ERP2U
(Entry Redundant Power 2U)

Power Supply Design Guide

A Server System Infrastructure (SSI) Specification
For 2U Rack Chassis Power Supplies

Version 1.0

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1 Purpose

This 2U Rack Power Supply Design Guide defines a common redundant power sub-system used in 2U rack mount servers. The power sub-system is made up of a cage and hot swap redundant power modules. This Design Guide covers the mechanical and electrical requirements of this power sub-system. The requirements of the individual hot swap modules are left open. This power sub-system may range from 350 to 600 watts and is used in a hot swap redundant configuration. The scope of this document defines the requirements for this power assembly. The parameters of this supply are defined in this design guide for open industry use.

2 Conceptual Overview

In the Entry server market, the bulk power system must source power on several output rails.

These rails are typically as follows:

- +3.3 V (optional from bulk supply)
- +5 V (optional from bulk supply)
- +12 V
- –12 V
- 5 V standby

NOTE

Local DC-DC converters shall be utilized for processor power, and will ideally convert power from the +12 V rail, however, they may also convert power from other rails.

The bulk power system may be a n+1 redundant power system or a non-redundant power system.

3 Definitions/Terms/Acronyms

Required	The status given to items within this design guide, which are required to meet SSI guidelines and a large majority of system applications.
Recommended	The status given to items within this design guide which are not required to meet SSI guidelines, however, are required by many system applications.
Optional	The status given to items within this design guide, which are not required to meet SSI guidelines, however, some system applications may optionally use these features.
Autoranging	A power supply that automatically senses and adjusts itself to the proper input voltage range (110 VAC or 220 VAC). No manual switches or manual adjustments are needed.
CFM	Cubic Feet per Minute (airflow).
Dropout	A condition that allows the line voltage input to the power supply to drop to below the minimum operating voltage.
Latch Off	A power supply, after detecting a fault condition, shuts itself off. Even if the fault condition disappears, the supply does not restart unless manual or electronic intervention occurs. Manual intervention commonly includes briefly removing and then reconnecting the supply, or it could be done through a switch. Electronic intervention could be done by electronic signals in the Server System.
Monotonically	A waveform changes from one level to another in a steady fashion, without intermediate retracement or oscillation.
Noise	The periodic or random signals over frequency band of 0 Hz to 20 MHz.
Overcurrent	A condition in which a supply attempts to provide more output current than the amount for which it is rated. This commonly occurs if there is a "short circuit" condition in the load attached to the supply.
PFC	Power Factor Corrected.
Ripple	The periodic or random signals over a frequency band of 0 Hz to 20 MHz.
Rise Time	Rise time is defined as the time it takes any output voltage to rise from 10% to 95% of its nominal voltage.
Sag	The condition where the AC line voltage drops below the nominal voltage conditions.
Surge	The condition where the AC line voltage rises above nominal voltage.
VSB or Standby Voltage	An output voltage that is present whenever AC power is applied to the AC inputs of the supply.
MTBF	Mean time between failure.
PWOK	A typical logic level output signal provided by the supply that signals the Server System that all DC output voltages are within their specified range.

4 *Mechanical Overview*

STATUS
Required (Optional)

Note: Some features are noted as optional in the enclosure drawing figure below. These features may be use in some chassis designs where only top access is allowed for the cage mounting.

The ERP2U is a power sub-system made up of a cage and redundant, hot swappable power supply modules. A mechanical drawing of the cage is shown below in Figure 1. This cage is intended to be mounted in the system and not redundant or hot swappable. The exterior face of the cage accepts hot swappable power supply modules. The cage distributes output power from the modules to a wire harness. Cooling fans may be located in the modules or cage. If the cooling fans are located in the cage, they may optionally be redundant. If the cage has redundant cooling the cage depth may be extended to allow for the additional series fan. A recommended power supply module solution is the SSI TPS power supply. Refer to www.ssiforum.org for the latest TPS Design Guide. The cage may have IEC inlet connector(s) and EMI filtering to distribute AC power to the power supply modules or the AC may plug directly into the modules. Three different configurations of the power sub-system are also shown below in Figure 1.

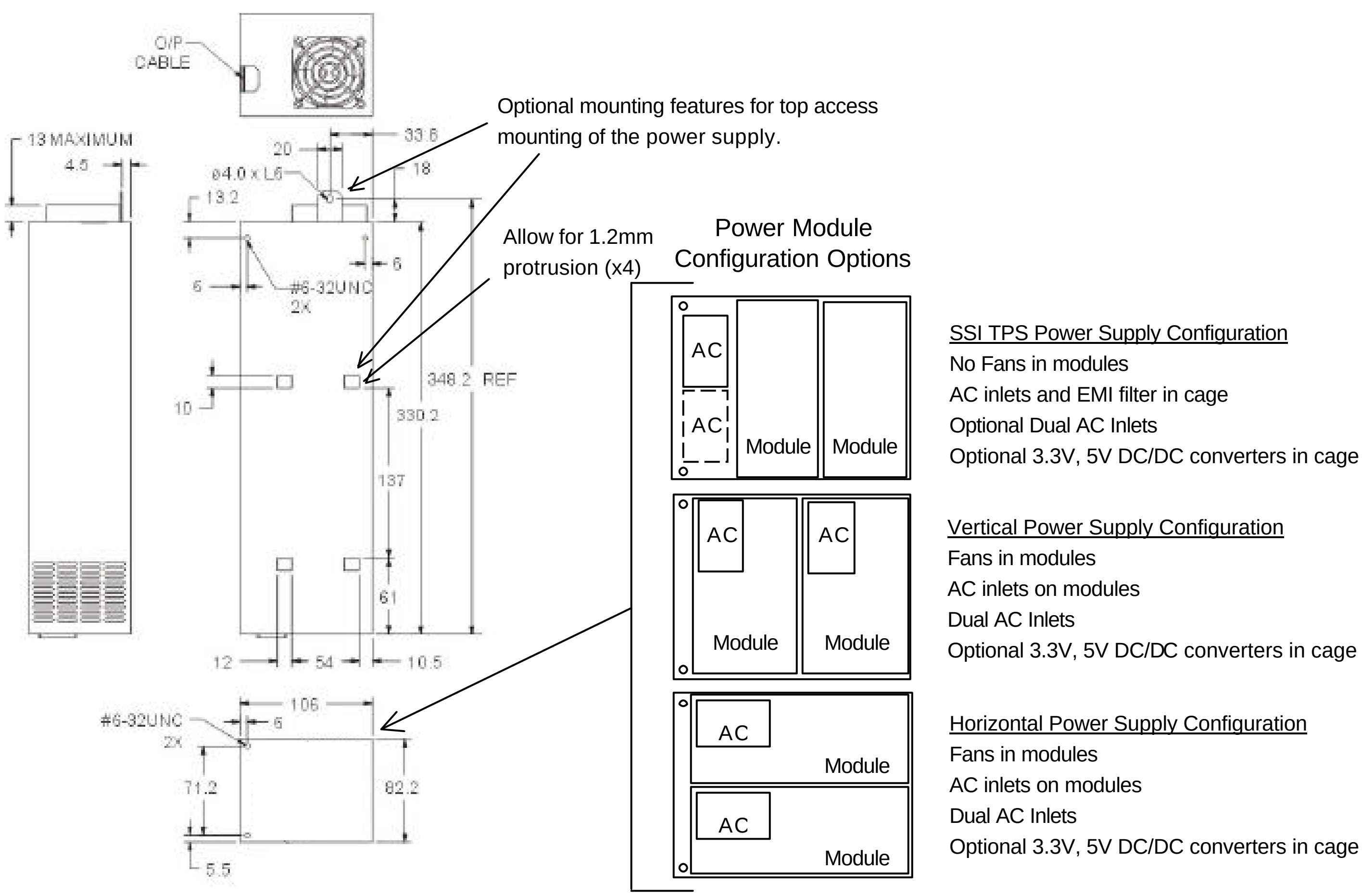
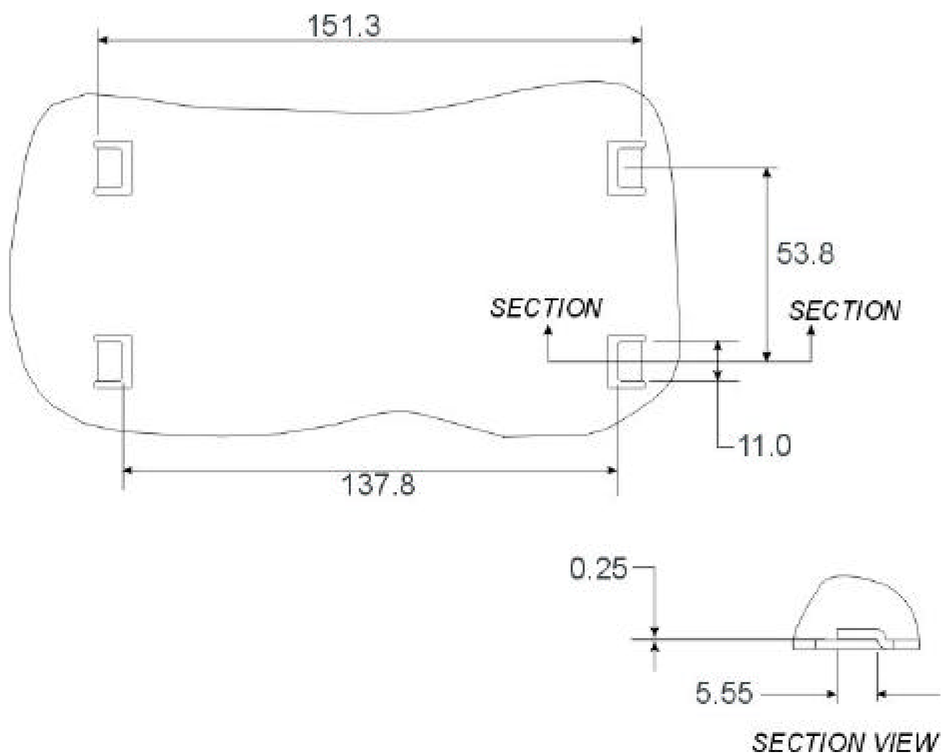


Figure 1: Enclosure Drawing

4.1 Optional Chassis Mounting Features

STATUS
Optional

The optional top access mounting method fastens to the system chassis via three mounting holes; two on the exterior face and one with the tab on the interior face of the cage. There are also four rectangular cutouts on the bottom of the cage. These are intended to drop over the top of rectangular features in the bottom of the chassis. This will help position the cage and secure it laterally. The features in the chassis are shown below as a reference.



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4.2 Airflow Requirements

STATUS
Recommended

The power supply cooling, whether in the cage or the module, shall have a two-speed fan(s) and provide cooling to both the supply and the system. During low-speed fan operation, the power supply must not exceed a noise level of 43 dBa measured at one meter on all faces. At low fan speed, the power supply shall provide a minimum of 6 CFM. At high fan speed, the power supply shall provide a minimum of 9 CFM.

4.2.1 Redundant Cooling

STATUS
Recommended

It is recommended that the power supply cooling be redundant. This means the cooling device is located in the hot swap power supply modules or there are redundant devices located on the cage.

4.3 Temperature Requirements

STATUS
Recommended

The power supply shall operate within all specified limits over the T_{op} temperature range. All airflow shall pass through the power supply and not over the exterior surfaces of the power supply.

Table 1: Thermal Requirements

ITEM	DESCRIPTION	MIN	MAX	UNITS
T_{op}	Operating temperature range.	0	50	°C
$T_{non\text{-}op}$	Non-operating temperature range.	-40	70	°C

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

5 AC Input Requirements

STATUS
Required

The power supply modules shall incorporate universal power input with active power factor correction, which shall reduce line harmonics in accordance with the EN61000-3-2 and JEIDA MITI standards.

5.1 AC Inlet Connector

STATUS
Required

The AC input connector shall be an *IEC 320 C-14* power inlet. This inlet is rated for 15 A/250 VAC. This connector may be located on the module or on the cage.

5.2 Redundant AC Inlets

STATUS
Recommended

The power supply assembly may have dual redundant AC inlets. The power supply shall be able to operate over its full, specified range of requirements with either or both AC input powered. If there is a loss of one AC inlet the power supplies shall continue to operate with no interruption of performance. It is required that all redundant power supply modules be present to support redundant AC inlets.

5.3 AC Input Voltage Specification

STATUS
Required

The power supply must operate within all specified limits over the following input voltage range. Harmonic distortion of up to 10% THD must not cause the power supply to go out of specified limits. The power supply shall operate properly at 85 VAC input voltage to guarantee proper design margins.

Table 2: AC Input Rating

PARAMETER	MIN	RATED	MAX	350W Max Rated Input Current	480W Max Rated Input Current
Voltage (110)	90 V_{rms}	100-127 V_{rms}	140 V_{rms}	5.5 A_{rms} [1]	7.0 A_{rms} [1]
Voltage (220)	180 V_{rms}	200-240 V_{rms}	264 V_{rms}	2.3 A_{rms} [1]	3.5 A_{rms} [1]
Frequency	47 Hz		63 Hz		

1 Maximum rated input current is measured at 100 VAC and 200 VAC.

5.4 Efficiency

STATUS
Required

The power supply shall have a minimum efficiency shown in the table below for the different power ratings. The power dissipated within the sub-system shall be kept to less than 150W. The sub-system shall meet the minimum efficiency at 100VAC and maximum output load.

Table 3: Efficiency

Output Power	Minimum Efficiency
350W	70%
480W	77%

5.5 AC Line Dropout

STATUS
Required

An AC line dropout is defined to be when the AC input drops to 0 VAC at any phase of the AC line for any length of time. During an AC dropout of one cycle or less the power supply must meet dynamic voltage regulation requirements over the rated load. An AC line dropout of one cycle or less shall not cause any tripping of control signals or protection circuits. If the AC dropout lasts longer than one cycle, the power supply should recover and meet all turn on requirements. The power supply must meet the AC dropout requirement over rated AC voltages, frequencies, and output loading conditions. Any dropout of the AC line shall not cause damage to the power supply. In the case of redundant AC inputs, the AC line dropout may occur on either or both AC inlet.

5.6 AC Line Fuse

STATUS
Required

The power supply shall incorporate one input fuse on the LINE side for input over-current protection to prevent damage to the power supply and meet product safety requirements. Fuses should be slow blow type or equivalent to prevent nuisance trips. 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.

5.7 AC Inrush

STATUS
Required

The power supply must meet inrush requirements for any rated AC voltage, during turn on at any phase of AC voltage, during a single cycle AC dropout condition, during repetitive ON/OFF cycling of AC, and over the specified temperature range (T_{op}). The peak inrush current shall be less than the ratings of its critical components (including input fuse, bulk rectifiers, and surge limiting device).

STATUS
Recommended

An additional inrush current limit is recommended for some system applications that require multiple systems on a single AC circuit. AC line inrush current shall not exceed 40 A peak. After one-quarter of the AC cycle, the input current should be no more than the specified maximum input current from Table 2.

5.8 AC Line Transient Specification

STATUS
Recommended

AC line transient conditions shall be defined as “sag” and “surge” conditions. Sag conditions (also referred to as “brownout” conditions) will be defined as the AC line voltage dropping below nominal voltage. Surge conditions will be defined as the AC line voltage rising above nominal voltage.

The power supply shall meet the requirements under the following AC line sag and surge conditions.

Table 4: AC Line Sag Transient Performance

AC Line Sag				
Duration	Sag	Operating AC Voltage	Line Frequency	Performance Criteria
Continuous	10%	Nominal AC Voltage ranges	50/60 Hz	No loss of function or performance
0 to 1 AC cycle	100%	Nominal AC Voltage ranges	50/60 Hz	No loss of function or performance
>1 AC cycle	>10%	Nominal AC Voltage ranges	50/60 Hz	Loss of function acceptable, self recoverable

Table 5: AC Line Surge Transient Performance

AC Line Surge				
Duration	Surge	Operating AC Voltage	Line Frequency	Performance Criteria
Continuous	10%	Nominal AC Voltages	50/60 Hz	No loss of function or performance
0 to ½ AC cycle	30%	Mid-point of nominal AC Voltages	50/60 Hz	No loss of function or performance

5.9 AC Line Fast Transient Specification

STATUS
Recommended

The power supply shall meet the *EN61000-4-5* directive and any additional requirements in *IEC1000-4-5:1995* and the Level 3 requirements for surge-withstand capability, with the following conditions and exceptions:

- These input transients must not cause any out-of-regulation conditions, such as overshoot and undershoot, nor must it cause any nuisance trips of any of the power supply protection circuits.
- The surge-withstand test must not produce damage to the power supply.
- The supply must meet surge-withstand test conditions under maximum and minimum DC-output load conditions.

6 DC Output Specification

These are the output requirements for the power supply assembly including cage and module.

6.1 Output Connectors

The power supply assembly shall have the following output connectors and wire harness configuration.

6.1.1 Required Baseboard power connector

Connector housing: 24-Pin Molex 39-01-2240 or equivalent

Contact: Molex 44476-1111 or equivalent

Table 6: P1 Baseboard Power Connector

Pin	Signal	18 AWG Color	Pin	Signal	18 AWG Color
1	+3.3 VDC	Orange	13	+3.3 VDC	Orange
2	+3.3 VDC	Orange	14	-12 VDC	Blue
3	COM	Black	15	COM	Black
4	+5 VDC	Red	16	PS_ON	Green
5	COM	Black	17	COM	Black
6	+5 VDC	Red	18	COM	Black
7	COM	Black	19	COM	Black
8	PWR OK	Gray	20	Reserved (-5 V in ATX)	N.C.
9	5 VSB	Purple	21	+5 VDC	Red
10	+12 V2	Yellow/Blue Stripe	22	+5 VDC	Red
11	+12 V2	Yellow/Blue Stripe	23	+5 VDC	Red
12	+3.3 VDC	Orange	24	COM	Black

6.1.2 Optional Processor Power Connector

This connector is needed for systems with dual processors at higher power levels.

Connector housing: 8-Pin Molex 39-01-2080 or equivalent

Contact: Molex 44476-1111 or equivalent

Table 7: Processor Power Connector

Pin	Signal	18 AWG color	Pin	Signal	18 AWG Color
1	COM	Black	5	+12 V1	Yellow/Black Stripe
2	COM	Black	6	+12 V1	Yellow/Black Stripe
3	COM	Black	7	+12 V1	Yellow/Black Stripe
4	COM	Black	8	+12 V1	Yellow/Black Stripe

6.1.3 Required Peripheral Power Connectors

Connector housing: Amp 1-480424-0 or equivalent

Contact: Amp 61314-1 contact or equivalent

Table 8: Peripheral Power Connectors

Pin	Signal	18 AWG Color
1	+12V2 (or +12V3)	Yellow
2	COM	Black
3	COM	Black
4	+5 VDC	Red

Note: The +12V power to peripherals may be split between 2 or 3 channel for the purpose of limiting power to less than 240VA.

6.1.4 Required Floppy Power Connector

Connector housing: Amp 171822-4 or equivalent

Table 9: P9 Floppy Power Connector

Pin	Signal	22 AWG Color
1	+5 VDC	Red
2	COM	Black
3	COM	Black
4	+12 V2 (or +12V3)	Yellow

Note: The +12V power to peripherals may be split between 2 or 3 channel for the purpose of limiting power to less than 240VA.

6.1.5 Optional Server Signal Connector

Connector housing: 5-pin Molex 50-57-9405 or equivalent

Contacts: Molex 16-02-0088 or equivalent (gold plated)

Notes:

It is recommended to use gold plated signal contacts on both the power supply connector and the baseboard header.

If the optional server signal connector is not used on the power supply the 3.3VRS and ReturnS lines shall be crimped into the contacts in the baseboard power connector.

If the server signal connector is unplugged, the power supply shall not shutdown or go into an over voltage condition.

Table 10: Server Signal Connector

Pin	Signal	24 AWG Color
1	I2C Clock	White/Green Stripe
2	I2C Data	White/Yellow Stripe
3	Reserved	NA
4	ReturnS	Black/White Stripe
5	3.3RS	Orange/White Stripe

6.2 Grounding

STATUS
Required

The ground of the pins of the power assembly wire harness provides the power return path. The wire harness ground pins shall be connected to safety ground (power supply enclosure).

6.3 Remote Sense

STATUS
Optional

The power assembly may have remote sense for the +3.3V (3.3VS) and return (ReturnS) if the Optional Server Signal connector is implemented and the module has a +3.3V output. The remote sense return (ReturnS) is used to regulate out ground drops for all output voltages. The +3.3V remote sense (3.3VS) is used to regulate out drops in the system for the +3.3 V output. The remote sense input impedance to the power sub-assembly must be greater than 200 ohms on 3.3 VS and ReturnS. This is the value of the resistor connecting the remote sense to the output voltage internal to the power assembly. Remote sense must be able to regulate out a minimum of 200 mV drop on the +3.3 V output. The remote sense return (ReturnS) must be able to regulate out a minimum of 200 mV drop in the power ground return. The current in any remote sense line shall be less than 5 mA to prevent voltage sensing errors. The power supply must operate within specification over the full range of voltage drops from the power assembly's output connector to the remote sense points.

6.4 Output Power/Currents

STATUS
Recommended

The following tables define the power and current ratings for two recommend power levels. Depending upon the system design, the power supply modules may have only three outputs (+12V, -12V, and 5VSB) or the full five outputs (+3.3V, +5V, +12V, -12V, and 5VSB). If only three outputs are provided from the module, the cage shall have additional DC/DC converters to generate +5V and +3.3V from the +12V provided by the modules. The combined output power of all outputs from the cage shall not exceed the rated output power. The power assembly shall meet both static and dynamic voltage regulation requirements over the full load ranges. The power sub-assembly shall supply redundant power over the full load ranges.

Table 11: 350 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V [7]	0.5 A	20 A	
+5 V [7]	2.0 A	20 A	
+12V2 (baseboard connector)	0.5 A	12 A	15 A
+12V3 (peripheral connectors)	1.0 A	13 A	15A
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	2.0 A	

1 Maximum continuous total DC output power should not exceed 350 W.
2 Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 115 W.
3 Maximum Peak total DC output power should not exceed 410 W.
4 Peak power and current loading shall be supported for a minimum of 10 second.
5 Maximum combined current for the 12 V outputs shall be 25 A.
6 Maximum 12V combined peak current shall be 30A.
7 The 3.3V and 5V may be supply by the module or DC/DC converters powered from +12V in the cage.

Table 12: 480 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V [7]	0.5 A	20 A	
+5 V [7]	2.0 A	20 A	
+12V1 (processor connector)	0.5 A	15 A	18 A
+12V2 (baseboard connector)	1.0 A	12 A	
+12V3 (peripheral connectors)	0.5 A	10 A	16 A
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	2.0 A	

1. Maximum continuous total DC output power should not exceed 480 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 115 W.
3. Maximum Peak total DC output power should not exceed 620 W.
4. Peak power and current loading shall be supported for a minimum of 10 second.
5. Maximum combined current for the 12 V outputs shall be 37 A.
6. Maximum 12V combined peak current shall be 46 A.
7. The 3.3V and 5V may be supply by the module or DC/DC converters powered from +12V in the cage.

6.4.1 Standby Outputs

STATUS
Required

The 5 VSB output shall be present when an AC input greater than the power supply turn on voltage is applied.

6.5 Voltage Regulation

STATUS
Required

The power assembly 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 specified in Section 5.9. All outputs are measured with reference to the return remote sense (ReturnS) signal. The 5 V, 12V1, 12V2, 12V3, –12 V and 5 VSB outputs are measured at the power assembly connectors referenced to ReturnS. The +3.3 V is measured at its remote sense signal (3.3VS) located at the signal connector.

Table 13: Voltage Regulation Limits

Parameter	MIN	NOM	MAX	Units	Tolerance
+3.3 V (optional)	+3.20	+3.30	+3.46	V_{rms}	+5/-3%
+5 V (optional)	+4.80	+5.00	+5.25	V_{rms}	+5/-4%
+12V1	+11.52	+12.00	+12.60	V_{rms}	+5/-4%
+12V2	+11.52	+12.00	+12.60	V_{rms}	+5/-4%
+12V3 (optional)	+11.52	+12.00	+12.60	V_{rms}	+5/-4%
-12 V	-11.40	-12.20	-13.08	V_{rms}	+9/-5%
+5 VSB	+4.85	+5.00	+5.25	V_{rms}	+5/-3%

STATUS
Optional

Some system applications may require tighter regulation limits on the +5 V output. The optional regulation limits are shown below.

Table 14: Optional +5V Regulation Limits

Parameter	MIN	NOM	MAX	Units	Tolerance
+5 V	+4.85	+5.00	+5.25	V_{rms}	+5/-3%

6.6 Dynamic Loading

STATUS
Required

The output voltages shall remain within the limits specified in Table 13 for the step loading and within the limits specified in Table 15 for the capacitive loading. The load transient repetition rate shall be tested between 50 Hz 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 shown in Table 11.

Table 15: Transient Load Requirements

Output	D Step Load Size	Load Slew Rate	Capacitive Load
+3.3 V	30% of max load	0.5 A/μs	1,000 μF
+5 V	30% of max load	0.5 A/μs	1,000 μF
12V1+12V2+(12V3)	65% of max load	0.5 A/μs	1,000 μF
+5 VSB	25% of max load	0.5 A/μs	1 μF

6.7 Capacitive Loading

STATUS
Required

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

Note: Up to 10,000 μF of the +12V capacitive loading may be on the +12V1 output.

Table 16: Capacitve Loading Conditions

Output	MIN	MAX	Units
+3.3 V	10	12,000	μF
+5 V	10	12,000	μF
+12 V	10	11,000	μF
-12 V	1	350	μF
+5 VSB	1	350	μF

6.8 Ripple / Noise

STATUS
Required

The maximum allowed ripple/noise output of the power supply is defined in Table 17. This is measured over a bandwidth of 0 Hz to 20 MHz at the power supply output connectors. A 10 μF tantalum capacitor in parallel with a 0.1 μF ceramic capacitor are placed at the point of measurement.

Table 17: Ripple and Noise

+3.3 V	+5 V	+12 V	-12 V	+5 VSB
50 mVp-p	50 mVp-p	120 mVp-p	120 mVp-p	50 mVp-p

6.9 Redundancy

The power sub-system may have different levels of redundancy depending upon the availability requirements of the system. The Required, Recommended, and Optional items are broken down here. To be redundant each item must be in the hot swap power supply module.

STATUS
Required

The power sub-system shall have redundancy of the main power converters for the power factor correction stage and the main +12V output.

STATUS
Recommended

It is recommended the power sub-system have redundancy for the following items, however, depending upon the system availability requirements, these items may be non-redundant.

It is recommended to have redundancy for the output or'ing devices, fans, AC bridge, output capacitors, -12V converter, and 5VSB converter.

STATUS
Optional

It is optional to have redundancy for the AC EMI filter components, 3.3V output converter, and 5V output converter.

6.10 Hot Swap Requirements

STATUS
Required

The power supply modules shall be hot swappable. Hot swapping a power supply is the process of inserting and extracting a power supply from an operating power system. During this process the output voltages shall remain within the limits specified in Table 13 with the capacitive load specified Table 16. The hot swap test must be conducted when the sub-system is operating under both static and dynamic conditions. The sub-system shall not exceed the maximum inrush current as specified in section 5.7. The power supply can be hot swapped by the following methods:

- AC connecting separately to each module. Up to two power supplies may be on a single AC power source. Extraction: The AC power will be disconnected from the power supply first and then the power supply is extracted from the sub-system. This could occur in standby mode or powered on mode. Insertion: The module is inserted into the cage and then AC power will be connected to the power supply module.

- For power modules with AC docking at the same time as DC. Extraction: The module is extracted from the cage and both AC and DC disconnect at the same time. This could occur in standby or power on mode. No damage or arcing shall occur to the DC or AC contacts which could cause damage. Insertion: The AC and

DC connect at the same time as the module is inserted into the cage. No damage to the connector contacts shall occur. The module may power on or come up into standby mode.

Many variations of the above are possible. Supplies need to be compatible with these different variations depending upon the sub-system construction. In general, a failed (off by internal latch or external control) supply may be removed, then replaced with a good power supply, however, hot swap needs to work with operational as well as failed power supplies. The newly inserted power supply may get turned on by inserting the supply into the system or by system management recognizing an inserted supply and explicitly turning it on.

6.11 Timing Requirements

STATUS
Required

These are the timing requirements for the power assembly operation. The output voltages must rise from 10% to within regulation limits (T_{vout_rise}) within 5 to 200ms. The +3.3 V, +5 V and +12 V output voltages should start to rise at about the same time. All outputs must rise monotonically. The +5 V output needs to be greater than the +3.3 V output during any point of the voltage rise. The +5V output must never be greater than the +3.3V output by more than 2.25 V. Each output voltage shall reach regulation within 50 ms (T_{vout_on}) of each other during turn on of the power supply. Each output voltage shall fall out of regulation within 400 ms (T_{vout_off}) of each other during turn off. Figure 2 and Figure 3 show the turn ON and turn OFF timing requirements. In Figure 3, the timing is shown with both AC and PSON# controlling the ON/OFF of the power supply.

Table 18: Output Voltage Timing

Item	Description	MIN	MAX	Units
T_{vout_rise}	Output voltage rise time from each main output.	5	200	ms
T_{vout_on}	All main outputs must be within regulation of each other within this time.		50	ms
T_{vout_off}	All main outputs must leave regulation within this time.		400	ms

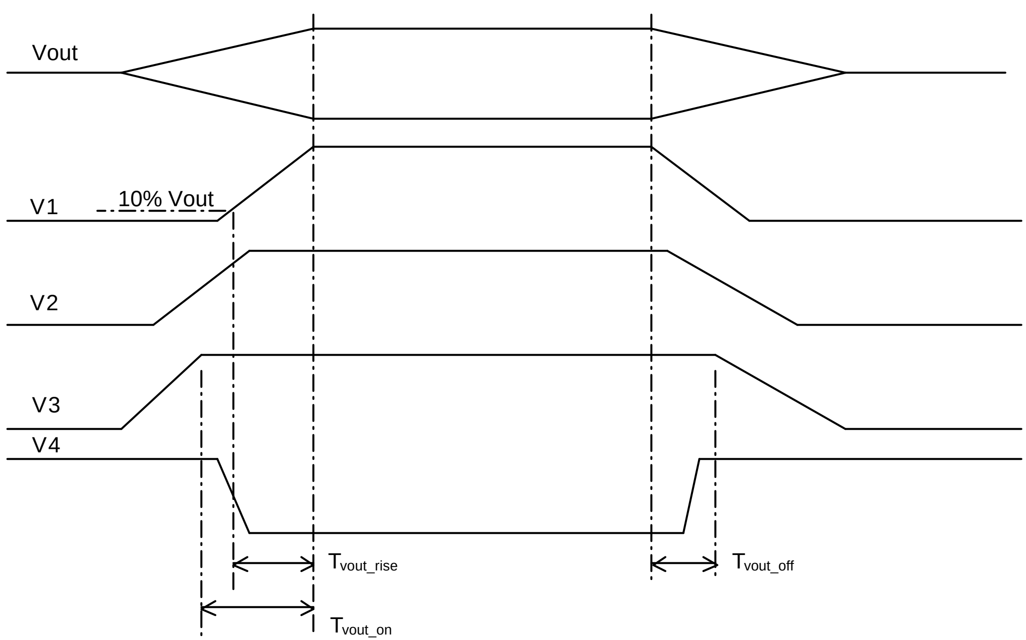

Figure 2: Output Voltage Timing

Table 19: Turn On/Off Timing

Item	Description	MIN	MAX	UNITS
$T_{sb\_on\_delay}$	Delay from AC being applied to 5 VSB being within regulation.		1500	ms
$T_{ac\_on\_delay}$	Delay from AC being applied to all output voltages being within regulation.		2500	ms
T_{vout_holdup}	Time all output voltages stay within regulation after loss of AC.	18		ms
T_{pwok_holdup}	Delay from loss of AC to deassertion of PWOK.	17		ms
$T_{pson\_on\_delay}$	Delay from PSON# active to output voltages within regulation limits.	5	400	ms
T_{pson_pwok}	Delay from PSON# deactive to PWOK being deasserted.		50	ms
T_{pwok_on}	Delay from output voltages within regulation limits to PWOK asserted at turn on.	200	1000	ms
T_{pwok_off}	Delay from PWOK deasserted to output voltages (3.3 V, 5 V, 12 V, -12 V) dropping out of regulation limits.	1		ms
T_{pwok_low}	Duration of PWOK being in the deasserted state during an off/on cycle using AC or the PSON# signal.	100		ms
T_{sb_vout}	Delay from 5 VSB being in regulation to O/Ps being in regulation at AC turn on.	50	1000	ms

STATUS
Recommended

Item	Description	MIN	MAX	UNITS
T_{vout_holdup}	Time all output voltages stay within regulation after loss of AC.	21		ms
T_{pwok_holdup}	Delay from loss of AC to deassertion of PWOK.	20		ms
T_{sb_holdup}	Time 5VSB output voltage stays within regulation after loss of AC.	70		ms

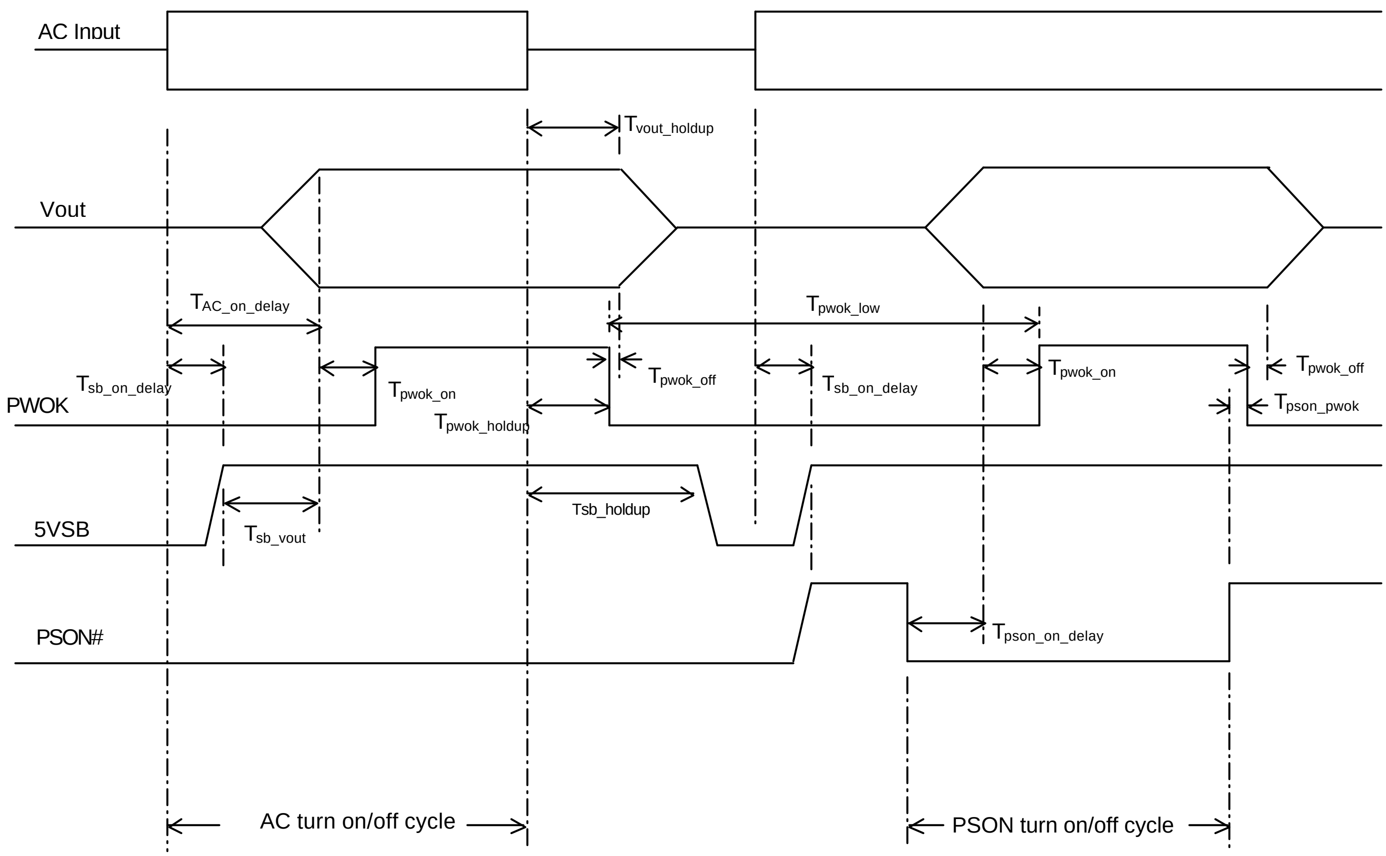

Figure 3: Turn On/Off Timing

7 Protection Circuits

STATUS
Required

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 15 s and a PSON# cycle HIGH for 1 s must be able to reset the power supply.

7.1 Current Limit

STATUS
Required

The power supply shall have current limit to prevent the +3.3 V, +5 V, and +12 V outputs from exceeding the values shown in Table 20. If the current limits are exceeded, the power supply shall shutdown and latch off. 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. -12 V and 5 VSB shall be protected under over current or shorted conditions so that no damage can occur to the power supply.

Table 20: Over Current Protection

Voltage	Over Current Limit (Iout limit)
+3.3 V	110% minimum; 150% maximum
+5 V	110% minimum; 150% maximum
+12V (combined)	Peak combine current minimum; 150% maximum

7.2 240VA Protection

STATUS
Recommended

System designs may require user access to energized areas of the system. In these cases the power supply may be required to meet regulatory 240VA energy limits for any power rail. Since the +12V rail combined power exceeds 240VA it must be divided into separate channels to meet this requirement. Each separate rail needs to be limited to less than 20A for each +12V rail. The separate +12V rails do not necessarily need to be independently regulated outputs. They can share a common power conversion stage. The +12V rail is divided into two rails for the 350W power level and three rails for the 480W power level. See section 6.4 for how the +12V rail is split between different output connectors.

Table 21: Over Current Protection

Voltage	Over Current Limit (Iout limit)
+3.3 V	110% minimum; 150% maximum
+5 V	110% minimum; 150% maximum
+12V1,2,3	Peak current minimum; 20A maximum

7.3 Over Voltage Protection

STATUS
Required

The power supply over voltage protection shall be locally sensed in the hot swap modules. 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. Table 22 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 22: Over Voltage Limits

Output Voltage	MIN (V)	MAX (V)
+3.3 V	3.9	4.5
+5 V	5.7	6.5
+12V1,+12V2, +12V3	13.3	14.5
-12 V	-13.3	-14.5
+5 VSB	5.7	6.5

7.4 Over Temperature Protection

STATUS
Recommended

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, the power supply shall restore power automatically. The OTP circuit must have built in hysteresis 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 hysteresis.

8 *Control and Indicator Functions*

The following sections define the input and output signals from the power supply.

Signals that can be defined as low true use the following convention:

signal# = low true

8.1 PSON#

STATUS
Required

The PSON# signal is required to remotely turn on/off the power supply. PSON# is an active low signal that turns on the +3.3 V, +5 V, +12 V, and -12 V power rails. When this signal is not pulled low by the system, or left open, the outputs (except the +5 VSB and Vbias) turn off. This signal is pulled to a standby voltage by a pull-up resistor internal to the power supply. Refer to *Figure 3* for timing diagram.

Table 23: PSON# Signal Characteristic

Signal Type	Accepts an open collector/drain input from the system. Pull-up to VSB located in power supply.	
PSON# = Low	ON	
PSON# = Open or High	OFF	
	MIN	**MAX**
Logic level low (power supply ON)	0 V	1.0 V
Logic level high (power supply OFF)	2.0 V	5.25 V
Source current, Vpson = low		4 mA
Power up delay: $T_{pson\_on\_delay}$	5 ms	400 ms
PWOK delay: T_{pson_pwok}		50 ms

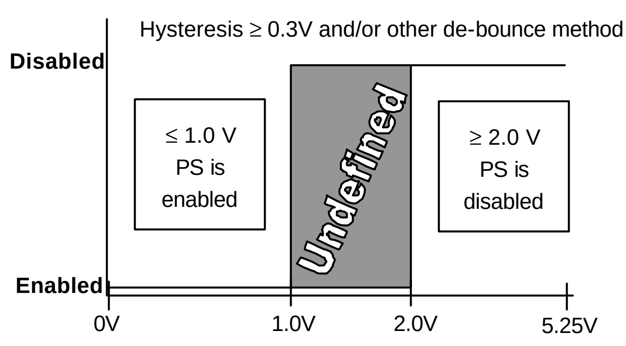

Figure 4: PSON# Signal Characteristics

8.2 PWOK (Power OK)

STATUS
Required

PWOK is a power OK signal and will be pulled HIGH by the power supply to indicate that all the outputs are within the regulation limits of the power supply. When any output voltage falls below regulation limits or when AC power has been removed for a time sufficiently long so that power supply operation is no longer guaranteed, PWOK will be deasserted to a LOW state. See *Figure 3* for a representation of the timing characteristics of PWOK. The start of the PWOK delay time shall be inhibited as long as any power supply output is in current limit.

Table 24: PWOK Signal Characteristics

Signal Type	Open collector/drain output from power supply. Pull-up to VSB located in power supply.	
PWOK = High	Power OK	
PWOK = Low	Power Not OK	
	MIN	**MAX**
Logic level low voltage, Isink = 4 mA	0 V	0.4 V
Logic level high voltage, Isource=200 mA	2.4 V	5.25 V
Sink current, PWOK = low		4 mA
Source current, PWOK = high		2 mA
PWOK delay: T_{pwok_on}	200 ms	1000 ms
PWOK rise and fall time		100 µs
Power down delay: T_{pwok_off}	1 ms	200 ms

8.3 SMBus Communication

STATUS
Optional

There may be SMBus communication to the power assembly to monitor the cage and modules. This would require a serial EEPROM to store FRU data of each module and communicate the information onto the SMBus. There may also be a device in the cage to monitor the module failure and presence status via the SMBus. If there is a fan in the cage, the SMBus device in the cage may also monitor the fan(s) for failure.

8.3.1 Field Replacement Unit (FRU) Signals

STATUS
Optional

Two pins will be allocated for the FRU information on the power supply connector. One pin is the Serial Clock (SCL). The second pin is used for Serial Data (SDA). Both pins are bi-directional and are used to form a serial bus. The FRU circuits inside the power supply must be powered off of 5 VSB output and grounded to ReturnS (remote sense return). The Write Control (or Write protect) pin should be tied to ReturnS inside the power supply so that information can be written to the EEPROM.

8.3.2 Module FRU Data

FRU data shall be stored starting in address location 8000h through 80FFh. The FRU data format shall be compliant with the IPMI specifications. The current version of these specifications are available at: *http:\\developer.intel.com/design/servers/ipmi/spec.htm*.

8.3.3 Module FRU Data Format

The information to be contained in the FRU device is shown in the following table.

Table 25: FRU Device Information

Area Type	**Description**
Common Header	As defined by the FRU document
Internal Use Area	Not required, do not reserve
Chassis Info Area	Not applicable, do not reserve
Board Info Area	Not applicable, do not reserve

8.3.3.1 Product Info Area

As defined by the IPMI FRU document. Product information shall be defined as follows:

Table 26: FRU Device Product Information Area

Field Name	**Field Description**
Manufacturer Name	{Formal name of manufacturer}
Product Name	{Manufacturer's model number}
Product part/model number	Customer part number
Product Version	Customer current revision
Product Serial Number	{Defined at time of manufacture}

Asset Tag	{Not used, code is zero length byte}
FRU File ID	{Not required}
PAD Bytes	{Added as necessary to allow for 8-byte offset to next area}

8.3.3.2 MultiRecord Area

As defined by the IPMI FRU document. The following record types shall be used on this power supply:

- Power Supply Information (Record Type 0x00)
- DC Output (Record Type 0x01)
- No other record types are required for the power supply.

MultiRecord information shall be defined as follows:

Table 27: FRU Device Product Information Area

Field Name (PS Info)	Field Information Definition
Overall Capacity (watts)	480
Peak VA	550
Inrush current (A)	50
Inrush interval (ms)	5
Low end input voltage range 1	90
High end input voltage range 1	140
Low end input voltage range 2	180
High end input voltage range 2	264
A/C dropout tol. (ms)	20
Binary flags	Set for: Hot Swap support, Autoswitch, and PFC
Peak Wattage	Set for: 10 s, 550 W
Combined wattage	Set for 5 V & 3.3V combined wattage of 115 W
Predictive fail tach support	Not supported, 00h value
Field Name (Output)	Field Description: Five outputs are to be defined from #1 to #5, as follows: +3.3 V, +5 V, +12 V, -12V, and +5 VSB.
Output Information	Set for: Standby on +5 VSB, No Standby on all others.
All other output fields	Format per IPMI specification, using parameters in the EPS12V specification.

8.4 LED Indicators

STATUS
Required

There shall be a single bi-color LED OR two LEDs, one AMBER and one GREEN, on each hot swap power module to indicate power supply status. When AC is applied to the power supply and standby voltages are available the GREEN LED shall BLINK. The GREEN LED shall turn ON to indicate that all the power outputs are available. The AMBER LED shall turn ON to indicate that the power supply has failed, shutdown due to over current, or shutdown due to over temperature. Refer to *Table 28: LED Indicators* for conditions of the LED(s).

Table 28: LED Indicators

POWER SUPPLY CONDITION	Power Supply LED(s)	
	AMBER	GREEN
No AC power to all PSU	OFF	OFF
No AC power to this PSU only	AMBER	OFF
AC present / Only Standby Outputs On	OFF	BLINK
Power supply DC outputs ON and OK	OFF	ON
Power supply failure (includes over voltage, over temperature)	ON	OFF
Current limit	ON	OFF

The LED(s) shall be visible on the power supply's exterior face. The LED location shall meet ESD requirements. LED shall be securely mounted in such a way that incidental pressure on the LED shall not cause it to become displaced.

9 MTBF

STATUS
Recommended

The power module shall have a minimum MTBF at continuous operation of 1) 50,000 hours at 100% load and 45 °C, as calculated by Bellcore RPP, or 2) 100,000 hours demonstrated at 100% load and 50 °C.

The power cage shall have a minimum MTBF at continuous operation of 1) 200,000 hours at 100% load and 45 °C, as calculated by Bellcore RPP, or 2) 400,000 hours demonstrated at 100% load and 50 °C

10Agency Requirements

STATUS
Recommended

The power supply must comply with all regulatory requirements for its intended geographical market. Depending on the chosen market, regulatory requirements may vary. Although a power supply can be designed for worldwide compliance, there may be cost factors that drive different versions of supplies for different geographically targeted markets.

This specification requires that the power supply meet all regulatory requirements for the intended market at the time of manufacturing. Typically this includes:

- UL
- CSA
- A Nordic CENELEC
- TUV
- VDE
- CISPR Class B
- FCC Class B

The power supply, when installed in the system, shall meet immunity requirements specified in EN55024. Specific tests are to be EN61000-4-2 ,-3, -4, -5, -6, -8, -11, EN61000-3-2, -3, and JEIDI MITI standard. The power supply must maintain normal performance within specified limits. This testing must be completed by the system EMI engineer. Conformance must be designated with the European Union CE Marking. Specific immunity level requirements are left to customer requirements.