Compuware Technology Inc.

Power Supply Specification

Model: CPR-3221-1M1

Revision Histories

Rev.	Description	Issued Date	Released by
1.0	Product Specification	March 31, 2025	
1.1			
1.2			
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			

Specification is subject to change without notice

Approved by : **Checked by :** **Prepared by :**

04-0102-05B

1. Introduction

This specification defines the performance characteristics of a single-phase (3-wire), digital 3200W redundant, single output power supply with wide range input AC capability (90-264VAC/47-63Hz), HVDC (200-240Vdc) and Titanium level. The power supply shall be designed for parallel operation and with DSP controllers. In the event of a power supply failure, the redundant power supply continues to power the system even under over voltage fault. The number of power supplies per system will be limited to a maximum of eight. The power supply shall be designed for “hot swap” exchange and must contain the OR-ing isolation MOSFETs for all outputs and shall communicate to external devices through Inter-Integrated (I2C) Circuit protocol. The power supply will have an EEPROM for storing powers supply FRU information, DSSI, and meet PMBus Revision 1.2 requirement. This product follows the M- CRPS base specification. Refer to M-CRPS specification for additional requirements.

1.1. Design and Assembly Standard

This model is designed to be long life product with expected life time of 5 years of operation following and meet IPC9592B Class I stress factor de-rating requirements and with at least 5 years life and endurance, and quality control criteria should be based on IPC- A-610 class 2. All units shipped should meet IPC-A-610 class 2 guideline for assembly quality acceptance. The assembly process should follow IPC-J-STD-075, IPC-J-STD-001, IPC-J-STD-003, IPC-7711A/7721A, IPC-HDBK-830, and other IPC, and J-STD for general production practice. All cable and wire harness assemblies should meet IPC-A-620 class II requirements. Printed boards should meet IPC-A-600 class II requirements.

1.2. Reference Documents

This power supply specification should follow the complete Modular Hardware System-Common Redundant Power Supply (M-CRPS) Base Specification version 1.05.00 RC5, Sept 25th, 2024 (refer as M-CRPS specification).
The CPR-3221-1M1 power supply is the 73.5mm width, 185mm length, 240Vac input type M-CRPS power supply within the M-CRPS specification category.
This specification includes the additional requirements on top of the M-CRPS specification.

M-CRPS specification:
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M-CRPS design specification:
https://drive.google.com/file/d/15psXIKUgrnZfGFWwS5OMqxvZMXw0XmSZ/view

2. Mechanical Overview

The CPR-3221-1M1 physical size of the power supply enclosure is 40mm x 73.5mm x 185mm.
The power supply contains a 40x40x28mm fan. The power supply has a card edge output that interfaces with a 2x25 card edge connector in the system. The AC plugs directly into the external face of the power supply. For CPR-3221-1M1 refer to M-CRPS 185mm by 73.5mm specification for additional requirements, detail drawing and tolerance.

M-CRPS mechanical files

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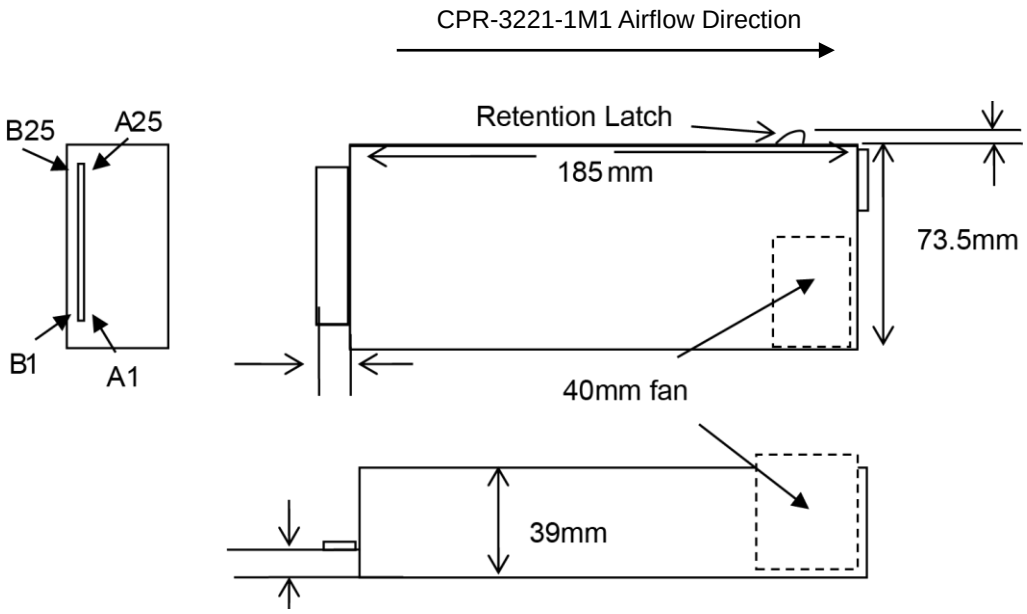
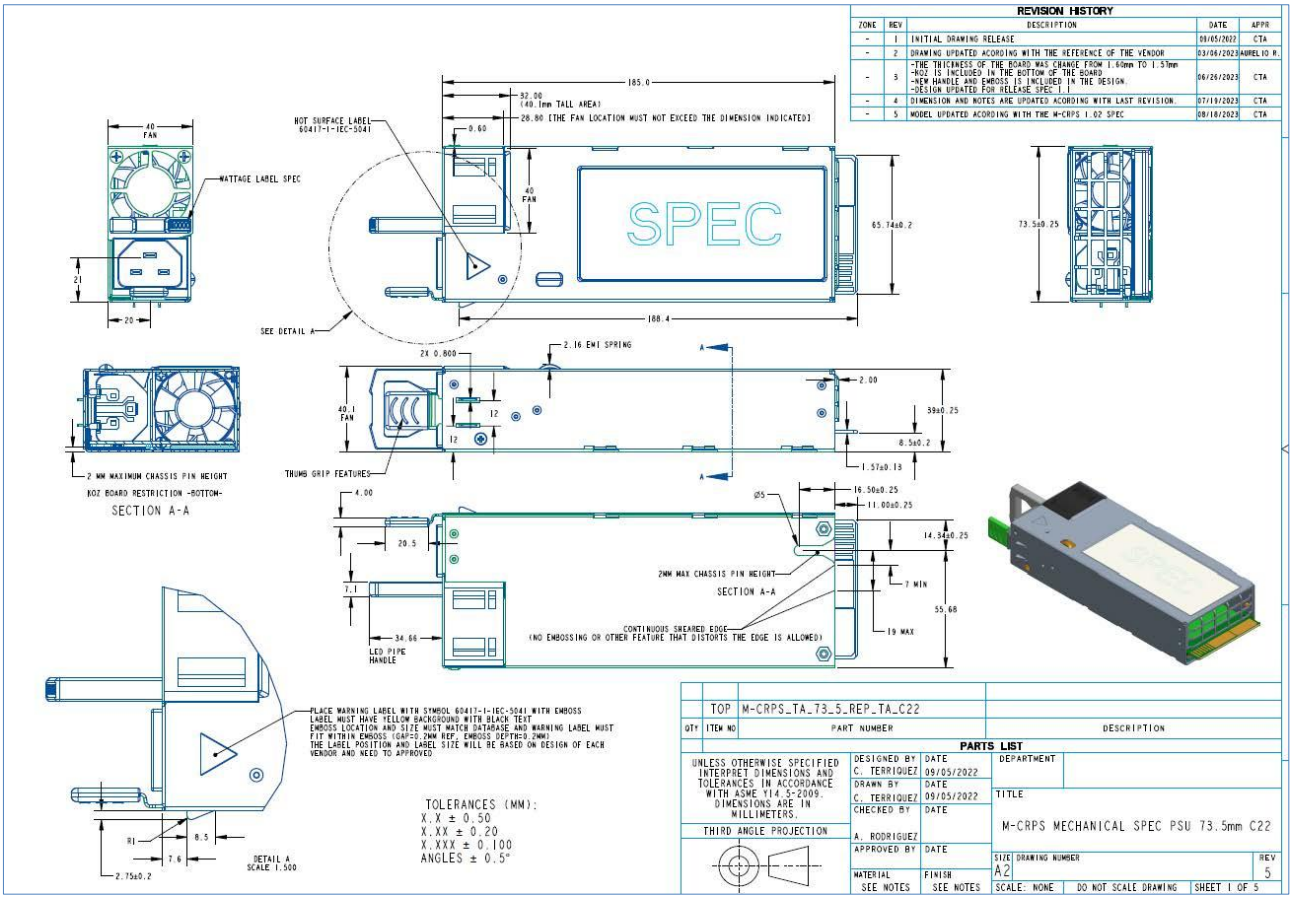
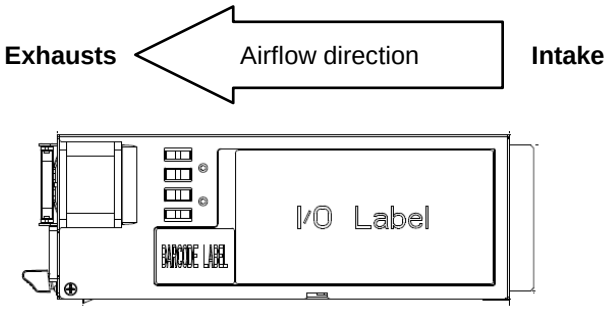




2.1. Airflow direction

CPR-3221-1M1 air direction is:



2.2. DC Output Connector

The power supply shall use a card edge output connection for power and signal that is compatible with a 2x25 Power Card Edge connector.

Table 2-1 CPR-3221-1M1 Pinout definition:

Name	High power conn [1]	Regular conn [2]		Regular conn [2]	High power conn [1]	Name
GND	P1	A1		B1	P7	GND
GND		A2		B2		GND
GND		A3		B3		GND
GND	P2	A4		B4	P8	GND
GND		A5		B5		GND
GND		A6		B6		GND
GND	P3	A7		B7	P9	GND
GND		A8		B8		GND
GND		A9		B9		GND
+12V	P4	A10		B10	P10	+12V
+12V		A11		B11		+12V
+12V		A12		B12		+12V
+12V	P5	A13		B13	P11	+12V
+12V		A14		B14		+12V
+12V		A15		B15		+12V
+12V	P6	A16		B16	P12	+12V
+12V		A17		B17		+12V
+12V		A18		B18		+12V
PMBus SDA	S1	A19		B19	S8	A0 (SMBus address) [5]

PMBus SCL	S2	A20		B20	S9	A1 (SMBus address) [4]
PSON#	S3	A21		B21	S10	+12Vstby
SMBAlert#	S4	A22		B22	S11	Cold Redundancy Bus
Return sense /PS_Kill [6]	S5	A23		B23	S12	12V load share bus
+12V Remote sense	S6	A24		B24	S13	Imon [3]
PWOK	S7	A25		B25	S14	VINOK

Notes:

1. Regular 50-pin card edge connector Table 2-2. The description is based on the receptacle connector's perspective.
2. High power connector listed in Table 2-2. The description is based on the receptacle connector's perspective.
3. Imon output signal current information based on 12V main output's loading condition, please see details in M-CRPS Section 9.5 Imon Signal (Output).
4. A1 pin shall support bi-directional serialization mechanism described in M-CRPS Section 12.7 Data & Sideband Serialization Interface (DSSI).
5. A0 pin shall be connected to an ADC input in the secondary side MCU to support up to 6 SMBus addresses, levels are describ ed in M-CRPS Section 9.6.1 A0 Input Addressing.
6. This pin is dual purpose, for more information refers to M-CRPS Section 9.7 Remote Sense and Return Sense / PSKILL.

2.3. Temperature and Altitude Requirements

The power supply shall operate within all specified limits over the Top temperature range.

All airflow shall pass through the power supply and not over the exterior surface of th power supply.

Table 2-2 Environmental Requirements

ITEM	DESCRIPTION	MIN	MAX	UNITS
Top	Operating temperature range (100% loading)	-5	55	°C
Top_redundant	Operating temperature range (60% loading)	-5	60	°C
Tnon-op	Non-operating temperature range	-40	70	°C
Texit	Maximum exit air temperature		68	°C
Altitude	Maximum operating altitude (higher altitude than M-CRPS spec)		5000	Meter

Note: Under normal conditions, the exit air temperature shall be less than 65 °C. 68°C is provided for absolute worst case conditions and is expected only to exist when the inlet ambient reaches 55°C. The system level fan speed control shall be able to influence the system fans and power supply fans to increase fan speeds, as necessary, to maintain cooling up to 14 CFM total flow.

The power supply must meet UL enclosure requirement for temperature rise limits. All sides of the power supply with exceptio n to the air exhaust side must be classified as "Handle, knobs, grips, etc. held for short periods of time only."

2.4. LED Marking and Identification

The power supply shall use a bicolor LED, Green & Amber. Below table shows the LED states for each power supply operating state and the LED's wavelength characteristics. The LEDs shall be controlled by Firmware to easily change blink rates and colors for the different states using update to the PSU secondary side Firmware's configuration file as defined in M-CRPS spec Section 12.8.3.1 LED Behavior Configuration Block. This allows the M-CRPS to be reprogrammed to match different customer's LED state requirements. The default LED settings are listed on below table for Default LED definition.

LED Characteristics

Color	Nominal λd Wavelength	Luminosity (cd/m^2)	Units
Green	525	500 +/-100	nm
Amber	590	500 +/-100	nm

Notes:

For luminosity measurements please refer to Supplemental Material N Luminosity Measurements in M-CRPS spec

Table 2-2 Default LED Definition

Power Supply Condition	**LED State**
Output ON and OK	GREEN
No AC power to all power supplies	OFF
PSU standby state AC present / Only 12VSB on	1 Hz Blink GREEN
Power supply is cold standby state or always standby state as defined in the Cold Redundancy section of the CRPS Common Requirements Specification	1 Hz Blink GREEN
AC cord unplugged, or AC power lost; with a second power supply in parallel still with AC input power.	AMBER
Power supply critical event causing a shutdown; failure, over current, short circuit, over voltage, fan failure, over temperature	AMBER
Power supply warning events where the power supply continues to operate; high temp, high power, high current, slow fan.	1 Hz Blink Amber
Power Supply Firmware updating	2 Hz Blink Green

3. AC Input Requirements

3.1. AC Inlet Connector

The AC input connector shall be an IEC 320 C20 power inlet. This inlet is rated for 16A / 250VAC. Refers to M-CRPS specification for additional requirements.

3.2. Input Voltage Specification

The power supply must operate within all specified limits over the following input voltage range. In all operating condition shall not cause damage to the power supply, including a blown fuse. Refer to M-CRPS specification for additional requirements.

PARAMETER	MIN	RATED	VMAX	Startup VAC	Power Off VAC
Voltage (Wide range)	90 Vrms	100-127 Vrms 200-240 Vrms	264 Vrms	84Vrms – 90Vrms	79Vrms – 85Vrms
Frequency	47 Hz	50/60	63 Hz		
PARAMETER	**MIN**	**RATED**	**VMAX**	**Startup Vdc**	**Power Off Vdc**
DC240 input	192Vdc	240Vdc	310Vdc	180-192Vdc	175-187Vdc
Hysteresis for DC240				5Vdc	5Vdc

Notes:

1. With DC input, the power supply must work normally when the DC input positive terminal is connected to the either pole, AC “Line L” or AC “Neutral N”, of the inlet connector.
2. Start up and Power Off voltage levels must always have a 5VRMS hysteresis.

Application of an input voltage below the power off threshold shall not cause damage to the power supply, including a blown fuse

3.3. AC Line Fuse

The power supply shall have one line fused in the **single line fuse** on the line (Hot) wire of the AC input. The line fusing shall be acceptable for all safety agency requirements. The input fuse shall be a fast blow type. AC inrush current shall not cause the AC line fuse to blow under any conditions. All protection circuits in the power supply shall not cause the AC fuse to blow unless a component in the power supply has failed. This includes DC output load short conditions.

3.4. AC Inrush

AC line inrush current shall not exceed **35A peak** for up to 10ms, after which, the input current should be no more than the specified maximum input current. The peak inrush current shall be less than the ratings of its critical components (including input fus e, bulk rectifiers, and surge limiting device). The power supply must meet the inrush requirements for any rated AC voltage, during turn on at any phase of AC voltage, during a single cycle AC dropout condition as well as upon recovery after AC dropout of any duration, and over the specified temperature range (Top).

4. Efficiency, iTHD, Power Factor

The following table provides the required minimum efficiency level/Power factor/Input current THD at various loading conditions. These are provided at four different load levels; 100%, 50%, 20%, and 10%. Output shall be load according to the proportional loading method defined by 80 Plus. Refer to M-CRPS specification for additional requirements. The power supply should meet 80Plus Titanium Internal 230Vac criteria.

Table 4-1 Efficiency, PF, iTHD Requirement

Load (%)	Input 115Vac			Input 230Vac		
		Power Factor	Efficiency (%)		Power Factor	Efficiency (%)
10		At least 0.92	At least 88		At least 0.92	At least 90.0
20		At least 0.96	At least 90		At least 0.96	At least 94.0
50		At least 0.98	At least 92		At least 0.98	At least 96.0
100		At least 0.99	At least 90		At least 0.99	At least 92.5

Note: At no load or at sleep state (100-240Vac input), the power supply should consume less than 10W (with fan) when measured by power meter (with filtering on).

Note*:* The power supply should pass all efficiency measurements by 0.2% to guarantee design margins for production.

% input current	0%	5%	10%	20%	50%	100%
Current iTHD (230Vac 50hz)	< 40%	< 25%	< 10%	< 7.5%	< 5.0%	< 4.0%
Current iTHD (120Vac 60hz)	< 40%	< 25%	< 10%	< 7.5%	< 5.0%	< 4.0%

Notes:

1. Tested according to Generalized Internal Power Supply Efficiency Testing Protocol. This is posted at https://www.clearesult.com/80plus/sites/80plus/files/2023-02/Generalized%20Test%20Protocol_Rev%206.7.2_Final.pdf
2. No single harmonic should exceed 80% of the total harmonic distortion.
3. iTHD validation should be done by setting the load from No Load to 100% Load (or 100% to No Load) in steps of 5%. At each point iTHD and Input Current should be recorded in addition to Input Voltage, Power Factor, and Output Load Current etc. Then a graph s hould be plotted for iTHD vs Input Current.
4. iTHD should also be validated at each design stage at 100Vac / 60 Hz and 200Vac / 50Hz.

5. DC Output Specification

5.1. Output Power / Current for Single PSU

The following table defines the minimum power and current ratings. The power supply must meet both static and dynamic voltage regulation requirements for all conditions. Refer to M-CRPS specification for additional requirements.

Table 5-1 Minimum Load Rating

Parameter	Min	For safety rating	PL1 Max. Continuous[4]	PL2[2] (%)	PL3[3] (%)	PL4 (%)[7]
12V main (219.1-240Vac rated. DC240V rated), 3200W	0	266.6	266.6 A	306.6A (115%)	413.2A (155%)	439.9A (165%)
12V main (207.1-219Vac rated), 3000W	0	250	250A	306.6A (115%)	413.2A (155%)	439.9A (165%)
12V main (200-207Vac rated), 2900W	0	241.6	241.6	306.6A (115%)	413.2A (155%)	439.9A (165%)
12V main (100-127Vac rated), 1400W	0	116.6	116.6A	134A (115%)	180.7A (155%)	192.4A (165%)

12Vstby	0.0	4A (higher than the 3A noted on the M-CRPS spec)	4A	4.53A (113%)	NA	NA
Peak Ride Through			NA	20 s	10ms	20 us
Peak Response Ride Through			NA	Dependent on OTW	5ms	80 us
Total Peak Time			NA	>=20s	15ms	100 us
Duty Cycle			NA	Not defind	25%	
PMBus STATUS Register Trigger Method			Moving Average: PL2 Peak ride through (20 s)	OTW	Timer: PL3 Peak ride through (10 ms)	Timer: PL4 Peak ride through (20 us)

The power supply shall be stable operating at any load point from rated power up to the peak load.

Notes:

1. 12VSB must provide 6.0A with two power supplies in parallel. The Fan may work when Standby current >1.5A and the ambient temperature is higher than 35C.
2. PL2 Peak load duration is based on thermal sensor and assertion of the SMBAlert# signal. Minimum peak power duration shall be 20 seconds without asserting the SMBAlert# signal at maximum operating temperature. The power supply shall support 115% of its rating; however any load between 101% to 115% is considered PL2 level for definition purposes. PL2 level support shall be 115% of the maximum output rating at any given input voltage and change dynamically based on the declared input voltage ranges.
3. PL3 peak duty cycle shall be 25%; 4msec at PL3 / 12msec at PL2 Peak. Applying a PL3 peak load must not trip the SMBAlert# signal. The maximum length of time the PL3 peak must be supported is based on the SMBAlert# signal asserting. The PSU must support this peak load for 5msec after SMBAlert# asserts. The power supply shall support 155% of its rating; however any load between 116% to 155% is considered PL3 for timer start purposes. If this peak load pattern continues indefinitely the power supply shall protect itself by tripping its thermal sensor. PL3 level support shall be 155% of the maximum rating using the highest voltage of low and high line as reference.
4. When applying a repetitive or non-repetitive transient load profile, the effective Iavg load must never exceed the maximum current rating as stated on PL1.
5. Refer to *Section 8.1.2 Averaging Mechanism* for more details about the averaging algorithm, accuracy, and timing.
6. This power supply is intended for pass-through applications using a power shelf and bus bar in the rack, and a Hot Swap Controller inside the power supply module.
7. The power supply shall support 165% of its rating; however any load between 156% to 165% is considered PL4 for timer start purposes. PL4 level support shall be 165% of the maximum rating using the highest voltage of low and high line as reference.

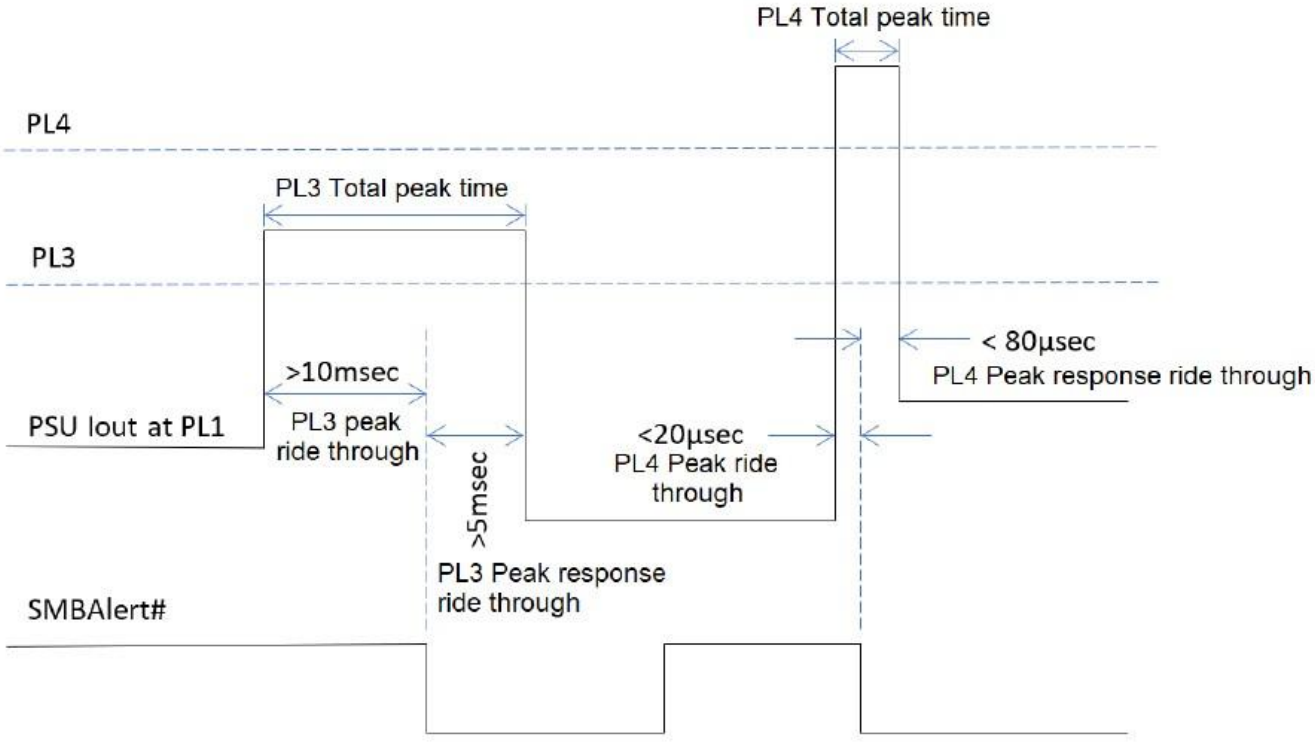


Figure 5-1 PSU Peak power timing example

Notes:

1. Clear command shall be sent to the M-CRPS to de-assert SMBAlert# prior to a PL4 event to be able to send the notification to the system when PL4 event happens by asserting SMBAlert# back again.

5.2. Timing Requirements

Refer to M-CRPS specification for timing requirements. For Tvout_rise timing, it would have a tightened timing of Min 10ms, max 20ms, yet still within the M-CRPS specification. For other timing requirements, please refer to M-CRPS specification.

Table 5-2 Timing Requirements

ITEM	DESCRIPTION	MIN	MAX	UNITS
Tvout_rise	Output voltage rise time for 12V from 10% to within regulation limits.	10	20	ms
Tvsbout_rise	Output voltage rise time for 12VSB from 10% to within regulation limits.	10	70	ms
Tvout_holdup (45-100% load)	Time 12V output voltage stay within regulation after loss of AC with 45-100% load (180Vac-264Vac 47-63hz, 192-310Vdc).	11		ms
Tvout_holdup (22.5- 45% load)	Time 12V output voltage stay within regulation after loss of AC with 22.5-45% load (180Vac-264Vac 47-63hz, 192-310Vdc).	20		ms
Tvout_holdup (11.3- 22.5% load)	Time 12V output voltage stay within regulation after loss of AC with 11.3-22.5% load (180Vac-264Vac 47-63hz, 192-310Vdc).	40		ms
Tvout_holdup (0-11.3% load)	Time 12V output voltage stay within regulation after loss of AC with 0-11.3% load (180Vac-264Vac 47-63hz, 192-310Vdc).	80		ms
Tpwok_holdup	Delay from loss of AC input (180Vac-264Vac 47-63hz, 192-310Vdc) to de-assertion of PWOK	10/19/39/79 depending on loading, refer		ms

		to Tvout_holdup		
T12VSB_holdup	Time the 12VSB output voltage stays within regulation after loss of input.	70		ms
Tpwok_off	Delay from PWOK de-asserted to output voltages dropping out of regulation limits.	1		
Holdup_decay	Holdup Duration to 10.5Vdc (Slope decay from 11.40V to 10.50V)	1	10	ms

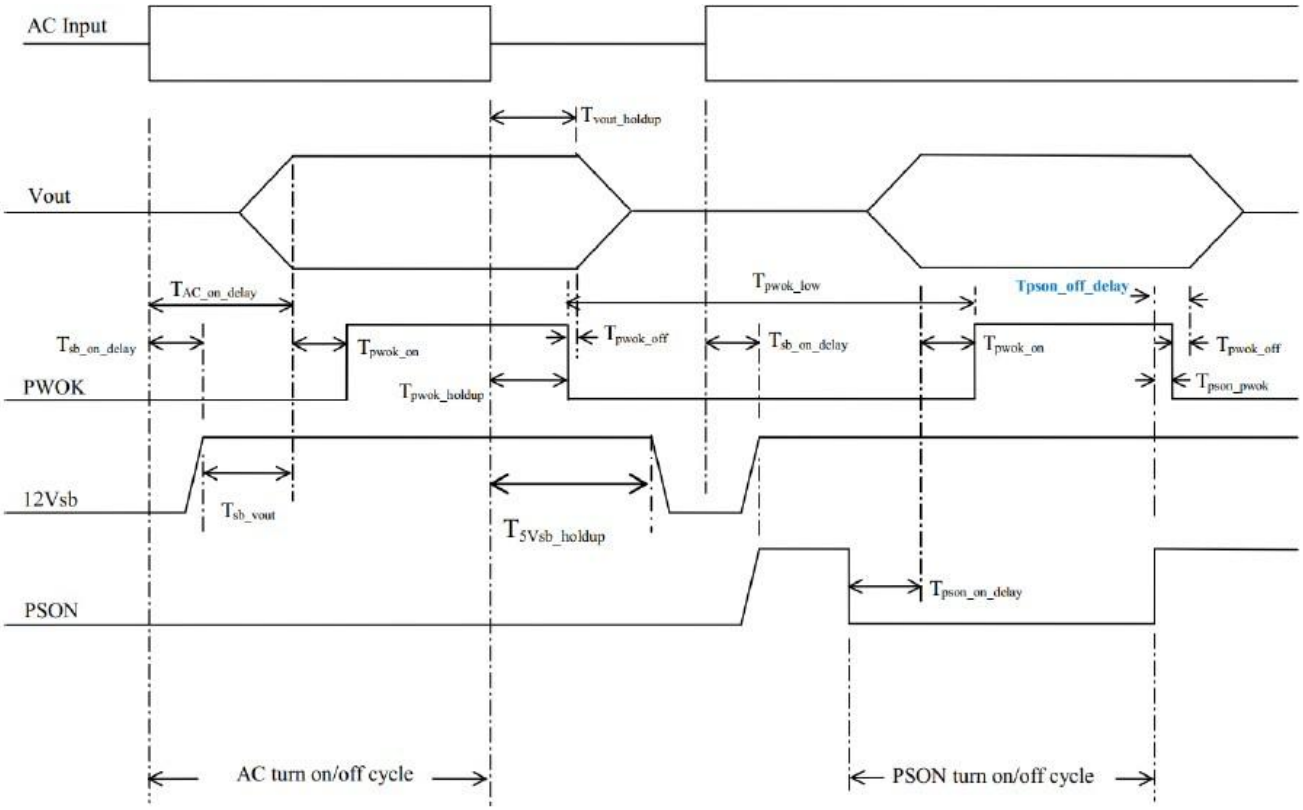


Figure 5-2 Turn on/off Timing (Power Supply Signals)

5.3. Output Voltage Setpoint

The main 12V voltage Output voltage set point when the PSU is standalone shall be 12.2V ±40mV at 50% loading condition and vary from 12.06V at 100% loading condition to 12.34V at 0% loading condition measured at the mating connector. The droop bandwidth shall be equivalent to the +12Vmain voltage regulation loop.

The 12Vsb Voltage calibration setpoint shall be 12.075V±40mV at 1.5Amps load (during power supply standby). During PSON, the 12Vsb will transfer switch to 12Vmain as described in Section 7.17 12V Internal Transfer Switch of M-CRPS spec.

Output voltages are measured at the fixture connector pin immediately mating with the power supply output connector.

5.4. Voltage Regulation and Dynamic Load

The power supply output voltages must stay within the following voltage limits when operating at steady state and dynamic loading conditions. These limits include the peak-peak ripple/noise. These shall be measured at the output connectors. The output voltages shall remain within limits specified for the step loading and capacitive loading specified in the table below. The load transient repetition rate shall be tested between 50Hz and 5 KHz at duty cycles ranging from 10%-90%. The load transient repetition rate is only a test specification. The Δ step load may occur anywhere within the MIN load to the MAX load conditions.

Table 5-3 Voltage Regulation Limit

PARAMETER	MIN (Vdc)	NOM (Vdc)	MAX (Vdc)	Slew Rate (A/μsec)	Test capacitive Load (μF)
+12V (100% step load)	+11.04	+12.20	+12.96	2.5	3300
+12V (70% step load)	+11.28	+12.20	+12.72	2.5	4400
+12V (60% step load)	+11.16	+12.20	+12.84	2.5	1000
+12V (60% step load)	+11.28	+12.20	+12.84	2.5	1x 2,200
+12V (60% step load)	+11.40	+12.20	+12.84	2.5	3x 2,200
+12V Static load	+12.06	+12.20	+12.34		
+12VSB (1A step)	+11.04	+12.20	+12.96	1	1000
+12VSB Static Load	+11.65	+12.20	+12.35		

Note:

1. For 100% step dynamic condition it shall be tested from 5% to 105% loading.
2. For step loading condition +12V minimum loading is 5% of rated current and the step can be anywhere between 5% of rated current to max load. E.g., if the 100% load rated current of the power supply is 108 Amperes, then the minimum loading shall be 5.4 Amperes. If two power supplies are in parallel, then each power supply shall have 5% as minimum loading condition.
3. The capacitor type used for this test shall be Aluminum Electrolytic.
4. The voltage measurement shall be done at the output of the power supply.
5. Conditions in this table are for system designers to determine voltage limits under different external capacitance for various dynamic load steps.
6. When there is not sufficient min load, the power supply should not protect or shutdown or damage during dynamic or step load. However, the output voltage regulation requirements can be temporary be exceeded.

Additionally, the power supply shall support the transient conditions stated in below table.

Table 5-4 Additional transient load requirements

Profile	Starting Load		End Load		Step Size %	Frequency Hz	Duty Cycle %	Load Slew Rate A/us
	%	Mode	%	Mode				
A[3]	70	CC	170	CC	100	100	20	2.5
B[3]	85	CR	170	CC	85	40	8	2.5
C	90	CC	140	CC	50	40	20	2.5

D[3]	77	CR	165	CC	88	28	40	2.5
E[4]	2	CC	52	CC	50	50	50	2.5
F	5	CC	105	CC	100	50	50	2.5
G4	0	CC	50	CC	50	50	50	2.5

Notes:

1. CC = Constant Current, CR = Constant Resistance.
2. For all test conditions the regulation limits are +-8% with 3,300uF.
3. The intent of this profile is to trigger the constant current mode of the M-CRPS.
4. Starting load below 5% is intended to cross the threshold current to turn ON the output synchronous rectifiers when the transient load is applied.

5.5. Capacitive Loading

The power supply shall be stable and meet all requirements with the following capacitive loading ranges.

Table 5-5 Capacitive Loading Conditions

Output	MIN	MAX	Units
+12VSB	270	4700	μF
+12V	2000	70000	μF

Note: The minimum capacitive load on 12V output is required to hold regulation during cold redundancy mode PSU failures and PSU hot swapping.

5.6. Ishare bus

This is an analog signal that is used to insure current sharing of the main output between redundant power supplies. It also represents the amount of the loading on the power supply (or supplies). The Host system may use this signal to monitor power supply loa ding. Please see M-CRPS spec for additional requirements for Ishare bus and the measurement.

Table 5-6 Ishare Voltage

% of max. current capacity	Min (Vdc)	Typical (Vdc)	Max (Vdc)
0	0.000	0.000	0.482
5	0.318	0.400	0.482
50	3.900	4.000	4.100
100	7.880	8.000	8.120
200	15.840	16.000	16.160

5.7. Imon Signal

The power supply should provide the Imon signal for fast output current reading. The signal should follow the below parameters

Parameter Description	Min	Typ	Max	Units	

% Base Tolerance on Imon - ≥10% to 140% Load	-1%		1%	%	
% Base Tolerance on Imon - >140% to 200% Load	0%		0%	%	
% Read Tolerance on Imom - ≥10% to 140% Load	-1%		1%	%	
% Read Tolerance on Imom - >140% to 200% Load	-2%		2%	%	
140% Output Current		373.24		A	
Full Scale (200%) Current Source Output		2		mA	
Imon Accuracy vs % Loading	**Iout (A)**	**Iout error (A)**		**Imon (mA) -Current Source Output**	
% Load	**Typ**	**Min**	**Max**	**Min**	**Max**
10%	26.66	-4.00	4.00	0.079	0.121
20%	53.32	-4.27	4.27	0.178	0.222
30%	79.98	-4.53	4.53	0.277	0.323
40%	106.64	-4.80	4.80	0.376	0.424
50%	133.3	-5.07	5.07	0.475	0.525
60%	159.96	-5.33	5.33	0.574	0.626
70%	186.62	-5.60	5.60	0.673	0.727
80%	213.28	-5.87	5.87	0.772	0.828
90%	239.94	-6.13	6.13	0.871	0.929
100%	266.6	-6.40	6.40	0.97	1.03
110%	293.26	-6.67	6.67	1.069	1.131
120%	319.92	-6.93	6.93	1.168	1.232
130%	346.58	-7.20	7.20	1.267	1.333
140%	373.24	-7.46	7.46	1.366	1.434
150%	399.9	-8.00	8.00	1.465	1.535
160%	426.56	-8.53	8.53	1.564	1.636
170%	453.22	-9.06	9.06	1.663	1.737
180%	479.88	-9.60	9.60	1.762	1.838
190%	506.54	-10.13	10.13	1.861	1.939
200%	533.2	-10.66	10.66	1.96	2.04

6. Protection

6.1. Output Over Voltage Protection:

The power supply over voltage protection shall be locally sensed. The power supply shall shutdown and latch off after an over voltage condition occurs. This latch shall be cleared by toggling the PSON signal or by an AC power interruption. Below table contains the over voltage limits. The values are measured at the output of the power supply's connectors. The voltage shall never exceed the maximum levels when measured at the power pins of the power supply connector during any single point of fail. The voltage shall never trip any lower than the minimum levels when measured at the power pins of the power supply connector.

Table 6-1 Over Voltage Limits

Output Voltage	MIN (V)	MAX (V)
+12 V	13.6	14.5
+12VSB	13.6	14.5

6.2. Output Under Voltage Protection

The power supply output under voltage protection shall be locally sensed. The power supply shall shutdown and latch off after an under voltage condition occurs for longer than 1 second delay. This latch shall be cleared by toggling the PSON signal or by an AC power interruption. Below table contains the over voltage limits. The values are measured at the output of the power supply's connectors.

Table 6-2 Under Voltage Limits

Output Voltage	MIN (V)	MAX (V)	Delay
+12 V	9.5	10.0	Delay at least 1 second
+12VSB	9.5	10.0	Delay at least 1 second

6.3. Over Thermal Protection

The power supply will be protected against over temperature conditions caused by loss of fan cooling or excessive ambient temperature. In an OTP condition the PSU will shutdown. When the power supply temperature drops to within specified limits, t he power supply shall restore power automatically, while the 12Vsb remains always on. The OTP circuit must have built in margin such that the power supply will not oscillate on and off due to temperature recovering condition. The OTP trip level shall have a minimum of 4°C of ambient temperature margin.

6.4. Short Circuit Protection

All outputs (including output signals) shall be protected and into latch off (except 12Vsb rail) mode so that no damage occurs to the power supply under a shorted output condition i.e. short outputs to GND or short 12V and 12Vsb each other . This latch shall be cleared by toggling the PSON signal or by an AC power interruption.

12Vsb should be protected and into auto-restart mode. No damage occurs to the power supply under a shorted output condition, and should be output normally after shorted output released.

The total average input power dissipation should be less than 3W during auto-restart mode of 12Vsb rail.

6.5. Over Current Protection and Over Power Protection (OCP & OPP)

Protection circuits inside the power supply shall cause only the power supply's main outputs to shutdown. If the power supply latches off due to a protection circuit tripping, an AC cycle OFF for 10 seconds and a PSON cycle HIGH for 1 second shall be able to reset the power supply.

The power supply shall have current limit to prevent +12 V outputs from exceeding the values shown in below table. The 12V current limits are exceeded, the power supply shall be delayed according requirements before shutting down and latch

with no damage occur to power supply. The latch will be cleared by toggling the PSON signal or by an AC power interruption. The power supply shall not be damaged from repeated power cycling in this condition.

For purposes of definition, the operational range (over the specified time segment per Figure 8-6 PSU Output Current vs. Time) of the power supply has been divided up into 4 categories. The graph is intended to provide an illustrative means of describing PSU regulation & protection behaviors based on time vs. load. It does not capture tolerances and or programmable aspects such as assertion thresholds and timings.

- <100% Load: This load range represents the sub 100% loading area of the PSU. The voltage regulation limits, slew rate and capacitance are called out in this specification.
- Extended Voltage Regulation: This load range represents load step levels >50% to ≤ 100%the PSU. Depending on the size of the load step and starting point, will dictate the regulation range the PSU shall comply with Table 7.5 Transient load requirements.
- Constant Current: This load range represents the PSU transitioning from a voltage controlled current source to a fixed current source. This mode of operation is considered a protection mode, for which the PSU shall limit its current to a fixed value.
- Primary Power Limit: PSU shall contain a primary pulse by pulse current / power limit set at the equivalent output current levels located in Table 8-3 below. Upon entering this range, the PSU shall limit the power until such time as secondary constant current has been asserted.

Table 6-3 PSU vs. Load Behaviors – Constant Current and Primary Power Limit

Specification	Description	Min	Typ	Max	Units
Initial Constant Current Set Point	Value represents the constant current set point of the PSU. This set point represents the output current that the PSU will clamp its output to.	157.5	160	162.5	(% of full load rating)
Constant Current Level Drift	Value represents the amount of change in the output current once it is clamped to its set point value. This is measured over a 5ms time period.			+/- 2.5	(% of full load rating)
Constant Current Assertion Time	PSU shall not transition to constant current mode in less time than the minimum time specified. This time is used to establish the amount of time it takes the PSU output to transition from being a voltage controlled current source to a fixed constant current source.	2		3	ms
Constant Current Settling Time	The amount of time starting from constant assertion to the PSU output current reaching the initial constant current set point. Measurement made with minimum output capacitance under section 3.4	200		6000	us
Transition Limits Constant Current to Constant Voltage	Upon the PSU clamping its output current to its fixed value, the criteria for exiting constant current mode shall be the load falling below the clamped output current level. During this transition the PSU shall maintain the extended output voltage regulation.			Refer to M-CPRS spec Section Table 7-5 Transient load requirements at the location referred to as regulation limits.	
Primary Power Limit	PSU shall contain a primary pulse by pulse current / power limit set at the equivalent output current levels located to the right.	170		180	(% of full load rating)

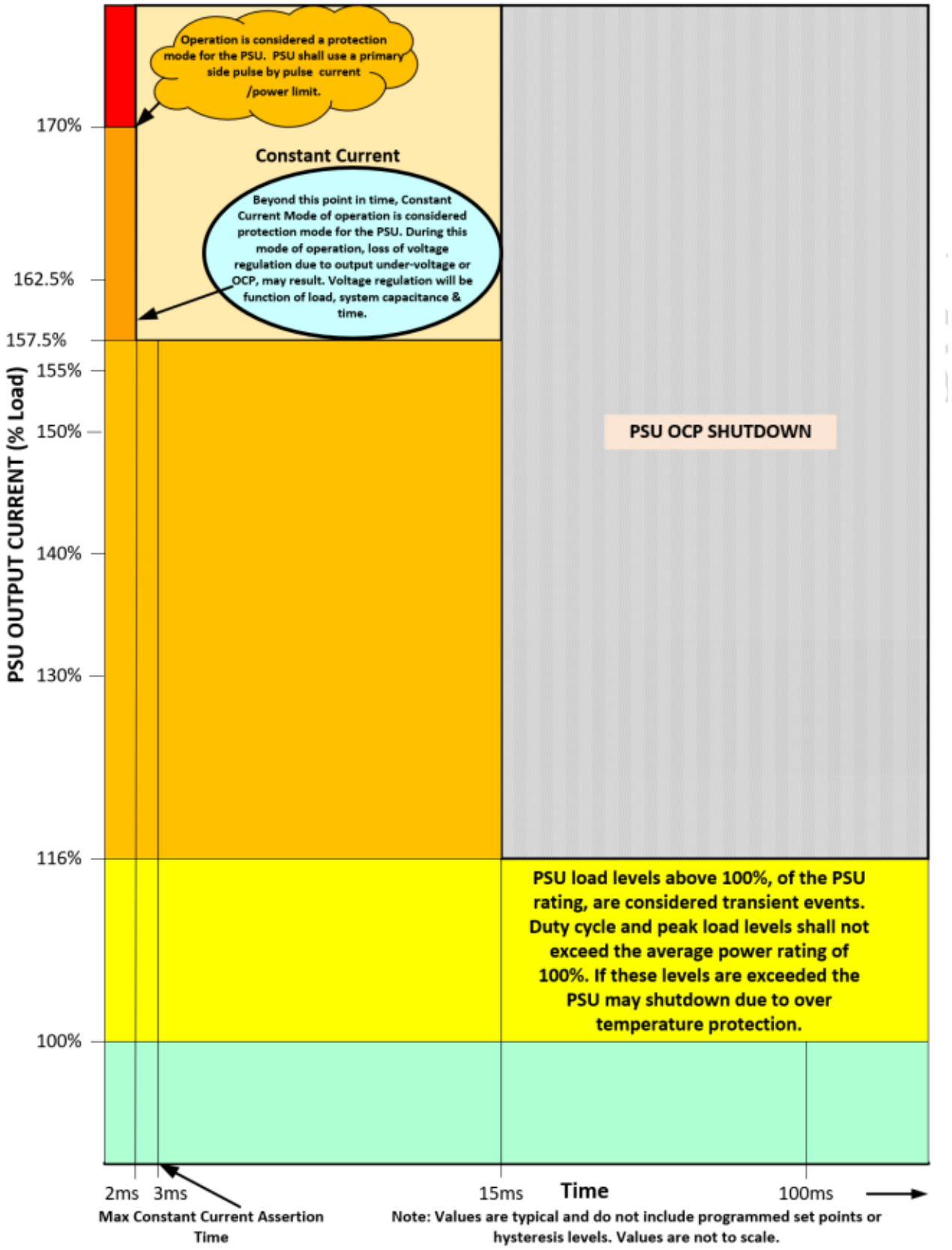


Figure 6-1 PSU output Current vs Time

6.5.1. Constant Current during Start Up into Overcurrent Condition

In an event when output current exceeds constant current thresholds defined in Table 8-3 PSU vs. Load Behaviors – Constant Current and Primary Power Limit, the power supply shall go into constant current mode. In the event of an overcurrent start up condition, in which PWOK does not assert and the start condition is valid the PSU shall issue an OC_FAULT, the OCWPL1, OCWPL3 and the under - voltage protection (UVP) shall remain disabled. In an overcurrent startup condition, in which PWOK is asserted before the 495ms window has expired, OCWPL1, OCWPL3 and Vout_UV shall be enabled before the PSU is Turned ON.

The reporting of status register related with over current conditions and Status Word are as shown in the flowchart shown in Figure 6-2 PSU Start up in to Over Current Condition.

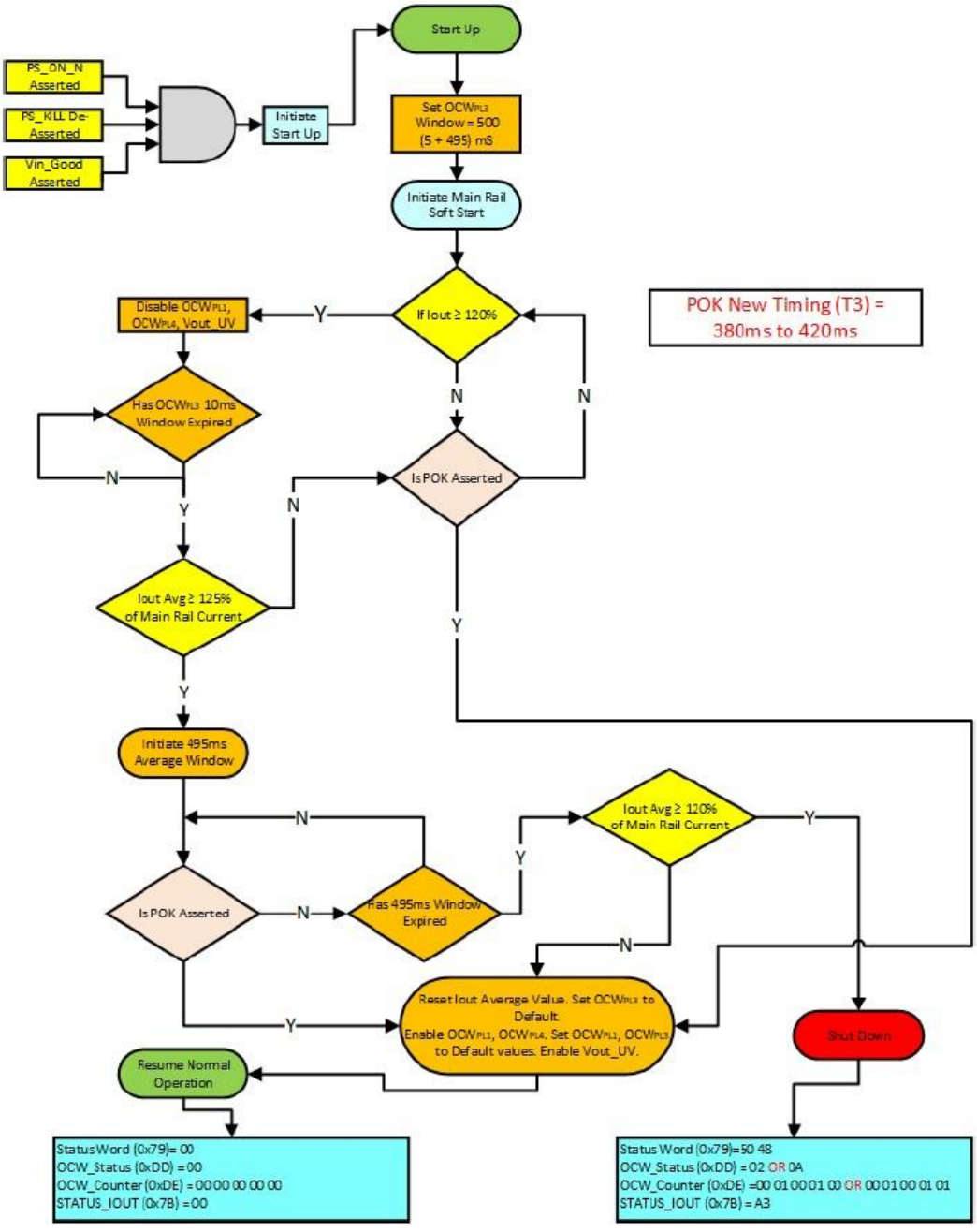


Figure 6-2 PSU Start up in to Over Current Condition

6.5.2. Fast Output Current Sensing for Fast Over Current Warning

The power supply shall have a circuit to quickly assert the SMBAlert# signal when the output current exceeds the over power protection threshold in the PSU. The SMBAlert# signal must always assert before the overpower protection threshold is exceeded. SMBAlert# must always latch for about 100msec before being released. See M-CRPS spec for the OCW and OCWPL1, OCWPL2, OCWPL3, OCWPL4 functions.

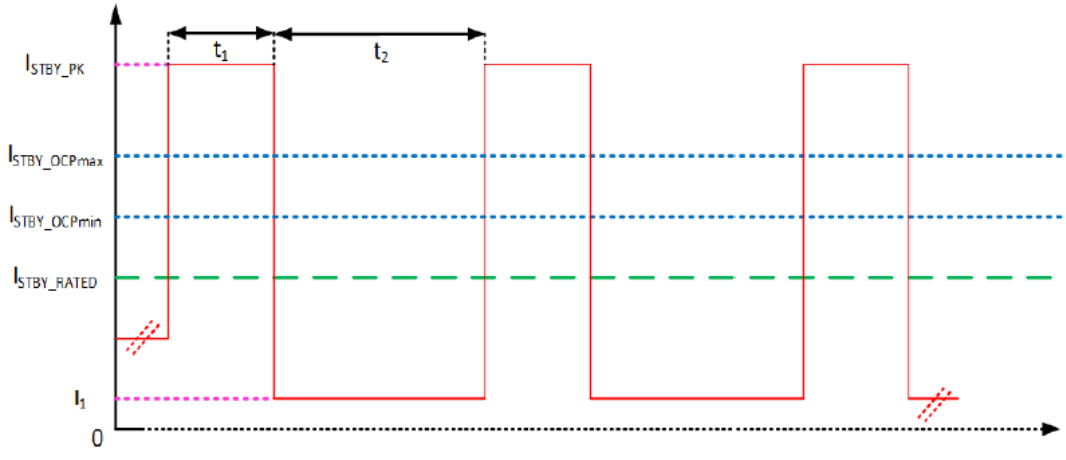
Table 6-4 3200W, 12.2V OCW Threshold Settings

HL Current (A) 266.6	LL Current (A) 116.6	High Line (HL) 180Vac-264Vac, 180-300Vdc			Low Line 90-140Vac		
		Maximum	Default	Minimum	Maximum	Default	Minimum
OCWPL1	Range Settings (A)	130% 346.58	130% 346.58	115% 306.59	130% 151.58	130% 151.58	115% 134.09
OCWPL3	Range Settings (A)	116% 309.26			125% 145.75		
OCWPL4	Range Settings (A)	156% 415.896			156% 181.896		
Short Circuit Protection	Range Settings (A)	170% 453.22			170% 198.22		

6.5.3. Auxiliary (Stand-by) Output Over Current Protection Behavior

12 VSB shall be protected under over current or shorted conditions so that no damage can occur to the power supply. 12Vsb over current protection should be in hiccup mode (with at least 500ms delay between hiccup) and OCP shall be delayed (see below table for details for delay timing) before shutting down. All outputs shall be protected so that no damage occurs to the power supply under a shorted output condition.

During initial power on, 12VSB output OCP is blanked for a period Tblank_startup to allow starting into rated load with the maximum external capacitive loading across the auxiliary (Stand-by) output. At end of the period Tblank_startup 12VSB output shall be in regulation if the 12VSB current is ≤ ISTBY_RATED.12VSB output shall support peaks currents (after start-up – 12VSB output in regulation) as defined in the diagram shown in figure below.



$D = t1/(t1+t2)$

$I_{STBY\_Average} = I_1 + D * (I_{STBY\_PK} - I_1)$

$I_{STBY\_Average} \leq I_{STBY\_RATED}$

Notes:

1. ISTBY_OCP= 4.8A(min) to 5.9A(max), ISTBY_PK= 6A (min) to 10A (max), t1=10ms (min) to 15ms (max), tblank_startup= 50 msec (min) to 70msec (max), t2=90(min) to 105ms(max)
2. If either the duration of ISTBY_ PK (> t1 AND / OR the peak current is > ISTBY_ PK, 12VSB output shall enter in OCP Mode.
3. Standby Output shall be capable of handling repetitive peaks as long as the Average value of 12VSB output current is (Averaged over 100ms- 120ms) ≤ ISTBY_RATED. If the Average during repetitive peak events exceeds ISTBY_RATED (-0%,+5%), but falls within the 12VSB OCP limits, 12VSB output shall enter in OCP Mode.
4. If the Average value of 12VSB output current exceeds ISTBY_RATED but is lower than value of ISTBY_OCP, 12VSB output is allowed to Droop, but should remain > UVP Limit and shall continue to operate without hazard OR may shut down due to OTP.
5. Each PSU design shall be tested by disabling OCP on 12VSB and setting the 12VSB load to 0.95 * Max Value of ISTBY_OCP limit of the design (which should be the maximum value of OCP obtained by WCEPTA) to ensure that the PSU satisfies either of the conditions defined in “1” above. This test is only a design validation test performed at each stage during development.

7. Regulatory Agency Requirements

The power supply must comply with all regulatory requirements for its intended geographical market as computer server of Information Technology Equipment.

The power supply must meet all regulatory requirements for the intended market at the time of manufacturing. This power supply shall have below certificates for ITE category:

1. UL/C-UL
2. CQC 5000m (higher than the 3000m requirement than the M-CRPS spec)
3. CB
4. CISPR32 Class A
5. FCC Class A
6. CE criteria B for power supply itself
7. RoHS
8. Efficiency 80plus Titanium Single Output
9. Immunity to meet ITE machine category on EN61000-4-X; IEC 61000-4-2/4-3/4-4/4-5/4-6/4-8/4-11
10. BSMI

Regulatory requirement:

Meet:

IEC/EN/UL 62368-1 Ed 3.0

IEC 61000-4-2:2008, IEC61000-4-3:2006/A1:2007/A2:2010, IEC 61000-4-4:2004/A1:2012

IEC61000-4-5:2017, IEC61000-4-6:2013, IEC61000-4-8:2009, IEC61000-4-11:2020

AS/NZS CISPR 32:2015 AMD: 2020 Class A

EMS EN55035

EN55032:2015/A11:2020 Class A

EN 61000-3-2-:2019+A1:2021

EN 61000-3-3:2013+A1:2019

ICES-003 issue 7, Class A

GB4943.1-2022

GB9254-2021

GB17625.1-2022

CNS 15598-1:2020

CNS 115936:2016(甲類)

CNS15663

LVD 2014/35/EU

EMCD 2014/30/EU

RoHS 2011/65/EU; 2015/863/EC

IEC 61984

The power supply itself meets class A with -6 dB margin of EMI limits for CE, FCC, CISPR tested with min. to full output resistance loading, and certificated with CE compliance.

The power supply, when installed in the system, shall meet immunity requirements specified in EN55032:2012 & EN55024:2010. Specific tests are to be EN61000-4-2, -3, -4, -5, -6, -8, and -11. The power supply must maintain normal performance within specified limits. Conformance must be designated with the European Union CE Marking. Specific immunity level requirements are left to customer requirements.

Note: The UUT must be warmed above 30 minutes with max load before run Conducted & Radiated Emission test in lab. The UUT must be verified with 20%, 50%, and 100% of max load (resistor) for main DC-DC output voltage & 12Vsb respectively when run Conducted & Radiated Emission, EMI, EMS, Harmonic test in lab.

7.1. Dielectric Strength testing

Each unit of production must pass a routine hi-pot test between primary to chassis ground in accordance with EN 62911, Table 1 test voltage for accessible parts connected to protective earth.

If a PSU is intended to be used in an ungrounded system, each unit of production must pass a routine hi-pot test between primary to chassis ground using the test voltage for accessible parts not connected to protective earth.

During DVT, PVT, mass production, all units must pass Hi-pot test: AC & DC voltage for

1. AC 3000V : primary to secondary, AC 1800V : primary to FG; (10mA, 1 minute)
2. DC 4242V: primary to secondary, DC 2500V: primary to FG. (10mA, 1 minute) Note: PCB layout must take meeting CCC 5000m into account.

7.2. Ground Continuity Testing

Each unit of production must pass a routine ground continuity test at 25 A for at least 1 s with less than 0.1 ohm from the

safety ground (third wire) input pin to the power supply chassis. Each unit must be marked to indicate it.

7.3. Leakage Current

The AC leakage current must be less than 0.625mA@264Vac, 1.25mA(rms) for sine wave, 1.7675mA (Peak) for Non-sine wave for IEC62368 @264Vac for a single power supply module. The PSU should pass the leakage current test for IEC62368 when tested with 4 PSU in redundant.

7.4. Surge Immunity

The power supply shall be tested with the system for immunity to AC Unidirectional wave as shown in the table below per EN 55035:2017/A11:2020, IEC 61000-4-5:2014+A1:2017.

The pass criteria include: No unsafe operation is allowed under any condition; all power supply output voltage levels to stay within proper spec levels; No change in operating state or loss of data during and after the test profile; No component damage und er any condition.

Table 7-1 Surge immunity requirements

Condition	Surge immunity (for EN55035)	Surge immunity (GR-1089)2,3
Line to ground (tested for design margin)	2.5kV	2.5kV for AC input
Line to line (tested for design margin)	1.5kV	2.5kV for AC input

Notes:

1. Margin test shall be conducted only during development.
2. Tests shall be conducted using 2Ω impedance for generator for both AC and -48Vdc Input PSUs as defined in GR-1089.
3. AC/DC Input PSUs - for Phase to Neutral, Phase to Ground, Neutral to Ground per requirement of GR1089 Table 4.2 items 20 (AC Power ports with SPD), items 23 (DC power ports).

The power supply shall comply with the limits defined in EN 55035:2017/A11:2020 with 500V margin using the IEC 61000-4-5:2014+A1:2017 test standard and performance criteria A defined in Annex B of CISPR 35.

8. Environmental Requirements

8.1. Temperature

Minimum start-up and operating ambient: -5°C

Maximum operating ambient: See Section 2.3 for operating requirements.

Non-operating ambient: -40°C to +70°C (Maximum rate of change of 20°C/hour)

8.2. Humidity

Operating: To 85% relative humidity (non-condensing)

Non-Operating: To 95% relative humidity (non-condensing)

NOTE: 95% relative humidity is achieved with a dry bulb temperature of 55°C and a wet bulb temperature of 54°C.

8.3. Altitude

Operating: to 5000 m

Non-operating: to 15200 m

8.4. Mechanical Shock

Non-operating: 50 G Trapezoidal Wave, Velocity change = 170 in. / sec. Three drops in each of six directions are applied to each of the samples

8.5. Random Vibration

Non-operating

Sine sweep:

5Hz to 500Hz @ 0.5gRMS at 0.5 octave/min; dwell 15 min at each of 3 resonant points; Random profile:

5Hz @ 0.01g²/Hz to 20Hz @ 0.02g²/Hz (slope up); 20Hz to 500Hz @ 0.02g²/Hz (flat); Input acceleration = 3.13gRMS; 10 min. per axis for 3 axis on all samples

8.6. Thermal Shock (Shipping)

Non-operating: -40°C to +70°C, 50 cycles, 30*C/min. * transition time * 15*C/min., duration of exposure to temperature extremes for each half cycle shall be 30 minutes.

9. Acoustic Requirements

See MCRPS spec for requirements

10. MTBF and Quality Data

The power supply shall have a minimum of (MTBF 400,000hours), 100% load duty cycle at 30 °C ambient, 45% RH ± 10%, 100% total output load, 100-240Vac input voltage, sea level operation per Telcordia Technologies Issue 3 or later, SR-332

11. Serial number:

CPR-3221-1M1: 32211YWWRMSSSS

12. Outline Drawing