

EPS12V

Power Supply Design Guide

*A Server System Infrastructure (SSI) Specification
For Entry Chassis Power Supplies*

Version 2.92

Orig./Rev.	Description of Changes
2.1	Posted design guide
2.8	<p>Remove references to common and split 12V planes. Added higher power levels up to 800W. Reduced holdup time requirements to 75% of max load. Added cross loading plots. Added option for tighter 12V regulation. Add new SSI efficiency requirements (recommended level & loading conditions). Increase 12V rail currents. Tpwok_on max time reduced to 500msec. Change 5VSB to 3.0A for higher power levels. Added reference to PSMI spec. Modified SMBus section (FRU and PSMI) to 3.3V with 5V tolerance. Modified 240VA section; removed common plane, change to <20A for all 12V outputs. Updated sound power & airflow requirements Add SATA and PCI-Express GFX connectors Updated efficiency testing method</p>
2.9	<p>Increase 5V current to 30A and combined 3.3V/5V power to 160W for the 650-800W power levels. Increase 12V1/2 current for 550W-600W power levels. Relax require regulation limits. Added optional regulation limits.</p>
2.91	<p>Fixed error in 3.3V and 5V loading at higher power levels. Increased 3.3V/5V combined loading to 170W.</p>
2.92	<p>Higher power levels; 850W, 900W, 950W for dual GFX and 16xDIMMs. Increase 5VSB capability for 4A and 6A options. Add 12V5 and associated connectors. New efficiency specs. Update cross loading requirements; lower 12V min loading.</p>

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Contents

1	Purpose.....	7
2	Conceptual Overview	7
3	Definitions/Terms/Acronyms.....	8
4	Mechanical Overview	9
4.1	Acoustic Requirements	10
4.2	Airflow Requirements	10
4.3	Temperature Requirements	11
5	AC Input Requirements.....	12
5.1	AC Inlet Connector.....	12
5.2	AC Input Voltage Specification	12
5.3	Input Under Voltage	12
5.4	Efficiency.....	12
5.5	AC Line Dropout.....	13
5.6	AC Line Fuse	13
5.7	AC Inrush	13
5.8	AC Line Transient Specification.....	14
5.9	AC Line Fast Transient Specification.....	14
6	DC Output Specification	15
6.1	Output Connectors	15
6.1.1	Baseboard power connector	15
6.1.2	Processor Power Connector	15
6.1.3	+12V4 and +12V5 Baseboard Power Connector	16
6.1.4	Peripheral Power Connectors.....	16
6.1.5	Floppy Power Connector	17
6.1.6	Serial ATA Power Connector.....	18
6.1.7	Server Signal Connector.....	19
6.1.8	Workstation Power Connector for High Power Graphics Cards	19
6.2	Grounding.....	20
6.3	Remote Sense	20
6.4	Output Power/Currents	20
6.4.1	Standby Outputs	29
6.5	Voltage Regulation.....	29
6.6	Dynamic Loading	30
6.7	Capacitive Loading.....	30
6.8	Ripple / Noise.....	30
6.9	Timing Requirements	31
7	Protection Circuits.....	35
7.1	Current Limit.....	35
7.2	240VA Protection	35
7.3	Over Voltage Protection	36
7.4	Over Temperature Protection.....	36
8	Control and Indicator Functions	36
8.1	PSON#	37
8.2	PWOK (Power OK)	37
8.3	SMBus Communication.....	38
8.4	Power Supply Management Interface.....	38
8.5	Field Replacement Unit (FRU) Signals	38

8.5.1	FRU Data	39
8.5.2	FRU Data Format.....	39
9	MTBF	40
10	Agency Requirements.....	41

Figures

Figure 1:	Enclosure Drawing	9
Figure 2	System Airflow Impedance.....	10
Figure 3	Cross Loading Graph for 550W Configuration.....	21
Figure 4	Cross Loading Graph for 600W Configuration.....	22
Figure 5	Cross Loading Graph for 650W Configuration.....	23
Figure 6	Cross Loading Graph for 700W Configuration.....	24
Figure 7	750W Cross loading graph.....	25
Figure 8	Cross Loading Graph for 800W Configuration.....	26
Figure 9	Cross Loading Graph for 850W Configuration.....	27
Figure 10	Cross Loading Graph for 950W Configuration.....	28
Figure 11:	Output Voltage Timing.....	32
Figure 12:	Turn On/Off Timing (Single Power Supply).....	34
Figure 13:	PSO# Signal Characteristics	37

Tables

Table 1	Recommended Acoustic Sound Power Levels	10
Table 2:	Thermal Requirements.....	11
Table 3:	AC Input Rating	12
Table 4:	Efficiency	13
Table 5:	AC Line Sag Transient Performance.....	14
Table 6:	AC Line Surge Transient Performance	14
Table 7:	P1 Baseboard Power Connector.....	15
Table 8:	Processor Power Connector.....	16
Table 9	12V4 and 12V5 Power Connectors	16
Table 10:	Peripheral Power Connectors.....	17
Table 11:	Floppy Power Connector	17
Table 12:	Floppy Power Connector	18
Table 13:	Server Signal Connector	19
Table 14	PCI Express Graphic Card Power Connector(s).....	19
Table 15:	550 W Load Ratings	21
Table 16:	600 W Load Ratings	22
Table 17:	650 W Load Ratings	23
Table 18:	700 W Load Ratings	24
Table 19:	750W Load Ratings	25
Table 20:	800 W Load Ratings	26
Table 21:	850 W Load Ratings	27
Table 22:	950 W Load Ratings	28
Table 23:	Voltage Regulation Limits.....	29
Table 24:	Optional Regulation Limits.....	29
Table 25:	Transient Load Requirements	30
Table 26:	Capacitive Loading Conditions.....	30
Table 27:	Ripple and Noise	31
Table 28:	Output Voltage Timing.....	32

Table 29: Turn On/Off Timing.....	33
Table 30: Over Current Protection.....	35
Table 31: Over Current Limits	36
Table 32: Over Voltage Limits	36
Table 33: PSON [#] Signal Characteristic	37
Table 34: PWOK Signal Characteristics.....	38
Table 35: FRU Device Information	39
Table 36: FRU Device Product Information Area	39
Table 37: MultiRecord information Area	40

1 Purpose

This specification defines a non-redundant power supply that supports entry server computer systems. Recommendations for 550 W, 600 W, 650 W, 700W, 750W, 800W, 850W, and 950W power supplies with up to 9 outputs (3.3 V, 5 V, 12V1, 12V2, 12V3, 12V4, 12V5, -12 V, and 5 VSB) are provided. The form factor is based on the PS/2 power supply, with three enclosure lengths defined to support various output power levels. Connector/cable assemblies are required for the motherboard power, remote sensing, control functions, and peripheral power. Because of its connector leads, the entry-level power supply is not intended to be a hot swap type of power supply. The cooling fan should meet the acoustical requirements for the system, while providing system cooling.

The parameters of this supply are defined in this specification 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
- +5 V
- +12 V
- -12 V
- +5 V standby

NOTES

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 +12V rail may be separated into three +12V rails to meet regulatory requirements for energy hazards (240VA).

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

Three enclosure size options are defined to accommodate various power levels. Recommended power levels for each enclosure length are shown below. Refer to Figure 1 for details. The two rear mounting tabs on the enclosure are OPTIONAL and may not be required for many systems.

Length	Recommended power levels
140mm	< 450W
180mm	450W to 750W
230mm	> 800W

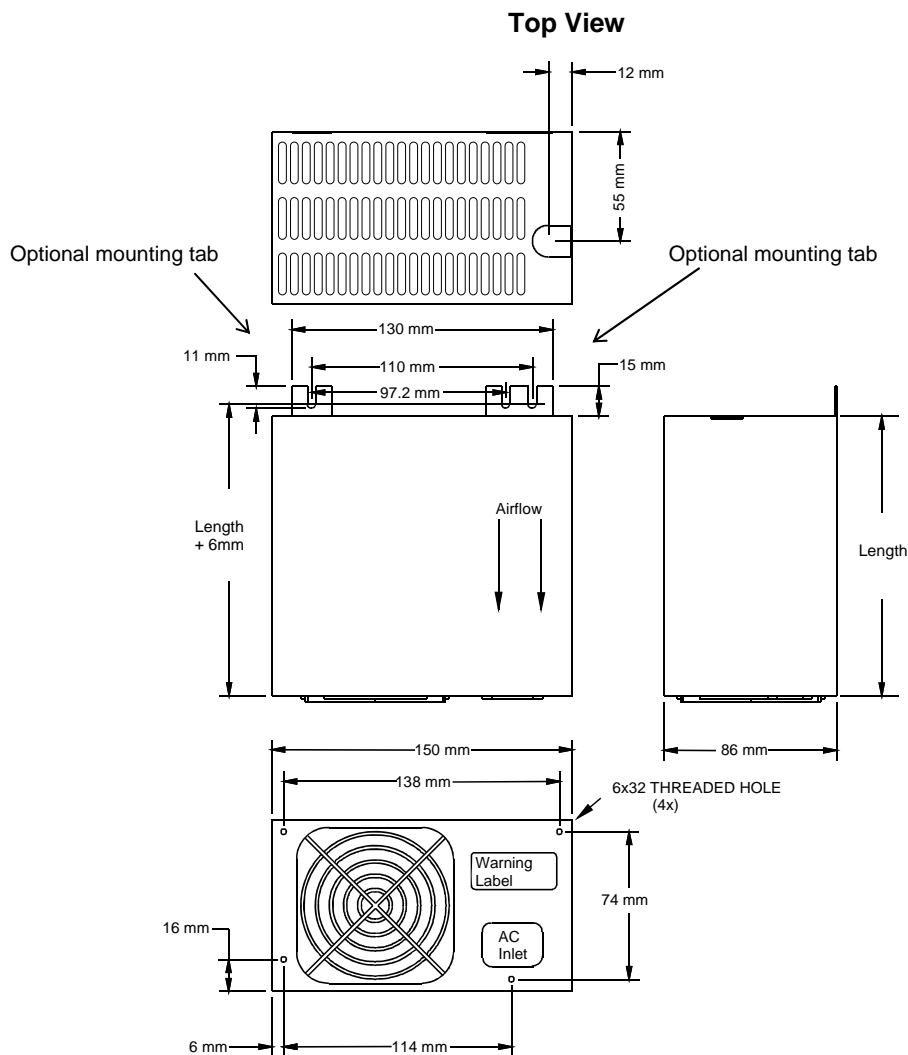


Figure 1: Enclosure Drawing

4.1 Acoustic Requirements

STATUS
Recommended

It is recommended the power supply have a variable speed fan based on temperature and loading conditions. There are three different acoustic sound power levels defined at different ambient temperatures and loading conditions.

Table 1 Recommended Acoustic Sound Power Levels

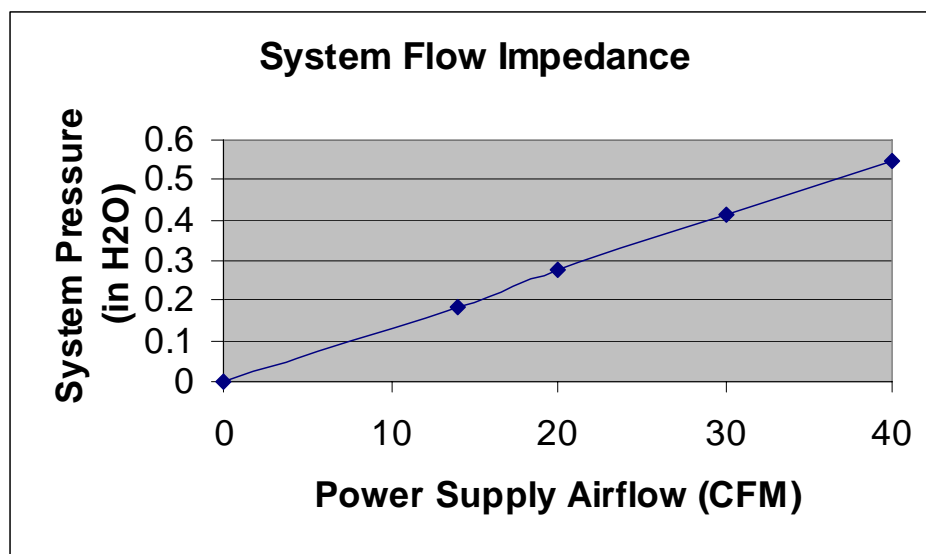
	Idle	Typical	Max
Ambient Temperature	35°C	40°C	45°C
% Loading	40%	60%	100%
Sound Power (BA)	4.0	4.7	6.0

4.2 Airflow Requirements

STATUS
Recommended

It is recommended the power supply have no less than 14 CFM of airflow to provide proper airflow to system components. The air shall exit the power supply on the AC inlet face. The power supply shall meet all requirements with the below system airflow impedance presented to the power supplies airflow path.

Figure 2 System Airflow Impedance



4.3 Temperature Requirements

STATUS
Recommended

The power supply shall operate within all specified limits over the T_{op} temperature range. The average air temperature difference (ΔT_{ps}) from the inlet to the outlet of the power supply shall not exceed the values shown below in Table 2. All airflow shall pass through the power supply and not over the exterior surfaces of the power supply.

Table 2: Thermal Requirements

ITEM	DESCRIPTION	MIN	MAX	UNITS
T_{op}	Operating temperature range.	0	45	°C
T_{non-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 of 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 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.

5.2 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 3: AC Input Rating

PARAMETER	MIN	RATED	MAX
Voltage (110)	90 V _{rms}	100-127 V _{rms}	140 V _{rms}
Voltage (220)	180 V _{rms}	200-240 V _{rms}	264 V _{rms}
Frequency	47 Hz		63 Hz

5.3 Input Under Voltage

STATUS
Required

The power supply shall contain protection circuitry such that application of an input voltage below the minimum specified in Section 5.2 shall not cause damage to the power supply.

5.4 Efficiency

STATUS
Recommended / Required

The following table provides recommended and required minimum efficiency levels. These are provided at three different load levels; 100%, 50% and 20%. The “required” minimum efficiency levels are for the purpose of proper power supply cooling when installed in the system. The “recommended” minimum efficiency levels are for the

purpose of reducing the system's AC power consumption. The efficiency is specified at 50% and 20% loading conditions to help reduce system power consumption at typical system loading conditions.

Efficiency shall be tested at AC input voltages of 115VAC and 230VAC. Refer to www.efficientpowersupplies.org for details on proper efficiency testing methods.

Table 4: Efficiency

Loading	100% of maximum	50% of maximum	20% of maximum
Required minimum	70%	72%	65%
Recommended minimum	80%	80%	80%

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 75% or less of the rated output loading conditions. Any dropout of the AC line shall not cause damage to the power supply.

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 50 A peak for one-quarter of the AC cycle, after which, the input current should be no more than the specified maximum input current from Table 3.

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 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 5: 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 6: 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

6.1 Output Connectors

The power supply shall have the following output connectors.

6.1.1 Baseboard power connector

STATUS
Required

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

Contact: Molex 44476-1111 or equivalent

Table 7: P1 Baseboard Power Connector

Pin	Signal	18 AWG Color	Pin	Signal	18 AWG Color
1	+3.3 VDC ¹	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 V ₃ ²	Yellow/Blue Stripe	22	+5 VDC	Red
11	+12 V ₃ ²	Yellow/Blue Stripe	23	+5 VDC	Red
12	+3.3 VDC	Orange	24	COM	Black

1. 3.3V remote sense signal double crimped with 3.3V contact.
2. If 240VA limiting is not a requirement for the power supply then all +12V outputs are common and may have the same wire color (yellow).

6.1.2 Processor Power Connector

STATUS
Required

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

Contact: Molex 44476-1111 or equivalent

Table 8: 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 V2	Yellow
4	COM	Black	8	+12 V2	Yellow

If 240VA limiting is not a requirement for the power supply then all +12V outputs are common and may have the same wire color (yellow).

6.1.3 +12V4 and +12V5 Baseboard Power Connector

STATUS
+12V4 Required for 700W, 750W, and 800W power levels
+12V5 Required for 850W and 950W power levels

Systems that require more than 16A of +12V current to the baseboard will require this additional 2x2 power connector. This is due to the limited +12V capability of the 2x12 baseboard power connector. +12V4 will power the 2x2 connector.

Systems with 16xDIMMs and/or dual graphic cards will require the +12V5 output and added +12V5 2x2 connector.

Connector housing: 4-Pin Molex 39-01-2040 or equivalent

Contact: Molex 44476-1111 or equivalent

Table 9 12V4 and 12V5 Power Connectors

Pin	Signal	18 AWG color	Pin	Signal	18 AWG Color
1	COM	Black	3	+12 V4 / +12 V5	Yellow/Green Stripe
2	COM	Black	4	+12 V4 / +12 V5	Yellow/Green Stripe

If 240VA limiting is not a requirement for the power supply then all +12V outputs are common and may have the same wire color (yellow).

6.1.4 Peripheral Power Connectors

STATUS
Required

Connector housing: Amp 1-480424-0 or equivalent

Contact: Amp 61314-1 contact or equivalent

Table 10: Peripheral Power Connectors

Pin	Signal	18 AWG Color
1	+12V4	Yellow/Green stripe
2	COM	Black
3	COM	Black
4	+5 VDC	Red

1. The +12V power to peripherals may be split between the second, third, or fourth +12V channel for the purpose of limiting power to less than 240VA.
2. If 240VA limiting is not a requirement, all +12V outputs are common and may have the same wire color.

6.1.5 Floppy Power Connector

STATUS
Required

Connector housing: Amp 171822-4 or equivalent

Table 11: Floppy Power Connector

Pin	Signal	22 AWG Color
1	+5 VDC	Red
2	COM	Black
3	COM	Black
4	+12V4	Yellow/Green Stripe

1. The +12V power to peripherals may be split between the second, third, or fourth +12V channel for the purpose of limiting power to less than 240VA.
2. If 240VA limiting is not a requirement for the power supply then all +12V outputs are common and may have the same wire color.

6.1.6 Serial ATA Power Connector

STATUS
Optional

This is a required connector for systems with serial ATA devices.

The detailed requirements for the serial ATA connector can be found in the “Serial ATA : High Speed Serialized AT Attachment “ specification at www.serialata.org.

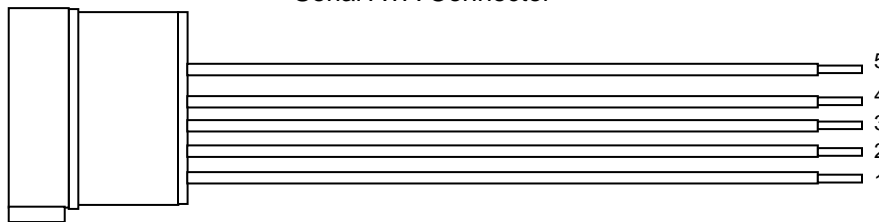
Molex Housing #675820000

Molex Terminal #67510000

Table 12: Floppy Power Connector

Pin	Signal	18 AWG Color
5	+3.3VDC	Orange
4	COM	Black
3	+5VDC	Red
2	COM	Black
1	+12V4	Yellow/Green Stripe

Serial ATA Connector



6.1.7 Server Signal Connector

STATUS
Optional

For server systems with SMBus features, the power supply may have an additional connector, which provides serial SMBus for FRU data and remote sense on 3.3V and Return.

If the optional server signal connector is not used on the power supply or the connector is unplugged, the power supply shall utilize the 3.3RS on the baseboard connector (Pin 1).

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

Contacts: Molex 16-02-0088 or equivalent

Table 13: Server Signal Connector

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

6.1.8 Workstation Power Connector for High Power Graphics Cards

STATUS
Optional

For workstation systems with high-power graphics cards additional power connectors will be needed. The +12V4 connector is needed for powering a system with a single 150W graphics card. +12V4 and +12V5 connectors are needed for powering a system with dual 150W graphics cards.

Connector housing: 6-pin Molex 45559-0002 or equivalent

Contacts: Molex 39-00-0207 or equivalent

Table 14 PCI Express Graphic Card Power Connector(s)

PIN	SIGNAL	18 AWG Colors	PIN	SIGNAL	18 AWG Colors
1	+12V4 / +12V5	Yellow/Green	4	COM	Black
2	+12V4 / +12V5	Yellow/Green	5	COM	Black
3	+12V4 / +12V5	Yellow/Green	6	COM	Black

6.2 Grounding

STATUS
Required

The ground of the pins of the power supply 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 supply may have remote sense for the +3.3V (3.3VS) and return (ReturnS) if the Optional Server Signal connector is implemented. The remote sense return (ReturnS) is used to regulate out ground drops for all output voltages; +3.3V, +5 V, +12V1, +12V2, +12V3, -12 V, and 5 VSB. 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 supply must be greater than 200 W 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 supply. 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 supply's output connector to the remote sense points.

6.4 Output Power/Currents

STATUS
Recommended

The following tables define power and current ratings for four recommended power levels selected to cover different types of systems and configurations.

The combined output power of all outputs shall not exceed the rated output power. Load ranges are provided for each output level. The power supply must meet both static and dynamic voltage regulation requirements for the minimum loading conditions.

Table 15: 550 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	1.5 A	24 A	
+5 V	1.0 A	24 A	
+12V1	0 A	16 A	18 A
+12V2	0 A	16 A	18 A
+12V3	0.1 A	14 A	
+12V4	0 A	8.0 A	13 A
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A	3.5 A

1. Maximum continuous total DC output power should not exceed 550 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 140 W.
3. Maximum peak total DC output power should not exceed 660 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 41 A.
6. Peak current for the combined 12 V outputs shall be 50 A.

Figure 3 Cross Loading Graph for 550W Configuration

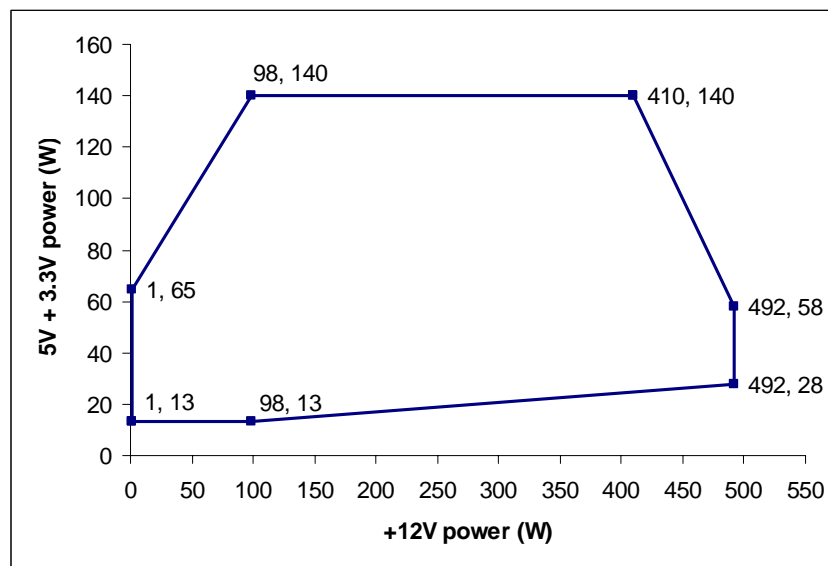


Table 16: 600 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	1.5 A	24 A	
+5 V	1.0 A	24 A	
+12V1	0 A	16 A	18 A
+12V2	0 A	16 A	18 A
+12V3	0.1 A	16 A	18 A
+12V4	0 A	16 A	18 A
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A	3.5 A

1. Maximum continuous total DC output power should not exceed 600 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 140 W.
3. Maximum peak total DC output power should not exceed 680 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 48 A.
6. Peak current for the combined 12 V outputs shall be 54 A.

Figure 4 Cross Loading Graph for 600W Configuration

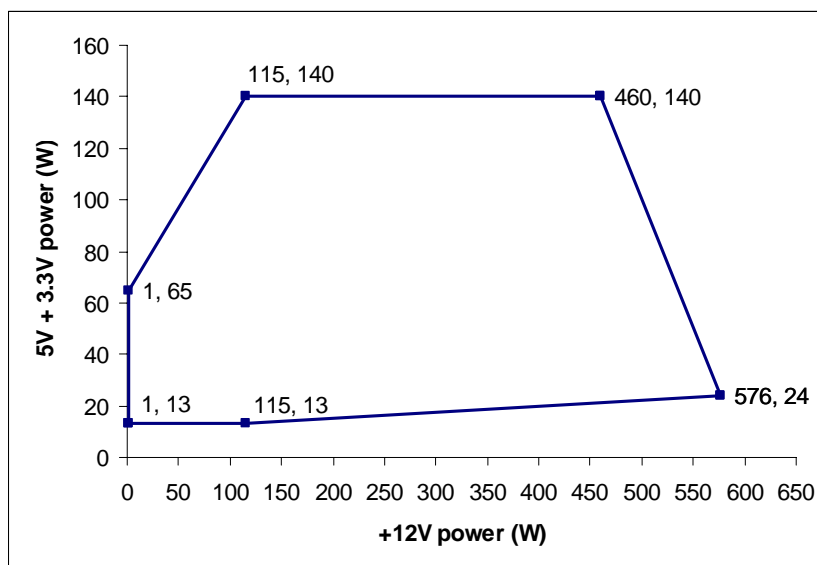


Table 17: 650 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	1.5 A	24 A	
+5 V	1.0 A	30 A	
+12V1	0 A	16 A	18 A
+12V2	0 A	16 A	18 A
+12V3	0.1 A	16 A	18 A
+12V4	0 A	16 A	18 A
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A	3.5 A

1. Maximum continuous total DC output power should not exceed 650 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 170 W.
3. Maximum peak total DC output power should not exceed 730 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 52 A.
6. Peak current for the combined 12 V outputs shall be 58 A.

Figure 5 Cross Loading Graph for 650W Configuration

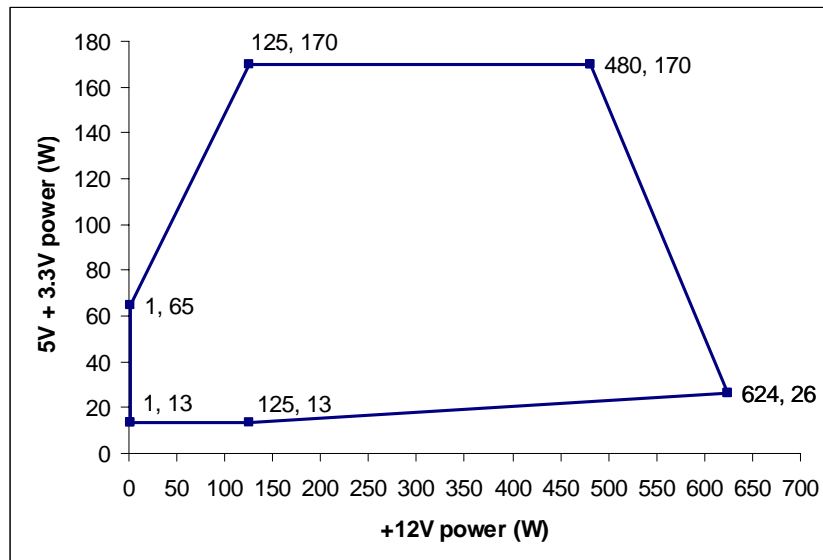


Table 18: 700 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	1.5 A	24 A	
+5 V	1.0 A	30 A	
+12V1	0.8 A	16 A	18 A
+12V2	0.8 A	16 A	18 A
+12V3	0.5 A	16 A	18 A
+12V4	1.0 A	16 A	18 A
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A / 4.0 A ⁷	3.5 A / 4.5 A ⁷

1. Maximum continuous total DC output power should not exceed 700 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 170 W.
3. Maximum peak total DC output power should not exceed 780 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 56 A.
6. Peak current for the combined 12 V outputs shall be 62 A.
7. 4.0 A / 4.5 A peak of +5 VSB is required only for power supplies in systems supporting ACPI S3 power state; suspend to memory. ACPI S3 is used to support workstation's suspend to memory power state. Servers do not typically support suspend to memory power state.

Figure 6 Cross Loading Graph for 700W Configuration

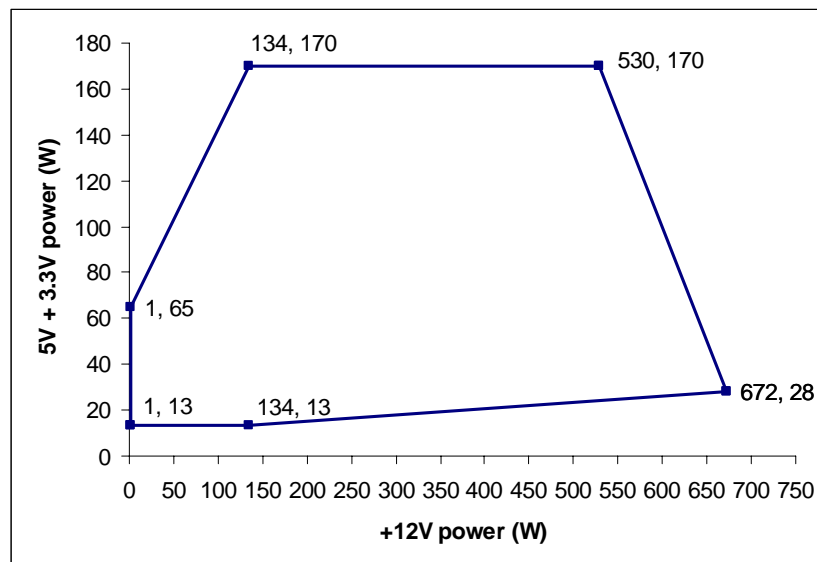


Table 19: 750W Load Ratings

Voltage	Minimum	Maximum	Peak
+3.3 V	1.5 A	24 A	
+5 V	1.0 A	30 A	
+12 V1	0 A	16 A	18 A
+12 V2	0 A	16 A	18 A
+12 V3	0.9 A	16 A	18 A
+12 V4	0.1 A	18 A	22 A ⁷
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A / 4.0 A ⁸	3.5 A / 4.5 A ⁸

1. Maximum continuous total DC output power should not exceed 750 W.
2. Peak load on the combined 12 V output shall not exceed 66A.
3. Maximum continuous load on the combined 12 V output shall not exceed 60 A.
4. Peak total DC output power should not exceed 850 W.
5. Peak power and current loading shall be supported for a minimum of 12 seconds.
6. Combined 3.3V and 5V power shall not exceed 170W.
7. Peak current on 12V4 shall be supported for a minimum of 0.5 seconds.
8. 4.0 A / 4.5 A peak of +5 VSB is required only for power supplies in systems supporting ACPI S3 power state; suspend to memory. ACPI S3 is used to support workstation's suspend to memory power state. Servers do not typically support suspend to memory power state.

Figure 7 750W Cross loading graph

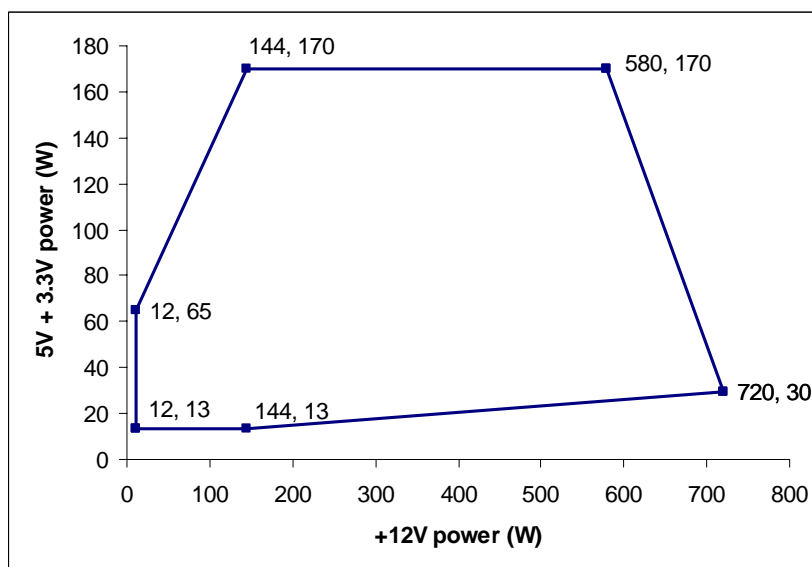


Table 20: 800 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	0.8 A	24 A	
+5 V	0.5 A	30 A	
+12V1	0 A	16 A	18 A
+12V2	0 A	16 A	18 A
+12V3	0.9 A	16 A	18 A
+12V4	0.1 A	18 A	22 A ⁷
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A / 4.0 A ⁸	3.5 A / 4.5 A ⁸

1. Maximum continuous total DC output power should not exceed 800 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 170 W.
3. Maximum peak total DC output power should not exceed 880 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 64 A.
6. Peak current for the combined 12 V outputs shall be 70 A.
7. Peak power on the +12V4 rail shall be sustained for a minimum of 500msec.
8. 4.0 A / 4.5 A peak of +5 VSB is required only for power supplies in systems supporting ACPI S3 power state; suspend to memory. ACPI S3 is used to support workstation's suspend to memory power state. Servers do not typically support suspend to memory power state.

Figure 8 Cross Loading Graph for 800W Configuration

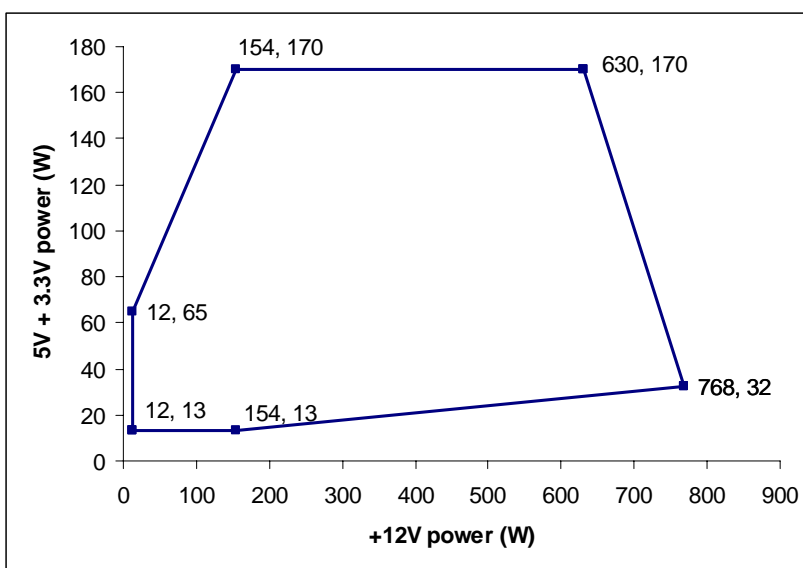


Table 21: 850 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	0.8 A	24 A	
+5 V	0.5 A	30 A	
+12V1	0 A	16 A	18 A
+12V2	0 A	16 A	18 A
+12V3	0.9 A	16 A	18 A
+12V4	0.1 A	18 A	22 A ⁷
+12V5	0 A	18 A	
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A / 4.0 A ⁸	3.5 A / 4.5 A ⁸

1. Maximum continuous total DC output power should not exceed 850 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 170 W.
3. Maximum peak total DC output power should not exceed 930 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 68 A.
6. Peak current for the combined 12 V outputs shall be 74 A.
7. Peak power on the +12V4 rail shall be sustained for a minimum of 500msec.
8. 4.0 A / 4.5 A peak of +5 VSB is required only for power supplies in systems supporting ACPI S3 power state; suspend to memory. ACPI S3 is used to support workstation's suspend to memory power state. Servers do not typically support suspend to memory power state.

Figure 9 Cross Loading Graph for 850W Configuration

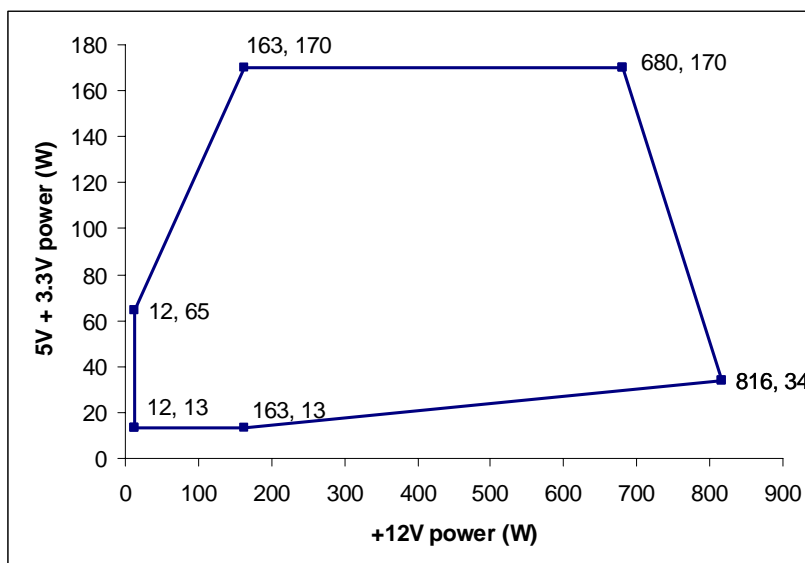
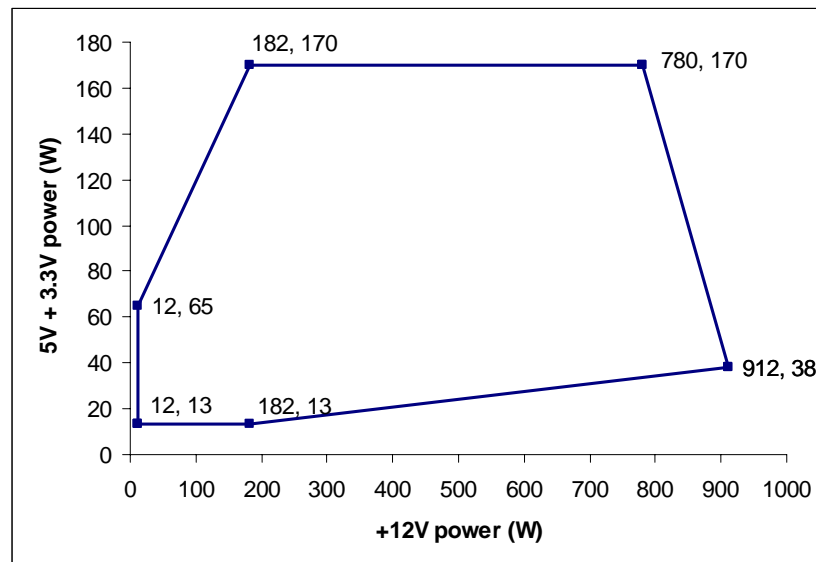


Table 22: 950 W Load Ratings

Voltage	Minimum Continuous	Maximum Continuous	Peak
+3.3 V	0.8 A	24 A	
+5 V	0.5 A	30 A	
+12V1	0 A	16 A	18 A
+12V2	0 A	16 A	18 A
+12V3	0.9 A	16 A	18 A
+12V4	0.1 A	18 A	22 A ⁷
+12V5	0 A	18 A	
-12 V	0 A	0.5 A	
+5 VSB	0.1 A	3.0 A / 6.0 A ⁸	3.5 A / 6.5 A ⁸

1. Maximum continuous total DC output power should not exceed 950 W.
2. Maximum continuous combined load on +3.3 VDC and +5 VDC outputs shall not exceed 170 W.
3. Maximum peak total DC output power should not exceed 1030 W.
4. Peak power and current loading shall be supported for a minimum of 12 second.
5. Maximum combined current for the 12 V outputs shall be 76 A.
6. Peak current for the combined 12 V outputs shall be 80 A.
7. Peak power on the +12V4 rail shall be sustained for a minimum of 500msec.
8. 6.0 A / 6.5 A peak of +5 VSB is required only for power supplies in systems supporting ACPI S3 power state; suspend to memory. ACPI S3 is used to support workstation's suspend to memory power state. Servers do not typically support suspend to memory power state.

Figure 10 Cross Loading Graph for 950W Configuration



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 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 specified in Section 6.8. 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 supply connectors referenced to ReturnS. The +3.3 V is measured at its remote sense signal (3.3VS) located at the signal connector.

Table 23: Voltage Regulation Limits

Parameter	MIN	NOM	MAX	Units	Tolerance
+3.3 V	+3.14	+3.30	+3.47	V _{rms}	+/-5%
+5 V	+4.75	+5.00	+5.25	V _{rms}	+/-5%
+12V1,2,3,4,5	+11.40	+12.00	+12.60	V _{rms}	+/-5%
-12 V	-10.80	-12.20	-13.20	V _{rms}	+/-10%
+5 VSB	+4.75	+5.00	+5.25	V _{rms}	+5/-5%

STATUS
Optional

Some system applications may require tighter regulation limits on the outputs. The optional regulation limits are shown below.

Table 24: Optional Regulation Limits

Parameter	MIN	NOM	MAX	Units	Tolerance
+3.3V	+3.20	+3.30	+3.47	V _{rms}	+5/-3%
+5 V	+4.85	+5.00	+5.25	V _{rms}	+5/-3%
+12V1,2,3,4,5	+11.64	+12.00	+12.60	V _{rms}	+5/-3%
-12V	-11.40	-12.00	-13.08	V _{rms}	+9/-5%
+5 VSB	+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 23 for the step loading and within the limits specified in Table 25 for the capacitive loading specified in below. 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 range.

Table 25: Transient Load Requirements

Output	Δ Step Load Size	Load Slew Rate	Capacitive Load
+3.3 V	30% of max load	0.5 A/ μ s	1000 μ F
+5 V	30% of max load	0.5 A/ μ s	1000 μ F
12V1+12V2+12V3+12V4+12V5	65% of max load	0.5 A/ μ s	2200 μ F
+5 VSB	25% of max load	0.5 A/ μ s	1 μ F

6.7 Capacitive Loading

STATUS
Required

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

Table 26: Capacitive Loading Conditions

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

6.8 Ripple / Noise

STATUS
Required

The maximum allowed ripple/noise output of the power supply is defined in Table 27. This is measured over a bandwidth of 0 Hz to 20 MHz at the power supply output connectors. A 10 μ F tantalum capacitor in parallel with a 0.1 μ F ceramic capacitor are placed at the point of measurement.

Table 27: 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 Timing Requirements

STATUS
Required

These are the timing requirements for the power supply operation. The output voltages must rise from 10% to within regulation limits ($T_{\text{vout_rise}}$) within 5 to 70 ms; except for 5VSB which is required to rise from 10% to regulation limits within 1 to 25ms. 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 ($T_{\text{vout_on}}$) of each other during turn on of the power supply. Each output voltage shall fall out of regulation within 400 ms ($T_{\text{vout_off}}$) of each other during turn off. Figure 11 and Figure 12 show the turn ON and turn OFF timing requirements. In Figure 12 the timing is shown with both AC and PSON# controlling the ON/OFF of the power supply.

Table 28: Output Voltage Timing

Item	Description	MIN	MAX	Units
T_{vout_rise}	Output voltage rise time from each main output.	5	70	ms
	Output voltage rise time for the 5VSB output.	1	25	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

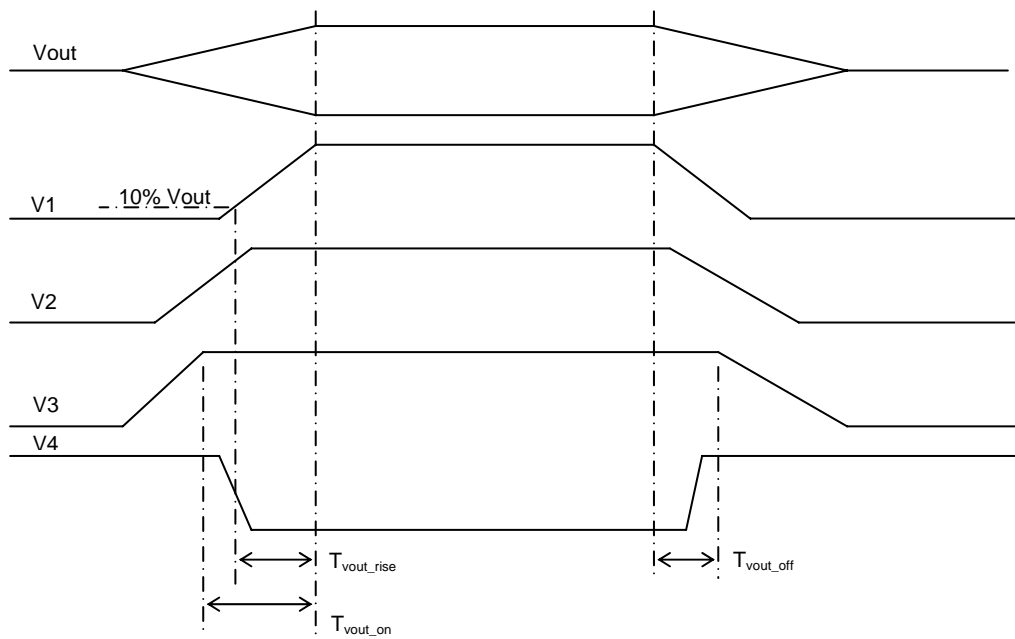


Figure 11: Output Voltage Timing

Table 29: 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. Tested at 75% of maximum load and over 100-240VAC input.	18		ms
T _{pwok_holdup}	Delay from loss of AC to deassertion of PWOK. Tested at 75% of maximum load and over 100-240VAC input.	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.	100	500	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

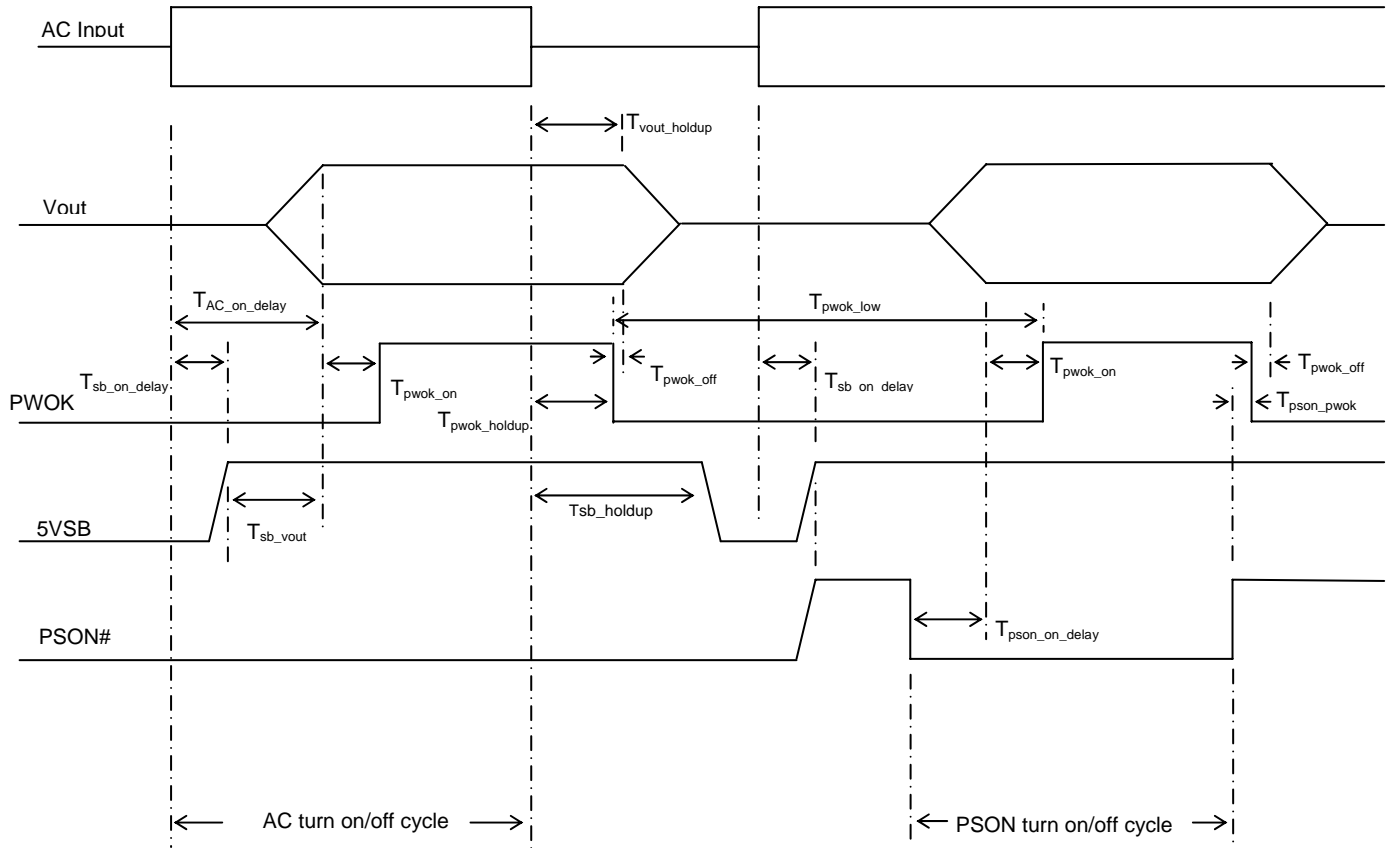


Figure 12: Turn On/Off Timing (Single Power Supply)

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 second 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 30. 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. All outputs shall be protected so that no damage occurs to the power supply under a shorted output condition.

Table 30: Over Current Protection

Voltage	Over Current Limit (I _{out} limit)
+3.3 V	110% minimum; 150% maximum
+5 V	110% minimum; 150% maximum
+12V	110% minimum; 150% maximum

Note: If the power supply supports 240VA protection, section 7.2 should be used instead to determine over current protection requirements.

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 split into four rails. Refer to section 6.4 for how the 12V rail is split between different output connectors.

Table 31: Over Current Limits

Voltage	Over Current Limit (lout limit)
+3.3 V	110% minimum; 150% maximum
+5 V	110% minimum; 150% maximum
+12V1,2,3,4,5	Peak current minimum; 20A maximum
+12V4 (750W-950W)	Peak current minimum; 22A maximum ¹

- +12V4 peak current for the 750W and 800W power supplies shall be maintained for a minimum of 500msec. The maximum duration of the peak current exceeding the 240VA limit should be limited to meet safety regulations. A maximum duration of 1 second is recommended.

7.3 Over Voltage Protection

STATUS
Required

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. Table 32 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 32: Over Voltage Limits

Output Voltage	MIN (V)	MAX (V)
+3.3 V	3.9	4.5
+5 V	5.7	6.5
+12V1,2,3,4,5	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) turn off. This signal is pulled to a standby voltage by a pull-up resistor internal to the power supply. Refer to Figure 12 for timing diagram.

Table 33: 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, $V_{pson} = \text{low}$		4 mA
Power up delay: $T_{pson_on_delay}$	5 ms	400 ms
PWOK delay: T_{pson_pwok}		50 ms

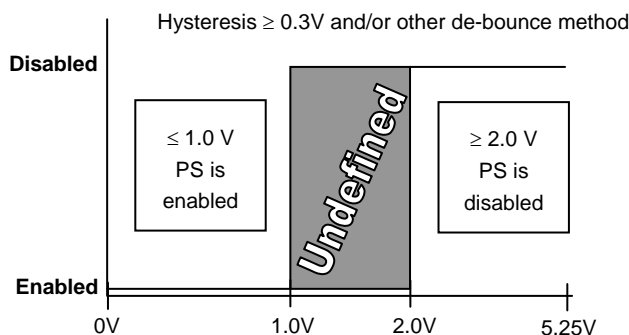


Figure 13: PSON# Signal Characteristics

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 12 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 34: PWOK Signal Characteristics

Signal Type	+5V TTL Compatible output signal	
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 μA	2.4 V	5.25 V
PWOK delay: T_{pwok_on}	200 ms	1000 ms
PWOK rise and fall time		100 μ s
Power down delay: T_{pwok_off}	1 ms	

8.3 SMBus Communication

STATUS
Optional

The serial bus communication devices for PSMI and FRU data in the power supply shall be compatible with both SMBus 2.0 'high power' and I²C V_{dd} based power and drive. This bus shall operate at 3.3V but tolerant of 5V signaling. The SMBus pull-ups are located on the motherboard and may be connected to 3.3V or 5V.

Two pins are allocated on the power supply. One pin is the Serial Clock (PSM Clock). The second pin is used for Serial Data (PSM Data). Both pins are bi-directional and are used to form a serial bus. The circuits inside the power supply shall derive their power from the 5VSB bus. No pull-up resistors shall be on SCL or SDA inside the power supply. These pull-up resistors should be located external to the power supply.

8.4 Power Supply Management Interface

STATUS
Optional

The PSMI device in the power supply shall derive its power off of the 5VSB output and grounded to ReturnS. It shall be located at address B0h. Refer to the PSMI specification posted on the www.ssiforum.org website for details on the Power Supply Monitoring Interface requirements. PSMI is a SMBus interface used to communicate power management information to the system.

8.5 Field Replacement Unit (FRU) Signals

STATUS
Optional

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.

8.5.1 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 versions of these specifications are available at:

<http://developer.intel.com/design/servers/ipmi/spec.htm>.

8.5.2 FRU Data Format

Table 35: 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

8.5.2.1 Product Info Area

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

Table 36: 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}

8.5.2.2 MultiRecord Area

Implement 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 37: MultiRecord information Area

Field Name (PS Info)	Field Information Definition
Overall Capacity (watts)	550 {Low power version would be 450}
Peak VA	610 {Low power version would be 490}
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, 610 W {Low power version would be 490 W}
Combined wattage	Set for 5 V & 3.3V combined wattage of 115 W {Low power version would be 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.

9 MTBF

STATUS
Recommended

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

10 Agency 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.