FP2000 Power Converter System Installation Manual for Indoor Units

W10303

Approved Use

External Use – NDA Required	**X**
Internal Use Only	

Revision History

Revision	Date	Description of Change
A	07/27/2016	Initial release.
B	10/11/2017	Updates to comply with UL1741 certification standards for indoor units.
C	02/05/2018	Updated for UL1741 compliance review by Certification Agency (QPS).
D	02/13/2018	Updated for UL1741 compliance.

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Contact

If Northern Power needs to be contacted during the installation or operation of the power converter at any time for any reason (e.g. clarification of procedures described herein, or report of damage to the FP2000 Power Converter), contact information is listed below:

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Requests for additional documentation, technical support, as well as all comments, suggestions, or questions about this manual, email us at support@northernpower.com or call us at:

1-877-90-NORTH

1-877-906-6784

1 Introduction

1.1 *About This Manual*

This manual is intended instructions for the installation of Northern Power Systems FP2000 Power Converter Systems (PCS) in energy storage applications.

This manual specifically applies to FP2000 PCS for indoor applications; as further specified by the following list of NPS part numbers:

1019250-01 (single inverter with side AC connections)

1019250-02 (single inverter with top AC connections)

1019250-03 (dual inverter with side AC connections)

1019250-04 (dual inverter with top AC connections)

Any personnel who operate or maintain this equipment should be familiar with the operation and maintenance manual *Y10284 – FP2000 Power Converter O&M Manual* and should have it available for reference. Be sure to read the important safety instructions in Section 2, Safety Information.

Refer to this Installation Manual and to the O&M Manual for system specific procedures and information including safety procedures, converter lock-out, rigging & lifting, cooling system and system operation.

1.2 *References*

System reference documents

1. Y10284: FP2000 Operation and Maintenance Manual

2 Safety Information

IMPORTANT SAFETY INSTRUCTIONS. SAVE THESE INSTRUCTIONS.

This manual contains important instructions for all FP2000 models that must be followed during installation and maintenance of the power converter.

2.1 *Safety Symbols and Definitions*

Table 2-1 is a list of safety symbols noted throughout the manual and/or located on the equipment. Symbols are displayed on the left and their corresponding definitions to the right.

Table 2-1: Safety Symbols and Definitions.

DANGER	**DANGER** indicates a potentially hazardous situation that if not avoided will result in death or serious injury.		
WARNING	**WARNING** indicates a potentially hazardous situation that if not avoided could result in death or serious injury.		
NOTICE	**NOTICE** indicates a potentially hazardous situation in which failure to follow instructions may result in damage to the equipment.		
	This symbol indicates a potential risk of electrical shock.		This symbol indicates that accompanying documents should be consulted prior to installation and operation.
	This symbol indicates a potential risk of arc flash.		This symbol indicates a potential slipping hazard.
	This symbol indicates a device is susceptible to electrostatic discharge (ESD)		

	This symbol indicates that only authorized personnel may service this equipment		This symbol indicates power must be disconnected from the system prior to servicing.

2.2 *Electrical Equipment Hazards*

The following equipment electrical hazards may be present during installation. Table 2-2 displays the standard electrical hazards of the equipment and Table 2-3 provides the short circuit current contribution that may be provided by the converter.

Table 2-2: Standard Equipment Electrical Hazards.

Equipment	Nominal Operating Voltage
DC distribution	Up to 1000 Vdc
AC distribution	Up to 480 Vrms
Control system	24 Vdc, 480 Vrms

Table 2-3: Output Short Circuit Current (SCC) Contribution (two-inverter option).

Parameter	Value	Unit	Duration (ms)
Initial SCC	<2652	A_{RMS}	16.7
Max SCC	<5000	A_{PEAK}	8.0
Breaking SCC	2400	A_{RMS}	steady-state

2.3 *Safety Warnings*

Table 2-4 is a list of safety warnings of events that may occur during installation of the converter.

Table 2-4: Safety Warnings.

		**HIGH VOLTAGE**
		**Shock and arc flash explosion hazards.** Follow all requirements in NFPA 70E for safe work practices and for personal protective equipment.
		Hazardous voltage. Disconnect power before servicing. ONLY authorized personnel may service this equipment.
		**Utility Interconnected** Power fed from more than one source. Disconnect all power supplies before servicing.
		Wait at least 20 minutes for capacitors to discharge before removing back panels.
		Contains parts and assemblies susceptible to damage by electrostatic discharge (ESD). ONLY authorized personnel may service this equipment.
		Replace fuse with same type and rating.

2.4 *Battery Overcurrent Protection*

WARNING: Overcurrent protection for the Battery Circuit must be provided by the user.

The FP2000 PCS includes DC Input overcurrent protection for the PCS which is described in the operation and maintenance manual *Y10284 – FP2000 Power Converter O&M Manual*

3 System Overview

The FP2000 Power Converter is a water cooled, IGBT-based, AC-DC power converter for use in energy storage applications. The FP2000 Power Converter uses NPS's proprietary FlexPhase™ power modules. The FP2000 Power Converter cabinet contains one or two inverter circuits, each with an electrically-operated AC breaker and DC contactor. For detailed information on commissioning, operation and maintenance instructions, please see *Y10284 – FP2000 Power Converter O&M Manual*.

3.1 *Cabinet Overview and Options*

The main connection points are shown in Figure 3-1 and further discussed in Section 5, Electrical Installation.

The side access option (Direct Bus Coupler option), shown in Figure 3-2 allows the cabinet to be attached directly to a transformer for shorter AC connections.

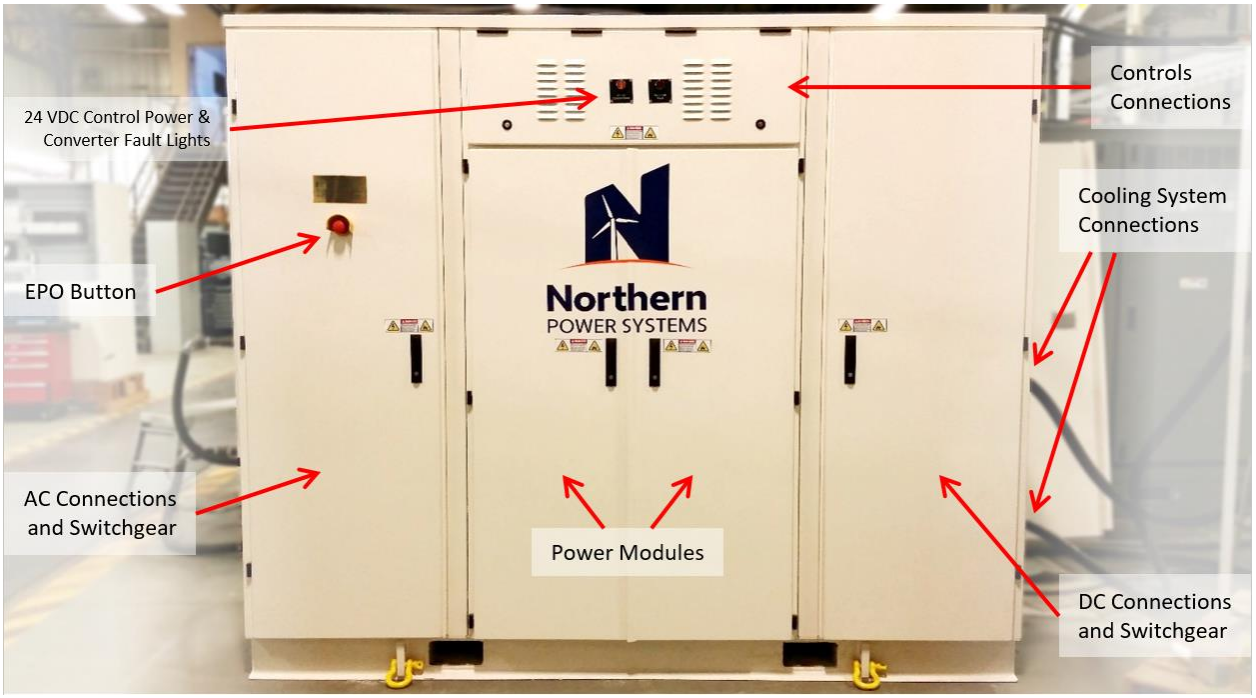


Figure 3-1: Converter Cabinet Locations of Major Components and Connection Points.

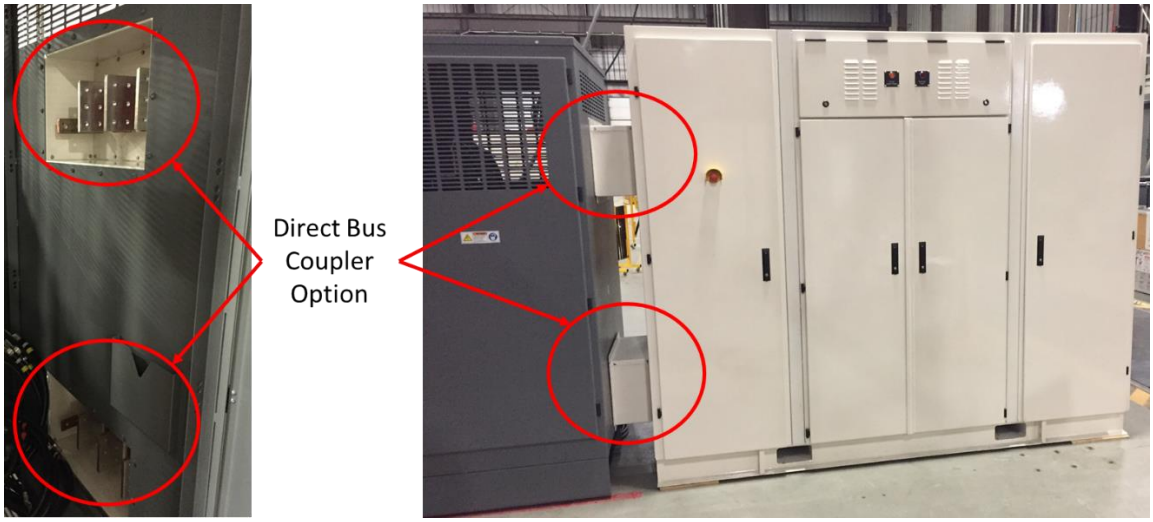


Figure 3-2: AC Connection with Direct Bus Coupler Option (one per AC circuit breaker).

FP2000 PCS can be configured for one or two inverter circuits. Cabinets with one inverter will have three modules in the bottom racks and cabinets with two inverters will have six modules in the top and bottom racks, see Figure 3-3.



Figure 3-3: Cabinet configurations with one inverter circuit (left, 3 modules) and two inverter circuits (right, 6 modules).

3.2 *System Specifications*

Error! Reference source not found. displays the PCS specifications for installation and storage.

Table 3-1: Power Converter Specifications.

Parameter	Value	Units
Enclosure Rating	NEMA 1	
Ambient Temperature (rated)	35	℃
Ambient Temperature (range)	-25 to 40	℃
Storage Temperature	-40 to 50	℃
Relative Humidity (non-condensing)	5 to 95	%
Converter Mass (includes modules)	1900 (3 modules)	kg
	2650 (6 modules)	
Inverter Module Mass	155	kg
Dimensions (WxHxD) (includes base frame with fork pockets)	2882 x 2229 x 977	mm
AC Power Entry	Left Side or Top Left	
DC Power Entry	Top Right or Bottom Right	
Dowfrost HD 50/50 Coolant Flowrate	1.3 (3 modules)	l/s
	2.2 (6 modules)	
Coolant Volume (converter only)	13 (3 modules)	l
	16 (6 modules)	
Max Coolant Conductivity	5	mS/cm

3.3 *Voltage & Frequency Trip Limits*

Refer to *Y10284 – FP2000 Power Converter O&M Manual* for description of the available voltage and frequency protections, as well as default protection settings and ranges for adjustability by the user.

4 Mechanical Installation

4.1 *Converter Inspection and Unpacking*

The converter is shipped either on a wooden skid with wooden crating, or tarped. Upon receipt and while unpacking, inspect for visible damage that may have occurred during shipment. If damage is found, document it and notify the carrier and Northern Power.

4.2 *Handling and Movement*

4.2.1 Cabinet

The converter cabinet has integral provisions for forklift use. See Figure 4-1.

The cabinet may be hoisted by crane using load rated shackles or brackets located at each of four lifting locations adjacent to the fork pockets in the cabinet base weldment (indicated by the red arrows in Figure 4-1). The hole diameter for the shackle pins is 1". The cabinet is not designed to be lifted from the top structure.

NOTICE	**To prevent damage to the converter, hoist converter only using a spreader bar that is equal width to the cabinet or other suitable lifting fixture.**

When moving the cabinet, make sure all modules are secured and all doors are fully closed and secured.



Figure 4-1: Proper Movement of the Cabinet with a Forklift. The red arrows indicate 3 of the 4 lifting locations for crane use; the other is on the back left forklift pocket.

4.2.2 Modules

The power modules are shipped installed in the converter cabinet. All power modules have a threaded hole on the top of the module for the installation of an M10x1.5 lifting eye bolt. The modules should be lifted using this point. For more details on module insertion/removal, refer to the FP2000 Operations and Maintenance Manual. The specific module masses are listed in Table 3-1: Power Converter Specifications.

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4.3 *Location and Mounting Requirements*

4.3.1 Environmental

The NEMA1 version of the container is designed for mounting in a container or building.

Acceptable temperature and relative humidity ranges are specified in Section 3.2

4.3.2 Mechanical Mounting

The converter must be mounted on a flat rigid surface capable of supporting the total converter mass and any customer installed ancillary equipment.

Set converter cabinet in desired location. Shim or level to prevent motion. Secure to concrete and/or floor as required. The suggested method is to use strap or setup clamps bolted into the pad or floor.

Contact NPS for recommendation and consultation if you have specific questions regarding your installation and site plan.

Space Requirements:

1. Access for routing electrical and control cables is required.
2. Adequate clearance for cooling connections.
3. Front access is required for converter service and general maintenance. The access area needs to be large enough for the doors to open and power modules to be removed.
4. For more details, see Figure 4-2: Converter Mechanical Mounting – Isometric View and Figure 4-3: Cabinet Door Swing – Top View.

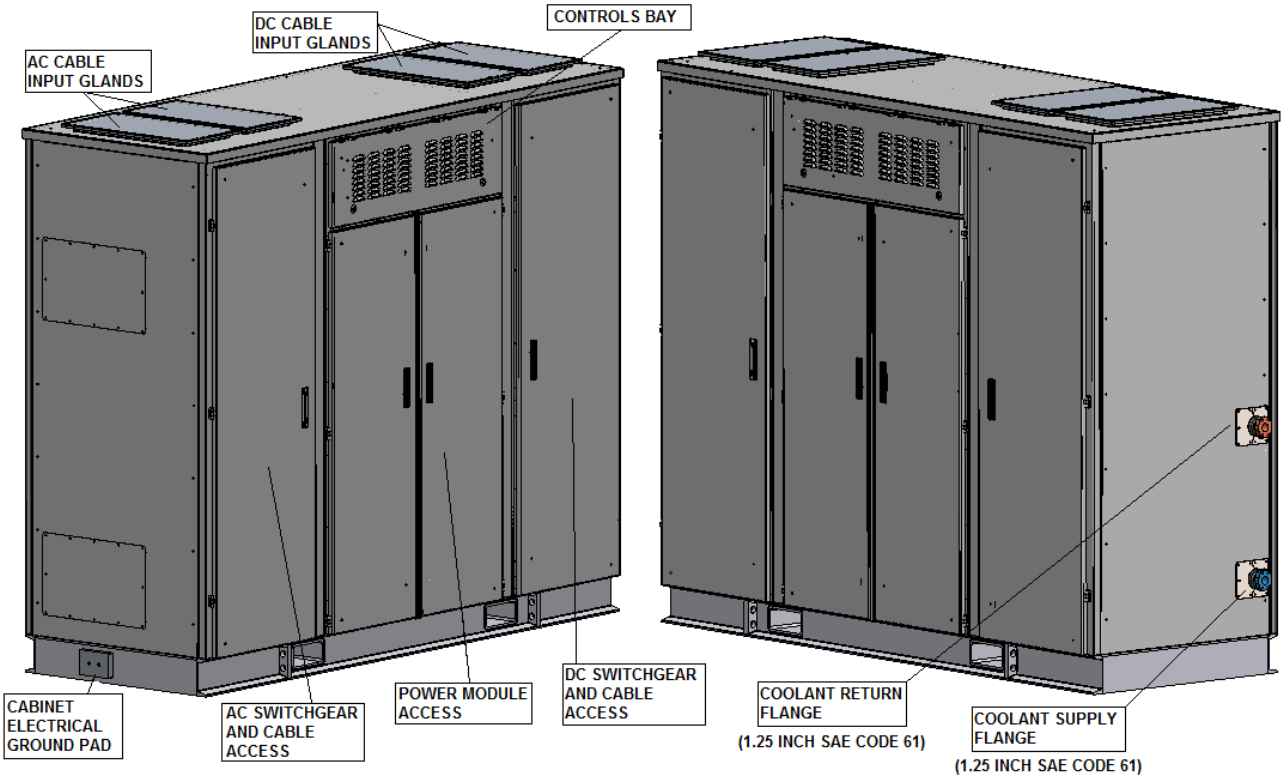


Figure 4-2: Converter Mechanical Mounting – Isometric View.

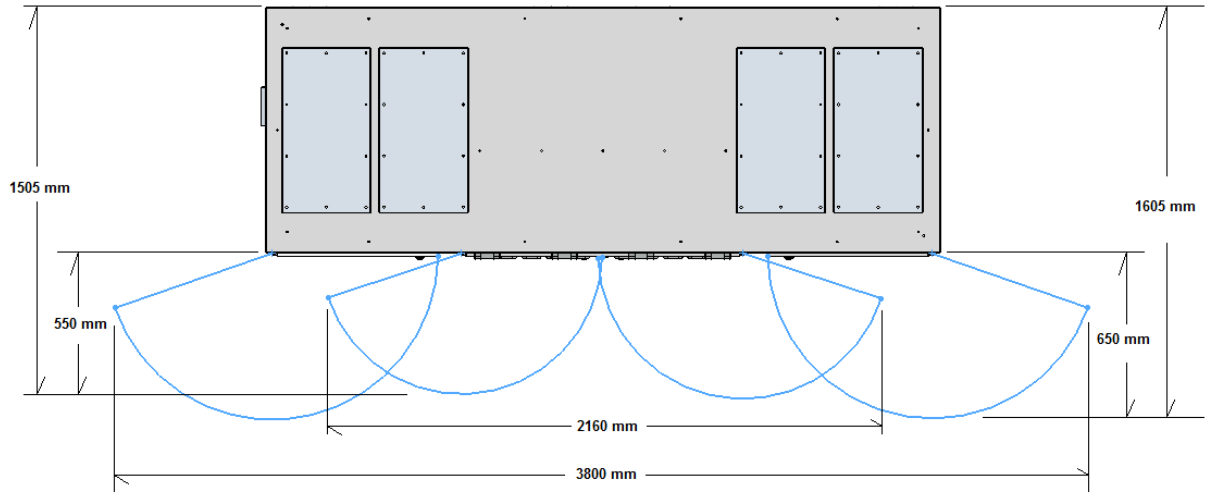


Figure 4-3: Cabinet Door Swing – Top View.

4.4 *Cooling System*

The FP2000 Power Converter requires an external cooling system, per the specifications listed in Table 3-1.

Use ONLY DowFrost 50/50 HD coolant in the FP2000 Power Converter.

The coolant should be within the coolant manufacturer's specifications and should have a maximum conductivity of 5mS/cm.

NOTICE	
	DowFrost HD 50/50 is a propylene glycol-based coolant. Slipping hazards may be present if coolant is spilled. Proper PPE is recommended.

The cooling system connections on the inverter cabinet protrude from the right end of the cabinet (facing the front) as shown in Figure 4-2. Note the supply to the cabinet is the lower connection, while the return to the cooling system is the top connection. These inlet and outlet connection interfaces are made with 1-1/4" SAE CODE 61 flat face flanges and require the like from the external cooling system. Contact Northern Power System for more information or assistance with selecting and installing an external cooling system to the FP2000 Power Converter.

The converter system is shipped without coolant, however a residual amount of coolant remains in the converter from factory testing and may drain out when the cooling flange caps are removed to make the cooling system connections.

Refer to *Y10284 – FP2000 Operations and Maintenance Manual* for more info regarding operation of the converter in high humidity conditions.

NOTE: If a leak occurs when initially filling and pressurizing the system, contact Northern Power Systems immediately for further direction as the cooling system may have been damaged during shipping.

5 Electrical Installation

WARNING: These installation instructions are for use by qualified personnel only.

This section contains important instructions for electrical installation of all FP2000 Power Converter models. To reduce the risk of electric shock, do not perform any servicing other than that specified in the installation instructions unless you are qualified to do so.

DANGER		**HIGH VOLTAGE MAY BE PRESENT.** Contact with energized components will cause electrical shocks and may result in burns, serious injury or death. Turn off and lock out the system and any power sources prior to servicing.
WARNING		**ENERGY MAY BE STORED IN CAPACITORS.** Wait at least 20 minutes for capacitors to discharge before removing back panels or dead front panels from AC Bay or DC Bay, or FlexPhase™ Power Modules.
NOTICE		**AUTHORIZED PERSONNEL ONLY.** Only authorized personnel may service this equipment.

The converter requires the electrical interconnections listed in Table 5-1. Details can be found in the following sections.

Utility interconnection may require approval from the local authority having jurisdiction.

Conductor sizing should be made in compliance the National Electrical Code, ANSI/NFPA 70, taking into account installation conditions.

Table 5-1: Electrical Interfaces.

Function	Voltage	Phase	Current	Location
Grid Power Connection(s)	320 / 480 VAC	3	1200 or 2x1200 or 2400 Arms Max (actual based on application)	Top entry or roof external bus coupler connection(s) to AC cabinet bay.
DC Source Connection(s)	480 - 1000 VDC	DC	1250 or 2x1250 A Max (actual based on application)	Through roof or through floor in DC cabinet bay.
PCS Control Power	400-480 VAC	3	5 Arms	Connections in top center of cabinet, hole penetration location is application specific.
	24 Vdc (an AC option is also required)	DC	40 A	
Control Inputs/Outputs	Outputs: Dry contacts rated to 250V	N/A	<1A	Connections in top center of cabinet, hole penetration location is application specific.
	Inputs: 24 VDC, expecting customer to use isolated dry contact	N/A	<50 mA	

5.1 *Power Cables*

Installation instructions and pictures for the electrical interconnections required to operate the converter are described in this section. The general locations for power connection points are shown in Figure 3-1: Converter Cabinet Locations of Major Components and Connection Points.

5.1.1 AC Connection

5.1.1.1 Location

AC busbars for phases A, B and C and ground are labeled as ‘A’, ‘B’, ‘C’ and ‘GND’ respectively; each are followed by a ‘1’ or ‘2’ to indicate whether they are connected to Inverter 1 (bottom, modules FM1-3) or Inverter 2 (top, modules FM4-6). Note that the AC neutral point is NOT bonded to ground.

For units requiring top entry cable routing, AC output connections are made to the busbars shown in Figure 5-1. They are located on the right side looking into the back of cabinet. Conductors should be routed out the top of the cabinet and arranged in ABC+G bundles if possible.



Figure 5-1: AC Connection Points for Inverter 1 requiring Top Entry Cables.

For units with the Direct Bus Coupler Option, AC output connections are made to the busbars shown in Figure 5-2 and protrude from the AC-side of the cabinet. This option allows for shorter cables that do not need to exit the enclosure of the isolation transformer.



Figure 5-2: AC Connection Points for Inverter 1 for Units with the Direct Bus Coupler Option.

5.1.1.2 Terminal Connection Hardware

For phases A,B,C there are through holes (6 holes per phase) in the bus bar; for the internal ground connection there are 2 through holes. Cables can be affixed on either side of the bus bar, allowing for a maximum of 12 cables/phase. Use an appropriately specified corrosion inhibitor when deemed necessary.

The following are guidelines for the connection hardware to be used:

- Busbars are C11000 Electrolytic Tough Pitch Copper, tin-plated per ASTM B-545
- Use Zinc-plated steel bolts, nuts, and flat washers
- M12 x 1.75, grade 8.8, dry threads (no lube)
- Use one conical washer, compliant with DIN 6796 or equivalent, combined with a fender washer, compliant with DIN 9021 or equivalent, to maintain constant contact pressure
- Tightening torque 93Nm
- Bolt length as required to achieve 100% thread engagement with a minimum of 2 threads protruding from the face of the nut. Avoid bolt lengths which cause clearance issues to adjacent phases, or grounds.

5.1.1.3 Cable Requirements

Each AC phase has a maximum current of 1200 Arms per inverter (2400Arms for two inverters) and a rated nominal output voltage range of 320 to 480Vac. Cables should be sized to for a maximum temperature of 90C. The cable should be sized for the ampacity of the actual application or the current mentioned in this section. Any cables connected to the AC busbars should be rated for at least 600 V and 90C in order to comply with the National Electric Code, ANSI/NFPA 70E. If the cables are connected to an external piece of equipment that exceeds the ratings listed here, then the cables shall be rated and sized to comply with the ratings of the external equipment.

Size ground cables according to the National Electric Code, ANSI/NFPA 70E.

5.1.2 DC Connection

5.1.2.1 Location

Positive and negative DC busbars are labeled inside the cabinet as ‘DC+’ and ‘DC-‘; each are followed by a ‘1’ or ‘2’ to indicate whether they are connected to Inverter 1 (bottom, modules FM1-3) or Inverter 2 (top, modules FM4-6).

DC source connections are made to the busbars shown in Figure 5-3. They are located on the left looking into the back of the cabinet. Conductors should be routed through the top of the cabinet and arranged in positive and negative pairs. Depending on the sizing of the wires, air gaps between the bundles may be required.

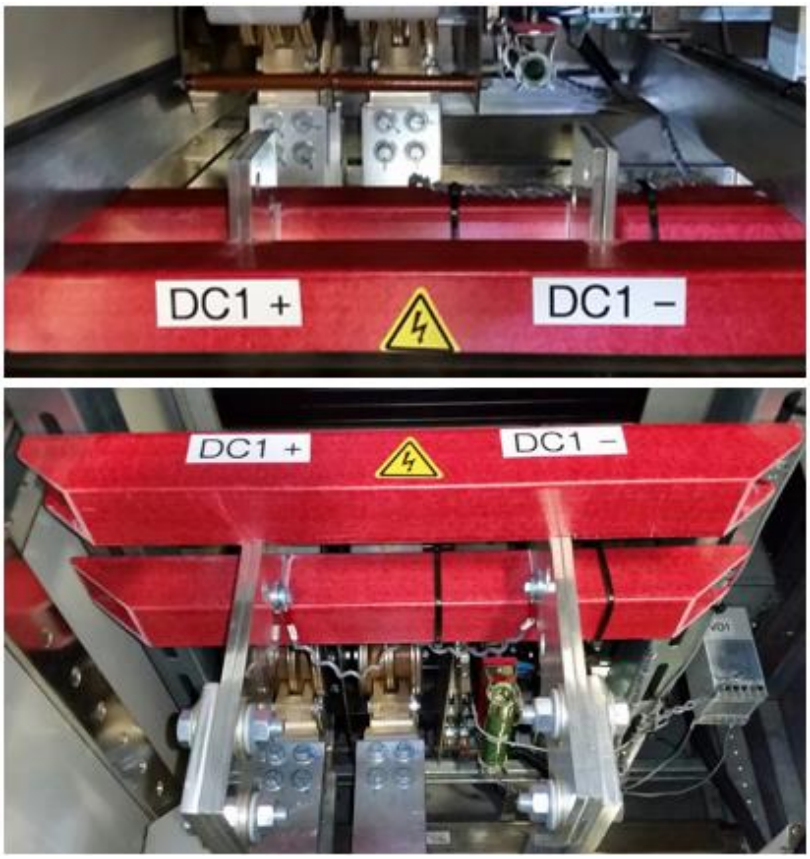


Figure 5-3: DC Connection Points for Invert 1 requiring Top Entry Cables.

The ground connection for the DC side of the converter is a vertical bar located on the right side (facing the doors) of the cabinet and is labeled as 'GND', see Figure 5-4. This location is always the same regardless of circuit configuration. Note that in cabinets with two inverters the DC busbars for Inverter 2 will leave less room for routing the ground cable from this location.



Figure 5-4: Ground Connection on the DC-Side (outlined in red), Looking into the Back of the Cabinet.

5.1.2.2 Terminal Connection Hardware

Follow the same guidelines for connection hardware shown in Section 5.1.1.2.

5.1.2.3 Cable Requirements

Each DC busbar is rated for a maximum current of 1250 ADC for each inverter and a maximum voltage of up to 1000 VDC, depending on the circuit configuration of the PCS. Any cables connected to the DC busbars should be rated for at least 1000 VDC and sized for a maximum temperature of 90°C that comply with the National Electric Code, ANSI/NFPA 70E. If the cables are connected to an external piece of equipment that exceeds the ratings listed here, then the cables shall be rated and sized to comply with the ratings of the external equipment.

5.1.3 Auxiliary Power

Auxiliary power supply for the converter controls must be 400/480 V, 60Hz three phase and 5 A. Use copper wire rated to 90°C and 600V; sizes 8 – 14 AWG.

The connections are made to the top of S20, located in the AC-side of the converter near the top and attached to the outside of the controls bay (the switch used to manually control it is located to the left inside the controls bay). These wires are to be run through the top of the cabinet, see Figure 5-5. The wire connections to S20 are listed in Table 5-2.

A ground is not required at this location but a provision is made for termination of one (included in Figure 5-5). Do NOT connect a neutral wire to the N terminal in S20.

These wires leave the enclosure and therefore must be enclosed themselves in conduit, a cable or another form of protection that complies with local electric code.

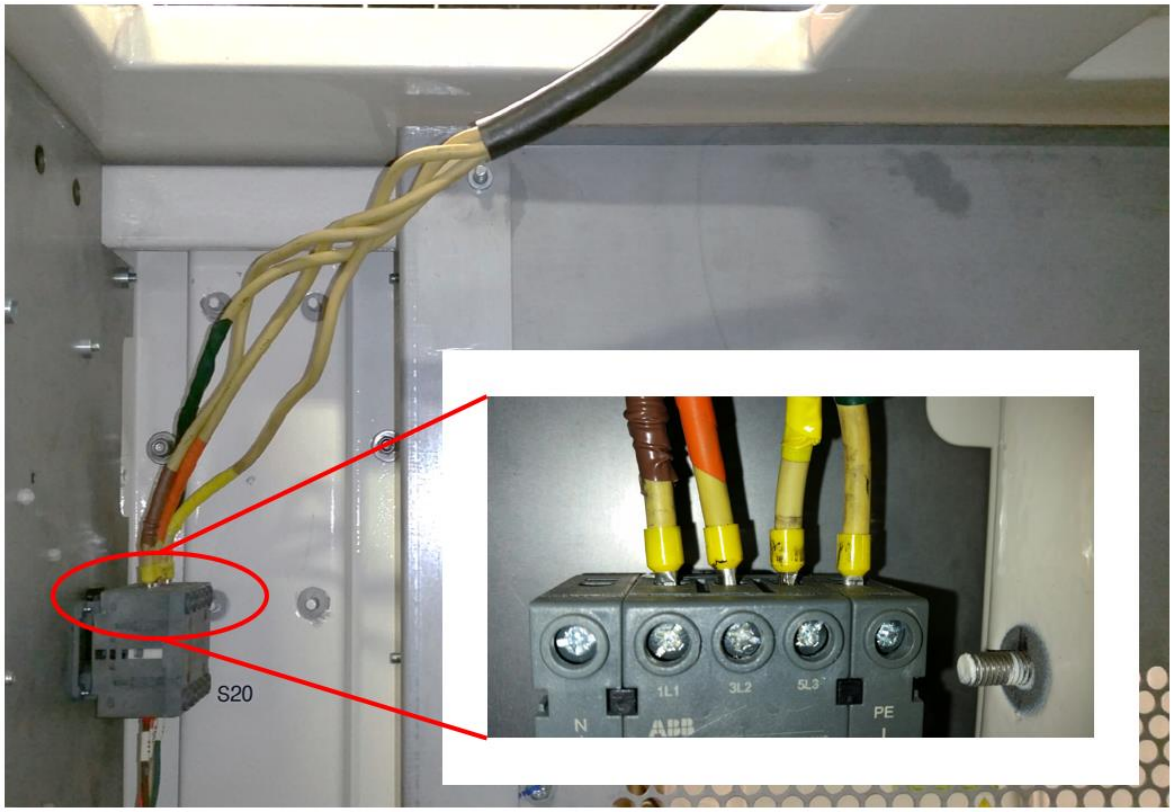


Figure 5-5: Auxiliary power Connections to S20 Requiring a Top Entry Cable.

Table 5-2: Auxiliary Power connections to S20.

AUX Power Connections		S20 Terminal
Neutral		N
400-480V	Phase A	1L1
	Phase B	3L2
	Phase C	5L3
Ground		PE

5.1.4 24 VDC Connection Option

This supply can be used with or as an alternative to the 400/480V auxiliary power. The connection point is located in the top center of the controls bay and requires 24 VDC and 40A. See Figure 5-6.

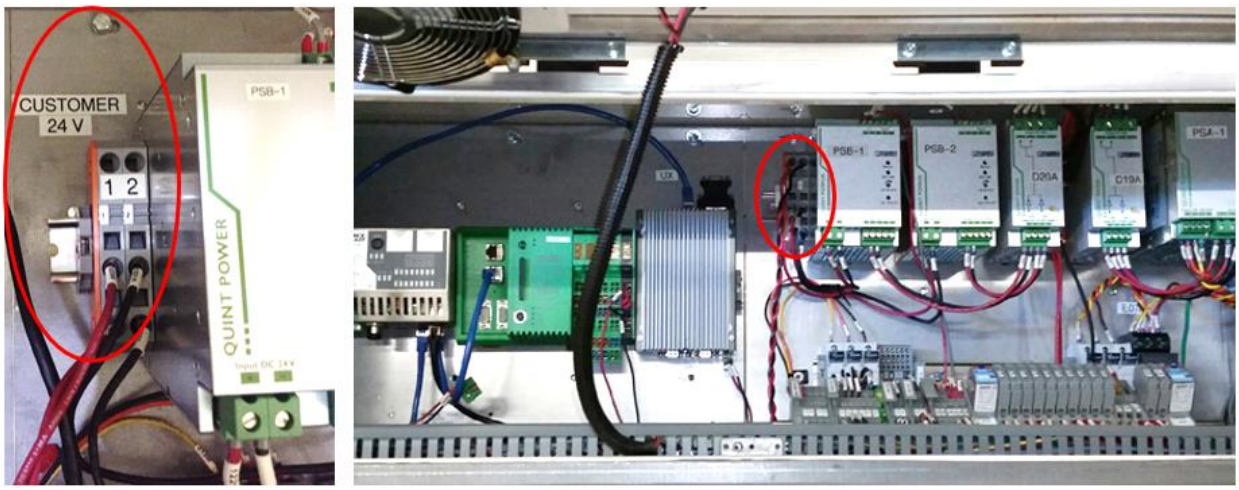


Figure 5-6: Customer Supplied 24 VDC Option (circled in red).

5.2 *Control & Communication Cables*

5.2.1 Locations

The controls cables terminate in the controls bay in the top center of the PCS cabinet; Figure 5-7 indicates the locations of these terminations. For access door location, refer to Figure 3-1Figure 3-1: Converter Cabinet Locations of Major Components and Connection Points.

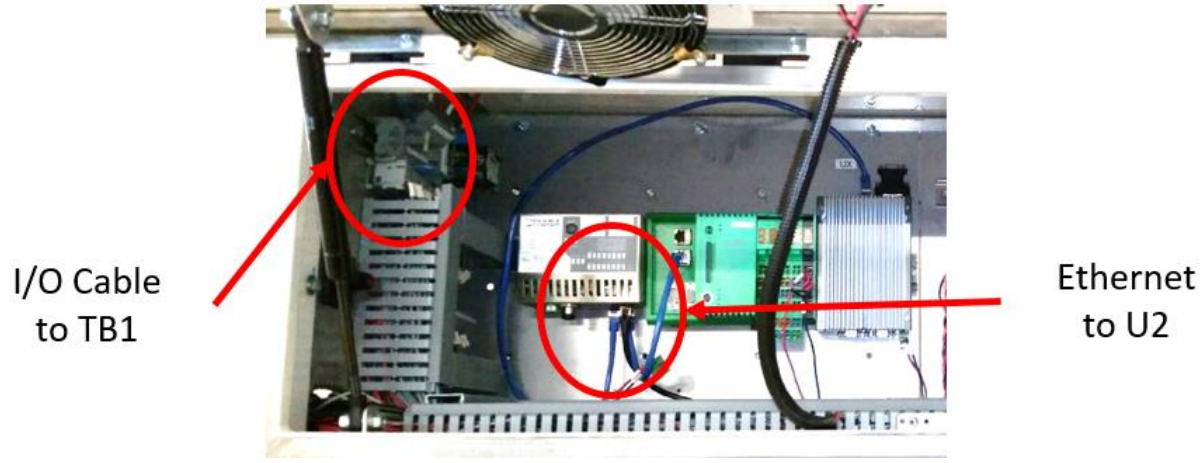


Figure 5-7: Controls wiring connection locations.

5.2.2 Routing & Requirements

The required controls connections are:

- Ethernet cable connection, CAT5/E or CAT6, shield recommended (1x).
- I/O Signal cable connection (1x 10 conductor)

Control wires should be routed along a continuous ground plane and away from power wiring. Grounding jumpers are recommended to maintain a continuous ground plane.

Parallel routing of control and power wiring should be avoided whenever possible. Control wiring should cross power wiring only at 90 degree angles.

Use of a shielded cable with shield ground terminated at each end is recommended for all control wiring. If there are unused conductors within a multi-conductor cable, then all unused conductors should be grounded at one end of the cable.

5.2.3 Connections

5.2.3.1 Ethernet connection:

The FP2000 Power Converter is factory configured as follows:

- Customer connection: Port 5 of the managed Ethernet Switch (U2), See **Error! Reference source not found.**.
- Cooling system connection: Port 3 of the managed Ethernet Switch (U2), See **Error! Reference source not found.**.
- Port Specifications: RJ-45 (suitable for CAT5/E or CAT6).

The managed Ethernet switch is located in the Controls Bay. In order to maintain the converter's IP rating, a cable gland must be used to completely seal the cable entrance location. For instructions on how to setup communications for operation, see *Y10284 – FP2000 Power Converter O&M Manual*.



Figure 5-8: U2 in controls bay, Available Ethernet ports are indicated by the red arrow.

5.2.3.2 I/O Signal cable connection:

Control wires are to be installed on TB1, located in the upper left corner of the controls bay, see Figure 5-9. Connections should be made to the terminals circled in red. Their functions are listed in Table 5-3.

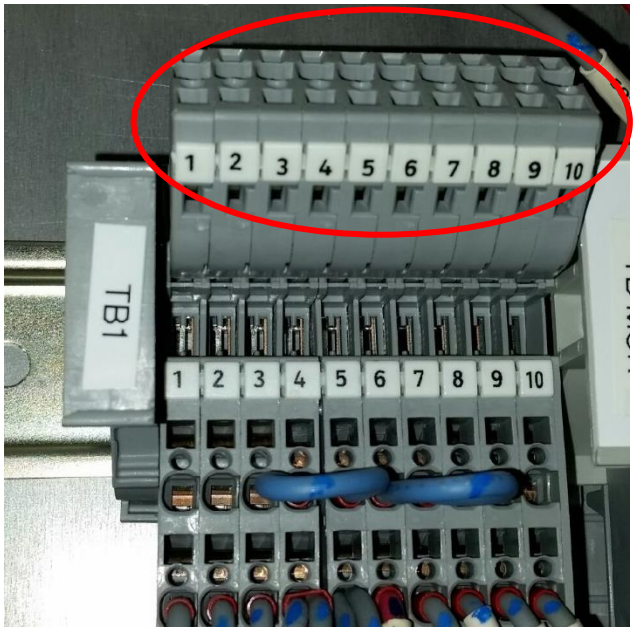


Figure 5-9: TB1.

Table 5-3: I/O Signal Cable Connections and Functions.

TB1 Terminal	Function	
1	EPO Button NC Contact (Customer Return)	
2	EPO Button NO Contact (Customer Return)	
3	Customer Supply to E-Stop Button	
4	Run permissive out to customer (24VDC)	Jumper Installed at Factory
5	Run Permissive return	
6	Start permissive out to customer (24VDC)	Jumper Installed at Factory
7	Start permissive return	
8	PCS Fault Relay NO Contact	
9	PCS Fault Relay NC Contact	
10	Customer Supply to PCS Fault Relay	

5.3 *Grounding the Cabinet*

5.3.1 Location

Internal ground connections are located next to the AC busbar connections for both top-entry and side-entry units, see Figure 5-1 and Figure 5-2, as well as vertically along the side of the DC Bay, see Figure 5-4.

An external cabinet ground connection is located outside of the cabinet, on the bottom of the AC-side. See Figure 5-10.

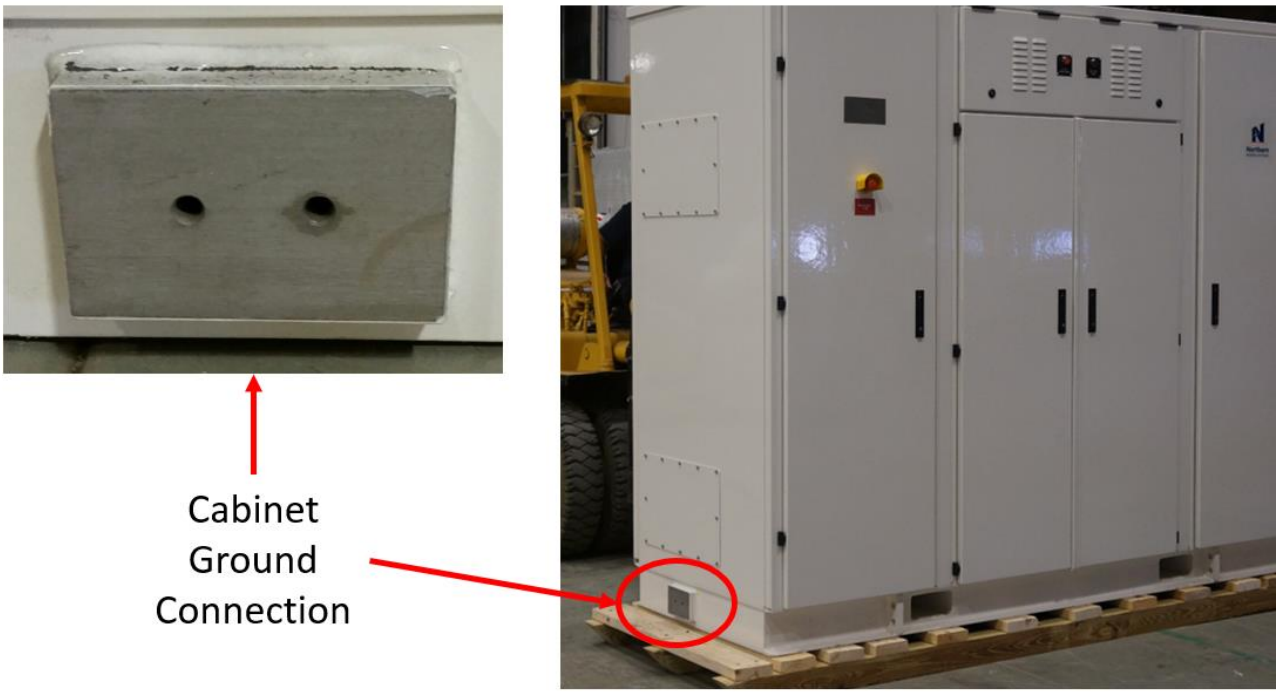


Figure 5-10: External Cabinet Ground Connection.

5.3.2 Routing & Requirements

NOTE: At least one of these ground connections (internal or external) is required to be installed to an external Earth ground connection prior to operation of the converter.

Use an appropriately sized cable to comply with the National Electric Code, ANSI/NFPA 70E.

5.3.3 Terminal Connection Hardware

Hardware installation instructions for the internal ground connection are provided in Sections 5.1.1, AC Connection, and 5.1.2, DC Connection.

The external cabinet ground connection has two threaded holes, each designed for M12x1.25 hardware. It is recommended to use screws that allow thread engagement between 20mm and 24mm, a fender washer and a compression lug, such that the lug is touching the ground connection point, to make this connection, See Figure 5-11. The use of a conductive thread paste, such as Noalax, is also

recommended, but not required. Torque this hardware to 60Nm if thread paste is used or 93Nm if the threads are left dry.



Figure 5-11: External Cabinet Ground Connection with Hardware Installed.

5.4 *External Equipment Requirements*

5.4.1 Isolation Transformer

Table 5-4 below displays the required electrical ratings of an external transformer that is to be connected to the AC side of the converter.

Table 5-4: Electrical Ratings for External Isolation Transformer.

NPS PCS Circuit Configuration		3XX	6XX	3XX	6XX
Number of Inverters per Cabinet		1	2	1	2
Number of Modules per Cabinet		3	6	3	6
PCS-side Voltage, Nominal	Vrms	480		320	
Apparent Power, Minimum Continuous @ 35 °C*	kVA	952	1904	665	1330
PCS-side Winding Configuration		Delta			
PCS-side Minimum BIL	kV	10			
Grid-side Voltage, Nominal	Vrms	As required			
Grid-side Winding Configuration		As required			
Nominal Frequency	Hz	60			
Nominal Impedance	%Z	5 to 6			
K Factor		K04			
Shield or Screen		Recommended			

5.4.2 **Battery**

The FP2000 Power Converter is versatile in the battery technologies it can support; some examples include lithium, lead acid and flow batteries. Regardless of which battery technology selected, it is essential that it meets the operating ranges of the power converter in order to perform as designed. Note that the converter does not monitor the cooling means of any connected batteries.

WARNING: Installation of a battery or other means of energy storage that do not meet the operating ranges of the power converter may result in damage to the equipment and harm to nearby personnel.

5.4.2.1 Nominal Voltage Ratings

Batteries or other means of energy storage connected to the converter must have nominal voltages that are within the nominal DC input range for the converter. These ranges vary based on the output AC voltage configuration and are listed in Table 5-5. Note that the values for maximum DC input voltage are limited to comply with UL 1741 certification.

Table 5-5: DC Input Voltage Ranges.

NPS PCS Circuit Configuration		3XX	6XX	3XX	6XX
Number of Inverters per Cabinet		1	2	1	2
Number of Modules per Cabinet		3	6	3	6
Nominal AC Voltage	Vrms	480		320	
Maximum DC (Input) Voltage	VDC	1000		1000	
DC Voltage Range	VDC	720 - 1000		480 - 1000	

5.4.2.2 Overcurrent Protection

WARNING: Overcurrent protection for the Battery Circuit must be provided by the user.

The FP2000 PCS includes DC Input overcurrent protection for the PCS which is described in the operation and maintenance manual *Y10284 – FP2000 Power Converter O&M Manual*

5.4.3 **AC Disconnect**

An external AC disconnect is to be installed in between the grid connection and the external isolation transformer. This disconnect should be rated to a minimum of the converter specifications, listed in Table 5-1: Electrical Interfaces, or to a minimum of the external isolation transformer specifications – whichever are greater.

5.4.4 **DC Disconnect**

An additional external DC disconnect is to be installed in between the converter and the battery. This disconnect should be rated to a minimum of 1250 A and have a short circuit rating suitable for the attached battery. All other ratings should meet either the converter specifications, listed in Table 5-1: Electrical Interfaces, or the battery specifications – whichever are greater.

5.4.5 **Anti-islanding Protection**

Anti-islanding protection is not provided in the equipment and may be subject to investigation by local authorities having jurisdiction.

6 Glossary

Term	Definition
CB	Circuit Breaker
Control Constants	Parameters which must be set while the converter is in the Off state as part of the commissioning process. Values may be entered while the converter is operating; however, they will not be updated and utilized until after the converter has stopped.
DC	Direct Current
DSP	Digital Signal Processor
EPO	Emergency Power Off
ESD	Electrostatic Discharge
IGBT	Integrated Gate Bi-polar Transistor
I/O	Input / Output
LED	Light Emitting Diode
LAN	Local Area Network
MIB	Module Interface Board
PCS	Power Converter System
PPE	Personal Protection Equipment
RTD	Resistance Temperature Detector
RTU	Remote Terminal Unit
SCB	System Control Board – Northern Power Systems DSP based converter control board
TB	Terminal Block
TCP	Transmission Control Protocol
UPS	Uninterruptible Power Supply
VA	Apparent Power
VAC	Volts Alternating Current
VAR	Volt-Ampere Reactive
VDC	Volts Direct Current