Power Systems

XR08.48 Rectifier

Technical Product Description

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1 Introduction

1.1 Scope

This document describes the specifications for the AC to DC rectifier XR08.48 (hereafter referred to as the Rectifier).

1.2 Architecture

The Rectifier is a 800 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 XR08.48 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.

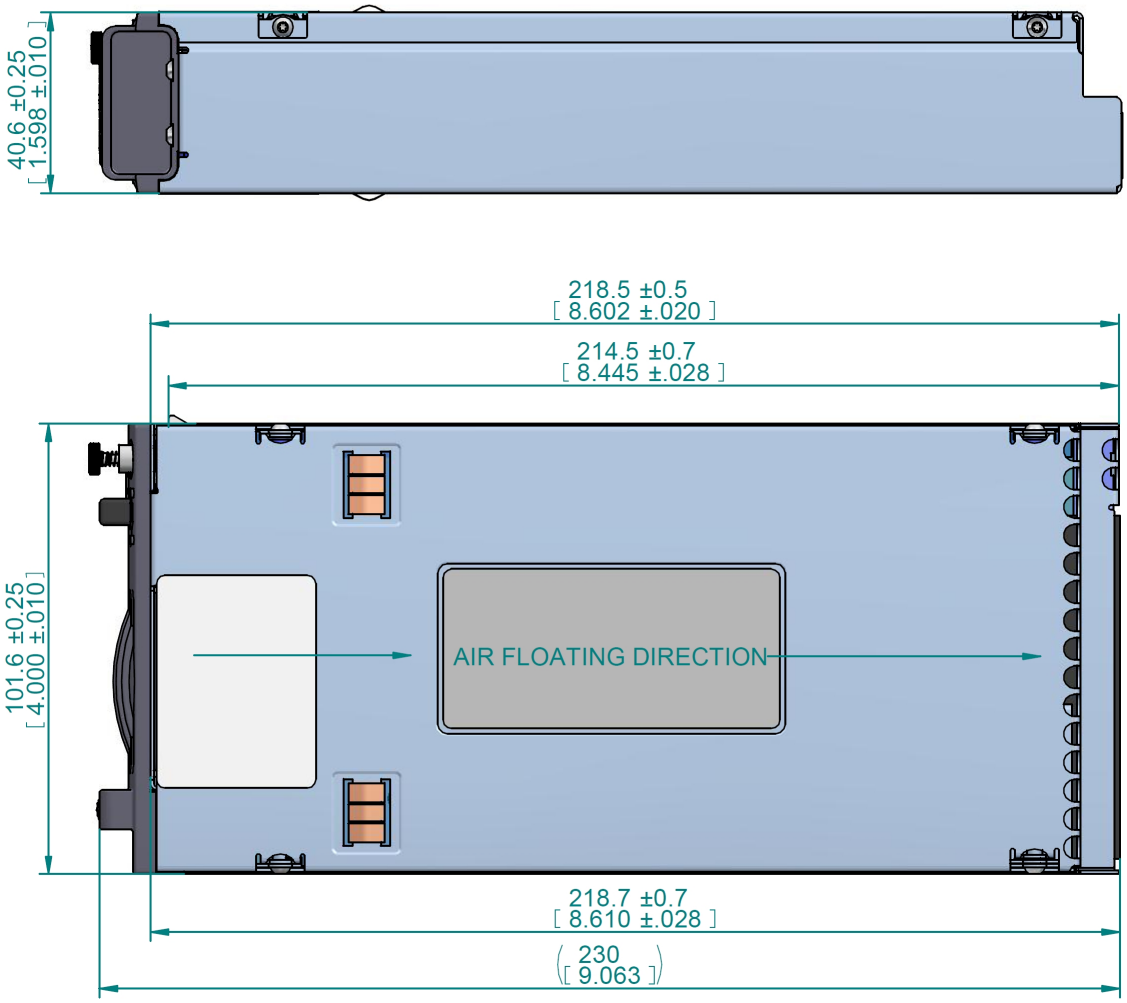
A wide variety of distribution options are available to provide the maximum system flexibility for a wide range of communications applications that demand efficiency, reliability, and flexibility including wireless base stations, remote switches and broadband access.

The XR08.48 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 Measures



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			9.3	12	I_{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 Table-4.

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	Apk
Max Input Current	V_i = 85 VAC, $P_{o\ max}$,			12	Arms
Leakage Current	Vi = 264 VAC, 60 Hz			0.05	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

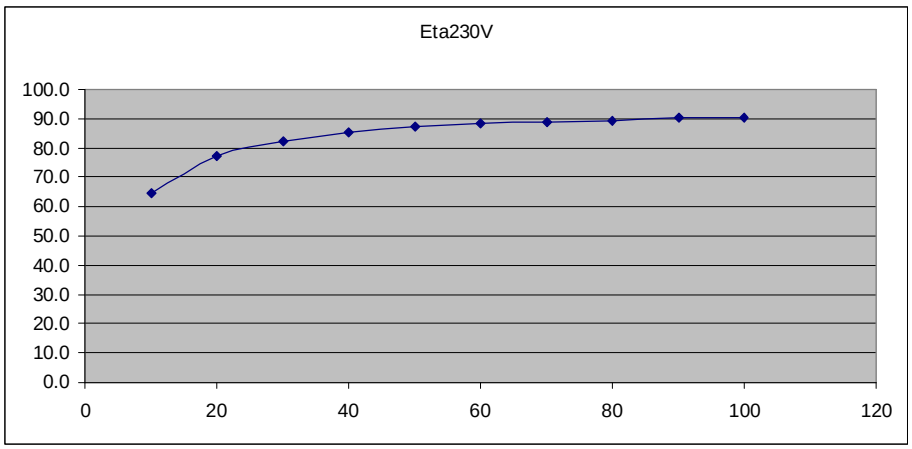
3.7 Input Efficiency

The Rectifier has a nominal efficiency as given in Table-7 for a 230 VAC input at nominal output current. Figure 3-1 displays the efficiency characteristics versus output current and ambient temperature.

Table-7

Parameter	Condition / Description	Min	Nom	Max	Unit
Efficiency	V_i = 230 VAC, $P_{o\ max}$, T_c =25^{o}C	90		91	%

Figure 3-1 Efficiency at U_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	15	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 setpoint.

Table-9

Parameter	Condition / Description	Min	Nom	Max	Unit
Nominal Output Voltage	$I_{o\ nom/2}$ = 23.3 A at 25^{o} C ambient temperature		53.5		VDC
Output Voltage Setpoint Accuracy		-0.3		+0.3	% V_{o_set}
Output Voltage Range	V_i = 230 VAC, I_{o1} = 7.5 A, T_c = 25^{o}C	46	53.5	57	VDC

Output voltage trimming is available using RS485 communcation within the output voltage range provided in Table 9.

4.2 Output Power and Current Ratings

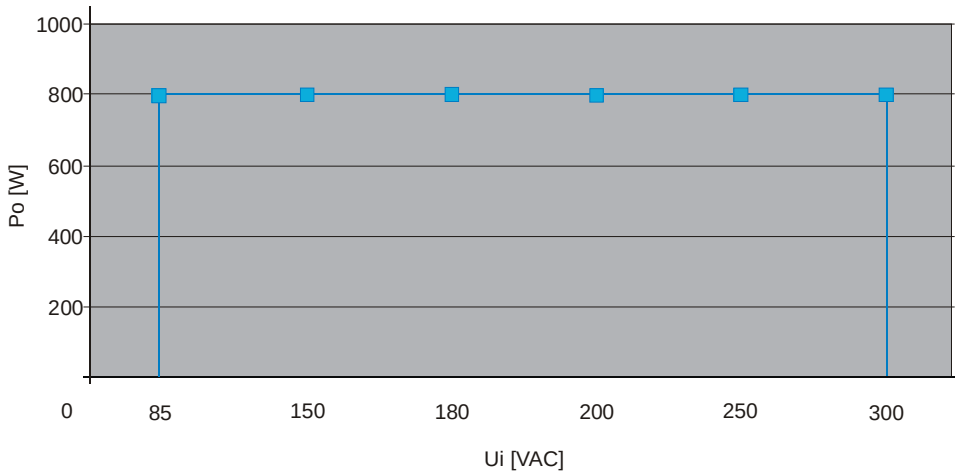
The Rectifier will provide nominal output power and Current as listed in Table 10.

Table-10

Parameter	Condition / Description	Nom	Unit
Nominal Output Power	V_o = 53.5 V	800	W
Nominal Output Current	V_i = 85 <-> 300 VAC, P_o = 800 W, V_o = 53.5 V	15	ADC

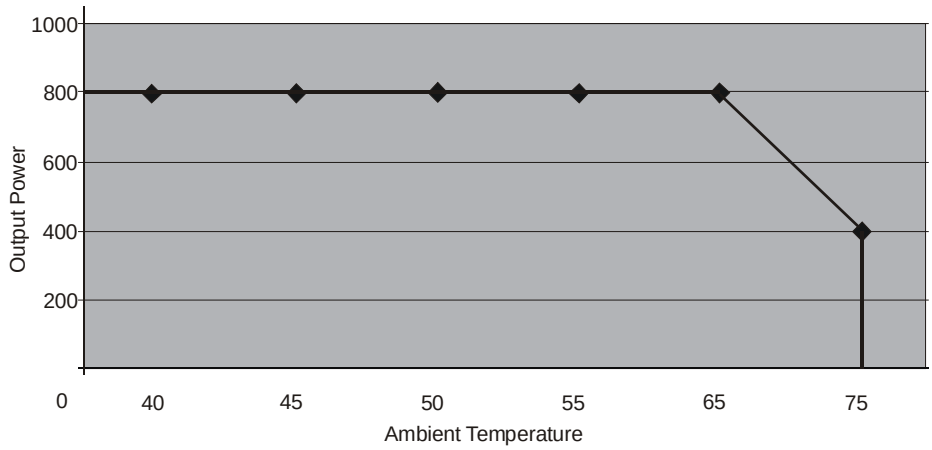
Rectifier output power versus input AC voltage is provided according to Figure 4-1.

Figure 4-1 Output Power vs. Input AC Voltage



The Rectifier Output Power depending on ambient temperature is provided in Figure 4-2.

Figure 4-2 Output Power vs. Ambient Temperature



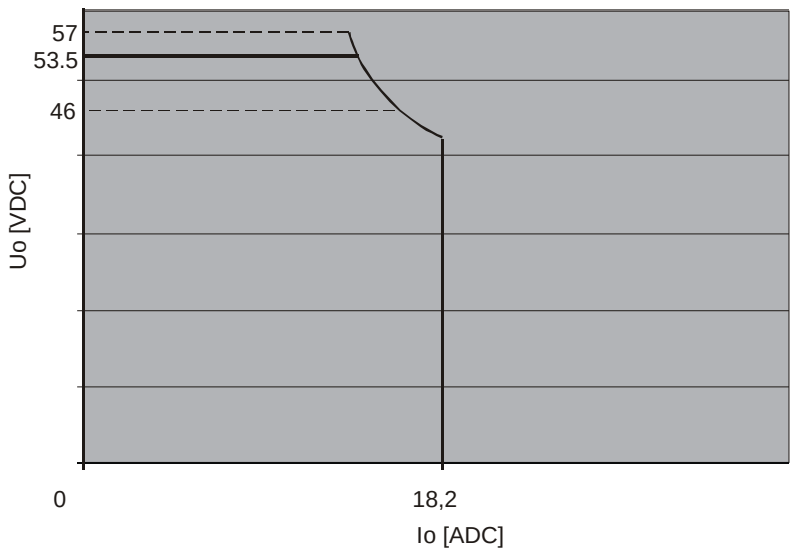
4.2.1 Power and Current Limitation

The Rectifier automatically limits the output current according to the output voltage and power. Table and Figure 4-3 describes the current limitation characteristics.

Table-11

Parameter	Condition / Description	Min	Nom	Max	Unit
Current Limitation	$I_{o1\ max}$; V_o = 57.0 V	14.0			ADC
	$I_{o1\ max}$; V_o = 53.5 V	15.0			ADC
	$I_{o1\ max}$; V_o = 46.0 V	17.4			ADC
	$I_{o1\ max}$; V_o < 44.0 V			18.2	ADC

Figure 4-3 Output Voltage vs.Output Current



4.3 Output Voltage Droop

The static load droop characteristics of the Rectifier is provided in Table 12. Dynamic load regulation (voltage deviation above droop) is provided as shown in Table 13.

Table-12

Parameter	Condition / Description	Min	Nom	Max	Unit
Static Load Droop	V_i= 230 VAC, 0 -100 % $I_{o\ nom}$		100		mV

Table-13

Parameter	Condition / Description	Min	Nom	Max	Unit
Dynamic Load Regulation	Load change 10% <—> 90% or 90% <—> 10%, Io load, dI_o/dt =1 A/µs Voltage deviation (droop + over- or undershoot) Max. recovery time to within 1 % of V_{o_set}	-3	 100	+3 1000	% V_o us

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 the (maximum) 1second startup-time until the Rectifier can provide an output within regulation. Subsequently there will be a walk-in time of 11 seconds (typical) before the Rectifier can provide nominal DC voltage output. Startup characteristics are shown in Table 14 and Figure 4-4.

Table-14

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})		1 100	1.5	s ms
Walk-in time			11		

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 15.

Table-15

Parameter	Condition / Description	Min	Nom	Max	Unit
Output Voltage Ripple and Noise	V_o, BW=20MHz, Filter 10nF/ 10uF, over line and load,25°C V_o, BW=100MHz, Filter 10nF/ 10uF, over line and load,25°C		260 260		mV_{pp}

4.5.1 Psophometric Noise

The Rectifier meets the ETS300-132-2 requirements for psophometric noise as shown in Table 16.

Table-16

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 17 for maximum capacitive load per ampere.

Table-17

Parameter	Condition / Description	Min	Nom	Max	Unit
Capacitive Load	Worst case capacitive load at T_C = 25 °C			500	µF/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 18 describes the maximum deviaton from the reference current used to regulate the output current from the Rectifier.

Table-18

Parameter	Condition / Description	Min	Nom	Max	Unit
Current Sharing	Difference in current between two units for I_{o1} at full load	-5		+5	$\%I_{o\ nom}$

5 Protection

The Rectifier features the following for input and output protection:

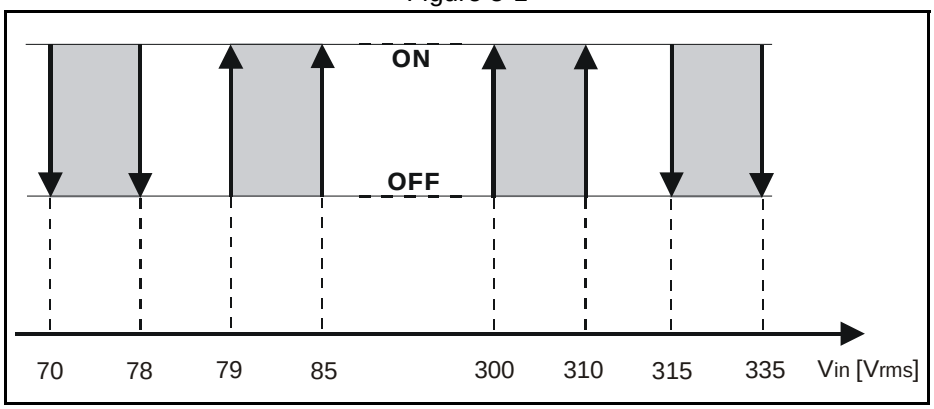
Table-19

Parameter	Condition/Description	Min	Nom	Max	Unit
2 x Input fuse	Not user accessible	12 AF			
Inrush Current Limitation		with resistors and relay			
Inrush Overvoltage Limitation		325 VAC ±10 VAC			
Output Current		No-load-, short circuit - and overload proof			
Over-voltage protection latching*	- 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 46 46	59.5	60 60 60	V
Over-temperature Protection	Automatic power shutdown at T_A	70		80	^oC

* After 2 triggering within a short time (5 s) the unit stays latched and it is necessaru 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-20

Parameter	Condition / Description	Min	Max	Unit
Input Voltage	Continuous		300	VAC
Audible Noise	at 230 V AC and 70% load and ambient temperature of 25^{o}C		60	dBA
Operating Ambient Temperature	$V_{i\ min}$ - $V_{i\ max}$, $I_{o\ nom,}$ cooling by internal fan at P_o= 400 W	-40	65	^{o}C
	Derated from 65^{o}C	65	75	^{o}C
	Reduced specification (for 3000 m altitude derate by 5%)	-40	25	^{o}C
Storage Temperature	Non operational	-40	85	^{o}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 32A. The minimun cross section of AC input cable is determined according IEC60950-1/UL60950-1. The minimum cross section of AC input cable is 1mm^2 / 16AWG at input voltage 100VAC.			

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-21

Parameter	**Condition / Description**
Status Indication	LED1 = AC OK (green) ; LED2 = Module alarm (red) – V_O output is out of regulation limits, caused from overvoltage 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 22 describes the signaling.

Table-22

Parameter	**Condition / Description**
AC fail / Input voltage fault	Provides a RS485 information that the input voltage is under 85 VAC or overvoltage. 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} – 5K], RS485.
DC fail / Output voltage fault	Internal under and over voltage supervision of V_O.
DC voltage monitoring	Monitors the output voltage V_O : Accuracy ± 0.2 V (at 20°C)
DC current monitoring	Monitors the output current I_O : Accuracy ± 1% I_{o_lim} (at 20°C)
DC voltage trimming	Output voltage trimming V_o = 46 <->57 VDC Setting accuracy : RS485 ± 0.4% of V_o (at 20°C) Margin pin ± 1% of V_o (at 20°C)
Fan speed control	Fan speed levels automatically set depending on the internal temperature.

Fan OK	Indicates if the fans are operating or have failed.
RS485 digital bus	Monitors alarm functions and sets parameters. Provides start-up and real-time diagnostic results.
Power supply present pin	Contact closure to SGND (internal pull-down resistor of 1 kΩ)
Power Supply OK pins	From SGND & SGNDA isolated optocoupler output. Shorted if AC OK & DC OK & no overtemperature & fan working
DC current trimming (RS485)*	Output current trimming I_{o_set} = 0 – 18.2 ADC Setting accuracy : RS485 ± 2 % of I_{o_lim} (at 20°C)
Inhibit pin	TTL compatible signal, enabled when tight to SGND
Power fail	From SGND & SGNDA isolated optocoupler output ; Power fail – open or high; Power fail – low (AC OK & DC OK & no overtemperature & fans working)

Table-23 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 the unit is not able to deliver power
Bit 3: Over voltage shutdown	This bit is set if the unit is shut down because of an OVP
Bit 4: Current limiting	Not used
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	This bit is set if the temperature is at the high limit or above
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	This bit is set at: output over-voltage, internal over-temperature or fan failure
Bit 7: Fan prewarning	This bit is set if one of the fans are running on low speed.

7.3 Switching Frequencies

The Rectifier utilizes the switching frequencies listed below:

- Auxiliary:100 kHz
- PFC: 123Khz
- DC/DC is a resonant converter, the frequency changes in the range form 160 kHz to 340 kHz. At the nominal condition it is about 170 kHz (Vout = 53.5 V and I_{load}=23 A)

8 Electromagnetic Compatibility

8.1 EMC Immunity

Table-24

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 (10V/m)	Performance criterion A
Radiated Immunity	GR-1089 R3-11 GR-1089 R3-12 GR-1089 R3-13 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) (2/4kV) Telcordia GR-1089-Core, Level 2 (L/L,L/E) (6/6kV)	Performance criterion B Performance criterion D
GR-1089 R4-24, R4-25	First level surge line-line 1000 V, line-earth 1000 V, rep. each polarity - 4 pulses. Second level surge, line-line 6000 V, line-earth 6000 V, unit must not be functional after the test, rep. each polarity - 1pulse	Performance criterion B

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 inducted by radio frequency fields IEC/EN 61000-4-6; GR-1089	Level 3, 10 VAC, AM 80%, 1 kHz, 0.15..80MHz,	Performance criterion A
Voltage sag	SEMI F47-0200, (120 VAC / 230 VAC)	No voltage fluctuations

8.2 EMC Emission

Table-25

Parameter	**Condition/Description**	**Criterion**
Conducted Noise Input RFI level conducted 0.15 .. 30 MHz:	EN55022 / CISPR 22 Class B, FCC E222CFR Title 47 part 15	Class B; 3dBuV margin
Conducted emissions on the AC Power ports 450 kHz - 30 MHz	GR-1089 R3-5 : Only with QSP detector over 50R, 50uH LISN Limit: 450kHz-1.705MHz: ClassA=60dBuV; ClassB=47.9dBuV 1.705MHz-30MHz: ClassA=69.5dBuV; ClassB=47.9dBuV	Class B
Conducted emissions on the AC and DC Power Ports 10 kHz - 30 MHz	GR-1089 R3-6 : Av.detector 10 kHz -150 kHz; QSP detector 150 kHz -30 MHz Measured with EMI current probe; Power supply powered thought LISN Limit: 10kHz - 270kHz = 79dBArms 270kHz - 800kHz = 67.6dBArms - 20dBuArms log f 800 kHz - 30 kHz = 69.5 dBuArms	Class A

Conducted Emissions on signal leads	GR1089, R3-6 CISPR 22/EN 55022 GR-1089 R3-8 : Av.detector 10 kHz -150 kHz; QSP detector 150 kHz -30 MHz Measured with EMI current probe; Power supply powered thought LISN Limit: 10 kHz - 270 kHz = 79 dBArms 270 kHz - 800 kHz = 67.6 dBArms - 20 dBuArms log f 800 kHz - 30 kHz = 69.5 dBuArms	Class B
Radiated Noise Input RFI level radiated 30 .. 1000 MHz:	EN55022 / CISPR 22 Class B, FCC CFR Title 47 part 15 Measurement conditions defined according the requirements to meet level B	Class B 6dB Margin
Radiated Emissions	GR1089, R3-1, R3-2, R3-3 CISPR 22/EN 55022	Class A Class B
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_{onom}...100%I_{onom}	< 10%

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-26

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 Input to output Output to case Power fail to case Output to power fail	2.12 Note 0.75 0.75 0.1			kVDC kVDC kVDC kVDC

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

10 Environmental Characteristics

Table-27

Parameter	Condition/Description	Min	Nom	Max	Unit
Altitude	Operating			3000	m
Relative Humidity, non-condensating	Operating			95	% RH
Temperature Coefficient	-40^{o}C to 65^{o}C (after 15 min warm-up)			0.02	%/K
Audible Noise	According to ISO7779			60	dBA
Shock	Non-operational Operational, Half - sine, 10ms 3-axis			40 20	G_{pk} G_{pk}

Sinusoidal Vibration	Operational, Sine, 5-2000-5 Hz, 0.02iDA, 32-2000 Hz Non operational, Random, 10-2000 Hz			3 6.16	G_{pk} G_{rms}
Damp Heat	IEC60068-2-78				PASS
Package Drop Test	Compliance to FedEx drop test requirements				PASS

11 Input - Output Connector Pinning and Signal Specification

Table-28 Output Connector Pinning and Signal Specification

Output Connector Describtion	Pin Location	Type	Low Level High Level	U Max I Max
Reserve	U1	-	-	-
ADDR3, RS485 address bus	U2	DIP switch or wire to SGND	Switch closed Switch open	5V -
Power Supply Present	U3	Resistor (1 kΩ, 90mW) connected to SGND	- -	- -
Reserve	U4	-	-	-
Power Supply OK	U5	Optocoupler output (Emitter), protected by 16 V Zener diode and 10 Ω resistor in series	<0.4 V @ 1 mA Open	15 V 1 mA
ADDR0, RS485 address bus	T1	DIP switch or wire to internal ground	Switch closed Switch open	5 V -
ADDR1, RS485 address bus	T2	DIP switch or wire to internal ground	Switch closed Switch open	5 V -
ADDR2, RS485 address bus	T3	DIP switch or wire to internal ground	Switch closed Switch open	5 V -
Reserve	T4	-	-	-
Power Supply OK	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
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)	-	3 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-29 Input Connector Pinning and Signal Specification

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

Figure 1-1 Input -Output Connection