Power Supply

Design Guide for Desktop Platform Form Factors

Revision 1.0

June 2006

*Other names and brands may be claimed as the property of others.

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Revision	Description	Date
0.5	• Initial release of combined power supply design guide • Combined CFX12V, LFX12V, ATX12V, SFX12V, and TFX12V content into one desktop power supply design guide • CFX12V content derived from revision 1.2 — - Updated 12V1 current for 300 W configuration — - Updated efficiency loading for 300 W configuration • LFX12V content derived from revision 1.1 • ATX12V content derived from revision 2.2 • SFX12V content derived from revision 3.1 • TFX12V content derived from revision 2.1 — - Updated 12V1 current for 300 W configuration — - Updated efficiency loading for 300 W configuration • Updated Capacitive Load section to use standard capacitor values • Updated 5 VSB efficiency recommendations for Digital Office platforms • Removed power-down warning from power supply timing diagram • Marked sections with labels to indicate REQUIRED, RECOMMENDED, or OPTIONAL items	January 2006
1.0	• Added 12V2 Current for Processor Configurations table • Added revision numbers to form factor specific chapters • Changed Input Line Current Harmonic Content to OPTIONAL to better reflect geographical requirements	June 2006

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1 Introduction

This document provides design suggestions for various power supply form factors. The power supplies are primarily intended for use with desktop system designs. It should not be inferred that all power supplies must conform exactly to the content of this document, though there are key parameters that define mechanical fit across a common set of platforms. Since power supply needs vary depending on system configuration, the design specifics described are not intended to support all possible systems.

1.1 Reference Documentation

The following documents are referenced in various sections of this design guide. For guidelines not specifically mentioned here, please reference the appropriate document.

Document	Document Number/Source or Password
European Association of Consumer Electronics Manufacturers (EACEM*) Hazardous Substance List / Certification	AB13-94-146
IEEE* Recommended Practice on Surge Voltages in Low-Voltage AC Circuits	ANSI* C62.41-1991
IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits	ANSI C62.45-1992
Nordic national requirement in addition to EN 60950	EMKO-TSE (74-SEC) 207/94
American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz for EMI testing	ANSI C63.4 – 1992
UL 60950-1 First Edition (2003) –CAN/CSA-C22.2 No. 60950-1-03 First Edition,	
IEC 60950-1: 2001 + Amendments and National Deviations,	
EN 60950-1: 2001 + Amendment A11: 2004,	
EU Low Voltage Directive (73/23/EEC) (CE Compliance)	
GB-4943-2001 (China)	
CNS 14336: 2004 (Taiwan BSMI)	
FCC*, Class B, Part 15 (Radiated & Conducted Emissions)	
CISPR* 22 / EN55022, 5th Edition (Radiated & Conducted Emissions)	
EN55024 (ITE Specific Immunity)	
EN 61000-4-2 – Electrostatic Discharge	
EN 61000-4-3– Radiated RFI Immunity	
EN 61000-4-4– Electrical Fast Transients	

Document	Document Number/Source or Password
EN 61000-4-5 – Electrical Surge	
EN 61000-4-6 – RF Conducted	
EN 61000-4-8 – Power Frequency Magnetic Fields	
EN 61000-4-11 – Voltage Dips, Short Interrupts and Fluctuations	
EN61000-3-2 (Harmonics)	
EN61000-3-3 (Voltage Flicker)	
EU EMC Directive ((8/9/336/EEC) (CE Compliance)	

1.2 Terminology

Table 1 defines the acronyms, conventions, and terminology that are used throughout the design guide.

Table 1. Conventions and Terminology (Sheet 1 of 2)

Acronym, Convention / Terminology	Definition
AWG	American Wire Gauge
BA	Declared sound power, LwAd. The declared sound power level shall be measured according to ISO* 7779 for the power supply and reported according to ISO 9296.
CFM	Cubic Feet per Minute (airflow).
Monotonically	A waveform changes from one level to another in a steady fashion, without oscillation.
MTBF	Mean time between failure.
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.
PWR_OK	PWR_OK is a “power good” signal used by the system power supply to indicate that the +5VDC, +3.3 VDC and +12VDC outputs are within the regulation thresholds of the power supply.
Ripple noise	The periodic or random signals over a frequency band of 0 Hz to 20 MHz.

Table 1. Conventions and Terminology (Sheet 2 of 2)

Acronym, Convention / Terminology	Definition
Rise Time	Rise time is defined as the time it takes any output voltage to rise from 10% to 95% of its nominal voltage.
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.

Table 2. Support Terminology

Category	Description
Optional	The status given to items within this design guide, which are not required to meet design guide, however, some system applications may optionally use these features. May be a required or recommended item in a future design guide.
Recommended	The status given to items within this design guide, which are not required to meet design guide, however, are required by many system applications. May be a required item in a future design guide.
Required	The status given to items within this design guide, which are required to meet design guide and a large majority of system applications.

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2 Platform Configurations

2.1 Digital Home and Digital Office Platform Configurations - RECOMMENDED

Table 1 and Table 3 show power supply recommendations for various platform configurations. These configurations are based on platforms described in the Digital Home and Digital Office Desktop Platform Vision Guides for 2006. Additional configuration details can be found at the Intel® Platform Vision Program website: http://www.intel.com/platforms/desktop/vision/

The configurations here and the recommended power supplies are suggestions. System designers should perform engineering analysis based on the specific system configuration to determine the appropriate power supply for their needs.

Table 3. Digital Office Platform Configurations for 2006

	Fundamental	Professional
Form Factor	BTX family	Small form factor based on BTX
Volume / profile	~13 to 25 liter desktop or tower	~7 to 11 liter 3-4" thick desktop or mini-tower
Power supply	CFX12V 300 W	LFX12V ≥ 240 W

Table 4. 12V2 Current for Processor Configurations

	12V2 Current Recommendation	
Processor Configuration	Continuous	Peak[1]
04A	13 A	-
04B	13 A	-
05A	13 A	16.5 A
05B	16 A	19 A
06	8 A	13 A

NOTES:
1. The power supply should be able to supply peak current for at least 10 ms.

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3 Electrical

The following electrical requirements are required and must be met over the environmental ranges as defined in Chapter 6 (unless otherwise noted).

3.1 AC Input - REQUIRED

Table 5 lists AC input voltage and frequency requirements for continuous operation. The power supply shall be capable of supplying full-rated output power over two input voltage ranges rated 100-127 VAC and 200-240 VAC rms nominal. The correct input range for use in a given environment may be either switch-selectable or auto-ranging. The power supply shall automatically recover from AC power loss. The power supply must be able to start up under peak loading at 90 VAC.

Note: OPTIONAL - 115 VAC or 230 VAC only power supplies are an option for specific geographical or other requirements.

Table 5. AC Input Line Requirements

Parameter	Minimum	Nominal[1]	Maximum	Unit
V_{in} (115 VAC)	90	115	135	VAC_{rms}
V_{in} (230 VAC)	180	230	265	VAC_{rms}
V_{in} Frequency	47	-	63	Hz
I_{in} (115 VAC)	-	-	6	A_{rms}
I_{in} (230 VAC)	-	-	3	A_{rms}

NOTES:

1. Nominal voltages for test purposes are considered to be within ±1.0 V of nominal.

3.1.1 Input Over Current Protection - REQUIRED

The power supply is required to incorporate primary fusing 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.

3.1.2 Inrush Current Limiting - REQUIRED

Maximum inrush current from power-on (with power-on at any point on the AC sine) and including, but not limited to, three line cycles, shall be limited to a level below the surge rating of the input line cord, AC switch if present, bridge rectifier, fuse, and EMI filter components. Repetitive ON/OFF cycling of the AC input voltage should not damage the power supply or cause the input fuse to blow.

3.1.3 Input Under Voltage - REQUIRED

The power supply is required to contain protection circuitry such that the application of an input voltage below the minimum specified in Table 5, shall not cause damage to the power supply.

3.2 DC Output - REQUIRED

3.2.1 DC Voltage Regulation

The DC output voltages are required to remain within the regulation ranges shown in Table 6, when measured at the load end of the output connectors under all line, load, and environmental conditions specified in Chapter 6.

Table 6. DC Output Voltage Regulation

Output	Range	Min	Nom	Max	Unit
+12V1DC[1]	±5%	+11.40	+12.00	+12.60	V
+12V2DC[2]	±5%	+11.40	+12.00	+12.60	V
+5VDC	±5%	+4.75	+5.00	+5.25	V
+3.3VDC[3]	±5%	+3.14	+3.30	+3.47	V
-12VDC	±10%	-10.80	-12.00	-13.20	V
+5VSB	±5%	+4.75	+5.00	+5.25	V

NOTES:
1. At +12V1 VDC peak loading, regulation at the +12V1 VDC output can go to ±10%.
2. Minimum voltage during peak loading is 11.0 VDC for the 12V2 output.
3. Voltage tolerance is required at main connector and SATA connector (if used).

3.2.2 Output Transient Response - REQUIRED

Table 7 summarizes the expected output transient step sizes for each output. The transient load slew rate is = 1.0 A/µs.

Table 7. DC Output Transient Step Sizes[1]

Output	Maximum Step Size (% of rated output amps)	Maximum Step Size (A)
+12 V1DC	40%	-
+12 V2DC	60%	-
+5 VDC	30%	-
+3.3 VDC	30%	-
-12 VDC	-	0.1
+5 VSB	-	0.5

NOTES:
1. For example, for a rated +5 VDC output of 14 A, the transient step would be 30% × 14 A = 4.2 A.

Output voltages should remain within the regulation limits of Table 6, for instantaneous changes in load as specified in Table 7 and for the following conditions:

- Simultaneous load steps on the +12 VDC, +5 VDC, and +3.3 VDC outputs (all steps occurring in the same direction)
- Load-changing repetition rate of 50 Hz to 10 kHz
- AC input range per Section 2.1 and Capacitive loading per Table 11.

3.2.3 Remote Sensing - REQUIRED

The +3.3 VDC output should have provisions for remote sensing to compensate for excessive cable drops. The default sense should be connected to pin 13 of the main power connector (Figure 4). The power supply should draw no more than 10 mA through the remote sense line to keep DC offset voltages to a minimum.

3.2.4 Energy Star* - RECOMMENDED

The Energy Star* efficiency requirements of the power supply depend on the intended system configuration. In the low power / sleep state (S1 or S3) the system should consume power in accordance with the values listed in Table 8.

Table 8. Energy Star* Input Power Consumption

Maximum Continuous Power Rating of Power Supply	RMS Watts from the AC Line in Sleep/low Power Mode
≤ 200 W	≤ 15 W
> 200 W ≤ 300 W	≤ 20 W
> 300 W ≤ 350 W	≤ 25 W
> 350 W ≤ 400 W	≤ 30 W
> 400 W	10% of the maximum continuous output rating

3.2.5 Other Low Power System Requirements - RECOMMENDED

To help meet the Blue Angel* system requirements, RAL-UZ 78, US Presidential executive order 13221, future EPA requirements, and other low Power system demands, It is recommended that the +5 VSB standby supply efficiency should be as high as possible. Standby efficiency is measured with the main outputs off (PS_ON# high state). Standby efficiency should be as shown in Table 9. This recommendation is applicable primarily to Digital Office platforms.

Table 9. Recommended 5 VSB Efficiency

Load	Efficiency
100 mA	≥ 50%
250 mA	≥ 60%
≥ 1 A	≥ 70%

3.2.6 Output Ripple Noise - REQUIRED

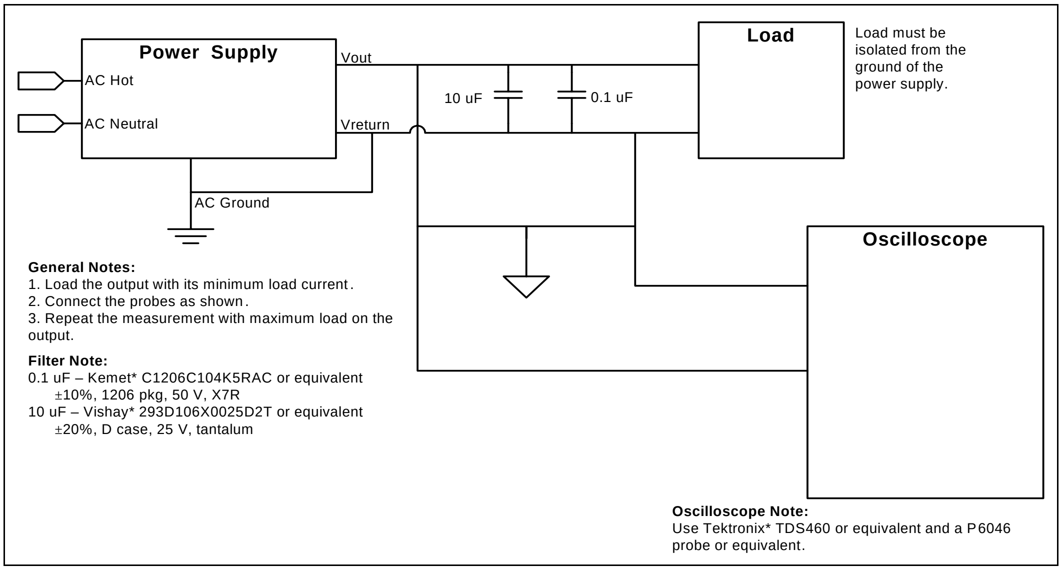
The output ripple noise requirements listed in Table 10 should be met throughout the load ranges specified for the appropriate form factor and under all input voltage conditions as specified in Table 5.

Ripple and noise are defined as periodic or random signals over a frequency band of 10 Hz to 20 MHz. Measurements shall be made with an oscilloscope with 20 MHz of bandwidth. Outputs should be bypassed at the connector with a 0.1µF ceramic disk capacitor and a 10 µF electrolytic capacitor to simulate system loading. See Figure 1 for the differential noise measurement setup.

Table 10. DC Output Noise / Ripple

Output	Maximum Ripple and Noise (mV p-p)
+12 V1DC	120
+12 V2DC	120
+5 VDC	50
+3.3 VDC	50
-12 VDC	120
+5 VSB	50

Figure 1. Differential Noise Test Setup



3.2.7 Capacitive Load - REQUIRED

The power supply should be able to power up and operate with the regulation limits defined in Table 6, with the following capacitances simultaneously present on the DC outputs.

Table 11. Output Capacitive Loads

Output	Capacitive Load (µF)
+12 V1DC	4700
+12 V2DC	3300
+5 VDC	10000
+3.3 VDC	5600
-12 VDC	330
+5 VSB	330

3.2.8 Closed Loop Stability - REQUIRED

The power supply shall be unconditionally stable under all line/load/transient load conditions including capacitive loads specified in Section 3.2.7. A minimum of 45 degrees phase margin and 10 dB gain margin is recommended at both the maximum and minimum loads.

3.2.9 +5 VDC / +3.3 VDC Power Sequencing - REQUIRED

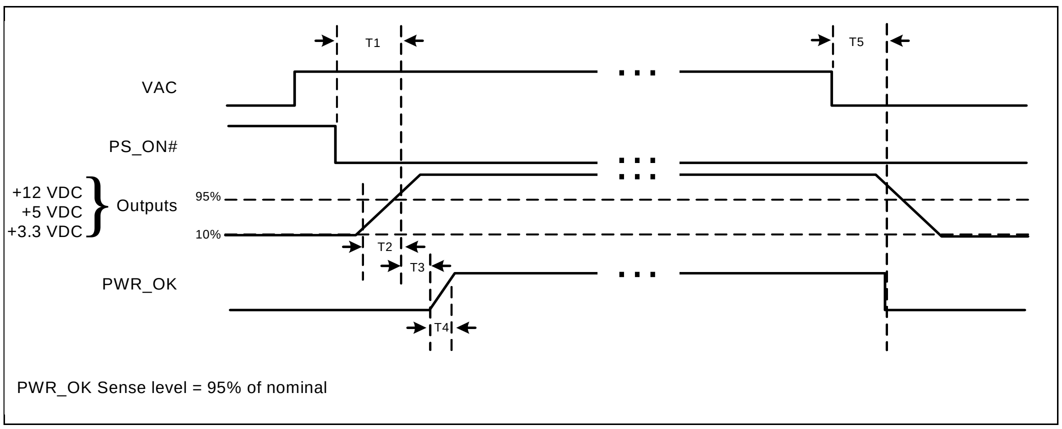
The +12V1 DC / +12V2 DC and +5 VDC output levels must be equal to or greater than the +3.3 VDC output at all times during power-up and normal operation. The time between any output of +12V1 DC / +12V2 DC and +5 VDC reaching its minimum in-regulation level and +3.3 VDC reaching its minimum in-regulation level must be ≤ 20 ms.

3.2.10 Voltage Hold-up Time - REQUIRED

The power supply should maintain output regulations per Table 6 despite a loss of input power at the low-end nominal range-115 VAC / 47 Hz or 230 VAC / 47 Hz - at maximum continuous output load as applicable for a minimum of 17 ms.

3.3 Timing, Housekeeping and Control - REQUIRED

Figure 2. Power Supply Timing



3.3.1 PWR_OK

PWR_OK is a “power good” signal. This signal should be asserted high by the power supply to indicate that the +12 VDC, +5 VDC, and +3.3 VDC outputs are within the regulation thresholds listed in Table 6 and that sufficient mains energy is stored by the converter to guarantee continuous power operation within specification for at least the duration specified in Section 3.2.10. Conversely, PWR_OK should be de-asserted to a low state when any of the +12 VDC, +5 VDC, or +3.3 VDC output voltages falls below its under voltage threshold, or when mains power has been removed for a time sufficiently long such that power supply operation cannot be guaranteed beyond the power-down warning time. The electrical and timing characteristics of the PWR_OK signal are given in Table 13 and in Figure 2.

Table 12. PWR_OK Signal Timing

Parameter	Description	Value
T1	Power-on time	< 500 ms
T2	Rise time	0.2 - 20 ms
T3	PWR_OK delay	100 - 500 ms
T4	PWR_OK rise time	< 10 ms
T5	AC loss to PWR_OK hold-up time	> 16 ms

Table 13. PWR_OK Signal Characteristics

Signal type	+5 V TTL compatible
Logic level low	< 0.4 V while sinking 4 mA
Logic level high	Between 2.4 V and 5 V output while sourcing 200 μA
High state output impedance	1 kΩ from output to common

3.3.2 PS_ON#

PS_ON# is an active-low, TTL-compatible signal that allows a motherboard to remotely control the power supply in conjunction with features such as soft on/off, Wake on LAN*, or wake-on-modem. When PS_ON# is pulled to TTL low, the power supply should turn on the four main DC output rails: +12 VDC, +5 VDC, +3.3 VDC, and -12 VDC. When PS_ON# is pulled to TTL high or open-circuited, the DC output rails should not deliver current and should be held at zero potential with respect to ground. PS_ON# has no effect on the +5 VSB output, which is always enabled whenever the AC power is present. Table 14 lists PS_ON# signal characteristics.

The power supply shall provide an internal pull-up to TTL high. The power supply shall also provide de-bounce circuitry on PS_ON# to prevent it from oscillating on/off at startup when activated by a mechanical switch. The DC output enable circuitry must be SELV-compliant.

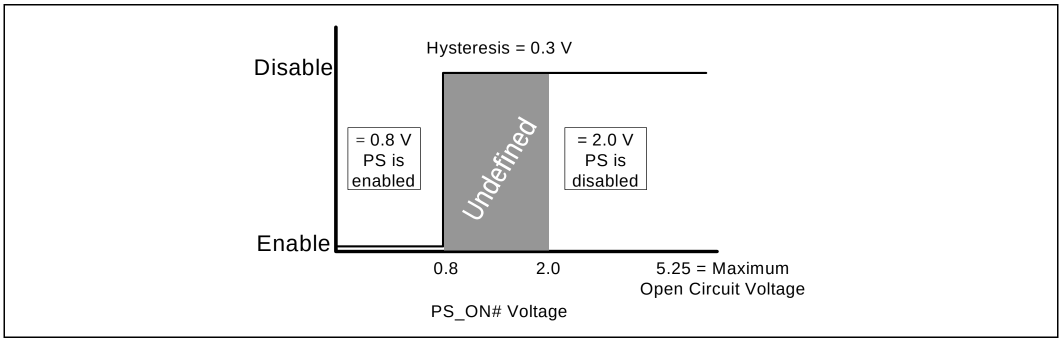
The power supply shall not latch into a shutdown state when PS_ON# is driven active by pulses between 10 ms to 100 ms during the decay of the power rails.

Table 14. PS_ON# Signal Characteristics

Parameter	Minimum	Maximum
V_{IL}	0	0.8 V
IIL (V_{IN} = 0.4 V)	-	-1.6 mA[1]
V_{IH} (I_{IN} = - 200 uA)	2.0 V	-
V_{IH} open circuit	-	5.25 V

NOTES:
1. Negative current indicates that the current is flowing from the power supply to the motherboard.

Figure 3. PS_ON# Signal Characteristics



3.3.3 +5 VSB

+5 VSB is a standby supply output that is active whenever the AC power is present. This output provides a power source for circuits that must remain operational when the five main DC output rails are in a disabled state. Example uses include soft power control, Wake on LAN, wake-on-modem, intrusion detection, or suspend state activities.

The power supply must be able to provide the required power during a “wake up” event. If an external USB device generates the event, there may be peak currents as high as 2.5 A., lasting no more than 500 ms.

Over current protection is required on the +5 VSB output regardless of the output current rating. This ensures the power supply will not be damaged if external circuits draw more current than the supply can provide.

3.3.4 Power-on Time

The power-on time is defined as the time from when PS_ON# is pulled low to when the +12 VDC, +5 VDC, and +3.3 VDC outputs are within the regulation ranges specified in Table 6. The power-on time shall be less than 500 ms ($T1 < 500$ ms).

+5 VSB shall have a power-on time of two seconds maximum after application of valid AC voltages.

3.3.5 Rise Time

The output voltages shall rise from 10% of nominal to within the regulation ranges specified in Table 6 within 0.2 ms to 20 ms ($0.2 \text{ ms} \le T2 \le 20 \text{ ms}$).

There must be a smooth and continuous ramp of each DC output voltage from 10% to 90% of its final set point within the regulation band, while loaded as specified.

The smooth turn-on requires that, during the 10% to 90% portion of the rise time, the slope of the turn-on waveform must be positive and have a value of between 0 V/ms and [Vout, nominal / 0.1] V/ms. Also, for any 5 ms segment of the 10% to 90% rise time waveform, a straight line drawn between the end points of the waveform segment must have a slope ≥ [Vout, nominal / 20] V/ms.

3.3.6 Overshoot at Turn-on / Turn-off

The output voltage overshoot upon the application or removal of the input voltage, or the assertion/de-assertion of PS_ON#, under the conditions specified in Table 6, shall be less than 10% above the nominal voltage. No voltage of opposite polarity shall be present on any output during turn-on or turn-off.

3.4 Reset after Shutdown

If the power supply latches into a shutdown state because of a fault condition on its outputs, the power supply shall return to normal operation only after the fault has been removed and the PS_ON# has been cycled OFF/ON with a minimum OFF time of one second.

3.4.1 +5 VSB at Power-down

After AC power is removed, the +5 VSB standby voltage output should remain at its steady state value for the minimum hold-up time specified in Section 3.2.10 until the output begins to decrease in voltage. The decrease shall be monotonic in nature, dropping to 0.0 V. There shall be no other disturbances of this voltage at or following removal of AC power.

3.5 Output Protection - REQUIRED

3.5.1 Over Voltage Protection

The over voltage sense circuitry and reference shall reside in packages that are separate and distinct from the regulator control circuitry and reference. No single point fault shall be able to cause a sustained over voltage condition on any or all outputs. The supply shall provide latch-mode over voltage protection as defined in Table 15.

Table 15. Over Voltage Protection

Output	Minimum (V)	Nominal (V)	Maximum (V)
+12 VDC (or 12V1DC & 12V2DC)	13.4	15.0	15.6
+5 VDC	5.74	6.3	7.0
+3.3 VDC	3.76	4.2	4.3
5 VSB[1]	5.74	6.3	7.0

NOTES:
1. Over voltage protection is RECOMMENDED but not REQUIRED for this output.

3.5.2 Short Circuit Protection

An output short circuit is defined as any output impedance of less than 0.1 ohms. The power supply shall shut down and latch off for shorting the +3.3 VDC, +5 VDC, or +12 VDC rails to return or any other rail. The +12V1 DC and 12V2 DC should have separate short circuit and over current protection. Shorts between main output rails and +5 VSB shall not cause any damage to the power supply. The power supply shall either shut down and latch off or fold back for shorting the negative rails. +5 VSB must be capable of being shorted indefinitely, but when the short is removed, the power supply shall recover automatically or by cycling PS_ON#. The power supply shall be capable of withstanding a continuous short circuit to the output without damage or overstress to the unit (for example, to components, PCB traces, and connectors) under the input conditions specified in Table 5.

3.5.3 No-load Situation

No damage or hazardous condition should occur with all the DC output connectors disconnected from the load. The power supply may latch into the shutdown state.

3.5.4 Over Current Protection

Current protection should be designed to limit the current to operate within safe operating conditions.

3.5.5 Over Temperature Protection

As an option, the power supply may include an over-temperature protection sensor, which can trip and shut down the power supply at a preset temperature point. Such an overheated condition is typically the result of internal current overloading or a cooling fan failure. If the protection circuit is non-latching, then it should have hysteresis built in to avoid intermittent tripping.

3.5.6 Output Bypass

The output return may be connected to the power supply chassis, and will be connected to the system chassis by the system components.

3.5.7 Separate Current Limit for 12V2 - RECOMMENDED

The 12 V rail on the 2x2 power connector should be a separate current limited output to meet the requirements of UL and EN 60950.

3.5.8 Overall Power Supply Efficiency

The efficiency of the power supply should be tested at nominal input voltage of 115 VAC input and 230 VAC input, under the load conditions defined in the form factor specific sections, and under the temperature and operating conditions defined in Chapter 6. The loading condition for testing efficiency shown in the form factor specific guidelines sections represent fully loaded systems, typical (50%) loaded systems, and light (20%) loaded systems. Refer to Chapter 10 through Chapter 14 for the efficiency loading for each power supply form factor.

Table 16. Efficiency Versus Load

Loading	Full Load	Typical Load	Light Load	PFC
REQUIRED Minimum Efficiency	70%	72%	65%	-
RECOMMENDED Minimum Efficiency	74%	77%	72%	-
OPTIONAL Minimum Efficiency	80%	80%	80%	0.9

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4 Mechanical

This section contains mechanical guidelines that apply to desktop power supplies regardless of form factor. For form factor specific design guides refer to Chapter 10 through Chapter 14.

4.1 Labeling and Marking - RECOMMENDED

The following is a non-inclusive list of suggested markings for each power supply unit. Product regulation stipulations for sale into various geographies may impose additional labeling requirements.

Manufacturer information: manufacturer's name, part number and lot date code, etc., in human-readable text and/or bar code formats

Nominal AC input operating voltages (100-127 VAC and 200-240 VAC) and current rating certified by all applicable safety agencies

DC output voltages and current ratings

Access warning text (“Do not remove this cover. Trained service personnel only. No user serviceable components inside.”) must be in English, German, Spanish, French, Chinese, and Japanese with universal warning markings.

4.2 Connectors - REQUIRED

4.2.1 AC Connector

The AC input receptacle should be an IEC 320 type or equivalent. In lieu of a dedicated switch, the IEC 320 receptacle may be considered the mains disconnect.

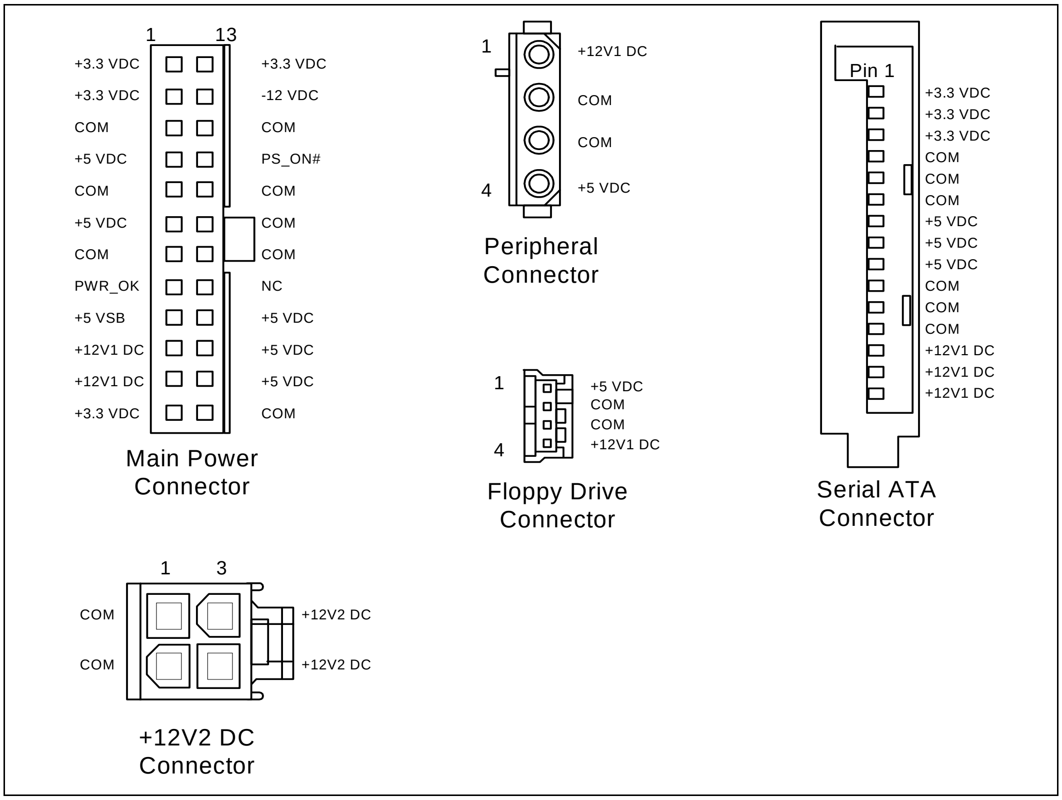
4.2.2 DC Connectors

Figure 4 shows pin outs and profiles for typical power supply DC harness connectors. The power supply requires an additional two-pin, power connector.

UL Listed or recognized component appliance wiring material rated min 85 °C, 300 VDC shall be used for all output wiring.

There are no specific requirements for output wire harness lengths, as these are largely a function of the intended end-use chassis, motherboard, and peripherals. Ideally, wires should be short to minimize electrical/airflow impedance and simplify manufacturing, yet they should be long enough to make all necessary connections without any wire tension (which can cause disconnections during shipping and handling). Recommended minimum harness lengths for general-use power supplies is 150 mm for all wire harnesses. Measurements are made from the exit port of the power supply case to the wire side of the first connector on the harness.

Figure 4. Connectors (Pin-side view, not to scale)



4.2.2.1 Main Power Connector

Connector: Molex* Housing: 24 Pin Molex Mini-Fit Jr. PN# 39-01-2240 or equivalent.

Contact: Molex 44476-1112 (HCS) or equivalent (Mating motherboard connector is Molex
44206-0007 or equivalent).

18 AWG is suggested for all wires except for the +3.3 V supply and sense return wires combined into pin 13 (22 AWG).

Table 17. Main Power Connector Pin-out

Pin	Signal	Color	Pin	Signal	Color
1	+3.3 VDC	Orange	13 [13]	+3.3 VDC [+3.3 V default sense]	Orange [Brown]
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

Table 17. Main Power Connector Pin-out

Pin	Signal	Color	Pin	Signal	Color
7	COM	Black	19	COM	Black
8	PWR_OK	Gray	20	Reserved	NC
9	+5 VSB	Purple	21	+5 VDC	Red
10	+12 V1DC	Yellow	22	+5 VDC	Red
11	+12 V1DC	Yellow	23	+5 VDC	Red
12	+3.3 VDC	Orange	24	COM	Black

4.2.2.2 Peripheral Connectors

Connector: AMP* 1-480424-0 or Molex* 8981-04P or equivalent.

Contacts: AMP 61314-1 or equivalent.

Table 18. Peripheral Connector Pin-out

Pin	Signal	Color[1]
1	+12 V1DC	Yellow
2	COM	Black
3	COM	Black
4	+5 VDC	Red

NOTES:
1. 18 AWG wire.

4.2.2.3 Floppy Drive Connector

Connector: AMP* 171822-4 or equivalent.

Table 19. Floppy Connector Pin-out

Pin	Signal	Color[1]
1	+5 VDC	Red
2	COM	Black
3	COM	Black
4	+12 V1DC	Yellow

NOTES:
1. 20 AWG wire.

4.2.2.4 +12 V Power Connector

Connector: Molex* 39-01-2040 or equivalent.

Contact: Molex 44476-1112 (HCS) or equivalent (Mating motherboard connector is Molex
39-29-9042 or equivalent).

Table 20. +12 V Power Connector Pin-out

Pin	Signal	Color[1]	Pin	Signal	Color[1]
1	COM	Black	3	+12 V2DC	Yellow
2	COM	Black	4	+12 V2DC	Yellow

NOTES:
1. 18 AWG wire.

4.2.2.5 Serial ATA* Power Connectors

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

The detailed requirements for the Serial ATA Power Connector can be found in the "Serial ATA: High Speed Serialized AT Attachment" specification, Section 6.3 "Cables and connector specification".
http://www.serialata.org/

Note: Connector pin numbers and wire numbers are not 1:1. Carefully check to confirm the correct arrangement.

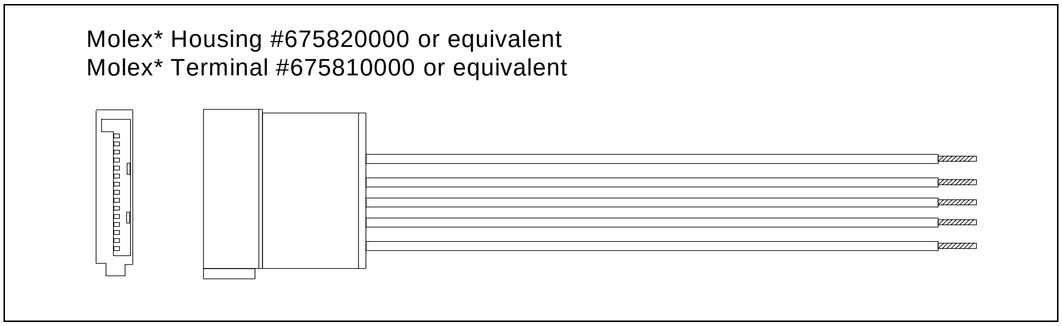
Assembly: Molex* 88751 or equivalent.

Table 21. Serial ATA* Power Connector Pin-out

Wire	Signal	Color[1]
5	+3.3 VDC	Orange
4	COM	Black
3	+5 VDC	Red
2	COM	Black
1	+12 V1DC	Yellow

NOTES:
1. 18 AWG wire.

Figure 5. Serial ATA* Power Connector



4.3 Airflow and Fans - RECOMMENDED

The designer's choice of a power supply cooling solution depends in part on the targeted end-use system application(s). At a minimum, the power supply design must ensure its own reliable and safe operation.

4.3.1 Fan Location and Direction

In general, exhausting air from the system chassis enclosure via a power supply fan at the rear panel is the preferred, most common, and most widely applicable system-level airflow solution. However, some system/chassis designers may choose to use other configurations to meet specific system cooling requirements.

4.3.2 Fan Size and Speed

A thermally sensitive fan speed control circuit is recommended to balance system-level thermal and acoustic performance. The circuit typically senses the temperature of the secondary heatsink and/or incoming ambient air and adjusts the fan speed as necessary to keep power supply and system component temperatures within specification. Both the power supply and system designers should be aware of the dependencies of the power supply and system temperatures on the control circuit response curve and fan size and should specify them carefully.

The power supply fan should be turned off when PS_ON# is de-asserted (high). In this state, any remaining active power supply circuitry must rely only on passive convection for cooling.

4.3.3 Venting

In general, more venting in a power supply case yields reduced airflow impedance and improved cooling performance. Intake and exhaust vents should be large, open, and unobstructed as possible so as not to impede airflow or generate excessive acoustic noise. In particular, avoid placing objects within 0.5 inches of the intake or exhaust of the fan itself. A flush-mount wire fan grill can be used instead of a stamped metal vent for improved airflow and reduced acoustic noise.

The limitations to the venting guidelines above are:

- Openings must be sufficiently designed to meet the safety requirements described in Chapter 8.
- Larger openings yield decreased EMI-shielding performance (see Chapter 7).
- Venting in inappropriate locations can detrimentally allow airflow to bypass those areas where it is needed.

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5 Acoustics

5.1 Acoustics - RECOMMENDED

It is recommended that the power supply be designed with an appropriate fan, internal impedance, and fan speed control circuitry capable of meeting the acoustic targets listed in Table 22.

The power supply assembly shall not produce and prominent discrete tone determined according to ISO 7779, Annex D.

Sound power determination is to be performed at 43 C, at 50% of the maximum rated load, at sea level. This test point is chosen to represent the environment seen inside a typical system at the idle acoustic test condition, with the 43 C being derived from the standard ambient assumption of 23 C, with 20 C added for the temperature rise within the system (what is typically seen by the inlet fan). The declared sound power shall be measured according to ISO 7779 and reported according to ISO 9296.

Table 22. Recommended Power Supply Acoustic Targets

	Idle (BA)	Typical (50% load) (BA)	Maximum (BA)
Minimum	3.5	4.0	5.0
Target	3.0	3.8	4.5

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6 Environmental

The following subsections define environmental specifications and test parameters, based on the typical conditions to which a power supply may be subjected during operation or shipment.

6.1 Temperature - RECOMMENDED

Operating ambient +10 °C to +50 °C (At full load, with a maximum temperature rate of change of 5 °C/10 minutes, but no more than 10 °C/hr.)

Non-operating ambient -40 °C to +70 °C (Maximum temperature rate of change of 20 °C/hr.)

6.1.1 Thermal Shock (Shipping)

- Non-operating -40 °C to +70 °C
- 15 °C/min ≤ dT/dt ≤ 30 °C/min
- Tested for 50 cycles; Duration of exposure to temperature extremes for each half cycle shall be 30 minutes.

6.2 Humidity - RECOMMENDED

Operating To 85% relative humidity (non-condensing)

Non-operating To 95% relative humidity (non-condensing)

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

6.3 Altitude - RECOMMENDED

Operating To 10,000 ft

Non-operating To 50,000 ft

6.4 Mechanical Shock - RECOMMENDED

Non-operating 50 g, trapezoidal input; velocity change ≥ 170 in/s

Three drops on each of six faces are applied to each sample.

6.5 Random Vibration - RECOMMENDED

Non-operating 0.01 g^2/Hz at 5 Hz, sloping to 0.02 g^2/Hz at 20 Hz, and maintaining 0.02 g^2/Hz from 20 Hz to 500 Hz. The area under the PSD curve is 3.13 gRMS. The duration shall be 10 minutes per axis for all three axes on all samples.

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7 Electromagnetic Compatibility

The following subsections outline applicable product regulatory requirements for the power supplies. Additional requirements may apply dependent upon the design, product end use, target geography, and other variables.

7.1 Emissions - REQUIRED

The power supply shall comply with FCC Part 15, EN55022 and CISPR 22, 5th ed., meeting Class B for both conducted and radiated emissions with a 4 dB margin. Tests shall be conducted using a shielded DC output cable to a shielded load. The load shall be adjusted as follows for three tests: No load on each output; 50% load on each output; 100% load on each output. Tests will be performed at 100 VAC 50Hz, 120 VAC 60 Hz, and 230 VAC 50 Hz power. Additionally, for FCC certification purposes, the power supply shall be tested using the methods in 47 CFR 15.32(b) and authorized under the Declaration of Conformity process as defined in 47 CFR 2.906 using the process in 47 CFR 2.1071 through 47 CFR 2.1077.

7.2 Immunity - REQUIRED

The power supply shall comply with EN 55024:1998 and CISPR 24 prior to sale in the EU (European Union), Korea, and possibly other geographies.

7.3 Input Line Current Harmonic Content - OPTIONAL

For sales in EU (European Union) the power supply shall meet the requirements of EN61000-3-2:2000 (IEC 61000-3-2:2000, modified).

Class D and the Guidelines for the Suppression of Harmonics in Appliances and General Use Equipment Class D for harmonic line current content at full rated power. See for the harmonic limits.

For sales in Japan the power supply shall meet the requirements of JEIDA MITI.

Table 23. Harmonic Limits, Class D Equipment

	Per EN61000-3-2	Per: JEIDA MITI
Harmonic Order (n)	Maximum permissible harmonic current at 230 VAC / 50 Hz (A)	Maximum permissible harmonic current at 100 VAC / 50 Hz (A)
3	2.3	5.29
5	1.14	2.622
7	0.77	1.771
9	0.4	0.92
11	0.33	0.759
13	0.21	0.483
15 = n = 39	0.15 x (15/n)	0.345 x (15/n)

7.4 Magnetic Leakage Fields - REQUIRED

A PFC choke magnetic leakage field should not cause any interference with a high-resolution computer monitor placed next to or on top of the end-use chassis.

7.5 Voltage Fluctuations and Flicker - REQUIRED

The power supply shall meet the specified limits of EN61000-3-3:1995 (IEC 61000-3-3:1994) and amendment A1:2001 to EN 61000-3-3:1995 (IEC 61000-3-3:1994/A1:2001) for voltage fluctuations and flicker for equipment drawing not more than 16AAC, connected to low voltage distribution systems.

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8 Safety

The following subsections outline sample product regulations requirements for a typical power supply. Actual requirements will depend on the design, product end use, target geography, and other variables. Consult your company's Product Safety and Regulations department or an accredited third party certification agency for more details.

8.1 North America - REQUIRED

The power supply must be certified by an NRTL (Nationally Recognized Testing Laboratory) for use in the USA and Canada under the following conditions:

- The power supply UL report "Conditions of Acceptability" shall meet in the intended application of the power supply in the end product.
- The supply must be recognized for use in Information Technology Equipment including Electrical Business Equipment per UL 60950-1 First Edition (2003). The certification must include external enclosure testing for the AC receptacle side of the power supply (see Appendices A, B, C, and D).
- The supply must have a full complement of tests conducted as part of the certification, such as input current, leakage current, hi-pot, temperature, energy discharge test, transformer output characterization test (open-circuit voltage, short-circuit performance), and abnormal testing (to include stalled-fan tests and voltage-select–switch mismatch).
- The enclosure must meet fire enclosure mechanical test requirements per clauses 2.9.1 and 4.2 of the above-mentioned standard.
- Production hi-pot testing must be included as a part of the certification and indicated as such in the certification report.
- There must not be unusual or difficult conditions of acceptability such as mandatory additional cooling or power de-rating. The insulation system shall not have temperatures exceeding their rating when tested in the end product.
- The certification mark shall be marked on each power supply.
- The power supply must be evaluated for operator-accessible secondary outputs (reinforced insulation) that meet the requirements for SELV.
- The proper polarity between the AC input receptacle and any printed wiring boards connections must be maintained (that is, brown=line, blue=neutral, and green=earth/chassis).
- The fan shall be protected by a guard to prevent contact by a finger in compliance with UL accessibility requirements.

8.2 International - REQUIRED

The vendor must provide a complete CB certificate and test report to IEC 60950-1:2001. The CB report must include ALL CB member country national deviations as appropriate for the target market. All evaluations and certifications must be for reinforced insulation between primary and secondary circuits.

The power supply must meet the RoHS requirements for the European Union and other countries which have adopted the RoHS requirements for banned materials.

8.3 Proscribed Materials

The following materials must not be used during design and/or manufacturing of this product:

- Cadmium should not be used in painting or plating - REQUIRED.
- Quaternary salt and PCB electrolytic capacitors shall not be used - REQUIRED.
- CFC's or HFC's shall not be used in the design or manufacturing process - REQUIRED.
- Mercury shall not be used - REQUIRED.
- Some geographies require lead free or RoHS compliant power supplies - RECOMMENDED.

8.4 Catastrophic Failure Protection - REQUIRED

Should a component failure occur, the power supply should not exhibit any of the following:

- Flame
- Excessive smoke
- Charred PCB
- Fused PCB conductor
- Startling noise
- Emission of molten material
- Earth ground fault (short circuit to ground or chassis enclosure)

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9 Reliability

9.1 Reliability - RECOMMENDED

The de-rating process promotes quality and high reliability. All electronic components should be designed with conservative device de-ratings for use in commercial and industrial environments.

Electrolytic capacitor and fan lifetime and reliability should be considered in the design as well.

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10 CFX12V Specific Guidelines 1.3

For Compact Form Factor with 12-volt connector power supplies.

10.1 Typical Power Distribution - RECOMMENDED

DC output power requirements and distributions will vary based on specific system options and implementation.

Significant dependencies include the quantity and types of processors, memory, add-in card slots, and peripheral bays, as well as support for advanced graphics or other features. Figure 7 through Figure 10 shows the power distribution and cross loading tables for power supplies in the range of 220 W to 300 W. These are recommendations but it is ultimately the responsibility of the designer to define a power budget for a given target product and market.

Figure 6. Cross Loading Graph for 220 W Configurations

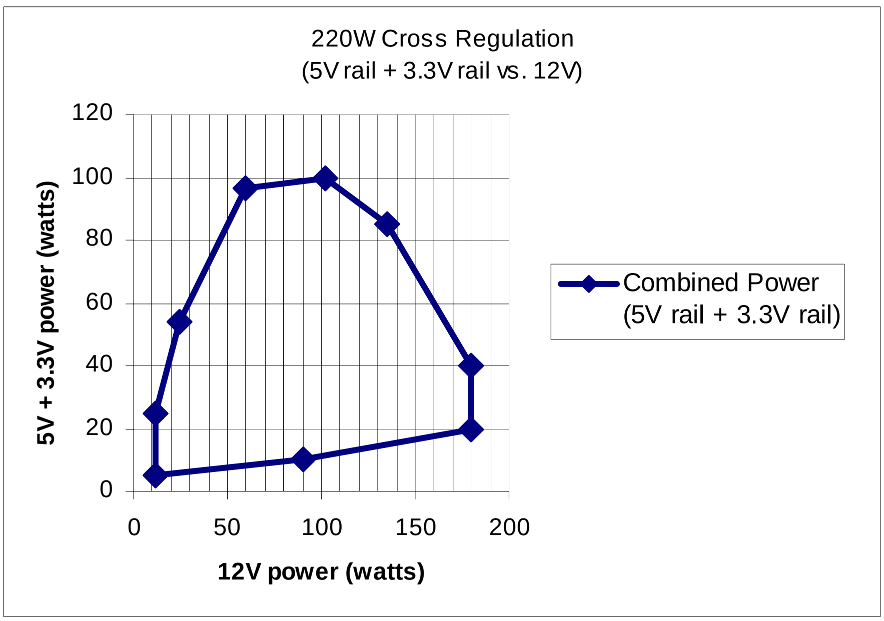


Table 24. Typical Power Distribution for 220 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+12 VDC	1.0	15.0	17.0
+5 VDC[1]	0.3	12.0	-
+3.3 VDC	0.5	12.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Total combined output of 3.3 V and 5 V is ≤100 W.

Figure 7. Cross Loading Graph for 240 W Configurations

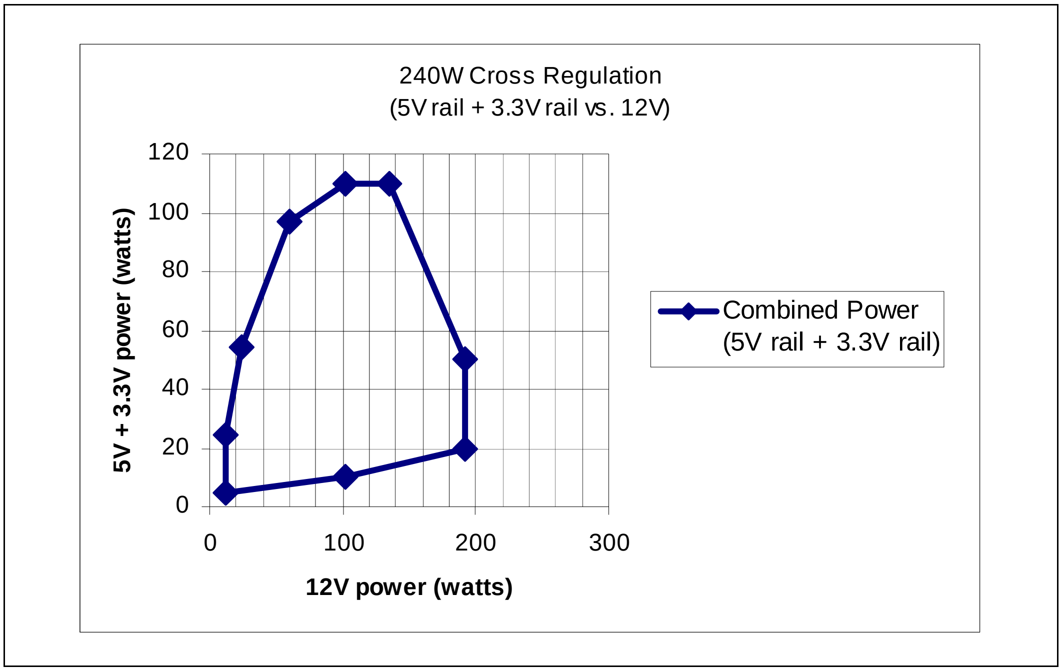


Table 25. Typical Power Distribution for 240 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+12 VDC	1.0	16.0	18.0
+5 VDC[1]	0.3	12.0	-
+3.3 VDC	0.5	14.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Total combined output of 3.3 V and 5 V is ≤110 W.

Figure 8. Cross Loading Graph for 275 W Configuration

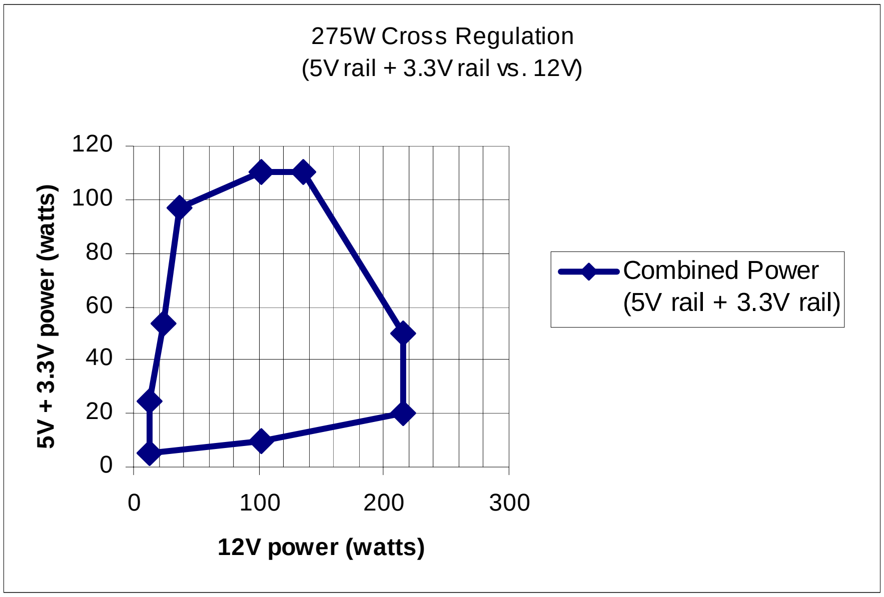


Table 26. Typical Power Distribution for 275 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+12 V1DC	1.0	5.0	7.0
+12 V2DC[1]	1.0	13.5	16.5
+5 VDC[2]	0.3	12.0	-
+3.3 VDC	0.5	16.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. 12V2 supports processor power requirements and must have a separate current limit and provide 16.5 A peak current lasting for 10 ms. The minimum voltage during peak is > 11.0 VDC.
2. Total combined output of 3.3 V and 5 V is ≤110 W.

Figure 9. Cross Loading Graph for 300 W Configuration

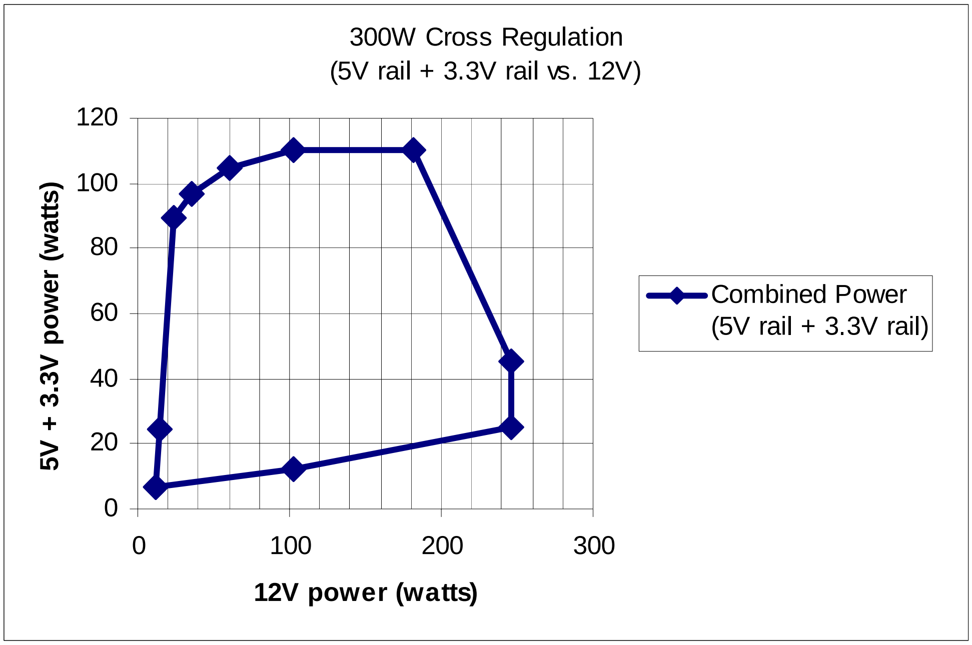


Table 27. Typical Power Distribution for 300 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+12 V1DC	1.0	8.0	9.0
+12 V2DC[1]	1.0	16.0	19.0
+5 VDC[2]	0.35	12.0	-
+3.3 VDC	0.5	20.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:
1. 12V2 supports processor power requirements and must have a separate current limit and provide 19 A peak current lasting for 10 ms. The minimum voltage during peak is > 11.0 VDC.
2. Total combined output of 3.3 V and 5 V is ≤110 W.

Table 28. 240 W Loading for Efficiency Measurements[1]

Loading	+12 V	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	12.5	9.3	10.9	0.2	1.0
Typical (A)	6.2	4.7	5.5	0.1	1.0
Light (A)	2.5	1.9	2.2	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 29. 275 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	4.0	10.8	9.6	12.8	0.2	1.0
Typical (A)	2.0	5.4	4.8	6.4	0.1	1.0
Light (A)	1.0	2.2	1.9	2.6	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 30. 300 W Loading for Efficiency Measurements[1]

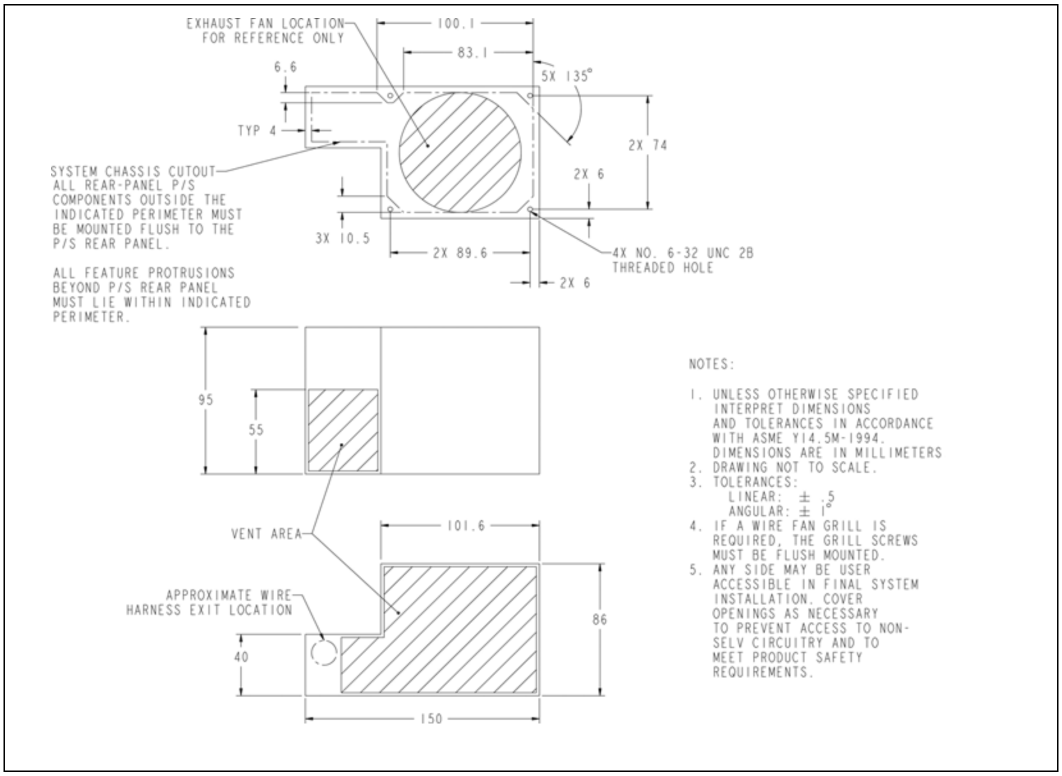
Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	5.7	11.3	8.5	14.1	0.2	1.0
Typical (A)	2.8	5.7	4.2	7.1	0.1	1.0
Light (A)	1.1	2.3	1.7	2.8	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

10.2 Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 10.

Figure 10. CFX12V Mechanical Outline



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11 LFX12V Specific Guidelines 1.1

For Low Profile Form Factor with 12-volt connector power supplies.

11.1 Typical Power Distribution - RECOMMENDED

DC output power requirements and distributions will vary based on specific system options and implementation.

Significant dependencies include the quantity and types of processors, memory, add-in card slots, and peripheral bays, as well as support for advanced graphics or other features. Figure 11 through Figure 14 shows the power distribution and cross loading tables for power supplies in the range of 180 W to 260 W. These are recommendations but it is ultimately the responsibility of the designer to define a power budget for a given target product and market.

Figure 11. Cross Loading Graph for 180 W Configurations

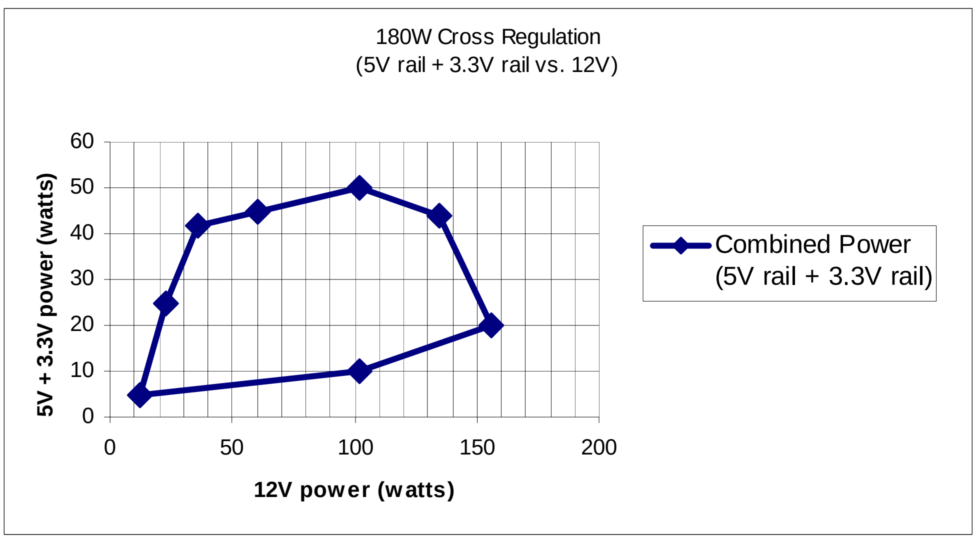


Table 31. Typical Power Distribution for 180 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+12 VDC	1.0	13.0	15.0
+5 VDC[1]	0.3	7.0	-

Table 31. Typical Power Distribution for 180 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+3.3 VDC	0.5	6.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:
1. Total combined output of 3.3 V and 5 V is ≤ 50 W.

Figure 12. Cross Loading Graph for 200 W Configurations

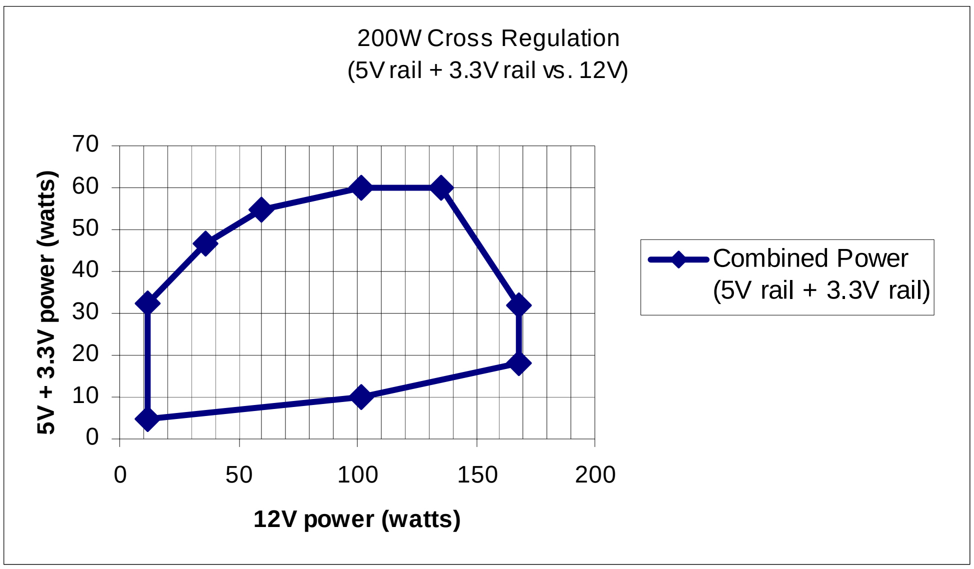


Table 32. Typical Power Distribution for 200 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)
+12 VDC	1.0	13.5	15.5
+5 VDC[1]	0.3	7.0	-
+3.3 VDC	0.5	8.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:
1. Total combined output of 3.3 V and 5 V is ≤ 60 W.

Figure 13. Cross Loading Graph for 240 W Configurations

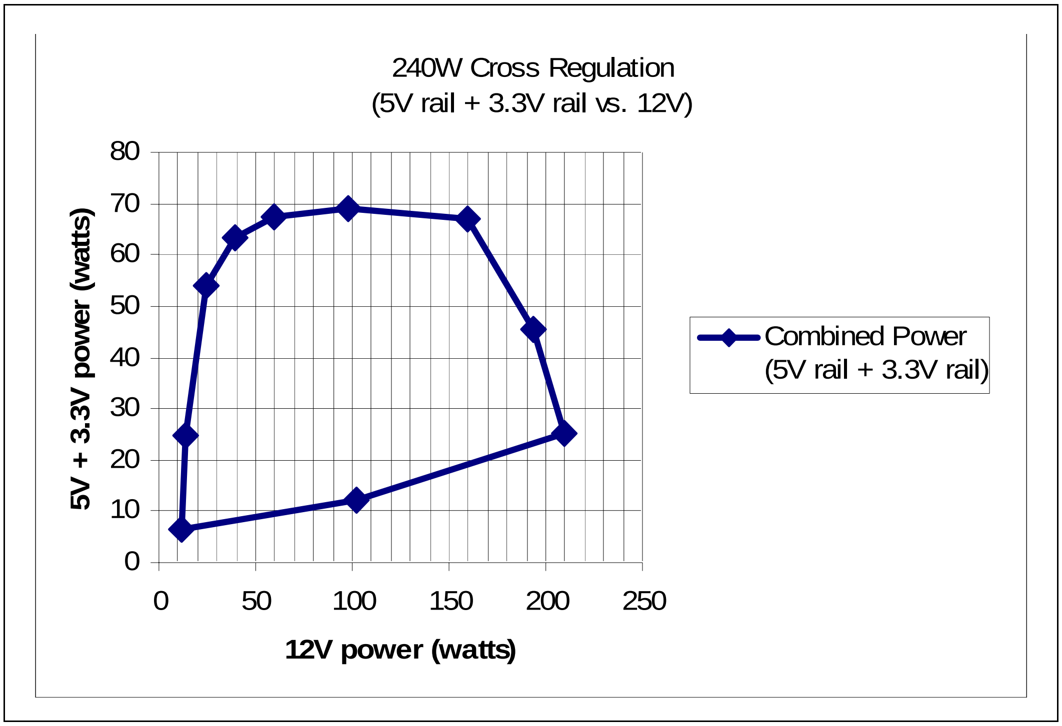


Table 33. Typical Power Distribution for 240 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	3.0	4
+12 V2DC[2, 3]	1.0	13.0	16.5
+5 VDC[4]	0.3	8.0	-
+3.3 VDC[4]	0.5	10.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 70 W.

Figure 14. Cross Loading Graph for 260 W Configurations

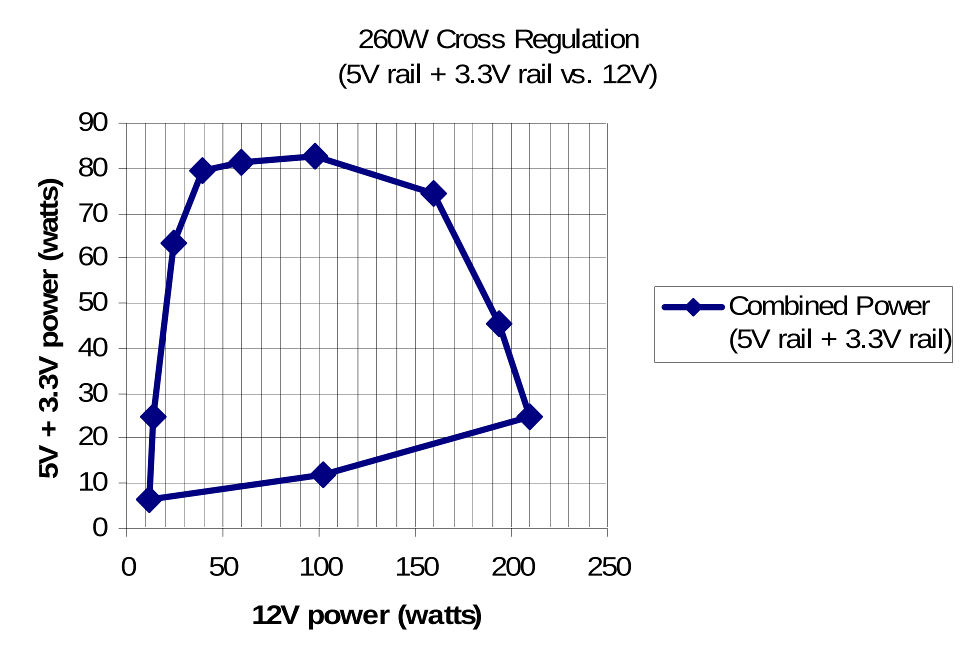


Table 34. Typical Power Distribution for 260 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	5.0	6
+12 V2DC[2, 3]	1.0	13.0	16.5
+5 VDC[4]	0.3	10.0	-
+3.3 VDC[4]	0.5	12.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 80 W.

Table 35. 240 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	2.6	11.4	7.0	8.7	0.3	1.0
Typical (A)	1.3	5.7	3.5	4.4	0.1	1.0
Light (A)	1.0	2.3	1.4	1.7	0.1	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 36. 260 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	4.1	10.7	8.2	9.9	0.2	1.0
Typical (A)	2.1	5.4	4.1	4.9	0.1	1.0
Light (A)	1.0	2.1	1.6	2.0	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

11.2 Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 15, applicable. Mechanical details are shown in Figure 16. Details on the power supply slot feature are shown in Figure 17. The recommended chassis slot feature details are shown in Figure 18.

Figure 15. Mechanical Outline

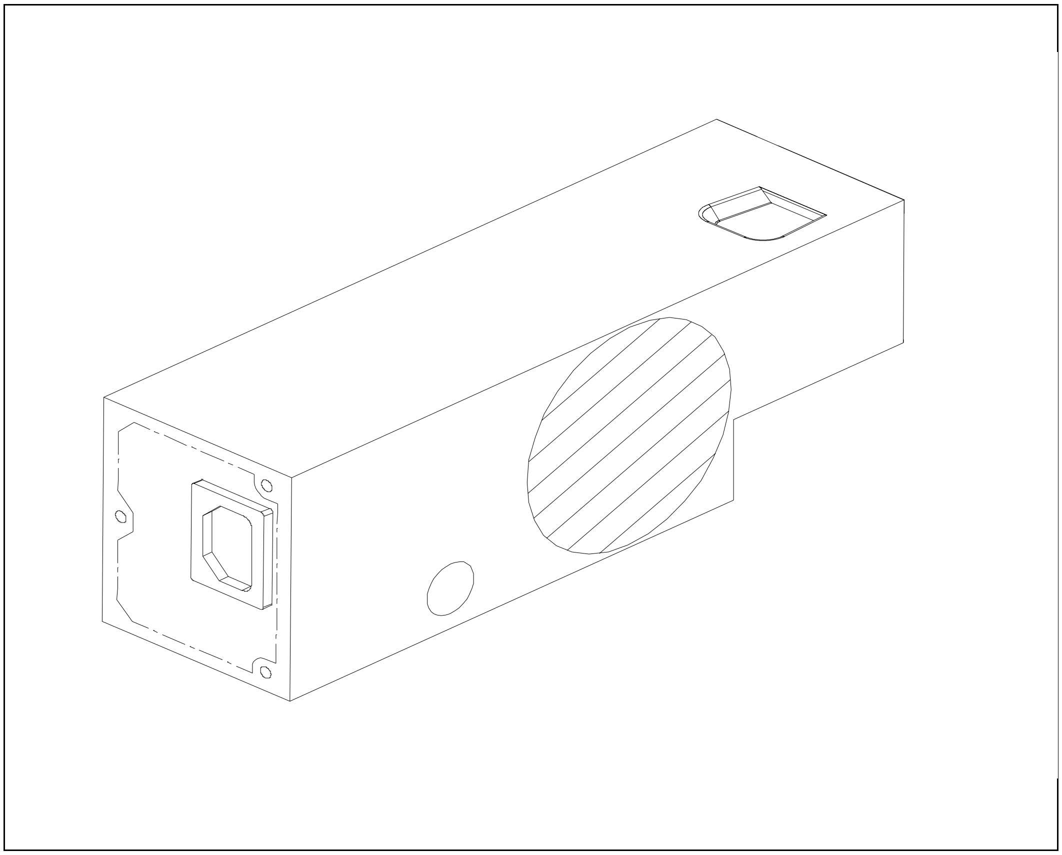


Figure 16. Mechanical Details

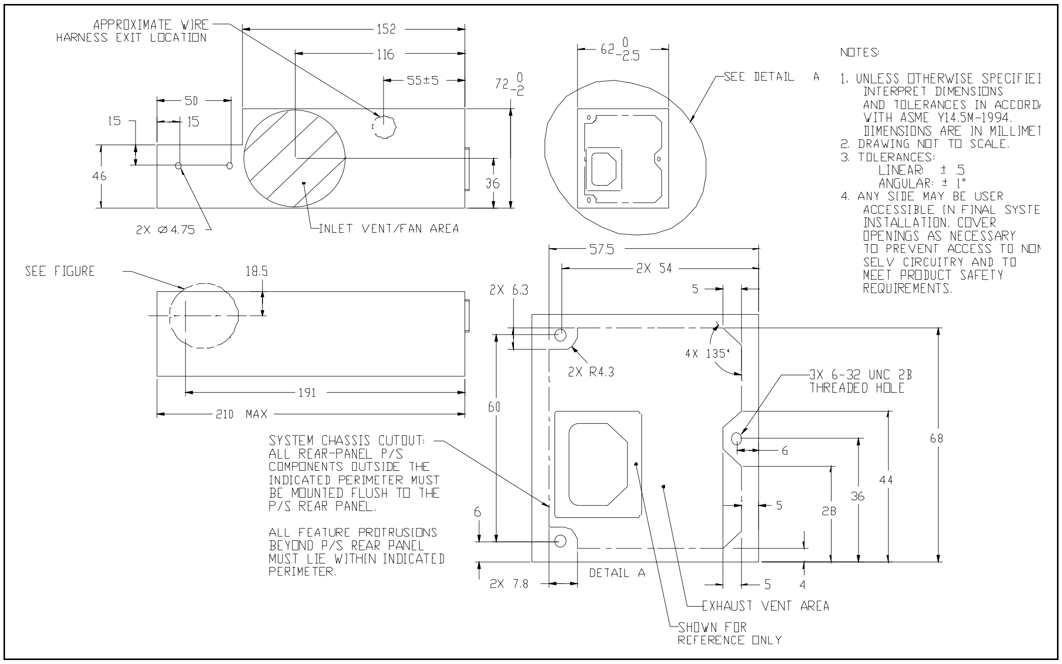


Figure 17. PSU Slot Feature Detail

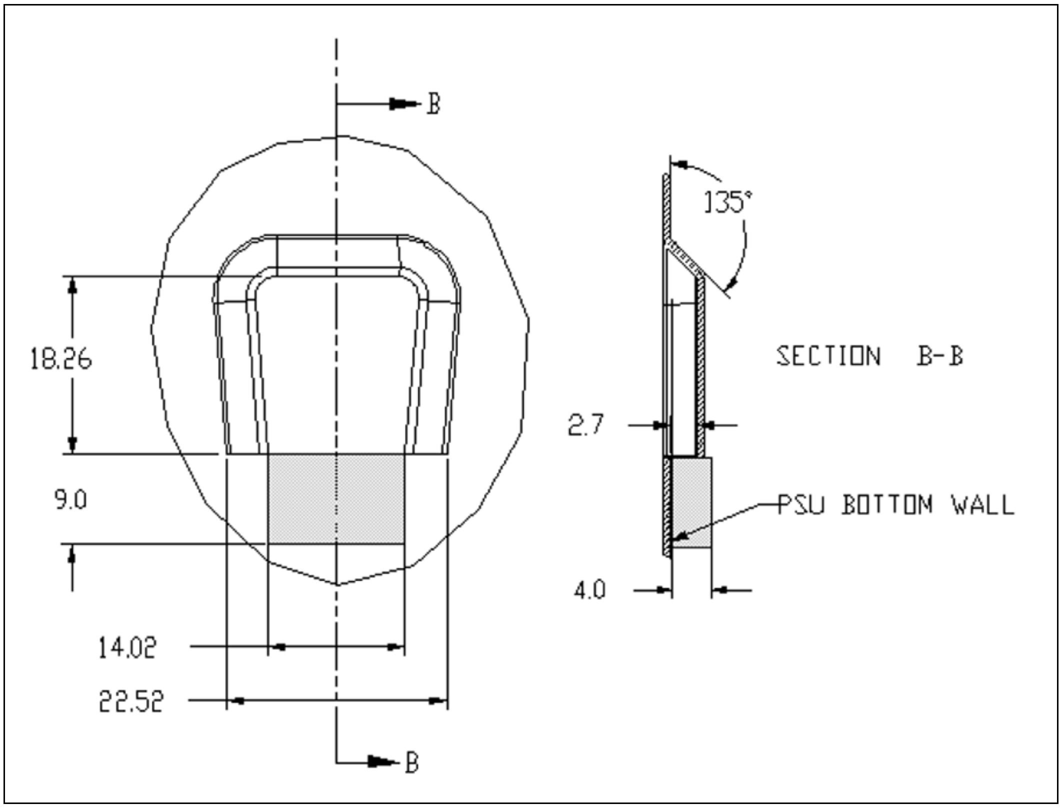
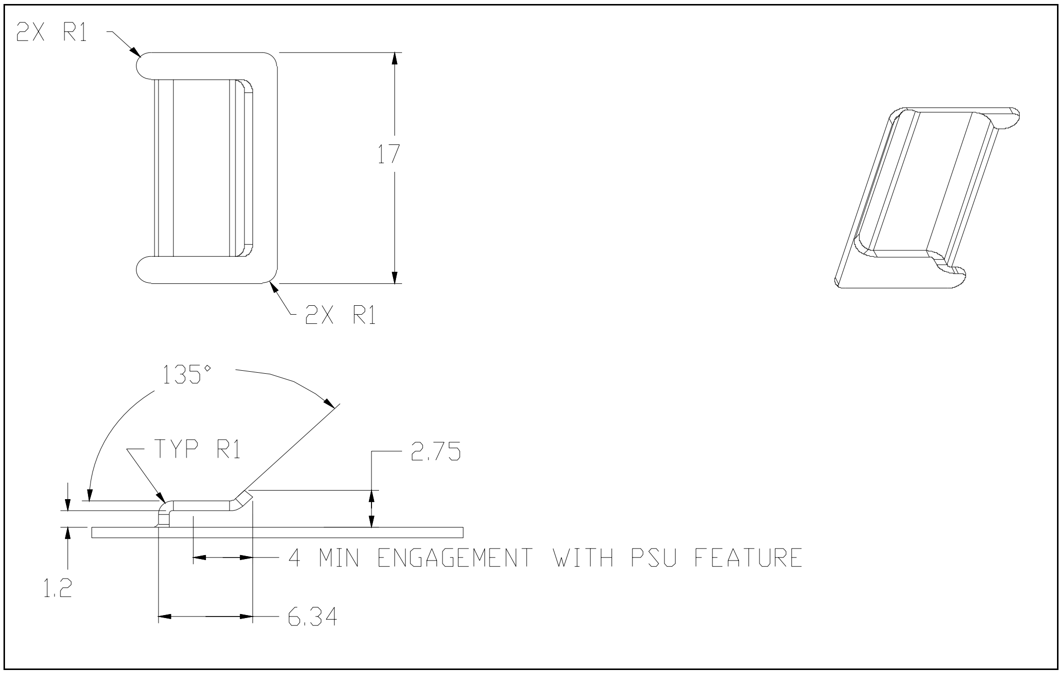


Figure 18. Recommended Chassis Tab Feature



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12 ATX12V Specific Guidelines 2.2

For ATX Form Factor with 12-volt connector power supplies.

12.1 Typical Power Distribution - RECOMMENDED

DC output power requirements and distributions will vary based on specific system options and implementation.

Significant dependencies include the quantity and types of processors, memory, add-in card slots, and peripheral bays, as well as support for advanced graphics or other features. Figure 19 through Figure 23 shows the power distribution and cross loading tables for power supplies in the range of 250 W to 450 W. These are recommendations but it is ultimately the responsibility of the designer to define a power budget for a given target product and market.

Figure 19. Cross Loading Graph for 250 W Configurations

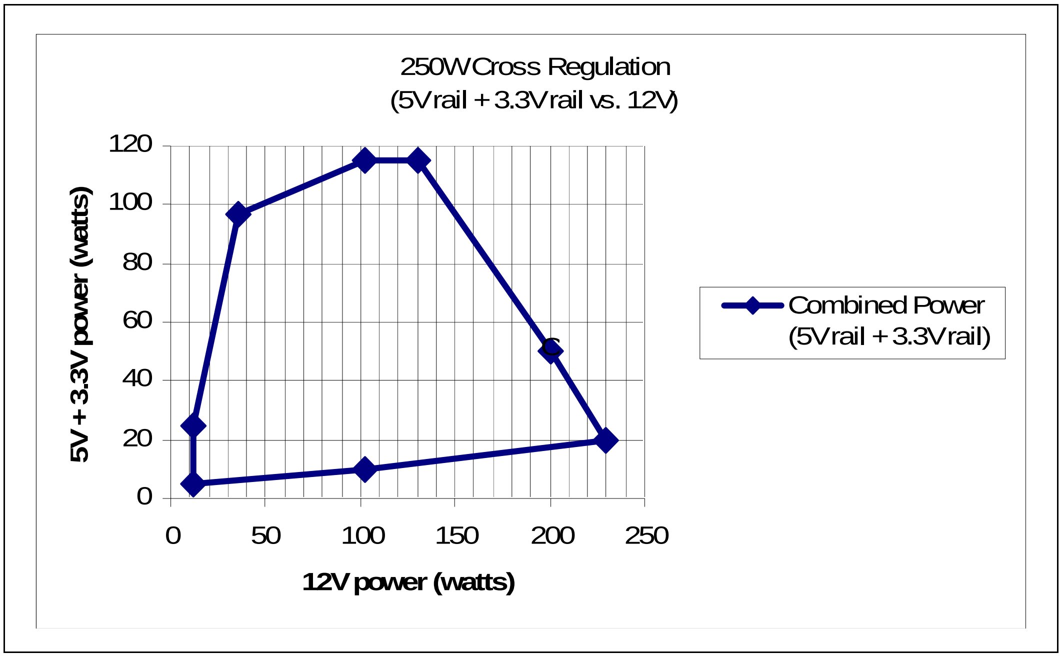


Table 37. Typical Power Distribution for 250 W Configurations

Output	Minimum Current (A)	Maximum Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	8.0	9.0
+12 V2DC[2, 3]	1.0	13.0	16.5
+5 VDC[4]	0.3	12.0	-

Table 37. Typical Power Distribution for 250 W Configurations

Output	Minimum Current (A)	Maximum Current (A)	Peak Current (A)[1]
+3.3 VDC[4]	0.5	14.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.5	3.5

NOTES:
1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 115 W.

Figure 20. Cross Loading Graph for 300 W Configurations

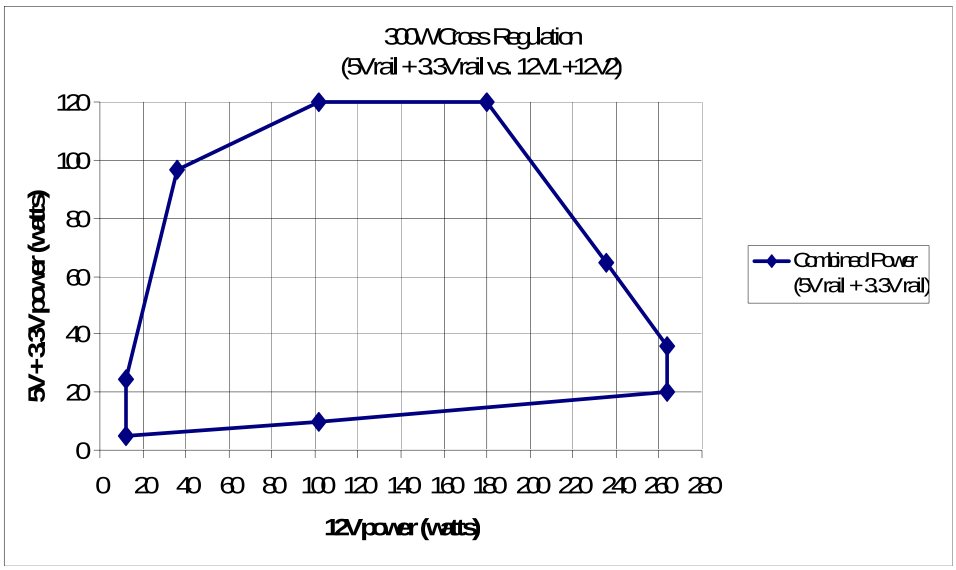


Table 38. Typical Power Distribution for 300 W Configurations

Output	Minimum Current (A)	Maximum Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	8.0	9.0
+12 V2DC[2, 3]	1.0	13.0	16.5
+5 VDC[4]	0.3	12.0	-
+3.3 VDC[4]	0.5	18.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.5	3.5

NOTES:
1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.

4. Total combined output of 3.3 V and 5 V is ≤ 120 W.

Figure 21. Cross Loading Graph for 350 W Configurations

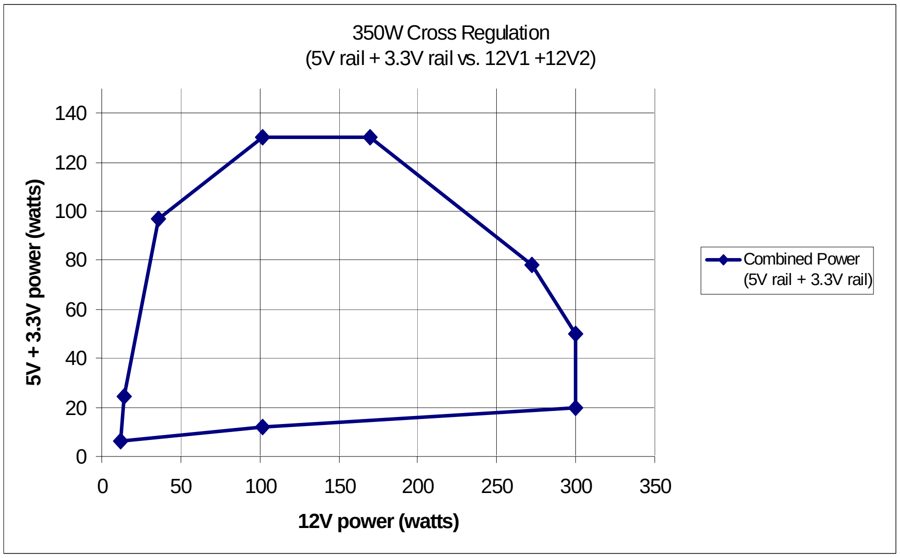


Table 39. Typical Power Distribution for 350 W Configurations

Output	Minimum Current (A)	Maximum Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	10.0	11.0
+12 V2DC[2, 3]	1.0	13.0	16.5
+5 VDC[4]	0.3	12.0	-
+3.3 VDC[4]	0.5	20.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.5	3.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 130 W.

Figure 22. Cross Loading Graph for 400 W Configurations

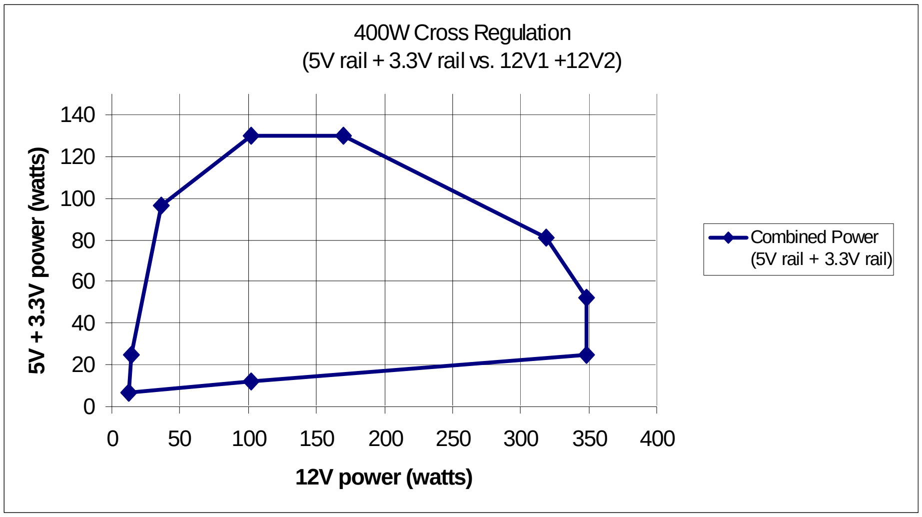


Table 40. Typical Power Distribution for 400 W Configurations

Output	Minimum Current (A)	Maximum Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	14.0	15.0
+12 V2DC[2,3]	1.0	13.0	16.5
+5 VDC[4]	0.3	14.0	-
+3.3 VDC[4]	0.5	20.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.5	3.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 130 W.

Figure 23. Cross Loading Graph for 450 W Configurations

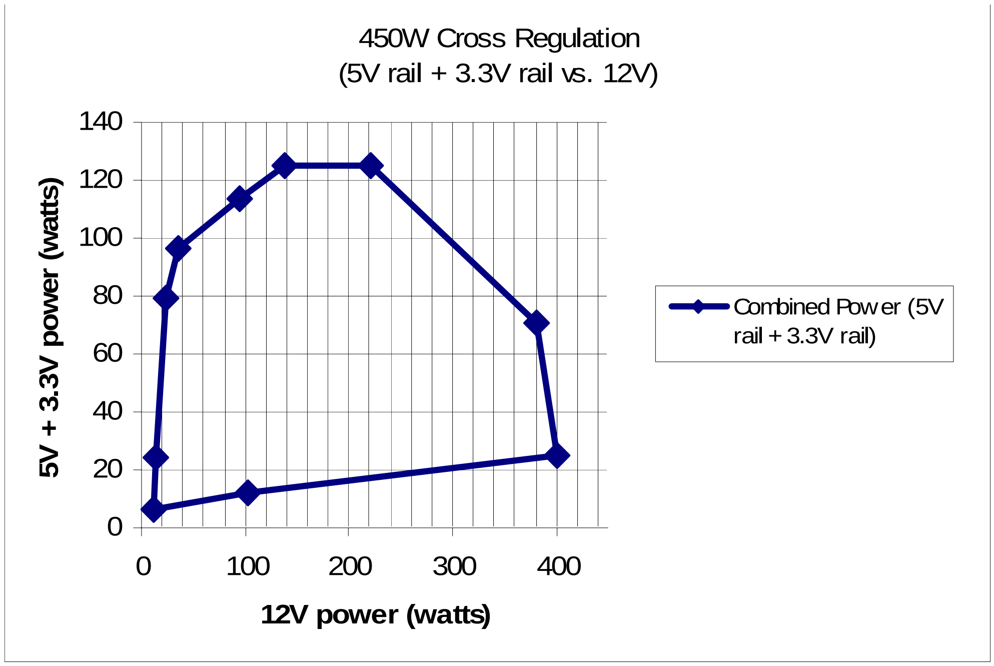


Table 41. Typical Power Distribution for 450 W Configurations

Output	Minimum Current (A)	Maximum Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	14.0	15.0
+12 V2DC[2, 3]	1.0	16.0	19.0
+5 VDC[4]	0.3	15.0	-
+3.3 VDC[4]	0.5	22.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.5	3.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 130 W.

Table 42. 250 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	5.4	8.8	8.1	9.5	0.2	1.0
Typical (A)	2.7	4.4	4.1	4.7	0.1	1.0
Light (A)	1.1	1.8	1.6	1.9	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 43. 300 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	6.3	10.2	9.4	14.2	0.2	1.0
Typical (A)	3.1	5.1	4.7	7.1	0.1	1.0
Light (A)	1.3	2.0	1.9	2.8	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 44. 350 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	8.5	11.1	10.2	17.0	0.3	1.0
Typical (A)	4.3	5.5	5.1	8.5	0.1	1.0
Light (A)	1.7	2.2	2.0	3.4	0.1	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 45. 400 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	11.9	11.1	11.9	17.0	0.3	1.0
Typical (A)	6.0	5.5	6.0	8.5	0.1	1.0
Light (A)	2.4	2.2	2.4	3.4	0.1	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 46. 450 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	12.2	13.9	13.1	19.2	0.3	1.0
Typical (A)	6.1	7.0	6.5	9.6	0.1	1.0
Light (A)	2.4	2.8	2.6	3.8	0.1	1.0

NOTES:

1. Loading calculated by method available at http://www.efficientpowersupplies.org.

12.2 Physical Dimensions - REQUIRED

Figure 24. Power Supply Dimensions for Chassis that does not Require Top Venting

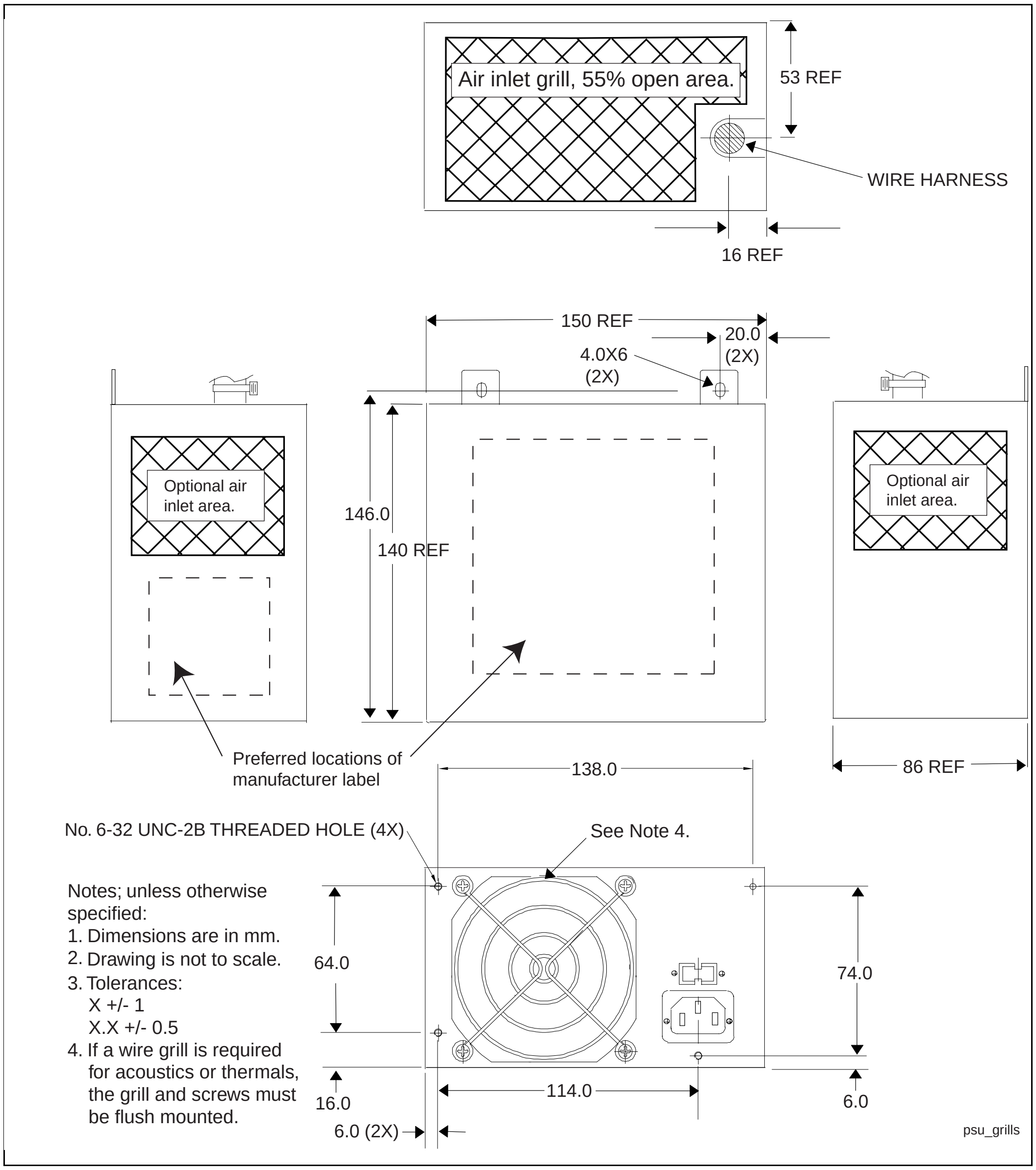
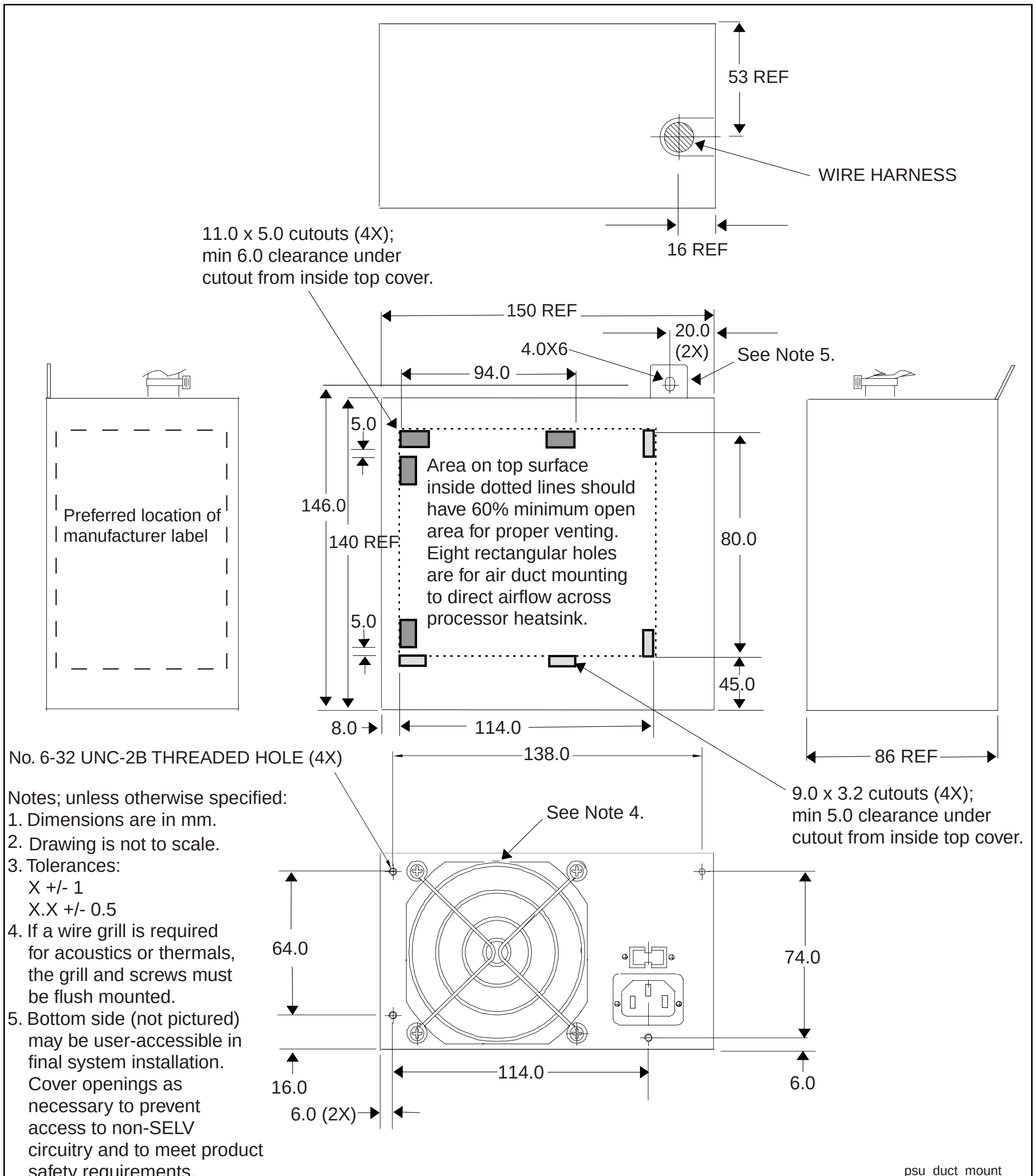


Figure 25. Power Supply Dimensions for Chassis that Require Top Venting



Notes; unless otherwise specified:
1. Dimensions are in mm.
2. Drawing is not to scale.
3. Tolerances:
   X +/- 1
   X.X +/- 0.5
4. If a wire grill is required for acoustics or thermals, the grill and screws must be flush mounted.
5. Bottom side (not pictured) may be user-accessible in final system installation. Cover openings as necessary to prevent access to non-SELV circuitry and to meet product safety requirements.

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13 SFX12V Specific Guidelines 3.1

For Small Form Factor with 12-volt connector power supplies.

13.1 Typical Power Distribution - RECOMMENDED

DC output power requirements and distributions will vary based on specific system options and implementation.

Significant dependencies include the quantity and types of processors, memory, add-in card slots, and peripheral bays, as well as support for advanced graphics or other features. Figure 29 through Figure 31 shows the power distribution and cross loading tables for power supplies in the range of 160 W to 300W. These are recommendations but it is ultimately the responsibility of the designer to define a power budget for a given target product and market.

Figure 26. Cross Loading Graph for 160 W Configurations

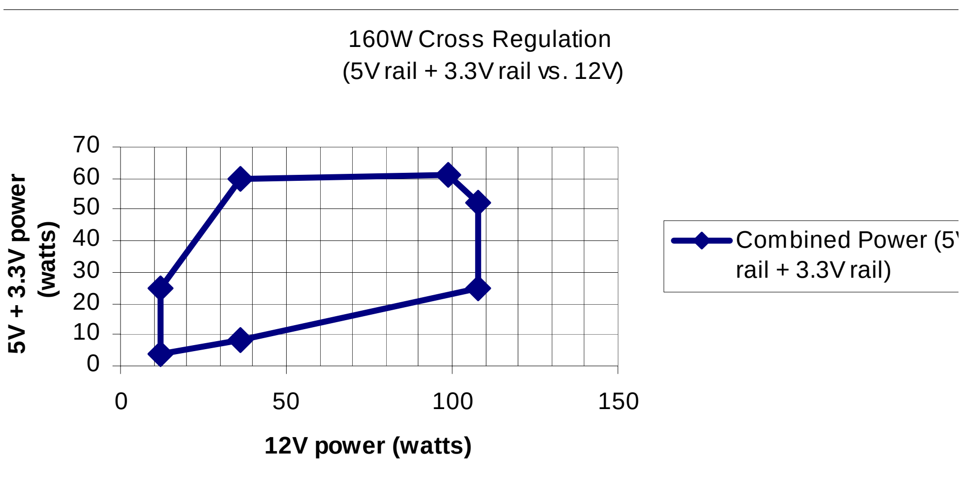


Table 47. Typical Power Distribution for 160 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	9.0	11.0
+5 VDC[2]	0.3	12.0	-

Table 47. Typical Power Distribution for 160 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+3.3 VDC	0.5	16.7	-
-12 VDC	0.0	0.3	-
+5 VSB	0.0	1.5	2.0

NOTES:
1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 61 W.

Figure 27. Cross Loading Graph for 180 W Configurations

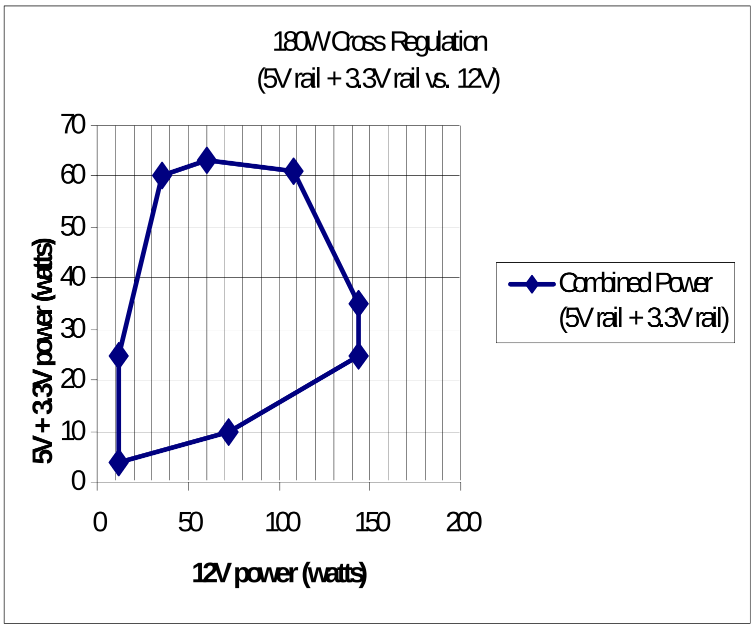


Table 48. Typical Power Distribution for 180 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	13.0	15.0
+5 VDC[2]	0.3	10.0	-
+3.3 VDC	0.5	12.0	-
-12 VDC	0.0	0.3	-
+5 VSB	0.0	2.0	2.5

NOTES:
1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 63 W.

Figure 28. Cross Loading Graph for 220 W Configurations

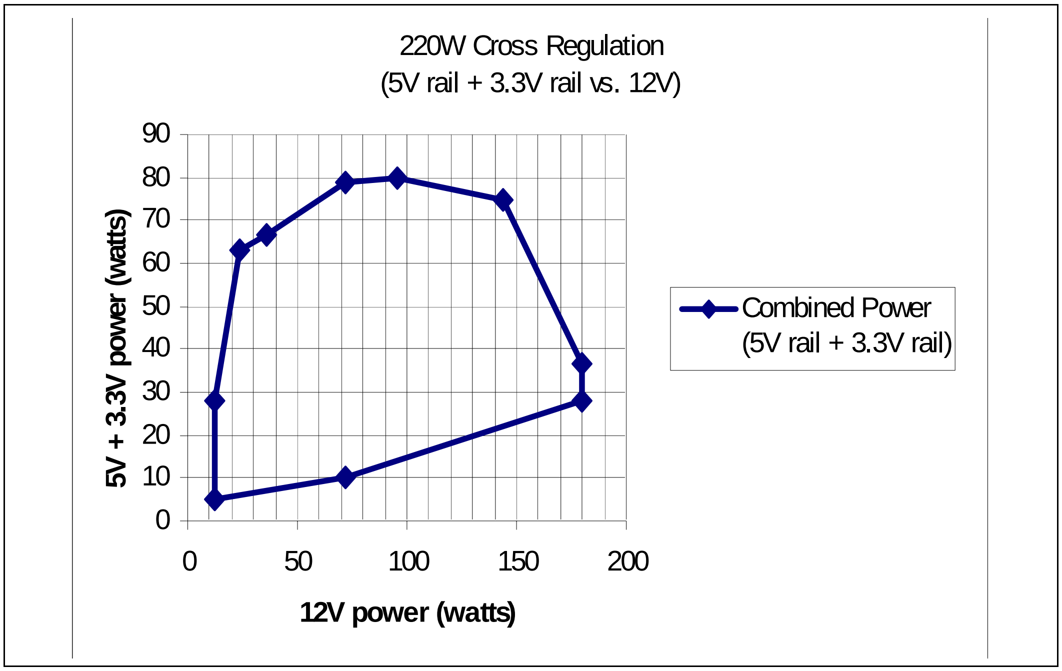


Table 49. Typical Power Distribution for 220 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	15.0	17.0
+5 VDC[2]	0.3	12.0	-
+3.3 VDC	0.5	12.0	-
-12 VDC	0.0	0.3	-
+5 VSB	0.0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 80 W.

Figure 29. Cross Loading Graph for 240 W Configurations

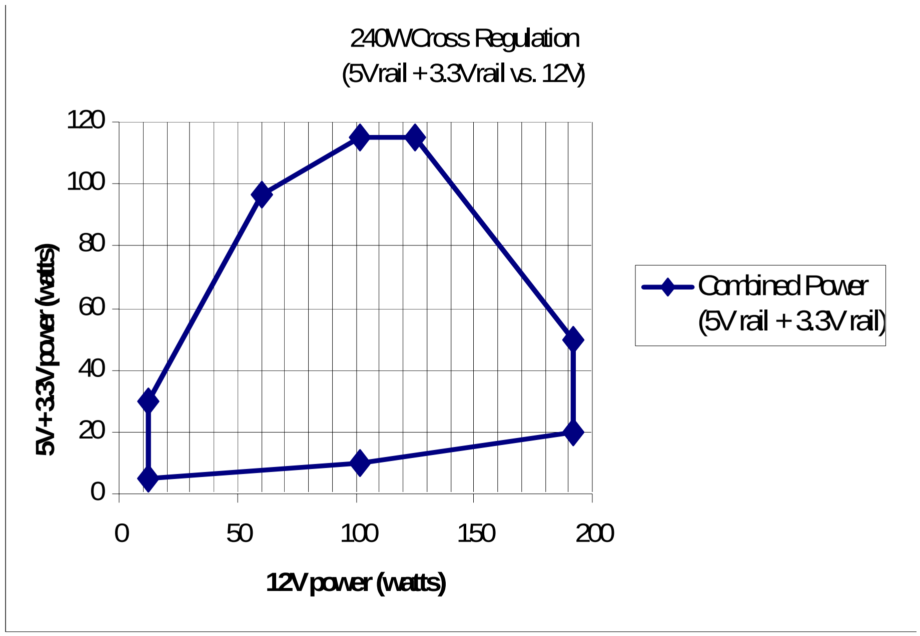


Table 50. Typical Power Distribution for 240 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	16.0	18.0
+5 VDC[2]	0.3	12.0	-
+3.3 VDC	0.5	14.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 115 W.

Figure 30. Cross Loading Graph for 270 W Configurations

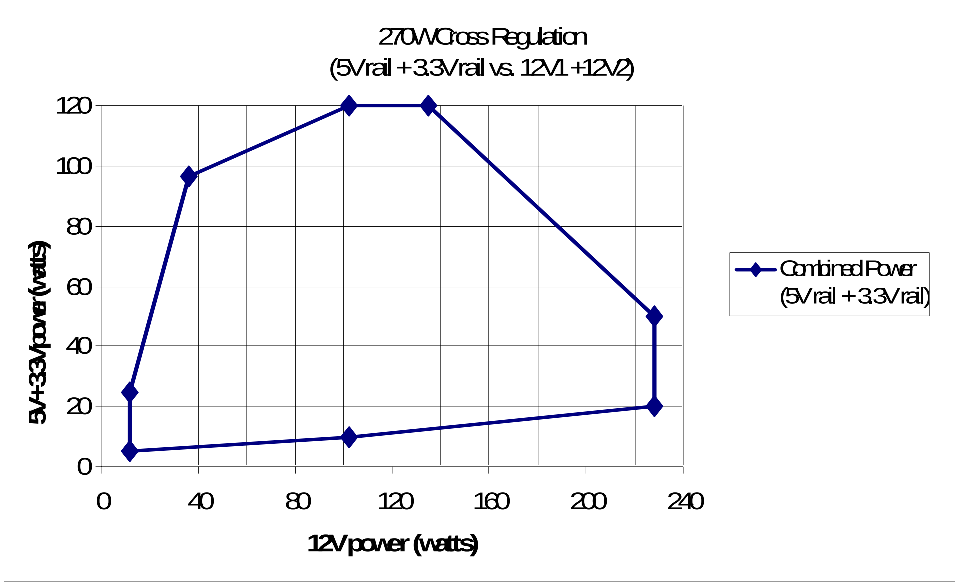


Table 51. Typical Power Distribution for 270 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 V1DC	1.0	7.0	8.0
+12 V2DC[2]	1.0	13.0	16.5
+5 VDC[3]	0.3	12.0	-
+3.3 VDC	0.5	16.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current lasting for 10ms; minimum voltage during peak is > 11.0 VDC
3. Total combined output of 3.3 V and 5 V is ≤120 W.

Figure 31. Cross Loading Graph for 300 W Configurations

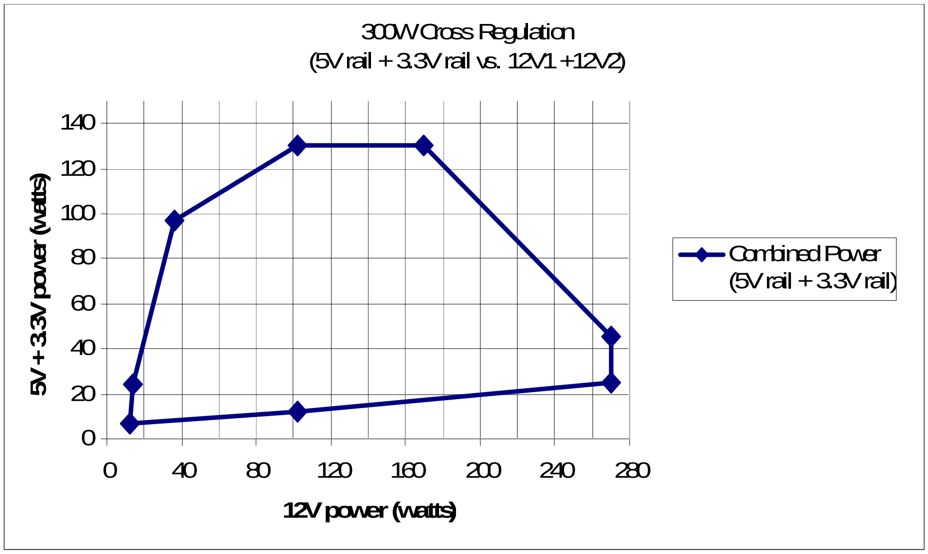


Table 52. Typical Power Distribution for 300 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 V1DC	1.0	8.0	9.0
+12 V2DC[2]	1.0	16.0	19.0
+5 VDC[3]	0.5	12.0	-
+3.3 VDC	0.5	20.0	-
-12 VDC	0	0.4	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V2DC supports processor power requirements and must have a separate current limit and provide 19 A peak current lasting for 10 ms; minimum voltage during peak is > 11.0 VDC
3. Total combined output of 3.3 V and 5 V is ≤ 125 W.

Table 53. 240 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	12.5	9.3	10.9	0.2	1.0
Typical (A)	6.2	4.7	5.5	0.1	1.0
Light (A)	2.5	1.9	2.2	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 54. 270 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	5.2	9.7	8.9	11.9	0.2	1.0
Typical (A)	2.6	4.8	4.5	5.9	0.1	1.0
Light (A)	1.0	1.9	1.8	2.4	0	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 55. 300 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	5.6	11.3	8.5	14.1	0.3	1.0
Typical (A)	2.8	5.6	4.2	7.0	0.1	1.0
Light (A)	1.1	2.3	1.7	2.8	0.1	1.0

NOTES:
1. Loading calculated by method available at http://www.efficientpowersupplies.org.

13.2 Lower Profile Package - Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 32.

13.3 Fan Requirements - REQUIRED

The fan will draw air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure shall exhaust the air through a grill located on the rear panel. See Figure 33. The movement of the fan to the computer system cavity is to help limit the acoustic noise of the unit.

The fan will be 40 mm.

Figure 32. 40 mm Profile Mechanical Outline

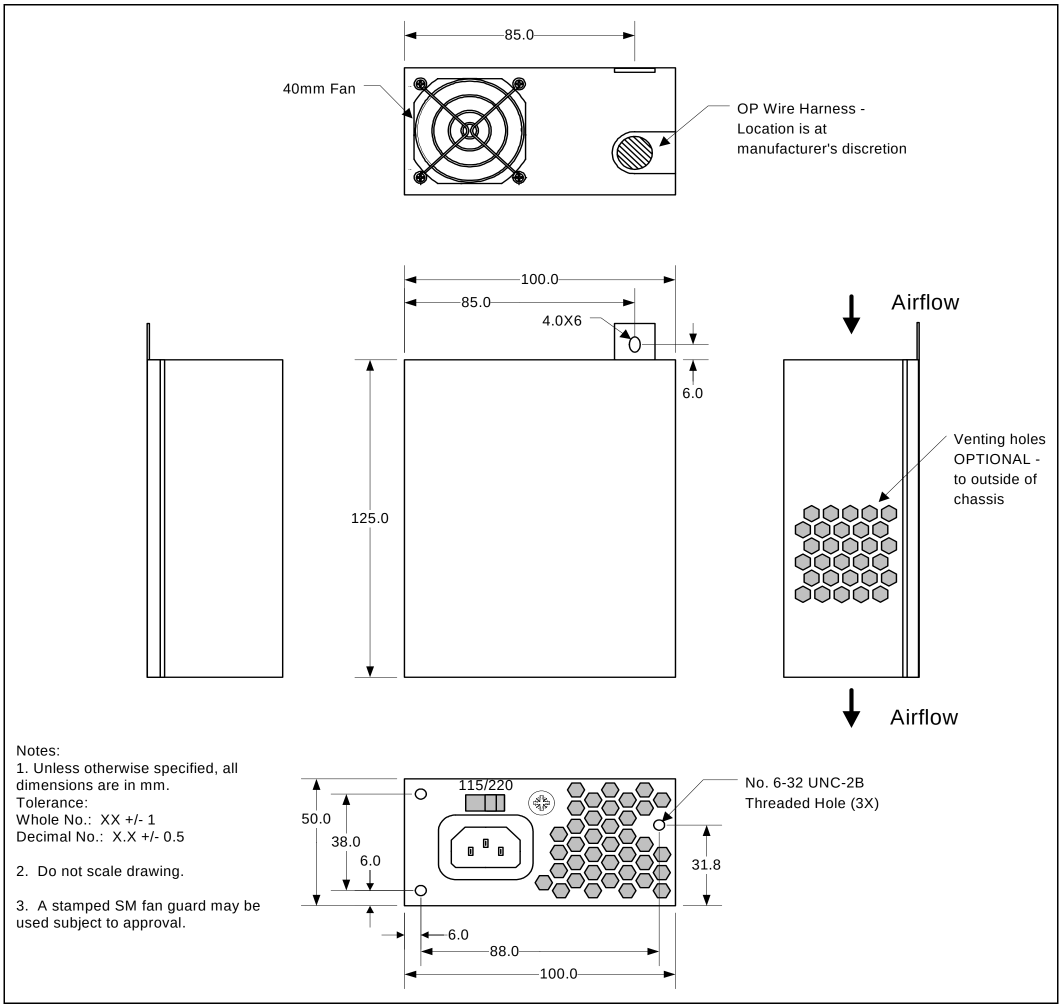
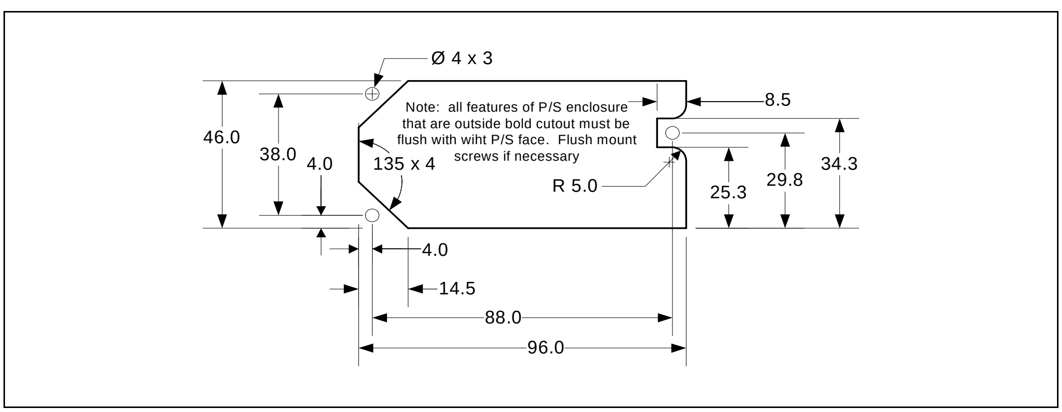


Figure 33. Chassis Cutout



13.4 Top Fan Mount Package - Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 34.

13.5 Fan Requirements - REQUIRED

The fan will draw air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure shall exhaust the air through a grill located on the rear panel. See Figure 35. Moving the fan to the computer system cavity helps to limit the acoustic noise of the unit.

The fan will be 80mm.

To prevent damage to the fan during shipment and handling, the power supply designer should consider recessing the fan mounting, as shown in Figure 36.

Figure 34. Top Mount Fan Profile Mechanical Outline

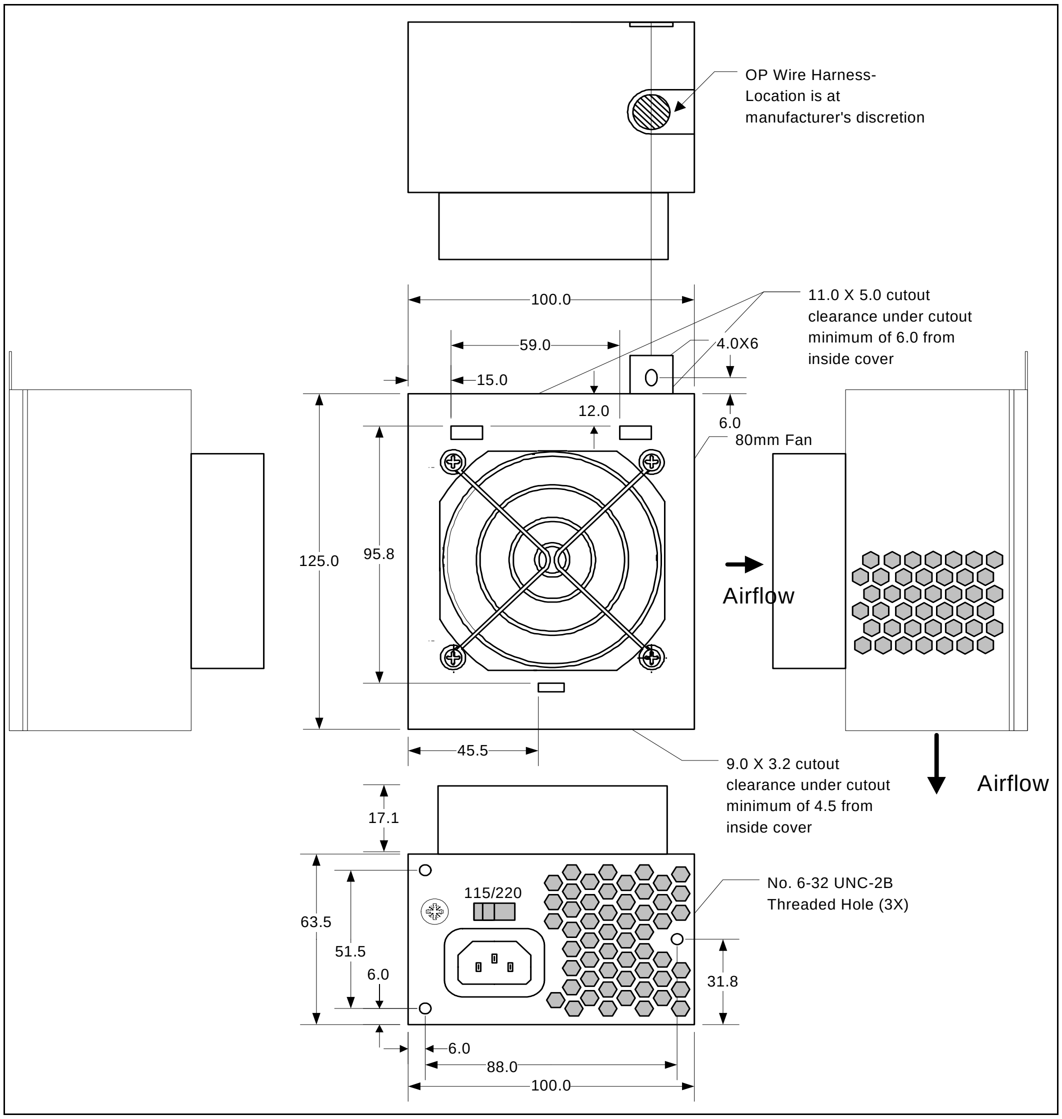


Figure 35. Chassis Cutout

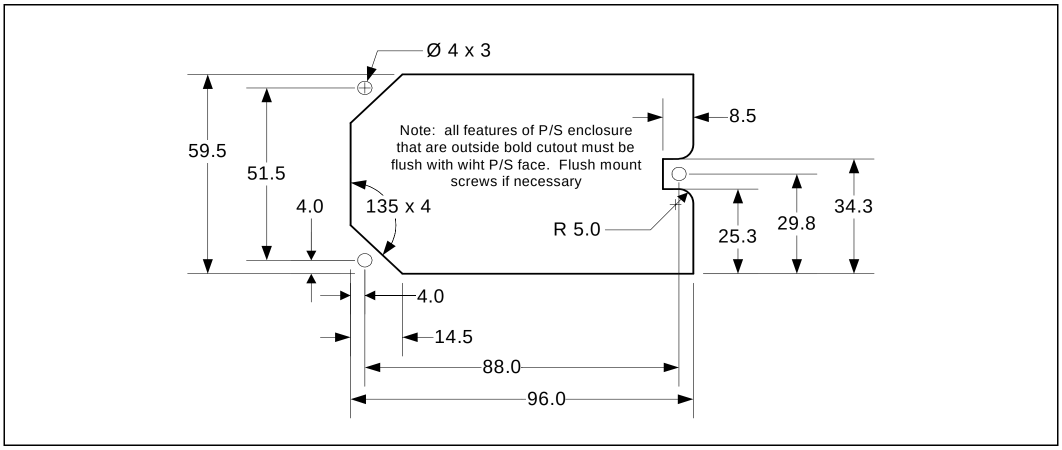
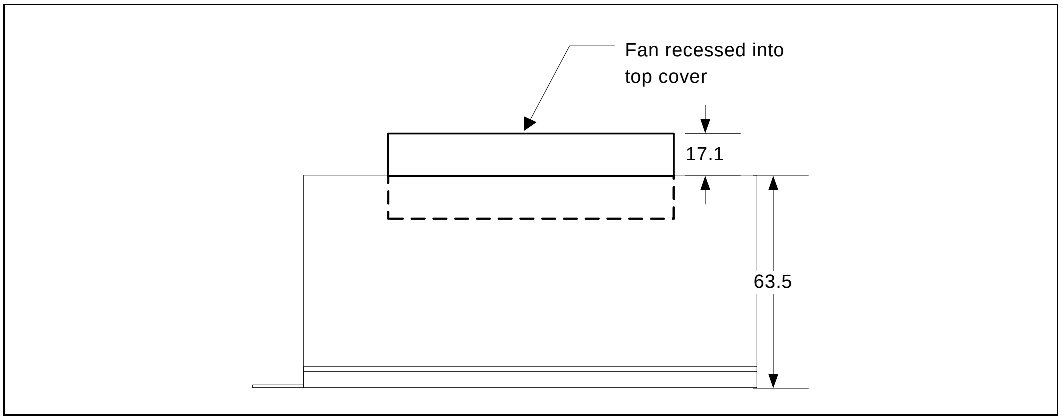


Figure 36. Recessed Fan Mounting



13.6 Reduced Depth Top Mount Fan - Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 37.

13.7 Fan Requirements - REQUIRED

The fan will draw air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure shall exhaust the air through a grill located on the rear panel. See Figure 38. Moving the fan to the computer system cavity helps to limit the acoustic noise of the unit.

The fan will be 80 mm.

Figure 37. Reduced Depth Top Mount Fan Profile Mechanical Outline

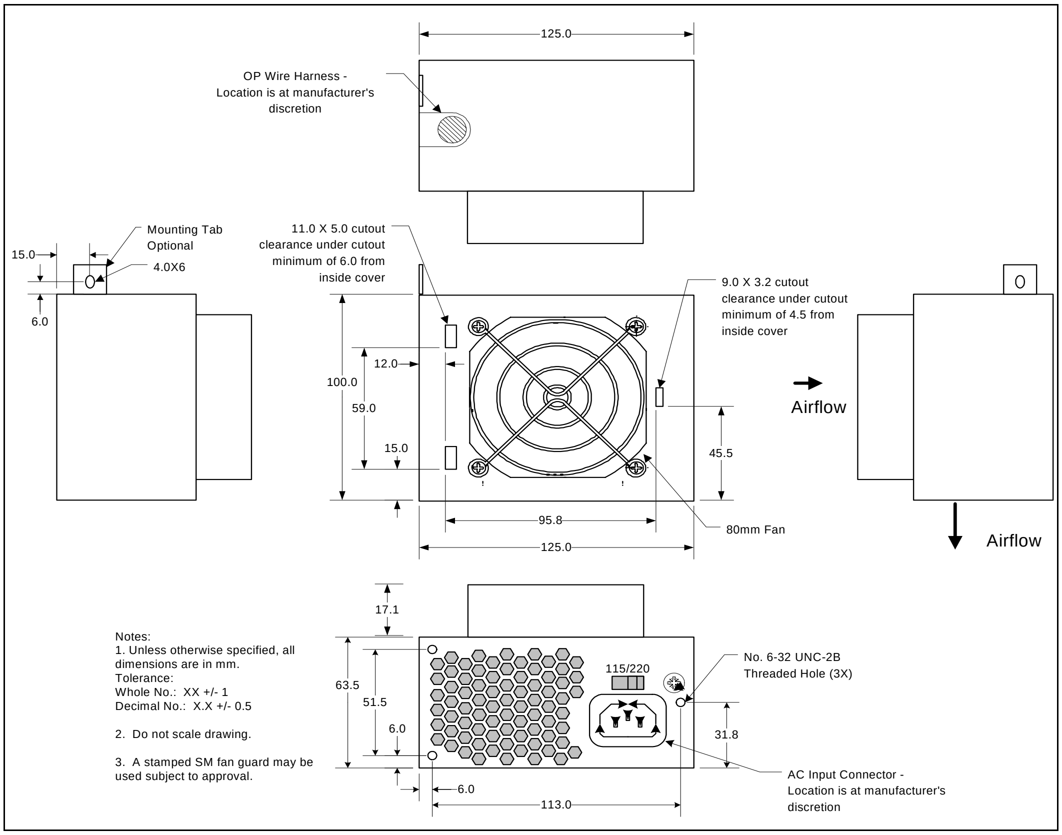
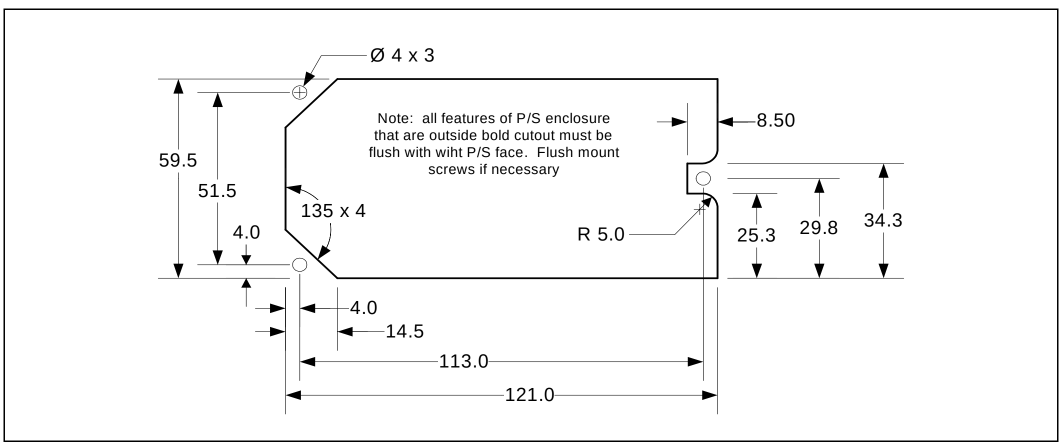


Figure 38. Chassis Cutout



13.8 Standard SFX Profile Package - Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 39.

13.9 Fan Requirements - REQUIRED

The fan will draw air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure shall exhaust the air through a grill located on the rear panel. See Figure 40. The movement of the fan to the computer system cavity is to help limit the acoustic noise of the unit.

The fan will be 60 mm.

Figure 39. 60 mm Mechanical Outline

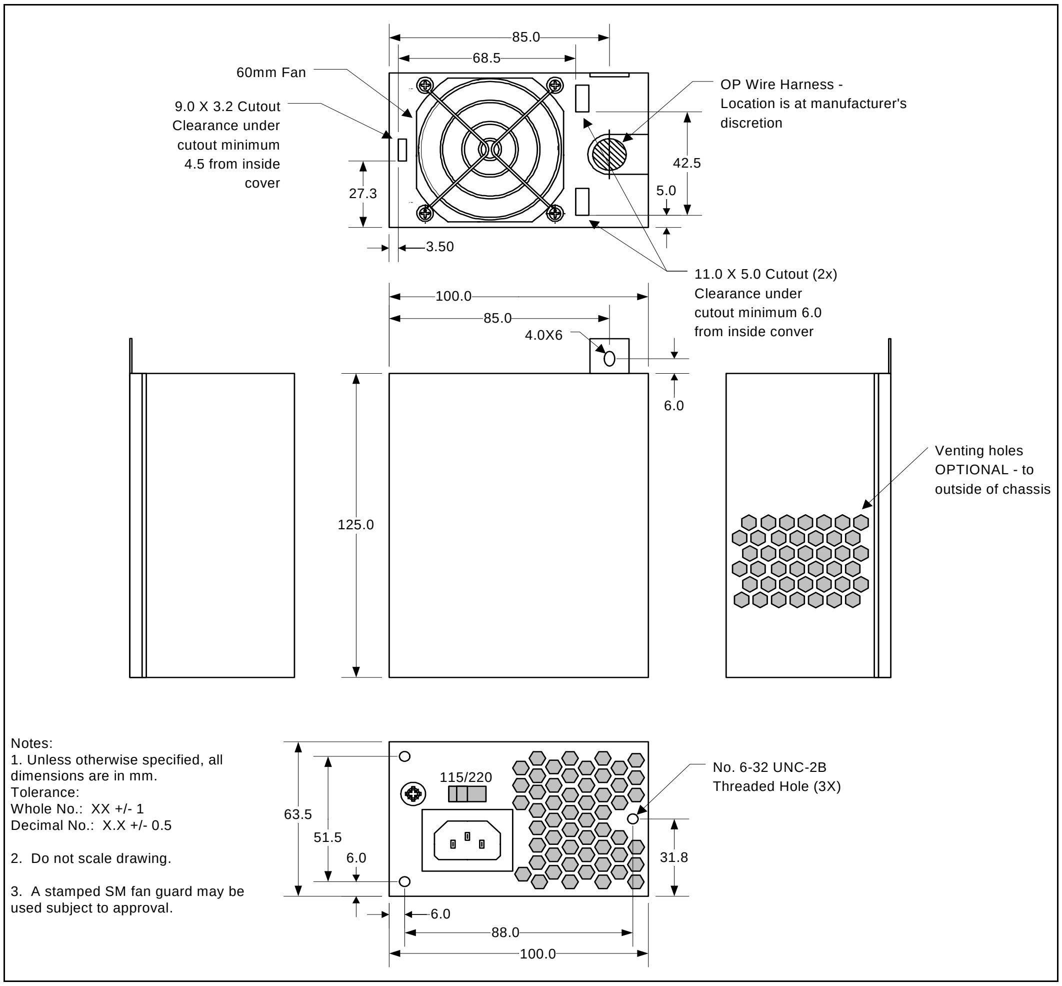
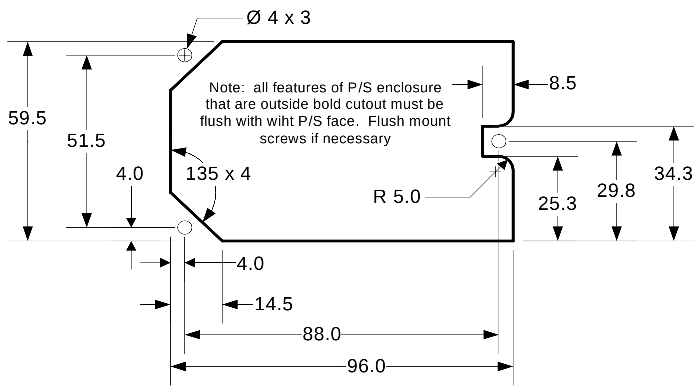


Figure 40. Chassis Cutout



13.10 PS3 Form Factor- Physical Dimensions - REQUIRED

The power supply shall be enclosed and meet the physical outline shown in Figure 41.

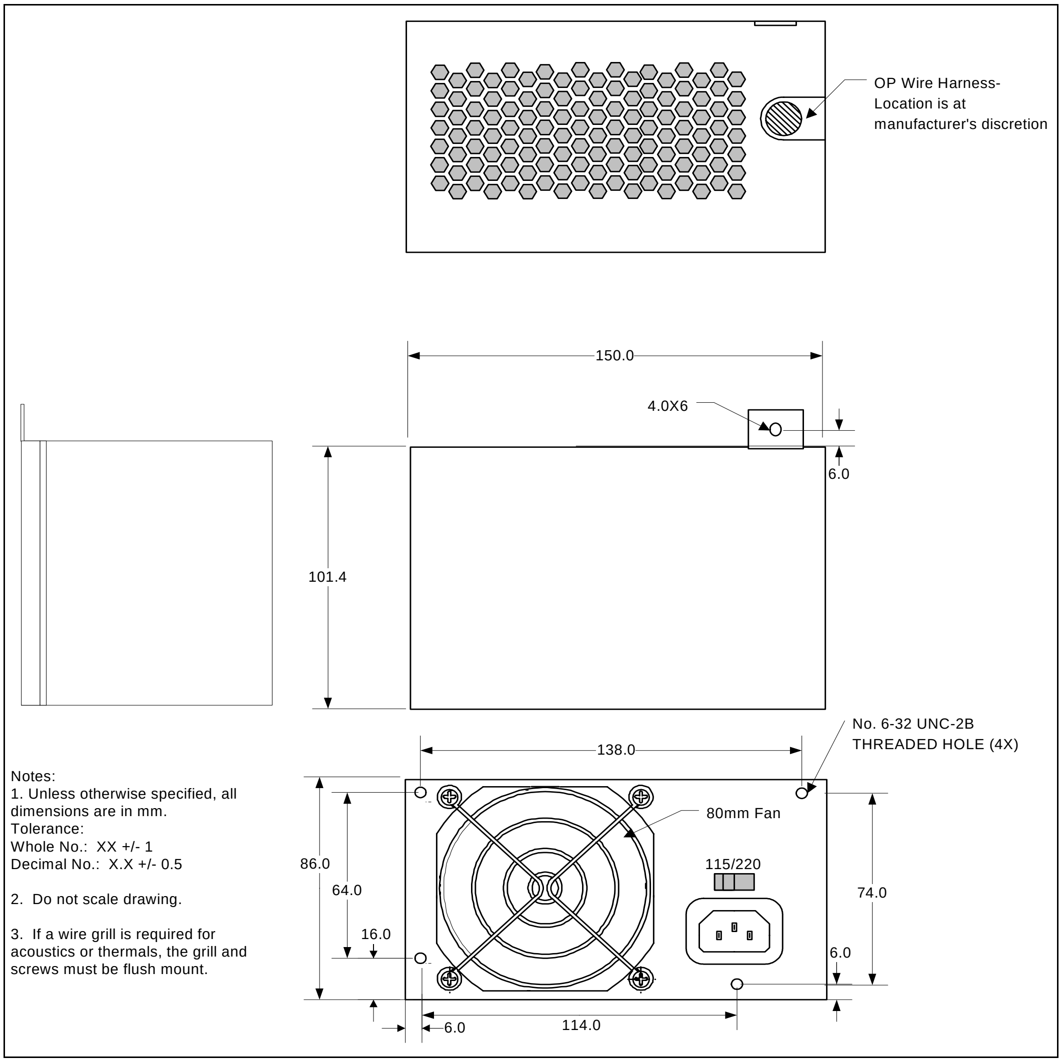
13.11 Fan Requirements - REQUIRED

An 80 mm axial fan is typically needed to provide enough cooling airflow through a high performance Micro ATX system. Exact CFM requirements vary by application and end-use environment, but 25-35 CFM is typical for the fan itself.

For consumer or other noise-sensitive applications, it is recommended that a thermally sensitive fan speed control circuit be used to balance system-level thermal and acoustic performance. The circuit typically senses the temperature of an internal heatsink and/or incoming ambient air and adjusts the fan speed as necessary to keep power supply and system component temperatures within specification. Both the power supply and system designers should be aware of the dependencies of the power supply and system temperatures on the control circuit response curve and fan size and should specify them very carefully.

The power supply fan should be turned off when PS_ON# is de-asserted (high). In this state, any remaining active power supply circuitry must rely only on passive convection for cooling.

Figure 41. PS3 Mechanical Outline



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14 TFX12V Specific Guidelines 2.2

For Thin Form Factor with 12-volt connector power supplies.

14.1 Typical Power Distribution - RECOMMENDED

DC output power requirements and distributions will vary based on specific system options and implementation.

Significant dependencies include the quantity and types of processors, memory, add-in card slots, and peripheral bays, as well as support for advanced graphics or other features. Figure 44 through Figure 46 shows the power distribution and cross loading tables for power supplies in the range of 180 W to 300 W. These are recommendations but it is ultimately the responsibility of the designer to define a power budget for a given target product and market.

Figure 42. Cross Loading Graph for 180 W Configurations

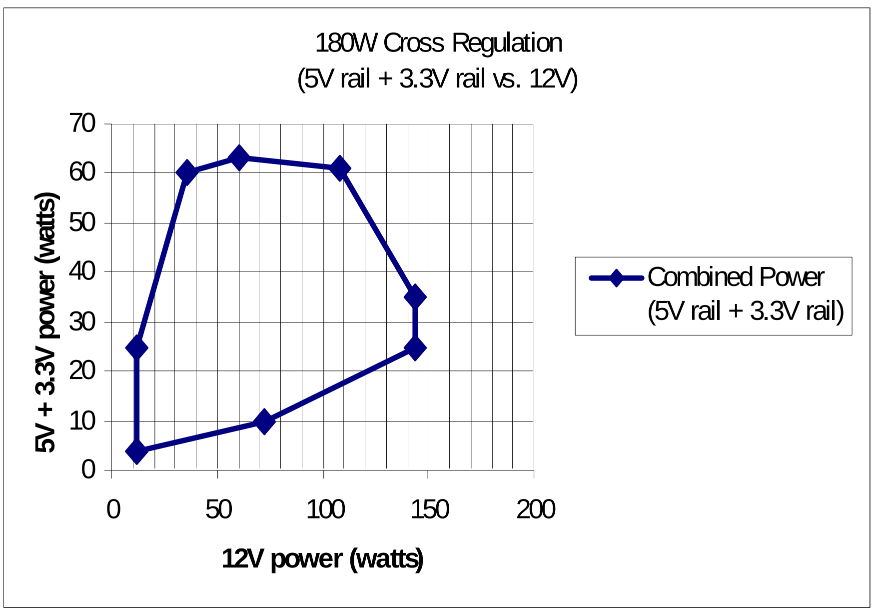


Table 56. Typical Power Distribution for 180 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	13.0	15.0
+5 VDC[2]	0.3	12.0	-
+3.3 VDC[2]	0.5	9.0	-
-12 VDC	0.0	0.3	-
+5 VSB	0.0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 63 W.

Figure 43. Cross Loading Graph for 220 W Configurations

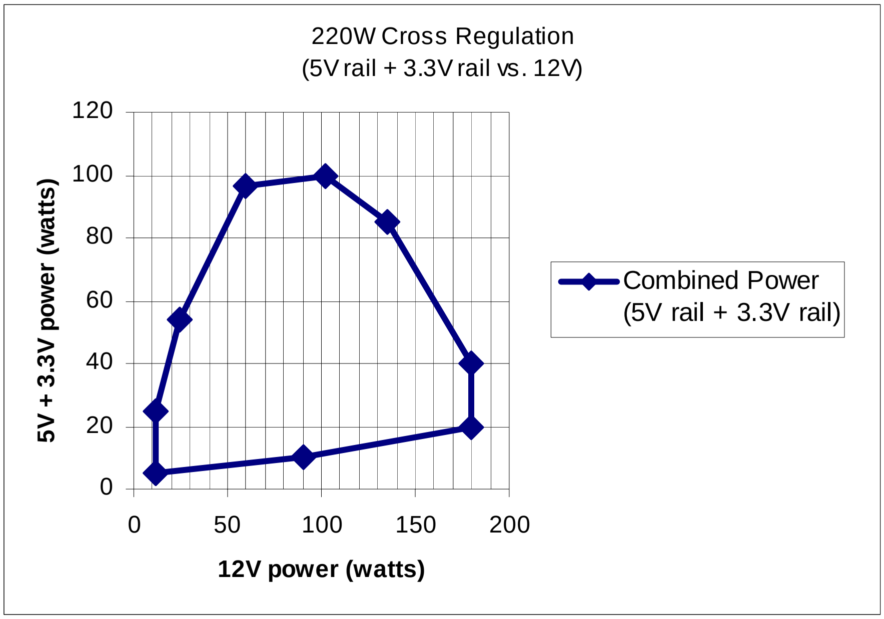


Table 57. Typical Power Distribution for 220 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	15.0	17.0
+5 VDC[2]	0.3	12.0	-
+3.3 VDC[2]	0.5	12.0	-
-12 VDC	0.0	0.3	-
+5 VSB	0.0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 100 W.

Figure 44. Cross Loading Graph for 240 W Configurations

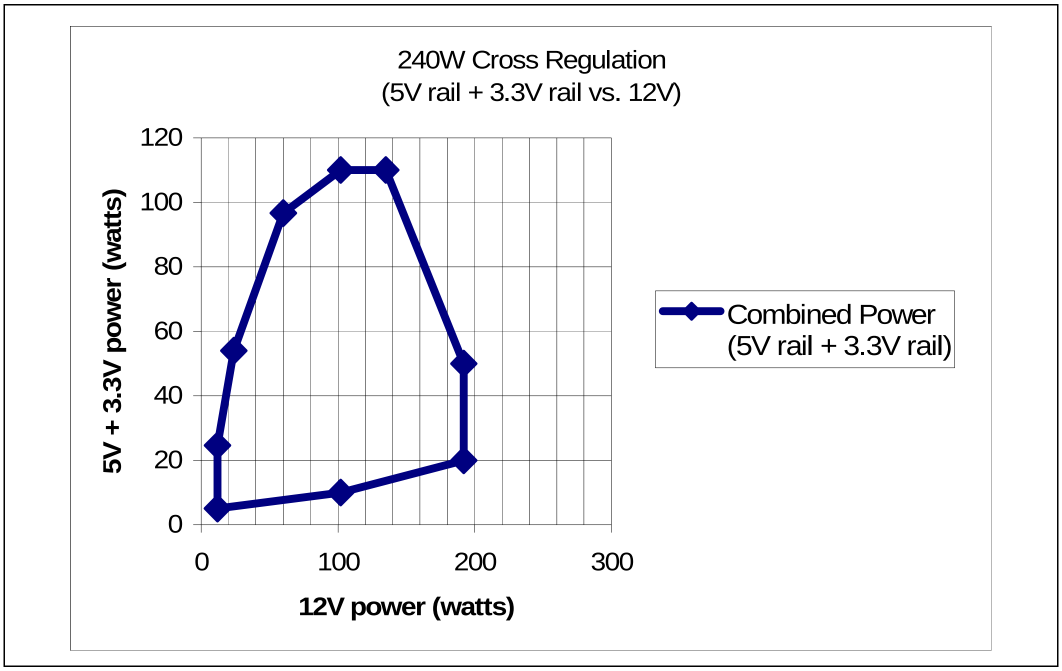


Table 58. Typical Power Distribution for 240 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 VDC	1.0	16.0	18.0
+5 VDC[2]	0.3	12.0	-
+3.3 VDC[2]	0.5	14.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. Total combined output of 3.3 V and 5 V is ≤ 110 W.

Figure 45. Cross Loading Graph for 275 W Configurations

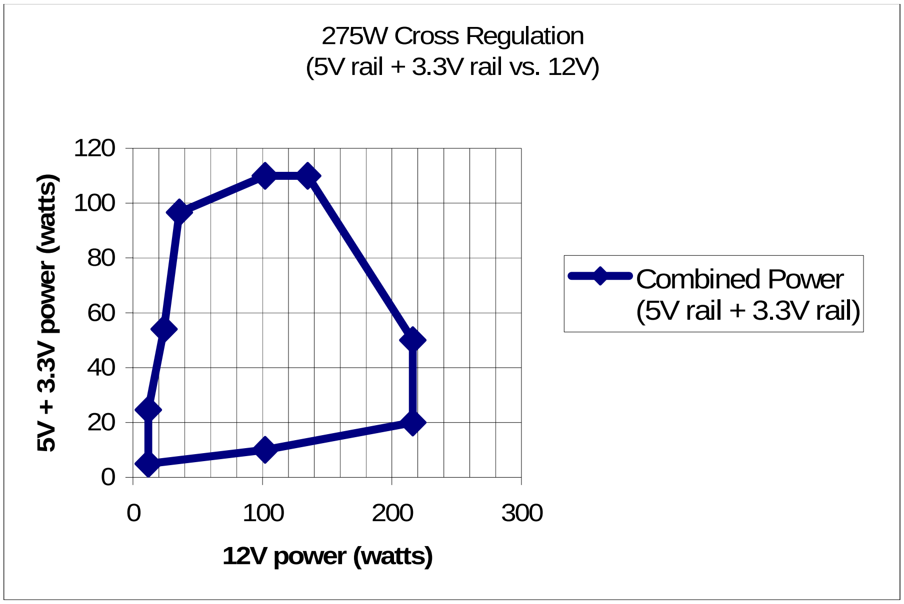


Table 59. Typical Power Distribution for 275 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	5.0	6.0
+12 V2DC[2, 3]	1.0	13.0	16.5
+5 VDC[4]	0.3	12.0	-
+3.3 VDC[4]	0.5	16.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 16.5 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 110W.

Figure 46. Cross Loading Graph for 300 W Configurations

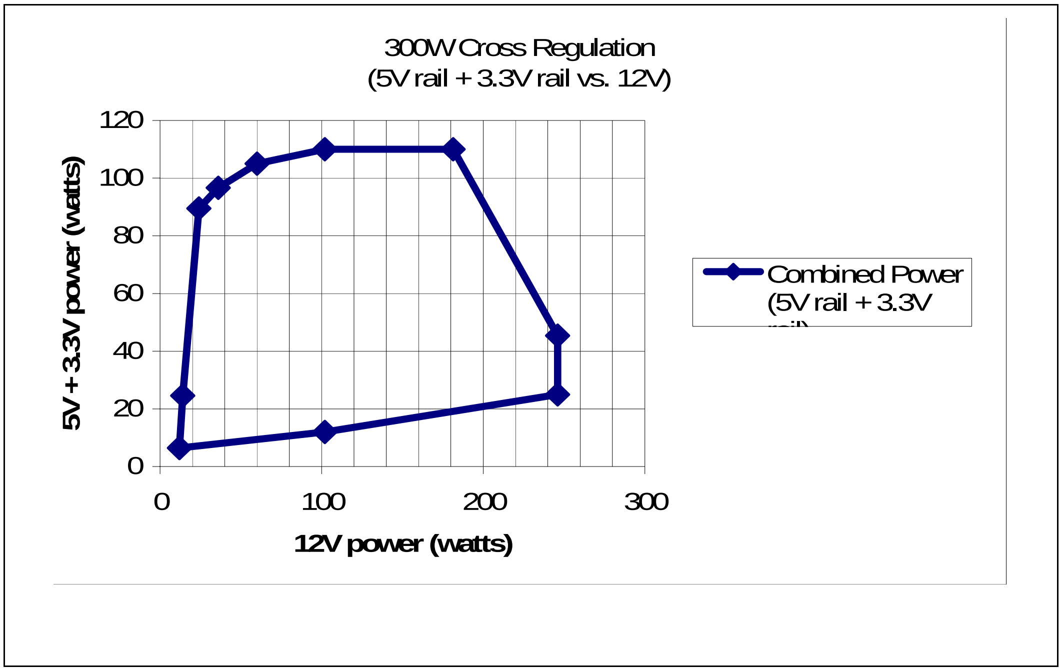


Table 60. Typical Power Distribution for 300 W Configurations

Output	Minimum Current (A)	Rated Current (A)	Peak Current (A)[1]
+12 V1DC[2]	1.0	8.0	9.0
+12 V2DC[2, 3]	1.0	16.0	19.0
+5 VDC[4]	0.5	12.0	-
+3.3 VDC[4]	0.5	20.0	-
-12 VDC	0	0.3	-
+5 VSB	0	2.0	2.5

NOTES:

1. Peak currents may last up to 17 seconds with not more than one occurrence per minute.
2. 12V1DC and 12V2DC should have separate current limit circuits.
3. 12V2DC supports processor power requirements and must have a separate current limit and provide 19 A peak current for 10 ms; minimum voltage during peak is > 11.0 VDC.
4. Total combined output of 3.3 V and 5 V is ≤ 110W.

Table 61. 240 W Loading for Efficiency Measurements[1]

Loading	+12 V	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	12.5	9.3	10.9	0.2	1.0
Typical (A)	6.2	4.7	5.5	0.1	1.0
Light (A)	2.5	1.9	2.2	0	1.0

NOTES:

1. Loading calculated by method available at http:// www.efficientpowersupplies.org.

Table 62. 275 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	4.1	10.6	9.7	13.0	0.2	1.0
Typical (A)	2.0	5.3	4.9	6.5	0.1	1.0
Light (A)	1.0	2.1	1.9	2.6	0	1.0

NOTES:

1. Loading calculated by method available at http://www.efficientpowersupplies.org.

Table 63. 300 W Loading for Efficiency Measurements[1]

Loading	+12 V1	+12 V2	+5 V	+3.3 V	-12 V	+5 VSB
Full (A)	5.7	11.3	8.5	14.1	0.2	1.0
Typical (A)	2.8	5.7	4.2	7.1	0.1	1.0
Light (A)	1.1	2.3	1.7	2.8	0	1.0

NOTES:

1. Loading calculated by method available at http://www.efficientpowersupplies.org.

14.2 Physical Dimensions - REQUIRED

Figure 47. Dimensions & Recommended Feature Placements (not to scale)

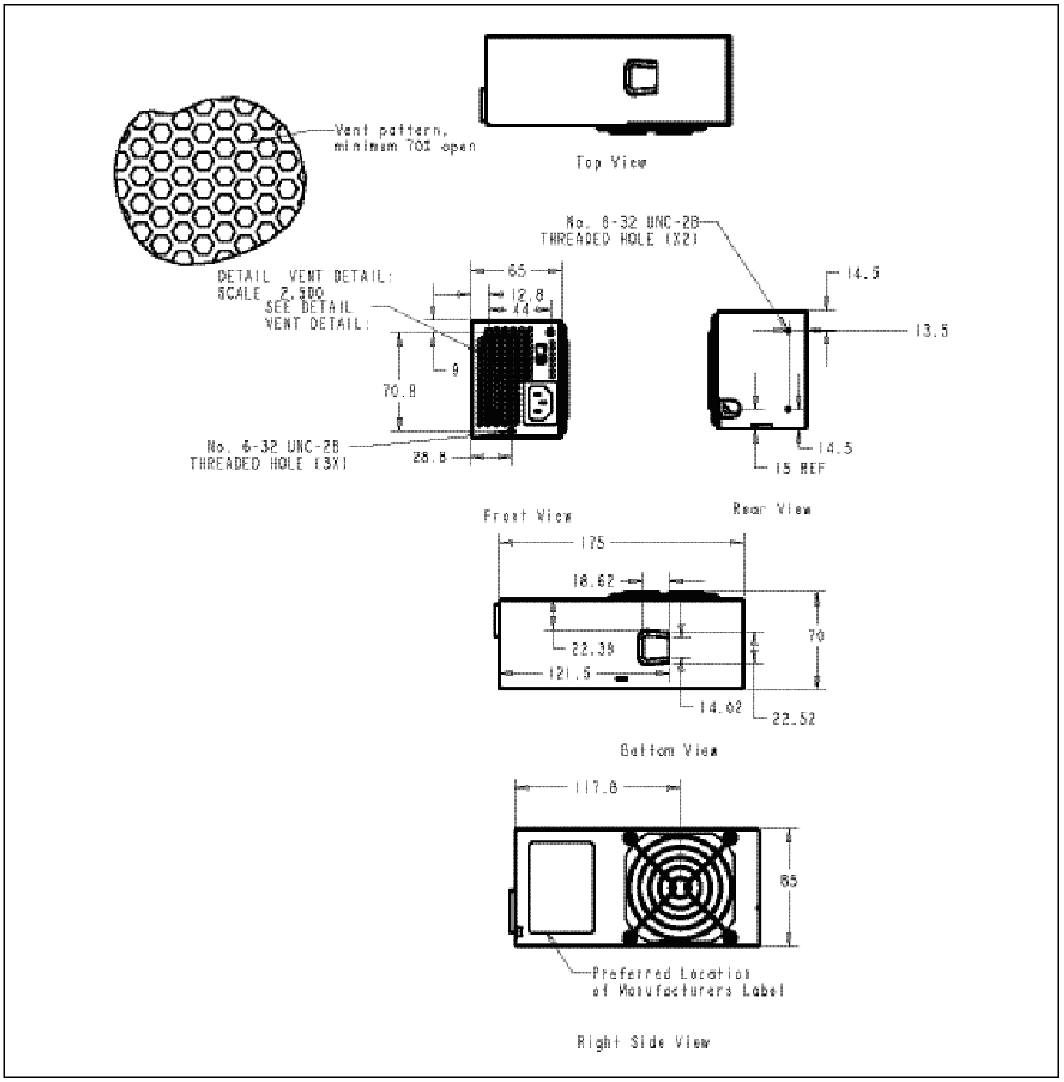
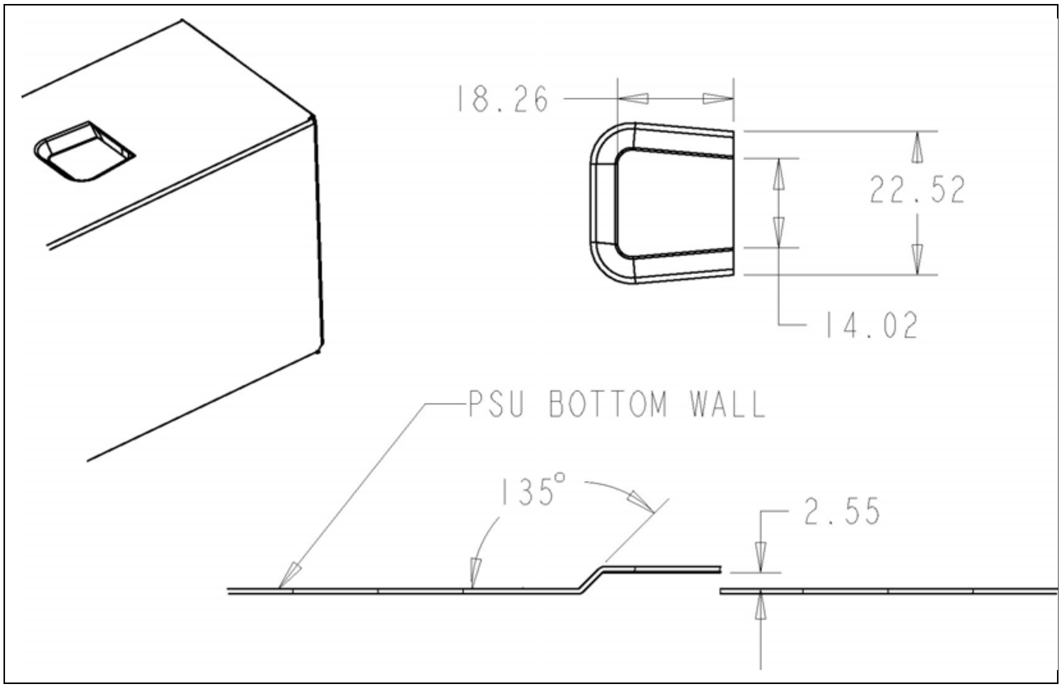


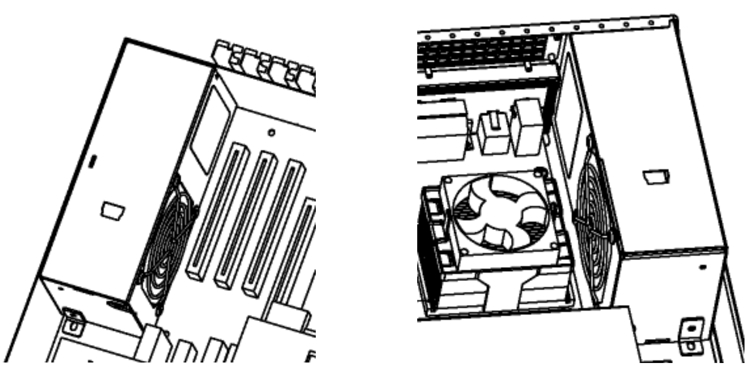
Figure 48. Power Supply Mounting Slot Detail



14.3 Mounting Options - RECOMMENDED

The TFX12V mechanical design provides two options for mounting in a system chassis. The unit can be mounted using one of the mounting holes on the front end (non-vented end) or a chassis feature can be designed to engage the slot provided in the bottom of the supply. In order to accommodate different system chassis layouts, the TFX12V power supply is also designed to mount in two orientations (fan left and fan right) as shown in Figure 49. A mounting hole and slot should be provided for each orientation as shown in Figure 47. Details of a suggested geometry for the mounting slot are shown in Figure 48.

Figure 49. Fan Right and Fan Left Orientations of Power Supply in a Chassis



14.4 Chassis Requirements - RECOMMENDED

To ensure the power supply can be easily integrated, the following features should be designed into a chassis intended to use a TFX12V power supply:

- Chassis cutout (normally in the rear panel of the chassis) as shown in Figure 50.
- EITHER a mounting bracket to interface with the forward mounting hole on the power supply OR a mounting tab as shown in Figure 51 to interface with the mounting slot on the bottom of the power supply.

Figure 50. Suggested TFX12V Chassis Cutout

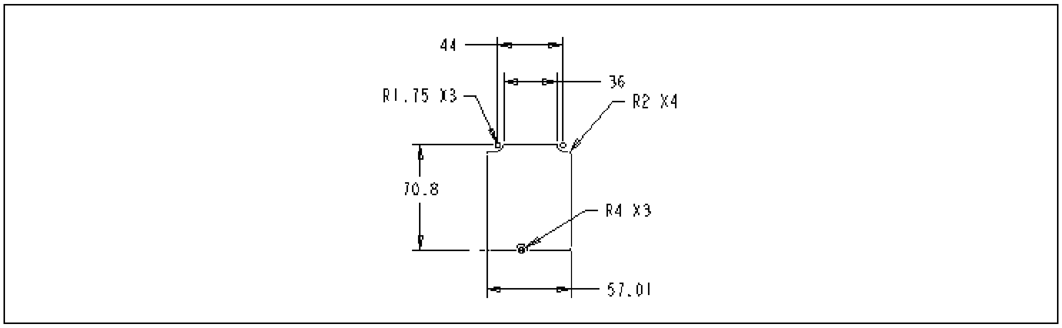


Figure 51. Suggested Mounting Tab (chassis feature)