Cordex® HP 2.4/3.0 kW Switched Mode Rectifier Systems

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Effective: 03/2023

Read this document carefully
Learn how to protect your equipment from damage and fully understand its functions.

Cordex® HP 2.4/3.0 kW Switched Mode Rectifier Systems

NOTICE

For the latest version of software, firmware, and product documentation, visit the Alpha® website, www.alpha.com or www.alpha.ca.

NOTICE

Photographs contained in this document are for illustrative purposes only. These photographs may not match your installation.

NOTICE

Operator is cautioned to review the drawings and illustrations contained in this document before proceeding. If there are questions regarding the safe operation of this powering system, contact Alpha Technologies Ltd. or your nearest Cordex® power system representative.

NOTICE

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1. Safety

Save these instructions

This document contains important safety instructions that must be followed during the installation, servicing, and maintenance of the product. Keep it in a safe place. Review the drawings and illustrations contained in this document before proceeding. If there are any questions regarding the safe installation or operation of this product, contact Alpha Technologies Ltd. or the nearest Cordex® power system representative.

1.1 Safety symbols

To reduce the risk of injury or death, and to ensure the continued safe operation of this product, the following symbols have been placed throughout this document. Where these symbols appear, use extra care and attention.

Symbol	Type	Description
	WARNING	Risk of serious injury or death Equipment in operation poses a potential electrical hazard which could result in serious injury or death to personnel. This hazard may continue even when power is disconnected.
	CAUTION	Cautions indicate the potential for injury to personnel.
	CAUTION	Risk of burns A device in operation can reach temperature levels which could cause burns.
	ATTENTION	The use of attention indicates specific regulatory or code requirements that may affect the placement of equipment or installation procedures. Follow the prescribed procedures to avoid equipment damage or service interruption.
	GROUNDING	This symbol indicates the location or terminal intended for the connection to protective earth. An enclosure that is not properly connected to protective earth presents an electrical hazard. Only a licensed electrician can connect AC power and protective earth to the enclosure.
	NOTICE	A notice provides additional information to help complete a specific task or procedure or general information about the product.

1.2 General warning and cautions

WARNING

This system is designed to be installed in a restricted access location that is inaccessible to the general public.

Ce système est conçu pour être installé dans un endroit à accès restreint inaccessible au grand public.

WARNING

This equipment is not suitable for use in locations where children are likely to be present.

Cet équipement ne convient pas pour une utilisation dans des lieux ou des enfants sont susceptibles d'être présents.

WARNING

You must read and understand the following warnings before installing the enclosure and its component. Failure to do so could result in personal injury or death.

- Read and follow all instructions included in this document.
- Only trained personnel are qualified to install or replace this equipment and its components.
- Use proper lifting techniques whenever handling equipment, parts, or batteries.

1.3 Mechanical safety

- Keep hands and tools clear of fans. Fans are thermostatically controlled and switch on automatically.
- Power supplies can reach extreme temperatures under load.
- Use caution around sheet metal components and sharp edges.

1.4 Electrical safety

WARNING

Hazardous voltages are present at the input of power systems. The DC output from rectifiers, though not dangerous in voltage, has a high short-circuit current capacity that can cause severe burns and electrical arcing.

The DC output from converters is a potentially hazardous voltage. Do not touch the output connections when under power. Ensure that power has been removed from the outputs before working on them.

Before working with any live battery or power system, follow these precautions:

- Remove all metallic jewelry, such as watches, rings, metal rimmed glasses, or necklaces.
- Wear safety glasses with side shields at all times during the installation.
- Use OSHA (or international equivalent) insulated hand tools. Do not rest tools on top of batteries.

WARNING

Lethal voltages are present within the power system. Always assume that an electrical connection or conductor is energized. Check the circuit with a voltmeter with respect to the grounded portion of the enclosure (both AC and DC) before performing any installation or removal procedure.

- Do not work alone under hazardous conditions.
- A licensed electrician is required to install permanently wired equipment. Input voltages can range up to 480 Vac. Ensure the utility power is disconnected and locked out before performing any installation or removal procedure.
- Ensure that no liquids or wet clothes come into contact with internal components.
- Hazardous electrically live parts inside this unit are energized from the batteries even when the AC input power is disconnected.

WARNING

High leak current

Earth connection is essential before connecting the supply.

1.5 Battery safety

- Servicing and connection of batteries must be performed by, or under the direct supervision of, personnel knowledgeable of batteries and the required safety precautions.
- Always wear eye protection, rubber gloves, and a protective vest when working near batteries. Remove all metallic objects from your hands and neck.
- Use OSHA approved insulated hand tools. Do not rest tools on top of batteries.
- Batteries contain or emit chemicals known to cause cancer and birth defects or other reproductive harm. Battery post terminals and related accessories contain lead and lead compounds. Wash your hands after handling batteries.

WARNING

Follow the battery manufacturer's safety recommendations when working around battery systems. Do not smoke or introduce an open flame when batteries (especially vented batteries) are charging. When charging, batteries vent hydrogen gas, which can explode.

Batteries are hazardous to the environment and should be disposed at a recycling facility. Consult the battery manufacturer for recommended local authorized recyclers.

ATTENTION

Battery safety data sheets

Read the battery safety data sheet (SDS) before installing batteries in the power system. The SDS provides important information including hazard identification, first aid measures, handling and storage, and PPE.

2. Introduction

2.1 Document scope

This document covers the features, options, installation, and startup of Cordex® HP 2.4/3.0 kW rectifier systems. Images contained in this document are for illustrative purposes only and may not exactly match your installation. To assist with installation, refer to the drawings at the end of this document. This document covers:

- Cordex® HP 3.0 kW rectifiers and shelves
- Cordex® HP 2.4 kW rectifiers and shelves

2.2 Product overview

A complete rectifier system consists of one or more power modules in a common shelf enclosure. The shelf has connections for AC inputs, DC output, and system communications. The wide AC input operating range for global installations and wide operating temperature ranges for installation in uncontrolled environments along with high efficiency (>96.5 percent; Cordex® HP 3.0 kW rectifiers) reduces the carbon footprint and the operating expenses.

Rectifier modules use a high frequency, switched mode conversion technique to provide a fully regulated and isolated DC output from the AC mains. Multiple 48 V configurations are available up to 312.5 A in a compact 1RU shelf system. Industry leading power density (35 W/in^3) yields more space for revenue generating equipment.

Rectifier power modules are hot swappable meaning they can be inserted or removed from the shelf without cutting power to or from the system or the load. Additional power modules can be included with the system at the time of ordering or added after the shelf has been installed.

The shelf rectifier system is designed to operate with the Cordex® CXC HP system controller. This controller allows you to configure, monitor, and control the entire DC power system from its touchscreen display which includes temperature compensation, auto equalization, remote access, dial out on alarm, battery diagnostics, as well as web server and SNMP support for configuration and monitoring. Details of controller operation are provided in the software manual. A small controller can be installed in one of the rectifier slots using the in-shelf adapter.

External system controller models communicate with the shelf via RJ12 shelf connectors. In a power system, up to five rectifier shelves can be stacked and connected to the same controller. The controller, featuring a color touchscreen LCD with front Ethernet and USB connectors, is available as a panel mount controller or as part of the Cordex® CXPS-E3 edge power system.

Shelf ID location technology is built into the Cordex® HP 3.0 kW rectifier. This feature is capable of remotely locating the exact position of a rectifier within a large system. This can be useful for quickly locating a unit during a service interruption or when a unit has failed.

Figure 1: Cordex® HP 2.4/3.0 kW 19-inch rectifier shelf

2.3 Part numbers

The product, options, and accessories can be ordered by using the part numbers in the following tables.

2.3.1 Cordex® HP 3.0 kW rectifier systems

Description	Part numbers
23-inch 1RU universal mount 15,000 W shelf[1] • Bulk power for external distribution • Up to five Cordex® HP 3.0 kW rectifiers	0300216-001 (shelf/slot ID supported)
19-inch 1RU universal mount 12,000 W shelf[1] • Bulk power for external distribution • Up to four Cordex® HP 3.0 kW rectifiers	0300228-001 (shelf/slot ID supported)
Cordex® HP 3.0 kW rectifier	0100037-001
Module blank	7400424-001
Rear DC output 19-inch shelf cover	0370250-001
Rear DC output 23-inch shelf cover	0370250-002
[1] Standard DC busbars available up to a maximum of five shelves per system.	

2.3.2 Cordex® HP 2.4 kW rectifier systems

Description	Part number
23-inch 1RU universal mount 12,000/15,000 W shelf[1] • Bulk power for external distribution • Up to five Cordex® HP 2.4/3.0 kW rectifiers	0300057-001
19-inch 1RU universal mount 9,600/12,000 W shelf[1] • Bulk power for external distribution • Up to four Cordex® HP 2.4/3.0 kW rectifiers	0300040-001
19-inch 1RU universal mount, 4 × 2.4/3.0 kW outputs • Individual rectifier outputs • Up to four Cordex® HP 2.4/3.0 kW rectifiers	0300040-002
19-inch 1RU universal mount, 3 × 2.4/3.0 kW outputs • Bulk power for external distribution • IEC320 C20 rear receptacles	0300301-001
19-inch 1RU universal mount, 4 × 2.4/3.0 kW outputs • Bulk power for external distribution • IEC320 C20 rear receptacles	0300301-002
Cordex® HP 2.4 kW rectifier	0100003-001
Fan assembly replacement	7400374-001
Module blank	7400424-001
Rear DC output 19-inch shelf cover[2]	0370250-001
Rear DC output 23-inch shelf cover[2]	0370250-002
[1] Standard DC busbars available up to a maximum of five shelves per system. [2] Not compatible with IEC shelves	

3. Specifications

3.1 Cordex® HP 3.0 kW rectifiers

Table A — Cordex® HP 3.0 kW rectifier specifications

Electrical	
Input specifications	
Nominal input	208 to 277 Vac
Full power	187 to 300 Vac
Input operational	90 to 300 Vac
Input extended high	277 to 300 Vac reduced input PF
Input extended low	90 to 187 Vac derate linearly to 1,500 W
Input frequency	45 to 65 Hz
Input nominal	15.5 A at 208 to 277 Vac
Input maximum	16.5 A at 185 Vac
Power factor	>98% at nominal input 50 to 100% load
Inrush current	≤ Full load steady state current of the rectifier within rated limits
Start-up ready times	<5 seconds
Start-up delay	Programmable up to 120 seconds
Soft start	User adjustable to at least 5 seconds
Protection	10 kA interrupting in L and N wires
THD current	<5% at nominal input 100% load
Input leakage current	<3.5 mA at 265 Vac with two rectifiers
Output specifications	
Output voltage	42 to 58 Vdc
Maximum power	3,000 W
Output current	55.5 A at 54 Vdc
Maximum output current	62.5 A at 48 Vdc
Holdup time	>5 ms at 100% Load
Characteristics	
Efficiency	>96.5% peak; 95% at nominal input 50 to 100% load
Acoustic noise	<55 dBa at 1 m (3 ft) 30°C (86°F)
Static load regulation	±0.5% for any load change within full load limits
Dynamic load regulation (40 to 90%, 90 to 40%)	±3.0% for any load change within rated limits
Static line regulation	≤ 0.1% for any change in input voltage within full load limits
Temperature stability	≤100 ppm/°C (55.6 ppm/°F) over operating temperature
Time stability	≤ 0.2% per year
Electrical noise (nominal voltages)	
Voice band	<53 dBrnc
Wide band 10 kHz to 10 MHz	<260 mVrms

Wide band 10 kHz to 100 MHz	<180 vmV pk-pk
Reliability	
MTBF	623,860 hours • Telcordia SR-332 Issue 3 • Method 1 Case 3, Parts Count Method, Quality Level II • Ambient temperature 30°C (86°F), Environment: Ground Fixed, Controlled, 100% Duty Cycle, Full Load **Remarks:** Devices are assumed to be operating at ambient temperature and 50 percent rated electrical stress. However, the operating point and temperature of selected critical components was measured and included in the model for improved accuracy. All components are assumed to be necessary for operation of the product. Failures are expected to have an exponential distribution during the useful life period of the product. The MTBF calculation does not include batteries, software, or mechanical parts.
Mechanical	
Dimensions H × W × D	41 × 104 × 333 mm (1.6 × 4.1 × 13.1 in.)
Weight	1.76 kg (3.9 lb)
Environmental	
Temperature	
Operating full power	–40 to 55°C (–40 to 131°F)
Extended	55 to 75°C (131 to 167°F) derated to 600 W
Storage	–40°C to 85°C (–40 to 185°F)
Characteristics	
Relative humidity	0 to 95% (non-condensing)
Heat dissipation	<146.5 W (500 BTU/h) worst case, 100% load at 187 Vac
Elevation	Up to 3,000 m (9,842 ft)
Agency compliance	
Safety	CAN/CSA-C22.2 No. 62368-1:14
	ANSI/UL 62368-1 (Second Edition)
	IEC 62368-1:2014 (Second Edition)
	EN 62368-1:2014+A11:2017
EMC	FCC CFR 47 PART 15/B – Class A
	CAN ICES-003(A)/NMB-003(A)
	IEC/EN 55035:2017+A11:2020
	IEC/EN 55032/CISPR 32 Class A
	IEC/EN 61000-3-2, IEC/EN 61000-3-3
	IEC/EN 61000-4-2, IEC/EN 61000-4-3, IEC/EN 61000-4-4, IEC/EN 61000-4-5, IEC/EN 61000-4-6, IEC/EN 61000-4-8, IEC/EN 61000-4-11
	IEC/EN 61000-6-4
	EN 300 386 v1.6.1

Directives	2014/35/EU Low Voltage Directive (LVD)
	2014/30/EU EMC Directive
	2015/816/EU Restriction on use of Hazardous Substances (RoHS10)
	Category of EEE (Annex 1): Category 3 IT and Telecommunications Equipment
	Category of EEE (Annex 1): Category 11 Other Electrical and Electronic Equipment
Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.	

3.1.1 Cordex® HP 3.0 kW rectifier shelves

23-inch 1RU universal mount 15,000 W shelf PN: 0300216-001 (shelf/slot ID supported)	
Number of rectifiers	Up to five Cordex® HP 3.0 kW rectifiers
Nominal AC input current (two modules per feed)	120 Vac; 29 A (per feed); 50/60 Hz
	208 to 277 Vac; 31 to 24 A (per feed); 50/60 Hz
Recommended input feeder breakers (three feeds per shelf)	40 A per feed for rectifier pairs with nominal 120, 208, 240, 277 Vac
	20 A per feed for individual rectifier with nominal 120, 208, 240, 277 Vac
Recommended AC input wire size	**40 A:** 10 mm² (8 AWG) line; 6 mm² (10 AWG) protective earth
	20 A: 4 mm² (12 AWG) line; 2.5 mm² (14 AWG) protective earth
Shelf output power	15 kW maximum
Distribution	Bulk power for external distribution
Dimensions H × W × D	44 × 537 × 420 mm (1.75 × 21.1 × 16.5 in.)
Weight	5.7 kg (12.6 lb)
Communications ports	**CAN:** Interface to control rectifiers and smart peripherals
	Shelf ID: Interface to connect to Shelf/Bay ID peripheral
19-inch 1RU universal mount 12,000 W shelf PN: 0300228-001 (shelf/slot ID supported)	
Number of rectifiers	Up to four Cordex® HP 3.0 kW rectifiers
Nominal AC input current (one module per feed)	120 Vac; 14.2 A (per feed); 50/60 Hz
	208 to 277 Vac; 15.5 to 12 A (per feed); 50/60 Hz
Recommended input feeder breakers (four feeds for shelf)	20 A per feed for nominal 120, 208, 240, 277 Vac
Recommended AC input wire size	4 mm² (12 AWG) line; 2.5 mm² (14 AWG) protective earth
Shelf output power	12 kW maximum
Distribution	Bulk power for external distribution
Dimensions H × W × D	44 × 438 × 420 mm (1.75 × 17.3 × 16.5 in.)
Weight	4.5 kg (9.9 lb)
Communications ports	**CAN:** Interface to control rectifiers and smart peripherals
	Shelf ID: Interface to connect to Shelf/Bay ID peripheral

3.2 Cordex® HP 2.4 kW rectifiers

Table B — Cordex® HP 2.4 kW rectifier specifications

Electrical	
Input voltage	
Nominal	208 to 277 Vac
Operating	90 to 310 Vac
Extended	90 to 187 Vac (derated power)
Input frequency	44 to 66 Hz
Power	2,400 W continuous
	1,200 W output at 120 Vac Input
Power factor	>99% (50 to 100% load)
THD	<5%
Efficiency	96.2% peak
Output voltage	42 to 58 Vdc (No load 46.5 to 58 Vdc)
Output current	44.5 A at 54 Vdc (50 A max. at 48 Vdc)
	~25 A at 48 Vdc at 120 Vac input
Load regulation	<±0.7% (static)
Line regulation	<±0.1% (static)
Transient response	±3% for 40 to 90% load step
Electrical noise (nominal voltages)	
Voice band	<38 vdBrnC
Wide band 10 kHz to 10 MHz	<20 mV RMS
Wide band 10 kHz to 100 MHz	<150 vmV pk-pk
Psophometric	<2 mV RMS
Acoustic	<60 dBa at 1 m (3 ft), 30°C (86°F)
Reliability	
MTBF	627,000 hours per Telcordia SR-332 Issue 3 (2011)
Mechanical	
Dimensions H × W × D	41 × 104 × 333 mm (1.6 × 4.1 × 13.1 in.)
Weight	1.76 kg (3.9 lb)
Environmental	
Temperature	
Operation	–40 to 75°C (–40 to 149°F)
Full nominal output power	–40 to 55°C (–40 to 131°F); >2,000 W at 65°C (167°F)
Storage	–40 to 85°C (–40 to 185°F)
Characteristics	
Relative humidity	0 to 95% (non-condensing)
Heat dissipation	<102.6 W (350 BTU/h) typical
	<146.5 W (500 BTU/h) worst case: 100% load at 187 Vac

Agency compliance	
Safety	CAN/CSA-C22.2 No. 62368-1:14
	ANSI/UL 62368-1 (Second Edition)
	IEC 62368-1:2014 (Second Edition)
	EN 62368-1:2014+A11:2017
EMC	FCC CFR 47 PART 15/B – Class A
	CAN ICES-003(A)/NMB-003(A)
	IEC/EN 55035:2017+A11:2020
	IEC/EN 61000-3-2
	IEC/EN 61000-4-2, IEC/EN 61000-4-3, IEC/EN 61000-4-4, IEC/EN 61000-4-5, IEC/EN 61000-4-6, IEC/EN 61000-4-11
	EN 300 386 v1.6.1
Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.	

3.2.1 Cordex® 2.4 kW rectifier shelves

23-inch 1RU universal mount 12,000/15,000 W shelf PN: 0300057-001	
Number of rectifiers	Up to five Cordex® HP 2.4/3.0 kW rectifiers
Nominal AC input current (two modules per feed)	120 Vac; 23 A (per feed); 50/60 Hz
	208 to 277 Vac; 25 to 19 A (per feed); 50/60 Hz
Recommended input feeder breakers (three feeds per shelf)	40 A per feed for rectifier pairs with nominal 120, 208, 240, 277 Vac
	20 A per feed for individual rectifier with nominal 120, 208, 240, 277 Vac
Recommended AC input wire size	**40 A:** 10 mm² (8 AWG) line; 6 mm² (10 AWG) protective earth
	20 A: 4 mm² (12 AWG) line; 2.5 mm² (14 AWG) protective earth
Shelf output power	15 kW maximum
Distribution	Bulk power for external distribution
Dimensions H × W × D	44 × 537 × 420 mm (1.75 × 21.1 × 16.5 in.)
Weight	5.7 kg (12.6 lb)
Communications ports	**CAN:** Interface to control rectifiers and smart peripherals
19-inch 1RU universal mount 9,600/12,000 W shelf PN: 0300040-001/002	
Number of rectifiers	Up to four Cordex® HP 2.4/3.0 kW rectifiers
Nominal AC input current (one module per feed)	120 Vac; 11.5 A (per feed); 50/60 Hz
	208 to 277 Vac; 12.5 to 9.5 A (per feed); 50/60 Hz
Recommended input feeder breakers (four feeds for shelf)	20 A per feed for nominal 120, 208, 240, 277 Vac
Recommended AC input wire size	4 mm² (12 AWG) line; 2.5 mm² (14 AWG) protective earth
Shelf output power	12 kW maximum
Distribution options	Bulk power for external distribution (PN: 0300040-001)
	Separate feed I/O (PN: 0300040-002)
Dimensions H × W × D	44 × 438 × 420 mm (1.75 × 17.3 × 16.5 in.)
Weight	4.5 kg (9.9 lb)
Communications ports	**CAN:** Interface to control rectifiers and smart peripherals
19-inch 1RU universal mount up to 9,600/12,000 W shelf PN: 0300301-001/002	
Number of rectifiers	Up to three Cordex® HP 2.4/3.0 kW rectifiers (PN: 0300301-001)
	Up to four Cordex® HP 2.4/3.0 kW rectifiers (PN: 0300301-002)
Nominal AC input current (one module per feed)	120 Vac; 11.5 A (per feed); 50/60 Hz
	208 to 250 Vac; 12.5 to 10.5 A (per feed); 50/60 Hz
Recommended input feeder breakers (four feeds for shelf)	20 A per feed for nominal 120, 208, 240, 250 Vac
Recommended AC input wire size	4 mm² (12 AWG) line; 2.5 mm² (14 AWG) protective earth
Shelf output power	12 kW maximum
Distribution option	Bulk power for external distribution
Dimensions H × W × D	44 × 438 × 480 mm (1.75 × 17.3 × 18.9 in.)
Weight	4.6 kg (10.2 lb)
Communications ports	**CAN:** Interface to control rectifiers and smart peripherals

4. Features

4.1 Cordex® HP 3.0 kW rectifiers

4.1.1 Front panel LEDs

The front panel LEDs indicate the rectifier status summary and patterned response to **Locate Module** command.

	Alarm/Fault	The red LED is on during an active **Module Fail** alarm if the module is unable to source power due to a fault condition. Refer to the relevant controller manual for fault details. The LED flashes (~2 Hz) when a minor alarm is detected if the module's output capability has been reduced or a minor failure is detected. The red LED will remain active if the module is receiving power from the DC bus.
	DC ON	The green LED is on when the rectifier is delivering power to the load. The LED goes out when the rectifier is off. For example, when commanded by the controller.
	AC ON	The green LED is on when the AC input voltage is qualified and within the operational AC input range and input frequency.

LED activity during the Locate Module command from controller

The **Locate Module** command from the Cordex® CXC HP controller, causes the LEDs of the target rectifier to flash in a cyclical pattern. This flashing lasts approximately 60 seconds.

LED activity during power save

When a rectifier is put into power save mode, only the AC ON LED remains illuminated.

4.1.2 True module fail alarm

The power modules have a true fail alarm that provides a true indication of the power module’s ability to source current. When the module’s output current drops below 2.5 percent of the rated output, a low output current condition is detected and the **Module Fail** detection circuit is activated. This circuit momentarily ramps up the output voltage to determine if the module will source current. If no increase in current is detected, the **Module Fail** alarm is activated. The module will test once every 60 seconds for the condition until a current is detected. The output voltage ramping ceases upon detection of current. A minimum 2.5 percent load is required to avoid the **Ramp Test Fail** alarm. This load can be provided with the parallel system battery. Activation of this alarm could indicate a failed module or a failed load.

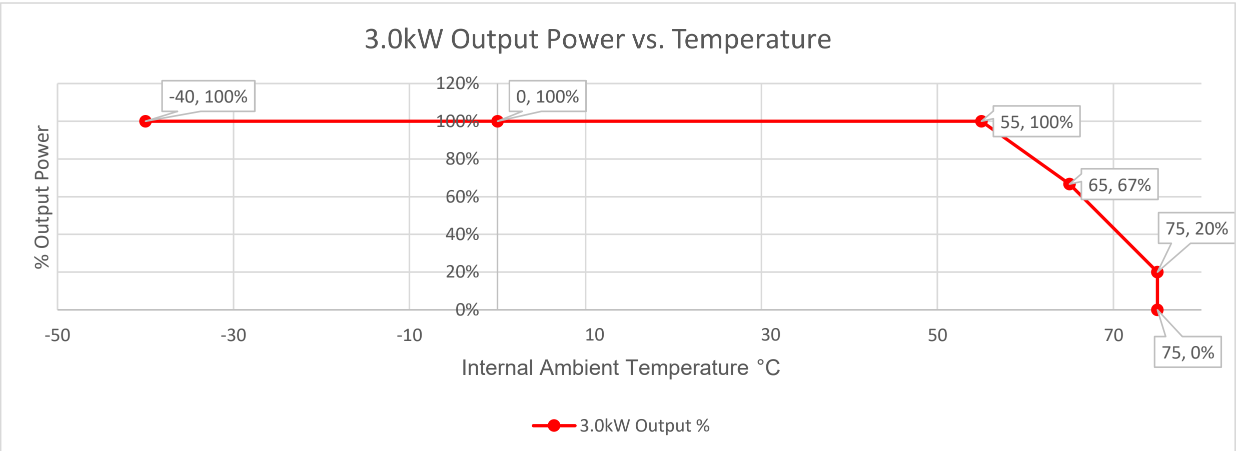
To avoid nuisance alarms for rectifier systems without batteries, or with a very light load (below 2.5 percent of the rated output), the ramp test should be disabled. Disable the **Ramp Test** via the controller menu: **Systems > DC System > Inventory > Rectifiers > Configuration**.

4.1.3 Heat dissipation

Each rectifier module is equipped with a front-mounted, variable-speed fan. The fan speed is determined based on ambient temperature, rectifier temperature, and the load. Air flow is front-to-rear with the exhaust air exiting through internal vents at the rear of the unit. The fan may spin in required situations.

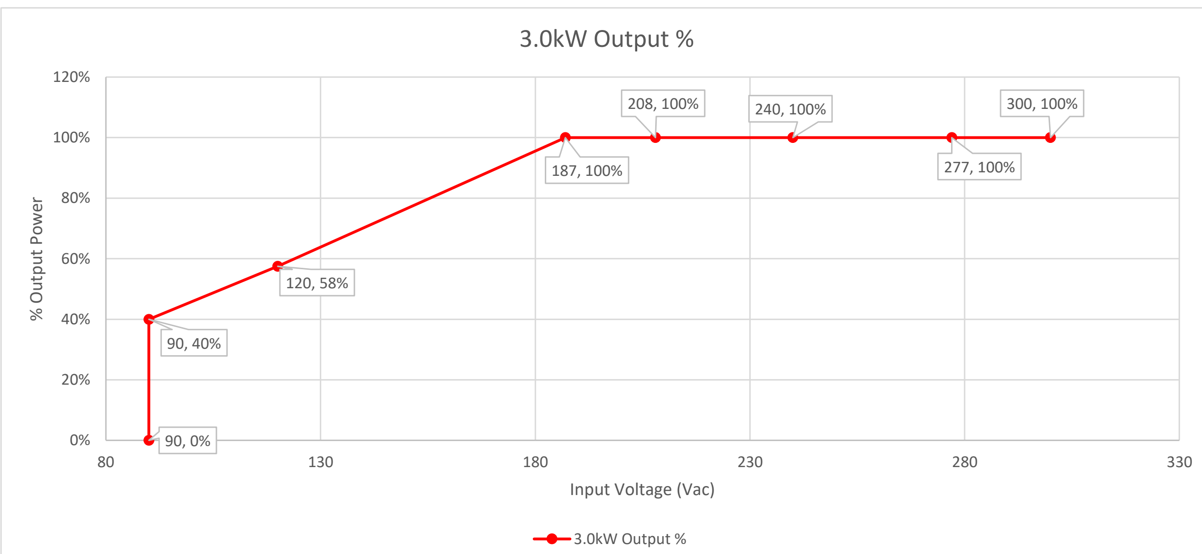
4.1.4 Over temperature protection

Blockage or obstruction to the air flow can result in the internal temperature to rise and reduce the output power or even shut down the rectifier. The rectifier will resume normal operation when the temperature reduces to a safe level. Over temperature shut down can also occur when a fan failure has occurred. The rectifier; to protect itself from ambient over temperature scenarios; will limit its output power.



4.1.5 AC input power derating

The Cordex® HP 3.0 kW rectifier power varies with different input voltages. This is to reduce the chance of having an AC input breaker trip from drawing the same amount of power at lower input voltages.



4.1.6 AC inrush and transient suppression

To prevent a surge on the AC input line, the inrush current of a rectifier module is limited to the full load steady state line current. Modules are also protected from input lightning and transient surges in accordance with ANSI/IEEE C62.41 Category B3 standards.

4.1.7 Soft start

A soft start feature is used to eliminate an instantaneous demand on the AC power source. A soft start, sometimes referred to as a current walk-in, works by gradually (up to five seconds) ramping up the DC output current limit from zero to the actual or defined customer setting. The rectifier output voltage is ramped from the minimum voltage to the float voltage.

This feature along with **Start Delay** prevents any instantaneous surge demand on the utility.

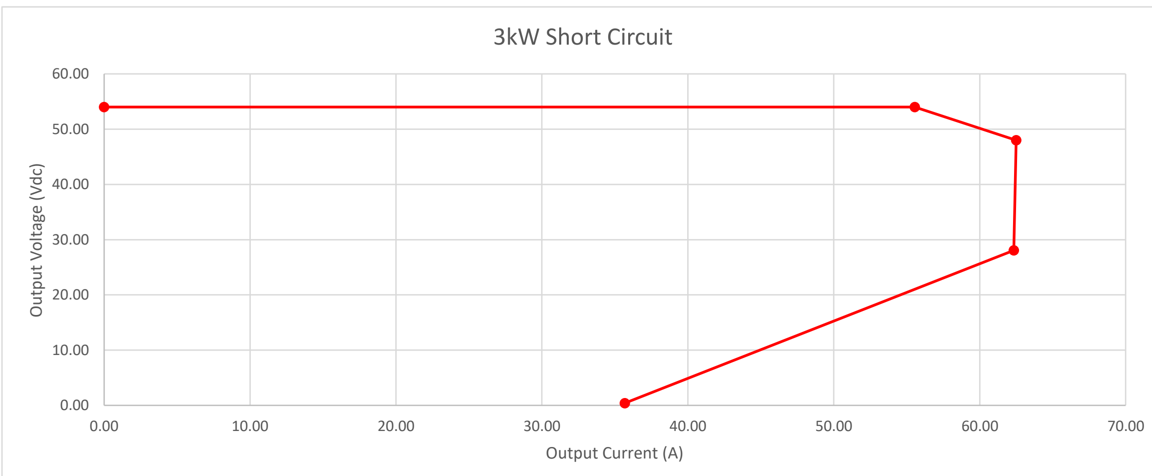
4.1.8 Start delay

The rectifier modules are equipped with a delay timer to stagger-start a series of modules. When multiple modules and multiple shelves, part of a larger system are used in conjunction with a controller, a start delay prevents all rectifiers from starting at the same time and causing an inrush on the utility. The default start delay is set to 1 second and can be adjusted up to 250 seconds on the controller. The built-in timer delays the switching on of the module by the start delay interval (up to 250 seconds), which is set in the controller.

4.1.9 Current limit and short circuit protection

The current limit function determines the maximum output current limit of the rectifier module, regardless of the output voltage or power. The maximum output current is limited to a constant value down to a short circuit condition. Current limiting can be used to mate the rectifier output current ampacity to the needs of the load and parallel battery to minimize excessive battery recharge currents.

The rectifier will sustain a continuous short circuit at the output terminals. The maximum short circuit current will not exceed 62.5 A per module.



4.1.10 Power limiting

Each rectifier module is designed to limit the power output to the module specification. This enables more current to be supplied at lower output voltages, and allows matching the output power to the demands of constant-power loads often seen in telecom equipment.

This feature can also be used for a faster recharge of flooded batteries paralleled with the load.

NOTICE

The current limiting feature overrides the power-limiting feature.

4.1.11 High voltage shutdown

This feature protects the load from over-voltages originating in the rectifiers. The offending rectifier module is shut down when a high output voltage condition occurs. The red alarm (**Module Fail**) LED will illuminate. The module will restart automatically. However, if more than three over-voltage conditions occur within one minute, the module will latch off and remain shut down until it is reset.

4.1.12 Battery eliminator operation

Rectifier modules maintain all specifications (except where indicated) with or without a battery or a DC source attached in parallel to the output. Under these conditions there will be no monitoring or control activity if AC power failure occurs.

4.1.13 Mechanical

An integral handle provides a means to both insert and remove the rectifier as well as locking the rectifier in place.

4.1.14 Firmware update

The rectifier module should have its operating firmware updated through the controller. Using the latest firmware will ensure the controller has the latest features and that all corrections have been applied.

NOTICE

The Cordex® HP 3.0 kW rectifier requires AC input power to be connected to perform the firmware update.

4.1.15 Distribution

Bulk distribution

- 23 inch 1RU universal mount PN: 0300057-001 (2.4 kW compatible), 0300216-001 (shelf ID support)
- 19-inch 1RU universal mount PN: 0300040-001 (2.4 kW compatible), 0300228-001 (shelf ID support)
- 19-inch 1RU universal mount with IEC PN: 0300301-001 (2.4 kW compatible)
- 19-inch 1RU universal mount with IEC PN: 0300301-002 (2.4 kW compatible)

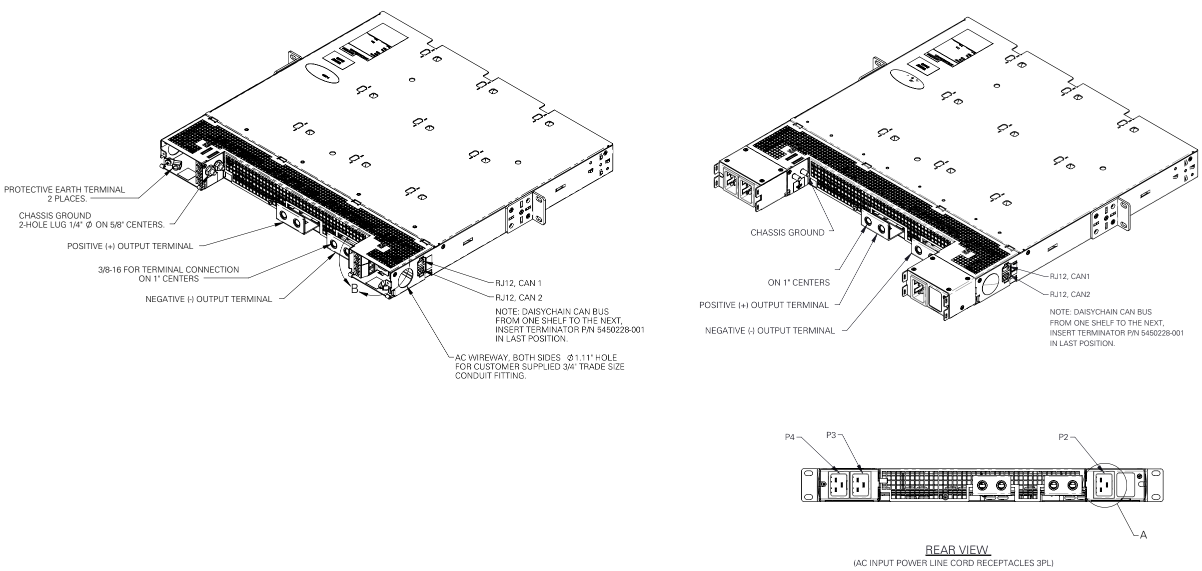


Figure 2: 19-inch shelf with bulk distribution busbars

4.1.16 Controller

The Cordex® HP 3.0 kW rectifier shelf is designed to operate with the Cordex® CXCi HP in-shelf controller. A controller adds the following capabilities to the rectifiers:

- Local and remote communications and monitoring
- User definable alarms
- Daily logging of events and system statistics
- Load sharing
- Power save

NOTICE

The Cordex® HP 3.0 kW shelf is also designed to operate without a controller; however, load balancing among the rectifiers won't be as efficient, particularly at lower input voltages. The rectifier will enter safe voltage when communication is lost with the controller.

The Cordex® CXC HP controller requires version 5.20 (or later) of the software in order to correctly display the system capacity at 120 Vac.

4.1.17 Internal CAN bus

A CAN bus is used to transmit all alarm and control functions between the controller and rectifier shelves. Two CAN serial ports (modular jacks), are located on the left side of the rectifier shelf as viewed from the front.

The CAN bus can be daisy-chained from shelf to shelf (CAN 1 of one shelf to CAN 2 of another). The last shelf is terminated using a CAN terminator.

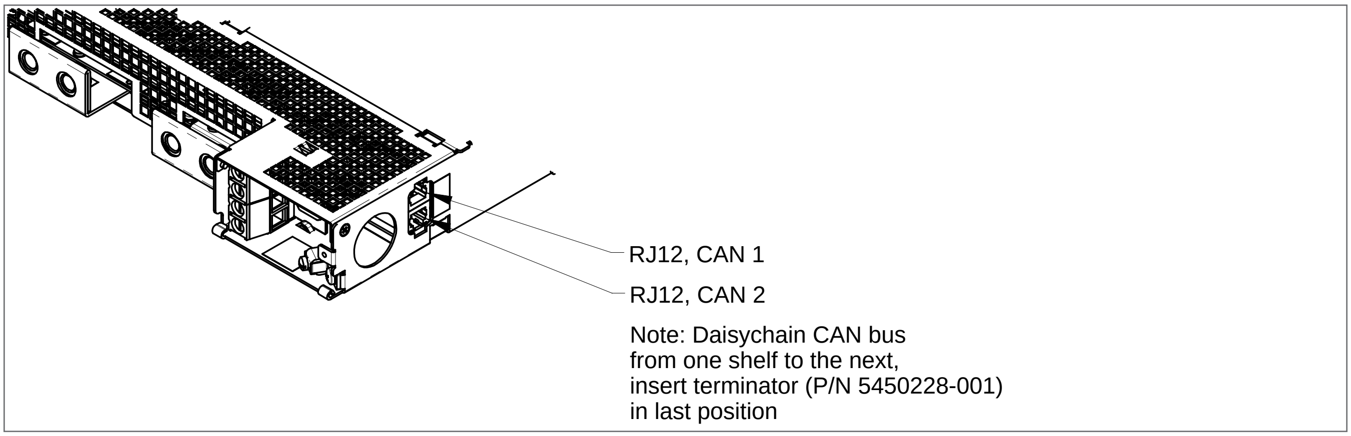
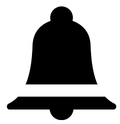
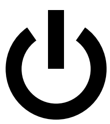


Figure 3: CAN bus connections

4.2 Cordex® HP 2.4 kW rectifiers

4.2.1 Front panel LEDs

The front panel LEDs indicate the rectifier status summary and patterned response to **Locate Module** command.

	**Alarm/Fault**	The red LED is on during an active **Module Fail** alarm if the module is unable to source power due to a fault condition. Refer to the relevant controller manual for fault details. The LED flashes (~2 Hz) when a minor alarm is detected if the module's output capability has been reduced or a minor failure is detected. The red LED will remain active if the module is receiving power from the DC bus.
	**DC ON**	The green LED is on when the rectifier is delivering power to the load. The LED goes out when the rectifier is off. For example, when commanded by the controller.
	**AC ON**	The green LED is on when the AC input voltage is qualified and within the operational AC input range and input frequency.

LED activity during the Locate Module command from controller

The **Locate Module** command from the controller, causes the LEDs of the target rectifier to flash in a cyclical pattern. This flashing normally lasts 60 seconds.

LED activity during power save

When a rectifier is put into power save mode, only the AC ON LED remains illuminated.

4.2.2 Rectifier shelf rear panel

Refer to drawings at the end of this manual for shelf power and communications connections (compatible with Cordex® HP 2.4 kW and 3.0 kW rectifiers):

- 0300057-08
- 0300040-08

4.2.3 True module fail alarm

The power modules have a true fail alarm that provides a true indication of the power module's ability to source current. When the module's output current drops below 2.5 percent of the rated output, a low output current condition is detected and the **Module Fail** detection circuit is activated. This circuit momentarily ramps up the output voltage to determine if the module will source current. If no increase in current is detected, the **Module Fail** alarm is activated. The module will test once every 60 seconds for the condition until a current is detected. The output voltage ramping ceases upon detection of current. A minimum 2.5 percent load is required to avoid the **Ramp Test Fail** alarm. This load can be provided with the parallel system battery. Activation of this alarm could indicate a failed module or a failed load.

To avoid nuisance alarms for rectifier systems without batteries, or with a very light load (below 2.5 percent of the rated output), the ramp test should be disabled. Disable the **Ramp Test** via the controller software menu: **Systems > DC System > Inventory > Rectifiers > Configuration**.

4.2.4 Heat dissipation

Each rectifier module is equipped with a front-mounted, variable-speed fan. The fan speed is determined based on ambient temperature, rectifier temperature and the load. Air flow is front-to-rear with the exhaust air exiting through internal vents at the rear of the unit.

4.2.5 Over temperature protection

Blockage or obstruction to the air flow can result in the internal temperature to rise and reduce the output power or even shut down the rectifier. The rectifier will resume normal operation when the temperature reduces to a safe level. Over temperature shut down can also occur when a fan failure has occurred.

4.2.6 Wide AC range

The rectifier delivers up to 2,400 W of power between 187 Vac and 310 Vac input voltage. The rectifier can deliver up to 1,200 W between 90 Vac and 187 Vac.

During start up the rectifier begins to provide power for input voltage >95 Vac and shuts down if the input voltage drops below 85 Vac. The THD and power factor will be out of specification for input >277 Vac.

4.2.7 AC inrush and transient suppression

To prevent a surge on the AC input line, the inrush current of a rectifier module is limited to the full load steady state line current. Modules are also protected from input lightning and transient surges in accordance with ANSI/IEEE C62.41 Category B3 standards.

4.2.8 Soft start

A soft start feature is used to eliminate an instantaneous demand on the AC power source. A soft start, sometimes referred to as a current walk-in, works by gradually (up to five seconds) ramping up the DC output current limit from zero to the actual or defined customer setting. The rectifier output voltage is ramped from the minimum voltage to the float voltage.

This feature along with **Start Delay** prevents any instantaneous surge demand from the utility.

4.2.9 Start delay

The rectifier modules are equipped with a delay timer to stagger-start a series of modules. When multiple modules and multiple shelves, part of a larger system are used in conjunction with a controller, a start delay prevents all rectifiers from starting at the same time and causing an inrush on the utility. The default start delay is set to 1 second and can be adjusted up to 250 seconds on the controller. The built-in timer delays the switching on of the module by the start delay interval (up to 250 seconds), which is set in the controller.

4.2.10 Current limit and short circuit protection

The current limit function determines the maximum output current limit of the rectifier module, regardless of the output voltage or power. The maximum output current is limited to a constant value down to a short circuit condition. Current limiting can be used to mate the rectifier output current ampacity to the needs of the load and parallel battery to minimize excessive battery recharge currents.

The rectifier will sustain a continuous short circuit at the output terminals. The maximum short circuit current will not exceed 50 A per module.

4.2.11 Power limiting

Each rectifier module is designed to limit the power output to the module specification. This enables more current to be supplied at lower output voltages, and allows matching the output power to the demands of constant-power loads often seen in telecom equipment.

This feature can also be used for a faster recharge of flooded batteries paralleled with the load.

NOTICE

The current limiting feature overrides the power-limiting feature

4.2.12 High voltage shutdown

This feature protects the load from over-voltages originating in the rectifiers. The offending rectifier module is shut down when a high output voltage condition occurs. The red alarm (**Module Fail**) LED will illuminate. The module will restart automatically. However, if more than three over-voltage conditions occur within one minute, the module will latch off and remain shut down until it is reset by restarting the rectifier via the controller.

4.2.13 Battery eliminator operation

Rectifier modules maintain all specifications (except where indicated) with or without a battery or a DC source attached in parallel to the output. Under these conditions there will be no monitoring or control activity if AC power failure occurs.

4.2.14 Distribution

Bulk distribution

- 23-inch 1RU universal mount 12,000/15,000 W PN: 0300057-001
- 19-inch 1RU universal mount 9,600/12,000 W PN: 0300040-001
- 19-inch 1RU universal mount with IEC 7,200/9,000 W PN: 0300301-001
- 19-inch 1RU universal mount with IEC 9,600/12,000 W PN: 0300301-002

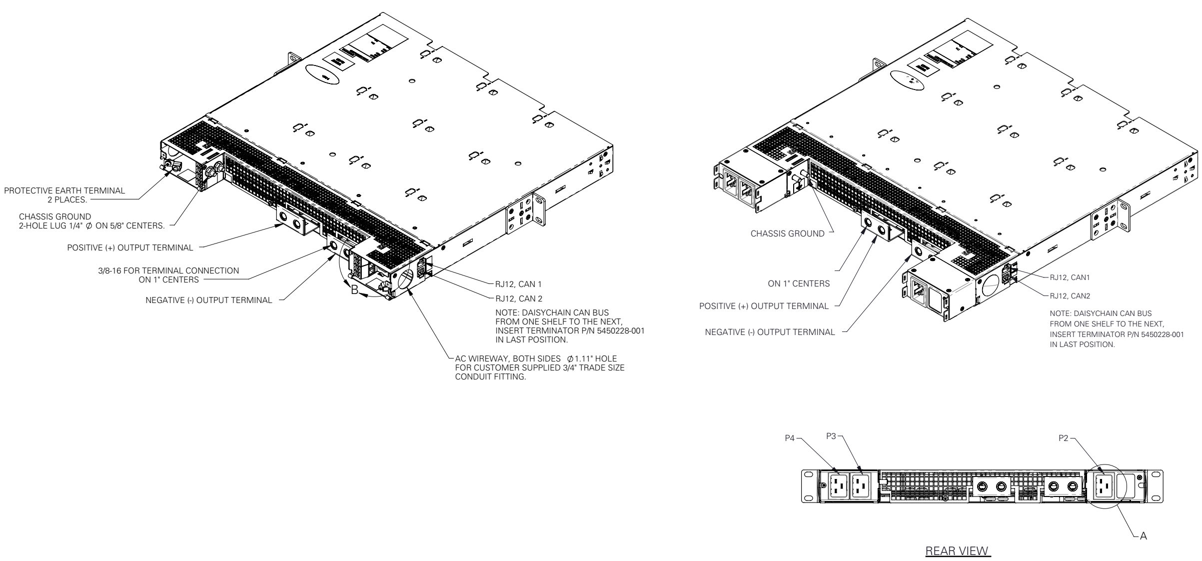


Figure 4: 19-inch shelf with bulk distribution busbars

Separate feed I/O

19-inch 1RU universal mount 4 × 2,400 W PN: 0300040-002

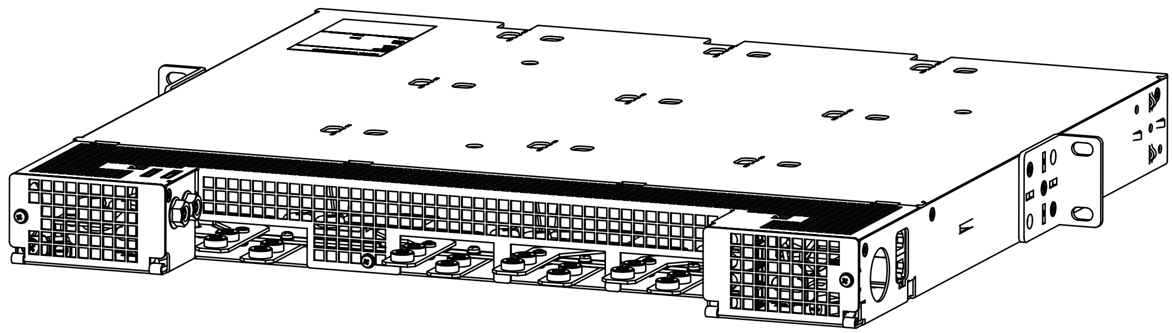


Figure 5: 19-inch shelf with single component distribution

4.2.15 Controller

The Cordex® HP 2.4 kW rectifier shelf is designed to operate with the controller (rack or panel) or the Cordex® CXCi HP controller. A controller adds the following capabilities to the rectifiers:

- Local and remote communications and monitoring
- User definable alarms
- Daily logging of events and system statistics
- Load sharing
- Power save

NOTICE

The Cordex® HP 2.4 kW shelf is also designed to operate without a controller; however load balancing among the rectifiers won't be as efficient, particularly at lower input voltages. The rectifier will enter safe voltage when communication is lost with the controller.

4.2.16 Internal CAN bus

A CAN bus is used to transmit all alarm and control functions between the controller and rectifier shelves. Two CAN serial ports (modular jacks), are located on the left side of the rectifier shelf as viewed from the front.

The CAN bus can be daisy-chained from shelf to shelf (CAN 1 of one shelf to CAN 2 of another). The last shelf is terminated using a CAN terminator.

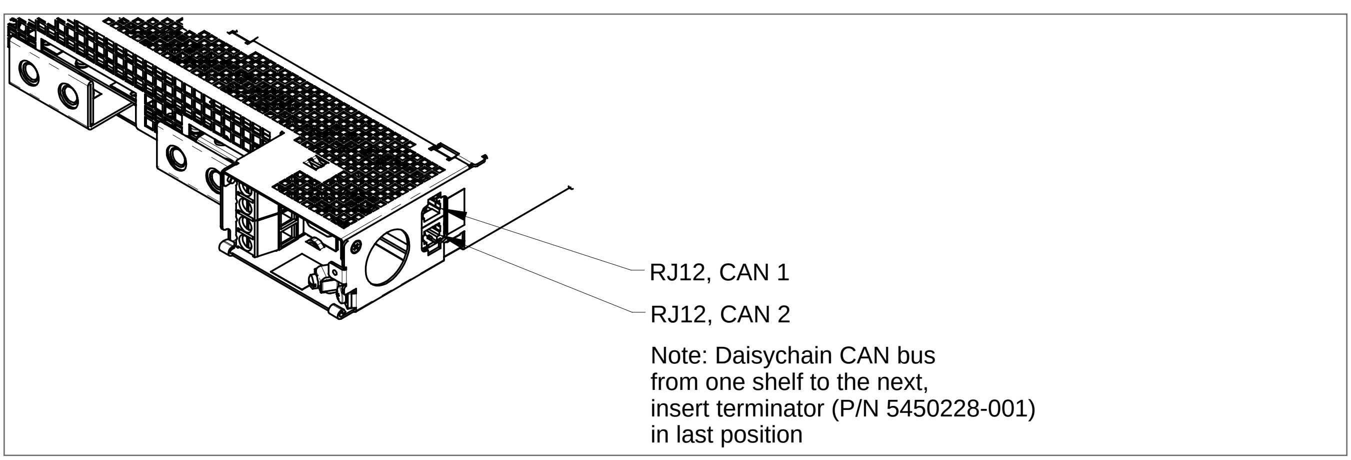


Figure 6: CAN bus connections

5. Inspection

5.1 Packing materials

Alpha Technologies Ltd. is committed to providing products and services that meet our customers' needs and expectations in a sustainable manner, while complying with all relevant regulatory requirements. As such Alpha strives to follow our quality and environmental objectives from product supply and development through to the packaging for our products.

Rectifiers and batteries are shipped on individual pallets and are packaged according to the manufacturer's guidelines.

Almost all Alpha Technologies Ltd. packaging material is from sustainable resources and or is recyclable.

5.2 Returns for service

NOTICE

Alpha Technologies Ltd. is not responsible for damage caused by improper packaging of returned products.

Save the original shipping container. If the product needs to be returned for service, it should be packaged in its original shipping container. If the original container is unavailable, make sure that the product is packed with at least three inches of shock-absorbing material to prevent shipping damage.

5.3 Check for damage

Before unpacking the product, note any damage to the shipping container. Unpack the product and inspect the exterior for damage. If any damage is observed, contact the carrier immediately. Continue the inspection for any internal damage. In the unlikely event of internal damage, inform the carrier and contact Alpha Technologies Ltd. for advice on the impact of any damage.

5.4 General receipt of shipment

The inventory included with your shipment depends on the options you have ordered. The options are clearly marked on the shipping container labels and bill of materials.

5.5 Miscellaneous small parts

Review the packing slip and bill of materials to determine the part number of the configuration kits included with your system. Review the bill of materials to verify that all the small parts are included. Contact us if you have any questions before you proceed.

6. Installation

The equipment is suitable for installation in Network Telecommunication Facilities.

WARNING

This system is designed to be installed in a restricted access location that is inaccessible to the general public.

Ce système est conçu pour être installé dans un endroit à accès restreint inaccessible au grand public.

The following procedure is written for qualified personnel to install this product in a clean and dry environment. For the battery installation, refer to the manufacturer’s manual.

6.1 Installation overview

1. Install shelf in a standard EIA relay rack
2. Connect the shelf chassis ground
3. DC output connections
4. AC input connection
5. Communication cabling (optional)
6. Verify AC and power the rectifier shelf
7. Check battery polarity and connections
8. Final tests

6.2 Safety precautions

Refer to "Safety" on page 5 before beginning this installation.

6.3 Installation tools

Various insulated tools are essential for the installation. Use this list as a guide:

- Battery lifting apparatus if required
- Electric drill with hammer action, ½ inch capacity
- Various crimping tools and dies to match lugs used in installation
- Load bank of sufficient capacity to load largest rectifier to its current limit
- Digital voltmeter equipped with test leads
- Cable cutters
- Torque wrench: ¼ inch drive, 0 to 17 Nm (0 to 150 in-lb)
- Torque wrench: ⅜ inch drive, 0 to 135 Nm (0 to 100 ft-lb)
- Insulating canvases as required
- Various insulated hand tools including:

  - Combination wrenches - Ratchet and socket set
  - Various screwdrivers - Electricians knife
- Battery safety spill kit required for wet cells only
- Cutters and wire strippers 2.5 to 0.34 mm² (14 to 22 AWG)
- Cutters and wire strippers 10 to 4 mm² (8 to 25 AWG)

6.4 Assembly and mounting

WARNING

Ensure that the power is switched off by switching off breakers and removing battery line fuses, turn off battery breakers before attempting work on the wiring. Use a voltmeter to verify the absence of a voltage. Clearly mark the correct polarity of the battery leads before starting work on DC connections.

6.4.1 Mounting and grounding a rectifier shelf

NOTICE

Mount the shelf in a clean and dry environment. Allow at least 4.45 cm (1.75 in.) of free space in front of the unit for unrestricted cooling airflow. Sufficient free space must be provided at the front and rear of the power system. This is to meet the cooling requirements of the rectifiers and to allow easy access to the power system components.

The 19-inch and 23-inch shelves have been designed for mid mounting in a standard EIA relay rack. Mounting brackets accommodate either 1 inch or 1-¾ inch rack spacing.

Options for flush mounting in a 19-inch or 23-inch rack are also available, but require additional mechanical support at the rear of the unit unless connected to busbars

1. Mount the shelf to the customer-provided rack using at least two 12 – 24 × ½ inch screws in each bracket. Use Phillips type screws and screwdriver to eliminate the possibility of slippage and scratching of the unit's exterior.
2. Connect the shelf chassis ground to the rack. The primary option is using the intended chassis ground location located on the back of the rectifier shelf using a 2-hole lug, ¼ inch on ⅝ inch center. The secondary option is to use rack the shelf is installed into for grounding through the mounting ears. Ensure to be using thread forming screws and star washers to sufficiently remove any paint on non-conductive material and establish a metal to metal contact to ensure a proper electrical bond.

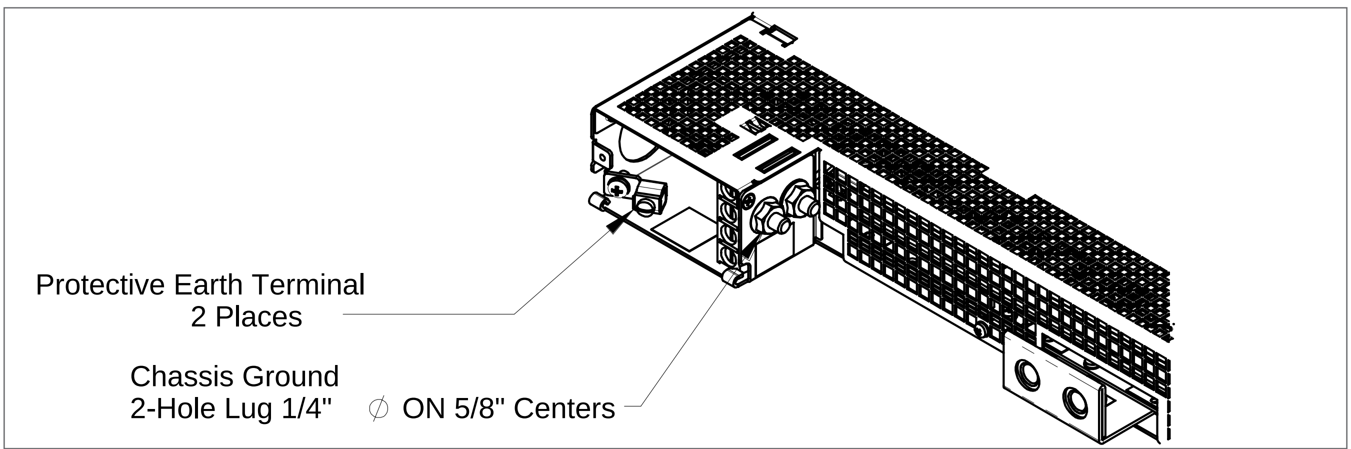


Figure 7: Protective earth terminal and chassis ground

NOTICE

In a power system, up to five rectifier shelves may be stacked before a gap must be left for adequate cooling of the rectifiers and shelves.

6.5 DC output connections- bulk distribution

WARNING

Do not complete the final live connections to the battery. Leave open and insulate the final connections or remove the battery fuses. Switch off the battery contacts if used.

The DC output wire must be UL approved XHHW or RHH/RHW (for Canadian users RW90; for European users, must be EN or IEC approved wire). Control and sense wires must be UL approved 1015 (for Canadian users TEW type; for European users, must be EN or IEC approved wire).

If the systems is operating in a floating output then no reference or common ground is required to be connected to the power system. If the system is intended to operate in a common bond network than the common output leg must be connected to ground.

Typical locations for connecting reference ground:

1. Battery termination bar
2. Common return bar on the distribution
3. Connection on the back of the shelf

The 23-inch and 19-inch bulk distribution models have positive and negative output bars.

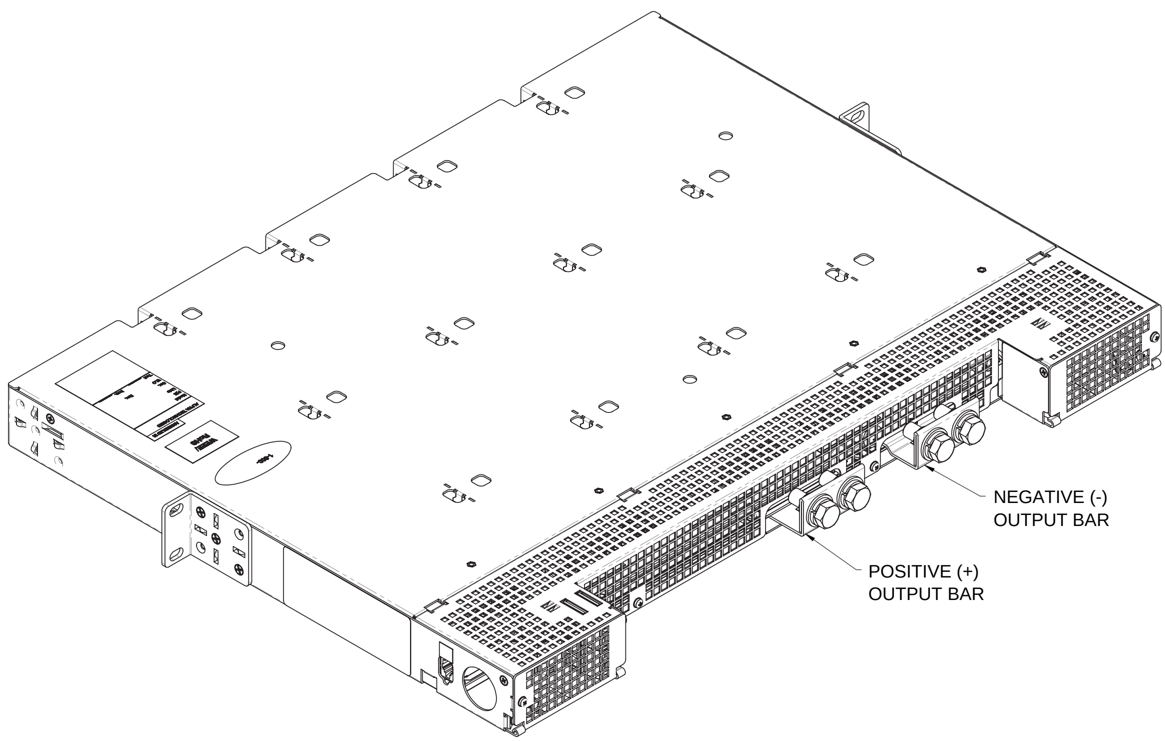


Figure 8: Positive and negative output bars on 23-inch and 19-inch bulk distribution models

6.5.1 Busbar connection

Multiple shelves can be connected directly to customers' vertical busbar.

1. Remove the bolts and washers at both positive and negative output bars. Bolts are ⅜-16 × 1 inch, and can accommodate up to ¼ inch thick busbar.
2. Use fasteners removed from the previous step to secure the vertical busbars to shelf positive and negative output bars. Install all fasteners finger tight, then apply 27.12 Nm (20 ft-lb) torque to each bolt.

NOTICE

In a power system, up to five rectifier shelves may be stacked before a gap must be left for adequate cooling of the rectifiers and shelves.

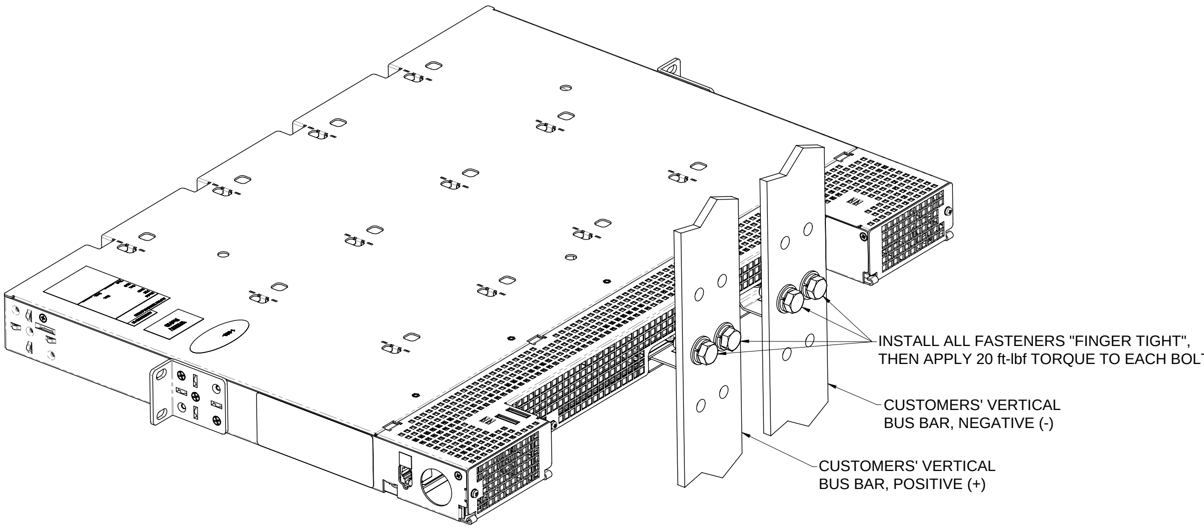


Figure 9: Connecting output bars to customer's vertical busbars

6.5.2 Cable connection

When attaching cables directly to the output bars, use appropriately sized cables terminated with crimp lugs with ⅜ inch holes on 1 inch centers.

1. Remove the bolts and washers at both positive and negative output bars. Bolts are ⅜-16 × 1 inch.
2. Use fasteners removed from the previous step to secure the positive and negative cables to the shelf output bars. Install all fasteners finger tight.
3. Use tongue and groove or similar pliers to hold and stabilize the output bar, torque each bolt to 27.12 Nm (20 ft-lb).

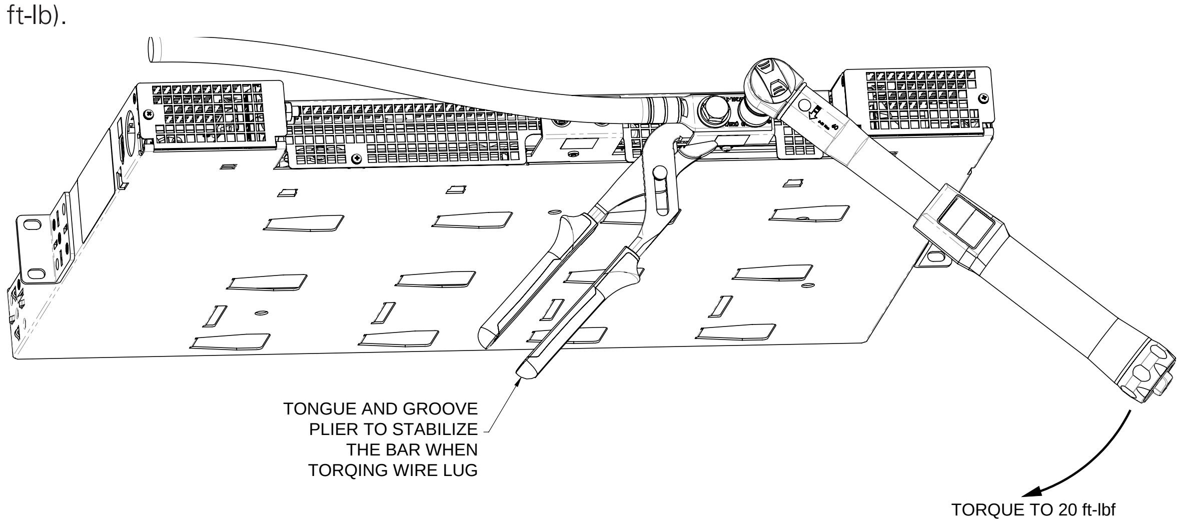


Figure 10: Connecting output bars directly to cables

6.5.3 DC output connections - single component distribution

Cordex® HP 2.4 kW rectifier systems only

When attaching cables directly to the output bars, use appropriately sized cables terminated with crimp lugs with M6 bolts on ⅝ inch centers.

Remove the bolts and washers at both positive and negative output bars. Bolts are M6 × 1.0 × 16. Note that PEM nuts are installed on the busbar for easier installation.

Use the fasteners removed from the previous step to secure the positive and negative cables to the shelf output bars. Install all fasteners finger tight.

Use tongue and groove or similar pliers to hold and stabilize the output bar, torque each bolt to 10.85 Nm (8 ft-lb).

The shelf is intended to operate as four independent outputs. Ensure that the controller connected has all load balancing, and power save features disabled.

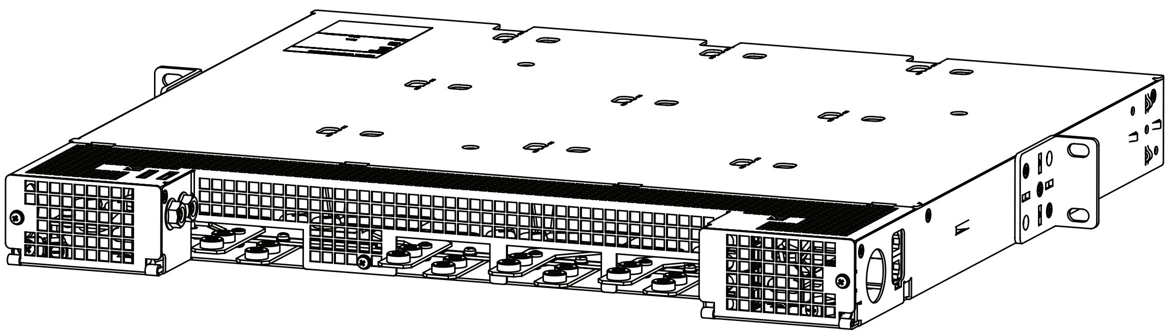


Figure 11: 19-inch shelf with single component distribution

WARNING

Do not complete the final live connections to the battery. Leave open and insulate the final connections or remove the battery fuses. Switch off the battery contacts if used.

6.6 AC wiring 23-inch shelf

6.6.1 AC feeder protection and sizing

To maximize system reliability it is recommended that, each power module be fed from a dedicated protection feeder breaker located at the AC distribution panel. The feeder breaker can also act as the disconnect device for the connected module. Refer to Specifications for breaker and wire size recommendations.

6.6.2 AC input connections

CAUTION

To minimize EMI disturbances, route the AC input wires in flexible or rigid conduit and located as far away as possible from the DC power wires.

WARNING

Use care when removing or replacing the covers for the AC input connections. Never assume that an electrical connection or conductor is not energized.

1. Ensure that all modules are removed from the shelf.
2. At the rear of the shelf, remove screw and flip the cover down (two places) to access the AC input terminal blocks: each terminal pair corresponds to either two rectifiers or a single rectifier.
3. The wire way is designed for two customer-supplied, ¾ inch trade size conduit fittings for the AC supplies located on each side of the shelf. Attach the conduit retainers to the wire way holes and route the AC cables through them.
4. Secure the wires to the AC input and AC ground terminals (torque to 1.69 Nm or 15 in-lb) and AC ground terminal (torque to 3.95 Nm or 35 in-lb). Refer to Figure 12 and customer connection drawing 0300057-08 and 0300216-08 at the end of this document.
5. Tighten the cable connector to the AC cable (conduit similar).
6. Replace rear covers once all connections have been completed.

Rectifier slot numbers 1 to 5 from the left front of the shelf (for reference only).

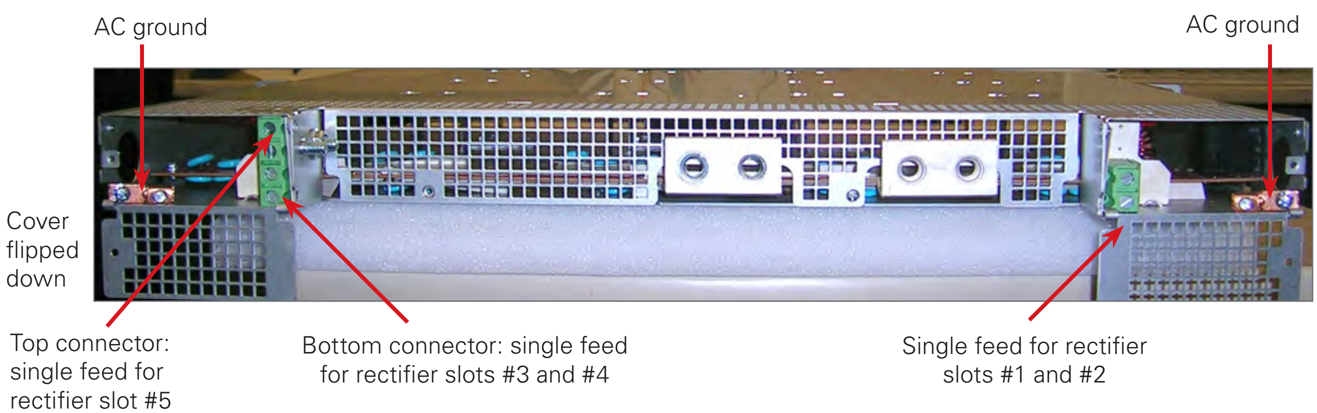


Figure 12: AC input and ground for 23-inch shelf

6.7 AC wiring 19-inch shelf

For the 19-inch shelf, AC wiring is fed separately to each of the four rectifiers.

6.7.1 AC feeder protection and sizing

To maximize system reliability it is recommended that, each power module be fed from a dedicated protection feeder breaker located at the AC distribution panel. The feeder breaker can also act as the disconnect device for the connected module. Refer to Specifications for breaker and wire size recommendations.

6.7.2 AC input connections

WARNING

Use care when removing or replacing the covers for the AC input connections. Never assume that an electrical connection or conductor is not energized.

CAUTION

To minimize EMI disturbances, route the AC input wires in flexible or rigid conduit and located as far away as possible from the DC power wires.

1. Ensure that all rectifier modules are removed from the shelf.
2. At the rear of the shelf, remove the screw and flip the cover down (two places) to access the AC input terminal blocks. Each terminal pair corresponds to an individual rectifier as marked.
3. The wire way is designed for two customer-supplied, ¾ inch trade size conduit fittings on each side of the shelf. Attach the conduit retainers to the wire way holes and route the AC cables through them.
4. Secure the wires to the AC input connections (torque to 1.69 Nm or 15 in-lb) and AC ground terminal (torque to 3.95 Nm or 35 in-lb) as shown in drawings 0300040-08 and 0300228-08 at the end of this document.
5. Tighten the cable connector to the AC cable (conduit similar).
6. Replace rear covers once all connections have been completed.
7. For shelves with IEC320-C20 receptacles, plug in an IEC320-C19 4 mm² (12 AWG) power connector into the respective module AC input.

6.8 Communication cabling (optional)

6.8.1 CAN serial ports (rectifier shelf)

Two CAN serial ports (modular jacks), are provided for communications with controllers and other CAN-enabled equipment. These are located on the left side of the rectifier shelf as viewed from the front.

1. Daisy-chain from shelf to shelf (CAN 1 of one shelf to CAN 2 of another).
2. Insert a CAN terminator (PN: 5450228-001) in the last CAN bus position at the end of the daisy chain.

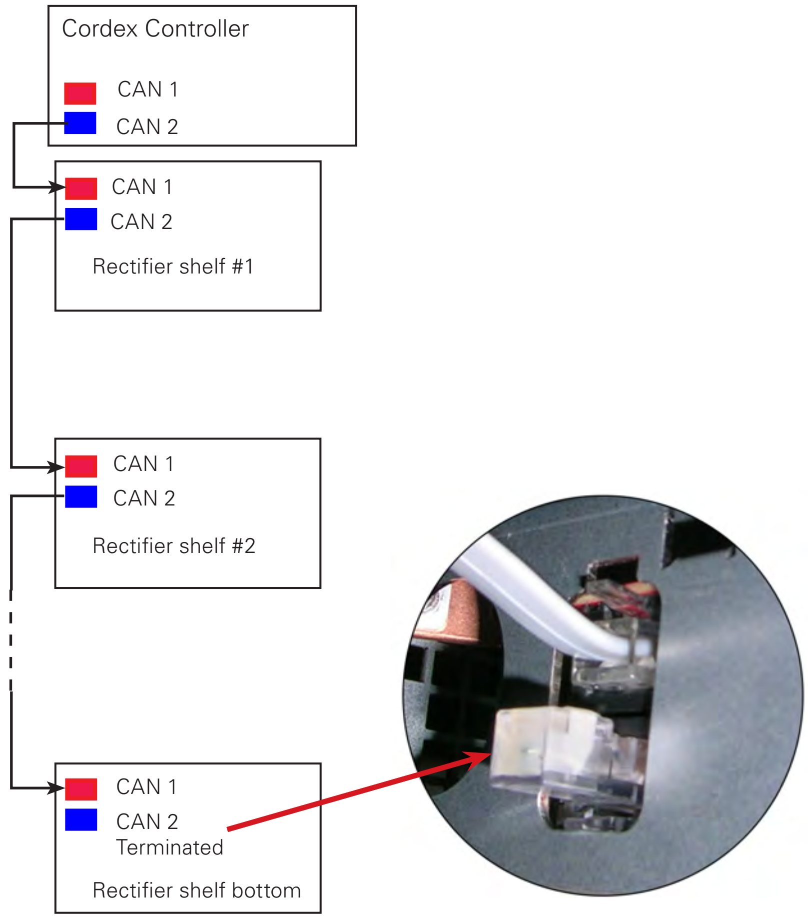


Figure 13: CAN bus cabling

6.8.2 Shelf/Bay ID connection (Cordex® HP 3.0 kW rectifier systems only)

The Cordex® CXC HP Shelf/Bay ID peripheral can be used for loading individual rectifiers when multiple shelves are used in multiple bays.

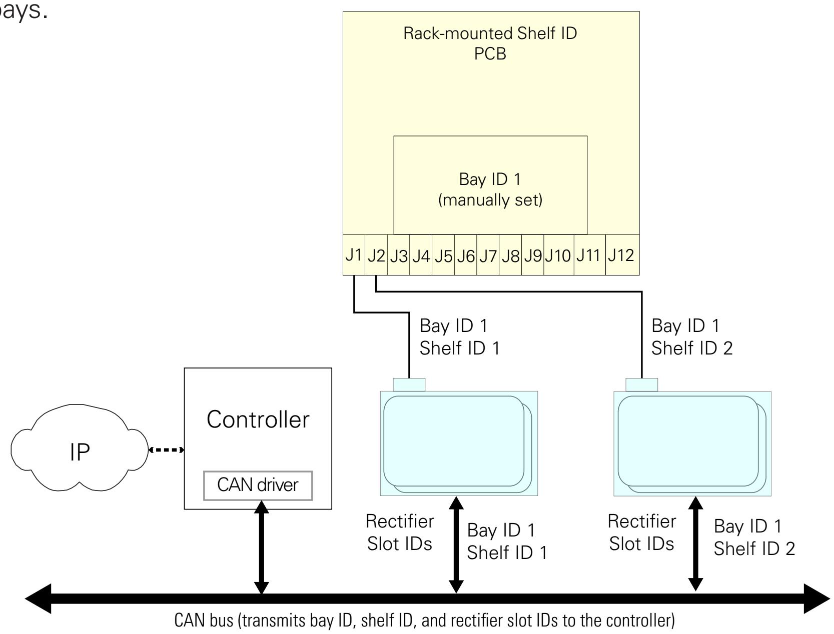
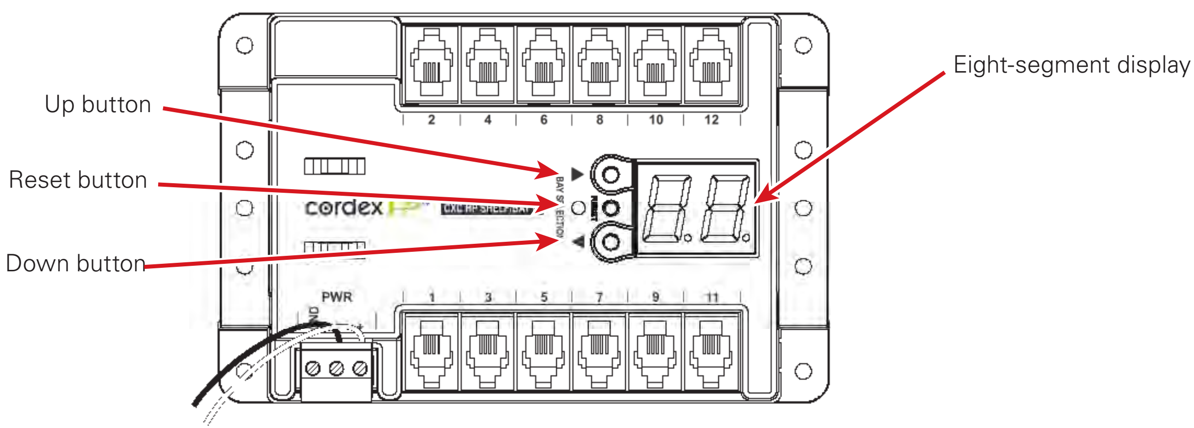
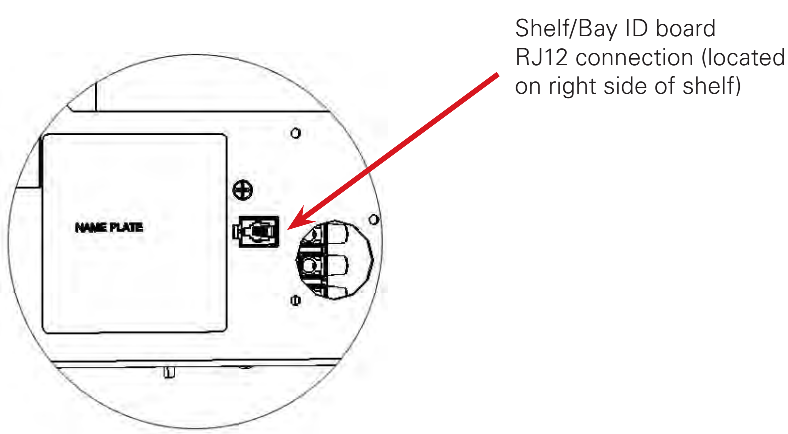


Figure 14: Example of a single bay with two rectifier shelves





6.8.3 Signal wiring connections to Cordex® CXC HP L-ADIO peripheral (optional)

For terminal block connections, the recommended wire sizes are 0.823 to 0.129 mm² (18 to 26 AWG) for the temperature range of 0 to 50 degrees Celsius (32 to 122 degrees Fahrenheit) as per UL/CSA.

CAUTION

To reduce risk of fire, use only 0.129 mm² (26 AWG) or larger wire.

6.8.4 Relay outputs

Terminals provide contacts for extending various alarm or control signals. Each relay output can be wired for normally open (NO) or normally closed (NC) operation during an alarm or control condition.

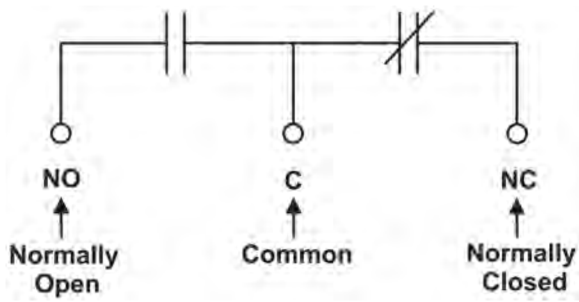


Figure 15: Relay connections in the de-energized state

Relays can be programmed to energize or de-energize during an alarm condition (see the software manual). When the controller reset button is pressed or power is lost, all relays de-energize.

6.8.5 Digital inputs

The digital input channels are used to monitor various alarm and control signals. All input channels are voltage activated and accept a bipolar (negative or positive) DC signal directly.

Connection method

Typical systems use the reset with hot and trigger with ground connection. The digital input is wired in such a way that the hot is wired directly into one of the input terminals. For example, the positive input for +24 V systems. The other input terminal is wired to the ground (common) of the system through a dry contact relay usually located on the equipment requiring monitoring. This method allows the digital input to receive or not receive a ground signal on an alarm.

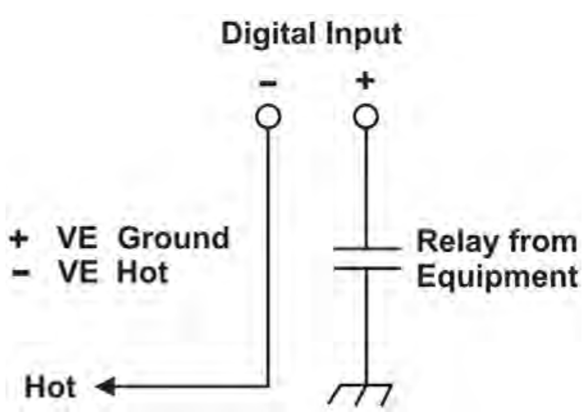


Figure 16: Digital input connection method

6.9 System startup

Visually inspect the installation thoroughly.

After completing the system installation and power system wiring, perform the following startup and test procedure to ensure proper operation:

6.9.1 Check system connections

1. Make sure that the AC input power is switched off, the batteries are disconnected, and all the power modules are removed from the shelf.
2. Triple-check the polarity of all connections.

6.9.2 Verify AC and power the rectifier shelf

NOTICE

Do not force a module into position if it does not seat properly. All modules are keyed to ensure that the correct module (voltage/polarity) type is used.

1. Install one power module into the left most position using the side of the shelf as a guide.
   a. Place the power module on the shelf bottom and slide the module into the rear connector (inside the shelf).
   b. Apply pressure on the module handle to engage the rear connector in the shelf receptacle.
   c. Place the handle in the down position to secure the module to the shelf.
2. Verify that the AC input voltage is correct and switch on the corresponding feeder breaker. The power module AC ON LED illuminates after a preset start delay. (See Features for a description of the LEDs.)
3. Use the controller, if installed, to test the functionality of various module alarms and controls.

6.9.3 Check battery polarity and connections

1. Use a voltmeter to verify that the battery polarity is correct. Ensure that no cells or batteries are reversed.
2. Connect the batteries to the output of the system.
3. Install the remaining power modules.
4. In the adjustments menu of the controller, set the float and equalize voltages to the levels specified by the battery manufacturer.
5. Using the controller, test the functionality of the various module alarms and controls. Perform a load test with the system using a resistive load box.
6. Enable the temperature compensation (temp comp) feature in the batteries menu. Program the settings for slope and breakpoints (upper and lower) according to the specific batteries used.

7. Wiring

This chapter provides cabling details and notes on cable sizing for DC applications with respect to the product.

WARNING

Ensure that the power is switched off by switching off rectifiers and removing battery line fuses, turn off battery breakers before attempting work on the wiring. Use a voltmeter to verify the absence of a voltage. Clearly mark the correct polarity of the battery leads before starting work on DC connections.

7.1 Installation notes

Refer to the Installation section for safety precautions and tools required.

7.1.1 Calculating output wire size requirements

Although DC power wiring and cabling in telecommunication applications tend to exceed electrical code requirements, mostly due to the voltage drop requirements, all applicable electrical codes take precedence over the guidelines and procedures in the present chapter, wherever applicable.

Wire size is calculated by first determining the appropriate maximum voltage drop requirement. Use the following formula to calculate the circular mil area (CMA) wire size requirement. Determine the size and number of conductors required to satisfy the CMA requirement.

$$\mathbf{CMA = (A \times LF \times K) / AVD}$$

A = Ultimate drain in amps.

LF = Conductor loop feet.

K = 11.1 constant factor for commercial (TW type) copper wire.

AVD = Allowable voltage drop.

Check again that the ampacity rating of the cable meets the requirement for the installation application. Consult local electrical codes (for example, National Electrical Code® and Canadian Electrical Code) for guidelines. If required, increase the size of the cable to meet the code.

Refer to Table H for cable size equivalents.

Table C — Cable size equivalents (AWG to Metric)

Cable size	Circular mils	Square millimeters	Equivalent metric cable
20 AWG	1020	0.519	1
18 AWG	1624	0.8232	1
16 AWG	2583	1.309	1.5
14 AWG	4107	2.081	2.5
12 AWG	6530	3.309	4
10 AWG	10380	5.261	6
8 AWG	16510	8.368	10
6 AWG	26250	13.30	16
4 AWG	41740	21.15	25
2 AWG	66370	33.63	35
0 AWG (or 1/0)	105600	53.48	50 or 70
00 AWG (or 2/0)	133100	67.42	70
0000 AWG (or 4/0)	211600	107.2	120
313 MCM (or kcmil)	313600	159	150 or 185
350 MCM (or kcmil)	350000	177.36	185

Table C — Cable size equivalents (AWG to Metric)

Cable size	Circular mils	Square millimeters	Equivalent metric cable
373 MCM (or kcmil)	373700	189	185 or 240
500 MCM (or kcmil)	500000	253.36	300
535 MCM (or kcmil)	535300	271	300
750 MCM (or kcmil)	750000	380.00	400
777 MCM (or kcmil)	777700	394	400

7.1.2 Required torque values

The following table lists the recommended torque values for connection to the power system with the following hardware:

- Clear hole connections (nut and bolt)
- PEM studs
- PEM threaded inserts
- Thread formed connections (in copper busbar)

Grade 5 rated hardware is required for these torque values.

Table D — Recommended torque values

Size	Torque value
1/4 inch	11.93 Nm (8.8 ft-lb)
3/8 inch	44.06 Nm (32.5 ft-lb)
1/2 inch	98.97 Nm (73 ft-lb)

7.2 Grounding

Connect the isolated power system battery return bus (BRB) to the building master ground bus (MGB), or floor ground bus (FGB) in a larger building. This acts as a system reference and as a low impedance path to the ground for surges, transients and noise. The MGB or FGB must have a direct low impedance path to the building grounding system.

The cable from the power system to the MGB or FGB must be sized to provide sufficient ampacity to clear the largest fuse or breaker on the power system, excluding the battery protection fuse or circuit breaker. This is the minimum requirement. Other factors including length of cable and special grounding requirements of the load must also be factored in. The insulated cable must be equipped with two-hole crimp type lugs and must not have any tight bends or kinks.

Table E — Typical ground reference conductor selection

Power system ampacity	Recommended ground reference conductor size
<30A	6 mm² (10 AWG)
30A to 100A	16 to 35 mm² (6 to 2 AWG)
100A to 400A	107 mm² (0000 AWG)
400A to 800A	185 mm² (350 MCM)
>800A	400 mm² (750 MCM)

The power system frame must also be connected to the MGB or FGB. This is done for personnel safety and to meet many telecom grounding requirements. Each bay must have its own frame or site ground connection. Refer also to the customer connections drawing at the end of this document.

8. Rectifier modes and factory defaults

8.1 Rectifier modes

There are two main rectifier modes:

- Output voltage mode
- Output current and power mode.

8.1.1 Output voltage modes

Voltage modes are under software control, and can be used to directly adjust the output voltage. The qualification of under software control is made because there are processes that occur in the rectifier that can change the output voltage that do not adjust the output voltage directly, for example, if the rectifier has reached the current limit.

Table F lists output voltage modes and a description of when they are active. These modes can be set via the controller.

Table F — Output voltage modes

Output voltage modes	Active when…
Float	Output voltage is set to the float voltage setting.
Equalize	Output voltage is set to the equalize voltage setting.
Battery Test	Output voltage is set to the battery test voltage setting.
Safe	If the rectifier is not connected to a controller, the rectifiers will switch to safe mode (51.4 V default) after five minutes.

8.1.2 Output current and power modes

These modes directly affect the output current and power. Table G lists the output current and power modes and a description of when they are active.

Table G — Output current and power modes

Output current modes	Active when…
Temperature foldback mode	Output current and power limit have been reduced because a high temperature has been detected on the heatsink or internal ambient temperature sensor.
AC foldback mode	Output current and power limits have been reduced because the AC input voltage is low. This will reduce the risk of tripping an AC breaker due to increased AC current draw as the AC voltage decreases.
Short circuit foldback mode	Output current limit has been reduced due to a short circuit at the output.
Internal fault foldback mode	Output current limit has been reduced due to an internal fault.
Constant power mode	If the output current exceeds max rated current, the rectifier puts out constant power within a specific voltage range. The rectifier is in constant power mode.
Overload	If the load current increases further, the output voltage and current will reduce. This mode is called fold back mode or Over Load.

8.2 Factory ranges and defaults

Table H shows the rectifier settings, ranges, and default values. Changes are made through the controller interface.

Table H — Rectifier factory ranges and defaults

Setting	Range (minimum to maximum)	Default
Float (FL) Voltage	47.5 to 58 V	54 V
Equalize (EQ) Voltage	49.8 to 60 V	55 V
Battery Test (BT) Voltage	44 to 52 V	46 V
Over Voltage Protection (OVP)[1]	63 V	63 V
Current Limit (CL)	20 to 100%	100%
Power Limit (PL)	0 to 100%	100%
Module Start Delay	0 to 250 s	1 s
System Start Delay	0 to 600 s	0 s
Low Voltage Alarm (LVA)	42 to 52 V	44 V
High Voltage Alarm (HVA)	52 to 63 V	55.5 V
EQ Timeout	1 to 2399 h	30 h
BT Timeout	1 to 250 h	8 h
Softstart Ramp-rate	Normal/Fast	Normal
CL/PL Alarm	Enable/Disable	Enable
Remote Shutdown	Enable/Disable	Enable
Ramp Test	Enable/Disable	Enable

[1] The OVP value cannot be set below the present system, FL, EQ, BT voltage setting or the safe mode voltage of 51.4 V.

9. Maintenance

Although very little maintenance is required with Cordex® power systems, routine checks and adjustments are recommended to ensure optimum system performance. Qualified service personnel should do the repairs. The following table lists a few maintenance procedures for this system. These procedures should be performed at least once a year.

To order more breakers refer to the options listed in the specifications. Always replace circuit breakers with the same type and rating.

Consult support or sales for all replacement parts.

WARNING

Use extreme care when working inside the unit while the system is energized. Do not make contact with live components or parts.

ATTENTION

Circuit cards, including semiconductor devices, can be damaged by static electricity. Always wear a grounded wrist strap when handling or installing circuit cards.

ATTENTION

Ensure redundant modules or batteries are used to eliminate the threat of service interruptions while performing maintenance on the system's alarms and control settings.

Table I — Sample maintenance log

Procedure	Date completed
Inspect all system connections. Re-torque if necessary.	
Verify alarm and control settings.	
Verify alarm relay operation.	
Clean ventilation openings of the rectifiers and converters.	

9.1 Replacing a rectifier module via the controller

When a rectifier is permanently removed, the system generates a **Rectifier Comms Lost** alarm. That alarm is cleared by removing the rectifier from the system inventory.

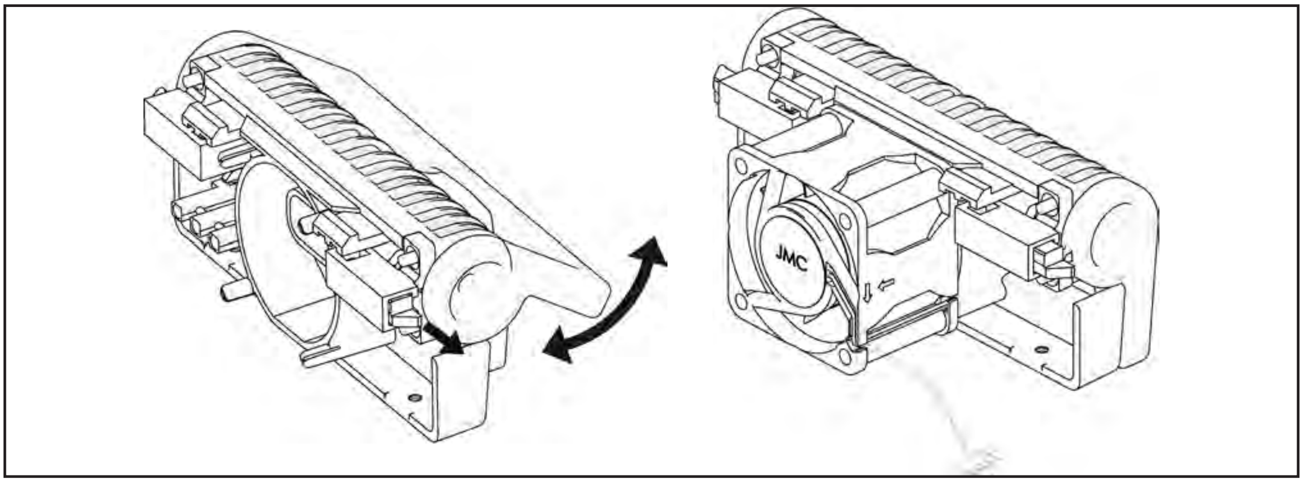
To remove the rectifier from the system inventory do the following:

1. Remove the defective rectifier from the shelf.
2. To remove a module, flip the handle up and pull the module away from the rear connector and out of the shelf.
3. In the web interface go to **Systems** > **DC System** > **Inventory** > **Rectifiers** > **Status**.
4. Select the **UNASSIGN** button on the rectifier to be removed and confirm.
5. Place the new rectifier in the shelf.
6. Rectifiers are Plug and Play, but you may still need to map the new rectifier to an AC phase.
7. If not set to auto-assign, go to **Modules** and in the **CAN Modules** table, assign the new rectifier.
8. Confirm the assignment.

9.2 Fan replacement

The fan on the individual rectifiers is designed for very high reliability and long life. During year six of the life of the product the manufacturer recommends replacement of the fan assembly.

1. Lift the locking handle and slide the module 10 cm (4 in.) out of the shelf. Wait ten minutes for the module capacitors to discharge and then slide the rectifier out of the shelf.
2. Remove the two bottom screws that secure the front panel to the module chassis.
3. Push in the two plastic protrusions on top of the rectifier and disengage the front panel and attached fan from the rectifier.
4. Disconnect the fan cables from the module by pulling out the fan cable connector.



5. Discard the old fan assembly and unpack the new replacement assembly.
6. Reconnect the fan cable. Insert the connector into the fan connector in the module. Ensure proper polarity and that the wires stay clear of the fan blade.
7. Slide the front panel into the rectifier body.
8. Ensure the metal tabs of the rectifier body aligned with the screw holes of the front panel.
9. Ensure the plastic tabs of the front panel are protruding through the metal cutouts in the rectifier body.
10. Secure the front cover by hand tightening the bottom screws.

10. Troubleshooting

The rectifiers and the shelves are designed for simple installation and reliable, trouble-free operation.

In most cases the rectifiers will recover from minor alarms and faults automatically. However under certain conditions the rectifiers may need remote control. And under very rare cases the rectifier may need a manual reset (unplug and reinsert the rectifier). In the unlikely event of a rectifier failure, it may need replacement.

A rectifier shelf can accommodate up to four or five rectifiers, depending on the model. The rectifiers have three LED indicators that provide information about the system.

When the shelf system is used in conjunction with a controller, detailed system information and status can be easily obtained. Even more information can be obtained via the web interface using the Ethernet port.

This table provides a quick look up at the LEDs and the corresponding rectifier states.

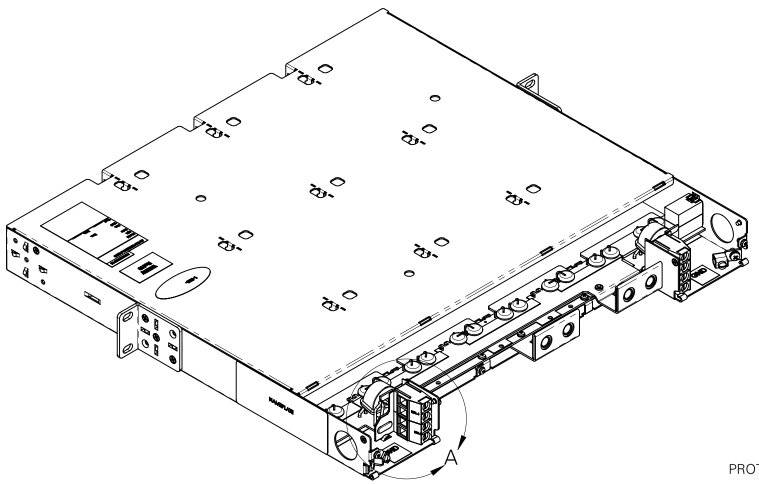
Table J — Rectifier alarm and fault states

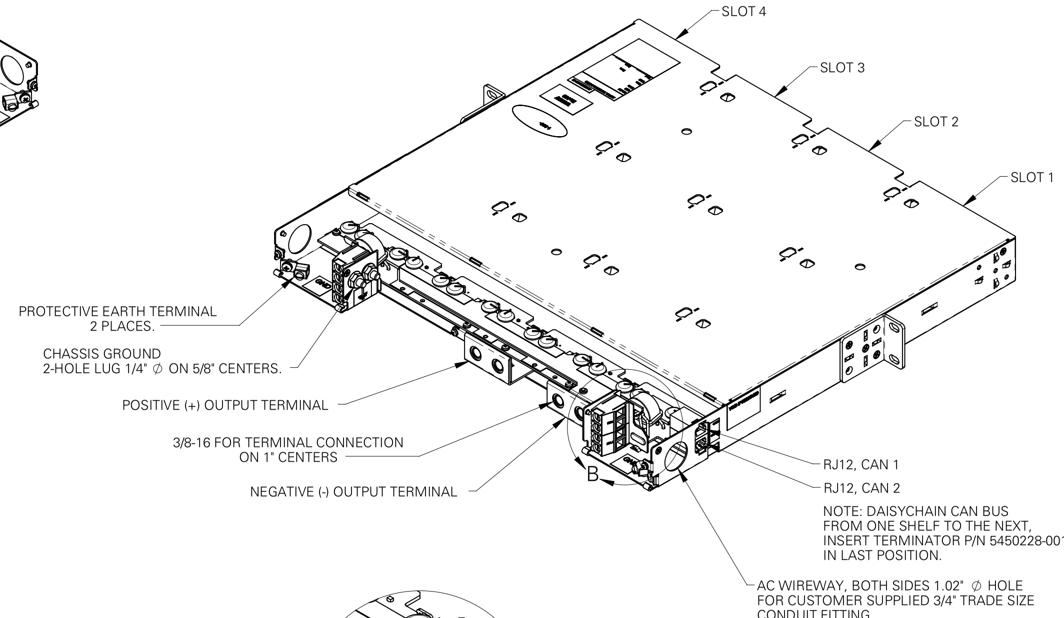
AC	DC	Alarm/fault	Rectifier state	Possible causes	Solutions
Green	Green	Off	Normal operation		
Green	Off	Off	Unit has no DC output	Unit is in **Power Save** mode	Unit will automatically resume power delivery power when load is increased or when the Remote restart is enabled.
Off	Off	Off	Unit may not be plugged in or system is off or unit has failed.		Plug in unit completely, check AC and DC wiring.
Off	Off	Red	Unit has shut down due to a fault and may need to be reset. Check controller or web interface to find the fault details.	AC not qualified unit has failed.	
Green	Off	Red	Unit has shut down due to a fault and may need to be reset. Check controller or web interface to find the fault details.	Depending on the fault the unit may or may not recover automatically.	Over temperature fault, will auto recover, plug unit into the shelf.
Green	Off	Blinking red	Unit has an alarm.		Check the controller front panel or web interface to find out the details of the alarm.
Green	Green	Blinking red	Unit has an alarm.		Check the controller front panel or web interface to find out the details of the alarm.
Green	Green	Red	Normal operation	Unit is on **No LOAD**, and no battery is connected. The controller will report ramp test fail.	Add load or connect battery, or disable ramp test.

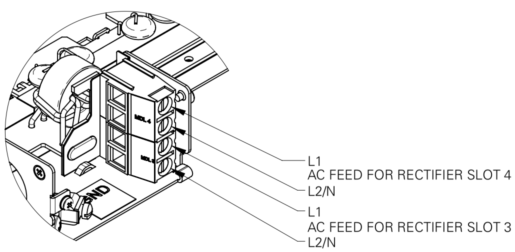
11. Acronyms and definitions

AC	Alternating current
ANSI®	American National Standards Institute
AWG	American Wire Gauge
BTU	British thermal unit
CAN	Controller area network
CEC	Canadian Electrical Code
CSA®	Canadian Standards Association
CX	Cordex® series; CXC for Cordex system controller
DC	Direct current
DHCP	Dynamic Host Configuration Protocol
EIA	Electronic Industries Alliance
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
ERM	Electromagnetic Compatibility and Radio Spectrum Matters
ESD	Electrostatic Discharge
FCC	Federal Communications Commission (for the US)
HVSD	High voltage shutdown
IEC®	International Electrotechnical Commission
IEEE®	The Institute of Electrical and Electronics Engineers, Inc.
IP	Internet Protocol
LED	Light emitting diode
LVD	Low voltage disconnect
LVBD	Low voltage battery disconnect
MIL	One thousandth of an inch; used in expressing wire cross sectional area
MOV	Metal oxide varistor
MUX	Multiplexer
MTBF	Mean time between failures
NC	Normally closed
NEC®	National Electrical Code® (for the US)
NO	Normally open
OSHA	Occupational Safety & Health Administration
OSP	Outside Plant
OVP	Over voltage protection
RU	Rack unit (44.45 mm; 1.75 in.)
TCP/IP	Transmission Control Protocol / Internet Protocol
THD	Total harmonic distortion
TVSS	Transient Voltage Surge Suppressor
UL®	Underwriters Laboratories®
UATS	Universal Automatic Transfer Switch
VRLA	Valve regulated lead acid

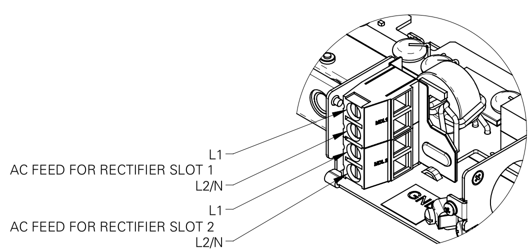
CUSTOMER CONNECTION,
SHELF, 19" 1RU, 48V-2.4KW







DETAIL A
SCALE: 1 : 2

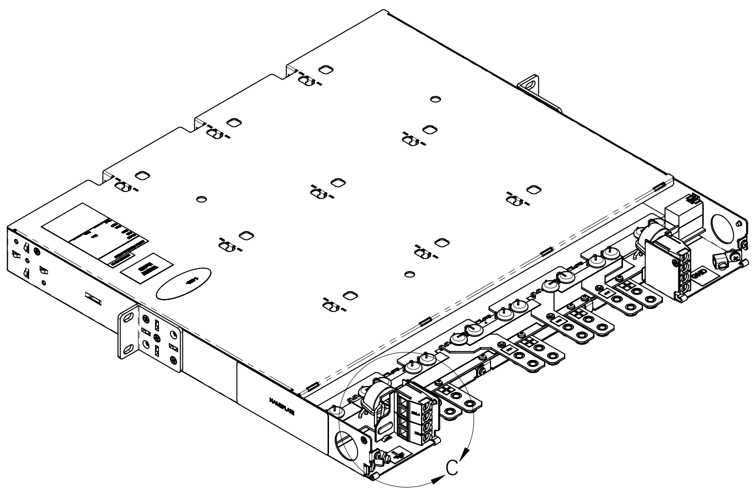


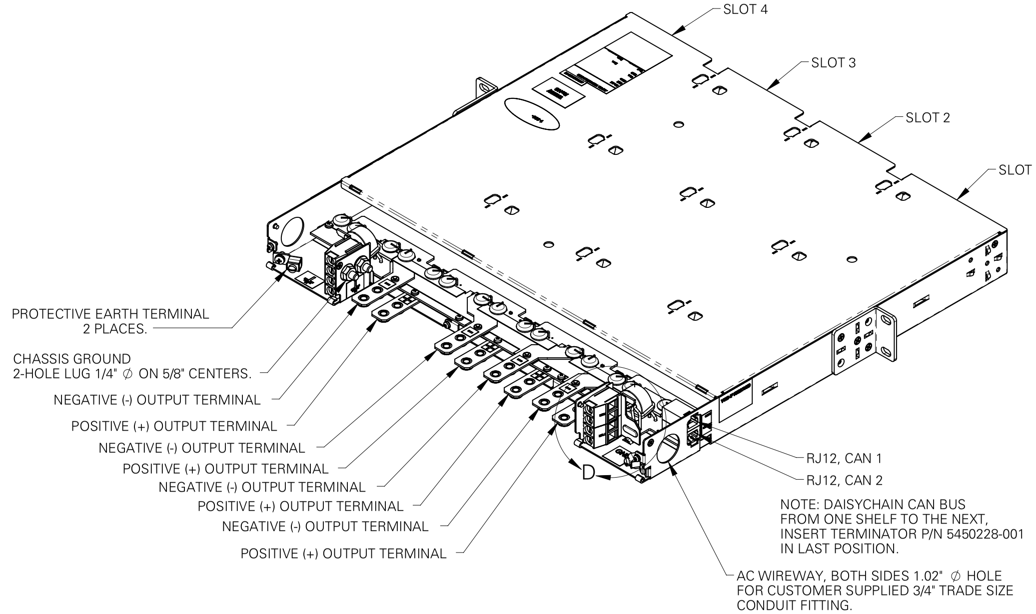
DETAIL B
SCALE: 1 : 2

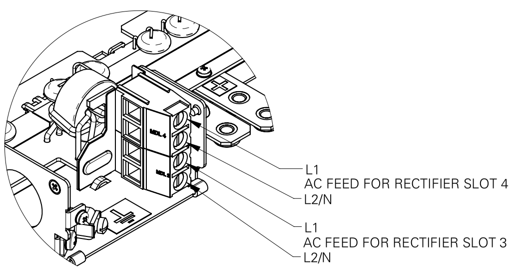
LIST OPTION 0300040-001

0300040-08

CUSTOMER CONNECTION,
SHELF, 19" 1RU, 48V-2.4KW







DETAIL C
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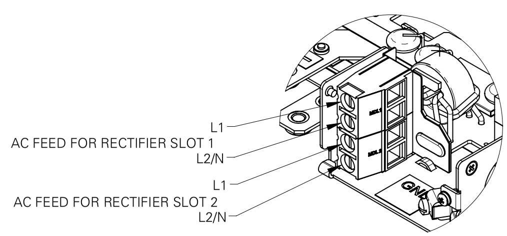
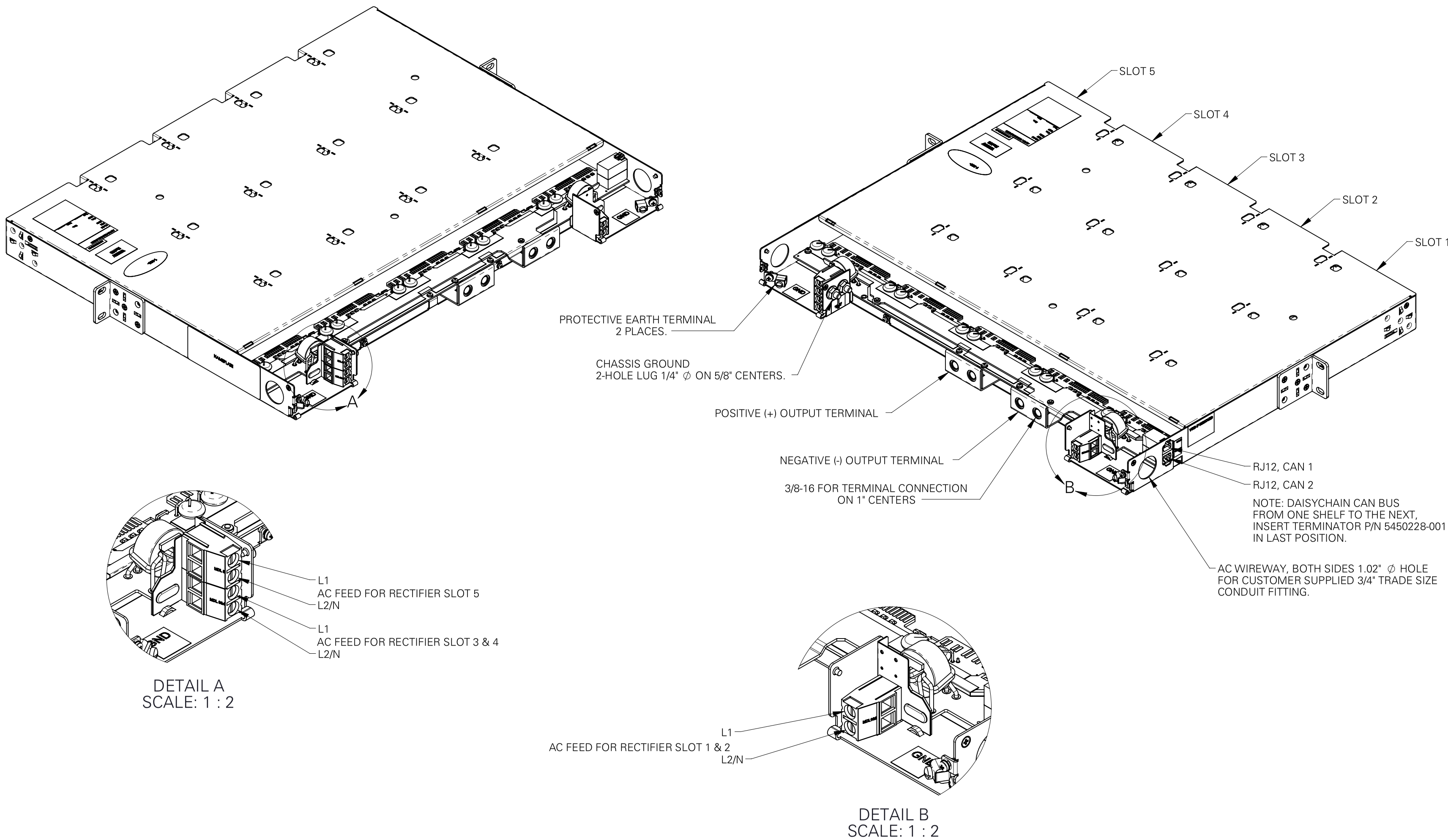


DETAIL D
SCALE: 1 : 2

LIST OPTION 0300040-002

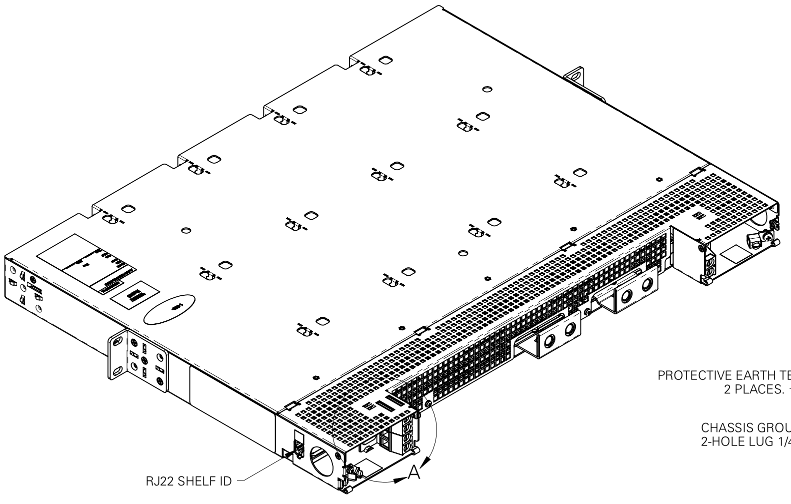
CUSTOMER CONNECTION,
SHELF, 23" 1RU, 48V-2.4KW

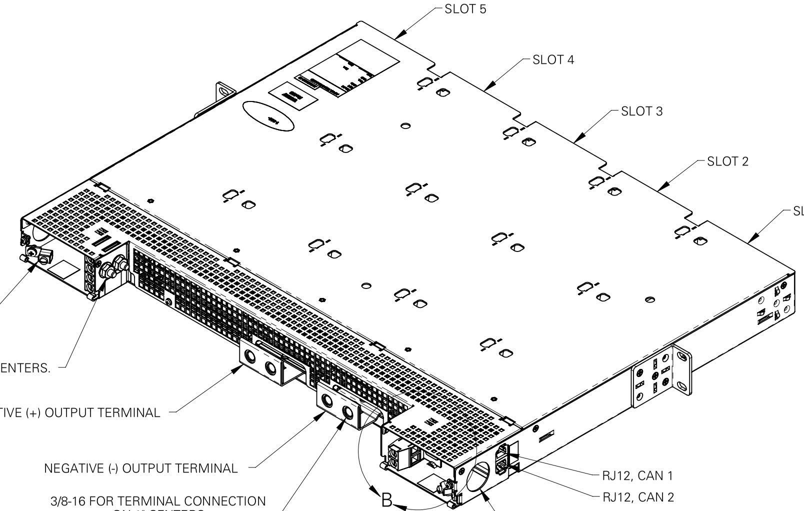


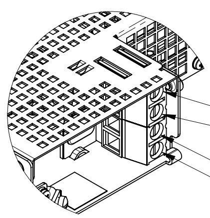
0300057-08

SHEET 1 OF 1

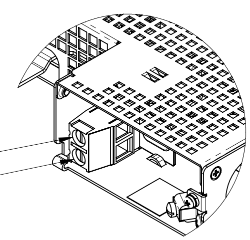
CUSTOMER CONNECTION,
SHELF, 23" 1RU, 48V-3KW







DETAIL A
SCALE: 1 : 2

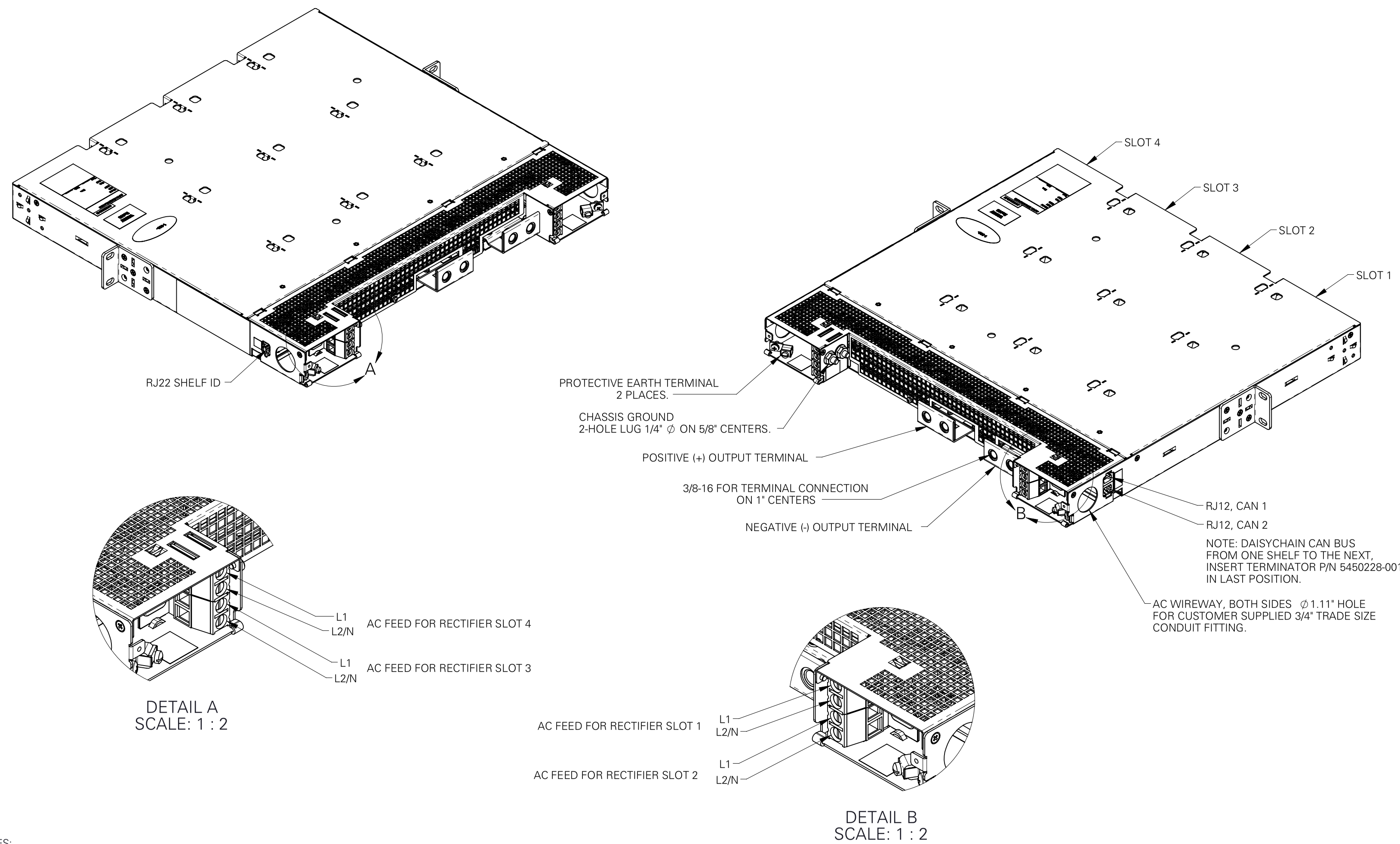


DETAIL B
SCALE: 1 : 2

NOTES:

1. THIS SHELF IS FOR ALPHA CXRF-HP 3kW MODULE ONLY

CUSTOMER CONNECTION,
SHELF, 19" 1RU, 48V-3KW



NOTES:

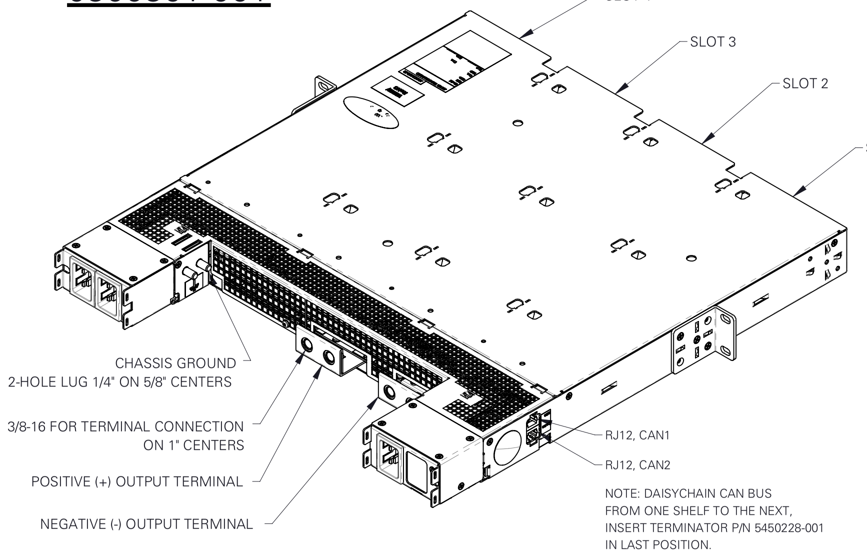
1. THIS SHELF IS FOR ALPHA CXRF-HP 3kW MODULE ONLY

0300228-08

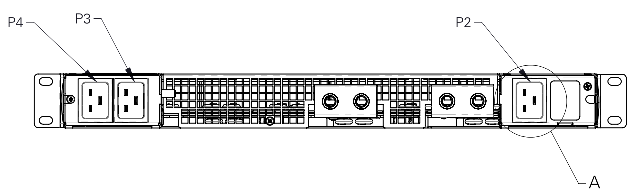
SHEET 1 OF 1

CUSTOMER CONNECTION DWG, SHLF,
19",1RU,4MDL,CX48V-2.4/3.0KW,3/4 IEC

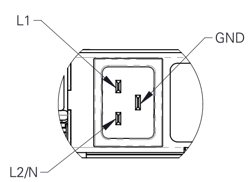
0300301-001



REAR ISO VIEW



REAR VIEW
(AC INPUT POWER LINE CORD RECEPTACLES 3PL)



DETAIL A
IEC C20 AC RECEPTACLE

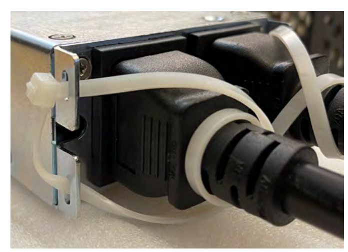
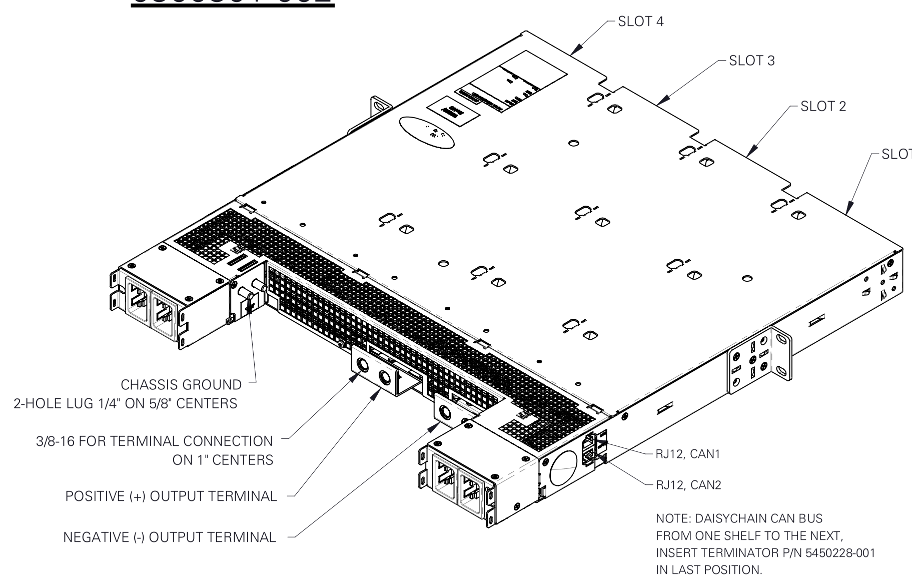
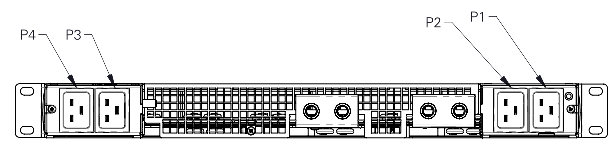


PHOTO: IEC C19 POWER CORD RETENTION

0300301-002



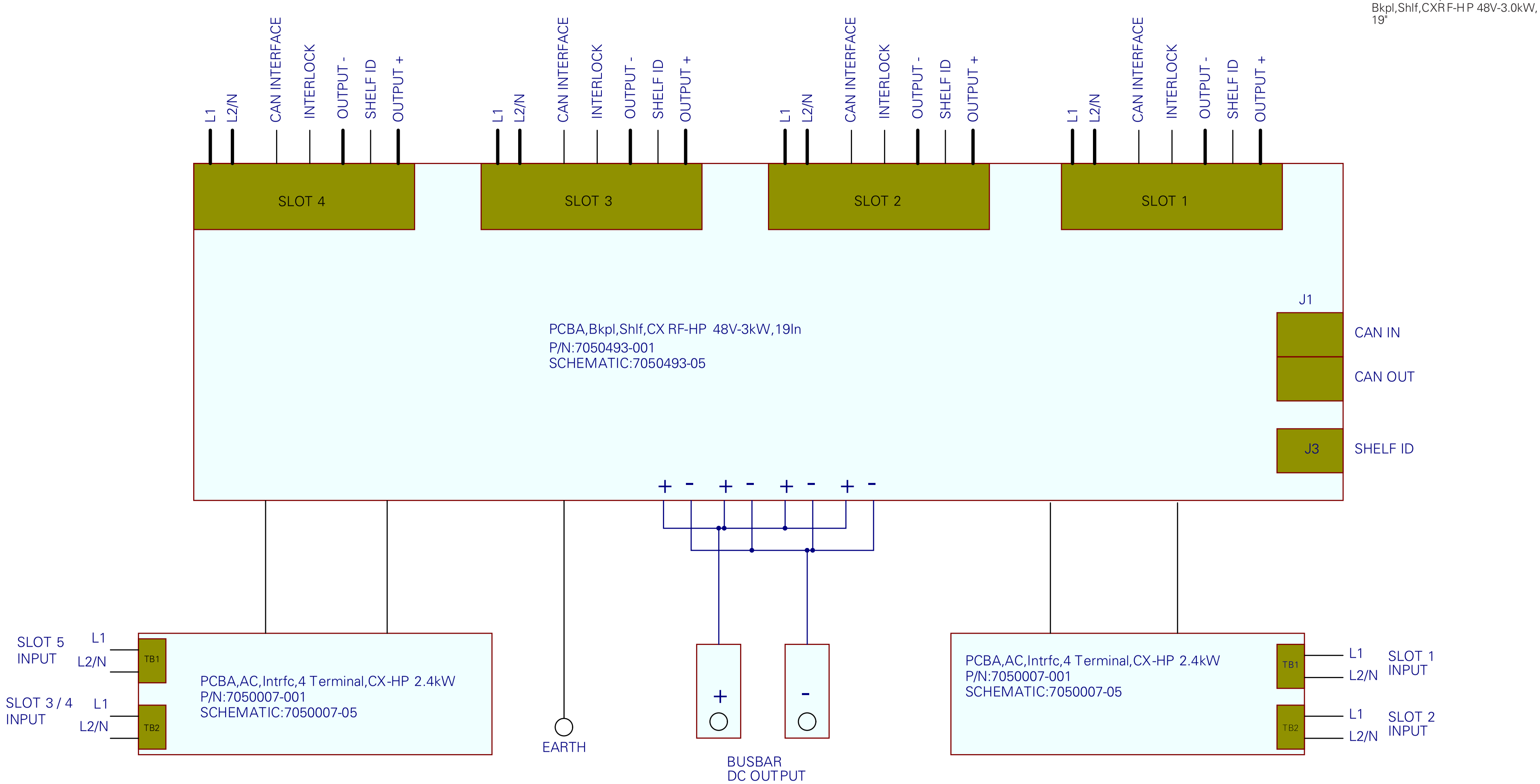
REAR ISO VIEW



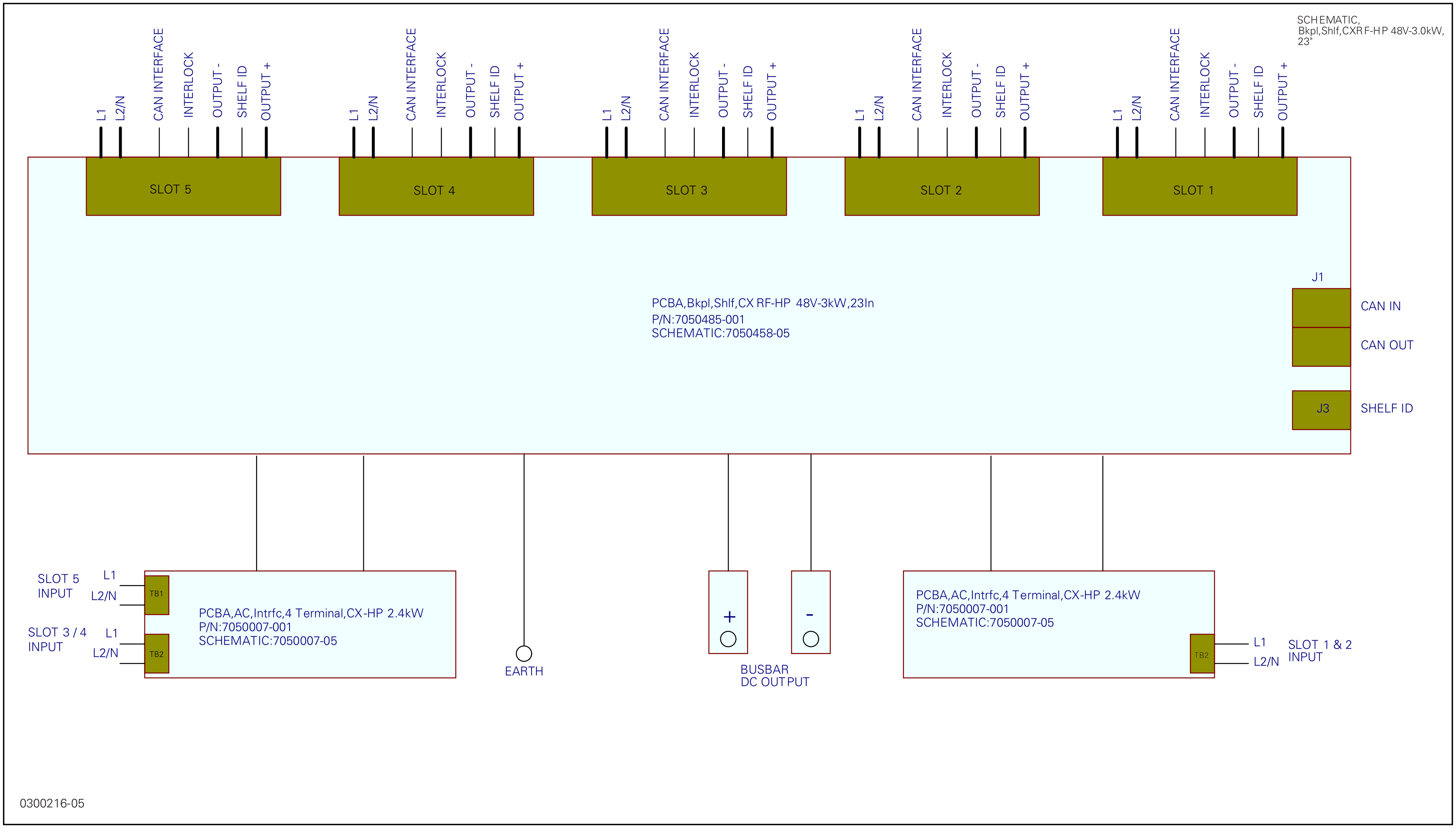
REAR VIEW
(AC INPUT POWER LINE CORD RECEPTACLES 4PL)

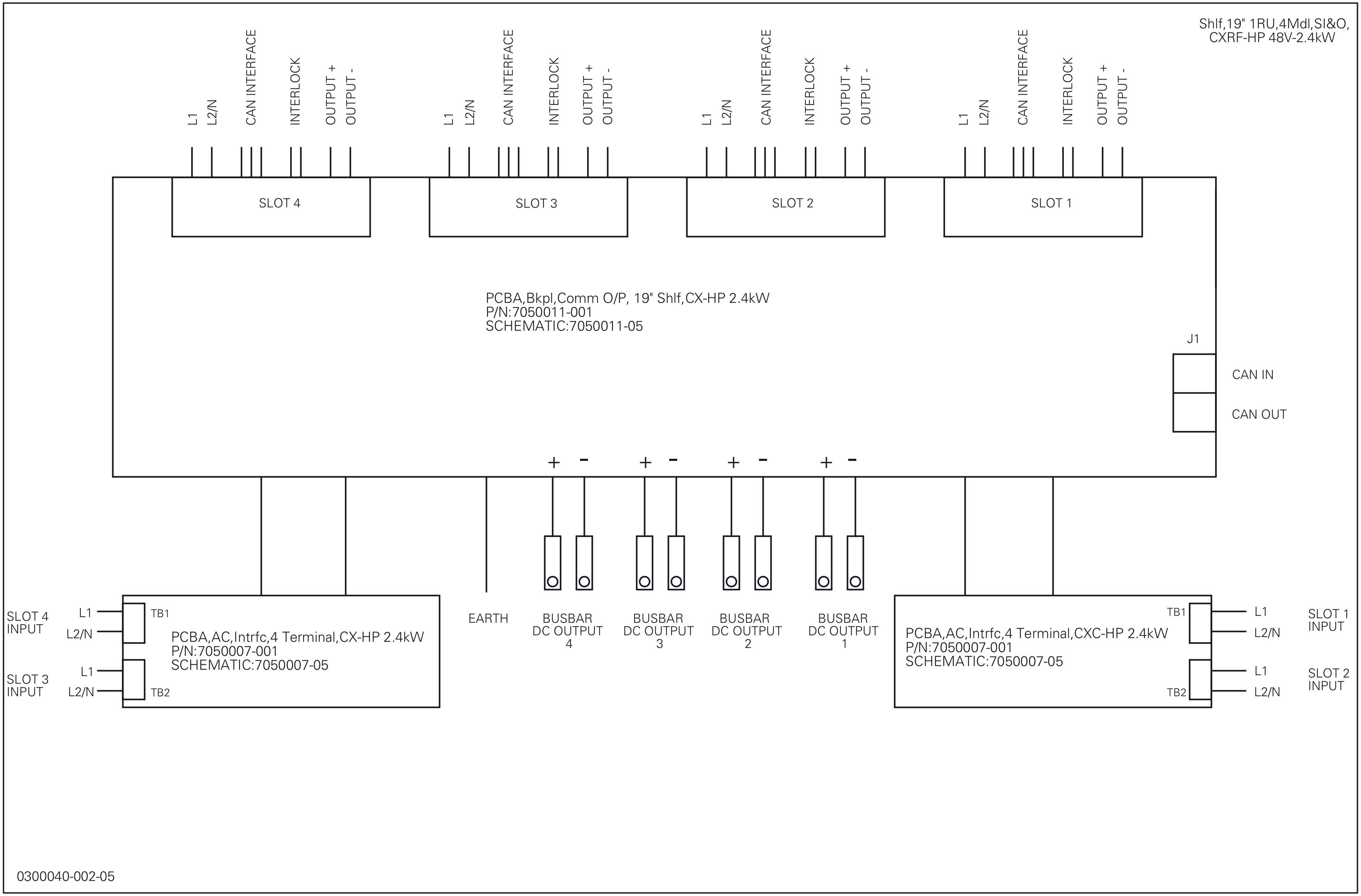
NOTE: AC POWER LINE CORDS ARE NOT INCLUDED WITH THE SYSTEM

SCHEMATIC,
Bkpl,Shlf,CXRF-HP 48V-3.0kW,
19"



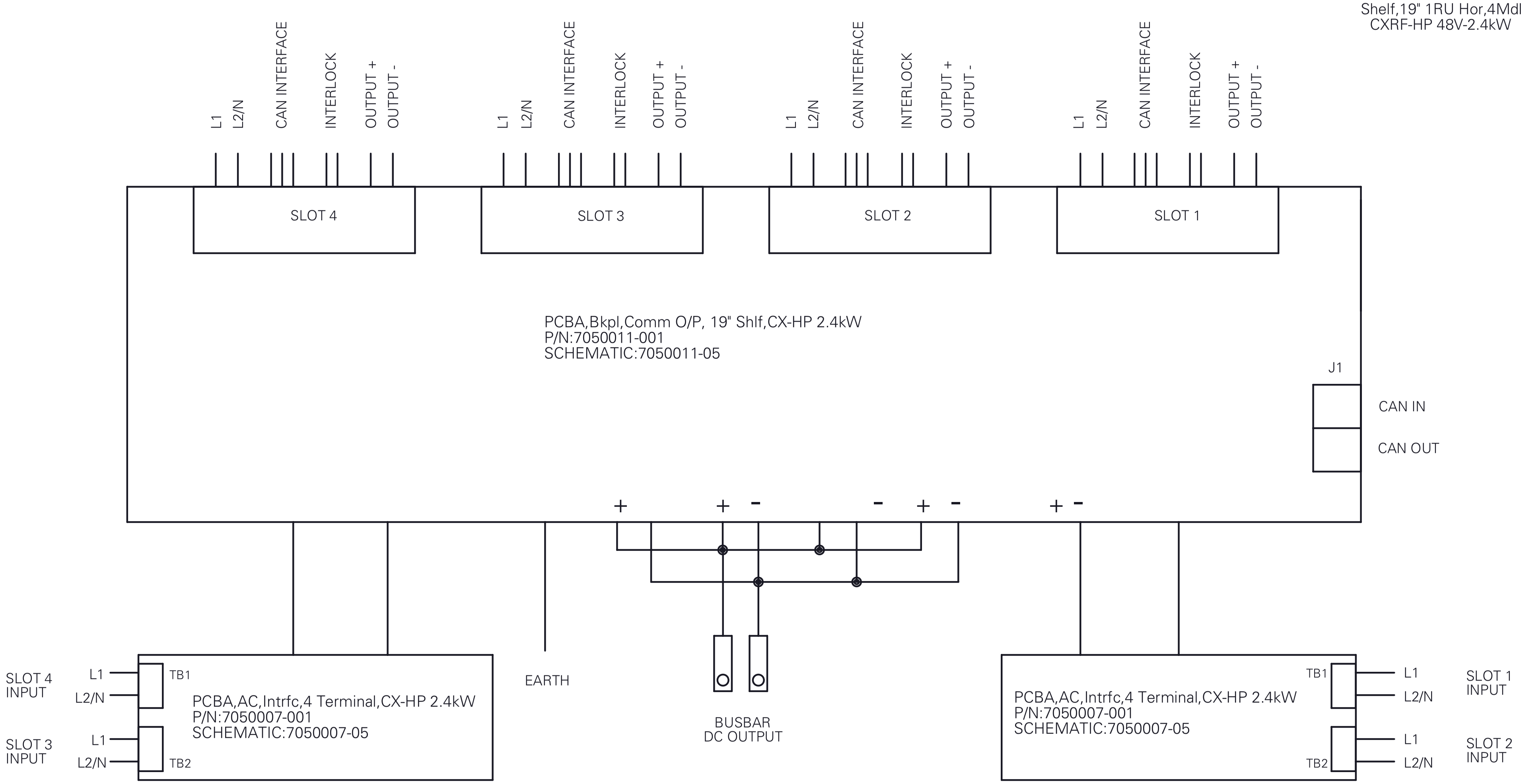
0300228-05


SCHEMATIC,
Bkpl,Shlf,CXRF-HP 48V-3.0kW,
23"
L1
L2/N
CAN INTERFACE
INTERLOCK
OUTPUT -
SHELF ID
OUTPUT +
SLOT 5
SLOT 4
SLOT 3
SLOT 2
SLOT 1
PCBA,Bkpl,Shlf,CX RF-HP 48V-3kW,23In
P/N:7050485-001
SCHEMATIC:7050458-05
J1
CAN IN
CAN OUT
J3
SHELF ID
SLOT 5
INPUT
SLOT 3 / 4
INPUT
TB1
TB2
PCBA,AC,Intrfc,4 Terminal,CX-HP 2.4kW
P/N:7050007-001
SCHEMATIC:7050007-05
EARTH
+
-
BUSBAR
DC OUTPUT
PCBA,AC,Intrfc,4 Terminal,CX-HP 2.4kW
P/N:7050007-001
SCHEMATIC:7050007-05
TB2
SLOT 1 & 2
INPUT
0300216-05



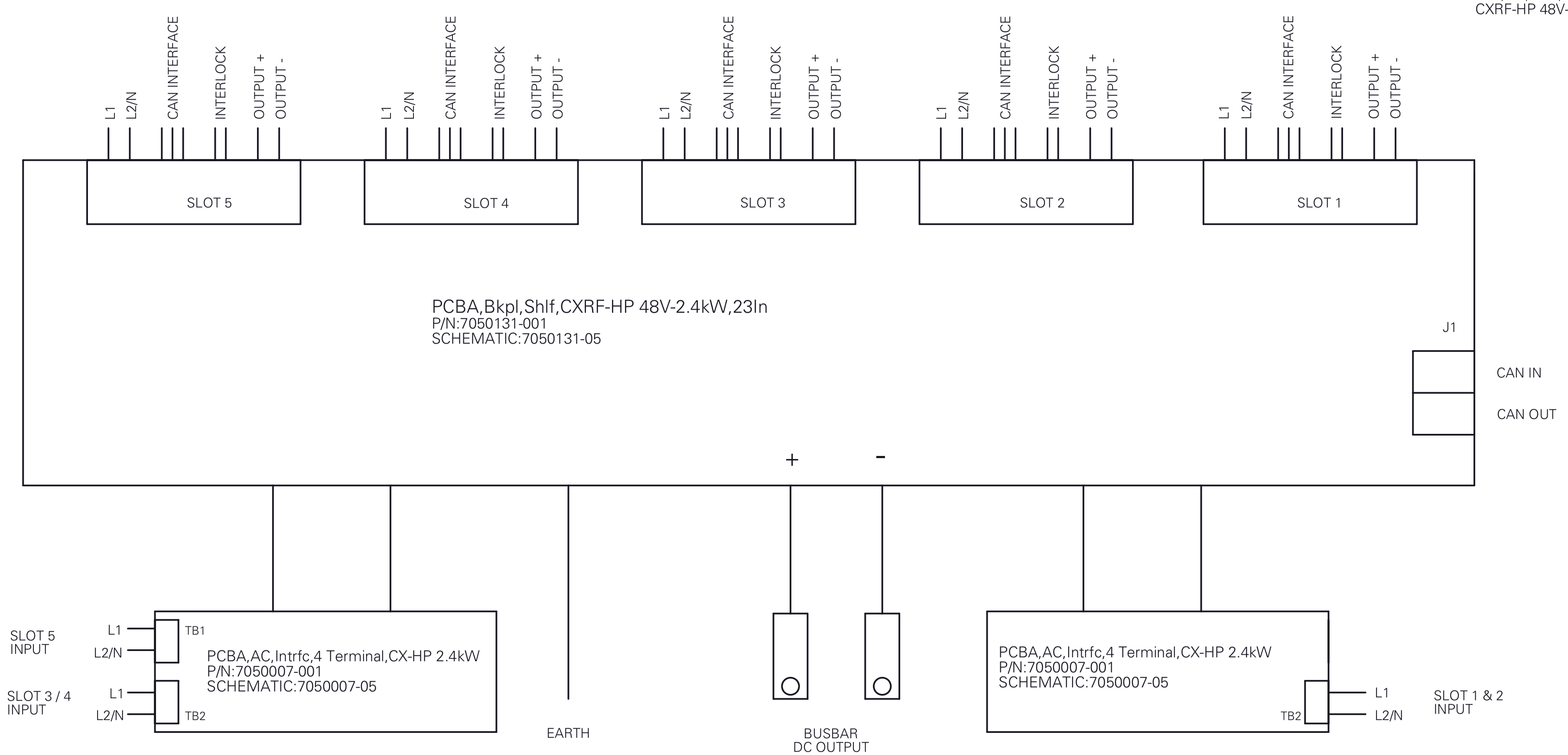
Shlf,19" 1RU,4Mdl,SI&O,
CXRF-HP 48V-2.4kW
L1
L2/N
CAN INTERFACE
INTERLOCK
OUTPUT +
OUTPUT -
SLOT 4
SLOT 3
SLOT 2
SLOT 1
PCBA,Bkpl,Comm O/P, 19" Shlf,CX-HP 2.4kW
P/N:7050011-001
SCHEMATIC:7050011-05
J1
CAN IN
CAN OUT
EARTH
BUSBAR DC OUTPUT 4
BUSBAR DC OUTPUT 3
BUSBAR DC OUTPUT 2
BUSBAR DC OUTPUT 1
PCBA,AC,Intrfc,4 Terminal,CX-HP 2.4kW
P/N:7050007-001
SCHEMATIC:7050007-05
PCBA,AC,Intrfc,4 Terminal,CXC-HP 2.4kW
P/N:7050007-001
SCHEMATIC:7050007-05
TB1
TB2
SLOT 4 INPUT
SLOT 3 INPUT
SLOT 1 INPUT
SLOT 2 INPUT
0300040-002-05

Shelf,19" 1RU Hor,4Mdl,
CXRF-HP 48V-2.4kW



0300040-001-05

Shelf,23",1RU,Hor,5Mdl,
CXRF-HP 48V-2.4KW



0300057-001-05

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