of this permissible tolerance range may cause internal protection devices to turn ON or can cause damage to the unit. Also, the input frequency should be within ±5% of the specified input frequency.
3. Proper coordination of the motor and VSD is required. For submersible and surface motor applications. Consult with Sensia when utilizing this VSD for a new application.
4. This VSD is designed to operate both standard NEMA B and submersible pump motors. Consult InTouch before using the VSD for special applications such as an explosion-proof motor or one with a repetitive type of piston load.
5. Do not touch any internal part with power applied to the VSD; first remove the power supply from the drive and wait until the DC bus is discharged. Charged capacitors can present a hazard even if source power is removed. Use appropriate lockout/tagout procedures (refer to SENS-HSE-S027) to ensure that the VSD power is off before proceeding with the checks and the procedures inside the drive or the junction box.

Potential Severity: Major
Potential Loss:Assets, Personnel
Hazard Category: Electrical, Explosives

Do not operate this VSD with its cabinet door open.

6. Do not apply commercial power to the output terminals U/T1, V/T2, or W/T3 even if the VSD source power is off. This will cause damage to components within the drive. Disconnect the VSD from the motor before using a megger or applying bypass voltage to the motor.
7. Interface problems can occur when this drive is used in conjunction with some types of process controllers. Signal isolation may be required to prevent controller and/or drive malfunction. Contact Sensia or the process controller manufacturer for additional information about compatibility and signal isolation.
8. Do not open and then reclose a secondary magnetic contactor between the drive and the load unless the drive is OFF (output frequency has dropped to zero) and the motor is not rotating. Abrupt reapplication of the load while the drive is on or while the motor is rotating can cause drive damage.
9. Use caution when setting output frequency. Increasing the motor speed beyond its normal capacity can decrease its torque-developing capability and can result in damage to the motor and/or driven equipment.
10. Use caution when setting the acceleration and deceleration time. Unnecessarily short time settings can cause tripping of the drive and mechanical stress to loads.
11. Only qualified personnel should have access to the adjustments and operation of this equipment. They should be familiar with the drive operating instructions and with the machinery being driven.
12. Only properly trained and qualified personnel should be allowed to service this equipment.

13. Follow all warnings and precautions. Do not exceed equipment ratings.

DANGER

Potential Severity: Major

Potential Loss:Assets, Personnel

Hazard Category: Electrical, Explosives

The input power to the Control Power Transformer 4 (CPT4) circuit is applied at all times. Opening the molded case circuit breaker (MCCB) does not remove power from the CPT4 circuit. Ensure that the 3-phase power to the system is off and that the system is locked out and tagged out before performing maintenance or repairs on the VSD. (**Note:** The CPT may be labelled with other number in some drives, eg. CPT5. Please review the engineering drawings of the drive to accurately identify the CPT that is connected to the input of MCCB.)

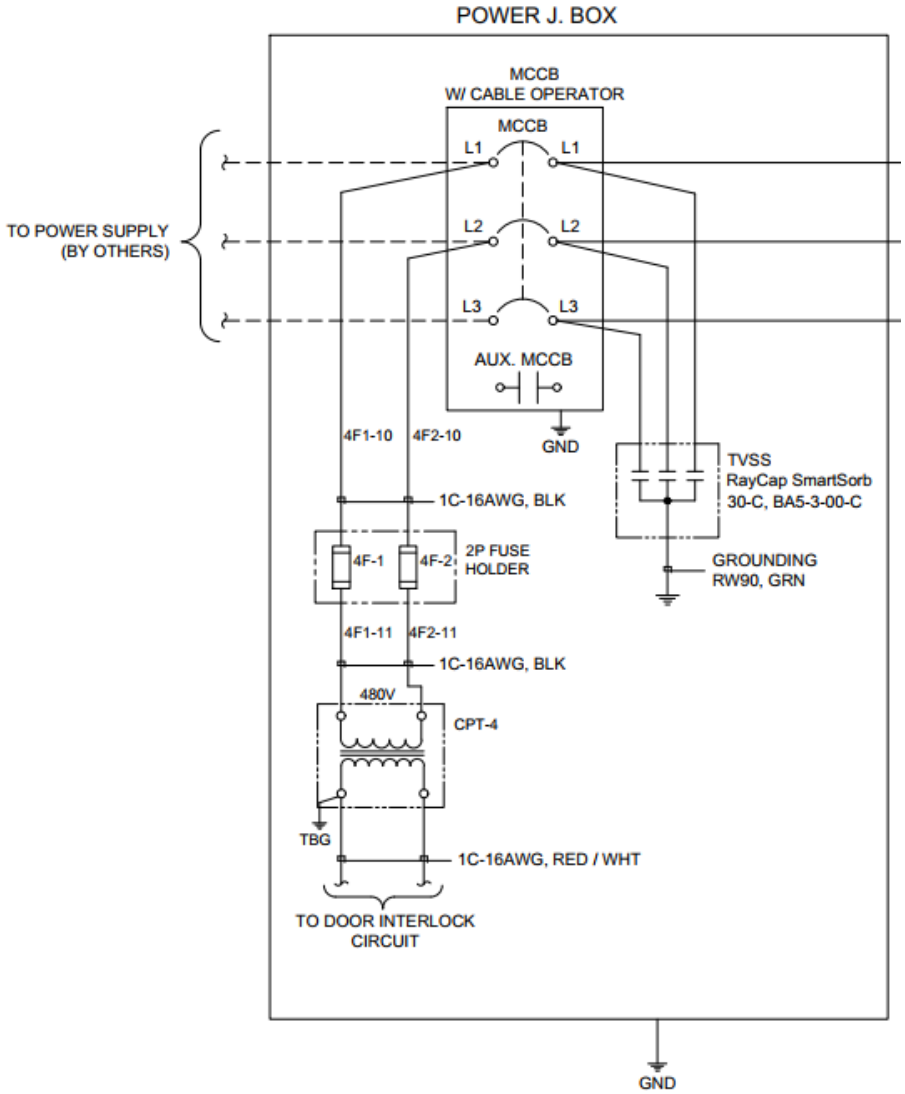


Figure 2-1: Placement of Control Power Transformer 4 in E30 VSD

2.2 INSTALLATION AND MAINTENANCE SAFETY

 WARNING	**Potential Severity: Serious** **Potential Loss: Assets, Personnel** **Hazard Category: Electrical, Machinery equipment hand tools** Ignoring the following instructions can cause physical injury or death, or damage to the equipment.

1. Never work on the drive, motor cable or motor when main power is applied.
2. After disconnecting the input power, always wait for 15 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor, or motor cable.
3. Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that:
   - Voltage between drive input phases L1, L2 and L3 and the frame is close to 0 V
   - DC bus voltage at the -DC and +DC is close to 0 V.
4. Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may cause dangerous voltages inside the drive even when the main power on the drive is switched off.
5. Do not make any insulation or voltage withstand tests on the drive.
6. Do not connect the drive to a voltage higher than what is marked on the nameplate.

NOTE	• The motor cable terminals on the drive are at a dangerously high voltage when the input power is on, regardless of whether the motor is running or not. • The DC terminals (+DC, -DC) carry a dangerous DC voltage (over 500 V) when internally connected to the intermediate DC circuit. • Depending on the external wiring, dangerous voltages (115 V, 220 V or 230 V) may be present on the terminals of relay outputs.

Section 3: **Inspection/Storage/Disposal**

This chapter describes how to inspect a VSD when it first arrives at the wellsite or jobsite, how to ship or store the unit if it will not be immediately connected and put in service, and how to dispose of any old or previously installed electrical/electronic drive equipment.

3.1 INSPECTION OF NEW UNIT

1. Immediately upon receipt of the drive it should be un-crated and a thorough visual inspection for damage should be made.
2. Check the unit for loose, broken, bent, or otherwise damaged parts due to shipping.
3. Check to see that the rated capacity and the model number specified on the nameplate conform to the order specifications.
4. Shut and seal the drive door before storing or shipping. Ensure there are no openings in the drive for moisture or dust to enter.

3.2 STORAGE AND SHIPPING

For packaging and international shipping requirements, refer to InTouch Content ID 5170246. For general storage and shipment refer below:

1. Store the unit and any optional equipment in a clean, dry, and well-ventilated location. The VSD must be stored and shipped upright.
2. Avoid storage in locations with high humidity and dust. It is highly recommended to store drives indoors. If for any reason the drive cannot be stored inside, it should not be left outside for more than 30 days.
3. Spare part PCBs are to be stored in anti-static packages in a dry environment.
4. Drives should be stored and shipped with all inspection plates and doors properly closed, including the C-clamps surrounding the door frame.
5. Drives that have been running or opened for inspection must have a dry interior before shipping or storing. Dry the cabinet in any appropriate fashion including using heaters. Do not heat components over 140 degF (60 degC) while drying. After the drive is dry, it is optional to add desiccants or corrosion inhibitor packages. Shut and seal the drive doors. Protective external wrapping is required to keep the drive clean on the exterior or to prevent abrasions during shipping.
6. The capacitors must be reformed if the drive has been stored for a year or more. Refer to 10.10 Reforming the Capacitors for more details.
7. The following shipping and storage environmental conditions should not be exceeded:
   - Outdoor Drives: -40 degF (-40 degC) to 158 degF (70 degC) for shipping and storing.
8. The drive should be warmed to 5 degF (-15 degC) before connecting power and running a load.

3.3 DISPOSAL

Lithium batteries MUST be removed from the drive and motor controller prior to disposal of the unit. The batteries MUST be disposed of separately and according to local regulations.

The circuit boards and display module of the drive and motor controller used in this equipment may contain lead solder and solder paste. The boards should be disposed of according to local regulations.

Please contact your local environmental agency or Sensia HSE advisor for details on proper disposal of electrical components and packaging in your particular area.

Potential Severity: Major

Potential Loss: Personnel

Hazard Category: Electrical, Explosives, Fire flammable, Toxic corrosive hazardous substances

Never dispose of electrical components by incineration.

Section 4: **Specifications**

4.1 OPERATING SPECIFICATIONS

The following table lists operating specifications and ranges for the E30 drive.

Table 4-1: E30 Drive Operating Specifications

ITEM		STANDARD SPECIFICATIONS
Principal Control Parameters	Control System	Pulse-Width Modulation (PWM) with Constant V/Hz Control
	Input Voltage Supply	380-480 V ±10%, 50/60 Hz ±3Hz
	Output Voltage Regulation	0 - 480 V (≤ Power supply voltage)
	Frequency Setting	0…325 Hz at 2 kHz carrier, 0.1Hz resolution 0…590 Hz at 4 kHz carrier, 0.1Hz resolution
	Carrier Frequency	Adjustable between 2 and 4kHz
	Converter Type	Silicon controlled rectifier(SCR), or External Diode bridge rectifier
	Nominal DC bus (full load)	Nominal 540-648 VDC constant (Based on Input Voltage)
	Inverter Type	IGBT (Insulated Gate Bipolar Transistor)
	Intermittent overload	110% overload capability for up to 60s.
	Displacement Power Factor	0.98 at nominal loads
	Inverter Efficiency	0.975 at rated amps, nominal line volts
	Starting Frequency	0 – 10Hz
	Voltage Boost	0 - 30%
	Cooling Fan Control	Automatic
Inverter	Protective functions	AC input overvoltage/undervoltage, DC bus overvoltage/undervoltage, drive overcurrent, line transients, heatsink overtemperature, emergency stop, control logic noise immunity, power ride-through, logic control ride-through, ground fault, short circuit, communication error.
	Operating functions	Accel/Decel Time, Forward and Reverse, Frequency Jumps, Automatic Restart, Rocking Start
	Electronic Thermal Characteristics	Adjustable for motor rated amperage.
Motor Controller	Power Supply	100-240 volts AC ±10%, 50/60Hz
	Display	LCD, Color GUI, back lit with heater
	Mode of Operation	Hand - Auto - Off
	Communication	Modbus TCP/IP with inverter
	Expansion Slot	4 slots

ITEM		STANDARD SPECIFICATIONS
Enclosure	Type	NEMA4 for drive sections, NEMA3R for transformer section. Floor mount, forklift slots and lifting eyes are provided
	Dimensions (H x W x D)	kVA size dependent. Refer to manufacturer's drawings for details
	Door Handle	Multi-Latch
	Door Interlock	Doors with access to high voltages are interlocked and cannot be accessed until the drive is de-energized
	Cooling Method	Forced air cooling. Heat exchanger for electronics compartment
	Color	White
	Ambient Temperature	-15 to +50°C (5 to 122°F). -15 to +40°C (5 to 122°F) for Frame 8 and above, deratings required for 50°C.
	Relative Humidity	5 - 95% maximum (non-condensing).
	Vibrations	1.000 mm (0.040 in.) displacement, 1 g peak
	Altitude	1000 m (3280 ft)
	Service Environment	Consult factory for harsh environment applications such as offshore, cold climate or desert environments. Deratings may be required for direct sunlight and harsh environments.
Sinewave filter	Type	A specially designed three phase reactor and three phase capacitors (LC filter) to convert a PWM waveform to sinusoidal waveform
	Construction	Integral part of VSD housed inside a NEMA-rated enclosure

4.2 AMBIENT TEMPERATURE DERATE

The E30 drive is rated for 100% continuous load at 40°C for all the frame sizes.

For 50°C and 55°C ambient, no derate would be required for Frame 7 and below. Whereas for Frame 8 and above, a derate of about 19% would be required. The same derate would be applied for both 50°C and 55°C. Please refer to the table below for the derated current and KVA for Frame 8 and above.

Table 4-2: Temperature Derate Table

	40°C RATING		50°C & 55°C RATING	
Frame	Amp	kVA	Amp	kVA
8	545	453	443	368
8	617	513	502	417
8	710	590	577	480
8	740	615	602	500
9	800	665	650	541
9	960	798	780	649
9	1045	869	850	706
9	1135	944	923	767
9	1365	1135	1110	923
9	1420	1181	1154	960
10	1525	1268	1240	1031
10	2070	1721	1683	1399

4.3 ACCURACY OF THE POWER ANALYZER

The accuracy of the measurements provided by the Power Analyzer Voltage Sensor varies with the type of voltage waveform being measured, the operating frequency and the amount of loading on the equipment. The operation of the voltage sensor was evaluated with a Switchboard, a VSD with a PWM output voltage waveform and a VSD with a sinewave output voltage waveform.

Table 4-3 provides a summary of the accuracies for the measurements for the various operations. It should be noted that there was no significant variation in the accuracy due to loading in the case of the voltage sensor operating with a VSD with a sinewave output voltage waveform.

Table 4-3: Power Analyzer - Accuracy of Measurements

OPERATING FREQ	SWITCHBOARD	VSD PWM OUTPUT (NO LOAD)	VSD PWM OUTPUT (100 % LOAD)	VSD SINEWAVE OUTPUT (100 % LOAD)
40 Hz	N/A	14%	6%	3%
50 Hz	3%	7%	4%	3%
60 Hz	3%	7%	4%	3%

4.4 INCREASED DRIVE AMPACITY FOR 400V INPUT

The standard drives are rated to 480V, however if the drive has a 400V supply instead of 480V it is possible to increase the drive ampacity by configuring it to 400V drive. Table 4-4 illustrates the ampacity of the drive with 480V and 400V input setting for standard offering.

Before configuring the drive from 480V to 400V, it is important to ensure all components in the drive package such as the circuit breaker and sinewave filter have enough capacity for this additional ampacity of the drive.

Table 4-4: 480V vs 400V ampacity

DRIVE AMP @ 480V	DRIVE AMP @ 400V	SINEWAVE FILTER RATING, A	MCCB RATING AND TYPE	MCCB MAX DRIVE AMP*	IS INCREASED AMPACITY WITHIN ALL COMPONENT'S CAPACITY
96	104	110	225A, T/M, 80%	151	yes
156	170	160	250A, T/M, 80%	178	no
248	260	250	400A, T/M, 80%	274	no
361	367	362	400A, LSI, 100%	386	no
477	477	480	800A, T/M, 80%	518	yes
617	650	650	800A, T/M, 100%	715	yes
740	770	750	800A, LSI, 100%	773	no
1045	1090	1080	1200A, LSI, 100%	1208	no
1420	1480	1500	2000A, LSIG, 80%	1546	yes
2070	2150	2250	3000A, LSIG, 100%	2551	yes

*This is the maximum drive current the MCCB can carry, taking into consideration 80% and 100% rating, temperature derate and power factor.

Section 5: **Wiring**

This chapter contains intra- and interconnection information for the VSDs:

- To incoming (customer-supplied) power
- From the main power bus through the drive and other components inside the drive enclosures
- Between the drives' major components (between the motor controller/operator interface and the VSD) and optional equipment (site communications equipment)
- From the outgoing power to output transformer (when used) and on to the motor(s).

5.1 IMPORTANT NOTES ON DRIVE WIRING

1. Properly ground the drive cabinet with a copper conductor to meet local electrical codes. For VSD applications, metal conduit is not an acceptable ground. Cabinet ground connection must also comply with NEC-Article 250 and CEC-Section 10.
2. The motor should be grounded to the same point in the drive cabinet as the copper wire. Do not mix input and output conductors in the same conduit. Ground connection must also comply with NEC-Article 250 and CEC-Section 10.
3. A power junction box is available to simplify the installation of input and output cables. Terminals are marked identically to the drive and accessible from a separate box outside the enclosure.
4. Step-Up transformers have numerous tap settings for different motors and cable lengths. Contact InTouch Support before starting a new application to ensure correct sizing and wiring.

5.2 SELECTION OF WIRING EQUIPMENT AND STANDARD CABLE SIZES

1. Any customer-supplied Molded Case Circuit Breaker (MCCB), Magnetic Circuit Protector (MCP), or fuses between the 3-phase power source and the VSD, should be in accordance with the short circuit current setting of the VSD and 2008 NEC Article 430.
2. Wire sizing should be based upon NEC Table 310.16 or CEC Table 2 using 75 degC cable, an ambient of 30 degC, cable runs for less than 300 ft, and copper wiring for no more than three conductors in the raceway, cable or earth (directly buried). A derating factor should be considered for 50 degC as per NEC, CEC code, or applicable local area code. The customer should consult the NEC, CEC, or applicable local area codes standard wire tables for their own particular application and wire sizing and ambient de-rating factors.
3. Use parallel conductors instead of a single conductor (this will allow for the proper wire bending radius within the cabinet). Use separate conduits for routing parallel conductors. This prevents the need for conductor derating (see **Note 2**).
4. Lug sizes are based on using copper/aluminum bonding conductor. Refer to CEC Table 16 for copper wire and NEC Table 250.122, based on copper.

NOTE	1. Contactors used to connect drive terminals should be capable of switching low-current signals (i.e., 5 mA). 2. When wiring with parallel conductors, the conductors should be kept together in phase sets with U1, V1, W1 in one conduit and parallel conductors U2, V2, W2 in another conduit. The ground conductor should be in one of these conduits. 3. Twisted-pair wiring should be used for pressure feedback signal wiring terminals. 4. Pressure feedback input: 4 to 20 mA or 1 to 5 V signal, use two–wire twisted pair, #20 AWG; Other signal circuits use #18 AWG.

 WARNING	**Potential Severity: Serious** **Potential Loss: Assets, Personnel** **Hazard Category: Electricity** Turn off power and lockout/tagout (refer to SENS-HSE-S027) the drive before making any wiring changes.

 CAUTION	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Electrical** Use separate conduits for routing incoming power, power to motor, and control conductors. Use no more than three power conductors and a ground conductor per conduit.

5.3 GROUNDING

The VSD should be grounded in accordance with Article 250 of the NEC or Section 10 of the CEC, Part I, and the grounding conductor should be sized in accordance with NEC Table 250.122 or CEC, Part I Table 16. Refer to 5.2 Selection of Wiring Equipment and Standard Cable Sizes. Local grounding codes may apply. A ground lug is provided inside the VSD on the ground bus.

 CAUTION	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Electrical** Conduit is not a suitable ground for the inverter.

5.4 WIRING CONSIDERATIONS FOR MECHANICAL EQUIPMENT

The following cautions and warnings are special considerations that should be made for mechanical equipment and components such as motors, shafts, and bearings when this equipment will be driven and controlled by a variable speed drive.

 CAUTION	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Machinery equipment hand tools, Temperature** Surface motors operating from adjustable-speed drive power sources tend to operate at higher temperatures which may increase the need for more frequent lubrication cycles. Failure to lubricate motors driven by adjustable-speed drives could cause premature failure of the motor.

 WARNING	**Potential Severity: Serious** **Potential Loss: Assets, Personnel** **Hazard Category: Electrical, Explosives** Operating motors at carrier frequencies higher than 5 kHz may require the motor shaft to be grounded or motor bearings to be insulated to prevent current from being passed down the shaft by capacitive coupling to ground.

 WARNING	**Potential Severity: Serious** **Potential Loss: Assets, Personnel** **Hazard Category: Electrical** Submersible motors powered by VSD output transformers require special application concerns. Contact InTouch or LCS Engineering before starting a new VSD application.

5.5 VSD INTERCONNECTION WIRING

The following subsections describe how the motor controller and the VSD are interconnected for power, control, and communication both within the drive and to external or optional equipment. Refer to Figure 5-1 for a simplified diagram of how the E30 drive, controller, site communications equipment (if required), and external devices (if required) are connected. Detailed interconnection diagrams are presented in the respective subsystem manuals.

NOTE	Do not use these interconnection wirings for construction purposes.

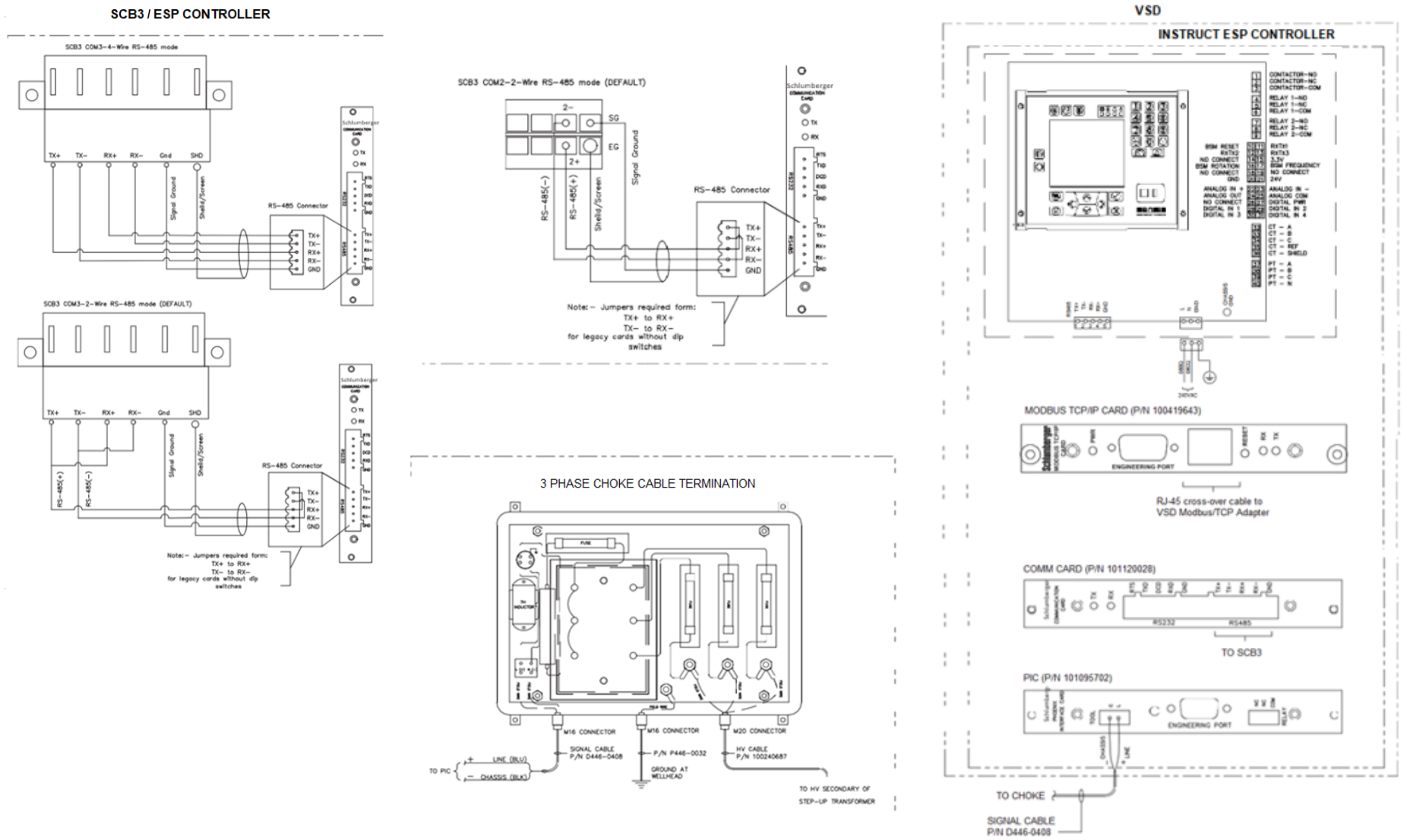


Figure 5-1: Typical E30 - ESP Controller Interconnection/ Communication Wiring

5.5.1 MOTOR CONTROLLER WIRING

Refer to the controller manual for detailed wiring and connection information*: INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576).

5.5.2 CONTROLLER- VSD WIRING

For the purpose of discussion in this manual, VSD wiring is confined to interconnection or communication wiring to or from the drive, or to the motor controller or other external devices in the Sensia VSD systems. Wiring internal to the E30 drives is not within the scope of this manual.

The controller connects to the E30 drive via Modbus TCP Protocol. To enable this communication, a Modbus TCP/IP card shall be inserted into one of the four slots in the controller while a 20-COMM-M card shall be inserted into port 6 of the option module slots in the drive control pod. Connect the Ethernet port of the 20-COMM-M card to the Ethernet port of the Controller Modbus TCP/IP Card using a crossover Ethernet cable.

Refer to Figure 5-1 for the typical connections, or manufacturer drawings for the detailed wirings.

NOTE	Refer to the *LCS-ENG-M0005 INSTRUCT ESP Controller-E30 Drive Configuration Manual* to set up the communication with the drive.

5.5.3 POWER ANALYZER CARD WIRING

The Power Analyzer (PA) Card (P/N 100840440) provides 3-phase power monitoring (including 3-phase voltage measurement and 3-phase current measurement), and digital and analog connectivity for interfacing with external devices. It interfaces with a PA 5kV Voltage Sensor (P/N 100840441) via an 8m PA cable (P/N 101947905).

Figure 5-2 shows the Power Analyzer Card connector pin assignment, which may be a useful reference for wiring. The terminals of the PA card are pre-wired to the low-voltage junction box of the drive for ease of installation. Table 5-1 shows the mapping of PA Card terminals to low-voltage junction box terminals.

NOTE	Refer to the *INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576) for the specification of the PA card I/O.

This card has three relay outputs, one analog output, one differential analog input and four digital inputs. In the E30 VSD, the *contactor* relay output is wired to switch the running indication light while the *relay-1* output is wired to switch the alarm indication light.

This card can read the high-voltage measurements and backspin information through an interface with the PA 5kV Voltage Sensor. Pins 10 to 21 support the voltage sensor connection. In the E30 VSD, the 8m INSTRUCT Power Analyzer Cable is provided as standard. One end of this cable is connected to the PA card (via pins 10 to 21) while the other end is connected to the PA 5kV Voltage Sensor.

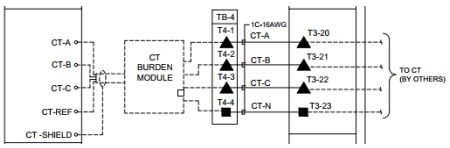
Current Input: The PA Card contains three AC current transformer (CT) inputs for measuring and monitoring 3-phase motor current via the CT Burden Module.

Voltage Input: The PA Card contains three AC potential transformer (PT) voltage inputs for measuring and monitoring 3-phase motor voltage.

	1		Contactor -NO
	2		Contactor -NC
	3		Contactor -COM
	4		Relay 1 -NO
	5		Relay 1 -NC
	6		Relay 1 - COM
	7		Relay 2 -NO
	8		Relay 2 -NC
	9		Relay 2 - COM
BSM Reset	10	11	RXTX1
RXTX2	12	13	RXTX3
No Connect	14	15	3.3V
BSM Rotation	16	17	BSM Frequency
No Connect	18	19	No Connect
GND	20	21	24V
Analog In +	22	23	Analog In -
Analog Out	24	25	Analog COM
No Connect	26	27	Digital PWR
Digital In 1	28	29	Digital In 2
Digital In 3	30	31	Digital In 4
	32		CT - A
	33		CT - B
	34		CT - C
	35		CT - Ref
	36		CT - Shield
	37		PT - A
	38		PT - B
	39		PT - C
	40		PT - N

Figure 5-2: INSTRUCT Power Analyzer Card Connection Pin Assignment

Table 5-1: Mapping of PA Card Terminals to Low-Voltage Junction Box Terminals

TERMINAL IN PA CARD	SIGNAL DESCRIPTION	TERMINAL IN LOW VOLTAGE JUNCTION BOX	REMARKS
1	Contactor-NO	TB3-1	Pre-wired to switch running indication light
2	Contactor-NC	TB3-2	
3	Contactor-COM	TB3-3	
4	Relay 1-NO	TB3-4	Pre-wired to switch alarm indication light
5	Relay 1-NC	TB3-5	
6	Relay 1-COM	TB3-6	
7	Relay 2-NO	TB3-7	
8	Relay 2-NC	TB3-8	
9	Relay 2-COM	TB3-9	
10~21	5KV Voltage Sensor Connection	-	An 8m sensor cable with connectors at both ends is provided as standard. Route this cable through the junction box and connect it directly to the PA card.
22	Analog In +	TB3-10	
23	Analog In -	TB3-11	
24	Analog Out	TB3-12	
25	Analog COM	TB3-13	
26	No Connect	TB3-14	
27	Digital PWR	TB3-15	
28	Digital In 1	TB3-16	
29	Digital In 2	TB3-17	
30	Digital In 3	TB3-18	
31	Digital In 4	TB3-19	
32	CT-A	These terminals are to be connected to CT burden module which would be installed in the LV compartment. (Note: CT burden module is not provided as standard)	The CT cables from the field to be connected to T3-20 (CT-A), T3-21(CT-B), T3-22(CT-C), T3-23(CT-N) in junction box. These terminals are pre-wired to T4-1, T4-2, T4-3, and T4-4 in the LV compartment. These terminals are to be connected to CT burden module which would also be installed in the LV compartment. (Note: CT burden module is not provided as standard) 
33	CT-B		
34	CT-C		
35	CT-Ref		
36	CT-Shield		
37	PT-A	TB3-24	
38	PT-B	TB3-25	
39	PT-C	TB3-26	
40	PT-N	TB3-27	

5.5.4 INSTRUCT POWER ANALYZER 5KV VOLTAGE SENSOR WIRING

The INSTRUCT Power Analyzer 5kV Voltage Sensor (P/N 100840441) is delivered loose with the E30 VSD and must be installed at the step-up transformer outputs to measure motor phase-to-phase and phase-to-ground voltages. The three high-voltage input cables are connected to the output terminals of the transformer, and the ground line is connected to the star-point/Neutral point of the transformer in a WYE configuration.

The 5kV Voltage Sensor was not designed for Delta configurations. The measurement accuracy in a Delta system may be less accurate. The recommendation would be to leave the ground cable floating instead of connecting it to system ground if an imbalance is observed.

The PA 5kV Voltage Sensor is connected to the Power Analyzer Card via an 8m signal cable (P/N 101947905) supplied loose with the E30 VSD as standard. This cable comes with connectors at both ends and its connection points are not reversible. The end that connects to the PA 5kV Voltage Sensor is labelled “Sensor” and the end that connects to the PA Card (which has the cable shielding connection) is labelled “PA”. Connector pins 10 to 21 on the PA Card are for the PA 5kV Voltage Sensor connection.

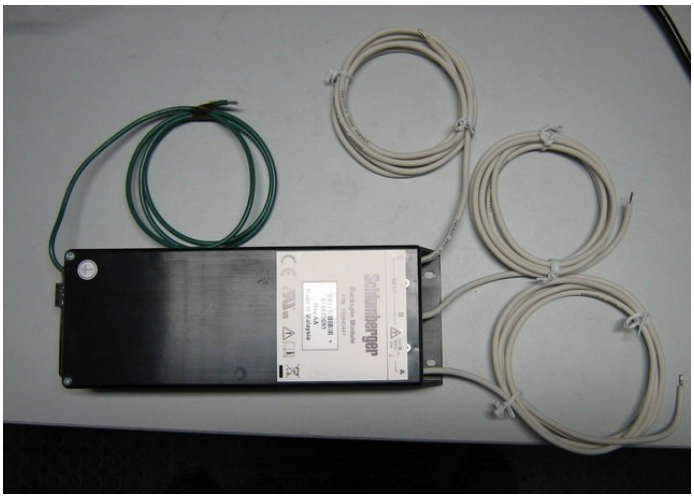


Figure 5-3: INSTRUCT Power Analyzer 5kV Voltage Sensor

Figure 5-4: INSTRUCT Power Analyzer 5kV Voltage Sensor Signal Cable

The signal cable (P/N 101947905, revision AC onwards) would have the wires and connectors labelled. Each wire is labelled to its corresponding connector pin number, refer Figure 5-5.

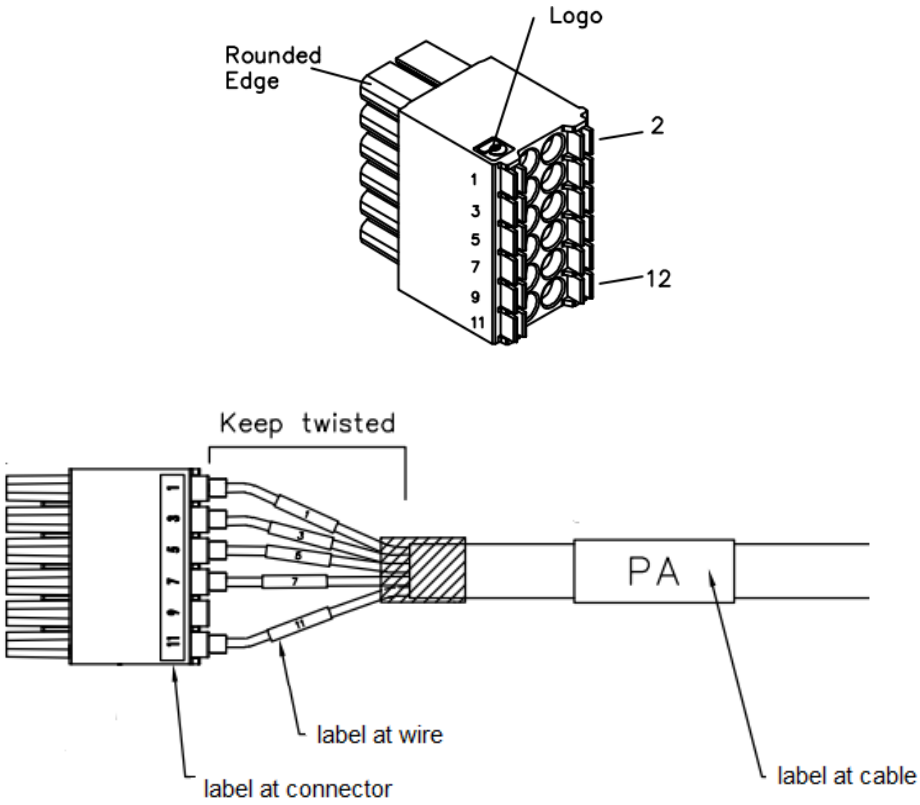


Figure 5-5: Label at Cable, Wire, and Connector

5.5.5 VSD I/O MODULE (20-750-2262C-2R) WIRING

The VSD I/O Module card has six digital inputs, two relay outputs, two analog inputs, two analog outputs and one motor PTC input. Refer Section 5.7.2 for the detailed specification of this I/O module.

In E30 VSD, the following signals are connected to the I/O module by default:

- DI1: Emergency Shutdown pushbutton
- DI2: Heat Exchanger Alarm
- DI3: Step-up transformer door interlock* and MCCB-2 Aux contact (for 12-pulse VSD)
- DI4: Sinewave filter reactor and bridge thermal switches
- DI5: VSD door interlock bypassed
- R1: Off-delay timer (for cooling fans control)

* The transformer door interlock is a signal external to the VSD. The user is required to bring in the door switch signal and connect to terminals TB3-28 and TB3-29 in the low voltage junction box. When the door switch is not used, these two terminals shall be connected by a jumper.

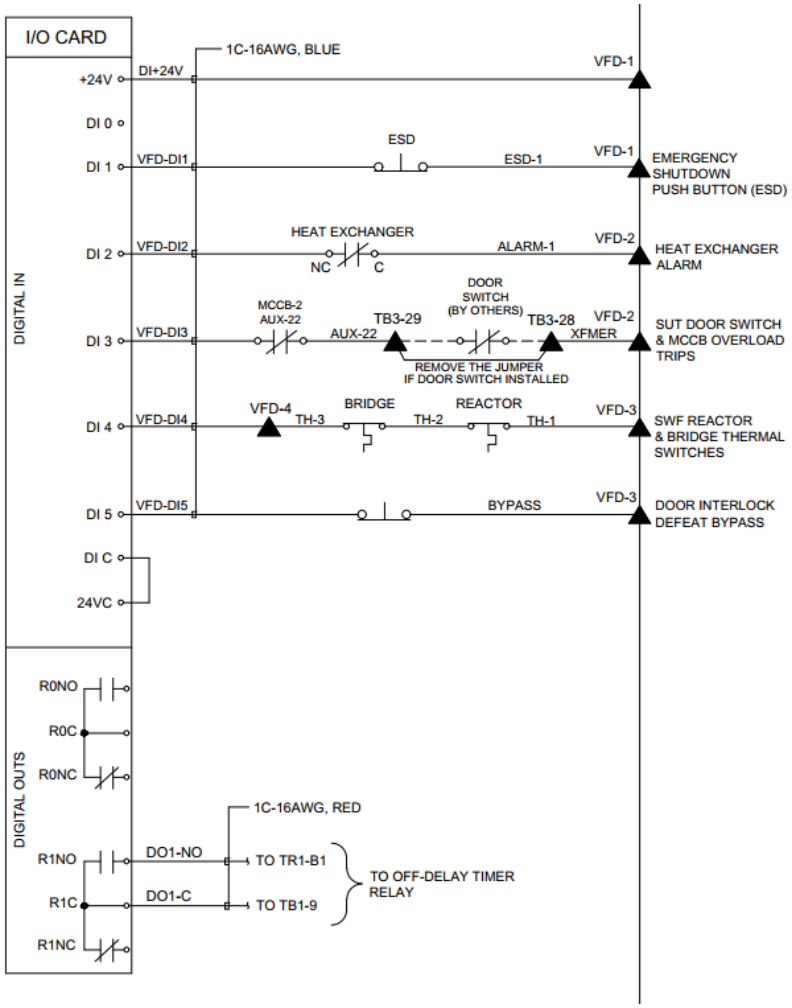


Figure 5-6: Signals to Drive I/O Module in E30 VSD

5.6 POWER JUMPER CONFIGURATION

The drives contain protective MOVs and common mode capacitors that are referenced to ground. To guard against drive damage and/or operation problems, these devices must be properly configured.

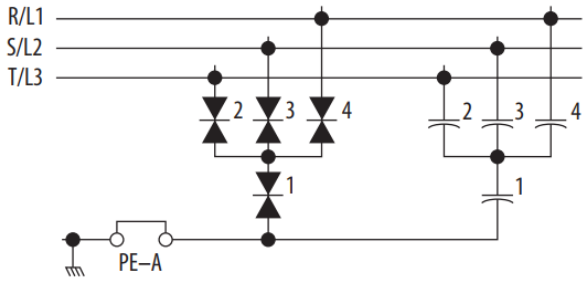


Figure 5-7: MOV and AC EMI Capacitor Phase to Ground (Frames 1…7)

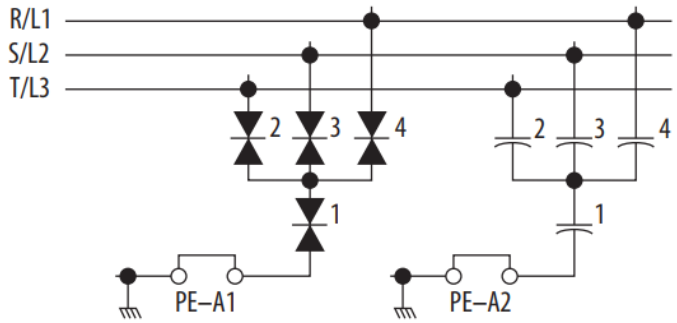


Figure 5-8: MOV and AC EMI Capacitor Phase to Ground (Frames 8…10) AC Input Only

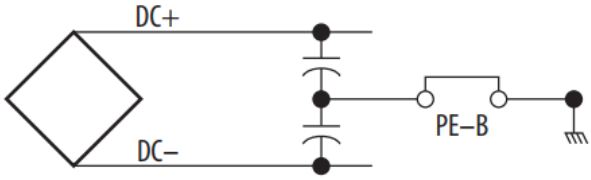


Figure 5-9: Common Mode Capacitors to Ground (All Frames)

NOTE	A properly configured drive has either all jumpers connected, or all jumpers disconnected, depending on whether the power source is solid grounded or non-solid grounded. If jumpers are neither all connected nor all disconnected, the power jumpers **are not** properly configured. The drive power source type must be accurately determined, and the jumpers must be configured for the power source.

Table 5-2: Recommended Power Jumper Configurations for Frames 1…7

POWER SOURCE TYPE	JUMPER PE-A (1) (2) (MOV/INPUT FILTER CAPS)	JUMPER PE-B (DC BUS COMMON MODE CAPS)	BENEFITS OF CORRECT CONFIGURATION ON POWER SOURCE TYPE
Non-Solid Ground • AC fed ungrounded • Impedance grounded • B phase ground • DC fed from an active converter	Disconnected	Disconnected	Helps avoid severe equipment damage when ground fault occurs
Solid Ground • AC fed solidly grounded • DC fed from passive rectifier that has a solidly grounded AC source	Connected	Connected	• UL compliance • Reduced electrical noise • Most stable operation • EMC compliance • Reduced voltage stress on components and motor bearings

(1) When MOVs are disconnected, the power system must have its own transient protection to confirm known and controlled voltages.

(2) Frame 5…7 common DC input drives do not have the PE-A jumper.

Table 5-3: Recommended Power Jumper Configurations for Frames 8…10

POWER SOURCE TYPE	JUMPER PE-A1 (1) (MOV)	JUMPER PE-A2 (INPUT FILTER CAPS)	JUMPER PE-B (DC BUS COMMON MODE CAPS)	BENEFITS OF CORRECT CONFIGURATION ON POWER SOURCE TYPE
Non-Solid Ground • AC fed ungrounded • Impedance grounded • B phase ground • DC fed from an active converter	Disconnected	Disconnected	Disconnected	Helps avoid severe equipment damage when ground fault occurs
Solid Ground • AC fed solidly grounded • DC fed from passive rectifier that has a solidly grounded AC source	Connected	Connected	Connected	• UL compliance • Reduced electrical noise • Most stable operation • EMC compliance • Reduced voltage stress on components and motor bearings

(1) When MOVs are disconnected, the power system must have its own transient protection to confirm known and controlled voltages.

5.6.1 FRAMES 6 AND 7 POWER JUMPER WIRE REMOVAL AND STORAGE

Frames 6 and 7 use jumper wires to complete an electrical connection when installed. When jumper wires are connected, use this torque and tools:

- Recommended torque (screws and nuts) = 1.36 N•m (12.0 lb•in)
- Recommended hex socket = 7 mm
- Recommended screwdriver = T20 hexalobular

 WARNING	**Potential Severity: Serious** **Potential Loss: Assets** **Hazard Category: Electrical** Hazard of equipment damage exists if jumpers are not properly disconnected. For Frames 6 and 7, secure the disconnected jumper wire to the insulated position provided.

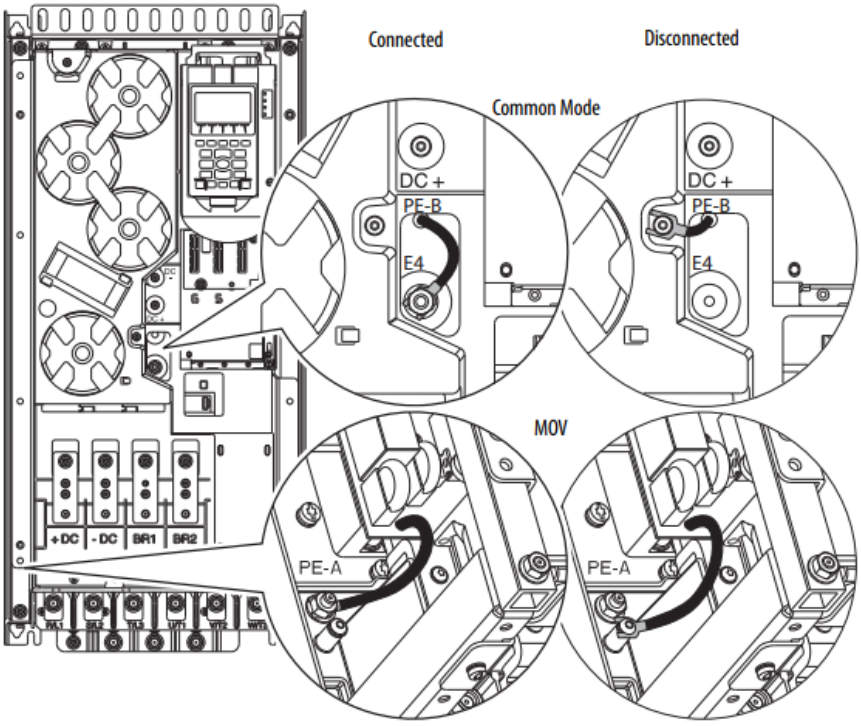


Figure 5-10: Frame 6 Jumper Wire Locations

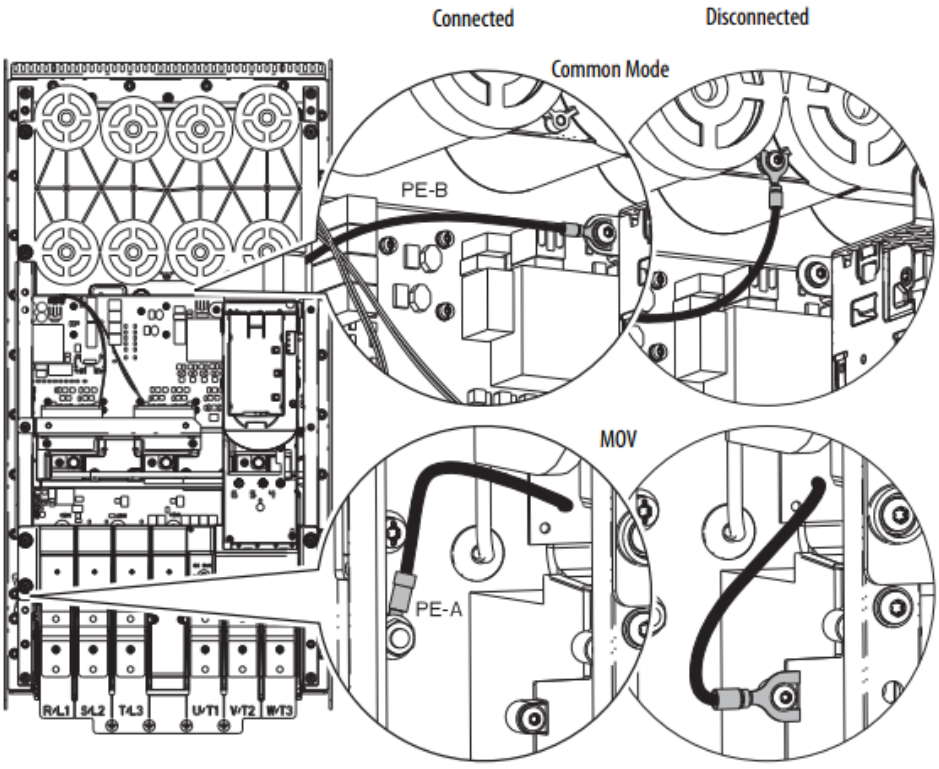


Figure 5-11: Frame 7 Jumper Wire Locations

5.6.2 FRAMES 8…10 DRIVE ASSEMBLY JUMPER REMOVAL AND STORAGE

Frames 8…10 drive assemblies use jumper plugs to complete an electrical connection when installed.

WARNING	**Potential Severity: Serious** **Potential Loss: Assets** **Hazard Category: Electrical** Hazard of equipment damage exists if jumpers are not properly disconnected or are set differently between drive assemblies. For Frame 8…10 drive assemblies, secure the disconnected jumper plug in the socket that is provided and verify that all drive assemblies are configured the same.

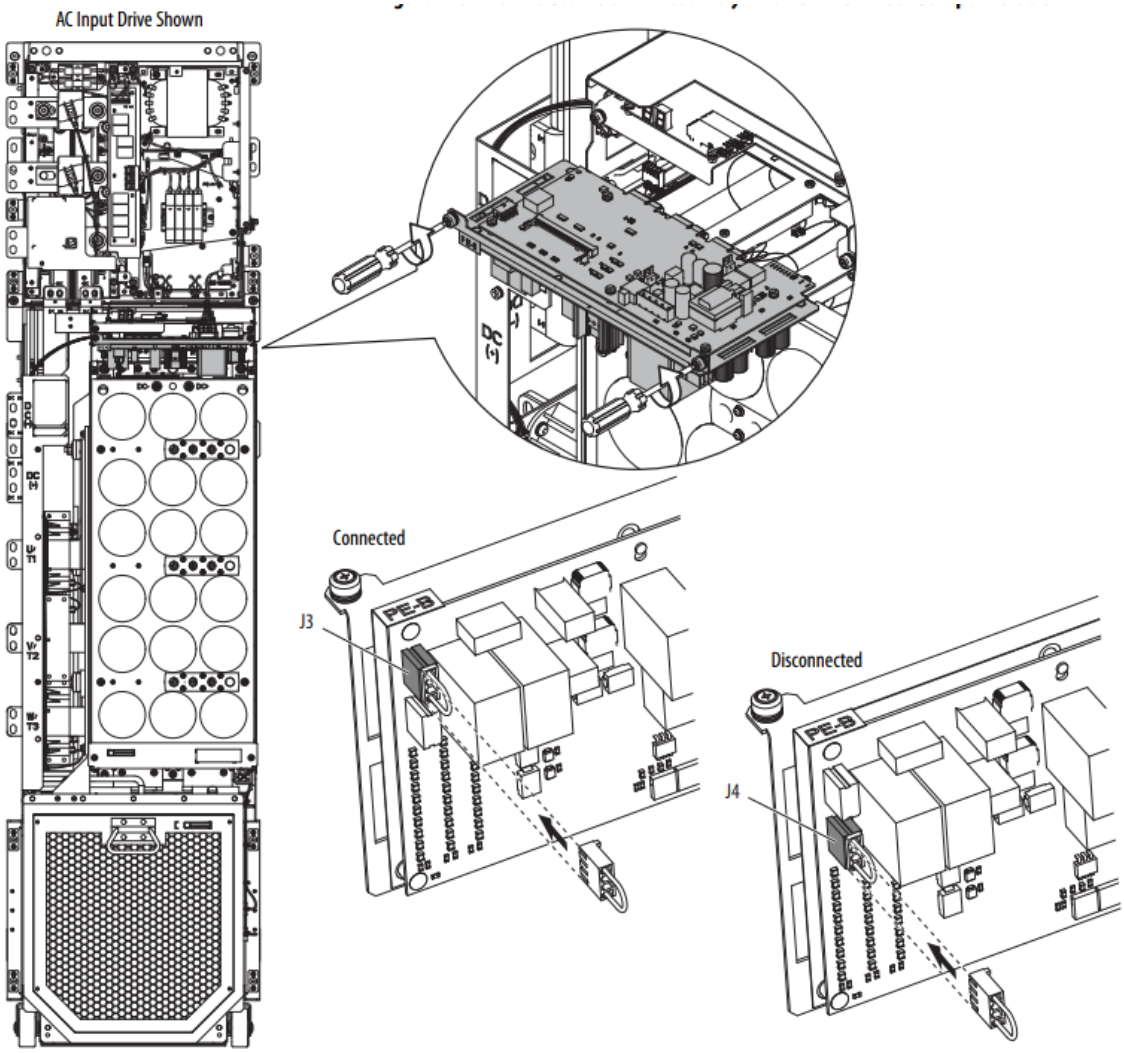


Figure 5-12: Frames 8…10 Drive Assembly PE-B Common Mode Jumper Location

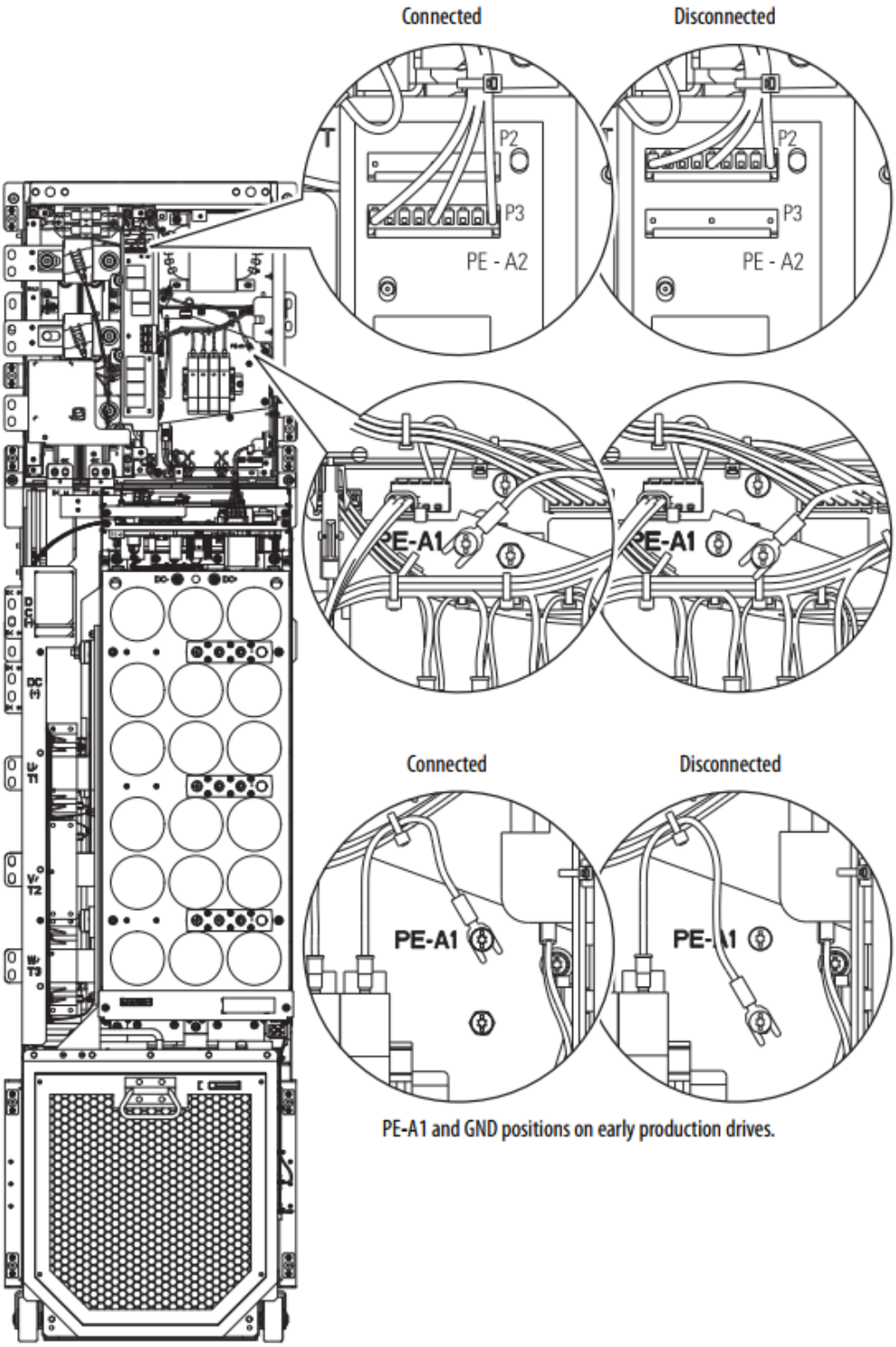


Figure 5-13: Frames 8…10 Drive Assembly PE-A1 MOV and PE-A2 Input Filter Caps Jumper Location

When the PE-A1 jumper wire is connected, use this torque and tool:

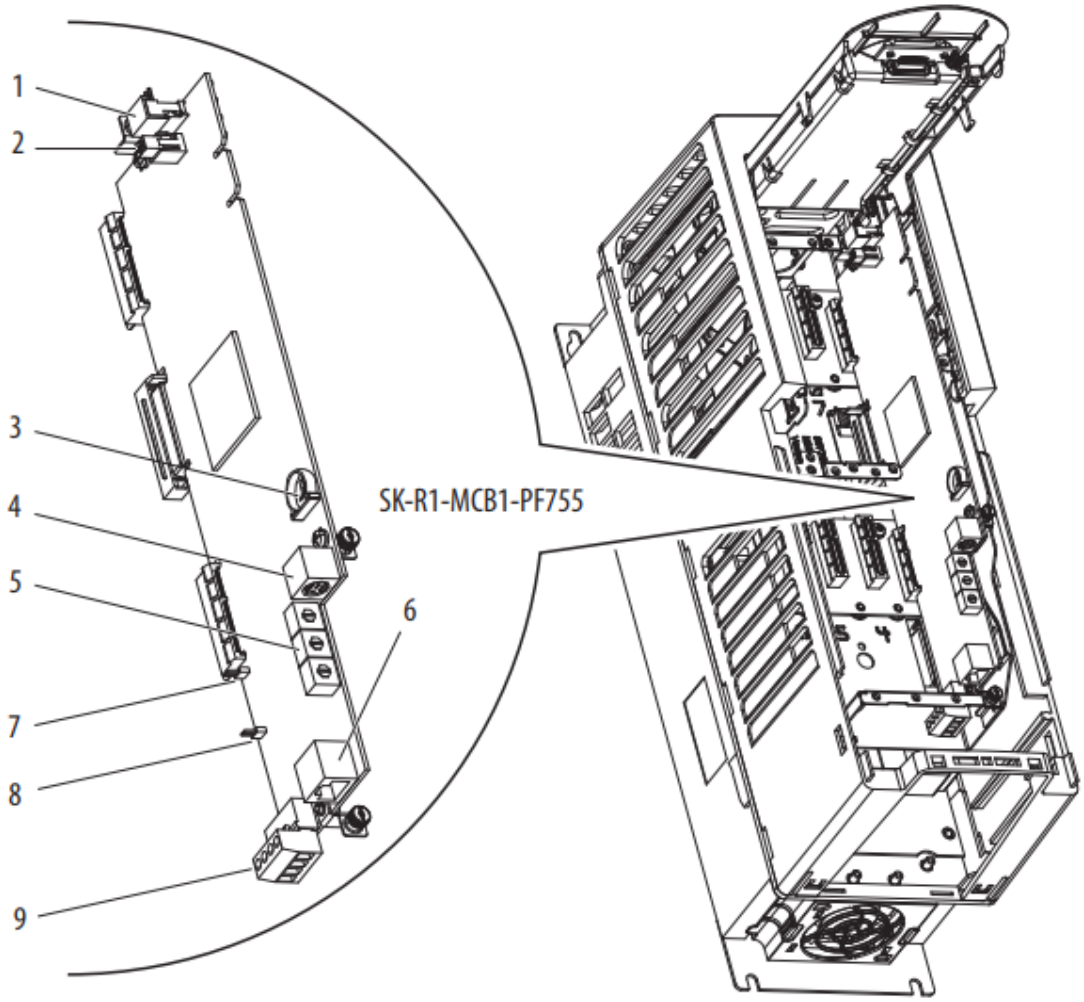
- Recommended torque = 1.8 N•m (16.0 lb•in)
- Recommended screwdriver = T20 hexalobular

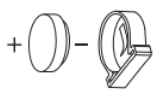
5.7 DRIVE CONTROL BOARD AND OPTION MODULES TERMINAL DESIGNATIONS

This topic describes the VSD main control board and its option modules.

5.7.1 VSD MAIN CONTROL BOARD

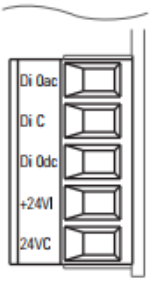
5.7.1.1 FR1 to FR7



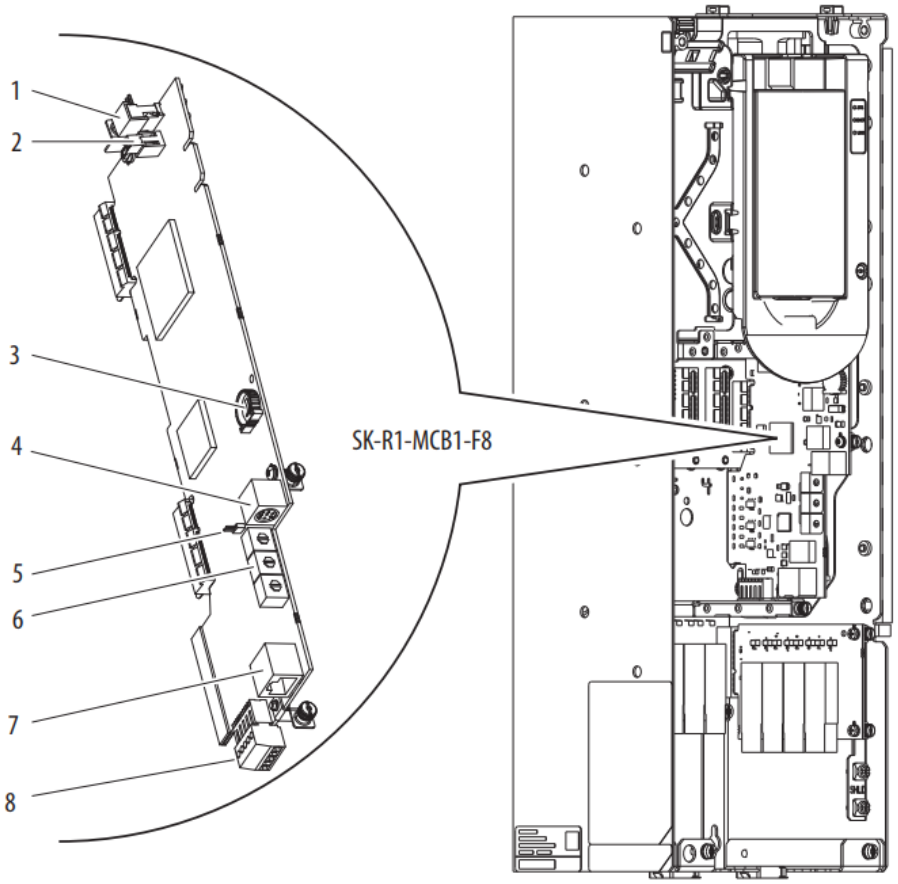
NO.	NAME	DESCRIPTION
1	Human Interface Module (HIM) connector	DPI port 1 (HIM Cradle) connection
2	Fan connector	Power supply for internal cooling fan (Frames 2 and 3)
3	Battery receptacle 	User installed CR1220 lithium coin cell battery provides power to the real-time clock (optional, not supplied). Preserves the real-time clock setting in the event power to the drive is lost or cycled
4	DPI port 2	Cable connection for handheld and remote HIM options
5	Embedded Ethernet/IP address selectors	Rotary switches for setting lowest octet of Ethernet address (forces address to 192.168.1.*xxx*)

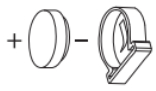
NO.	NAME	DESCRIPTION
6	Embedded Ethernet/IP connector	Network cable connection.
7	SAFETY jumper	Safety enable jumper. Removed when safety option is installed
8	ENABLE jumper	Hardware enables jumper. TB1 becomes an Enable when this jumper is removed.
9	TB1	I/O terminal block

TB1 I/O Terminal Designations

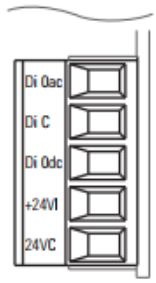
FIXED I/O	TERMINAL	NAME	DESCRIPTION
	Di 0ac	Digital input 0 120V AC (132V AC max)	Connections for AC power supply: High state: 100…132V AC Low state: 0…30V AC
	Di C	Digital input common	Digital input common
	Di 0dc	Digital input 0 24V DC (30V DC max)	Connections for DC power supply: High state: 20…24V DC Low state: 0…5V DC
	+24V	+24V power (50 m [164 ft] A max)	Connections for drive supplied 24V power.
	24VC	24V common	

5.7.1.2 FR8 to FR10

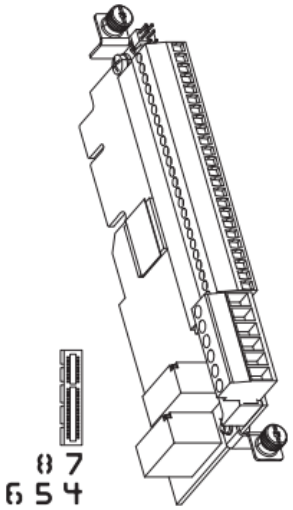


NO.	NAME	DESCRIPTION
1	HIM connector	DPI port 1 (HIM Cradle) connection.
2	Fan connector	Power supply for internal cooling fan.
3	Battery receptacle 	User installed CR1220 lithium coin cell battery provides power to the real-time clock (optional, not supplied). Preserves the real-time clock setting in the event power to the drive is lost or cycled.
4	DPI port 2	Cable connection for handheld and remote HIM options.
5	ENABLE jumper	Hardware enables jumper. TB1 becomes an Enable when this jumper is removed.
6	Embedded Ethernet/IP address selectors	Rotary switches for setting lowest octet of Ethernet address (forces address to 192.168.1.*xxx*).
7	Embedded Ethernet/IP connector	Network cable connection.
8	TB1	I/O terminal block.

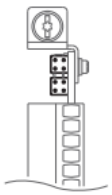
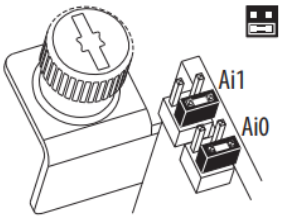
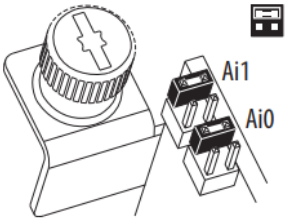
TB1 I/O Terminal Designations

FIXED I/O	TERMINAL	NAME	DESCRIPTION
	Di 0ac	Digital input 0 120V AC (132V AC max)	Connections for AC power supply. High state: 100…132V AC Low state: 0…30V AC
	Di C	Digital input common	Digital input common
	Di 0dc	Digital input 0 24V DC (30V DC max)	Connections for DC power supply. High state: 20…24V DC Low state: 0…5V DC
	+24V	+24V power	Connections for drive supplied 24V power. 150 m (492.1 ft) A max
	24VC	24V common	

5.7.2 VSD I/O OPTION MODULE (20-750-2262C-2R)

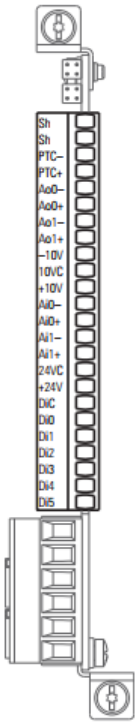


Input Mode Jumpers

JUMPER POSITION	VOLTAGE MODE	CURRENT MODE
		

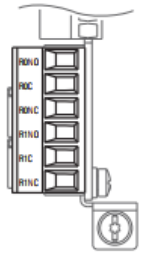
TB1 Terminal Designations

	TERMINAL	NAME	DESCRIPTION	RELATED PARAMETER(4)
	Sh	Shield	Terminating point for wire shields when an EMC plate or conduit box is not installed.	
	Sh			
	Ptc–	Motor PTC (–)		

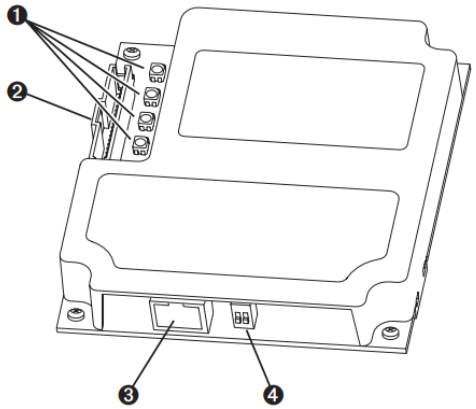
	TERMINAL	NAME	DESCRIPTION	RELATED PARAMETER(4)
	Ptc+	Motor PTC (+)	Motor protection device (Positive Temperature Coefficient).	40 On port X
	Ao0–	Analog out 0 (–)	Bipolar, ±10V, 11 bit and sign, 2 k Ω minimum load. 4…20 mA, 11 bit and sign, 400 Ω maximum load.	75 On port X
	Ao0+	Analog out 0 (+)		
	Ao1–	Analog Out 1 (–)		85 On port X
	Ao1+	Analog Out 1 (+)		
	–10V	–10V reference	2k Ω minimum.	
	10VC	10V common	For (–) and (+) 10V references.	
	+10V	+10V reference	2k Ω minimum.	
	Ai0–	Analog input 0 (–)	Isolated(2), bipolar, differential, 11 bit and sign. Voltage Mode: ±10V at 88k Ω input impedance. Current Mode: 0…20 mA at 93 Ω input impedance.	50, 70 On port X
	Ai0+	Analog input 0 (+)		
	Ai1–	Analog Input 1 (–)		60, 70 On port X
	Ai1+	Analog Input 1 (+)		
	24VC	24V common	Drive supplied logic input power. 200 mA max per I/O module 600 mA max per drive	
	+24V	+24V DC		
	Di C	Digital input common	Common for Digital inputs 0…5	
	Di 0	Digital input 0 (1)	24V DC (30V DC max) – Opto isolated High state: 20…24V DC 11.2 mA DC Low state: 0…5V DC 120V AC (132V AC max) 50/60 Hz(3) – Opto isolated High state: 100…132V AC Low state: 0…30V AC	1 On port X
	Di 1	Digital input 1 (1)		
	Di 2	Digital input 2 (1)		
	Di 3	Digital input 3 (1)		
	Di 4	Digital input 4 (1)		
	Di 5	Digital input 5 (1)		

(1) Digital Inputs are either 24Vs DC or 115Vs AC (2262D) based on module catalog number. Verify applied voltage is correct for I/O module.
(2) Differential Isolation – External source must be maintained at less than 160V with respect to PE. Input provides high common mode immunity.
(3) For CE compliance use shielded cable. Do not exceed cable length of 30 m (98.4 ft).
(4) I/O Module parameters also have a port designation

TB2 Terminal Designations (Two Relay Outputs: 2R)

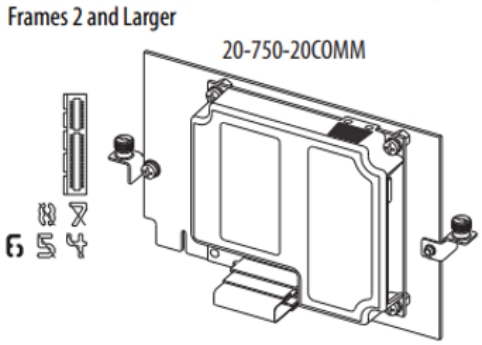
RELAY OUT	TERMINAL	NAME	DESCRIPTION	RELATED PARAMETER
	R0NO	Relay 0 N.O.	Relay normally open contact output: 240V AC, 24V DC, 2 A max General-purpose (inductive)/resistive	10, 100, 101, 105, 106 On port X
	R0C	Relay 0 Common		
	R0NC	Relay 0 N.C.		
	R1NO	Relay 1 N.O.	Relay normally closed contact output: 240V AC, 24V DC, 2 A max Only resistive	20, 110, 111, 115, 116 On port X
	R1C	Relay 1 Common		
	R1NC	Relay 1 N.C.		

5.7.3 VSD MODBUS/TCP ADAPTER (20-COMM-M)



ITEM	PART	DESCRIPTION
1	Status Indicators	Four LEDs that indicate the status of the DPI, the adapter, and network connection. Refer to Appendix D: VSD Modbus/TCP Adapter Status Indicator.
2	DPI Connector	A 20-pin, single-row shrouded male header. An Internal Interface cable is connected to this connector and a connector on the drive.
3	Ethernet Connector	An RJ-45 connector for the Ethernet cable. The connector is CAT-5 compliant to ensure reliable data transfer on 100Base-TX Ethernet connections.
4	Web Pages Switch (SW2)	Enables or disables the adapter web pages. SW1 is unused.

The VSD Modbus/TCP adapter is attached to the 20-750-20COMM carrier kit. This carrier kit enables the use of the adapter with the drives.



The carrier kit shall be installed at Port 6 of the drive. Installing it at Port 4 or Port 5 makes the adjacent left port inaccessible to other option modules and can interfere with network cable connections.

NOTE	The 20-COMM-M only passes on Modbus commands from the drive's DPI Port 0 to 6.

5.8 VOLTAGE TAPPING/VOLTAGE SELECTOR

Components such the control power transformer (CPT) and heat exchanger have multiple taps or voltage selector that can be configured to take in different supply voltage levels. These voltage taps and voltage selector must be configured appropriately according to the incoming supply level.

5.8.1 CPT IN VSD ENCLOSURE

These CPTs are located at the backpan of the VSD enclosure to provide control voltage for the drive, typically in the size of 250VA, 500VA and 1kVA. The primary voltage taps are either 380/415/480V or 380/440/480V, while the secondary taps are 120/240V.

The quantity and arrangement of the CPTs vary from one drive to the other. Refer to the respective engineering drawings for details.

Figure 5-14:
250VA CPT, 380/415/480V primary

Figure 5-15:
1000VA CPT, 380/440/480V primary

Primary side connection:

- Connect one lead of the supply voltage to COMM
- Connect the other lead of the supply voltage according to its voltage level, i.e. 380V, 415V, 440V or 480V.

Secondary side connection:

- The output voltage will be from terminal X1 and X4.
- For 120V output, jumper up X1 and X3 as well as X2 and X4.
- For 240V output, jumper up X2 and X3.

5.8.2 CPT IN VSD MODULE

This is a 1000VA CPT which is only available to Frame 8 modules. It is located at the converter (AC-input drive) or precharge (DC-input) section of the drive. Each drive module has a CPT installed in it.

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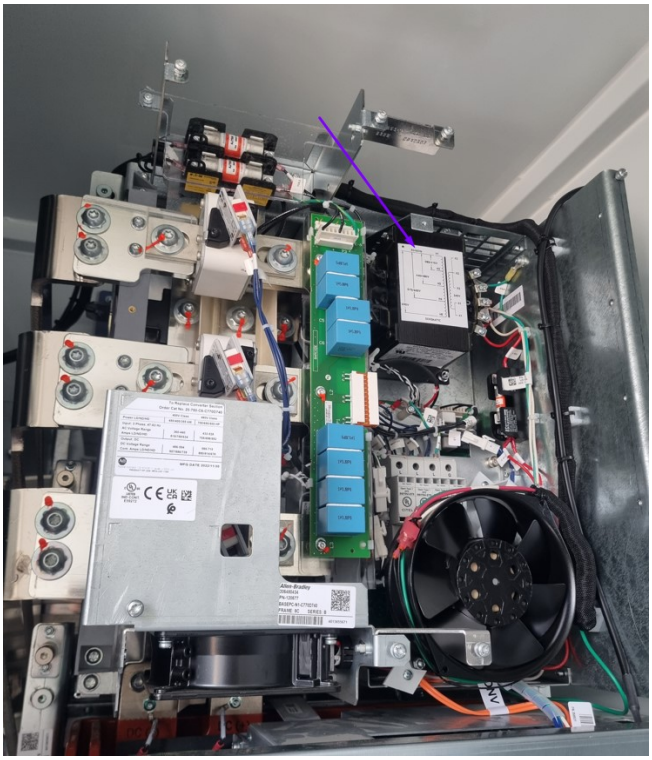


Figure 5-16: Location of CPT in an AC input drive (top right corner)

Figure 5-17: Location of CPT in an DC-input drive (top right corner)

AC-input drive

The available taps at the primary are: 380/415V, 440/480V, 575/600V and 690V, while the secondary has only 240V tap

For the primary side connection, connect one lead of the supply voltage to H1 and the other according to supply voltage level:

- H2 (380/415V)
- H3 (440/480V)
- H4 (575/600V)
- H5 (690V)

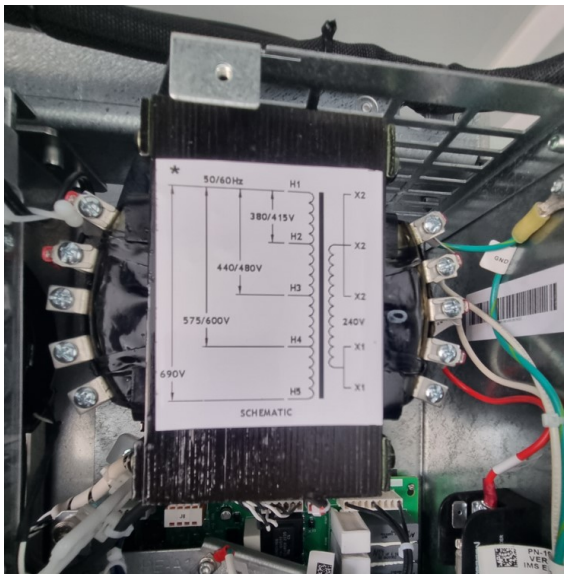


Figure 5-18: AC input drive CPT schematics

DC-input drive

Both the primary and secondary of the transformer has 120/240V tapping.

For the primary side connection, connect one lead of the supply voltage to H1 and the other according to supply voltage level:

- H2 (120V). (Note: 120V is the factory default.)
- H3 (240V)

The secondary side wirings were already prewired in the factory according to the voltage requirements of the control circuits.

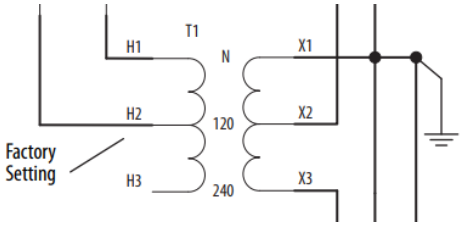


Figure 5-19: DC input drive CPT schematics

5.8.3 VOLTAGE SELECTOR FOR HEAT EXCHANGER

The heat exchanger has a voltage selector to select between 400V and 460V input.

Figure 5-20: Heat Exchanger Voltage section label

By default, the voltage selector is wired to 460V. In case of 400V supply voltage, this jumper must be connected to terminal 2 and 3.

Figure 5-21 – Heat Exchanger Voltage Selection Jumper

Section 6: **Operator Interface**

For the operator interface of the motor controller, refer to *INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576).

Section 7: **Installation**

This chapter describes how to install the VSD on location. Installation procedures for optional and combinable equipment for the drive (site communications, external inputs, or output devices such as transducers) are discussed in Section 9: Optional and Combinable Equipment of this manual.

Potential Severity: Major

Potential Loss: Assets, Personnel, Reputation

Hazard Category: Electrical, Explosives, Machinery equipment hand tools

Troubleshooting or servicing a VSD must be performed by qualified personnel. *Qualified personnel* are defined as personnel who have attended and successfully completed the required training. Only then should qualified personnel contact InTouch for additional support and troubleshooting/repair instructions.

7.1 INSTALLATION SAFETY PRECAUTIONS

1. Install the drive in a secure and upright position in a well-ventilated location. NEMA3R/NEMA4 enclosure is used in outdoor applications. A sunshade roof is recommended if the drive is installed in direct sunlight. A temperature derating factor may be required. Temperature should range from 32 degF (0 degC) to 104 degF (40 degC) unless the drive is customized for higher temperature rating. It is recommended when the ambient temperature reaches 104 degF (40 degC) to install the sunshade. Although the ambient temperature may be within the drive temperature limit, the temperature within the enclosure of the drive would be much higher than this and it may be exceeding maximum temperature rating.
2. Allow adequate clearance space for proper ventilation and maintenance works. Do not obstruct any of the ventilation openings and allow clearance of at least 1 meter (40 inches) from the ventilation hoods. The ventilation requires free air flow for proper cooling.
3. Avoid installation in areas where extreme vibration, extreme heat, or sources of electrical noise are present.
4. Adequate working space should be provided for adjustment, inspection, and maintenance of the drive.
5. Adequate lighting should be available for troubleshooting and maintenance.
6. A non-combustible insulating floor or mat should be provided in the area immediately surrounding the electrical system where maintenance is required.
7. Always ground the unit properly to prevent electrical shock and to help reduce electrical noise.

Potential Severity: Serious

Potential Loss: Assets, Personnel

Hazard Category: Electrical, Explosives

A separate ground cable should be run inside the conduit with the input, output, and control power cables (Refer to 5.3 Grounding in the Wiring chapter of this manual). The metal of conduit is not an acceptable ground.

8. Use lockout/tag out procedures (SEN-HSE-S027) before connecting 3-phase power of the correct voltage to input terminals (L1, L2, L3 [R, S, T]) and connect 3-phase power from output terminals (T1, T2, T3 [U, V, W]) to a motor of the correct voltage and type for the application. Size the conductors in accordance with Section 5.2 Selection of Wiring Equipment and Standard Cable Sizes.

9. If conductors of a smaller than recommended size are used in parallel to share current, then the conductors should be kept together in sets i.e., U1, V1, W1 in one conduit and U2, V2, W2 in another. National and local electrical codes should be checked for possible cable-derating factors if more than three power conductors are run in the same conduit, through the same hole in the cabinet or through a non-metallic flange or bulkhead.

   Temperatures can become excessive if phase U1, U2, and/or U3 cables are in proximity to each other (eddy current field effect).

10. Use separate metal conduits for routing the input power, output power, and control circuits.
11. Installation of drive systems should conform to the National Electrical Code, regulations of the Occupational Safety and Health Administration, and all national, regional, or industry codes and standards when installed in the United States. Other codes may apply if installed outside of the US.

 WARNING	**Potential Severity: Serious** **Potential Loss: Assets, Personnel** **Hazard Category: Electrical, Explosives** Power factor improvement capacitors or surge absorbers must not be installed on the VSDs output.

12. Never install any type of starter(s) or contactor(s) on the drive output to switch motor loads instantaneously.
13. Only qualified personnel should install this equipment.

7.2 INPUT AND OUTPUT POWER WIRING

Complete the following procedures to connect to the input and output of the drive. Refer to Section 5: Wiring for power cable sizing and grounding connections.

1. Connect the incoming cables to input terminals L1, L2, and L3, or to the terminals of the input Molded Case Circuit Breaker (MCCB) with the lugs provided.
2. Connect the outgoing cables to the output terminals T1, T2, and T3.

The power junction box is installed at the drive. In some drives, the terminals for both the input and output of the drive are located at power junction box, see Figure 7-1. In other drives, the input MCCB is installed in this junction box and the input cables would be terminated to this MCCB, see Figure 7-2.

Figure 7-1: Terminals in Power Junction Box

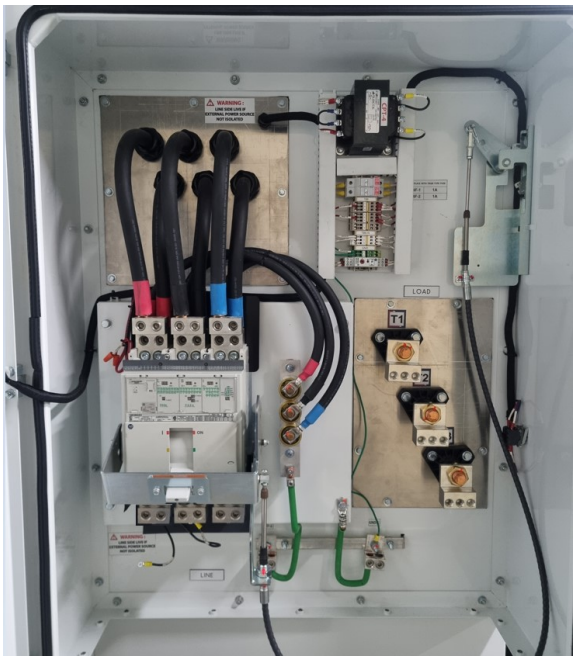


Figure 7-2: Input MCCB and Output Terminals in Power Junction Box

7.3 CONTROLLER INSTALLATION

For drives that require the controller to be installed on site, this section provides the details for installing an INSTRUCT ESP Intelligent Controller onto the E30 drive. A minimum of two qualified personnel shall be available for this installation.

DANGER	**Potential Severity: Major** **Potential Loss:Assets, Personnel** **Hazard Category: Electrical** Make sure that proper PPE is worn before any work on the VSD. Failure to do so can cause physical injury or damage to the equipment.

DANGER	**Potential Severity: Major** **Potential Loss:Assets, Personnel** **Hazard Category: Electrical** Before any work on the VSD, use a multimeter to make sure that all the power sources are off. The power at the incoming lines (at the top of the fuse disconnect switch), motor terminals and DC bus must be measured to make sure that there is no electrical hazard present.

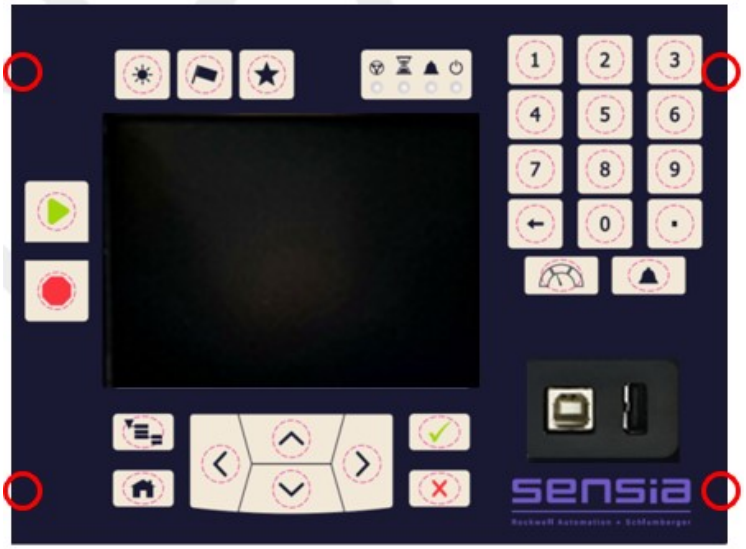
1. Make sure that the tools listed in the table below are available.

No.	Description	Illustration
1	7/64" Hex Key	
2	2 x 100 mm Philips Screw Driver	
3	Torque Screwdriver set	
4	3/8" Nut Driver	

5	Adjustable Wrench	
6	USB flash drive (having FAT 32 file system)	
7	USB Type-B cable (Quantity 2)	
8	USB Isolator (SLB PN: 102837305, MFG PN: B&B UH401)	
9	StarView v5+ software application	-

Figure 7-3: Required Tools for Installation

2. Make sure that the VSD is de-energized and lockout-tagout (LOTO) is performed on external equipment supplying power to the VSD.
3. Make sure that the connectors and cables for communication, power, and ground are not damaged.
4. Remove the screws from the controller's bezels with a 7/64-in hex key.



5. Install the controller into the opening provided on the VSD door and hold it in place from the inside of the VSD door.

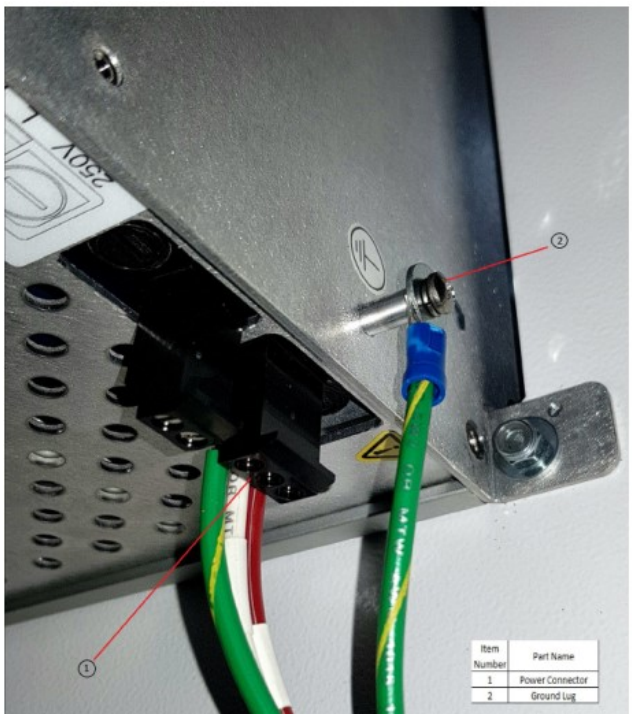
NOTE	A minimum of two qualified personnel is necessary: one person to hold the nuts and the controller from inside of the drive, and another person to install the screws from outside of the drive.

6. Inform the second person to install the screws into the four pre-drilled holes outside of the VSD door. Install these screws with a 2 x 100 mm Philips screwdriver.

NOTE	A 3/8-in nut driver or an adjustable wrench is necessary to hold the nuts from inside of the VSD door, while the screws are installed from the outside of the VSD door (torque to 16 lbf-in). The recommended screw size is MS Binding 10-32 x 5/8-in Slot Drive, and the recommended nut size is Locknut Hex 10-32 Steel Zinc KEPS.

7. Make sure that the controller is correctly secured on the drive's cabinet.

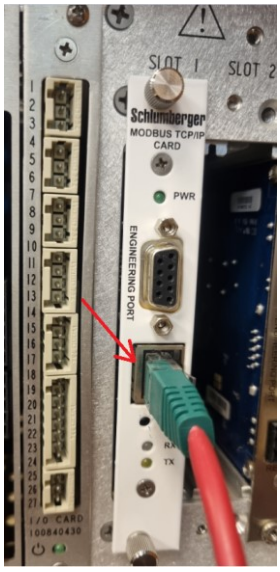
8. Connect the power connector and the ground lug to the controller.



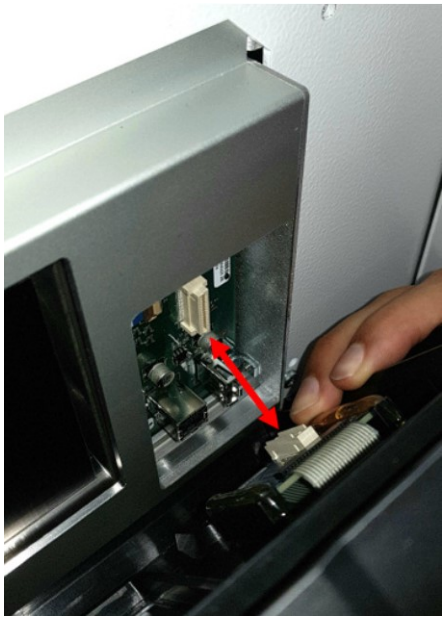
WARNING	**Potential Severity: Serious** **Potential Loss: Assets** **Hazard Category: Electrical** Before the power connector for AC power supply is plugged in, verify that L, N, Ground wires are not interchanged and are as per the input label on the controller. For DC power supply, make sure that DC ± are not interchanged.

NOTE	For the ground Lug, the screw is MS Pan #6-32 x 1/4 SS Phillips Drive. Make sure that the hardware for the ground lug is installed in this sequence: flat washer, lock washer, and screw. Torque the screw to 5 lbf-in.

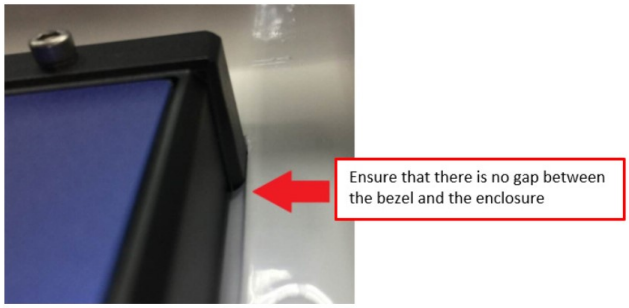
9. Connect the cross-over Ethernet cable to the RJ-45 connector of the controller's Modbus TCP/IP card.



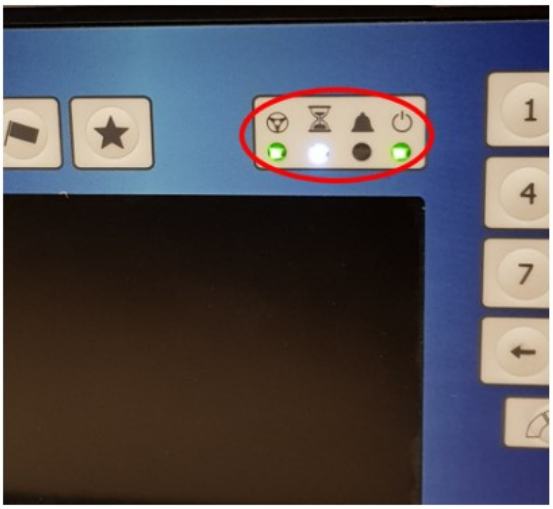
10. Align the display connector with the bezel of the controller.



11. Install the screws again on the bezel. Torque the screws to 3 lbf-in.



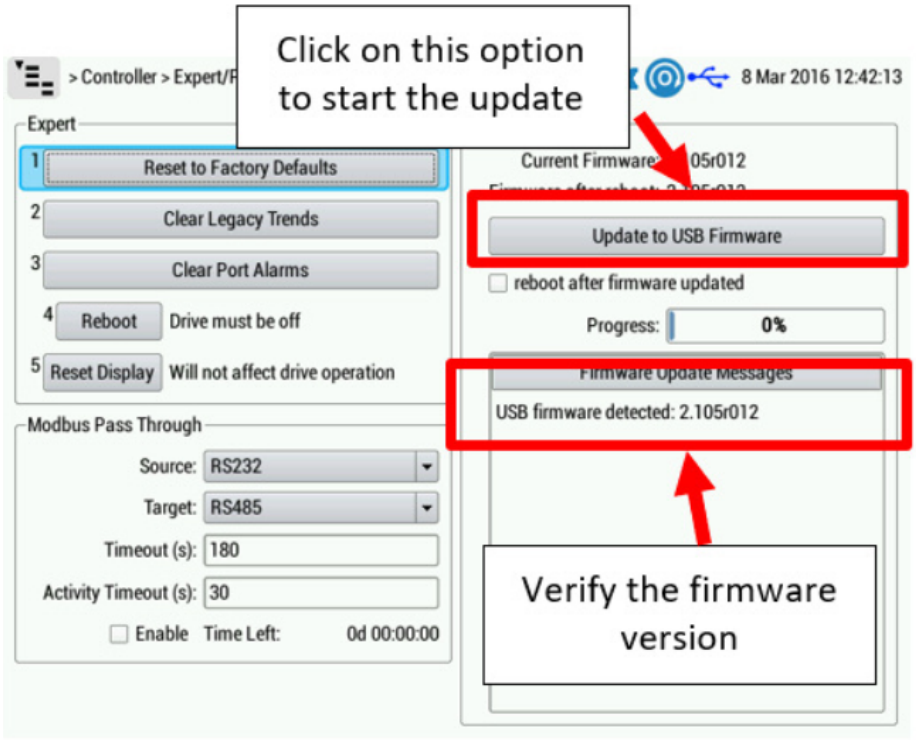
12. Apply external power to the VSD by removing the lockout-tagout (LOTO) on external equipment supplying power to the VSD. Close the fuse disconnect switch to power up the drive.



NOTE	As soon as the power is applied to the controller, the screen will remain blank while green and red LEDs will blink and turn on for some time. After this action, the Sensia logo will be displayed on the screen and subsequently the controller will become functional.

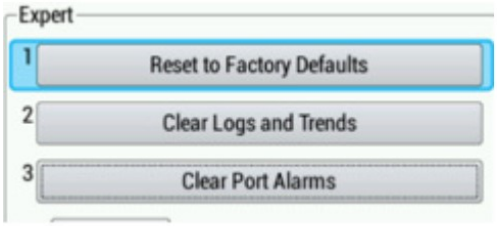
13. Go to **Home > Menu > Controller > Expert/Updates** and check whether the controller firmware version displayed on the controller shows the latest officially released version. Refer to InTouch ID 6145281 for the latest Released Controller firmware version.
14. If the controller firmware is not the latest version:
    - Download the latest firmware version based on InTouch content 6145281 (for released firmware) or InTouch content 7079236 (for field test firmware) and transfer this firmware on to a USB flash drive.
    - Plug in the USB flash drive inside the controller and ensure that the USB flash drive is detected.

    - On the controller, go to Home > Menu > Controller > Expert/Updates and then select the Update to USB Firmware button.



NOTE	If the **Reboot after firmware update** option is selected, the controller will reboot automatically. If that option is not selected, you can push the **Reboot** option to manually reboot the controller. This software update will take approximately 18 minutes on the controller.

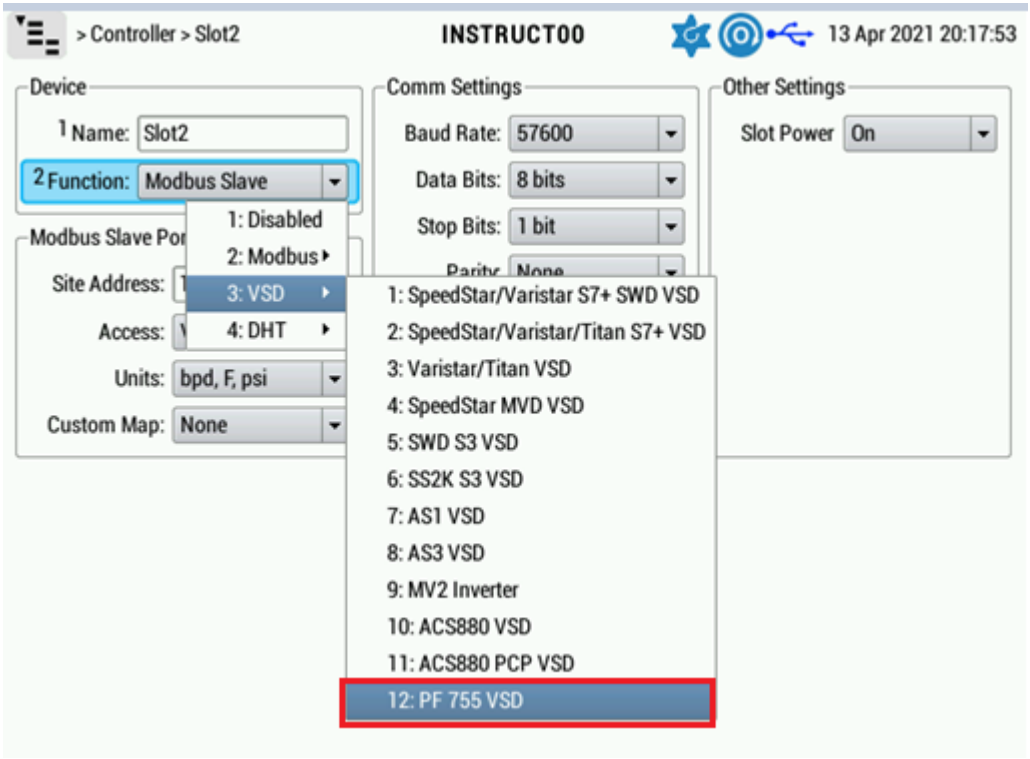
15. Reset the controller to the factory default settings by pressing **Home > Menu > Controller > Expert/Updates**. Then select **Reset to Factory Defaults**.



NOTE	A factory reset can only be done when the controller is in the Off state.

16. Configure the communication port by pressing **Home > Menu > Controller > Slot** *x*. *X* is the slot where the Modbus TCP/IP card is installed.

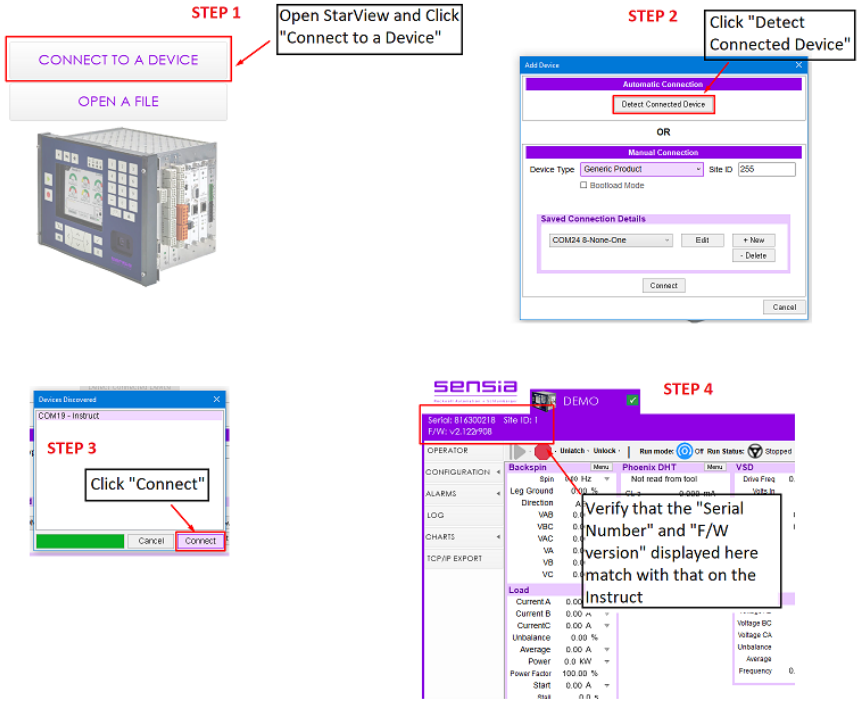
    The following figure depicts the configuration of Slot2 where the Modbus TCP/IP card is installed. The card can be installed on any of the four expansion slots and configured for the VSD.



17. Connect the controller to a PC with two USB Type B cables and the USB isolator.

Item Number	Description
1	Connect one of the USB type-B cable to the PC.
2	Connect the other USB type-B Cable to the Instruct.

18. Verify that the controller can communicate with the StarView module.



NOTE	Make sure that you use the latest version of StarView as per InTouch content 6031798.

7.4 OPTION MODULES INSTALLATION (INTO DRIVE CONTROL POD)

Each E30 drive has a slot-based architecture. Option modules provide additional analog and digital I/O, feedback, and auxiliary power options.

7.4.1 ACCESS DRIVE CONTROL POD

To access the drive control pod, follow the steps for the frame size of your drive.

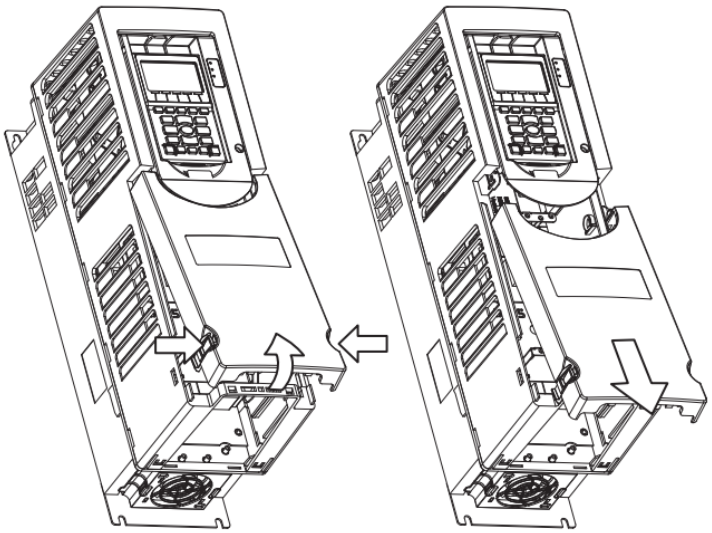
7.4.1.1 For Frames 1…7,

1. Remove the drive cover.

   For Frames 1…5, follow these steps:

   a. Squeeze locking tabs and pull out the bottom of the cover.

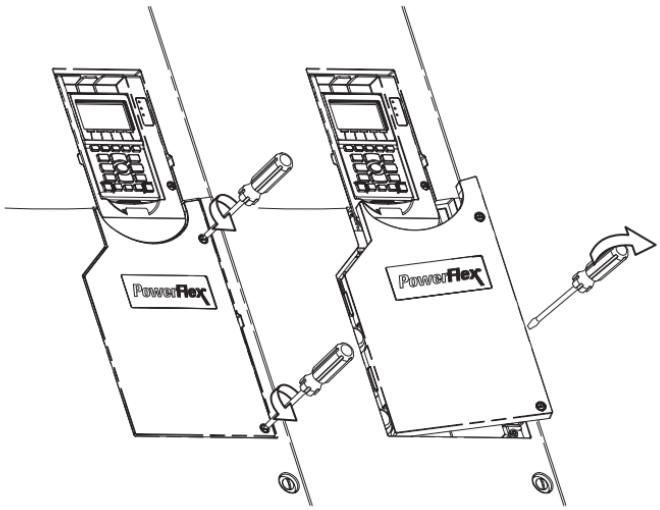
   b. Pull the cover down and away from the chassis.



   For Frames 6…7, follow these steps:

   a. Loosen door screws.

   b. Gently pry the door open to remove.

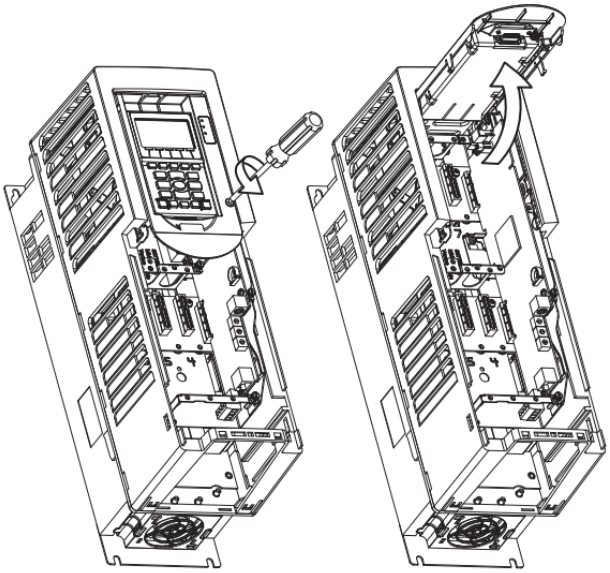


2. To access the control pod, continue with these steps:

   a. Lift the Human Interface Module (HIM) cradle.

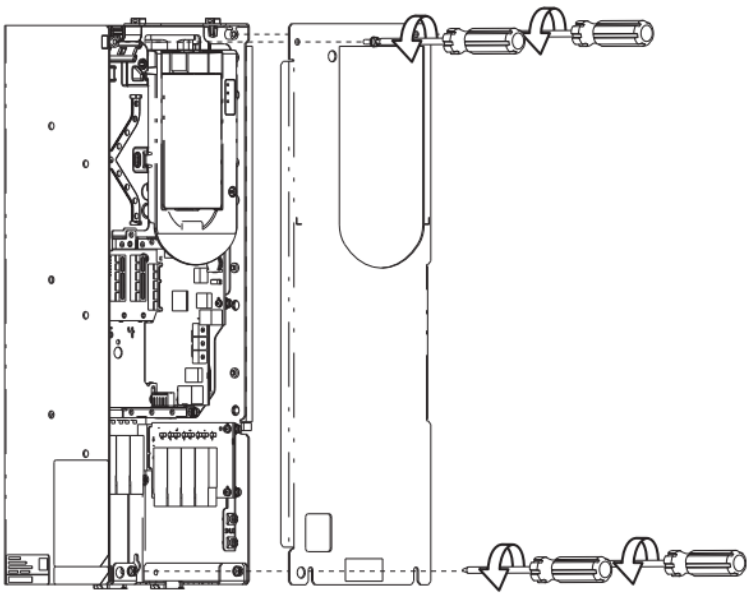
   b. Loosen the retention screw.

c. Lift the cradle until the latch engages.

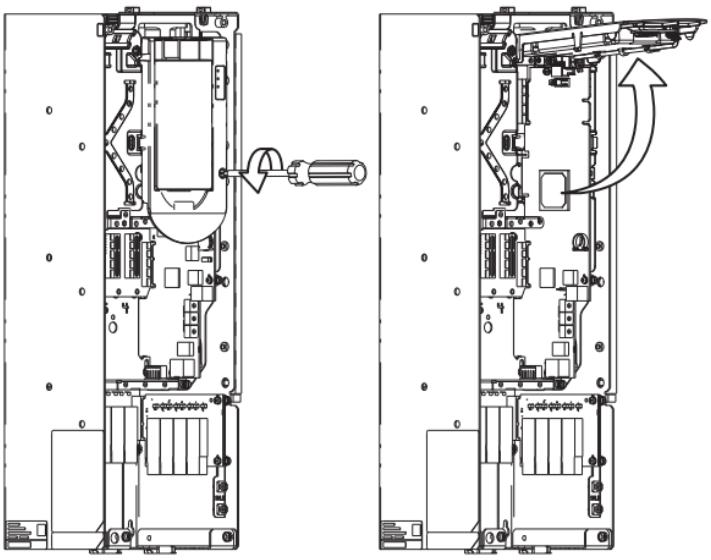


7.4.1.2 For Frames 8…10,

1. Remove the drive cover.
   a. Remove top screws.
   b. Loosen bottom screws.
   c. Remove the right front cover.

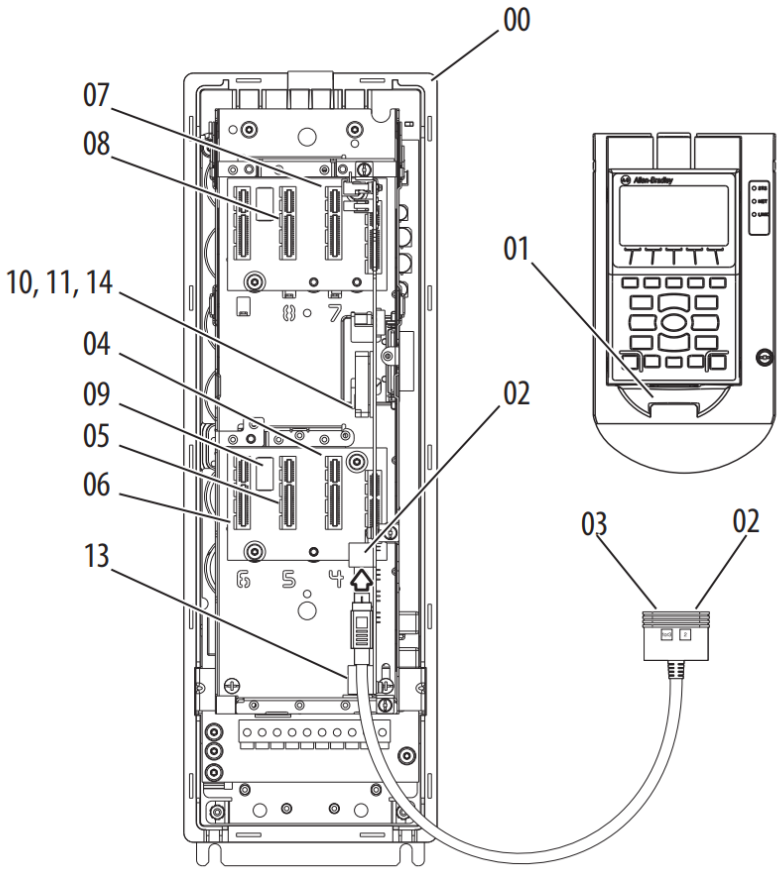


2. To access to the drive control pod, continue with these steps:
   a. Loosen the retention screw.
   b. Lift the cradle until the latch engages.



7.4.2 DRIVE DEVICE PORT

Connectors, embedded devices, and installed option modules such as I/O and communication adapters have unique port number assignments. Connectors and embedded devices have fixed port numbers that cannot be changed. Option modules are assigned a port number when installed.

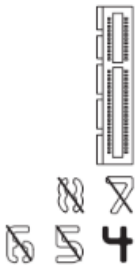


PORT	DEVICE	DESCRIPTION
00	Host drive	Fixed port for the drive
01	Human Interface Module (HIM)	Fixed port at HIM cradle connector. Splitter cable connector provides Port 01 when HIM cradle connector is unused.
02	DPI port	Handheld or remote HIM connection Splitter cable connection
03	Splitter cable	Connects to DPI port 02 Provides Port 02 and Port 0.
04…08	Option modules	Available ports for option module: **IMPORTANT:** Ports 07 and 08 are available on PowerFlex 755 Frame 2 drives and larger only. PowerFlex 755 Frame 1 drives and 753 drives do not support ports 07 and 08.
09	Auxiliary power supply option module	Designated port for the auxiliary power supply when connected via cable (PowerFlex 755 Frame 1 and 753 drives only)

PORT	DEVICE	DESCRIPTION
10	Inverter	Fixed port for inverter (PowerFlex 755 Frame 8 drives and larger only)
11	Converter	Fixed port for converter (PowerFlex 755 Frame 8 drives and larger only)
12	Reserved for future use.	
13	Ethernet/IP	Fixed port for embedded Ethernet/IP (PowerFlex 755 drives only)
14	DeviceLogix	Fixed port for embedded DeviceLogix

7.4.3 OPTION MODULE INSTALLATION

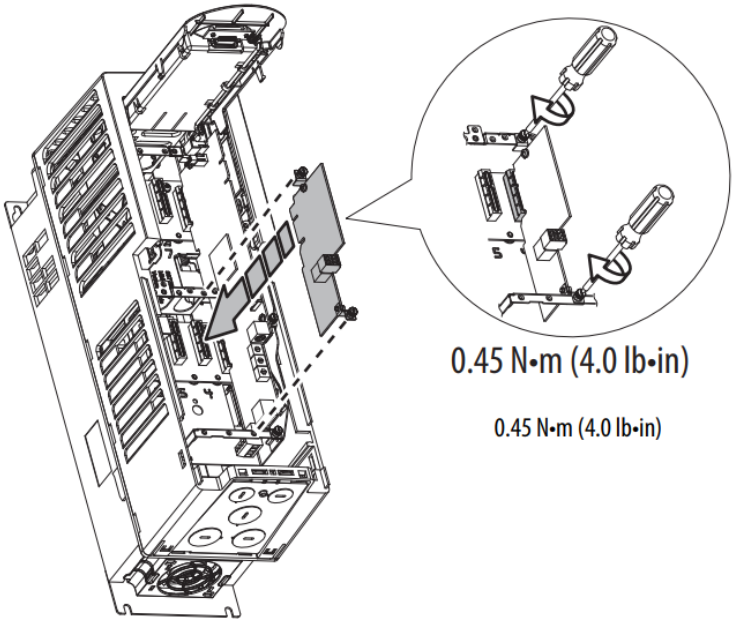
Compatible port locations can be restricted for each module. An icon with position numbers is provided to indicate which option module ports are compatible. For example, the icon on the right indicates that the option module is only compatible with port 4.



CAUTION	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Electrical** Hazard of equipment damage exists if an option module is installed or removed while the drive is powered. To avoid damaging the drive, verify that the voltage on the bus capacitors has discharged completely and all control power is removed before performing any work on the drive.

To install an option card, follow these steps:

1. Press the module edge connector firmly into the desired port.
2. Tighten the top and bottom retaining screws. Do not overtighten the retaining screws.
   - Recommended torque = 0.45 N•m (4.0 lb•in)
   - Recommended screwdriver = T15 hexalobular



NOTE	Option modules are assigned a port number when installed. Avoid swapping the module to a different port after it is installed. Swapping the module can cause a hardware configuration change alarm in the drive and prevent the drive from starting. A hardware configuration change alarm can only be acknowledged by the HIM or CCW.

7.5 INSTALLATION OF THE POWER ANALYZER (PA) KIT

The voltage sensor (P/N:100840441) and 8m cable (P/N: 101947905) of the Power Analyzer kit are delivered loose with the VSD and require the user to install them inside the step-up transformer. This section provides an example of a general procedure for installing the kit and taking high voltage measurements in an ESP step-up transformer. It is recommended that the field develops its own procedure with site-specific procedures and information and use the procedure as described here as a guideline.

The voltage sensor should be mounted near the high voltage terminals on the step-up transformer to minimize the distance of the installation route for the high voltage leads. Also, care should be taken to install the high voltage leads where they are adequately protected from damage and do not pose an electrical risk to personnel working in the area.

DANGER	**Potential Severity: Major** **Potential Loss: Assets, Personnel** **Hazard Category: Electrical** Make sure that proper PPE is worn before any work on the VSD and transformer. Failure to do so can cause physical injury or damage to the equipment.

DANGER	**Potential Severity: Major** **Potential Loss: Assets, Personnel** **Hazard Category: Electrical** Before any work on the VSD and transformer, use a multimeter to make sure that all the power sources are off. The power at the incoming lines (at the top of the fuse disconnect switch), motor terminals and DC bus must be measured to make sure that there is no electrical hazard present.

1. Open the VSD input circuit breaker(s) to de-energize the VSD.
2. De-energize all power sources to the VSD.

3. Lock-out and tag-out the power sources.
4. Wait at least 15 minutes after de-energizing the VSD to allow sufficient time for the capacitors in the drive to completely discharge.
5. Open the doors in the terminal box on the transformer to gain access to the low-voltage terminals.

DANGER	The following step involves low voltage (480 V and below) measurements to verify the transformer is de-energized. Personal must wear proper PPE for this work.

6. Measure the phase-to-phase voltages and the phase-to-ground voltages at the low-voltage terminals (X1, X2, X3) with a multimeter. Verify all the voltages are at zero volts.
7. Check the nameplate on the transformer to verify that the rated voltages do not exceed 5000 VAC.

DANGER	DO NOT connect the voltage sensor if the nameplate indicates voltages that exceed 5000 VAC. The voltage sensor is rated for use up to a maximum of 5000 VAC.

8. Mount and secure the voltage sensor in close proximity to the high-voltage terminals on the transformer.

i Each HV lead is approx. 1.6 meter in length. Make sure the voltage sensor is secured properly.

DANGER	DO NOT hold the voltage sensor while it is in operation.

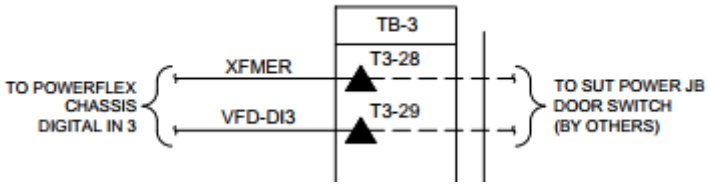
9. Connect the high-voltage leads for Phase A, Phase B and Phase C in the voltage sensor to the corresponding high-voltage terminals in the transformer. Field user to provide suitable lugs for the termination of the HV leads.
10. Connect the ground lead in the voltage sensor to the ground pad in the transformer.
11. Locate a route for installing the signal cable which will run from the voltage sensor to the power analyzer card in the controller at the VSD. The signal cable should enter the VSD from the low voltage junction box and route to the low voltage compartment of the VSD where the controller is located.

i The provided signal cable is 8 meters in length.

12. Install and secure the signal cable along the route and terminate the ends of the cable at the voltage sensor and the power analyzer card.

7.6 INSTALLATION OF THE DOOR SWITCH FOR STEP-UP TRANSFORMER

1. Follow steps 1 to 6 in Section 7.5 to ensure zero voltage at transformer and lockout and tagout are implemented.
2. Mount and secure the limit switch in the step-up transformer. The limit switch shall be mounted in the vicinity of the doors to detect the door opening. Typically, the transformer terminal box has two overlapping doors; one must be opened before the other can open. The limit switch should be placed at this first door.
3. The field user shall provide the control cable for this limit switch.
4. Locate a route for installing the control cable that will run from this limit switch to the low voltage junction box of the VSD.
5. Install and secure the signal cable along the route and terminate the ends of the cable to terminal T3-28 and T3-29 at the low voltage junction box.



7.7 INSTALLATION OF HIM KEYPAD

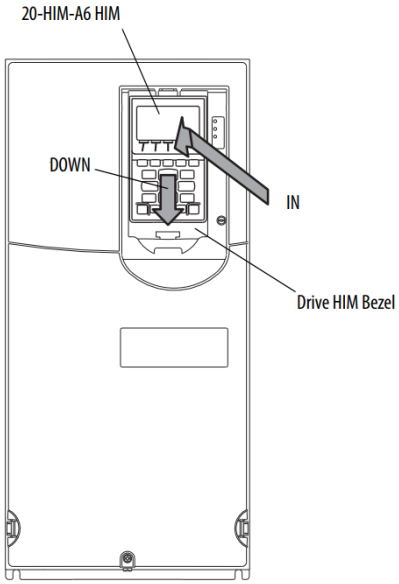
The HIM keypad is not provided in the standard E30 drives. If needed, the keypad and its accessories can be ordered with the following part numbers. There are two types of HIM:

- NEMA Type 1 (PN: *20-HIM-A6*)
- Remote-mount NEMA Type 4X/12 (PN: *20-HIM-C6S*), which also includes a 1202-C30 interface cable for connection to the drive

PART NUMBER	DESCRIPTION	REMARKS
20-HIM-A6	HIM, NEMA 1	Can be installed in the drive HIM bezel (drive Port 1). For temporary hand-held operation, connect it into drive Port 2 (near the bottom of the drive control pod) using a 1m/3.28ft long 20-HIM-H10 cable.
20-HIM-C6S	Remote Mount HIM, IP66 (NEMA 4X/12)	Includes 1202-C30 cable (3m/9.8ft long). For remote installation, such as at the door of VSD panel.
20-HIM-H10	Remote HIM cable	1 meter long (supplied separately). Needed when connecting 20-HIM-A6 for remote or hand-held operation.
1202-H03	HIM Extension cable - Length 0.33m	
1202-H10	HIM Extension cable - Length 1m	
1202-H30	HIM Extension cable - Length 3m	
1202-H90	HIM Extension cable - Length 9m	

7.7.1 20-HIM-A6 INSTALLATION

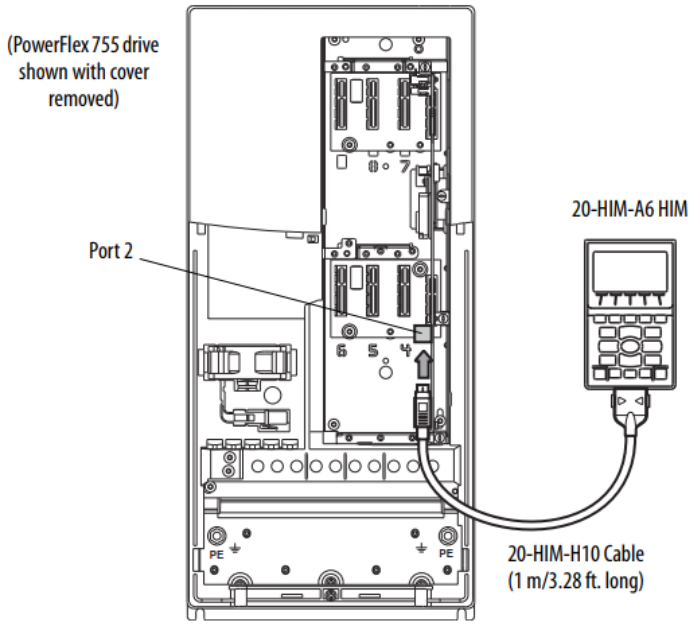
For installation in the drive HIM bezel, just place the HIM into the drive HIM bezel by inserting it straight back into the top of the bezel and then sliding it down into the base of the bezel on the mating connector.



NOTE	The HIM can be installed in the drive HIM bezel with the drive powered or unpowered.

For hand-held operation, attach a 20-HIM-H10 cable to the bottom of the HIM. Then plug the other end of the cable into Port 2 near the bottom of the drive control pod. If the distance from the drive to the HIM is more than 1 meter, use one of the following male-female extension cable kits with the 20-HIM-H10 to extend the cable length (up to 10meters):

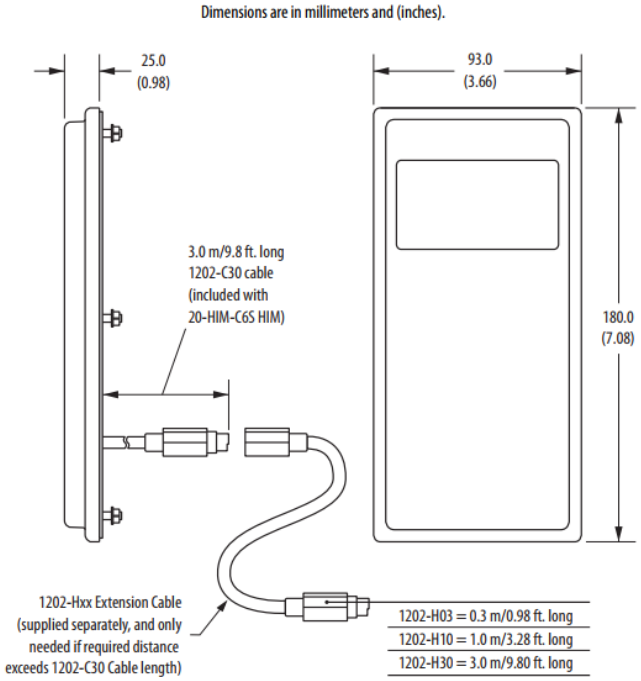
- 1202-H03 (0.33 Meters)
- 1202-H10 (1 Meter)
- 1202-H30 (3 Meter)
- 1202-H90 (9 Meter)



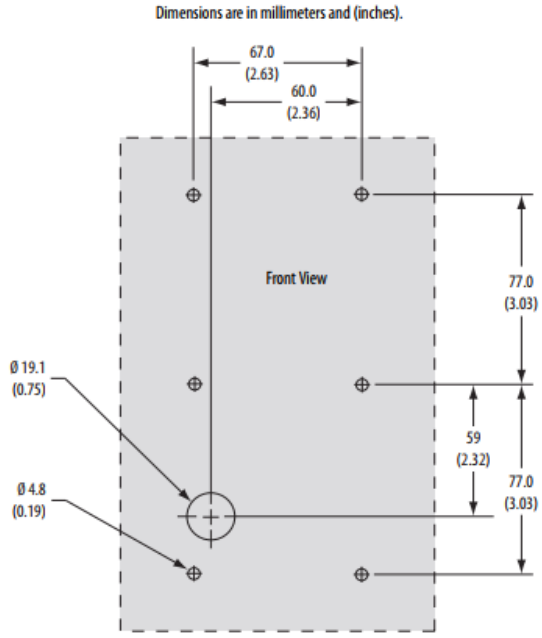
7.7.2 20-HIM-C6S INSTALLATION

The 20-HIM-C6S HIM is designed for remote installation such as at the VSD door panel and includes a 3m/9.8ft. long cable*(PN: 1202-C30)*. The distance between the HIM and drive can be increased using the following male-female extension cable kits with the 1202-C30 cable:

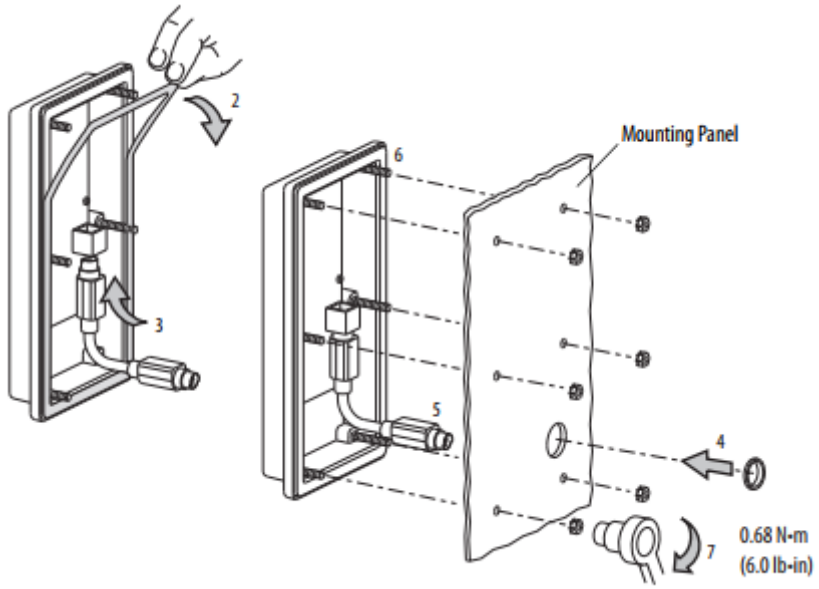
- 1202-H03 (0.33 Meters)
- 1202-H10 (1 Meter)
- 1202-H30 (3 Meter)
- 1202-H90 (9 Meter)



1. Drill the required hole pattern in the panel. See figure below for the dimensions. (A conversion template is provided with 20-HIM-C6S kit, includes a drilling pattern and mounting instructions to assist with HIM installation).



2. Peel the protective film from the gasketed surface on the back of the HIM. Do note that the adhesive coated gasket is designed for one-time only installation.



3. Insert the supplied 3 m/9.8 ft. long 1202-C30 HIM cable into the mating socket on the back of the HIM.
4. Install the supplied O-ring into the cable routing hole on the panel to protect the cable.
5. Route the HIM cable through the cable routing hole on the panel.
6. Align the six threaded studs of the HIM with the panel clearance holes and place the HIM against the panel.
7. Tighten the nuts onto the six threaded studs of the HIM extending behind the panel.

   Recommended torque is 0.68 N•m (6.0 lb•in).
8. Route the HIM cable to the drive.
9. Connect the HIM cable to the DPI Port 2 on the drive.

7.8 CONFIRMATION OF WIRING

Make the following checks before applying power to the unit:

1. Confirm that source power is connected to terminals L1, L2, and L3.

   The 3-phase source power should be within the correct voltage and frequency tolerances.

   The output leads must be connected to terminals T1, T2, and T3.

2. Make sure there are no short circuits or inadvertent grounds and tighten any loose connector terminal screws.

NOTE	The controller contains an internal lithium-ion battery that backs up the power to the Real-Time Clock and SRAM. The battery has an expected lifetime of greater than five years on standby and should normally not need to be replaced during the lifetime of an operating controller. If the **U Battery** alarm displays constantly on the controller, the battery does need to be replaced. It is recommended that the unit be returned to the factory for installation.

7.9 START-UP TEST

 WARNING	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Electrical** Prior to releasing an electrical drive system for regular operation after installation, the system should be given a start-up test by qualified personnel. This start-up test assures correct operation of the equipment, system reliability, and safe performance. It is important to schedule time for a start-up test, to conduct it, and to document it. Perform start-up testing as described in Chapter Section 8: Start-up and Commissioning. When you apply power for the first time, the drive's parameters are set to default values that may or may not be appropriate for your application. If these settings are not optimal for the application, the desired settings must be programmed before initiating a run. The drive can be operated with no motor connected.

NOTE	Operation with no motor connected or use with a small trial motor is recommended for initial adjustment or for learning to adjust and operate the drive.

Section 8: **Start-up and Commissioning**

This chapter describes step-by-step procedures for starting-up and commissioning new VSD installations. Some steps are included for equipment that is optional and combinable with the drives, where practical. If this manual does not include information for the optional equipment attached to your drive application, refer to the appendices of this manual (specifically reference material and third-party information) for additional information.

If at any point in the Start-up and Commissioning procedure it is found that there are damaged components or unexpected results, please refer to the Troubleshooting procedure in Section 11:Troubleshooting.

Potential Severity: Major

Potential Loss: Assets, Personnel, Reputation

Hazard Category: Electrical, Explosives

Troubleshooting or servicing a Sensia VSD must be performed by qualified personnel. *Qualified personnel* are defined as those who have attended and successfully completed the required training. Completion of this training course is NOT a substitute for field experience. Course-trained personnel should be accompanied and mentored by experienced personnel until deemed competent to work unsupervised. Qualified personnel should have their course reference material on hand. Only then should they contact InTouch Support for additional support and troubleshooting/repair instructions.

8.1 REQUIRED START-UP EQUIPMENT AND TOOLS

Before attempting any start-up procedures, ensure that the personnel assigned to the job have the required equipment and tools. The commonly used tools for installation and servicing the drives are listed in the following table. This list of tools can also be found in our P/N 50370678.

TOOL DESCRIPTION	DETAILS
Multimeter	Digital multimeter, capable of AC and DC voltage, continuity, resistance, capacitance measurements, and forward diode bias tests. Fluke model 87 III or equivalent
Allen socket wrench	4 mm, 5 mm
Allen-socket wrench extension	254 mm (10 in.)
Flat-nose screwdriver	5 mm (0.19 in.), 6.4 mm (0.25 in.), 9.5 mm (0.375 in.), #1, #2
Hexalobular screwdriver/bit	#15, #20, #25, #30, #40, #45
Hexagonal socket wrench	7 mm, 8 mm, 10 mm, 12 mm, 13 mm, 17 mm, 18 mm
Combination wrench	10 mm, 17 mm
Phillips screwdriver/bit	#2, 492-C
Pozidriv	#2, M3 x 7
Torque wrench	1...12 N•m (8.8…106 lb•in)
Torque wrench	6...50 N•m (53…443 lb•in)
VSD Loading Plate	Part Number SUB_1937470 **IMPORTANT**: This VSD loading plate is required to remove Frame 8 and larger drive assemblies from the enclosure.

Other equipment or tools generally used in start-up are listed in the VSD Tools Kit (P/N 100072064). Items can be selected from this list and ordered through Lift Control Systems.

8.2 PRE-POWER UP CHECKS FOR INITIAL START-UP

Potential Severity: Major

Potential Loss: Assets, Personnel

Hazard Category: Electrical, Explosives

Use appropriate lockout/tagout procedures (refer to SEN-HSE-S027) to ensure that VSD power is OFF before proceeding with the following checks and procedures.

Use a Volt Ohm Meter (VOM) to verify that ALL power is OFF on the VSD, including:

- Incoming line at the bottom of the circuit breaker
- Motor terminals
- The DC bus

8.2.1 INSTALLATION CHECKLIST

Complete the following installation checks before you start up the drive:

ITEM	DESCRIPTION	CHECK (✓)
1	The ambient operating conditions meet the specifications.	
2	The drive cabinet has been fixed to floor, and if necessary due to vibration, etc., also from top to the wall or roof.	
3	The cooling air will flow freely in and out of the drive cabinet.	
4	If the drive has been stored for over one year, verify that the electrolytic DC capacitors in the DC link of the drive have been reformed. Refer to 10.10 Reforming the Capacitors.	
5	There is an adequately sized protective earth (ground) conductor between the drive and the switchboard, the conductor has been connected to an appropriate terminal, and the terminal has been tightened. (Pull the conductor to check.) Proper grounding has also been measured according to the regulations.	
6	The input power cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.)	
7	There is an adequately sized protective earth (ground) conductor between the motor and the drive, and the conductor has been connected to the appropriate terminal, and the terminal has been tightened. (Pull on the conductors to check.) Proper grounding has also been measured according to the regulations.	
8	The motor cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull on the conductors to check.)	
9	The motor cable (and brake resistor cable, if present) has been routed away from other cables.	
10	No power factor compensation capacitors have been connected to the motor cable.	
11	The control cables have been connected to the appropriate terminals, and the terminals have been tightened. (Pull on the conductors to check.)	
12	The supply voltage matches the nominal input voltage of the drive. Check the type of designation label.	
13	The voltage setting of the control power transformers and other components is correct. (Refer to 5.8 Voltage Tapping/Voltage Selector Voltage Tapping/Voltage Selector)	

ITEM	DESCRIPTION	CHECK (✓)
	• CPT in the VSD package • CPT in the VSD module • Heat Exchanger	
14	The power jumper configuration is correct to the type of power source. Refer to 5.6 Power Jumper Configuration.	
15	If a drive bypass connection will be used, verify that the direct-on-line contactor of the motor and the drive output contactor are either mechanically or electrically interlocked, i.e., cannot be closed simultaneously.	
16	There are no tools, foreign objects, or dust from drilling inside the drive.	
17	The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	
18	All shrouds and the cover of the motor connection box are in place. Cabinet doors have been closed.	
19	The motor and the driven equipment are ready for start.	

8.2.2 COMMUNICATION SETTINGS

Refer to the *LCS-ENG-M0005 INSTRUCT ESP Intelligent Controller-E30 VSD Configuration Manual*.

8.2.3 BASIC VSD CONFIGURATION

Refer to the *LCS-ENG-M0005 INSTRUCT ESP Intelligent Controller-E30 VSD Configuration Manual*.

8.3 START-UP PROCEDURE

Make sure that the following steps are included in your basic start-up procedure.

1. Check the mechanical and electrical installation of the drive.
2. Close the cabinet doors.
3. Make sure that it is safe to connect voltage. Ensure that:
   - cabinet doors are closed.
   - nobody is working on the drive or circuits that have been wired from outside into the drive cabinet.
   - cover of the motor terminal box is in place.
4. Close the main breaker or fuse disconnect switch (FDS) of the drive.
5. Ensure that the drive communication and configuration are set up properly.
6. Ensure that the **VSD > Configure** section is properly set up with proper transformer ratio and motor parameters.
7. Perform the first start of the drive and motor.
8. Stop the motor and drive.
9. Check that the cooling fans rotate freely in the right direction, and the air flows upwards. A paper sheet set on the intake (door) gratings stays. The fans run noiselessly.
10. Check that the motor starts, stops, and follows the speed reference in the correct direction when controlled with the controller.

8.4 COMMISSIONING PROCEDURES

8.4.1 STEP-UP TRANSFORMER (IF INSTALLED) START-UP AND CHECK

Perform the following steps to verify that the output transformer is functioning properly:

1. If the door switch (P/N 77027099) is installed and connected to the VSD, check if the controller in the VSD is reading the signal from the switch correctly. Set the parameter *Safety Switch (DI3) Action* in the controller to *Log and Stop*. The controller should register an alarm when the transformer door is opened.
2. Set the output transformer for the correct output voltage for the application.
3. Connect transformer input terminals to the drive output terminals.
4. Close the main breaker/fuse disconnect switch (FDS) of the drive.
5. Start the VSD and ramp the drive up to the target frequency.
6. Check the voltage at the transformer output. The output voltages measured at the transformer should be balanced at ±2%.

Potential Severity: Major
Potential Loss:Assets, Personnel
Hazard Category: Electrical, Explosives
Only designated personnel qualified to operate high voltage equipment shall be permitted to take measurements. Use appropriate PPE when taking these measurements.

7. Stop the VSD after confirming correct output voltages at the output transformer.
8. Open the main breaker/fuse disconnect switch (FDS) of the drive.

8.4.2 CONNECTING THE VSD TO DOWNHOLE EQUIPMENT

Once the controller, the E30 drive, and the output transformer (if installed) are verified, perform the following steps to connect the drive to downhole equipment, start it up, and check for proper operation.

1. Verify that all downhole equipment has been checked out before and after being run in the hole. Verify motor resistances (phase-to-phase and phase-to-ground) are correct.
2. Connect the VSD output cables to the downhole equipment at the wellhead.
3. Close the main breaker/fuse disconnect switch (FDS) of the drive.
4. Start the VSD.
5. Reset the UNDERLOAD, TARGET, and OVERLOAD CURRENT settings of the VSD.
6. If the artificial lift system is equipped with pressure-monitoring equipment, the VSD must be calibrated to the pressure transducers providing the output signal.
7. Once all external signals and subsystems have been connected to the drive, run the drive for a reasonable period of time to confirm proper operation and ensure that no faults or shutdowns occur.
8. Download configuration/history/data for future reference.

NOTE	Save the site file (.site) in StarView to record the drive configuration.

 WARNING	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Electrical, Machinery equipment hand tools** Depending on the type of external devices connected to the VSD and their functions, it may be best to test drive shutdowns and other conditions with only the transformer connected to minimize wear and tear on the downhole equipment. A load bank may be used, if available.

Section 9: **Optional and Combinable Equipment**

Data acquisition and remote access equipment, such as SCADA systems, are optional for drives and must be specified and ordered for the individual application. For Controller, an expansion card for SCADA applications is shipped with the controller and appropriate documentation is included with it when ordered.

Detailed theory and complex troubleshooting techniques for optional equipment are beyond the scope of this manual. Where applicable, a reference or link to additional reference material for optional equipment is included.

9.1 SCADA EQUIPMENT INTERFACE WITH CONTROLLER

If the drive to be installed or serviced is configured for remote data acquisition or control, SCADA equipment is connected to the drive. This section describes how the equipment is physically connected to the VSD.

9.1.1 PHYSICAL CONNECTION

Refer to the controller manual for the physical connection to SCADA system: *INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576)

9.1.2 TEMPORARY SCADA CONNECTION

For installations that require temporary connection, or are point-to-point in nature, a DB-9F connector can be used to mate with the DB-9M connector provided. Additional handshaking signals are available on the DB-9M connector. These signals include CTS/RTS and DSR/DTR. At the present time, the Modbus Driver software does not support or require the use of these signals. Should your application require the use of one or more of these handshakes signaling lines, please contact InTouch Support. The port can be configured for RS485 4–wire or RS232.

9.1.3 MODBUS ADDRESS MAP

Refer to Telemetry Tables for Modbus Addresses: *INSTRUCT ESP Intelligent Controller Firmware and Release Notes* (InTouch ID 6145281).

9.2 COMMUNICATION EQUIPMENT INSTALLATION, COMMISSIONING, MAINTENANCE, AND TROUBLESHOOTING

SCADA equipment or site communication equipment is optional for E30 drive systems. The standard site communication solution for Sensia drives is the Site Communication Box (SCB). However, equipment other than the SCB may be specified. Anyone installing site communication equipment other than the SCB must refer to the manufacturer's recommendations and documentation.

Training is required before installing, commissioning, and operating Sensia site communication equipment. Training level and skill set are defined in the following note.

NOTE	Only qualified personnel should perform SCB installations. Installation requires knowledge of the PAC, satellite modem, satellite network, end devices, and industrial electrical and communication wiring. The installer is responsible for installing the equipment according to local electrical and hazardous location regulations.

For detailed installation instructions for the SCB, refer to InTouch Content ID 6037869. Installation topics include SCB mounting location, antenna installation, antenna aiming, satellite modem installation, PAC setup, power and communication cabling, and appendices which contain field wiring instructions for external devices to the SCB. Also included is information on operation, maintenance, and troubleshooting of the SCB.

9.3 SURGE PROTECTION OPTION

The E30 comes with a surge protection device that provides protection to nominal 277V phase to earth voltage as standard. In case of a corner grounded delta power source, order three of the following SPD modules and do the replacement in the field.

ITEM NO.	DESCRIPTION	SENSIA PART NO.	QTY REQUIRED
1	Strikesorb 30 Class II, Type 2, 480V	Strikesorb 30-D	3

9.4 INSTRUCT ESP CONTROLLER EXPANSION CARD

Power Analyzer (PA) Card (P/N 100840440) and Modbus TCP/IP Communication (P/N 100419643) are provided in standard E30 VSD and pre-installed to INSTRUCT ESP Controller. In case other expansion cards are required, order any of these cards and install it into the available slots in the controller.

ITEM NO.	DESCRIPTION	SENSIA PART NO.	QTY
1	INSTRUCT ESP IO Card	100840430	1
2	INSTRUCT ESP RS232/RS485 Communication Card	101120028	1

Section 10: **Maintenance**

This chapter discusses preventive maintenance that is required for E30 drives. Recommended service intervals for maintenance procedures (especially life-limited parts and components) are included.

 CAUTION	**Potential Severity: Light** **Potential Loss: Assets, Personnel, Reputation** **Hazard Category: Electrical, Machinery equipment hand tools** Troubleshooting or servicing a Sensia VSD must be performed by qualified personnel. *Qualified personnel* are defined as those who have attended and successfully completed the required training. Completion of the training course is NOT a substitute for field experience. Course-trained personnel should be accompanied and mentored by experienced personnel until deemed competent to work unsupervised. Qualified personnel should have their course reference material on hand. Only then should they contact InTouch Support for additional support and troubleshooting/repair instructions.

10.1 PERIODIC INSPECTION

Maintenance for variable speed drives includes periodic inspections for drives that seemingly are functioning properly but have been in service for a reasonable amount of time. Often, visual inspection can identify a problem or malfunction before it gets serious enough to require the drive to be shut down for maintenance or repair, or the drive registers a fault and shuts down by itself.

 CAUTION	**Potential Severity: Light** **Potential Loss: Assets, Personnel, Reputation** **Hazard Category: Electrical** Use lockout/tagout procedures in accordance with local electrical codes before performing any drive maintenance (SEN-HSE-S027). Do not use liquid cleaning agents.

Inspect and clean the power section components (IGBTs, SCRs, and capacitors) as part of the annual clean and inspection cycle (as access allows). Do not remove the whole drive assembly to gain access to the components. The life expectancies of the power section components are designed to last for the life of the drive for wall-mounted drives. The actual life is dependent on ambient and environmental conditions, load, variation of load, power system configuration, output and carrier frequency configuration, cooling system, and other application-related factors.

The design life expectancy of the overall components normally exceeds 10 years (in some cases it can last 20 years or more) in normal operating environments.

10.1.1 MAINTENANCE INTERVALS

The table below shows the maintenance tasks which can be done by the end user.

The maintenance and component replacement intervals assume that the equipment is operated within the specified ratings and ambient conditions. Sensia recommends annual drive inspections to ensure the highest reliability and optimum performance.

This annual preventive maintenance program includes the following primary tasks:

- A visual inspection of all drive components visible from the front of the unit
- Resistance checks on the power components
- Power-supply voltage level checks
- General cleaning and maintenance
- Tightness checks on all accessible power connections

NOTE	Duty cycle, load profile, temperature, altitude, incoming line conditions, and other operating/environmental conditions greatly affect reliability of a drive. Long-term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Consult InTouch for additional maintenance recommendations.

Table 10-1: Descriptions of Symbols

CODE	TASK	DESCRIPTION
I	Inspect	Inspect the component for signs of excessive accumulation of dust, dirt, or external damage. For example, inspect the filter capacitors for bulges in the case, inspect the filters/fan inlet screens for debris that can block the airflow path.
C	Clean	Clean the components that can be reused, specifically the door-mounted air filters and fan inlet screens.
M	Maintain	This type of maintenance task can include an inductance test of line reactors/DC links, a full test of an isolation transformer, and so on
P	Perform	Performance of on/off-site work (commissioning, tests, measurements, or other work)
R	Replace	This component has reached its mean operational life. Replace the component to decrease the chance of failure. It is likely that components can exceed the designed life in the drive, but component life is dependent on many factors such as usage and heat.
RFB/R	Refurbish/Replace	The parts can be refurbished, at lower cost, or replaced with new ones.
Rv	Review	A review is recommended to help determine whether any of the enhancements/changes made to the drive hardware and control could benefit the application.

Table 10-2: Recommended Annual Maintenance Actions by the User

Sensia recommends these annual inspections to ensure the highest reliability and optimum performance.

Maintenance Action	Code
Connections and environment	
Sine wave cabinet filter	C/R
Quality of supply voltage	P
Spare parts	
Spare parts	I
DC circuit capacitors reforming, spare modules and spare capacitors	P
Inspections by the user	
Tightness of terminals	I
Dustiness, corrosion and temperature	I
Heat sink cleaning	I

Table 10-3: Recommended Drive Maintenance Tasks and Schedule (Frame 7 and below)

Years >		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Components and Activities																						
Air-Cooling System	Door mounted Air Filters (1)	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Heatsink Cooling Fan(s)		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Door mounted Cooling Fans		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Capacitor Bank Cooling Fans (Internal Stirring Fan)		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Converter Input Fuse Stirring Fan		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Converter Gate Board Stirring Fan		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	DC Pre-charge Control Board Stirring Fan		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R

(1) *Inspect and replace filters every 3 months or more frequently, depending on the environment*.

Table 10-4: Recommended Drive Maintenance Tasks and Schedule (Frame 8 and above)

Years >		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Components and Activities																						
Air-Cooling System	Door mounted Air Filters (1)	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Heatsink Fan Assembly		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Door mounted Cooling Fans		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Capacitor Bank Cooling Fans (Internal Stirring Fan)		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Converter Input Fuse Stirring Fan (AC Input Only)		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Converter Gate Board Stirring Fan (AC Input Only)		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	DC Pre-charge Control Board Stirring Fan		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
Power Switching Components	Converter Power Devices (SCR) (AC Input Only)		I	I	I	I	I	I	I	I	I	I	I	R	I	I	I	I	I	I	I	I
	Inverter Power Devices (IGBT)		I	I	I	I	I	I	I	I	I	I	I	R	I	I	I	I	I	I	I	I
	Electronic Bus Capacitors (Inverter Capacitor Bank)		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Capacitor Balance Resistors		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R
	Power Supply Circuit Board		I	I	I	I	RFB /R	I	I	I	I	RFB /R	I	I	I	I	RFB /R	I	I	I	I	RFB /R
	Pre-charge Resistors (Common DC Input Only		I	I	I	I	I	I	I	I	I	R	I	I	I	I	I	I	I	I	I	R
	Molded Case Switch (Common DC Input Only)		I	I	I	I	I	I	I	I	I	R	I	I	I	I	I	I	I	I	I	R
	Undervoltage Delay Bracket (Common DC Input Only)		I	I	I	I	I	I	I	I	I	R	I	I	I	I	I	I	I	I	I	R
	Line Reactor (2)		I	I	I	I	M	I	I	I	I	M	I	I	I	I	M	I	I	I	I	M

Years >		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Components and Activities																						
Integral Magnetics/ Power Filters	DC Link/ Common-Mode Choke (AC Input Only)		I	I	I	I	M	I	I	I	I	M	I	I	I	I	M	I	I	I	I	M
Control Pod Components	Converter Gate Circuit Board Removal/ Installation		I	I	I	I	RFB /R	I	I	I	I	RFB /R	I	I	I	I	RFB /R	I	I	I	I	RFB /R
	Main Control Boards		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Fiber Interface Control Boards		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
	Batteries (DCBs and CIB) (3)		I	I	R	I	I	R	I	I	R	I	I	R	I	I	R	I	I	R	I	I
	Fiber-optic Cables		I	I	I	I	R	I	I	I	I	R	I	I	I	I	R	I	I	I	I	R

(1) *Inspect and replace filters every 3 months or more, depending on the environment*.
(2) *Associated devices that are integrated into drive modules cannot be replaced individually. It is recommended to replace the entire module at the specified interval*.
(3) *User-installed CR1220 lithium coin cell battery (optional, not supplied) provides power to the real-time clock. It preserves the real-time clock setting in the event power to the drive is lost or cycled*.

10.2 REQUESTING MAINTENANCE SUPPORT

Refer to InTouch ID 4202020 for an example of an Application Data/Problem Information Sheet. The Application Data/Problem Information Sheet is created to correspond to information flow on InTouchSupport.com so that the field user can complete a hardcopy version on site and enter the information on the InTouchsupport.com database upon returning to the Sensia service center or shop.

Refer to B.2 Application Data and Issue identification Table for the necessary information required to request assistance from LCS engineers. This data will ensure assistance is given in the most complete and timely manner possible.

10.3 WARRANTY CLAIM PROCEDURE

Contact Lift Control Systems for warranty claim request.

10.4 DRIVE MODULE MAINTENANCE

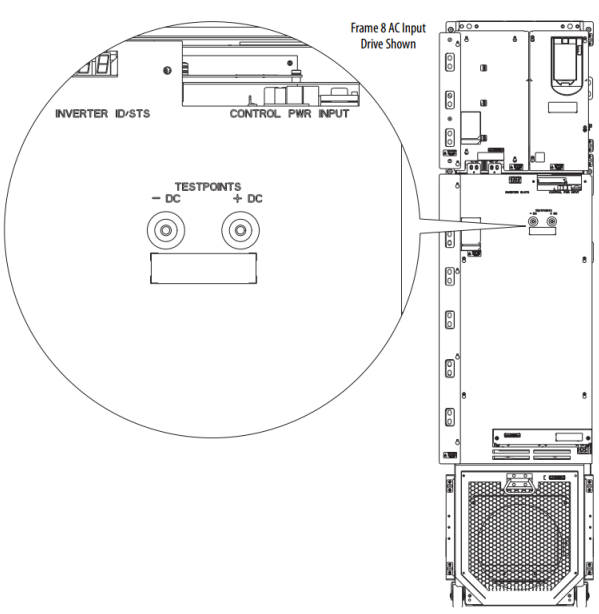
The drive shall be kept free of contamination as far as practical. If inspection reveals that dust, dirt, moisture, or other contamination has reached the control equipment, the cause must be eliminated. This contamination can indicate an incorrect or ineffective enclosure, unsealed enclosure openings (conduit or other), or incorrect operating procedures. Dirty, wet, or contaminated parts must be replaced unless they can be cleaned effectively by vacuuming or wiping.

CAUTION	**Potential Severity: Light** **Potential Loss: Assets** **Hazard Category: Machinery equipment hand tools** Use a vacuum cleaner with an antistatic hose and nozzle. Using a normal vacuum cleaner creates static discharges which can damage circuit boards.

10.4.1 FRAME 8 - REMOVE POWER FROM THE DRIVE

WARNING	**Potential Severity: Serious** **Potential Loss: Personnel** **Hazard Category: Electrical, Personnel** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Measure the DC bus voltage at the -DC and +DC TESTPOINT sockets on the front of the power module.

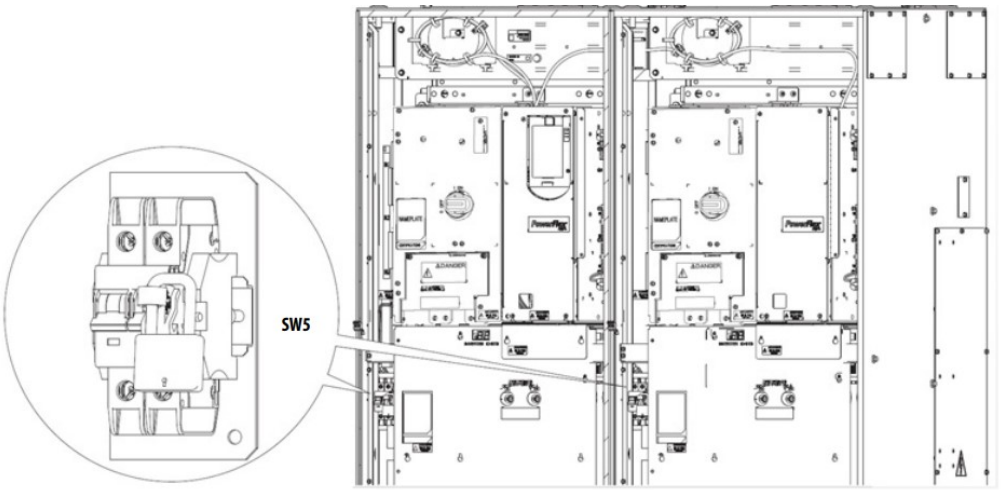
1. Turn off and lockout all input power, including any external power sources (such as a regenerative power supply or other DC power source).
2. Wait 15 minutes and verify that there is no voltage at the drive input power terminals.
3. Measure the DC bus voltage at the -DC and +DC TESTPOINT sockets on the front of the power module.



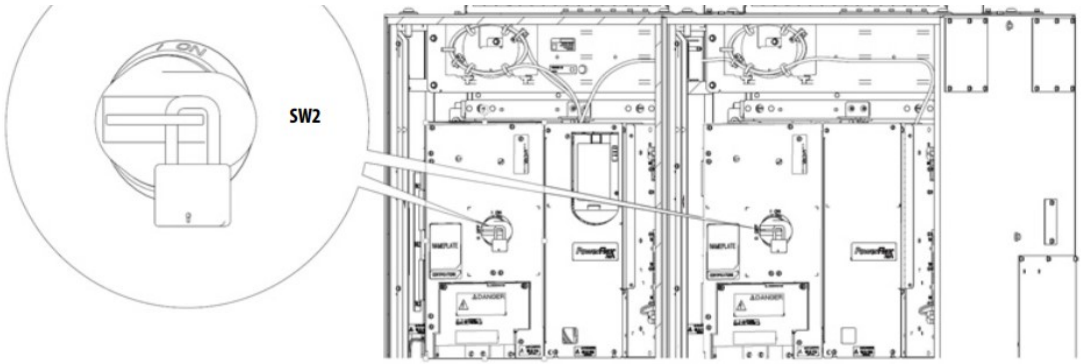
4. Measure the DC bus voltage at the -DC and +DC TESTPOINT sockets on the front of the power module.

5. For common **DC input drives** only, follow steps a…e to turn off and lockout additional input power sources.

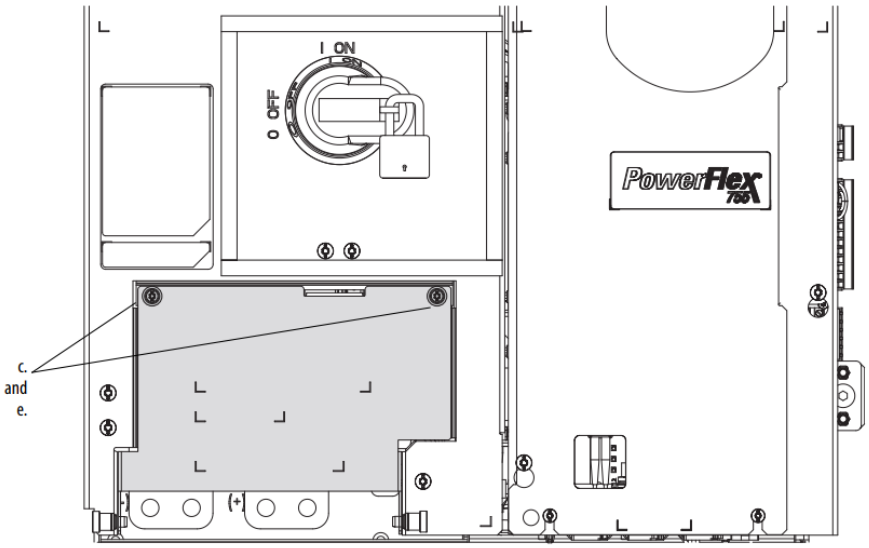
   a. Turn off and lock the drive circuit breaker SW5 (if used).



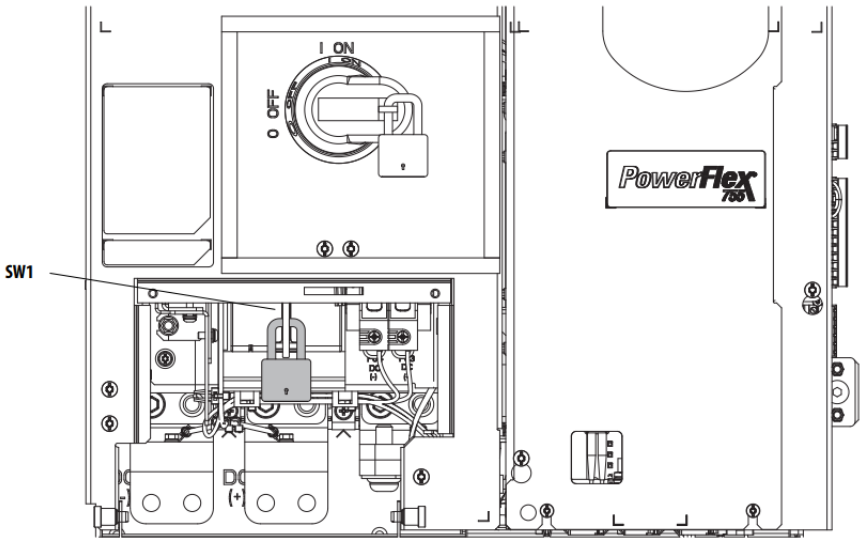
   b. Turn off and lock the drive disconnect switch SW2.



   c. For common DC input drives with a circuit breaker access door (DC input with pre-charge units 20-750-P6-xnnnxnnn and later), loosen the two hexalobular screws that secure the circuit breaker access door to the door panel and lower the door.



d. Close and lock the hasp on the molded case switch SW1.



e. If you must remove the drive from the cabinet, close and secure the circuit breaker access door before removal.

10.4.2 FRAME 8 - RELEASE DRIVE ASSEMBLY FROM CABINET

1. Open the cabinet door.
2. Remove the side shield (see number 4 in Figure 10-1).
3. Remove the bus bar connector bolts (see numbers 1, 2, and 3 in Figure 10-1).
4. Disconnect the two captive bolts that connect the converter chassis to the exhaust vent. (See number 5 in Figure 10-2).
5. Disconnect the four captive bolts that connect the converter chassis to the cabinet frame. (See number 6 in Figure 10-2).

NOTE	When removing both the inverter and converter drive sections from the cabinet, do not disconnect the captive bolts that hold the two sections together. The inverter-to-converter connector bolts are labelled number 8 in Figure 10-2.

6. Disconnect the six captive bolts that connect the inverter chassis to the cabinet frame. (See number 7 in Figure 10-2).

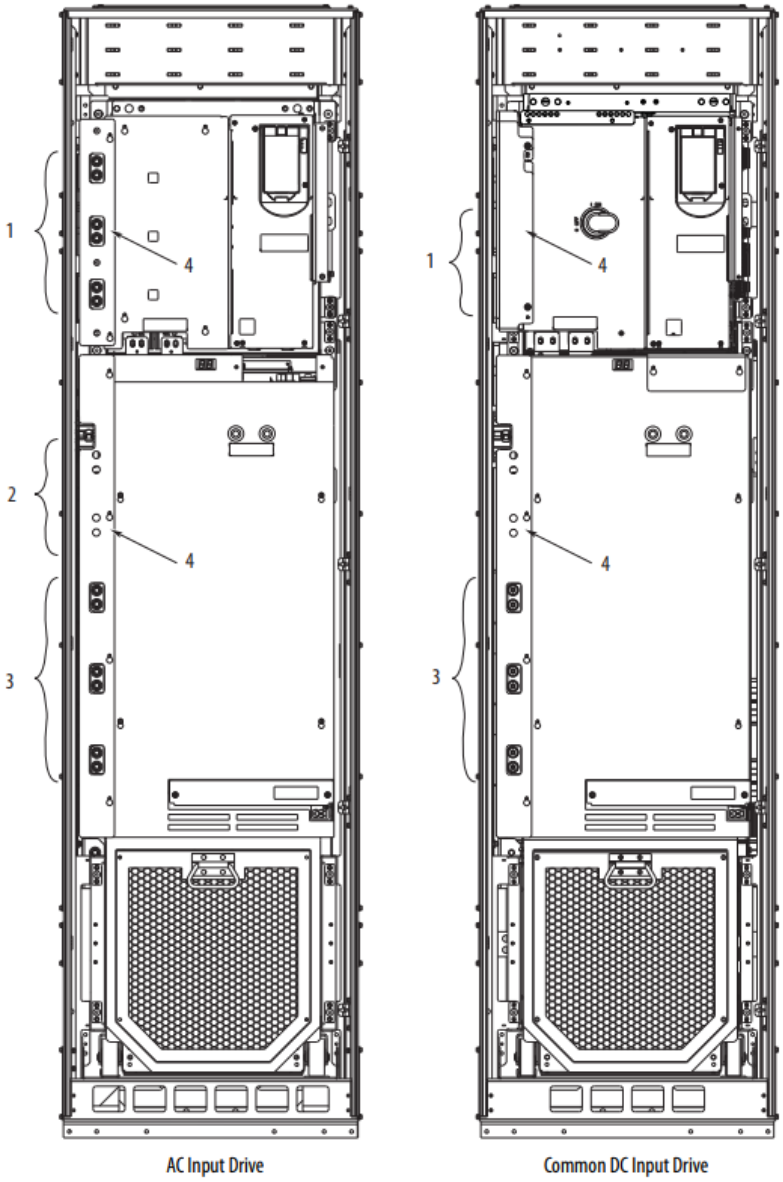


Figure 10-1: Side Shield and Bus Bar Connections

NO.	DESCRIPTION	TORQUE, N•M (LB•IN)	RECOMMENDED TOOL
1	Converter input power connections	22.6 (200)	T45 hexalobular (Torx)
2	DC bus connections (if equipped)		
3	Inverter output power connections		
4	Side shields	2.8 (25)	T25 hexalobular (Torx)

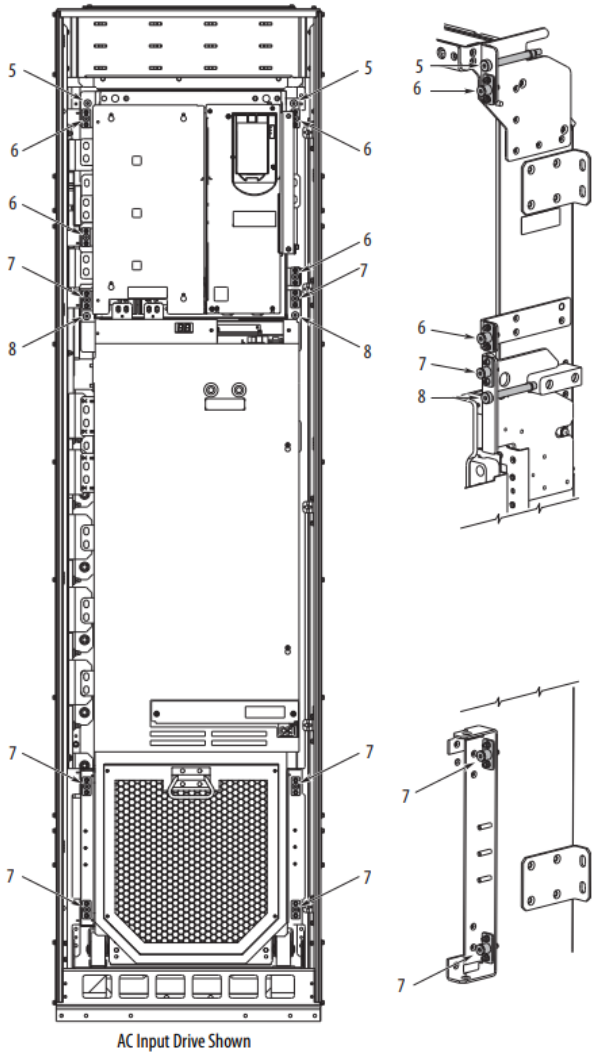
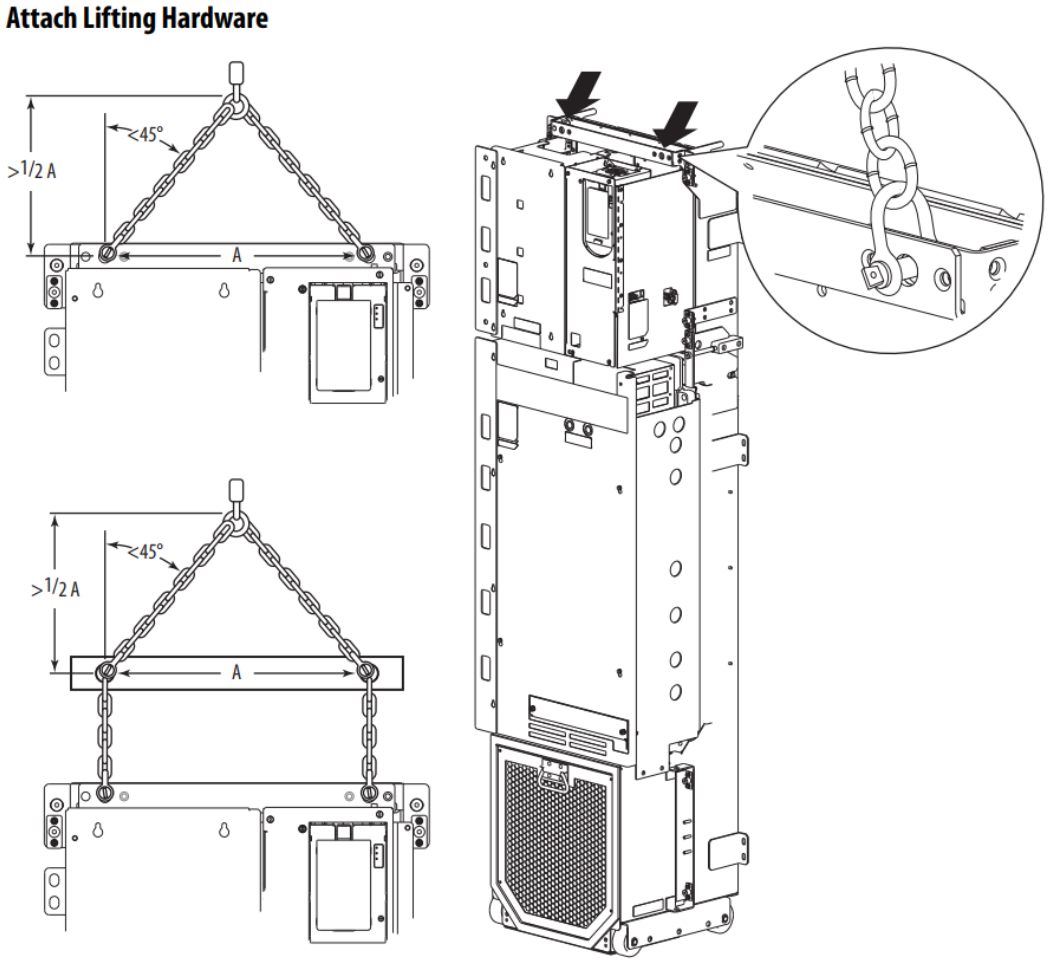


Figure 10-2: Drive-to-Cabinet Connections

NO.	DESCRIPTION	TORQUE, N•M (LB•IN)	RECOMMENDED TOOL
5	Converter-to-vent hood anchor bolts (two places)	11.3 (100)	5 mm hex key (Allen)
6	Converter-to-cabinet anchor bolts (four places)		
7	Inverter-to-cabinet anchor bolts (six places)		
8	Inverter-to-converter connector bolts (two places)		

10.4.3 FRAME 8 - ATTACH LIFTING HARDWARE



10.4.4 FRAME 8 - REPLACING THE DRIVE MODULE

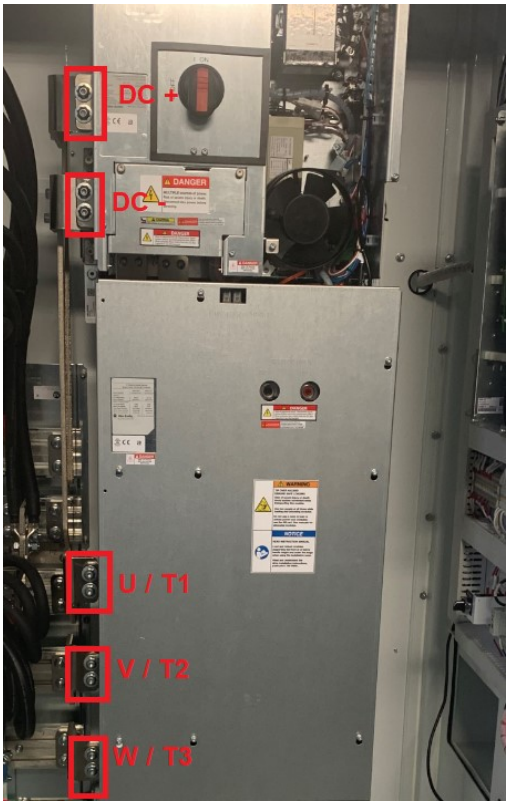
To replace the drive module, you need the following:

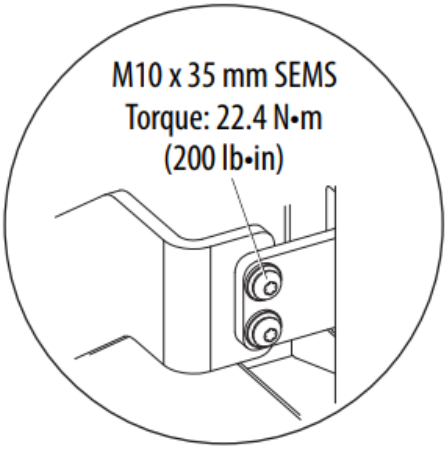
- two people (recommended)
- lifting chains
- lifting device
- set of screwdrivers
- torque wrench
- loading plate (PN: *SUB_1937470*)

Obey the instructions in 2.2 Installation and Maintenance Safety**.** If you ignore them, then damage to the equipment, personal injury, or death can occur.

WARNING	**Potential Severity: Serious** **Potential Loss: Personnel** **Hazard Category: Potential Energy** Make sure that the cabinet is secured to the floor. If not, the cabinet can topple over when the heavy drive module slides toward the front of the cabinet. This can cause physical injury or death and damage to the equipment.

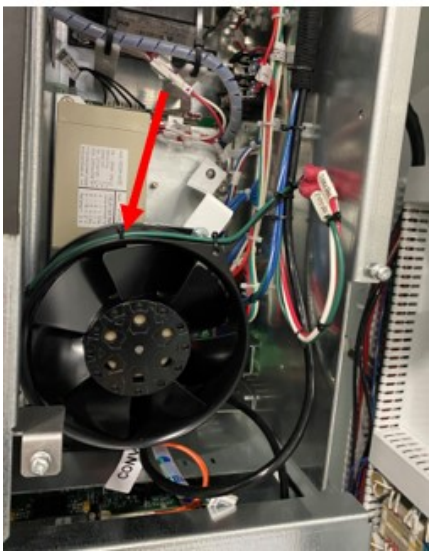
1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Open the drive enclosure door. Remove the plexiglass barrier of the module shielding the busbar connections.
3. Remove the bus bars connections from the power terminals.





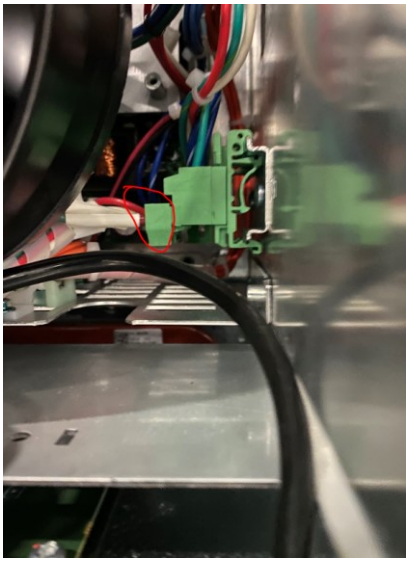
Bus Bar to Power Terminal Detail

4. Disconnect all the wires that are connected external to the module:
   - 120V power cable to the axial fan

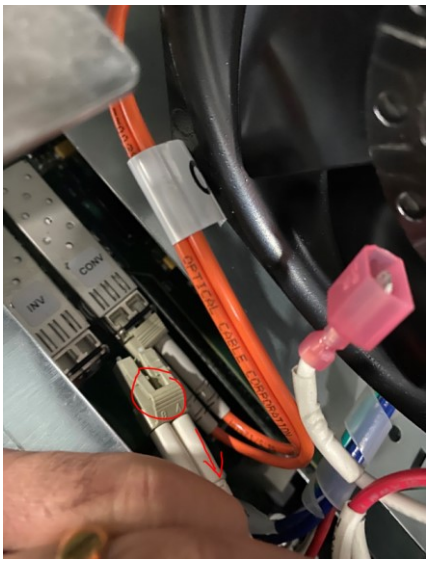


- 240V power cable to the pre-charge board

- 24V cable to the control pod



- INV cable to the control pod



5. Remove the screws that secure the heatsink fan airway cover to the chassis, then remove the cover. Remove the bolts that are securing the module to the bottom of the enclosure. These bolts are installed under the module, remove the bolts using the power rachet.

6. Disconnect the captive bolts that connect the assembly chassis to the cabinet frame. See 10.4.2 Frame 8 - Release Drive Assembly From Cabinet.

7. Remove the drive assembly from the enclosure. Pull the module carefully to the loading plate (PN SUB_1937470). At least two people are required to pull this drive.

8. Attach the lifting hardware to the lifting angle of the drive assembly. See 10.4.3 Frame 8 - Attach Lifting Hardware. Using crane, move the old module from the rollout cart and place the new module on to the rollout cart.

COMPONENT	WEIGHT, KG (LB)	
	AC INPUT	COMMON DC INPUT
Converter/DC input with pre-charge	64 (140)	64 (140)
Inverter	222 (490)	165 (363)
Drive assembly (Open, IP00)	286 (630)	229 (504)
Cabinet options assembly with circuit breaker and reactor	296 (653)	-

9. Install the new drive module in the reverse order of removal.

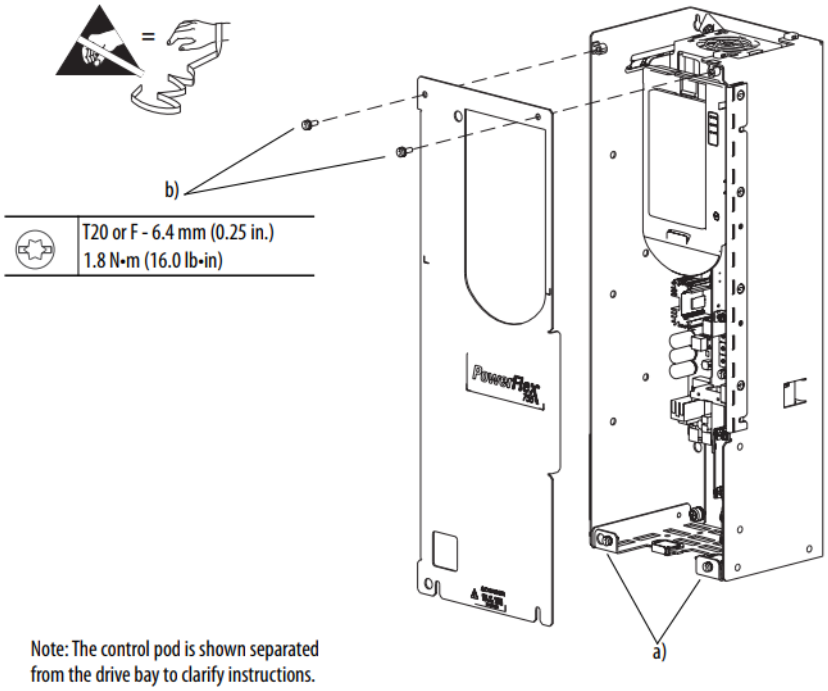
10.5 COOLING DEVICES MAINTENANCE

Inspect blowers and fans that are used for forced air cooling. Replace any that have bent, chipped, or missing blades or if the shaft does not turn freely. Apply power momentarily to check operation. If the unit does not operate, check, and replace wiring, fuse, blower, or fan motor as appropriate. Clean or change air filters as recommended.

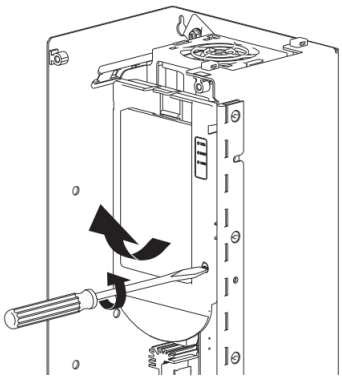
10.5.1 FRAME 8 - REPLACING CONTROL POD FAN

Part Number: SK-R9-FAN2-F23

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the control pod cover.
   a. Loosen, but do not remove, the bottom two M4 x 12 mm slotted hexalobular screws that secure the cover to the assembly.
   b. Remove the top two M4 x 12 mm slotted hexalobular screws that secure the cover to the assembly and remove the cover.

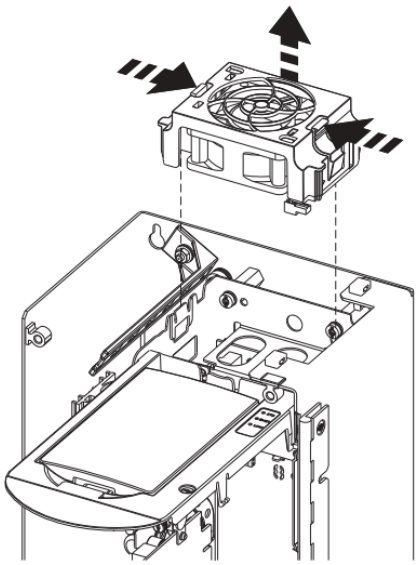


   c. Loosen the retention screw that secures the HIM cradle to the control pod frame and swing the cradle upward until the latch engages.



3. Disconnect the stirring fan power wire connectors from the main control board.

4. Press the two tabs on the sides of the fan housing inward and remove the stirring fan assembly from the top of the control pod chassis.

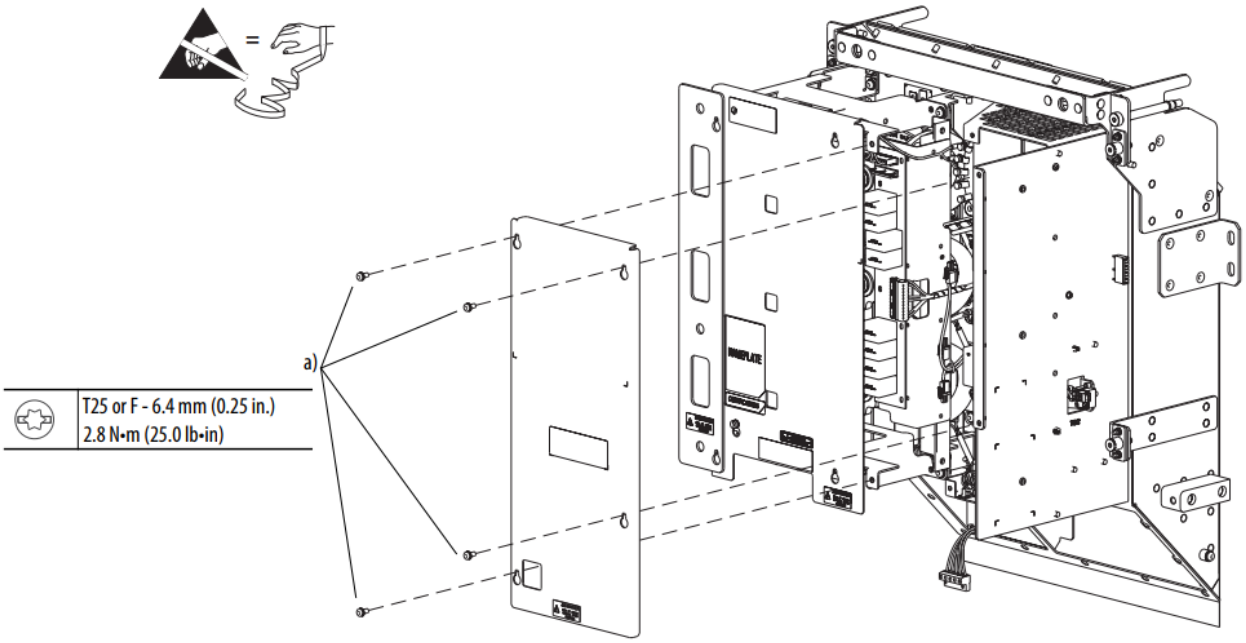


5. Install the new fan in the reverse order of removal.

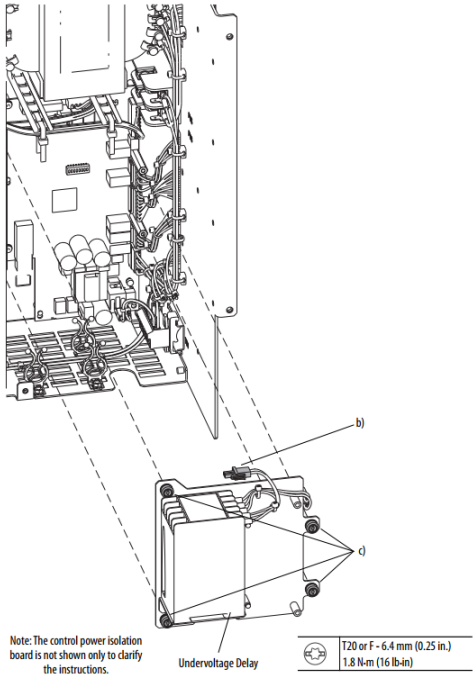
10.5.2 FRAME 8 – DC-INPUT DRIVE ONLY – REPLACING DC PRE-CHARGE CONTROL BOARD STIRRING FAN

Part Number: 20-750-CFANKIT-F8

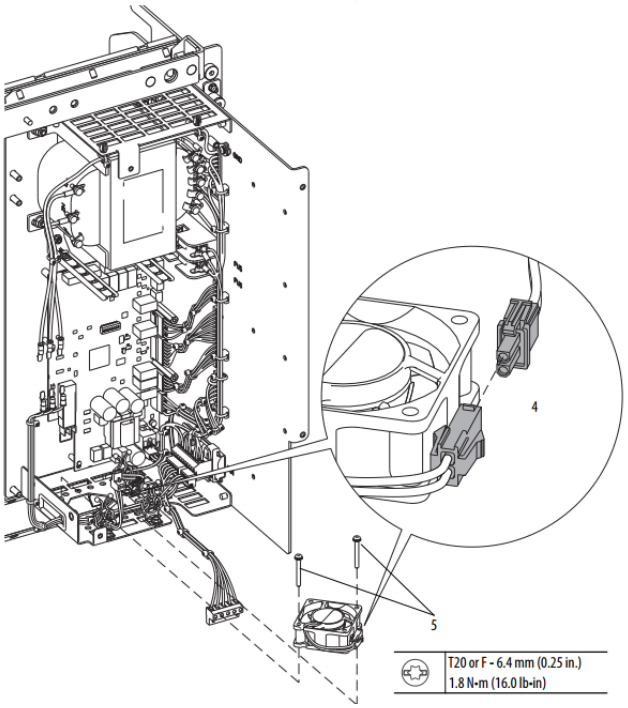
1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. If the control pod is installed, then rotate the control pod to gain access to the DC input with the pre-charge assembly control panel. If the control pod is not installed, then remove the right cover.
   a. Remove the four M5 x 14 mm screws that secure the cover to the assembly and remove the cover.



3. Remove the undervoltage delay bracket.
   a. Disconnect the undervoltage wire harness connector from terminal P5 on the DC pre-charge control board.
   b. Disconnect the undervoltage wire harness connector from connector UV on the molded-case switch control wire harness.
   c. Loosen the four M4 captive panel fasteners on the undervoltage delay bracket and remove bracket.



4. Disconnect the two-position fan connector from the stirring fan to the 24V/120V/240V wire harness.
5. Remove two M4 x 35 mm long screws that secure the stirring fan to the control panel and remove the stirring fan.

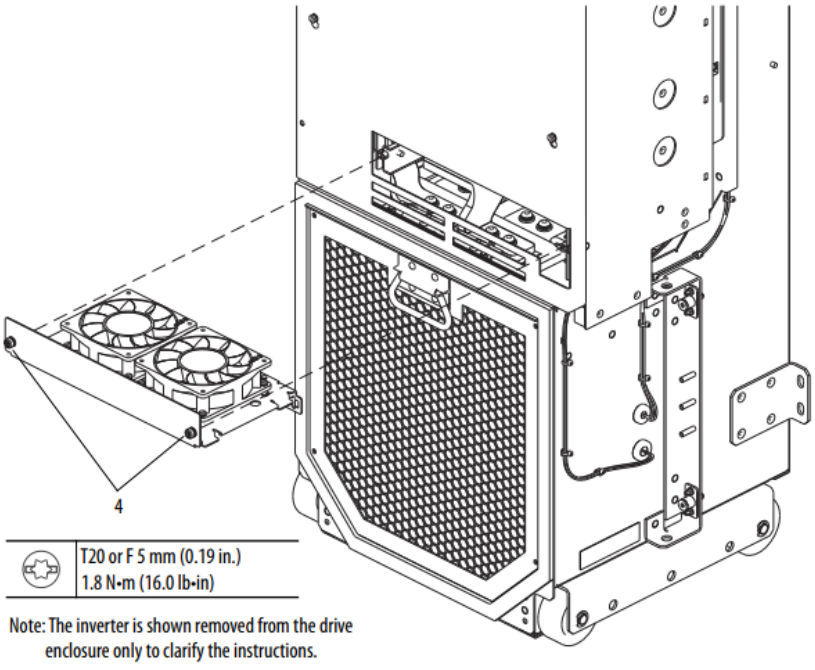


6. Install the stirring fan in the reverse order of removal.

10.5.3 FRAME 8 - REPLACING CAPACITOR BANK STIRRING FAN

Part Number: SK-R1-FAN2-F8

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Loosen the two captive screws on the face of the fan tray and pull the tray straight out from the inverter frame.

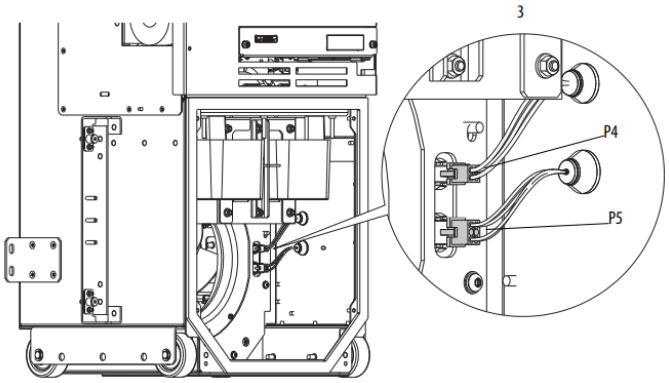


3. Install the stirring fan in the reverse order of removal.

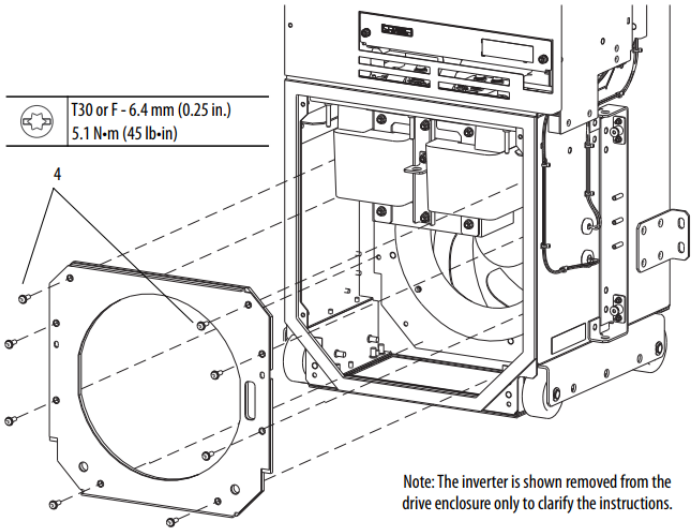
10.5.4 FRAME 8 - REPLACING HEAT SINK FAN ASSEMBLY

Part Number: SK-R1-FAN1-F8

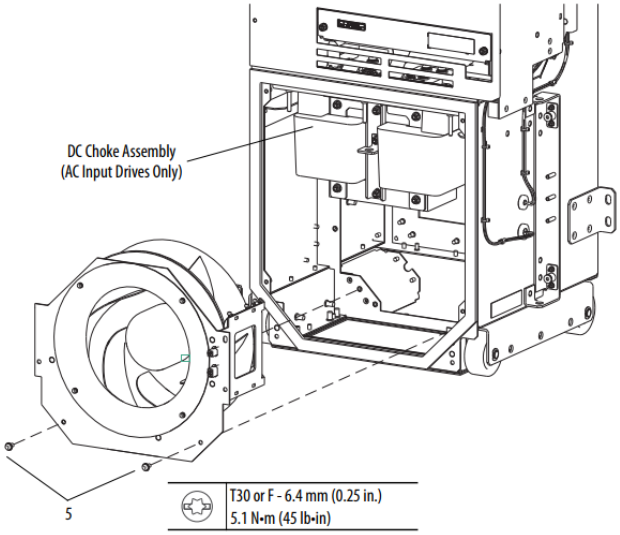
1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the heatsink fan inlet screen.
3. Disconnect the control and power wire connectors P4 and P5 from the front, right side of the fan assembly.



4. Remove the eight M6 x 20 mm screws that secure the inlet seal mounting plate to the chassis and remove the plate.



5. Remove the two M6 x 20 mm screws from the fan assembly. The assembly rests on two guide pins on the back wall.
6. Remove the fan assembly:
   a. By using both hands, pull the assembly slightly forward until it comes off the guide pins.
   b. Pull the bottom of the assembly toward the front of the inverter chassis and tilt the top backward so it clears the DC choke assembly (if installed). Remove the assembly.

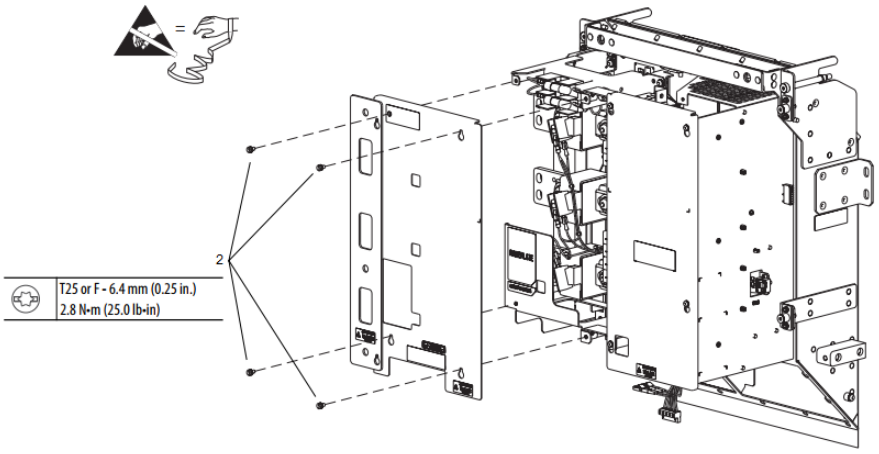


7. Install the heatsink fan assembly in the reverse order of removal.

10.5.5 FRAME 8 – AC-INPUT DRIVE ONLY – REPLACING CONVERTER INPUT FUSE STIRRING FAN

Part Number: SK-R1-FUSEFAN-F8

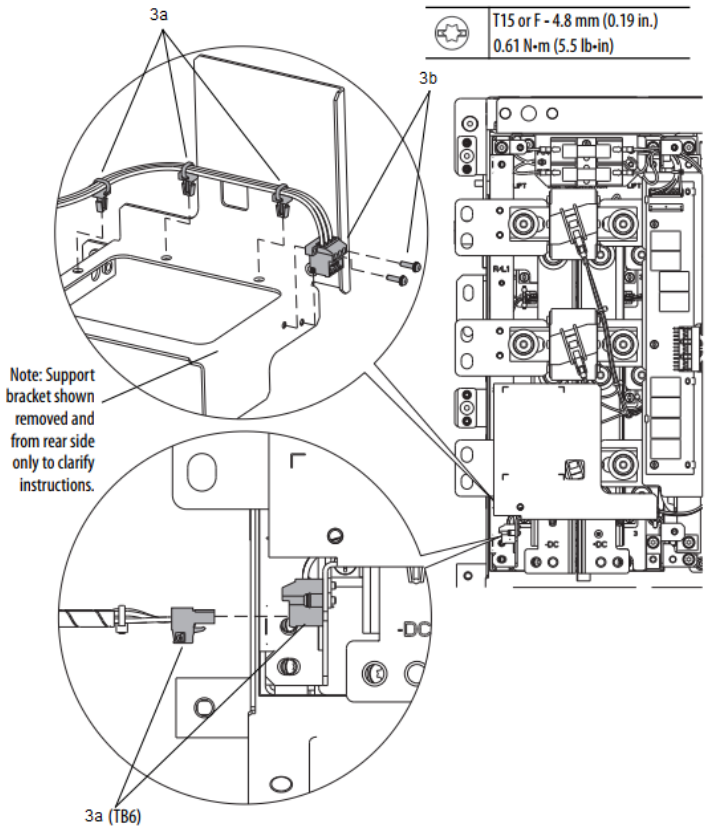
1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the left converter cover by removing the four M5x14mm screws that secure the cover to the assembly.



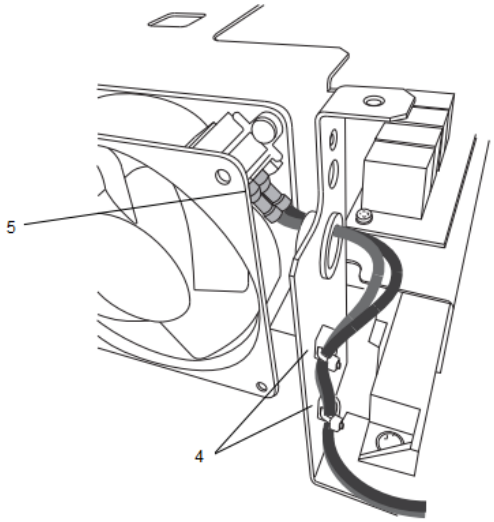
3. For frame 8 drives, continue with step 4. For frame 9 and larger drives only, complete these steps.
   a. Disconnect the cabinet-side, three-position DC bus fuse wire harness connector from terminal block TB6 on the lower left side of the converter.

b. Remove the two M3 x 12 mm screws that secure the harness terminal block TB6 to the cover support bracket.

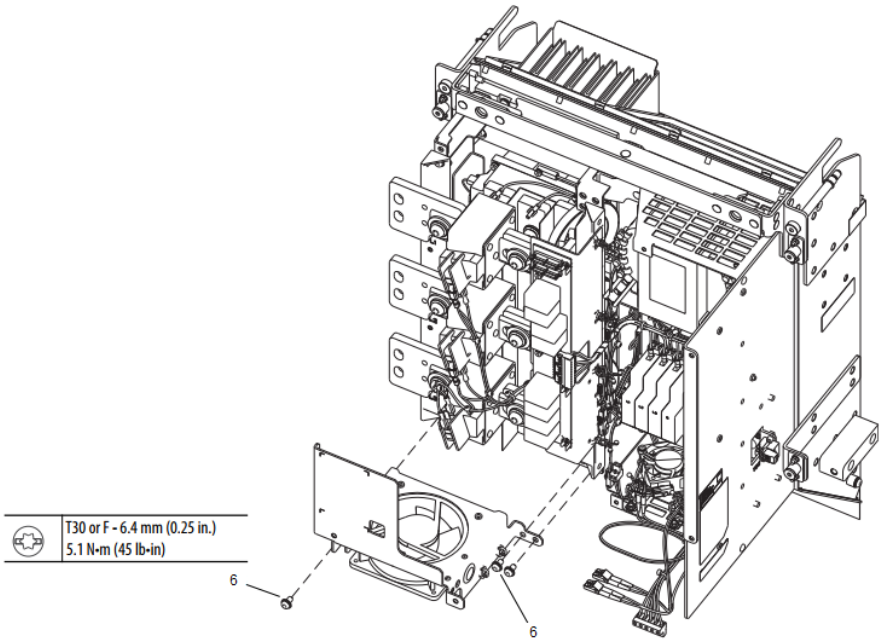
c. Disengage the three cable tie push mounts that secure the harness to the cover support bracket and remove the harness.



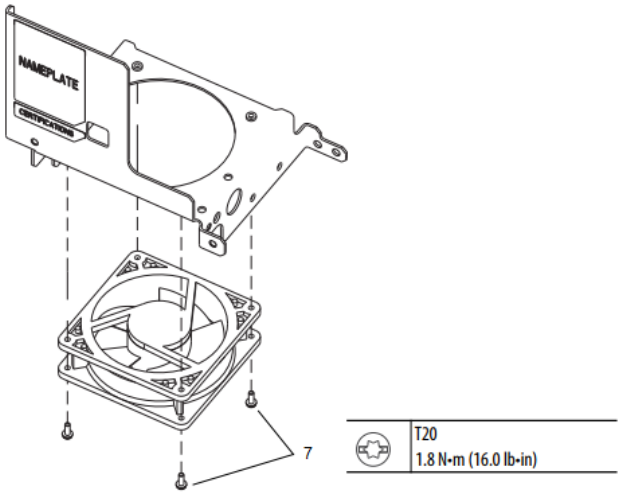
4. Disengage the two cable tie push mounts that secure the fan harness to the bracket.
5. Disconnect the Fan (+) and Fan (-) power wires from the fan terminals and pull the terminal wires through the hole in the bracket.



6. Remove the three M6 x 14 mm screws that secure the label bracket and stirring fan to the rail support and remove the bracket.



7. Remove the four M4 x 12 mm hexalobular screws that secure the stirring fan to the support bracket and remove the stirring fan.



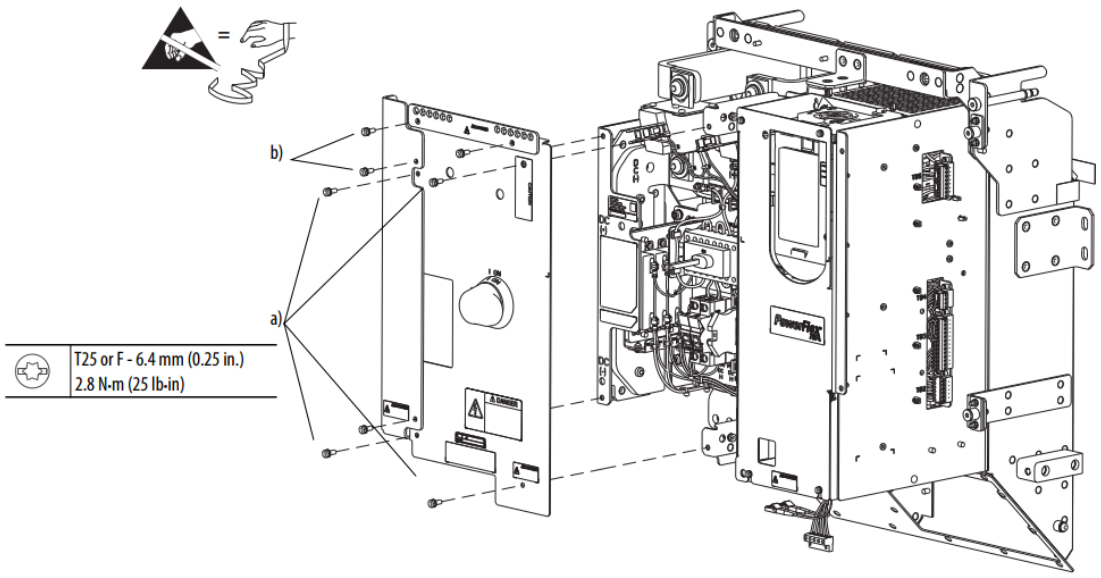
10.6 FRAME 8 CONTROL BOARD REPLACEMENT

10.6.1 FRAME 8 - DC-INPUT DRIVE ONLY – DC PRECHARGE CONTROL CIRCUIT BOARD

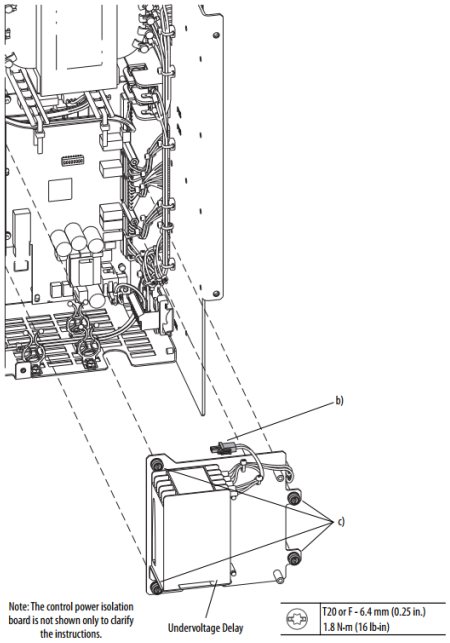
Part Number: SK-R1-CBPCTRL-F8

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the left cover, top guard, and left guard assembly.
   a. Remove only the four M5 x 14 mm screws that secure the cover to the assembly and remove the cover with the top and left guards attached.

   b. If necessary, remove the four M5 x 14 mm screws that secure the top and left guards to the cover; and remove the guards.

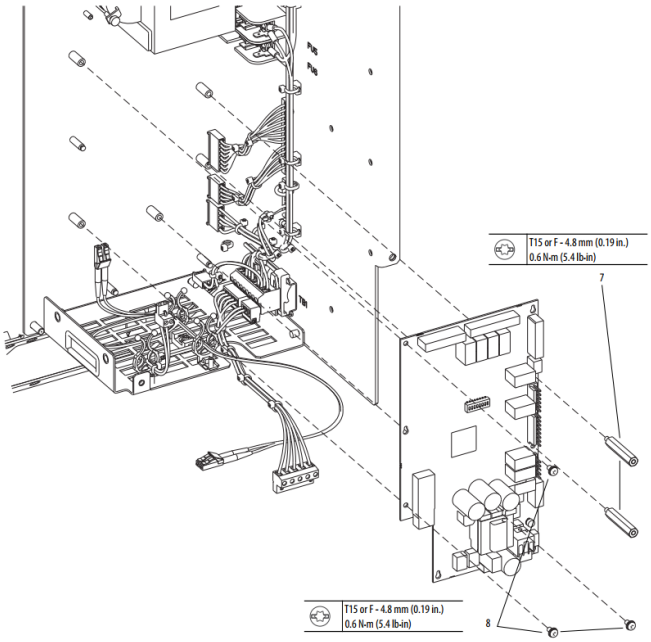


3. If the control pod is installed, then rotate the control pod to gain access to the DC input with pre-charge assembly control panel. If the control pod is not installed, then remove the right cover. Remove the four M5 x 14 mm screws that secure the cover to the assembly and remove the cover.
4. Remove the undervoltage delay bracket.
   a. Disconnect the undervoltage wire harness connector from terminal P5 on the DC pre-charge control board.
   b. Disconnect the undervoltage wire harness connector from connector UV on the molded-case switch control wire harness.
   c. Loosen the four M4 captive panel fasteners on the undervoltage delay bracket and remove bracket.



5. Disconnect the wire harnesses from the DC pre-charge control board.
6. From the fiber-optic cage in the lower left corner of the DC pre-charge control board, remove the fiber-optic transceiver by pulling its wire latch. Set the transceiver aside and save for reinstallation.
7. Remove the two M4 x 40 mm hex standoffs.

8. Remove the three M4 x 8 mm screws that secure the DC pre-charge control board to the DC input control panel, slide the DC pre-charge control board up to disengage its four keyhole slots, and remove the board.

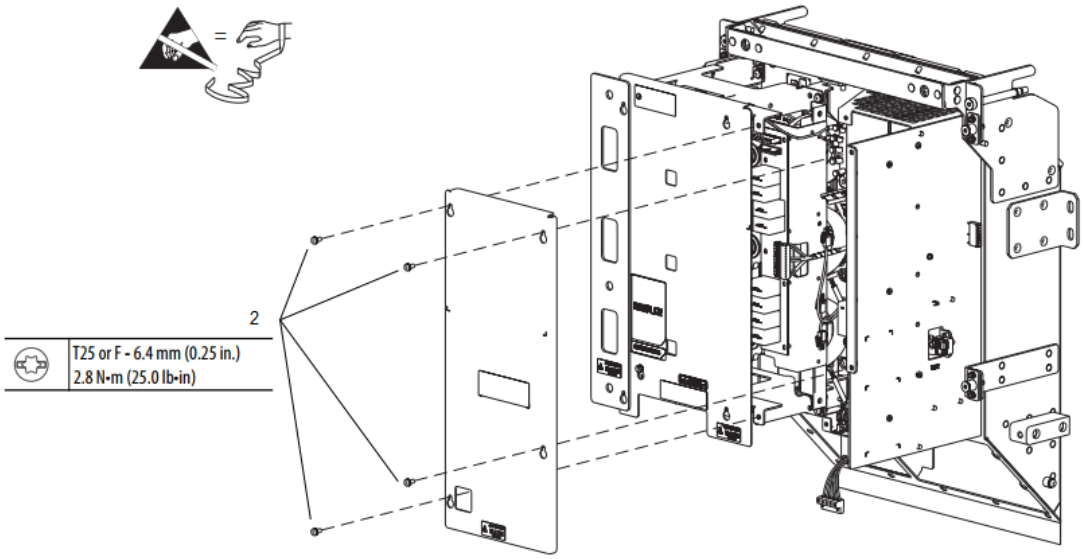


9. Install the new control board in the reverse order of removal.

10.6.2 FRAME 8 - AC-INPUT DRIVE ONLY - CONVERTER GATE CIRCUIT BOARD

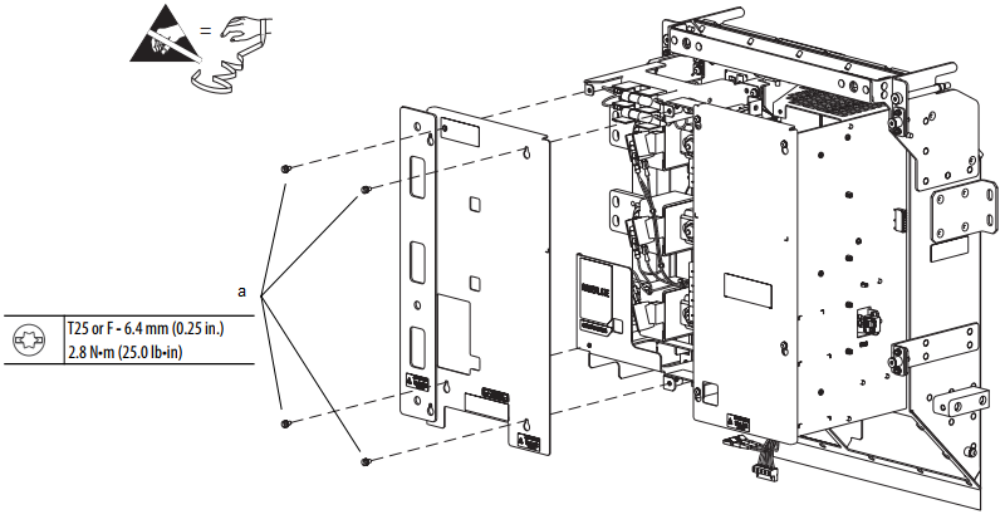
Part Number: SK-R1-CGDB4-CD-F8

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. If the control pod is not installed, then go on to remove the converter's right cover – remove the four M5x14mm screws that secure the cover to the assembly and remove the cover.

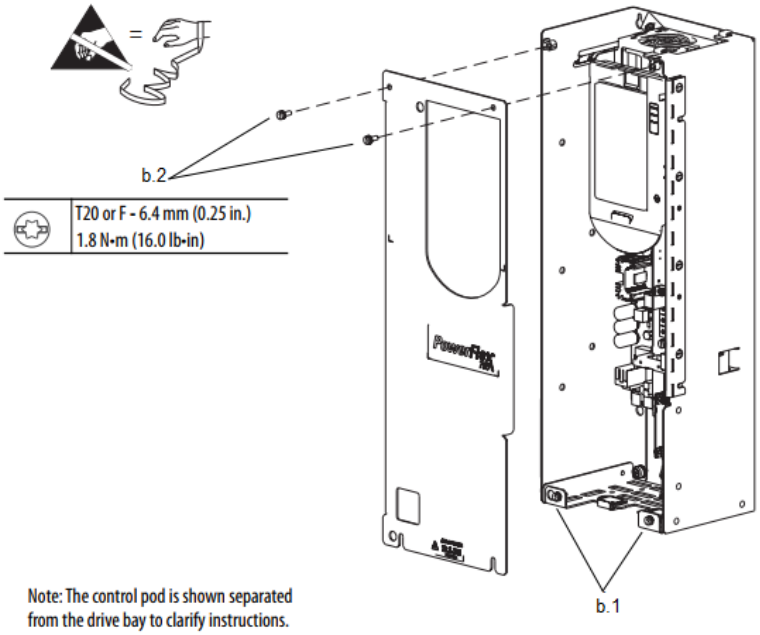


If the control pod is installed, then rotate the control pod to gain access to the converter control panel with steps a….g.

a. Remove the converter left cover by removing the four M5x14mm screws that secure the cover to the assembly and remove the cover.

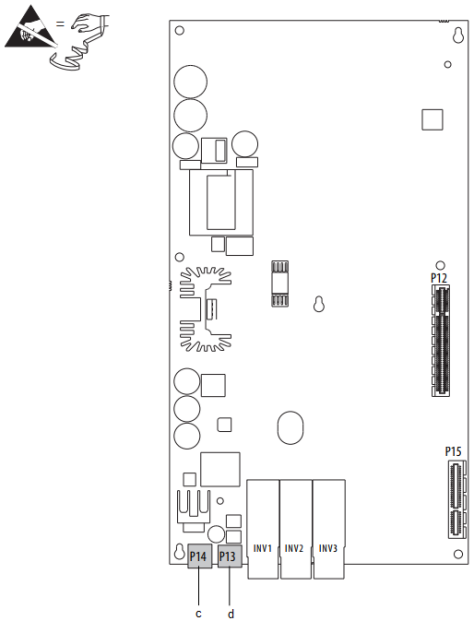


b. Remove the control pod cover. First loosen but do not remove the bottom two M4x12mm slotted hexalobular screws that secure the cover to the assembly. Then remove the top two M4x12mm slotted hexalobular screws that secure the cover to the assembly and remove the cover.

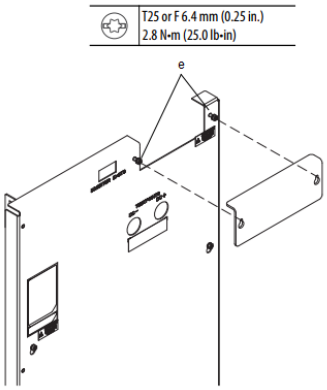


c. Disconnect the drive internal 24V wire harness J14 connector from the fiber interface board P14 terminal.

d. If installed, disconnect the external supplied 24V supply power wiring from the fiber interface board P13 terminal.

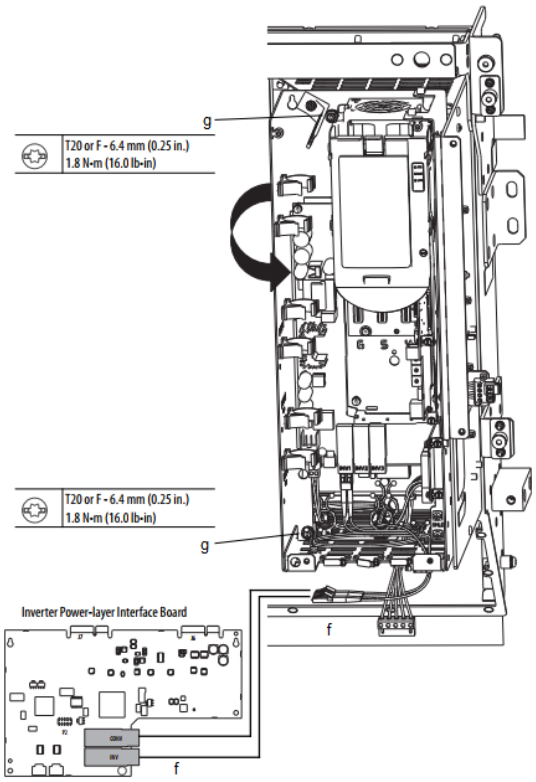


e. Remove the inverter circuit board connections cover from the inverter by loosening the two M5x14mm screws that secure the clear cover to the inverter front cover and remove the cover.



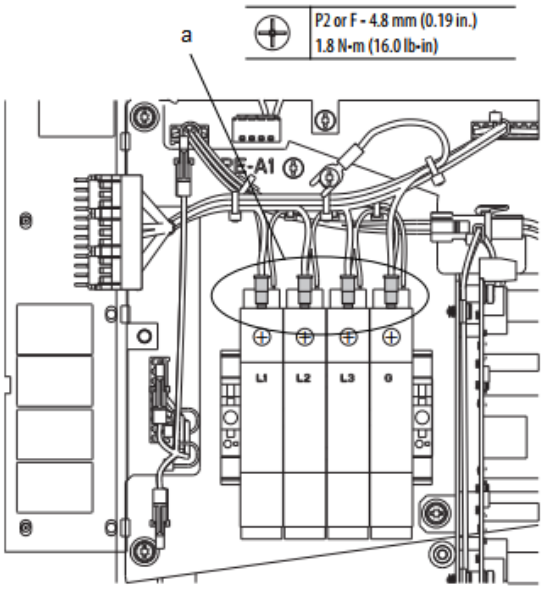
f. Disconnect the inverter fiber-optic cable from INV and the converter fiber-optic cable from CONV on the inverter power-layer interface board in the inverter card cage assembly. Place the cables on the bottom of the control pod and follow the minimum bend radius requirement. Verify that cable damage does not occur when moving the control pod.

g. Loosen the two M4 captive panel fasteners that secure the control pod to the converter control panel and rotate the control pod forward.

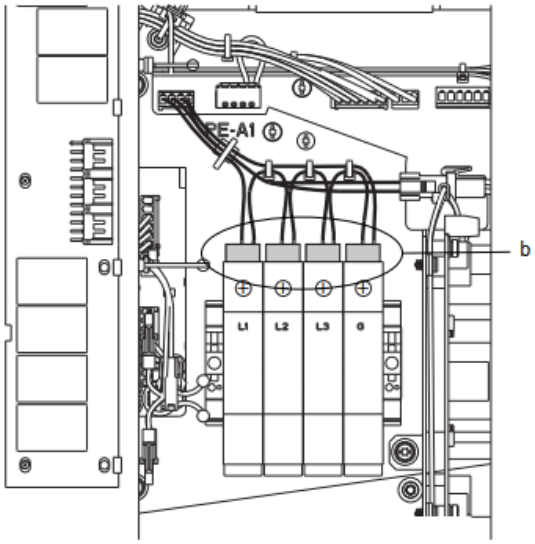


3. Remove the surge suppressor assembly.

   a. Loosen the Phillips head screws that secure the wires to the surge suppressor L1, L2, L3, and G terminals and remove the wires.

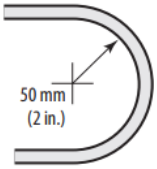


   b. Remove the four, three-position surge suppressor sense wire terminal blocks from the surge suppressor.



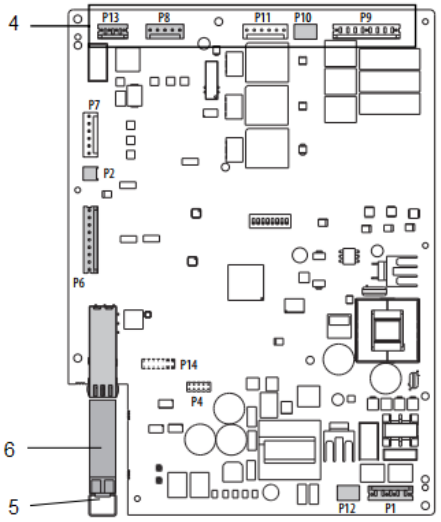
c. Release the surge suppressor from the DIN rail and remove the surge suppressor.

4. Disconnect all wire harnesses from the converter gate board.

NOTE	Minimum inside bend radius for fiber-optic cable is 50 mm (2 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii. 

5. Disconnect the fiber-optic cable from the port in the lower left corner of the gate board.

6. From the fiber-optic cage in the lower left corner of the converter gate board, remove the fiber-optic transceiver by pulling its wire latch. Set the transceiver aside and save for reinstallation.

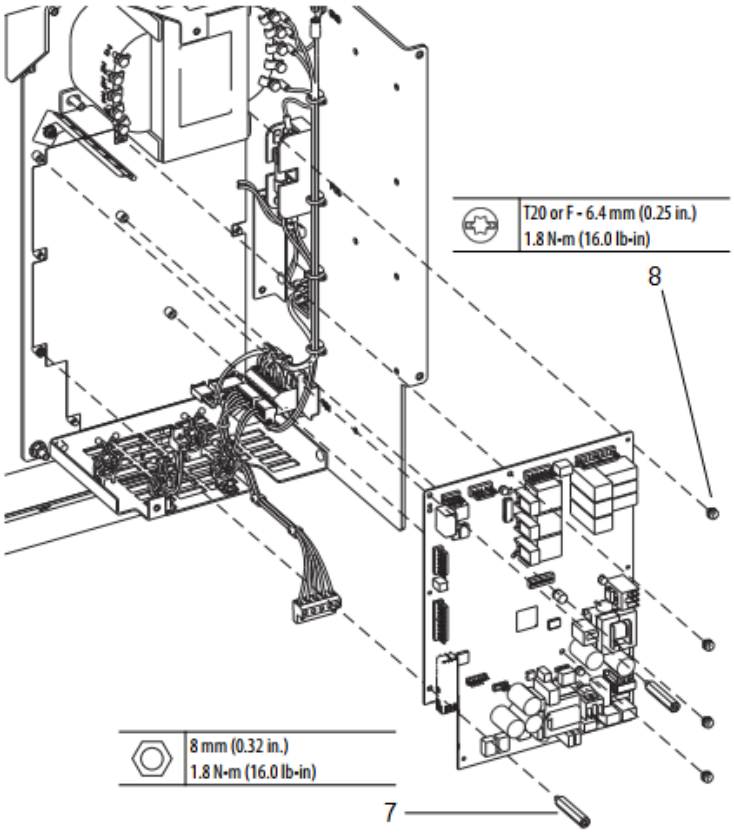


NOTE	When installing the fiber-optic cable, be sure that the wire latch is down.

7. Remove the two M4 x 40 mm hex standoffs.

8. Remove the four M4 x 6 mm screws that secure the converter gate board to the converter control panel. Slide the converter gate board up to disengage its four keyhole slots and remove the board.

NOTE	Do not remove the insulation sheet that is attached to the converter duct.

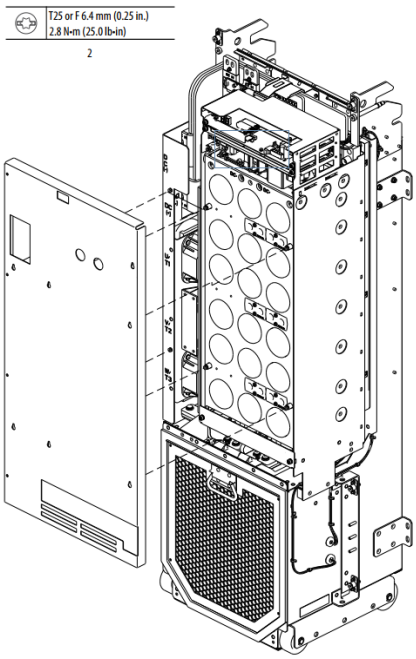


9. Install the new control board in the reverse order of removal.

10.6.3 FRAME 8 - POWER LAYER INTERFACE CIRCUIT BOARD

Part Number: SK-R1-PINT2-F8

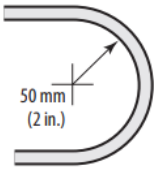
1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the inverter front cover: Loosen the six M5 x 14 mm screws, raise the front cover vertically, and lift it off the screws.



3. Disconnect the terminal block from P6 on the power control board.

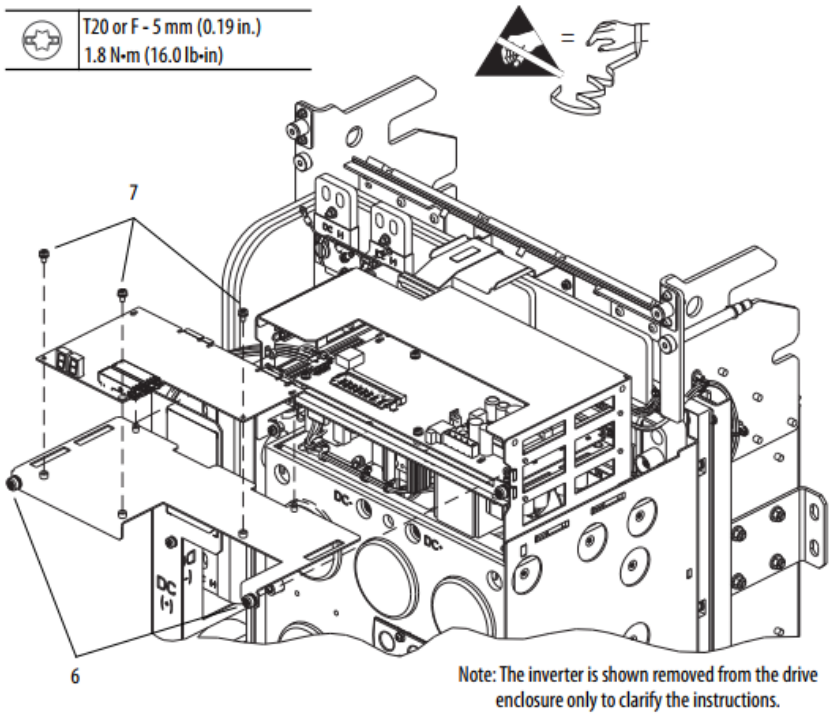
NOTE

Minimum inside bend radius for fiber-optic cable is 50 mm (2 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii.



4. Disconnect the fiber-optic cables from CONV and INV on the power layer interface board.
5. From the INV and CONV fiber-optic cages on the power layer interface board, remove each fiber-optic transceiver by pulling its wire latch. Set the transceivers aside and save for reinstallation.
6. Fully loosen the two captive screws on the face of the top tray in the card cage, pull forward, and remove the tray. Note that the right front corner of the power layer interface board may not clear the card cage frame. Lift the tray up to clear the card cage.

7. Remove the three M4 x 8 mm screws that secure the power layer interface board to the tray and push the board slightly back and then up to remove it from the two keyhole standoffs on the tray.



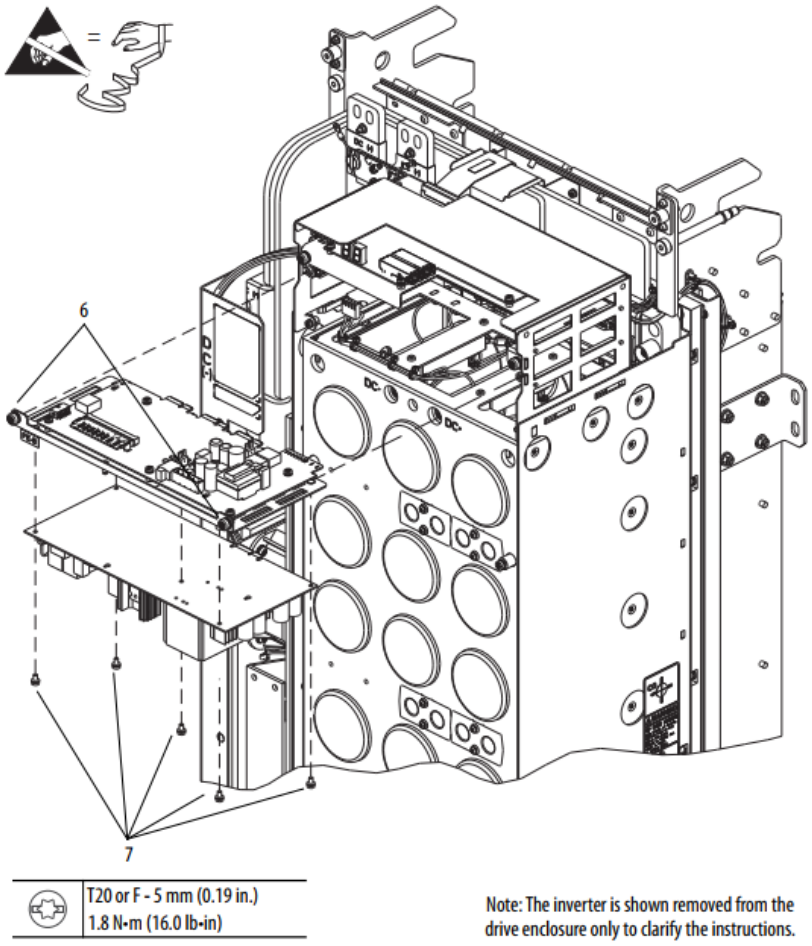
8. Install the new control board in the reverse order of removal.

10.6.4 FRAME 8 - POWER SUPPLY CIRCUIT BOARD

Part Number: SK-R1-PWRS1-CD-F8

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the inverter front cover: Loosen the six M5 x 14 mm screws, raise the front cover vertically, and lift it off the screws.
3. Disengage the locking tabs and disconnect the wire connector from P1 on the power control board.
4. Disconnect the terminal block from P6 on the power control board.
5. Disengage the locking tabs and disconnect the wire connector from J1 on the power supply board.
6. Fully loosen the two captive screws on the face of the bottom tray in the card cage and pull the tray out of the cage.

7. Remove the five M4 x 8 mm screws that secure the power supply board to the tray and pull the board slightly forward and then down to remove it from the two keyhole standoffs on the tray.



8. Install the new control board in the reverse order of removal.

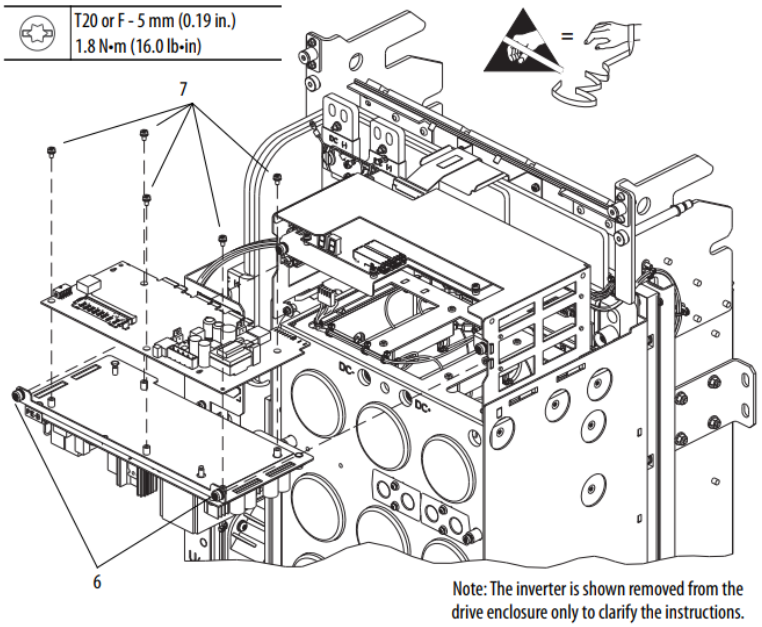
10.6.5 FRAME 8 - POWER CONTROL CIRCUIT BOARD

Part Number: SK-R1-PC1-F8

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the inverter front cover: Loosen the six M5 x 14 mm screws, raise the front cover vertically, and lift it off the screws.
3. Disengage the locking tabs and disconnect the wire connector from P1 on the power control board.

   TIP: During Installation mate P1 to J1.
4. Disconnect the terminal block from P6 on the power control board.
5. Disengage the locking tabs and disconnect the wire connector from J1 on the power supply board.
6. Fully loosen the two captive screws on the face of the bottom tray in the card cage and pull the tray out of the cage.

7. Remove the five M4 x 8 mm screws that secure the power control board to the tray and pull the board slightly back and then up to remove it from the two keyhole standoffs on the tray.



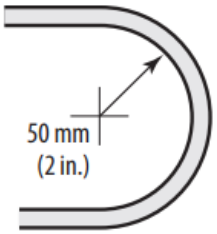
8. Install the new control board in the reverse order of removal.

10.6.6 FRAME 8 - FIBER INTERFACE BOARD (INSIDE CONTROL POD)

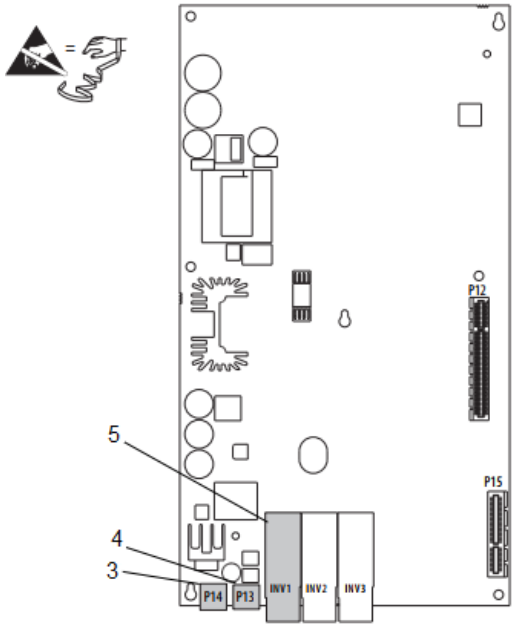
Part Number: SK-R1-FIB1-F8

1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the control pod cover.
3. Disconnect the J14 connector from the fiber interface board P14 terminal.
4. If installed, disconnect the external supplied 24V supply power wiring from the fiber interface board P13 terminal.

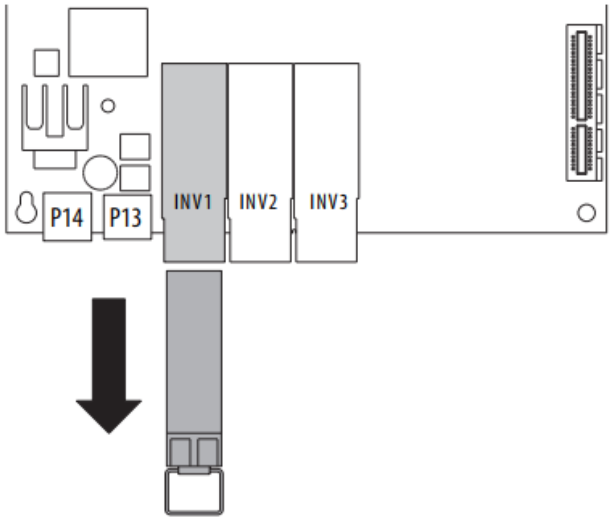
IMPORTANT Minimum inside bend radius for fiber-optic cable is 50 mm (2 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii.



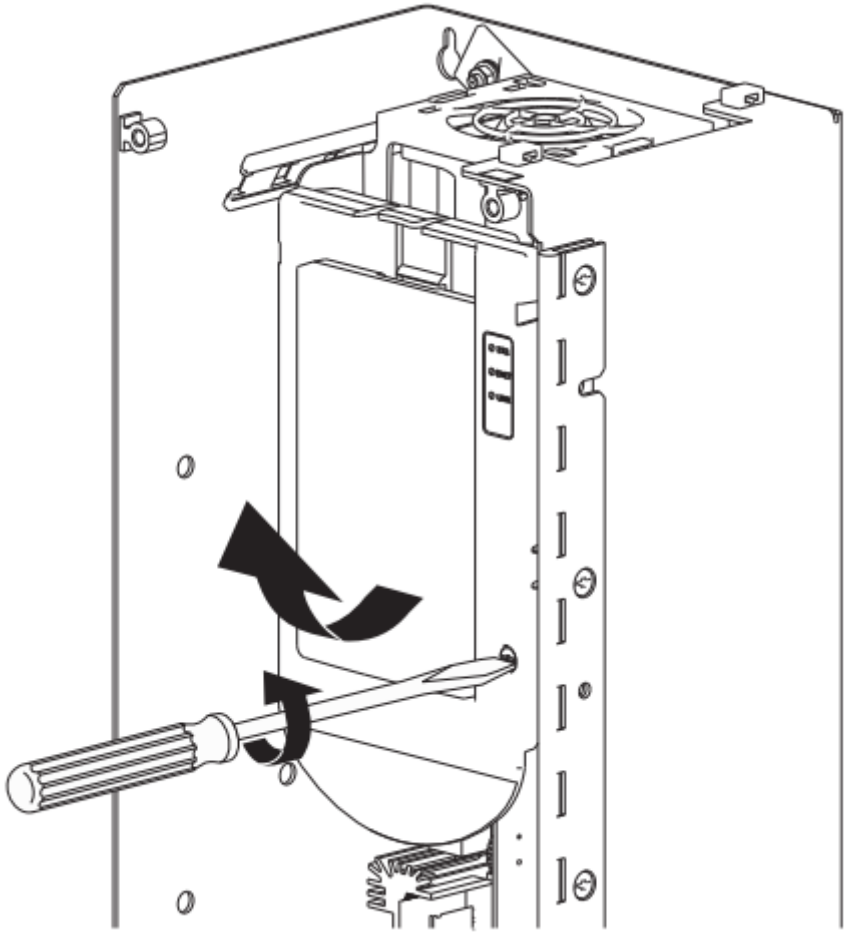
5. Disconnect the inverter fiber-optic cable from INV1 on the fiber interface board, carefully coil the fiber-optic cable, and place it in the bottom of the control pod. Follow the minimum bend radius requirement.



6. From fiber-optic cage INV1 on the fiber interface board, remove the transceiver by pulling its wire latch. Set the transceiver aside and save for reinstallation.

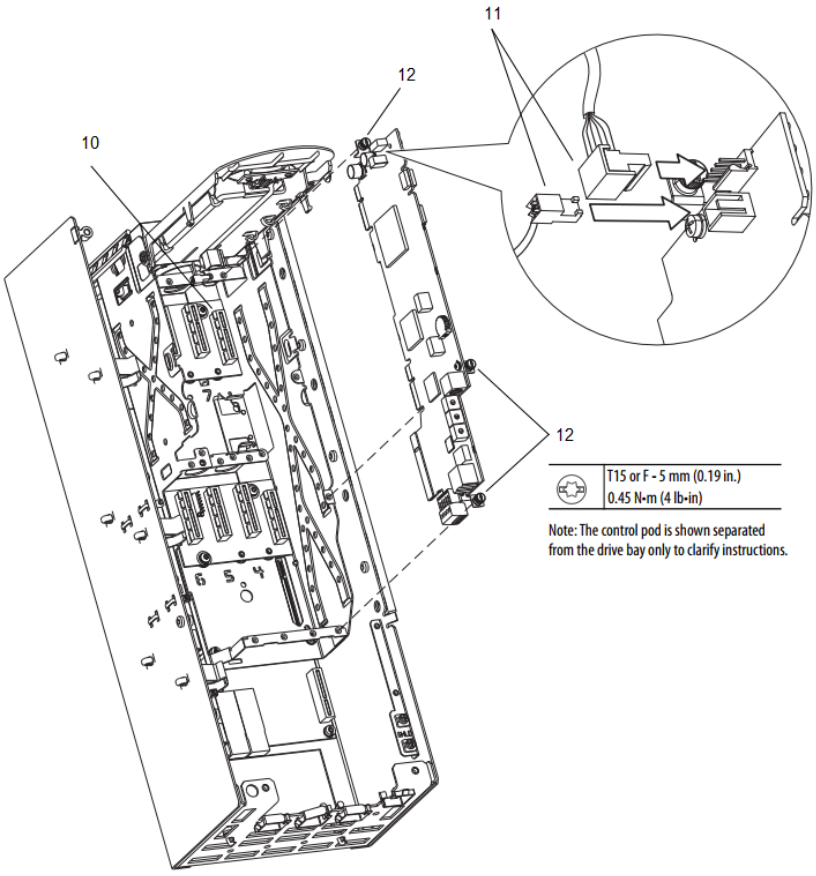


7. Loosen the retention screw that secures the HIM cradle to the control pod frame and swing the cradle upward until the latch engages.

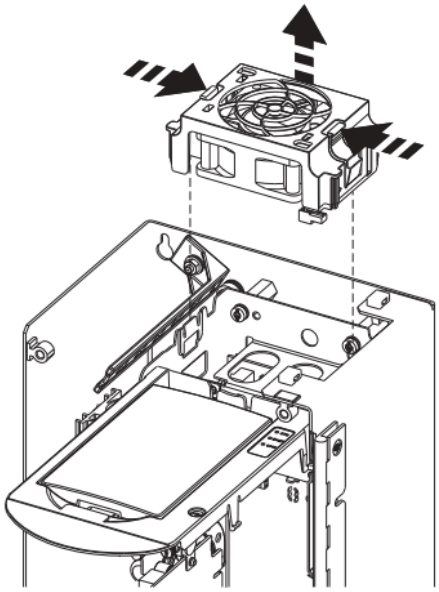


8. Disconnect all wiring to the main control-board terminal block (TB1).
9. If installed, disconnect all wiring to all option module terminal blocks.
10. If installed, remove the option module in slot 7, by loosening the two captive thumb screws on the module and by pulling the board out of the control pod. The torque requirement for installation is the same as for the main control board.
11. Disconnect the HIM and stirring fan power wire connectors from the main control board.

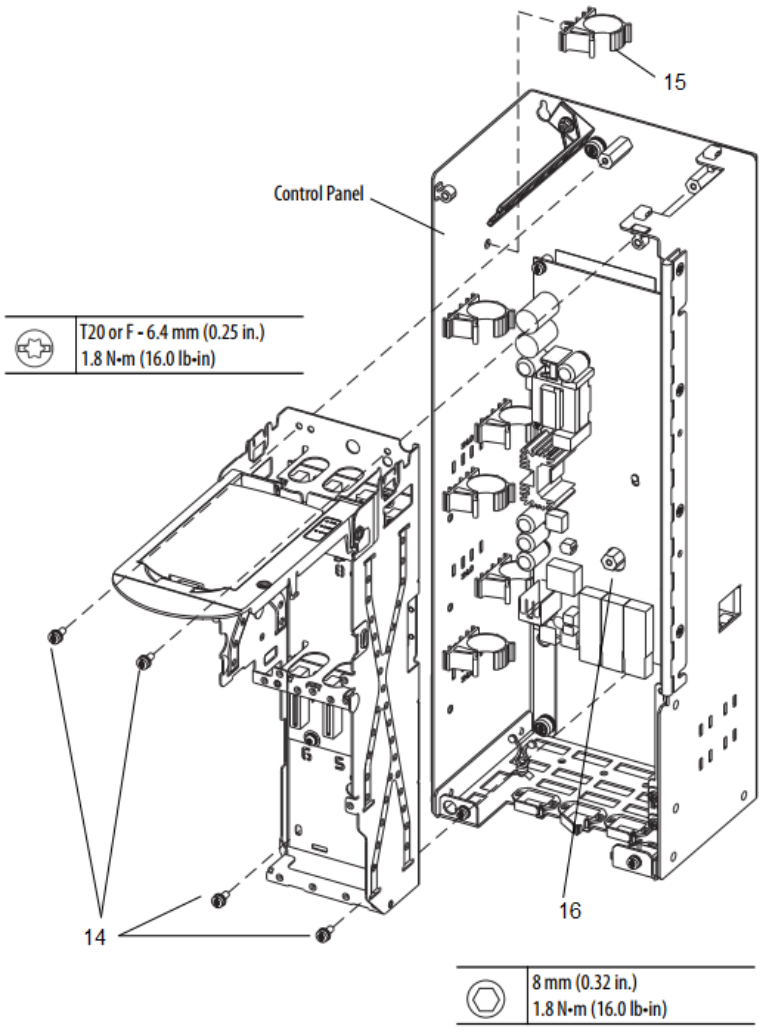
12. Loosen the three captive thumb screws and remove the board.



13. Press the two tabs on the sides of the fan housing inward and remove the stirring fan assembly from the top of the control pod chassis.

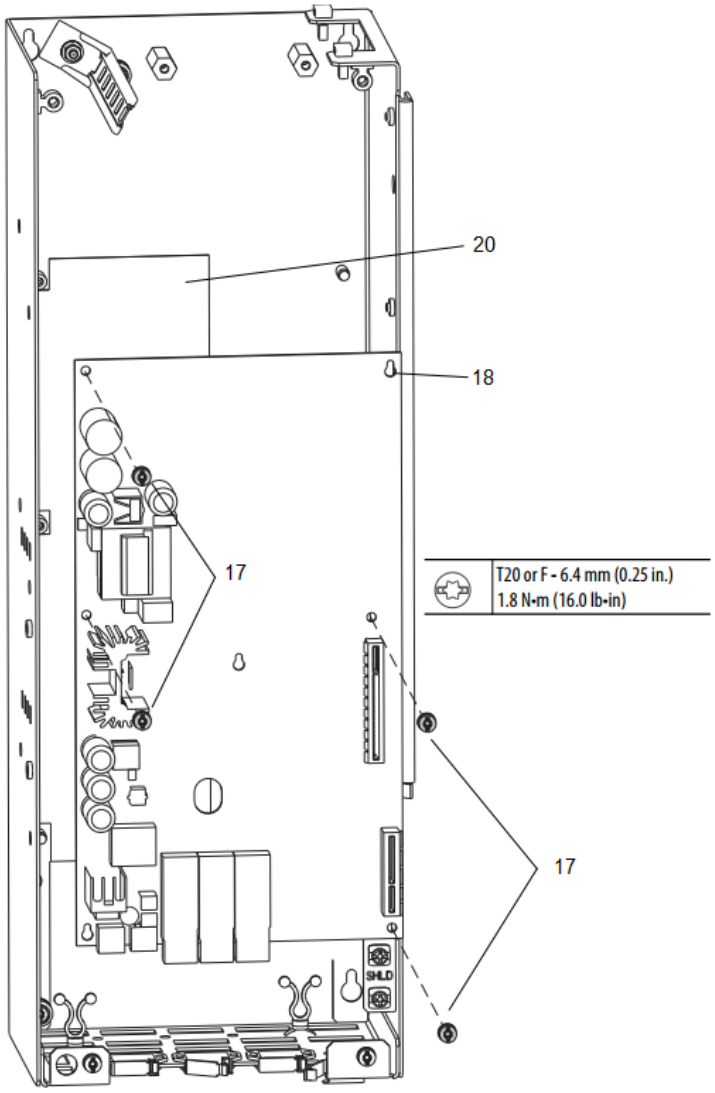


14. Remove the four M4 x 12 mm screws that secure the control pod chassis to the standoffs on the control panel, then remove control pod chassis.
15. Remove all routed wiring and six anchors from the left sidewall of the control panel and move the wiring to the outside of the control panel.
16. Remove the M4 hex stand from the center of the fiber interface circuit board.



17. Remove the four M4 x 10 mm long screws that secure fiber interface board to the control pod.
18. Move the fiber interface board slightly upward toward top of the control pod, so that keyholes on board clear the mounting posts and lift off the board.
19. The right side of the board must clear the mounting tab in the right sidewall of the control pod. Slowly rotate the left side of fiber interface board away from the control pod. Remove the board from the control pod.

20. Inspect the fiber interface board-insulator sheet and replace it if damaged.

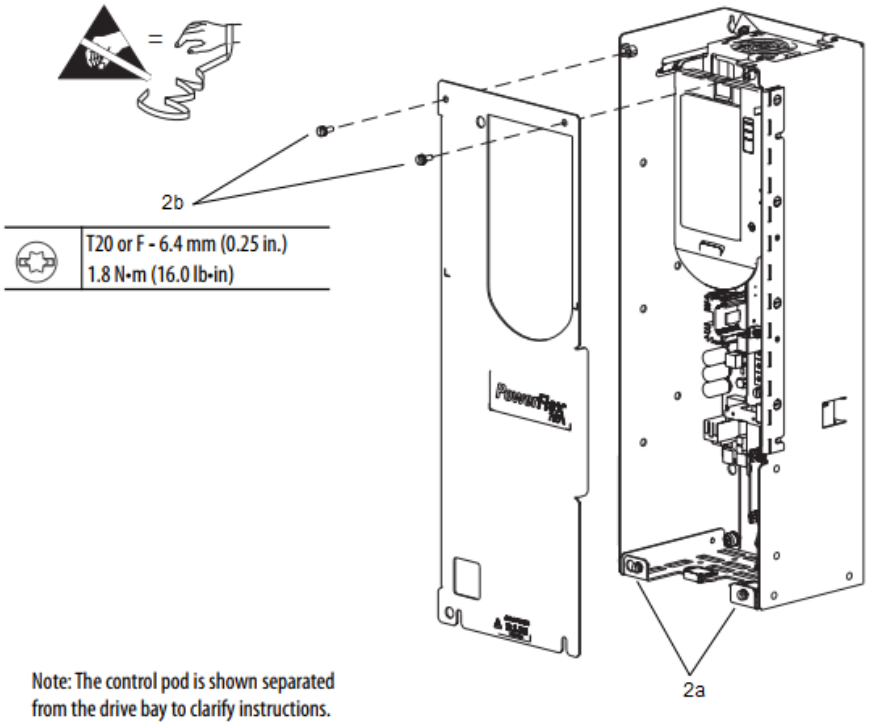


21. Install the new control board in the reverse order of removal.

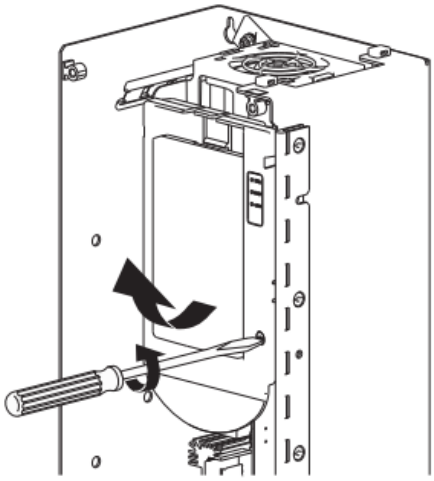
10.6.7 FRAME 8 – MAIN CONTROL BOARD

Part Number: SK-R1-MCB1-F8

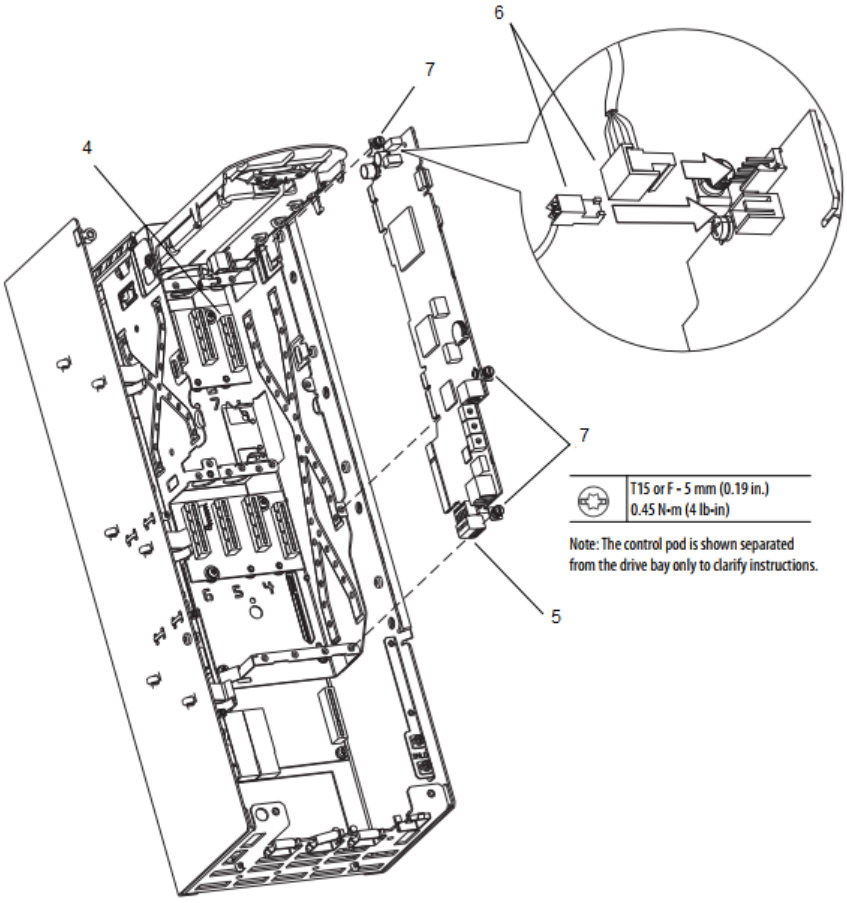
1. Remove power from the drive. See 10.4.1 Frame 8 - Remove Power from the Drive.
2. Remove the control pod cover.
   a. Loosen, but do not remove the bottom two M4 x 12mm slotted hexalobular screws that secure the cover to the assembly.
   b. Remove the top two M4 x 12mm slotted hexalobular screws that secure the cover to the assembly and remove the cover.



3. Loosen the retention screw that secures the HIM cradle to the control pod frame and swing the cradle upward until the latch engages.



4. If installed, remove the option module in slot 7, by loosening the two captive thumb screws on the module and by pulling the board out of the control pod. The torque requirement for installation is the same as for the main control board.
5. Disconnect the plug-in terminal block (TB1) on the main control board.
6. Disconnect the HIM and stirring fan power wire connectors from the main control board.
7. Loosen the three captive thumb screws and remove the board.

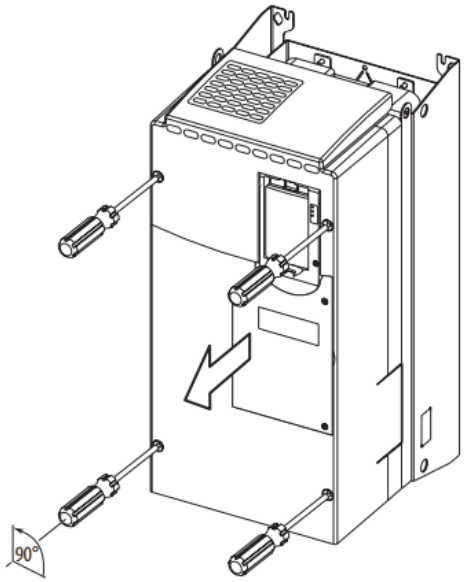


8. Install the main control board in the reverse order of removal.

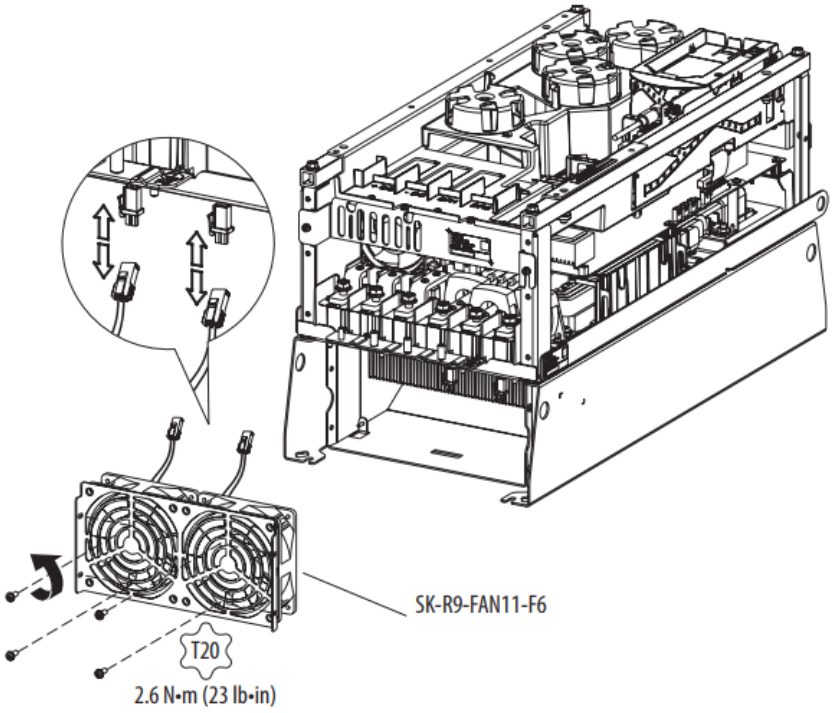
10.7 FRAME 6 AND 7 FAN REPLACEMENT

10.7.1 FRAME 6 DRIVES – FAN REPLACEMENT

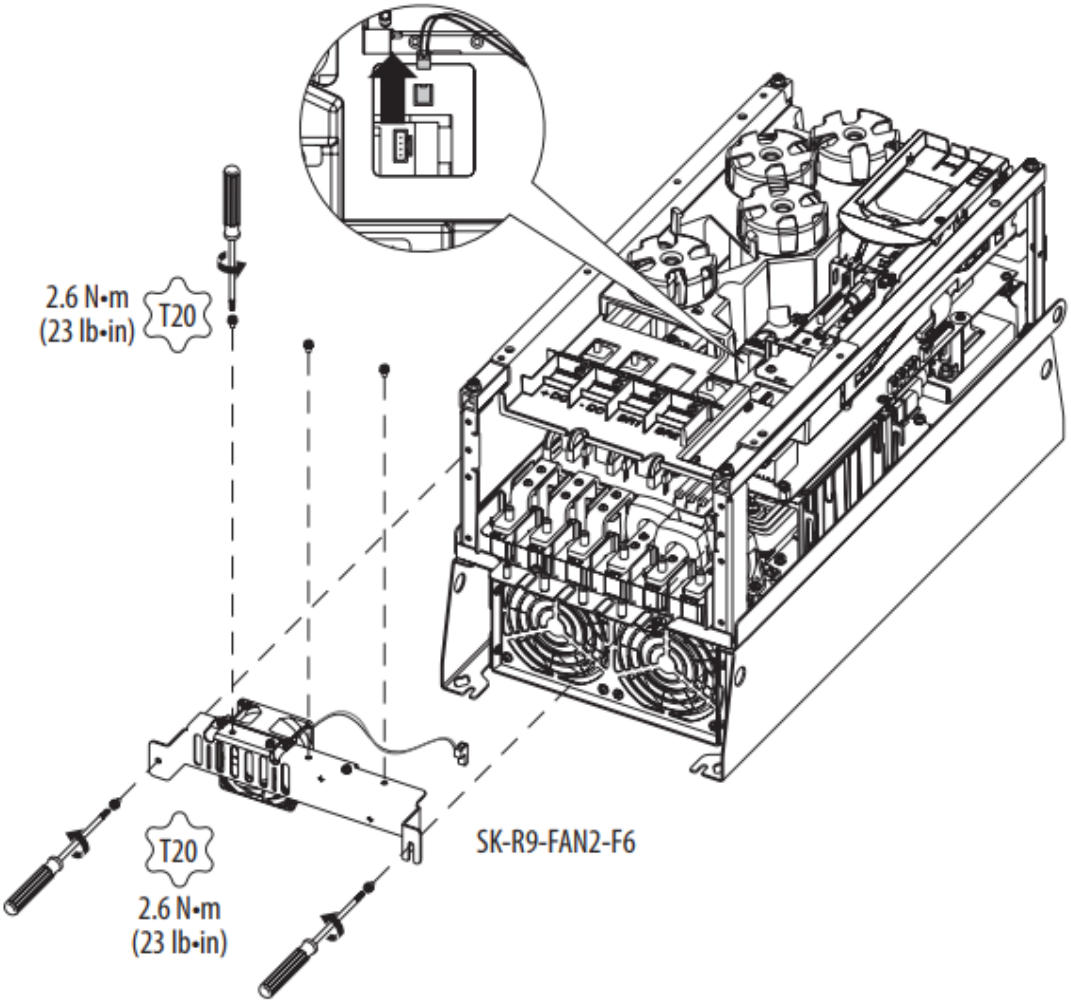
1. Turn off the power. Lock out and tag out the power supply.
2. Using a 9.5mm (0.375 in.) flathead screwdriver, loosen the screws and open the inverter cover.



3. Measure the DC bus bar and make sure it is fully discharged before any further work on the inverter.
4. **Heat sink fan replacement**. Using T20 screwdriver, loosen the screws securing the fan kit. Also remove the two connectors connecting to the fan kit. Replace the heatsink fan *SK-R9-FAN11-F6*. Connect back the connectors and secure the fan kit in place by tightening the screws to 2.6Nm(23lb-in)



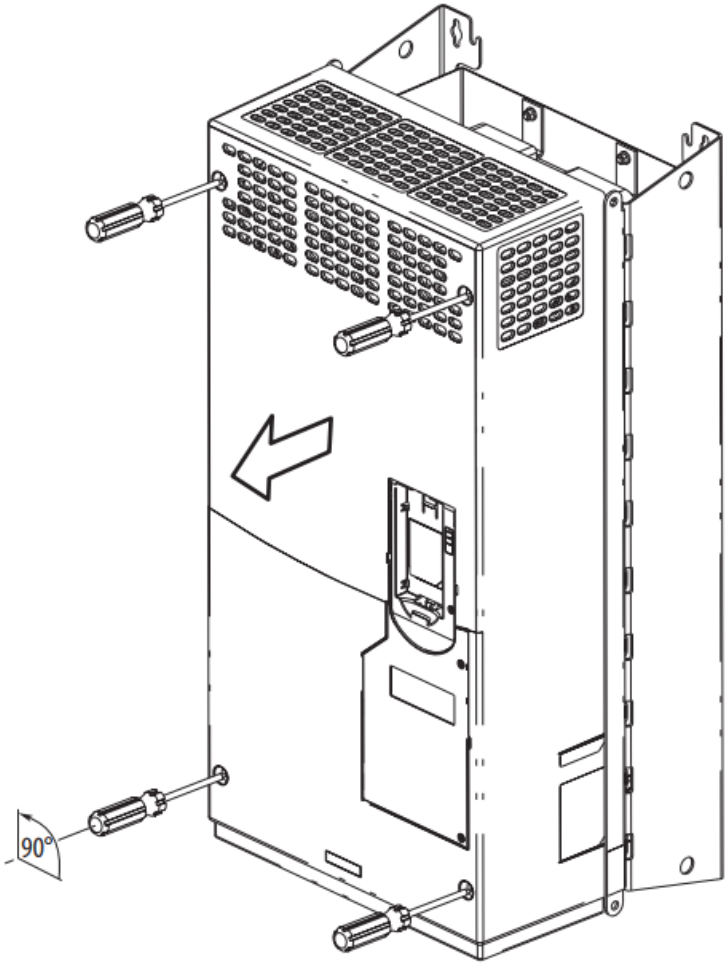
5. **Internal fan replacement**. Using T20 screwdriver, loosen the screws securing the fan kit. Also remove the connector connecting to the fan kit. Replace the internal fan *SK-R9-FAN2-F6*. Reconnect the connector and secure the fan kit in place by tightening the screws to 2.6Nm(23lb-in).



6. Reinstate the inverter in the reverse order of removal.

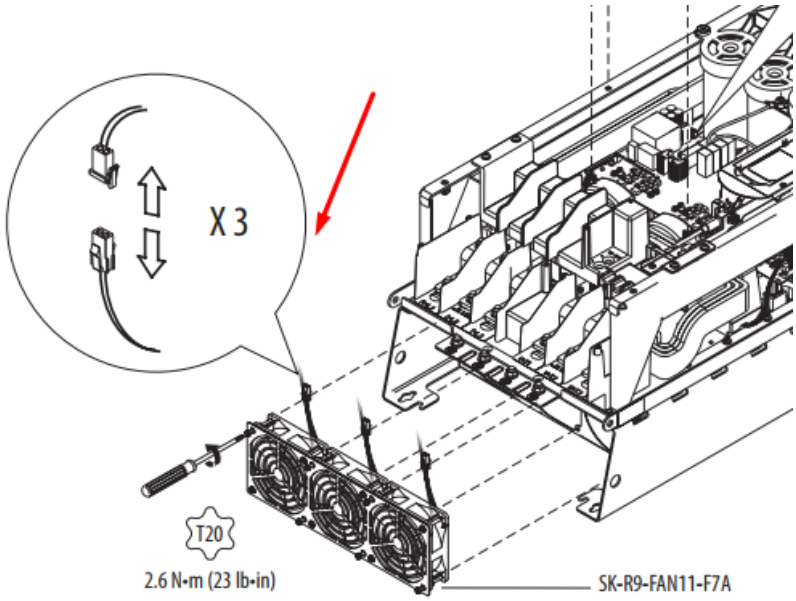
10.7.2 FRAME 7 DRIVES – FAN REPLACEMENT

1. Turn off the power. Lock out and tag out the power supply.
2. Using a 9.5mm(0.375in.) flathead screwdriver, loosen the screws and open the inverter cover.

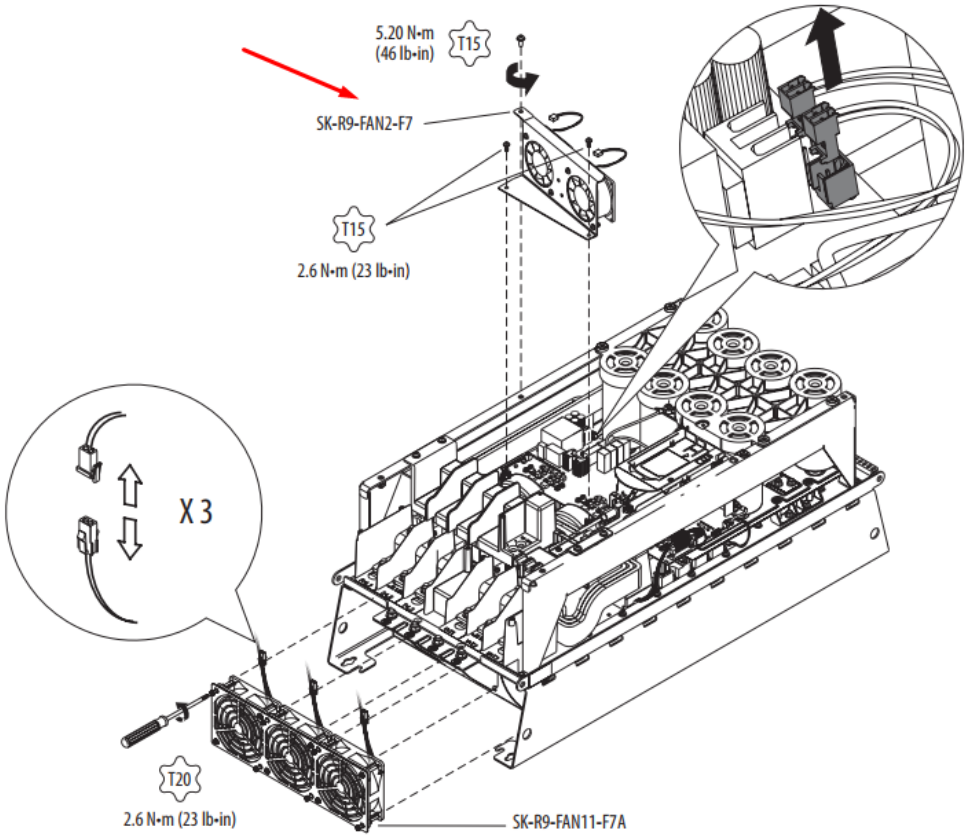


3. Measure the DC bus bar and make sure it is fully discharged before any further work on the inverter.

4. **Heat sink fan replacement**. Using T20 screwdriver, loosen the screw securing the heat sink fan kit. Also remove the three connectors connecting to the fan kit. Replace the heatsink fan *SK-R9-FAN11-F7A*. Connect back the connectors and secure the fan kit in place by tightening the screws to 2.6Nm(23lb-in).

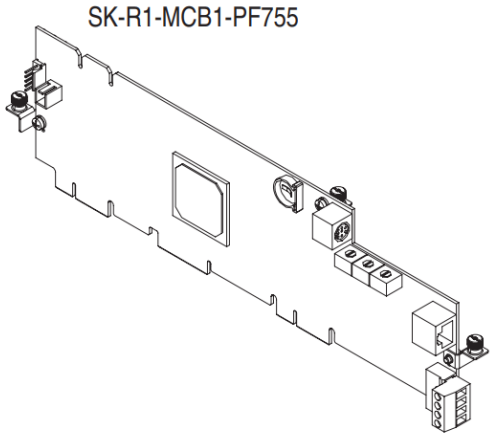


5. **Internal fan replacement.** Using T20 screwdriver, loosen the screws securing the fan kit. Also remove the connectors connecting to the fan kit. Replace the internal fan SK-R9-FAN2-F7. Connect back the connector and secure the fan kit in place by tightening the screws to 2.6Nm(23lb-in) and 5.2Nm(46lb-in) respectively.



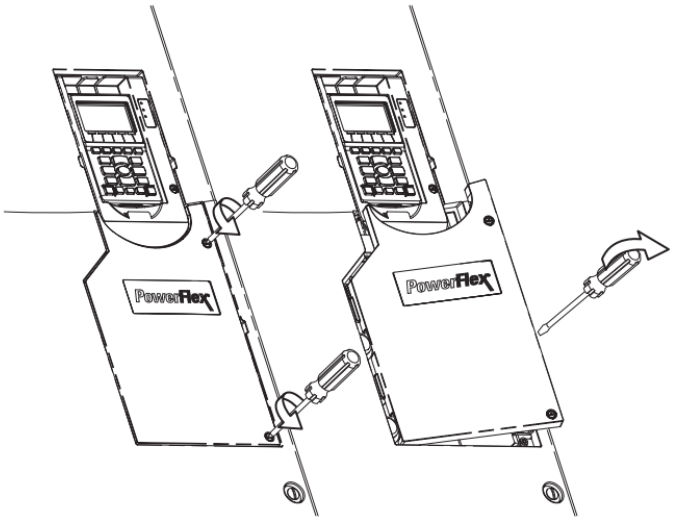
6. Reinstate the inverter in the reverse order of removal.

10.8 FRAME 6 AND 7 – MAIN CONTROL BOARD REPLACEMENT

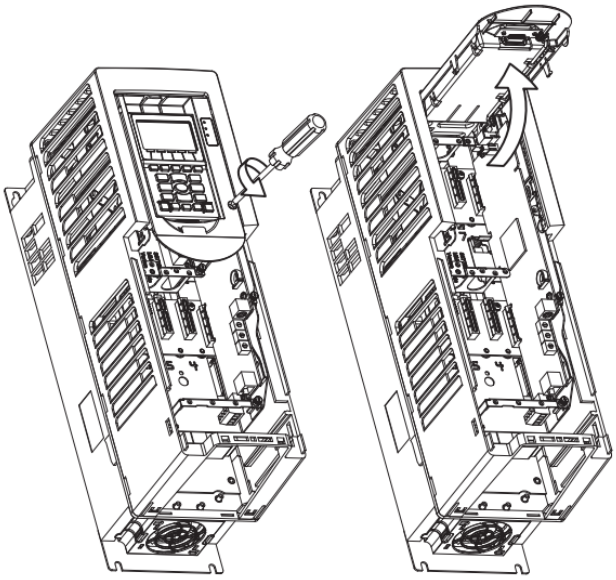


Board PN	Description
SK-R1-MCB1-PF755	PF755 Main Control Board, Frames 2-7

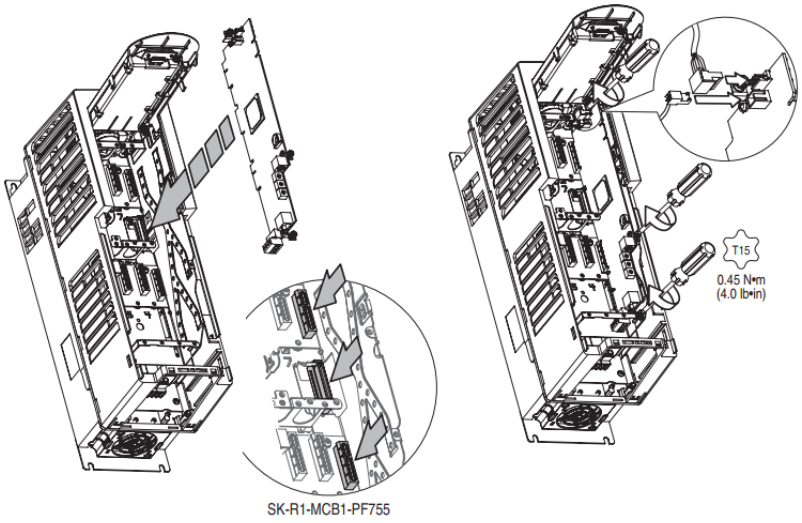
1. Turn off the power. Lock out and tag out the power supply.
2. Measure the DC bus bar and make sure it is fully discharged before any further work on the inverter.
3. Using a 6.4mm(0.25in) flathead or T20 Hexalobular screwdriver, loosen the door screws and gently pry the door open to remove.



4. Loosen the retention screw and lift the cradle until latch engages.



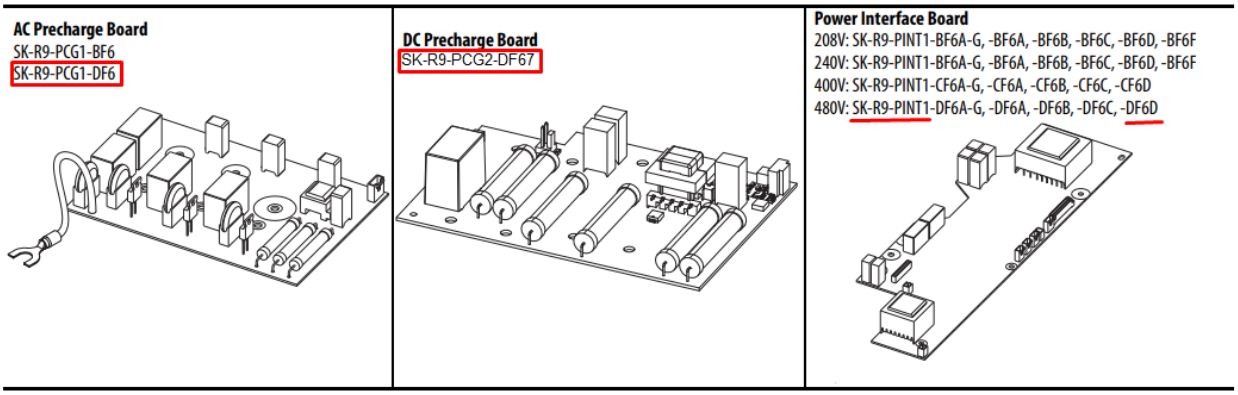
5. To remove the main control board, loosen the captive screws and unplug the connecting cables from the connectors. Replace the main control board, *SK-R1-MCB1-PF755.* Reconnect the cables and secure the board in place by tightening the captive screws to 0.45Nm (4.0lb-in).



6. Reinstate the inverter in the reverse order of removal.

10.9 FRAME 6 AND 7 – PRECHARGE BOARD AND POWER INTERFACE BOARD REPLACEMENT

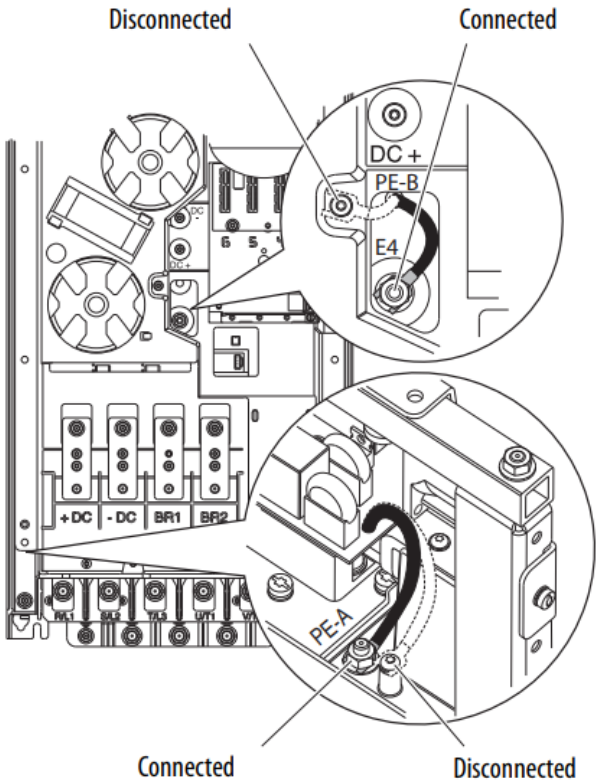
10.9.1 FRAME 6 BOARD PART NUMBERS



Frame	Board PN	Description
6	SK-R9-PCG1-DF6	PF750 Precharge Kit, Frame 6
6 & 7	SK-R9-PCG2-DF67	PF750 Series, DC Precharge Kit, 400/480 V, Frame 6 & Frame 7
6 (248A)	SK-R9-PINT1-DF6D	PF750 Power Interface, 480V, 200HP, Frame 6

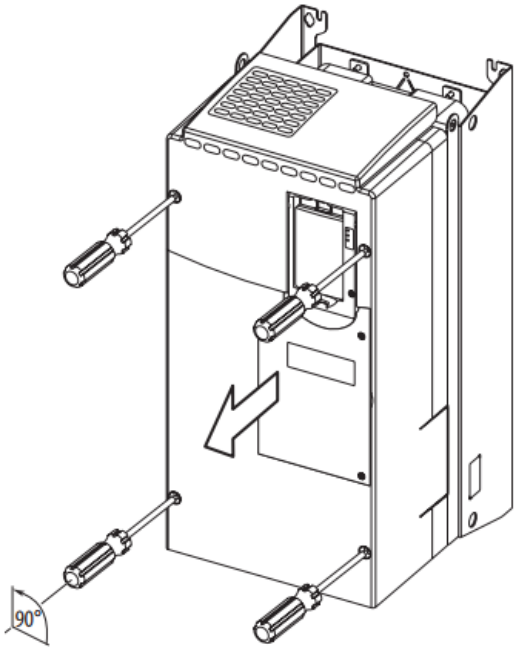
CAUTION

Replacing the Precharge Board and Power Interface Board requires power jumper wires to be disconnected. Note where the PE-A and PE-B jumper wires are terminated before disassembly. Use the same position when installing the replacement board.



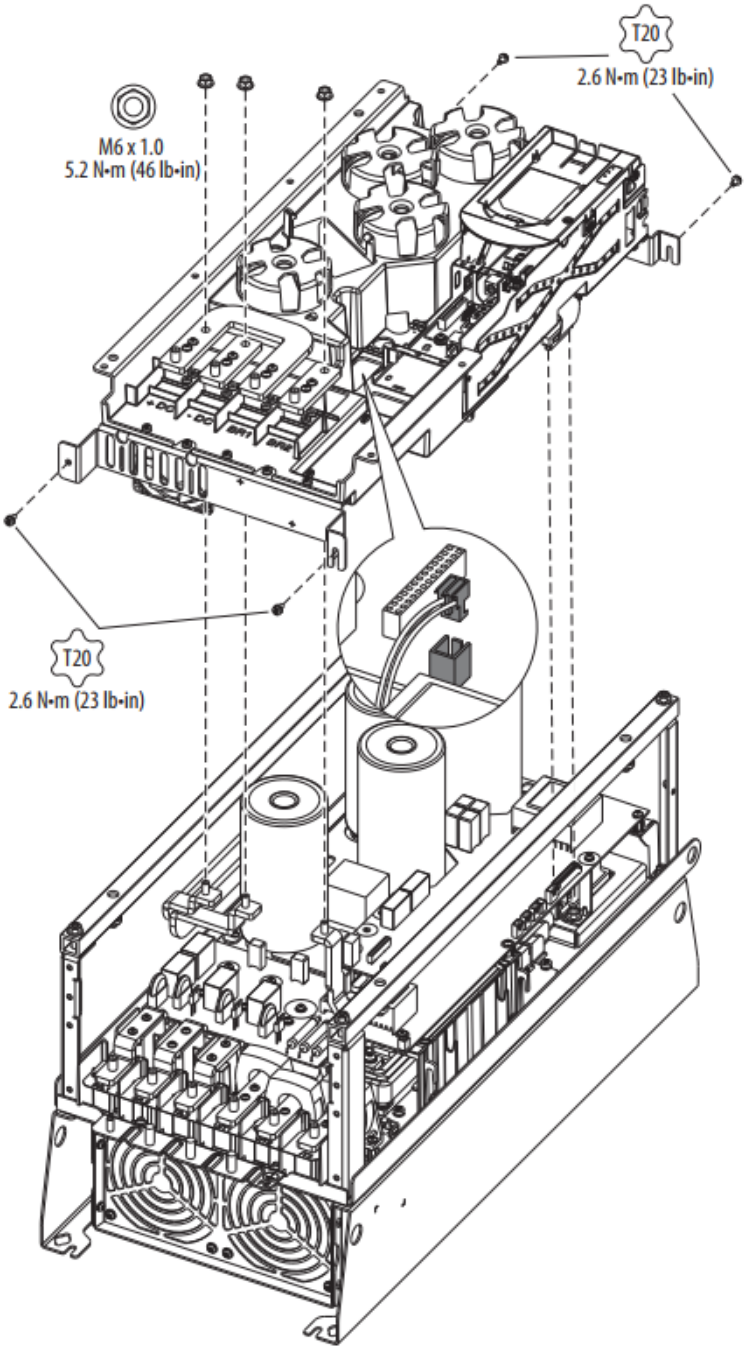
10.9.1.1 Frame 6 Drives – AC and DC Pre-charge Board Replacement Procedures

1. Turn off the power. Lock out and tag out the power supply.
2. Using a 9.5mm (0.375 in.) flathead screwdriver, loosen the screws and open the inverter cover.



3. Measure the DC bus bar and make sure it is fully discharged before any further work on the inverter.

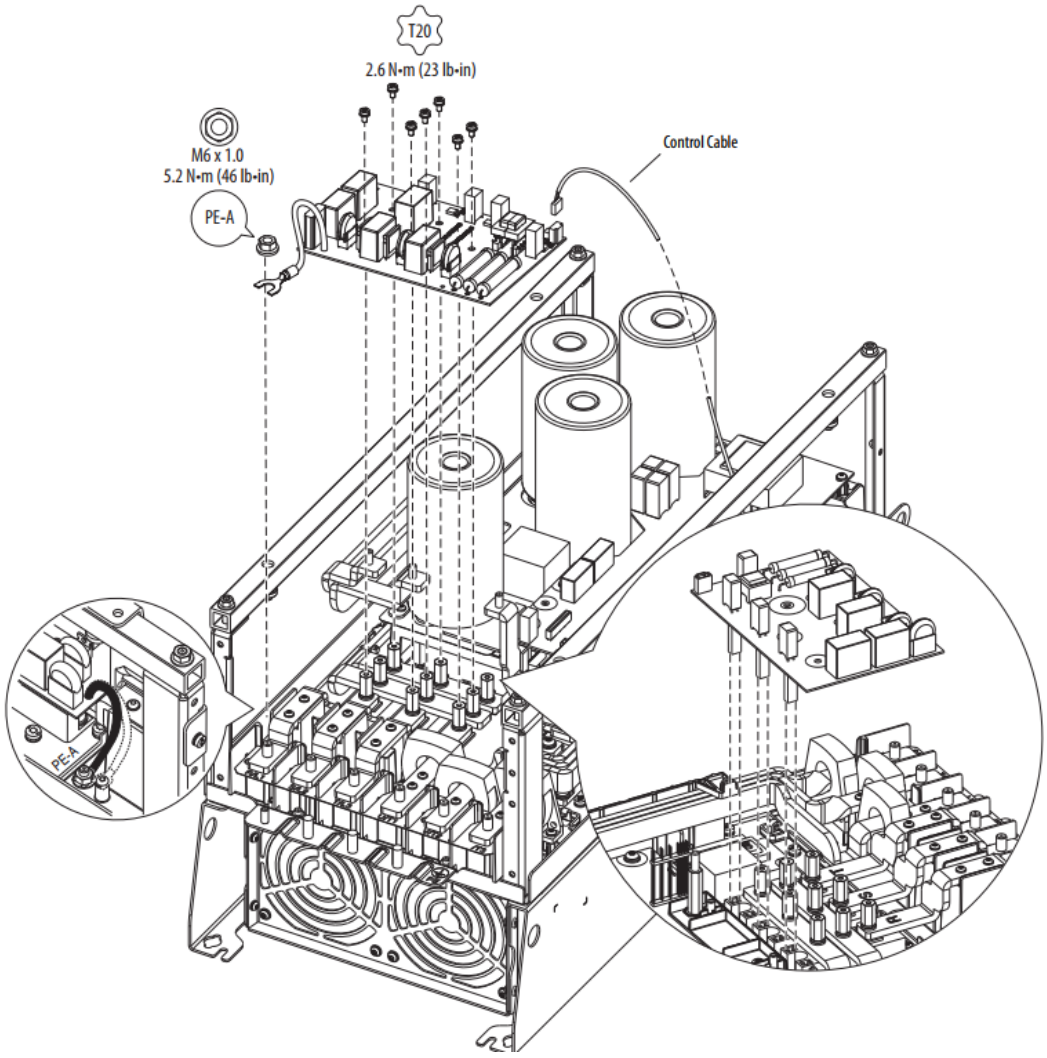
4. To remove the top assembly from the module, (1) loosen the M6 Hex nuts and (2) T20 screws fastening the top assembly, as well as (3) unplug the control cable from its connector.



5. To dismount the Precharge Board, (1) loosen the T20 screws on the Precharge Board, (2) unplug the control cable from its connector and (3) disconnect the power jumper wire.

   Important: Note the position of the PE-A jumper wire before disassembly (AC Precharge Boards only). Use the same position when installing the replacement board.

   Replace the Precharge Board, and (1) reconnect back the control cable, (2) reconnect the power jumper wire, tighten the hex nut to 2.6Nm (23lb.in), (3) secure the Precharge board in place, tighten the screws to 2.6Nm (23lb.in).



CAUTION	Hazard of equipment damage exists if any board connector is not in full contact with its corresponding socket when power is applied. When installing the replacement board, carefully align and fully seat the pin connectors, plug in the control cable, be sure that the PE-A jumper wire is properly terminated (AC Precharge Boards only), and install all fastening screws and torque as indicated.

6. Reinstate the inverter in the reverse order of removal.

10.9.1.2 Frame 6 Drives – Power Interface Board Replacement Procedures

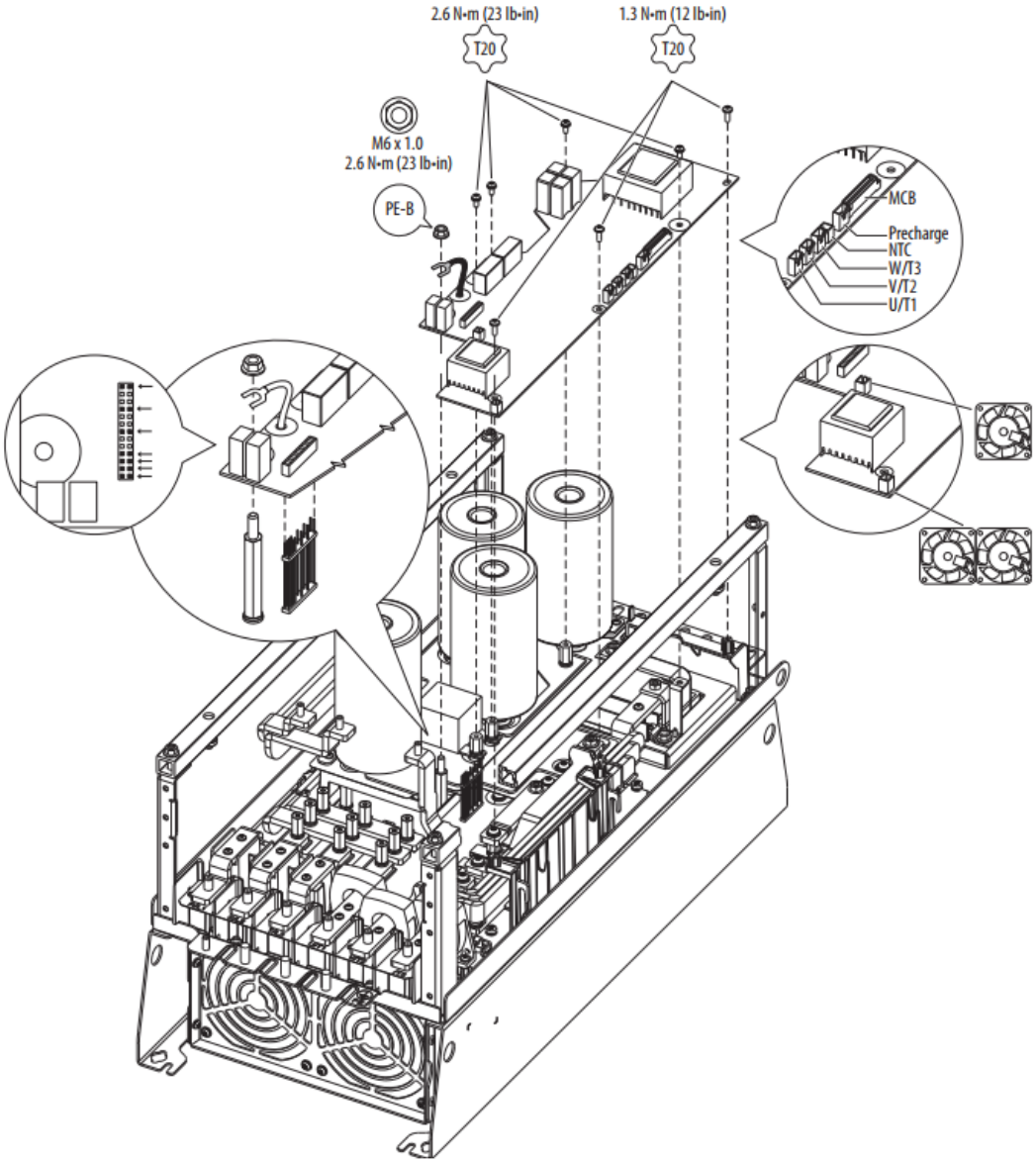
 CAUTION	Replacing the power interface board results in the loss of drive data including elapsed power consumption, elapsed runtimes, and preventive maintenance data.

1. Follow steps 1 to 4 in Section 10.9.1.1.
2. To dismount the Power Interface Board, (1) loosen the T20 screws on the Power Interface Board, (2) unplug the cables from their connectors and (3) disconnect the power jumper wire.

   Important: Note the position of the PE-B jumper wire before disassembly. Use the same position when installing the replacement board.

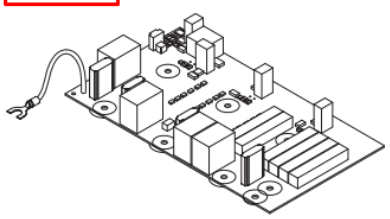
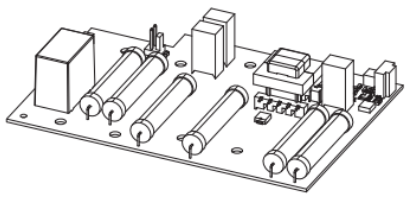
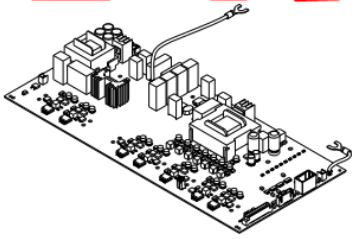
   Replace the Power Interface Board, and (1) reconnect back the control cables, (2) reconnect the power jumper wire, tighten the hex nut 2.6Nm (23lb.in), (3) secure the Power Interface Board in place, tighten the screws to 2.6Nm(23 lb-in) and 1.3Nm(12 lb-in) respectively according to the diagram below.

 CAUTION	Hazard of equipment damage exists if any board connector is not in full contact with its corresponding socket when power is applied. When installing the replacement board, be sure that the pin connector is aligned, all plugs are fully seated the PE-B jumper wire is properly terminated, and all fastening screws are installed and torques as indicated.



3. Reinstate the inverter in the reverse order of removal.

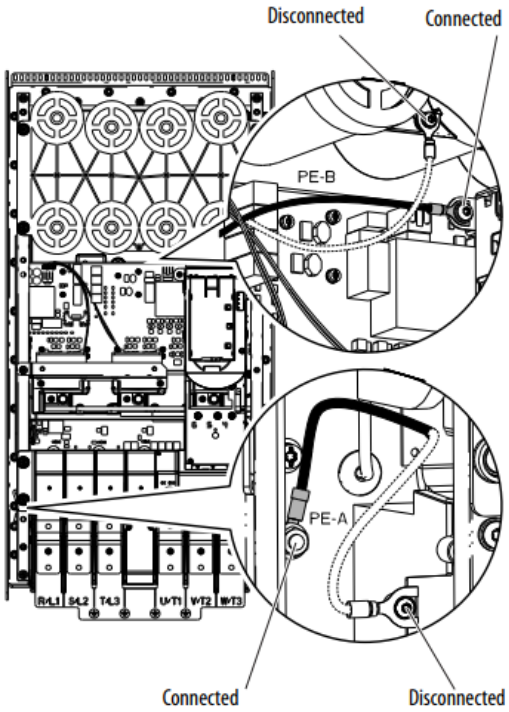
10.9.2 FRAME 7 BOARD PART NUMBERS

AC Precharge Board	DC Precharge Board	Power Interface Board
SK-R9-PCG1-BF7 SK-R9-PCG1-DF7	SK-R9-PCG2-DF67	208V: SK-R9-PINT2-BF7A-G, -BF7A, -BF7B, -BF7C 240V: SK-R9-PINT2-BF7A-G, -BF7A, -BF7B, -BF7C 400V: SK-R9-PINT2-CF7A-G, -CF7A, -CF7B, -CF7C, -CF7D 480V: SK-R9-PINT2-DF7A-G, -DF7A, -DF7B, -DF7C, -DF7D
		

FRAME	BOARD PN	DESCRIPTION
7	SK-R9-PCG1-DF7	PF750 Precharge Kit, Frame 7
6 & 7	SK-R9-PCG2-DF67	PF750 Series, DC Precharge Kit, 400/480 V, Frame 6 & Frame 7
7 (361A)	SK-R9-PINT2-DF7B	PF750 Power Interface, 480V, 300HP, Frame 7
7 (477A)	SK-R9-PINT2-DF7D	PF750 Series, Power Interface, Frame 7, 480V, 400HP 477A ND

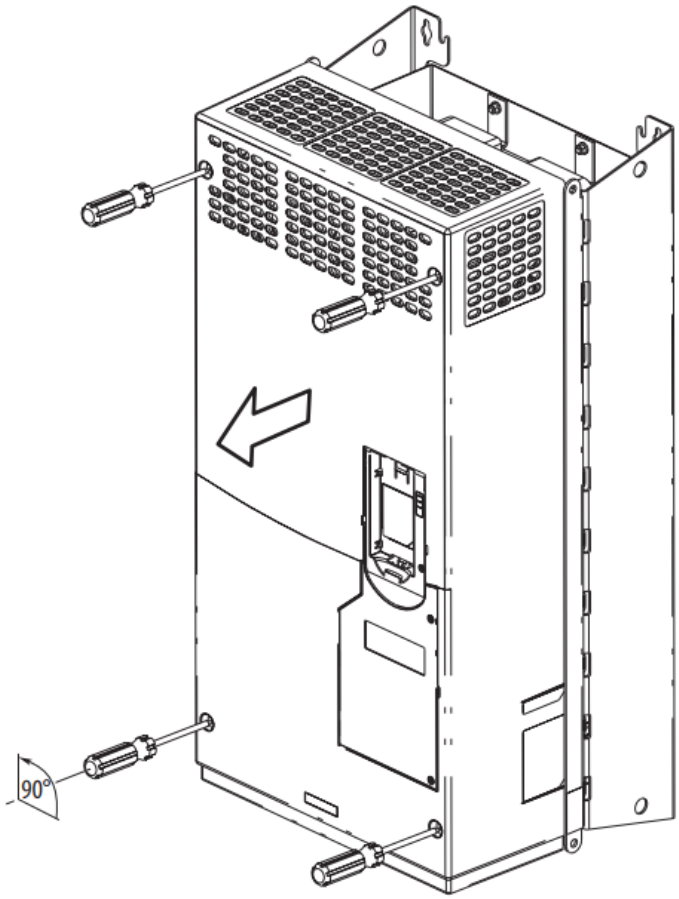
CAUTION

Replacing the Precharge Board and Power Interface Board requires power jumper wires to be disconnected. Note where the PE-A and PE-B jumper wires are terminated before disassembly. Use the same position when installing the replacement board.



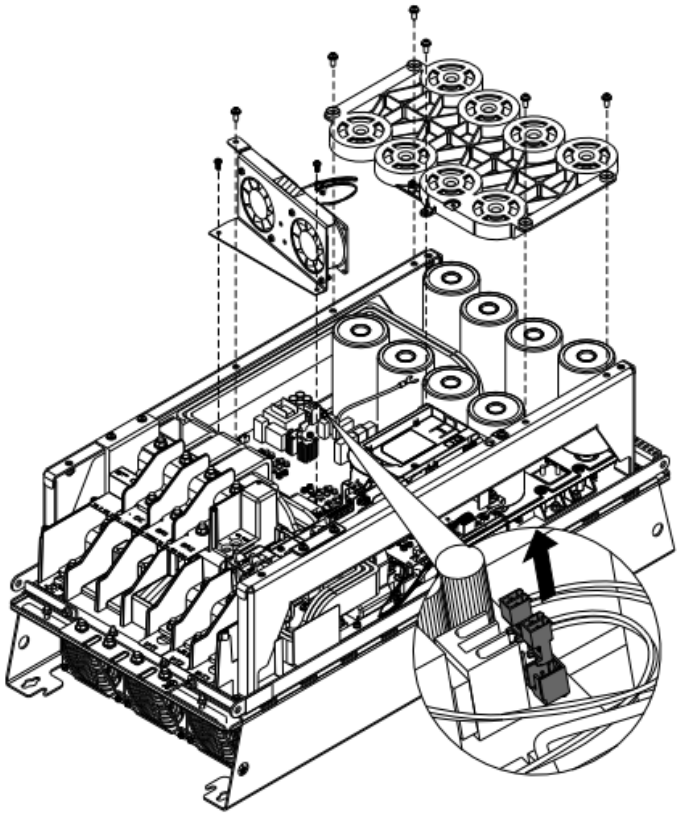
10.9.2.1 Frame 7 Drives – AC and DC Precharge Board Replacement Procedures

1. Turn off the power. Lock out and tag out the power supply.
2. Using a 9.5mm (0.375 in.) flathead screwdriver, loosen the screws and open the inverter cover.

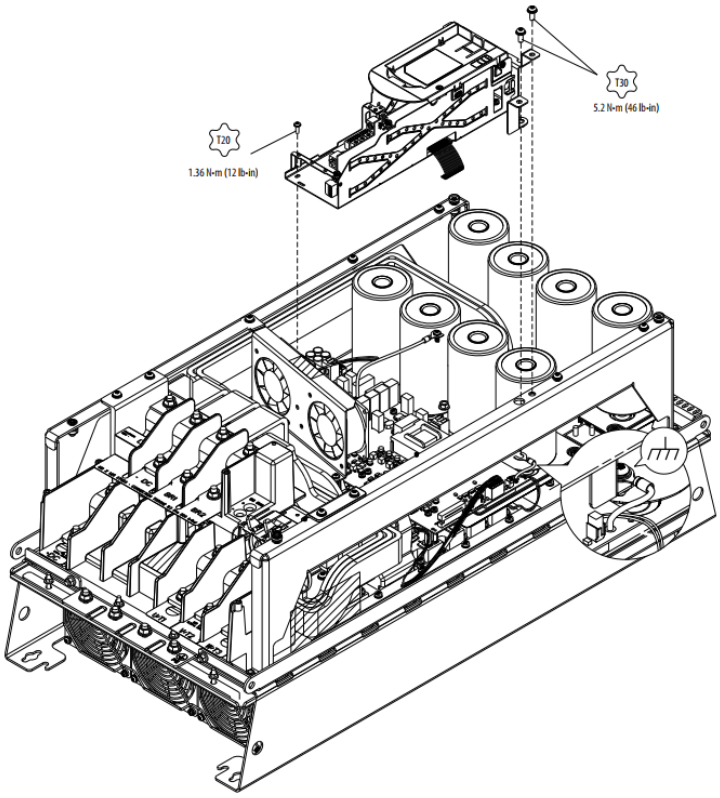


3. Measure the DC bus bar and make sure it is fully discharged before any further work on the inverter.

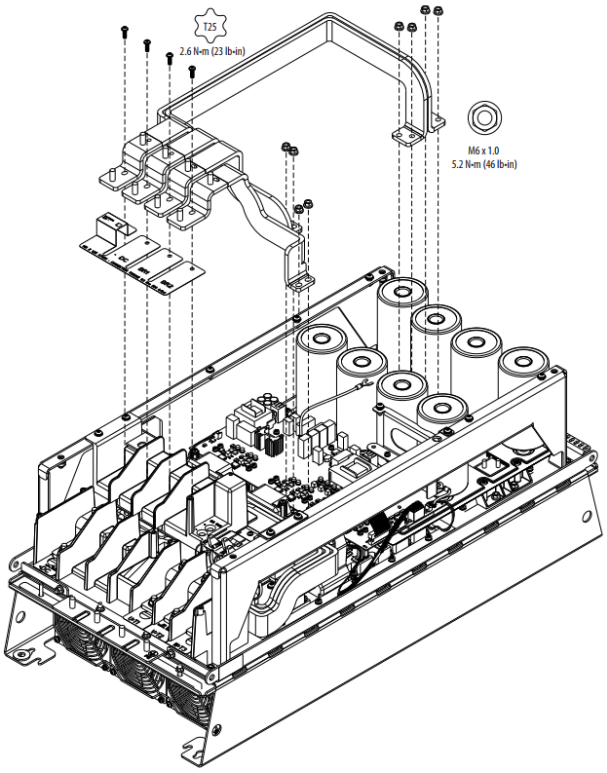
4. Loosen the screws fastening the internal fan and capacitor cover. Unplug the fan cables from the connectors. Remove the fan assembly and capacitor cover from the inverter module.



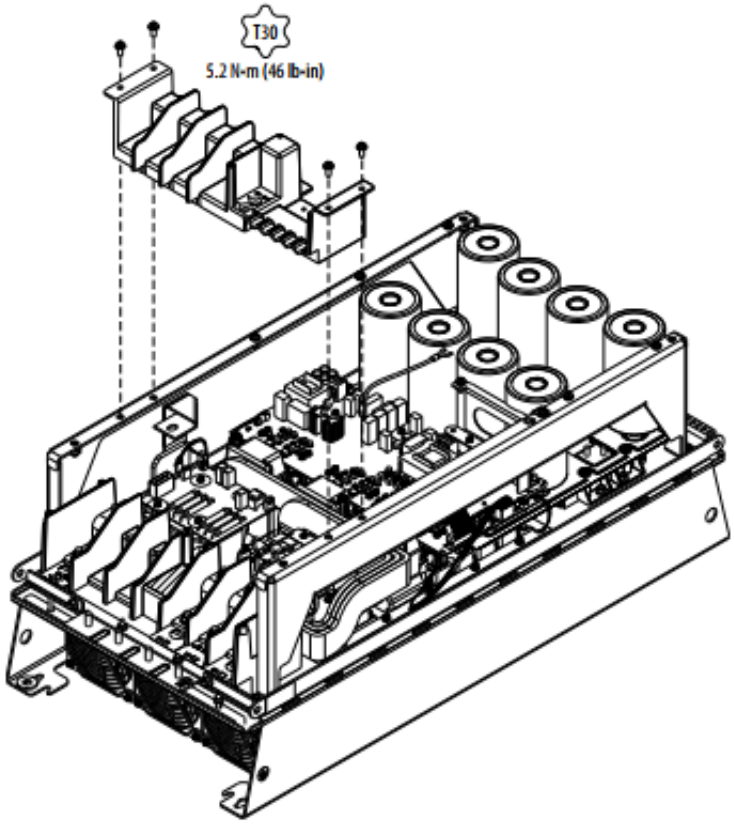
5. Loosen the T20 and T30 screws fastening the control pod. Disconnect the earth cable connecting to the control pod. Remove the control pod from the inverter module.



6. Loosen the T25 screws and the M6 hex nuts fastening the DC buses. Remove the DC buses from the inverter module.



7. Loosen the T30 screws fastening the DC bus terminals. Remove the DC bus terminals from the inverter module.

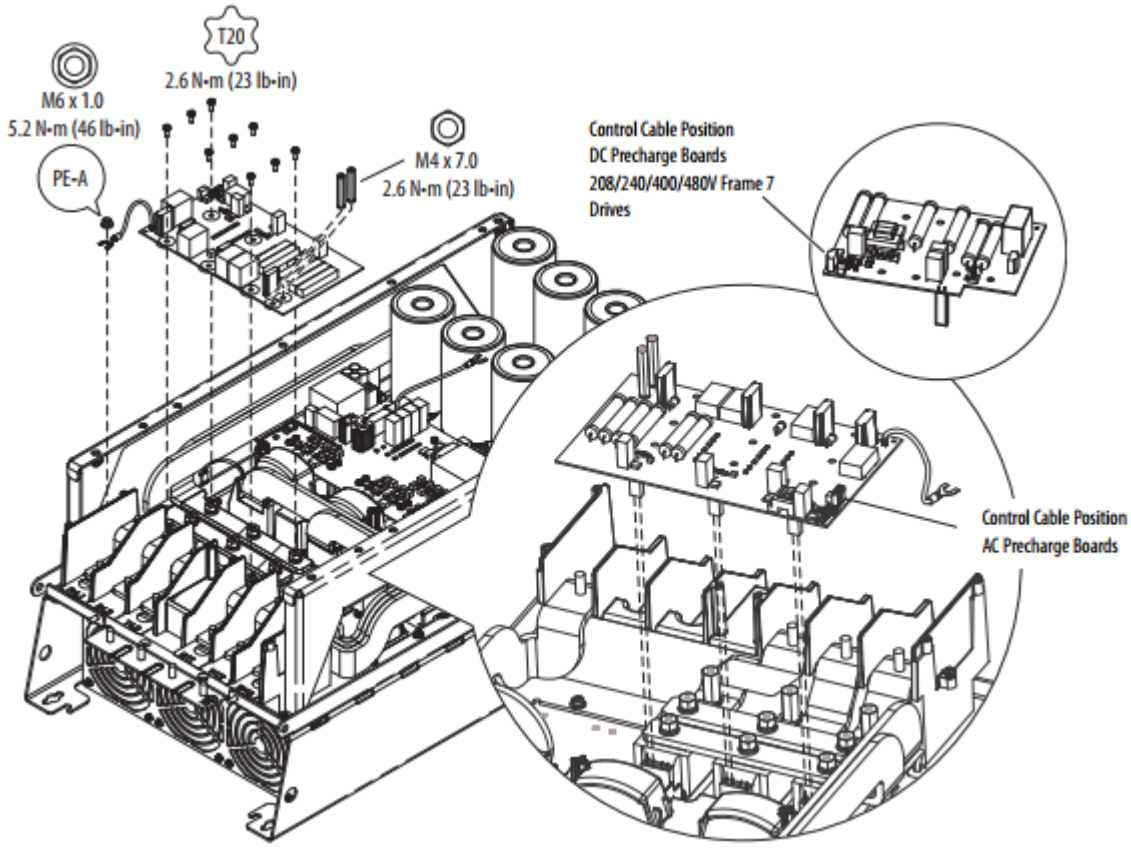


8. To dismount the Precharge Board, (1) loosen the T20 screws fastening the Precharge board, (2) loose the stand-off on the Precharge board, (3) unplug the control cable from the connector and (4) disconnect the power jumper wire.

   Important: Note the position of the PE-A jumper wire before disassembly (AC Precharge Boards only). Use the same position when installing the replacement board.

   Replace the Precharge Board, and (1) reconnect back the control cable, (2) reconnect the power jumper wire, tighten the hex nut to 5.2Nm (46lb.in), (3) secure the Precharge board in place, tighten the screws to 2.6Nm (23lb.in), (4) tighten the stand-off back to Precharge board to 2.6Nm (23lb.in).

CAUTION	Hazard of equipment damage exists if any board connector is not in full contact with its corresponding socket when power is applied. When installing the replacement board, carefully align and fully seat the pin connectors, plug in the control cable, be sure that the PE-A jumper wire is properly terminated (AC Precharge Boards only), and install all fastening screws and torque as indicated.



9. Reinstate the inverter in the reverse order of removal.

10.9.2.2 Frame 7 Drives – Power Interface Board Replacement Procedures

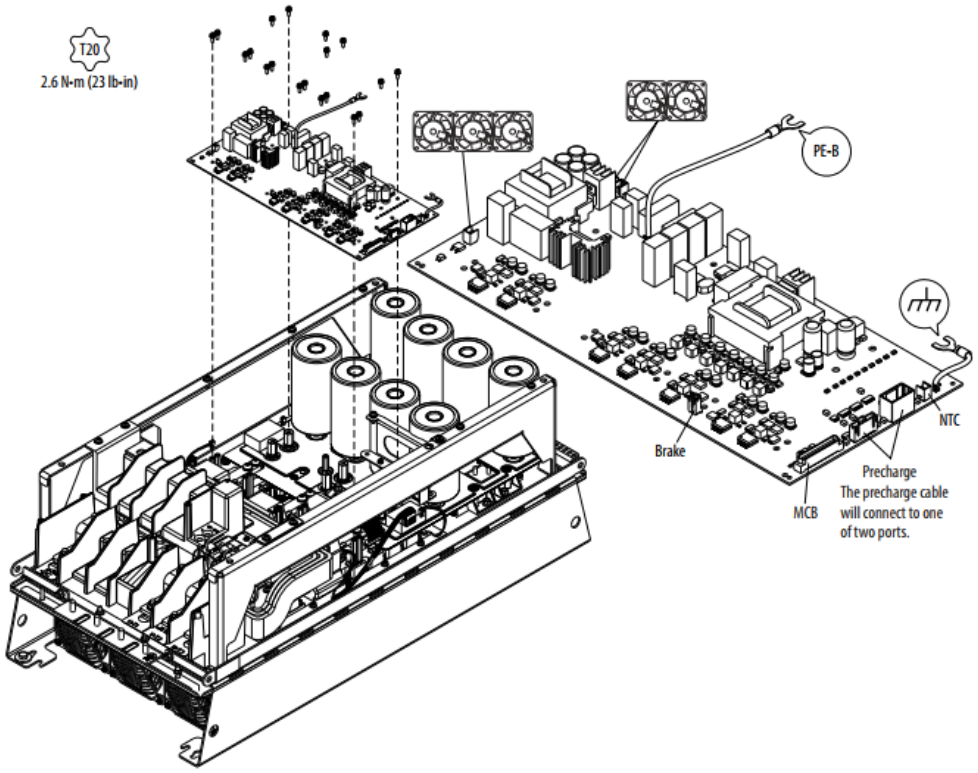
CAUTION	Replacing the power interface board results in the loss of drive data including elapsed power consumption, elapsed runtimes, and preventive maintenance data.

1. Follow steps 1 to 5 in Section 0.
2. To dismount the Power Interface Board, (1) loosen the T20 screws on the Power Interface Board, (2) unplug the cables from their connectors and (3) disconnect the power jumper wire and earth wire.
   Important: Note the position of the PE-B jumper wire before disassembly.

   Use the same position when installing the replacement board.

   Replace the Power Interface Board, and (1) reconnect back the control cables, (2) reconnect the power jumper wire and earth wire, tighten the hex nut 5.2Nm (46lb.in), (3) secure the Power Interface Board in place, tighten the screws to 2.6Nm(23 lb-in) according to the diagram below.

CAUTION	Hazard of equipment damage exists if any board connector is not in full contact with its corresponding socket when power is applied. When installing the replacement board, be sure that the pin connector is aligned, all plugs are fully seated the PE-B jumper wire is properly terminated, and all fastening screws are installed and torques as indicated.



3. Reinstate the inverter in the reverse order of removal.

10.10 REFORMING THE CAPACITORS

For drives that are in storage and do not have a voltage applied, maintenance of the capacitors in a drive product can also be required (See Figure 10-3). For drives that are stored for less than one year, no additional maintenance is required. For storage greater than one year, see Table 10-5: Drive Storage Duration and Reforming Recommendation for bus capacitor reforming requirements.

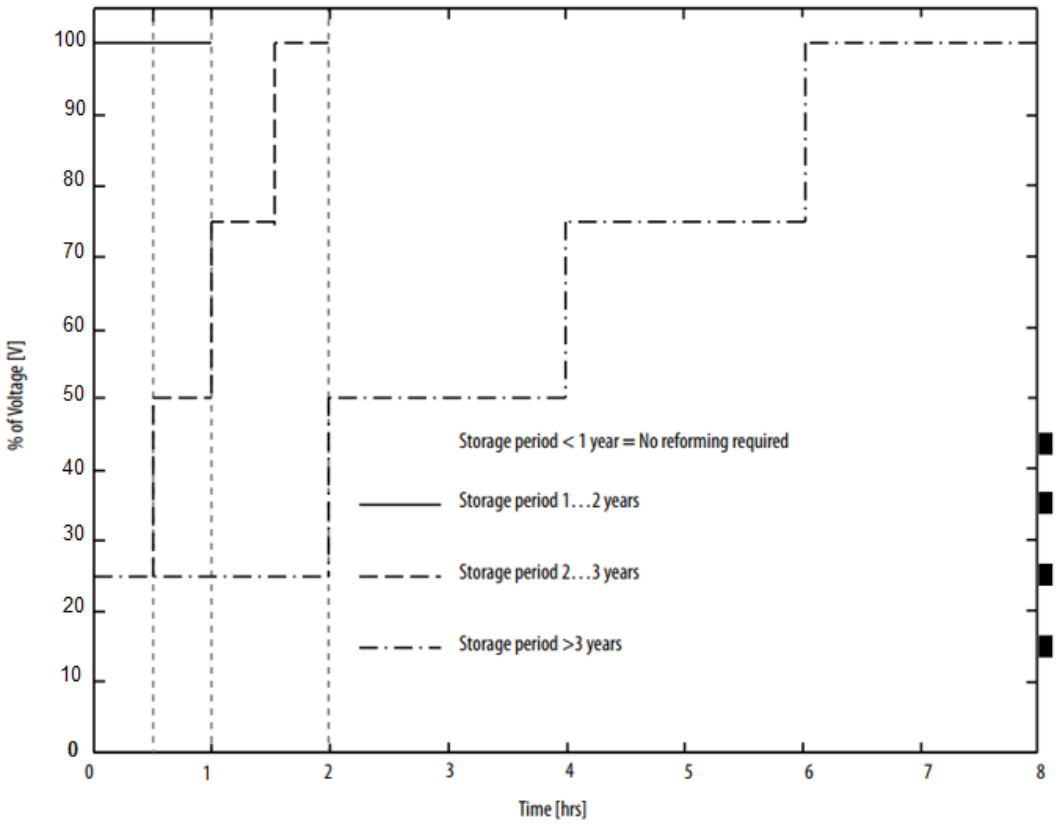


Figure 10-3: Bus Capacitor Reforming Guidelines

Table 10-5: Drive Storage Duration and Reforming Recommendation

DURATION	GUIDELINE(1)(2)
Under 1 year	No reforming required.
1–2 years	Apply rated voltage, per the normal method, for 60 minutes under no load.
2–3 years	Using a DC power supply that is connected directly to the DC terminals of the product, ramp-up voltage from 0…100% of DC bus voltage (see Table 10-6) in steps of 25%. Dwell at 25%, 50%, and 75% steps for 30 minutes each. At 100% voltage, dwell for 60 minutes, all under no load.
Over 3 years	Using DC power supply connect directly to the DC terminals of the product, ramp-up voltage from 0…100% of DC bus voltage (see Table 10-6) in steps of 25%. Dwell at each stem for 120 minutes.

(1) *The forming voltage must be 1.35…1.45 times the rated AC system voltage.*
(2) *The power supply current draw must not exceed 50 mA.*

Table 10-6: DC Bus Voltage Ramp-up Values

AC INPUT VOLTAGE	VOLTAGE ACROSS THE DC BUS
230V	325V DC
400/480V	680V DC
600V	848V DC
600/690V	976V DC

10.11 MOTOR CONTROLLER MAINTENANCE

Refer to the controller manual for detailed maintenance routines that should be performed periodically or as required: *INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576).

Section 11: **Troubleshooting**

This section provides troubleshooting procedures for drives that are in service and must be tested or are malfunctioning. These procedures are intended to help the field user identify which part of the drive is malfunctioning. Any attempted repairs to a VSD should be performed in conjunction with InTouch Support when necessary and should be performed by qualified personnel only as defined in the note that follows.

 CAUTION	**Potential Severity: Light** **Potential Loss: Assets, Personnel, Reputation** **Hazard Category: Electrical, Explosives, Machinery equipment hand tools** Troubleshooting or servicing a Sensia VSD must be performed by qualified personnel. *Qualified personnel* are defined as those who have attended and successfully completed the required training. Completion of the training course is NOT a substitute for field experience. Course-trained personnel should be accompanied and mentored by experienced personnel until deemed competent to work unsupervised. Qualified personnel should have their course reference material on hand. Only then should they contact InTouch Support for additional support and troubleshooting/repair instructions.

11.1 REQUIRED TROUBLESHOOTING EQUIPMENT AND TOOLS

Before attempting any troubleshooting procedures, ensure that the personnel assigned to the job have the required troubleshooting equipment and tools. Refer to 8.1 Required Start-up Equipment and Tools.

11.2 CAPTURING DRIVE DATA

The first steps in starting up or troubleshooting a VSD system are to capture all equipment and personnel contact data from the drive system.

1. Download the log file from the controller.

   For the controller, download both the .**H5** and site (.**ste**) files from the controller.

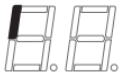
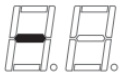
2. Refer to Figure 11-2: Application Data and Issue Identification Table (p. 1 of 2) for the required information to be saved about the VSD and system.

   These are essential tools in troubleshooting the drive and are necessary for problem identification. Refer to this data when contacting LCS Engineering or InTouch Support for further assistance.

NOTE	If the drive that you are troubleshooting fails or does not perform as expected, complete the questions found on In Touch 4202020 and contact InTouch Support for assistance.

NOTE

Frame 8 and larger drives provide a pair of 7-segment displays to indicate drive status and conditions.

Lit Segment	Indication	Description
	PWM Enable	IGBT gating is enabled. IGBT gating is enabled by setting bit 0 of the Config Register. IGBT gating is disabled by clearing bit 0 or by fault.
	Fault	Indicates that a fault condition exists.
	Initialization Done	Indicates that the control has initialized the PLI board.
	Fiber Loss	Actual state of the LOS pin. LOS is driven high when the optical power into the fiber-optic receiver is too low (broken, crimped, disconnected fiber, or transmitter at opposite end of fiber is not operating.
	On Line	The PLI is powered.
	System Safety Enable B	Pin 1 of the 541 PLI IGBT driver chip (U14) is low. This pin must be low to fire the IGBTs.
	Aux Power	A 24V auxiliary supply provide power for the PLI board.

11.3 PRELIMINARY POWER-UP CHECKS

Perform the following checks *before* applying any power to the drive.

Potential Severity: Major

Potential Loss: Personnel, Reputation

Hazard Category: Electrical, Explosives

Use appropriate lockout/tag out procedures (refer to SEN-HSE-S027) to ensure that VSD power is OFF before proceeding with the following checks and procedures.
Use a VOM to verify that ALL power is OFF on the drive, including.

- Incoming lines at the bottom of the circuit breaker
- Motor terminals
- The DC bus

Table 11-1: Power-up Checklist

ITEM	DESCRIPTION	CHECK (✓)
1	The ambient operating conditions meet the specifications.	
2	The drive cabinet has been fixed to floor, and if necessary due to vibration, etc., also from its top to the wall or roof.	
3	The cooling air will flow freely in and out of the drive cabinet.	
4	If the drive has been stored over one year, verify that the electrolytic DC capacitors in the DC link of the drive have been reformed.	
5	There is an adequately sized protective earth (ground) conductor between the drive and the switchboard, and the conductor has been connected to appropriate terminal, and the terminal has been tightened. (Pull the conductor to check.) Proper grounding has also been measured according to the regulations.	
6	The input power cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.)	
7	There is an adequately sized protective earth (ground) conductor between the motor and the drive, and the conductor has been connected to appropriate terminal, and the terminal has been tightened. (Pull on the conductors to check.) Proper grounding has also been measured according to the regulations.	
8	The motor cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull on the conductors to check.)	
9	The motor cable (and brake resistor cable, if present) has been routed away from other cables.	
10	No power factor compensation capacitors have been connected to the motor cable.	
11	The control cables have been connected to the appropriate terminals, and the terminals have been tightened. (Pull on the conductors to check.)	
12	The supply voltage matches the nominal input voltage of the drive. Check the type of designation label.	
13	The voltage setting of the control power transformers is correct.	
14	The power jumper configuration is correct to the type of power source.	
15	If a drive bypass connection will be used: The direct-on-line contactor of the motor and the drive output contactor are either mechanically or electrically interlocked, i.e., cannot be closed simultaneously.	
16	There are no tools, foreign objects or dust from drilling inside the drive.	
17	The area in front of the drive is clean: the drive cooling fan cannot draw any dust or dirt inside.	
18	All shrouds and cover of the motor connection box are in place. Cabinet doors have been closed.	

ITEM	DESCRIPTION	CHECK (✓)
19	The motor and the driven equipment are ready for start.	

11.4 DRIVE RESET

Refer to the *LCS-ENG-M0005 INSTRUCT ESP Controller-E30 Drive Configuration Manual*

11.5 TROUBLESHOOTING THE CONTROLLER

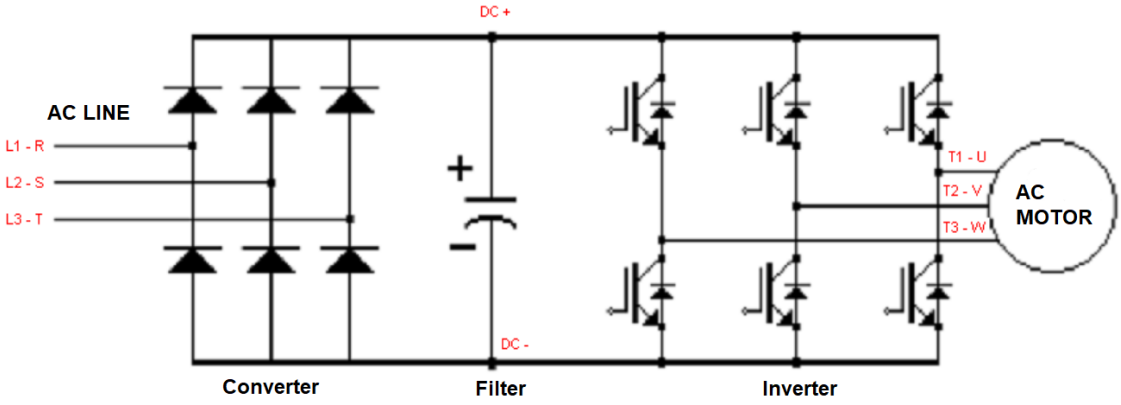
Refer to the controller manual for detailed troubleshooting information: *INSTRUCT ESP Intelligent Controller Manual* (InTouch ID 6128576).

11.6 FORWARD AND REVERSE BIASED SCR/DIODE TEST

This section contains procedures for performing both forward and reverse biased SCR/diode tests on the major power components of the drive. A failed test indicates damage to the components in the converter or inverter and requires replacement.

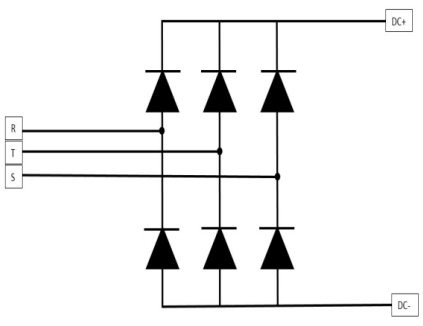
The power structure of an AC drive consists of diodes or SCRs on the input and IGBTs on the output. Diodes will go into conduction between 0.3 V - 0.7 V when forward biased and read OL (open circuit) when reverse biased. SCRs will read O.L. in forward or reverse bias. Meanwhile, IGBTs can be tested by measuring the flyback diode that is reverse biased across the IGBT. Therefore, all readings described below are done with a digital multi meter in diode test mode.

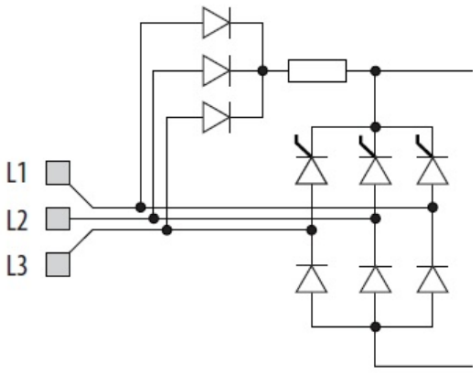
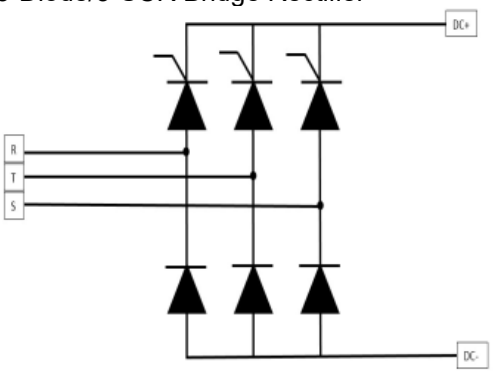
Schematic below shows the basic power structure of the drive and terminals.



Depending on the frame size, the components that make up the converter will differ and thus have different measurements. Following is the summary of the different converter construction for PowerFlex 755 modules:

Frame 1-4	6-Diode Bridge Rectifier



Frame 5-7	3-Diode/3-SCR Bridge Rectifier with Precharge Diodes 
Frame 8-10	3-Diode/3-SCR Bridge Rectifier 

11.6.1 PROCEDURES

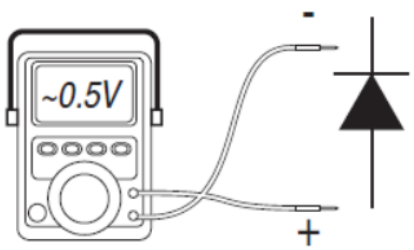
1. Remove power from the drive and wait for the drive to completely power down.
2. Open drive enclosure door to gain access to the module.
3. Verify DC bus is near 0 VDC by measuring from DC+ to DC- terminals.
4. Remove the control transformer primary fuses, FU4 and FU5 (applicable only to frame 8 to 10 drives).
5. Disconnect motor leads (U, V, and W) at the drive's terminals.
6. Disconnect line side leads (R, S, and T) at the drive's terminals.
7. It may be necessary to insert insulating material between U, V, and W to ensure these terminals do not make contact to receive accurate results.
8. Take the measurement as indicated in Section 11.6.3 and 11.6.4.
9. Reinstate the connections after the test is done.

11.6.2 MEASUREMENT VERIFICATION

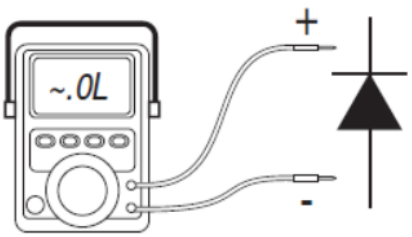
Set the digital multimeter to "diode check" and follow the table below for forward biased tests. Before conducting the test, make sure all the power terminals (R, S, T, DC+, DC-, U, V and W) have been tightened down. Failure to do this may result in an incorrect O.L. reading.

The voltage reading will differ for different frame sizes. Look for opens or short circuits, depending upon the test. If the drive has a problem related to the power structure, then typically one reading will be noticeably different from the others.

The tables below have diode or diode/SCR converters. Complete the tests according to the drive frame size.



Forward biased test on PN-junction



Reverse biased test on PN-junction

11.6.3 TEST FOR COVERTER SECTION

Frame 1-4 (6-Diode Bridge rectifier) and Frame 5-7 (3-Diode/3-SCR Bridge Rectifier with Precharge Diodes)

- Forward Biased Test

Meter Leads		Nominal meter reading
+	-	
L1	DC+	Value should gradually rise to about 0.5V
L2	DC+	
L3	DC+	
DC-	L1	
DC-	L2	
DC-	L3	

- Reversed Biased Test

Meter Leads		Nominal meter reading
+	-	
L1	DC-	Meter should display ".0L" (zero load)
L2	DC-	
L3	DC-	
DC+	L1	
DC+	L2	
DC+	L3	

Frame 8-10 (3-Diode/3-SCR Bridge Rectifier)

- Forward Biased Test

Meter Leads		Nominal Meter Reading
+	–	
R/L1	DC+	"0L" (open circuit) (1)
S/L2	DC+	
T/L3	DC+	
DC-	R/L1	The value should gradually rise to between 0.20V and 0.75V.(2)
DC-	S/L2	
DC-	T/L3	

(1) Residual voltage on the DC bus capacitors can affect this reading. If the capacitors are completely discharged (less than 1 volt), the meter initially shows a low voltage. This voltage reading is the residual bus voltage plus the drop through the low side diodes. The meter gradually charges the bus, and the voltage slowly increases, until eventually the meter switches to ".0L". This increase can take several minutes to occur.

(2) The actual voltage reading can vary depending upon your equipment.

- Reversed Biased Test

Meter Leads		Nominal Meter Reading
+	–	
R/L1	DC-	"0L" (open circuit) (1)
S/L2	DC-	
T/L3	DC-	
DC+	R/L1	
DC+	S/L2	
DC+	T/L3	

(1) Residual voltage on the DC bus capacitors can affect this reading. If the capacitors are completely discharged (less than 1 volt), the meter initially shows a low voltage. This voltage reading is the residual bus voltage plus the drop through the low side diodes. The meter gradually charges the bus, and the voltage slowly increases, until eventually the meter switches to ".0L". This increase can take several minutes to occur.

11.6.4 TEST FOR INVERTER/IGBT SECTION

- Forward Biased test

Meter Leads		Nominal Meter Reading
+	–	
DC-	U	The value should gradually rise to between 0.20V and 0.75V. (1)
DC-	V	
DC-	W	
U	DC+	
V	DC+	
W	DC+	

(1) The actual voltage reading can vary depending upon your equipment.

- Reverse Biased test

Meter Leads		Nominal Meter Reading
+	–	
U	DC-	"0L" (open circuit) (1)
V	DC-	
W	DC-	
DC+	U	
DC+	V	
DC+	W	

(1) Residual voltage on the DC bus capacitors can affect this reading. If the capacitors are completely discharged (less than 1 volt), the meter initially shows a low voltage. This voltage reading is the residual bus voltage plus the drop through the low side diodes. The meter gradually charges the bus, and the voltage slowly increases, until eventually the meter switches to ".0L". This increase can take several minutes to occur.

Appendix A: **Menu Maps**

Refer to the *LCS-ENG-M0005 INSTRUCT ESP Controller-E30 Drive Configuration Manual* for controller menu maps.

Appendix B: **Reference Material**

Often, newly released information will be included in reference material before being incorporated into the main manual chapters.

B.1 HARMONICS WORKSHEET

Please answer the following questions as completely as possible. This information will be used to run a computer simulation of your drive application to generate an estimate of the harmonic levels produced by any VSD loads. If some of the questions cannot be answered, some assumptions will be made about the system. Refer to the drawing(s) included in this manual and the drive cabinet for complete system details. When the questions below are completed, contact Artificial Lift InTouch Support for assistance.

NOTE	In the questions below, PCC refers to common point(s) of coupling on Figure 11-1: VSD Points of Common Coupling.

1. What is the utility input voltage and frequency to the main transformer (PCC1)? _____Volts _____Hz
2. What is the utility system short circuit duty amperage (Isc) immediately before the main transformer for the facility (PCC1)? _____Amps (*this is optional—provided by the utility—required only if PCC1 is the PCC of concern*)
3. What is the main transformer (T1) _____kVA? and the percent impedance? _____%
4. What is the impedance ratio of the main transformer (T1) _____ to _____?

   (*Inductance: Resistance - Typically 10:1 for large transformer, ratios higher than 10:1 will have negligible impact on results*)
5. What is the bus fault current (Isc) after the main transformer (at PCC2)? _____Amps
6. What is the main bus voltage of the (secondary of the main transformer T1)?_____Volts
7. What is the inductance or distance of the power line from the main transformer (PCC2) to the main plant power bus (PCC3) _____?
8. What is the inductance or distance of the power line from the main plant bus (PCC3) to the VSD isolation transformer_____?
9. What is the VSD isolation transformer (T2) kVA and % impedance? _____kVA_____ % (*transformer directly before the VSD*)
10. What is the impedance ratio of the input transformer (T2) _____?
    (*Inductance: Resistance - Typically 10:1 for large transformer, ratios higher than 10:1 will have negligible impact on results*)
11. Is an AC line reactor going to be used? _____ (YES / NO) If so, what is the impedance or reactance in microHenries? _____uH?
12. What is the system's nominal fundamental (other non-harmonic) load current on the main power bus? _____Amps
13. Are there other VSDs in the system? If so, how many? All information on the transformer associated with these VSDs must be supplied.
14. Are there any other harmonics on the system that need to be considered in this calculation? If so, please give the values of these harmonics.
15. What is the point of common coupling for the harmonic's measurements (PCC 1-7)? Refer to Figure 11-1: VSD Points of Common Coupling.

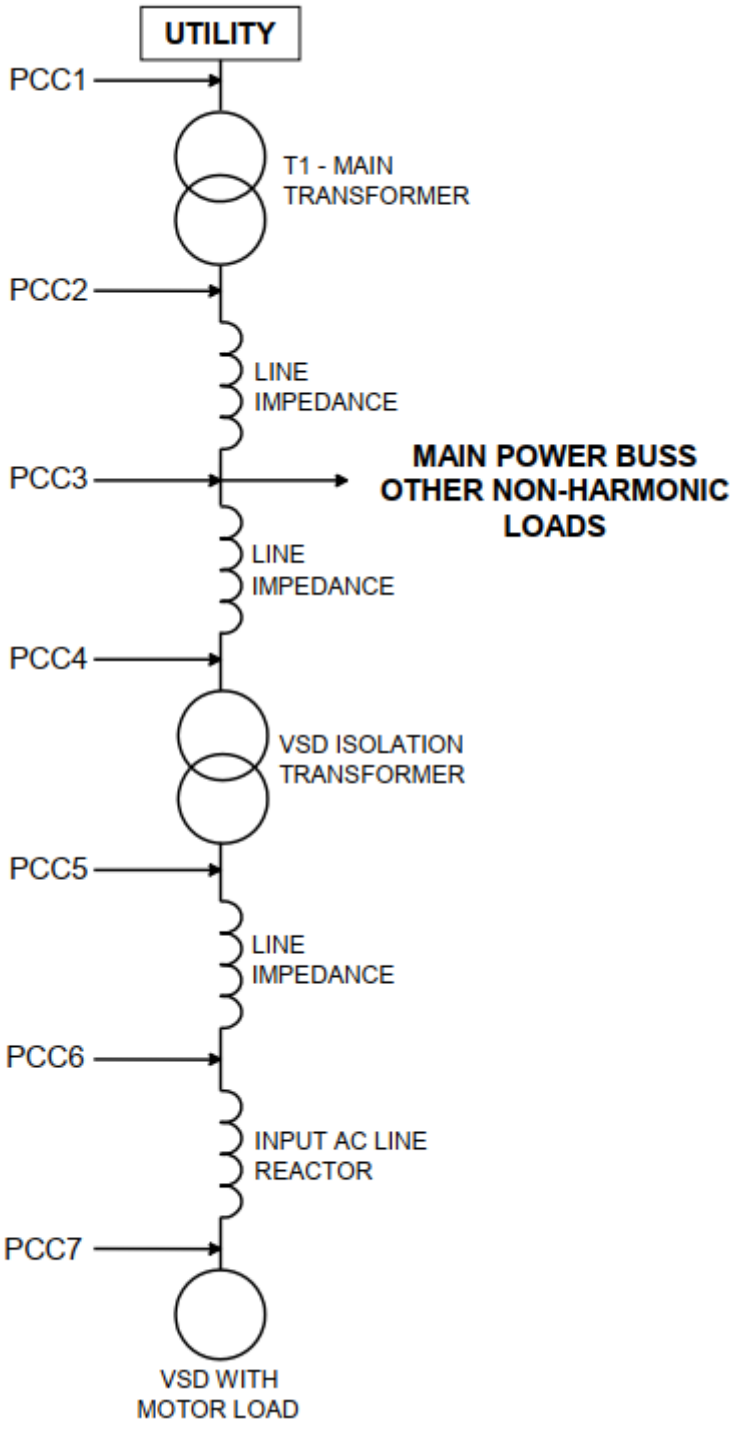


Figure 11-1: VSD Points of Common Coupling

In the above diagram, PCCs listed on the left identify common points of coupling.

B.2 APPLICATION DATA AND ISSUE IDENTIFICATION TABLE

The Figure 11-2: Application Data and Issue Identification Table (p. 1 of 2) provided here is used in the Troubleshooting chapter of this manual. This table provides information for InTouch to assist in the diagnosis and solution of a problem in the field. It is essential to have the answers to the questions on this sheet ready when requesting assistance to get the problem solved as quickly as possible.

Contact/LDAP:		Location:
Date:		
VSD Information		
VSD serial number:	Typeform:	Part Number:
Please provide the UniConn .ste file along with the information contained in this table		
Please provide pictures if applicable		
Input Transformer	Manufacturer:	kVA:
Primary:	Secondary:	Impedance:
Output Transformer	Manufacturer:	kVA:
Primary:	Secondary:	Impedance:
Input filter	Manufacturer:	Part number:
Output filter	Manufacturer:	Part number:
Additional equipment (SCADA, analog, digital, etc) details:		
Conditions (Ambient temperature, wind, rain, snow, heat, humidity, dust, salt, etc):		
Installation Details (Indoor, outdoor, offshore, etc):		
Connection Details		
Input voltage:	Frequency:	
Installation type (ESP, HPS, etc):		
No of cables per phase, cable type:		
% load of VSD:		
Motor Status		
Problem found during periodic inspection?		
Problem found when motor was started?		
Problem found during acceleration?		
Problem found during deceleration?		
Problem found when motor not running?		
Frequency of problem		
First time?		
How many times?		
Does the problem occur every time the motor is operated?		
When did the problem first occur?		
Error Message		
What was the error message on the UniConn/HMI/EOI?		

Figure 11-2: Application Data and Issue Identification Table (p. 1 of 2)

Detailed description of problem:

Troubleshooting performed:

Repairs made, list of failed components found:

Temporary diagnosis and corrective action:

Conclusions / Recommendations:

Figure 11-3: Application Data and Issue Identification Table (p. 2 of 2)

Appendix C: **VSD Module Catalogue Number Explanation**

The Catalogue Number of the power module is displayed on the product label attached to the module. The Catalogue Number explanation:

1…3	4	5	6	7	8…10	11	12	13	14	15	16	17	18	
20G	1	A	N	D	248	A	A	0	N	N	N	N	N	LD - P3 - P11…
a	*b*	*c*	*d*	*e*	*f1…f6*	*g*	*h*	*i*	*Positions 14…18 are not used.*					

a

Drive		
Code	Type	Frames
20F	PowerFlex® 753	1…7
20G	PowerFlex 755	1…10
21G	PowerFlex 755 Drive with Options	8…10

b

Future Use

c

Input Type		
Code	Description	Frames
1	AC Input with Precharge, includes DC Terminals	1…5 8…10
4	DC Input with Precharge	5…10
A	AC Input with Precharge, no DC Terminals	6…8 (1)

(1) The DC Bus Bar kit (20-750-DCBB1-Fx) is available for Frames 6…7 AC input drives that require DC bus terminals.

d

Enclosure		
Code	Description	Frames
R	IP20, NEMA/UL Type Open, Frame 1	1
F (1)	Flange (NEMA/UL Type 4X/12 back)	2…5
G	IP54, NEMA/UL Type 12	2…7
N (2)	IP20/IP00, NEMA/UL Type Open	2…7
B (3)	IP20, NEMA/UL Type 1, 600 mm (23.6 in.) Deep, Standard Cabinet Color (RAL 7032)	8…10
J (3)	IP54, UL Type 12, 800 mm (31.5 in.) Deep, Standard Cabinet Color (RAL 7032)	8…10
K (3)	IP54, NEMA 12, 2500 MCC Style Cabinet and Options w/MCC Power Bus, 800 mm (31.5 in.) Deep, Standard Cabinet Color (RAL 7032)	8…10
L (3)	IP20, NEMA/UL Type 1, 800 mm (31.5 in.) Deep, Standard Cabinet Color (RAL 7032)	8…10
P (3)	IP20, NEMA/UL Type 1, 2500 MCC Style Cabinet and Options w/MCC Power Bus, 800 mm (31.5 in.) Deep, Standard Cabinet Color (RAL 7032)	8…10
W (3)	IP20, NEMA/UL Type 1, 2500 MCC Style Cabinet and Options w/MCC Power Bus, 800 mm (31.5 in.) Deep, CenterLine 2100 Gray (ASA49)	8…10
Y (3)	IP54, NEMA 12, 2500 MCC Style Cabinet and Options w/MCC Power Bus, 800 mm (31.5 in.) Deep, CenterLine 2100 Gray (ASA49)	8…10
T	IP00, UL Open Type without Control POD	8…10

(1) For Frames 6…7, a user installed flange kit (20-750-FLNG4-Fx) is available to convert a Code N drive that provides a NEMA/UL Type 4X/12 back.
(2) Frames 2…5 are IP20, Frames 6…7 are IP00.
(3) Available as a drive with options (21G).

e

Voltage Rating	
Code	Voltage
B	240V AC (208V AC) (1) / 325V DC (281V DC) (1)
C	400V AC/540V DC
D	480V AC/650V DC
E	600V AC/810V DC
F	690V AC/932V DC (not UL Listed)

(1) Drive must be programmed to obtain low (208V AC) voltage rating.

f4

ND Rating								
480V, 60 Hz Input								
Code	Amps	Hp	Frame					
			Enclosure Code					
			B, J, L, T	F	G	N	K, P, W, Y	R
2P1	2.1	1	–	2	2	2	–	1
3P4	3.4	2						
5P0	5.0	3						
8P0	8.0	5						
011	11	7.5						
014	14	10						
022	22	15						–
027	27	20		3	3	3		
034	34	25						
040	40	30						
052	52	40		4	4	4		
065	65	50			5			
077	77	60		5		5		
096	96	75			6			
125	125	100		(1)		6		
156	156	125						
186	186	150						
248	248	200			7			
302	302	250				7		
361	361	300						
415	415	350						
430	430	350	8	–	–	–	8(2)	
477	477	400	–	(1)	–	7	–	
485	485	400	8	–	–	–	8(2)	
545	545	450						
617	617	500						
710	710	600						
740	740	650						
800	800	700	9				9(2)	
960	960	800						
1K0	1045	900						
1K2	1135	1000						
1K3	1365	1100						
1K4	1420	1250						
1K5	1525	1350	10				10(2)	
2K0	2070	1750						

(1) For Frames 6…7, a user installed flange kit (20-750-FLNG4-Fx) is available to convert a Code N drive that provides a NEMA/UL Type 4X/12 back.
(2) Available as a drive with options (21G).

g

Filtering and CM Cap Configuration		
Code	Filtering	Default CM Cap Connection
A	Yes	Jumper Removed
J	Yes	Jumper Installed

h

Dynamic Braking(1)		
Code	Internal Resistor(2)	Internal Transistor(3)
A	No	Yes
N	No	No

(1) Not available on Frames 8…10, specify Code 'N'.
(2) Frames 1…2 only. Internal Resistor kits (20-750-DB1-Dx) sold separately.
(3) Standard on Frames 1…5, optional on 6…7.

i

Door Mounted HIM (Frames 8…10)	
Code	Operator Interface
0	No Door Mounted HIM
2	Enhanced LCD, Full Numeric, IP20
4	Enhanced LCD, Full Numeric, IP66 NEMA Type 4X/12

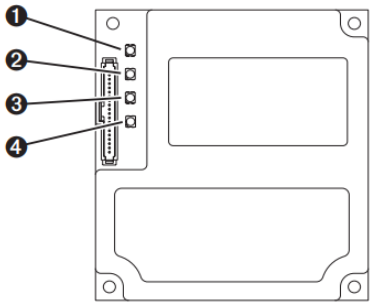
PowerFlex 755 w/Options (21G) Required Selections

Code	Option	Frames	Type
LD	Light Duty	8…10	System Overload Duty Cycle(1)
ND	Normal Duty		
HD	Heavy Duty		
P3	Input Thermal- magnetic Circuit Breaker	8…10	Power Disconnect(1)
P5	Input Non-Fused Molded Case Disconnect Switch	8 Only	
P14	Wiring Only Bay	8…10	Wiring Only Bay

(1) Only one option of this type can be selected.

Appendix D: **VSD Modbus/TCP Adapter Status Indicator**

The adapter has four status indicators. They can be viewed on the adapter.



ITEM	STATUS INDICATOR	DESCRIPTION
1	PORT	DPI Connection Status
2	MOD	Adapter Status
3	NET A	Modbus/TCP Connection Status
4	NET B	Modbus/TCP Transmit Status

D.1 PORT STATUS INDICATOR

This red/green bi-color LED indicates the status of the adapter's connection to the drive as shown in the table below:

STATUS	CAUSE	CORRECTIVE ACTION
Off	The adapter is not powered or is not properly connected to the drive.	• Securely connect the adapter to the drive using the Internal Interface (ribbon) cable. • Apply power to the drive (or adapter if mounted in a DPI External Comms Kit).
Flashing Red	The adapter is not receiving a ping message from the drive.	• Verify that cables are securely connected and not damaged. Replace cables if necessary. • Cycle power to the drive (or adapter if mounted in a DPI External Comms Kit).
Steady Red	The drive has refused an I/O connection from the adapter. Another DPI peripheral is using the same DPI port as the adapter.	**Important:** Cycle power to the drive (or adapter if mounted in a DPI External Comms Kit) after making any of the following corrections: • Verify that all DPI cables on the drive are securely connected and not damaged. Replace cables if necessary. • Verify that the DPI drive supports Datalinks. • Configure the adapter to use a Datalink that is not already being used by another peripheral.

STATUS	CAUSE	CORRECTIVE ACTION
Steady Orange	The adapter is connected to a product that does not support DPI™ communications.	Connect the adapter to a compatible product that supports DPI™ communications.
Flashing Green	The adapter is establishing an I/O connection to the drive.	No action required. Normal behavior if no DPI I/O is enabled.
Steady Green	The adapter is properly connected and is communicating with the drive.	No action required

D.2 MOD STATUS INDICATOR

This red/green bi-color LED indicates the status of the adapter as shown in the table below:

STATUS	CAUSE	CORRECTIVE ACTION
Off	The adapter is not powered or is not properly connected to the drive.	• Securely connect the adapter to the drive using the Internal Interface (ribbon) cable. • Apply power to the drive (or adapter if mounted in a DPI External Comms Kit).
Flashing Red	The adapter has failed the firmware test. The adapter is being flash upgraded.	• Clear faults in the adapter. • Cycle power to the drive (or adapter if mounted in a DPI External Comms Kit). • If cycling power does not correct the problem, the adapter parameter settings may have been corrupted. Reset defaults and reconfigure the adapter. • If resetting defaults does not correct the problem, flash the adapter with the latest firmware release.
Steady Red	The adapter has failed the hardware test.	• Cycle power to the drive (or adapter if mounted in a DPI External Comms Kit). • Replace the adapter.
Flashing Green	The adapter is operational but is not transferring I/O data.	• Verify that the controller can send messages to the adapter. • Normal behavior if no DPI I/O is enabled.
Steady Green	The adapter is operational and transferring I/O data.	No action required

D.3 NET A STATUS INDICATOR

This red/green bi-color LED indicates the status of the network connection as shown in the table below:

STATUS	CAUSE	CORRECTIVE ACTIONS
Off	The adapter is not powered, the adapter is not properly connected to the network, or the adapter needs an IP address.	• Securely connect the adapter to the drive using the Internal Interface (ribbon) cable and to the network using an Ethernet cable. • Correctly connect the Ethernet cable to the Ethernet connector. • Set a unique IP address using a BOOTP server or by disabling BOOTP and using adapter parameters. • Apply power to the drive (or adapter if mounted in a DPI External Comms Kit).
Steady Red	The adapter failed the duplicate IP address detection test.	Configure the adapter to use a unique IP address and cycle power.

STATUS	CAUSE	CORRECTIVE ACTIONS
Flashing Red	The Modbus/TCP connection has timed out.	Clear the fault on the drive and change **Parameter 19 - [Msg I/O Timer]** to a higher value or to zero (0) to disable Modbus/TCP connection timeouts.
Flashing Red/Green	The adapter is performing a self-test.	No action required.
Flashing Green	The adapter is properly connected but is not communicating with any devices on the network.	• Verify that the controller can send messages to the adapter. • Create an I/O connection with the adapter by sending it Modbus/TCP messages.
Steady Green	The adapter is properly connected and communicating on the network.	No action required

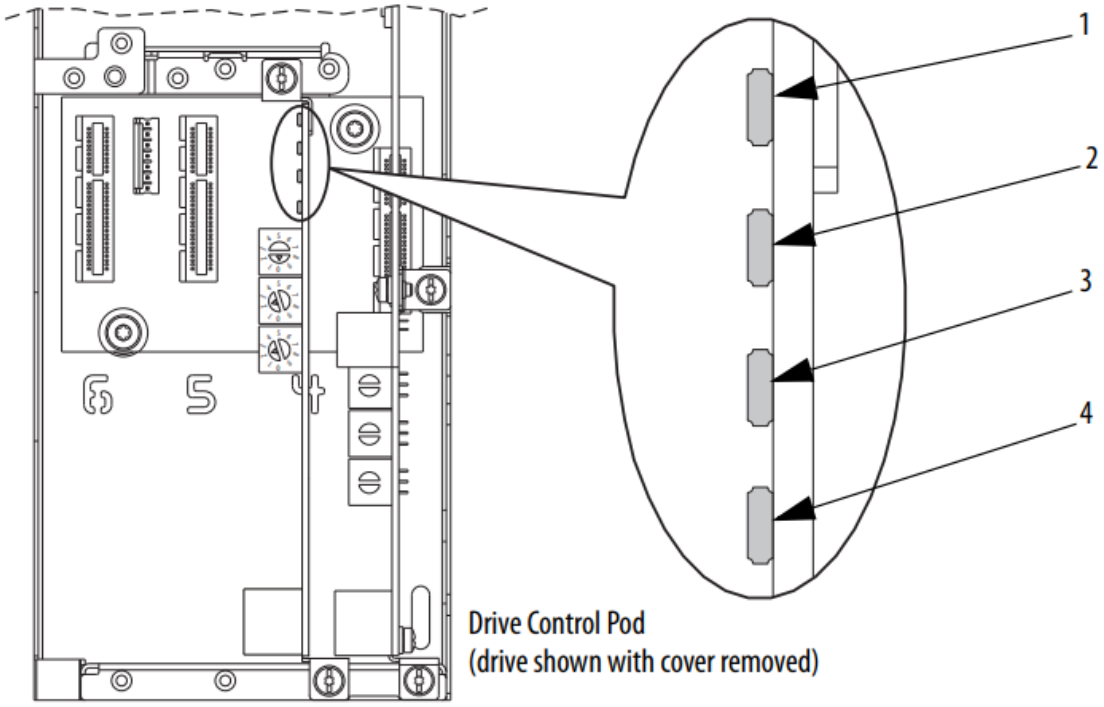
D.4 NET B STATUS INDICATOR

This green LED indicates the status of the adapter transmitting on the network as shown in the table below:

STATUS	CAUSE	CORRECTIVE ACTIONS
Off	The adapter is not powered or is not transmitting on the network.	If NET A indicator is off: • Securely connect the adapter to the drive using the Internal Interface (ribbon) cable and to the network using an Ethernet cable. • Correctly connect the Ethernet cable to the Ethernet connector. • Set a unique IP address using a BOOTP server or by disabling BOOTP and using adapter parameters. If NET A indicator is steady red: • Configure the adapter to use a unique IP address and cycle power. If NET A indicator is flashing red/green or red: • Check the IP address in the adapter and scanner and verify that the controller can communicate with the adapter. • Ping the adapter. Normal condition if the adapter is idle
Flashing Green	The adapter is transmitting on the network.	No action required.

Appendix E: **VSD Dual-port Ethernet/IP Option Module Status Indicator**

The option module has four status indicators. They can be viewed with the drive cover removed. The indicators operate differently in Adapter mode than in Tap mode. Only the Adapter mode is described here.



Item	Status Indicator	Description
1	PORT	DPI Connection Status
2	MOD	Option Module Status
3	NET A	Network Connection Status
4	NET B	Option Module Transmission Status

E.1 PORT STATUS INDICATOR

This red/green bi-color status indicator indicates the status of the option module connection to the drive as shown in this table:

STATUS	CAUSE	CORRECTIVE ACTION
Off	The option module is not powered or is not properly connected to the drive.	• Securely connect and ground the option module to the drive by fully inserting it into the drive port. Tighten the two captive screws of the module to the recommended torque. • Apply power to the drive.
Flashes Red	The option module is not communicating with the drive via DPI™.	• Verify that the option module is properly inserted in the drive port. • Cycle power to the drive.
Steady Red	The drive has refused an I/O connection from the option module.	**Important:** Cycle power to the drive after making any of the following corrections: • Securely connect and ground the option module to the drive by fully inserting it into the drive port. Tighten the two captive screws of the module to the recommended torque. • Verify that the drive supports the Comm Driver.
Flashes Orange	The option module is not compatible with the drive.	Install the option module into a compatible product of the same brand.
Flashes Green	The option module is establishing an I/O connection to the drive.	No action required. Normal behavior if no I/O is enabled
Steady Green	The option module is properly connected and is communicating with the drive.	No action required

E.2 MOD STATUS INDICATOR

This red/green bi-color LED indicates the status of the option module as shown in the table below:

STATUS	CAUSE	CORRECTIVE ACTION
Off	The option module is not powered or is not properly connected to the drive.	• Securely connect and ground the option module to the drive by fully inserting it into the drive port. Tighten the two captive screws of the module to the recommended torque. • Apply power to the drive.
Flashes Red	The drive is in firmware update mode. The option module has an EEPROM fault. The network address switches have been changed since powerup. A duplicate IP address fault has been detected. The DHCP lease has expired. The network address switches are set to ‘888’. The network configuration (IP address, subnet mask, gateway address) is invalid. The User FPGA configuration is invalid.	• View the option module event queue to determine which of these conditions is present. Then, depending on the cause, take the appropriate corrective action. • Clear faults in the option module. • Cycle power to the drive. • Cycle power. If the problem is not resolved, the option module parameter settings have been corrupted. Reset defaults and reconfigure the option module. • Reset defaults. If the problem is not resolved, update the option module with the latest firmware revision. • Change the network address switches to a value other than 888.
Flashes Green	The option module is operating normally but is not transferring I/O data to a controller.	• Place the scanner in RUN mode. • Program the controller to recognize and transmit I/O to the option module.

STATUS	CAUSE	CORRECTIVE ACTION
		• Configure the option module for the program in the controller. • Normal behavior if no I/O is being transferred
Steady Green	The option module is operating normally and is transferring I/O data to a controller.	No action required

E.3 NET A STATUS INDICATOR

This red/green bi-color status indicator indicates the status for the network connection as shown in this table:

STATUS	CAUSE	CORRECTIVE ACTIONS
Off	The option module is not powered. The option module is not properly connected to the network. The option module has not acquired its network configuration (IP address, subnet mask, gateway address) from the BOOTP/DHCP server.	• Securely connect and ground the option module to the drive by fully inserting it into the drive port. Tighten the two captive screws of the module to the recommended torque. • Correctly connect the Ethernet cable to the Ethernet connector. • Set a unique IP address with the option module rotary switches, option module parameters, or a BOOTP or DHCP server. • Apply power to the drive.
Flashes Red	The I/O connection has timed out.	• Place the controller in RUN mode or apply power to the peer device that sends I/O. • Check the IGMP Snooping/Ethernet Switches for correct operation. • Check the amount of traffic on the network.
Steady Red	A duplicate IP address fault has been detected. The DHCP lease has expired.	Configure the option module to use a unique IP address and cycle power.
Flashes Green	The option module is operating normally but does not have any CIP connections (I/O or MSG).	• Place the controller in RUN mode, or apply power to the peer device that sends I/O. • Program the controller or peer device to recognize and transmit I/O or make a message connection to the option module. • Configure the option module for the program in the controller or the I/O from the peer device.
Steady Green	The option module is operating normally and has at least one CIP connection (I/O or MSG).	No action required.

E.4 NET B STATUS INDICATOR

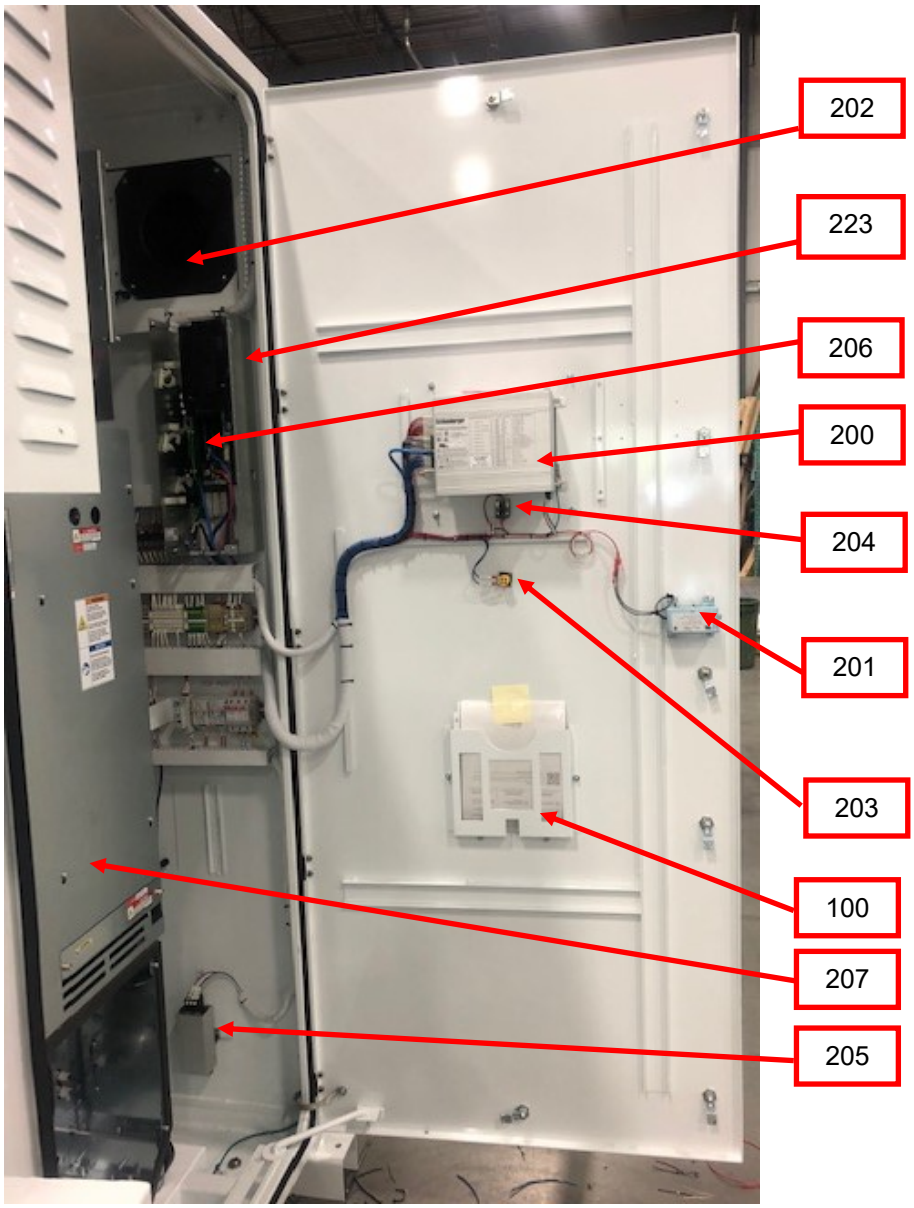
This green status indicator indicates the status of the option module that is transmitting on the network as shown this table:

STATUS	CAUSE	CORRECTIVE ACTIONS
Off	The option module is not transmitting on the network.	If NET A indicator is off: • Securely connect and ground the option module to the drive by fully inserting it into the drive port. Tighten the two captive screws to the recommended torque and connect the option module to the network by using an Ethernet cable. • Correctly connect the Ethernet cable to the Ethernet connector. • Set a unique IP address with the option module rotary switches, option module parameters, or a BOOTP or DHCP server. If NET A indicator is steady red: • Configure the option module to use a unique IP address and cycle power. If NET A indicator is flashing red/green or red: • Check the IP address in the option module and scanner and verify that the controller can communicate with the option module. • Ping the option module. • Normal condition if the option module is idle
Flashes Green	The option module is transmitting on the network.	No action required

Appendix F: **Parts Identification for E30 Drive**

18-pulse, Frame 8, 55degC, IP55

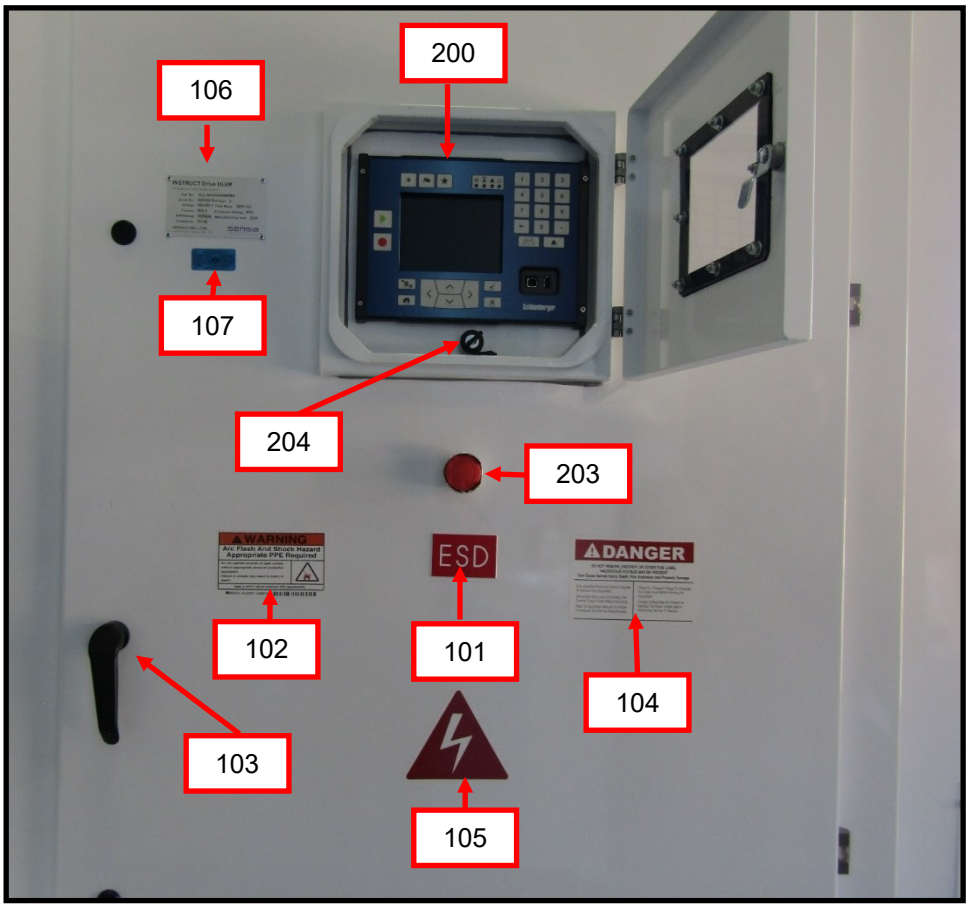
F.1 INSIDE FRONT VSD SECTION DOOR



ITEM #	DESCRIPTION
100	Standard Metal Document Holder
200	Instruct ESP Intelligent Controller & I/O Card Kit
201	Electric Door Interlock Device - 230V
202	8" Axial Fan, for Heat Exchanger

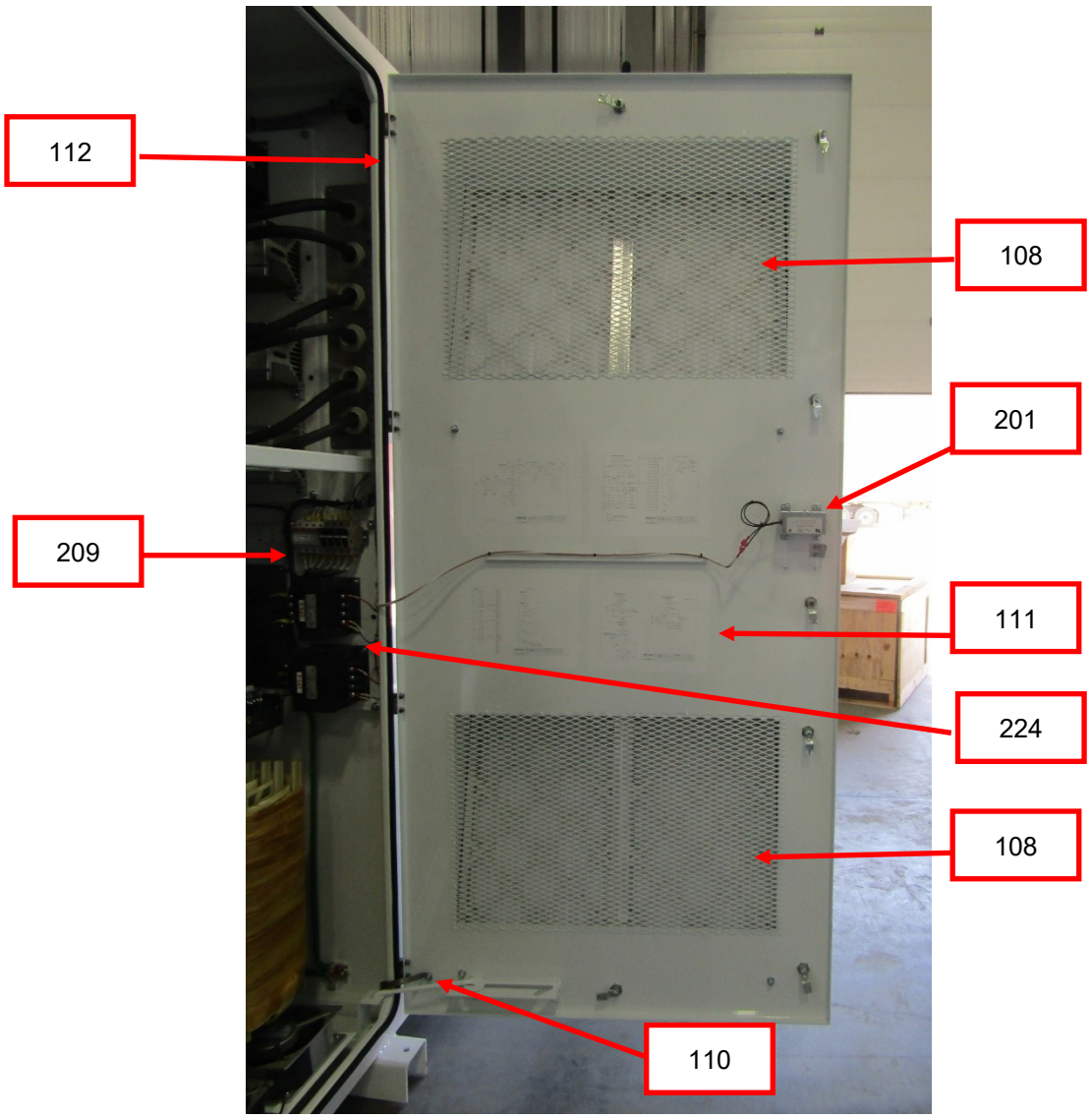
ITEM #	DESCRIPTION
203	Monolithic Emergency Stop, Red, 1NC
204	Key Switch, 22mm, 2 Pos.
205	Heater, 100W, AC/DC 110-250V
206	PowerFlex 755 Frame 8 Pod Bucket Kit
207	PowerFlex 755 Air Cooled AC Drive
223	Main Backpan @ VSD Section

F.2 OUTSIDE OF FRONT VSD COMPARTMENT DOOR



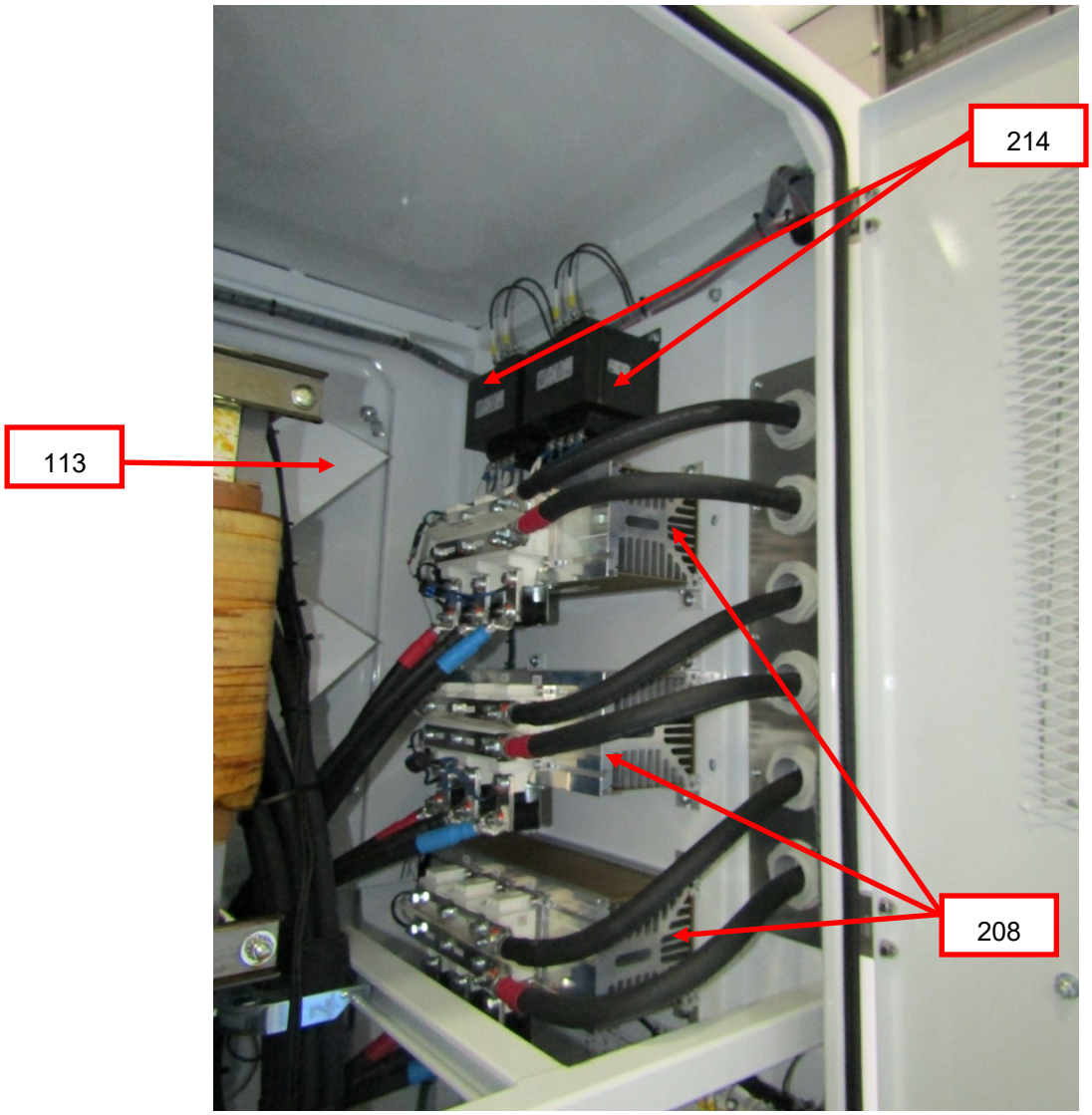
ITEM #	DESCRIPTION
101	3" x 2", ESD, White Letter on Red Background
203	Monolithic Emergency Stop, Red, 1NC
200	Instruct ESP Intelligent Controller & I/O Card Kit
102	Arc Flash Warning Label, 3.5" x 5", NFPA 70E
103	L-Handle with nut, black
104	Label, Danger, do not remove
105	Label, Hazardous Voltage, Red Triangle, 5"
204	Key Switch, 22mm, 2 Pos.
106	Nameplate, Aluminum, 112mm x 70mm, Colour, w/engraving
107	Special Inspection Label

F.3 FRONT TRANSFORMER COMPARTMENT DOOR



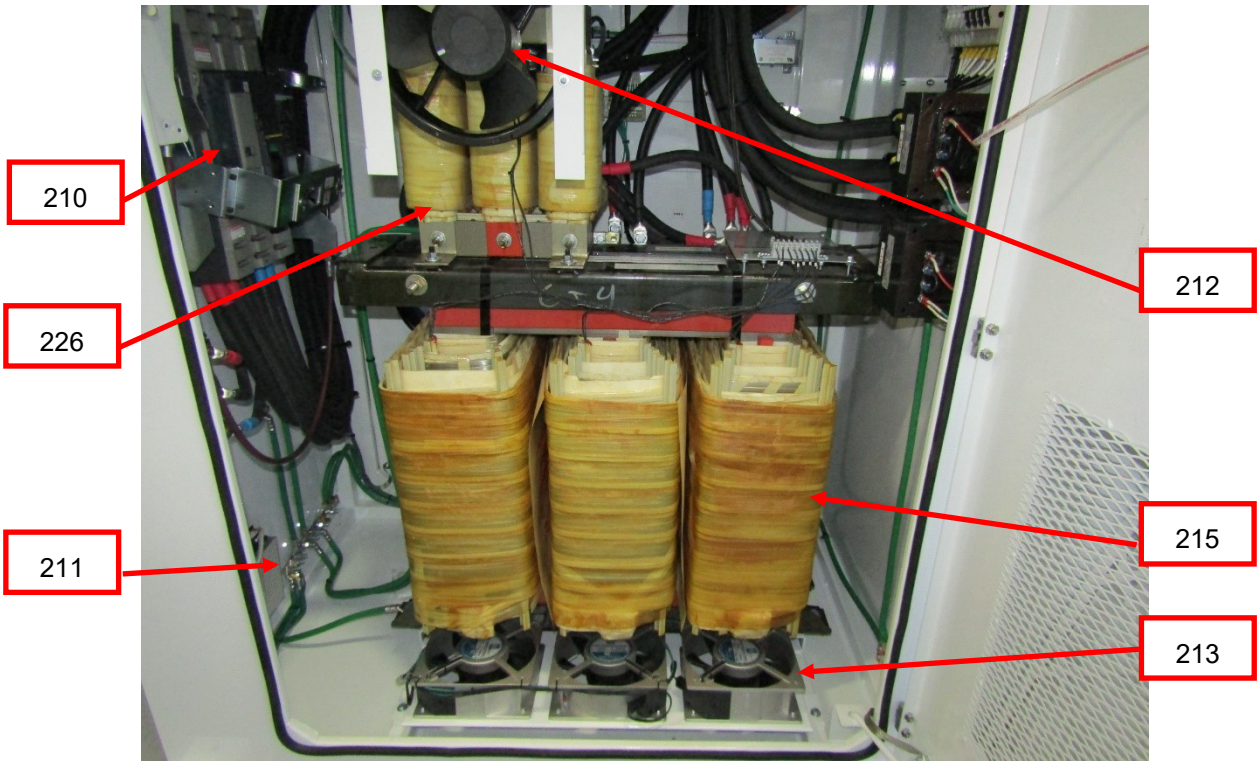
ITEM #	DESCRIPTION
201	Door Interlock Device - 230V
108	12"x24"x2" Pleated Air Filter
110	Standard 9" Door Bar
111	Wiring Diagram label
209	Fuse holder F1,2,3,4, 25, 26, 28, 29
112	Weatherproof door seal
224	CPT Mounting Pan inside Transformer Section

F.4 TRANSFORMER SECTION – UPPER RIGHT



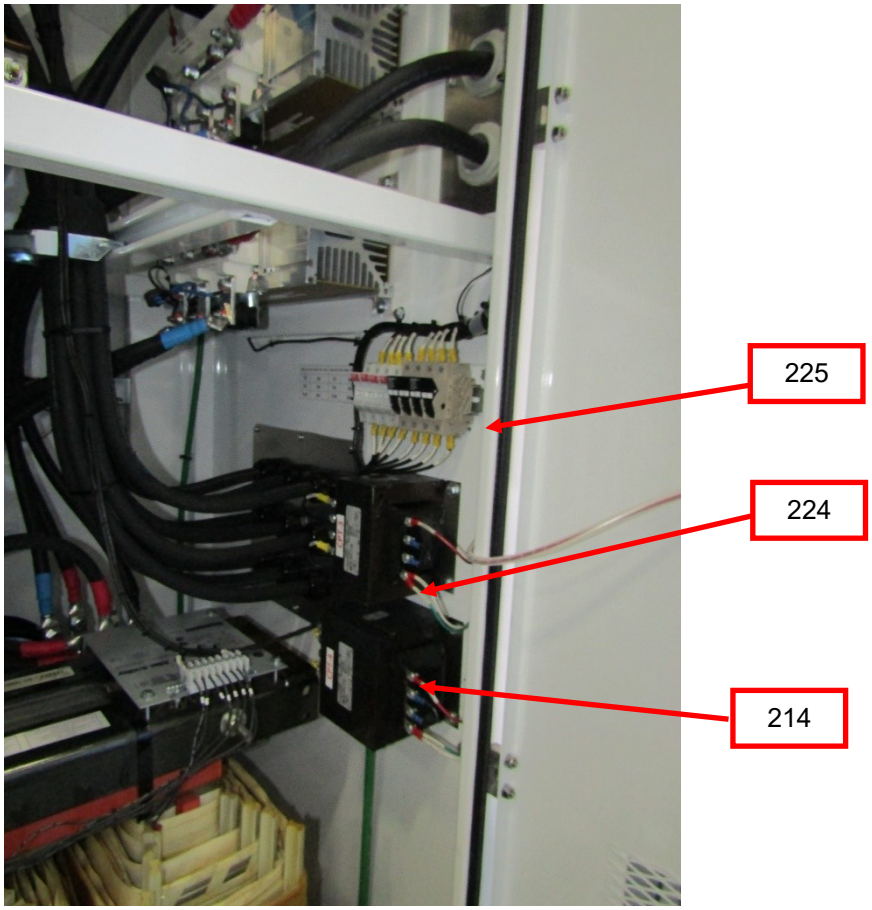
ITEM #	DESCRIPTION
208	6 Pulse Rectifier Stack - 380-480V, Max 350A, 526Watts
113	10" Axial Fan Airflow Diverter Plate
214	CPT1&2 Transformer, 1000VA, 380/440/480-120/240, 50/60 Hz, 70C

F.5 TRANSFORMER SECTION - LOWER



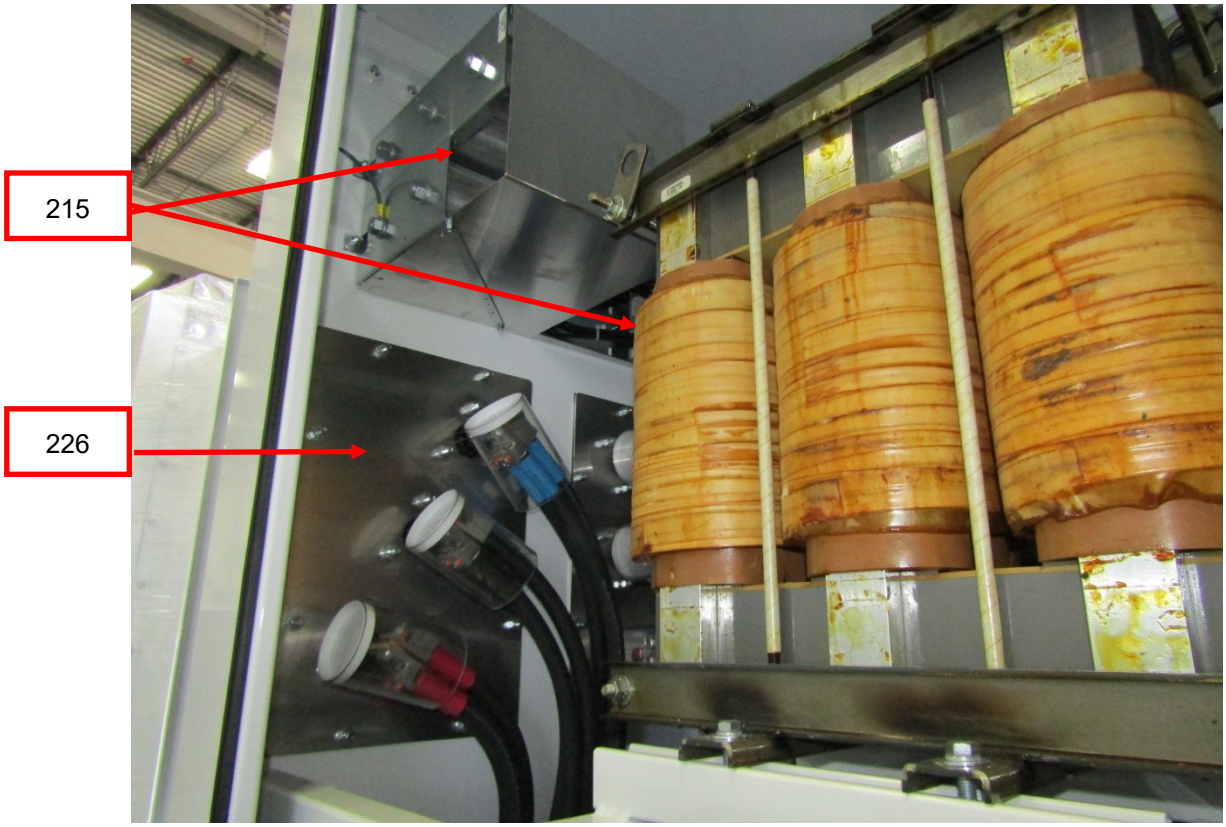
ITEM #	DESCRIPTION
210	SUBCOE Main Circuit Breaker, 1000A, 3P
211	Equipment Ground Bus Bar
212	Fan, 10" Axial, 850 CFM, 85 to 130 Vac
213	Fan 115Vac, 150mm x 55mm, 230 CFM
215	Phase Shifting Transformer
226	Line Reactor

F.6 TRANSFORMER SECTION – LOWER RIGHT



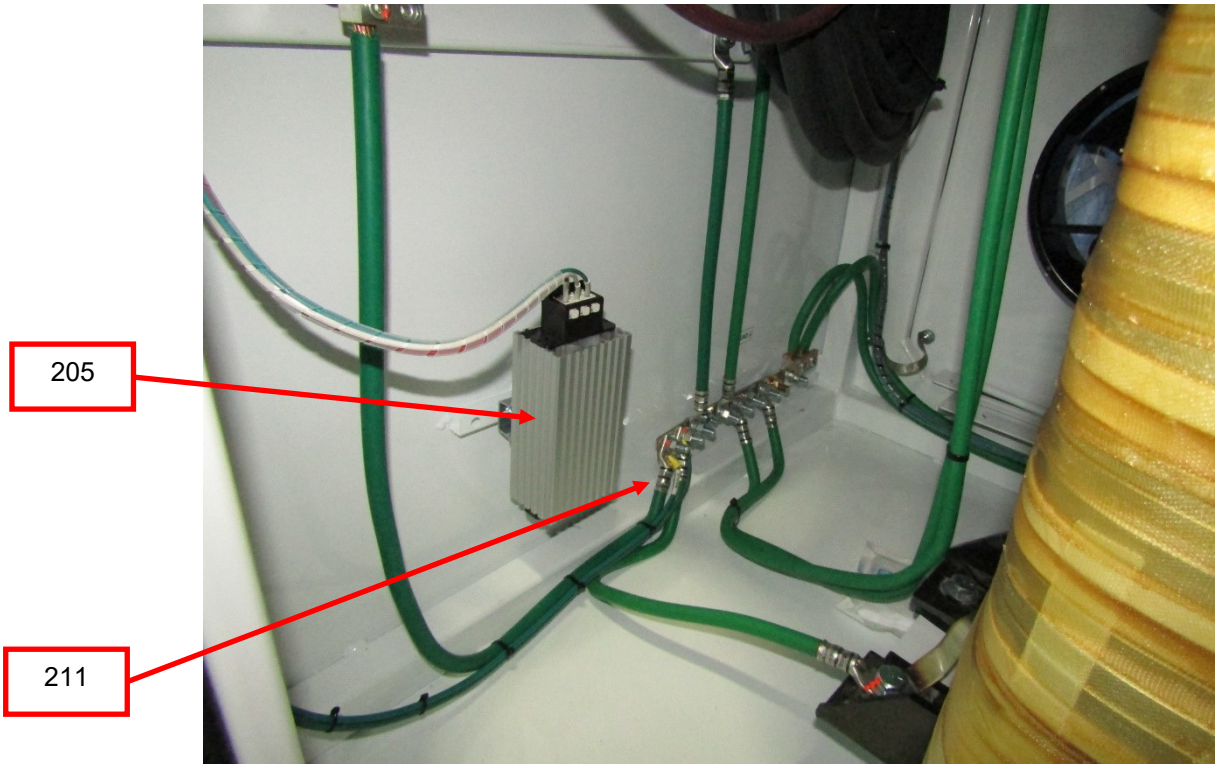
ITEM #	DESCRIPTION
214	CPT1&2 Transformer, 1000VA, 380/440/480-120/240, 50/60 Hz, 70C
224	Transformer, 500VA, 380/415/480-120/240, 50/60 Hz
225	Fuse F1, F2, F3, F4, F5, F6, F7, F8

F.7 TRANSFORMER SECTION – UPPER LEFT



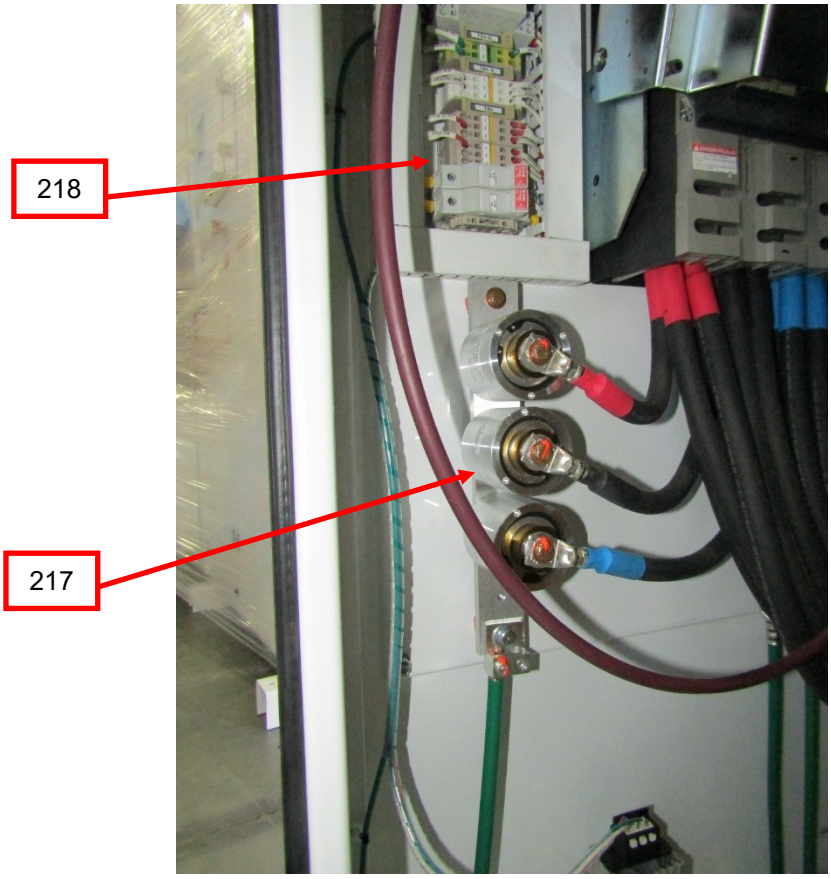
ITEM #	DESCRIPTION
215	MFC Sinewave Filter Kit, 480V, 600A
226	Power JB Output Gland Plate

F.8 TRANSFORMER SECTION – LOWER LEFT



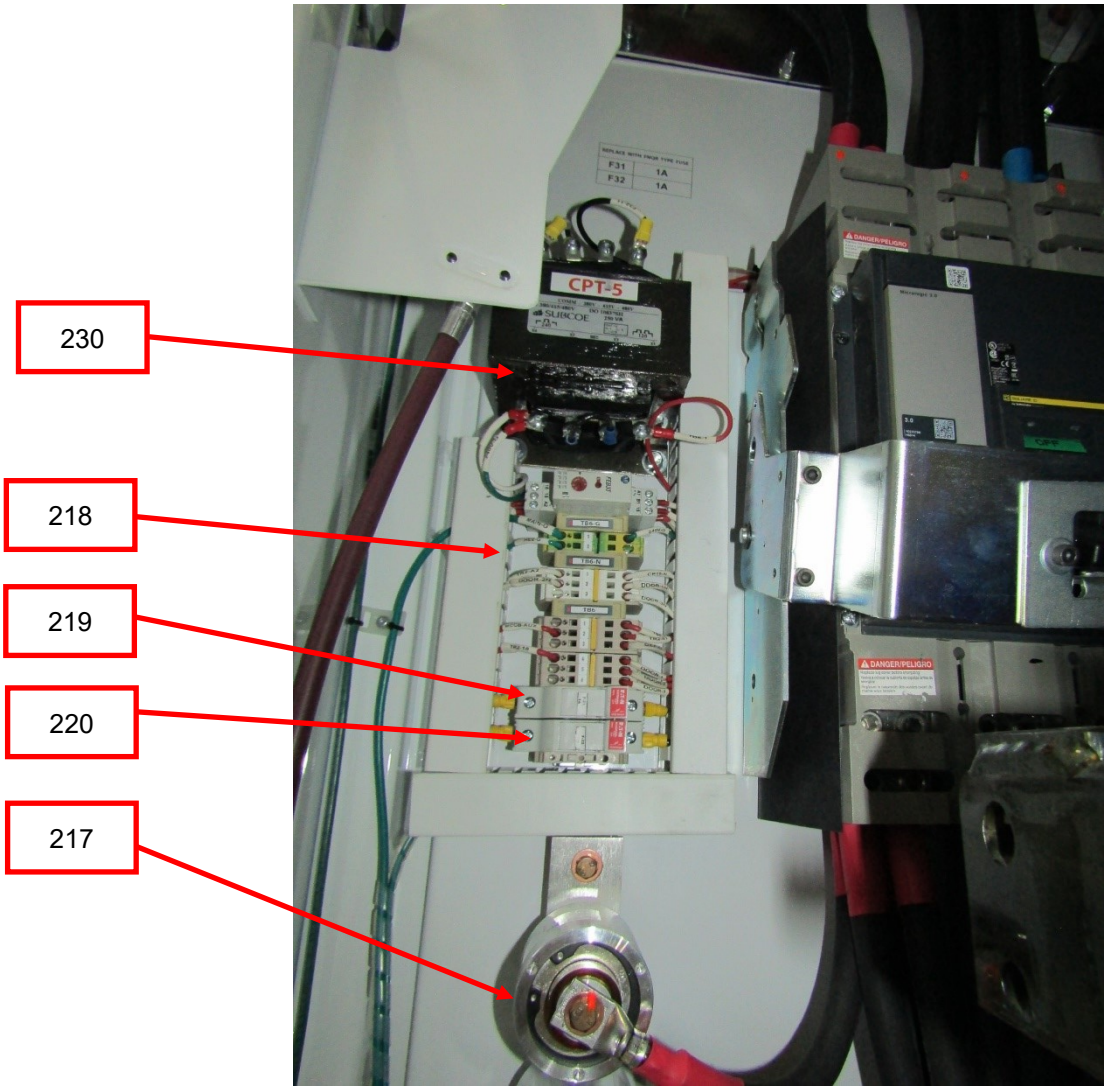
ITEM #	DESCRIPTION
205	Heater, 100W, AC/DC 110-250V
211	Equipment Ground Bus Bar inside Transformer Compartment

F.9 TRANSFORMER SECTION – LOWER LEFT(2)



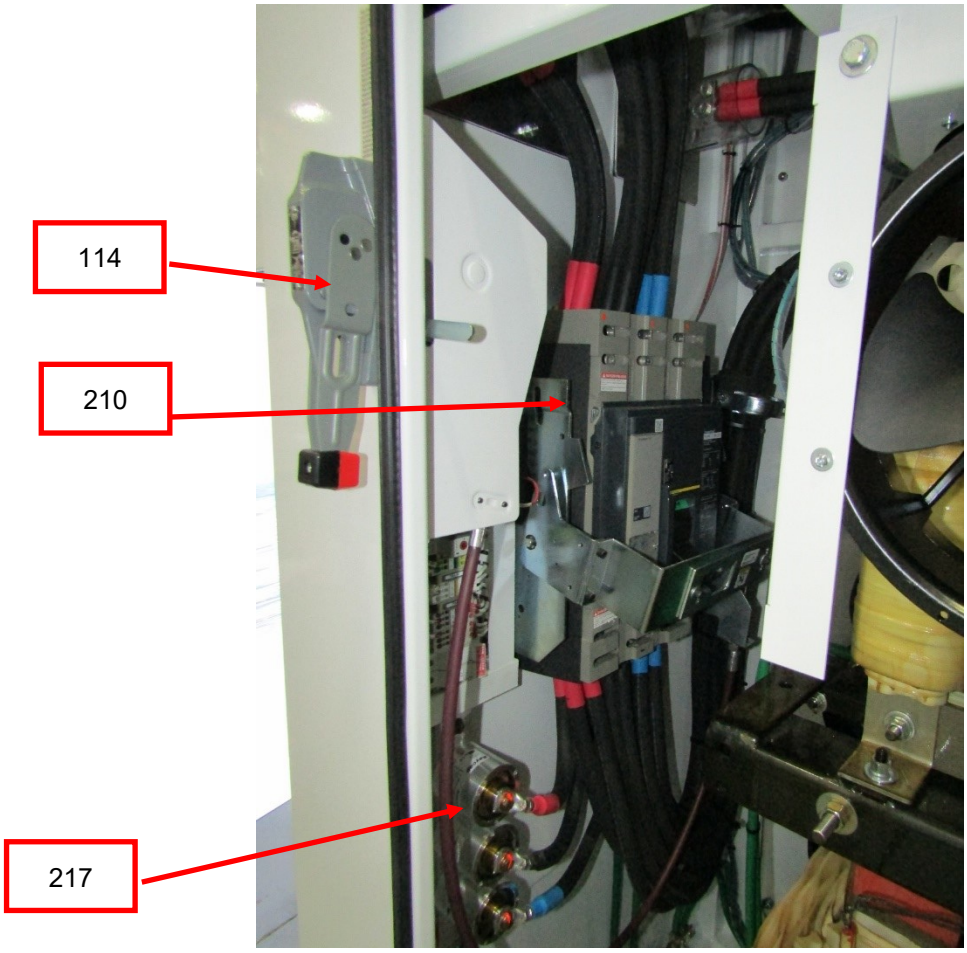
ITEM #	DESCRIPTION
217	TVSS Kit 40mm for installation 3 phase 480/277V
218	TB6, Terminal Block # 6, F31, F32

F.10 MAIN BREAKER MOUNTING PLATE IN TRANSFORMER SECTION



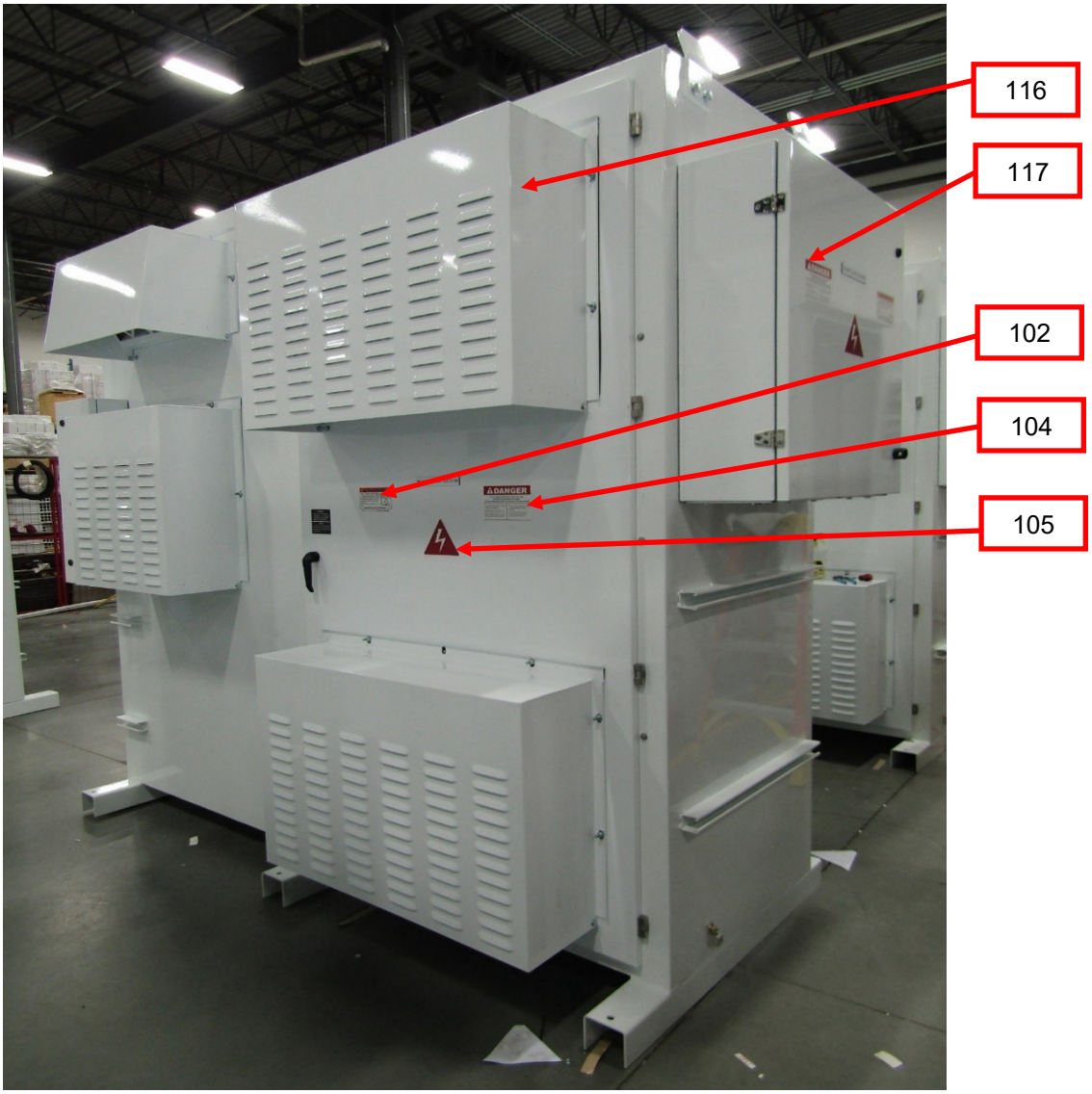
ITEM #	DESCRIPTION
217	TVSS Kit 40mm for installation 3 phase 480/277V
218	TB6, Terminal Block # 6, F31, F32, TR2
219	F31, 1A Fuse
220	F32, 1A Fuse
230	CPT 5, Transformer, 250VA, 380/415/480-120/240, 50/60 Hz

F.11 INSIDE TRANSFORMER SECTION



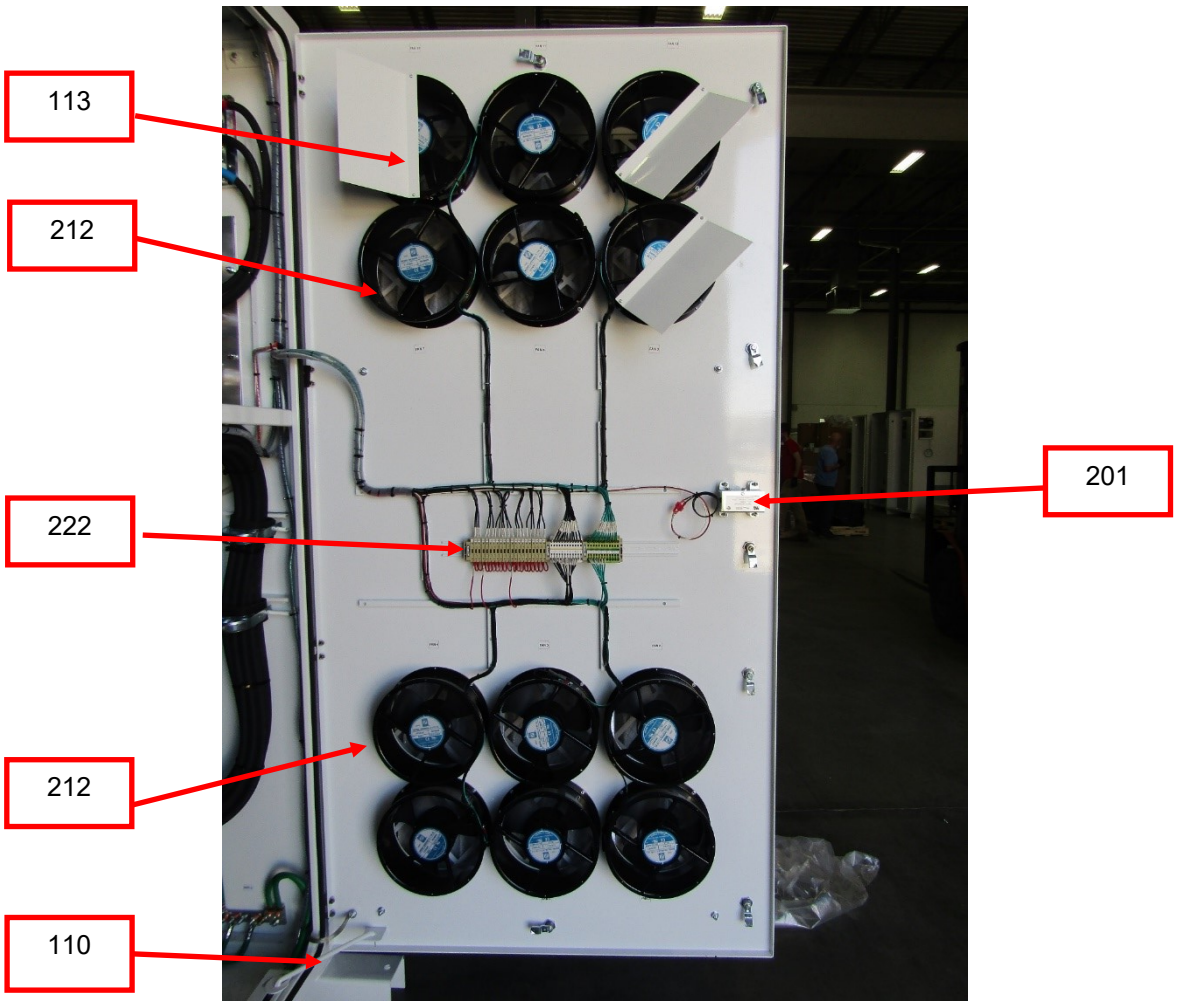
ITEM #	DESCRIPTION
114	Handle Assembly for 9422CMP50
210	Main Circuit Breaker, 1000A, 3P
217	TVSS Kit 40mm for installation 3 phase 480/277V

F.12 TRANSFORMER SECTION REAR DOOR



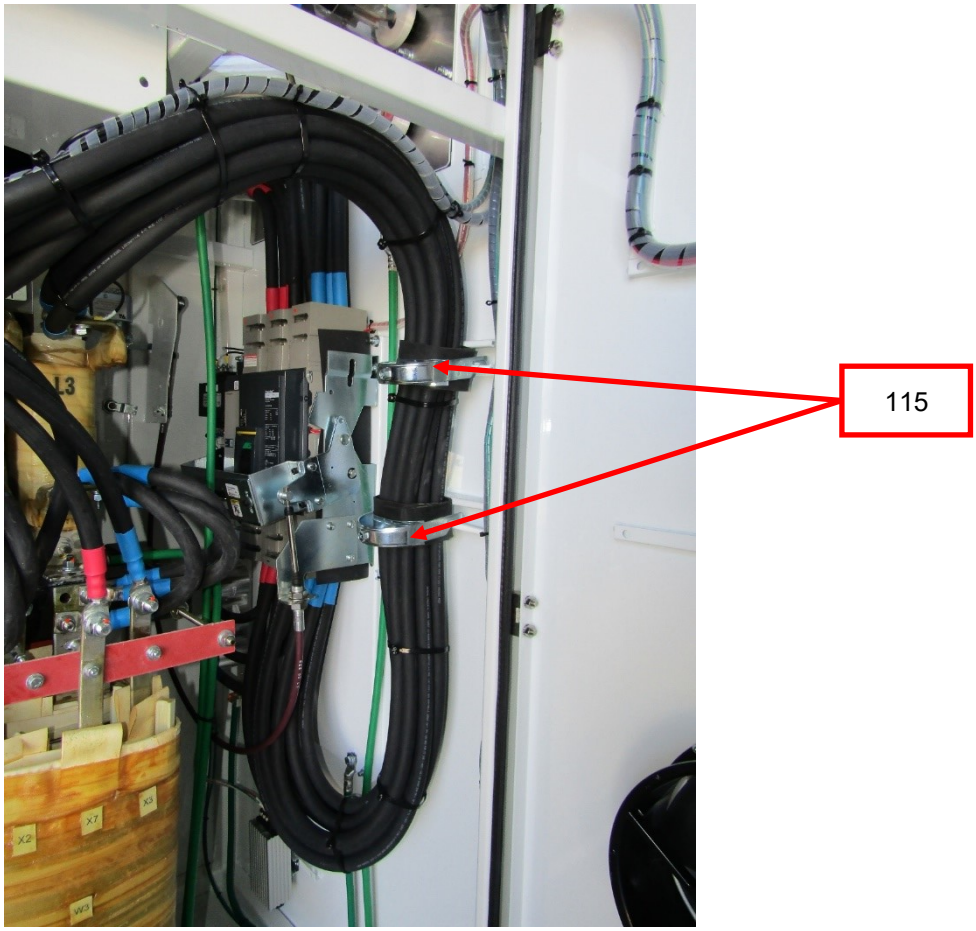
ITEM #	DESCRIPTION
116	Axial Fan Intake Hood
117	Main Power JB Box
105	Label, Hazardous Voltage, Red Triangle, 5"
102	Arc Flash Warning, 3.5" x 5", NFPA 70E
104	Label, Danger, do not remove---

F.13 TRANSFORMER SECTION REAR DOOR INSIDE



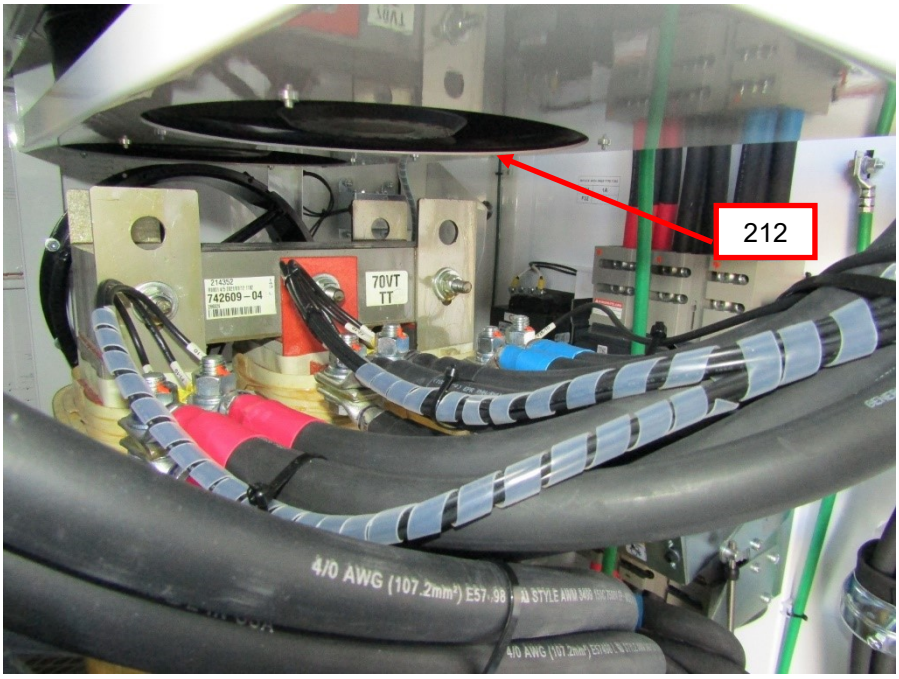
ITEM #	DESCRIPTION
110	Standard 9" Door Bar
212	Fan, 10" Axial, 850 CFM, 85 to 130 Vac
113	10" Axial Fan Airflow Diverter Plate
222	Fan Terminal Block
201	Electric Door Interlock Device - 230V

F.14 TRANSFORMER SECTION – RIGHT VIEW FROM REAR



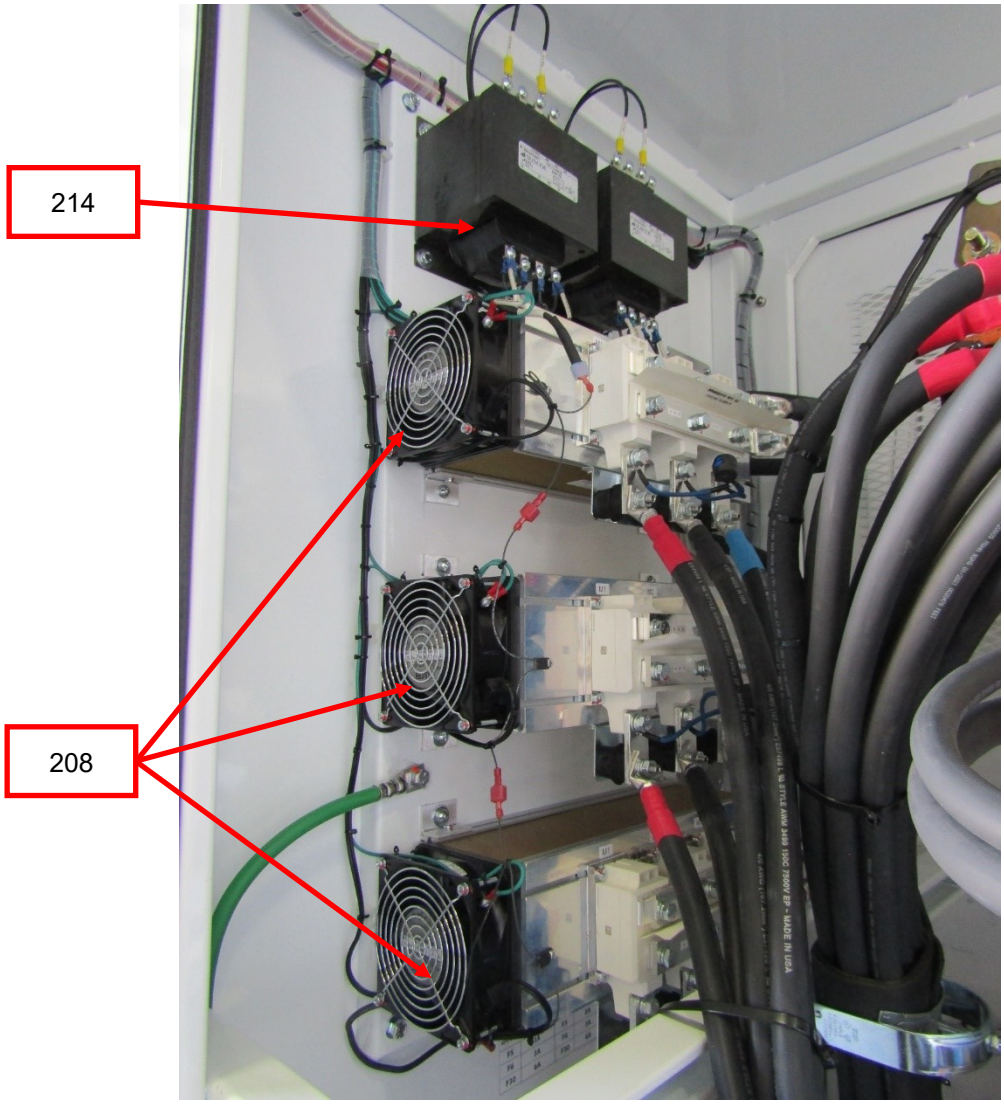
ITEM #	DESCRIPTION
115	Pipe Clamp, Cobra EMT/RIGID 3"

F.15 TRANSFORMER SECTION - MID



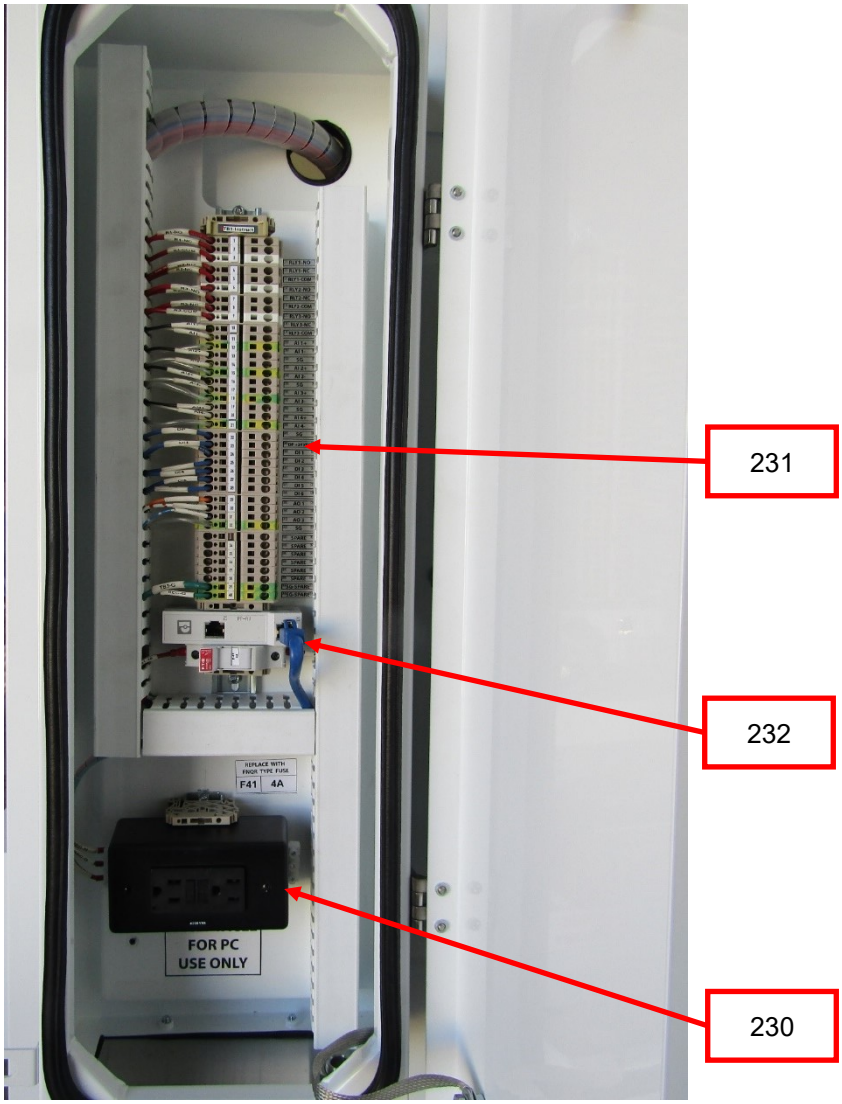
ITEM #	DESCRIPTION
212	Fan, 10" Axial, 850 CFM, 85 to 130 Vac

F.16 TRANSFORMER SECTION – LEFT VIEW FROM REAR



ITEM #	DESCRIPTION
214	CPT1&2 Transformer, 1000VA, 380/440/480-120/240, 50/60 Hz, 70C
208	6 Pulse Rectifier Stack - 380-480V, Max 350A

F.17 LOW VOLTAGE JUNCTION BOX



ITEM #	DESCRIPTION
230	DIN Rail GFCI Receptacle, 15A, 120V
231	TB3 Field Wiring Terminations
232	Patch Communications Port

Appendix G: **E30 Drive Support Resources**

PRODUCT DOCUMENTATION

This manual is the main product documentation for the INSTRUCT E30 Intelligent VSD.

GUIDES AND RELEASE NOTES

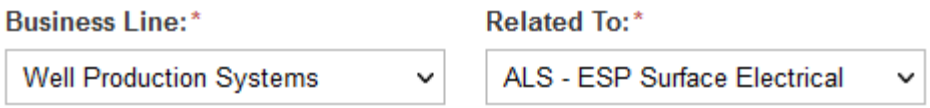
General guides, best practices, technical alerts and software release notes for the E30 drive are available at InTouch 7754390 Reference Page.

TECHNICAL SUPPORT

You can reach us via the Lift Control Systems Custom Service email:

liftcontrolsystems@sensiaglobal.com

- For Schlumberger customers, an InTouch ticket should be raised to Well Production System – ALS-ESP Surface Electrical helpdesk.



HOW TO REACH US

You can find more information about Sensia and the E30 drive here:

Sensia Home Page:	https://www.sensiaglobal.com/
Sensia Lift Control Solutions Page:	https://www.sensiaglobal.com/Sensia-Lift-Control-Systems
Sensia Lift Control Drives Page:	https://www.sensiaglobal.com/Sensia-Lift-Control-Systems/Lift-Control-Drives
Contact Us:	https://www.sensiaglobal.com/Contact