Intel ATX

Power Supply Design Guide

Version 0.9

Version 0.9, September 1998

Revision History

0.9	**Initial Release**

Contents

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1. Scope

This document outlines a reference ATX power supply that complies with the *ATX Specification, Version 2.02* for motherboards and chassis. It is intended to provide additional power supply design information not detailed in the ATX 2.02 specification, including information about the physical form factor of the power supply, cooling requirements, connector configuration, and pertinent electrical and signal timing specifications.

This document is provided as a convenience only and is not intended to replace or supplement the user's independent design and validation activity. It should not be inferred that all ATX power supplies must conform exactly to the content of this document. Neither are the design specifics described herein intended to support all possible system configurations, as system power supply needs will vary widely depending on application (desktop / workstation / server), intended ambient environment (temperature, line voltage), motherboard power requirements, etc.

With a few modifications, a standard PS/2† power supply can support an ATX form-factor system. At a high level, these modifications include consolidating various motherboard connectors into a single 20-pin connector, adding +3.3VDC and +5VSB output supply rails, adding a PS_ON# control input, and possibly repositioning the fan and/or venting locations.

2. Applicable Documents

The latest revision in effect of the following documents forms a part of this document to the extent specified.

AB13-94-146	EACEM European Association of Consumer Electronics Manufacturers. Hazardous Substance List / Certification.
ANSI C62.41-1991	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Circuits.
ANSI C62.45-1992	IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
MIL-STD-105K	Quality Control.
MIL-STD-217F	Reliability Predictions for Electronic Equipment.
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
CSA C22.2 No.234, Level 3	Safety of Component Power Supplies. Intended for use with Electronic Data Processing Equipment and Office Machines.
CAN/CSA C22.2 No.950-95, 3rd edition	Safety of Information Technology Equipment including Electrical Business Equipment.
UL 1950 without D3 Deviation, 3rd edition	Safety of Information Technology Equipment including Electrical Business Equipment.
IEC 950 plus A1, A2, A3, A4	Safety of Information Technology Equipment including Business Equipment.
EN60 950 plus A1, A2, A3, A4	Safety of Information Technology Equipment including Business Equipment.
EMKO-TSE (74-SEC) 207/94	Nordic National Requirement in addition to EN60950.
CISPR 22 and EN 55022	Limits and Methods of Measurements of Radio Interference Characteristics of Information Technology Equipment, Class B.
ANSI C63.4 – 1992	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.
EN50082-1 (1992)	Electromagnetic compatibility/generic immunity standard.
EN61000-3-2	Limits for Harmonic Current Emission, Class D.
Japan Electric Association	Guidelines for the Suppression of Harmonics in Appliances and General Use Equipment.
IEC801- / IEC1000-4-	Electromagnetic compatibility for industrial-process measurement and control equipment. Part -2: ESD Requirements. Part -3: Immunity to Radiated Electromagnetic Fields. Part -4: Electrical Fast Transients/Burst Requirements. Part -5: Surge Immunity Requirements.
IEC Publication 417	International Graphic Symbol Standard.
ISO Standard 7000	Graphic Symbols for Use on Equipment.
CFR 47, Part 15, Subpart B	FCC Rules.
PrEN 50082-1: 1995	Electromagnetic compatibility, generic immunity. Standard, Part 1: Residential, commercial and light industry.
ENV 50140	Radio frequency electromagnetic field test standard, Amplitude modulated.
ENV 50204	Radio frequency electromagnetic field-test standard, Keyed carrier.
ENV 50141	Radio frequency common mode test standard.
EN 61000-4-11	Voltage dips and interruptions test standard.

3. Electrical Specification

The electrical requirements that follow are to be met over the environmental ranges specified in Section 5 unless otherwise noted.

3.1 AC Input Requirements

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 input voltage, current, and frequency requirements for continuous operation are stated below. (Note that nominal voltages for test purposes are considered to be within ±1.0 V of nominal.) The power supply must be able to start up under peak loading at 90 VAC.

Table 1: AC Input Line Requirements

Parameter	Min	Nom	Max	Unit
V_{in} (115 VAC)	90	115	135	VAC_{rms}
V_{in} (230 VAC)	180	230	265	VAC_{rms}
V_{in} Frequency	47	--	63	Hz
I_{in} (115 VAC)			7.0	A_{rms}
I_{in} (230 VAC)			3.5	A_{rms}

3.1.1 Input Overcurrent Protection

The power supply shall incorporate primary fusing for input overcurrent protection. Fuses should be slow-blow type or equivalent to prevent nuisance trips.

3.1.2 Inrush Current Limiting

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

3.1.3 Input Undervoltage

The power supply shall contain protection circuitry such that the application of an input voltage below the minimum specified in Section 3.1, Table 1, shall not cause damage to the power supply.

3.1.4 Immunity

3.1.4.1 Slow Transients

The DC output(s) shall not exceed the limits specified in Section 3.2.1 as a result of the input power line noise defined in Table 2 under any load condition per EN 61000-4-11.

Table 2: AC Line Voltage Transient Limits

Duration	Sag / Surge	Operating AC Voltage	Line Frequency	Performance Criteria
0 to 500 ms	10%	Rated AC voltages	50/60 Hz	No loss of function or performance
0 to 15 minutes	15%	Mid-point of rated AC voltages	50/60 Hz	No loss of function or performance
0 to ½ AC cycle	30%	Mid-point of rated AC voltages	50/60 Hz	No loss of function or performance
0 to 5 AC cycles	50% sag only	Mid-point of rated AC voltages	50/60 Hz	Loss of function acceptable, self- recoverable

3.1.4.2 Surge Voltages

Input Surge Withstand Capability (Line Transients). The power supply shall meet the IEC801-5/IEC 1000-4-5 Level 1, Level 2, and Level 3 criteria for surge withstand capability, with the following conditions and exceptions. The power supply must meet the surge withstand test for the range of operation specified in Section 3.1.

The peak value of the injected unipolar wave form shall be 2.0 kV measured at the input of the power supply for the common and the normal modes of transient surge injection.

The surge withstand test must not produce:

- Damage to the power supply
- Disruption of the normal operation of the power supply
- Output voltage deviation exceeding the limits of Section 3.2.1.

3.1.4.2.1 Surge Immunity, IEC801-5/IEC1000-4-5

No unsafe operation is allowed under any condition. No user-noticeable performance degradation for 1 kV Differential Mode (DM) or 2 kV Common Mode (CM) is allowed. Automatic or manual recovery is allowed for other conditions.

3.1.4.2.2 Electrical Fast Transient / Burst, IEC801-4/IEC1000-4-4

No unsafe operation is allowed under any condition. No user-noticeable performance degradation up to 1 kV is allowed. Automatic or manual recovery is allowed for other conditions.

3.1.4.2.3 Ring Wave, ANSI C62.45-1992

The crest value of the first half peak of the injected oscillatory wave will be 3.0 kV open circuit, with 200 and 500 A short circuit currents for the common and the normal modes of transient surge injection, respectively. No unsafe operation is allowed under any condition. No user-noticeable performance degradation for 1 kV Differential Mode (DM) or 2 kV Common Mode (CM) is allowed. Automatic or manual recovery is allowed for other conditions.

3.1.4.2.4 Electrostatic Discharge, IEC801-2/IEC1000-4-2

In addition to IEC 801-2 / IEC1000-4-2, the following ESD tests should be conducted. Each surface area of the unit under test should be subjected to twenty (20) successive static discharges, at each of the following voltages: 2 kV, 3 kV, 4 kV, 5 kV, 6 kV, 8 kV, 10 kV, 15 kV, and 25 kV.

Performance criteria:

- All power supply outputs shall continue to operate within the parameters of this design guide, without glitches or interruption, while the supply is operating as defined and subjected to 2 kV through 15 kV ESD pulses. The direct ESD event shall not cause any out-of-regulation conditions such as overshoot or undershoot. The power system shall withstand these shocks without nuisance trips of the overvoltage protection, overcurrent protection, or remote +5VDC shutdown circuitry.
- The power supply, while operating as defined, shall not have a component failure when subjected to any discharge voltages up to and including 25 kV. Component failure is defined as any malfunction of the power supply that causes component degradation or failure requiring component replacement to correct the problem.

3.1.4.3 Radiated Immunity

3.1.4.3.1 IEC801-3/IEC 1000-4-3

Frequency	Electric Field Strength
27 MHz to 500 MHz, unmodulated	3 V/m

3.1.4.3.2 ENV 50140

Frequency	Electric Field Strength
80 to 1000 MHz, 1 kHz sine wave, 80% AM	3 V/m

3.1.4.3.3 Radio Frequency Common Mode, ENV 50141

Frequency	Level
.15 to 30 MHz, 1 kHz sine wave, 80% AM	3 V

3.1.5 Catastrophic Failure Protection

The primary circuit design and the components specified in the same should be such that, 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.

3.2 DC Output Requirements

3.2.1 DC Voltage Regulation

The DC output voltages shall remain within the regulation ranges shown in Table 3 when measured at the load end of the output connectors under all line, load, and environmental conditions. The voltage regulation limits shall be maintained under continuous operation for a period of time equal to or greater than the MTBF specified in Section 7.2 at any steady state temperature and operating conditions specified in Section 5.

Table 3: DC Output Voltage Regulation

Output	Range	Min.	Nom.	Max.	Unit
+12VDC*	±5%	+11.40	+12.00	+12.60	Volts
+5VDC	±5%	+4.75	+5.00	+5.25	Volts
+3.3VDC	±5%	+3.14	+3.30	+3.47	Volts
-5VDC	±10%	-4.50	-5.00	-5.50	Volts
-12VDC	±10%	-10.80	-12.00	-13.20	Volts
+5VSB	±5%	+4.75	+5.00	+5.25	Volts

* At +12 V peak loading, regulation at the +12VDC output can go to ±10%.

3.2.2 Remote Sensing

The +3.3VDC output should have provisions for remote sensing to compensate for 100 mV of cable, connector, and PCB trace drops. The default sense should be connected to pin 11 of the ATX main power connector. The power supply should draw no more than 10 mA through the remote sense line to keep DC offset voltages to a minimum.

3.3 Typical Power Distribution

Although power requirements and distributions will depend on the specific system options and implementation, this section identifies several potential configurations. For a single processor mini-tower configuration with one ISA slot, three PCI slots, one shared slot, and six peripheral bays, a minimum 160 W sustained (200 W peak) power supply should be sufficient for a typical application. For a full tower, dual processor configuration with one ISA slot, five PCI slots, one shared slot, and six peripheral bays, a 300 W sustained power supply should be sufficient. Tables 4, 5, 6, and 7 list the suggested power distribution for various configurations and applications.

Table 4: Typical Power Distribution for a 160 W Configuration

Output	Min. Current (amps)	Max. Current (amps)	Peak Current (amps)	Notes:
+12VDC	0.0	6.0	8.0	
+5VDC	1.0	18.0		+3.3VDC and +5VDC combined power 110 W max
+3.3VDC	0.3	14.0		Pin 11 default +3.3 V sense required
-5VDC	0.0	0.3		
-12VDC	0.0	0.8		
+5VSB	0.0	0.72		See Section 3.4.3.

Table 5: Typical Power Distribution for a 200 W Configuration

Output	Min. Current (amps)	Max. Current (amps)	Peak Current (amps)	Notes:
+12VDC	0.0	6.0	8.0	
+5VDC	1.0	21.0		+3.3VDC and +5VDC combined power 125 W Max
+3.3VDC	0.3	14.0		Pin 11 default +3.3 V sense required
-5VDC	0.0	0.3		
-12VDC	0.0	0.8		
+5VSB	0.0	0.72		See Section 3.4.3.

Table 6: Typical Power Distribution for a 250 W Configuration

Output	Min. Current (amps)	Max. Current (amps)	Peak Current (amps)	Notes: Requires the 1x6 auxiliary power connector to carry the 3.3 V & 5 V currents to the PCB.
+12VDC	0.0	10.0	12.0	
+5VDC	1.0	25.0		+3.3VDC and +5VDC combined power 145 W Max
+3.3VDC	0.3	16.0		Pin 11 default +3.3 V sense required
-5VDC	0.0	0.3		
-12VDC	0.0	0.8		
+5VSB	0.0	0.72		See Section 3.4.3.

Table 7: Typical Power Distribution for a 300 W Configuration

Output	Min. Current (amps)	Max. Current (amps)	Peak Current (amps)	Notes: Requires the 1x6 auxiliary power connector to carry the 3.3 V & 5 V currents to the PCB.
+12VDC	0.0	10.0	12.0	
+5VDC	1.0	30.0		+3.3VDC and +5VDC combined power 220 W Max
+3.3VDC	0.3	28.0		Pin 11 default +3.3 V sense required
-5VDC	0.0	0.3		
-12VDC	0.0	0.8		
+5VSB	0.0	0.72		See Section 3.4.3.

3.3.1 Power Limit

Under short circuit or overload conditions, no output shall exceed 240 VA under any conditions including single component fault conditions.

3.3.2 Efficiency

The efficiency of the power supply should be met over the AC input range defined in Table 1, under the load conditions defined in Section 3.3, and under the temperature and operating conditions defined in Section 5. The power supply should be a minimum of 68% efficient under maximum load as defined in the applicable configuration.

The “Energy Star” efficiency of the power supply should be a minimum of 56%. In the Energy Star state, the AC input power is limited to 15% of rated output power for the configuration. For example, in a 200 W configuration, the Energy Star input power limit is 200 W × 0.15 = 30 W. In a 300 W configuration, the Energy Star input power is limited to 300 W × 0.15 = 45 W.

The +5VSB standby supply efficiency should be 50% at 500 mA output. Standby efficiency is measured with the main outputs off and with PS_ON# high. The AC input power shall not exceed 5 W when the main outputs are in the “DC disabled” state with 500 mA load on +5VSB and the input is 230 VAC/50 Hz.

3.3.3 Output Ripple/Noise

The following output ripple/noise requirements should be met throughout the load ranges specified in Section 3.3, and under all input voltage conditions as specified in Section 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 bandwidth. Outputs should be bypassed at the connector with a 0.1 µF ceramic disk capacitor and a 10 µF electrolytic capacitor to simulate system loading.

Table 8: DC Output Noise/Ripple

Output	Max Ripple & Noise (mV_{pp})
+12VDC	120
+5VDC	50
+3.3VDC	50
-5VDC	100
-12VDC	120
+5VSB	50

3.3.4 Output Transient Response

The +3.3VDC and +5VDC outputs will see transients up to 30% of the rated output current (e.g., for a rated +5VDC output of 18 A, the transient step would be 0.3 × 18 A = 5.4 A). The +12VDC output will see transients up to 50% of the rated output current. The transient slew rate will be 2.5 A/µs. The power supply should be stable under all transient conditions from any steady state load, and the over/undershoot should be within the regulation band stated in Section 3.2.1.

3.3.5 Capacitive Load

The power supply should be able to power up and operate normally with the following capacitances simultaneously present on the DC outputs.

Output:	+12VDC	+5VDC	+3.3VDC	-5VDC	-12VDC	+5VSB
Capacitive load (µF):	1,000	10,000	6,000	350	350	350

3.3.6 Closed Loop Stability

The power supply shall be unconditionally stable under all line/load/transient load conditions including capacitive loads specified in Section 3.3.5. A minimum of 45 degrees phase and 10 dB-gain margin is required. The power supply vendor shall provide proof of the unit's closed-loop stability with local sensing through the submission of Bode plots. Closed-loop stability must be ensured at the maximum and minimum loads as applicable.

3.3.7 +5VDC/+3.3VDC Power Sequencing

The +5VDC output level must be equal to or greater than the +3.3VDC output at all times during power-up and normal operation. The time between the +5VDC output reaching its minimum in-regulation level and +3.3VDC reaching its minimum in-regulation level must be less than or equal to 20 ms.

3.3.8 Voltage Hold-up Time

The power supply shall maintain output regulation per Section 3.2.1 despite a loss of input power at the low-end nominal range (Low = 115 VAC, 57 Hz or 230 VAC, 47 Hz) at maximum continuous output load as applicable for a minimum of 17 ms.

3.4 Timing / Housekeeping / Control

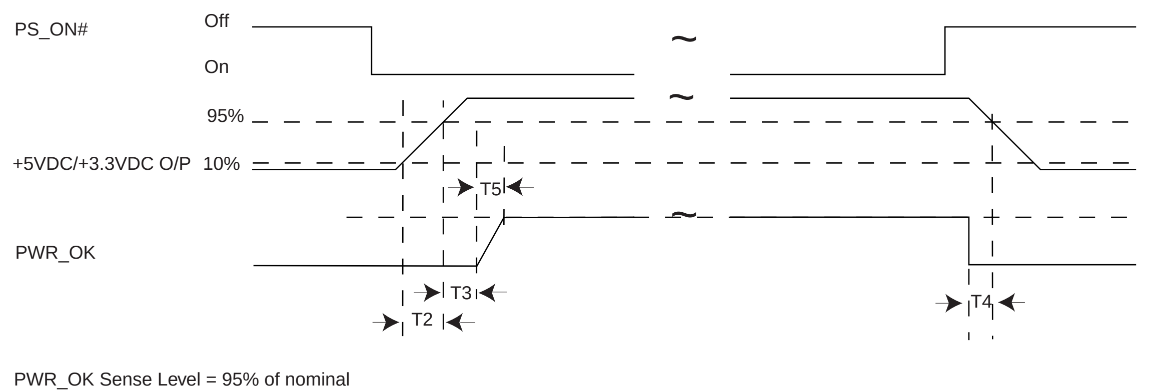

Figure 1: Power Supply Timing

Notes:

T_2 is defined in Section 3.4.5.

T_3, T_4, and T_5 are defined in Table 9.

3.4.1 PWR_OK

PWR_OK is a “power good” signal. It should be asserted high by the power supply to indicate that the +5VDC and +3.3VDC outputs are above the undervoltage thresholds listed in Section 3.2.1 and that sufficient mains energy is stored by the converter to guarantee continuous power operation within specification for at least the duration specified in Section 3.3.8. Conversely, PWR_OK should be deasserted to a low state when either the +5VDC or the +3.3VDC output voltages falls below the undervoltage threshold, or when mains power has been removed for a time sufficiently long such that power supply operation cannot be guaranteed beyond the hold-up time. The electrical and timing characteristics of the PWR_OK signal are given in Table 9 and in Figure 1.

Table 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 VDC and 5 VDC output while sourcing 200 µA
High state output impedance	1KΩ from output to common
PWR_OK delay	100 ms $< T_3 <$ 500 ms
PWR_OK rise time	$T_5 \leq$ 10 ms
Power down warning	$T_4 >$ 1 ms

3.4.2 PS_ON#

PS_ON# is an active-low, TTL-compatible signal that allows a motherboard to remotely control the power supply in conjunction with features such as soft on/off, wake-on-LAN, or wake-on-modem. When PS_ON# is pulled to TTL low, the power supply should turn on the five main DC output rails: +12VDC, +5VDC, +3.3VDC, -5VDC, and -12VDC. 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.

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

Table 10: PS_ON# Signal Characteristics

	Min.	Max.
V_{IL}, Input Low Voltage	0.0 V	0.8 V
I_{IL}, Input Low Current, Vin = 0.4 V		-1.6 mA
V_{IH}, Input High Voltage, Iin = -200 µA	2.0 V	
V_{IH} open circuit, Iin = 0		5.25 V

3.4.3 +5VSB

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

The +5VSB output should be capable of delivering a minimum of 720 mA at +5 V ±5% to external circuits. Because trends indicate a growing demand for standby power, it is recommended that a family of designs be created to supply 720 mA, 1.0 A, or 1.5 A to meet various customer requirements. Overcurrent 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.

3.4.4 Power-on Time

The power-on time is defined as the time from when PS_ON# is pulled low to when the +5VDC and +3.3VDC outputs are within the regulation ranges specified in Section 3.2.1. The power-on time shall be less than 500 ms.

+5VSB shall have a power-on time of 2 seconds maximum after application of valid AC voltages.

3.4.5 Risetime

The output voltages shall rise from <10% of nominal to within the regulation ranges specified in Section 3.2.1 within 0.1 ms to 20 ms (0.1 ms $\leq T_2 \leq$ 20 ms).

3.4.6 Overshoot at Turn-on/Turn-off

The output voltage overshoot upon the application or removal of the input voltage, or the assertion/deassertion of PS_ON#, under the conditions specified in Section 3.1, shall be less than 10% above the nominal voltage. There must be a smooth and continuous ramp of each DC output voltage from 10% to 90% of its final set point within the regulation band, while loaded as specified in Section 3.3. The smooth turn-on requires that during the 10% to 90% portion of the rise time, the slope of the turn-on waveform must be positive and have a value of between 0 V/ms and [Vout,nominal] V / 0.1 ms. Also, for any 5 ms segment of the 10% to 90% rise-time waveform, a straight line drawn between the end points of the waveform segment must have a slope ≥ [Vout,nominal] V / 20 ms. No voltage of opposite polarity shall be present on any output during turn-on or turn-off.

3.4.7 Reset after Shutdown

If the power supply latches into a shutdown state due to fault condition on its outputs, the power supply shall return to normal operation only after the fault has been removed and the PS_ON# (or AC input) has been cycled OFF/ON with a minimum OFF time of 1 second.

3.4.8 +5VSB at AC Power Down

After AC power is removed, the +5VSB standby voltage output should remain at its steady state value for the minimum holdup time specified in Section 3.3.8 until it begins to decrease in voltage. The decrease shall be monotonic in nature, dropping to 0.0 V. There shall be no other perturbations of this voltage at or following removal of AC power.

3.5 Output Protection

3.5.1 Overvoltage Protection

The overvoltage 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 overvoltage condition on any or all outputs. The supply shall provide latch-mode overvoltage protection as defined below.

Table 11: Overvoltage Protection

Output	Min.	Nom.	Max.	Unit
+12VDC	-	-	15.6	Volts
+5VDC	5.74	6.3	7.0	Volts
+3.3VDC	3.76	4.2	4.3	Volts

3.5.2 Short Circuit Protection

An output short circuit is defined as any output impedance of less than 0.1 ohms. The power supply shall shut down and latch off for shorting the +3.3VDC, +5VDC, or +12VDC rails to return or any other rail. 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. The +5VSB must be capable of being shorted indefinitely, but when the short is removed, the power supply shall recover automatically or by cycling the PS_ON#. The power supply shall be capable of withstanding a continuous short-circuit to the output without damage or overstress to the unit (components, PCB traces, connectors, etc.) under the input conditions specified in Section 3.1. The maximum short-circuit energy in any output shall not exceed 240 VA.

3.5.3 No Load Operation

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 Overcurrent Protection

Overload currents applied to each tested output rail will cause the output to trip before reaching or exceeding 240 VA. For testing purposes, the overload currents should be ramped at a minimum rate of 10 A/s starting from full load.

3.5.5 Output Bypass

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

4. Mechanical Requirements

4.1 Labeling / Marking

Each supply shall be marked with the following, at minimum:

- Access warning text ("Do not remove this cover. Trained service personnel only. No user serviceable components inside.") in English, German, Spanish, French, Chinese, and Japanese with universal warning markings.
- Manufacturer information: manufacturer's name, part number, and lot date code in human-readable text format, etc.
- Nominal AC input operating voltages (100-127 VAC and 200-240 VAC) and current rating certified by all agencies specified in Section 8.
- DC output voltages and current ratings.

4.2 Physical Dimensions

The supply shall be enclosed and meet the physical outline shown in either Figure 2 or 3, as applicable.

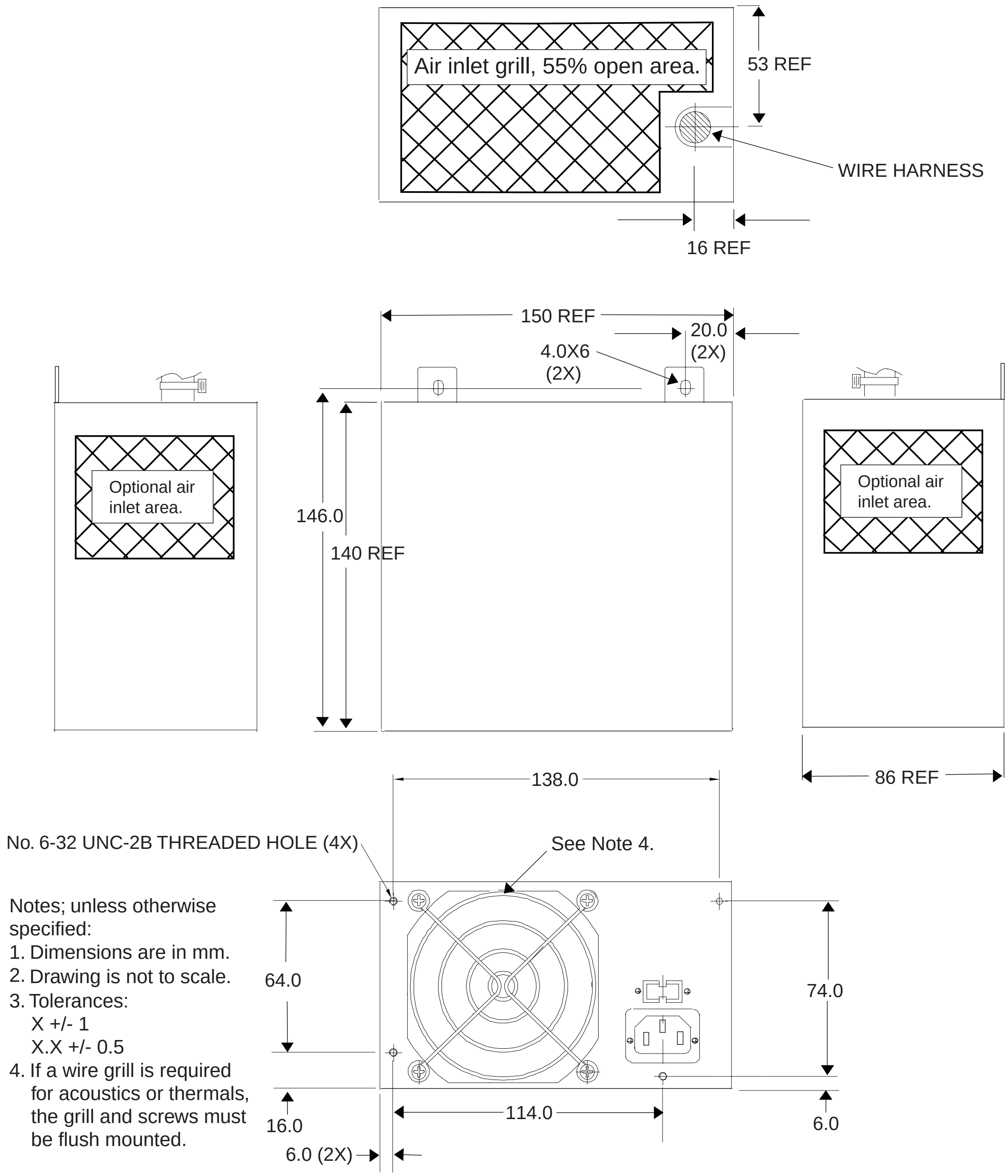

Figure 2: Power Supply Dimensions for Chassis in Which the P/S Does Not Cool Processor

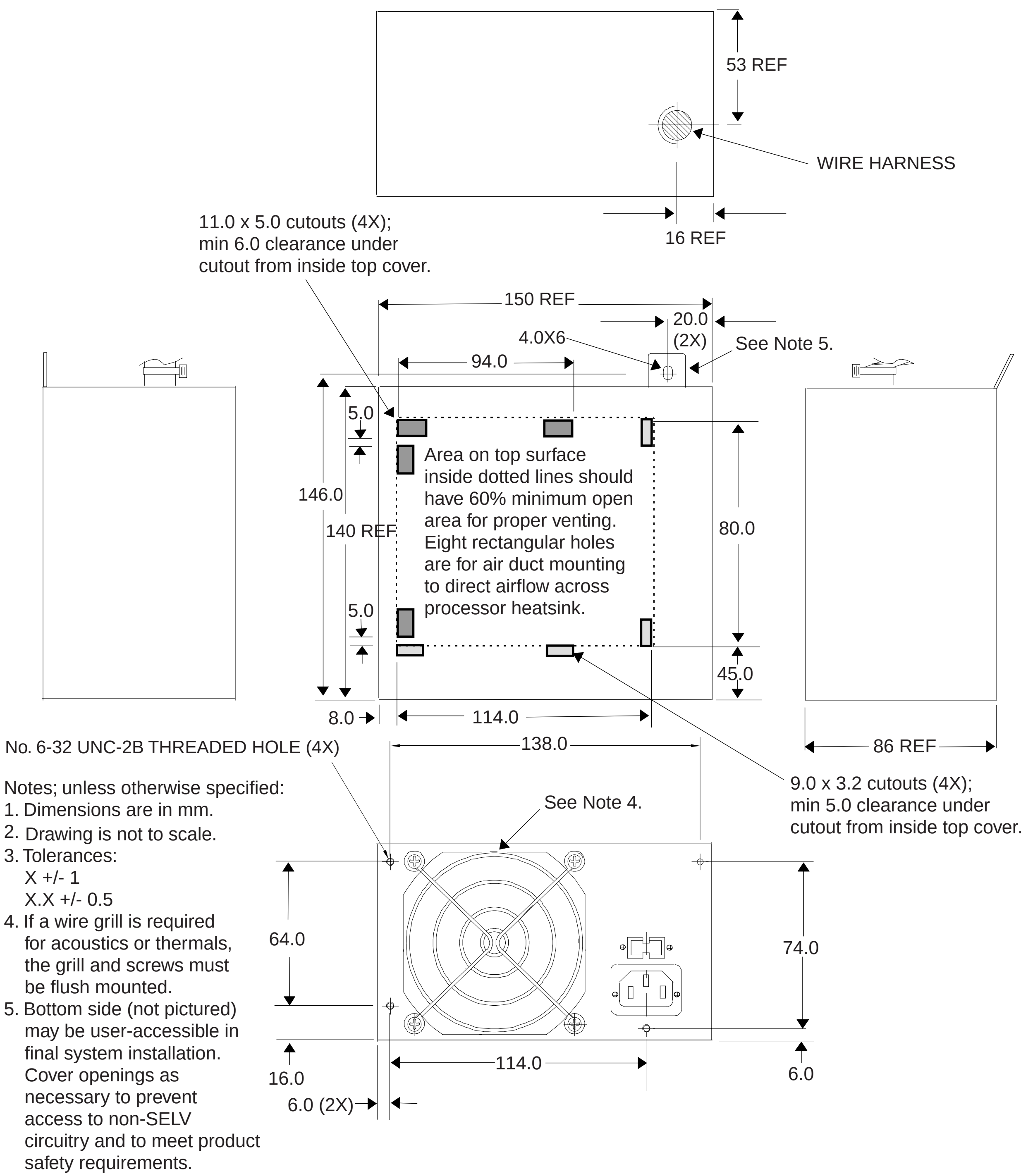

Figure 3: Power Supply Dimensions for Chassis in Which the P/S Cools the Processor

4.3 Airflow / Fan

In general, exhausting warm air from the chassis enclosure via a power supply fan at the rear panel is the preferred system-level airflow solution. Other solutions may be implemented, however, and some system/chassis designers may reverse this airflow to meet specific system cooling requirements. Ultimately, the choice of fan location and direction for a power supply in an ATX system must yield acceptable cooling for the power supply and all integrated chassis components.

It is suggested that an 80 mm ball bearing fan be used in conjunction with a thermally sensitive fan speed control circuit to balance system-level thermal and acoustic performance. The thermal fan speed control typically should sense the temperature of the secondary heatsink and/or incoming ambient air and adjust the fan speed as necessary to keep power supply and system component temperatures within specification. Both the power supply and system designer should be aware of the dependencies of the system and power supply temperatures on the control circuit response curve and fan size and specify them accordingly.

The intake and exhaust grills of the power supply should remain suitably free of obstruction so as not to hinder airflow or generate excessive acoustic noise (i.e. no objects within 0.5 inches of the intake or exhaust areas). The opening must be sufficiently protected to meet the safety requirements described in Section 8. For the grill pattern area relevant to a given chassis design, see Figures 2 and 3. A flush mount wire fan grill can be used instead of a stamped metal grill to maximize airflow and minimize acoustic noise.

4.4 AC Connector

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

4.5 DC Connectors

Figure 4 shows pinouts and profiles for typical ATX power supply DC harness connectors.

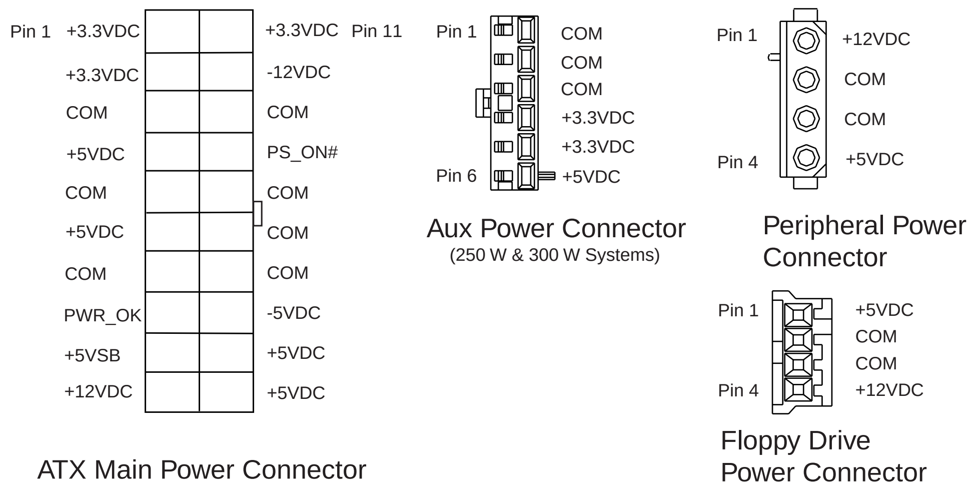

Figure 4: ATX Power Supply Connectors
(Pin-side view, not to scale)

Listed or recognized component appliance wiring material (AVLV2), CN, rated min 85 °C, 300 VDC shall be used for all output wiring. There are no specific requirements for length or color of wiring from the power supply. The following sections suggest wire color coding that is followed by many vendors, but this color coding is NOT required.

4.5.1 ATX Main Power Connector

Connector: MOLEX 39-01-2200 or equivalent
(Mating motherboard connector is Molex 39-29-9202 or equivalent)
18 AWG is suggested for all wires except for the +3.3 V supply and sense return wires combined into pin 11 (22 AWG).
For 300 W configurations, 16 AWG is recommended for all +5VDC, +3.3VDC, and COM.

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

4.5.2 Auxiliary Power Connector (for 250 W and 300 W Configurations)

Connector: Molex 90331-0010 (keyed pin 6) or equivalent		
Pin	**Signal**	**16 AWG Wire**
1	COM	Black
2	COM	Black
3	COM	Black
4	+3.3VDC	Orange
5	+3.3VDC	Orange
6	+5VDC	Red

4.5.3 Peripheral Connector(s)

Connector: AMP 1-480424-0 or MOLEX 8981-04P or equivalent. Contacts: AMP 61314-1 or equivalent.		
Pin	**Signal**	**18 AWG Wire**
1	+12VDC	Yellow
2	COM	Black
3	COM	Black
4	+5VDC	Red

4.5.4 Floppy Drive Connector

Connector: AMP 171822-4 or equivalent		
Pin	**Signal**	**20 AWG Wire**
1	+5VDC	Red
2	COM	Black
3	COM	Black
4	+12VDC	Yellow

5. Environmental Requirements

5.1 Temperature

Operating ambient	+10 °C min +50 °C max (At full load, with a maximum rate of change of 5 °C/10 minutes, but no more than 10 °C/hr.)
Nonoperating ambient	-40 °C to +70 °C

(Maximum rate of change of 20 °C/hr.)

5.2 Thermal Shock (Shipping)

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

5.3 Humidity

Operating	To 85% relative humidity (noncondensing)
Nonoperating	To 95% relative humidity (noncondensing) Note: 95% RH is achieved with a dry bulb temperature of 55 °C and a wet bulb temperature of 54 °C.

5.4 Altitude

Operating	To 10,000 ft
Nonoperating	To 50,000 ft

5.5 Mechanical Shock

Nonoperating	50 g, trapezoidal input; velocity change ≥ 170 in/s. Three drops on each of six faces are applied to each sample.

5.6 Random Vibration

Nonoperating	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.

5.7 Acoustics

Acoustic requirements will be set by the final computer OEM system-level requirements.

6. Electromagnetic Compatibility

6.1 EMI

The power supply shall comply with CISPR 22, 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; and 100% load on each output. Tests will be performed at 100 VAC 50 Hz, 120 VAC 60 Hz, and 220 VAC 50 Hz power.

6.2 Input Line Current Harmonic Content (Optional)

If applicable to sales in Japan or Europe, the power supply shall meet the requirements of EN61000-3-2 Class D and the Guidelines for the Suppression of Harmonics in Appliances and General Use Equipment Class D for harmonic line current content at full rated power.

6.3 Magnetic Leakage Fields

A PFC choke magnetic leakage field shall not cause any interference with a high-resolution computer monitor placed next to or on top of the end use chassis. Final acceptable leakage field strength will be determined by the end system vendor during system level testing in the end use chassis.

7. Reliability

7.1 Component Derating

The following component derating guidelines shall be followed:

- Semiconductor junction temperatures shall not exceed 110 °C with an ambient of 50 °C. Any exceptions are subject to final approval.
- Inductor case temperature shall not exceed safety agency requirements.
- Capacitor case temperature shall not exceed 95% of rated temperature.
- Resistor wattage derating shall be > 30%.
- Component voltage and current derating shall be > 10% at 50 °C. Any exceptions are subject to final approval.
- Magnetic saturation of any transformer will not be allowed under any line, load, startup, or transient condition including 100% transients on the five main outputs or +5VSB.

7.2 Mean Time Between Failures (MTBF)

The MTBF of the power supply shall be calculated utilizing the Part-Stress Analysis method of MIL-HDBK-217F using the quality factors listed in MIL-HDBK-217F. The calculated MTBF of the power supply shall be greater than 100,000 hours under the following conditions:

- Full rated load
- 120 VAC input
- Ground benign
- 25 °C ambient.

The calculated MTBF of the power supply shall be greater than 30,000 hours under the following conditions:

- Full rated load
- 120 VAC input
- Ground benign
- 50 °C ambient.

8. Safety Requirements

8.1 North America

The power supply must be certified by UL or CSA for use in the USA and Canada under the following conditions:

- The supply must be Recognized for use in Information Technology Equipment including Electrical Business Equipment per UL 1950, 3rd edition, without D3 deviations and CAN/CSA C22.2 no. 950-95. The certification must include external enclosure testing for the AC receptacle side of the power supply (see Figures 2 and 3).
- The supply must have a full complement of tests conducted as part of the certification, such as input current, leakage current, hipot, temperature, energy discharge test, transformer output characterization test (open circuit voltage, short circuit current and maximum VA output), 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 UL 1950, 3rd edition.

The supplier must supply the complete certification report including a test record. Production hipot 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 derating. 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.

A list of the minimum temperature ratings of all AC mains connected components and the printed wiring board(s) shall be provided. The power supply must be evaluated for operator-accessible secondary outputs (reinforced insulation) that meet the requirements for SELV and do not exceed 240 VA under any condition of loading.

The proper polarity between the AC input receptacle and any printed wiring boards connections must be maintained (i.e., brown=line, blue=neutral, green=earth/chassis).

Failure of any single component in the fan speed control circuit shall not cause the internal component temperatures to exceed the abnormal fault condition temperatures per IEC 950.

8.2 International

The vendor must provide a complete CB certificate and test report to IEC 950, 2nd edition + A1, A2, A3, and A4. The CB report must include ALL CB member country national deviations. CB report must include evaluation to EN60 950, + A1, A2, A3, A4 and EMKO-TSE (74-SEC) 207/94.

All evaluations and certifications must be for reinforced insulation between primary and secondary circuits.

It is highly recommended that the CB report be issued by NEMKO.

8.3 Proscribed Materials

Cadmium should not be used in painting or plating.

No quaternary salt electrolytic capacitors shall be used.