SPSPFE3-0XG

Power Shelf

SPSPFE3-0XG power-shelf solutions provide rectification, system management, and power distribution, while maintaining high reliability and offering flexibility for future expansion.

The power shelf can be configured with up to six hot-swap capable PFE3000-12-069RA AC/DC-DC power supplies that convert 3-phase AC mains power into a main output of 12 VDC for powering intermediate bus architectures (IBA) in high performance and reliability servers, routers, and network switches.

The shelf is compatible with the Open Compute Rack Design.

The shelf has an optional slot for Network Attached Controller for providing control functions and monitoring through a 10/100 MB base Ethernet port and can be connected directly to the data center management network.

Key Features & Benefits

- Two 3-Phase inputs, one AC inlet powers 3 power modules.
- Modules are hot-swap capable.
- Modules support I²C communication interface for control, programming and monitoring with PMBus® protocol.
- Modules implement the following protections: Overtemperature, output overvoltage and output overcurrent.
- RoHS Compliant.
- Available for OCP V1 and V2 bus-bar style connection.

Applications

- High Performance Servers
- Routers
- Switches

Disclaimer: PMBus is a registered trademark of SMIF, Inc.

1. ORDERING INFORMATION

MODEL	INPUT AND OUTPUT CONFIGURATION
SPSPFE3-05G	3-phase, 200-277 / 346-480 VAC Line to Line input with Neutral line 3 sets of output blades for +12 VDC output (each set of blades has max.585 A)
SPSPFE3-05CG	3-phase, 200-277 / 346-480 VAC Line to Line input with Neutral line 3 sets of output blades for +12 VDC output (each set of blades has max.585 A) Network Attached Controller included
SPSPFE3-06G	3-phase, 200-277 / 346-480 VAC Line to Line input with Neutral line 1 set of output blade for +12 VDC output
SPSPFE3-06CG	3-phase, 200-277 / 346-480 VAC Line to Line input with Neutral line 1 set of output blade for +12 VDC output Network Attached Controller included

2. TECHNICAL DATA

PARAMETER	DESCRIPTION / CONDITION
Input	3-phase, 200-277 / 346-480 VAC Line to Line input with Neutral[1]
AC Inlet Configuration	3 power modules are powered from one AC inlet
Auxiliary AC Outlet	3pcs. low power AC outlet providing 230 / 277 VAC output with max. 6A – 10A, Protected by T 10A – F 15 A / 500 VAC Fuse (serviceable) When T_A: +45 °C to +55 °C, Output load current must be derated to 75%.
Redundant Configuration	3+3 or 5+1 configuration
Rated Power 1	8700 W (3+3 configuration) [2]
Rated Power 2	14400 W (5+1 configuration) [2]
Output Connection	SPSPFE-05G: 3 sets of output blades for +12 VDC output (each set of blades has max.585 A) SPSPFE-06G: 1 set of output blade for +12 VDC output
Standby Output	60 W (Standby output 12 V / 5 A)
Communication	I^2C PMBus®
NAC1006-01	Network Attached Controller: Ethernet – SNMPv3 / HTTP

3. SAFETY WARNING

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies Bel Power Solutions Inc. from all claims arising from the handling or use of the goods. Persons handling the product(s) must have electronics training and observe good engineering practice standards.

CAUTION: Multiple power source. Disconnect all power cords before servicing.

4. REFERENCE DOCUMENTS

DOCUMENT NUMBER	DESCRIPTION
BCD.00297	PFE3000-12-069RA Datasheet
BCA.00070	PFE3000-12-069RA PMBus® Communication Manual
BCM.00177	Installation Instruction PFE3000-12-069RA
BCD.00926	NAC1006-01 Datasheet
BCA.00178	SPSPFE3-0XG Communication Manual
BCM.00444	Installation Instruction SPSPFE3-0XG
PCA9547PW	PCA9547PW Datasheet from NXP

[1] Power modules are connected Line to Neutral.
[2] Rated Power is reduced as per current share accuracy characteristic. See PFE3000-12-069RA Datasheet.

5. OVERVIEW

The SPSPFE3-0XG Power Shelf is a 1OU height power shelf. It can be configured with up to six hot-swap capable PFE3000-12-069RA AC/DC-DC power supplies that convert standard AC mains power into a main output of 12 VDC for powering intermediate bus architectures (IBA) in high performance and reliability servers, routers, and network switches.

The I²C communication is routed through an I²C Multiplexer (NXP PCA9547PW). PSU Modules support I²C communication interface for control, programming and monitoring with the PMBus® protocol.

The shelf has a slot for network attached controller (NAC) for providing control functions and monitoring through a 10/100 MB base Ethernet port and can be connected directly to the data center management network. It is hot-pluggable and supplied via the 12 V standby provided by the power supplies in the shelf. The controller can be configured through a web interface; the monitoring and control functions are accessed through SNMPv3.

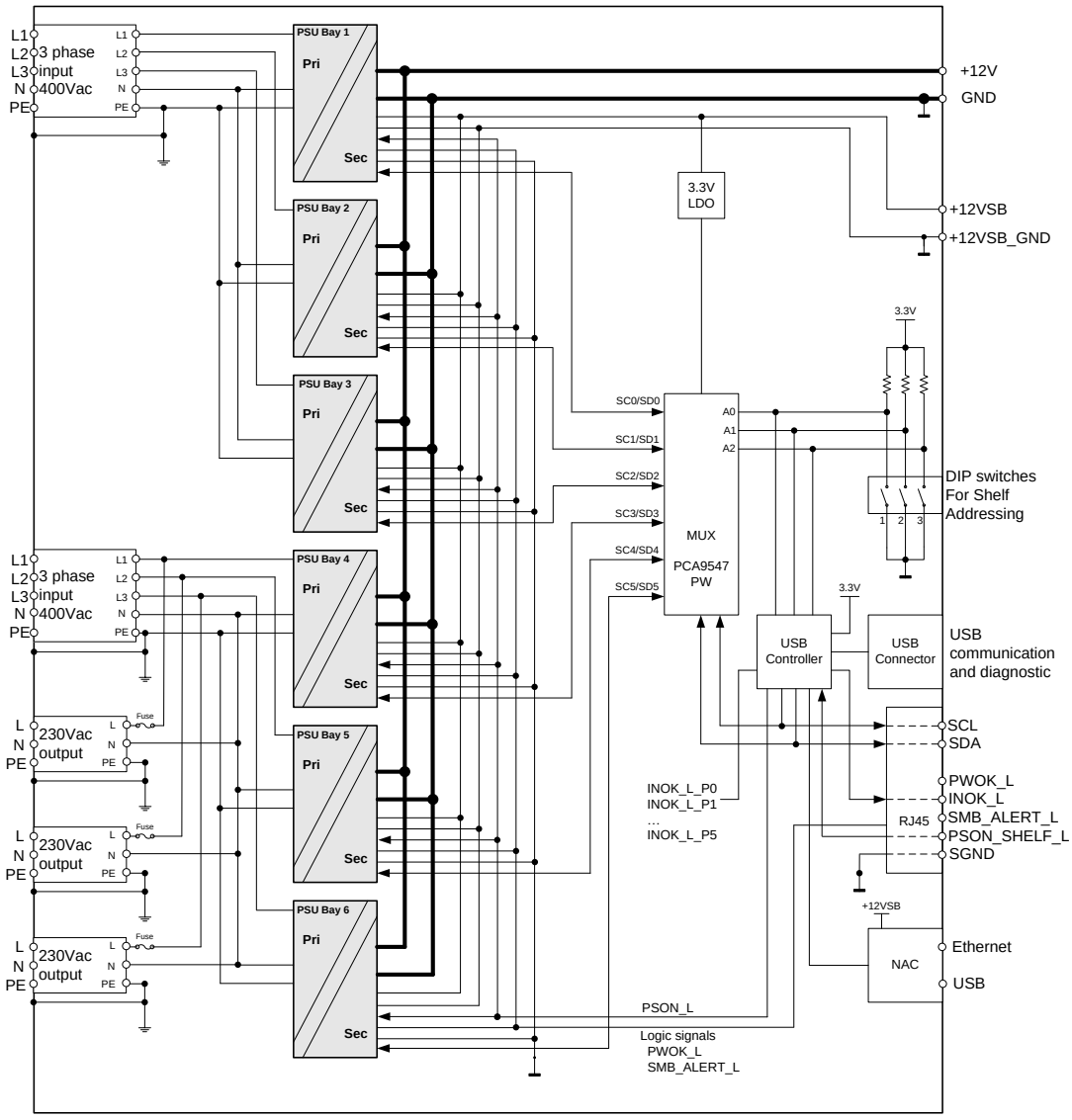

Figure 1. SPSPFE3-0XG Block Diagram

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6. INPUT SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITION	MIN	NOM	MAX	UNIT
Input Connector (J106, J107)					
AC Nominal Input Voltage	Line to Line input		400 / 480		VAC
AC Input Voltage Ranges	Line to Neutral input	180		300	VAC
Max Input Current	per line			23	Arms
Input Frequency		47	50 / 60	63	Hz

7. OUTPUT SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITION	MIN	NOM	MAX	UNIT
Main Output V1 (Output Bus Bar)					
Nominal Output Voltage			12.3		VDC
Voltage Regulation		-5		+5	% Vout nom
Nominal Output Power 1	3+3 configuration, $T_a < 45°C$			8700	W
Derated Output Power 1	3+3 configuration, $T_a = 55 °C$[3]			6525	W
Nominal Output Power 2	5+1 configuration, $T_a < 45°C$			14400	W
Derated Output Power 2	5+1 configuration, $T_a = 55 °C$[3]			10800	W
Nominal Output Current 1	3+3 configuration, $T_a < 45°C$			707	ADC
Derated Output Current 1	3+3 configuration, $T_a = 55 °C$[3]			530	ADC
Nominal Output Current 2	5+1 configuration, $T_a < 45°C$			1171	ADC
Derated Output Current 2	5+1 configuration, $T_a = 55 °C$[3]			878	ADC
Standby Output VSB (J23)					
Output Voltage			12		VDC
Voltage Regulation		-5		+5	% Vout nom
Output Power				60	W
Output Current				5	ADC
Auxiliary AC Outlet (J123, J124, and J125)					
AC Output Voltage (J123)	L1 to Neutral		230 / 277		VAC
AC Output Voltage (J124)	L2 to Neutral		230 / 277		VAC
AC Output Voltage (J125)	L3 to Neutral		230 / 277		VAC
AC Output Current (J123)	L3 to Neutral			6	Arms
AC Output Current (J124, J125)	L1, L2 to Neutral			10	Arms
Fuse Protection per Line (F123)	Serviceable (10 A / 500 VAC Time Lag fuse)				
Fuse Protection per Line (F124, F125)	Serviceable (15 A / 500 VAC Fast-Acting fuse)				

Note: When T_A: +45 °C to +55 °C, Output load current must be derated to 75%.

[3] Linear derating at T_a > 45°C is based per module, see PFE3000-12-069RA datasheet

7.1 PROTECTION (PER MODULE)

PARAMETER	DESCRIPTION / CONDITION	MIN	NOM	MAX	UNIT
Input Fuses (L+N)	Not user accessible, quick-acting (F)		25		A
OV Threshold V_1		13.6	14.2	14.8	VDC
OV Latch Off Time V_1				1	ms
OV Threshold V_{SB}		13.3	13.9	14.5	VDC
OV Latch Off Time V_{SB}				1	ms
Current Limitation	*Ta < 45°C* *Ta = 55 °C*	248 186		274 212	A
Current Limit Blanking Time	Time to latch off when in over current	20	22	24	ms
Current Limit During Short Time Overload V_1	Maximum duration 20ms, per module	292	300	308	A
Max Short Circuit Current V_1	V_1 < 3 V, per module			350[4]	A
Short Circuit Latch Off Time	Time to latch off when in short circuit		10		ms
Current Limitation V_{SB}	Per module	6		9	A
Current Limit Blanking Time	Time to hit hiccup when in over current			1	ms
Over Temperature on Critical Points	Inlet Ambient Temperature PFC Primary Heatsink Temperature Secondary Sync Mosfet Temperature Secondary OR-ing Mosfet Temperature			60 80 115 125	°C

7.2 INTERFACE & CONTROL SIGNALS

The PWOK_L is an open collector output of all modules and they are interconnected (wired-OR) within the shelf and this signal is fed to the signal connector. PWOK_L is low when there is at least one module in operation. SMB_ALERT_L is also wired-OR already in the shelf. Sink current must not exceed 4 mA on each of these signals.

The internal INOK_L_Px signal of each individual module is fed to the backplane microcontroller for modules synchronized AC startup. This allows the shelf to start up with load > 3000 W during AC application. The microcontroller provides an INOK_L output signal. INOK_L is low when there is at least one module supplied with correct input voltage.

PSON_SHELF_L signal is an internally pulled-up input signal (3.3 V) to enable / disable the main output V1 of the Shelf. This active-low pin is also used to clear any latched fault condition. This is similar to the PSON_L on the PSU level. PSON_SHELF_L is currently bypassed in ON_OFF_CONFIG command.

A pull up resistor of 10kΩ to 3.3 V within the shelf provides the high level voltage for the PWOK_L, INOK_L and SMB_ALERT_L signals.

RJ45 PIN OUTS (J20)	FUNCTION	DESCRIPTION
1 [5]	SCL	I2C clock signal line
2 [5]	SDA	I2C data signal line
3	NC	NC
4	PWOK_L	Power OK signal output: active-low
5	INOK_L	Input OK signal: active-low
6	SMB_ALERT_L	SMB Alert signal output: active-low
7	PSON_SHELF_L	Power Shelf on input: active-low
8	SGND	Signal ground

Table 1. I2C Interface and Signal Connector (RJ45) Pin Out

[4] Limit doesn't include effects of main output capacitive discharge
[5] External Pull-up resistor should be 2 – 5kΩ to ensure SMBUS compliant signal rise times

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7.3 I2C COMMUNICATION

The PSU Modules are set to a fixed I2C Address (0x20). PMBus® communication for the PSU Modules are described in more detail in document BCA.00070. The I2C communication to the PSU Modules are routed through an I2C Multiplexer. The I2C MUX Control Register needs to be configured so that the I2C frames are routed to the correct PSU Module. Refer to the I2C MUX datasheet for additional information.

The I2C MUX and backplane controller addresses are configurable via DIP Switches (SW1);

The PSON function of the shelf can also be controlled by a PMBus® command sent to the backplane Controller, see document BCA.00178 for further information and the table below.

COMMAND		ACCESS	DATA BYTES	COMMENTS
Code	*Name*			
0x01	OPERATION	Byte R/W	1	Supported Values: 0x00 = Unit Off 0x80 = Unit On (Default)
0x02	ON_OFF_CONFIG	Byte R/W	1	Supported Values: 0x19 (Default) 0x01, 0x11, 0x15, 0x1D

NOTE: A setting in the ON_OFF_CONFIGURATION register doesn't survive a power cycle. See also the PMBus® protocol definition.

7.4 I2C ADDRESSING (SHELF)

The shelf default MUX address is 0xEE and Controller address is 0x5E. When DIP switch (SW1) is in "ON" position means 0, "OFF" Position means 1.

POSITION 1	POSITION 2	POSITION 3	MUX ADDRESS (IN HEX)	Controller ADDRESS (IN HEX)
ON	ON	ON	0xE0	0x50
OFF	ON	ON	0xE2	0x52
ON	OFF	ON	0xE4	0x54
OFF	OFF	ON	0xE6	0x56
ON	ON	OFF	0xE8	0x58
OFF	ON	OFF	0xEA	0x5A
ON	OFF	OFF	0xEC	0x5C
OFF	OFF	OFF	0xEE	0x5E

NOTE: Communication Manual of shelf, see document BCA.00178.

Table 2. DIP Switch Setting (SW1)

7.5 NETWORK ATTACHED CONTROLLER

The Network Attached Controller (NAC1006-01) is a shelf level controller providing monitoring and control functions through a 10/100 MB base Ethernet port and can be connected directly to the data center management network. It is hot-pluggable and supplied via the 12 V redundant standby provided by the power supplies in the shelf. The controller can be configured through a web interface; the monitoring and control functions are accessed through SNMP.

See BCD.00926 for NAC1006-01 Datasheet.

7.6 CONTROL LEDs

Each PSU front-end module has 2 LEDs to indicate status condition. LED number one is green and indicates AC power is on or off, while LED number two is bi-colored: green and yellow and indicates DC power presence or fault situations.

PARAMETER	DESCRIPTION / CONDITION	LED SIGNALING
AC LED	AC Line within range	Solid Green
	AC Line UV condition	Off
DC LED [6]	Normal Operation	Solid Green
	PSON_L High	Blinking Yellow (1:1)
	V_1 or V_{SB} out of regulation	Solid Yellow
	Over temperature shutdown	
	Output over voltage shutdown (V_1 or V_{SB})	
	Output under voltage shutdown (V_1 or V_{SB})	
	Output over current shutdown (V_1 or V_{SB})	
	Over temperature warning	Blinking Yellow/Green (2:1)
	Minor fan regulation error (>5%, <15%)	Blinking Yellow/Green (1:1)

7.7 USB CONNECTOR TYPE B (J3)

This is used for Bel Power Diagnostic thru Bel Power Solutions I²C Utility GUI. This connection also provides access to FW boot loading of the PSU Modules.

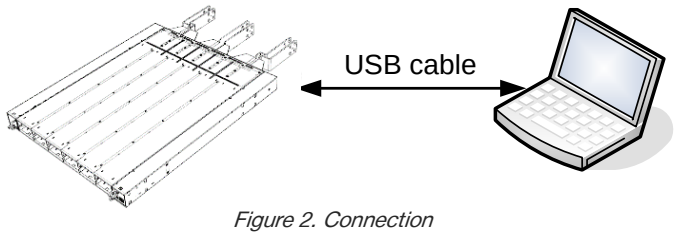


Figure 2. Connection

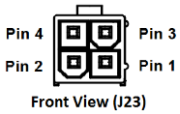
WARNING:

The USB interface is NOT galvanically isolated and referenced to the +12V_GND / SGND lines.
Preferably, use a battery operated laptop to avoid earth loop issues.
If a desktop computer is being used, there is a risk of generating earth loop currents, therefore the usage of a USB isolator is highly recommended in such a case.

7.8 +12VSB CONNECTOR (J23)

+12VSB output is capable of delivering 5A. The output is protected by a PTC (16R900GF from Littelfuse).
Mating Part: Molex 39-01-2045

PIN OUTS (J23)	FUNCTION	DESCRIPTION
1, 3	VSB_GND	+12VSB return
2, 4	VSB	+12VSB output



[6] The order of the criteria in the table corresponds to the testing precedence in the controller.

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7.9 AUXILIARY AC OUTLET

The 3 connectors (J123, J124, and J125) are used to provide AC power to the Network Switch Devices. Each connector is connected to one of the LIVE terminals (L1, L2, and L3) and NEUTRAL from the 3-phase input (J107). These are protected by a 10 A / 500 Vac Time Lag fuse on the LIVE terminal (F123) and 15 A / 500 Vac Fast-Acting fuse on the LIVE terminal (F124 and F125). See Safety Warning when servicing the fuse.

When power shelf is operated at ambient temp of +45 °C to +55 °C, the output load current must be derated to 75%.

8. SAFETY, REGULATORY AND EMC SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITION	CRITERION
Agency Approvals	Approved to the latest revisions/amendments of the following standards: UL 60950-1 Second Edition CAN/CSA-C22.2 No. 60950-1-07 Second Edition IEC 60950-1:2005 EN 60950-1:2006	Approved by independent body (see CE Declaration)
Insulation	Input (L/N) to case (PE) Input (L/N) to output Output to case (PE)	Basic Reinforced Functional
Creepage / Clearance (*d*c)	Primary (L/N) to protective earth (PE) Primary to secondary	
Electrical Strength Test	Input to case Input to output (tested by manufacturer only)	Min. 2121 VDC Min. 4242 VDC
Max. Leakage Current	AC input voltage of TBD VAC, Line to Neutral, AC line frequency of 50 Hz and ambient temperature of 25 °C.	TBD
Conducted Emission	EN55022 / CISPR 22: 0.15 … 30 MHz, QP and AVG	Class A
Radiated Emission	EN55022 / CISPR 22: 30 MHz … 1 GHz, QP	Class A
Harmonic Emissions (per module)	IEC61000-3-2, Vin = 230 VAC, 50 Hz, 100% Load (per module)	Class A
Acoustical Noise	Sound power statistical declaration (ISO 9296, ISO 7779, IS9295) @ 50% load	60 dBA
AC Flicker	IEC / EN 61000-3-3, d_{max} < 3.3%	PASS
ESD Contact Discharge	IEC / EN 61000-4-2, ±8 kV, 25+25 discharges per test point (metallic case, LEDs, connector body)	A
ESD Air Discharge	IEC / EN 61000-4-2, ±15 kV, 25+25 discharges per test point (non-metallic user accessible surfaces)	A
Radiated Electromagnetic Field	IEC / EN 61000-4-3, 10 V/m, 1 kHz/80% Amplitude Modulation, 1 µs Pulse Modulation, 10 kHz…2 GHz	A
Burst	IEC / EN 61000-4-4, level 3 AC port ±2 kV, 1 minute DC port ±1 kV, 1 minute	A
Surge	IEC / EN 61000-4-5 Line to earth: level 3, ±2 kV Line to line: level 2, ±1 kV	A
RF Conducted Immunity	IEC/EN 61000-4-6, Level 3, 10 Vrms, CW, 0.1 … 80 MHz	A
Voltage Dips and Interruptions (per module)	IEC/EN 61000-4-11 (per module) 1: Vi 230 VAC, 100% Load, Dip 100%, Duration 12 ms 2: Vi 230 VAC, 100% Load, Dip 100%, Duration < 150 ms 3. Vi 230 VAC, 100% Load, Dip 100%, Duration > 150 ms	 A V1: B, VSB: A B

9. ENVIRONMENTAL SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITION	MIN	NOM	MAX	UNIT
Operating Temperature	@ full load, up to 4000 m: @ full load, up to 1800 m: @ 75% load, up to 1800 m:	0 0 0		+35 +45 +55	°C
Non-Operating Temperature		-40		+70	°C
Humidity	Operating: @ at 40 °C, non-condensing Non-Operating: non-condensing	7 5		93 95	%RH
Altitude	Operating: Non-Operating:			4000 13000	m
Shock	Operating: 11 ms half-sine shocks in Z axis 10+ve, 10-ve Non-Operating: 11 ms half-sine shocks in Z axis 10+ve, 10-ve		5 30		g
Vibration	Operating: 0.2 g_{rms} random Non-Operating: 1 g_{rms} random	5 2		500 200	Hz
Acoustic Noise Emissions	@ normal operation, and 50% load sharing Fan speed			70 7000	dBA rpm
Cooling	When equipped with operating PSUs			50	Pa

10. MECHANICAL SPECIFICATIONS

PARAMETER	SPSPFE3-05G
Dimensions (W x H x D)	534.5 x 46.5x 650 mm (overall: 535 x 47 x 859.5 mm)
Weight (Shelf only)	16 kg
Weight (6 PSU installed)	32 kg

10.1 CONNECTORS

DESCRIPTION	REFERENCE DESIGNATOR	TYPE	MANUFACTURER	MPN
Input Connector	J106, J107	3-phase input	Positronic Industries	SP5YYE48M0LN9A1/AA-PA1067
USB I2C Connector	J3	USB – B type	Tyco	292304-1
I2C Interface and Signal Connector	J20	RJ45	FCI Connectors	87180-088LF
+12VSB output connector	J23		Molex	39-30-0040
Auxiliary AC Outlet	J123	Single phase output	Molex	172043-0302
Auxiliary AC Outlet	J124, J125	Single phase output	Rong Feng	RF-203P-HP-1.0
Auxiliary AC Outlet Fuse	F123	5 x 20 mm Time Lag Fuse	Bel Fuse Inc. Eaton	0ADKC9100-BE BK1-S505H-10-R
Auxiliary AC Outlet Fuse	F124, F125	6.3 x 32 mm Fast-Acting Fuse	Bel Fuse Inc. Littelfuse Inc.	0ADEC9150-BE 0505015.MXP

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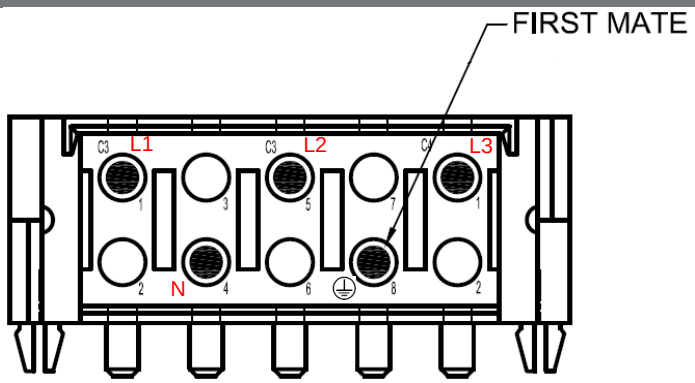
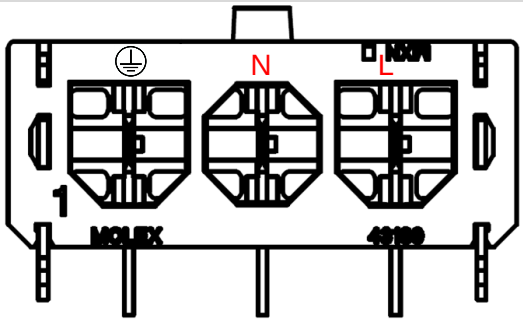
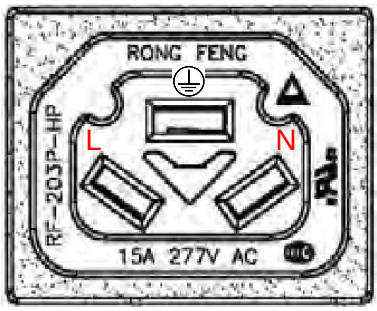
SHELF	HIGH VOLTAGE CONNECTOR PIN ASSIGNMENT
3-Phase Input Connector (J106, J107)	 Front View
MPN	SP5YYE48M0LN9A1/AA-PA1067
Mating Part	SP5YYE1F0091/AA
Auxiliary AC Outlet (J123)	 Front View
MPN	172043-0302
Mating Part	172672-2003
Auxiliary AC Outlet (J124, J125)	 Front View
MPN	RF-203P-HP-1.0

10.2 SPSPFE3-05G and SPSPFE3-06G MECHANICAL DATA

NOTE: finished good may look different from images.

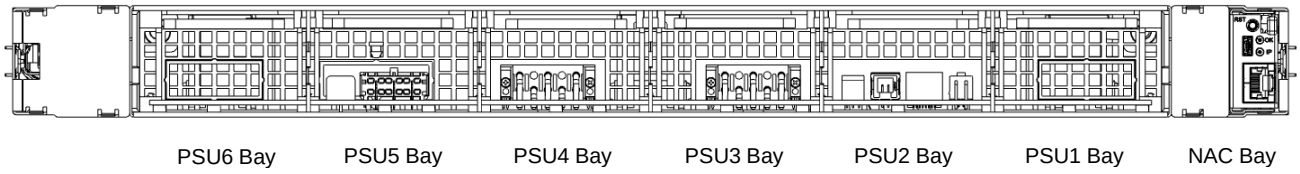


Figure 3. SPSPFE3-05G and SPSPFE3-06G Front View

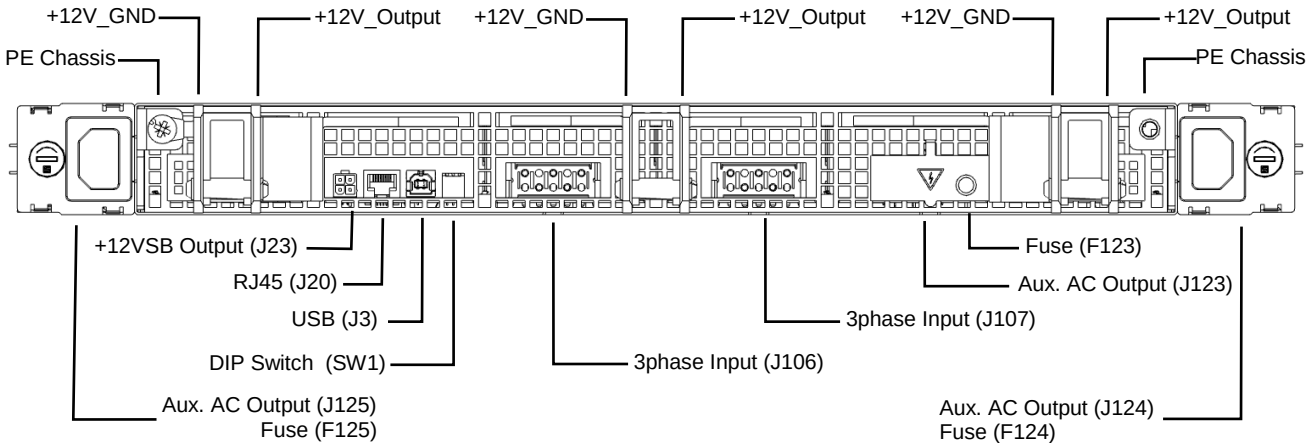


Figure 4. SPSPFE3-05G Rear View

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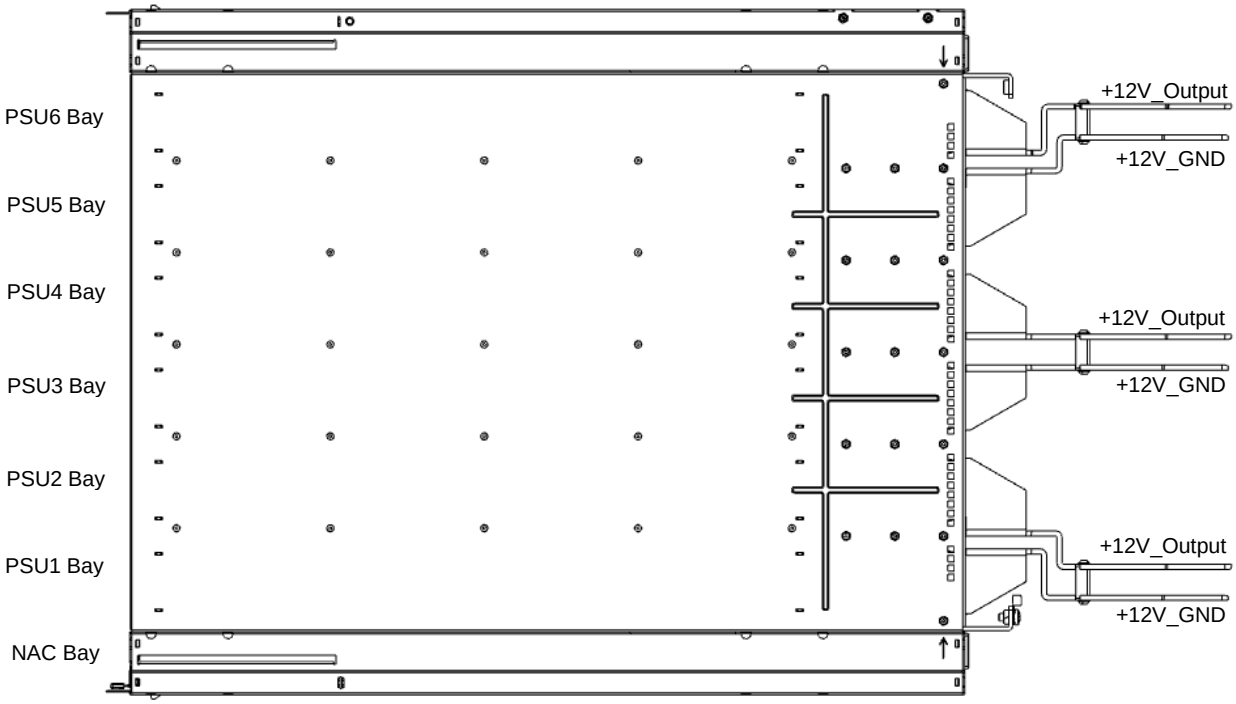

Figure 5. SPSPFE3-05G Top View

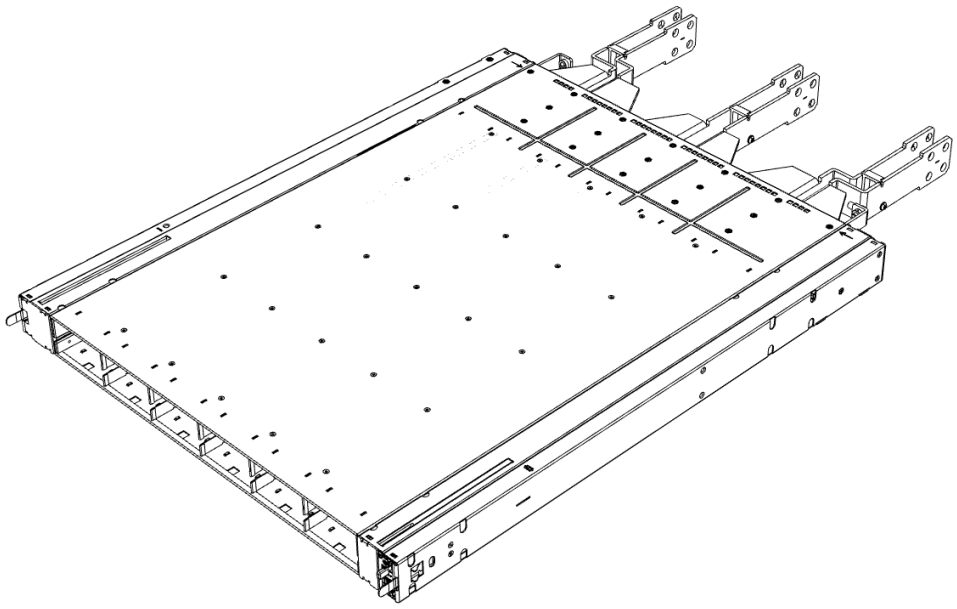

Figure 6. SPSPFE3-05G Isometric View

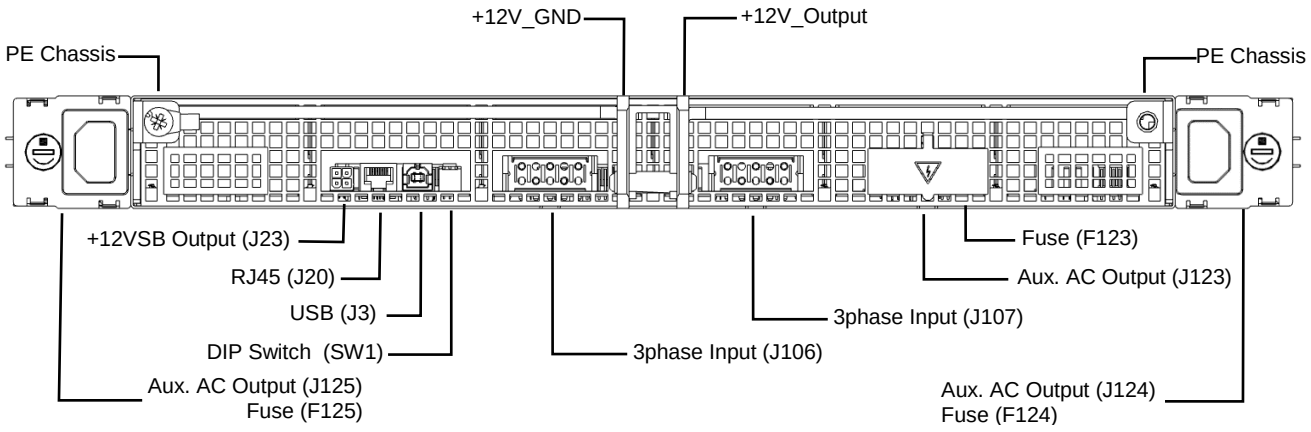

Figure 7. SPSPFE3-06G Rear View

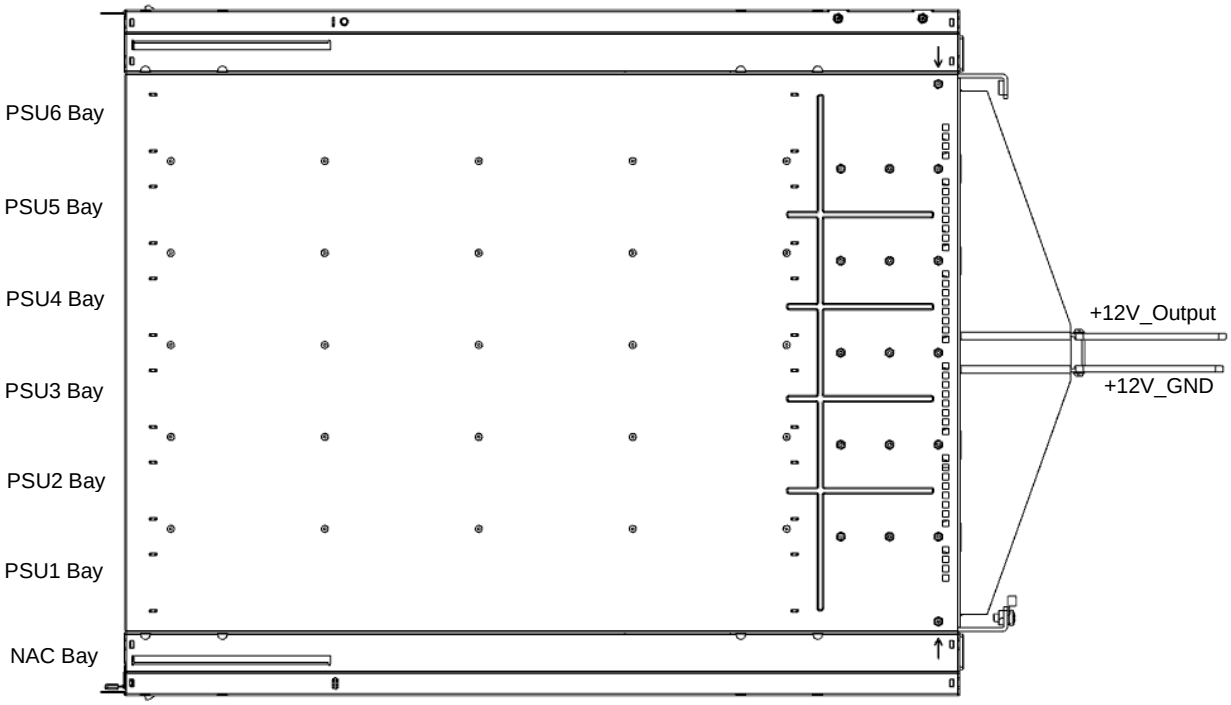

Figure 8. SPSPFE3-06G Top View

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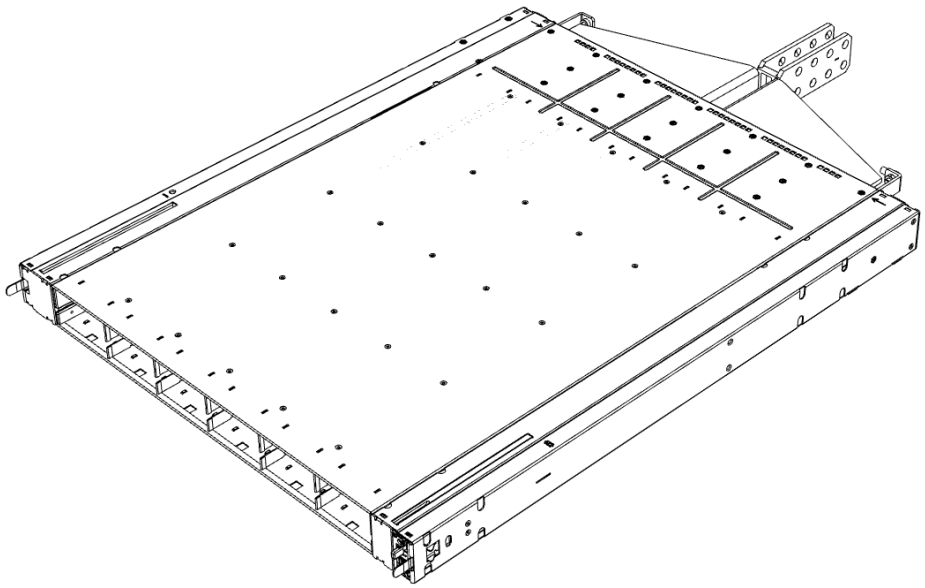
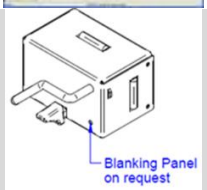


Figure 9. SPSPFE3-06G Isometric View

11. ACCESSORIES

ITEM	DESCRIPTION	ORDERING PN	SOURCE
	I²C Utility Windows Vista/7/8 compatible GUI to program, control and monitor PFE Front-Ends (and other I²C units)	N/A	belfuse.com/power-solutions
	Blanking Panel	SPSPFE3-BP01G	belfuse.com/power-solutions

12. REVISION HISTORY

REV	DESCRIPTION	PRODUCT VERSION	DATE	AUTHOR
001	PRELIMINARY: Initial Draft	V001	11-30-2016	GS
002	PRELIMINARY: Shelf Input Voltage is configured for 277Vac Update Auxiliary AC Outlet to meet 277Vac Update Fuse on Auxiliary AC Outlet Optional PE connection added	V002	08-31-2017	GS
003	Update Datasheet part number for NAC1006-01. Update Mechanical Drawings PMBus™ changed to PMBus®; a disclaimer added to the first page: Disclaimer: PMBus is a registered trademark of SMIF, Inc.	V003	02-28-2018	VS
004	Network Attached Controller is set to optional. Update Ordering Information. Update Max Input Current. Add note on AC auxiliary output load current. Removed Pending on Safety Agency Approvals	V004	04-24-2018	GS

For more information on these products consult: tech.support@psbel.com

NUCLEAR AND MEDICAL APPLICATIONS - Products are not designed or intended for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems.
TECHNICAL REVISIONS - The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.

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