ATX specification

December 1996

Release 2.0

New features and additional requirements of Release 2.0 of the ATX specification

Please Note
Release 2.0 of the ATX Specification incorporates a number of new features, additional requirements, and clarifications, as noted below. These changes take into account support for the next generation of ATX motherboards, while maintaining compatibility with the first generation. Readers should examine their combination of motherboard, power supply and chassis needs to determine whether they require the additional features found in Release 2.0 of the ATX Specification.

Changes from Release 1.1 to Release 2.0 of the ATX Specification

- Section 3.2 – The optional mounting hole has been changed to a required hole in chassis implementations. A previously required mounting hole has been changed to “not needed”.
- Section 3.3.5 – Added information and drawing to clarify I/O aperture requirements. Added corner radius information to the specification for clarity
- Section 3.4 – Height restrictions have been changed to facilitate future processor and onboard technologies.
- Section 4 – An explanation of the intent regarding the direction of air travel for cooling. The external fan shown on the drawing of a suggested ATX power supply has been removed. A caution has been added regarding external power supply fans. Comments and drawings for duct mounting have been added.
- Section 4.2 – Explanations added for PS-ON, PW-OK, 5Vsb power supply lines. The 3.3 VDC power rail and soft-power control signals are being changed to required.
- Section 4.3 – Added optional power connector for fan control, fan monitor, IEEE-1394 voltages, and remote 3.3 volt sensing.
- Section 4.4 – A section has been added to give a suggested color coding for power supply wiring.
- Section 4.5 – A section has been added suggesting a venting solution for power supplies.
- Section 5 – Chassis considerations have been added.
- Tables have been added throughout the specification for clarification and easy reference of recommended and required features.

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Revision 2.0, December 1996

Contents

1. Executive Summary

ATX was developed as an evolution of the Baby-AT form-factor and was defined to address four major areas of improvement: enhanced ease-of-use, better support for current and future I/O, better support for current and future processor technology, and reduced total system cost.

ATX combines the best functionality from the form factors that dominated the computer industry in the early 1990's: the high integration of LPX and the expandability of Baby-AT. The ATX form factor is essentially a Baby AT motherboard rotated 90 degrees within the chassis enclosure and providing a new mounting configuration for the power supply. The processor is relocated away from the expansion slots, allowing them all to hold full length add-in cards. The longer side of the board is used to host more on-board I/O.

A change to the system form-factor is ultimately of little benefit if it doesn't reduce overall system cost. ATX has achieved this in a number of ways. By allowing for integrating more I/O down onto the board and better positioning of the hard drive and floppy connectors (which allows the use of shorter cables), material cost of cables and add-in cards is reduced. By reducing the number of cables in the system, manufacturing time and inventory holding costs are also reduced. Another benefit of integrated I/O down is the potential for lower EMI emissions with the removal of serial and parallel cables that can act like antennas. Video-playback enhanced graphics and audio, the main hardware building blocks to support multimedia, are now becoming a standard on many PCs. At the entry level, these features are quickly becoming a commodity, and so to reduce cost in a highly dollar sensitive market segment, it makes sense to migrate these features down to the motherboard itself. Finally, by using a power supply that is specially optimized for ATX, it is possible to reduce cooling costs and lower acoustical noise. An ATX power supply, which has a side venting, allows direct cooling of the processor and add-in cards, making a secondary fan or active heatsink unnecessary in most system applications.

Feature	Benefit
Double height flexible I/O panel allows higher integration	• Lower system cost • Fewer cables • Improved reliability • Shorter assembly time • Support for future connectivity and I/O standards like USB, TV in/out, ISDN, etc. • Integrated graphics allows use of unified frame buffer architecture
Relocated drive I/O means shorter cables	• Reduced cost • Support for faster drives such as PIO Mode 4/5 IDE drives
System cooled by single fan in the power supply	• Reduced cost • More ergonomic (Reduced noise) • Improved reliability
Relocated processor and memory	• All full length expansion slots • Ease of use, upgrading the processor • Ease of use, upgrading memory • Ease of use, adding cards • Relocated processor allows easier use of bulk capacitance and voltage regulation circuitry

Table 1: ATX Feature Summary

The ATX specification is written as an open specification for the industry, designed to add value to PC architecture.

2. ATX form-factor overview

The ATX form-factor improves upon Baby AT and LPX in a number of ways. Because the power supply orientation and specification are modified, and the Baby AT motherboard is rotated through 90 degrees, the processor can be relocated away from the expansion slots, and the longer side of the board can be used to host more on-board I/O. The ATX power supply, rather than blowing air out of the chassis, as in most Baby AT platforms, provides airflow through the chassis and across the processor.

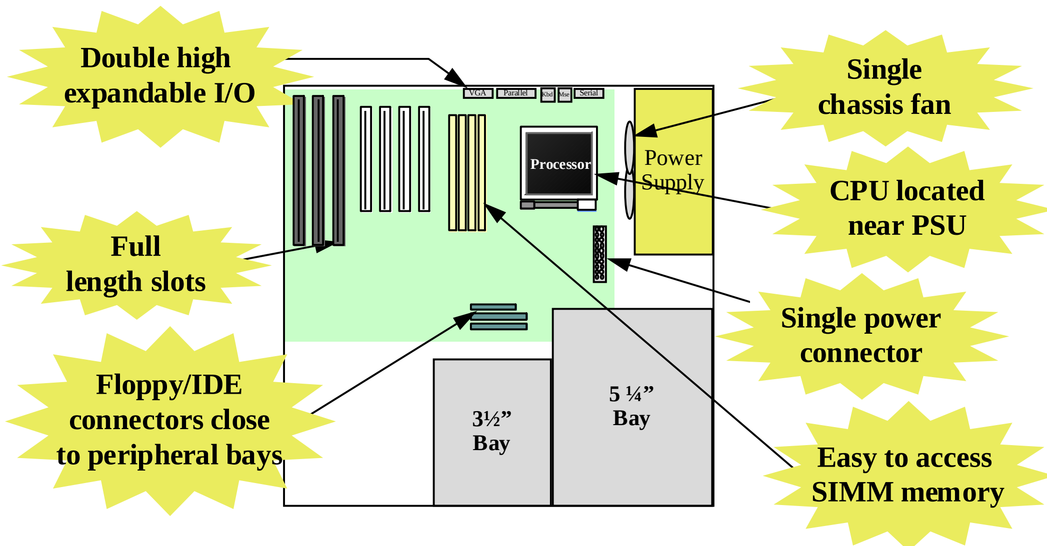

Figure 1: Summary of ATX chassis features

2.1 Improving the end-user experience

By simply rotating the board through 90 degrees within the chassis, the end-user gains a great deal in ease-of-use and improved functionality.

1. With the processor relocated, all expansion slots can be full-length.
2. Since the processor is not located between or under the add-in cards, a processor upgrade can now be performed without removing the installed cards.
3. The SIMM connectors can be relocated away from the expansion bays and slots, increasing ease-of-use by giving easy access to the user for memory upgrades, and increasing the total number of available full length slots.
4. The use of only a single fan within the system can reduce acoustic levels.
5. More I/O is integrated onto the motherboard, improving reliability and reducing the number of cables.
6. Disk I/O connectors are located closer to the peripheral bays, reducing cable lengths. This reduces the clutter in the chassis and allows the use of faster hard disk drives.
7. With increased ease of use, and a reduction in cable complexity, the technical support burden is lowered.

2.2 Benefits to manufacturers

As well as improving functionality, the ATX form-factor also reduces total system cost. This is achieved by moving more I/O onto the motherboard and reducing the number of fans and cables within the system, cutting material and installation cost. The mounting hole positions for the ATX form-factor motherboard were carefully chosen to be backward compatible with previous form-factor generations. Where possible, ATX utilizes the same mounting holes as Baby AT and full AT, simplifying the design of multi-purpose chassis. Full details can be found in section 3.2.

Another benefit is the potential for reduced EMI emissions through the use of integrated I/O connectors on the motherboard. Baby AT designs require that the parallel and serial I/O off the motherboard be cabled up to connectors on the chassis back-panel. These cables, not required on ATX motherboards, may act as antennas that pick up and radiate unwanted EMI in Baby AT designs.

2.3 Mini-ATX : a future avenue for cost reduction

ATX has been designed with headroom for the future. An ATX board measures 12” x 9.6” (305mm x 244mm). This board size allows a manufacturer to cut two boards out of every 24” x 18” (660mm x 457mm) panel. To optimize the panel utilization at the printed circuit board manufacturer a smaller ATX form-factor, Mini-ATX, may be implemented that allows manufacturers to achieve four printed circuit boards per panel. Board size could be reduced from 12” x 9.6” (305mm x 244mm) to a Mini-ATX size of 11.2” x 8.2” (284mm x 208mm). This would reduce the cost of the printed circuit board by approximately 30%. To standardize the inevitable migration towards this cost-reduced future form-factor, Mini-ATX is fully defined in this specification alongside full ATX.

3. Layout

The following section describes the mechanical specification of the ATX form-factor motherboard, including physical size, mounting hole placement, connector placement and component height constraints. Where appropriate, details of Mini-ATX are also included. This will enable chassis manufacturers to plan ahead now for this future development.

3.1 Board size

The maximum allowable width for the ATX board is 12 inches (305mm), the same width as a full AT board. This allows many existing AT form-factor chassis to accept Baby AT, Full AT, ATX, or Mini-ATX form-factor boards with a minimum number of changes. A full size ATX board is 12 inches wide by 9.6 inches deep (305mm x 244mm). The size of a Mini-ATX is 11.2” x 8.2” (284mm x 208mm).

3.2 Mounting hole placement

Feature	Status	Comment
Motherboard mounting locations	Required	See Figure 2 (all ATX board mounting locations shown should be implemented for full ATX 2.0 compliance)

Where possible, the ATX mounting holes line up with mounting holes used for Full AT and Baby AT boards. As shown in Figure 2, three new holes have been defined and added along the front edge of a full size ATX board to provide mechanical support. For the exact location of the mounting holes, refer to Figure 3.

All ATX board mounting locations shown in Figure 2 should be implemented for chassis assemblies and motherboards to achieve full ATX 2.0 compliance and provide proper support for the board in these areas.

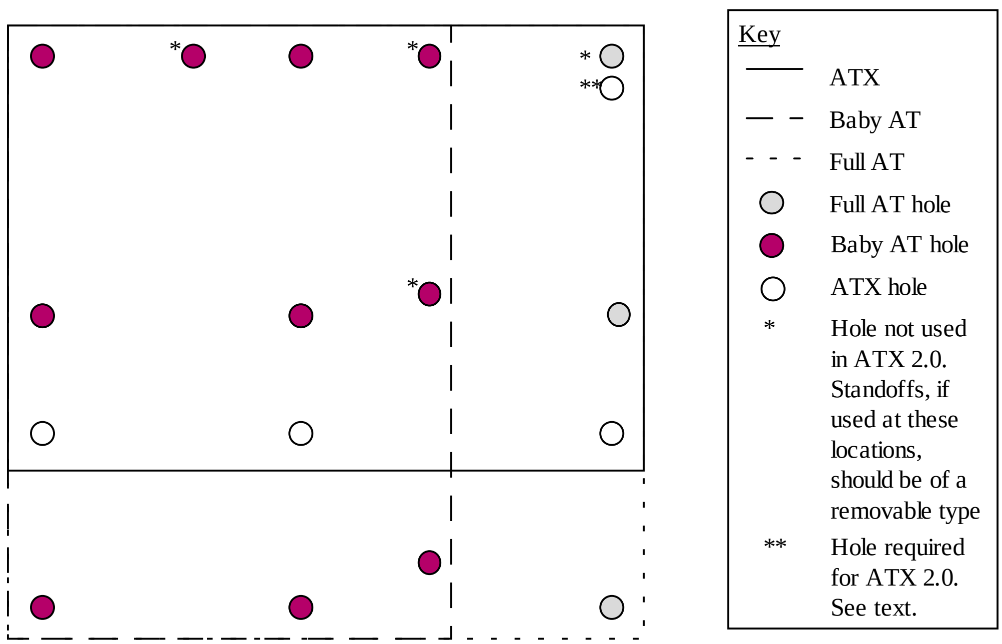

Figure 2: ATX, Baby AT and Full AT form-factor mounting holes

The two holes located on the right edge of the Baby AT board are not supported in the ATX form-factor (as shown in Figure 2). Mechanical support is not required in that location on ATX, and its presence would present unwanted difficulty in placement and routing of an ATX board. Note that one of the previously required mounting locations along the rear edge of the board is no longer required. If it is desired to implement a board mount in this area, it should be accommodated with a removable standoff to avoid problems with boards that do not use this mounting location.

The hole located in the upper right corner of the ATX board, previously labeled as an optional mounting hole in the ATX 1.1 specification, **must** be implemented in all ATX 2.0 compliant chassis assemblies to accommodate boards requiring this mounting hole. It should be noted that changing this mounting location from optional to required may not accommodate all ATX 1.0 and 1.1 compliant motherboards. To accommodate these motherboards, a removable standoff may be used. All ATX 2.0 compliant motherboards should implement this mounting location, or allow for a standoff in this area by implementing a component and trace keepout.

3.3 Connector placement

Feature	Status	Comment
PCI and ISA Connector locations	Required	See Figure 3
Power input connector location	Recommended	Right edge of board, near processor
Power input connector pinout	Required	See Figure 11
Optional Power connector pinout	Recommended	See Figure 13
Disk I/O connector location	Recommended	Front edge of board, near drive bays
Front panel I/O connector locations	Recommended	Front edge of board, right of expansion slots
Back panel I/O panel size and location	Required	See Section 3.3.5 and Figure 4
Back panel I/O connector arrangement	Optional	See Figures 5 and 6 for examples
Memory module connector location	Recommended	Between processor and expansion slots, or between processor and disk I/O connectors
Processor location	Recommended	Right of expansion slots, front of back panel I/O connectors

The location of the PCI and ISA connectors as well as the allowable placement area for I/O connectors on the back panel are clearly defined in Figure 3. The specification provides recommendations, but the exact locations of other connectors are left to the judgment of the motherboard designer working in conjunction with the system integrator.

3.3.1 Expansion slots

The ATX form-factor supports up to seven expansion slots. These slots may be any combination of ISA, PCI or shared ISA/PCI. Figure 3 shows a typical combination of the three ISA slots, three PCI slots and one shared ISA/PCI slot. The location of pin 1 is defined for each of the connectors. If a combination other than that shown in Figure 3 is desired, motherboard designers should extrapolate the location of pin one on each of the connectors. The slot spacing must remain constant. To allow all add-in cards to be full length, it is recommended that the height of any board component located to the left of the right edge of the seventh slot (plus clearance for the board components) is less than 0.6 inches (15.2mm). Further details on component height constraints can be found in section 3.4. It is suggested that mechanical support be implemented under expansion slots for extra support during add-in card insertion by use of a device such as a bumper.

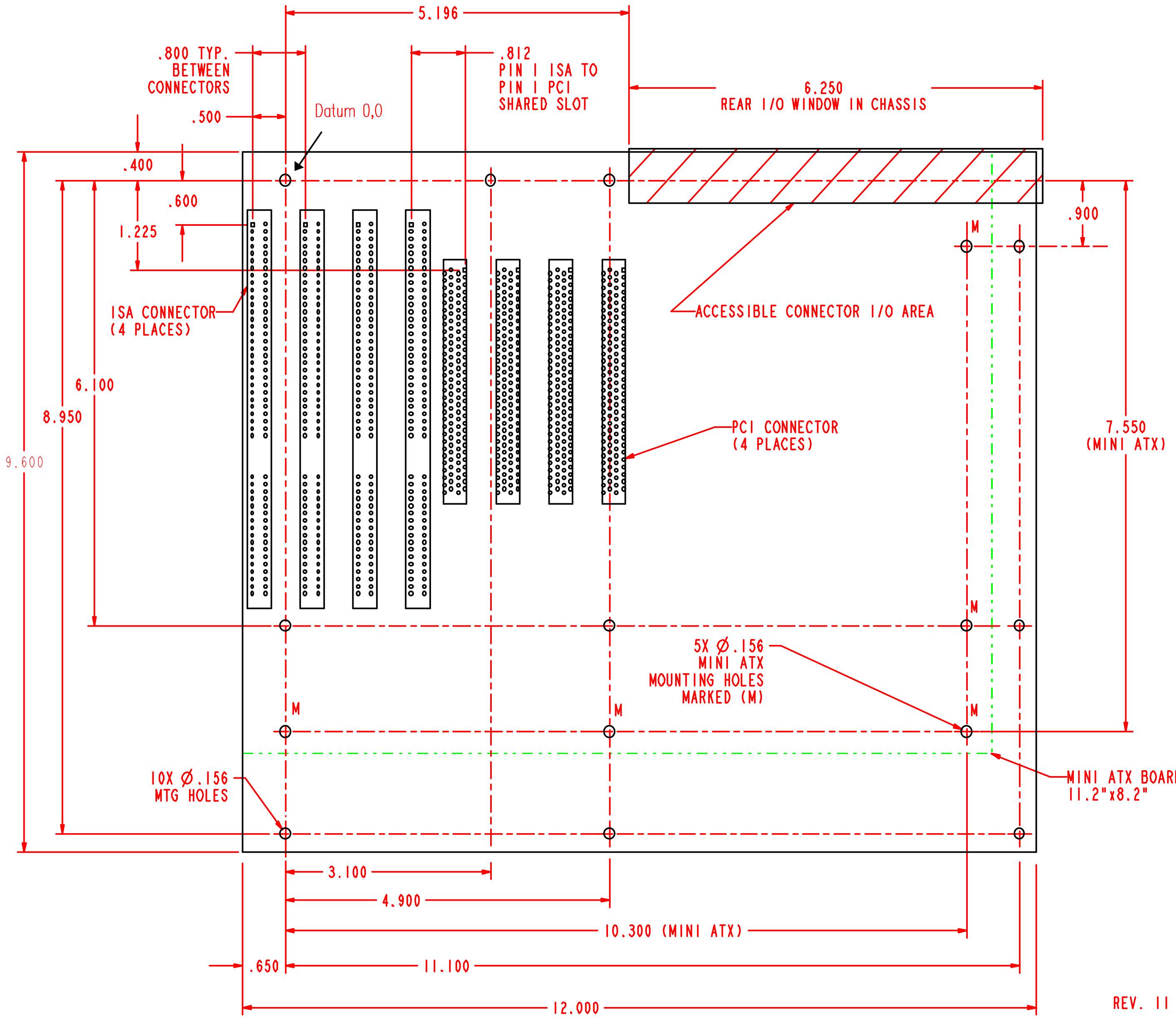

Figure 3: Sample ATX/Mini-ATX layout diagram
(all dimensions shown in inches)

3.3.2 Power input

Two power supply trends are driving change in the board power input connectors. First, to support future processor technologies and the expected transition to 3.3V PCI add-in cards, a 3.3V output is required directly from the power supply. Second, with the introduction of new operating systems, such as Microsoft* Windows* 95, that support the ability to power down the system from software, a soft-power connector will increasingly become a requirement. These two changes imply that two more connectors are required (3.3V and soft-power) in addition to the two already used on power supplies today. To reduce both material and manufacturing costs, ATX combines all four of these into a single 20-pin connector interface to the power supply which incorporates standard ±5V, ±12V, 3.3V and soft-power signals. Use of this connector will reduce production costs by cutting installation time and connection error rate. The connector is described in section 4.

The exact location of the power connector is not specified. It is recommended that it be placed along the right edge of the board considering the location of the processor, core logic and clearance for the peripheral bays. Locating the power connector near the processor will help to ensure clean power.

3.3.3 Disk I/O

The exact locations of the floppy, IDE and/or SCSI I/O connectors are not specified. It is recommended that they be placed along the front edge of the board to the right of the expansion slots. When placing connectors, the designer should keep in mind that proper clearance must be provided for the chassis peripheral bays.

3.3.4 Front panel I/O

The exact location of the front panel I/O connector is not specified. It is recommended that it be placed along the front edge of the board to the right of the expansion slots. When placing the connector, the designer should keep in mind that proper clearance must be provided for the chassis peripheral bays. Locating the front panel I/O connector along the left edge of the board is not recommended due to limited clearance with a full length add-in card. Locating it along the front edge of the board under the expansion slots using a right angle header may be acceptable provided clearance for the add-in cards and mechanical retention of the mating connector are properly accounted for.

3.3.5 Back panel I/O

With the PC platform evolving so fast, it makes sense to retain the greatest level of flexibility possible for external I/O. The multimedia explosion has demonstrated how user needs for enhanced I/O can change quickly over time. With technologies such as Universal Serial Bus and IEEE-1394 likely to quickly become standard features on PC platforms, it makes sense to retain flexibility for the future. Toward the rear of the chassis, ATX defines a stacked I/O area that is 6.25 inches (158.75mm) wide by 1.75 inches (44.45mm) tall. This area allows the use of stacked connectors on the motherboard to maximize the amount of I/O space available. As shown in Figure 5, the bottom of the back panel opening is located 0.15 inches (3.81mm) below the top of the motherboard. In addition, a 0.2” (5.08mm) keepout zone has been defined around the outside edge of the cutout area. This required keepout zone provides a reserved space that can be used to clip a chassis independent I/O shield to the chassis back-panel. If a chassis violates the keepout zone, it loses the opportunity to support an I/O shield that can be designed to fit all ATX chassis that meet the following specifications, as detailed in Figure 4.

- Cutout Size = 6.25” (158.75mm) by 1.75” (44.45mm).
- Distance from top of motherboard to bottom of I/O cutout hole = 0.15” (3.81mm).
- Allowable thickness of a chassis back panel that the I/O shield can clip into is in the range 0.037” (0.94mm) to 0.052” (1.32mm).
- The face of all I/O connectors overhang the board edge by 0.045” (1.14mm).
- The corners of the I/O aperture can be rounded to a maximum radius of .039” (0.99mm). This allowable rounding of the corners helps case manufacturers extend the life of their hard tooling while still complying with the specification.
- The keepout zone around the I/O aperture area is required in an ATX 2.0 compliant chassis. This allows ATX 2.0 compliant I/O shields to fit into ATX 2.0 compliant cases. The keepout area is needed for the shield attachment points. The keepout surrounds the I/O aperture and is 0.2” (5.08mm). See Figure 5 for details of this keepout.

- The I/O aperture should be a simple cutout of the chassis back panel. Recessing the I/O aperture will prevent the case from accepting ATX 2.0 compliant I/O shields.

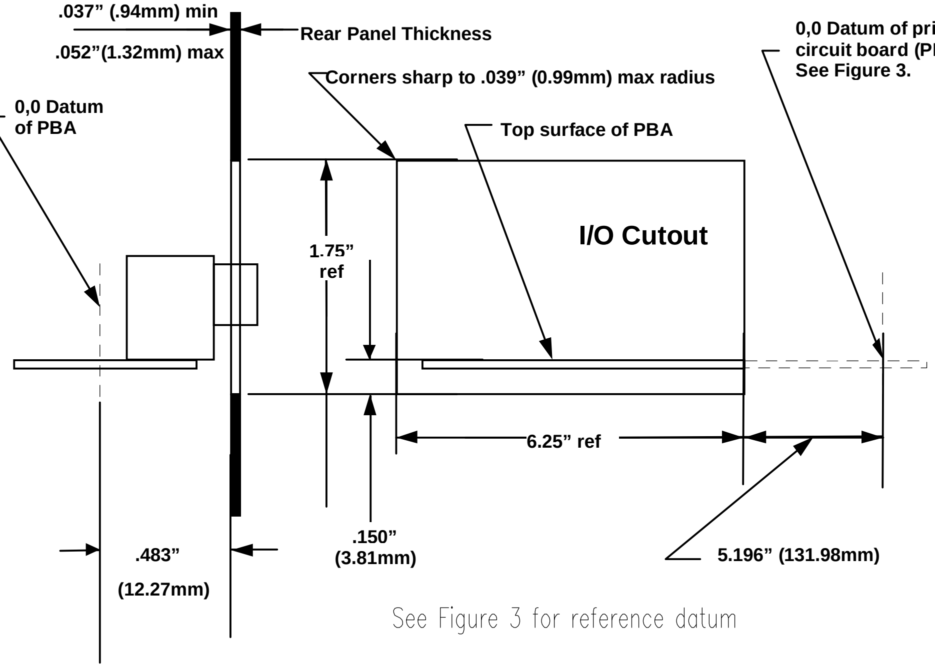

Figure 4: Detailed front and side view for I/O aperture

To retain maximum flexibility, the exact positioning of connectors within the I/O shield is left to the discretion of the motherboard designer (working in conjunction with the system integrator). Two example I/O panel configurations are shown in Figure 5 and Figure 6.

Figure 5 shows an example implementation for a standard I/O back panel, featuring a serial port, PS/2 mouse port, PS/2 keyboard port, parallel port, and secondary serial port. This configuration would be suitable for high-end boards requiring graphics and audio flexibility.

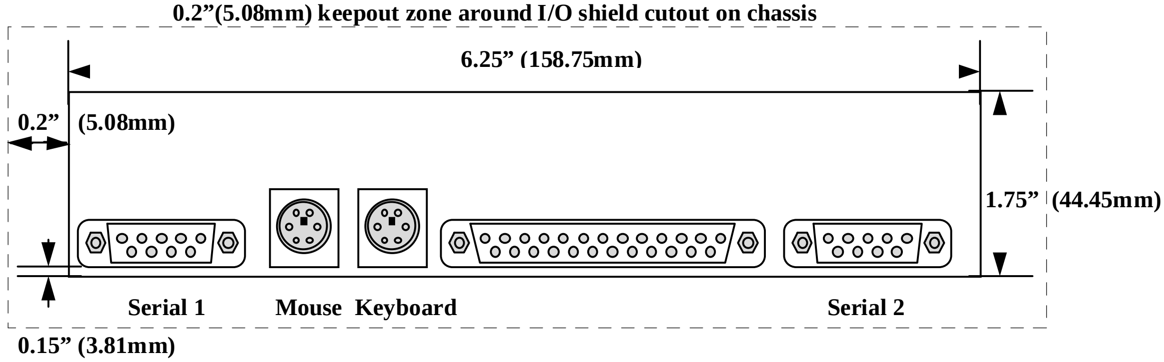

Figure 5: Example standard I/O back panel, no video, no audio

The example multimedia I/O panel shown in Figure 6 is a superset of the standard I/O panel. To position the VGA connector close to the probable location of the on-board graphics controller, the VGA connector replaces the second serial connector. Because the ATX form-factor board is fitted with a PS/2 style mouse connector, the need for a second serial port (for use with a serial mouse) is reduced. Some manufacturers may therefore wish to ship ATX form-factor products with only one serial port. For those manufacturers still requiring two serial ports on systems, a multimedia I/O panel could accommodate a second serial port directly above the first with a stacked connector.

Figure 6 shows the example multimedia I/O panel, featuring stacked serial ports, stacked keyboard and mouse, stacked audio jacks and midi port, and parallel port and VGA connector. LAN, modem, or ISDN connectors could be added if the manufacturer desired.

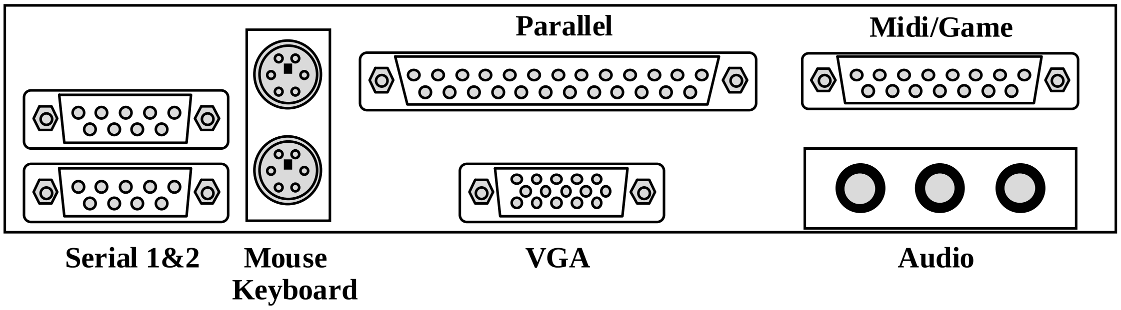

Figure 6: Example multimedia I/O back panel

This layout is only an example—the ATX form factor allows complete flexibility in the layout of rear panel I/O. Motherboard and chassis vendors should work together to agree on their own preferred layouts.

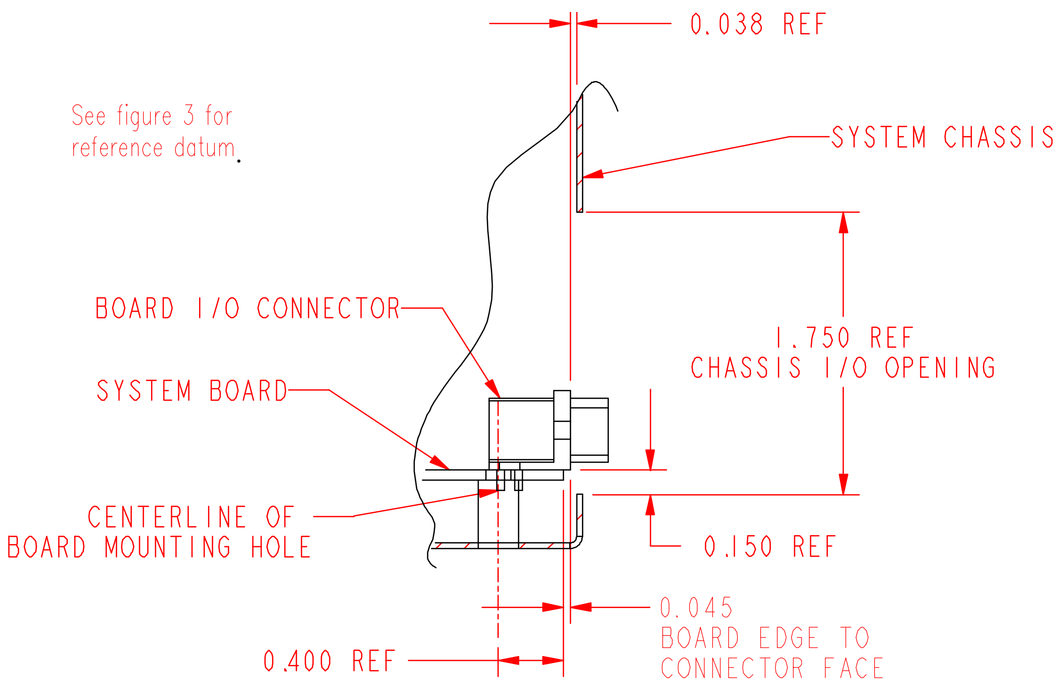

Figure 7: Detail side view of I/O connector placement in I/O back panel

(all dimensions shown in inches)

3.3.6 Memory sockets

The exact location of the memory sockets, whether they are SIMM, DIMM, or some other type of connector, is not rigidly specified. Ideally, the sockets should be located to the right of the seventh expansion slot and far enough toward the back edge of the board to clear the chassis peripheral bays. This will enable easy upgrade by the end user. Their exact location will be dictated by the processor and core logic placement requirements. Two of the most likely locations are

a) placed rear to front between the processor and the seventh expansion slot, or

b) placed left to right between the processor and the front edge of the board.

3.3.7 Processor

The exact location of the processor is not specified. It is recommended that it be located behind the external I/O connectors and to the right of the seventh expansion slot, such that it receives sufficient cooling. It may be cooled from either the fan located in the power supply, an active heat sink (fan attached to the processor) or normal airflow through the chassis. The exact method will depend on the specific processor cooling requirements.

3.4 Height constraints

Feature	Status	Comment
ATX Motherboard maximum component heights	Required	See Figure 8.
ATX chassis keepout in Area A	Required	3.0 inches. See Figure 8.
ATX chassis keepout in Area A	Recommended	3.5 inches. See Figure 8.

One of the major advantages of the ATX form factor is its accessibility and ease of expansion. Figure 8 shows the required **maximum component** height constraints for the components on the PC board. For full compliance with ATX 2.0, the motherboard should not encroach into these areas, which are reserved for ATX 2.0 compliant power supplies, standard peripherals, or chassis features. Similarly, ATX 2.0 compliant power supplies, peripherals, and chassis features should not extend into the motherboard component area.

It should be noted that all keepouts are now required for chassis implementations that are to be ATX 2.0 compliant. Of particular note is the revision in the component height restriction of area A. Motherboard components in Area A were limited to 2.20" in the ATX 1.1 specification but may extend to 2.80" high in the ATX 2.0 specification. The chassis keepout for Area A **must** be 3.0” to facilitate dynamic considerations of components in this area on the PC board. A clearance of 3.5” is **preferred** above the motherboard in area A to facilitate cooling solutions that require ducting. The bottom right corner of the board is the most constrained because of the presence of 5.25” and 3.5” peripherals in some chassis configurations. Careful placement of peripherals, power supply, and chassis features will be required to maintain strict compliance to the ATX 2.0 specification.

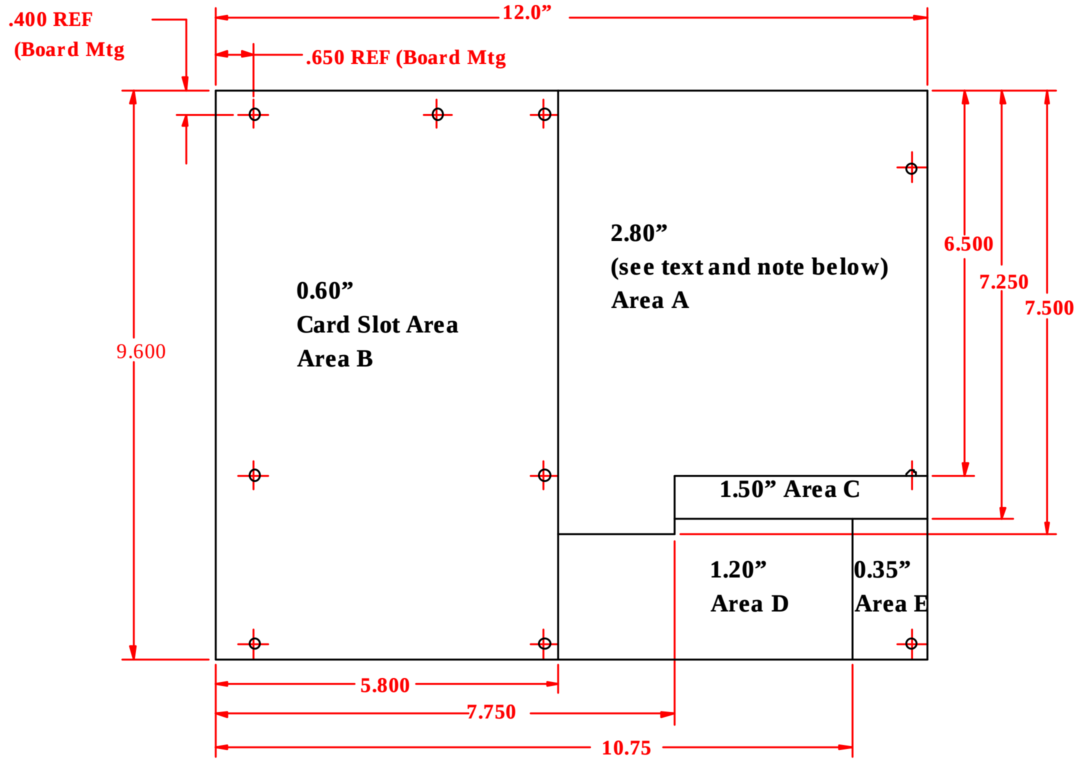

Figure 8: ATX motherboard maximum component height restrictions
(all dimensions in inches)

Note: The 2.80” height restriction in area A applies to the PC board component height. The required clearance for the chassis in this area is 3.0”. The difference in these heights is related to the need to accommodate dynamic excursion considerations for shipping. A clearance of 3.5” is recommended to facilitate alternative processor cooling solutions

4. ATX Power Supply

Feature	Status	Comment
ATX power supply overall dimensions	Required	See Figure 9.
ATX power supply cable lengths	Recommended	See Figure 16.
ATX power supply airflow	Recommended	23 CFM minimum at outlet, minimum.
ATX power supply ducting attachment features	Recommended	See Figure 10.

The intended location and fan direction in an ATX system is for the power supply fan to draw in cool air from outside the chassis and exhaust it directly onto the processor. In this configuration, cooling of the processor without the need of an active fan heatsink (heatsink with small fan mounted on top) is achievable in many cases (see Section 4.5 for a complete discussion of power supply airflow).

A standard PS/2 power supply can be modified to support an ATX form-factor system by making some modifications. These modifications include adding a 3.3V supply rail, PS_ON, 5Vsb, repositioning of fan venting locations to move air directly across the processor, and consolidating the motherboard connectors into one 20 pin header. Although pulling air through the power supply from outside the chassis and directing it onto the processor is the **preferred** airflow solution, other airflow solutions may be implemented to meet the specific cooling requirements. For example, one alternative solution would be to use a standard PS/2 power supply, modified with the 20 pin power connector, without repositioning the fan, but using an active fan heatsink to cool the microprocessor. Although ATX power supplies may use an external fan, care must be taken in implementing external fan configurations so the fan does not violate the keepout zones necessary for ATX 2.0 compliance (see Figure 8 for detailed keepout zones).

4.1 Form factor (power supply)

Required overall dimensions and the general form factor of an ATX power supply without an external fan are shown in Figure 9. Note that the previous version of the ATX 1.1 specification depicted a power supply with an external fan. See the previous section for discussion of external fans and keepout areas.

Future high performance processors also may require the power supply to accommodate special airflow ducting. Figure 10 suggests power supply attachment features that would accommodate the easy design of such ducting.

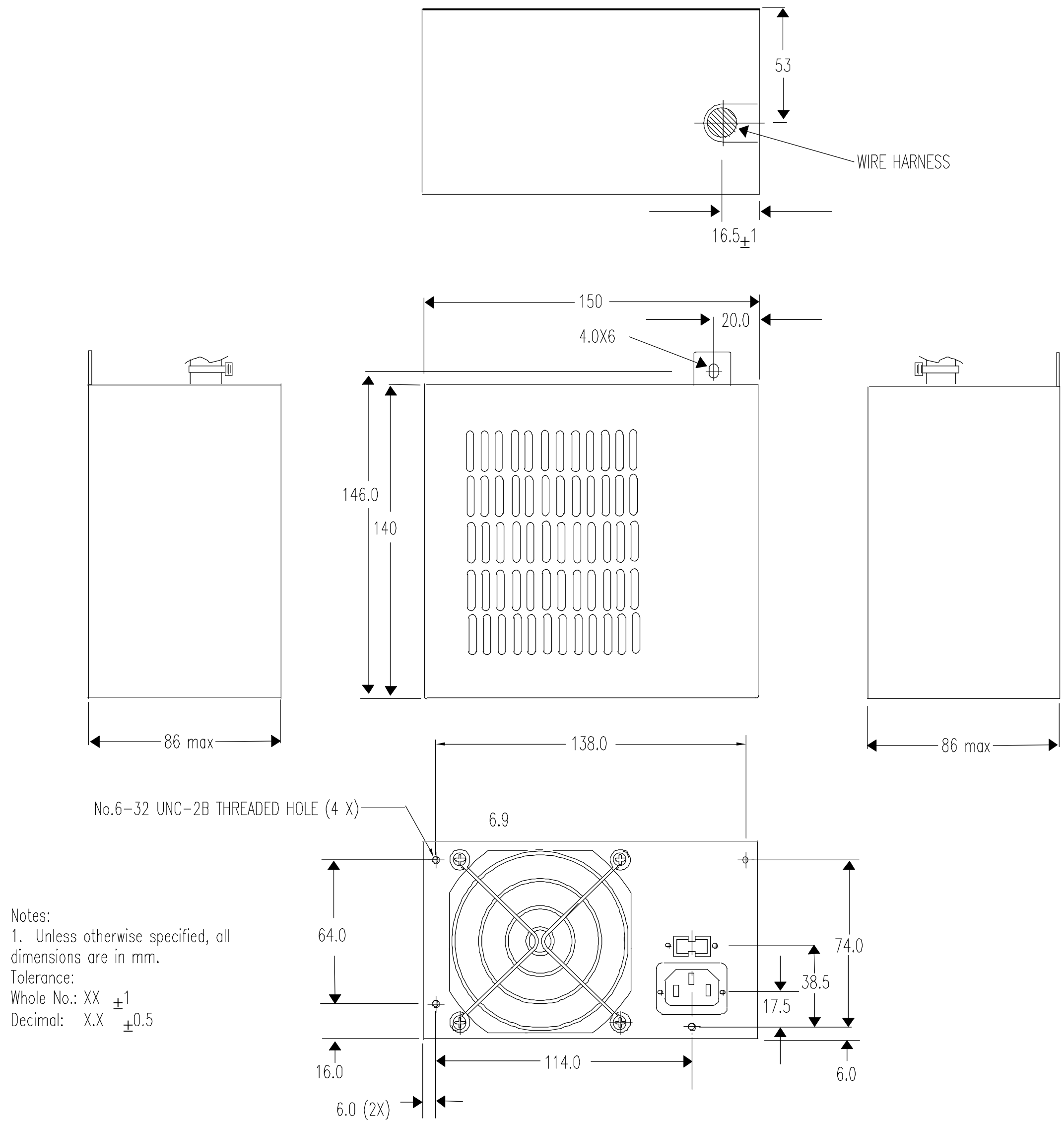

Figure 9: ATX Power supply mechanical diagram
(all dimensions in millimeters)

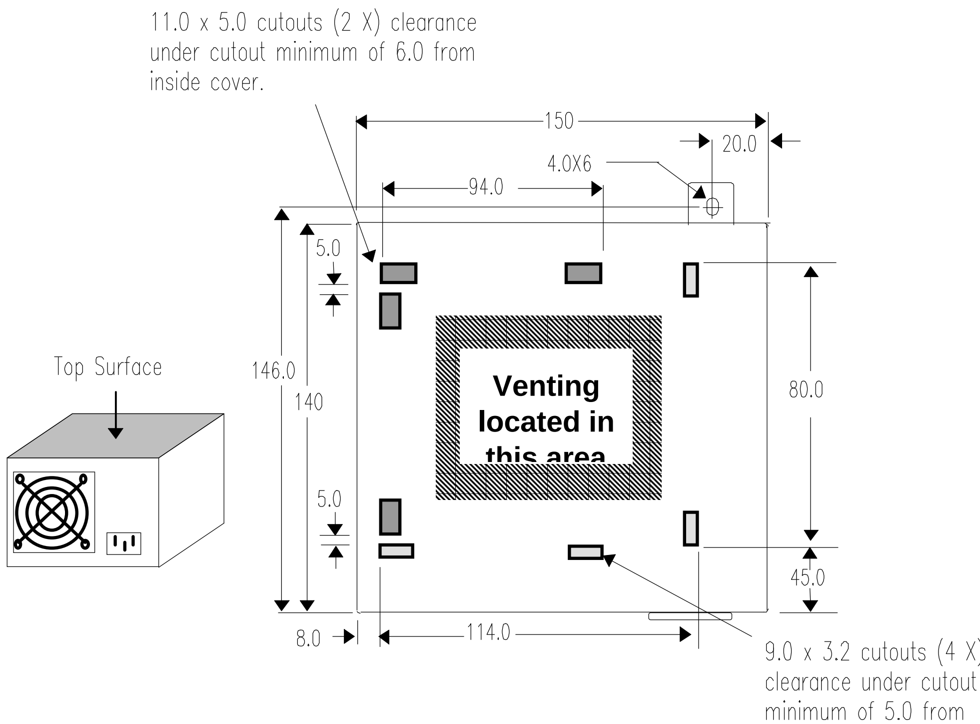

Figure 10: ATX Power supply duct mounting locations

(all dimensions in millimeters)

4.2 Power supply connector

The connector pinout for the main ATX power connector is shown in Figure 11. The board-mounted header is the Molex 39-29-9202 or equivalent. This mates with the power supply connector, Molex 39-01-2200 or equivalent. All signals and power rails on the main power connector are required to be implemented.

		Pin	Pin	
ALSO MAIN 3.3V SENSE)	3.3V	11	1	3.3V
	-12V	12	2	3.3V
	COM	13	3	COM
	PS-ON	14	4	5V
	COM	15	5	COM
	COM	16	6	5V
	COM	17	7	COM
	-5V	18	8	PW-OK
	5V	19	9	5VSB
	5V	20	10	12V

Figure 11: ATX power connector pin out

It is recommended that the 3.3VDC lines always be held at a lower potential than the +5VDC lines during power up and power down states. This feature allows for improved reliability of motherboard designs at a reduced cost.

Proper implementation of PS-ON, 5Vsb, and PW-OK are required for an ATX 2.0 compliant power supply.

4.2.1 PS-ON

PS-ON is an active low signal that turns on all of the main power rails including 3.3V, 5V, -5V, 12V, and -12V power rails. When this signal is held high by the PC board or left open circuited, outputs of the power rails should not deliver current and should be held at a zero potential with respect to ground. Power should only be delivered to the rails if the PS-ON signal is held at ground potential. This signal should be held at +5VDC by a pull-up resistor internal to the power supply.

4.2.2 5Vsb

5Vsb is a standby voltage that may be used to power circuits that require power input during the powered down state of the power rails. The 5Vsb pin should deliver 5V ± 5% at a minimum of 10mA for PC board circuits to operate. Conversely, PC boards should draw no more than 10mA maximum from this pin unless a power supply with higher current capabilities is clearly specified. This power may be used to operate circuits such as soft power control. For future implementation it is recommended that the 5Vsb line be capable of delivering 720mA. This increased current will be needed for future implementations with features such as “wake on LAN”.

4.2.3 PW-OK

PW-OK is a power good signal and should be asserted high by the power supply to indicate that the +5 VDC and +3.3 VDC outputs are above the under-voltage thresholds of the power supply. When this signal is asserted high, there should be sufficient mains energy stored by the converter to guarantee continuous power operation within specification. Conversely, when either the +5VDC or the +3.3VDC output voltages falls below the under-voltage threshold, or when mains power has been removed for a time sufficiently long to no longer guarantee power supply operation, PW-OK should be deasserted to a low state. Figure 12 shows a representation of the timing characteristics of the PW-OK, PS On, and germane power rail signals.

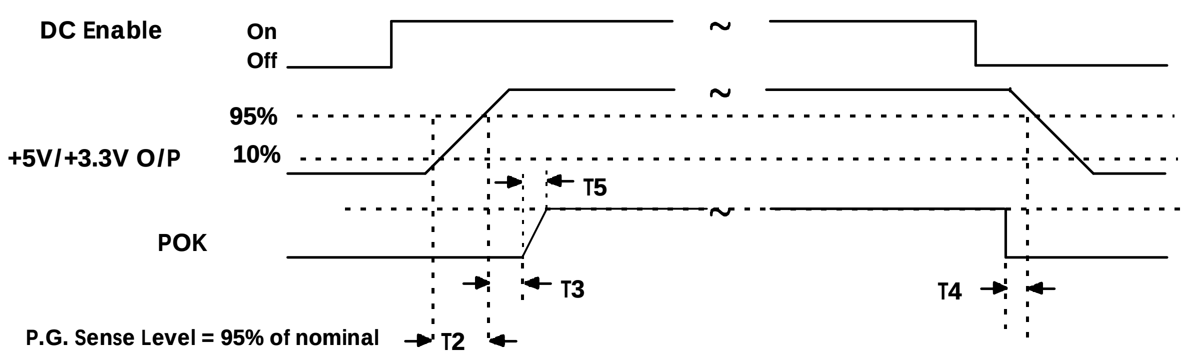

Figure 12: Timing of PS-ON, PW-OK, and germane voltage rails

Although there is no requirement to meet specific timing parameters, the following signal timings are **suggested**:

$$2\text{ms} \leq T_2 \leq 20\text{ ms}$$

$$100\text{ ms} < T_3 < 2000\text{ ms}$$

$$T_4 > 1\text{ ms}$$

$$T_5 \leq 10\text{ms}$$

It should also be noted that motherboards should be designed such that the above specified signal timings are used. Using these timing recommendations will help drive the industry to an acceptable standard. If timings other than these are implemented or required, this information should be clearly specified.

4.3 Optional power connector

In addition to the main power connector, a 2-by-3 optional connector from the power supply can be used for such ancillary functions as fan monitoring, fan control, IEEE-1394 power source, and a remote 3.3V sense line. Although this optional connector is **not** required for ATX compliance, it adds benefits that are compelling for a full featured system. The fan monitor features add the ability to monitor and detect fan failures. Implementation of a built in fan control also allows the motherboard to request fan shutdown when the system goes into a sleep or suspend mode. Fan speed control is also possible to allow for slower fan speeds during low power usage. The exact location of this connector on the motherboard is not specified but should be located near the main connector for convenience.

The optional power connector for an ATX system is provided by a 2-by-3 connector. The connector pinout is shown in Figure 13. The PC board connector should be implemented with a Molex 39-30-1060 or equivalent connector. This mates with the power supply connector, Molex 39-01-2060 or equivalent.

Proper implementation of FanM, FanC, 3.3V Sense, 1394V, and 1394R is discussed below and should be implemented according to these specifications if a standard optional connector is used.

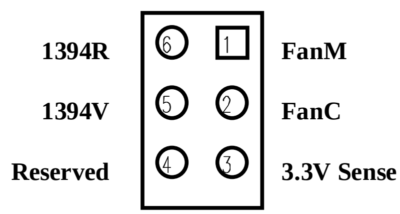

Figure 13: Optional power supply connector configuration

4.3.1 FanM

The FanM signal is an open collector, 2 pulse per revolution tachometer signal from the power supply fan. The signal stops cycling during a lock rotor state, the level can be either high or low. This signal allows the system to monitor the power supply for fan speed or failures. Implementation of this signal would allow a system designer to gracefully power down the system in the case of a critical fan failure. The monitoring circuit on the motherboard should use a 1k Ohm to 10k Ohm pull up resistor for this signal. The output of this signal should be fed into a high impedance gate for the motherboard implementation. See Figure 14 for a simple illustration of the basic circuit requirements. If this signal is not implemented on the motherboard, it should not impact the power supply function.

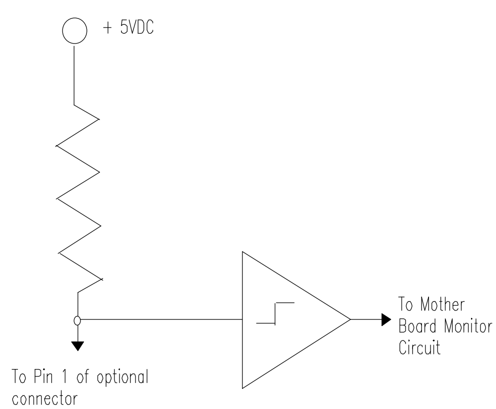

Figure 14: Simple implementation of a fan monitor circuit

4.3.2 FanC

The FanC signal is a variable resistance fan speed control for the power supply fan. This signal allows the system to request control of the power supply fan from full speed to off. Implementation of this signal would allow a system designer to implement a request fan speed control or shut down during low power states such as sleep or suspend. The control circuit on the motherboard should use resistance levels from 0k Ω to 10k Ω load resistors for the fan control request. If a resistance level of 100 Ω or less is sensed by the power supply at pin 2 of the optional connector, the fan is requested to shut down by the motherboard. In the case of a 10k Ω load, or open circuit, the fan in the power supply is requested to operate at full speed. A FET or other low impedance device can be used in series with the resistor to act as a switch. See Figure 15 for a simple illustration of the basic circuit implementation. Circuitry within the power supply is recommended to operate such that speed control of the fan may be achieved between 100 Ω and 10k Ω. In this way better acoustic performance could be achieved by the system during periods of lower power usage. For instance, a 5k Ω resistor should request operation of the fan at half the rated speed.

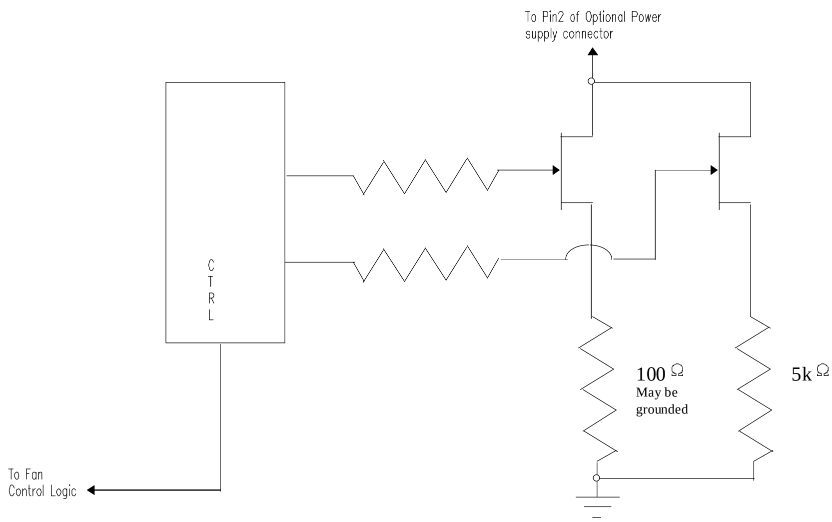

Figure 15: Simple implementation of a fan control circuit

4.3.3 3.3V Sense

A remote 3.3 V sense line can be added to the optional connector to allow for accurate control of the 3.3VDC line directly at motherboard loads. Due to potential voltage drops across the connector and traces leading to the motherboard components, it may be advantageous to implement a 3.3V sense line that remotely monitors the 3.3VDC power level at the load on the motherboard. The implementation of this signal should be such that if an NC condition is detected on this line, the default 3.3V sense line on the main connector would be used for sensing the 3.3 VDC voltage level.

4.3.4 1394V

This pin on the optional connector allows for implementation of a segregated voltage supply rail for use with unpowered IEEE-1394 solutions. The power derived from this pin should be used only to power 1394 connectors. The output of this power rail is dependent on the 1394 compatibility required. Use of this power rail for motherboard or other power needs may have unpredictable results as power for 1394 devices is not required to be regulated and may provide voltage levels between 8 and 40 volts. See the applicable IEEE-1394 specification for details on the specific power requirements for this voltage rail. If this power rail is implemented, it should operate such that the main PS-ON signal must be asserted low for power to be delivered at this connector.

4.3.5 1394R

The 1394R pin provides an isolated ground path for unpowered 1394 implementations. This ground should be used only for 1394 connections and should be fully isolated from other ground planes in the system.

4.4 Power supply wiring recommendations

There is no specific requirement for length or color of wiring from the power supply. Tables 2 and 3 suggest wire color coding that is followed by many vendors, but this color coding is NOT required. Figure 16 demonstrates typical cabling for an ATX power supply with suggested cable lengths.

18 AWG Wire	Signal	Pin	Pin	Signal	18 AWG Wire
Orange(22AWG) Brown(22AWG)	+3.3 VDC 3.3V sense	11 11	1	+3.3 VDC	Orange
Blue	-12 VDC	12	2	+3.3 VDC	Orange
Black	COM	13	3	COM	Black
Green	PS-ON	14	4	+5 VDC	Red
Black	COM	15	5	COM	Black
Black	COM	16	6	+5 VDC	Red
Black	COM	17	7	COM	Black
White	-5 VDC	18	8	POK	Gray
Red	+5 VDC	19	9	+5 V_{SB}	Purple
Red	+5 VDC	20	10	+12 VDC	Yellow

Table 2: Suggested wire color code for ATX power supplies

22 AWG Wire	Signal	Pin
White	FanM	1
White/Blue Stripe	FanC	2
White/Brown Stripe	Sense	3
NC	NC	4
White/Red Stripe	1394V	5
White/Black Stripe	1394R	6

Table 3: Suggested wire color code for optional ATX power supply connector

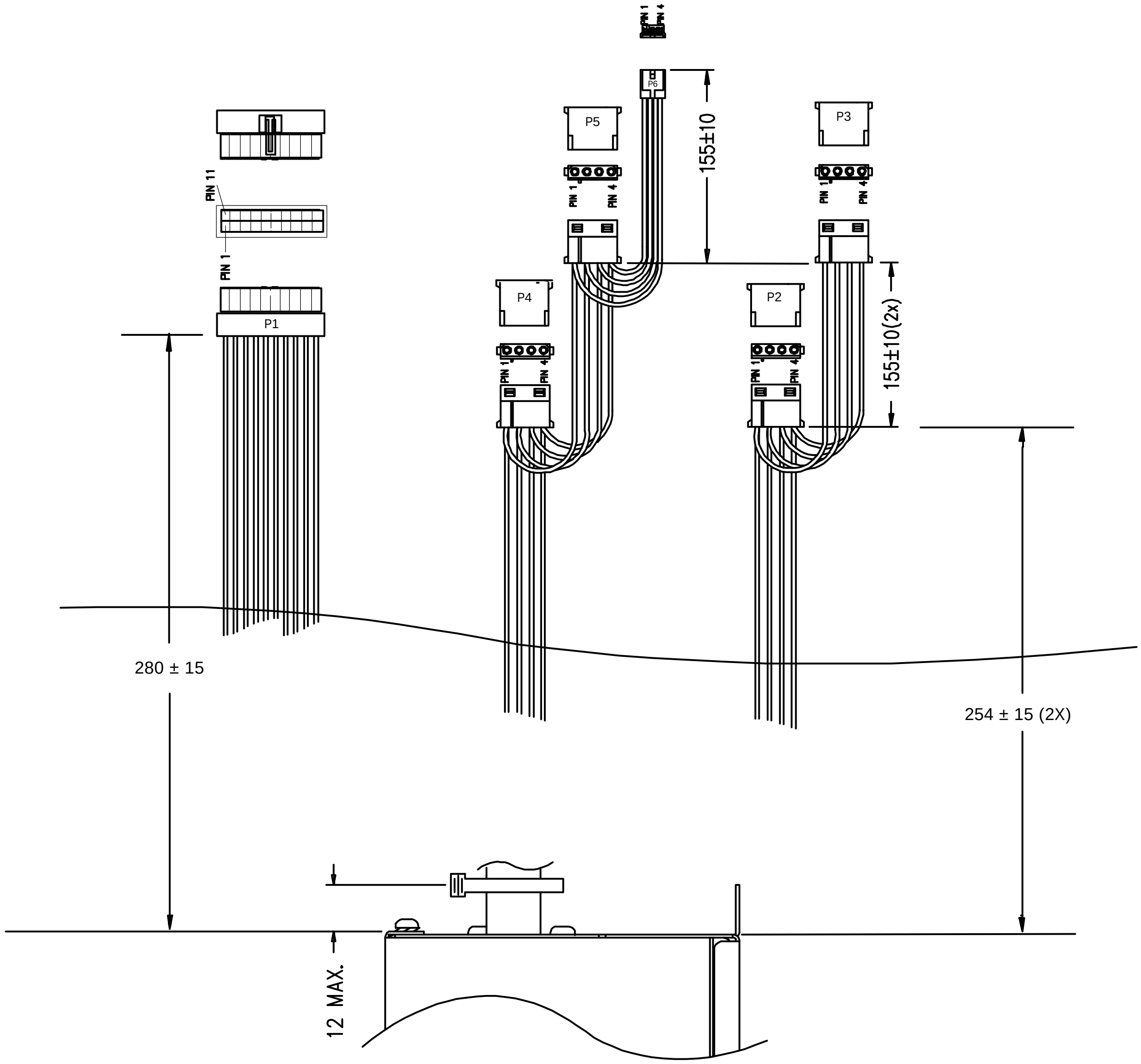

Figure 16: ATX Power supply wiring harness
(all dimensions in millimeters)

4.5 Power supply airflow

An ATX power supply should be designed to provide maximum airflow to cool both the power supply and key components inside the system such as the processor. The exact venting location and geometry as well as fan selection for the power supply will vary, depending on the complete system solution being implemented. The fan should allow sufficient airflow through the chassis to accommodate proper cooling. As a baseline for designing the power supply it is recommended that 23 CFM minimum be present at the outlet of the power supply. One possible configuration for the power supply vent inside the system is provided in Figure 17. The configuration for the power supply vent on the outside of the system should also provide the least possible restriction on the airflow. One recommended solution for providing the minimum impedance to airflow is to provide a **wire** fan grill such as shown in Figure 9 in lieu of the common stamped sheet metal designs.

It should be noted that tradeoffs exist between the airflow provided, acoustical noise generated by the system and cost. Structures that attempt to control or restrict airflow will generate acoustical noise and should be designed to provide minimum noise levels achievable. Well vented systems with low flow impedance may allow the use of quieter, lower power fans or minimize the need for costly secondary fans.

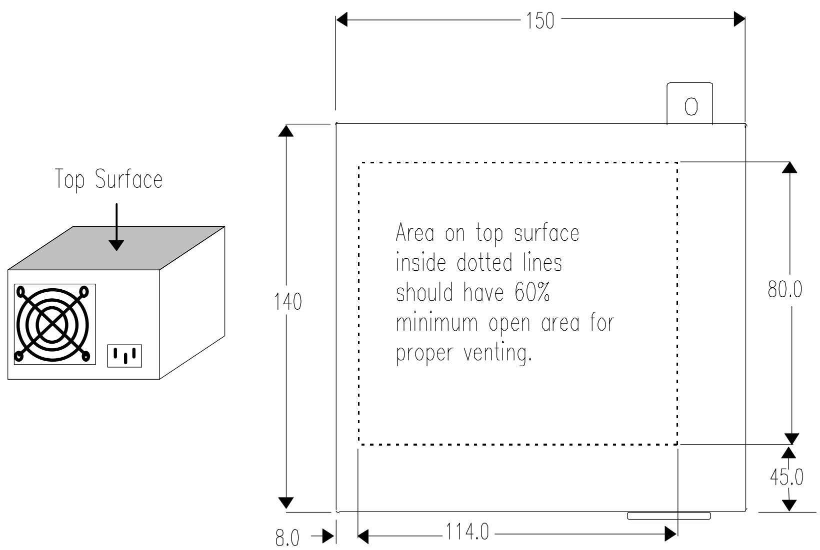

Figure 17: ATX Power supply suggested venting
(all dimensions in millimeters)

5. Other ATX Chassis Considerations

An ATX compliant chassis should be designed such that it will allow for all ATX 2.0 compliant motherboards to be integrated. Although not explicitly stated throughout the text, a chassis should implement all features necessary to properly support a complete ATX solution. Many of the chassis features are embedded in the text, but others that are related only to the chassis that will be pointed out in the following section.

5.1 Venting

Adequate venting should be provided in the system to allow for unimpeded and well directed airflow to cool key components such as the processor. One recommendation that is implicit in the ATX specification is the placement of the power supply. The power supply should be placed in close proximity to the processor if the power supply is expected to cool the processor properly (but be sure to observe the component height keepouts over the PC board). Chassis venting should be placed strategically to allow for proper cooling of other components such as peripherals and add-in cards. A secondary fan should be considered in cases where the power supply fan is incapable of cooling all system components.

5.2 Power supply mounting

If the power supply is mounted such that it must be removed to allow for integration of Field Replaceable Units (FRU), consideration should be made for easy removal of the power supply. Some of the typical FRU components that should be considered are the processor, memory, add-in cards, and peripherals. Use of a common fastener such as a standard screw that is easily accessible should be considered for mounting power supplies that interfere with easy component integration.