Single Rail Power Supply Desktop Platform Form Factors ATX12VO (12 V Only)

Design Guide

July 2019

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Contents

Figures

Tables

Revision History

Document Number	Revision Number	Description	Revision Date
613768	001	Initial Release	July 2019

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1 Introduction

This document provides design requirements for a new industry standard around single rail power supplies that still meets the existing mechanical size for power supplies. Multi-rail power supply design has been around for many decades but as computers are evolving, a new single Main-rail input power is needed to increase efficiency of the power supply. There is a lot of custom single rail power supply designs in the industry, but no standard for these type of designs.

These power supplies are primarily intended for use with desktop system designs. The key parameters that define mechanical fit across a common set of platforms does not change with existing power supply designs.

The Single Rail Power Supply Design Guide is intended to work for a majority of desktop computer designs, but it may not work for all possible systems. There are many custom single rail power supplies in the industry that cover other possibilities.

The marketing name for the Power Supply Design is ATX12VO, which stands for ATX 12 V only. If the mechanical size of the power supply is different than ATX, for example SFX, then it would be SFX12VO.

Feedback and questions can be directed via email to SingleRailPSUSpec@Intel.com.

1.1 Alternative Sleep Mode for Power Supplies

Computers are continuing to change and introducing new power states. One of these new power states is generically called as Alternative Sleep Mode (ASM). Some examples of Alternative Sleep Modes are Microsoft* Modern Standby or Lucid Sleep with Google* Chrome*. These new power states have created new requirements for power supplies. Below is a summary of these requirements. All ASM features are required in this Single Rail Desktop Power Supply Design Guide.

- Section 3.2.4, Table 3-4 shows that ASM requirements are at the 0.55 A and 1.5 A load levels.
- Section 3.3, Table 3-8 shows T1 and T3 recommended values to support ASM.
- Section 9.2 shows the number of times a PSU toggles on and off is expected to increase.

1.2 Reference Documentation

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

Document	Document Number / Source
IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less)AC Power Circuits	ANSI C62.41.1-2002
IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less)AC Power Circuits	ANSI C62.41.1-2002
IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits	ANSI C62.45-2002
European Association of Consumer Electronics Manufacturers (EACEM*) Hazardous Substance List / Certification	AB13-94-146
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 C63.4-2014
IEC/UL/CSA 62368-1 IEC/UL/CSA 60950-1 EN 60950-1 EU Low Voltage Directive (2014/35/EU) GB-4943 (China) CNS 14336 (Taiwan BSMI) CISPR32/EN55032 (Electromagnetic compatibility of multimedia equipment - Emission requirements) EU EMC Directive (2014/30/EU) CISPR35/EN55035 (Electromagnetic compatibility multimedia equipment Immunity requirements) FCC Part 15 Class B (Radiated and Conducted Emissions)	

1.3 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	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

Acronym, Convention / Terminology	Description
BA	The Declared sound power, LwAd level is 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 failures.
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 +5 VDC, +3.3 VDC and +12 VDC 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	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 the 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 the 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 the 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 the design guide and a majority of system applications.

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2 Processor Configurations

2.1 Processor Configurations - RECOMMENDED

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

Table 2-1: 12 V2 Current for Processor Configurations

PSU 12 V2 Capability Recommendations		
Processor TDP	**Continuous Current**	**Peak Current**
165 W	37.5 A	40 A
95 W	22 A	29 A
65 W	21 A	28 A
35 W	13 A	16.5 A

All values are based on peak and continuous current published in the most recent processor datasheets at publication of this document. EDS supersedes the values for future revisions of the processors. Table above needs to be updated for future Intel processors.

Latest 8th and 9th Generation Intel Core Processor Family peak power and current specification can be found in the 8th and 9th Generation Intel® Core™ Processor Families Datasheet.

- Peak Power called ICCMax 10 ms Max (PL4) for -S Processors
- Continuous Power called PL2 Level for -S Processors

Reference equation for 12 V2 capability calculation:

- 12 V2 Peak Current = (SoC Peak Power / VR efficiency) / 11.4 V
- 12 V2 Continuous Current = (SOC PL2 power / VR efficiency) / 11.4 V

NOTES:

1. PSU rail voltage 11.4 V, 12 V2 should be able to supply peak current for 10 ms.
2. Motherboard VR efficiency is 85% at TDC and 80% at SOC peak power (AKA IccMax)
3. Motherboard plane resistance is 1.1 m Ω.
4. If the power supply supports the 240 VA Energy Hazard protection requirement, then the current levels of the 12 V rail above 20 Amps is split into multiple 12 V rails.

2.2 High End Desktop Market Processor Considerations

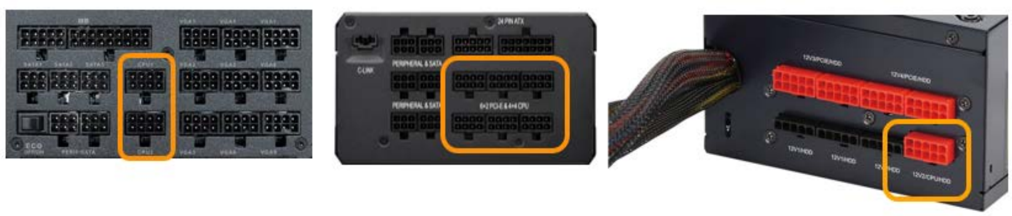
The High End Desktop market requires power supplies with higher power levels than the mainstream market. A Single Rail power supply can meet the needs of High End Desktop Computers. There can be unique needs for the High End Desktop market compared to the mainstream desktop market. In the Desktop Single Rail Power Supply design guide, higher power levels are included to incorporate the higher performance desktop computers.

2.2.1 Modular Power Supply Connectors

Power supplies 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 4pin (2x2) or 8pin (2x4) connector, detailed in Section 4.2.2.3. The Graphics Card Connector is either a 6pin (2x3) or 8pin (2x4) connector detailed in Section 4.2.2.4. Both the connectors use the 12 V 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 12 V power and then the end user can decide which cable to plug in to provide 12 V 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 12 V 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, the CPU power connectors can be applied:

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

The recommendation is based on the common design practice. The 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 the power levels are increased. If the power supply is expected to support end users who desire to overclock, then the 12 V power rail to the processor must 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 Chapter 6, unless otherwise noted.

3.1 AC Input - REQUIRED

Table below lists AC input voltage and frequency requirements for continuous operation. The power supply is 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 automatically recovers 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	Nominal[1]	Maximum	Unit
Vin (115 VAC)	90	115	135	VAC_{rms}
Vin (230 VAC)	180	230	265	VAC_{rms}
Vin Frequency	47	-	63	Hz

NOTE: [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 – 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, is limited to a level below the surge rating of the AC switch if present, bridge rectifier, and fuse components. Repetitive ON and 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, does not cause the damage to the power supply.

3.2 DC Output - REQUIRED

The Single Rail Desktop Power Supply uses +12 V for all main power to the computer with a +12 VSB that is used in Sleep or Off type modes. The +12 V power can be split into multiple 12 V rails to comply with 240VA safety requirements or be one large 12 V rail depending on power supply and system manufacturing needs.

3.2.1 DC Voltage Regulation – REQUIRED

The DC output voltages are required to remain within the regulation ranges shown in table below, when measured at the load end of the output connectors under all line, load, and environmental conditions specified in Chapter 1.

Table 3-2: DC Output Voltage Regulation

Output	Range	Min	Nom	Max	Unit
+12 V1DC[1]	±5%	+11.40	+12.00	+12.60	V
+12 V2DC[2]	±5%	+11.40	+12.00	+12.60	V
+12 VSB	±5%	+11.40	+12.00	+12.60	V

NOTES:

1. At +12 V1DC peak loading as defined in Table 2-1, regulation at the +12 V1DC and +12 V2DC outputs can go to ±5%.
2. At +12 V2DC peak loading as defined in Table 2-1, regulation at the +12 V1DC and +12 V2DC outputs can go to ±5%.
3. Voltage tolerance is required at all connectors.

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 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)
+12 V1DC	40% (Required) 70% (Recommended)	-
+12 V2DC	85%	-
+12 V3/4	80% (Recommended)	
+12 VSB	-	0.5

NOTES:

1. The numbers are based on the 10th generation Intel Core Desktop CPU family, subject to change. Contact your Intel representative for the up-to-date CPU electrical specification max step size of the CPUs that are assembled for system integration.
2. 12 V3/V4 rails are typically used for PCI-E Graphic Card Connectors. Some power supplies use one large 12 V rail or other configurations. This recommendation comes from Graphics card recommendations and should be applied to the amount of current of the 12 V rails associated with the graphic card connections. This is not an Intel requirement. It is 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 output (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 - OPTIONAL

Remote sensing can accurately control motherboard loads by adding it to the PSU connector. The default sense should be connected to pin 10 of the main power connector. Refer to Section 4.2.2.1. 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, CEC* Computers Standard, and other low power system demands, it is recommended that the +12 VSB standby supply power consumption should be as low as possible. To meet the 2013 ErP Lot 6 requirements and 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 below, which is measured with the main outputs off (PS_ON# high state).

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

12 VSB Load Target	12 VSB Actual Load	Efficiency Target (both 115V and 230V Input)	Remark
Max / Label	1.5A / Label	75%	Recommend
0.625 A		75%	ASM and ErP Lot 3 2014
400 mA		75%	Recommend
230 mA		75%	ASM and ErP* Lot 3 2014
38 mA		55%	Recommended
19 mA		45%	ErP* Lot 6 2013

3.2.5 Output Ripple Noise - REQUIRED

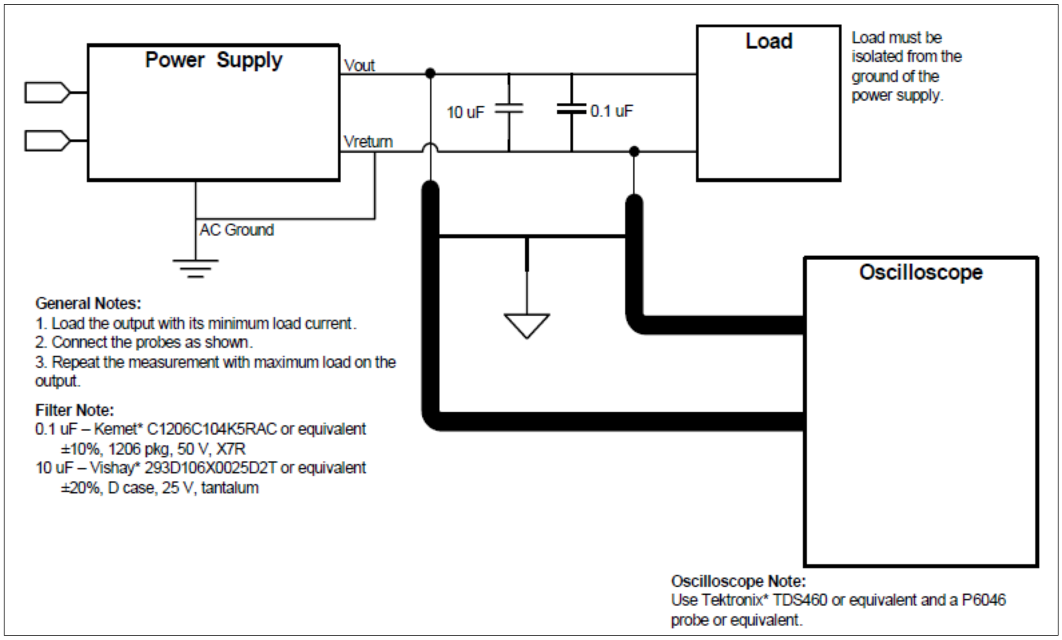
The output ripple and noise requirements listed in table below should be met throughout the load ranges specified for the appropriate form factor and under all input voltage conditions as specified in Table 3-1.

Ripple and noise are defined as periodic or random signals over a frequency band of 10 Hz to 20 MHz. Measurements are 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)
+12 V1DC	120
+12 V2DC	120
+12 VSB	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)
+12 V1DC	3,300
+12 V2DC	3,300
+12 VSB	3,300

3.2.7 Closed Loop Stability - REQUIRED

The power supply is 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 minimum and maximum loads.

3.2.8 Multiple 12 V Rail Power Sequencing - REQUIRED

If the power supply has multiple +12 VDC rails, all output rails must reach its minimum in-regulation level (11.4V) within 20ms of when the first +12 VDC rail reaches it minimum in-regulation level (11.4V).

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).

3.3 Timing Housekeeping and Control – REQUIRED

Figure 3-2: Power on Timing

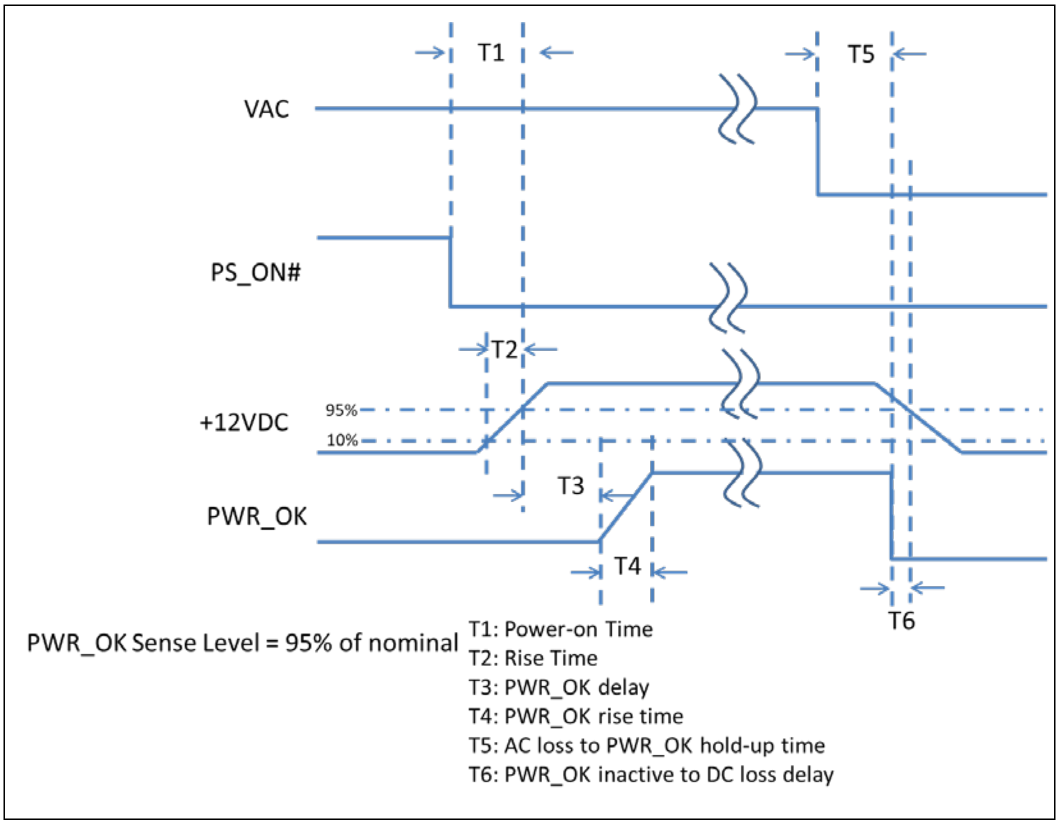


Table 3-7: Power Supply Timing

Parameter	Description	Required	Recommended
T0	AC power on time	<2 s	
T1	Power-on time	<150 ms	<100 ms
T2	Rise time	0.2 – 20 ms	
T3	PWR_OK delay	1ms[2] – 150 ms	1-100 ms
T4	PWR_OK rise time	< 10 ms	
T5	AC loss to PWR_OK hold-up time[3]	> 16 ms	

Parameter	Description	Required	Recommended
T6	PWR_OK inactive to DC loss delay	> 1 ms	

NOTES:

1. T1 and T3 required values are set to meet timing requirement for computers that use ASM.
2. T5 to be defined for both min/max load condition.
3. 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 VDCoutput is within the regulation thresholds listed in Table 3-2 and the 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 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 table below.

Table 3-8: 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 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 the 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 main DC output rail: +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 +12 VSB output, which is always enabled whenever the AC power is present. Table below lists PS_ON# signal characteristics.

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

The power supply does 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.

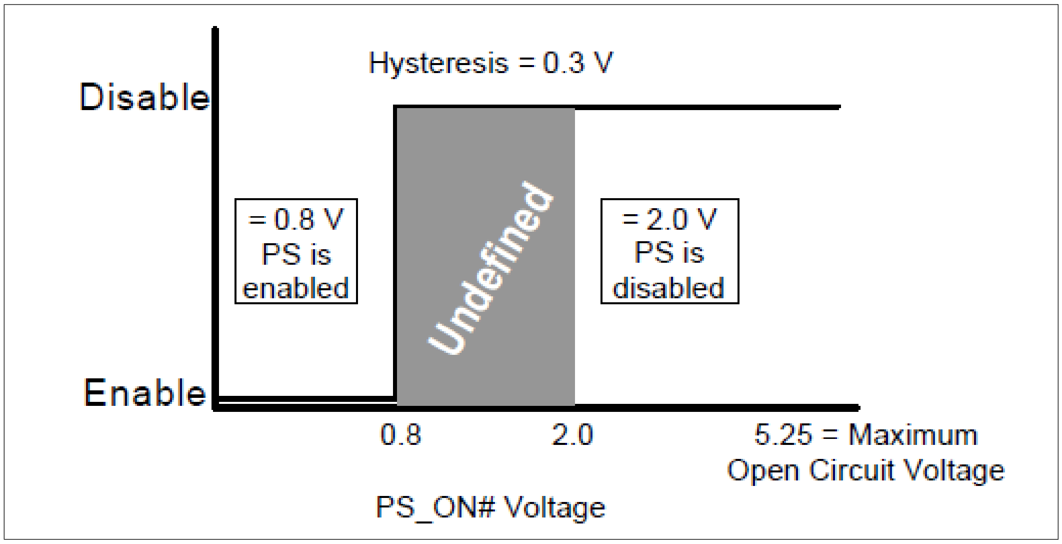
Table 3-9: PS_ON# Signal Characteristics

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, the system and PSU components reliability should be considered based on the days, months or years of claimed warranty listed on product specification. Refer to Section 9.2 for more details.

Figure 3-3: PS_ON# Signal Characteristics



3.3.3 +12 VSB – REQUIRED

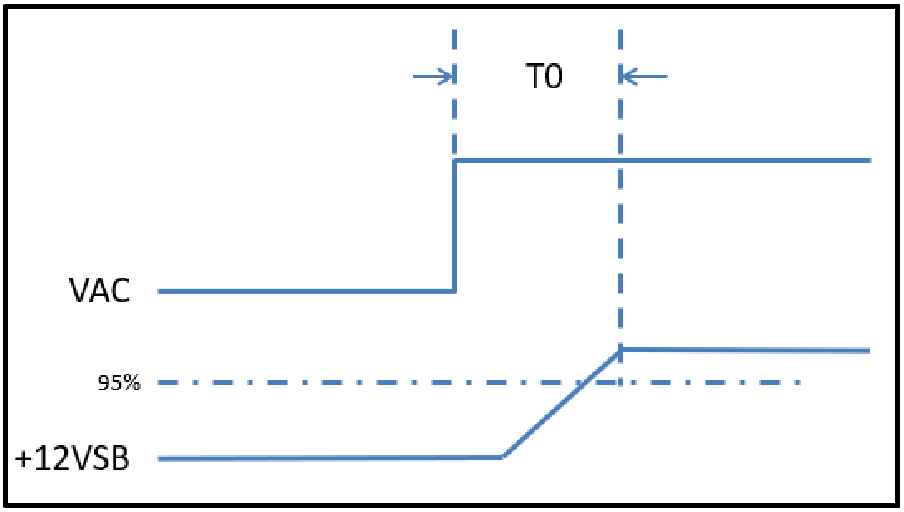
+12 VSB is a standby supply output that is active whenever the AC power is present. This output provides a power source for circuits that must remain operational when the main 12 V DC output rails are in a disabled state. Example includes soft power control, Wake on LAN*, wake-on-modem, intrusion detection, 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 around 2.0 A or higher, lasting no more than 500ms.

Over current protection is required on the +12 VSB output regardless of the output current rating. This ensures the power supply is not damaged if external circuits draw more current than the supply can provide.

With new modes of operation for computers such as Alternative Sleep Modes (ASM), the continuous current rating of the 12 VSB rail is recommended to be at least 1.5 A (18 Watts). Some scenarios such as USB Power Charging in Sleep or ASM requires more current on the 12 VSB rail such as 2.0 Amps or more depending on the design.

Figure 3-4 +12 VSB Power on Timing Versus VAC



3.3.4 Power-On Time – REQUIRED

The power-on time is defined as the time from when PS_ON# is pulled low when the +12 VDC output is within the regulation ranges specified in Table 3-2. The power-on time is less than 150 ms (T1 < 150 ms).

The +12 VSB have a power-on time of two second maximum after application of valid AC voltages as shown in Figure 3-4. The 12 VSB power on time is T0 as listed in Section 3.3.3.

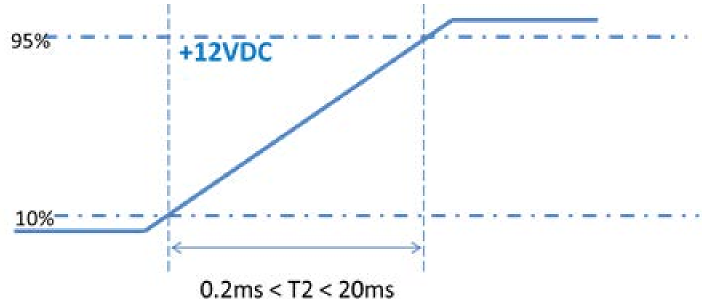
3.3.5 Rise Time – REQUIRED

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 3-7.

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 3-5: 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

3.3.6 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, is less than 10% above the nominal voltage. No voltage of opposite polarity is 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 returns 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.

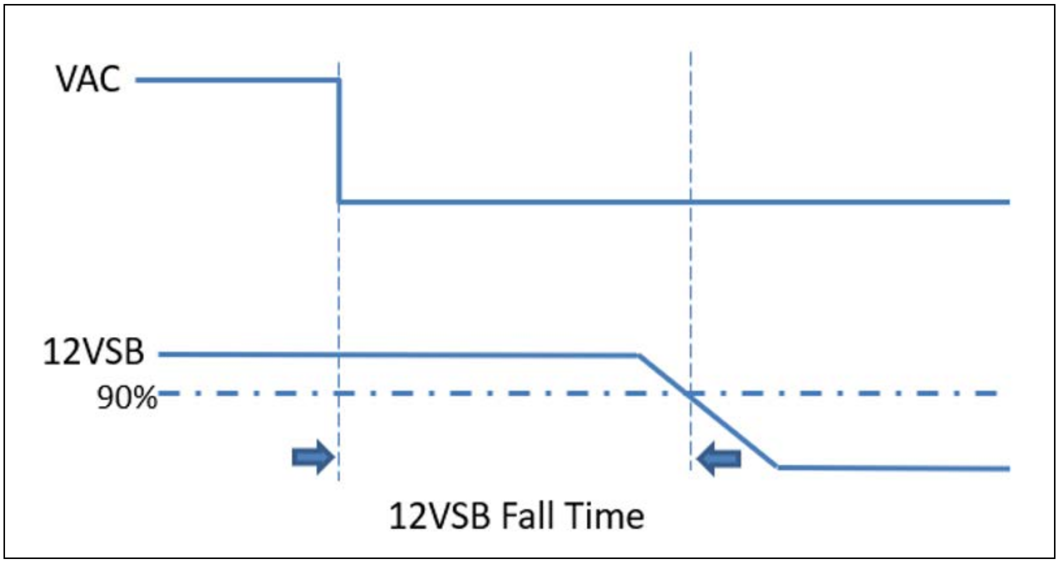
3.4.1 +12 VSB at Power-Down – REQUIRED

After AC power is removed, the +12 VSB 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 is monotonic in nature, dropping to 0.0 V. There is no other disturbances of this voltage or the following removal of AC power.

3.4.2 +12 VSB Fall Time - RECOMMENDATION

Power supply 12 VSB is recommended to go down to low level within 2 seconds under any load condition after AC power is removed as shown in Figure 3-6. Intel test plan tests at Light 20% Load. If the system requires specific +12 VSB fall time, the PSU design is recommended to support it.

Figure 3-6: 12 VSB Fall Time



3.5 Output Protection

3.5.1 Over Voltage Protection (OVP) – REQUIRED

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

Table 3-10: Over Voltage Protection

Output	Minimum (V)	Nominal (V)	Maximum (V)
+12 VDC (or 12 V1DC and 12 V2DC)	13.4	15.0	15.6
+12 VSB[1]	13.4	15.0	15.6

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 Ω. The power supply is shut down and latch off for shorting +12 V DC rails to return. The +12 V1 DC and 12 V2 DC should have separate short circuit and over current protection. Shorts between main output rails and +12 VSB does not cause any damage to the power supply. The power supply is either shut down and latch off or fold back for shorting the negative rails. +12 VSB must be capable of being shorted indefinitely.

When the short is removed, it is recommended that the power supply recovers automatically or by cycling PS_ON#. Optionally, the power supply may latch off when a +12 VSB short circuit event occurs. The power supply is capable of withstanding a continuous short circuit to the output without damage or overstress to the unit. For example, 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, the 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 is connected to the system chassis by the system components.

3.5.7 Separate Current Limit for 12 V2 - 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.

One of the main reasons to move to a Single Rail Desktop Power Supply design is the opportunity to increase the overall efficiency. The Efficiency requirements are equivalent to 80 Plus Bronze levels with the 80 Plus program. The Efficiency requirements listed below are applicable to AC Input voltage of 115V.

Table 3-11: Efficiency versus Load Minimum Requirements

Loading	Full Load (100%)	Typical Load (50%)	Light Load (20%)
REQUIRED Minimum Efficiency	82%	85%	82%

Low Load Efficiency

Computers have decreased Idle power greatly since 2005, where PSU loss is a big concern for overall AC power of a computer in Idle Mode. The lowest DC load for computers at this Idle Mode is determined to be 10 Watts for mainstream computers. Computers with PSU larger than 500 Watts are also expected to have more components and therefore the Idle Mode is at a higher DC Load. The PSU above 500 Watts uses the Low Load Efficiency set at the 2% level.

Low Load Efficiency is another significant advantage for Single Rail Desktop Power Supplies. Therefore, the Low Load Efficiency requirements are aggressive to help computers meet Energy Regulations that require a very low Idle Power.

Low Load Efficiency requirements are based on overall DC power output. These values are shown in table below.

Table 3-12: Low Load Efficiency Requirements depends on Overall PSU Size

DC Output Rating (W)	10W Load	2% Load
<400W	>75%	
400W – 500W	>72%	
>500W	-	>72%

The 10 Watt testing load conditions are defined as:

Table 3-13: 10W Load Condition, in Amps, for PSU < 500 Watts

Load	+12 VSB	+12 V
10W	0.042 A	0.80 A

3.5.9 Power Supply Efficiency for Energy Regulations - ENERGY STAR* and CEC* 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 the system being sold in 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

Visit ENERGY STAR* Computers Version 7.0 website for more details.
https://www.energystar.gov/products/spec/computers_specification_version_7_0_pd

Visit CEC* website for more details.
https://www.energy.ca.gov/appliances/2019-AAER-01/
or https://energycodeace.com/content/reference-ace-t20-tool then select section "(v) Computers..."

Table 3-14: 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 v7 for 500W and below
RECOMMENDED Minimum Efficiency	87%	90%	87%	⩾0.9	ES v7 for above 500W

Table 3-15: 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

Refer to CEC* computer regulation for more details on High Expandability Computers definition

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

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4 Mechanical

This chapter contains mechanical guidelines that apply to desktop power supplies regardless of mechanical form factor. 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 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 helps 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 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 is used for all output wiring.

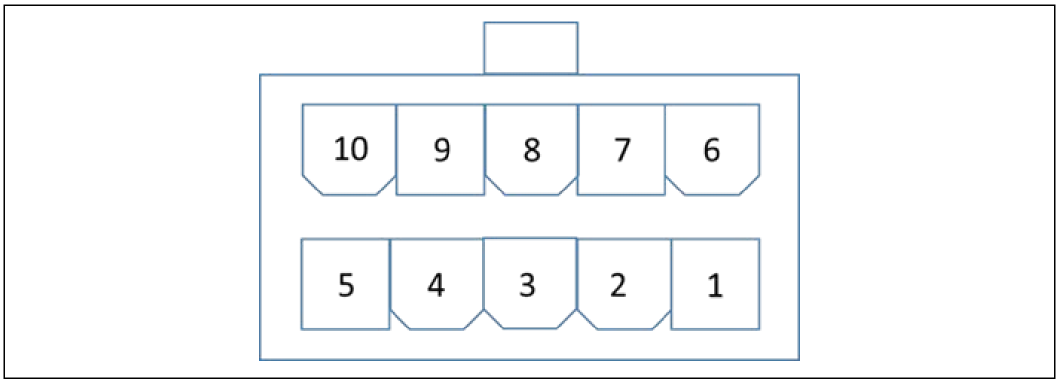
There are no specific requirements for output wire harness lengths as these are largely a function of the intended end-use chassis, motherboard, and peripherals. Ideally, wires should be short to minimize electrical/airflow impedance and simplify manufacturing, yet they should be long enough to make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

4.2.2.1 Main Power Connector – REQUIRED

Main Power Connector for motherboard with control and standby rail connections. Smaller board sizes can only use this connector.

- Molex Mini-Fit Jr type of connector – Part numbers are with: CviLux Corporation
- Cable Connector: PN# CP-01110031-X22 (94V-0 black)
- Motherboard Connector Part Number: CP0131013E-HC-NH-X22 (94V-0 black)

Note: Connector color can be changed. Motherboard connector color is recommended to be white.



18 AWG is suggested for all wires.

Table 4-1: Main Power Connector Pin-Out

Pin	Signal	Color	Pin	Signal	Color
1	PS_ON#	Green	6	PWR_OK	Gray
2	COM	Black	7	+12 VSB	Purple
3	COM	Black	8	+12 V1 DC	Yellow
4	COM	Black	9	+12 V1 DC	Yellow
5	Reserved	TBD	10	+12 V1 DC Voltage Sensing Pin	Yellow

This power connector is designed as the main board connector and for smaller to medium size boards, this is the only connector that is needed. This connector can provide up to 216 to 288 watts of power using the assumption that each pin can provide 6-8 Amps. Board designers need to figure out total board power and if this single connector provides enough power for each board.

Refer to Section 3.2.3 for more details on Voltage Sensing Pin.

4.2.2.2 Extra Board Connector

If the board power requirements are higher than what can be provided by the 10 pin Main Board Connector, the Extra Board Power connector can be used. This connector can provide an additional 216-288 watts of power. Two connectors can also be used if 240VA requirements are needed per connector.

The Extra Board Connector is designed for larger motherboards that have multiple PCIe connectors, multiple USB, or other expansion slots.

This connector is the same as the PCI-E Graphics Card Connector.

Table 4-2: Extra Board Power Connector 6 pin Connector Pin-out

Pin	Signal	Color		Pin	Signal	Color
1	+12 V1	Yellow		4	COM	Black
2	+12 V1	Yellow		5	COM	Black
3	+12 V1	Yellow		6	COM	Black

NOTE: 18 AWG wire

4.2.2.3 +12 V CPU Power Connector

Connector: Molex* 0039012040 or equivalent.

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

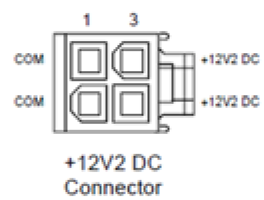


Table 4-3: +12 V Power 4 pin Connector Pin-out

Pin	Signal	Color1		Pin	Signal	Color1
1	COM	Black		3	+12 V2 DC	Yellow
2	COM	Black		4	+12 V2 DC	Yellow

NOTE: 18 AWG wire

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

Pin	Signal	Color1		Pin	Signal	Color1
1	COM	Black		5	+12 V2 DC	Yellow
2	COM	Black		6	+12 V2 DC	Yellow
3	COM	Black		7	+12 V2 DC	Yellow
4	COM	Black		8	+12 V2 DC	Yellow

NOTE: 18 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 4-5: PCI-E Graphics Card 6 pin Connector Pin-out

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

NOTE: 18 AWG wire

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

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

NOTE: 18 AWG wire

4.2.2.5 Peripheral Connectors - Recommended

Recommended for PSU designed for High End Desktop and Gaming systems that might need 12 V power for Fans, LEDs, or Liquid Cooling pumps. Only populate pin 1 and 2.

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

Contacts: AMP 61314-1 or equivalent.

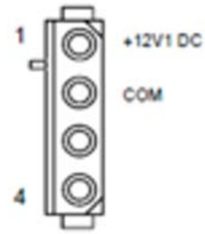


Table 4-7: Peripheral Connector Pin-out

Pin	Signal	Color1
1	+12 V1 DC	Yellow
2	COM	Black
3	No connect	
4	No connect	

NOTE: 18 AWG wire

4.3 Connector from Motherboard to Storage Devices - REFERENCE

Other components that require both 12 V and 5V power such as Storage and Optical drives get their power from the motherboard. The motherboard provides the voltage regulator that converts 12 V power into 5V. This connector needs to be **Black** for both the cable and board connector to easily identify that power is coming out of the power and this is not a connector that needs power from the power supply.

This is included in the power supply design guide to provide an industry standard connection from motherboard to these Storage or other devices using these connectors.

4.3.1 Motherboard Connector

Motherboard needs to provide power for Storage devices because they need both 12 V and 5V. The motherboard is recommended to provide power to either 4 or 6 storage drives. Current and near future platforms support 6 SATA connections. Based on the market, board size, cost considerations, the amount of storage drives supported needs to be considered. Based on per storage drive max requirements of 12 V @ 2-2.5 amps and 5V @ 1 amp, below are options for both options. If drive power changes then the number of drives per connector would also change.

Final connector will be defined as part of Rev 1.0 of this spec. Recommendation is to use a smaller connector such as the Molex Micro Fit Jr. type connector for board size consideration and because connector size is different than other connectors in a desktop computer to remove possible wrong cable connections. Recommended connector is:

Micro Fit 3.0, Pitch 3.0 mm, 18-30 AWG wire, 8.5A maximum per pin
https://www.molex.com/molex/products/family?key=microfit_30&channel=products&chanName=family&pageTitle=Introduction&parentKey=power_connectors

The 4-pin storage drive connector option is one cable with 4 storage drive connections over the length of the cable.

Table 4-8: +12 V Power 4 pin Connector Pin-out

Pin	Volts	Amp per Each SATA	Amp per Connector Pin to Support x4 SATA	Cable AWG (As Reference)	Crimp Pin AWG (As Reference)	MB conn (MOLEX P/N)	Mate (MOLEX P/N)	Crimp Pin (MOLEX P/N)
1	GND	1.02	4.08	2 x 22	16	206832-0401	206461-0400	2064600041
2	GND	2.5	10	18	18	206832-0401	206461-0400	2064600031
3	12	2.5	10	18	18	206832-0401	206461-0400	2064600031
4	5	1.02	4.08	2 x 22	16	206832-0401	206461-0400	2064600041

The 6-pin storage drive connector option is two cables that each support 3 storage drive connections over the length of the cable.

Table 4-9: +12 V Power 6 pin Connector Pin-out

Pin	Volts	Amp per Each SATA	Amp per Connector Pin to Support x4 SATA	Cable AWG (as reference)	Crimp Pin AWG (as reference)	MB conn (MOLEX P/N)	Mate (MOLEX P/N)	Crimp Pin (MOLEX P/N)
1	GND	2.5	7.5	18	18	206832-0601	206461-0600	2064600031
2	GND	1.02	6.12	2 x 22	16	206832-0601	206461-0600	2064600041
3	GND	2.5	7.5	18	18	206832-0601	206461-0600	2064600031
4	12	2.5	7.5	18	18	206832-0601	206461-0600	2064600031
5	5	1.02	6.12	2 x 22	16	206832-0601	206461-0600	2064600041

Pin	Volts	Amp per Each SATA	Amp per Connector Pin to Support x4 SATA	Cable AWG (as reference)	Crimp Pin AWG (as reference)	MB conn (MOLEX P/N)	Mate (MOLEX P/N)	Crimp Pin (MOLEX P/N)
6	12	2.5	7.5	18	18	206832-0601	206461-0600	2064600031

4.3.2 Serial ATA* Connectors – REFERENCE

This connector is used on the Storage Device cable coming from the motherboard.

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.

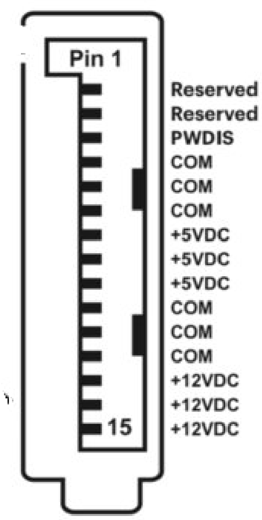


Table 4-10: Serial ATA* Power Connector Pin-out

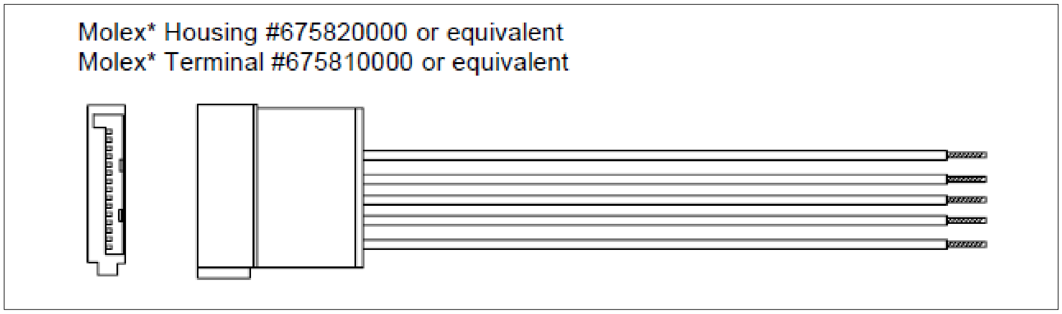
Wire	Signal	Color1
5	n/c 2	
4	COM	Black
3	+5V DC	Red

Wire	Signal	Color1
2	COM	Black
1	+12 V1 DC	Yellow

NOTES:

1. 18 AWG wire
2. +3.3V DC is removed from SATA V3.2 spec.

Figure 4-1: Serial ATA* Power Connector



4.4 Airflow and Fans - RECOMMENDED

The designer's choice of a power supply cooling solution depends on part on the targeted end-user system applications. The power supply design must ensure its own reliable and safe operation.

4.4.1 Fan Location and Direction

In general, exhausting air from the system chassis enclosure through 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.

4.4.2 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 the 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.

Fan should not turn on at the same time as PS_ON# is asserted. This is because of power optimization at low levels and Alternative Sleep Modes. Two options to consider:

1. Wait for at least 2 seconds before the fan turns on.

2. Fan needs to be only turned on when the PSU needs the thermal cooling.

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.

4.4.3 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 below.

The power supply assembly does not produce and prominent discrete tone determined according to ISO 7779, Annexure 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 $\leq$ dT/dt $\leq$ 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 $\geq$ 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 is 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 depending on the design, product end use, target geography, and other variables.

7.1 Emissions – REQUIRED

The power supply complies with FCC Part 15, EN55023 and CISPR 22, and 5th ed., meeting Class B for both conducted and radiated emissions with a 4 dB margin. Tests are conducted using a shielded DC output cable to a shielded load. The load is adjusted as follows for three tests:

- No load on each output.
- 50% load on each output.
- 100% load on each output.

Tests are performed at 100 VAC 50Hz, 120 VAC 60 Hz, and 230 VAC 50 Hz power. Additionally, for FCC certification purposes, the power supply is 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 complies 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 depending on 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

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 meets 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 a low voltage distribution systems.

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8 Safety

The following sections outline the sample product regulation requirements for a typical power supply. Actual requirements depending 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. 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 or manufacturing or both of this product:

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

8.4 Catastrophic Failure Protection - RECOMMENDED

If 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 the 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

To optimize desktop platform power consumption, Intel provides the 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# may toggle on/off periodically, for example, off for ~180s, then on for 1s, then off again 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. The S0ix mode is used in systems that use Alternative Sleep Modes.

In case, the computer turns on/off every 180 seconds, the worst case scenario would be 480 times in one day and 175,200 times in one year. The power supply must be able to handle these many cycles for the life of the power supply.

To have better user experience, avoid PSU fan acoustic noise annoyance and relieve problems of mechanical fan failure. 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 (IC, MOSFET, diode, transformer, inductor, capacitor, relay, and fan) 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. This is also mentioned in Section 4.4.2

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10 CFX12 V Specific Guidelines 1.63

For Compact Form Factor with 12 V connector power supplies.

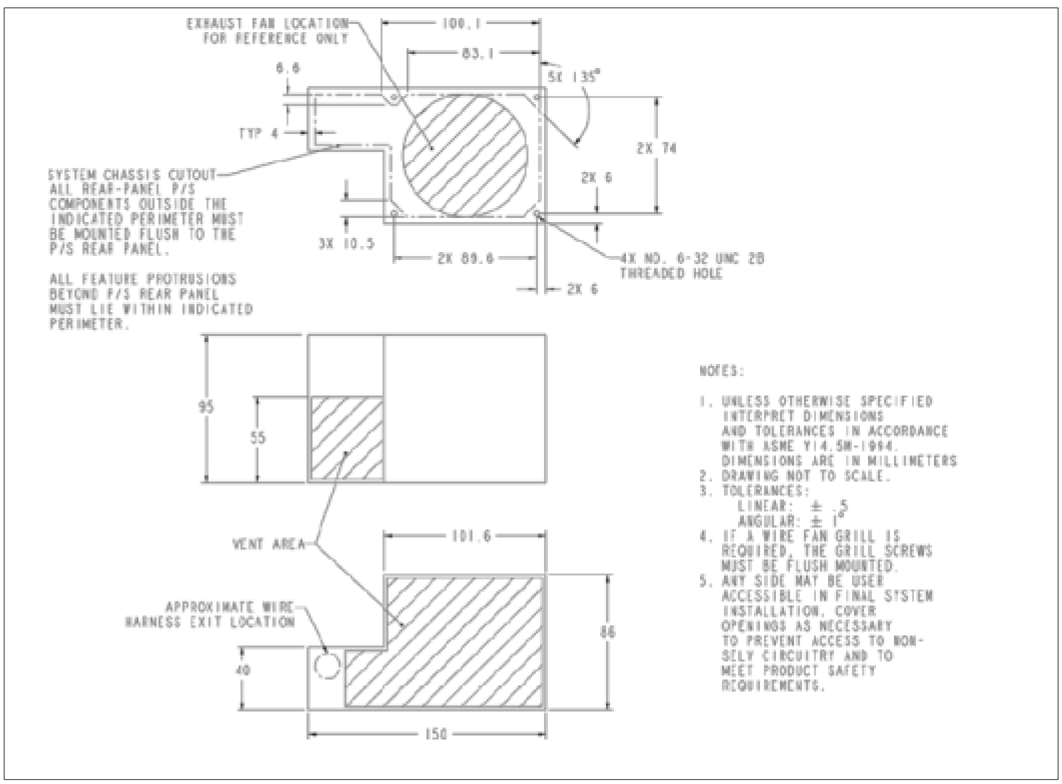
Mechanical dimension of power supplies has not changed from Multi Rail Desktop Power Supplies. Therefore, no need to change the chassis. Following is the current specification:

PSU DG	CFX12 V	LFX12 V	ATX12 V	SFX12 V	TFX12 V	Flex ATX
1.43	1.63	1.43	2.53	3.43	2.53	1.23

10.1 Physical Dimensions – REQUIRED

The power supply is enclosed and meet the physical outline shown.

Figure 10-1: CFX12 V Mechanical Outline



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11 LFX12 V Specific Guidelines 1.43

For Low Profile Form Factor with 12 V connector power supplies.

Mechanical dimension of power supplies has not changed from Multi Rail Desktop Power Supplies. Therefore, no need to change the chassis. Following is the current specification:

PSU DG	CFX12 V	LFX12 V	ATX12 V	SFX12 V	TFX12 V	Flex ATX
1.43	1.63	1.43	2.53	3.43	2.53	1.23

11.1 Physical Dimensions - REQUIRED

The power supply is enclosed and meet the physical outline shown in Figure 11-1, applicable. Mechanical details are shown in Figure 11-2. Details on the power supply slot feature are shown in Figure 11-3. The recommended chassis slot feature details are shown in Figure 11-4.

Figure 11-1: LFX 12 V Mechanical Outline

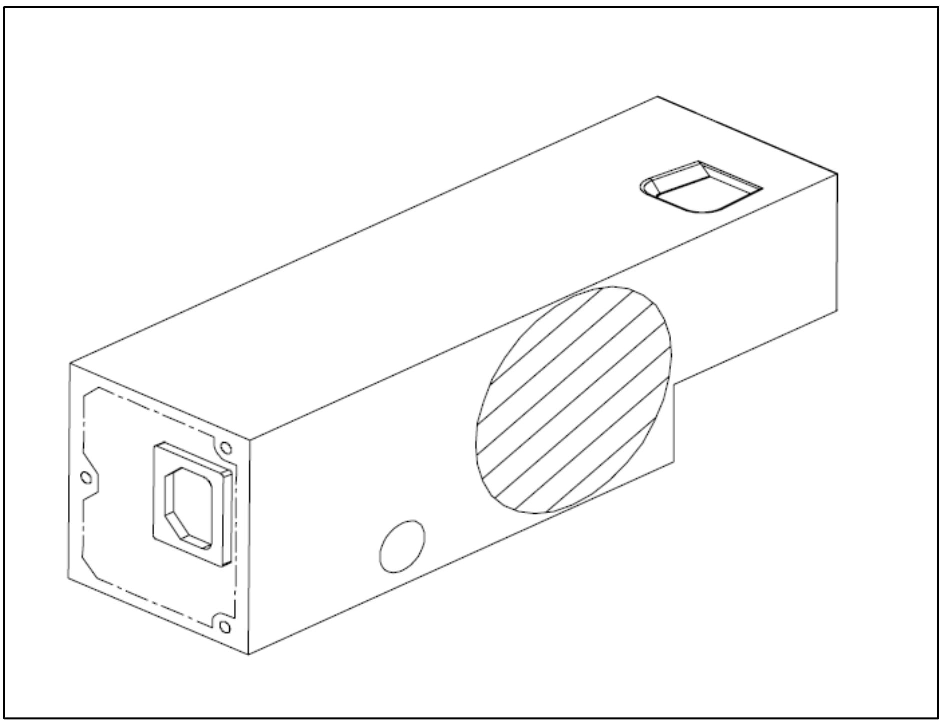


Figure 11-2 Mechanical Details

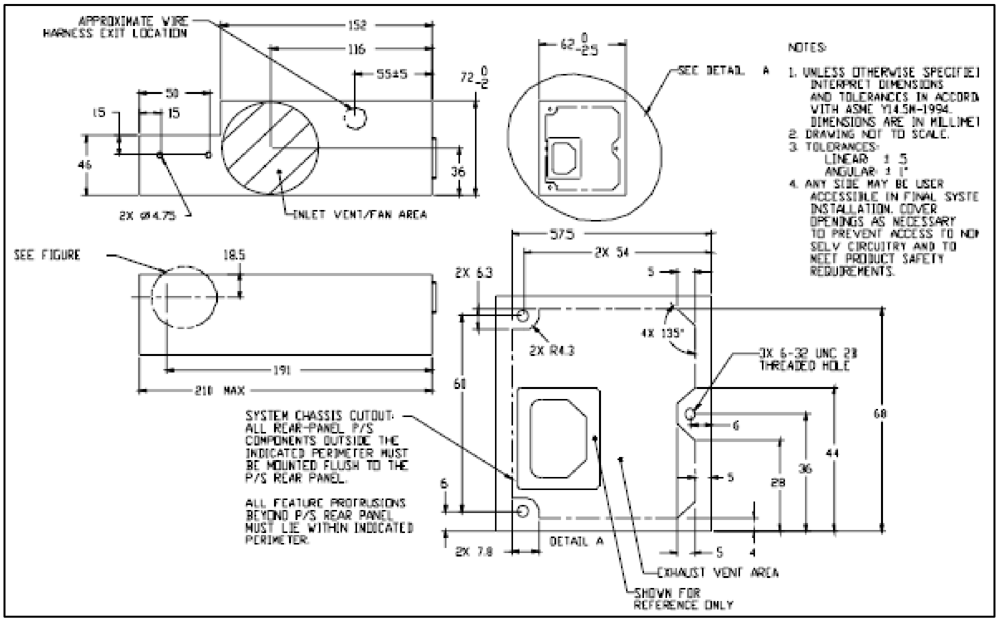


Figure 11-3: PSU Slot Feature Detail

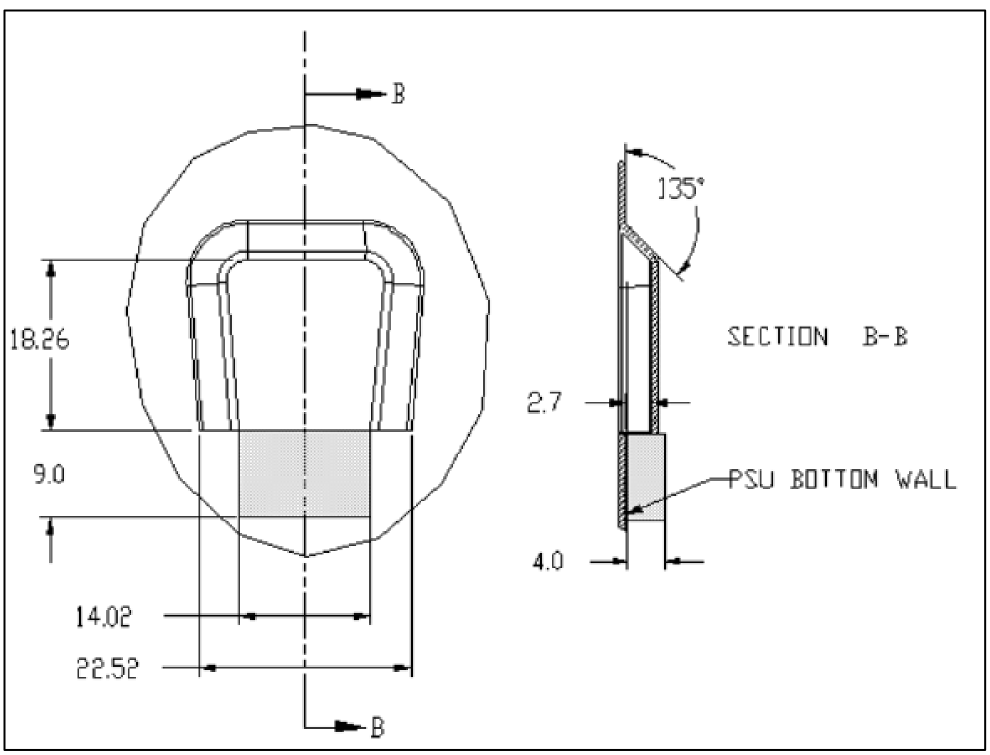
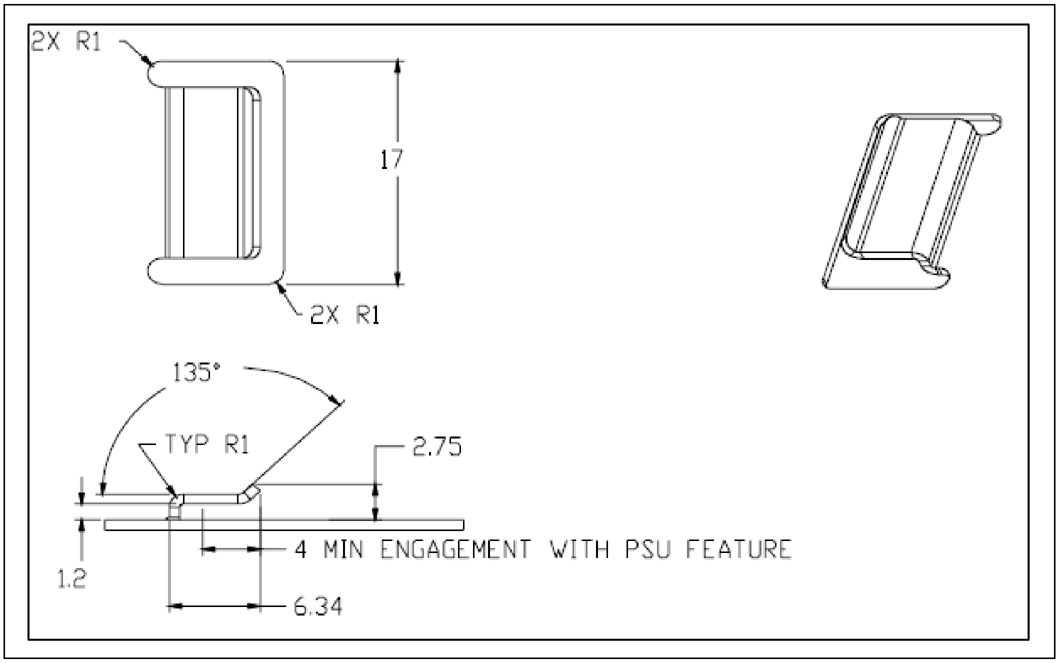


Figure 11-4: Recommended Chassis Tab Feature



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12 ATX12 V Specific Guidelines 2.53

For ATX Form Factor with 12 V connector power supplies.

Mechanical dimension of power supplies has not changed from Multi Rail Desktop Power Supplies. Therefore, no need to change the chassis. Following is the current specification:

PSU DG	CFX12 V	LFX12 V	ATX12 V	SFX12 V	TFX12 V	Flex ATX
1.43	1.63	1.43	2.53	3.43	2.53	1.23

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

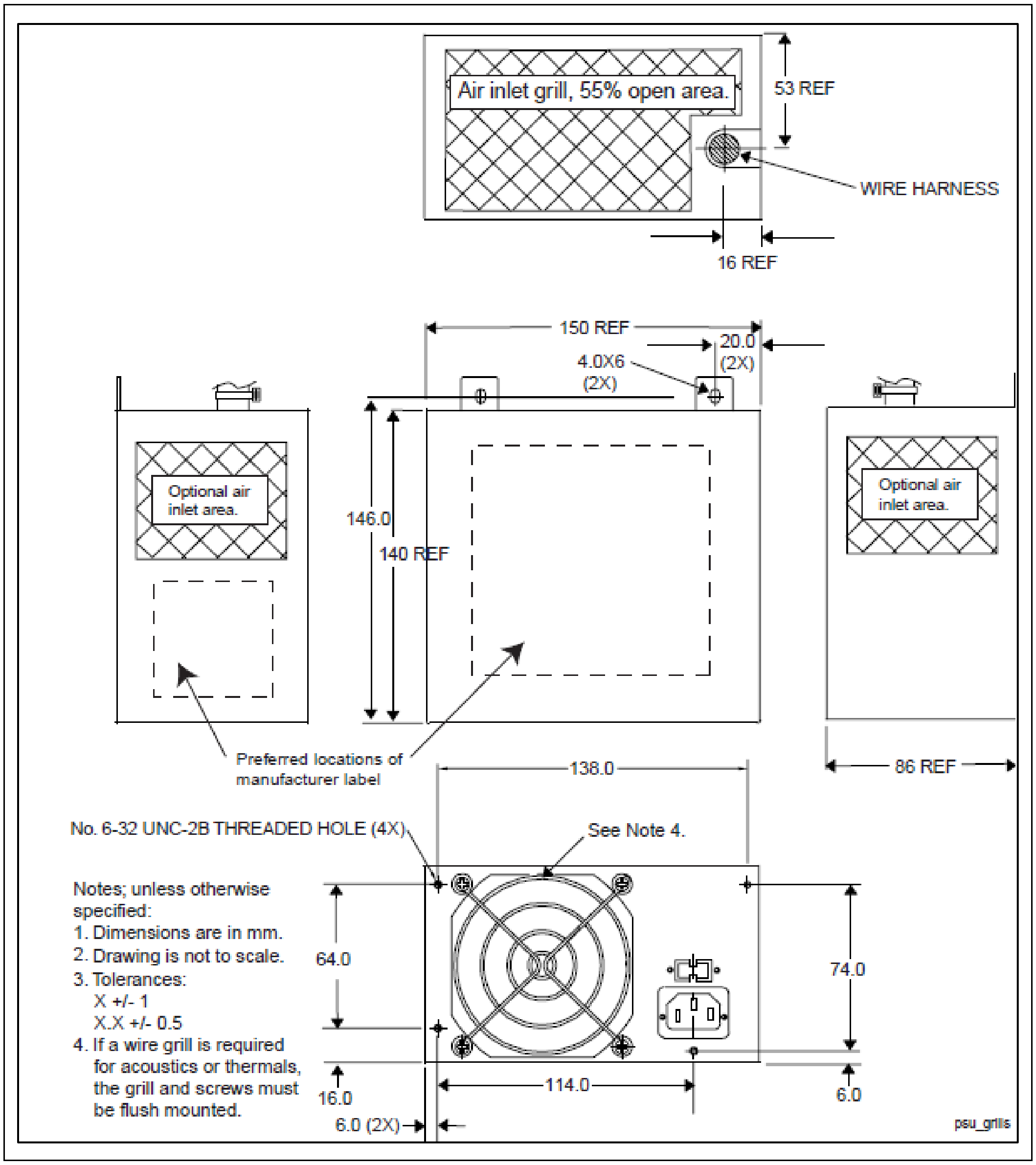
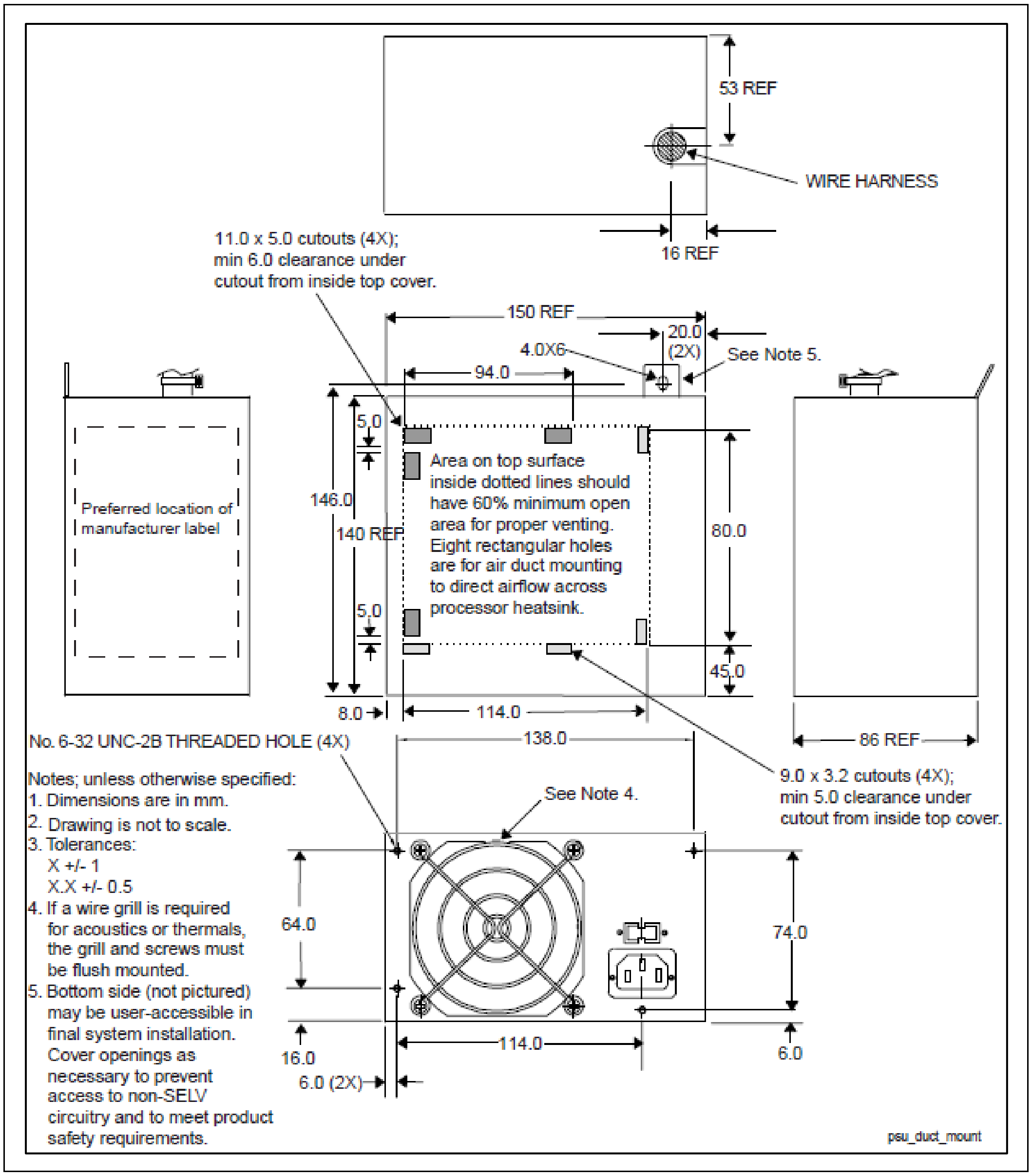


Figure 12-2: Power Supply Dimensions for Chassis that Require Top Venting



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13 SFX12 V Specific Guidelines 3.43

For Small Form Factor with 12 V connector power supplies.

Mechanical dimension of power supplies has not changed from Multi Rail Desktop Power Supplies. Therefore, no need to change the chassis. Following is the current specification:

PSU DG	CFX12 V	LFX12 V	ATX12 V	SFX12 V	TFX12 V	Flex ATX
1.43	1.63	1.43	2.53	3.43	2.53	1.23

13.1 Lower Profile Package - Physical Dimensions - REQUIRED

The power supply is enclosed and meets the physical outline as shown in Figure 13-1.

13.2 Fan Requirements - REQUIRED

The fan draws air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure exhausts the air through a grill located on the rear panel. Refer to Figure 13-2. The movement of the fan to the computer system cavity is to help limit the acoustic noise of the unit. The fan is 40 mm.

Figure 13-1: 40 mm Profile Mechanical Outline

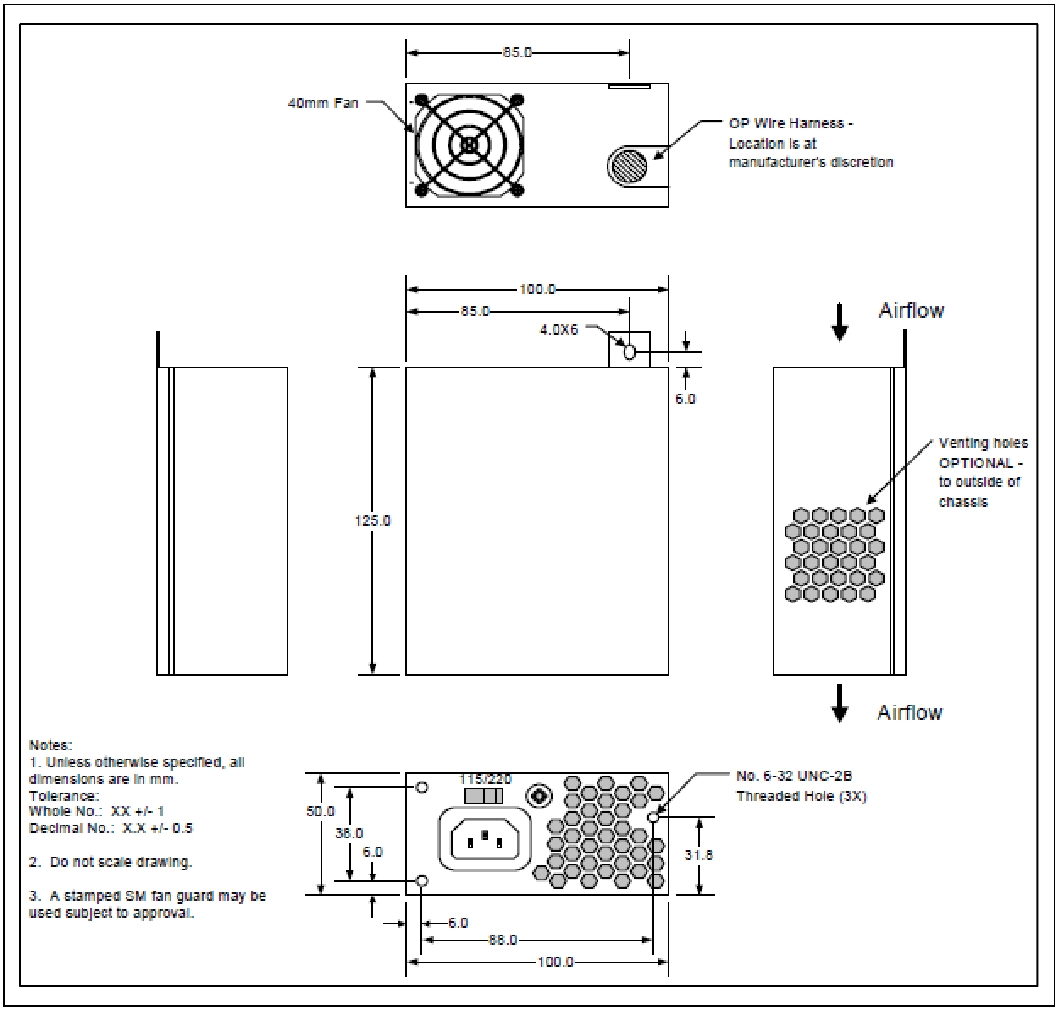
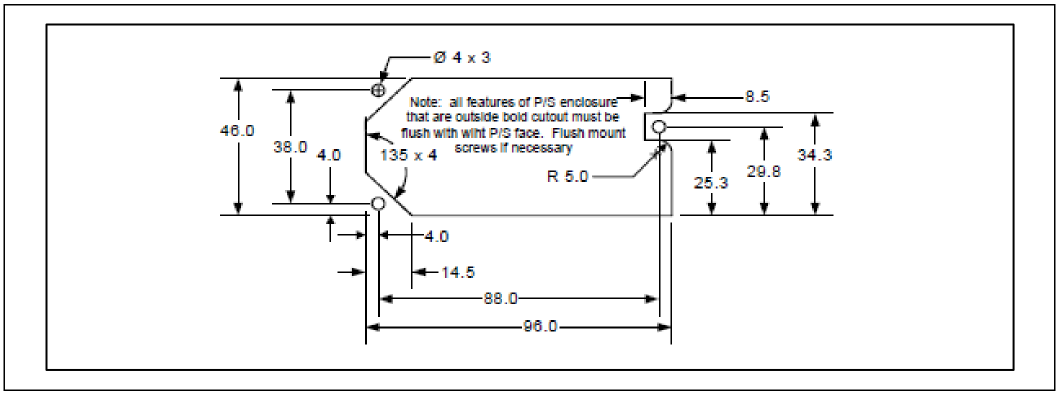


Figure 13-2: Chassis Cutout



13.3 Top Fan Mount Package - Physical Dimensions - REQUIRED

The power supply is enclosed and meets the physical outline as shown in Figure 13-3.

13.4 Fan Requirements - REQUIRED

The fan draws air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure exhausts the air through a grill located on the rear panel. Refer to Figure 13-4. Moving the fan to the computer system cavity helps to limit the acoustic noise of the unit. The fan is 80mm.

To prevent the damage to the fan during the 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

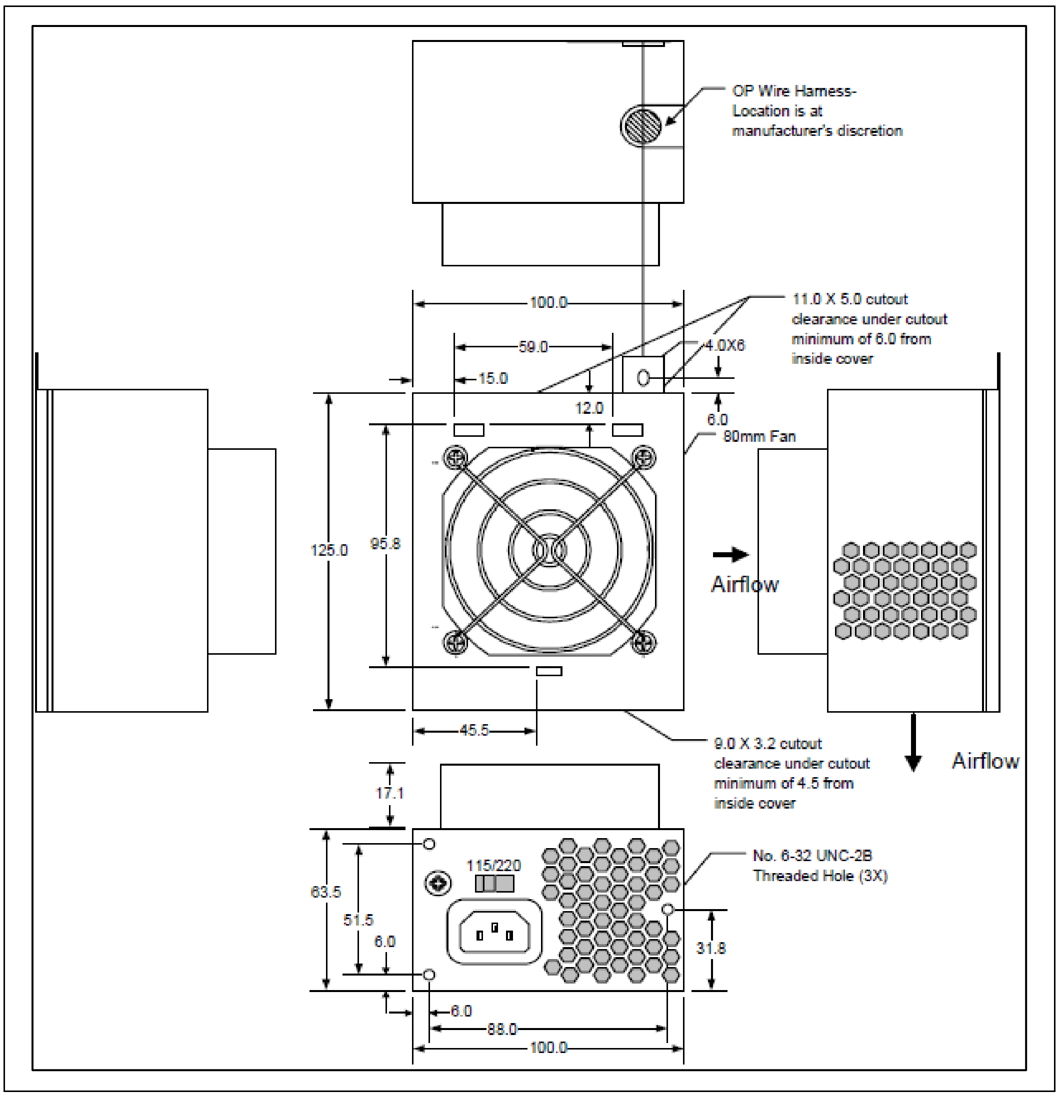


Figure 13-4: Chassis Cutout

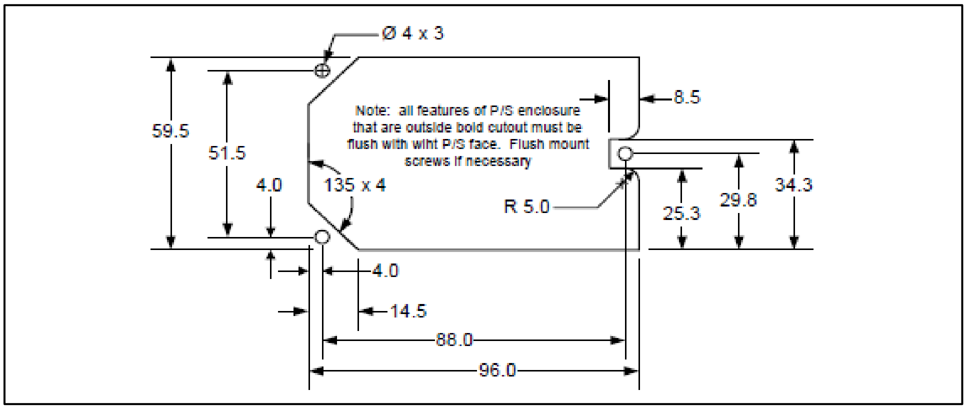
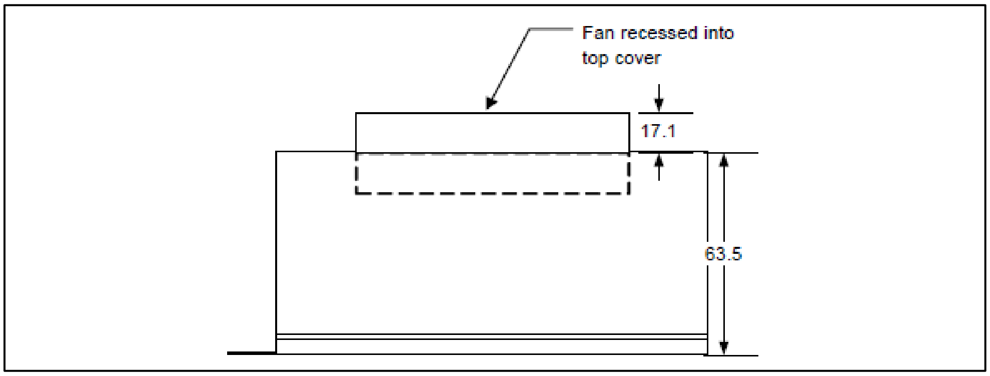


Figure 13-5: Recessed Fan Mounting



13.5 Reduced Depth Top Mount Fan - Physical Dimensions - REQUIRED

The power supply is enclosed and meets the physical outline as shown in Figure 13-6.

13.6 Fan Requirements - REQUIRED

The fan draws air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure exhausts the air through a grill located on the rear panel. Refer to Figure 13-7. Moving the fan to the computer system cavity helps to limit the acoustic noise of the unit. The fan is 80 mm.

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

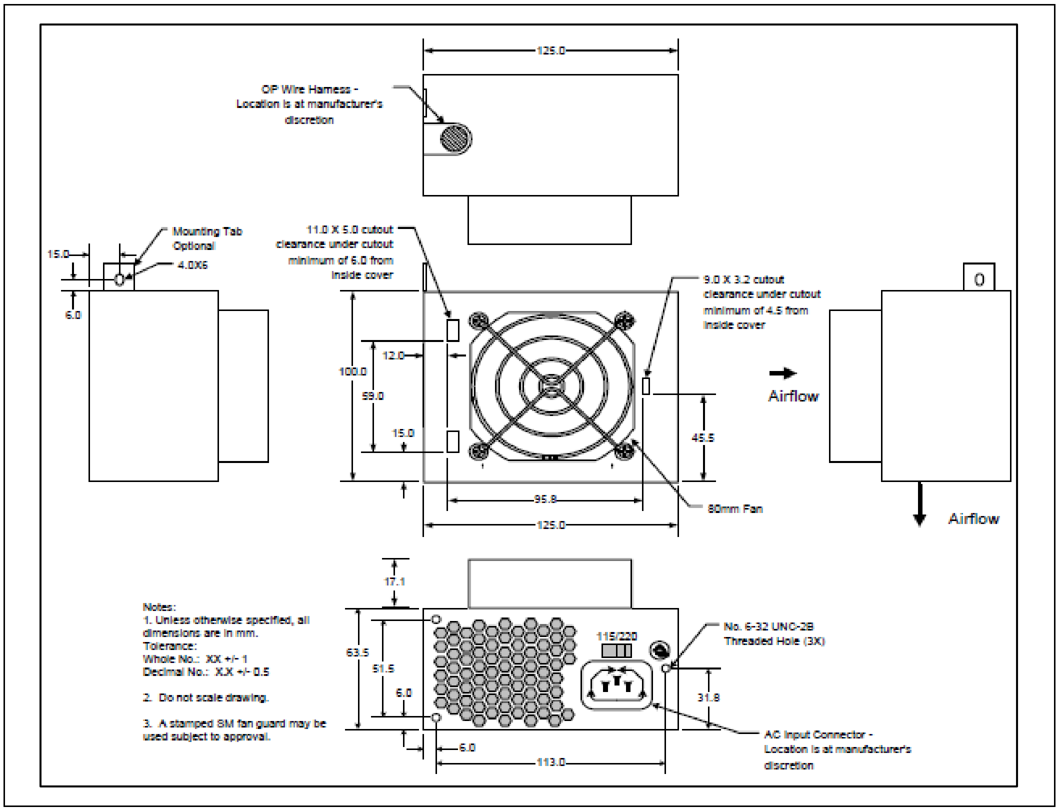
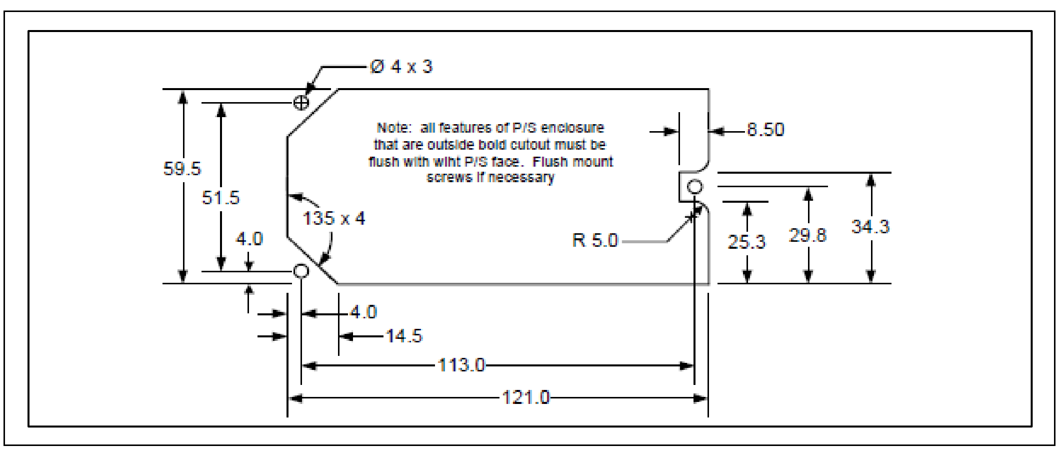


Figure 13-7: Chassis Cutout



13.7 Standard SFX Profile Package Physical Dimensions - REQUIRED

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

13.8 Fan Requirements - REQUIRED

The fan draws air from the computer system cavity pressurizing the power supply enclosure. The power supply enclosure exhausts the air through a grill located on the rear panel. Refer to Figure 13-9. The movement of the fan to the computer system cavity is to help limit the acoustic noise of the unit. The fan is 60 mm.

Figure 13-8: 60 mm Mechanical Outline

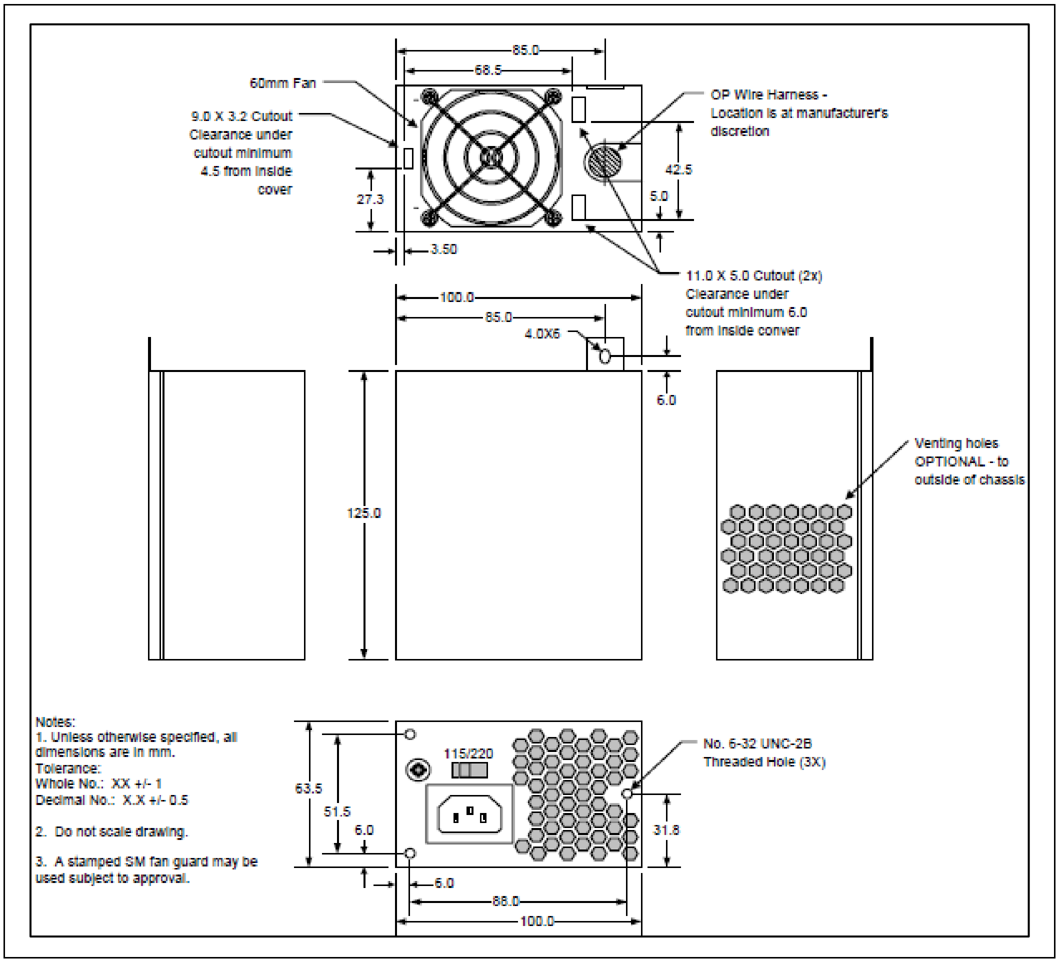
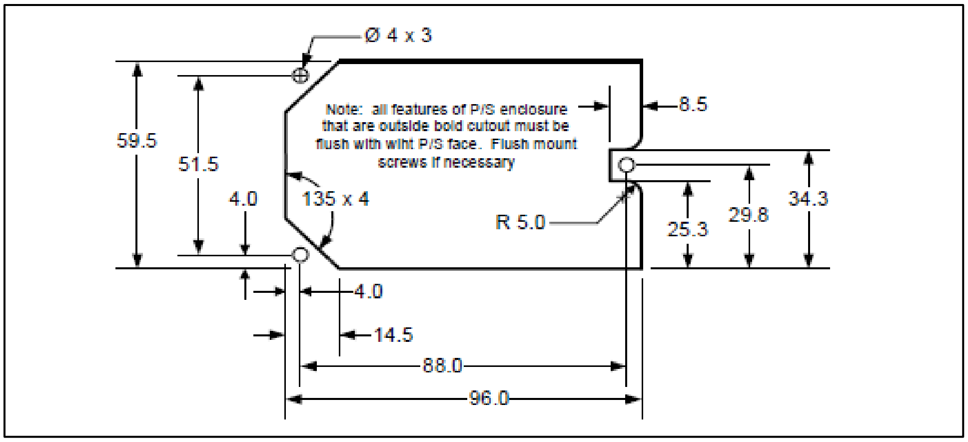


Figure 13-9: Chassis Cutout



13.9 PS3 Form Factor Physical Dimensions - REQUIRED

The power supply is enclosed and meets the physical outline as shown in Figure 13-10.

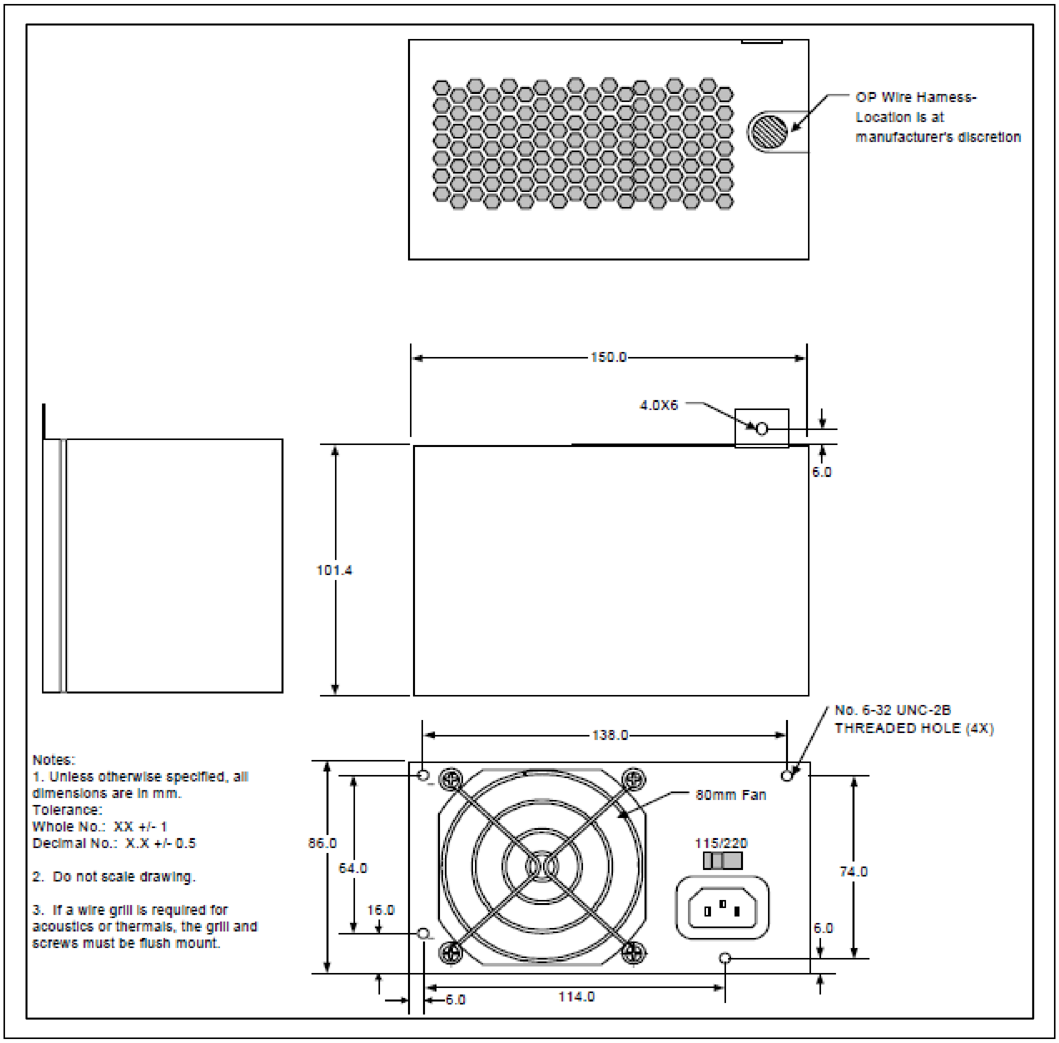
13.10 Fan Requirements - REQUIRED

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 the power supply and system component temperatures within the 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 the passive convection for cooling.

Figure 13-10: PS3 Mechanical Outline



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14 TFX12 V Specific Guidelines 2.53

For Thin Form Factor with 12 V connector power supplies.

Mechanical dimension of power supplies has not changed from Multi Rail Desktop Power Supplies. Therefore, no need to change the so chassis. Following is the current specification:

PSU DG	CFX12 V	LFX12 V	ATX12 V	SFX12 V	TFX12 V	Flex ATX
1.43	1.63	1.43	2.53	3.43	2.53	1.23

14.1 Physical Dimensions - REQUIRED

Figure 14-1: Mechanical Outline

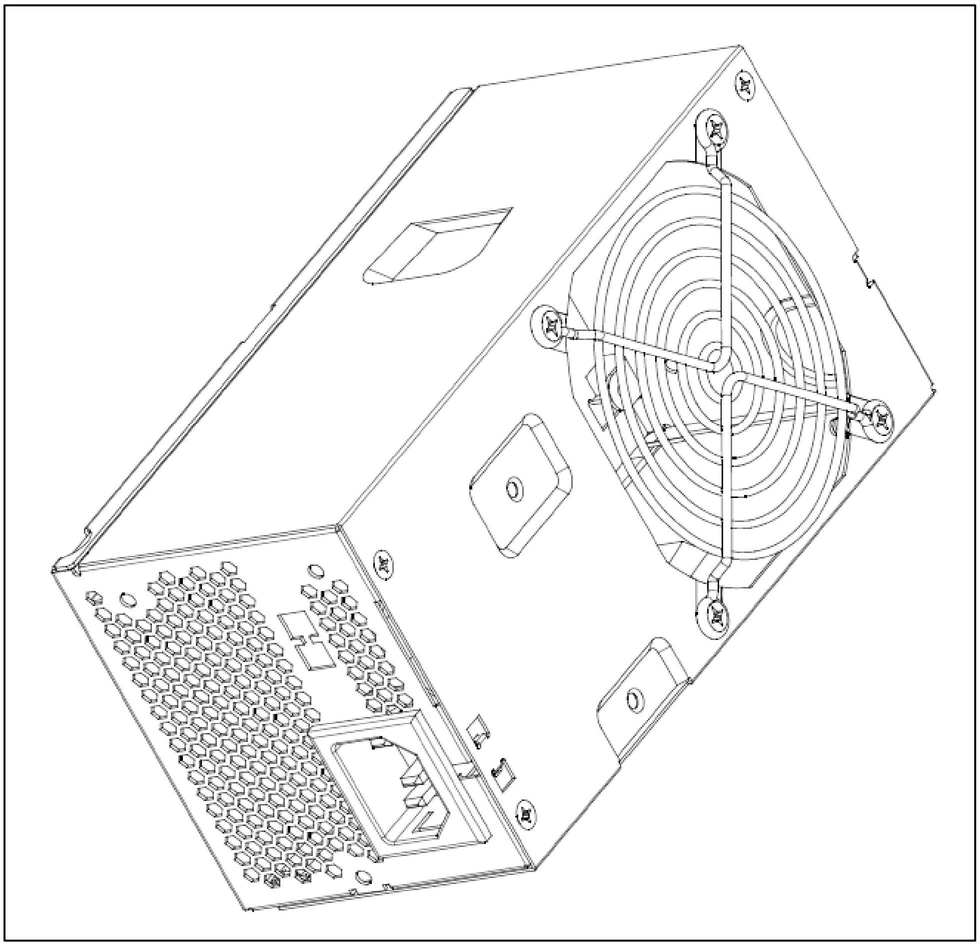


Figure 14-2: Dimensions and Recommended Feature Placements (Not to Scale)

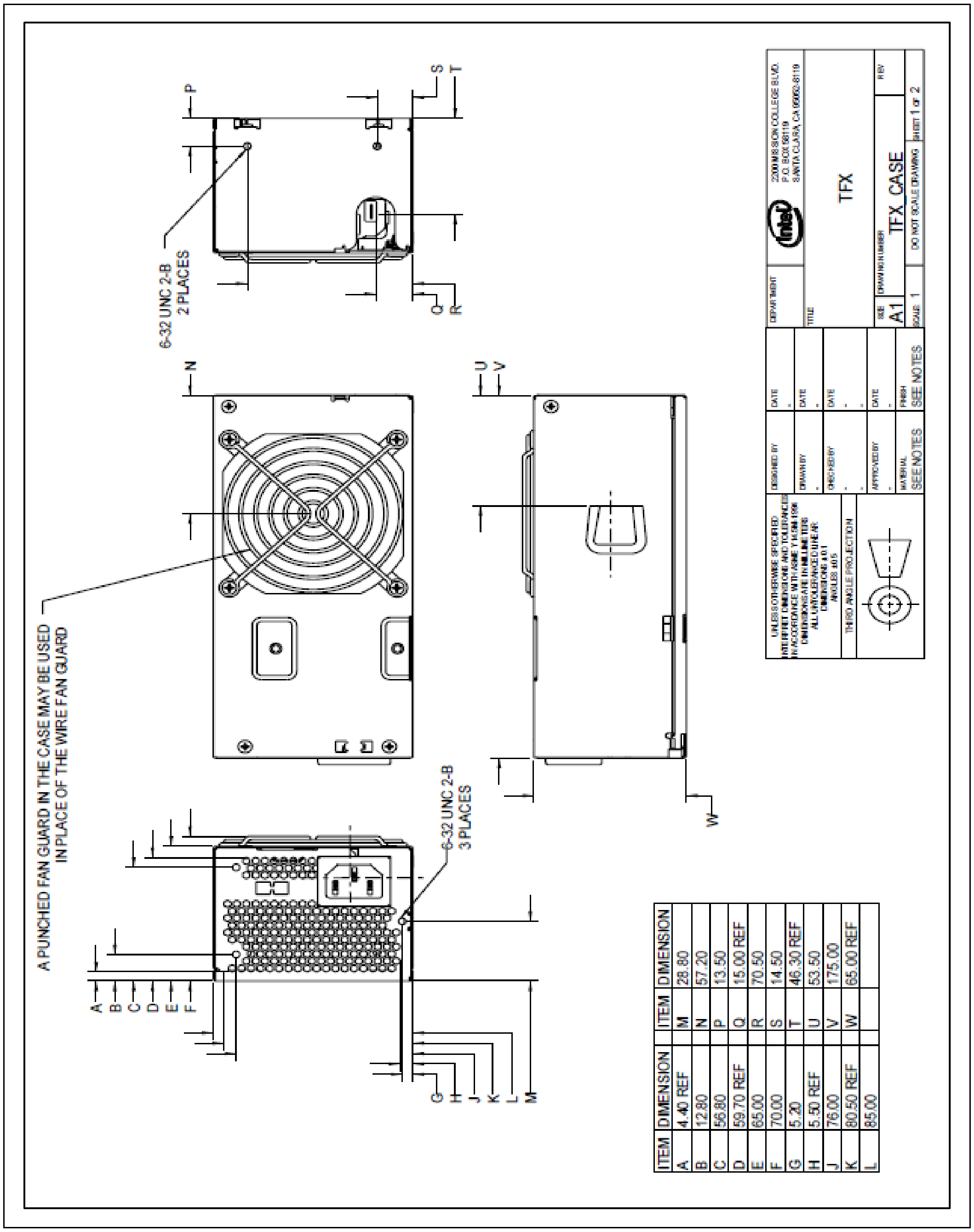
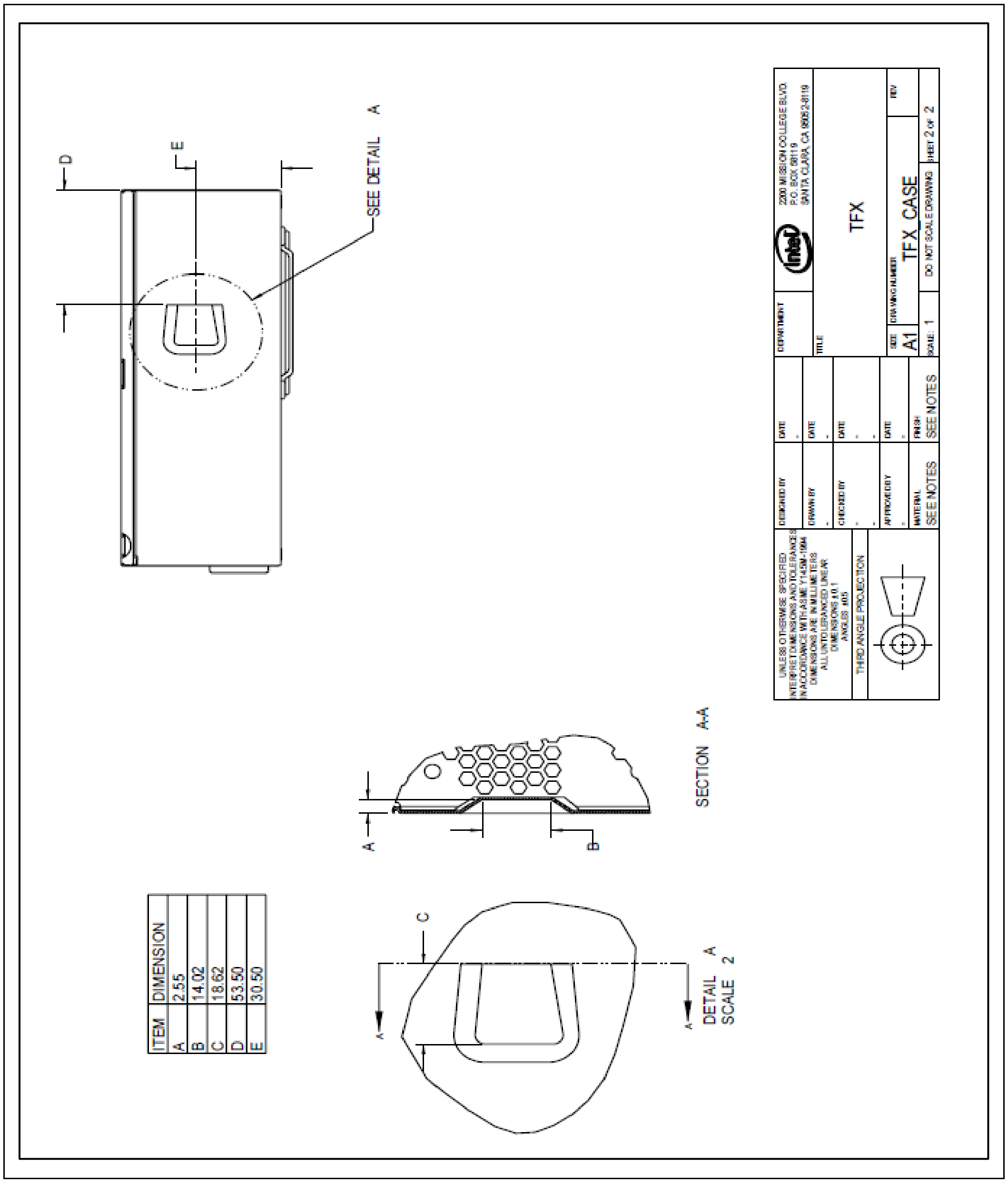


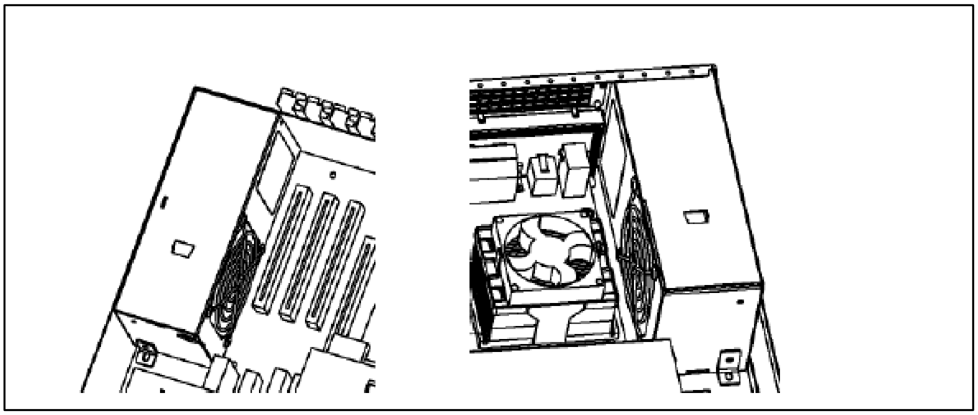
Figure 14-3: Power Supply Mounting Slot Detail



14.2 Mounting Options - RECOMMENDED

The TFX12 V mechanical design provides two options for mounting on 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. To accommodate different system chassis layouts, the TFX12 V power supply is also designed to mount in two orientations (fan left and fan right) as shown in Figure 14-4. A mounting hole and slot should be provided for each orientation as shown in Figure 14-2. Details of a suggested geometry for the mounting slot are shown in Figure 14-3.

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



14.3 Chassis Requirements - RECOMMENDED

To ensure the easy integration of power supply, the following features should be designed into a chassis intended to use a TFX12 V power supply:

- Chassis cutout, which is normally in the rear panel of the chassis as shown in Figure 14-5.
- Either a mounting bracket to interface with the forward mounting hole on the power supply or a mounting tab as shown in Figure 14-6 to interface with the mounting slot at the bottom of the power supply.

Figure 14-5: Suggested TFX12 V Chassis Cutout

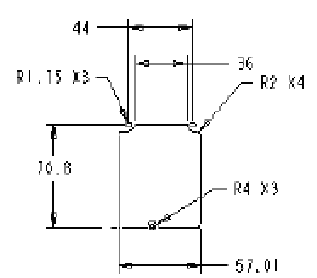
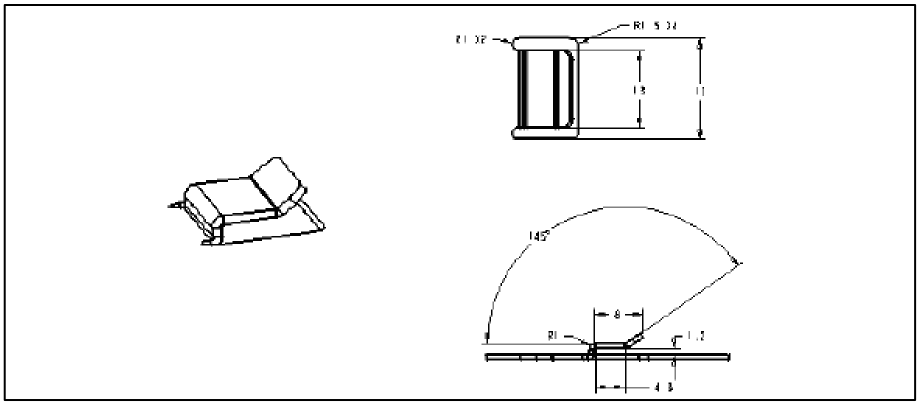


Figure 14-6: Suggested Mounting Tab (Chassis Feature)



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15 Flex ATX Specific Guidelines 1.23

For Flex ATX Form Factor with 12 V connector power supplies.

Mechanical dimension of power supplies has not changed from Multi Rail Desktop Power Supplies. Therefore, no need to change the chassis. Following is the current specification:

PSU DG	CFX12 V	LFX12 V	ATX12 V	SFX12 V	TFX12 V	Flex ATX
1.43	1.63	1.43	2.53	3.43	2.53	1.23

15.1 Physical Dimensions – REQUIRED

Figure 15-1: Mechanical Outline

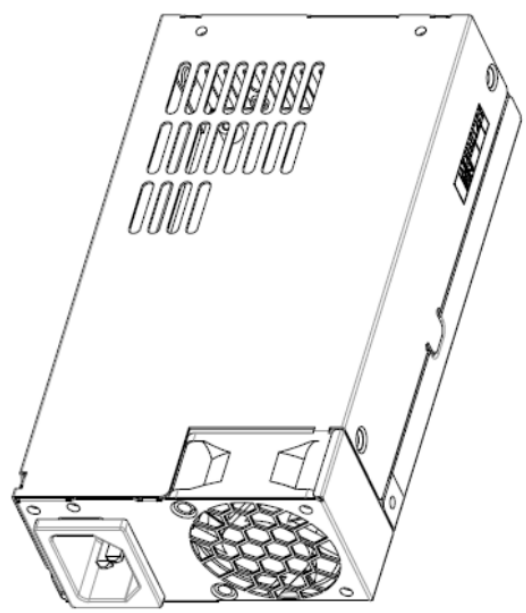
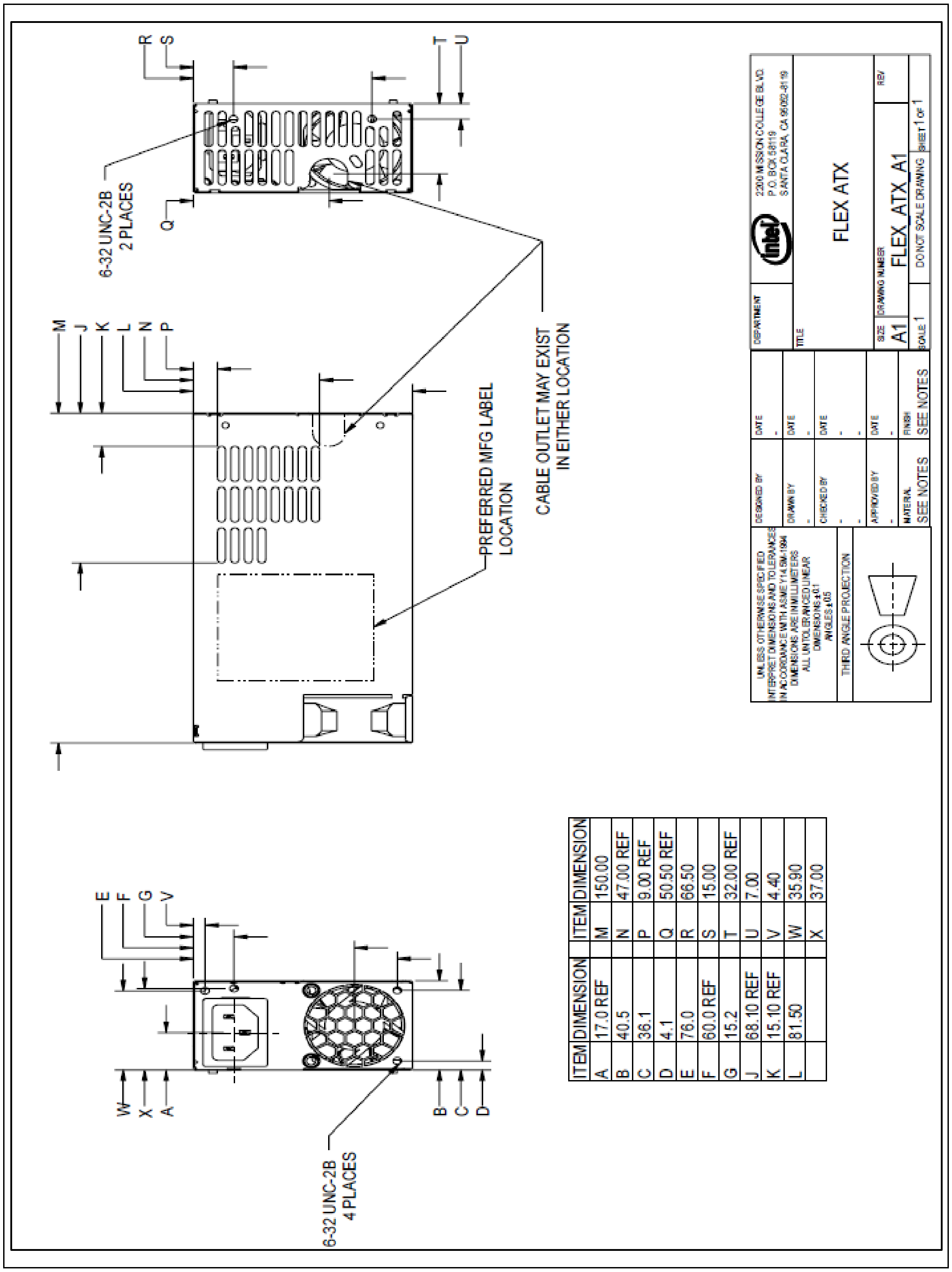


Figure 15-2: Dimensions and Recommended Feature Placements (Not to Scale)



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