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# SPSPFE3-04G

## Power Shelf

SPSPFE3-04G 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 can be mounted to a 19inch or 21inch rack system using adaptor mounting brackets and is compatible with the Open Compute rack design.



### 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.

### Applications

- High performance servers
- Routers
- Switches



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## 1. ORDERING INFORMATION

MODEL	INPUT CONFIGURATION
SPSPFE3-04G	3-phase, 400 VAC line to line input with Neutral line

## 2. TECHNICAL DATA

PARAMETER	DESCRIPTION/CONDITION
Input	3-phase, 400 VAC Line to Line input with Neutral <sup>1</sup>
AC Inlet Configuration	3 power modules are powered from one AC inlet
Auxiliary AC Outlet	3pcs low power AC outlet providing 230Vac output, protected by T 6.3 A / 250 VAC Fuse (serviceable)
Redundant Configuration	3+3 or 5+1 configuration
Rated Power 1	8700 W (3+3 configuration) <sup>2</sup>
Rated Power 2	14400 W (5+1 configuration) <sup>2</sup>
Output Connection	1 set of output blade for +12V DC output
Standby Output	60W (Standby output 12V/5A)
Communication	I <sup>2</sup> C PMBus™

## 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
BCA.00178	SPSPFE3-0XG Communication Manual
BCM.00389	Installation Instruction SPSPFE3-04G
PCA9547PW	PCA9547PW Datasheet from NXP

## 5. OVERVIEW

The SPSPFE3-04G Power Shelf is a 1U 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 I<sup>2</sup>C communication is routed thru an I2C Multiplexer (NXP PCA9547PW). PSU Modules support I2C communication interface for control, programming and monitoring with PMBus™ protocol.

<sup>1</sup> Power modules are connected Line to Neutral.

<sup>2</sup> Rated Power is reduced as per current share accuracy characteristic. See PFE3000-12-069RA Datasheet.

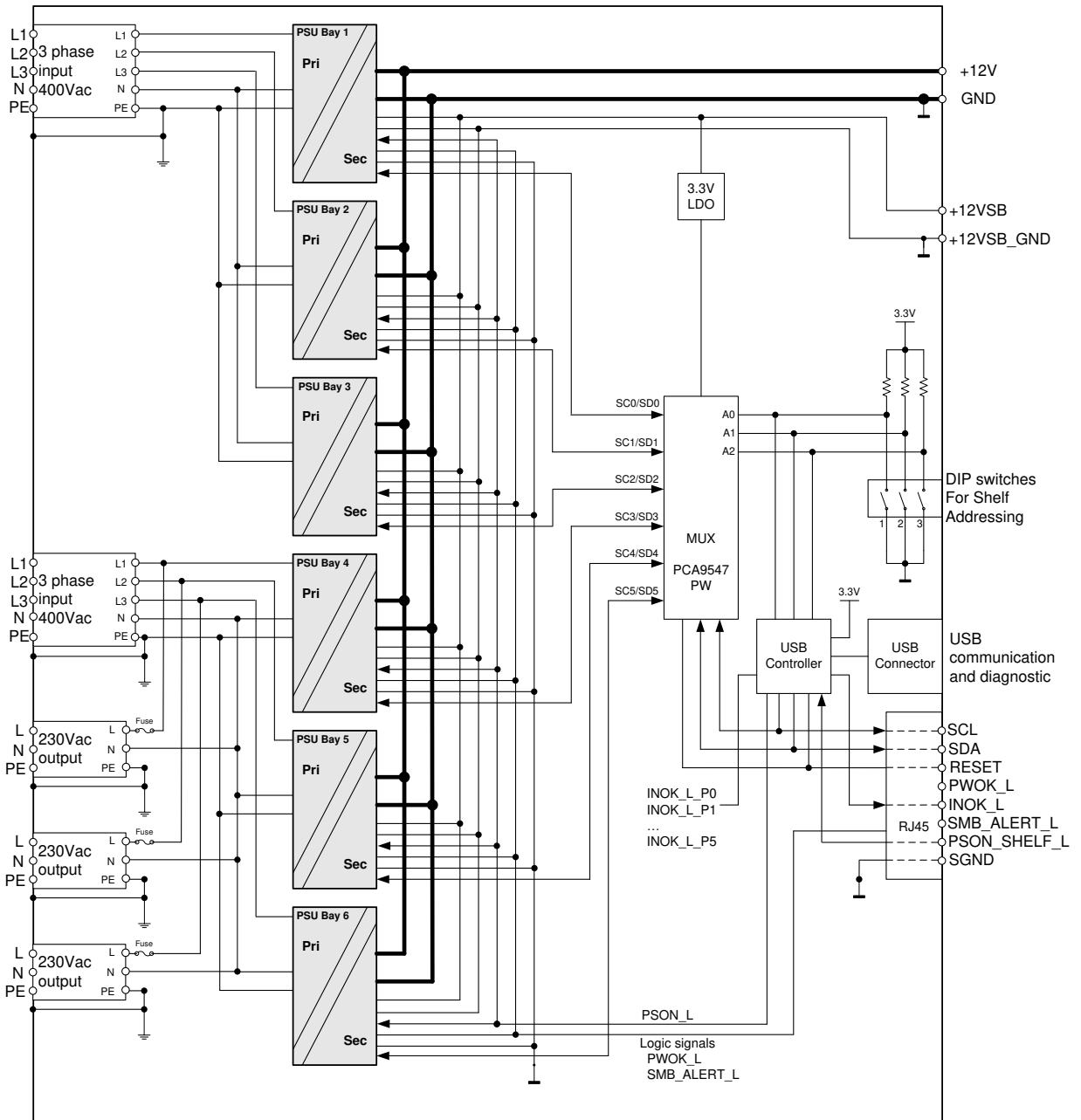


Figure 1. SPSPFE3-04G Block Diagram

## 6. INPUT SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITION	MIN	NOM	MAX	UNIT
<i>Input Connector (J106, J107)</i>					
AC Nominal Input Voltage	Line to Line input		400		VAC
AC Input Voltage Ranges		346		432	VAC
Max Input Current	per line			17	Arms
Input Frequency		47	50/60	63	Hz

## 7. OUTPUT SPECIFICATIONS

PARAMETER	DESCRIPTION / CONDITION	MIN	NOM	MAX	UNIT
<i>Main Output V1 (Output Bus Bar)</i>					
Nominal Output Voltage			12.3		VDC
Voltage Regulation		-5		+5	% Vout nom
Nominal Output Power 1	3+3 configuration, $T_a < 45^\circ\text{C}$		8700		W
Derated Output Power 1	3+3 configuration, $T_a = 55^\circ\text{C}^3$		6525		W
Nominal Output Power 2	5+1 configuration, $T_a < 45^\circ\text{C}$		14400		W
Derated Output Power 2	5+1 configuration, $T_a = 55^\circ\text{C}^3$		10800		W
Nominal Output Current 1	3+3 configuration, $T_a < 45^\circ\text{C}$		707		ADC
Derated Output Current 1	3+3 configuration, $T_a = 55^\circ\text{C}^3$		530		ADC
Nominal Output Current 2	5+1 configuration, $T_a < 45^\circ\text{C}$		1171		ADC
Derated Output Current 2	5+1 configuration, $T_a = 55^\circ\text{C}^3$		878		ADC
<i>Standby Output VSB (J23)</i>					
Output Voltage			12		VDC
Voltage Regulation		-5		+5	% Vout nom
Output Power				60	W
Output Current				5	ADC
<i>Auxiliary AC Outlet (J123, J124, and J125)</i>					
AC Output Voltage (J123)	L1 to Neutral		230		VAC
AC Output Voltage (J124)	L2 to Neutral		230		VAC
AC Output Voltage (J125)	L3 to Neutral		230		VAC
Fuse Protection per Line (F123, F124, F125)	Serviceable (6.3 A / 250 VAC Time lag fuse)				

<sup>3</sup> Linear derating at  $T_a > 45^\circ\text{C}$ , 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 $V_I$		13.6	14.2	14.8	VDC
OV Latch Off Time $V_I$				1	ms
OV Threshold $V_{SB}$		13.3	13.9	14.5	VDC
OV Latch Off Time $V_{SB}$				1	ms
Current Limitation	$T_a < 45^\circ\text{C}$ $T_a = 55^\circ\text{C}$	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 $V_I$	Maximum duration 20ms, per module	292	300	308	A
Max Short Circuit Current $V_I$	$V_I < 3\text{ V}$ , per module			350 <sup>4</sup>	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	$^\circ\text{C}$

## 7.2 INTERFACE & CONTROL SIGNALS

The PWOK\_L is an open collector output of all modules and are interconnected within the shelf, this signal is fed to the signal connector. The same applies to SMB\_ALERT\_L module and shelf signals. Sink current must not exceed 4 mA on each of these signals.

The internal INOK\_L signal of individual modules are fed to microcontroller for modules synchronized AC startup. This allows the shelf to start up with load > 3000 W during AC application. The microcontroller provides the INOK\_L output signal.

A pull up resistor of 10k $\Omega$  to 3.3 V within the shelf provides the high level voltage on PWOK\_L, INOK\_L and SMB\_ALERT\_L signals.

PWOK\_L is low when there is at least one module in operation. 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 of the PSU level.

RJ45 PIN OUTS (J20)	FUNCTION	DESCRIPTION
1 <sup>5</sup>	SCL	I2C clock signal line
2 <sup>5</sup>	SDA	I2C data signal line
3	RESET	Reset pin of I2C Mux
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-high
7	PSON_SHELF_L	Power Shelf on input: active-low
8	SGND	Signal ground

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

<sup>4</sup> Limit doesn't include effects of main output capacitive discharge

<sup>5</sup> External Pull-up resistor should be 2 – 5k $\Omega$  to ensure SMBUS compliant signal rise times

### 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 BCA.00070.

The I2C communication to the PSU Modules are routed thru 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 Controller address is configurable via DIP Switch (SW1).

The I2C MUX has a RESET input which can be used to recover from an I2C bus fault. A logic low signal on this pin resets the I2C MUX. If not used, this pin should be left floating.

PSON function of the shelf can also be controlled by PMBUS command set on the Controller, see document BCA.00178 for further information.

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: 0x1D (Default) 0x01, 0x11, 0x15, 0x19

**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	SELECTED UNIT
1	A0
2	A1
3	A2

Table 2. DIP Switch Position

A0	A1	A2	MUX ADDRESS (IN HEX)	Controller ADDRESS (IN HEX)
0	0	0	0xE0	0x50
1	0	0	0xE2	0x52
0	1	0	0xE4	0x54
1	1	0	0xE6	0x56
0	0	1	0xE8	0x58
1	0	1	0xEA	0x5A
0	1	1	0xEC	0x5C
1	1	1	0xEE	0x5E

**Note:** Communication Manual of shelf, see document BCA.00178.

Table 3. DIP Switch Setting (SW1)

**7.5 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
<b>AC LED</b>	AC Line within range	Solid Green
	AC Line UV condition	Off
	Normal Operation	Solid Green
	PSON_L High	Blinking Yellow (1:1)
<b>DC LED<sup>6</sup></b>	$V_I$ or $V_{SB}$ out of regulation	Solid Yellow
	Over temperature shutdown	
	Output over voltage shutdown ( $V_I$ or $V_{SB}$ )	
	Output under voltage shutdown ( $V_I$ or $V_{SB}$ )	Blinking Yellow/Green (2:1)
	Output over current shutdown ( $V_I$ or $V_{SB}$ )	
	Over temperature warning	
	Minor fan regulation error (>5%, <15%)	

**7.6 USB CONNECTOR TYPE B (J3)**

This is used for Bel Power Diagnostic thru Bel Power Solutions I<sup>2</sup>C Utility GUI. This connection also provides access to FW boot loading of the PSU Modules.

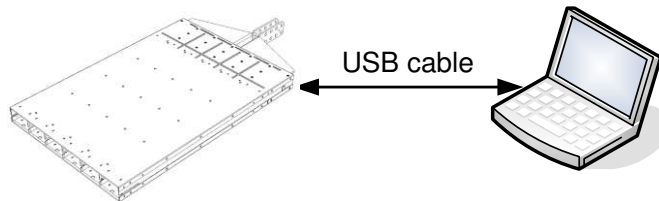


Figure 2. Connection

**WARNING:**



The USB interface is NOT galvanic isolated and referenced to the +12V\_GND / SGND lines. Preferably, use a battery operated laptop to avoid earth loop issue. If a Desktop Computer is being used, there is a risk of generating earth loop currents, therefore USB Isolators should be used.

**7.7 +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	VSB_GND	+12VSB return
2	VSB	+12VSB output
3	VSB_GND	+12VSB return
4	VSB	+12VSB output

<sup>6</sup> The order of the criteria in the table corresponds to the testing precedence in the controller.



## 7.8 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 6.3A/250Vac Time Lag fuse on the LIVE terminal (F123, F124, and F125).

See Safety Warning when servicing the fuse.

**Mating Part: Molex 172672-2003**

PIN OUTS	FUNCTION	DESCRIPTION
1	PE	Protective Earth Pin
2	Neutral	Neutral Pin
3	Live	Live Pin connected to each Live terminal of 3-phase input

## 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 ( <i>dc</i> )	Primary (L/N) to protective earth (PE) Primary to secondary	
Electrical Strength Test	Input to case Input to output (tested by manufacturer only)	Min. 2121Vdc Min. 4242Vdc
Max. Leakage Current	AC input voltage of 250 VAC, Line to Neutral, AC line frequency of 50Hz and ambient temperature of 25°C.	3.5 mA
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, $V_{in} = 115/230$ 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, $\pm 8$ kV, 25+25 discharges per test point (metallic case, LEDs, connector body)	A
ESD Air Discharge	IEC / EN 61000-4-2, $\pm 15$ 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 $\mu$ s Pulse Modulation, 10 kHz...2 GHz	A
Burst	IEC / EN 61000-4-4, level 3 AC port $\pm 2$ kV, 1 minute DC port $\pm 1$ kV, 1 minute	A
Surge	IEC / EN 61000-4-5 Line to earth: level 3, $\pm 2$ kV Line to line: level 2, $\pm 1$ 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: $V_i$ 230Volts, 100% Load, Dip 100%, Duration 12ms 2: $V_i$ 230Volts, 100% Load, Dip 100%, Duration < 150 ms 3: $V_i$ 230Volts, 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:	-5		+35	°C
	@ full load, up to 1800 m:	-5		+45	
	@ 75% load, up to 1800 m:	-5		+55	
Non-Operating Temperature		-40		+70	°C
Humidity	Operating: @ at 40 °C, non-condensing	7		93	%RH
	Non-Operating: non-condensing	5		95	
Altitude	Operating:			4000	m
	Non-Operating:			13000	
Shock	Operating: 11ms half-sine shocks in Z axis 10+ve, 10-ve		5		g
	Non-Operating: 11ms half-sine shocks in Z axis 10+ve, 10-ve		30		
Vibration	Operating: 0.2 g rms random	5		500	Hz
	Non-Operating: 1g rms random	2		200	
Acoustic Noise Emissions	@ normal operation, and 50% load sharing			70	dBA
	Fan speed			7000	
Cooling	When equipped with operating PSUs			50	Pa

## 10. MECHANICAL SPECIFICATIONS

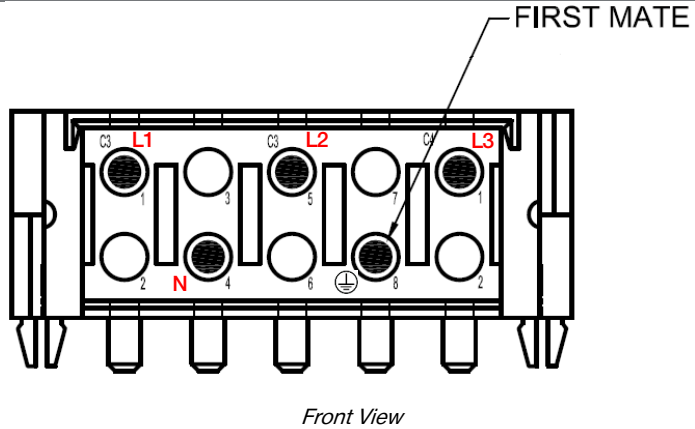
PARAMETER	SPSPFE3-04G
Dimensions (W x H x D)	436 x 46.5x 650 mm (overall : 436.5 x 46.75 <del>47</del> x 858.55 mm)
Weight (Shelf only)	14 kg
Weight (6 PSU installed)	30 kg

### 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, J124, J125	Single phase output	Molex	172043-0302
Auxiliary AC Outlet Fuse	F123, F124, F125	5 x 20 mm Time Lag Fuse	Bel Fuse Schurter Littelfuse Eaton	5HT 6.3-R 0001.2512 021506.3MXP S505-6.3-R

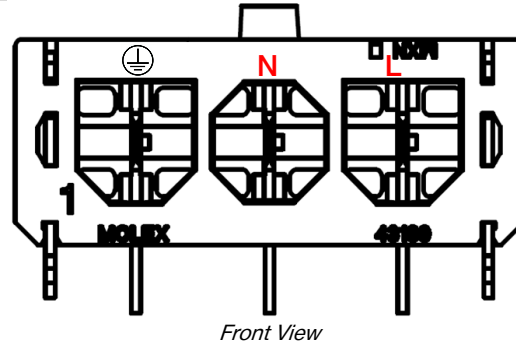
SHELF HIGH VOLTAGE CONNECTOR PIN ASSIGNMENT

3-Phase Input Connector  
(J106, J107)



MPN SP5YYE48M0LN9A1/AA-PA1067  
Mating Part SP5YYE1F0091/AA

Auxiliary AC Outlet  
(J123, J124, J125)



MPN 172043-0302  
Mating Part 172672-2003

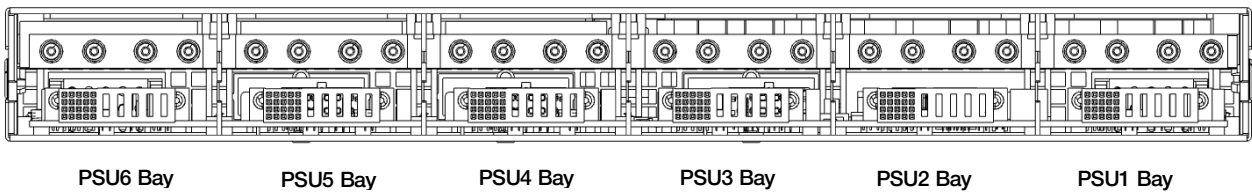


Figure 3. SPSPFE3-04G Front View

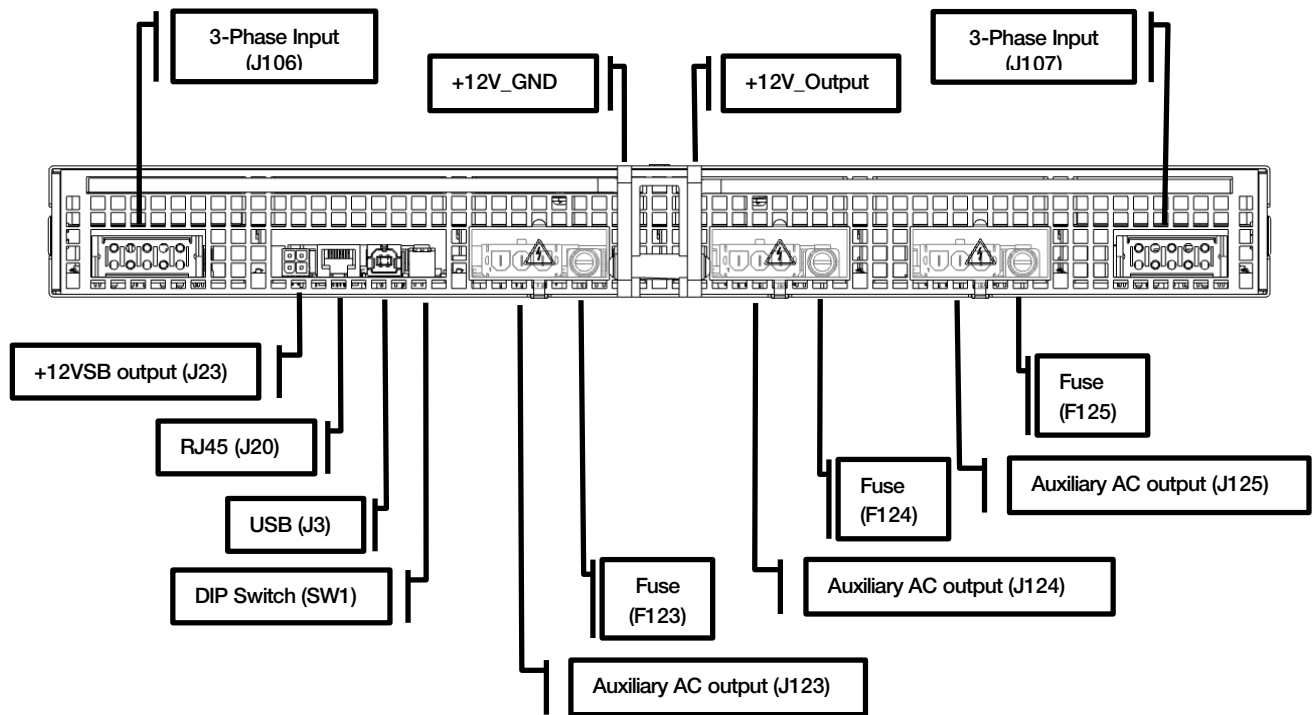


Figure 4. SPSPFE3-04G Rear View

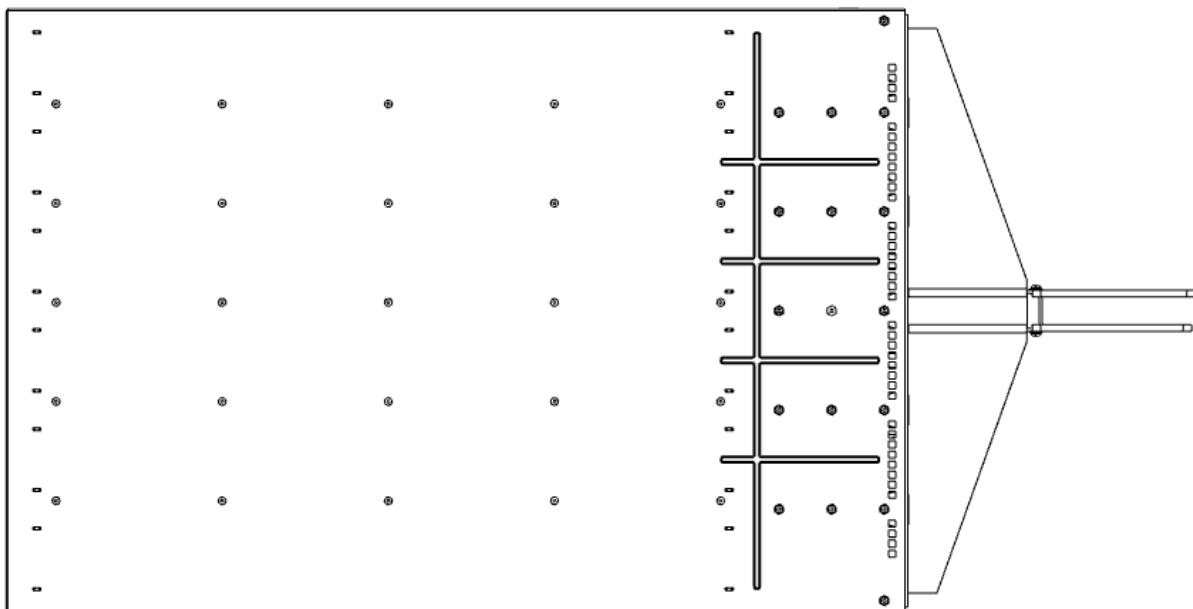


Figure 5. SPSPFE3-04G Top View

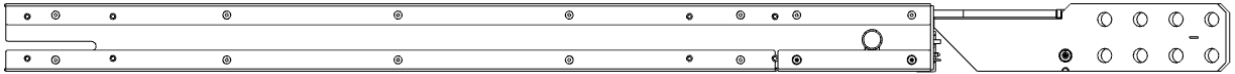


Figure 6. SPSPFE3-04G Right Side View

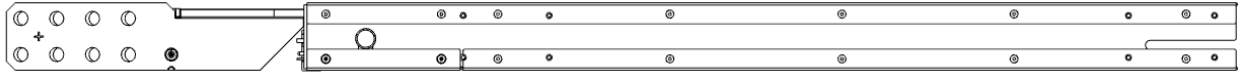


Figure 7. SPSPFE3-04G Left Side View

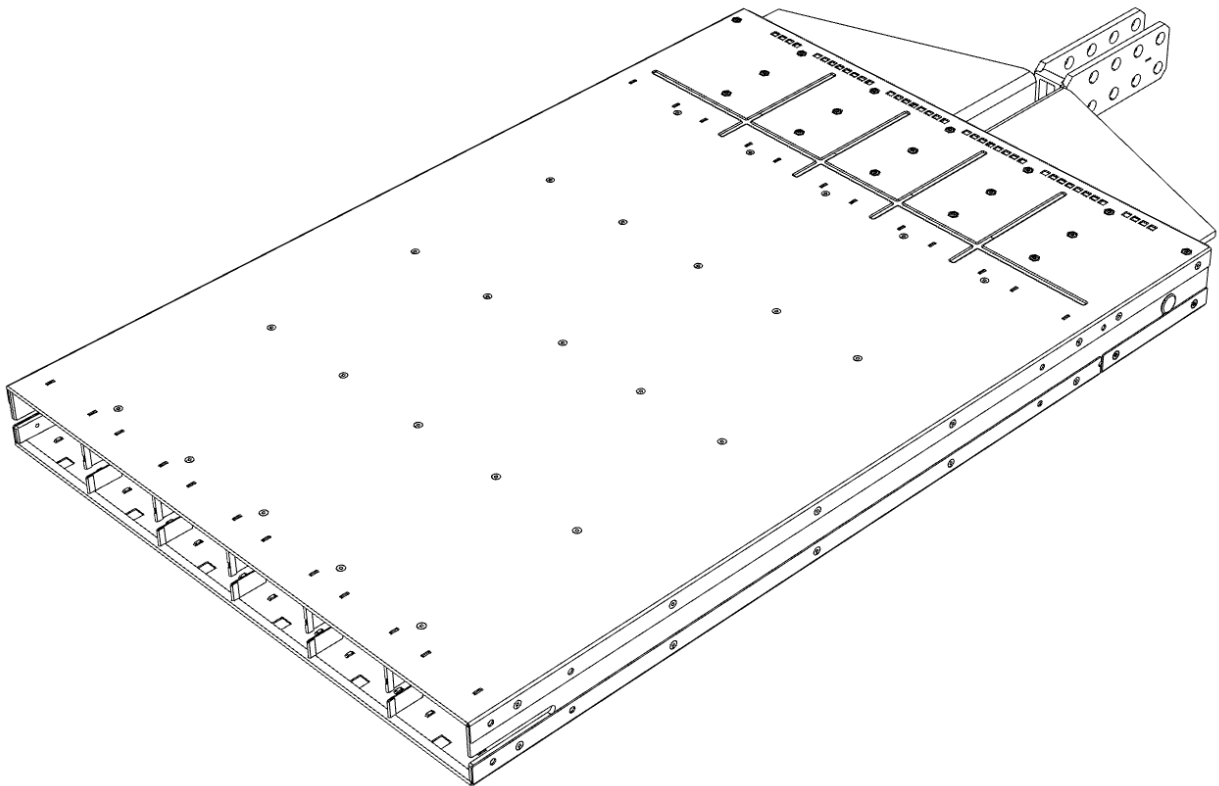


Figure 8. SPSPFE3-04G Isometric View

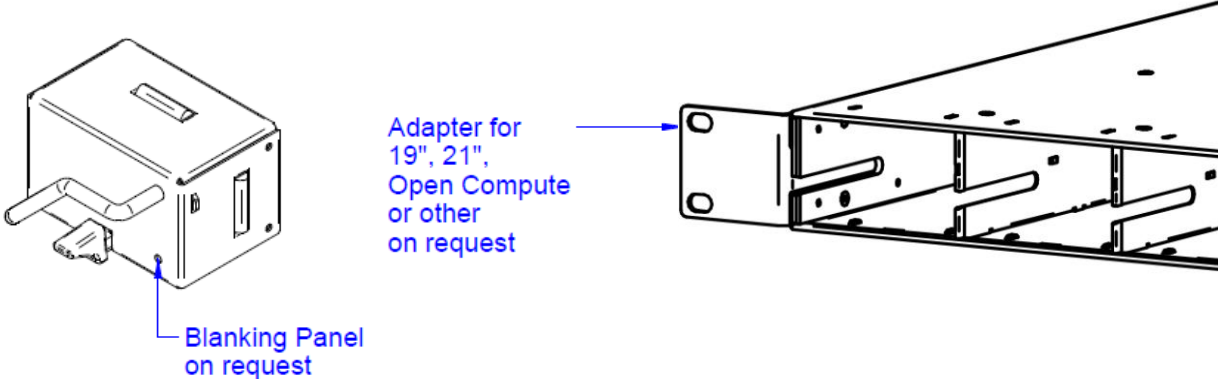


Figure 9. Accessories

Blanking Panel Item Number: SPSPFE3BP-01G  
Mounting "Ear" Brackets for 19" Rack – SPSPFE3-02GA  
Mounting "Ear" Brackets for 21" Rack – SPSPFE3-02GB

## 11. REVISION HISTORY

REV	DESCRIPTION	PRODUCT VERSION	DATE	AUTHOR
001	Initial Release of Datasheet	V001	10-30-2015	GS
	Safety Update:			
	1) Fuses on Auxiliary AC output (F123, F124, F125) was changed to High Breaking capacity (see section 10.1).			
	2) Added max leakage current. (see section 8).			
002	Mechanical Update:	V002	02-18-2016	GS
	3) Reduced the number of holes on Top Cover near output bus bar (see figure 5 and 8).			
	4) Implemented coating and added chamfer on output bus bar.			
	5) Added Key-In features inside shelf divider (see figure 8).			
	Safety Update:			
	1) Safety Agency Approvals are completed, removed pending statement (see section 8).			
003	Mechanical Update:	V003	05-09-2016	GS
	2) Key-In features were adjusted to include the side of the shelf in addition (see figure 8).			
	3) Added safety covers on Auxiliary AC output (J123, J124, J125) (see figure 4).			
	Mechanical Update:			
	1) Hard tool Mechanics are used.			
	2) Added chamfer and plastic spacer on output bus bar for improve alignment (see figure 5).			
004	3) Added embossed section on top cover near output bus bar to improve stiffness (see figure 5 and 8).	V004	06-16-2016	GS

For more information on these products consult: [tech.support@psbel.com](mailto:tech.support@psbel.com)

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