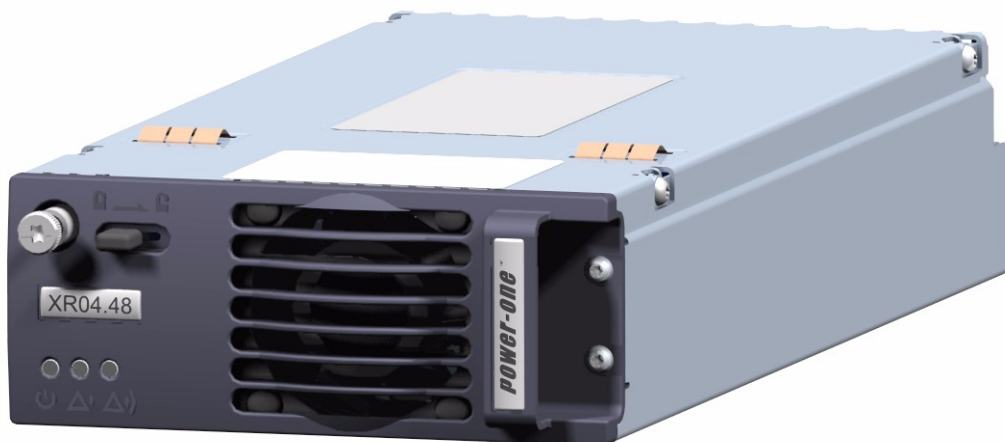




Power Systems

XR04.48 Rectifier

Technical Product Description



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1 Introduction

1.1 Scope

This document describes the specifications for the AC to DC rectifier XR04.48 (hereafter referred to as the Rectifier).

1.2 Architecture

The Rectifier is a 400 W (nominal) AC to DC power-factor-corrected power supply unit that converts standard AC mains power into DC output in the range of 46-57 VDC for powering telecommunication, data communication and other distributed power applications, and can be used in hot-swap redundant systems.

The XR04.48 rectifier provides extremely reliable DC power with very high power density. The module incorporate in power monitoring solutions through an internal microprocessor giving up to the second updates to the system controller and adjacent rectifier. This guarantee tightly controlled load sharing between rectifiers and provides status to the controller. The highly-efficient thermal design with internal fan cooling permits use in wide operating voltage and temperature ranges with very high reliability.

Status information is provided with front panel LEDs and via RS485 management interface. In addition, the RS485 bus can enable the power supply, adjust the output voltage and output current limitation and set/enable the over voltage protection limit.

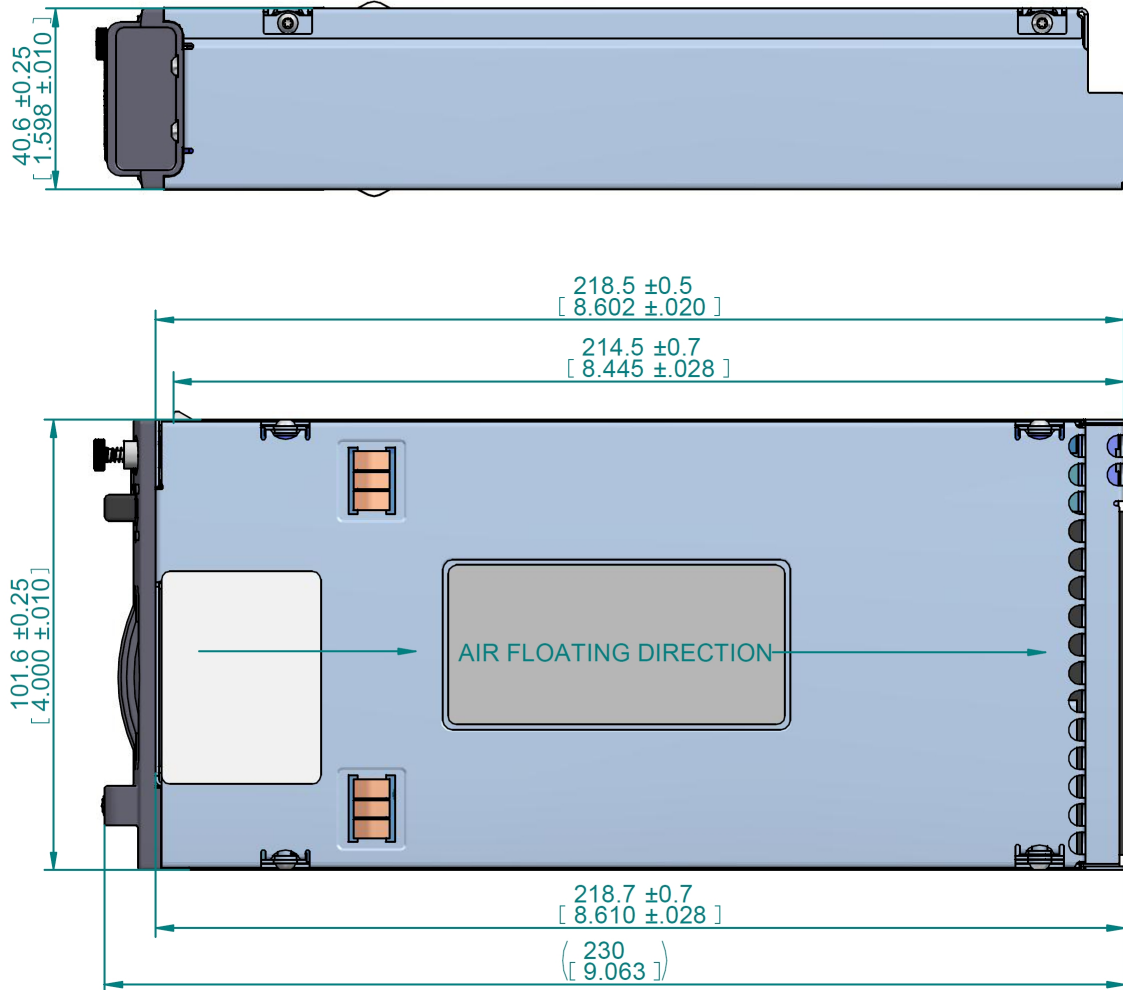
A wide variety of distribution options are available to provide the maximum system flexibility for a wide range of communications applications that demand efficiency, reliability, and flexibility including wireless base stations, remote switches and broadband access.

The XR04.48 meets international safety standards and displays the CE-Mark for the European Low Voltage Directive (LVD).

2 Mechanical Characteristics

Width	101.6 mm	4.0 inches
Height	40.6 mm	1.6 inches
Depth	230 mm	9.0 inches
Weight	1.1 kg	2.2 lbs

Figure 2-1 Rectifier Measure



3 Input Characteristics

3.1 Input Operating Voltage

The rectifier meets the specifications given in Table 1 over the normal AC input range, including startup. It also states the time the Rectifier will remain undamaged under abnormal AC input levels and the range for derated output power.

Table-1

Parameter	Condition / Description	Min	Nom	Max	Unit
Input Voltage	Nominal Variation	85	230	275	VAC
	Permitted Variation	85		300	VAC
	Survival 60 sec/Abnormal	300		350	VAC

3.2 Input Operating Frequency

The Rectifier will operate over the AC input frequency range given in Table 2.

Table-2

Parameter	Condition / Description	Min	Nom	Max	Unit
Input Frequency		47	50/60	63	Hz

3.3 Input Operating Current

Table-3

Parameter	Condition / Description	Min	Nom	Max	Unit
Max Input Current	$V_i = 85 \text{ VAC}$; $P_o = 400 \text{ W}$			6	A_{rms}

3.4 Turn-on and Turn-off Input Voltages

The Rectifier is provided with a minimum hysteresis of 3 V during turn-on and turn-off within the ranges shown in the table below.

Table-4

Parameter	Condition / Description	Min	Nom	Max	Unit
Turn-on input voltage	Ramping Up	79	-	85	VAC
Turn-off input voltage	Ramping Down	70	-	78	VAC

3.5 Input Inrush Current Limitation

The Rectifier meets the ETS300 132-1 specification for limiting input inrush current when applying AC power to the Rectifier.

Table-5

Parameter	Condition / Description	Min	Nom	Max	Unit
Input Inrush Limitation	115/230 VAC acc. ETS 300 132-1 < 100 ms			20	A _{pk}
Leakage Current	V _i = 264 VAC, 60 Hz			1.1	mA

3.6 Input Power Factor

Table-6

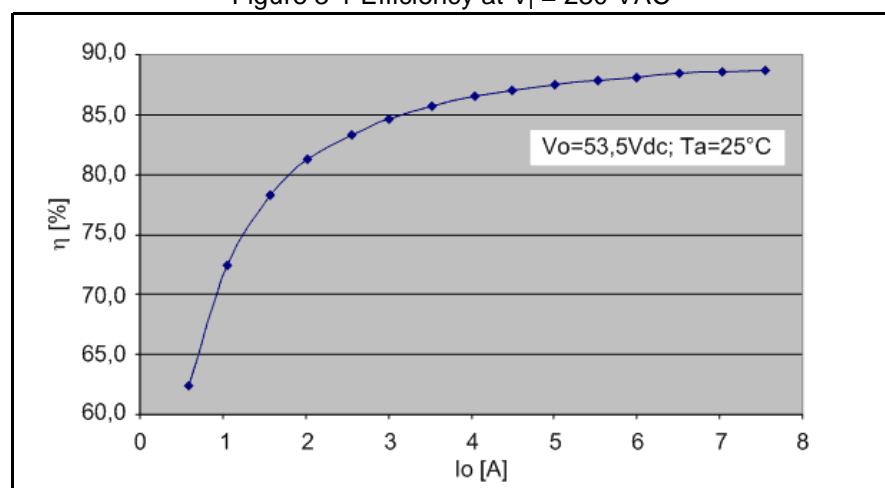
Parameter	Condition / Description	Min	Nom	Max	Unit
Power Factor	V _{i nom} , I _{o nom}	0.96			W/VA

3.7 Input Efficiency

The Rectifier has a nominal efficiency as given in Table 7 for a 230 VAC input at nominal output current. Figure displays the efficiency characteristics versus output current.

Table-7

Parameter	Condition / Description	Nom	Unit
Efficiency	V _i = 230 VAC, P _{o max} , T _c = 25°C	88	%

Figure 3-1 Efficiency at V_i = 230 VAC

3.8 Hold-up Time

The Rectifier will provide regulated voltage output for a hold-up time as given in Table 8 for a momentary power outage.

Table-8

Parameter	Condition / Description	Min	Unit
Hold-up time	After last AC line peak, $V_i = 230$ VAC, P_o nom, V_o retain above DC_OK threshold level > 44 VDC	20	ms

4 Output Characteristics

4.1 Output Voltage

The Rectifier will provide and output voltage as specified in Table 9. This table also specifies the accuracy of the output voltage compared to the voltage set point.

Table-9

Parameter	Condition / Description	Min	Nom	Max	Unit
Nominal Output Voltage	Default value w/o external controller; at 50% I_{load} and 2.23 V/cell (20°C)		53.5		VDC
Output Voltage Set point Accuracy		-0.5		+0.5	% V_{o_set}

The output voltage range for the Rectifier is specified in Table 10.

Table-10

Parameter	Condition / Description	Min	Nom	Max	Unit
Output Voltage Range	Adjustable; (see Figure 1, Figure 2)	46	53.5	57	VDC

Output voltage trimming is available using RS485 communication within the output voltage range provided in Table 10.

Figure 4-1 Example of output characteristic of rectifier module for set values of voltage (V_{o_set}) and current (I_{o_set})

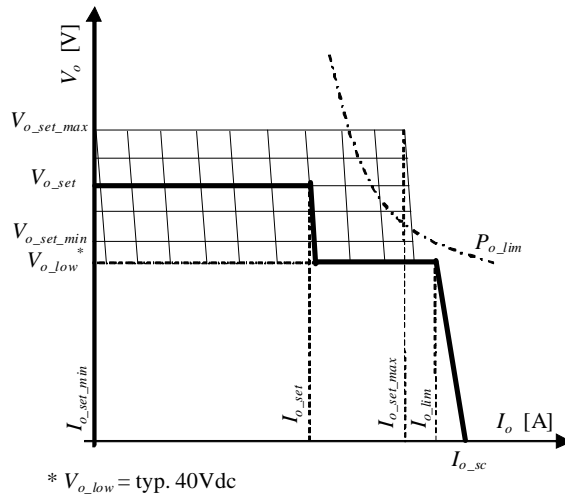
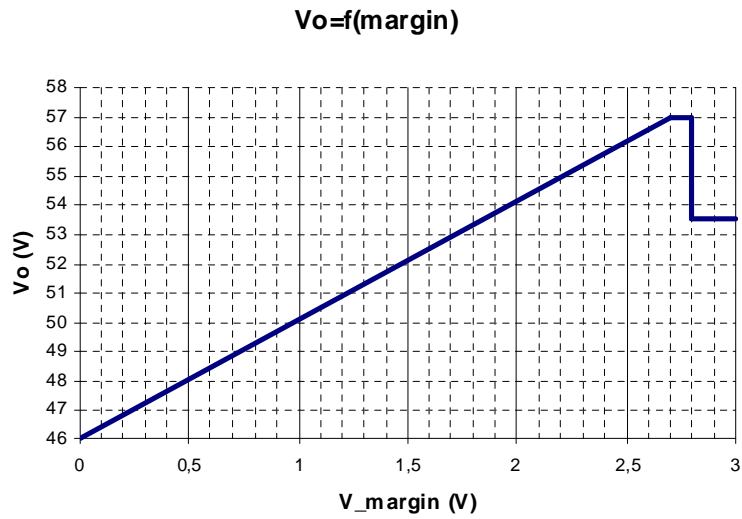


Figure 4-2 Output Voltage V_o vs. Margin pin (if no RS485communication)



4.2 Output Power and Current Ratings

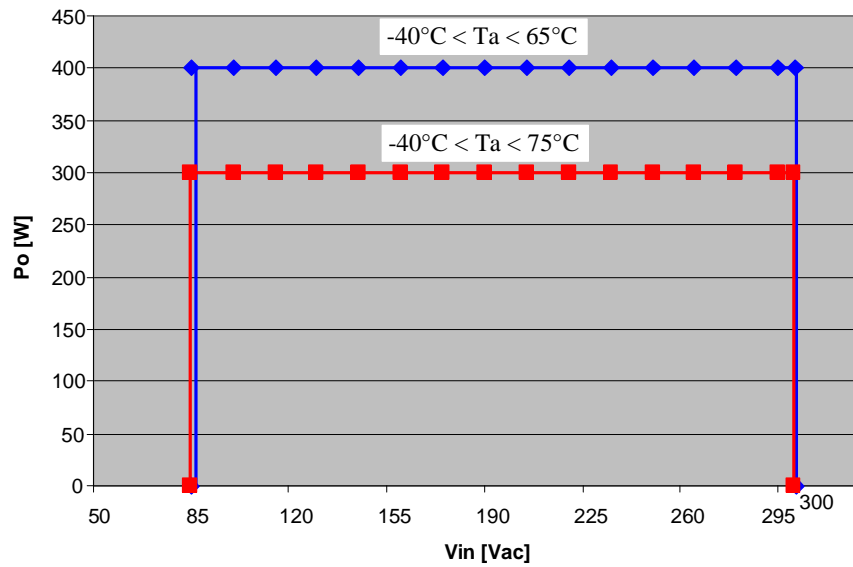
The Rectifier will provide nominal output power and Current as listed in Table 11.

Table-11

Parameter	Condition / Description	Nom	Unit
Nominal Output Power	$V_o = 46 \leftrightarrow 57$ VDC	400	W
Nominal Output Current	I_{o_nom} @ $V_i = 85 \leftrightarrow 300$ VAC; $P_o = 400$ W, $V_o = 53.5$ V	7.5	ADC

Rectifier output power versus input AC voltage is provided according to Figure 4-3.

Figure 4-3 Output Power Voltage vs. Input AC Voltage



4.2.1 Power and Current Limitation

The Rectifier automatically limits the output current according to the output voltage and power.

Table-12

Parameter	Condition / Description	Min	Nom	Max	Unit
Current Limitation	Po_nom @ Vadj min		9.1		ADC
	Vi min <-> Vi max	9.55		10.45	ADC
Power Limitation	Vi min <-> Vi max				
	Vo min <-> Vo max	420		460	W

4.3 Output Voltage Droop

The static load droop characteristics of the Rectifier is provided in Table 13. Dynamic load regulation (voltage deviation above droop) is provided as shown in Table 14.

Table-13

Parameter	Condition / Description	Min	Nom	Max	Unit
Static Load Droop	Vo set; Vi min <-> Vi max; 0 -100% Io set	- 0.5		+ 0.5	%Vo set

Table-14

Parameter	Condition / Description	Min	Nom	Max	Unit
Dynamic Load Regulation	Load change 10% <-> 90% or 90% <-> 10%, Io load, dIo/dt = 1 A/μs	-3		+3	% Vo
	Voltage deviation (droop + over- or undershoot) Max. recovery time to within 1% of Vo_set			1	ms

4.4 Output Startup Characteristic

The Rectifier startup sequence after the initial application of AC power defines the output DC voltage versus time. The DC output voltage will remain at 0 for 1.5 second startup-time until the Rectifier can provide an output within regulation. Subsequently there will be a walk-in time of (maximum) 11 seconds before the Rectifier can provide nominal DC voltage output. Startup characteristics are shown in Table 15 and Figure 4-4 on page 10.

Table-15

Parameter	Condition / Description	Min	Nom	Max	Unit
Start-up time	Time required for output within regulation after initial application of AC-input ($V_{i\ nom}$, $I_{o\ load}$) after removal of inhibit ($V_{i\ nom}$, $I_{o\ load}$)			1.5	s
			100		ms
Walk-in time				11	s

Figure 4-4 Start up behaviour typ.: Output Voltage vs. Time



NOTE In Figure 4-4 the unit is supplied with AC power At T = 0 sec.

4.5 Output Noise

The peak to peak output voltage ripple and noise is provided in Table 16.

Table-16

Parameter	Condition / Description	Min	Nom	Max	Unit
Output Voltage Ripple and Noise	V_o , BW=20 MHz, Filter 10 nF/10 uF, over line and load, 25°C	-0.5		+0.5	% V_{o_set}
	V_o , BW=100 MHz, Filter 10 nF/10 uF, over line and load, 25°C		TBD		mV _{pp}

4.5.1 Psophometric Noise

The Rectifier meets the ETS300-132-2 requirements for psophometric noise as shown in Table 17.

Table-17

Parameter	Condition / Description	Min	Nom	Max	Unit
Psophometric Noise	ETS300-132-2			2	mV

4.6 Output Capacitive Load

The Rectifier meets the requirements provided in Table 18 for maximum capacitive load per ampere.

Table-18

Parameter	Condition / Description	Min	Nom	Max	Unit
Capacitive Load	Worst case capacitive load at $T_c = 25\text{ }^\circ\text{C}$			500	$\mu\text{F/A}$

4.7 Current Sharing

When used in a multi-rectifier setup, the Rectifier is set up for current sharing among the installed rectifiers. Table 19 describes the maximum deviation from the reference current used to regulate the output current from the Rectifier.

Table-19

Parameter	Condition / Description	Min	Nom	Max	Unit
Current Sharing	Difference in current between two units for I_o at full load	-5		+5	$\%I_o \text{ nom}$

5 Protection

The Rectifier features the following for input and output protection:

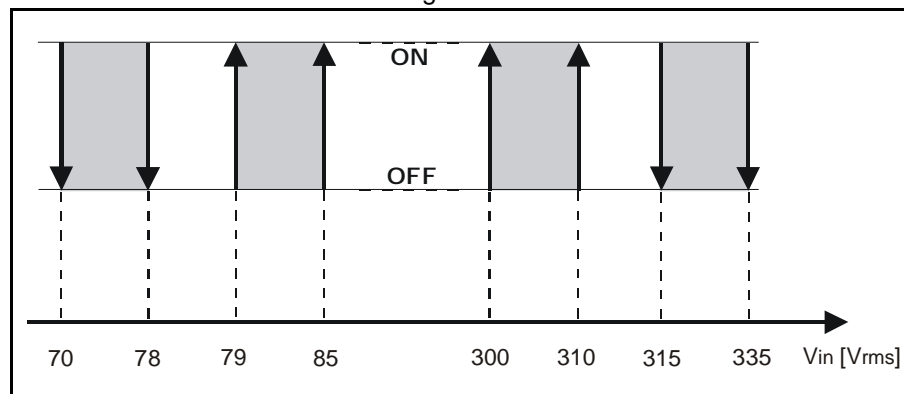
Table-20

Parameter	Condition / Description	Min	Nom	Max	Unit
2 x Input fuse	Not user accessible	8 AT			
Inrush Current Limitation		with resistors and relay			
Inrush Overvoltage Limitation		325 VAC \pm 10 VAC			
Output Current		No-load-, short circuit - and overload proof			
Over-voltage protection latching*	<ul style="list-style-type: none"> - Hardware OVP (always active) - Programmable via RS485 - if communication is detected and software "OVP on" bit is enabled. - If RS485 is without communication than V_o is controlled via "Margin" pin (R4) and software OVP is set 6% above V_o set 	59	59.5	60	V
		46		60	
		46		60	
Over-temperature Protection	Automatic power shutdown at T_c		80		$^{\circ}$ C

*After 2 triggering within a short time (5 s) the unit stays latched and it is necessary to remove input voltage to reset the OVP.

Figure 5-1 Shows the Rectifier input operating voltage with hysteresis.

Figure 5-1



6 General Electrical Characteristics

6.1 General Maximum Ratings

Table-21

Parameter	Condition / Description	Min	Max	Unit
Input Voltage	Continuous		300	VAC
Audible Noise	$V_{i \min}$ - $V_{i \max}$, $I_{o \text{ nom}}$ and ambient temperature of 25°C		54.5	dBA
Operating Ambient Temperature	$V_{i \min}$ - $V_{i \max}$, $I_{o \text{ nom}}$, cooling by internal fan at $P_o = 400 \text{ W}$	-40	65	°C
	$V_{i \min}$ - $V_{i \max}$, $I_{o \text{ nom}}$, cooling by internal fan at $P_o = 300 \text{ W}$ Comment: Reduced specification for 3000 m altitude derate by 5%.	-40	75	°C
Storage Temperature	Non operational	-40	85	°C
MTBF	Calculated per Bellcore (TR-NWT-000332, without fan): GB 25°C: Calculated Demonstrated	200 250		kh
AC Circuit Breaker	AC circuit breaker is determined by selectivity requirements, i.e. by the characteristics of CB versus rectifier fuse. The minimum recommended AC circuit breaker for one phase, three phase IT or three phase TN connection is Siemens C 25A. The minimum cross section of AC input cable is determined according IEC60950-1/UL60950-1. The minimum cross section of AC input cable is 0,75mm ² / 18AWG at input voltage 100 VAC.			

7 Signalling and Control

7.1 Front LED's

The Rectifier has three LED's for basic interface. LED number one is Green and signals AC power on or off. LED number two is Red and signals alarm, and LED number three is Yellow and signals warning / communication.

Table-22

Parameter	Condition / Description
Status Indication	LED1 = AC OK (green); LED2 = Module alarm (red) – Vo output is out of regulation limits, caused from over voltage shutdown, temp. shutdown, output disabled LED3 =Warning (yellow) – temperature pre-warning or fan fail; LED3 is blinking – no communication RS485

7.2 RS485 Communication

The RS485 digital bus monitors alarm functions and sets parameters for the rectifier. When used in a system with a controller, it is also used for inter-system communication. Table 23 describes the signaling.

Table-23

Parameter	Condition / Description
AC fail / Input voltage fault	Provides a RS485 information that the input voltage is under 85 VAC or over voltage. A Power Fail warning will turn off the green AC OK LED.
Temperature warning	RS485 critical temperature warning: Indicates that the operating temperature has been reached [$T_{shut_down} - 10K$], RS485.
DC fail / Output voltage fault	Internal under and over voltage supervision of Vo.
DC current fail	Over current on I_{o1}
DC voltage monitoring	Monitors the output voltage Vo: Accuracy $\pm 0.2 V$ (at 20°C)
DC current monitoring	Monitors the output current Io: Accuracy $\pm 3\% I_{o_lim}$ (at 20°C)
DC voltage trimming	Output voltage trimming $V_o = 46 \leftrightarrow 57 VDC$ Setting accuracy: RS485 $\pm 0.5\%$ of Vo (at 20°C) Margin pin $\pm 1\%$ of Vo (at 20°C)

Fan speed control	Fan speed levels automatically set depending on the internal temperature.
Fan OK	Indicates if the fan is operating or has failed.
RS485 digital bus	Monitors alarm functions and sets parameters.
Power supply present pin	Contact closure to SGND (internal pull-down resistor of 1 kΩ)
Inhibit pin	TTL compatible signal, inhibited when open contact, high or at TTL logic "1" Signal referenced to SGND
Power fail	From SGND & SGNDA isolated optocoupler output; Power fail – open or high; Power fail – low (AC OK & DC OK & no over temperature & fan working)

Table-24 Rectifier Readout

Status Byte	Condition / Description
Bit 0: Input voltage OK	This bit is set if the input voltage is in a valid range
Bit 1: Low voltage alarm	This bit is set if the output voltage is less than 44 VDC
Bit 2: Module alarm	This bit is set if OVP Error or Temperature Alarm or Low Voltage Alarm or Current Share Fault or Fan Failure
Bit 3: Over voltage shutdown	This bit is set if the unit is shut down because of an OVP
Bit 4: Current limiting	If $V_{omeas} < (V_o \text{ set} - 0.8 \text{ V})$ and not Temperature Shut Down, not OVP Shut Down, Input Voltage OK, Power ON
Bit 5: Power on	This bit is set if the unit is enabled
Bit 6: OVP enabled	This bit is set if OVP is enabled
Alarm Byte	
Bit 0: Current limit reduced	not used
Bit 1: Fan failure/ shutdown	This bit is set if one of the fans are not running
Bit 2: Current sharing	This bit is set if the current sharing is outside of the limit
Bit 3: Temperature alarm	Temperature pre-warning $T > T_{off} - 10^\circ\text{C}$
Bit 4: N.U.	Not Used
Bit 5: Temperature shutdown	This bit is set if there is a over temperature shutdown condition
Bit 6: Internal Failure	If is OVP Shut Down or Temperature shutdown or Fan Failure then Internal Failure is active
Bit 7: Fan pre-warning	If the fan is blocked for more than 60 s or if fan is blocked at heat sink temperature $> 60^\circ\text{C}$

7.3 Switching Frequencies

The Rectifier utilizes the switching frequencies listed below:

- n Auxiliary: 135 kHz
- n PFC: 135 kHz
- n DC/DC is a 2-switch forward converter, the switching frequency is 266 kHz.

8 Electromagnetic Compatibility

8.1 EMC Immunity

Table-25

Parameter	Condition / Description	Criterion
Electrostatic discharge IEC/EN 61000-4-2	Level 4 (contact/air) (8/15 kV)	Performance criterion B
Electromagnetic field IEC/EN 61000-4-3	Level 3 (10 V/m)	Performance criterion A
Radiated Immunity	GR-1089 R3-11	Performance criterion A
	GR-1089 R3-12	Performance criterion A
	GR-1089 R3-13	Performance criterion A
	GR1089 R3-14	Performance criterion A
Electrical fast transient/ burst IEC/EN 61000-4-4	Level 3 (in / out) (2/1kV)	Performance criterion B
Surge immunity test IEC/EN 61000-4-5	Level 3, (L/L, L/E) (2/4 kV) Telcordia GR-1089-Core, Level 2 (L/L,L/E) (6/6 kV)	Performance criterion A Performance criterion D
Voltage dips, interruptions and variations IEC/EN 61000-4-11	Dip 30%, 100 ms Dip 30%, 200 ms Dip 60%, 20 ms Dip 60%, 100 ms Dip > 95%, 20 ms Dip > 95%, 100 ms	Performance criterion A Performance criterion B Performance criterion A Performance criterion B Performance criterion A Performance criterion B

Conducted Disturbances induced by radio frequency fields IEC/EN 61000-4-6; GR-1089	Level 3, 10 VAC, AM 80%, 1 kHz, 0.15...80 MHz	Performance criterion A
Voltage sag	SEMI F47-0200, (120 VAC / 230 VAC)	No voltage fluctuations
EMC Tests in System		
ESD immunity IEC / EN 61000-4-2	Contact discharge: ± 8 kV, Air discharge: ± 15 kV	Criterion B

8.2 EMC Emission

Table-26

Parameter	Condition/Description	Criterion
Conducted noise 0.15.. 30 MHz	EN55022 / CISPR 22 Class B, FCC E222CFR Title 47 part 15, Setup according to the Standard AC cable connected to the LISN DC conducted measurement setup according to the C.1.1 or C.1.2 of the Standard	Class B; 3 dBuV margin
Radiated Noise 30... 1000 MHz	EN55022 / CISPR 22 Class B, FCC CFR Title 47 part 15 Measurement conditions: measured alone unit with the signal and input/output cables (length of the cables min. 0.8 m)	Class B; min. 6 dBuV margin
Voltage Fluctuation and Flicker Test	IEC61000-3-3	Pass
Harmonic Emissions	IEC61000-3-2	Pass
Total Harmonic Current Distortion (THD)	$V_i = 90$ VAC...275 VAC $I_o = 50\% I_o \text{ nom} \dots 100\% I_o \text{ nom}$ $V_i = 275$ VAC...300 VAC $I_o = 50\% I_o \text{ nom} \dots 100\% I_o \text{ nom}$	< 10% < 10% (only for TES)

9 Safety Approvals

Maximum electric strength testing is performed in the factory according to EN 550116, IEC/EN 60950, and UL 60950. Input-to-output electric strength tests should not be repeated in the field. Power-One will not honor any guarantee claims resulting from electric strength field tests.

Table-27

Parameter	Condition / Description	Min	Nom	Max	Unit
Agency Approvals	UL: UL60950-1/A11:2004 cUL: CAN/CSA-C22.2 No.60950-1-3 TÜV: EN60950-1/A11:2004 (TÜV) CB: EN60950-1/A11:2004 (CB) CE: Mark for LVD/EMI CCC approval				
Insulation Safety Rating	Input to case Input to output Output to case		Basic Reinforced Functional		
Electric Strength Test Voltage	Input to case	2.12			kVDC
	Input to output	Note			
	Output to case	0.75			kVDC
	Power fail to case	0.75			kVDC
	Output to power fail	0.1			kVDC

Note: Subassemblies are pre-tested with 4.2kV DC in accordance with EN50116 and IEC/EN60950

10 Environmental Characteristics

Table-28 Environmental Characteristics

Parameter	Condition / Description	Min	Nom	Max	Unit
Altitude	Operating			3000	m
Relative Humidity, non-condensating	Operating			95	% RH

Output and Input Connector Pinning and Signal Specification

Temperature Coefficient	-40°C to 75°C (after 15 min warm-up)			0.02	%/K
Audible Noise	According to ISO7779			54.5	dBA
Shock	Non-operational			40	G _{pk}
	Operational, Half - sine, 10 ms 3-axis			20	G _{pk}
Sinusoidal Vibration	Operational, Sine, 5-2000-5 Hz, 0.02iDA, 32-2000 Hz			3	G _{pk}
	Non operational, Random, 10-2000 Hz			6.16	G _{rms}
Damp Heat	IEC60068-2-78				PASS
Package Drop Test	Compliance to FedEx drop test requirements				PASS

11 Output and Input Connector Pinning and Signal Specification

Table-29 Output Connector Pinning and Specification

Output Connector Description	Pin Location	Type	Low Level High Level	U Max I Max
Reserve	U1	-	-	-
ADDR3, RS485 address bus	U2	DIP switch or wire to internal ground	Switch closed Switch open	3.3 V -
Power Supply Present	U3	Resistor (1 kΩ, 90mW) connected to SGND	- -	- -
Reserve	U4	-	-	-
Power fail	U5	Optocoupler output (Emitter), protected by 16 V Zener diode and 10 Ω resistor in series	<0.4 V @ 1 mA Open	12 V 1 mA
ADDR0, RS485 address bus	T1	DIP switch or wire to internal ground	Switch closed Switch open	3.3 V -
ADDR1, RS485 address bus	T2	DIP switch or wire to internal ground	Switch closed Switch open	3.3 V -
ADDR2, RS485 address bus	T3	DIP switch or wire to internal ground	Switch closed Switch open	3.3 V -
Reserve	T4	-	-	-
Power fail	T5	Optocoupler output (Collector), protected by 16 V Zener diode and 10 Ω resistor in series	<0.4 V @ 1 mA Open	15 V 1 mA

Output and Input Connector Pinning and Signal Specification

DATA 0, RS485 data line	S1	RS485 compatible signal referenced to RS485-GND	5 V logic	-
DATA 1, RS485 data line	S2	RS485 compatible signal referenced to RS485-GND	5 V logic	-
RS485 – Power	S3	RS485 – Input of supply, insulated from main output	5V	-
RS485 – GND	S4	RS485 –GND, insulated from main output	-	-
Reserve	S5	-	-	-
Output enable**	R1 (E)	DC-DC stage OFF when pin open/high impedance (referenced to logic GND)	<0.8 V >2.0 V	15 V -
Current share	R2	Current share bus (Reference to SGNDA)	-	4 V
SGNDA	R3	Return for current share and margin pin bus	-	-
Margin pin	R4	Output voltage adjustment	-	From 0 VDC to 2.7VDC
SGND	R5	Signal ground	-	-
V _o +	P4, P5	Main output + pins	-	-
V _o -	P6, P7	Main output – pins	-	-

Table-30 Input Connector Pinning and Signal Specification

Input Connector Description	Pin Location	Type
Phase	P1	L
Neutral	P2	N
Protective Earth	P3	PE

Figure 1-1 Input - Output Connector Description

