microATX System Design Suggestions

Version 1.0

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1. Overview

microATX is a new motherboard form factor designed to meet new market trends and PC technologies. Lower system cost is the main driving force for the new form factor. The size of the form factor allows for smaller chassis, motherboard, and power supply, thus reducing the cost of entire system. The microATX form factor is also backward-compatible with the ATX form factor with some modifications. This document is intended to provide system design suggestions as a reference for OEMs to help them realize the benefits of the microATX form factor. The document does not provide design details.

1.1 Related Documents

- *PC 98 System Design Guide* from Intel Corporation and Microsoft Corporation
- *microATX Motherboard Interface Specification* (see Web site *http://www.teleport.com/~microatx*)
- *microATX Chassis Design Suggestions*
- *microATX EMC Design Suggestions*
- *microATX Electrical Design Suggestions*
- *microATX Thermal Design Suggestions*
- *SFX Power Supply Design Guide* (small form factor power supply)

2. Hardware Design Suggestions

The design of a microATX system should make best use of existing industry standards for processors, memory, system buses, peripherals, modems, audio, video, I/O devices, I/O ports, power supply, and motherboards. The following paragraphs discuss the design goals, requirements, and recommendations as they apply to above mentioned items. The *PC 98 System Design Guide* presents a collection of PC system, bus, and device design guidelines.

Some of the documents listed above under "Related Documents" discuss microATX system and chassis design suggestions to manage EMI, thermal, and acoustics issues. *microATX Electrical Design Suggestions* discusses electrical design issues such as:

- Placing components
- Planning keepout zones
- Routing critical signals for high speed buses
- Integrating audio functions on the motherboard
- Integrating AGP functions on the motherboard
- Locating connectors for expansion slots

2.1 Processor and System Memory

It is recommended that the microATX system meet minimum performance requirements for PC 98 systems. In general, the future microATX system will be required to meet future requirements for PC compliance initiatives.

The choice of processor and system memory will impact the motherboard layout, system power consumption, power supply, and system EMI. Total power consumption in the system and EMI issues will impact chassis design, thermal management, and cooling methods. The thermal management and associated fans impact system acoustics.

It is recommended that the microATX system designer analyze worst case scenarios of power consumption for different combinations of processor and system memory. This data combined with other power consumption values, as shown in the section "DC Power Output Requirements," below, can be used to validate the chassis design and power supply design.

The checklist for processor and system memory is as follows:

- The selected processor and system memory combination meets PC 97 requirements.
- The selected processor and system memory combinations will meet PC 98 requirements.
- The power supply has enough capacity to support this combination for a worst case power demand of the system.
- The chassis design will pass EMI for the selected processor frequencies.
- The thermal management provides adequate cooling during worst case thermal load.

2.2 System Buses

The PC system design may include buses such as PCI, ISA, SCSI, IDE, USB, and 1394. In general, the use of these buses is shared by multiple devices or controllers. The products that interface with one or more of these buses are manufactured by many different vendors. The functionality offered by these products may vary, but the bus interface specification is common to all of them. Hence, to provide maximum end-user satisfaction, it is strongly recommended that the microATX system meet requirements for system buses as defined in the *PC 98 System Design Guide*.

2.3 Peripherals

The microATX system may include peripherals such as CD-ROM, floppy disk drive, hard disk drive, ZIP† drive, DVD, and tape cartridge. It is recommended that the devices used in the microATX system meet minimum requirements for peripherals as defined in the *PC 98 System Design Guide*.

2.4 Modems and Network Communications

It is recommended that the modems and network adapters used in the microATX system meet requirements as defined in the *PC 98 System Design Guide*.

2.5 Audio and AGP

It is recommended that the audio and AGP devices used in the microATX system meet requirements as defined in the *PC 98 System Design Guide*. The microATX system can have up to four expansion slots for add-in cards. These slots can be used to provide audio and AGP functions as well as add-in cards for modems, network adapters, enhanced graphics, 1394 bus, TV in/out, and other interfaces. It is recommended that the microATX system use onboard (on the motherboard) audio and AGP solutions so that the expansion slots are available for other functions.

2.6 I/O Devices and I/O Ports

A typical microATX system may include some of the following I/O ports:

- PS/2† mouse and keyboard
- Serial communication
- Parallel communication
- USB
- VGA output
- Audio (Line in/out, Mic in)
- TV video in/out
- 1394 bus
- Telephone jack
- Network Adapter ports
- Others

Some of these ports can be supported on the motherboard and others can be supported by add-in cards mounted in one of the expansion slots. The locations for ports supported on the motherboard must meet requirements for the back panel I/O as defined in the *microATX Motherboard Interface Specification*. This requirement ensures compatibility between microATX motherboards and microATX chassis.

Many vendors provide products that interface with one or more of these I/O ports. These products may serve different functions, but the bus specification does not change. Hence, to provide maximum end-user satisfaction, it is strongly recommended that the I/O device interfaces, I/O controllers, and the I/O ports used in the microATX system meet requirements as defined in the *PC 98 System Design Guide.*

2.6.1 Back Panel I/O

The microATX system chassis must meet the requirements of stacked I/O area as defined in the *microATX Motherboard Interface Specification*. However, this specification does not require a predefined connector layout.

Figure 1 shows example layouts for the back panel I/O connectors. For more examples of ATX I/O layouts, see the *Design Guide for ATX I/O Implementations,* V1.0.

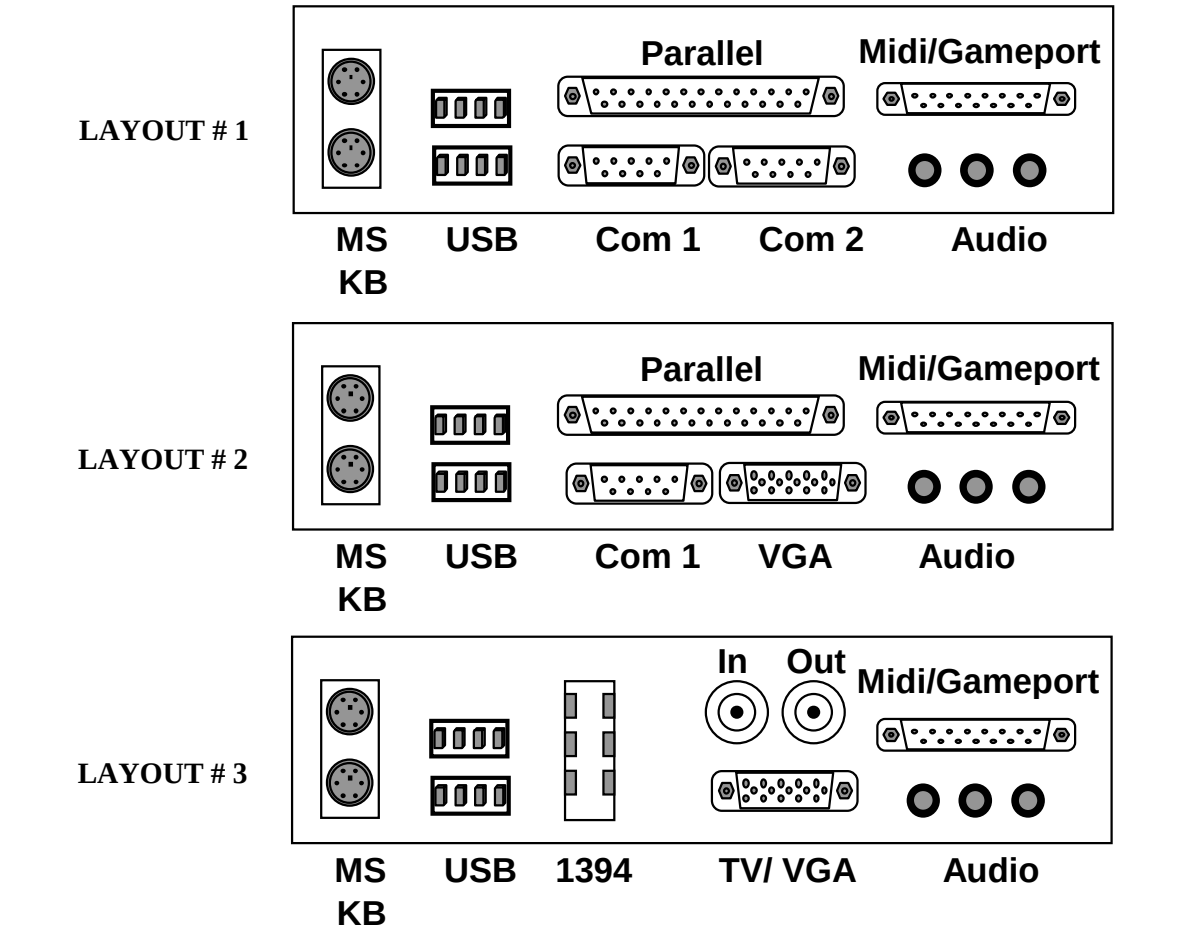


Figure 1: microATX Back Panel I/O Connector Layout, Examples

Notes:

Layout #1 is widely used in the industry.

In Layout #2, one of the serial ports is replaced by a VGA port, indicating a trend toward integrating video functions on the motherboard.

In Layout #3, some of the legacy connectors are replaced by a 1394 connector and TV video in/out connectors for an entertainment system.

2.7 Power Supply

The power supply for the microATX system must meet the requirements listed in the *microATX Motherboard Interface Specification*. There are no requirements for the size and the total DC power output capacity of the power supply.

The *SFX Power Supply Design Guide* describes a small form-factor power supply that delivers a low cost, low power alternative to typical power supplies available today.

2.7.1 Power Supply Suggestions

It is recommended that the microATX system use an SFX power supply or an ATX-compliant power supplies.

2.7.2 DC Power Output Requirements

The system designer can create a data worksheet as shown in Table 1. The output of this worksheet, when compared to DC power outputs of the power supply, provides design margin information. The power consumption values shown in the example are derived by analysis of data received from one or more of the following sources:

- Product data sheets from manufacturers
- Power consumption values measured during system test in laboratory
- Inputs from other experienced system designers
- System usage models with a variety of application software modules

The power consumption for a generic product such as a hard disk drive depends on the vendor of the product, the model number for the product, and the system usage model. Hence, it is strongly recommended that the microATX system designer use this information as reference data only.

Table 1: Power Consumption Worksheet for a microATX System

PC System Component	Max Power Watts *	Worst Case Power Watts **	Current +5V Amps	Current +12V Amps	Current +3.3V Amps	Current -5V Amps	Current +5VSB Amps	Current -12V Amps
System processor								
System memory								
Graphics memory								
Onboard voltage regulator								
Onboard audio processor								
Onboard AGP processor								
Onboard 1394 interface								
Onboard network communication								
Onboard speaker power Amp								
Onboard USB interface								
Processor interface chipsets								
Super I/O								
Bus termination resistors								
Clock drivers								
Hard disk drive								
Floppy disk drive								
Tape cartridge								
Tape drive								
CD-ROM drive								
DVD drive								
Network adapter, add-in card								
Modem; add-in card								
ISA audio; add-in card								
PCI audio, add-in card								
PCI graphics; add-in card								
TV in/out; add-in card								
System fan(s)								
IR interface								
IDE interface circuit								
Serial port(s) drivers								
Motherboard glue logic								
Other components								
Total power/current								

Notes to Table 1:

* The maximum power consumption value is specified by the manufacturer of the component. You must multiply the maximum power times the utilization factor (see Section 2.7.2.1) plus the load imposed by your software applications on the devices in your system.

** The worst case power is derived by the following equation:

Worst case power = Tp x Uf x SF

where

TP = Typical power consumption for a component; value is specified by the manufacturer.

Uf = Utilization of this component for a given software application (see section 2.7.2.1).

Sf = Safety factor (> or = 1), to be defined by the systems designer.

2.7.2.1 Utilization Factor

In a PC system, not all components are simultaneously active at full power. The system designer must define real-world system usage scenarios that generate the typical power demand for the power supply. As a result of this exercise, the user will be able to define the appropriate power supply and the worst case system thermal load. In most cases, this definition will result in cost savings because of lower power supply costs and less expensive solutions for thermal management.

The current state of an application software decides the utilization factor for any power-consuming component. For example, in an application performing file transfers, a hard disk drive will have a high utilization factor while the processor has a low factor. On the other hand, in an application requiring high resolution video and audio, the system processor, audio processor or audio add-in card, video/AGP processor or video add-in card, and system memory will have high values for utilization factors while a hard disk drive will be mostly in the idle mode.

A review of one data sheet from a tape drive vendor indicates that the drive described consumes 1.00 Watts in an idle state, 10 Watts in normal operating state, and 18 Watts as a maximum value; the drive can use as much as 26 Watts in a surge mode for a short duration of time. However, these values will be different for another vendor or another model of tape drive from the same vendor.

2.7.2.2 Recommended Procedure for Calculating Power Usage in a System

1. Start with the Table 1 blank worksheet, and list all power-consuming components in the system.
2. Use each vendor's technical specification to define maximum current at each voltage.
3. Add current values to define total current at each voltage.
4. Multiply the total current by the voltage to get wattage for each voltage level.
5. Add the total wattage for each voltage to arrive at a total combined power usage on the power supply.
6. Compare data from steps 4 and 5 with the power supply specification.
7. If the power supply can meet the maximum current and wattage requirements, then your calculation is complete. Otherwise, go to step 8.
8. If the power supply cannot meet maximum current and wattage requirements, then compute the worst case power for any anticipated application, add a safety factor, and repeat step 6.
9. Based on the data from the above steps, either select a new power supply or select different components such as add-in cards and peripherals.

2.7.3 -5V

It is recommended that the ISA add-in cards used in the microATX system do not require -5V. If this is not possible, there are two options:

- Provide -5V on the motherboard (convert from -12V).
- Use an ATX-compliant power supply that provides -5V.

2.7.4 Fan Monitor (FanM Signal)

The fan monitor features add the ability to monitor and detect fan failures. It is recommended but not required that the microATX system support the optional 6-pin power connector to provide the fan monitor feature. Refer to section 3.4 in the *microATX Motherboard Interface Specification*.

2.7.5 Fan Speed Control (FanC Signal)

The fan speed control allows the system software to request fan shutdown when the system goes into a sleep mode or suspend mode. The fan speed control can be used to run the fan at a lower speed and provide better acoustics performance. It is recommended but not required that the microATX system support the optional 6-pin power connector to provide built-in fan speed control for the power supply fan. Refer to section 3.4.2 in the *microATX Motherboard Interface Specification*. This connector is not used to control anything other than the power supply fan.

2.7.6 1394 Power

The 1394 connector has two power pins that can be used by the PC system to provide power to a device attached to the 1394 port. It is recommended but not required that the microATX system support the optional 6-pin power connector if 1394 ports are included in the back panel I/O. Refer to sections 3.4.4 and 3.4.5 in the *microATX Motherboard Interface Specification*.

2.7.7 Standby Power

The microATX system design should support the OnNow initiative as defined in the *PC 98 System Design Guide*. Standby power is required to support soft on/off functions and the wakeup functions. It is recommended that the microATX system use a power supply that provides a minimum of 0.72 Amps of standby power at +5V.

2.8 Additional System Fan(s)

It is recommended that the microATX motherboard provide one or more fan headers. In most cases, the power supply fan is sufficient to provide adequate air flow for the system. However, in some cases, the thermal design of the chassis may require use of the system fan(s) in addition to the power supply fan. The fan header can be a two-pin or three-pin header.

This fan is not required by the *microATX Motherboard Interface Specification*.

2.8.1 Two-pin Header

In a two-wire fan, one wire supplies DC voltage to the fan, and the other wire provides the return path to the system ground. The DC voltage ranges from 0V to around +12V. The actual value of the DC voltage decides the fan speed. The *PC 98 System Design Guide* requires that the systems operate as quietly as possible when in idle or sleep state. Thus, it is recommended that the circuit on the motherboard control the fan speed by controlling the DC voltage to the fan. The *microATX Electrical Design Suggestions* document shows an example of the fan control circuit.

2.8.2 Three-pin Header

In a three-wire fan, the third wire is a tach output from the fan. This is used for detecting fan failure in the system.

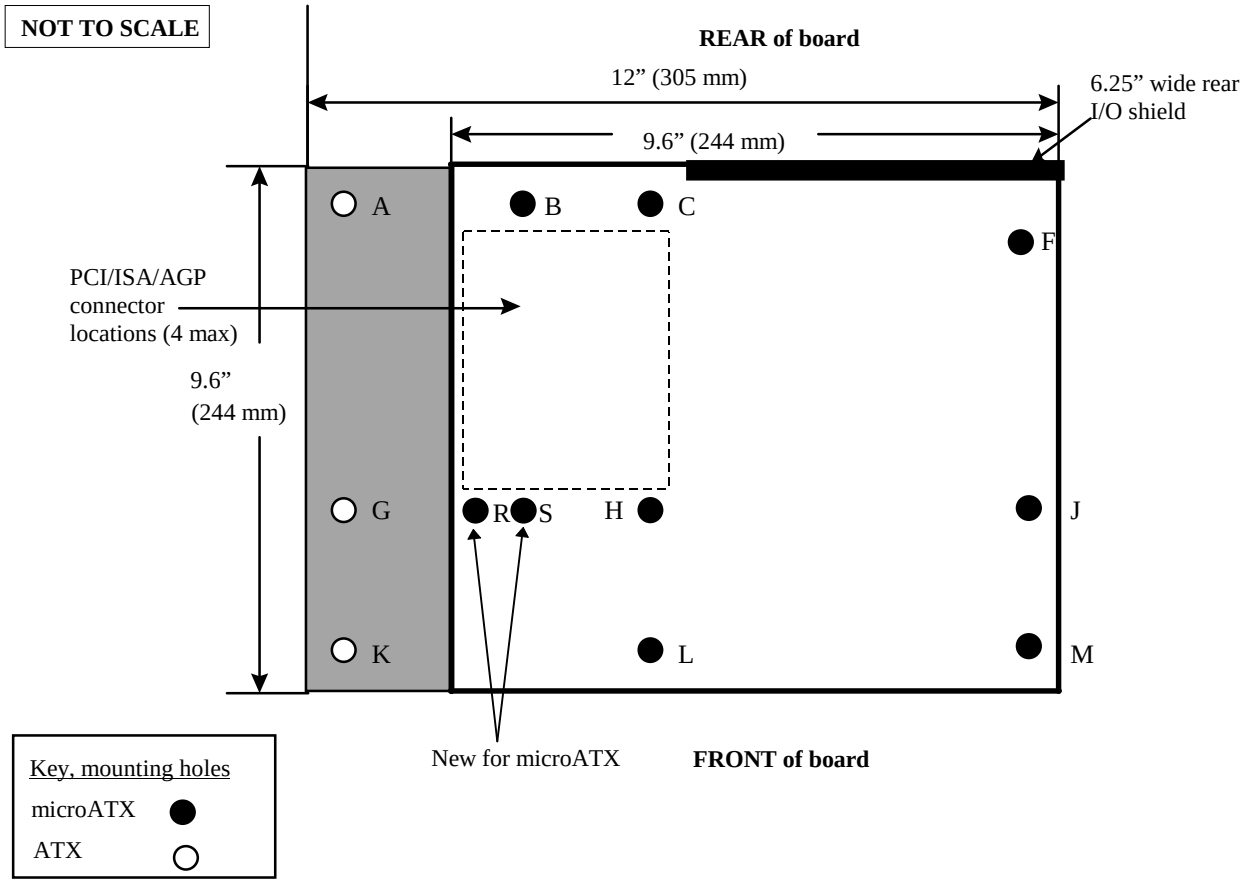
2.9 Motherboard Dimensions

The *microATX Motherboard Interface Specification* requires that the maximum allowable width must be 9.6 inches (244mm) and maximum allowable depth must be 9.6 inches (244mm). In this section:

- Width refers to the dimension along the back panel I/O.
- Depth refers to dimension that is parallel to the expansion slots.

The 9.6 inches (244mm) width allows for a maximum of four expansion slots. For every expansion slot that is deleted, the width can be reduced by 0.8 inch (20.32mm). Figure 2 shows an overview of motherboard mounting hole locations. Table 2 lists the suggested width dimensions for systems with different numbers of expansion slots.

The recommended mounting hole diameter is .156 +.003-.001 inch or 4.00+/-.05 mm.



Form factor	Mounting hole locations	Notes
microATX	B, C, F, H, J, L, M, R, S	Holes R and S are added for microATX form factor. Hole B was defined in Full AT format
ATX	A, C, F, G, H, J, K, L, M	Hole F must be implemented in all ATX 2.01-compliant chassis assemblies. It was optional in the ATX 1.1 specification.

Figure 2: microATX and ATX Form-factor Mounting Holes

Notes to Figure 2:

Figure is reproduced from the *microATX Motherboard Interface Specification*.

In Figure 2, the board is shown oriented with the rear of the board toward the top.

The shaded portion to the left indicates the greater width of the ATX form factor.

For details about mounting holes and board sizes, see the mechanical drawing in the *microATX Motherboard Interface Specification*.

Table 2: Suggested Width Dimension per Number of Expansion Slots

Number of slots and slot numbers *	**Recommended width**	**Mounting holes used, assuming that the depth is 9.6 inches (244mm) ****	**Comments**
Four (4, 5, 6, 7)	9.6 inches (244mm)	B, C, F, R, H, J, L, M	Maximum width allowed.
Three (5, 6, 7)	8.8 inches (223.5mm)	B, C, F, S, H, J, L, M	
Two (6 & 7)	8.5 inches (203.2mm)	B, C, F, S, H, J, L, M	Less than 8.5 inches (203.2mm) wide causes loss of mounting holes B and S. Use of 8.0 inch (203.2mm) width will require more support under slot # 6.
One (slot 7)	7.2 inches (182.9mm)	C, F, H, J, L, M	
None	6.7 inches (170.2mm)	C, F, H, J, L, M	Minimum width recommended to use specified mounting holes.

Notes:

* Refer to the *microATX Motherboard Interface Specification*.

** The depth of the motherboard will depend on the amount of area required to mount such components as processor, system memory, chipset, I/O connectors, expansion slot connectors, and power supply connector. The recommended depths are:

9.6 inches (244mm)

8.2 inches (223.5mm)

7.0 inches (177.8mm)

This range of recommended depths will enable motherboard installation using mounting holes specified in the *microATX Motherboard Interface Specification*. A depth of 8.2 inches (223.5mm) may require the use of two miniATX holes or other support features such as bumpers. See section 2.11 below for information about using standoffs (bumpers).

2.10 Physical Design Requirements

The microATX system should be user-friendly. The following is a summary of requirements or recommendations as defined in the *PC 98 System Design Guide*.

- All expansion slots in the system are accessible for the user to insert cards: required.

The microATX specification defines the location of the slots but does not include any requirements for accessibility.

- Connections are identified with icons (indicating the device, such as mouse) and use keyed or shrouded connectors: required.
- Internal system modification capabilities are not accessible to end users: recommended.
- The system design provides physical security using locks: recommended.

2.11 Supporting microATX Motherboard in Standard ATX Chassis

When a microATX motherboard is placed in a standard ATX chassis, the front left corner of the motherboard will be unsupported. This area needs some support because ISA or PCI cards will be inserted in and removed from the end slots. To provide support, two options can be used:

- An adhesive backed standoff can be used in the corner mounting hole. This standoff provides the best support for both installing and removing a card.
- A bumper support under the board can be used; however, a bumper provides support only when a card is inserted, not when a card is removed.

3. System Software

The end user of the microATX system expects the system to execute the latest versions of Microsoft Windows† or Windows NT† operating systems. For optimal user experience, it is required that:

- The BIOS in the microATX system meets PC 98 requirements for OnNow support.
- The BIOS in the microATX system meets PC 98 requirements for boot support.
- Each device connected to an expansion bus meets PC 98 requirements for Plug and Play.
- The microATX system design meets the ACPI 1.0 specification.

Refer to the *PC 98 System Design Guide* from Intel Corporation and Microsoft Corporation for more details.