Desktop Platform Form Factors Power Supply

Design Guide

June 2018

Revision 002

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Revision History

Document Number	Revision Number	Description	Revision Date
336521	001	• Initial Release	September, 2017
	002	• Updated Table 2-1: 12V2 Current for Processor Configurations. • Updated Figure 3-3: Power Supply Timing. • Added Figure 3-5: +5VSB Power on timing versus VAC. • Added note Table 4-8: +3.3V is removed from SATA V3.2 spec. • Updated Chapter 10: – CFX12V Specific Guidelines to version 1.62 – LFX12V Specific Guidelines to version 1.42 – ATX12V Specific Guidelines to version 2.52 – SFX12V Specific Guidelines to version 3.42 – TFX12V Specific Guidelines to version 2.52 – Flex ATX Specific Guidelines to version 1.22 • Removed Chapter 16 test plan. Refer to Document #595284 for test plan. • Added Section 9.2. Reliability – PS_ON# toggle for S0ix mode.	June, 2018

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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. The required sections are intended to be followed for all systems where the recommended sections could be modified based on system design.

1.1 Reference Documentation

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

Document	Document Number / Source
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

Document	Document Number / Source
UL 60950-1 First Edition –CAN/CSA-C22.2 No. 60950-1-03 First Edition, IEC 60950-1: 2001 + Amendments and National Deviations, EN 60950-1: 2001 + Amendment A11: EU Low Voltage Directive (73/23/EEC) (CE Compliance) GB-4943 (China) CNS 14336: (Taiwan BSMI) FCC*, Class B, Part 15 (Radiated and Conducted Emissions) CISPR* 22 / EN55022, 5th Edition (Radiated and 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 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)) IEC 62368	

1.2 Terminology

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

Table 1-1: Conventions and Terminology

Acronym, Convention / Terminology	Description
ASM	Alternative Sleep Mode, ASM replaces the traditional Sleep Mode (ACPI S3) with a new sleep mode. An example of ASM is with Microsoft* Modern Standby* or Lucid Sleep with Google* Chrome*
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.

Acronym, Convention / Terminology	Description
Noise	The periodic or random signals over frequency band of 0 Hz to 20 MHz.
Non-ASM	Computers that do not use Alternative Sleep Mode use traditional Sleep Mode (ACPI S3).
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 Correction.
P-P	Peak to Peak Voltage Measurement.
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 above the under voltage thresholds of the power supply.
Ripple Noise	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 90% 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 1-2: 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 Processor Configurations

2.1 Processor Configurations - Recommended

Table below shows various processor configurations for 12V2 current recommendation.

Table 2-1: 12V2 Current for Processor Configurations

PSU 12V2 Capability Recommendations		
Processor TDP	**Continuous Current**	**Peak Current**
165W	37.5A	45.0A
140W	28.0A	39.0A
95W	22.0A	29.0A
65W	21.0A	28.0A
35W	13A	16.5A

The table above is associated with 8th Gen Intel® Core™ Processor Families desktop processors for 35W, 65W, and 95W. The 140W and 165W TDP SKUs listed are for Intel® Core™ X-series Processors. All values are based on peak and continuous current published in processor Datasheet at publication of this document. Any future revisions of the processors Datasheet would supersede these values.

Latest 8th Gen Intel® Core™ Processor Families peak power and current specification can be found in 8th Gen Intel® Core™ Processor Families Datasheet.

Reference equation for 12V2 capability calculation:

- 12V2 Peak Current = (SoC Peak Power / VR efficiency) / 11.4V
- 12V2 Sustain Current = (SoC sustain power / VR efficiency) / 11.4V

Note: PSU rail voltage is 11.4V, 12V2 should be able to supply peak current for 10 ms.
Motherboard VR efficiency is 85% at TDC and 80% at SoC peak power (AKA IccMax)
Motherboard plane resistance is 1.2mOhm.
If the power supply supports the 240VA Energy Hazard protection requirement then Current levels for the 12 Volt rail above 20 Amps would have to be split into multiple 12V rails.

2.2 High End Desktop Market Processor Considerations

The High End Desktop market requires power supplies with higher power levels than the mainstream market. Sometimes the EPS12V specification is referenced for these designs. The EPS12V specification is a power supply form factor for the server market.

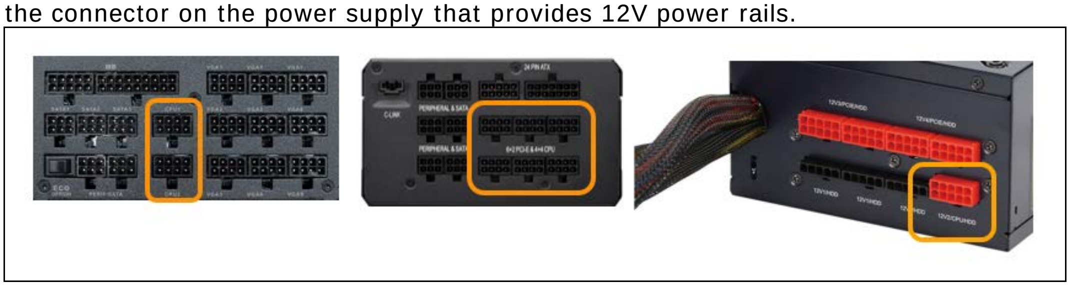
Here in the Desktop Power Supply design guide we are including higher power levels to incorporate these higher performance desktop computers.

2.2.1 Modular Power Supply Connectors

For power supplies to be made for multiple end user applications it is recommended to use a modular design with multiple cable options for the end user to decide how they want to use power. The CPU connectors on the motherboard are either a 4 pin (2x2) or 8 pin (2x4) connector, detailed in Section 4.2.2.5. The graphics card connector is either a 6 pin (2x3) or 8 pin (2x4) connector detail in Section 4.2.2.4. Both of these connectors use the 12V rail to power the component, but use different pin locations and keying so they are not interchangeable. Therefore, a modular design is recommended for multiple end user possibilities.

The end user might decide to use the power supply with a lower power or non-overclocked CPU and multiple graphics cards in the system and need more power cables for the graphics cards. Another option is to use a higher power CPU that might be overclocked and require more power connectors and less graphics cards in that system. The connectors on the power supply provide 12V power and then the end user can decide which cable to plug in to provide 12V power in their computer.

Here are some example modular designs. The orange box in each picture shows that the connector on the power supply that provides 12V power rails.



Based on the amount of current that is needed to support a specific current (power) level the guideline to follow is 6-8 Amps per pin. This is based on 18 AWG wire and a solid connector pin. Based on this recommendation, here is how this can be applied to the CPU power connectors:

- 12-16A support for 2x2 (4pin) connector
- 18-24A support for 2x3 (6pin) connector
- 24-32A support for 2x4 (8pin) connector

This recommendation is based on common design practice. PSU and system designer may design or use differently and should be responsible for designing the PSU to meet all electrical, thermal, safety and reliability requirements based on the application of the PSU.

2.2.2 Overclocking Recommendations

The power levels listed in Section 2.1 are for processors that follow the Plan Of Record (POR) power levels that include Turbo Mode. If the processor is overclocked then power levels will be increased. If the power supply is expected to support end users who desire to overclock then the 12V power rail to the processor will need to be higher than what is listed in Table 2-1.

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3 Electrical

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

3.1 AC Input - Required

Table below 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 3-1: AC Input Line Requirements

Parameter	Minimum	Nominal1	Maximum	Unit
Vin (115 VAC)	90	115	135	VACrms
Vin (230VAC)	180	230	265	VACrms
Vin Frequency	47	-	63	Hz

Note: 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 – 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 AC switch if present, bridge rectifier, and fuse 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 3-1, shall not cause damage to the power supply.

3.2 DC Output - Required

3.2.1 DC Voltage Regulation – Required

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

Table 3-2: 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[4]	±10%	-10.80	-12.00	-13.20	V
+5VSB	±5%	+4.75	+5.00	+5.25	V

Note:

1. At +12V1DC peak loading, regulation at the +12V1DC and +12V2DC outputs can go to ±5%.
2. At +12V2DC peak loading, regulation at the +12V1DC and +12V2DC outputs can go to ±5%
3. Voltage tolerance is required at main connector and SATA connector (if used)
4. -12VDC output is optional

3.2.2 DC Output Current – Required

Table below summarizes the expected output transient step sizes for each output. The transient load slew rate is = 1.0 A/µs. All items in the below table are REQUIRED, unless specifically called out as RECOMMENDED.

Table 3-3: DC Output Transient Step Sizes

Output	Maximum Step Size (% of rated output amps)	Maximum Step Size (A)
+12V1DC	40% (Required) 70% (Recommended)	-
+12V2DC	85%	-
+12V3/4	80% (Recommended)	
+5VDC	30%	-
+3.3VDC	30%	-
-12VDC	-	0.1
+5VSB	-	0.5

Note:

1. For example, for a rated +5 VDC output of 14A, the transient step would be
2. 30% x 14 A = 4.2 A.
3. The numbers are based on the 8th gen Intel® Core™ Desktop CPU family, subject to change. Contact the Intel® representative for the up to date CPU electrical specification max step size of the CPUs that will be assembled for system integration.
4. 12V3/V4 rails are typically used for PCI-E Graphic card connectors. Some power supplies use one large 12V rail or other configurations. This recommendation comes from Graphics card recommendations and should be applied to the amount of current of the 12V rails associated with the graphic card connections. This is not an Intel® requirement and so it will be treated as a recommendation during testing.

Output voltages should remain within the regulation limits of Table 3-2, for instantaneous changes in load as specified in Table 3-3 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 3-6

3.2.3 Remote Sensing - Recommended

Remote sensing is recommended. Remote sensing can accurately control motherboard loads by adding it to the PSU connector. The +3.3 VDC output should have provisions for remote sensing to compensate for excessive cable drops. In low power PSU, remote sensing is recommended. The default sense should be connected to pin 13 of the main power connector. Refer Figure 3-7. 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 Other Low Power System Requirements - Recommended

To help meet the Blue Angel* system requirements, RAL-UZ 78, US Presidential executive order 13221, ENERGY STAR*, ErP Lot6 requirements, and other low Power system demands, it is recommended that the +5VSB standby supply power consumption should be as low as possible. In order to meet the 2010 and 2013 ErP Lot 6 requirements, 2014 ErP Lot 3 requirements, and if any Computers use an Alternative Sleep Mode (ASM) then the 5V standby efficiency should be met as shown in Table 3-4 which is measured with the main outputs off (PS_ON# high state).

Table 3-4: Recommended System DC and AC Power Consumption

5VSB Load Target	5VSB Actual Load	Efficiency Target (both 115V and 230V input)	Remark
Max / Label	3.0A / Label	75%	Recommend
1.5 A		75%	ASM and ErP Lot 3 2014
1.00 A		75%	Recommend
0.55 A		75%	ASM and ErP* Lot 3 2014
90 mA		45%	ErP* Lot 6 2010
45 mA		45%	ErP* Lot 6 2013

3.2.5 Output Ripple Noise - Required

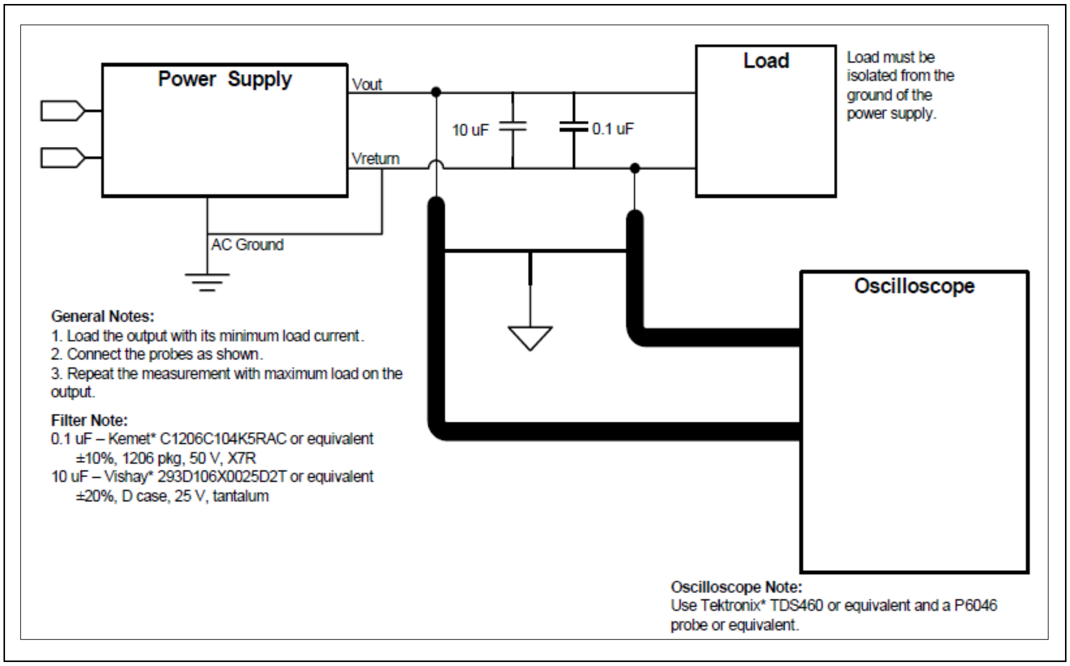
The output ripple and noise requirements listed in Table 3-5 should be met throughout the load ranges specified for the appropriate form factor and under all input voltage conditions as specified in Table 3-1.

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.
Refer to Figure 3-1 for the differential noise measurement setup.

Table 3-5: DC Output Noise/Ripple

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

Figure 3-1: Differential Noise Test Setup



3.2.6 Capacitive Load – Recommended

The power supply should be able to power up and operate within the regulation limits defined in Table 3-2, with the following capacitances simultaneously present on the DC outputs.

Table 3-6: Output Capacitive Loads

Output	Capacitive Load (µF)
+12V1DC	3,300
+12V2DC	3,300
+5VDC	3,300
+3.3VDC	3,300
-12VDC	3,300
+5VSB	3,300

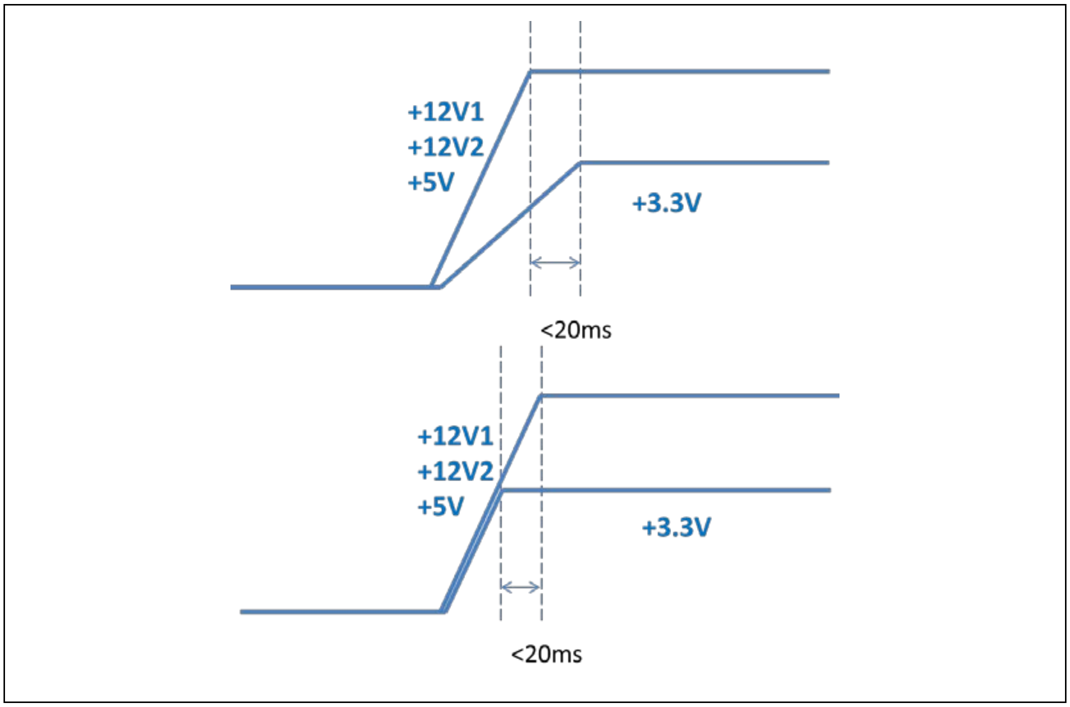
3.2.7 Closed Loop Stability - Required

The power supply shall be unconditionally stable under all line/load/transient load conditions including capacitive loads specified in Section 3.2.6. A minimum of 45 degrees phase margin and 10 dB gain margin is recommended at both the maximum and minimum loads.

3.2.8 +5V DC / +3.3V DC 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 as shown in the below figure.

Figure 3-2: Power Supply Timing



3.2.9 Voltage Hold-Up Time - Required

The power supply should maintain output regulations per Table 3-2 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 17ms (T5+T6).

3.2.10 12V2 DC Minimum Loading - Required

The power supply +12 V2DC should maintain output regulations per Table 3-2 and meet minimum current values below.

Table 3-7: 12V2 DC Minimum Current

Output	Minimum current (A)
+12V2 DC	0A (Required)
+12V1 DC	0 (recommended)

3.3 Timing, Housekeeping and Control – Required

Figure 3-3: Power on Timing

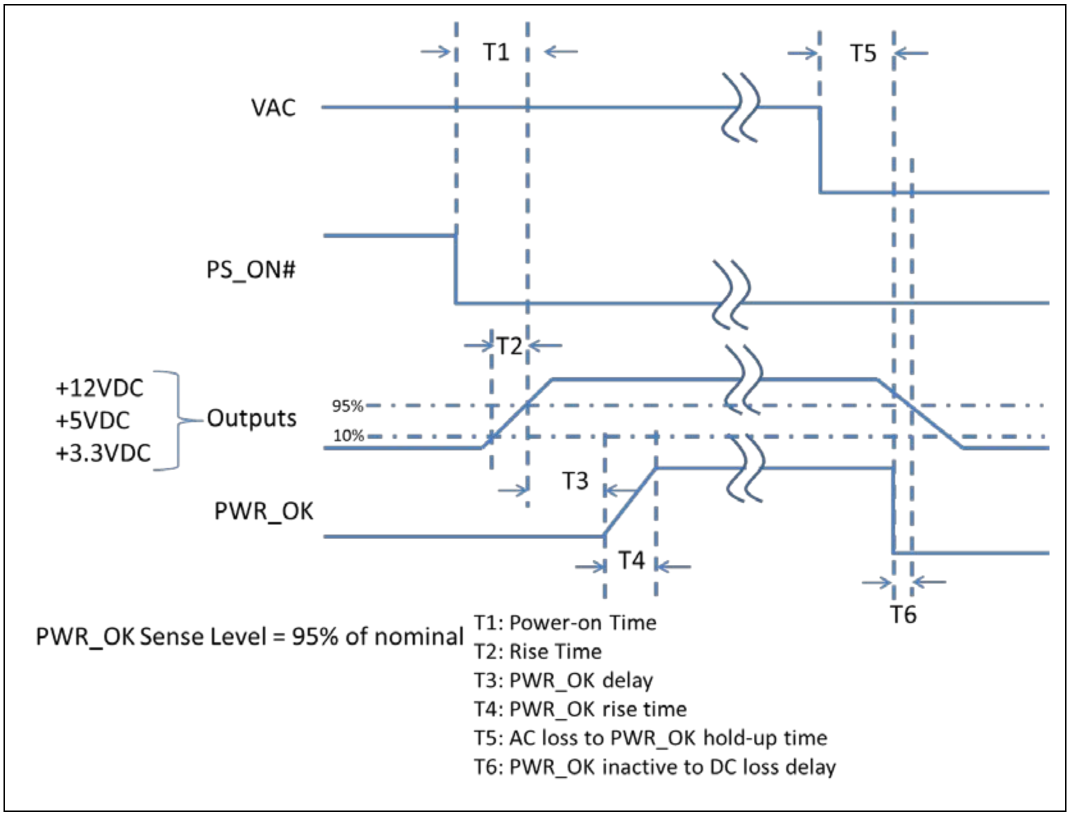


Table 3-8: Power Supply Timing

Parameter	Description	Value		
		Required	Recommended for Non-Alternative Sleep Mode1	Recommended for Alternative Sleep Mode
T0	AC power on time	<2s	-	-
T1	Power-on time	< 500ms	< 200ms	<150ms
T2	Rise time	0.2 – 20 ms	-	-
T3	PWR_OK delay	100[2] – 500 ms	100ms[2] – 250 ms	100ms[2] – 150ms
T4	PWR_OK rise time	< 10 ms	-	-
T5	AC loss to PWR_OK hold-up time[3]	> 16 ms	-	-
T6	PWR_OK inactive to DC loss delay	> 1 ms	-	-

1. Value in the recommended column for "Recommend for Non-Alternative Sleep Mode" to be required in the year 2020.
2. T3 minimum must not be faster than 100ms. All design tolerances must be considered to avoid T3 faster than 100ms.
   a. A T3 time less than 100ms may be designed based on system requirements and a need to provide faster PSU and system turn on capability. However, PSU and system designers are highly recommended to verify and ensure no PSU and system compatibility problems exist, especially for previous generation motherboards and systems.
3. T5 to be defined for both max/min load condition.
4. PSUs are recommended to label or indicate the timing value for system designer and integrator reference for T1 and T3. This allows system designers to optimize "turn on" time within the system.

3.3.1 PWR_OK – Required

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 3-2 and that sufficient mains energy is stored by the converter to guarantee continuous power operation within the specification for at least the duration specified in Section 3.2.9. 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 voltage threshold, or when mains power has been removed for a time sufficiently long enough, such that power supply operation cannot be guaranteed. The electrical and timing characteristics of the PWR_OK signal are given in the below table.

PSU manufacturers are required to label or tag PSU DG revision compliance to reflect the timing supported.

Table 3-9: 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
Max Ripple/Noise	400 mV p-p

3.3.2 Power-Up Cross Loading Condition – Required

In the time frame between PS_ON# assertion and PWR_OK assertion (T1+T3), the power supply may be subjected to a cross load condition on the 12 V, 3.3 V and 5 V rails. The power supply should be able to successfully power-up and assert PWR_OK when 12 V (or combination of 12V1 and 12V2) is loaded to ≤ 0.1 A and 3.3 V and/or 5 V are loaded to 0-5 A.

3.3.3 PS_ON# – Required

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 +5VSB output, which is always enabled whenever the AC power is present. Table below 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.

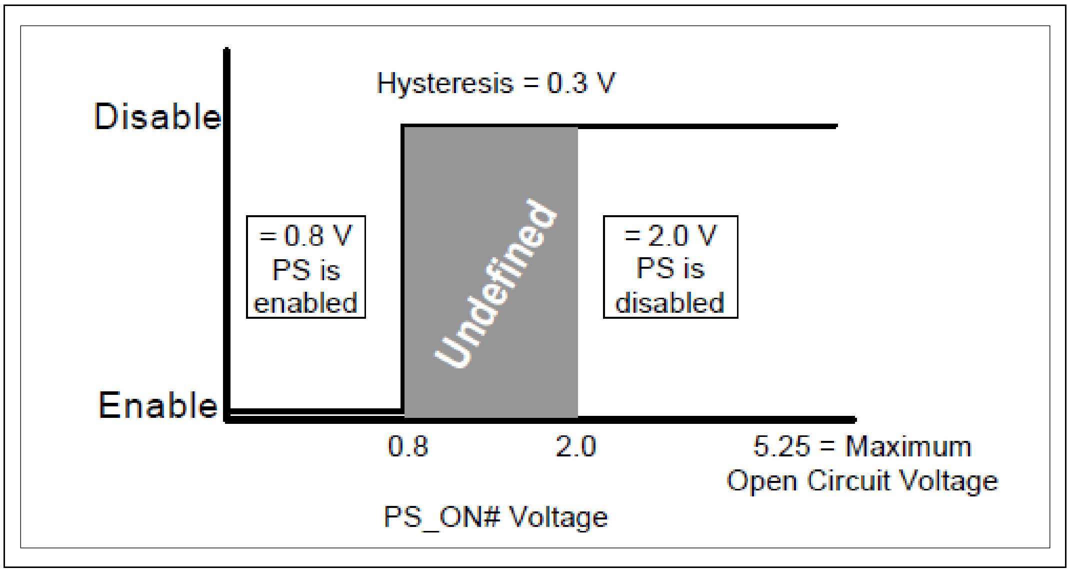
Table 3-10: PS_ON# Signal Characteristics

Parameter	Minimum	Maximum
V_{IL}	0	0.8 V
I_{IL} (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
Ripple / Noise		400 mV p-p

Note:

1. Negative current indicates that the current is flowing from the power supply to the motherboard.
2. Due to PS_ON# toggle on/off frequently, system and PSU components reliability should be considered based on the days, months or years of claimed warranty listed on product specification. Refer to Document PSU design consideration for S0ix mode.

Figure 3-4: PS_ON# Signal Characteristics



3.3.4 +5VSB – Required

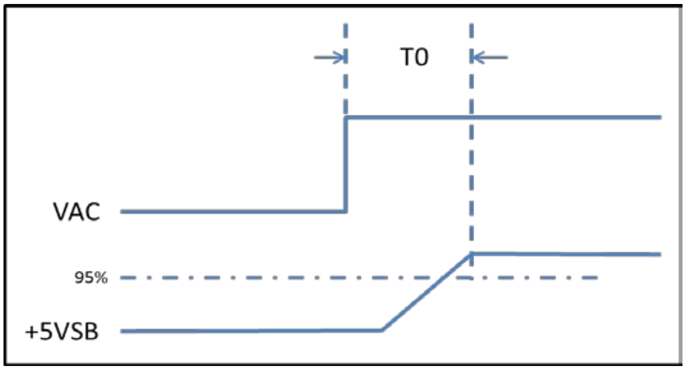
+5VSB is a standby supply output that is active whenever the AC power is present. This output provides a power source for circuits that must remain operational when the five main DC output rails are in a disabled state. Example uses include soft power control, Wake on LAN, wake-on-modem, intrusion detection, Alternative Sleep Modes (ASM) 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 3.5 A, lasting no more than 500ms.

Over current protection is required on the +5VSB 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.

With new modes of operation for computers like Alternative Sleep Modes (ASM) the continuous current rating of the 5VSB rail is recommended to be at least 3 A. Some scenarios like USB Power Charging in ASM could require more current on the 5VSB rail.

Figure 3-5 +5VSB Power on Timing Versus VAC



3.3.5 Power-On Time – Required

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 3-2. The power-on time shall be less than 500 ms (T1 < 500 ms).

+5VSB shall have a power-on time of two second maximum after application of valid AC voltages as shown in Figure 3-5. The 5VSB power on time is T0 as listed in Section 3.3.4.

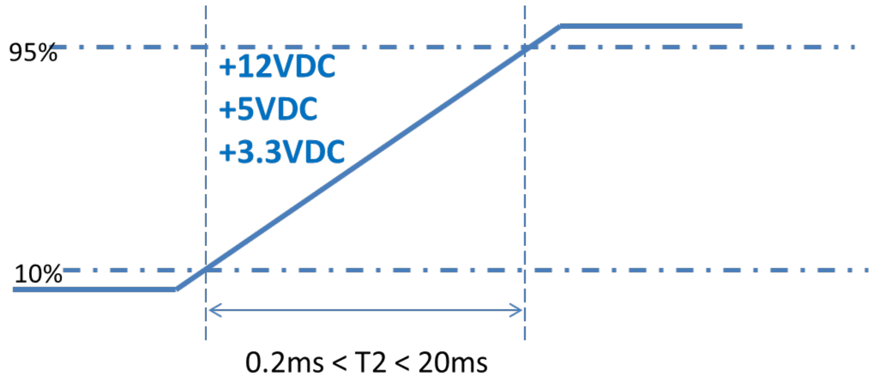
3.3.6 Rise Time – Required

The output voltages shall rise from 10% of nominal to within the regulation ranges specified in Table 3-2 within 0.2 ms to 20 ms (0.2 ms ≤ T2 ≤ 20 ms). The total time for Rise time of each voltage is listed in Table 3-8 as T2.

There must be a smooth and continuous ramp of each DC output voltage from 10% to 95% of its final set point within the regulation band, while loaded as specified.

The smooth turn-on requires that, during the 10% to 95% 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 / 0.2] V/ms. Also, for any 5 ms segment of the 10% to 95% rise time waveform, a straight line drawn between the end points of the waveform segment must have a slope ≥ [Vout, nominal / 20] V/ms.

Figure 3-6: Rise Time Characteristics



	Min slew rate (10-95%)	Max Slew Rate (10-95%)	Min Slew Rate for any 5ms segment (10-95%)
+12VDC	0V/ms	60V/ms	0.6V/ms
+5VDC	0V/ms	25V/ms	0.25V/ms
+3.3VDC	0V/ms	16.5V/ms	0.165V/ms

3.3.7 Overshoot at Turn-On / Turn-Off – Required

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 3-2, 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.

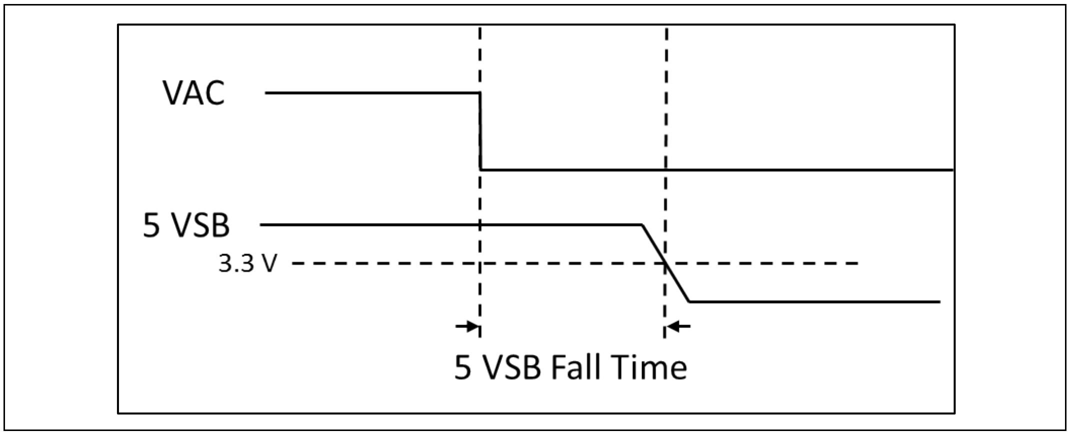
3.4.1 +5VSB at Power-Down – Required

After AC power is removed, the +5VSB standby voltage output should remain at its steady state value for the minimum hold-up time specified in Section 3.2.9 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.

3.4.2 +5VSB Fall Time - Recommendation

Power supply 5VSB is recommended to go down to low level within 2 seconds under any load condition after AC power is removed as shown in the below figure. Intel® test plan will test at Light 20% Load. If system requires specific +5VSB fall time, the PSU design is recommended to support it.

Figure 3-7: 5VSB Fall Time



3.5 Output Protection

3.5.1 Over Voltage Protection (OVP) – Required

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 the below table.

Table 3-11: Over Voltage Protection

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

Note: Over voltage protection is RECOMMENDED but not REQUIRED for this output. While over voltage protection is not required for this output, system damage may occur in the case of an over voltage event.

3.5.2 Short Circuit Protection (SCP) – Required

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 +3.3V DC, +5V DC, or +12V DC 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 +5VSB 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. +5VSB must be capable of being shorted indefinitely. When the short is removed, it is recommended that the power supply shall recover automatically or by cycling PS_ON#. Optionally, the power supply may latch off when a +5VSB short circuit event occurs. 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 3-1.

3.5.3 No-Load Situation – Required

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 (OCP) – Required

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

Over current protection schemes, where only the voltage output that experiences the over current event is shut off, may be adequate to maintain safe operation of the power supply and the system; however, damage to the motherboard or other system components may occur. The recommended over current protection scheme is for the power supply to latch into the shutdown state. PSU connectors, cables and all other components should not be melted or damaged prior reaching to the OCP trigger.

3.5.5 Over Temperature Protection (OTP) – Required

The power supply should 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. PSU connectors, cables and all other components should not be melted or damaged prior reaching to the OCP trigger.

3.5.6 Output Bypass – Required

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 Levels

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 **Generalized Test Protocol for Calculating the Energy Efficiency of Internal Ac-Dc and Dc-Dc Power Supplies** document. This document defines how to determine full load criteria based on the label of each rail of the power supply. The loading condition for testing efficiency represent fully loaded systems, typical (50%) loaded systems, and light (20%) loaded systems.

The Efficiency requirements listed below are applicable to AC Input voltage of 115V.

Table 3-12: Efficiency Versus Load Minimum Requirements

Loading	Full Load (100%)	Typical Load (50%)	Light Load (20%)
Required Minimum Efficiency	70%	72%	65%

Computers have decreased Idle power greatly since 2005, to where PSU loss is a big concern for overall AC power of a computer in Idle Mode. Power supplies need to design a good Low Load Efficiency so power supply loss is minimized during Idle state of a computer.

3.5.9 Power Supply Efficiency for Energy Regulations - Energy Star* and CEC (California Energy Commission) PC Computers with High Expandability Score - Recommended

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 represent fully loaded systems, typical (50%) loaded systems, and light (20%) loaded systems. For system being sold into the state of California that meet the High Expandability Computer definition (details at the referenced CEC website below) are required to meet the efficiency target list in Table 3-15: Efficiency versus Load for CEC PC Computers with High Expandability Computers*.

Visit ENERGY STAR* Computers Ver.7 website for more details.
https://www.energystar.gov/products/spec/computers_specification_version_7_0_pd

Visit CEC* website for more details.
http://www.energy.ca.gov/appliances/2016-AAER-02/rulemaking/

Note: Check ENERGY STAR* and CEC website for the latest specification update.

Table 3-13: Efficiency versus Load for Energy Star*

Loading	Full Load (100%)	Typical Load (50%)	Light Load (20%)	PFC @ 50% load	Remarks
Recommended Minimum Efficiency	82%	85%	82%	⩾0.9	ES v6.1 and ES v7 for 500W and below
Recommended Minimum Efficiency	87%	90%	87%	≥0.9	ES v7 for above 500W

Table 3-14: Efficiency Versus Load for CEC PC Computers with High Expandability Computers*

Loading	Full Load (100%)	Typical Load (50%)	Light Load (20%)	PFC
REQUIRED Minimum Efficiency for 115V PSU	87%	90%	87%	⩾0.9 @ 50% load
REQUIRED Minimum Efficiency for 230V PSU	88%	92%	88%	⩾0.9 @ 50% load

*Details about High Expandability Computers definition check CEC computer regulation.

The Recommended minimum efficiency levels shown in Table 3-14 are required for internal power supplies within the ENERGY STAR* Computers Version 6.1 and Version 7.0 specification.

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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.

PSU are required to label or tag Power Supply Design Guide revision compliance level to reflect the timing supported. There are three levels of timing for T1 and T3 a power supply can support. This will help system integrators and end users know the T1 and T3 timing that a power supply can support.

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.

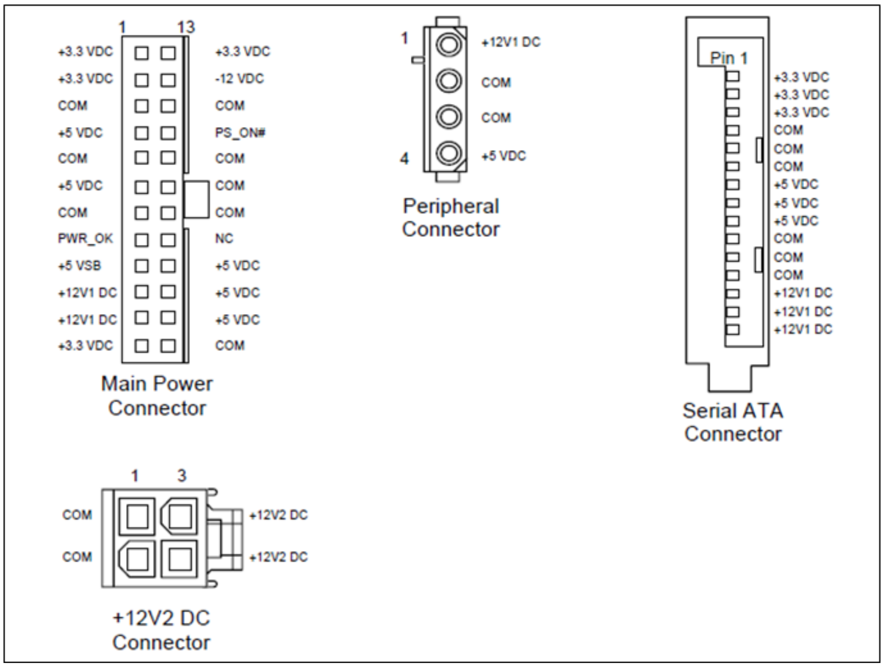
4.2.2 DC Connectors

Table 4-1: Main Power Connector Pin-Out 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 4-1: Connectors (Pin-side view, not to Scale)



Note: Peripheral Connector is optional, does not show PCI-E Graphic Card Connector or 8 pin 12V2 connector.

4.2.2.1 Main Power Connector – Required

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 4-1: Main Power Connector Pin-Out

Pin	Signal	Color	Pin	Signal	Color
1	+3.3V DC	Orange	13	+3.3V DC [+3.3 V default sense]	Orange [Brown]
2	+3.3V DC	Orange	14	-12V DC	Blue
3	COM	Black	15	COM	Black
4	+5V DC	Red	16	PS_ON#	Green
5	COM	Black	17	COM	Black
6	+5V DC	Red	18	COM	Black
7	COM	Black	19	COM	Black
8	PWR_OK	Gray	20	Reserved	NC
9	+5VSB	Purple	21	+5V DC	Red
10	+12V1 DC	Yellow	22	+5V DC	Red
11	+12V1 DC	Yellow	23	+5V DC	Red
12	+3.3V DC	Orange	24	COM	Black

4.2.2.2 Peripheral Connectors

Connector: AMP* 1-480424-0 or Molex* 15-24-4048 or equivalent.

Contacts: AMP 61314-1 or equivalent.

Table 4-2: Peripheral Connector Pin-Out

Pin	Signal	Color[1]
1	+12V1 DC	Yellow
2	COM	Black
3	COM	Black
4	+5 VDC	Red

Note: 18 AWG wire.

4.2.2.3 Floppy Drive Connector – Do Not Included (For Historical Reference Only)

Connector: AMP* 171822-4 or equivalent.

Table 4-3: Floppy Connector Pin-Out

Pin	Signal	Color[1]
1	+5V DC	Red
2	COM	Black
3	COM	Black
4	+12V1 DC	Yellow

Note: 20 AWG wire.

4.2.2.4 PCI-Express (PCI-E) Graphics Card Connector

This is an optional connector for the power supply to support additional power needed by a discrete graphics card over 75 watts.

Table 4-4: PCI-E Graphics Card 6 Pin Connector Pin-Out

Pin	Signal	Color	Pin	Signal	Color
1	+12V3/V4	Yellow	4	COM	Black
2	+12V3/V4	Yellow	5	COM	Black
3	+12V3/V4	Yellow	6	COM	Black

Note: 18 AWG wire.

Table 4-5: PCI-E Graphics Card 8 Pin (6+2) Connector Pin-Out

Pin	Signal	Color	Pin	Signal	Color
1	+12V3/V4	Yellow	5	COM	Black
2	+12V3/V4	Yellow	6	COM	Black
3	+12V3/V4	Yellow	7	COM	Black
4	COM	Black	8	COM	Black

Note: 18 AWG wire.

4.2.2.5 +12 V Power Connector

Connector: Molex* 0039012040 or equivalent.

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

Table 4-6: +12 V Power 4 Pin Connector Pin-Out

Pin	Signal	Color[1]	Pin	Signal	Color[1]
1	COM	Black	3	+12V2 DC	Yellow
2	COM	Black	4	+12V2 DC	Yellow

Note: 18 AWG wire.

Table 4-7: +12 V Power 8 Pin Connector Pin-Out

Pin	Signal	Color[1]	Pin	Signal	Color[1]
1	COM	Black	5	+12V2 DC	Yellow
2	COM	Black	6	+12V2 DC	Yellow
3	COM	Black	7	+12V2 DC	Yellow
4	COM	Black	8	+12V2 DC	Yellow

Note: 18 AWG wire.

4.2.2.6 Serial ATA* Connectors – Required

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.

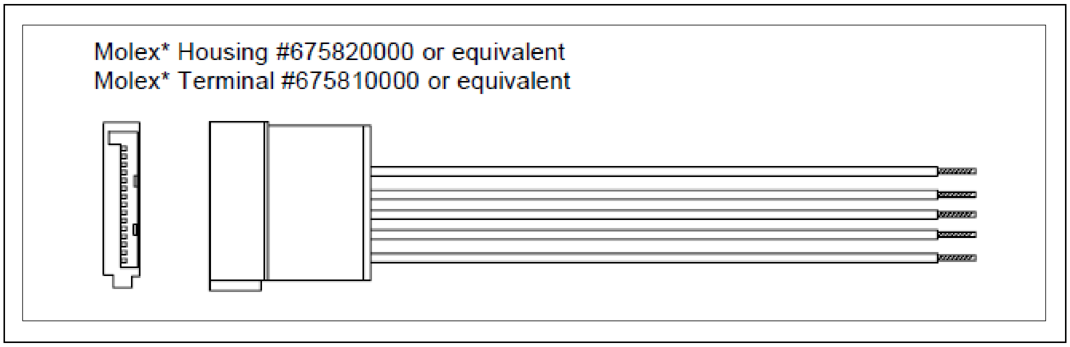
Table 4-8: Serial ATA* Power Connector Pin-Out

Wire	Signal	Color[1]
5	+3.3V DC	Orange [2]
4	COM	Black
3	+5V DC	Red
2	COM	Black
1	+12V1 DC	Yellow

Note:

1. 18 AWG wire.
2. +3.3V DC is removed from SATA V3.2 spec. but it is recommended if there is backward compatibility concern.

Figure 4-2: 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. Refer to 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 5-1: Recommended Power Supply Acoustic Targets.

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.

Different customers might have different acoustic specifications. Any power supply design is recommended to follow any specific customer requirements.

Table 5-1: 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 sections 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.)

6.2 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.

6.3 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.

6.4 Altitude – Recommended

- Operating to 10,000 ft.
- Non-operating to 50,000 ft.

6.5 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.

6.6 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 sections 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, EN55023 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 and CISPR 24 prior to sale in the EU (European Union), Korea, and possibly other geographies.

7.3 Input Line Current Harmonic Content - Optional

Class D harmonic limits will be determined at the time of measurement based on the actual power draw from the mains.

Table below is a partial list of countries and their current EMC requirements. Additional requirements may apply dependent upon the design, product end use, target geography, and other variables.

Table 7-1: EMC Requirement by Country

Country	Requirements Document
EU (European Union)	EN61000-3-2
Japan	JEIDA MITI
China	CCC and GB 17625.1
Russia	GOST R 51317.3.2

7.4 Magnetic Leakage Field - 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 (IEC 61000-3-3) and amendment A1 to EN 61000-3-3 (IEC 61000-3-3/A1) for voltage fluctuations and flicker for equipment drawing not more than 16VAC, connected to low voltage distribution systems.

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8 Safety

The following sections 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 the 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. The certification must include external enclosure testing for the AC receptacle side of the power supply.
- 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. 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, Peoples Republic of China 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 - Required.

8.4 Catastrophic Failure Protection - Recommended

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.

9.2 Reliability – PS_ON# Toggle for S0ix Mode

In order to optimize desktop platform power consumption, Intel® provides design recommendation to enable PSU PS_ON# toggle on/off during S0 idle power mode (S0ix) to save both system and PSU power. The PSU PS_ON# toggle on/off every 180s (PSU to be on for 1s and off for 180s) when customer desktop design implement S0 idle which is different from the legacy desktop platform design that PS_ON# only toggle once when turn on.

To have better user's experience and avoid PSU fan acoustic noise annoyance, system and PSU designers may consider to have at least two seconds delay time for the PSU fan to spin up after PS_ON# assertion. PSU is expected to support running at full load without any electrical, thermal components (i.e. IC, MOSFET, diode, transformer, inductor, capacitor, relay, fan, etc.) damaged or degradations during the period of time before the warranty expired. Due to the frequent PS_ON# toggle on/off, system and PSU components reliability should be considered based on the days, months or years of claimed warranty listed on product specification.

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10 CFX12V Specific Guidelines 1.62

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

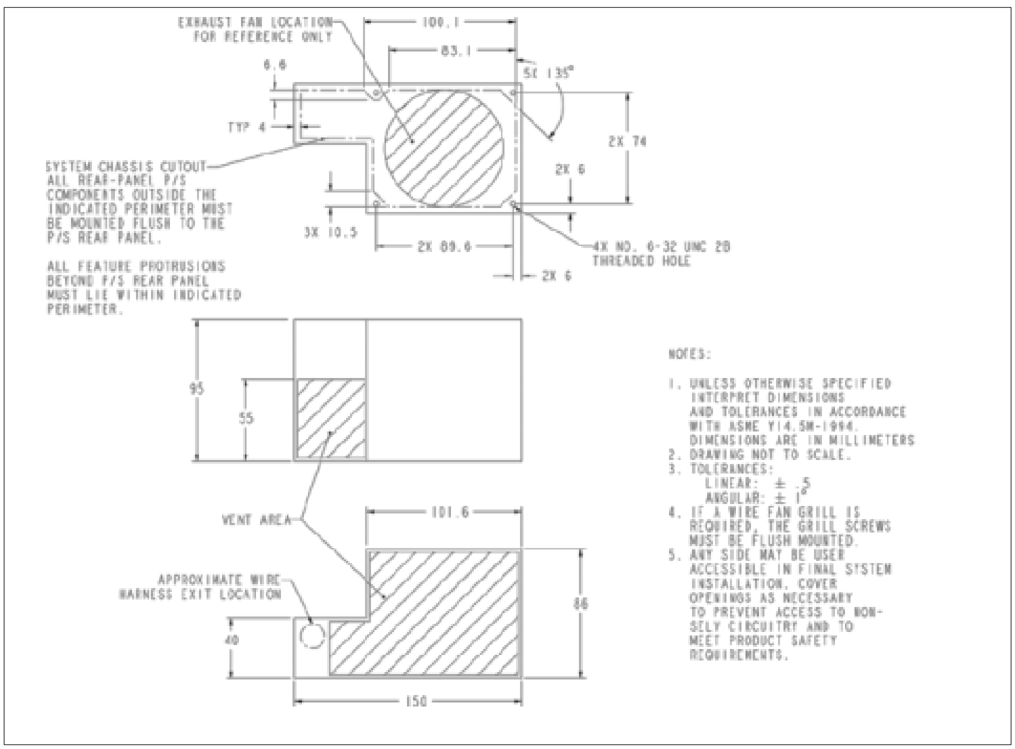
All Form Factors Revision Summary:

PSU DG	CFX12V	LFX12V	ATX12V	SFX12V	TFX12V	Flex ATX
1.31	1.5	1.3	2.4	3.3	2.4	1.1
1.4	1.6	1.4	2.5	3.4	2.5	1.2
1.42	1.62	1.42	2.52	3.42	2.52	1.22

10.1 Physical Dimensions – Required

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

Figure 10-1: CFX12V Mechanical Outline



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11 LFX12V Specific Guidelines 1.42

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

All Form Factors Revision Summary:

PSU DG	CFX12V	LFX12V	ATX12V	SFX12V	TFX12V	Flex ATX
1.31	1.5	1.3	2.4	3.3	2.4	1.1
1.4	1.6	1.4	2.5	3.4	2.5	1.2
1.42	1.62	1.42	2.52	3.42	2.52	1.22

11.1 Physical Dimensions - Required

The power supply shall be enclosed and meet the physical outline shown in Figure 10-1, applicable. Mechanical details are shown in the below figure. Details on the power supply slot feature are shown in Figure 11-2. The recommended chassis slot feature details are shown in Figure 11-3.

Figure 11-1: LFX 12V Mechanical Outline

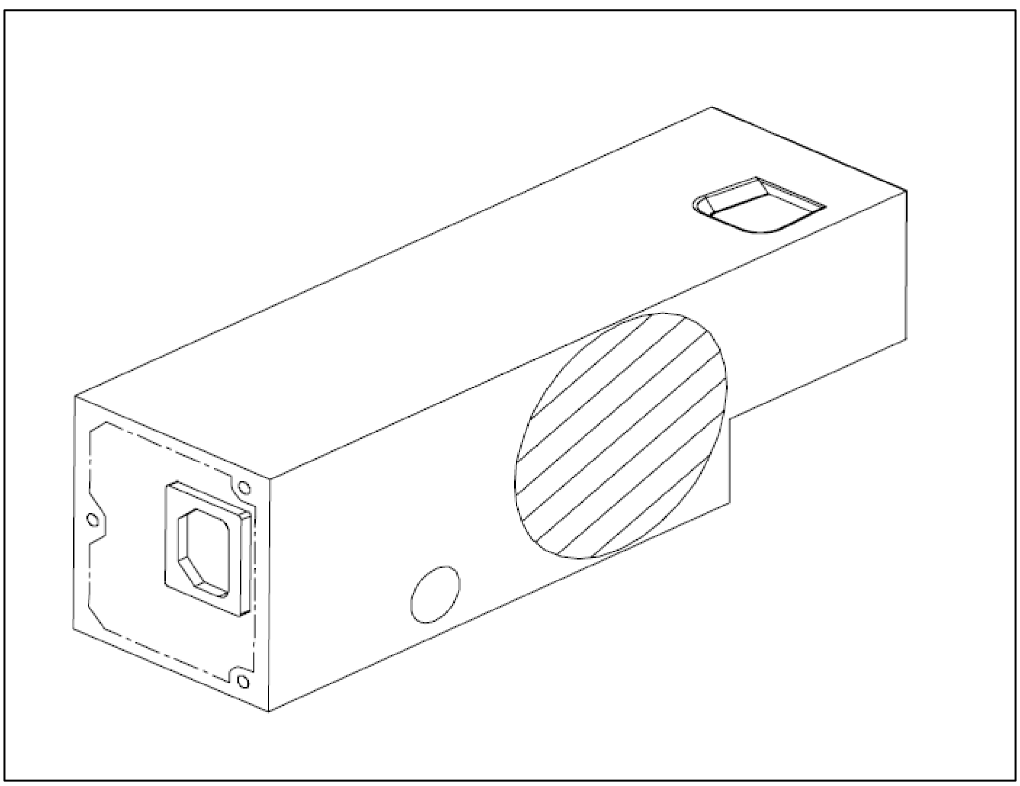


Figure 11-2 Mechanical Details

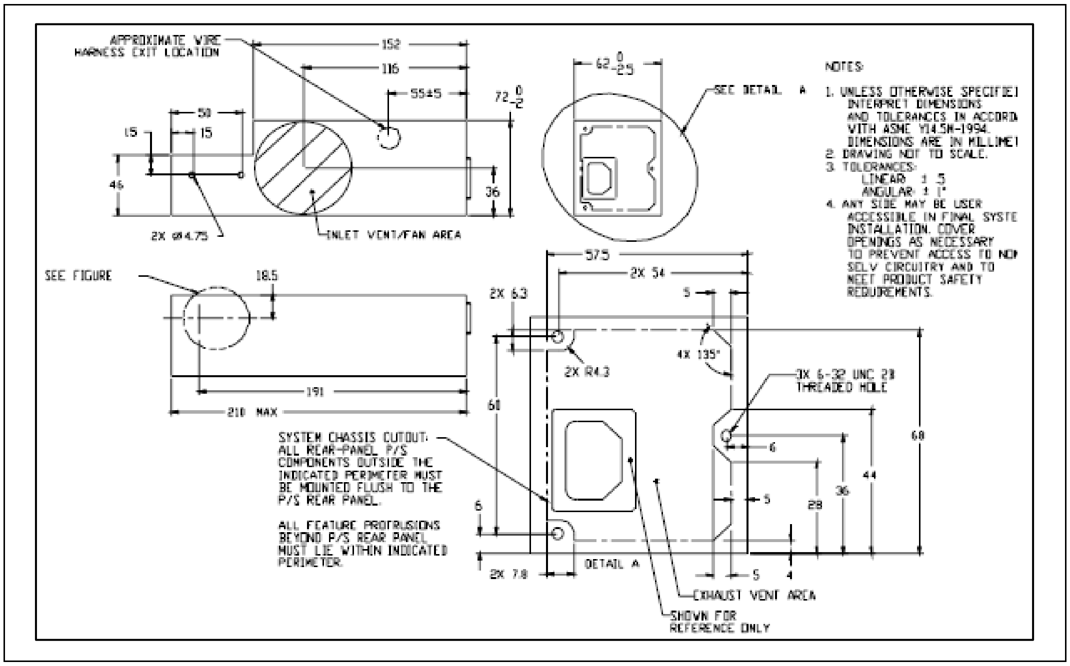


Figure 11-3: PSU Slot Feature Detail

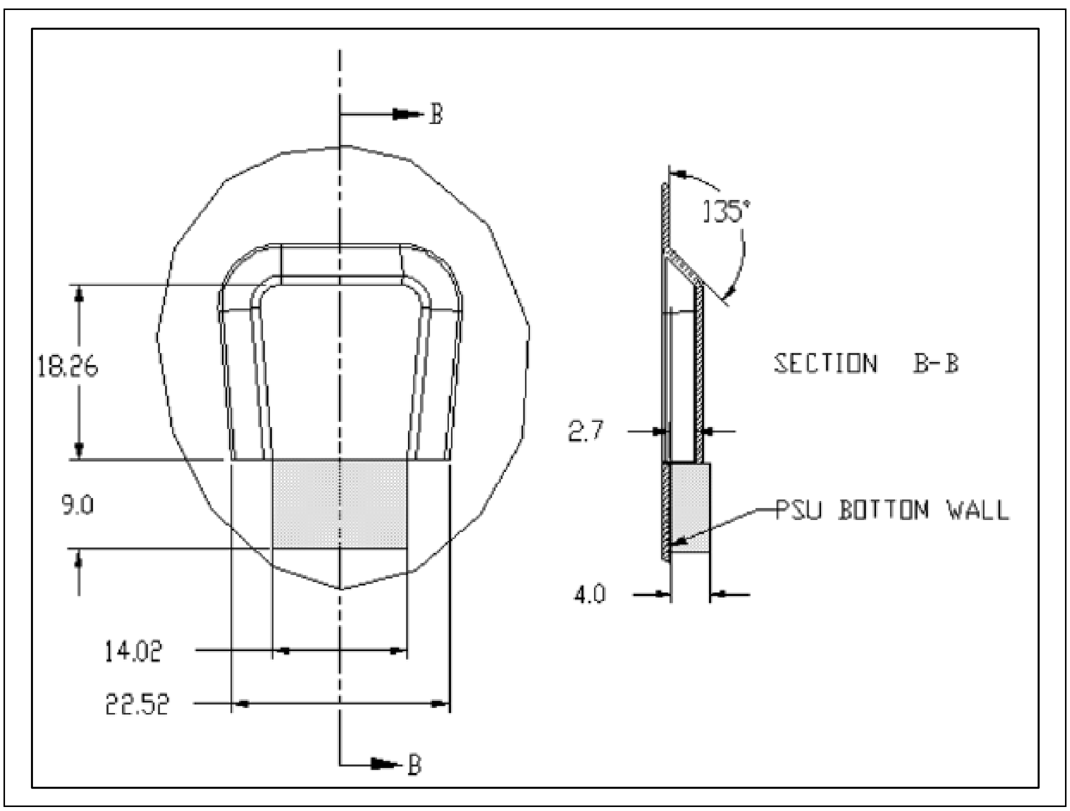
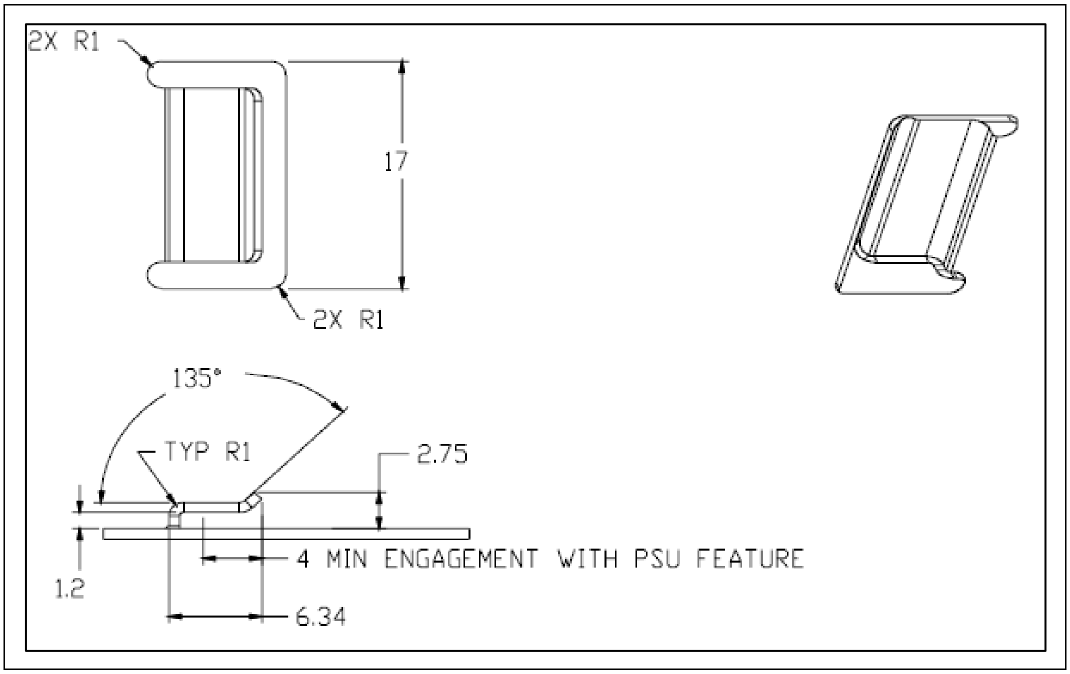


Figure 11-4: Recommended Chassis Tab Feature



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12 ATX12V Specific Guidelines 2.52

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

All Form Factors Revision Summary:

PSU DG	CFX12V	LFX12V	ATX12V	SFX12V	TFX12V	Flex ATX
1.31	1.5	1.3	2.4	3.3	2.4	1.1
1.4	1.6	1.4	2.5	3.4	2.5	1.2
1.42	1.62	1.42	2.52	3.42	2.52	1.22

Figure 12-1: Power Supply Dimensions for Chassis that does not Require Top Venting

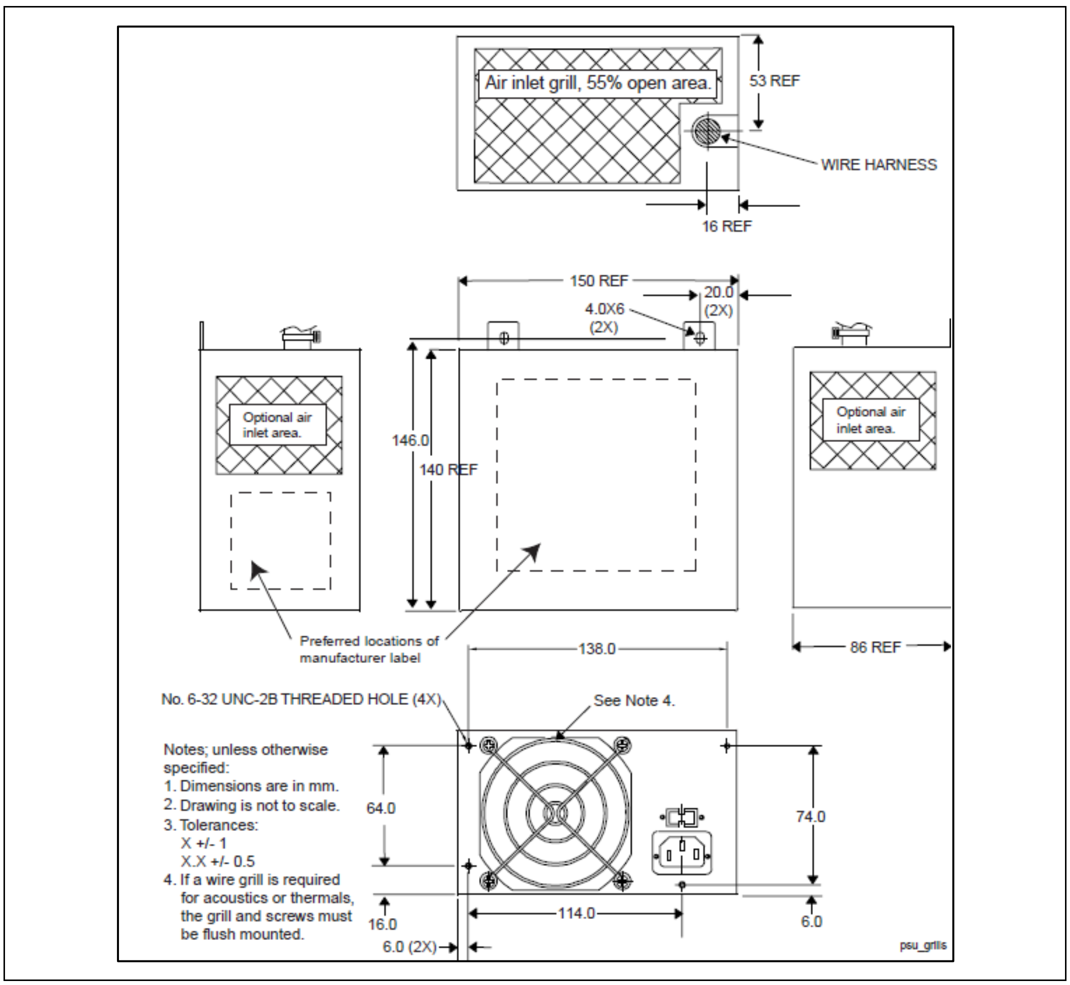
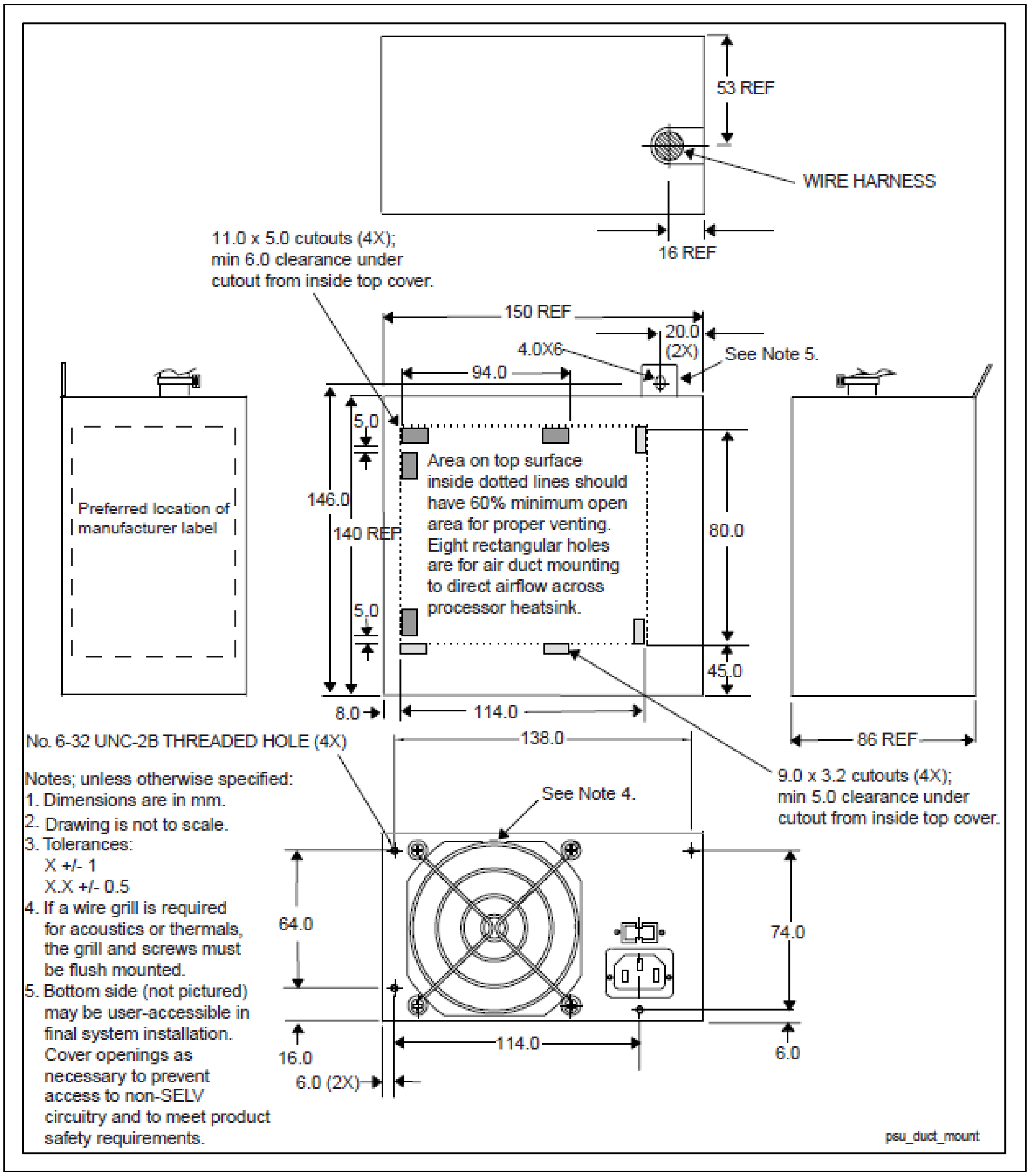


Figure 12-2: Power Supply Dimensions for Chassis that Require Top Venting



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13 SFX12V Specific Guidelines 3.42

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

All Form Factors Revision Summary:

PSU DG	CFX12V	LFX12V	ATX12V	SFX12V	TFX12V	Flex ATX
1.31	1.5	1.3	2.4	3.3	2.4	1.1
1.4	1.6	1.4	2.5	3.4	2.5	1.2
1.42	1.62	1.42	2.52	3.42	2.52	1.22

13.1 Lower Profile Package - Physical Dimensions - Required

The power supply shall be enclosed and meet the physical outline shown in Figure 12-2.

13.2 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. Refer to Figure 13-1. 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 13-1: 40 mm Profile Mechanical Outline

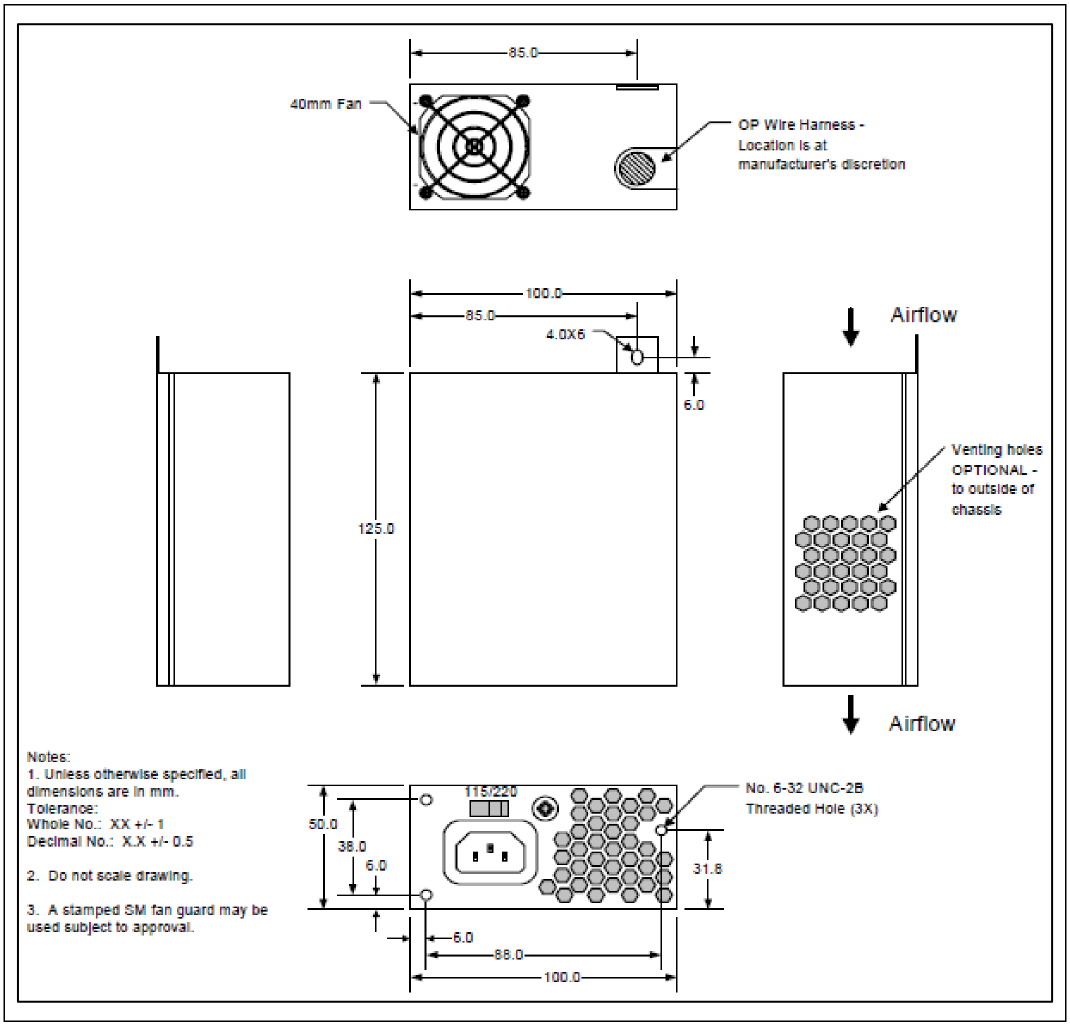
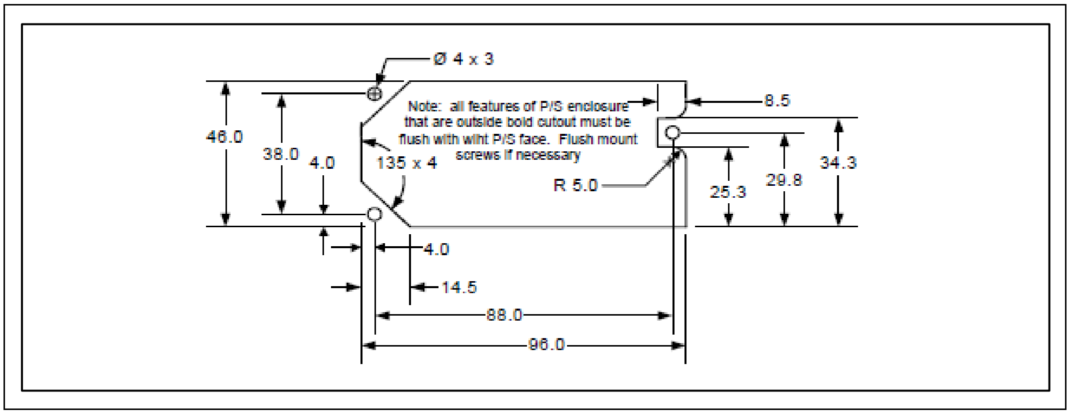


Figure 13-2: Chassis Cutout



13.3 Top Fan Mount Package - Physical Dimensions - Required

The power supply shall be enclosed and meet the physical outline shown in Figure 13-1.

13.4 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. Refer to Figure 13-3. 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 13-5.

Figure 13-3: Top Mount Fan Profile Mechanical Outline

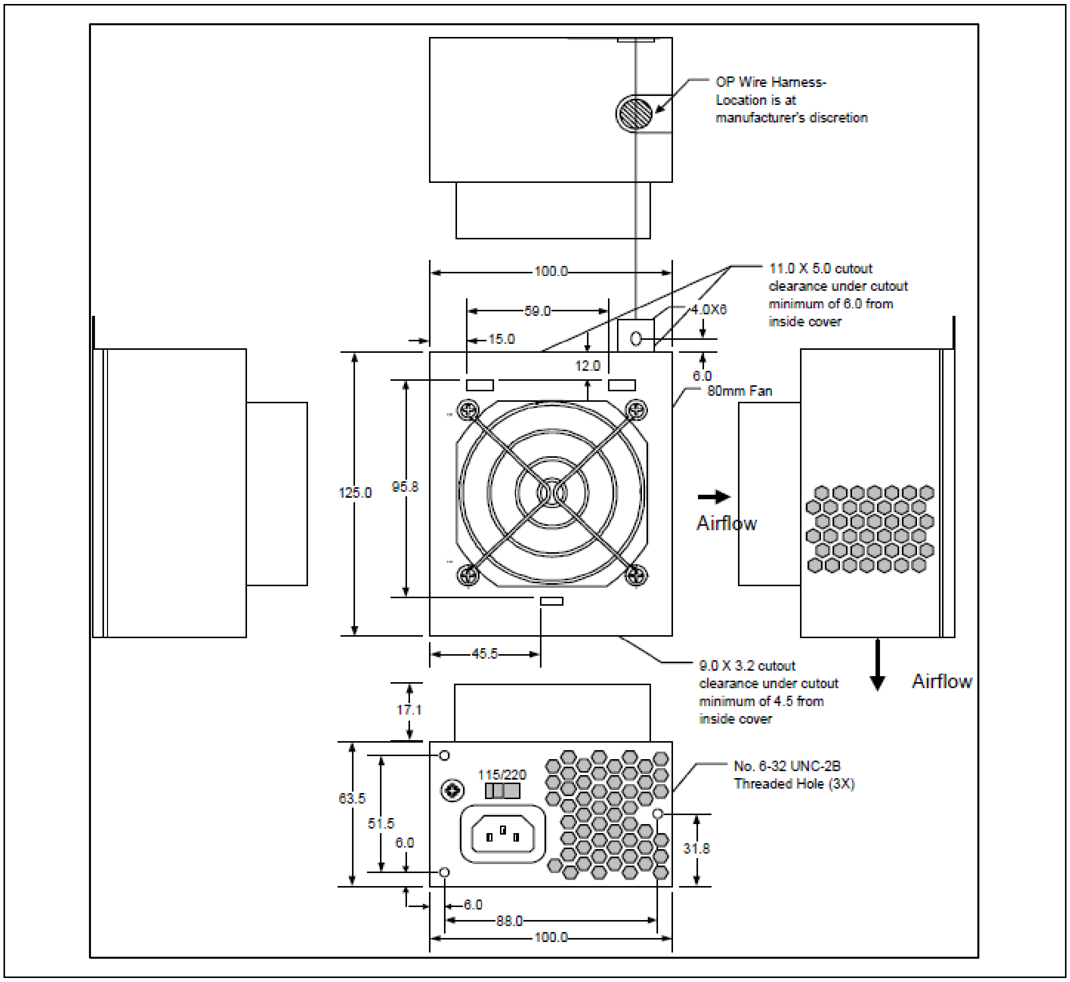


Figure 13-4: Chassis Cutout

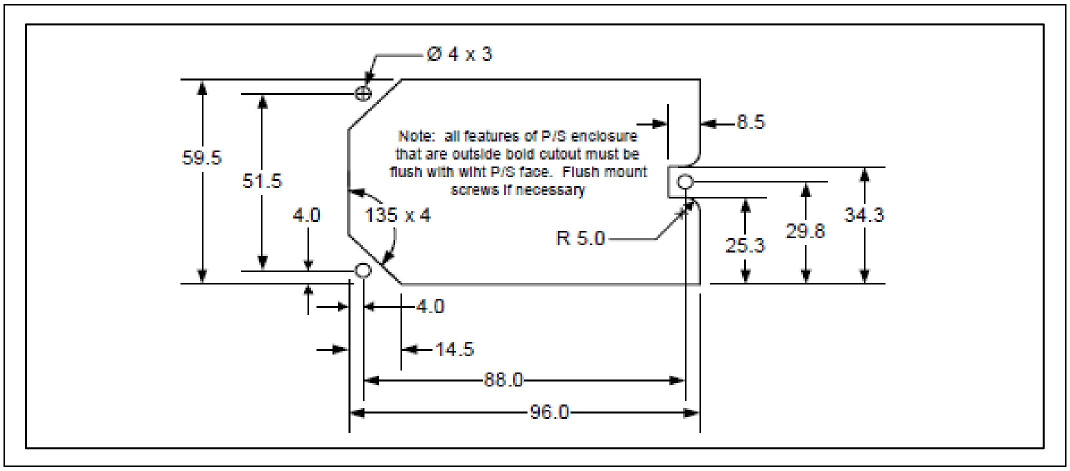
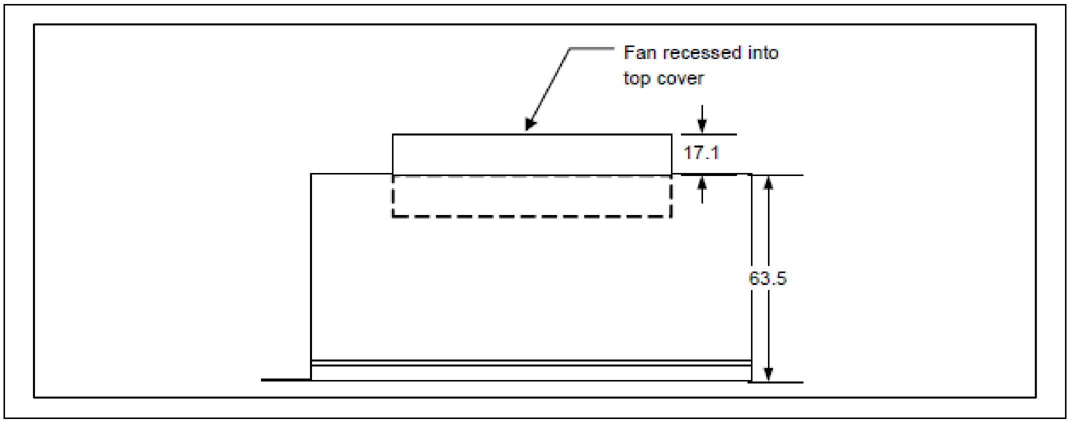


Figure 13-5: Recessed Fan Mounting



13.5 Reduced Depth Top Mount Fan - Physical Dimensions - Required

The power supply shall be enclosed and meet the physical outline shown in Figure 13-4.

13.6 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. Refer to Figure 13-5. Moving the fan to the computer system cavity helps to limit the acoustic noise of the unit.

The fan will be 80 mm.

Figure 13-6: Reduced Depth Top Mount Fan Profile Mechanical Outline

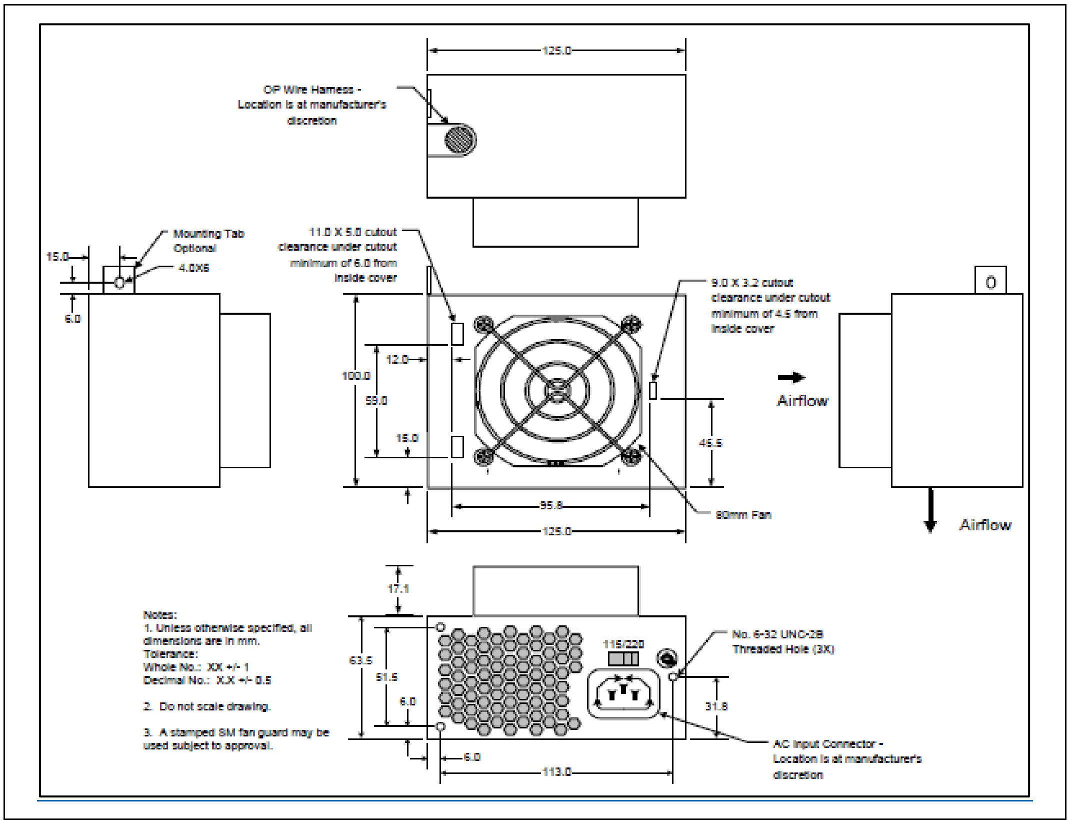
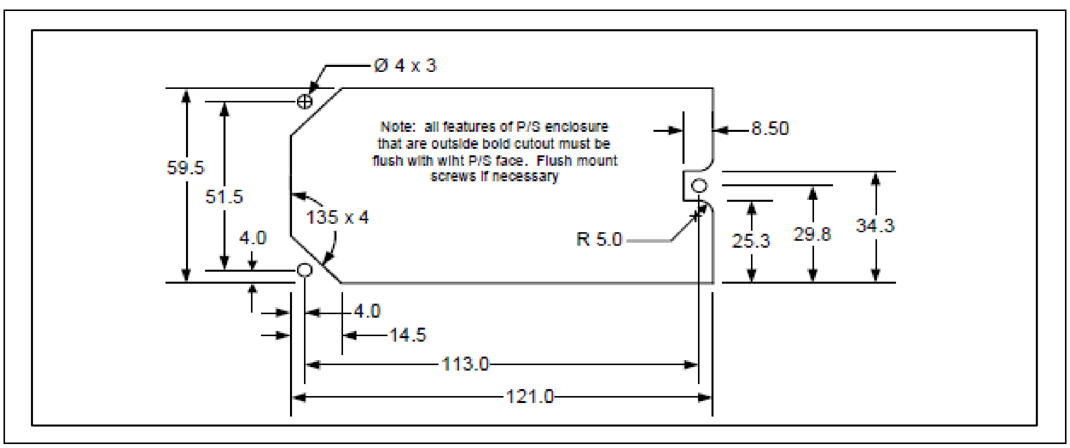


Figure 13-7: Chassis Cutout



13.7 Standard SFX Profile Package – Physical Dimensions - Required

The power supply shall be enclosed and meet the physical outline shown in Figure 13-8.

13.8 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. Refer to Figure 13-8. 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 13-8: 60 mm Mechanical Outline

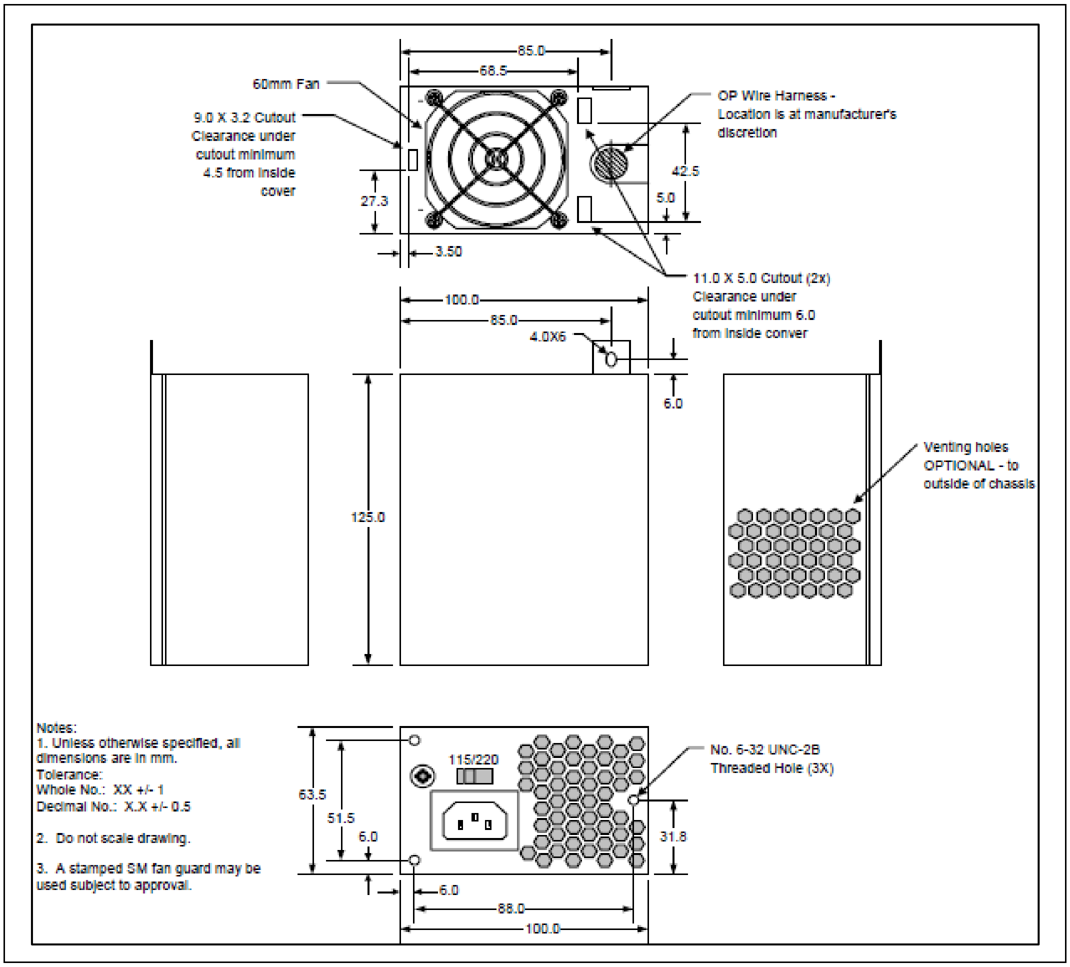
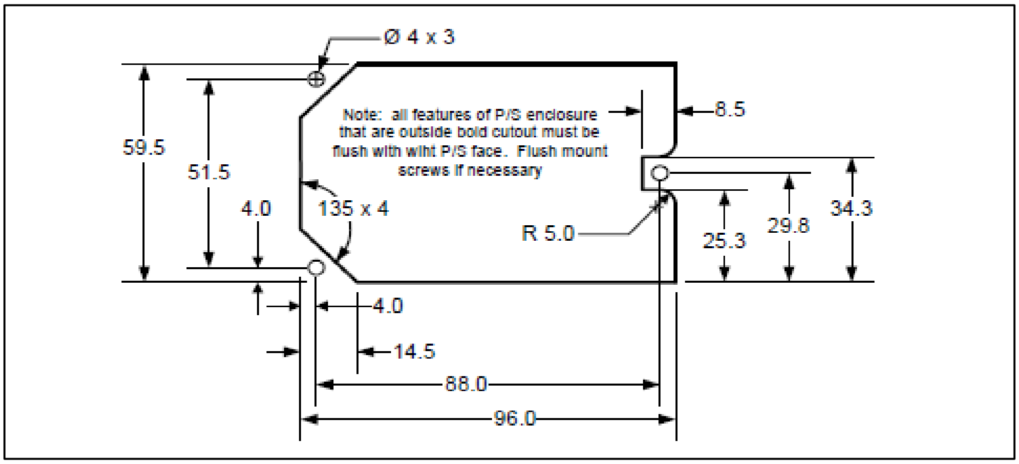


Figure 13-9: Chassis Cutout



13.9 PS3 Form Factor- Physical Dimensions - Required

The power supply shall be enclosed and meet the physical outline shown in Figure 13-10.

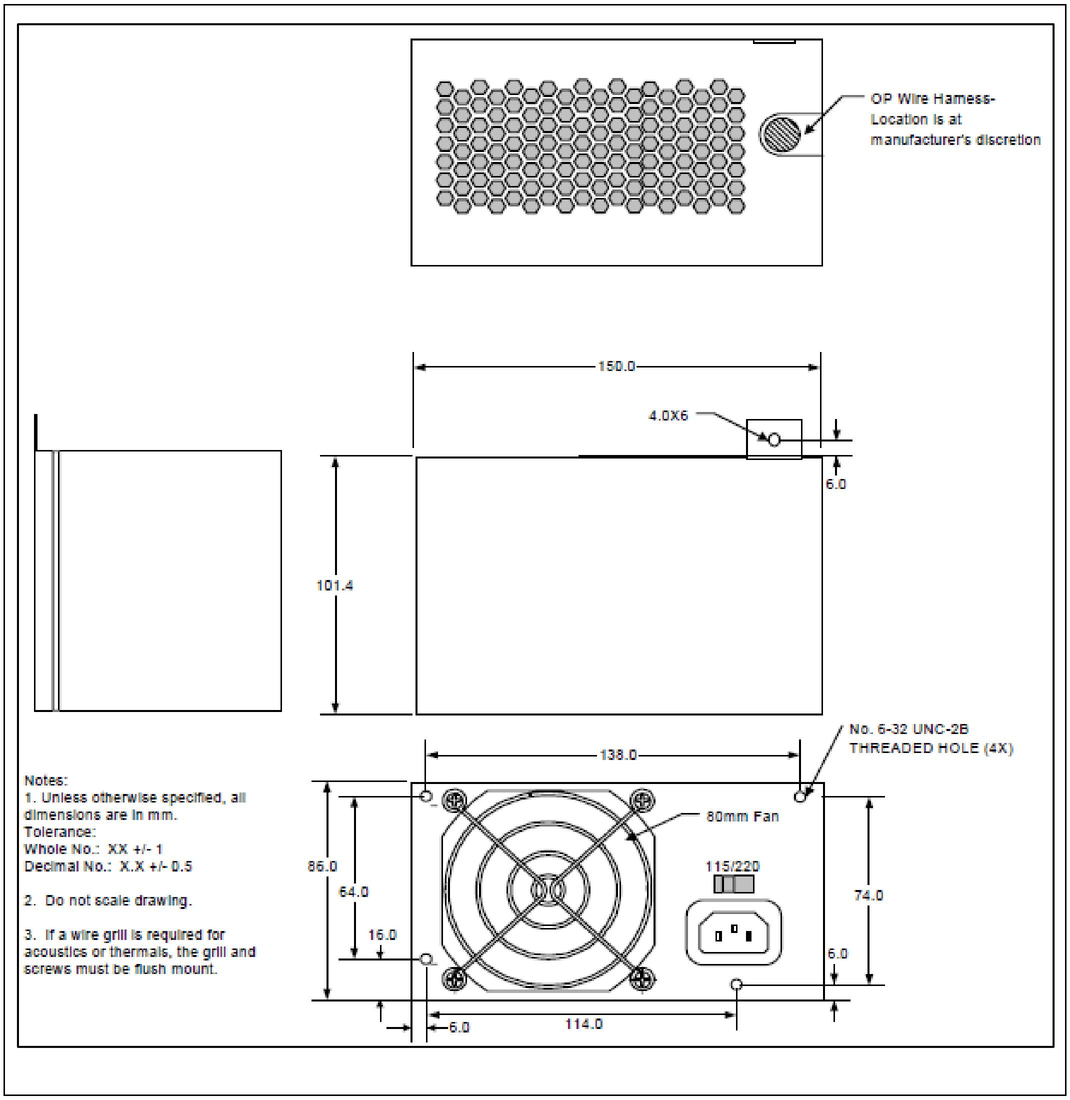
13.10 Fan Requirements - Required

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 endues 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 13-10: PS3 Mechanical Outline



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14 TFX12V Specific Guidelines 2.52

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

All Form Factors Revision Summary:

PSU DG	CFX12V	LFX12V	ATX12V	SFX12V	TFX12V	Flex ATX
1.31	1.5	1.3	2.4	3.3	2.4	1.1
1.4	1.6	1.4	2.5	3.4	2.5	1.2
1.42	1.62	1.42	2.52	3.42	2.52	1.22

14.1 Physical Dimensions - Required

Figure 14-1: Mechanical Outline

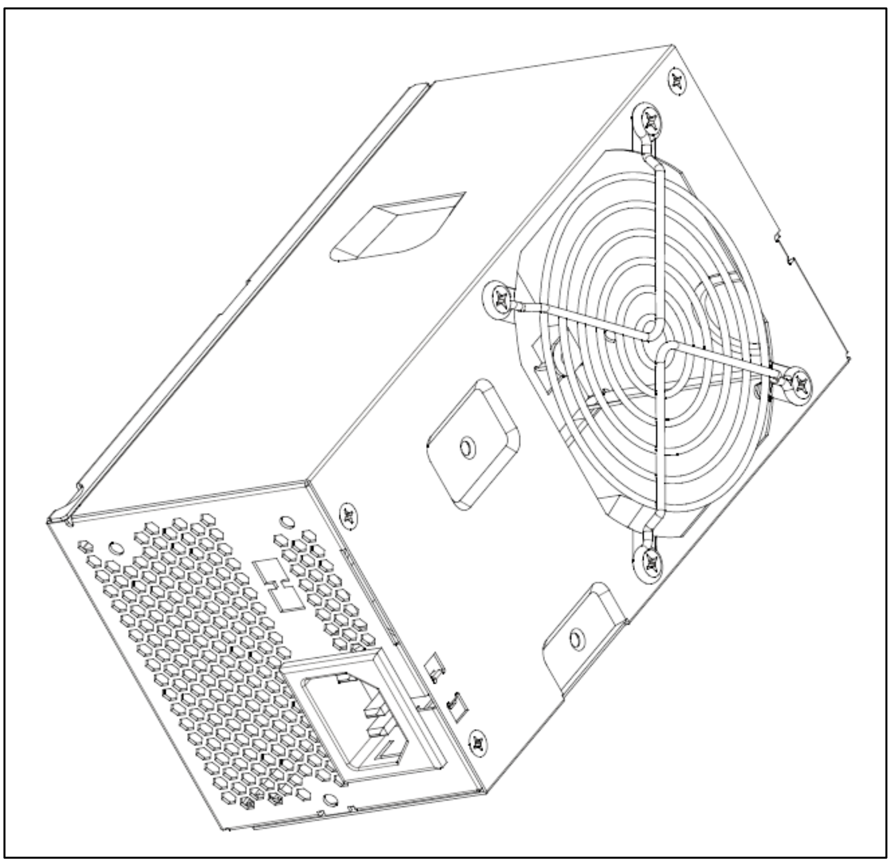
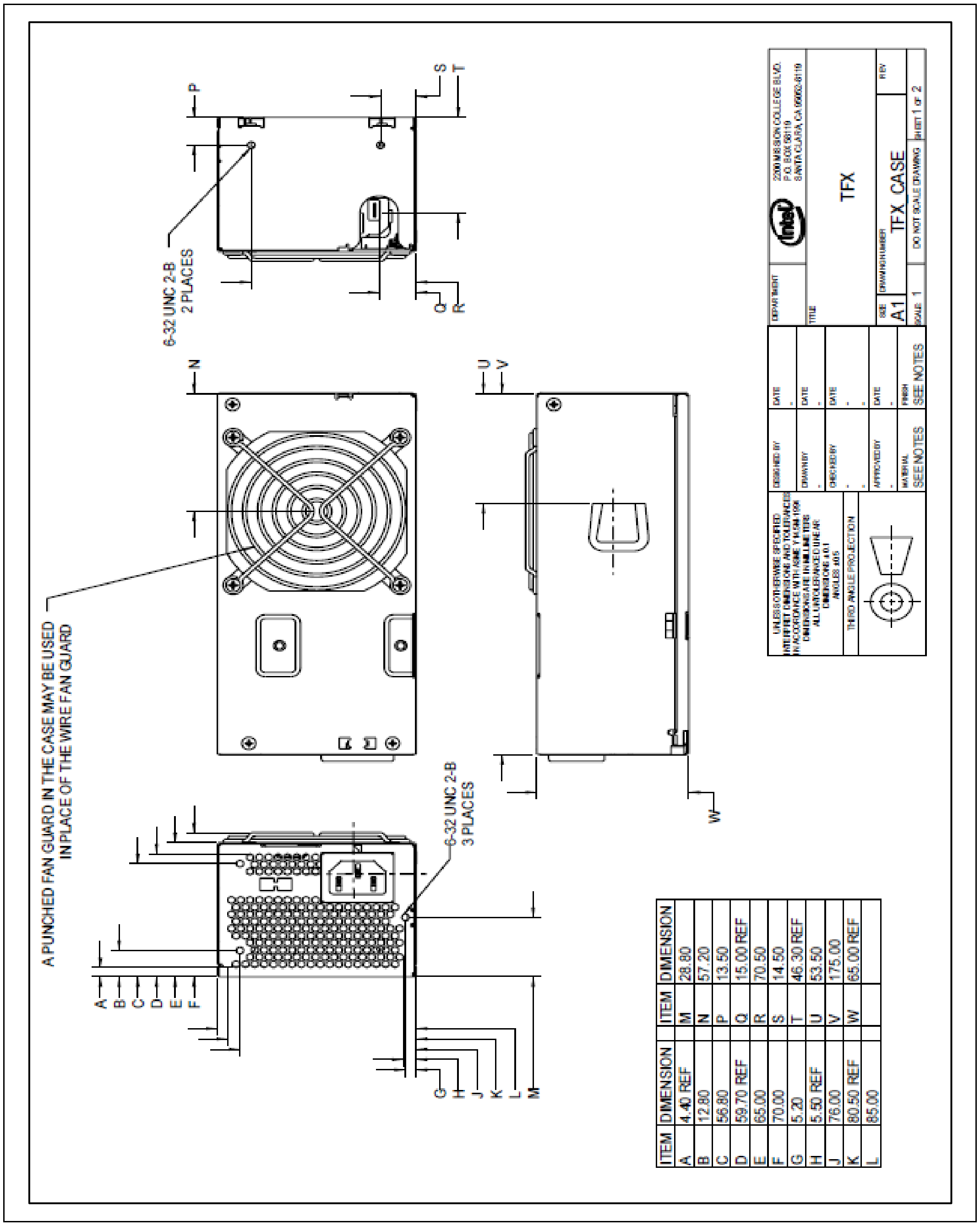
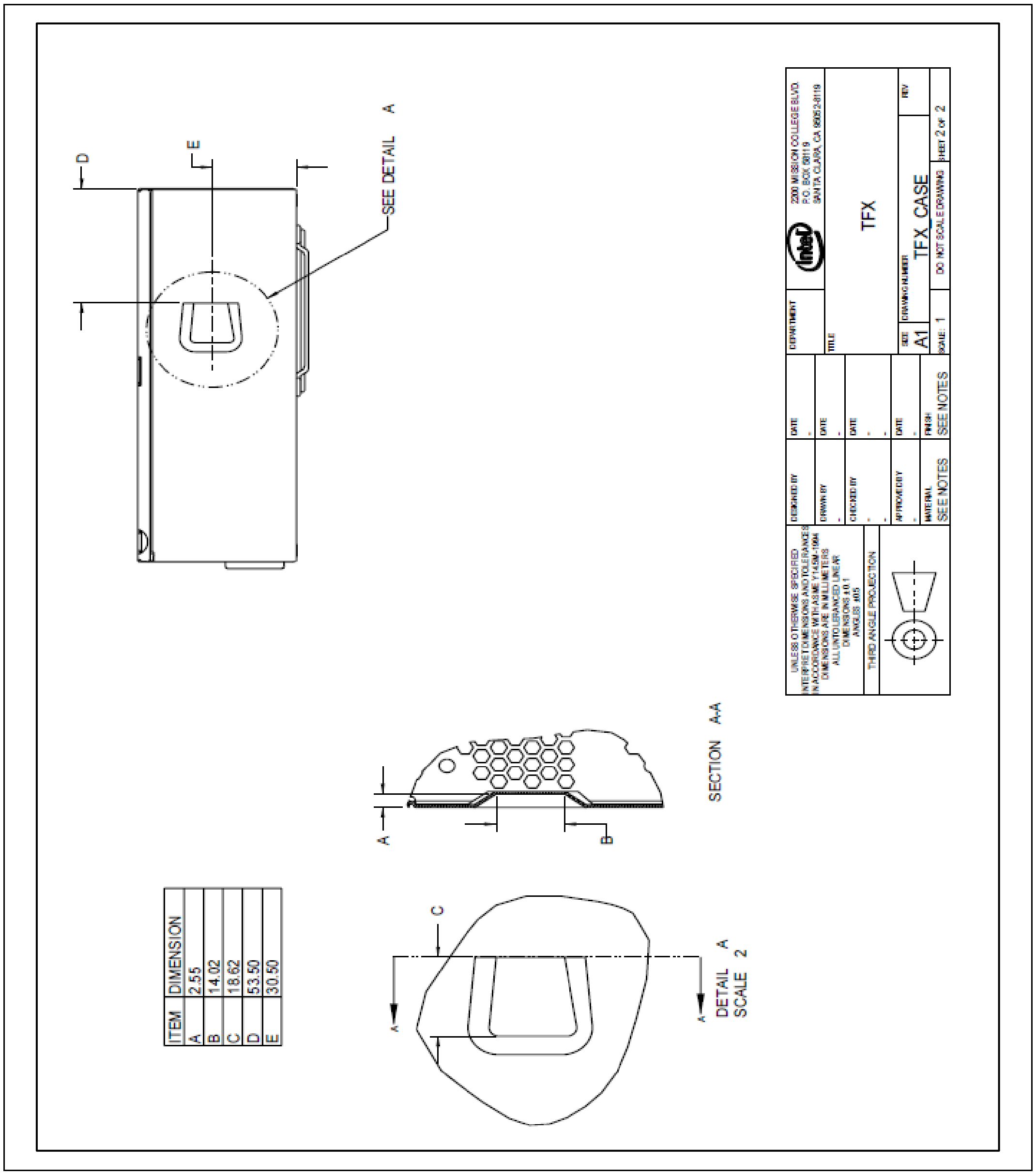


Figure 14-2: Dimensions and Recommended Feature Placements (not to scale)



ITEM	DIMENSION	ITEM	DIMENSION
A	4.40 REF	M	28.80
B	12.80	N	57.20
C	56.80	P	13.50
D	59.70 REF	Q	15.00 REF
E	65.00	R	70.50
F	70.00	S	14.50
G	5.20	T	46.30 REF
H	5.50 REF	U	53.50
J	76.00	V	175.00
K	80.50 REF	W	65.00 REF
L	85.00		

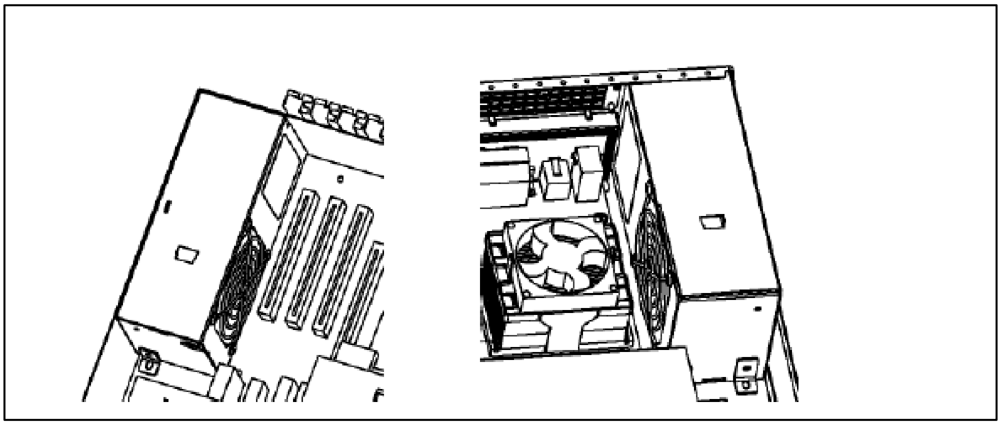
Figure 14-3: Power Supply Mounting Slot Detail



14.2 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 the above figure. A mounting hole and slot should be provided for each orientation as shown in Figure 14-1. Details of a suggested geometry for the mounting slot are shown in Figure 14-2.

Figure 14-4: Fan Right and Fan Left Orientations of Power Supply in a Chassis



14.3 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 the above figure.
- EITHER a mounting bracket to interface with the forward mounting hole on the power supply OR a mounting tab as shown in the below figure to interface with the mounting slot on the bottom of the power supply.

Figure 14-5: Suggested TFX12V Chassis Cutout

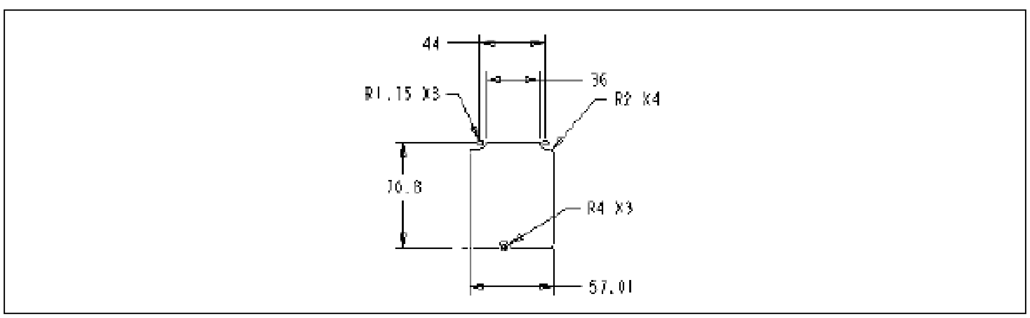
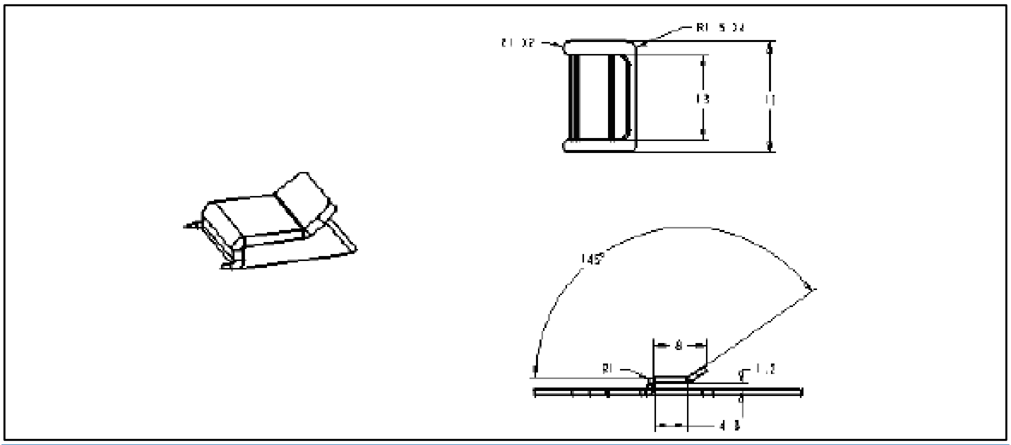


Figure 14-6: Suggested Mounting Tab (chassis feature)



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15 Flex ATX Specific Guidelines 1.22

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

All Form Factors Revision Summary:

PSU DG	CFX12V	LFX12V	ATX12V	SFX12V	TFX12V	Flex ATX
1.31	1.5	1.3	2.4	3.3	2.4	1.1
1.4	1.6	1.4	2.5	3.4	2.5	1.2
1.42	1.62	1.42	2.52	3.42	2.52	1.22

15.1 Physical Dimensions – Required

Figure 15-1: Mechanical Outline

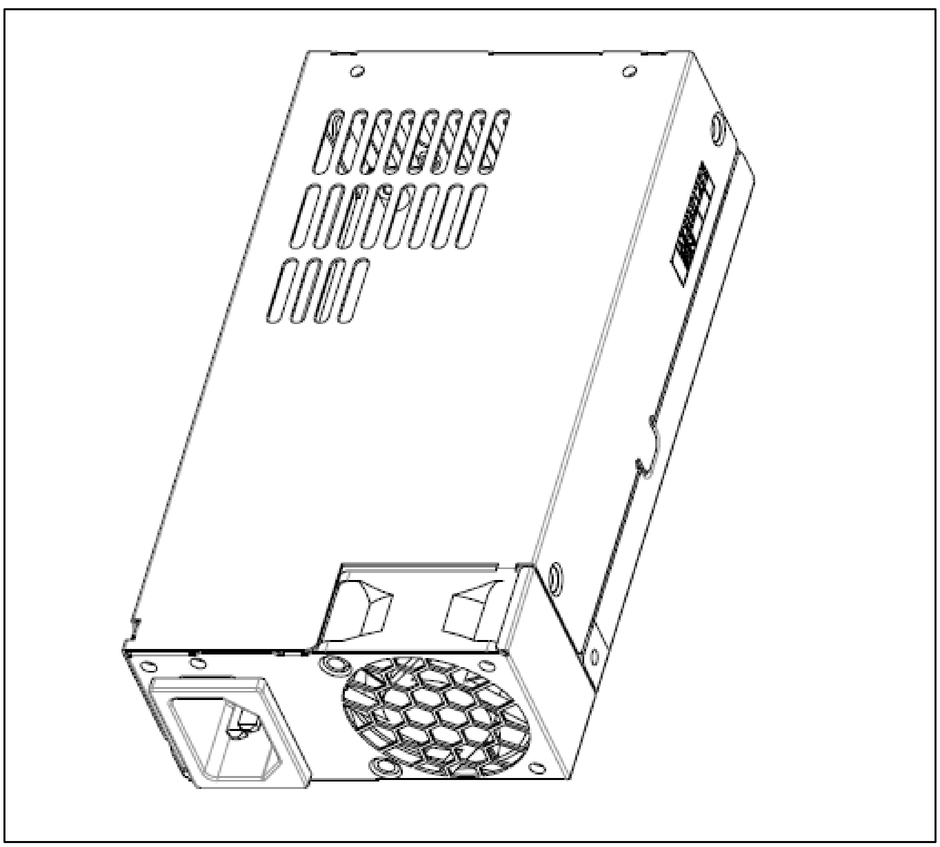
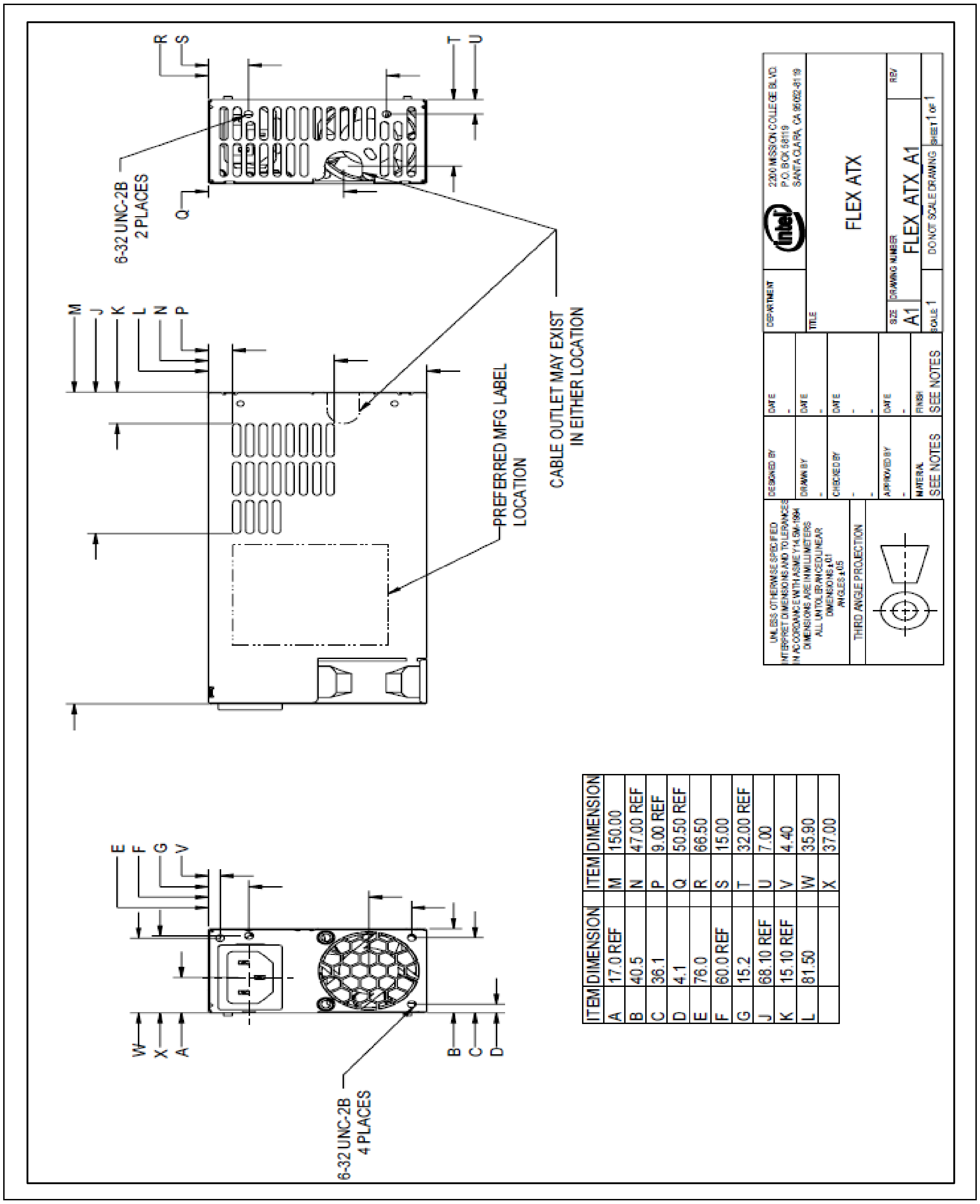


Figure 15-2: Dimensions and Recommended Feature Placements (not to scale)



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